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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



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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

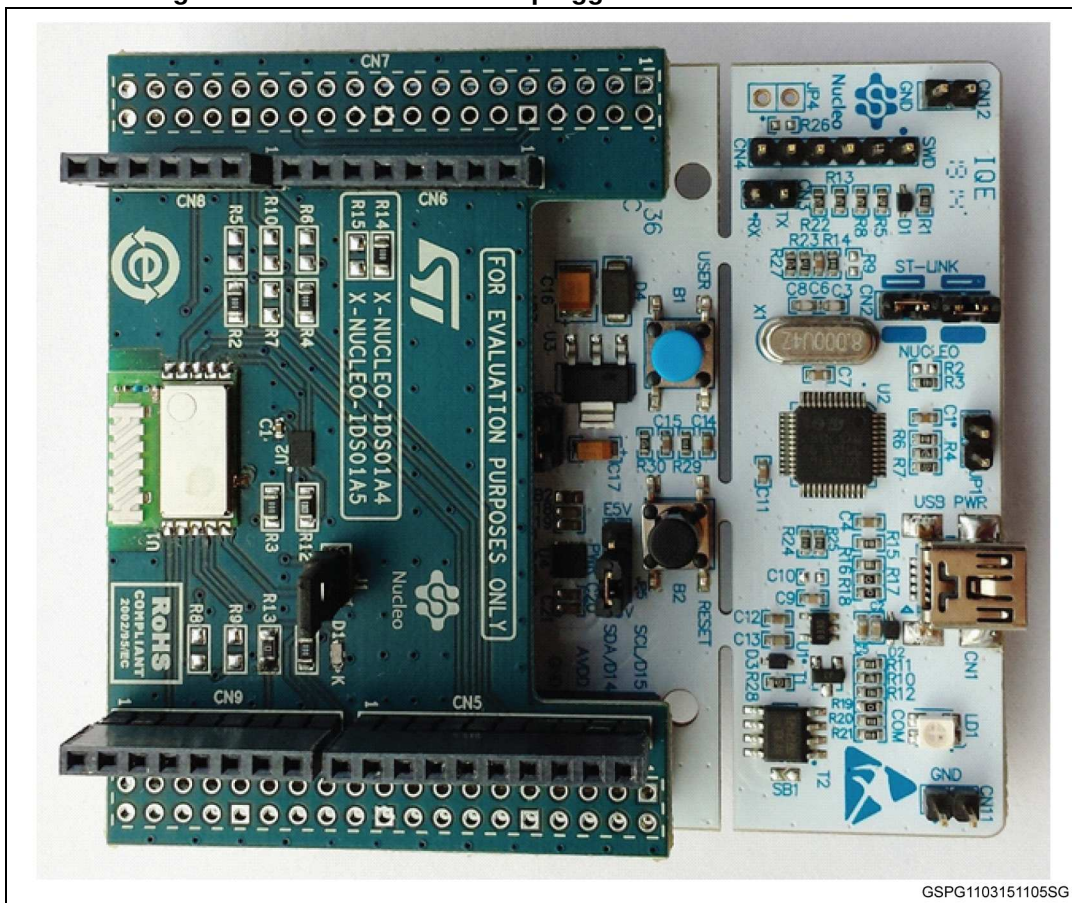
This section describes the hardware requirements for the X-NUCLEO-IDS01Ax evaluation boards.

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.

