# TEST REPORT

| | | |
|---|---|---|
| **Reference No.** | : | WTF21F09100452W001 |
| **FCC ID** | : | 2ALA3-CBM003A |
| **Applicant** | : | Casambi Technologies Oy |
| **Address** | : | Bertel Jungin Aukio 1 E, 02600 Espoo, Finland |
| **Manufacturer** | : | Sanmina Corporation |
| **Address** | : | 312, Qing Yang South Road, Economic and Technical Development Zone, Kunshan Jiangsu Sheng, 215300, China |
| **Product Name** | : | Lighting control systerm |
| **Model No** | : | CBM-003A |
| **Standards** | : | FCC CFR47 Part 15 Subpart C (Section 15.247): 2020 |
| **Date of Receipt sample** | : | 2021-10-22 |
| **Date of Test** | : | 2021-10-22 to 2021-11-02 |
| **Date of Issue** | : | 2021-11-30 |
| **Test Result** | : | **Pass** |

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.


**Prepared By:**
**Waltek Testing Group (Foshan) Co., Ltd.**
Address: No.13-19, 2/F., 2nd Building, Sunlink International Machinery City,
Chencun, Shunde District, Foshan, Guangdong, China
Tel:+86-757-23811398 Fax:+86-757-23811381 E-mail:info@waltek.com.cn


Compiled by:

Roy Hong / Project Engineer

Approved by:

Danny zhou / Manager

# 1 Revision History

| Test Report No. | Date of Issue | Description | Status |
|---|---|---|---|
| WTF21F09100452W001 | 2021-11-30 | Original | Valid |

# 2 Contents

# 3 General Information

## 3.1 General Description of E.U.T

| | | |
|---|---|---|
| **Product Name** | : | Lighting control systerm |
| **Model No.** | : | CBM-003A |
| **Model Description** | : | --- |
| **Rated Voltage** | : | DC 2.5-3.6V |
| **Battery Capacity** | : | --- |
| **Power Adapter** | : | --- |

## 3.2 Technical Characteristics of EUT

| | | |
|---|---|---|
| **Bluetooth Version** | : | V4.0(BLE mode) |
| **Frequency Range** | : | 2402-2480MHz |
| **RF Output Power** | : | -4.611dBm (Conducted ) |
| **Modulation** | : | GFSK |
| **Data Rate** | : | 1Mbps, 2Mbps |
| **Quantity of Channels** | : | 40 |
| **Channel Separation** | : | 2MHz |
| **Type of Antenna** | : | Chip Antenna |
| **Antenna Gain** | : | +4.71dBi |
| **Lowest Oscillation** | : | 32MHz |

## 3.3 Standards Applicable for Testing

The tests were performed according to following standards:

| | |
|---|---|
| FCC Rules Part 15.247 | Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz |
| 558074 D01 15.247 Meas Guidance v05r02 | 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 |
| ANSI C63.10-2013 | American National Standard for Testing Unlicensed Wireless Devices |

## 3.4 Test Facility

The test facility has a test site registered with the following organizations:

- **IC – Registration No.: 21895-1**

Waltek Testing Group (Foshan) Co., Ltd. has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration IC number:21895-1, Nov. 14, 2016.

- **FCC – Registration No.: 820106**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 820106, August 16, 2018

- **FCC – Designation No.: CN5034**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation No. CN5034.

- **NVLAP – Lab Code: 600191-0**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 600191-0.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

## 3.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test items: ---

Lab information: ---

## 3.6 Abnormalities from Standard Conditions

None.

# 4 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, with a duty cycle equal to 100%, and to measure its highest possible emissions level, more detailed description as follows:

**Test Mode List**

| Test Mode | Description | Remark |
|---|---|---|
| TM1 | Low Channel | 2402MHz |
| TM2 | Middle Channel | 2440MHz |
| TM3 | High Channel | 2480MHz |

**Test Conditions**

| | |
|---|---|
| Temperature: | 22~25℃ |
| Relative Humidity: | 50~55% |
| Atmospheric pressure: | 101.9kPa |

# 5 Equipment Used during Test

## 5.1 Equipment List

| Conducted Emissions | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Cal Date** | **Cal Due Date** |
| 1. | EMI Test Receiver | RS | ESCI | 101178 | 2021-01-09 | 2022-01-08 |
| 2. | LISN | RS | ENV216 | 101215 | 2021-01-09 | 2022-01-08 |
| 3. | Cable | HUBER+SUHNER | CBL2-NN-3M | 223NN322 | 2021-01-09 | 2022-01-08 |
| 4. | Test Software | FARATRONIC | EZ-EMC CON-03A1 | - | - | - |
| **3m Semi-anechoic Chamber for Radiation Emissions** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMI Test Receiver | RS | ESR7 | 101566 | 2021-01-09 | 2022-01-08 |
| 2. | EMC Analyzer | Agilent | N9020A | MY48011796 | 2021-01-09 | 2022-01-08 |
| 3. | Active Loop Antenna | SCHWARZBECK | FMZB1519B | 00004 | 2021-01-09 | 2022-01-08 |
| 4. | Trilog Broadband Antenna | SCHWARZBECK | VULB 9162 | 9162-117 | 2021-01-09 | 2022-01-08 |
| 5. | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9120 D | 01561 | 2021-01-09 | 2022-01-08 |
| 6. | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9170 | 335 | 2021-01-09 | 2022-01-08 |
| 7. | Amplifier | Lunar E M | LNA1G18-40 | 20160501002 | 2021-01-09 | 2022-01-08 |
| 8. | Coaxial Cable (below 1GHz) | H+S | CBL3-NN-12+3 m | 214NN320 | 2021-01-09 | 2022-01-08 |
| 9. | Coaxial Cable (above 1GHz) | Times-Micorwave | CBL5-NN | - | 2021-01-09 | 2022-01-08 |
| 10. | Test Software | FARATRONIC | EZ-EMC RA-03A1-1 | - | - | - |
| **RF Conducted Testing** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | Spectrum Analyzer | Agilent | N9020A | MY48011796 | 2021-01-09 | 2022-01-08 |
| 2. | Spectrum Analyzer | R&S | FSP40 | 100501 | 2021-01-09 | 2022-01-08 |
| 3. | Vector Signal Generator | Agilent | N5182A | MY50141533 | 2021-01-09 | 2022-01-08 |
| 4. | Analog Signal Generator | Agilent | N5181A | MY48180720 | 2021-01-09 | 2022-01-08 |
| 5. | Environmental Chamber | KSON | THS-D4C-100 | 5244K | 2021-01-09 | 2022-01-08 |
| 6. | RF Control Unit | CHANGCHUANG | JS0806-2 | - | 2021-01-09 | 2022-01-08 |

## 5.2 Special Accessories and Auxiliary Equipment

| Item | Equipment | Manufacturer | Model No. | Serial No. |
|---|---|---|---|---|
| 1. | / | / | / | / |

## 5.3 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| RF Output Power | ±0.95dB |
| Occupied Bandwidth | ±1.5% |
| Conducted Spurious Emission | ±2.7dB |
| Conducted Emission | ±2.7dB |
| Transmitter Spurious Emission | ±3.8dB (for 25MHz-1GHz) |
| | ±5.0dB (for 1GHz-18GHz) |

# 6 Summary of Test Result

| Test Items | FCC Rules | Result |
|---|---|---|
| Antenna Requirement | §15.203; §15.247(b)(4)(i) | Compliant |
| Restricted Band of Operation | §15.205 | Compliant |
| Conducted Emissions | §15.207(a) | Compliant |
| Radiated Spurious Emissions | §15.209(a) | Compliant |
| Power Spectral Density | §15.247(e) | Compliant |
| DTS Bandwidth | § 15.247(a)(2) | Compliant |
| RF Output Power | §15.247(b)(3) | Compliant |
| Band edge (Out of Band Emissions) | §15.247(d) | Compliant |
| RF Exposure | §2.1093 | Compliant |

Remark:

Pass Test item meets the requirement

Fail Test item does not meet the requirement

N/A Test case does not apply to the test object

## 6.1 Antenna Requirement

### 6.1.1 Standard Applicable

According to FCC Part 15.203, 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.

### 6.1.2 Evaluation Information

The EUT has a Chip Antenna, the gain is +4.71Bi, fulfil the requirement of this section.

## 6.2 RF Exposure Requirement

### 6.2.1 Standard Applicable

According to§1.1307 and §2.1093, the portable transmitter must comply the RF exposure requirements.

### 6.2.2 Test Result

This product complied with the requirement of the RF exposure, please see the RF Exposure Report WTF21F09100452W002.

## 6.3 Radiated Spurious Emissions

### 6.3.1 Standard Applicable

According to §15.247(d), 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, 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

### 6.3.2 Test Procedure

1) The EUT is placed on a turntable, which is 0.8m(Below 1G) 1.5m(above 1G)above ground plane.

2) The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

3) EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

4) Maximum procedure was performed on the six highest emissions to ensure EUT compliance.

5) And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

6) Repeat above procedures until the measurements for all frequencies are complete.

7) The radiation measurements are tested under 3-axes(X, Y, Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the Z position. So the data shown was the Z position only.

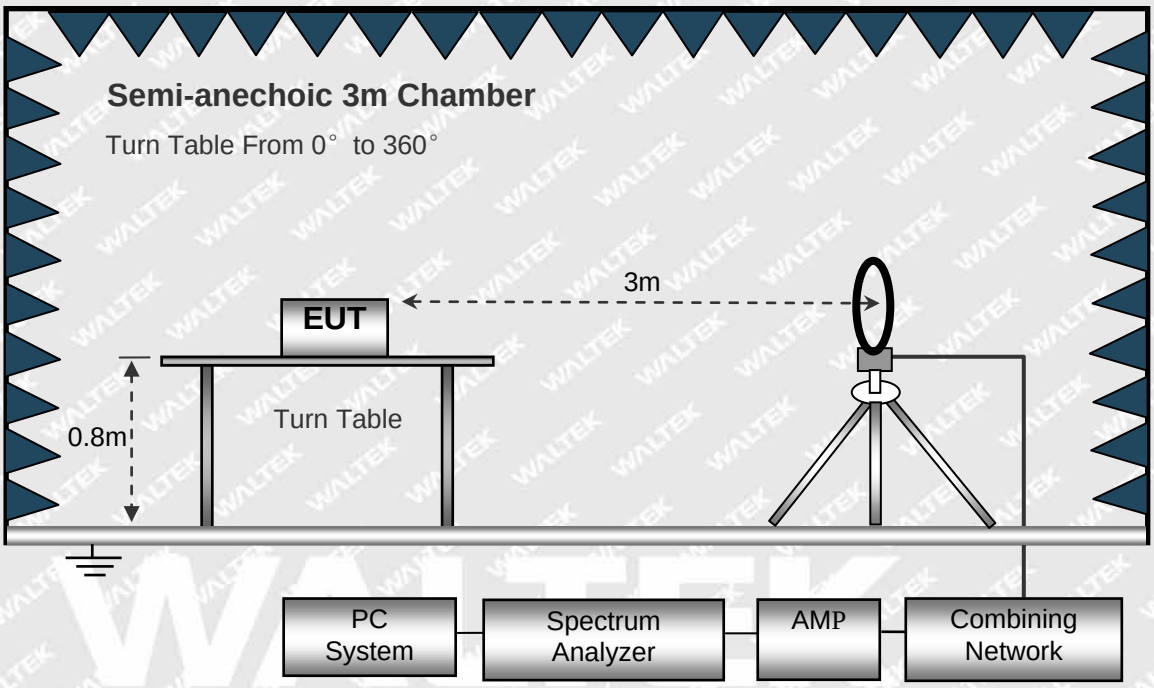
### 6.3.3 Test Setup

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.

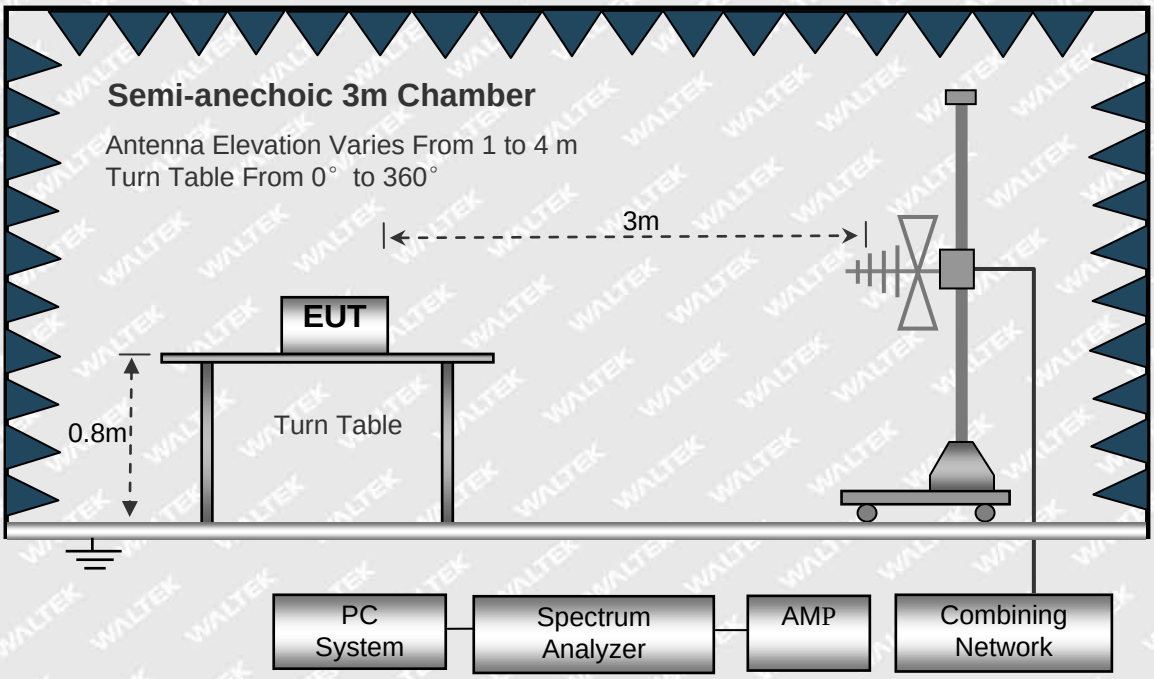
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

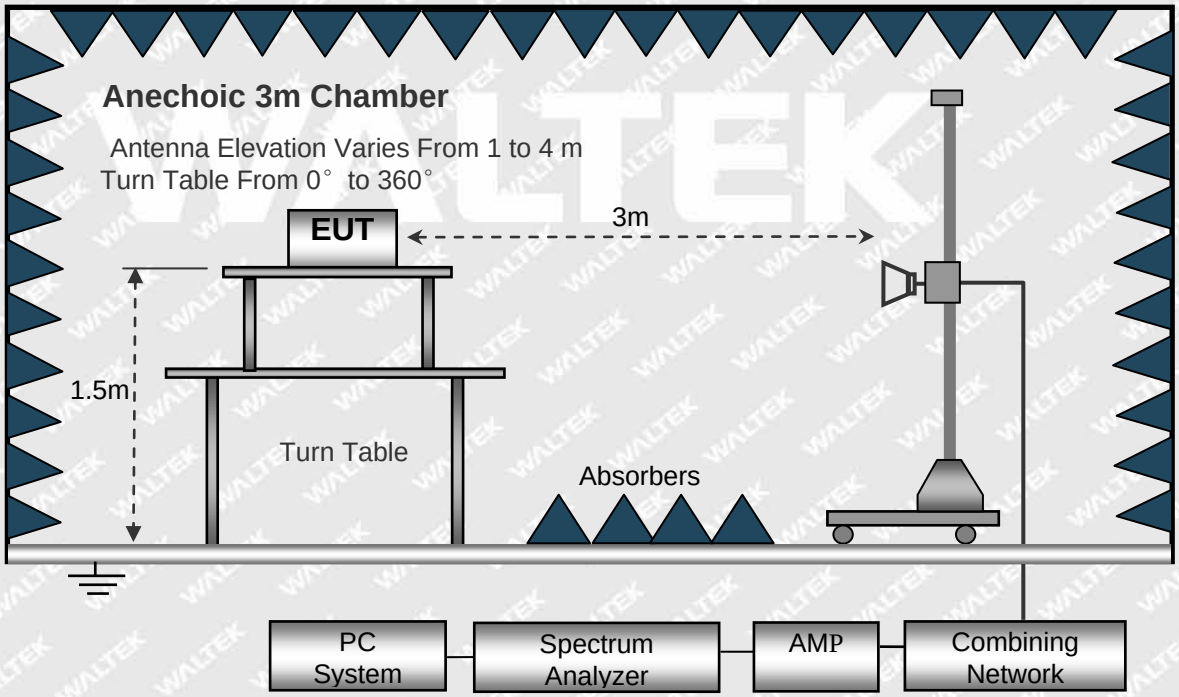
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.




The test setup for emission measurement above 1 GHz.



### 6.3.4 Spectrum Analyzer Setup

| 9KHz-30MHz | 30MHz-1GHz | Above 1GHz |
|---|---|---|
| RBW=10kHz | RBW=120kHz | RBW=1MHz |
| VBW=30kHz | VBW=300kHz | VBW=3MHz(Peak), 10MHz(AV) |
| Sweep time=Auto | Sweep time=Auto | Sweep time=Auto |
| Trace=Max hold | Trace=Max hold | Trace=Max hold |
| Detector function=peak | Detector function=peak, QP | Detector function=peak, AV |

### 6.3.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Corr. Factor

Corr.Factor=Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

### 6.3.6 Test Results

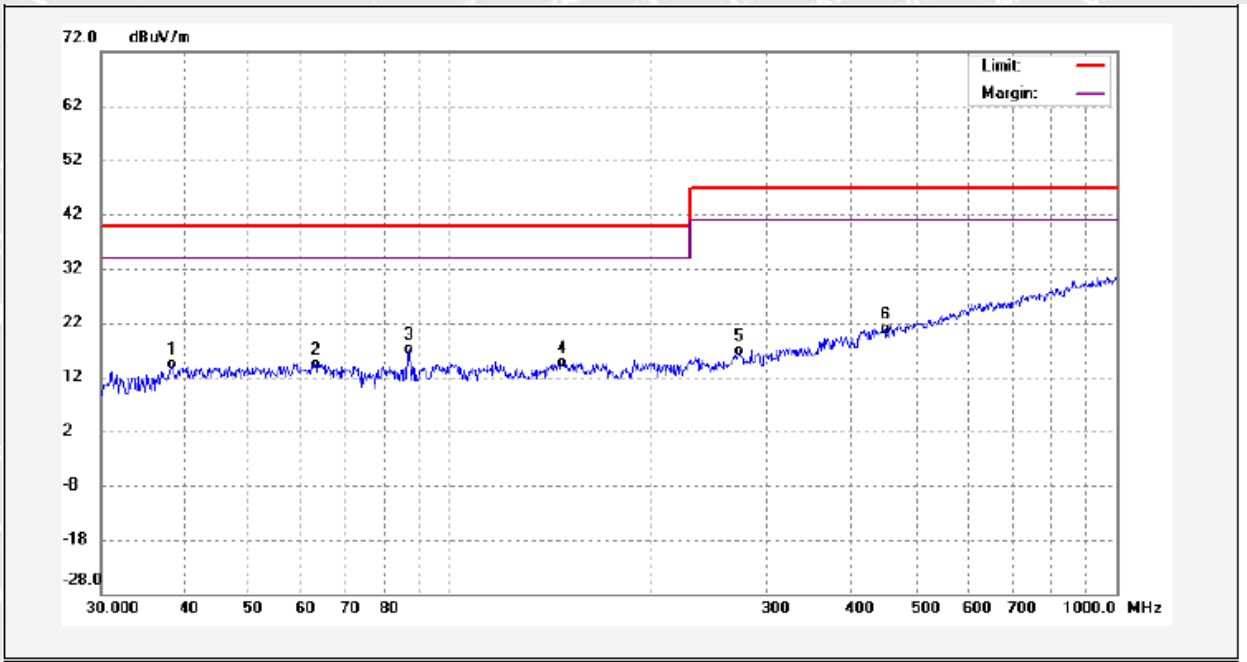
**Test Frequency: 9 kHz~30 MHz**

The measurements were more than 20 dB below the limit and not reported.

**Test Frequency: 30MHz ~ 1GHz**

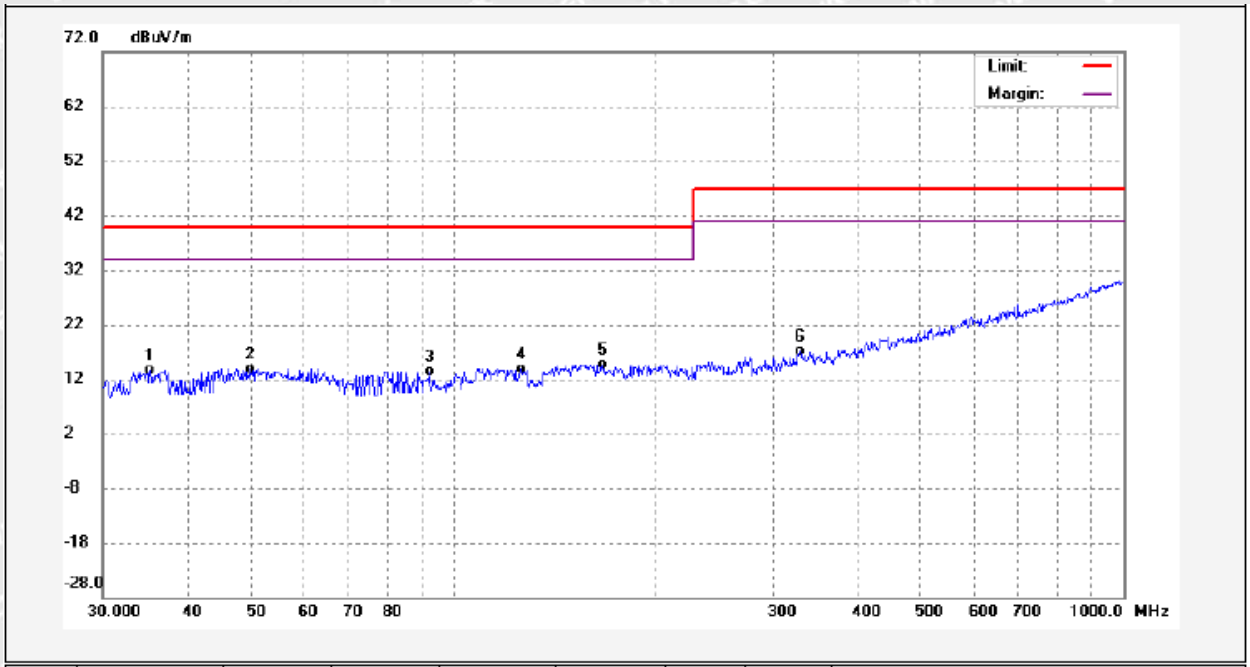
**2Mbps (worst case)**

**Test Channel** Low **Polarization** Vertical



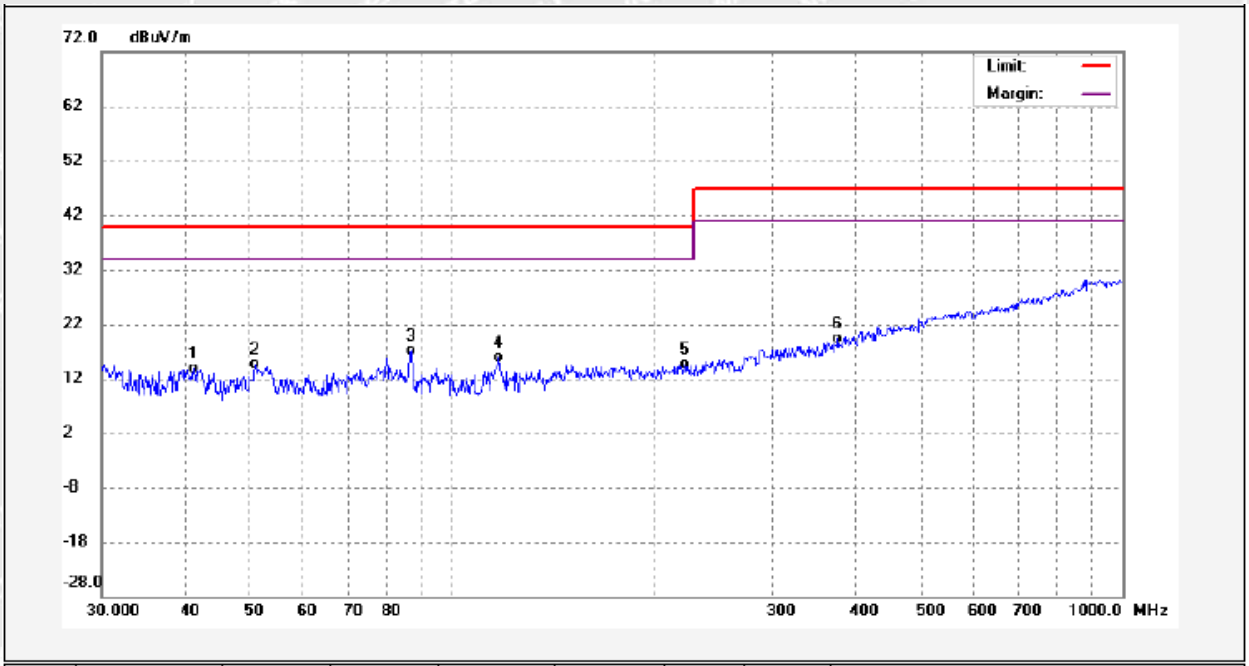

| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 38.3864 | 1.69 | 12.63 | 14.32 | 40.00 | -25.68 | QP | |
| 2 | 62.9810 | 2.21 | 12.25 | 14.46 | 40.00 | -25.54 | QP | |
| 3 | 87.0506 | 6.20 | 10.83 | 17.03 | 40.00 | -22.97 | QP | |
| 4 | 147.4036 | 3.25 | 11.31 | 14.56 | 40.00 | -25.44 | QP | |
| 5 | 272.7553 | 1.08 | 15.87 | 16.95 | 47.00 | -30.05 | QP | |
| 6 | 450.9768 | 1.04 | 19.90 | 20.94 | 47.00 | -26.06 | QP | |

**Test Channel** Low **Polarization** Horizontal



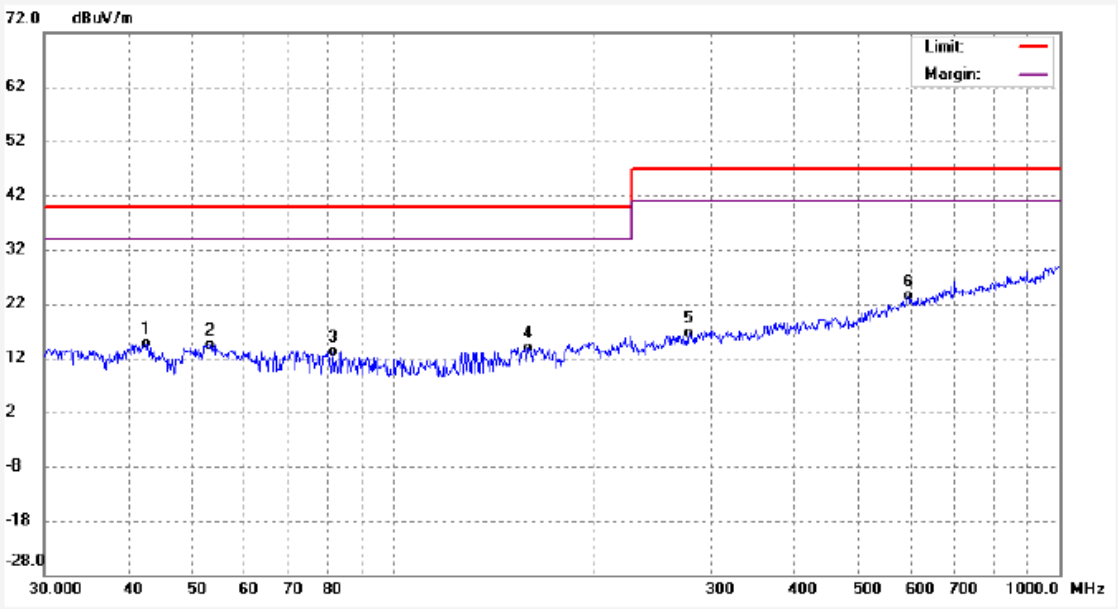

| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 35.2882 | 0.52 | 13.20 | 13.72 | 40.00 | -26.28 | QP | |
| 2 | 49.8287 | -0.07 | 13.92 | 13.85 | 40.00 | -26.15 | QP | |
| 3 | 92.2681 | 1.84 | 11.58 | 13.42 | 40.00 | -26.58 | QP | |
| 4 | 126.4171 | 3.29 | 10.58 | 13.87 | 40.00 | -26.13 | QP | |
| 5 | 167.7650 | 3.74 | 10.83 | 14.57 | 40.00 | -25.43 | QP | |
| 6 | 329.2697 | 0.61 | 16.52 | 17.13 | 47.00 | -29.87 | QP | |

**Test Channel** Middle Channel **Polarization** Vertical



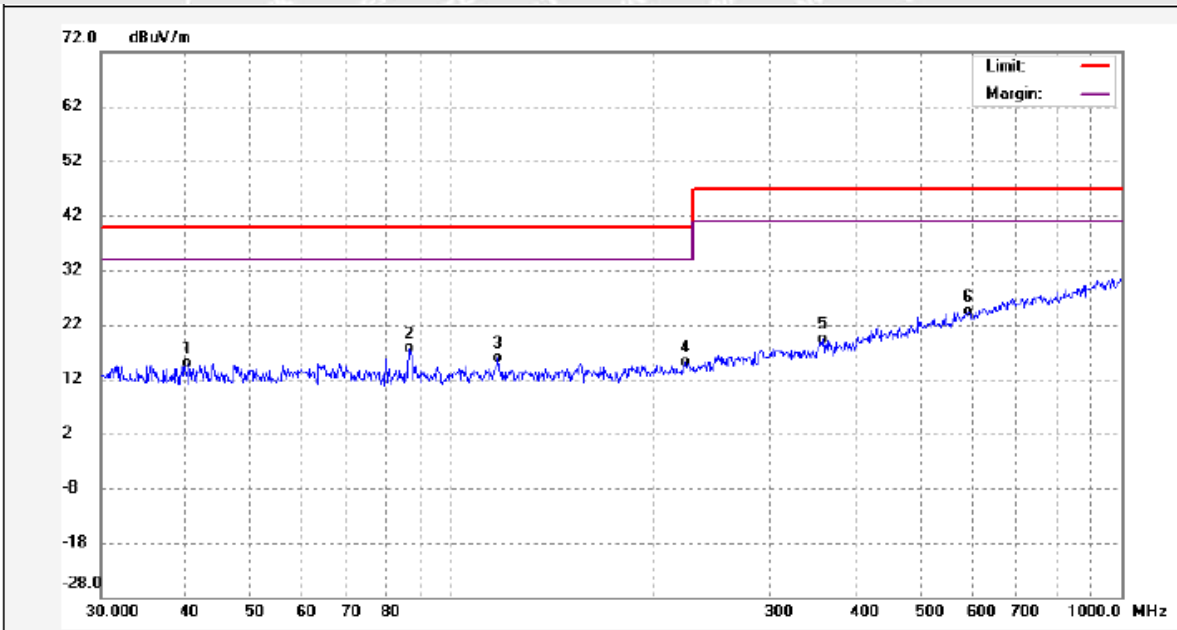

| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 41.2620 | 0.67 | 13.09 | 13.76 | 40.00 | -26.24 | QP | |
| 2 | 50.7635 | 1.26 | 13.39 | 14.65 | 40.00 | -25.35 | QP | |
| 3 | 87.0506 | 6.20 | 10.83 | 17.03 | 40.00 | -22.97 | QP | |
| 4 | 117.5249 | 3.44 | 12.35 | 15.79 | 40.00 | -24.21 | QP | |
| 5 | 222.5595 | -0.16 | 14.84 | 14.68 | 40.00 | -25.32 | QP | |
| 6 | 376.2022 | 1.31 | 18.06 | 19.37 | 47.00 | -27.63 | QP | |

**Test Channel** Middle Channel **Polarization** Horizontal



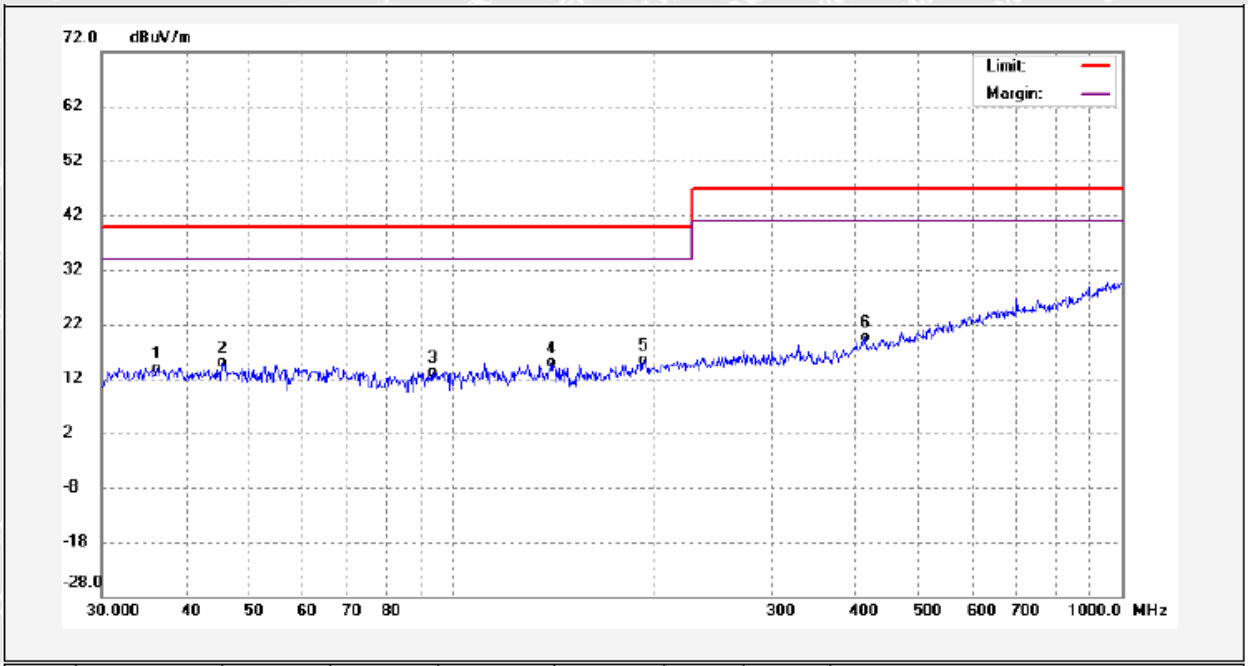

| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 42.6148 | -0.55 | 15.26 | 14.71 | 40.00 | -25.29 | QP | |
| 2 | 53.2805 | 0.77 | 13.58 | 14.35 | 40.00 | -25.65 | QP | |
| 3 | 81.7258 | 2.98 | 10.24 | 13.22 | 40.00 | -26.78 | QP | |
| 4 | 159.6160 | 3.42 | 10.46 | 13.88 | 40.00 | -26.12 | QP | |
| 5 | 278.1643 | 0.90 | 15.63 | 16.53 | 47.00 | -30.47 | QP | |
| 6 | 594.0901 | 1.25 | 22.06 | 23.31 | 47.00 | -23.69 | QP | |

**Test Channel** High Channel **Polarization** Vertical




| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 40.4738 | 1.91 | 12.96 | 14.87 | 40.00 | -25.13 | QP | |
| 2 | 86.7458 | 6.75 | 10.80 | 17.55 | 40.00 | -22.45 | QP | |
| 3 | 117.5249 | 3.44 | 12.35 | 15.79 | 40.00 | -24.21 | QP | |
| 4 | 223.8900 | 0.31 | 14.88 | 15.19 | 40.00 | -24.81 | QP | |
| 5 | 358.5568 | 1.61 | 17.77 | 19.38 | 47.00 | -27.62 | QP | |
| 6 | 592.2182 | 0.98 | 23.35 | 24.33 | 47.00 | -22.67 | QP | |

**Test Channel** High Channel **Polarization** Horizontal




| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 36.3430 | 0.61 | 13.35 | 13.96 | 40.00 | -26.04 | QP | |
| 2 | 45.3912 | -0.19 | 15.01 | 14.82 | 40.00 | -25.18 | QP | |
| 3 | 93.7026 | 1.40 | 11.71 | 13.11 | 40.00 | -26.89 | QP | |
| 4 | 140.9336 | 4.86 | 9.95 | 14.81 | 40.00 | -25.19 | QP | |
| 5 | 193.2975 | 2.56 | 12.72 | 15.28 | 40.00 | -24.72 | QP | |
| 6 | 414.2862 | 1.25 | 18.47 | 19.72 | 47.00 | -27.28 | QP | |

**Test Frequency: 1GHz~18GHz**

**2Mbps (worst case)**

| Frequency (MHz) | Reading (dBμV/m) | Detector | Polar (H/V) | Corrected Factor (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| Low Channel-2402MHz | | | | | | | |
| 4419.25 | 41.11 | Peak | H | -4.57 | 36.54 | 74 | -37.46 |
| 4419.25 | 30.00 | AVG | H | -4.57 | 25.43 | 54 | -28.57 |
| 10729.00 | 39.54 | Peak | H | 9.40 | 48.94 | 74 | -25.06 |
| 10729.00 | 28.07 | AVG | H | 9.40 | 37.47 | 54 | -16.53 |
| 4489.75 | 41.17 | Peak | V | -4.35 | 36.82 | 74 | -37.18 |
| 4489.75 | 29.53 | AVG | V | -4.35 | 25.18 | 54 | -28.82 |
| 11163.75 | 39.30 | Peak | V | 9.76 | 49.06 | 74 | -24.94 |
| 11163.75 | 29.17 | AVG | V | 9.76 | 38.93 | 54 | -15.07 |
| Middle Channel-2440MHz | | | | | | | |
| 4219.50 | 42.59 | Peak | H | -5.15 | 37.44 | 74 | -36.56 |
| 4219.50 | 31.24 | AVG | H | -5.15 | 26.09 | 54 | -27.91 |
| 10811.25 | 39.22 | Peak | H | 9.67 | 48.89 | 74 | -25.11 |
| 10811.25 | 27.77 | AVG | H | 9.67 | 37.44 | 54 | -16.56 |
| 3808.25 | 42.21 | Peak | V | -6.23 | 35.98 | 74 | -38.02 |
| 3808.25 | 32.52 | AVG | V | -6.23 | 26.29 | 54 | -27.71 |
| 11304.75 | 38.39 | Peak | V | 9.91 | 48.30 | 74 | -25.70 |
| 11304.75 | 27.76 | AVG | V | 9.91 | 37.67 | 54 | -16.33 |
| High Channel-2480MHz | | | | | | | |
| 4724.75 | 40.95 | Peak | H | -3.79 | 37.16 | 74 | -36.84 |
| 4724.75 | 30.78 | AVG | H | -3.79 | 26.99 | 54 | -27.01 |
| 11140.25 | 38.86 | Peak | H | 10.38 | 49.24 | 74 | -24.76 |
| 11140.25 | 28.39 | AVG | H | 10.38 | 38.77 | 54 | -15.23 |
| 4971.50 | 39.58 | Peak | V | -3.00 | 36.58 | 74 | -37.42 |
| 4971.50 | 28.62 | AVG | V | -3.00 | 25.62 | 54 | -28.38 |
| 11163.75 | 38.38 | Peak | V | 9.76 | 48.14 | 74 | -25.86 |
| 11163.75 | 28 | AVG | V | 9.76 | 37.76 | 54 | -16.24 |

**Test Frequency: 18GHz~25GHz**

The measurements were more than 20 dB below the limit and not reported.

## 6.4 Power Spectral Density

### 6.4.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

### 6.4.2 Test Procedure

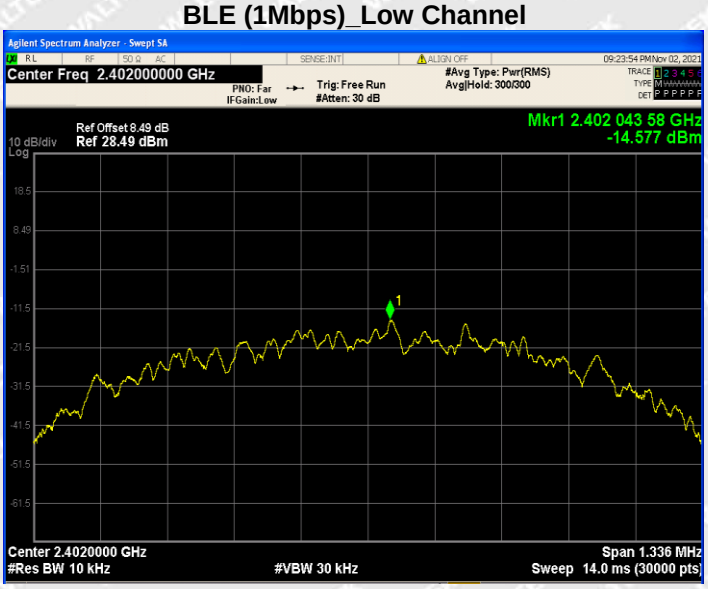
According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause 11.10.2, the test method of power spectral density as below:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 × RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

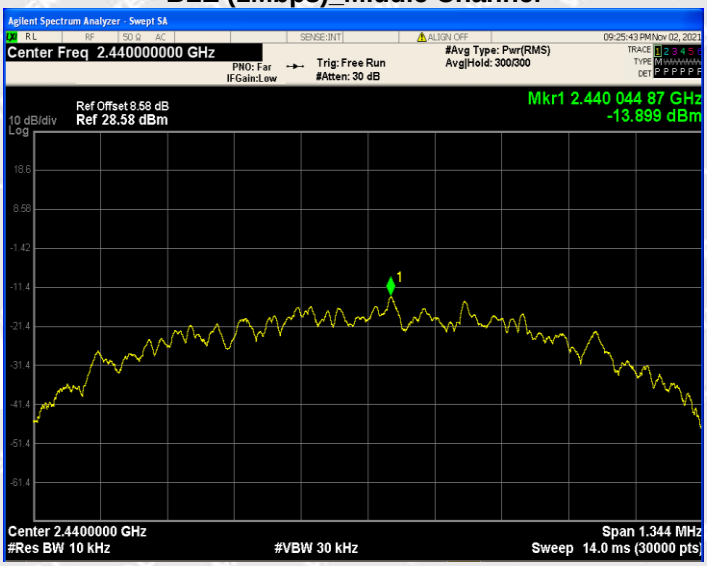
### 6.4.3 Test Result

| Test Mode | Test Channel | Power Spectral Density dBm/10kHz | Limit dBm/3kHz |
|---|---|---|---|
| BLE (1Mbps) | Low | -14.58 | 8 |
| | Middle | -13.9 | 8 |
| | High | -12.79 | 8 |
| BLE (2Mbps) | Low | -16.82 | 8 |
| | Middle | -16.31 | 8 |
| | High | -15.46 | 8 |

**BLE (1Mbps)_Low Channel**

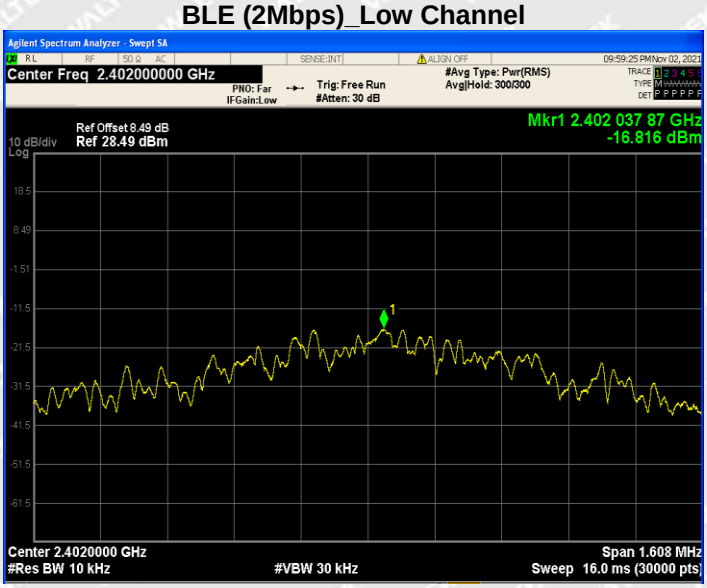



**BLE (1Mbps)_Middle Channel**



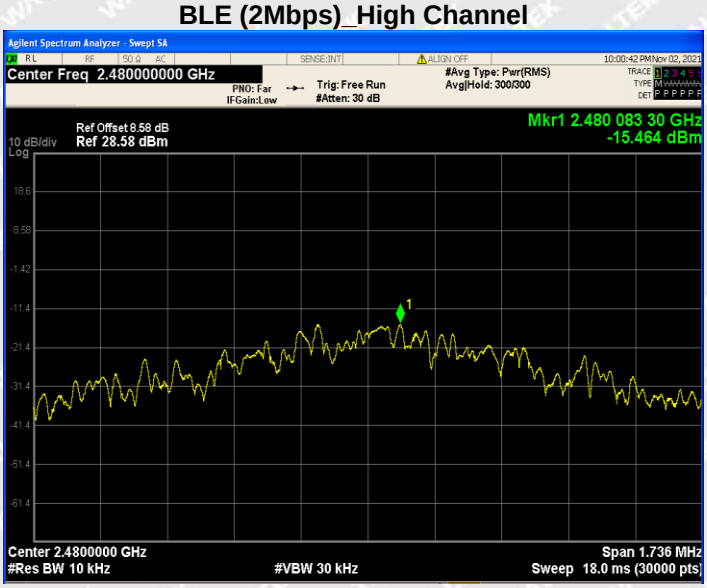

**BLE (1Mbps)_High Channel**

**BLE (2Mbps)_Low Channel**




**BLE (2Mbps)_Middle Channel**


**BLE (2Mbps)_High Channel**



## 6.5 DTS Bandwidth

### 6.5.1 Standard Applicable

According to 15.247(a)(2). Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 6.5.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.2 and ANSI C63.10-2013 Subclause 11.8.1, the test method of DTS Bandwidth as below:

a) Set RBW = 100 kHz.

b) Set the video bandwidth (VBW) ≥ 3 × RBW.

c) Detector = Peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

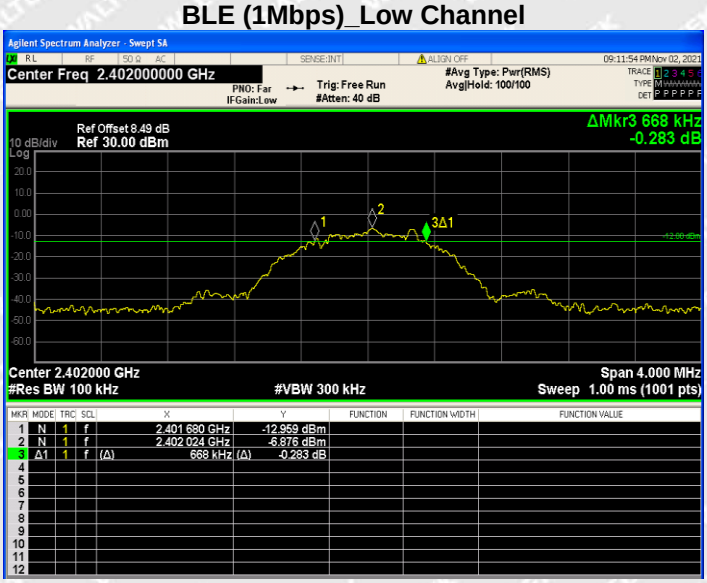
f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

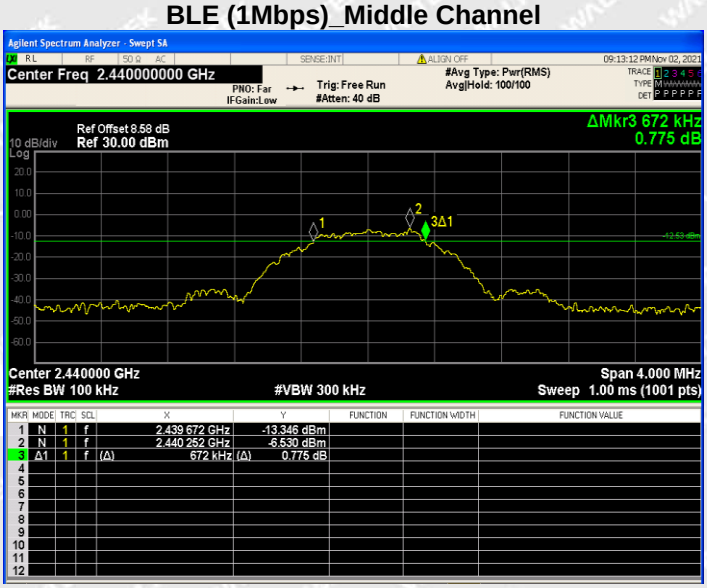
### 6.5.3 Test Result

| Test Mode | Test Channel | 6dB Bandwidth MHz | Limit kHz |
|---|---|---|---|
| BLE (1Mbps) | Low | 0.668 | ≥ 500 |
| | Middle | 0.672 | ≥ 500 |
| | High | 0.704 | ≥ 500 |
| BLE (2Mbps) | Low | 0.804 | ≥ 500 |
| | Middle | 0.636 | ≥ 500 |
| | High | 0.868 | ≥ 500 |

**BLE (1Mbps)_Low Channel**



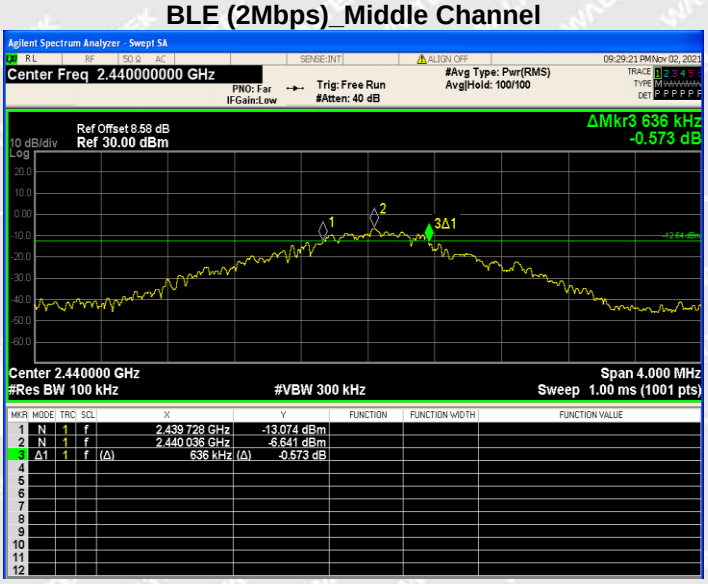

**BLE (1Mbps)_Middle Channel**



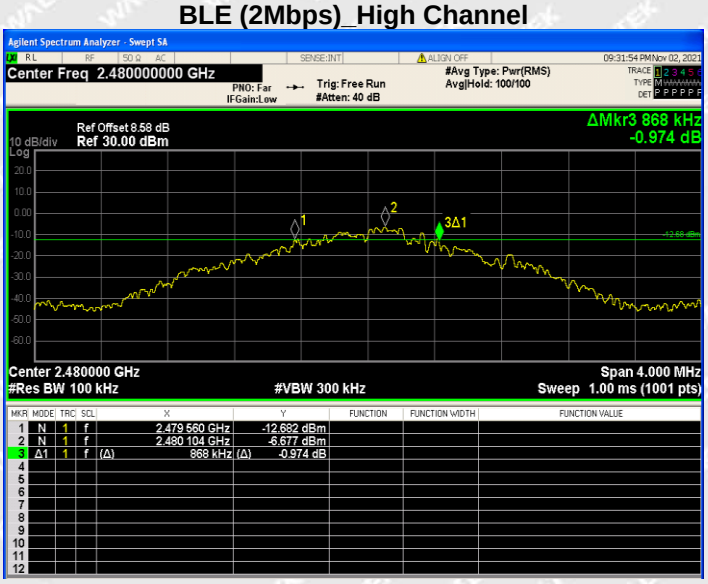

**BLE (1Mbps)_High Channel**

**BLE (2Mbps)_Low Channel**


**BLE (2Mbps)_Middle Channel**




**BLE (2Mbps)_High Channel**



## 6.6 RF Output Power

### 6.6.1 Standard Applicable

According to 15.247(b)(3). For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

### 6.6.2 Test Procedure

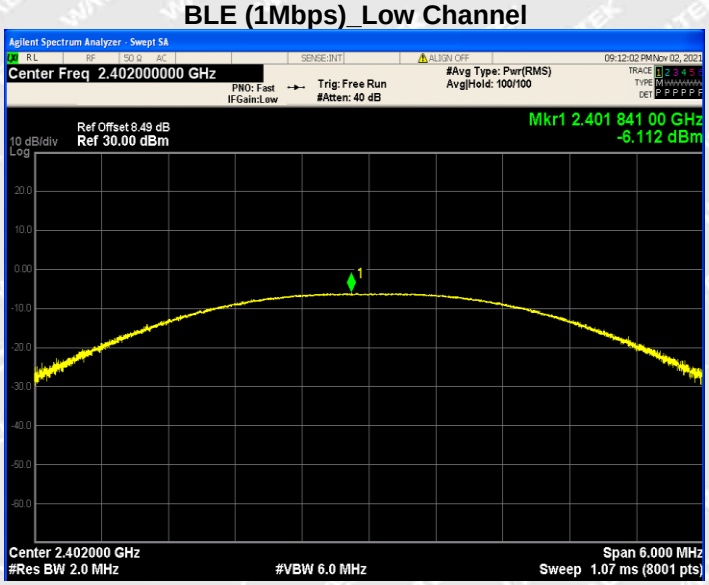
According to the KDB-558074 D01 v05r02 Subclause 8.3.1.1 and ANSI C63.10-2013 Subclause 11.9.1.1, this procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ 3 × RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

