
NDEF management with ST25TVxxxC products

Introduction

ST25TV512C and ST25TV02KC (hereinafter referred to as ST25TVxxxC) are EEPROM-based products designed to be accessed via a standard contactless ISO 15693 RFID interface. These devices can act as an NFC Type 5 Tag supporting NDEF messages.

This document shows how to configure an ST25TVxxxC device so that it can be detected as an NFC tag. It also lists the commands and operations compliant with the NFC Forum environment.

1 Acronyms and notational conventions

Table 1. List of acronyms

Acronym	Definition
CC	Capability container (see Section 3.1 for details)
EEPROM	Electrically erasable programmable read-only memory
ISO	International organization for standardization
MLEN	Encoded memory length (see Section 3.3 for details)
NDEF	NFC data exchange format (see Section Appendix A for details)
NFC	Near field communication
R	Read
RF	Radio frequency
RFID	Radio frequency identification
RFU	Reserved for future use
R/W	Read / Write
TLV	Data structure containing Tag, Length and Value fields
T5T	Type 5 tag (see Section Appendix A for details)
T5T_Area	Type 5 tag area
W	Write

1.1 Number representation

Binary numbers are represented by strings of 0 and 1 digits, with the most significant bit on the left, the least significant bit on the right, and a 'b' suffix added at the end. Example: 11110101b.

Hexadecimal numbers are represented by strings of numbers from 0 to 9 and letters from A to F, and an 'h' suffix added at the end. The most significant byte is shown on the left and the least significant byte on the right. Example: F5h.

Decimal numbers are represented without any trailing character. Example: 245.

2 NFC Forum

The NFC Forum specification reduces the amount of mandatory resources to activate an ISO/IEC 15693 device as a T5T (Type 5 tag).

RF exchanges are performed as follows:

- Up link: 100% amplitude modulation and "1 over 4" data coding, with a data rate of 26 Kbit/s
- Down link: single sub-carrier load modulation with Manchester data coding, with a data rate of 26 Kbit/s

The command set specified by the NFC Forum is detailed in the following table:

Table 2. T5T commands

NFC Forum name	ST25TVxxxC name
READ_SINGLE_BLOCK	ReadSingleBlock
WRITE_SINGLE_BLOCK	WriteSingleBlock
LOCK_SINGLE_BLOCK	LockBlock
READ_MULTIPLE_BLOCK	ReadMultipleBlocks
SELECT	Select
SLPV_REQ	StayQuiet

This reduced command set allows an NFC reader to manage NDEF messages stored on an ST25TVxxxC device. For additional details refer to the NFC Forum Type 5 Tag Technical Specification.

3 Configuration to support an NDEF message

The ST25TVxxxC products must be configured as T5T so that they can handle NDEF messages. Such a configuration consists in including valid CC (capability container) and T5T_Area fields in the memory area.

3.1 Capability container

The CC field manages the information of an NFC Forum T5T: it begins at the first byte of the memory area, and contains four bytes on an ST25TVxxxC product. The CC field is stored on contiguous bytes, and is directly followed by the T5T_Area field (see [Section 3.3 T5T_Area and MLEN](#)).

The table below details the structure of the four-byte CC that must be used.

Table 3. Four-byte capability container

Byte 0	Byte 1	Byte 2	Byte 3
Magic number	Version and access condition	MLEN	Additional feature information

The size of the T5T_Area field is coded by the MLEN byte of the CC field. MLEN is expressed in 8-byte units.

3.2 Magic number

The magic number makes possible to select between one- and two-byte address modes. ST25TVxxxC devices support only one-byte address mode, signaled by a magic number having E1h value.

3.3 T5T_Area and MLEN

The T5T_Area field is part of the user memory space available to contain a unique NDEF message TLV, and follows directly the CC field. The V field of the NDEF message TLV is used to store one or multiple NDEF records. A Terminator TLV is appended next to the NDEF message TLV if some memory space is available before the end of the T5T_Area.

