

ISED CABid: ES1909  
Lab. Company Number: 4621A

Test Report No:  
77596RRF.003A2

## Test Report

### USA FCC Part 15.247, 15.209

### CANADA RSS-247, RSS-Gen

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (*) Identification of item tested         | Worldsensing LoRa Module LR112X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| (*) Trademark                             | Loadsensing G7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| (*) Model and /or type reference          | WS-BRD-LR112X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Other identification of the product       | FCC ID: 2AHN4-WSBRDLR112X<br>IC: 21260-WSBRDLR112X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| (*) Features                              | LoRa Communication Module at 868, 915, 923 MHz and 2.4 GHz<br>HW version: WS-BRD-LR112X-2<br>SW version: 3.01                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Applicant                                 | Worldsensing S.L<br>C/ Viriat 47, planta 10, 08014, Barcelona, Spain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Test method requested, standard           | USA FCC Part 15.247 (10-1-21 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.<br>USA FCC Part 15.209 (10-1-21 Edition): Radiated emission limits; general requirements.<br>CANADA RSS-247 Issue 3 (August 2023).<br>CANADA RSS-Gen Issue 5 amendment 2 (February 2021).<br>Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules.<br>558074 D01 Meas Guidance v05r02 dated April 2, 2019.<br>ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. |
| Summary                                   | IN COMPLIANCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Approved by (name / position & signature) | José Manuel Gómez Galván<br>EMC Consumer & RF<br>Lab. Manager                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Date of issue                             | 2024-10-18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Report template No                        | FDT08_24<br>(*) "Data provided by the client"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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## Acronyms

| Acronym ID    | Acronym Description          |
|---------------|------------------------------|
| Detector      | Detector used                |
| Equipment     | Equipment Type               |
| Freq          | Frequency                    |
| Freq Rng      | Frequency Range              |
| MP            | Measurement Point            |
| Mod           | Modulation                   |
| Mode          | Mode                         |
| Pol           | Polarization                 |
| Port          | Active Port                  |
| Unwanted Freq | Unwanted Emissions Frequency |
| Unwanted Lvl  | Unwanted Emissions Level     |

## Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification S.A.U. is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification S.A.U. is an ISED-recognized accredited testing laboratory, CABid: ES1909, Company Number: 4621A, with the appropriate scope of accreditation that covers the performed tests in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

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## General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
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## Uncertainty

---

Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

The total uncertainty of the measurement system for the radiated emissions of EUT from 30 MHz to 1 GHz is:  
Measurement uncertainty  $\leq \pm 5,35$  dB with factor ( $k = 2$ ).

The total uncertainty of the measurement system for the radiated emissions of EUT from 1 GHz to 17 GHz is:  
Measurement uncertainty  $\leq \pm 4,32$  dB with factor ( $k = 2$ ).

The total uncertainty of the measurement system for the radiated emissions of EUT from 17 GHz to 26 GHz is:  
Measurement uncertainty  $\leq \pm 5,51$  dB with factor ( $k = 2$ ).

The total uncertainty of the measurement system for the conducted testing of EUT is:

RF Peak Output Power: Measurement uncertainty  $\leq \pm 0,80$  dB

RF Average Output Power: Measurement uncertainty  $\leq \pm 0,99$  dB

Power Spectral Density: Measurement uncertainty  $\leq \pm 0,99$  dB

6dB Bandwidth: Measurement uncertainty  $\leq \pm 2,84$  %

Occupied Channel Bandwidth: Measurement uncertainty  $\leq \pm 1,17$  %

Conducted Band-edge spurious emissions: Measurement uncertainty  $\leq \pm 1,76$  dB

## Data provided by the client

---

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample consists of a Worldsensing LoRa Module LR112X. LoRa module with optimized temperature stability for communicating in sub GHz and 2.4 GHz bands.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

## Usage of samples

Samples undergoing test have been selected by: The client.

| Id   | Control Number | Description          | Model                                     | Serial N° | Date of Reception | Application        |
|------|----------------|----------------------|-------------------------------------------|-----------|-------------------|--------------------|
| S/01 | 77596_15.1     | Module circuit board | WS-BRD-LR112X                             | -         | 2023-12-28        | Element Under Test |
| S/01 | 77596_2.1      | SMA cable            | -                                         | -         | 2023-12-05        | Element Under Test |
| S/01 | 77596_9.1      | Antenna              | Dipole swivel stick antenna - Pulse W1027 | -         | 2023-12-05        | Element Under Test |
| S/01 | 77596_8.1      | USB cable type C- A  | -                                         | -         | 2023-12-05        | Auxiliary Element  |
| S/02 | 77596_15.1     | Module circuit board | WS-BRD-LR112X                             | -         | 2023-12-28        | Element Under Test |
| S/02 | 77596_8.1      | USB cable type C- A  | -                                         | -         | 2023-12-05        | Auxiliary Element  |
| S/03 | 77596_15.1     | Module circuit board | WS-BRD-LR112X                             | -         | 2023-12-28        | Element Under Test |
| S/03 | 77596_5.1      | Antenna sticker      | FLEXIANT-AFFINI SRFL064                   | -         | 2023-12-05        | Element Under Test |
| S/03 | 77596_8.1      | USB cable type C- A  | -                                         | -         | 2023-12-05        | Auxiliary Element  |
| S/04 | 77596_15.1     | Module circuit board | WS-BRD-LR112X                             | -         | 2023-12-28        | Element Under Test |
| S/04 | 77596_8.1      | USB cable type C- A  | -                                         | -         | 2023-12-05        | Auxiliary Element  |

Notes referenced to samples during the project:

| Id   | Type                                                           |
|------|----------------------------------------------------------------|
| S/01 | Radiated tests for LoRa 2.4 GHz.                               |
| S/02 | Conducted tests for LoRa 2.4 GHz.                              |
| S/03 | Radiated tests for AU915-928.<br>Radiated tests for US902-928. |
| S/04 | Conducted tests AU915-928.<br>Conducted tests US902-928.       |

Test sample description

|                                               |                                                      |                                |                      |          |                                   |     |     |
|-----------------------------------------------|------------------------------------------------------|--------------------------------|----------------------|----------|-----------------------------------|-----|-----|
| Ports..... :                                  | Port name and description                            | Cable                          |                      |          |                                   |     |     |
|                                               |                                                      | Specified max length [m]       | Attached during test | Shielded | Coupled to patient <sup>(3)</sup> |     |     |
|                                               | USB-C for configuration and supply on the host board | .....                          | [X]                  | [ ]      | [ ]                               |     |     |
| Supplementary information to the ports..... : | .....                                                |                                |                      |          |                                   |     |     |
| Rated power supply .....                      | Voltage and Frequency                                |                                | Reference poles      |          |                                   |     |     |
|                                               |                                                      |                                | L1                   | L2       | L3                                | N   | PE  |
|                                               | [ ]                                                  | AC: .....                      | [ ]                  | [ ]      | [ ]                               | [ ] | [ ] |
|                                               | [X]                                                  | DC: 3.6 to 5V DC               |                      |          |                                   |     |     |
| Rated Power .....                             | 1W maximum required power                            |                                |                      |          |                                   |     |     |
| Clock frequencies.....                        | 32MHz and 32.768KHz                                  |                                |                      |          |                                   |     |     |
| Other parameters .....                        | .....                                                |                                |                      |          |                                   |     |     |
| Software version .....                        | 3.01                                                 |                                |                      |          |                                   |     |     |
| Hardware version .....                        | WS-BRD-LR112X-2                                      |                                |                      |          |                                   |     |     |
| Dimensions in cm (W x H x D) .....            | 24 x 36 x 4 mm (module)                              |                                |                      |          |                                   |     |     |
| Mounting position .....                       | [X]                                                  | Table top equipment            |                      |          |                                   |     |     |
|                                               | [X]                                                  | Wall/Ceiling mounted equipment |                      |          |                                   |     |     |
|                                               | [ ]                                                  | Floor standing equipment       |                      |          |                                   |     |     |
|                                               | [ ]                                                  | Hand-held equipment            |                      |          |                                   |     |     |
|                                               | [ ]                                                  | Other: .....                   |                      |          |                                   |     |     |
| Modules/parts..... :                          | Module/parts of test item                            |                                | Type                 |          | Manufacturer                      |     |     |
|                                               | .....                                                |                                | .....                |          | .....                             |     |     |
| Accessories (not part of the test item) ..... | Description                                          |                                | Type                 |          | Manufacturer                      |     |     |
|                                               | .....                                                |                                | .....                |          | .....                             |     |     |
| Documents as provided by the applicant .....  | Description                                          |                                | File name            |          | Issue date                        |     |     |
|                                               | .....                                                |                                | .....                |          | .....                             |     |     |

<sup>(3)</sup> Only for Medical Equipment

Identification of the client

Worldsensing S.L  
C/ Viriat 47, planta 10, 08014 Barcelona

## Testing period and place

|               |                                        |
|---------------|----------------------------------------|
| Test Location | DEKRA Testing and Certification S.A.U. |
| Date (start)  | 2024-01-15                             |
| Date (finish) | 2024-05-08                             |

## Document history

| Report number  | Date       | Description                                                                                                                                                                   |
|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 77596RRF.003   | 2024-05-21 | First release.                                                                                                                                                                |
| 77596RRF.003A1 | 2024-09-19 | Second release. It is modified due to some minor typos.<br>This modification test report cancels and replaces the test report 77596RRF.003                                    |
| 77596RRF.003A2 | 2024-10-18 | Third release. It is modified due to a change in declared frequencies and some minor typos. This modification test report cancels and replaces the test report 77596RRF.003A1 |

## Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

|                   |                              |
|-------------------|------------------------------|
| Temperature       | Min. = 15 °C<br>Max. = 35 °C |
| Relative humidity | Min. = 20 %<br>Max. = 75 %   |

In the semianechoic chamber, the following limits were not exceeded during the test.

|                   |                              |
|-------------------|------------------------------|
| Temperature       | Min. = 15 °C<br>Max. = 35 °C |
| Relative humidity | Min. = 20 %<br>Max. = 75 %   |

In the chamber for conducted measurements, the following limits were not exceeded during the test:

|                   |                              |
|-------------------|------------------------------|
| Temperature       | Min. = 15 °C<br>Max. = 35 °C |
| Relative humidity | Min. = 20 %<br>Max. = 75 %   |

## Remarks and comments

The tests have been performed by the technical personnel: Rafael Fernández.

Used instrumentation:

| Control No. | Equipment                                   | Model          | Manufacturer               | Next Calibration |
|-------------|---------------------------------------------|----------------|----------------------------|------------------|
| 07445       | DC POWER SUPPLY 30V/5A                      | U8002A         | KEYSIGHT TECHNOLOGIES      | N/A              |
| 07760       | DIGITAL MULTIMETER                          | 175            | FLUKE                      | 2024-11          |
| 06165       | EMI TEST RECEIVER 2Hz-7GHz                  | ESR7           | ROHDE AND SCHWARZ          | 2025-12          |
| 06496       | HORN ANTENNA 1-18GHz                        | BBHA 9120 D    | SCHWARZBECK                | 2026-12          |
| 06143       | HYBRID BILOG ANTENNA 30MHz-6GHz             | 3142E          | ETS LINDGREN               | 2027-01          |
| 07656       | LOW PASS FILTER TEMSTRON/TEMWELL DC - 1 GHZ | ST-1GA3250-LS  | TEMSTRON/TEMWELL           | 2025-02          |
| 03783       | PRE-AMPLIFIER G>30dB 1GHz-18GHz             | BLMA 0118-3A   | BONN ELEKTRONIK            | 2025-03          |
| 06142       | PRE-AMPLIFIER G>38dB 30MHz-6GHz             | BLNA 0360-01N  | BONN ELEKTRONIK            | 2024-06          |
| 06144       | PRE-AMPLIFIER G>40dB 10MHz-6GHz             | BLNA 0160-01N  | BONN ELEKTRONIK            | 2024-07          |
| 06791       | SEMIANECHOIC ABSORBER LINED CHAMBER IV      | FACT 3 200 STP | ETS LINDGREN               | N/A              |
| 06792       | Shielded Room                               | S101           | ETS LINDGREN               | N/A              |
| 08856       | PRE-AMPLIFIER G>30dB 18-40GHz               | BLMA 1840-4A   | BONN ELEKTRONIK            | 2025-02          |
| 04848       | SOFTWARE FOR EMC/RF TESTING                 | EMC32          | ROHDE AND SCHWARZ          | N/A              |
| 07873       | DC Power Supply 30V/5A                      | U8002A         | KEYSIGHT TECHNOLOGIES      | N/A              |
| 07758       | Digital Multimeter                          | 175            | FLUKE                      | 2024-11          |
| 06157       | Signal and Spectrum Analyzer 10 Hz - 40 GHz | FSV40          | ROHDE AND SCHWARZ          | 2025-01          |
| 07794       | Signal and Spectrum Analyzer 10 Hz - 40 GHz | FSV40          | ROHDE AND SCHWARZ          | 2025-04          |
| 03541       | Hybrid Bilog Antenna 30MHz-6GHz             | JB6            | SUNOL SCIENCES CORPORATION | 2024-11          |
| 08483       | TUNABLE NOTCH FILTER 500-1000 MHZ           | PE8737         | PASTERNAK                  | 2024-05          |
| 05850       | DIGITAL MULTIMETER                          | 179            | FLUKE                      | 2024-11          |
| 00922       | POWER SUPPLY DC 40 V / 40 A                 | NGPE 40/40     | ROHDE AND SCHWARZ          | N/A              |



| Control No. | Equipment                               | Model      | Manufacturer      | Next Calibration |
|-------------|-----------------------------------------|------------|-------------------|------------------|
| 08788       | PREAMPLIFIER 30dB 500MHz-18GHz          | BBV 9718 C | SCHWARZBECK       | 2025-01          |
| 06793       | SHIELDED ROOM                           | S101       | ETS LINDGREN      | N/A              |
| 06668       | SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz | FSV40      | ROHDE AND SCHWARZ | 2024-12          |
| 06794       | Shielded Room                           | S101       | ETS LINDGREN      | N/A              |

### Testing verdicts

|                |     |
|----------------|-----|
| Fail           | F   |
| Inconclusive   | I   |
| Not applicable | N/A |
| Not measured   | N/M |
| Pass           | P   |

### Summary

#### Appendix A: LoRa 2.4 GHz.

| FCC PART 15 PARAGRAPH / RSS-247               |                                              |         |        |
|-----------------------------------------------|----------------------------------------------|---------|--------|
| Requirement – Test case                       |                                              | Verdict | Remark |
| FCC 15.247 (a)(2) / RSS-247 5.2. (a)          | 6 dB Bandwidth                               | P       |        |
| FCC 15.247 (b) / RSS-247 5.4. (d)             | Maximum output power and antenna gain        | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Band-edge emissions compliance (Transmitter) | P       |        |
| FCC 15.247 (e) / RSS-247 5.2. (b)             | Power spectral density                       | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Emission limitations radiated (Transmitter)  | P       |        |
| <u>Supplementary information and remarks:</u> |                                              |         |        |
| Note: No FHSS.                                |                                              |         |        |

## Appendix B: LoRa AU915-928.

| FCC PART 15 PARAGRAPH/ RSS-247                |                                                  |         |        |
|-----------------------------------------------|--------------------------------------------------|---------|--------|
| Requirement – Test case                       |                                                  | Verdict | Remark |
| FCC 15.247 (a)(1) / RSS-247 5.1 (b)           | 20 dB Bandwidth and Carrier frequency separation | P       |        |
| FCC 15.247 (a)(1)(i) / RSS-247 5.1 (c)        | Number of hopping channels                       | P       |        |
| FCC 15.247 (f) / RSS-247 5.3 (a)              | Time of occupancy (Dwell Time)                   | P       |        |
| FCC 15.247 (b) / RSS-247 5.4. (d)             | Maximum output power and antenna gain            | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Band-edge emissions compliance (Transmitter)     | P       |        |
| FCC 15.247 (f) / RSS-247 5.3. (b)             | Power spectral density for hybrid systems        | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Emission limitations radiated (Transmitter)      | P       |        |
| <u>Supplementary information and remarks:</u> |                                                  |         |        |
| Note: Hybrid.                                 |                                                  |         |        |

## Appendix C: LoRa US902-928.

| FCC PART 15 PARAGRAPH/ RSS-247                |                                                  |         |        |
|-----------------------------------------------|--------------------------------------------------|---------|--------|
| Requirement – Test case                       |                                                  | Verdict | Remark |
| FCC 15.247 (a)(1) / RSS-247 5.1 (b)           | 20 dB Bandwidth and Carrier frequency separation | P       |        |
| FCC 15.247 (a)(1)(i) / RSS-247 5.1 (c)        | Number of hopping channels                       | P       |        |
| FCC 15.247 (f) / RSS-247 5.3 (a)              | Time of occupancy (Dwell Time)                   | P       |        |
| FCC 15.247 (b) / RSS-247 5.4. (d)             | Maximum output power and antenna gain            | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Band-edge emissions compliance (Transmitter)     | P       |        |
| FCC 15.247 (f) / RSS-247 5.3. (b)             | Power spectral density for hybrid systems        | P       |        |
| FCC 15.247 (d) / RSS-247 5.5.                 | Emission limitations radiated (Transmitter)      | P       |        |
| <u>Supplementary information and remarks:</u> |                                                  |         |        |
| Note: Hybrid.                                 |                                                  |         |        |

# Appendix A: Test results. LoRa 2.4 GHz

|                                                                                             |           |
|---------------------------------------------------------------------------------------------|-----------|
| TEST CONDITIONS .....                                                                       | 13        |
| <i>Occupied Channel Bandwidth 99% .....</i>                                                 | <i>16</i> |
| <i>RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6 dB Bandwidth .....</i>                            | <i>20</i> |
| <i>RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density .....</i>                        | <i>24</i> |
| <i>RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum output power and antenna gain .....</i>     | <i>28</i> |
| <i>RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) .....</i>      | <i>32</i> |
| <i>RSS-247 5.5 / FCC 15.247 (d) [RSE] Emission limitations radiated (Transmitter) .....</i> | <i>35</i> |

## TEST CONDITIONS

(\*): Data provided by the client.

**POWER SUPPLY (\*):**

Vnominal: 5 V  
Type of Power Supply: DC (USB-C).

**ANTENNA (\*):**

Type of Antenna LoRa 2.4 GHz: Omnidirectional external antenna.  
Maximum Declared External Antenna Gain LoRa 2.4 GHz: 2.0 dBi  
Type of Antenna LoRa 2.4 GHz: FPC omnidirectional internal antenna.  
Maximum Declared FPC Antenna Gain LoRa 2.4 GHz: 3.9 dBi

According preliminary radiated spurious emissions the External Antenna is a worst case.

**TEST FREQUENCIES (\*):**

| Modulation | Low Channel: | Middle Channel | High Channel |
|------------|--------------|----------------|--------------|
| LoRa       | 2403 MHz     | 2425 MHz       | 2479 MHz     |

During transmitter test the EUT was controlled by a SW tool provided by the client to operate in a continuous transmit mode on the modulation schemes and test channels as required.

**CONDUCTED MEASUREMENTS:**

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



**RADIATED MEASUREMENTS:**

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1.5 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

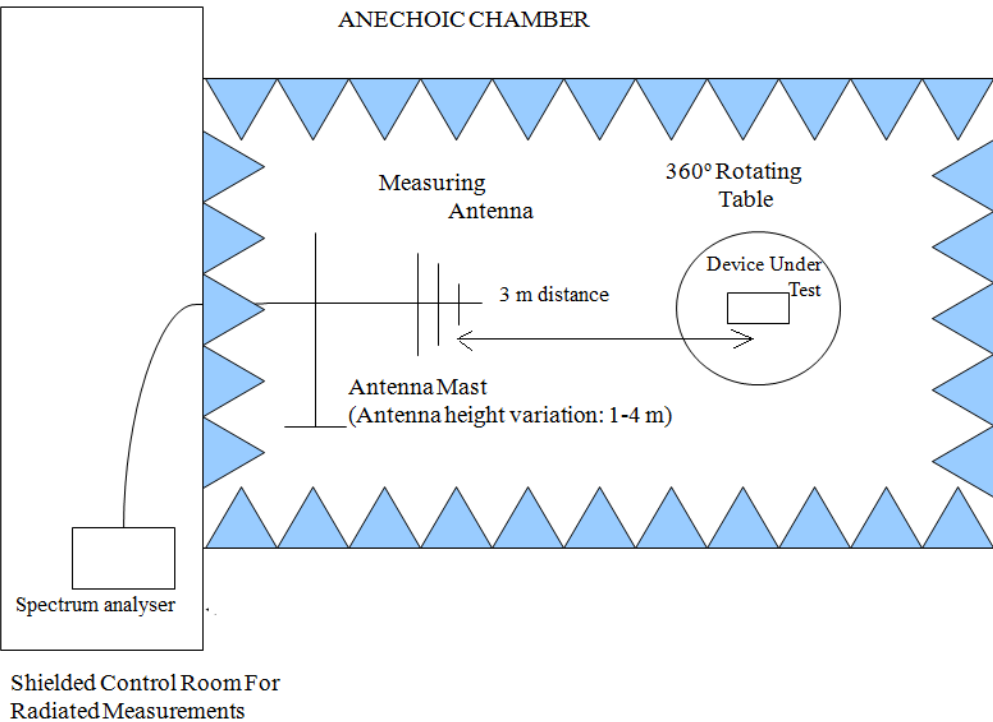
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

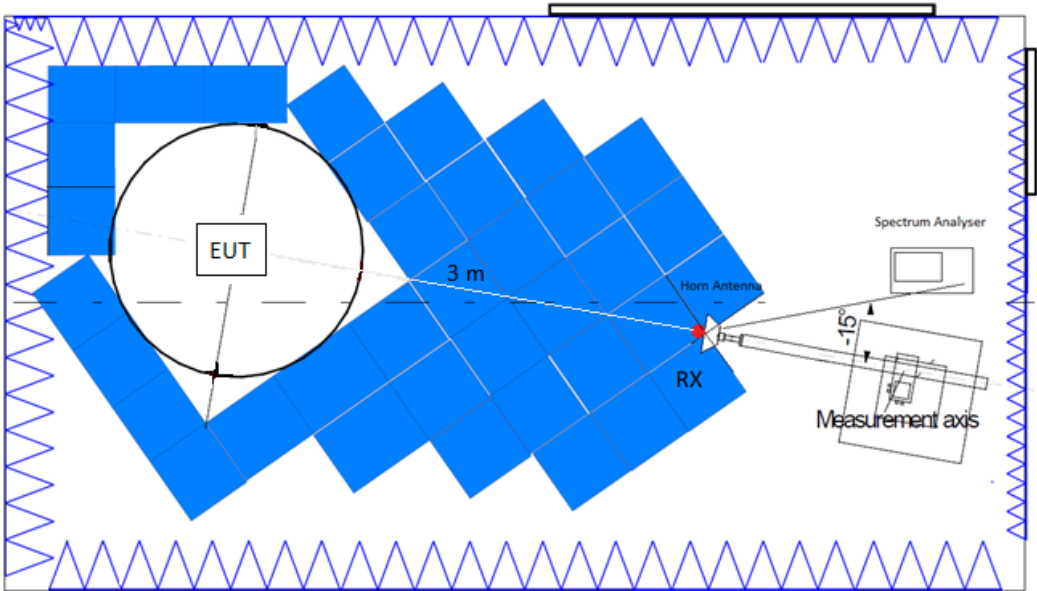
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

