AN3408
Application note

Using LRIxx, LRISxx and M24Lxx-R products as NFC vicinity tags

Introduction

The NFC technology allows accessing standard ISO/IEC 15693 products such as STMicroelectronics Dual interface EEPROMs (M24LR04E-R, M24LR16E-R and M24LR64E-R) and ST ISO/IEC 15693 RFID tag products (LRI1K, LRI2K, LRIS2K and LRIS64K).

The NFC forum specifies a data structure standard named NDEF allowing user data exchange. Data can be either text, URI or picture.

RFID or NFC tag memory can embed NDEF messages and share it with different hosts (reader, mobile phone).

This application note explains how to apply the NDEF format to STMicroelectronics ISO/IEC 15693 products (LRI1K, LRI2K, LRIS2K, LRIS64K and M24LR64-R).

Reference documents

- ISO/IEC standards
  - [15693-3]: ISO/IEC 15693-3: Identification cards - Contactless integrated circuit(s) cards - Vicinity cards - Part 3: Anti-collision and transmission protocol
- NFC forum documents
  - [NDEF]: NFC Data Exchange Format (NDEF) Technical Specification; NFC Forum™; NDEF 1.0
  - [URI]: URI Record Type Definition document; NFC Forum™
  - [RTD] : NFC Record Type Definition; NFC forum
  - [BLUETOOTH] : Bluetooth Secure Simple Pairing Using NFC; NFC forum
  - [TEXT] : Text Record Type Definition; NFC forum
  - [TAG-2]: Type 2 Tag Operation Technical Specification; NFC Forum™; 1.1
- ST documents
  - LRI1K datasheet
  - LRI2K datasheet
  - LRIS2K datasheet
  - LRIS64K datasheet
  - M24LR64-R datasheet

Table 1 lists the products concerned by this application note.

Table 1. Applicable products

Type	Applicable products
Dual interface EEPROMs	M24LR04E-R, M24LR16E-R and M24LR64E-R
RFID & RF Memory ICs	LRI1K, LRI2K, LRIS2K and LRIS64K

Contents

List of tables

1 Memory organization for STMicroelectronics ISO/IEC 15693 products

The ST ISO/IEC 15693 contactless tag (LRI1K, LRI2K, LRIS2K, LRIS64K) and the dual interface memory (M24LR04E-R, M24LR16E-R and M24LR64E-R) is divided into three different areas:

- User memory area, where the user can read and write data.
- System area, which contains UID, DSFID and AFI fields.
- Protection system area, which contains the user memory area protection.

Access rights to the different memory fields are given in *Table 2*.

Table 2. Access rights to memory fields

Operation	User memory area	System area		Protection system
		UID	DSFID and AFI	
Read	Yes	Yes	Yes	Yes
Write	Yes	No	Yes	Yes
Lock	Yes	Locked by IC manufacturer	Yes	NA

For more details on the protection system, refer to the corresponding STMicroelectronics datasheet.

1.1 User memory area

The user memory stores NDEF messages. This area can be write-protected by the user.

The user memory size depends on ISO/IEC 15693 contactless tag, as shown in *Table 3*.

Table 3. ST ISO/IEC 15693 memory size

	LRI1K	LRI2K	LRIS2K	LRIS64K	M24LR04E-R	M24LR16E-R	M24LR64E-R
User memory size	1 kbit	2 kbits	2 kbits	64 kbits	2 kbits	16 kbits	64 kbits
	128 bytes	256 bytes	256 bytes	8192 bytes	512 bytes	2048 bytes	8192 bytes
First RF block	0	0	0	0	0	0	0
Last RF block	31	63	63	2047	127	511	2047
NDEF memory size	128 bytes (1)	256 bytes (1)	256 bytes (1)	8192 bytes (1) (2)	512 bytes (1)	2048 bytes (1) (2)	8192 bytes (1) (2)

1. NDEF memory size includes User area and CC field memory area.
2. If NDEF message size exceeds 2040 bytes, bit 2 of CC3 shall be set (see *Chapter 2.2: Capability container field*).

Note: M24LR64E-R and M24LR16E-R have a specific format for read and write commands. Their block number is coded on two bytes instead of one. For more details, refer to LRIS64K, M24LR16E-R and M24LR64E-R datasheets.

1.2 DSFID and AFI system area

For more details on DSFID and AFI system area, please refer to the corresponding STMicroelectronics datasheet.

1.3 Unique identifier

The unique identifier (UID) is an 8-byte field used to identify an IC. The UID is defined by the IC manufacturer and is write-protected.

The UID bytes are given in *Table 4*. The first byte value is fixed to 0xE0, and the second byte value contains the IC manufacturer code.

Table 4. UID field description

UID 7	UID 6	UID 5	UID 4-0
0xE0	IC manufacturer code	IC product code	Contactless tag unique number

Note: The IC manufacturer code of STMicroelectronics is 0x02 on 8 bits (refer to [15693-3] *– on page 1).*

Table 5. IC product code for ISO15639 STMicroelectronics products

	LRI1K	LRI2K	LRIS2K	LRIS64 K(1)	M24LR64-R(1)	M24LR04 E-R	M24LR64 E-R	M24LR16 E-R
UID 5 (1 byte)	0b010000xx	0b001000xx	0b001010xx	0x44	0x2C	0x2C	0x2C	0x4E

1. M24LR64-R and LRIS64k have an extended addressing mode; refer to product datasheet.

1.4 Protection system

The user memory area of ISO/IEC 15693 STMicroelectronics products can be write-protected. The granularity of the protection can be either 4 bytes or 128 bytes as defined in *Table 6* below.

Table 6. ST ISO/IEC 15693 sector size

	LRI1K	LRI2K	LRIS2K	LRIS64K	M24LR4E-R	M24LR16E-R	M24LR64 E-R
Memory block size	4 bytes			128 bytes			

For more details on the protection system, please refer to the corresponding STMicroelectronics datasheet.

- The LRIS64K and M24LRxx memory write-protected granularity is the sector.
- The LRI1K, LRI2K and LRIS2K memory write-protected granularity is the block.

2 NDEF data

NDEF, which stands for NFC data exchange, is a data format defined by the NFC forum. This format defines a message encapsulation format to exchange information between a reader and a contactless tag.

NDEF can be used to exchange different types of information such as text, URI and others. This chapter details NDEF for the following types of information:

- text
- URI
- vCard, which is a virtual business card
- Bluetooth, that allows to carry out the pairing between two bluetooth devices.

2.1 Overview

NDEF data is composed of:

- Capability container
- TLV field, which includes the NDEF message.

The TLV field is located after the CC field. The size of a TLV field is computed according to the CC2 byte value.

