

RR051-15-103539-1-A Ed. 0

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| <h2 style="margin: 0;">Certification Radio test report</h2> <p style="margin: 10px 0 0 0;">According to the standard: CFR 47 FCC PART 15</p> <p style="margin: 10px 0 0 0;">Equipment under test: LoRa IoT Station 915MHz</p> <p style="margin: 10px 0 0 0;">FCC ID: 2AFYS-KLK915LOI</p> <p style="margin: 10px 0 0 0;">Company: KERLINK</p> |
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|-----|--------------|----------------|------------|------|---|------|
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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: LoRa IoT Station 915MHz

Serial number (S/N): 0x8080011

Reference / model (P/N): LoRa IoT STATION 915

Software version: PROD_FW=wirmaV2_wirgrid_v2.1

MANUFACTURER: KERLINK

COMPANY SUBMITTING THE PRODUCT:

Company: KERLINK

Address: 1, RUE JACQUELINE AURIOL
35235 THORIGNE-FOUILLARD
FRANCE

Responsible: Mr GILBERT

DATES OF TEST: From 14 September 2015 to 23 September 2015

TESTING LOCATION: EMITECH ANGERS laboratory at JUIGNE SUR LOIRE (49) FRANCE
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49610 Juigne sur Loire
France
FCC Accredited under US-EU MRA Designation Number: FR0009
Test Firm Registration Number: 873677

TESTED BY: S. LOUIS / M.DUMESNIL

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 | 12 |
| 8. RADIATED EMISSION LIMITS | 16 |
| 9. MEASUREMENT OF THE CONDUCTED DISTURBANCES | 18 |
| 10. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS | 33 |
| 11. MAXIMUM PEAK OUTPUT POWER | 36 |
| 12. INTENTIONAL RADIATOR | 39 |
| 13. PEAK POWER DENSITY | 48 |

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: Spectral density

1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment: **LoRa IoT Station 915MHz** in accordance with normative reference.

The device under test integrates:

- a multifrequencies wireless transceiver LoRa.
- A GPS module already certified FCC and IC.
- A 2G / 3G module (HUAWEI MU509c) already certified FCC and IC (FCCID: QISMU509C and IC Number: 6369A-MU509C).

The applicant declares that the distance between the whip antenna for LoRa mode and integral antenna for GSM mode will be superior to 20cm.

So collocation tests are limited: only measurement of the conducted disturbances are necessary and performed.

The host device of certified modules shall be properly labeled to identify the module within.

2. PRODUCT DESCRIPTION

| | |
|----------------------------|---|
| Class: | A |
| Utilization: | Tele transmission |
| Antenna type and gain: | External antenna 6dBi |
| Operating frequency range: | from 923.3MHz to 927.5MHz |
| Number of channels: | 8 |
| Channel spacing: | 600 kHz |
| Modulation: | LoRa |
| Power source: | 48Vdc via POE or solar panel (range 11Vdc to 30Vdc) |

The modulation plan in transmission (Downlink) is the following:

| SF | BW (KHz) | Débit (kbps) |
|----|----------|--------------|
| 7 | 500 | 21875 |
| 8 | 500 | 12500 |
| 9 | 500 | 7031 |
| 10 | 500 | 3906 |
| 11 | 500 | 2148 |
| 12 | 500 | 1172 |

The rates evaluated at the request of the applicant are: SF7 and SF12.

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 (2015) | 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. |
| 558074 D01 DTS v03r02 | Guidance for Performing Compliance on Digital Transmission Systems Operating under §15.247 |

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
- Paragraph 111: Antenna power conduction limits for receivers

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 |
| 4088 | R&S FSP40 | Spectrum Analyzer | 22/08/2013 | 22/08/2015 | 22/10/2015 |
| 7310 | Filtek HP12/1200-5AA | High-pass filter | 16/01/2014 | 16/01/2016 | 16/03/2016 |
| 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 |
| 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 |
| 8548 | Midwest Microwave 10dB | Attenuator | 23/06/2014 | 23/06/2016 | 23/08/2016 |
| 8593 | SIDT Cage 2 | Anechoic chamber | / | / | / |
| 8635 | R&S EZ-25 | High-pass filter | 05/08/2014 | 05/08/2016 | 05/10/2016 |
| 8671 | Huger | Meteo station | 03/09/2014 | 03/09/2016 | 03/11/2016 |
| 8676 | ISOTECH IDM106N | Multimeter | 21/05/2015 | 21/05/2017 | 21/07/2017 |
| 8702 | R&S NRVS | Power meter | 05/09/2013 | 05/09/2015 | 05/11/2015 |
| 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 |
| 8742 | R&S NRV-Z52 | Sensor | 05/09/2013 | 05/09/2015 | 05/11/2015 |
| 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 |
| 8775 | Fontaine FTN 2515B | Power source | * | * | * |
| 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 | / | / | / |

| Equipment | Model | Type | Last verification | Next verification | Validity |
|-----------|---------------------------|---------------------------|-------------------|-------------------|------------|
| 8972 | K&L Microwave 500-1000MHz | Notch filter | / | / | / |
| 10390 | BL Microwave L250-6CN | Low pass filter | 24/07/2013 | 24/07/2015 | 24/09/2015 |
| 10651 | Absorber sheath current | Emitech | 17/10/2013 | 17/10/2015 | 17/12/2015 |
| 11684 | R&S CMU 200 | Radiocommunication tester | 19/01/2015 | 19/01/2017 | 19/03/2017 |
| / | GPIB SHOT | Software | / | / | / |

** The equipment is not verified; instead, the output voltage is checked before each measurement with the calibrated multimeter.*

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

§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 shall include the following informations:

§15.21:

Any changes or modifications to this equipment not expressly approved by KERLINK 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 Note 1 Note2 |
| FCC Part 15.107 | CONDUCTED LIMITS | X | | | | Class A |
| FCC Part 15.109 | RADIATED EMISSION LIMITS | X | | | | Class A |
| FCC Part 15.111 | ANTENNA POWER CONDUCTED LIMITS FOR RECEIVER | | | X | | |

NAp: Not Applicable

NAs: Not Asked

USER NOTICE SHALL CONTAIN

The user notice shall include the following informations:

§ 15.105:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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 | | |
| | (a) (2) Digital modulation techniques | X | | | | Note 4 |
| | (b) Maximum peak output power | X | | | | Note 5 |
| | (c) Operation with directional antenna gains > 6 dBi | | | X | | |
| | (d) Intentional radiator | X | | | | |
| | (e) Peak power spectral density | X | | | | |
| | (f) Hybrid system | | | X | | |
| | (g) Frequency hopping requirements | | | X | | |
| | (h) Frequency hopping intelligence | | | X | | |
| | (i) RF exposure compliance | X | | | | |

NAp: Not Applicable

NAs: Not Asked

Note 1: 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 minimum 6 dB bandwidth of the equipment is 605.6 kHz (see appendix 4).

Note 5: Conducted measurement is performed (whip antenna).

RF EXPOSURE:

Maximum measured power = 3097.4 mW

with $P = (E \times d)^2 / (30 \times G_p)$ with $d = 3 \text{ m}$ and $G_p = 4$

In accordance with KDB 447498 D01 General RF Exposure Guidance v05r02

$PSD = EIRP / (4 \times \pi \times R^2) = 3097.4 / (4 \times \pi \times (20 \text{ cm})^2) = 0.616 \text{ mW/cm}^2$ (limit = 1 mW/cm^2).

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 A

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. The equipment is powered via a POE with the AC power operating voltage of 120 V / 60 Hz.

See photos in appendix 2

Frequency range: 150 kHz - 30 MHz

Detection mode: Peak / Quasi-peak / Average

Bandwidth: 10 kHz / 9 kHz

Equipment under test operating condition:

The equipment is blocked in reception mode.

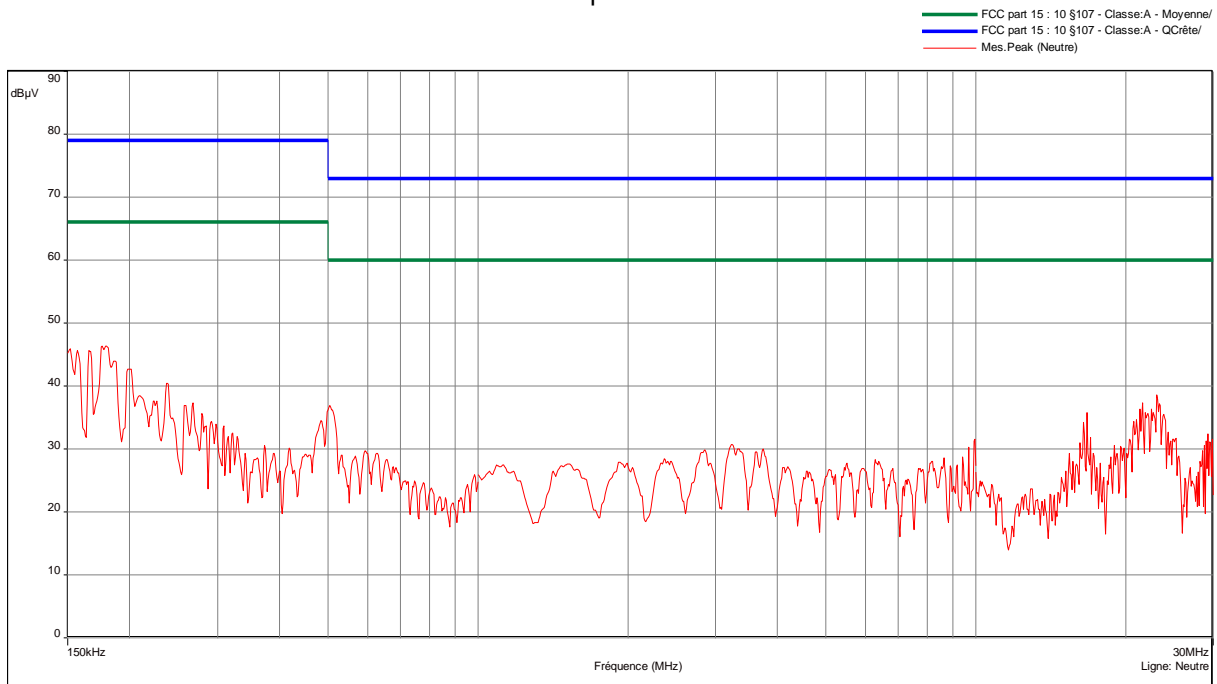
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 46

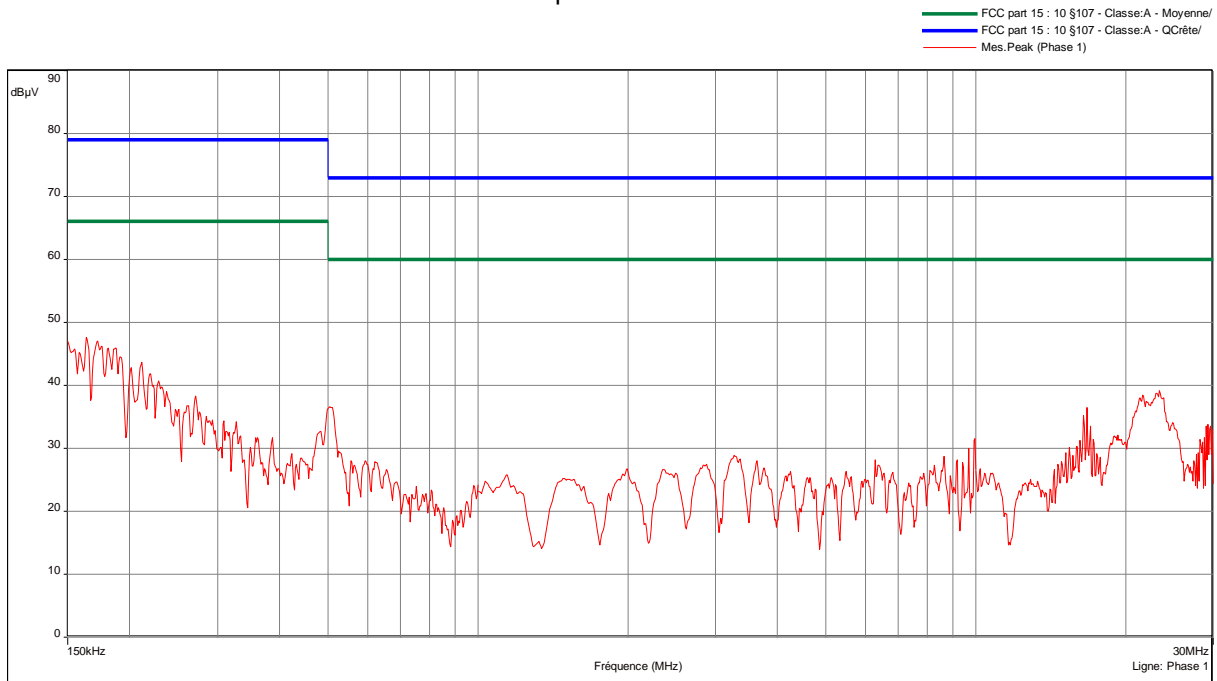
Sample N° 1: LoRa in reception mode (Central channel) with SF7 + 2G 1900MHz in idle mode

Measurement on the mains power supply: The measurement is realized with Peak detector.

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



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



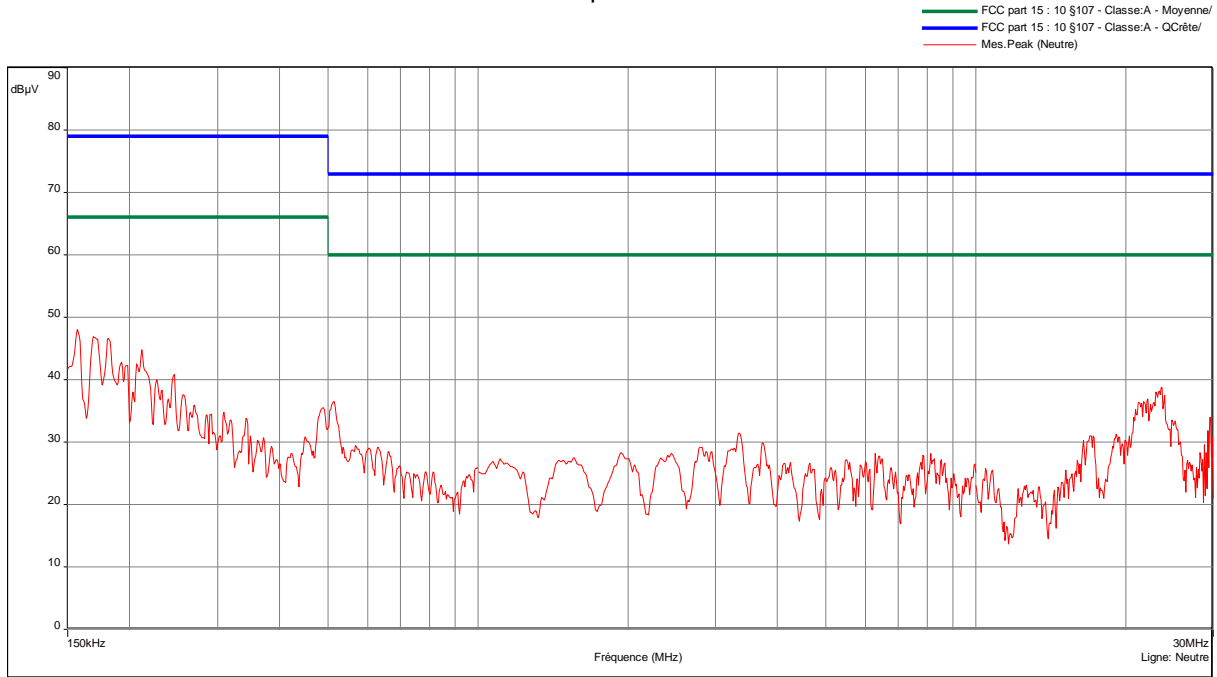
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 46

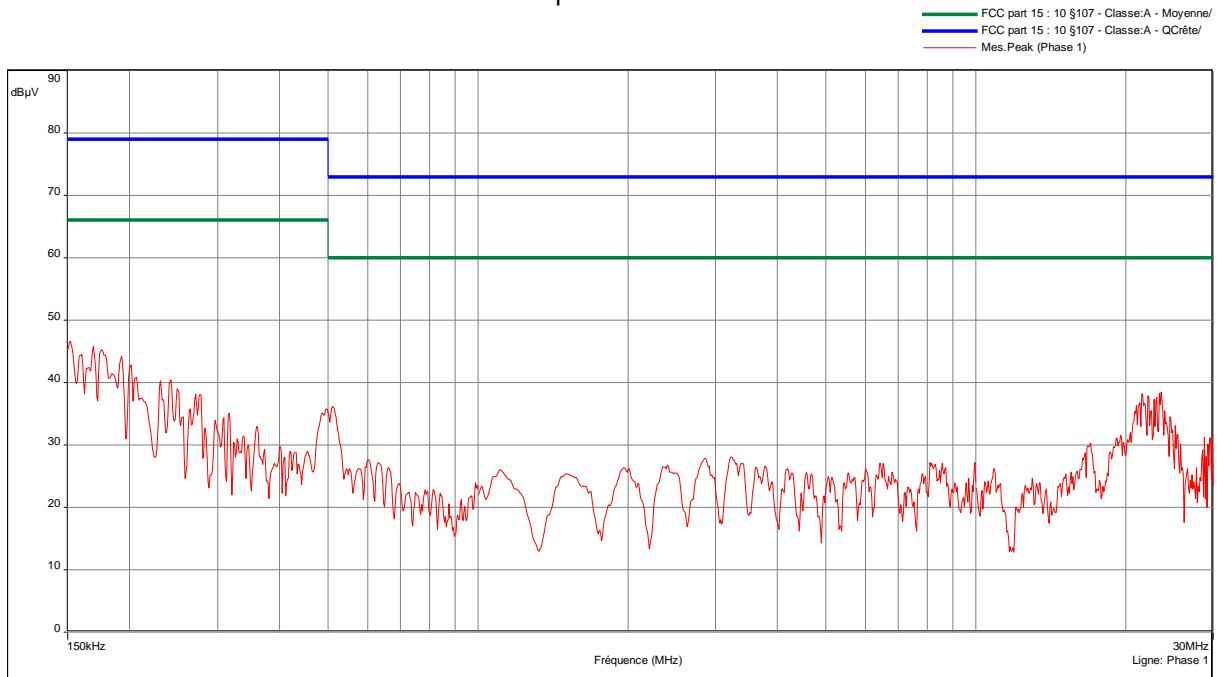
Sample N° 1: LoRa in reception mode (Central channel) with SF10 + 2G 850MHz in idle mode

Measurement on the mains power supply: The measurement is realized with Peak detector.

Curve N° 3: measurement on the Neutral with peak detector



Curve N° 4: measurement on the Line with peak detector



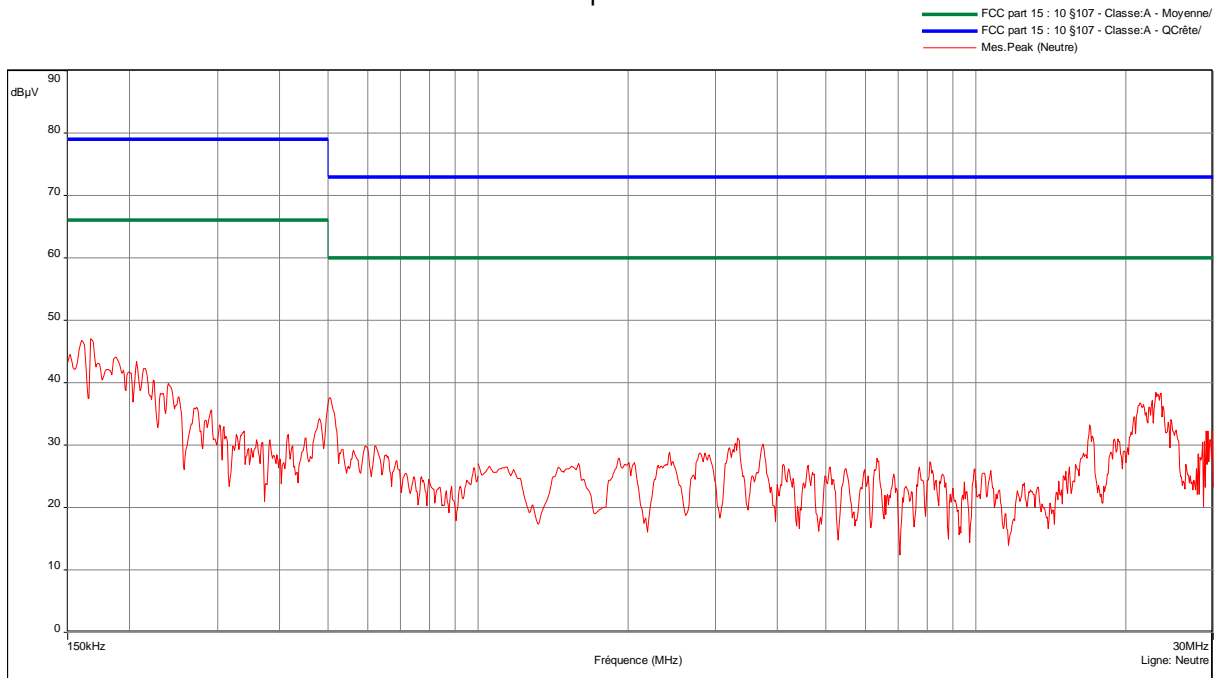
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 46

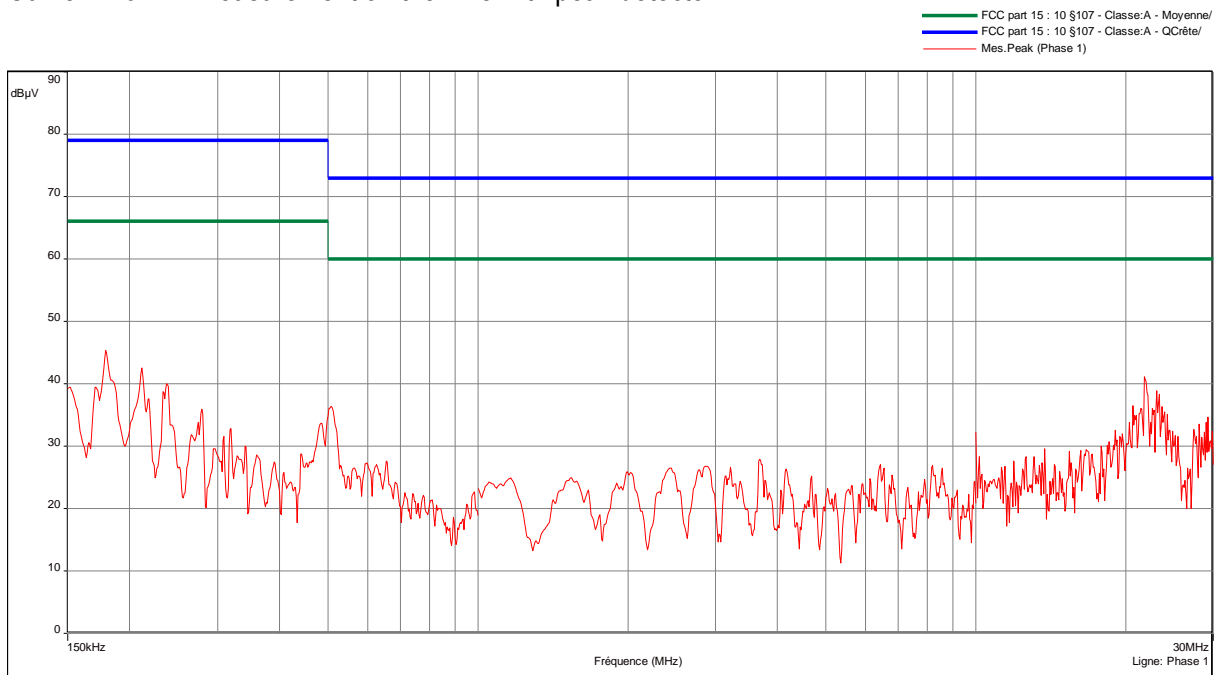
Sample N° 1: LoRa in reception mode (Central channel) with SF12 + 2G 850MHz in idle mode

Measurement on the mains power supply: The measurement is realized with Peak detector.

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



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



Test conclusion:

RESPECTED STANDARD

8. RADIATED EMISSION LIMITS

Standard: FCC Part 15

Test procedure: paragraph 109

Limit class: Class A

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 9.8GHz (5th harmonic of the highest frequency used).

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.

Results:

Ambient temperature (°C): 26
 Relative humidity (%): 43

Power source: 48Vdc via POE

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) |
|-------------------|---------------------------------------|---------------------|------------------|--|-------------------------|-----------------|-------------|
| 30 | QP | 287 | 263 | V | 9.5 | 39.1 | 29.6 |
| 40 | QP | 100 | 351 | V | 9.9 | 39.1 | 29.2 |
| 61.4 | QP | 100 | 52 | V | 14.2 | 39.1 | 24.9 |
| 400 | QP | 360 | 0 | V | 20.9 | 46.4 | 25.5 |
| 480 | QP | 400 | 37 | H | 27.8 | 46.4 | 18.6 |
| 532 | QP | 300 | 150 | H | 35.6 | 46.4 | 10.8 |
| 666 | QP | 110 | 146 | H | 21 | 46.4 | 25.4 |

Applicable limits: for $30 \text{ MHz} \leq F \leq 88 \text{ MHz}$: 39.1 dBμV/m at 10 meters
 for $88 \text{ MHz} < F \leq 216 \text{ MHz}$: 43.5 dBμV/m at 10 meters
 for $216 \text{ MHz} < F \leq 960 \text{ MHz}$: 46.4 dBμV/m at 10 meters
 Above 960 MHz : 49.5 dBμV/m at 10 meters

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. The equipment is powered via a POE with the AC power operating voltage of 120 V / 60 Hz.

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 modulated transmission mode, at the highest output power level at which the transmitter is intended to operate.