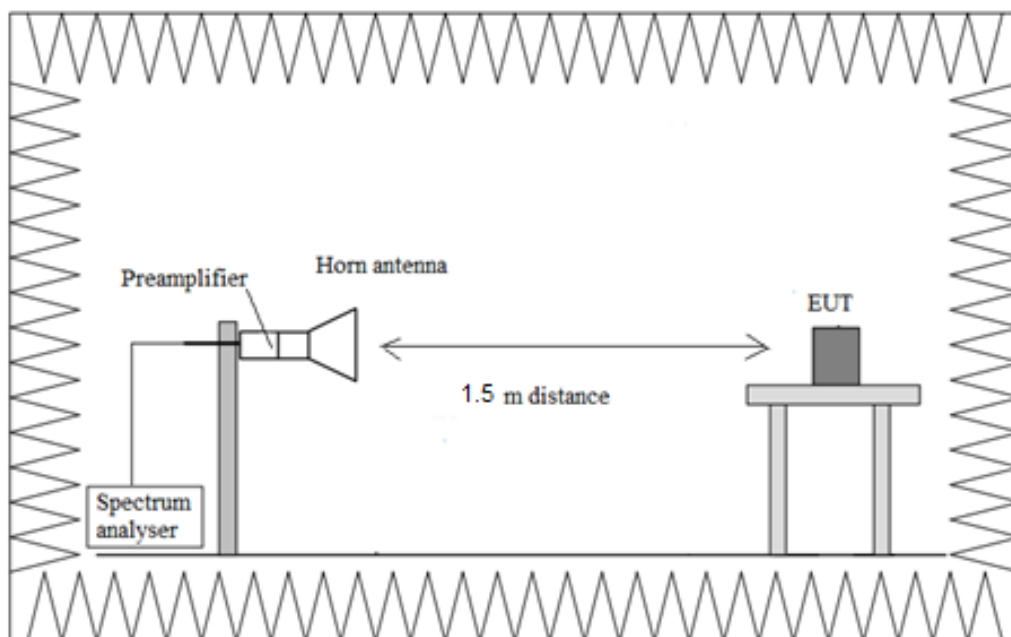
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup  $f > 17$  GHz:



## Occupied Channel Bandwidth 99%

**Limits**

\* RSS-Gen Clause 6.7:

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Modulation: LoRa

Mode: SISO

**Results**

| Freq (MHz) | Occ Ch BW (kHz) |
|------------|-----------------|
| 2403       | 849             |
| 2425       | 848.7           |
| 2479       | 844.5           |

**Verdict**

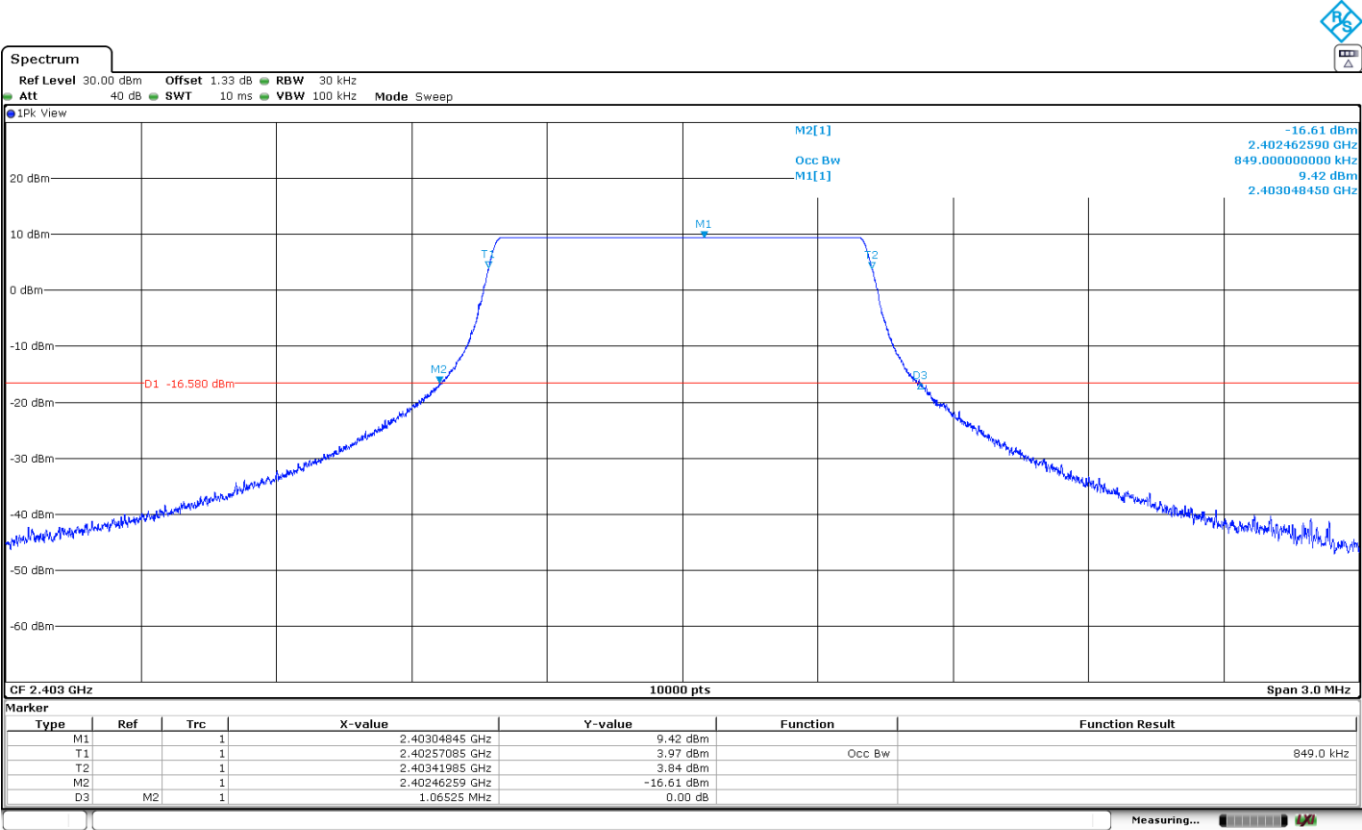
Pass



Attachments

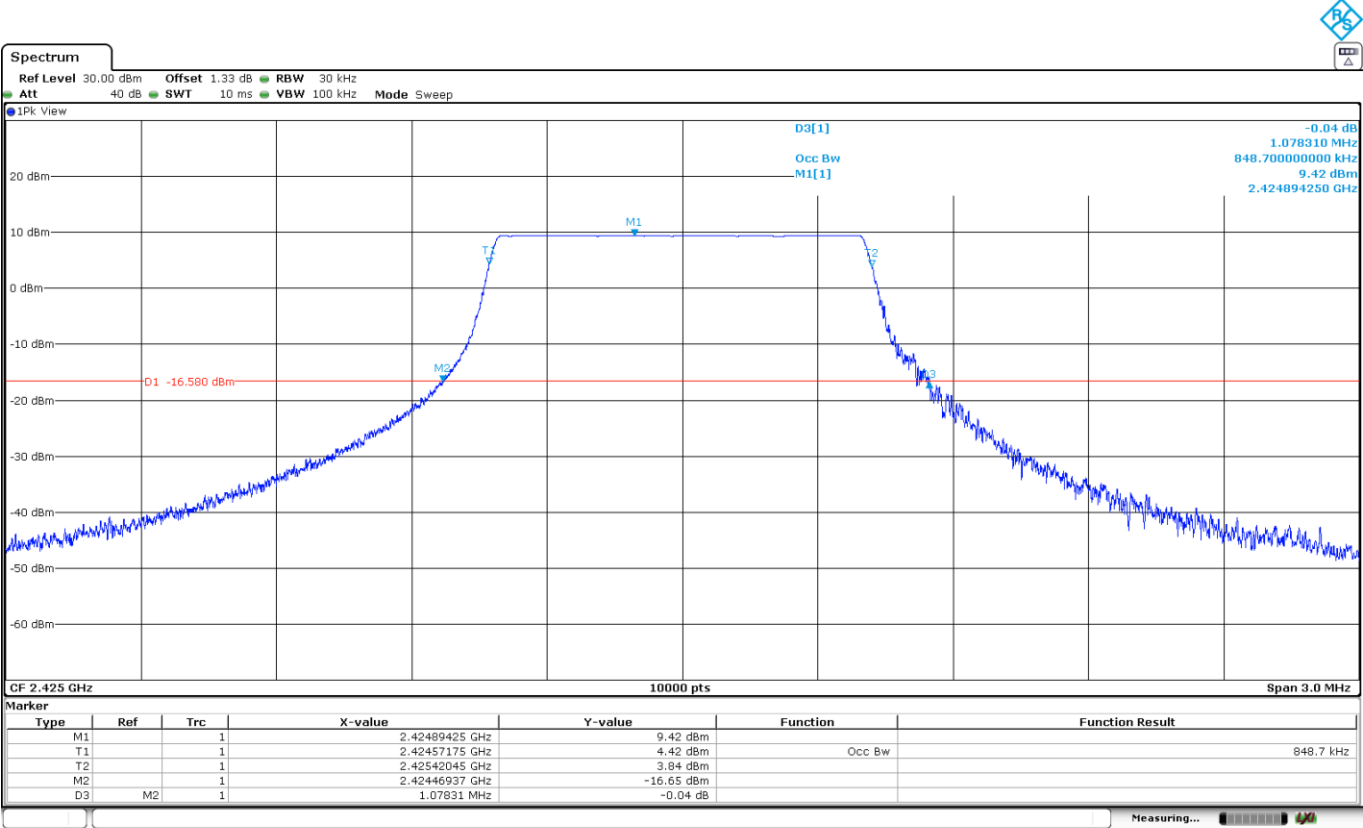
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2403  
Mode = SISO    Active Port = 1

Images:



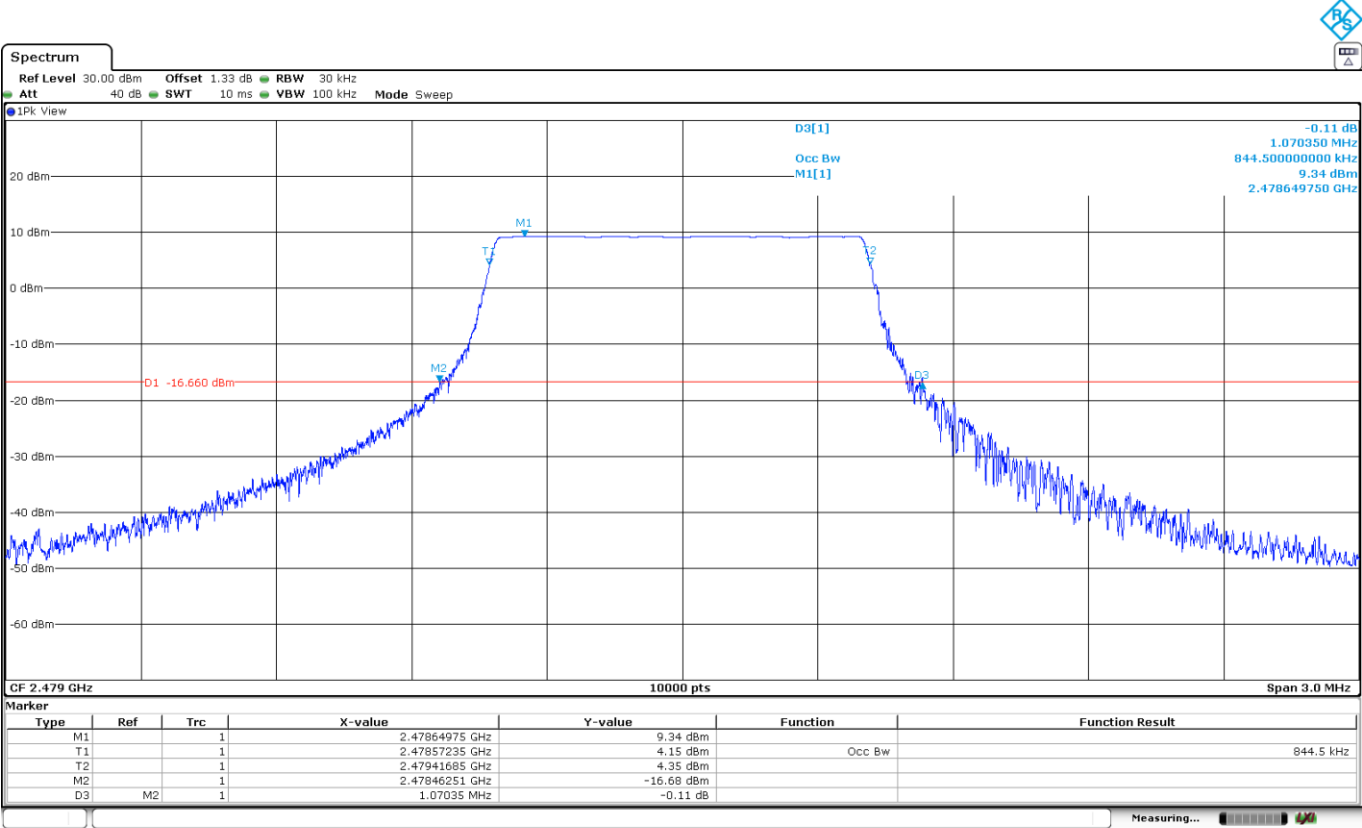
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2425  
Mode = SISO    Active Port = 1

Images:



Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2479  
Mode = SISO    Active Port = 1

Images:



RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6 dB Bandwidth

Limits

The minimum 6 dB bandwidth shall be at least 500 kHz.

Modulation: LoRa

Mode: SISO

Results

| Freq (MHz) | Ebw (kHz) |
|------------|-----------|
| 2403       | 851.42    |
| 2425       | 851.52    |
| 2479       | 848.45    |

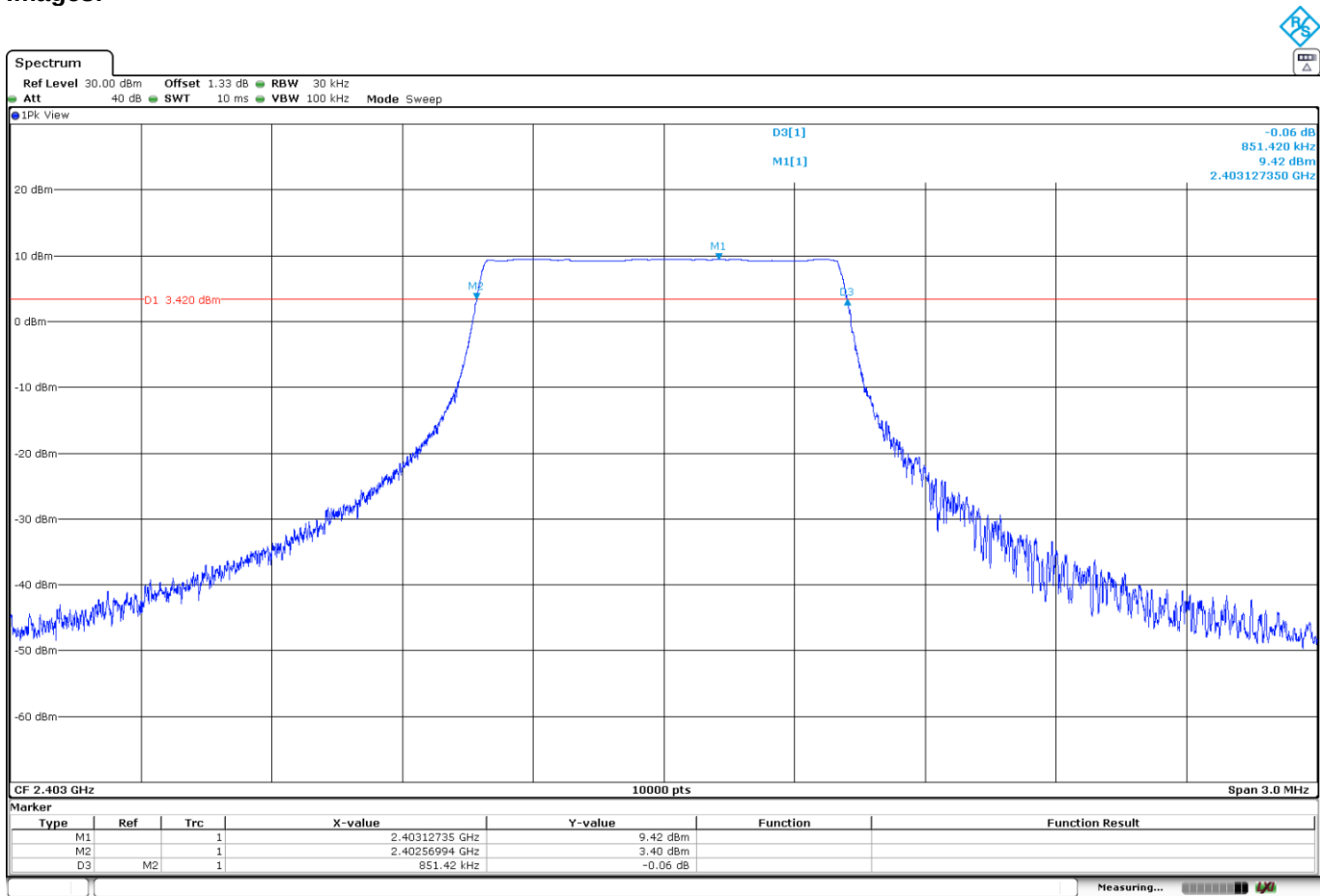
Verdict

Pass

Attachments

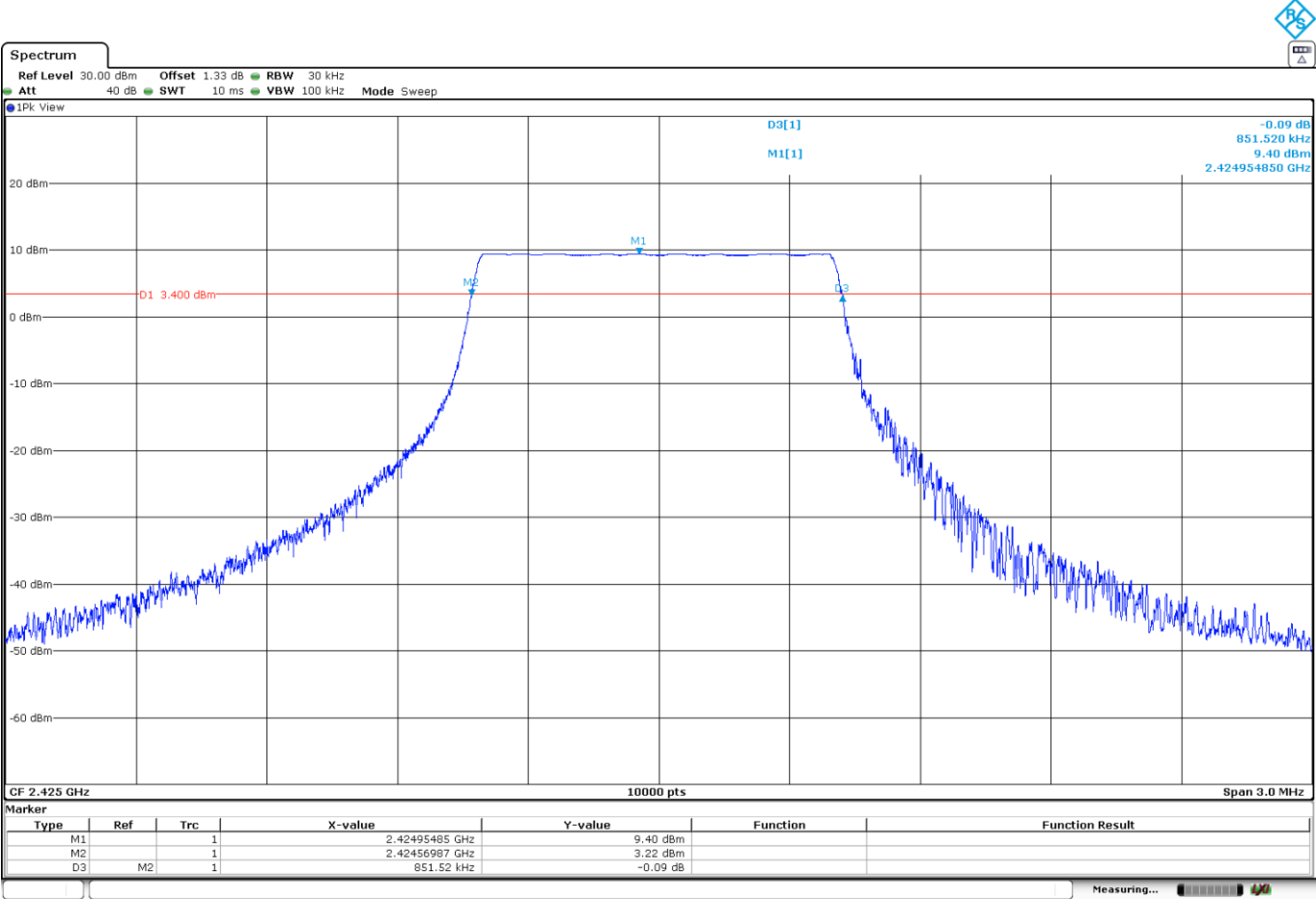
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Frequency MHz = 2403    Mode = SISO  
Active Port = 1

Images:



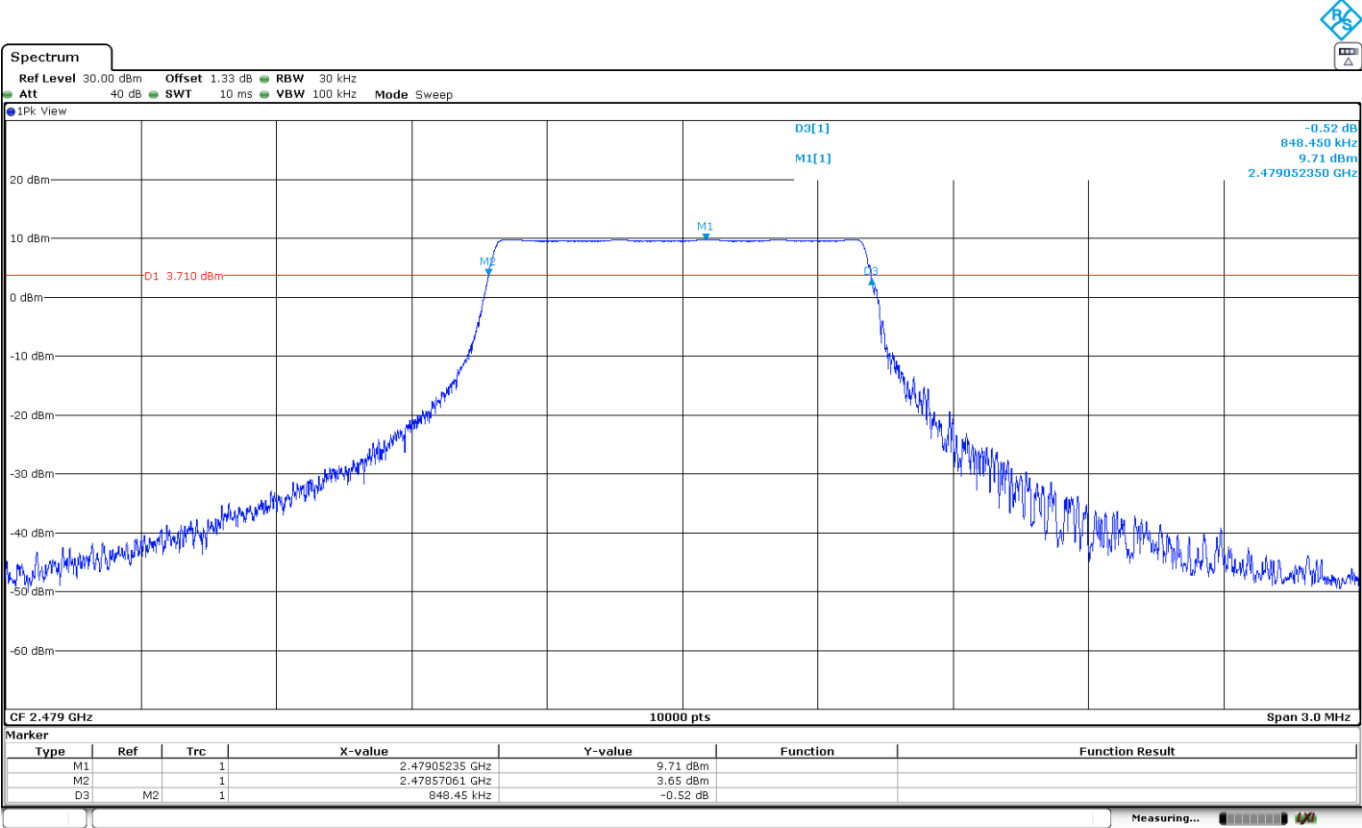
Bandwidth MHz = 1      Modulation = LoRa  
Frequency MHz = 2425    Mode = SISO  
Active Port = 1

Images:



Bandwidth MHz = 1      Modulation = LoRa  
Frequency MHz = 2479    Mode = SISO  
Active Port = 1

Images:



RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density

Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Modulation: LoRa

Mode: SISO

Results

| Freq (MHz) | PSD (dBm) |
|------------|-----------|
| 2403       | 2.71      |
| 2425       | 2.84      |
| 2479       | 2.85      |

Verdict

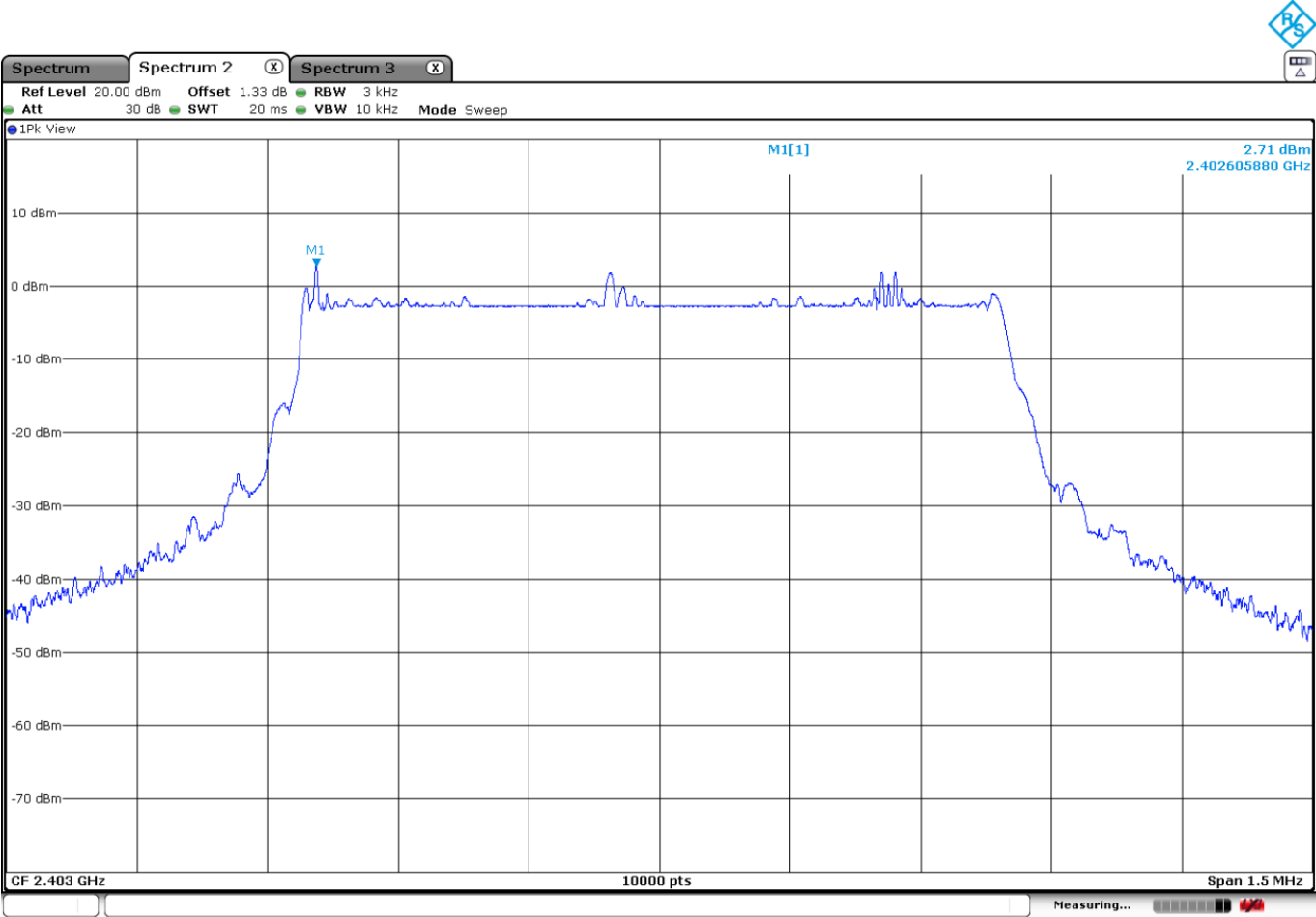
Pass



Attachments

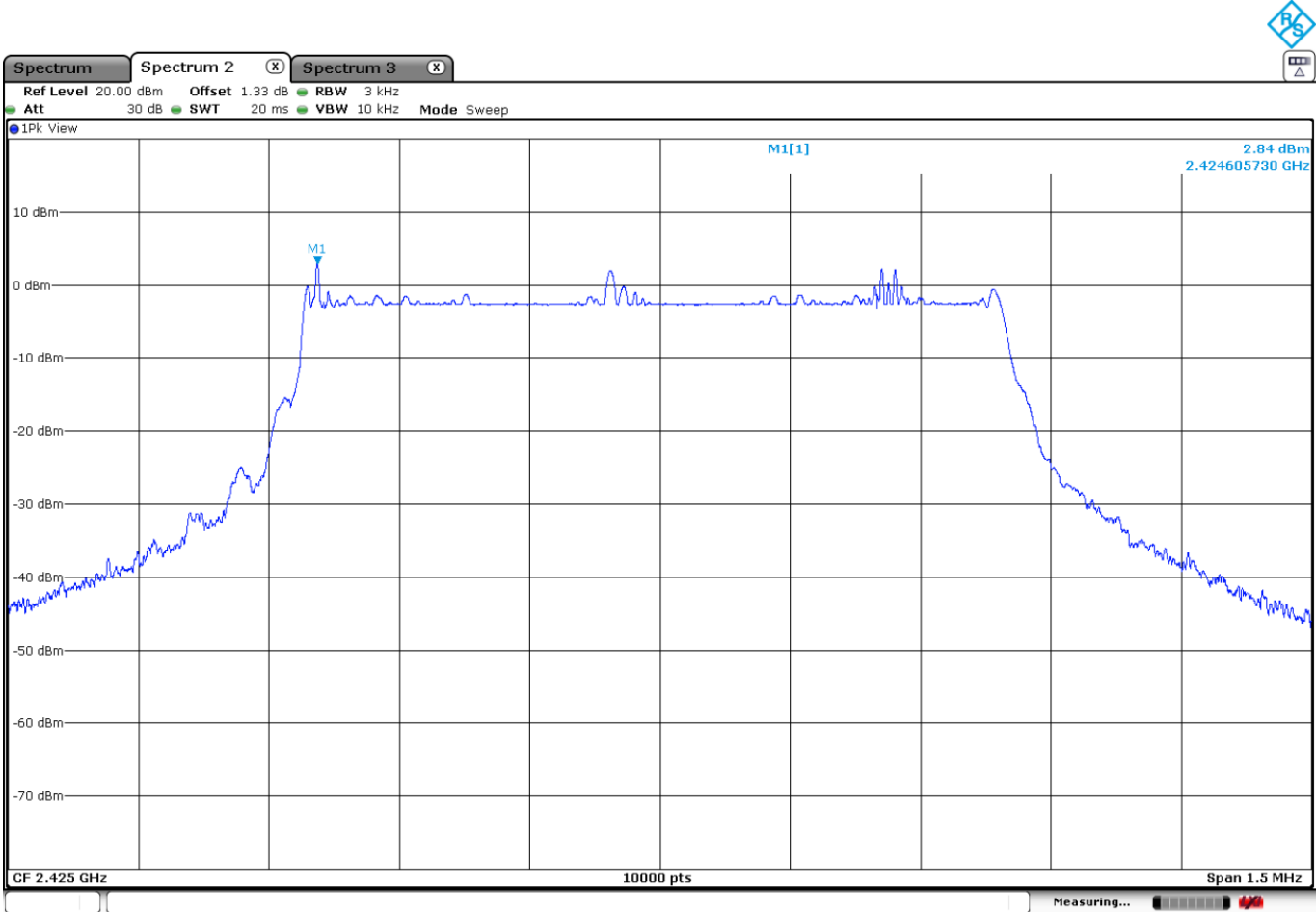
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2403  
Mode = SISO    Active Port = 1

Images:



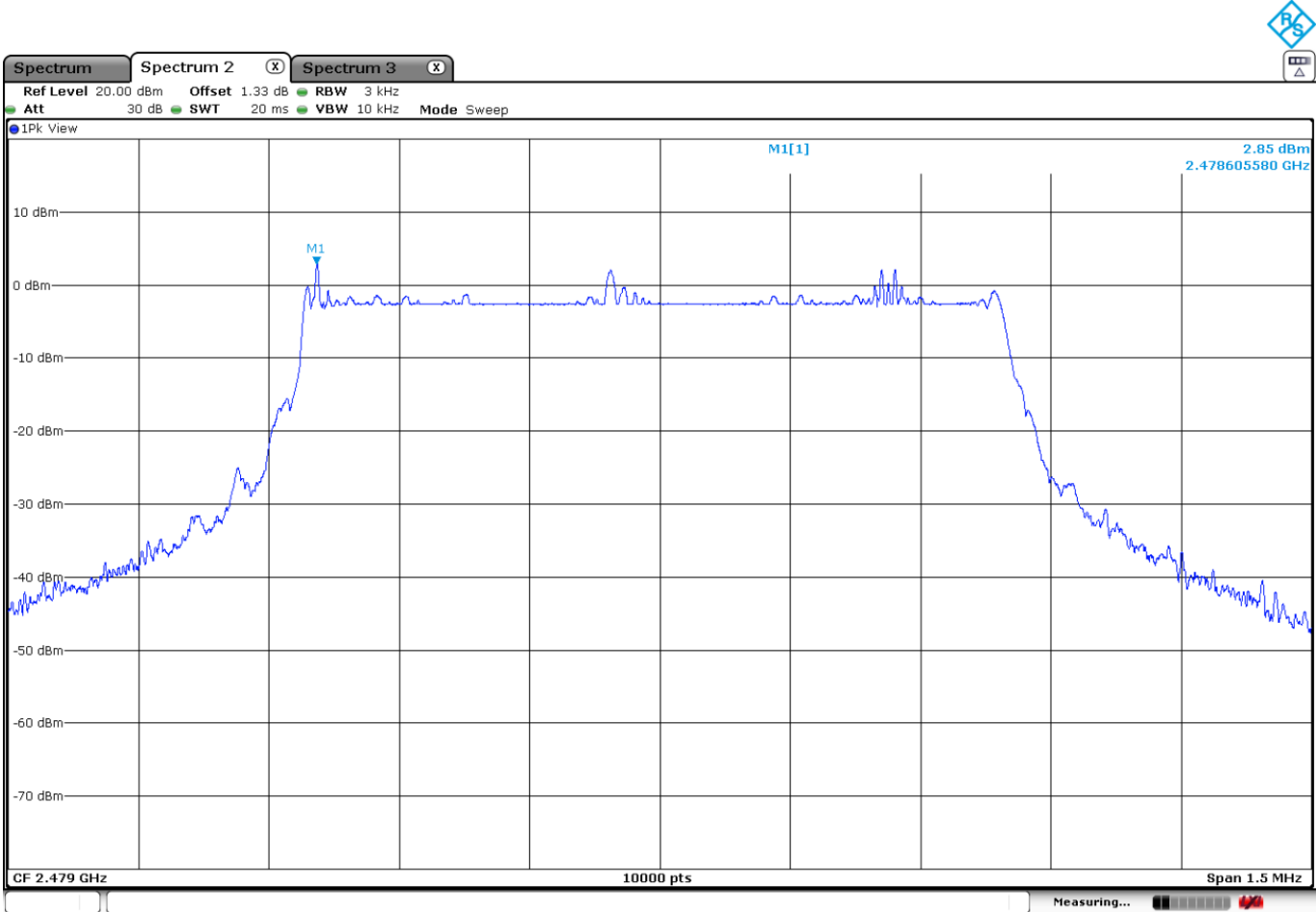
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2425  
Mode = SISO    Active Port = 1

Images:



Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2479  
Mode = SISO    Active Port = 1

Images:



# RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum output power and antenna gain

**Limits**

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).  
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

Modulation: LoRa  
Mode: SISO

**Results**

The maximum peak conducted output power level in the fundamental emission was measured using the method according to point 11.9.1.1 "RBW ≥ DTS bandwidth" of ANSI C.63.10-2013.

Measured Duty Cycle:  $x = 0.50535$   
Duty Cycle Correction:  $10 \times \log(1/x) = 2.964 \text{ dB}$

Declared Antenna Gain External: 2 dBi

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

| Freq (MHz) | Power (dBm) | Power with Duty Cycle correction (dBm) | E.I.R.P. (dBm) |
|------------|-------------|----------------------------------------|----------------|
| 2403       | 8.87        | 11,83                                  | 13.83          |
| 2425       | 8.81        | 11,77                                  | 13.77          |
| 2479       | 8.68        | 11,64                                  | 13.64          |

Declared Antenna Gain FPC: 3.9 dBi

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

| Freq (MHz) | Power (dBm) | Power with Duty Cycle correction (dBm) | E.I.R.P. (dBm) |
|------------|-------------|----------------------------------------|----------------|
| 2403       | 8.87        | 11,83                                  | 15.73          |
| 2425       | 8.81        | 11,77                                  | 15.67          |
| 2479       | 8.68        | 11,64                                  | 15.54          |

**Verdict**

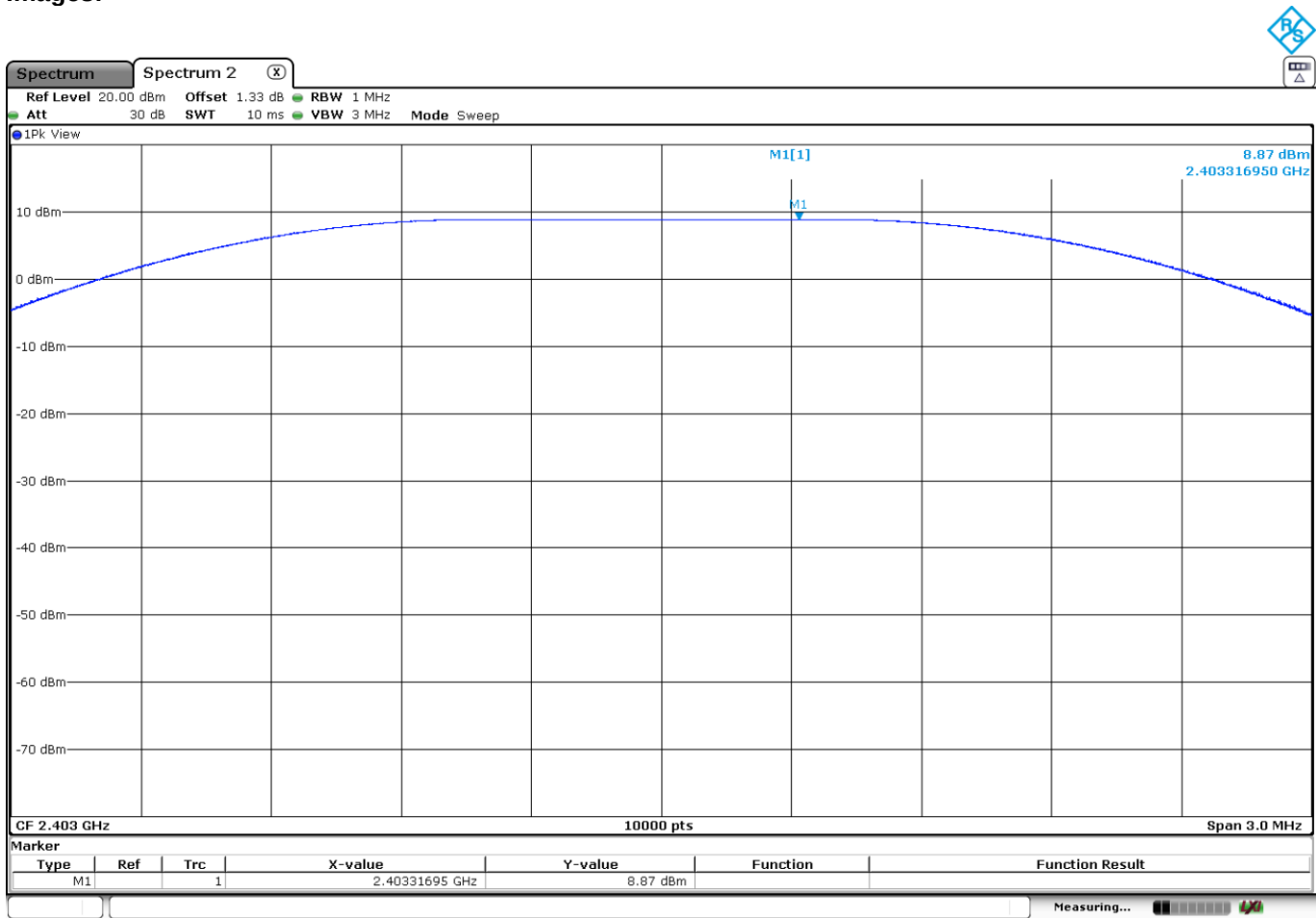
Pass

Maximum Average Output Power:

Attachments

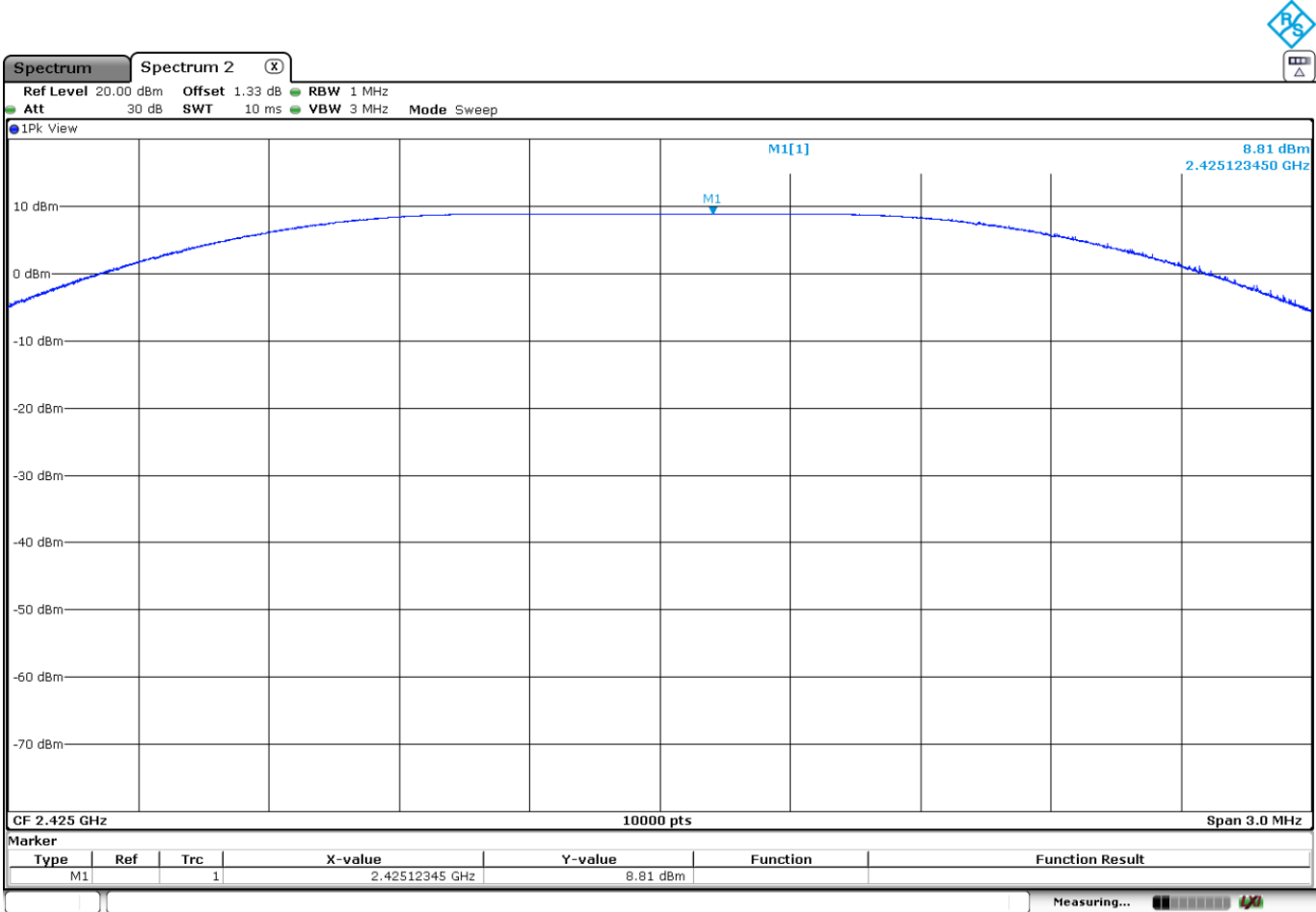
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2403  
Mode = SISO    Active Port = 1