2.2 Capability container field

The Capability container field (CC field) is a 4-byte field that contains an identification value used to store an NDEF message. The signification of each byte is explained in *Table 7*.

Table 7. Capability container field description

Byte name	Byte number	Value	Bit	Function
CC0	0	0xE1	7:0	NDEF message is present into memory (called magic number)
CC1	1	0xXX	7:6	Major version number
			5:4	Minor version number
			3:2	Read access condition
			1:0	Write access condition
CC2	2	0xXX	7:0	Memory size of data field and CC field in bytes (= CC2 * 8)
CC3	3	0x0X	7:3	RFU
			2	1: the IC memory size exceeds 2040 bytes (CC2 overflow) 0: the IC memory size is only defined by CC2 value (1)
			1	RFU
			0	1: IC supports ReadMultipleBlocks Command 0: IC does not support ReadMultipleBlocks Command

1. If bit number 2 of CC3 is set, the memory size exceeds 2040 bytes (CC2 overflow). The real memory size can be obtained with the GetSystemInformation command. For more information about the GetSystemInformation command, refer to the corresponding STMicroelectronics datasheet.

Read access condition values defined by bit 3 and bit 4 of CC1 byte are described in *Table 8*.

Table 8. Read access condition

Read access condition value	Description
0b00	Free read access
0b01	RFU
0b10	RFU
0b11	RFU

Write access condition values defined by bit 0 and bit 1 of CC1 byte are described in *Table 9*. Write access condition values depend on the product. For more details, refer to the corresponding STMicroelectronics datasheet.

Table 9. Write access condition

Write access condition value	Description	LRI1k, LRI2k	LRIS2k, LRIS64k, M24LR64-R
0b00	Free write access	Yes	Yes
0b01	RFU	No	No
0b10	Write password access (data can be written after sending a password)	No	Yes
0b11	No write access	Yes	Yes

Note: *Bit 2 and bit 3 of CC1 byte (read access values) shall be reset to 0b00 value.*

The user shall set the write protection bit according to bit 0 and bit 1 of CC1 byte. For more details, refer to the definition of the lock command in the corresponding STMicroelectronics datasheet.

Example 1

Table 10. CC field example

Byte name	Value	Bit	Function
CC0	0xE1	7:0	Magic number
CC1	0x40	7:6	Major version number: 0b01
		5:4	Minor version number: 0b00
		3:2	Read access condition: 0b00 (free read access)
		1:0	Write access condition: 0b00 (free write access)
CC2	0x10	7:0	Data field and CC field size = 16*8 = 128 bytes
CC3	0x00	7:0	IC does not support Read multiple block

2.3 NDEF message using TLV format

A TLV format is a generic data structure used to embed information and to store NDEF messages. The TLV format is composed of three fields:

- Type field (T)
- Length field (L)
- Value field (V): contained user message.

Table 11. TLV format description

	T field	L field	V field
Length (bytes)	1	1 or 3	L field value
Data description	Type of TLV block, see *Table 12*	Number of bytes of V field	Data

For more information on the TLV format, refer to [TAG-2] NFC forum *– on page 1*.

2.3.1 T field values

Table 12 below lists the T field values as defined by the NFC forum.

Table 12. T field values and description

TLV block name	T field value	Description
NULL TLV	0x00	Used to padding.
Lock control TLV	0x01	It defines details of the lock bits.
Memory control TLV	0x02	It identifies reserved memory areas.
NDEF message TLV	0x03	It contains NDEF message.
Proprietary TLV	0xFD	Tag proprietary information.
Terminator TLV	0xFE	Last TLV block in the data area.

2.3.2 L field format

The L field can be either coded on 1 or 3 bytes, as shown in *Table 13*.

Table 13. L field byte format

Byte format	Byte number	Value
1	1	0x00 to 0xFE
3	1	0xFF
	3	0x00FF to 0xFFFE(1)

1. The 0xFF FFFF value is the concatenation of the bytes 0xFF and 0xFFFF.

2.3.3 V field: NDEF message

The V field is composed of a record head byte, the NDEF message and TLV terminator. The record head byte is described in *a): Record head byte*.

An application example is given to illustrate a TLV field: it is a URL, as specified in the "URI Record Type Definition" document (NFC forum). see *Chapter 4.2: URI record*.

a) Record head byte

An NDEF message can contain 1 or more NDEF records. The record head byte gives some information on the current NDEF record.

The different fields of record head byte are described in *Table 14*.

Table 14. Record head byte fields description

Name	Bit	Function
MB (message begin)	7	1: This record is the first of NDEF message.
		0: This record is not the first of NDEF message.
ME (message end)	6	1: This record is the last of NDEF message.
		0: This record is not the last of NDEF message.
CF (chunk flag)	5	1: this record is the initial or middle record chunk.
		0: this record is the terminating record chunk.
SR (short record)	4	1: the payload(1) length is on one byte.
		0: the payload(1) length is more than one byte.
IL (ID_length flag)	3	1: ID length field is present.
		0: ID length field is omitted.
TNF	2:0	TNF indicates the structure of the type field (see *Table 15*).

1. Payload is NDEF message body.

b) Type name format field values

The type name format (TNF) is a 3 bits value that indicates the structure of the value of the type field.

Table 15. Type name format field values

Type name format	Value
Empty	0b000
NFC forum well known type	0b001
Media type as defined in RFC 2046	0b010
Absolute URI as defined in RFC 3986	0b011
NFC forum external type	0b100
Unknown	0b101
Unchanged	0b110
Reserved	0b111

Example 1

This record head defines an NDEF message which is composed of one record (MB = ME = 1).

Table 16. Example of a record head byte structure

Record head byte	MB	ME	CF	SR	IL	TNF
0xD1	1	1	0	1	0	001
Type record head byte						
This is the first record						
This is the last record						
This record is the termination chunk						
The payload length size in on one byte						
The ID length is omitted						
NFC forum well known type						

For more information about the record head byte, refer to the NDEF data exchange format (NDEF) document.

2.3.4 Specific TLV field

The two following specific TLV fields only contain a T field.

a) NULL TLV

The NULL TLV can be used for padding of the data area.

Table 17. NULL TLV field description

	T field	L field	V field
Length (bytes)	1	0	0
Description	0x00	Not present	Not present

b) Terminator TLV

The terminator TLV shall be the last TLV block of the user data field.

Table 18. Terminator TLV description

	T field	L field	V field
Length (bytes)	1	0	0
Description	0xFE	Not present	Not present

3 Storing an NDEF message in STMicroelectronics ISO15693 products

3.1 Memory organization of LRI1K, LRI2K and LRIS2K

The storage of a generic NDEF message in LRI1K, LRI2K and LRIS2K products is described in *Table 19*. It also includes CC field value.