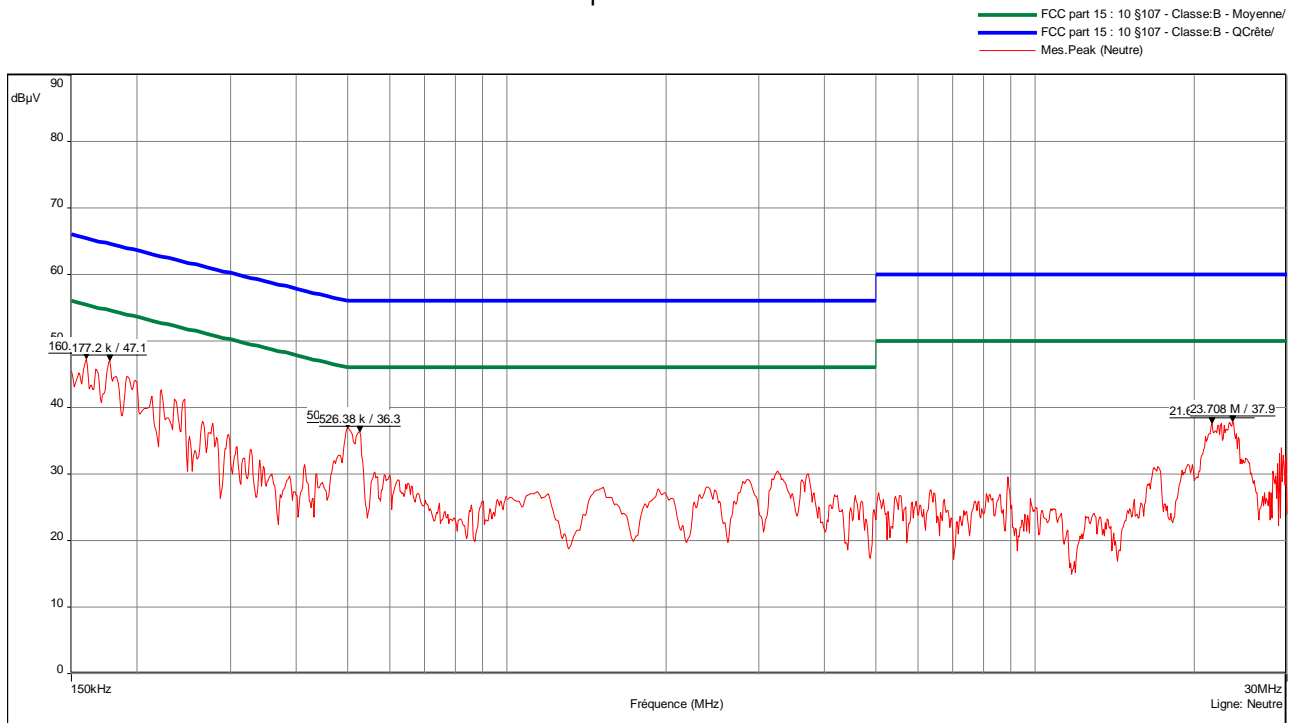
Results:

Ambient temperature (°C): 24
 Relative humidity (%): 47

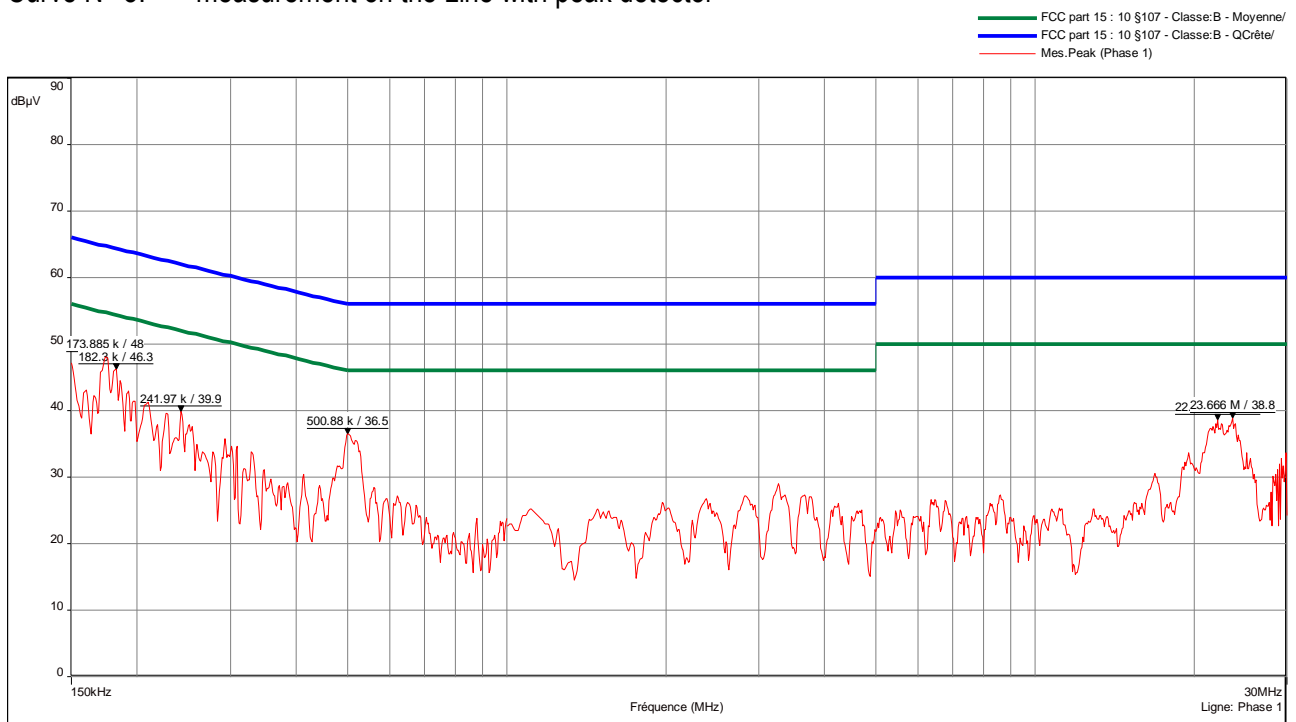
Sample N° 1: LoRa in transmission mode (Low channel) with SF7

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 7: measurement on the Neutral with peak detector

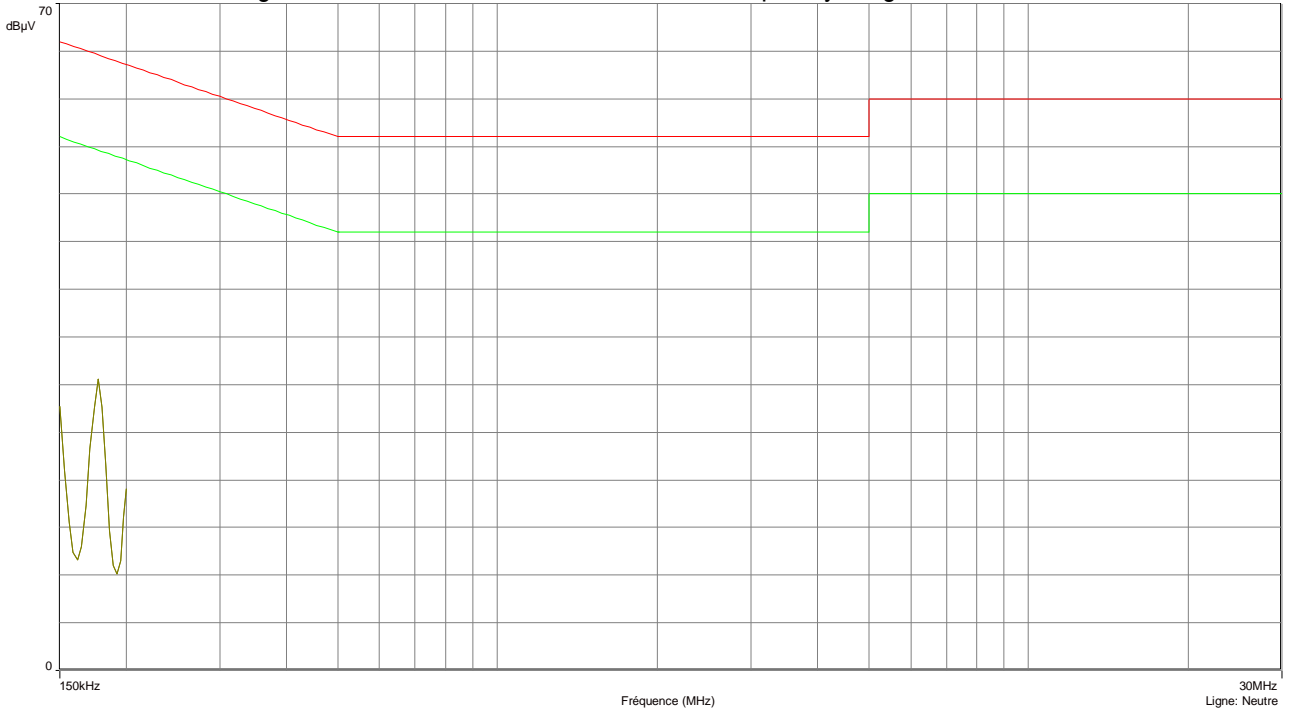


Curve N° 8: measurement on the Line with peak detector

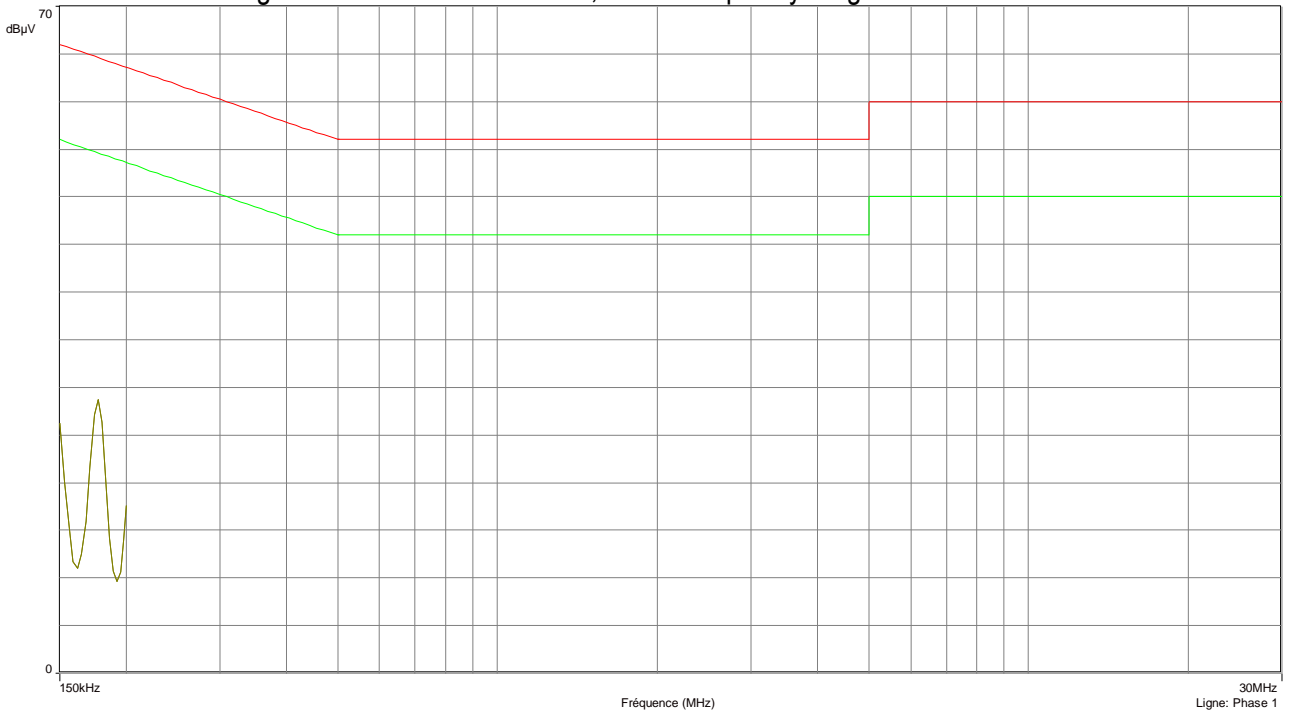


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 9: average measurement on the Neutral, for the frequency range: 150 KHz – 200 KHz



Curve N° 10: average measurement on the Line, for the frequency range: 150 KHz – 200 KHz



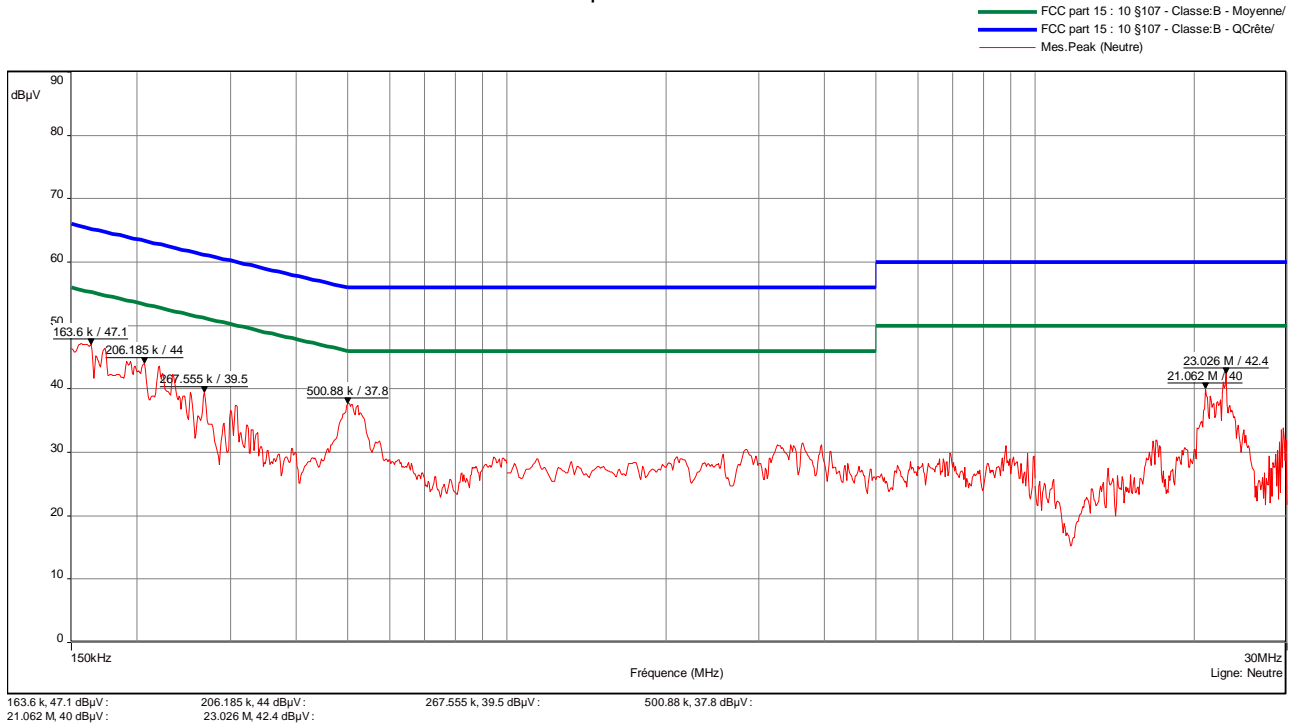
Results:

Ambient temperature (°C): 24
 Relative humidity (%): 47

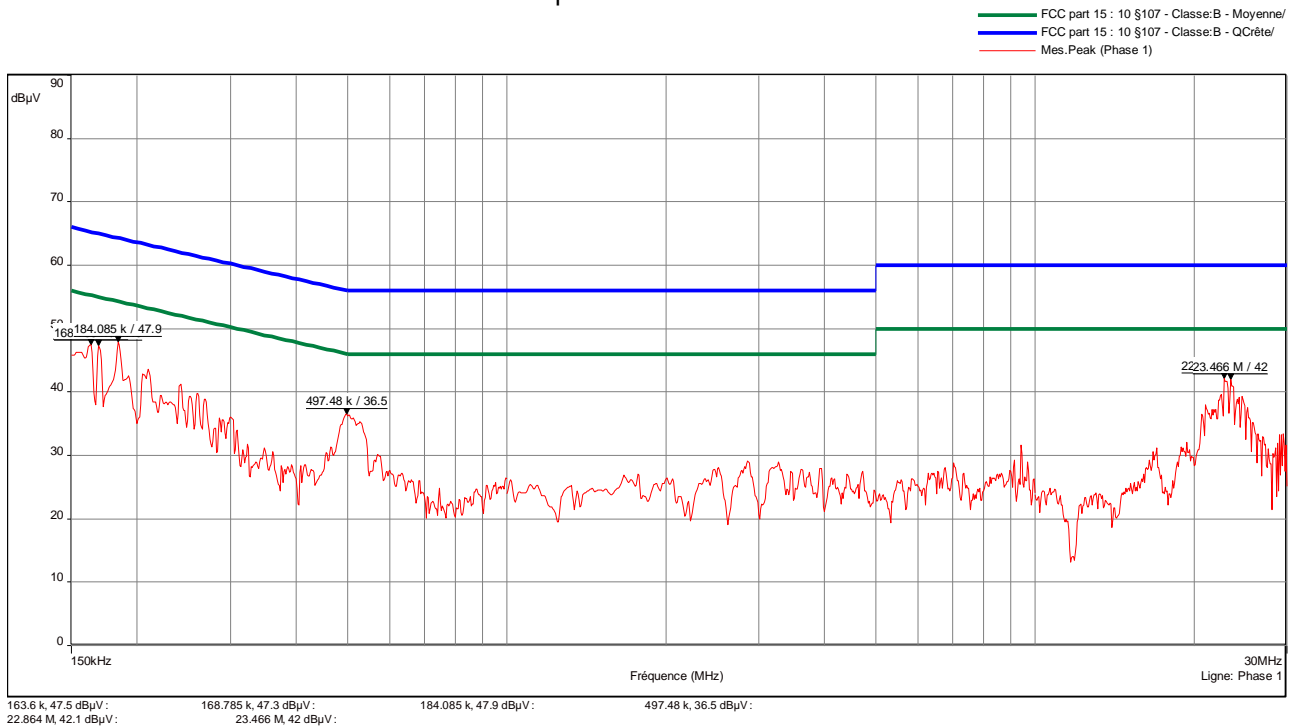
Sample N° 1: LoRa in transmission mode (Low channel) with SF12

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 11: measurement on the Neutral with peak detector

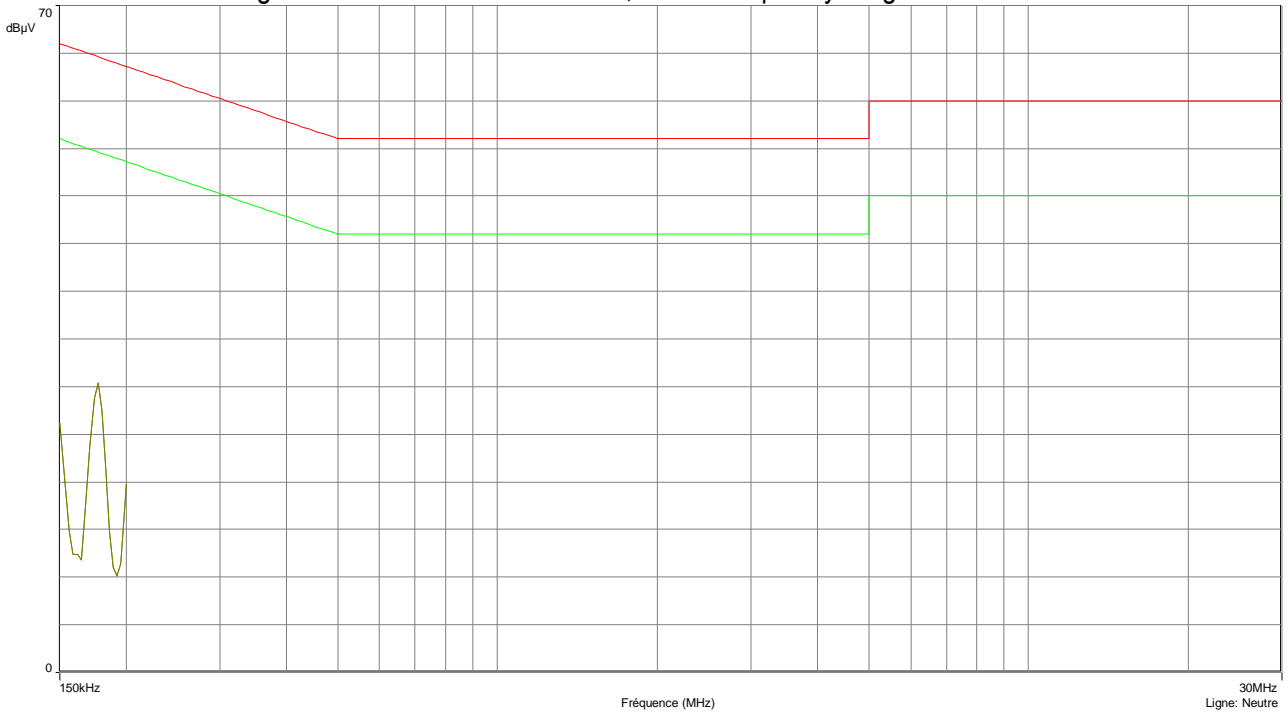


Curve N° 12: measurement on the Line with peak detector

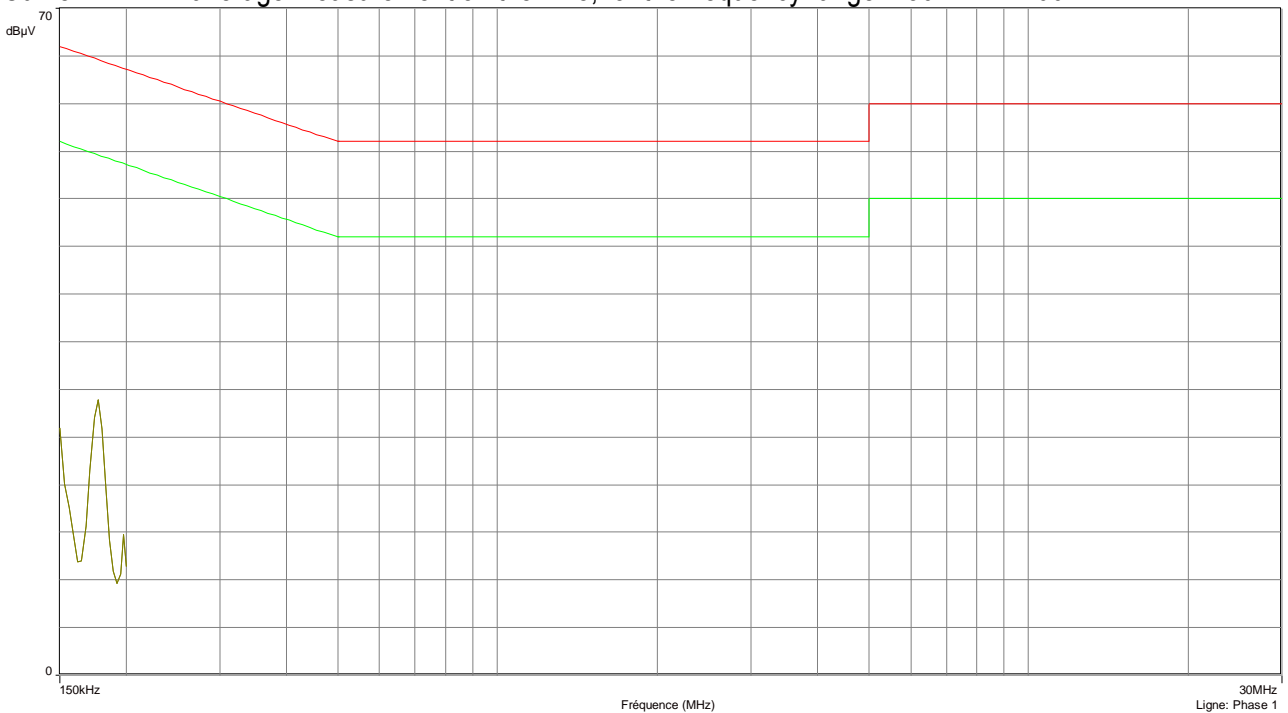


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 13: average measurement on the Neutral, for the frequency range: 150 KHz – 200 KHz



Curve N° 14: average measurement on the Line, for the frequency range: 150 KHz – 200 KHz



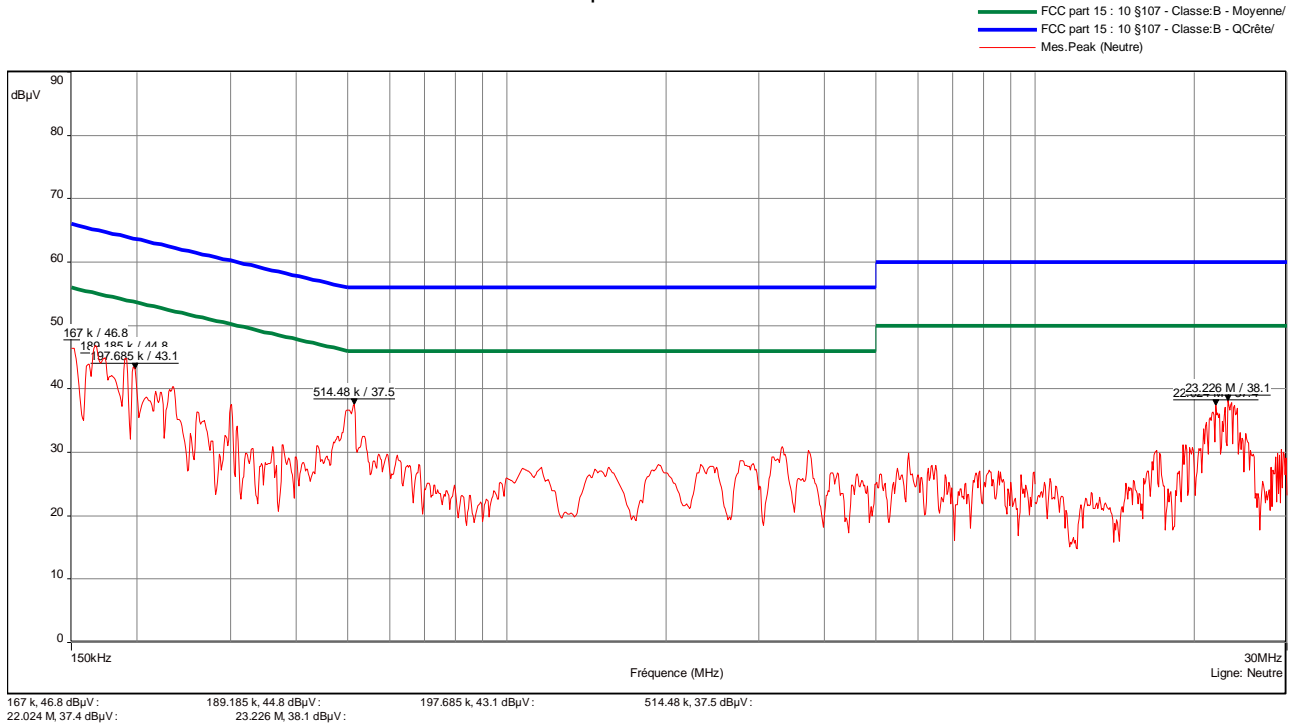
Results:

Ambient temperature (°C): 24
 Relative humidity (%): 47

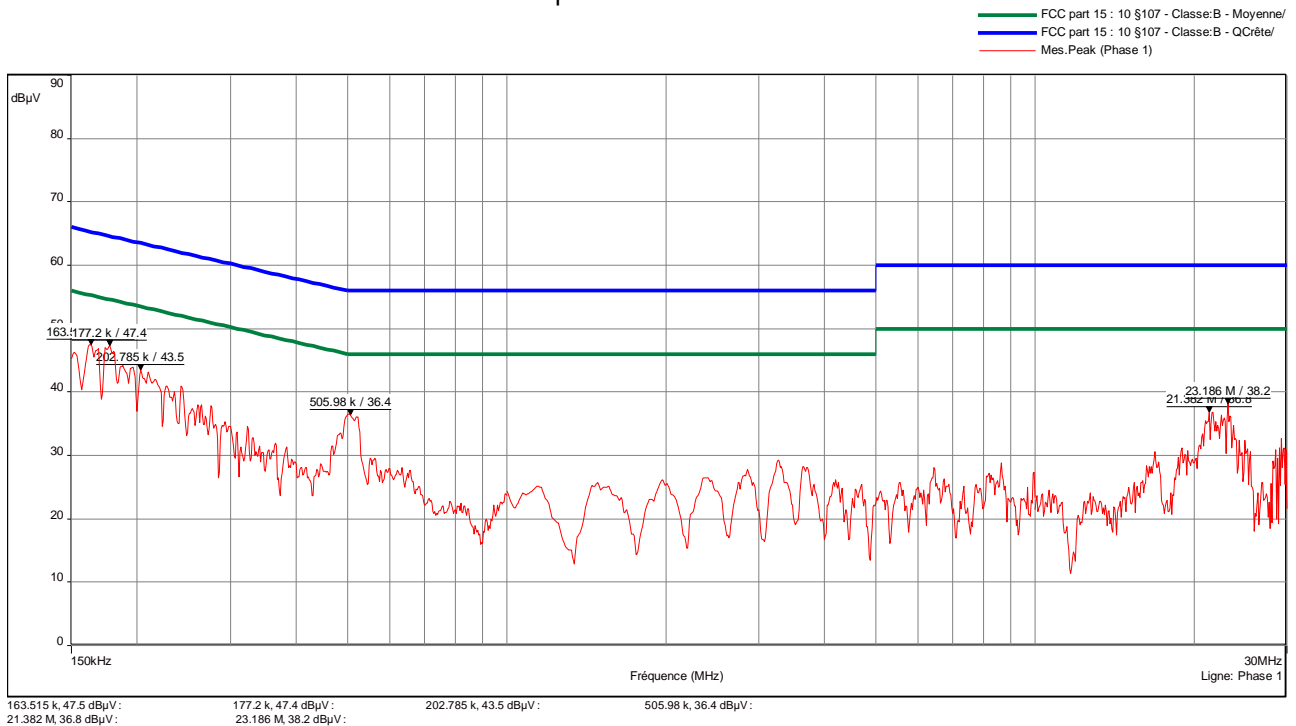
Sample N° 1: LoRa in transmission mode (High channel) with SF7

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 15: measurement on the Neutral with peak detector

