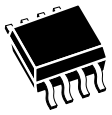
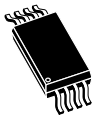
ST25DV04K ST25DV16K ST25DV64K

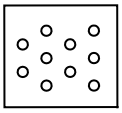
Datasheet

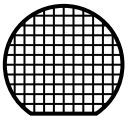
Dynamic NFC/RFID tag IC with 4-, 16-, or 64-Kbit EEPROM, and fast transfer mode capability

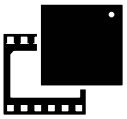

SO8


TSSOP8


UFDFPN8


WLCSP10


Wafer


UFDFPN12

Near Field Communication CERTIFIED™

Product status link
ST25DV04K
ST25DV16K
ST25DV64K

Features

I2C interface

- Two-wire I^2C serial interface supports 1 MHz protocol
- Single supply voltage: 1.8 to 5.5 V
- Multiple byte programming (up to 256 bytes)

Contactless interface

- Based on ISO/IEC 15693
- NFC Forum Type 5 tag, certified by the NFC Forum
- Supports all ISO/IEC 15693 modulations, coding, sub-carrier 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 (up to 4) blocks write (same for extended commands)
- Internal tuning capacitance: 28.5 pF

Memory

- Up to 64 kbits of EEPROM (depending on version)
- I^2C interface accesses bytes
- RF interface accesses blocks of 4 bytes
- Write time:
  - From I^2C: typical 5 ms for 1 byte
  - From RF: typical 5 ms for 1 block
- Data retention: 40 years
- Write cycles endurance:
  - 1 million at 25 °C
  - 600 k at 85 °C
  - 500 k at 105 °C
  - 400 k at 125 °C

Fast transfer mode

- Fast data transfer between I^2C and RF interfaces
- Half-duplex 256-byte 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^2C
- System configuration: protected in write by one 64-bit password in RF, and one 64-bit password in I^2C

GPO

- Interruption pin configurable on multiple RF events (field change, memory write, activity, Fast Transfer end, user set/reset/pulse)
- Open drain or CMOS output (depending on version)

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

- Input pin to trigger low power mode

RF management

- RF command interpreter enabled/disabled from I^2C host controller

Temperature range

- Range 6:
  - From -40 to 85 °C
- Range 8:
  - From -40 to 105 °C (UDFPN8 and UDFPN12 only)
  - From -40 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 ST25DV04K, ST25DV16K and ST25DV64K devices (hereinafter referred collectively to as ST25DVxxx) are NFC RFID tags offering, respectively 4, 16, and 64 Kbit of electrically erasable programmable memory (EEPROM). These devices feature two interfaces: the first one is an I^2C serial link that can be operated from a DC power supply, the second one is an RF link activated when the device acts as a contactless memory powered by the received carrier electromagnetic wave.

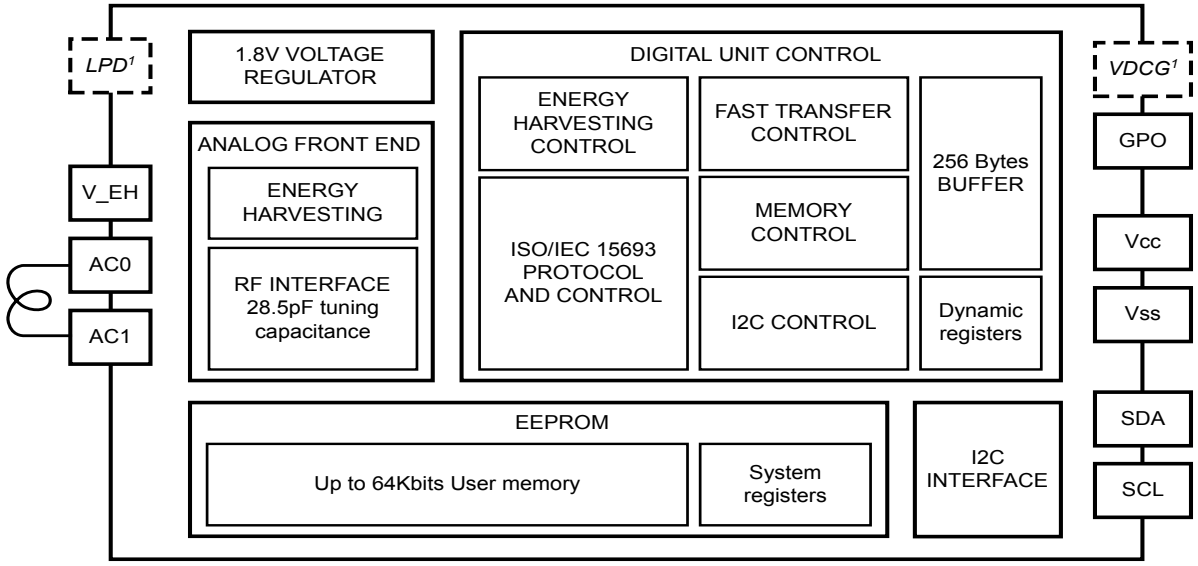
In I^2C mode, the user memory contains up to 512, 2048, or 8192 bytes, which can be split in four flexible and protectable areas.

In RF mode, following ISO/IEC 15693 or NFC Forum Type 5 recommendations, the user memory contains up to 128, 512, or 2048 blocks of 4 bytes, which can be split in four flexible and protectable areas.

The ST25DVxxx devices offer a fast transfer mode between the RF and contact worlds, thanks to a 256 bytes volatile buffer (also called Mailbox). In addition, the GPO pin provides data about incoming events, like RF field detection, RF activity in progress, or mailbox message availability. An energy harvesting feature is also available, when external conditions make it possible.

1.1 ST25DVxxx block diagram

Figure 1. ST25DVxxx block diagram



1. *V_{DCG} and LPD are included only in 10-ball and 12-pin packages.*

1.2 ST25DVxxx packaging

The ST25DVxxx devices are provided in different packages:

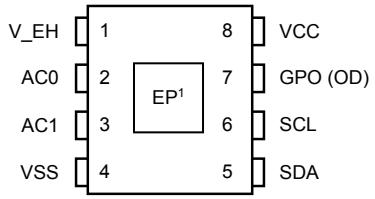
- 8 pins (S08N or TSSPOP8 or UFDFPN8) for the open drain version of Interrupt output
- 10 balls (WLCSP) and 12 pins (UFDFPN12) for a CMOS interrupt output. These packages include an additional LPD pin, to minimize standby consumption.

Table 1. 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_{CC}	Supply voltage	Power
V_{SS}	Ground	-
LPD (1)	Low power down mode	Input
V_{DCG} (1)	Supply voltage for GPO driver	Power
NC	Not connected	Must be left floating
EP (2)	Exposed pad	Must be left floating

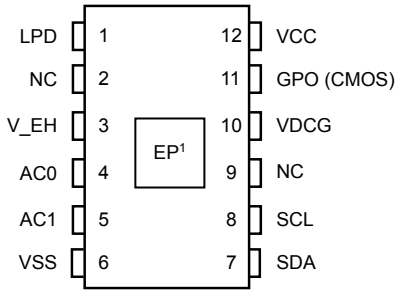
1. *Available only on 10-ball and 12-pin packages.*
2. *Available only on UFDPN8 and UFDFPN12 packages.*

Figure 2. 8-pin packages: connections with open drain Interrupt output



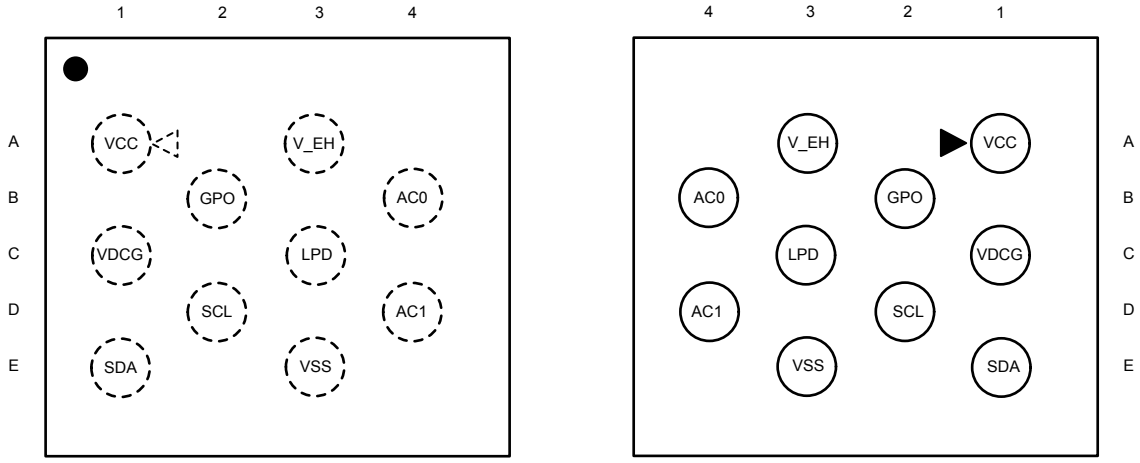
1. *Exposed pad available only on UFDFPN8 package.*

Figure 3. 12-pin package: connections with CMOS Interrupt output (GPO)



1. *Exposed pad available only on UFDFPN12 package.*

Figure 4. **10-ball WLCSP package: connections with CMOS Interrupt output (GPO)**



Marking side
(top view)

Bump side
(bottom view)

2 Signal descriptions

2.1 Serial link (SCL, SDA)

2.1.1 Serial clock (SCL)

This input signal is used to strobe data in and out of the device. 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: I^2C 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 device. It is an open drain output that may be wire-ORed 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 76 indicates how to calculate the value of the pull-up resistor).

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 ST25DVxxx, 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 internal supply. When LPD is high, the regulator is shut off and its consumption is reduced below 1 µA. The regulator has a turn on time in the 100 µs range, to be added to the boot duration, before the device becomes fully operational. The LPD pin is internally pulled down by a 10kΩ resistor and can be left unconnected. The internal pull-down is deactivated when the voltage on the pin exceeds the VIH_LPD level defined in Table 246 and Table 247.

This feature is available only on the 10-ball and 12-pin packages. The LPD pin is internally pulled-down.

2.2.3 Ground (V_{SS})

V_{SS} is the reference for the V_{CC} and V_{DCG} supply voltages and V_EH analog output voltage.

2.3 RF link (AC0 AC1)

2.3.1 Antenna coil (AC0, AC1)

These inputs are used to connect the ST25DVxxx device exclusively to an external coil. Do not 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 (V_{DCG}, GPO)

2.4.1 Driver supply voltage (V_{DCG})

This pin, available only with ST25DVxx-JF version, can be connected to an external DC supply voltage. It supplies only the GPO driver block, not the whole device. If V_{DCG} is left floating, no information is available on the GPO pin.

2.4.2 General purpose output (GPO)

The ST25DVxxx feature a configurable output GPO pin used to provide RF activity information to an external device. ST25DVxx-IE offers a GPO open drain. This GPO pin must be connected to an external pull-up resistor (> 4.7 kΩ) to operate.

The interrupt consists in pulling the state to a low level, or outputting a low level pulse on the GPO pin.

ST25DVxx-JF offers a GPO CMOS output, which requires to connect V_{DCG} pin to an external power supply. The interrupt consists in 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 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 5.2: GPO for details.

2.5 Energy harvesting analog output (V_EH)

This analog output pin is used to deliver the analog voltage V_EH available when the Energy harvesting mode is enabled, if the RF field strength is sufficient. When the Energy harvesting mode is disabled, or the RF field strength is not sufficient, V_EH pin is in high-Z state (see Section 5.3: Energy harvesting (EH) for details).

Energy harvesting voltage output is not regulated.

3 Power management

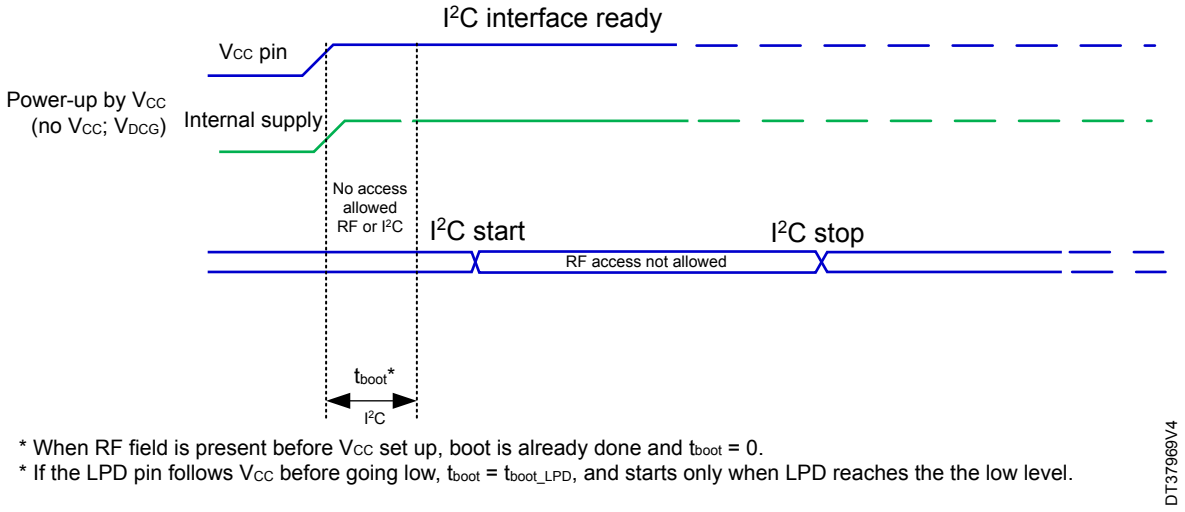
3.1 Wired interface

Operating supply voltage V_{CC}

In contact mode, before 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 (see Table 243. I²C operating conditions) must be applied. To maintain a stable DC supply voltage, it is recommended to decouple the V_{CC} line with a suitable capacitor (10 to 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 I²C write cycle (t_W). Instructions are not taken into account until completion of the boot sequence (see Figure 5).

Figure 5. Power-up sequence (no RF field, LPD pin tied to V_{SS} or package without LPD pin)



* When RF field is present before V_{CC} set up, boot is already done and t_{boot} = 0.
* If the LPD pin follows V_{CC} before going low, t_{boot} = t_{boot_LPD}, and starts only when LPD reaches the the low level.

Power-up conditions

When the power supply is turned on, V_{CC} rises from V_{SS} to V_{CC}. The rise time must not be faster than 1 V/µs.

Device reset in I²C mode

To prevent unwanted write operations during power-up, a power-on reset (POR) circuit is included. At power-up (continuous rise of V_{CC}), the device does not respond to any I²C instruction until V_{CC} has reached the power-on reset threshold voltage (lower than the minimum V_{CC} operating voltage defined in Table 243. I²C operating conditions). When V_{CC} passes over the POR threshold, the device is reset and enters the Standby power mode. 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 the time necessary by the device to set-up (t_{BootDC}) has passed. In the version supporting LPD pin, the 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 the I²C address counter is reset.

Power-down mode

During power-down (V_{CC} decreasing continuously) 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

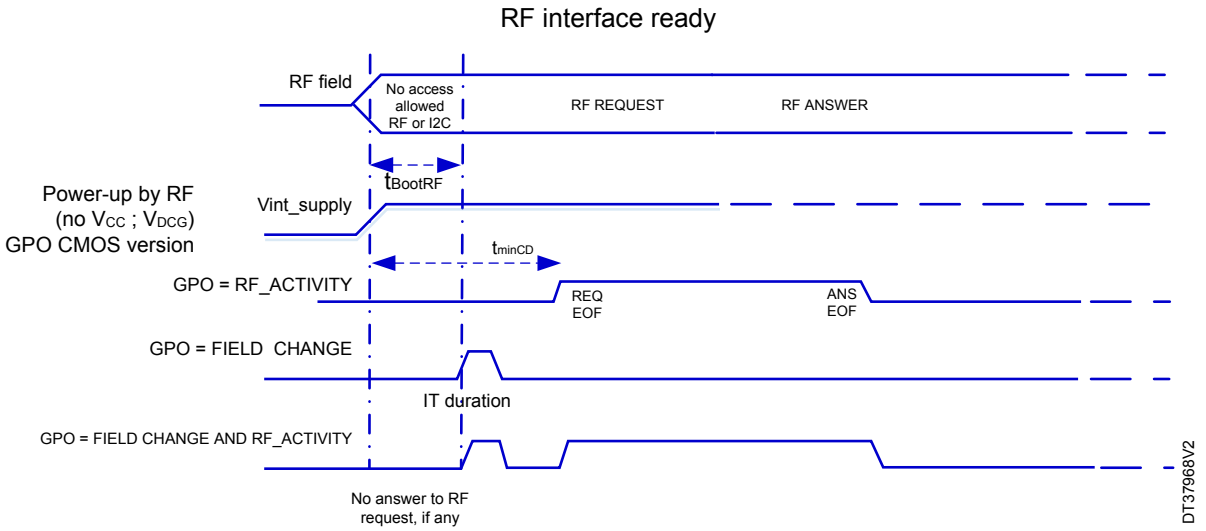
To ensure a proper boot of the RF circuitry, the RF field must be turned on without any modulation for a minimum period of time t_{BootRF}. Before this time, the device ignores all received RF commands (see Figure 6).

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 period of time (t_{RF_OFF}).

The RF access can be temporarily or indefinitely disabled by setting the appropriate value in the RF_MNGT or RF_MNGT_Dyn registers.

Figure 6. RF power-up sequence (no DC supply)



4 Memory management

4.1 Memory organization overview

The ST25DVxxx memory is divided in four main memory areas:

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

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

The ST25DVxxx dynamic registers are accessible by RF or I^2C host and provide dynamic activity status or allow temporary activation or deactivation of some features.

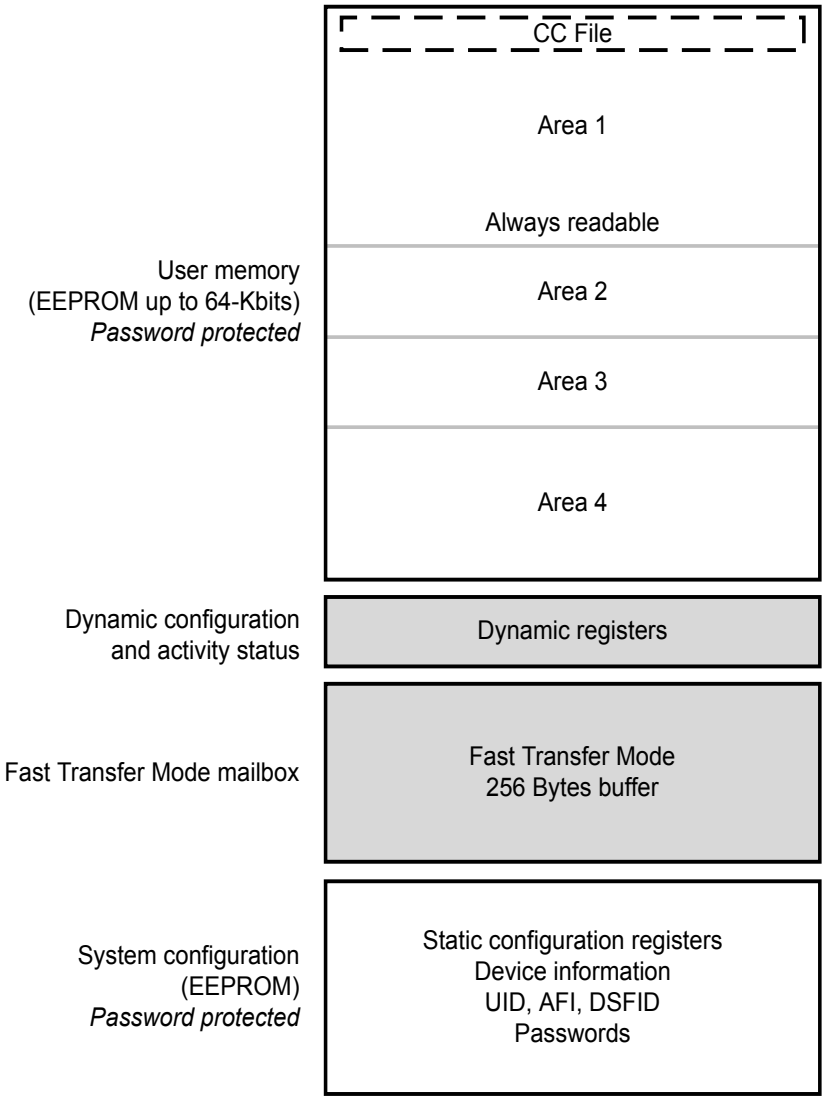
The ST25DVxxx also provides a 256-byte fast transfer mode buffer, acting as a mailbox between RF and I^2C interface, allowing fast data transfer between contact and contactless worlds.

Finally, the ST25DVxxx system configuration area contains static registers to configure the device features, which can be tuned by user. Its access is protected by a 64-bit configuration password.

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

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

Figure 7. **Memory organization**



4.2 User memory

This memory is accessible from both RF contactless and I^2C wired interfaces.

From RF interface, the user memory is addressed as blocks of 4 bytes, starting at address 0. RF extended read and write commands can be used to address all memory blocks. Other read and write commands can address only up to block FFh.

From I^2C interface, user memory is addressed as bytes, starting at address 0. Device select must be set with E2 = 0.

The 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 2 shows how memory is seen from RF and I^2C interfaces.

Table 2. User memory as seen by RF and by I²C

RF command (block addressing)	User memory				I²C 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				I²C Read command I²C Write command Device select E2 = 0
	I²C byte 0003h	I²C byte 0002h	I²C byte 0001h	I²C byte 0000h	
	RF block (00)01h				
	I²C byte 0007h	I²C byte 0006h	I²C byte 0005h	I²C byte 0004h	
	RF block (00)02h				
	I²C byte 000Bh	I²C byte 000Ah	I²C byte 0009h	I²C byte 0008h	
	....				
	RF block (00)7Fh (1)				
	I²C byte 01FFh	I²C byte 01FEh	I²C byte 01FDh	I²C byte 01FCh	
	....				
	RF block (00)FFh (2)				
	I²C byte 03FFh	I²C byte 03FEh	I²C byte 03FDh	I²C 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				
	I²C byte 0403h	I²C byte 0402h	I²C byte 0401h	I²C byte 0400h	
	....				
	RF block 01FFh (3)				
	I²C byte 07FFh	I²C byte 07FEh	I²C byte 07FDh	I²C byte 07FCh	
	....				
	RF block 07FFh (4)				
	I²C byte 1FFFh	I²C byte 1FFEh	I²C byte 1FFDh	I²C byte 1FFCh	

1. *Last block of user memory in ST25DV04K-XX..*
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 ST25DV16K-XX.*
4. *Last block of user memory in ST25DV64K-XX.*

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.

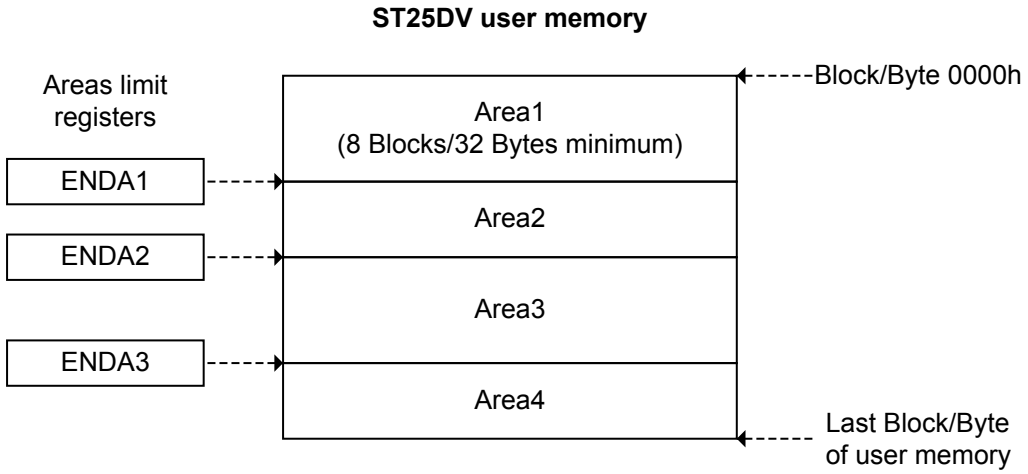
RF and I²C read and write commands are legal only within the same zone:

- In RF, a multiple read or a multiple write command is not executed and returns the error code 0Fh if addresses cross the area borders.
- In I²C, a read data always return FFh after crossing an area border. A write command is not acknowledged and not executed if the command crosses the area border.

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

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

Figure 8. ST25DVxxx user memory areas



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

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

An area end limit is coded as follows in $ENDA_i$ registers:

- Last RF block address of area = 8 * $ENDA_i$ + 7 → $ENDA_i$ = int(Last $Area_i$ RF block address / 8)
- Last I²C byte address of area = 32 * $ENDA_i$ + 31 → $ENDA_i$ = int(Last $Area_i$ I²C byte address / 32)
- As a consequence, ENDA1 = 0 minimum size of Area 1 is 8 blocks (32 bytes).

Table 3. Maximum user memory block and byte addresses and $ENDA_i$ value

Device	Last user memory block address seen by RF	Last user memory byte address seen by I²C	Maximum $ENDA_i$ value
ST25DV04K-xx	007Fh	01FFh	0Fh
ST25DV16K-xx	01FFh	07FFh	3Fh
ST25DV64K-xx	07FFh	1FFFh	FFh

Table 4. Areas and limit calculation from ENDA$_i$ registers

Area	Seen from RF interface	Seen from I²C interface
Area 1	Block 0000h … Block (ENDA1 * 8) + 7	Byte 0000h … Byte (ENDA1 * 32) + 31
Area 2	Block (ENDA1 + 1) * 8 … Block (ENDA2 * 8) + 7	Byte (ENDA1 + 1) * 32 … Byte (ENDA2 * 32) + 31
Area 3	Block (ENDA2 + 1) * 8 … Block (ENDA3 * 8) + 7	Byte (ENDA2 + 1) * 32 … Byte (ENDA3 * 32) + 31
Area 4	Block (ENDA3 + 1) * 8 … Last memory block	Byte (ENDA3 + 1) * 32 … Last memory byte

The organization of user memory in areas has 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 can be defined by setting ENDA1 < ENDA2 = ENDA3 = End of user memory.
- Three areas can be defined by setting ENDA1 < ENDA2 < ENDA3 = End of user memory.
- A maximum of four areas can be defined by setting ENDA1 < ENDA2 < ENDA3 < End of user memory.
- Area 1 specificities:
  - Start is always block/byte address 0000h
  - Minimum size is 8 blocks (32 bytes) when ENDA1 = 00h
  - Always readable
- The last area always finishes on the last user memory block/byte address (ENDA4 does not 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 ENDAi registers.

I²C host must first open I²C security session to write ENDAi registers.

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

- ENDAi-1 < ENDAi ≤ ENDAi + 1 = End of memory.

This means that prior to programming any ENDAi register, its successor (ENDAi + 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 I2C, and programming is not done. To respect this rule, the following procedure is recommended when programming areas size (even for changing only one):

1. Ends of Areas 3 and 2 must first be set to the end of memory 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 ST25DV64K-xx):

1. Initial state, two areas are defined:
   a. ENDA1 = 10h (last block of Area 1: (10h * 8) + 7 = 0087h)
   b. ENDA2 = FFh (last block of Area 2: (FFh * 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 * 8) + 7 = 01FFh)
   d. Set ENDA2 = 5Fh (last block of Area 1: (5Fh * 8) + 7 = 02FFh)
   e. Set ENDA3 = BFh (last block of Area 1: (BFh * 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 * 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 results in an error, since rule ENDAi - 1 < ENDAi is not respected (ENDA2 = ENDA3 in that case).

Registers for user memory area configuration

Table 5. ENDA1 access

RF		I2C	
Command	**Type**	**Address**	**Type**
Read Configuration (code A0h) @05h Write Configuration (code A1h) @05h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0005h	R always, W if I2C security session is open

Table 6. 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^2C)	ST25DV04K-xx: 0Fh ST25DV16K-xx: 3Fh ST25DV64K-xx: FFh

Note: Refer to Table 11. System configuration memory map for ENDA1 register.

Table 7. ENDA2 access

RF		I2C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @07h Write Configuration (cmd code A1h) @07h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0007h	R always, W if I2C security session is open

Table 8. ENDA2

Bit	Name	Function	Factory value
b7-b0	ENDA2	End Area 2 = 8 * ENDA2 + 7 when expressed in blocks (RF) End Area 2 = 32 * ENDA2 + 31 when expressed in bytes (I^2C)	ST25DV04K-xx: 0Fh ST25DV16K-xx: 3Fh ST25DV64K-xx: FFh

Note: Refer to Table 11. System configuration memory map for ENDA2 register.

Table 9. ENDA3 access

RF		I2C	
Command	Type	Address	Type
Read Configuration (code A0h) @09h Write Configuration (code A1h) @09h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0009h	R always, W if I2C security session is open

Table 10. 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^2C)	ST25DV04K-xx: 0Fh ST25DV16K-xx: 3Fh ST25DV64K-xx: FFh

Note: Refer to Table 11. System configuration memory map for ENDA3 register.

4.3 System configuration area

In addition to EEPROM user memory, ST25DVxxx includes a set of static registers located in the system configuration area memory (EEPROM nonvolatile registers). Those registers are set during device configuration (i.e.: area extension), or by the application (i.e.: area protection). Static registers content is read during the boot sequence and define basic ST25DVxxx behavior.

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^2C host.

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

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

Table 11. System configuration memory map shows the complete map of the system configuration area, as seen by RF and I^2C interface.

Table 11. System configuration memory map

RF access		Static Register		I^2C access		
Address	Type	Name	Function	Device select	Address	Type
00h	RW (1)	GPO	Enable/disable ITs on GPO	E2=1	0000h	RW (2)
01h	RW(1)	IT_TIME	Interruption pulse duration	E2=1	0001h	RW(2)
02h	RW(1)	EH_MODE	Energy Harvesting default strategy after Power ON	E2=1	0002h	RW(2)
03h	RW(1)	RF_MNGT	RF interface state after Power ON	E2=1	0003h	RW(2)
04h	RW(1)	RFA1SS	Area1 RF access protection	E2=1	0004h	RW(2)
05h	RW(1)	ENDA1	Area 1 ending point	E2=1	0005h	RW(2)
06h	RW(1)	RFA2SS	Area2 RF access protection	E2=1	0006h	RW(2)
07h	RW(1)	ENDA2	Area 2 ending point	E2=1	0007h	RW(2)
08h	RW(1)	RFA3SS	Area3 RF access protection	E2=1	0008h	RW(2)
09h	RW(1)	ENDA3	Area 3 ending point	E2=1	0009h	RW(2)
0Ah	RW(1)	RFA4SS	Area4 RF access protection	E2=1	000Ah	RW(2)
No access		I2CSS	Area 1 to 4 I^2C access protection	E2=1	000Bh	RW(2)
N/A	RW (3) (4)	LOCK_CCFILE	Blocks 0 and 1 RF Write protection	E2=1	000Ch	RW(2)
0Dh	RW(1)	MB_MODE	Fast transfer mode state after power ON	E2=1	000Dh	RW(2)
0Eh	RW(1)	MB_WDG	Maximum time before the message is automatically released	E2=1	000Eh	RW(2)
0Fh	RW(1)	LOCK_CFG	Protect RF Write to system configuration registers	E2=1	000Fh	RW(2)
N/A	WO (5)	LOCK_DSFID	DSFID lock status	E2=1	0010h	RO
NA	WO (6)	LOCK_AFI	AFI lock status	E2=1	0011h	RO
N/A	RW(5)	DSFID	DSFID value	E2=1	0012h	RO
N/A	RW(6)	AFI	AFI value	E2=1	0013h	RO
N/A	RO	MEM_SIZE	Memory size value in blocks, 2 bytes	E2=1	0014h to 0015h	RO
	RO	BLK_SIZE	Block size value in bytes	E2=1	0016h	RO
N/A	RO	IC_REF	IC reference value	E2=1	0017h	RO
NA	RO	UID	Unique identifier, 8 bytes	E2=1	0018h to 001Fh	RO

RF access		Static Register		I²C access		
Address	Type	Name	Function	Device select	Address	Type
No access		IC_REV	IC revision	E2 = 1	0020h	RO
		-	ST reserved	E2 = 1	0021h	RO
		-	ST reserved	E2=1	0022h	RO
		-	ST reserved	E2 = 1	0023h	RO
		I2C_PWD	I²C security session password, 8 bytes	E2=1	0900h to 0907h	R/W (7) (8)
N/A	WO (9)	RF_PWD_0	RF configuration security session password, 8 bytes	No access		
N/A	WO(9)	RF_PWD_1	RF user security session password 1, 8 bytes			
N/A	WO(9)	RF_PWD_2	RF user security session password 2, 8 bytes			
N/A	WO(9)	RF_PWD_3	RF user security session password 3, 8 bytes			

1. *Write access is granted if RF configuration security session is open and configuration is not locked (LOCK_CFG register equals to 0).*
2. *Write access if I²C security session is open.*
3. *Write access to bit 0 if Block 00h is not already locked and to bit 1 if Block 01h is not already locked.*
4. *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)*
5. *Write access if DSFID is not locked*
6. *Write access if AFI is not locked.*
7. *Write access with I²C Write Password command, only after presenting a correct I²C password.*
8. *Read access is granted if I²C security session is open.*
9. *Write access only if corresponding RF security session is open.*

4.4 Dynamic configuration

ST25DV 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^2C, the corresponding dynamic register is automatically updated.

Other, dynamic registers, automatically updated, contain indication on ST25DV activity. (i.e.: 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^2C, dynamic registers can be accessed with I^2C read and write commands with device select E2=0. 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.

Table 12. Dynamic registers memory map shows the complete map of dynamic registers, as seen by RF interface and by I^2C interface.

Table 12. Dynamic registers memory map

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

4.5 Fast transfer mode mailbox

ST25DVxxx fast transfer mode uses a dedicated mailbox buffer for transferring messages between RF and I^2C 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^2C.

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^2C, 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^2C, but fast transfer mode must be enabled.

Table 13. Fast transfer mode mailbox memory map shows the map of fast transfer mode mailbox, as seen by RF interface and by I^2C interface.

Table 13. Fast transfer mode mailbox memory map

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

5 ST25DVxxx specific features

ST25DVxxx 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^2C.
- A GPO pin, which indicates incoming event to the contact side, like RF Field changes, RF activity in progress, RF writing completion or Mailbox message availability.
- An Energy Harvesting element to deliver µW of power when external conditions make it possible.
- RF management, which allows ST25DVxxx to ignore RF requests.

All these features can be programmed by setting static and/or dynamic registers of the ST25DVxxx. ST25DVxxx can be partially customized using configuration registers located in the E^2 system area.

