

RR051-15-102314-3-A Ed. 0

Certification Radio test report

According to the standard:
CFR 47 FCC PART 15

Equipment under test:
RADIO BRIDGE FOR SEISMIC ACQUISITION SYSTEM

FCC ID:
KQ9-0104A

Company:
SERCEL

DISTRIBUTION: Mr TIJOU

(Company: SERCEL)

Number of pages: 95 with 9 appendixes

Ed.	Date	Modified pages	Written by		Technical Verification and Quality Approval	
			Name	Visa	Name	Visa
0	21-JULY-2015	Creation	S. LOUIS	SL		

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This document is the result of testing a specimen or a sample of the product submitted. It does not imply an assessment of the conformity of the whole manufactured products of the tested sample.



DESIGNATION OF PRODUCT: Radio Bridge for seismic acquisition system

Serial number (S/N): 328

Reference / model (P/N): LRC

Software version: —

MANUFACTURER: SERCEL

COMPANY SUBMITTING THE PRODUCT:

Company: SERCEL

Address: ZI 16 RUE DU BEL AIR
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FRANCE

Responsible: Mr TIJOU

Person present during the tests: Mr BREMAUD

DATES OF TEST: Between 29-JUNE-2015 to 03-JULY-2015

TESTING LOCATION: EMITECH ANGERS laboratory at JUIGNE SUR LOIRE (49) FRANCE
21 rue de la Fuye
49610 Juigne sur Loire
France
FCC 2.948 Listed Site Registration Number: 90469
FCC Accredited under US-EU MRA Designation Number: FR0009
Test Firm Registration Number: 873677

TESTED BY: S. LOUIS

CONTENTS

<i>TITLE</i>	<i>PAGE</i>
1. INTRODUCTION	4
2. PRODUCT DESCRIPTION	4
3. NORMATIVE REFERENCE	5
4. TEST METHODOLOGY	5
5. TEST EQUIPMENT CALIBRATION DATES	6
6. TESTS AND CONCLUSIONS	8
7. MEASUREMENT OF THE CONDUCTED DISTURBANCES	13
8. RADIATED EMISSION LIMITS	16
9. MEASUREMENT OF THE CONDUCTED DISTURBANCES	18
10. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS	25
11. MAXIMUM PEAK OUTPUT POWER	29
12. INTENTIONAL RADIATOR	33
APPENDIX 1: Photos of the equipment under test	
APPENDIX 2: Test set up	
APPENDIX 3: Test equipment list	
APPENDIX 4: 6 dB bandwidth	
APPENDIX 5: 20 dB bandwidth	
APPENDIX 6: Band edge	
APPENDIX 7: Channel spacing	
APPENDIX 8: Time of occupancy on any frequency	
APPENDIX 9: Number of hopping channels	

1. INTRODUCTION

This report presents the results of radio test carried out on the following radio equipment: **Radio Bridge for seismic acquisition system**, in accordance with normative reference.

The device under test integrates a multifrequency transceiver (FHSS 2.4GHz).

2. PRODUCT DESCRIPTION

Class:	B
Utilization:	SEISMIC DATA ACQUISITION
Antenna type and gain:	External antenna 7.4dBi
Operating frequency range:	From 2405MHz to 2469MHz
Frequency tested:	2405 MHz (low channel), 2437 MHz (central channel), 2469 MHz (high channel)
Number of channels:	17
Channel spacing:	4MHz
Modulation:	FHSS (Proprietary module)
Power source:	48 Vdc by an external product

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 (2014) Radio Frequency Devices

ANSI C63.4 2009
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 2009
Testing Unlicensed Wireless Devices.

Public Notice DA 00-705 Filing and Measurement Guideline for Frequency Hopping Spread
Spectrum Systems.

4. TEST METHODOLOGY

Radio performance tests procedures given in CFR 47 part 15:

Subpart A –General

Paragraph 19: labelling requirements
Paragraph 21: information to user

Subpart B –Unintentional Radiators

Paragraph 105: information to the user
Paragraph 107: Conducted limits
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 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

Equipment	Model	Type	Last verification	Next verification	Validity
0000	BAT-EMC	Software	/	/	/
1406	EMCO 6502	Loop antenna	27/01/2015	27/01/2017	27/03/2017
1922	Microwave DB C020180F-4B1	Low-noise amplifier	20/08/2014	20/08/2015	20/10/2015
1939	IMC WR42	Antenna	20/04/2012	20/04/2016	20/06/2016
1940	IMC WR42	Antenna	20/04/2012	20/04/2016	20/06/2016
3036	ALC Microwave ALN02-0102	Low-noise amplifier	14/05/2014	14/05/2015	14/07/2015
4087	Filtek LP03/1000-7GH	Low Pass Filter	24/02/2014	24/02/2016	24/04/2016
4088	R&S FSP40	Spectrum Analyzer	22/08/2013	22/08/2015	22/10/2015
7299	Microtronics BRM50702	Reject band filter	25/10/2013	25/10/2015	25/12/2015
8508	California instruments 1251RP	Power source	22/08/2014	22/08/2015	22/10/2015
8511	HP 8447D	Low noise preamplifier	20/08/2014	20/08/2015	20/10/2015
8523	R&S FSEM30	Spectrum analyzer	20/05/2014	20/05/2016	20/07/2016
8524	HP 8591EM	Test receiver	30/07/2013	30/07/2015	30/09/2015
8526	Schwarzbeck VHBB 9124	Biconical antenna	12/06/2012	12/06/2016	12/08/2016
8528	Schwarzbeck VHA 9103	Biconical antenna	24/09/2013	24/09/2017	24/11/2017
8534	EMCO 3115	Antenna	30/10/2012	30/10/2016	30/12/2016
8535	EMCO 3115	Antenna	29/10/2012	29/10/2016	29/12/2016
8543	Schwarzbeck UHALP 9108A	Log periodic antenna	12/06/2012	12/06/2016	12/08/2016
8593	SIDT Cage 2	Anechoic chamber	/	/	/
8671	HUGER	Meteo station	04/09/2014	04/09/2016	04/11/2016
8675	La Crosse Technology WS-9232	Meteo station	03/09/2014	03/09/2016	03/11/2016
8707	R&S ESI7	Test receiver	11/12/2014	11/12/2016	11/02/2017
8719	Thurbly Thandar Instruments 1600	LISN	23/06/2014	23/06/2016	23/08/2016
8732	Emitech	OATS	23/08/2013	23/08/2016	23/10/2016
8749	La Crosse Technology WS-9232	Meteo station	03/09/2014	03/09/2016	03/11/2016
8750	La Crosse Technology WS-9232	Meteo station	03/09/2014	03/09/2016	03/11/2016
8763	HP11947A	Transient limiter	24/02/2014	24/02/2016	24/04/2016
8783	EMCO 3147	Log periodic antenna	24/09/2013	24/09/2017	24/11/2017
8864	Champ libre Juigné. V3.4	Software	/	/	/

8893	Emitech	Outside room Hors cage	/	/	/
8896	ACQUISYS GPS8	Satellite synchronized frequency standard	/	/	/
9489	Absorber sheath current	Emitech	08/10/2014	08/10/2016	08/12/2016
/	GPIB SHOT	Software	/	/	/

6. TESTS AND CONCLUSIONS

6.1 general (subpart A)

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.19	LABELLING REQUIREMENTS				X	See certification documents
FCC Part 15.21	INFORMATION TO USER				X	See certification documents

NAp: Not Applicable

NAs: Not Asked

LABEL SHALL CONTAIN

The label shall be located in a conspicuous location on the device

The label shall not be a stick-on, paper label. The label on these products shall be permanently affixed to the product and shall be readily visible to the purchaser at the time of purchase

FCC ID: KQ9-0104A

IC ID: 1317A-0104A

MODEL: LRC

§15.19: (can be placed in the user manual if the product is too small)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

USER NOTICE SHALL CONTAIN

The user notice, not provided during tests, shall include the following informations:

§15.21:

Any changes or modifications to this equipment not expressly approved by SERCEL may cause, harmful interference and void the FCC authorization to operate this equipment

6.2 unintentional radiator (subpart B)

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAP	NAs	
FCC Part 15.105	INFORMATION TO THE USER				X	See certification documents
FCC Part 15.107	CONDUCTED LIMITS	X				Class B
FCC Part 15.109	RADIATED EMISSION LIMITS	X				Class B

NAP: Not Applicable

NAs: Not Asked

USER NOTICE SHALL CONTAIN

The user notice, not provided during tests, shall include the following informations:

§ 15.105:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference's by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

6.3 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				Note 4
	(a) (2) Digital modulation techniques			X		
	(b) Maximum peak output power	X				
	(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: Professionally installed equipment.

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 system hops to channel frequencies from a pseudo randomly ordered list of hopping frequencies. Each frequency is used equally on the average by the transmitter, and separated by a minimum of 25 kHz / 20 dB bandwidth of the hopping channel (see appendix 7).
The frequency hopping system uses 17 channels (see appendix 9).

For a rate of 2.4Kbit/s, the timing by channel is 382ms (see appendix 8).

During 17 channels $\times 0.4\text{ s} = 6.8\text{s}$, any channel is used 1 time (see appendix 8), then $1 \times 382\text{ ms} = 382\text{ ms}$, 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 in second (0.4s * Number of channel)	Maximal duration of each burst (ms)	Number of burst repetition during observation period	average time of occupancy on any channel (s)	Limits (s)
17	6.8	381	1	0.381	0.4

For a rate of 100kbit/s, the timing by channel is 21.6ms (see appendix 8).

During 17 channels $\times 0.4\text{ s} = 6.84\text{s}$, any channel is used 14 times (see appendix 8), then $14 \times 21.6\text{ ms} = 302.4\text{ ms}$, 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 in second (0.4s * Number of channel)	Maximal duration of each burst (ms)	Number of burst repetition during observation period	average time of occupancy on any channel (s)	Limits (s)
17	6.8	21.6	14	0.302	0.4

For a rate of 500Kbit/s, the timing by channel is 8.4ms (see appendix 8).

During 17 channels $\times 0.4\text{ s} = 6.84\text{s}$, any channel is used 28 times (see appendix 8), then $28 \times 8.4\text{ ms} = 235.2\text{ ms}$, 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 in second (0.4s * Number of channel)	Maximal duration of each burst (ms)	Number of burst repetition during observation period	average time of occupancy on any channel (s)	Limits (s)
17	6.8	8.4	28	0.235	0.4

RF EXPOSURE:

In accordance with KDB 447498 D01 General RF Exposure Guidance v05r02

Maximum measured power = 117 dB μ V/m = 27.360 mW

$P = (E \times d)^2 / (30 \times G_p)$ with $d = 3$ m and $G_p = 5.5$

Antenna gain: 7.4 dBi

$PSD = EIRP / (4 \times \pi \times R^2) = 27.36 / (4 \times \pi \times (20 \text{ cm})^2) = 0.0054 \text{ mW/cm}^2$ (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.

To declare, or not, the compliance with the specifications, it was not explicitly taken into account of uncertainty associated with the results

7. MEASUREMENT OF THE CONDUCTED DISTURBANCES

Standard: FCC Part 15

Test procedure: Paragraph 15.107

Limits: Class B

Software used: BAT-EMC V3.6.0.32

Test set up:

The EUT is isolated and placed on a wooden table, 0.8 m over an horizontal reference plane and 0.4 m from a vertical reference plane. It is powered by an artificial main network placed on the ground reference plane. A SCI module provided by SERCEL is powered with the AC power operating voltage of 120 V / 60 Hz permitting to supply the equipment.

See photos in appendix 2

Frequency range: 150 kHz - 30 MHz

Detection mode: Peak / Average

Bandwidth: 10 kHz / 9 kHz

Equipment under test operating condition:

The equipment is blocked in reception mode.

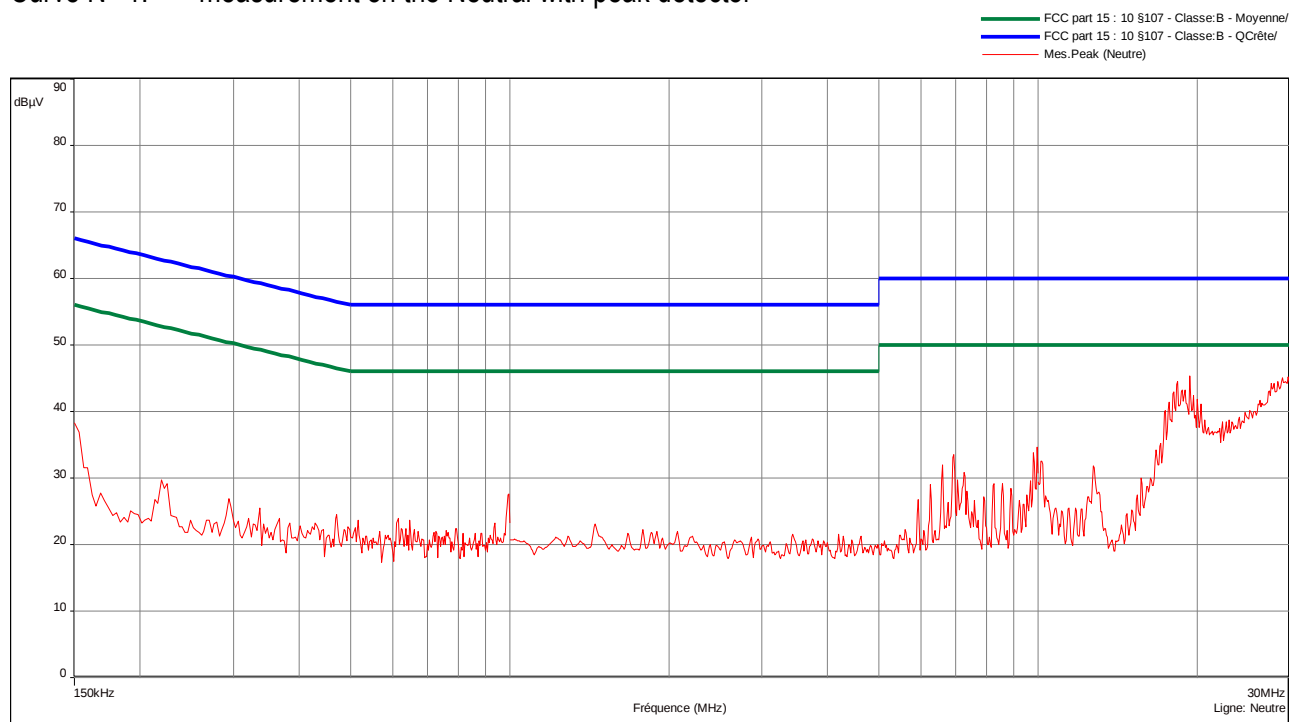
Results:

Ambient temperature (°C): 27.5
Relative humidity (%): 51

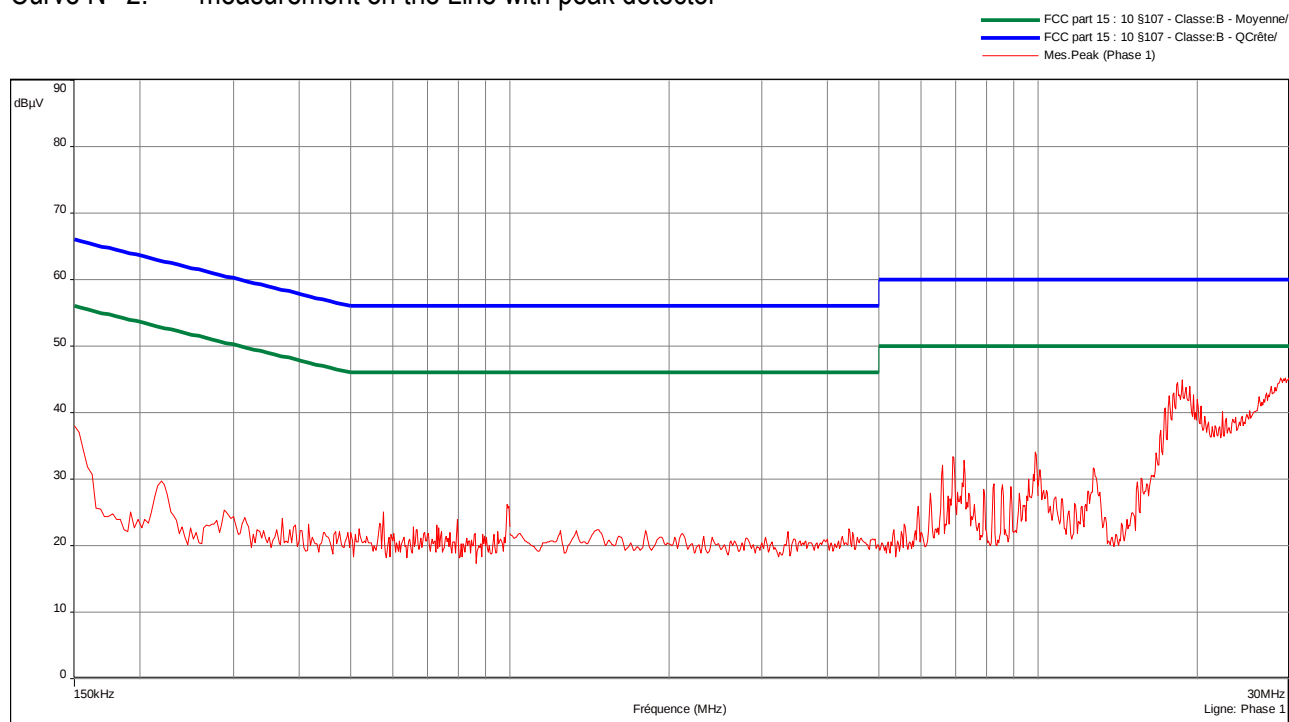
Measurement on the mains power supply:

The measurement is first realized with Peak detector.

Curve N° 1: measurement on the Neutral with peak detector

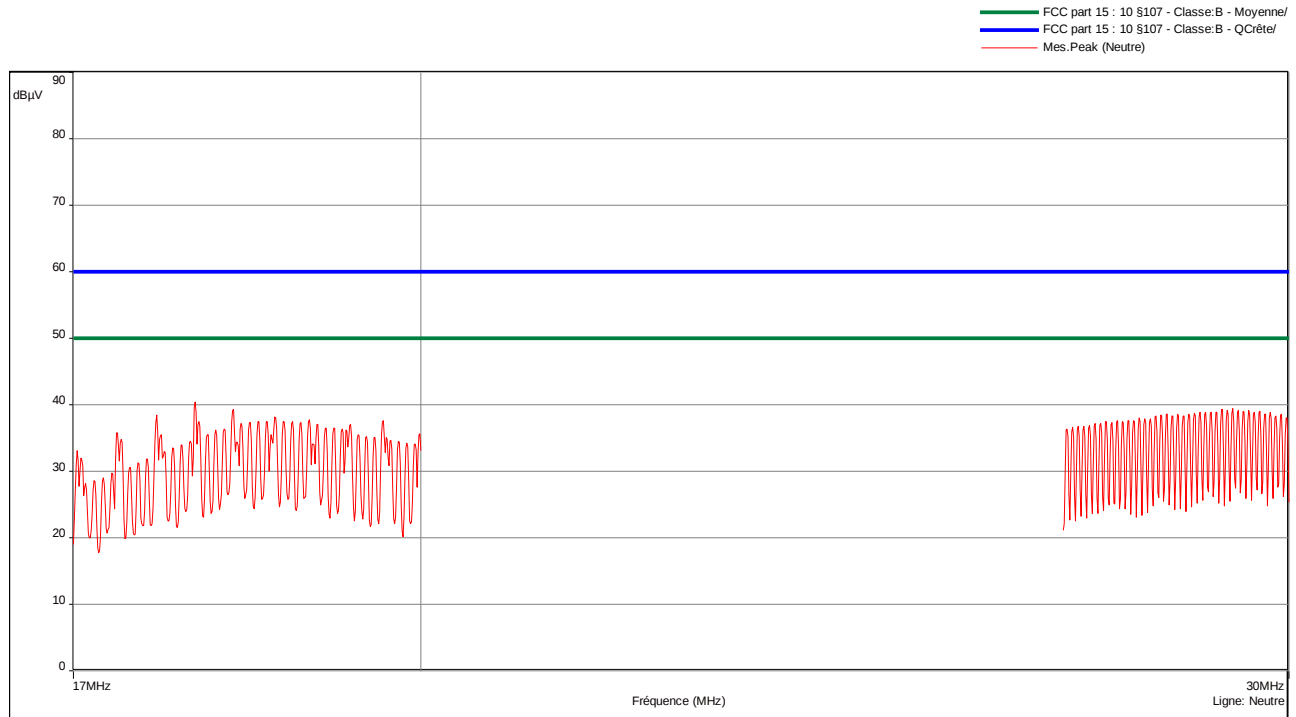


Curve N° 2: measurement on the Line with peak detector

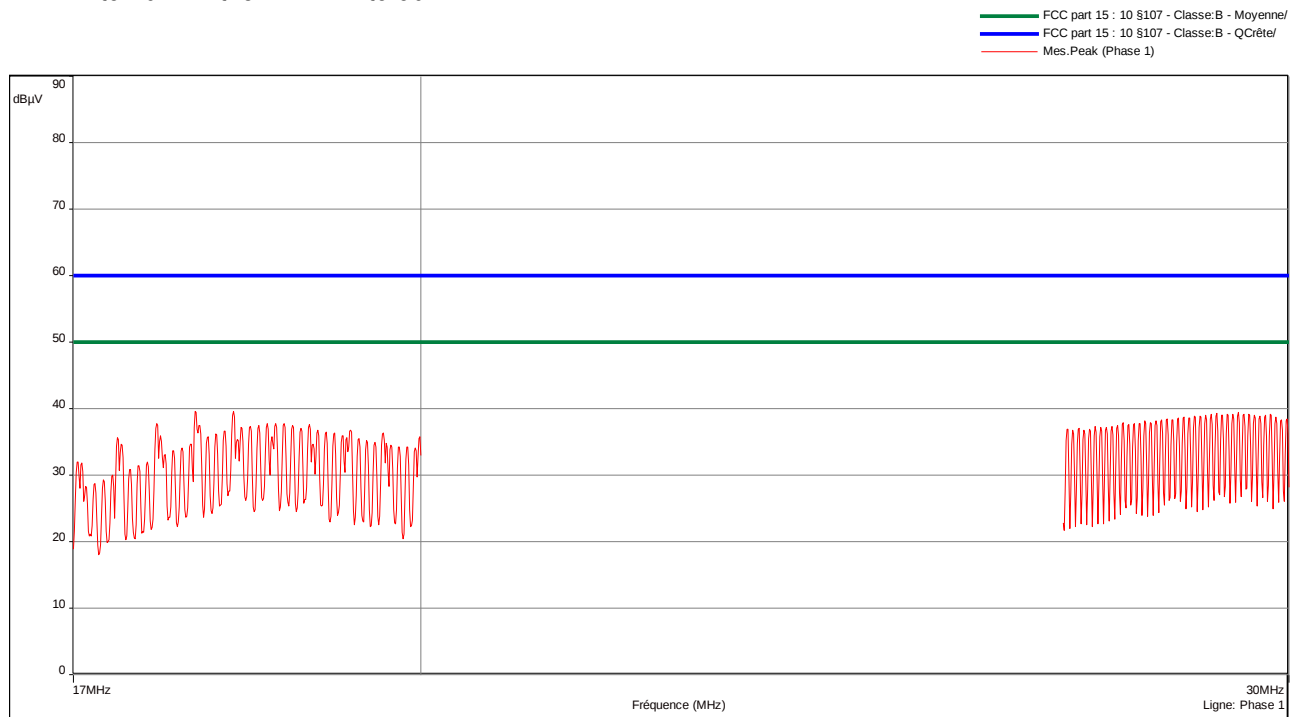


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 3: average measurement on the Neutral, for the frequency range:
17MHz to 20MHz then 27MHz to 30MHz



Curve N° 4: average measurement on the Line, for the frequency range:
17MHz to 20MHz then 27MHz to 30MHz



Test conclusion:

RESPECTED STANDARD

8. RADIATED EMISSION LIMITS

Standard: FCC Part 15

Test procedure: paragraph 109

Limit class: Class B

Test set up:

The 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 30 MHz to 5th harmonic of the highest frequency used (12.4GHz).

Detection mode: Quasi-peak ($F < 1 \text{ GHz}$) Average ($F > 1 \text{ GHz}$)

Bandwidth: 120 kHz ($F < 1 \text{ GHz}$) 1 MHz ($F > 1 \text{ GHz}$)

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 reception mode.

Results:

Ambient temperature (°C): 24.6
Relative humidity (%): 51

External Power source: Output of CX-508 Module provided by the applicant regulated to 48Vdc

Sample N° 1

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi- Peak	Antenna height (cm)	Azimuth (degree)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
128	QP	400	169	V	12.7	33	20.3
199	QP	331	277	V	10.6	33	22.4
210	QP	376	234	H	13.8	33	19.2
256	QP	320	167	V	18.6	35.5	16.9
320	QP	100	0	V	21.5	35.5	14
640	QP	400	0	V	19.5	35.5	22.4

Note: any spurious which has more than 20 dB of margin compared to the applicable limit is not necessarily reported.

Test conclusion:

RESPECTED STANDARD

9. MEASUREMENT OF THE CONDUCTED DISTURBANCES

Standard: FCC Part 15

Test procedure: Paragraph 15.207

Software used: BAT-EMC V3.6.0.32

Test set up:

The EUT is isolated and placed on a wooden table, 0.8 m over an horizontal reference plane and 0.4 m from a vertical reference plane. It is powered by an artificial main network placed on the ground reference plane. A SCI module provided by SERCEL is powered with the AC power operating voltage of 120 V / 60 Hz permitting to supply the equipment.

See photos in appendix 2

Frequency range: 150 kHz - 30 MHz

Detection mode: Peak / Average

Bandwidth: 10 kHz / 9 kHz

Equipment under test operating condition:

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

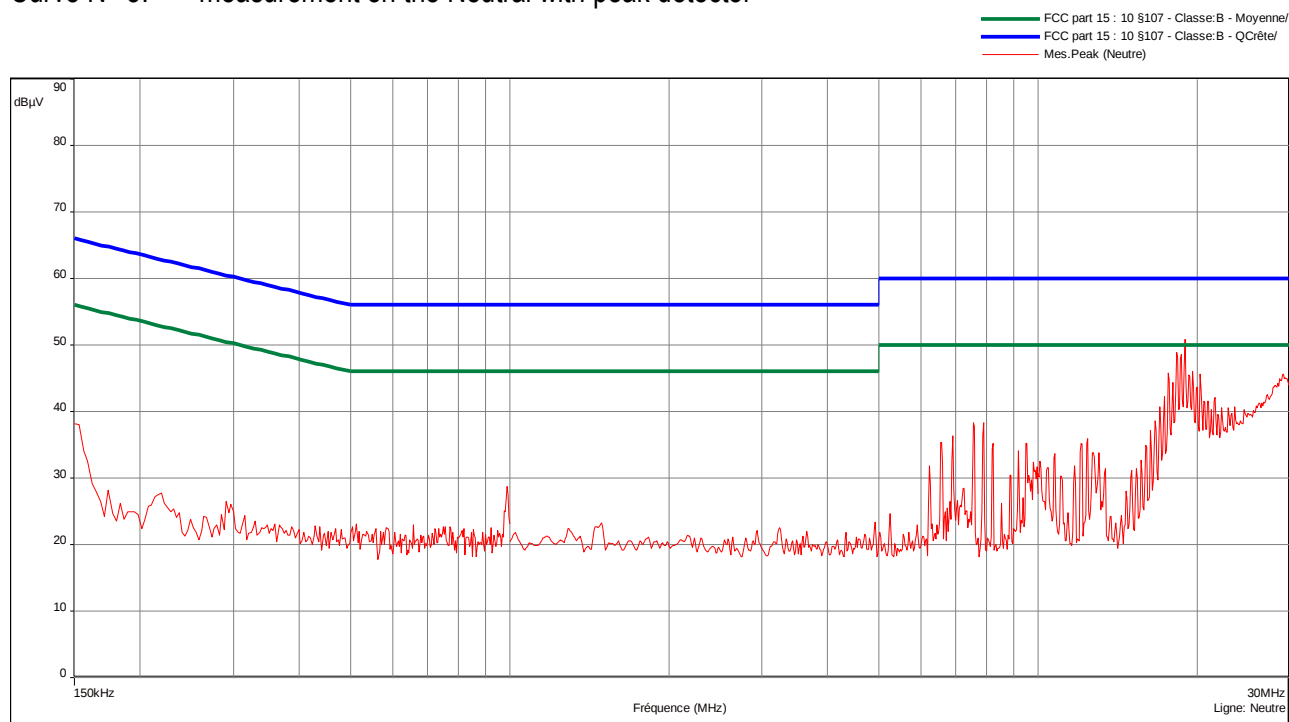
Results:

Ambient temperature (°C): 26
Relative humidity (%): 54

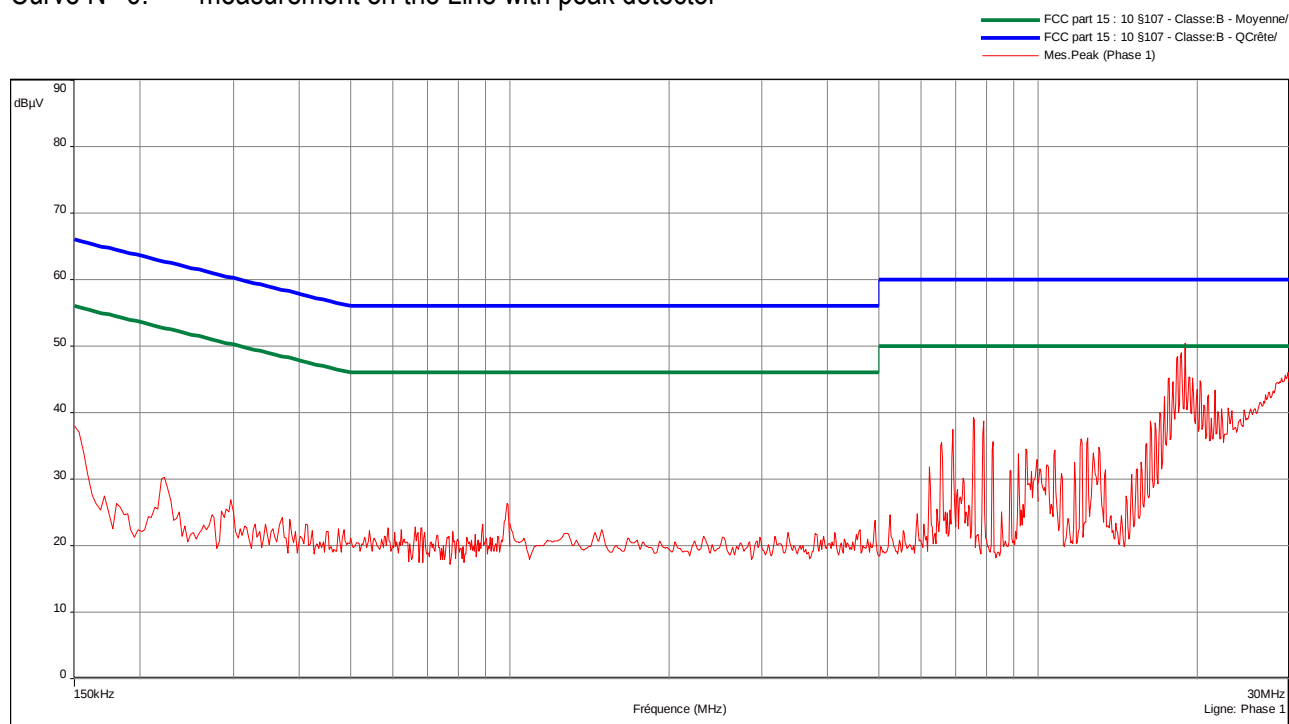
Measurement on the mains power supply with rate of 2.4kbit/s:

The measurement is first realized with Peak detector.

