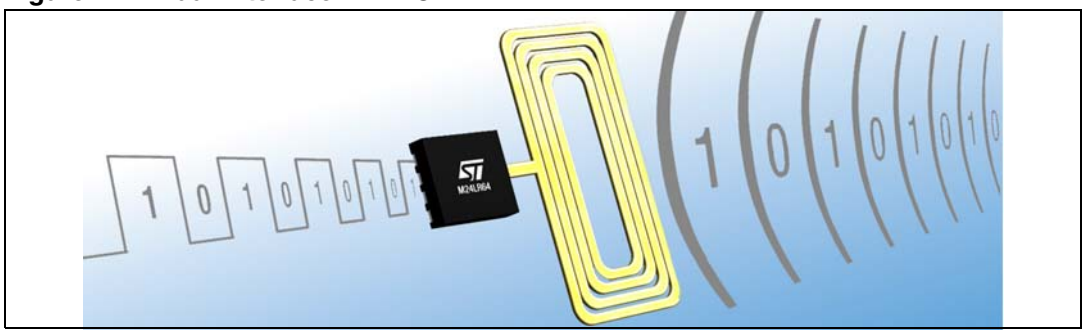
AN3163
Application note

Configuring your ISO 15693 reader to support the M24LRxx-R and M24LRxxE-R devices

Introduction

The M24LRxx-R or M24LRxxE-R device is a dual-interface EEPROM from STMicroelectronics. It consists of an EEPROM memory bank that can be accessed via either a wired interface or an RF interface. Different sizes of memory exist: 4-Kbit, 16-Kbit, and 64-Kbit.

Figure 1. Dual-interface EEPROM



The RF interface of the M24LRxx-R or M24LRxxE-R device:

- is based on a passive RFID technology supporting the ISO 15693 standard
- communicates with ISO 15693 RF systems (called RFID readers)
- only requires an antenna to operate. The energy and data come from the RFID reader.

The aim of this application note is to explain the software upgrades to be brought to standard ISO 15693 RF readers for them to support the M24LRxx-R or M24LRxxE-R IC. It also provides a short list of these upgrades. The inventory commands remain unchanged. Access to the IC information and memory requires a dedicated management of the Request_flag and addressing format.

To benefit from the M24LRxx advanced features, you have to implement the corresponding custom commands.

Reference documents available from www.st.com

- M24LRxx-R or M24LRxxE-R application software user guide.

Table 1 lists the products concerned by this application note.

Table 1. Applicable products

Type	Applicable products
Dual interface EEPROMs	M24LRxx-R, M24LRxxE-R

Note: The standard M24LRxx-R and energy-harvesting M24LRxxE-R devices will be referred to as M24LRxx devices throughout the document.

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1 Accessing the M24LRxx memory

Access to the memory contents of the M24LRxx dual-interface memory is a three-step process:

1. Inventory of the tags present in the reader field:

   This is performed by **ISO 15693 RF readers**, by using the standard Inventory command or, if the population is already known, by issuing a product-dedicated command like Initiate, Inventory Initiated, Fast Initiate or Fast Inventory Initiated. These commands are all available with the M24LRxx.

Table 2. 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	

   At this step, **ISO 15693 RF readers** knows all tags present in its RF field.

   The unique identifier (UID) specifies the chip provider, and the data storage format identifier (DSFID) indicates the data storage organization.

   Your **ISO 15693 RF reader** is now ready to manage the tag population by using the mandatory or optional commands (Select, Stay Quiet, Reset to Ready) to access a single tag (M24LRxx).

2. Recognition of the chip and its data structure:

   Once the tag has been isolated, the **ISO 15693 RF reader** can access it and get an overview of the device capability by using the Get System Info command.

   The “memory size” of the M24LRxx needs to be coded on 3 bytes. To tell the **ISO 15693 RF reader** that it will receive one more byte than usual, the Get System Info command requests the setting of the Protocol_Extension _flag (bit 4) to ‘1’ in the Request_flag byte preceding the command code. (See *Table 5: Definition of request flags when the Inventory_flag is NOT set*.)

   An **ISO 15693 RF reader** looking for M24LRxx devices has to issue the Get System Info command with the Protocol_Extension _flag at ‘1’ to receive a valid response. (The reader can also alternate the value of the Protocol_Extension_flag, to detect other devices.)

