

Getting started with the NFC card reader expansion board based on ST25R3916 for STM32 and STM8 Nucleos

Introduction

The X-NUCLEO-NFC06A1 NFC card reader expansion board is based on the ST25R3916 device.

The expansion board is configured to support ISO14443A/B, ISO15693, FeliCa™ and AP2P communication.

The ST25R3916 manages frame coding and decoding in reader mode for standard applications, such as NFC, proximity and vicinity HF RFID standards. It supports ISO/IEC 14443 Type A and B, ISO/IEC 15693 (single subcarrier only) and ISO/IEC 18092 communication protocols as well as the detection, reading and writing of NFC Forum Type 1, 2, 3, 4 and 5 tags.

The on-board low power capacitive sensor performs ultra-low power wake-up without switching the reader field on and traditional inductive wake-up to select amplitude or phase measurement.

The automatic antenna tuning (AAT) technology enables operation close to metallic parts and/or in changing environments.

Figure 1. X-NUCLEO-NFC06A1 expansion board



1 Getting started

1.1 Overview

X-NUCLEO-NFC06A1 expansion board main features:

- On-board NFC card reader IC: [ST25R3916](#)
- 47 mm x 34 mm, four turns, 13.56 MHz inductive antenna etched on PCB and associated tuning circuit
- Six general purpose LEDs
- ISO 18092 passive and active initiator, ISO 18092 passive and active target
- NFC-A and NFC-F card emulation
- ISO 14443A and ISO14443B
- ISO 15693
- FeliCa™
- Up to 1.7 W output power with differential antenna
- Possibility of driving two antennas in single ended configuration
- Inductive and capacitive wake-up
- Automatic antenna tuning system
- Transparent and Stream modes to implement MIFARE™ Classic compliant or other custom protocols
- Equipped with Arduino UNO R3 connector
- Free comprehensive development firmware library compatible with [STM32Cube](#) and samples for [ST25R3916](#)
- Scalable solution for multiple board cascade
- FCC certified
- RoHS and WEEE compliant

1.2 Board connection

Connect the **X-NUCLEO-NFC06A1** to an [STM32 Nucleo-64](#) development board via Arduino UNO R3 connectors. The PC USB port has to be capable of delivering at least 300 mA at 5 V supply.

A green LED indicates whether the 5 V supply is present, while the six status LEDs are controlled via MCU.

Provision for unpopulated jumpers enable alternative connections of all lines (except the SPI) to the STM32 MCU.

To demonstrate the wake-up feature, two capacitive electrodes are placed on the PCB and the automatic antenna tuning variable capacitors are also implemented.

1.3 Hardware requirements

The **X-NUCLEO-NFC06A1** expansion board is designed to be used with any [STM32 Nucleo](#) board, although complete testing has been performed using the [NUCLEO-L476RG](#) hosting the [STM32L476RG](#) microcontroller.

The STM32 Nucleo firmware and the related documentation are available at <http://www.st.com/stm32nucleo>.

1.4 System requirements

To use [STM32 Nucleo](#) boards with the **X-NUCLEO-NFC06A1** expansion board the following software and hardware are required:

- an STM32 Nucleo-64 development board
- a Windows® PC to install the firmware package
- a USB type A to Mini-B USB cable to connect the Nucleo board to the PC
- unit must be supplied by a Safety Extra Low Voltage with falling characteristics (<5 V, <15 W), according to EN60950-1. This power supply shall be classified ES1 (Electrical Source1), PS1 according to EN62368-1

To install the board firmware package (order code: [X-CUBE-NFC6](#)) the PC must have:

- 128 MB of RAM

- 40 MB of free hard disk space

The [X-CUBE-NFC6](#) firmware and the related documentation are available at www.st.com.

2 Board setup

To set up the board:

- Step 1.** Connect the [X-NUCLEO-NFC06A1](#) expansion board to the [STM32 Nucleo](#) board from the top through the Arduino UNO R3 connectors
- Step 2.** Power the [STM32 Nucleo](#) board using a Mini-B USB cable
- Step 3.** Program the firmware on the [STM32 Nucleo](#) board using the provided example
- Step 4.** Reset the MCU using the reset button available on the [STM32 Nucleo](#) board.
The evaluation kit is ready to be used.

3 Hardware

The **X-NUCLEO-NFC06A1** expansion board allows the user to test the functionality of the **ST25R3916**, which supports the reader/writer and the card emulation modes.

