Corecell Gateway Reference design US version

Performance Report

Abstract

The CoreCell gateway reference design is the first platform which implements the new SX1302 baseband processor and SX1250 RF transceiver.This document presents the results of compliance measurements to the tests required by US regulation as well as the performance and robustness measurements for a LoRa gateway.

History

Rev.	Ref.	Change	Author	Date
1.0	-	Doc creation	S. Naik	Sep. 2019

Contents

Part I

General

1 Introduction

1.1 Presentation

The CoreCell reference design is a new generation of LoRa gateway designed based on the highly integrated SX1302 baseband processor and SX1250 RF transceiver. It is designed to meet the market needs for improved capacity, low cost, low power consumption, and fast time to market.

1.2 Scope

This document is the performance report which presents the measurement performed on the Corecell gateway reference design for the **US region**.

1.3 References Documents

The following documents are cited in the present one:

1. **Part 15 of Title 47 of the Code of Federal Regulations** Official FCC rules that shall be fulfil by any RF device designed for the US market.
2. **LoRaWAN v1.1 specification** describes the LoRaWAN™ network protocol.
3. **AN1200.37 - Application Note: Recommendations for Best Performance** provides recommendations on PCB design to fight against crystal heating.

1.4 Document Convention

Excepted if it is explicitly mentioned, all measurements are performed at ambient temperature i.e +25°C.

→ **Any text inside a framed box means a conclusion of the current section.**

2 Test Bench

2.1 General Description

The general test bench used along this document to measure and validate the Corecell gateway reference design performances and its compliance to the regulation limits is shown in figure 2.1.

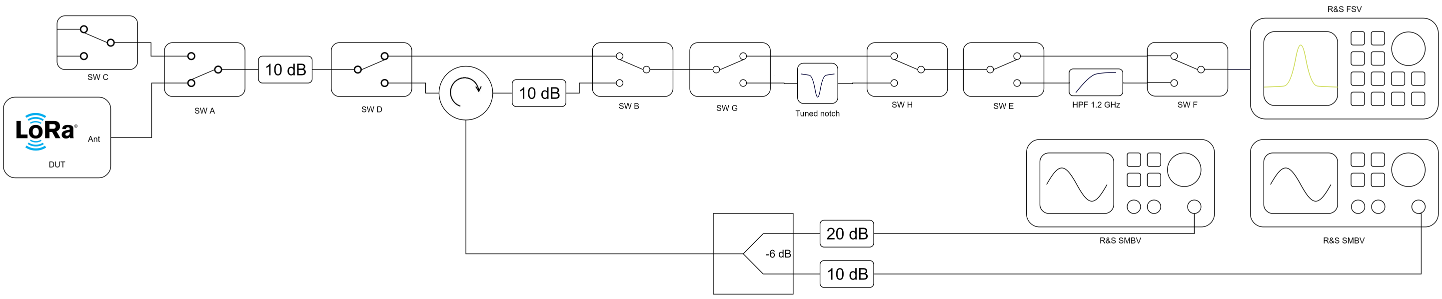


Figure 2.1: Overall test bench setup - Default configuration

According to the specificities of each measurement, the various switches are commuted to select or not some filters. The switch C is used in case of a gateway with two separated RF chains. It is not used in the measurements of this report.

2.2 Tx Measurements

The setup presented in the figure 2.2 is used for the Tx measurements.

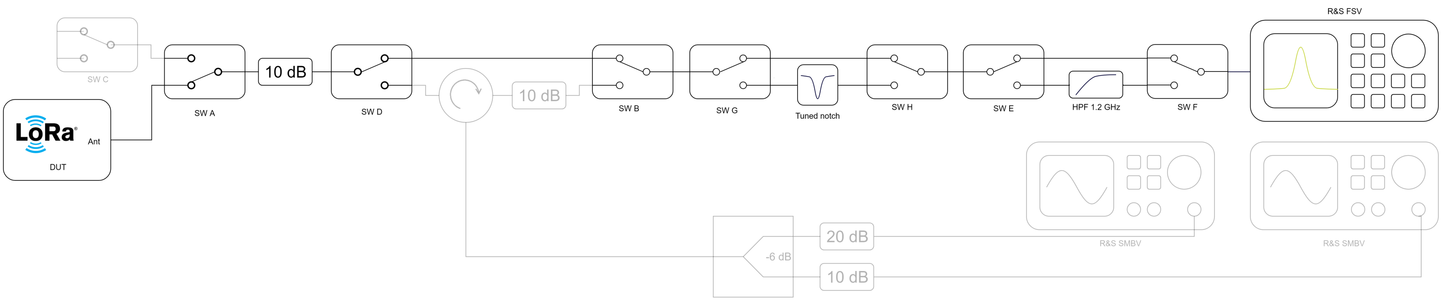


Figure 2.2: Configuration of the test bench for Tx measurements

The 10 dB attenuator after the switch A allows to mitigate effect of impedance mismatch as well as protect the output power amplifier from reflected power due to the notch or the HPF. The notch and the HPF are only enabled for spurious emission measurements to decrease the carrier level. Finally, loss of attenuator, switch and cables have been previously measured and compensated in the spectrum analyzer (Ref. Level Offset). Other instrument settings are defined for each individual test.

2.3 Rx Measurements

All the Rx measurements are performed using the setup of the figure 2.3

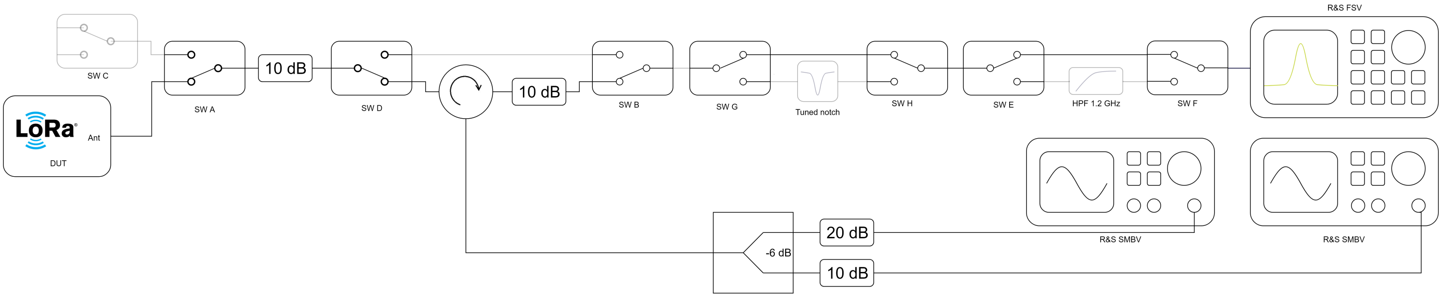


Figure 2.3: Test bench configuration for the Rx measurements

The circulator allows to simultaneously inject a signal into the DUT and measure the emission from it. The 10 dB attenuator between the circulator and the switch B mitigates effect of impedance mismatch in order to provided stable and quasi-constant loss over the circulator operating frequency range.

For simple Rx measurements (Sensitivity level, RSSI and SNR, Frequency error tolerance), only one signal generator is used, the output of the second one is OFF. The other generator is used for the blocking measurement to inject an interferer at various frequencies. The attenuators of 20 and 10 dB at the right of the power splitter allow to mitigate the effect of impedance mismatch on its characteristics as well as protect each signal generator output from the power from the other one or the DUT.

2.4 Over Temperature Measurement

All the temperature measurements are performed by placing the DUT in a climatic room (see figure 2.4). The probe of an additional thermometer is placed in the climatic room to check the temperature inside.

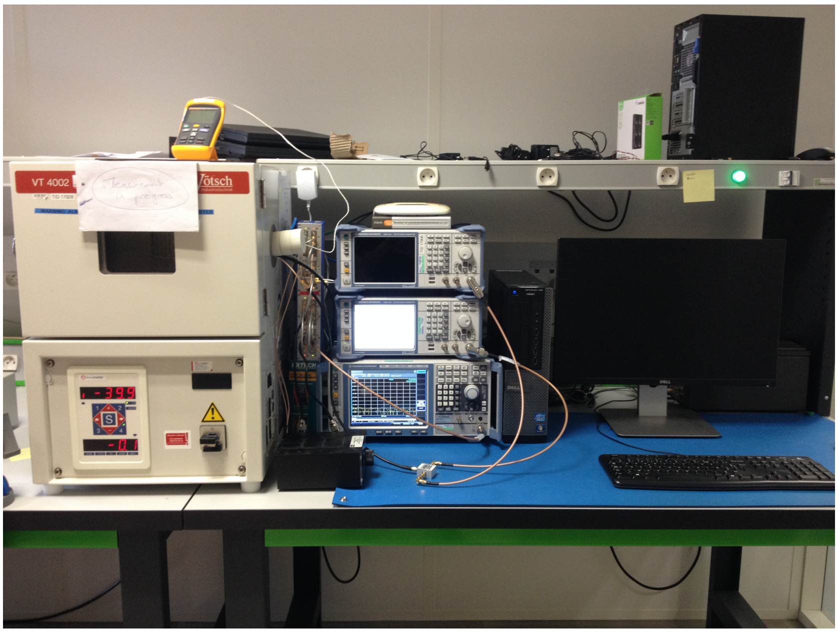


Figure 2.4: Temperatures measurements are performed in climatic room.

Only the DUT is placed in the climatic oven; the rest of the testbench is placed outside.

3 Device Under Test (DUT)

3.1 General Description

The board used to perform measurements for the performance report is the corecell reference design (PCB_E539V01A) board, with US BOM populated. The corecell reference design board was mounted on an interface board (PCB_E525V02A) along with a RaspberryPi3 hosting the HAL and the packet forwarder (see figure 3.1).

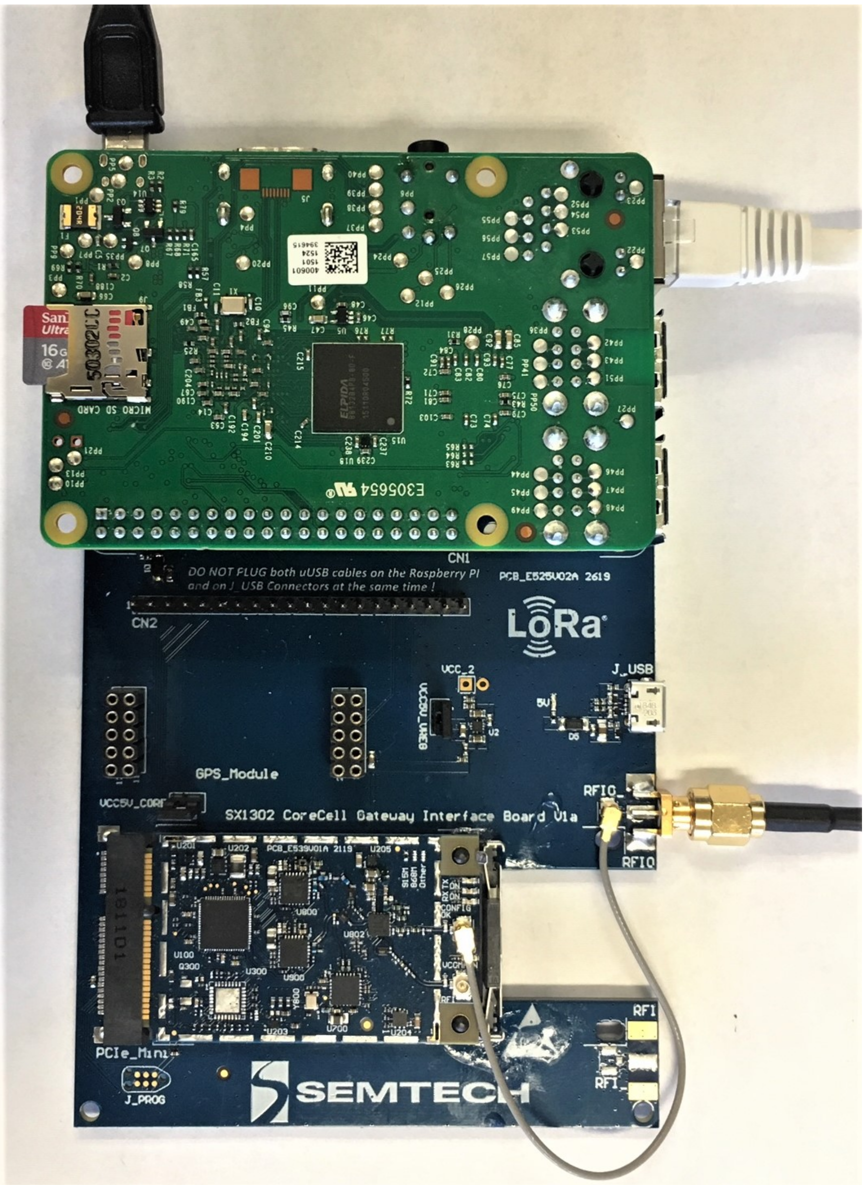


Figure 3.1: CoreCell gateway platform consisting of reference design board mounted on interface board with Raspberry Pi 3

3.2 Board Updates

The following updates have been performed on the Corecell reference design:

- The 3 dB pad in TX path was removed and updated with following changes: R802 = R804 = NC; R803 = 0R
- The VCC_FEM regulator output capacitor C206 has been replaced by a bigger one (from 1 to 4.7µF). The component reference is the one of capacitors C204, C207 and C822.

