UM01881

ST Nucleo LoRa GW HW User Manual

V1.0

Document information

Info	Content
Keywords	*RisingHF, ST, Loriot, LoRa, Gateway, Nucleo*
Abstract	This document describes how to use ST Nucleo F7 LoRa Gateway to connect to Loriot server or others similar server which support packet forwarder mode.

Content

1 Introduction

The ST Nucleo LoRa GW is a kit based on Nucleo-F746ZG Board and ST Nucleo LoRa GW Module which is designed by RisingHF (www.risinghf.com). The ST Nucleo LoRa GW Module includes the high performance LoRa baseband processor SX1301 from Semtech corporation. With Loriot (https://www.loriot.io/) LoRaWAN cloud server or others server with packet forward service, it provides support bidirectional communication with end devices in both Class A and Class C of LoRaWAN protocol, and complete compliant with the LoRaWAN™ specifications V1.0.2.
ST Nucleo LoRa GW have two part numbers, LRWAN_GS_HF1 and LRWAN_GS_LF1.
This document describes HW information of the ST Nucleo LoRa GW shield.
The ST Nucleo LoRa GW is composed of two boards:

- Nucleo-F746ZG Board
- ST Nucleo LoRa GW Module

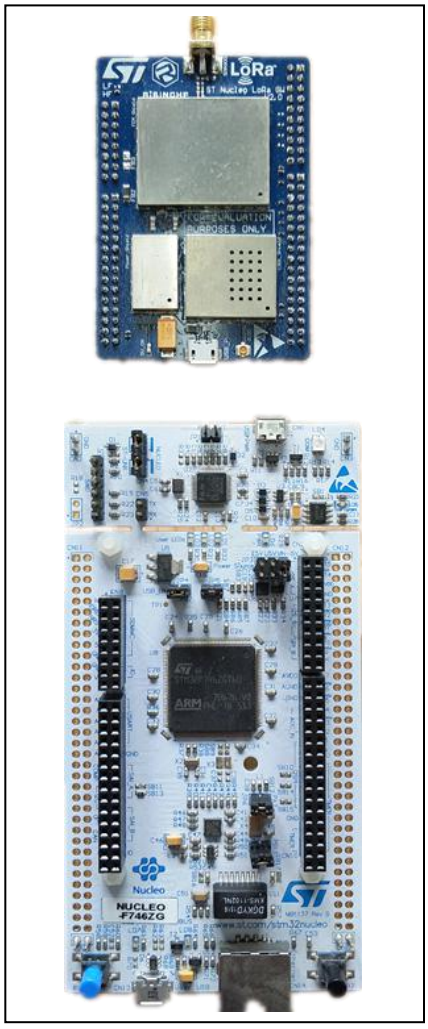

Figure 1-1 Nucleo F7 board and LoRa GW module

2 Features

Option 1: LRWAN_GS_LF1: Cover either 434MHz for EU and CN or 470MHz for CN;
Option 2: LRWAN_GS_HF1: Cover either 868MHz for EU or 915MHz for US and Asia;
Programmable parallel demodulation paths;
LoRa demodulators and 1 GFSK demodulator embedded;
Automatic adaptive to spreading factor from SF12 to SF7 in each of 8 channels;
High performance:
-140dBm sensitivity @300bps ;
6dBm max output power without PA;
Single +5V supply;
Support LoRaWAN protocol, Class A and Class C;
Support Loriot Cloud Server;
Support Semtech Packet forwarder;
Support DNS;
Support NTP;
AT command interface to re-configure the parameters of the GW;
--change frequency plan;
--change IP of the GW;
--change MAC address of the GW;
--change Cloud server which support packet forwarder;
--to support public server or private server;
--change DNS address;
--change NTP server address;

3 Ordering information

LRWAN_GS_HF1 and LRWAN_GS_LF1 are two seperated parts from ST LoRa kit P-NUCLEO-LRWAN2 and P-NUCLEO-LRWAN3.

P-NUCLEO-LRWAN2: LoRa™ HF band sensor and gateway

P-NUCLEO-LRWAN3: LoRa™ LF band sensor and gateway

Table 3-1 Ordering information

Order Code	Device list
P-NUCLEO-LRWAN2	LRWAN_GS_HF1
	I-Nucleo-LRWAN1
P-NUCLEO-LRWAN3	LRWAN_GS_LF1
	LRWAN_NS1

4 Quick start

The ST Nucleo Lora gateway is a low-cost and easy-to-use development platform used to quickly evaluate and start a development for LoRaWAN network system.