The **ST25R3916** IC module and the **STM32 Nucleo** board are connected through CN5, CN6, CN8 and CN9 connectors (see the tables below).

Table 1. Interconnections between the X-NUCLEO-NFC06A1 expansion board and the NUCLEO-L476RG board (left side)

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC06A1
NC	CN6 Power	1	-	-
IREF		2	-	(NC)
RESET		3	-	-
3V3		4	-	3V3 (VDD_IO)
5V		5	-	5V (VDD)
GND		6	-	GND
GND		7	-	GND
VIN		8	-	-
A0	CN8 Power	1	PA0	IRQ_MCU
A1		2	PA1	MCU_LED1
A2		3	PA4	MCU_LED2
A3		4	PB0	MCU_LED3
A4		5	PC1	MCU_LED4
A5		6	PC0	MCU_LED5

Table 2. Interconnections between the X-NUCLEO-NFC06A1 expansion board and the NUCLEO-L476RG board (right side)

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC06A1
D15	CN5 Digital	10	PB8	SCL_MCU
D14		9	PB9	SDA_MCU
AVDD		8	AVDD	NC
GND		7	GND	GND
D13		6	PA5	SCLK_MCU
D12		5	PA6	MISO_MCU
D11		4	PA7	MOSI_MCU
D10		3	PB6	/SS_MCU
D9		2	PC7	IRQ_MCU (alt.)
D8		1	PA9	/SS_MCU (alt.)

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC06A1
D7	CN9 Digital	8	PA8	MCU_LED6
D6		7	PB10	MCU_LED6 (alt.)
D5		6	PB4	/SS_MCU (alt.)
D4		5	PB5	MCU_LED2 (alt.)
D3		4	PB3	SCLK_MCU (alt.)
D2		3	PA10	MCU_LED3 (alt.)
D1		2	PA2	NC
D0		1	PA3	NC

3.1 Host interface and GPIO connection

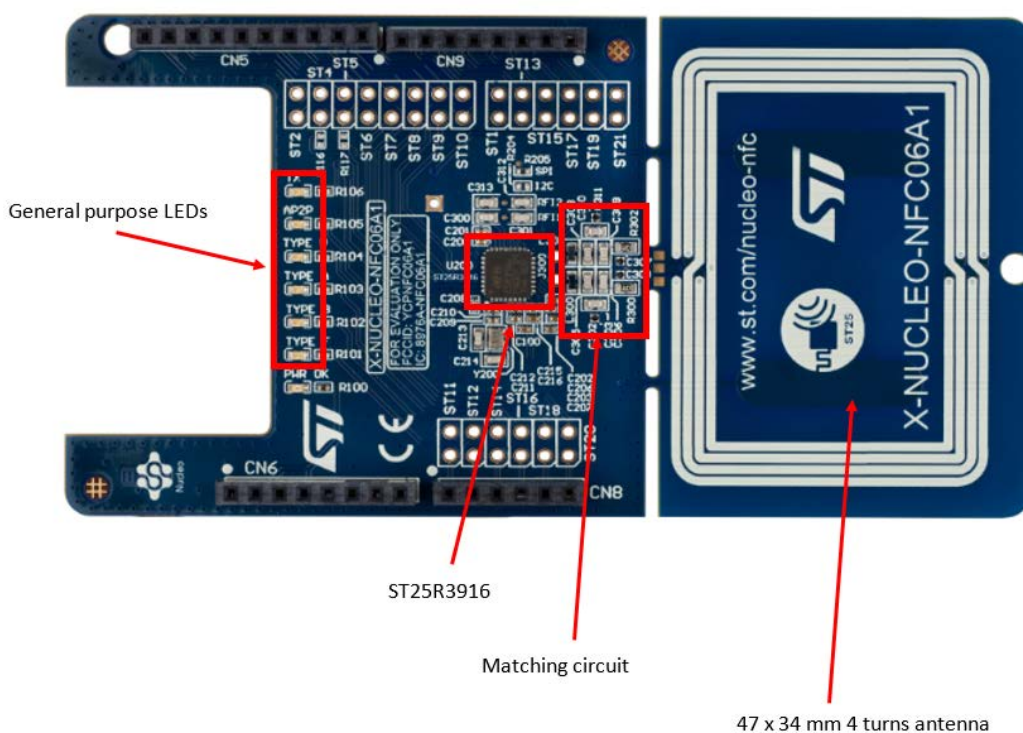
The **X-NUCLEO-NFC06A1** expansion board contains the ST25R3916-AQFT chip and is powered by the **STM32 Nucleo** board.