3.3 Firmware

The following repository contains the HAL and Packet Forwarder which are used for the corecell reference design validation: `https://github.com/Lora-net/sx1302_hal`

Part II

Transmitter

4 Modulation Bandwidth (FCC)

4.1 Description

This test refers to the chapter 15.247(a)(2) of the FCC regulation. The 6 dB bandwidth of the transmitted signal shall be at least 500 kHz.

4.2 Setup

The setup used to measure the occupied bandwidth is shown in figure 2.2. Only the direct path is used for this measurement, the notch or the high pass filter is used to measure spurious level far from the carrier frequency.

4.3 LoRa 500 kHz

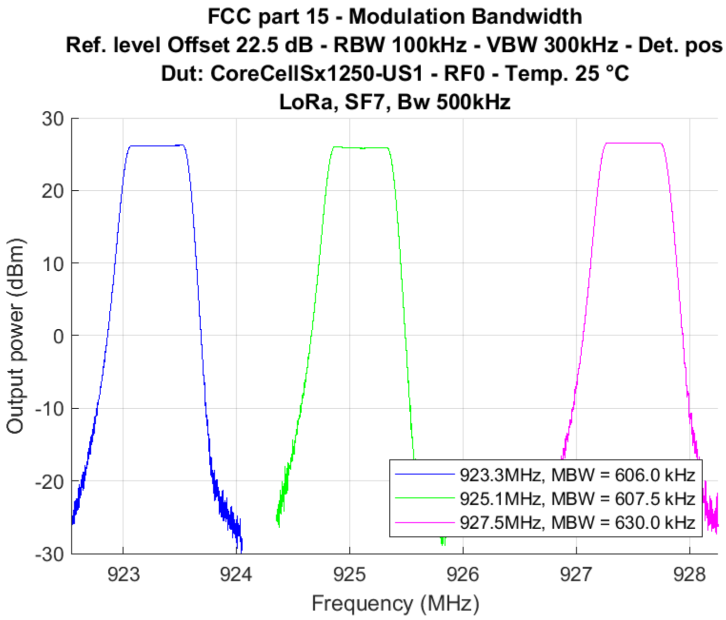


Figure 4.1: Modulation bandwidth, 27 dBm, LoRa SF7 500kHz, Ambient temperature

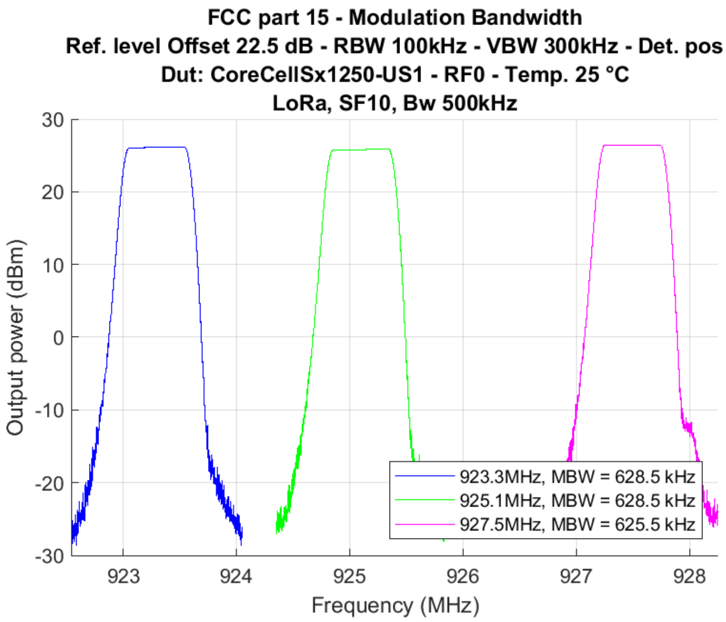


Figure 4.2: Modulation bandwidth, 27 dBm, LoRa SF10 500kHz, Ambient temperature

→ **The results of this measurement is in compliant with the FCC requirement of 6dB bandwidth of the transmitted signal shall be at least 500kHz**

5 Emissions in Non-Restricted Frequency Bands

5.1 Description

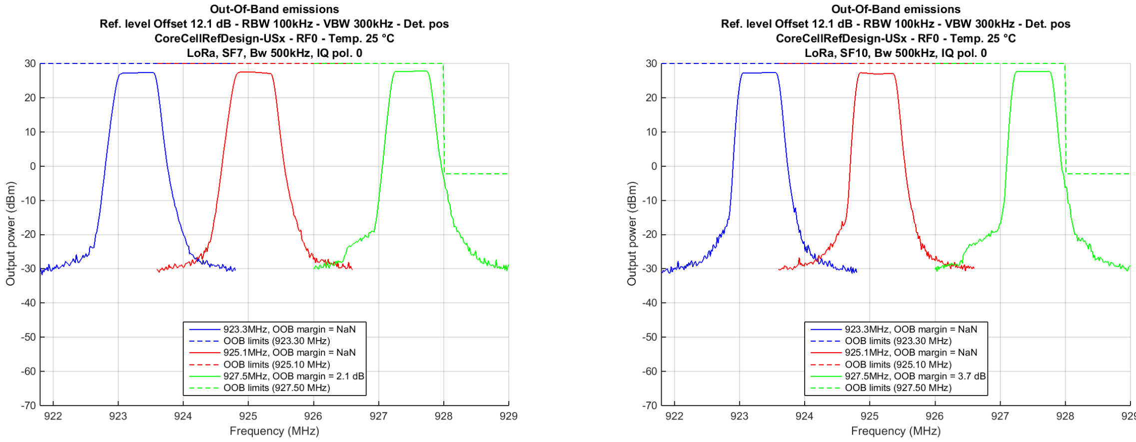
The measurement mentioned in this chapter refers to the paragraph 15.247(d) of the FCC regulation (see document [1]) and describes the power level allowed outside the normal emission frequency band (902 to 928 MHz).

5.2 Setup

The setup used to measure the out of band emission is show in Figure 2.2. Only the direct path is used for this measurement. Measured in a 100 kHz bandwidth, the power level shall be attenuated by at least 20 dB compared to the highest carrier power level or 30 dB if the measurement uses an RMS averaging over a time interval.

5.3 Ambient Temperature

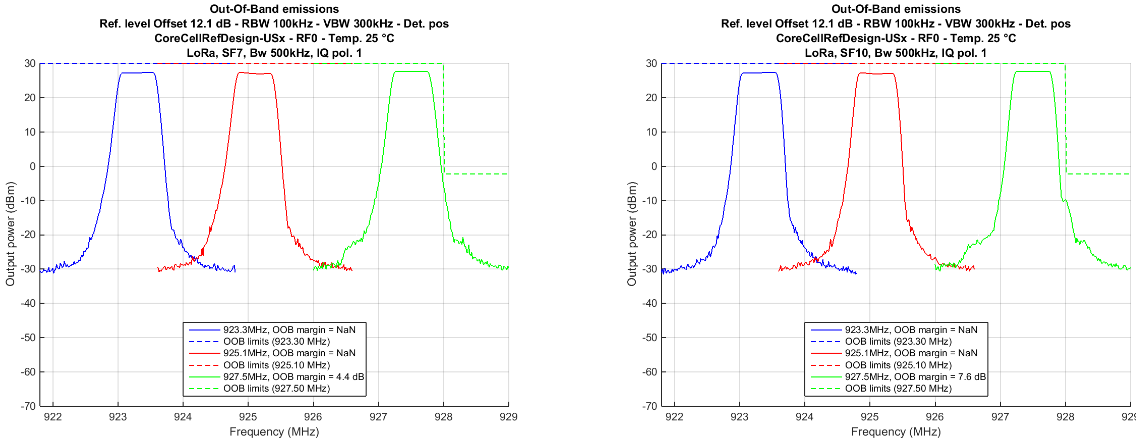
5.3.1 LoRa SF7/10 500 kHz Normal IQ



(a) SF7 (b) SF10

Figure 5.1: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm, Normal IQ

5.3.2 LoRa SF7/10 500 kHz Inverted IQ

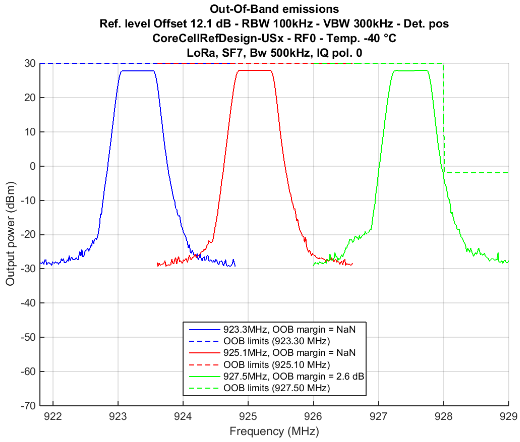


(a) SF7 (b) SF10

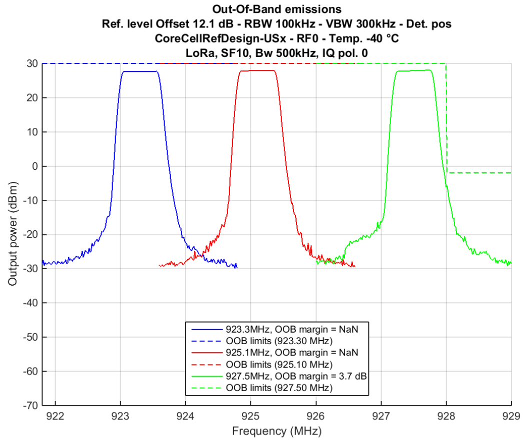
Figure 5.2: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm, Inverted IQ

5.4 Low Temperature: -40°C

5.4.1 LoRa SF7/10 500 kHz Normal IQ



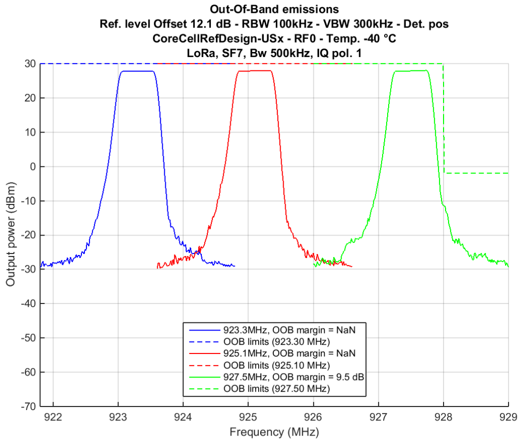
(a) SF7



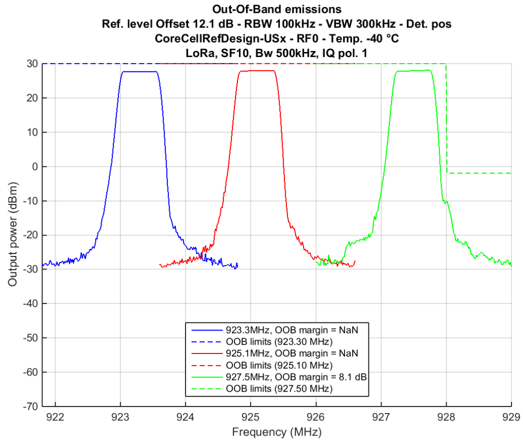
(b) SF10

Figure 5.3: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm,Normal IQ

5.4.2 LoRa SF7/10 500 kHz Inverted IQ



(a) SF7

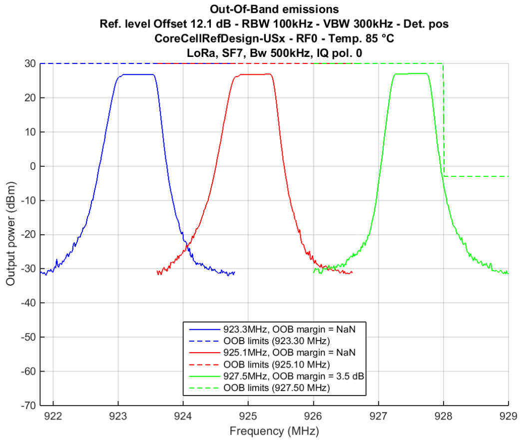


(b) SF10

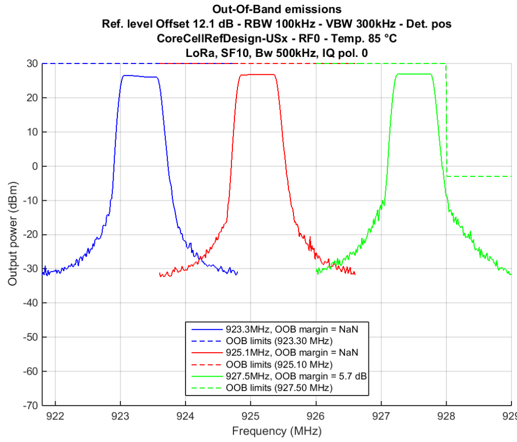
Figure 5.4: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm, Inverted IQ

5.5 High Temperature: +85°C

5.5.1 LoRa SF7/10 500 kHz Normal IQ



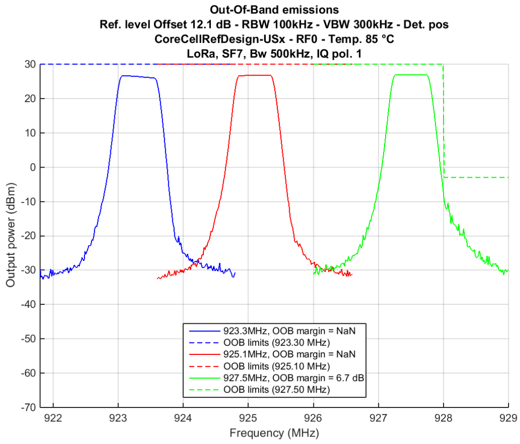
(a) SF7



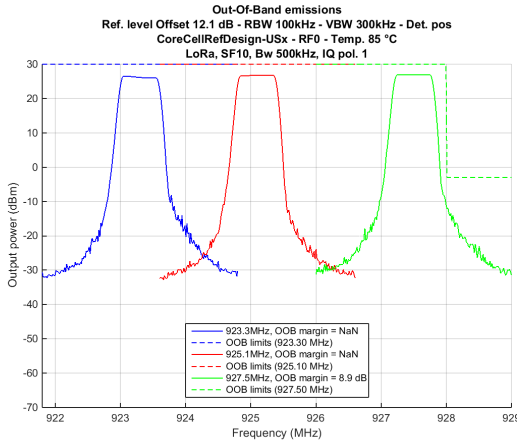
(b) SF10

Figure 5.5: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm, Normal IQ

5.5.2 LoRa SF7/10 500 kHz Inverted IQ



(a) SF7



(b) SF10

Figure 5.6: Emissions in Non-Restricted frequency bands, RF0, LoRa 500 kHz, SF7 or SF10, +27 dBm, Inverted IQ

→ As illustrated, emissions in the non-restricted band are greater than 30 dB below the reference emission level and hence the LoRa® modulation can be seen to comply with the FCC Regulation.

