AN14362

NTAG X DNA - Energy harvesting

Rev. 1.0 — 27 May 2025 | Application note

Document information

Information	Content
Keywords	NTAG X DNA
Abstract	This document provides assistance in NFC system development and describes the main features of NTAG X DNA NFC field energy harvesting.

1 Introduction

This document presents how to use the NTAG X DNA NFC field harvesting feature, which conditions are required, and how to design a circuit which optimizes the energy harvesting capabilities of the IC.

This document addresses developers who are developing applications based on NTAG X DNA. This document shall be used in addition to the NTAG X DNA data sheet ref.[1]. The best use of this application note is achieved by reading the mentioned data sheet in advance.

Note: *This application note does not replace any of the relevant functional specifications, data sheets, or design guides.*

2 NTAG X DNA energy harvesting use case

NTAG X DNA provides the capability to harvest transmitted power from the RF field. All power which is not needed for internal operation of the IC can be output to a dedicated pin (GPIO1) and can be used to supply external circuits or devices (for example, microcontrollers, sensors, battery charging etc.).

The principle of energy harvesting use case is that a part of the power that is transmitted via the RF field and that is not needed for the internal operation of the NTAG X DNA can be output to a GPIO1 pin and can be used for supplying directly another device, charging a battery or capacitance. The power output can reach ~20mW, which at a maximum output voltage of 1.8 V (max. up to 2.0 V) results in a current of ~11 mA. The available field strength must be large enough (for example, if a Class 1 antenna is targeted, field strength shall be over 3.5 A/m).

NTAG X DNA consists of a configurable voltage and current detection block. It allows triggering energy harvesting only when enough energy can be retrieved from RF to provide the expected power level.

The power provided to the peripherals shall not lead to instabilities, hang-ups, or malfunction on the contactless interface. Therefore, it is recommended to design a robust NFC system (an HF reader and a tag).

2.1 Target applications

- Mobile cases with LEDs (with MCU or without MCU)
- Charging peripheral system
- Read the sensor data
- Smart diagnostics
- MCU battery-less FW update

2.2 Models of application

2.2.1 Dual interface and energy harvesting

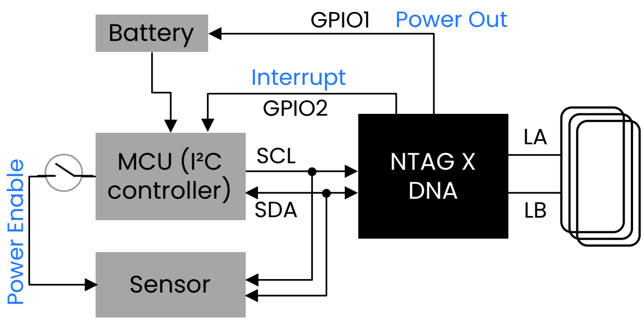

Figure 1. Example diagram: Dual interface and energy harvesting

An example of the combination of Dual Interface and energy harvesting can be seen in the following figure Figure 2.

The following steps are shown:

1. NFC field presence (by reader's RF field ON, or arriving to proximity)
2. NTAG X DNA boots-up via contactless interface
3. NFC reader/writer device does ISO14443-4 activation

