Getting started with the X-NUCLEO-S2915A1 Sub-1 GHz 915 MHz RF expansion board based on S2-LP radio for STM32 Nucleo

Introduction

The X-NUCLEO-S915A1 expansion board is based on the S2-LP radio and operates in the 915 MHz ISM frequency band.

The expansion board is compatible with ST morpho and Arduino UNO R3 connectors.

The X-NUCLEO-S2915A1 interfaces with the STM32 Nucleo microcontroller via SPI connections and GPIO pins. You can change some of the GPIOs by mounting or removing the resistors.

The boards are equipped with the following features:

- On-board S2-LP, sub-1 GHz transceiver device
- SPI EEPROM for saving parameters
- 860 to 930 MHz RF Front-End Module(power amplifier)
- 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 S2-LP for STM32

Contents

1 Description

The X-NUCLEO-S2915A1 boards contain the S2-LP radio which is a high performance ultra-low power, sub-1 GHz, RF transceiver.

Table 1. Expansion board details

Evaluation board	RF communication frequency	Description
X-NUCLEO-S2868A1	868 MHz	868 MHz RF expansion board based on S2-LP RF transceiver.
X-NUCLEO-S2915A1	915 MHz	915 MHz RF expansion board based S2-LP RF transceiver

1.1 Typical applications

The evaluation boards can be used for evaluation of the S2-LP 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
- 6LoWPAN applications
- SigFox Communication

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:

- SigFox Communication
- 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
TBD	To Be Done

2 Getting started

This section describes the hardware requirements for the X-NUCLEO-S2915A1 evaluation boards.

2.1 Overview

The X-NUCLEO-S2915A1 main features are:

- Based on S2-LP radio
- S2-LP narrow band ultra-low power sub-1 GHz transceiver tuned for 860 - 940 MHz frequency band
- Modulation schemes: 2-FSK, 2-GFSK05,2-GFSK1, 4-FSK, 4-GFSK05
- Air data rate from 0.1 to 500 kbps
- Ultra-low power consumption: 7 mA RX and 10 mA TX
- IEEE 802.15.4g hardware packet support with whitening, FEC, CRC and dual SYNC word detection
- RX and TX 128 byte FIFO buffers
- Support to wireless M-Bus
- Excellent performance of receiver sensitivity (up to -130 dBm)
- Automatic acknowledgement, retransmission and timeout protocol engine
- Compatible with STM32 Nucleo boards
- Compatible with Arduino UNO R3 connectors
- Support SMA antennas
- BALF-SPI2-01D3 IPD balun for matching network and harmonics filter
- Sigfox compatible
- Sample firmware for P2P communication
- 6LoWPAN compatible thanks to STM32Cube
- RoHS compliant

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- Automatic meter reading
- Home and building automation
- WSN
- Industrial monitoring and control
- Wireless fire and security alarm systems

2.2 Hardware and software requirements

To use STM32 Nucleo development boards with the X-NUCLEO-S2915A1 expansion board, connect the boards as shown below.

Figure 2. X-NUCLEO-S2915A1 expansion board connected to an STM32 Nucleo development board
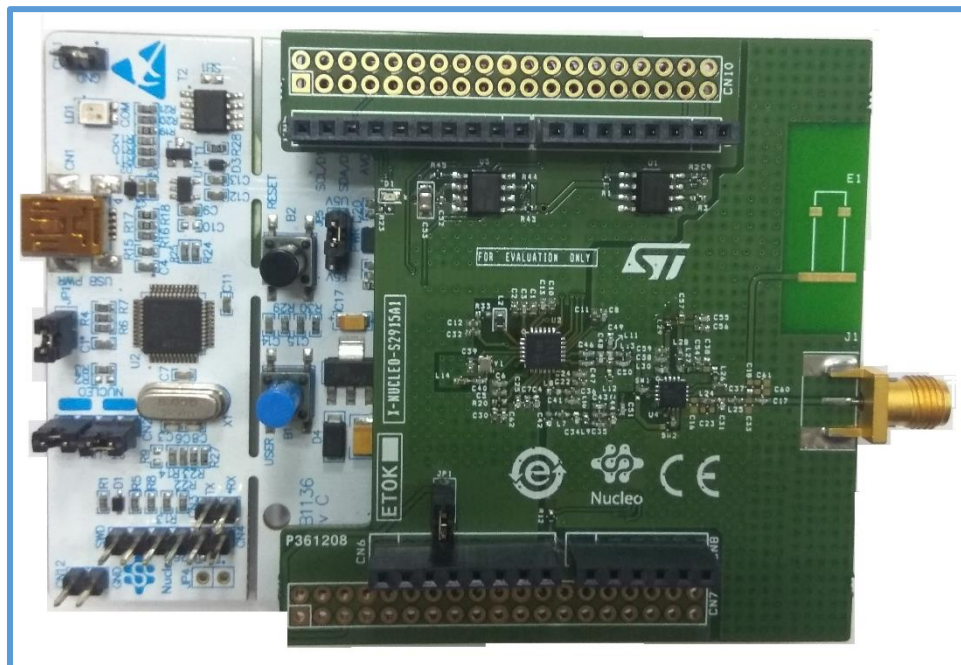
The interconnection between the STM32 Nucleo and the X-NUCLEO-S2915A1 has been designed to allow using any STM32 Nucleo board, although complete testing has been performed using NUCLEO-L053R8, NUCLEOF401RE and NUCLEO-L152RE boards hosting the ultra-low power STM32.