6 Maximum power spectral density level (FCC)

6.1 Description

The chapter 15.247(e) of the FCC regulation mentions the power spectral density shall not be greater than +8 dBm in any 3 kHz band during any time interval of continuous transmission.

6.2 Setup

The setup used to measure the PSD is shown in Figure 2.2. Only the direct path is used for this measurement, the notch or the high pass filter is used to measure spurious level far from the carrier frequency.

6.3 Ambient temperature

The conducted power spectral density shall not exceed 8 dBm in any 3 kHz band during continuous transmission, measured in accordance with the same method as used to determine the conducted output power

6.3.1 LoRa SF7/10 500 kHz

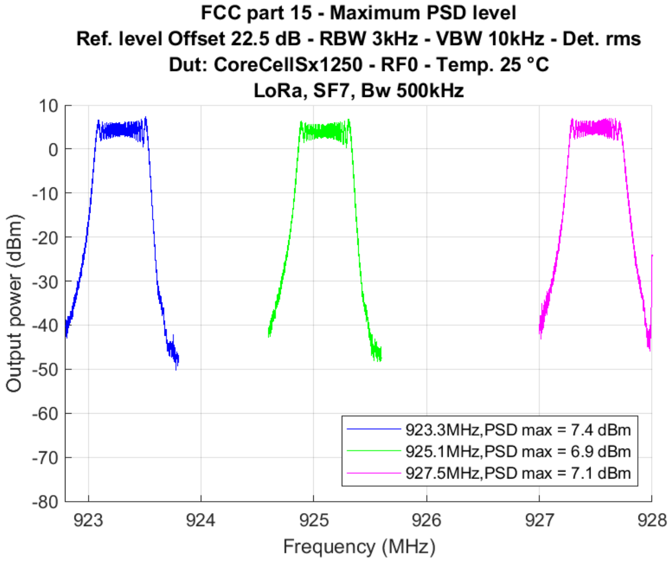


Figure 6.1: Maximum power spectral density level - Pout = +27 dBm - SF7

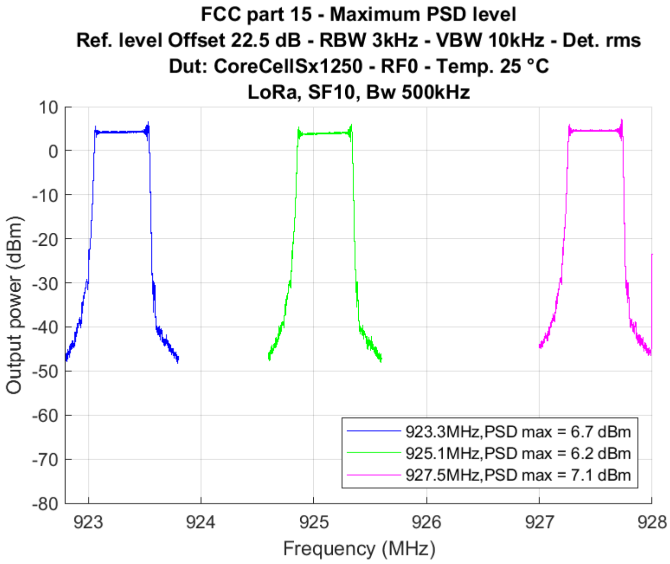


Figure 6.2: Maximum power spectral density level - Pout = +27 dBm - SF10

→ **The +8 dBm / 3 kHz max PSD limit is compliant for conditions specified, SF7/10 500kHz SF10 and SF7**

7 Spurious Emission: Unwanted Emissions In The Spurious Domain (FCC)

7.1 Description

The measurement mentioned in this chapter refers to the paragraph 15.247(d) of the FCC regulation and describes the power level allowed outside the normal emission frequency band.
In any 100 kHz bandwidth outside the frequency band in which the system is operating, the power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph 15.247(b)(3), the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
Attenuation below the general limits specified in 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in 15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see 15.205(c)).
As specified in paragraph 15.33(a)(1), the spectrum shall be investigated from 9 kHz up to at least the tenth harmonic of the highest fundamental frequency.

Part 15.205 Restricted Frequency Bands

Frequency			
MHz	**MHz**	**MHz**	**GHz**
0.090–0.110	16.42–16.423	399.9–410	* **4.5–5.15 (5)**
0.495–0.505	16.69475–16.69525	608–614	* **5.35–5.46 (6)**
2.1735–2.1905	16.80425–16.80475	960–1240	* **7.25–7.75 (8)**
4.125–4.128	25.5–25.67	1300–1427	* **8.025–8.5 (9)**
4.17725–4.17775	37.5–38.25	1435–1626.5	* **9.0–9.2 (10)**
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	* **2690–2900 (3)**	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
2.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	* **3600–4400 (4)**	Above 38.6
13.36-13.41			
* **Harmonic (n) of emission between 902 – 928 MHz may fall within a restricted band of operation**			

Part 15.209 Radiated Emission Limits for Frequencies above 30 MHz

Frequency (MHz)	Field Strength (µV / m)	Measurement Distance (m)	Conducted Power (dBm)
30-88	100	3	-55.2
88-216	150	3	-51.7
216-960	200	3	-49.2
Above 960	500	3	-41.2

Figure 7.1: FCC Restricted Frequency Bands and radiated Emission limit

7.2 Setup

The setup used for the spurious measurements is shown in figure 2.2. The various switches are controlled by the measurement script. The RF front end is protected from the energy sent back by the notch filter by a 10 dB attenuator.

7.3 Spurious Emission Above 1 GHz

For spurious measurements above 1 GHz, the notch filter is bypassed and the high pass filter with a cut-off frequency at 1.2 GHz is used. Above the cut-off frequency, the attenuation is about 1 dB. So, loss is considered perfect and not compensated while the spurious are far to the regulation limit.

7.3.1 Emission at SF7

Figure 7.2: Spurious emission above GHz, 27 dBm, LoRa 500 kHz SF7

7.3.2 Emission at SF10

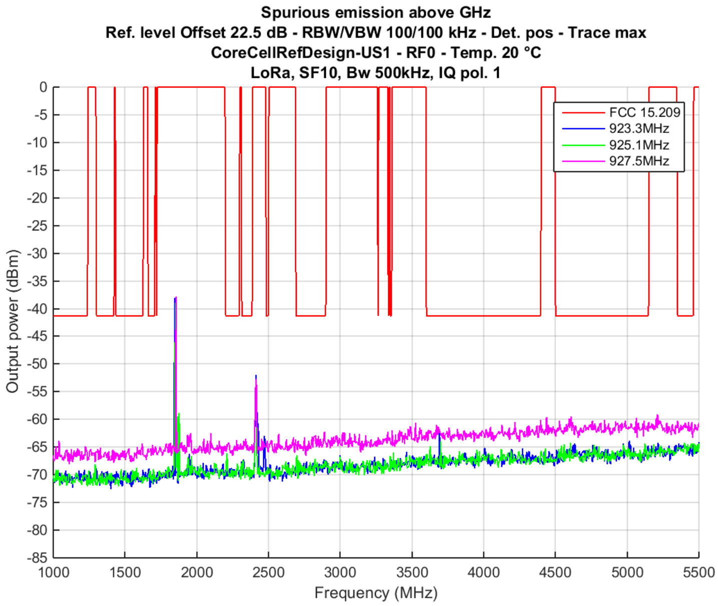


Figure 7.3: Spurious emission above GHz, 27 dBm, LoRa 500 kHz SF10

→ **Note: The Emission at 2.4 GHz is spurious from nearby wifi picked up by cables and not a harmonic**

7.4 Sub GHz Spurious Emission

For spurious measurements below 1 GHz, a notch filter is manually tuned for each frequency and allows to reject the fundamental power in order to reduce the instrument reference level and then increase the measurement dynamic. The ripple of notch filter response is lower than 1 dB from 280 MHz to 1 GHz. As a consequence, it is considered perfect in this frequency range. A more accurate measurement of the notch filter response will only be performed if a spurious is detected close to the regulations limit.

7.4.1 Emission at SF7

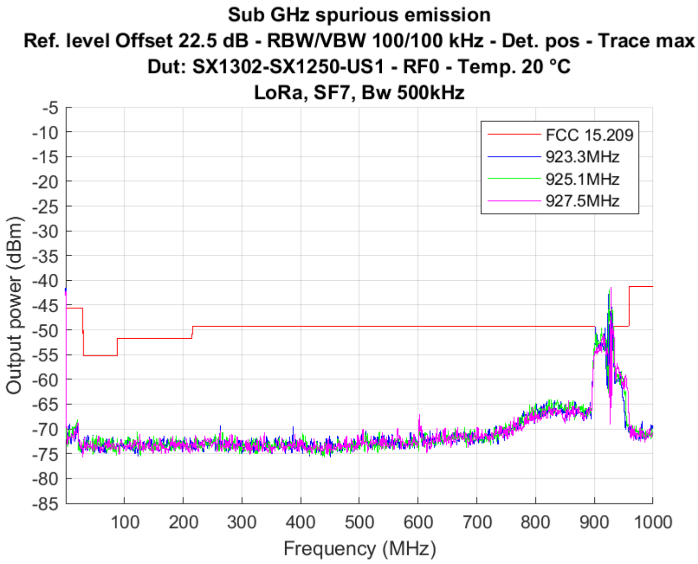


Figure 7.4: Sub GHz spurious emission, 27 dBm, LoRa 500 kHz SF7

7.4.2 Emission at SF10

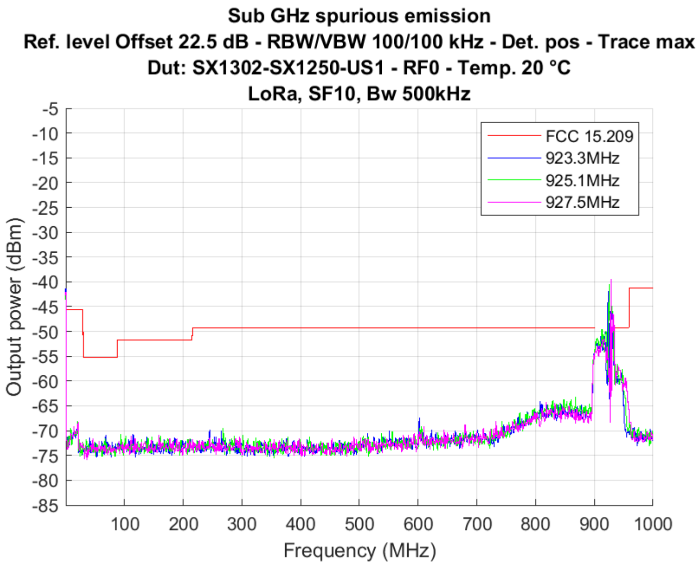


Figure 7.5: Sub GHz spurious emission, 27 dBm, LoRa 500 kHz SF10

Part III

Receiver

8 Sensitivity Level And PER

8.1 Description

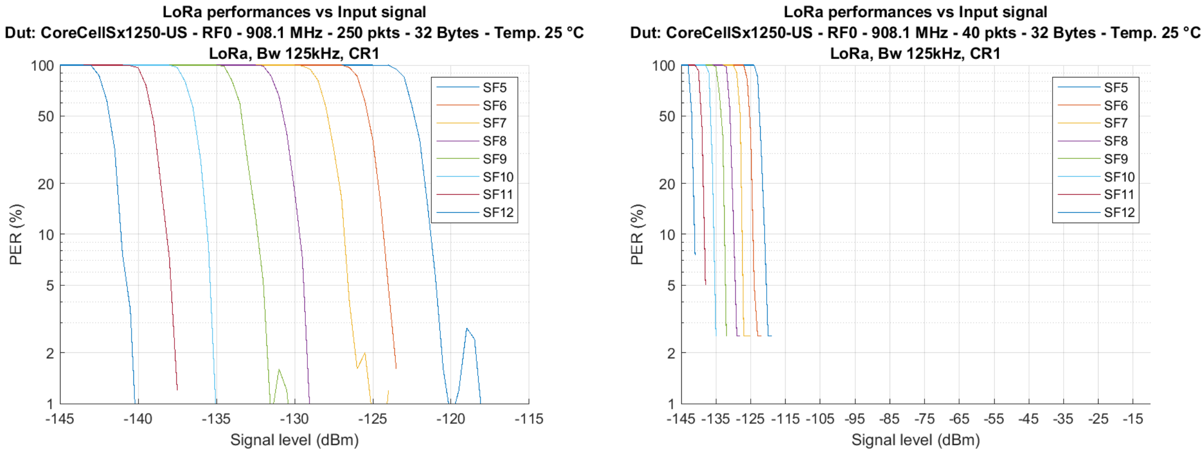
This test determines the sensitivity level i.e. the minimum RF input power needed to demodulate the received packet. It is determined for a PER of 10%. It also verifies the PER remains null for input power above the sensitivity level i.e. no saturation occurs.