The **ST25R3916** is driven by the microcontroller via SPI interface.

The six LEDs indicate the detected RFID technology (for example, ISO14443 Type A for LED4).

3.2 X-NUCLEO-NFC06A1 expansion board component placement

Figure 2. X-NUCLEO-NFC06A1 component placement



3.3 ST25R3916 device

The **ST25R3916** is a high performance NFC universal device supporting NFC initiator, NFC target, NFC reader, and NFC card emulation modes.

The [ST25R3916](#) includes an advanced analog front end (AFE) and a highly integrated data framing system for:

- ISO 18092 passive and active initiator, ISO18092 passive and active target
- NFC-A/B (ISO 14443A/B) reader including higher bit rates
- NFC-F (Felica™) reader
- NFC-V (ISO 15693) reader up to 53 kbps
- NFC-A and NFC-F card emulation

Special stream and transparent modes of the AFE and framing system can be used to implement other custom protocols such as MIFARE® classic in reader or card emulation mode.

4 Schematic diagrams

Figure 3. X-NUCLEO-NFC06A1 circuit schematic (1 of 3)

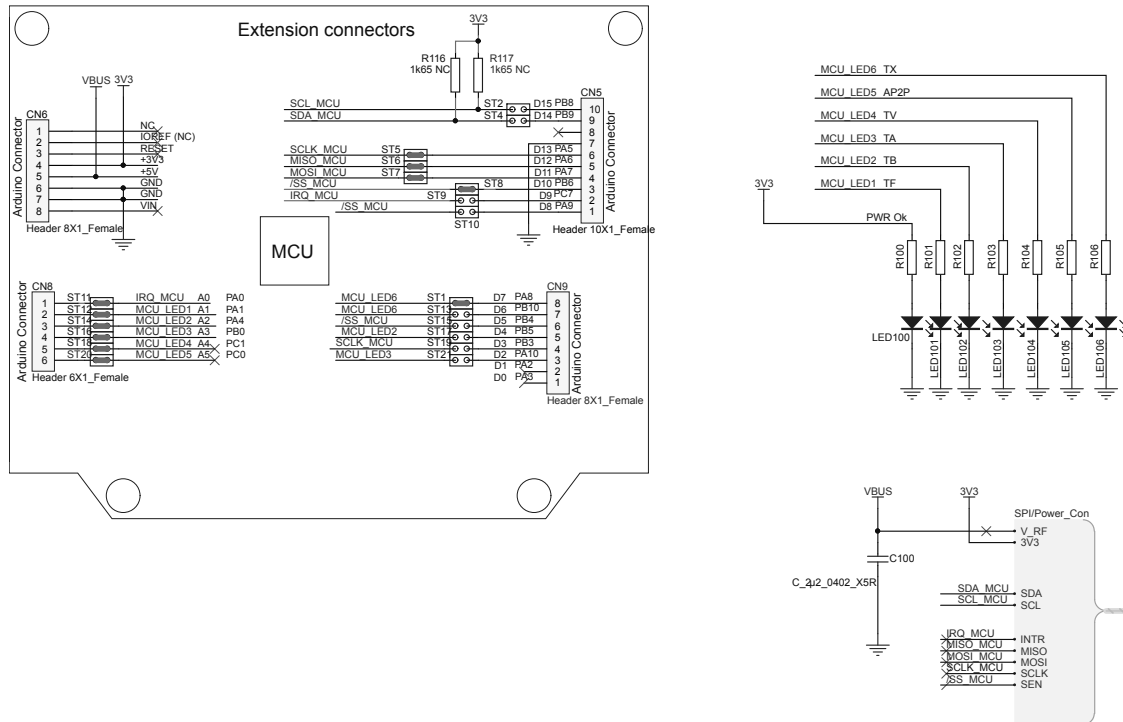
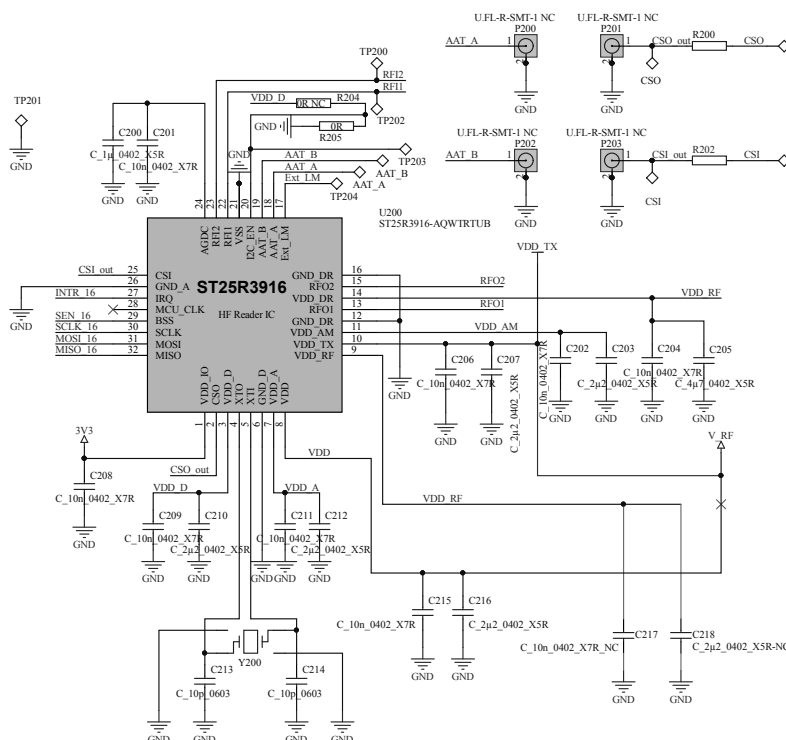
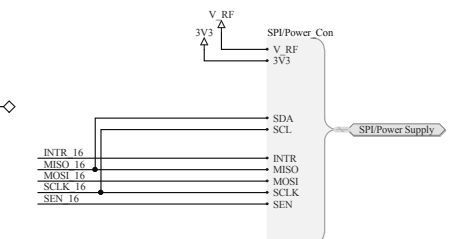


