AN2091
APPLICATION NOTE

CRX14 vs Short Range Contactless Memory: Description of the I²C Bus Commands

The purpose of this Application Note is to explain how ST Short Range Contactless Memories can be accessed through the I²C bus of the CRX14. It also describes the set of commands used.

INTRODUCTION

To access a Short Range Contactless Memory, the application host microcontroller needs to generate read and write commands on the I²C bus of the CRX14. For that purpose the host has to sequentially generate a list of commands in its software, to perform the actions described below:

- Initialize the CRX14 Parameter Register. When the default value is set:
  - the CRX14 is set to the ISO14443 Type-B mode
  - the external oscillator frequency is 13.56MHz
  - Tag Answer Frames are delimited by SOF (Start Of Frame) and EOF (End Of Frame)
  - the ASK modulation for Request Frames is set to 10%
  - the Output RF signal is OFF
  - a Watchdog delay is set for standard commands
- Switch ON the Output RF signal by setting Parameter Register bit 4 to '1'
- Generate an INITIATE command throught the input/output frame register to put all tag in the INVENTORY state
- Trigger the anti-collision sequence, if needed, with the use of the Slot Marker Register. This sequence allows the application to identify all the tags available and generates a list of Chip_ID.
- Select each identified tags individually, with the use of their own Chip_ID, and access their memory contents using read and write commands.
- Deselect the tags
- Switch the RF signal OFF, if necessary, by resetting Parameter Register bit 4 to '0'.

This Application Note describes all command accesses to the Short Range Contactless Memory, or tag, using the I²C serial bus and RF transmission.

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Anti-collision Access Using the Slot Marker Register (03h)

The Slot Marker Register is used to trigger an automated anti-collision sequence between the CRX14 and any STMicroelectronics Short Range Contactless Memory present in the electromagnetic field. The memory must be in the Inventory state before the anti-collision sequence is initiated. That is, it must have received an INITIATE command.

With one I²C access, the CRX14 launches a complete stream of commands starting with PCALL16(), SLOT_MARKER(1), SLOT_MARKER(2) and ending with SLOT_MARKER(15), and stores all the identified Chip_ID in the Input/Output Frame Register (I²C address 01h). This automated anti-collision sequence simplifies the host software development and reduces the time required to interrogate the 16 slots of the STMicroelectronics anti-collision mechanism. It is located at the I²C address 03h.

When accessed in I²C write mode, the CRX14 starts generating the anti-collision commands sequentially. After each command, the CRX14 waits for the Short Range Contactless Memory Answer Frame that contains the Chip_ID. The validity of the answer is checked and the answer is stored in the corresponding status slot bit (Byte 1 and Byte 2 as described in Table 1.). If the answer is 'OK', the status slot bit is set to '1' and the Chip_ID is stored in the corresponding Slot_Register. If no answer or a CRC error is detected, the status slot bit is set to '0' and the corresponding Slot_Register is set to 00h for "NO ANSWER" or to FFh for "CRC ERROR". Each time the Slot Marker Register is accessed in I²C write mode, Byte 0 of the Input/Output Frame Register is set to '12h', Bytes 1 & 2 provide the status slot information bits and Byte 3 to Byte 18 store the Chip_ID or the error code.

Access in I²C read mode is not possible. To get all the anti-collision data, the Input/Output Frame Register has to be read at the I²C address 01h.

Table 1. Description of the Slot Marker Register in the I²C READ Mode

	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
Byte 0	Number of stored Bytes: fixed to 18							
Byte 1	status Slot bit 7	status Slot bit 6	status Slot bit 5	status Slot bit 4	status Slot bit 3	status Slot bit 2	status Slot bit 1	status Slot bit 0
Byte 2	status Slot bit 15	status Slot bit 14	status Slot bit 13	status Slot bit 12	status Slot bit 11	status Slot bit 10	status Slot bit 9	status Slot bit 8
Byte 3	Slot_Register 0 = Chip_ID value detected in Slot 0							
Byte 4	Slot_Register 1 = Chip_ID value detected in Slot 1							
Byte 5	Slot_Register 2 = Chip_ID value detected in Slot 2							
Byte 6	Slot_Register 3 = Chip_ID value detected in Slot 3							
Byte n	.....							
Byte 17	Slot_Register 14 = Chip_ID value detected in Slot 14							
Byte 18	Slot_Register 15 = Chip_ID value detected in Slot 15							