Note: Depending on the size of the NDEF message, some memory space can remain unused in the T5T_area. The size of the T5T_Area field is coded by the MLEN byte, as described in [Section 3.3.1](#).

3.3.1 MLEN encoding rule (compliant with NFC Forum T5T specification)

As stated in the NFC Forum T5T specification, MLEN must be equal to $N / 8$, where N is the number of bytes from the T5T_Area field. This rule must be respected to achieve NFC Forum certification.

Examples for 320 bytes (ST25TV02KC) memory size and 4 bytes capability container (CC):

- the whole user memory is used for the T5T application: $N = 320 - 4$, $MLEN = (320 - 4) / 8 = 39$ (27h)
- only part of user memory (say 128 bytes) is used for the T5T application: $N = 128$, $MLEN = 128 / 8 = 16$ (10h)

Note: iOS™ and Android™ after version Oreo fully support MLEN encoded according to this rule. Android™ up to version Oreo (v8.1.0) does not support MLEN encoded according to this rule, unless bit 2 in byte 3 of CC field is set to 1b, which is not an NFC Forum T5T compliant setting. Alternately, the non-compliant MLEN encoding rule described in the next section may be used for the tag to operate with Android™ up to version Oreo (v8.1.0).

3.3.2 MLEN specific encoding rule to support Android up to version Oreo (v8.1.0)

For smartphones supporting Android up to version Oreo, MLEN must be equal to the entire user memory size, in bytes, divided by 8.

As an example, for a 320 bytes (ST25TV02KC) memory and 4 bytes CC, $MLEN = 320 / 8 = 40$ (28h).

Note: MLEN encoding defined in this section is not compliant with the NFC Forum T5T specification, but is supported by iOS and any version of Android.

3.4 Version and access condition (byte 1)

The table below details the structure of byte 1. For Version 1.0 (all accesses granted) the value is 40h.

Table 4. Version and access condition byte

b7	b6	b5	b4	b3	b2	b1	b0
Major version		Minor version		Read access		Write access	
• 01b: Version 1.x		• 00b: Version y.0		<ul style="list-style-type: none"> • 00b: Always • 01b: RFU • 10b: Proprietary • 11b: RFU 		<ul style="list-style-type: none"> • 00b: Always • 01b: RFU • 10b: Proprietary • 11b: Never 	

3.5 Additional feature information (byte 3)

ST25TVxxxC devices support Special Frame and Multiple Byte read. All blocks can be locked. The additional feature information byte is usually set to 09h.

Table 5. Additional feature information byte description

b7	b6	b5	b4	b3	b2 ⁽¹⁾	b1	b0
RFU ⁽²⁾			Special frame	Lock block	RFU ⁽²⁾		MBREAD

1. Refer to [Section 3.3.1](#) for the specific usage of this bit.

2. Must be set to 0.

CC byte 3 indicates the additional features supported by the T5 tag:

- Special frame: ST25TVxxxC support special frame
- Lock block: ST25TVxxxC support LOCK_BLOCK command
- MBREAD: ST25TVxxxC support READ_MULTIPLE_BLOCK command

4 Examples of capability container

This section provides two examples of programming values for the CC field of an ST25TVxxxC as a T5T. Refer to [Section 3.1](#) , [Section 3.2](#) , [Section 3.3](#) , [Section 3.4](#) and [Section 3.5](#) for details.

4.1 ST25TV02KC

- E1 40 28 09h to work properly with any smartphone
- E1 40 27 09h for NFC Forum certification

4.2 ST25TV512C

- E1 40 08 09h to work properly with any smartphone
- E1 40 07 09h for NFC Forum certification

5 NDEF: NFC data exchange format

This section illustrates access to the NDEF content stored on an ST25TVxxxC device.

5.1 Reference

Refer to the dedicated NFC Forum specification (list available in [Section Appendix A](#)).