8.2 Setup

The sensitivity measurement setup is shown in figure 2.3. Only one signal generator is used here, the output of the second one is OFF. It generates LoRa packets toward the DUT for several output powers and frequencies. The effect of impedance mismatch is mitigated by the use of attenuators at the power splitter inputs and along the switch matrix.

The **packet forwarder** software running on the RPI3 pulls data from the SX1302 by SPI bus and send them to the computer through UDP protocol.

8.3 MultiSF Modem Versus Spreading Factor

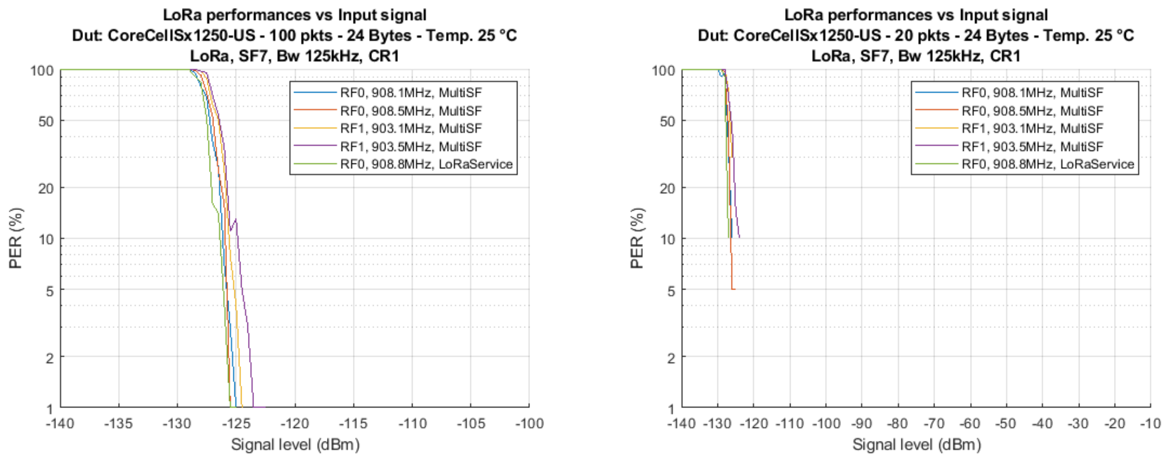


(a) Sensitivity level

(b) High level

Figure 8.1: Sensitivity level and PER, MultiSF 125 kHz modem vs SF, 908.1 MHz, Ambient temperature

8.4 MultiSF and SingleSF Modems Versus channels

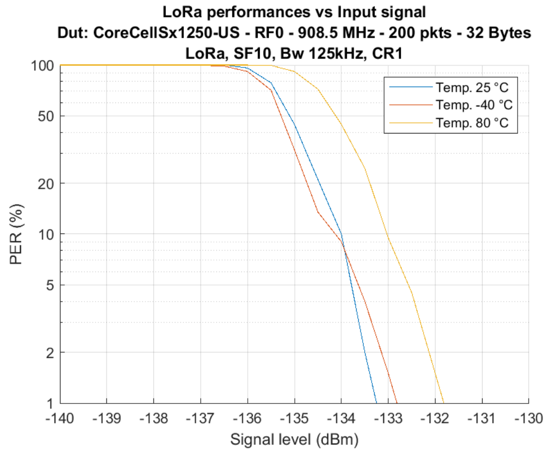


(a) Sensitivity level

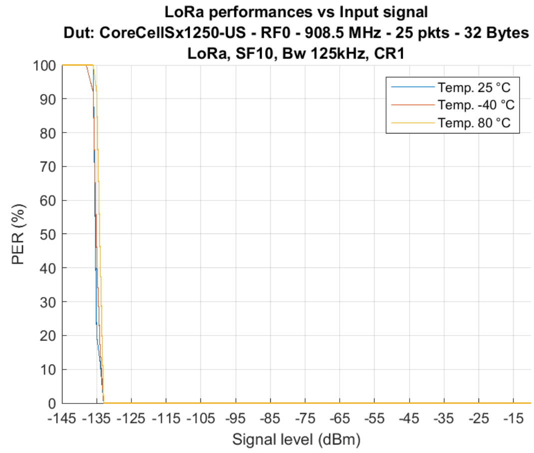
(b) High level

Figure 8.2: Sensitivity level and PER, MultiSF and SingleSF modems versus channels, SF7, Bw 125 kHz

8.5 MultiSF Modem Versus Temperature



(a) Sensitivity level

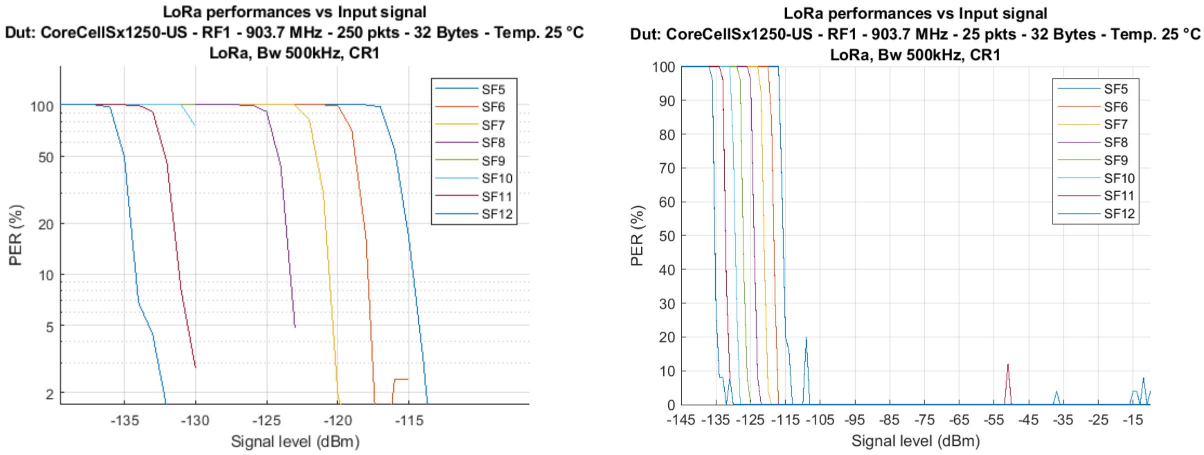


(b) High level

Figure 8.3: Sensitivity level and PER, MultiSF modem versus temperature, SF10, Bw 125 kHz

8.6 SingleSF Modem Vs Spreading Factor

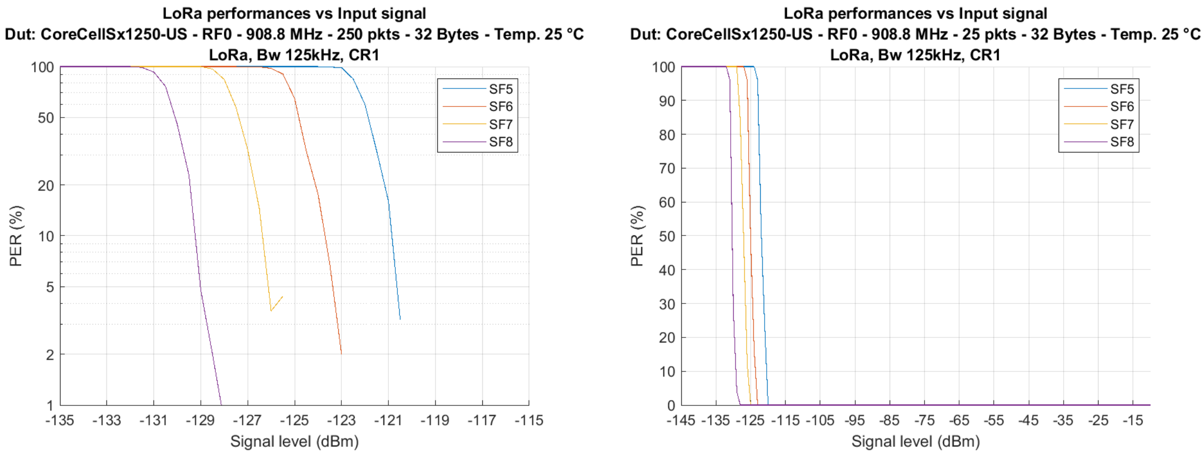
8.6.1 Bandwidth 500 kHz



(a) Sensitivity level (b) High level

Figure 8.4: Sensitivity level and PER, SingleSF modem versus spreading factor (5 to 12), Bandwidth 500 kHz

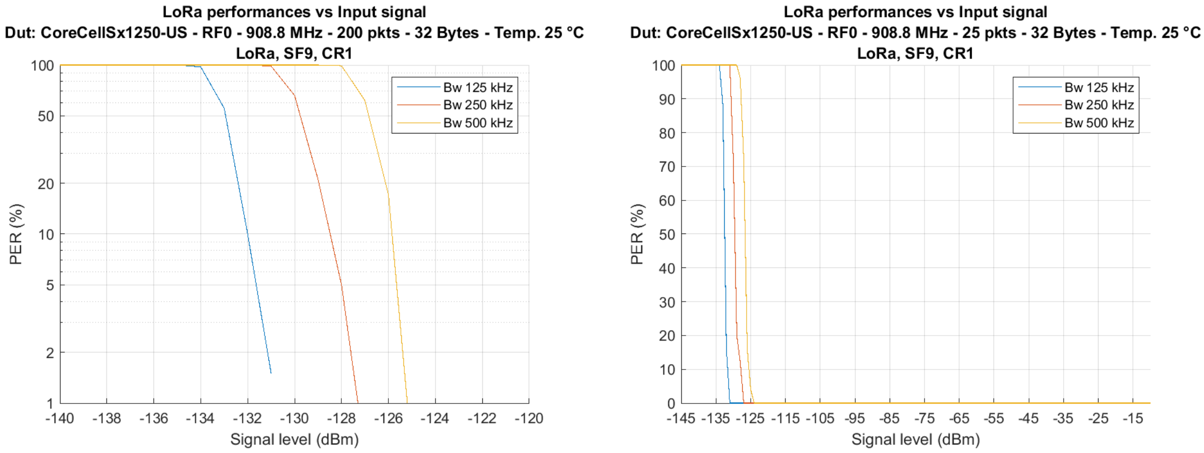
8.6.2 Bandwidth 125 kHz



(a) Sensitivity level (b) High level

Figure 8.5: Sensitivity level and PER, SingleSF modem versus spreading factor (5 to 8), Bandwidth 125 kHz

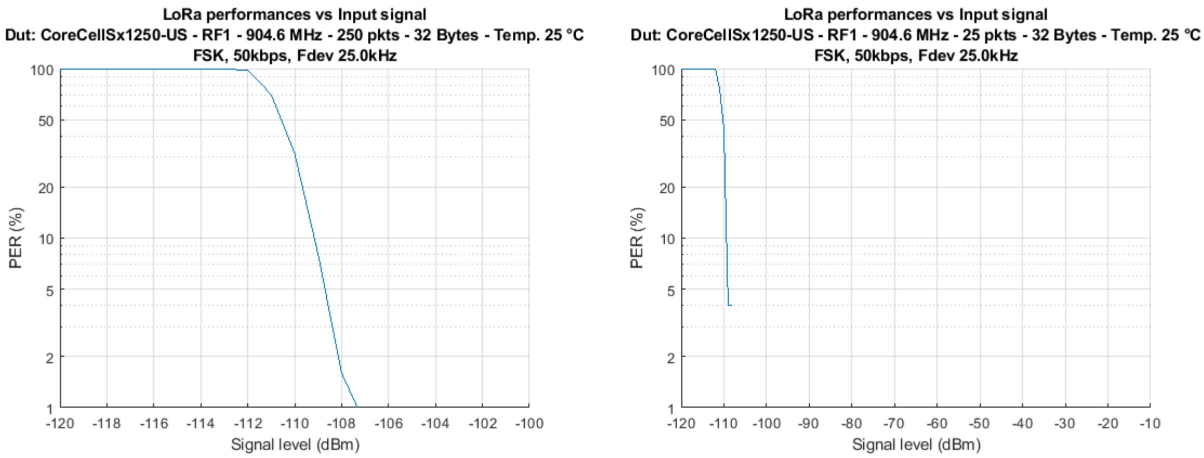
8.7 SingleSF Modem vs Bandwidth



(a) Sensitivity level (b) High level

Figure 8.6: Sensitivity level and PER, SingleSF modem vs bandwidth, 908.8 MHz, SF9

