AN4962
Application note

S2-LP ETSI compliance test at 868 MHz SRD band

Introduction

This application note provides the relevant test results of the S2-LP under ETSI EN 300 220-1 V3.1.0 (2016-05).

The S2-LP is a very low power RF transceiver in the sub-1 GHz band. It is designed to operate in both of the license-free ISM and SRD frequency bands.

All tests are performed using an STEVAL-FKI868V1 kit and S2-LP DK graphical user interface (GUI).

For details on the regulatory limits in the SRD frequency bands, refer to the ETSI EN 300 220-1 V3.1.0 (2016-05): “Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement” [2]. These can be downloaded from www.etsi.org.

Contents

1 List of acronyms and abbreviations

Table 1. List of acronyms and abbreviations

Acronym / abbreviation	Description
ACP	Adjacent channel power
ARQ	Automatic repeat request
BER	Bit error rate
e.r.p.	Effective radiated power
FEC	Forward error correction
OOB	Out-of-band domain
OC	Operating channel
OCW	Operating channel width
RBW	Resolution bandwidth
VBN	Video bandwidth

2 S2-LP RF evaluation board

The STEVAL-FKI868V1 board is tuned to work in the 860 - 940MHz band. *Figure 1: S2-LP application board plugged into the motherboard* shows the S2-LP application board.

For correct functionality, the STEVAL-FKI868V1 must be plugged into a NUCLEO-L152RE board.

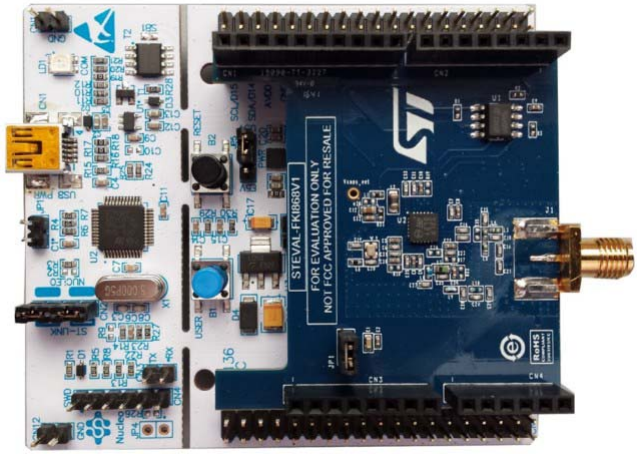
The NUCLEO-L152RE is an STM32 Nucleo-64 development board with an STM32L152RE MCU, which supports Arduino and ST morpho connectivity.

The microcontroller on the NUCLEOL152RE is programmed with the S2-LP firmware of the S2-LP DK and is used to drive the device with the GUI or through the library examples.

The following is a list of some of the features available on the STEVAL-FKI868V1 board:

- S2-LP
- High frequency 50 MHz crystal
- Balun, matching network and harmonic filter
- Arduino™ Uno V3 connectivity
- SMA connector
- An EEPROM to store the manufacturing data
- NUCLEO-L152RE board (refer to UM1724 for further details)

Figure 1. S2-LP application board plugged into the motherboard



3 Measurements to comply with ETSI recommendations

Different RF parameters described in ETSI EN 300 220-1 V3.1.0 document are tested to verify the S2-LP performance.

For transmission mode the following parameters have been checked: effective radiated power (conducted measurement), TX out-of-band emissions, unwanted emissions in the spurious domain and transient power.

In narrowband channelized applications, the adjacent channel power (ACP) has also been measured.

In RX mode, the requirement for ETSI Class 1.5 receiver has been checked. Category 1.5 is an improved performance level of receiver category 2. For Class 1.5 compliance, the following measurements must be performed: RX sensitivity level and Blocking.

Compliance with each of the above ETSI measurement points is summarized in *Table 2: ETSI measurements*.

Table 2. ETSI measurements

Parameter	EN 30022001 spec number
Effective radiated power conducted measurement	Sub clause 5.2.2.1
Adjacent channel power	Sub clause 5.11
TX out-of-band emissions	Sub clause 5.8
Unwanted emissions in the spurious domain	Sub clause 5.9
Transient power	Sub clause 5.10
RX sensitivity level	Sub clause 5.15
Blocking	Sub clause 5.19

4 Transmitter measurements

All the measurements reported below are conducted with the following parameters:

Tc = 25 °C, Vdd = 3.3 V, fc= 868.3 MHz.

All the tests have been performed with a PN9 test baseband signal as a representative signal of normal operation of the EUT.

- Effective radiated power conducted measurement
- Adjacent channel power
- TX out-of-band emissions
- Unwanted emissions in the spurious domain
- Transient power

The measurements are performed in accordance with the ETSI EN 300 220-3-1 V2.1.0.

4.1 Effective radiated power (conducted measurement)

The S2-LP has been switched on in transmission mode with an unmodulated carrier at the highest power level (16 dBm).

The spectrum analyzer has been tuned to the center frequency (868.3 MHz) with an RBW of wide enough to cover the complete power envelope of the transmitted signal.

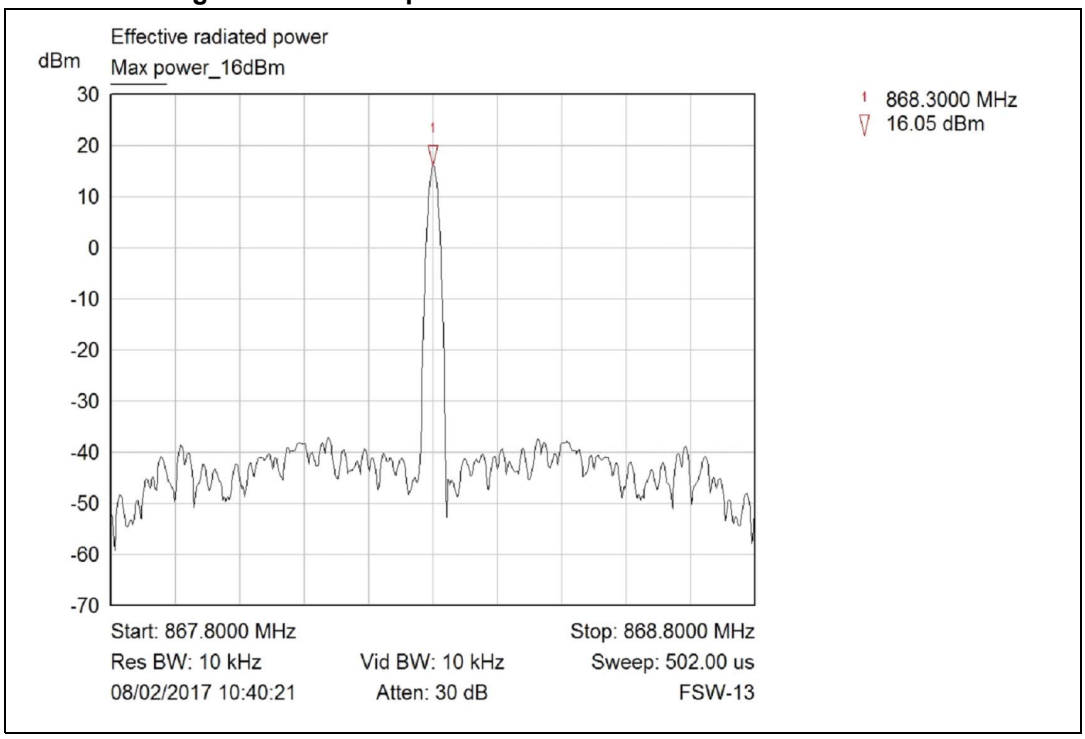
The radiated power (e.r.p.) limit applies to the maximum measured conducted power value adjusted by the antenna gain (relative to a dipole).

The measurement of the effective radiated power is recorded in the following table.

Table 3. Effective radiated power

Value	Notes
Test environment	Unmodulated carrier
Center frequency	868.3 MHz
RBW	10 kHz
VBN	10 kHz
Measured effective radiated power	16.05 dBm

Figure 2. Effective power radiated conducted measurement



4.2 Adjacent channel power

Adjacent channel power is defined as the amount of modulated RF signal power which falls into the adjacent channel. ACP measurements are applicable only to narrowband systems.

The adjacent channels and alternate adjacent channels are defined in *Table 4: Offset and RBWREF parameters*.

This test measures the power transmitted in the adjacent channel during continuous modulation.