5.2 Dedicated PC applicative SW

Refer to *Software toolbox for NFC tags* (UM2444), available at www.st.com.

5.3 Application example with ST25TV02KC

This section demonstrates access to an NDEF message when the user memory is fully dedicated to T5T_Area.

5.3.1 CC content

Figure 1. CC content example screen

Select a tag: E00208000ED1E016 (ST25TV02KC)

TYPE5 CAPACITY CONTAINER FILE EDITOR

Block 0

Byte	Value
Byte 0	E1
Byte 1	40
Byte 2	28
Byte 3	09

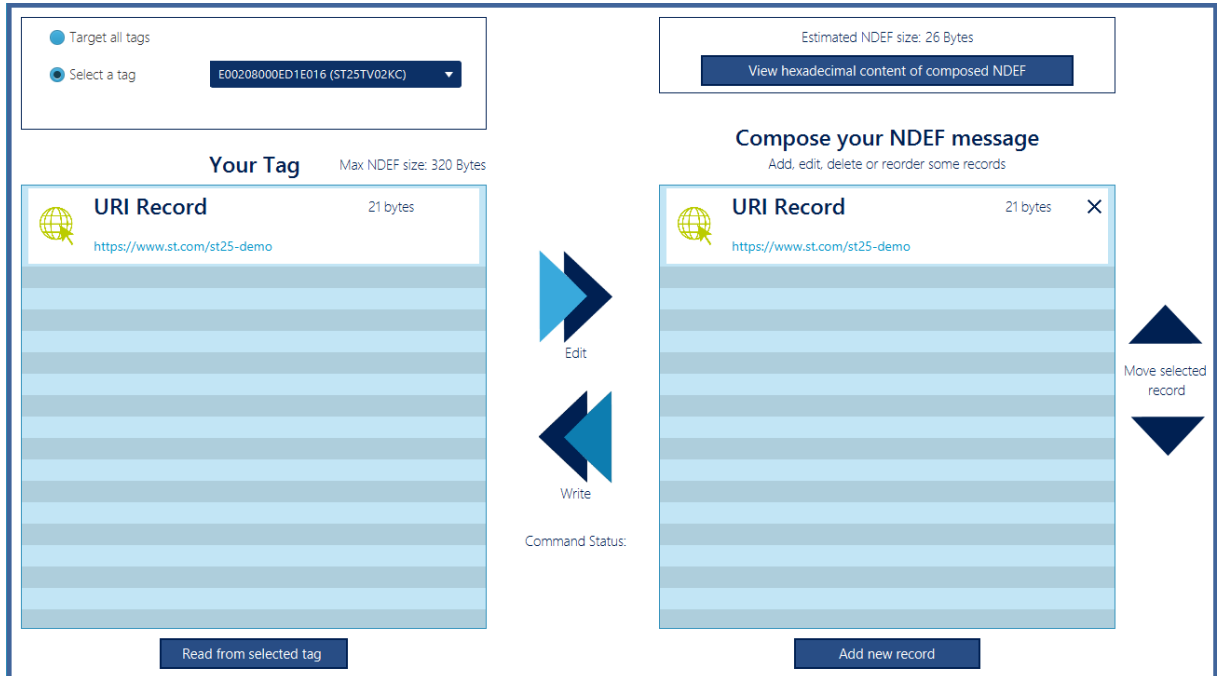
Display 8-Byte formatted CC File

	Byte 3 : Additional feature information	Value
b7	RFU	0
b6	RFU	0
b5	RFU	0
b4	Special frame	0
b3	Lock Block	1
b2	RFU	0
b1	RFU	0
b0	MBREAD	1