Status bit value:

- 1: No error detected. The Chip_ID stored in the Slot Register is valid.
- 0: Error detected
- Slot Register = 00h: No answer frame detected from the Short Range Contactless Memory
- Slot Register = FFh: Answer Frame detected with a CRC error. Collision may occur

Figure 1. Start of the Anti-Collision TAG Sequence

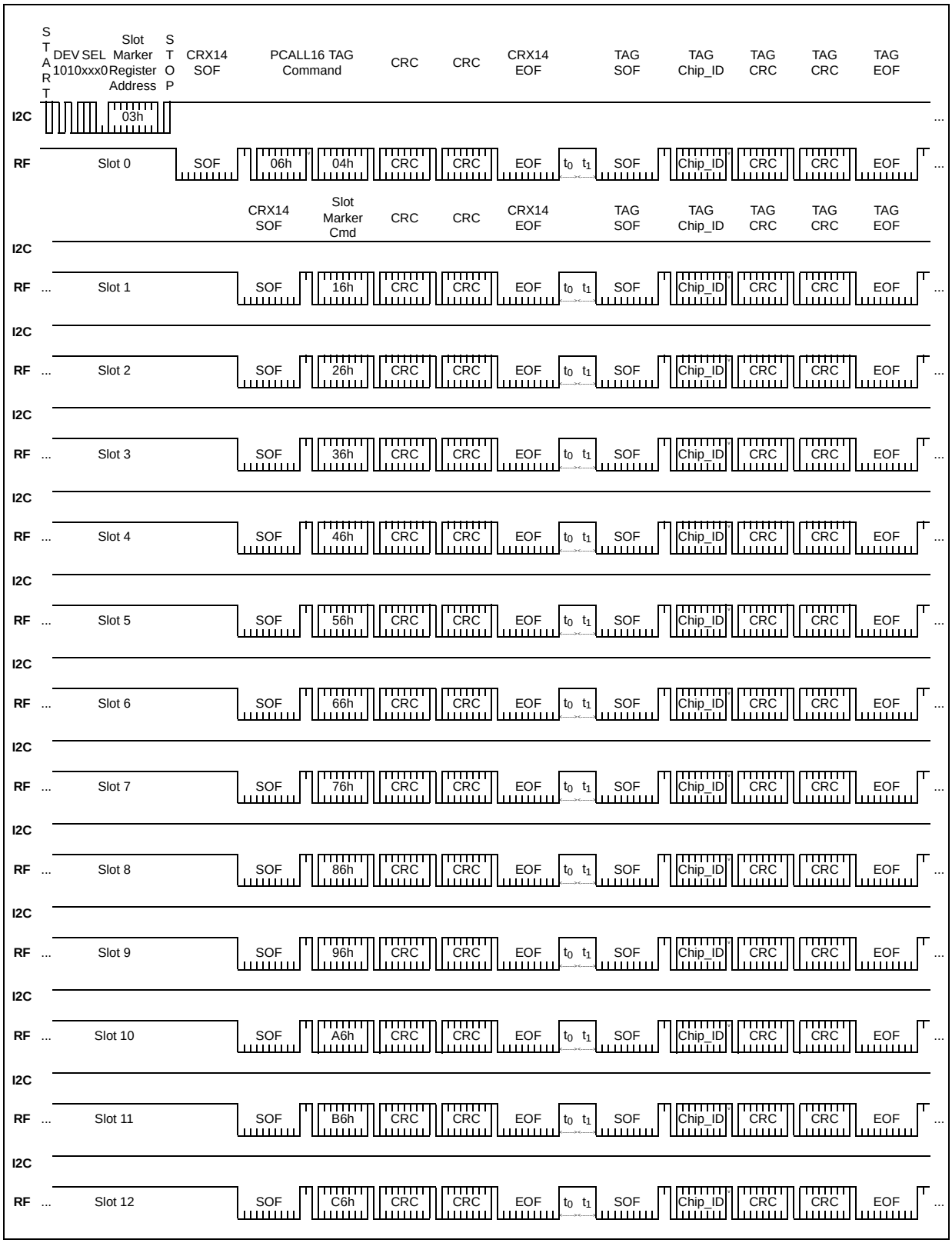
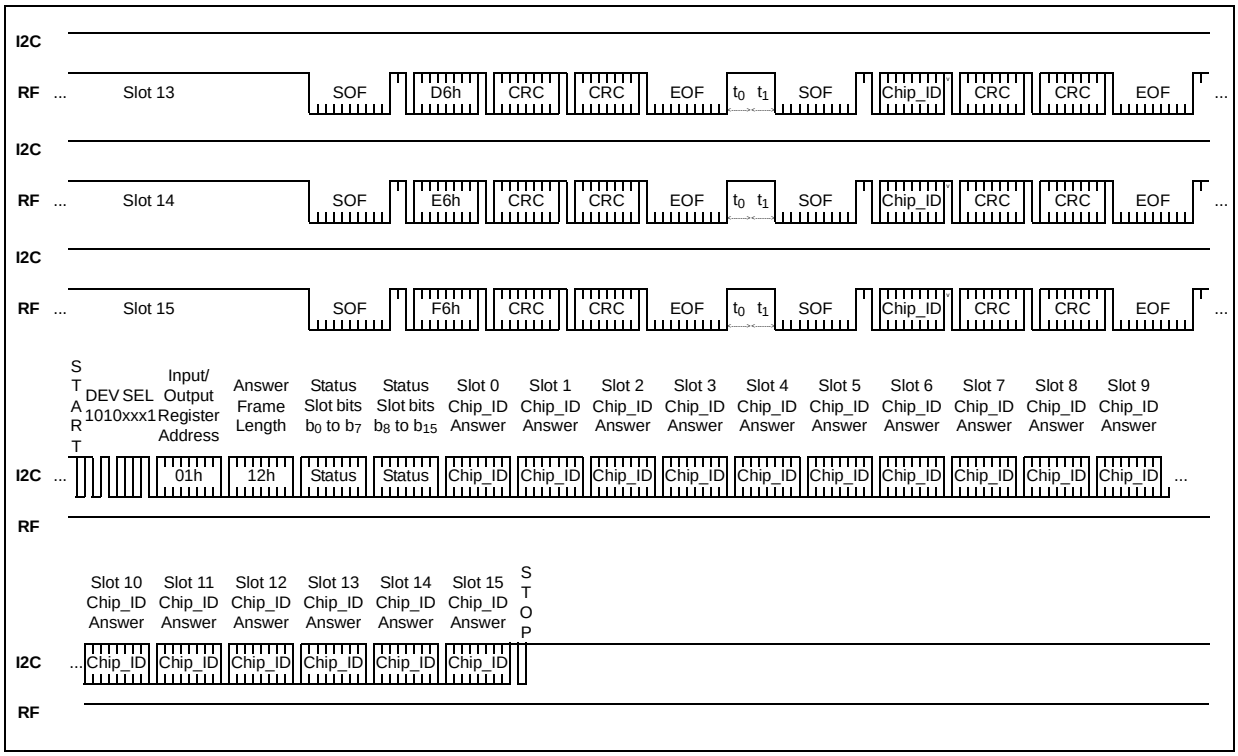