Table 3. Get System Info request format

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

1. See *Table 5: Definition of request flags when the Inventory_flag is NOT set*.
2. Gray means that the field is optional.

Table 4. Get System Info response format when Error_flag is NOT set

Response SOF	Response _flags	Information flags	UID	DSFID	AFI	Memory Size	IC reference	CRC16	Response EOF
	00h	0Fh	64 bits	8 bits	8 bits	0307FFh	2Ch	16 bits	

The M24LRxx is now clearly recognized by the **ISO 15693 RF reader** via its IC reference code (2Ch).

The **ISO 15693 RF reader** can now use the M24LRxx's custom set of commands and make the most of the M24LRxx's broad data management capability.

Table 5. Definition of request flags when the Inventory_flag is NOT set

Bit No	Flag	Level	Description
Bit 1	Subcarrier_flag(1)	0	A single subcarrier frequency is used by the M24LRxx
		1	Two subcarrier frequencies are used by the M24LRxx
Bit 2	Data_rate_flag(2)	0	Low data rate is used
		1	High data rate is used
Bit 3	Inventory_flag	0	Defines the meaning of flags 5 to 8 as described below.
Bit 4	Protocol_extension_flag	0	No Protocol format extension
		1	Protocol format extension
Bit 5	Select flag(3)	0	The request is executed by any M24LRxx according to the setting of Address_flag
		1	The request is executed only by the M24LRxx in Selected state
Bit 6	Address flag(3)	0	The request is not addressed. UID field is not present. The request is executed by all M24LRxxs.
		1	The request is addressed. UID field is present. The request is executed only by the M24LRxx 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. Subcarrier_flag refers to the M24LRxx-to-VCD communication.
2. Data_rate_flag refers to the M24LRxx-to-VCD communication
3. 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.

3. Access to the user memory:

   The **ISO 15693 RF reader** is now able to use the extended command set provided with the M24LRxx to access and manage its memory contents:

Present-sector Password, Read Single Block, Read Multiple Block, Fast Read Single Block, Fast Read Multiple Block and Write Single Block commands.

ISO 15693 RF readers are designed to manage data memories of up to 8 Kbits when using 32-bit blocks.

To manage the M24LRxx which offers a memory capacity of 64 Kbits, we have extended the addressing capability of ISO 15693 by modifying the optional commands (Read Single Block, Write Single Block & Read Multiple Block), and the custom commands (Fast Read Single Block and Fast Read Multiple Block).

For all these commands, an **ISO 15693 RF reader** must set the Protocol-extension (bit 4) to '1' in the Request_Flag and code the first block number on two bytes (16 bits).

Command codes and other parameters remain unchanged.

Table 6. 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	16 bits	8 bits	16 bits	

1. Gray means that the field is optional.

The response format remains unchanged.

Table 7. Read Multiple Block response format when Error_flag is NOT set

Response SOF	Response _flags	Sector security status(1)	Data	CRC16	Response EOF
	8 bits	8 bits(2)	32 bits(2)	16 bits	

1. Gray means that the field is optional.
2. Repeated as needed.

2 Configuring your M24LRxx and managing user's access rights

The **M24LRxx** can be customized by using optional commands:
Write AFI, Lock AFI, Write DSFID, Lock DSFID.

The **M24LRxx** provides useful security features that manage the memory access rights per sector: Write-sector Password, Lock-sector Password, Present-sector Password, Get Multiple Block Security Status.

- For the Lock-sector Password command, the Protocol_extension_flag (bit 4) in the Request_flag must be set to '1' and "Sector number" must be coded on two bytes (16 bits).

Table 8. Lock-sector Password request format

Request SOF	Request _flags	Lock-sector Password	IC Mfg code	UID(1)	Sector number	Sector security status	CRC16	Request EOF
	8 bits	B2h	02h	64 bits	16 bits	8 bits	16 bits	

1. Gray means that the field is optional.

- For the Get Multiple Block Security Status command, the Protocol_extension_flag (bit 4) in the Request_flag must be set to '1', "First block number" and "Number of blocks" must be coded on two bytes (16 bits).

