AN5931

Application note

Introduction to ETSI compliance test at 868 MHz SRD band for STM32WL33xx MCUs

Introduction

The STM32WL33xx devices are very-low power RF transceivers in the sub-1 GHz band. They operate in both the license-free ISM and SRD frequency bands.

The purpose of this application note is to provide the relevant test results for STM32WL33xx devices under ETSI EN 300 220-1 V3.1.1 (2017-02). All the measurements are performed in conducted mode, and according to the ETSI standard. All tests are performed by using an Nucleo-WL33CC1 application kit and the STM32WL33xx DK graphical user interface.

For more details on the regulatory limits in the SRD frequency bands, refer to the dedicated documentation [2].

1 General information

This document applies to the STM32WL3 single-core Arm®-based microprocessors.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

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Table 1. Reference documents

Reference	Title
[1]	STM32WL33xx datasheet
[2]	ETSI EN 300 220-1 V3.1.1 (2017-02): *Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement*.
[3]	ETSI EN 300 220-2 V3.2.1 (2018-06): *Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 2: Harmonised Standard for access to radio spectrum for non-specific radio equipment*

Table 2. List of acronyms and abbreviations

Term	Meaning
ACP	Adjacent channel power
BER	Bit error rate
BW	Bandwidth
CF	Carrier frequency
DUT	Device under test
ERP	Effective radiated power
ETSI	European telecommunications standards institute
OCW	Operating channel width
OoB	Out-of-band domain
PERP	Peak effective radiated power
RF	Radio frequency
RBW	Resolution bandwidth
RBW_{REF}	Reference bandwidth

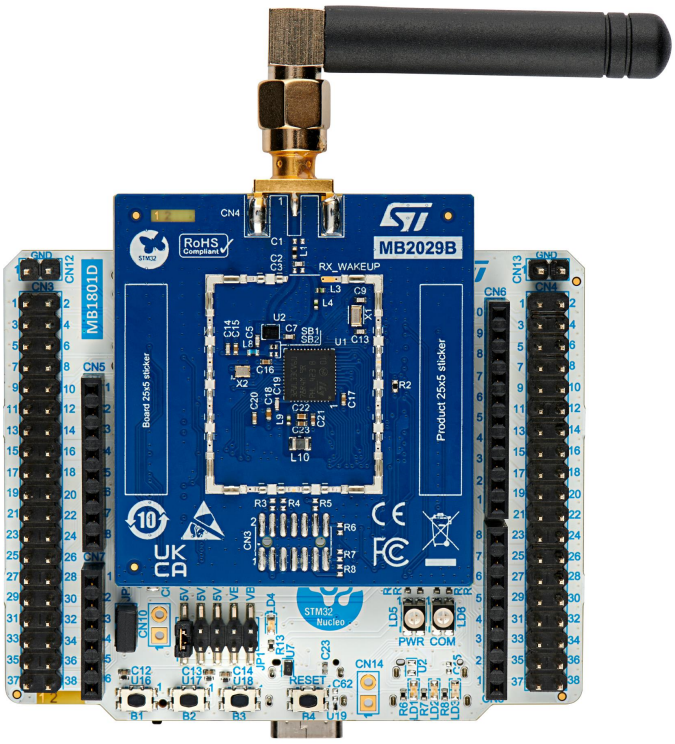
2 STM32WL33xx RF evaluation board

The Nucleo-WL33CC1 application board is tuned to work in the 826-958 MHz band.
The following features are available in the Nucleo-WL33CC1 application board:

- STM32WL33xx
- High frequency 48 MHz crystal
- Low-speed frequency crystal 32.768 kHz
- Matching network and harmonic filter
- ARDUINO® compliant connectors
- SMA connector

Figure 1 shows the STM32WL33xx application board.

Figure 1. Nucleo-WL33CC1 application board



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3 Measurements to comply with ETSI recommendations

Various RF parameters, described in the reference document , are tested to check the STM32WL33xx performance.

For the transmission mode, the following parameters are checked:

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

For the reception mode, the requirement for an ETSI class 1.5 receiver is 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.

The compliance with each of the above ETSI measurement points is summarized in Table 3.

Table 3. ETSI measurements

Parameter	Specification number: EN 300220-01 V3.1.1 (2017-02)
Effective radiated power measurement conducted	subclause 5.2.2.1
Adjacent channel power	subclause 5.11
Tx out-of-band emissions	subclause 5.8
Unwanted emissions in the spurious domain	subclause 5.9
Transient power	subclause 5.10
Rx sensitivity level	subclause 5.14
Blocking	subclause 5.18

4 Transmitter measurements

All the measurements are made with the following parameters: case temperature (T_C) = 25°C, V_{DD} = 3.3 V, and carrier frequency (CF) = 868 MHz.

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

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

4.1 Effective radiated power

This method applies only to the device under test with a permanent external antenna connector.

The STM32WL33xx is switched on in transmission mode, with an unmodulated carrier at the highest power level (16 dBm).

The spectrum analyzer is tuned to the carrier frequency (868 MHz) with a resolution bandwidth (RBW) wide enough to cover the complete power envelope of the transmitted signal.

The peak effective radiated power applies to the maximum measured conducted power (Pconducted) value adjusted by the antenna gain.

$$Perp = Pconducted + Antenna\ gain$$

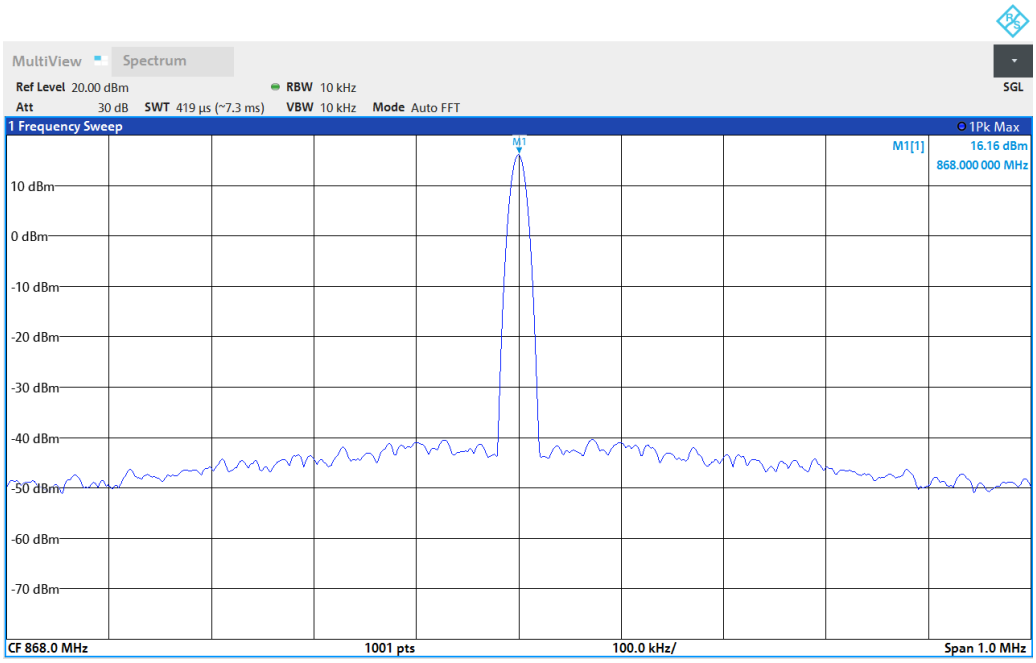
Note: The antenna gain is relative to a dipole.

Table 4 displays information recorded in the test report.

