RR051-19-100037-3-A Ed. 0

Certification Radio test report

According to the standard:

CFR 47 FCC PART 15

Equipment under test:
Wireless seismic acquisition unit
DFU

FCC ID: KQ9-0801A

Company:

SERCEL Inc

Distribution: Mr TIJOU **(Company:** SERCEL NANTES**)**

Number of pages: 40 with 4 appendixes

Ed.	Date	Modified Page(s)	Technical Verification and Quality Approval Name and Function / Visa
0	4-Mar-22	Creation	M. DUMESNIL, Radio Technical Manager

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S51 RTY 000 INT 00004 [02]

DESIGNATION OF PRODUCT:	***Wireless seismic acquisition unit***
Serial number (S/N):	Sample 1: 1182155 (Radiated tests)
Reference / model (P/N):	DFU
Software version:	301.6.1
MANUFACTURER:	SERCEL Inc

COMPANY CERTIFYING THE PRODUCT:

Company:	SERCEL Inc
Address:	17200 Park Row TEXAS 77084 UNITED STATES
Responsible:	Mr PARRISH

COMPANY SUBMITTING THE PRODUCT:

Company:	SERCEL NANTES
Address:	16, RUE DU BEL AIR BP 30439 44470 CARQUEFOU FRANCE
Responsible:	Mr TIJOU

DATES OF TEST:	From 17-Mar-20 to 25-Mar-20
TESTING LOCATION:	EMITECH ANGERS laboratory at JUIGNE SUR LOIRE (49) FRANCE FCC Accredited under US-EU MRA Designation Number: FR0009 Test Firm Registration Number: 873677
TESTED BY:	S. LOUIS ***VISA:***
WRITTEN BY:	S. LOUIS

CONTENTS

1. INTRODUCTION

This report presents the results of radio test carried out on the following radio equipment: **Wireless seismic acquisition unit, DFU**, in accordance with normative reference.

The equipment under test integrates:

- SRD Multifrequencies proprietary transceiver operational in the band (2400MHz – 2483.5MHz). Two different modulations are used (GFSK and LoRa)
- GNSS module operational in the band 1559MHz – 1610MHz

This report refers only of proprietary transceiver radio part.

According to KDB publication n° 558074 D01 v05r02, the compliance demonstration for these two modulations is carried out according DTS requirements.

2. PRODUCT DESCRIPTION

Class:	A
Utilization:	Industrial
Antenna type and gain:	2 dBi / integral antenna
Operating frequency range:	From 2400 MHz to 2483.5 MHz
Number of channels:	77
Channel spacing:	1MHz
Modulation:	GFSK and LoRa
Power source:	3.6Vdc by internal Li-ion Batteries Pack
Power soft adjusted to	9dBm

Power level, frequency range and channels characteristics are not user adjustable.
The details pictures of the product and the circuit boards are joined with this file.

3. NORMATIVE REFERENCE

The standards and testing methods related throughout this report are those listed below.
They are applied on the whole test report even though the extensions (version, date and amendment) are not repeated.

CFR 47 FCC Part 15 (2020)	Radio Frequency Devices
ANSI C63.10	2013 Procedures for ComplianceTesting of Unlicensed Wireless Devices.
558074 D01 DTS v05 r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules.

4. TEST METHODOLOGY

Radio performance tests procedures given in CFR 47 part 15:

Subpart C – Intentional Radiators

- Paragraph 203: Antenna requirement
- Paragraph 205: Restricted bands of operation
- Paragraph 207: Conducted limits
- Paragraph 209: Radiated emission limits; general requirements
- Paragraph 215: Additional provisions to the general radiated emission limitations
- Paragraph 247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

5. TEST EQUIPMENT CALIBRATION DATES

Emitech Number	Model	Type	Last calibration	Calibration interval (years)	Next calibration due
0	BAT-EMC V3.17.0.25	Software	/	/	/
1406	EMCO 6502	Loop antenna	18/04/2019	1	17/04/2020
4087	Filtek LP03/1000-7GH	Low Pass Filter	30/03/2018	2	29/03/2020
6884	Suhner 1.5m	Cable	30/03/2018	2	29/03/2020
7124	A.H. Systems SAS-572	Antenna	05/01/2019	3	04/01/2022
7240	Emco 3110	Biconical antenna	09/03/2019	3	08/03/2022
7299	Microtronics BRM50702	Reject band filter	04/09/2019	2	03/09/2021
8511	HP 8447D	Low-noise amplifier	25/02/2020	1	24/02/2021
8526	Schwarzbeck VHBB 9124	Biconical antenna	17/08/2018	3	16/08/2021
8535	EMCO 3115	Antenna	10/04/2017	3	10/04/2020
8543	Schwarzbeck UHALP 9108A	Log periodic antenna	17/08/2018	3	16/08/2021
8593	SIDT Cage 2	Anechoic chamber	/	/	/
8704	LUCIX Corp S180265L3201 LNA	Low-noise amplifier	17/09/2019	1	16/09/2020
8750	La Crosse Technology WS-9232	Meteo station	25/09/2018	2	24/09/2020
8896	ACQUISYS GPS8	Satellite synchronized frequency standard	/	/	/
8974	STORM MICROWAE k-20cm	cable	14/11/2019	2	13/11/2021
8975	STORM MICROWAE k-20cm	cable	14/11/2019	2	13/11/2021
9398	N-1.5m	cable	30/03/2018	2	29/03/2020
10730	Mini-circuit ZFL-1000LN	Low-noise amplifier	14/02/2020	1	13/02/2021
10759	COMTEST Cage 3	Anechoic chamber	/	/	/
10789	MATURO	Turntable and mat controller NCD	/	/	/
12590	LUCIX Corp S005180M3201	Low-noise amplifier	03/09/2019	1	02/09/2020
12911	Huber + Suhner N-2m	cable	30/03/2018	2	29/03/2020
12912	Huber + Suhner N-5m	cable	30/03/2018	2	29/03/2020
14303	SUCOFLEX N-2m	cable	15/12/2018	2	14/12/2020
14304	SUCOFLEX N-2.5m	cable	15/12/2018	2	14/12/2020
14736	MATURO	Turntable and mat controller MCU	/	/	/
14903	Fluke 177	Multimeter	25/02/2020	2	24/02/2022
15666	R&S FSV40	Spectrum Analyzer	20/07/2018	2	19/07/2020
15882	SUCOFLEX	cable N 5m	28/11/2018	2	27/11/2020
16109	C&C HPF180400	High pass filter	26/03/2019	2	25/03/2021

6. TESTS RESULTS SUMMARY

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.203	ANTENNA REQUIREMENT	X				*Note 1*
FCC Part 15.205	RESTRICTED BANDS OF OPERATION	X				
FCC Part 15.207	CONDUCTED LIMITS			X		*Supplied by batteries*
FCC Part 15.209	RADIATED EMISSION LIMITS; general requirements	X				*Note 2*
FCC part 15.215	ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS					
	(a) Alternative to general radiated emission limits	X				
	(b) Unwanted emissions outside of §15.247 frequency bands	X				*Note 3*
	(c) 20 dB bandwidth and band-edge compliance	X				
FCC Part 15.247	OPERATION WITHIN THE BANDS 902-928 MHZ, 2400-2483.5 MHz and 5725-5850 MHz					
	(a) (1) Hopping systems			X		
	(a) (2) Digital modulation techniques	X				*Note 4*
	(b) Maximum peak output power	X				*Note 5*
	(c) Operation with directional antenna gains > 6 dBi			X		
	(d) Intentional radiator	X				
	(e) Peak power spectral density	X				
	(f) Hybrid system			X		
	(g) Frequency hopping requirements			X		
	(h) Frequency hopping intelligence			X		
	(i) RF exposure compliance	X				

NAp: Not Applicable NAs: Not Asked

Note 1: Integral antenna without standard connector.

Note 2: See FCC part 15.247 (d).

Note 3: See FCC part 15.209. Unwanted emissions levels are all below the fundamental emission field strength level.

Note 4: The minimum 6 dB bandwidth of the equipment is 663 kHz for GFSK and 545 kHz for LoRa (see appendix 2).

Note 5: Conducted measurement is not possible (integral antenna), so we used the radiated method in open field.

7. MEASUREMENT UNCERTAINTY

To declare, or not, the compliance with the specifications, it was not explicitly taken into account of uncertainty associated with the result(s)

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for normal distribution corresponds to a coverage probability of approximately 95%.

Parameter	Emitech Uncertainty
RF power, conducted	± 0.75dB
Radiated emission valid to 26 GHz F < 62.5 MHz: 62.5 MHz < F < 1 GHz: 1 GHz < F < 26 GHz:	 ± 5.14 dB ± 5.13 dB ± 5.16 dB
AC Power Lines conducted emissions	± 3.38 dB
Temperature	± 1 °C
Humidity	± 5 %

8. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS

Temperature (°C) : 22.3 **Humidity (%HR):** 46 **Date :** March 17, 2020
Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: Paragraph 15.215

Test set up:

Test realized in near field. All field strength measurements are correlated with the radiated maximum peak output power

Test operating condition of the equipment:

The equipment is blocked in continuous modulated transmission mode by an internal data signal at the highest power level at which the transmitter is intended to operate.

P Software adjusted to +9dBm

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (Vdc):	4.06
Voltage at the end of test (Vdc):	4.04
Percentage of voltage drop during the test (%):	0.5
Limits (%):	± 5

Results:

Lower Band Edge: From 2398 MHz to 2400 MHz
Upper Band Edge: From 2483.5 MHz to 2485.5 MHz

Sample N° 1: GFSK

Fundamental frequency (MHz)	Field Strength Level of fundamental (dBµV/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB) (1)	Calculated Max Out-of-Band Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2402.5	107.2	Peak	2399.31	55.0	53.2	87.2	34.0
2478.5	108.2	Peak	2483.57	48.3	59.9	74	14.1
2478.5	108.2	Average	2483.58	59.4	48.8	54	5.2

(1) Marker-Delta method

Band-edge curves are given in appendix 4.

Sample N° 1: LoRa

Fundamental frequency (MHz)	Field Strength Level of fundamental (dBµV/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB) (1)	Calculated Max Out-of-Band Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2402.5	107.1	Peak	2399.67	55.1	52	87.1	35.1
2478.5	108.1	Peak	2483.70	45.3	62.8	74	11.2
2478.5	108.1	Average	2483.53	58.5	49.6	54	4.4

(1) Marker-Delta method

Band-edge curves are given in appendix 4.

Test conclusion:

RESPECTED STANDARD

9. MAXIMUM PEAK CONDUCTED OUTPUT POWER

Temperature (°C) : 22.3 **Humidity (%HR):** 46 **Date :** March 17, 2020
Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 15.247 (b)

DTS:
RBW≥DTS bandwidth method of paragraph 11.9.1.1 of ANSI C63.10

Test set up:

First an exploratory radiated measurement was performed.