Figure 4. X-NUCLEO-NFC06A1 circuit schematic (2 of 3)

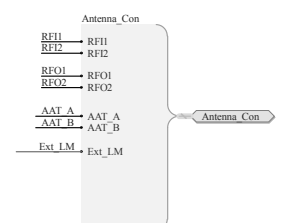
ST25R3916 NFC initiator/HF reader



Controller interface



Antenna connection



Antenna Circuit incl. EMI Filter and Matching



5 Bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	9	AAT_A, AAT_B, CSI, CSO, TP200, TP201, TP202, TP203, TP204		Test points	Any	Any
2	6	C100, C203, C207, C210, C212, C216	2 μ 2 X5R 0402 6.3 V $\pm$ 20%	Capacitors	MURATA	GRM155R60J225ME15D
3	1	C200	1 μ X5R 0402 25 V $\pm$ 10%	Capacitors	MURATA	GRM155R61C105KA12D
4	8	C201, C202, C204, C206, C208, C209, C211, C215	10 n_x7R 0402 25 V $\pm$ 10%	Capacitors	AVX	04023C103KAT2A
5	1	C205	4 μ 7 X5R 0402 6.3 V $\pm$ 10%	Capacitors	TDK	C1005X5R0J475K050BC
6	4	C213, C214, C301, C312	10 p COG 0603 50 V $\pm$ 1%	Capacitors	MULTICOMP	MC0603N100F500CT
7	1	C217	10 n X7R NC 0402 25 V $\pm$ 10%	Capacitors	AVX	04023C103KAT2A NOT FITTED
8	1	C218	2 μ 2 X5R NC 0402 6.3 V $\pm$ 20%	Capacitors	MURATA	GRM155R60J225ME15D NOT FITTED
9	2	C300, C313	180 p COG 0603 50 V $\pm$ 1%	Capacitors	MURATA	GRM1885C1H181GA01D
10	3	C302, C311, C314	CSP_06_06	Capacitors	muRata	LXRW0YV600-054
11	2	C304, C307	CSP_06_07	Capacitors	muRata	LXRW0YV600-054
12	2	C303, C310	100 p COG 0603 50 V $\pm$ 1%	Capacitors	MURATA	GRM1885C1H101FA01D
13	2	C305, C308	680 p COG 0603 $\pm$ 2%	Capacitors	MURATA	GRM1885C1H681GA01D
14	2	C306, C309	56 p COG 0603	Capacitors	MURATA	GRM1885C1H560FA01D
15	2	C315, C316	82 p COG 0603	Capacitors	MURATA	GRM1885C1H820FA01D
16	1	C317	47 p COG NC 0603	Capacitors	MURATA	GRM1885C1H470FA01D
17	1	CN5	Single row, female	10-pin header	Samtec	SSQ-110-03-L-S
18	2	CN6, CN9	Single row, female	8-pin header	Samtec	SSQ-108-03-L-S
19	1	CN8	Single row, female	6-pin header	Samtec	SSQ-106-03-L-S
20	1	D300	SOT323	Dual surface mount switching diode	Diodes Inc	BAV70W-7-F
21	1	J300	Male single row horizontal 2 pin_NC	Jumper	Any	Any
22	2	L300, L301	LQW18CNR27J00 D 0603 550 mA	Multi-layer ferrite	TDK	MLJ1608WR27JT000
23	1	LED100	0603	Green LED	Lite-On	LTST-C190KGKT