Table 4. Effective radiated power

Value	Notes
Test environment	Unmodulated carrier
Carrier frequency	868 MHz
Measured conducted power	16.1 dBm

Figure 2. **Effective power conducted measurement**



4.2 Adjacent channel power

Adjacent channel power (ACP) is defined as the amount of RF power that falls into the adjacent channel. ACP measurements are applicable only to narrow band systems.

The adjacent and alternate channels are defined in Table 5. The same table reports the integration bandwidth, which is equal to 70% of the OCW.

This test measures the power transmitted in the adjacent channel with the device under test (DUT), which transmits continuously a modulated signal.

Table 5. **Offset and RBW_{REF} parameters**

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

Where the operating channel width is less than or equal to 25 kHz, the reference limits of the power in the adjacent channels are reported in Table 6.

Table 6. **Adjacent channel power limits, transmitter OCW ≤ 25 kHz**

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

A conducted measurement procedure has been performed. It connects the Nucleo-WL33CC1 application board to the spectrum analyzer and configures the STM32WL33xx in continuous transmission mode.

The ACP function of a spectrum analyzer is used, integrating the power over an RBW_{REF} bandwidth centered to an offset from the center frequency as specified in Table 5.

Table 7 shows that the spectrum analyzer configuration conforms to the requirements given in the document .

Table 7. Spectrum analyzer settings for ACP measurement

Spectrum analyzer setting	Value
Operating frequency	8.68E+08
Span	At least 5 x operating channel width
RBW	100 Hz
VBW	≥ 3 x RBW
Detector function	RMS
Trace mode	Linear averaging

4.2.1 ACP measurements with OCW = 25 kHz

The modulated signal used for this test is a 2GFSK05 with 9.6 kbps sample rate, and 2.4 kHz of frequency deviation. The ACP is measured with a spectrum analyzer that conforms to the requirements given in the document Section . It is summarized in Table 8.

Table 8. Spectrum analyzer settings for 25 kHz channel spacing

Settings	Values
Carrier frequency	868.002 MHz
RBW	100 Hz
VBW	300 Hz
Span	125 kHz
Detector mode	RMS
Trace mode	Linear averaging

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

The test results show that the ACP is 12.58 dB lower than the ETSI limit (-37 dBm). For the alternate channel, the integrated power is 10.98 dB lower than the ETSI limit (-40 dBm). It illustrates the measured adjacent and alternate powers.

Table 9. ACP 25 kHz OCW test results

2GFSK05 with 9.6 kbps and 2.4 kHz deviation

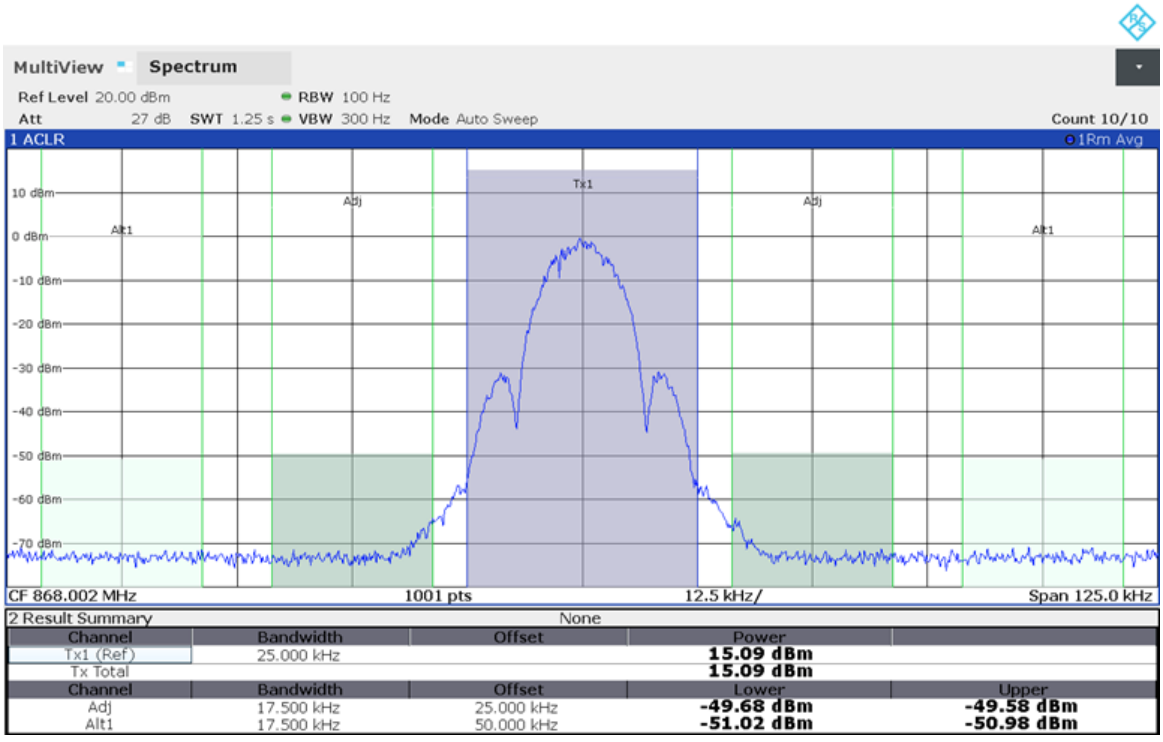
OCW	Test condition	Adjacent channel (1)		ETSI limit for alternate adjacent channel (2)	
12.5 kHz	Normal	ETSI limit	STM32WL33xx	ETSI limit	STM32WL33xx
		-37 dBm	-49.58 dBm	-40 dBm	-50.98 dBm

1. *Power integrated over 0.7 x OCW*
2. *Power integrated over 0.7 x OCW*

Figure 3 illustrates the measured adjacent and alternate powers.

Figure 3. Adjacent and alternate power measurements

25 kHz Channel spacing, 9.6 kbps, 2.4 kHz deviation



4.2.2 ACP measurements with OCW = 12.5 kHz

Two different RF modulated signals are considered:

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

Table 10 summarizes the spectrum analyzer settings.

Table 10. Spectrum analyzer settings for 12.5 kHz channel spacing

Setting	Value
Carrier frequency	868.002 MHz
RBW	100 Hz
VBW	300 Hz
Span	62.5 kHz
Detector mode	RMS
Trace mode	Linear averaging

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

Table 11. ACP 12.5 kHz OCW test results

2GFSK05 with 2.4 kbps and 2.4 kHz deviation

OCW	Test condition	Adjacent channel (1)		ETSI limit for alternate adjacent channel (2)	
< 20 kHz	Normal	ETSI limit	STM32WL33xx	ETSI limit	STM32WL33xx
		-20 dBm	-41.10 dBm	-20 dBm	-41.33 dBm

1. *Power integrated over 0.7 x OCW*
2. *Power integrated over 0.7 x OCW*

Table 12. ACP 12.5 kHz OCW test results

2GFSK05 with 4.8 kbps and 2.4 kHz deviation

12 OCW	Test condition	Adjacent channel (1)		ETSI limit for alternate adjacent channel (2)	
< 20 kHz	Normal	ETSI limit	STM32WL33xx	ETSI limit	STM32WL33xx
		-20 dBm	-41.13 dBm	-20 dBm	-54.26 dBm

1. *Power integrated over 0.7 x OCW*
2. *Power integrated over 0.7 x OCW*

The STM32WL33xx is fully compliant with the requirements of the ETSI transmitter adjacent-channel power with margin.

Figure 4 and Figure 5 show the measured ACP for the two RF-modulated signals.