Figure 2. End of the Anti-Collision TAG Sequence



- Anti-collision access is supported by the following Short Range Contactless Memories:
  - SRIX512
  - SRIX4K

Input/Output Frame Register (01h)

The Input/Output Frame Register is a 36-Byte buffer located at the I²C address 01h. It is accessed serially from Byte 0 up to Byte 35. The first Byte (Byte 0) is used to store the frame length for both transmission and reception.

The Input/Output Frame Register is used by the CRX14 to store the data Bytes of the Request Frame to be sent to the Short Range Contactless Memory.

The data Bytes of the Answer Frame received from the Short Range Contactless Memory are stored automatically by the Input/Output Frame Register.

When accessed in I²C write mode, the Input/Output Frame Register stores the Request Frame Bytes that are transmitted to the Short Range Contactless Memory. The Request Frame length (in Bytes) must be written to Byte 0, the Request Frame Bytes are stored from Byte 1. At the end of the transmission, the 16-bit CRC is automatically added by the CRX14. After the transmission, the CRX14 waits for the Short Range Contactless Memory to send back an Answer Frame. Once this has been correctly decoded, the Bytes it contains are stored into the Input/Output Frame Register from Byte 1. Byte 0 contains the number of Bytes received from the Short Range Contactless Memory.

When accessed in I²C read mode, the Input/Output Frame Register sends back the Short Range Contactless Memory Answer Frame Bytes last received, if any, with Byte 0 transmitted first. The 16-bit CRC is not stored nor sent back on the I²C bus.