The following software and hardware specifications are required:

- a PC/laptop with Microsoft Windows (7 and above) to install the software package (X-CUBE-SUBG1)

- a type A USB to mini-B USB cable to connect the STM32 Nucleo board to the PC/laptop
- 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 sample.

2.3 Board setup

Perform the following steps to set up the board:

Step 1. Check that the jumper on J1 connector is connected to provide the required voltage to the board devices.

Step 2. Connect the X-NUCLEO-S2915A1 to the STM32 Nucleo board as shown in Figure 2. X-NUCLEOS2915A1 expansion board connected to an **STM32 Nucleo development board**

Step 3. Power the Nucleo development board using the Mini-B USB cable

Step 4. Program the firmware in the STM32 on the Nucleo development board using the firmware sample provided

Step 5. Reset the MCU board using the reset button on the Nucleo development board

Step 6. The evaluation kit is ready-to-use

3 Hardware description and configuration

This section describes the X-NUCLEO-S2915A1 features and provides information which could be useful to understand the board schematics.

3.1 Interconnection details

The X-NUCLEO-S2915A1 expansion board and the NUCLEO-F401RE or NUCLEO-L152RE board connection details are listed in the table below.

Table 3. Left connector connection details

Signal name	NC	IOREF	RESET	$3V_3$	$5V$	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-L152RE MCU port										PA0	PA1	PA4	PB0	PC1	PC0
CLEO-S2915A1 sion board signals				$3V_3$		GND	GND			GPIO0	CSN	GPIO1	GPIO2	GPIO0*	GPIO3

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-L152RE MCU port	PB8	PB9			PA5	PA6	PA7	PB6	PC7	PA9		PA8	PB10	PB4	PB5	PB3	PA10	PA2	PA3
X-NUCLEO-S2915A1 Expansion boards signals	SCL	SDA		GND	SPI_CLK*	SPI_MISO	SPI_MOSI	SPI_CSN*		nS*		SDN	SDN*	nS		SPI_CLK			

Note: * = Optional connection

3.2 SPI and GPIO connection options

The SPI and GPIO connection options between the STM32 and S2-LP can be used to enable different configurations in case a signal conflict occurs when using other expansion boards.

Table 5. S2-LP interface (optional) with Nucleo board

S2-LP signal	Default STM32 port	Optional STM32 port
CSn	PA1	PB6 To use optional connection mount R9, demount R13
CLK	PB3	PA5 To use optional connection mount R6, demount R11
nS	PB4	PA9 To use optional connection mount R7, demount R19
SDN	PA8	PB10 To use optional connection mount R18, demount R10

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

SKY66420 power amplifier setting:

	SW1	SW2
LNA ON	soldered a 100 pF cap between 1 – 2	soldered a 100 pF cap between 1 - 3
LNA OFF	soldered a 100 pF cap between 1 - 3	soldered a 100 pF cap between 1 - 2

| SKY66420 signal	Default STM32 port	Optional STM32 port
GPIO0	PA0	PC1 To use optional connection mount R25, demount R12
GPIO1	PA4	NA
GPIO2	PB0	NA

3.3 Current measurement

To monitor the power consumption of the entire S2-LP X-NUCLEO-S2915A1 board, jumper J1 can be used. Connect an ammeter probe between pins 1 and 2 of the connector for measurements.

3.4 X-NUCLEO-S2915A1 component placement details

Figure 3 shows the component placement on the S2-LP expansion X-NUCLEO-S2915A1 board.