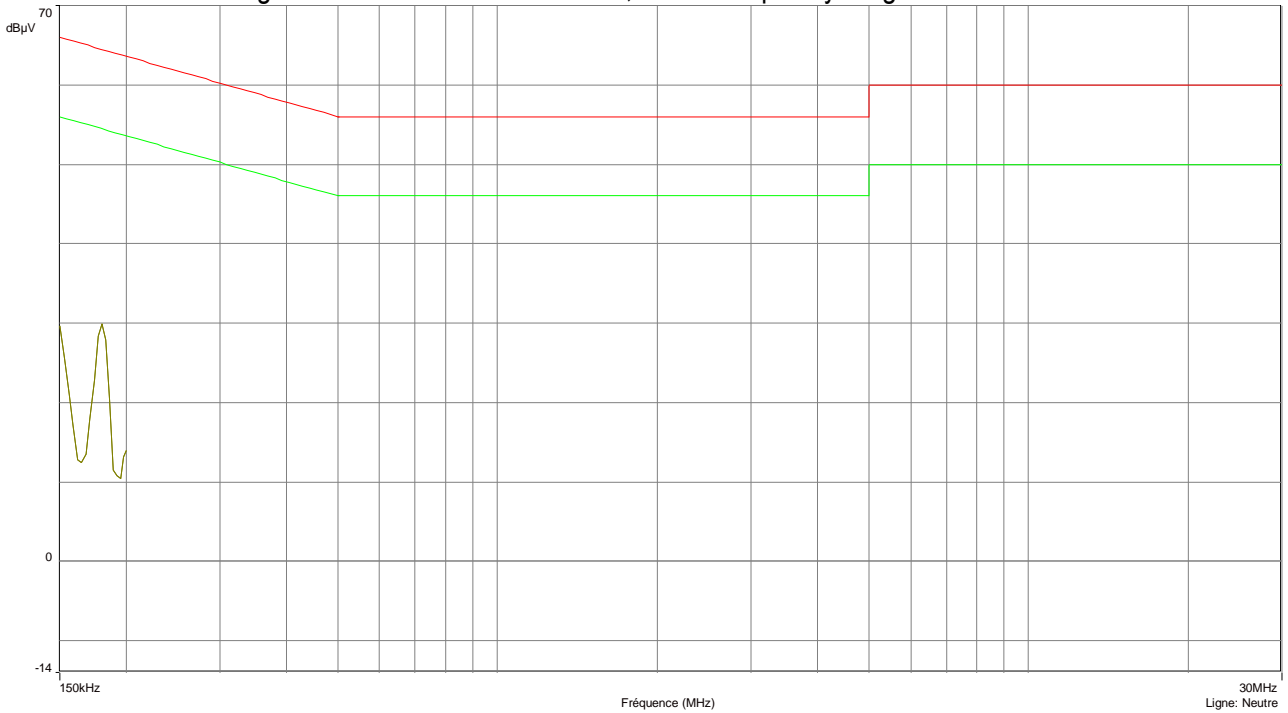


Curve N° 16: measurement on the Line with peak detector

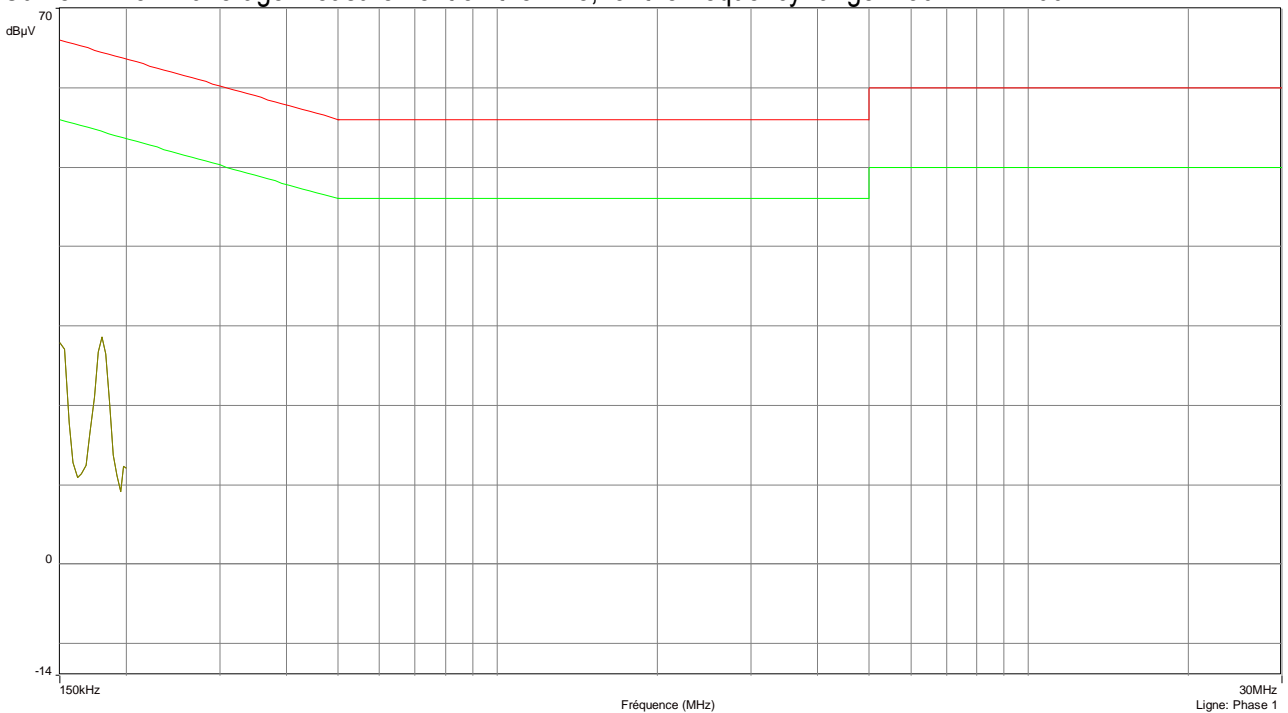


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 17: average measurement on the Neutral, for the frequency range: 150 KHz – 200 KHz



Curve N° 18: average measurement on the Line, for the frequency range: 150 KHz – 200 KHz



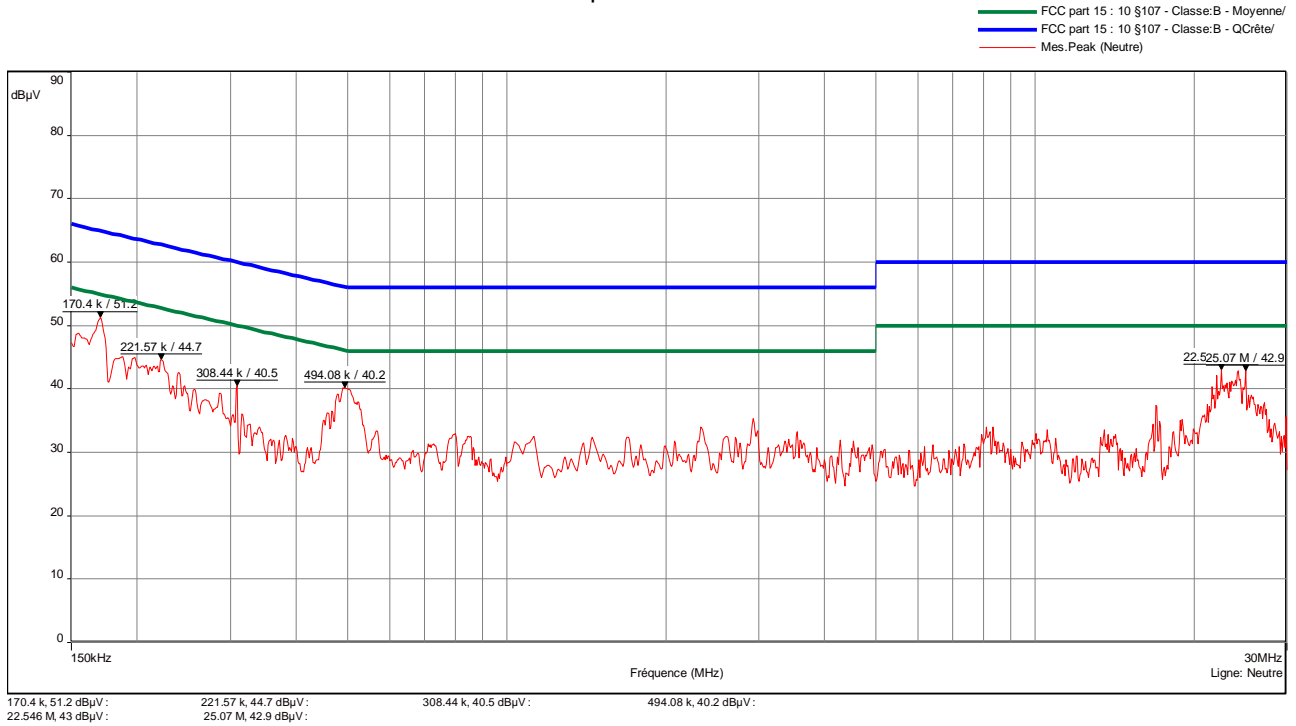
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 47

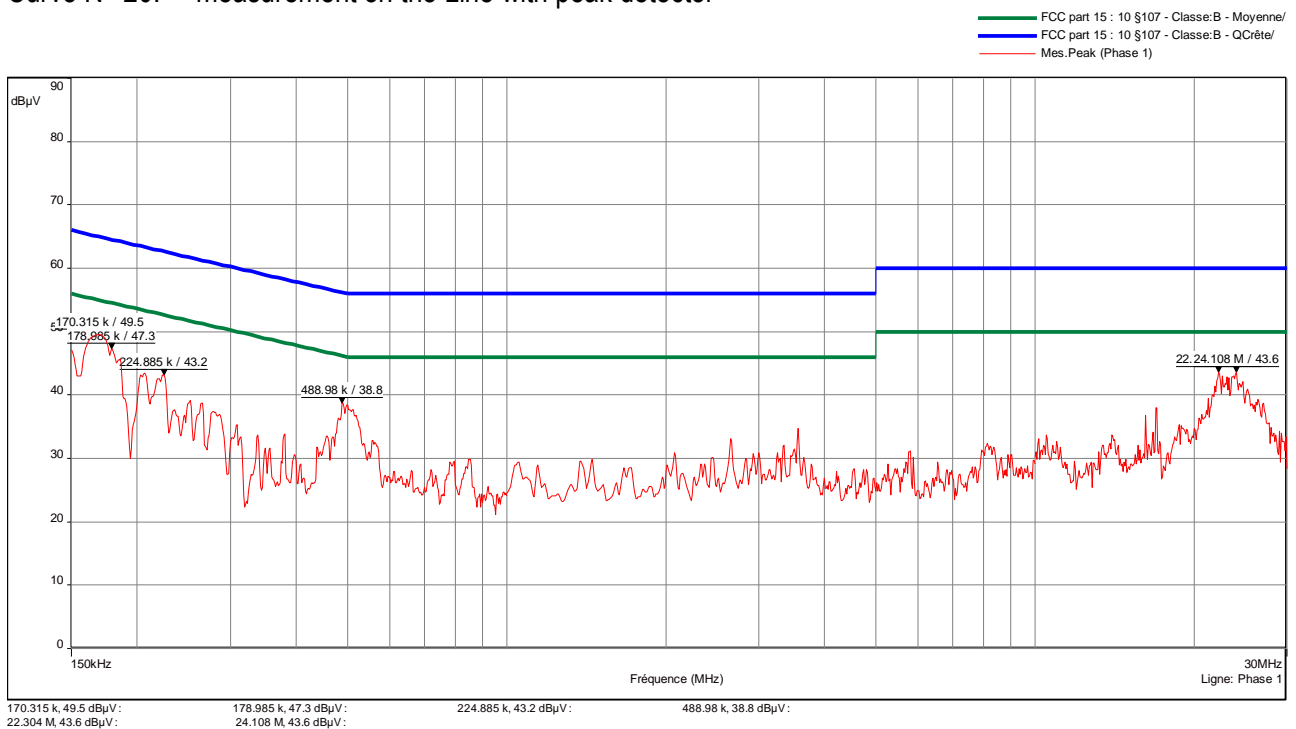
Sample N° 1: LoRa (Low channel) with SF7 + 2G 850MHz in transmission mode

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 19: measurement on the Neutral with peak detector

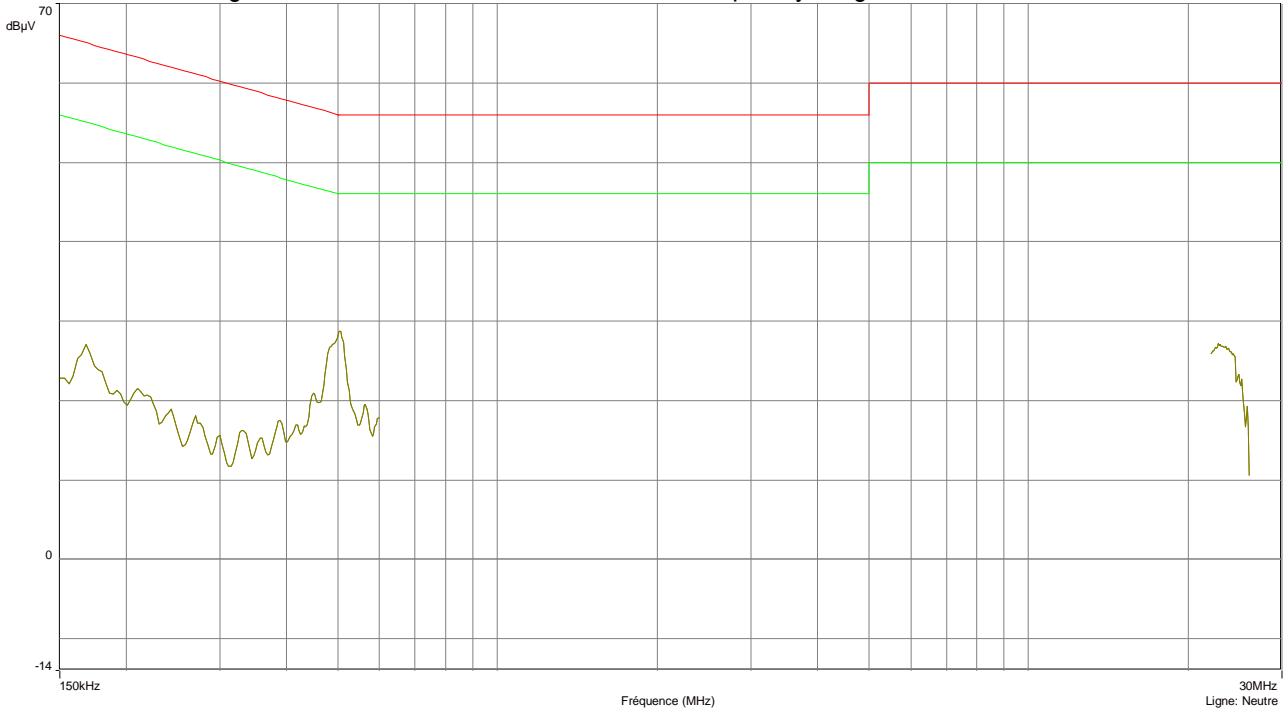


Curve N° 20: measurement on the Line with peak detector

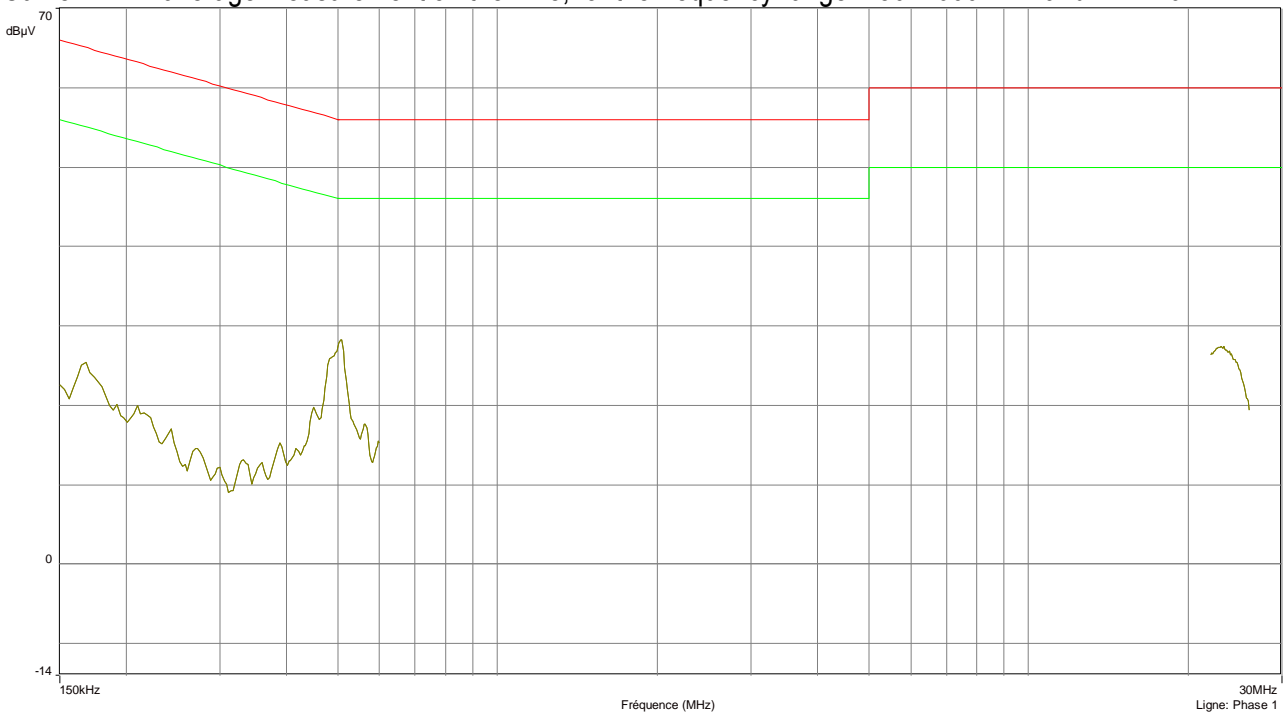


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 21: average measurement on the Neutral, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



Curve N° 22: average measurement on the Line, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



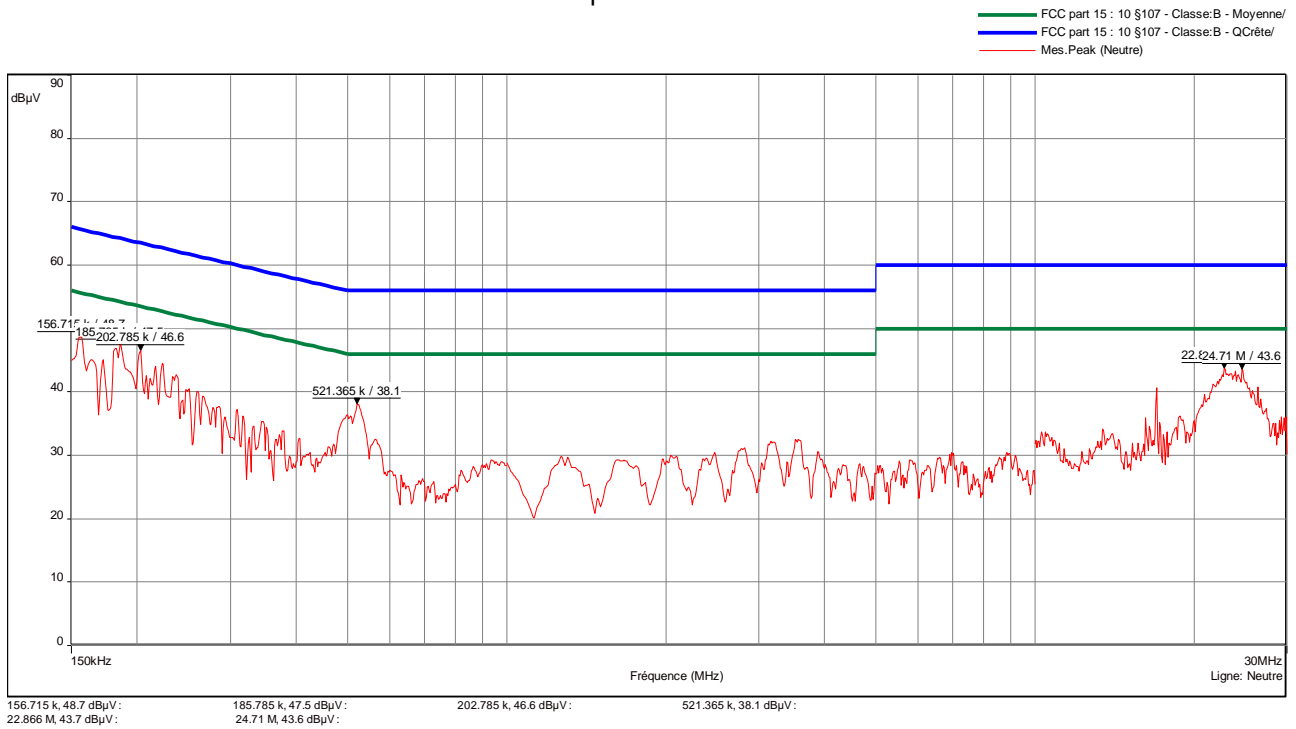
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 47

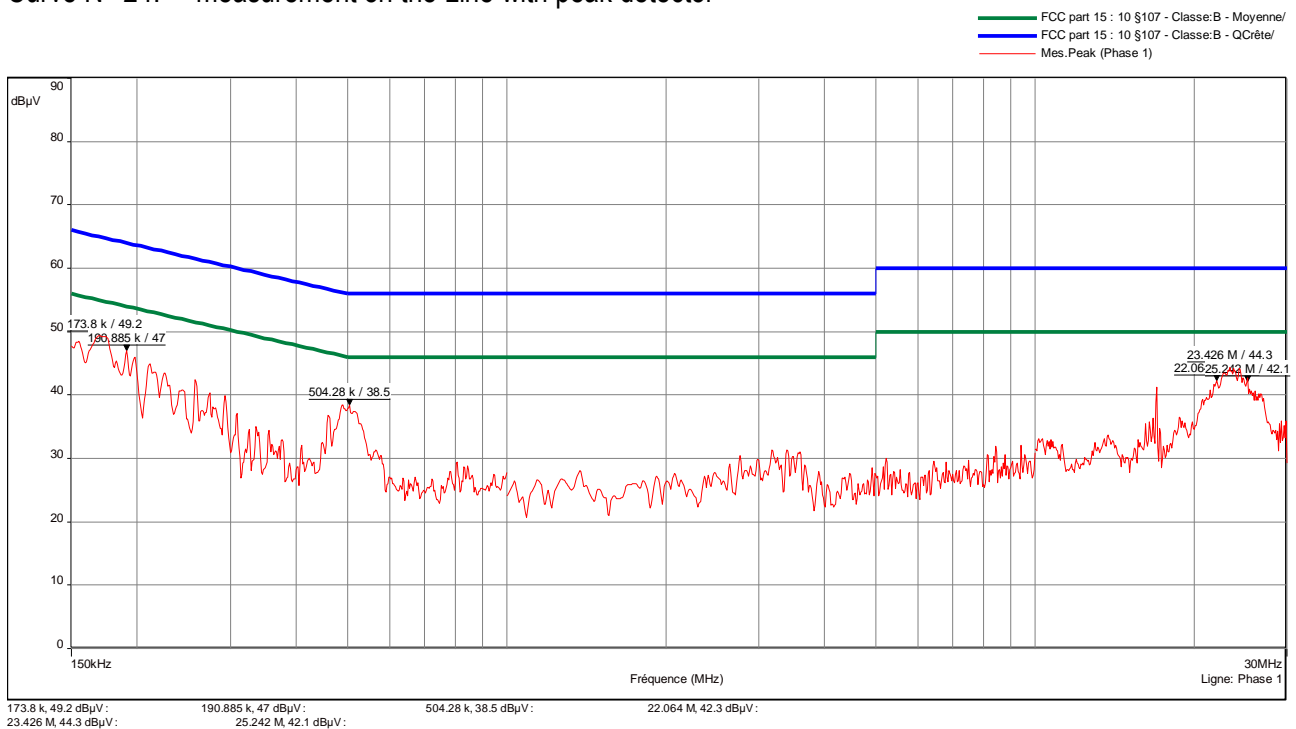
Sample N° 1: LoRa (Low channel) with SF7 + 2G 1900MHz in transmission mode

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 23: measurement on the Neutral with peak detector

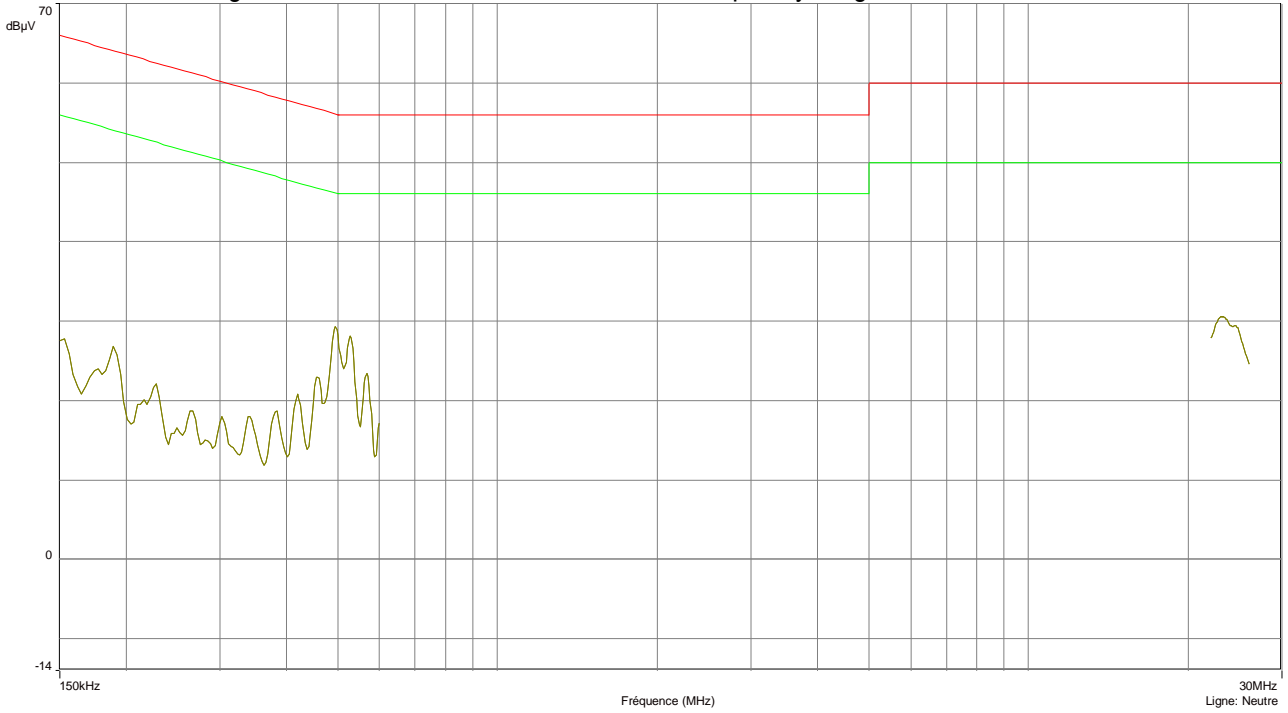


Curve N° 24: measurement on the Line with peak detector

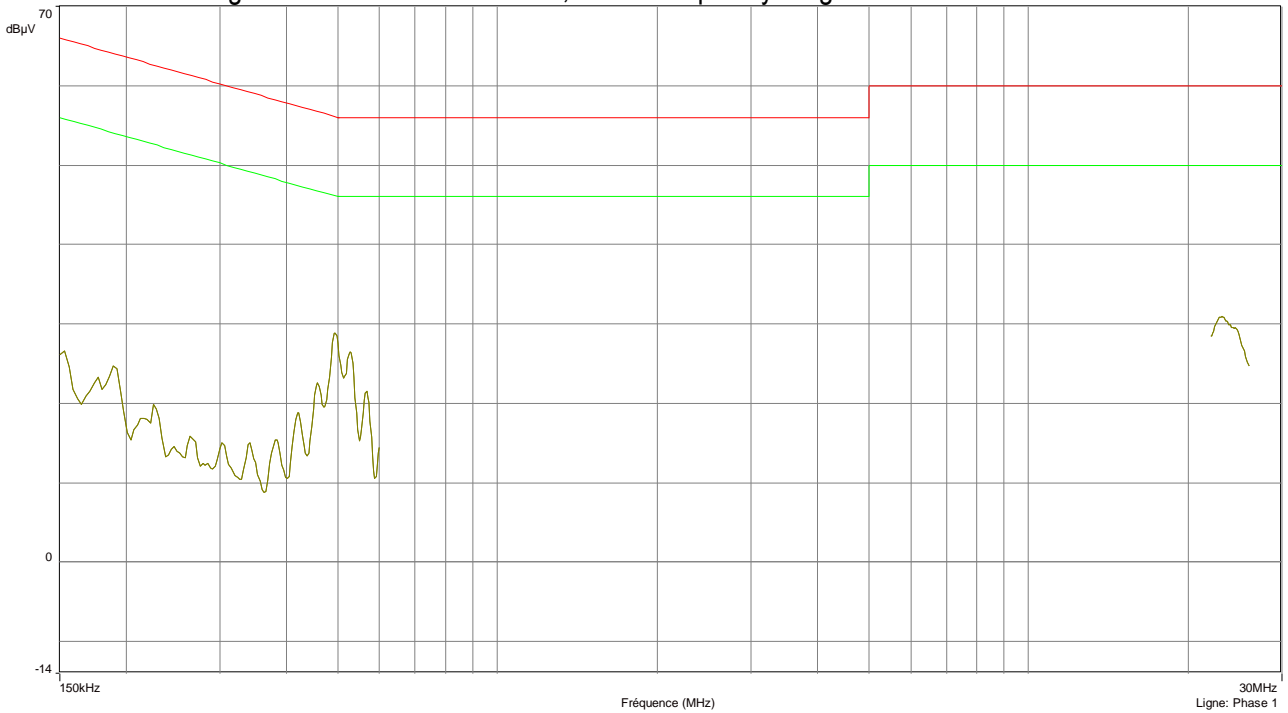


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 25: average measurement on the Neutral, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



