UM1872
User manual

Getting started with the Sub-1 GHz expansion board based on SPSGRF-868 and SPSGRF-915 modules for STM32 Nucleo

Introduction

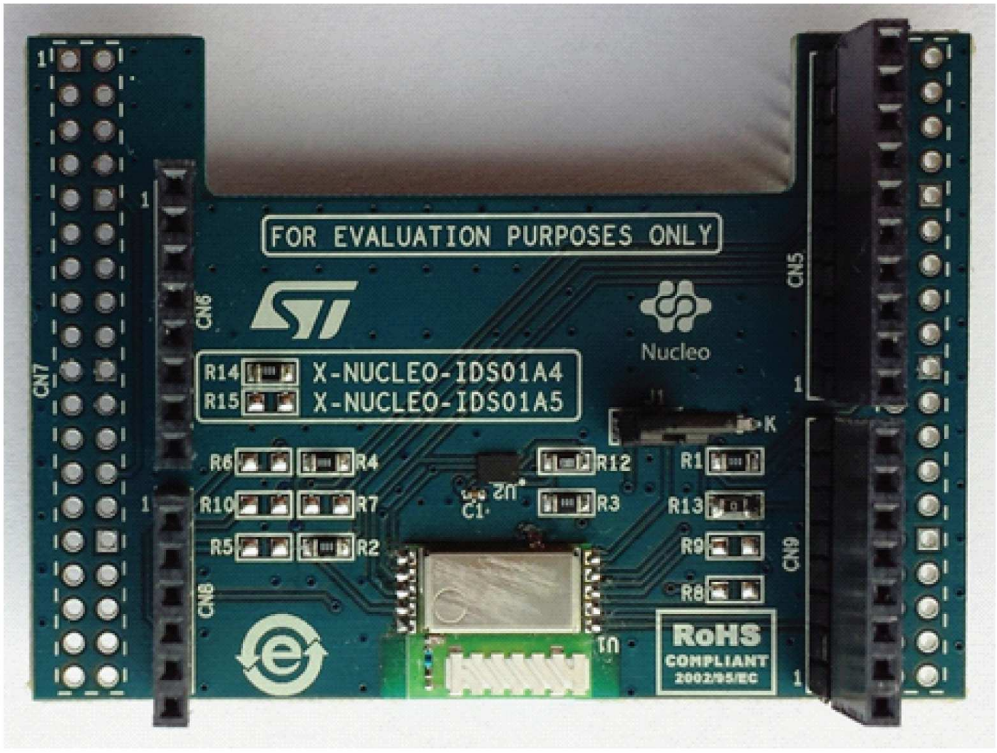
The X-NUCLEO-IDS01A4 and X-NUCLEO-IDS01A5 are evaluation boards intended to provide a platform for testing the features and capabilities of the SPSGRF modules, based on the SPIRIT1 low data rate, low power sub-1 GHz transceiver device.

These expansion boards can be plugged into the Arduino UNO R3 connectors of any STM32 Nucleo board. The user can mount ST Morpho connectors if required. Other expansion boards can easily be stacked to allow evaluation of different devices using sub-1 GHz communication.

The boards are equipped with the following features:

- On-board SPSGRF module based on the SPIRIT1 sub-1 GHz transceiver device
- SPI EEPROM for saving parameters
- LED for user interface
- Jumper at 3V3 for checking the current consumption of the expansion board

Figure 1. Sub-1 GHz expansion board based on SPSGRF module for STM32



Contents

1 Description

The X-NUCLEO-IDS01A4 and X-NUCLEO-IDS01A5 boards contain the module SPSGRF-868 or SPSGRF-915 based on SPIRIT1 low data rate, low power sub-1 GHz transceiver. The PCB layout is the same for both boards, with the only difference being the module used with it.

Table 1. Expansion board details

Evaluation board	RF communication frequency	Identification resistors	Module used	Description
X-NUCLEO-IDS01A4	868 MHz	R14 mounted	SPSGRF-868	868 MHz RF expansion board based on ETSI certified module SPSGRF-868 for STM32 Nucleo
X-NUCLEO-IDS01A5	915 MHz	R15 mounted	SPSGRF-915	915 MHz RF expansion board based on FCC and IC certified module SPSGRF-915 for STM32 Nucleo

Identification of the RF communication frequency can be easily performed using the identification resistors (R14 or R15) mounted on the PCBs. Only 1 of the two resistors is mounted on the board to ensure quick identification. This information is also available in the PCB silk screen.