Table 4. Offset and RBWREF parameters

Measurement	Offset from center frequency	RBW_{REF}
Adjacent channel	±OCW	±0.7 x OCW
Alternate channel	±2 x OCW	±0.7 x OCW

Where the operating channel width (OCW) is less than or equal to 25 kHz, the reference limits of the power in the adjacent channels are reported in *Table 5*.

Table 5. Adjacent channel power limits for transmitters with OCW ≤ 25 kHz

Description	Adjacent 0.7xOCW [dBm]	Alternate 0.7xOCW [dBm]
OCW < 20 kHz (normal test condition)	-20	-20
OCW ≥ 20 kHz (normal test condition)	-37	-40

Conducted measurement procedure has been performed connecting the STEVAL-FKI868V1 to a spectrum analyzer and configuring the S2-LP in continuous transmission mode.

The spectrum analyzer's ACP function has been used integrating the power over a RBW_{REF} bandwidth centered to an offset from center frequency, as specified in *Table 4*.

Table 6: Spectrum analyzer settings for ACP measurement shows that the spectrum analyzer configuration conforms to the requirements given in the EN 300 220-1 V3.1.0.

Table 6. Spectrum analyzer settings for ACP measurement

Spectrum analyzer setting	Value
Center operating frequency	868.3 MHz
Span	At least 5 x operating channel width
RBW	100 Hz
VBW	≥ 3 x RBW
Detector function	RMS
Trace mode	Linear AVG

4.2.1 ACP measurements with 25 kHz of channel spacing

The modulated signal used for this test is a 2GFSK05 with 9.6 kbps sample rate and 2.4 kHz frequency deviation. The ACP is measured with a spectrum analyzer conforming to the requirements given in EN 300 220-1 V3.1.0 and summarized in the following table.

Table 7. Spectrum analyzer settings for 25 kHz channel spacing

Setting	Value
Center frequency	868.3 MHz
RBW	100 Hz
VBW	300 Hz
Span	200 kHz
Detector mode	RMS
Trace mode	Linear averaging

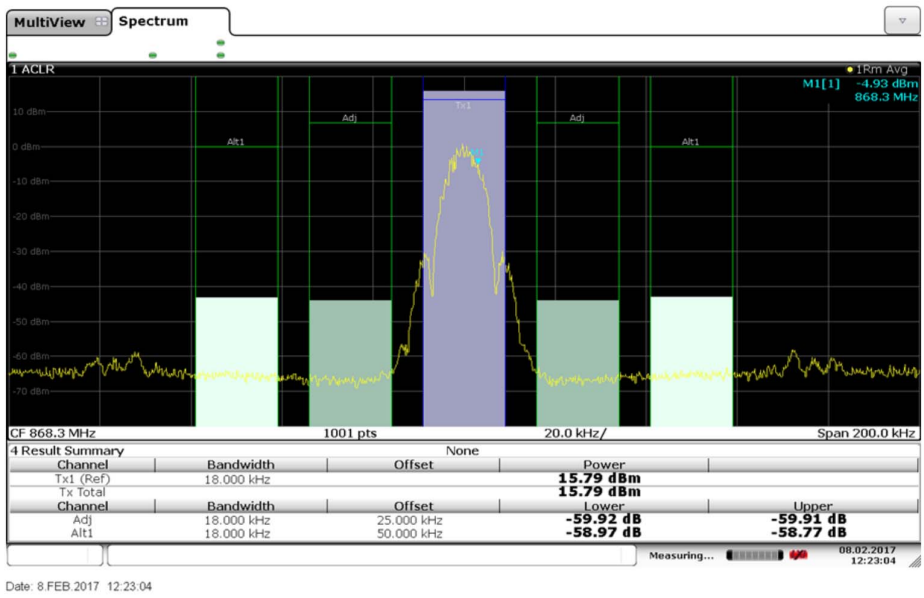
The integrated bandwidth at the adjacent and alternate channel is 17.5 kHz (0.7*OCW) and the ETSI limit are -37 dBm for the adjacent and -40 dBm for the alternate.

The test results show that the ACP is 6.8 dB lower than the ETSI limit (-37 dBm). For the alternate channel, the integrated power is 4.7 dB lower than the ETSI limit (-40 dBm). *Figure 3: Adjacent and alternate power measurements, 25 kHz channel spacing, 9.6 kbps sample rate, 2.4 kHz deviation* and *Figure 4: Adjacent power measurement, 12.5 kHz channel spacing, 2.4 kbps sample rate, 2.4 kHz deviation* illustrate the measured adjacent and alternate powers.

Table 8. ACP 25 kHz OCW test results

OCW	Test condition	Adjacent channel Power integrated over 0.7x OCW		ETSI limit for alternate adjacent channel Power integrated over 0.7 x OCW	
12.5 kHz	Normal	ETSI limit	S2-LP	ETSI limit	S2-LP
		-37 dBm	-59.9 dBm	-40 dBm	-58.9 dBm

Figure 3. Adjacent and alternate power measurements, 25 kHz channel spacing, 9.6 kbps sample rate, 2.4 kHz deviation



4.2.2 ACP measurements with 12.5 kHz channel spacing

Two different RF modulated signals have been considered:

1. 2GFSK05 with 2.4 kbps and 2.4 kHz of frequency deviation.
2. 2GFSK05 with 4.8 kbps and 2.4 kHz of frequency deviation.

Table 9: Spectrum analyzer settings for 12.5 kHz channel spacing summarizes the spectrum analyzer settings.

Table 9. Spectrum analyzer settings for 12.5 kHz channel spacing

Setting	Value
Center operating frequency	868.3 MHz
RBW	100 Hz
VBW	300 Hz
Span	75 kHz
Detector mode	RMS
Trace mode	Linear averaging

The integrated bandwidth at the adjacent and alternate channel is 8.75 kHz (0.7*OCW) and the ETSI limit is 10 µW (–20 dBm).

Table 10. ACP 12.5 kHz OCW test results (2GFSK05 with 2.4 kbps sample rate and 2.4 kHz deviation)

OCW	Test condition	Adjacent channel. Power integrated over 0.7x OCW		ETSI limit for alternate adjacent channel. Power integrated over 0.7 x OCW	
< 20 kHz	Normal	ETSI limit	S2-LP	ETSI limit	S2-LP
		-20 dBm	-44.3 dBm	-40 dBm	-41.1 dBm

Table 11. ACP 12.5 kHz OCW test results (2GFSK05 with 4.8 kbps sample rate and 2.4 kHz deviation)

OCW	Test condition	Adjacent channel. Power integrated over 0.7x OCW		ETSI limit for alternate adjacent channel. Power integrated over 0.7 x OCW	
< 20 kHz	Normal	ETSI limit	S2-LP	ETSI limit	S2-LP
		-20 dBm	-41.77 dBm	-40 dBm	-43.44 dBm

Figure 4: Adjacent power measurement, 12.5 kHz channel spacing, 2.4 kbps sample rate, 2.4 kHz deviation and *Figure 5: Adjacent power measurement, 12.5 kHz channel spacing, 4.8 kbps sample rate, 2.4 kHz deviation* show the measured ACP for the two different RF modulated signals.

The S2-LP is fully compliant with the ETSI transmitter adjacent channel power requirements with margin.

Figure 4. Adjacent power measurement, 12.5 kHz channel spacing, 2.4 kbps sample rate, 2.4 kHz deviation