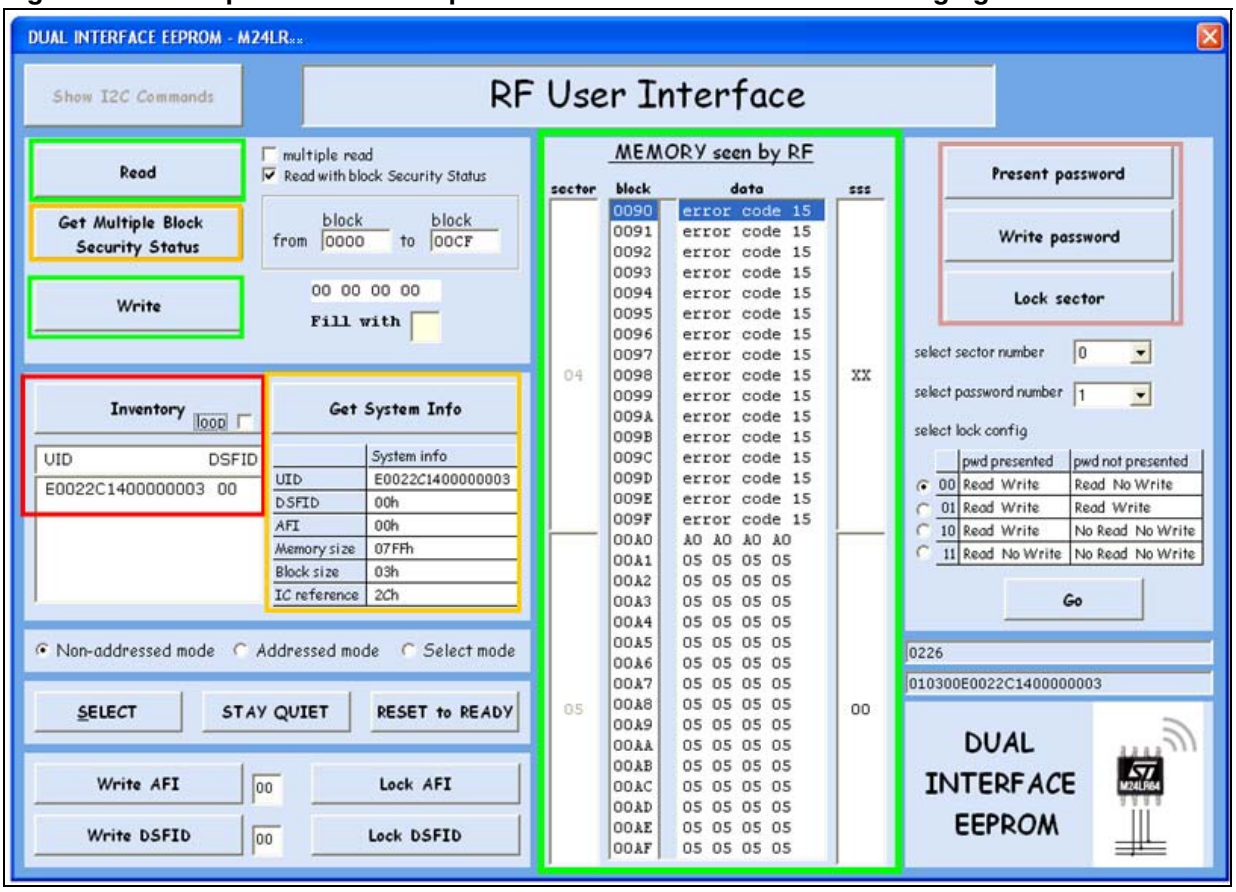
Table 9. Get Multiple Block Security Status request format

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	16 bits	16 bits	16 bits	

1. Gray means that the field is optional.

Figure 2 shows an example of data received by an ISO 15693 RF reader from an M24LRxx tag.

Figure 2. Example of the control panel of an ISO 15693 RF reader managing an M24LRxx



The Inventory command is used to identify the dual-interface memory: this command is framed in red in *Figure 2*. To issue this command, no update is required (see *Table 2: Inventory request format*).

The Get System Info command is used to get information on the dual-interface memory: this command is framed in orange in *Figure 2*. When issuing the command, the RF reader needs to set the Protocol_Extension_flag bit (bit 4) in the Request_flags (see *Table 3: Get System Info request format*).

The Read and Write Multiple Block commands are used to access or modify the dual-interface memory contents: these commands are framed in green in *Figure 2*. When issuing the commands, the RF reader needs to set the Protocol_Extension_flag bit (bit 4) in the Request_flags and to code the first block number on two bytes (see *Table 6: Read Multiple Block request format*).