4.1 Getting started

Follow sequence below to quickly setup the gateway.

1. Assembly the gateway shield and the nucleo board. Skip to next step if you get a assembly one.
2. Install the LoRa antenna.
3. Connect the Nucleo to the PC with USB cable.
4. Connect the gateway to the router via ethernet.
5. Connect the micro USB connector of gateway shield to a 5V adapter and power on the device.

Now you could open the SSCOM or Tera Term to begin to configure and test the gateway.

4.2 System requirements

- Windows® OS (7, 8 and 10)
- USB Type-A to Micro-B cable x 2
- 5V 2A adapter
- Ethernet cable
- SSCOM or Tera Term for debugging

5 Hardware layout and configuration

5.1 System structure

ST Nucleo LoRa gateway include two boards, the Nucleo-F746ZG Board and ST Nucleo LoRa GW shield. Please refer to bleow for the connection between the two boards.

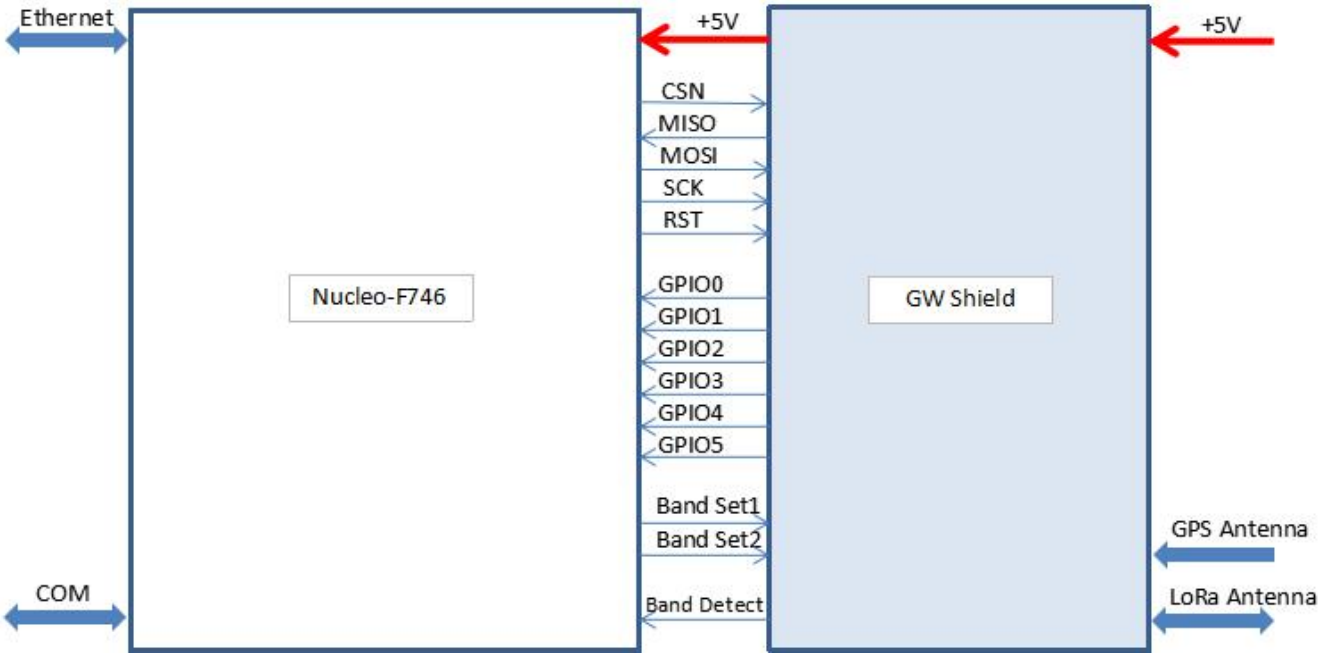

Figure 5-1 system structure

5.2 Hardware layout and configuration of the gateway shield

5.2.1 HW structure of the gateway shield

Figure 5-2 show the hardware structure of the gateway shield. The Module is composed of one pcs of SX1301 and two pcs of SX125x FEM. SX1255 is for LF band (434MHz and 470MHz); SX1257 is for HF band (868MHz and 915MHz). The SX1301 will be controlled and configured by ST Nucleo-F746ZG board via SPI. In this module, the external PA is removed refer to Semtech's reference design. The maximum output power will decrease to be about 6dBm for downlink. To get a wider operation bandwidth for evaluation, two parallel SAWs will be used instead of the single band SAW. Two RF switches are used to select the target band which would be used in the application. And the band selection is done automatically by software with frequency channel identification. Users no need to set it by manual.