Images:



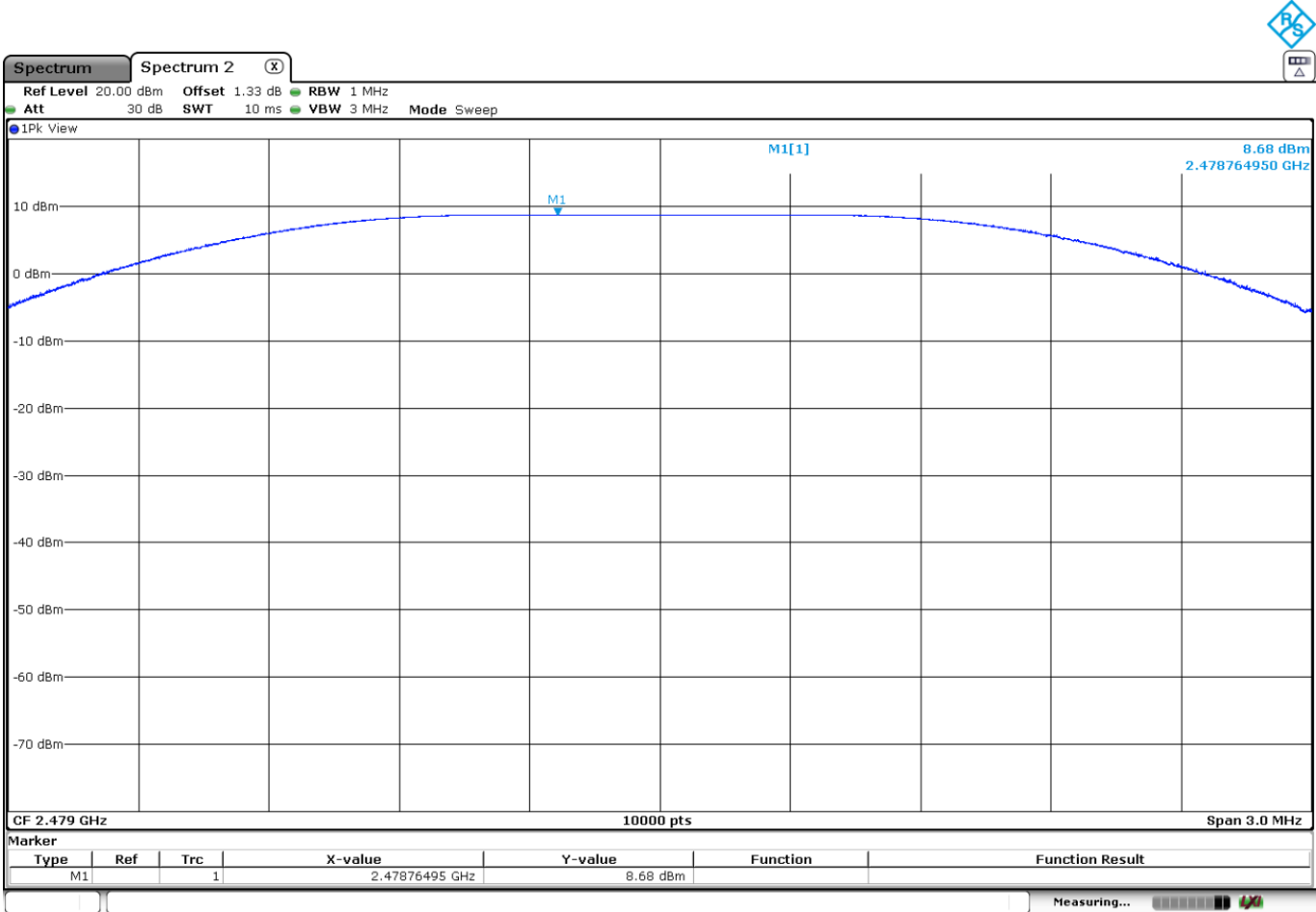
Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2425  
Mode = SISO    Active Port = 1

Images:



Equipment Type = Digital Transmission System (DTS)    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 2479  
Mode = SISO    Active Port = 1

Images:



# RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter)

**Limits**

In any 100 kHz bandwidths outside the frequency band in which the 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Modulation: LoRa

Mode: SISO

**Results**

The attenuation of highest emissions at the band-edge is more than 30 dB respect to the highest level of the desired power.

| Channel Frequency<br>(MHz) | Frequency<br>(MHz) | Inband Peak Lvl<br>(dBm) |
|----------------------------|--------------------|--------------------------|
| 2403                       | 2.4029455          | 8.53                     |
| 2479                       | 2.4788541          | 8.47                     |

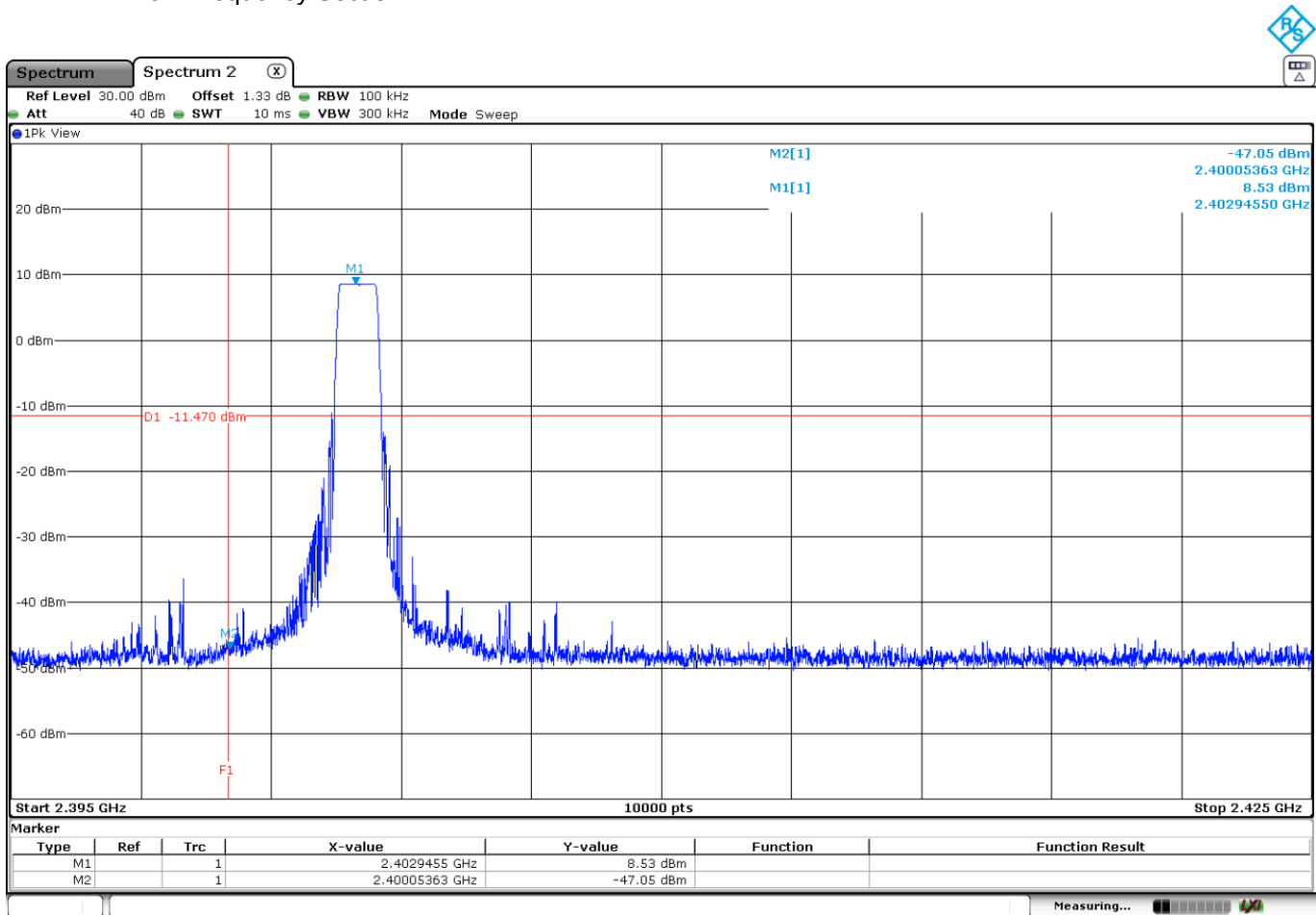
**Verdict**

Pass

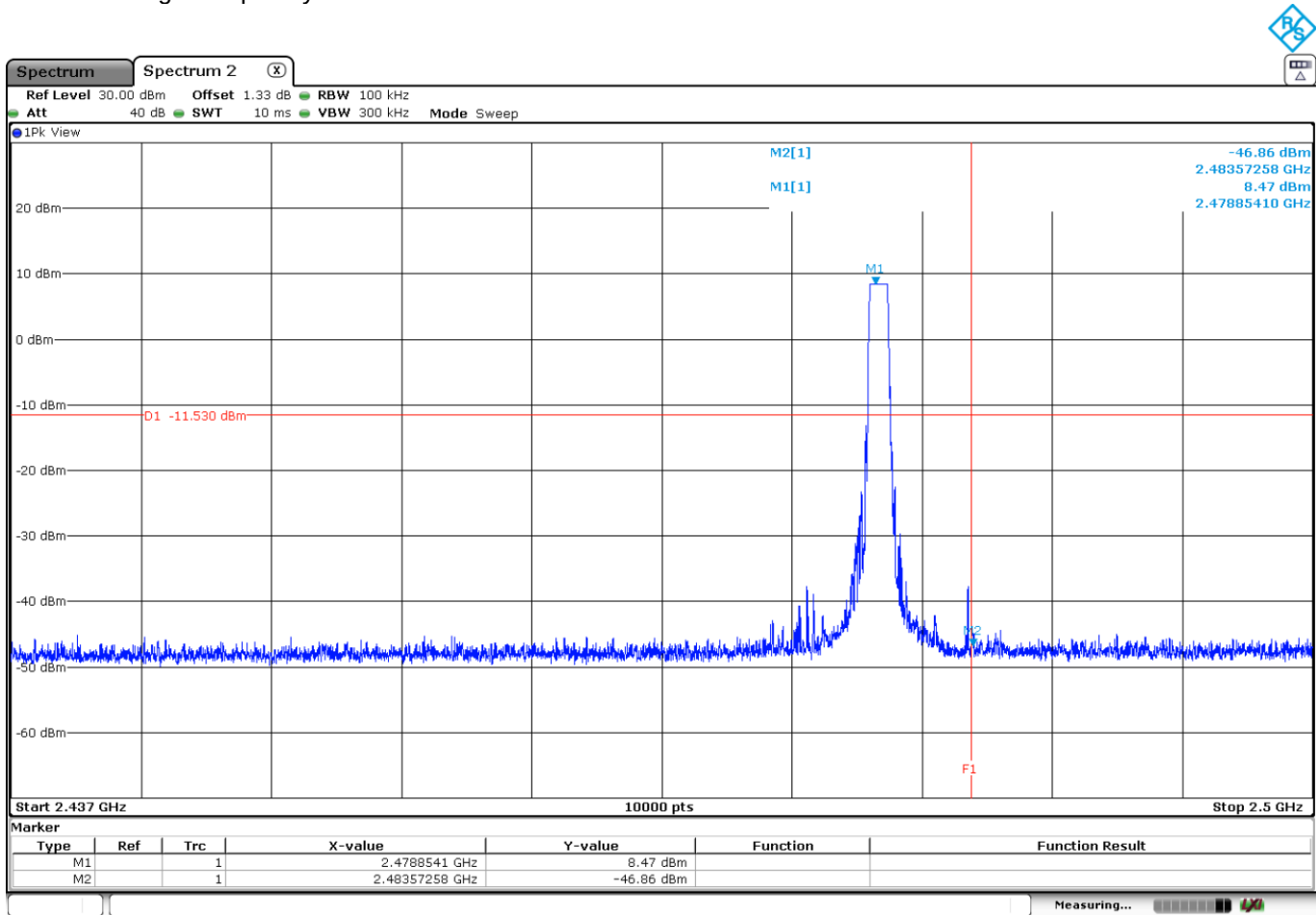


Attachments

- Low Frequency Section:



- High Frequency Section:



# RSS-247 5.5 / FCC 15.247 (d) [RSE] Emission limitations radiated (Transmitter)

## Limits

\* FCC 15.247:  
Radiated emissions which fall in the restricted bands, 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)/RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|-----------------------|-----------------------|-------------------------|--------------------------|
| 0.009-0.490           | 2400/F(kHz)           | -                       | 300                      |
| 0.490-1.705           | 24000/F(kHz)          | -                       | 30                       |
| 1.705 - 30.0          | 30                    | -                       | 30                       |
| 30 - 88               | 100                   | 40                      | 3                        |
| 88 - 216              | 150                   | 43.5                    | 3                        |
| 216 - 960             | 200                   | 46                      | 3                        |
| Above 960             | 500                   | 54                      | 3                        |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

\* RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

## Frequency range tested for Radiated emissions

Start frequency: no radiofrequency signal generated in the device found below 10<sup>th</sup> sub-armonic, no further investigation required.

Stop frequency: it has been performed the radiated spurious emissions until 10<sup>th</sup> armonic.

Modulation: LoRa

MIMO Mode: SISO

## Results

| Freq Rng (GHz) | Freq (MHz) | Unwanted Freq (MHz) | Unwanted Lvl (dBµV/m) | Pol | Detector |
|----------------|------------|---------------------|-----------------------|-----|----------|
| [0.03, 1]      | 2403       | 35.972              | 28.07                 | V   | QP       |
| [0.03, 1]      | 2403       | 39.458              | 34.25                 | V   | QP       |
| [0.03, 1]      | 2403       | 44.035              | 27.70                 | V   | QP       |
| [0.03, 1]      | 2403       | 48.006              | 30.43                 | V   | QP       |
| [0.03, 1]      | 2403       | 59.918              | 34.51                 | V   | QP       |
| [0.03, 1]      | 2403       | 62.737              | 25.81                 | V   | QP       |
| [0.03, 1]      | 2403       | 71.953              | 25.50                 | V   | QP       |
| [0.03, 1]      | 2403       | 83.956              | 24.78                 | V   | QP       |
| [0.03, 1]      | 2425       | 30.303              | 32.44                 | V   | QP       |
| [0.03, 1]      | 2425       | 31.182              | 34.06                 | V   | QP       |

| Freq Rng (GHz) | Freq (MHz) | Unwanted Freq (MHz) | Unwanted Lvl (dBµV/m) | Pol | Detector |
|----------------|------------|---------------------|-----------------------|-----|----------|
| [0.03, 1]      | 2425       | 32.728              | 38.05                 | H   | QP       |
| [0.03, 1]      | 2425       | 34.880              | 30.08                 | V   | QP       |
| [0.03, 1]      | 2425       | 36.002              | 34.75                 | V   | QP       |
| [0.03, 1]      | 2425       | 38.972              | 29.69                 | H   | QP       |
| [0.03, 1]      | 2425       | 45.035              | 27.38                 | H   | QP       |
| [0.03, 1]      | 2425       | 50.976              | 23.75                 | V   | QP       |
| [0.03, 1]      | 2425       | 71.983              | 22.25                 | H   | QP       |
| [0.03, 1]      | 2479       | 35.972              | 27.84                 | V   | QP       |
| [0.03, 1]      | 2479       | 40.367              | 34.66                 | V   | QP       |
| [0.03, 1]      | 2479       | 43.368              | 30.86                 | V   | QP       |
| [0.03, 1]      | 2479       | 47.975              | 30.92                 | V   | QP       |
| [0.03, 1]      | 2479       | 59.918              | 36.71                 | V   | QP       |
| [0.03, 1]      | 2479       | 71.922              | 25.29                 | V   | QP       |
| [0.03, 1]      | 2479       | 83.926              | 23.57                 | V   | QP       |
| [1, 3]         | 2479       | 2484.338            | 68.79                 | H   | PK       |
| [1, 3]         | 2479       | 2484.338            | 49.73                 | H   | AVG      |
| [3, 17]        | 2403       | 12015.580           | 54.54                 | V   | PK       |
| [3, 17]        | 2403       | 12015.580           | 43.80                 | V   | AVG      |
| [3, 17]        | 2425       | 7275.740            | 58.18                 | H   | PK       |
| [3, 17]        | 2425       | 7275.740            | 52.82                 | H   | AVG      |
| [3, 17]        | 2425       | 12125.200           | 57.46                 | V   | PK       |
| [3, 17]        | 2425       | 12125.200           | 48.71                 | V   | AVG      |
| [17, 26]       | 2403       | 19224.500           | 54.58                 | V   | PK       |
| [17, 26]       | 2403       | 19224.500           | 45.85                 | V   | AVG      |
| [17, 26]       | 2479       | 19831.700           | 50.31                 | V   | PK       |

Verdict

Pass

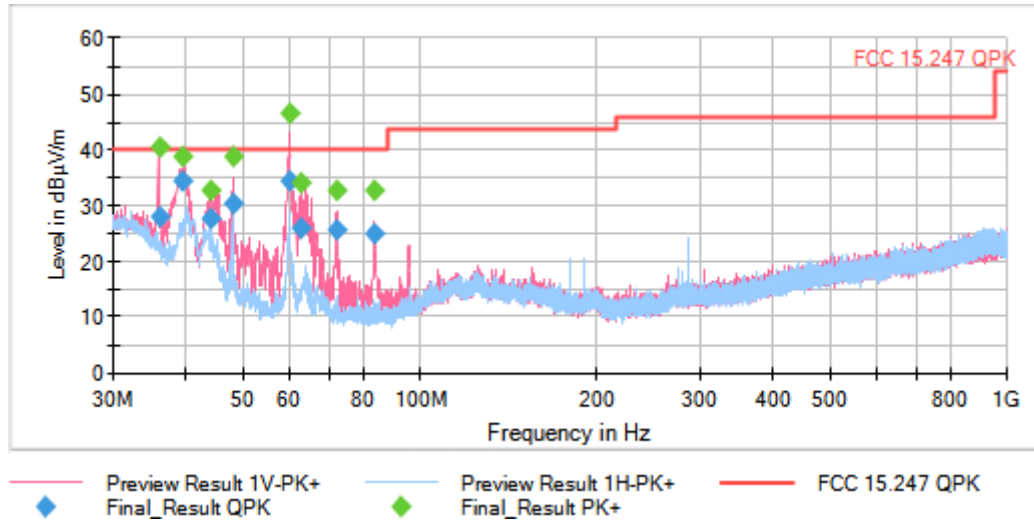
## Attachments

Frequency Range GHz = [0.03, 1] Equipment Type = Digital Transmission System (DTS)

Modulation = LoRa Frequency MHz = 2403

MIMO Mode = SISO Active Port = 1

## Images:

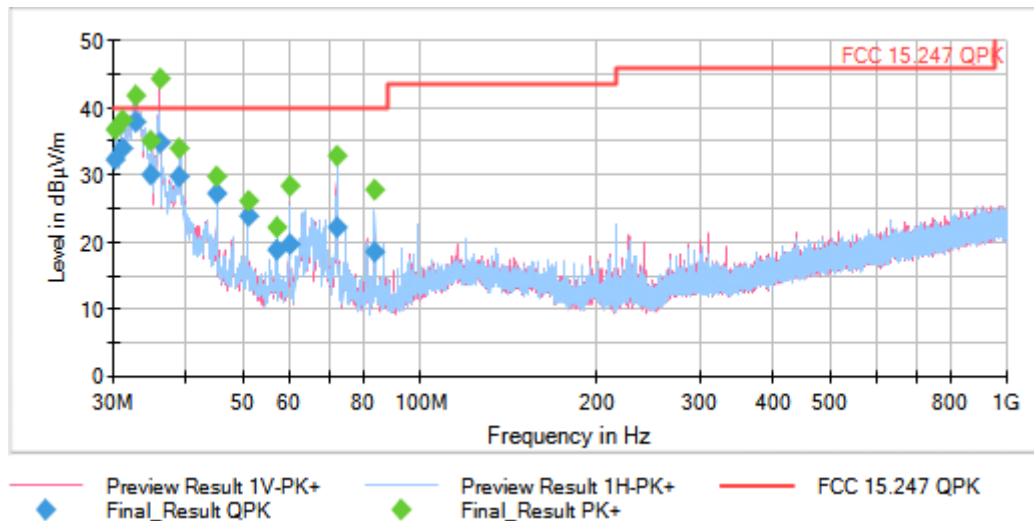


Frequency Range GHz = [0.03, 1] Equipment Type = Digital Transmission System (DTS)

Modulation = LoRa Frequency MHz = 2425

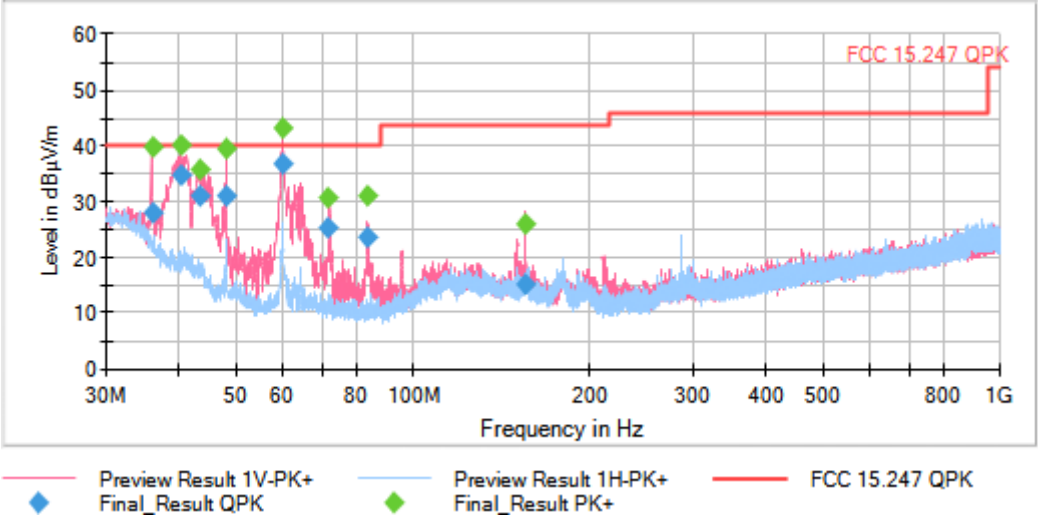
MIMO Mode = SISO Active Port = 1

## Images:



Frequency Range GHz = [0.03, 1]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2479  
MIMO Mode = SISO    Active Port = 1