The Lock-sector Password command is used to manage the dual-interface memory sector protection: this command is framed in pink in *Figure 2*. When issuing the command, the RF reader needs to set the Protocol_Extension_flag bit (bit 4) in the Request_flags (see *Table 8: Lock-sector Password request format*).

3 ISO 15693 RF reader upgrades

Summary of upgrades to be brought to standard ISO 15693 RF readers to make them support M24LRxx devices:

- Set the Protocol _extension_flag to ‘1’ in the Get System Info command (2Bh): “Memory size” in the response will subsequently be coded on 3 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Get Multiple block Security Status command (2Ch) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Read Single block command (20h) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Fast Read Single block command (C0h) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Write Single block command (21h) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Read Multiple block command (23h) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Fast Read Multiple block command (C3h) and code “first block number” on 2 bytes.
- Set the Protocol _extension_flag to ‘1’ in the Lock Sector Password command (B2h) and code “Sector number” on 2 bytes.

The Request_flags settings of the custom commands should be as follows. Please check the flag values when using the commands:

- **Inventory commands:** Inventory, Inventory Initiated, Fast Inventory Initiated

  Table 10 shows the values of the flags for Inventory commands.

Table 10. Flags for inventory commands

RFU(B8)	Op	Slot	AFI	Prot Ext	INV	D R	S C (B1)
0	0	x	x	0	1	x	x

- **Read commands:** Read Single Block, Read Multiple Block, Fast Read Single Block, Fast Read Multiple Block (Option: add Status to the reply).

  Table 11 shows the values of the flags for read commands.

Table 11. Flags for read commands

RFU(B8)	Op	Add	Sel	Prot Ext	INV	D R	S C (B1)
0	x	x	x	1	0	x	x

- **Info commands:** Get System Info, Get Multiple Block Security Status.
  Table 12 shows the values of the flags for Info commands.

Table 12. Flags for Info commands

RFU(B8)	Op	Add	Sel	Prot Ext	INV	D R	S C (B1)
0	0	x	x	1	0	x	x

- **Write Single Block command** (Option: Reply after marker).
  Table 13 shows the values of the flags for the Write Single Block command.

Table 13. Flags for the Write Single Block command

RFU(B8)	Op	Add	Sel	Prot Ext	INV	D R	S C (B1)
0	x	x	x	1	0	x	x

- **Other write commands:** Write AFI, Lock AFI, Write DSFID, Lock DSFID. Write-sector Password, Lock-sector Password, Present-sector Password (Option: Reply after marker).
  Table 14 shows the values of the flags for other write commands.

Table 14. Flags for other write commands

RFU(B8)	Op	Add	Sel	Prot Ext	INV	D R	S C (B1)
0	x	x	x	0	0	x	x

- **Other commands:** Stay Quiet, Select, Reset to Ready, Initiate, Fast initiate.
  Table 15 shows the values of the flags for other commands.

Table 15. Flags for other commands

RFU(B8)	Op	Add	Sel	Prot Ext	INV	D R	S C (B1)
0	0	x	x	0	0	x	x

The various command codes are summarized in *Table 16*.

Table 16. Command codes

Command code standard	Function
01h	Inventory
02h	Stay Quiet
20h	Read Single Block
21h	Write Single Block
23h	Read Multiple Block
25h	Select

Command code custom	Function
2Ch	Get Multiple Block Security Status
B1h	Write-sector Password
B2h	Lock-sector Password
B3h	Present-sector Password
C0h	Fast Read Single Block
C1h	Fast Inventory Initiated

Table 16. Command codes (continued)

Command code standard	Function
26h	Reset to Ready
27h	Write AFI
28h	Lock AFI
29h	Write DSFID
2Ah	Lock DSFID
2Bh	Get System Info

Command code custom	Function
C2h	Fast Initiate
C3h	Fast Read Multiple Block
D1h	Inventory Initiated
D2h	Initiate

For all the commands that appear in gray in *Table 16*, changes should be made to the ISO 15693 RF reader's request frames for the reader to support the M24LRxx.

4 Revision history

Table 17. Document revision history

Date	Revision	Changes
26-Feb-2010	1	Initial release.
24-Oct-2012	2	M24LR64-R replaced by M24LRxx-R and M24LRxxE-R on the cover page, then by M24LRxx (see *Note:*). On the cover page: - Added different EEPROM sizes to the *Introduction*. - Edited *Reference documents available from www.st.com*. - Added *Table 1: Applicable products*.