The Input/Output Frame Register is set to all 00h between transmission and reception. If there is no answer from the Short Range Contactless Memory, Byte 0 is set to 00h. In the event of a CRC error, Byte 0 is set to FFh, data are discarded and they are not stored into the register.

Table 2. Description of the Input/Output Frame Register

Byte 0	Byte 1	Byte 2	Byte 3	...	Byte 34	Byte 35
Frame Length	**First data byte**	**Second data byte**				**Last data byte**
	<---------- Request and Answer Frame bytes exchanged through the RF ---------->					
00h	No byte transmitted					
FFh	CRC Error					
xxh	Number of transmitted bytes					

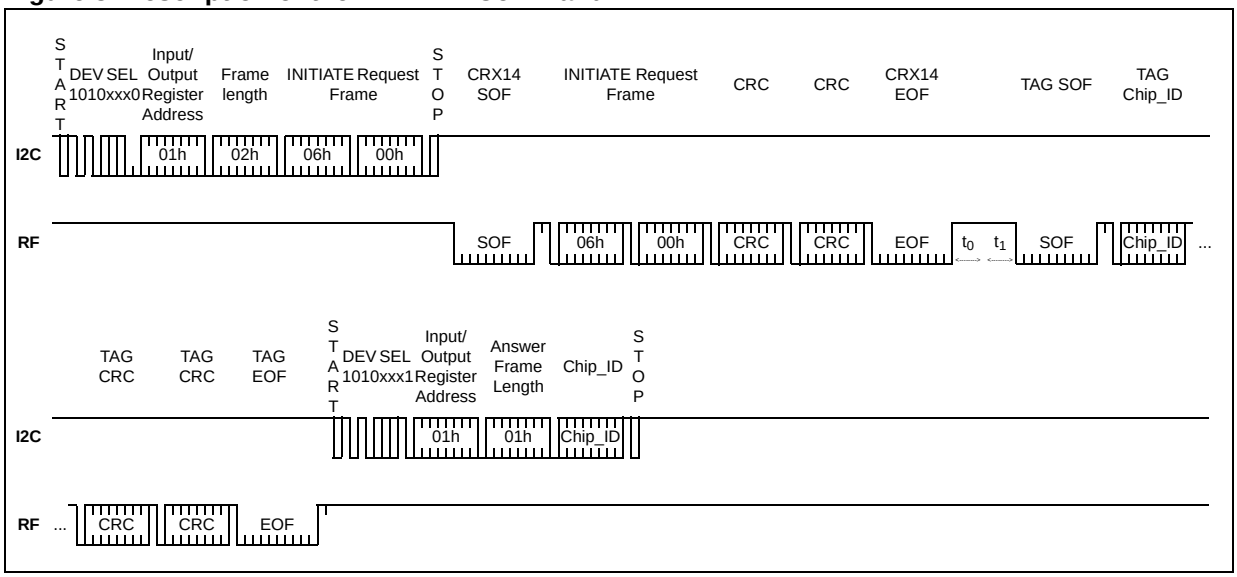
SHORT RANGE CONTACTLESS MEMORY COMMAND SET USING THE CRX14 I²C ACCESS

INITIATE() Command

Command Code = 06h - 00h

INITIATE() is used to initiate the anti-collision sequence of the Short Range Contactless Memory. When receiving the INITIATE() command, all tags in the READY state switch to the INVENTORY state and return their Chip_ID value. This command is useful specially when there is only one tag in the READY state in the CRX14 field range. In this way the Chip_ID of the tag is returned immediately.

Figure 3. Description of the INITIATE Command



- The INITIATE() command is supported by the following Short Range Contactless Memories:
  - SR176
  - SRIX512
  - SRIX4K