During this phase the product is oriented in these two normal positions.

Then the final measurement is realized with the product on the most critical orientation.

The system is tested in anechoic chamber, the EUT is placed on a rotating table, 1.5 m from a ground plane.

Zero degree azimuths correspond to the front of the device under test.

See photos in appendix 2.

Distance of antenna: 3 meters (in anechoic room)

Antenna height: 1.5 meter (in anechoic room)

Antenna polarization: vertical and horizontal (only the highest level is recorded)

The measurement of the radiated electro-magnetic field is realized with an analyser and peak detector. The resolution bandwidth is adjusted at 3 MHz and video bandwidth at 10 MHz. (11.9.1.1 of ANSI C63.10)

Finally the radiated electro-magnetic field is converted in dBm with the following formula:
EIRP(dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 0 dBi.

Equipment under test operating condition:

The equipment is blocked in continuous modulated transmission mode by an internal data signal at the highest power level at which the transmitter is intended to operate.

P Software adjusted to +9dBm

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (Vdc):	4.06
Voltage at the end of test (Vdc):	4.04
Percentage of voltage drop during the test (%):	0.5
Limits (%):	± 5

Results: GFSK

Sample N° 1 Low Channel (F = 2402.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	107.2	9.97	0.0099	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 Central Channel (F = 2439.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	108.2	10.97	0.0125	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 High Channel (F = 2478.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	107.6	10.37	0.0109	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Maximum Peak conducted output power:
EIRP(dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 2 dBi.

Results: LoRa

Sample N° 1 Low Channel (F = 2402.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	107.1	9.87	0.0097	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 Central Channel (F = 2439.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	108.1	10.87	0.0122	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 High Channel (F = 2478.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted output power		Limit
		(dBm)	(W)	(W)
Nominal supply voltage: 3.6Vdc	107.5	10.27	0.0106	1

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Maximum Peak conducted output power:
EIRP(dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 2 dBi.

Test conclusion:

RESPECTED STANDARD

10. INTENTIONAL RADIATOR

Temperature (°C) : 20.3 to 22 **Humidity (%HR):** 40 to 45 **Date :** March 18, 2020 to March 20, 2020

Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 15.205, paragraph 15.209, paragraph 15.247 (d)

DTS:
Emissions in non-restricted frequency bands method of paragraph 11.11 of ANSI C63.10
Emissions in restricted frequency bands method of paragraph 11.12 of ANSI C63.10

Test set up:

First an exploratory radiated measurement was performed.

During this phase the product is oriented in these two normal positions.

Then the final measurement is realized with the product on the most critical orientation.

The measure is realized on open area test site under 1 GHz and in anechoic chamber above 1 GHz.

When the system is tested in an open area test site (OATS), the EUT is placed on a rotating table, 0.8m from a ground plane.

When the system is tested in anechoic chamber, the EUT is placed on a rotating table, 1.5 m from a ground plane.

Zero degree azimuths correspond to the front of the device under test.

See photos in appendix 2.

Frequency range: From 9 kHz to 26GHz / 10th harmonic of the highest fundamental frequency (2478.5MHz)

Detection mode: Quasi-peak (F < 1 GHz) Peak / Average (F > 1 GHz)

Bandwidth: 200Hz (9 kHz < F < 150kHz)
9 kHz (150 kHz < F < 30MHz)
120 kHz (30 MHz < F < 1 GHz)
100 kHz / 1 MHz (F > 1 GHz)

Distance of antenna: 10 meters (in open area test site) / 3 meters (in anechoic room)

Antenna height: 1 to 4 meters (in open area test site) / 1.5 meter (in anechoic room)

Antenna polarization: vertical and horizontal (only the highest level is recorded)

Equipment under test operating condition:

The equipment is blocked in continuous modulated transmission mode by an internal data signal at the highest power level at which the transmitter is intended to operate.

P Software adjusted to +9dBm

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (Vdc):	4.05
Voltage at the end of test (Vdc):	4.02
Percentage of voltage drop during the test (%):	0.75
Limits (%):	± 5

Results: GFSK

Sample N° 1 Low Channel (F = 2402.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4805 (1)	P	150	1000	1	H	47.5 (2)	74	26.5
7207.5	P	150	100	1	H	56.8	87.2	30.4
9610	P	150	100	2	H	55.6	87.2	31.6

P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Sample N° 1 Central Channel (F = 2439.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4879 (1)	P	150	1000	1	H	47.7 (2)	74	26.3
7218.5 (1)	P	150	1000	1	H	58.0	74	16.0
7218.5 (1)	Av	150	1000	1	H	52.4	54	1.6
9758	P	150	100	2	H	54.7	87.2	32.5

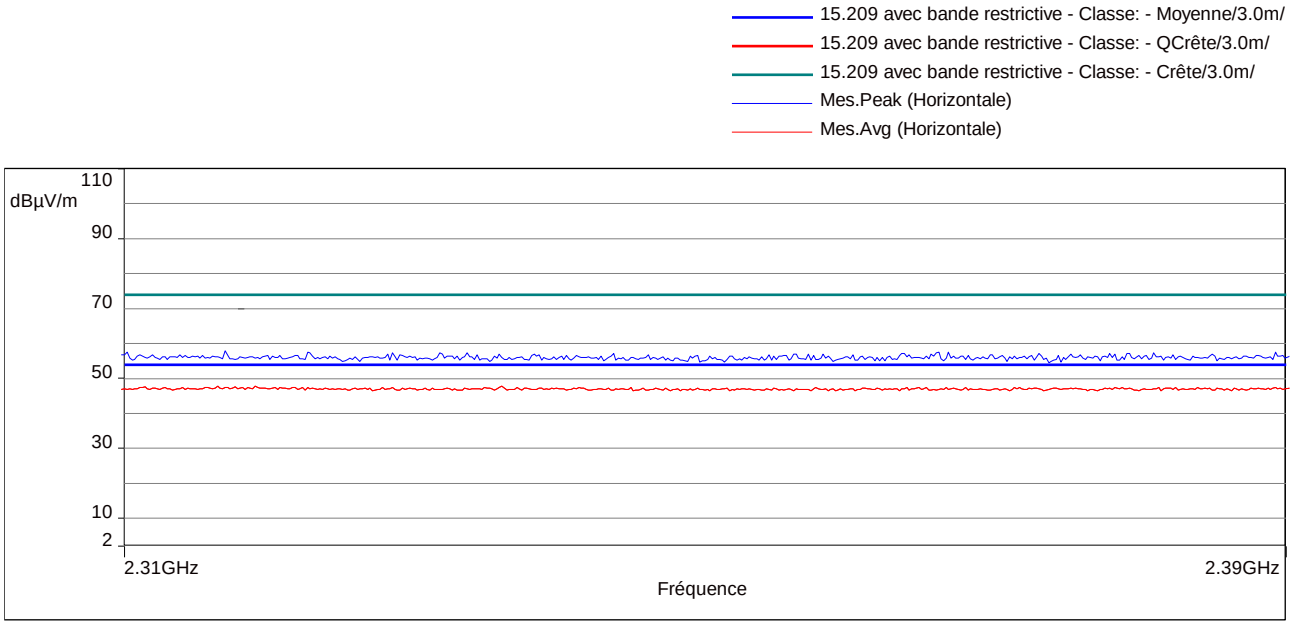
P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Sample N° 1 High Channel (F = 2478.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4957 (1)	P	150	1000	1	H	49.7 (2)	74	24.3
7435.5 (1)	P	150	1000	1	H	55.5	74	18.5
7435.5 (1)	Av	150	1000	1	H	49.9	54	4.1

P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Band edge worst case measurement (band 2.31GHz to 2.39GHz)



Applicable limits: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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.

The highest level recorded in a 100 kHz bandwidth is 107.2 dBµV/m on central channel.
So the applicable limit is 87.2 dBµV/m.
In addition, radiated emissions which fall in the restricted band, as defined in section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see section 15.205 (c)).

Results: LoRa

Sample N° 1 Low Channel (F = 2402.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4805 (1)	P	150	1000	1	H	48.2 (2)	74	25.8
7207.5	P	150	100	1	H	57.0	87.1	30.1
9610	P	150	100	2	H	55.5	87.1	31.6

P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Sample N° 1 Central Channel (F = 2439.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4879 (1)	P	150	1000	1	V	48.4 (2)	74	25.6
7218.5 (1)	P	150	1000	1	H	57.9	74	16.1
7218.5 (1)	Av	150	1000	1	H	53.9	54	0.1
9758	P	150	100	2	H	55.0	87.1	32.1

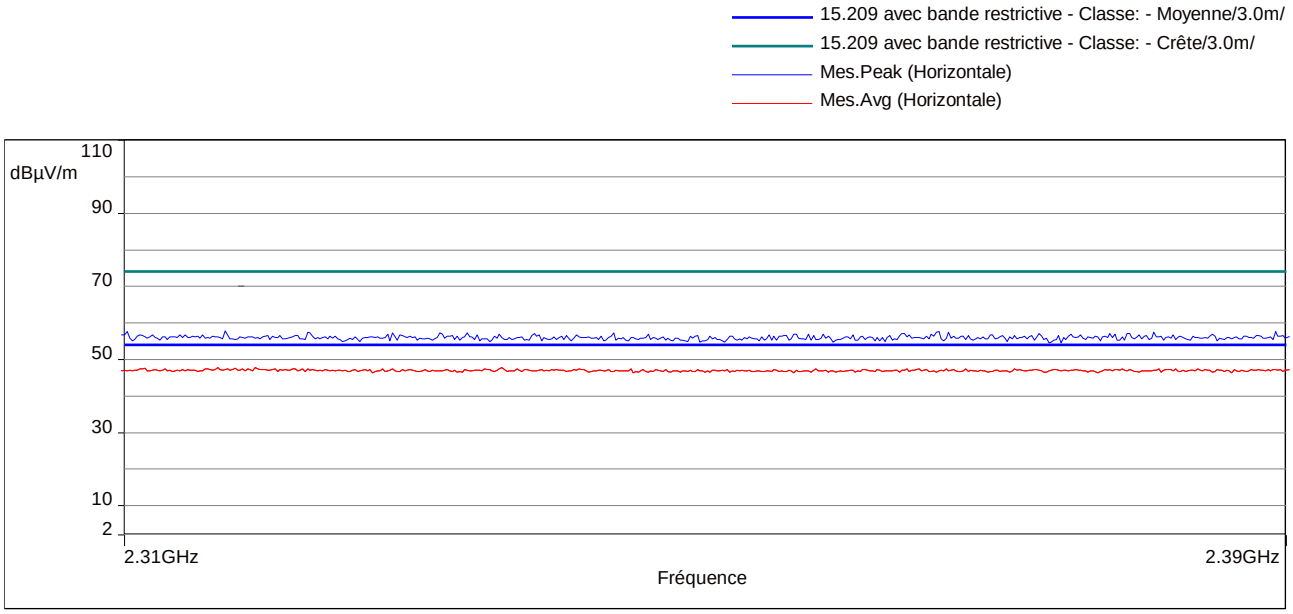
P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Sample N° 1 High Channel (F = 2478.5 MHz)

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength Measured at 3 m (dBµV/m)	Limits (dBµV/m) or (dBm)	Margin (dB)
4957 (1)	P	150	1000	1	H	49.6 (2)	74	24.4
7435.5 (1)	P	150	1000	1	H	56.8	74	17.2
7435.5 (1)	Av	150	1000	1	H	52.9	54	1.1
9914	P	150	100	2	H	51.2	87.1	35.9

P= Peak, QP=Quasi-peak, Av=Average
(1) Restricted bands of operation in 15.205
(2) The peak level is lower than the average limit (54 dBµV/m)

Band edge worst case measurement (band 2.31GHz to 2.39GHz)



Applicable limits: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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.

