

FCC

RF

TEST REPORT

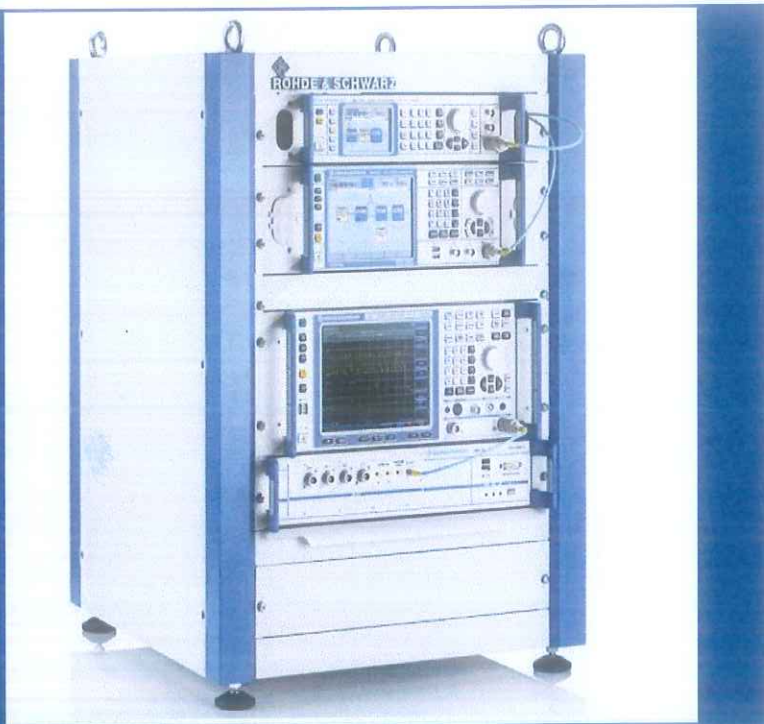
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
LoRaWan Module

ISSUED TO
RuiXingHengFang Network(Shenzhen) Co., Ltd.

Room 601, Building 10, Software Park phase 2, Keji Mid 2nd Road,
Nanshan District, Shenzhen, Guangdong, China 518017



Tested by: *Hu Chao*
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Date: *Dec. 06, 2018*

Approved by: *Wei Yanquan*
Wei Yanquan
(Chief Engineer)
Date: *Dec. 06, 2018*



Report No.: BL-SZ18B0165-601
EUT Name: LoRaWan Module
Model Name: RHF0M010
Brand Name: RisingHF
Test Standard: 47 CFR Part 15 Subpart C
FCC ID: 2AJUZ0M010

Test Conclusion: Pass
Test Date: Nov. 14, 2018 ~ Nov. 22, 2018
Date of Issue: Dec. 06, 2018

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Revision History

| <u>Version</u> | <u>Issue Date</u> | <u>Revisions Content</u> |
|----------------|----------------------|--------------------------|
| <u>Rev. 01</u> | <u>Dec. 06, 2018</u> | <u>Initial Issue</u> |

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1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

| | |
|--------------|---|
| Company Name | Shenzhen BALUN Technology Co., Ltd. |
| Address | Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China |
| Phone Number | +86 755 6685 0100 |
| Fax Number | +86 755 6182 4271 |

1.2 Identification of the Responsible Testing Location

| | |
|---------------------------|---|
| Test Location | Shenzhen BALUN Technology Co., Ltd. |
| Address | Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China |
| Accreditation Certificate | <p>The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1.</p> <p>The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.</p> <p>The laboratory is a testing organization accredited by American Association for Laboratory Accreditation (A2LA) according to ISO/IEC 17025. The accreditation certificate is 4344.01.</p> <p>The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.</p> |
| Description | All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055 |

1.3 Laboratory Condition

| | |
|---------------------------|--------------------|
| Ambient Temperature | 20°C to 25°C |
| Ambient Relative Humidity | 45% to 55% |
| Ambient Pressure | 100 kPa to 102 kPa |

1.4 Announce

- (1) The test report reference to the report template version v2.2.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without

prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

| | |
|-----------|--|
| Applicant | RuiXingHengFang Network(Shenzhen) Co., Ltd. |
| Address | Room 601, Building 10, Software Park phase 2, Keji Mid 2nd Road, Nanshan District, Shenzhen, Guangdong, China 518017 |

2.2 Manufacturer Information

| | |
|--------------|--|
| Manufacturer | RuiXingHengFang Network(Shenzhen) Co., Ltd. |
| Address | Room 601, Building 10, Software Park phase 2, Keji Mid 2nd Road, Nanshan District, Shenzhen, Guangdong, China 518017 |

2.3 Factory Information

| | |
|---------|-----|
| Factory | N/A |
| Address | N/A |

2.4 General Description for Equipment under Test (EUT)

| | |
|---|----------------|
| EUT Type | LoRaWan Module |
| Model Name Under Test | RHF0M010 |
| Series Model Name | N/A |
| Description of Model name differentiation | N/A |
| Hardware Version | V3 |
| Software Version | 2.1.19 |
| Dimensions (Approx.) | N/A |
| Weight (Approx.) | N/A |

2.5 Ancillary Equipment

| | |
|---------------------|---------|
| Ancillary Equipment | Antenna |
|---------------------|---------|

2.6 Technical Information

| | |
|-----------------------------------|------|
| Network and Wireless connectivity | Lora |
|-----------------------------------|------|

The requirement for the following technical information of the EUT was tested in this report:

| | |
|------------------------------------|--|
| Modulation Technology | Frequency hopping system, Hybrid system |
| Modulation Type | LoRa |
| Product Type | <input checked="" type="checkbox"/> Mobile <input type="checkbox"/> Portable <input type="checkbox"/> Fix Location |
| Frequency Range | The frequency range used is 902 MHz to 928 MHz. |
| Number of channel | 64 for Hopping mode, and 8 for DTS. |
| Tested Channel | 0 (902.3 MHz), 32 (908.7 MHz), 63 (914.9 MHz) |
| Antenna Type | PIFA Antenna |
| Antenna Gain | 2.67 dBi (In test items related to antenna gain, the final results reflect this figure.) |
| Antenna System(MIMO Smart Antenna) | N/A |
| About the Product | The EUT is supply the DTS, Frequency hopping system and Hybrid system, only the frequency hopping system and hybrid system were tested in this report. |

All channel was listed on the following table:

125kHz for Hoping channel

| Channel number | Freq. (MHz) | Channel number | Freq. (MHz) | Channel number | Freq. (MHz) | Channel number | Freq. (MHz) |
|----------------|--------------|----------------|--------------|----------------|-------------|----------------|--------------|
| 0 | 902.3 | 20 | 906.3 | 40 | 910.3 | 60 | 914.3 |
| 1 | 902.5 | 21 | 906.5 | 41 | 910.5 | 61 | 914.5 |
| 2 | 902.7 | 22 | 906.7 | 42 | 910.7 | 62 | 914.7 |
| 3 | 902.9 | 23 | 906.9 | 43 | 910.9 | 63 | 914.9 |
| 4 | 903.1 | 24 | 907.1 | 44 | 911.1 | - | - |
| 5 | 903.3 | 25 | 907.3 | 45 | 911.3 | - | - |
| 6 | 903.5 | 26 | 907.5 | 46 | 911.5 | - | - |
| 7 | 903.7 | 27 | 907.7 | 47 | 911.7 | - | - |
| 8 | 903.9 | 28 | 907.9 | 48 | 911.9 | - | - |
| 9 | 904.1 | 29 | 908.1 | 49 | 912.1 | - | - |
| 10 | 904.3 | 30 | 908.3 | 50 | 912.3 | - | - |
| 11 | 904.5 | 31 | 908.5 | 51 | 912.5 | - | - |
| 12 | 904.7 | 32 | 908.7 | 52 | 912.7 | - | - |
| 13 | 904.9 | 33 | 908.9 | 53 | 912.9 | - | - |
| 14 | 905.1 | 34 | 909.1 | 54 | 913.1 | - | - |
| 15 | 905.3 | 35 | 909.3 | 55 | 913.3 | - | - |
| 16 | 905.5 | 36 | 909.5 | 56 | 913.5 | - | - |
| 17 | 905.7 | 37 | 909.7 | 57 | 913.7 | - | - |
| 18 | 905.9 | 38 | 909.9 | 58 | 913.9 | - | - |
| 19 | 906.1 | 39 | 910.1 | 59 | 914.1 | - | - |

500kHz for DTS channel

| Channel number | Freq. (MHz) | Channel number | Freq. (MHz) |
|----------------|---------------|----------------|---------------|
| 0 | 903.00 | 4 | 909.40 |
| 1 | 904.60 | 5 | 911.00 |
| 2 | 906.20 | 6 | 912.60 |
| 3 | 907.80 | 7 | 914.20 |

2.7 Additional Instructions

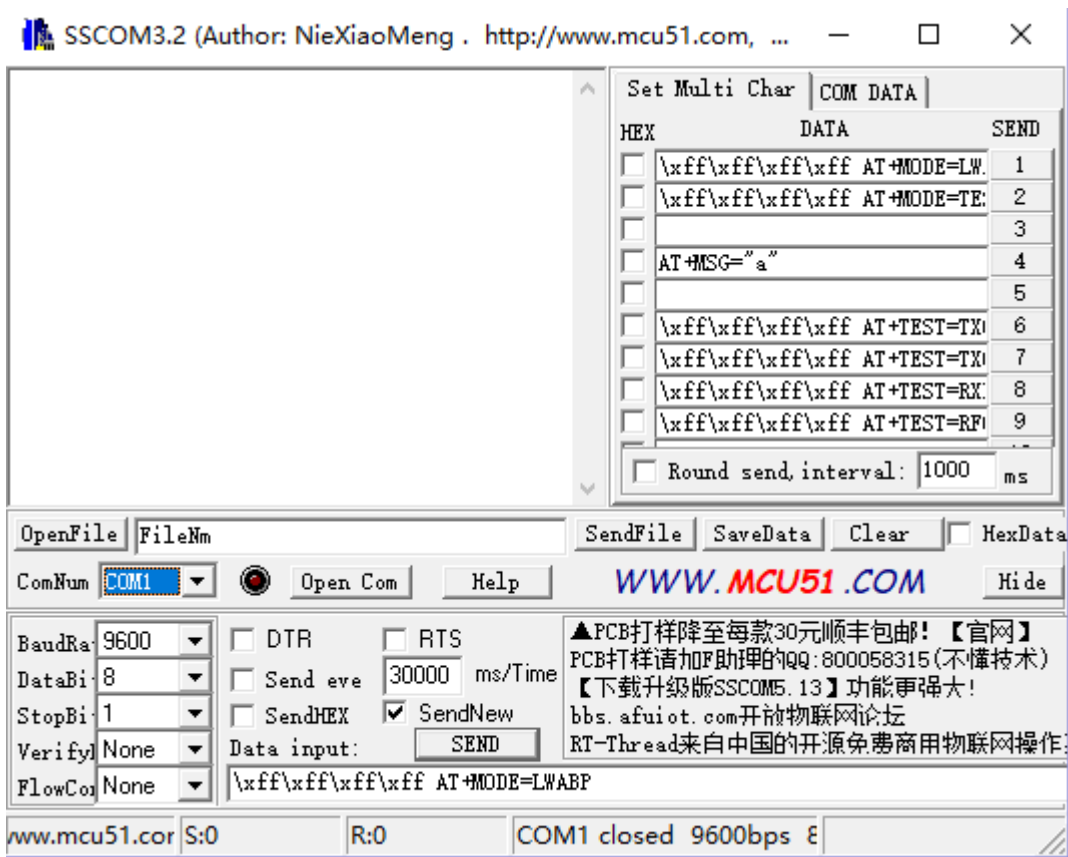
EUT Software Settings:

| | |
|------|--|
| Mode | <input checked="" type="checkbox"/> Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually. |
|------|--|

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

| Power level setup in software | | |
|-------------------------------|---------|----------|
| Test Software Version | Channel | Soft Set |
| Mode | | |
| LoRa | ALL | 8 |

Run Software



3 SUMMARY OF TEST RESULTS

3.1 Test Standards

| No. | Identity | Document Title |
|-----|---|--|
| 1 | 47 CFR Part 15, Subpart C (Oct.01 2017) | Miscellaneous Wireless Communications Services |
| 2 | FCC PUBLIC NOTICE DA 00-705 (Mar. 30, 2000) | Filling and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems |
| 3 | ANSI C63.10-2013 | American National Standard for Testing Unlicensed Wireless Devices |
| 4 | KDB Publication 558074 D01v05 | GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES |

3.2 Verdict

| No. | Description | FCC Part No. | Modulation Technology | Channel | Test Result | Verdict | Remark |
|-----|---|---------------------|---|-------------------------------|-------------|---------|-------------------|
| 1 | Antenna Requirement | 15.203 | N/A | N/A | -- | Pass | Note ¹ |
| 2 | Number of Hopping Frequencies | 15.247(a) | Frequency hopping system | Hopping Mode | ANNEX A.1 | N/A | |
| 3 | Peak Output Power | 15.247(b) | Frequency hopping system, Hybrid system | Low/Middle/High | ANNEX A.2 | Pass | |
| 4 | Occupied Bandwidth | 15.247(a) | Frequency hopping system, Hybrid system | Low/Middle/High | ANNEX A.3 | Pass | |
| 5 | Carrier Frequency Separation | 15.247(a) | Frequency hopping system, Hybrid system | Hopping Mode | ANNEX A.4 | Pass | |
| 6 | Time of Occupancy (Dwell time) | 15.247(a) | Frequency hopping system, Hybrid system | Hopping Mode | ANNEX A.5 | Pass | |
| 7 | Conducted Spurious Emission & Authorized-band band-edge | 15.247(d) | Frequency hopping system, Hybrid system | Low/Middle/High, Hopping Mode | ANNEX A.6 | Pass | |
| 8 | Conducted Emission | 15.207 | Frequency hopping system, Hybrid system | Low/Middle/High | ANNEX A.7 | N/A | Note ² |
| 9 | Radiated Spurious Emission | 15.209 15.247(d) | Frequency hopping system, Hybrid system | Low/Middle/High, Hopping Mode | ANNEX A.8 | Pass | |
| 10 | Band Edge(Restricted-band band-edge) | 15.209 15.247(d) | Frequency hopping system, Hybrid system | Low/Middle/High, Hopping Mode | ANNEX A.9 | Pass | |
| 11 | Power spectral density | 15.247 | Hopping off mode | Low/Middle/High, | ANNEX A.10 | Pass | |

Note ¹: Please refer to section 5.1

Note ²: The EUT is powered by battery, so the Conducted Emission is not applicable.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

| | | |
|----------------------------|-------------------------|----------------|
| Relative Humidity | 45% to 55% | |
| Atmospheric Pressure | 100 kPa to 102 kPa | |
| Temperature | NT (Normal Temperature) | +22°C to +25°C |
| Working Voltage of the EUT | NV (Normal Voltage) | 3.3 V |