Table 19. Storing an NDEF message in LRI1K, LRI2K and LRIS2K (1)

RF block address	Bits [31:24]	Bits [23:16]	Bits [15:8]	Bits [7:0]
0	CC0	CC1	CC2	CC3
1	NDEF Data 0	NDEF Data 1	NDEF Data 2	NDEF Data 3
2	NDEF Data 4	...		
...	...			
n (2)	...			

1. The UID field in system area is defined and written by STMicroelectronics and is write-protected.
2. n = 31 for LRI1K, n = 63 for LRI2K and LRIS2K.

3.2 Memory organization of LRIS64K and M24LRxx devices

User memory mapping is divided in 64 sectors. A sector size is 128 bytes.

Table 20. Storing an NDEF message in LRIS64K and M24LRxx

Sector	Area	Sector security status
0	1 kbit EEPROM sector	5 bits
1	1 kbit EEPROM sector	5 bits
2	1 kbit EEPROM sector	5 bits
3	1 kbit EEPROM sector	5 bits
...		
n (1)	1 kbit EEPROM sector	5 bits

1. n = 3 for M24LR04-R, n = 15 for M24LR16-R and n = 64 for M24LR64X-R.

3.2.1 Description of the first sector

The NDEF message is located in the first sector, as shown in *Table 21*.

Table 21. First sector details on M24LR64-R

Sector	RF block address	I2C block address	Bits [31:24]	Bits [23:16]	Bits [15:8]	Bits [7:0]
	0	0	CC0	CC1	CC2	CC3
	1	4	Data 0	Data 1	Data 2	Data 3
0	2	8	Data 4	...		
	...	...	...			
	31	124	...			

3.3 CC2 value

The CC2 byte defines the IC memory size available for a user application. It includes a CC field and a User memory area. CC2 value = IC memory size in bytes / 8.

Table 22. CC2 value for ISO/IEC 15693 products

Product	LRI1K	LRI2K	LRIS2K	LRIS64K	M24LR64X	M24LR16E-R	M24LR04E-R
Memory size	128 bytes (1024 bits)	256 bytes (2048 bits)	256 bytes (2048 bits)	8192 bytes (64 kbits)	8192 bytes (64 kbits)	256 bytes (2048 bits)	64 bytes (512 bits)
CC2 value (1)	16 = 0x10	32 = 0x20	32 = 0x20	0xFF (2)	0xFF (2)	0xFF (2)	0x40

1. CC2 value is equal to memory size in bytes divided by 8. The value is expressed in hexadecimal.
2. If the contactless tag memory size exceeds the CC2 field (CC2 overflow), bit 2 of CC3 shall be set.
CC2 = 8192 / 8 = 1024d = 0x400. 0x400 value exceed 8 bits, thus CC2 of M24LR64-R is set to 0xFF (2040 bytes).

4 Example of NDEF record

4.1 Text record

Example 1: With the text “ISO15693 as NFC tag”, the structure of the NDEF message is described in *Table 23*.

The record header is 0xD1.

The value of payload is 0x02 + “en” + “ISO15693 as NFC tag”.

Table 23. “ISO15693 as NFC tag” NDEF message structure

T	L	V as defined into NFC document (1)							Terminator
0x03	0x1A	0xD1	0x01	0x16	0x54	0x02	“en”	“ISO15693 as NFC tag”	0xFE
Type NDEF message TLV									
Length (26 bytes)									
Record head									
Type length									
Payload length (22 bytes) (2)									
Type (T value) for text record type									
Status byte (UTF-8 and 2 bytes for language code)									
Language code “en” is the ISO code for English (UTF-8 string)									
UTF-8 string									
Terminator TLV									

1. Refer to [TEXT] document *– on page 1*.
2. Payload length = status byte + Language code + UTF-8 string length = 1 + 2 + 19 = 22d.

4.1.1 Memory mapping for text record type on LRI2K

Each message character is written in hexadecimal.

Table 24. LRI2K memory mapping for "ISO15693 as NFC tag" NDEF message

RF block	Byte number	0	1	2	3
0	CC field	0xE1	0x10	0x20	0x00
1	User data field	0x03	0x1A	0xD1	0x01
2		0x16	0x54	0x02	0x65[e]
3		0x6E[n]	0x49[I]	0x53[S]	0x4F[O]
4		0x31[1]	0x35[5]	0x36[6]	0x39[9]
5		0x33[3]	0x20[ ]	0x61[a]	0x73[s]
6		0x20[ ]	0x4E[N]	0x46[F]	0x43[C]
7		0x20[ ]	0x74[t]	0x61[a]	0x67[g]
8		0xFE			

4.2 URI record

Example 2: This example defines an NDEF message which is made of one single record. The message is the URL "http://www.st.com".

The record header is 0xD1.

In this case, the payload is 0x01 and "st.com".

Table 25. URI record message structure

NDEF data								
T	L	V as defined into URI Record Definition document(1)						Terminator
0x03	0x0B	0xD1	0x01	0x07	0x55	0x01	"st.com"	0xFE
Type NDEF message TLV								
Length (11 bytes)								
Record head								
Type length								
Payload length (07 bytes)(2)								
Type (U value) for URI record type								
URI header identifier (http://www.)								
URI body Identifier in UTF-8 string								
Terminator TLV								

1. Refer to [URI] document – *on page 1*.
2. Payload length = URI identifier + UTF-8 string length = 1 + 6 = 7d.

4.2.1 Memory mapping for URI record message on LRI2K

Table 26. LRI2K memory mapping for URI record message “http://www.st.com”

RF block	Byte number	0	1	2	3
0	CC field	0xE1	0x40	0x20	0x01
1	User data field	0x03	0x0B	0xD1	0x01
2		0x07	0x55	0x01	0x73[s]
3		0x74[t]	0x2E[.]	0x63[c]	0x6F[o]
4		0x6D[m]	0xFE		

4.3 Smart poster record

The smart poster record can be composed of one or more NDEF records, and one of these records can be an "action":

- the Title record
- the URI record
- the Action record
- the Icon record
- the Size record
- the Type record

4.3.1 Title record

The title record is a text record. For more details, please refer to *Section 4.1: Text record*.

4.3.2 URI record

For more details on URI record, please refer to *Section 4.2: URI record*.

4.3.3 Action record

The action record defines a local action of the previous record. It can be, for example, launching a web browser or sending an SMS.

The "smart poster record type definition" specification defines the available actions. Those actions are listed in *Table 27* below.

Table 27. List of available actions

Value	Action
0x00	Do the action (send the SMS, launch the browser, make the telephone call)
0x01	Save for later (store the SMS in INBOX, put the URI in a bookmark, save the telephone number in contacts)
0x02	Open for editing (open an SMS in the SMS editor, open the URI in a URI editor, open the telephone number for editing)
0x3 to 0xFF	RFU

Its type value is the three ASCII characters 'act'.