Note that R14 and R15 are for identification purposes only, and changing these resistors does not change the RF frequency of the SPIRIT1 device.

For information common to both boards, the nomenclature “X-NUCLEO-IDS01Ax” is used hereafter in this document.

1.1 Typical applications

The evaluation boards can be used for evaluation of the SPIRIT1 device in multiple applications.

The following demo examples are available for testing with the evaluation boards

- wM-Bus: Wireless Metering Bus demo
- Point-to-point communication protocol demo

Please refer to the data brief for the firmware, available on www.st.com.

Users can develop other applications for evaluating the devices. Some of these applications are:

- Automatic meter reading
- Home and building automation
- WSN (wireless sensor network)

- Industrial monitoring and control
- Wireless fire and security alarm systems

1.2 Abbreviations

Table 2. Abbreviation

Term	Meaning
AMR	Automatic meter reading
EEPROM	Electrically erasable programmable read only memory
GHz	Giga Hertz
GUI	Graphical user interface
LED	Light emitting diode
MCU	Microcontroller unit
P2P	Point-to-point communication
RF	Radio frequency communication
SPI	Serial peripheral interface
USB	Universal serial bus
wM-Bus	Wireless metering bus
WSN	Wireless sensors network

2 Getting started

This section describes the hardware requirements for the X-NUCLEO-IDS01Ax evaluation boards.

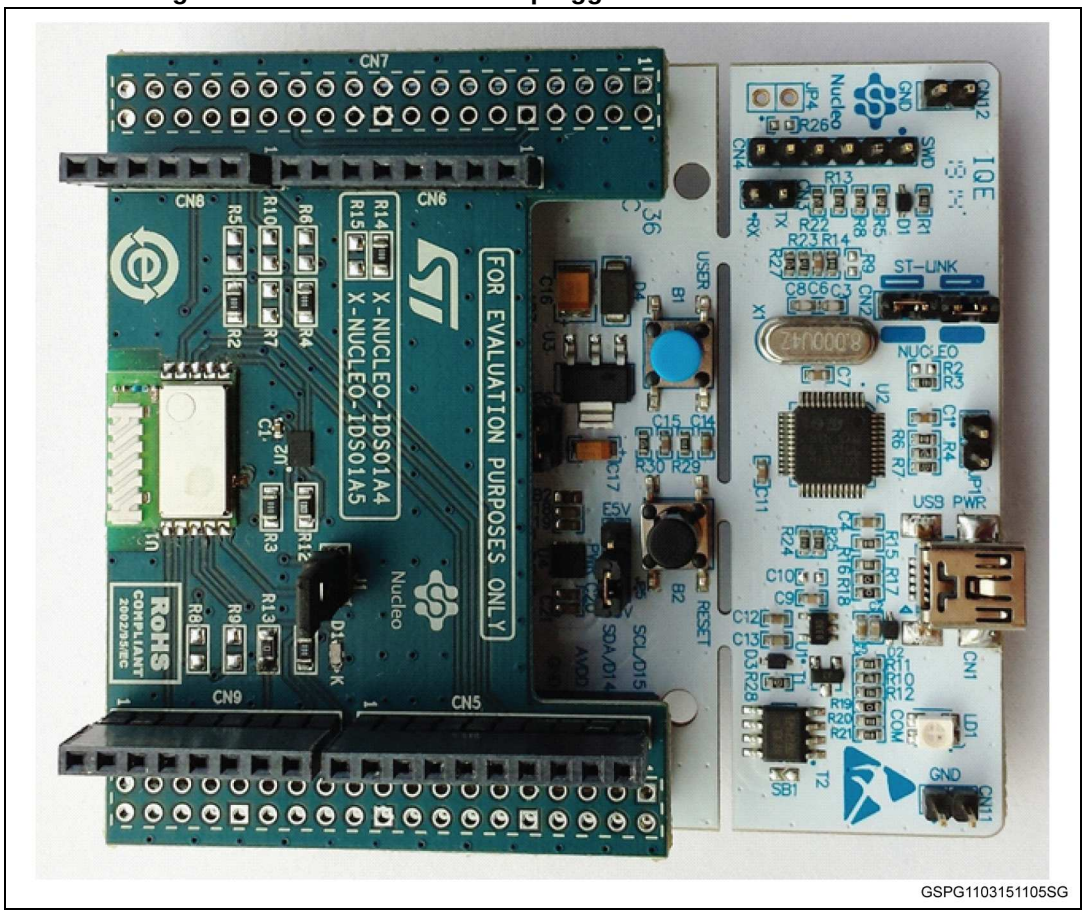
2.1 Hardware requirements

The X-NUCLEO-IDS01Ax is an expansion board for use with the STM32 Nucleo. To function correctly, the X-NUCLEO-IDS01Ax must be connected to the STM32 Nucleo board as shown in *Figure 2* below.