8.8 FSK Modem



(a) Sensitivity level (b) High level

Figure 8.7: Sensitivity level and PER, FSK modem, 904.6 MHz

9 RSSI

9.1 Description

The LoRa modems returns two indicators of the received signal level: RSSI Channel and RSSI Signal

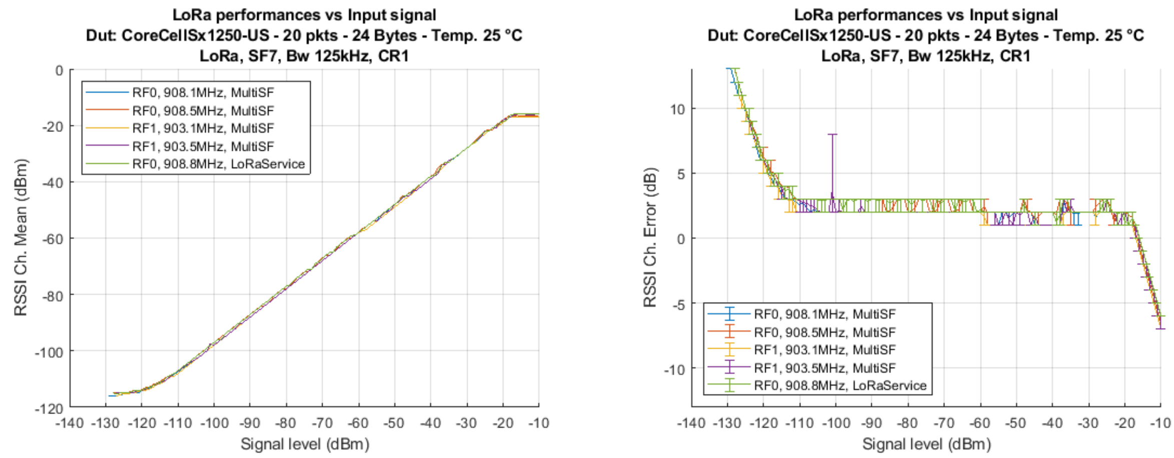
- RSSI Channel: This indicator represents the power in the channel bandwidth, taken care the power of signal and the thermal noise. It concerns LoRa and FSK modulation.
- RSSI Signal: This indicator represents the LoRa signal only without taken care the thermal noise power. It only concerns the LoRa modulation; this indicator is not available for FSK modulation.

9.2 Setup

The RSSI measurement is performed simultaneously of the PER one. The setup is shown in figure 2.3. Only one signal generator is used here, the output of the second one is OFF. It generates LoRa packets toward the DUT for several output powers and frequencies. The effect of impedance mismatch is mitigated by the use of attenuators at the power splitter inputs and along the switch matrix.

The **packet forwarder** software running on the RPI3 pulls data from the SX1302 by SPI bus and send them to the computer through UDP protocol.

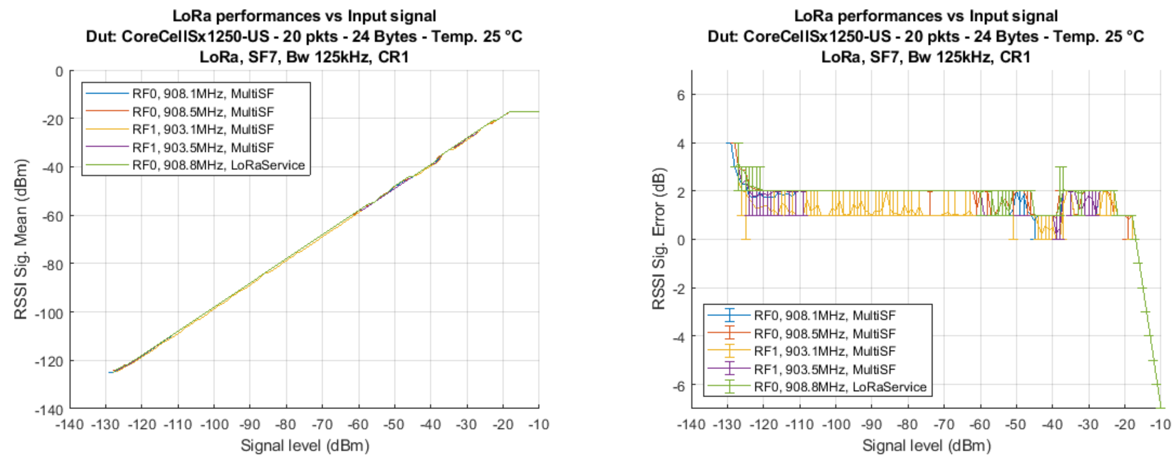
9.3 MultiSF And SingleSF Modem Versus Channels



(a) RSSI Channel mean

(b) RSSI Channel error

Figure 9.1: RSSI Channel, MultiSF and SingleSF modems versus channels, SF7, Ambient temperature

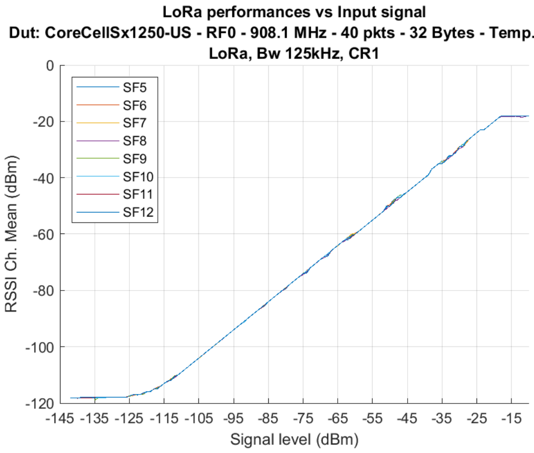


(a) RSSI Signal mean

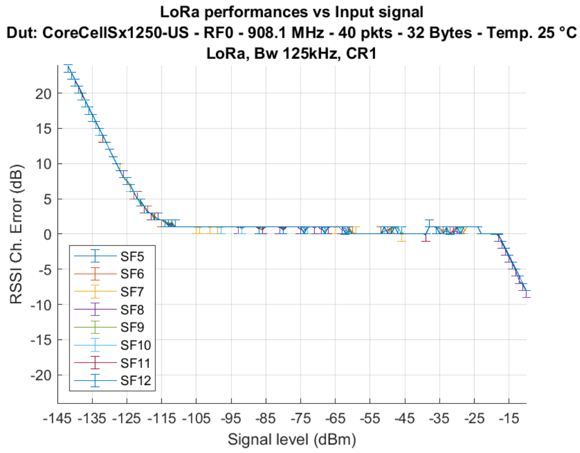
(b) RSSI Signal error

Figure 9.2: RSSI Signal, MultiSF and SingleSF modems versus channels, SF7, Ambient temperature

9.4 MultiSF Modem Versus Spreading Factor

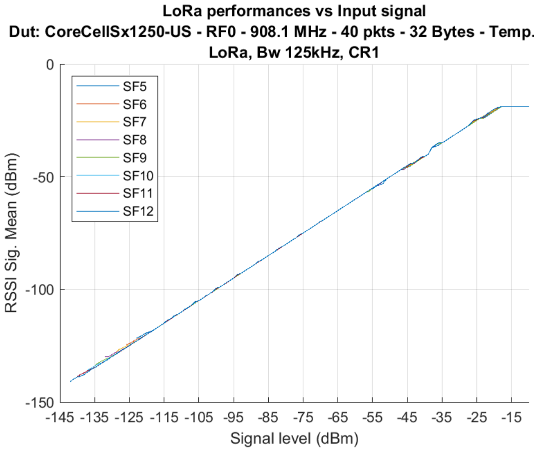


(a) RSSI Channel mean

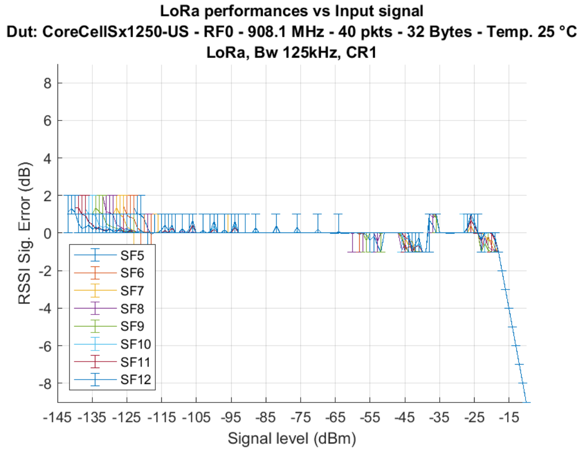


(b) RSSI Channel error

Figure 9.3: RSSI Channel, MultiSF modem vs Spreading factors, 908.1 MHz, Ambient temperature



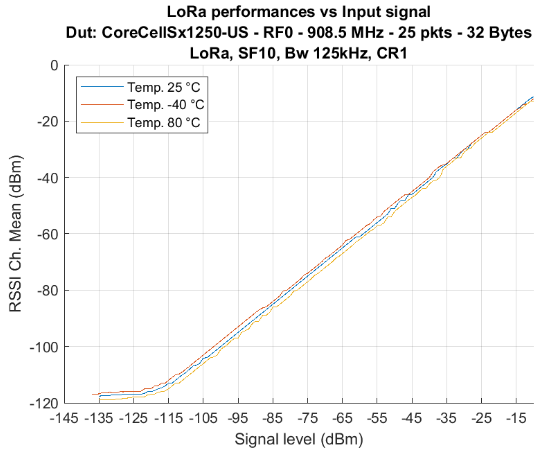
(a) RSSI Signal mean



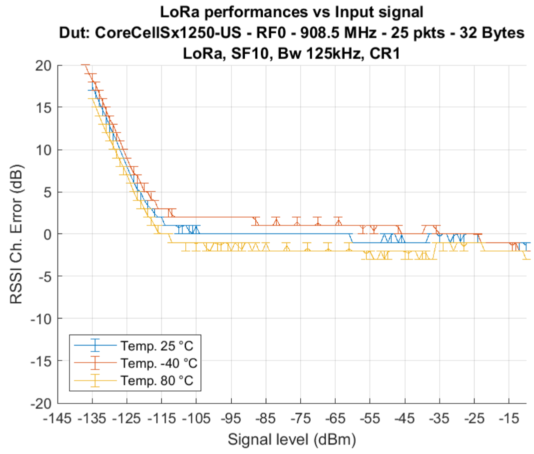
(b) RSSI Signal error

Figure 9.4: RSSI Signal, MultiSF modem vs Spreading factors, 908.1 MHz , Ambient temperature

9.5 MultiSF Modem Versus Temperature

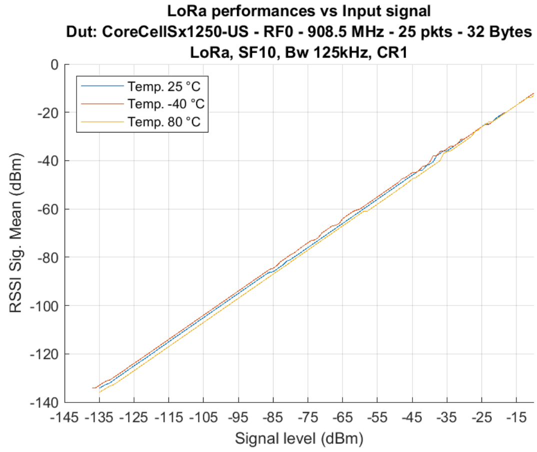


(a) RSSI Channel mean

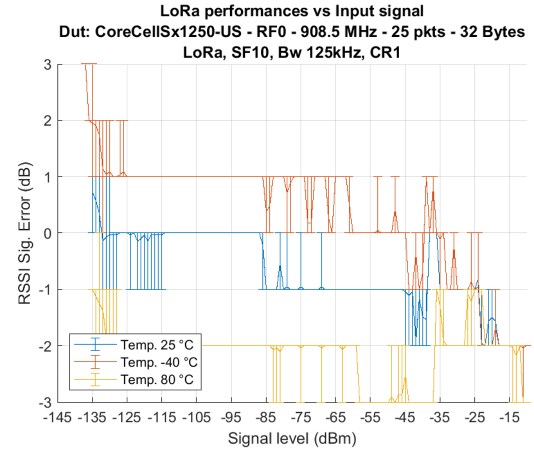


(b) RSSI Channel error

Figure 9.5: RSSI Channel, MultiSF modem vs Temperature, 908.5 MHz, SF 10, BW 125kHz