4.3.4 Icon record

The icon record contains an image (bmp or jpg) or a media type (such as an mpeg file).

4.3.5 Size record

The size record is coded on 4 bytes and defines the number of bytes. Its type value is the ASCII character 's'.

4.3.6 Type record

The type record is UTF-8 string that describes a MIME type. Its type value is the ASCII character 't'.

4.3.7 Example of a smart poster record composed of a Title and a URI

Table 28. Smart poster record with a Title and a URI

NDEF message				
0x03	**0x24**	**Smart poster record**	**URL record**	**Text record**
Type NDEF message TLV				
Number of bytes of the NDEF message				
Smart poster record				
URL record				
Text record				

Table 29 below details the smart poster record.

Table 29. NDEF message

0xD1	**0x02**	**0x1F**	**0x5370**
Record header			
Record type length			
Length of the smart poster			
Record type 'Sp'			

Table 30 below details the record header of the smart poster record.

Table 30. Record header = 0xD1

MB	ME	CF	SR	IL	TNF
1	1	0	1	0	0b001
This is the first record					
This is the last record					
This record is the terminating record chunk					
The payload length is on one byte					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

Table 31 below details the URI record.

Table 31. URI record

0x91	0x01	0x07	0x55	0x01	0x73 74 2e 63 6F 6D
Record header					
Record type length					
Payload length					
Record type 'U'					
Abbreviation: "http://www."					
URI: st.com					

Table 32 below details the text record.

Table 32. Text record

0x51	0x01	0x10	0x54	0x02	0x656E	(1)
Record header						
Record type length						
Payload length						
Record type 'T'						
Language "en"						
Carrier data reference length						
Text "Welcome to ST"						

1. (1)57 65 6C 63 6F 6D 65 20 74 6F 20 53 54

4.3.8 Memory mapping of the smart poster record

Table 33. Memory mapping of the smart poster record

RF block		0	1	2	3
0x00	CC field	0xE1	0x40	0xFF	0x03
0x01	User data field	0x03	0x24	0xD1	0x02
0x02		0x1F	0x53	0x70	0x91
0x03		0x01	0x07	0x55	0x01
0x04		0x73	0x74	0x2E	0x63
0x05		0x6F	0x6D	0x51	0x01
0x06		0x10	0x54	0x02	0x65
0x07		0x6E	0x57	0x65	0x6C
0x08		0x63	0x6F	0x6D	0x65
0x09		0x20	0x74	0x6F	0x20
0x0A		0x53	0x54	0xFE	

4.4 vCard record

The vCard is a file format standard for electronic business cards. vCard can contain name and address information, phone numbers, e-mail addresses, URLs, logos, photographs, and audio clips.

Table 34. vCard information

0x03	0xFF 01 BC	0xC2	0x0C	0x00 00 01 AA	(1)	Vcf file
Type NDEF message TLV						
	Number of bytes of the NDEF message					
		Record header				
			Type length			
				Payload length		
					Type: text/x-vCard	
						Vcf file

1. 0x74 65 78 74 2F 78 2D 76 43 61 72 64

The following is an example of a vCard file containing information for one person:

```
BEGIN:VCARD
VERSION:2.1
N:Gump;Forrest
FN: Mr. john doe
ORG: MMS
TITLE: application field engineer
TEL;WORK;VOICE:(111) 555 5453
TEL;WORK;FAX:(404) 555 6463
ADR;WORK;PREF;ENCODING=QUOTED-PRINTABLE:;;coq;Rousset;bouches du
rhones;131006;FRANCE LABEL;WORK;PREF;ENCODING=QUOTED-
PRINTABLE:coq=0D=0A=131006 Rousset=0D=0A=FRANCE
URL;WORK:www.st.com EMAIL;PREF;INTERNET:john.doe@st.com
REV:20120417T121053Z
END:VCARD
```

Table 35. Record header = 0xC2

MB	ME	CF	SR	IL	TNF
1	**1**	**0**	**0**	**0**	**0b010**
This is the first record					
This is the last record					
This record is the terminating record chunk					
The payload length is on four bytes					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

4.5 Bluetooth record

The Bluetooth record was defined to simplify the pairing between a host and a Bluetooth device. The host shall know the Bluetooth address to initialize the communication with the Bluetooth device. The NDEF message contains the information required on the Bluetooth device (its address, name, class…) to identify it and to promptly initialize a communication between the host and the Bluetooth device. For example, the host is an NFC mobile phone and the Bluetooth device is a headset. The contactless tag that contains the NDEF message, thus the Bluetooth record, is on the headset. The NFC mobile phone will first read the NDEF message and then initialize the Bluetooth communication with the headset.

The Bluetooth record is defined in the NFC forum application document and provides the required information to carry out the pairing between the host and the Bluetooth device.

The Bluetooth record is composed of three records, as shown in the following table.

Table 36. Bluetooth record

Handover select record	Alternative carrier record	Bluetooth carrier configuration record
Defines the version		
Defines the usable carrier frequency		
Defines the Bluetooth configuration parameters		

Those records are detailed in *Table 37*. The three records are appended together in the contactless tag memory.

Table 37. Handover select record

0x91	0x02	0x0A	0x48 73	0x12
Record header				
Record type length				
Payload length				
Record type 'Hs'				
Version number 1.2				

Table 38 below details the record header 0x91. For more details about the record header meaning, refer to *a): Record head byte*.

Table 38. Record header = 0x91

MB	ME	CF	SR	IL	TNF
1	**0**	**0**	**1**	**0**	**0b001**
This is the first record					
This isn't the last record					
This record is the terminating record chunk					
The payload length is on one byte					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

Table 39. Alternative carrier record

0xD1	0x02	0x04	0x61 63	0x03	0x01	0x30	0x00
Record header							
Record type length							
Payload length							
Record type 'ac'							
Carrier flags CPS = 3 "unknown"							
Carrier data reference length							
Carrier data reference "0"							
Auxiliary data reference count: 0							

Table 40 below details the record header 0xD1. For more details about the record header meaning, refer to *a): Record head byte*.