Curve N° 5: measurement on the Neutral with peak detector

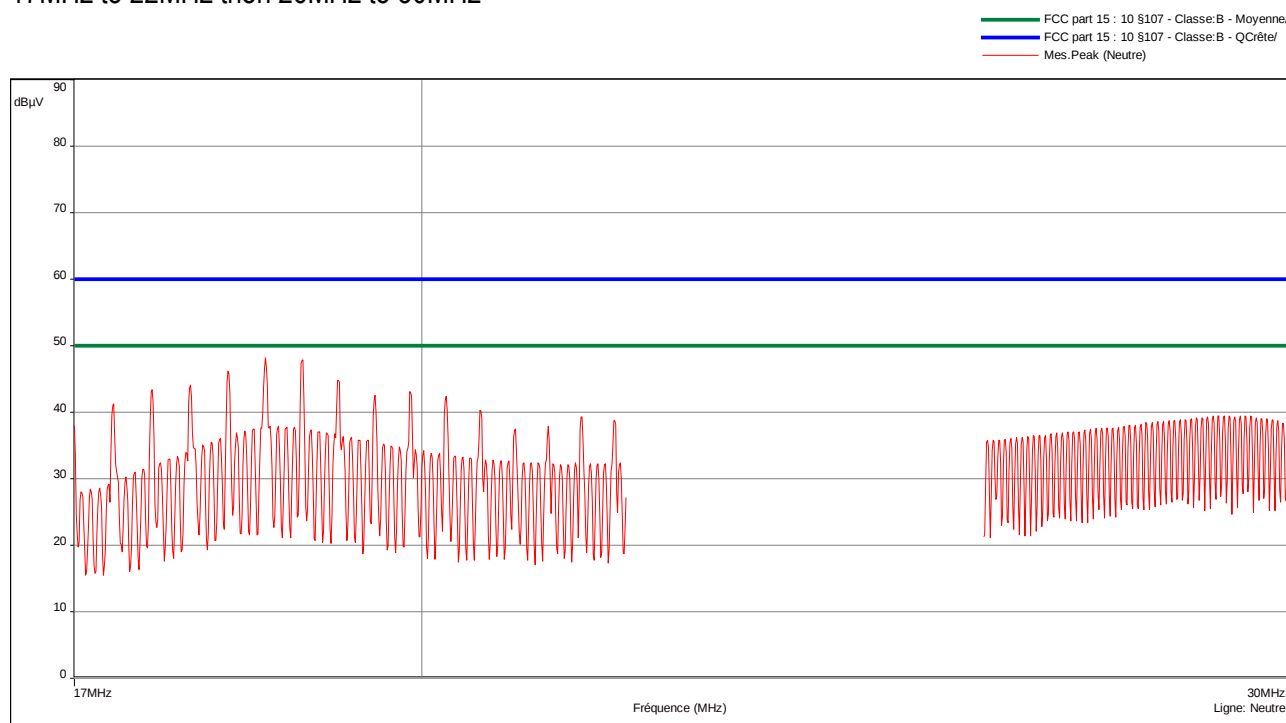


Curve N° 6: measurement on the Line with peak detector

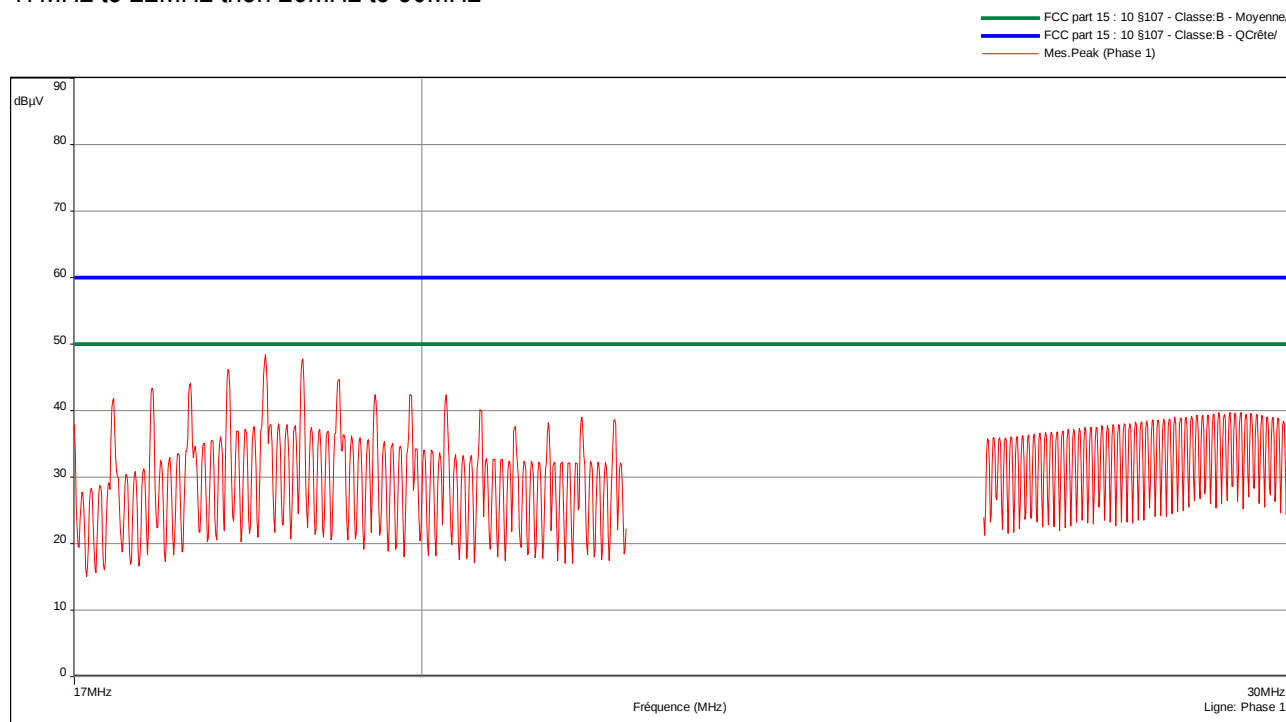


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 7: average measurement on the Neutral, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



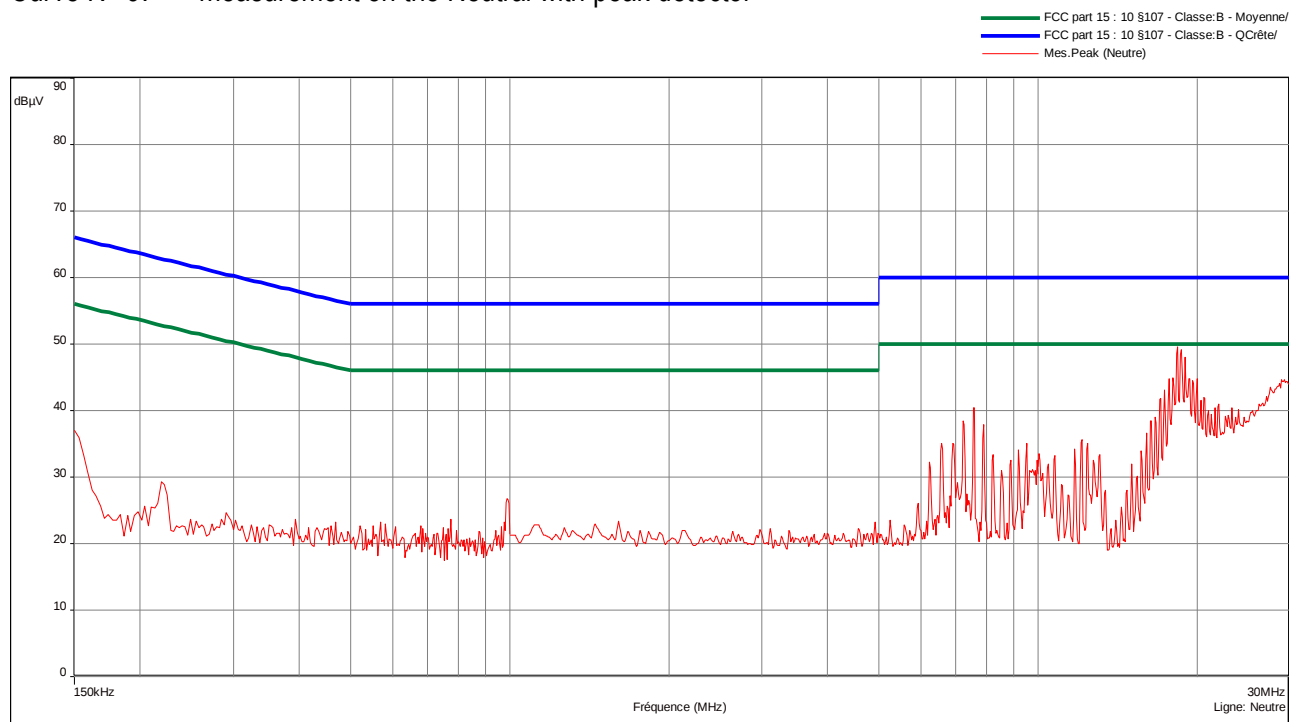
Curve N° 8: average measurement on the Line, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



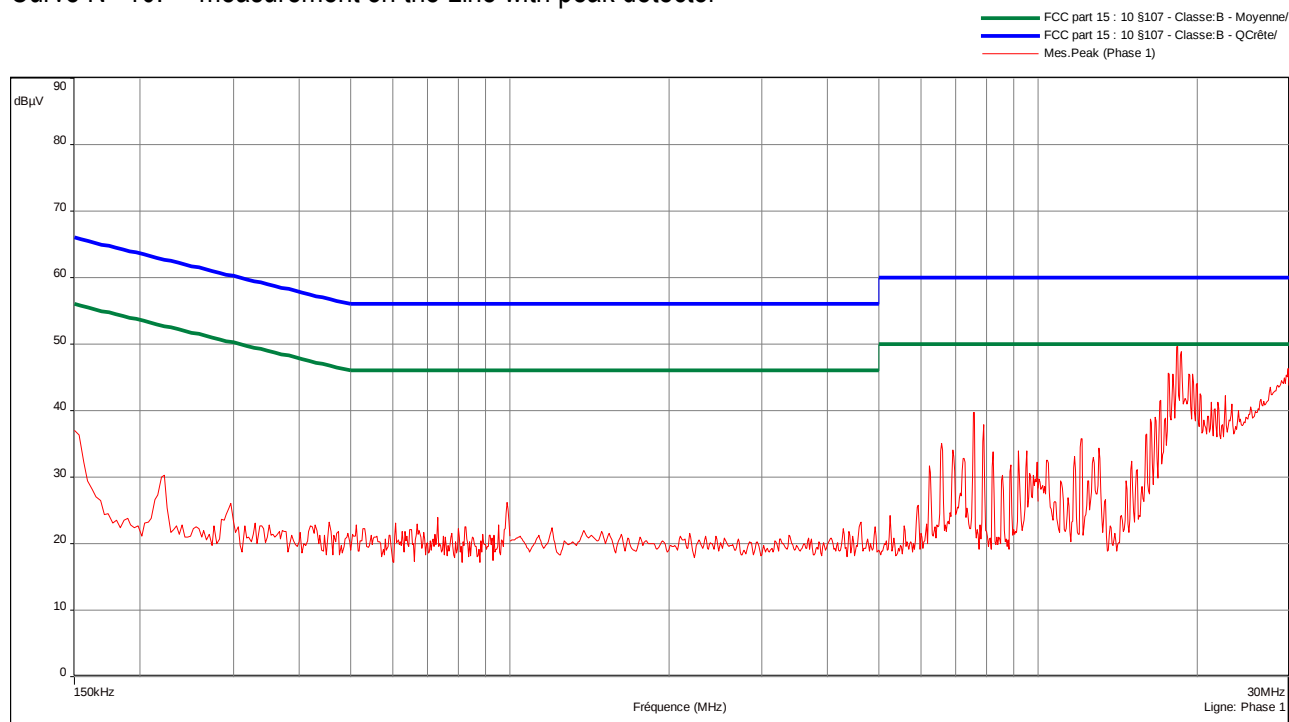
Measurement on the mains power supply with rate of 100kbit/s:

The measurement is first realized with Peak detector.

Curve N° 9: measurement on the Neutral with peak detector

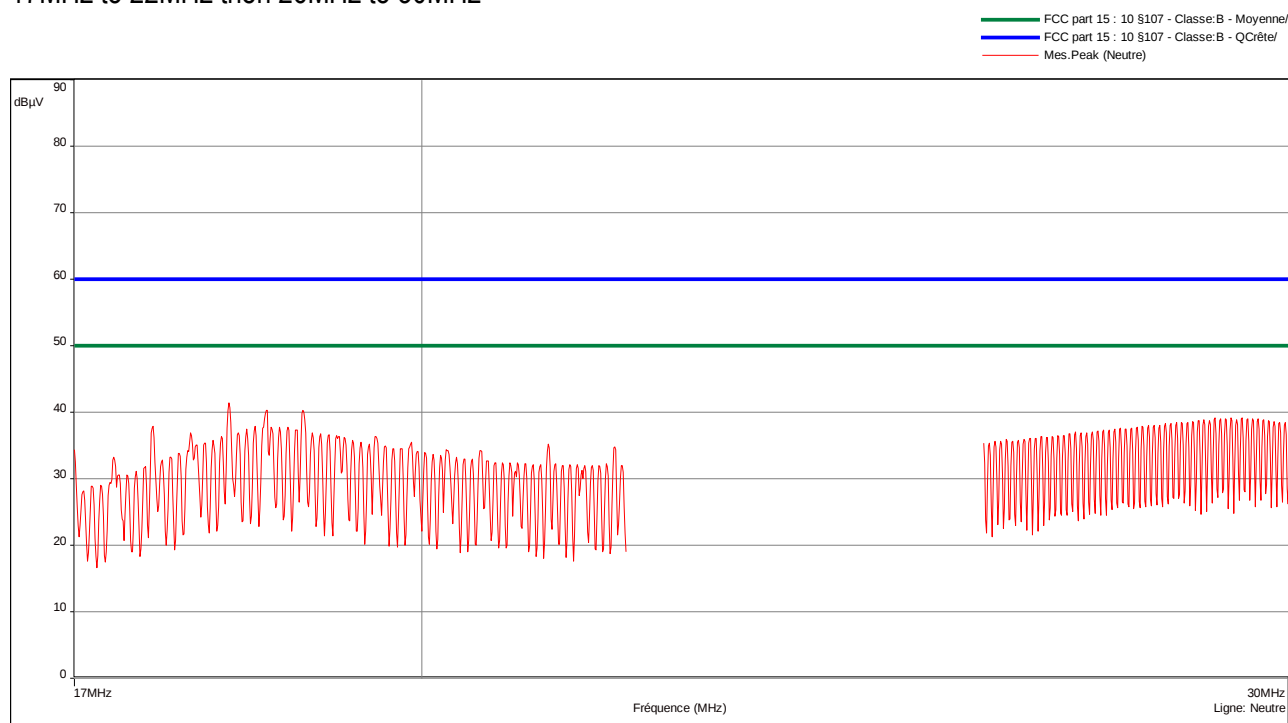


Curve N° 10: measurement on the Line with peak detector

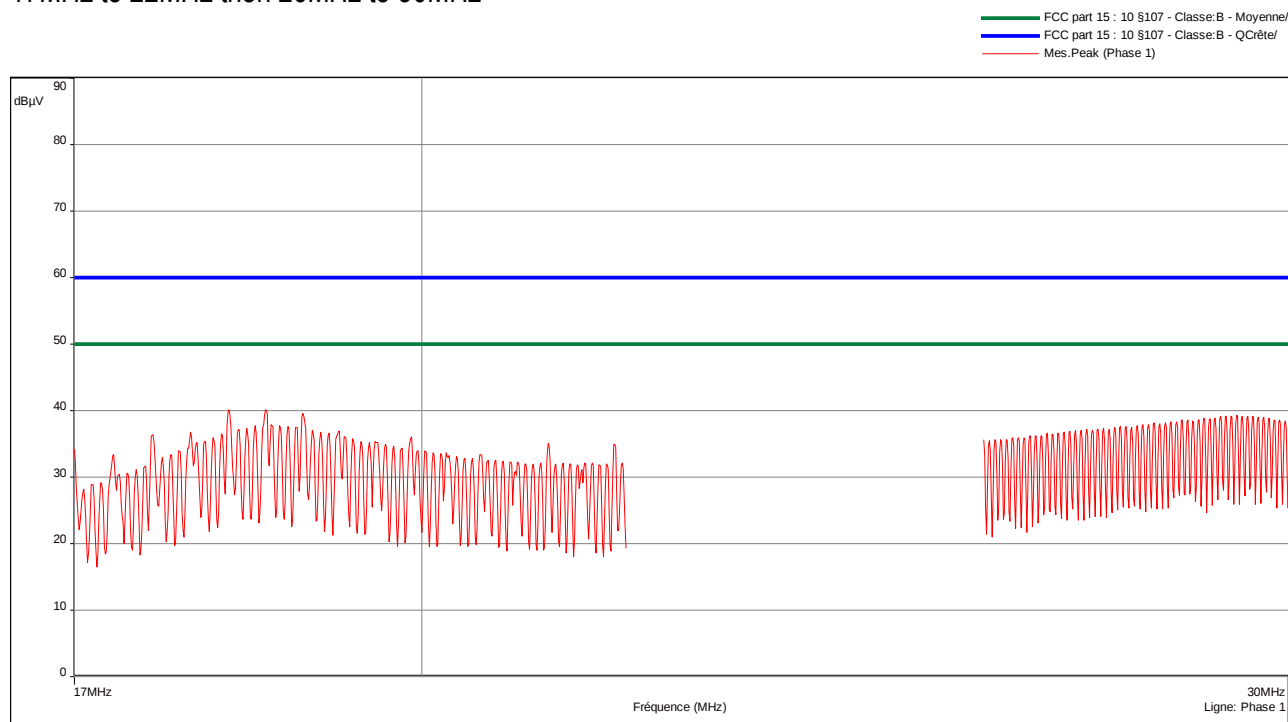


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 11: average measurement on the Neutral, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



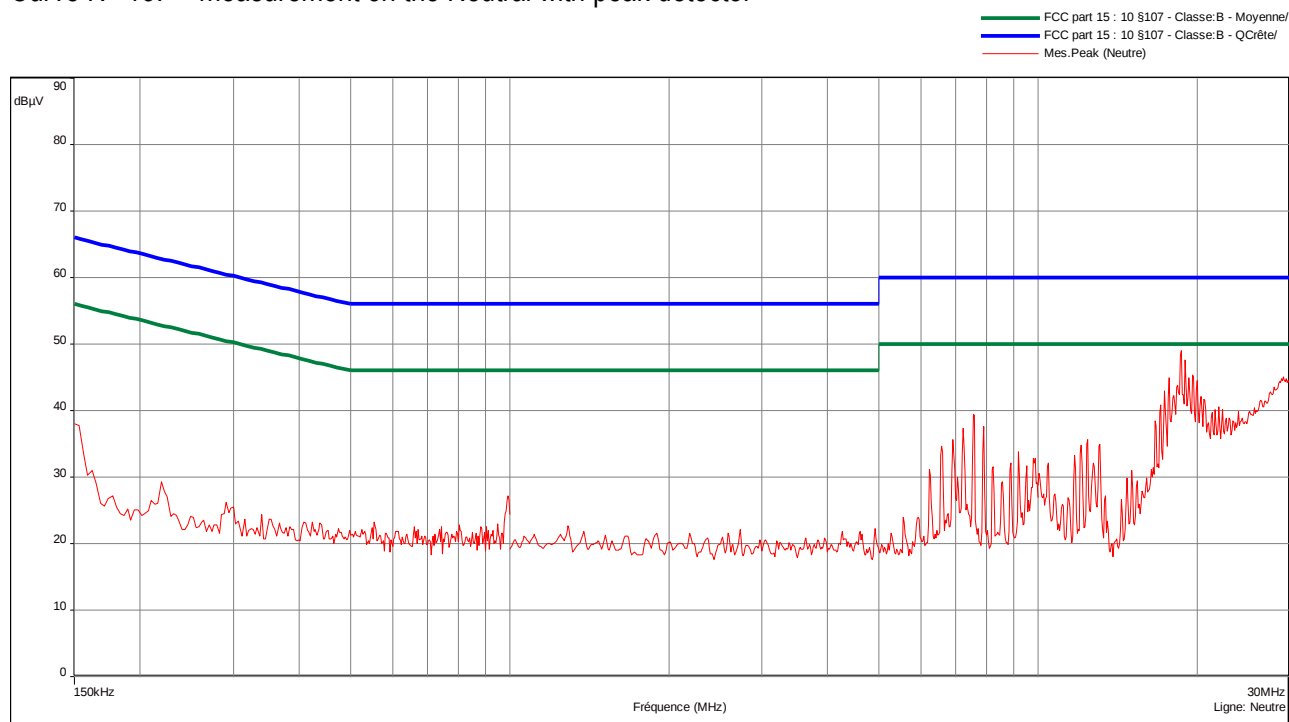
Curve N° 12: average measurement on the Line, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



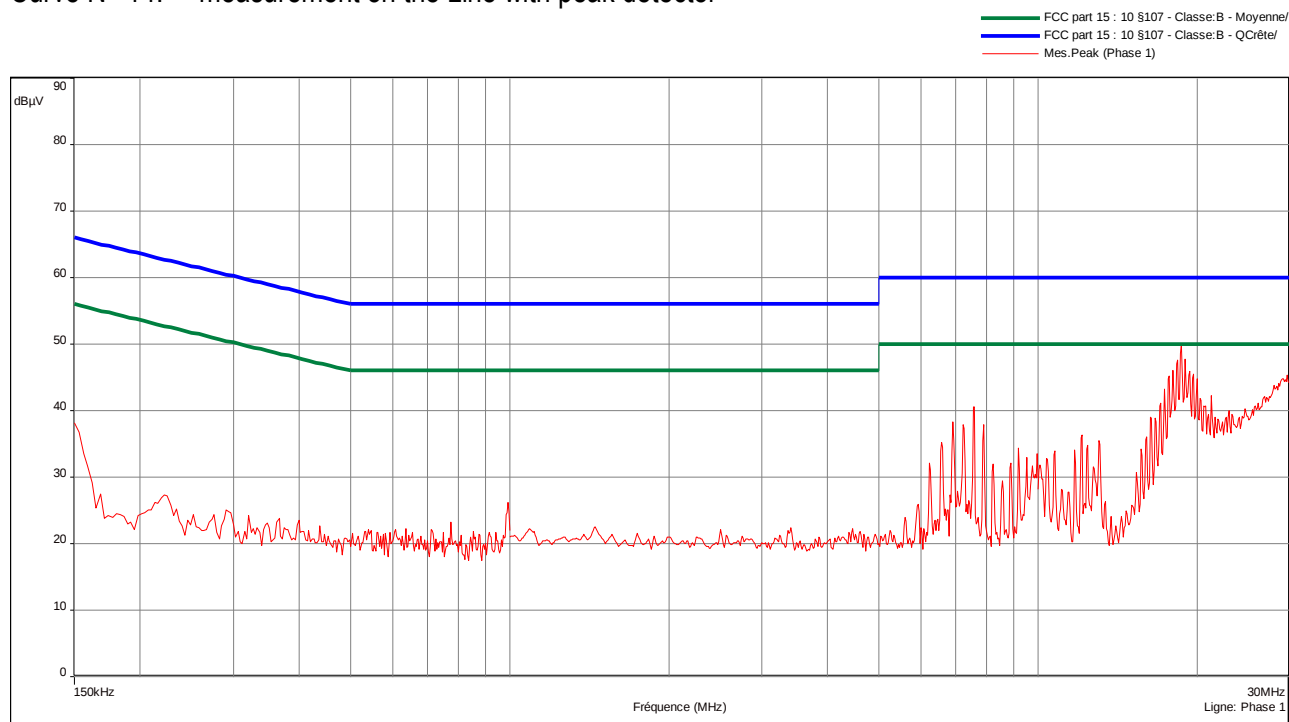
Measurement on the mains power supply with rate of 500kbit/s:

The measurement is first realized with Peak detector.

Curve N° 13: measurement on the Neutral with peak detector

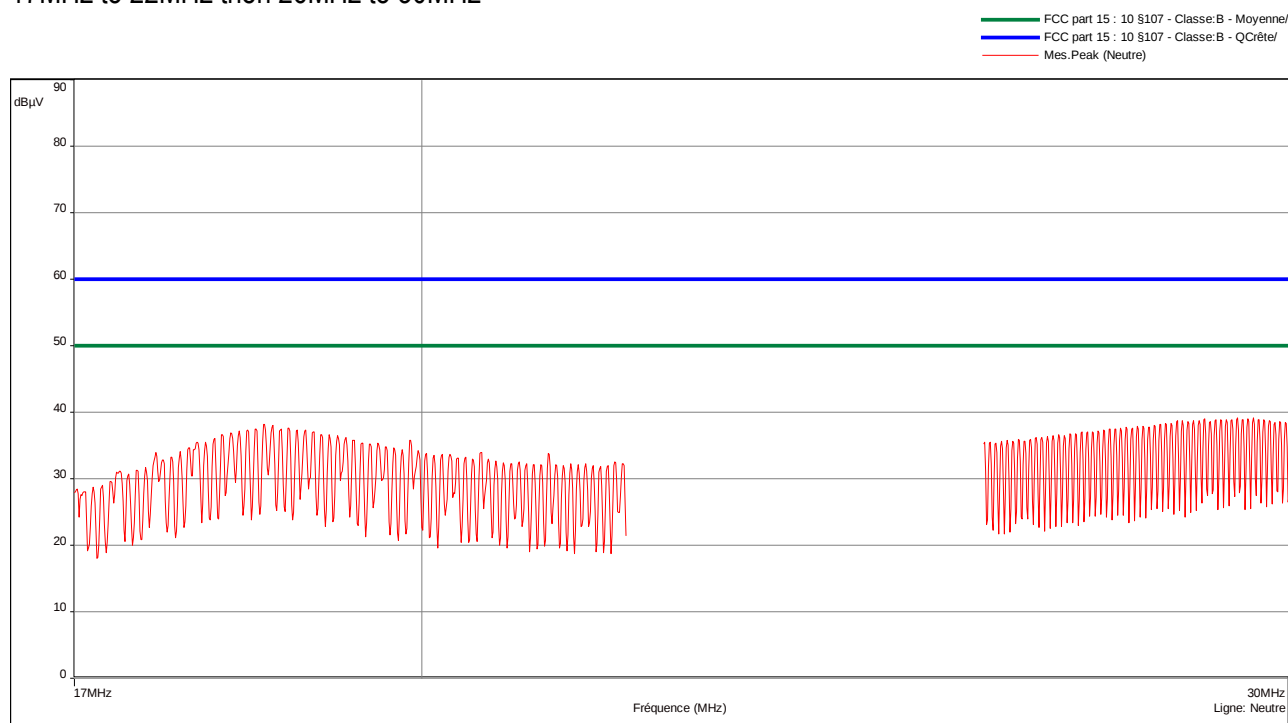


Curve N° 14: measurement on the Line with peak detector

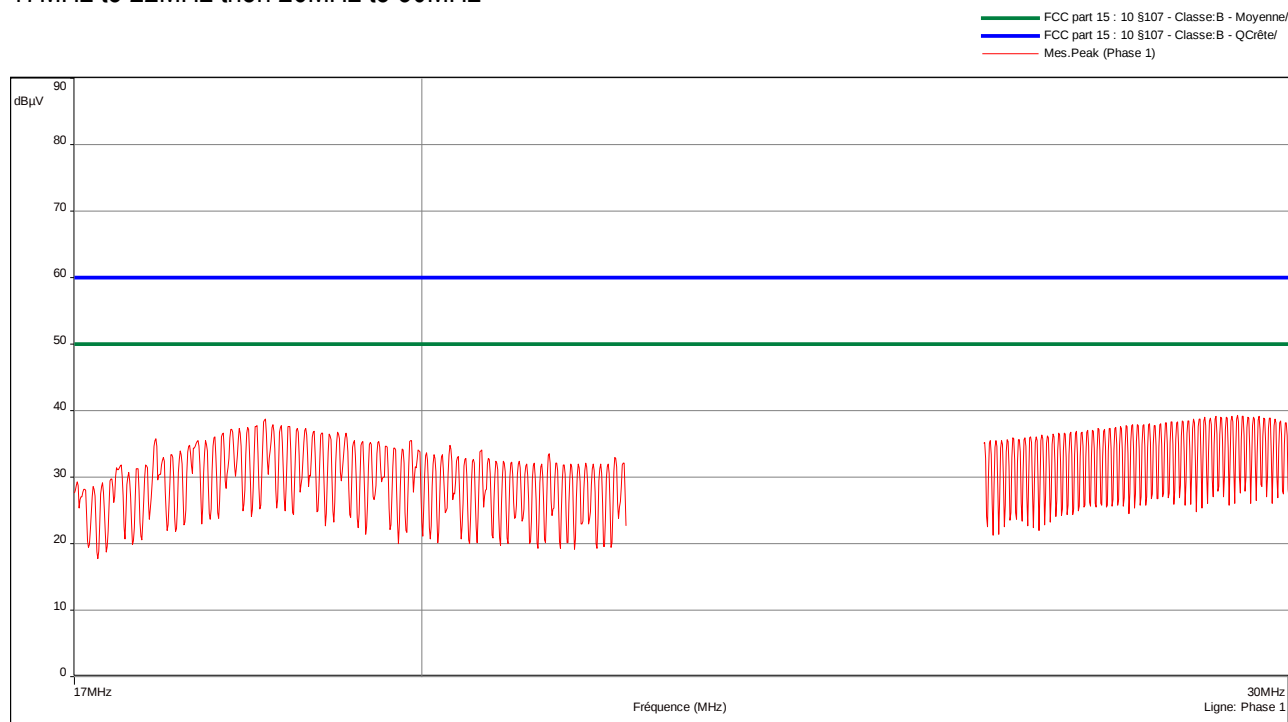


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 15: average measurement on the Neutral, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



Curve N° 16: average measurement on the Line, for the frequency range:
17MHz to 22MHz then 26MHz to 30MHz



Test conclusion:

RESPECTED STANDARD

10. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS

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 hopping transmission mode, modulated by internal data signal, at the highest output power level which the transmitter is intended to operate.

Results:

Ambient temperature (°C):	21.6
Relative humidity (%):	47

External Power source: Output of CX-508 Module provided by the applicant regulated to 48Vdc

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

Sample N° 1 with a rate of 2.4kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.9	-54.3	61.7	96	34.3
2469	115	PEAK	2483.7	-54.7	60.3	74	13.7
2469	114	AVERAGE	2483.7	-68.8	45.2	54	8.8

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

Sample N° 1 with a rate of 2.4kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.9	-52.4	63.6	96	32.4
2469	115	PEAK	2485.1	-51.1	63.9	74	10.1
2469	114	AVERAGE	2485.1	-65.9	48.1	54	5.9

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

20 dB bandwidth curves are given in appendix 5; band-edge curves are given in appendix 6.

Sample N° 1 with a rate of 100kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.4	-55.1	60.9	96	35.1
2469	115	PEAK	2483.9	-53.7	61.3	74	12.7
2469	114	AVERAGE	2483.9	-67.4	46.6	54	7.4

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

Sample N° 1 with a rate of 100kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.6	-52.9	63.1	96	32.9
2469	115	PEAK	2484.0	-51.2	63.7	74	10.3
2469	114	AVERAGE	2483.8	-65.5	48.5	54	5.5

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

20 dB bandwidth curves are given in appendix 5; band-edge curves are given in appendix 6.

Sample N° 1 with a rate of 500kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.8	-53.2	62.8	96	33.2
2469	115	PEAK	2483.9	-54.6	60.4	74	13.6
2469	114	AVERAGE	2483.7	-67.6	46.4	54	7.6

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

Sample N° 1 with a rate of 500kbit/s – 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)*	Calculated Max Out-of-Band Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2405	116	PEAK	2399.7	-52.1	63.9	96	33.1
2469	115	PEAK	2484.5	-50.8	64.2	74	9.8
2469	114	AVERAGE	2483.6	-67.4	46.6	54	7.4

* Marker-Delta method

** The peak level is lower than the average limit (54dBμV/m).

20 dB bandwidth curves are given in appendix 5; band-edge curves are given in appendix 6.