The highest level recorded in a 100 kHz bandwidth is 107.1 dBµV/m on central channel.
So the applicable limit is 87.1 dBµV/m.
In addition, radiated emissions which fall in the restricted band, as defined in section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see section 15.205 (c)).

Test conclusion:

RESPECTED STANDARD

11. MAXIMUM PEAK CONDUCTED POWER DENSITY

Temperature (°C) : 22.3 **Humidity (%HR):** 46 **Date :** March 17, 2020
Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 15.247 (e), paragraph 15.247 (f)

PKPSD (Peak PSD) method of paragraph 11.10.2 of ANSI C63.10

Test set up:

First an exploratory radiated measurement was performed.

During this phase the product is oriented in these two normal positions.

Then the final measurement is realized with the product on the most critical orientation.

The system is tested in anechoic chamber, the EUT is placed on a rotating table, 1.5 m from a ground plane.

Zero degree azimuths correspond to the front of the device under test.

See photos in appendix 2.

Distance of antenna: 3 meters (in anechoic room)

Antenna height: 1.5 meter (in anechoic room)

Antenna polarization: vertical and horizontal (only the highest level is recorded)

The measurement of the radiated electro-magnetic field is realized with an analyser.

Span:	2MHz
Resolution bandwidth:	3kHz
Video bandwidth:	10kHz
Detector:	Peak
Number of points:	Auto
Sweep time:	Auto
Trace mode:	MaxHold

Then the peak marker function is used.

Finally the radiated electro-magnetic field is converted in dBm with the following formula:
EIRP(dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 0 dBi.

Equipment under test operating condition:

The equipment is blocked in continuous modulated transmission mode by an internal data signal at the highest power level at which the transmitter is intended to operate.

P Software adjusted to +9dBm

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (Vdc):	4.06
Voltage at the end of test (Vdc):	4.04
Percentage of voltage drop during the test (%):	0.5
Limits (%):	± 5

Results: GFSK

Sample N° 1 Low Channel (F = 2402.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	94.7	-2.53	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 Central Channel (F = 2439.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	96.0	-1.23	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 High Channel (F = 2478.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	96.0	-1.23	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Maximum Peak conducted power density:
EIRP(dBm / 3 kHz) = E (dBµV/m / 3 kHz) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 2 dBi.

Declared maximum antenna gain: 2 dBi

Results: LoRa

Sample N° 1 Low Channel (F = 2402.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	95.5	-1.73	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 Central Channel (F = 2439.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	96.9	-0.33	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Sample N° 1 High Channel (F = 2478.5 MHz)

	Electro-magnetic field (dBµV/m):	Maximum Peak conducted power density (dBm / 3 kHz)	Limit (dBm / 3 kHz)
Nominal supply voltage:	96.0	-1.23	8

Polarization of test antenna: horizontal (height: 150 cm)
Position of equipment: Position 2 - (azimuth: 130 degrees)

Maximum Peak conducted power density:
EIRP(dBm / 3 kHz) = E (dBµV/m / 3 kHz) + 20log(D) - 104.8; where D is the measurement distance in meters and antenna Gain = 2 dBi.

Declared maximum antenna gain: 2 dBi

Test conclusion:

RESPECTED STANDARD

□□□ End of report, 4 appendixes to be forwarded □□□

APPENDIX 1: Test equipment list

Additional provisions to the general radiated emission limitations

TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Turntable controller 1060C	MATURO	14736
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSV40	Rohde & Schwarz	15666
Antenna 3115	EMCO	8535
N-2M Cable	Huber + Suhner	12911
N-5M Cable	SUCOFLEX	15882
Multimeter 177	Fluke	14903
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.17.0.25	0000

Maximum peak conducted output power

TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Turntable controller 1060C	MATURO	14736
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSV40	Rohde & Schwarz	15666
Antenna 3115	EMCO	8535
N-2M Cable	Huber + Suhner	12911
N-5M Cable	SUCOFLEX	15882
Multimeter 177	Fluke	14903
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.17.0.25	0000

Intentional radiator

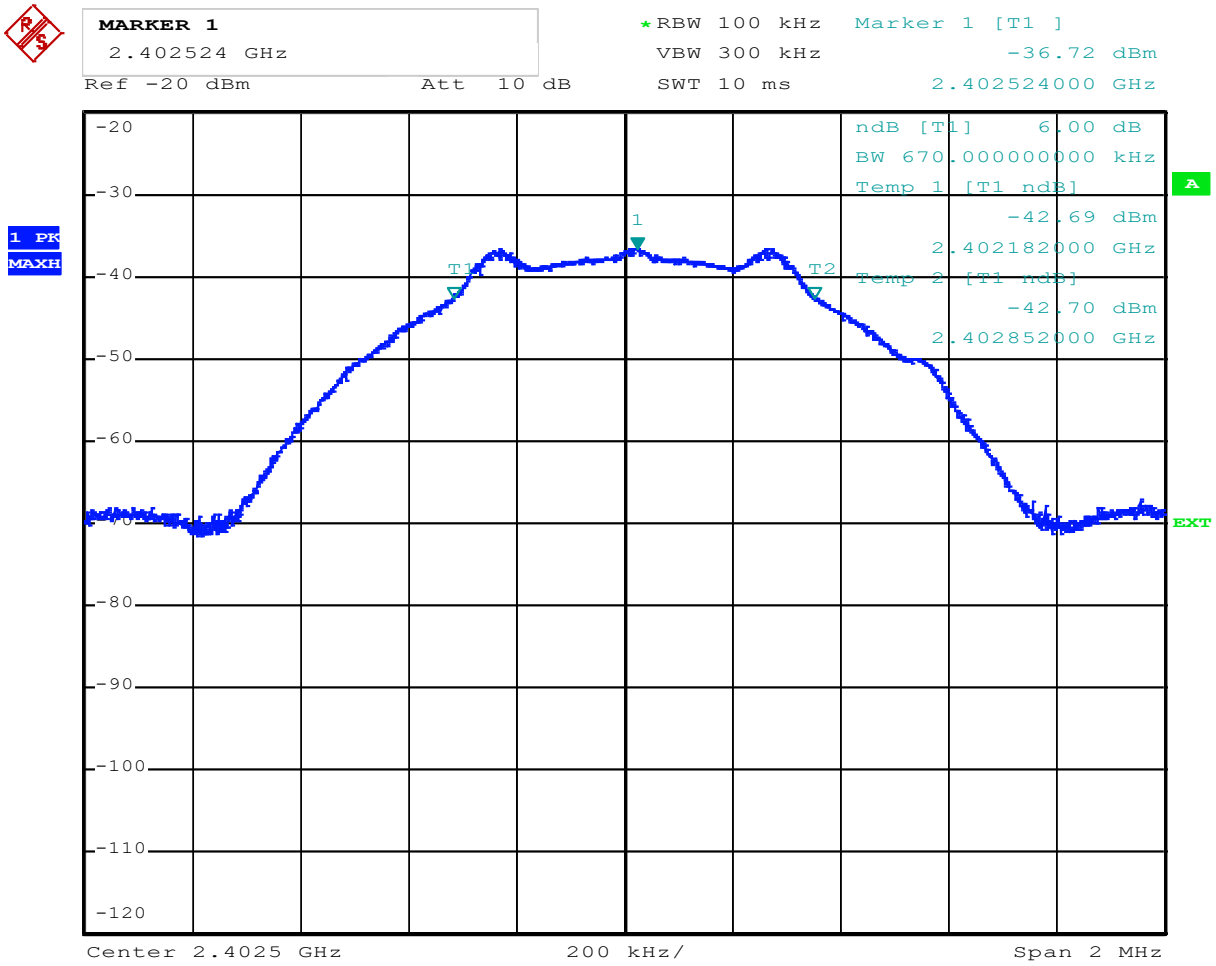
TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Turntable controller 1060C	MATURO	14736
Full anechoic chamber	EMITECH	10759
Turntable and mat controller NCD	MATURO	10789
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSV40	Rohde & Schwarz	15666
Loop antenna 6502	EMCO	1406
Biconical antenna VHBB 9124	Schwarzbeck	8526
Biconical antenna 3110	Emco	7240
Log periodic antenna UHALP 9108A	Schwarzbeck	8543
Antenna 3115	EMCO	8535
Antenna SAS-572	A.H Systems	7124
Low-noise amplifier 8447D	Hewlett Packard	8511
Low-noise amplifier ZFL-1000LN	Mini-circuit	10730
Low-noise amplifier S005180M3201	LUCIX Corp.	12590
Low-noise amplifier S180265L3201	LUCIX Corp.	8704
N-1.5M Cable	Huber + Suhner	6884
N-1.5M Cable	SUCOFLEX	9398
N-2M Cable	Huber + Suhner	12911
N-5M Cable	SUCOFLEX	15882
N-2M Cable	SUCOFLEX	14303
N-2.5M Cable	SUCOFLEX	14304
N-5M Cable	Huber + Suhner	12912
Cable k-20cm	STORM MICROWAE	8974
Cable k-20cm	STORM MICROWAE	8975
Low pass filter LP03/1000-7GH	Filtek	4087
Reject band filter BRM50702	Microtronics	7299
High pass filter HPF180400	C&C	16109
Multimeter 177	Fluke	14903
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.17.0.25	0000