Figure 4. Adjacent power measurement (2.4 kbps)

12.5 kHz Channel spacing, 2.4 kbps, 2.4 kHz deviation

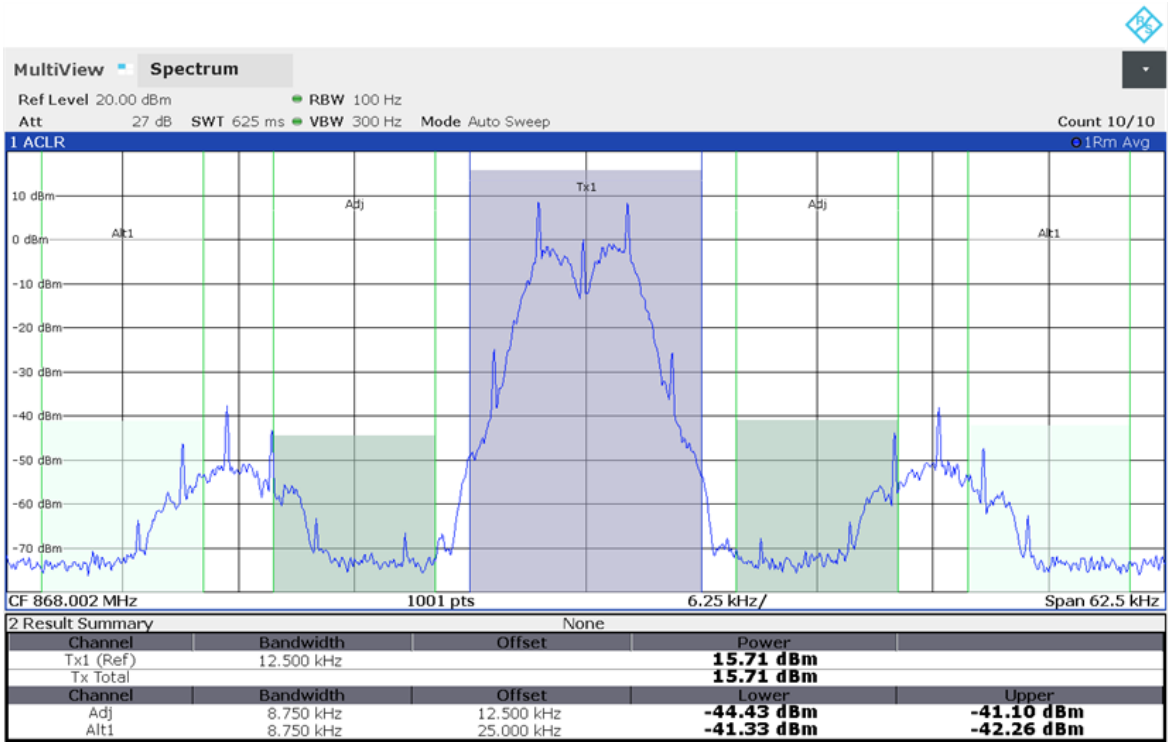
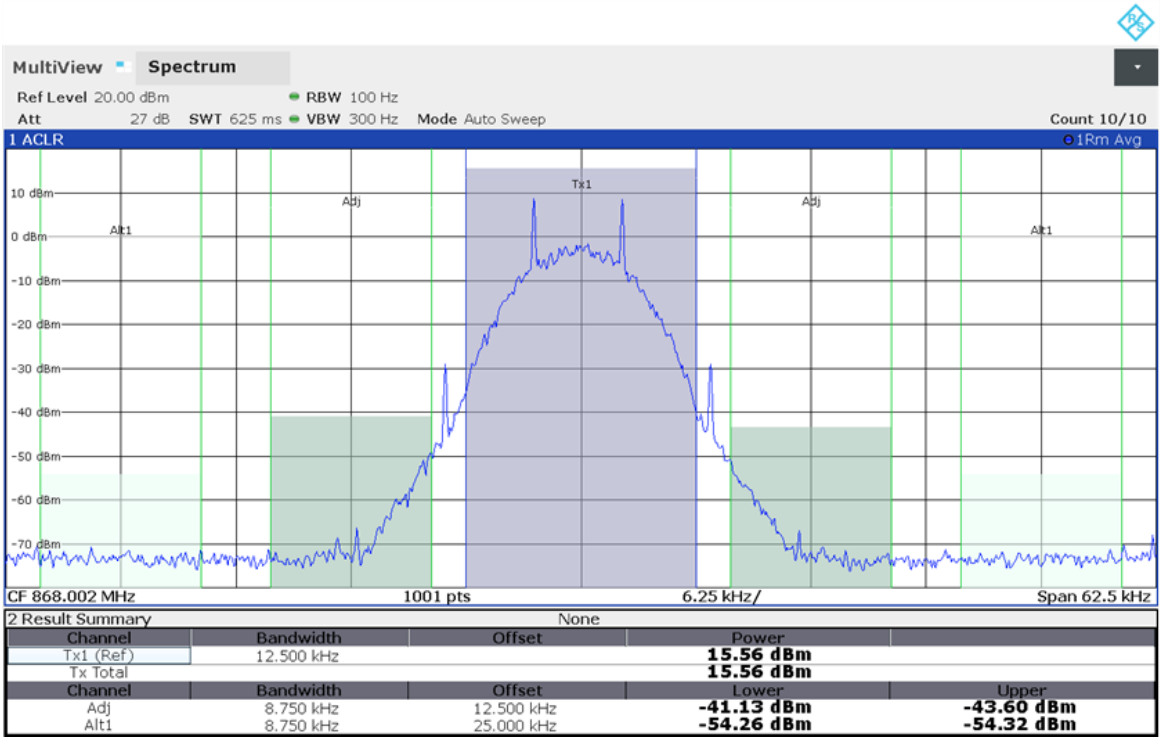


Figure 5. Adjacent power measurement (4.8 kbps)

12.5 kHz Channel spacing, 4.8 kbps, 2.4 kHz deviation



4.3 Tx out-of-band emissions

The ETSI definition for the 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 operational frequency band is defined as an entry in the frequency allocation table. It targets short-range devices performing the intended function of the equipment, operating within two frequency edge values defined as: Flow_OFB and Fhigh_OFB.

For instance:

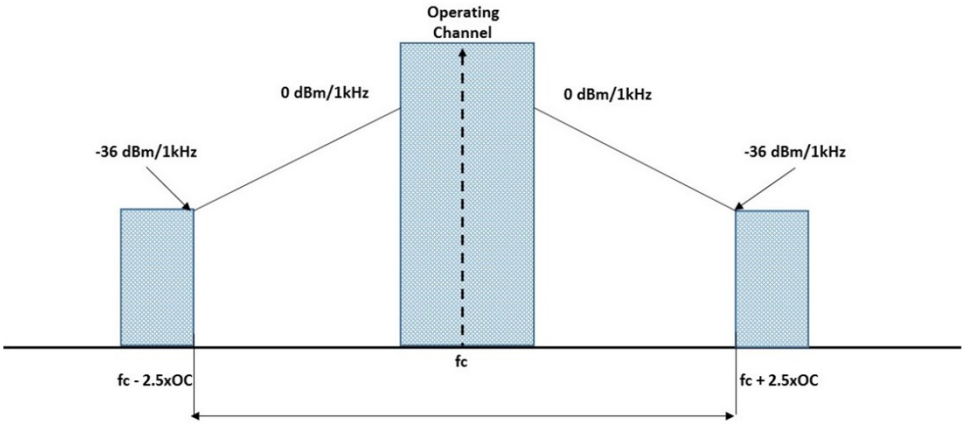
Flow_OFB = 868.000 MHz

Fhigh_OFB = 868.600 MHz

*Note: For more information, consult Table B.1 (operational frequency band **M**): EU-wide harmonized national radio interfaces from 25 MHz to 1 000 MHz (annex B) in the referenced document [3].*

The out-of-band domain is shown in Figure 6, and applies within the operational frequency band.