Test conclusion:

RESPECTED STANDARD

11. MAXIMUM PEAK OUTPUT POWER

Standard: FCC Part 15

Test procedure: paragraph 15.247 (b)

Test set up:

The 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, 1.5m from a ground plane.

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

See photos in appendix 2.

The measurement of the electro-magnetic field is realized, with a resolution bandwidth adjusted at 1MHz and video bandwidth at 3MHz.

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)

Equipment under test operating condition:

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

Results:

Ambient temperature (°C): 25.1
Relative humidity (%): 47

External Power source: Output of CX-508 Module provided by the applicant regulated to 48Vdc

Sample N° 1 Low Channel (F=2405MHz) with rate: 2.4Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	116	21.733	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 101 degrees)

Sample N° 1 Central Channel (F=2437MHz) with rate: 2.4Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	117	27.360	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 144 degrees)

Sample N° 1 High Channel (F=2469MHz) with rate: 2.4Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	115	17.263	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 104 degrees)

* $P = (E \times d)^2 / (30 \times G_p)$ with $d = 3 \text{ m}$ and $G_p = 5.5$

Antenna gain = 7.4dBi

Sample N° 1 Low Channel (F=2405MHz) with rate: 100Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	116	21.733	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 150 degrees)

Sample N° 1 Central Channel (F=2437MHz) with rate: 100Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	117	27.360	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 143 degrees)

Sample N° 1 High Channel (F=2469MHz) with rate: 100Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	115	17.263	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 153 degrees)

* $P = (E \times d)^2 / (30 \times G_p)$ with $d = 3 \text{ m}$ and $G_p = 5.5$

Antenna gain = 7.4dBi

Sample N° 1 Low Channel (F=2405MHz) with rate: 500Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	116	21.733	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 139 degrees)

Sample N° 1 Central Channel (F=2437MHz) with rate: 500Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	117	27.360	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 141 degrees)

Sample N° 1 High Channel (F=2469MHz) with rate: 500Kbit/s

	Electro-magnetic field (dBμV/m):	Conducted power * (mW)	Limit (mW)
Nominal supply voltage: 48V	115	17.263	91.2

Polarization of test antenna: Vertical (height: 150 cm)

Position of equipment: see photos in annex 2 (azimuth: 147 degrees)

* $P = (E \times d)^2 / (30 \times G_p)$ with $d = 3 \text{ m}$ and $G_p = 5.5$

Antenna gain = 7.4dBi

Test conclusion:

RESPECTED STANDARD

12. INTENTIONAL RADIATOR

Standard: FCC Part 15

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

Test set up:

The 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 25GHz (10th harmonic of the highest fundamental frequency).

Detection mode: Quasi-peak ($F < 1 \text{ GHz}$)

Peak / Average ($F > 1 \text{ GHz}$)

Bandwidth: 200Hz ($9 \text{ kHz} < F < 150\text{kHz}$)
9 kHz ($150 \text{ kHz} < F < 30\text{MHz}$)
120 kHz ($30 \text{ MHz} < F < 1 \text{ GHz}$)
100 kHz / 1 MHz ($F > 1 \text{ GHz}$)

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.

Results:

Ambient temperature (°C): 26.1
Relative humidity (%): 47

External Power source: Output of CX-508 Module provided by the applicant regulated to 48Vdc

Sample N° 1 Low Channel (F=2405MHz) with rate of 2.4Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi- Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7215	P	150	308	100	V	45.8	95	49.2
9620	P	150	331	100	V	47	95	48

Sample N° 1 Central Channel (F=2437MHz) with rate of 2.4Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi- Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7311	P	150	62	1000	H	51.5**	74	22.5
9748.2	P	150	88	100	H	49.9	95	45.1

Sample N° 1 High Channel (F=2469MHz) with rate of 2.4Kbit/s

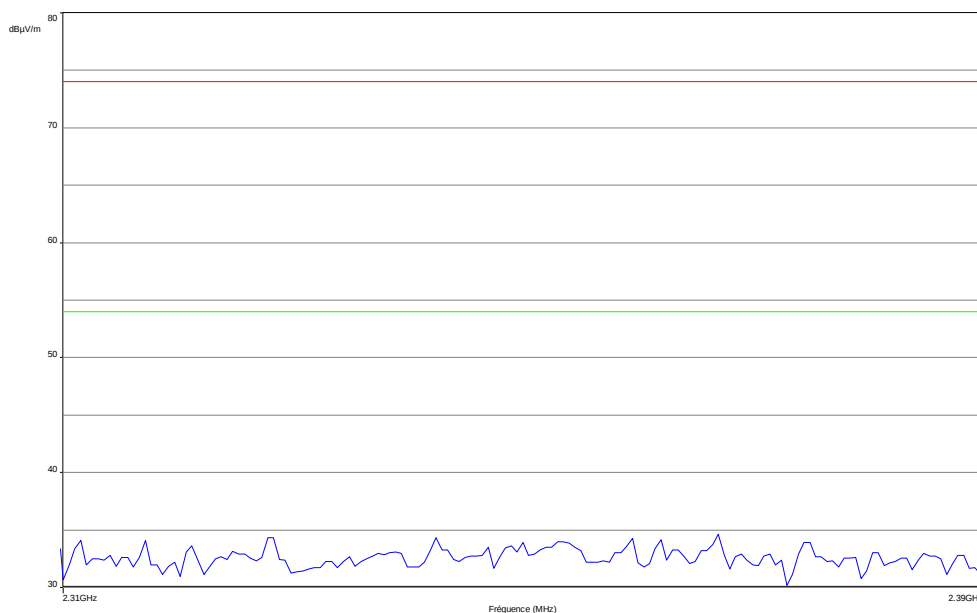
FREQUENCIES (MHz)	Detector P: Peak QP: Quasi- Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7407	P	150	59	1000	H	50**	74	24
9871.8	P	150	92	100	H	45.8	95	49.2

* restricted bands of operation in 15.205

**the peak level is lower than the average limit (54 dBμV/m).

Band edge worst case results

Low channel



Sample N° 1 Low Channel (F=2405MHz) with rate of 100Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7215	P	150	222	100	H	44	95	51
9620	P	150	238	100	H	45.1	95	49.9

Sample N° 1 Central Channel (F=2437MHz) with rate of 100Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7311	P	150	300	1000	H	51.4**	74	22.6
9748	P	150	337	100	V	46.2	95	48.8

Sample N° 1 High Channel (F=2469MHz) with rate of 100Kbit/s

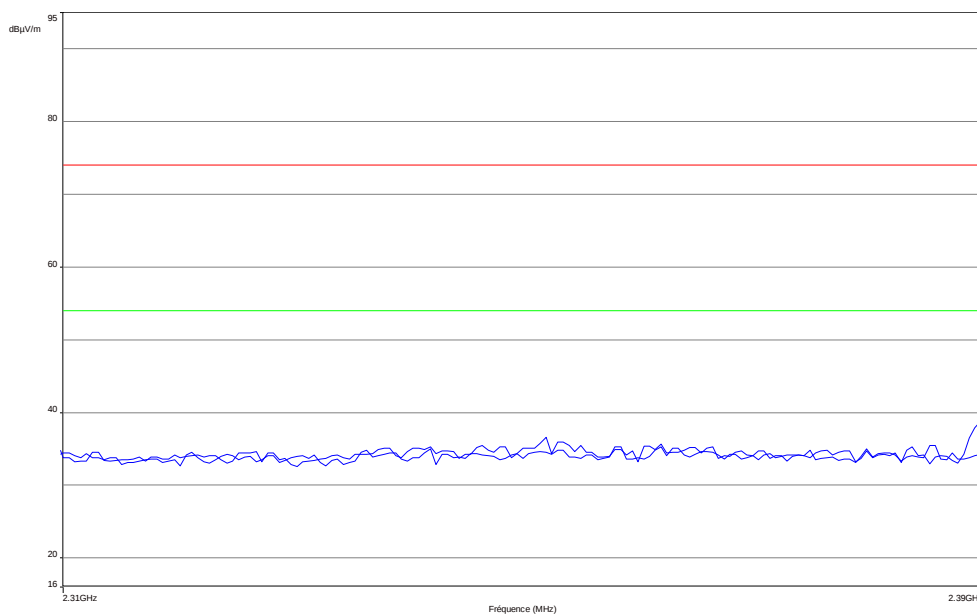
FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
7407	P	150	340	1000	H	52.4**	74	21.6
9876	P	150	—	100	H	45.4	95	49.6

* restricted bands of operation in 15.205

**the peak level is lower than the average limit (54 dBμV/m).

Band edge worst case results

Low channel



Sample N° 1 Low Channel (F=2405MHz) with rate of 500Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
7215	P	150	316	100	V	43.5	95	51.5
9620	P	150	—	100	V	44.4	95	50.6

Sample N° 1 Central Channel (F=2437MHz) with rate of 500Kbit/s

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
7311	P	150	—	1000	H	48.2**	74	25.8
9748	P	150	—	100	V	43.5	95	51.5

Sample N° 1 High Channel (F=2469MHz) with rate of 500Kbit/s

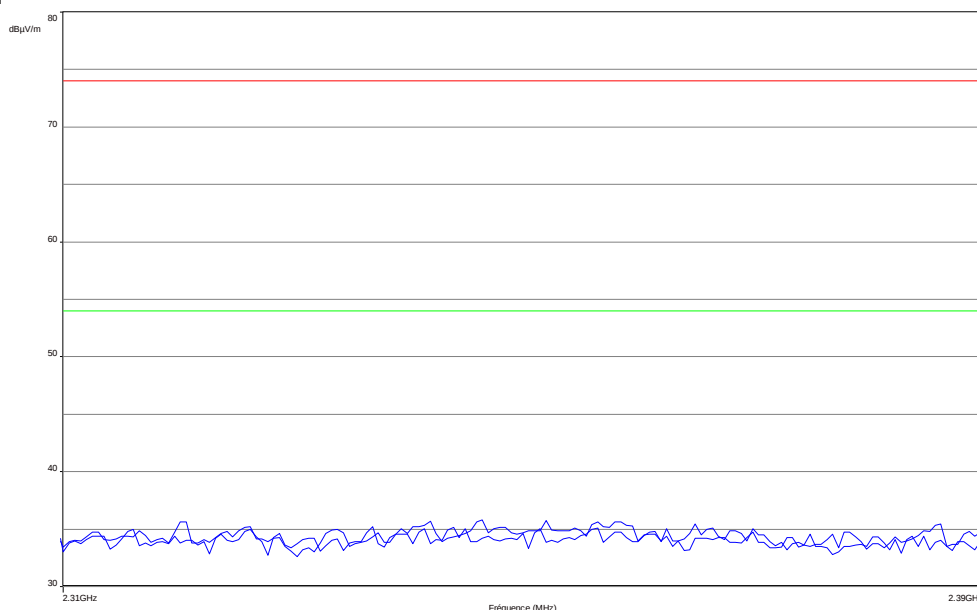
FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
7407	P	150	—	1000	H	49.8**	74	24.2
9876	P	150	—	100	H	44.3	95	50.7

* restricted bands of operation in 15.205

**the peak level is lower than the average limit (54 dB μ V/m).

Band edge worst case results

Low channel



Note: any spurious which has more than 20 dB of margin compared to the applicable limit is not necessarily reported.

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 115dBμV/m on high channel.
So the applicable limit is 95dBμV/m.

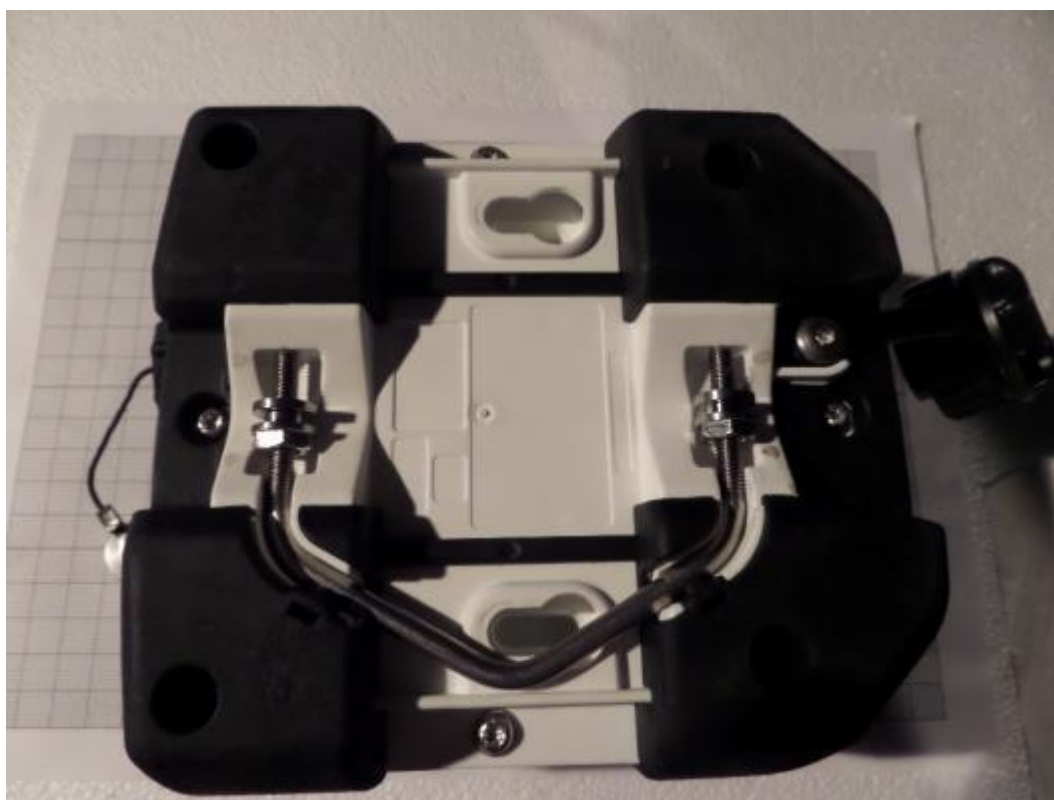
In addition, radiated emissions which fall in the restricted band, as defined in section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see section 15.205 (c)).

Test conclusion:

RESPECTED STANDARD

□□□ End of report, 9 annexes to be forwarded □□□

APPENDIX 1: Photos of the equipment under test





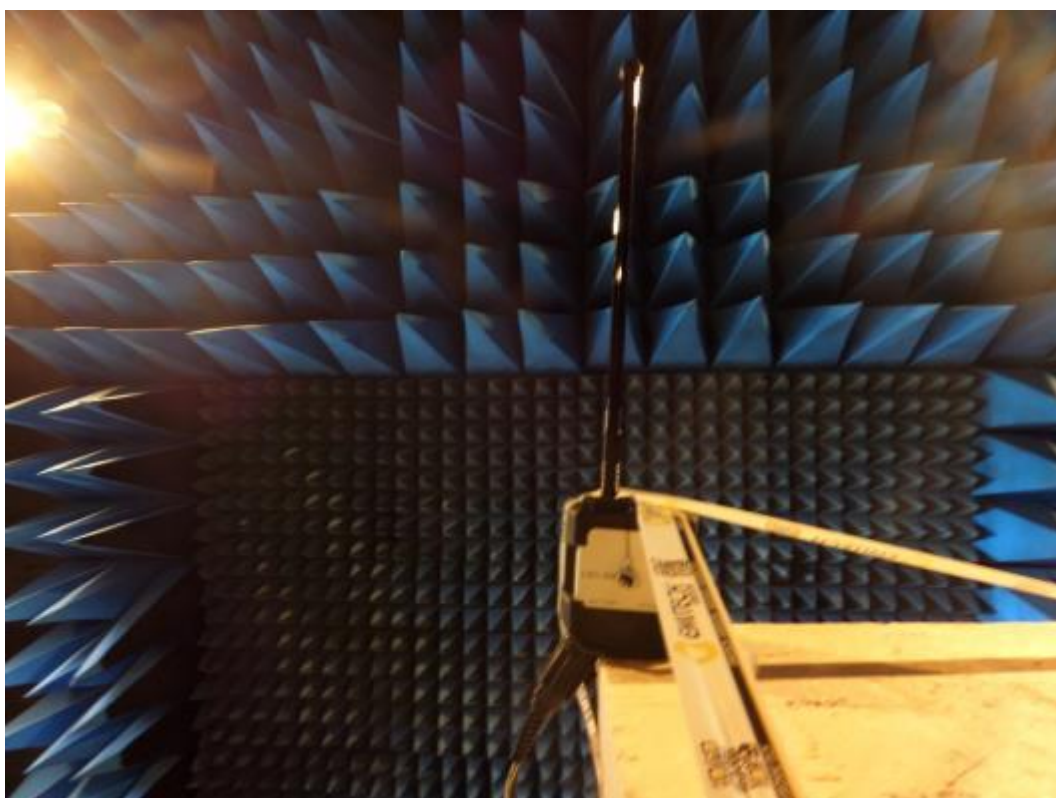
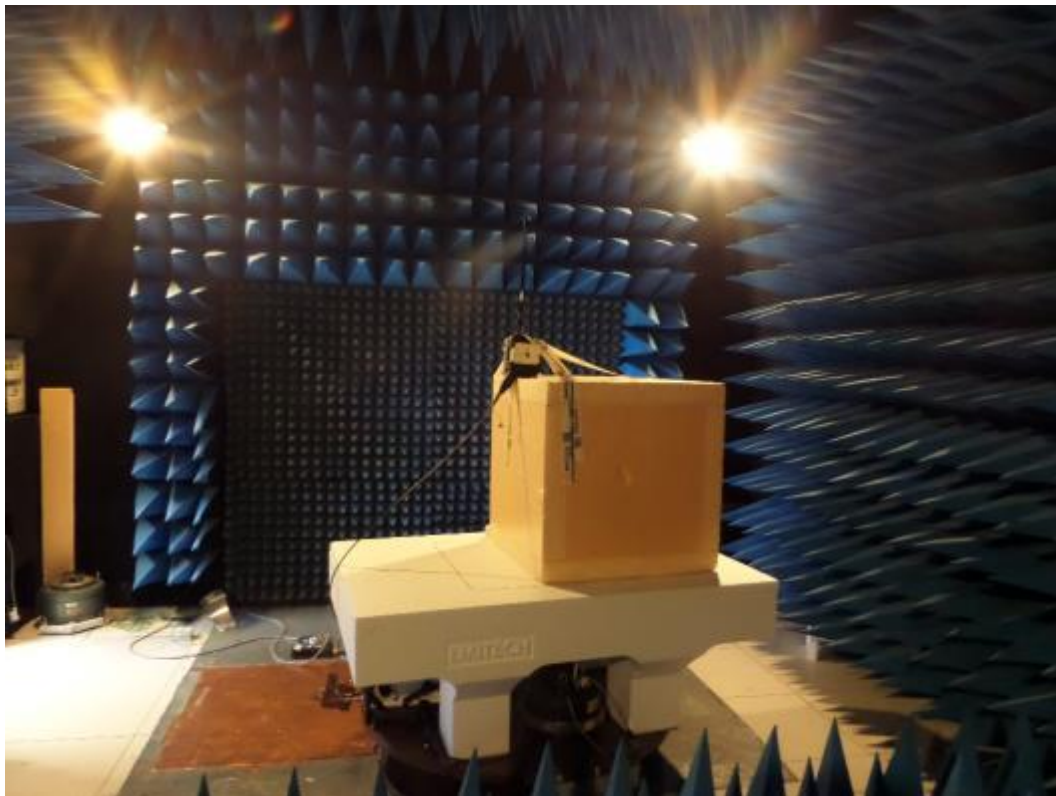


Antenna



APPENDIX 2: Test set up

Indoor test site



Outdoor test site



Conducted disturbances test







APPENDIX 3: Test equipment list

Measurement of the conducted disturbances

TYPE	MANUFACTURER	EMITECH NUMBER
Outside room Hors cage	Emitech	8893
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver HP 8591EM	Hewlett Packard	8524
Transient limiter 11947A	Hewlett Packard	8763
LISN 1600	Rohde & Schwarz	8719
Absorber sheath current	Emitech	9489
Power source 1251RP	California instruments	8508
Multimeter MN5102B	AOIP	8675
Meteo station	HUGER	8671
Software	BAT-EMC V3.6.0.32	0000

Radiated emission limits

TYPE	MANUFACTURER	EMITECH NUMBER
Open test site	EMITECH	8732
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Test receiver ESI7	Rohde & Schwarz	8707
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Biconical antenna VHBB 9124	Schwarzbeck	8526
Biconical antenna VHA 9103	Schwarzbeck	8528
Log periodic antenna UHALP 9108A	Schwarzbeck	8543
Log periodic antenna 3147	EMCO	8783
Antenna 3115	EMCO	8535
Antenna WR42	IMC	1939
Antenna WR42	IMC	1940
Low-noise amplifier 8447D	Hewlett Packard	8511
Low-noise amplifier C020180F-4B1	Microwave DB	1922
Low-noise amplifier ALN02-0102	ALC Microwave	3036
Multimeter MN5102B	AOIP	8675
Meteo station WS-9232	La Crosse Technology	8749
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000
Software	Champ libre Juigné. V3.4	8864

Additional provisions to the general radiated emission limitations

TYPE	MANUFACTURER	EMITECH NUMBER
Outside room Hors cage	Emitech	8893
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Spectrum Analyzer FSEM30	Rohde & Schwarz	8523
Antenna 3115	EMCO	8535
Multimeter MN5102B	AOIP	8675
Meteo station WS-9232	La Crosse Technology	8750
Software	GPIBShot V2.4	-

Maximum peak output power

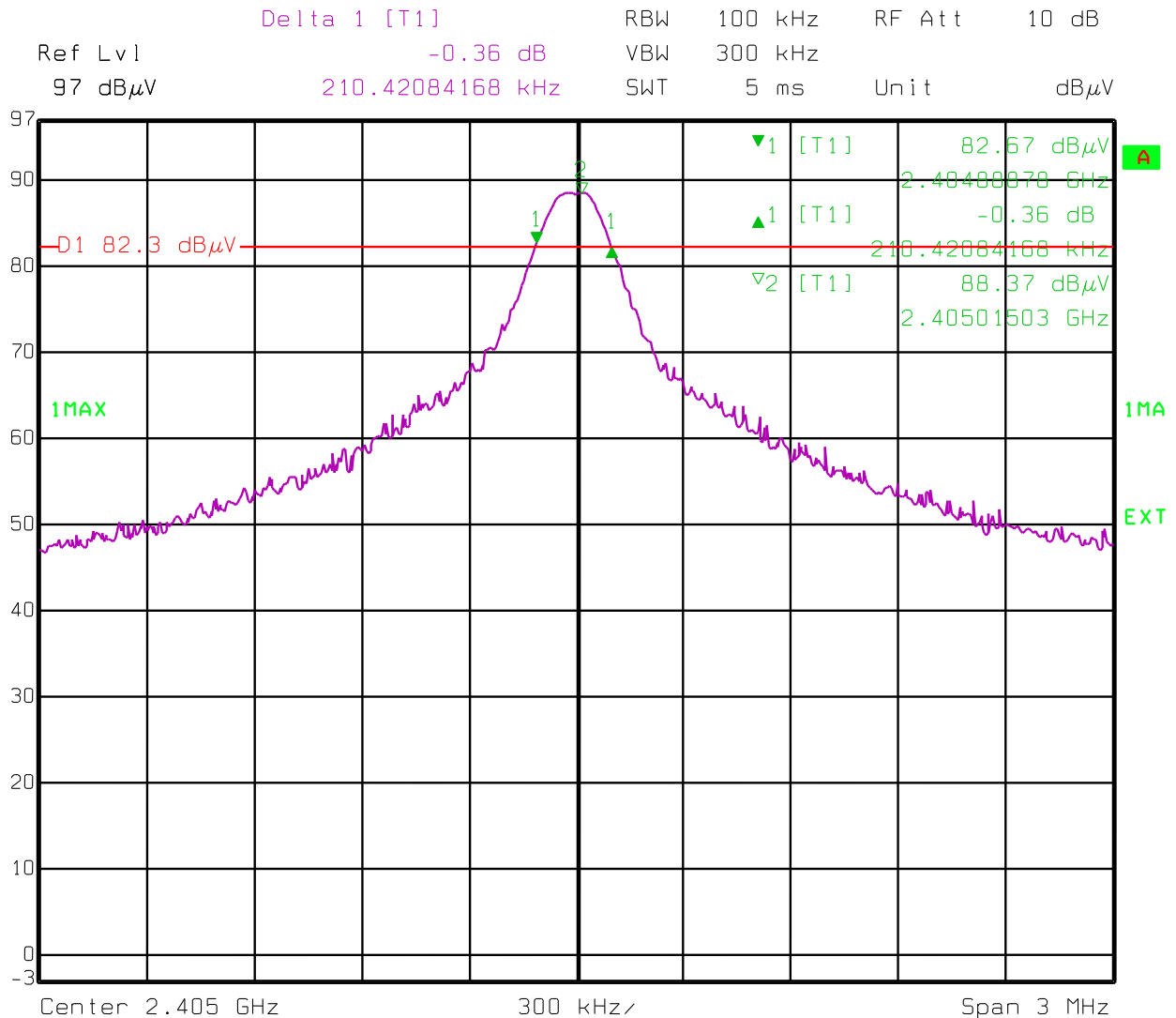
TYPE	MANUFACTURER	EMITECH NUMBER
Anechoic Chamber	EMITECH	8593
Satellite synchronized frequency standard GPS8	ACQUISYS	8896
Spectrum Analyzer FSP40	Rohde & Schwarz	4088
Antenna 3115	EMCO	8535
Multimeter MN5102B	AOIP	8675
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000

Intentional radiator

TYPE	MANUFACTURER	EMITECH NUMBER
Open test site	EMITECH	8732
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 VHBB 9124	Schwarzbeck	8526
Biconical antenna VHA 9103	Schwarzbeck	8528
Log periodic antenna UHALP 9108A	Schwarzbeck	8543
Log periodic antenna 3147	EMCO	8783
Antenna 3115	EMCO	8535
Antenna WR42	IMC	1939
Antenna WR42	IMC	1940
Low-noise amplifier 8447D	Hewlett Packard	8511
Low-noise amplifier C020180F-4B1	Microwave DB	1922
Low-noise amplifier ALN02-0102	ALC Microwave	3036
Low pass filter LP03/1000-7GH	Filtek	4087
Reject band filter BRM50702	Microtronics	7299
Multimeter MN5102B	AOIP	8675
Meteo station WS-9232	La Crosse Technology	8749
Meteo station WS-9232	La Crosse Technology	8750
Software	BAT-EMC V3.6.0.32	0000
Software	Champ libre Juigné. V3.4	8864