(a) RSSI Signal mean

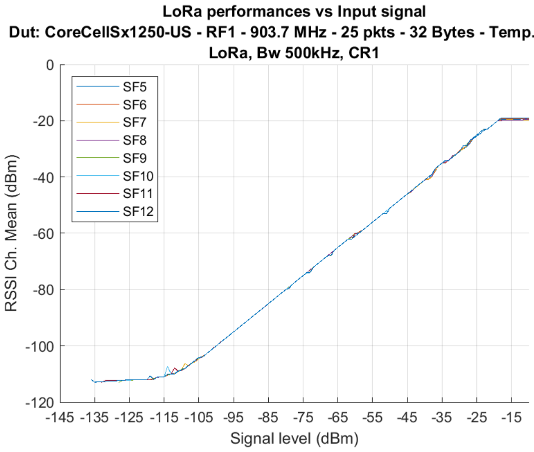


(b) RSSI Signal error

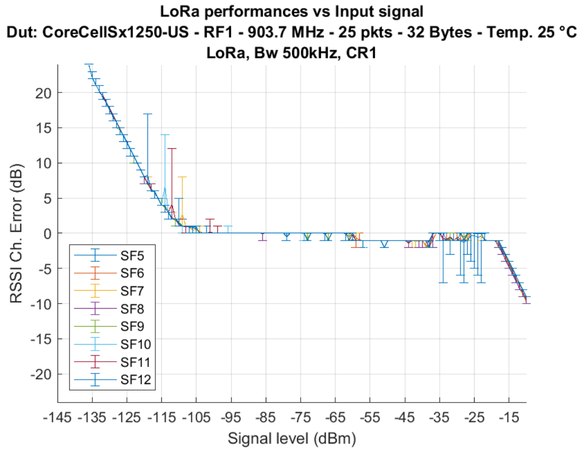
Figure 9.6: RSSI Signal, MultiSF modem vs Temperature, 908.5 MHz, SF 10, BW 125kHz

9.6 SingleSF Modem Versus Spreading Factor

9.6.1 Bandwidth 500 kHz

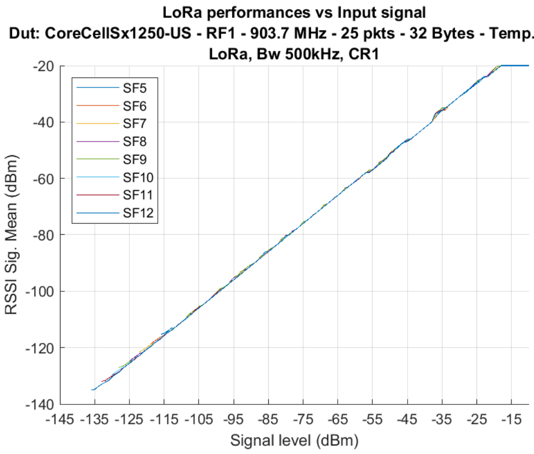


(a) RSSI Channel mean

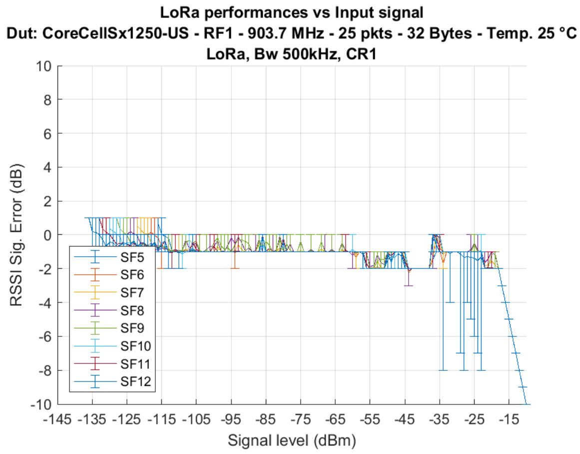


(b) RSSI Channel error

Figure 9.7: RSSI Channel, SingleSF modem vs spreading factor , 903.7 MHz, Bw 500 kHz



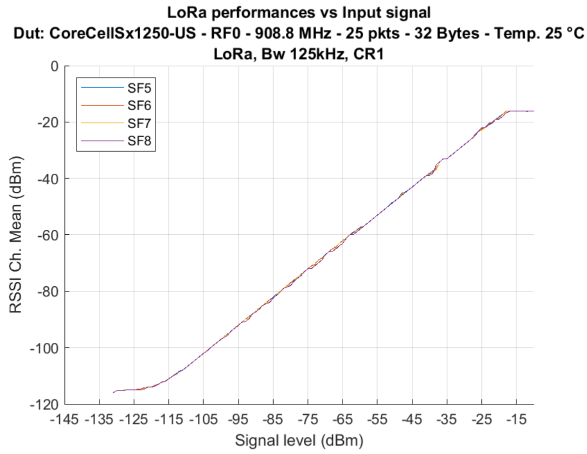
(a) RSSI Signal mean



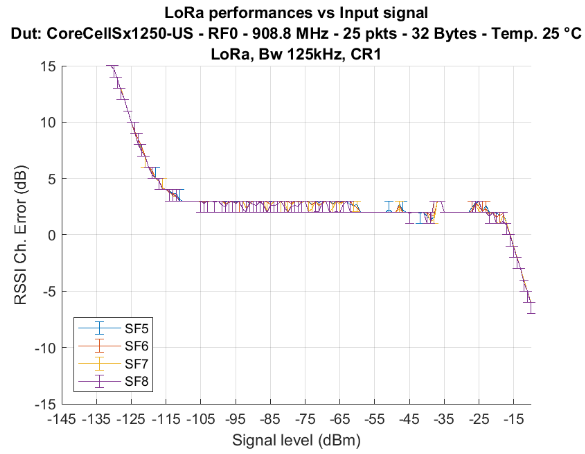
(b) RSSI Signal error

Figure 9.8: RSSI Signal, SingleSF modem vs spreading factor , 903.7 MHz, Bw 500 kHz

9.6.2 Bandwidth 125 kHz

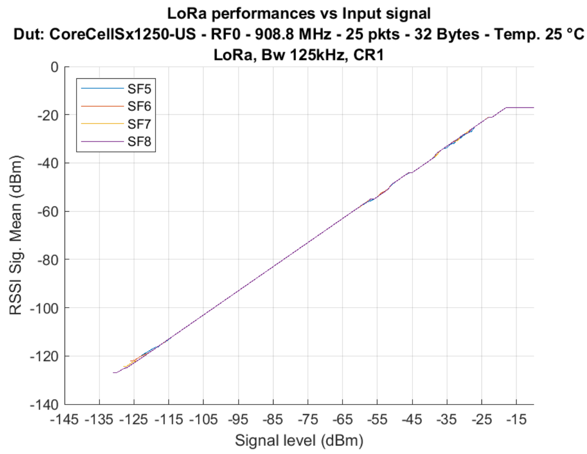


(a) RSSI Channel mean

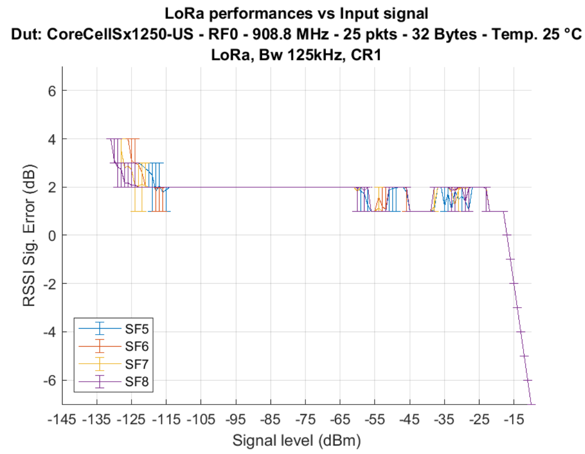


(b) RSSI Channel error

Figure 9.9: RSSI Channel, SingleSF modem vs spreading factor , 908.8 MHz, BW 125kHz



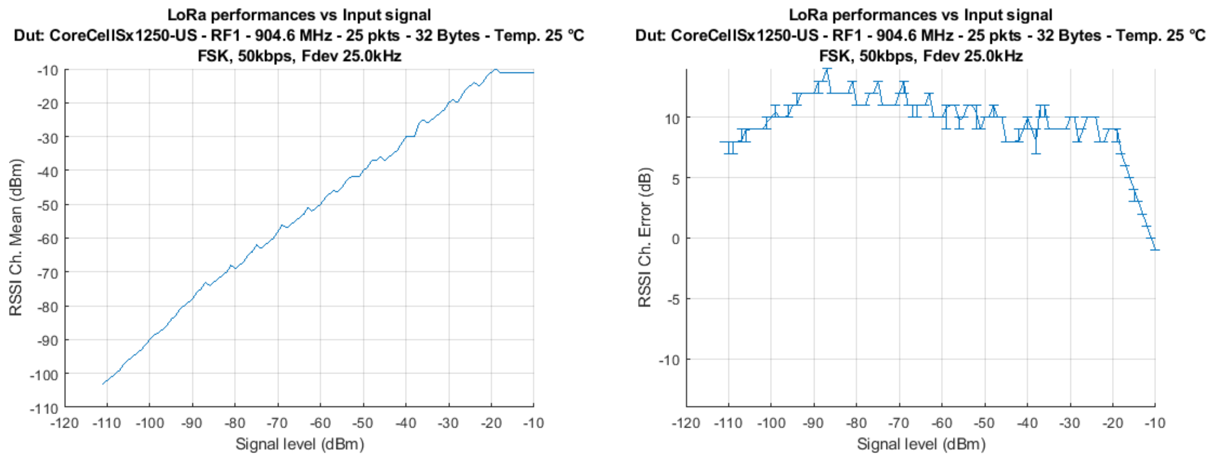
(a) RSSI Signal mean



(b) RSSI Signal error

Figure 9.10: RSSI Signal, SingleSF modem vs spreading factor , 908.8 MHz, BW 125kHz

9.7 FSK Modem



(a) RSSI Channel mean

(b) RSSI Channel error

Figure 9.11: RSSI Channel, FSK modem, 904.6 MHz

10 SNR

10.1 Presentation

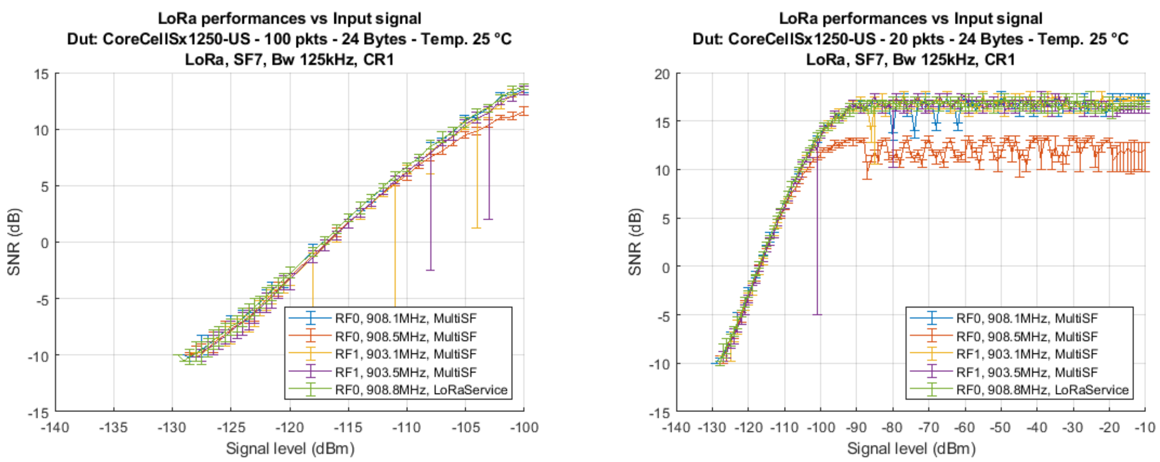
In conjunction with the RSSI value, the LoRa modem determines the Signal-To-Noise Ratio while receiving packets. This test verifies the accuracy of this indicators whatever the SF, the bandwidth, the payload length and its content.

10.2 Setup

The SNR is measured using the setup presented in the figure 2.3 (Sensitivity, RSSI). The DUT is connected to the SPDT A "common path".

The SNR measurement presents the mean value computed with the linear values of measured samples then expressed in a logarithm way. For each measurement step, the top and bottom horizontal bars represent the maximum and the minimum SNR value. They should be close to the mean value.