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
24	6	LED101, LED102, LED103, LED104, LED105, LED106	0603	Blue LED	Lite-On	LTST-C190TBKT
25	4	P200, P201, P202, P203	U.FL-R-SMT-1 (not fitted)	Co-axial connectors	HIROSE(HRS)	U.FL-R-SMT-1(10)
26	1	Q300	NX3008NBK SOT23	NCh MOSFET	NEXPERIA	NX3008NBK
27	1	R100	680 R, 0402 100 V 1/16 A $\pm 5\%$	Resistors	Yageo	RC0402JR-07680RL
28	6	R101, R102, R103, R104, R105, R106	1k, 0402	Resistors	Panasonic	ERJ2GEJ102X
29	2	R116, R117	1 k65, 0402 (not fitted)	Resistors	MULTICOMP	MC00625W040211K65
30	2	R200, R202	50 R, 0402 50 V	Resistors	MULTICOMP	MCMR04X49R9FTL
31	1	R204	0 R, 0402 (not fitted)	Resistors	MULTICOMP	MC00625W040210R
32	1	R205	0 R, 0402	Resistors	MULTICOMP	MC00625W040210R
33	2	R300, R302	2 R4, 0603	Resistors	Any	Any
34	1	R301	100 R 0402	Resistors	ANY	Any
35	1	R303	47 K 0402	Resistors	ANY	Any
36	1	R304	0 R, 0603	Resistors	Any	Any
37	11	ST1, ST5, ST6, ST7, ST8, ST11, ST12, ST14, ST16, ST18, ST20	CONN HE14 2PTS male vertical (not fitted)	Connectors	Any	Any
38	9	ST2, ST4, ST9, ST10, ST13, ST15, ST17, ST19, ST21	CONN HE14 2PTS male vertical (not fitted)	Connectors	Any	Any
39	1	U200	ST25R3916- AQWTRTUB	High performance NFC universal device and EMVCo reader	ST	ST25R3916
40	1	Y200	NDK NX2016SA 27.12 MHz	Crystal	MURATA	NX2016SA STD-CZS-5

6 Federal Communications Commission (FCC) and Industry Canada (IC) compliance

6.1 FCC Compliance Statement

6.1.1 Part 15.19

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

6.1.2 Part 15.21

Any changes or modifications to this equipment not expressly approved by STMicroelectronics may cause harmful interference and void the user's authority to operate this equipment.

6.1.3 Part 15.105

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

6.1.4 FCC ID

FCC ID: YCPNFC06A1

6.2 Formal notices required by Industry Canada ("IC")

6.2.1 Compliance Statement

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation.

6.2.2 Declaration de Conformité

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

6.2.3 IC ID

IC ID: 8976A-NFC06A1

Revision history

Table 3. Document revision history

Date	Version	Changes
18-Jul-2019	1	Initial release.
18-Sep-2019	2	Minor text changes.
11-Nov-2019	3	Updated Table 2 . Interconnections between the X-NUCLEO-NFC06A1 expansion board and the NUCLEO-L476RG board (right side).

List of tables

Table 1.	Interconnections between the X-NUCLEO-NFC06A1 expansion board and the NUCLEO-L476RG board (left side)	5
Table 2.	Interconnections between the X-NUCLEO-NFC06A1 expansion board and the NUCLEO-L476RG board (right side)	5
Table 3.	Document revision history	13

List of figures

Figure 1.	X-NUCLEO-NFC06A1 expansion board.	1
Figure 2.	X-NUCLEO-NFC06A1 component placement.	6
Figure 3.	X-NUCLEO-NFC06A1 circuit schematic (1 of 3)	8
Figure 4.	X-NUCLEO-NFC06A1 circuit schematic (2 of 3)	8
Figure 5.	X-NUCLEO-NFC06A1 circuit schematic (3 of 3)	9

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