The STM32 Nucleo firmware and related documentation is available on www.st.com at

http://www.st.com/stm32nucleo

Figure 2. X-NUCLEO-IDS01Ax plugged to STM32 Nucleo board



The interconnection between the STM32 Nucleo and the X-NUCLEO-IDS01Ax has been designed to permit the use of any STM32 Nucleo board, although complete testing has been performed using the NUCLEO-L053R8 and NUCLEO-F401RE hosting the ultra-low power STM32.

2.2 System requirements

Using the Nucleo boards with the X-NUCLEO-IDS01Ax expansion board requires the following software and hardware:

- Windows PC (XP, Vista, 7, 8) to install the firmware package
- USB type A to Mini-B USB cable to connect the Nucleo board to the PC

Installation of the board firmware package and the wM-Bus graphical user interface utility on the user's PC requires the following:

- 128 MB of RAM
- Approximately 40 MB of hard disk space for the firmware
- Approximately 15 MB of hard disk space for the wM-Bus GUI

The use of the wM-Bus concentrator with the GUI requires additional boards to be connected to the PC. The GUI can be used to check the wM-Bus communication example. The Nucleo board acts as a meter and the STEVAL-IKR001Vx board connected to the PC acts as a concentrator. Please note that the wM-Bus example is valid only for X-NUCLEO-IDS01A4 (868 MHz version).

2.3 Setting up the board

Perform the following steps to set up the board:

1. Check that the jumper on the J1 connector is connected. This jumper provides the required voltage to the devices on the board
2. Connect the X-NUCLEO-IDS01Ax to the Nucleo board from the top, as shown in *Figure 2*.
3. Power the Nucleo board using the Mini-B USB cable
4. Program the firmware in the STM32 on the Nucleo board using the firmware example provided
5. Reset the MCU board using the reset button on the Nucleo board
6. The evaluation kit is ready for use

3 Hardware description

This section describes the X-NUCLEO-IDS01Ax features and provides information which could be useful to understand the board schematics.

3.1 Interconnection details

The table below explains the connection details of the X-NUCLEO-IDS01Ax board with the NUCLEO-L053R8 board.

Table 3. Left connector connection details

Signal name	NC	IOREF	RESET	3V3	5V	GND	GND	VIN		A0	A1	A2	A3	A4	A5
	Left connector														
Connector name	CN6 Power									CN8 Analog					
Pin#	1	2	3	4	5	6	7	8		1	2	3	4	5	6
NUCLEO-L053R8 (MCU port)										PA0	PA1	PA4	PB0	PC1/ PB9	PC0/ PB8
NUCLEO-L053R8 MCU signals										ADC_IN0	ADC_IN1	ADC_IN4	ADC_IN8	ADC_IN11 (PC1) or I2C1_SDA (PB9)	ADC_IN10(PC0) or I2C1_SCL (PB8)
X-NUCLEO-IDS01Ax Expansion board signals				3V3		GND	GND			SPIRIT1_GPIO3 (Opt)	SPIRIT1_CSn (Opt)	SPIRIT1_GPIO2 (Opt)	SPIRIT1_GPIO1 (Opt)	SPIRIT1_GPIO0 (Opt)	

Table 4. Right connector connection details

Signal name	D15	D14	AREF	GND	D13	D12	D11	D10	D9	D8		D7	D6	D5	D4	D3	D2	D1	D0
	Right connector																		
Connector name	CN5 Digital											CN9 Digital							
Pin#	10	9	8	7	6	5	4	3	2	1		8	7	6	5	4	3	2	1
NUCLEO-L053R8 MCU port	PB8	PB9			PA5	PA6	PA7	PB6	PC7	PA9		PA8	PB10	PB4	PB5	PB3	PA10	PA2	PA3
NUCLEO-L053R8 MCU signals	I2C1_SCL	I2C1_SDA	AVDD	Ground	SPI1_SCK	SPI1_MISO	TIM22_CH2	SPI1_CS	TIM22_CH2				TIM2_CH3	TIM22_CH1		TIM2_CH2_SCK		USART2_TX	USART2_RX
X-NUCLEO-IDS01Ax Expansion boards signals				GND	CLK (Opt)	MISO (SPIRIT1)	MOSI(SPIRIT1)	SPIRIT1_CSn	SPIRIT1_GPIO3				EEPROM_nS	LED1		CLK	SDn		

Note: Opt = Optional connection

3.2 SPI and GPIO connection options

Table 5 shows the SPI and GPIO connection options between the STM32 and SPIRIT1 hosted on the SPSGRF module. These can be used to enable different configurations in cases where a signal conflict occurs when using with other expansion board.