Figure 3. X-NUCLEO-S2915A1 component placement details
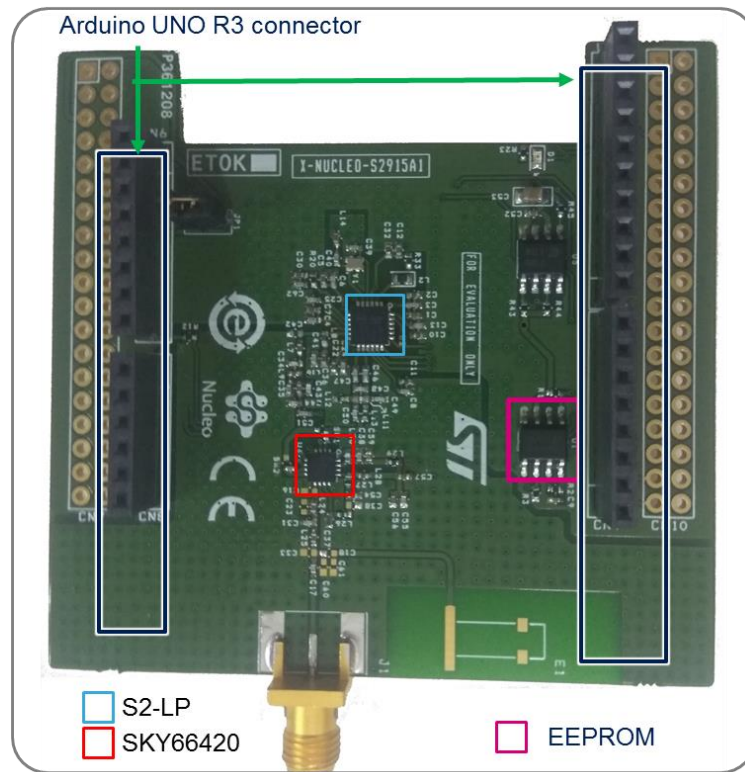
4 Component description

This section describes the devices on the board.

4.1 S2-LP Radio

The X-NUCLEO-S2915A1 expansion board is based on the S2-LP standalone RF transceiver. It operates in the 915 MHz ISM frequency band and wireless M-Bus.

Table 7. S2-LP details

Features	Description
Order code	S2-LPQTR
Package	QFN24 4x4x1
Operating voltage	1.8 to 3.6 V

S2-LP narrow band ultra-low power sub-1 GHz transceiver is tuned for 902~928 MHz, frequency bands

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 S2-LP RF 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 R22 resistor on the board.

5 Formal Notices Required by the U.S. Federal Communications Commission ("FCC") (TBD)

FCC NOTICE: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Additional warnings for FCC

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's by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the 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.

RF exposure warning

This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users and installers must be provide with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

6 Formal Notices Required by the Industry Canada ("IC")

Innovation, Science and Economic Development Canada Compliance - This device complies with Innovation, Science and Economic Development RSS standards. 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. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Conformité à Innovation, Sciences et Développement Économique Canada - Cet appareil est conforme aux normes RSS d'Innovation, Science et Développement économique. L'utilisation est soumise aux deux conditions

suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles, et (2) cet appareil doit accepter de recevoir tous les types d'interférence, y comprises les interférences susceptibles d'entraîner un fonctionnement

indésirable. Les changements ou les modifications non expressément approuvés par le fabricant pourraient annuler le permis d'utiliser l'équipement.

Radio Frequency (RF) Exposure Information
The radiated output power of the Wireless Device is below the Industry Canada (IC) radio frequency exposure limits. The Wireless Device should be used in such a manner such that the potential for human contact during normal operation is minimized.

This device has also been evaluated and shown compliant with the IC RF Exposure limits under mobile exposure conditions. (antennas are greater than 20cm from a person's body).

Informations concernant l'exposition aux fréquences radio (RF)
La puissance de sortie émise par l'appareil de sans fil est inférieure à la limite d'exposition aux fréquences radio d'Industry Canada (IC). Utilisez l'appareil de sans fil de façon à minimiser les contacts humains lors du fonctionnement normal.

Ce périphérique a également été évalué et démontré conforme aux limites d'exposition aux RF d'IC dans des conditions d'exposition à des appareils mobiles (antennes sont supérieures à 20 cm à partir du corps d'une personne)

This radio transmitter 8976C-S2915A1 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio 8976C-S2915A1 *a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.*

 antenna type: Dipole
 antenna gain: 3dBi
 antenna impedance:50Ω

7   OEM Integration Instructions.

This device is intended only for OEM integrators under the following conditions :

The LMA (Limited Modular Approval) is applied to this module because of below two concerns:

1. There is no shied case, so the shielding policy is not complied with.
2. The standard antenna connector is used for this module.

To comply with FCC15.212 requirement, when this module is installed into the host, the OEM integrator must ensure:

1. Another C2PC or New Filing is required for that host to approve all of technical requirement is complied with.
2. The Professional Installation policy is applicable to that host, and then the C2PC or New Filing is required for that host to approve the antenna requirement is complied with.

As long as two conditions above are met, this module could be installed into that host. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirement with this module installed; example, digital device emission, PC peripheral requirements, ….and so on.

The final end product must be labeled in a visible area with the following: "Contains FCC ID: S9NS2915A, and "Contains IC: 8976C-S2915A1".The equipment complies with FCC RF exposure limits set forth for an uncontrolled environment. The equipment must not be co-located or operating in conjunction with any other antenna or transmitter.

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