Figure 6. OoB domain for operating channel with reference BW



Tx out-of-band emissions apply to all transmitters with OCW > 25 kHz.

The OCW (Operating channel width) is defined as the bandwidth between two frequencies Flow and Fhigh declared by the manufacturer as an operating channel (Reference [2] Chapter 3.1 "Definitions"). The OCW includes XTAL tolerances and drift.

Indeed, in the following measurements (Figure 7 and Figure 8) the OCW is greater than the Carson rule. In the out-of-band domain, the power level must be below the spectrum masks given in Table 13.

Table 13. Emission limits in the OoB domains

Domain	Value	RBWREF	Max power limit
OoB limits applicable to operating Channel (1)	f = CF - 2.5 x OCW	1 kHz	-36 dBm
	CF - 2.5 x OCW ≤ f ≤ CF – 0.5 x OCW	1 kHz	-(1)
	f = CF - 0.5 x OCW	1 kHz	0 dBm
	f = CF + 0.5 x OCW	1 kHz	0 dBm
	CF + 0.5 x OCW ≤ f ≤ CF + 2.5 x OCW	1 kHz	-(1)
	f = CF + 2.5 x OCW	1 kHz	-36 dBm

1. See Figure 6.

Table 14 shows the spectrum analyzer parameters used for out-of-band for operating channel measurement.

Table 14. Test parameters for OoB for operating channel measurement

Spectrum analyzer setting	Value
Carrier frequency operating frequency	8.68E + 08 Hz
Span	6 x OCW
RBW	1 kHz
Detector function	RMS
Trace mode	Linear averaging

Figure 7 and Figure 8 show the spectral mask measures for the following two modulated signals:

- Carrier frequency (CF) = 868 MHz, sample rate = 9.6 ksps, deviation = 2.4 kHz, modulation 2GFSK with BT = 1
- Carrier frequency (CF) = 868 MHz, sample rate = 38.4 ksps, deviation = 20 kHz, modulation 2GFSK with BT = 1

Figure 7. Spectral mask measurement (9.6 ksps data rate)

OCW=25 kHz, 9.6 ksps data rate, 2.4 kHz frequency deviation

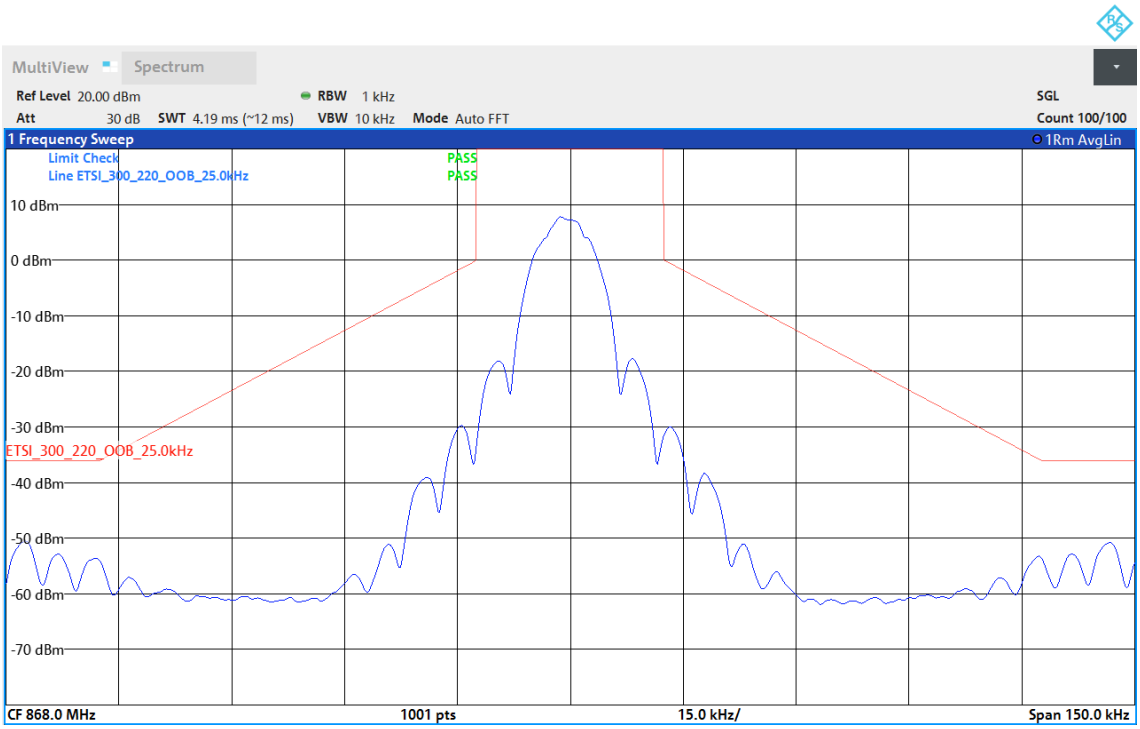
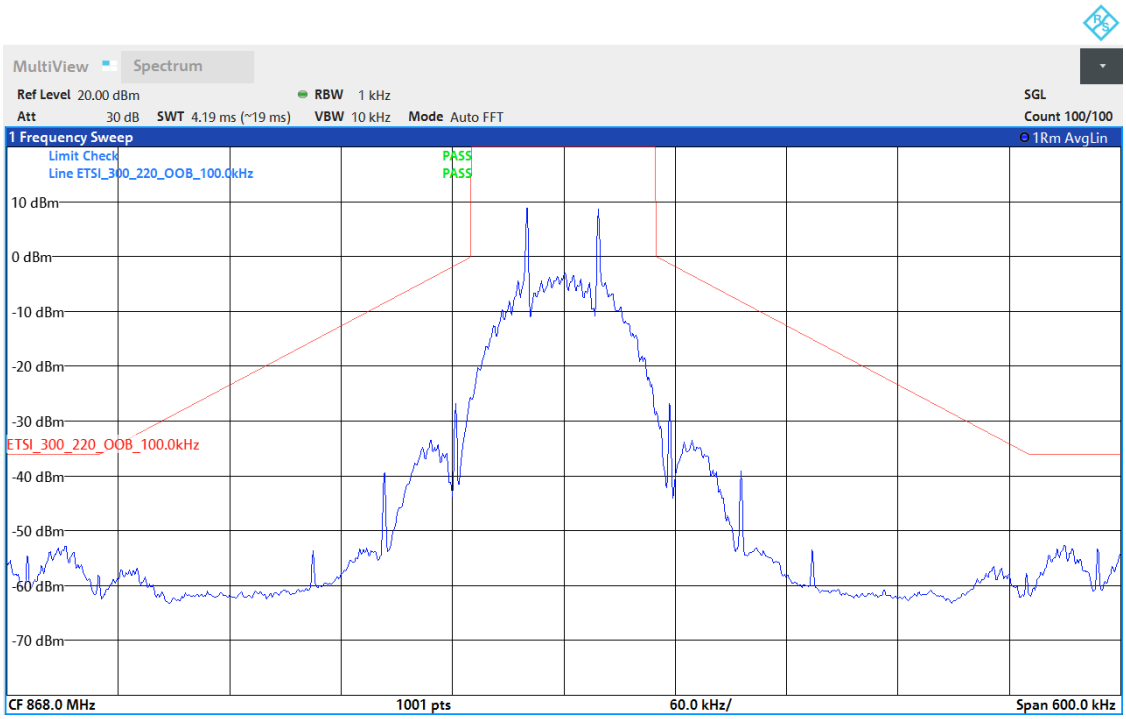


Figure 8. Spectral mask measurement (38.4 ksps data rate)

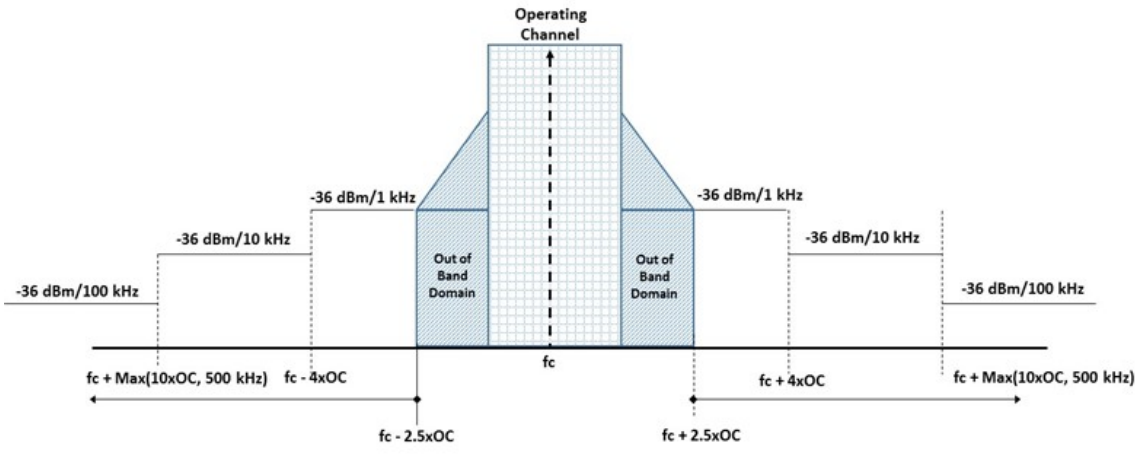
OCW=100 kHz, 38.4 kbps data rate, 20 kHz frequency deviation



4.4 Unwanted emissions in the spurious domain

The ETSI document defines spurious emission as: unwanted emissions in the spurious domain at frequencies other than those of the operating channel and its OoB domain. The spurious domain is shown in Figure 9.

Figure 9. Unwanted emission-spectrum mask - spurious domain, reference BW



For conducted measurement, the Nucleo-WL33CC1 application board is connected to the spectrum analyzer, which is used as an external receiver. In Tx mode, the frequency for conducted spurious radiation ranges from 9 kHz to 6 GHz as described in *subclause 5.9.3.3.1* of the referenced document .

The measurement is performed by applying different resolution bandwidths as shown in Table 15.

Table 15. Parameters for Tx spurious radiation measurement

Frequency range(1)	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
1 GHz < f ≤ 6 GHz	1 MHz

1.
- *f is the measurement frequency.*
- *fc is the operating frequency.*
- *m is 10 x OC or 500 kHz, whichever is greater.*
- *n is 4 x OC or 100 kHz, whichever is greater.*
- *p is 2.5 x OC.*

The measurement is performed using the STM32WL33xx without modulation, at its maximum operating power level and considering 100 kHz of operating channel width.

The measurement is split into two figures: Figure 10 for frequency below fc-2.5xOCW, and Figure 11 for frequency from fc+2.5xOCW up to 6 GHz. In the two figures, the mask emission requested from the ETSI is also reported.

Figure 10. Unwanted spurious emission, 9 kHz to fc-2.5xOCW

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Figure 11. **Unwanted spurious emission, fc+2.5xOCW to 6 GHz**

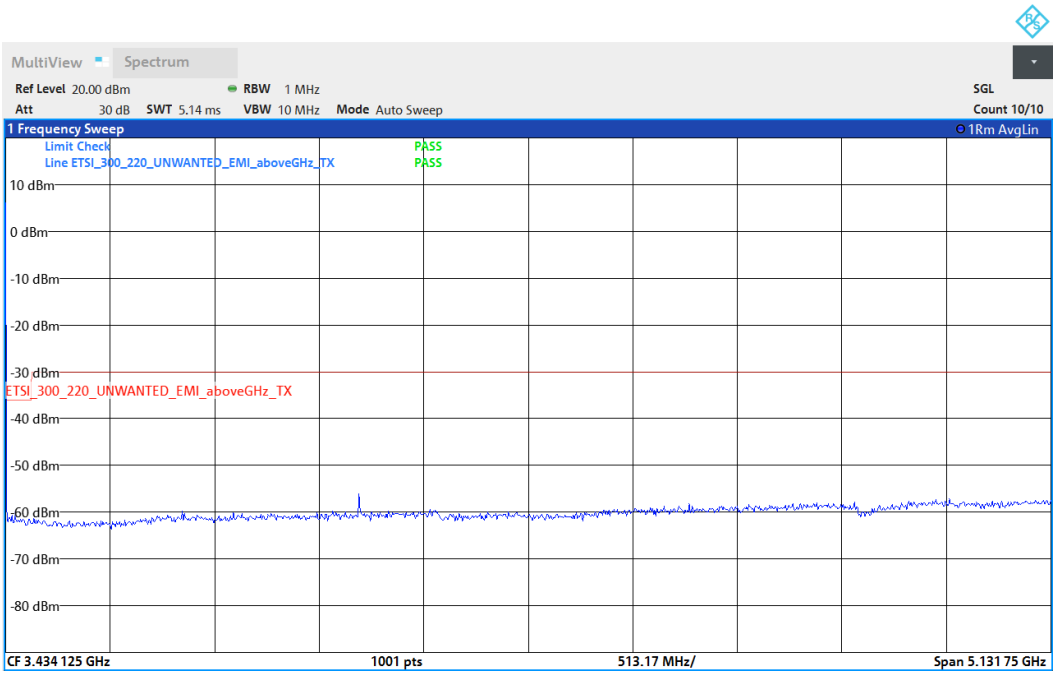

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Figure 12 and Figure 13 show the emissions radiated in the spurious domain in Rx mode.

Figure 12. **Unwanted emissions - spurious domain, 9 kHz to fc-2.5xOCW, Rx mode**

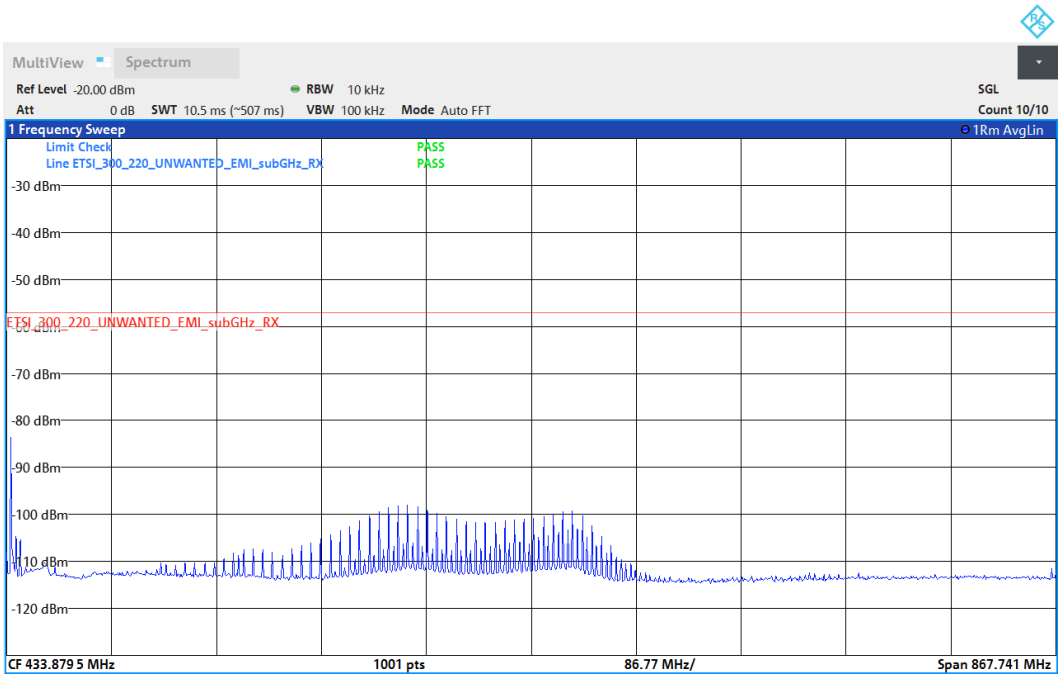

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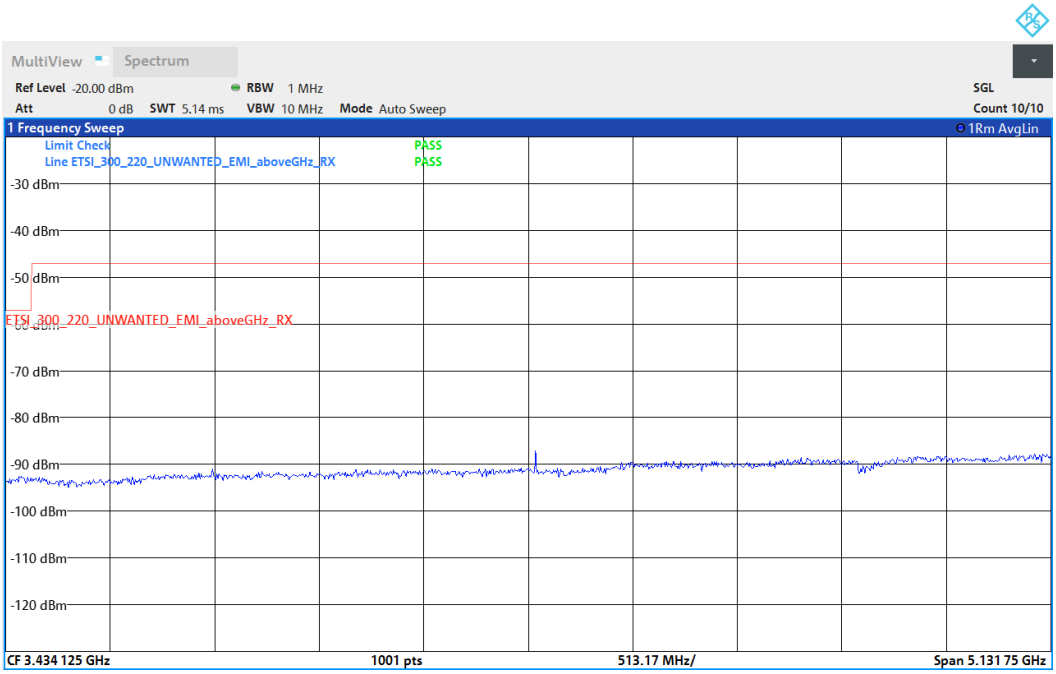
Figure 13. **Unwanted emissions - spurious domain, fc+2.5xOCW to 9 GHz, Rx mode**



The unwanted emissions in the spurious domain of the STM32WL33xx comply with ETSI subclause 5.9.2.

Table 16. **Spurious domain emission limits**

Frequency	Reference limit Tx mode	Reference limit Rx mode
47 MHz to 74 MHz	-54 dBm	-57 dBm
87.5 MHz to 118 MHz		
174 MHz to 230 MHz		
470 MHz to 790 MHz		
Other frequencies below 1 GHz	-36 dBm	-57 dBm
Frequencies above 1 GHz	-30 dBm	-47 dBm

4.5 Transient power

The transient power is the power falling into frequencies other than the operating channel. It is due to the turning on/off of the transmitter during normal operation. The transient power must not exceed the value given in Table 17.

Table 17. **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 is performed using a PN9 signal as a representative signal of normal operation. This baseband signal is modulated using: 2GFSK modulation with 9.6 ksps sample rate, 2.4 kHz of frequency deviation, and an 868 MHz operating center frequency.

For this test, an OCW of 25 kHz is chosen. The analyzer settings used for the measurement are listed in Table 18.

The measurement is done in zero span mode. The analyzer center frequency is set to different offset values from the operating center frequency. Offset values and their corresponding RBW are listed in Table 18.

Table 18. 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

In a sweep time of 500 ms, more than five test signals (D-M3) are transmitted. A peak value is recorded for each offset frequency mentioned in Table 19.

Table 19. Spectrum analyzer parameters for transient power measurement

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

1. *Rectangular filter used.*

Table 20. Offset and resolution bandwidth for transient power measurement

Offset[Hz] from carrier frequency for OCW = 25 kHz	Frequency	Analyzer RBW	RBW_{REF}
-15500	867.9845	1 kHz	1 kHz
15500	868.0155	1 kHz	1 kHz
-25000	867.975	3 kHz	1 kHz
25000	868.025	3 kHz	1 kHz
-412500	867.5875	100 kHz	1 kHz
412500	868.4125	100 kHz	1 kHz
-1212500	866.7875	300 kHz	1 kHz
1212500	869.2125	300 kHz	1 kHz

The recorded power values are converted to power values measured in RBW_{REF} by the formula below:

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

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

Figure 14. **Transient power offset -0.5xOCW-3kHz versus 0.5xOCW+3 kHz**

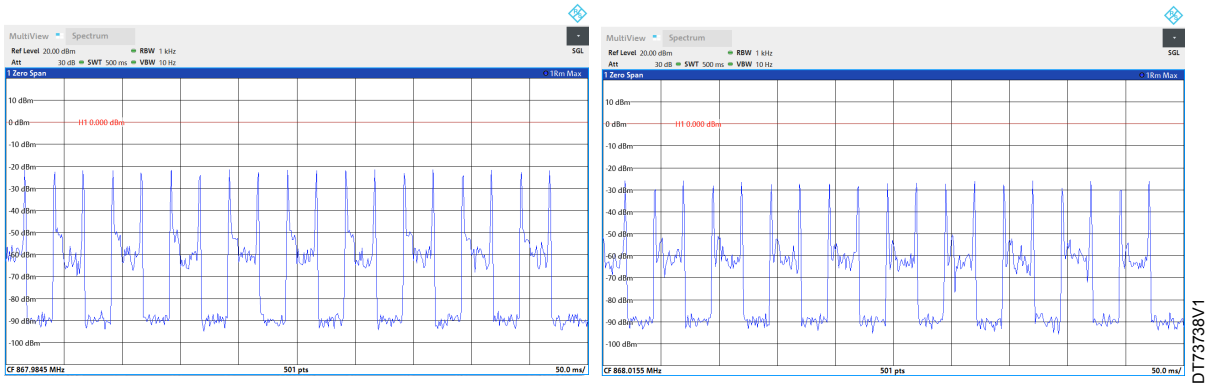


Figure 15. **Transient power offset -25 kHz versus 25 kHz**

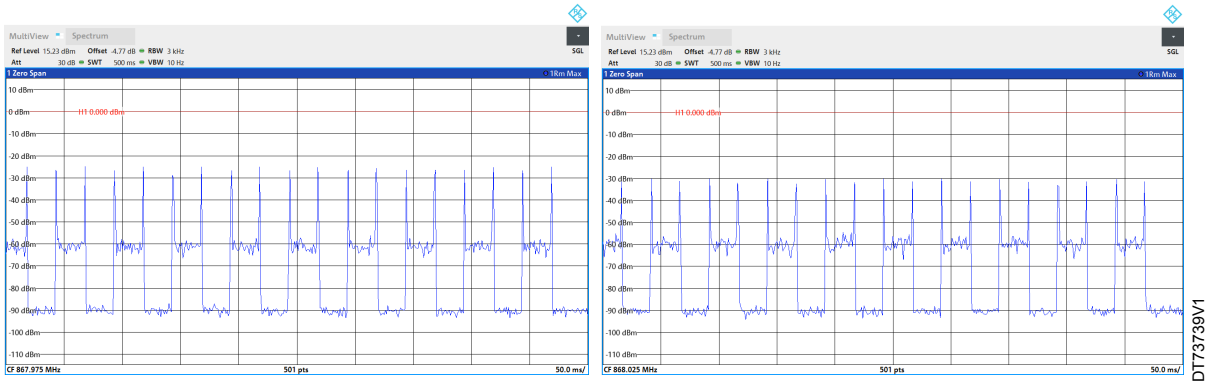


Figure 16. **Transient power offset -0.5xOCW-400kHz versus 0.5xOCW+400 kHz**

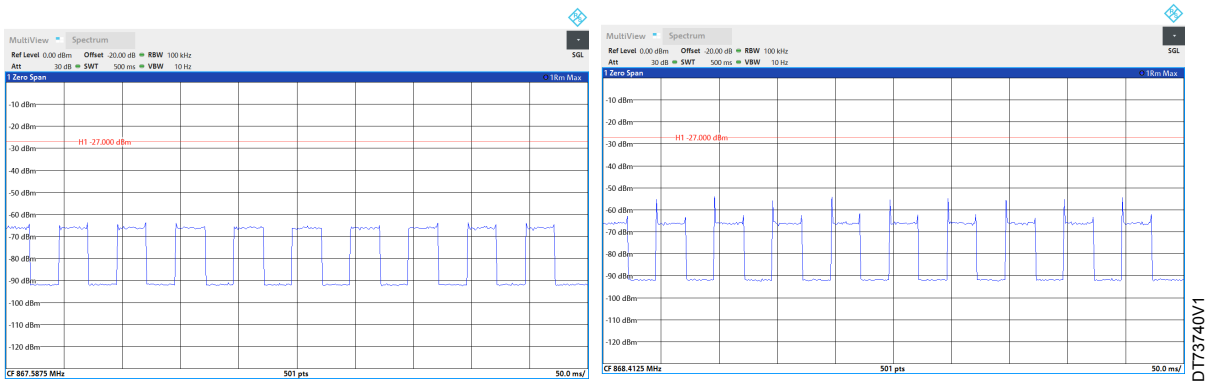
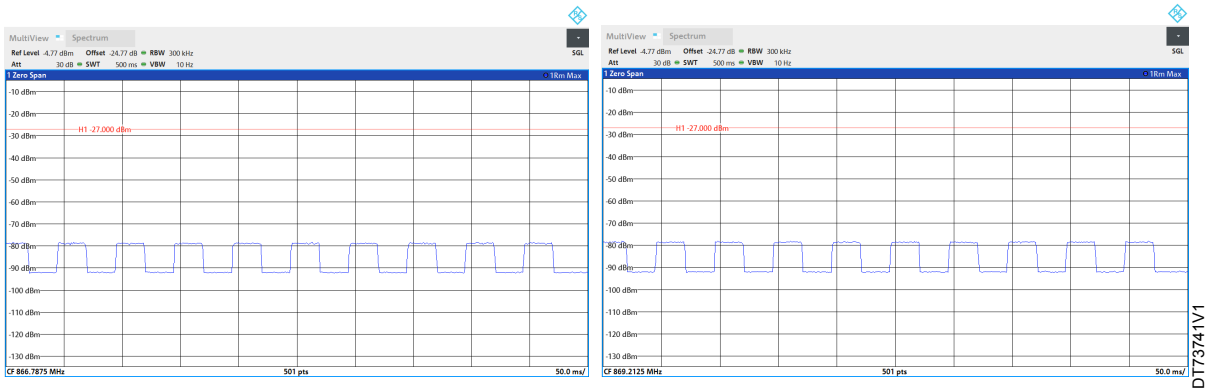


Figure 17. Transient power offset -0.5xOCW-1200kHz versus transient power offset 0.5xOCW+1200 kHz



5 Receiver measurement

There are two types of parameters that are measured for the receivers:

- Receiver 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 that the STM32WL33xx 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. It is referred to a carrier at the nominal frequency of the receiver. Moreover, it is also modulated with the normal test signal modulation, which produces the general performance criterion 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

Note: The general performance criterion is also stated in clause 4.1 of ETSI EN 300 220-1 V3.1.1 in the document .

The sensitivity for receivers must be:

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

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 STM32WL33xx 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.

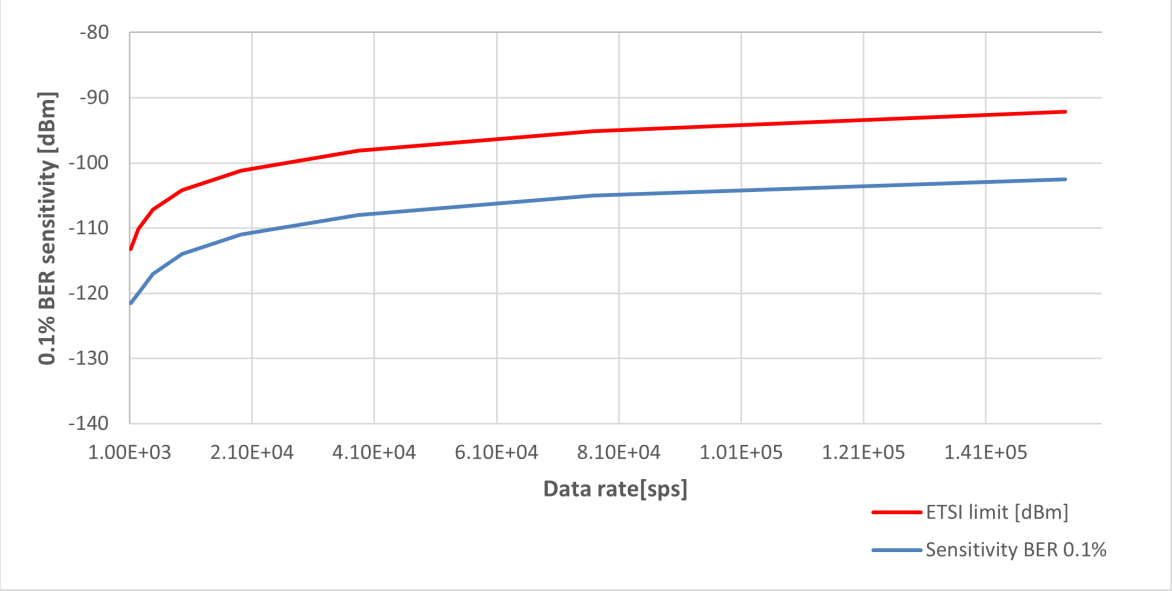
Figure 18 shows the ETSI 0.1% BER sensitivity limit (red line) and the STM32WL33xx sensitivity for different data rate.

In Table 21 the list of the cases investigated is displayed. All the cases include a modulation index equal to 1.

Table 21. Sensitivity 0.1% BER

Modulation	Data rate [sps]	Deviation [Hz]	BW [kHz]	Sensitivity 0.1 % [dBm]
2GFSK05	1.20E+03	600	2.40E+00	-121.5
2GFSK05	2.40E+03	1200	4.80E+00	-120
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	-105
2GFSK05	1.54E+05	76800	3.07E+02	-102.5

Figure 18. **Sensitivity versus data rate with 0.1% BER**



5.2 Blocking

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

To measure the blocking results, the power of the wanted input signal is set 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 minicircuits 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 is: –43 dBm at ±2 MHz, –33 dBm at ±10 MHz, and -33 dBm at 5% of the carrier frequency (43.4 MHz) or 15 MHz (whichever is the greater).