Table 5. SPIRIT1 interface (optional) with Nucleo board

SPIRIT1 signal	SPSGRF pin	Default STM32 port	Optional STM32 port
GPIO3	1 - SP1_GPIO3	PC7	PA0 To use optional connection mount R6, demount R1
CSn	10 - SPI_CS	PB6	PA1 To use optional connection mount R5, demount R2
SCLK	7 - SPI_CLK	PB3	PA5 To use optional connection mount R7, demount R4

In addition, to use the additional connections to the SPIRIT1 module and to use the on-board EEPROM, use the options in *Table 6*.

Table 6. SPIRIT1 interface with Nucleo board (additional connections)

Signal	Default connection	Optional STM32 connection
SPIRIT1 GPIO2 (SPSGRF pin 2)	Not connected	PA4 To use optional connection mount R8
SPIRIT1 GPIO1 (SPSGRF pin 3)	Not connected	PB0 To use optional connection mount R9
SPIRIT1 GPIO0 (SPSGRF pin 4)	Not connected	PC1 To use optional connection mount R10
EEPROM nS	Not connected	PB10 To use EEPROM, mount R3

Please refer to the schematics for details.

To use the optional connections, modify the firmware based on the STM32 resources used.

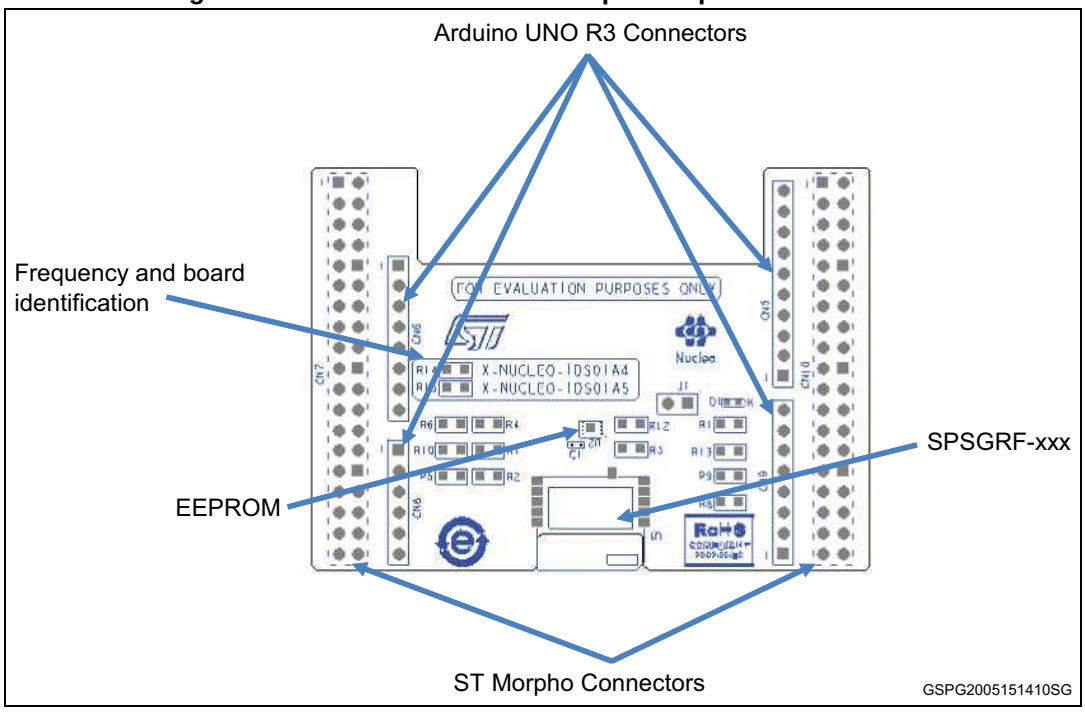
3.3 Current measurement

To monitor the power consumption of the entire SPIRIT1 X-NUCLEO-IDS01Ax board, jumper J1 can be used. Connect an ammeter probe between pins 1 and 2 of the connector for measurements.

3.4 X-NUCLEO-IDS01Ax component placement details

Figure 3 shows the component placement on the SPIRIT1 expansion X-NUCLEO-IDS01Ax board.

Figure 3. X-NUCLEO-IDS01Ax component placement details



4 Component description

This section describes the devices on the board.

4.1 SPSGRF-868 / SPSGRF-915 module

The SPSGRF modules are based on the SPIRIT1 device which is a low data rate, low power sub-1 GHz transceiver. The SPSGRF-868 module is for 868 MHz RF communication and the SPSGRF-915 module is for 915 MHz RF communication. The SPSGRF-868 is an ETSI certified module and SPSGRF-915 is an FCC and IC certified module SPSGRF-915 (FCC ID: S9NSPSGRF and IC: 8976C-SPSGRF).

The interface of the device to the STM32 Nucleo boards is through an SPI interface and some GPIOs. The SPSGRF module also integrates the balun BALF-SPI-01D3 and a chip antenna.

The part numbers used to develop this application are shown in *Table 7*.

Table 7. SPIRIT1 details

Features	Description
Order code	SPSGRF-868, SPSGRF-915
Package	SMD 11 pin
Operating voltage	1.8 to 3.6 V

The SPIRIT1 device is designed to operate both in the license-free ISM and SRD frequency bands at 169, 315, 433, 868, and 915 MHz.

The SPSGRF modules are designed for fixed frequencies specified in the part number.

4.2 SPI EEPROM

The M95640-R is a 64 Kbit serial SPI bus EEPROM with high-speed clock interface. The device can be used to store the configuration parameters related to application or settings of the SPIRIT1 device.

The part numbers used to develop this application are shown in *Table 8*.

Table 8. SPI EEPROM details

Features	Description
Order code	M95640-RMC6TG
Package	MLP8
Operating voltage	1.8 to 5.5 V

To use the on-board SPI EEPROM, mount the R3 resistor on the board.

5 Formal Notices Required by the U.S. Federal Communications Commission (“FCC”)

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.

The X-NUCLEO-IDS01A5 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 any interference that may cause undesired operation.

The X-NUCLEO-IDS01A5 contains FCC ID: S9NSPSGRF.

6 Formal Notices Required by the Industry Canada (“IC”)

English:

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 of the device.

French:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. '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.

The X-NUCLEO-IDS01A5 contains IC certified module SPBTLE-RF (IC:8976C-SPSGRF).

7 Hardware schematic diagrams

Figure 4. Nucleo connectors

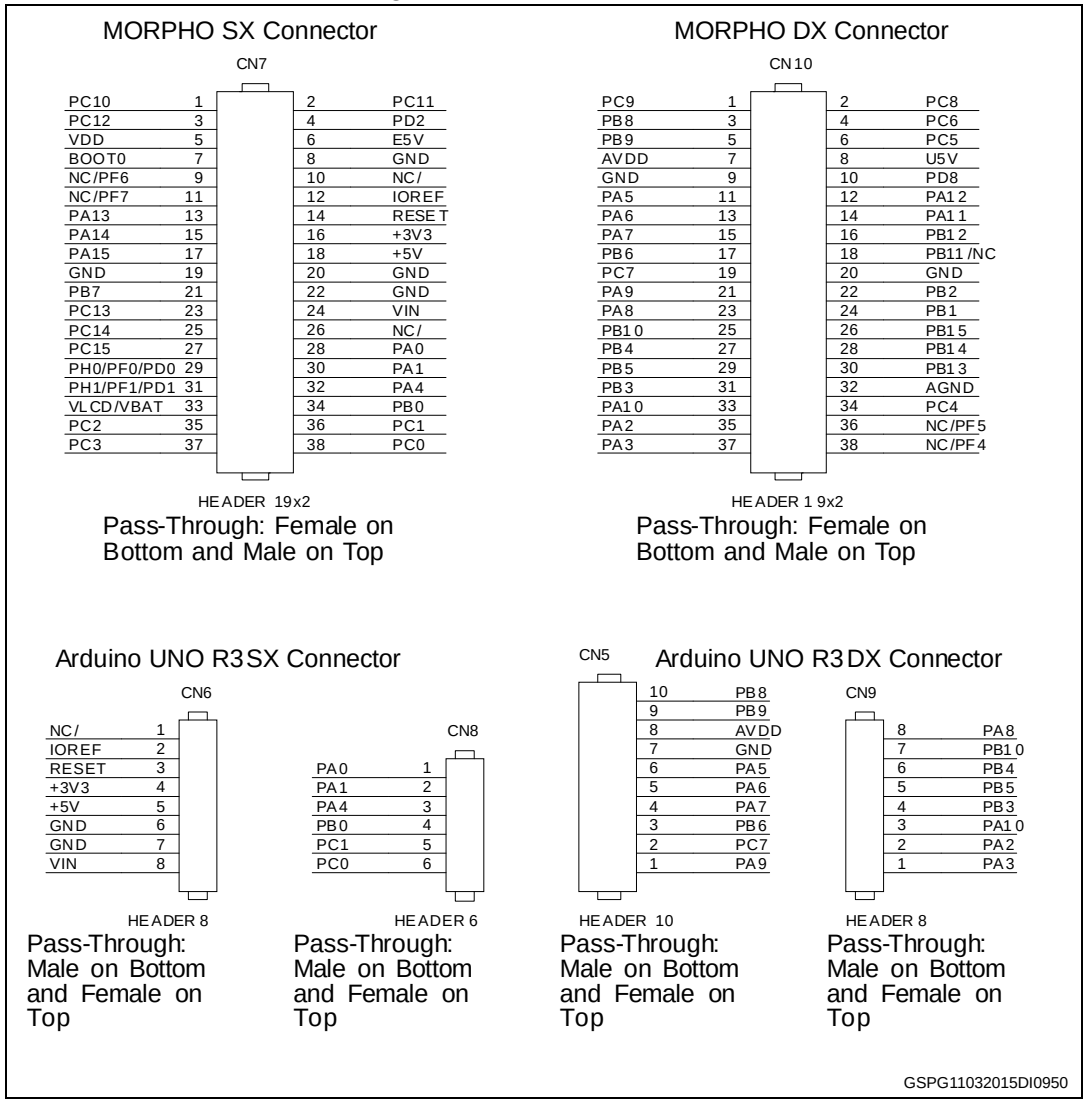


Figure 5. SPSGRF-868, SPSGRF-915

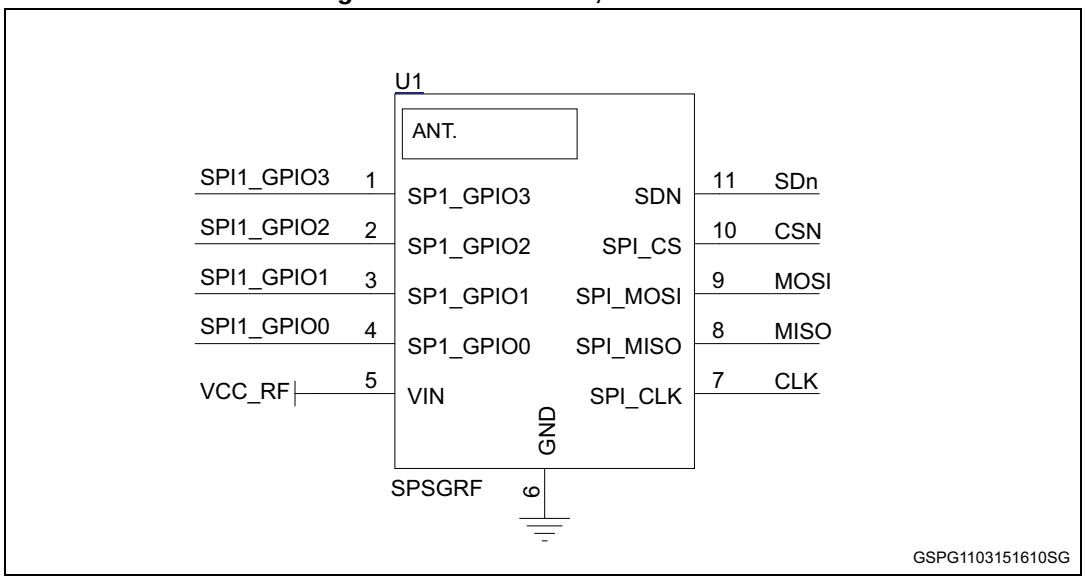


Figure 6. Nucleo connections

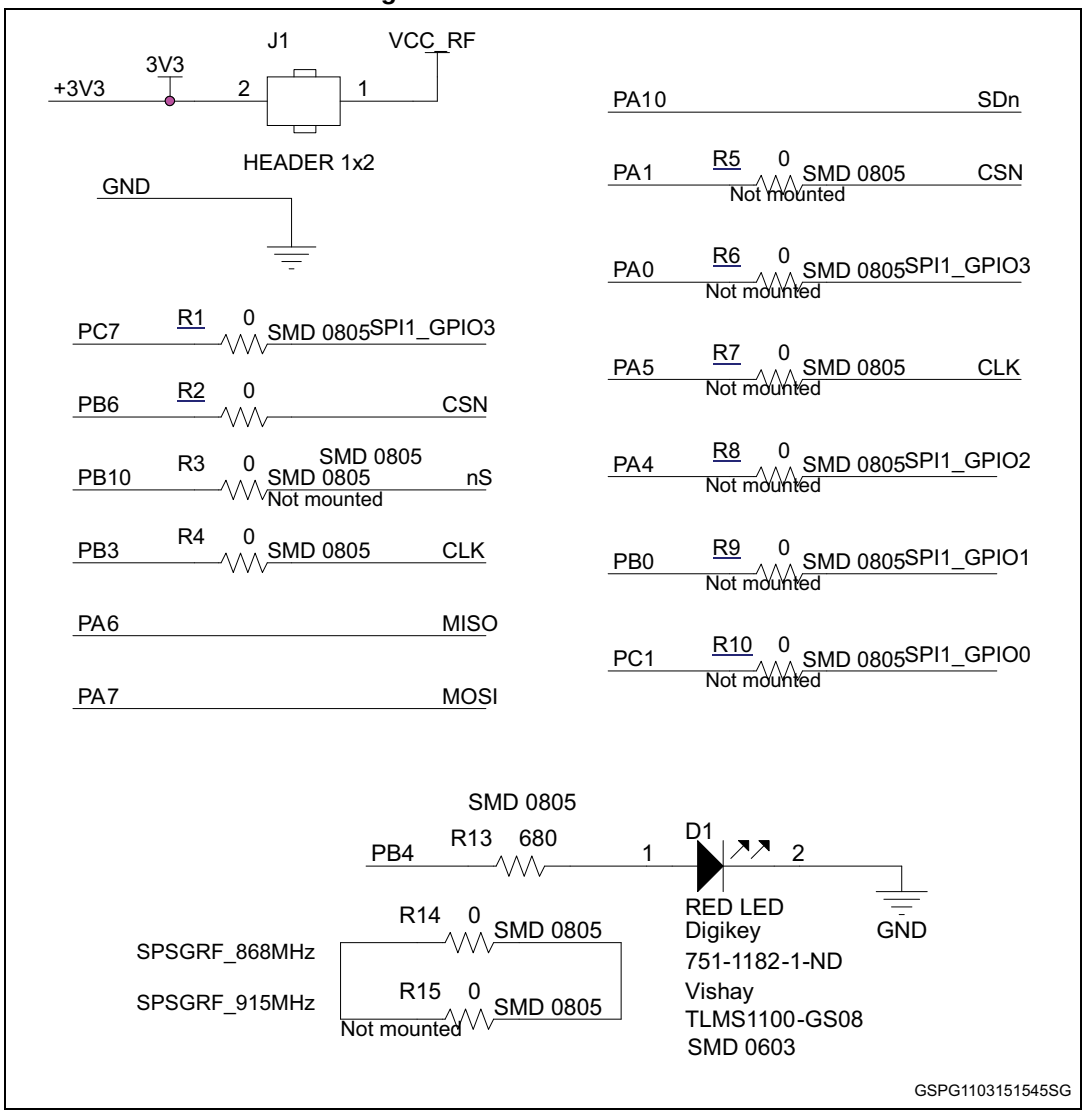
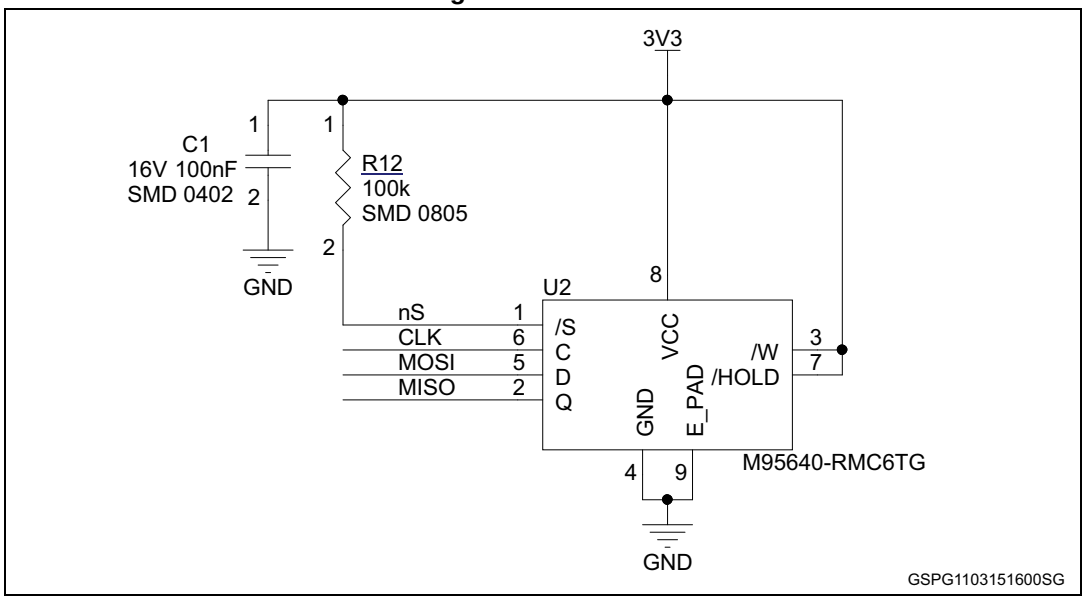


Figure 7. EEPROM



8 Bill of material

Table 9. BOM list

Item	Qty	Ref.	Part / Value	Type / Add. Notes	Toler.	Package	Manuf.	Part num./ Order code	Supplier	Suppl. order code
X-NUCLEO-IDS01A4 (SPSGRF-868 Nucleo expansion board specific components)										
1	1	U1	SPSGRF-868			SMD 11 pins	ST	SPSGRF-868	ST SUPPLY	SPSGRF-868
2	1	R14	0	R15 NOT MOUNTED		SMD 0805	ANY	ANY		
X-NUCLEO-IDS01A5 (SPSGRF-915 Nucleo expansion board specific components)										
1	1	U1	SPSGRF-915			SMD 11 pins	ST	SPSGRF-868	ST SUPPLY	SPSGRF-868
2	1	R15	0	R14 NOT MOUNTED		SMD 0805	ANY	ANY		
X-NUCLEO-IDS01A4, X-NUCLEO-IDS01A5: SPIRIT1 expansion board common components										
3	1	U2	M95640-RMC6TG			UFDFPN8 2X3 mm (MLP8)	ST	M95640-RMC6TG	ST SUPPLY	M95640-RMC6TG
4	1	CN5	Arduino Connector CN5 10 pins			Pass-Through: Male on Bottom, Female on Top. 10x1 2.54mm pitch	SAMTEC	SSQ-110-03-F-S	Farnell	2283783
5	2	CN6, CN9	Arduino Connectors CN6 and CN9 8 pins			Pass-Through: Male on Bottom, Female on Top. 8x1 2.54mm pitch	SAMTEC	SSQ-108-03-F-S	Farnell	2283782
6	2	CN7, CN10	MORPHO Connectors CN7 and CN10 38 pins	NOT MOUNTED		Pass-Through: Female on Bottom, Male on Top. 19x2 2.54mm pitch				
7	1	CN8	Arduino Connector CN8 6 pins			Pass-Through: Male on Bottom, Female on Top. 6x1 2.54mm pitch	SAMTEC	SSQ-106-03-G-S	Farnell	2283759
8	1	C1	100nF	Ceramic X7R	±10%	SMD 0402	Murata	GRM155R71C104KA88		

Table 9. BOM list (continued)

Item	Qty	Ref.	Part / Value	Type / Add. Notes	Toler.	Package	Manuf.	Part num./ Order code	Supplier	Suppl. order code
9	1	J1	Jumper			Through hole 2 x1 2.54 mm pitch	ANY	ANY		
10	12	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R14, R15	0	R3, R5, R6, R7, R8, R9, R10,R15 NOT MOUNTED	±1%	SMD 0805	ANY	ANY		
11	1	R12	100 k		±1%	SMD 0805	ANY	ANY		
12	1	R13	680		±1%	SMD 0805	ANY	ANY		
13	1	D1	RED LED			SMD 0603	Vishay	TLMS1100-GS08	Digikey	751-1182-1-ND

9 Revision history

Table 10. Document revision history

Date	Revision	Changes
20-May-2015	1	Initial release.
23-Jun-2015	2	Added: - *Section 6: Formal Notices Required by the Industry Canada (“IC”)*.