10.3 MultiSF And SingleSF Modem Versus Channels

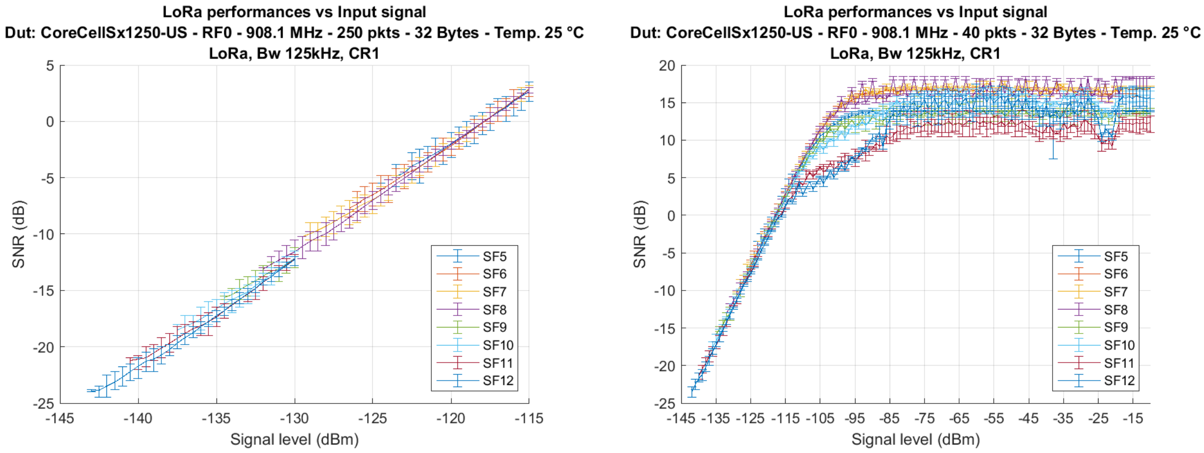


(a) Sensitivity level

(b) High level

Figure 10.1: SNR, MultiSF and SingleSF modems versus channels, Ambient temperature

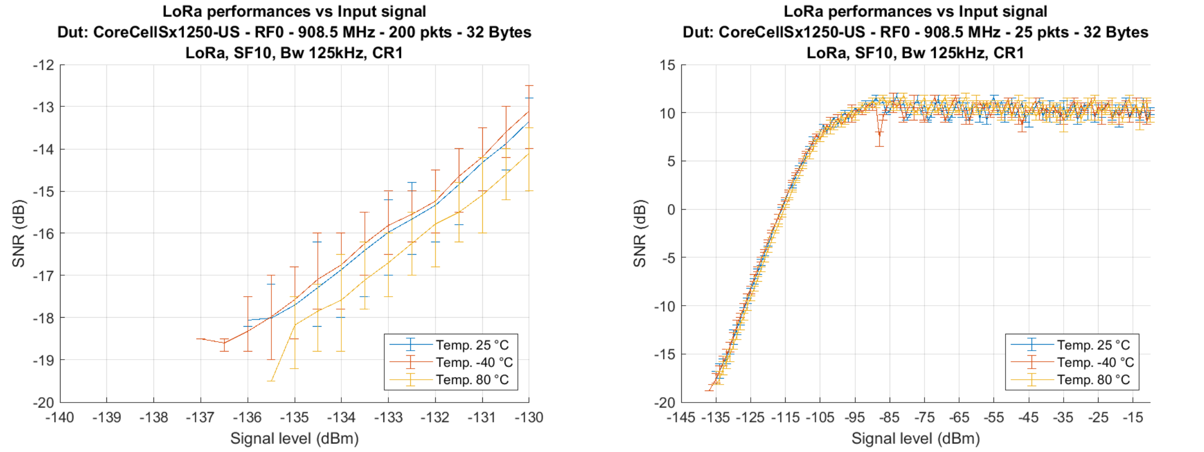
10.4 MultiSF Modem Versus Spreading Factor



(a) Sensitivity level (b) High level

Figure 10.2: SNR, MultiSF modems versus Spreading Factor, Ambient temperature

10.5 MultiSF Modem Versus Temperature

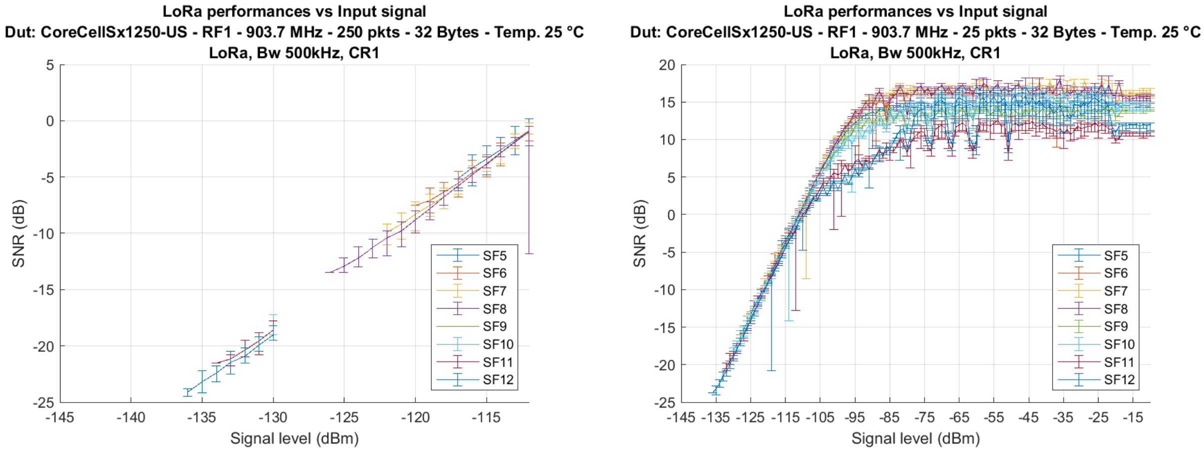


(a) Sensitivity level (b) High level

Figure 10.3: SNR, MultiSF modem versus temperature, 908.5 MHz, SF10, Bw 125 kHz

10.6 SingleSF Modem Vs Spreading Factor

10.6.1 Bandwidth 500 kHz

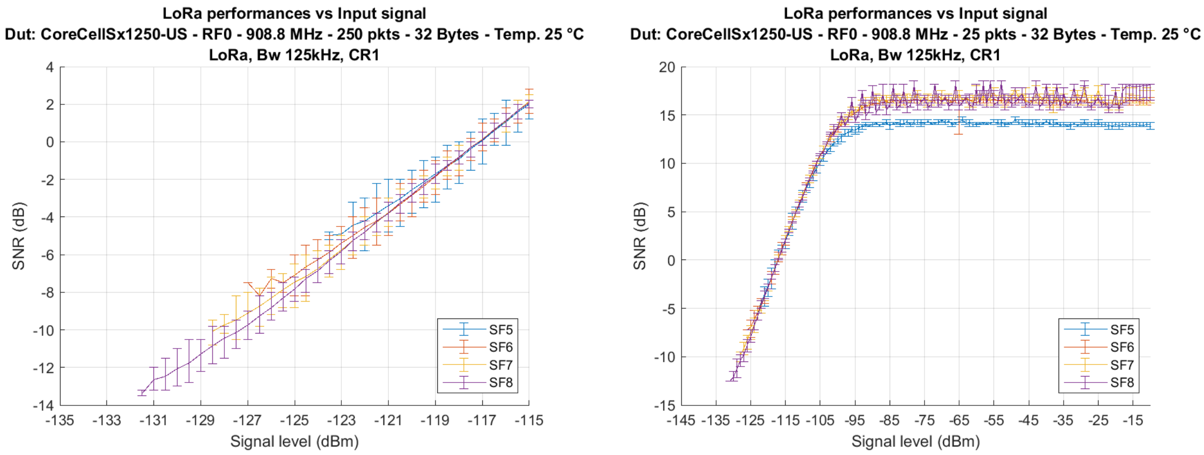


(a) Sensitivity level

(b) High level

Figure 10.4: SNR, SingleSF modem versus spreading factor , 903.7 MHz, Bw 500 kHz

10.6.2 Bandwidth 125 kHz



(a) Sensitivity level

(b) High level

Figure 10.5: SNR, SingleSF modem versus spreading factor , 908.8 MHz, Bw 125 kHz

11 Blocking And Immunity To Interferer

11.1 Description

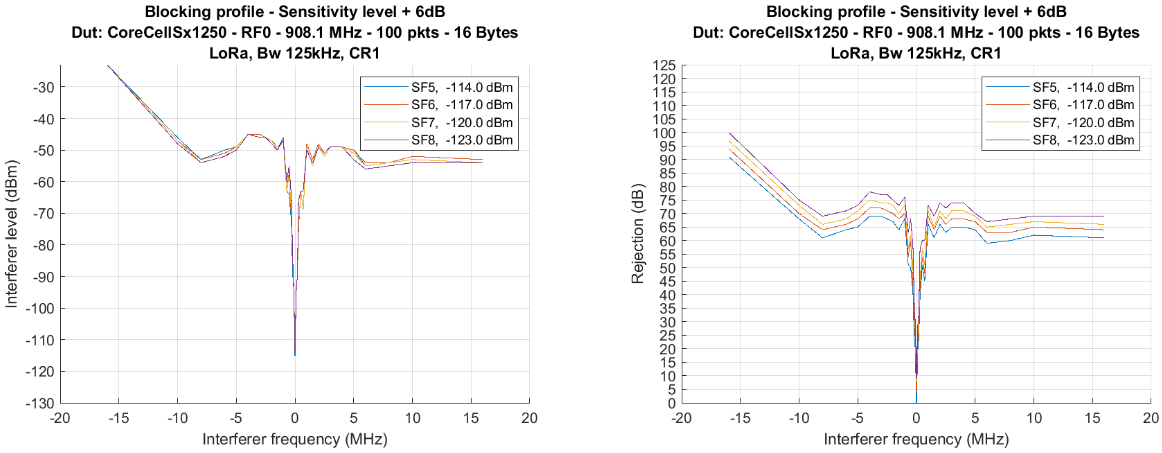
A blocking measurement is performed to evaluate the robustness of the system to interferer in the vicinity of the gateway.

11.2 Setup

The test bench allowing to assess the coexistence robustness is shown in figure 2.3. Useful signal and interferer are combined in the power splitter/combiner. The attenuators allow to reduce the mutual interference between both signal generators.

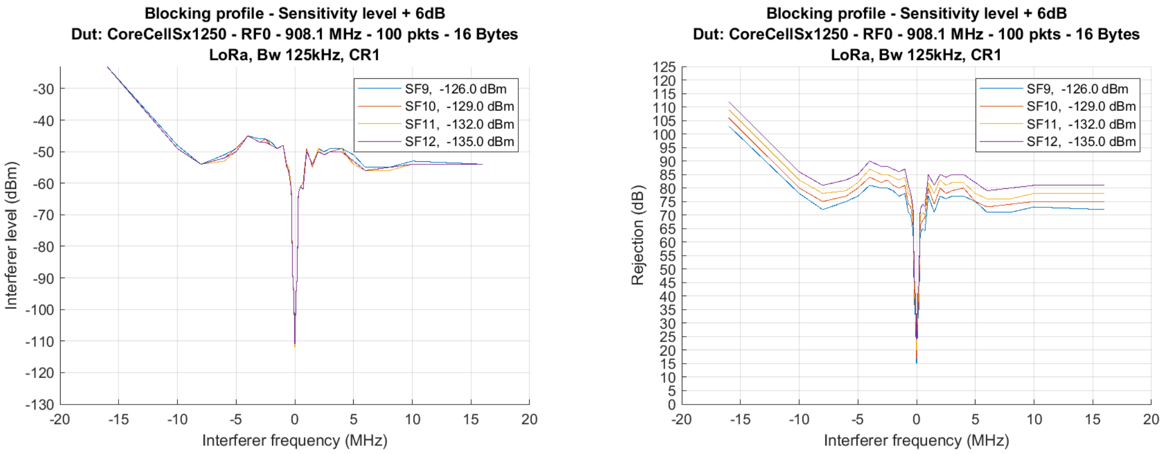
The interferer is a continuous carrier wave swept from -16 to +16 MHz in comparison with the carrier frequency, with a variable step in order to find sensitive frequencies.
For each interferer step, the output power of the useful signal is set to the sensitivity level + 3 dB . The PER measurement is done on 100 or 50 packets based on the measurement condition. The interferer level is adjusted automatically to cause a PER of 10%.

11.3 MultiSF Modem Versus Spreading Factor



(a) Interferer level (dBm) (b) Rejection (dB)

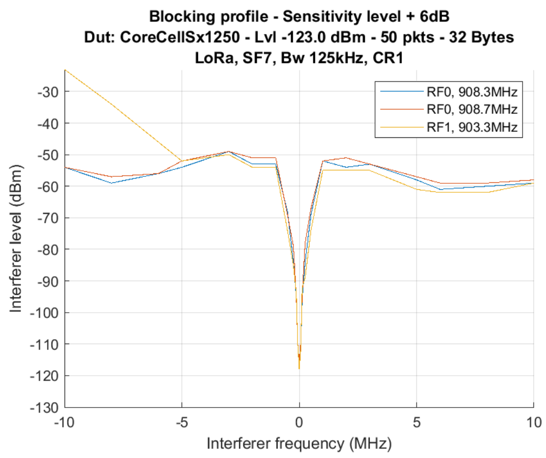
Figure 11.1: Blocking profile, MultiSF modem versus Spreading Factor (5 to 8)



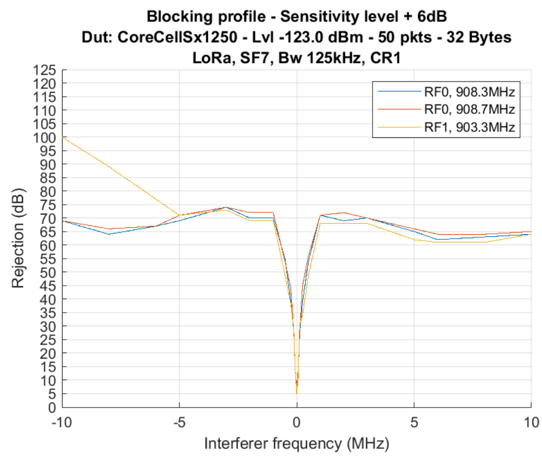
(a) Interferer level (dBm) (b) Rejection (dB)

Figure 11.2: Blocking profile, MultiSF modem versus Spreading Factor (9 to 12)

11.4 MultiSF Modem Versus Channels



(a) Interferer level (dBm)