4.2 Test Equipment List

| Description | Manufacturer | Model | Serial No. | Cal. Date | Cal. Due |
|-----------------------------------|----------------------|-------------------|------------|------------|------------|
| Spectrum Analyzer | ROHDE&SCHWARZ | FSV-30 | 103118 | 2018.06.15 | 2019.06.14 |
| Vector Signal Generator | ROHDE&SCHWARZ | SMBV100A | 260592 | 2018.06.15 | 2019.06.14 |
| Signal Generator | ROHDE&SCHWARZ | SMB100A | 177746 | 2018.06.15 | 2019.06.14 |
| Switch Unit with OSP-B157 | ROHDE&SCHWARZ | OSP120 | 101270 | 2018.06.15 | 2019.06.14 |
| Spectrum Analyzer | AGILENT | E4440A | MY45304434 | 2018.11.01 | 2019.10.31 |
| EMI Receiver | ROHDE&SCHWARZ | ESRP | 101036 | 2018.06.13 | 2019.06.12 |
| LISN | SCHWARZBECK | NSLK 8127 | 8127-687 | 2018.06.13 | 2019.06.12 |
| Bluetooth Tester | ROHDE&SCHWARZ | CBT | 101005 | 2018.06.15 | 2019.06.14 |
| Power Splitter | KMW | DCPD-LDC | 1305003215 | -- | -- |
| Power Sensor | ROHDE&SCHWARZ | NRP-Z21 | 103971 | 2018.06.15 | 2019.06.14 |
| Attenuator (20 dB) | KMW | ZA-S1-201 | 110617091 | -- | -- |
| Attenuator (6 dB) | KMW | ZA-S1-61 | 1305003189 | -- | -- |
| DC Power Supply | ROHDE&SCHWARZ | HMP2020 | 018141664 | 2018.06.14 | 2019.06.13 |
| Temperature Chamber | ANGELANTIONI SCIENCE | NTH64-40A | 1310 | 2018.06.26 | 2019.06.25 |
| Test Antenna-Loop(9 kHz-30 MHz) | SCHWARZBECK | FMZB 1519 | 1519-037 | 2017.11.09 | 2019.11.08 |
| Test Antenna-Bi-Log(30 MHz-3 GHz) | SCHWARZBECK | VULB 9163 | 9163-624 | 2017.07.22 | 2019.07.21 |
| Test Antenna-Horn(1-18 GHz) | SCHWARZBECK | BBHA 9120D | 9120D-1148 | 2018.07.11 | 2020.07.10 |
| Test Antenna-Horn(15-26.5 GHz) | SCHWARZBECK | BBHA 9170 | 9170-305 | 2018.06.21 | 2019.06.20 |
| Test Antenna-Horn (18-40 GHz) | A-INFO | LB-180400KF | J211060273 | 2017.01.06 | 2019.01.05 |
| Anechoic Chamber | RAINFORD | 9m*6m*6m | N/A | 2017.02.21 | 2019.02.20 |
| Anechoic Chamber | EMC TECHNOLOGY LTD | 21.1m*11.6m*7.35m | N/A | 2017.08.08 | 2019.08.07 |
| Shielded Enclosure | ChangNing | CN-130701 | 130703 | -- | -- |
| Signal Generator | ROHDE&SCHWARZ | SMB100A | 177746 | 2018.06.15 | 2019.06.14 |
| Power Amplifier | OPHIR RF | 5225F | 1037 | 2018.02.16 | 2019.02.15 |

| Description | Manufacturer | Model | Serial No. | Cal. Date | Cal. Due |
|---------------------|---------------|------------------------------|------------|------------|------------|
| Power Amplifier | OPHIR RF | 5273F | 1016 | 2018.02.16 | 2019.02.15 |
| Directional Coupler | Werlantone | C5982-10 | 109275 | N/A | N/A |
| Directional Coupler | Werlantone | CHP-273E | S00801z-01 | N/A | N/A |
| RF Cable 1 | ROHDE&SCHWARZ | JUNFLON | APR0914004 | 2018.07.10 | 2019.10.09 |
| RF Cable 2 | Huber&suhner | RG_400_/U | N/A | 2018.07.10 | 2019.10.09 |
| RF Cable 3 | Huber&suhner | RG_400_/U | N/A | 2018.07.10 | 2019.10.09 |
| RF Cable 4 | Huber&suhner | SX_04172_ B-60 | N/A | 2018.07.10 | 2019.10.09 |
| RF Cable 5 | COM-MW | RFJA360- 2.92mm- J/J3M | N/A | 2018.07.10 | 2019.10.09 |

Note: The calibration period on the Cable is three month.

4.3 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Measurement | Value |
|-----------------------------------|---------|
| Occupied Channel Bandwidth | ±4% |
| RF output power, conducted | ±1.4 dB |
| Power Spectral Density, conducted | ±2.5 dB |
| Unwanted Emissions, conducted | ±2.8 dB |
| All emissions, radiated | ±5.4 dB |
| Temperature | ±1°C |
| Humidity | ±4% |

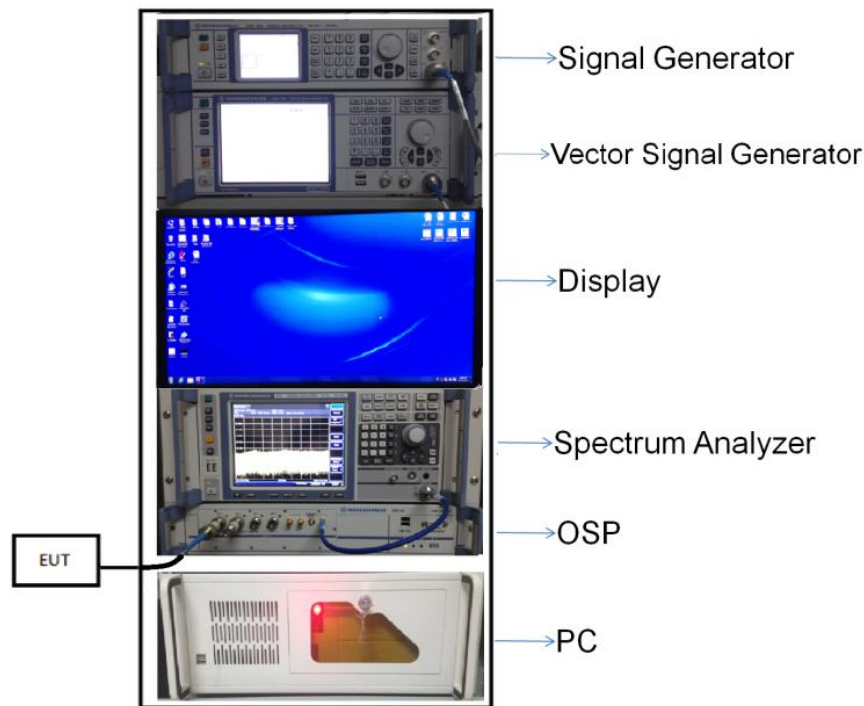
4.4 Description of Test Setup

4.4.1 For Antenna Port Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

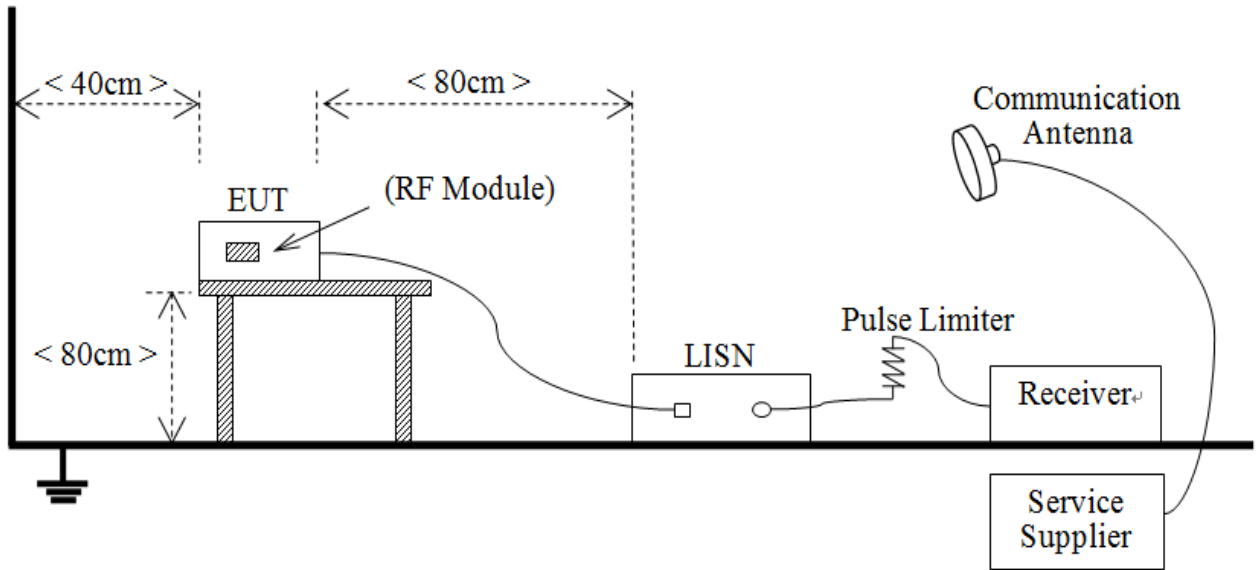
For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:

Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm



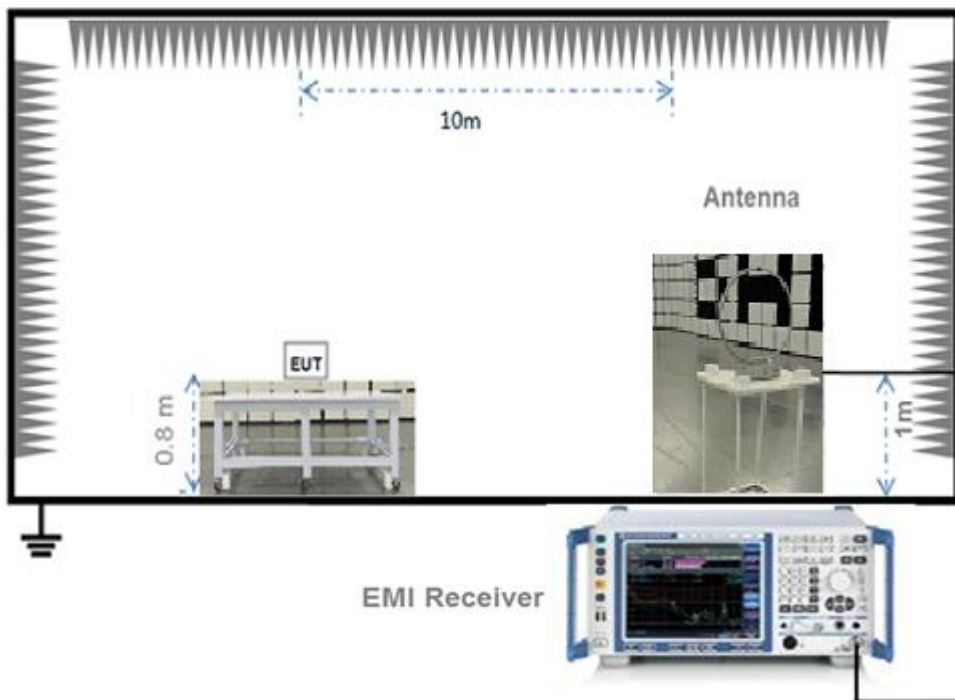
(Diagram 1)

4.4.2 For AC Power Supply Port Test



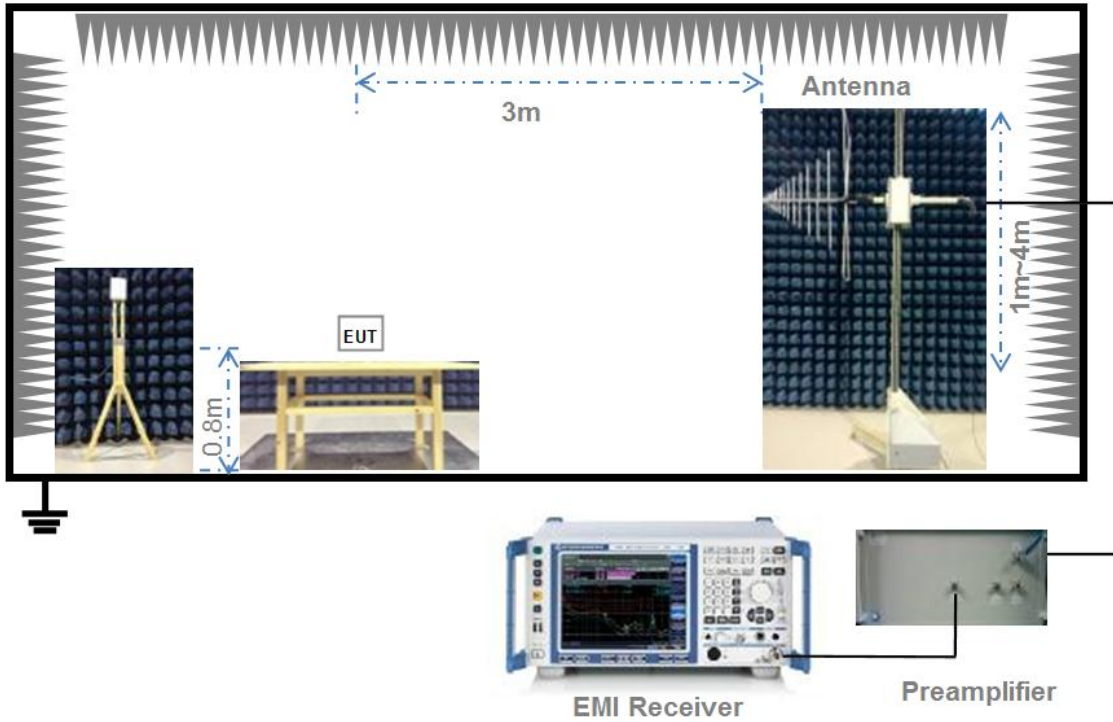
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



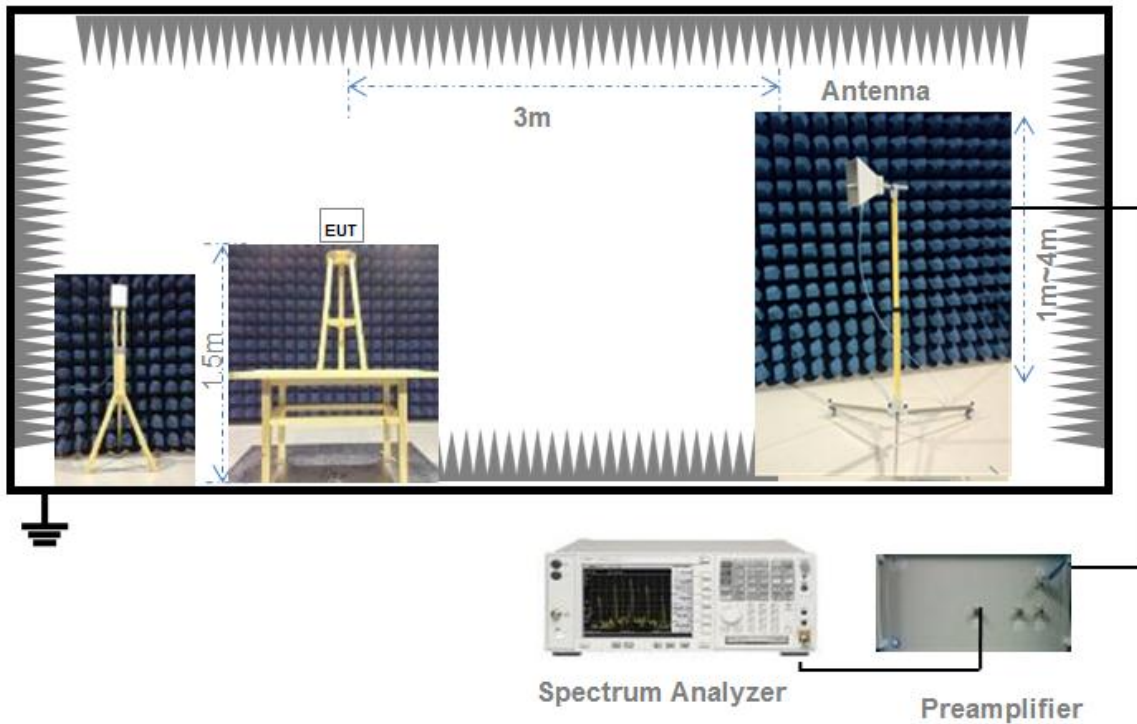
(Diagram 3)

4.4.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.5 Measurement Results Explanation Example

4.5.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

4.5.2 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.

The average level is derived from the peak level corrected with "Duty cycle correction factor".

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)

Duty cycle correction factor (dB) = $20 * \log(\text{Duty cycle})$.

Duty cycle = on time / 100 milliseconds

On time = dwell time * hopping number in 100 ms

For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then

Duty cycle correction factor (dB) = $20 * \log((2.9 * 3) / 100) = -21.21 \text{ dB}$

Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.