Table 40. Record header = 0xD1

MB	ME	CF	SR	IL	TNF
1	**1**	**0**	**1**	**0**	0b001
This is the first record					
This is the last record					
This record is the terminating record chunk					
The payload length is on one byte					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

Table 41. Bluetooth carrier configuration record

0x5A	0x20	0x1F	0x01	(1)	0x30	0x1F 00	(2)	0x04	0x0D	(3)	0x05	0x03	(4)	0x0B	0x09	(5)
Record header	Record type length	Payload length	Payload Id length	Record type 'application/vnd.bluetooth.ep.oob'	Payload ID: '0'	Bluetooth OOB Data length	Bluetooth device address: 01:bf:88:80:07:03	EIR data length	EIR data type	Class of device: 0x04: Service class = Rendering 0x06: Major Device class = Imaging 0x80: Minor Device class = Printer	EIR data length	EIR data type	16-bit Service Class UUID list	EIR data length	EIR data type	Bluetooth local name: DeviceName

1. 0x61 70 70 6C 69 63 61 74 69 6F 6E 2F 76 6E 64 2E 62 6C 75 65 74 6F 6F 74 68 2E 65 70
2. 0x 03 07 80 88 BF 01
3. 0x 80 06 04
4. 0x18 11 23 11
5. 0x 44 65 79 69 63 65 4E

Table 42 below details the record header 0x5A. For more details about the record header meaning, refer to *a): Record head byte*.

Table 42. Record header = 0x5A

MB	ME	CF	SR	IL	TNF
0	**1**	**0**	**1**	**1**	**0b010**
This isn't the first record					
This is the last record					
This record is the terminating record chunk					
The payload length is on one byte					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

4.5.1 Memory mapping of an M24LR64E-R EEPROM

Table 43. Memory mapping of an M24LR64E-R EEPROM

RF block		0	1	2	3
0x00	CC field	0xE1	0x40	0xFF	0x03
0x01	User data field	0x91	0x02	0x0A	0x48
0x02		0x73	0x12	0xD1	0x02
0x03		0x04	0x61	0x63	0x03
0x04		0x01	0x30	0x00	0x5A
0x05		0x20	0x1F	0x01	0x61
0x06		0x70	0x70	0x6C	0x69
0x07		0x63	0x61	0x74	0x69
0x08		0x6F	0x6E	0x2F	0x76
0x09		0x6E	0x64	0x2E	0x62
0x0A		0x6C	0x75	0x65	0x74
0x0B		0x68	0x2E	0x65	0x70
0x0C		0x30	0x1F	0x00	0x03
0x0D		0x07	0x80	0x88	0xBF
0x0E		0x01	0x04	0x0D	0xB0
0x0F		0x06	0x04	0x05	0x03
0x10		0x18	0x11	0x23	0x11
0x11		0x0B	0x09	0x44	0x65
0x12		0x79	0x69	0x63	0x65
0x13		0x4E	0xFE		

4.5.2 Simplified Bluetooth record for a single carrier wave

The simplified Bluetooth record will propose one alternative carrier. In this case, the NDEF message will contain only one record: the Bluetooth OOB record.

Table 44. Simplified Bluetooth record for a single carrier wave

0xD2	0x20	0x21	[1]	0x21 00	[2]	0x0D	0x09	[3]	0x04	0x0D	[4]	0x05	0x03	[5]
Record header	Record type length	Payload length	Record type 'application/vnd.bluetooth.ep.oob'	OOB optional data length	Bluetooth device address: 01:bf:88:80:07:03	EIR data length	EIR data type	Bluetooth local name: DeviceName	EIR data length	EIR data type	Class of Device: 0x20: Service class = Audio 0x04: Major Device class = Audio/Video 0x04: Minor Device class = Wearable headset device	EIR data length	EIR data type	16-bit Service Class UUID list

1. 0x61 70 70 6C 69 63 61 74 69 6F 6E 2F 76 6E 64 2E 62 6C 75 65 74 6F 6F 74 68 2E 65 70
2. 0x 03 07 80 88 BF 01
3. 0x 48 65 61 64 53 65 74 20 4E 61 6D 65
4. 0x 04 04 20
5. 0x1E 11 0B 11

Table 45 below details the record header 0xD2. For more details about the record header meaning, refer to *a): Record head byte*.

Table 45. Record header = 0xD2

MB	ME	CF	SR	IL	TNF
1	**1**	**0**	**1**	**1**	**0b010**
This is the first record					
This is the last record					
This record is the terminating record chunk					
The payload length is on one byte					
ID length field is omitted					
Indicates the structure of the type field (see *Table 15*)					

4.5.3 Memory mapping of an M24LR64E-R EEPROM

Table 46. Memory mapping of an M24LR64E-R EEPROM

RF block		0	1	2	3
0x00	CC field	0xE1	0x40	0xFF	0x03
0x01	User data field	0xD2	0x20	0x21	0x61
0x02		0x70	0x70	0x6C	0x69
0x03		0x63	0x61	0x74	0x69
0x04		0x6F	0x6E	0x2F	0x76
0x05		0x6E	0x64	0x2E	0x62
0x06		0x6C	0x75	0x65	0x74
0x07		0x68	0x2E	0x65	0x70
0x08		0x21	0x00	0x03	0x80
0x09		0x88	0xBF	0x01	0x0d
0x0A		0x09	0x48	0x65	0x61
0x0B		0x64	0x53	0x65	0x74
0x0C		0x20	0x4E	0x61	0x6D
0x0D		0x65	0x04	0x0D	0x04
0x0E		0x04	0x20	0x05	0x03
0x0F		0x1E	0x11	0x0B	0x11
0x10		0xFE			

5 User application flow charts

The following flow charts give an example of algorithms that allow to identify, read or write an NDEF message contained inside ISO15693 contactless tag.

