EMITECH GROUPE

RR051-17-104472-1-A Ed. 0

Certification Radio test report

According to the standard:
CFR 47 FCC PART 15

Equipment under test:
INDUSTRIAL TRACKER

FCC ID: 2AOSP-U200

Company:
ABEEWAY

Distribution: Mr DANCHESI **(Company:** ABEEWAY**)**

Number of pages: 69 with 6 appendixes

Ed.	Date	Modified Page(s)	Technical Verification and Quality Approval Name and Function	Visa
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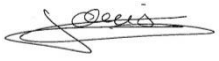
S51 RTY 000 RAD 00004 [00]

DESIGNATION OF PRODUCT:	**INDUSTRIAL TRACKER**
Serial number (S/N):	20635F0OC80001FB
Reference / model (P/N):	U200
Software version:	actt-macro-mtos-rev1.2-4 Asset Tracker v1.x (for production)
MANUFACTURER:	ABEEWAY

COMPANY SUBMITTING THE PRODUCT:

Company:	ABEEWAY
Address:	635 ROUTE DES LUCIOLES 06560 VALBONNE FRANCE
Responsible:	Mr DANCHESI
***Person present during the tests*:**	Mr DANCHESI (30 and 31 Aug-18)
DATES OF TEST:	From 30-Aug-18 to 5-Sep-18
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
WRITTEN BY:	S. LOUIS

VISA:



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1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment:: **Industrial Tracker** in accordance with normative reference.

The device under test integrates a multifrequencies wireless transceiver LoRa.

The products integrate also a Wi-Fi module already certified (FCCID: 2AC7Z-ESPWROOM02) and a GPS receiver.

This radio test report concerns only the results for certification procedure on the LoRa part, for test under subpart B see radio test report RR051-17-104472-3-A Ed. 0.
The two transceivers (LoRa and Wi-Fi) can't emit simultaneously as declared by the manufacturer.

2. PRODUCT DESCRIPTION

Class: B

Utilization: Residential

Antenna type and gain: Integrated antenna, gain declared by the applicant (considered 1 dBi)

Power adjusted by software: The power level is tuned to reach max power

Operating frequency range: From 902.3 MHz to 914.9 MHz

Frequency tested: 902.3MHz, 908.7MHz, 914.9MHz for transmission
923.3MHz, 925.1MHz, 927.5MHz for reception

Frequencies plan detailed transmitter:

Channel frequencies	LoRa bandwidth (KHz)	Number of channel	Channel width (KHz)
902,3+i*0,2MHz (i=0 à 63)	125	64	200

Frequencies plan detailed receiver:

Channel frequencies	LoRa bandwidth (KHz)	Number of channel	Channel width (KHz)
923,3+i*0.6MHz (i=0 à 7)	500	8	600

Number of channels: 64

Channel spacing: 200 kHz

Modulation: LoRa

Spread factor: 7 and 10

Power source: No rechargeable 3.6Vdc Battery.

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 (2018)	Radio Frequency Devices
ANSI C63.4	2014 Methods of measurement of Radio-Noise Emissions from low-voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C63.10	2013 Testing Unlicensed Wireless Devices.
558074 D01 DTS v05	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.
447498 D01 General RF Exposure Guidance v06	RF Exposure procedures and equipment authorization policies for mobile and portable equipment

4. TEST METHODOLOGY

Radio performance tests procedures given in CFR 47 part 15:

Subpart B –Unintentional Radiators
- Paragraph 109: Radiated emission limits

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 212: Modular transmitter
- 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 V3.16.0.64	Software	/	/	/
1406	EMCO 6502	Loop antenna	13/04/2017	2	13/04/2019
2648	ALC ALN02-0032	Low-noise amplifier	30/03/2018	1	30/03/2019
4088	R&S FSP40	Spectrum Analyzer	21/02/2018	2	21/02/2020
4393	Wainwright WLJS800-C11/60EE	Low Pass Filter	29/03/2018	2	29/03/2020
6884	Suhner 1.5m	Cable	29/03/2018	2	29/03/2020
7190	R&S HL223	Antenna	15/03/2016	3	15/03/2019
7240	Emco 3110	Biconical antenna	15/03/2016	3	15/03/2019
7310	Filtek HP12/1200-5AA	High-pass filter	29/03/2018	2	29/03/2020
8511	HP 8447D	Low-noise amplifier	01/02/2018	1	01/02/2019
8534	EMCO 3115	Antenna	16/03/2016	3	16/03/2019
8535	EMCO 3115	Antenna	10/02/2016	4	10/02/2020
8578	2GHz	Cable	29/03/2018	2	29/03/2020
8593	SIDT Cage 2	Anechoic chamber	/	/	/
8707	R&S ESI7	Test receiver	13/02/2018	1	13/02/2019
8732	Emitech	OATS	11/10/2016	3	11/10/2019
8749	La Crosse Technology WS-9232	Meteo station	23/09/2016	2	23/09/2018
8750	La Crosse Technology WS-9232	Meteo station	23/09/2016	2	23/09/2018
8783	EMCO 3147	Log periodic antenna	15/03/2016	3	15/03/2019
8864	Champ libre Juigné. V3.4	Software	/	/	/
8896	ACQUISYS GPS8	Satellite synchronized frequency standard	/	/	/
8972	K&L Microwave 500-1000MHz	Notch filter	/	/	/
10730	Mini-circuit ZFL-1000LN	Low-noise amplifier	12/02/2018	1	12/02/2019
10739	LUCIX Corp S005180M3201	Low-noise amplifier	29/03/2018	1	29/03/2019
12911	Huber + Suhner N-2m	cable	29/03/2018	2	29/03/2020
12912	Huber + Suhner N-5m	cable	29/03/2018	2	29/03/2020
14476	Fluke 177	Multimeter	20/07/2018	2	20/07/2020
-	GPIB SHOT V2.4	Software	/	/	/

6. TESTS AND CONCLUSIONS

6.1 unintentional radiator (subpart B)

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.109	RADIATED EMISSION LIMITS	X				

NAp: Not Applicable NAs: Not Asked

6.2 intentional radiator (subpart C)

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		
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		
	(b) Maximum peak output power	X				*Note 4*
	(c) Operation with directional antenna gains > 6 dBi			X		
	(d) Intentional radiator	X				
	(e) Peak power spectral density	X				
	(f) Hybrid system	X				*Note 5* *Note 6*
	(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.

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

Note 5: The transceiver used is SX1272 of Semtech also LoRa protocol is used.

The frequency hopping system uses 64 channels

Each frequency is used equally on the average time by the transmitter.

With Spread Factor 7:

The timing by channel is 36ms (see appendix 5).

During 64 channels × 0.4 s = 25.6 s, any channel is used 1 time , then 1 x 36ms = 36ms, thus the average time of occupancy on any channel is less than 400 ms within a period of 0.4 seconds multiplied by the number of hopping channels employed, in normal operating mode.

Number of channels	Observation period (0.4s * Nbr of channel) (s)	Maximal Duration of each burst (ms)	Number of burst repetition during observation period	average time of occupancy on any channel (s)	Limits (s)
64	25.6	36	1	0.036	0.4

With Spread Factor 10:

The timing by channel is 248.4ms (see appendix 5).

During 64 channels × 0.4 s = 25.6 s, any channel is used 1 time , then 1 x 248.4ms = 248.4ms, thus the average time of occupancy on any channel is less than 400 ms within a period of 0.4 seconds multiplied by the number of hopping channels employed, in normal operating mode.

Number of channels	Observation period (0.4s * Nbr of channel) (s)	Maximal Duration of each burst (ms)	Number of burst repetition during observation period	average time of occupancy on any channel (s)	Limits (s)
64	25.6	248.4	1	0.248	0.4

Note 6:
The minimum 6 dB bandwidth of the equipment is 260 kHz on high channel (see appendix 2).
The maximum 99% bandwidth of the equipment is 126 kHz (see appendix 3).

7. RF EXPOSURE

LoRa part:
Maximum measured power = 108.7 dBµV/m = 0.179 W at 914.9 MHz
with $P = (E \times d)^2 / (30 \times Gp)$ *with d = 10 m and Gp = 1.26*

In accordance with KDB 447498 D01 General RF Exposure Guidance v06:

PSD= EIRP/(4*π*R^2)

⇨ 0.179/(4*π*(20 cm)²)= 0.036 x 10^{-3} mW/cm² (limit = f / 1500 = 914.9 / 1500 = 0.6 mW/cm²).

The equipment fulfils the requirements on power density for general population/uncontrolled exposure and therefore fulfils the requirements of 47 CFR §1.1310.

WiFi Part:
According grant maximum measured power = 108.7 dBµV/m = 0.167 W for 2412 - 2462 MHz frequency band.

In accordance with KDB 447498 D01 General RF Exposure Guidance v06:

PSD= EIRP/(4*π*R^2)

⇨ 0.167/(4*π*(20 cm)²)= 0.033 x 10^{-3} mW/cm² (limit = 1 mW/cm²).

The equipment fulfils the requirements on power density for general population/uncontrolled exposure and therefore fulfils the requirements of 47 CFR §1.1310.

8. 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 %

9. RADIATED EMISSION LIMITS

Temperature (°C) : 23.2 **Humidity (%HR):** 50 **Date :** August 29, 2018

Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 109

Limit class: Class B

Test set up:

First an exploratory radiated measurement was performed. During this phase the product is oriented in three orthogonal planes.

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, 1.5m 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 5 GHz / 5th harmonic of the highest frequency used (928MHz).

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

Bandwidth: 120 kHz (F < 1 GHz) 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 reception mode using SF10 Spread Factor.

Results:

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

Voltage at the beginning of test (V):	3.88
Voltage at the end of test (V):	3.73
Percentage of voltage drop during the test (%):	3.87

Sample N° 1 Channel Low, Central and High

Not any spurious has been detected.

Applicable limits:	for 30 MHz ≤ F ≤ 88 MHz :	40 dBµV/m at 3 meters
	for 88 MHz < F ≤ 216 MHz :	43.5 dBµV/m at 3 meters
	for 216 MHz < F ≤ 960 MHz :	46 dBµV/m at 3 meters
	Above 960 MHz :	54 dBµV/m at 3 meters

Test conclusion:

RESPECTED STANDARD

10. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS

Temperature (°C) : 22.2 **Humidity (%HR):** 38 **Date :** September 5, 2018
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 under test is blocked in continuous modulated transmission mode, at the highest output power level at which the transmitter is intended to operate.
The power level is tuned to reach max power.

Results:

Power source:
We used for power source the internal battery of the equipment and we noted:
Voltage at the beginning of test (V): 3.69
Voltage at the end of test (V): 3.64
Percentage of voltage drop during the test (%): 1.35

Lower Band Edge: from 900MHz to 902MHz
Upper Band Edge: from 928MHz to 930MHz

Sample N° 1 with Spead Factor 7 – Hopping mode off:

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)	Limit (dBc)	Margin (dB)
902.3	103.40	P	901.98	45.39	-30 dBc (2)	15.39
914.9	106.80	P	928.04	60.90	-30 dBc (2)	30.90

(1) *Marker-Delta method*
(2) *According to KDB 558074 §11.1, as the output power was measured with an average detection the limit is -30 dBc*
99% bandwidth curves are given in appendix 3; band-edge curves are given in appendix 4.

Sample N° 1 with Spead Factor 7 – Hopping mode on:

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)	Limit (dBc)	Margin (dB)
902.3	103.40	P	901.98	46.36	-30 dBc (2)	16.36
914.9	106.80	P	928.21	60.96	-30 dBc (2)	30.96

(1) *Marker-Delta method*
(2) *According to KDB 558074 §11.1, as the output power was measured with an average detection the limit is -30 dBc*
99% bandwidth curves are given in appendix 3; band-edge curves are given in appendix 4.

Sample N° 1 with Spead Factor 10 – Hopping mode off:

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)	Limit (dBc)	Margin (dB)
902.3	104.10	P	901.99	46.31	-30 dBc (2)	16.31
914.9	108.30	P	928.07	61.01	-30 dBc (2)	31.01

(1) *Marker-Delta method*
(2) *According to KDB 558074 §11.1, as the output power was measured with an average detection the limit is -30 dBc*
99% bandwidth curves are given in appendix 3; band-edge curves are given in appendix 4.

Sample N° 1 with Spead Factor 10 – Hopping mode on:

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)	Limit (dBc)	Margin (dB)
902.3	104.10	P	901.97	51.37	-30 dBc (2)	21.37
914.9	108.30	P	928.08	61.40	-30 dBc (2)	31.40

(1) *Marker-Delta method*
(2) *According to KDB 558074 §11.1, as the output power was measured with an average detection the limit is -30 dBc*
99% bandwidth curves are given in appendix 3; band-edge curves are given in appendix 4.

Test conclusion:

RESPECTED STANDARD

11. MAXIMUM PEAK CONDUCTED (AVERAGE) OUTPUT POWER

Temperature (°C) : 24.3 **Humidity (%HR):** 39 **Date :** September 4, 2018
Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 15.247 (b)

AVGSA-1 of paragraph 11.9.2.2.2 of ANSI C63.10

Test set up:

First an exploratory radiated measurement was performed.
During this phase the product is oriented in three orthogonal planes.

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

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.

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

See photos in appendix 2.

Distance of antenna: 10 meters (in open area test site)

Antenna height: 1 to 4 meters (in open area test site)

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

The measure of average output power is measured with a spectrum analyzer:

Resolution bandwidth:	1% to 5% of the OBW, not to exceed 1 MHz.
Video bandwidth:	3 x RBW
Span:	At least 1.5 x OBW
Detector:	RMS
Sweep points:	At least 2 x SPAN/RBW
Sweep time:	Auto
Trace:	Average detector RMS
Trace Number:	At least 100 traces

Then channel power function is used to compute power on OBW band.

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 = 1 dBi.

Equipment under test operating condition:

The equipment under test is blocked in continuous modulated transmission mode, at the highest output power level at which the transmitter is intended to operate.
The power level is tuned to reach max power.

Results:

Power source:
We used for power source the internal battery of the equipment and we noted:
Voltage at the beginning of test (V): 3.76
Voltage at the end of test (V): 3.71
Percentage of voltage drop during the test (%): 1.33

Sample N° 1 Low Channel 902.3MHz – SF7

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	103.4	0.058	1

Polarization of test antenna: Horizontal (height: 118 cm)
Position of equipment: Position 3 (azimuth: 0 degrees)

Sample N° 1 Central Channel 908.7MHz – SF7

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	105.1	0.086	1

Polarization of test antenna: Horizontal (height: 116 cm)
Position of equipment: Position 1 (azimuth: 172 degrees)

Sample N° 1 High Channel 914.9MHz –SF7

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	106.8	0.127	1

Polarization of test antenna: Horizontal (height: 116 cm)
Position of equipment: Position 1 (azimuth: 167 degrees)

(1) $P = (E \times d)^2 / (30 \times Gp)$ with d = 10 m and Gp = 1.26
Antenna gain: 1 dBi

Sample N° 1 Low Channel 902.3MHz – SF10

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	104.1	0.068	1

Polarization of test antenna: Horizontal (height: 116 cm)
Position of equipment: Position 1 (azimuth: 0 degrees)

Sample N° 1 Central Channel 908.7MHz – SF10

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	106.2	0.110	1

Polarization of test antenna: Horizontal (height: 121cm)
Position of equipment: Position 1 (azimuth: 178 degrees)

Sample N° 1 High Channel 914.9MHz –SF10

	Electro-magnetic field (dBµV/m):	Conducted power (1) (W)	Limit (W)
Nominal supply voltage: 3.6V	108.3	0.179	1

Polarization of test antenna: Horizontal (height: 225 cm)
Position of equipment: Position 1 (azimuth: 169 degrees)

(1) $P = (E \times d)^2 / (30 \times Gp)$ with d = 10 m and Gp = 1.26
Antenna gain: 1 dBi

Test conclusion:

RESPECTED STANDARD

12. INTENTIONAL RADIATOR

Temperature (°C) : 23.2 **Humidity (%HR):** 52 **Date :** August 30, 2018
Technician : S. LOUIS

Standard: FCC Part 15

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

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 three orthogonal planes.

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, 1.5m from a ground plane.

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

See photos in appendix 2.

Emissions in non-restricted frequency bands method of paragraph 11 of KDB 558074 and Emissions in restricted frequency bands method of paragraph 12 of KDB 558074 are apply.

Frequency range: From 9 kHz to 9.28GHz / 10th harmonic of the highest fundamental frequency (928MHz)

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 under test is blocked in continuous modulated transmission mode, at the highest output power level at which the transmitter is intended to operate.
The power level is tuned to reach max power.