SX1301/8 communicate with two SX1255/7 with two groups of SPI. A LTCC low pass filter is used in the transmit link to improve the harmonic level of the signal out of from FEM SX125x. The SAW filter is a narrow band component. So we need two SAW filters to support two frequency band in one PCB. And the two SAW filters will be siwtched by two switches which are controlled by the nucleo-F746ZG board. A LNA is inserted before the SX125x to improve the SNR and then have a higher sensitivity. The switch near antenna port is used to switch the tx and rx link. The gateway is a half-duplex mode.

The difference of the low band gateway and high band gateway:

- FEM with SX1255 support low band, FEM with SX1257 support high band.
- The LTCC LPF on the TX link will be different.
- The SAW filter on the RX link will be different.
- The mathing for PA will be different.
- The mathing for input of FEM (SX125x) will be different.

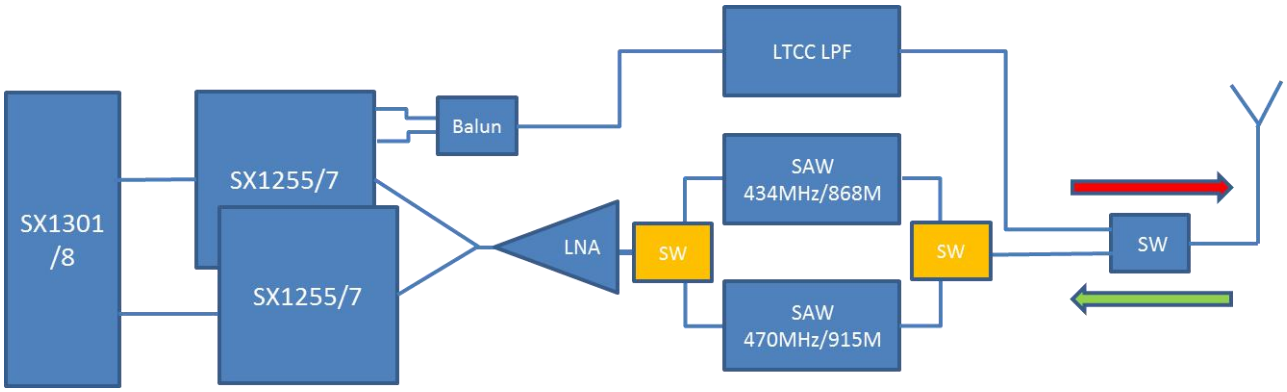

Figure 5-2 HW structure of the gateway shield

5.2.2 Power supply and consumption

5.2.2.1 Power supply

The power supply +5V will be injected into the system via micro USB connector of the Nucleo shield (blue board) from an external adapter. The max rated current of this adapter is suggested to be more than 1A. The Nucleo board (white board) should be powered by the supply from the shield board. So the Nucleo board (white board) would be power supplied by VIN (Pin15 of CN8 on the Nucleo F7 board).

On the LoRa gateway shield, a dual output DC to DC regulator U201 generate a +3.3V and a +1.8V power supply to SX1301. +3.3V is the supply for digital logic circuit of SX1301, +1.8V is the supply for core of SX1301. Another dual output LDO U202 generate two +3.3V for two SX125x. Ultra low noise LDO U204 LP5907 inject to the LNA.