4. NFC reader/writer device selects NDEF Application (DF Name: 0xD2760000850101)
5. NFC reader/writer device configures NTAG X DNA (example):
   - GPIO1 Mode: Energy harvesting
   - GPIO2 Mode: output
   - InRush target: 2V/10mA (shall be the same as target voltage/current level), InRush duration: 0x0100 (1 ms)
6. R-APDU (response APDU) from NTAG X DNA
7. NFC reader/writer device sends ManageGPIO to trigger current and voltage measurement
8. NTAG X DNA returns available (measured) power yield
9. NFC reader/writer device sends ManageGPIO command to enable voltage on its GPIO1 pin
10. S(WTX) - waiting time extension is requested/returned by NTAG X DNA
11. NTAG X DNA provides configured voltage/current on it' GPIO1
12. MCU boots
13. MCU enables power to external devices (for example, via its GPIO)
14. MCU goes to low power mode and waits for NTAG X DNA's interrupt to handle it
15. NTAG X DNA releases WTX from point 10
16. R-APDU is returned
17. NFC reader/writer device sends a read command for the file configured for "NFC Pause" (NFCPauseFileNo)
18. S(WTX) - waiting time extension is requested/returned by NTAG X DNA
19. NTAG X DNA toggles GPIO2 to notify MCU to provide/write the data into NFCPauseFileNo file
20. MCU fetches the (for example, sensor) data
21. The peripheral device returns its data
22. MCU prepares the data to be written
23. MCU writes the data into NFCPauseFileNo
24. NTAG X DNA releases WTX from point 18
25. Data from NFCPauseFile (processed data) is returned to the NFC reader/writer device

Note: *Additionally Mutual authentication (SIGMA-I or AES) may be included before step 5, so only an authentic NFC reader/writer device is allowed to execute the flow.*