Curve N° 26: average measurement on the Line, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



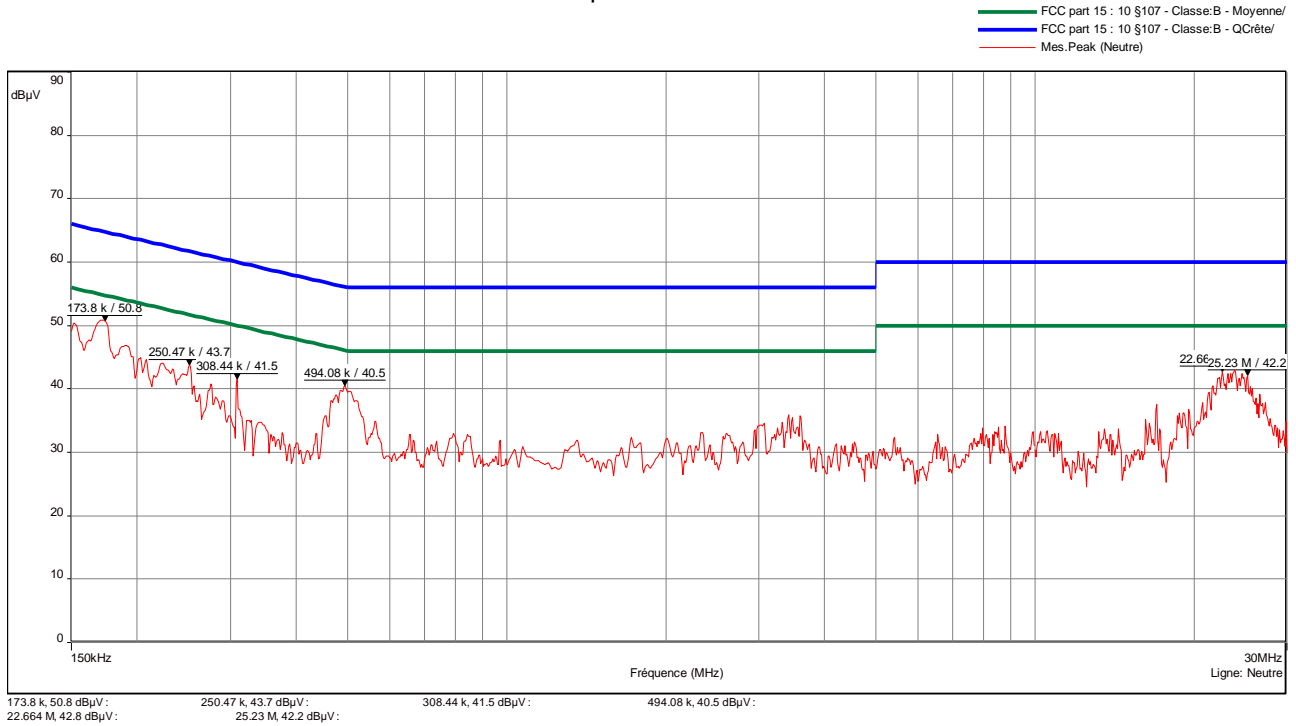
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 47

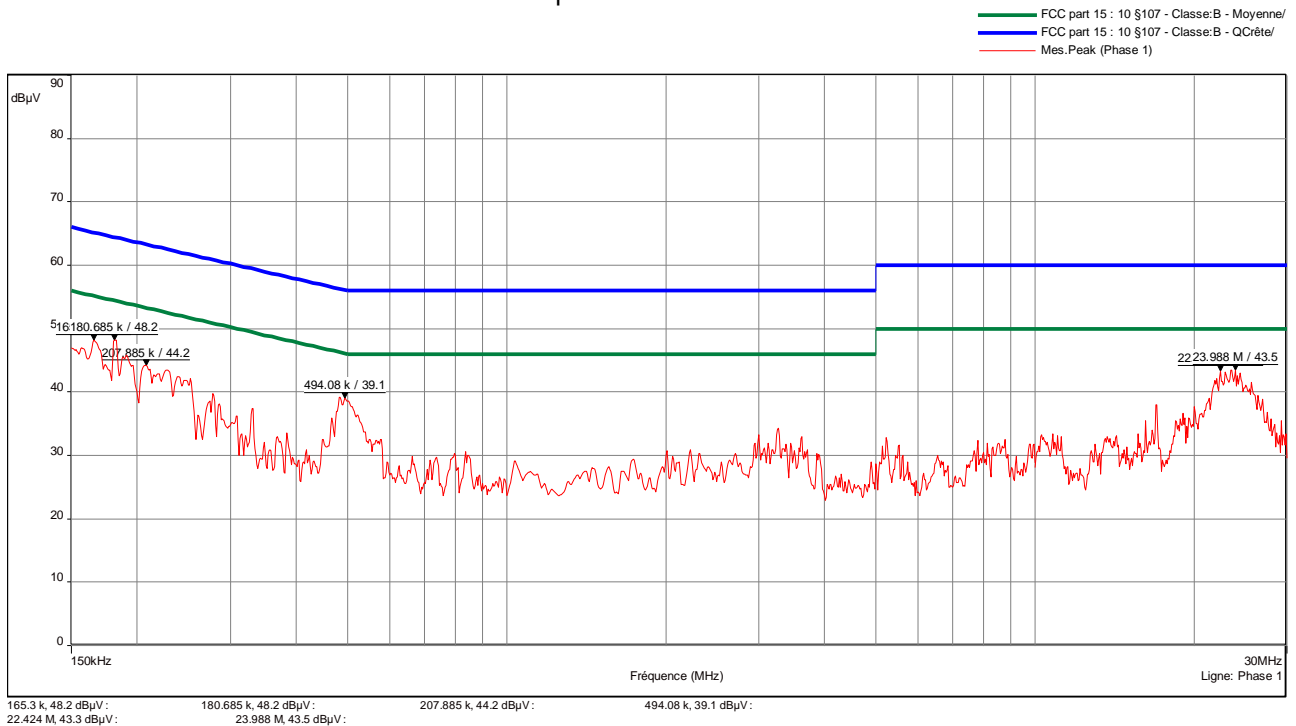
Sample N° 1: LoRa (Low channel) with SF12 + 2G 850MHz in transmission mode

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 27: measurement on the Neutral with peak detector

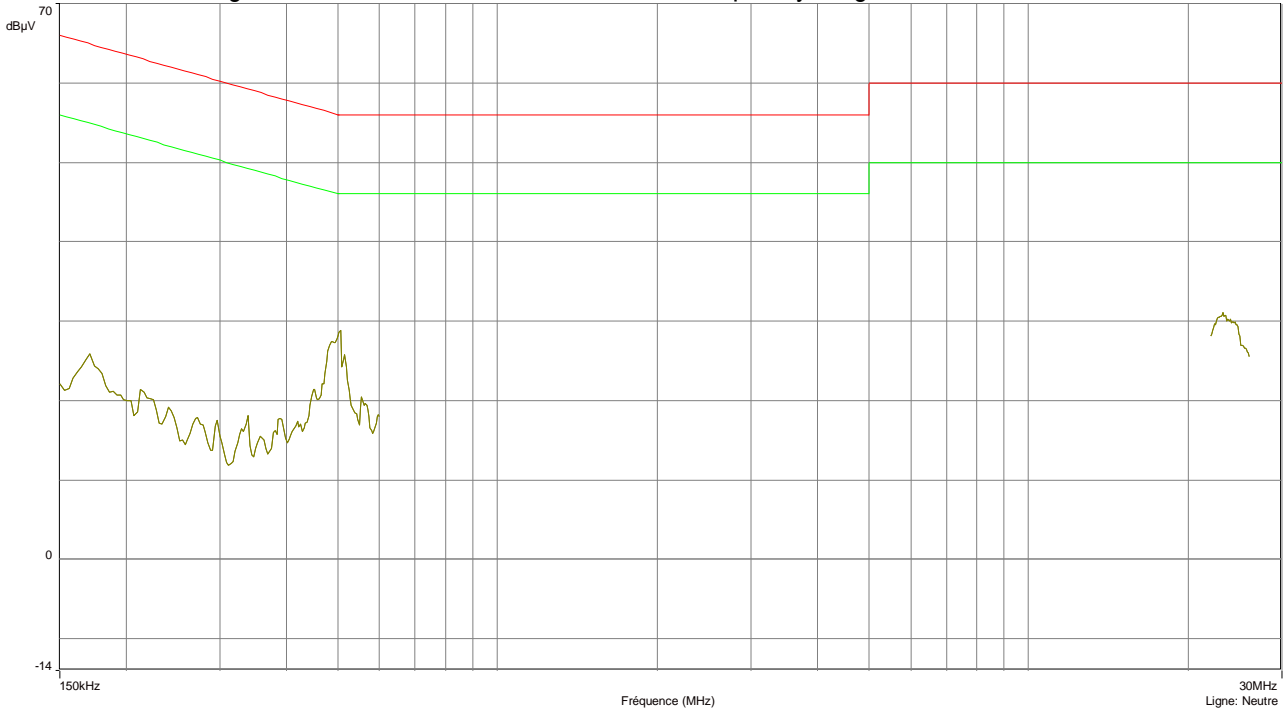


Curve N° 28: measurement on the Line with peak detector

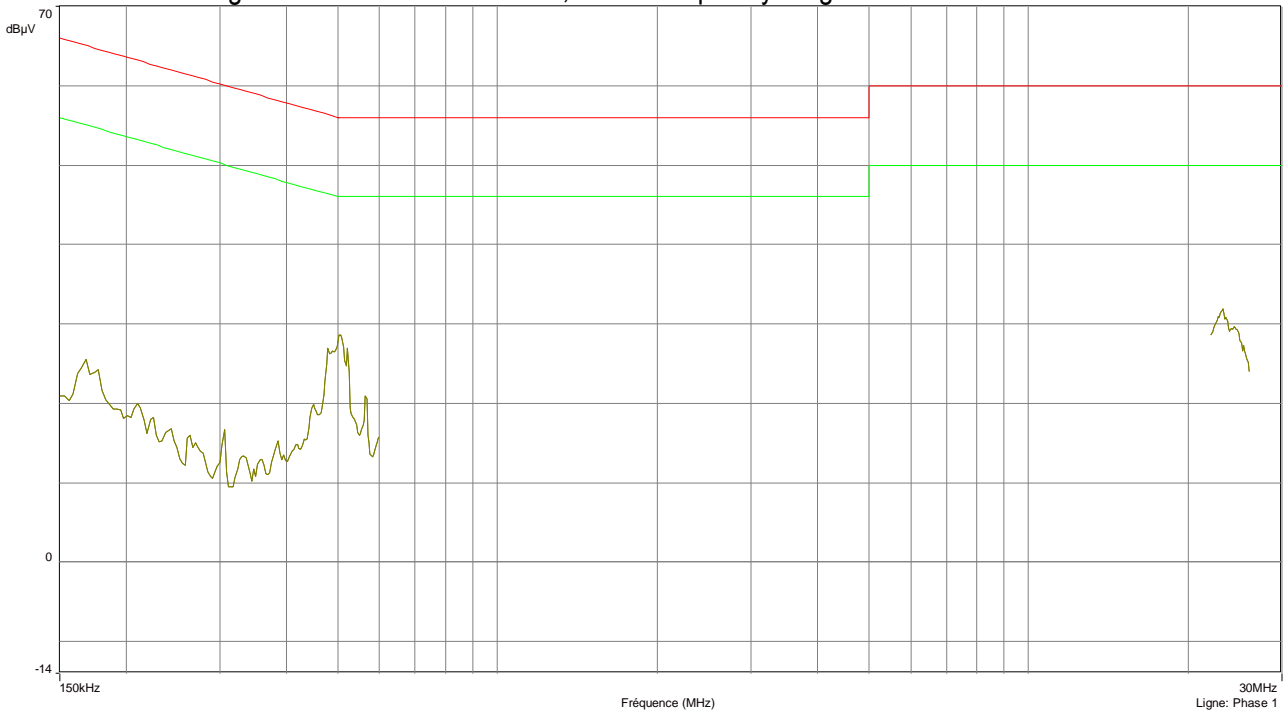


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 29: average measurement on the Neutral, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



Curve N° 30: average measurement on the Line, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



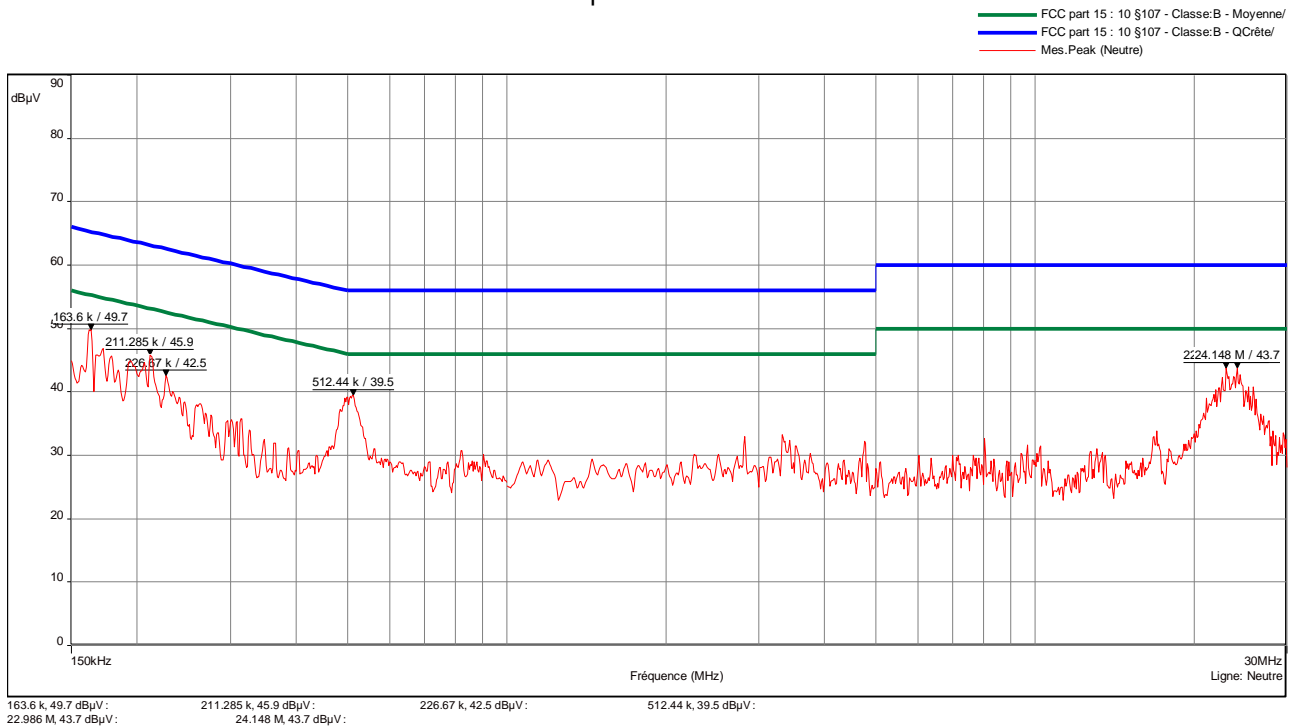
Results:

Ambient temperature (°C): 25
 Relative humidity (%): 47

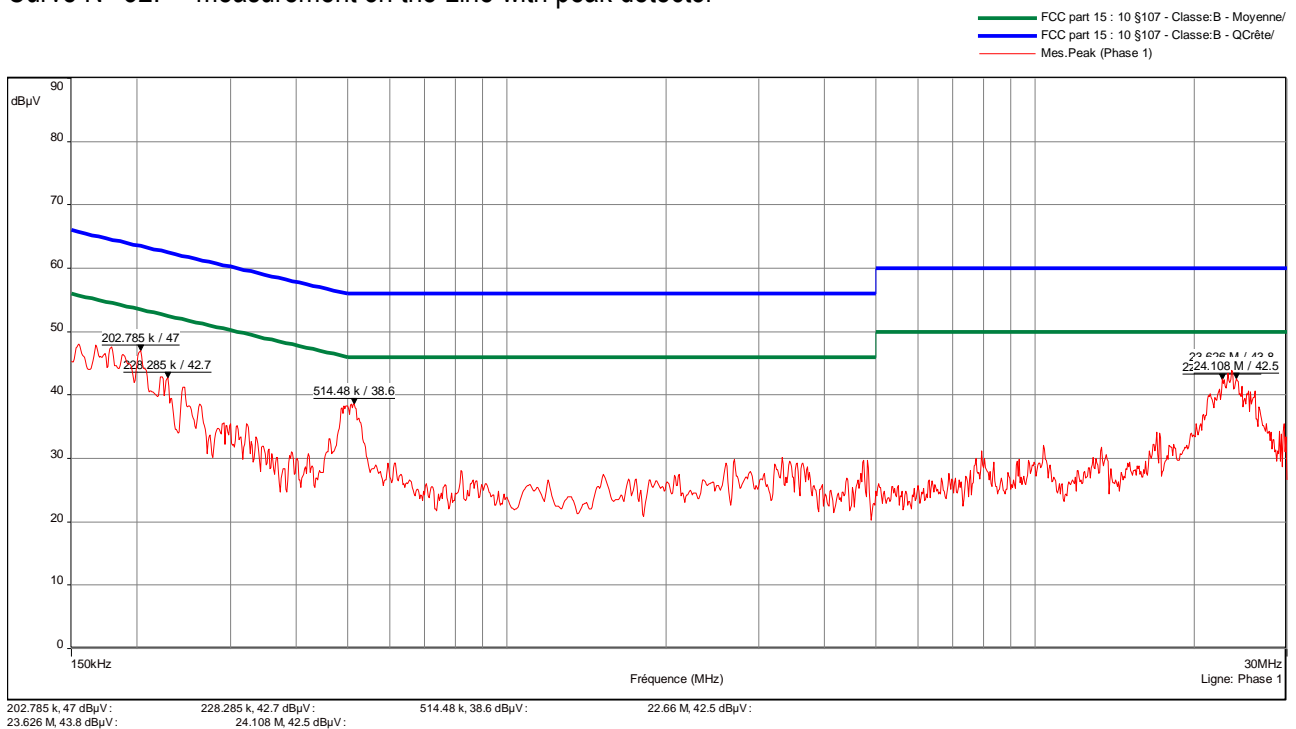
Sample N° 1: LoRa (Low channel) with SF12 + 2G 1900MHz in transmission mode

Measurement on the mains power supply: The measurement is first realized with Peak detector.

Curve N° 31: measurement on the Neutral with peak detector

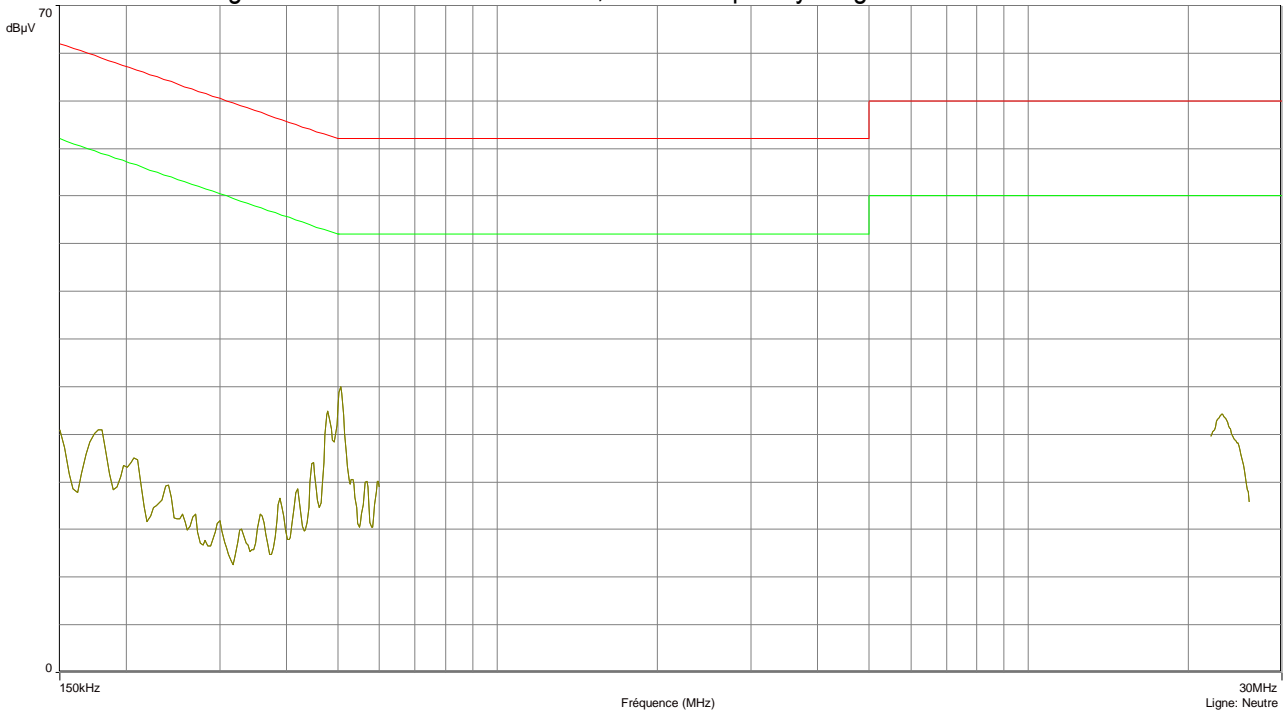


Curve N° 32: measurement on the Line with peak detector

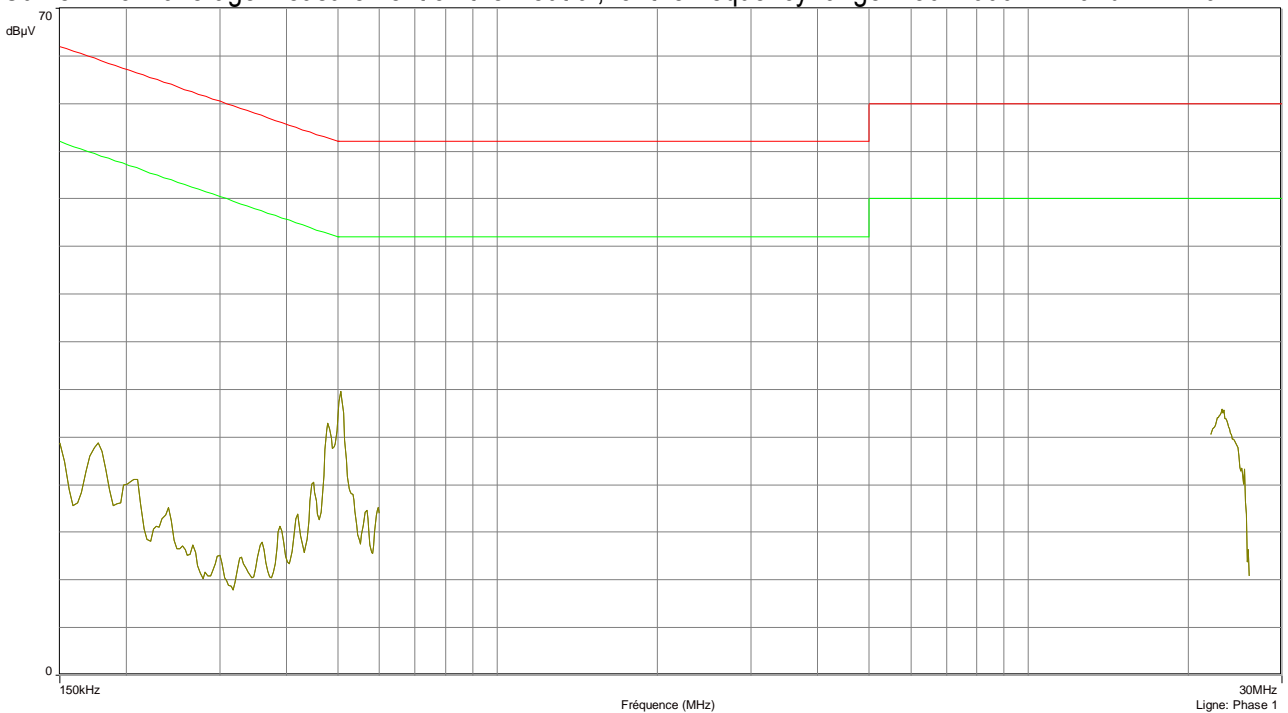


The frequencies which are not 6 dB under the Average limit are then analyzed with Average detector.

Curve N° 33: average measurement on the Neutral, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



Curve N° 34: average measurement on the Neutral, for the frequency range: 150 – 600 KHz and 22 – 26MHz.



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

Results:

Ambient temperature (°C): 23.7
 Relative humidity (%): 48

We used for power source an external power supply regulated to +24Vdc

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

Sample N° 1: With SF7

| Fundamental frequency (MHz) | Field Strength Level of fundamental (dB μ V/m) | Detector (Peak or Average) | Frequency of maximum Band-edges Emission (MHz) | Delta Marker (dB)* | Calculated Max Out-of-Band Emission Level (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
|-----------------------------|--|----------------------------|--|--------------------|--|----------------------|-------------|
| 923.3 | 130.14 | P | 901.99 | >50 | <80.14 | 110.14 | >30 |
| 927.5 | 129.79 | P | 928.02 | 20.60 | 109.19 | 109.79 | 0.6 |

Sample N° 1: With SF12

| Fundamental frequency (MHz) | Field Strength Level of fundamental (dB μ V/m) | Detector (Peak or Average) | Frequency of maximum Band-edges Emission (MHz) | Delta Marker (dB)* | Calculated Max Out-of-Band Emission Level (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
|-----------------------------|--|----------------------------|--|--------------------|--|----------------------|-------------|
| 923.3 | 130.13 | P | 901.99 | >50 | <80.13 | 110.13 | >30 |
| 927.5 | 129.82 | P | 928.01 | 32.17 | 90.65 | 109.82 | 19.17 |

* *Marker-Delta method*

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

Results:

Ambient temperature (°C): 23.7
 Relative humidity (%): 48

Power source:
 We used for power source a POE provided by the applicant.

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

Sample N° 1: With SF7

| 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) |
|-----------------------------|--|----------------------------|--|--------------------|--|----------------|-------------|
| 923.3 | 130.02 | P | 901.84 | 58.63 | 71.39 | 110.02 | 38.63 |
| 927.5 | 129.88 | P | 928.02 | 33.32 | 96.56 | 109.88 | 13.32 |

Sample N° 1: With SF12

| 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) |
|-----------------------------|--|----------------------------|--|--------------------|--|----------------|-------------|
| 923.3 | 130.00 | P | 901.87 | 57.72 | 72.28 | 110.00 | 37.72 |
| 927.5 | 129.87 | P | 928.01 | 34.28 | 95.59 | 109.87 | 14.28 |

* Marker-Delta method

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 measure is realized in conducted mode with a calibrated average power responding power meter.

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): 22.8
 Relative humidity (%): 49

Power source: External power supply regulated to +24Vdc (Solar panel)

Sample N° 1 Low Channel (SF7)

| | Conducted power (W) | Limit (W) |
|-------------------------|---------------------|-----------|
| Nominal supply voltage: | 0.778 | 1 |

Sample N° 1 Central Channel (SF7)

| | Conducted power (W) | Limit (W) |
|-------------------------|---------------------|-----------|
| Nominal supply voltage: | 0.750 | 1 |

Sample N° 1 High Channel (SF7)

| | Conducted power (W) | Limit (W) |
|-------------------------|---------------------|-----------|
| Nominal supply voltage: | 0.718 | 1 |

Sample N° 1 Low Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.776 | 1 |

Sample N° 1 Central Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.741 | 1 |

Sample N° 1 High Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.723 | 1 |

Power source: 48Vdc via POE

Ambient temperature (°C): 23.9
 Relative humidity (%): 49

Sample N° 1 Low Channel (SF7)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.757 | 1 |

Sample N° 1 Central Channel (SF7)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.750 | 1 |

Sample N° 1 High Channel (SF7)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.733 | 1 |

Sample N° 1 Low Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.753 | 1 |

Sample N° 1 Central Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.745 | 1 |

Sample N° 1 High Channel (SF12)

| | Conducted power (W) | Limit (W) |
|--------------------------------|----------------------------|------------------|
| Nominal supply voltage: | 0.731 | 1 |

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 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 10GHz (10th harmonic of the highest fundamental frequency)

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.

Results:

Ambient temperature (°C): 22
 Relative humidity (%): 48

Power source:

We used for power source a POE provided by the applicant.

Sample N° 1 Low Channel – SF7

| 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) |
|----------------------|--|---------------------------|---------------------|----------------------------------|--|-------------------------------------|--------------------------|----------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1846.5 | P | 150 | 320 | 100 | H | 38.4 | 109 | 70.6 |
| 2770.5* | P | 150 | — | 1000 | H | 43.1** | 74 | 30.9 |
| 3692.5* | P | 150 | — | 1000 | V | 45** | 74 | 29 |
| 4616* | P | 150 | — | 1000 | H | 48.5** | 74 | 25.5 |
| 5540 | P | 150 | 80 | 100 | H | 48.9 | 109 | 60.1 |
| 6463.6 | P | 150 | 180 | 100 | V | 58.3 | 109 | 50.7 |
| 7388.8* | P | 150 | 335 | 1000 | H | 55 | 74 | 19 |
| 7388.8* | Av | 150 | 335 | 1000 | H | 47.4 | 54 | 6.6 |
| 8308.4* | P | 150 | — | 1000 | V | 51** | 74 | 23 |

Sample N° 1 Central Channel – SF7

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1850.5 | P | 150 | 175 | 100 | V | 36.8 | 109 | 72.2 |
| 2775* | P | 150 | — | 1000 | V | 44.8** | 74 | 29.2 |
| 3700.5* | P | 150 | — | 1000 | V | 44.4** | 74 | 29.6 |
| 4625.5* | P | 150 | — | 1000 | H | 48.7** | 74 | 25.3 |
| 5550.5 | P | 150 | 210 | 100 | V | 46.9 | 109 | 62.1 |
| 6475.2 | P | 150 | 180 | 100 | V | 57 | 109 | 52 |
| 7403.2* | P | 150 | 0 | 1000 | H | 57.5 | 74 | 16.5 |
| 7403.2* | Av | 150 | 0 | 1000 | H | 48.7 | 54 | 5.3 |
| 8326.8* | P | 150 | — | 1000 | H | 51.7** | 74 | 22.3 |

Sample N° 1 High Channel – SF7

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1855 | P | 150 | 260 | 100 | V | 37.2 | 109 | 71.8 |
| 2782.5* | P | 150 | — | 1000 | H | 42.6** | 74 | 31.4 |
| 3711* | P | 150 | — | 1000 | V | 44.2** | 74 | 29.8 |
| 4637.5* | P | 150 | — | 1000 | H | 50.3** | 74 | 23.7 |
| 5565 | P | 150 | 0 | 100 | H | 48.1 | 109 | 60.9 |
| 6492.8 | P | 150 | 185 | 100 | V | 57.8 | 109 | 51.2 |
| 7418.8* | P | 150 | 10 | 1000 | V | 55 | 74 | 19 |
| 7418.8* | Av | 150 | 10 | 1000 | V | 47.8 | 54 | 6.2 |
| 8348.4* | P | 150 | — | 1000 | V | 49.9** | 74 | 24.1 |

Sample N° 1 Low Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1847 | P | 150 | 210 | 100 | H | 36.9 | 109 | 72.1 |
| 2771* | P | 150 | — | 1000 | H | 42.8** | 74 | 31.2 |
| 3693.5* | P | 150 | — | 1000 | V | 44.9** | 74 | 29.1 |
| 4616* | P | 150 | — | 1000 | H | 49.1** | 74 | 24.9 |
| 5539 | P | 150 | 25 | 100 | V | 47 | 109 | 62 |
| 6462.4 | P | 150 | 180 | 100 | V | 56.5 | 109 | 52.5 |
| 7388.8* | P | 150 | — | 1000 | H | 53.4** | 74 | 20.6 |
| 8311.2* | P | 150 | — | 1000 | V | 51.8** | 74 | 22.2 |

Sample N° 1 Central Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1850.5 | P | 150 | 240 | 100 | V | 35.8 | 109 | 73.2 |
| 2775* | P | 150 | — | 1000 | V | 42.7** | 74 | 31.3 |
| 3700.5* | P | 150 | — | 1000 | V | 44.2** | 74 | 29.8 |
| 4625.5* | P | 150 | — | 1000 | H | 49.1** | 74 | 24.9 |
| 5550.5 | P | 150 | 20 | 100 | H | 46.6 | 109 | 62.4 |
| 6475.2 | P | 150 | 170 | 100 | V | 57.1 | 109 | 51.9 |
| 7402.8* | P | 150 | 0 | 1000 | H | 54.2 | 74 | 19.8 |
| 7402.8* | Av | 150 | 0 | 1000 | H | 52.3 | 54 | 1.7 |
| 8325.6* | P | 150 | — | 1000 | V | 51.2** | 74 | 22.8 |

Sample N° 1 High Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1855 | P | 150 | 200 | 100 | V | 36.8 | 109 | 72.2 |
| 2782* | P | 150 | — | 1000 | H | 41.8** | 74 | 32.2 |
| 3711* | P | 150 | — | 1000 | H | 45** | 74 | 29 |
| 4638.5* | P | 150 | — | 1000 | H | 49.7** | 74 | 24.3 |
| 5565 | P | 150 | 335 | 100 | V | 45.9 | 109 | 63.1 |
| 6492.8 | P | 150 | 180 | 100 | V | 57 | 109 | 52 |
| 7421.6* | P | 150 | — | 1000 | H | 52.1** | 74 | 21.9 |
| 8348* | P | 150 | — | 1000 | H | 50.5** | 74 | 23.5 |

* restricted bands of operation in 15.205

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

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 129 dB μ V/m on low channel.

So the applicable limit is 109 dB μ V/m.

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

Results:

Ambient temperature (°C): 22
 Relative humidity (%): 48

Power source:

We used for power source an external power source regulated to +24Vdc to simulate a solar panel.

Sample N° 1 Low Channel – SF7

| 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) |
|----------------------|--|---------------------------|---------------------|----------------------------------|--|-------------------------------------|--------------------------|----------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1846.5 | P | 150 | 325 | 100 | H | 38.9 | 109 | 70.1 |
| 2769.5* | P | 150 | — | 1000 | H | 43.5** | 74 | 30.5 |
| 3693* | P | 150 | — | 1000 | V | 44.2** | 74 | 29.8 |
| 4616* | P | 150 | — | 1000 | H | 48** | 74 | 26 |
| 5540 | P | 150 | 75 | 100 | H | 49 | 109 | 60 |
| 6464 | P | 150 | 175 | 100 | V | 58.3 | 109 | 50.7 |
| 7388.4* | P | 150 | 5 | 1000 | V | 55.2 | 74 | 18.8 |
| 7388.4* | Av | 150 | 5 | 1000 | V | 47 | 54 | 7 |
| 8308.8* | P | 150 | — | 1000 | H | 52.6** | 74 | 21.4 |

Sample N° 1 Central Channel – SF7

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1850 | P | 150 | 330 | 100 | H | 38.7 | 109 | 70.3 |
| 2775* | P | 150 | — | 1000 | V | 42.5** | 74 | 31.5 |
| 3701* | P | 150 | — | 1000 | H | 44.1** | 74 | 29.9 |
| 4624.5* | P | 150 | — | 1000 | H | 49.1** | 74 | 24.9 |
| 5551 | P | 150 | 80 | 100 | H | 48.1 | 109 | 60.9 |
| 6476 | P | 150 | 165 | 100 | V | 58.2 | 109 | 50.8 |
| 7402.4* | P | 150 | — | 1000 | V | 53.9** | 74 | 20.1 |
| 8325.6* | P | 150 | — | 1000 | V | 52** | 74 | 22 |

Sample N° 1 High Channel – SF7

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1855 | P | 150 | 340 | 100 | H | 38.2 | 109 | 70.8 |
| 2783.5* | P | 150 | — | 1000 | H | 42.8** | 74 | 31.2 |
| 3710.5* | P | 150 | — | 1000 | H | 44.5** | 74 | 29.5 |
| 4639* | P | 150 | — | 1000 | H | 50.7** | 74 | 23.3 |
| 5565 | P | 150 | 65 | 100 | H | 48.3 | 109 | 60.7 |
| 6492.8 | P | 150 | 160 | 100 | V | 58.1 | 109 | 50.9 |
| 7418.8* | P | 150 | 10 | 1000 | V | 54.2 | 74 | 19.8 |
| 7418.8* | Av | 150 | 10 | 1000 | V | 48.1 | 54 | 5.9 |
| 8346.8* | P | 150 | — | 1000 | H | 51.8** | 74 | 22.2 |

Sample N° 1 Low Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1846.5 | P | 150 | 330 | 100 | H | 38.8 | 109 | 70.2 |
| 2769.5* | P | 150 | — | 1000 | H | 43.5** | 74 | 30.5 |
| 3693.5* | P | 150 | — | 1000 | H | 45.8** | 74 | 28.2 |
| 4616* | P | 150 | — | 1000 | H | 48.3** | 74 | 25.7 |
| 5539 | P | 150 | 70 | 100 | H | 48.7 | 109 | 60.3 |
| 6464 | P | 150 | 180 | 100 | V | 58.5 | 109 | 50.5 |
| 7388.4* | P | 150 | — | 1000 | V | 53.3** | 74 | 20.7 |
| 8311.2* | P | 150 | — | 1000 | H | 51.7** | 74 | 22.3 |

Sample N° 1 Central Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1850.5 | P | 150 | 330 | 100 | H | 38.7 | 109 | 70.3 |
| 2776* | P | 150 | — | 1000 | H | 43** | 74 | 31 |
| 3701* | P | 150 | — | 1000 | H | 44.7** | 74 | 29.3 |
| 4627* | P | 150 | — | 1000 | H | 49.7** | 74 | 24.3 |
| 5550.5 | P | 150 | 80 | 100 | H | 49.3 | 109 | 59.7 |
| 6475.6 | P | 150 | 160 | 100 | V | 58.6 | 109 | 50.4 |
| 7399.2* | P | 150 | 20 | 1000 | V | 54.9 | 74 | 19.1 |
| 7399.2* | Av | 150 | 20 | 1000 | V | 52.5 | 54 | 1.5 |
| 8327.2* | P | 150 | — | 1000 | V | 51.9** | 109 | 57.1 |

Sample N° 1 High Channel – SF12

| 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) |
|-------------------|--|---------------------|------------------|----------------------------|--|-------------------------------|-----------------------|-------------|
| 30 | QP | 108 | 255 | 120 | V | 24.7 | 40 | 15.3 |
| 40 | QP | 100 | 346 | 120 | V | 23.8 | 40 | 16.2 |
| 61.4 | QP | 100 | 146 | 120 | V | 32.9 | 40 | 7.1 |
| 400 | QP | 178 | 137 | 120 | V | 27.4 | 46 | 18.6 |
| 480 | QP | 400 | 37 | 120 | H | 38.2 | 46 | 7.8 |
| 532 | QP | 300 | 150 | 120 | H | 46 | 46 | 0 |
| 666 | QP | 126 | 0 | 120 | H | 31.4 | 46 | 14.6 |
| 1855 | P | 150 | 320 | 100 | H | 38.5 | 109 | 70.5 |
| 2782.5* | P | 150 | — | 1000 | H | 42.9** | 74 | 31.1 |
| 3711* | P | 150 | — | 1000 | H | 45.2** | 74 | 28.8 |
| 4639* | P | 150 | — | 1000 | H | 49** | 74 | 25 |
| 5565 | P | 150 | 80 | 100 | H | 49.9 | 109 | 59.1 |
| 6492.8 | P | 150 | 350 | 100 | H | 59.2 | 109 | 49.8 |
| 7421.6* | P | 150 | 320 | 1000 | H | 54.1 | 74 | 19.9 |
| 7421.6* | Av | 150 | 320 | 1000 | H | 49.8 | 54 | 4.2 |
| 8348* | P | 150 | — | 1000 | V | 50.7** | 74 | 23.3 |

* restricted bands of operation in 15.205

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

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 129 dB μ V/m on low channel.

So the applicable limit is 109 dB μ V/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. PEAK POWER DENSITY

Standard: FCC Part 15

Test procedure: paragraph 15.247 (e)

Test set up:

We used the same method of the peak output power measurement, but the equipment under test power level is recorded with the spectrum analyzer.

Resolution bandwidth: 3 kHz

Video bandwidth: 10 kHz

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): 23.6
 Relative humidity (%): 48

Power source:

We used for power source an external power source regulated to +24Vdc to simulate a solar panel.

Sample N° 1 Low Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 923.3 MHz |
| Normal test conditions | +7.98 dBm |
| Limits | +8 dBm |

Sample N° 1 Central Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 925.1 MHz |
| Normal test conditions | +7.80 dBm |
| Limits | +8 dBm |

Sample N° 1 High Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 927.5 MHz |
| Normal test conditions | +7.69 dBm |
| Limits | +8 dBm |

Sample N° 1 Low Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 923.3 MHz |
| Normal test conditions | -16.87 dBm |
| Limits | +8 dBm |

Sample N° 1 Central Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 925.1 MHz |
| Normal test conditions | -15.98 dBm |
| Limits | +8 dBm |

Sample N° 1 High Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 927.5 MHz |
| Normal test conditions | -16.97 dBm |
| Limits | +8 dBm |

Results:

Ambient temperature (°C): 23.9
 Relative humidity (%): 49

Power source:

We used for power source a POE provided by the applicant.

Sample N° 1 Low Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 923.3 MHz |
| Normal test conditions | +7.99 dBm |
| Limits | +8 dBm |

Sample N° 1 Central Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 925.1 MHz |
| Normal test conditions | +7.61 dBm |
| Limits | +8 dBm |

Sample N° 1 High Channel – SF7

| | |
|-------------------------------|---|
| | Peak power density at frequency: 927.5 MHz |
| Normal test conditions | +7.54 dBm |
| Limits | +8 dBm |

Sample N° 1 Low Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 923.3 MHz |
| Normal test conditions | -16.71 dBm |
| Limits | +8 dBm |

Sample N° 1 Central Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 925.1 MHz |
| Normal test conditions | -16.04 dBm |
| Limits | +8 dBm |

Sample N° 1 High Channel – SF12

| | |
|-------------------------------|---|
| | Peak power density at frequency: 927.5 MHz |
| Normal test conditions | -15.87 dBm |
| Limits | +8 dBm |

Test conclusion:

RESPECTED STANDARD

□□□ End of report, 7 annexes to be forwarded □□□

APPENDIX 1: Photos of the equipment under test

CONFIDENTIAL

APPENDIX 2: Test set up

CONFIDENTIAL

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 ESI7 | Rohde & Schwarz | 8707 |
| Radiocommunication analyser CMU200 | Rohde & Schwarz | 11684 |
| LISN 1600 | Thurbly Thandar Instruments | 8719 |
| High-pass filter EZ-25 | Rohde & Schwarz | 8635 |
| Absorber sheath current | Emitech | 10651 |
| Power source 1251RP | California instruments | 8508 |
| Multimeter IDM106N | ISOTECH | 8676 |
| Meteo station | HUGER | 8671 |
| Software | BAT-EMC V3.6.0.32 | 0000 |

Radiated emission limits; general requirements

| 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 |
| Radiocommunication analyser CMU200 | Rohde & Schwarz | 11684 |
| 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 |
| Low-noise amplifier 8447D | Hewlett Packard | 8511 |
| Low-noise amplifier C020180F-4B1 | Microwave DB | 1922 |
| Power source 1251RP | California instruments | 8508 |
| Power source FTN 2515B | Fontaine | 8775 |
| Multimeter IDM106N | ISOTECH | 8676 |
| 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 |
| Satellite synchronized frequency standard GPS8 | ACQUISYS | 8896 |
| Spectrum Analyzer FSP40 | Rohde & Schwarz | 4088 |
| Power Meter NRVS | Rohde & Schwarz | 8702 |
| Sensor VRV-Z52 | Rohde & Schwarz | 8742 |
| Attenuator 10dB | Midwest Microwave | 8548 |
| Power source 1251RP | California instruments | 8508 |
| Power source FTN 2515B | Fontaine | 8775 |
| Multimeter IDM106N | ISOTECH | 8676 |
| Meteo station WS-9232 | La Crosse Technology | 8750 |
| Software | GPIBShot V2.4 | - |

Maximum Peak Output Power and Peak Power Density

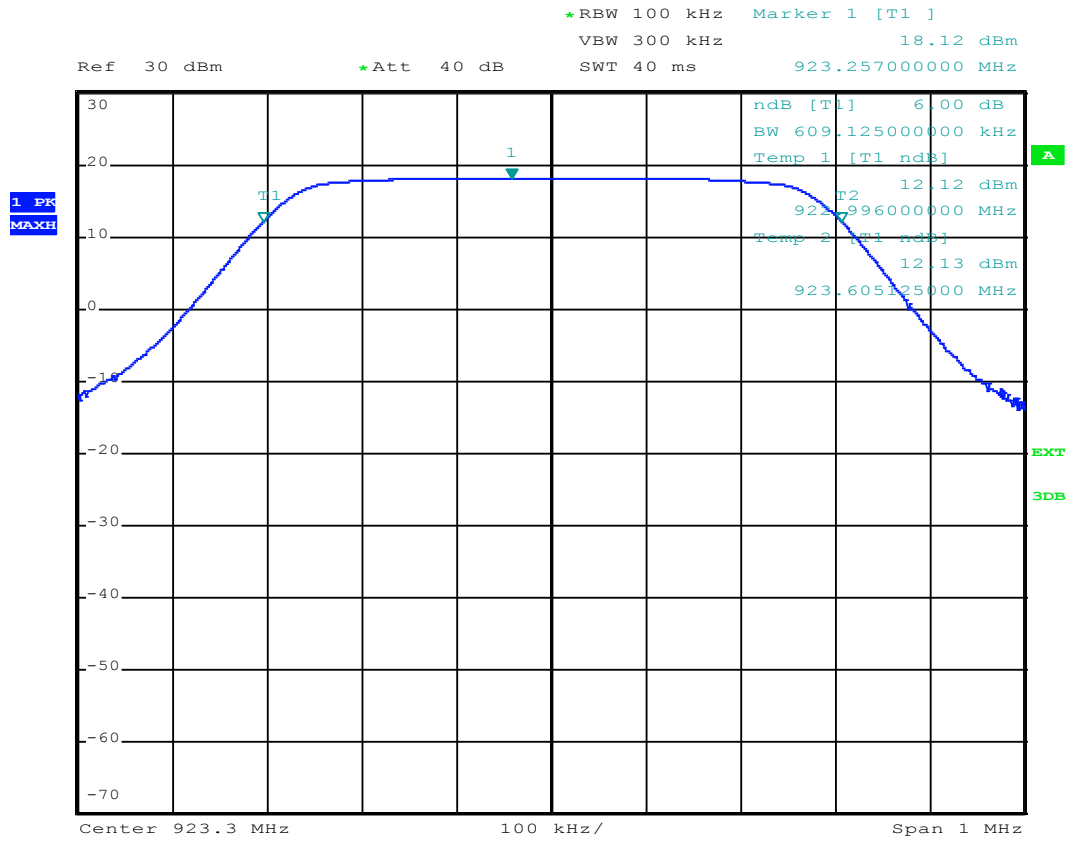
| TYPE | MANUFACTURER | EMITECH NUMBER |
|--|------------------------|----------------|
| Outside room Hors cage | Emitech | 8893 |
| Satellite synchronized frequency standard GPS8 | ACQUISYS | 8896 |
| Spectrum Analyzer FSP40 | Rohde & Schwarz | 4088 |
| Power Meter NRVS | Rohde & Schwarz | 8702 |
| Sensor VRV-Z52 | Rohde & Schwarz | 8742 |
| Attenuator 10dB | Midwest Microwave | 8548 |
| Power source 1251RP | California instruments | 8508 |
| Power source FTN 2515B | Fontaine | 8775 |
| Multimeter IDM106N | ISOTECH | 8676 |
| Meteo station WS-9232 | La Crosse Technology | 8750 |
| Software | GPIBShot V2.4 | - |

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 |
| Low-noise amplifier 8447D | Hewlett Packard | 8511 |
| Low-noise amplifier C020180F-4B1 | Microwave DB | 1922 |
| Notch filter 500-1000MHz | K&L Microwave | 8972 |
| Low pass filter L250-6CN | BL Microwave | 10390 |
| High Pass Filter HP12/1200-5AA | Filtek | 7310 |
| Power source 1251RP | California instruments | 8508 |
| Power source FTN 2515B | Fontaine | 8775 |
| Multimeter IDM106N | ISOTECH | 8676 |
| 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 |

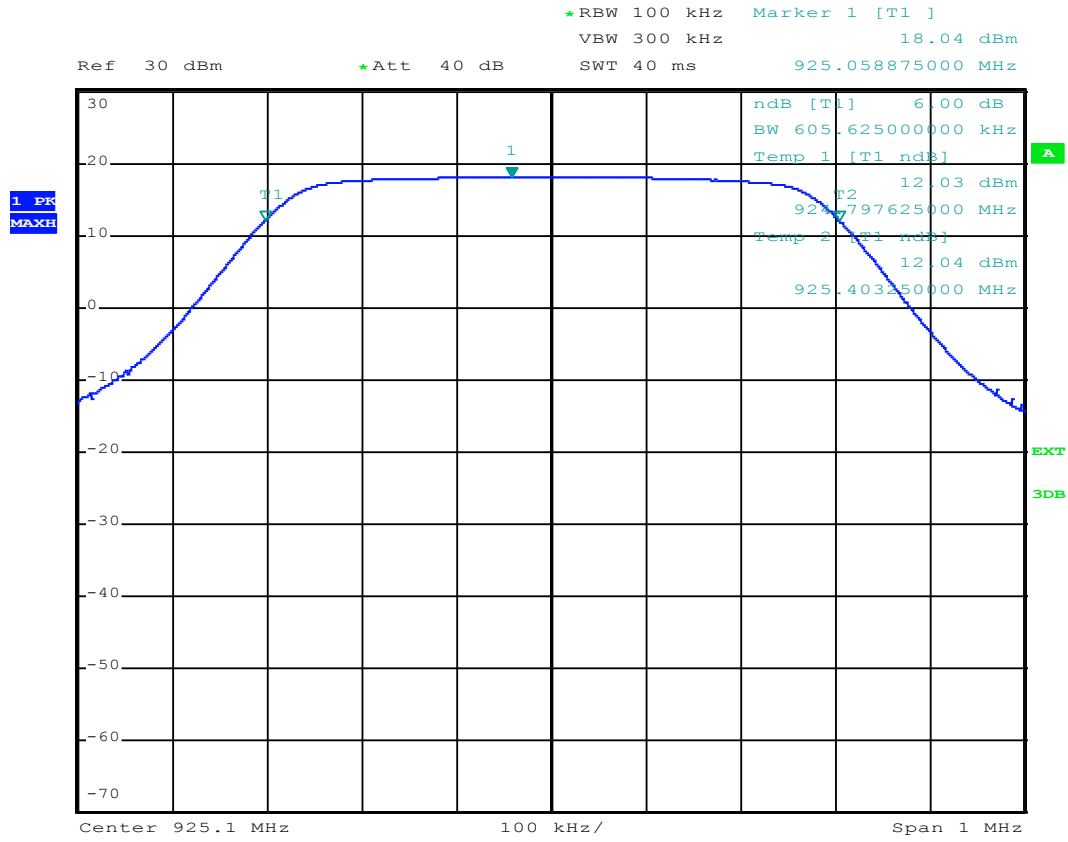
APPENDIX 4: 6 dB bandwidth

Low Channel – DC supply – SF7



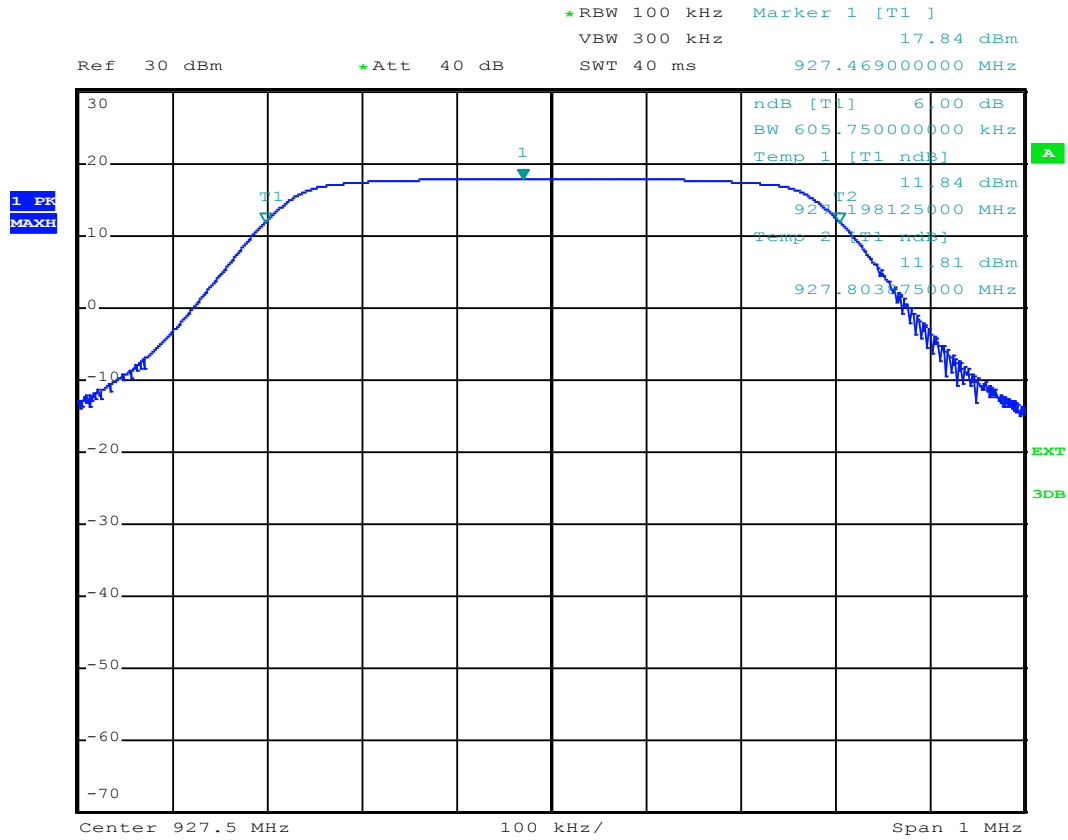
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Central Channel – DC supply – SF7