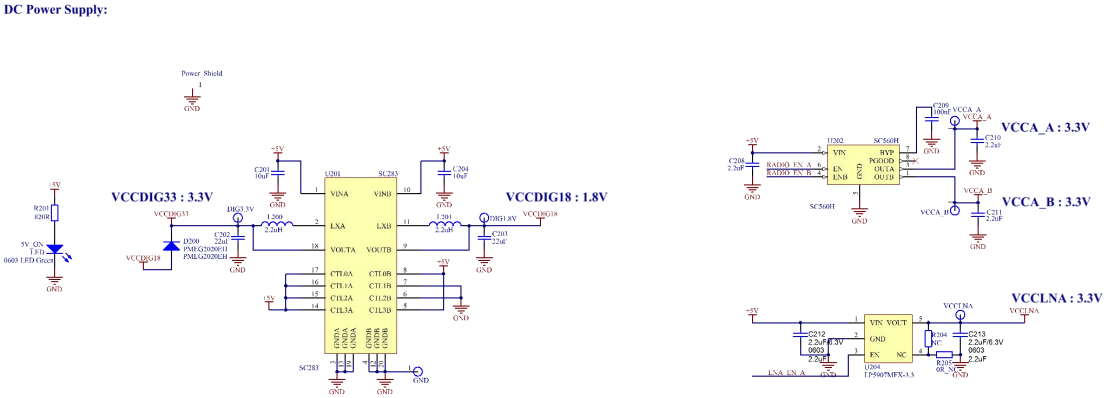

Figure 5-3 Schematic of power supply

5.2.2.2 Power consumption

Table 5- 1 below shows the current consumption of the Nucleo shield module in different mode. The maximum current would be almost 360mA when both uplink and downlink are on.

Table 5- 1 Power consumption of ST LoRa Nucleo GW Module

Band	Standby consumption	Current @TX max OP	Consumption @8 CH RX Only	RX/TX ON Max Current
LF	39mA	131mA	335mA	336mA

HF	39mA	175mA	330mA	364mA

For the consumption of the Nucleo F746ZG board, please refer to the manual from ST. The max current of this board would be more than 200mA depend on the source code and peripheral interface used.

5.2.3 LED status

On the GW shield (Blue board), there is only one LED to show power supply.

- 5V_ON (Green): When there is external power supply +5V to the system from adapter, this LED will be ON.

5.2.4 SX1301 part

SX1301 is the core part of the shield. The host MCU on the Nucleo F746ZG board control the slave SX1301 via a SPI (Ext_CSN, Ext_SCK, Ext_MISO and Ext_MOSI). Two clock are needed for SX1301, one is 133MHz from a VCXO as the clock of the digital and logic, another one is 32MHz from SX125x for analog. And two groups of SPI from master SX1301 will be used to communicate with the two slave SX125x.

3 pairs of IQ signal:

TxD_A_P/TxD_A_N is for transmitter for Radio A. Because we just have one transmitter, only 1 pair of IQ signal just inject to Radio A but nothing to Radio B.

RxD_A_P/RxD_A_N is for receiver for Radio A.

RxD_B_P/RxD_B_N is for receiver for Radio B.