Results:

Power source:
We used for power source the internal battery of the equipment and we noted:
Voltage at the beginning of test (V): 3.76
Voltage at the end of test (V): 3.62
Percentage of voltage drop during the test (%): 3.72

Sample N° 1 Low Channel – SF7

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1804.6	P	150	100	3	H	46.3	88.7	42.4
2706.9 (1)	P	150	1000	3	H	50.2 (2)	74	23.8
3609.2 (1)	P	150	1000	3	H	50.6 (2)	74	23.4
4511.5 (1)	P	150	1000	3	H	50.8 (2)	74	23.2
5413.8 (1)	P	150	1000	1	V	47.8 (2)	74	26.2
6316.1	P	150	100	3	H	48.2	88.7	40.5
7218.4	P	150	100	1	H	53.7	88.7	35.0
8120.7 (1)	P	150	1000	1	H	53.9 (2)	74	20.1
8120.7 (1)	P	150	1000	1	H	50.3	54	3.7
9023 (1)	P	150	1000	3	H	59.1	74	14.9
9023 (1)	Av	150	1000	3	H	53.9	54	0.1

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 Low Channel – SF10

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1804.6	P	150	100	3	H	46.8	88.7	41.9
2706.9 (1)	P	150	1000	3	H	51 (2)	74	23.0
3609.2 (1)	P	150	1000	3	H	50.4 (2)	74	23.6
4511.5 (1)	P	150	1000	3	H	50.4 (2)	74	23.6
5413.8 (1)	P	150	1000	3	H	48.6 (2)	74	25.4
6316.1	P	150	100	1	V	48.2	88.7	40.5
7218.4	P	150	100	1	H	52.3	88.7	36.4
8120.7 (1)	P	150	1000	1	H	54.1	74	20.1
8120.7 (1)	Av	150	1000	1	H	50.3	54	3.7
9023 (1)	P	150	1000	3	H	58.4	74	15.6
9023 (1)	Av	150	1000	3	H	53.9	54	0.1

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 Central Channel – SF7

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1817.4	P	150	100	3	H	44.2	88.7	44.5
2726.1 (1)	P	150	1000	3	H	49.8 (2)	74	24.2
3634.8 (1)	P	150	1000	3	H	48.4 (2)	74	25.6
4543.5 (1)	P	150	1000	3	H	50.0 (2)	74	24.0
5452.2 (1)	P	150	1000	1	V	47.2 (2)	74	26.8
6360.9	P	150	100	2	V	47.8	88.7	40.9
7269.6 (1)	P	150	1000	1	H	53.2 (2)	74	20.8
8178.3 (1)	P	150	1000	1	H	53.9 (2)	74	20.1
8178.3 (1)	Av	150	1000	1	H	50.1	54	0.9
9087 (1)	P	150	1000	3	H	59.1	74	14.9
9087 (1)	Av	150	1000	3	H	53.9	54	0.1

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 Central Channel – SF10

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1817.4	P	150	100	3	H	43.5	88.7	45.2
2726.1 (1)	P	150	1000	3	H	50.2 (2)	74	23.8
3634.8 (1)	P	150	1000	3	H	48.1 (2)	74	25.9
4543.5 (1)	P	150	1000	3	H	50.0 (2)	74	24.0
5452.2 (1)	P	150	1000	1	V	46.8 (2)	74	27.2
6360.9	P	150	100	2	V	47.2	88.7	41.5
7269.6 (1)	P	150	1000	1	H	53.4 (2)	74	20.6
8178.3 (1)	P	150	1000	1	H	53.9 (2)	74	20.1
8178.3 (1)	P	150	1000	1	H	51.2	54	2.8
9087 (1)	P	150	1000	3	H	58.8	74	15.2
9087 (1)	Av	150	1000	3	H	53.9	54	0.1

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 – SF7

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1829.8	P	150	100	3	H	41.2	88.7	47.5
2744.7 (1)	P	150	1000	3	H	47.8 (2)	74	26.2
3659.6 (1)	P	150	1000	3	H	48.0 (2)	74	26.0
4574.5 (1)	P	150	1000	3	H	49.5 (2)	74	24.5
5489.4 (1)	P	150	1000	1	V	45.6 (2)	74	28.4
6404.3	P	150	100	2	V	47.1	88.7	41.6
7319.2 (1)	P	150	1000	1	H	52.2 (2)	74	21.8
8234.1 (1)	P	150	1000	1	H	57.0	74	17.0
8234.1 (1)	Av	150	1000	1	H	52.9	54	1.1
9149 (1)	P	150	1000	3	H	58.6	74	14.9
9149 (1)	Av	150	1000	3	H	53.8	54	0.2

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 – SF10

Frequencies (MHz)	Detector P QP Av	Antenna height (cm)	RBW (kHz)	Position	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
1829.8	P	150	100	3	H	41.3	88.7	47.4
2744.7 (1)	P	150	1000	3	H	48.1 (2)	74	25.9
3659.6 (1)	P	150	1000	3	H	48.1 (2)	74	25.9
4574.5 (1)	P	150	1000	3	H	48.8 (2)	74	25.2
5489.4 (1)	P	150	1000	1	V	45.8 (2)	74	28.2
6404.3	P	150	100	2	V	46.6	88.7	42.1
7319.2 (1)	P	150	1000	1	H	52.1 (2)	74	25.9
8234.1 (1)	P	150	1000	1	H	57.2	74	16.8
8234.1 (1)	P	150	1000	1	H	53.1	54	0.9
9149 (1)	P	150	1000	3	H	58.8	74	15.2
9149 (1)	Av	150	1000	3	H	53.9	54	0.1

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).*

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 30 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 118.7 dBµV/m at 3m on high channel.

So the applicable limit is 88.7 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

13. MAXIMUM CONDUCTED POWER DENSITY

Temperature (°C) : 21 **Humidity (%HR):** 43 **Date :** September 5, 2018
Technician : S. LOUIS

Standard: FCC Part 15

Test procedure: paragraph 15.247 (e)

AVGPSD-1 of paragraph 11.10.3 of ANSI C63.10

Test set up:

The system is tested in anechoic chamber. The EUT is placed on a rotating table, 1.5m from a ground plane. Zero degree azimuth corresponds to the front of the device under test.

The measure is realized in radiated mode taking into account a correlation between the maximal Peak Output Power found in Open test area and near field found in the anechoic room.

The PSD is measured with a spectrum analyzer.

Resolution bandwidth:	3 kHz
Video bandwidth:	10 kHz
Span:	At least 1.5 x OBW
Detector:	RMS
Sweep points:	At least 2 x SPAN
Sweep time:	Auto
Trace:	Average detector RMS
Trace Number:	At least 100 traces

Then the peak marker function is used.

Equipment under test operating condition:

The equipment under test is blocked in continuous modulated transmission mode, at the highest output power level at which the transmitter is intended to operate.
The power level is tuned to reach max power

Results:

Power source:
We used for power source the internal battery of the equipment and we noted:
Voltage at the beginning of test (V): 3.76
Voltage at the end of test (V): 3.71
Percentage of voltage drop during the test (%): 1.33

Sample N° 1 Low Channel – SF7

	Peak power density at frequency: 902.3 MHz
Normal test conditions	+3.9dBm
Limits	+8 dBm

Sample N° 1 Central Channel – SF7

	Peak power density at frequency: 908.7 MHz
Normal test conditions	+6.1dBm
Limits	+8 dBm

Sample N° 1 High Channel – SF7

	Peak power density at frequency: 914.9 MHz
Normal test conditions	+7.1dBm
Limits	+8 dBm

Sample N° 1 Low Channel – SF10

	Peak power density at frequency: 902.3 MHz
Normal test conditions	+4.5dBm
Limits	+8 dBm

Sample N° 1 Central Channel – SF10

	Peak power density at frequency: 908.7 MHz
Normal test conditions	+7.3dBm
Limits	+8 dBm

Sample N° 1 High Channel – SF10

	Peak power density at frequency: 914.9 MHz
Normal test conditions	+7.9dBm
Limits	+8 dBm

Test conclusion:

RESPECTED STANDARD

□□□ End of report, 6 appendixes to be forwarded □□□

APPENDIX 1: Test equipment list

Radiated emission limits

TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Biconical antenna 3110	EMCO	7240
Log periodic antenna HL223	Rohde & Schwarz	7190
Antenna 3115	EMCO	8535
Low-noise amplifier 8447D	Hewlett Packard	8511
Low-noise amplifier S005180M3201	LUCIX Corp.	10739
Cable N-2m	Huber + Suhner	12911
Cable N-5m	Huber + Suhner	12912
Cable N-1.5m	Suhner	6884
Multimeter 177	FLUKE	14476
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000

Additional provisions to the general radiated emission limitations

TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Log periodic antenna HL223	Rohde & Schwarz	7190
Cable N-2m	Huber + Suhner	12911
Cable N-5m	Huber + Suhner	12912
Cable N-1.5m	Suhner	6884
Multimeter 177	FLUKE	14476
Meteo station WS-9232	La Crosse Technology	8750
Software	GPIBShot V2.4	-

Maximum Peak Conducted (Average) Output Power

TYPE	MANUFACTURER	EMITECH NUMBER
Open test site	EMITECH	8732
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver ESI7	Rohde & Schwarz	8707
Log periodic antenna 3147	EMCO	8783
Cable N-2GHz	/	8578
Multimeter 177	FLUKE	14476
Meteo station WS-9232	La Crosse Technology	8749
Software	Champ libre Juigné. V3.5	8864

Intentional Radiator

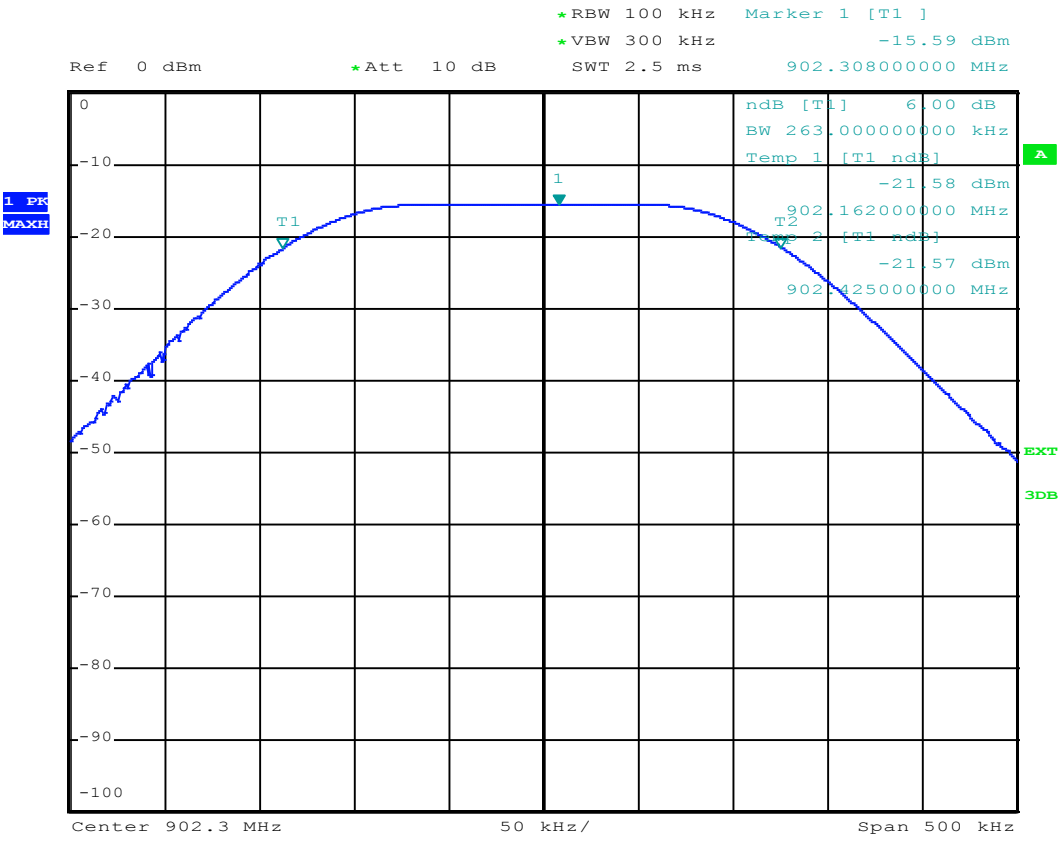
TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver ESI7	Rohde & Schwarz	8707
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Loop antenna 6502	EMCO	1406
Biconical antenna 3110	EMCO	7240
Log periodic antenna HL223	Rohde & Schwarz	7190
Antenna 3115	EMCO	8534
Low-noise amplifier 8447D	Hewlett Packard	8511
Low-noise amplifier ZFL-1000L	Mini Circuit	10730
Low-noise amplifier ALN02-0032	ALC Microwave	2648
Low pass filter WLJS800-C11/60EE	Wainwright	4393
Notch filter 500-1000MHz	K&L Microwave	8972
High pass filter HP12/1200-5AA	Filtek	7310
Cable N-2m	Huber + Suhner	12911
Cable N-5m	Huber + Suhner	12912
Cable N-1.5m	Suhner	6884
Multimeter 177	FLUKE	14476
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000

Maximum Conducted Power Density

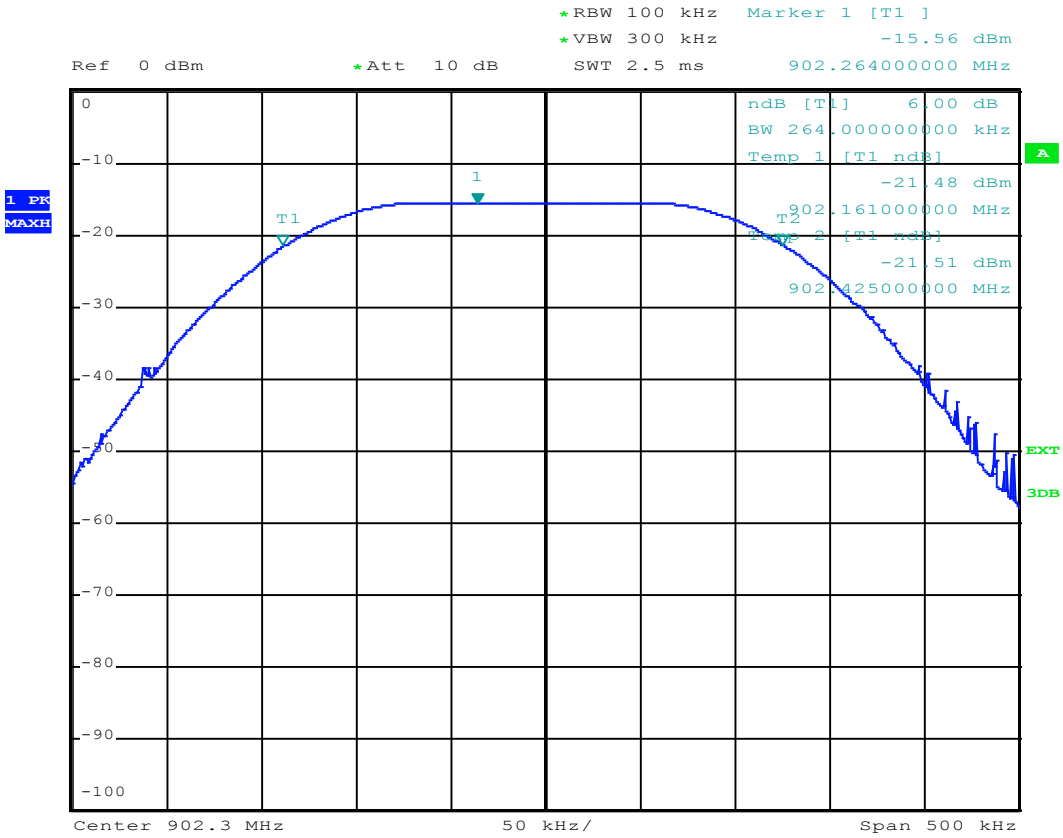
TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Log periodic antenna HL223	Rohde & Schwarz	7190
Cable N-2m	Huber + Suhner	12911
Cable N-5m	Huber + Suhner	12912
Cable N-1.5m	Suhner	6884
Multimeter 177	FLUKE	14476
Meteo station WS-9232	La Crosse Technology	8750
Software	GPIBShot V2.4	-

