NDEF management with ST25DV-I2C and ST25TV products

Introduction

In this document, ST25DV-I2C is referring to ST25DV04K, ST25DV16K, ST25DV64K, ST25DV04KC, ST25DV16KC and ST25DV64KC products. ST25TV is referring to ST25TV16K, ST25TV64K, ST25TV16KC and ST25TV64KC. The ST25DV-I2C are dual EEPROM devices designed to be accessed via two different interfaces: a wired I²C interface and a standard contactless ISO 15693 RFID interface.

ST25TV devices are NFC and RFID tag offering up to 64 Kbits of electrically erasable programmable memory (EEPROM).

ST25DV-I2C and ST25TV can act as an NFC Type 5 Tag supporting NDEF message.

The purpose of this document is to present the way to configure ST25DV-I2C, ST25DV-I2C and ST25TV so that they can be detected as NFC tags. It also lists the commands and operations compliant with the NFC Forum environment.

This application note applies to the products listed in Table 1. Applicable products.

Table 1. Applicable products

Reference	Part number
ST25DV-I2C	ST25DV04K, ST25DV16K, ST25DV64K, ST25DV04KC, ST25DV16KC, ST25DV64KC
ST25TV	ST25TV16K, ST25TV64K, ST25TV16KC, ST25TV64KC

1 Acronyms and notational conventions

Table 2. List of acronyms

Acronym	Definition
CC	Capability container (see Section 3.1: Capability container (CC) for details)
EEPROM	Electrically-erasable programmable read-only memory
I^2C	Inter-integrated circuit
ISO	International organization for standardization
IT	Interrupt
MLEN	Encoded memory length (see Section 3.3: T5T_Area and MLEN for details)
NDEF	NFC data exchange (see Appendix for details)
R	Read
RF	Radio frequency
RFID	Radio frequency identification
RFU	Reserved for future use
R/W	Read / Write
T5T	Type 5 tag (see Appendix for details)
T5T_Area	Type 5 tag area
W	Write

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

1.1 Binary 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

1.2 Hexadecimal number representation

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

1.3 Decimal number representation

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 ISO/IEC 15693 device as a T5T (type 5 tag).

RF exchanges are performed as follows:

- For the up link: 100 % amplitude modulation and 1 over 4 data coding with a data rate of 26 Kbit/s
- For the down link: Single sub-carrier load modulation with Manchester data coding at a high data rate of 26 Kbit/s

The command set specified by the NFC Forum is composed of the following commands:

- Read_Single_Block
- Write_Single_Block
- Lock_Single_Block
- Read_Multiple_Block
- Extended_Read_Single_Block
- Extended_Write_Single_Block
- Extended_Lock_Single_Block
- Extended_Read_Multiple_Block
- Select
- SLPV_Req

This reduced command set allows a NFC device to manage NDEF (NFC data exchange) implemented in a ST25DV-I2C or a ST25TV devices.

Please refer to the NFC Forum Type 5 Tag technical specification for details.

3 ST25DV-I2C and ST25TV configuration to support a NDEF message

The products in the ST25DV-I2C and ST25TV devices must be configured as T5T so that they can handle NDEF messages.

Such a configuration consists in including a valid CC (capability container) in the first memory blocks.

Caution: *For products with memory larger than 8 Kbits (i.e. 16 kbits and 64 kbits), reading NDEF messages is not natively supported on Android™ devices embedding older Android™ version than version O.*

3.1 Capability container (CC)

The CC manages the information of a NFC Forum T5T.

The CC begins at the first byte of the memory area and contains four or eight bytes.

The CC is stored on contiguous bytes.

A four-byte CC limits the maximum data area size of a ST25DV-I2C and ST25TV devices to 2040 bytes (the number of blocks is coded on one byte), 504 bytes maximum for ST25DV04K and ST25DV04KC.

An eight-byte CC allows a larger data area (the number of blocks is coded on two bytes).

The CC contains information (MLEN, encoded memory length) that represents the part of the memory that is allocated for storing the NDEF Message T5T_Area. It is calculated from the T5T_Area in byte as follows:

MLEN = T5T_Area / 8

For ST25DV-I2C and ST25TV devices, the CC can be coded either on four bytes or on eight bytes depending on the number of memory blocks that are dedicated to the message.

Table 3. Four-byte capability container details the structure of a four-byte CC to be used for ST25DV04K and ST25DV04KC products.

Table 3. Four-byte capability container

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

Table 4. Eight-byte capability container details the structure of an eight-byte CC to be used for ST25DV16K, ST25DV16KC, ST25DV64K, ST25DV64KC, ST25TV16K, ST25TV64K ST25TV16KC and ST25TV64KC products.

Table 4. Eight-byte capability container

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Magic number	Version and access condition	00h	Additional feature information	RFU	RFU	MLEN	

3.2 Magic number

The magic number allows the selection between one-byte address mode and two-byte address mode:

- The T5T sets the magic number (byte 0) in CC to E1h when one-byte address mode is supported
- The T5T sets the magic number in CC to E2h, if two-byte address mode is supported

ST25DV-I2C and ST25TV devices support one- or two-byte address for each block. Consequently, E1h or E2h can be used for memory sizes below 16 Kbits. For memories larger than or equal to 16 Kbits, E2h must be chosen.

Note: Two bytes CC file with magic number E2h is not natively supported by Android™ up to version Oreo™ included. iOS® and Android™ after version Oreo™ natively support 2 bytes CC file with magic number E2h.

3.3 T5T_Area and MLEN

T5T_Area is part of the user memory space available to contain a NDEF message TLV. The NDEF message is stored inside the V-field of the NDEF Message TLV. The Terminator TLV is the last TLV structure in the T5T_Area.

Note: Depending on the size of the NDEF message, some memory space can remain unused in the T5T_area.

The T5T_Area size measured in bytes is equal to 8 x MLEN. The T5T_Area directly follows the CC in the memory of the Type 5 Tag.

3.3.1 MLEN encoding rule

MLEN must be equal to T5T_Area size, in bytes, divided by 8, as defined in NFC Forum T5T specification.

Achieving NFC Forum certification requires obeying to this MLEN encoding rule.

Example 1: MLEN encoding for a ST25DV04K (512 bytes memory size) and 4 bytes capability container (CC):

- If the entire user memoryfull user memory is used to store NDEF, T5T_Area=512-4
  - MLEN = (512 – 4) / 8 = 63 (3Fh)
- If only part of user memory is used to store NDEF, T5T_Area = 128 bytes (1 Kbits) for example
  - MLEN = 128 / 8 = 16 (10h)

Example 2: MLEN encoding for a ST25DV64K (8192 bytes memory size) and 8 bytes capability container (CC):

- If the entire user memory full, user memory is used to store NDEF, T5T_Area=8192-8
  - MLEN = (8192 – 8) / 8 = 1023 (03FFh)
- If only part of user memory is used to store NDEF, T5T_Area = 512 bytes (4 Kbits) for example
  - MLEN = 512 / 8 = 64 (40h)
-

Caution: *iOS® and Android™ after version Oreo™ fully support MLEN encoded according to this rule. But for older version of Android ™ (up to version Oreo™ included), a specific MLEN encoding rule must be used, as described in next chapter.*

3.3.2 MLEN specific encoding rule to support Android™ up to version Oreo™ included

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

Example 1: MLEN encoding for a ST25DV04K (512 bytes memory size) and 4 bytes capability container (CC):

- MLEN = 512 / 8 = 64 (40h)

Example 2: MLEN encoding for a ST25DV64K (8192 bytes memory size) and 8 bytes capability container (CC):

- MLEN = 8192 / 8 = 1024 (400h)

Note: *Smartphones supporting Android™ up to version Oreo also support MLEN encoded according to Section 3.3.1: MLEN encoding rule, but in this case CC-byte3-bit2 must be set to 1b.*

Caution: *Encodings defined above are not compliant with NFC Forum certification, but are supported by iOS® and any version of Android™.*

3.4 Version and access condition (byte 1)

Table 5. Version and access condition byte description details the structure of the version and access condition byte:

Table 5. Version and access condition byte description

b7	b6	b5	b4	b3	b2	b1	b0
Major version 01b: Version 1.x		Minor version 00b: Version y.0		Read Access 00b: Always 01b: RFU 10b: Proprietary 11b: RFU		Write Access 00b: Always 01b: RFU 10b: Proprietary 11b: Never	

For version 1.0 with all accesses granted, the byte value is 40h.

3.5 Additional feature information (byte 3)

Table 6. Additional feature information byte description

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

1. *RFU bits must be set to 0.*
2. *Refer to Section 3.3.2: MLEN specific encoding rule to support Android™ up to version Oreo™ included for CC-byte3-bit2 specific usage.*

CC byte 3 indicates which additional features are supported by the T5 tag.

Special frame:

- ST25DV-I2C and ST25TV support special frame.

Lock block:

- ST25DV-I2C and ST25TV support (Ext) Lock Block command, but only blocks 0 and 1 (CC) can be locked using this command. In order to write protect other blocks of the user memory, Areas protection mechanism should be used (see ST25DV-I2C and ST25TV datasheets for user memory description).
- It is recommended to set this bit to 0.

MBREAD:

- ST25DV-I2C support (Ext) Read Multiple Block command.

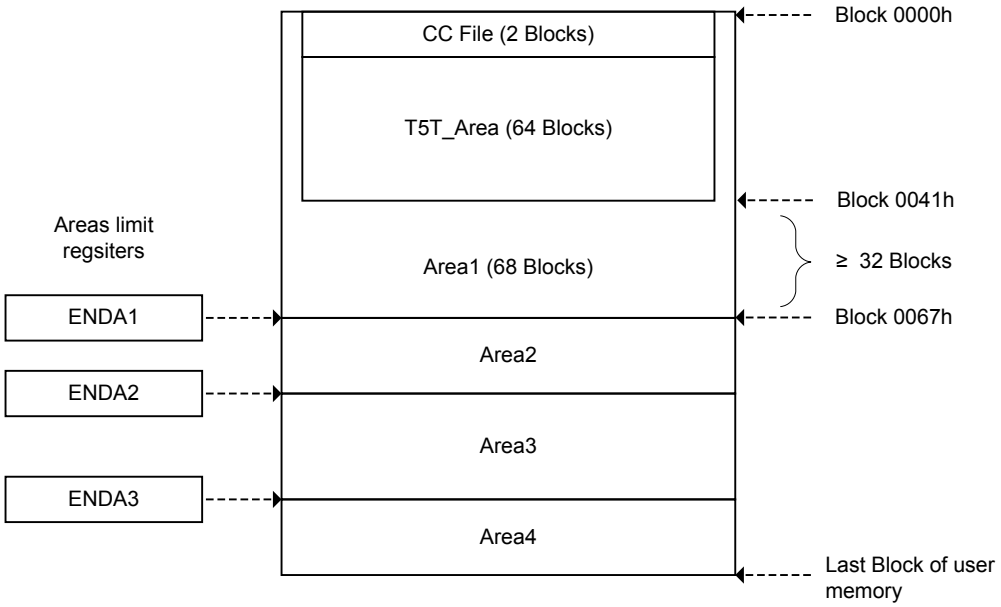
Caution: *In ST25DV04K, ST25DV16K, ST25DV64K, ST25TV16K and ST25TV64K a (Ext) Read Multiple Block command receives an error if crossing a user area border (see respective datasheets). In Android™, if MBREAD is set to 1, Read Multiple Blocks of 32 blocks (128 bytes) are performed. Therefore, in order to avoid any read across user area borders if multiple block read is preferred (MBREAD=1), it is recommended to set user Area1 end, at least 32 blocks after the end of the T5T_Area, or at the end of user memory (single user area).*

In ST25DV04KC, ST25DV16KC, ST25DV64KC, ST25TV16KC and ST25TV64KC a (Ext) Read Multiple Block command does not fail if crossing user area border, so no special precaution should be taken when assigning areas size.

Example of user Area 1 setting with MBREAD=1 and MLEN=0x20 (T5T_Area=256 bytes) and CC File coded on 8 bytes:

- CC File size is 2 blocks (E2 40 00 01 00 00 00 20h)
- T5T_Area size is (MLEN*8)/4 = 64 blocks
  - T5T_Area ends at block address 65 (41h)
- User Area1 must end at least at block 65+32=97 (61h)
  - ENDA1 = int(97/8) = 12 (0Ch). Last block of user Area1 is block address 103 (67h) (see ST25DV-I2C, and ST25TV datasheets for area end calculation description)

Figure 1. ST25DV-I2C and ST25TV user memory



4 Example of capability container for ST25DV-I2C and ST25TV

This section provides two examples of programming values for the CC field of ST25DV-I2C and ST25TV as a T5T. Refer to Section 3.1: Capability container (CC), Section 3.2: Magic number, Section 3.3: T5T_Area and MLEN, Section 3.4: Version and access condition (byte 1) and Section 3.5: Additional feature information (byte 3) for details.

4.1 ST25DV04K

Full user memory dedicated to store NDEF message:

- E1 40 40 00h to work properly with smartphone.
- E1 40 3F 00h for NFC Forum certification.

4.2 ST25DV64K and ST25TV64K

Part of the user memory (2 Kbits) dedicated to store NDEF message:

- E2 40 00 00 00 00 04 00h to work properly with smartphone
- E2 40 00 00 00 00 00 20h for NFC Forum certification

Full user memory dedicated to store NDEF message, with multiple read enabled (assuming user Area1 is set to full memory size):

- E2 40 00 01 00 00 04 00h to work properly with smartphone
- E2 40 00 01 00 00 03 FFh for NFC Forum certification

4.3 ST25DV16KC

Part of the user memory (12 Kbits) dedicated to store NDEF message, with multiple authorized read:

- E2 40 00 01 00 00 01 00h to work properly with smartphone
- E2 40 00 01 00 00 00 C0h for NFC Forum certification

5 NDEF : NFC data exchange

This section illustrates NDEF with ST25DV-I2C, and ST25TV devices.

5.1 Reference

Refer to the dedicated NFC Forum specification (list available in Appendix A: Reference NFC Forum documents).

5.2 Dedicated PC applicative software for CR95HF

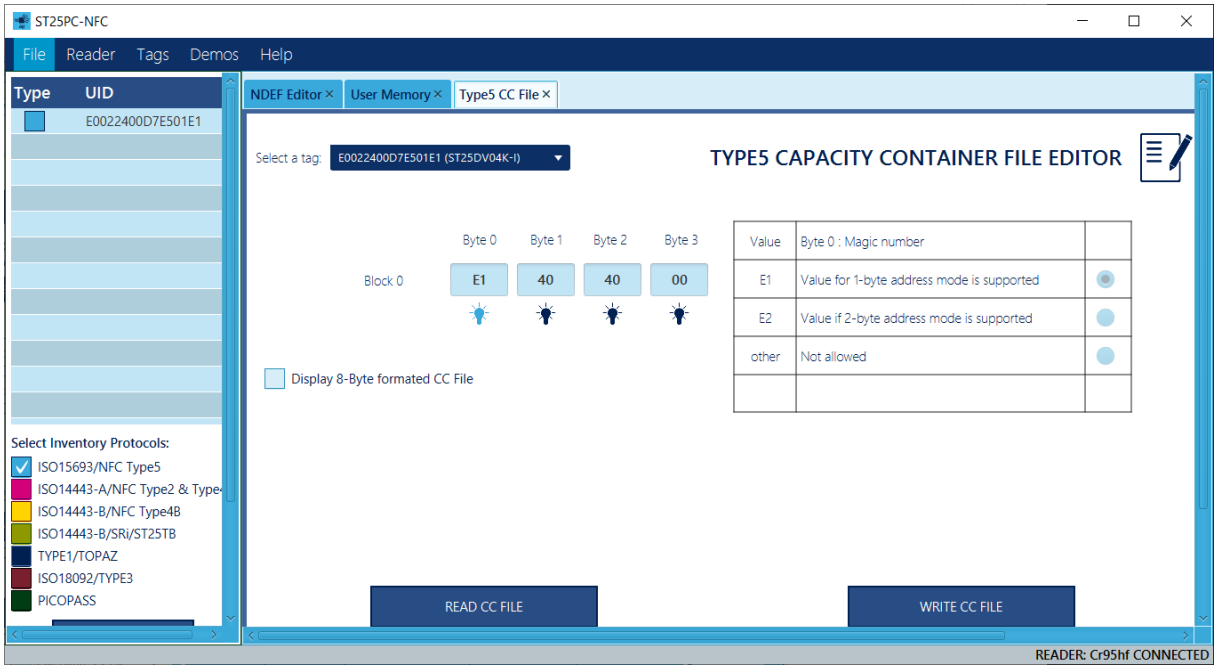
This section shows screenshots of the ST25PC-NFC software, using a CR95HF NFC reader.

5.3 PC software application example with ST25DV04K

This section demonstrates the storage of an NDEF message when the user memory is fully dedicated to NDEF.

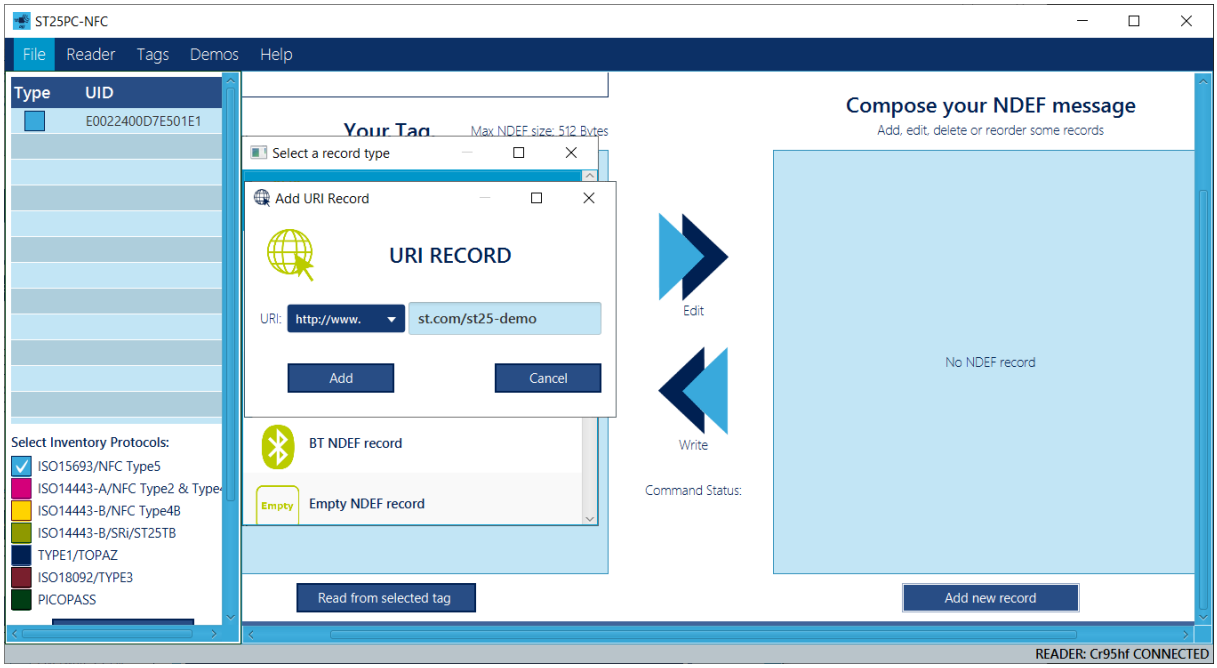
5.3.1 CC content (ST25DV04K)

Figure 2. CC content example screen for ST25DV04K



5.3.2 NDEF message (ST25DV04K)

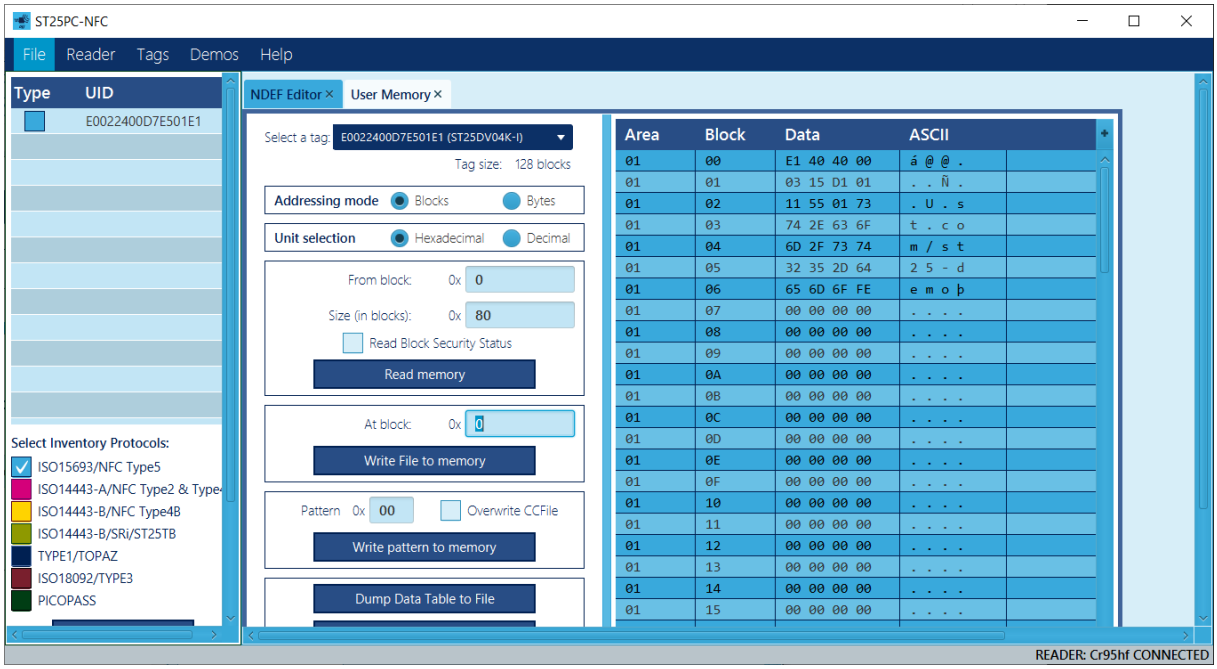
Figure 3. NDEF message example screen for ST25DV04K



5.3.3 User memory content (ST25DV04K)

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

Figure 4. User memory content example screen for ST25DV04K

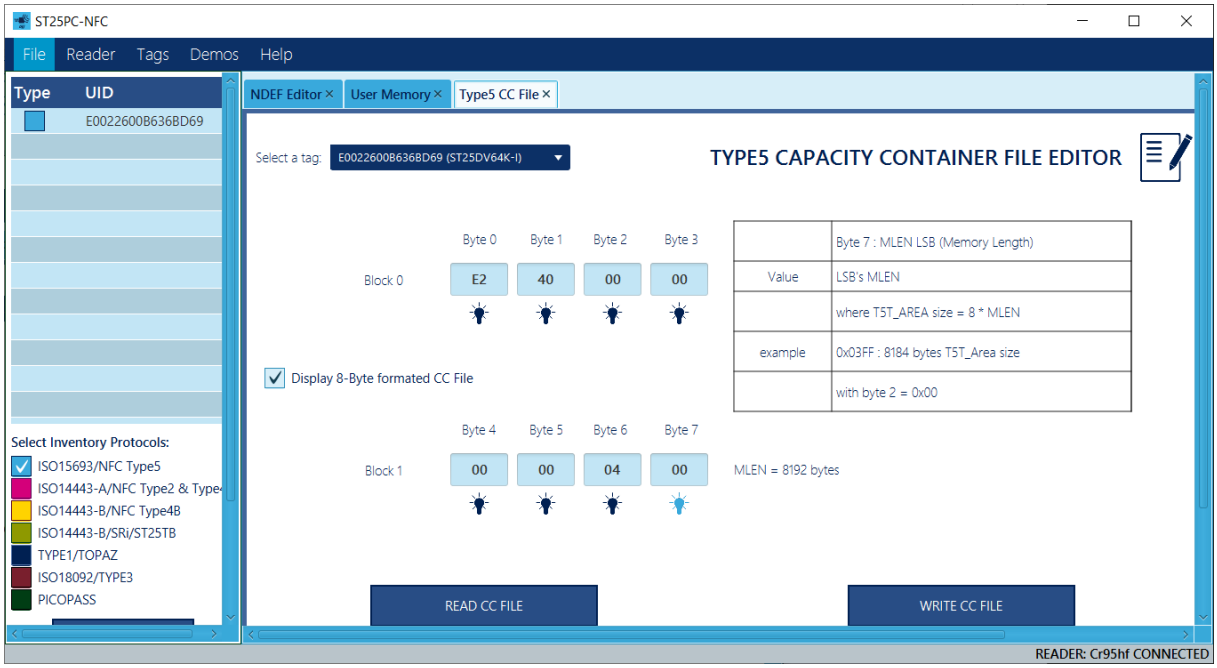


5.4 PC software application example with ST25DV64K AND ST25TV64K

This section demonstrates the storage of an NDEF message to be compatible with a smartphone.

5.4.1 CC content (ST25DV64K and ST25TV64K)

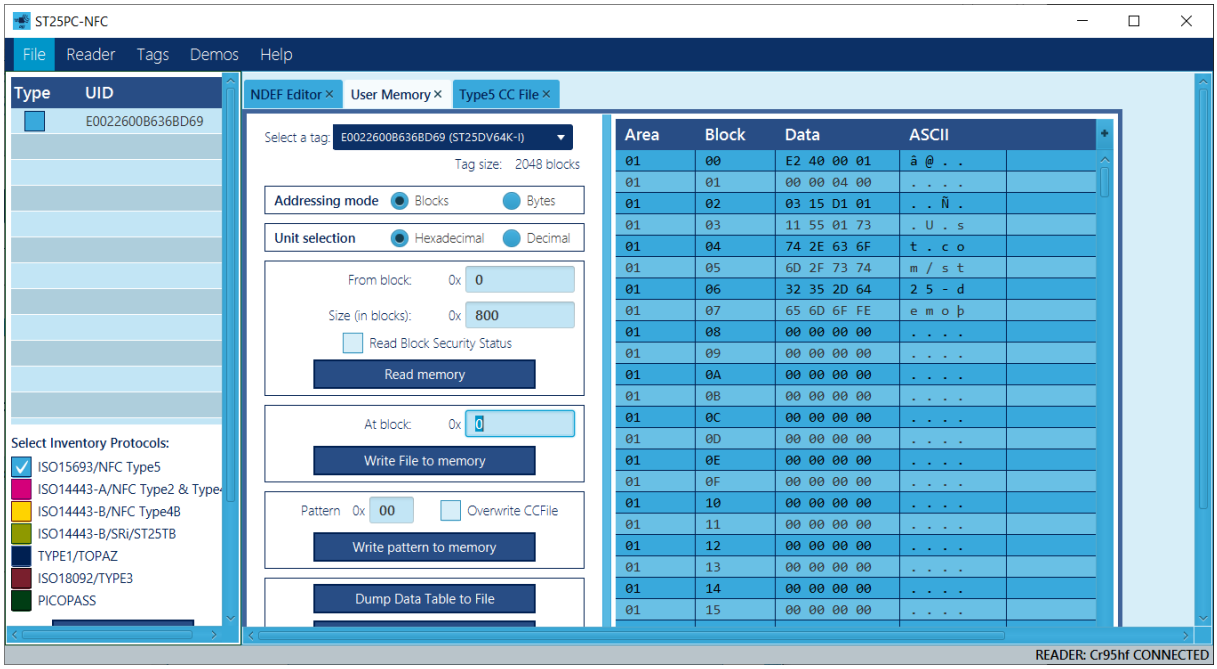
Figure 5. CC content example screen for ST25DV64K



5.4.2 User memory content (ST25DV64K)

- Block 00h: Capability Container
- Blocks 02h to 07h: NDEF message

Figure 6. User memory content example screen for ST25DV64K



6 ST25DV-I2C and ST25TV as Type 5 Tag: NFC state transition

An NFC Forum device can detect ST25DV-I2C and ST25TV as T5T in different states. The state is encoded in the byte 1 of the CC.

An ST25DV-I2C (or ST25TV) acting as NFC Forum T5T platform can be issued in any valid state.

As a result, an ST25DV-I2C (or ST25TV) 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 the T5T_Area are accessible for reading and writing data
   - The CC area is encoded properly with the bits b3 to b0 of byte 1 equal to 0000b (read/write access granted)
   - The T5T_Area contains an NDEF Message TLV The L-field of NDEF Message TLV is equal to 00h.
2. In the Read/Write state, the CC and the T5T_Area are accessible for reading and writing data.
   - The CC area is encoded properly with b3 to b0 of byte 1 equal to 0000b (read/write access granted)
   - The T5T_Area contains an NDEF Message TLV The L-field of NDEF Message TLV is different than zero.
3. In the Read-only state, the CC and the T5T_Area are set to read-only
   - The CC area is encoded properly with b3 to b0 of byte 1 equal to 0001b, 0010b or 0011b (only read access granted)
   - The T5T_Area contains an NDEF message TLV The L-field of NDEF message TLV is different than zero.
   - All blocks of the T5T_Area shall be locked

When ST25DV-I2C and ST25TV devices act as a Type 5 Tag , area 1 is dedicated to T5T_Area,

The first two blocks are reserved for CC usage and can be locked individually if requested, using ISO 15693 RF Lock Block or Extended Lock Block command.

Area 1 of ST25DV-I2C, ST25TV16K and ST25TV64K devices can be locked globally setting the corresponding RF access protection modifying RFA1SS register value located in system area (refer to Data Protection Management : RFA1SS).

Note: Area 1 is always readable so that access to CC content is always possible. Refer to ST25DV-I2C datasheet "Dynamic NFC/RFID tag IC with 4-Kbit, 16-Kbit or 64-Kbit EEPROM and Fast Transfer Mode capability" or to the ST25TV16K and ST25TV64K datasheet "16 Kbit or 64 Kbit EEPROM tag IC with passwords based on ISO/IEC 15693 and NFC type 5 tag", for more details on data protection management.

Appendix A Reference NFC Forum documents

- **Type 5 Tag operation specification**
  Type 5 Tag defines how an NFC device can interact with an NFC Forum Type 5 Tag, that is, an ISO/IEC 15693 tag that is configured to be able to store an NDEF message. As with other NFC Forum Tag operation specifications, the specification defines how to interact with, not build, a tag. The Type 5 Tag operation specification is focused on supporting poll-side, 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 (RTD) technical specifications**
  Technical 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 iInformation 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 7. **Document revision history**

Date	Revision	Changes
01-Mar-2017	1	Initial release.
13-Dec-2017	2	1. Updated: – Introduction in cover page – Section 3.1: Capability Container – Section 3.3: T5T_Area & MLEN – Section 3.5: Additional feature information (byte 3) – Section 4.1: ST25DV04K – Section 4.2: ST25DV64K and ST25TV64K – Figure 1: CC content example screen, – Figure 2: NDEF message example screen – Figure 3: User memory content example screen – Figure 4: CC content example screen, – Figure 5: NDEF message example screen – Figure 6: User memory content example screen. – Section 6: ST25DVxxx as Type 5 Tag : NFC State Transition 2. Added: – in all document reference to ST25TV64K – note in Section 3.2: Magic number
01-Feb-2018	3	Updated: • Section 3.3: T5T_Area & MLEN • Section 4.2: ST25DV64K and ST25TV64K
31-Jul-2018	4	1. Updated: – *Section 3.2 Magic number* – *Section 3.5 Additional feature information (byte 3)* – *Section 4.1 ST25DV04K* – *Section 4.2 ST25DV64K and ST25TV64K* – *Figure 4. User memory content example screen for ST25DV04K* – *Figure 6. User memory content example screen for ST25DV64K* 2. Added: – *Section 3.3.1 MLEN encoding rule* – *Section 3.3.2 MLEN specific encoding rule to support Android™ up to version Oreo™ included* – *Figure 1. ST25DV-I2C, ST25TV16K and ST25TV64K user memory*

Date	Revision	Changes
20-May-2021	5	1. Updated: – Document title – *Section Introduction, Section 3.5 Additional feature information (byte 3), Section 4.2 ST25DV64K and ST25TV64K, Section 5.2 Dedicated PC applicative software for CR95HF, Section 5.4 PC software application example with ST25DV64K AND ST25TV64K* – *Figure 2. CC content example screen for ST25DV04K, Figure 3. NDEF message example screen for ST25DV04K, Section 5.3.3 User memory content (ST25DV04K), Figure 5. CC content example screen for ST25DV64K, Figure 6. User memory content example screen for ST25DV64K* 2. *Replaced any occurrence of ST25DVxxx with ST25DV-I2C and any occurrence of ST25TVxxx with ST25TV16K and ST25TV64K in whole document.* 3. Added *Section 4.3 ST25DV16KC* 4. Removed section NDEF message in *Section 5.4 PC software application example with ST25DV64K AND ST25TV64K* and Appendix A.2 Data protection management: RFA1SS
16-Nov-2026	6	Updated: • Title • Section Introduction .Minor text changes.

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