Images:



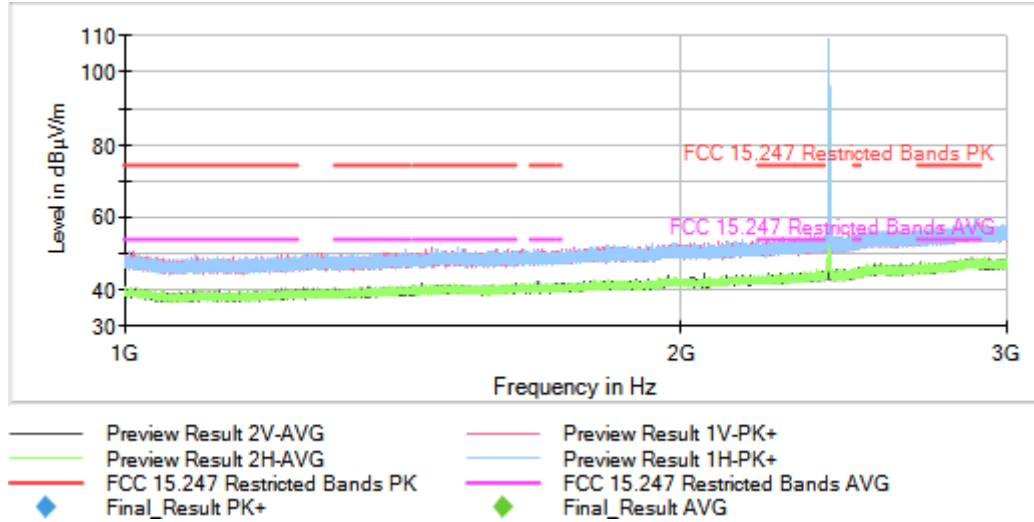
Tables:

Spectrum Analyzer Parameters

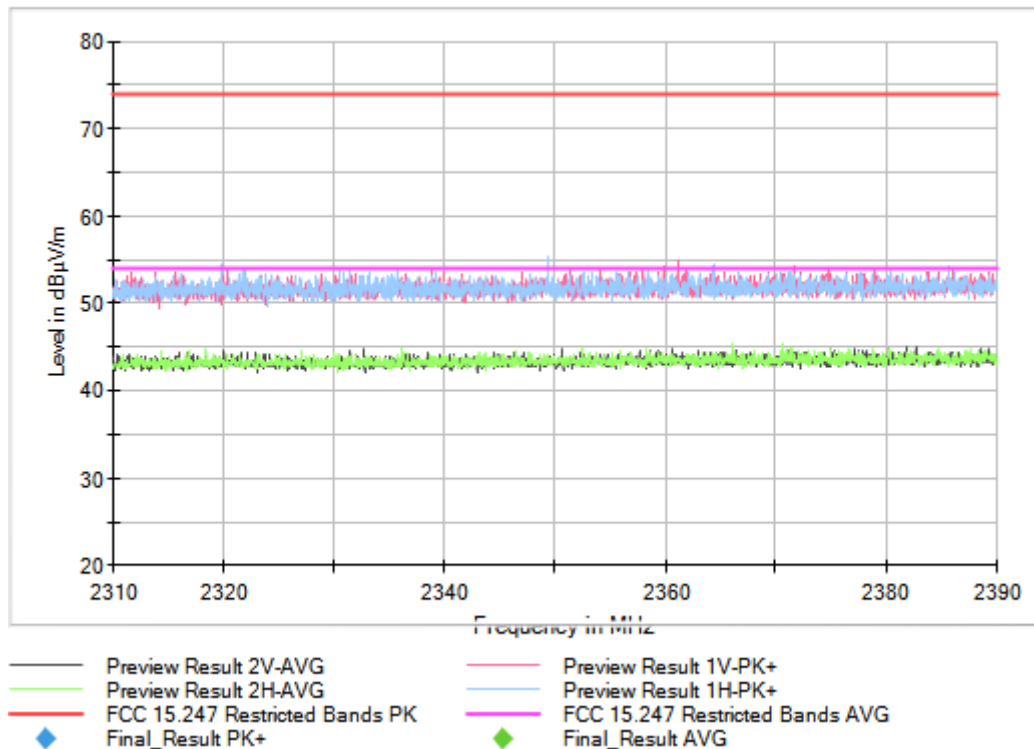
|  | Subrange          | Step Size  | Detectors | Bandwidth | Sweep Time | Preamp |
|--|-------------------|------------|-----------|-----------|------------|--------|
|  | Receiver: [ESR 7] |            |           |           |            |        |
|  | 30 MHz - 1 GHz    | 30,312 kHz | PK+       | 100 kHz   | 1 s        | 0 dB   |

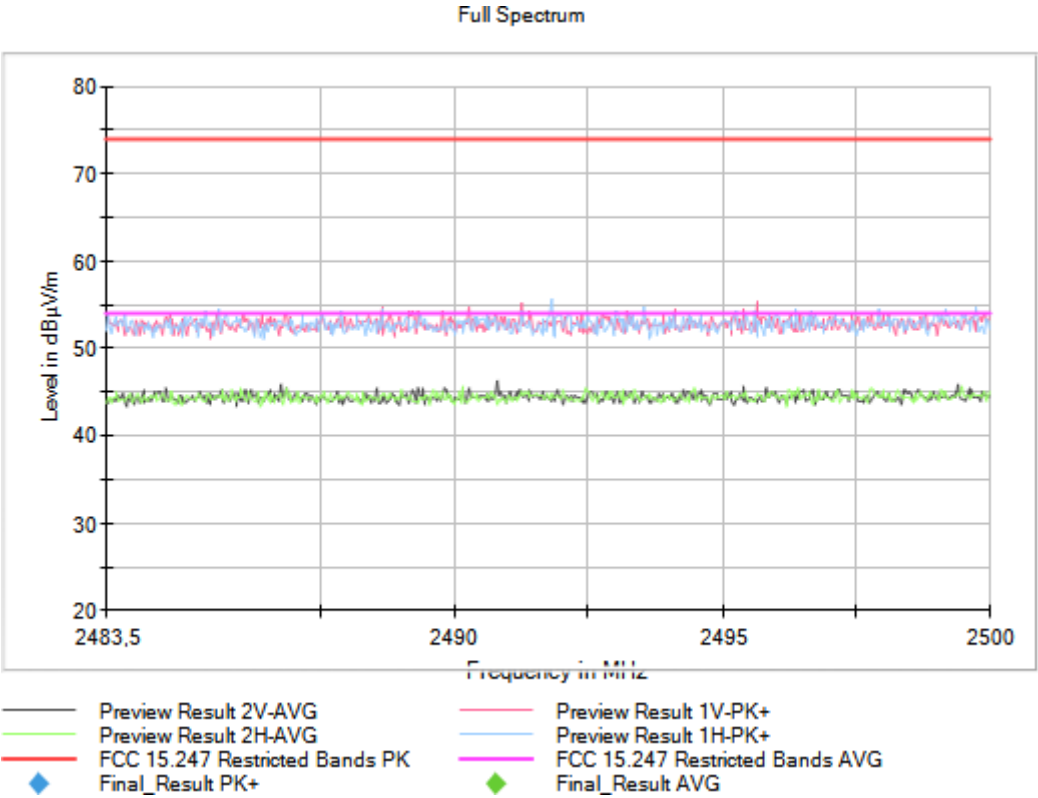
Frequency Range GHz = [1, 3]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2403  
MIMO Mode = SISO    Active Port = 1

**Images:**



Full Spectrum





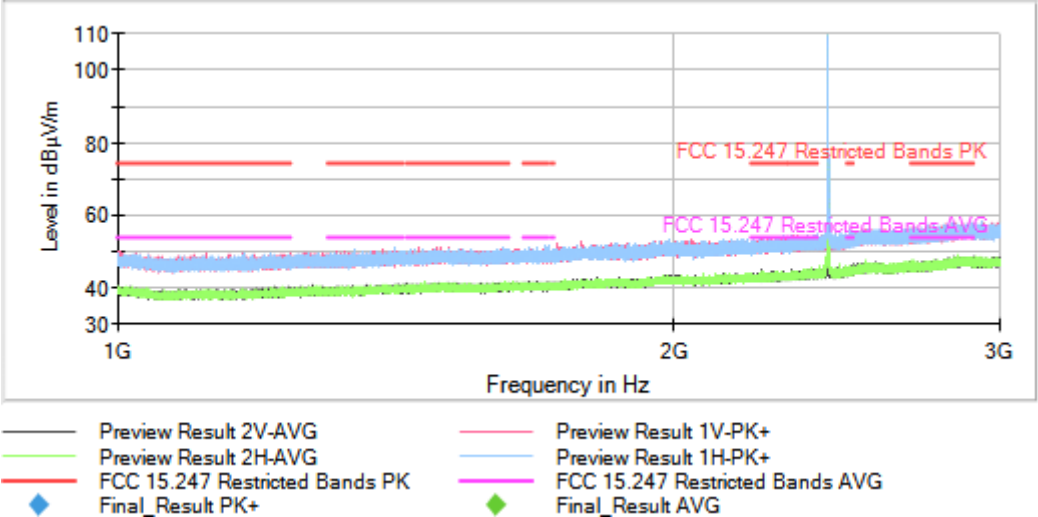
Tables:  
Spectrum Analyzer Parameters

|  | Subrange          | Step Size  | Detectors | Bandwidth | Sweep Time | Preamp |
|--|-------------------|------------|-----------|-----------|------------|--------|
|  | Receiver: [ESR 7] |            |           |           |            |        |
|  | 1 GHz - 3 GHz     | 30,769 kHz | PK+ ; AVG | 1 MHz     | 1 s        | 0 dB   |

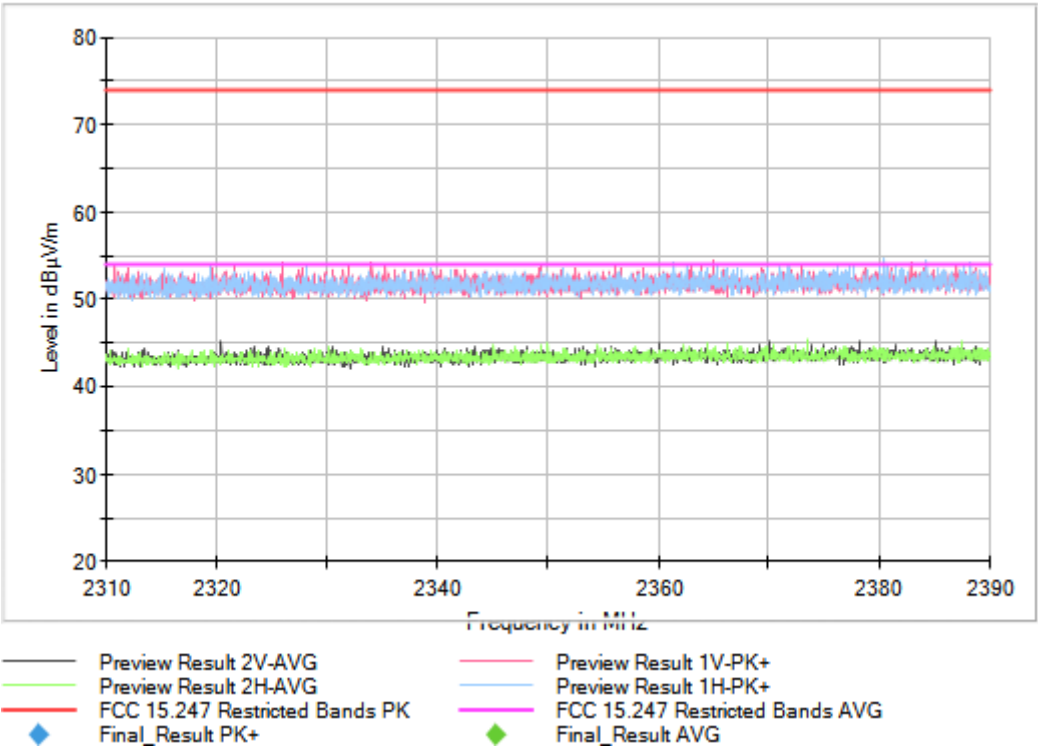


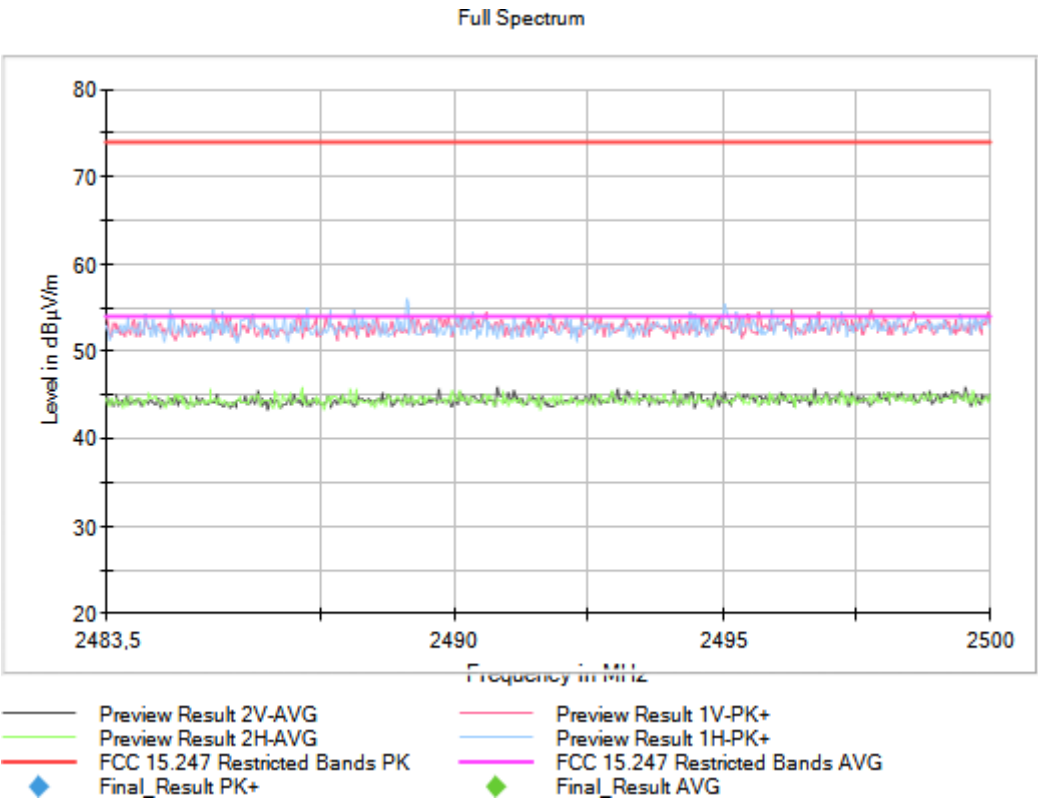
Frequency Range GHz = [1, 3]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2425  
MIMO Mode = SISO    Active Port = 1

Images:



Full Spectrum



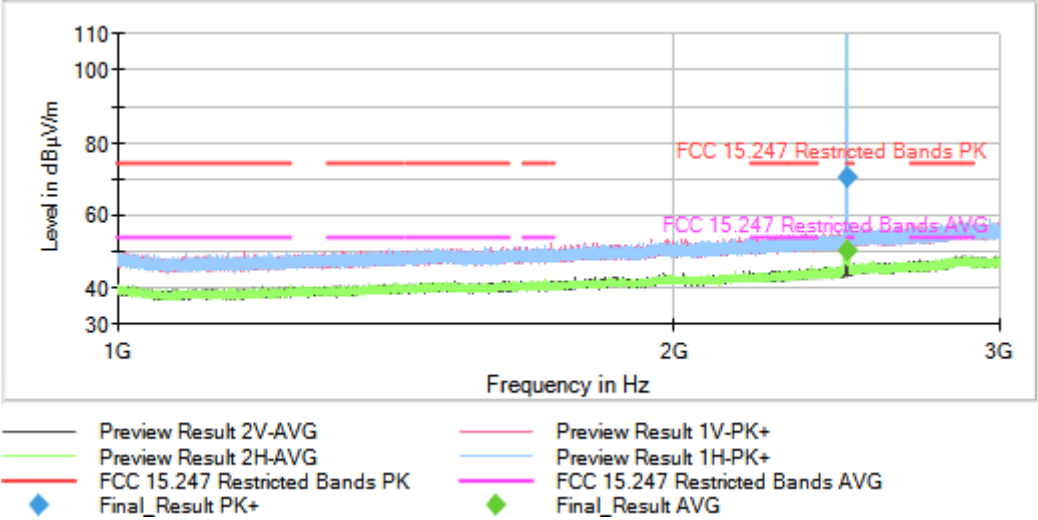


Tables:  
Spectrum Analyzer Parameters

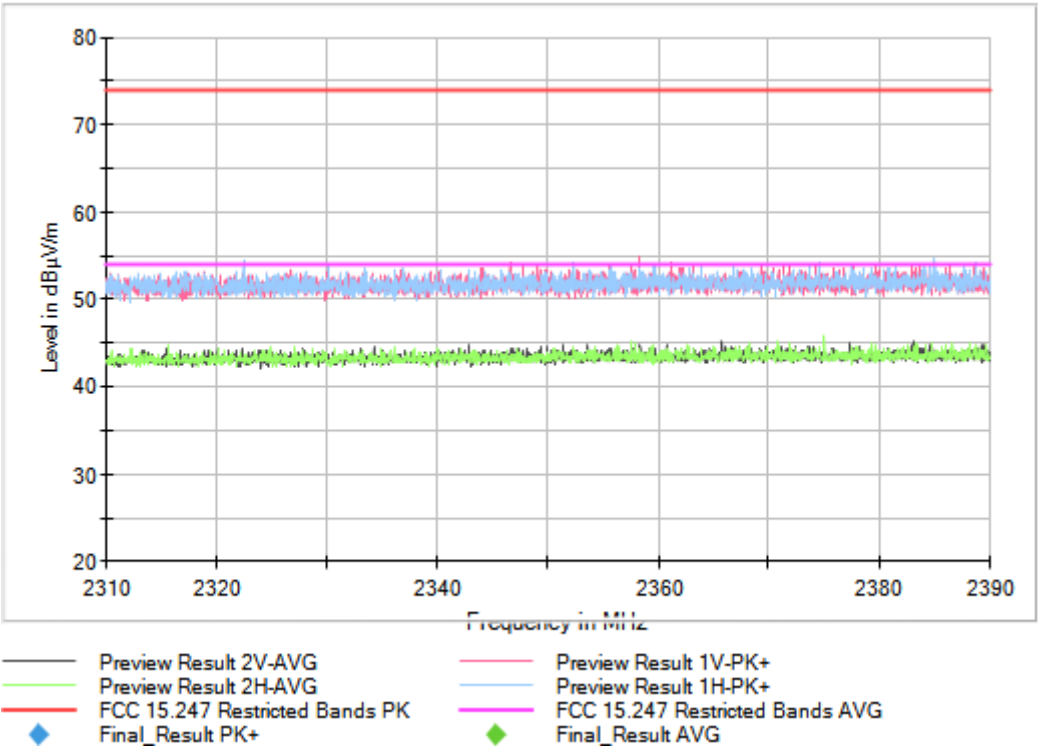
| Subrange          | Step Size  | Detectors | Bandwidth | Sweep Time | Preamp |
|-------------------|------------|-----------|-----------|------------|--------|
| Receiver: [ESR 7] |            |           |           |            |        |
| 1 GHz - 3 GHz     | 30,769 kHz | PK+ ; AVG | 1 MHz     | 1 s        | 0 dB   |

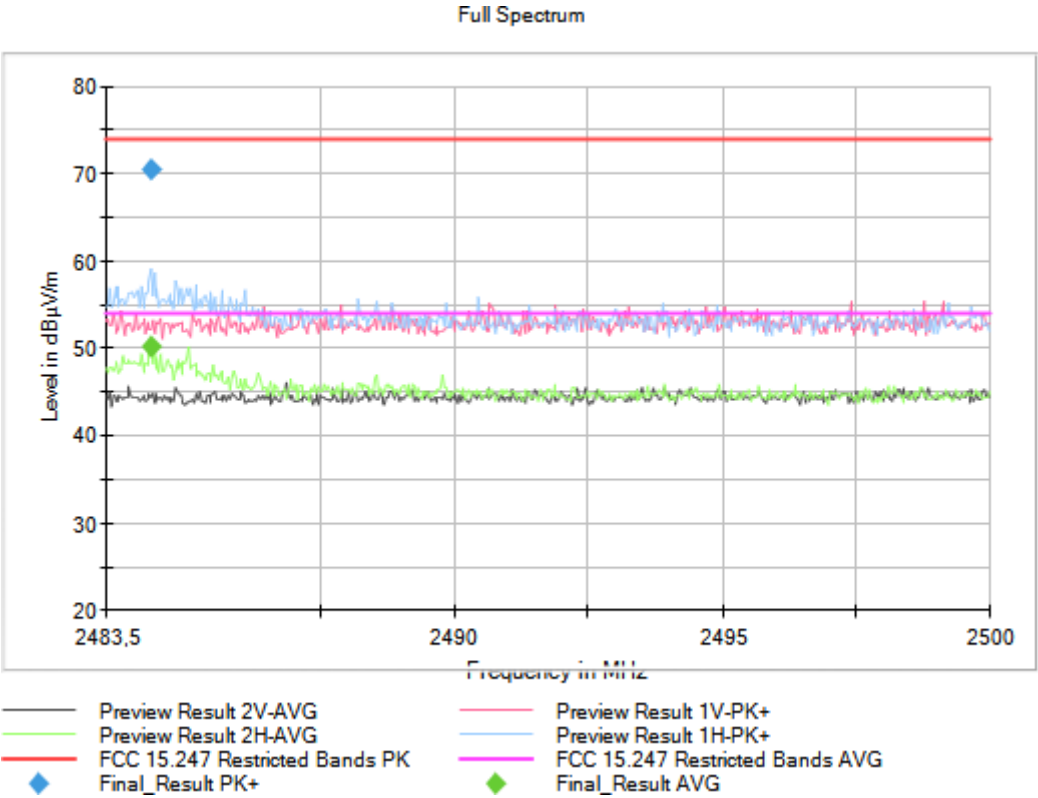
Frequency Range GHz = [1, 3]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2479  
MIMO Mode = SISO    Active Port = 1