APPENDIX 2: 6 dB bandwidth

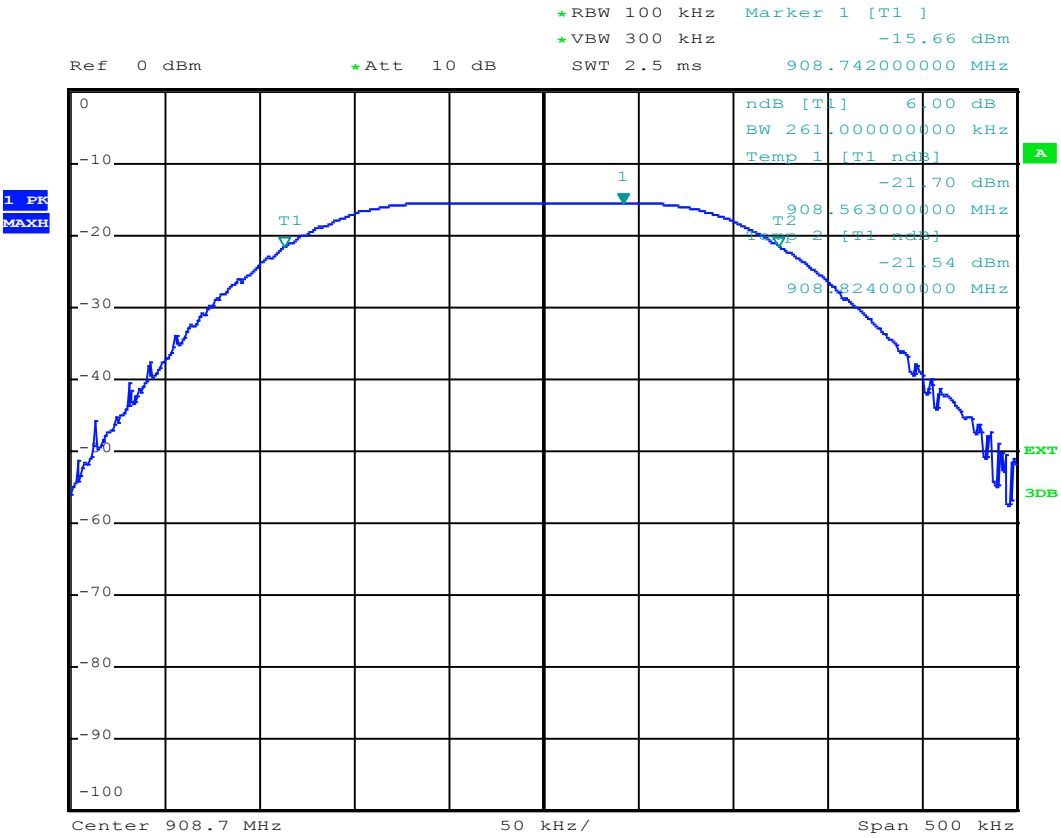
Low Channel – SF7



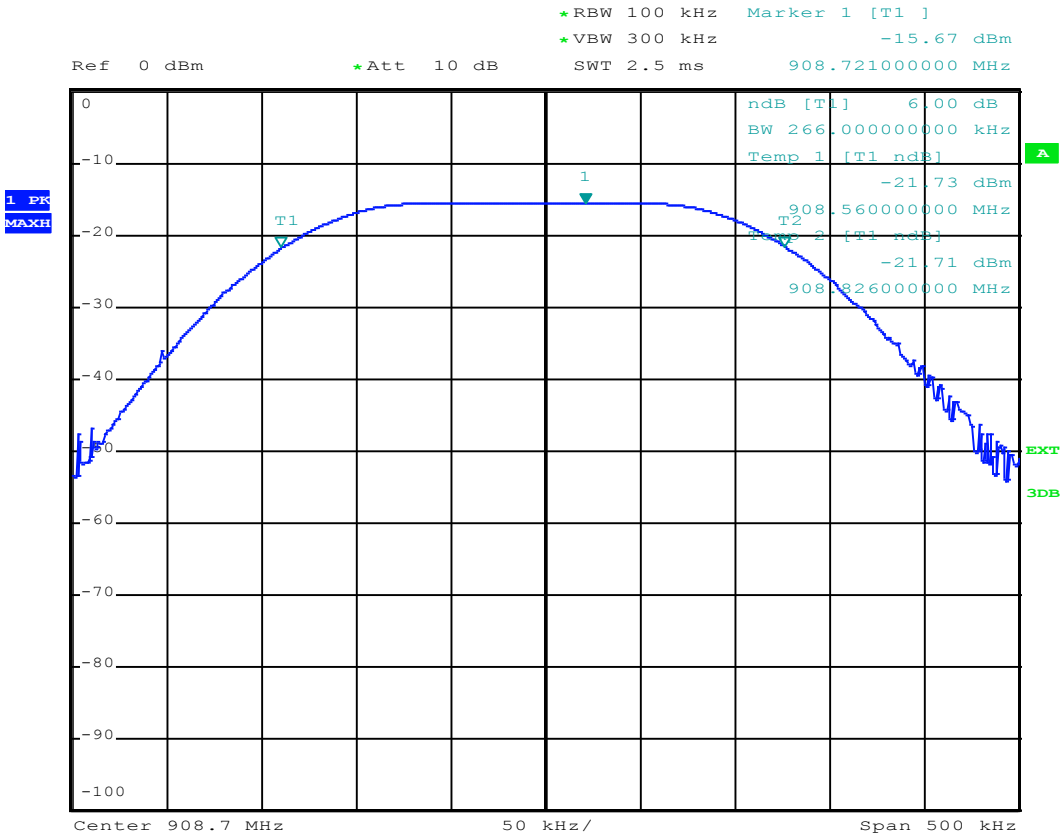
Low Channel – SF10



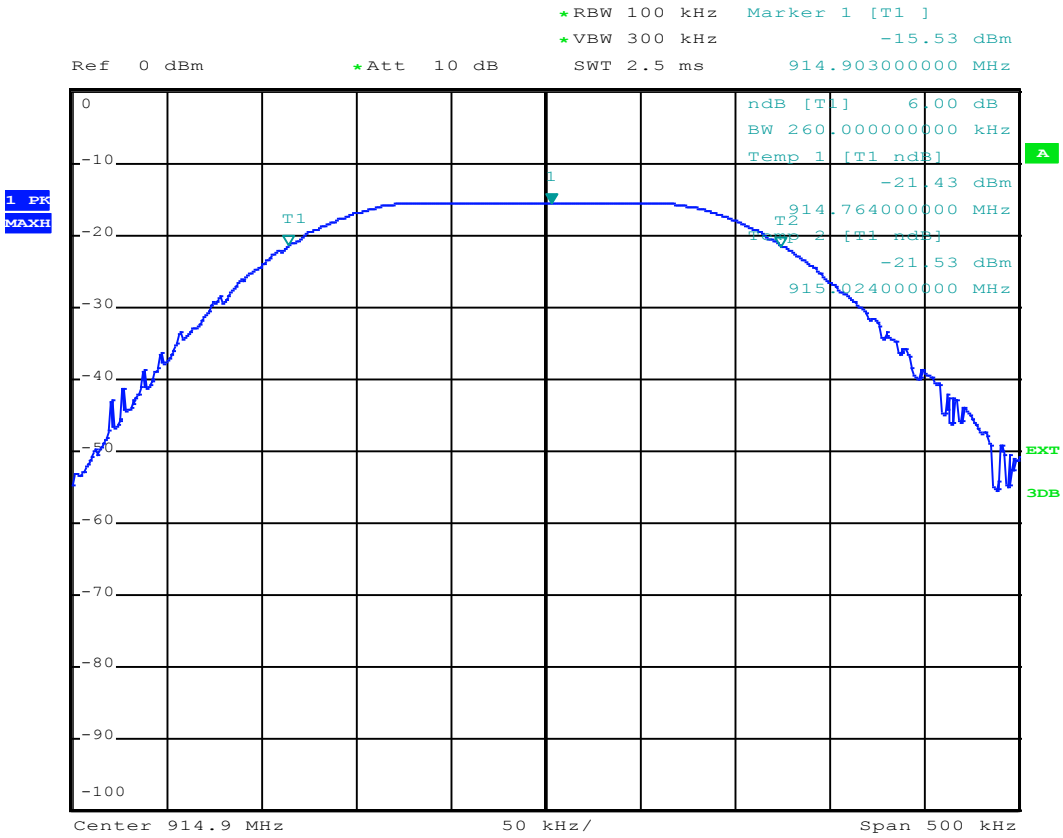
Central Channel – SF7



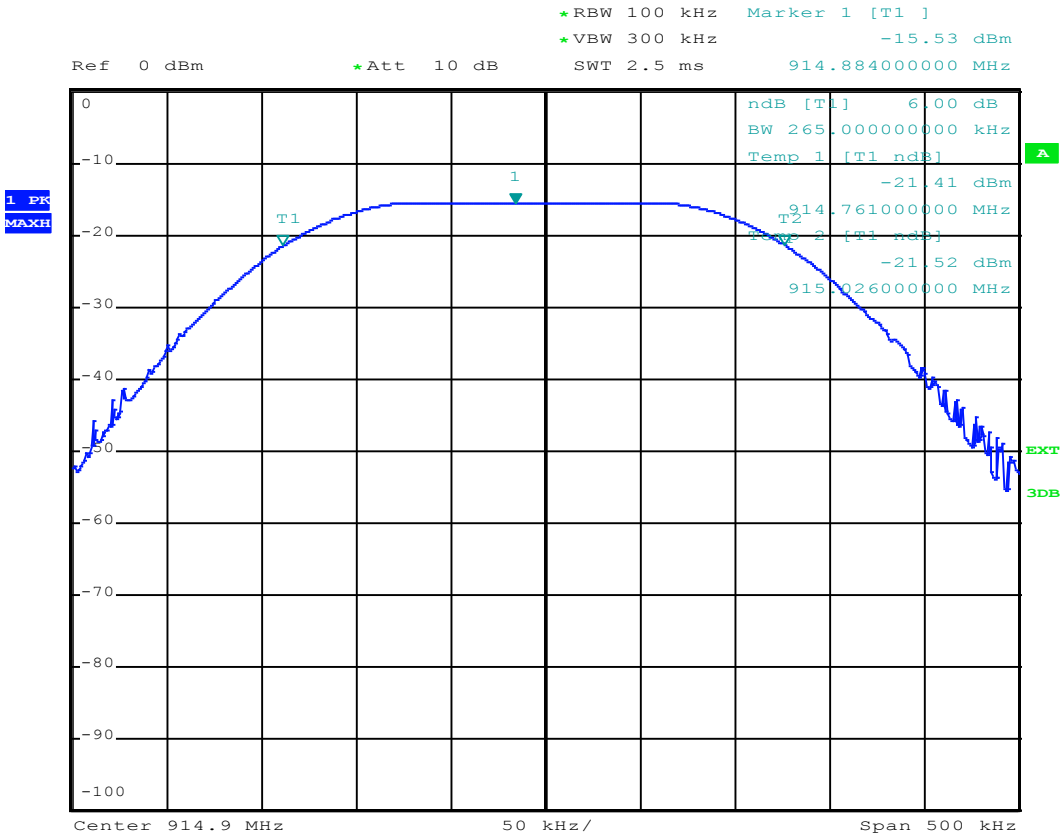
Central Channel – SF10



High Channel –SF7

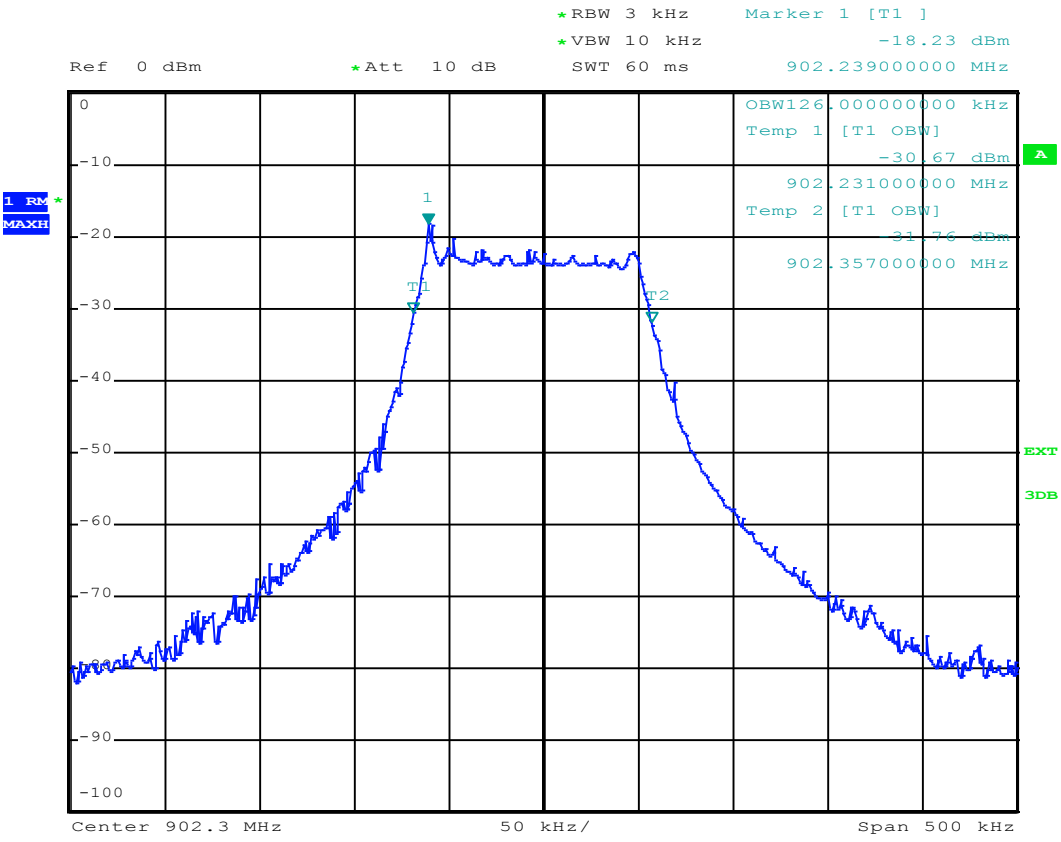


High Channel –SF10

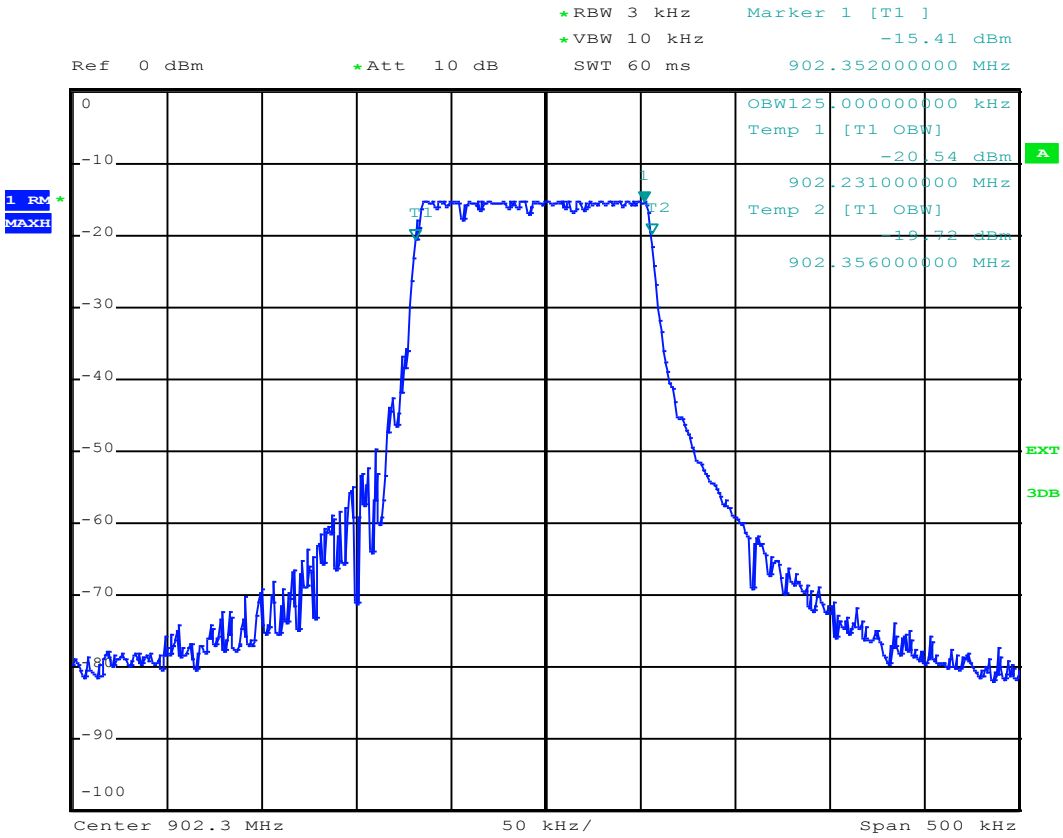