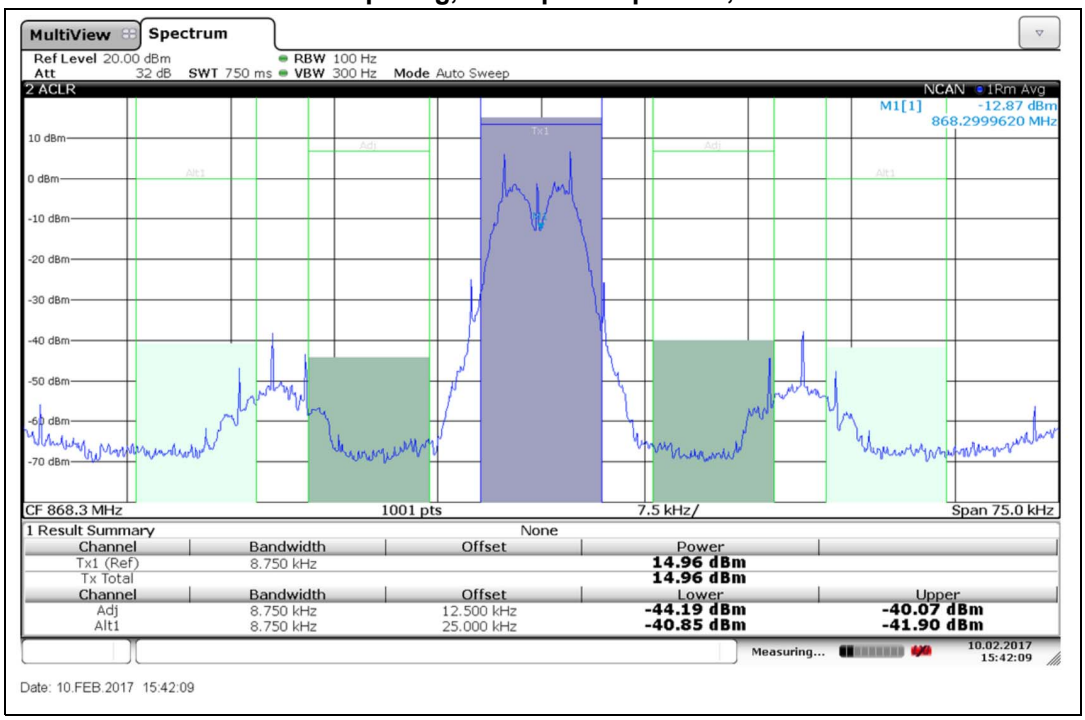
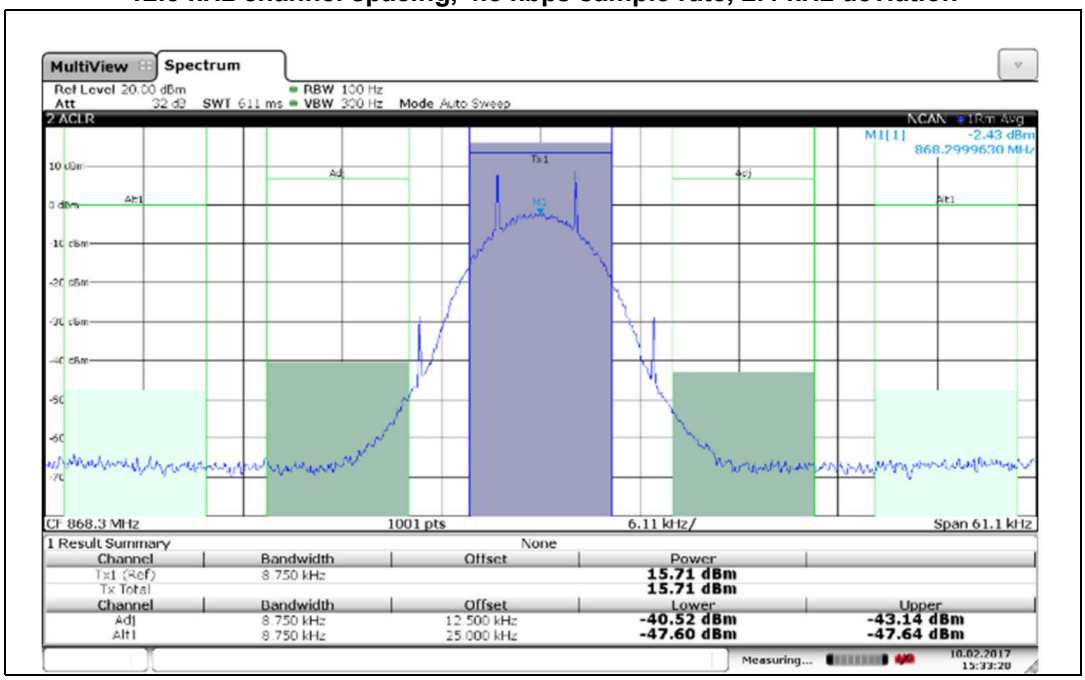


Figure 5. Adjacent power measurement, 12.5 kHz channel spacing, 4.8 kbps sample rate, 2.4 kHz deviation

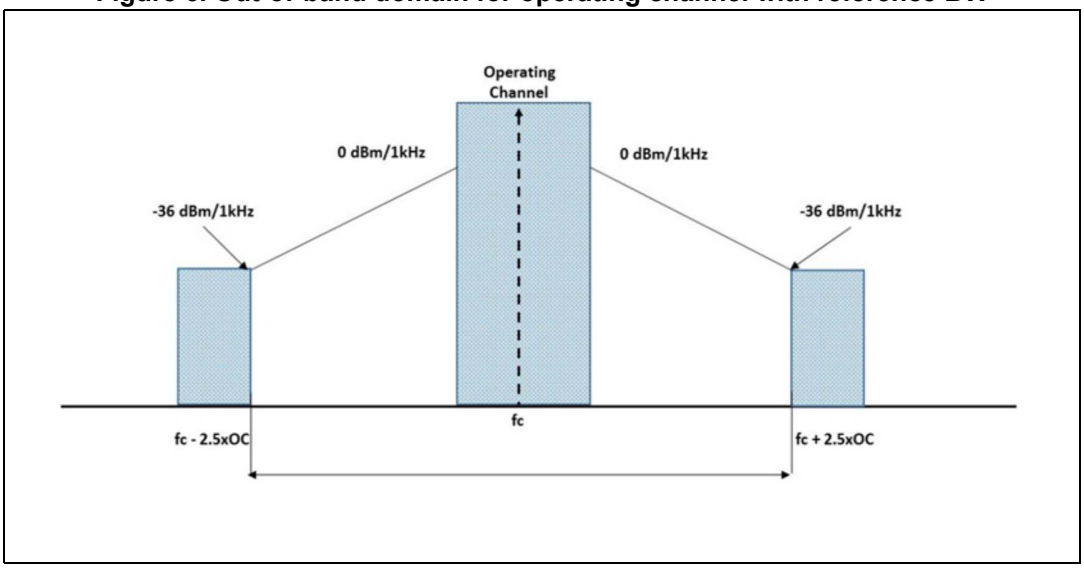


4.3 TX out-of-band emissions

The ETSI definition for out-of-band emission is: "*Unwanted emissions in the out-of-band domain are those falling in the frequency range immediately below the lower, and above the upper, frequency of the Operating Channel. The OOB domain includes both frequencies outside the Operating Channel within the Operational Frequency Band and frequencies outside the Operational Frequency Band.*"

The out-of-band domain is shown in *Figure 6: Out-of-band domain for operating channel with reference BW* and applies within the Operational Frequency Band.

Figure 6. Out-of-band domain for operating channel with reference BW



In the out-of-band domain, the power level must be below the spectrum masks given in *Table 12: Emission limits in the out-of-band domains*. For conducted measurement, the STEVAL-FKI868V1 has been connected to the spectrum analyzer which is used as an external receiver. In TX mode, the frequency range for conducted spurious radiation is from 9 kHz to 6 GHz as described in the ETSI [2] sub-clause 5.9.3.3.1.

Table 12. Emission limits in the out-of-band domains

Domain	Value	RBWREF	Max power limit
OOB limits applicable to operating channel (see *Figure 6*)	f = fc- 2.5 x OCW	1 kHz	-36 dBm
	fc – 2.5 x OCW ≤ f ≤ fc – 0.5 x OCW	1 kHz	See *Figure 6*
	f = fc – 0.5 x OCW	1 kHz	0 dBm
	f = fc + 0.5 x OCW	1 kHz	0 dBm
	fc + 0.5 x OCW ≤ f ≤ fc + 2.5 x OCW	1 kHz	See *Figure 6*
	f = fc+ 2.5 x OCW	1 kHz	-36 dBm

The spectrum analyzer settings used for OOB are summarized in *Table 13*.

Table 13. Test parameters for out-of-band for operating channel measurement

Spectrum analyzer setting	Value
Center operating frequency	868.3 MHz
Span	6xOCW
RBW	1 kHz
Detector function	RMS
Trace mode	Linear AVG

Three different examples of modulation have been considered:

1. fc = 868.3 MHz, sample rate = 9.6 ksps sample rate, deviation = 2.4 kHz, modulation 2GFSK with BT=1 (*Figure 7*)
2. fc = 868.3 MHz, sample rate = 38.4 ksps sample rate, deviation = 20 kHz, modulation 2GFSK with BT=1(*Figure 8*)
3. fc = 868.3 MHz, sample rate = 250 ksps sample rate, deviation = 125 kHz, modulation 2GFSK with BT=1 (*Figure 9*)

Figure 7. TX out-of-band emissions, 25 kHz channel spacing, 16 dBm, Fc = 868.3 MHz, 2GFSK1, 9.6 ksps data rate, 2.4 kHz frequency deviation

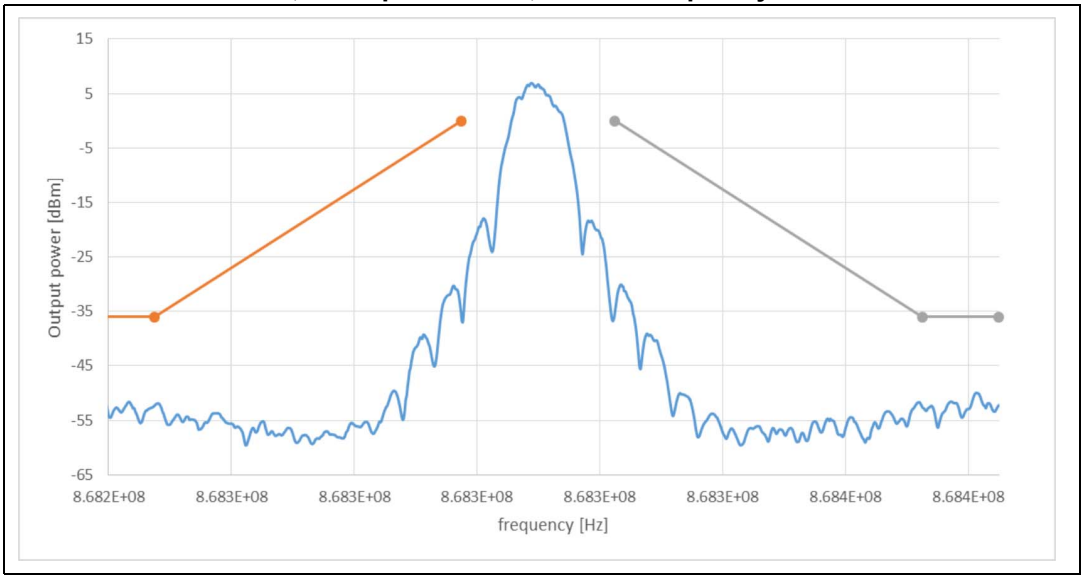


Figure 8. TX out-of-band emissions. 100 kHz channel spacing,16 dBm, 2GFSK1, Fc=868.3 MHz, 38.4 kbps data rate, 20 kHz frequency deviation

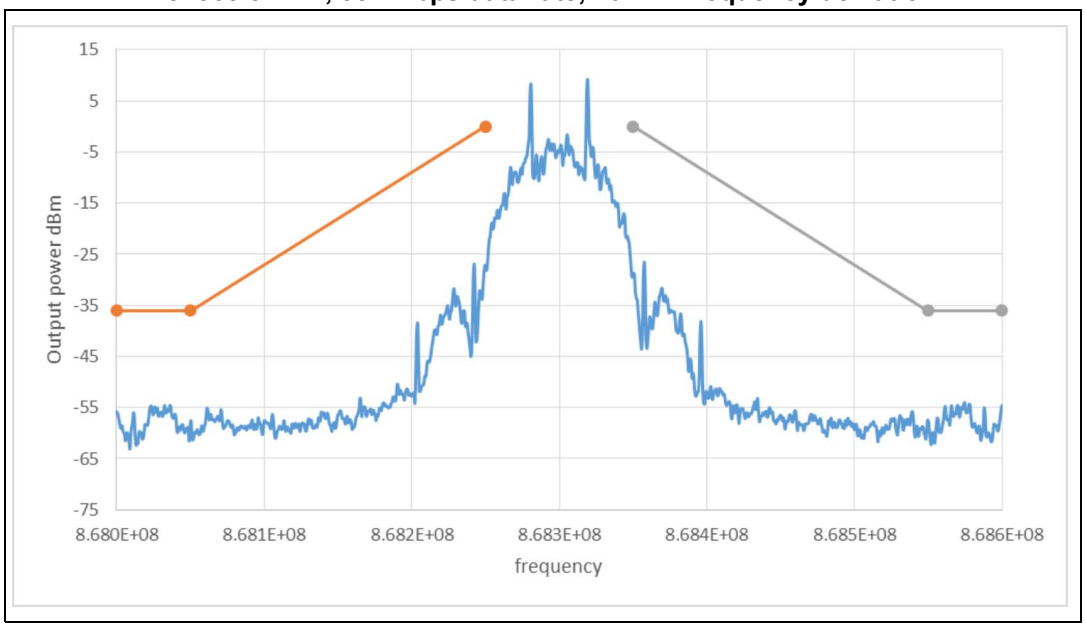
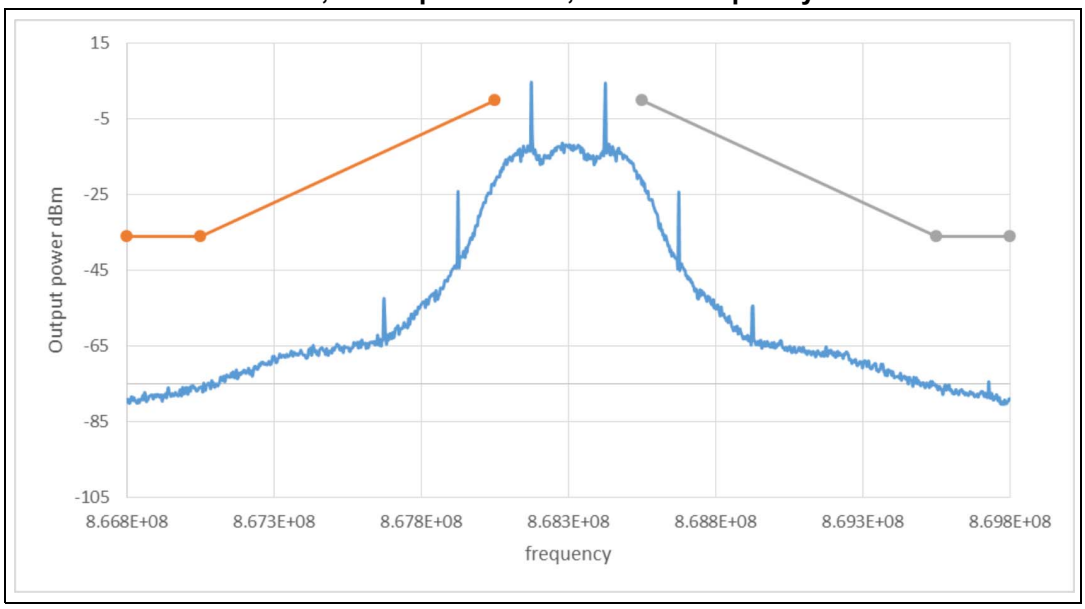


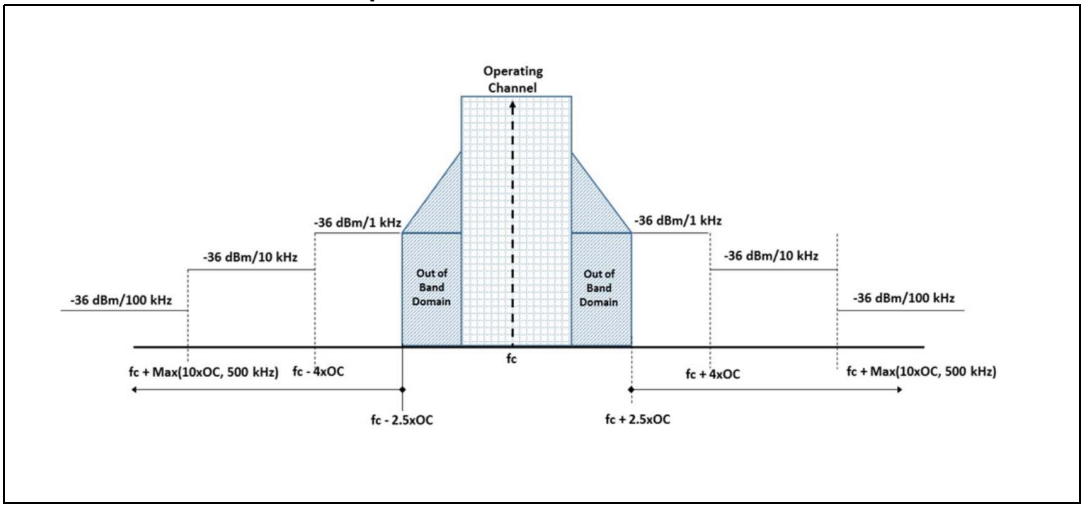
Figure 9. TX out-of-band emissions, 500 kHz channel spacing, 16 dBm, 2GFSK1, Fc=868.3 MHz, 250 kbps data rate, 125 kHz frequency deviation



4.4 Unwanted emissions in the spurious domain

The ETSI document defines spurious emissions as unwanted emissions in the spurious domain at frequencies other than in those the operating channel and its out-of-band domain. The spurious domain is shown in *Figure 10: Spectrum mask for unwanted emissions in the spurious domain with reference BW*.

Figure 10. Spectrum mask for unwanted emissions in the spurious domain with reference BW



For conducted measurement, the STEVAL-FKI868V1 has been connected to the spectrum analyzer which is used as an external receiver. In TX mode, the frequency range for conducted spurious radiation is from 9 kHz to 6 GHz as described in the ETSI [2] sub-clause 5.9.3.3.1.

The measurement is performed applying different resolution bandwidth as shown in *Table 14: Parameters for TX spurious radiation measurement*.

Table 14. Parameters for TX spurious radiation measurement

Frequency range	RBW_{REF}
9 kHz ≤ f < 150 kHz	1 kHz
150 kHz ≤ f < 30 MHz	10 kHz
30 MHz ≤ f < fc – m	100 kHz
fc - m ≤ f < fc – n	10 kHz
fc - n ≤ f < fc - p	1 kHz
fc + p < f ≤ fc + n	1 kHz
fc + n < f ≤ fc + m	10 kHz
fc + m < f ≤ 1 GHz	100 kHz

Table 14. Parameters for TX spurious radiation measurement (continued)

Frequency range	RBW_{REF}
1 GHz < f ≤ 6 GHz	1 MHz
f is the measurement frequency fc is the operating frequency m is 10 x OC or 500 kHz, whichever is the greater n is 4 x OC or 100 kHz, whichever is the greater p is 2.5 x OC	

The measurement is performed setting the S2-LP without modulation, at its maximum operating power level (16 dBm) and considering 100 kHz of operating channel width.

The measurement is split as follows: *Figure 11* for frequencies below fc-2.5xOCW and *Figure 12* for frequencies from fc+2.5xOCW up to 6 GHz. In the two pictures the mask emission requested from the ETSI is reported also.

Figure 13 and *Figure 14* show the emissions radiated in the spurious domain in RX mode.

The unwanted emissions in the spurious domain of the S2-LP comply with ETSI [2] subclause 5.9.2.

Table 15. Spurious domain emission limits

Frequency	Reference limit TX mode [dBm]	Reference limit RX mode [dBm]
47 MHz to 74 MHz	-54	-57
87.5 MHz to 118 MHz		
174 MHz to 230 MHz		
470 MHz to 790 MHz		
Other frequencies below 1 GHz	-36	-57
Frequencies above 1 GHz	-0	-47

Figure 11. Unwanted spurious emissions from 9 KHz up to fc-2.5xOCW in TX mode with OCW=100 KHz - PMAX 16 dBm

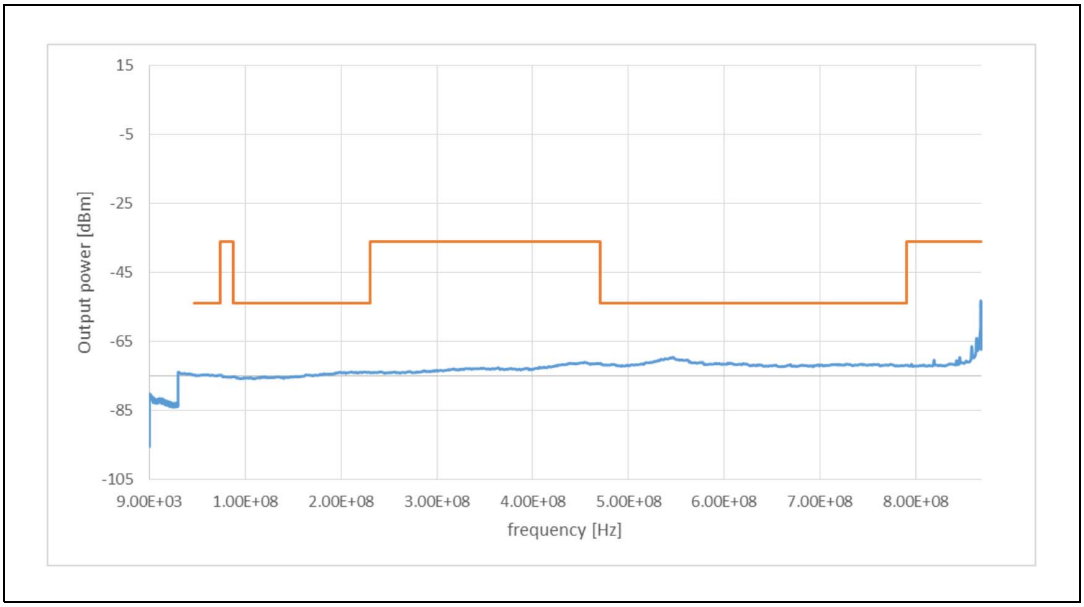


Figure 12. Unwanted spurious emissions from fc+2.5xOCW up to 6 GHz in TX mode OCW 100 KHz - PMAX 16 dBm

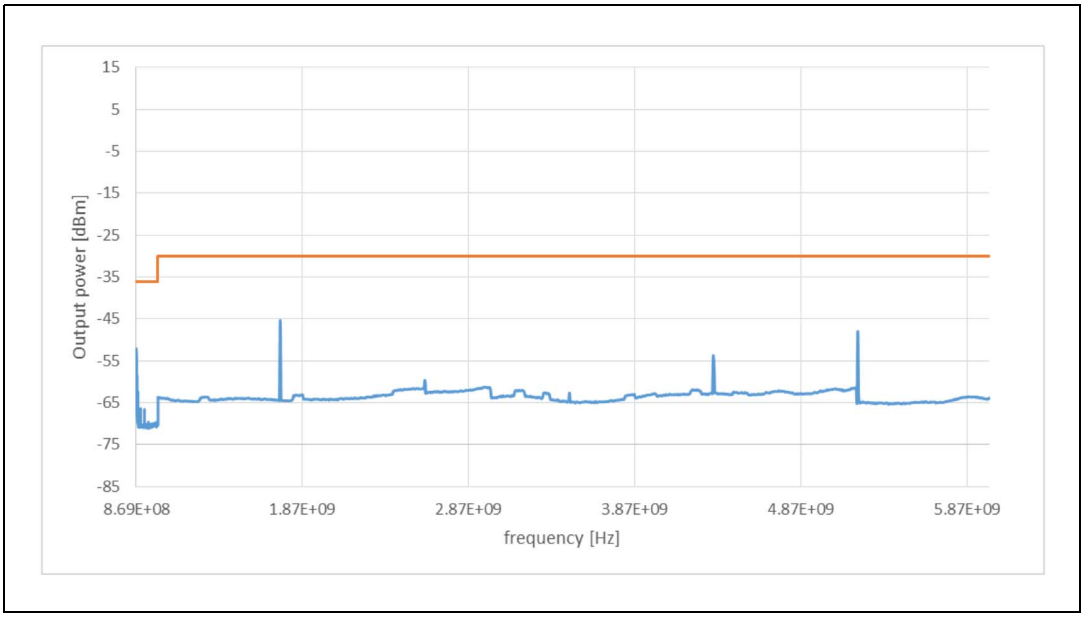


Figure 13. Unwanted emissions in the spurious domain from 9 KHz up to fc-2.5xOCW in RX mode

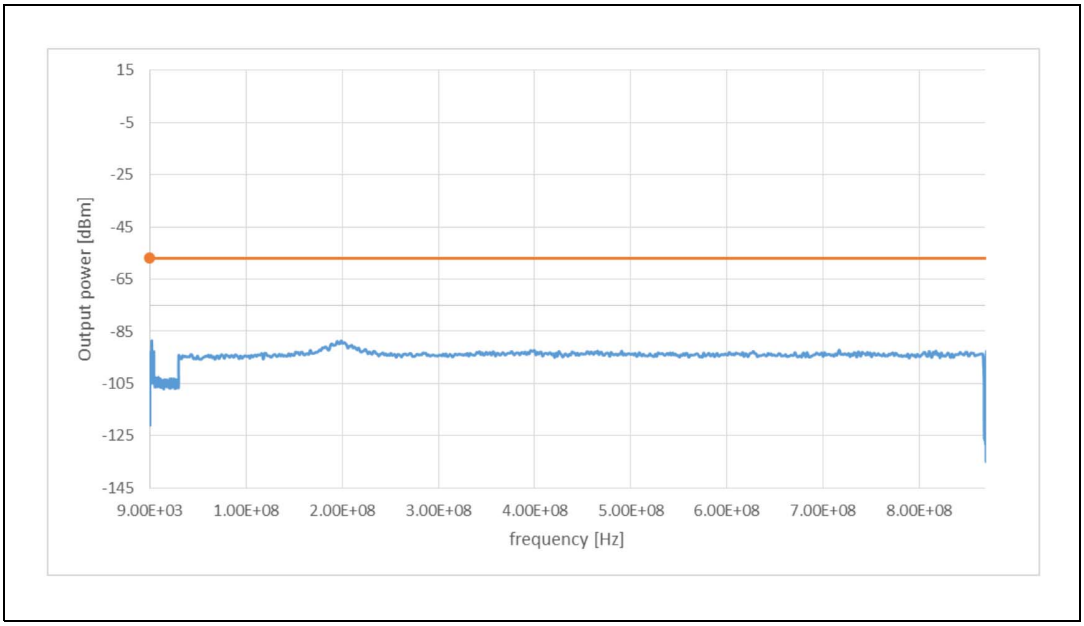
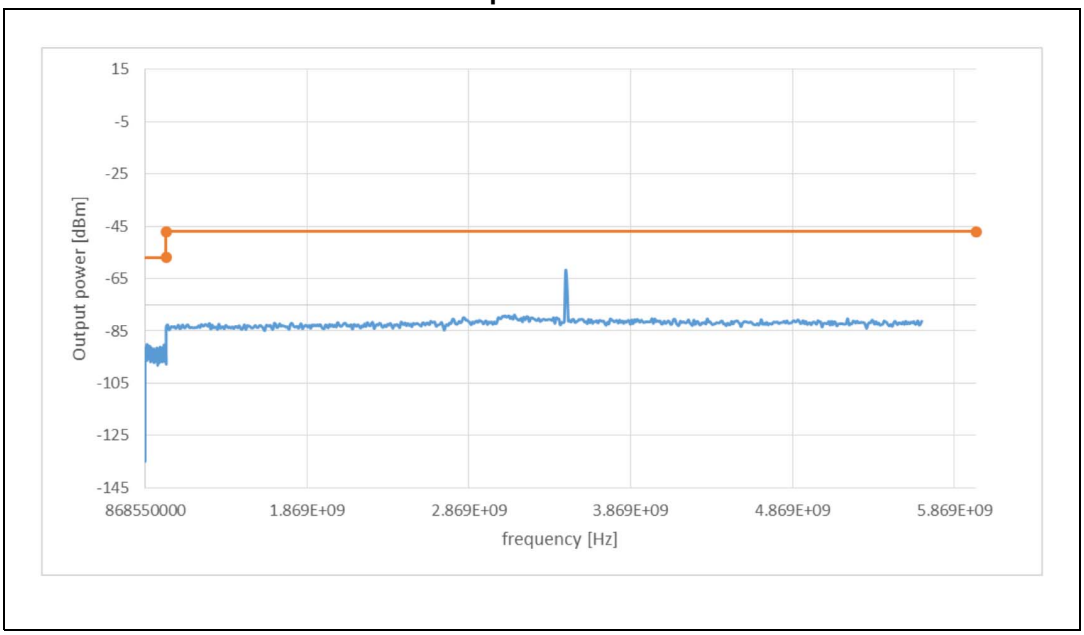


Figure 14. Unwanted emissions in the spurious domain from fc+2.5xOCW up to 9 GHz in RX mode



4.5 Transient power

Transient power is power falling into frequencies other than the operating channel due the turning on/off of the transmitter during normal operation.

The transient power shall not exceed the values given in *Table 16: Transmitter transient power limits*.

Table 16. Transmitter transient power limits

Absolute offset from center frequency	RBWREF	Peak power limit applicable at measurement points
≤ 400 kHz	1 kHz	0 dBm
> 400 kHz	1 kHz	-27 dBm

This test has been performed using a PN9 signal as representative signal of normal operation. This base band signal has been modulated using a 2GFSK modulation with 9.6 ksps of sample rate, 2.4 kHz of frequency deviation, 868.3 MHz of operating center frequency with an OCW equal to 25 kHz.

The analyzer settings used for the measurements are listed in *Table 18*.

The analyzer's center frequency has been set at different offset values from the operating center frequency. Offset values and their corresponding RBW are listed in *Table 17*.

Table 17. t_{RBW} for transient power measurement

Offset from center frequency	Analyzer RBW	RBWREF
-0.5 x OCW - 3 kHz	1 KHz	1 kHz
0.5 x OCW + 3 kHz	1 KHz	1 kHz
Not applicable for OCW < 25 kHz	1 KHz	1 kHz
±max (12.5 kHz, OCW)	Max (RBW pattern 1,3,10) ≤ Offset frequency/6	1 kHz
-0.5 x OCW - 400 kHz	100 kHz	1 kHz
0,5 x OCW + 400 kHz	100 kHz	1 kHz
-0.5 x OCW -1 200 kHz	300 kHz	1 kHz
0.5 x OCW + 1 200 kHz	300 kHz	1 kHz

More than five test signal have been transmitted and peak value recorded for each offset frequency mentioned in *Table 19: Offset and resolution bandwidth for transient power measurement*.

Table 18. Spectrum analyzer parameters for transient power measurement

Spectrum analyzer settings	Setting value	Notes
VBW/RBW	10	At higher RBW values VBW may be clipped to its maximum value
Sweep time	500 ms	
Span	0	
Filter	Gaussian(1)	
Trace detector function	RMS	
Trace mode	Max hold	
Sweep points	501	
Measurement mode	Continuous sweep	

1. Rectangular filter used.

Table 19. Offset and resolution bandwidth for transient power measurement

Offset from center frequency for OCW = 25 KHz	Frequency	Analyzer RBW	RBWREF
-15500	868.2845	1 KHz	1 kHz
15500	868.3155	1 KHz	1 kHz
-25000	868.325	3 kHz	1 kHz
25000	868.275	3 kHz	1 kHz
-412500	867.8875	100 kHz	1 kHz
412500	868.7125	100 kHz	1 kHz
-1212500	867.0875	300 kHz	1 kHz
1212500	869.5125	300 kHz	1 kHz

The recorded power values have been converted to power values measured in RBWREF by the following formula:

Equation 1

$$B = A + 10\log\left(\frac{RBW_{REF}}{RWB_{MEASURED}}\right)$$

Where: A is the measured power measured with $RWB_{measured}$ bandwidth.

Figure 15. Transient power at Offset = 0.5xOCW + 3 kHz

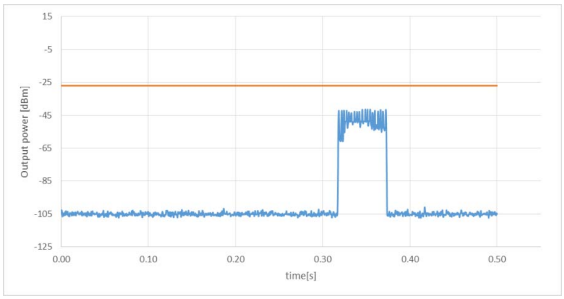


Figure 16. Transient power at Offset = 0.5xOCW + 3 kHz

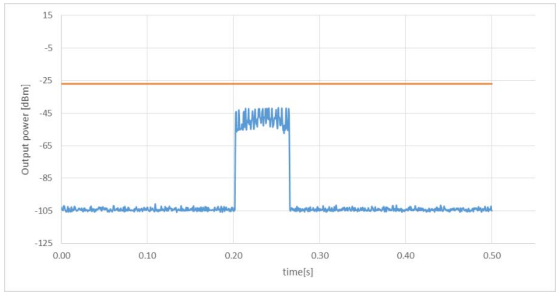


Figure 17. Transient power at Offset = -OCW = -25 KHz

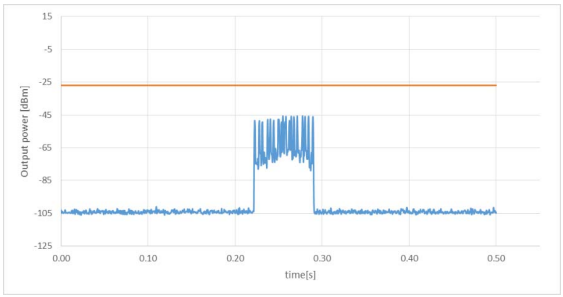


Figure 18. Transient power at Offset = OCW = 25 KHz

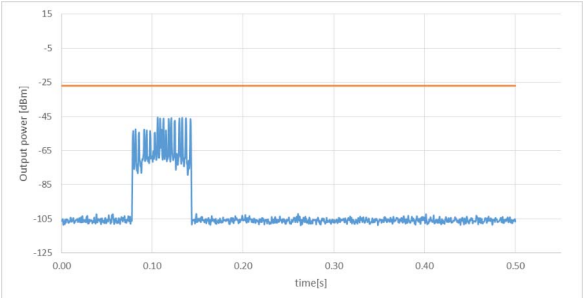


Figure 19. Transient power at Offset = -OCW/2 - 400 kHz

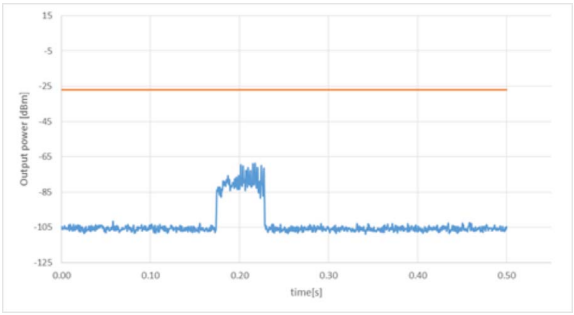


Figure 20. Transient power at Offset = OCW/2 + 400 kHz

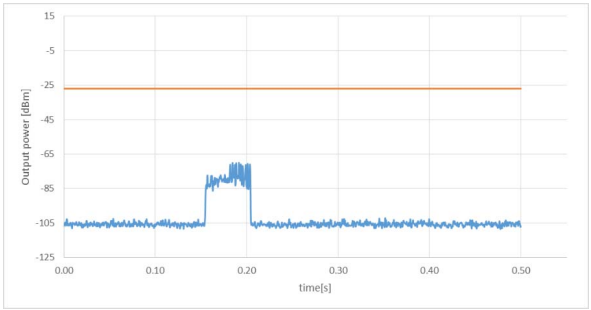


Figure 21. Transient power at Offset = -OCW/2 - 1.2 MHz

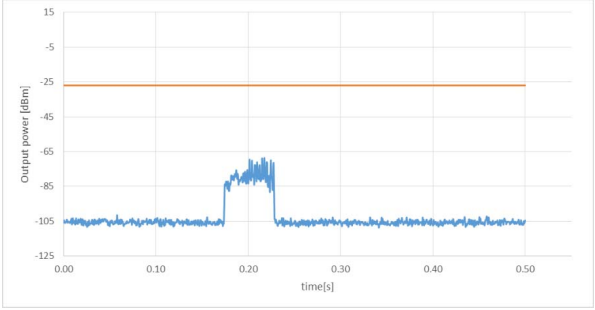
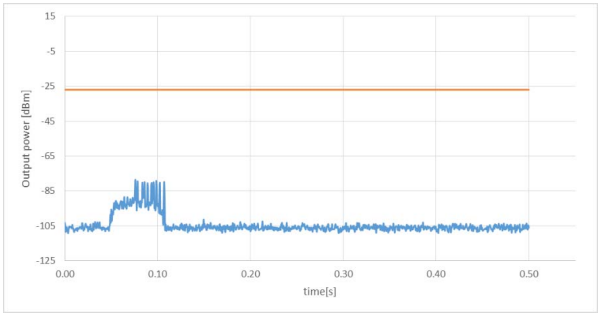


Figure 22. Transient power at Offset = OCW/2 + 1.2 MHz



5 Receiver measurement

- RX sensitivity level
- Blocking

The short range radio devices are divided into three receiver categories, each having a set of relevant receiver requirements and minimum performance criteria. The set of receiver requirements depends on the choice of receiver category. The test results show S2-LP meets the requirement for category 1.5. Category 1.5 is an improved performance level of receiver category 2.

5.1 Receiver sensitivity

The receiver sensitivity is the minimum power level of the signal at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal modulation, which produces the general performance criterion stated in clause 4.1 of ETSI EN 300 220-1 V3 and reported below:

- after demodulation, a raw data signal with a BER of 10-3 without correction;
- after demodulation, a message success ratio equivalent to above BER;
- (1-p)n where p is the probability of single bit error (10-3) and n the number of bits;

The sensitivity for receivers shall be below:

Equation 2

$$Sp[dBm] = 10\log RB_{kHz} - 117dBm$$

where:

- Sp is the sensitivity in dBm
- RB is the declared receiver bandwidth in kHz

The receiver sensitivity is measured without Forward Error Correction (FEC) or Automatic Repeat request (ARQ) function disabled.

The measurement is performed using an RF signal source generator centered at the same receiver frequency as the wanted modulation signal. The demodulated data and clock are taken from the S2-LP receiver and sent to the same generator to do the BER measurement. The generator signal level is reduced until the BER of 0.1% is obtained.

Figure 23: Sensitivity vs. data rate with 0.1% BER shows the ETSI 0.1% BER sensitivity limit (red line) and the S2-LP sensitivity for different data rate. *Table 20* lists the cases investigated, all with modulation index equal to 1.

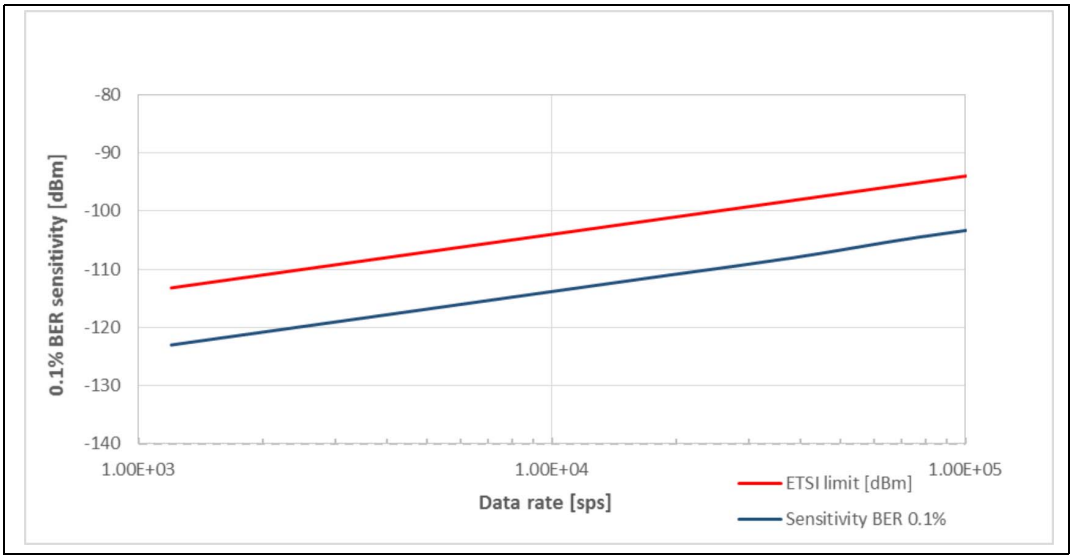
Table 20. Sensitivity test results

Modulation	Data rate [sps]	Deviation [Hz]	BW [kHz]	Sensitivity 0.1% [dBm]
2GFSK05	1.20E+03	600	2.40E+00	-123
2GFSK05	2.40E+03	1200	4.80E+00	-120

Table 20. Sensitivity test results (continued)

Modulation	Data rate [sps]	Deviation [Hz]	BW [kHz]	Sensitivity 0.1% [dBm]
2GFSK05	4.80E+03	2400	9.60E+00	-117
2GFSK05	9.60E+03	4800	1.92E+01	-114
2GFSK05	1.92E+04	9600	3.84E+01	-111
2GFSK05	3.84E+04	19200	7.68E+01	-108
2GFSK05	7.68E+04	38400	1.54E+02	-104.5
2GFSK05	1.54E+05	76800	3.07E+02	-101.5

Figure 23. Sensitivity vs. data rate with 0.1% BER



5.2 Blocking

Blocking is a measurement of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequency other than those of the spurious responses or the adjacent channels or bands.