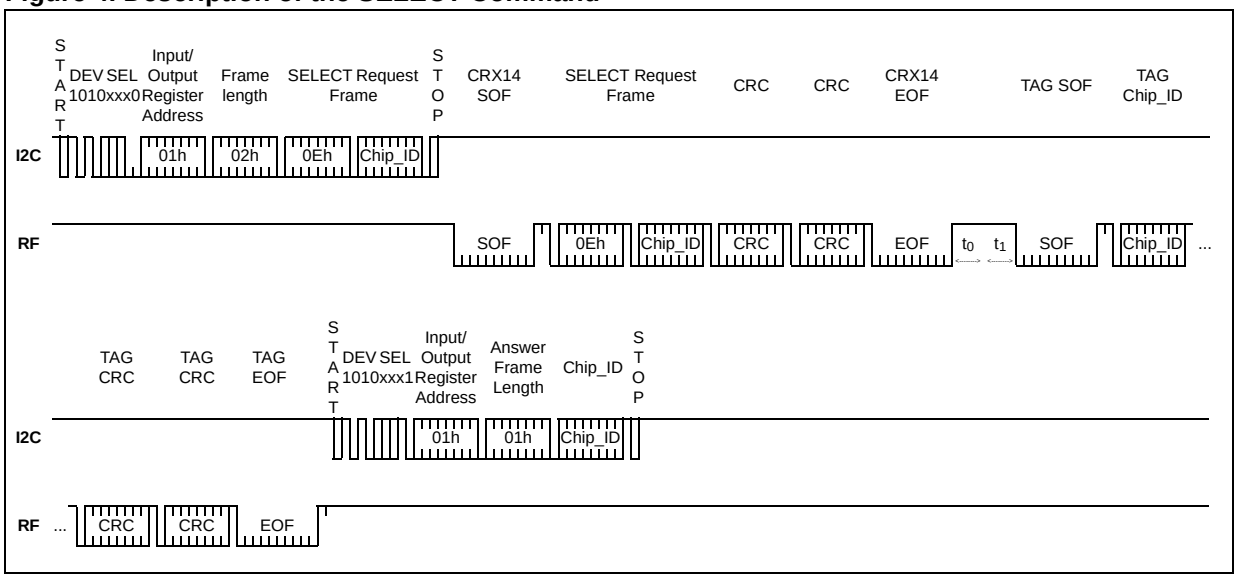
SELECT() Command

Command Code = 0Eh

The SELECT() command is used to place a specific tag in the SELECTED state, where it will respond to all commands. A tag that is not in the SELECTED state will respond only to the INITIATE(), PCALL16() and SLOT_MARKER() commands, all other commands will be ignored.

The SELECT() command contains the 8-bit Chip_ID of the tag to be placed in the SELECTED state. A tag in the SELECTED state that receives a SELECT() command that does not match its Chip_ID will automatically revert to the DESELECTED state.

Figure 4. Description of the SELECT Command



- The SELECT() command is supported by the following Short Range Contactless Memories:
  - SR176
  - SRIX512
  - SRIX4K

COMPLETION() Command

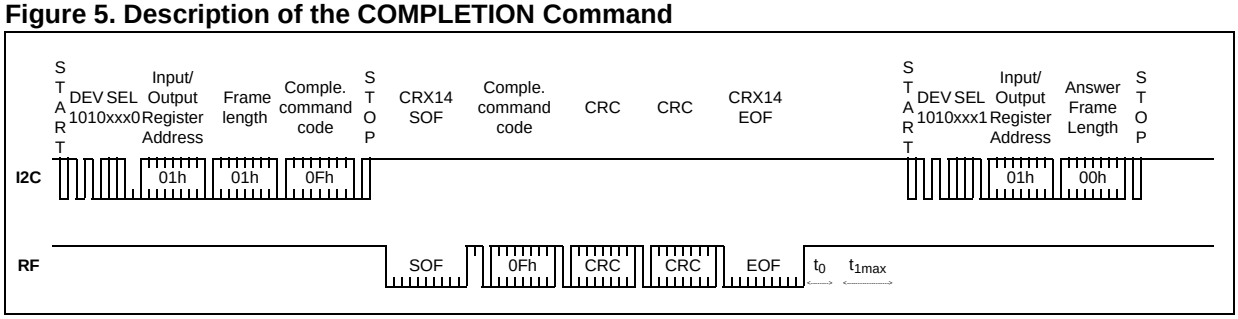
Command Code = 0Fh

The COMPLETION() command is used to switch the Short Range Contactless Memory in the SELECTED state to the DE-ACTIVATED state where it will not decode any further commands. The Short Range Contactless Memory is then locked in the DE-ACTIVATED state until a complete reset is done (tag taken out of the field range).

The COMPLETION() command makes it possible to access a new memory by sending a SELECT() command, without having to remove the previous memory from the field. The COMPLETION() command does not generate any response from the memory.

All Short Range Contactless Memories that are not in the SELECTED state when the COMPLETION() command is issued, ignore the command.