Example:

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)
= $45.61 + (-21.21) = 24.4 \text{ (dBuV/m)}$

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

| Protected Method | Description |
|--|---|
| The antenna is embedded in the product | The antenna is welded on the mainboard, can't be replaced by the consumer |

| Reference Documents | Item |
|---------------------|--|
| Photo | <p style="text-align: center;">Lora Antenna</p> <p style="text-align: center;">RF Module</p> |

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Number of Hopping Frequencies

5.2.1 Limit

FCC §15.247(a) (1) (i); RSS-247, 5.1 (4)

For frequency hopping systems operating in the 902-928 MHz band: the system shall use at least 50 hopping frequencies.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.2.2 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW \geq 1% of the span

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.3 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power and E.I.R.P

5.3.1 Test Limit

FCC § 15.247(b)(1)

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, as permitted under paragraph (a)(1)(i) of this section.

RSS-247, 5.4 (2)

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 hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a)(1)(i); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

5.4.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a)(1); RSS-247, 5.1 (2)

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.

5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) \geq 1% of the span

Video (or Average) Bandwidth (VBW) \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

5.5.4 Test Result

Please refer to ANNEX A.4.

5.6 Time of Occupancy (Dwell time)

5.6.1 Limit

FCC §15.247(a)(1)(i); RSS-247, 5.1 (4)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

5.6.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

5.6.4 Test Result

Please refer to ANNEX A.5

5.7 Conducted Spurious Emission & Authorized-band band-edge

5.7.1 Limit

FCC §15.247(d); RSS-247, 5.5

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, based on either an RF conducted or a radiated measurement.

5.7.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.7.4 Test Result

Please refer to ANNEX A.6 and A.7

5.8 Conducted Emission

5.8.1 Limit

FCC §15.207; RSS-GEN, 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

| Frequency range (MHz) | Conducted Limit (dB μ V) | |
|--------------------------|------------------------------|----------|
| | Quai-peak | Average |
| 0.15 - 0.50 | 66 to 56 | 56 to 46 |
| 0.50 - 5 | 56 | 46 |
| 0.50 - 30 | 60 | 50 |

5.8.2 Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Radiated Spurious Emission

5.9.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency (MHz) | Field Strength (μV/m) | Measurement Distance (m) |
|-----------------|-----------------------|--------------------------|
| 0.009 - 0.490 | 902/F(kHz) | 300 |
| 0.490 - 1.705 | 9020/F(kHz) | 30 |
| 1.705 - 30.0 | 30 | 30 |
| 30 - 88 | 100 | 3 |
| 88 - 216 | 150 | 3 |
| 216 - 960 | 200 | 3 |
| Above 960 | 500 | 3 |

Note:

1. Field Strength (dBμV/m) = 20*log[Field Strength (μV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.9.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.10.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

A.1 Number of Hopping Frequency

Note: not application.

A.2 Peak Output Power

Peak Power Test Data

125 kHz

| Channel | Measured Output Peak Power | | Limit | | Verdict |
|---------|----------------------------|-------|-------|------|---------|
| | LoRa | | dBm | mW | |
| | dBm | mW | | | |
| Low | 19.90 | 97.72 | 30 | 1000 | Pass |
| Middle | 19.76 | 94.62 | | | Pass |
| High | 19.99 | 99.77 | | | Pass |

500 kHz

| Channel | Measured Output Peak Power | | Limit | | Verdict |
|---------|----------------------------|--------|-------|------|---------|
| | LoRa | | dBm | mW | |
| | dBm | mW | | | |
| Low | 22.24 | 167.49 | 30 | 1000 | Pass |
| Middle | 22.26 | 168.27 | | | Pass |
| High | 21.97 | 157.40 | | | Pass |

A.3 20 dB and 99% bandwidth

Test Data

125kHz

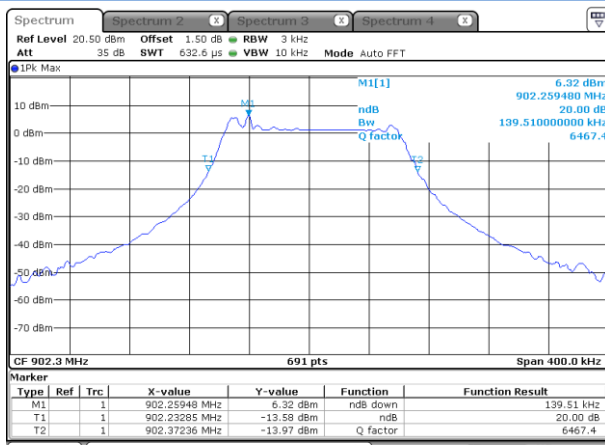
| LoRa | | | |
|---------|-----------------------|---------------------|---------|
| Channel | 20 dB Bandwidth (kHz) | 99% Bandwidth (kHz) | Verdict |
| Low | 139.510 | 126.773 | Pass |
| Middle | 139.510 | 126.773 | Pass |
| High | 140.090 | 126.773 | Pass |

500kHz

| LoRa | | | |
|---------|-----------------------|---------------------|---------|
| Channel | 20 dB Bandwidth (kHz) | 99% Bandwidth (kHz) | Verdict |
| Low | 295.800 | 723.589 | Pass |
| Middle | 295.800 | 723.589 | Pass |
| High | 295.800 | 717.800 | Pass |

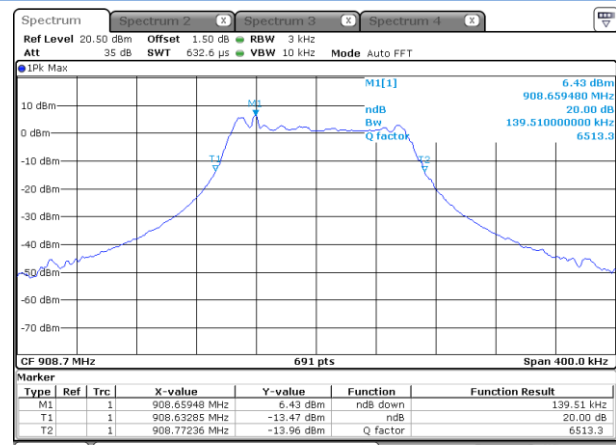
Test plots (20 dB Bandwidth) (125kHz)

LOW CHANNEL



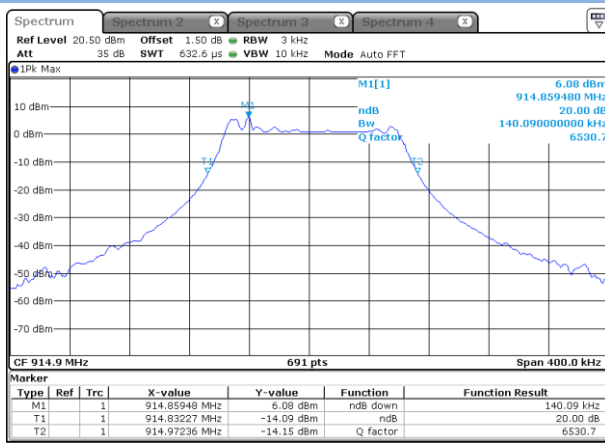
Date: 22.NOV.2018 15:04:38

MIDDLE CHANNEL



Date: 22.NOV.2018 15:06:11

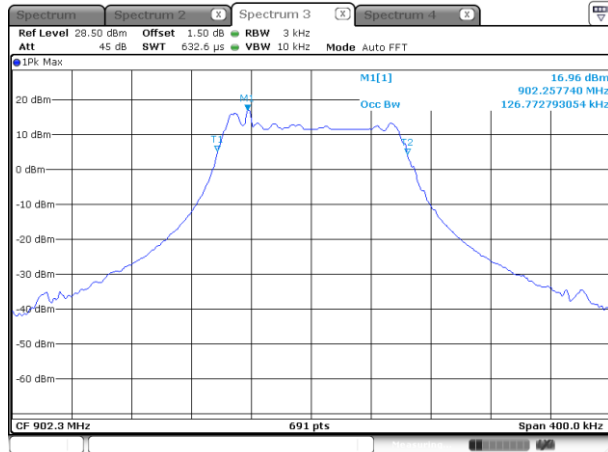
HIGH CHANNEL



Date: 22.NOV.2018 15:06:40

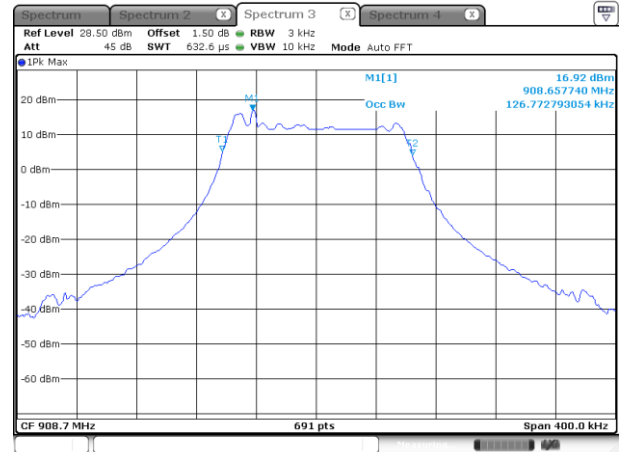
Test plots (99% Bandwidth) (125kHz)

LOW CHANNEL



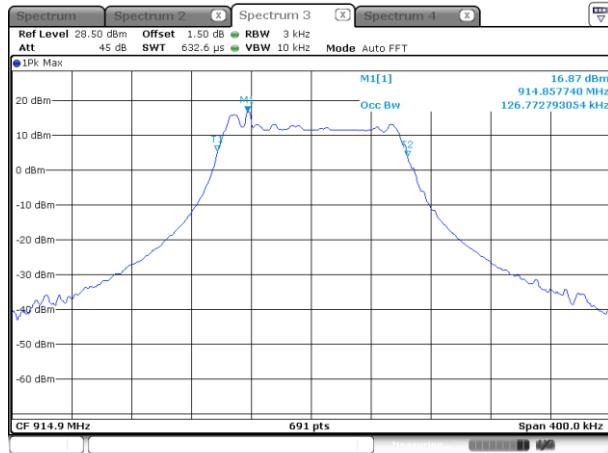
Date: 22.NOV.2018 15:23:48

MIDDLE CHANNEL



Date: 22.NOV.2018 15:24:38

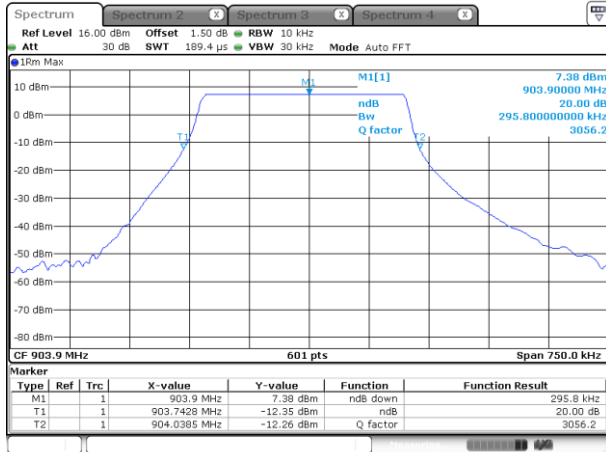
HIGH CHANNEL



Date: 22.NOV.2018 15:25:19

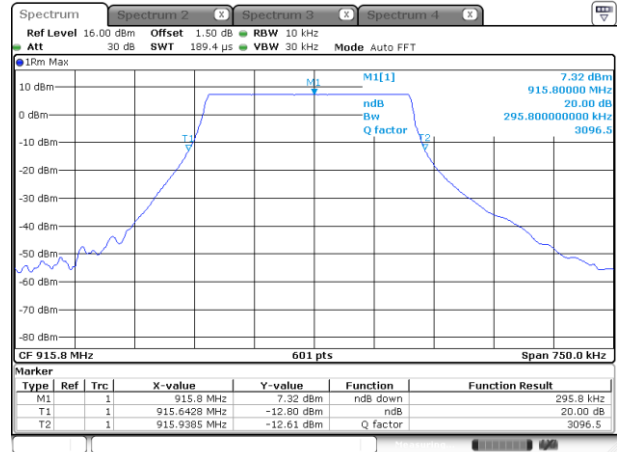
Test plots (20 dB Bandwidth) (500kHz)

LOW CHANNEL



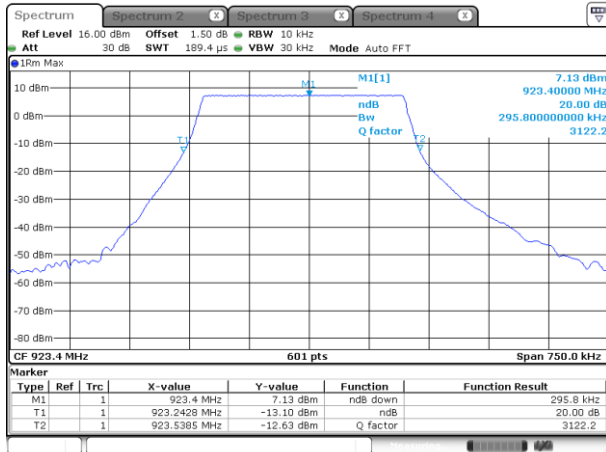
Date: 30 OCT 2018 13:28:11

MIDDLE CHANNEL



Date: 30 OCT 2018 13:31:08

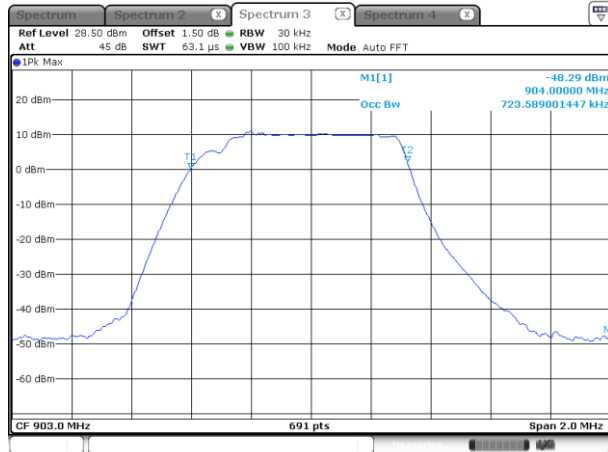
HIGH CHANNEL



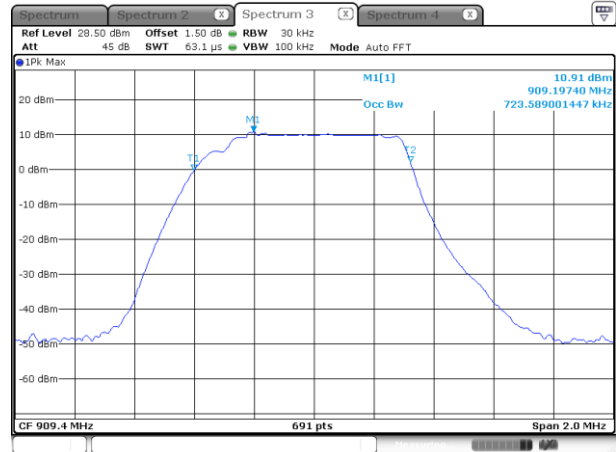
Date: 30 OCT 2018 13:32:03

Test plots (99% Bandwidth) (500kHz)

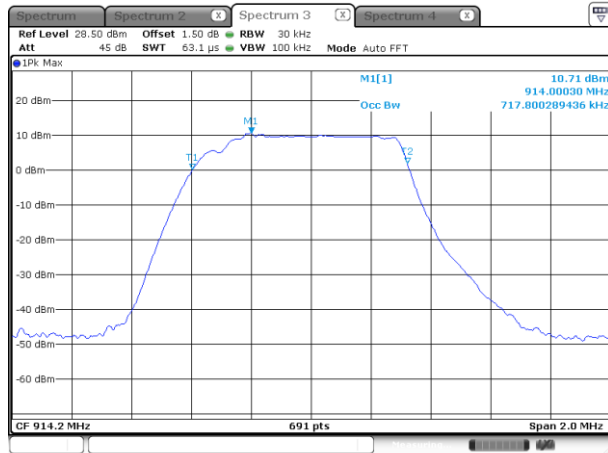
LOW CHANNEL



MIDDLE CHANNEL



HIGH CHANNEL



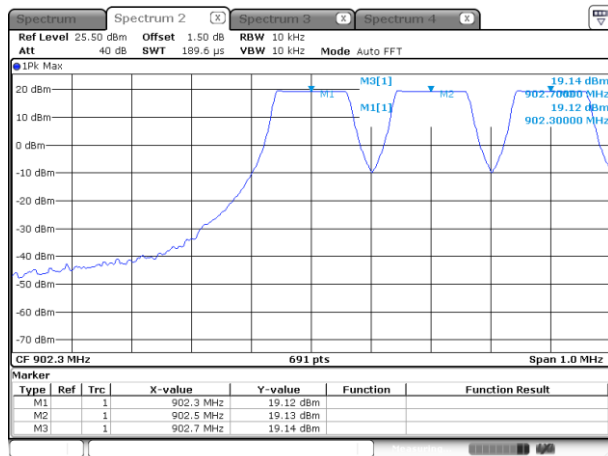
A.4 Hopping Frequency Separation

Test Data

| Mode | Frequency separation (MHz) | Max 20 dB Bandwidth (MHz) | Verdict |
|------|----------------------------|---------------------------|---------|
| LoRa | 201.200 | 139.510 | Pass |
| | 201.200 | 139.510 | Pass |
| | 201.200 | 140.090 | Pass |

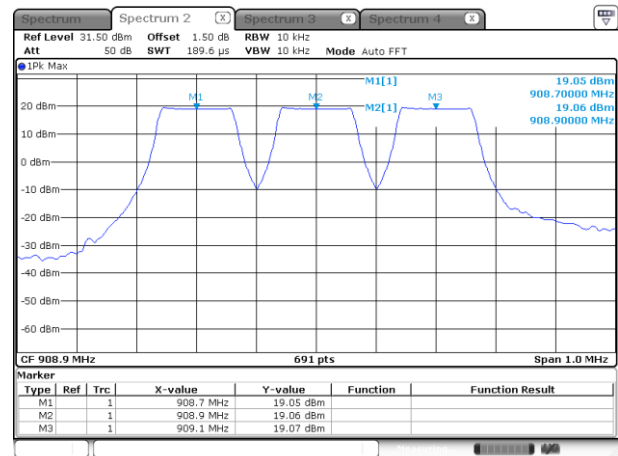
Test Plots

LOW CHANNEL



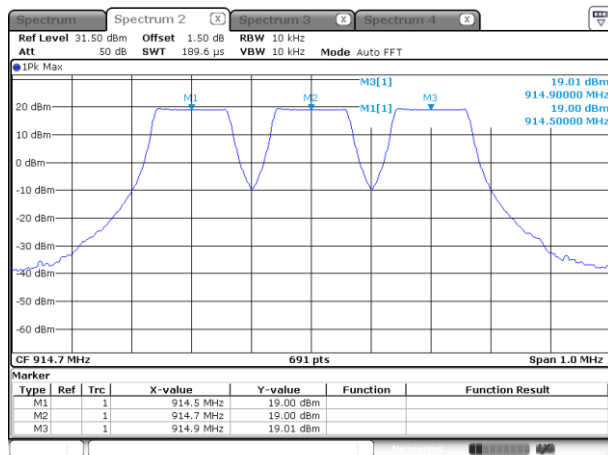
Date: 22 NOV 2018 15:16:37

MIDDLE CHANNEL



Date: 22 NOV 2018 15:19:33

HIGH CHANNEL



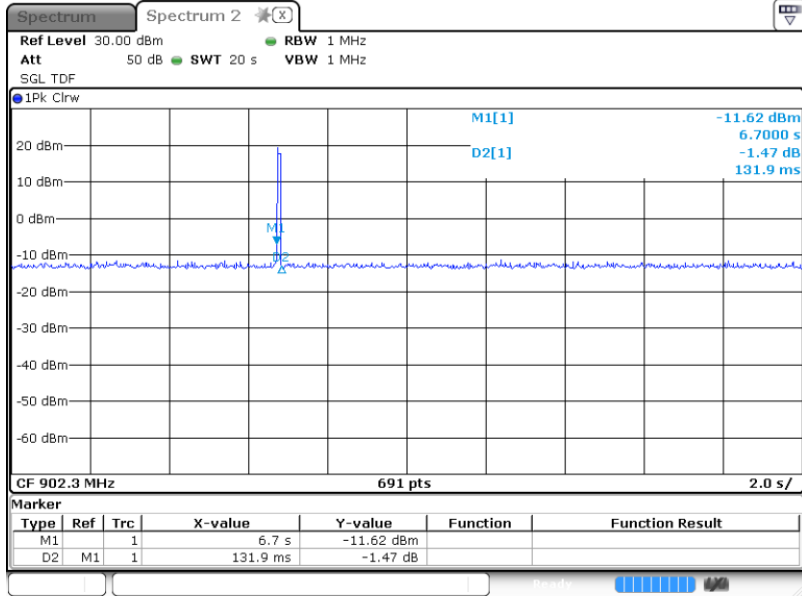
Date: 22 NOV 2018 15:20:58

A.5 Average Time of Occupancy

Test Data

| Total of Dwell(ms) | Limit (sec) | Verdict |
|--------------------|-------------|---------|
| 131.9 | 0.4 | Pass |

LoRa



Date: 7.DEC.2018 13:50:00

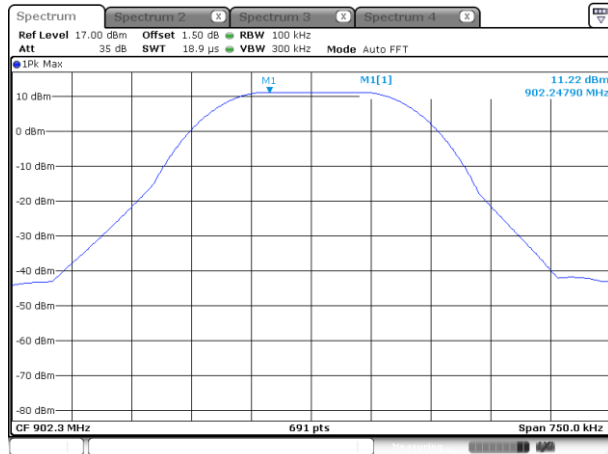
A.6 Conducted Spurious Emissions & Authorized-band band-edge

Test Data

| LoRa | | | | |
|---------|--|---------------|-------------------------|---------|
| Channel | Measured Max. Out of Band Emission (dBm) | Limit (dBm) | | Verdict |
| | | Carrier Level | Calculated 20 dBc Limit | |
| Low | -38.50 | 13.06 | -6.94 | Pass |
| Middle | -38.55 | 13.63 | -6.37 | Pass |
| High | -37.42 | 13.71 | -6.29 | Pass |

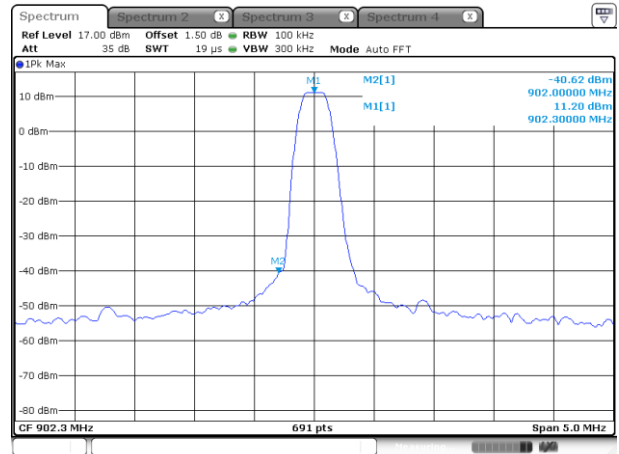
Test Plots

LOW CHANNEL, CARRIER LEVEL



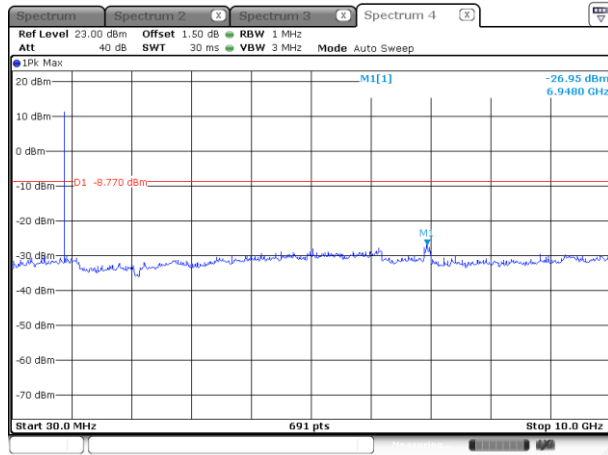
Date: 22.NOV.2018 16:19:17

LOW CHANNEL, Band Edge



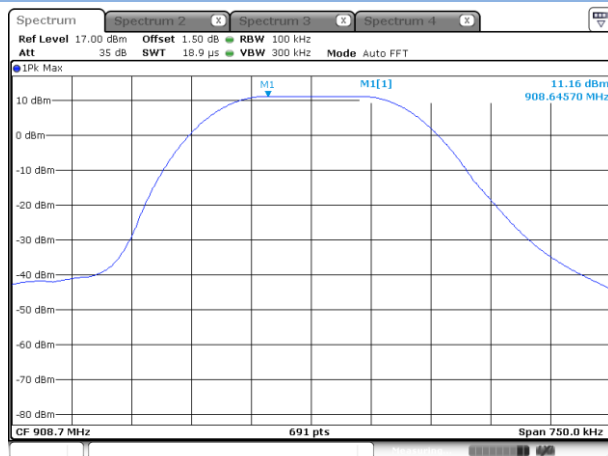
Date: 22.NOV.2018 16:13:09

LOW CHANNEL, SPURIOUS 30 MHz ~ 10 GHz



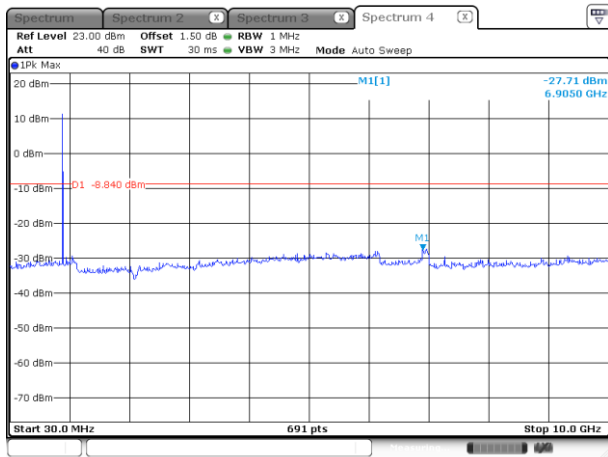
Date: 22.NOV.2018 16:19:52

MIDDLE CHANNEL, CARRIER LEVEL



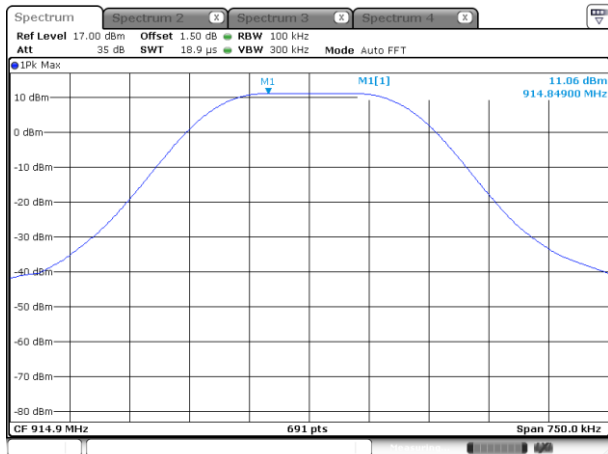
Date: 22.NOV.2018 16:18:12

MIDDLE CHANNEL , SPURIOUS 30 MHz ~ 10GHz



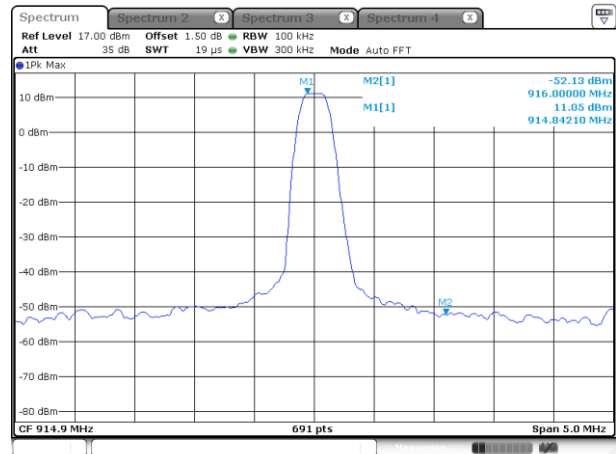
Date: 22.NOV.2018 16:18:44

HIGH CHANNEL, CARRIER LEVEL



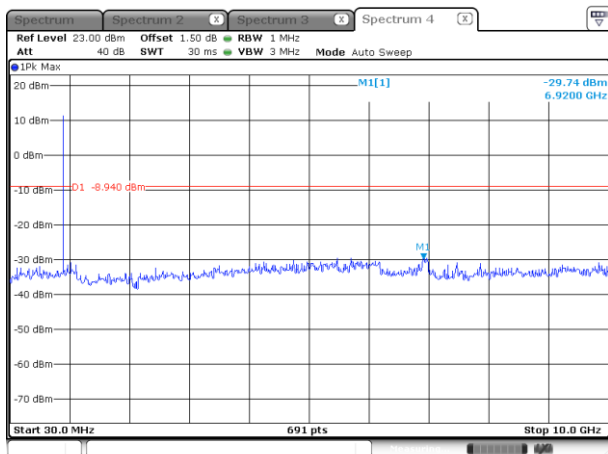
Date: 22.NOV.2018 16:15:55

HIGH CHANNEL , BAND EDGE



Date: 22.NOV.2018 16:14:46

HIGH CHANNEL , SPURIOUS 30 MHz ~ 10 GHz



Date: 22.NOV.2018 16:17:20

A.7 Conducted Emissions

Note: Not Applicable.

A.8 Radiated Spurious Emission

Note 1: The symbol of "--" in the table which means not application.

Note 2: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

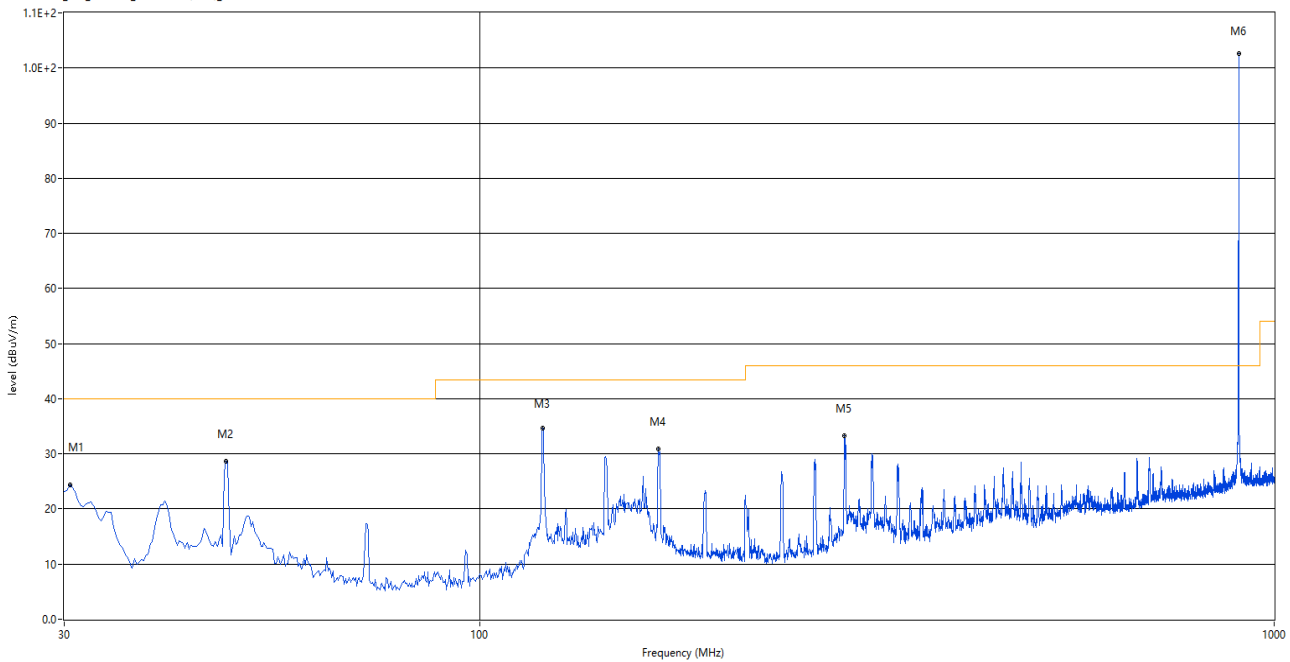
Note 3: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note 4: The worst configurations is below 1 GHz, only the worst configuration (Low Channel) shown here.

Test Data and Plots

LOW CHANNEL ANT V

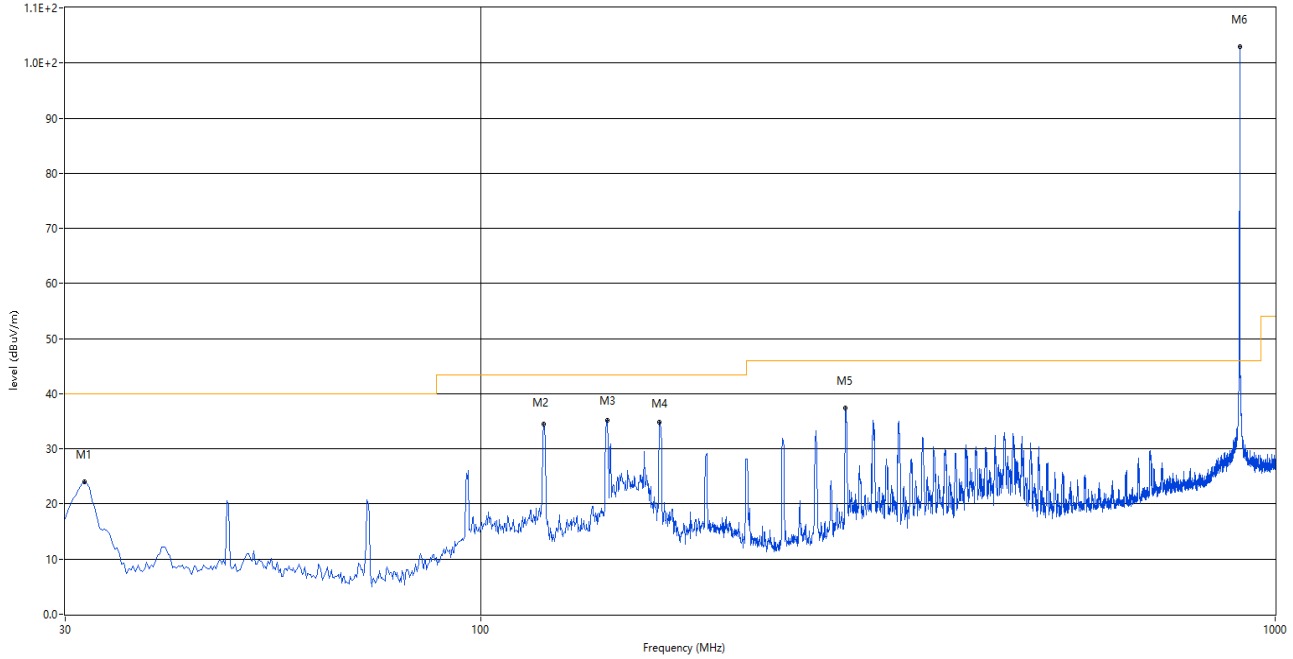
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_30MHz-1GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1 | 30.485 | 24.31 | -27.54 | 40.0 | -15.69 | Peak | 0.00 | 200 | V | Pass |
| 2 | 47.945 | 28.68 | -27.07 | 40.0 | -11.32 | Peak | 0.00 | 200 | V | Pass |
| 3 | 119.967 | 34.73 | -27.35 | 43.5 | -8.77 | Peak | 190.00 | 200 | V | Pass |
| 4 | 167.982 | 30.81 | -25.60 | 43.5 | -12.69 | Peak | 94.00 | 200 | V | Pass |
| 5 | 287.778 | 33.33 | -25.18 | 46.0 | -12.67 | Peak | 104.00 | 100 | V | Pass |
| 6 | 902.273 | 102.67 | -9.86 | 46.0 | 56.67 | Peak | 266.00 | 200 | V | N/A |

LOW CHANNEL, ANT H

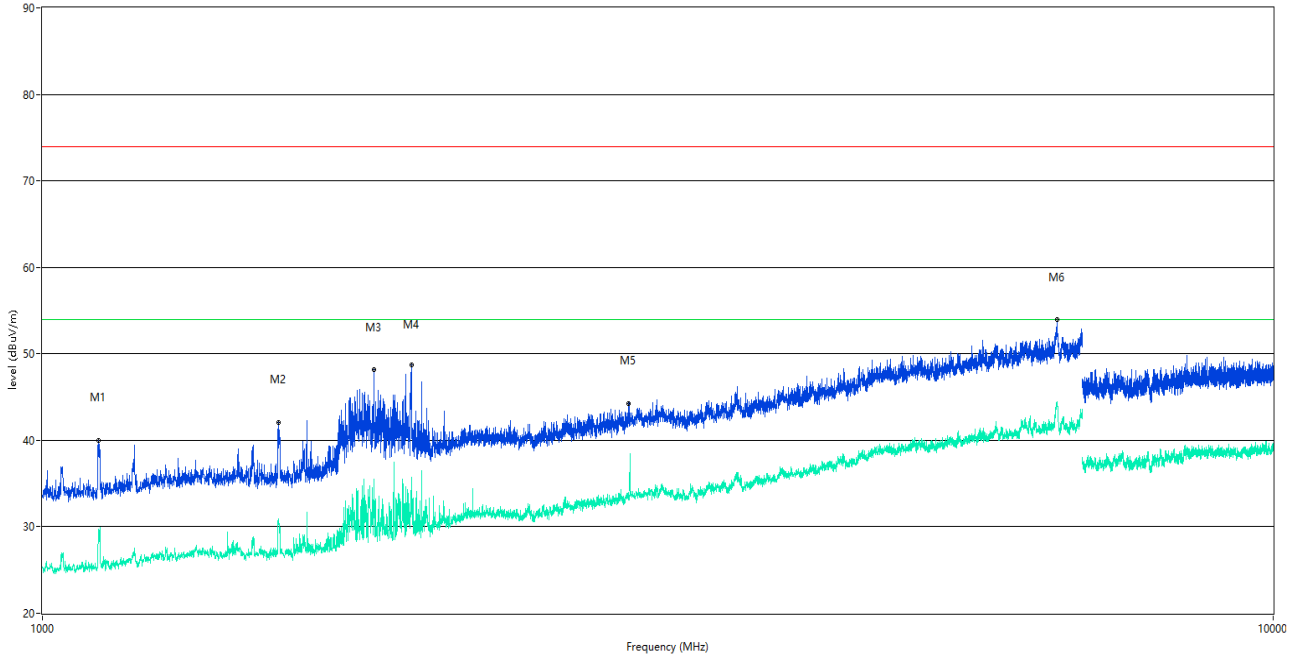
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_30MHz-1GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1 | 31.698 | 24.08 | -27.52 | 40.0 | -15.92 | Peak | 154.00 | 200 | H | Pass |
| 2 | 119.967 | 34.47 | -27.35 | 43.5 | -9.03 | Peak | 74.00 | 200 | H | Pass |
| 3 | 144.218 | 35.16 | -25.54 | 43.5 | -8.34 | Peak | 197.00 | 100 | H | Pass |
| 4 | 167.740 | 34.77 | -25.59 | 43.5 | -8.73 | Peak | 60.00 | 100 | H | Pass |
| 5 | 288.020 | 37.40 | -25.14 | 46.0 | -8.60 | Peak | 173.00 | 200 | H | Pass |
| 6 | 902.273 | 102.94 | -9.86 | 46.0 | 56.94 | Peak | 183.00 | 200 | H | N/A |

125KHz LOW CHANNEL 1 GHz to 10 GHz, ANT V

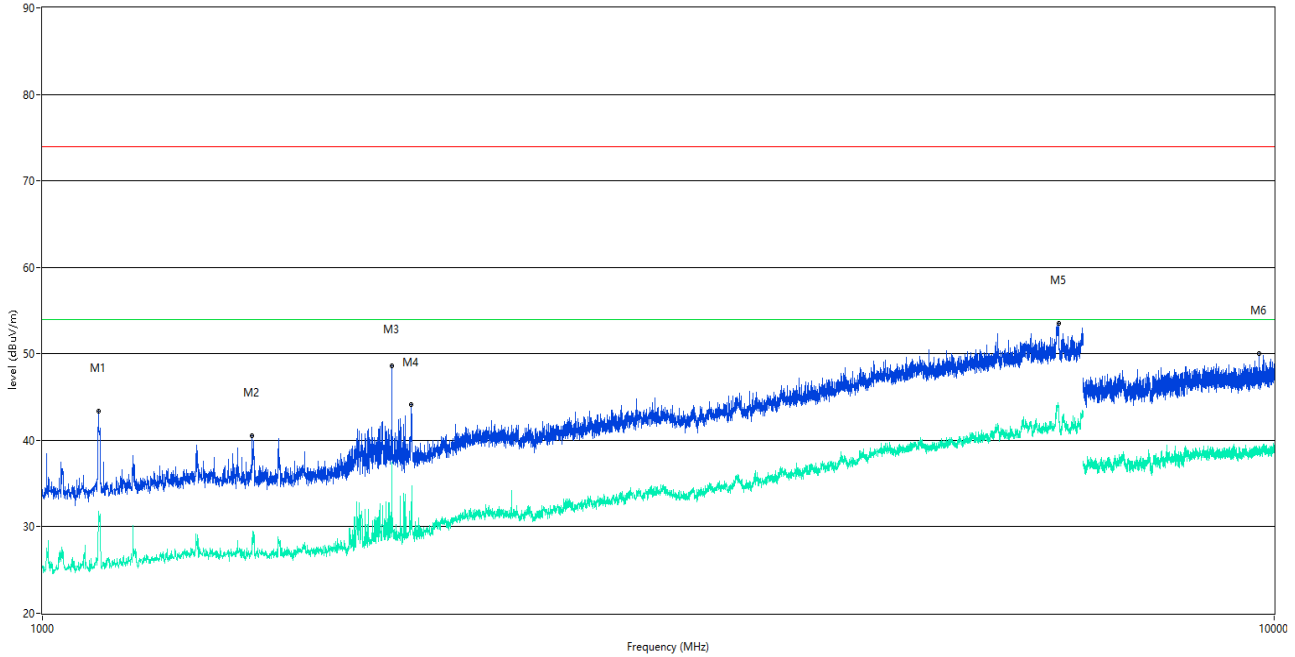
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1111.500 | 28.56 | -18.14 | 54.0 | -25.44 | AV | 191.00 | 150 | V | Pass |
| 1 | 1111.500 | 39.99 | -18.14 | 74.0 | -34.01 | Peak | 191.00 | 150 | V | Pass |
| 2** | 1556.000 | 30.55 | -17.02 | 54.0 | -23.45 | AV | 150.00 | 150 | V | Pass |
| 2 | 1556.000 | 42.05 | -17.02 | 74.0 | -31.95 | Peak | 150.00 | 150 | V | Pass |
| 3** | 1859.500 | 33.69 | -15.75 | 54.0 | -20.31 | AV | 203.00 | 150 | V | Pass |
| 3 | 1859.500 | 48.14 | -15.75 | 74.0 | -25.86 | Peak | 203.00 | 150 | V | Pass |
| 4** | 1995.000 | 32.58 | -14.94 | 54.0 | -21.42 | AV | 146.00 | 150 | V | Pass |
| 4 | 1995.000 | 48.67 | -14.94 | 74.0 | -25.33 | Peak | 146.00 | 150 | V | Pass |
| 5** | 3000.000 | 33.36 | -9.07 | 54.0 | -20.64 | AV | 288.00 | 150 | V | Pass |
| 5 | 3000.000 | 42.15 | -9.07 | 74.0 | -31.85 | Peak | 288.00 | 150 | V | Pass |
| 6** | 6671.000 | 44.23 | 2.08 | 54.0 | -9.77 | AV | 138.00 | 150 | V | Pass |
| 6 | 6671.000 | 53.91 | 2.08 | 74.0 | -20.09 | Peak | 138.00 | 150 | V | Pass |

125KHz LOW CHANNEL 1 GHz to 10 GHz, ANT H

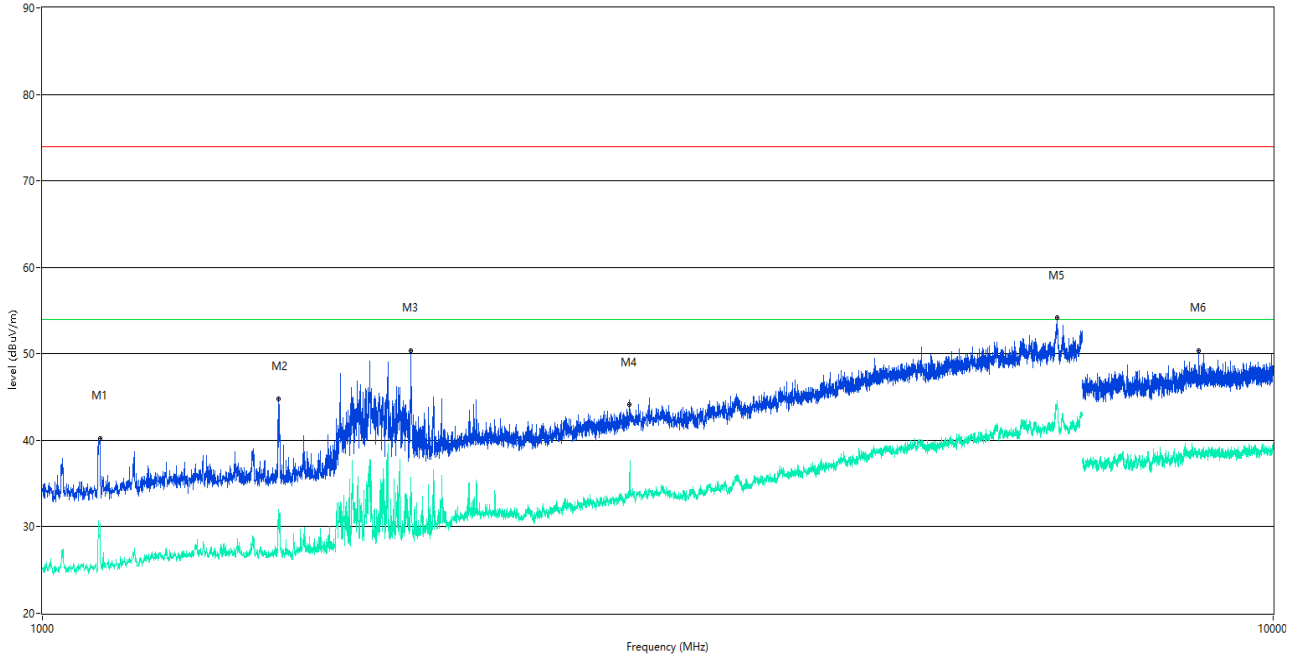
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1111.000 | 30.91 | -18.17 | 54.0 | -23.09 | AV | 270.00 | 150 | H | Pass |
| 1 | 1111.000 | 43.37 | -18.17 | 74.0 | -30.63 | Peak | 270.00 | 150 | H | Pass |
| 2** | 1479.500 | 28.13 | -16.79 | 54.0 | -25.87 | AV | 207.00 | 150 | H | Pass |
| 2 | 1479.500 | 40.58 | -16.79 | 74.0 | -33.42 | Peak | 207.00 | 150 | H | Pass |
| 3** | 1921.000 | 30.23 | -15.42 | 54.0 | -23.77 | AV | 258.00 | 150 | H | Pass |
| 3 | 1921.000 | 48.57 | -15.42 | 74.0 | -25.43 | Peak | 258.00 | 150 | H | Pass |
| 4** | 1993.000 | 30.93 | -14.99 | 54.0 | -23.07 | AV | 50.00 | 150 | H | Pass |
| 4 | 1993.000 | 44.10 | -14.99 | 74.0 | -29.90 | Peak | 50.00 | 150 | H | Pass |
| 5** | 6682.000 | 43.64 | 1.17 | 54.0 | -10.36 | AV | 75.00 | 150 | H | Pass |
| 5 | 6682.000 | 53.52 | 1.17 | 74.0 | -20.48 | Peak | 75.00 | 150 | H | Pass |
| 6** | 9727.000 | 38.88 | -0.21 | 54.0 | -15.12 | AV | 152.00 | 150 | H | Pass |
| 6 | 9727.000 | 50.07 | -0.21 | 74.0 | -23.93 | Peak | 152.00 | 150 | H | Pass |

125KHz MIDDLE CHANNEL 1 GHz to 10 GHz, ANT V

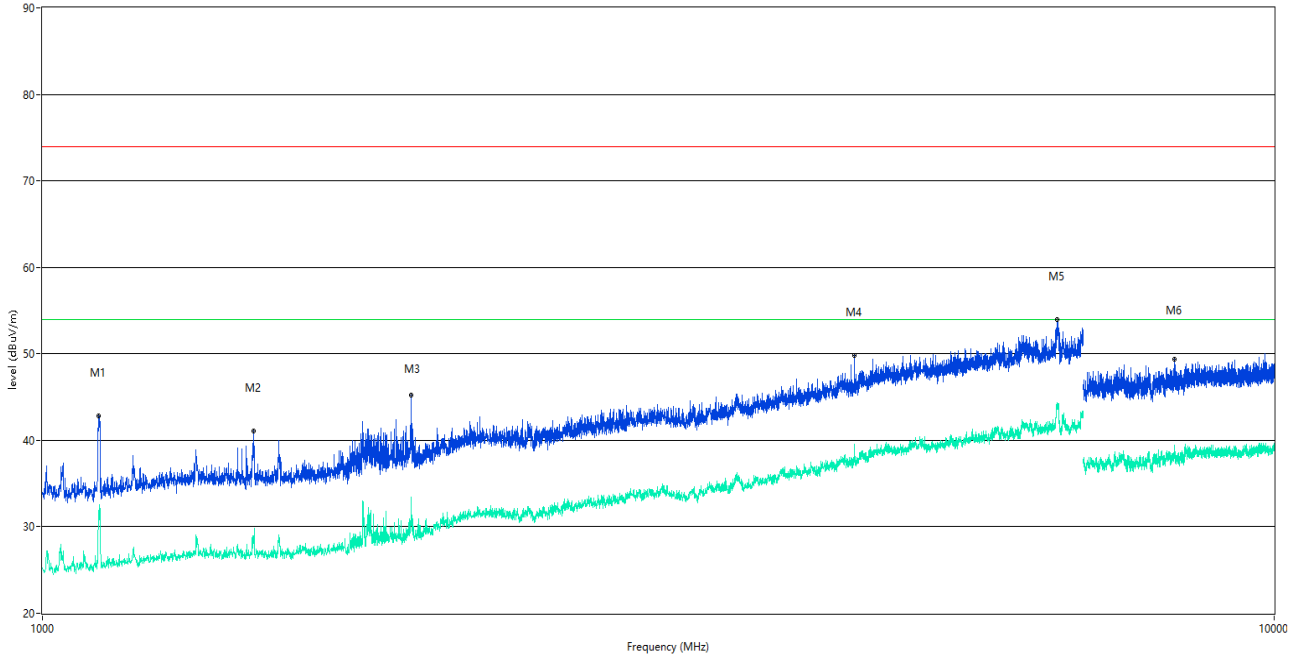
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1113.500 | 29.41 | -18.09 | 54.0 | -24.59 | AV | 303.00 | 150 | V | Pass |
| 1 | 1113.500 | 40.24 | -18.09 | 74.0 | -33.76 | Peak | 303.00 | 150 | V | Pass |
| 2** | 1556.000 | 30.06 | -17.02 | 54.0 | -23.94 | AV | 159.00 | 150 | V | Pass |
| 2 | 1556.000 | 44.77 | -17.02 | 74.0 | -29.23 | Peak | 159.00 | 150 | V | Pass |
| 3** | 1992.500 | 34.98 | -14.98 | 54.0 | -19.02 | AV | 149.00 | 150 | V | Pass |
| 3 | 1992.500 | 50.41 | -14.98 | 74.0 | -23.59 | Peak | 149.00 | 150 | V | Pass |
| 4** | 3000.000 | 36.25 | -9.07 | 54.0 | -17.75 | AV | 169.00 | 150 | V | Pass |
| 4 | 3000.000 | 44.10 | -9.07 | 74.0 | -29.90 | Peak | 169.00 | 150 | V | Pass |
| 5** | 6679.000 | 44.00 | 1.57 | 54.0 | -10.00 | AV | 278.00 | 150 | V | Pass |
| 5 | 6679.000 | 54.14 | 1.57 | 74.0 | -19.86 | Peak | 278.00 | 150 | V | Pass |
| 6** | 8705.500 | 38.62 | -1.34 | 54.0 | -15.38 | AV | 107.00 | 150 | V | Pass |
| 6 | 8705.500 | 50.37 | -1.34 | 74.0 | -23.63 | Peak | 107.00 | 150 | V | Pass |

125KHz MIDDLE CHANNEL 1 GHz to 10 GHz, ANT H

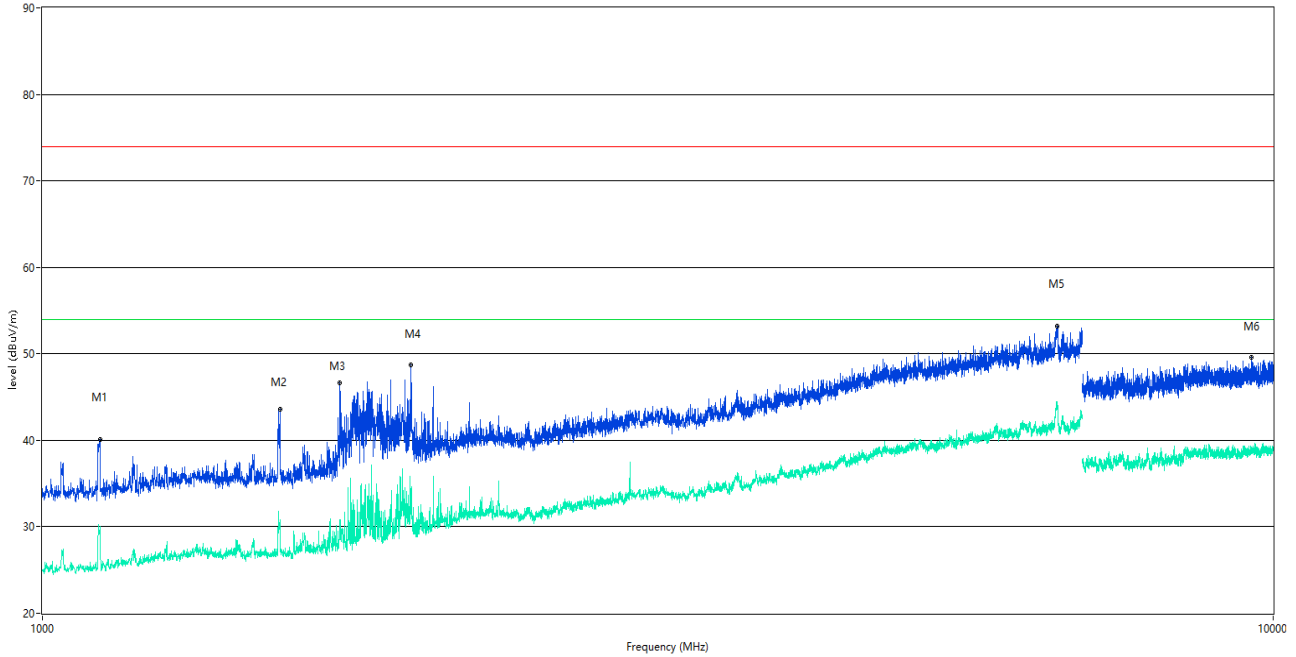
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1111.500 | 31.38 | -18.14 | 54.0 | -22.62 | AV | 155.00 | 150 | H | Pass |
| 1 | 1111.500 | 42.78 | -18.14 | 74.0 | -31.22 | Peak | 155.00 | 150 | H | Pass |
| 2** | 1483.500 | 28.12 | -16.85 | 54.0 | -25.88 | AV | 218.00 | 150 | H | Pass |
| 2 | 1483.500 | 41.13 | -16.85 | 74.0 | -32.87 | Peak | 218.00 | 150 | H | Pass |
| 3** | 1991.500 | 30.17 | -14.97 | 54.0 | -23.83 | AV | 226.00 | 150 | H | Pass |
| 3 | 1991.500 | 45.21 | -14.97 | 74.0 | -28.79 | Peak | 226.00 | 150 | H | Pass |
| 4** | 4560.000 | 37.88 | -4.35 | 54.0 | -16.12 | AV | 283.00 | 150 | H | Pass |
| 4 | 4560.000 | 49.80 | -4.35 | 74.0 | -24.20 | Peak | 283.00 | 150 | H | Pass |
| 5** | 6670.000 | 44.05 | 2.08 | 54.0 | -9.95 | AV | 88.00 | 150 | H | Pass |
| 5 | 6670.000 | 54.02 | 2.08 | 74.0 | -19.98 | Peak | 88.00 | 150 | H | Pass |
| 6** | 8305.000 | 38.64 | -0.93 | 54.0 | -15.36 | AV | 93.00 | 150 | H | Pass |
| 6 | 8305.000 | 49.39 | -0.93 | 74.0 | -24.61 | Peak | 93.00 | 150 | H | Pass |

125KHz HIGH CHANNEL 1 GHz to 10 GHz, ANT V

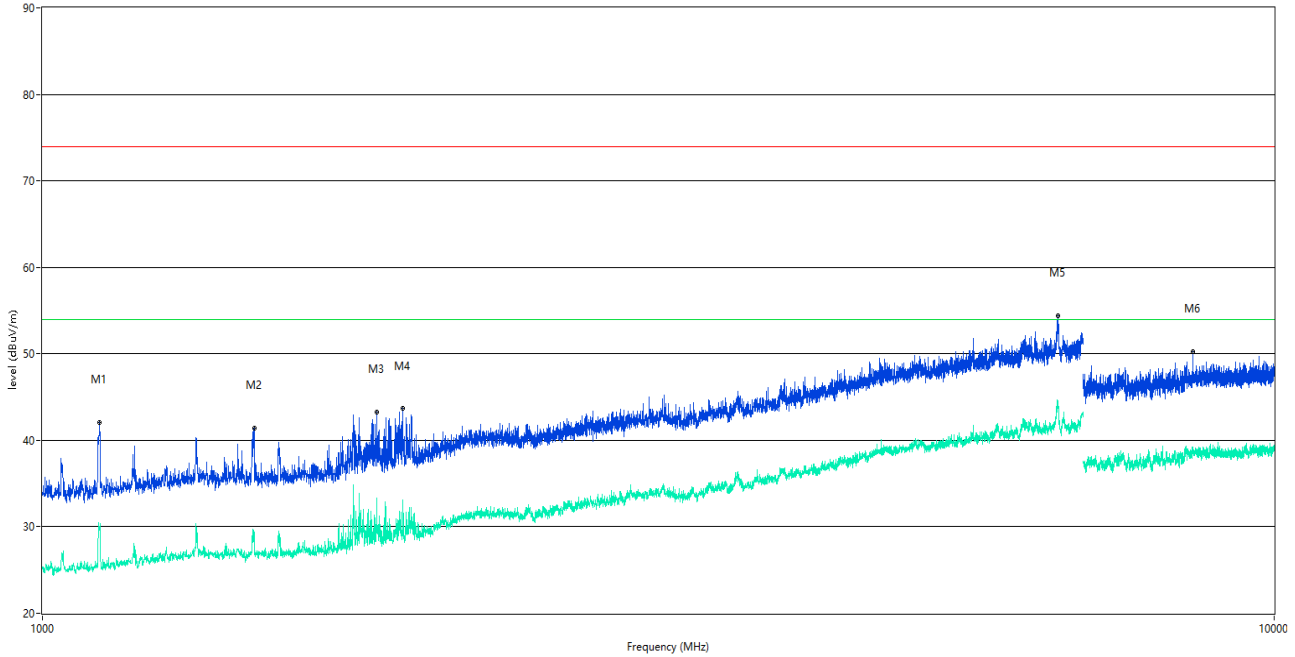
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1114.000 | 30.06 | -18.08 | 54.0 | -23.94 | AV | 173.00 | 150 | V | Pass |
| 1 | 1114.000 | 40.05 | -18.08 | 74.0 | -33.95 | Peak | 173.00 | 150 | V | Pass |
| 2** | 1559.500 | 29.65 | -17.18 | 54.0 | -24.35 | AV | 127.00 | 150 | V | Pass |
| 2 | 1559.500 | 43.58 | -17.18 | 74.0 | -30.42 | Peak | 127.00 | 150 | V | Pass |
| 3** | 1744.500 | 29.67 | -16.44 | 54.0 | -24.33 | AV | 150.00 | 150 | V | Pass |
| 3 | 1744.500 | 46.62 | -16.44 | 74.0 | -27.38 | Peak | 150.00 | 150 | V | Pass |
| 4** | 1991.500 | 31.68 | -14.97 | 54.0 | -22.32 | AV | 110.00 | 150 | V | Pass |
| 4 | 1991.500 | 48.77 | -14.97 | 74.0 | -25.23 | Peak | 110.00 | 150 | V | Pass |
| 5** | 6671.000 | 44.00 | 2.08 | 54.0 | -10.00 | AV | 107.00 | 150 | V | Pass |
| 5 | 6671.000 | 53.14 | 2.08 | 74.0 | -20.86 | Peak | 107.00 | 150 | V | Pass |
| 6** | 9598.000 | 38.66 | 0.07 | 54.0 | -15.34 | AV | 293.00 | 150 | V | Pass |
| 6 | 9598.000 | 49.65 | 0.07 | 74.0 | -24.35 | Peak | 293.00 | 150 | V | Pass |

125KHz HIGH CHANNEL 1 GHz to 10 GHz, ANT H

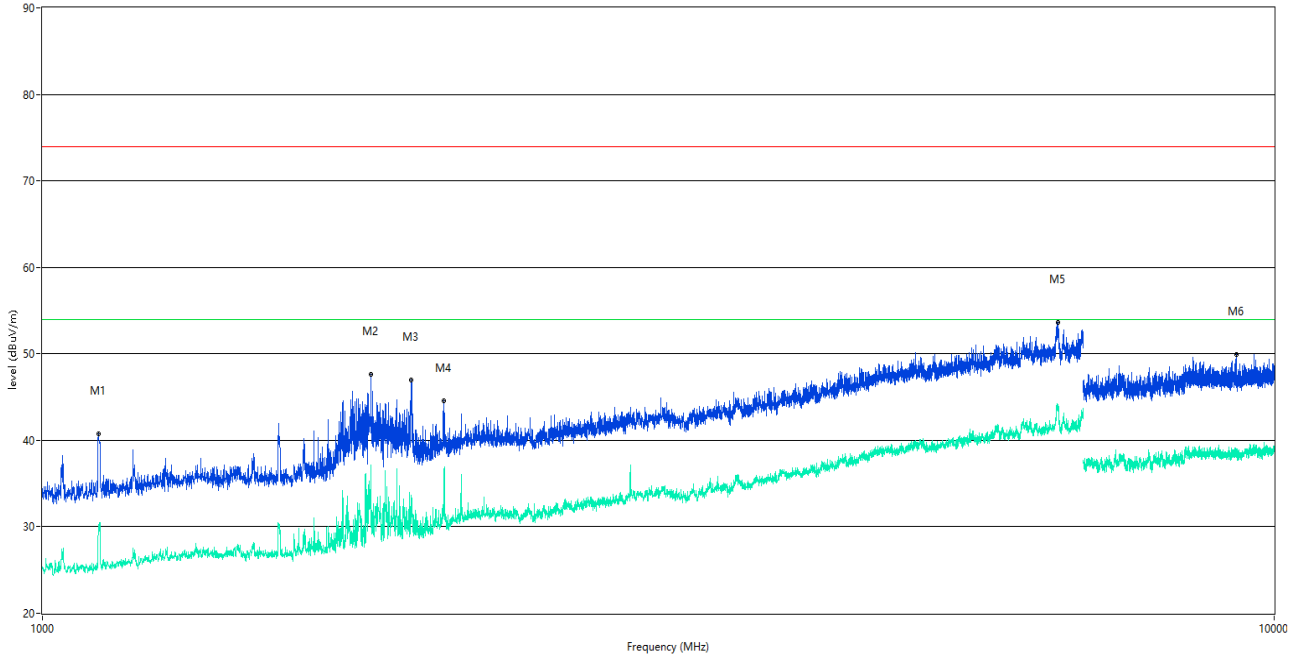
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1113.000 | 29.78 | -18.10 | 54.0 | -24.22 | AV | 216.00 | 150 | H | Pass |
| 1 | 1113.000 | 42.11 | -18.10 | 74.0 | -31.89 | Peak | 216.00 | 150 | H | Pass |
| 2** | 1485.500 | 29.38 | -16.87 | 54.0 | -24.62 | AV | 192.00 | 150 | H | Pass |
| 2 | 1485.500 | 41.42 | -16.87 | 74.0 | -32.58 | Peak | 192.00 | 150 | H | Pass |
| 3** | 1867.500 | 29.41 | -15.72 | 54.0 | -24.59 | AV | 149.00 | 150 | H | Pass |
| 3 | 1867.500 | 43.29 | -15.72 | 74.0 | -30.71 | Peak | 149.00 | 150 | H | Pass |
| 4** | 1960.000 | 29.26 | -15.23 | 54.0 | -24.74 | AV | 247.00 | 150 | H | Pass |
| 4 | 1960.000 | 43.66 | -15.23 | 74.0 | -30.34 | Peak | 247.00 | 150 | H | Pass |
| 5** | 6671.000 | 44.37 | 2.08 | 54.0 | -9.63 | AV | 149.00 | 150 | H | Pass |
| 5 | 6671.000 | 54.45 | 2.08 | 74.0 | -19.55 | Peak | 149.00 | 150 | H | Pass |
| 6** | 8585.500 | 38.88 | -1.55 | 54.0 | -15.12 | AV | 0.00 | 150 | H | Pass |
| 6 | 8585.500 | 50.30 | -1.55 | 74.0 | -23.70 | Peak | 0.00 | 150 | H | Pass |

500KHz LOW CHANNEL 1 GHz to 10 GHz, ANT V

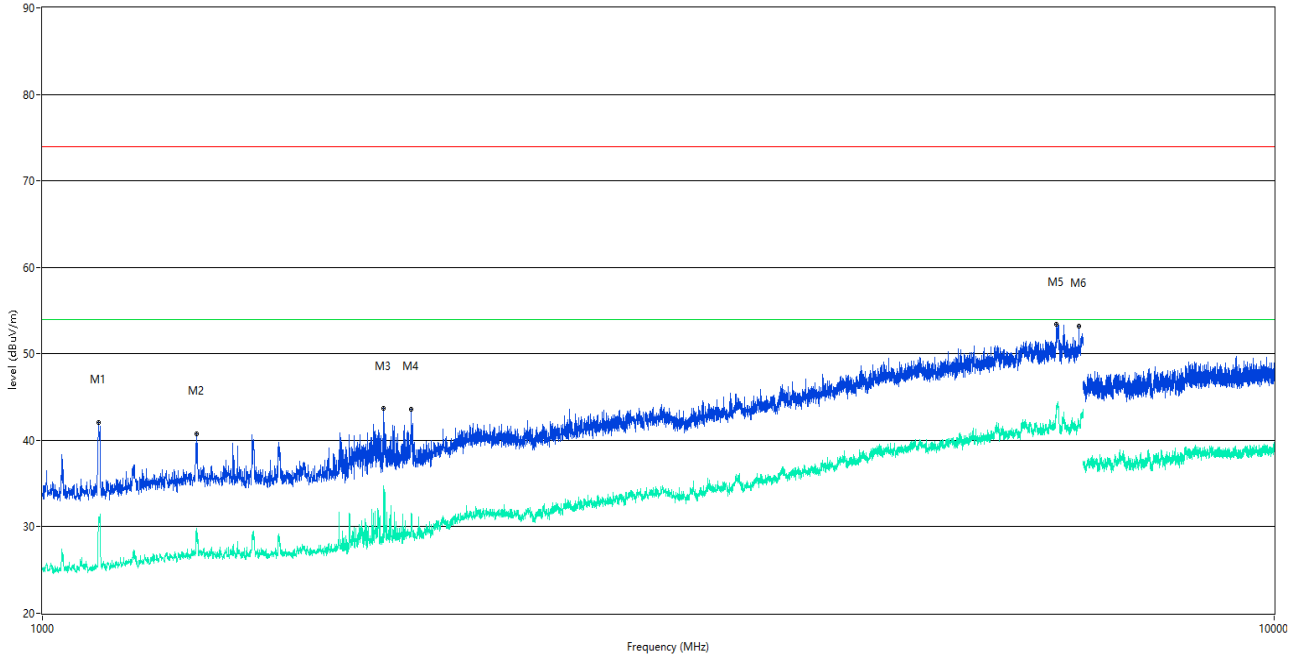
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1110.000 | 30.23 | -18.22 | 54.0 | -23.77 | AV | 162.00 | 150 | V | Pass |
| 1 | 1110.000 | 40.77 | -18.22 | 74.0 | -33.23 | Peak | 162.00 | 150 | V | Pass |
| 2** | 1847.500 | 33.64 | -15.92 | 54.0 | -20.36 | AV | 173.00 | 150 | V | Pass |
| 2 | 1847.500 | 47.62 | -15.92 | 74.0 | -26.38 | Peak | 173.00 | 150 | V | Pass |
| 3** | 1991.500 | 31.14 | -14.97 | 54.0 | -22.86 | AV | 127.00 | 150 | V | Pass |
| 3 | 1991.500 | 46.96 | -14.97 | 74.0 | -27.04 | Peak | 127.00 | 150 | V | Pass |
| 4** | 2119.000 | 36.55 | -13.04 | 54.0 | -17.45 | AV | 144.00 | 150 | V | Pass |
| 4 | 2119.000 | 44.62 | -13.04 | 74.0 | -29.38 | Peak | 144.00 | 150 | V | Pass |
| 5** | 6676.000 | 43.39 | 1.77 | 54.0 | -10.61 | AV | 339.00 | 150 | V | Pass |
| 5 | 6676.000 | 53.68 | 1.77 | 74.0 | -20.32 | Peak | 339.00 | 150 | V | Pass |
| 6** | 9313.000 | 38.60 | -0.74 | 54.0 | -15.40 | AV | 245.00 | 150 | V | Pass |
| 6 | 9313.000 | 49.92 | -0.74 | 74.0 | -24.08 | Peak | 245.00 | 150 | V | Pass |

500KHz LOW CHANNEL 1 GHz to 10 GHz, ANT H

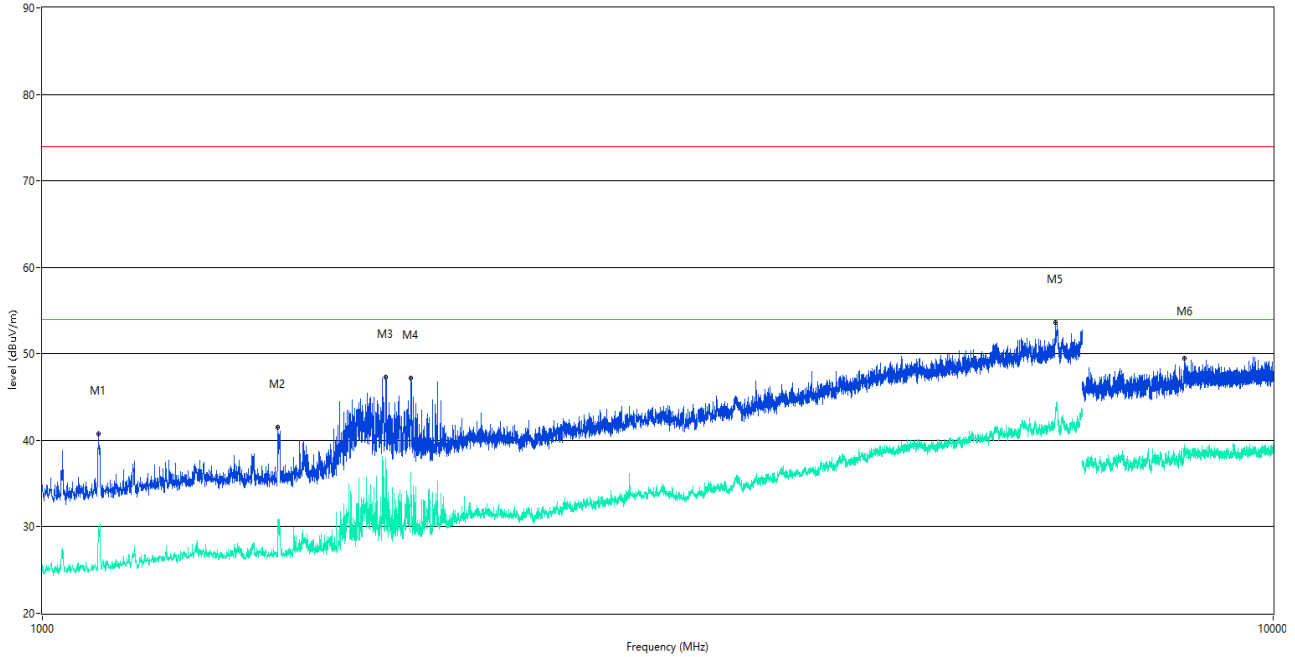
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1111.500 | 30.12 | -18.14 | 54.0 | -23.88 | AV | 223.00 | 150 | H | Pass |
| 1 | 1111.500 | 42.08 | -18.14 | 74.0 | -31.92 | Peak | 223.00 | 150 | H | Pass |
| 2** | 1333.500 | 28.58 | -16.73 | 54.0 | -25.42 | AV | 186.00 | 150 | H | Pass |
| 2 | 1333.500 | 40.77 | -16.73 | 74.0 | -33.23 | Peak | 186.00 | 150 | H | Pass |
| 3** | 1892.000 | 34.25 | -15.62 | 54.0 | -19.75 | AV | 237.00 | 150 | H | Pass |
| 3 | 1892.000 | 43.65 | -15.62 | 74.0 | -30.35 | Peak | 237.00 | 150 | H | Pass |
| 4** | 1992.000 | 31.38 | -14.97 | 54.0 | -22.62 | AV | 215.00 | 150 | H | Pass |
| 4 | 1992.000 | 43.57 | -14.97 | 74.0 | -30.43 | Peak | 215.00 | 150 | H | Pass |
| 5** | 6658.000 | 43.78 | 1.46 | 54.0 | -10.22 | AV | 294.00 | 150 | H | Pass |
| 5 | 6658.000 | 53.37 | 1.46 | 74.0 | -20.63 | Peak | 294.00 | 150 | H | Pass |
| 6** | 6941.000 | 42.26 | 0.15 | 54.0 | -11.74 | AV | 302.00 | 150 | H | Pass |
| 6 | 6941.000 | 53.23 | 0.15 | 74.0 | -20.77 | Peak | 302.00 | 150 | H | Pass |

500kHz MIDDLE CHANNEL 1 GHz to 10 GHz, ANT V

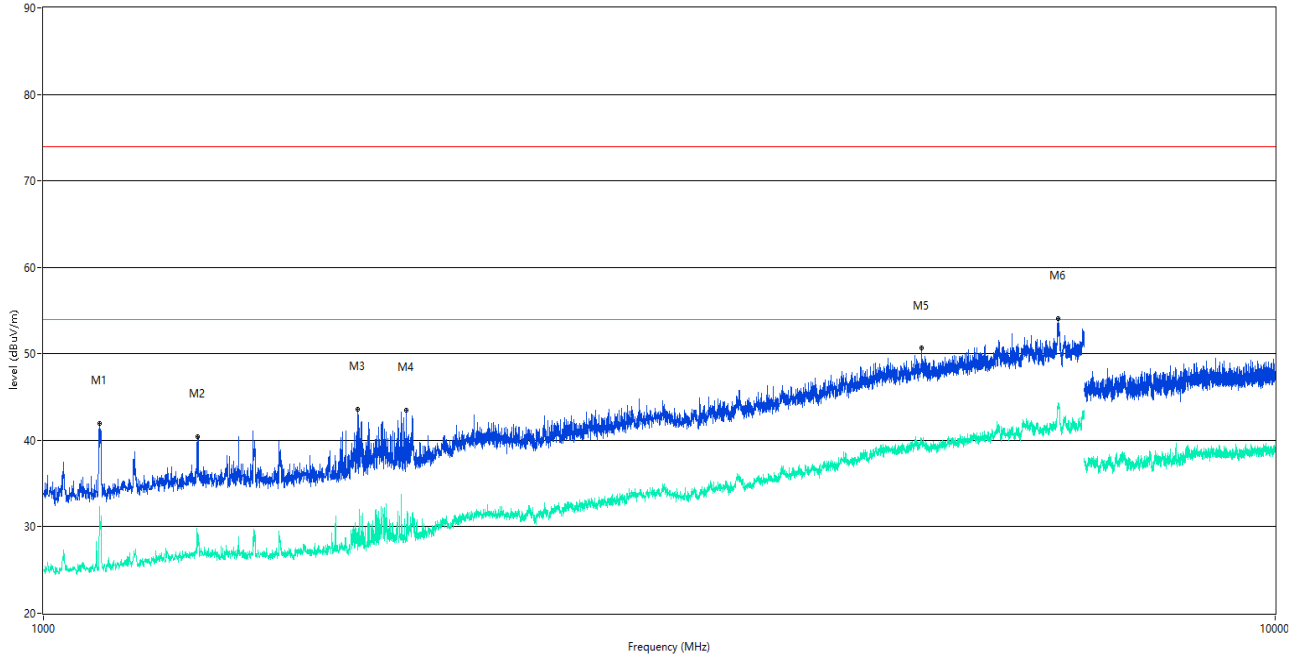
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1110.500 | 30.08 | -18.19 | 54.0 | -23.92 | AV | 154.00 | 150 | V | Pass |
| 1 | 1110.500 | 40.79 | -18.19 | 74.0 | -33.21 | Peak | 154.00 | 150 | V | Pass |
| 2** | 1553.000 | 27.93 | -17.06 | 54.0 | -26.07 | AV | 141.00 | 150 | V | Pass |
| 2 | 1553.000 | 41.49 | -17.06 | 74.0 | -32.51 | Peak | 141.00 | 150 | V | Pass |
| 3** | 1900.500 | 32.86 | -15.38 | 54.0 | -21.14 | AV | 179.00 | 150 | V | Pass |
| 3 | 1900.500 | 47.32 | -15.38 | 74.0 | -26.68 | Peak | 179.00 | 150 | V | Pass |
| 4** | 1992.500 | 36.27 | -14.98 | 54.0 | -17.73 | AV | 116.00 | 150 | V | Pass |
| 4 | 1992.500 | 47.24 | -14.98 | 74.0 | -26.76 | Peak | 116.00 | 150 | V | Pass |
| 5** | 6658.000 | 43.42 | 1.46 | 54.0 | -10.58 | AV | 136.00 | 150 | V | Pass |
| 5 | 6658.000 | 53.67 | 1.46 | 74.0 | -20.33 | Peak | 136.00 | 150 | V | Pass |
| 6** | 8475.250 | 39.26 | -0.75 | 54.0 | -14.74 | AV | 190.00 | 150 | V | Pass |
| 6 | 8475.250 | 49.51 | -0.75 | 74.0 | -24.49 | Peak | 190.00 | 150 | V | Pass |

500KHz MIDDLE CHANNEL 1 GHz to 10 GHz, ANT H

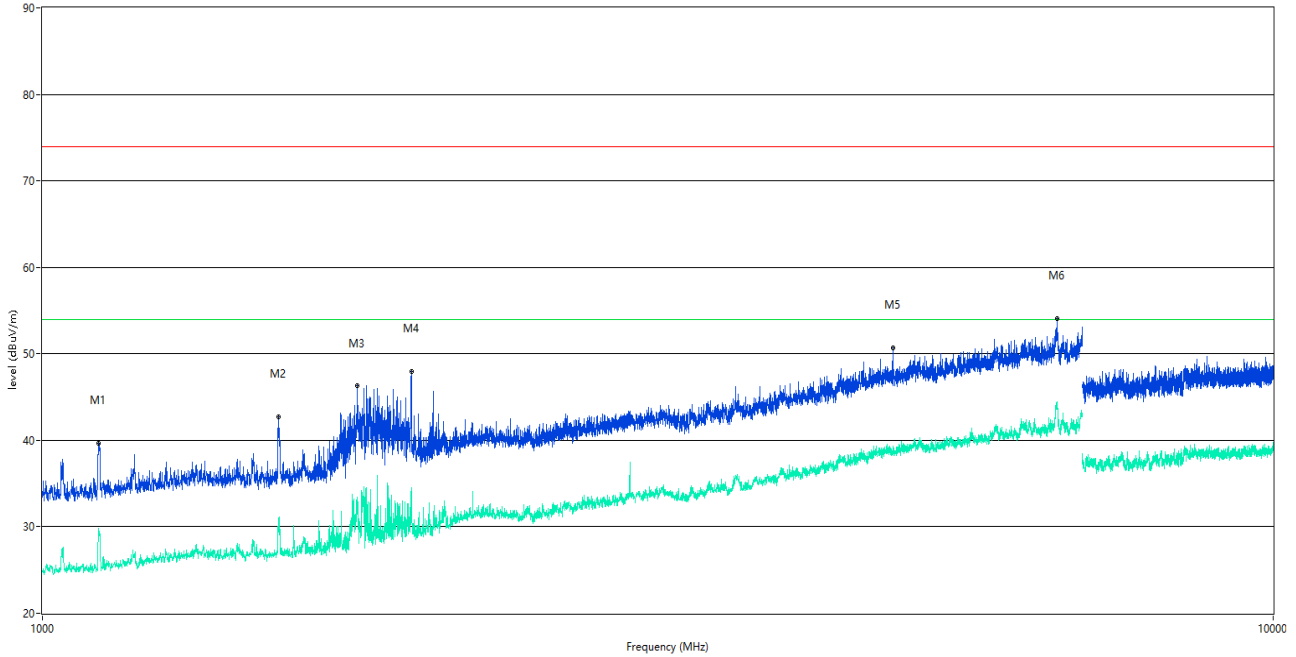
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1110.000 | 30.18 | -18.22 | 54.0 | -23.82 | AV | 213.00 | 150 | H | Pass |
| 1 | 1110.000 | 42.00 | -18.22 | 74.0 | -32.00 | Peak | 213.00 | 150 | H | Pass |
| 2** | 1333.000 | 27.99 | -16.71 | 54.0 | -26.01 | AV | 187.00 | 150 | H | Pass |
| 2 | 1333.000 | 40.43 | -16.71 | 74.0 | -33.57 | Peak | 187.00 | 150 | H | Pass |
| 3** | 1798.000 | 28.22 | -16.12 | 54.0 | -25.78 | AV | 142.00 | 150 | H | Pass |
| 3 | 1798.000 | 43.64 | -16.12 | 74.0 | -30.36 | Peak | 142.00 | 150 | H | Pass |
| 4** | 1971.500 | 28.38 | -15.08 | 54.0 | -25.62 | AV | 213.00 | 150 | H | Pass |
| 4 | 1971.500 | 43.49 | -15.08 | 74.0 | -30.51 | Peak | 213.00 | 150 | H | Pass |
| 5** | 5161.000 | 39.92 | -2.51 | 54.0 | -14.08 | AV | 93.00 | 150 | H | Pass |
| 5 | 5161.000 | 50.65 | -2.51 | 74.0 | -23.35 | Peak | 93.00 | 150 | H | Pass |
| 6** | 6666.000 | 43.83 | 1.82 | 54.0 | -10.17 | AV | 341.00 | 150 | H | Pass |
| 6 | 6666.000 | 54.05 | 1.82 | 74.0 | -19.95 | Peak | 341.00 | 150 | H | Pass |

500KHz HIGH CHANNEL 1 GHz to 10 GHz, ANT V

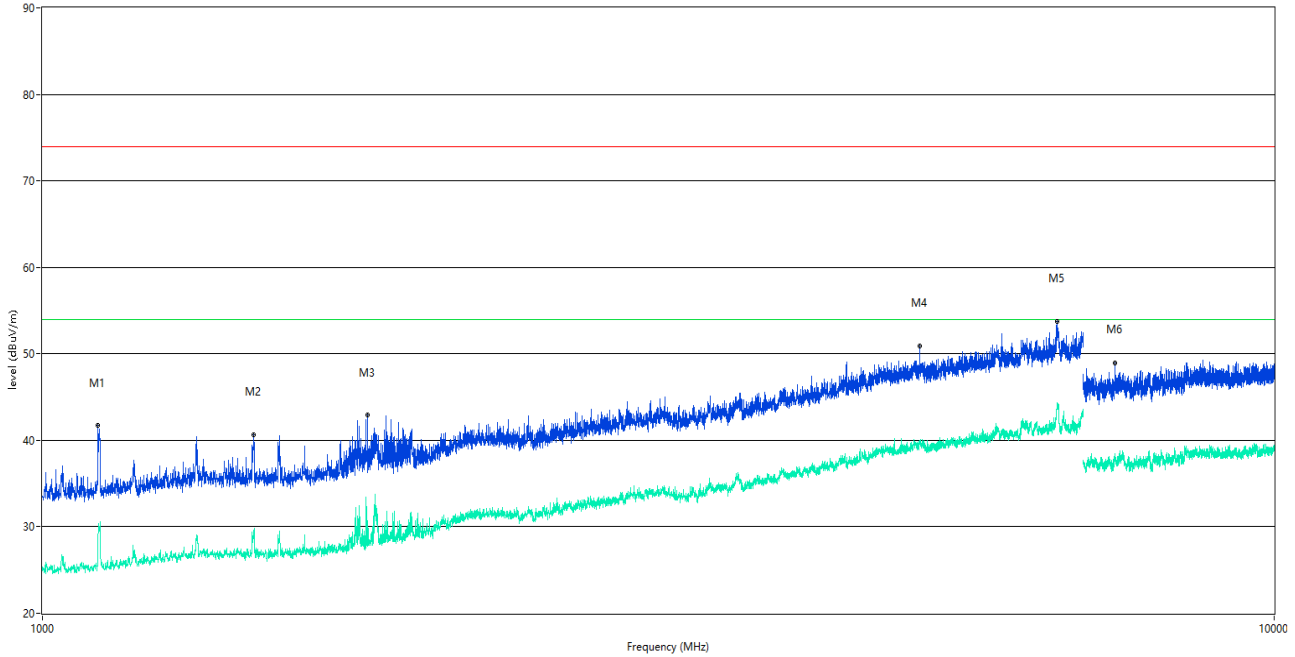
RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1110.500 | 29.19 | -18.19 | 54.0 | -24.81 | AV | 158.00 | 150 | V | Pass |
| 1 | 1110.500 | 39.67 | -18.19 | 74.0 | -34.33 | Peak | 158.00 | 150 | V | Pass |
| 2** | 1554.500 | 29.40 | -17.05 | 54.0 | -24.60 | AV | 151.00 | 150 | V | Pass |
| 2 | 1554.500 | 42.75 | -17.05 | 74.0 | -31.25 | Peak | 151.00 | 150 | V | Pass |
| 3** | 1802.000 | 33.03 | -16.18 | 54.0 | -20.97 | AV | 138.00 | 150 | V | Pass |
| 3 | 1802.000 | 46.28 | -16.18 | 74.0 | -27.72 | Peak | 138.00 | 150 | V | Pass |
| 4** | 1995.500 | 31.07 | -14.93 | 54.0 | -22.93 | AV | 132.00 | 150 | V | Pass |
| 4 | 1995.500 | 47.99 | -14.93 | 74.0 | -26.01 | Peak | 132.00 | 150 | V | Pass |
| 5** | 4908.000 | 38.63 | -3.21 | 54.0 | -15.37 | AV | 269.00 | 150 | V | Pass |
| 5 | 4908.000 | 50.74 | -3.21 | 74.0 | -23.26 | Peak | 269.00 | 150 | V | Pass |
| 6** | 6673.000 | 44.20 | 1.94 | 54.0 | -9.80 | AV | 25.00 | 150 | V | Pass |
| 6 | 6673.000 | 54.12 | 1.94 | 74.0 | -19.88 | Peak | 25.00 | 150 | V | Pass |

500KHz HIGH CHANNEL 1 GHz to 10 GHz, ANT H

RE Test case_FCC_Part 15C_FCC 15.247(2.4G)_1GHz-12.75GHz



| No. | Frequency (MHz) | Results (dBuV/m) | Factor (dB) | Limit (dBuV/m) | Over Limit (dB) | Detector | Table (o) | Height (cm) | ANT | Verdict |
|-----|-----------------|------------------|-------------|----------------|-----------------|----------|-----------|-------------|-----|---------|
| 1** | 1109.500 | 28.00 | -18.25 | 54.0 | -26.00 | AV | 222.00 | 150 | H | Pass |
| 1 | 1109.500 | 41.69 | -18.25 | 74.0 | -32.31 | Peak | 222.00 | 150 | H | Pass |
| 2** | 1484.000 | 28.64 | -16.85 | 54.0 | -25.36 | AV | 197.00 | 150 | H | Pass |
| 2 | 1484.000 | 40.64 | -16.85 | 74.0 | -33.36 | Peak | 197.00 | 150 | H | Pass |
| 3** | 1837.000 | 28.19 | -16.10 | 54.0 | -25.81 | AV | 53.00 | 150 | H | Pass |
| 3 | 1837.000 | 42.89 | -16.10 | 74.0 | -31.11 | Peak | 53.00 | 150 | H | Pass |
| 4** | 5154.000 | 39.60 | -2.35 | 54.0 | -14.40 | AV | 49.00 | 150 | H | Pass |
| 4 | 5154.000 | 50.93 | -2.35 | 74.0 | -23.07 | Peak | 49.00 | 150 | H | Pass |
| 5** | 6660.000 | 43.78 | 1.54 | 54.0 | -10.22 | AV | 325.00 | 150 | H | Pass |
| 5 | 6660.000 | 53.76 | 1.54 | 74.0 | -20.24 | Peak | 325.00 | 150 | H | Pass |
| 6** | 7426.750 | 37.93 | -2.57 | 54.0 | -16.07 | AV | 172.00 | 150 | H | Pass |
| 6 | 7426.750 | 48.96 | -2.57 | 74.0 | -25.04 | Peak | 172.00 | 150 | H | Pass |

A.9 Band Edge (Restricted-band band-edge)

Pass

Note: The adjacent to the restricted frequency band (608-614MHz and 960-1240MHz) is far away the fundamental, it is noise only. Please refer to Section A.8 for test data.

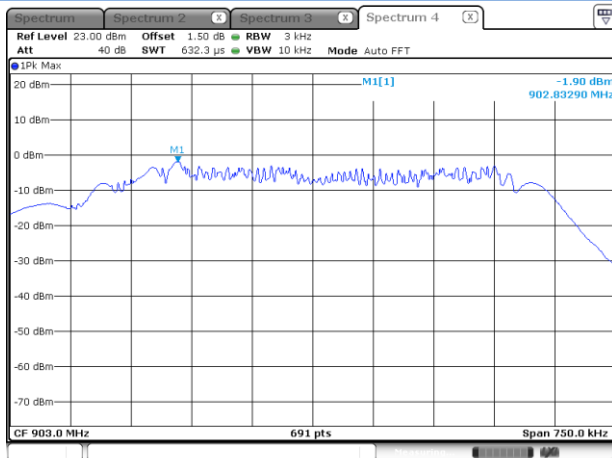
A.10 Power Spectral Density

Test data 500K

| LoRa | | | |
|---------|--------------|-----------------|---------|
| Channel | Measure data | Limit(dBm/3KHz) | Verdict |
| Low | -1.90 | 8 | Pass |
| Middle | -2.09 | 8 | Pass |
| High | -2.11 | 8 | Pass |

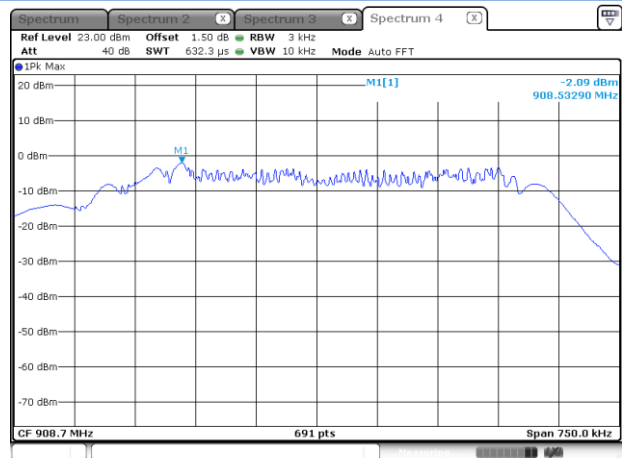
Test plots (PSD) (500kHz)

LOW CHANNEL



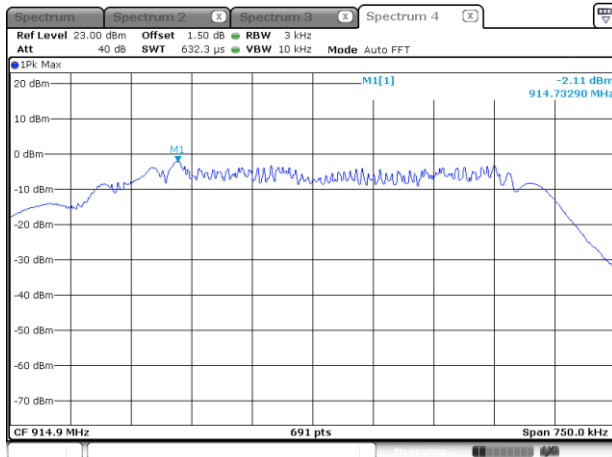
Date: 22.NOV.2018 15:40:29

MIDDLE CHANNEL



Date: 22.NOV.2018 15:41:49

HIGH CHANNEL



Date: 22.NOV.2018 15:43:14

ANNEX B TEST SETUP PHOTOS

Please refer the document "BL-SZ18B0165-AR.PDF".

ANNEX C EUT INTERNAL PHOTOS

Please refer the document "BL- SZ18B0165-AI1.PDF".

--END OF REPORT--