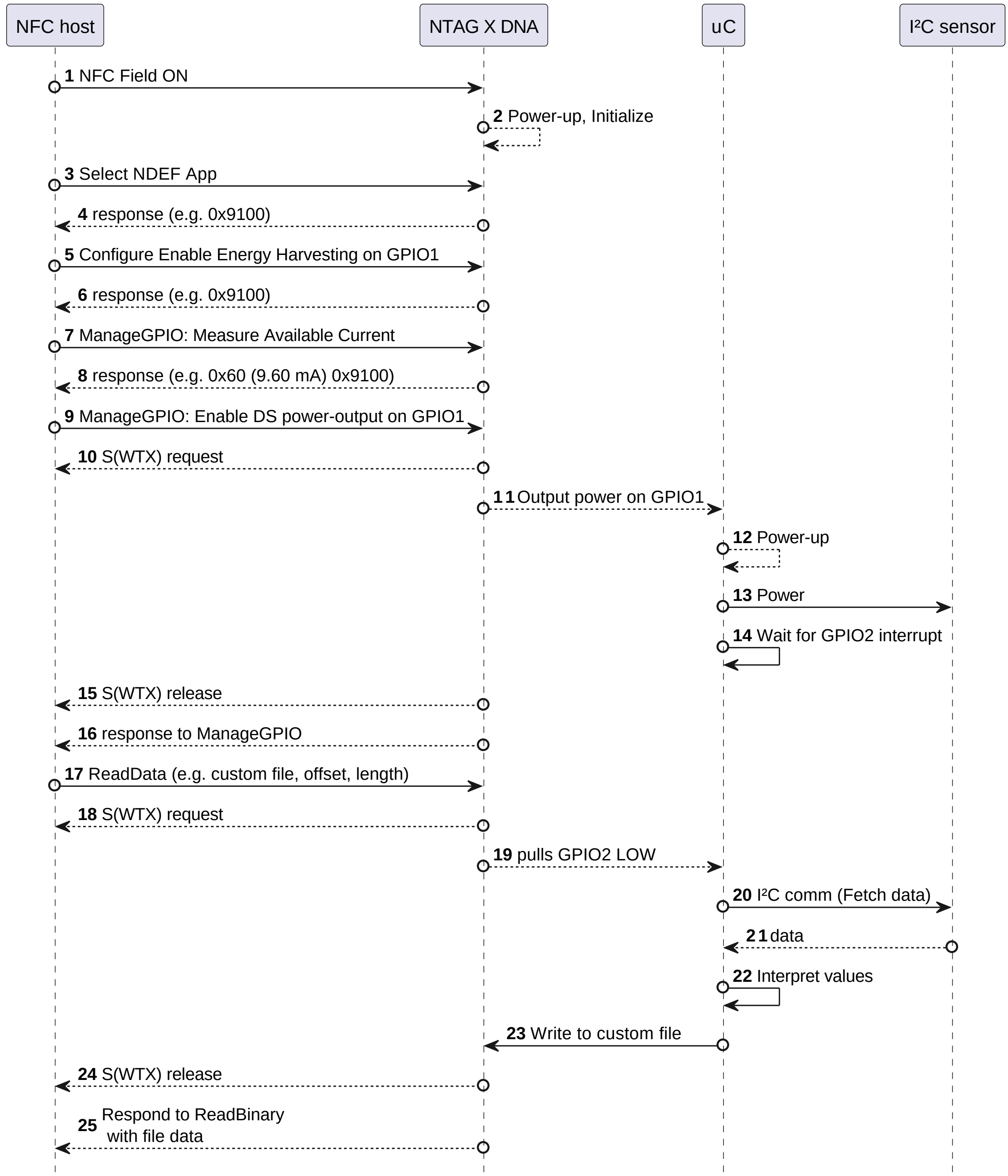

Figure 2. Example flow of how to enable energy harvesting

3 NTAG X DNA hardware integration

3.1 Example application circuit

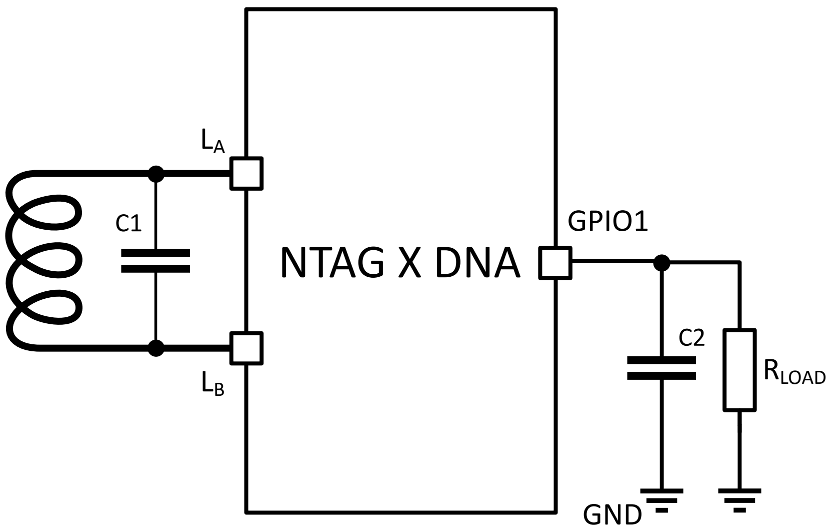

Figure 3. Example application circuit

3.2 Design considerations

3.2.1 Limitations

NTAG X DNA can deliver up to 5.5 mA at 1.8V. For applications where more power is needed, "alternative NFC field harvesting" is recommended through NXP wireless charging products or passive components with additional rectifier.

3.2.2 Antenna design

Optimal energy harvesting application shall be based on a specifically designed NFC reader and tag's antennas. NFC mobiles, due to low power policies, generally do not deliver NFC field strength high enough.

Optimal energy transfer on Tag's side can be achieved by considering the following recommendations:

1. larger antenna size with lesser turns
2. antenna size close to a reader's antenna size (but not the exact same size to avoid decoupling effect at low or zero distance)

NXP recommends that during antenna design, the following tool is used:

https://www.nxp.com/products/rfid-nfc/nfc-hf/nfc-readers/nfc-antenna-design-hub:NFC-ANTENNA-DESIGN-TOOL