READ CC FILE WRITE CC FILE

5.3.2 NDEF message

Figure 2. NDEF message example screen



5.3.3 User memory content (Read single block)

- Block 00h: Capability Container
- Blocks 01h to 06h: NDEF message

Figure 3. User memory content example screen

Select a tag: E00208000ED1E016 (ST25TV02KC) Tag size: 80 blocks

Addressing mode Blocks Bytes

Unit selection Hexadecimal Decimal

From block: 0x 0
 Size (in blocks): 0x 50
 Read Block Security Status

Read memory

At block: 0x 0

Write File to memory

Pattern 0x 00 Overwrite CCFile

Write pattern to memory

Dump Data Table to File

Compare Data Table with File

Command Status:

Area	Block	Data	ASCII	
01	00	E1 40 28 09	á @ (.	
01	01	03 15 D1 01	. . Ñ .	
01	02	11 55 02 73	. U . s	
01	03	74 2E 63 6F	t . c o	
01	04	6D 2F 73 74	m / s t	
01	05	32 35 2D 64	2 5 - d	
01	06	65 6D 6F FE	e m o þ	
01	07	00 00 00 00	. . . .
01	08	00 00 00 00	. . . .
01	09	00 00 00 00	. . . .
01	0A	00 00 00 00	. . . .
01	0B	00 00 00 00	. . . .
01	0C	00 00 00 00	. . . .
01	0D	00 00 00 00	. . . .
01	0E	00 00 00 00	. . . .
01	0F	00 00 00 00	. . . .
01	10	00 00 00 00	. . . .
01	11	00 00 00 00	. . . .
01	12	00 00 00 00	. . . .
01	13	00 00 00 00	. . . .
01	14	00 00 00 00	. . . .
01	15	00 00 00 00	. . . .
01	16	00 00 00 00	. . . .
01	17	00 00 00 00	. . . .
01	18	00 00 00 00	. . . .
01	19	00 00 00 00	. . . .
01	1A	00 00 00 00	. . . .

Double-Click on a line to edit it.

6 ST25TVxxxC as Type 5 Tag: NFC state transition

An NFC Forum device can detect an ST25TVxxxC as T5T in different states. The state is encoded in the byte 1 of the CC field and in the L field of the NDEF message TLV.

An ST25TVxxxC acting as NFC Forum T5T platform can be issued in any valid state.

As a result, an ST25TVxxxC T5T platform can be issued in the INITIALIZED state, the READ/WRITE state or even in the READ-ONLY state with a predefined NDEF message stored in it.

1. In the INITIALIZED State, the CC and T5T_Area fields are accessible for reading and writing data
 - CC is encoded properly with bits b3 to b0 of byte 1 equal to 0000b (read/write access granted).
 - T5T_Area contains an NDEF Message TLV. The L-field of NDEF Message TLV is equal to 0.
2. In the READ/WRITE State, the CC and T5T_Area fields are accessible for reading and writing data.
 - CC is encoded properly with bits b3 to b0 of byte 1 equal to 0000b (read/write access granted)
 - T5T_Area contains an NDEF Message TLV. The L-field of NDEF Message TLV is different from 0.
3. In the READ/ONLY state, the CC and T5T_Area fields are accessible only for reading data
 - CC is encoded properly with bits b3 to b0 of byte 1 equal to 0010b or 0011b (only read access granted)
 - T5T_Area contains an NDEF Message TLV. The L-field of NDEF Message TLV is different from 0.
 - All blocks from the CC and T5T_Area fields must be locked.

When ST25TVxxxC devices act as a Type 5 Tag, the first block of AREA1 is reserved for CC field usage, and the following blocks are dedicated to the T5T_Area field.

Each AREA1 block can be locked individually with the LOCK_SINGLE_BLOCK command.

Note: Block 00h is always readable, hence the CC content is always accessible.