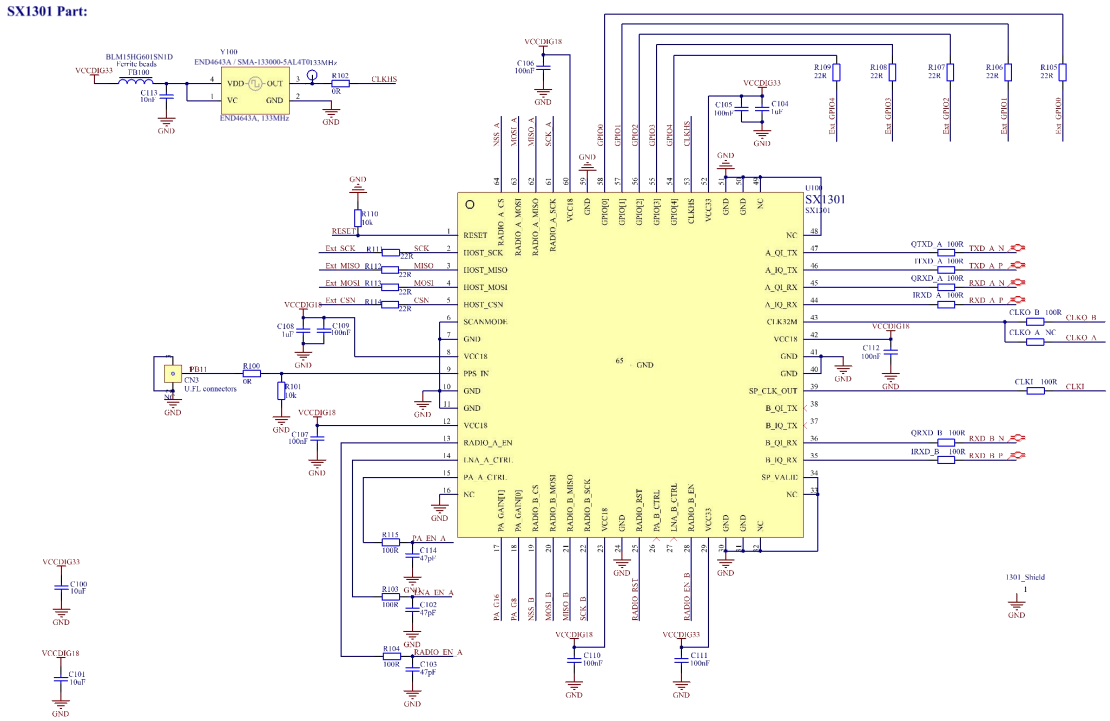

Figure 5-4 Schematic of SX1301 part

5.2.5 Receiver

Two SX125x are needed here. That's because one SX125x could only cover 1MHz analysis bandwidth. But we want to have 8 channel gateway with channel bandwidth=125kHz.

A 32 MHz TCXO will be used as the clock for the analog circuit of the FEM. This clock should be high accuracy, ultra low phase noisy, and stable.

To have dual bands for only one HW, we paralell two narrow band SAW filters but use switches to choose which band in application. The two switches will be controlled by the Nucleo board.

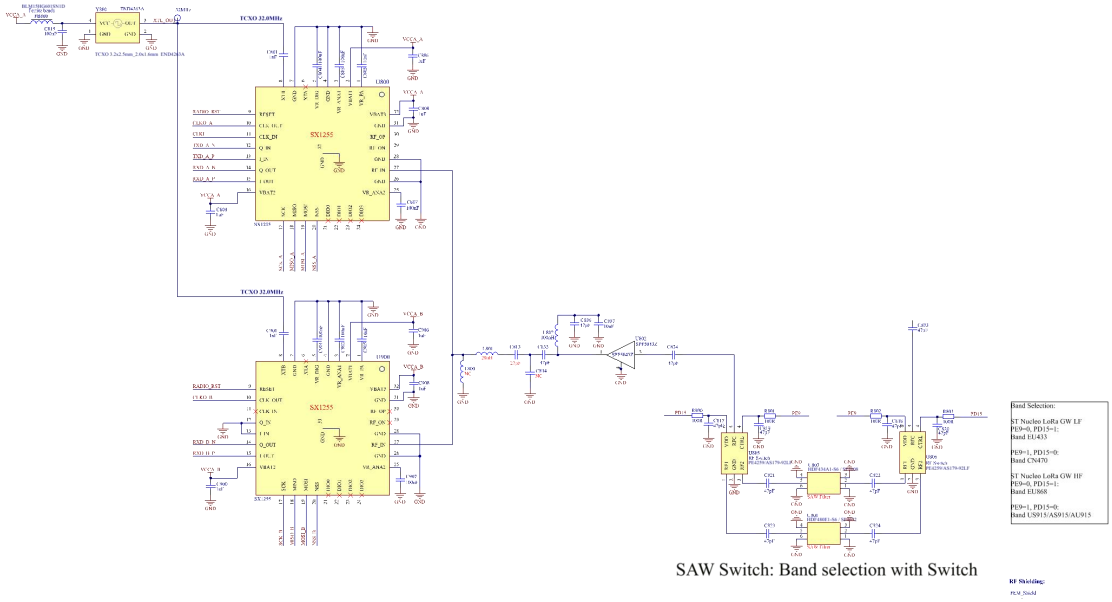

Figure 5-5 Schematic of the FEM part

5.2.6 Transmitter

Only one transmitter output from one SX125x we called Radio A. Radio B is not used. A LTCC low pass filter is behind the balun to reject the harmonic.

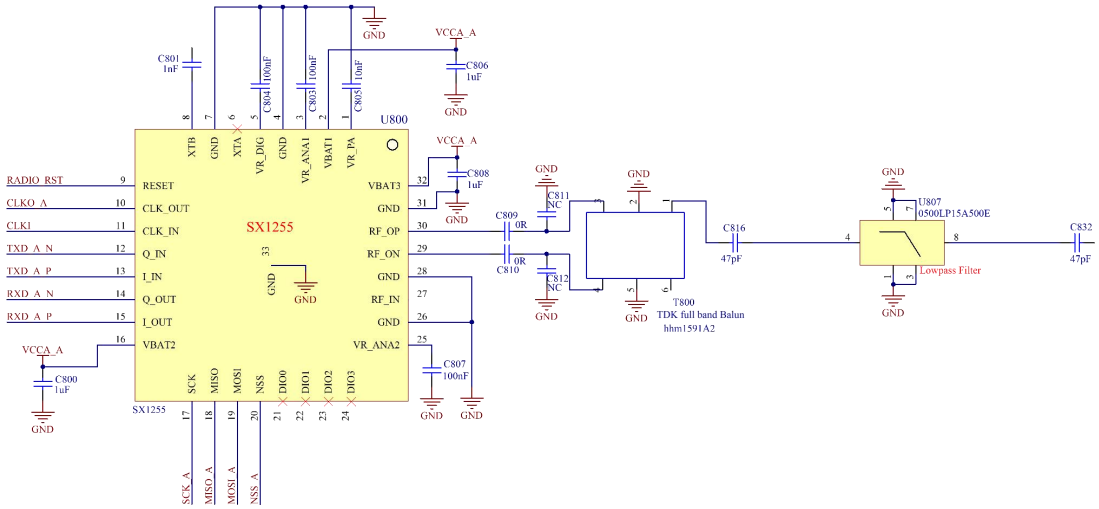

Figure 5-6 Schematic of the transmitter part

5.2.7 Band detect

Two resistors LF and HF are kept for band detection. Only one resistor would be populated.
When LF resistor is ON, PC8 is Low means low band gateway is detected.
When HF resistor is ON, PC8 is high means high band gateway is detected.

5.2.8 Connectors and GPIO Mapping

5.2.8.1 LoRa antenna

A SMA connector is used to connect to LoRa antenna. And a switch is used to switch to RX or TX link. The gateway is a half-duplex one.

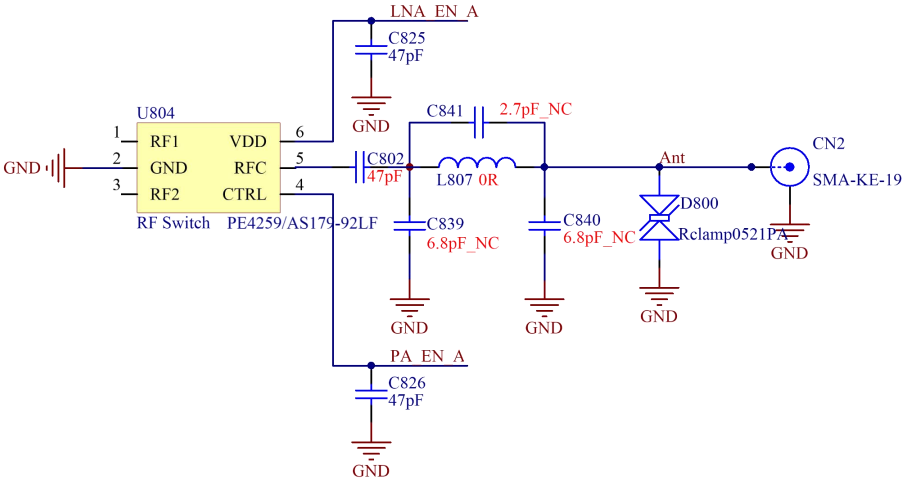

Figure 5-7 Schematic of the Receiver part

5.2.8.2 GPS antenna

A U.FL connector is used to connect to a GPS antenna for inputting GPS signal. The GPS signal will be injected into SX1301 directly. The U.FL connector is nearby the SX1301 on the layout.

5.2.8.3 GPIO Mapping

Figure 5-3 show the signals connected by default to ST morpho connector (CN7 to CN10) of STM32 Nucleo board. Figure 5-4show the GPIO mapping on the shield.