3.3 Applications example diagrams

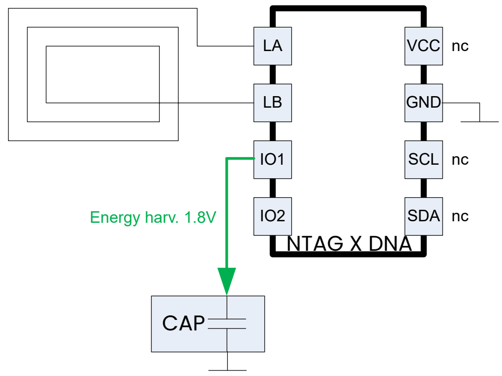

Figure 4. Example diagram - Charging a capacitor

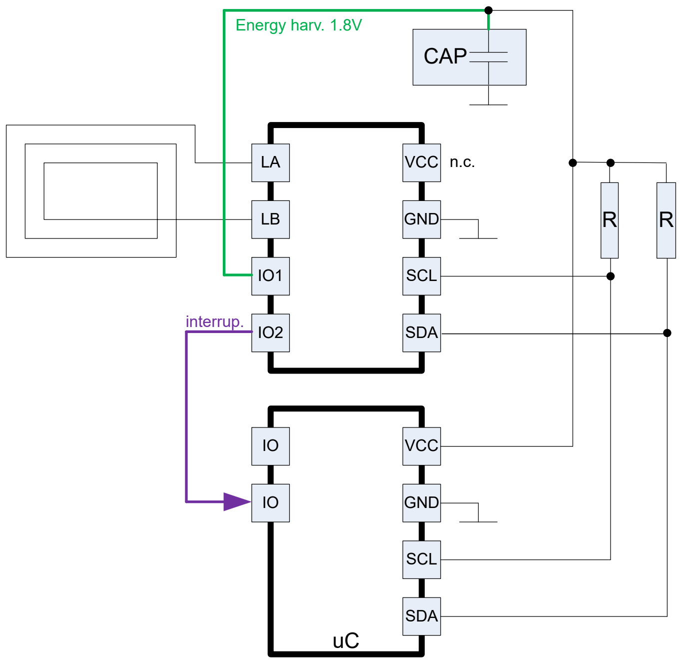

Figure 5. Example diagram - energy harvesting system for dual Interface

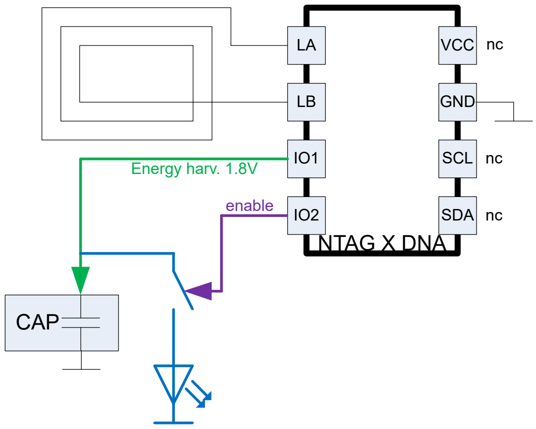

Figure 6. Example diagram - Powering peripherals

4 Abbreviations

Table 1. Abbreviations

Acronym	Description
EH	Energy harvesting (NFC Field)
AID	Application IDentifier
APDU	Application Protocol Data Unit
DF-Name	ISO7816 Dedicated filename
C-APDU	Command APDU
CMAC	MAC according to NIST Special Publication 800-38B
CRC	Cyclic Redundancy Check
IC	Integrated Circuit
KDF	Key derivation function
LRP	Leakage resilient primitive
LSB	Lowest Significant Byte
LSb	Lowest Significant bit
MAC	Message Authentication Code
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
NVM	Non-volatile memory
PCD	Proximity Coupling Device
PICC	Proximity-Integrated Circuit Card
PRF	Pseudo Random Function
R-APDU	Response APDU (received from PICC)
SSM	Standard Secure Messaging
SUN	Secure Unique NFC Messaging
UID	Unique Identifier
URI	Uniform Resource Identifier
URL	Uniform Resource Locator

5 References

[1] Data sheet - NTAG X DNA - Secure NFC Forum T4T compliant IC with PKI (Public Interface Structure) (link)

6 Revision history

Table 2. Revision history

Document ID	Release date	Description
AN14362 v.1.0	27 May 2025	• Initial version

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