Images:



Full Spectrum





Tables:  
Spectrum Analyzer Parameters

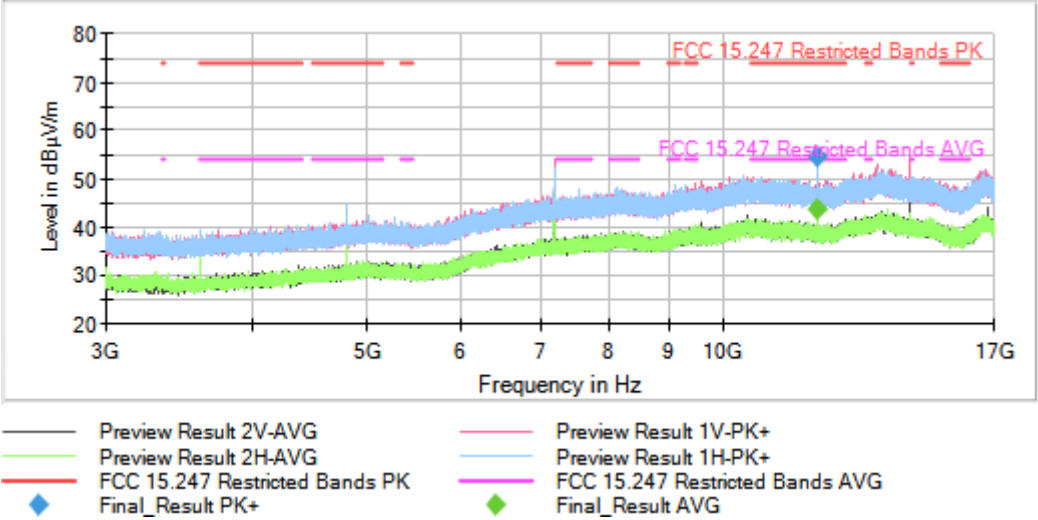
|  | Subrange          | Step Size  | Detectors | Bandwidth | Sweep Time | Preamp |
|--|-------------------|------------|-----------|-----------|------------|--------|
|  | Receiver: [ESR 7] |            |           |           |            |        |
|  | 1 GHz - 3 GHz     | 30,769 kHz | PK+ ; AVG | 1 MHz     | 1 s        | 0 dB   |

Frequency Range GHz = [3, 17]    Equipment Type = Digital Transmission System (DTS)

Modulation = LoRa                      Frequency MHz = 2403

MIMO Mode = SISO                      Active Port = 1

Images:

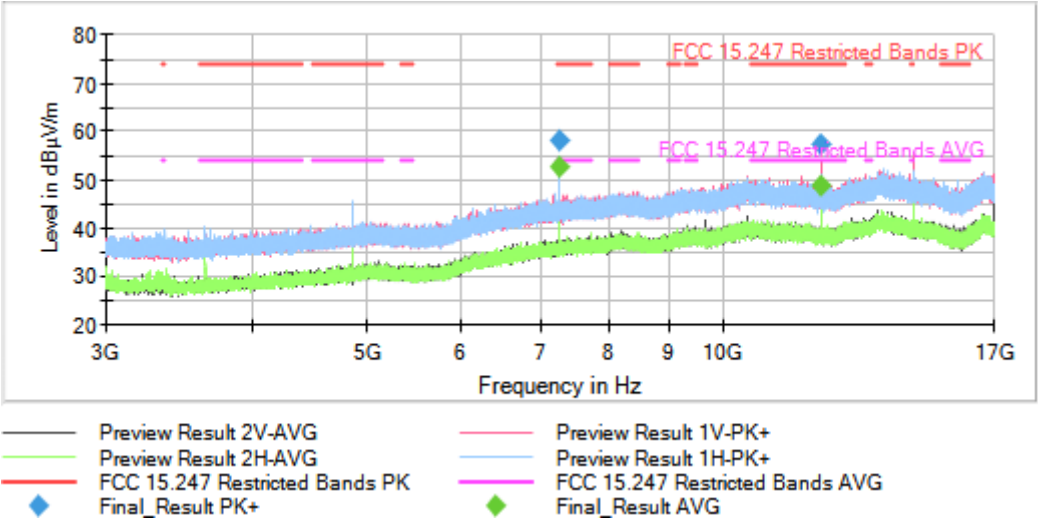


Frequency Range GHz = [3, 17]    Equipment Type = Digital Transmission System (DTS)

Modulation = LoRa                      Frequency MHz = 2425

MIMO Mode = SISO                      Active Port = 1

Images:



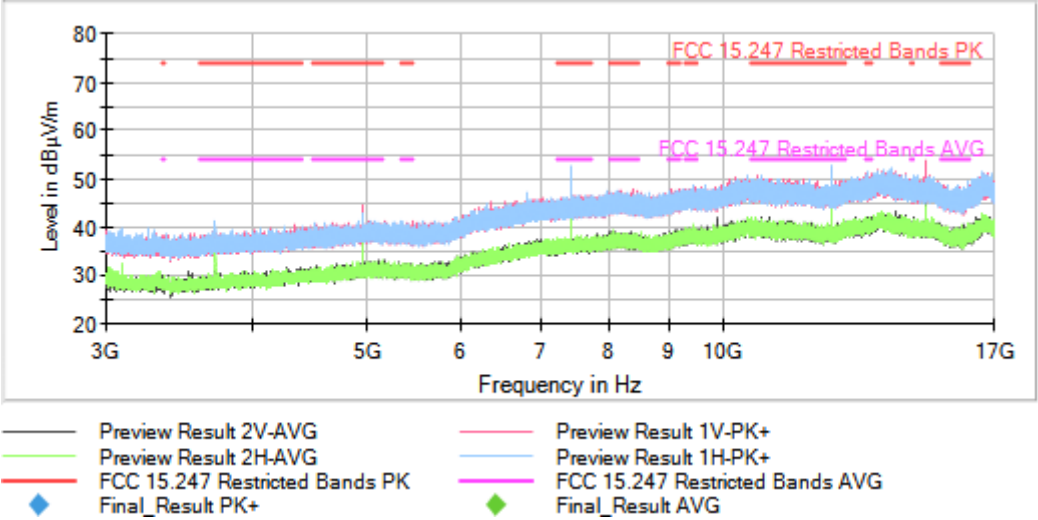
Tables:

Spectrum Analyzer Parameters

| Subrange           | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|--------------------|-----------|-----------|-----------|------------|--------|
| Receiver: [FSV 40] |           |           |           |            |        |
| 3 GHz - 17 GHz     | 140 kHz   | PK+ ; AVG | 1 MHz     | 1 s        | 30 dB  |

Frequency Range GHz = [3, 17]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa                      Frequency MHz = 2479  
MIMO Mode = SISO                      Active Port = 1

Images:



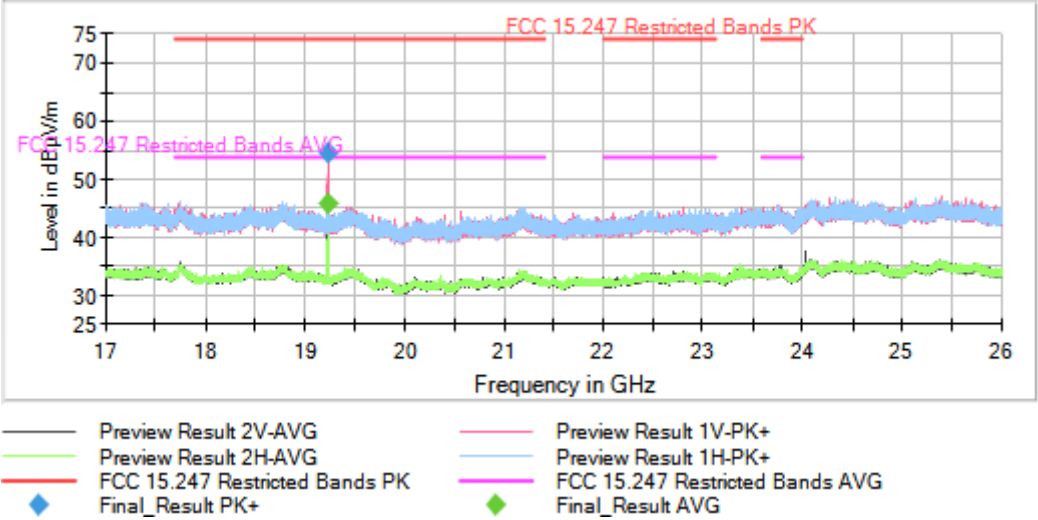
Tables:

Spectrum Analyzer Parameters

|  | Subrange           | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|--|--------------------|-----------|-----------|-----------|------------|--------|
|  | Receiver: [FSV 40] |           |           |           |            |        |
|  | 3 GHz - 17 GHz     | 140 kHz   | PK+ ; AVG | 1 MHz     | 1 s        | 30 dB  |

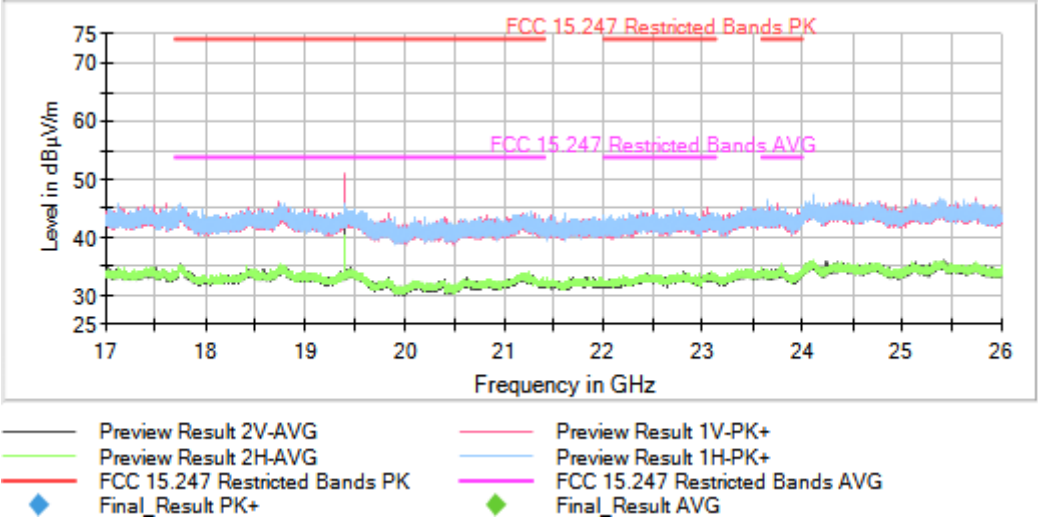
Frequency Range GHz = [17, 26]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2403  
MIMO Mode = SISO    Active Port = 1

Images:



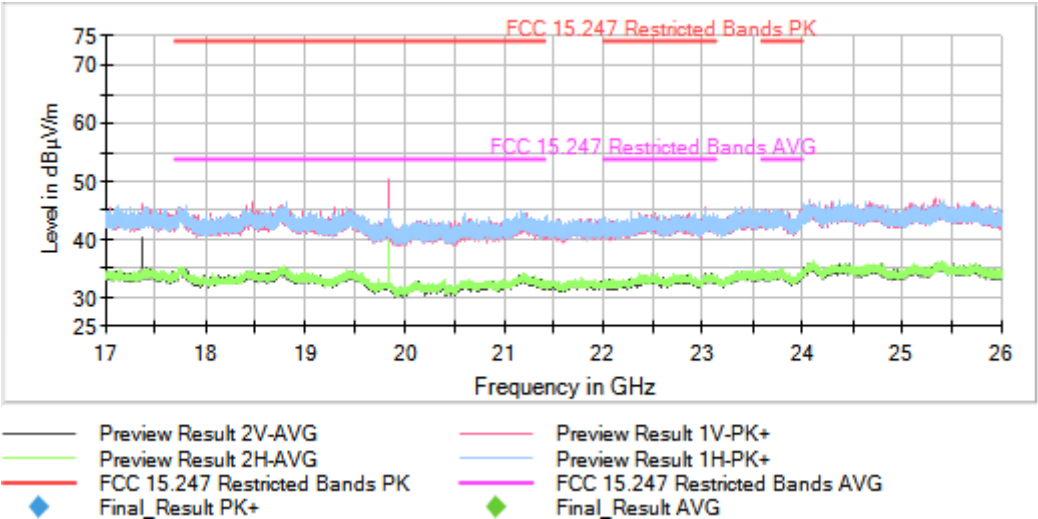
Frequency Range GHz = [17, 26]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2425  
MIMO Mode = SISO    Active Port = 1

Images:



Frequency Range GHz = [17, 26]    Equipment Type = Digital Transmission System (DTS)  
Modulation = LoRa    Frequency MHz = 2479  
MIMO Mode = SISO    Active Port = 1

Images:



Tables:  
Spectrum Analyzer Parameters

|  | Subrange           | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|--|--------------------|-----------|-----------|-----------|------------|--------|
|  | Receiver: [FSV 40] |           |           |           |            |        |
|  | 17 GHz - 26 GHz    | 300 kHz   | PK+ ; AVG | 1 MHz     | 1 s        | 0 dB   |



## Appendix B: Test results. LoRa AU915-928

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## TEST CONDITIONS

(\*): Data provided by the client.

**POWER SUPPLY (\*):**

Vnominal: 5 V  
Type of Power Supply: DC (USB-C).

**ANTENNA (\*):**

Type of Antenna LoRa 900 MHz: Omnidirectional external antenna.  
Maximum Declared External Antenna Gain LoRa 900 MHz: -0.2 dBi  
Type of Antenna LoRa 900 MHz: FPC omnidirectional internal antenna.  
Maximum Declared FPC Antenna Gain LoRa 900 MHz: 1.71 dBi

According preliminary radiated spurious emissions the FPC Antenna is a worst case.

**TEST FREQUENCIES (\*):**

| Modulation     | Low Channel: | Middle Channel | High Channel |
|----------------|--------------|----------------|--------------|
| LoRa AU915-928 | 915.3 MHz    | 921.5 MHz      | 927.7 MHz    |

During transmitter test the EUT was controlled by a SW tool provided by the client to operate in a continuous transmit mode on the modulation schemes and test channels as required.

**CONDUCTED MEASUREMENTS:**

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



**RADIATED MEASUREMENTS:**

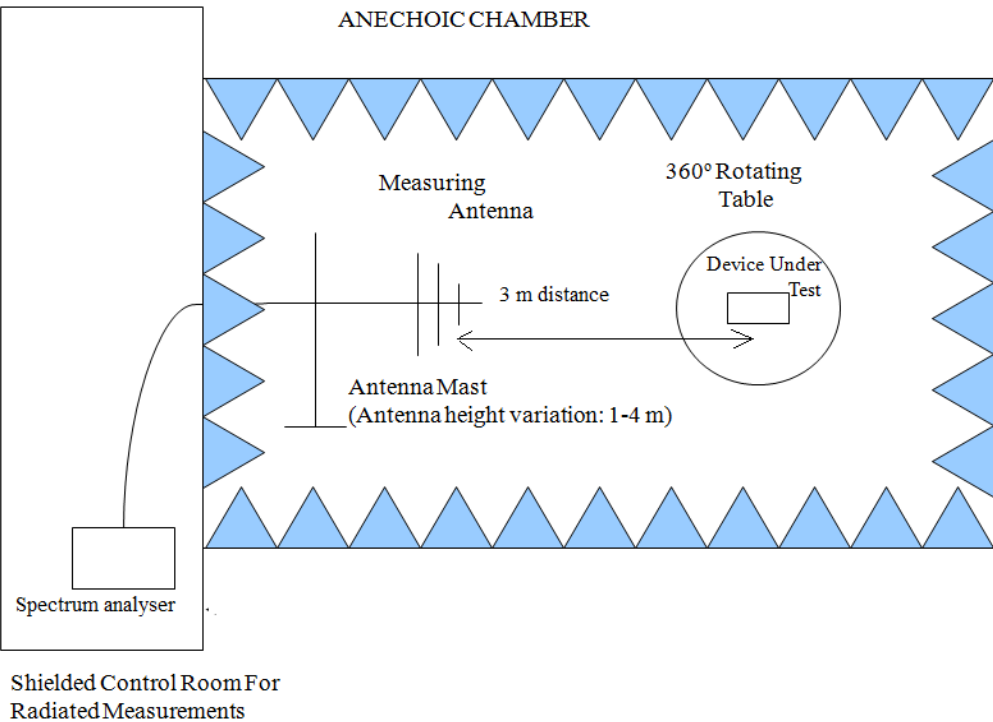
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-10 GHz Double ridge horn antenna) is situated at a distance of 3 m.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

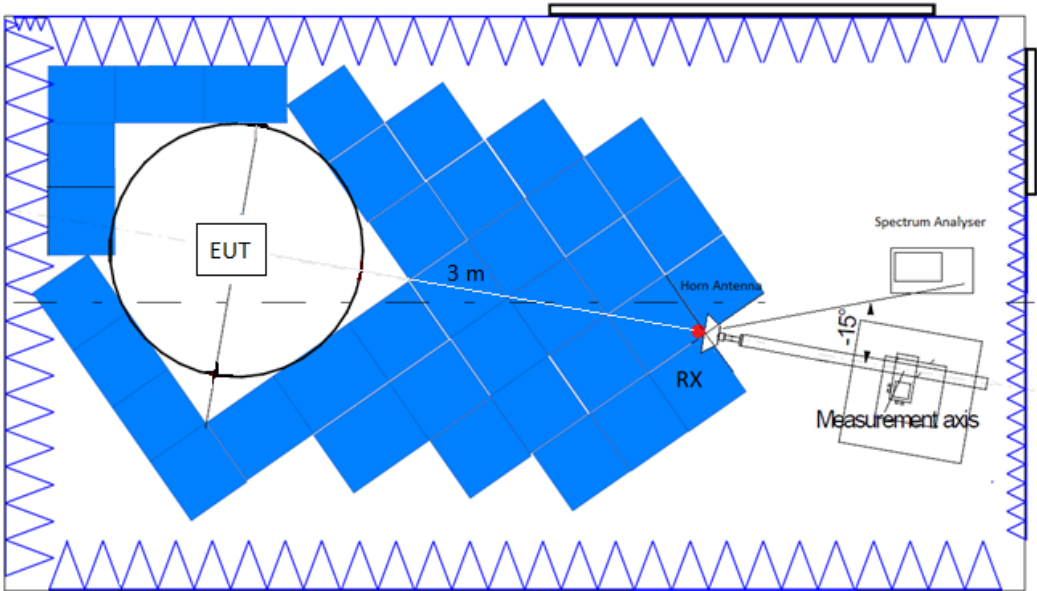
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 10 GHz:



## Occupied Channel Bandwidth 99%

### Limits

\* RSS-Gen Clause 6.7:

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Modulation: LoRa

Mode: SISO

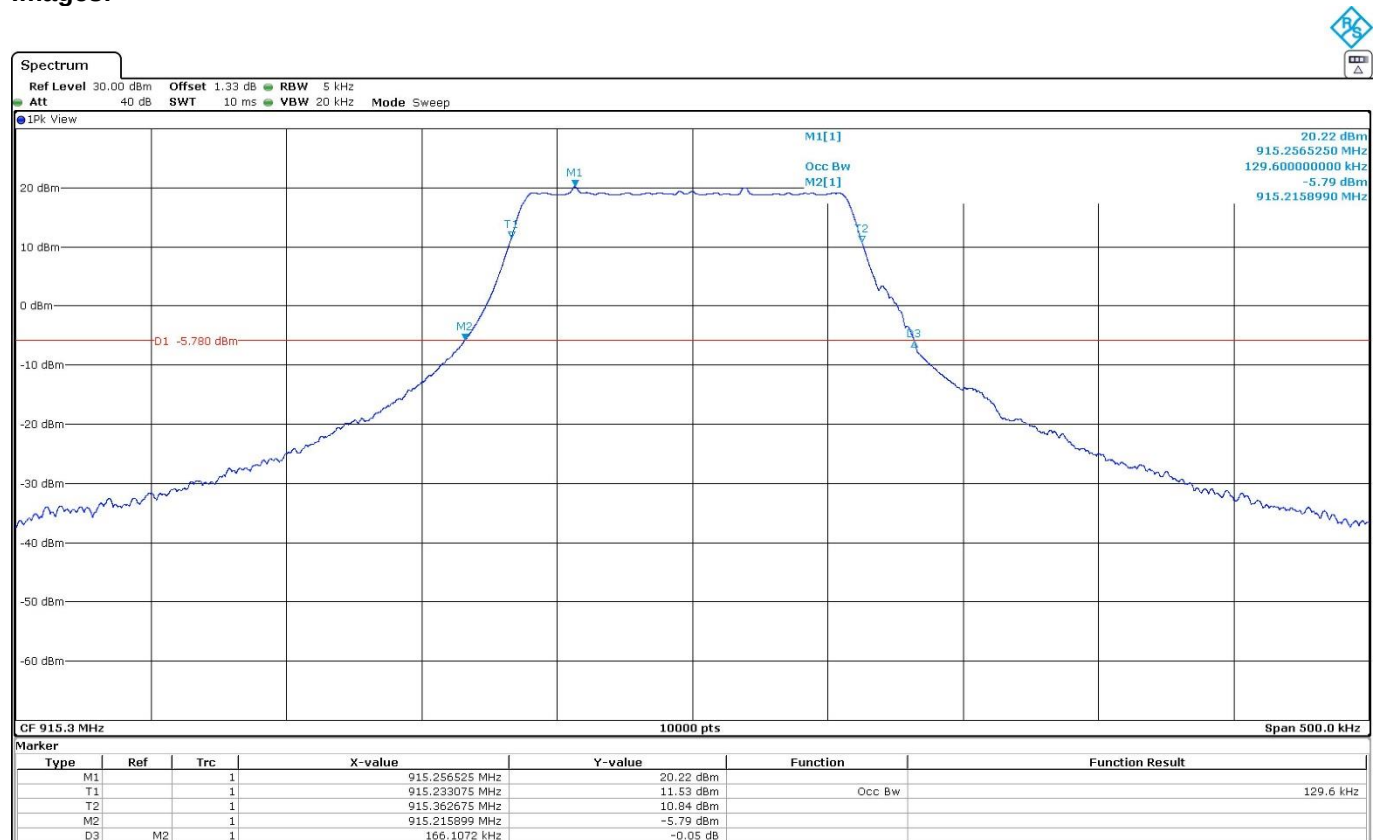
### Results

| Freq (MHz) | Occ Ch BW (kHz) |
|------------|-----------------|
| 915.3      | 129.6           |
| 921.5      | 129.7           |
| 927.7      | 129.85          |