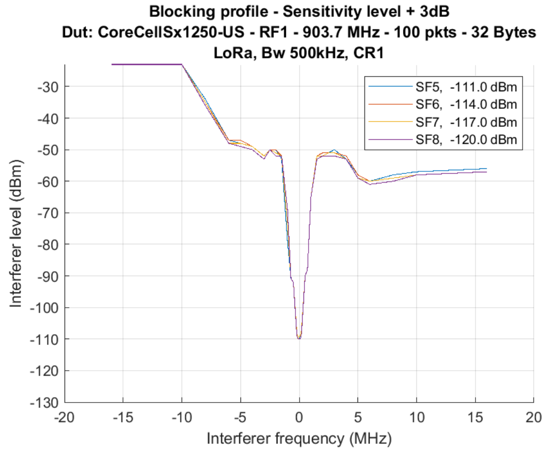


(b) Rejection (dB)

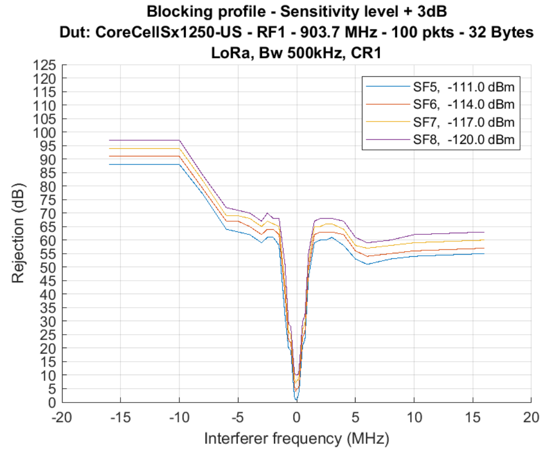
Figure 11.3: Blocking profile, MultiSF modem versus channels, SF7, Sensitivity level + 3dB (-123 dBm)

11.5 SingleSF Modem Versus Spreading Factor

11.5.1 Bandwidth 500 kHz

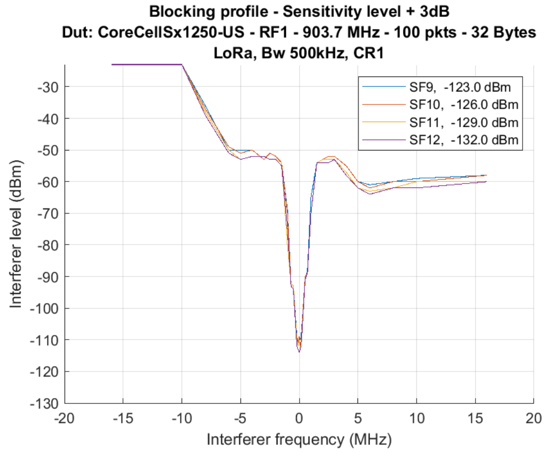


(a) Interferer level (dBm)

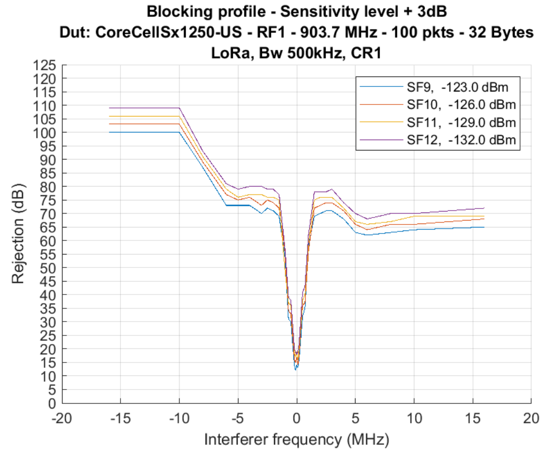


(b) Rejection (dB)

Figure 11.4: Blocking profile, SingleSF modem versus spreading factor (5 to 8), Bandwidth 500 kHz



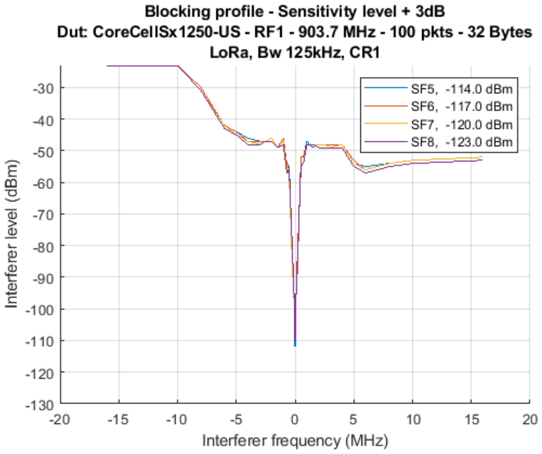
(a) Interferer level (dBm)



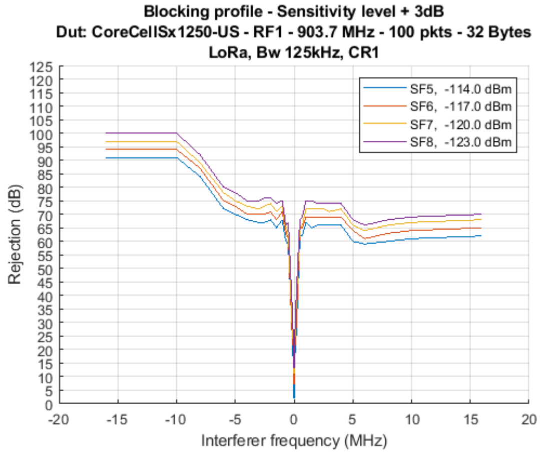
(b) Rejection (dB)

Figure 11.5: Blocking profile, SingleSF modem versus spreading factor (9 to 12), Bandwidth 500 kHz

11.5.2 Bandwidth 125 kHz

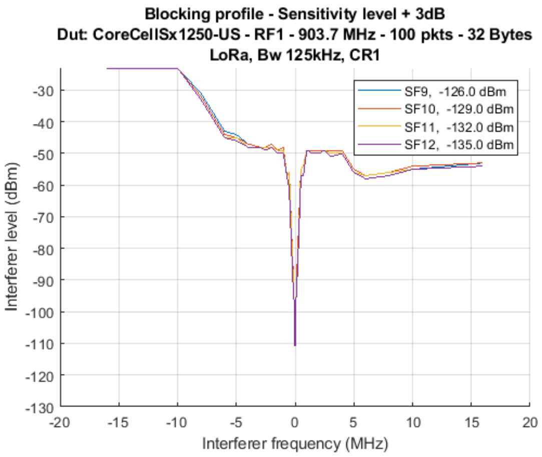


(a) Interferer level (dBm)

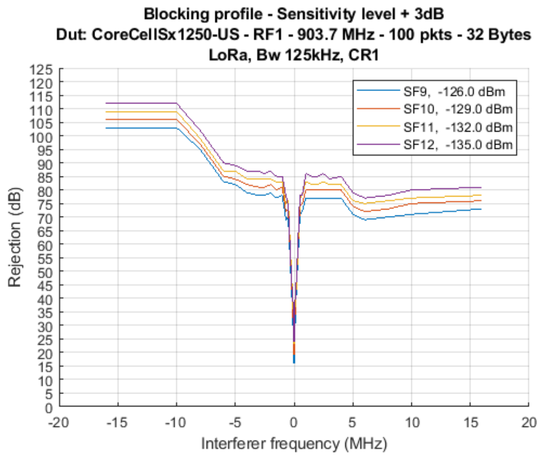


(b) Rejection (dB)

Figure 11.6: Blocking profile, SingleSF modem versus spreading factor (5 to 8), Bandwidth 125 kHz



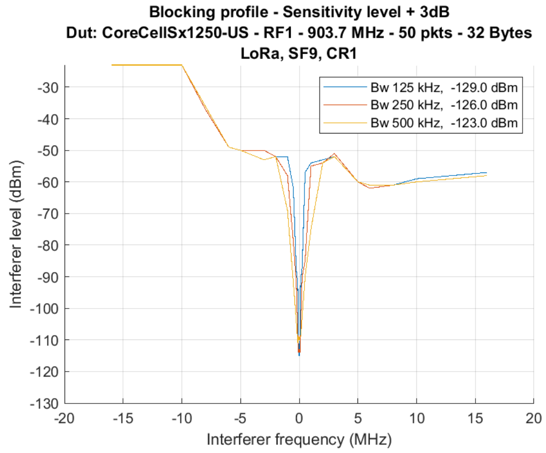
(a) Interferer level (dBm)



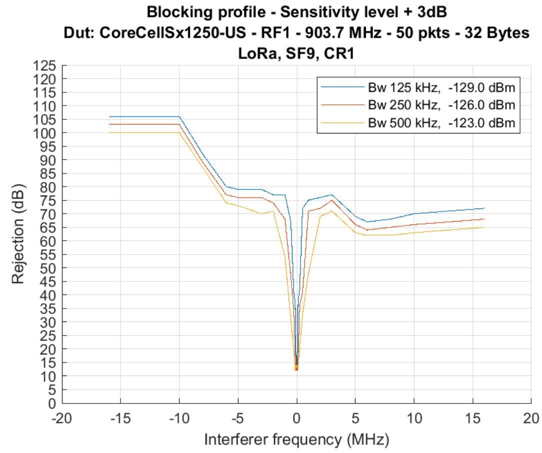
(b) Rejection (dB)

Figure 11.7: Blocking profile, SingleSF modem versus spreading factor (9 to 12), Bandwidth 125 kHz

11.6 SingleSF Modem Versus Bandwith



(a) Interferer level (dBm)



(b) Rejection (dB)

Figure 11.8: Blocking profile, SingleSF modem versus bandwidth, SF9, 903.7 MHz, Sensitivity level + 3dB

Part IV

Annexes

A Acronyms and Glossary

ADC chipset function, analog digital converter

ARIB Association of Radio Industries and Businesses

ATE automatic test equipment used to test the integrated chipset

AWGN Additive White Gaussian Noise

BOM bill of material for a given printed board circuit

BS base station of a radio system

CCAS Clear Channel assessment. This process is intended to be used for allocating or reserving the correct channel for the RF transmission

CDMA code division multiple access. In order to have several communication on the same medium, we can separate them by code projection means

CW carrier wave, used in radio frequency transmission

CPW coplanar waveguide for a transmission line

CPWG coplanar grounded waveguide for a transmission line

CPU central processing unit

DAC Digital Analog Converter

dBc unit description, decibel relative to the carrier maximum power

dBd dB towards dipole antenna (2.14 dBi)

dBi dB isotropic, used to define antenna gain

dBm unit description, decibel relative to milliwatt

DRC Design Rules Check

DPI Design Public Interface, define the interface of a design in terms of mechanics, materials, constraint.

DUT Device Under Test during measurement

EIRP Emitted Isotropic Radiated Power

EMC electromagnetic compliance

ERC Electrical Rules Check

ETSI European Telecommunications Standard Institute

FCC Federal Communications Commission

FEC Forward Error Correction, algorithm used by combining received data and redundancy codes to recover from false data

FER Frame Error Rate

FHSS Frequency Hopping Spread Spectrum used in radio frequency transmission

FM Frequency Modulation used in radio frequency transmission

FTS Fine TimeStamps identifying when a packet is received

HAL Hardware Abstraction Layer

IEC International Electrotechnical Commission

IF radio frequency term as intermediate frequency, used to describe the frequency used in up or down conversion system

IFA inverted F antenna : an antenna that looks like and inverted F letter

IL Insertion Loss

ISA industry standard architecture

ISM industrial, scientific and medical frequency band as described in the ERC70-3

JIT Just In Time TX scheduling

LBT Listen Before Talk. Process that oblige a device to listen a RF channel before using it, in order to ensure that this channel is not occupied

LIC Least Interferer Channel. A type of LBT process

LOS Line Of Sight. This term describe how the wave are propagated between a transmitter and a receiver, in a direct manner

LPF Low Pass Filter. Electronic function where high frequencies are attenuated whereas low frequencies stay unchanged

MIPS million instruction per second

MMIC Monolithic Microwave Integrated Circuit used to describe the integrated circuit in microwave technologies

MOSI Master Output Slave Input, Synchronous Serial Link

MISO Master Input Slave Output, Synchronous Serial Link

MS mobile station

N/A not applicable or not available

NLOS Non Line Of Sight. This term describe how the wave are propagated between a transmitter and a receiver, in a non direct manner. only reflection are taken into account

NRI National Radio Interface

OCW Occupied Channel Bandwidth

OOB out of band, describe the spurious that do not belong to the wanted emission spectrum, and outside the authorized band in usage

OSR Over Sampling Ratio, uses to determine a sampling frequency

p.d.f. probability density function

PA Power Amplifier

PIFA plate inverted F antenna describe an antenna that looks like a plate that has a F letter shape seen from the side

PPS Pulse Per Second. Electrical signal uses for precise timekeeping and time measurement

PSD Power Spectral Density

PSU Power Supply Unit

RBW resolution bandwidth, spectrum analyzer setting

RF Radio Frequency

RFU Reserved for Future Use

RPI Raspberry Pi, development board

RSSI receiving signal strength indicator used in radio frequency system

RAM random access memory

Rx Receiver

SF Spreading Factor, a LoRa modulation parameter

SNR Ratio of signal power to the noise power

SPDT single path dual through, describe the type of switch only a single is connected at a given time

SPI serial peripheral interface used to connect different chip with a reduced number of signals

SRD Short Range Devices

SWR Standing Wave Ratio, a measurement to express the impedance matching efficiency

UFL U.FL miniature microwave connector

VBW video bandwidth, spectrum analyzer setting

VLT Victim Link transmitter

VNA Vector Network Analyzer

XO crystal oscillator