APPENDIX 3: 99% bandwidth

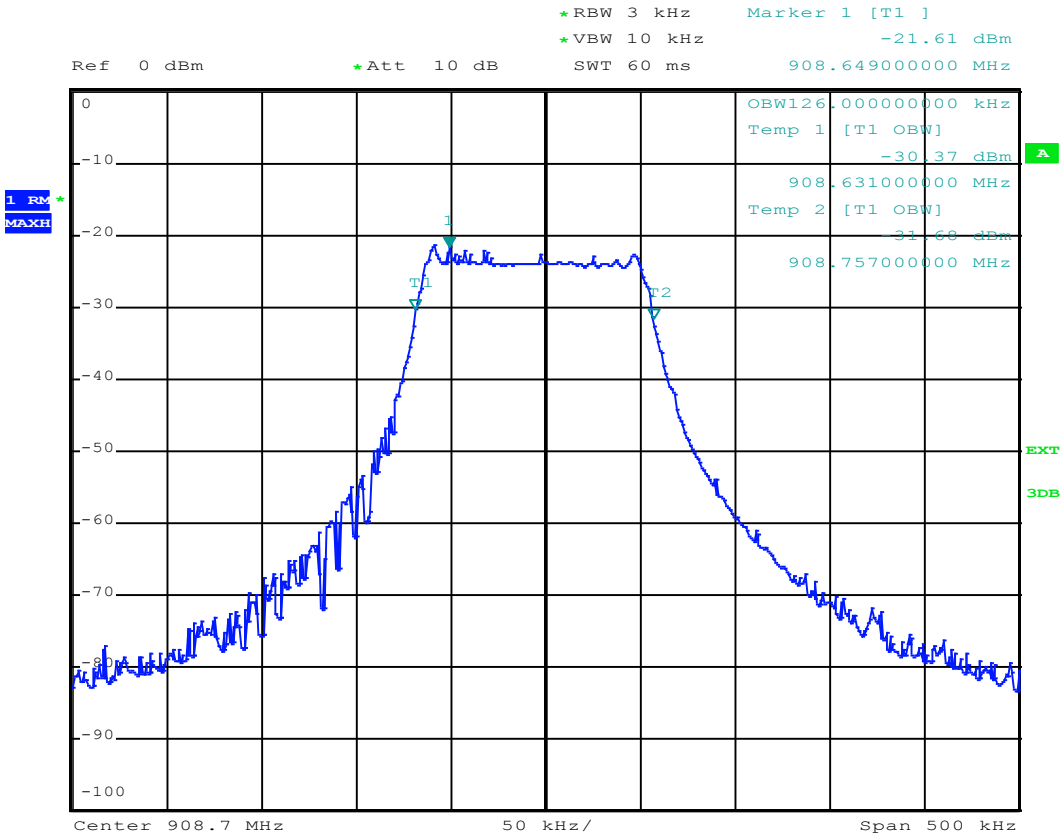
Low Channel – SF7



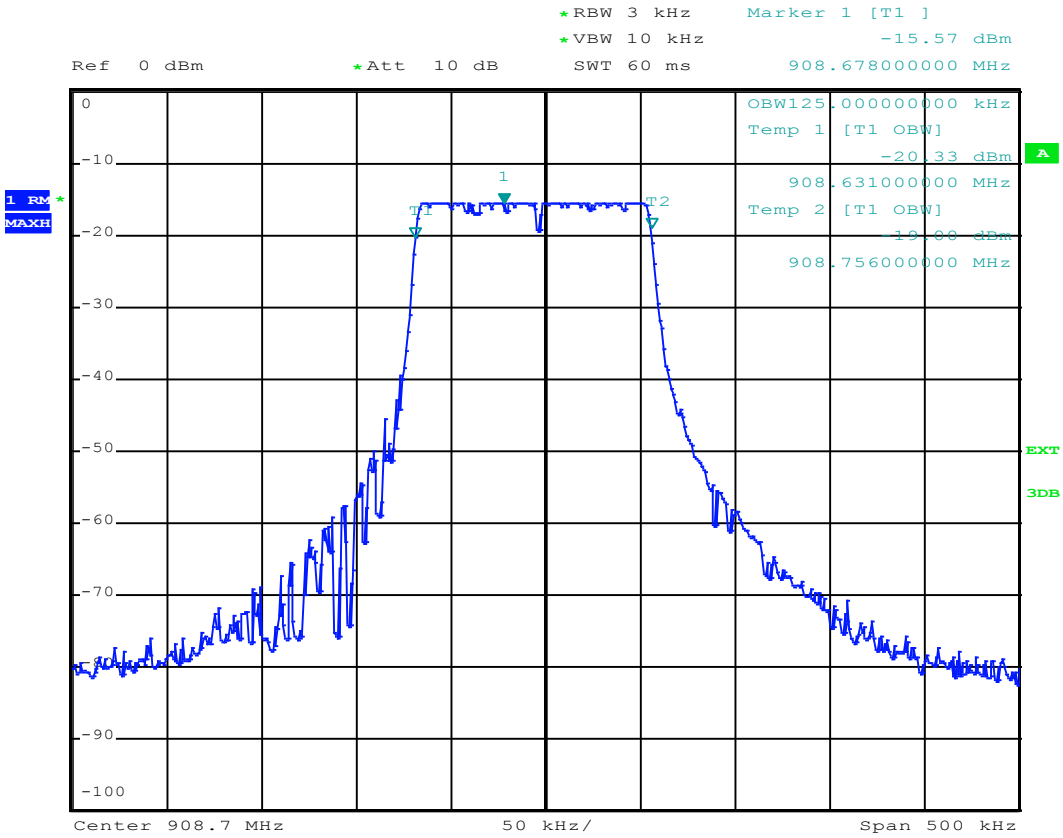
Low Channel – SF10



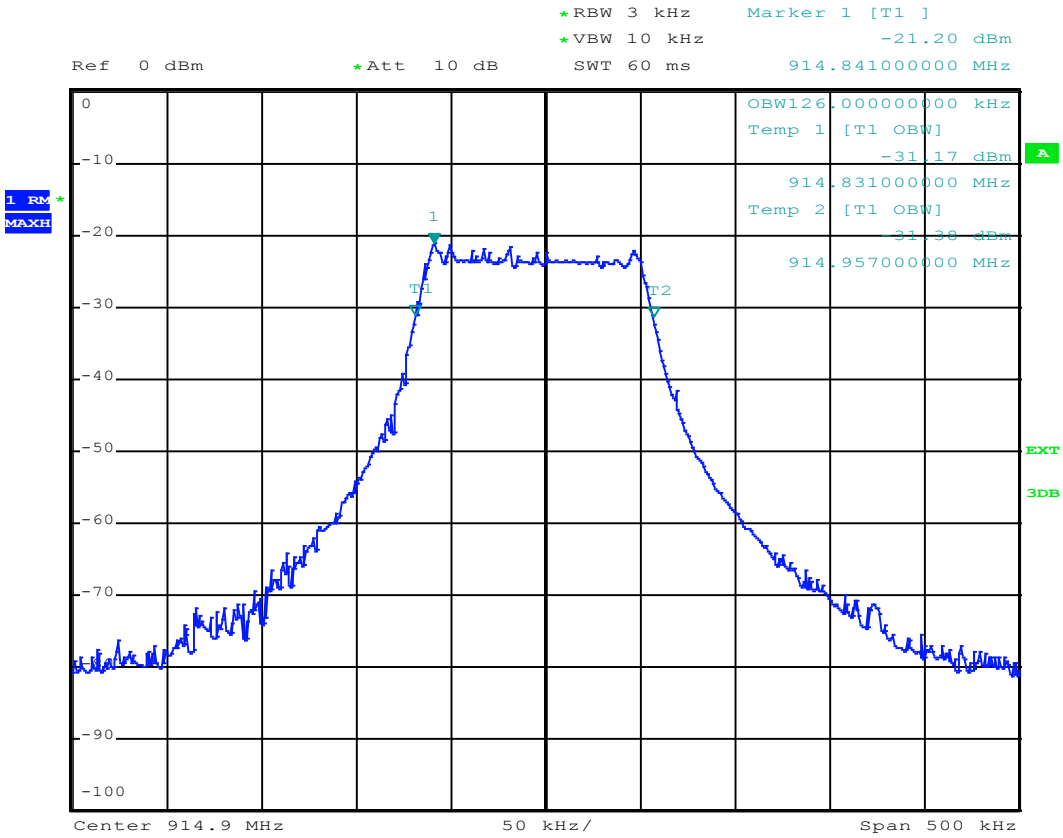
Central Channel – SF7



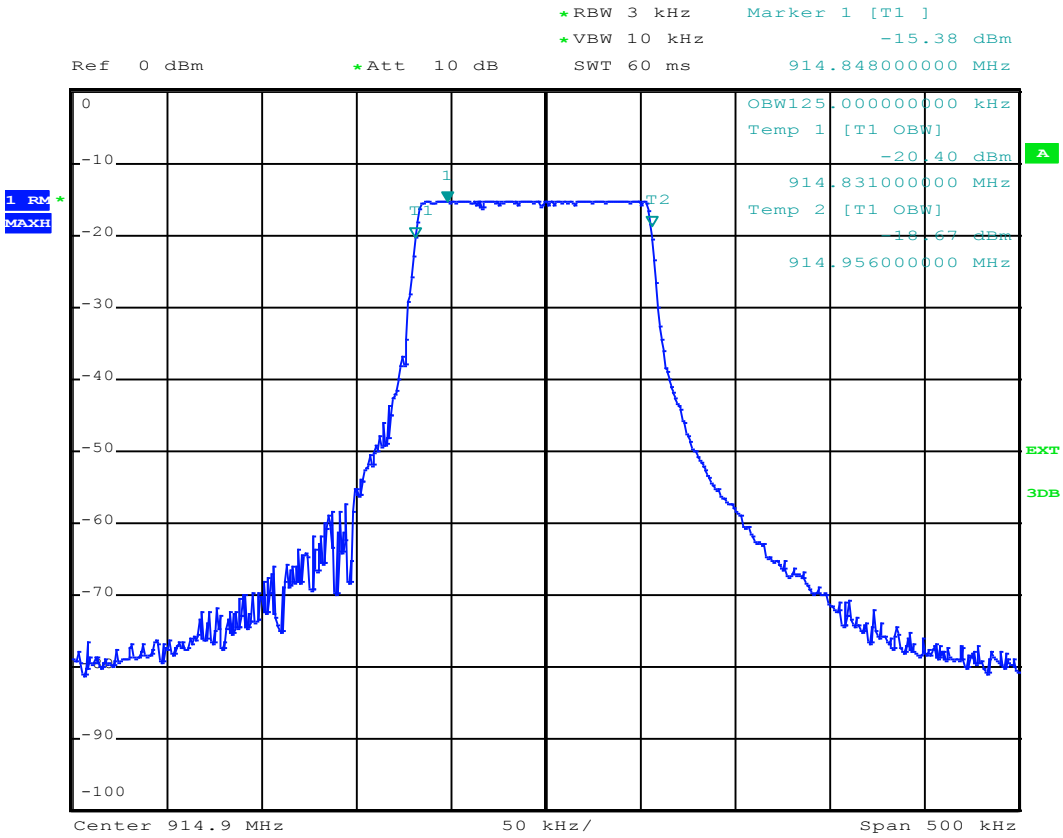
Central Channel – SF10



High Channel – SF7

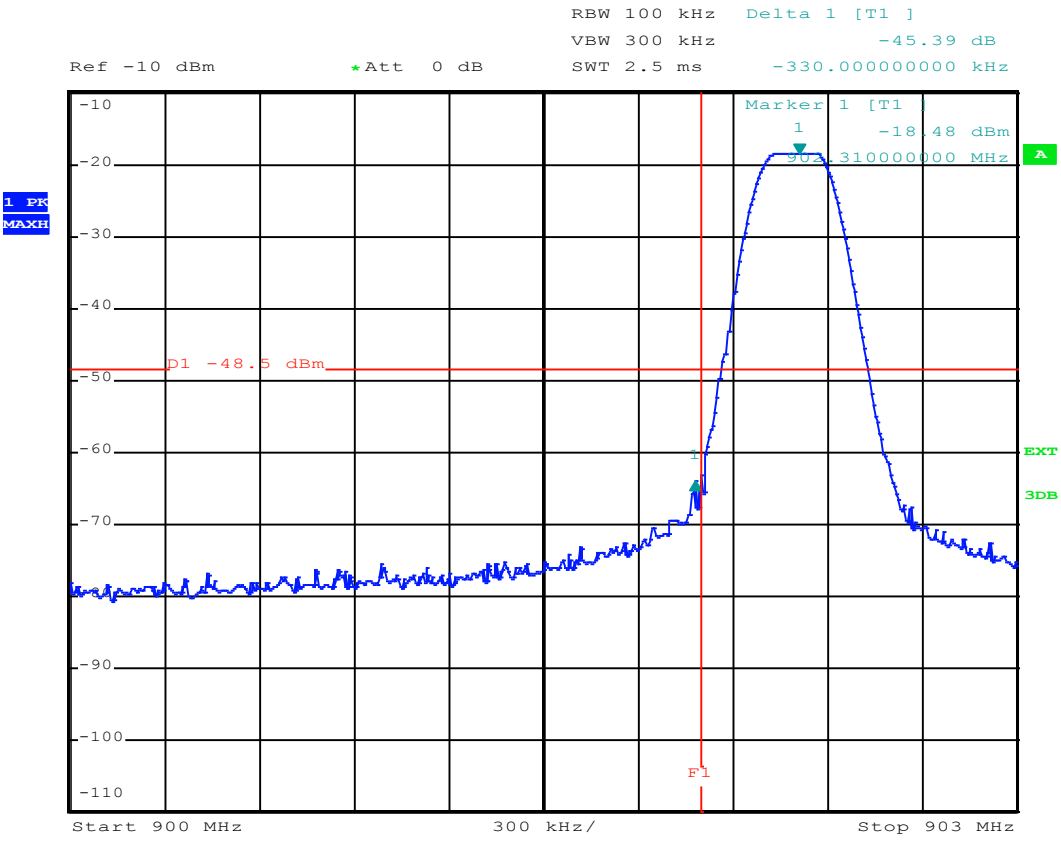


High Channel – SF10

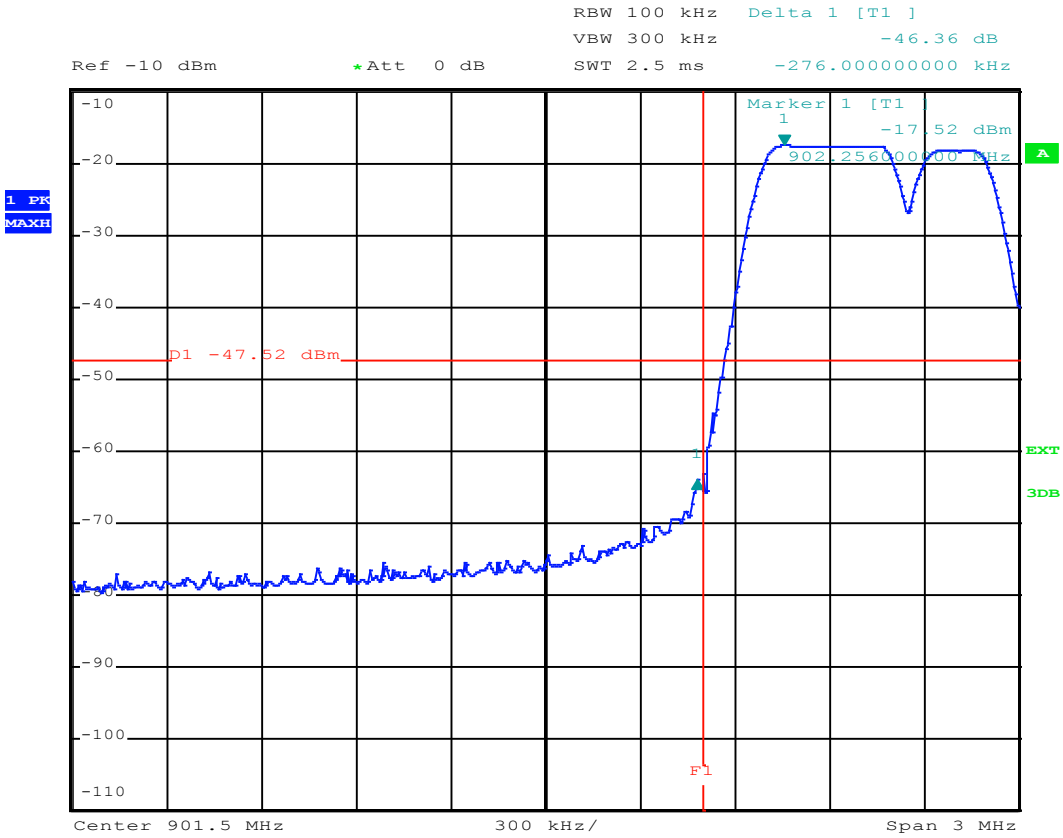


APPENDIX 4: Band edge