Appendix A Reference NFC Forum documents

- **Type 5 Tag Technical Specification:** defines the behaviour of NFC Forum Type 5 Tag, which means a tag that supports short-range communication with ISO/IEC 15693 tags containing an NDEF message.
- **Data Exchange Specifications**
- **NFC Data Exchange Format (NDEF) Technical Specification:** specifies a common data format for NFC Forum-compliant devices and NFC Forum-compliant tags.
- **Record Type Definition Technical Specifications:** specifications for Record Type Definitions (RTDs) and four specific RTDs: Text, URI, Smart Poster, and Generic Control.
- **NFC Record Type Definition (RTD) Technical Specification:** specifies the format and rules for building standard record types used by NFC Forum application definitions and third parties that are based on the NDEF data format. The RTD specification provides a way to efficiently define record formats for new applications and gives users the opportunity to create their own applications based on NFC Forum specifications.
- **Text RTD Technical Specification:** provides an efficient way to store text strings in multiple languages by using the RTD mechanism and NDEF format. An example of using this specification is included in the Smart Poster RTD.
- **URI RTD Technical Specification:** provides an efficient way to store Uniform Resource Identifiers (URI) by using the RTD mechanism and NDEF format. An example of using this specification is included in the Smart Poster RTD.
- **Verb RTD Technical Specification:** used to encode generic and carrier-specific supported services, which can then be used by implementations of the Connection Handover 1.4 candidate specification to offer an enhanced user experience. The Verb Record can, for example, encode the service to trigger the printing of a document or picture that will be transferred via the Bluetooth® or WLAN connection.
- **Smart Poster RTD Technical Specification:** defines an NFC Forum Well Known Type to put URLs, SMSs or phone numbers on an NFC tag, or to transport them between devices. The Smart Poster RTD builds on the RTD mechanism and NDEF format and uses the URI RTD and Text RTD as building blocks.
- **Signature Record Type Definition Technical Specification**
- **Signature RTD Certificate Policy:** defines the procedural and operational requirements that the NFC Forum expects Certificate Authorities (CAs) to adhere to, when issuing and managing certificates to create signatures for NDEF messages. Provides users with the possibility of verifying the authenticity and integrity of data within the NDEF message, and specifies the format used when signing single or multiple NDEF records.
- **NFC Device Information RTD Technical Specification:** defines the Device Information record type, which conveys fundamental model and identity identification information. The purpose of the Device Information record is to convey host information in a record format that can be used across different carrier types or service types.
- **Reference Application Technical Specifications**
- **Connection Handover Technical Specification**
- **Personal Health Device Communication Technical Specification**

Revision history

Table 6. Document revision history

Date	Revision	Changes
28-Jan-2021	1	Initial release.

Contents

1	Acronyms and notational conventions	2
1.1	Number representation	2
2	NFC Forum	3
3	Configuration to support an NDEF message	4
3.1	Capability Container	4
3.2	Magic number	4
3.3	T5T_Area and MLEN	4
3.3.1	MLEN encoding rule (compliant with NFC Forum TST specification)	4
3.3.2	MLEN specific encoding rule to support Android up to version Oreo (v8.1.0)	4
3.4	Version and access condition (byte 1)	5
3.5	Additional feature information (byte 3)	5
4	Examples of capability container	6
4.1	ST25TV02KC	6
4.2	ST25TV512C	6
5	NDEF: NFC data exchange format	7
5.1	Reference	7
5.2	Dedicated PC applicative SW	7
5.3	Application example with ST25TV02KC	7
5.3.1	CC content	7
5.3.2	NDEF message	8
5.3.3	User memory content (Read single block)	8
6	ST25TVxxxC as Type 5 Tag: NFC state transition	10
Appendix A	Appendix	11
	Revision history	12

List of tables

Table 1.	List of acronyms	2
Table 2.	T5T commands	3
Table 3.	Four-byte capability container	4
Table 4.	Version and access condition byte	5
Table 5.	Additional feature information byte description	5
Table 6.	Document revision history	12

List of figures

Figure 1.	CC content example screen	7
Figure 2.	NDEF message example screen	8
Figure 3.	User memory content example screen	9

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2021 STMicroelectronics – All rights reserved