All the blocking results are measured by setting the power of the wanted input signal at 3 dB above the measured sensitivity limit. A second generator, with an unmodulated signal, is used as the interferer and combined with the primary signal using a power combiner such as Mini-Circuits ZFSC-2-4-S+. The interferer signal is placed at the desired frequency offset and the power is increased until the BER of 0.1% is obtained.

ETSI specifies the blocking limits in absolute values at three points: ±2, ±10 MHz and ±Max (5% of fc, 15 MHz).

The limit for Class 1.5 receivers are: –43 dBm at ±2 MHz, –33 dBm at ±10 MHz and -33 dBm at 5% of the center frequency (43.4 MHz) or 15 MHz (whichever is greater).

5.2.1 12.5 kHz channel spacing

- Modulation 2GFSK05
- Data rate 1.2 ksps frequency deviation 1.2 kHz
- Filter BW 4 kHz
- Sensitivity 0.1% = -120.5 dBm

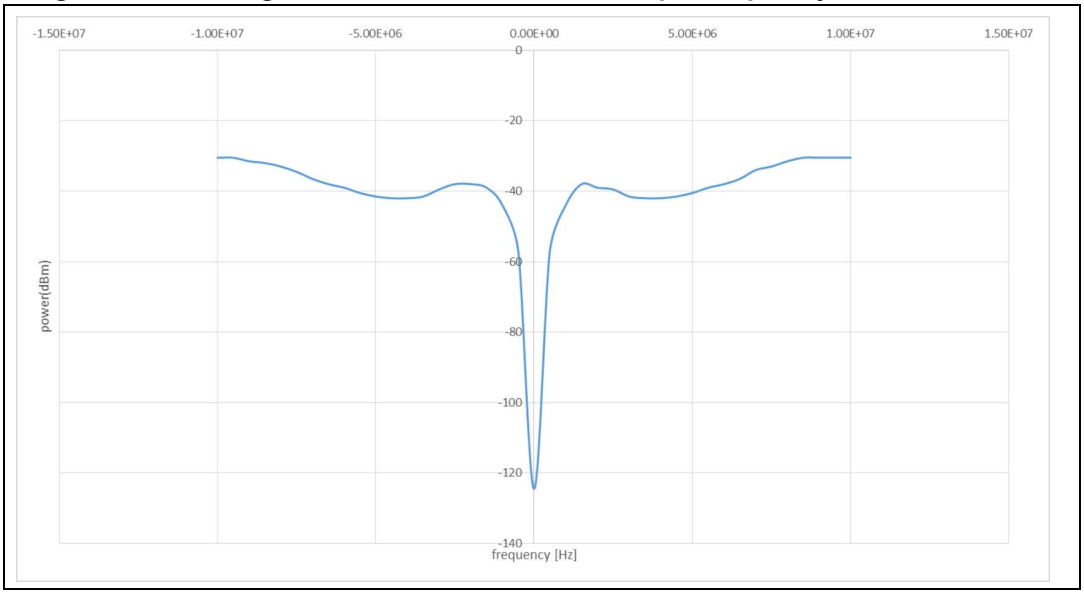
This test has been performed with a wanted modulated signal with 2GFSK05 modulation with 1.2 kbps data rate and 1.2 kHz deviation.

The primary generator is set to –117.5 dBm, which is 3 dB above the ETSI RX sensitivity limit measured with a RX bandwidth at 4 kHz.

Table 21. Blocking test results for 4 kHz channel filter

2GFSK05, frequency deviation 1.2 kHz, data rate 1.2 ksps, Filter BW 4 kHz	Category 3 [dBm]	Category 2 [dBm]	Category 1. 5 [dBm]	S2-LP results [dBm]
Blocking at -2 MHz from OC edge	≥ -80	≥ -69	≥ -43	-38
Blocking at 2 MHz from OC edge	≥ -80	≥ -69	≥ -43	-38
Blocking at-10 MHz from OC edge	≥ -60	≥ -44	≥ -33	-30.5
Blocking at 10 MHz from OC edge	≥ -60	≥ -44	≥ -33	-29.5
Blocking at -5% of Center Frequency (43.4MHz) or 15 MHz, whichever is greater	≥ -60	≥ -44	≥ -33	-24
Blocking at 5% of Center Frequency (43.4MHz) or 15 MHz, whichever is greater	≥ -60	≥ -44	≥ -33	-23

Figure 24. Blocking: fc 868.3 MHz, data rate 1.2 ksps, frequency deviation 1.2 kHz



5.2.2 100 kHz channel spacing

- Modulation 2GFSK05
- Data rate 38.4 ksps frequency deviation 20 kHz
- Filter BW 100 kHz
- Sensitivity 0.1% = -107 dBm

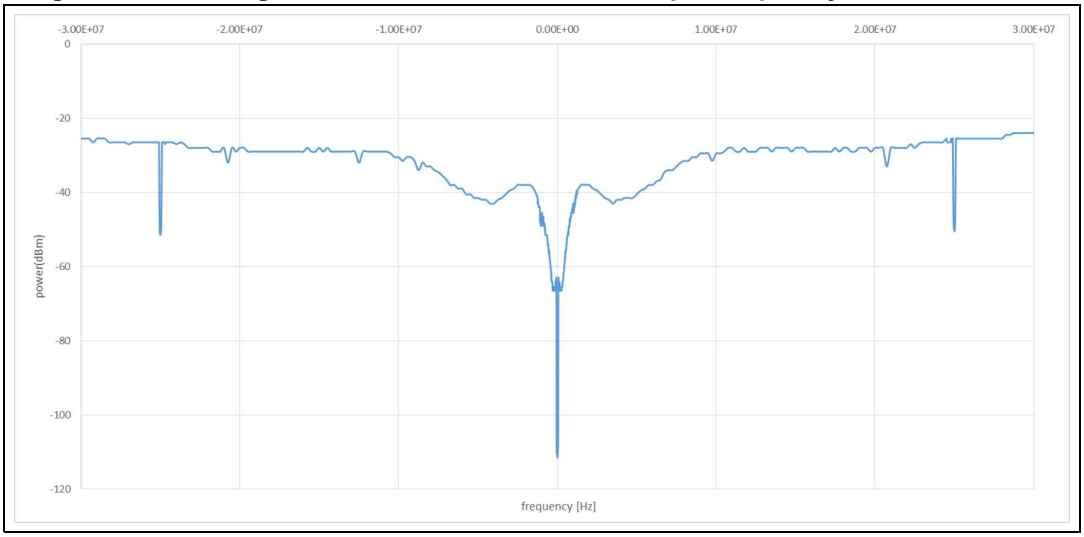
The primary generator provides a modulated signal obtained modulating PN9 signal with a 2GFSK05 modulation, at 38.4 kbps data rate and 20 kHz of deviation. The amplitude of this wanted signal is set to –114 dBm, which is 3 dB above the ETSI RX sensitivity limit measured with a RX bandwidth equal to 100 kHz.

Table 22. Blocking test results for 100 kHz channel filter

2GFSK05 frequency deviation 20 kHz, data rate 38.4 kHz, Filter BW 100 kHz	Category 3 [dBm]	Category 2 [dBm]	Category 1. 5 [dBm]	S2-LP results [dBm]
Blocking at -2 MHz from OC edge	≥ -80	≥ -69	≥ -43	-39
Blocking at 2 MHz from OC edge	≥ -80	≥ -69	≥ -43	-39
Blocking at -10 MHz from OC edge	≥ -60	≥ -44	≥ -33	-30.5
Blocking at 10 MHz from OC edge	≥ -60	≥ -44	≥ -33	-29.5
Blocking at -5% of center frequency (43.4MHz) or 15 MHz, whichever is greater	≥ -60	≥ -44	≥ -33	-24
Blocking at 5% of centre frequency (43.4MHz) or 15 MHz, whichever is greater	≥ -60	≥ -44	≥ -33	-23

The S2-LP is fully compliant with the ETSI class 1.5 receiver blocking requirements.

Figure 25. Blocking: fc 868.3 MHz, data rate 38.4 ksps, frequency deviation 20 kHz



6 Measurement equipment

The following equipment was used for the measurements.

Table 23. Sensitivity test results

Measurement	Instrument type	Instrument model
RX	Signal generator	Agilent ESG E4438C Agilent ESG E4438C
TX	Signal analyzer	R&S FSIQ7

7 Reference

[1] S2-LP datasheet.

[2] ETSI EN 300 220-1 V3.1.0 (2016-05): “Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement”.

8 Revision history

Table 24. Document revision history

Date	Revision	Changes
13-Mar-2017	1	Initial release.