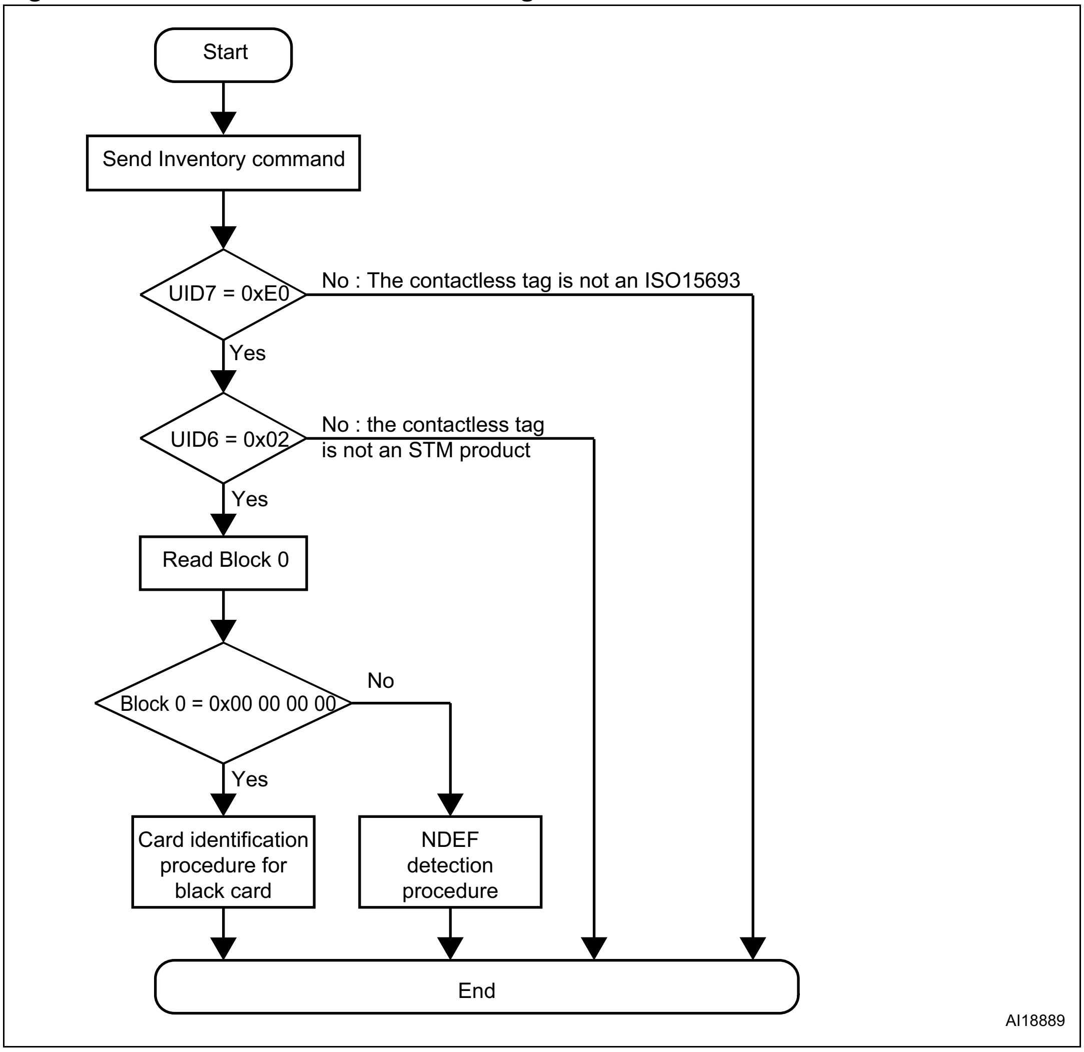
The ISO15693 commands are used. Refer to ISO/IEC 15693-3 description.

The card identification procedure checks the ISO/IEC 15693 specification compatibility with the contactless tag present in the field.

5.1 ISO/IEC 15693 contactless tag identification flow chart

The following graph is a procedure to identify a contactless tag.

Figure 1. ISO/IEC 15693 contactless tag identification flow chart

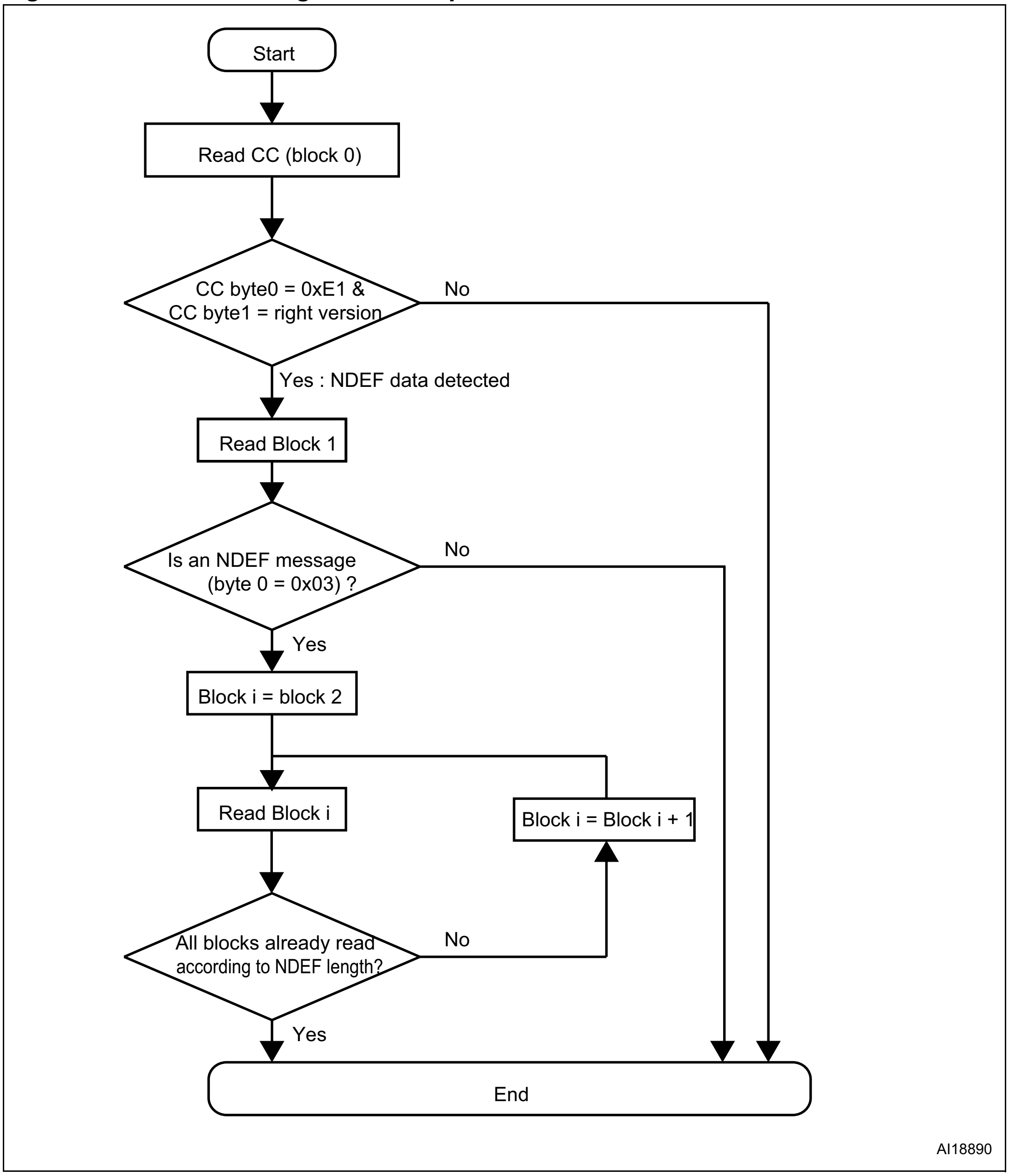


1. Inventory is a command defined in IEC/ISO 15693 specification or STM products datasheet.

5.2 Reading an NDEF message in an ISO/IEC 15693 contactless tag

This sequence defines a user algorithm to detect an NDEF message writing into a contactless tag memory.