Figure 5. Description of the COMPLETION Command



- The COMPLETION() command is supported by the following Short Range Contactless Memories:
  - SR176
  - SRIX512
  - SRIX4K

RESET_TO_INVENTORY() Command

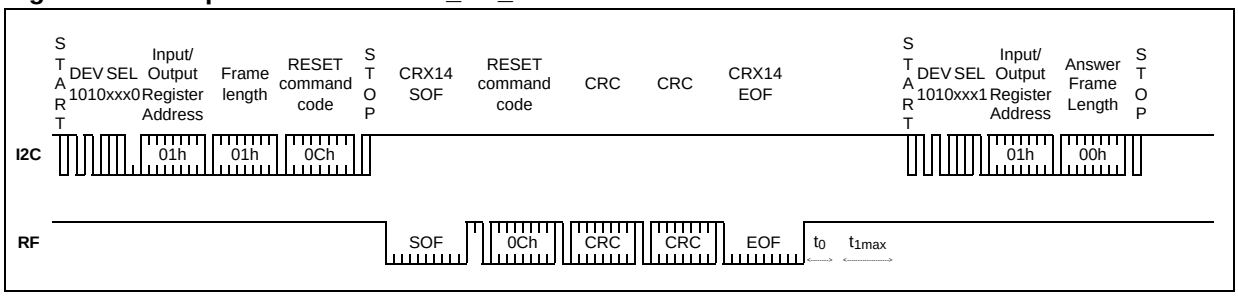
Command Code = 0Ch

The RESET_TO_**INVENTORY**() command is used to switch the Short Range Contactless Memory in the SELECTED state to the INVENTORY state. In this way the Short Range Contactless Memory is re-introduce into the anti-collision sequence. This command is useful when two memories with the same 8-bit Chip_ID are in the SELECTED state at the same time. Forcing the memories back to the anti-collision sequence allows the reader to generates new PCALL16() commands and so to set new random Chip_ID.

The RESET_TO_INVENTORY() does not generate any response from the memory.

All Short Range Contactless Memories that are not in the SELECTED state ignore the RESET_TO_**INVENTORY**() command.

Figure 6. Description of the RESET_TO_INVENTORY Command



- The RESET_TO_INVENTORY() command is supported by the following Short Range Contactless Memories:
  - SRIX512
  - SRIX4K

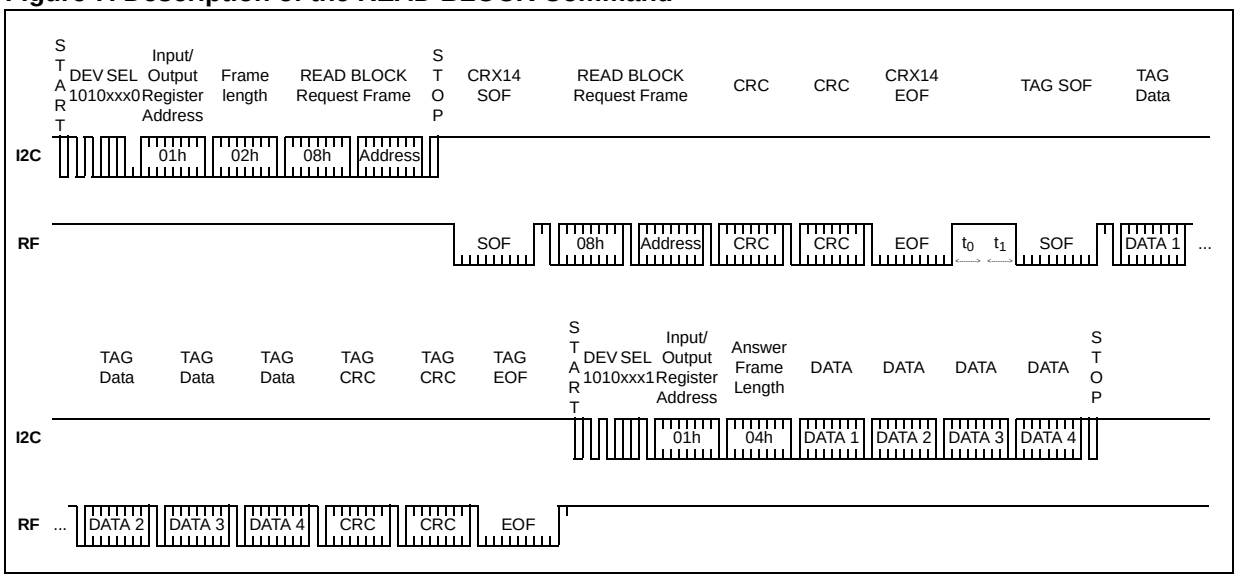
READ_BLOCK() command

Command Code = 08h

The READ_BLOCK command is used to read a specific Short Range Contactless Memory block. On receiving the command, the memory reads the desired block and returns the 4 data Bytes in its response. The data Bytes are transmitted Least Significant Byte (LSByte) first and each Byte is transmitted Least Significant Bit (LSBit) first. The READ_BLOCK Request Frame contains the address Byte used to access the desired Short Range Contactless Memory block.