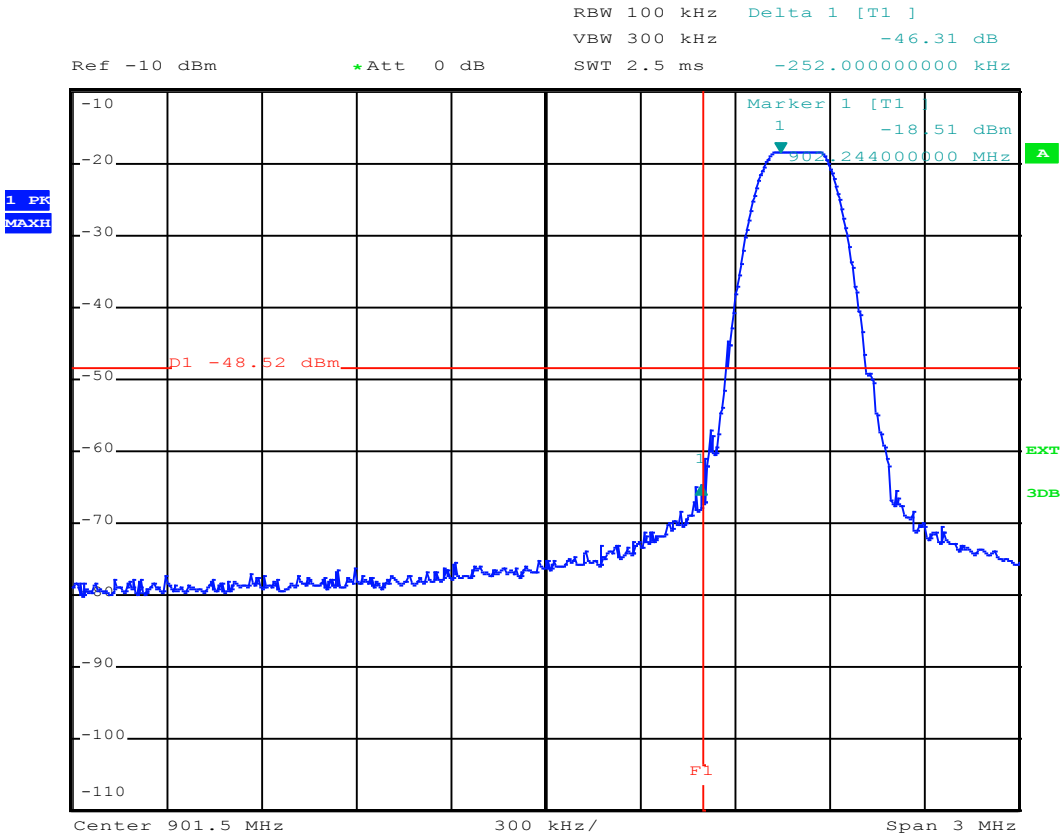
Low Channel with hopping mode off – SF7



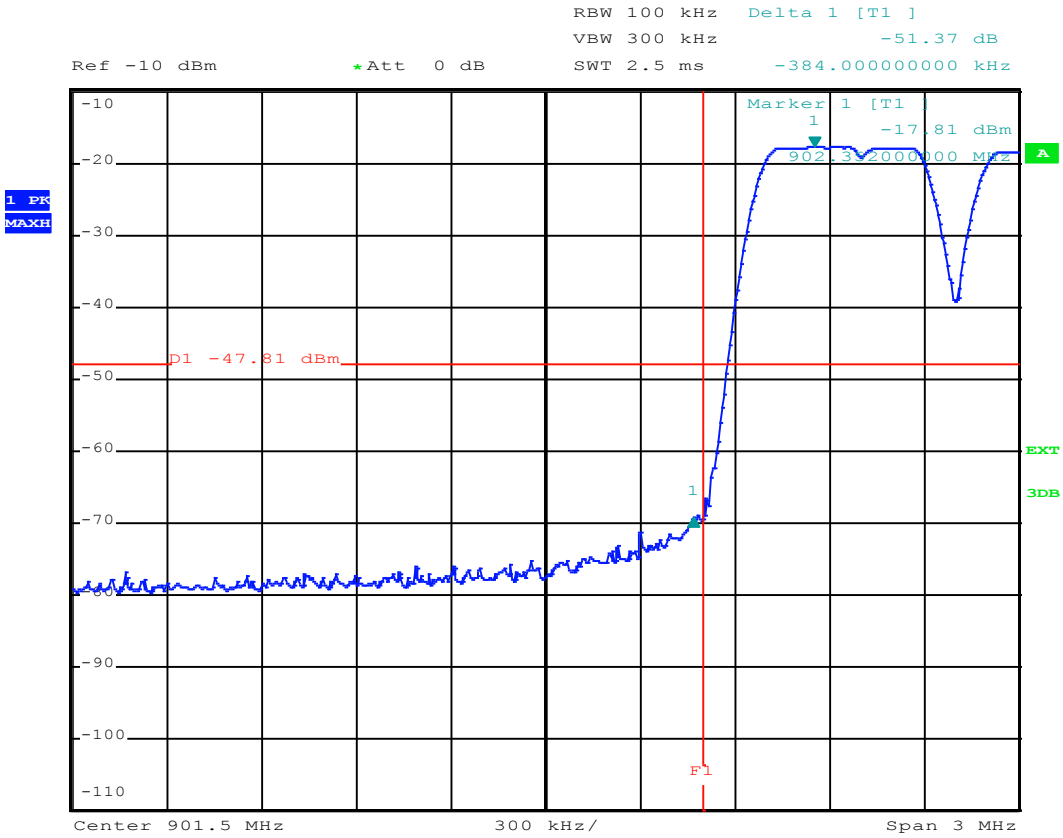
Low Channel with hopping mode on – SF7



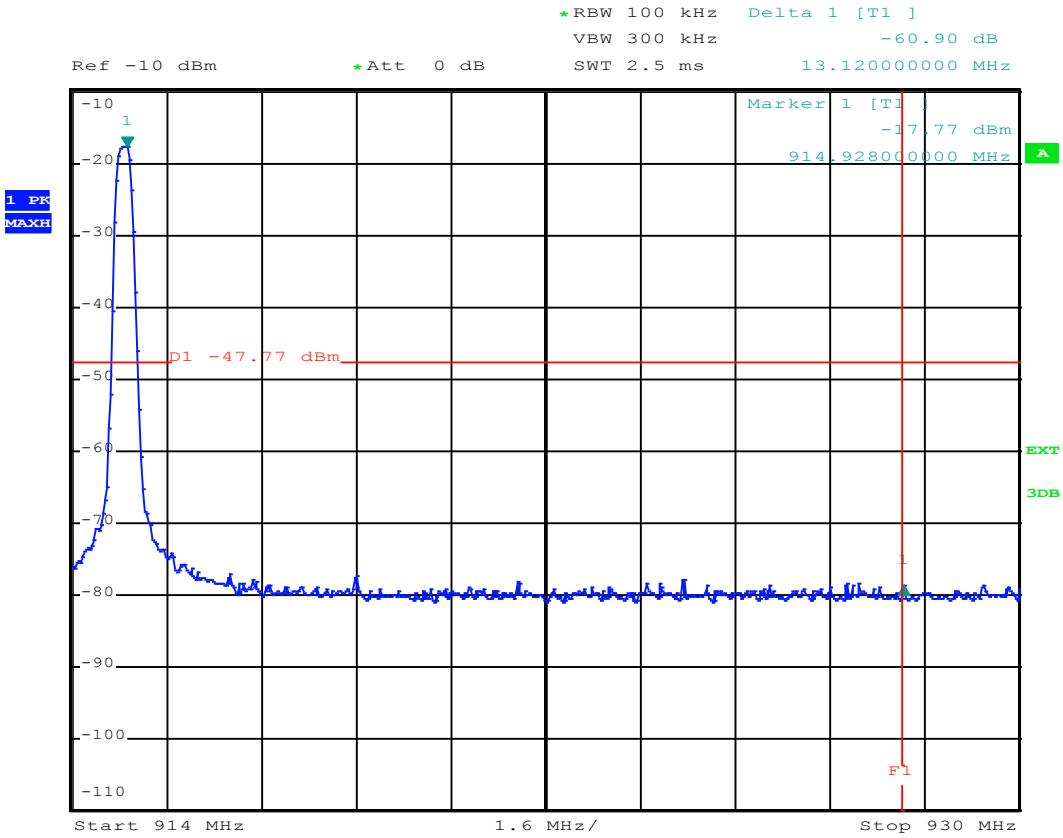
Low Channel with hopping mode off – SF10



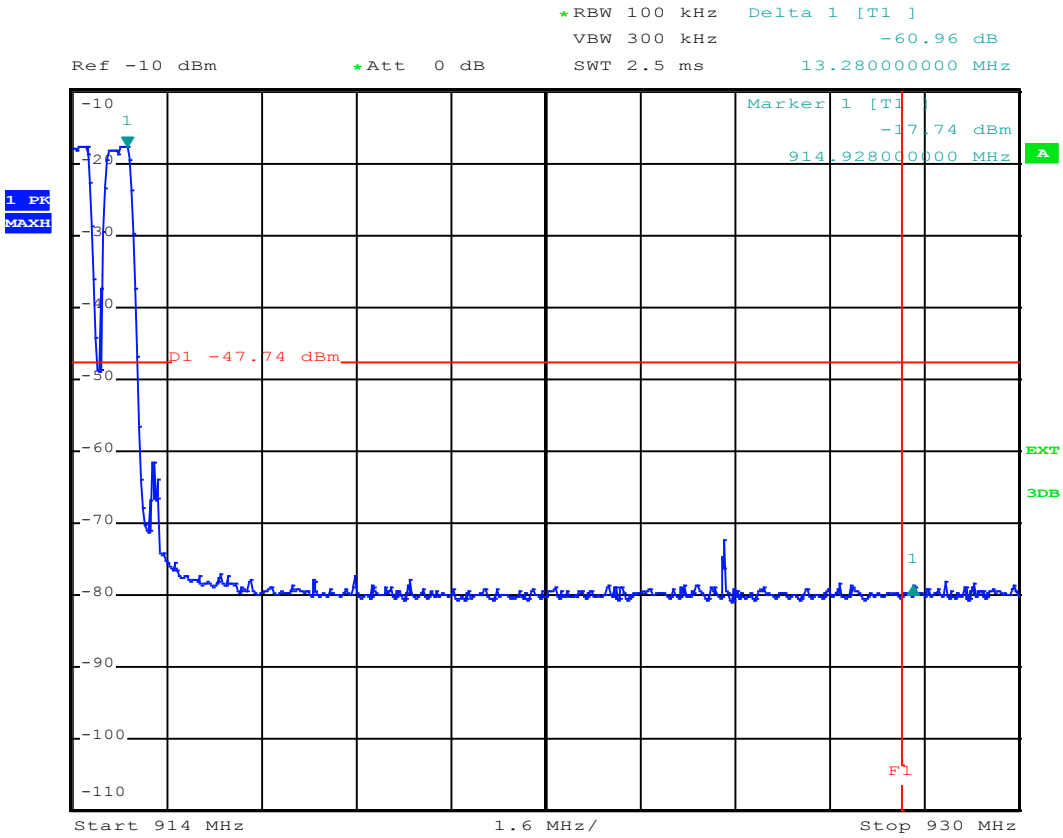
Low Channel with hopping mode on – SF10



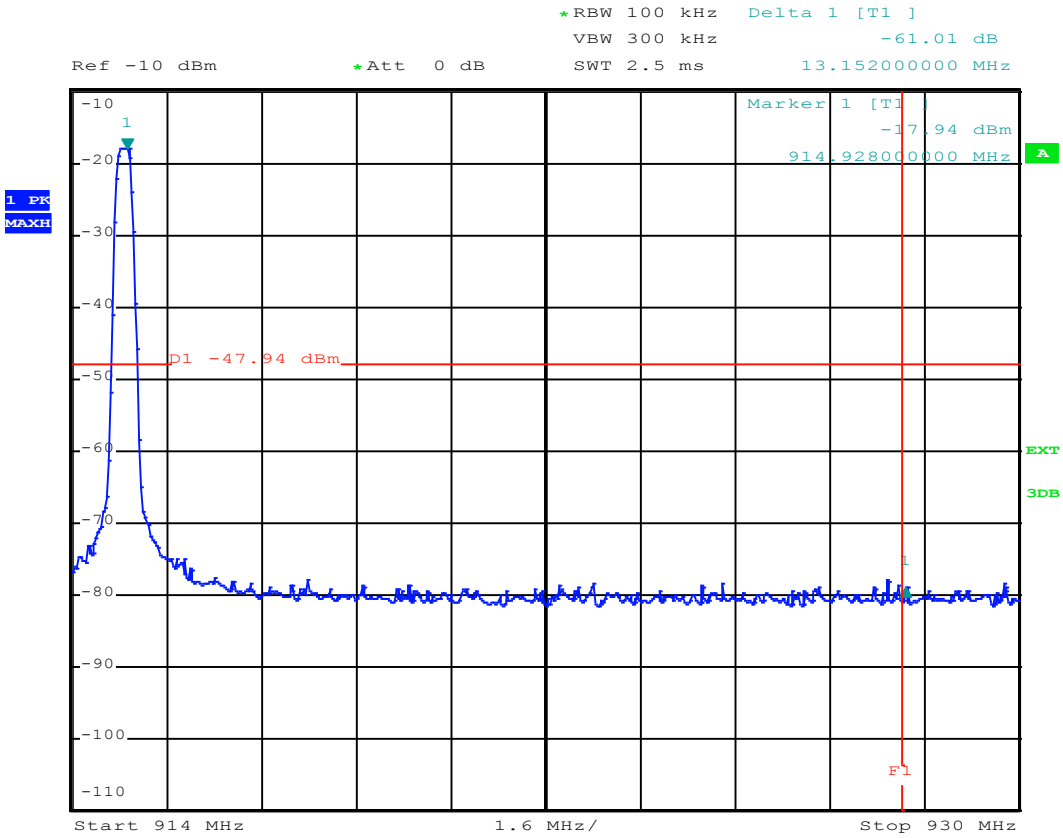
High Channel with hopping mode off – SF7