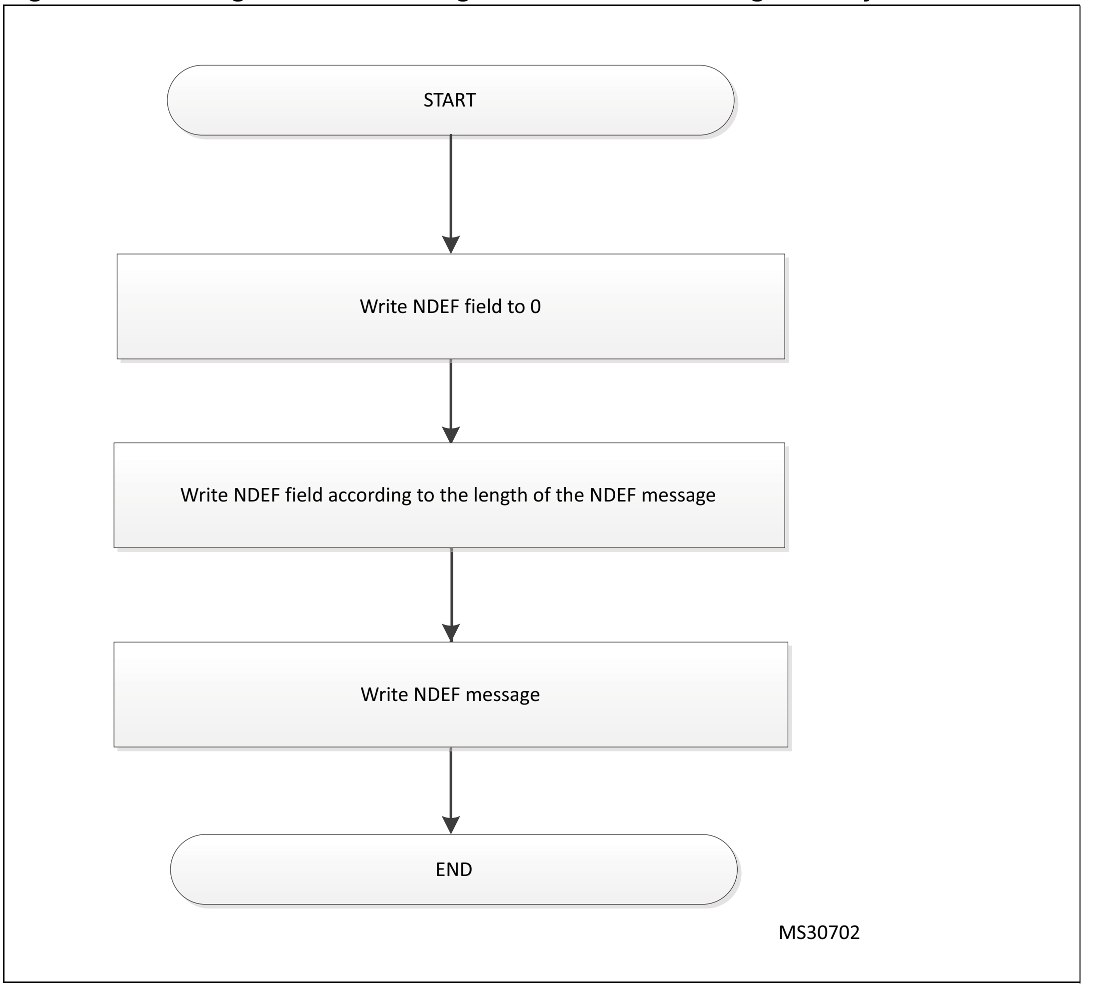
Figure 2. NDEF message detection procedure



5.3 WRITING an NDEF message in an ISO/IEC 15693 contactless tag

This sequence defines a user algorithm to write an NDEF message into a contactless tag memory.

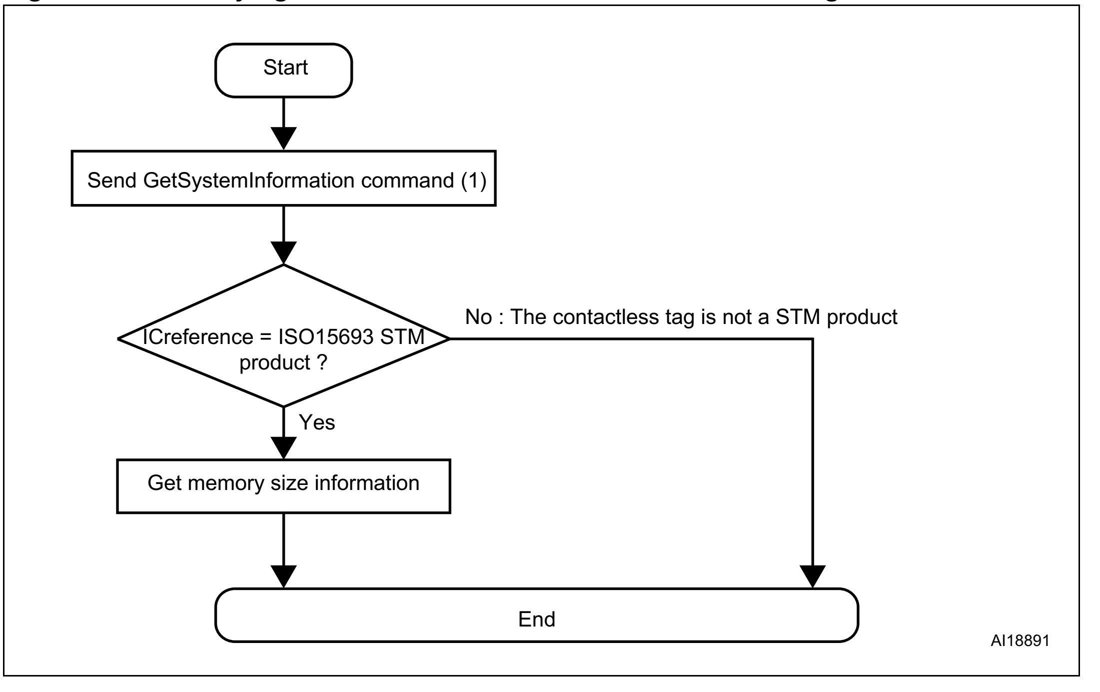
Figure 3. Writing an NDEF message into a contactless tag memory



5.4 Identifying a blank card ISO/IEC 15693 contactless tag

This procedure identifies an ISO/IEC 15693 STMicroelectronics product and obtains information on its memory layout. This information is extracted from the contactless tag response to a GetSystemInformation command.