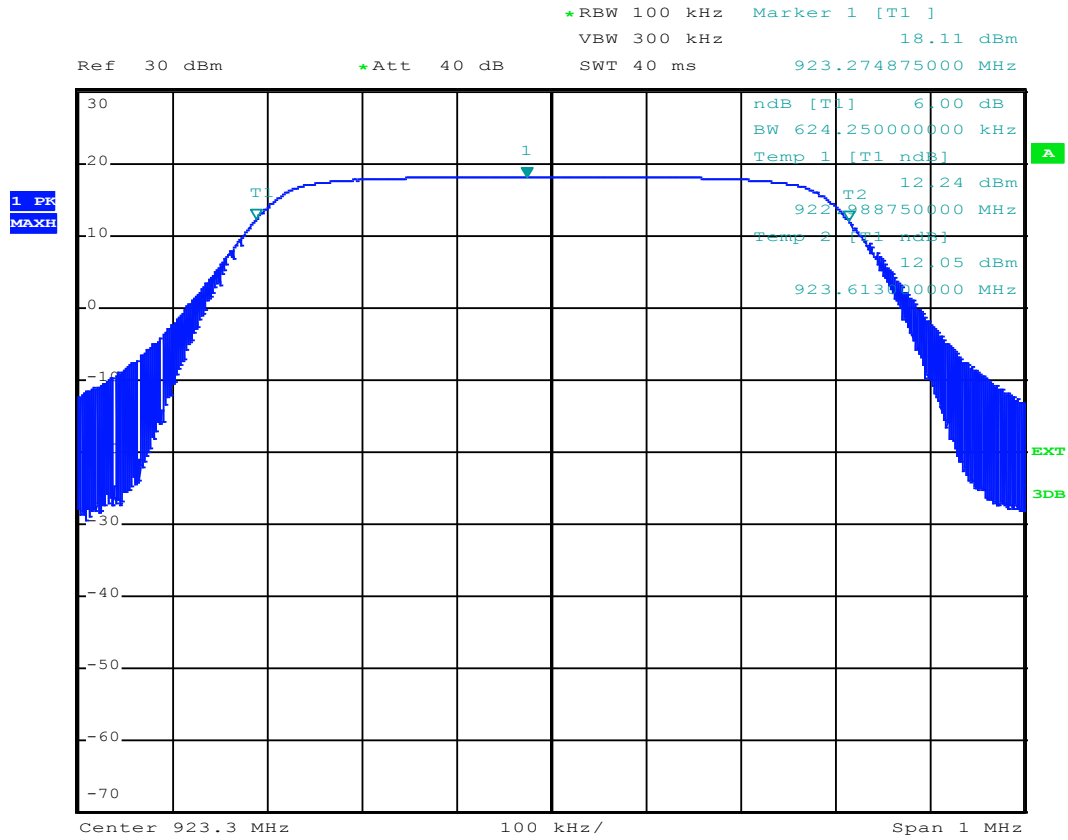
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High Channel – DC supply – SF7



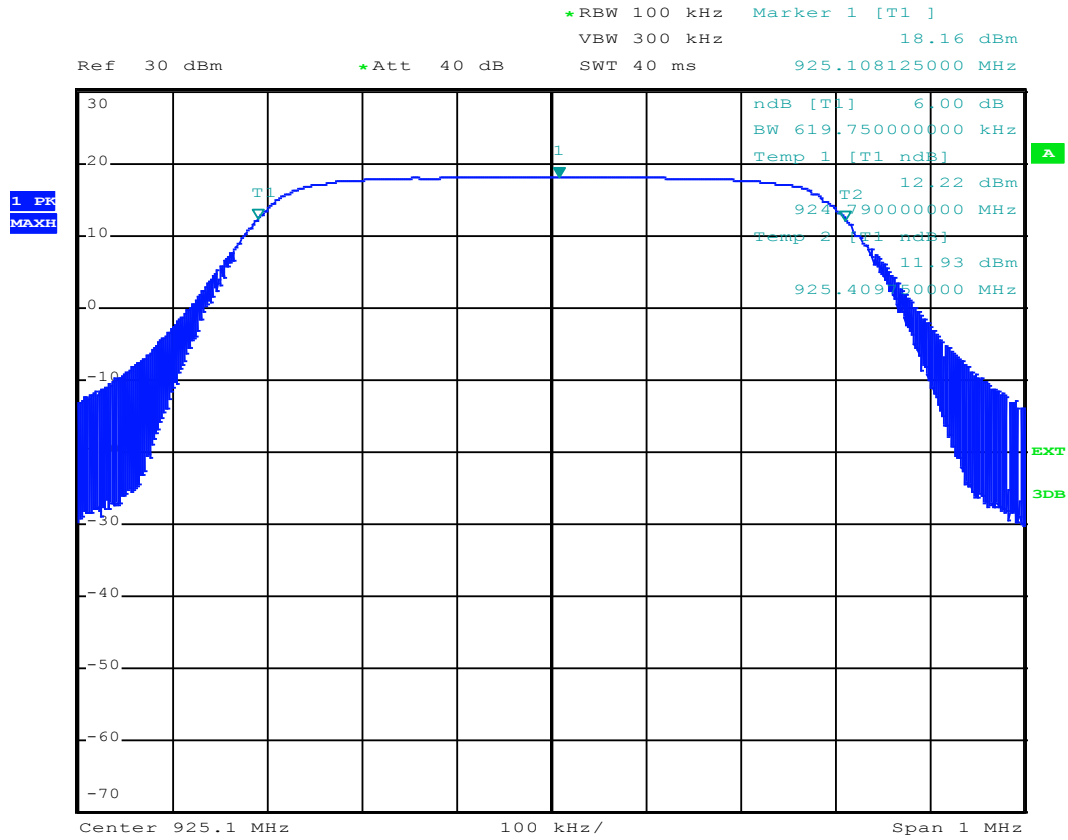
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Low Channel – DC supply – SF12



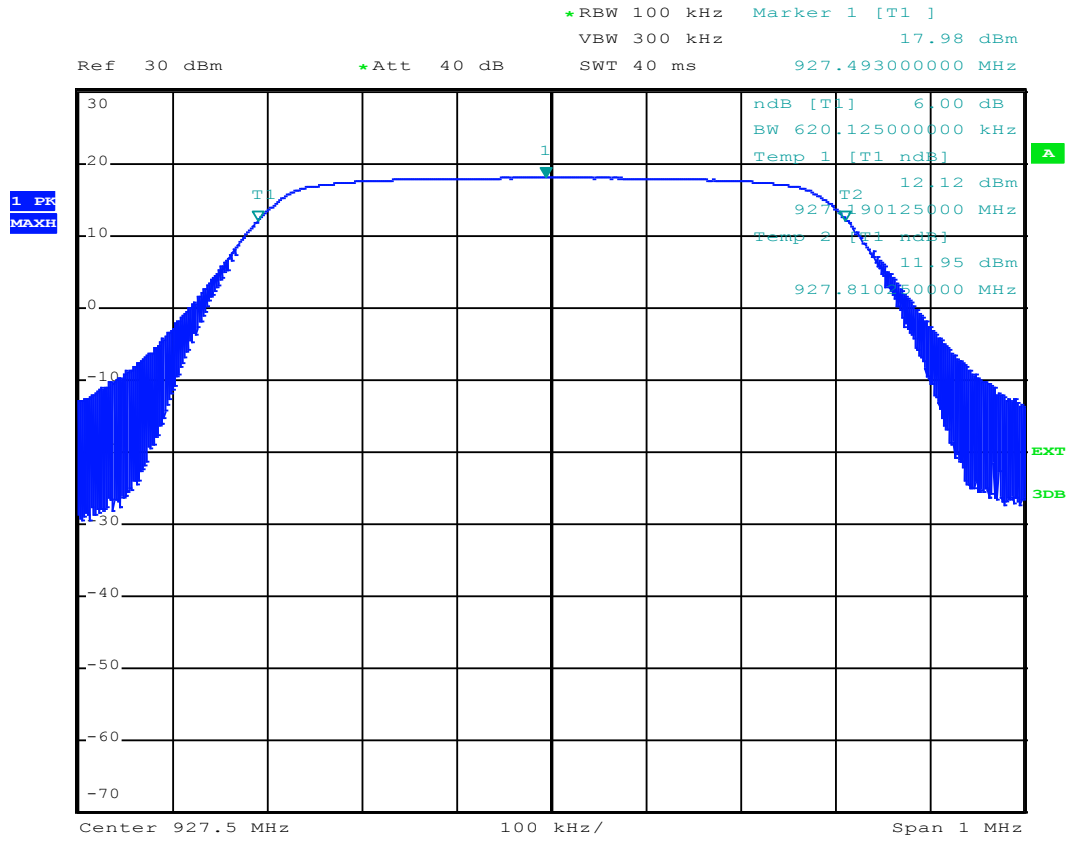
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Central Channel – DC supply – SF12



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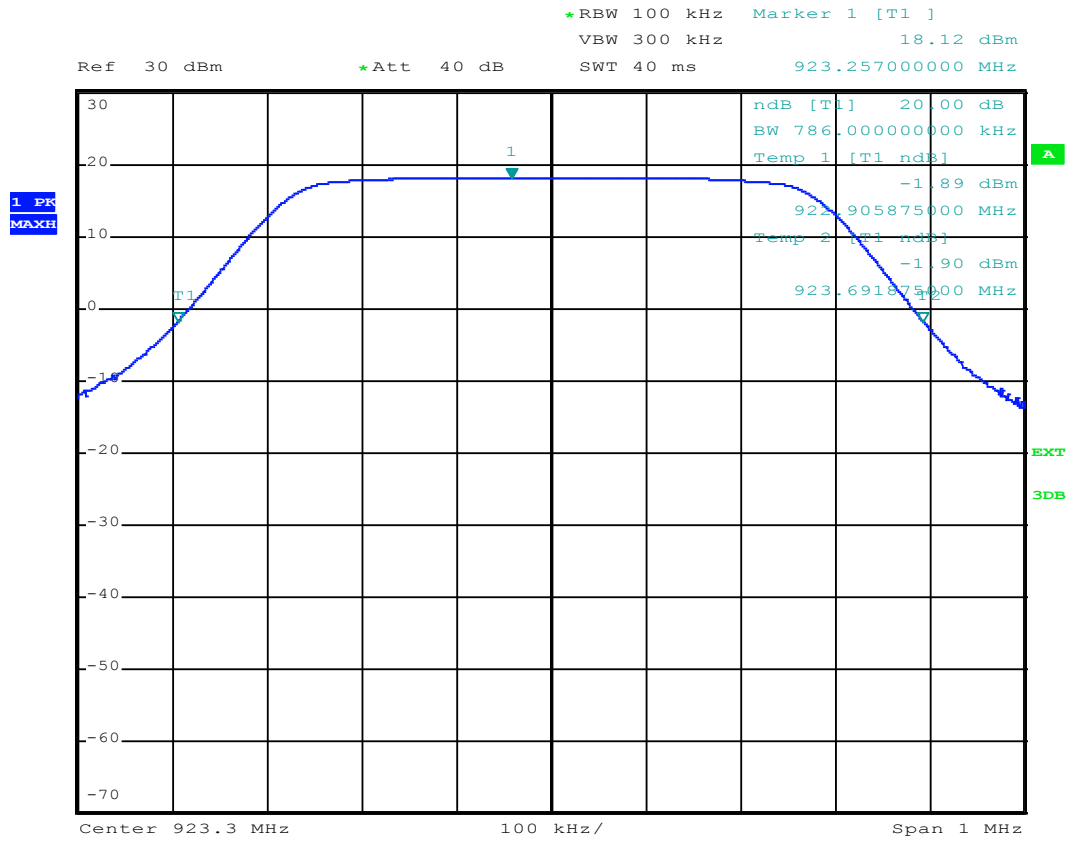
High Channel – DC supply – SF12



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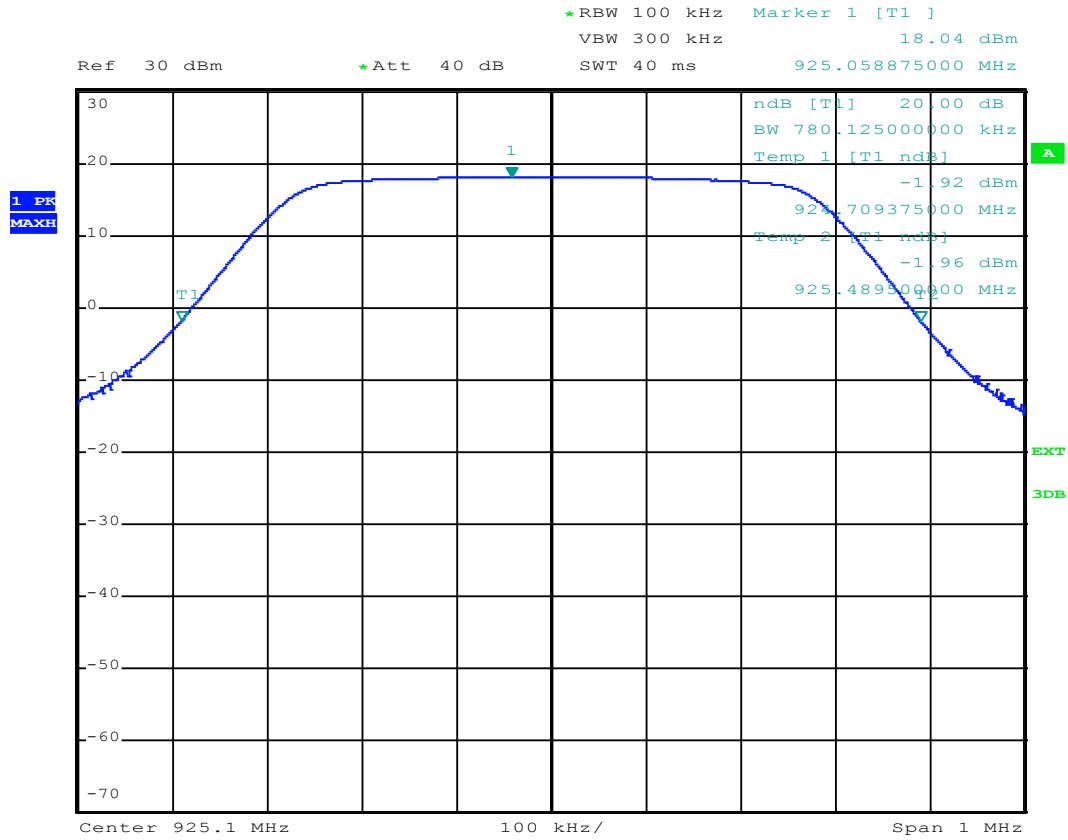
APPENDIX 5: 20 dB bandwidth

Low Channel – DC supply – SF7



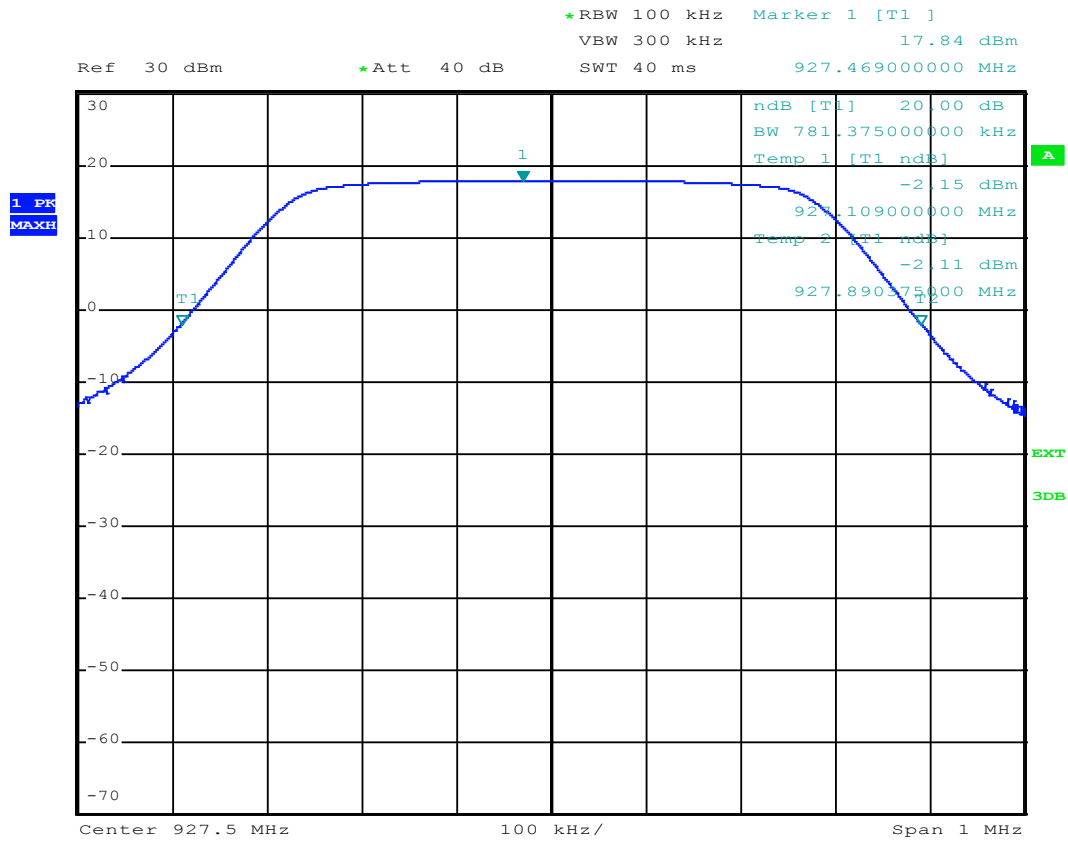
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Central Channel – DC supply – SF7



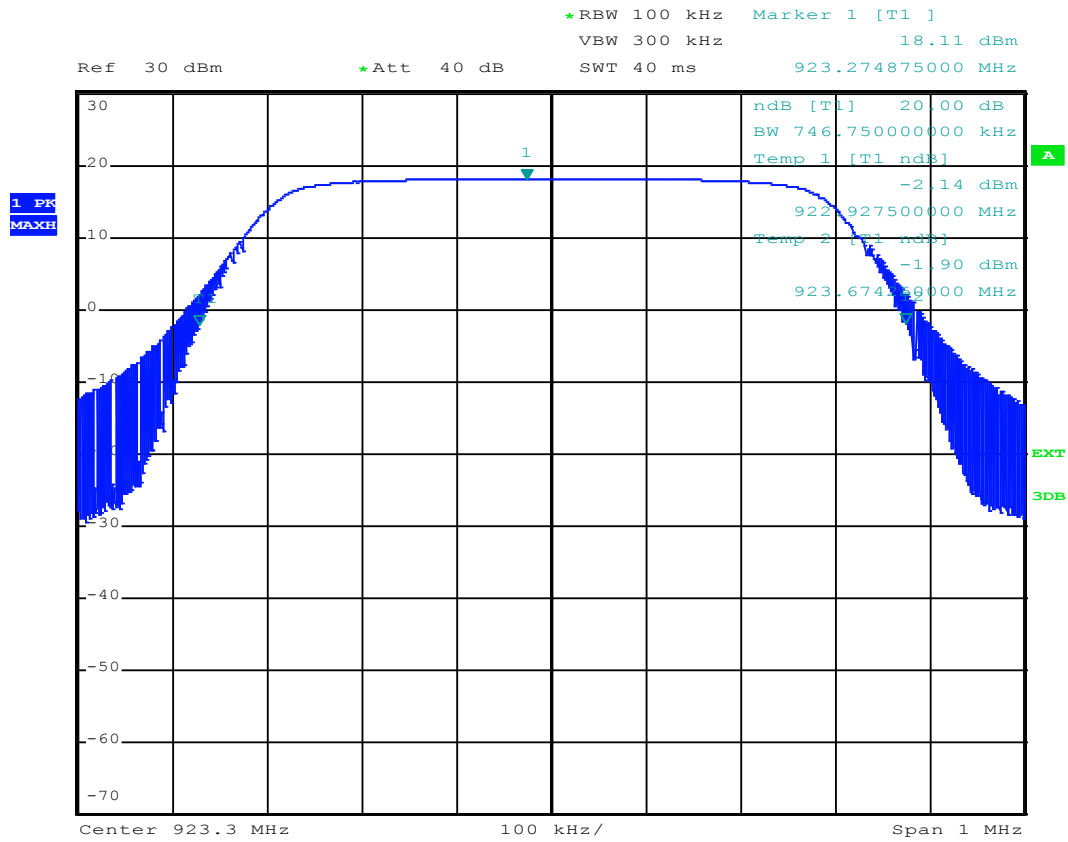
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High Channel – DC supply – SF7



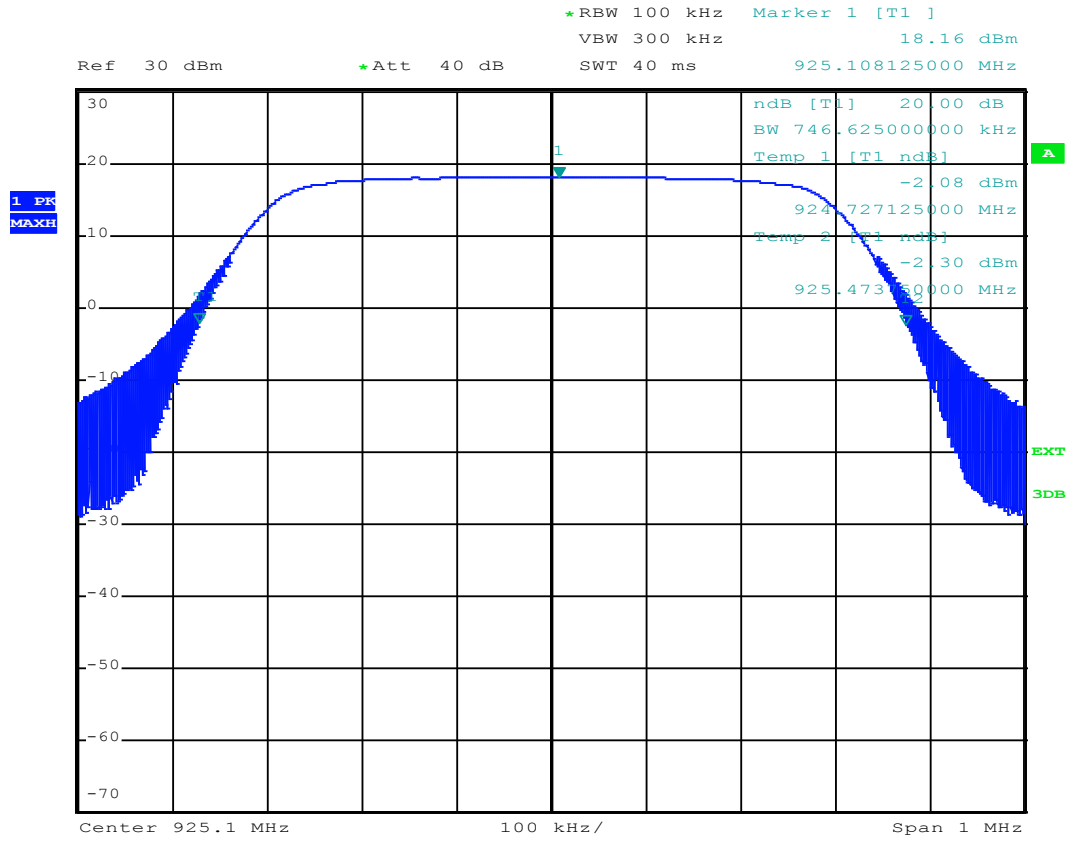
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Low Channel – DC supply – SF12



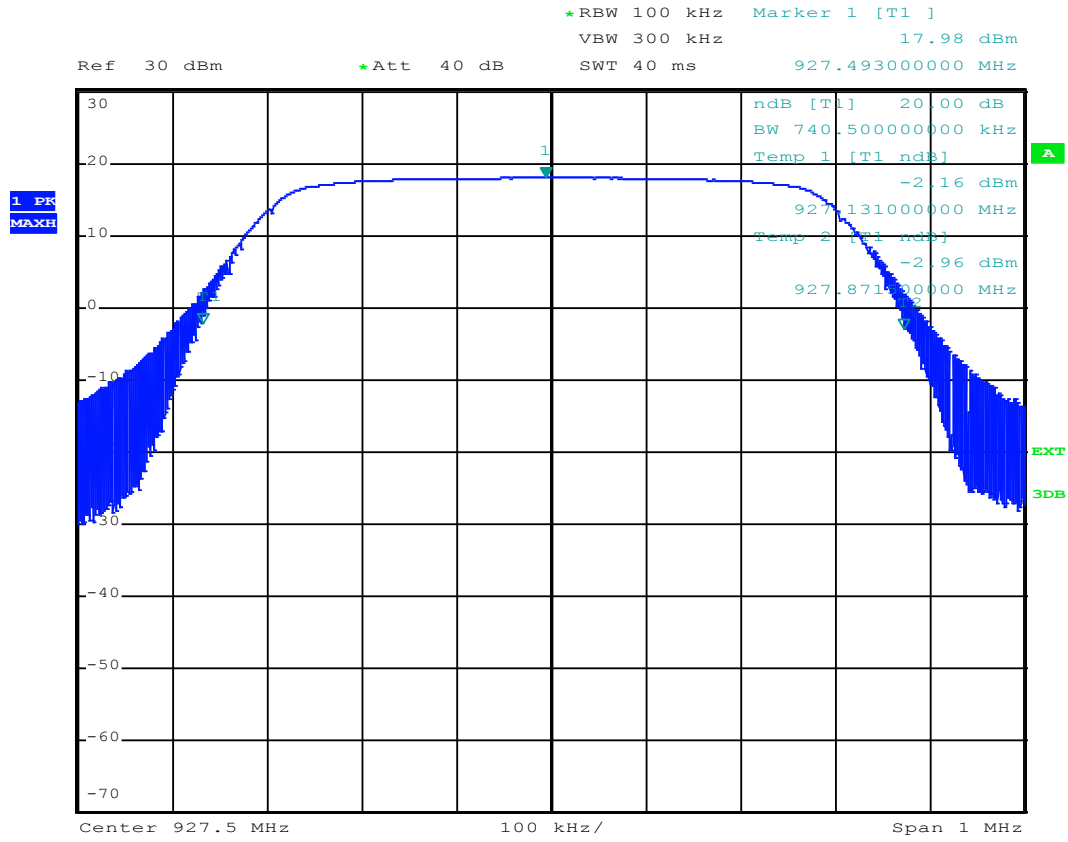
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Central Channel – DC supply – SF12



Date: 18.SEP.2015 10:06:20

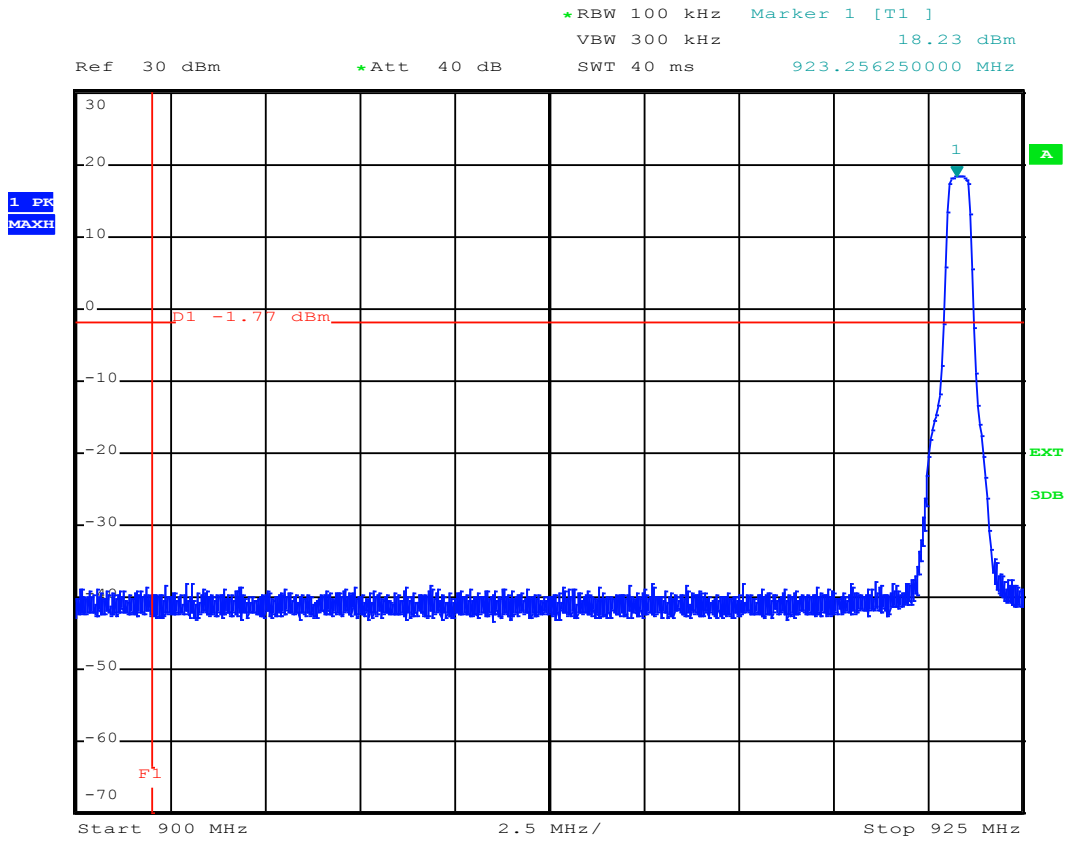
High Channel – DC supply – SF12



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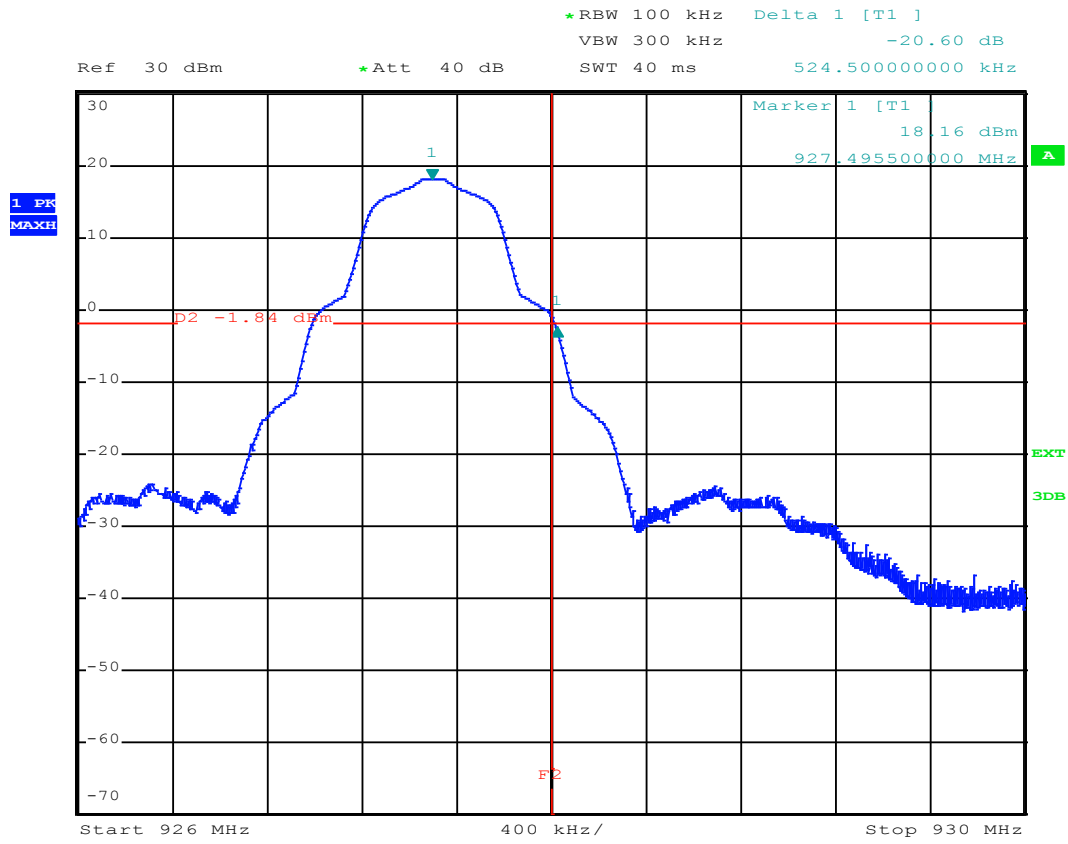
APPENDIX 6: Band edge

Low Channel – DC supply SF7



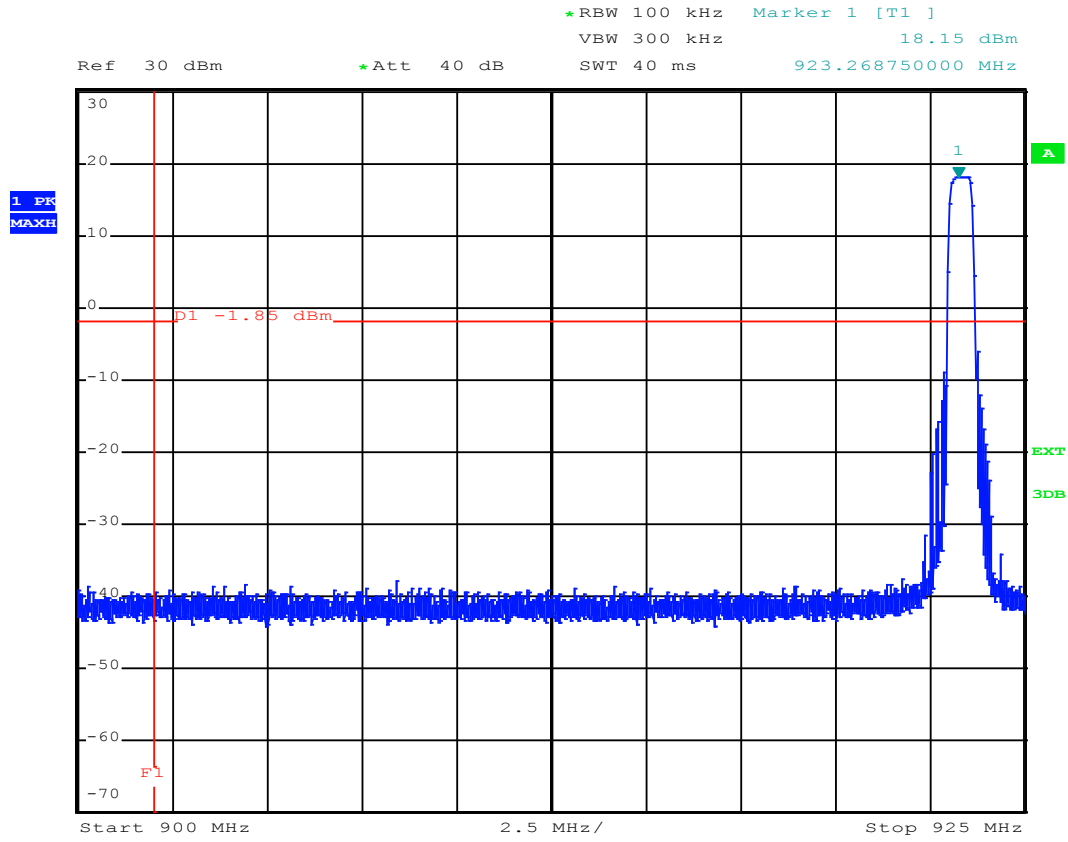
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High Channel – DC supply – SF7



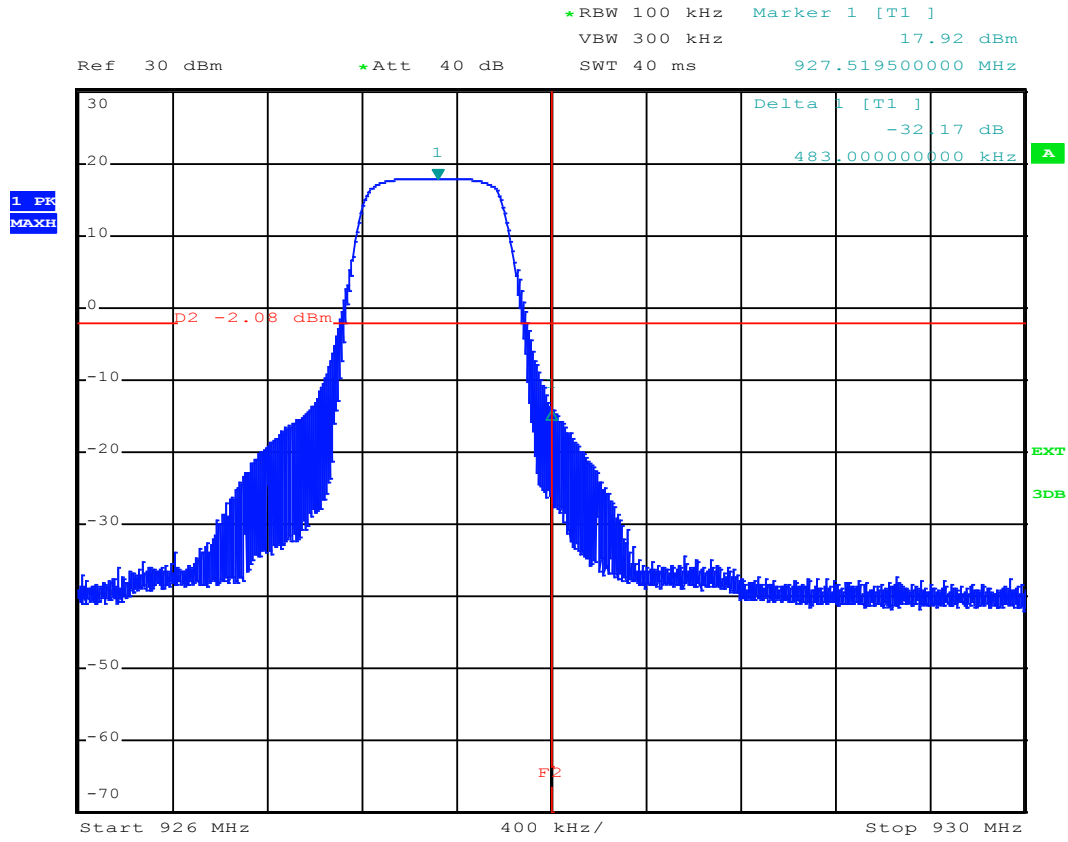
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Low Channel – DC supply – SF12



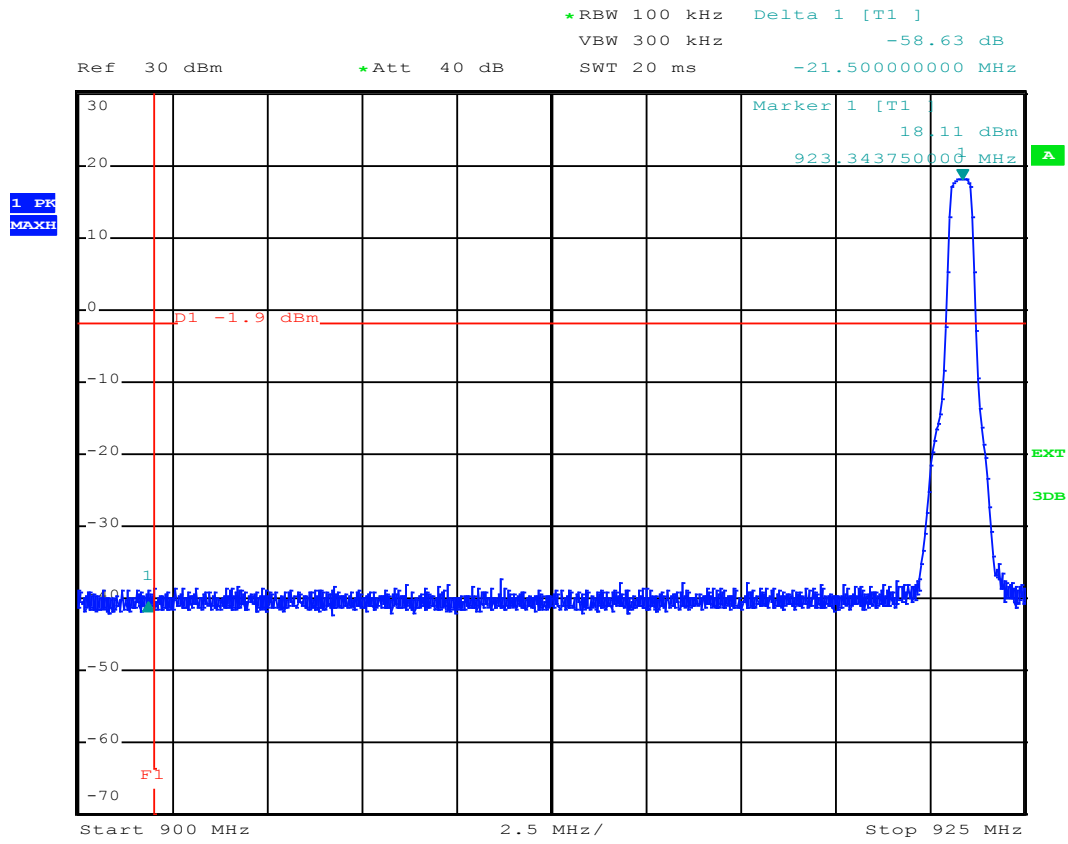
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High Channel – DC supply – SF12



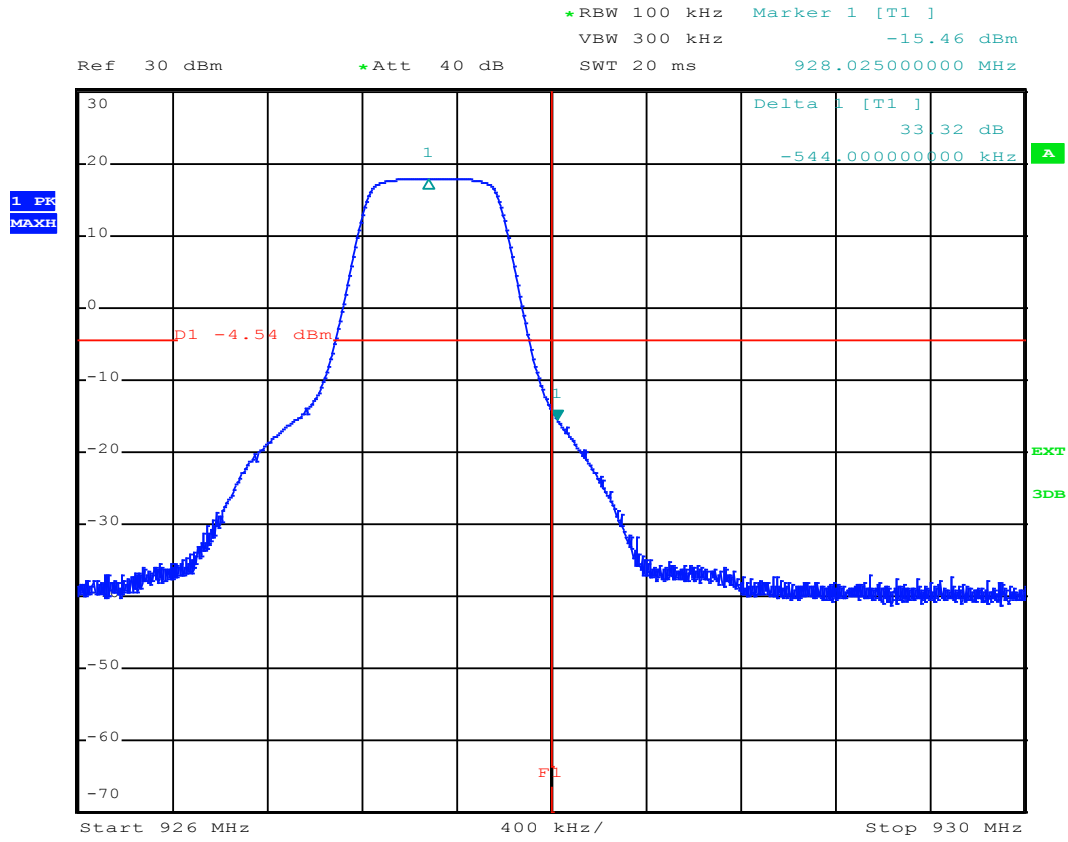
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Low Channel – POE supply – SF7



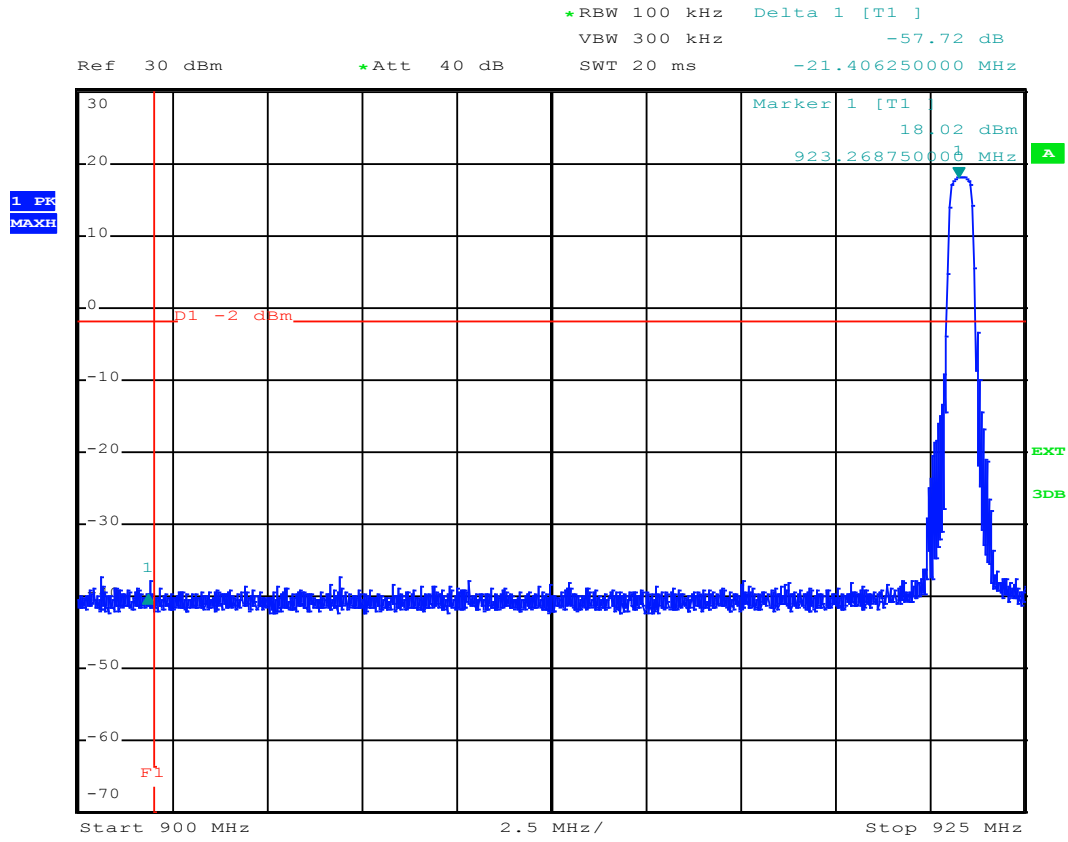
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High Channel – POE supply – SF7



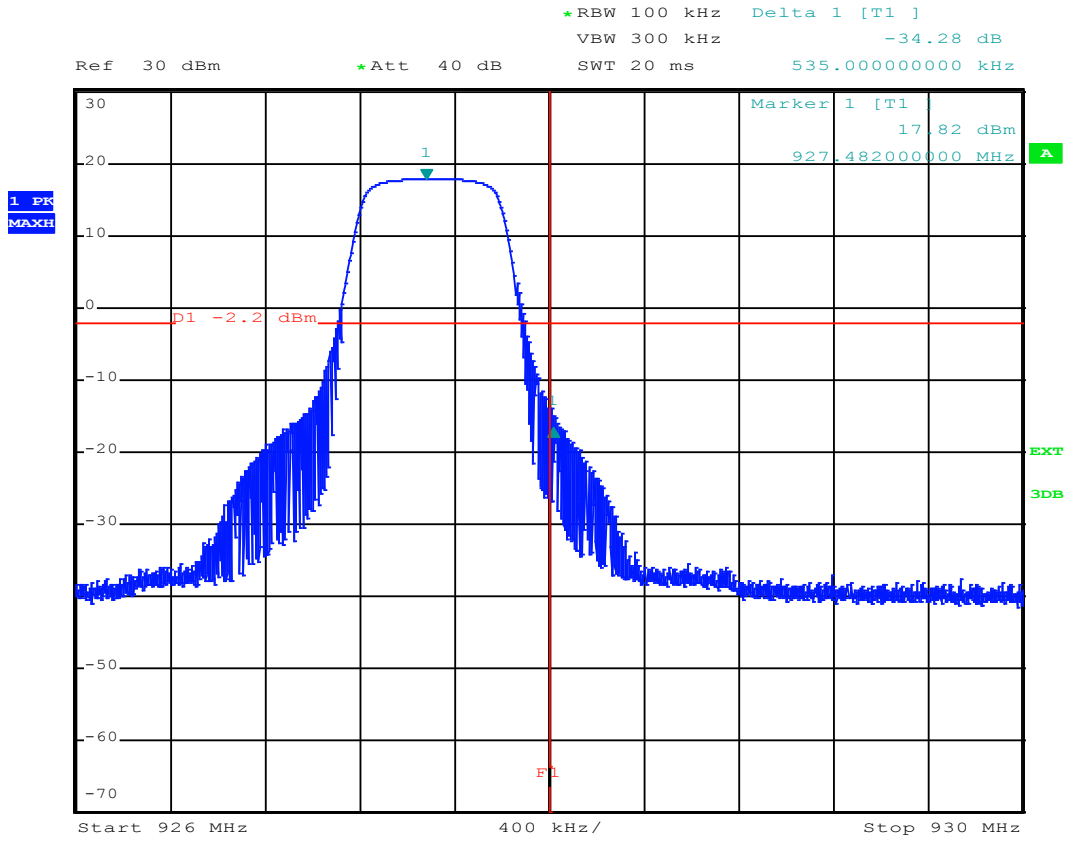
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Low Channel – POE supply – SF12



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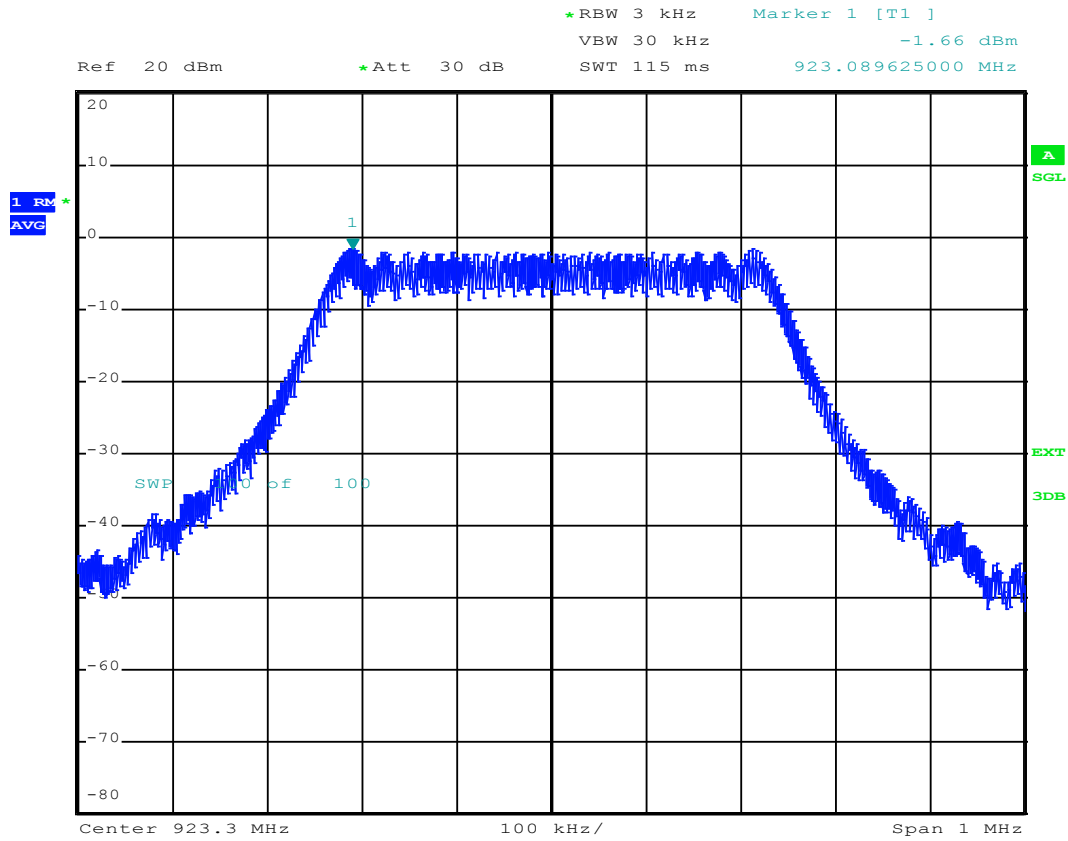
High Channel – POE supply – SF12



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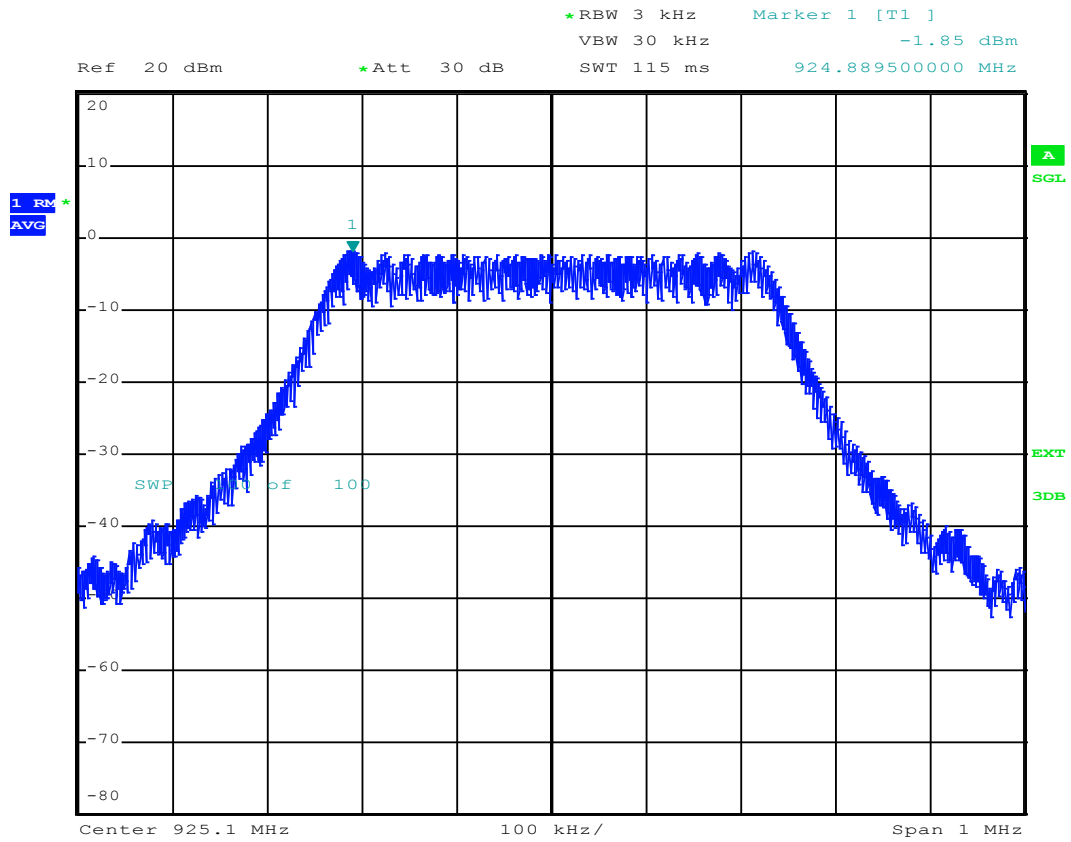
APPENDIX 7: Spectral density

Low Channel – SF7 – Supply +24Vdc



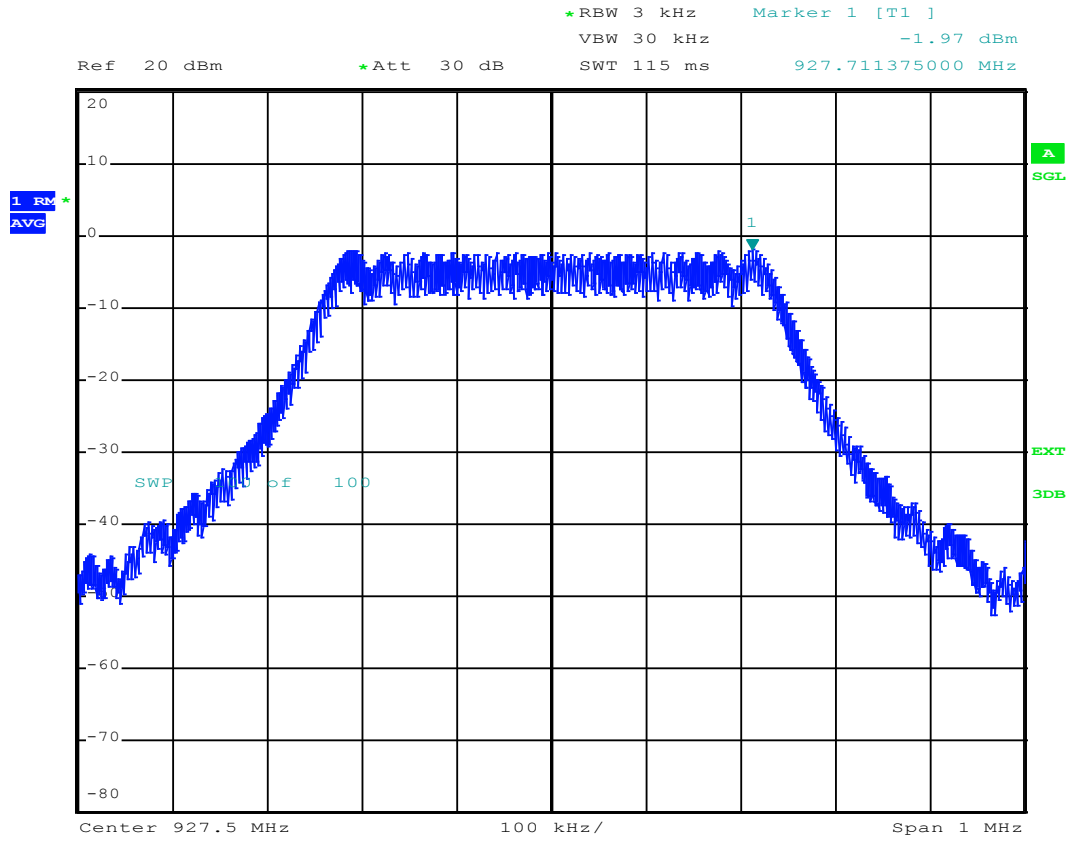
Date: 18.SEP.2015 09:47:42

Central Channel – SF7 – Supply +24Vdc



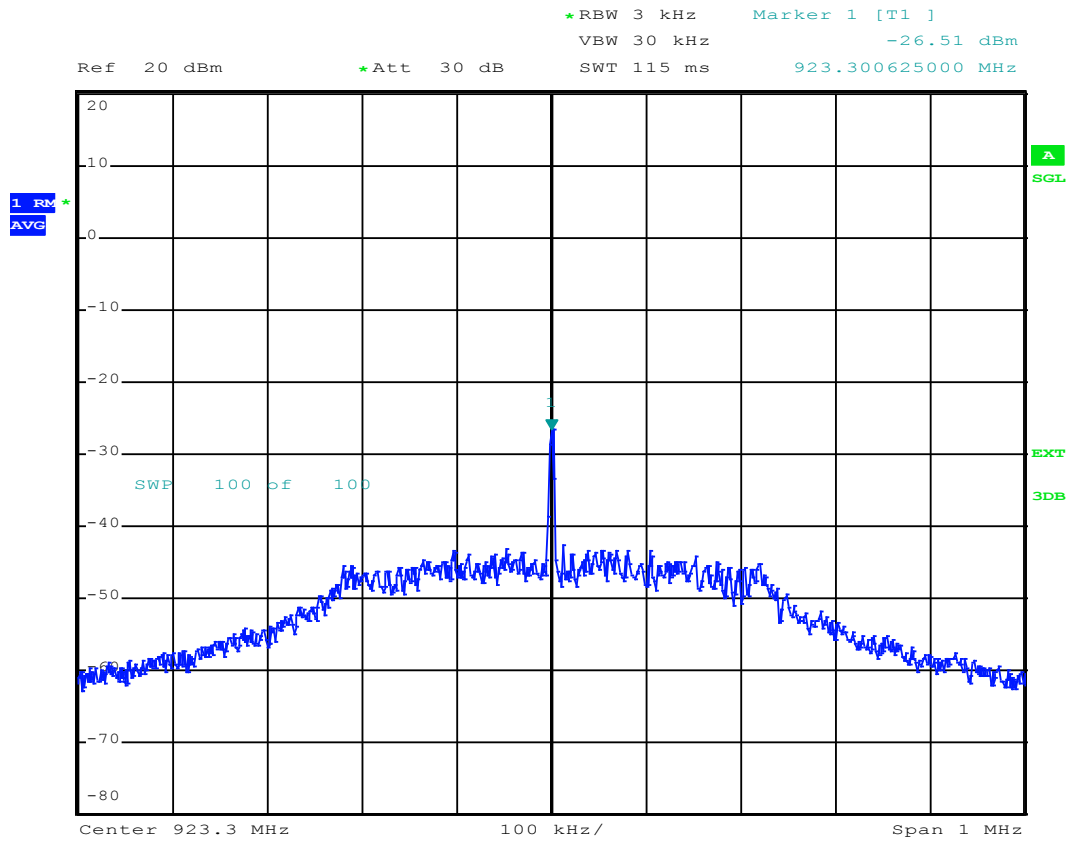
Date: 18.SEP.2015 09:52:48

High Channel – SF7 – Supply +24Vdc



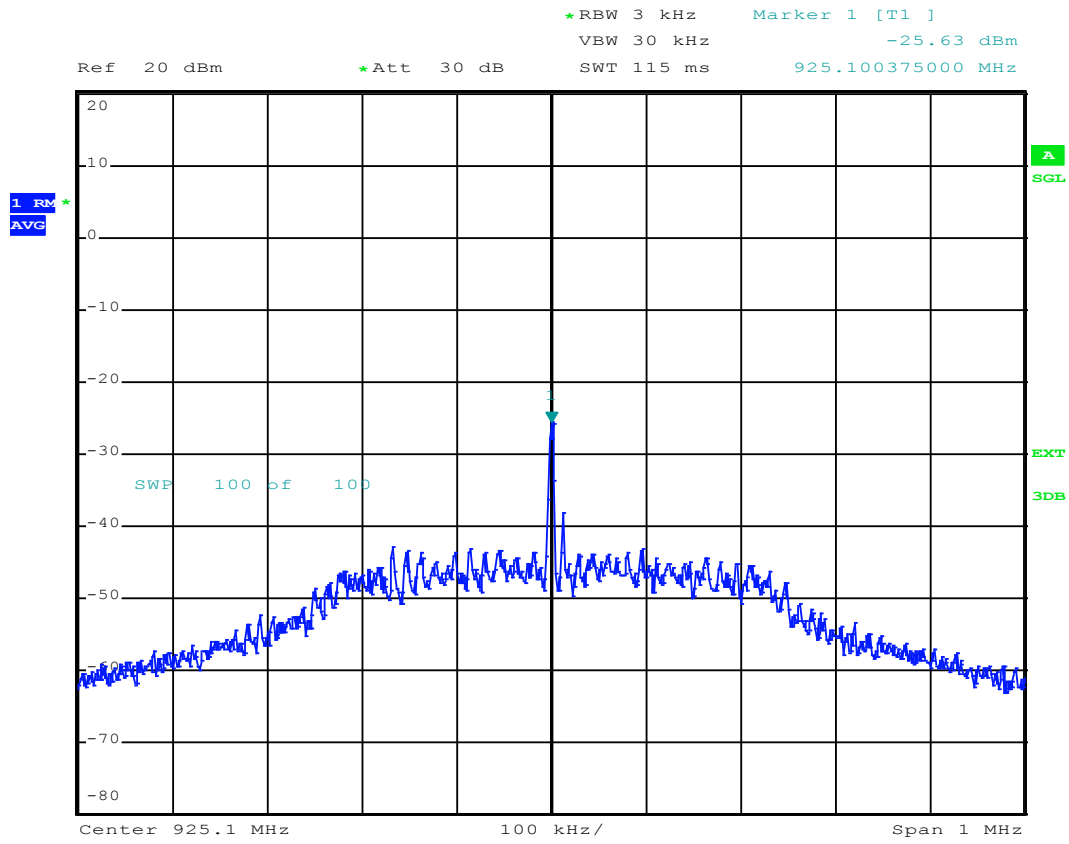
Date: 18.SEP.2015 09:54:08

Low Channel – SF12 – Supply +24Vdc



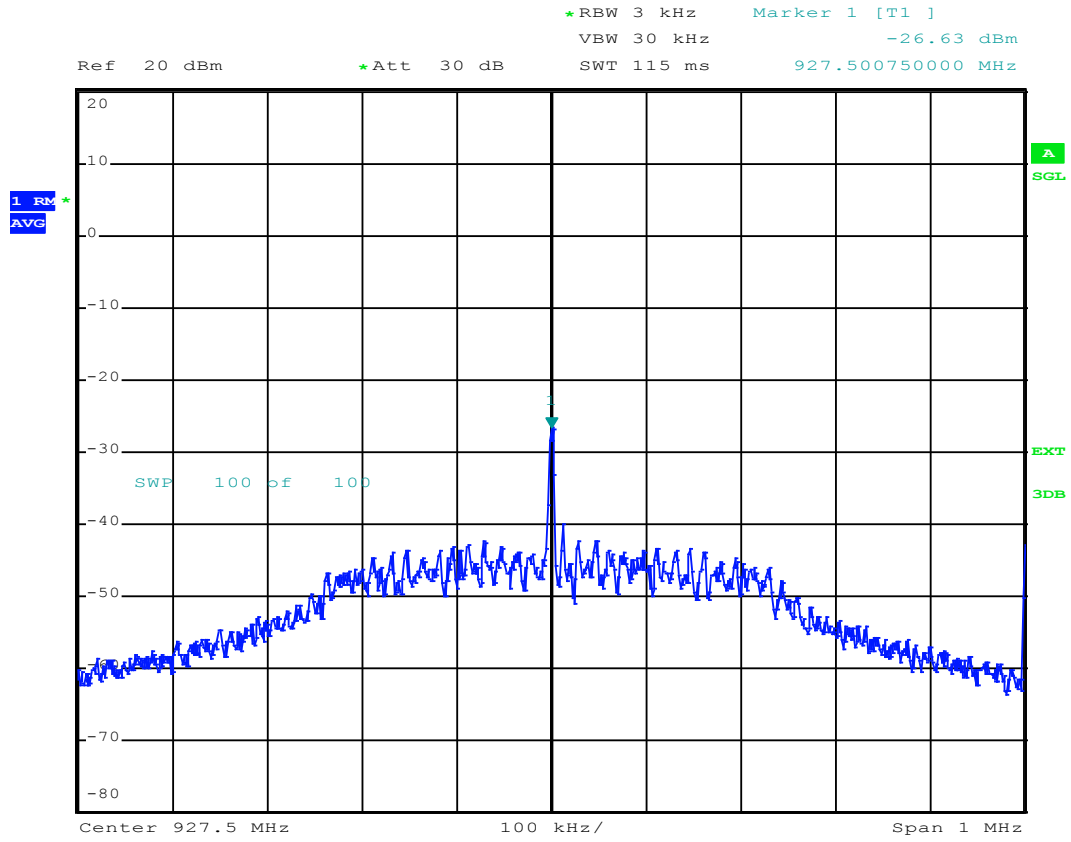
Date: 18.SEP.2015 09:49:58

Central Channel – SF12 – Supply +24Vdc



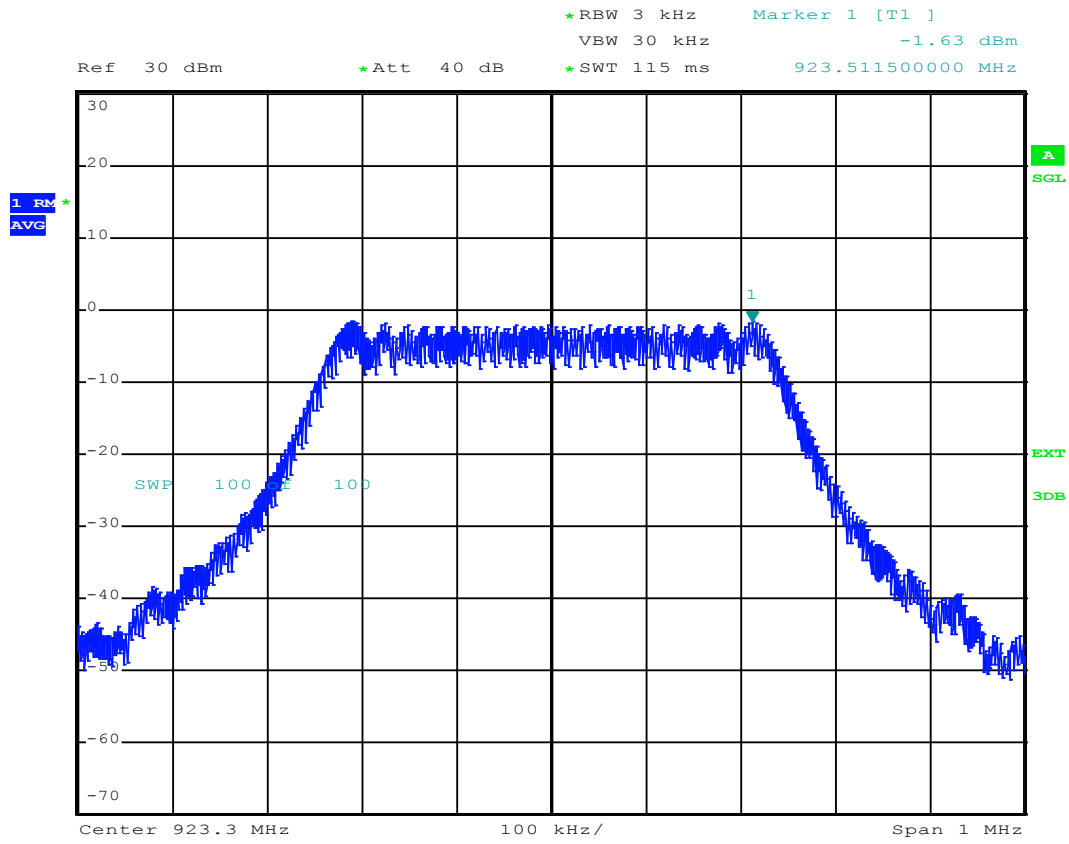
Date: 18.SEP.2015 09:51:16

High Channel – SF12 – Supply +24Vdc



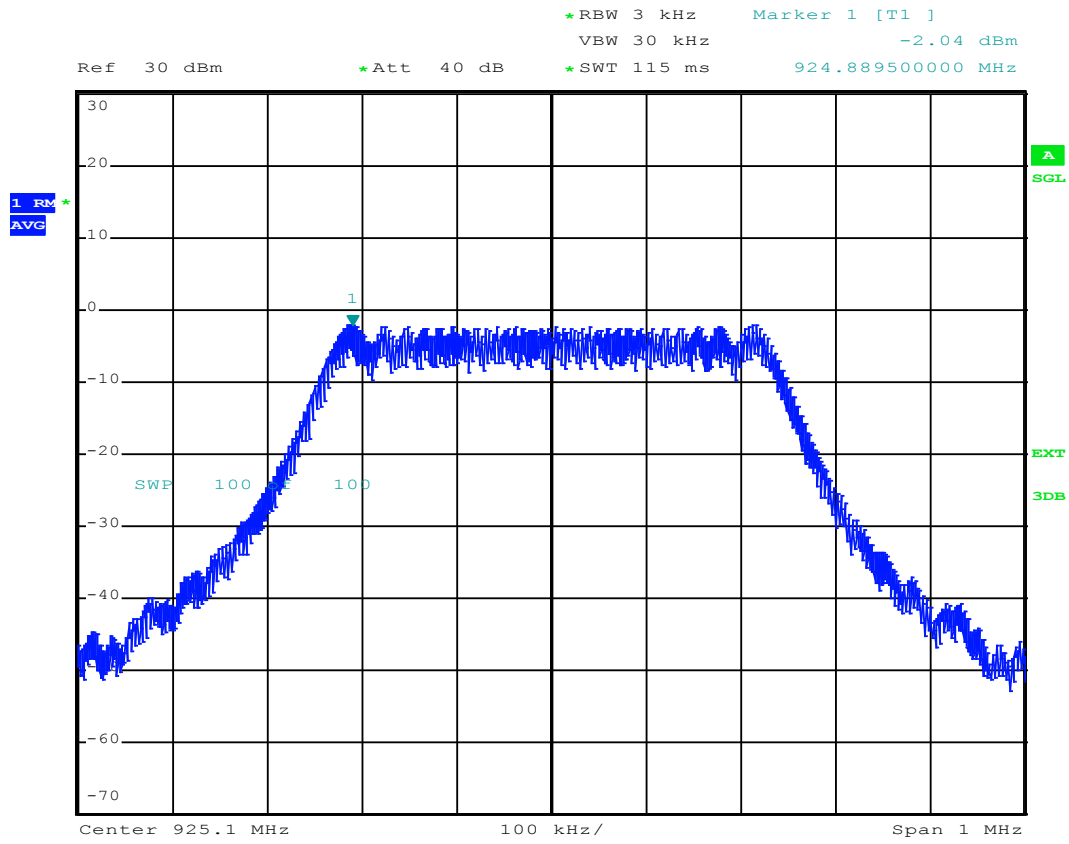
Date: 18.SEP.2015 09:55:12

Low Channel – SF7 – Supply POE



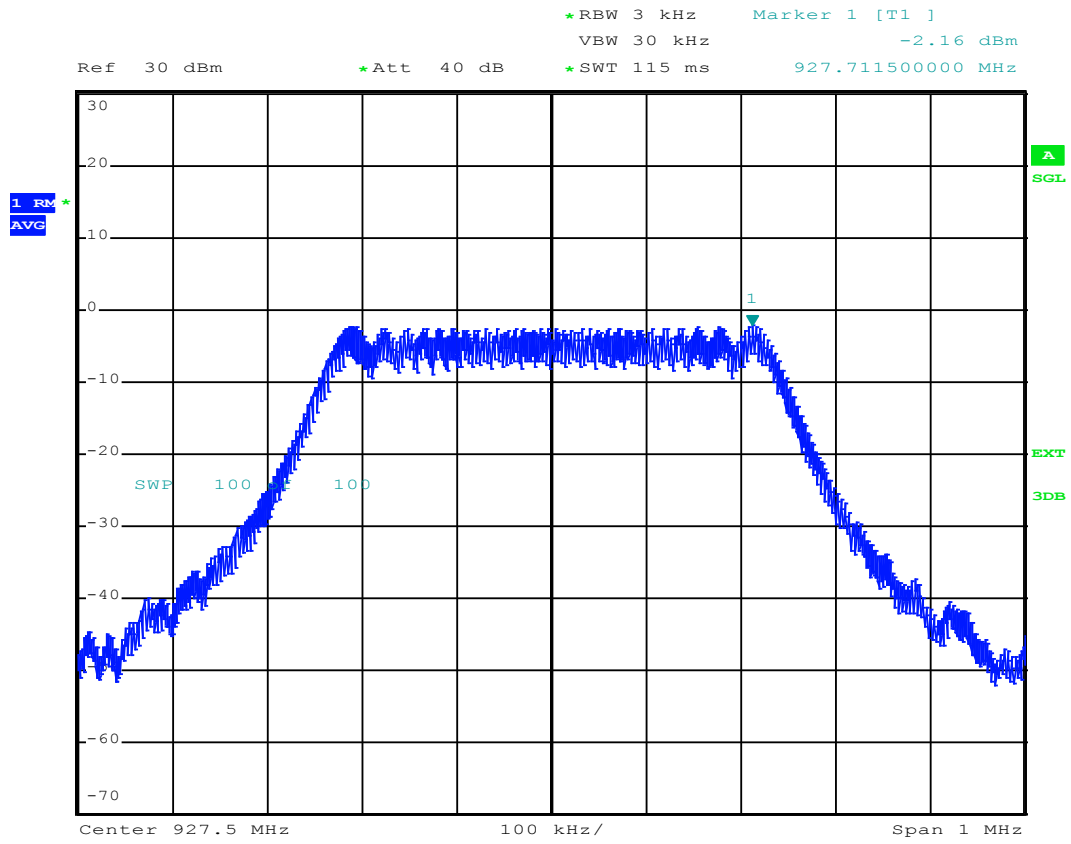
Date: 18.SEP.2015 11:45:59

Central Channel – SF7 – Supply POE



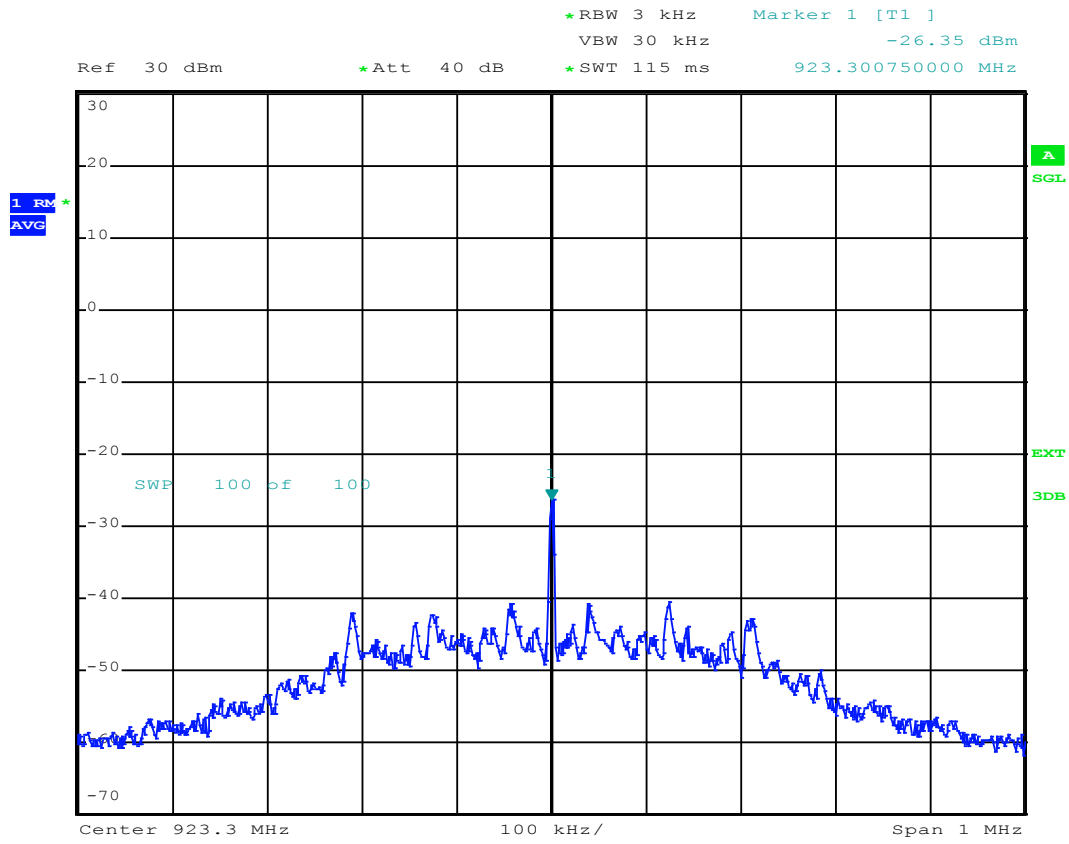
Date: 18.SEP.2015 11:50:51

High Channel – SF7 – Supply POE



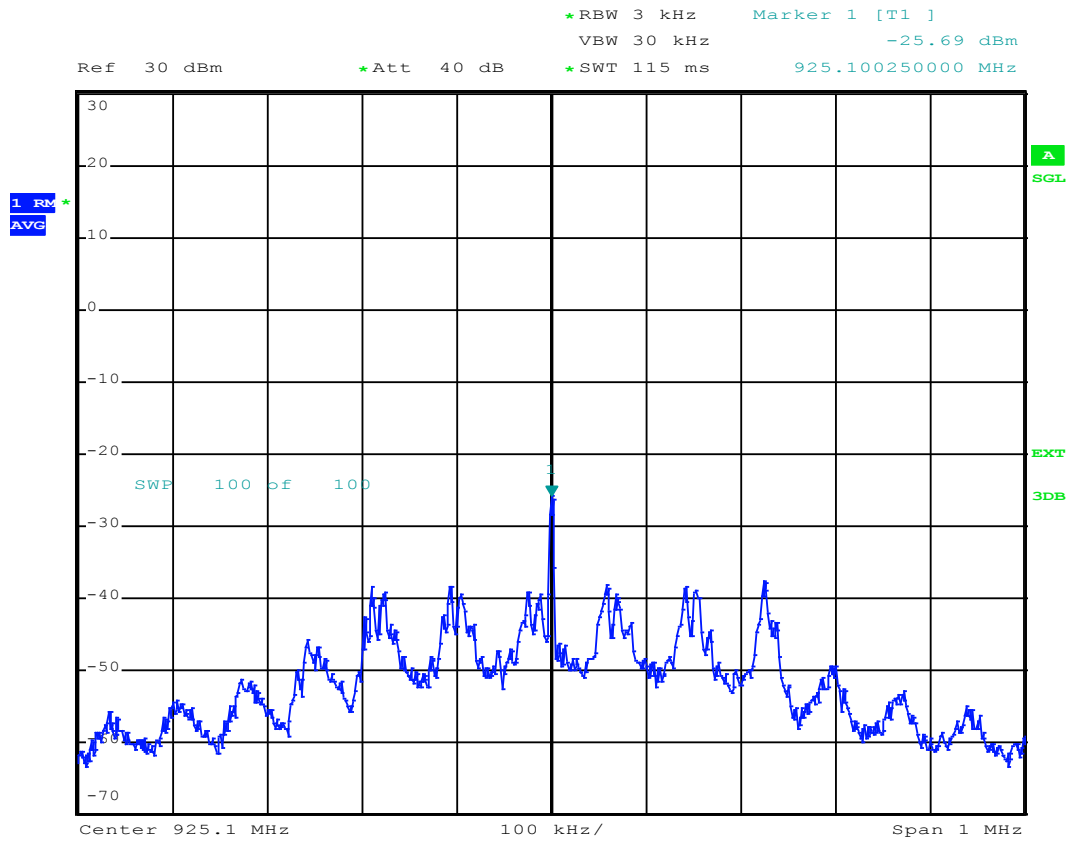
Date: 18.SEP.2015 11:53:55

Low Channel – SF12 – Supply POE



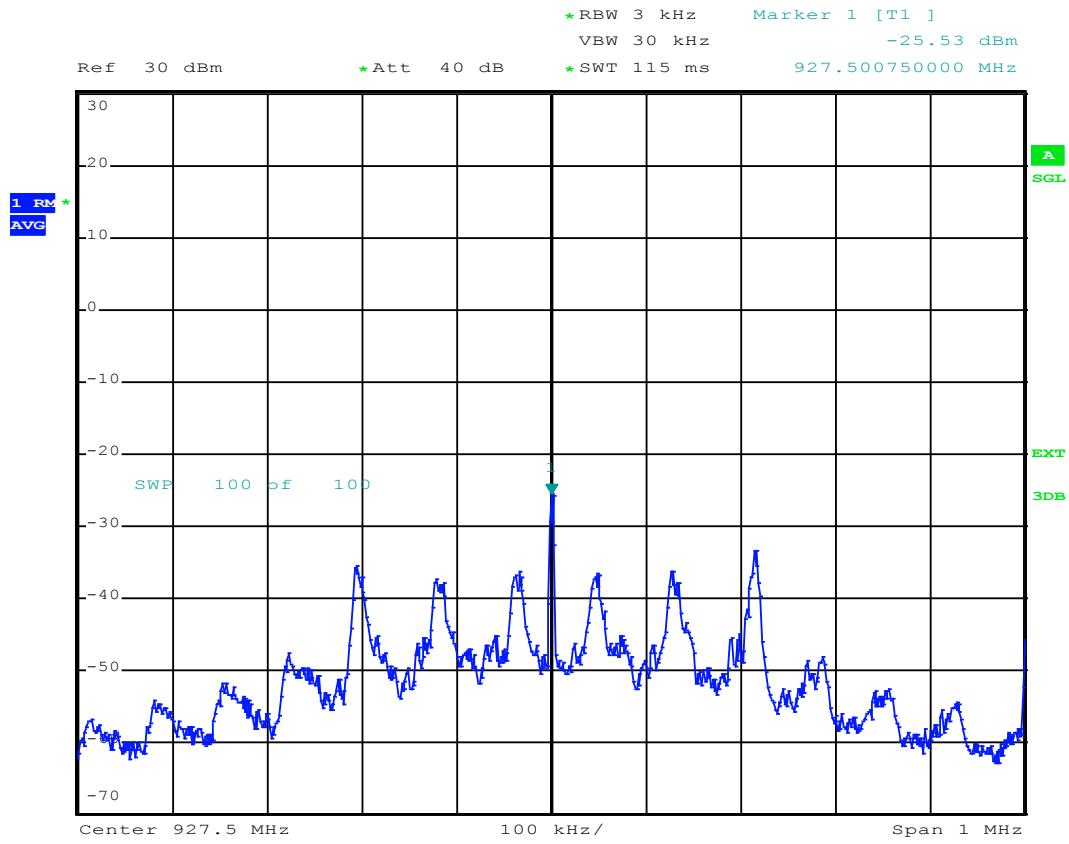
Date: 18.SEP.2015 11:48:05

Central Channel – SF12 – Supply POE



Date: 18.SEP.2015 11:52:16

High Channel – SF12 – Supply POE



Date: 18.SEP.2015 11:59:26