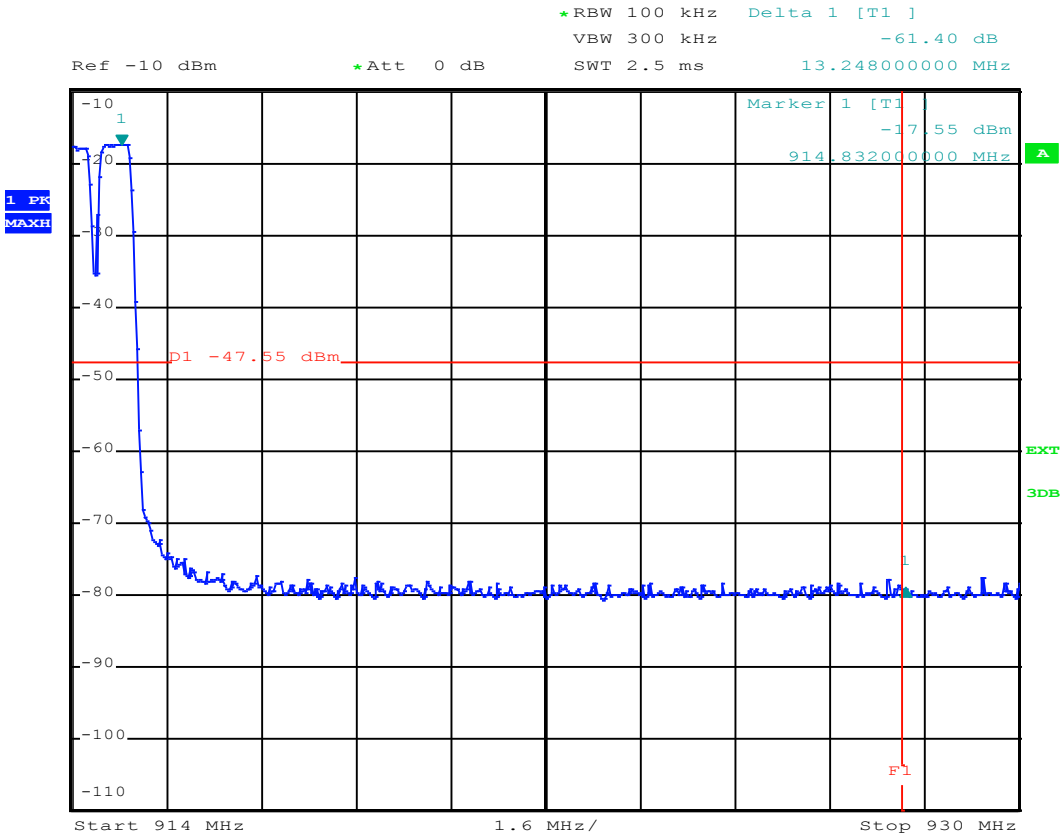
High Channel with hopping mode on – SF7



High Channel with hopping mode off – SF10

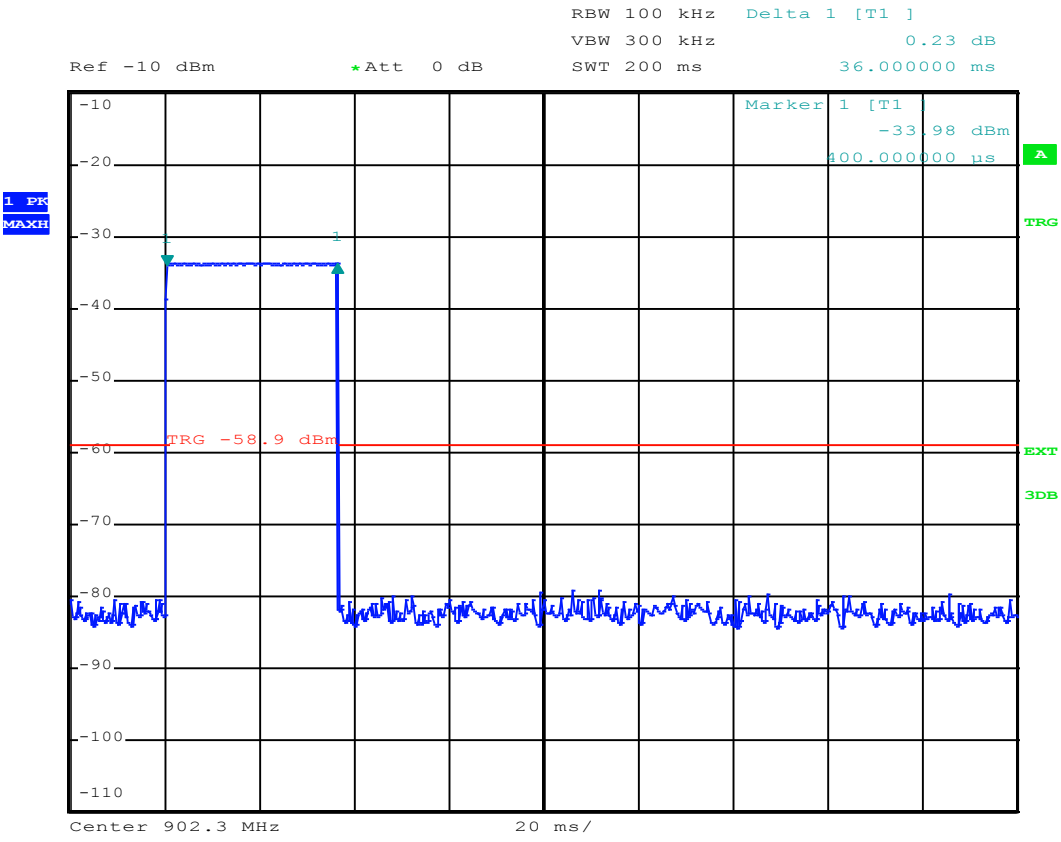


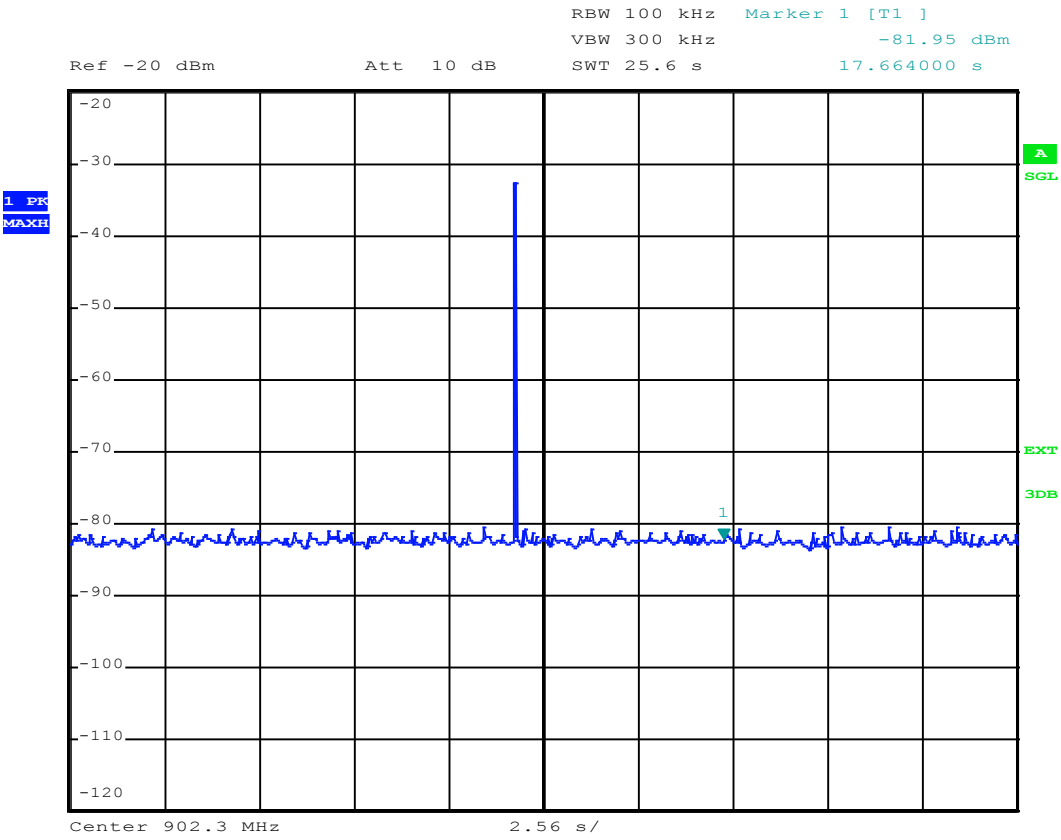
High Channel with hopping mode on – SF10



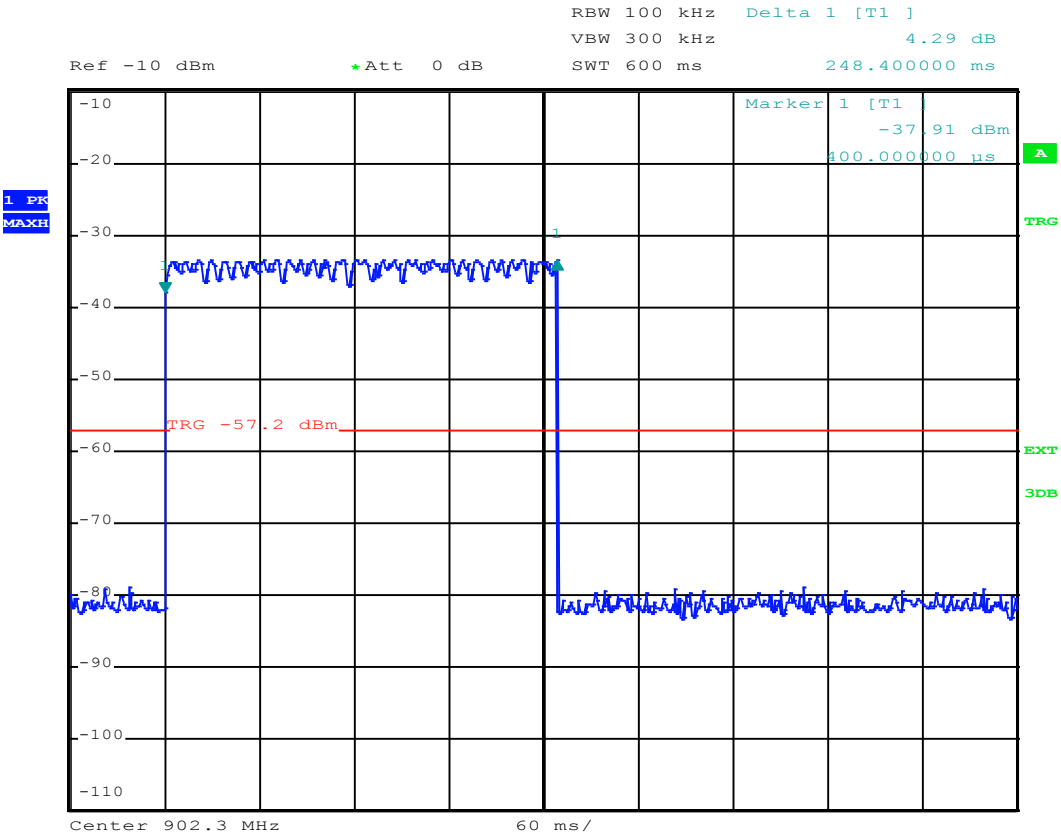
APPENDIX 5: Time of occupancy on any frequency

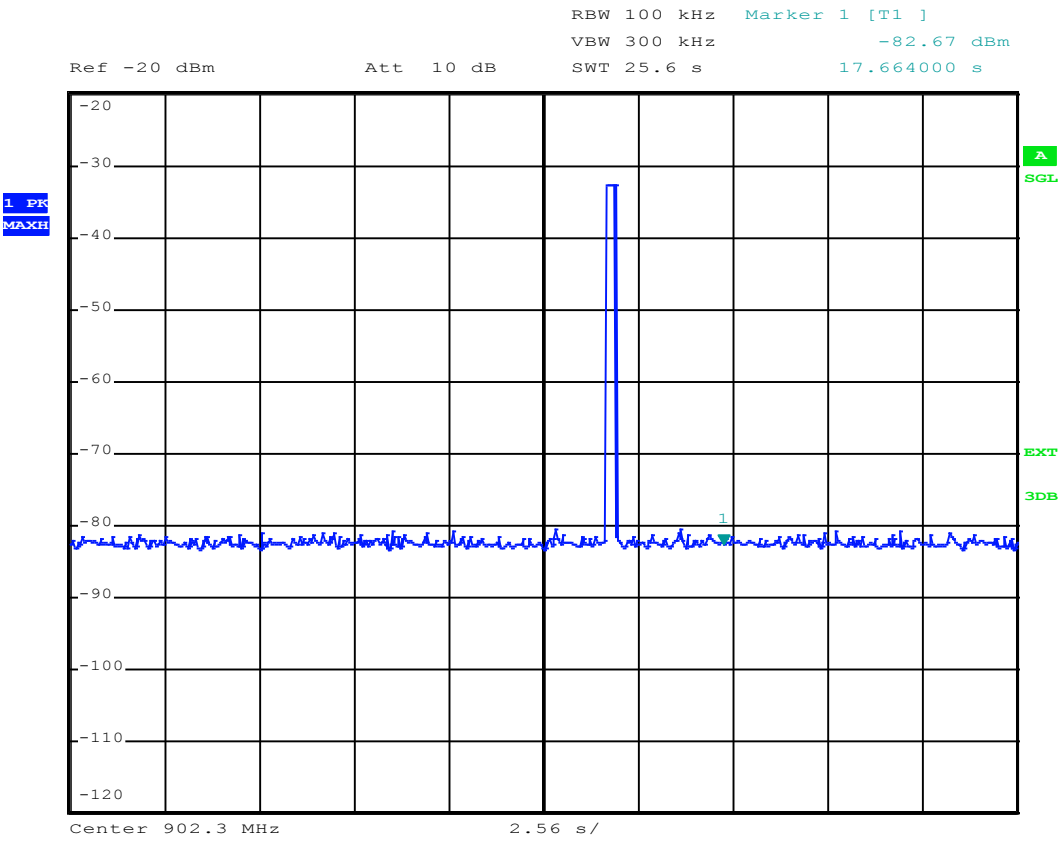
Low Channel - SF7



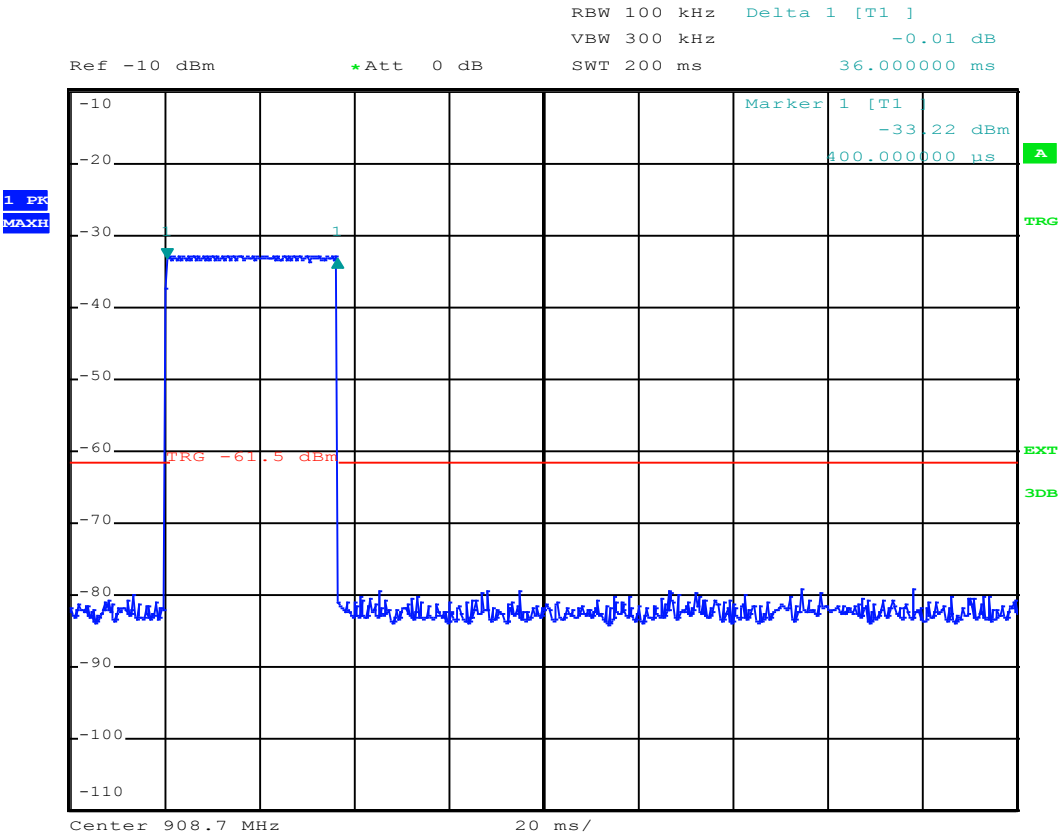

RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-81.95 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
1 PK
MAXH
A
SGL
EXT
3DB
1
Center 902.3 MHz
2.56 s/