5.2.1 1.2 ksps data rate

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

The primary generator is set to –117.5 dBm. This is 3 dB above the ETSI Rx sensitivity limit measured with an Rx bandwidth at 4 kHz.

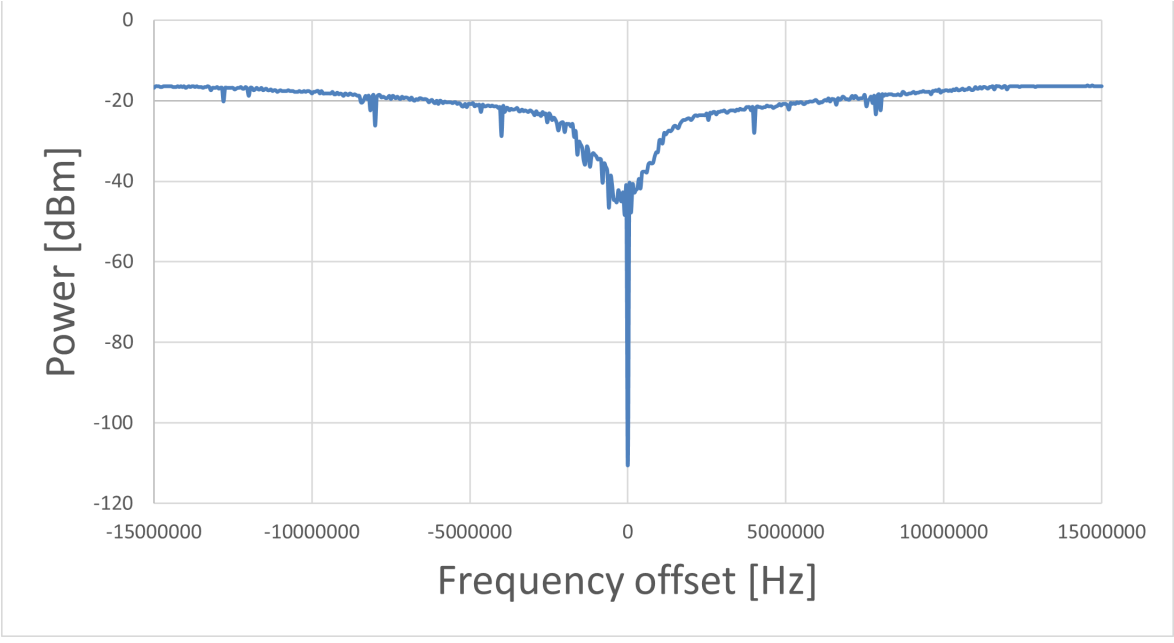
Table 22. Blocking test results for 4 kHz channel filter

2GFSK05 (1)	Category 3	Category 2	Category 1. 5	STM32WL3 results
Blocking at -2 MHz from OC edge	≥ -80 dBm	≥ -69 dBm	≥ -43 dBm	-27.8 dBm
Blocking at 2 MHz from OC edge	≥ -80 dBm	≥ -69 dBm	≥ -43 dBm	-24.8 dBm
Blocking at-10 MHz from OC edge	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-18.2 dBm
Blocking at 10 MHz from OC edge	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-17.6 dBm
Blocking at -5% of carrier frequency (43.4 MHz) or 15 MHz, whichever is the greater	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-16.8 dBm
Blocking at 5% of carrier frequency (43.4 MHz) or 15 MHz, whichever is the greater	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-16.4 dBm

1. *Frequency deviation 1.2 kHz, data rate 1.2 ksps, filter BW 4 kHz*

Figure 19. 1.2 ksps blocking data rate

CF 868 MHz, data rate 1.2 ksps, frequency deviation 1.2 kHz



5.2.2 38.4 ksps data rate

The primary generator provides a modulated signal obtained by modulating the 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. This is 3 dB above the ETSI Rx sensitivity limit measured with an Rx bandwidth equal to 100 kHz.

The STM32WL33xx is fully compliant with the ETSI class 1.5 receiver blocking requirements.

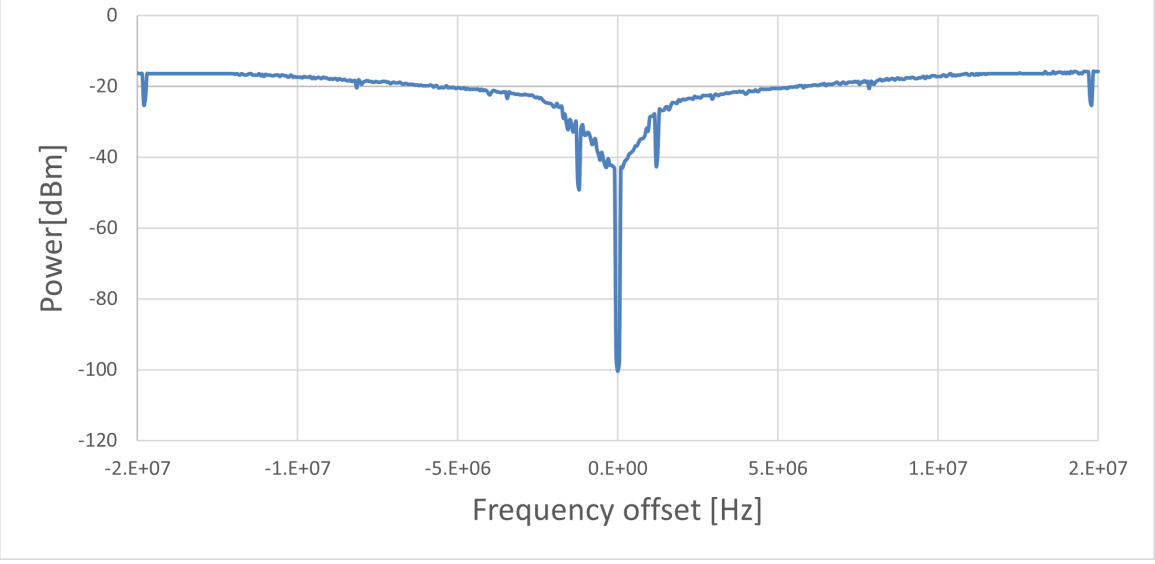
Table 23. Blocking test results for 100 kHz channel filter

2GFSK05 (1)	Category 3	Category 2	Category 1. 5	STM32WL33xx results
Blocking at -2 MHz from OC edge	≥ -80 dBm	≥ -69 dBm	≥ -43 dBm	-25.8 dBm
Blocking at 2 MHz from OC edge	≥ -80 dBm	≥ -69 dBm	≥ -43 dBm	-23.8 dBm
Blocking at -10 MHz from OC edge	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-17.4 dBm
Blocking at 10 MHz from OC edge	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-17.2 dBm
Blocking at -5% of carrier frequency (43.4 MHz) or 15 MHz, whichever is the greater	≥ -60 dBm	≥ -44 dBm	≥ -33 dBm	-16.2 dBm
Blocking at 5% of carrier frequency (43.4 MHz) or 15 MHz, whichever is the greater	≥ -60	≥ -44	≥ -33	-15.8

1. *Frequency deviation 20 kHz, data rate 38.4 kHz, filter BW 100 kHz*

Figure 20. 38.4 ksps blocking data rate

CF 868 MHz, data rate 38.4 ksps, frequency deviation 20 kHz



6 Measurement equipment

The following equipment is used for the measurements.

Measurement	Instrument type	Instrument model
Rx	Signal generator	Agilent ESG E4438C Agilent ESG E4438C
Tx	Spectrum analyzer	R&S FSW13

Revision history

Table 24. **Document revision history**

Date	Version	Changes
10-Dec-2024	1	Initial release.

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