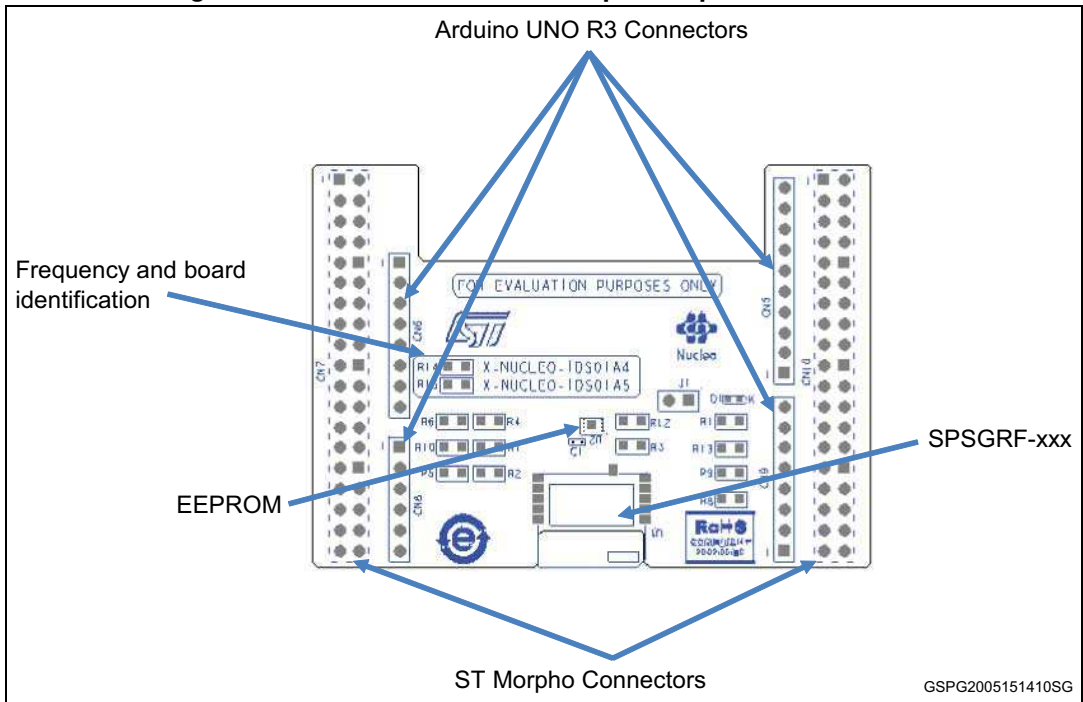
3.3 Current measurement

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. 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.