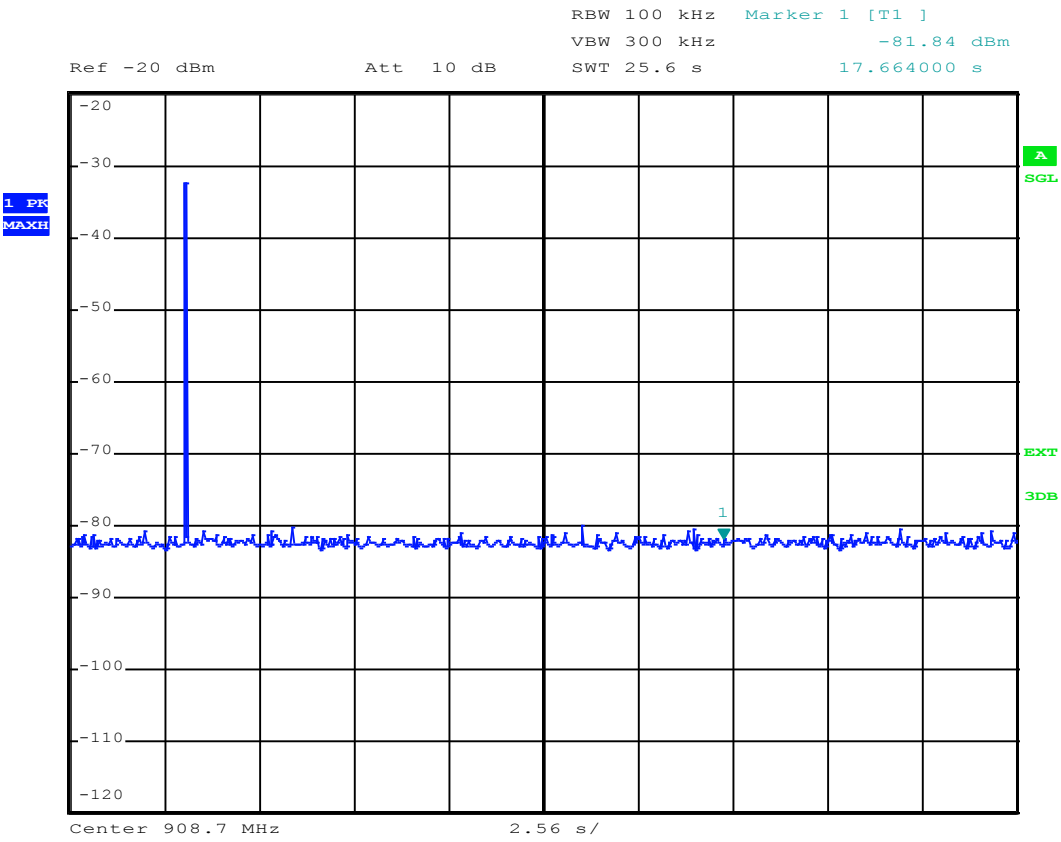
Low Channel – SF10



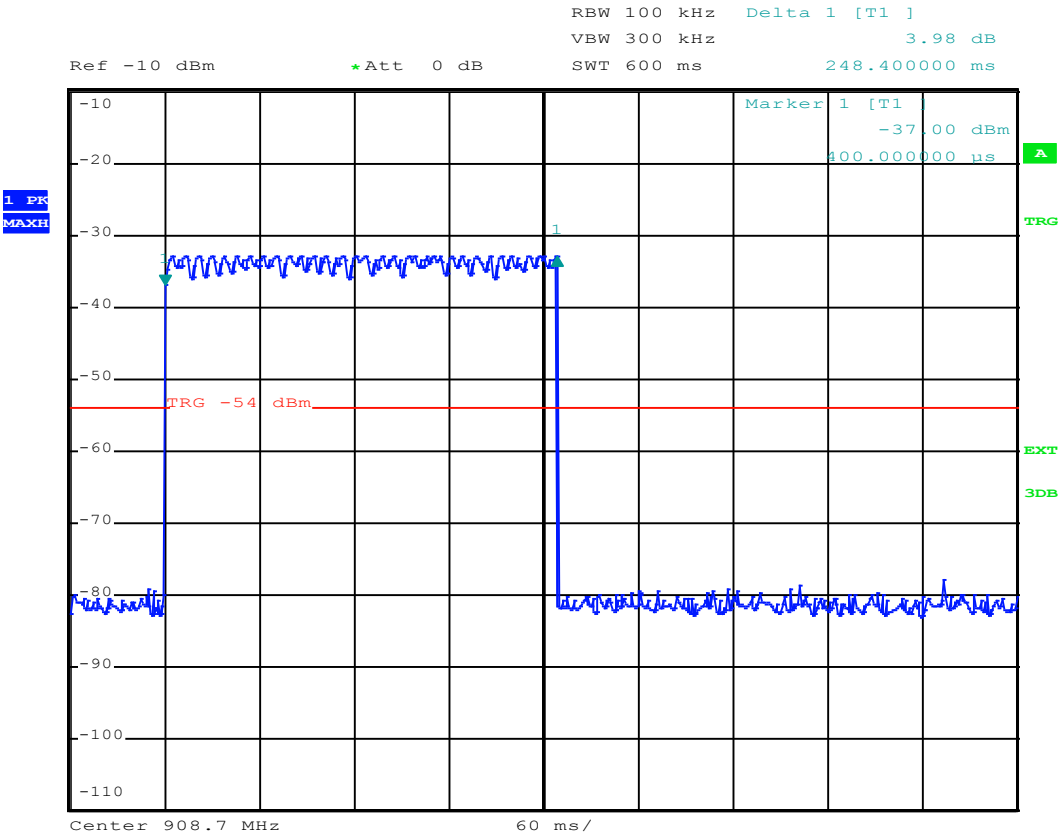

RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-82.67 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
1 PK
MAXH
A
SGL
EXT
3DB
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
Center 902.3 MHz
2.56 s/

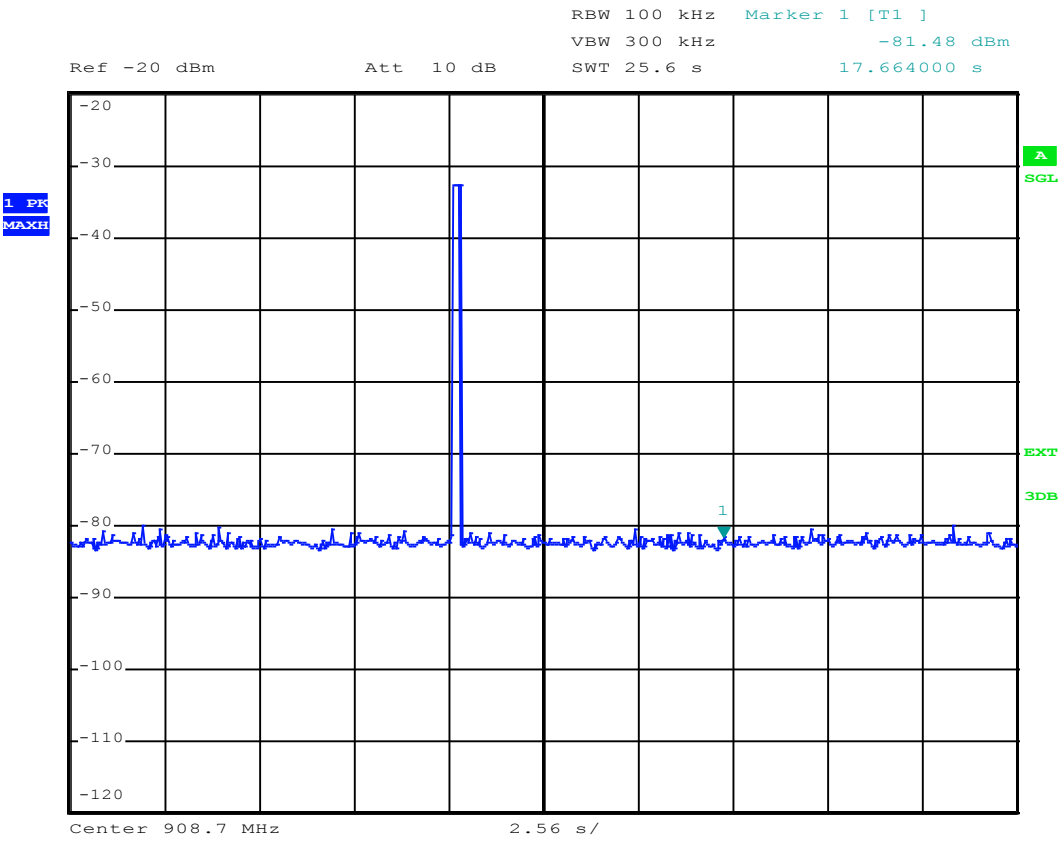
Central Channel – SF7



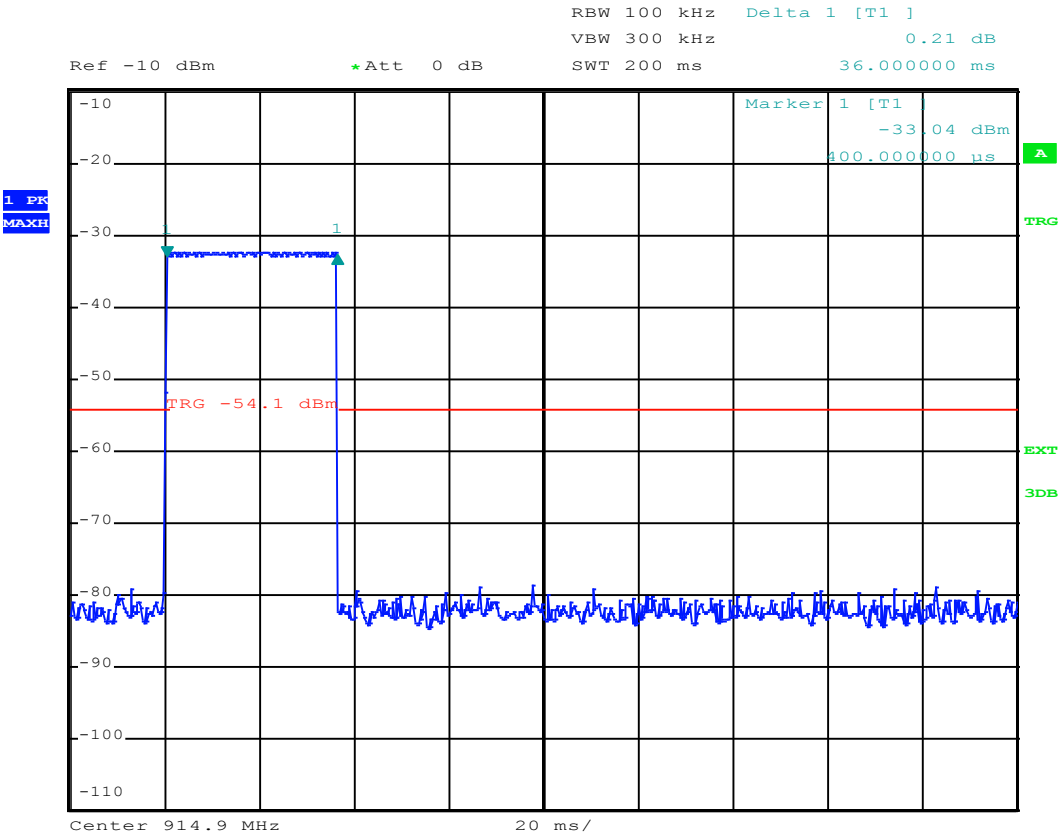

RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-81.84 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
1 PK
MAXH
A
SGL
EXT
3DB
1
Center 908.7 MHz
2.56 s/

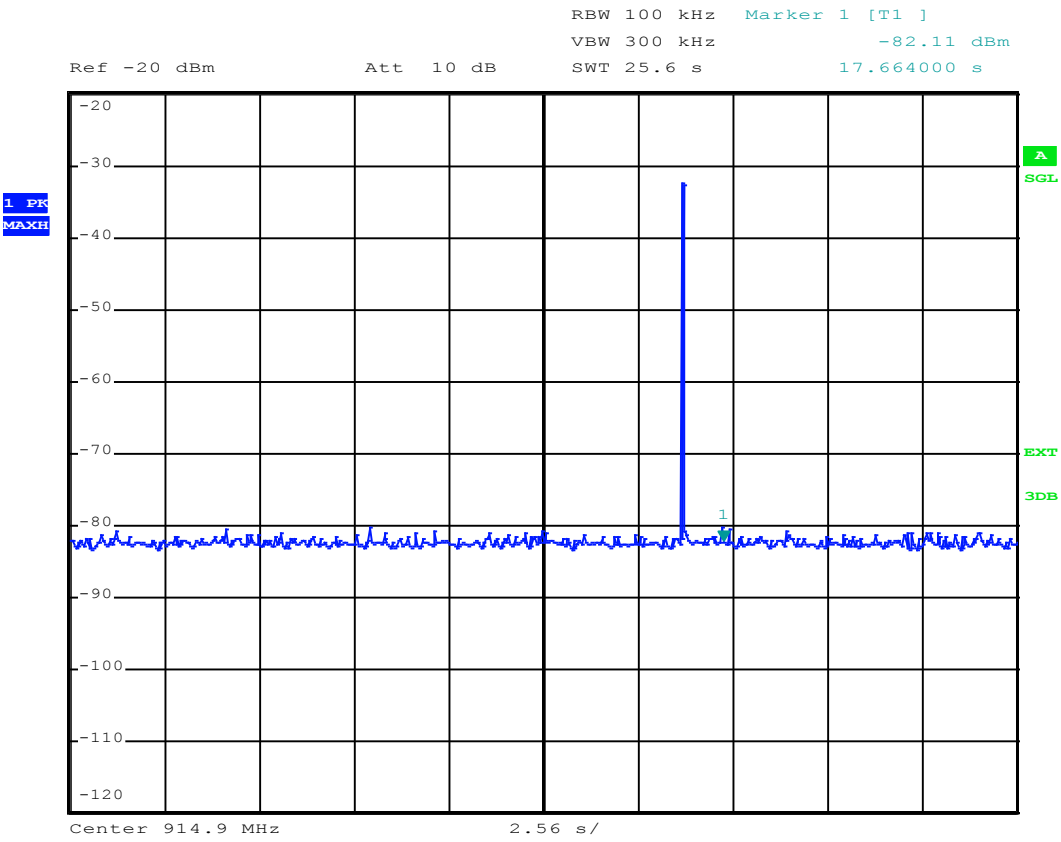
Central Channel – SF10



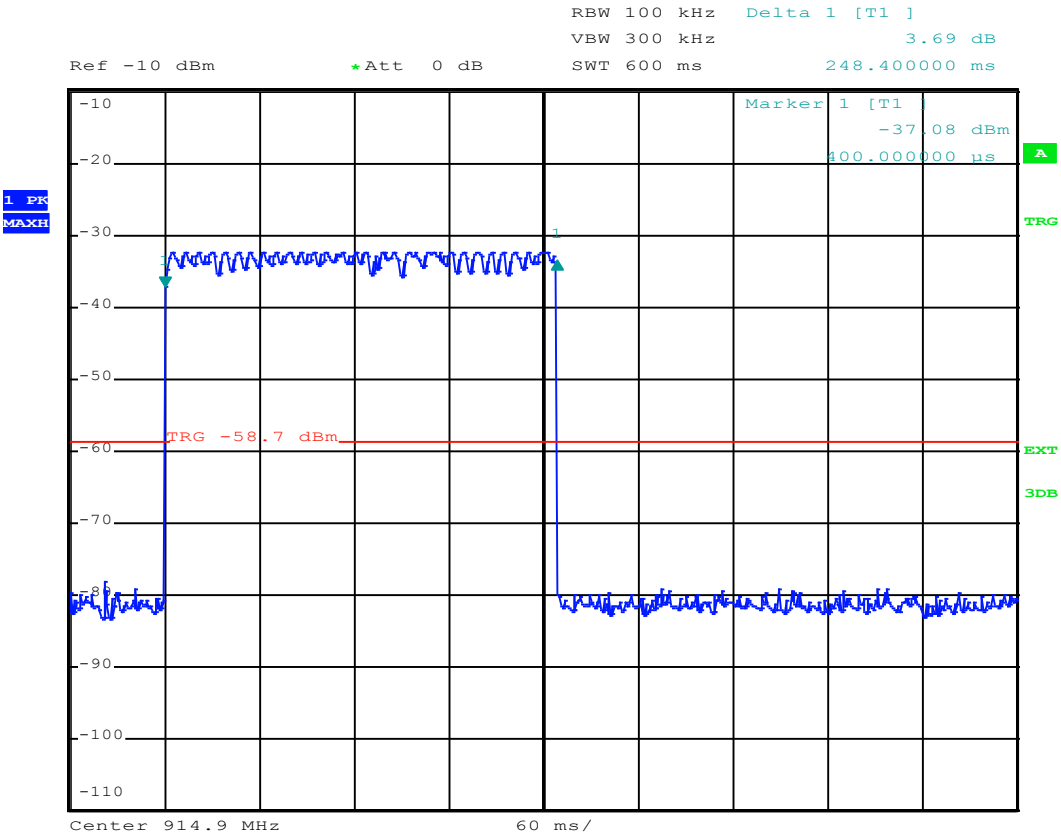

RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-81.48 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
1 PK
MAXH
A
SGL
EXT
3DB
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
1
Center 908.7 MHz
2.56 s/