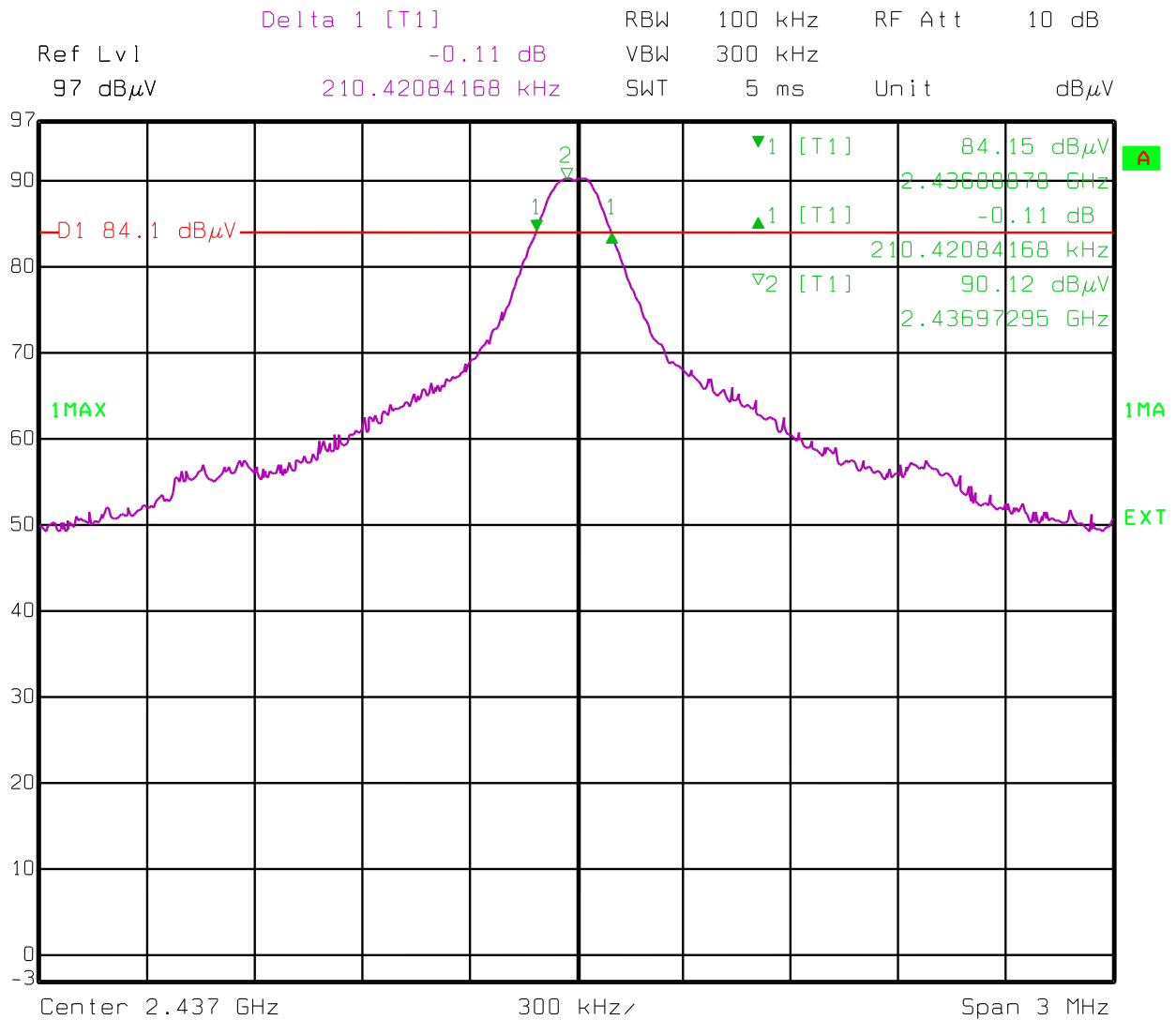
APPENDIX 4: 6 dB bandwidth

Low Channel – 2.4Kbit/s



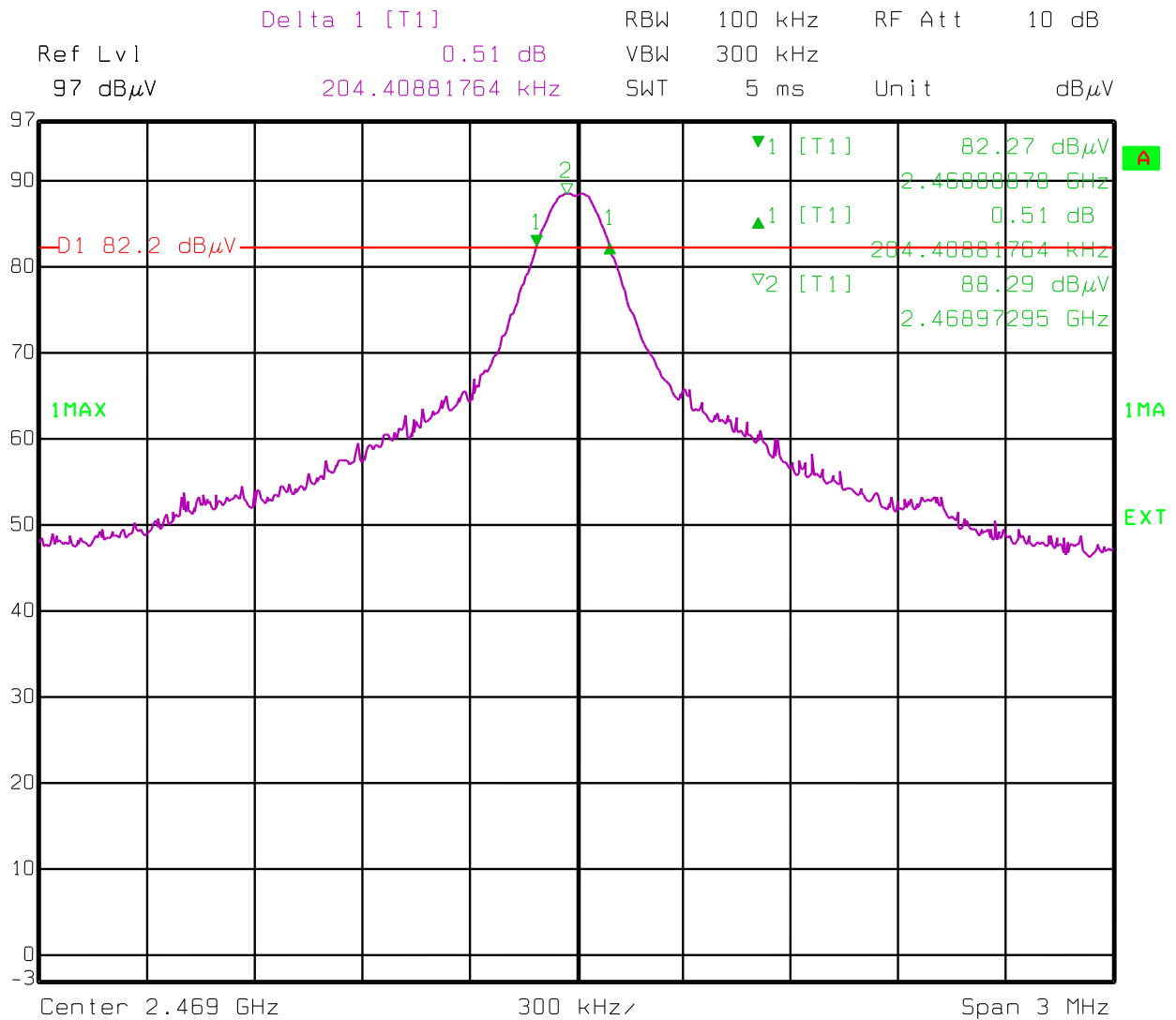
Date: 30.JUN.2015 14:00:54

Central Channel – 2.4Kbit/s



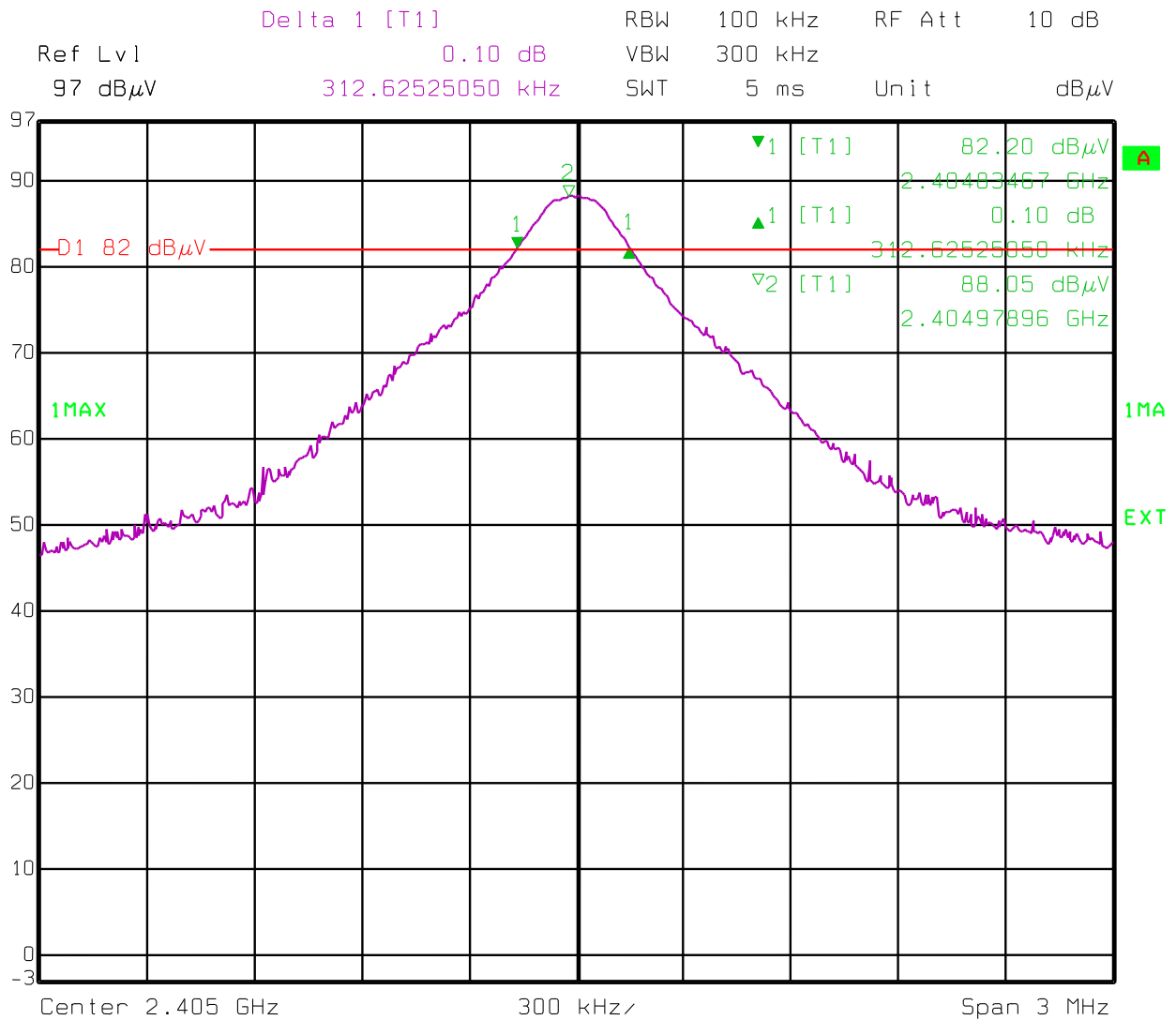
Date: 30.JUN.2015 14:07:18

High Channel – 2.4Kbit/s



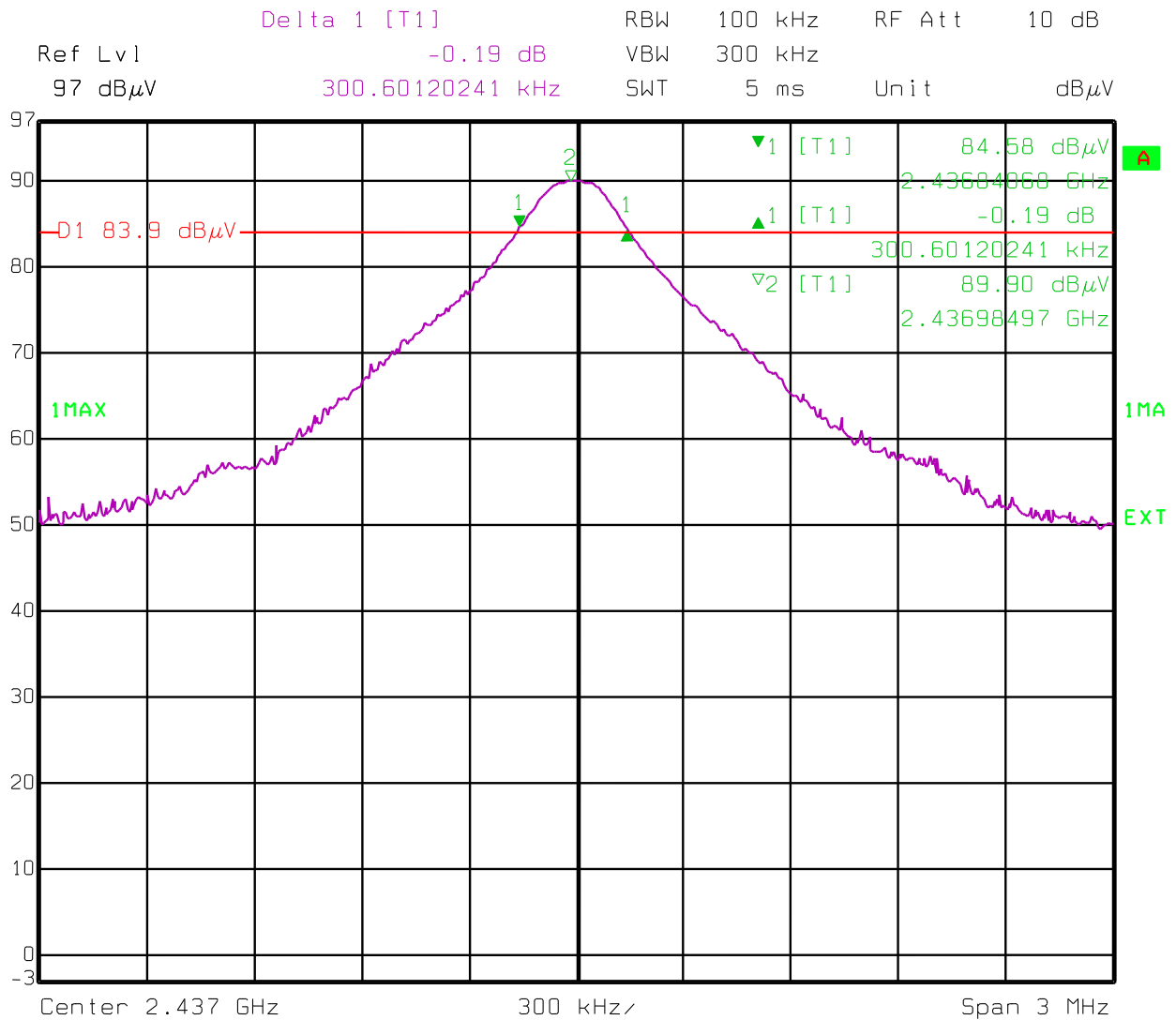
Date: 30.JUN.2015 14:08:57

Low Channel – 100Kbit/s



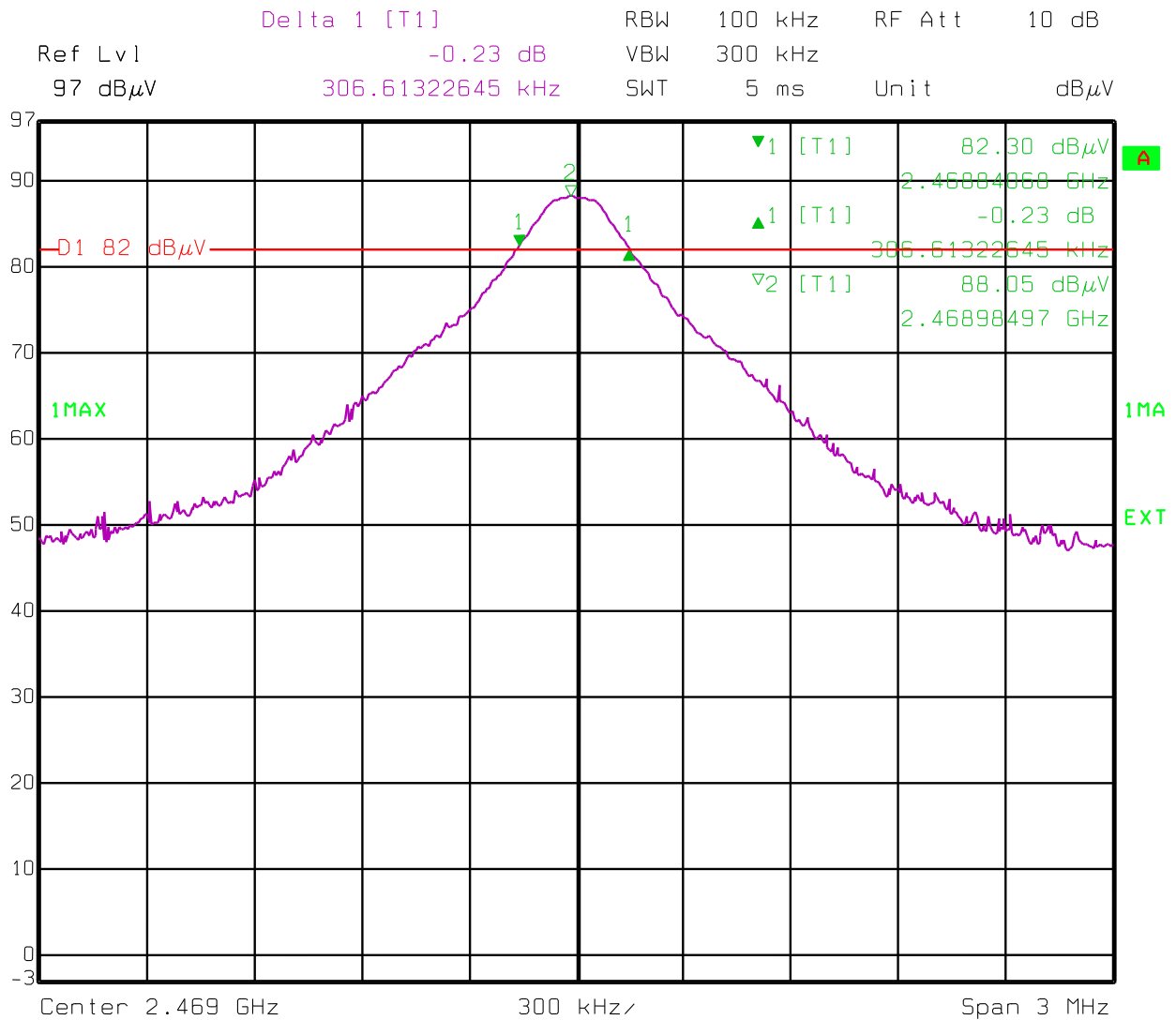
Date: 30.JUN.2015 13:33:58

Central Channel – 100Kbit/s



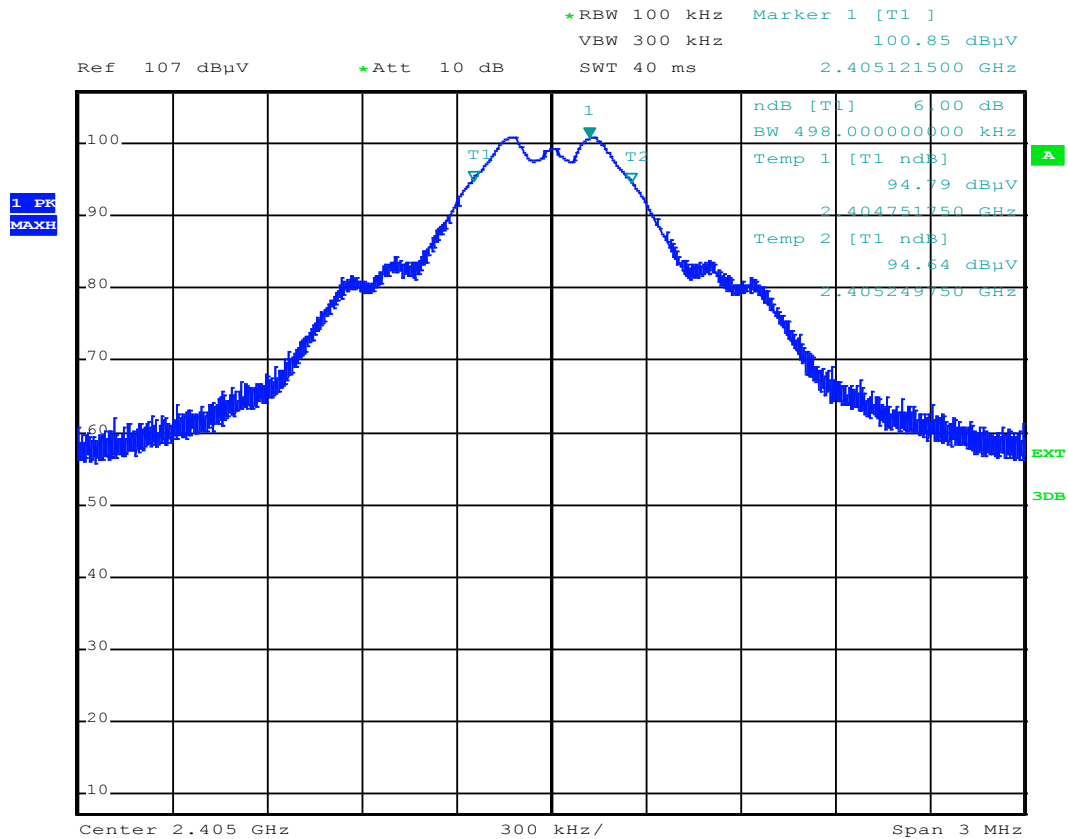
Date: 30.JUN.2015 13:30:46

High Channel – 100Kbit/s



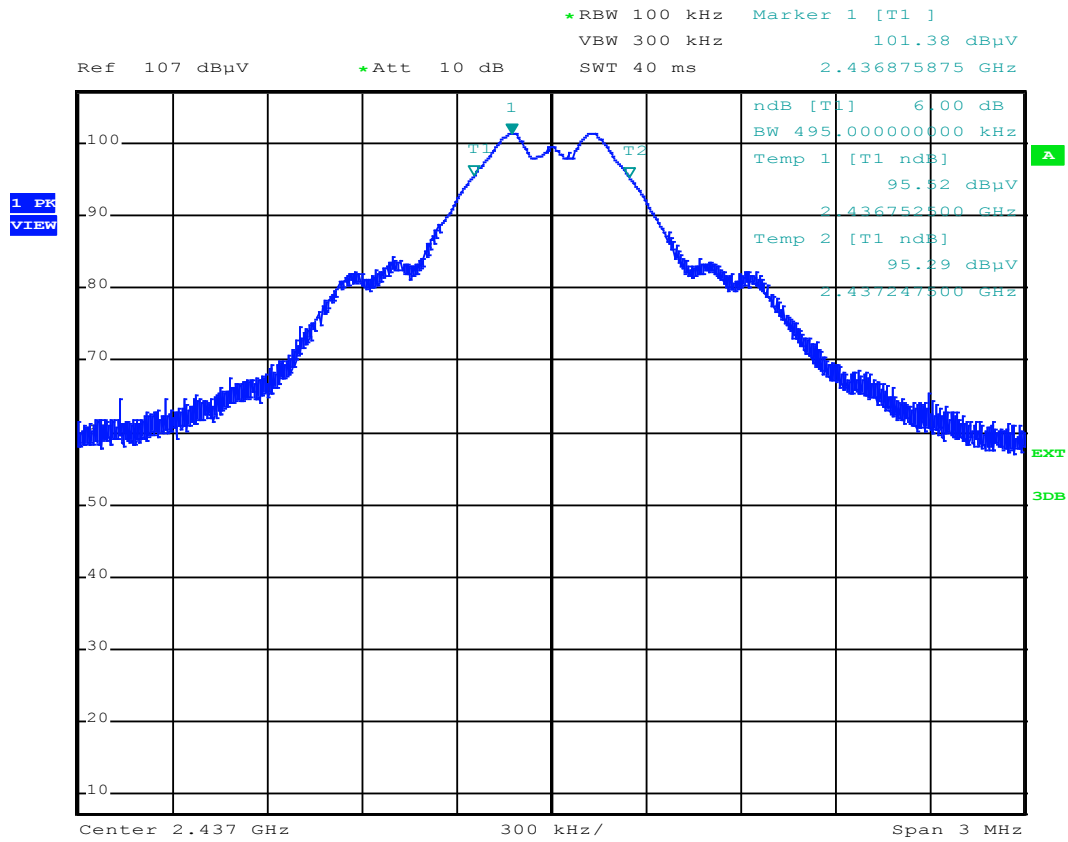
Date: 30.JUN.2015 13:36:55

Low Channel – 500Kbit/s



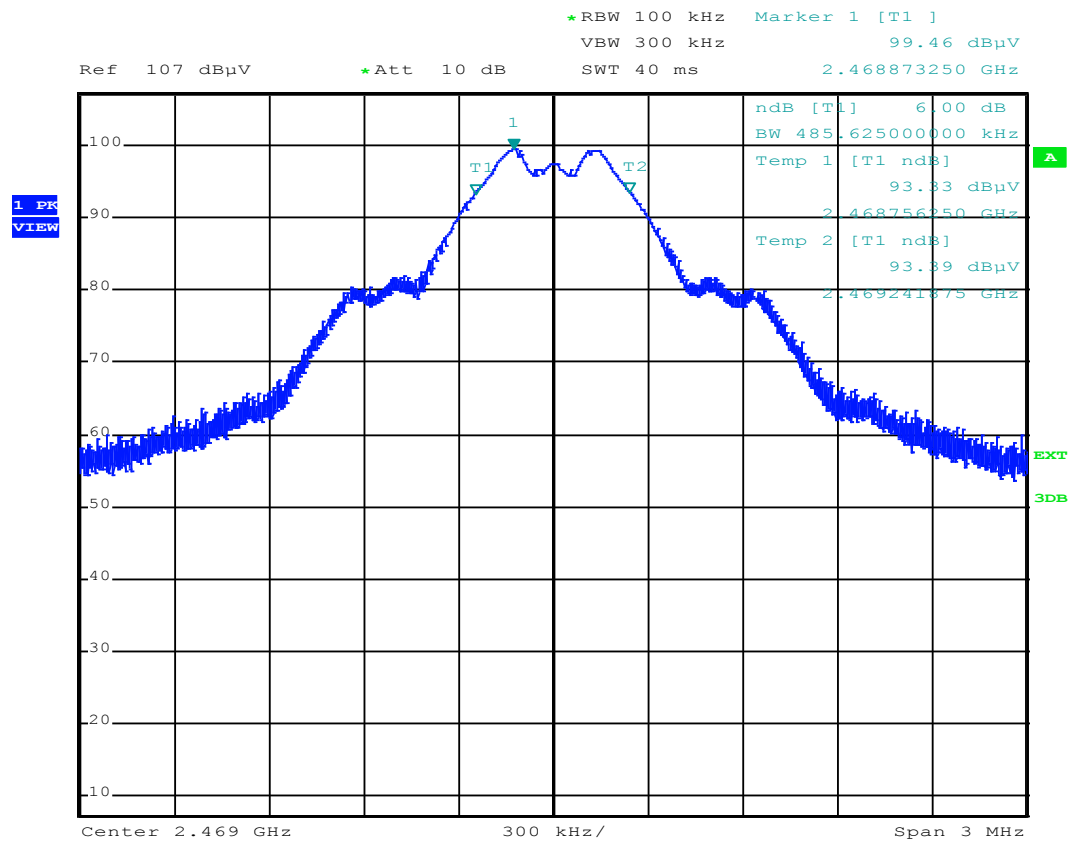
Date: 22.SEP.2014 10:00:36

Central Channel – 500Kbit/s



Date: 22.SEP.2014 10:04:26

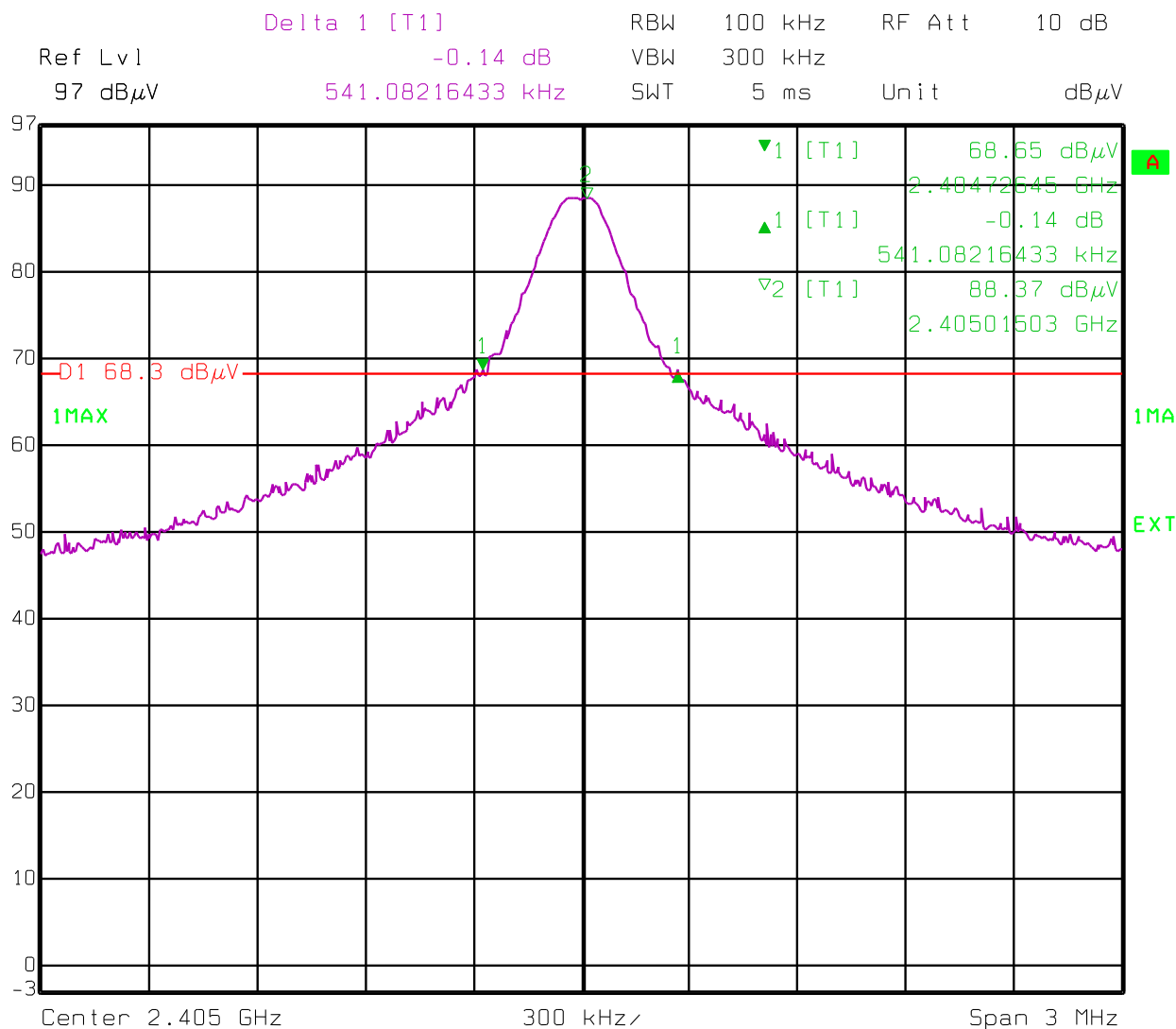
High Channel – 500Kbit/s



Date: 22.SEP.2014 10:06:02

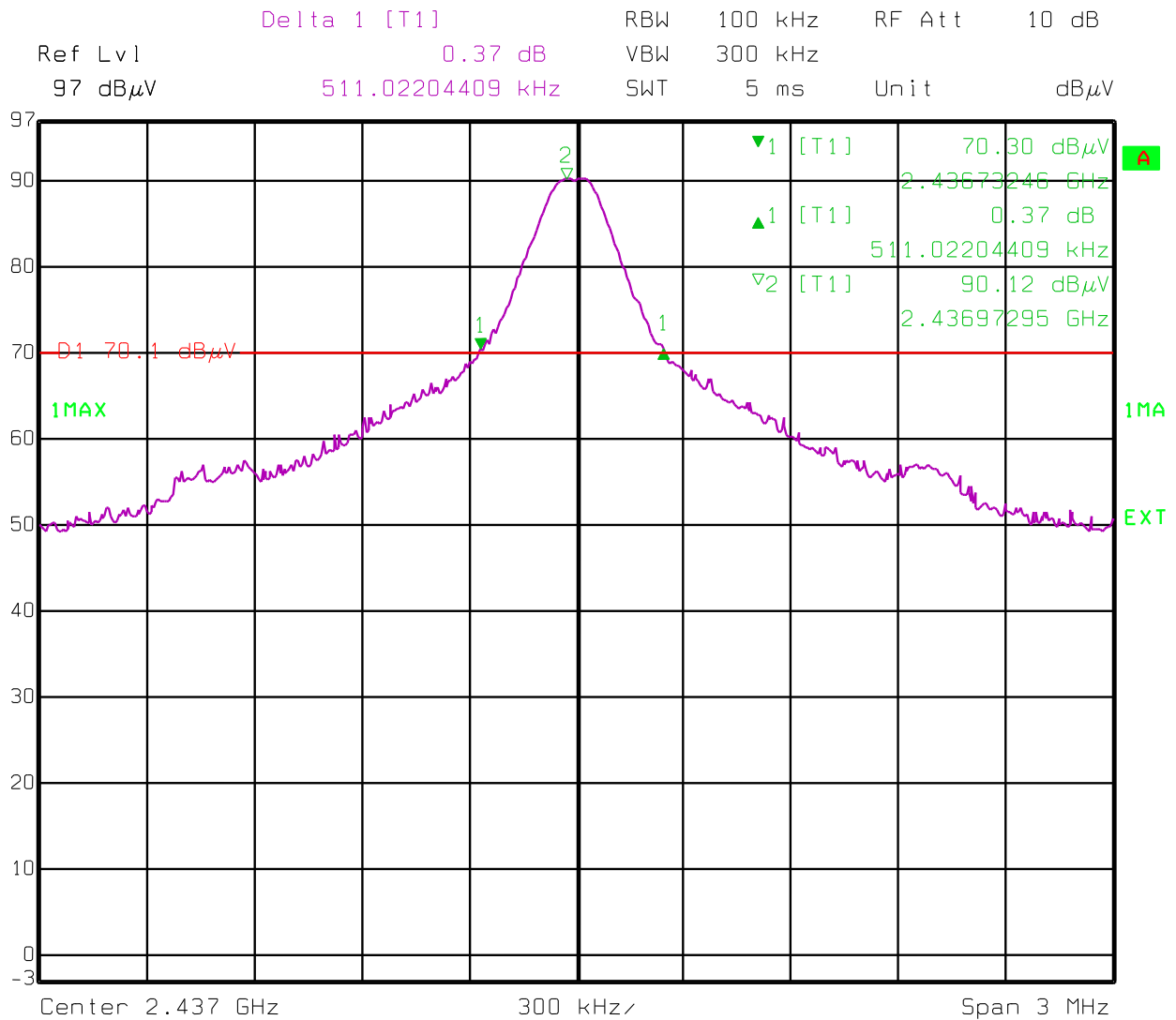
APPENDIX 5: 20 dB bandwidth

Low Channel – 2.4Kbit/s



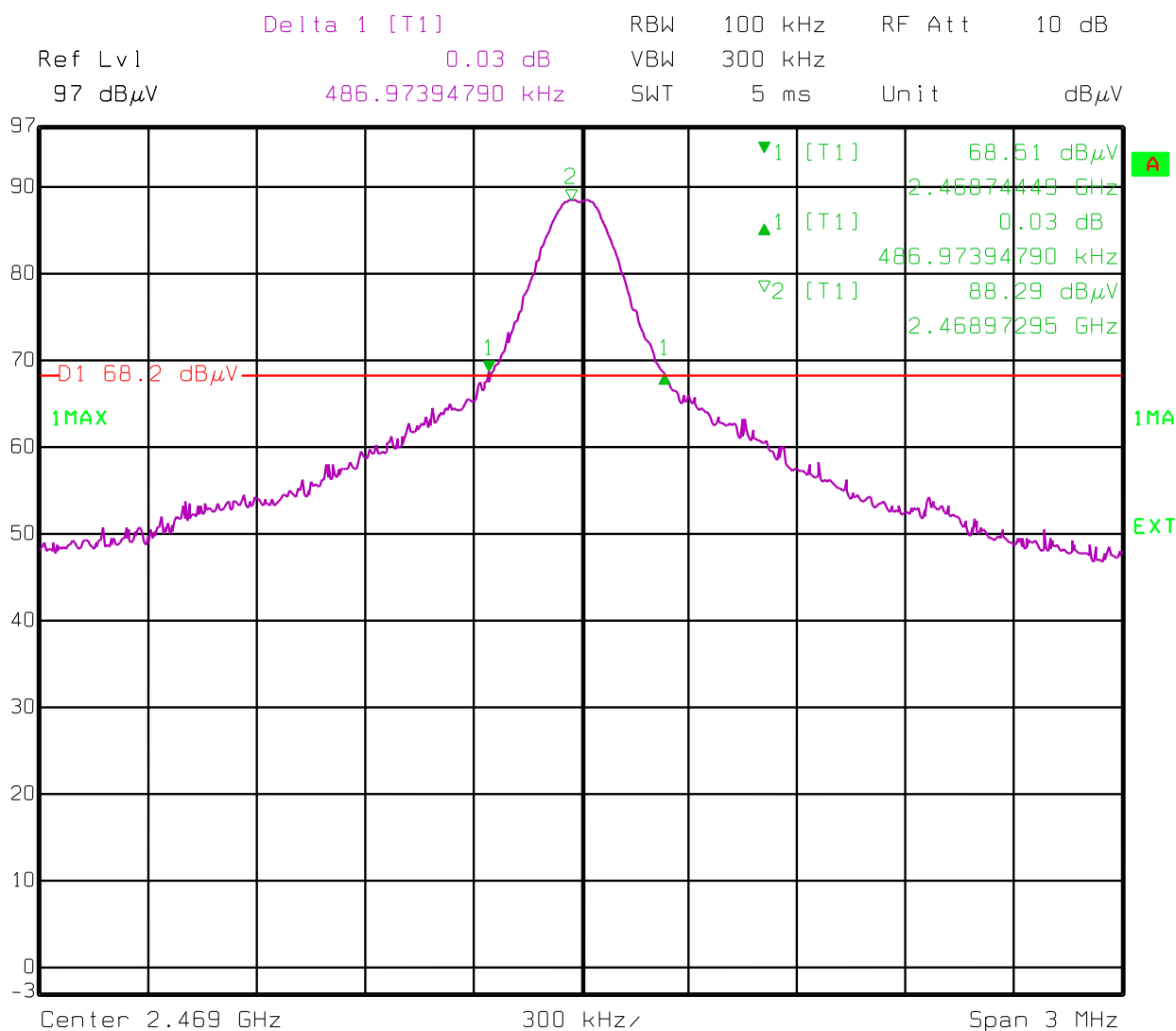
Date: 30.JUN.2015 14:02:13

Central Channel – 2.4Kbit/s



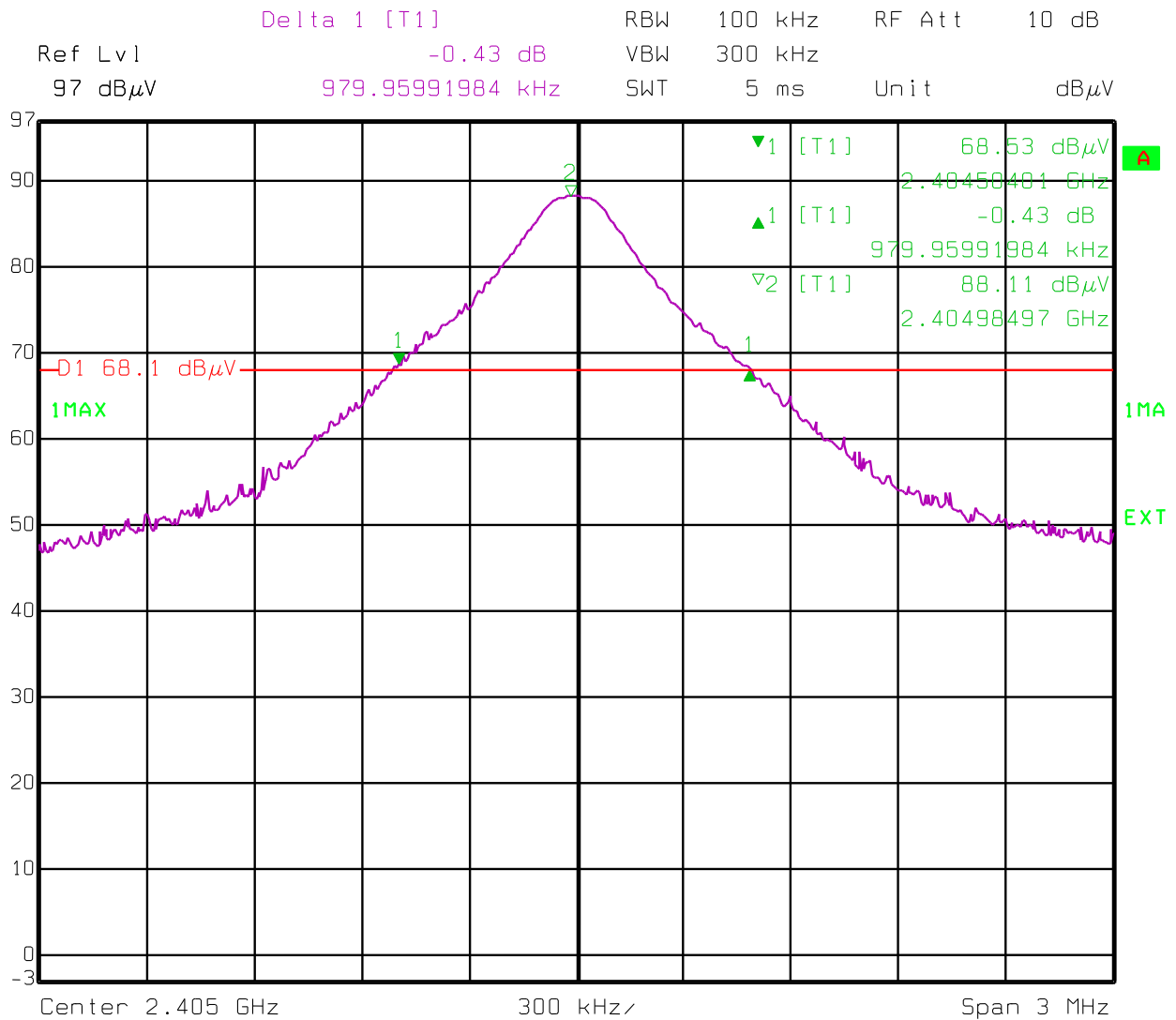
Date: 30.JUN.2015 14:06:05

High Channel – 2.4Kbit/s



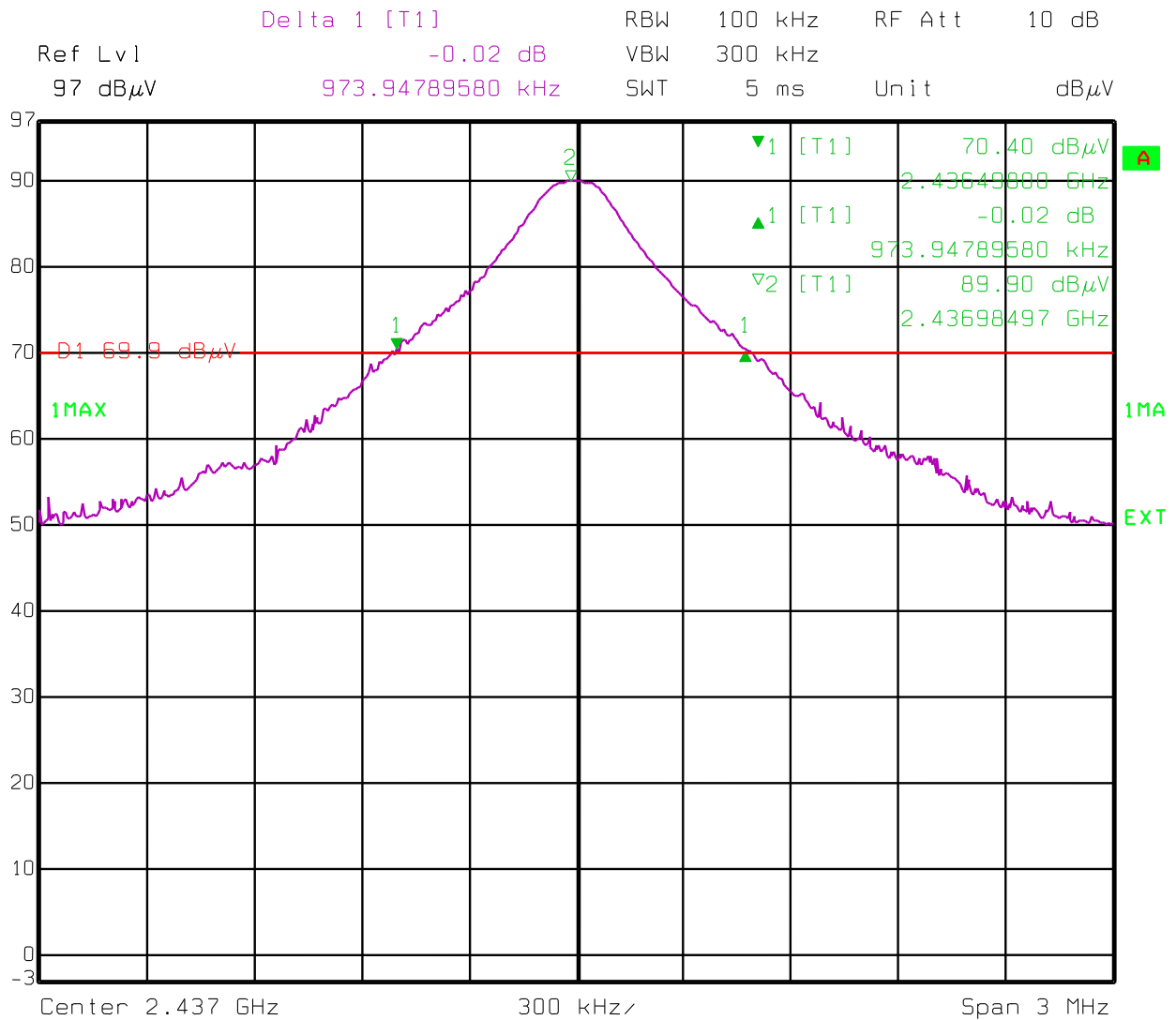
Date: 30.JUN.2015 14:10:02

Low Channel – 100Kbit/s



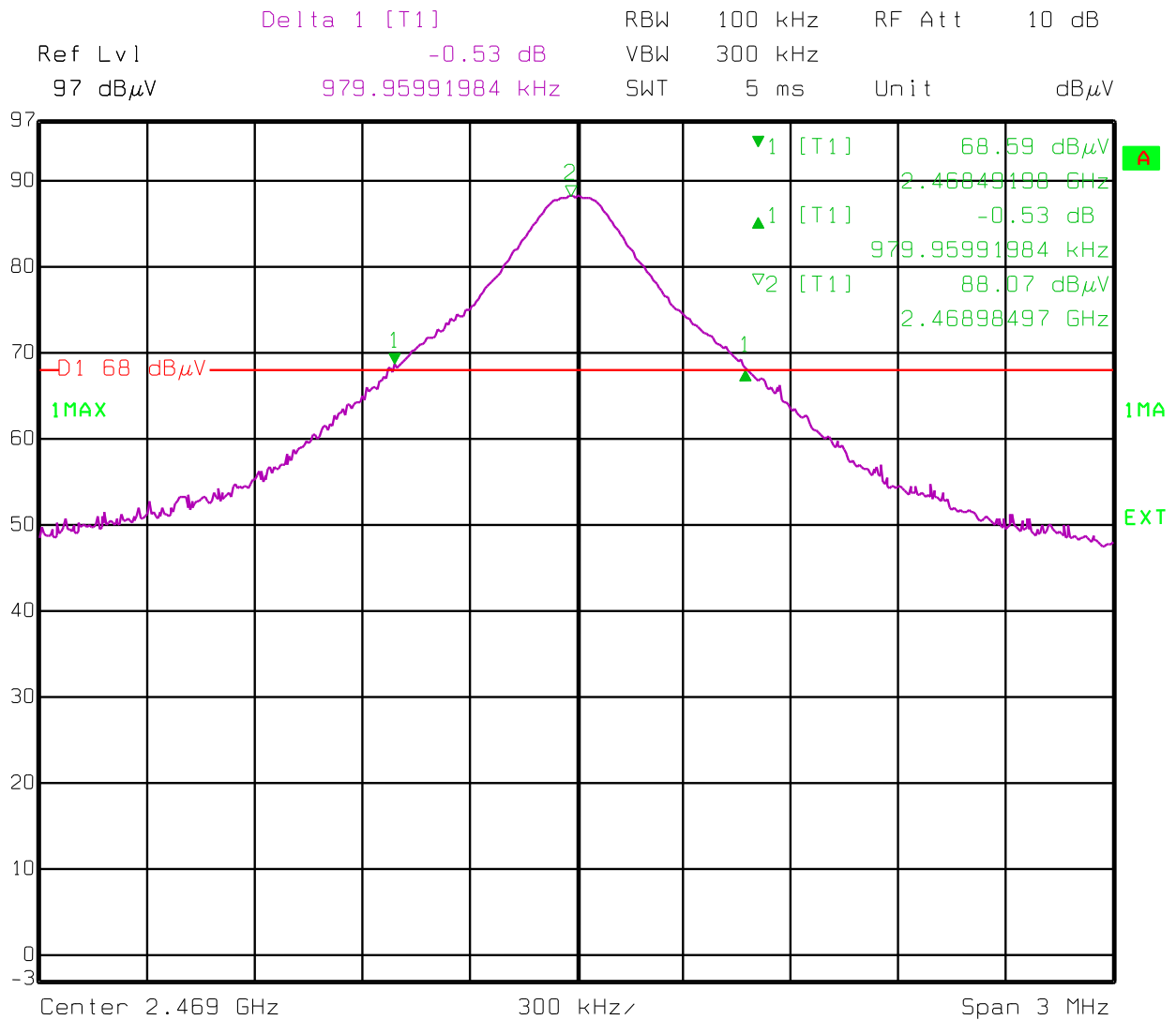
Date: 30.JUN.2015 13:35:05

Central Channel – 100Kbit/s



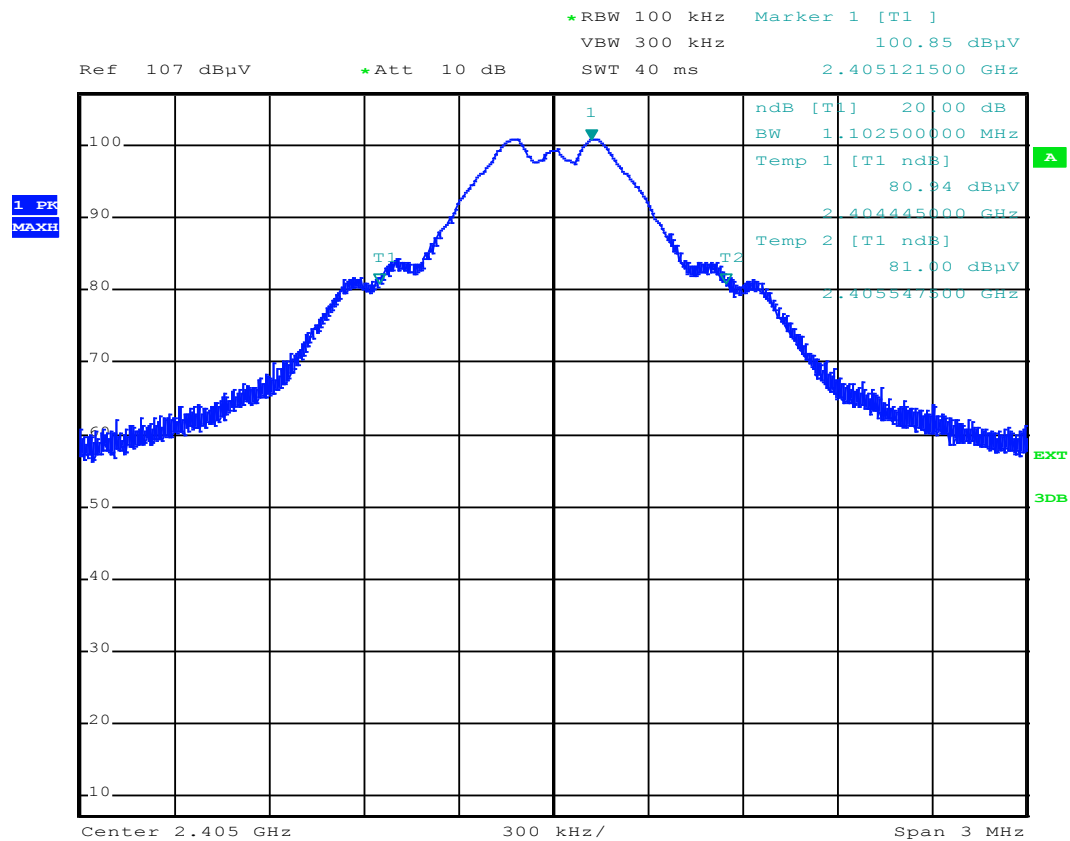
Date: 30.JUN.2015 13:32:00

High Channel – 100Kbit/s



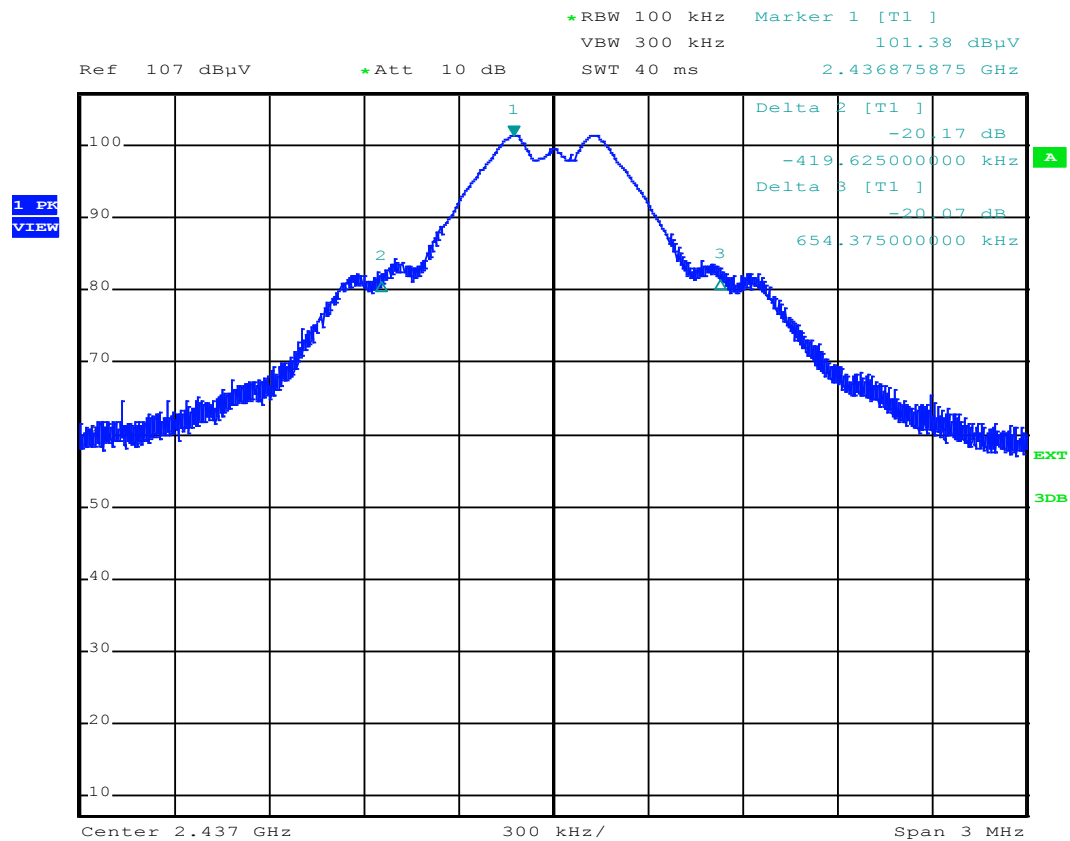
Date: 30.JUN.2015 13:40:09

Low Channel – 500Kbit/s



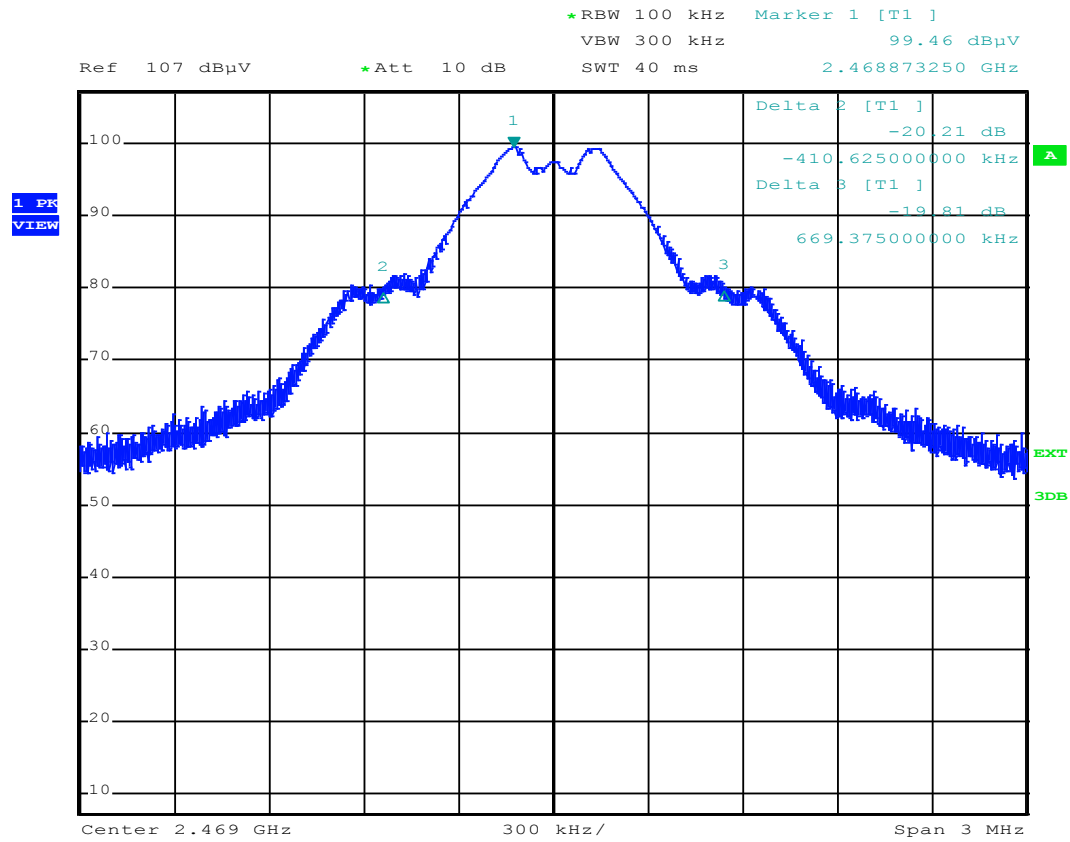
Date: 22.SEP.2014 10:01:26

Central Channel – 500Kbit/s



Date: 22.SEP.2014 10:03:59

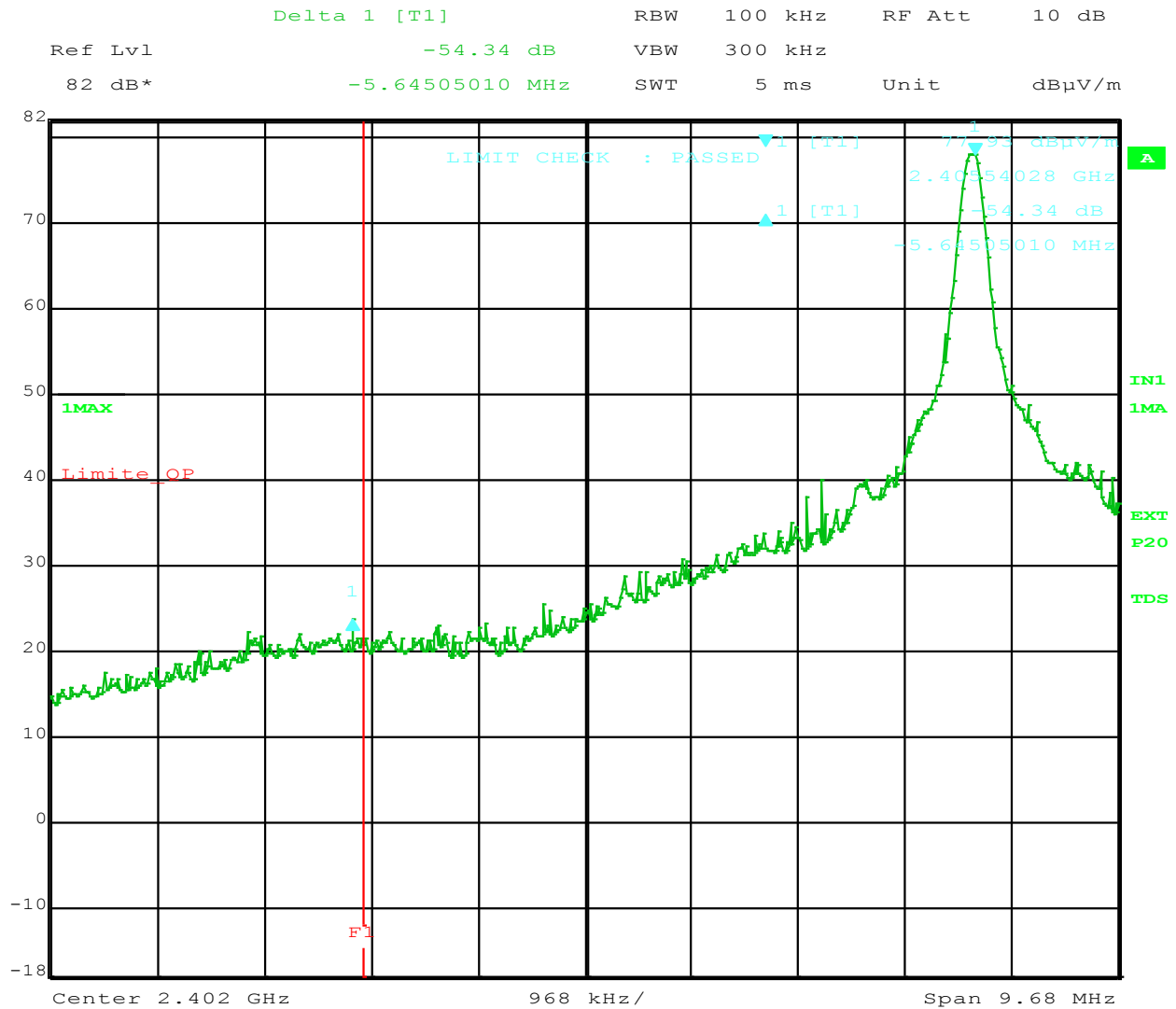
High Channel – 500Kbit/s



Date: 22.SEP.2014 10:07:27

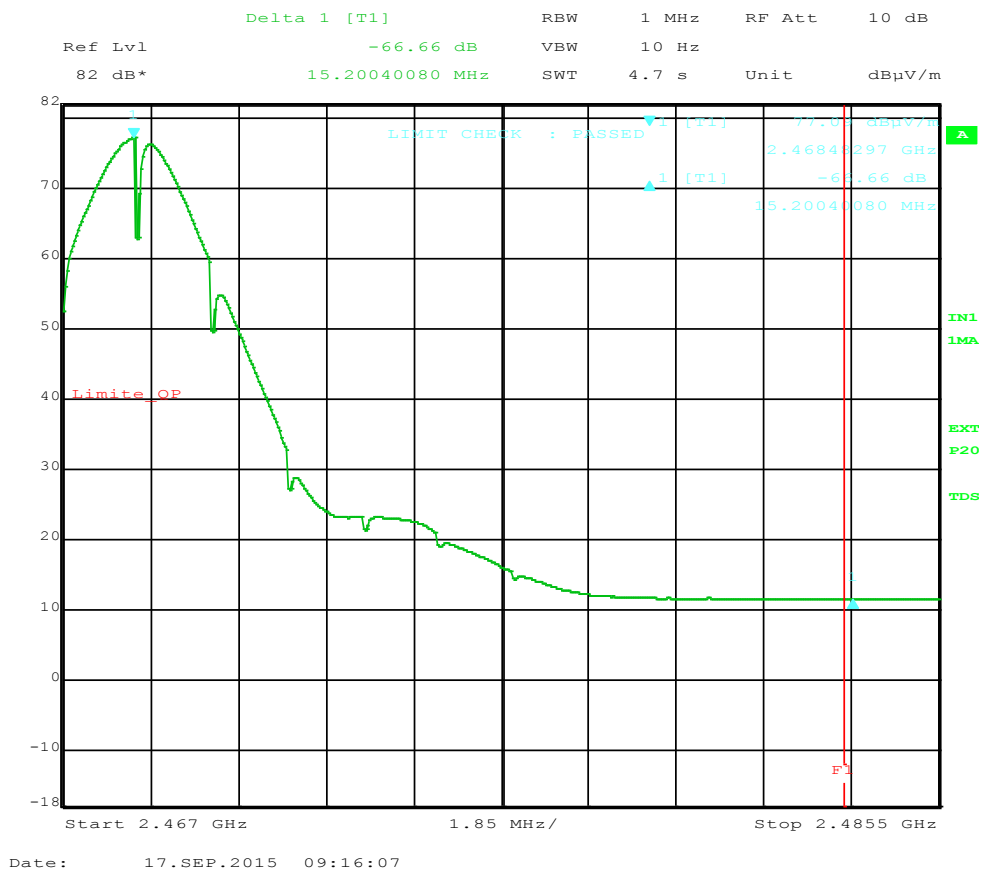
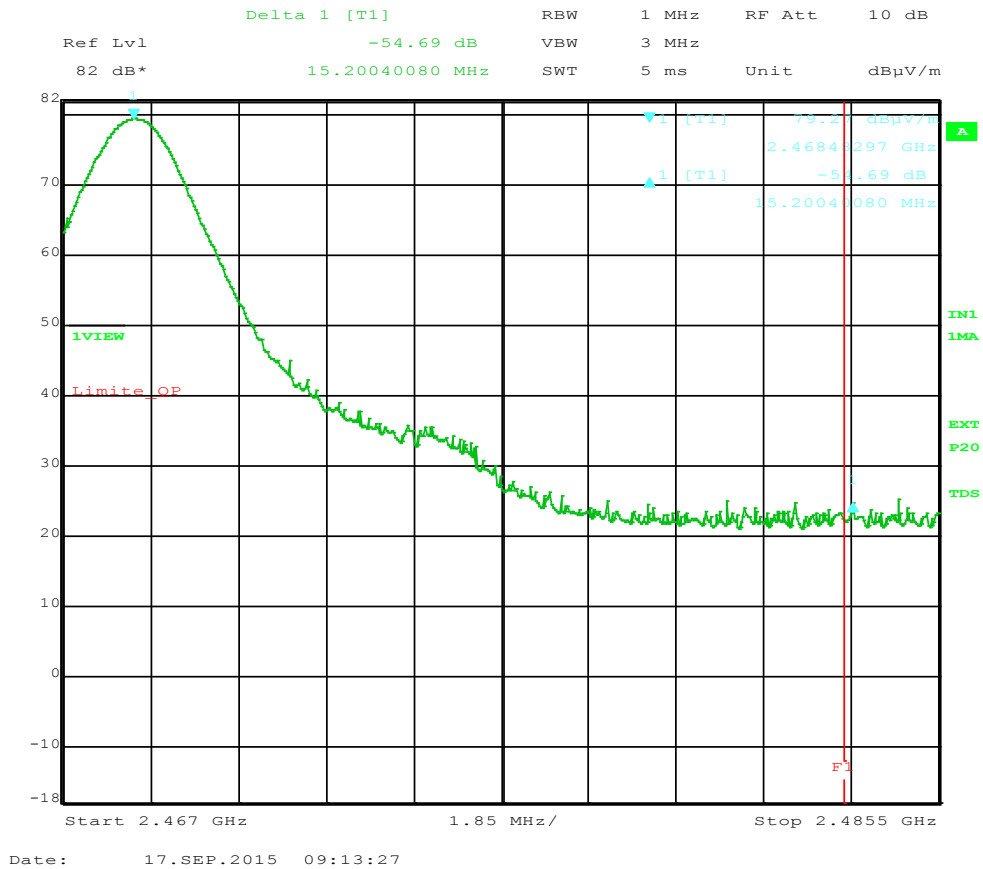
APPENDIX 6: Band edge

Low channel – 2.4Kbit/s with hopping off mode

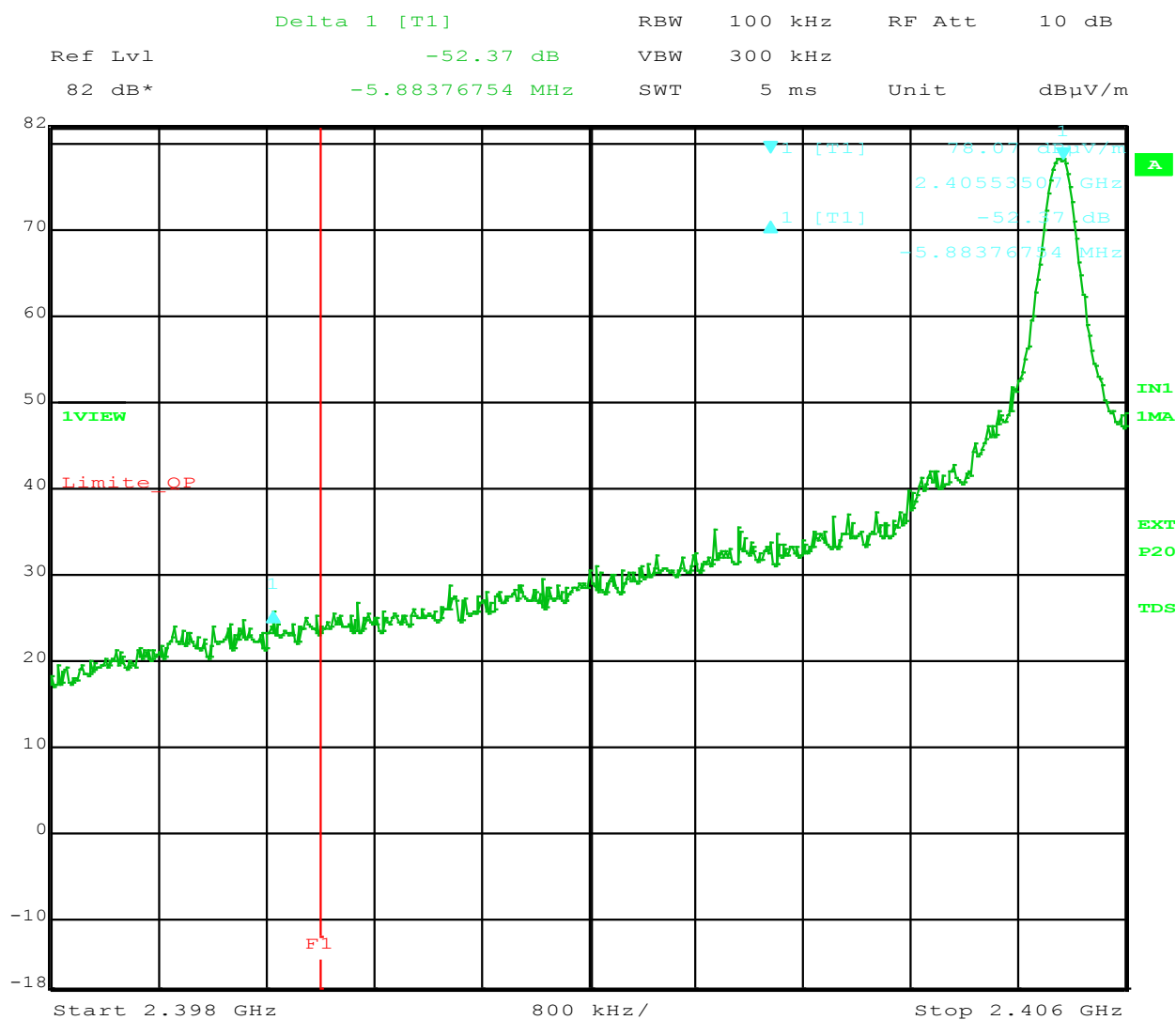


Date: 17.SEP.2015 09:04:41

High channel – 2.4Kbit/s with hopping off mode

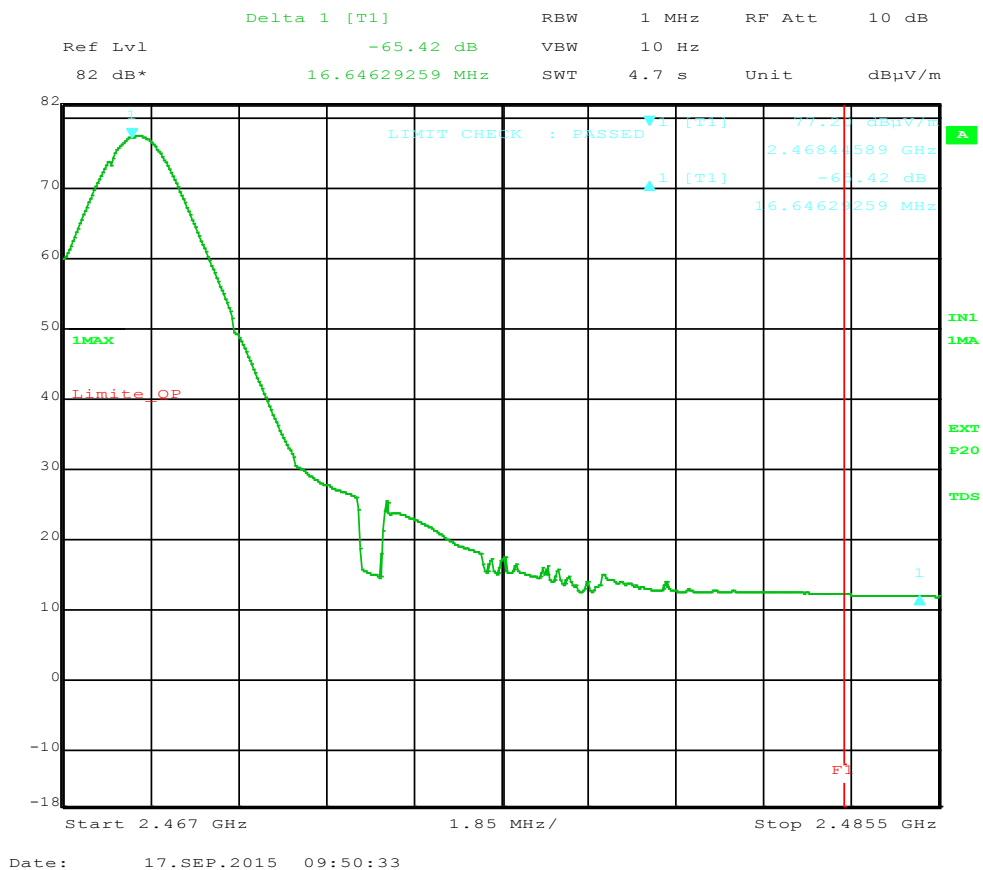
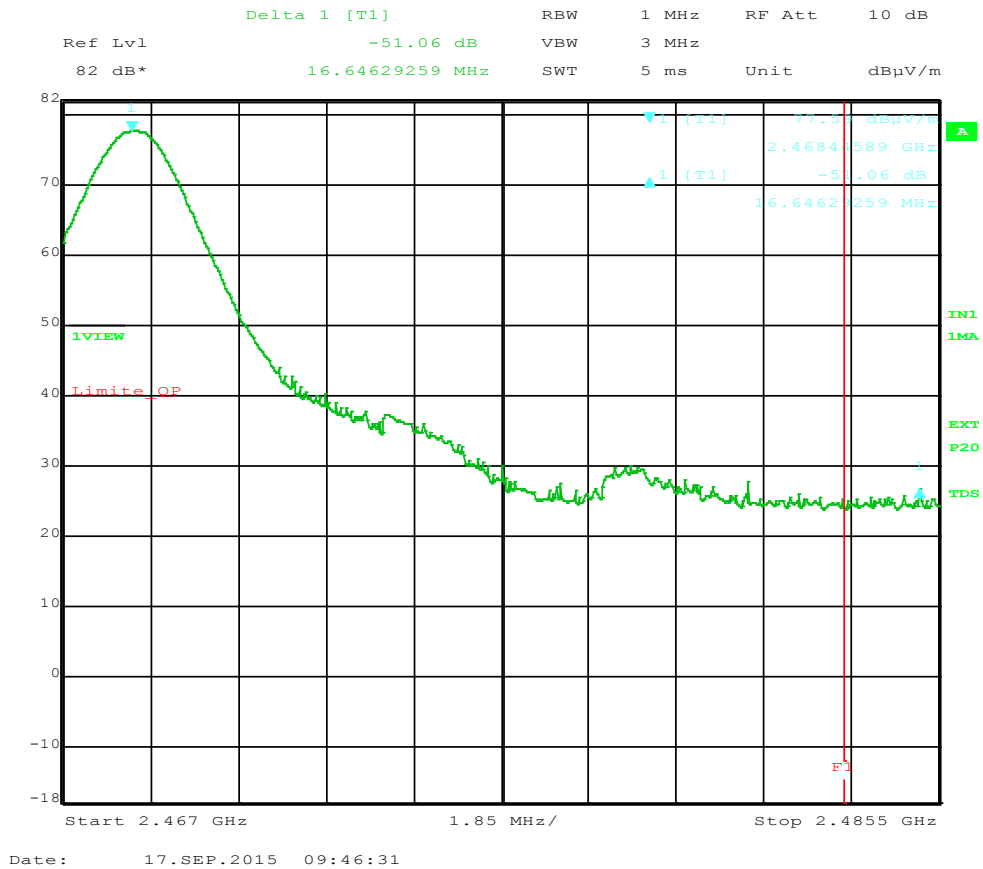


Low channel – 2.4Kbit/s with hopping on mode

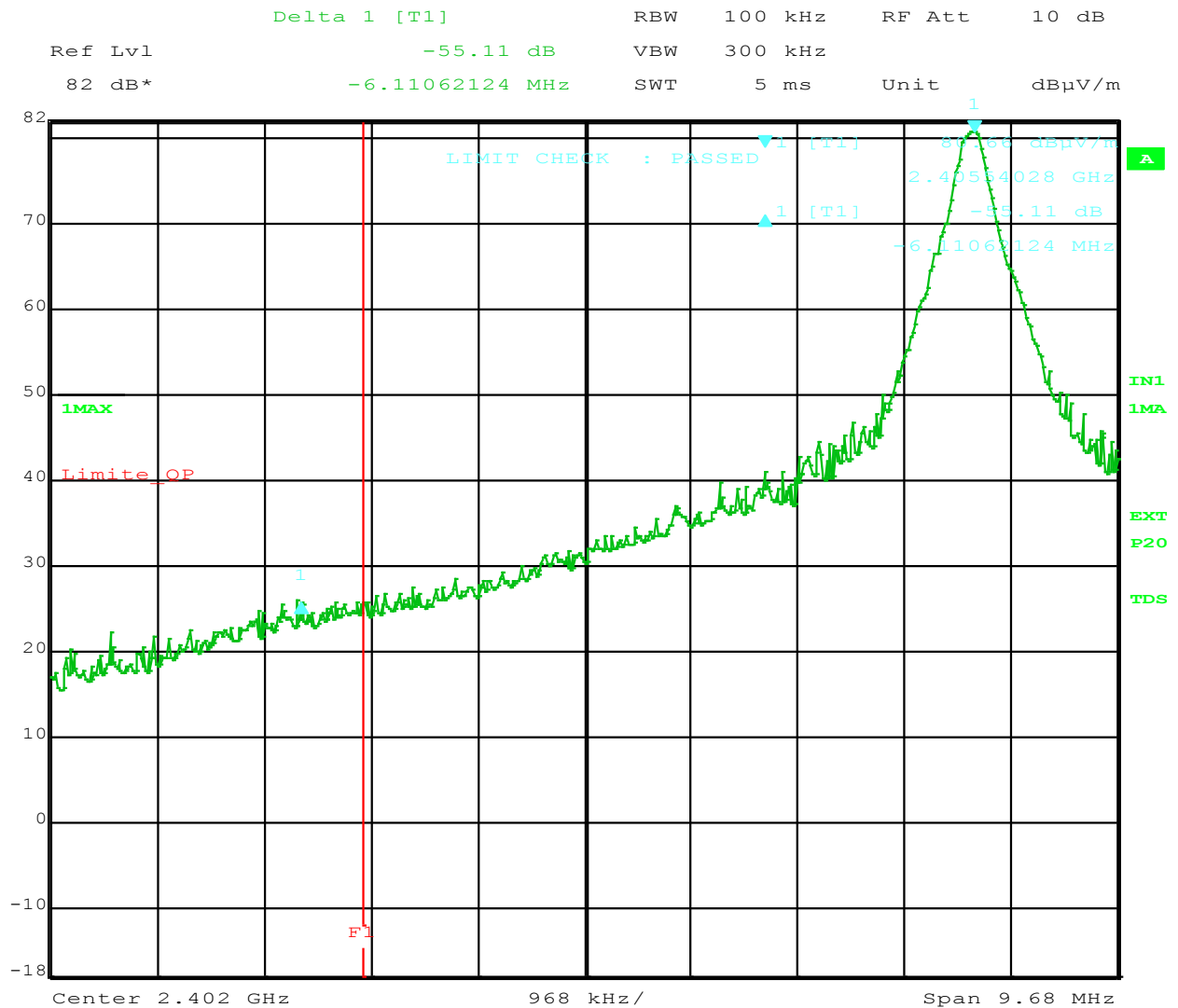


Date: 17.SEP.2015 09:43:07

High channel – 2.4Kbit/s with hopping on mode

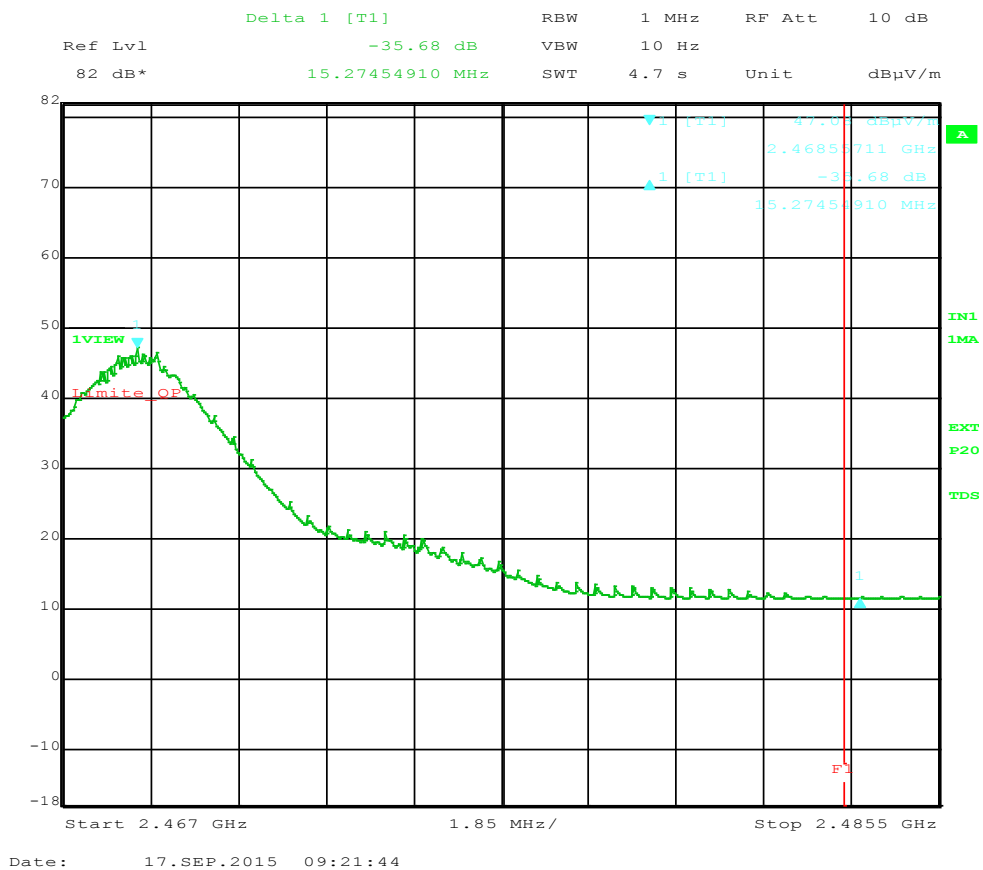
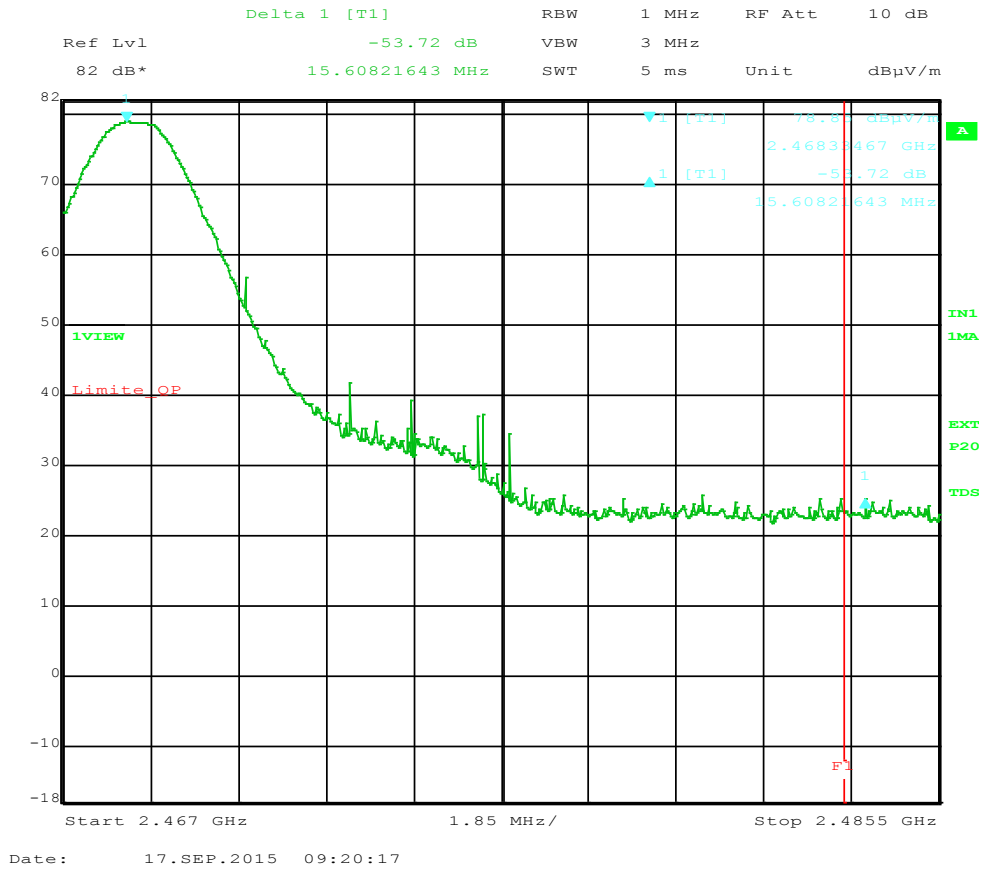


Low channel – 100Kbit/s with hopping off mode

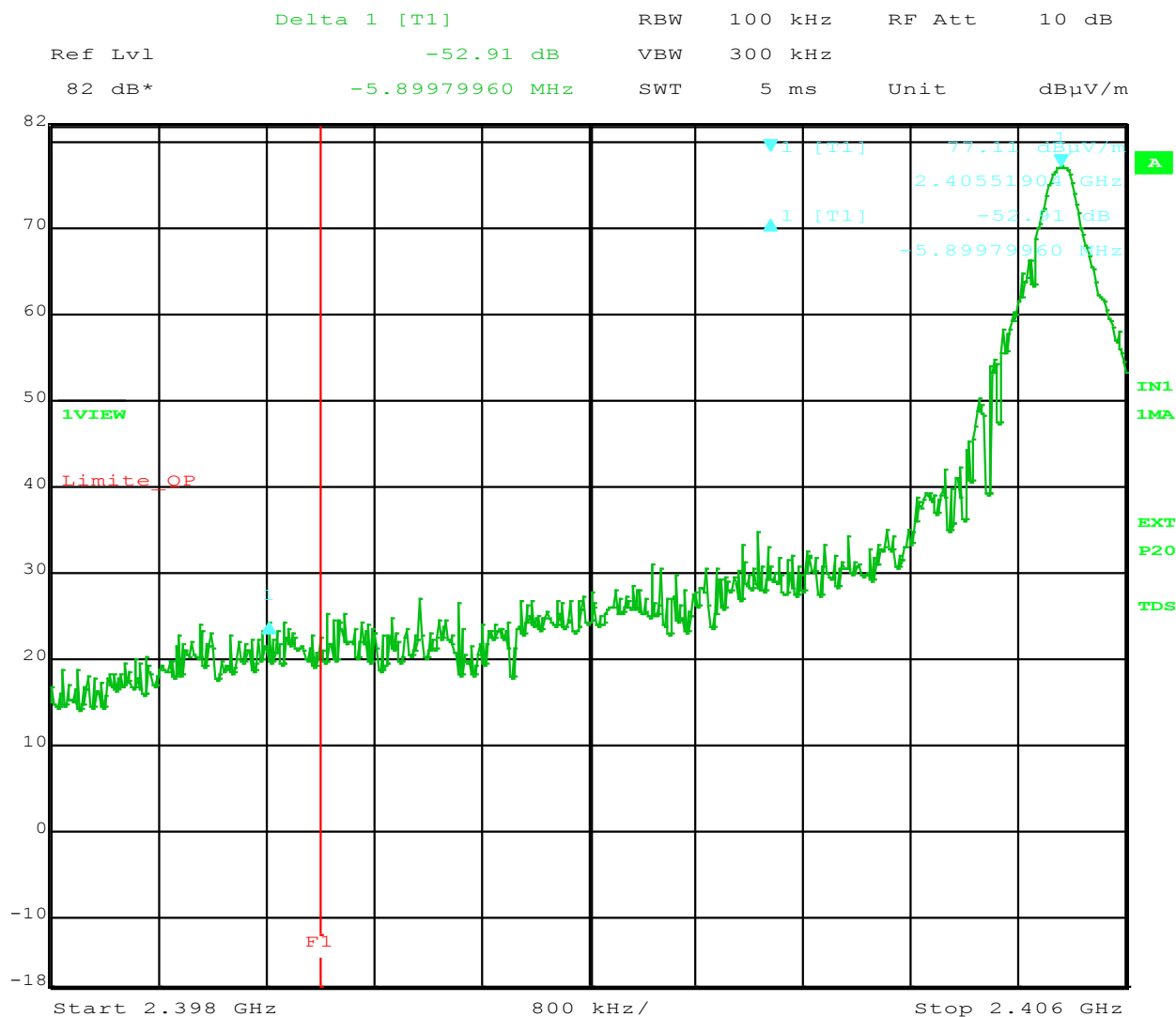


Date: 17.SEP.2015 09:07:10

High channel – 100Kbit/s with hopping off mode

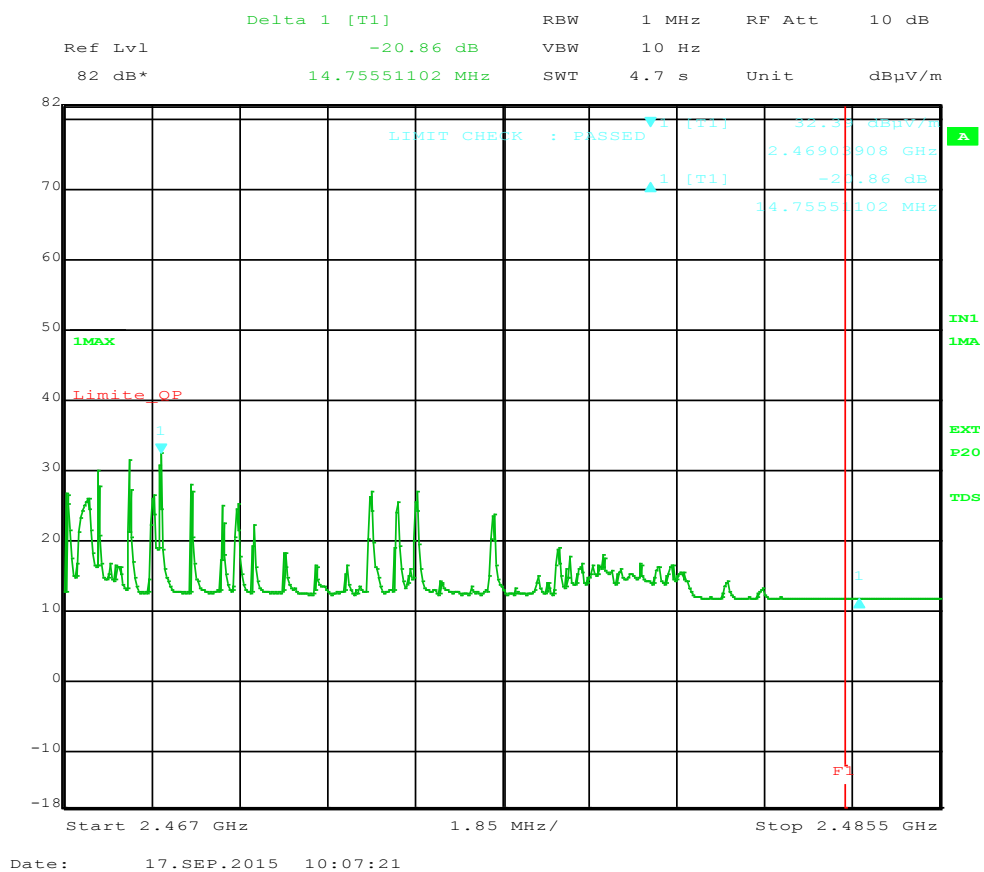
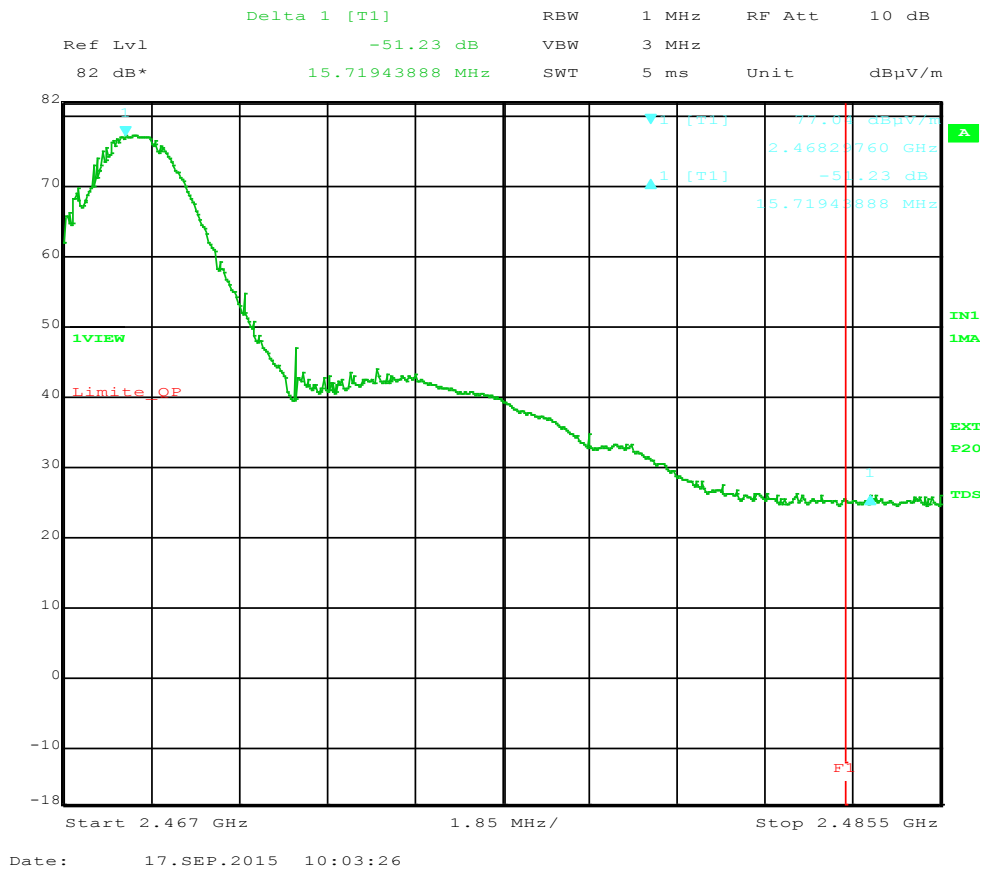


Low channel – 100Kbit/s with hopping on mode

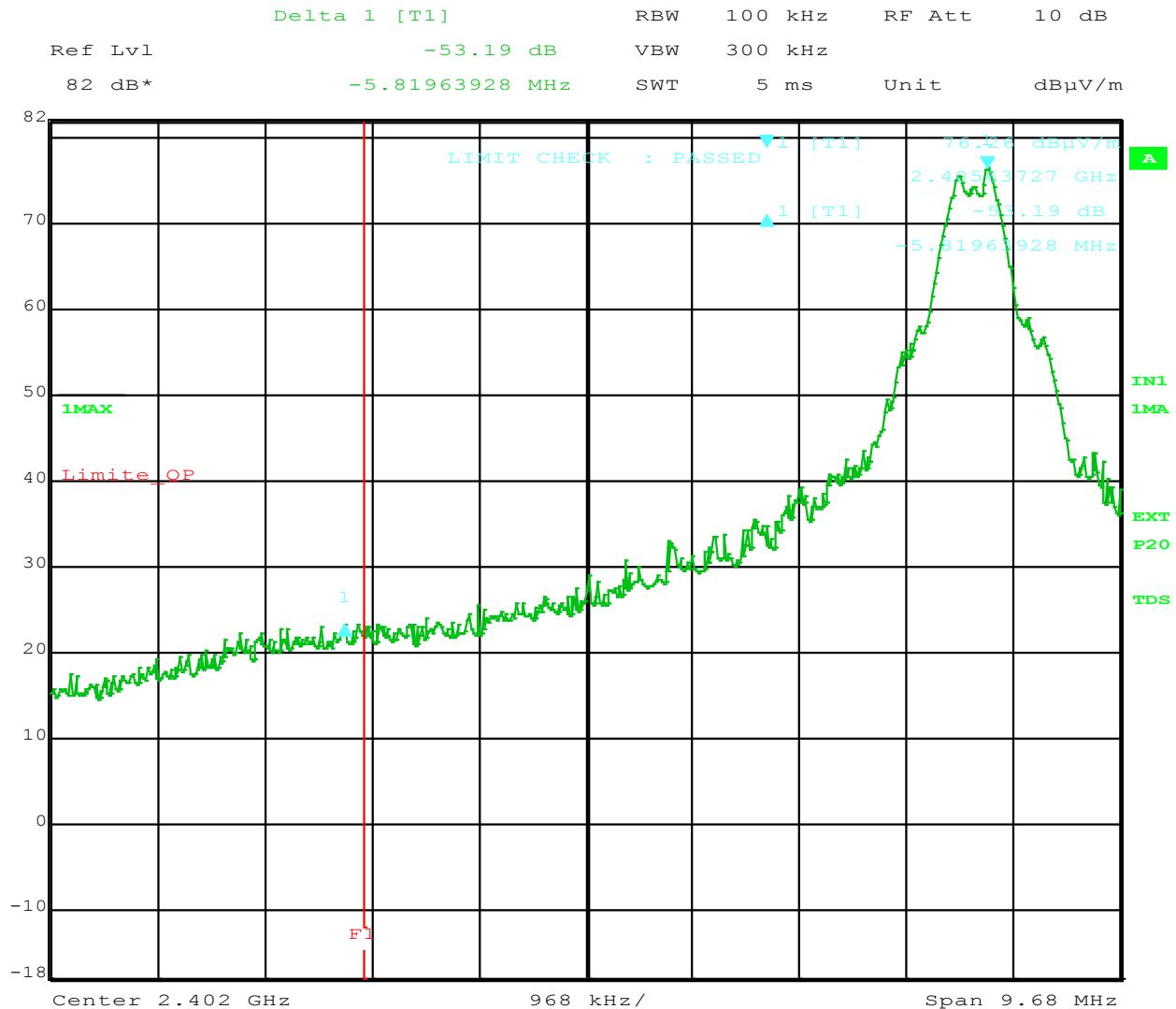


Date: 17.SEP.2015 10:10:59

High channel – 100Kbit/s with hopping on mode

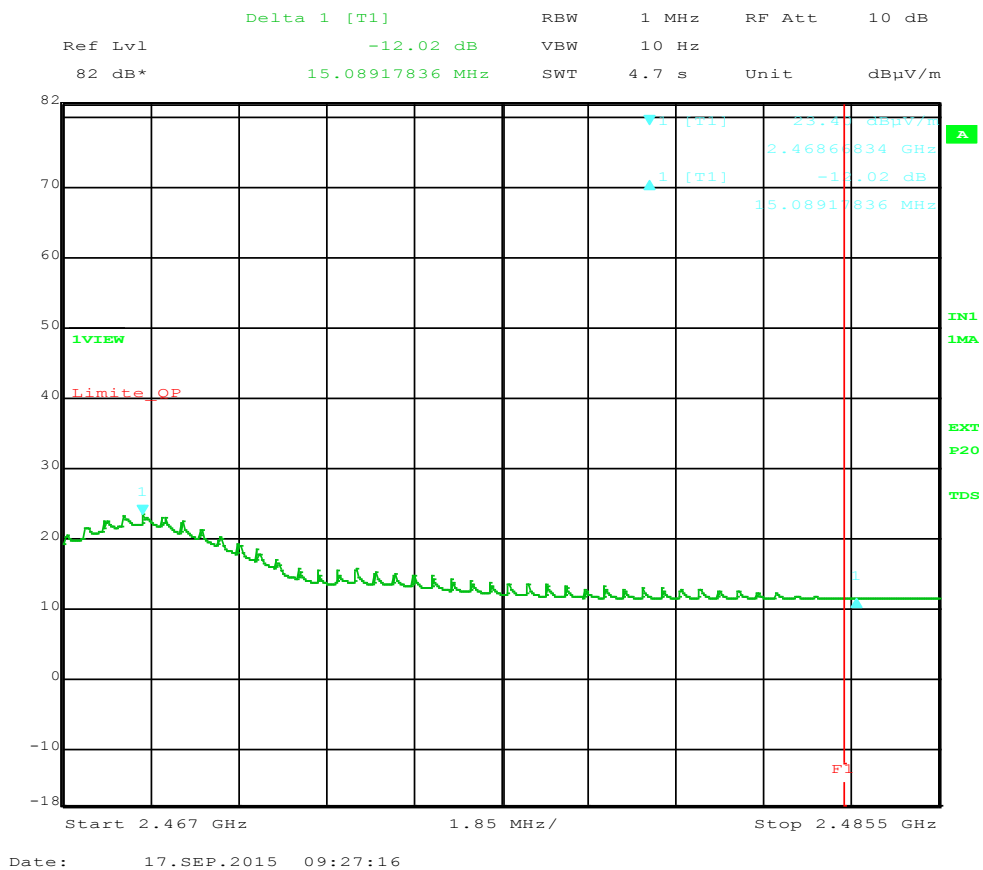
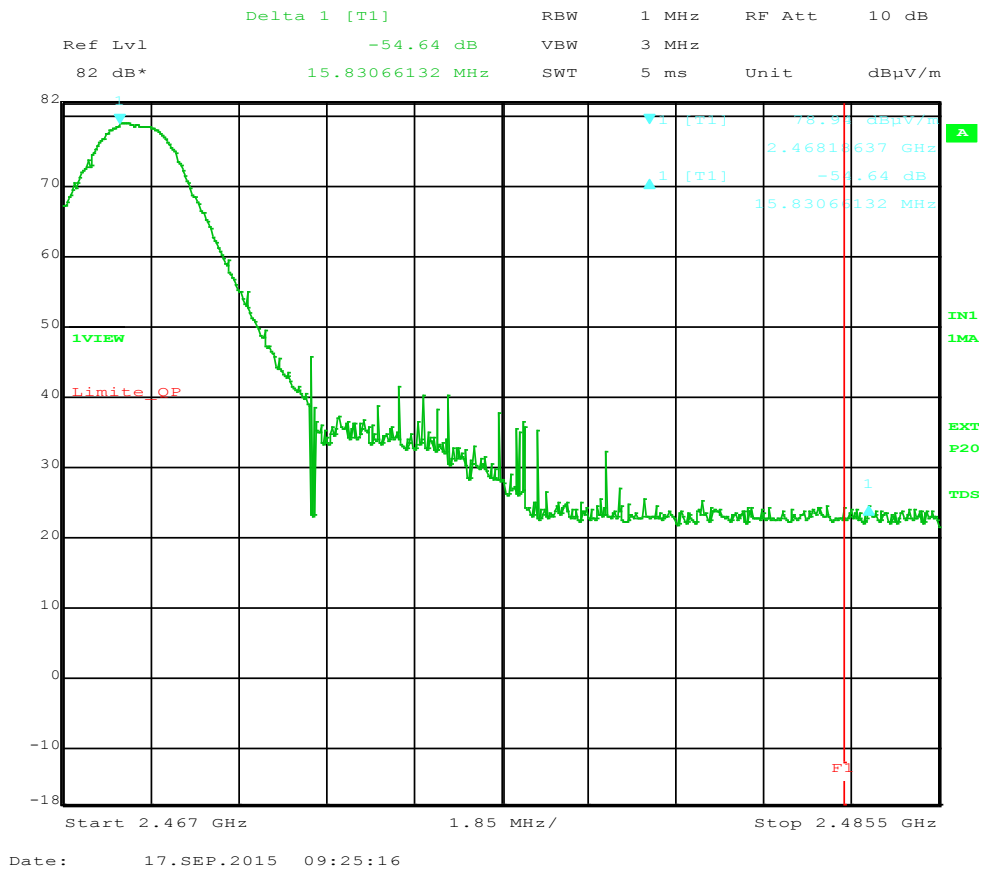


Low channel – 500Kbit/s with hopping off mode

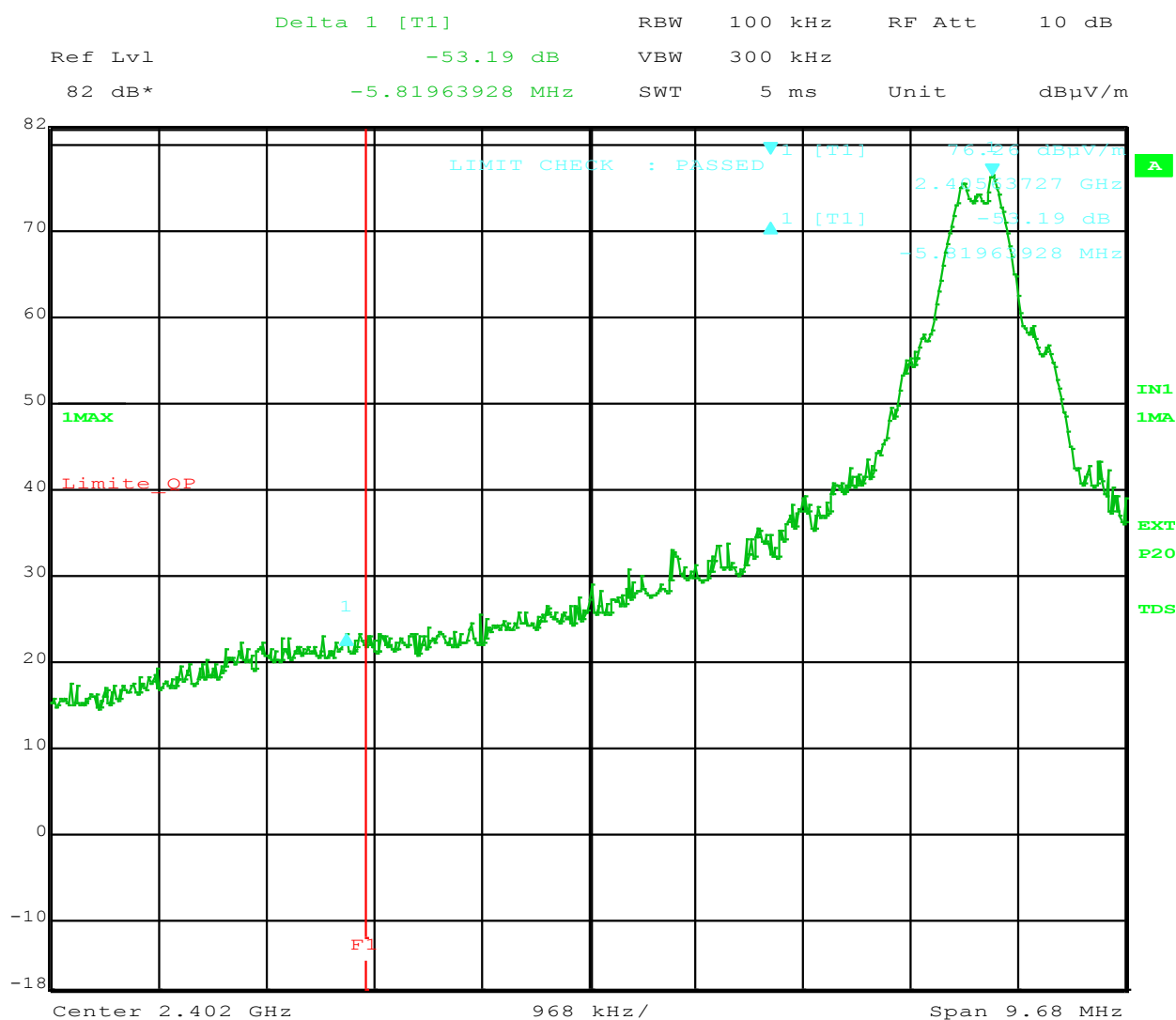


Date: 17.SEP.2015 09:09:26

High channel – 500Kbit/s with hopping off mode

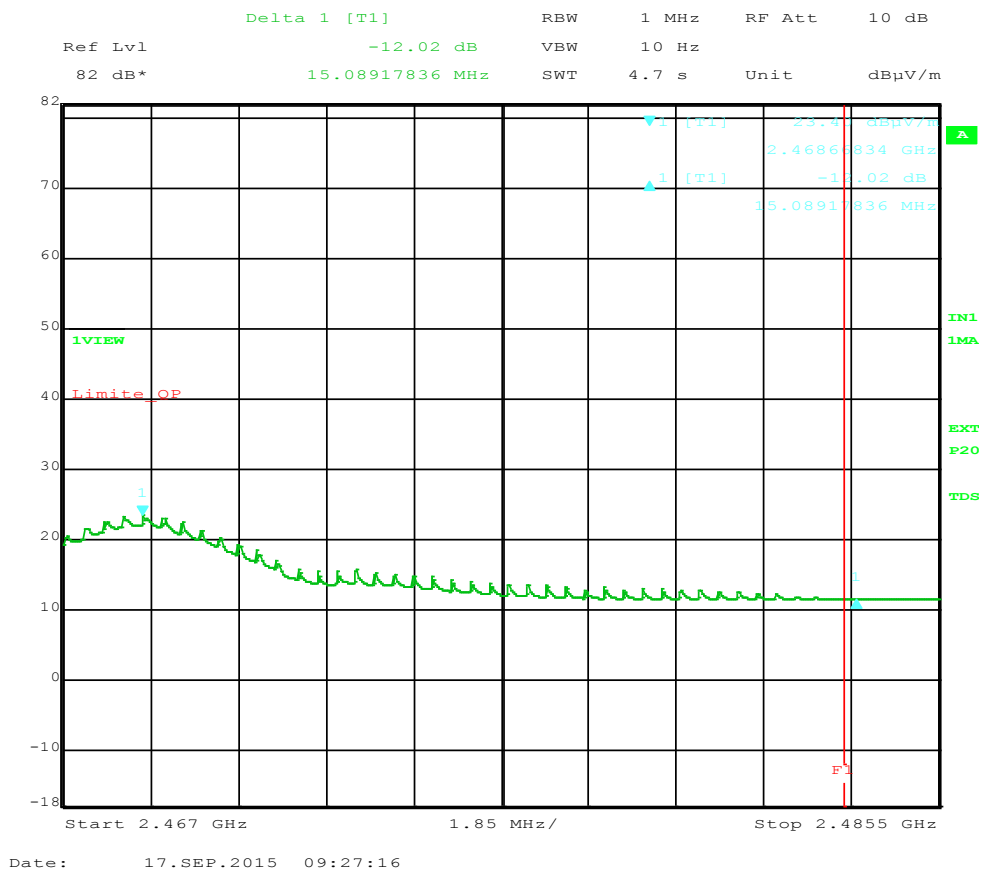
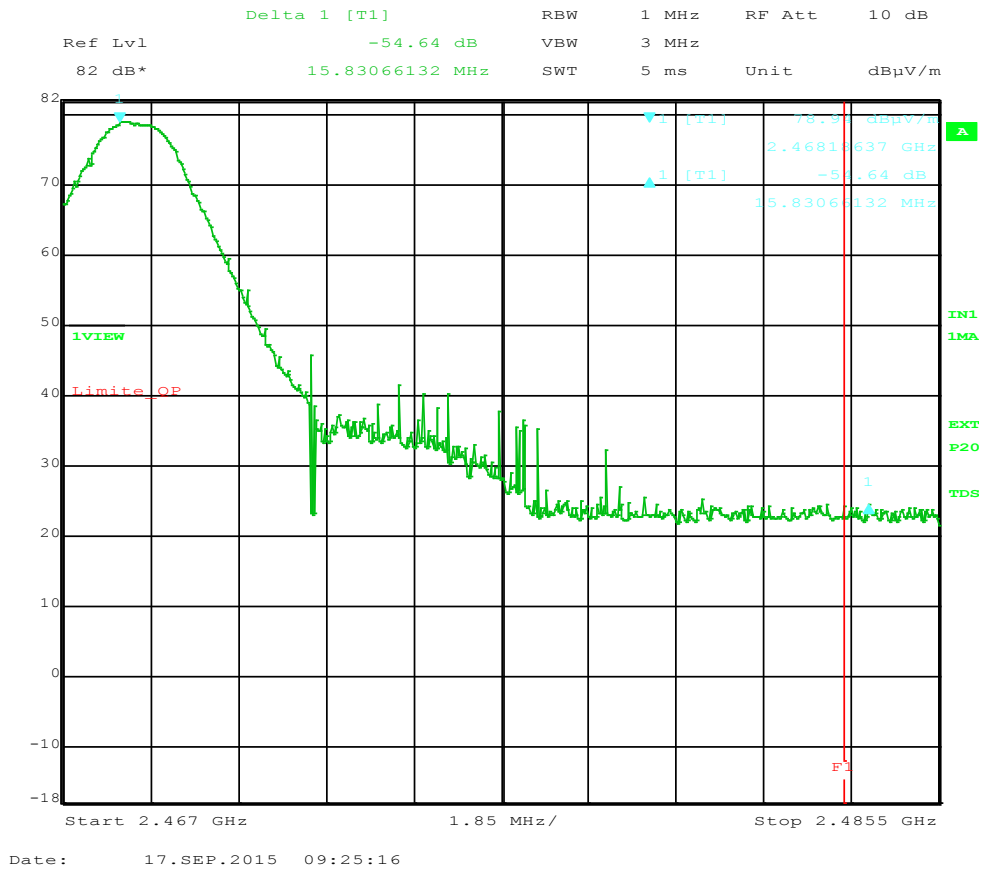


Low channel – 500Kbit/s with hopping on mode



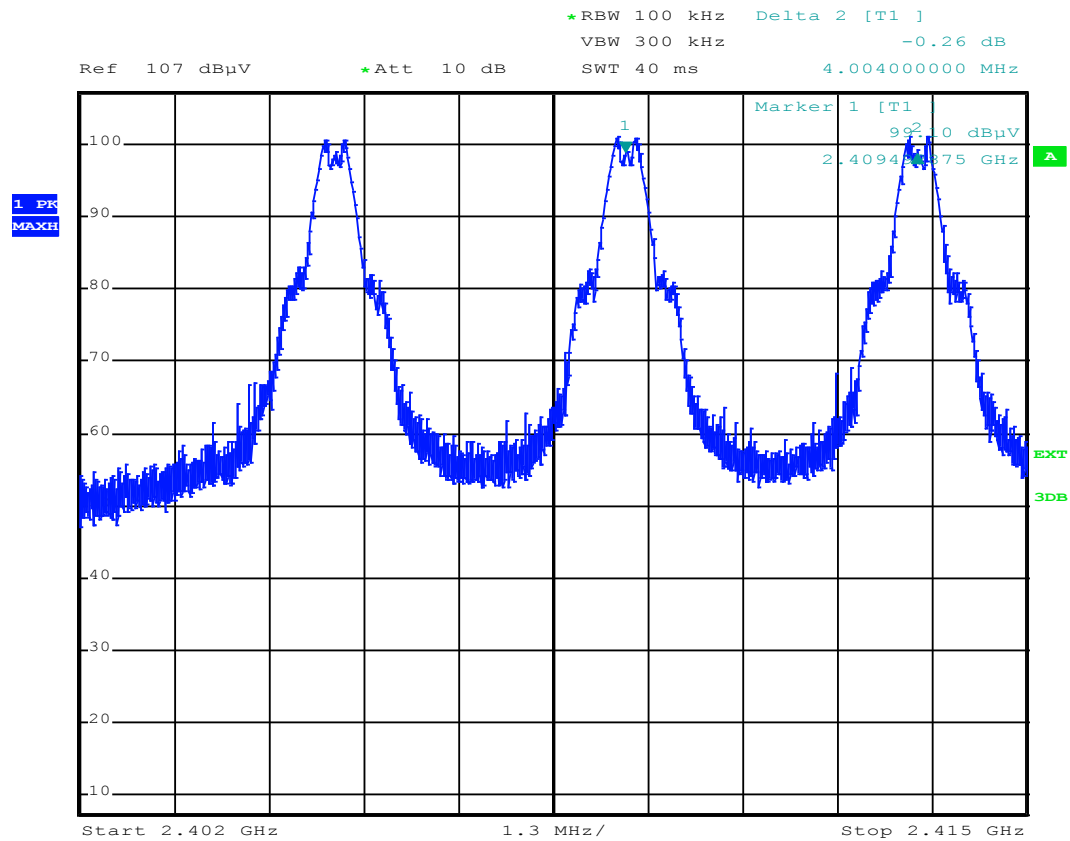
Date: 17.SEP.2015 09:09:26

High channel – 500Kbit/s with hopping on mode



APPENDIX 7: Channel spacing

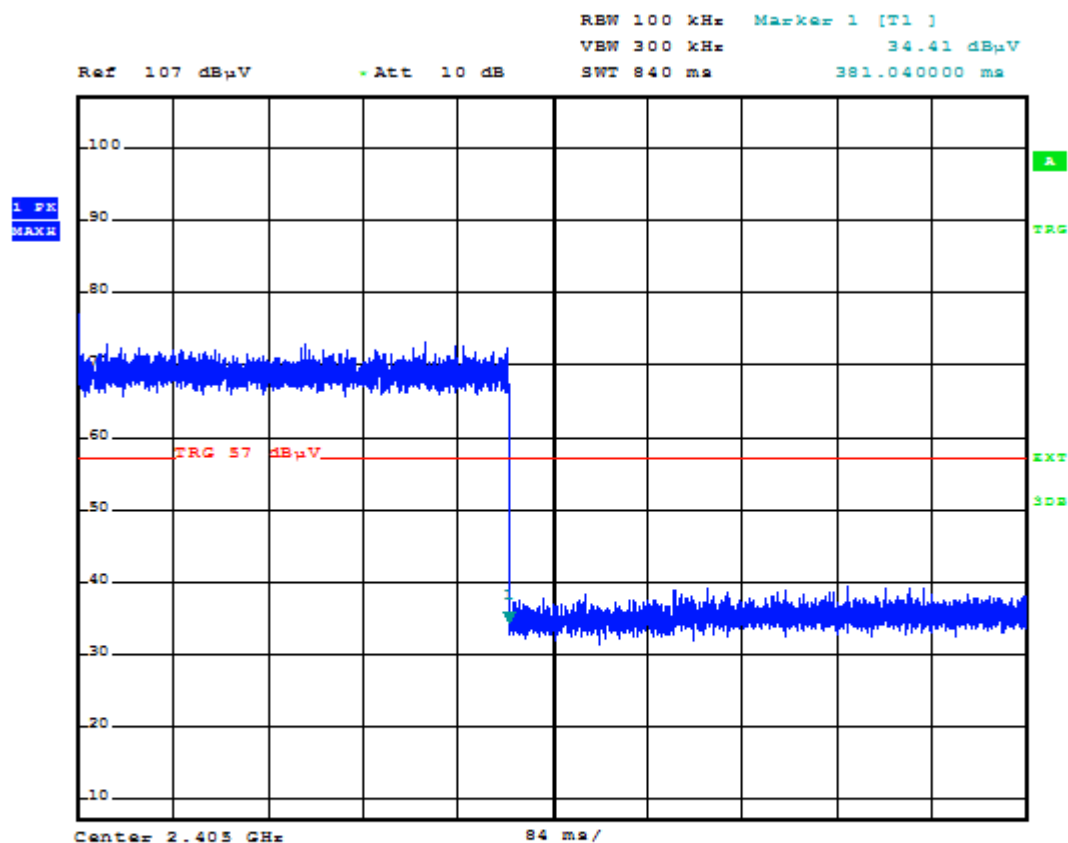
Rate: 500Kbit/s



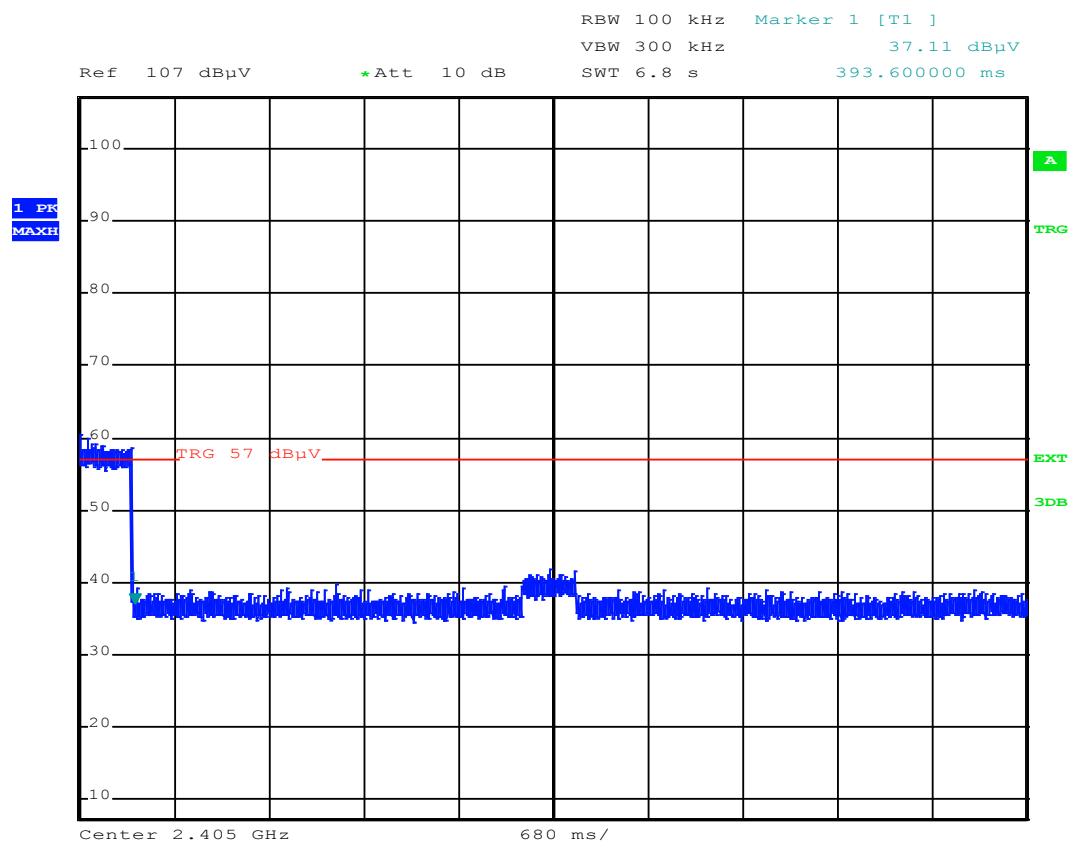
Date: 22.SEP.2014 10:35:19

APPENDIX 8: Time of occupancy on any frequency

Low channel – Rate 2.4Kbit/s

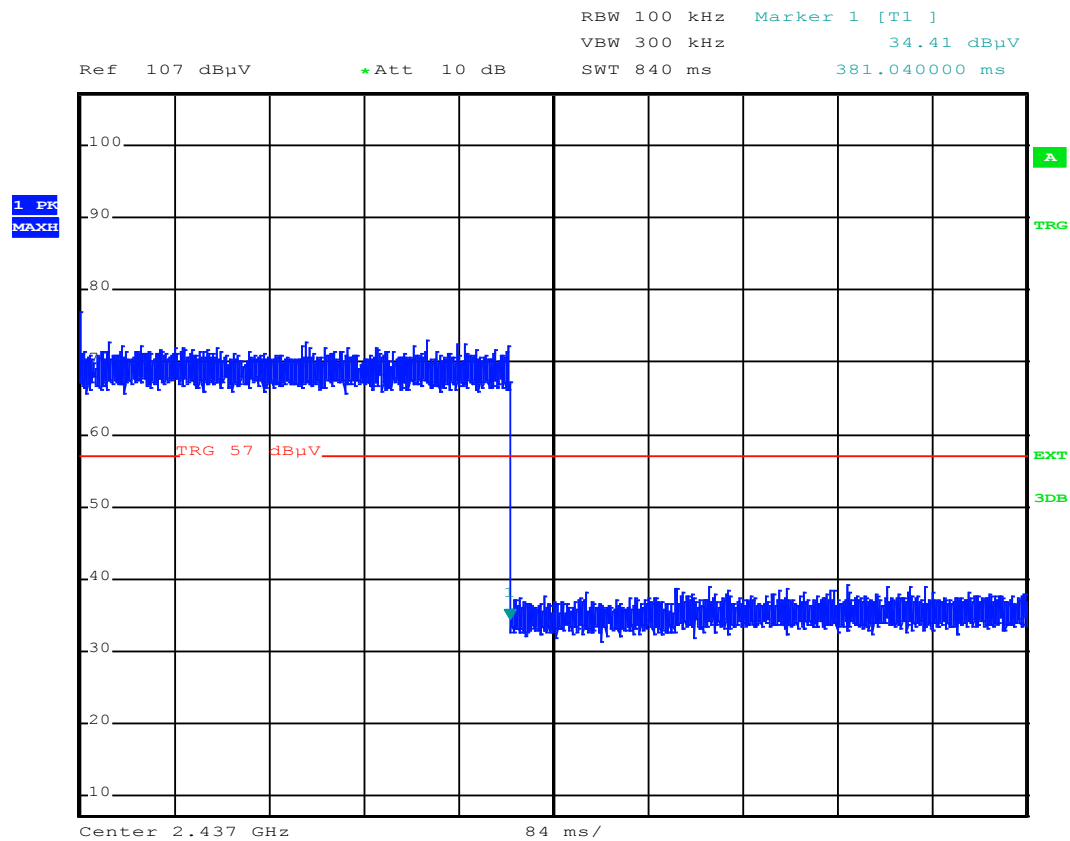


Date: 22.SEP.2014 11:25:35



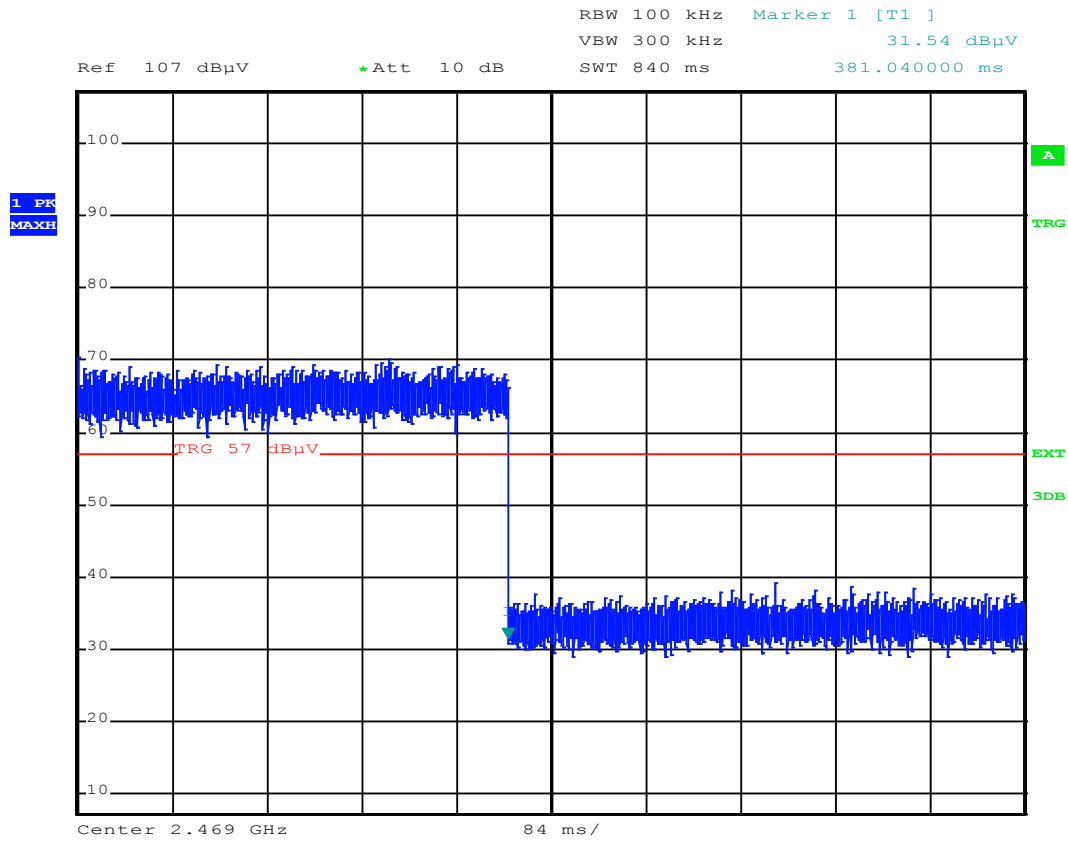
Date: 22.SEP.2014 11:57:54

Central channel – Rate 2.4Kbit/s



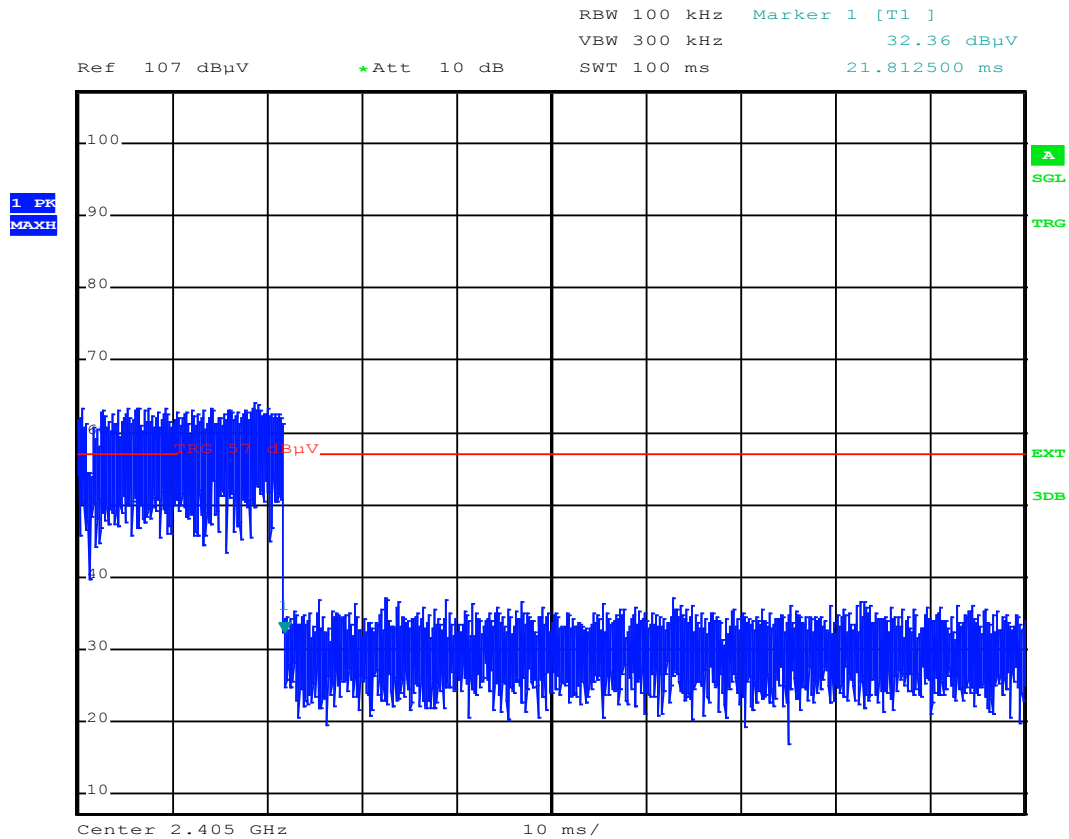
Date: 22.SEP.2014 11:26:04

High channel – Rate 2.4Kbit/s



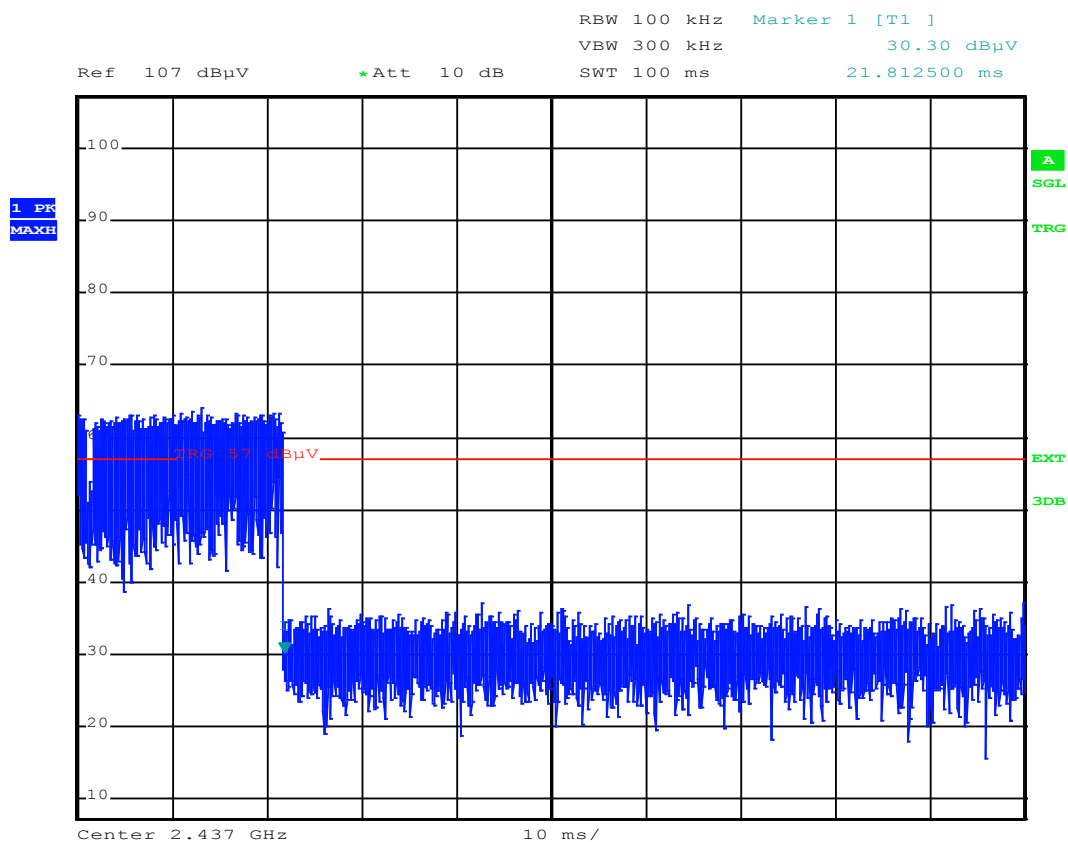
Date: 22.SEP.2014 11:26:22

Low channel – Rate 100Kbit/s



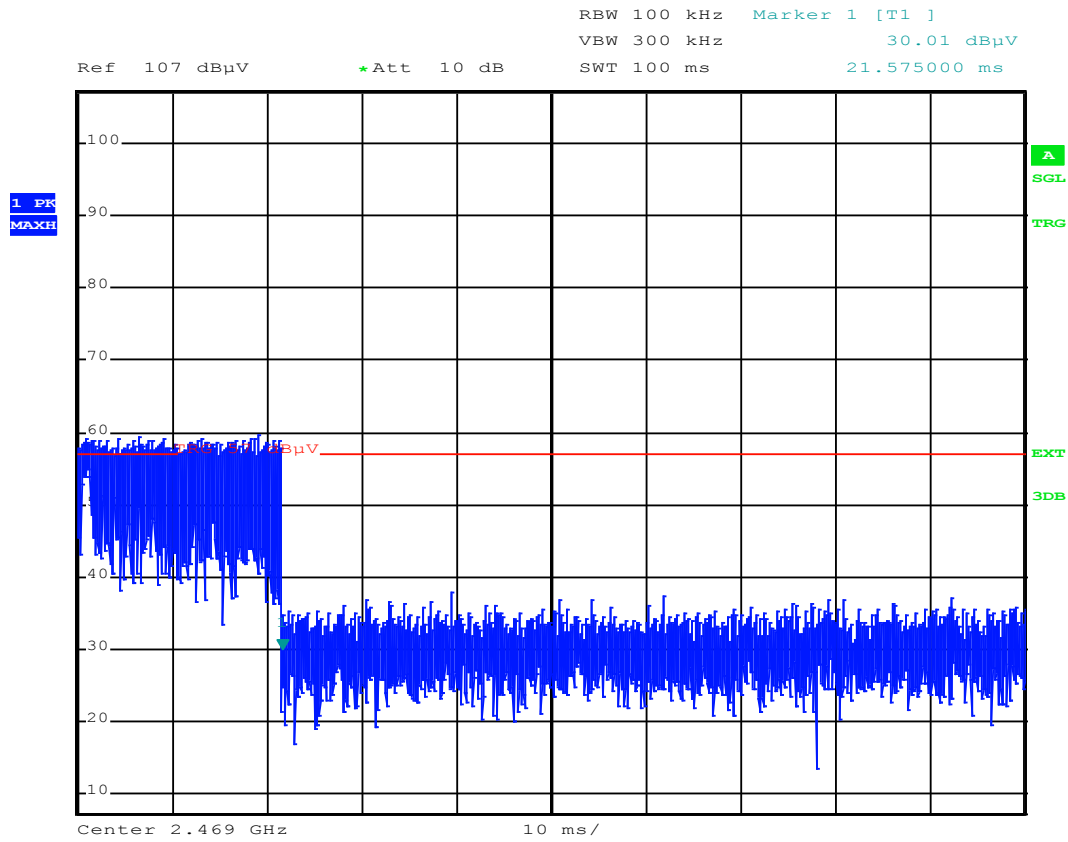
Date: 22.SEP.2014 12:10:32

Central channel – Rate 100Kbit/s

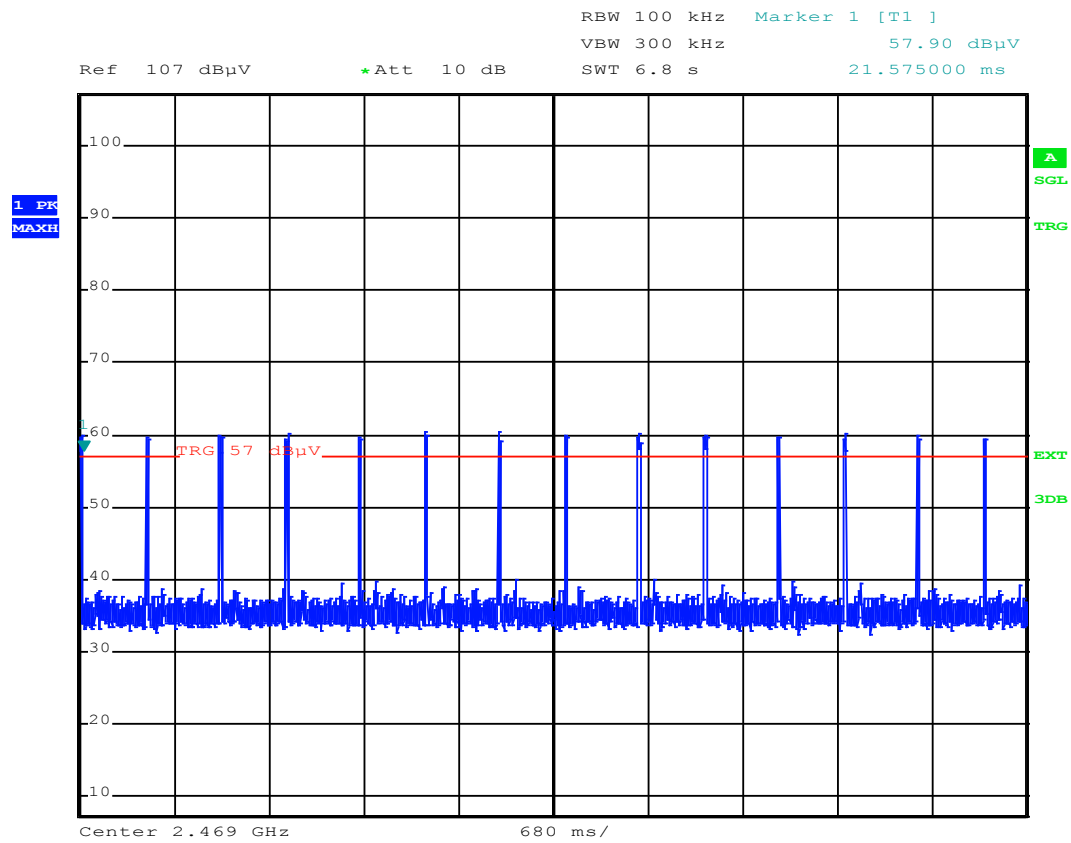


Date: 22.SEP.2014 12:11:01

High channel – Rate 100Kbit/s

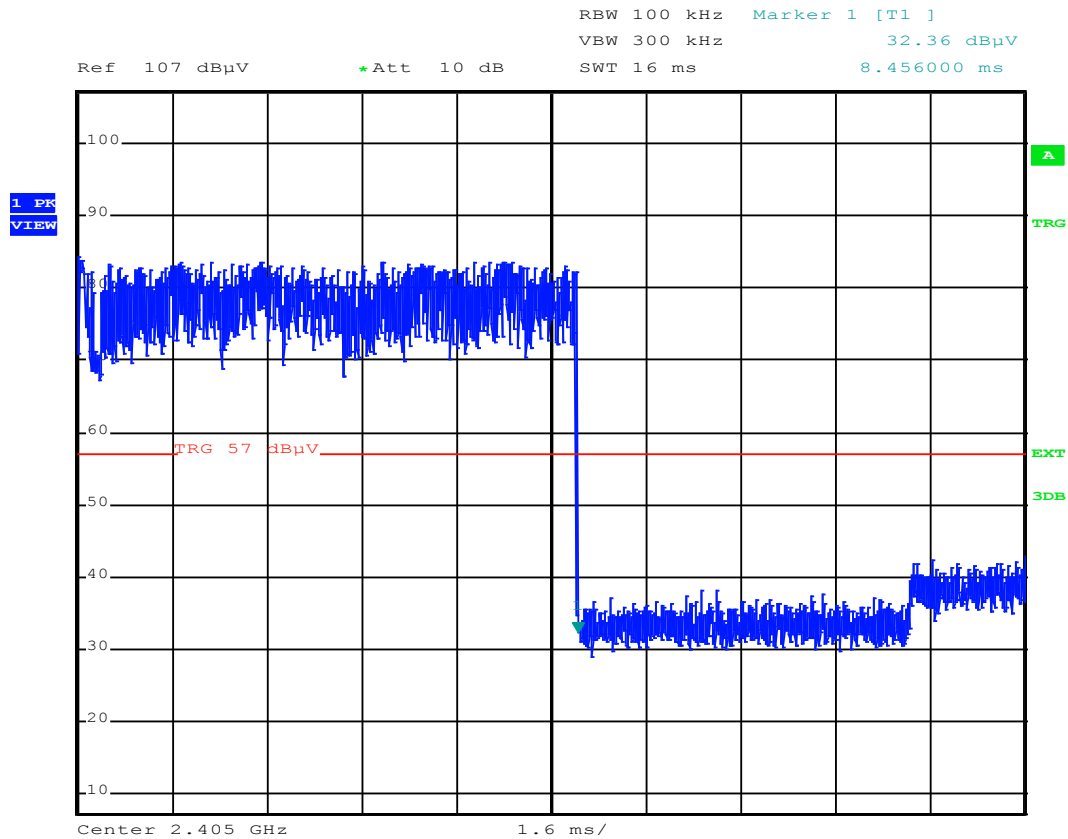


Date: 22.SEP.2014 12:11:18

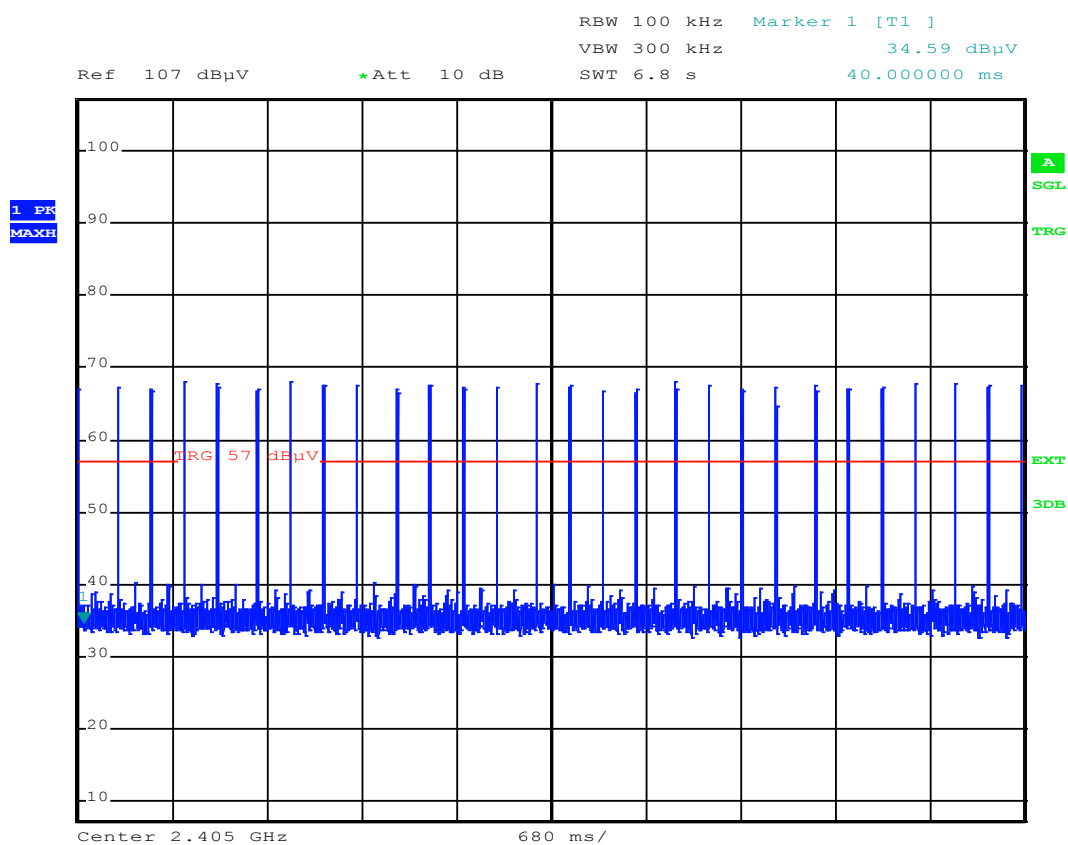


Date: 22.SEP.2014 12:12:11

Low channel – Rate 500Kbit/s

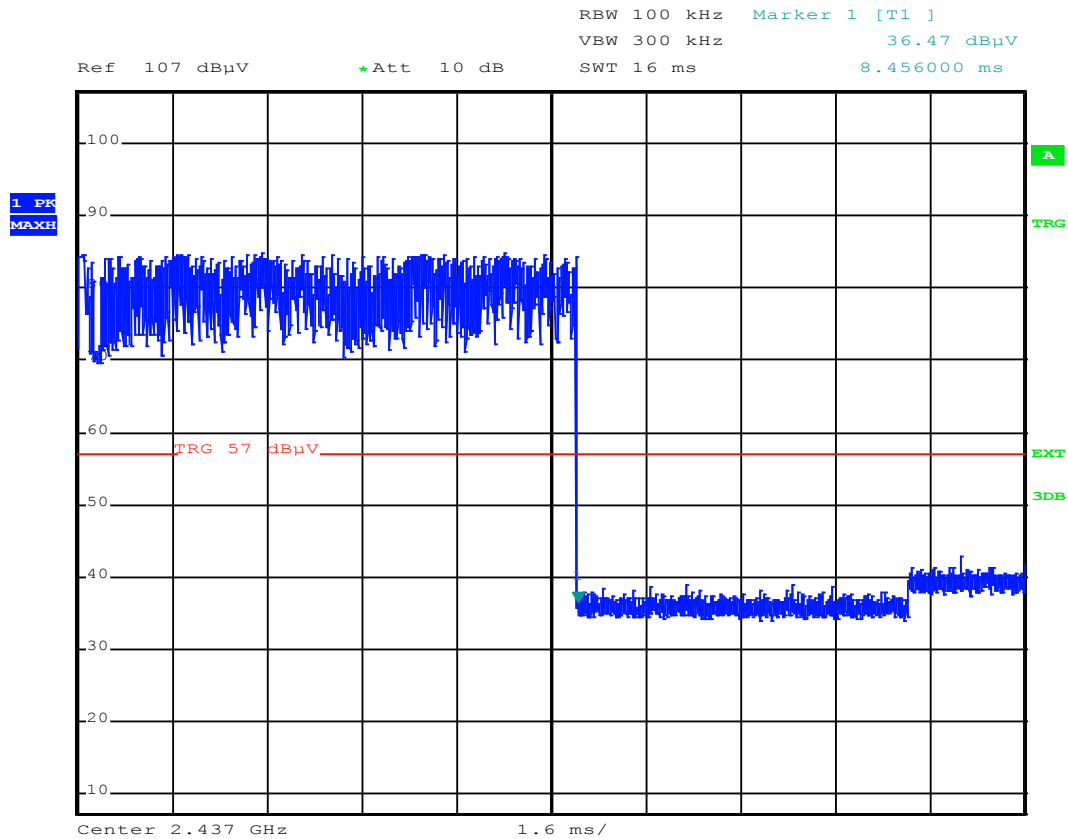


Date: 22.SEP.2014 10:36:47



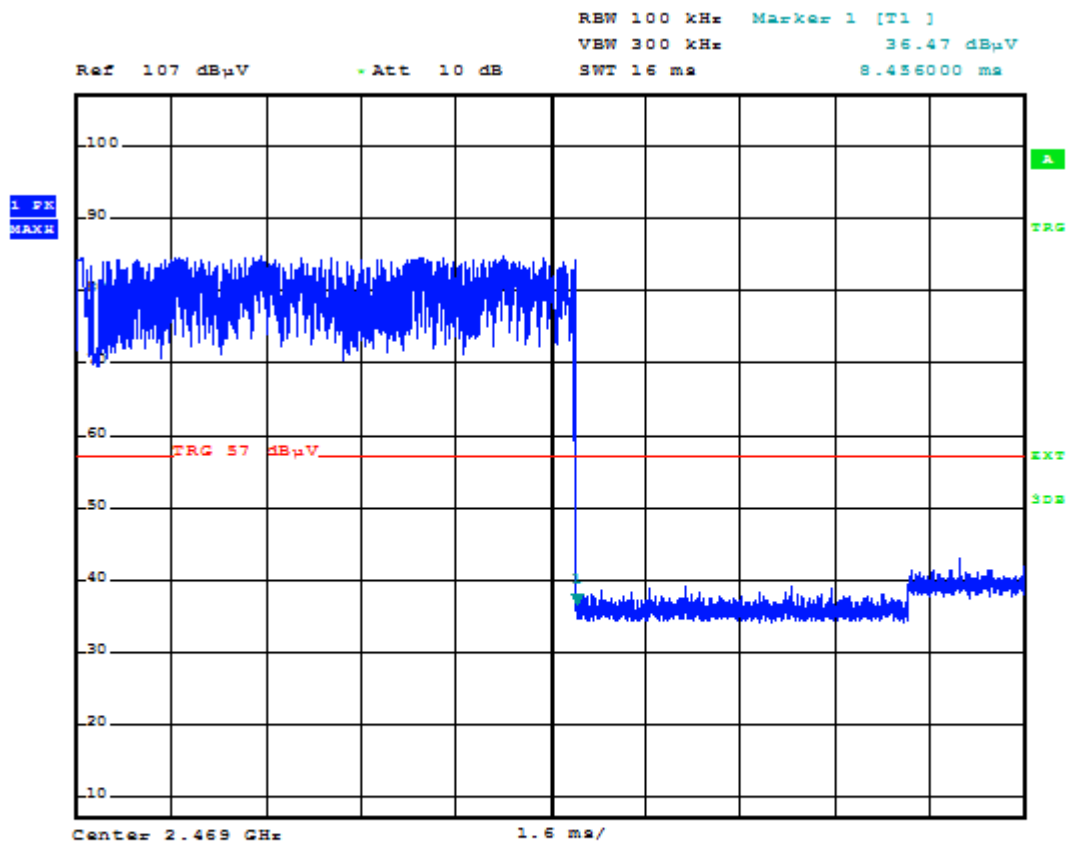
Date: 22.SEP.2014 12:06:02

Central channel – Rate 500Kbit/s



Date: 22.SEP.2014 10:39:32

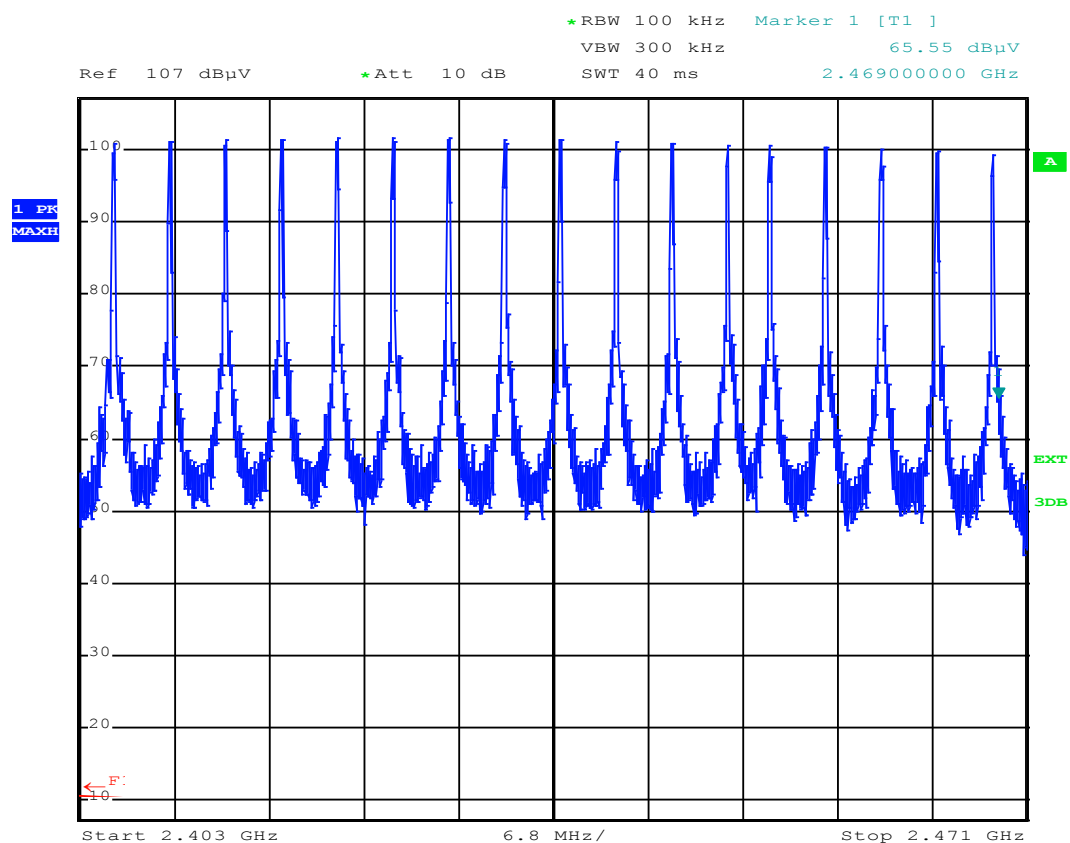
High channel – Rate 500Kbit/s



Date: 22.SEP.2014 11:22:31

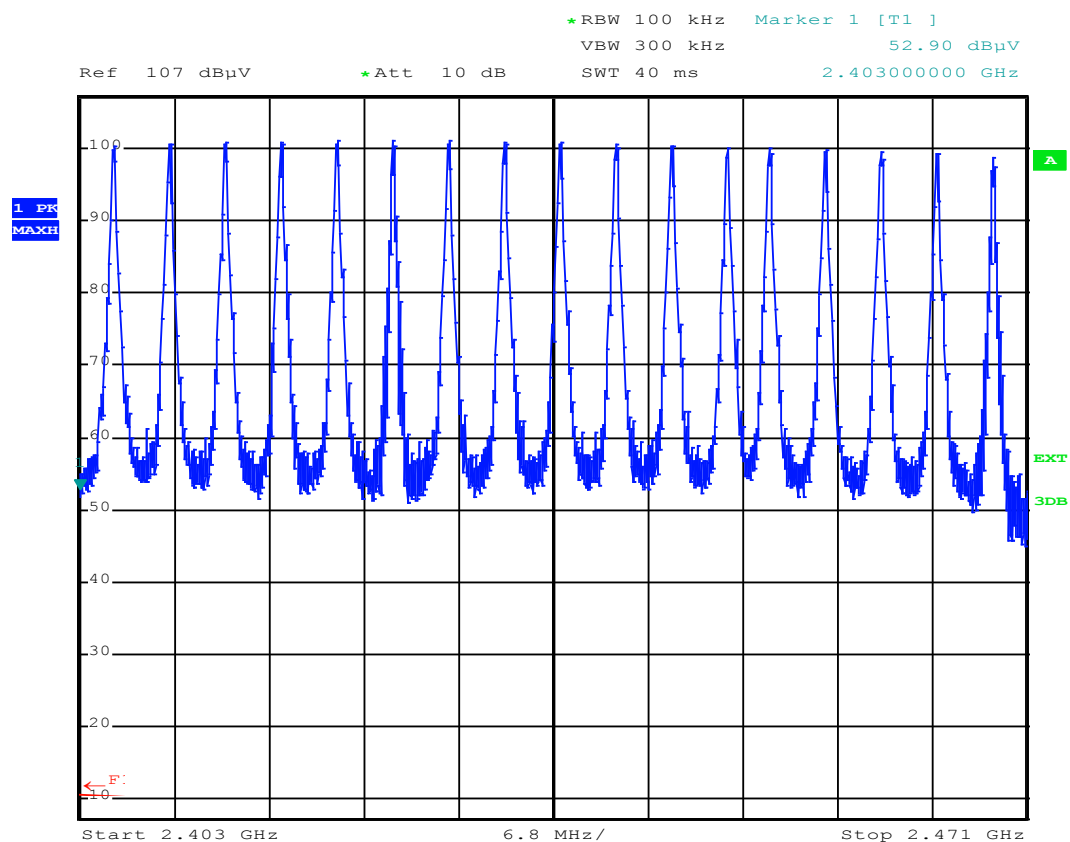
APPENDIX 9: Number of hopping channels

Rate: 2.4Kbits/s



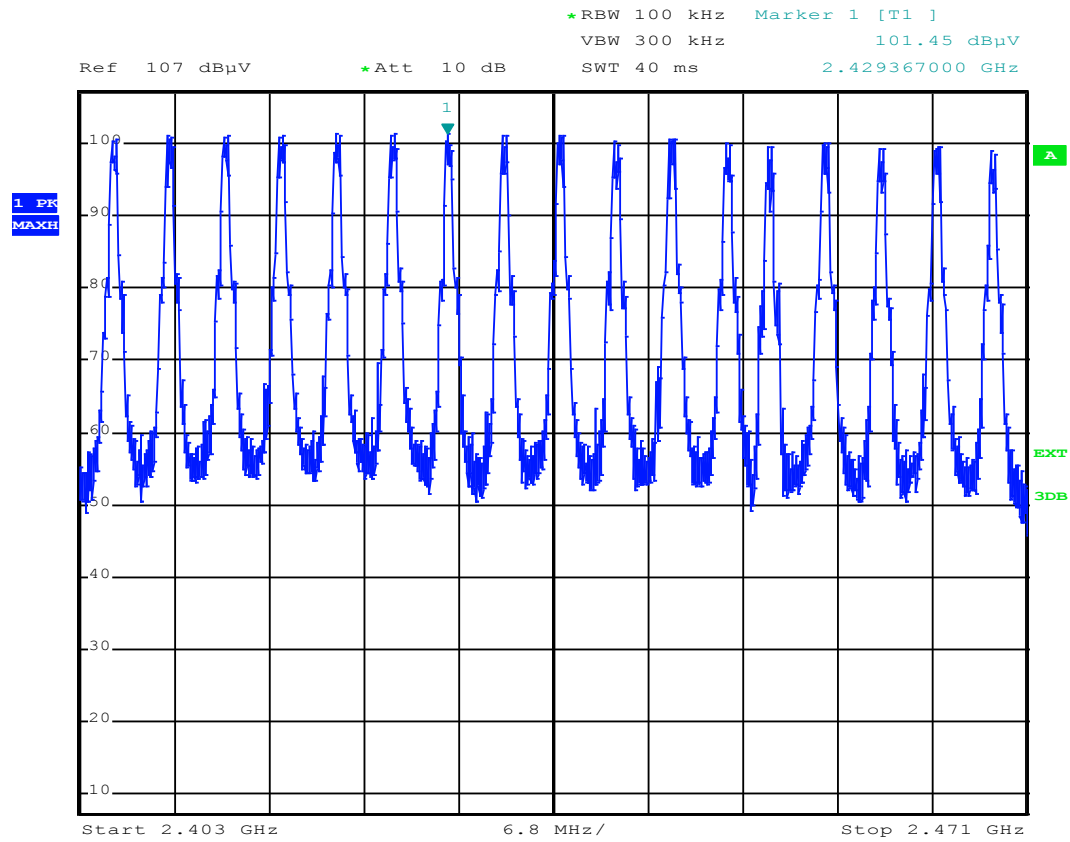
Date: 22.SEP.2014 11:27:25

Rate: 100Kbits/s



Date: 22.SEP.2014 11:06:41

Rate: 500Kbits/s



Date: 22.SEP.2014 10:32:40