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

7 Hardware schematic diagrams

Figure 4. Nucleo connectors

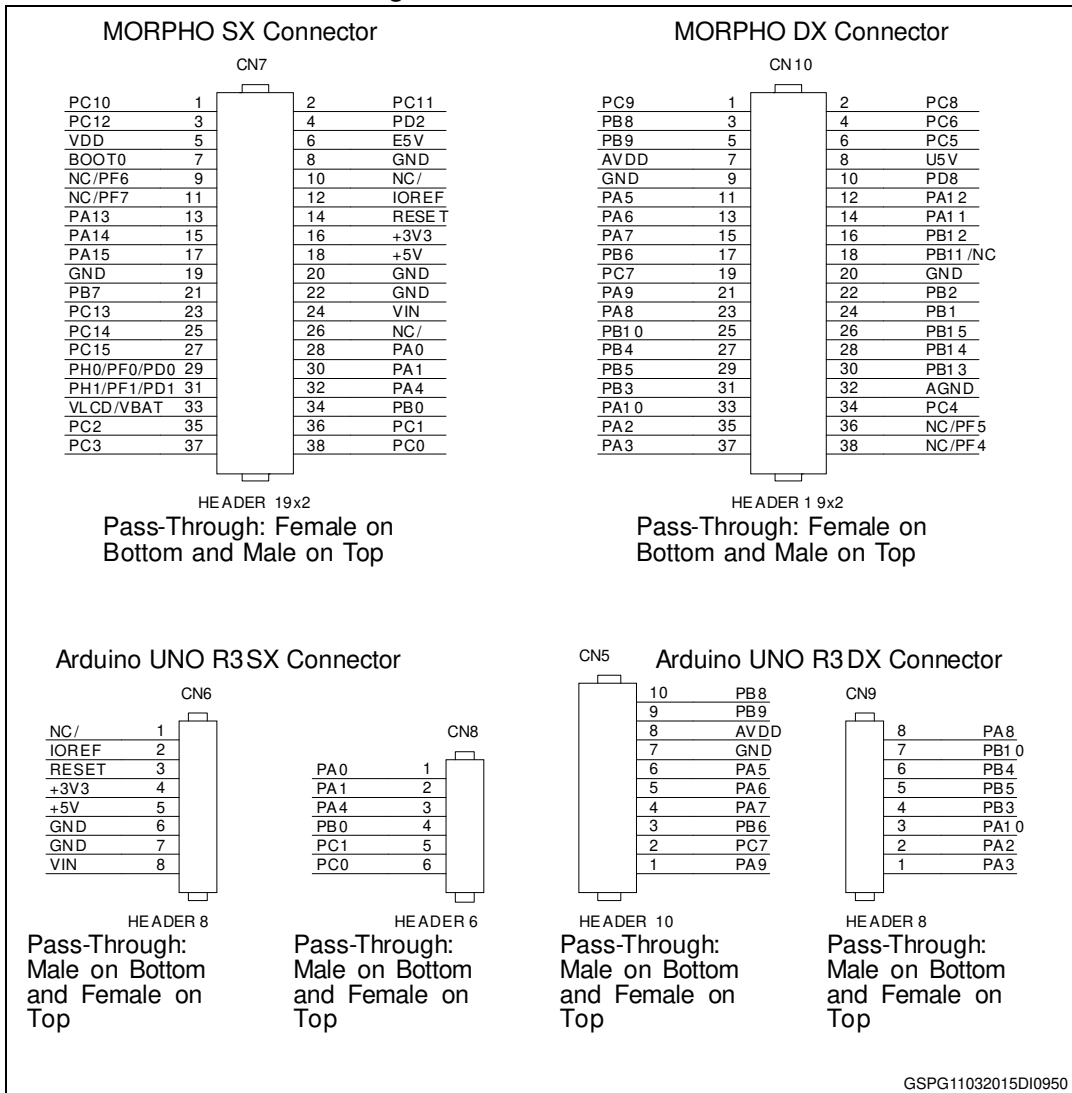


Figure 5. SPSGRF-868, SPSGRF-915

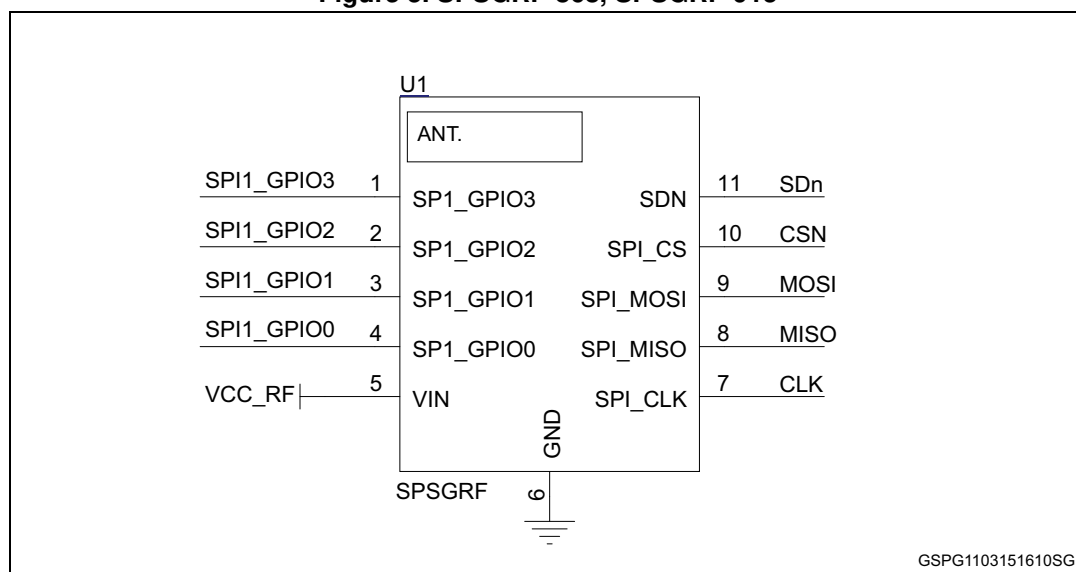


Figure 6. Nucleo connections

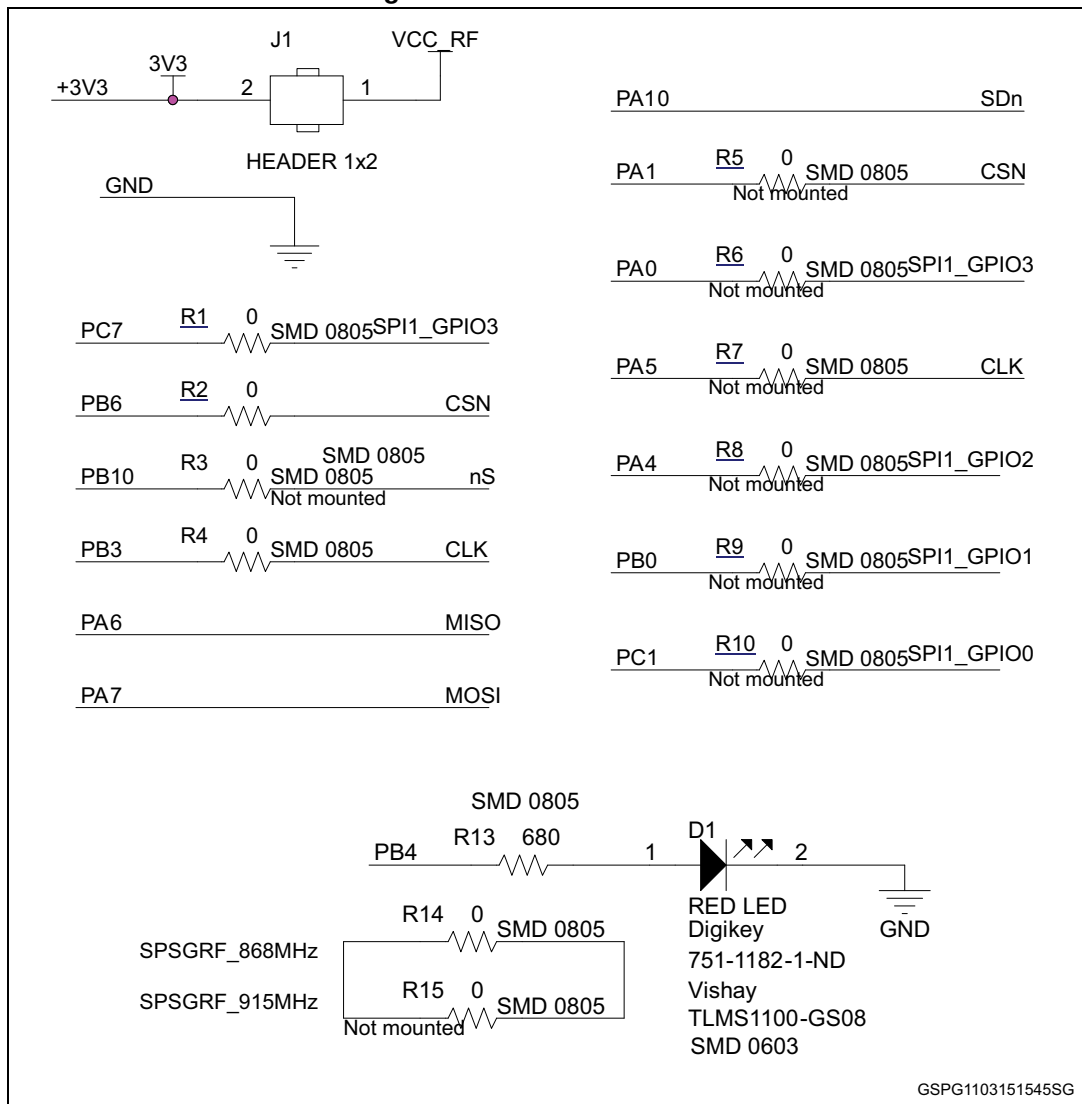
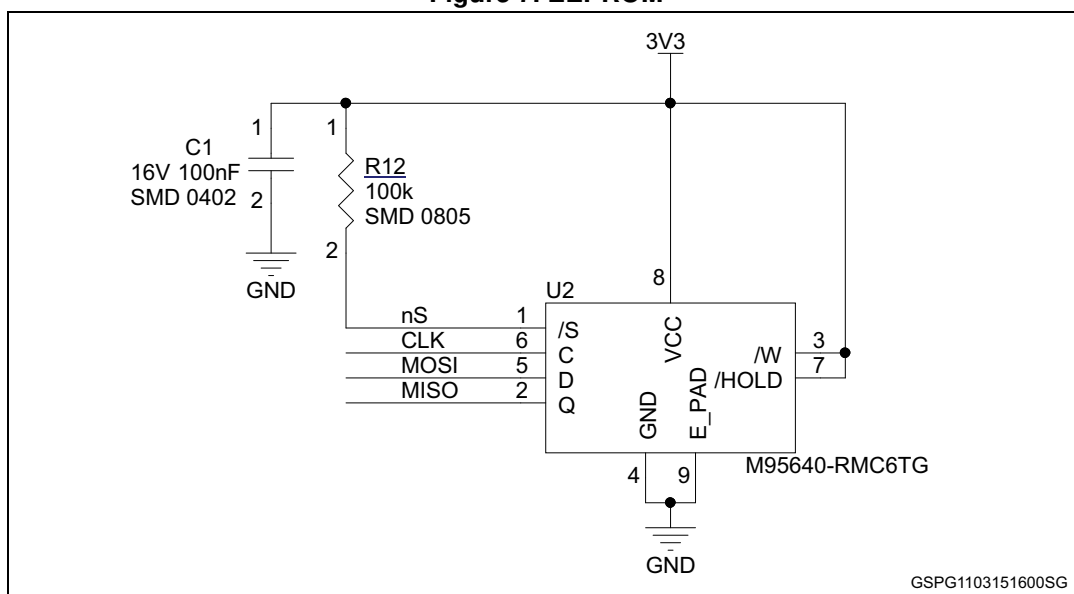


Figure 7. EEPROM



GSPG1103151600SG

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 | SAMTE C | 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 | SAMTE C | 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 | SAMTE C | SSQ-106-03-G-S | Farnell | 2283759 |
| 8 | 1 | C1 | 100nF | Ceramic X7R | ±10% | SMD 0402 | Murata | GRM155R71 C104KA88 | | |



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: - <i>Section 6: Formal Notices Required by the Industry Canada ("IC")</i> . |

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