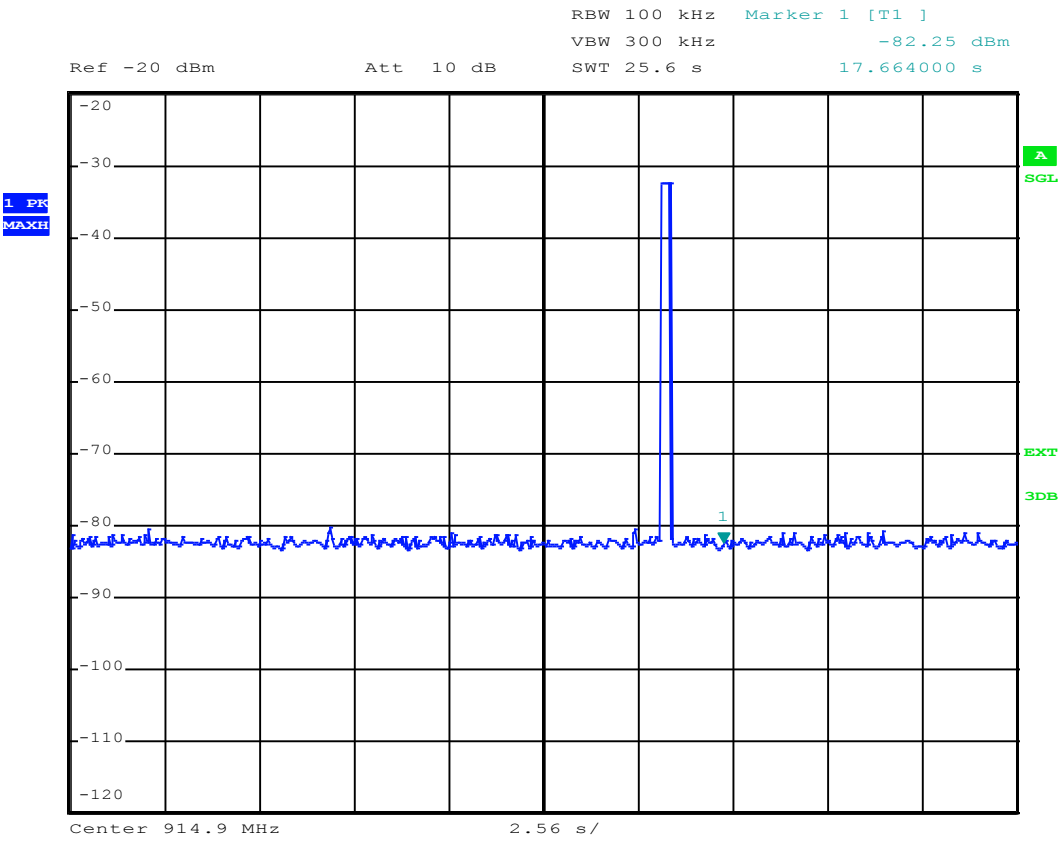
High Channel – SF7




RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-82.11 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
1 PK
MAXH
A
SGL
EXT
3DB
1
Center 914.9 MHz
2.56 s/

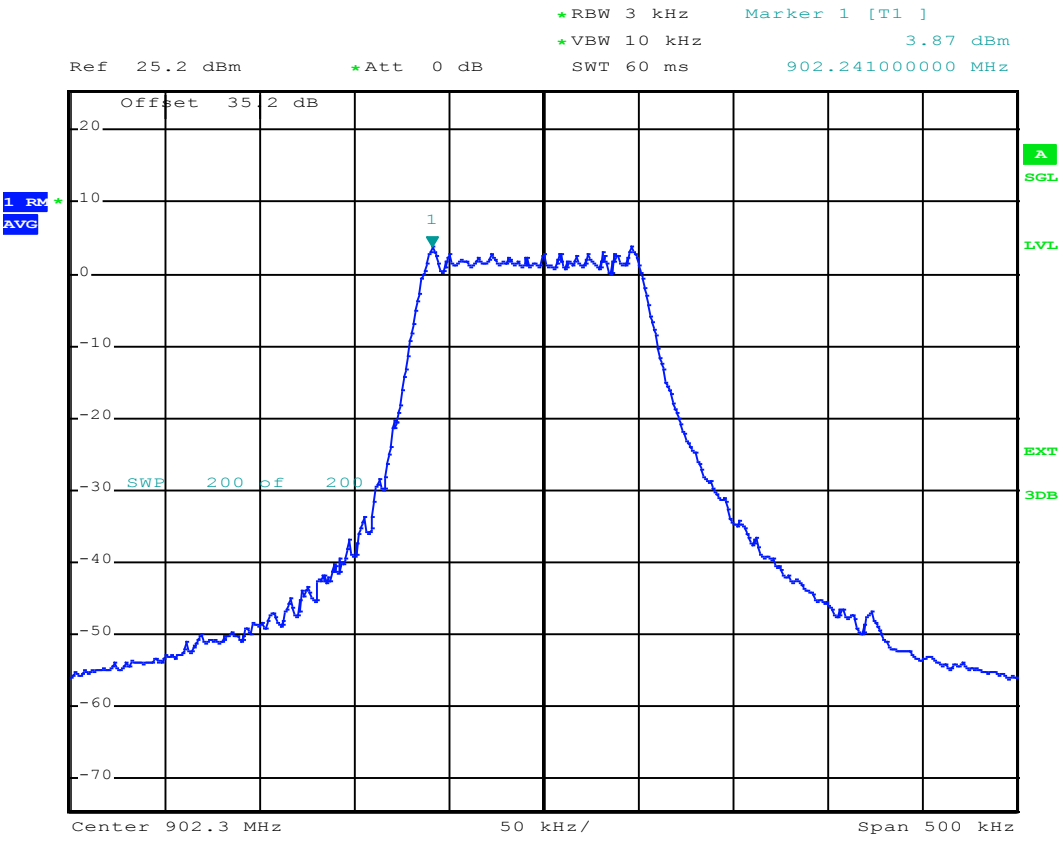
High Channel – SF10



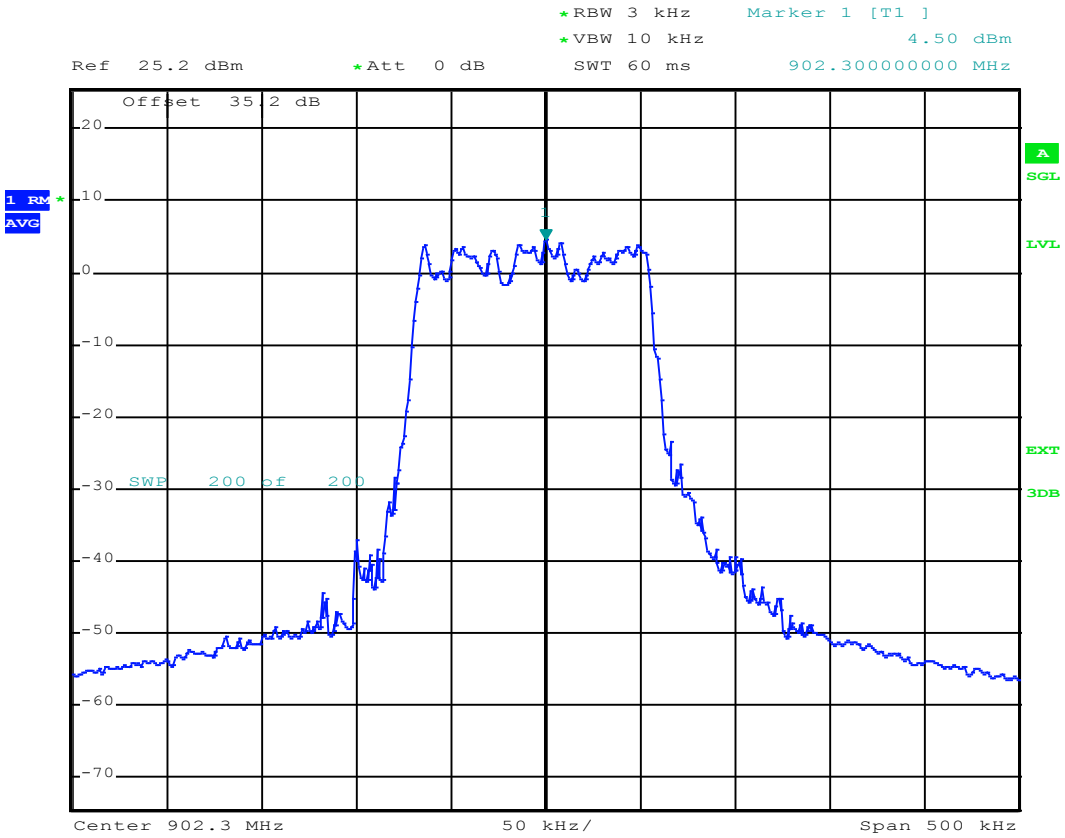

RBW 100 kHz
Marker 1 [T1]
VBW 300 kHz
-82.25 dBm
Ref -20 dBm
Att 10 dB
SWT 25.6 s
17.664000 s
1 PK
MAXH
A
SGL
EXT
3DB
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
1
Center 914.9 MHz
2.56 s/

APPENDIX 6: Peak Power Density

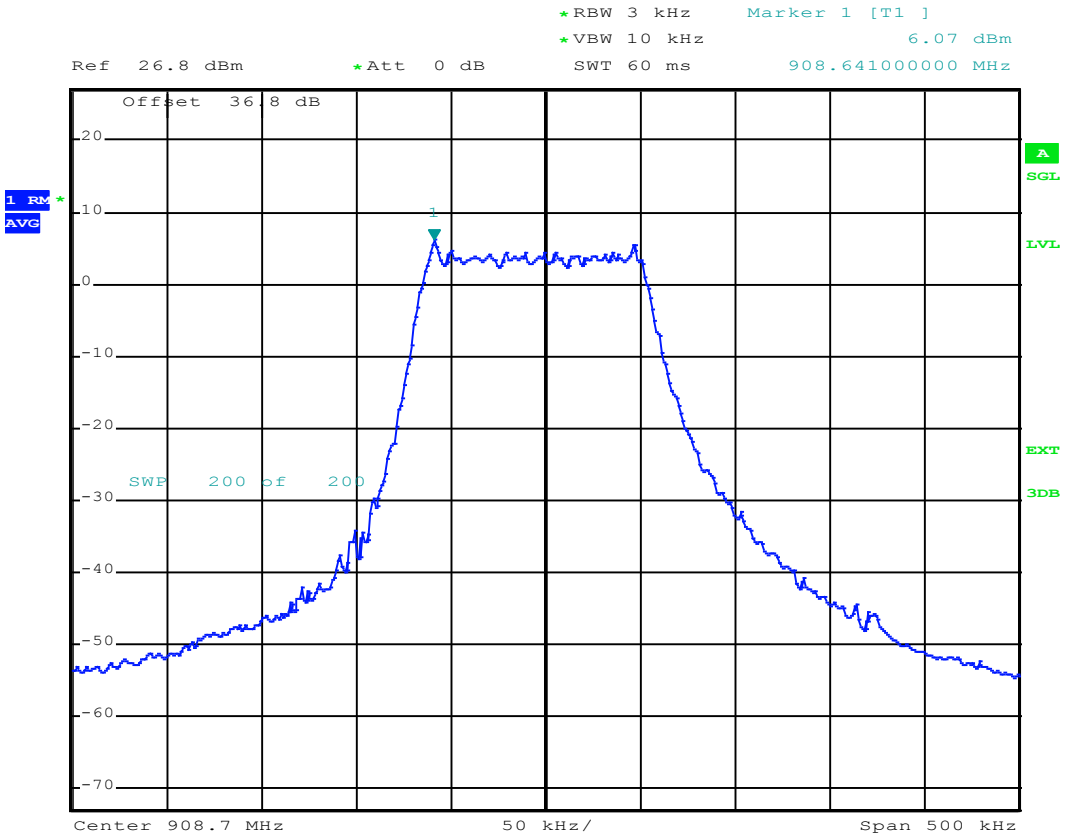
Low Channel – SF7



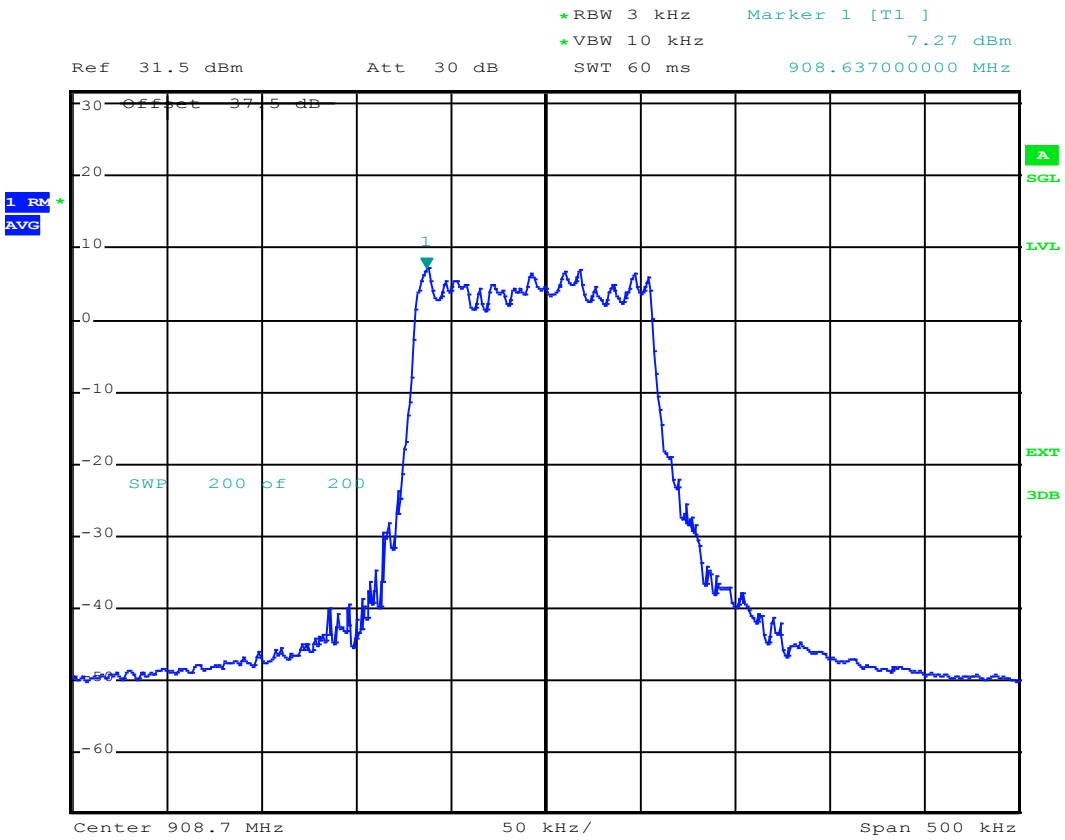
Low Channel – SF10



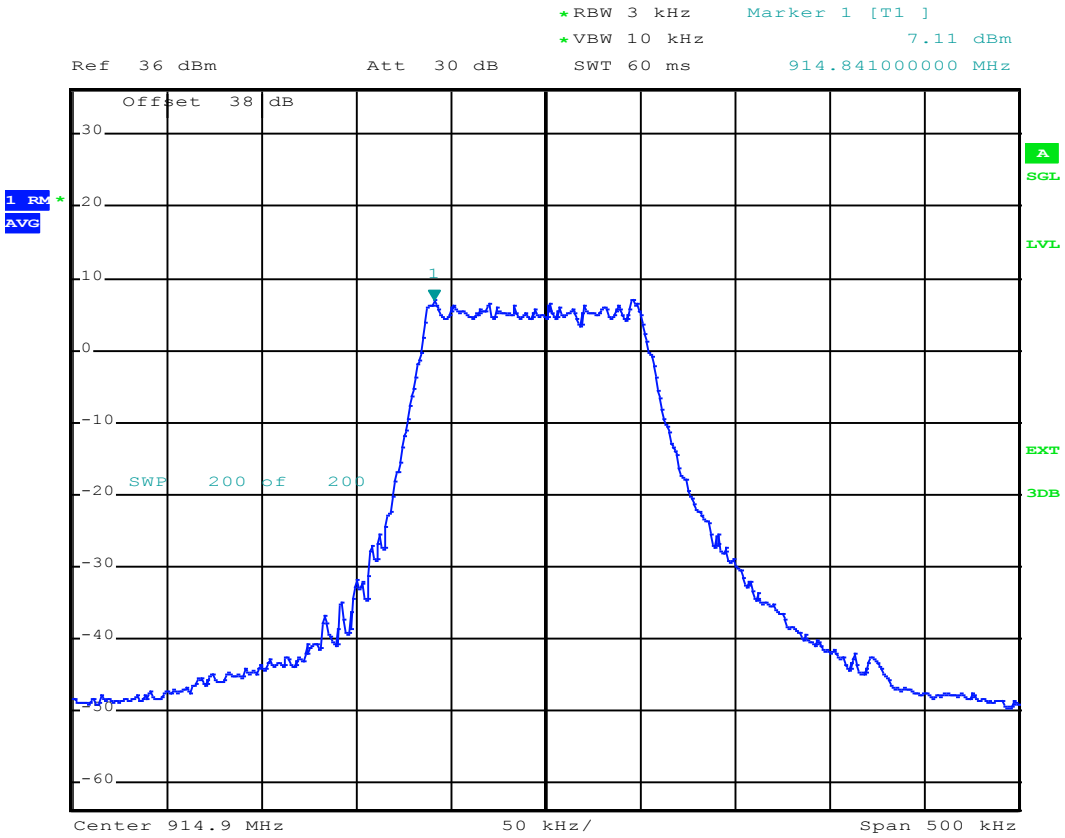
Central Channel – SF7



Central Channel – SF10



High Channel – SF7



High Channel – SF10