The Short Range Contactless Memory must be placed in the SELECTED state by a SELECT() command before it can respond to any READ_BLOCK() command. Otherwise the Short Range Contactless Memory ignores the command.

Figure 7. Description of the READ BLOCK Command



- The READ_BLOCK() command is supported by the following Short Range Contactless Memories:
  - SR176
    Note: The SR176 Block length is 2 Bytes and not 4 Bytes as described above.
  - SRIX512
  - SRIX4K

WRITE_BLOCK() Command

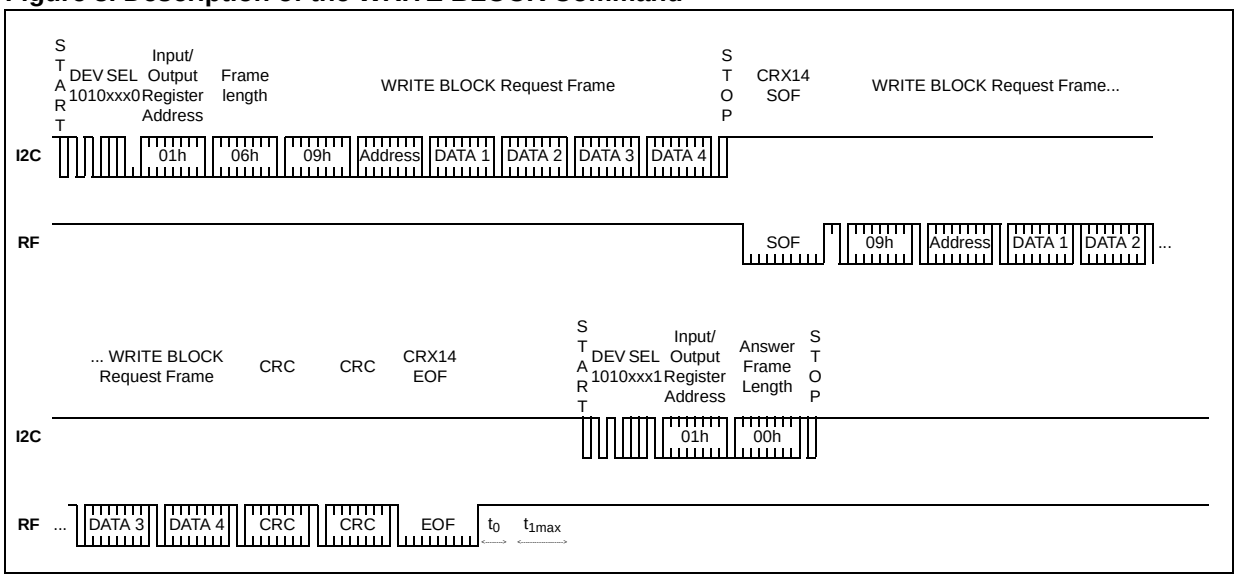
Command Code = 09h

The WRITE_BLOCK() command is used to write to a specific Short Range Contactless Memory block. On receiving the command the memory writes the 4-Byte data sent in the command to the addressed block, unless the block is unavailable or write-protected. Refer to the corresponding Short Range Contactless Memory datasheet for details of the block behavior when it is write-protected.

The data Bytes are transmitted Least Significant Byte (LSByte) first and each Byte is transmitted Least Significant Bit (LSBit) first. The WRITE_BLOCK Request Frame contains the address Byte used to access the desired Short Range Contactless Memory block.

The Short Range Contactless Memory must be placed in the SELECTED state by a SELECT() command before it can respond to any WRITE_BLOCK() command. Otherwise the Short Range Contactless Memory ignores the command.