These registers are:

- dedicated to Data Memory organization and protection $ENDA_i$, I2CSS, RFAiSS, LOCK_CCFILE.
- dedicated to fast transfer mode MB_WDG, MB_MODE
- dedicated to observation, GPO, IT_TIME
- dedicated to RF , RF_MNGT, EH_MODE
- dedicated the device's structure LOCK_CFG

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

In I²C,

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^2C password. Configuration register are located from @00h to 0Fh in the system area (device code 111)

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^2C 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, ST25DVxxx uses the dynamic configuration register to manage its processes. A dynamic configuration register updated by the application will recover 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^2C, read and write of the Dynamic registers is done using usual I^2C read & write command at dedicated address. (E2 =0 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 14. MB_MODE access

RF		I2C	
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, 000Dh	R always, W if I2C security session is open

Table 15. MB_MODE

Bit	Name	Function	Factory Value
b0	MB_MODE	0: Enabling fast transfer mode is forbidden. 1: Enabling fast transfer mode is authorized.	0b
b7-b1	RFU	-	0000000b

Note: Refer to Table 11. System configuration memory map for the MB_MODE register.

Table 16. MB_WDG access

RF		I2C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @0Eh Write Configuration (cmd code A1h) @0Eh	R always, W if RF configuration security session is open and configuration not locked	E2=1, 000Eh	R always, W if I^2C security session is open

Table 17. MB_WDG

Bit	Name	Function	Factory Value
b2-b0	MB_WDG	Watch dog duration = $2^{(MB_WDG-1)}$x30ms±6 If MD_WDG = 0, then watchdog duration is infinite	111b
b7-b3	RFU	-	00000b

Note: Refer to Table 11. System configuration memory map for the MB_WDG register.

Dynamic Registers

Table 18. MB_CTRL_Dyn access

RF		I2C	
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, 2006h	b0: R always, W always b7-b1: RO

Table 19. MB_CTRL_Dyn

Bit	Name	Function	Factory Value
b0	MB_EN (1)	0: Disable FTM, FTM mailbox is empty 1: Enable FTM	0b
b1	HOST_PUT_MSG	0: No I^2C message in FTM mailbox 1: I^2C 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^2C 1: I^2C 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^2C 1: Current Message in FTM mailbox comes from I^2C	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 register is reset to 0.*

Note: Refer to Table 12. Dynamic registers memory map for the MB_CTRL_Dyn register.

Table 20. MB_LEN_Dyn access

RF		I2C	
Command	Type	Address	Type
Read Message Length (cmd code ABh) Fast Read Message Length (cmd code CBh)	RO	E2 = 0, 2007h	RO

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 ST25DVxxx)	0h

Note: Refer to Table 12. Dynamic registers memory map for the MB_LEN_Dyn register.

5.1.2 Fast transfer mode usage

ST25DV acts as mailbox between RF (reader, smartphone, ...) and an I^2C host (microcontroller...). Each interface can send a message containing up to 256 bytes of data to the other interface through that mailbox.

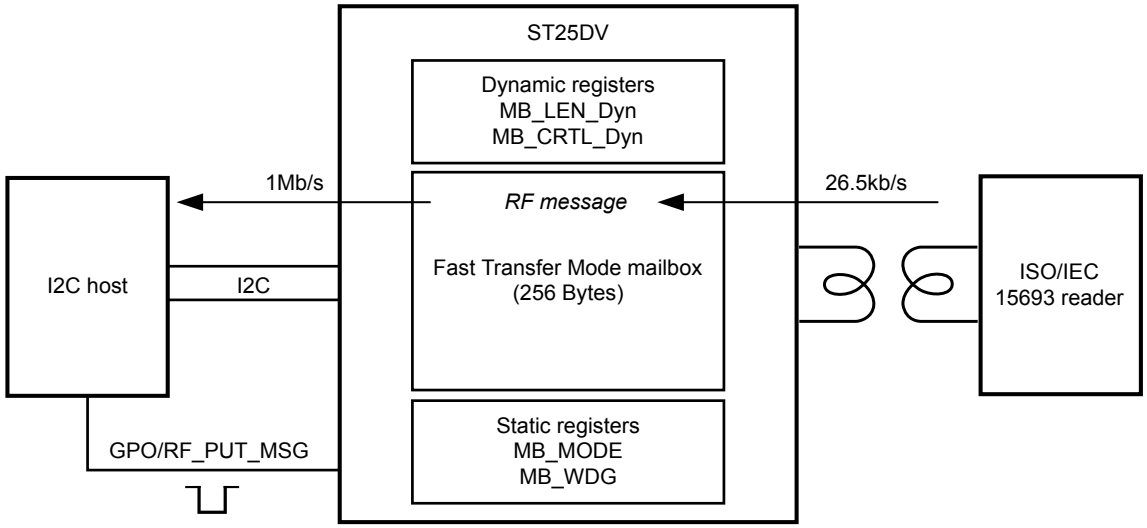
To send data from RF reader to I^2C host, fast transfer mode must be enabled, the mailbox must be free, V_{CC} power must be present, and the RF user must first writes the message containing data in the mailbox.

I^2C 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^2C, 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^2C host by polling on MB_CTRL_Dyn register.

Figure 9. RF to I²C fast transfer mode operation



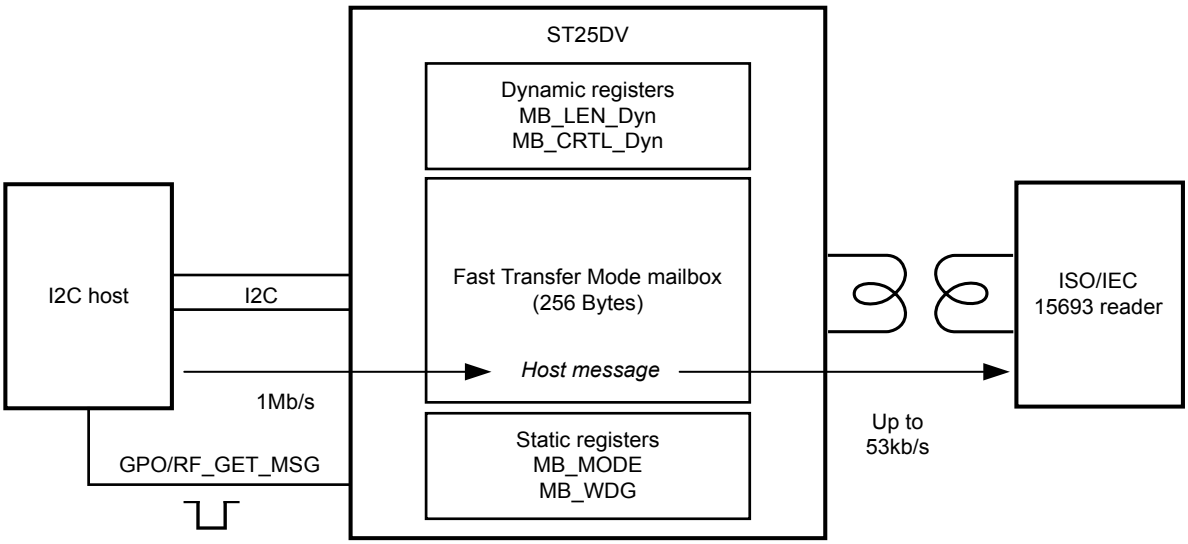
To send data from the I²C host to the RF reader, fast transfer mode must be enabled, the mailbox must be free, V_{CC} power must be present, and the I2C host must first write the message containing data in the mailbox.

The RF user must poll on MB_CTRL_Dyn register to check for the presence of a message from I²C 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 I²C 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 10. I²C to RF fast transfer mode operation



V_{CC} 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^2C message by RF, and complete reading of RF message by I^2C).

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 or system memory (EEPROM), either from I^2C or from RF, transits via the 256-Bytes fast transfer mode's buffer. Consequently fast transfer mode must be deactivated (MB_EN=0) before starting any write operation in user or system memory, otherwise command will be NotACK for I^2C or get an answer 0Fh for RF and programming is not done.*

I^2C access to mailbox

The access by I^2C can be done by dedicated address mapping to mailbox (2008h to 2107h) with device identifier E2 = 0.

I^2C 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).

A I^2C reading operation will never clear HOST_PUT_MSG, and the message remains available for RF.

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

A I^2C 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 (rollover feature not supported).

At the end of a successful I^2C 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).

A 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.

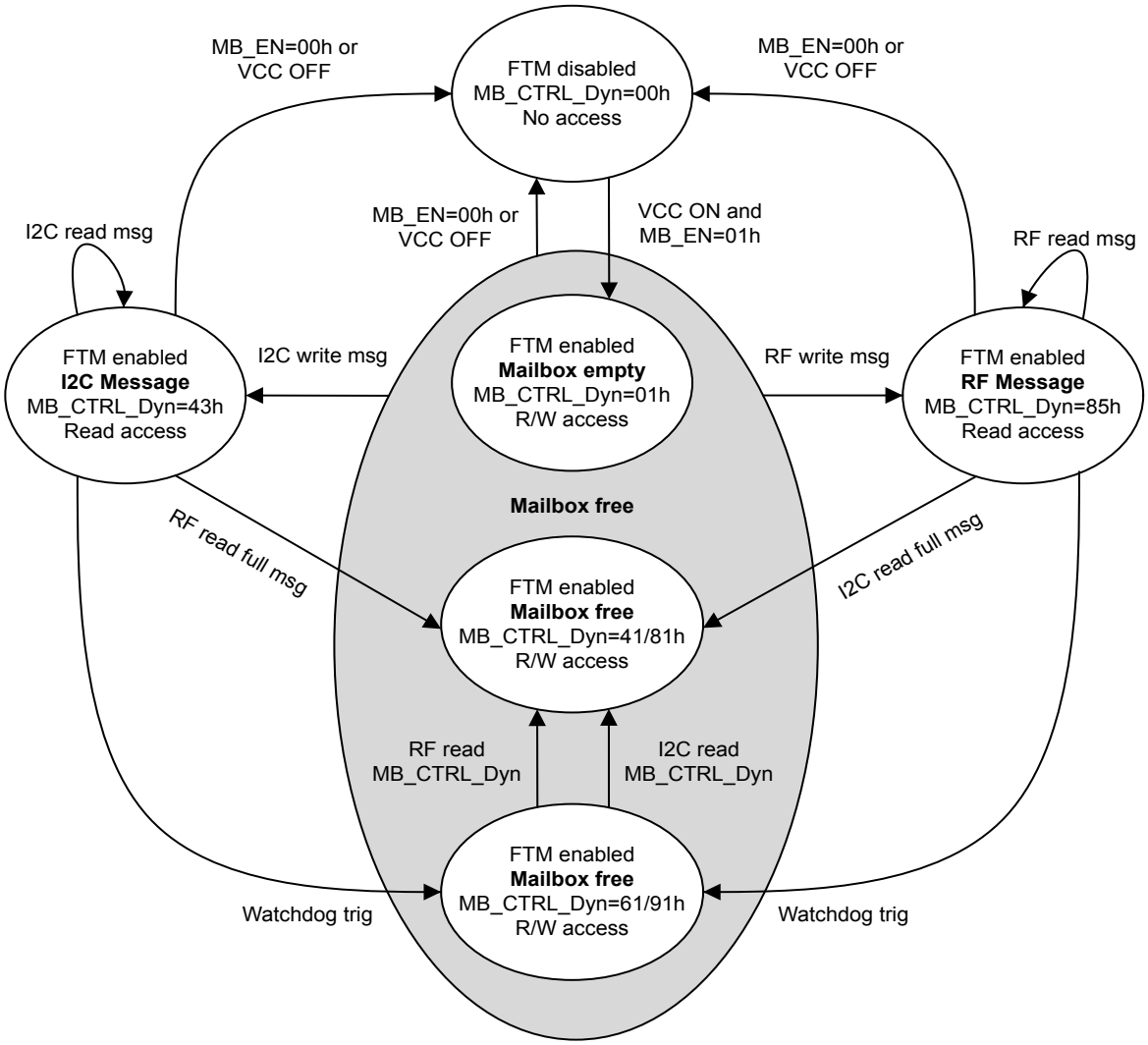
A RF reading operation will never clear RF_PUT_MSG , the message will remain available for I^2C.

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^2C) and wireless world (RF ISO15693) using fast transfer mode supported by ST25DVxxx).

Figure 11. **Fast transfer mode mailbox access management.**



Note: Assuming MB_MODE=01h

Assuming no error occurred

5.2 GPO

GPO signal is used to alert the I^{2}C host of external RF events or ST25DVxxx processes activity. Several causes could be used to request a host interruption. RF user can also directly drive GPO pin level using a dedicated RF command.

5.2.1 Interrupt capabilities on RF events

The ST25DVxxx devices support multi interruption mode, and can report several events occurring through RF interface.

In this chapter, all drawings refer to the open drain version of GPO output (ST25DVxxK-IE).

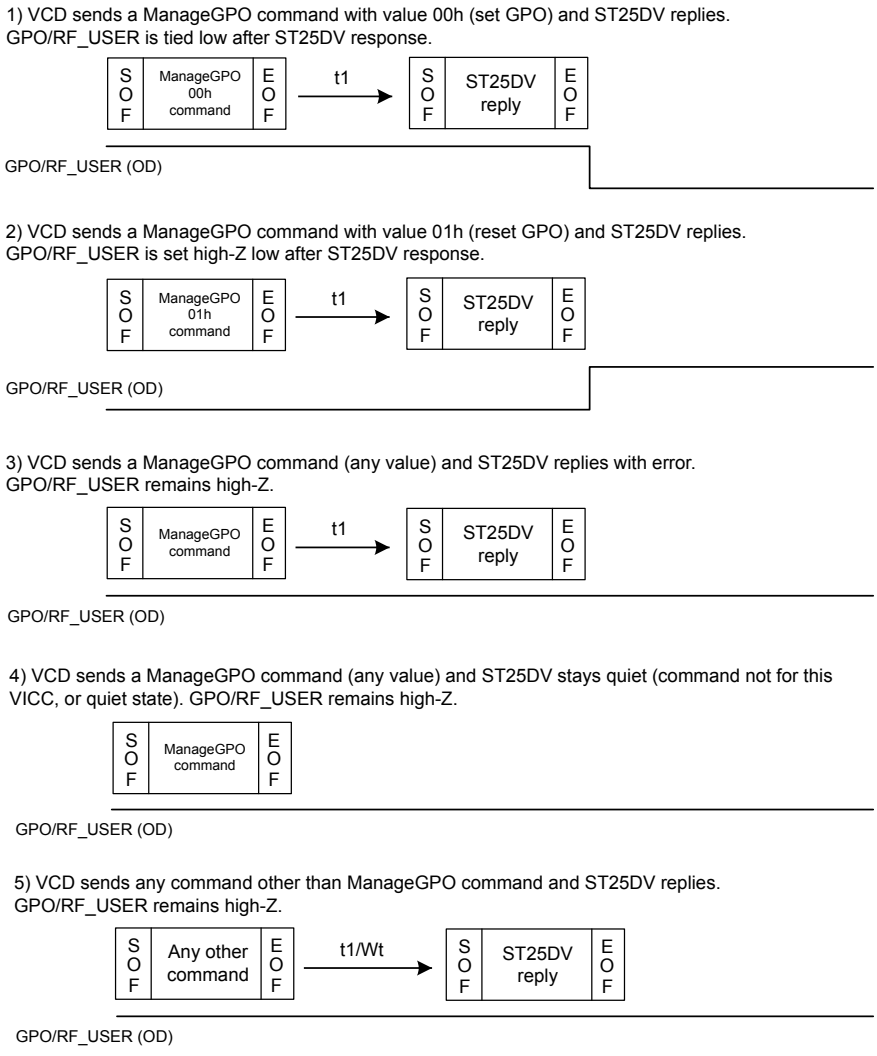
The reader can retrieve the behaviour of CMOS version (ST25DVxxK-JF) by inverting the GPO curve polarity, and replacing text “released” or “high-Z” by “pull to ground”.

Supported RF events are 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 ST25DV 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).

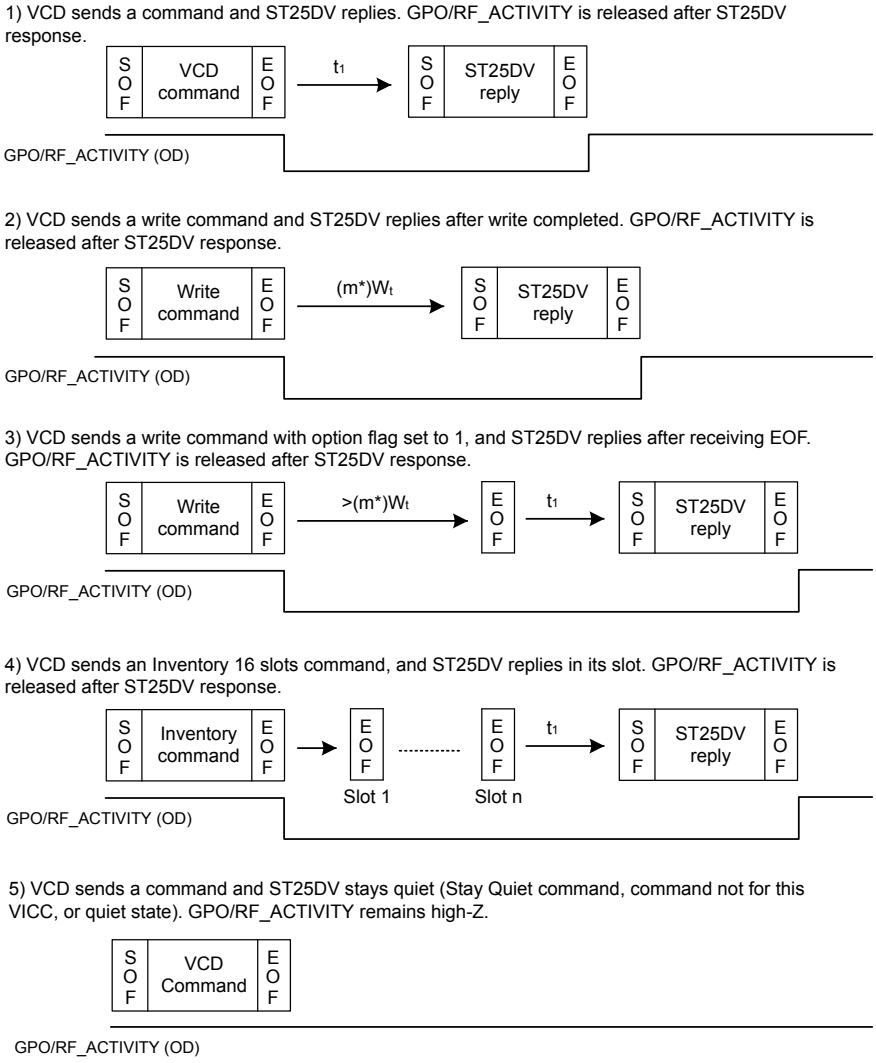
Figure 12. RF_USER sequence



RF_ACTIVITY:

- GPO output level reflects the RF activity.
- When RF_ACTIVITY is activated, a GPO output level change from RF command EOF to ST25DV response EOF.

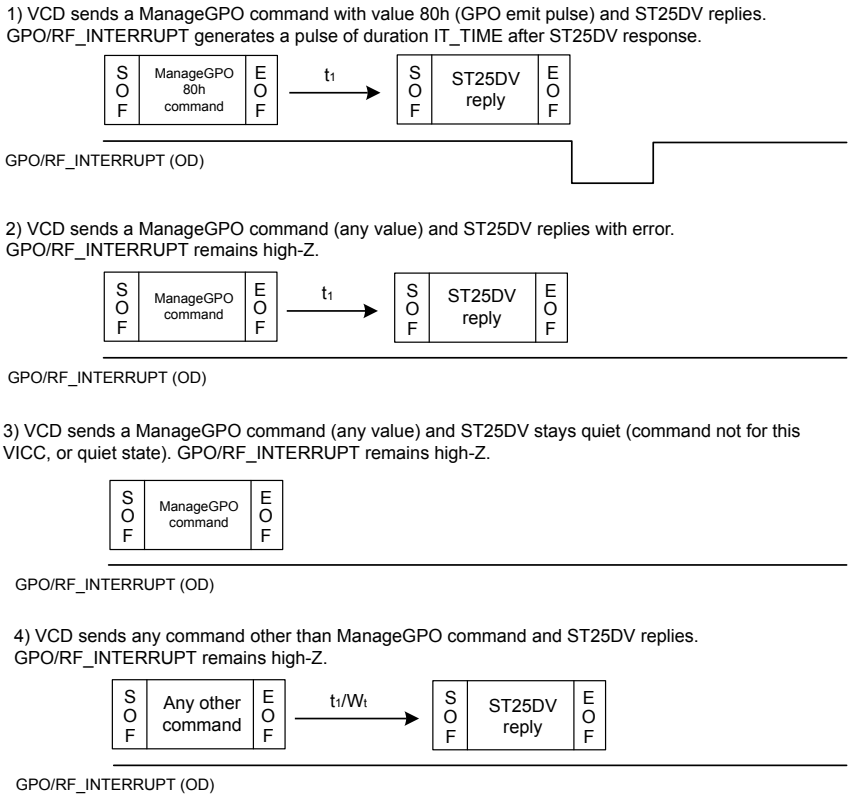
Figure 13. RF_ACTIVITY sequence



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 ST25DV response to a Manage GPO interrupt command (see Section 7.6.30: Manage GPO).

Figure 14. RF_INTERRUPT sequence



FIELD_CHANGE:

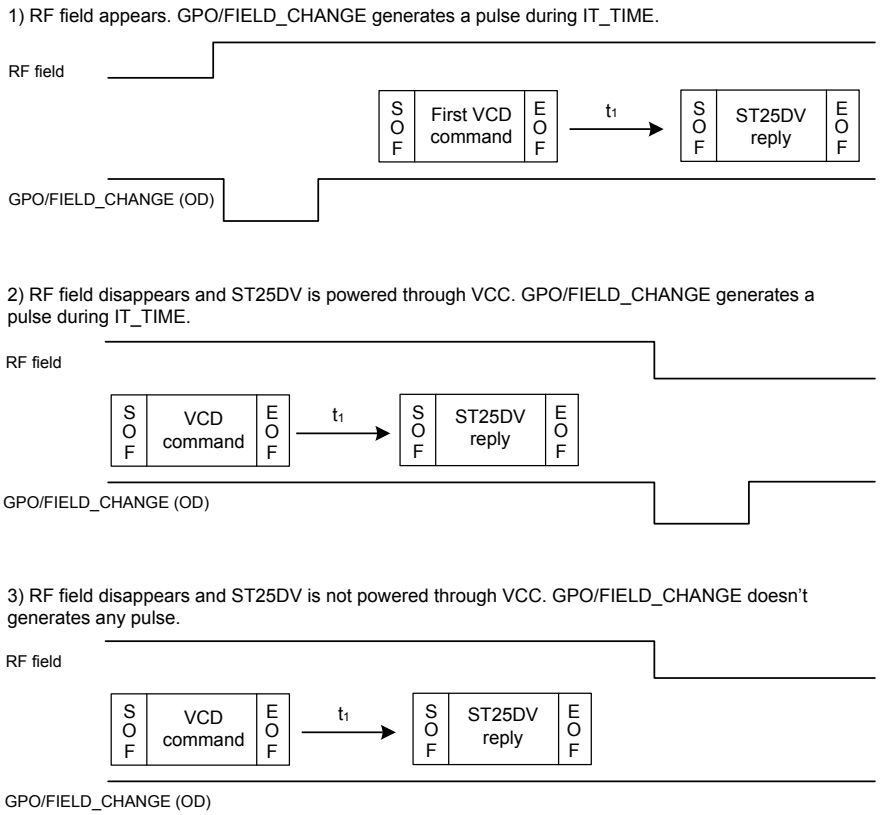
- A pulse is emitted on GPO to signal a change in RF field state.
- When FIELD_CHANGE is activated, and when RF field appear or disappear, GPO emits a pulse of duration IT_TIME.
- If RF field disappears, the pulse is emitted only if V_{CC} power supply is present.
- If RF is configured in RF_SLEEP mode, field change are not reported on GPO, even if FIELD_CHANGE event is activated, as shown in Table 22.

Table 22. FIELD_CHANGE when RF is disabled or in sleep mode

RF_DISABLE	RF_SLEEP	GPO behaviour when FIELD_CHANGE is enabled
0	0	A pulse is emitted on GPO if RF field appears or disappears (1)
1	0	
X	1	GPO remains high-Z (OD) or tied low (CMOS)
X	1	IT_STS_Dyn register is not updated.

1. *assuming that GPO output is enabled (GPO_EN = 1).*

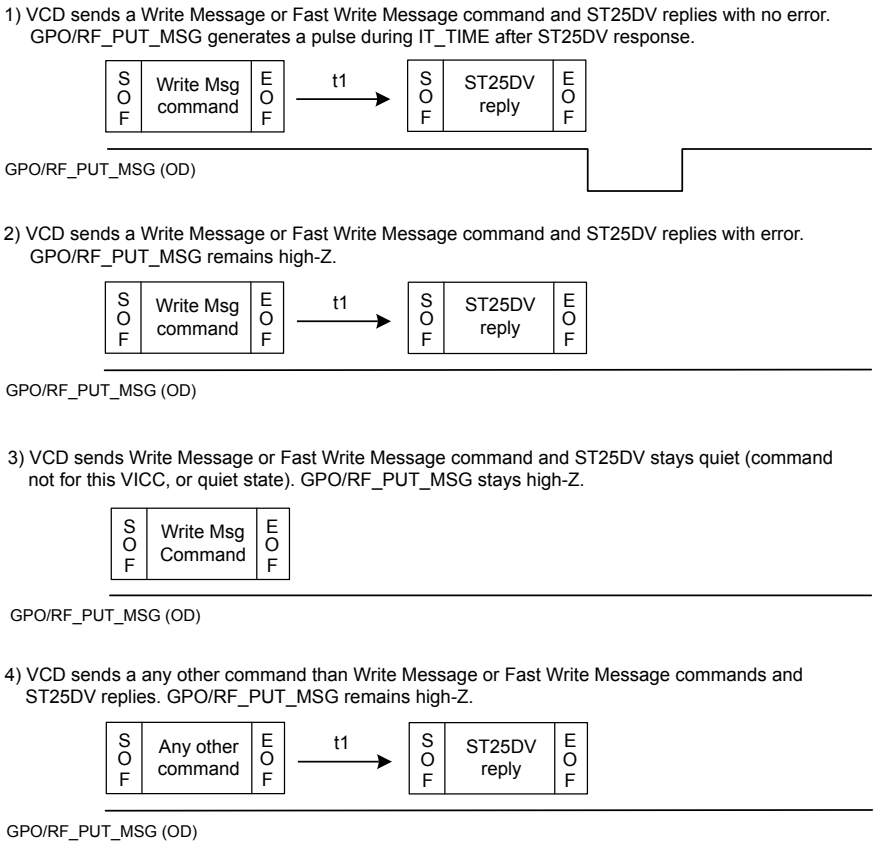
Figure 15. FIELD_CHANGE sequence



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 ST25DV response).

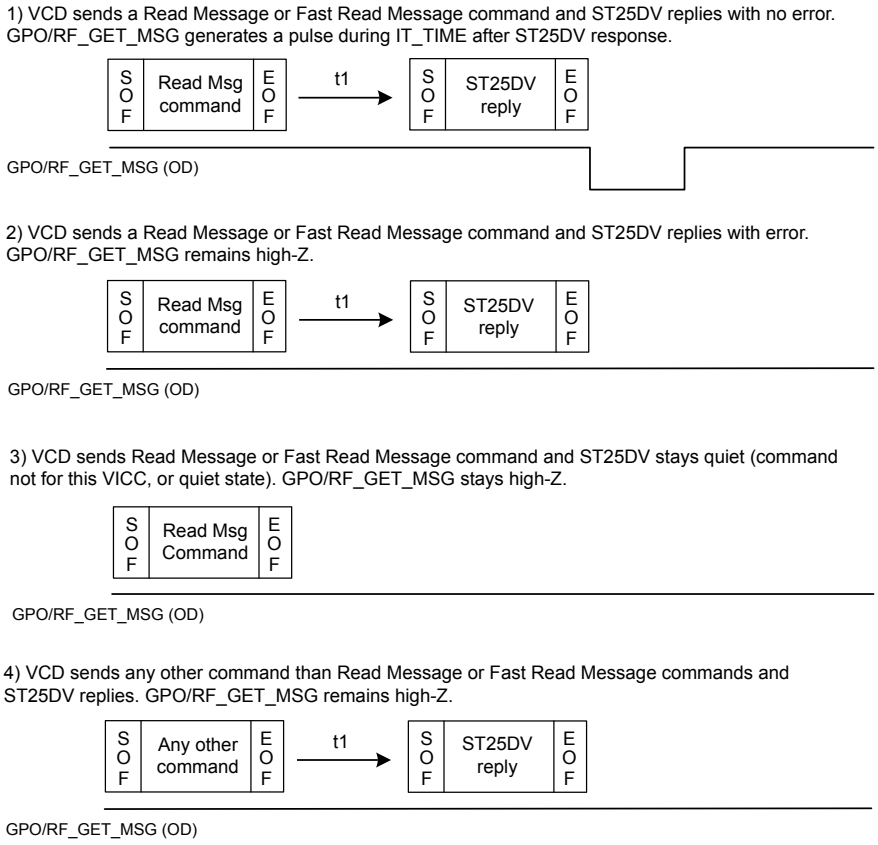
Figure 16. RF_PUT_MSG sequence



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 ST25DV response), and end of message has been reached.

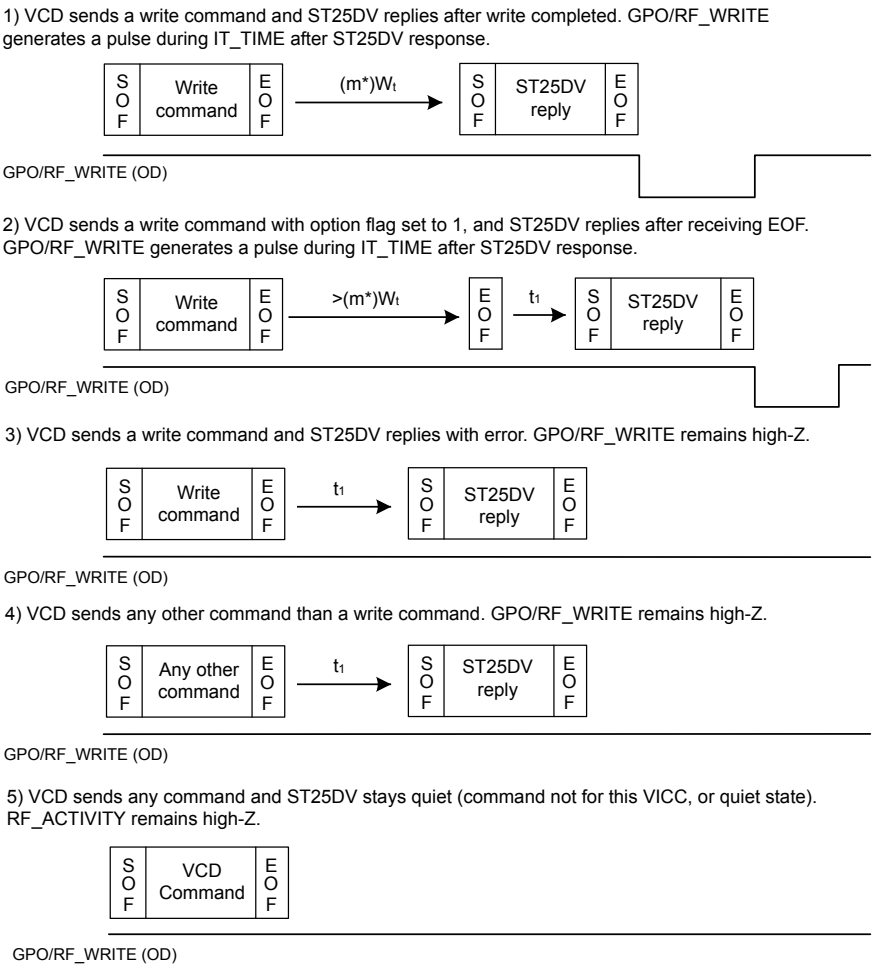
Figure 17. RF_GET_MSG sequence



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 ST25DV 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 18. RF_WRITE sequence



5.2.2 GPO and power supply

When at the same time RF field is present and V_{CC} is ON, GPO is acting as configured in GPO, GPO_CTRL_Dyn and IT_TIME registers.

When the RF field disappears, the GPO state is reset and the output level is set to high-Z (open drain) or tied low (CMOS). Interruption status in IT_STS_Dyn register is maintained until next I^2C read or V_{CC} power off.

Table 23. GPO interrupt capabilities in function of RF field

RF field on	RF field off
GPO state is function of RF events (1)	GPO remains High-Z (OD) or tied low (CMOS)

1. *If pull-up resistor is powered (Open Drain-IE version), and V_{DCG} is powered (CMOS –JF version).*

When V_{CC} is not present, or ST25DVxxx is in low power mode, all events are available on GPO pin, assuming pull-up resistor is supplied with correct voltage (Open Drain-IE version) or V_{DCG} is powered (CMOS-JF version). The host can be waken up using GPO interrupt in any power condition.

The exception is FIELD_CHANGE when RF field is falling, which can't be reported on GPO output if V_{CC} is off or in low power mode (no power supply on ST25DVxxx).

Table 24. GPO interrupt capabilities in function of V_{CC} power supply

GPO events	V_{CC} OFF	V_{CC} ON and LPD high (1) (low power mode)	V_{CC} ON and LPD low(1)
FIELD_CHANGE if RF field disappears	GPO remains High-Z (OD) or tied low (CMOS)	GPO remains High-Z (OD) or tied low (CMOS) (2)	Pulse emitted on GPO
Any other activated RF event	GPO state is function of RF events(2)	GPO state is function of RF events(2)	GPO state is function of RF events(2)

1. *For STM25DVxxK-JF only.*
2. *If pull-up resistor is powered (Open Drain-IE version) and V_{DCG} is powered (CMOS-JF version).*

5.2.3 GPO registers

Four registers are dedicated to this feature: two (static) in system configuration, and two dynamic.

Table 25. GPO access

RF		I2C	
Command	**Type**	**Address**	**Type**
Read Configuration (cmd code A0h) @00h Write Configuration (cmd code A1h) @00h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0000h	R always, W if I^2C security session is open

Table 26. GPO

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

Note: Refer to Table 11. System configuration memory map for the GPO 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 (b7) allows to disable GPO output (High-Z for open drain version, driven low for CMOS version). Interruptions are still reported in IT_STS_Dyn register.
- RF configuration security session (present RF password 0) or I^2C security session (present I^2C password) must be open in order to write the GPO register.

Table 27. IT_TIME access

RF		I2C	
Command	**Type**	**Address**	**Type**
Read Configuration (cmd code A0h) @01h Write Configuration (cmd code A1h) @01h	R always, W if RF configuration security session is open and configuration not locked	E2=1, 0001h	R always, W if I^2C security session is open

Table 28. IT_TIME

Bit	Name	Function	Factory Value
b2-b0	IT_TIME	Pulse duration = 301 us - IT_TIME x 37.65 us ± 2 us	011b
b7-b3	RFU	-	00000b

Note: Refer to Table 11. System configuration memory map for the IT_TIME register.

- Defines interrupt pulse duration on GPO pin for the flowing events: RF_INTERRUPT, FIELD_CHANGE, RF_PUT_MSG, RF_GET_MSG and RF_WRITE.
- See Eq. (1) for interrupt duration calculation.
- RF configuration security session (present RF password 0) or I^2C security session (present I^2C password) must be open in order to write IT_TIME register.

Table 29. GPO_CTRL_Dyn access

RF		I2C	
Command	**Type**	**Address**	**Type**
Read Dynamic Configuration (cmd code ADh) @00h Fast Read Dynamic Configuration (cmd code CDh) @00h	RO	E2 = 0, 2000h	b0-b6: RO b7 : R always, W always

Table 30. GPO_CTRL_Dyn

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

Note: Refer to Table 12. Dynamic registers memory map for the GPO_CTRL_Dyn register.

- Allows I^2C host to dynamically enable or disable GPO output by writing in GPO_EN bit (b7).
- 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_CTRL_Dyn 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_{CC}).
- GPO_CTRL_Dyn bit 7 (GPO_EN) can be written even if I^2C security session is closed (I^2C password not presented) but is read only for RF user.
- Modifying GPO_CTRL_Dyn, the bit 7 GPO_EN does not affect the value of GPO register bit 7 GPO_EN

Table 31. IT_STS_Dyn access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 0, 2005h	RO

Table 32. 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 has been reached.	0b
b7	RF_WRITE	0: No write in EEPROM 1: Write in EEPROM	0b

Note: Refer to Table 12. Dynamic registers memory map for the IT_STS_Dyn register.

- Cumulates all events which generate interruptions. It should be checked by I^2C 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_{CC}).

5.2.4 Configuring GPO

GPO and interruption pulse duration can be configured by RF user or by I²C 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 GPO and IT_TIME registers, after presenting a valid RF configuration password to open RF configuration security session.

I²C host can write GPO and IT_TIME registers, after presenting a valid I²C password to open I²C security session.

Enabling or disabling GPO output:

- RF user and I²C host can disable or enable GPO output at power up time by writing in GPO_EN bit 7 of GPO register (if write access is granted).
- I²C host can temporarily enable or disable GPO output at any time by toggling GPO_EN bit 7 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 GPO or in GPO_CTRL_Dyn registers) does not disable interruption report in IT_STS_Dyn status register.

Table 33. Enabling or disabling GPO interruptions

GPO bit 7: GPO_EN	GPO_CTRL_Dyn bit 7: GPO_EN	GPO output
0	0	GPO remains High-Z (OD) or tied low (CMOS)
1	0	GPO remains High-Z (OD) or tied low (CMOS)
0	1	Activated RF events are reported on GPO output (1)
1	1	Activated RF events are reported on GPO output(1)

1. *If pull-up resistor is powered (Open Drain -IE version), and V_{DCG} is powered (CMOS –JF version).*

Interruption pulse duration configuration:

- Interrupt pulse duration is configured by writing pulse duration value in IT_TIME register.
- Pulse duration is calculated with the following equation

IT pulse duration equation:

$$ITpulse\ duration = 301\mu s - IT_TIME \times 37.65\mu s \pm 2\mu s \quad (1)$$

5.3 Energy harvesting (EH)

5.3.1 Energy harvesting registers

Table 34. EH_MODE access

RF		I2C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @02h Write Configuration (cmd code A1h) @02h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0002h	R always, W if I^2C security session is open

Table 35. 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 11. System configuration memory map for the EH_MODE register.

Table 36. EH_CTRL_Dyn access

RF		I2C	
Command	Type	Address	Type
Read Dynamic Configuration (cmd code ADh) @02h Fast Read Dynamic Configuration (cmd code CDh) @02h Write Dynamic Configuration (cmd code AEh) @02h Fast Write Dynamic Configuration (cmd code CEh) @02h	b0: R always, W always b1 - b7: RO	E2=0, 2002h	b0: R always, W always b1-b7 : RO

Table 37. 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 ST25DVxxx may communicate in RF	Depending of power source
b3	VCC_ON	0: No DC supply detected on V_{CC} pin or Low Power Down mode is forced (LPD is high) 1: V_{CC} 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 12. Dynamic registers memory map for the EH_CTRL_Dyn register.

5.3.2 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 38. 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 will automatically set EH_EN bit to 1, and thus activate energy harvesting.

Writing 1 in EH_MODE at any time after boot will not modify EH_EN bit (until next reboot) and thus will 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 a RF field
- VCC_ON is set when Host power supply is on, and low power-down mode is not forced.

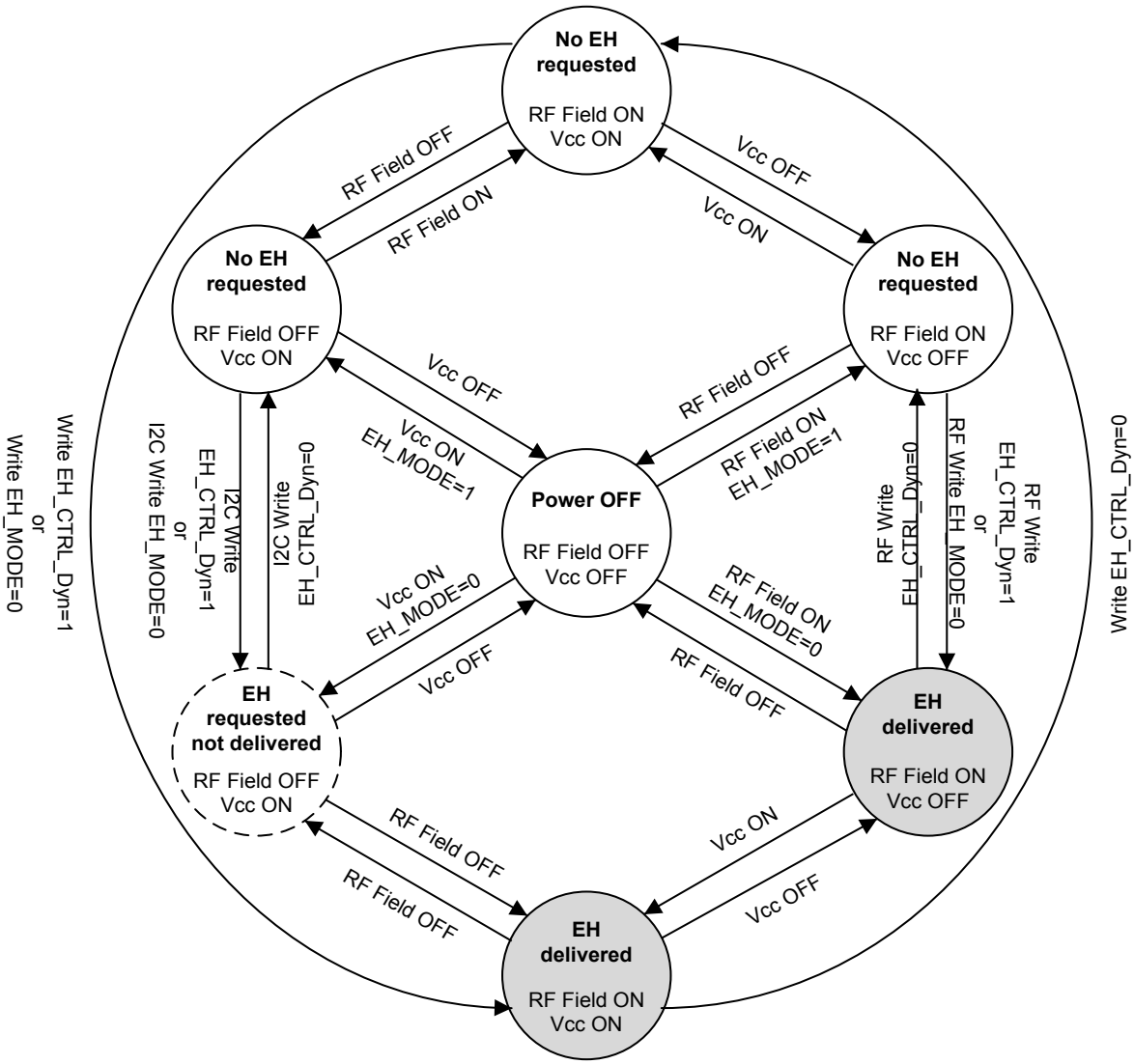
During boot, EH is not delivered to avoid alteration in device configuration.

Caution: *Communication is not guaranteed during EH delivery. Refer to the application note AN4913 (Energy harvesting delivery impact on ST25DVxxx behaviour during RF communication).*

Energy harvesting can be set even if ST25DVxxx is in RF disabled or RF Sleep mode, or in Low power mode. In all these cases, ST25DVxxx will deliver power on V_EH pin if RF field is present. Energy harvesting voltage output is not regulated.

5.3.3 EH delivery state diagram

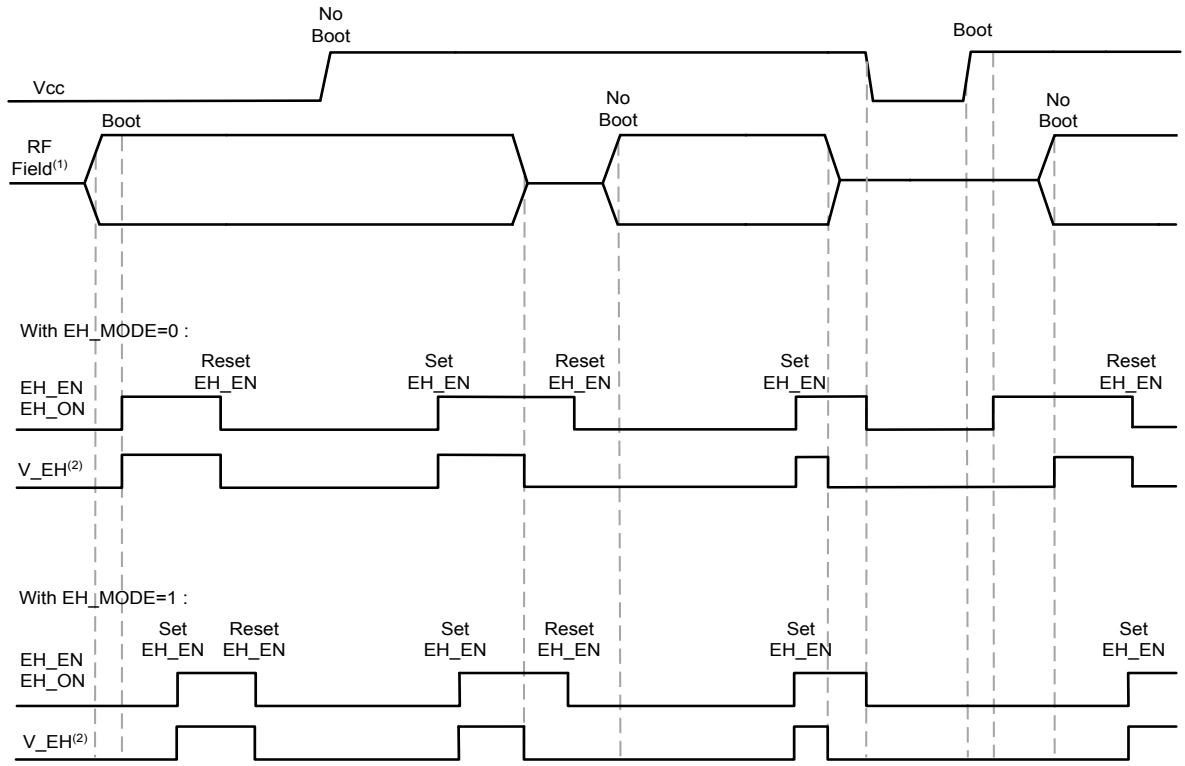
Figure 19. **EH delivery state diagram**



Note: Power is delivered on V_EH only if harvested energy is sufficient to supply ST25DV and leave over power. Grey color indicates the states where power is delivered on V_EH pin.

5.3.4 EH delivery sequence

Figure 20. ST25DVxxx Energy Harvesting Delivery Sequence



1. *We suppose that the captured RF power is sufficient to trig EH delivery.*
2. *V_EH = 1 means some µW are available on V_EH pin.*
   V_EH = 0 means V_EH pin is in high-Z.

5.4 RF management feature

5.4.1 RF management registers

Table 39. RF_MNGT access

RF		I2C	
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, 0003h	R always, W if I^2C security session is open

Table 40. 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 11. System configuration memory map for the RF_MNGT register.

Table 41. RF_MNGT_Dyn access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 0, 2003h	R always, W always

Table 42. RF_MNGT_Dyn

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	-	0000000b

Note: Refer to Table 12. Dynamic registers memory map for the RF_MNGT_Dyn register.

5.4.2 RF management feature description

RF_MNGT Register is used to control the RF communication between ST25DVxxx and a RF reader.

At boot time, and each time RF_MNGT register it is updated, content of RF_MNGT_Dyn register is copied from RF_MNGT register. The content of RF_MNGT_Dyn register is used during application to set ST25DVxxx behavior.

Content of this dynamic register RF_MNGT_Dyn can be updated on the fly, to temporarily modify the behavior of ST25DVxxx without affecting the static value of RF_MNGT which will be recovered at next POR.

RF_MNGT register is composed of two bits (see Table 42. RF_MNGT_Dyn): RF_DISABLE and RF_SLEEP

For a normal usage of RF interface, bits RF_SLEEP and RF_DISABLE must be set to 0.

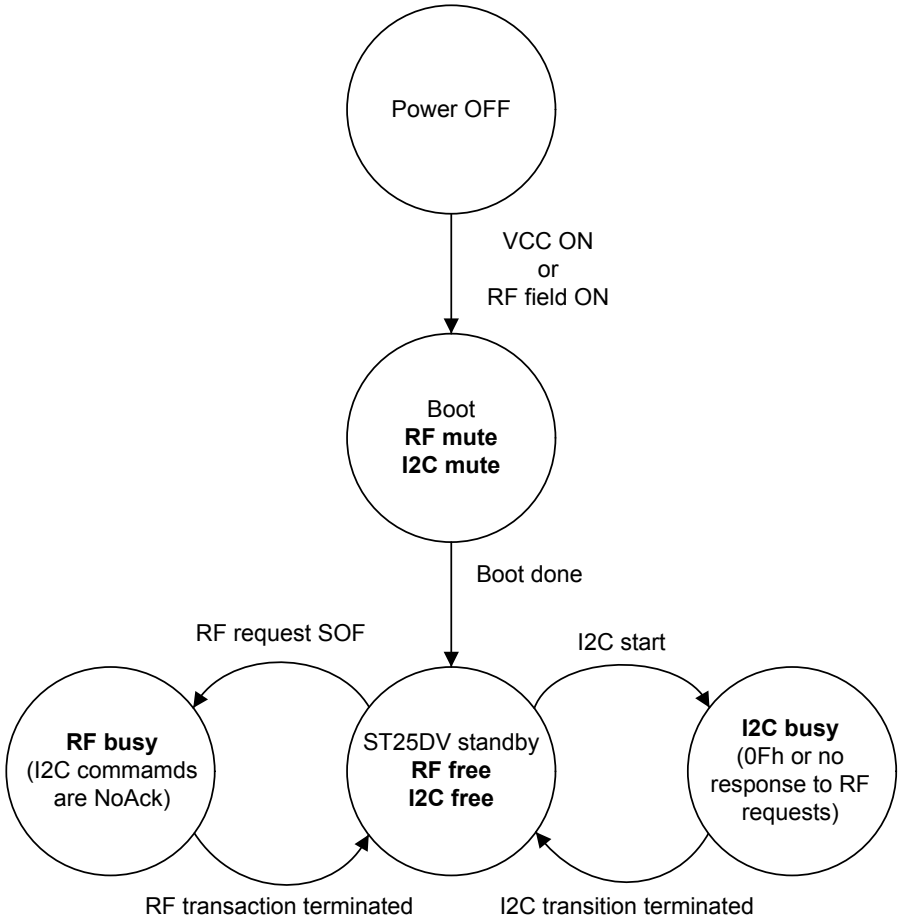
For RF are offered three modes:

- RF sleep mode:
  - When RF_SLEEP is set to 1, all RF communications are disabled, RF interface doesn't interpret commands, but minimizes consumption of RF interface.
- RF disable mode:
  - When RF_SLEEP is set to 0 and RF_DISABLE is set to 1, RF commands are interpreted but not executed. In case of a valid command, ST25DVxxx will respond after t_1 with the error code 0Fh. The Inventory command is not answered.
- RF normal mode:
  - In normal usage, RF_SLEEP and RF_DISABLE are set to 0, ST25DVxxx will process the request and respond accordingly when I^2C is not accessing ST25DVxxx. If I^2C is busy, ST25DV will respond to RF request with the error code 0Fh.

5.5 Interface arbitration

The device automatically arbitrates the exclusive usage of RF and I^2C interfaces. Arbitration scheme obeys to “first talk first served” principle (see Figure 21).

Figure 21. Arbitration between RF and I^2C



RF transaction is terminated:

- at response EOF if answered
- at request EOF is not answered
- at RF field OFF.

I2C 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: I2C write operations for write time calculation
- at stop condition for any other I2C transaction
- at VCC power off
- at any I2C error (terminated before stop condition)
- at I2C timeout if it occurs

When RF is busy, I^2C interface answers by NoAck on any I^2C command.

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

5.6 Data Protection

ST25DVxxx 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^2C assess.

5.6.1 Data protection registers

Table 43. RFA1SS access

RF		I2C	
Command	**Type**	**Address**	**Type**
Read Configuration (cmd code A0h) @04h Write Configuration (cmd code A1h) @04h	R always, W if RF configuration security session is open and configuration not locked	E2 = 1, 0004h	R always, W if I^2C security session is open

Table 44. 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 11. System configuration memory map for the RFA1SS register.

Table 45. RFA2SS access

RF		I2C	
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, 0006h	R always, W if I^2C security session is open

Table 46. 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 11. System configuration memory map for the RFA2SS register.

Table 47. RFA3SS access

RF		I2C	
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, 0008h	R always, W if I^2C security session is open

Table 48. 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 11. System configuration memory map for the RFA3SS register.

Table 49. RFA4SS access

RF		I2C	
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, 000Ah	R always, W if I^2C security session is open

Table 50. RFA4SS

Bit	Name	Function	Factory Value
b1-b0	PWD_CTRL_A4	00: Area 4RF 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 11. System configuration memory map for the RFA4SS register.

Table 51. I2CSS access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 1, 000Bh	R always, W if I^2C security session is open

Table 52. **I2CSS**

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

Note: Refer to Table 11. System configuration memory map for the I2CSS register.

Table 53. LOCK_CCFILE access

RF		I2C	
Command	**Type**	**Address**	**Type**
Lock Block (cmd code 22h) @00h/01h Ext Lock Block (cmd code 32h) @00h/01h Read Block (cmd code 20h) @00h/01h Fast Read Block(1) (cmd code C0h) @00h/01h Ext Read Block(1) (cmd code 30h) @00h/01h Fast Ext Read Block(1) (cmd code C4h) @00h/01h Read Multi Block(1) (cmd code 23h) @00h/01h Ext Read Multi Block(1) (cmd code 33h) @00h/01h Fast Read Multi Block(1) (cmd code C3h) @00h/01h Fast Ext Read Multi Block(1) (cmd code C5h) @00h/01h Get Multi Block SS (cmd code 2Ch) @00h/01h Ext Get Multi Block SS (cmd code 3Ch) @00h/01h	R always b0: W if Block 00h is not already locked, b1: W if Block 01h is not already locked.	E2 = 1, 000Ch	R always, W if I^2C security session is open

1. *With option flag set to 1.*

Table 54. 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 11. System configuration memory map for the LOCK_CCFILE register.

Table 55. LOCK_CFG access

RF		I2C	
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, 000Fh	R always, W if I^2C security session is open

Table 56. 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 11. System configuration memory map for the LOCK_CFG register.

Table 57. I2C_PWD access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 1, 0900h to 0907h, Present/Write password command format.	R if I^2C security session is open, W if I^2C security session is open

Table 58. I2C_PWD

I2C address	Bit	Name	Function	Factory Value
0900h	b7-b0	I2C_PWD	Byte 7 (MSB) of password for I^2C security session	00h
0901h	b7-b0		Byte 6 of password for I^2C security session	00h
0902h	b7-b0		Byte 5 of password for I^2C security session	00h
0903h	b7-b0		Byte 4 of password for I^2C security session	00h
0904h	b7-b0		Byte 3 of password for I^2C security session	00h
0905h	b7-b0		Byte 2 of password for I^2C security session	00h
0906h	b7-b0		Byte 1 of password for I^2C security session	00h
0907h	b7-b0		Byte 0 (LSB) of password for I^2C security session	00h

Note: Refer to Table 11. System configuration memory map for the I2C_PWD register.

Table 59. RF_PWD_0 access

RF		I2C	
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 60. 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 11. System configuration memory map for the RF_PWD_0 register.

Table 61. RF_PWD_1 access

RF		I2C	
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 62. 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 11. System configuration memory map for the RF_PWD_1 register.

Table 63. RF_PWD_2 access

RF		I2C	
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 64. 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 11. System configuration memory map for the RF_PWD_2 register.

Table 65. RF_PWD_3 access

RF		I2C	
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 66. RF_PWD_3

Bit	Name	Function	Factory Value
b7-b0	RF_PWD_3	Byte 0 (LSB) of password 3for 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 11. System configuration memory map for the RF_PWD_3 register.

Table 67. I2C_SSO_Dyn access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 0, 2004h	RO

Table 68. I2C_SSO_Dyn

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

Note: Refer to Table 12. Dynamic registers memory map for the I2C_SSO_Dyn register.

5.6.2 Passwords and security sessions

ST25DVxxx provides protection of user memory and system configuration static registers. RF user and I^2C 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 Table 69. Security session type:

Table 69. 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 (1) (RF_PWD_1, RF_PWD_2, RF_PWD_3)	RF user access to protected user memory as defined in RFA$_i$SS registers RF user write access to RF password 1, 2 or 3 (2)
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^{2}C	I^{2}C password (I2C_PWD)	I^{2}C host access to protected user memory as defined in I2CSS register I^{2}C host write access to configuration static registers I^{2}C host write access to I^{2}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-bits long, and default factory passwords value is 0000000000000000h.

The ST25DVxxx passwords management is organized around RF and I^{2}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 7.6.35: Write 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.

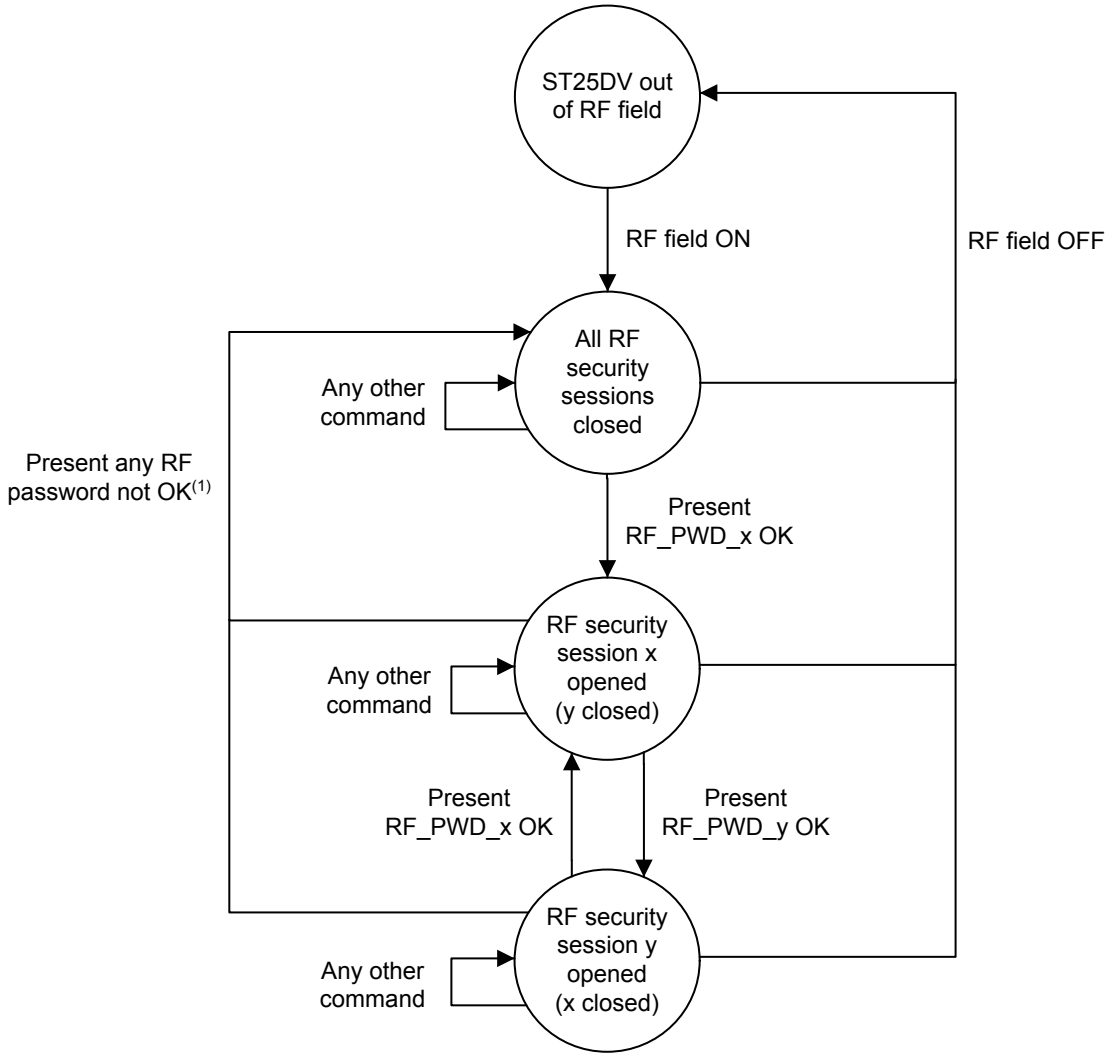
Opening any new RF security session (user or configuration) automatically close the previously open one (even if it fails).

There is no interaction between I^{2}C and RF security sessions. Both are independent, and can run in parallel.

Caution: *If ST25DVxxx is powered through V_{CC}, removing V_{CC} during a RF 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}, 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 22. RF security sessions management



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

The dedicated password commands in I^2C mode are:

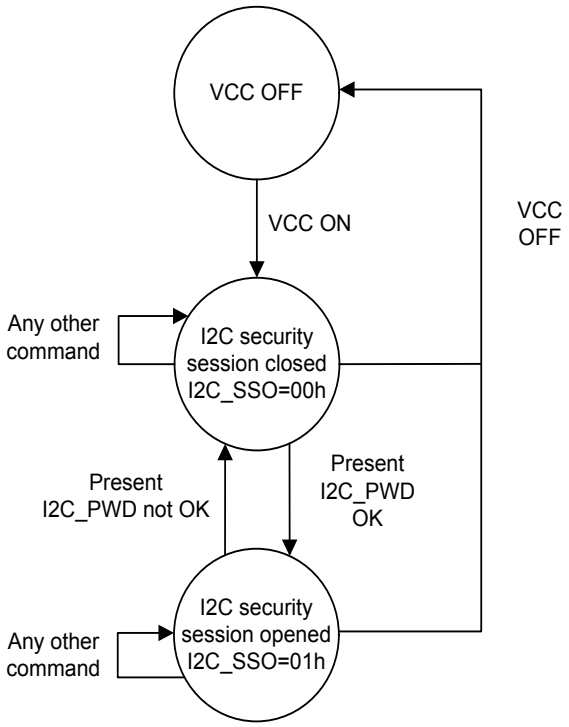
- I^2C Write Password command: see Section 6.6.2: I2C write password command description.
- I^2C Present Password command: see Section 6.6.1: I2C present password command description.

I^2C host possible actions for security sessions are:

- **Open I^2C security session**: I^2C Present Password command with valid I^2C password.
- **Write I^2C password**: I^2C Present Password command with valid I^2C password. Then I^2C Write Password command with new I^2C password.
- **Close I^2C security session**: I^2C Present Password command with wrong I^2C password. Or remove tag V_{CC} power supply (POR).
- **Check if I^2C security session is open**: I^2C host can read the current status (open or closed) of I^2C security session by reading the I2C_SSO_Dyn register.

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

Figure 23. I²C 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 I²C.

Area 1 is always readable (from RF and I²C).

Furthermore, RF blocks 0 and 1 (I²C bytes 0000h to 0007h) can be independently write locked.

User memory protection from RF access

In RF mode, each memory area of the ST25DVxxx 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$_i$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 44. RFA1SS, Table 46. RFA2SS, Table 48. RFA3SS, and Table 50. RFA4SS for details about available read and write protections).

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

When updating RFA$_i$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.
  - A 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^2C host).

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

User memory protection from I^2C access

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

The I2CSS register is used to set protection against read and write operation for each area (see Table 52. 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^2C 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 will respond 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^2C 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^2C security session is open or closed.

For blocks 0 and 1 (Bytes 0000h to 0007h in I^2C 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^2C.

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

I^2C host doesn't have read or write access to RF passwords.

By default, I^2C 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^2C 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^2C).
- RF user cannot unlock system configuration if LOCK_CFG=01h, even after opening RF configuration security session (only I^2C 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^2C). 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^2C.

5.7 Device parameter registers

Table 70. LOCK_DSFID access

RF		I2C	
Command	Type	Address	Type
Lock DSFID (command code 2Ah)	WO if DSFID not locked	E2 = 1, 0010h	RO

Table 71. 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 11. System configuration memory map for the LOCK_DSFID register.

Table 72. LOCK_AFI access

RF		I2C	
Command	Type	Address	Type
Lock AFI (command code 28h)	WO if AFI not locked	E2 = 1, 0011h	RO

Table 73. 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 11. System configuration memory map for the LOCK_AFI register.

Table 74. DSFID access

RF		I2C	
Command	Type	Address	Type
Inventory (command code 01h) Get System Info (command code 2Bh) Ext Get System Info (command code 3Bh) Write DSFID (command code 28h)	R always, W if DSFID not locked	E2 = 1, 0012h	RO

Table 75. DSFID

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

Note: Refer to Table 11. System configuration memory map for the DSFID register.

Table 76. AFI access

RF		I2C	
Command	Type	Address	Type
Inventory (command code 01h) Get System Info (command code 2Bh) Ext Get System Info (command code 3Bh) Write AFI (command code 27h)	R always, W if AFI not locked	E2 = 1, 0013h	RO

Table 77. AFI

Bit	Name	Function	Factory value
b7-b0	AFI	ISO/IEC 15693 application family identifier	00h

Note: Refer to Table 11. System configuration memory map for the AFI register.

Table 78. MEM_SIZE access

RF		I2C	
Command	Type	Address	Type
Get System Info (command code 2Bh) (1) Ext Get System Info (command code 3Bh)	RO	E2=1, 0014h to 0015h	RO

1. *Only ST25DV04K-IE and ST25DV04K-JF*

Table 79. MEM_SIZE

I²C address	Bit	Name	Function	Factory value
0014h	b7-b0	MEM_SIZE	Address 0014h: LSB byte of the memory size expressed in RF blocks	ST25DV04K-xx: 7Fh ST25DV16K-xx: FFh ST25DV64K-xx: FFh
0015h	b7-b0		Address 0015h: MSB byte of the memory size expressed in RF blocks	ST25DV04K-xx: 00h ST25DV16K-xx: 01h ST25DV64K-xx: 07h

Note: Refer to Table 11. System configuration memory map for the MEM_SIZE register.

Table 80. BLK_SIZE access

RF		I2C	
Command	Type	Address	Type
Get System Info (command code 2Bh) (1) Ext Get System Info (command code 3Bh)	RO	E2 = 1, 0016h	RO

1. *Only ST25DV04K-IE and ST25DV04K-JF*

Table 81. BLK_SIZE

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

Note: Refer to Table 11. System configuration memory map for the BLK_SIZE register.

Table 82. IC_REF access

RF		I2C	
Command	Type	Address	Type
Get System Info (command code 2Bh) Ext Get System Info (command code 3Bh)	RO	E2 = 1, 0017h	RO

Table 83. IC_REF

Bit	Name	Function	Factory value
b7-b0	IC_REF	ISO/IEC 15693 IC reference	ST25DV04K-IE: 24h ST25DV16K-IE: 26h ST25DV64K-IE: 26h ST25DV04K-JF: 24h ST25DV16K-JF: 26h ST25DV64K-JF: 26h

Note: Refer to Table 11. System configuration memory map for the IC_REF register.

Table 84. UID access

RF		I2C	
Command	Type	Address	Type
Inventory (command code 01h) Get System Info (command code 2Bh) Ext Get System Info (command code 3Bh)	RO	E2=1, 0018h to 001Fh	RO

Table 85. UID

I²C address	Bit	Name	Function	Factory value
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	ST25DV04K-IE: 24h ST25DV16K-IE: 26h ST25DV64K-IE: 26h ST25DV04K-JF: 25h ST25DV16K-JF: 27h ST25DV64K-JF: 27h
001Eh			ISO/IEC 15693 UID byte 6: IC manufacturing code	02h
001Fh			ISO/IEC 15693 UID byte 7 (MSB)	E0h

Note: Refer to Table 11. System configuration memory map for the UID register.

Table 86. IC_REV access

RF		I2C	
Command	Type	Address	Type
No access		E2 = 1, 0020h	RO

Table 87. IC_REV

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

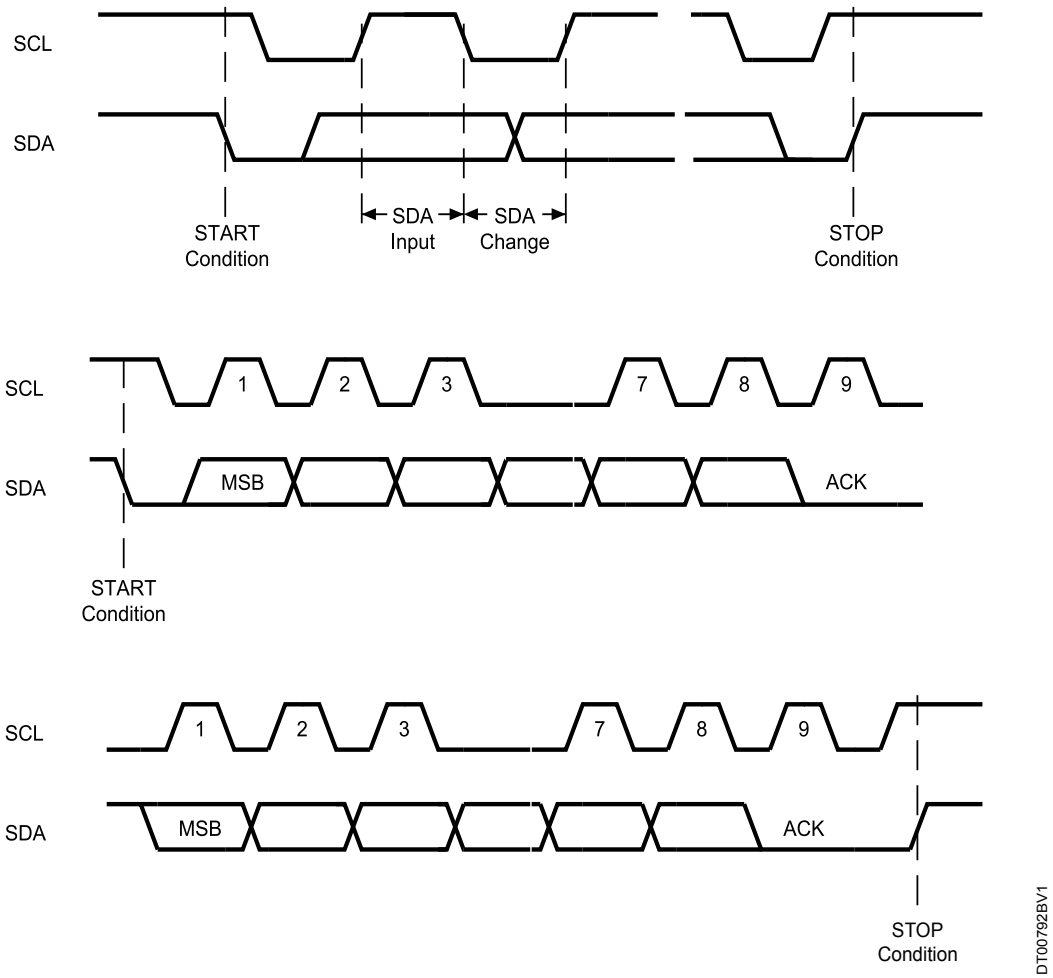
Note: Refer to Table 11. System configuration memory map for the IC_REV register.

6 I2C operation

6.1 I2C protocol

The device supports the I²C protocol. This is summarized in Figure 24. I²C 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 ST25DVxxx device is a slave in all communications.

Figure 24. I²C 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 controller. 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 controller or a target device, releases the serial data (SDA) after sending eight bits of data. During the ninth 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 I2C timeout

During the execution of an I²C operation, RF communications are not possible.

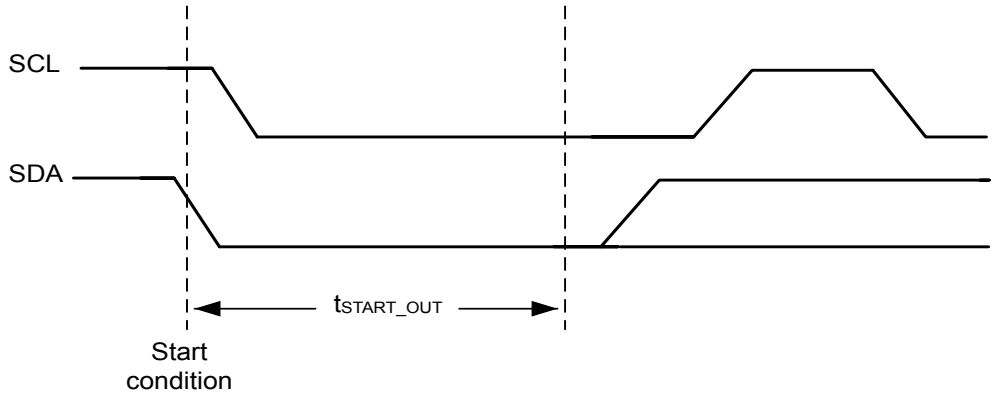
To prevent RF communication freezing due to inadvertent indeterminate instructions sent to the I²C bus, the ST25DVxxx features a timeout mechanism that automatically resets the I²C logic block.

6.2.1 I2C timeout on Start condition

I²C 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_{START_OUT} time (see Section 9.2: I²C parameters and Section 9.2: I²C parameters), the I²C logic block is reset and further incoming data transfer is ignored until the next valid Start condition.

Figure 25. I²C timeout on Start condition



6.2.2 I2C timeout on clock period

During data transfer on the I²C bus, if the serial clock pulse width high (t_{CHCL}) or serial clock pulse width low (t_{CLCH}) exceeds the maximum value specified in Section 9.2: I²C parameters and Section 9.2: I²C parameters, the I²C 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 Table 88. Device select code (on Serial Data (SDA), the most significant bit first).

The device select code consists of a 4-bit device type identifier and a 3-bit Chip Enable “Address” (E2,1,1). To address the memory array, the 4-bit device type identifier is 1010b. Refer to Table 88. Device select code.

The eighth bit is the Read/Write bit ($R\overline{W}$). It is set to 1 for Read and to 0 for Write operations.

Table 88. Device select code

	Device type identifier (1)				Chip Enable address			$R\overline{W}$
	b7	b6	b5	b4	b3	b2	b1	b0
Device select code	1	0	1	0	E2(2)	1	1	$R\overline{W}$

1. *The most significant bit, b7, is sent first.*
2. *E2 is not connected to any external pin. It is however used to address the ST25DVxxx as described in Section 4: Memory management.*
   - *E2 = 0, access to user memory, Dynamic registers or Mailbox.*
   - *E2 =1, access to system area.*

If a match occurs on the device select code, the corresponding device gives an acknowledgment 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 89. 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 I2C 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 it, 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 90) is sent first, followed by the least significant byte (see Table 91). Bits b15 to b0 form the address of the byte in memory.

Table 90. Address most significant byte

b15	b14	b13	b12	b11	b10	b9	b8

Table 91. 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 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, the device enters in I2C dead state: the internal address counter is not incremented, and the device waits for a full new I2C instruction (address counter stops to be incremented after the first NoAck bit).

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

Caution: *I^2C Writing data in user or system memory (EEPROM), transit via the 256-byte fast transfer mode's buffer. Consequently fast transfer mode must be deactivated before starting any write operation in user or system memory, otherwise the command is NotACK, programming is not done and device goes in Standby mode.*

6.4.1 I2C 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 26. Write mode sequences when write is not inhibited).

For byte write in EEPROM (user memory or system configuration), internal programming starts after the Ack, for a duration of t_W (as defined in Section 9.2: I^2C parameters and Section 9.2: I^2C parameters).

For writes in fast transfer mode buffer or Dynamic registers, internal programming is done at the Ack.

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 27. 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^2C 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^2C 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 I2C Sequential write

The I^2C sequential write allows up to 256 bytes to be written in one command, provided they are all located in the same user memory area or 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 last Ack, 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 at the Ack.
- If some bytes have been NotAck'ed, no internal programming is done (0 byte written).

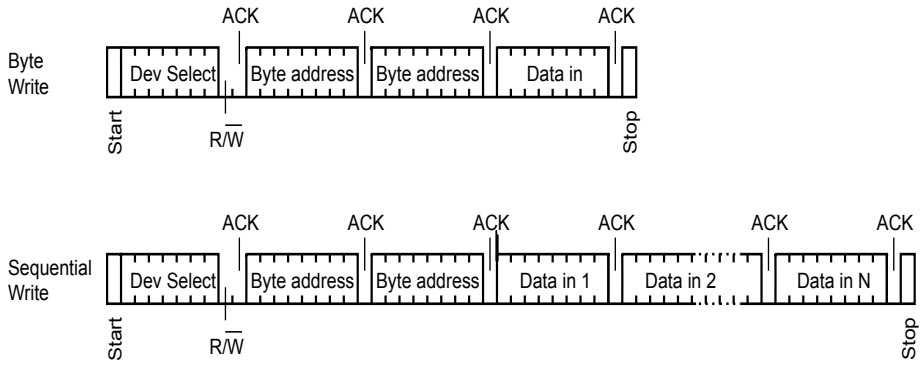
Byte write is inhibited if byte complies with conditions described in Section 6.4.1: I2C Byte write, in addition:

- 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.

EEPROM memory (user memory and system configuration) is internally organized in pages of 4 bytes long. Data located in a same page all share the same most significant memory address bits b16-b2.

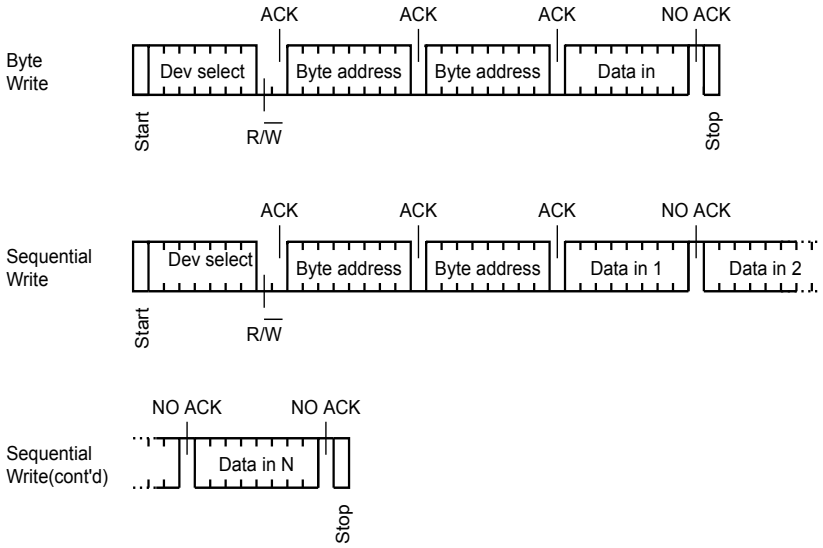
I²C sequential write programming time in the EEPROM memory is dependent on this internal organization: total programming time is the I²C write time t_W (as defined in Section 9.2: I²C parameters and Section 9.2: I²C parameters) multiplied by the number of internal EEPROM pages where the data must be programmed, including incomplete pages. For example, a 256 Bytes I²C sequential write, starting at address 0002h will write data over 65 pages. Total write time in this case is t_W x 65.

Figure 26. Write mode sequences when write is not inhibited



Note: N ≤ 256

Figure 27. Write mode sequences when write is inhibited



Note: N ≤ 256

6.4.3 Minimizing system delays by polling on ACK

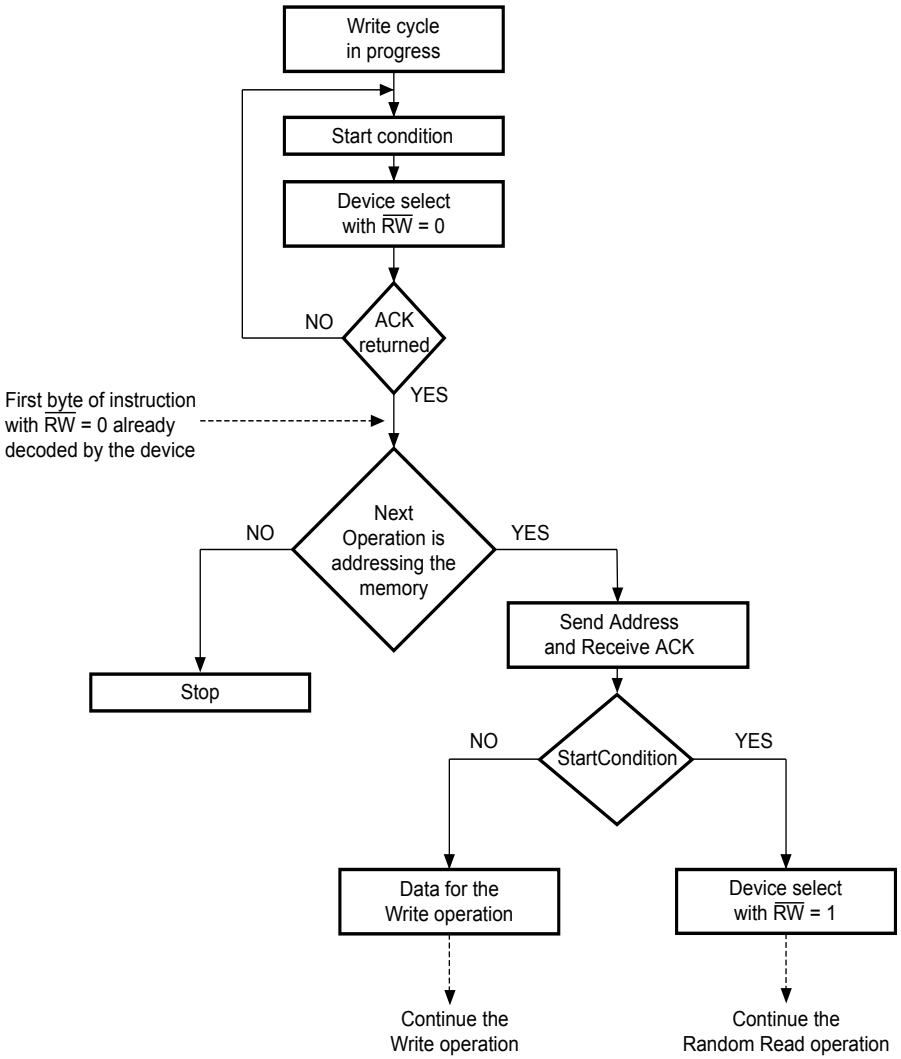
During the internal write cycle, the device disconnects itself from the bus, and writes a copy of the data from its internal latches to the memory cells. The maximum I²C write time (t_w) is shown in Section 9.2: I²C parameters and Section 9.2: I²C parameters, but the typical time is shorter. To make use of this, a polling sequence can be used by the bus master.

The sequence, as shown in Figure 28, 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 28. Write cycle polling flowchart using ACK



6.5 I2C read operations

Read operation in user memory is performed successfully only if:

- Area to which the byte belongs is not read protected by I2CSS register.
- Area to which the byte belongs is read protected by I2CSS register, but I^2C 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^2C 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, ST25DVxxx releases the bus and I²C 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, ST25DVxxx enters in I²C dead state: internal address counter is not incremented, and ST25DVxxx is waiting for a full new I²C instruction.

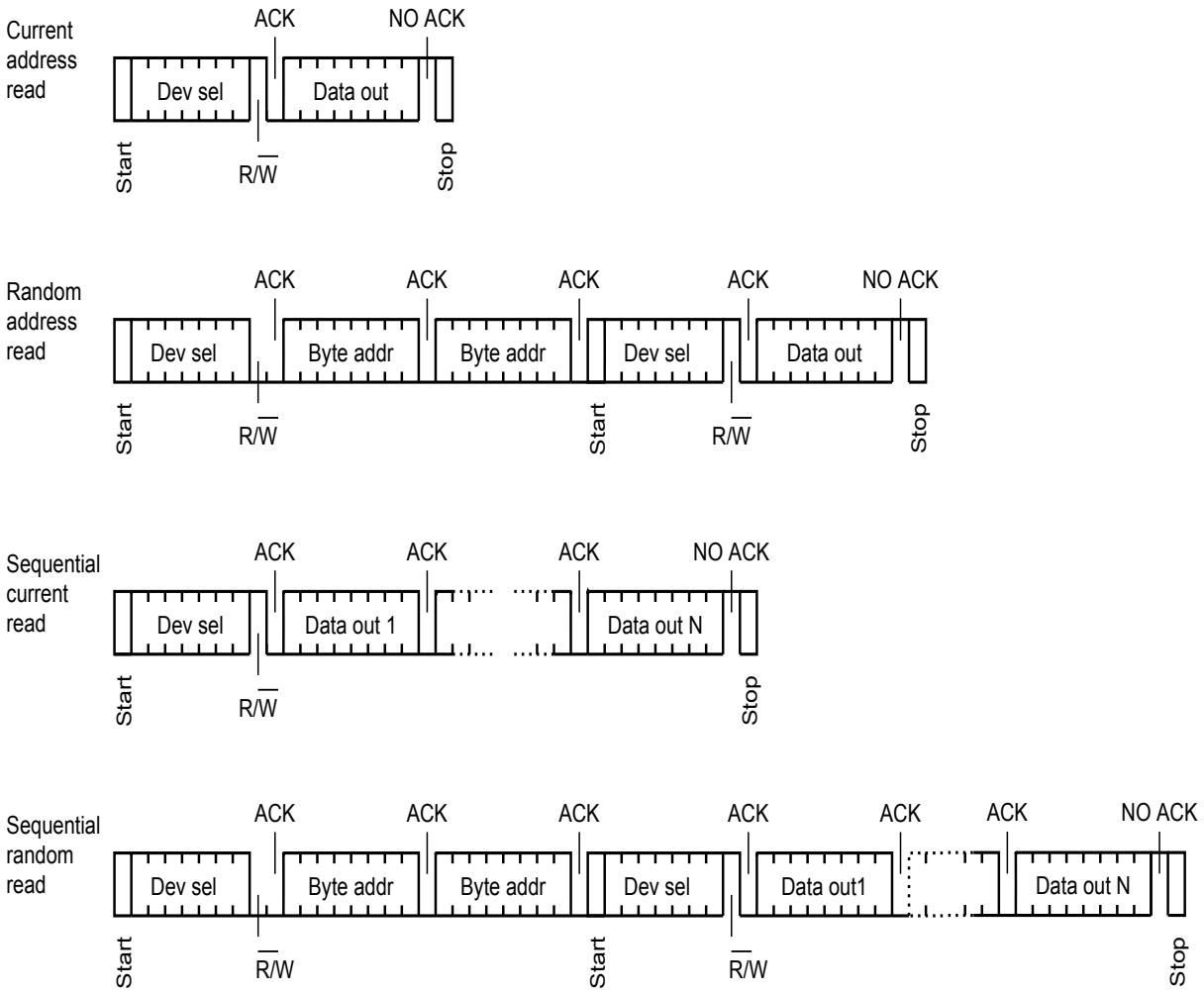
6.5.1 Random Address Read

A dummy write is first performed to load the address into this address counter (as shown in Figure 29. Read mode sequences) but without sending a Stop condition. Then, the bus master sends another Start condition, and repeats the device select code, with the Read/Write bit (R/W) 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 (R/W) 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 Figure 29. Read mode sequences, without acknowledging the byte.

Figure 29. 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 29. 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 cannot cross area borders. After reaching area border, device continues to output FFh
- There is no roll over inside area or at the end of user memory (ST25DVxxx returns only FFh after last user memory byte address).

Sequential read in system memory:

- There is no roll over after reaching end of system memory (ST25DVxxx returns only FFh after last system memory byte address).
- Sequential read in dynamic registers:
- It is possible to read sequentially dynamic registers and fast transfer mode's mailbox (contiguous I^2C addresses).

Sequential read in dynamic registers:

- There is no roll over at the end of the mailbox (ST25DVxxx returns only FFh after last system 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 I2C password management

The ST25DVxxx controls I^2C security session using an I^2C 64-bit password. This I^2C password is managed with two I^2C dedicated commands: I^2C present password and I^2C write password.

6.6.1 I2C present password command description

The I^2C present password command is used in I^2C mode to present the password to the ST25DVxxx. This is used to open I^2C security session or to allow I^2C password modification (see Section 5.6: Data Protection for detailed explanation about password usage).

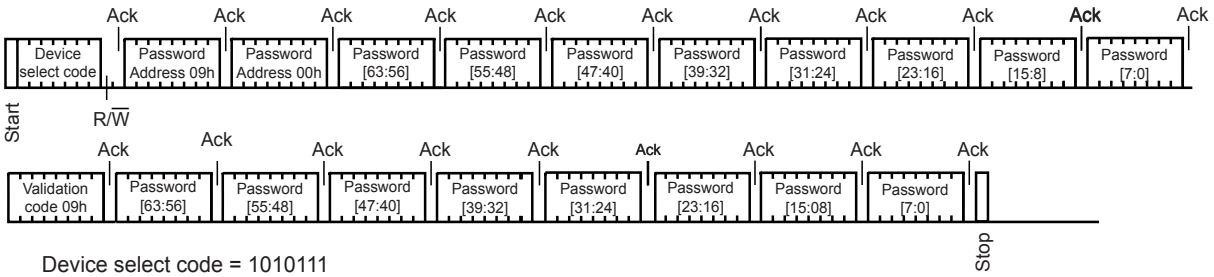
Following a Start condition, the bus master sends a device select code with the Read/$\overline{\text{Write}}$ bit (R$\overline{\text{W}}$) reset to 0 and the Chip Enable bit E2 at 1. The device acknowledges this, as shown in Figure 30. I^2C Present Password Sequence, and waits for two I^2C password 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 ST25DVxxx 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 ST25DVxxx compares the 64 received data bits with the 64 bits of the stored I^2C password. If the values match, the I^2C security session is open, and the I2C_SSO_Dyn register is set to 01h. If the values do not match, the I^2C 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^2C host to know If I^2C security session is open.

Figure 30. I²C Present Password Sequence



Device select code = 1010111
Ack generated during 9th bit time slot.

6.6.2 I2C write password command description

The I²C write password command is used to update the I²C password value (register I2C_PWD). It cannot be used to update any of the RF passwords. After the write cycle, the new I²C password value is automatically activated. The I²C password value can only be modified after issuing a valid I²C present password command.

Following a Start condition, the bus master sends a device select code with the Read/$\overline{\text{Write}}$ bit (R$\overline{\text{W}}$) reset to 0 and the Chip Enable bit E2 at 1. The device acknowledges this, as shown in Figure 31. I²C Write Password Sequence, and waits for the two I²C 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.

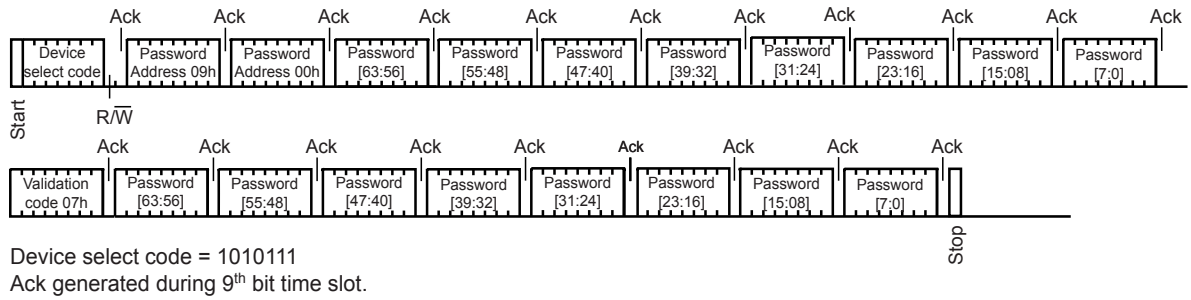
It is necessary to send twice the 64-bit password to prevent any data corruption during the write sequence. If the two 64-bit passwords sent are not exactly the same, the ST25DVxxx does not modify the I²C password value.

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: *I²C write password command data transits via the 256-Bytes 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 31. I²C Write Password Sequence



Device select code = 1010111
Ack generated during 9th bit time slot.

7 RF operation

Contactless exchanges are performed in RF mode as specified by ISO/IEC 15693 or NFC Forum Type 5. The ST25DVxxx communicate via the 13.56 MHz carrier electromagnetic wave, on which incoming data are demodulated from the received signal amplitude modulation (ASK: amplitude shift keying). The received ASK wave is 10% or 100% modulated, with a data rate of 1.6 Kbit/s using the 1/256 pulse coding mode, or a data rate of 26 Kbit/s using the 1/4 pulse coding mode.

Outgoing data are generated by the ST25DVxxx load variation using Manchester coding with one or two subcarrier frequencies at 423 and 484 kHz. Data are transferred from the ST25DVxxx at 6.6 Kbit/s in low data rate mode, at 26 Kbit/s in high data rate mode. The ST25DVxxx supports 53 Kbit/s in high data rate mode in one subcarrier frequency at 423 kHz.

The ST25DVxxx follows ISO/IEC 15693 or NFC Forum Type 5 recommendations for radio-frequency power and signal interface and for anticollision and transmission protocol.

7.1 RF communication

7.1.1 Access to an ISO/IEC 15693 device

The dialog between the “RF reader” and the ST25DVxxx takes place as follows:

- device activation by the RF operating field of the reader
- transmission of a command by the reader (the device detects carrier amplitude modulation)
- transmission of a response by the device using load modulation

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

Operating field

The ST25DVxxx operates continuously between the minimum and maximum values of the electromagnetic field H defined in Table 253. RF characteristics. The reader must generate a field within these limits.

Power transfer

Power is transferred to the ST25DVxxx by radio frequency at 13.56 MHz via coupling antennas. The RF operating field of the reader is transformed on the device antenna into an AC voltage, which is rectified, filtered and internally regulated. During communication, the amplitude modulation (ASK) on this received signal is demodulated by the ASK demodulator

Frequency

The ISO 15693 standard defines the carrier frequency (f_C) of the operating field as 13.56 MHz ±7 kHz.

7.2 RF communication and energy harvesting

As the current consumption can affect the AC signal delivered by the antenna, RF communications with ST25DVxxx are not guaranteed during voltage delivery on the energy harvesting analog output V_EH.

RF communication can disturb and possibly stop Energy Harvesting mode.

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 ST25DVxxx in both directions. It is based on the concept of “VCD talks first”.

This means that a ST25DVxxx 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:

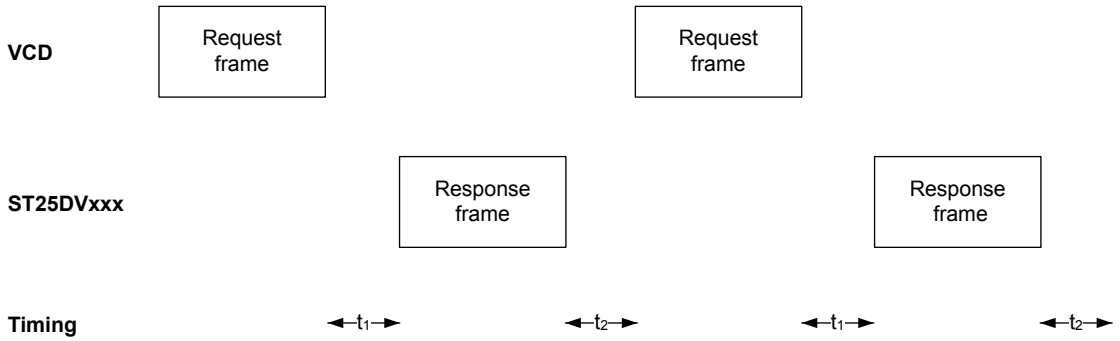
- a request from the VCD to the ST25DVxxx,
- a response from the ST25DVxxx to the VCD.

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 32. ST25DVxxx protocol timing



7.4.2 ST25DVxxx states referring to RF protocol

The ST25DVxxx can be in one of four states:

- Power-off
- Ready
- Quiet
- Selected

Transitions between these states are specified in Figure 33. ST25DVxxx state transition diagram and Table 92. ST25DVxxx response depending on Request_flags.

Power-off state

The ST25DVxxx is in the Power-off state when it does not receive enough energy from the VCD.

Ready state

The ST25DVxxx is in the Ready state when it receives enough energy from the VCD. When in the Ready state, the ST25DVxxx answers any request where the Select_flag is not set.

Quiet state

When in the Quiet state, the ST25DVxxx answers any request with the Address_flag set, except for Inventory requests.

Selected state

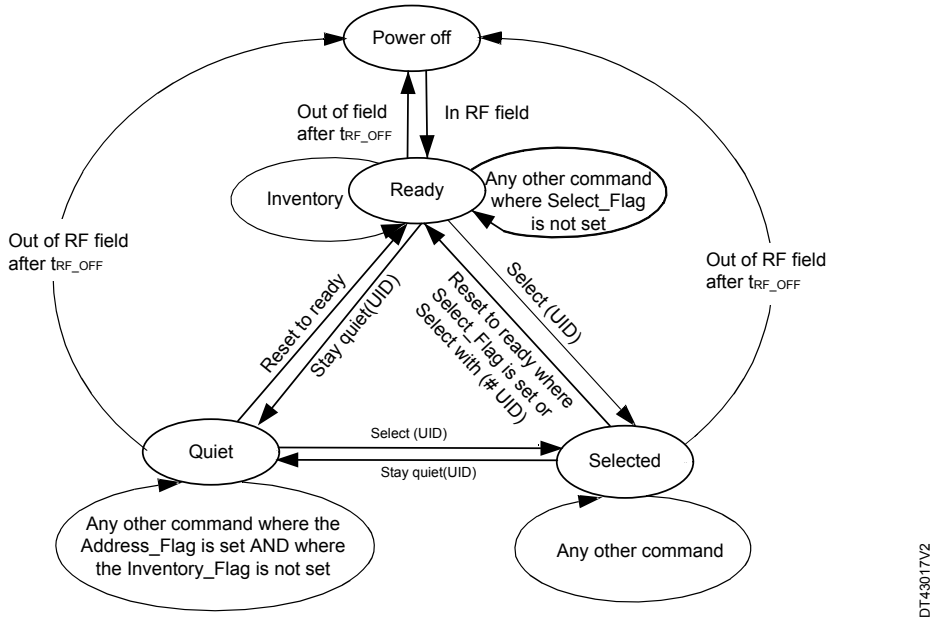
In the Selected state, the ST25DVxxx answers any request in all modes (see Section 7.4.3: Modes):

- 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 92. ST25DVxxx response depending on Request_flags

Flags	Address_flag		Select_flag	
	1 Addressed	0 Non addressed	1 Selected	0 Non selected
ST25DVxxx in Ready or Selected state (Devices in Quiet state do not answer)	-	X	-	X
ST25DVxxx in Selected state	-	X	X	-
ST25DVxxx in Ready, Quiet or Selected state (the device which matches the UID)	X	-	-	X
Error (03h) or no response (command dependent)	X	-	X	-

Figure 33. ST25DVxxx state transition diagram



1. The ST25DVxxx 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 ST25DVxxx 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 ST25DVxxx 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 ST25DVxxx.

Any ST25DVxxx that receives a request with the Address_flag set to 1 compares the received Unique ID to its own. If it matches, then the ST25DVxxx 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 ST25DVxxx 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 ST25DVxxx in the Selected state answers a request where the Select_flag is set to 1.

The system design ensures that only one ST25DVxxx 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 93. General request format

SOF	Request_flags	Command code	Parameters	Data	2 bytes CRC	EOF

7.4.5 Request flags

In a request, the “flags” field specifies the actions to be performed by the ST25DVxxx 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 ST25DVxxx selection criteria. When bit 3 is set (1), bits 5 to 8 define the ST25DVxxx Inventory parameters.

Table 94. Definition of request flags 1 to 4

Bit No	Flag	Level	Description
Bit 1	Subcarrier_flag (1)	0	A single subcarrier frequency is used by the ST25DVxxx
		1	Two subcarriers are used by the ST25DVxxx
Bit 2	Data_rate_flag (2)	0	Low data rate is used
		1	High data rate is used
Bit 3	Inventory_flag	0	The meaning of flags 5 to 8 is described in Table 95. Request flags 5 to 8 when inventory_flag, Bit 3 = 0
		1	The meaning of flags 5 to 8 is described in Table 96. Request flags 5 to 8 when inventory_flag, Bit 3 = 1
Bit 4	Protocol_extension_flag	0	No Protocol format extension
		1	Protocol format extension. Reserved for future use.

1. *Subcarrier_flag refers to the ST25DVxxx-to-VCD communication.*
2. *Data_rate_flag refers to the ST25DVxxx-to-VCD communication.*

Table 95. Request flags 5 to 8 when inventory_flag, Bit 3 = 0

Bit nb	Flag	Level	Description
Bit 5	Select flag (1)	0	The request is executed by any ST25DVxxx according to the setting of Address_flag
		1	The request is executed only by the ST25DVxxx in Selected state
Bit 6	Address flag	0	The request is not addressed. UID field is not present. The request is executed by all ST25DVxxxs.
		1	The request is addressed. UID field is present. The request is executed only by the ST25DVxxx 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 96. 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 97. 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 ST25DVxxx and whether corresponding fields are present or not. The response flags consist of eight bits.

Table 98. Definitions of response flags 1 to 8

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

7.4.8 Response and error code

If the Error_flag is set by the ST25DVxxx in the response, the Error code field is present and provides information about the error that occurred.

Error codes not specified in Table 99 are reserved for future use.

Table 99. 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_1: ST25DVxxx response delay

Upon detection of the rising edge of the EOF received from the VCD, the ST25DVxxx 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 100. Timing values.

t_2: VCD new request delay

t_2 is the time after which the VCD may send an EOF to switch to the next slot when one or more ST25DVxxx responses have been received during an Inventory command. It starts from the reception of the EOF from the ST25DVxxxs.

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 ST25DVxxx.

t_2 is also the time after which the VCD may send a new request to the ST25DVxxx, as described in Figure 32. ST25DVxxx protocol timing.

Values of t_2 are given in Table 100. Timing values.

t_3: VCD new request delay when no response is received from the ST25DVxxx

t_3 is the time after which the VCD may send an EOF to switch to the next slot when no ST25DVxxx 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 ST25DVxxx.

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 100. Timing values

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

1. *VCD request will not be interpreted during the first milliseconds following the RF field rising.*
2. *t_{1max} does not apply for write-alike requests. Timing conditions for write-alike requests are defined in the command description.*
3. *t_{SOF} is the time taken by the ST25DVxxx to transmit an SOF to the VCD. t_{SOF} depends on the current data rate: High data rate or Low data rate.*
4. *t_{NRT} is the nominal response time of the ST25DVxxx. t_{NRT} depends on V_{ICC} to ST25DVxxx data rate and subcarrier modulation mode.*

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

7.6 RF commands

7.6.1 RF command code list

The ST25DVxxx supports the following legacy and extended RF command set:

- **Inventory**, used to perform the anticollision sequence.
- **Stay Quiet**, used to put the ST25DVxxx in quiet mode, where it does not respond to any inventory command.
- **Select**, used to select the ST25DVxxx. After this command, the ST25DVxxx processes all Read/Write commands with Select_flag set.
- **Reset To Ready**, used to put the ST25DVxxx 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 ouput 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 ST25DVxxx supports the commands described in this section. Their codes are given in Table 101. Command codes.

Table 101. 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	AEh	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
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
2Ah	Lock DSFID	CDh	Fast Read Dynamic configuration
2Bh	Get System Info	CEh	Fast Write Dynamic Configuration
2Ch	Get Multiple Block Security Status	-	-
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 will describe the expected behavior for each command.

But in case of an invalid command, in a general manner, the ST25DVxxx will behave as follows:

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

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

- if select flag and address flags are not set at the same time (except if ST25DVxxx is in quiet state)
- if select flag is set and ST25DVxxx is in selected state.

For all other commands, if I^2C is busy, no response will be issued by ST25DVxxx.

7.6.4 Inventory

Upon receiving the Inventory request, the ST25DVxxx runs the anticollision sequence. The Inventory_flag is set to 1. The meaning of flags 5 to 8 is shown in Table 96. 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 ST25DVxxx does not generate any answer in case of error.

Table 102. 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 103. 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 ST25DVxxx response, it waits for a time t_3 before sending an EOF to switch to the next slot. t_3 starts from the rising edge of the request EOF sent by the VCD.

- If the VCD sends a 100% modulated EOF, the minimum value of t_3 is:
  $t_3min = 4384/f_C$ (323.3µs) + t_{SOF}
- If the VCD sends a 10% modulated EOF, the minimum value of t_3 is:
  $t_3min = 4384/f_C$ (323.3µs) + t_{NRT} + t_{2min}

where:

- t_{SOF} is the time required by the ST25DVxxx to transmit an SOF to the VCD,
- t_{NRT} is the nominal response time of the ST25DVxxx.

t_{NRT} and t_{SOF} are dependent on the ST25DVxxx-to-VCD data rate and subcarrier modulation mode.

Note: In case of error, no response is sent by ST25DVxxx.

7.6.5 Stay Quiet

On receiving the Stay Quiet command, the ST25DVxxx 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 ST25DVxxx does not process any request if the Inventory_flag is set,
- the ST25DVxxx processes any Addressed request.

The ST25DVxxx exits the Quiet state when:

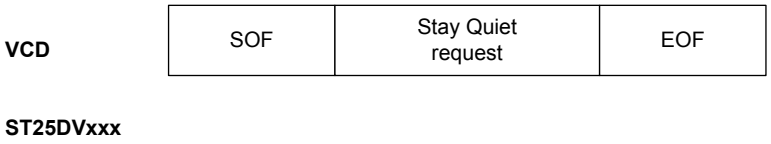
- it is reset (power off),
- receiving a Select request. It then goes to the Selected state,
- receiving a Reset to Ready request. It then goes to the Ready state.

Table 104. **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 34. **Stay Quiet frame exchange between VCD and ST25DVxxx**



7.6.6 Read Single Block

On receiving the Read Single Block command, the ST25DVxxx 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 the first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 105. **Read Single Block request format**

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

1. *This the field is optional.*

Request parameters:

- Request flags
- UID (optional)
- Block number

Table 106. **Read Single Block response format when Error_flag is NOT set**

Response SOF	Response_flags	Block security status (1)	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. *This field is optional.*

Response parameters:

- Block security status if Option_flag is set (see Table 107. Block security status)
- Four bytes of block data

Table 107. **Block security status**

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

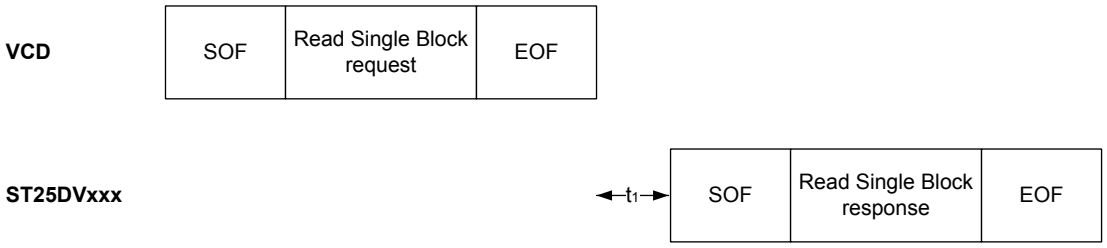
Table 108. Read Single Block response format when Error_flag is set

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 35. Read Single Block frame exchange between VCD and ST25DVxxx



7.6.7 Extended Read Single Block

On receiving the Extended Read Single Block command, the ST25DVxxx 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 ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 109. Extended Read Single Block request format

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

1. *This field is optional.*

Request parameters:

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

Table 110. Extended Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status (1)	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. *This field is optional.*

Response parameters:

- Block security status if Option_flag is set (see Table 107. Block security status)
- Four bytes of block data

Table 111. Block security status

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

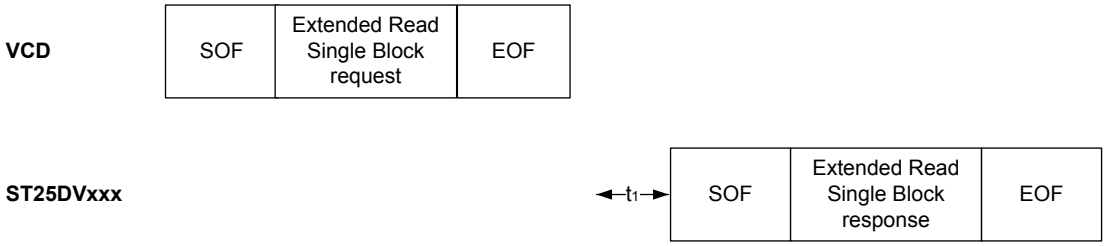
Table 112. Extended Read Single Block response format when Error_flag is set

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 36. Extended Read Single Block frame exchange between VCD and ST25DVxxx



7.6.8 Write Single Block

On receiving the Write Single Block command, the ST25DVxxx 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 ST25DVxxx may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 113. Write Single Block request format

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

1. *This field is optional.*

Request parameters:

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

Table 114. 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 115. Write Single Block response format when Error_flag is set

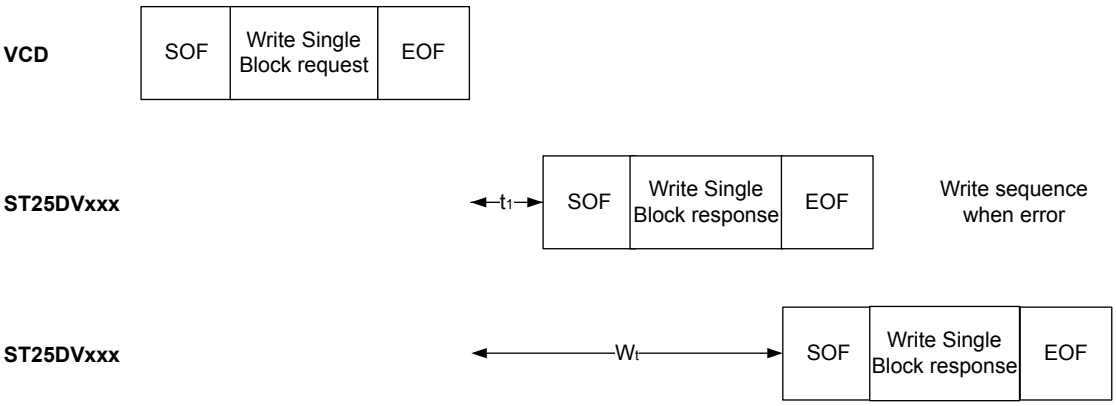
Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

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 7. Memory organization.

Figure 37. Write Single Block frame exchange between VCD and ST25DVxxx



7.6.9 Extended Write Single Block

On receiving the Extended Write Single command, the ST25DVxxx 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 ST25DVxxx may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 116. Extended Write Single request format

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

1. *This field is optional.*

Request parameters:

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

Table 117. 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.

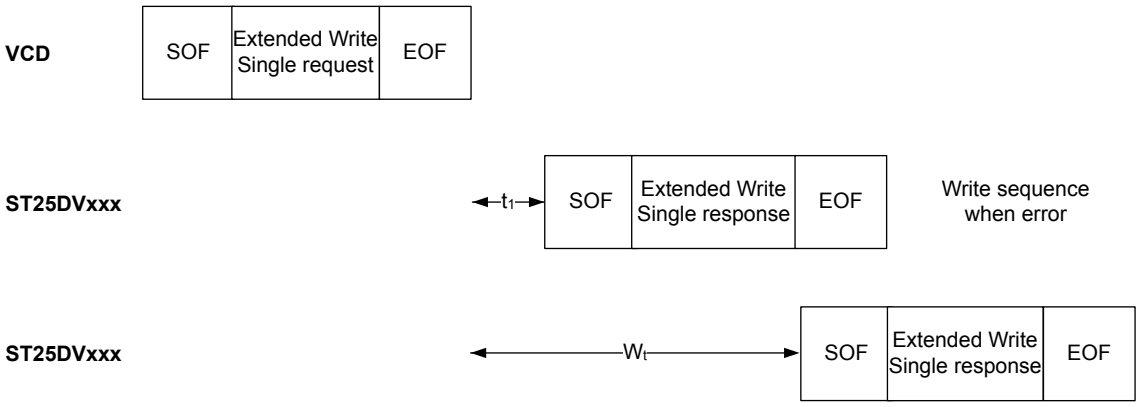
Table 118. Extended Write Single response format when Error_flag is set

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 38. **Extended Write Single frame exchange between VCD and ST25DVxxx**



7.6.10 Lock Block

On receiving the Lock block request, the ST25DVxxx 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$_i$SS 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 ST25DVxxx may not lock correctly the single block value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 119. **Lock block request format**

Request SOF	Request_flags	Lock block	UID (1)	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 120. **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

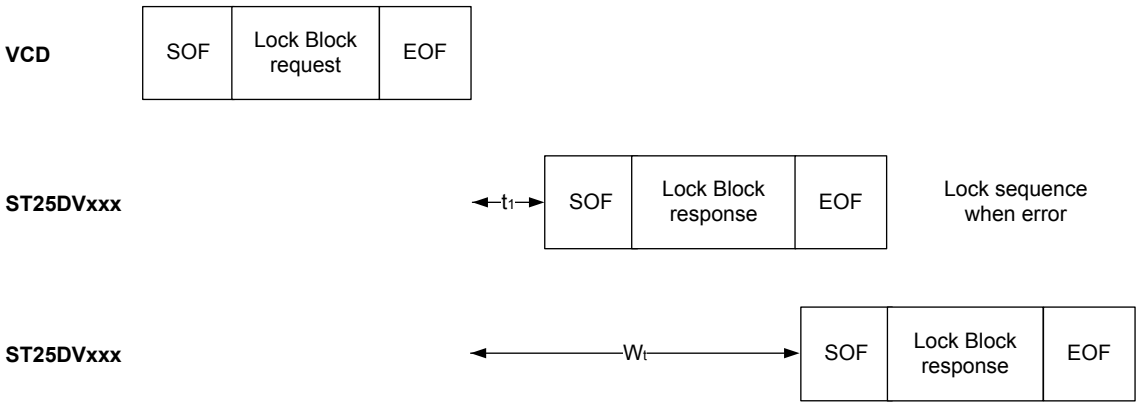
Table 121. **Lock block response format when Error_flag is set**

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 39. Lock Block frame exchange between VCD and ST25DVxxx



7.6.11 Extended Lock block

On receiving the extended Lock block request, the ST25DVxxx 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 ST25DVxxx may not lock correctly the single block value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 122. Extended Lock block request format

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

1. *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 123. 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

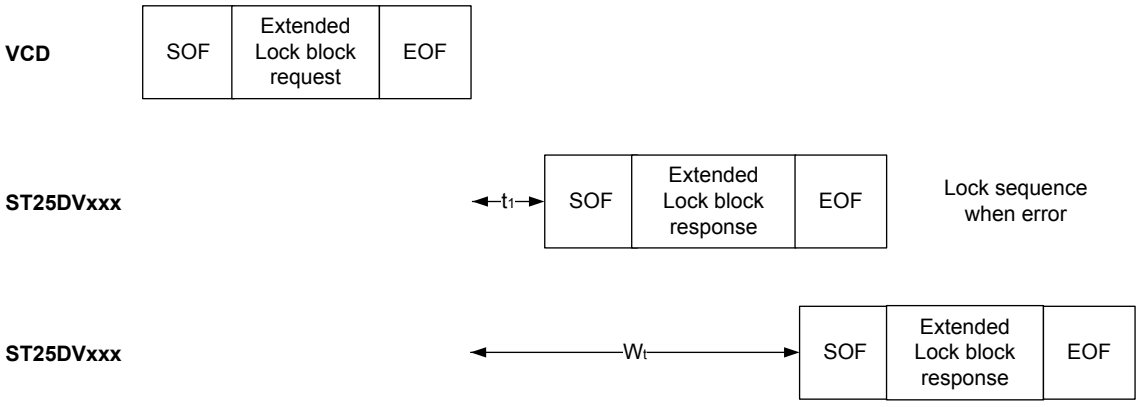
Table 124. Extended Lock block response format when Error_flag is set

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 40. Extended Lock block frame exchange between VCD and ST25DVxxx



7.6.12 Read Multiple Blocks

When receiving the Read Multiple Block command, the ST25DVxxx reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to FFh in the request and the value is minus one (–1) in the field. For example, if the “Number of blocks” field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed at 256 assuming that they are all located in the same area. If the number of blocks overlaps areas or overlaps the end of user memory, the ST25DVxxx returns an error code. When the Option_flag is set, the response returns the Block Security Status.

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 125. Read Multiple Block request format

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

1. *The field is optional.*

Request parameters:

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

Table 126. Read Multiple Block response format when Error_flag is NOT set

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

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

Response parameters:

- Block security status if Option_flag is set (see Table 127. Block security status)
- N blocks of data

Table 127. Block security status

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

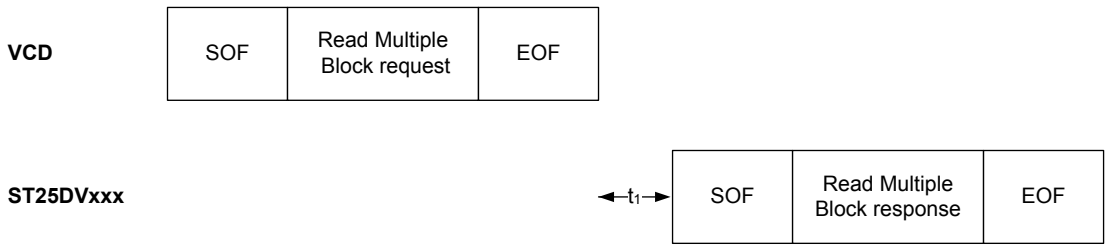
Table 128. Read Multiple Block response format when Error_flag is set

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 41. Read Multiple Block frame exchange between VCD and ST25DVxxx



7.6.13 Extended Read Multiple Blocks

When receiving the Extended Read multiple block command, the ST25DVxxx reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to last block of memory in the request and the value is minus one (-1) in the field. For example, if the “Number of blocks” field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed at 2047 assuming that they are all located in the same area. If the number of blocks overlaps areas or overlaps the end of user memory, the ST25DVxxx returns an error code. When the Option_flag is set, the response returns the Block Security Status.

The Inventory_flag must be set to 0.

Block number is coded on 2 Bytes so all memory blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 129. Extended Read Multiple Block request format

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

1. *This field is optional.*

Request parameters:

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

Table 130. Extended Read Multiple Block response format when Error_flag is NOT set

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

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

Response parameters:

- Block security status if Option_flag is set (see Table 131. Block security status)
- N blocks of data

Table 131. Block security status

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

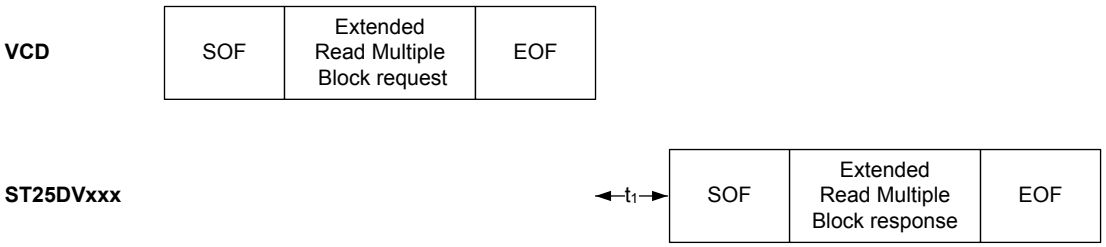
Table 132. Extended Read Multiple Block response format when Error_flag is set

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 42. **Extended Read Multiple Block frame exchange between VCD and ST25DVxxx**



7.6.14 Write Multiple Blocks

On receiving the Write Multiple Block command, the ST25DVxxx writes the data contained in the request to the requested blocks, and reports whether the write operation were successful in the response. ST25DVxxx supports up to 4 blocks, data field must be coherent with the number of blocks to program.

If some blocks overlaps areas, or overlap end of user memory, the ST25DVxxx returns an error code and none of the blocks are programmed. When the Option_flag is set, wait for EOF to respond. During the RF write cycle Wt, there should be no modulation (neither 100% nor 10%), otherwise the ST25DVxxx may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + m × 302 µs < 20 ms. (m is an integer, it is function of Nb number of blocks to be programmed).

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 133. **Write Multiple Block request format**

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

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

Request parameters:

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

Table 134. **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.

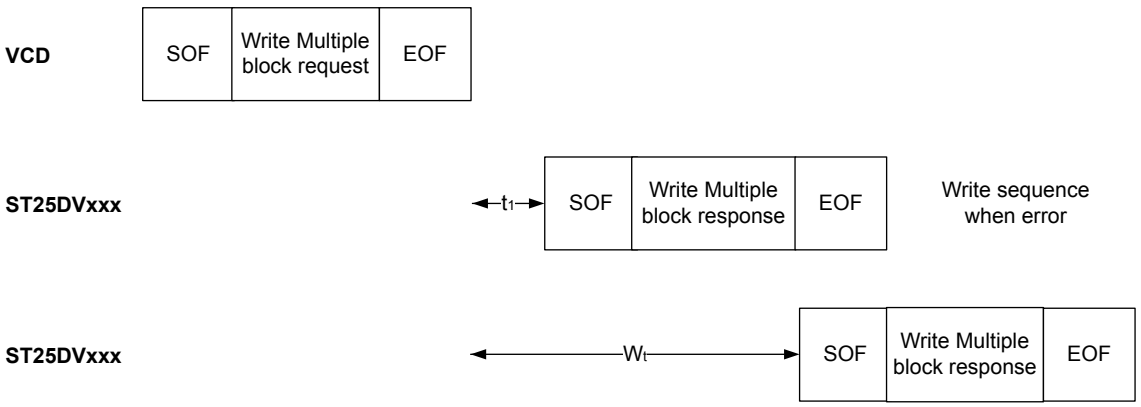
Table 135. Write Multiple Block response format when Error_flag is set

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 43. Write Multiple Block frame exchange between VCD and ST25DVxxx



7.6.15 Extended Write Multiple Blocks

On receiving this command, the device writes the data contained in the request to the targeted blocks and reports whether the write operation was successful in the response. ST25DVxxx supports up to four blocks, data field must be coherent with number of blocks to program.

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

When the Option_flag is set, wait for EOF to respond. During the RF write cycle Wt, there should be no modulation (neither 100% nor 10%), otherwise the ST25DVxxx may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + m × 302 µs < 20 ms (m is an integer function of Nb number of blocks to be programmed).

The inventory_flag must be set to 0.

Block number is coded on 2 bytes, so all memory blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 136. Extended Write Multiple Block request format

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

1. *This field is optional.*
2. *The number of blocks in the request is one less than the number of blocks that the VICC must 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 137. 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.

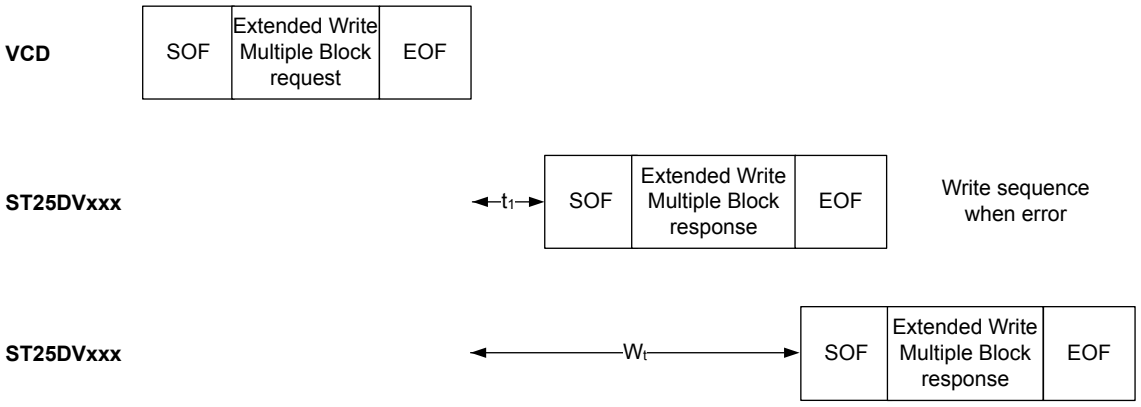
Table 138. Extended Write Multiple Block response format when Error_flag is set

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 44. Extended Write Multiple Block frame exchange between VCD and ST25DVxxx



7.6.16 Select

When receiving the Select command:

- If the UID is equal to its own UID, the ST25DVxxx enters or stays in the Selected state and sends a response.
- If the UID does not match its own UID, the selected ST25DVxxx returns to the Ready state and does not send a response.

The ST25DVxxx 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 ST25DVxxx remains in its current state.

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

Table 139. Select request format

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

Request parameter:

- UID

Table 140. 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

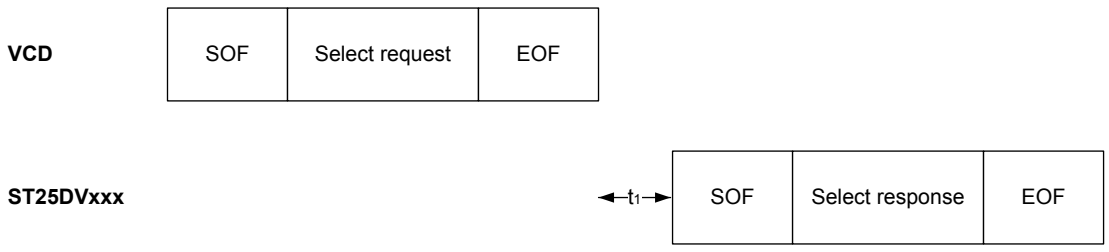
Table 141. Select response format when Error_flag is set

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 45. Select frame exchange between VCD and ST25DVxxx



7.6.17 Reset to Ready

On receiving a Reset to Ready command, the ST25DVxxx returns to the Ready state if no error occurs. In the Addressed mode, the ST25DVxxx 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 142. Reset to Ready request format

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

1. *This field is optional.*

Request parameter:

- UID (optional)

Table 143. 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

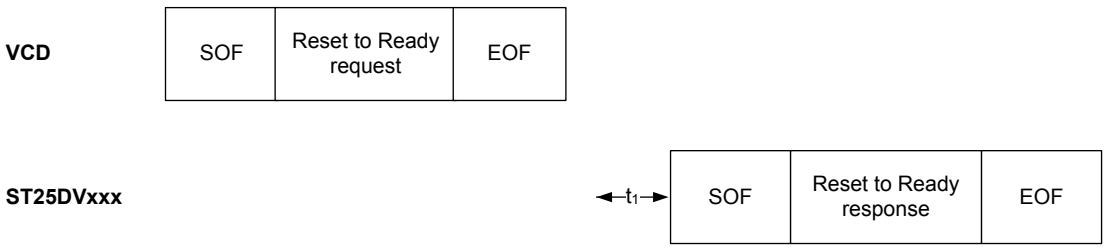
Table 144. Reset to ready response format when Error_flag is set

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 46. Reset to Ready frame exchange between VCD and ST25DVxxx



7.6.18 Write AFI

On receiving the Write AFI request, the ST25DVxxx 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 ST25DVxxx may not write correctly the AFI value into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 145. Write AFI request format

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)
- AFI

Table 146. 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

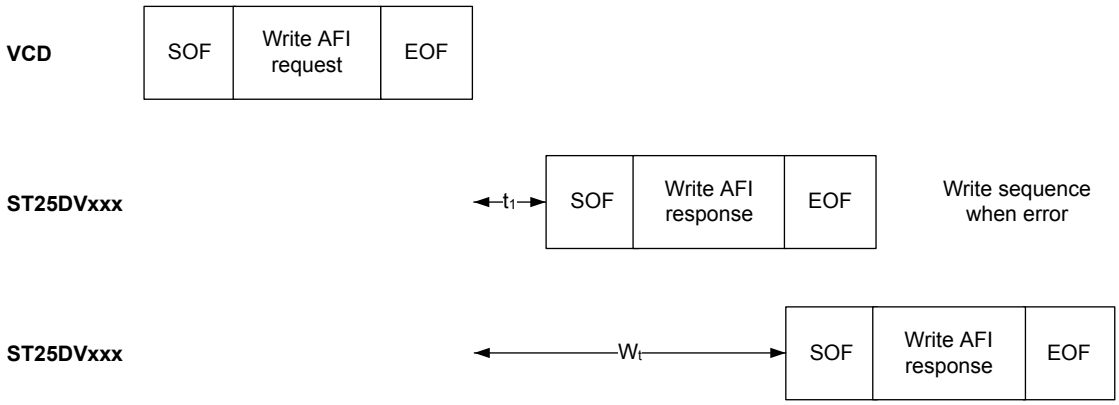
Table 147. Write AFI response format when Error_flag is set

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 47. **Write AFI frame exchange between VCD and ST25DVxxx**



7.6.19 Lock AFI

On receiving the Lock AFI request, the ST25DVxxx 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 ST25DVxxx may not lock correctly the AFI value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 148. **Lock AFI request format**

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

1. *This field is optional.*

Request parameter:

- Request Flags
- UID (optional)

Table 149. **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

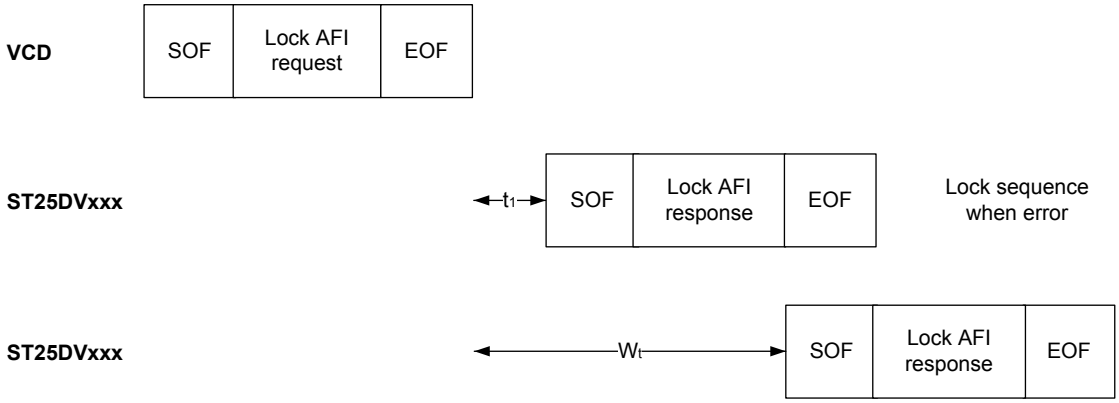
Table 150. **Lock AFI response format when Error_flag is set**

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 48. Lock AFI frame exchange between VCD and ST25DVxxx



7.6.20 Write DSFID

On receiving the Write DSFID request, the ST25DVxxx 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 ST25DVxxx may not write correctly the DSFID value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 151. Write DSFID request format

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)
- DSFID

Table 152. 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

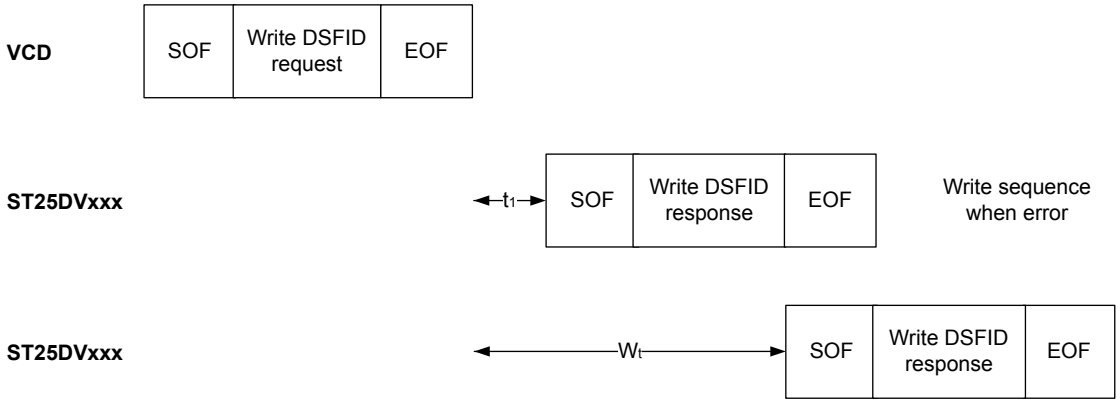
Table 153. Write DSFID response format when Error_flag is set

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 49. Write DSFID frame exchange between VCD and ST25DVxxx



7.6.21 Lock DSFID

On receiving the Lock DSFID request, the ST25DVxxx 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 ST25DVxxx may not lock correctly the DSFID value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 154. Lock DSFID request format

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)

Table 155. 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.

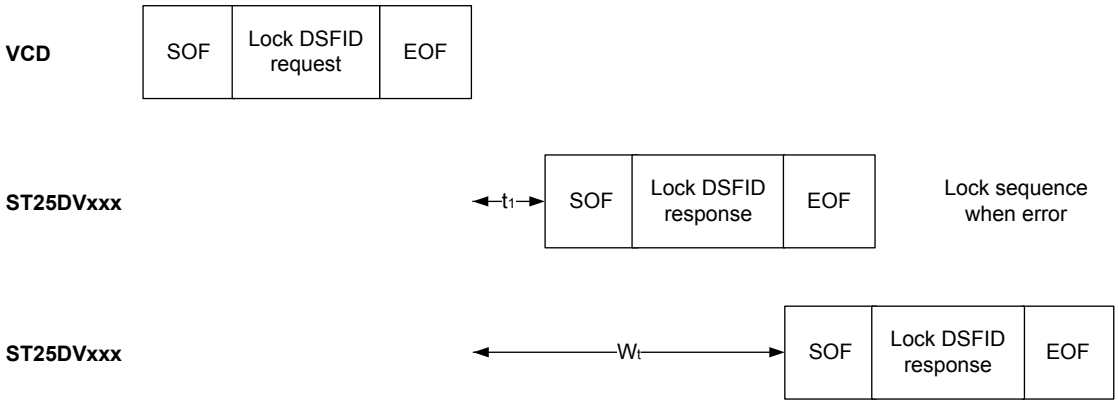
Table 156. Lock DSFID response format when Error_flag is set

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 50. Lock DSFID frame exchange between VCD and ST25DVxxx



7.6.22 Get System Info

When receiving this command, the device sends back its information data in the response.

The Option_flag is not supported. The Inventory_flag must be set to 0. The command can be issued in both Addressed and Non Addressed modes.

Table 157. Get System Info request format

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)

Table 158. Get System Info response format Error_flag is NOT set

Device	Response SOF	Response flags	Information flags	UID	DSFID	AFI	Memory size	IC ref	CRC16	Response EOF
ST25DV64K-xx ST25DV16K-xx	-	00h	0Bh	64 bits	8 bits	8 bits	NA (1)	26h	16 bits	-
ST25DV04K-xx			0Fh				037Fh	24h		

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 ST25DV04K-xx configurations)

Table 159. Memory size

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

- ST25DVxxx IC reference: the 8 bits are significant.

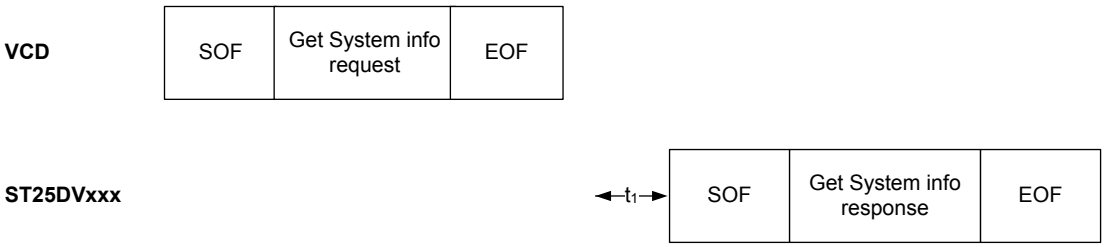
Table 160. Get System Info response format when Error_flag is set

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 51. **Get System Info frame exchange between VCD and ST25DVxxx**



7.6.23 Extended Get System Info

When receiving this command, the device sends back its information data in the response.

The Option_flag is not supported. The Inventory_flag must be set to 0. The command can be issued in both Addressed and Non Addressed modes.

Table 161. **Extended Get System Info request format**

Request SOF	Request_flags	Extended Get System Info	Parameter request field	UID (1)	CRC16	Request EOF
-	8 bits	3Bh	8 bits (0xx1xxxxb)	64 bits	16 bits	-

1. *This field is optional.*

- Request flags
- Request parameters
- UID (optional)

Table 162. **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 163. Extended Get System Info response format when Error_flag is NOT set

Response SOF	Response_flags	Information flags	UID	DSFID (1) (2)	AFI(2) (1)	Other field(2) (1)	CRC16	Response EOF
-	00h	8 bits(1)	64 bits	8 bits	8 bits	Up to 64 bits (3)	16 bits	-

1. *See Table 164. Response Information Flag.*
2. *This field is optional.*
3. *The number of bytes is a function of the selected parameter list.*

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 164. 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 165. Response other field: ST25DVxxx VICC memory size

MSB				LSB
24	22	21	17	16 01
RFU		Block size in byte		Number of blocks
0h		03h		07FFh (ST25DV64K-xx) 01FFh (ST25DV16K-xx) 007Fh (ST25DV04K-xx)

Table 166. Response other field: ST25DVxxx IC Ref

1 byte
ICRef
24h (ST25DV04K-xx) or 26h (ST25DV16K-xx and ST25DV64K-xx)

Table 167. Response other field: ST25DVxxx 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 168. Response other field: ST25DVxxx 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 169. Response other field: ST25DVxxx 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 170. Response other field: ST25DVxxx 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 171. Response other field: ST25DVxxx VICC command list Byte 4

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

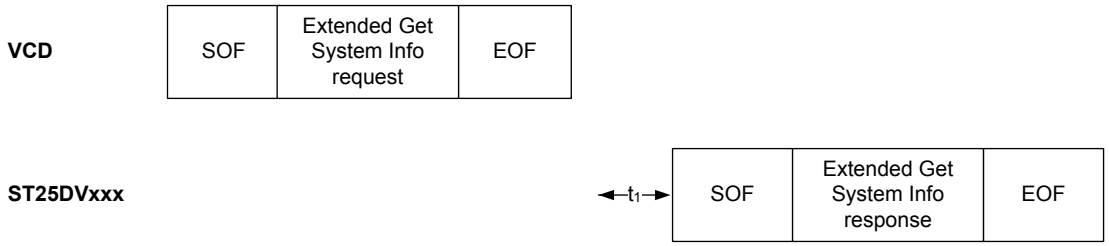
Table 172. Extended Get System Info response format when Error_flag is set

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 52. Extended Get System Info frame exchange between VCD and ST25DVxxx



7.6.24 Get Multiple Block Security Status

When receiving the Get Multiple Block Security Status command, the ST25DVxxx sends back its security status for each address block: 0 when block is writable else 1 when block is locked for writing. The blocks security status are defined by the area security status (and by LCK_CCFILE register for blocks 0 and 1). The blocks are numbered from 00h up to the maximum memory block number in the request, and the value is minus one (–1) in the field. For example, a value of “06” in the “Number of blocks” field requests will return the security status of seven blocks. This command does not respond an error if number of blocks overlap areas or overlap the end of the user memory.

The number of blocks is coded on 1 Byte and only first 256 blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

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

Table 173. Get Multiple Block Security Status request format

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

1. *This field is optional.*

Request parameter:

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

Table 174. Get Multiple Block Security Status response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status	CRC16	Response EOF
-	8 bits	8 bits (1)	16 bits	-

1. *Repeated as needed.*

Response parameters:

- Block security status

Table 175. Block security status

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

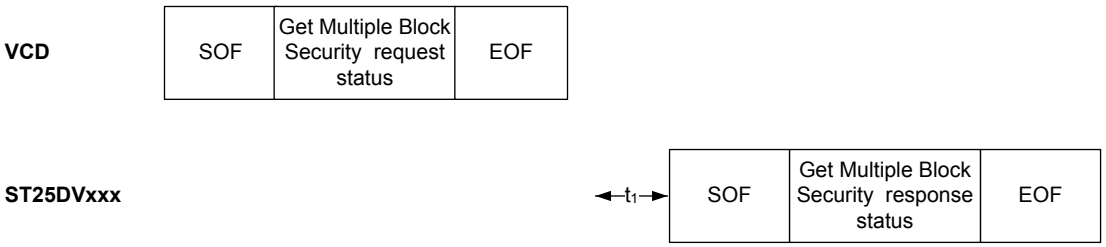
Table 176. Get Multiple Block Security Status response format when Error_flag is set

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 53. **Get Multiple Block Security Status frame exchange between VCD and ST25DVxxx**



7.6.25 Extended Get Multiple Block Security Status

When receiving this command, the device sends back the security status for each address block: 0 when the block is writable, 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 '06' in the “Number of blocks” field requests to return the security status of seven blocks.

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

The number of blocks is coded on two bytes, so all memory blocks of ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

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

Table 177. **Extended Get Multiple Block Security Status request format**

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

1. *This field is optional.*

Request parameter:

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

Table 178. **Extended Get Multiple Block Security Status response format when Error_flags NOT set**

Response SOF	Response_flags	Block security status	CRC16	Response EOF
-	8 bits	8 bits (1)	16 bits	-

1. *Repeated as needed.*

Response parameters:

- Block security status

Table 179. **Block security status**

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

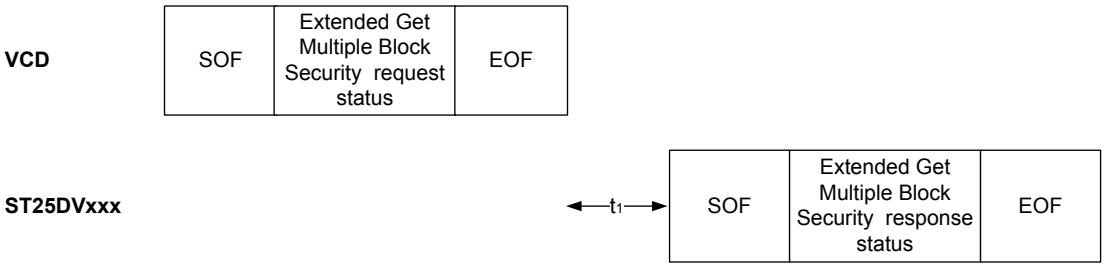
Table 180. Extended Get Multiple Block Security Status response format when Error_flag is set

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 54. Extended Get Multiple Block Security Status frame exchange



7.6.26 Read Configuration

On receiving the Read Configuration command, the ST25DVxxx 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 181. Read Configuration request format

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

1. *This field is optional.*

Note: Please refer to Table 11. System configuration memory map for details on register addresses.

Request parameters:

- System configuration register pointer
- UID (optional)

Table 182. 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

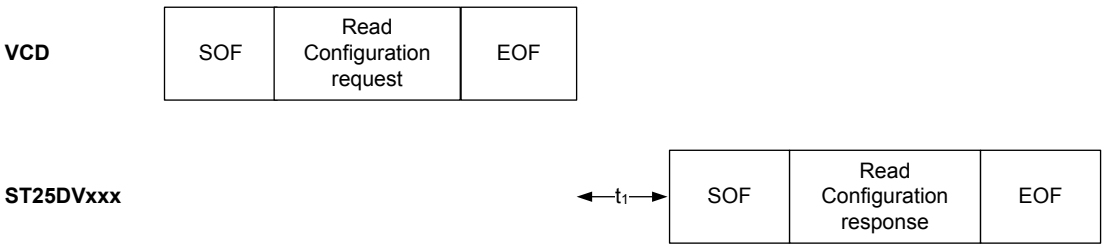
Table 183. Read Configuration response format when Error_flag is set

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 55. Read Configuration frame exchange between VCD and ST25DVxxx



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 ST25DVxxx 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 ST25DVxxx may not program correctly the data into the Configuration byte. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 184. Write Configuration request format

Request SOF	Request_flags	Write Configuration	IC Mfg code	UID (1)	Pointer	Register value(2)	CRC16	Request EOF
-	8 bits	A1h	02h	64 bits	8 bits	8 bits	16 bits	-

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

Request parameters:

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

Table 185. 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 11. System configuration memory map for details on register addresses.

Response parameter:

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

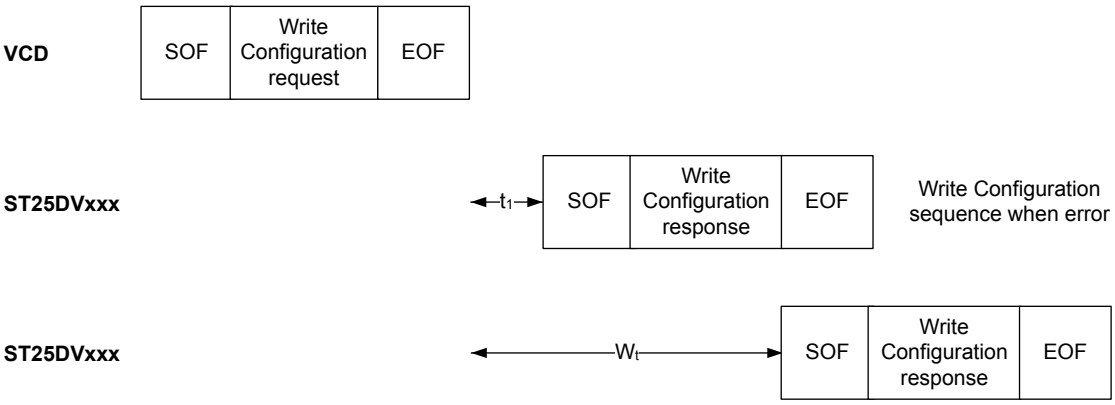
Table 186. Write configuration response format when Error_flag is set

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 56. **Write Configuration exchange between VCD and ST25DVxxx**



7.6.28 Read Dynamic Configuration

On receiving the Read Dynamic Configuration command, the ST25DVxxx 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 187. **Read Dynamic Configuration request format**

Request SOF	Request_flags	Read Dynamic Configuration	IC Mfg code	UID (1)	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 188. **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 11. System configuration memory mapfor details on register addresses.

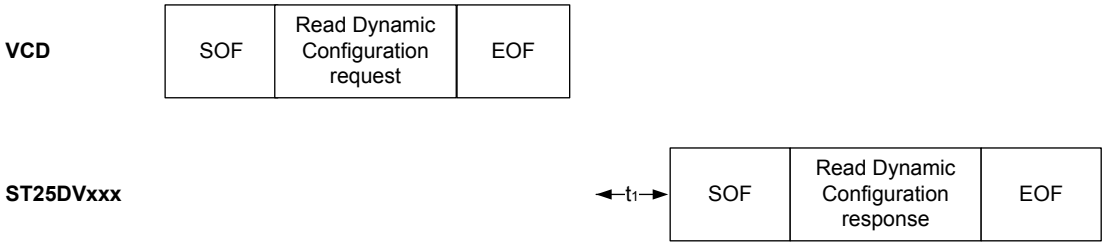
Table 189. **Read Dynamic Configuration response format when Error_flag is set**

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 57. **Read Dynamic Configuration frame exchange between VCD and ST25DVxxx**



7.6.29 Write Dynamic Configuration

On receiving the Write Dynamic Configuration command, the ST25DVxxx updates the Dynamic register addressed by the pointer.

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

Table 190. **Write Dynamic Configuration request format**

Request SOF	Request_flags	Write Dynamic Configuration	IC Mfg code	UID (1)	Pointer address	Register value	CRC16	Request EOF
-	8 bits	AEh	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 191. **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.

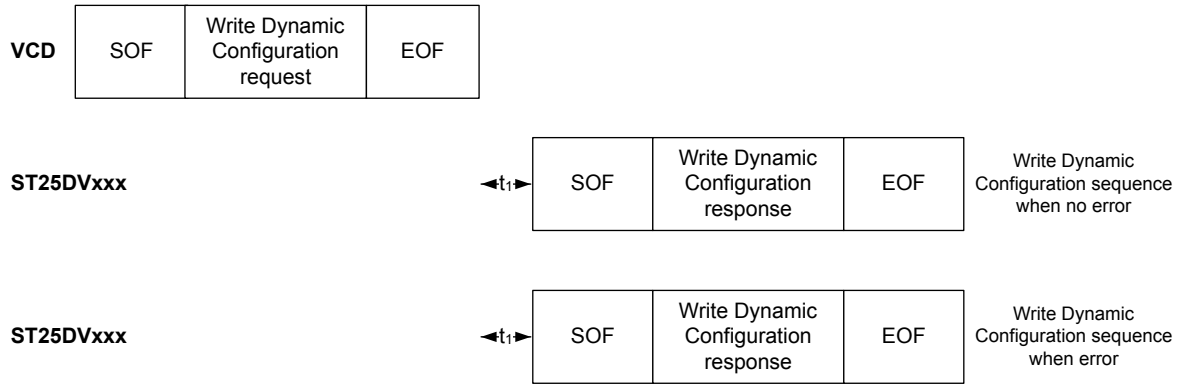
Table 192. **Write Dynamic Configuration response format when Error_flag is set**

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 58. **Write Dynamic Configuration frame exchange between VCD and ST25DVxxx**



7.6.30 Manage GPO

On receiving the Manage GPO command. Depending on the command argument, the ST25DV 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 ST25DVxxx responds an Error code “0F”.

The IT duration is defined by IT_TIME register and occurs just after the command response.

For the ST25DVxx-JF (CMOS output), a set means that the GPO pin is driven to a High level (V_{DCG}) and a Reset pulls the GPO pin to a low level (V_{SS}).

The IT corresponds to a transmission of a positive pulse on the GPO pin.

For the ST25DVxx-IE (open drain output), a Set means that the GPO pin is driven to a low level (V_{SS}) and a Reset releases the GPO (High impedance).

IT corresponds to the GPO pin driven to ground during the IT duration, then pin is released. Thanks to an external pull up, the high level will be recovered.

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

Table 193. **ManageGPO request format**

Request SOF	Request_ flags	ManageGPO	IC Mfg code	UID (1)	GPO VAL(2)	CRC16	Request EOF
-	8 bits	A9h	02h	64 bits	8 bits	16 bits	-

1. *This field is optional.*
2. *See Table 194*

Table 194. **GPOVAL**

GPOVAL	IT	ST25DVxx-IE (OD)	ST25DVxx-JF (CMOS)
0xxxxxx0b	RF_USER enabled	Pin pull to 0	GPO Pin set to logic One (V_{DCG})
0xxxxxx1b	RF_USER enabled	Pin released (HZ)	GPO Pin reset to logic zero
1xxxxxxb	RF_INTERRUPT enabled	GPO pin pulled to 0 during IT Time then released (HZ)	GPO Pin drives a positive pulse
Any other conditions		GPO released (Hz)	GPO pin reset to logic zero

Request parameters:

- Request flag
- UID (optional)
- Data: Define static or dynamic Interrupt

Table 195. ManageGPO 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.

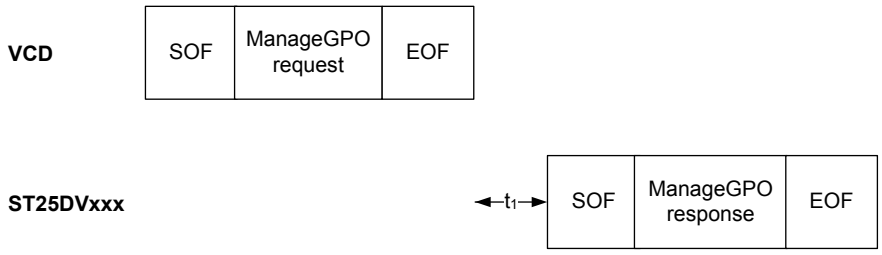
Table 196. ManageGPO response format when Error_flag is set

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 ManageCPO GPOVAL value is not in line with the GPO interrupts setting as specified in Table 194. GPOVAL)

Figure 59. Manage GPO frame exchange between VCD and ST25DVxxx



7.6.31 Write Message

On receiving the Write Message command, the ST25DVxxx 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 ST25DVxxx 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^2C 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 197. Write Message request format

Request SOF	Request_ flags	Write Message	IC Mfg code	UID (1)	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 198. 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.

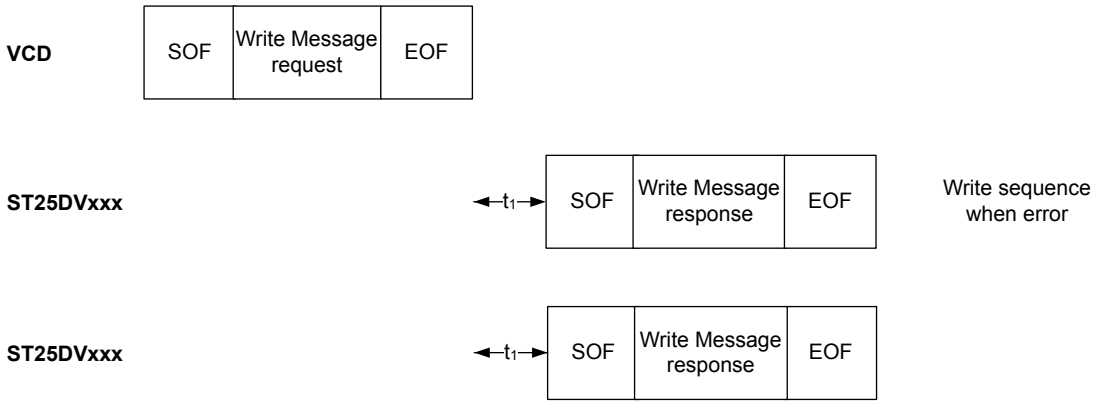
Table 199. Write Message response format when Error_flag is set

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 60. Write Message frame exchange between VCD and ST25DVxxx



7.6.32 Read Message Length

On receiving the Read Message Length command, the ST25DVxxx 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 200. Read Message Length request format

Request SOF	Request_flags	Read Message Length	IC Mfg code	UID (1)	CRC16	Request EOF
-	8 bits	ABh	02h	64 bits	16 bits	-

1. *The field is optional.*

Request parameters:

- UID (Optional)

Table 201. 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

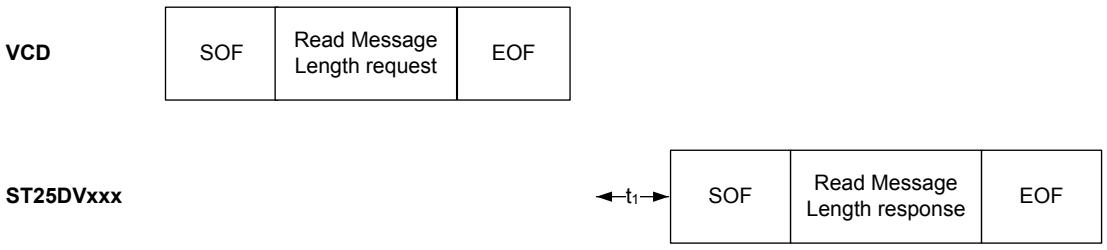
Table 202. Read Message Length response format when Error_flag is set

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 61. Read Message Length frame exchange between VCD and ST25DVxxx



7.6.33 Read Message

On receiving the Read Message command, the ST25DVxxx 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 203. Read Message request format

Request SOF	Request_flags	Read Message	IC Mfg code	UID (1)	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 204. 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 (1)	16 bits	-

1. *Number of message Bytes when Number of Bytes is set to 00h.*

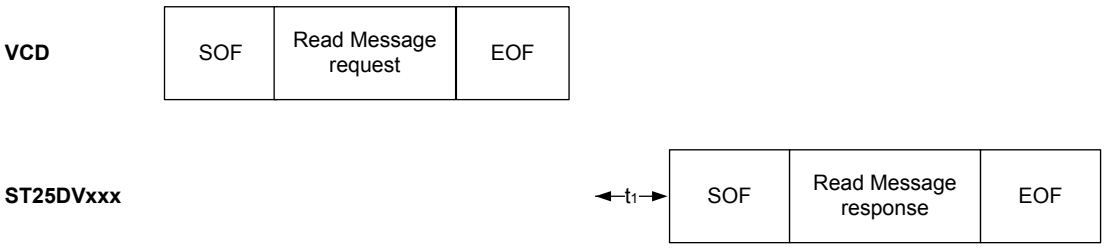
Response parameters:

- (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 62. Read Message frame exchange between VCD and ST25DVxxx



7.6.34 Fast Read Message

On receiving the Fast Read Message command, the ST25DVxxx 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 compated to Read Message.

The subcarrier_flag should be set to 0, otherwise the ST25DVxxx answers with an error code. The Option_flag is not supported, and the Inventory_flag must be set to 0.

Table 205. Fast Read Message request format

Request SOF	Request_flags	Fast Read Message	IC Mfg code	UID(1)	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 206. 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(1)	16 bits	64 bits

1. *Number of message Bytes when Number of Bytes is set to 00h*

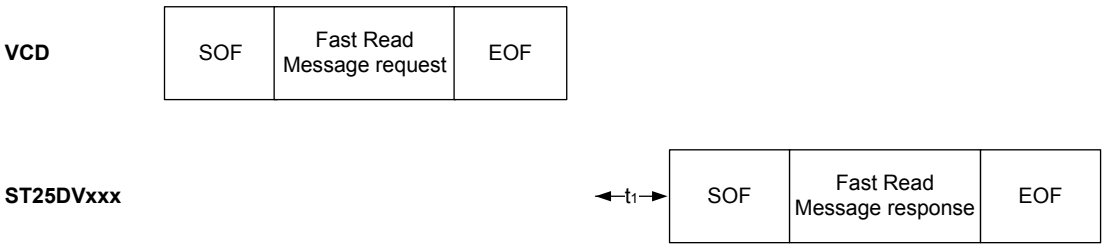
Response parameters:

- (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 63. Fast Read Message frame exchange between VCD and ST25DVxxx



7.6.35 Write Password

On receiving the Write Password command, the ST25DVxxx 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 ST25DVxxx may not correctly program the data into the memory.

The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer). After a successful write, the new value of the selected password is automatically activated. It is not required to present the new password value until the ST25DVxxx power-down.

Caution: *If ST25DVxxx 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 207. Write Password request format

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)
- Password number:
  - 00h = RF configuration password RF_PWD_0,
  - 01h = RF_PWD_1,
  - 02h = RF_PWD_2,
  - 03h = RF_PWD_3,
  - other = Error
- Data

Table 208. 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.

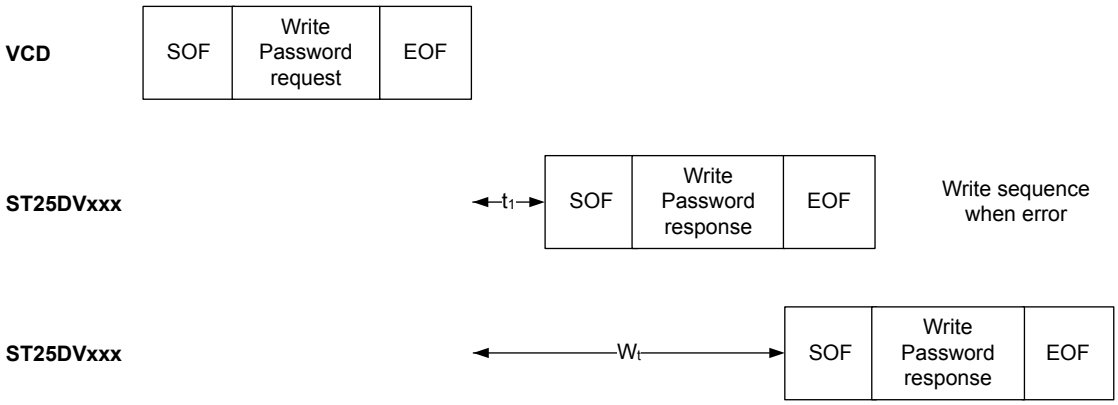
Table 209. Write Password response format when Error_flag is set

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 64. **Write Password frame exchange between VCD and ST25DVxxx**



7.6.36 Present Password

On receiving the Present Password command, the ST25DVxxx 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 210. **Present Password request format**

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

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)
- Password Number:
  - 00h = RF configuration password RF_PWD_0
  - 01h = RF_PWD_1
  - 02h = RF_PWD_2
  - 03h = RF_PWD_3
  - other = Error
- Password

Table 211. **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.

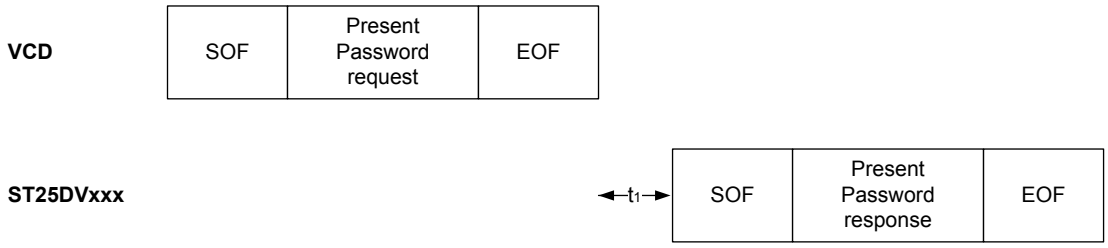
Table 212. Present Password response format when Error_flag is set

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 65. Present Password frame exchange between VCD and ST25DVxxx



7.6.37 Fast Read Single Block

On receiving the Fast Read Single Block command, the ST25DVxxx 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 ST25DVxxx 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 ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 213. Fast Read Single Block request format

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

1. *This field is optional.*

Request parameters:

- Request flags
- UID (optional)
- Block number

Table 214. Fast Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status (1)	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. *This field is optional.*

Response parameters:

- Block security status if Option_flag is set (see Table 215. Block security status)
- Four bytes of block data

Table 215. Block security status

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

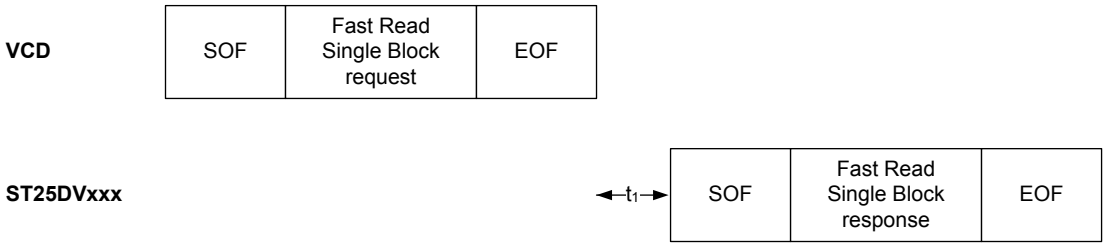
Table 216. Fast Read Single Block response format when Error_flag is set

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 66. Fast Read Single Block frame exchange between VCD and ST25DVxxx



7.6.38 Fast Extended Read Single Block

On receiving the Fast Extended Read Single Block command, the ST25DVxxx 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 ST25DVxxx 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 ST25DV16K-xx and ST25DV64K-xx can be addressed using this command

Table 217. Fast Extended Read Single Block request format

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

1. *This field is optional.*

Request parameters:

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

Table 218. Fast Extended Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status (1)	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. *This field is optional.*

Response parameters:

- Block security status if Option_flag is set (see Table 219. Block security status)
- Four bytes of block data

Table 219. Block security status

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

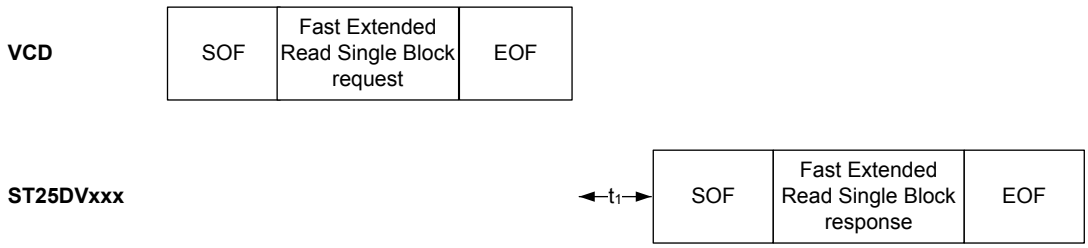
Table 220. Fast Extended Read Single Block response format when Error_flag is set

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 67. Fast Extended Read Single Block frame exchange between VCD and ST25DVxxx



7.6.39 Fast Read Multiple Blocks

On receiving the Fast Read Multiple Blocks command, the ST25DVxxx reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h up to the last block of user memory in the request, and the value is minus one (–1) in the field. For example, if the “Number of blocks” field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed to 256 assuming that they are all located in the same area. If the number of blocks overlaps area or overlaps the end of user memory, the ST25DVxxx returns an error code.

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

The subcarrier_flag should be set to 0, otherwise the ST25DVxxx 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 ST25DV16K-xx and ST25DV64K-xx can be addressed using this command.

Table 221. Fast Read Multiple Block request format

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

1. *This field is optional.*

Request parameters:

- Request flag
- UID (Optional)
- First block number
- Number of blocks

Table 222. Fast Read Multiple Block response format when Error_flag is NOT set

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

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

Response parameters:

- Block security status if Option_flag is set (see Table 223. Block security status if Option_flag is set)
- N block of data

Table 223. Block security status if Option_flag is set

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

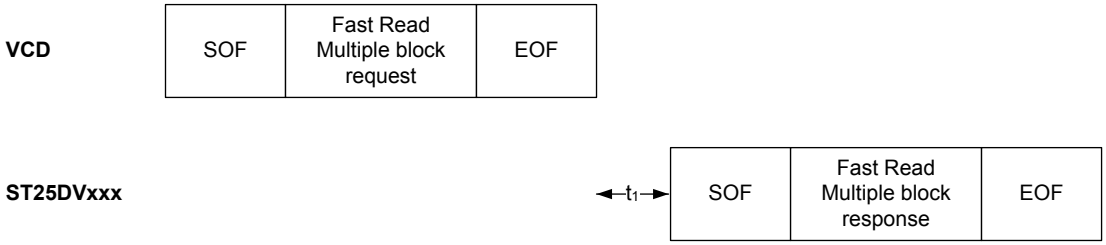
Table 224. Fast Read Multiple Block response format when Error_flag is set

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 68. Fast Read Multiple Block frame exchange between VCD and ST25DVxxx



7.6.40 Fast Extended Read Multiple Block

On receiving the Fast Extended Read Multiple Block command, the ST25DVxxx reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to up to the last block of memory in the request and the value is minus one (–1) in the field. For example, if the “Number of blocks” field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed to 2047 assuming that they are all located in the same area. If the number of blocks overlaps several areas or overlaps the end of user memory, the ST25DVxxx returns an error code.

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

The subcarrier_flag should be set to 0, otherwise the ST25DVxxx 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 ST25DV16K-xx and

ST25DV64K-xx can be addressed using this command.

Table 225. Fast Extended Read Multiple Block request format

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

1. *This field is optional.*

Request parameters:

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

Table 226. Fast Extended Read Multiple Block response format when Error_flag is NOT set

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

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

Response parameters:

- Block security status if Option_flag is set (see Table 223. Block security status if Option_flag is set)
- N block of data

Table 227. Block security status if Option_flag is set

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

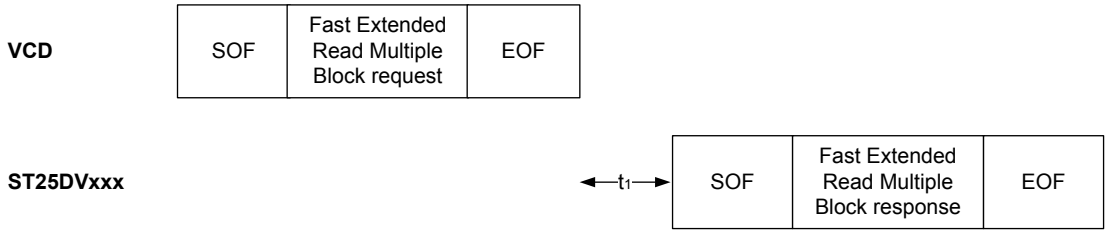
Table 228. Fast Read Multiple Block response format when Error_flag is set

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 69. Fast Extended Read Multiple Block frame exchange between VCD and ST25DVxxx



7.6.41 Fast Write Message

On receiving the Fast Write Message command, the ST25DVxxx 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 ST25DVxxx 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^2C 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 ST25DVxxx answers with an error code.

Table 229. Fast Write Message request format

Request SOF	Request_flags	Fast Write Message	IC Mfg code	UID (1)	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 230. 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.

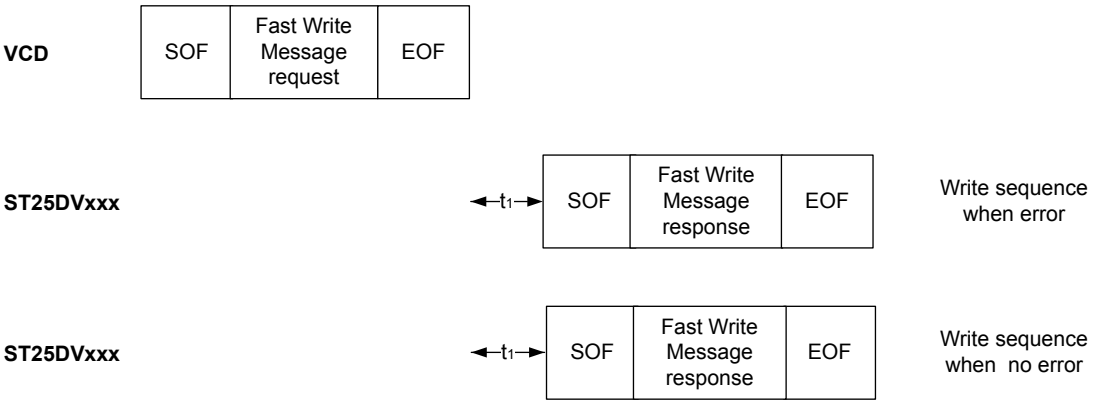
Table 231. Fast Write Message response format when Error_flag is set

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 70. Fast Write Message frame exchange between VCD and ST25DVxxx



7.6.42 Fast Read Message Length

On receiving the Fast Read Message Length command, the ST25DV 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 ST25DVxxx answers with an error code.

The data rate of the response is multiplied by 2 compared to Read Message Length command.

Table 232. Fast Read Message Length request format

Request SOF	Request_flags	Fast Read Message Length	IC Mfg code	UID (1)	CRC16	Request EOF
-	8 bits	CBh	02h	64 bits	16 bits	-

1. *This field is optional.*

Request parameters:

- Request flag
- UID (optional)

Table 233. 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.

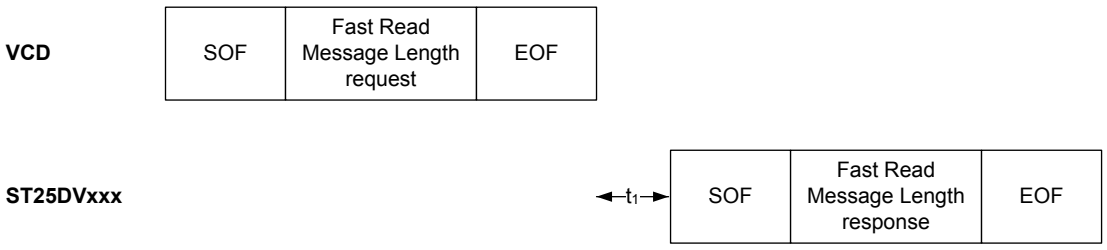
Table 234. Fast Read Message Length response format when Error_flag is set

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 71. Fast Read Message Length frame exchange between VCD and ST25DVxxx



7.6.43 Fast Read Dynamic configuration

On receiving the Fast Read Dynamic configuration command, the ST25DVxxx 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 ST25DVxxx answers with an error code.

The data rate of the response is multiplied by 2 compared to Read Dynamic configuration command.

Table 235. Fast Read Dynamic configuration request format

Request SOF	Request_flags	Fast Read Dynamic configuration	IC Mfg code	UID (1)	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 236. 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

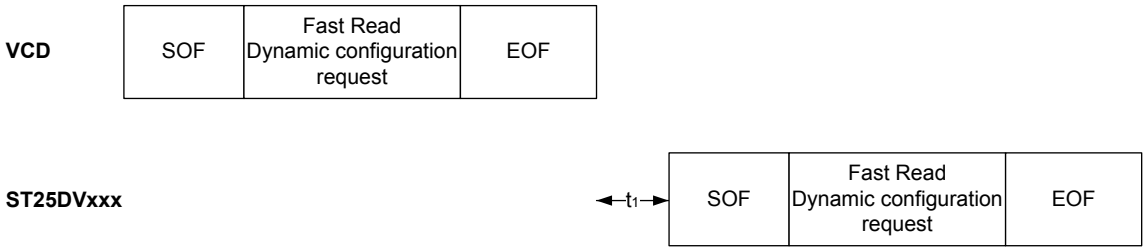
Table 237. Fast Read Dynamic configuration response format when Error_flag is set

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 72. Fast Read Dynamic configuration frame exchange between VCD and ST25DVxxx



7.6.44 Fast Write Dynamic Configuration

On receiving the Fast Write Dynamic Configuration command, the ST25DV 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 238. Fast Write Dynamic Configuration request format

Request SOF	Request_flags	Fast Write Dynamic Configuration	IC Mfg code	UID (1)	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 239. 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.

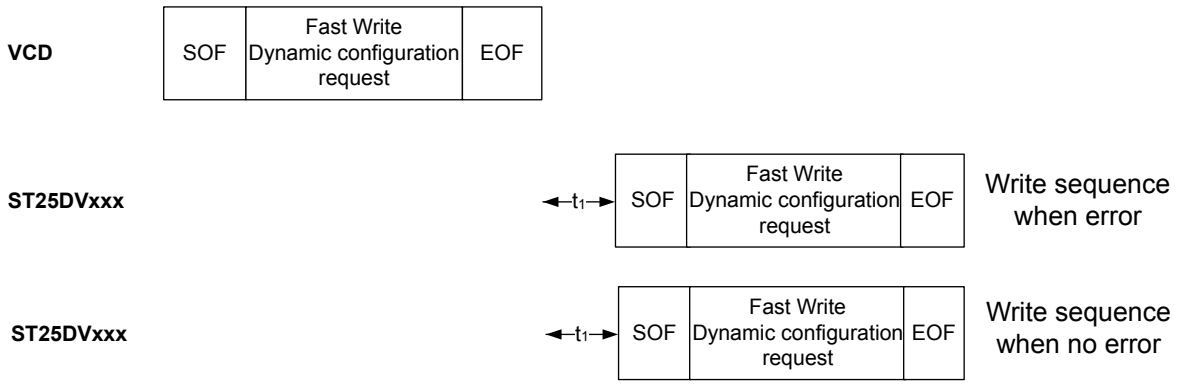
Table 240. Fast Write Dynamic Configuration response format when Error_flag is set

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 73. Fast Write Dynamic Configuration frame exchange between VCD and ST25DVxxx



8 Unique identifier (UID)

The ST25DVxxx 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 241. UID format

MSB				LSB			
63	56	55	48	47	40	39	0
0xE0		0x02		ST product code (1)		Unique serial number	

1. *See Table 85. UID for ST product code value definition.*

With the UID, each ST25DVxxx can be addressed uniquely and individually during the anticollision loop and for one-to-one exchanges between a VCD and an ST25DVxxx.

9 Device parameters

9.1 Maximum ratings

Stressing the device above the ratings listed in Table 242 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 242. Absolute maximum ratings

Symbol	Parameter				Min.	Max.	Unit
T_A	Ambient operating temperature	Range 6	All packages	RF and I^2C interfaces	-40	85	°C
		Range 8	UFDFPN8, UFDFPN12	RF and I^2C interfaces	-40	105	
			SO8N, TSSOP	RF interface	-40	105	
				I^2C interface	-40	125	
T_{STG}	Storage temperature	Sawn wafer on UV tape, kept in its original packing form			15	25	°C
		UFDFPN8 (MLP8),SO8N, TSSOP8, UFDFPN12, WLCSP10			-65	150	
t_{STG}	Retain	Sawn wafer on UV tape, kept in its original packing form			-	9 (1)	months
T_{LEAD}	Lead temperature during soldering				See note (2)		°C
V_{IO}	I^2C input or output range				- 0.50	6.5	V
V_{DCG}	Supply GPO CMOS driver				- 0.50	6.5	
V_{CC}	I^2C supply voltage				- 0.50	6.5	
$I_{OL_MAX_SDA}$	DC output current on pin SDA (when = equal to 0)				-	5	mA
$I_{OL_MAX_GPO_OD}$	DC output current on pin GPO open drain (when equal to 0)				-	1.5	
V_{MAX_1} (3)	RF input voltage amplitude peak to peak between AC0 and AC1, V_{SS} pin left floating			V_{AC0} - V_{AC1}	-	11	V
V_{MAX_2} (3)	AC voltage between AC0 and V_{SS}, or AC1 and V_{SS}			V_{AC0} - V_{SS}, or V_{AC1} - V_{SS}	- 0.50	5.5	
V_{ESD}	Electrostatic discharge voltage (human body model) (4)			All pins	-	2000	

1. *Counted from ST production date.*
2. *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.*
3. *Evaluated by characterization, not tested in production.*
4. *AEC-Q100-002 (compliant with JEDEC Std JESD22-A114, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω)*

9.2 I²C parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device in I²C mode. The parameters are derived from tests performed under the measurement conditions summarized in the relevant tables. Check that the operating conditions in the circuit match the measurement conditions when relying on the quoted parameters.

Table 243. I²C operating conditions

Symbol	Parameter			Min.	Max.	Unit
V_{CC}	Supply voltage			1.8	5.5	V
T_A	Ambient operating temperature	Range 6	All packages	-40	85	°C
		Range 8	UFDFPN8, UFDFPN12	-40	105	
			SO8N, TSSOP8	-40	125	

Table 244. AC test measurement conditions

Symbol	Parameter	Min.	Max.	Unit
C_L	Load capacitance	100		pF
t_r, t_f	Input rise and fall times	-	50	ns
V_{hi-lo}	Input levels	0.2 V_{CC} to 0.8 V_{CC}		V
$V_{ref(t)}$	Input and output timing reference levels	0.3 V_{CC} to 0.7 V_{CC}		

Figure 74. AC test measurement I/O waveform

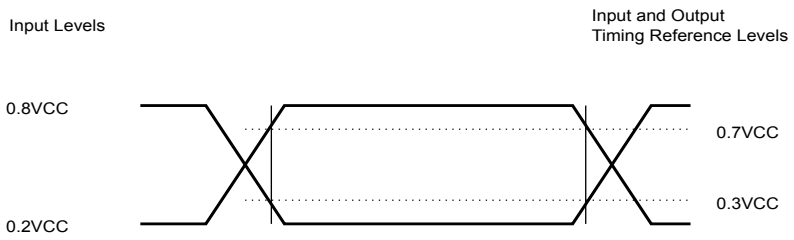


Table 245. Input parameters

Symbol	Parameter	Min.	Max.	Unit
C_{IN}	Input capacitance (SDA)	-	8	pF
C_{IN}	Input capacitance (other pins)	-	6	
t_{NS} (1)	Pulse width ignored (input filter on SCL and SDA)	-	80	ns

1. *Evaluated by characterization, not tested in production.*

Table 246. I²C DC characteristics (up to 85 °C)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA)	V_{IN} = V_{SS} or V_{CC} device in Standby mode	-	0.03	± 0.1	µA
I_{LI}	Input leakage current (LPD)	V_{IN} = V_{SS} device in Standby mode	-	0.1	± 0.5	

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{LO}	Operating leakage current (SDA)	SDA in Hi-Z, external voltage applied on SDA: V_{SS} or V_{CC}		-	0.03	± 0.1	µA
$I_{CC_E^2}$	Operating supply current (device select E^2 address) Read(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	116	160	µA
		V_{CC} = 3.3 V		-	220	240	
		V_{CC} = 5.5 V		-	510	550	
I_{CC_MB}	Operating supply current (device select MB address) Read(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	116	160	µA
		V_{CC} = 3.3 V		-	220	240	
		V_{CC} = 5.5 V		-	510	550	
I_{CC0}	Operating supply current (device select E^2 address) Write(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	110	300	µA
		V_{CC} = 3.3 V		-	110	330	
		V_{CC} = 5.5 V		-	130	430	
I_{CC0_MB}	Operating supply current (device select MB address) Write(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	170	200	µA
		V_{CC} = 3.3 V		-	280	300	
		V_{CC} = 5.5 V		-	520	600	
I_{CC1} (LPD = 1)	Low power down supply current	V_{CC} = 1.8 V		-	0.84	1.5	µA
		V_{CC} = 3.3 V		-	1.3	2.0	
		V_{CC} = 5.5 V		-	1.7	3.0	
I_{CC1_PON} (LPD = 0)	Static standby supply current after power ON, or device select stop, or time out	V_{CC} = 1.8 V		-	72	100	µA
		V_{CC} = 3.3 V		-	76	100	
		V_{CC} = 5.5 V		-	87	120	
V_{IL}	Input low voltage (SDA, SCL)	V_{CC} = 1.8 V		-0.45	-	0.25 V_{CC}	V
		V_{CC} = 3.3 V			-	0.30 V_{CC}	
		V_{CC} = 5.5 V			-	0.30 V_{CC}	
V_{IL_LPD}	Input low voltage (LPD)	V_{CC} = 3.3 V		-0.45	-	0.20 V_{CC}	V
V_{IH}	Input high voltage (SDA, SCL)	V_{CC} = 1.8 V		0.75 V_{CC}	-	6.5	V
		V_{CC} = 3.3 V			-		
		V_{CC} = 5.5 V			-		
V_{IH}	Input high voltage (LPD)	V_{CC} = 1.8 V		0.85 V_{CC}	-	6.5	V
		V_{CC} = 3.3 V			-		
		V_{CC} = 5.5 V			-		
V_{OL_SDA}	Ouput low voltage SDA (1 MHz)	V_{CC} = 1.8 V, I_{OL} = 1.0 mA		-	50	400	mV
		V_{CC} = 3.3 V, I_{OL} = 2.1 mA		-	75		
		V_{CC} = 5.5 V, I_{OL} = 3.0 mA		-	90		
$V_{CC_Power_up}$	Device select acknowledge	f_C = 100 kHz(2)		-	1.48	1.7	V

1. *SCL, SDA connected to ground or V_{CC}. SDA connected to V_{CC} through a pull-up resistor.*
2. *Evaluated by characterization, not tested in production.*

Table 247. I²C DC characteristics (up to 125 °C)

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA)	V_{IN} = V_{SS} or V_{CC} device in Standby mode		-	0.03	± 0.1	µA
I_{LI}	Input leakage current (LPD)	V_{IN} = V_{SS} device in Standby mode		-	0.1	± 0.5	
I_{LO}	Operating leakage current (SDA)	SDA in Hi-Z, external voltage applied on SDA: V_{SS} or V_{CC}		-	0.03	± 0.1	
$I_{CC_E^2}$	Operating supply current (device select E^2 address) Read(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	126	180	µA
		V_{CC} = 3.3 V		-	230	260	
		V_{CC} = 5.5 V		-	510	550	
I_{CC_MB}	Operating supply current (device select MB address) Read(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	126	180	µA
		V_{CC} = 3.3 V		-	230	260	
		V_{CC} = 5.5 V		-	510	550	
I_{CC0}	Operating supply current (device select E^2 address) Write(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	120	310	µA
		V_{CC} = 3.3 V		-	120	350	
		V_{CC} = 5.5 V		-	140	450	
I_{CC0_MB}	Operating supply current (device select MB address) Write(1)	V_{CC} = 1.8 V	f_C = 1 MHz (rise/fall time < 50 ns)	-	180	220	µA
		V_{CC} = 3.3 V		-	290	320	
		V_{CC} = 5.5 V		-	520	600	
I_{CC1} (LPD = 1)	Low power down supply current	V_{CC} = 1.8 V		-	2.5	5	µA
		V_{CC} = 3.3 V		-	3.0	6	
		V_{CC} = 5.5 V		-	4.0	7	
I_{CC1_PON} (LPD = 0)	Static standby supply current after power ON, or device select stop, or time out	V_{CC} = 1.8 V		-	78	110	V
		V_{CC} = 3.3 V		-	82	110	
		V_{CC} = 5.5 V		-	95	130	
V_{IL}	Input low voltage ((SDA, SCL)	V_{CC} = 1.8 V		-0.45	-	0.25 V_{CC}	V
		V_{CC} = 3.3 V			-	0.30 V_{CC}	
		V_{CC} = 5.5 V			-	0.30 V_{CC}	
V_{IL_LPD}	Input low voltage (LPD)	V_{CC} = 3.3 V		-0.45	-	0.20 V_{CC}	V
V_{IH}	Input high voltage (SDA, SCL)	V_{CC} = 1.8 V		0.75 V_{CC}	-	6.5	V
		V_{CC} = 3.3 V			-		
		V_{CC} = 5.5 V			-		
V_{IH_LPD}	Input high voltage (LPD)	V_{CC} = 1.8 V		0.85 V_{CC}	-	6.5	V
		V_{CC} = 3.3 V			-		
		V_{CC} = 5.5 V			-		
V_{OL_SDA}	Ouput low voltage SDA (1 MHz)	V_{CC} = 1.8 V, I_{OL} = 1.0 mA		-	50	400	mV
		V_{CC} = 3.3 V, I_{OL} = 2.1 mA		-	80		
		V_{CC} = 5.5 V, I_{OL} = 3.0 mA		-	100		
$V_{CC_Power_up}$	Device select acknowledge	f_C = 100 kHz(2)		-	1.48	1.7	V

1. *SCL, SDA connected to ground or V_{CC}. SDA connected to V_{CC} through a pull-up resistor.*
2. *Evaluated by characterization, not tested in production.*

Table 248. I²C AC characteristics (up to 85 °C)

Test conditions specified in Table 243					
Symbol	**Alt.**	**Parameter**	**Min.**	**Max.**	**Unit**
f_C	f_{SCL}	Clock frequency	0.05	1000	kHz
t_{CHCL}	t_{HIGH}	Clock pulse width high(1)	0.26	25000 (2)	µs
t_{CLCH}	t_{LOW}	Clock pulse width low(1)	0.5	25000 (3)	
t_{START_OUT}	-	I²C timeout on Start condition(1)	35	-	ms
t_{XH1XH2}	t_R	Input signal rise time(1)	(4)	(4)	ns
t_{XL1XL2}	t_F	Input signal fall time(1)	(4)	(4)	
t_{DL1DL2}	t_F	SDA (out) fall time(1)	20	120	
t_{DXCX}	$t_{SU:DAT}$	Data in set up time(1)	0	-	
t_{CLDX}	$t_{HD:DAT}$	Data in hold time	0	-	
t_{CLQX}(5)	t_{DH}	Data out hold time	100	-	
t_{CLQV}(6)	t_{AA}	Clock low to next data valid (access time)	-	450	
t_{CHDX}(7)	$t_{SU:STA}$	Start condition set up time	250	-	
t_{DLCL}	$t_{HD:STA}$	Start condition hold time	0.25	35000 (8)	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	500	-	
t_W	-	I²C write time(9)	-	5	ms
t_{bootDC}	-	RF OFF and LPD = 0(1)	-	0.6	
$t_{bootLPD}$	-	RF OFF(1)	-	0.6	

1. *Evaluated by characterization, not tested in production.*
2. *t_{CHCL} timeout.*
3. *t_{CLCH} timeout.*
4. *There are no min. or max. values for the input signal rise and fall times. The I^2C specification recommends that they are less than 120 ns when f_C < 1 MHz.*
5. *To avoid spurious Start and Stop conditions, a minimum delay is put 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 0.8 V_{CC} in a compatible way with the I^2C specification ($t_{SU:DAT}$ (min) = 100 ns), assuming that the R_{bus} × C_{bus} time constant is less than 150 ns (as specified in Figure 76).*
7. *For a restart condition, or following a write cycle.*
8. *t_{DLCL} timeout.*
9. *I^2C write time for 1, 2, 3, or 4 bytes in EEPROM (user memory and system configuration), provided they are all located in the same memory page, that is, the most significant memory address bits (b16-b2) are the same.*

Table 249. I²C AC characteristics (up to 125 °C)

Test conditions specified in Table 243					
Symbol	**Alt.**	**Parameter**	**Min.**	**Max.**	**Unit**
f_C	f_{SCL}	Clock frequency	0.05	1000	kHz
t_{CHCL}	t_{HIGH}	Clock pulse width high(1)	0.26	25000(2)	µs
t_{CLCH}	t_{LOW}	Clock pulse width low(1)	0.5	25000(3)	

Test conditions specified in Table 243					
Symbol	**Alt.**	**Parameter**	**Min.**	**Max.**	**Unit**
t_{START_OUT}	-	I²C timeout on Start condition(1)	35	-	ms
t_{XH1XH2}	t_R	Input signal rise time(1)	(4)	(4)	ns
t_{XL1XL2}	t_F	Input signal fall time(1)	(4)	(4)	
t_{DL1DL2}	t_F	SDA (out) fall time(1)	20	120	
t_{DXCX}	$t_{SU:DAT}$	Data in set up time(1)	0	-	
t_{CLDX}	$t_{HD:DAT}$	Data in hold time(1)	0	-	
t_{CLQX}(5)	t_{DH}	Data out hold time	100	-	
t_{CLQV}(6)	t_{AA}	Clock low to next data valid (access time)	-	450	
t_{CHDX}(7)	$t_{SU:STA}$	Start condition set up time	250	-	
t_{DLCL}	$t_{HD:STA}$	Start condition hold time	0.25	35000(8)	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	500	-	
t_W	-	I²C write time (9)	-	5.5	ms
t_{bootDC}	-	RF OFF and LPD = 0(1)	-	0.6	
$t_{bootLPD}$	-	RF OFF(1)	-	0.6	

1. *Evaluated by characterization, not tested in production.*
2. *t_{CHCL} timeout.*
3. *t_{CLCH} timeout.*
4. *There are no min. or max. values for the input signal rise and fall times. The I^2C specification recommends that they are less than 120 ns when f_C < 1 MHz.*
5. *To avoid spurious Start and Stop conditions, a minimum delay is put 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 0.8 V_{CC} in a compatible way with the I^2C specification ($t_{SU:DAT}$ (min) = 100 ns), assuming that the R_{bus} × C_{bus} time constant is less than 150 ns (as specified in Figure 76).*
7. *For a restart condition, or following a write cycle.*
8. *t_{DLCL} timeout.*
9. *I^2C write time for 1, 2, 3, or 4 bytes in EEPROM (user memory and system configuration), provided they are all located in the same page, that is, the most significant memory address bits (b16-b2) are the same.*

Figure 75. I²C AC waveforms

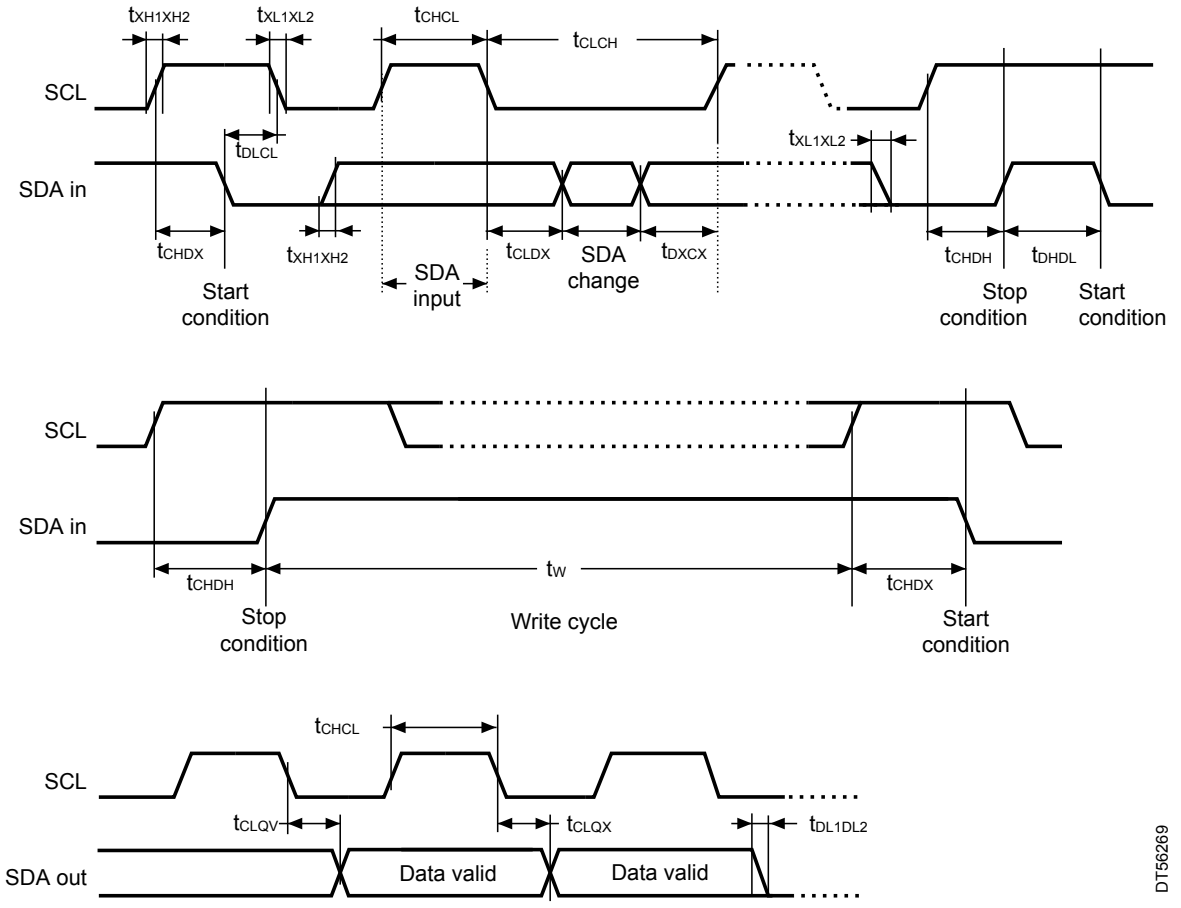
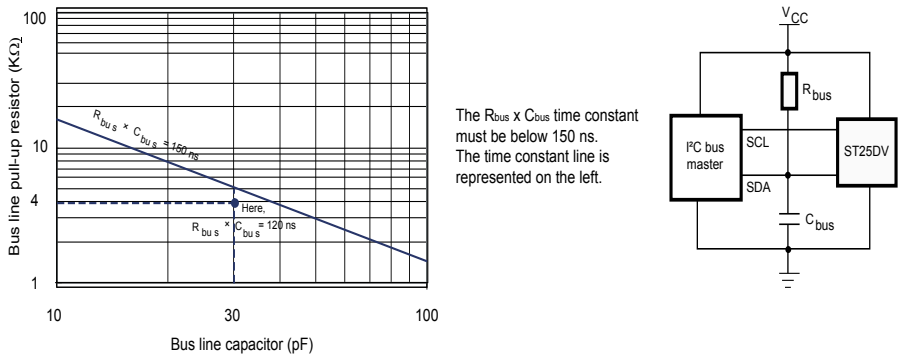


Figure 76 shows how to calculate the value of the pull-up resistor. In applications where this method of synchronization is not employed, the pull-up resistor is not necessary, provided that the bus master has a push-pull (rather than open drain) output.

Figure 76. I²C Fast mode (f_C = 1 MHz): maximum R_{bus} value versus bus parasitic capacitance (C_{bus})



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 250. GPO DC characteristics up to 85°C

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{OL}_GPO_CMOS	Output low voltage (GPO CMOS)	V_{DCG} = 1.8 V, I_{OL} = 0.5 mA	-	-	0.4	V
		V_{DCG} = 3.3 V, I_{OL} = 0.5 mA	-	-	0.4	
		V_{DCG} = 5.5 V, I_{OL} = 0.5 mA	-	-	0.4	
V_{OH}_GPO_CMOS	Output high voltage (GPO CMOS)	V_{DCG} = 1.8 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	V
		V_{DCG} = 3.3 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	
		V_{DCG} = 5.5 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	
V_{OL}_GPO_OD	Output low voltage (GPO open drain)	IOL = 1 mA, VCC = 1.8 V	-	0.28	0.4	V
		IOL = 1 mA, VCC = 3.3 V	-	0.20	0.4	
		IOL = 1 mA, VCC = 5.5 V	-	0.20	0.4	
I_L_GPO_OD	Output leakage (GPO open drain)	GPO in Hi-Z, external voltage applied on: GPO, V_{SS} or V_{CC}	- 0.15	0.06	0.15	µA
I_{LI}_V_{DGC}	Input leakage (V_{DGC})	V_{DGC} = 5.5 V	-	-	0.1	µA

Table 251. GPO DC characteristics up to 125°C

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{OL}_GPO_CMOS	Output low voltage (GPO CMOS)	V_{DCG} = 1.8 V, I_{OL} = 0.5 mA	-	-	0.4	V
		V_{DCG} = 3.3 V, I_{OL} = 0.5 mA	-	-	0.4	
		V_{DCG} = 5.5 V, I_{OL} = 0.5 mA	-	-	0.4	
V_{OH}_GPO_CMOS	Output high voltage (GPO CMOS)	V_{DCG} = 1.8 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	V
		V_{DCG} = 3.3 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	
		V_{DCG} = 5.5 V, I_{OH} = - 0.5 mA	V_{DCG} - 0.4	-	-	
V_{OL}_GPO_OD	Output low voltage (GPO open drain)	IOL = 1 mA, VCC = 1.8 V	-	0.28	0.4	V
		IOL = 1 mA, VCC = 3.3 V	-	0.22	0.4	
		IOL = 1 mA, VCC = 5.5 V	-	0.21	0.4	
I_L_GPO_OD	Output leakage (GPO open drain)	GPO in Hi-Z, external voltage applied on GPO: V_{SS} or V_{CC}	- 0.15	0.06	0.15	µA
I_{LI}_V_{DGC}	Input leakage (V_{DGC})	V_{DGC} = 5.5 V	-	-	0.1	µA

Table 252. GPO AC characteristics

Symbol	Parameter	Condition	Min	Max	Unit
t_r_GPO_CMOS	Output rise time	C_L = 30 pF, V_{DCG} = 1.8 V to 5.5 V	-	50	ns
t_f_GPO_CMOS	Output fall time	C_L = 30 pF, V_{DCG} = 1.8 V to 5.5 V	-	50	

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 following tables are derived from tests performed under the measurement conditions summarized in the relevant tables. Check that the operating conditions in the circuit match the measurement conditions when relying on the quoted parameters.

Table 253. RF characteristics

Symbol	Parameter	Condition		Min	Typ	Max	Unit
f_{CC}	External RF signal frequency	-		13.553	13.56	13.567	MHz
H_ISO	Operating field according to ISO(1)	Range 6	T_A = -40 °C to 85 °C	150	-	5000	mA/m
		Range 8	T_A = -40 °C to 105 °C				
$MI_{CARRIER}$	10% carrier modulation index MI = (A - B) / (A + B)	150 mA/m > H_ISO > 1000 mA/m		10	-	30	%
	100% carrier modulation index(1)	MI= (A - B) / (A + B)		95	-	100	
t_{MINCD}	Minimum time from carrier generation to first data(1)	From H-field min		-	-	1	ms
f_{SH}	Subcarrier frequency high(1)	f_{CC}/32		-	423.75	-	kHz
f_{SL}	Subcarrier frequency low(1)	f_{CC}/28		-	484.28	-	
t_1	Time for ST25DVxxx response(1)	4352/f_C		318.6	320.9	323.3	µs
t_2	Time between commands(1)	4192/f_C		309	311.5	314	
t_3	Time between commands(1)	4384/f_C		323.3	-	-	
W_{t_Block}	RF user memory write time (including internal Verify) (1)(2)	1 block		-	5.2	-	ms
		4 blocks		-	19.7	-	
W_{t_Byte}	RF system memory write time including internal Verify)(1)(2)	1 byte		-	4.9	-	ms
W_{t_MB}	RF mailbox write time (from VCD request SOF to ST25DVxxx response EOF)(2)(3)	256 bytes		-	80.7	-	ms
t_{Read_MB}	RF mailbox read time (from VCD request SOF to ST25DVxxx response EOF) (2)(3)	256 bytes		-	81	-	ms
C_{TUN}	Internal tuning capacitor(3)	f = 13.56 MHz		26.5	28.5	30.5	pF
V_{BACK}	Backscattered level, as defined by ISO test(1)	-		10	-	-	mV
V_{MIN_1} (1)	RF input voltage amplitude between AC0 and AC1, V_{SS} pin left floating, VAC0 - VAC1 peak to peak(1)	Inventory and Read operations		-	4.8	-	V
		Write operations		-	5.25	-	
V_{MIN_2} (1)	AC voltage between AC0 and V_{SS}, or between AC1 and V_{SS} (1)	Inventory and Read operations		-	2.25	-	V
		Write operations		-	2.7	-	
t_{BootRF}	Without DC supply (no V_{CC})	Set up time		-	0.6	-	ms
t_{RF_OFF}	RF OFF time	Chip reset		2	-	-	

1. *Evaluated by characterization, not tested in production.*
2. *For VCD request coded in 1 out of 4 and ST25DVxxx response in high data rate, single sub carrier.*
3. *Evaluated by characterization at 25 °C. Tested in production at 25 °C, by correlating industrial tester measures with characterization data.*

Note: *T_A= -40 to 105°C. Characterized only.*

All timing characterization performed on a reference antenna witht the following characteristics:

- *ISO antenna class 1*
- *Tuning frequency = 13.7 MHz.*

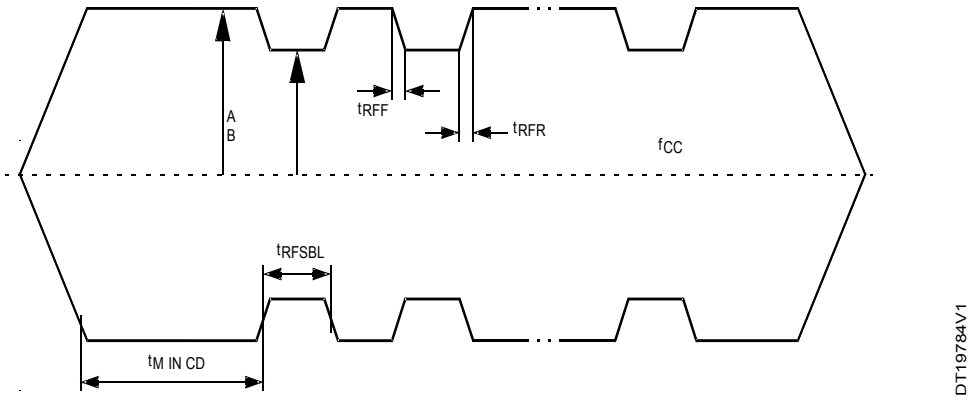
Table 254. Operating conditions

Symbol	Parameter		Min.	Max.	Unit
T_A	Ambient operating temperature	Range 6	-40	85	°C
		Range 8	-40	105	

Figure 77 shows an ASK modulated signal from the VCD to the ST25DVxxx. The test conditions for the AC/DC parameters are:

- Close coupling condition with tester antenna (1 mm)
- ST25DVxxx performance measured at the tag antenna
- ST25DVxxx synchronous timing, transmit and receive

Figure 77. ASK modulated signal



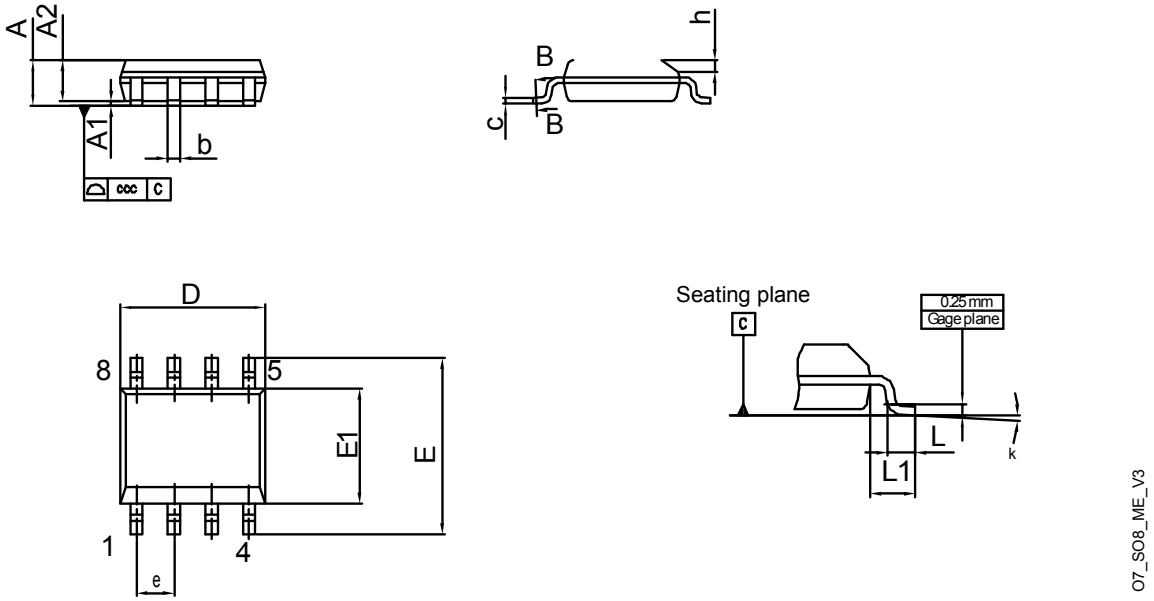
10 Package information

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. ECOPACK is an ST trademark.

10.1 SO8N package information

This SO8N is an 8-lead, 4.90 x 6.00 mm, plastic small outline package.

Figure 78. SO8N - Outline



Note: The drawing is not to scale.

Table 255. **SO8N - Mechanical data**

Symbol	Millimeters			Inches[1]		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.75	-	-	0.0689
A1	0.10	-	0.25	0.0039	-	0.0098
A2	1.25	-	-	0.0492	-	-
b	0.28	-	0.48	0.0110	-	0.0189
c	0.17	-	0.23	0.0067	-	0.0091
D[2]	4.80	4.90	5.00	0.1890	0.1929	0.1969
E	5.80	6.00	6.20	0.2283	0.2362	0.2441
E1[3]	3.80	3.90	4.00	0.1496	0.1535	0.1575
e	-	1.27	-	-	0.0500	-
h	0.25	-	0.50	0.0098	-	0.0197
L	0.40	-	1.27	0.0157	-	0.0500
L1	-	1.04	-	-	0.0409	-
k	0°	-	8°	0°	-	8°
ccc	-	-	0.10	-	-	0.0039

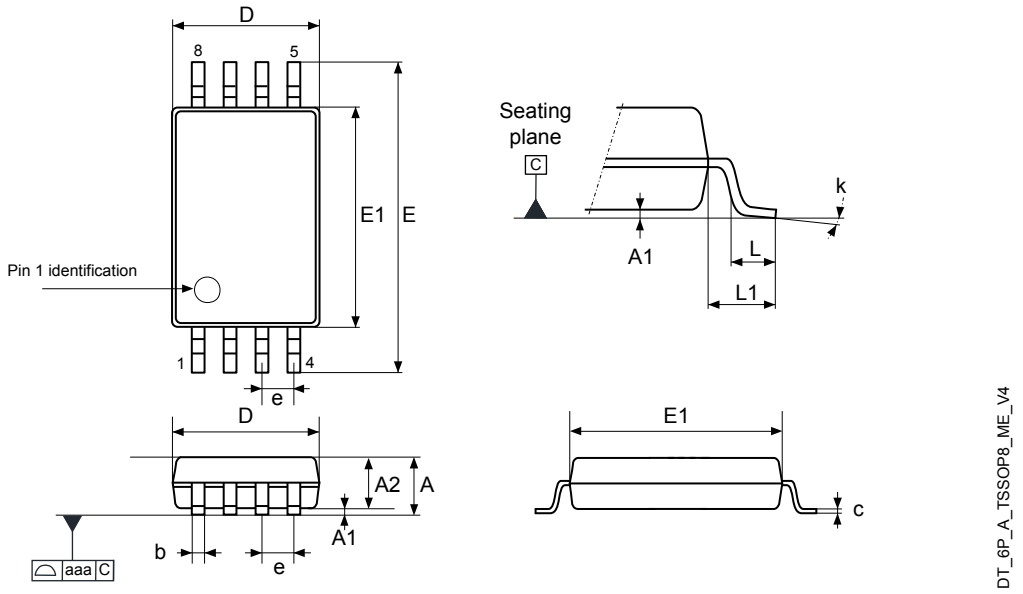
1. *Values in inches are converted from mm and rounded to four decimal digits.*
2. *Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm per side*
3. *Dimension “E1” does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.*

Note: The package top can be smaller than the package bottom. Dimensions D and E1 are determined at the outermost extremes of the plastic body exclusive of the mold flash, tie bar burrs, gate burrs, and interleads flash, but including any mismatch between the top and bottom of the plastic body. The measurement side for the mold flash, protrusions, or gate burrs is the bottom side.

10.2 TSSOP8 package information

This TSSOP is an 8-lead, 3 x 6.4 mm, 0.65 mm pitch, thin shrink small outline package.

Figure 79. **TSSOP8 – Outline**



1. *Drawing is not to scale.*

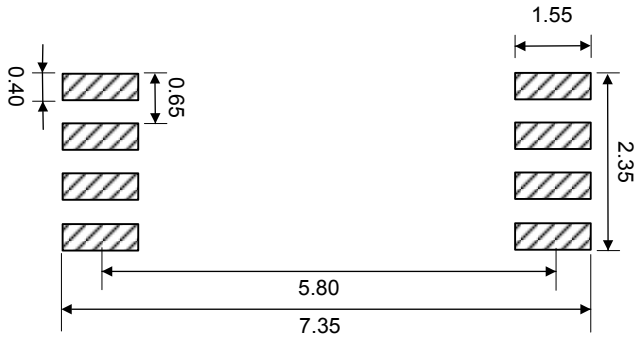
Table 256. **TSSOP8 - Mechanical data**

Symbol	millimeters			inches [1]		
	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
D[2]	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[3]	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.*
2. *Dimension D does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.*
3. *Dimension E1 does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.*

Note: The package top may be smaller than the package bottom. Dimensions D and E1 are determinated at the outermost extremes of the plastic body exclusive of the mold flash, tie bar burrs, gate burrs, and interleads flash, but including any mismatch between the top and bottom of the plastic body. The measurement side for the mold flash, protrusions, or gate burrs is the bottom side.

Figure 80. **TSSOP8 – Footprint example**

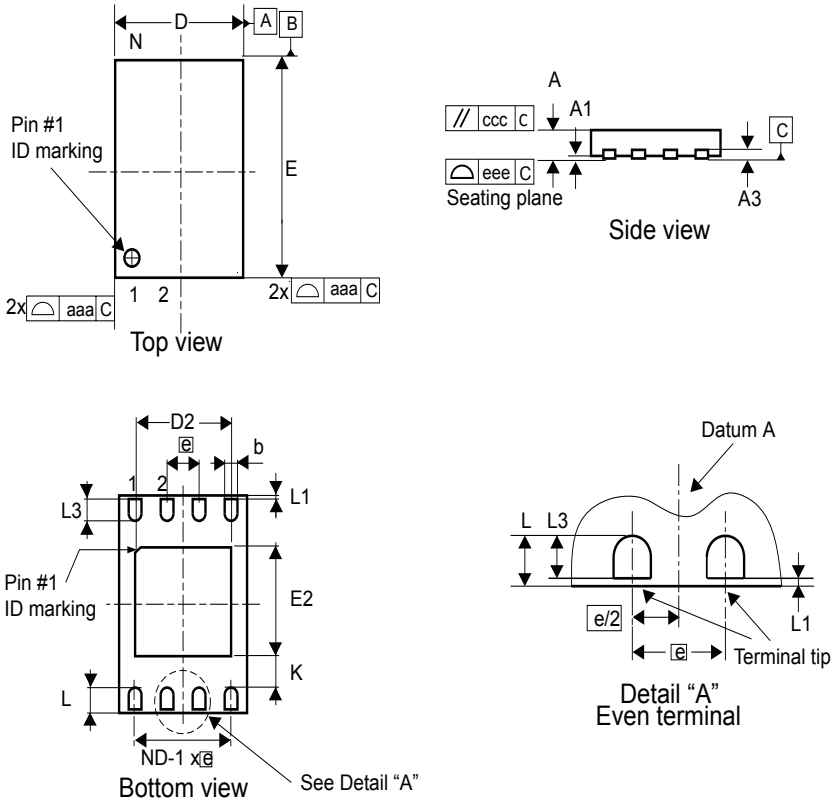


1. *Dimensions are expressed in millimeters.*

10.3 UFDFN8 package information

UFDFPN8 is an 8-lead, 2 × 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package.

Figure 81. UFDFN8 - 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 257. **UFDFN8 - Mechanical data**

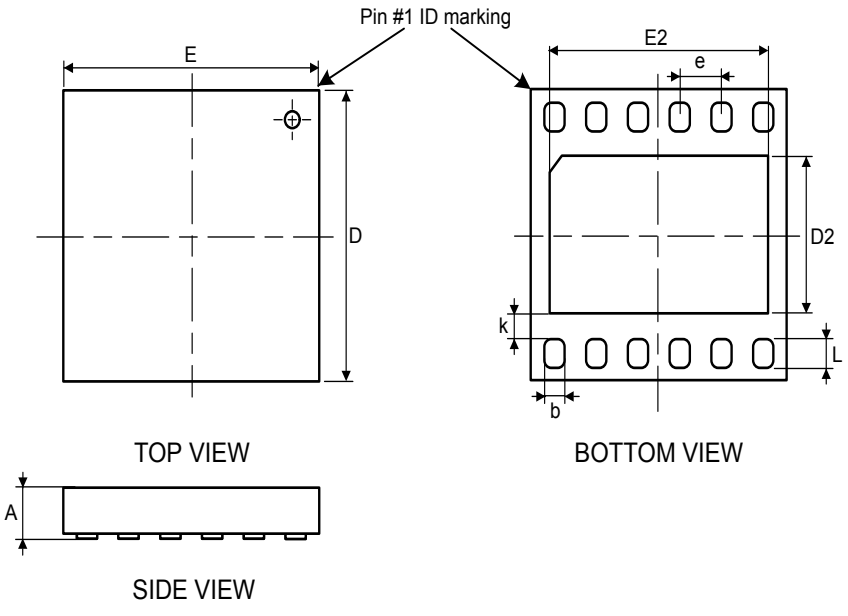
Symbol	millimeters			inches [1]		
	Min	Typ	Max	Min	Typ	Max
A	0.450	0.550	0.600	0.0177	0.0217	0.0236
A1	0.000	0.020	0.050	0.0000	0.0008	0.0020
b[2]	0.200	0.250	0.300	0.0079	0.0098	0.0118
D	1.900	2.000	2.100	0.0748	0.0787	0.0827
D2	1.200	-	1.600	0.0472	-	0.0630
E	2.900	3.000	3.100	0.1142	0.1181	0.1220
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 [3]	-	-	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 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 82. **UFDFPN12 - Outline**



1. *Drawing is not to scale.*

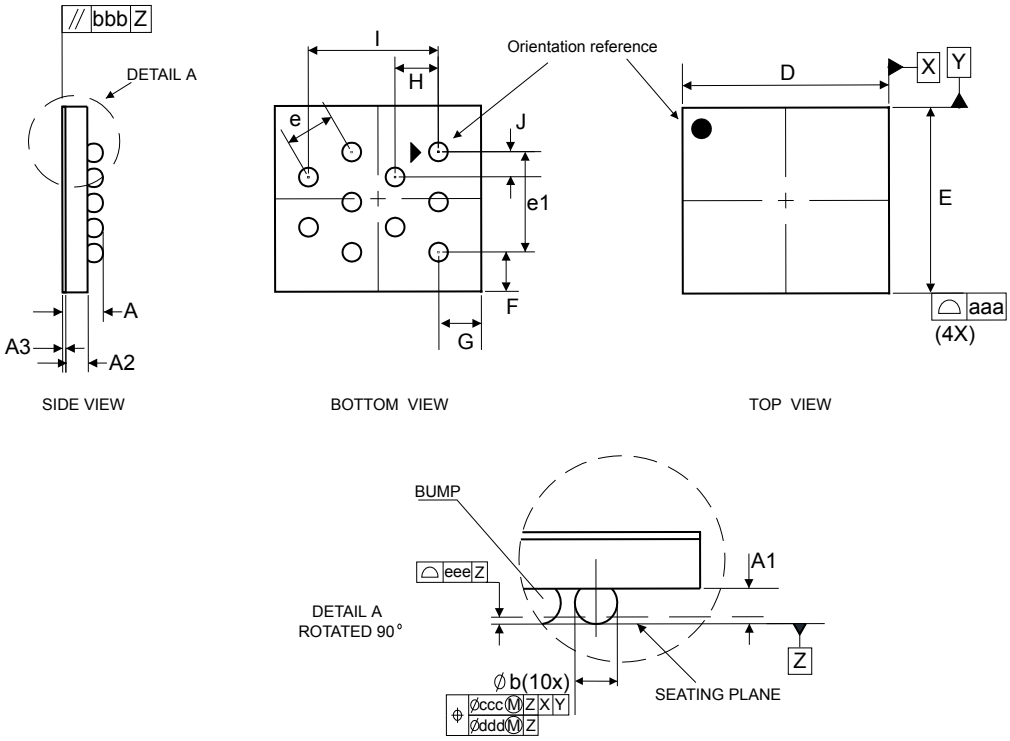
Table 258. UFDFPN12 - Mechanical data

Symbol	millimeters			inches (1)		
	Min	Typ	Max	Min	Typ	Max
A(2)	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.*

10.5 WLCSP10 package information

Figure 83. 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 259. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale mechanical data

Symbol	millimeters			inches [1]		
	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	-
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 84. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale recommended footprint

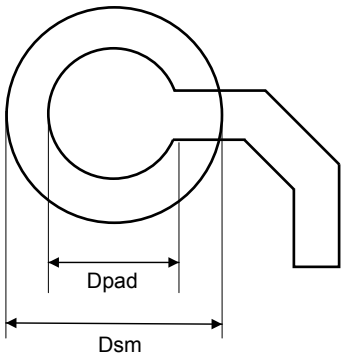


Table 260. WLCSP10 recommended PCB design rules

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

11 Ordering information

Table 261. Ordering information scheme

Example: ST25DV 64K -JF R 6 D 3

Device type

ST25DV = Dynamic NFC/RFID tag based on ISO 15693 and NFC T5T

Memory size

04K = 4 Kbits

16K = 16 Kbits

64K = 64 Kbits

Device features

IE = I^2C and GPO open drain, fast transfer mode and energy harvesting

JF = I^2C and GPO CMOS, fast transfer mode, energy harvesting and low power mode

Operating voltage

R = V_{CC} = 1.8 to 5.5 V

Device grade

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

8 = Industrial: device tested with standard test flow over the -40 to 105 °C range (UFDFPN8 and UFDFPN12), or over the -40 to 125 °C range (SO8N and TSSOP8 only, 105 °C for the RF interface)

Package

D = UFDFPN12

S = SO8N

T = TSSOP8

C = UFDFPN8 (only for 04K version)

U = 725 µm ± 20 µm unsawn wafer (only for 04K version)

L = WLCSP thin 10 balls (only for 04K version)

Capacitance

3 = 28.5 pF

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

For a list of available options (speed, package, etc.), or for further information on any aspect of this device, contact your nearest ST sales office.

Appendix A Bit representation and coding for fast commands

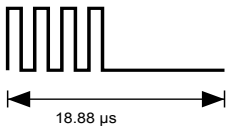
Data bits are encoded using Manchester coding, according to the following schemes. For the low data rate, same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4 and all times increase by this factor. For the Fast commands using one subcarrier, all 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 µs, as shown in Figure 85.

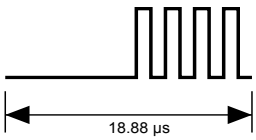
Figure 85. Logic 0, high data rate, fast commands



DT12066bV1

For the Fast commands, a logic 1 starts with an unmodulated time of 9.44 µs followed by four pulses of 423.75 kHz (f_C/32), as shown in Figure 86.

Figure 86. Logic 1, high data rate, fast commands

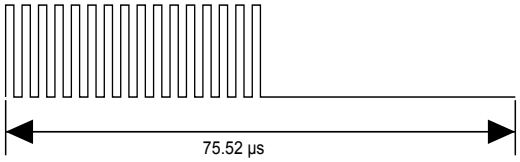


DT12067bV1

A.1.2 Low data rate

For the Fast commands, a logic 0 starts with 16 pulses at 423.75 kHz (f_C/32) followed by an unmodulated time of 37.76 µs, as shown in Figure 87.

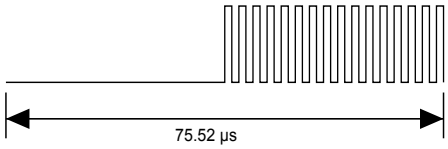
Figure 87. Logic 0, low data rate, fast commands



DT12069bV1

For the Fast commands, a logic 1 starts with an unmodulated time of 37.76 µs followed by 16 pulses at 423.75 kHz (f_C/32), as shown in Figure 88.

Figure 88. **Logic 1, low data rate, fast commands**



DT12071bV1

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

A.2 ST25DVxxx to VCD frames

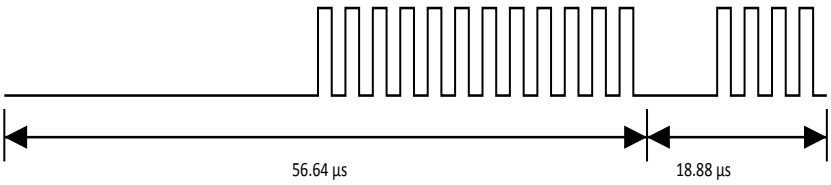
Frames are delimited by an SOF and an EOF. They are implemented using code violation. Unused options are reserved for future use. For the low data rate, the same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4. For the Fast commands using one subcarrier,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

A.3 SOF when using one subcarrier

A.3.1 High data rate

For the Fast commands, the SOF comprises an unmodulated time of 28.32 µs, followed by 12 pulses at 423.75 kHz (f_C/32), and a logic 1 that consists of an unmodulated time of 9.44 µs followed by four pulses at 423.75 kHz, as shown in Figure 89.

Figure 89. **Start of frame, high data rate, one subcarrier, fast commands**

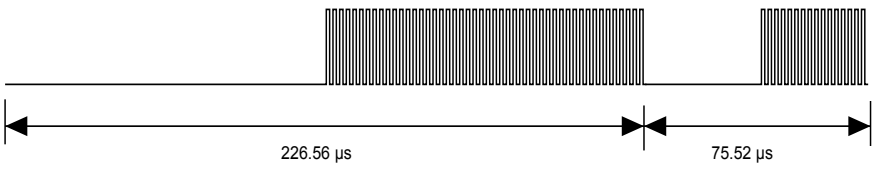


DT12079bV1

A.3.2 Low data rate

For the Fast commands, the SOF comprises an unmodulated time of 113.28 µs, followed by 48 pulses at 423.75 kHz (f_C/32), and a logic 1 that includes an unmodulated time of 37.76 µs followed by 16 pulses at 423.75 kHz, as shown in Figure 90.

Figure 90. **Start of frame, low data rate, one subcarrier, fast commands**



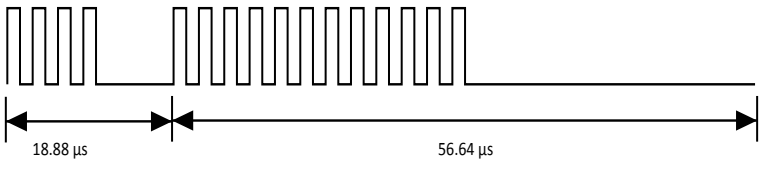
DT12081bV1

A.4 EOF when using one subcarrier

A.4.1 High data rate

For the Fast commands, the EOF comprises a logic 0 that includes four pulses at 423.75 kHz and an unmodulated time of 9.44 µs, followed by 12 pulses at 423.75 kHz (f_C/32) and an unmodulated time of 37.76 µs, as shown in Figure 91.

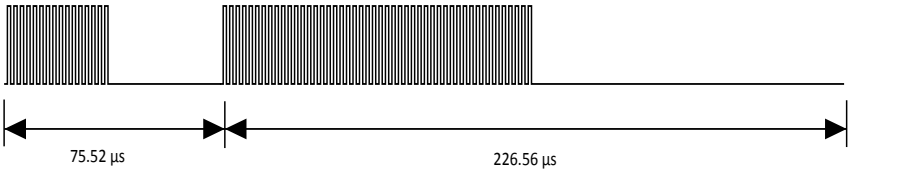
Figure 91. End of frame, high data rate, one subcarrier, fast commands



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 µs, followed by 48 pulses at 423.75 kHz (f_C/32) and an unmodulated time of 113.28 µs, as shown in Figure 92.

Figure 92. 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 I²C sequences

B.1 Device select codes

Table 262. **Device select usage**

Device select value		Comment
Hexadecimal	Binary	
-	1010 E211 R/$\overline{W}$	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
AEh	1010 1110b	System memory writing
AFh	1010 1111b	System memory reading

B.2 I²C Byte writing and polling

B.2.1 I2C byte write in user memory

Table 263. **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 264. Polling during programming after byte writing in user memory

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
...		... 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 265. Byte Write in user memory when write operation is not 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
-	NoACK	9th bit: Write access not granted or FTM activated.
Stop	-	No Programming Device return in Standby

B.2.2 I²C byte writing in dynamic registers and polling

Table 266. Byte Write in dynamic register (if not read only)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
Dynamic register ADDRESS_LSB	-	Send address LSB (1 byte) Dynamic register are located from address 2000h to 2007h, some are only readable
-	ACK	Ninth bit
DATA	-	Send data
-	ACK	Ninth bit
Stop	-	**Immediate** update of Dynamic register

Table 267. Polling during programming after byte write in dynamic register

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit device busy Dynamic register updates is immediate
Stop	-	End of polling

Table 268. Byte Write in dynamic register if read only

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h	-	Send address MSB (1 byte)
-	NoACK	Ninth bit
RO Dynamic Register ADDRESS_LSB	-	Send address LSB (1 byte) Addresses 2001h, 2004h, 2005h and 2007h are read only registers.
-	ACK	Ninth bit
DATA	-	Send Data
-	NoACK	Ninth bit
Stop	-	No programming Device returns in Standby

B.2.3 I²C byte write in mailbox and polling

Table 269. Byte Write in mailbox when mailbox is free from RF message and fast transfer mode is activated

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h	-	Send mailbox address MSB (1 byte)
-	ACK	Ninth bit
08h	-	Send address LSB (1 byte) Write must be done at the first address of the mailbox
-	ACK	Ninth bit
DATA	-	Send data
-	ACK	Ninth bit
Stop	-	Immediate update of mailbox

Table 270. Byte Write in mailbox when mailbox is not free from RF message fast transfer mode is not activated

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h	-	Send mailbox address MSB (1 byte)
-	ACK	Ninth bit
08h	-	Send address LSB (1 byte) Write must be done at the first address of the mailbox
-	ACK	Ninth bit
DATA	-	Send data
-	NoACK	Ninth bit access Mailbox busy or FTM not activated
Stop	-	No programming Device return in Standby

B.2.4 I²C byte write and polling in system memory

Table 271. Byte write if I²C security session is open and register is not RO

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
DATA	-	Send data
-	ACK	Ninth bit
Stop	-	Start of programming

Table 272. Polling during programming after byte write if I²C security session is open and register is not RO

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	NoACK	Ninth bit device busy
Start AEh	-	Device select for writing
-	NoACK	Ninth bit device busy
Start AEh	-	Device select for writing
-	...	Ninth bit
Start AEh	-	Device select for writing
-	ACK	Ninth bit device ready Programing completed
Stop	-	End of polling

Table 273. Byte write if I²C security session is closed or register is RO

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
DATA	-	Send data
-	NoACK	Ninth bit
Stop	-	No programming Device return in Standby

B.3 I2C sequential writing and polling

B.3.1 I²C sequential write in user memory and polling

Table 274. Sequential write user memory when write operation is allowed and all bytes belong to same area

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
DATA 0	-	Send Data 0
-	ACK	Ninth bit
DATA 1	-	Send data 1
-	ACK	Ninth bit
...	-	...
-	...	...
DATA n	-	Send data n n ≤ 256
-	ACK	Ninth bit
Stop	-	Start of programming

Table 275. Polling during programming after sequential write in user memory when write operation allowed and all bytes belong to the same area.

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	NoACK	Ninth bit device busy
Start A6h	-	Device select for writing
-	NoACK	Ninth bit device busy
Start A6h	-	Device select for writing
-	...	Ninth bit device busy
Start A6h	-	Device select for writing
-	ACK	Ninth bit device ready Programming completed
Stop	-	End of polling

Table 276. Sequential write in user memory when write operation is allowed and crossing over area border

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
DATA 0	-	Send Data 0
-	ACK	Ninth bit
DATA 1	-	Send data 1
-	ACK	Ninth bit
...	-	...
-	...	...
DATA n	-	Send data n Address is located in the next memory area
-	NoACK	Ninth bit
Stop	-	No programming Device return in Standby

Table 277. Polling during programming after sequential write in user memory when write operation is allowed and crossing over area border

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit device ready No programming
Stop	-	End of polling

B.3.2 I²C sequential write in mailbox and polling

Table 278. Sequential write in mailbox when mailbox is free from RF message and fast transfer mode is activated

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send mailbox Address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send mailbox address LSB (1 byte)
-	ACK	Ninth bit
DATA 0	-	Send Data 0
-	ACK	Ninth bit
DATA 1	-	Send Data 1
-	ACK	Ninth bit
...	-	...
-	...	...
DATA n	-	Send data n n ≤ 256
-	ACK	Ninth bit
Stop	-	Immediate mailbox content update

Table 279. Polling during programming after sequential write in the mailbox

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit device ready Mailbox is immediately updated
Stop	-	End of polling

B.4 I²C read current address

B.4.1 I²C current address read in user memory

Table 280. Current byte read in user memory if read operation is allowed (depending on area protection and RF user security session)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data located on the last pointed address+1, or at address 0 after power-up, in user memory
NO_ACK	-	Ninth bit
Stop	-	End of Reading

Table 281. Current Read in user memory if read operation is not allowed (depending on area protection and RF user security session)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	FFh	Read of data not allowed ST25DV release SDA
NO_ACK	-	Ninth bit
Stop	-	End of Reading

B.5 I²C random address read

B.5.1 I²C random address read in user memory

Table 282. Random byte read in user memory if read operation is allowed (depending on area protection and RF user security session)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data
NO_ACK	-	Ninth bit
Stop	-	End of Reading

Table 283. Random byte read in user memory if operation is not allowed (depending on area protection and RF user security)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	FFh	Read of data not allowed release SDA
NO_ACK	-	Ninth bit
Stop	-	End of Reading

B.5.2 I²C random address read in system memory

Table 284. Byte read system memory (Static register or I²C password after a valid Present I²C password)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start AFh	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data
NO_ACK	-	Ninth bit
Stop	-	End of reading

B.5.3 I²C random address read in dynamic registers

Table 285. Random byte read in dynamic registers

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data
NO_ACK	-	Ninth bit
Stop	-	End of reading

B.6 I²C sequential read

B.6.1 I²C sequential read in user memory

Table 286. Sequential read user memory if read operation is allowed (depending on area protection and RF user security session) and all bytes belong to the same area

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h0	-	Device select for reading
-	ACK	Ninth bit
-	DATA 0	Receive data 0
ACK	-	Ninth bit
-	DATA 1	Receive data 1
ACK	-	Ninth bit
-	...	...
...	-	...
-	DATA n	Receive data n
NO_ACK	-	Ninth bit
Stop	-	End of Reading

Table 287. 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
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA 0	Receive data 0
ACK	-	Ninth bit
-	DATA 1	Receive data 1
ACK	-	Ninth bit
-	...	...
...	-	...
-	DATA n	Receive data last address available
ACK	-	Ninth bit
-	FFh	Data is located in the next memory area ST25DV release SDA
ACK	-	Ninth bit
-	...	...
...	-	...
-	FFh	Data is located in the next memory area ST25DV release SDA
Stop	-	End of reading

Table 288. Sequential Read user memory if read operation is allowed (depending on area protection and RF user security session)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	FFh	ST25DV release SDA Reading access not granted
ACK	-	Ninth bit
-	...	...
...	-	...
-	FFh	ST25DV release SDA Reading access not granted
NO_ACK	-	Ninth bit
Stop	-	End of reading

B.6.2 I²C sequential read in system memory

Table 289. Sequential in read system memory (I²C security session open if reading I2C_PWD)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
ADDRESS_MSB	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start AF7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data 0
ACK	-	Ninth bit
-	DATA	Receive data 1
ACK	-	Ninth bit
-	...	...
...	-	...
-	DATA	Receive data n
NO_ACK	-	Ninth bit
Stop	-	End of Reading

Table 290. **Sequential Read system memory when access is not granted (I²C password I2C_PWD)**

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
90h	-	Send address MSB (1 byte)
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte)
-	ACK	Ninth bit
Start AFh	-	Device select for reading
-	ACK	Ninth bit
-	DATA	Receive data 0
-	FFh	ST25DV release SDA Reading access is not granted
ACK	-	Ninth bit
-	...	...
...	-	...
-	FFh	ST25DV release SDA Reading access is not granted
NO_ACK	-	Ninth bit
Stop	-	End of reading

B.6.3 I2C sequential read in dynamic registers

Table 291. **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) Fynamic 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 292. Sequential read in Dynamic register and mailbox continuously if 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 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
Start 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
Stop	-	End of reading

B.6.4 I²C sequential read in mailbox

Table 293. **Sequential in mailbox if fast transfer mode is activated**

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h or 21h	-	Send address MSB (1 byte) 2007h < @ 2108h
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte) 2007h < @ 2108h
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	DATA 0	Receive data 0
ACK	-	Ninth bit
-	DATA 1	Receive data 1
ACK	-	Ninth bit
-	...	...
...	-	...
-	Data n	Receive data n
NO_ACK	-	Ninth bit
Stop	-	End of reading

Table 294. Sequential read in mailbox if fast transfer mode is not activated

Request/Response Frame		Comment
Controller drives SDA	Target drives SDA	
Start A6h	-	Device select for writing
-	ACK	Ninth bit
20h or 21h	-	Send address MSB (1 byte) 2007h < @ 2108h
-	ACK	Ninth bit
ADDRESS_LSB	-	Send address LSB (1 byte) 2007h < @ 2108h
-	ACK	Ninth bit
Start A7h	-	Device select for reading
-	ACK	Ninth bit
-	FFh	release SDA
ACK	-	Ninth bit
-	FFh	release SDA
ACK	-	Ninth bit
-	...	...
...	-	...
-	FFh	release SDA
NO_ACK	-	Ninth bit
Stop	-	End of reading

B.7 I²C password relative sequences

B.7.1 I²C write password

Table 295. Write password when the I²C security session is already open and fast transfer mode is not activated

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
09h	-	Send I2C_PWD MSB address
-	ACK	Ninth bit
00h	-	Send I2C_PWD LSB address
-	ACK	Ninth bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	Ninth bit
I2C_PWD_BYTE_6	DATA 0	Send data
-	ACK	Ninth bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	Ninth bit
07h	-	Write password command
-	ACK	Ninth bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	Ninth bit
I2C_PWD_BYTE_6	DATA 0	Send data
-	ACK	Ninth bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	Ninth bit
Stop	-	Start of I²C password programming

Table 296. Write password when the I²C security session is not open or fast transfer mode activated

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
09h	-	Send I2C_PWD MSB address
-	ACK	Ninth bit
00h	-	Send I2C_PWD LSB address
-	NoACK	Ninth bit
Stop	-	No PWD programming Device return in Standby

B.7.2 I²C present password

Table 297. Present password (whatever status of I²C security session or fast transfer mode)

Request/Response frame		Comment
Controller drives SDA	Target drives SDA	
Start AEh	-	Device select for writing
-	ACK	Ninth bit
09h	-	Send I2C_PWD MSB address
-	ACK	Ninth bit
00h	-	Send I2C_PWD LSB address
-	ACK	Ninth bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	Ninth bit
I2C_PWD_BYTE_6	DATA 0	Send data
-	ACK	Ninth bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	Ninth bit
09h	-	Present password command
-	ACK	Ninth bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	Ninth bit
I2C_PWD_BYTE_6	-	Send data
-	ACK	Ninth bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	Ninth bit
Stop	-	ST25DV with active I2C_PWD. Result is immediate.

Revision history

Table 298. **Document revision history**

Date	Revision	Changes
23-Feb-2017	1	Initial release.
20-Sep-2017	2	Updated: • Features • Section 4: Memory management • Section 5: ST25DVxxx specific features • Section 5.6.4: System memory protection • Section 6.4.2: I2C Sequential write • Section 6: I2C operation • Section 7: RF operation • Section 9.1: Maximum ratings • Table 158. Get System Info response format Error_flag is NOT set • Table 242. Absolute maximum ratings • Table 244. AC test measurement conditions • Table 246. I^2C DC characteristics (up to 85 °C) • Section 9.2: I^2C parameters • Table 250. GPO DC characteristics up to 85°C • Table 253. RF characteristics • Table 254. Operating conditions • Table 256. TSSOP8 - Mechanical data • Table 261. Ordering information scheme • Figure 30. I^2C Present Password Sequence • Figure 31. I^2C Write Password Sequence • Figure 79. TSSOP8 – Outline Added Table 159. Memory size, Table 243. I^2C operating conditions, Table 247. I^2C DC characteristics (up to 125 °C), Section 9.2: I^2C parameters, and Table 251. GPO DC characteristics up to 125°C.
04-Oct-2017	3	Updated Features and Section 10: Package information. Added NFC certified logo.
19-Dec-2017	4	Added: • Figure 4. 10-ball WLCSP package: connections with CMOS Interrupt output (GPO) • Section 10.5: WLCSP10 package information • Table 259. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale mechanical data • Figure 83. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale package outline • Figure 84. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale recommended footprint Updated Features, Section 1: Description, Section 2.5: Energy harvesting analog output (V_EH), Section 5.3.2: Energy harvesting feature description, Section 6.4.1: I2C Byte write, and Section 6.4.2: I2C Sequential write. Updated Figure 21. Arbitration between RF and I^2C. Updated Table 242. Absolute maximum ratings, Table 243. I^2C operating conditions, and Table 261. Ordering information scheme. Deleted Device summary.
14-Jun-2018	5	Updated: • Table 21. MB_LEN_Dyn • Section 5.1.2: Fast transfer mode usage, Section 5.6.2: Passwords and security sessions, Section 7.6.2: Command codes list, Section 7.6.35: Write Password, and Section 10.5: WLCSP10 package information • Figure 83. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale package outline and Figure 84. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale recommended footprint Added Table 260. WLCSP10 recommended PCB design rules.
01-Aug-2018	6	Updated:

Date	Revision	Changes
		• Section 2.2.2: Low power down (LPD) • Section 5.1.2: Fast transfer mode usage • Section 5.2.3: GPO registers • Figure 22. RF security sessions management • Section 7.6.7: Extended Read Single Block • Section 7.6.9: Extended Write Single Block • Section 7.6.10: Lock Block • Section 7.6.11: Extended Lock block • Section 7.6.13: Extended Read Multiple Blocks • Section 7.6.15: Extended Write Multiple Blocks • Section 7.6.25: Extended Get Multiple Block Security Status • Section 7.6.38: Fast Extended Read Single Block • Section 7.6.40: Fast Extended Read Multiple Block • Section 9.1: Maximum ratings
08-Nov-2018	7	Updated Table 205. Fast Read Message request format and Table 206. Fast Read Message response format when Error_flag is NOT set.
04-May-2020	8	Updated: • Section 2.2.2: Low power down (LPD) • Section 5.4.2: RF management feature description • Section 5.6.2: Passwords and security sessions • Table 79. MEM_SIZE • Table 161. Extended Get System Info request format • Table 231. Fast Write Message response format when Error_flag is set
19-Feb-2021	9	Updated: • Section 4.2.1: User memory areas • Section 5.2.2: GPO and power supply • Section 5.2.3: GPO registers • Section 5.4.2: RF management feature description • Section 6.4: I2C write operations • Section 6.6.1: I2C present password command description • Table 253. RF characteristics
11-Jan-2023	10	Updated Section 1: Description, Section 1.2: ST25DVxxx packaging, Section 3.2: Contactless interface, and Section 7.1.1: Access to an ISO/IEC 15693 device. Updated Table 246. I^2C DC characteristics (up to 85 °C), Table 247. I^2C DC characteristics (up to 125 °C), Section 9.2: I^2C parameters,Section 9.2: I^2C parameters, Table 253. RF characteristics, and their footnotes. Updated . Updated Figure 5. Power-up sequence (no RF field, LPD pin tied to V_{SS} or package without LPD pin), Figure 6. RF power-up sequence (no DC supply), and Figure 75. I^2C AC waveforms. Minor text edits across the whole document.
24-Jan-2023	11	Updated Table 161. Extended Get System Info request format. Minor text edits across the whole document.
03-Nov-2026	12	Updated Section 2.2.2: Low power down (LPD) and Section 9.2: I^2C parameters.

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