Maximum Peak conducted power density

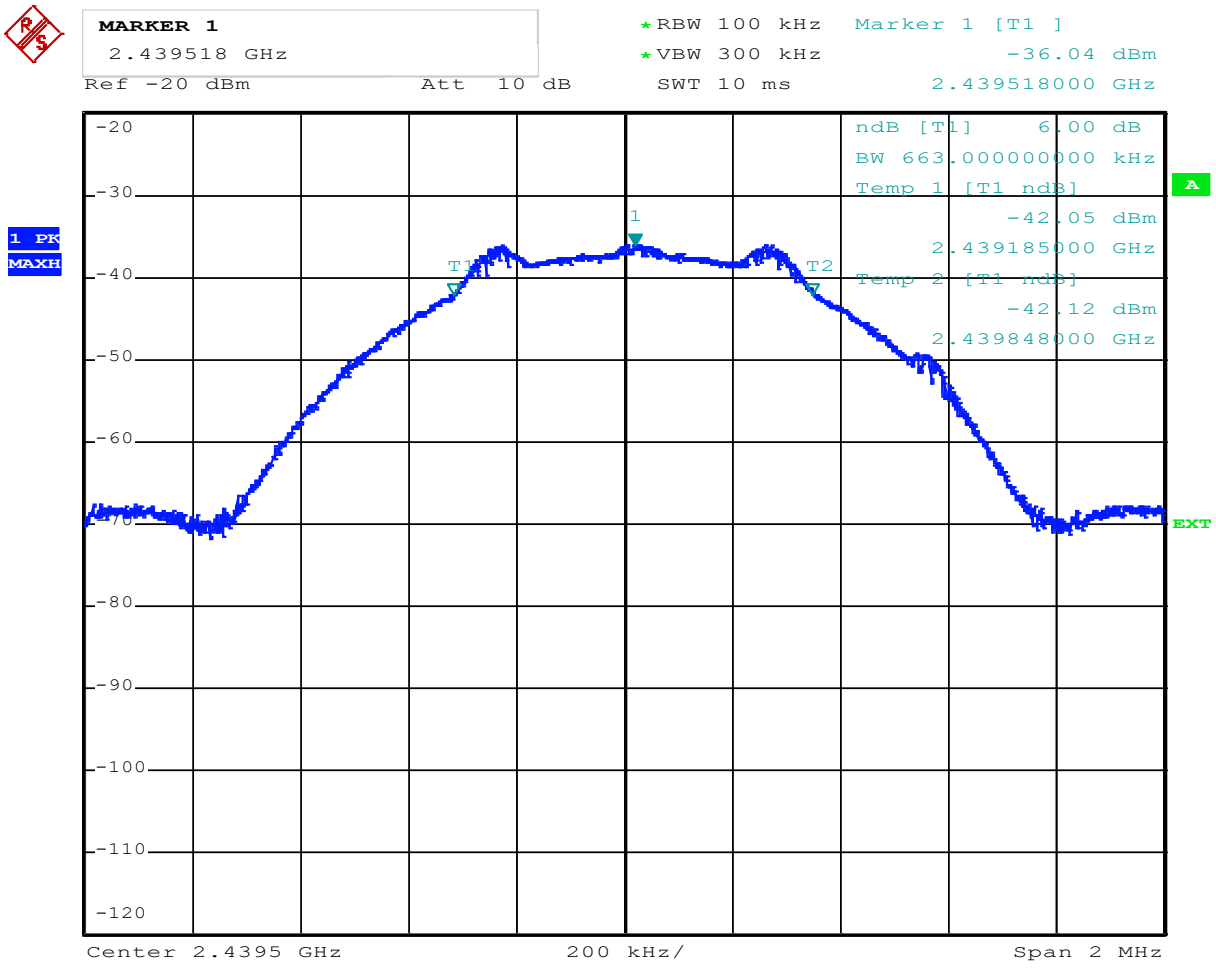
TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Turntable controller 1060C	MATURO	14736
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSV40	Rohde & Schwarz	15666
Antenna 3115	EMCO	8535
N-2M Cable	Huber + Suhner	12911
N-5M Cable	SUCOFLEX	15882
Multimeter 177	Fluke	14903
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.17.0.25	0000

APPENDIX 2: 6 dB bandwidth

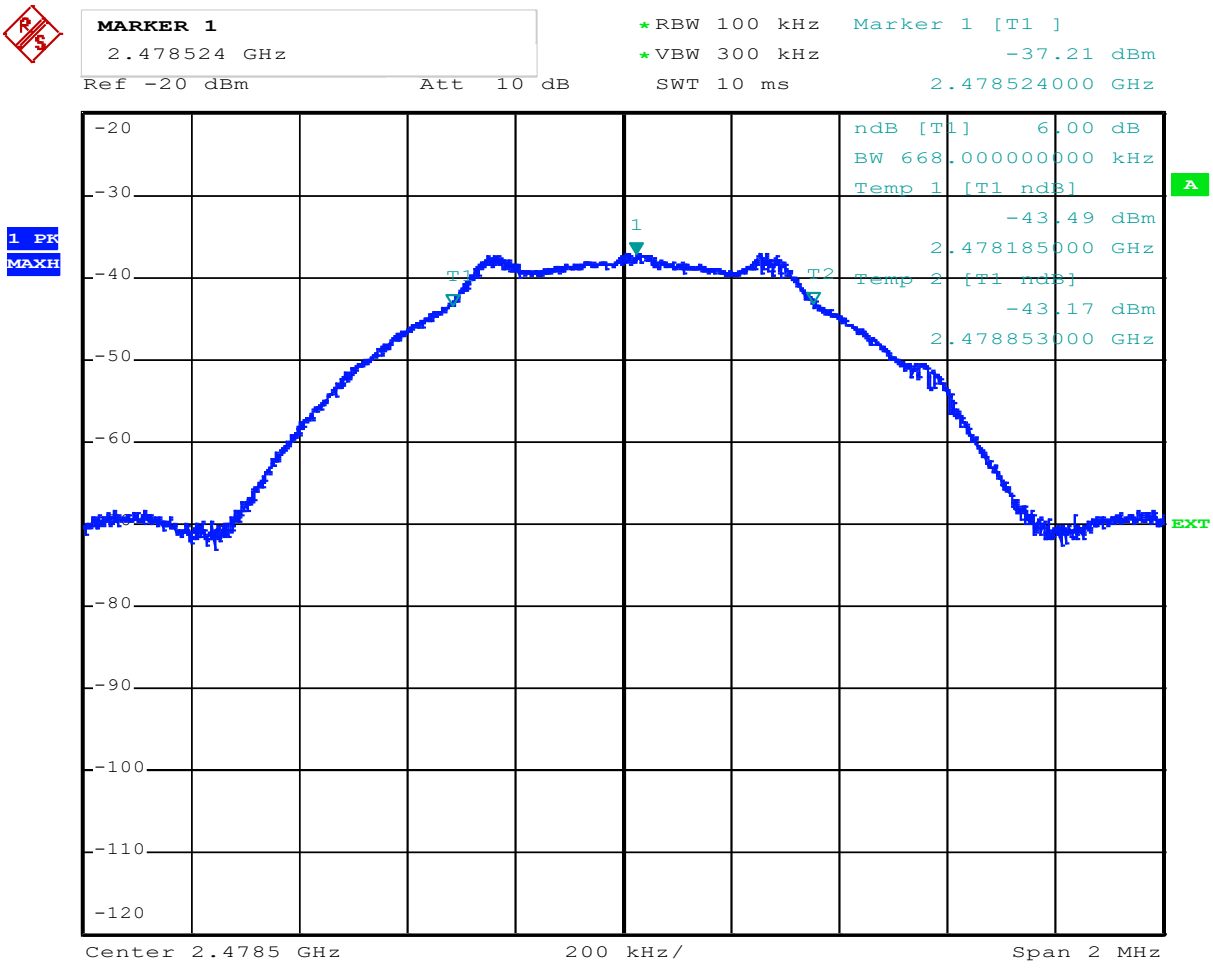
Low Channel – GFSK



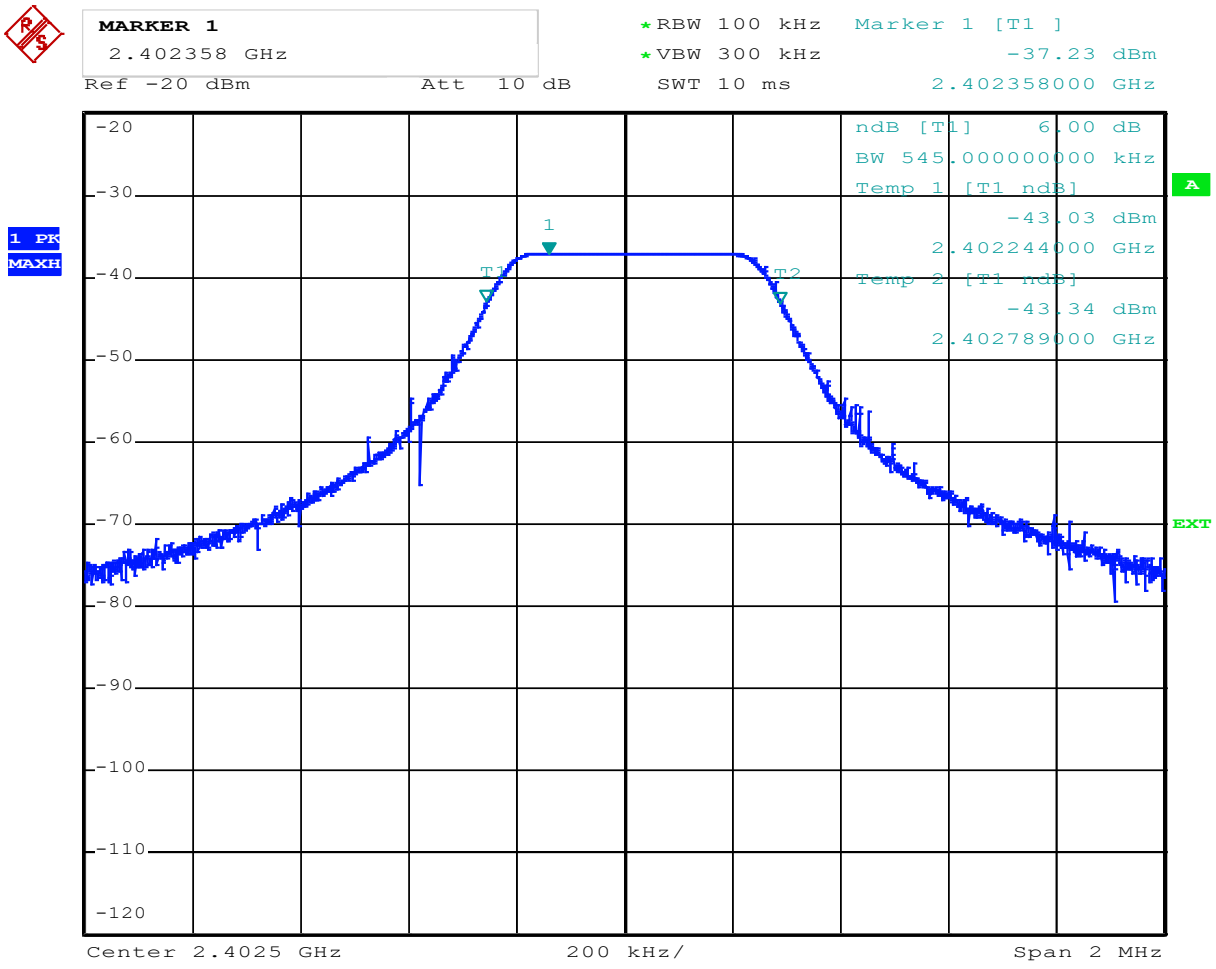
Central Channel – GFSK



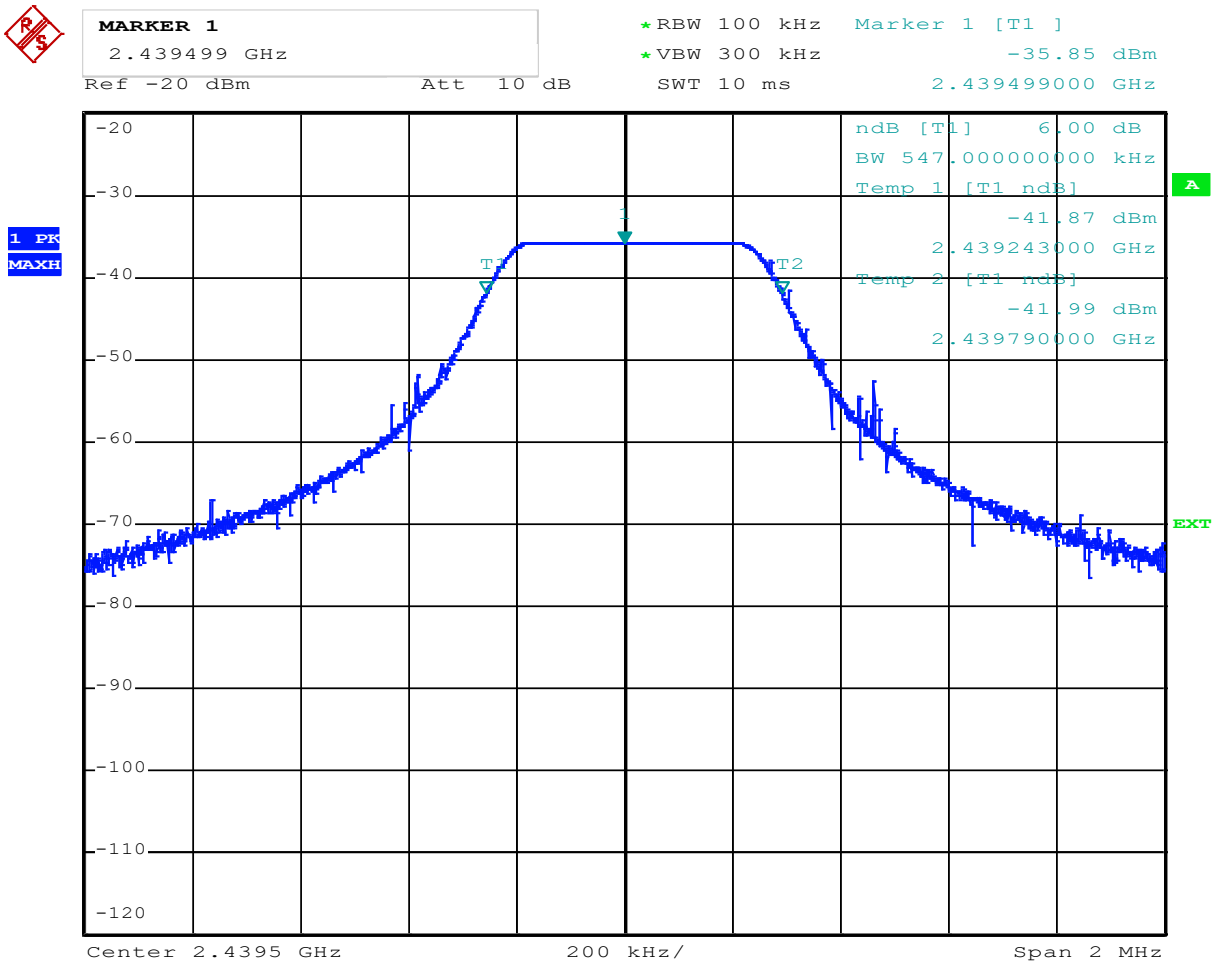
High Channel – GFSK



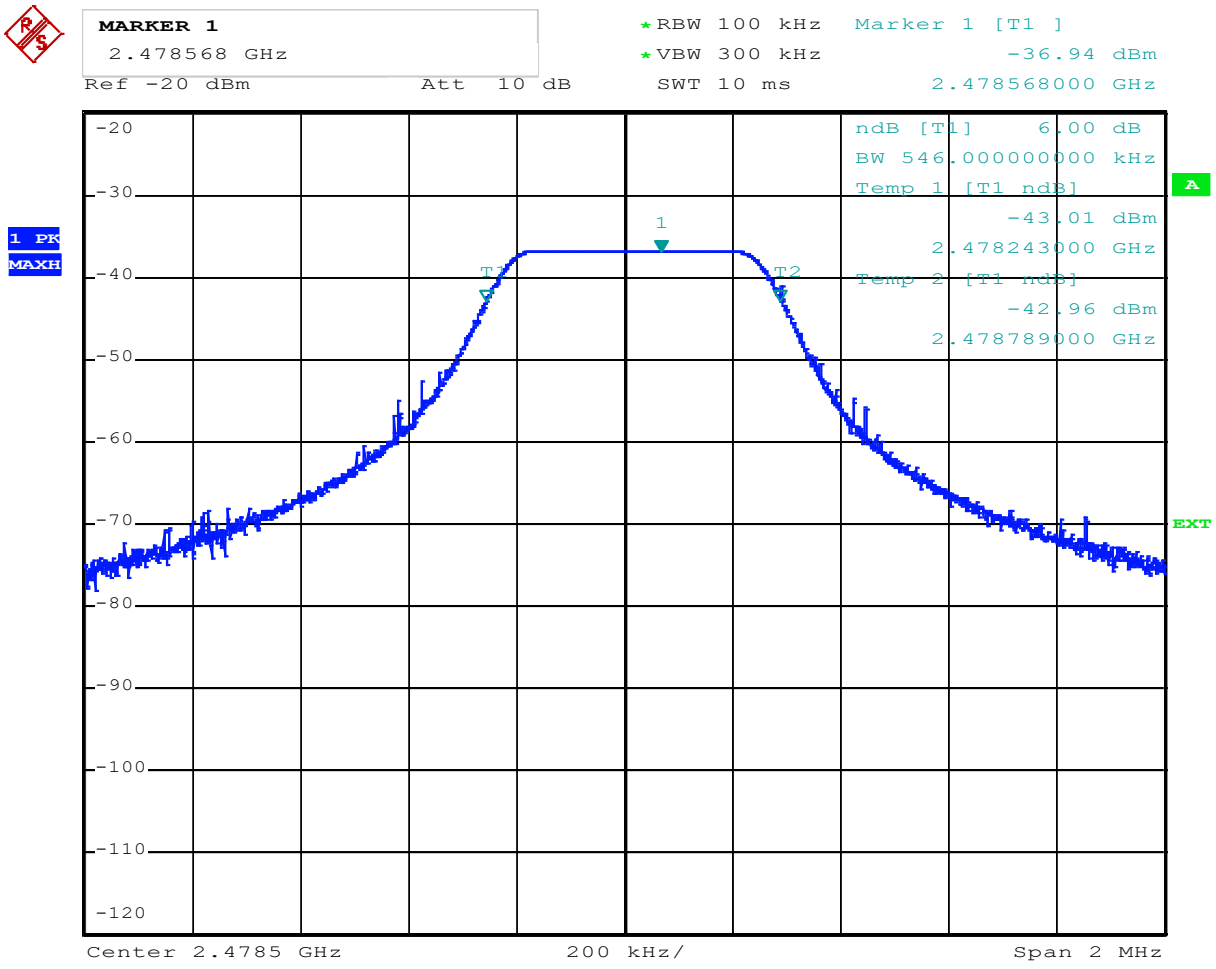
Low Channel – LoRa



Central Channel – LoRa

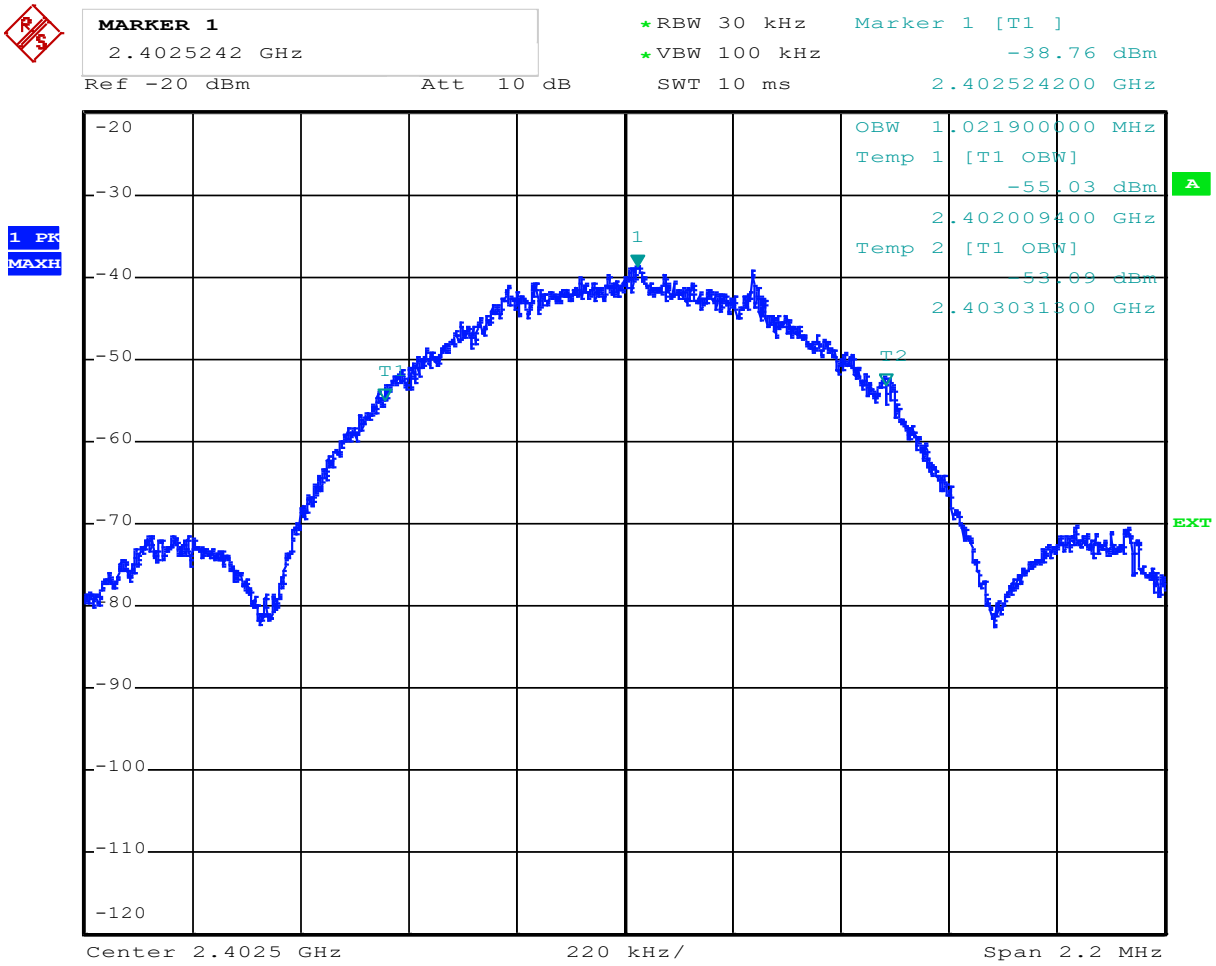


High Channel – LoRa

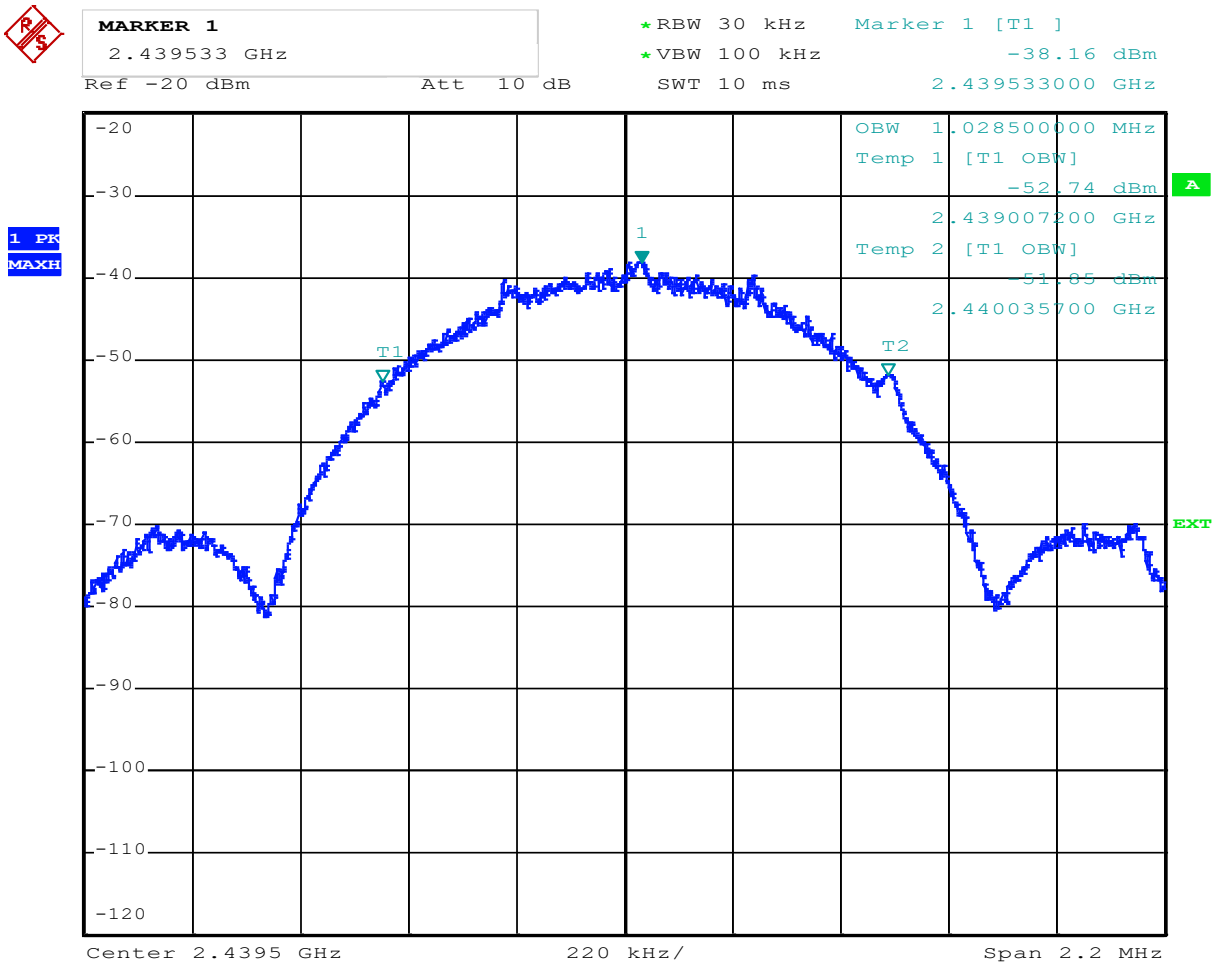


APPENDIX 3: 99% bandwidth

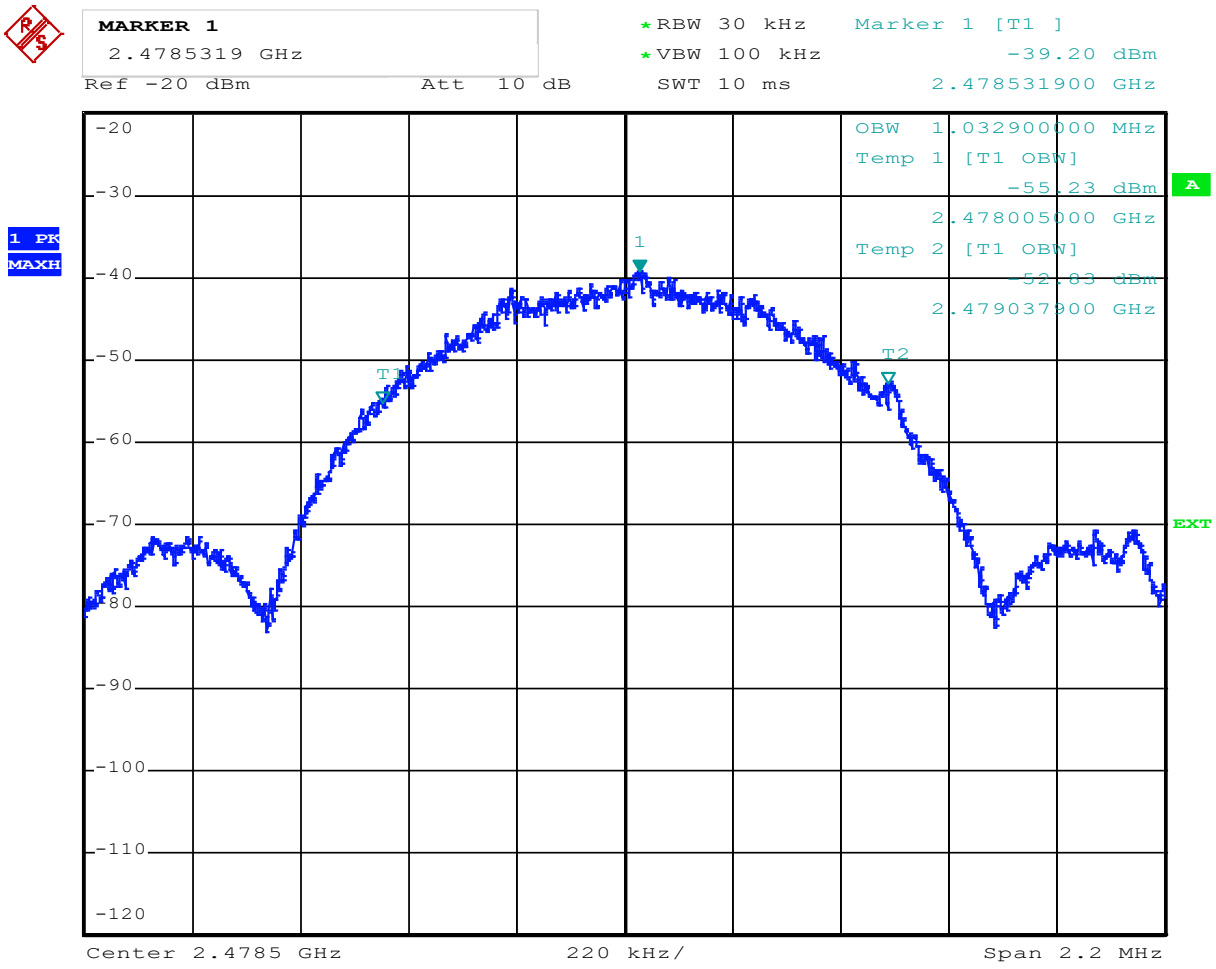
Low Channel – GFSK



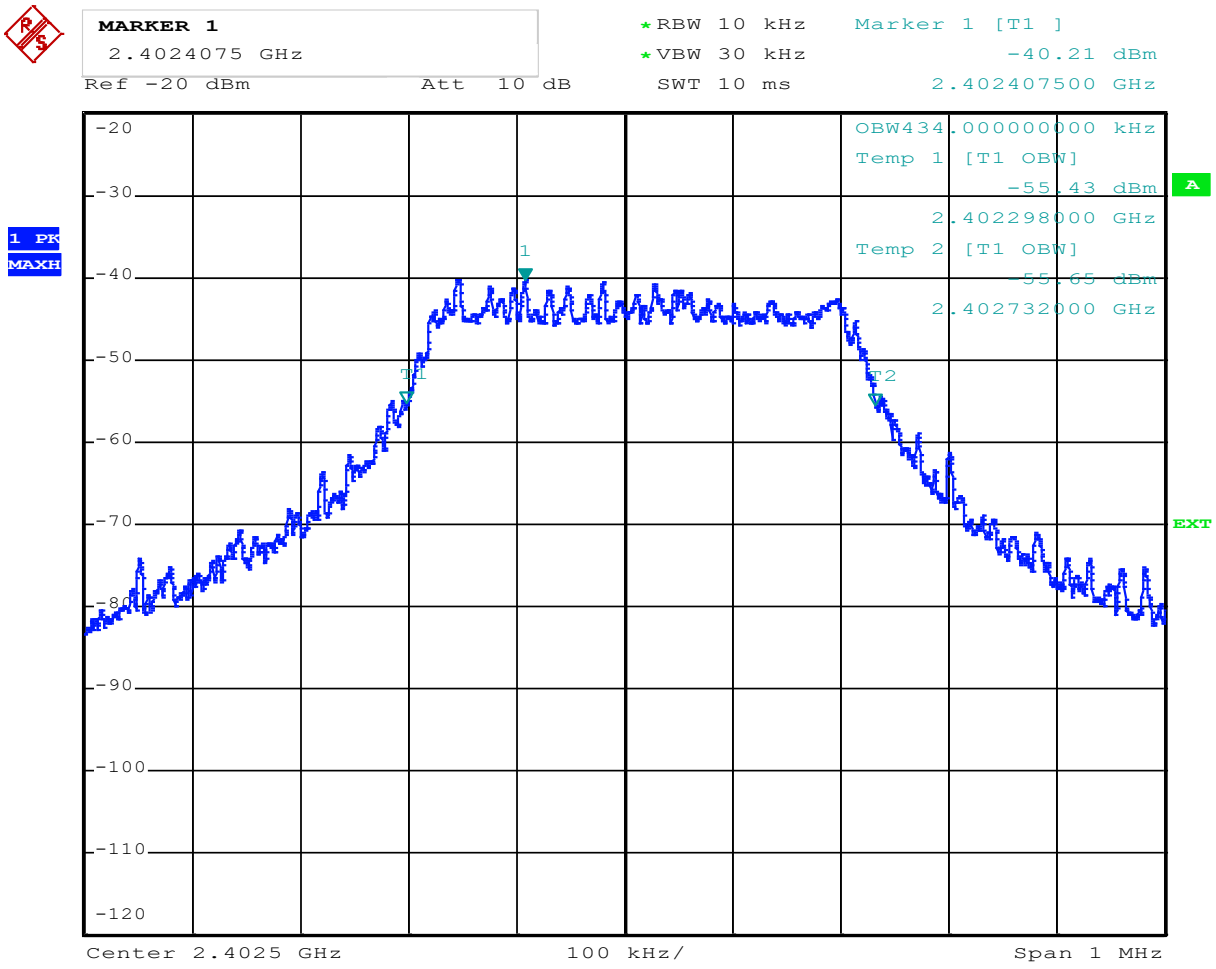
Central Channel – GFSK



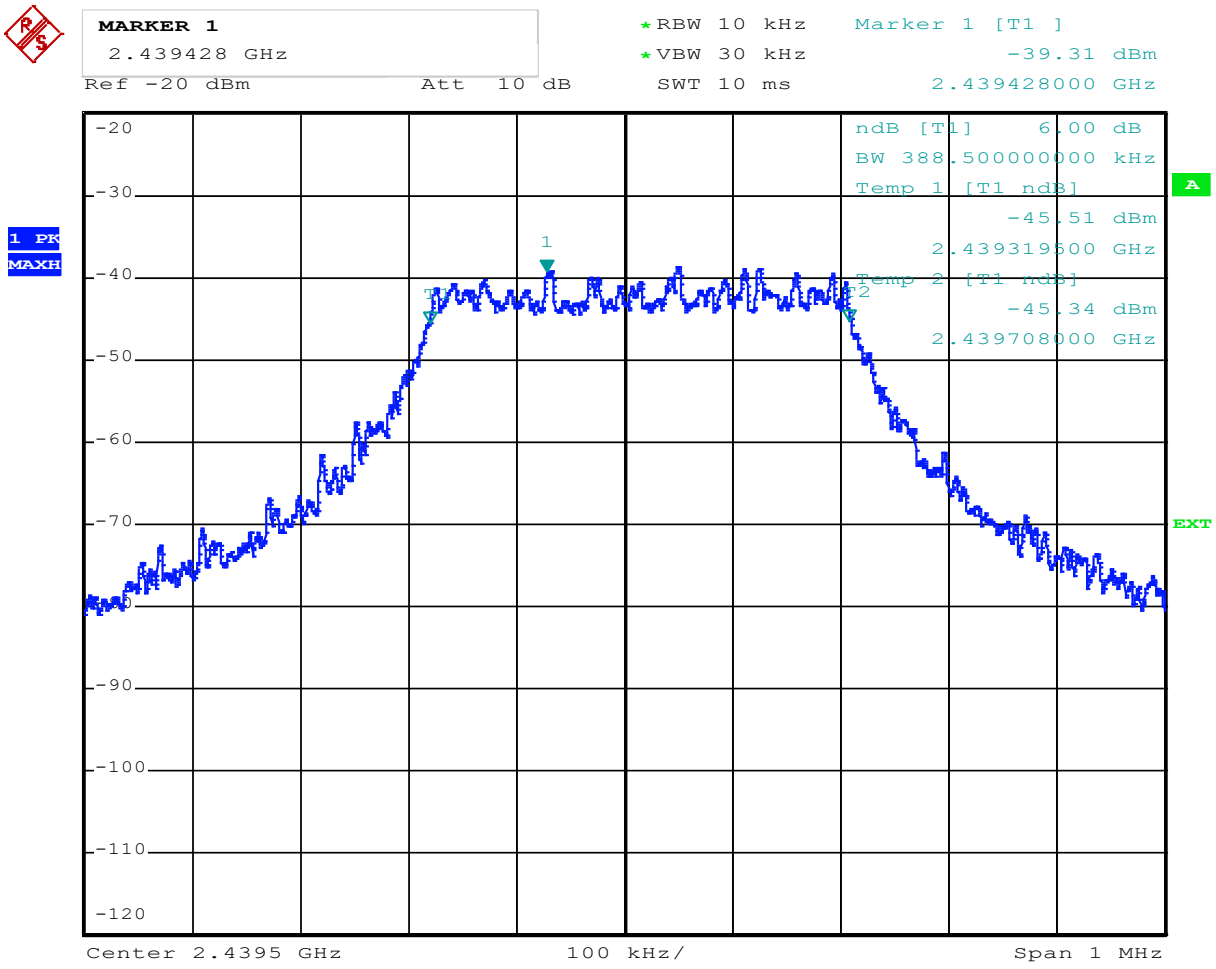
High Channel – GFSK



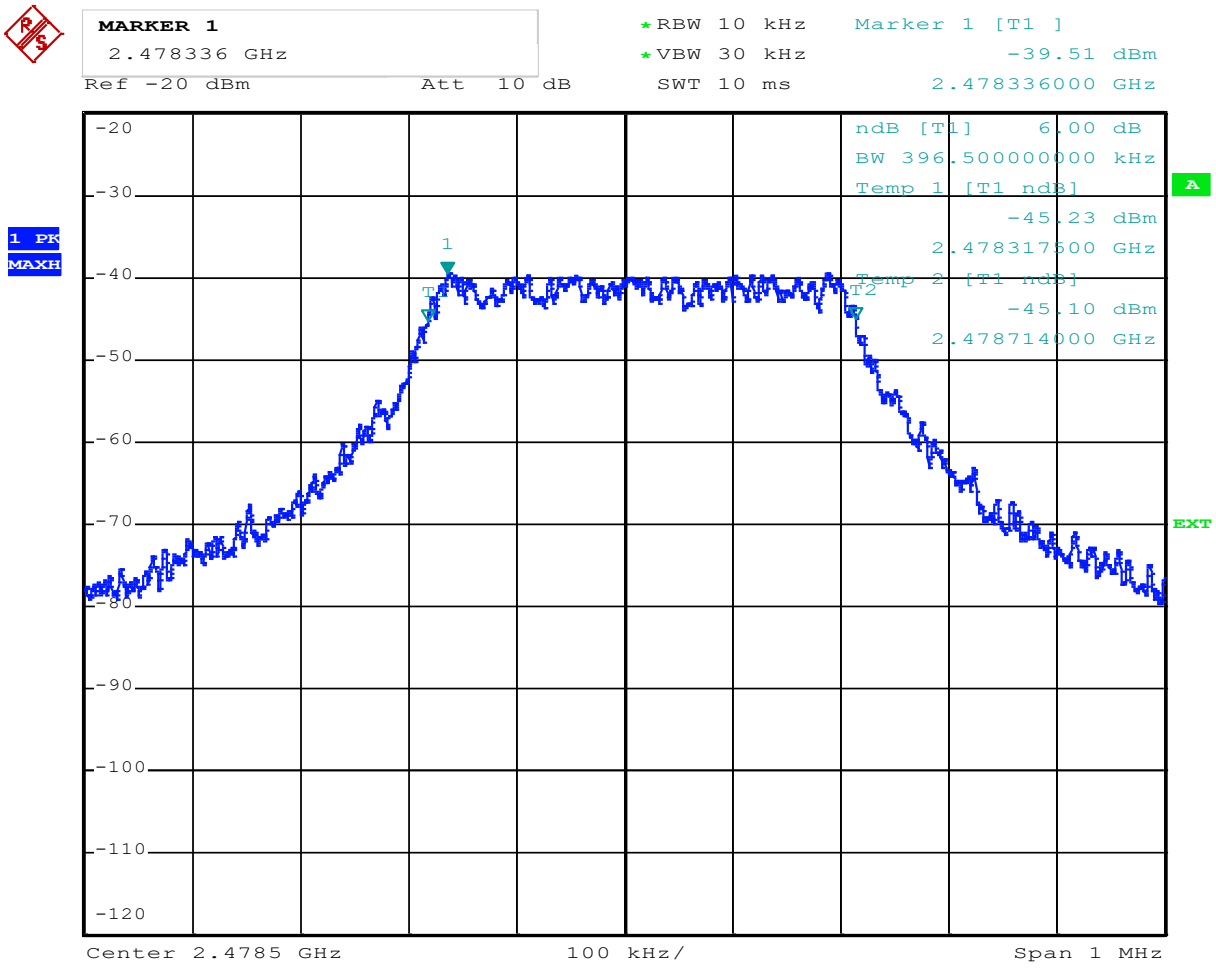
Low Channel – LoRa



Central Channel – LoRa

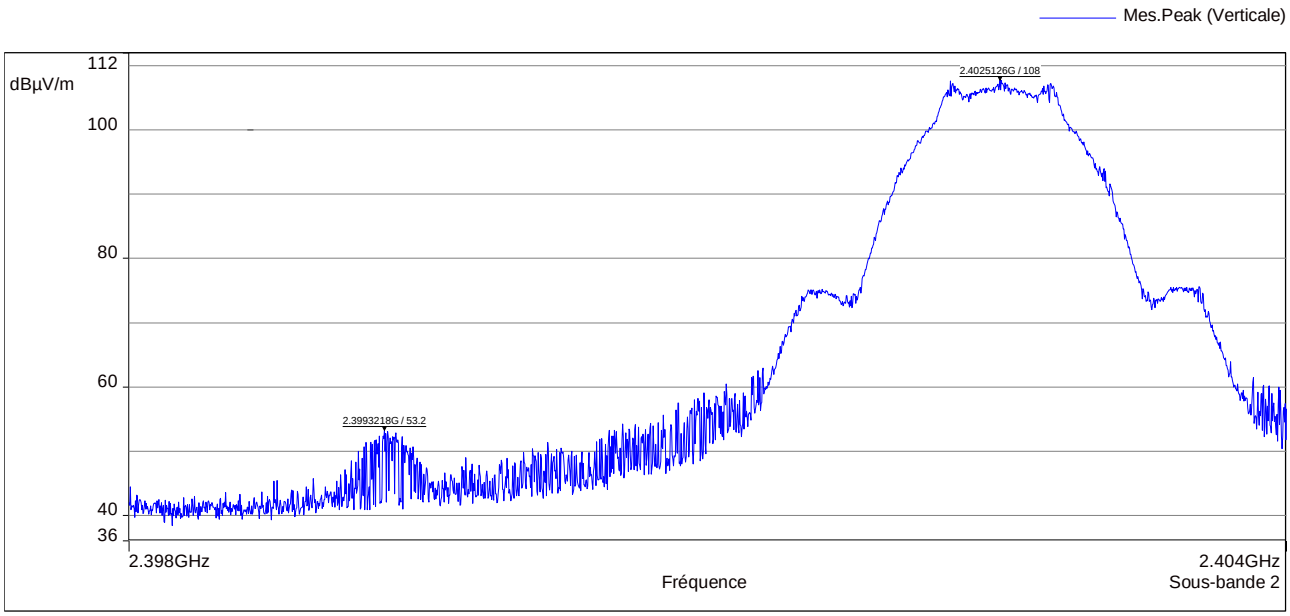


High Channel – LoRa



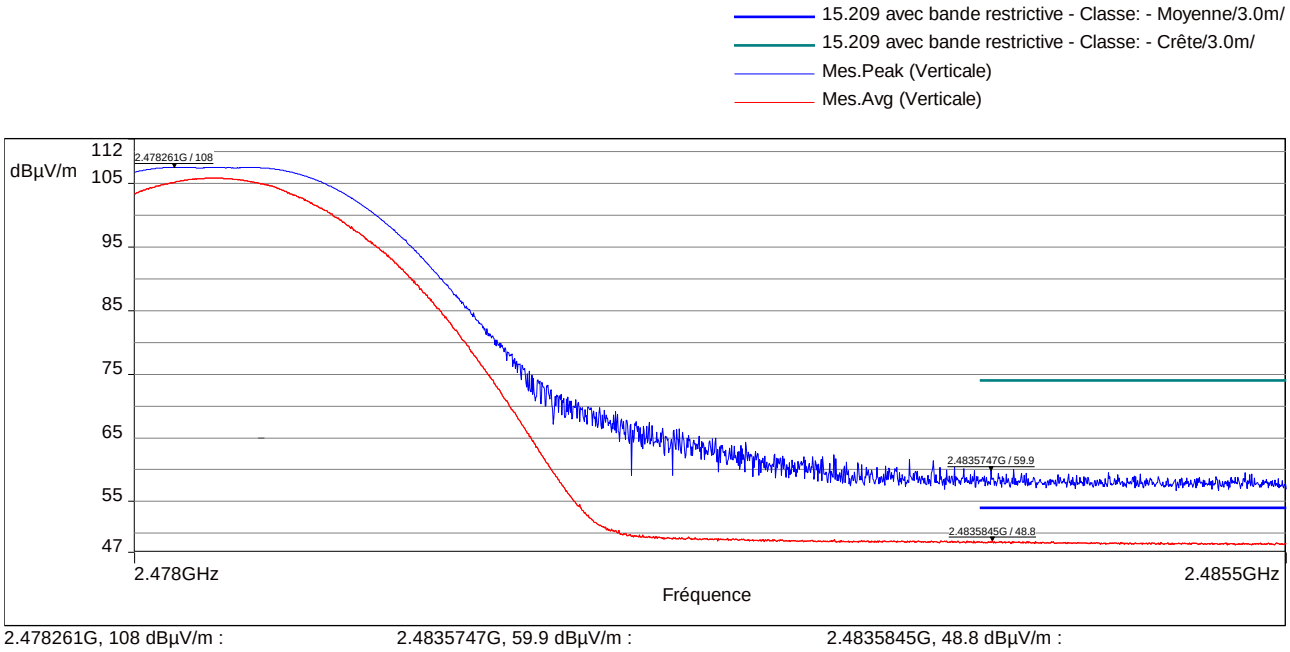
APPENDIX 4: Band edge

Low Channel – GFSK: Band edge worst case measurement



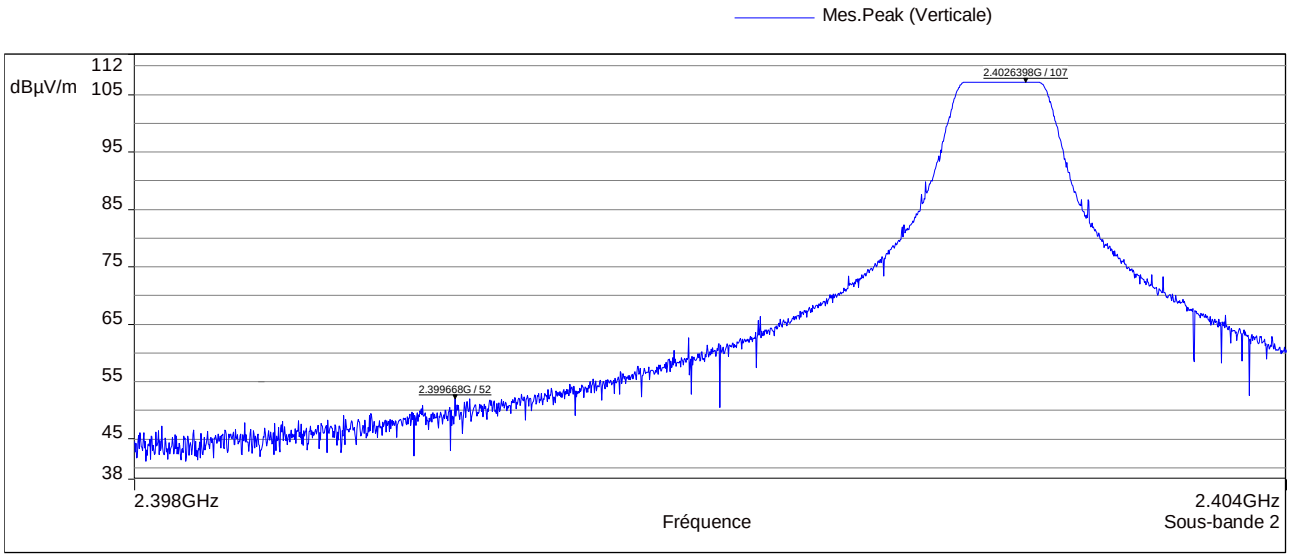
2.3993218G, 53.2 dBµV/m : 2.4025126G, 108 dBµV/m :

High Channel – GFSK: Band edge worst case measurement



2.478261G, 108 dBµV/m : 2.4835747G, 59.9 dBµV/m : 2.4835845G, 48.8 dBµV/m :

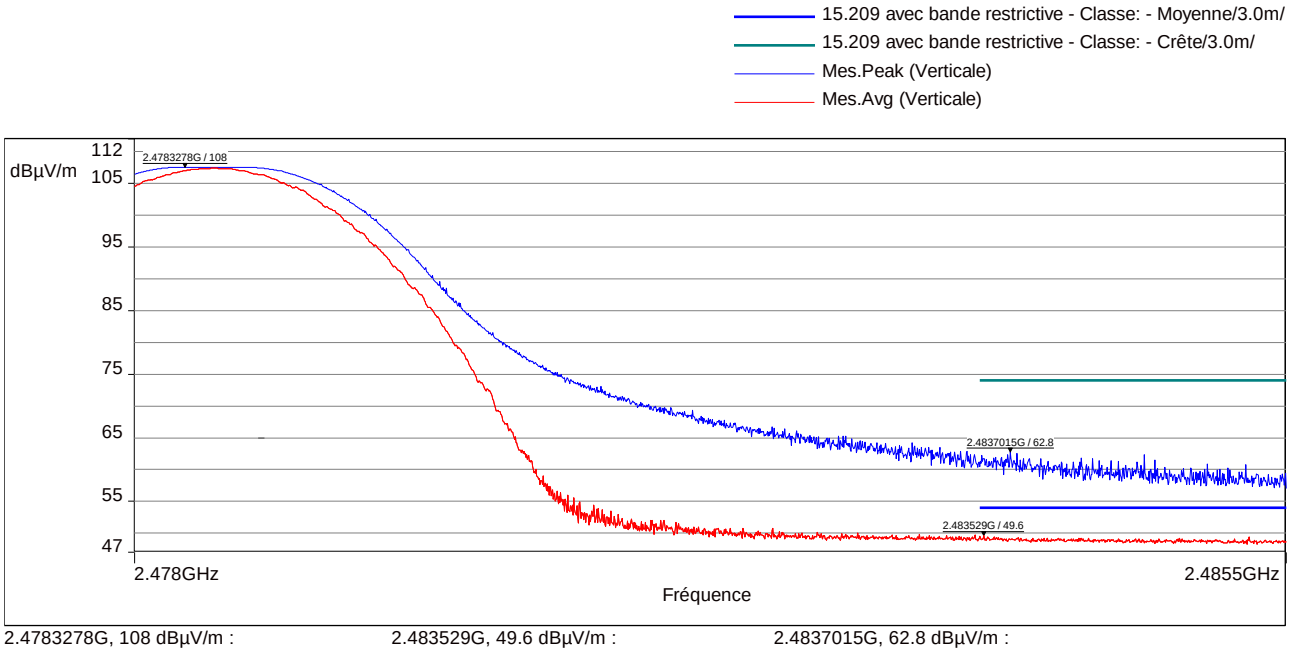
Low Channel – LoRa: Band edge worst case measurement



2.399668G, 52 dBµV/m :

2.4026398G, 107 dBµV/m :

High Channel – LoRa: Band edge worst case measurement



2.4783278G, 108 dBµV/m :

2.483529G, 49.6 dBµV/m :

2.4837015G, 62.8 dBµV/m :