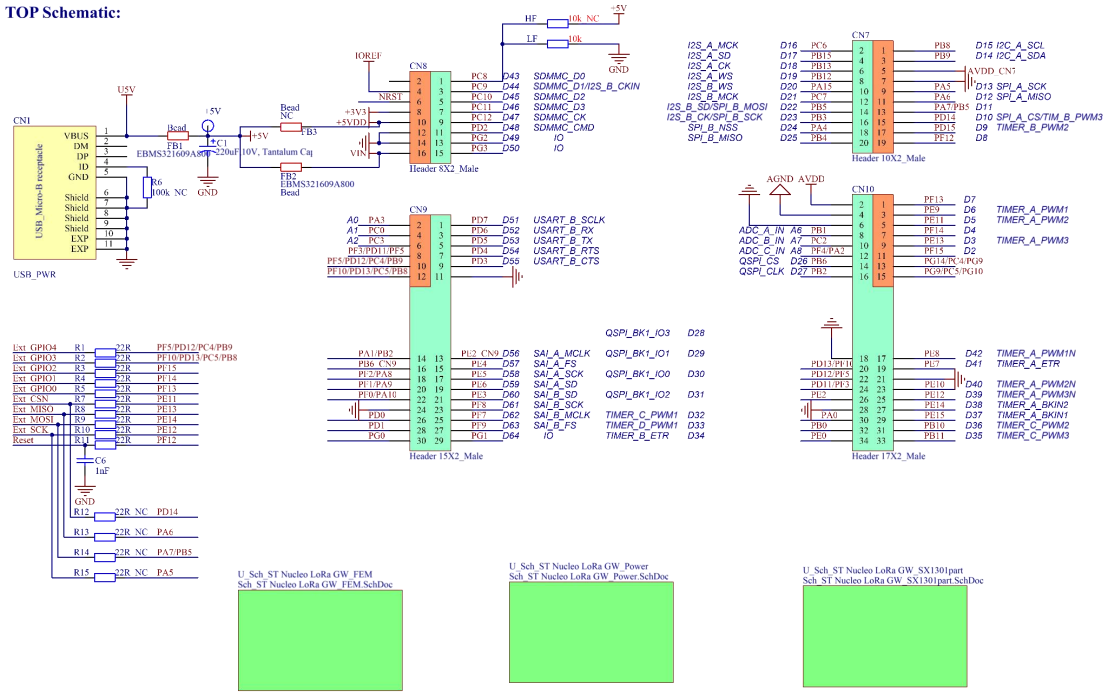

Figure 5-8 Extension connectors

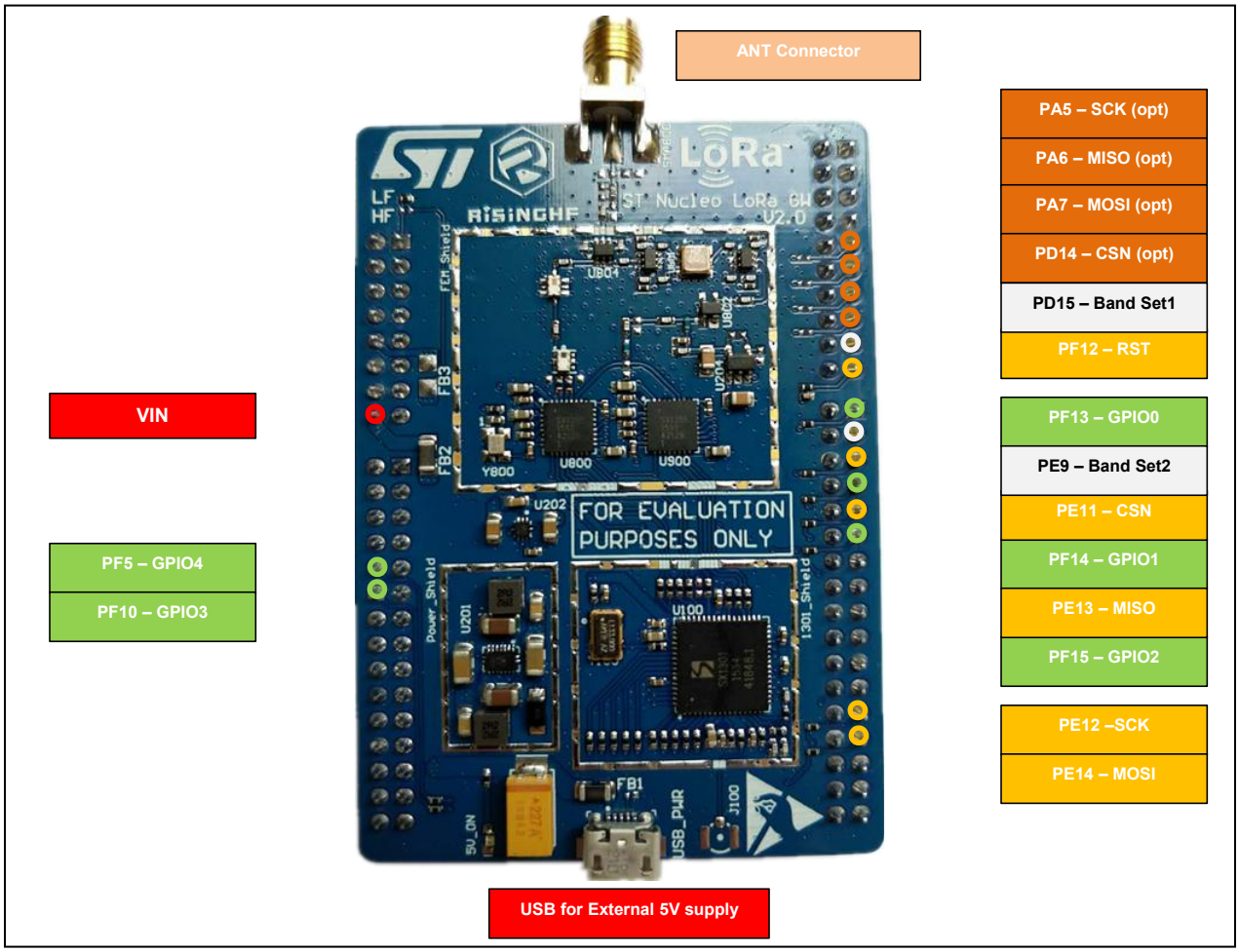

Figure 5-9 Pin description of ST Nucleo LoRa GW Module

Table 3-2 Pin description of ST Nucleo LoRa GW Module

PIN NAME	*PIN Description*
VIN	Power supply to Nucleo-F746ZG Board from External 5V
PF5/PD12/PC4/PB9 -GPIO4	GPIO4 from SX1301
PF10/PD13/PC5/PB8 -GPIO3	GPIO3 from SX1301
PF15-GPIO2	GPIO2 from SX1301
PF14-GPIO1	GPIO1 from SX1301
PF13-GPIO0	GPIO0 from SX1301
PE11-CSN	CSN of SPI for SX1301
PE13-MISO	MISO of SPI for SX1301
PE12-SCK	SCK of SPI for SX1301

PE14-MOSI	MOSI of SPI for SX1301
PE15-RST	Reset for SX1301
PD15-Band Set1	**ST Nucleo LoRa GW LF** PE9=0, PD15=1: Band EU433 PE9=1, PD15=0: Band CN470
PE9-Band Set2	**ST Nucleo LoRa GW HF** PE9=0, PD15=1: Band EU868 PE9=1, PD15=0: Band US915/AS915/AU915
PA5-SCK (opt)	Backup SCK of SPI for SX1301 (NO connection on board in default)
PA6-MISO (opt)	Backup MISO of SPI for SX1301 (NO connection on board in default)
PA7/PB5-MOSI (opt)	Backup MOSI of SPI for SX1301 (NO connection on board in default)
PD14-CSN(opt)	Backup CSN of SPI for SX1301 (NO connection on board in default)

6 RF performance measurement

Table 6-1 below shows the RF performance in conductive test. Please note that, there is no external PA refer to Semtech's reference design, so the RF power is output from SX125x FEM directly. The maximum output power normally would be 6-7dBm type in different band.

Table 6-1 RF performance

Band	Frequency	TX op max/dBm	Harmonic/dBm	Sensitivity/dBm	
LF	434MHz	7dBm type	Below -56dBm	SF12 125kHz	-140dBm
				SF11 125kHz	-137dBm
				SF10 125kHz	-134dBm
				SF9 125kHz	-131dBm
				SF8 125kHz	-128dBm
				SF7 125kHz	-125dBm
	470MHz	7dBm type	Below -56dBm	SF12 125kHz	-140dBm
				SF11 125kHz	-137dBm
				SF10 125kHz	-134dBm
				SF9 125kHz	-131dBm
				SF8 125kHz	-128dBm
				SF7 125kHz	-125dBm
HF	868MHz	6dBm type	Below -56dBm	SF12 125kHz	-140dBm
				SF11 125kHz	-137dBm
				SF10 125kHz	-134dBm
				SF9 125kHz	-131dBm
				SF8 125kHz	-128dBm
				SF7 125kHz	-124dBm
	915MHz	6dBm type	Below -56dBm	SF12 125kHz	-140dBm
				SF11 125kHz	-137dBm
				SF10 125kHz	-134dBm
				SF9 125kHz	-131dBm

				SF8 125kHz	-128dBm
				SF7 125kHz	-124dBm

7 Reference documents

a) UM1974-User manual, STM32 Nucleo-144 board; STMicroelectronics
b) LoRaWAN™ Specification 1.0.2; LoRa Alliance
c) Data sheet of SX1301; Semtech

Revision

V1.0 2018-10-8

+ First version

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