Figure 8. Description of the WRITE BLOCK Command



- The WRITE_BLOCK() command is supported by the following Short Range Contactless Memories:
  - SR176
    Note: The SR176 Block length is 2 Bytes and not 4 Bytes as described above.
  - SRIX512
  - SRIX4K

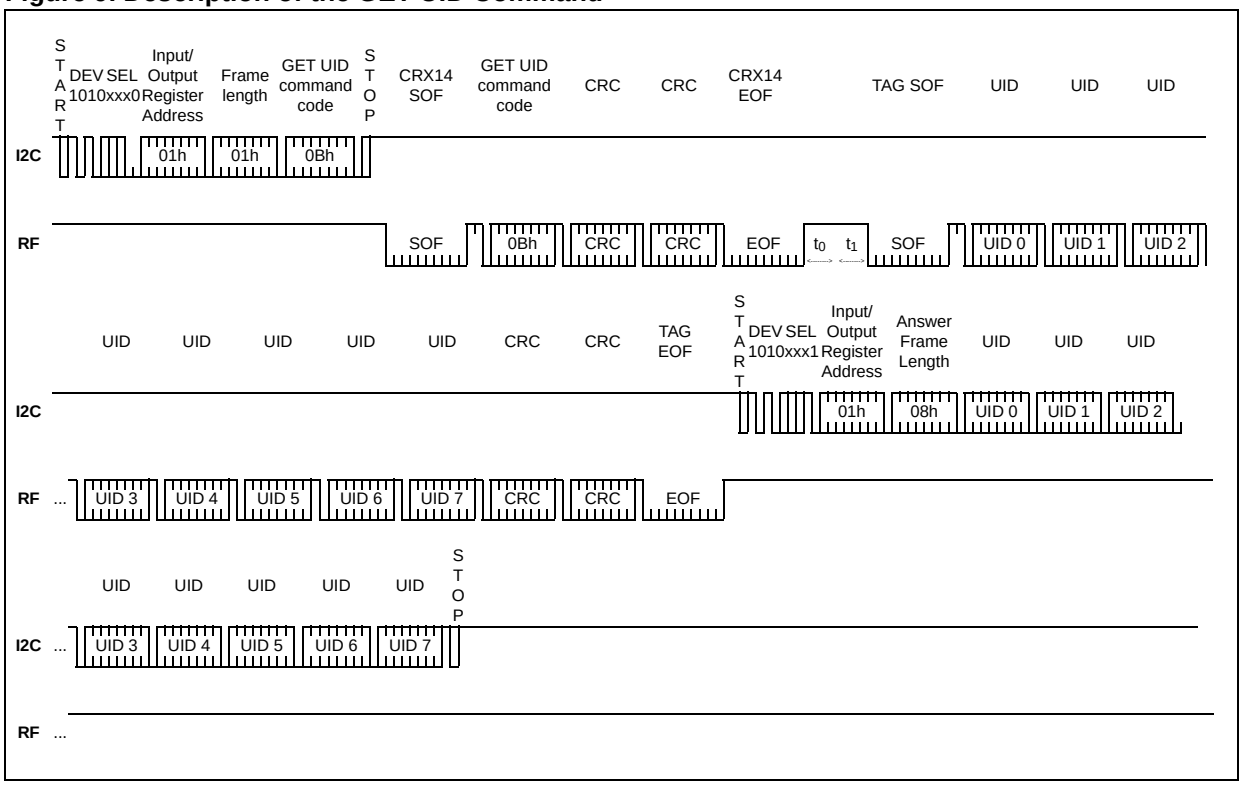
GET_UID() Command

Command Code = 0Bh

The GET_UID command is used to obtain the Short Range Contactless Memory's 8 UID Bytes. On receiving the command, the memory sends its 8 UID Byte value in the response. The UID Bytes are transmitted Least Significant Byte (LSByte) first and each Byte is transmitted Least Significant Bit (LSBit) first.

The Short Range Contactless Memory must be placed in the SELECTED state by a SELECT() command before it can respond to any GET_UID() command. Otherwise the Short Range Contactless Memory ignores the command.

Figure 9. Description of the GET UID Command



- The GET_UID command is supported by the following Short Range Contactless Memories:
  - SRIX512
  - SRIX4K

REVISION HISTORY

Table 3. Document Revision History

Date	Version	Revision Details
03-Jan-2004	1.0	First Issue

If you have any questions or suggestions concerning the matters raised in this document, please refer to the MPG request support web page:

http://www.st.com/askmemory