Figure 4. Identifying a blank card ISO/IEC 15693 contactless tag



1. GetSystemInformation is a command defined in IEC/ISO 15693 specification or STM products datasheet.

Information on the contactless tag response of GetSystemInformation command is given in *Table 47*.

Table 47. Contactless tag response of GetSystemInformation command

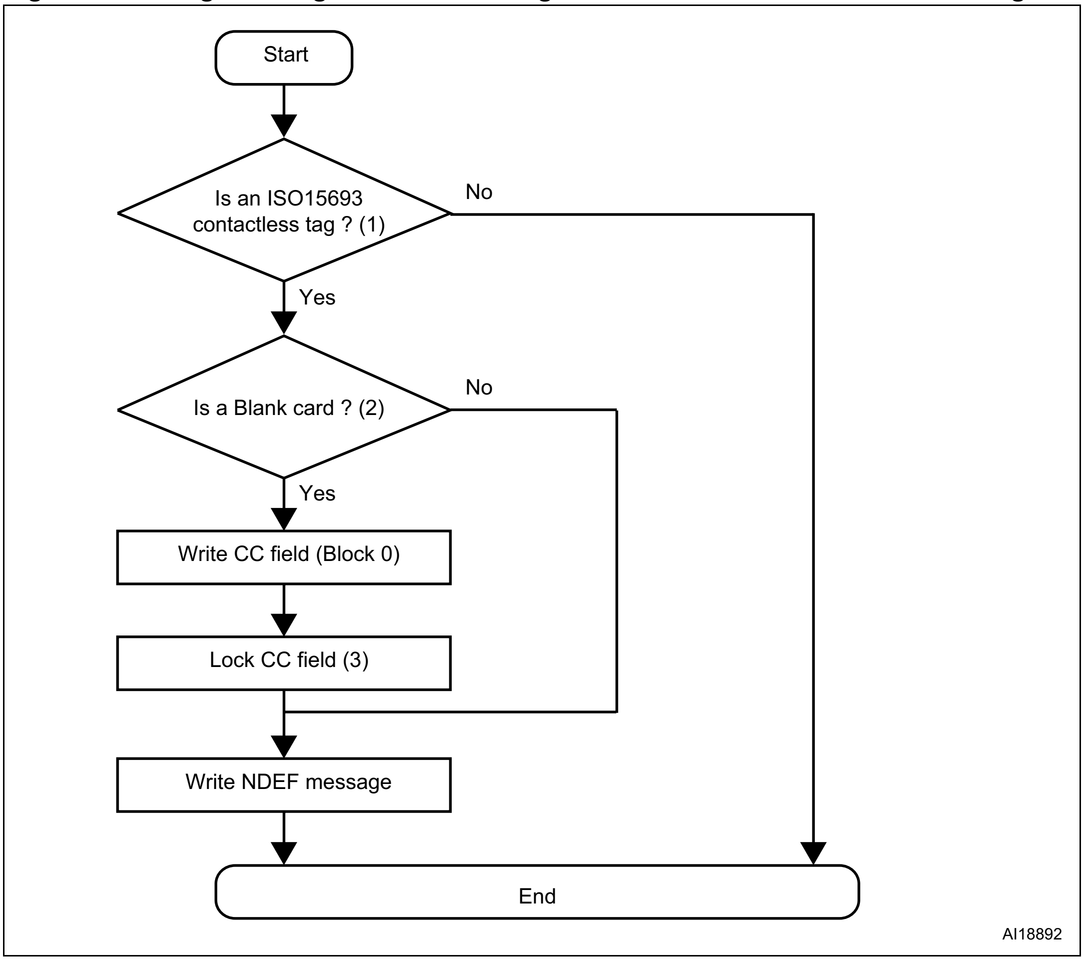
	LRI1K	LRI2K	LRIS2K	LRIS64K	M24LR64-R
IC reference (1 byte)	0b010000xx	0b001000xx	0b001010xx	010001xxb	0b001011xx
Block size (bytes) (1)	0x03	0x03	0x03	0x03	0x03
Memory size (bytes) (2)	0x1F	0x3F	0x3F	0x07FF	0x07FF

1. Block size = 0x03 means that the number of bytes of the block is 4 bytes.
2. The number of blocks of a contactless tag is Memory size value +1.

5.5 Programming an NDEF message in an ISO/IEC 15693 contactless tag

This flow chart is a procedure to write an NDEF message on a contactless tag.

Figure 5. Programming an NDEF message in an ISO/IEC 15693 contactless tag



1. Use Contactless tag identification procedure defined previously.
2. Use Blank card identification procedure defined previously.
3. The CC field can be protected by using a lock command. For more details on the lock command, please refer to the corresponding STMicroelectronics datasheet.

Appendix A Acronym and notational conventions

Table 48. List of acronyms

Acronym	Definition
AFI	Application Family Identifier
CC	Capability Container
CF	Chunk Flag
IC	Integrated Circuit
IL	Id_Length flag
DSFID	Data Storage Format IDentifier
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
MB	Message Begin
ME	Message End
MCU	Microcontroller Unit
OOB	Out of band
RF	Radio Frequency
RFU	Reserved for Future Use
SR	Short Record
TLV	Type Length Value
TNF	Type Name Format
UID	Unique IDentifier
URI	Uniform Resource Identifier
URL	Uniform Resource Locator (this is a special type of an URI)

A.1 Representation of numbers

The following conventions and notations apply in this document unless otherwise stated.

Binary number representation

Binary numbers are represented by strings of digits 0 and 1 shown with the most significant bit (MSB) on the left, the least significant bit (LSB) on the right, and a “0b” added at the beginning.

Example: 0b11110101

Hexadecimal number representation

Hexadecimal numbers are represented by using the numbers 0 to 9 and the characters A – F, and adding an “0x” at the beginning. The Most Significant Byte (MSB) is shown on the left and the Least Significant Byte (LSB) on the right.

Example: 0xF5

Decimal number representation

Decimal numbers are represented as is without any trailing character.

Example: 245

Revision history

Table 49. Document revision history

Date	Revision	Changes
14-June-2011	1	Initial release.
24-Jul-2012	2	Updated Acronym section and moved it to *Appendix A: Acronym and notational conventions*. Updated *Table 5.: IC product code for ISO15639 STMicroelectronics products*. Updated Binary notations, e.g. in *Table 8*, *Table 9* and *Table 10*. Updated *Section 3.2: Memory organization of LRIS64K and M24LRxx devices*. Updated *Table 22: CC2 value for ISO/IEC 15693 products*. Added *Section 4: Example of NDEF record*. Added *Section 4.3: Smart poster record* to *Section 4.5.3: Memory mapping of an M24LR64E-R EEPROM*. Added *Section 5.3: WRITING an NDEF message in an ISO/IEC 15693 contactless tag*.