### Verdict

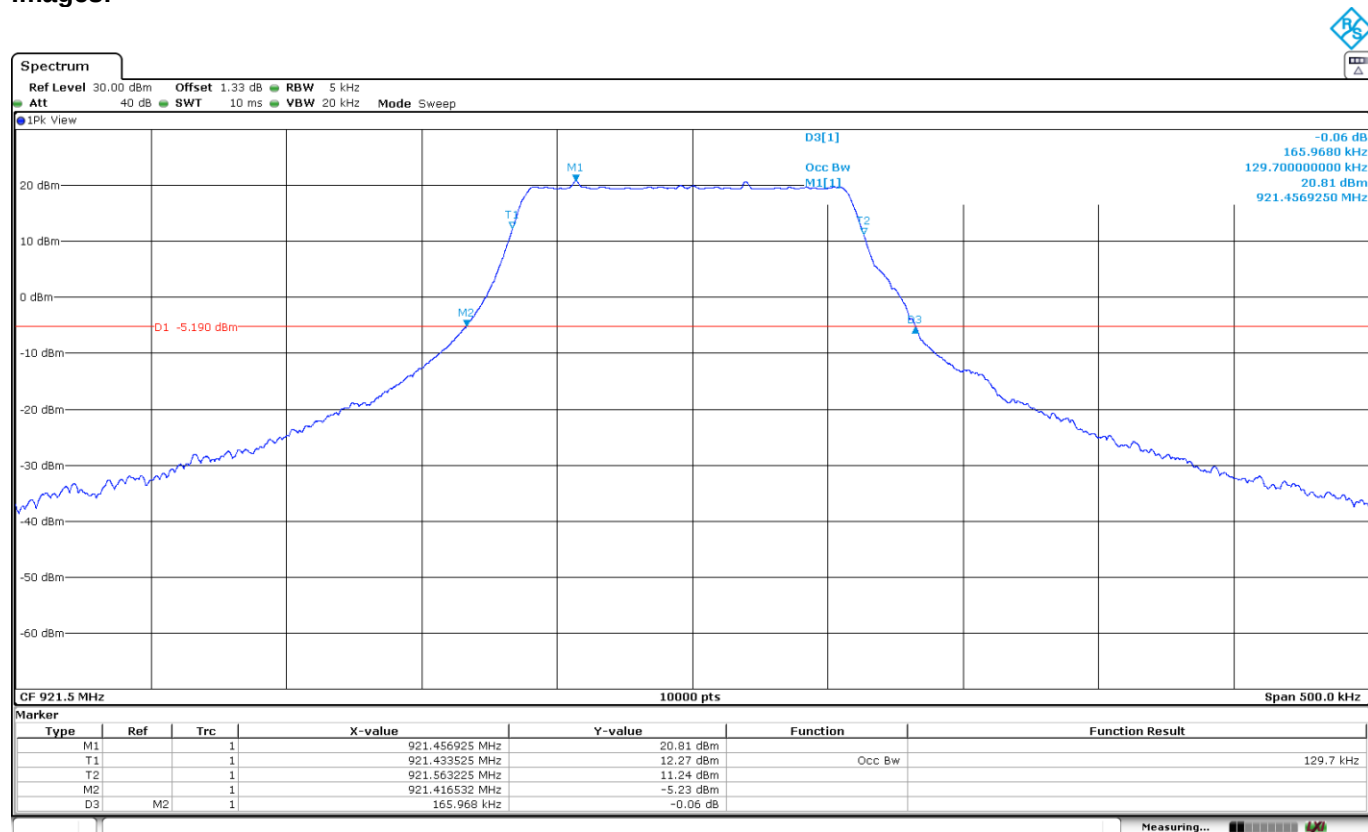
Pass

|                         |                       |
|-------------------------|-----------------------|
| Equipment Type = Hybrid | Bandwidth MHz = 1     |
| Modulation = LoRa       | Frequency MHz = 915.3 |
| Mode = SISO             | Active Port = 1       |



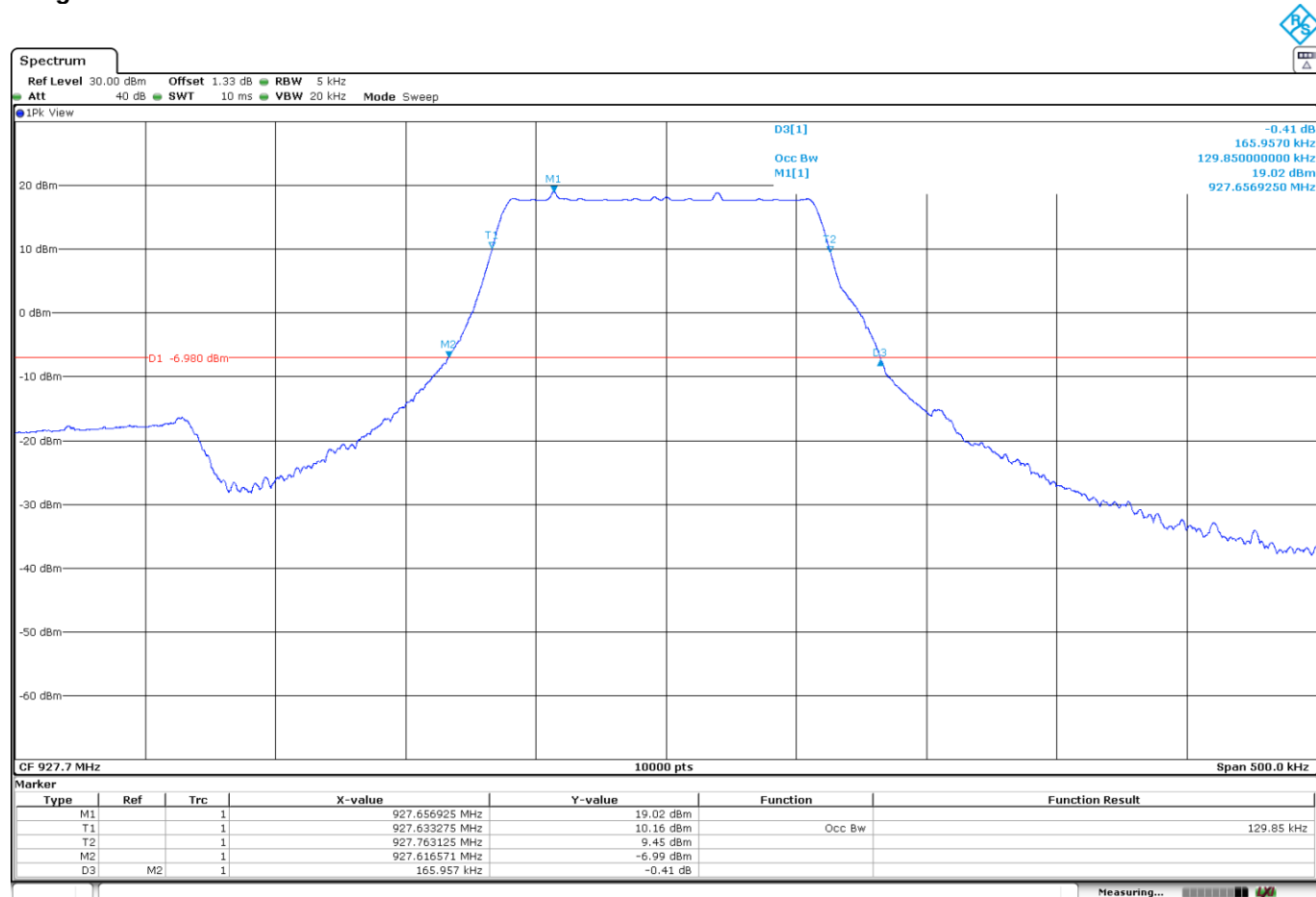
|                         |                       |
|-------------------------|-----------------------|
| Equipment Type = Hybrid | Bandwidth MHz = 1     |
| Modulation = LoRa       | Frequency MHz = 921.5 |
| Mode = SISO             | Active Port = 1       |

**Images:**



|                         |                       |
|-------------------------|-----------------------|
| Equipment Type = Hybrid | Bandwidth MHz = 1     |
| Modulation = LoRa       | Frequency MHz = 927.7 |
| Mode = SISO             | Active Port = 1       |

**Images:**





FCC 15.247 (a)(1) / RSS-247 5.1 (b) 20 dB Bandwidth and Carrier frequency separation

Limits

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

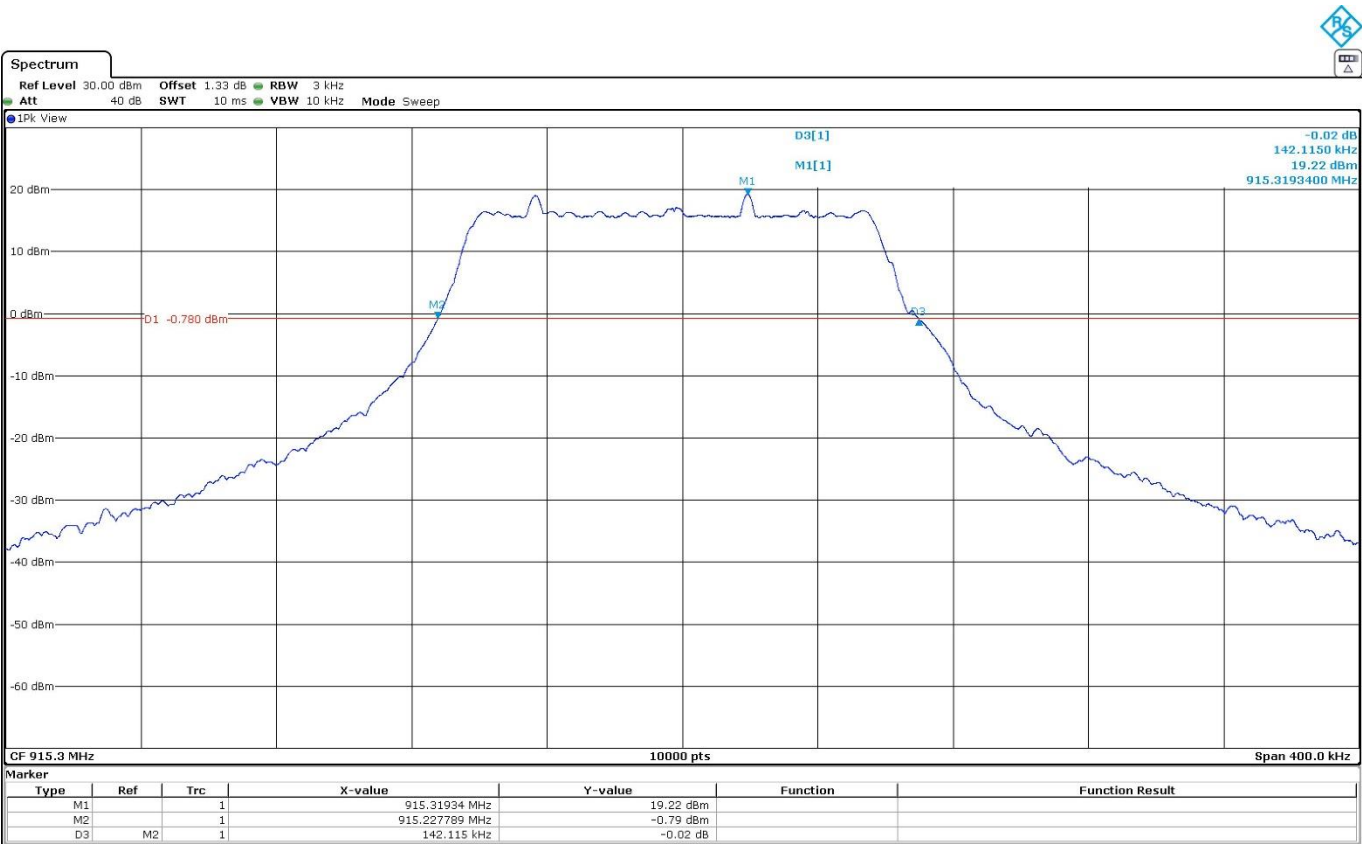
Results

|                                | Low Channel | Middle Channel | High Channel |
|--------------------------------|-------------|----------------|--------------|
| 20 dB Spectrum bandwidth (kHz) | 142.115     | 142.187        | 142.518      |

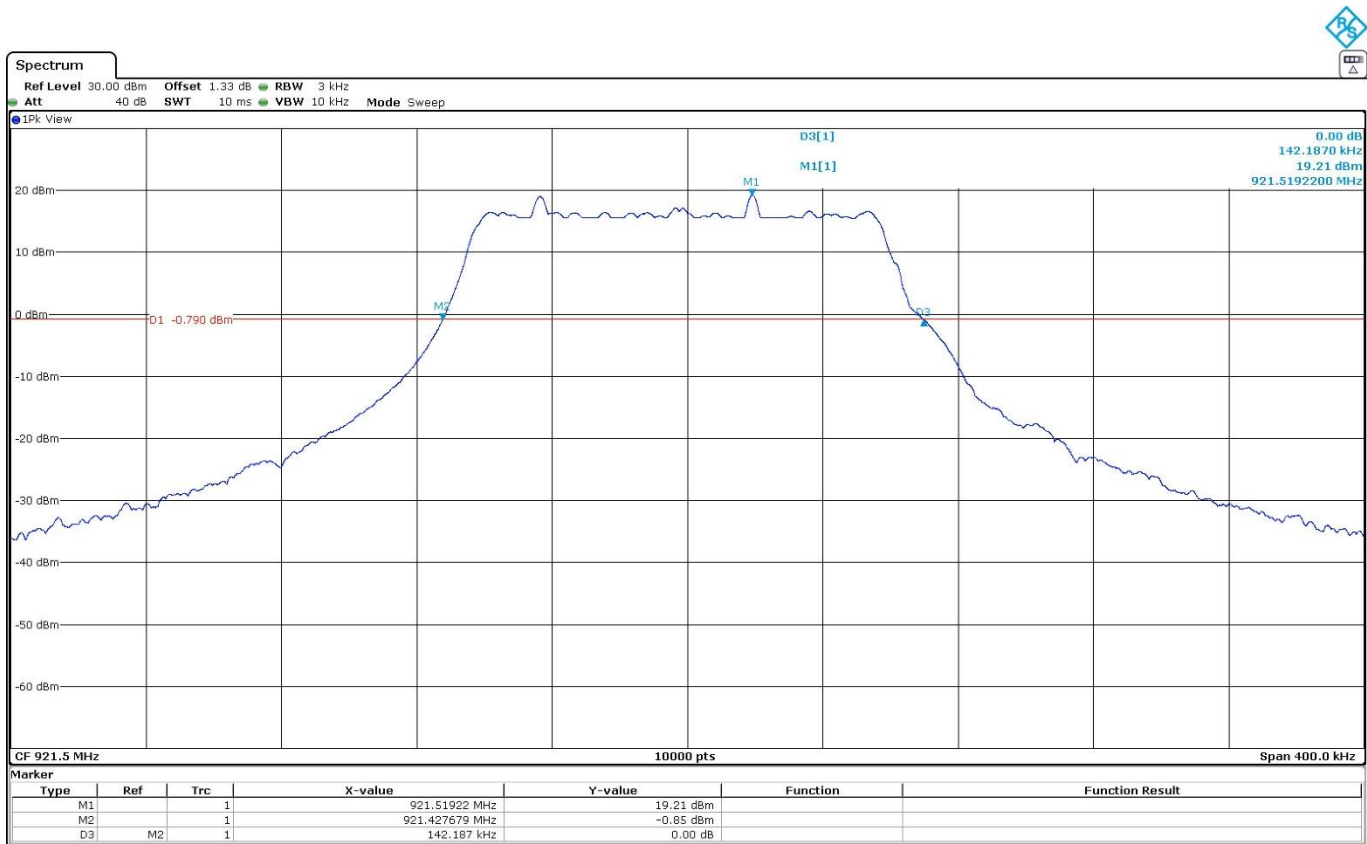
Verdict

PASS

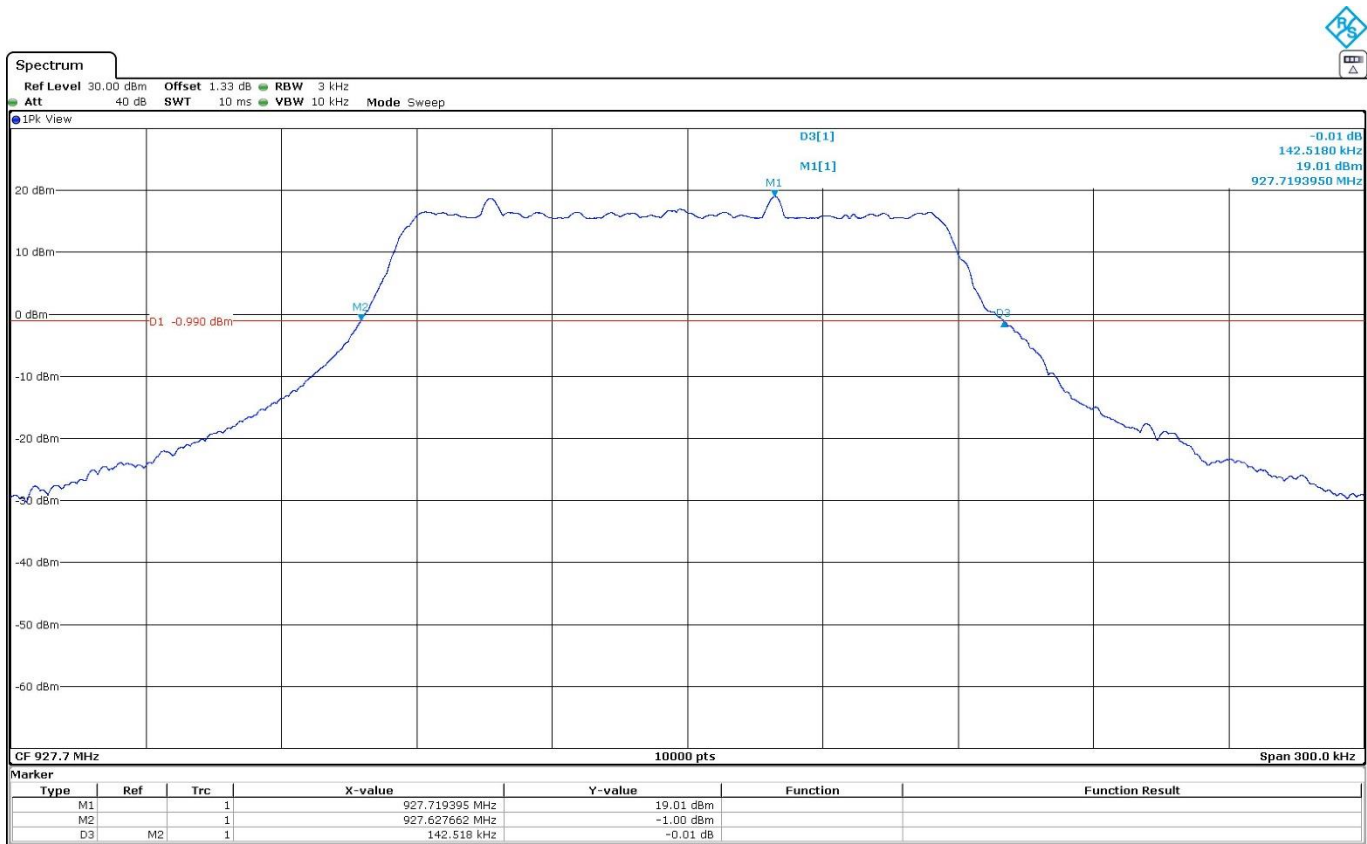
- Low Channel:



- Middle Channel:

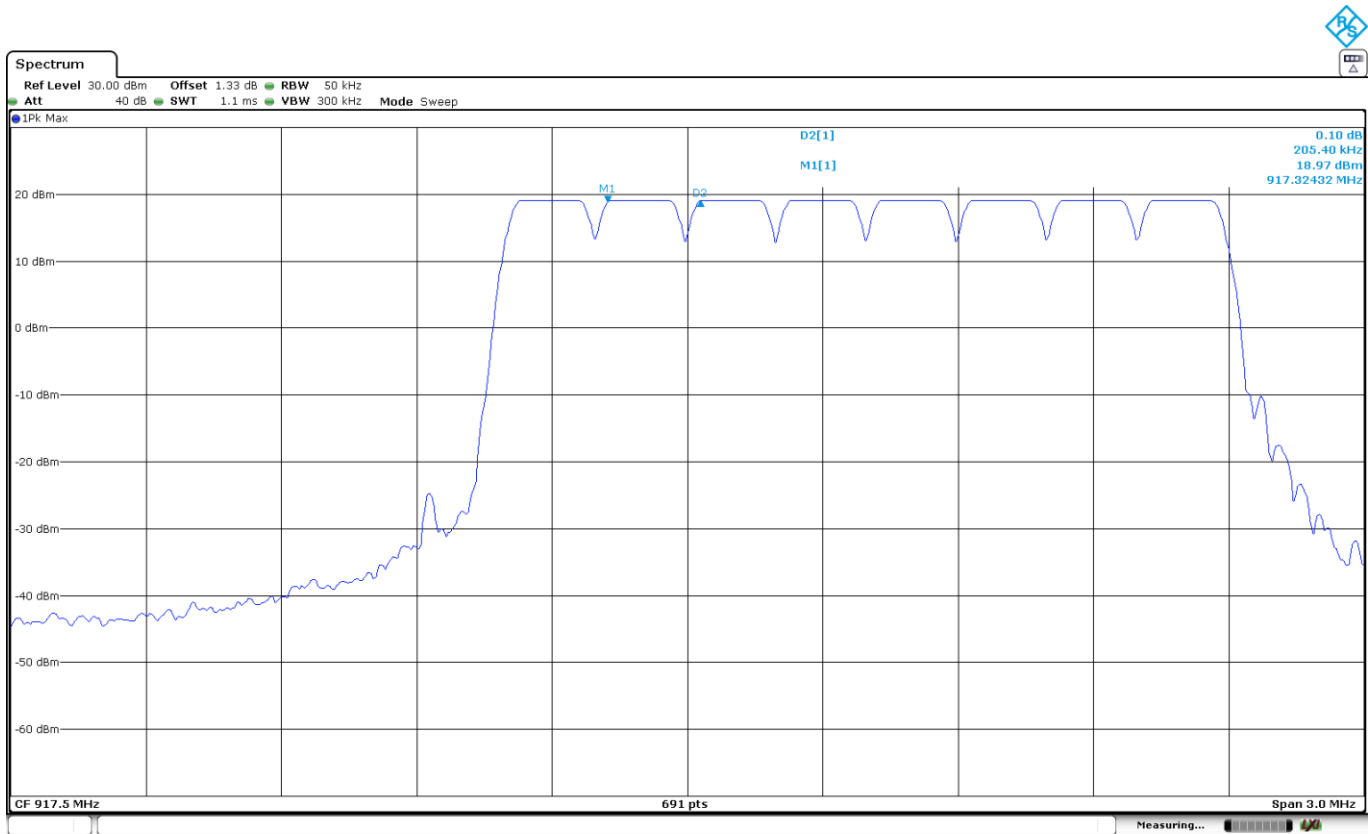


- High Channel:



Carrier frequency separation:

205.4 kHz



The hopping-channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

Verdict

PASS

## FCC 15.247 (f) / RSS-247 5.3 (a) Time of occupancy (Dwell Time) for hybrid systems

### Limits

Hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

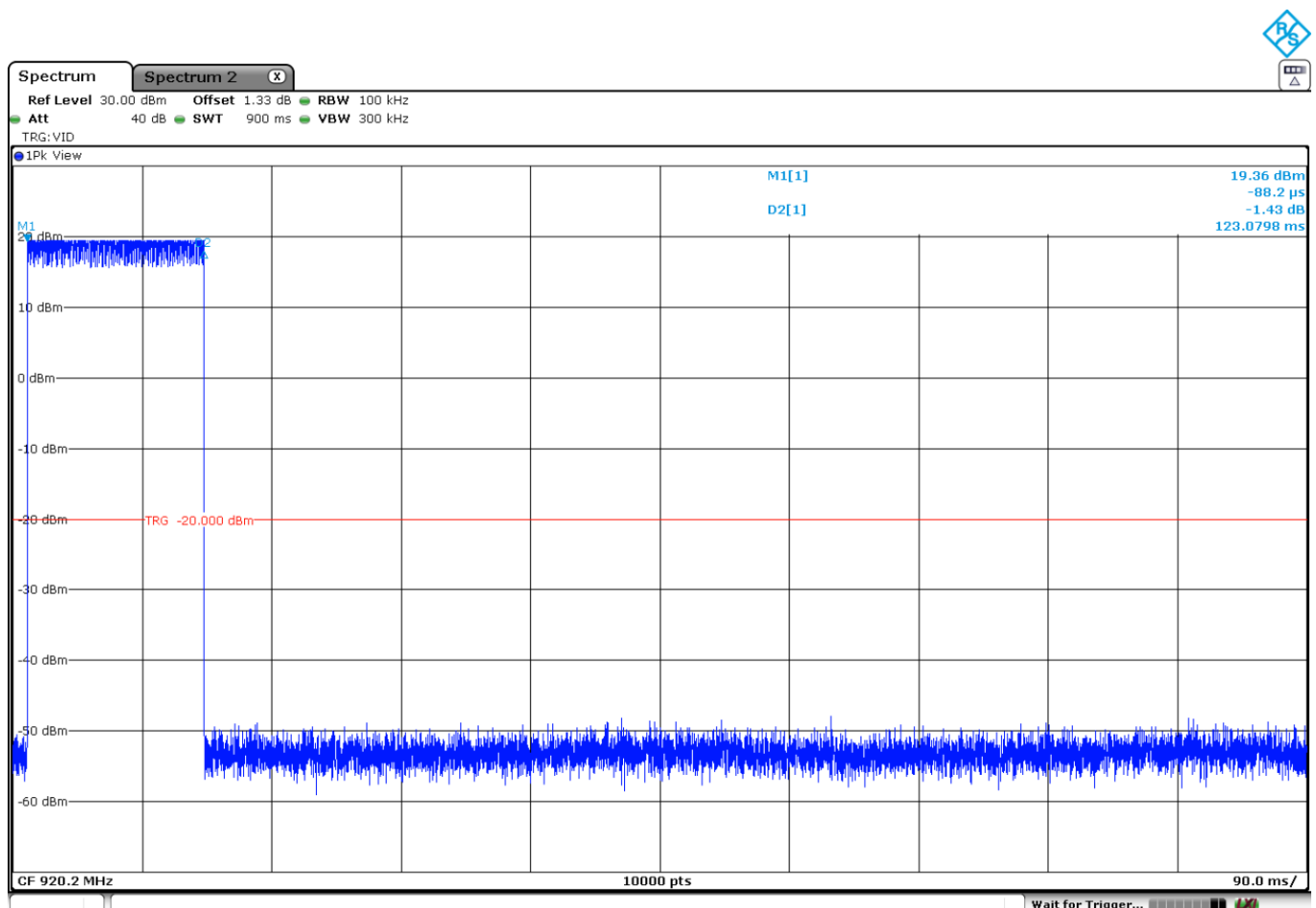
### Results

Operation as a frequency hopping system using 8 hopping channels:

- Time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4:  
 $8 \text{ hopping channels} \times 0.4 \text{ s} = 3.2 \text{ s}$

Measurement is performed over a period of 0.9 seconds (worst case).

- TX time per hop: 123.0798 ms (see next plots)
- Number of hops over a period of 0.9 s: 1 (see next plots)



- **Average Time of Occupancy** =  $123.0798 \text{ ms} \times 1 \text{ hops} = 123.0798 \text{ ms per } 0.9 \text{ s}$ .

Average Time of Occupancy is less than 0.4 s per time period in seconds equal to the number of hopping frequencies employed (8) multiplied by 0.4.

### **Verdict**

PASS

# RSS-247 5.3 (b) / FCC 15.247 (f) Power spectral density for hybrid systems

**Limits**

Hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques.

The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Modulation: LoRa

Mode: SISO

**Results**

The maximum power spectral density level was measured using the method AVGPST-2 according to clause 11.10.5 (trace averaging across ON and OFF times of the EUT transmissions, followed by duty cycle correction) of ANSI C.63.10-2013.

Measured Duty Cycle:  $x = 0.552817986$   
Duty Cycle Correction:  $10 \times \log(1/x) = 2.574 \text{ dB}$

| Freq (MHz) | PSD (dBm) | PSD with Duty Cycle correction (dBm) |
|------------|-----------|--------------------------------------|
| 915.3      | 3.92      | 6.494                                |
| 921.5      | 3.67      | 6.244                                |
| 927.700000 | 3.87      | 6.444                                |

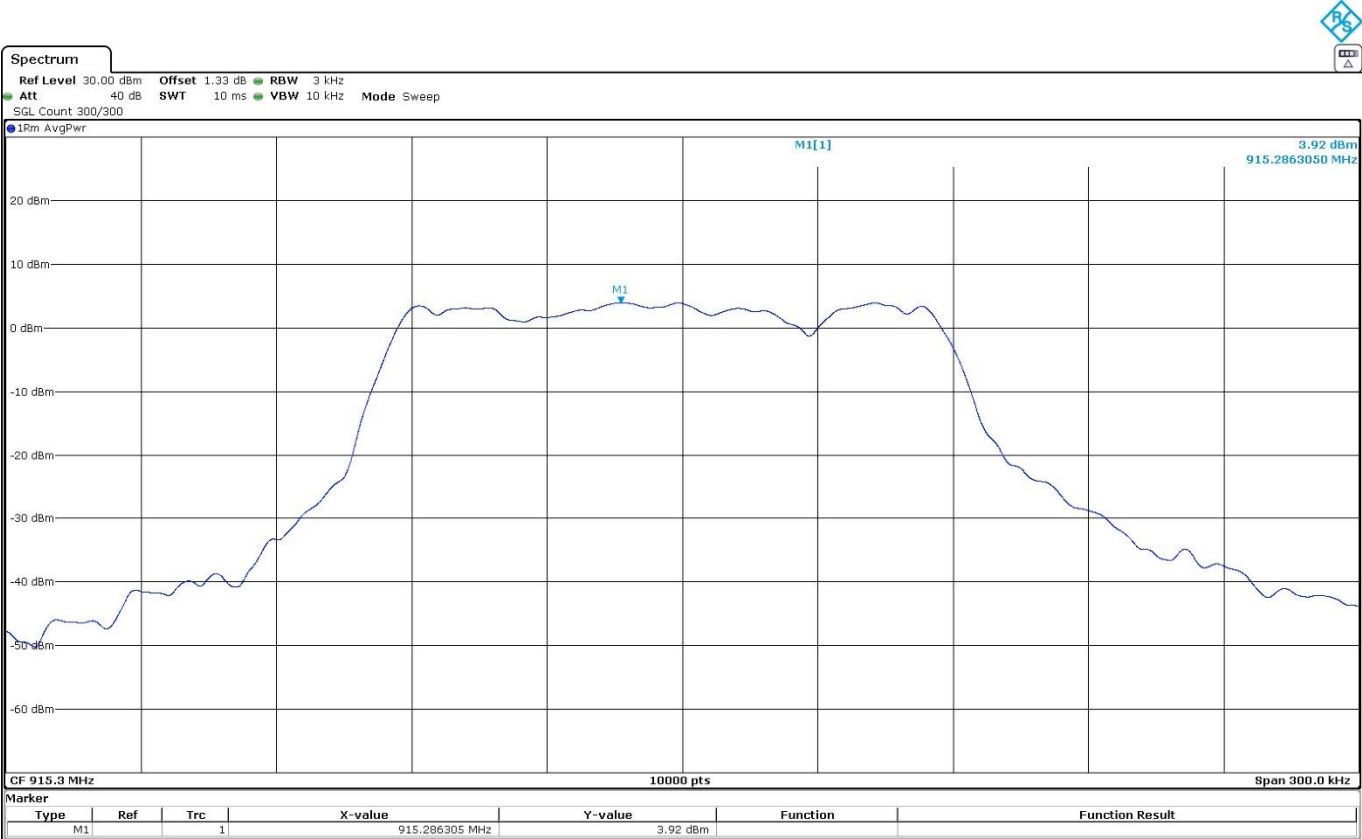
**Verdict**

Pass

Attachments

Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa            Frequency MHz = 915.3  
Mode = SISO                    Active Port = 1

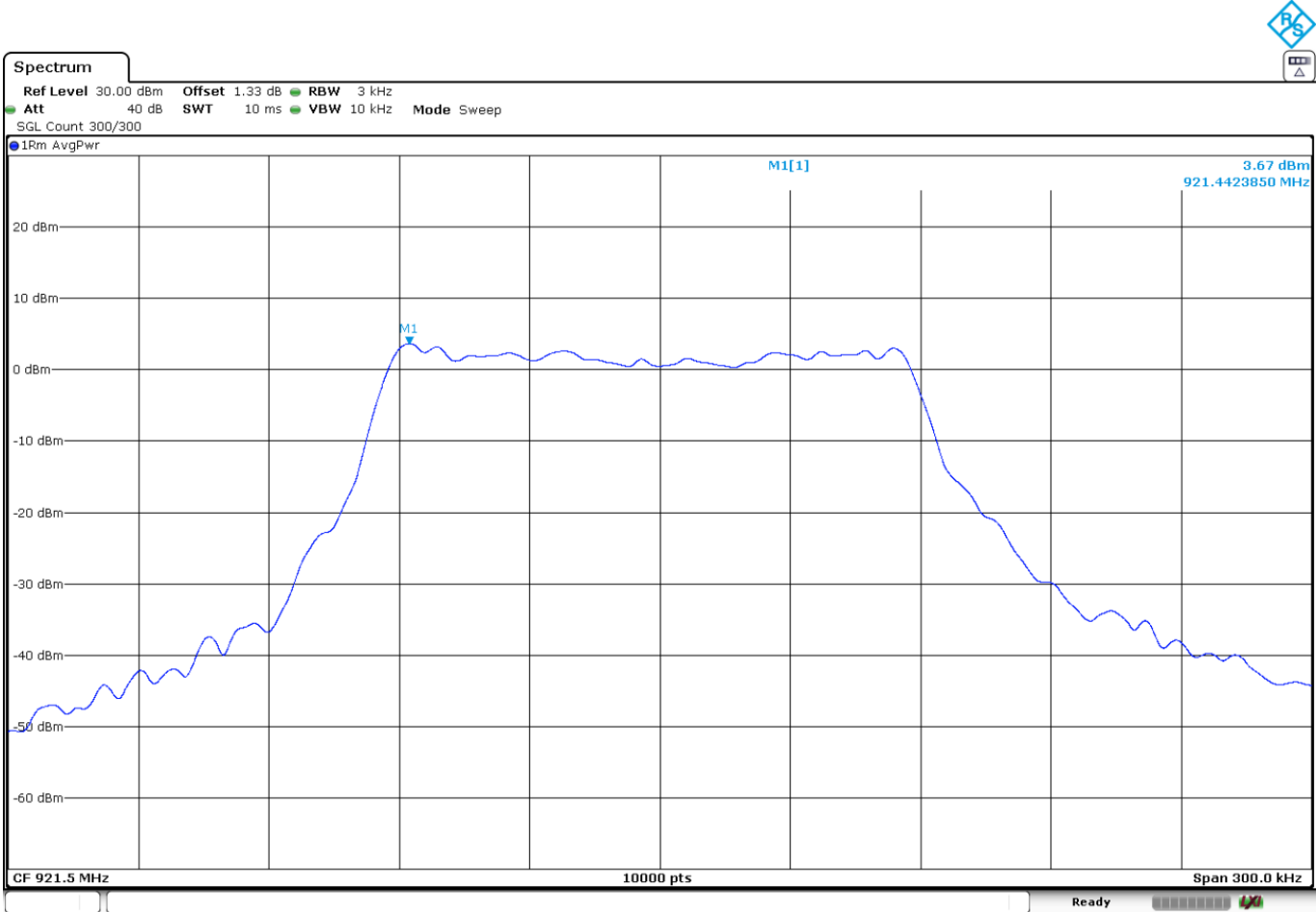
Images:





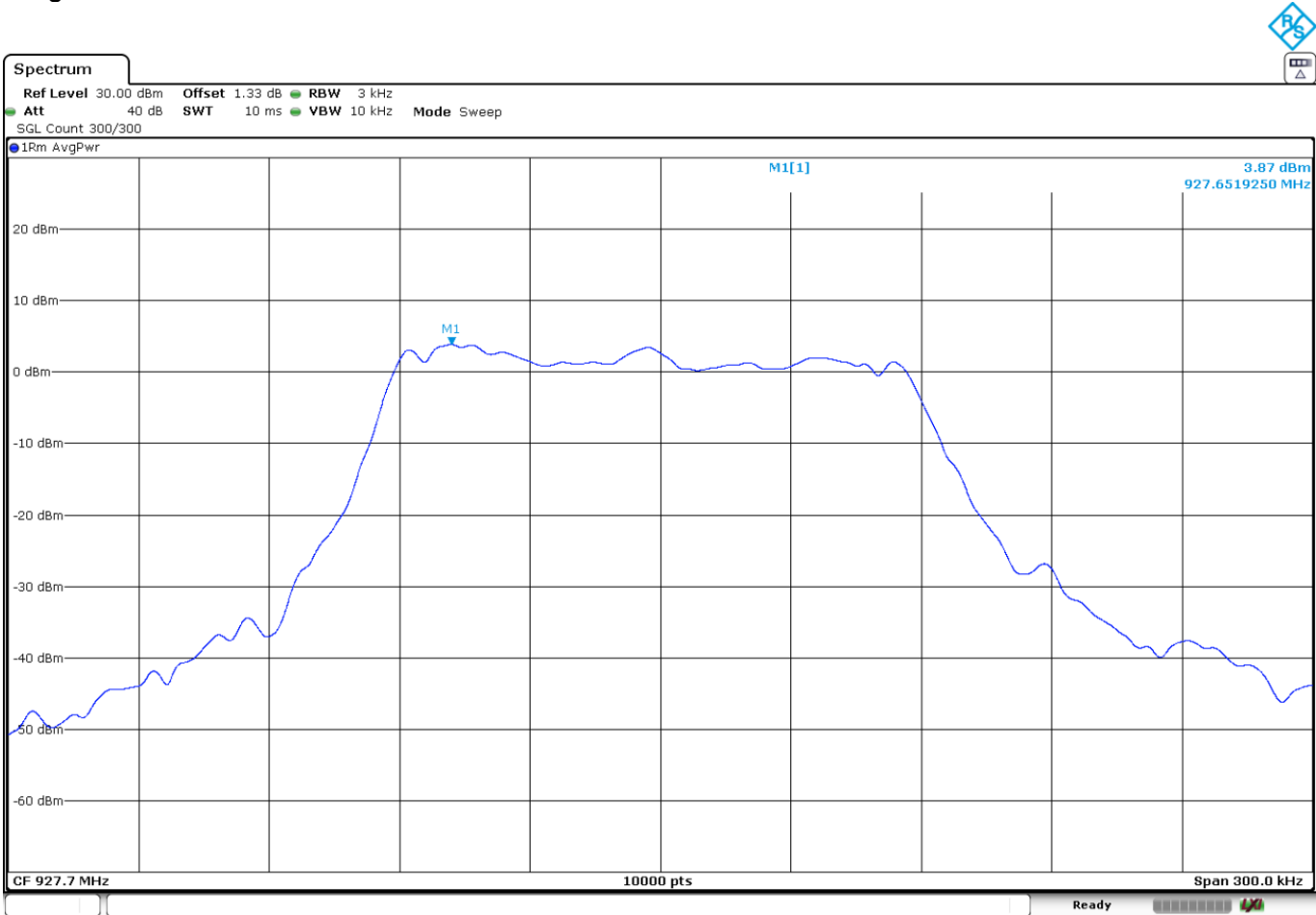
Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa    Frequency MHz = 921.5  
Mode = SISO    Active Port = 1

Images:



Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa        Frequency MHz = 927.7  
Mode = SISO              Active Port = 1

Images:



# RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum output power and antenna gain for hybrid systems

**Limits**

\* FCC 15.247:  
For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels. Hybrid systems shall comply with the 1 W limit.

\* RSS-247:  
For FHSS operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hop set uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hop set uses less than 50 hopping channels.  
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

Modulation: LoRa  
Mode: SISO

**Results**

The maximum conducted (average) output power was measured using the method AVGSA-2 according to clause 11.9.2.2.4 (trace averaging across ON and OFF times of the EUT transmissions, followed by duty cycle correction) of ANSI C.63.10-2013.

The e.i.r.p. power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: 1.71 dBi  
Measured Duty Cycle:  $x = 0.5528$   
Duty Cycle Correction:  $10 \times \log(1/x) = 2.574 \text{ dB}$

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

| Freq (MHz) | Power (dBm) | Power with Duty Cycle correction (dBm) | E.I.R.P. (dBm) |
|------------|-------------|----------------------------------------|----------------|
| 915.3      | 17.76       | 20.33                                  | 22.04          |
| 921.5      | 17.32       | 19.89                                  | 21.60          |
| 927.7      | 17.97       | 20.54                                  | 22.25          |

**Verdict**

Pass

Maximum Average Output Power:

Attachments

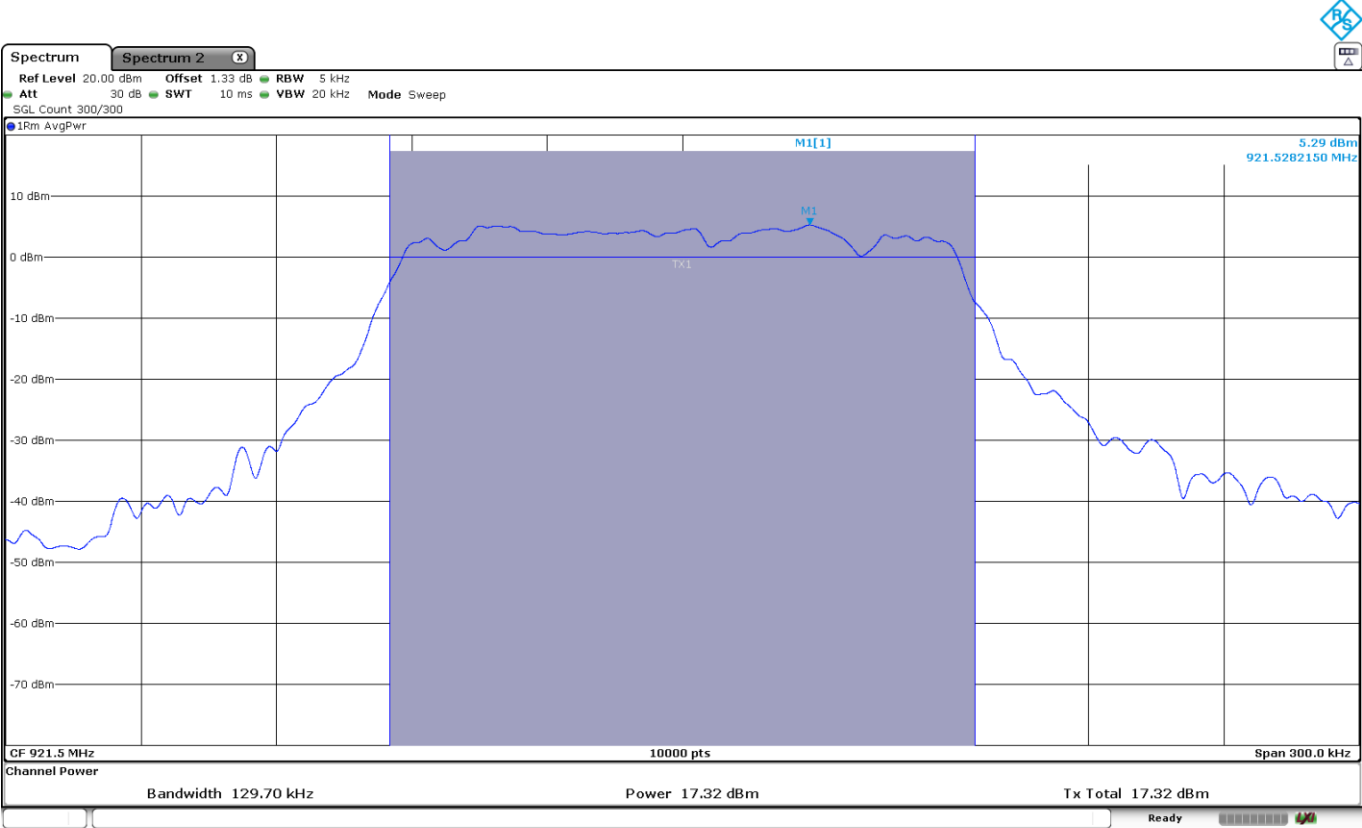
Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa            Frequency MHz = 915.3  
Mode = SISO                  Active Port = 1

Images:



Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa            Frequency MHz = 921.5  
Mode = SISO                  Active Port = 1

Images:



Equipment Type = Hybrid    Bandwidth MHz = 1  
Modulation = LoRa            Frequency MHz = 927.7  
Mode = SISO                  Active Port = 1

Images:

