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NDEF management with ST25DV02K-W1 and ST25DV02K-W2

Introduction

The ST25DV02K-W1 and ST25DV02K-W2 (hereinafter referred to as ST25DV02K-Wx) products are EEPROM devices designed to be accessed via a standard contactless ISO 15693 RFID interface.

ST25DV02K-Wx devices can act as NFC Type 5 Tags supporting NDEF messages.

This document details the configuration to use to make the ST25DV02K-Wx devices detectable as NFC tags, and lists the commands and operations compliant with the NFC Forum environment.

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1 Acronyms and notational conventions

Table 1. List of acronyms

Acronym	Definition
CC	Capability container (see *Section 3* 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 (see *Section 4* 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 *Section 6* 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 specification

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:

- 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
- SELECT
- SLPV_REQ

This reduced command set allows an NFC device to manage NDEF (NFC data exchange) implemented in ST25DV02K-Wx devices.

For details refer to the NFC Forum "Type 5 Tag Technical Specification".

3 Capability container (CC)

The ST25DV02K-Wx products must be configured as T5T to handle NDEF messages: this configuration consists in including a valid CC (capability container) in the first memory block.

The CC manages the information of an NFC Forum T5T.

The CC begins at the first byte of the memory area and contains four bytes. The CC is stored on contiguous bytes, *Table 2* details the structure to use.

Table 2. Four-byte capability container

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

3.1 Byte 0: magic number

ST25DV02K-Wx devices support only one-byte address mode.

The T5T must set the magic number (CC block, Byte 0) to E1h.

3.2 Byte 1: version and access condition

Table 3 details the structure of the version and access condition byte.

Table 3. Version and access condition byte

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.

3.3 Byte 2: MLEN

This section describes the encoding rules to build the MLEN register content.

Note that the T5T_Area is part of the user memory. It contains the NDEF message, and directly follows the capability container (CC block).

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.

The achievement of the NFC Forum certification requires to respect this rule.

Examples for a 256 bytes (2 Kbits) memory size and 4 bytes capability container (CC):

- If the entire user memory is used to store NDEF, T5T_Area = 256 - 4

  MLEN = (256 – 4) / 8 = 31 (1Fh)
- If only part of user memory is used to store NDEF, e.g. T5T_Area = 128 bytes (1 Kbit)

  MLEN = 128 / 8 = 16 (10h)

Caution: iOS™ and Android™, after version Oreo (8.0), fully support MLEN encoded according to this rule. For older version of Android™ (up to version Oreo (8.0) included), a specific MLEN encoding rule must be used, as described in *Section 3.3.2*.

3.3.2 MLEN specific encoding rule to support Android™ up to version Oreo (8.0) included

For smart phones supporting Android™ up to version Oreo (8.0), MLEN must be equal to the entire user memory size, in bytes, divided by 8.

Examples for a 256 bytes (2kbits) memory size and 4 bytes capability container (CC):

- MLEN = 256 / 8 = 32 (20h)

Note: *Smart phones supporting Android™ up to version Oreo (8.0) also support MLEN encoded according to Section 3.3.1, but in this case CC-byte3-bit2 must be set to 1b.*

Caution: Encodings defined in this section are not compliant with NFC Forum certification, but are supported by iOS™ and any version of Android™.

3.4 Byte 3: additional feature information

ST25DV02K-Wx devices support Special frame and Multiple byte read. All blocks can be locked. The additional feature information byte is usually set to 01h.

Table 4. Additional feature information byte description

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

1. RFU bits must be set to 0.

2. Refer to *Section 3.3.2* for CC-byte3-bit2 specific usage.

3.5 Examples of capability container

This section provides examples of CC file programming value for ST25DV02K-Wx used as T5T devices. Refer to sections *3.1* to *3.4* for details.

For NFC Forum certification

- E1 40 1F 01h if the full user memory is dedicated to store NDEF messages
- E1 40 08 01h if only part of user memory is dedicated to store NDEF messages (64 bytes in this example)

For smart phones

- E1 40 20 01h

4 NFC Data Exchange Format (NDEF)

This section illustrates NDEF with ST25DV02K-Wx.

4.1 References

Refer to the dedicated NFC Forum specifications (list available in *Section 6*).

4.2 PC SW application for ST25R NFC devices

ST25PC-NFC software, available on *www.st.com,* allows the user to control ST25R reader devices. Refer to *Software toolbox for NFC tags* (UM2444) for details on how to use it.

4.3 PC SW application example with ST25DV02K-Wx

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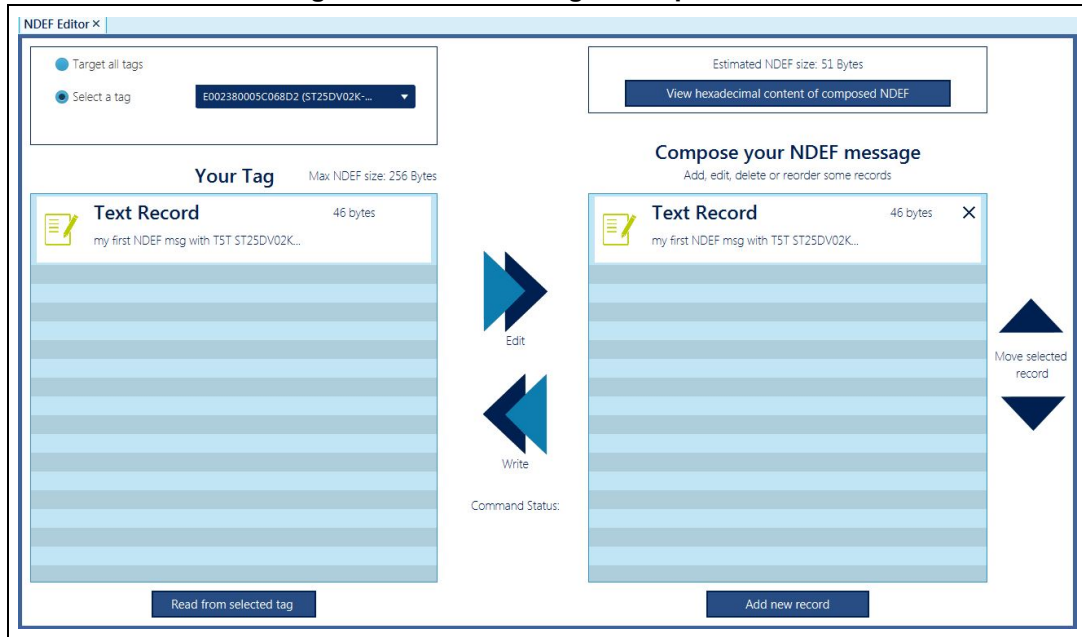
4.3.1 CC content

Figure 1. CC content example screen
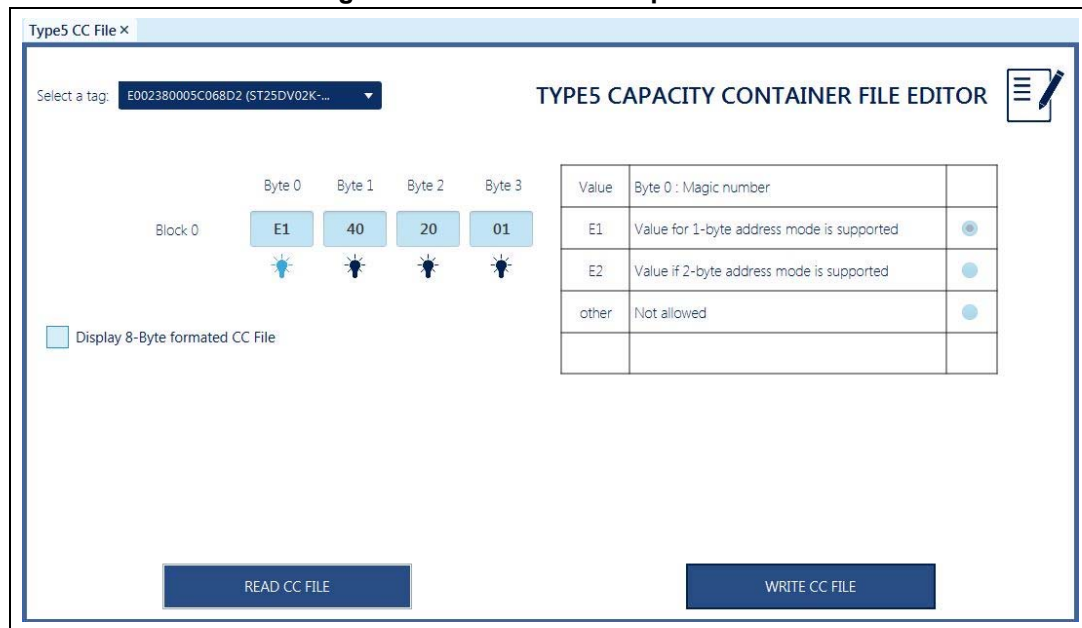
4.3.2 NDEF message

Figure 2. NDEF message example screen

4.3.3 User memory content (Read multiple blocks)

- Block 00h: capability container
- Blocks 01h to 0Dh: NDEF message (in this example Text type)

Figure 3. User memory content example screen

5 NFC state transition

An NFC Forum device can detect the ST25DV02K-Wx as T5T in different states. The state is encoded in the byte 1 of the CC.

An ST25DV02K-Wx acting as NFC Forum T5T platform can be issued in any valid state.

As a result, an ST25DV02K-Wx T5T platform can be issued in INITIALIZED state, in READ/WRITE state or even in 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 from 0

3. In the READ-ONLY state, the CC and the T5T_Area are set to read-only
   – The CC area is encoded properly with bits b3 to b0 of byte 1 equal to 0010b or 0011b (only read access granted)
   – The T5T_Area contains an NDEF Message TLV. The L-field of NDEF Message TLV is different from 0
   – The CC and all blocks of the T5T_Area must be locked

When ST25DV02K-Wx act as a Type 5 Tag:

- Area0 (first memory block) is reserved for CC block
- Area1 (or part of it) is dedicated to T5T_Area
- Area2 (or part of it) can be used in addition to the whole Area1, to extend T5T_Area size

Here are the available lock mechanisms:

- Each block of Area0, Area1 and Area2 can be (write-) locked individually with the ISO 15693 Lock_Single_Block command. This is the default way to manage the READ_ONLY state.
- Area1 and Area2 can also be locked in Write by using password mechanism, as described in ST25DV02K-Wx datasheets (available on *www.st.com*). This results in a faster lock, as the whole Area write-lock can be enabled with fewer commands. Moreover this mechanism is reversible, something not possible with ISO15693 Lock_Single_Block command.
- Area 0 of ST25DV02K-Wx devices is always readable, so that the CC content is always accessible.

6 Reference documents

- **Type 5 Tag technical specification**

  Defines the behavior of NFC Forum Type 5 Tag, one that supports short-range communication with ISO/IEC 15693 tags containing an NDEF message.

- **Data exchange specification**

- **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 specification**

  Technical specifications for record type definitions (RTDs) and four specific RTDs: Text, URI, Smart poster and Generic control.

- **NFC 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 specification**

- **Connection handover technical specification**

- **Personal health device communication technical specification**

7 Revision history

Table 5. Document revision history

Date	Revision	Changes
21-Mar-2018	1	Initial release.
31-May-2018	2	Updated *Section 3.3: Byte 2: MLEN*, *Section 3.3.1: MLEN encoding rule*, *Section 3.3.2: MLEN specific encoding rule to support Android™ up to version Oreo (8.0) included* and *Section 3.5: Examples of capability container*. Updated *Table 4: Additional feature information byte description* and its footnotes.
24-Jul-2019	3	Updated *Section 3.3.1: MLEN encoding rule*, *Section 3.3.1: MLEN encoding rule* and *Section 4.2: PC SW application for ST25R NFC devices*. Updated *Figure 1: CC content example screen*, *Figure 2: NDEF message example screen* and *Figure 3: User memory content example screen*. Minor text edits across the whole document.

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