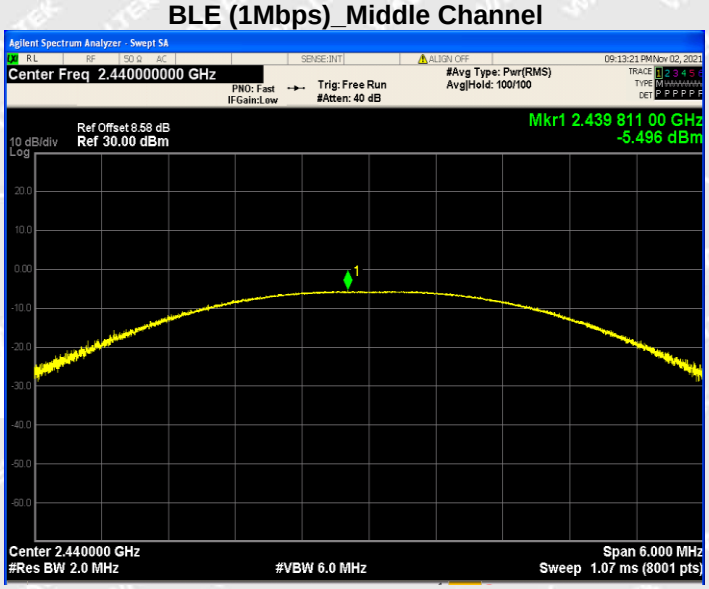
### 6.6.3 Test Result

| Modulation | Test Channel | Reading (dBm) | Output Power (mW) | Limit (mW) |
|---|---|---|---|---|
| BLE (1Mbps) | Low | -6.112 | 0.245 | 1000 |
| | Middle | -5.496 | 0.282 | 1000 |
| | High | -4.611 | 0.346 | 1000 |
| BLE (2Mbps) | Low | -6.124 | 0.244 | 1000 |
| | Middle | -5.300 | 0.295 | 1000 |
| | High | -4.625 | 0.344 | 1000 |

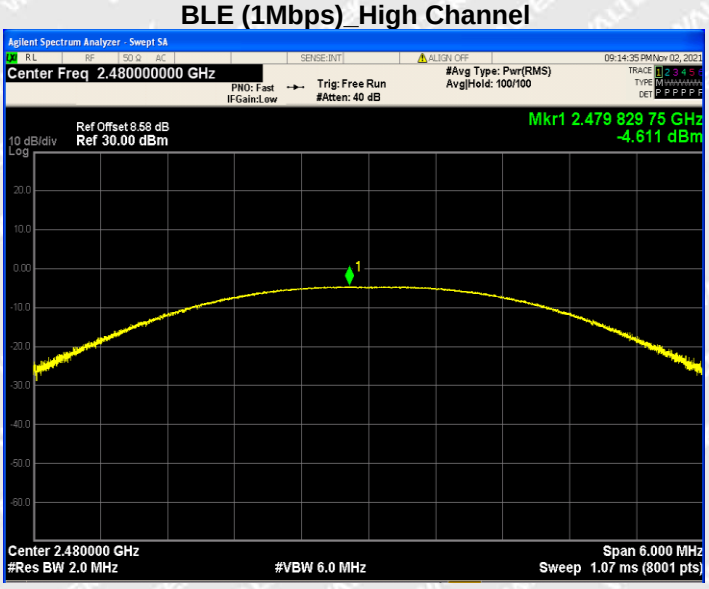
**BLE (1Mbps)_Low Channel**



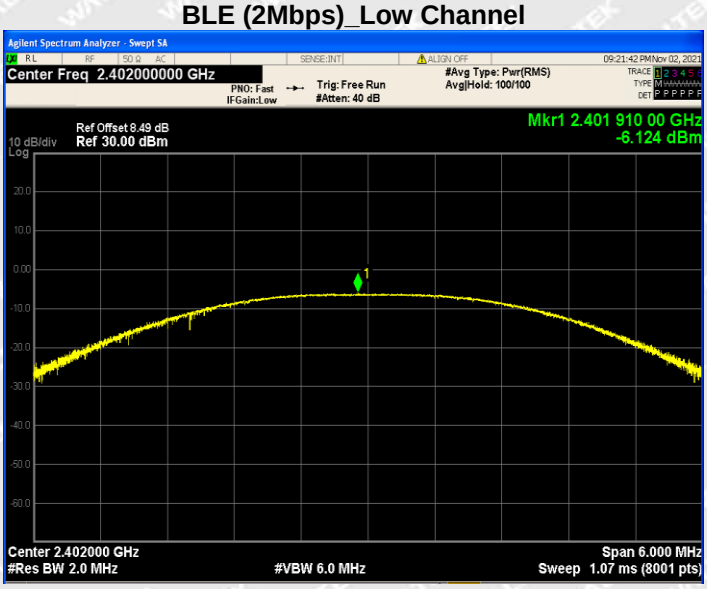

**BLE (1Mbps)_Middle Channel**




**BLE (1Mbps)_High Channel**



**BLE (2Mbps)_Low Channel**




**BLE (2Mbps)_Middle Channel**


**BLE (2Mbps)_High Channel**

## 6.7 Out of Band Emissions

### 6.7.1 Standard Applicable

According to §15.247 (d) 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, 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

### 6.7.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause 11.11, the Emissions in nonrestricted frequency bands test method as follows:

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

According to the KDB 558074 D01 v05r02 Subclause 8.5 and ANSI C63.10-2013 Subclause 11.12, the Emissions in restricted frequency bands test method as follows:

A. Radiated emission measurements:
Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge,
as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz
for low bandedge, 2460MHz to 2500MHz for the high bandedge)
RBW = 1MHz, VBW = 1MHz for peak value measured
RBW = 1MHz, VBW = 10Hz for average value measured
Sweep = auto; Detector function = peak/average; Trace = max hold
All the trace to stabilize, set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emissions must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205.

Note that the method of measurement KDB publication number: 913591 may be used for the radiated band edge measurements.

B. Antenna-port conducted measurements

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 9/

b) VBW ≥ [3 × RBW].

c) Detector = peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be lengthened for low-duty-cycle applications.)

**Table 9—RBW as a function of frequency**

| Frequency | RBW |
|---|---|
| 9 kHz to 150 kHz | 200 Hz to 300 Hz |
| 0.15 MHz to 30 MHz | 9 kHz to 10 kHz |
| 30 MHz to 1000 MHz | 100 kHz to 120 kHz |
| >1000 MHz | 1 MHz |

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

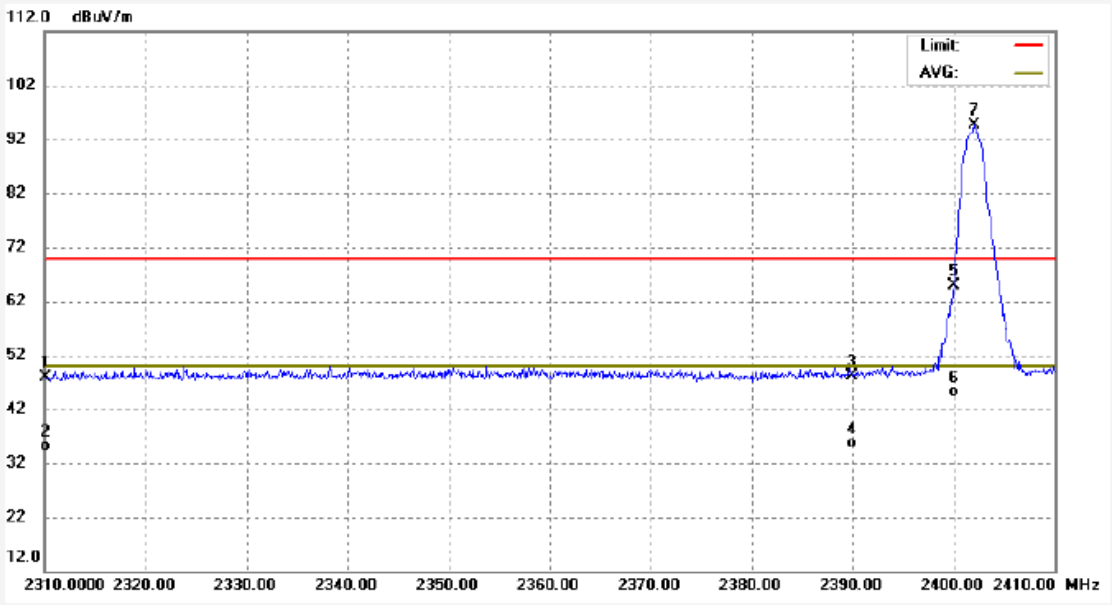
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1.

### 6.7.3 Test Result

**Radiated Test**

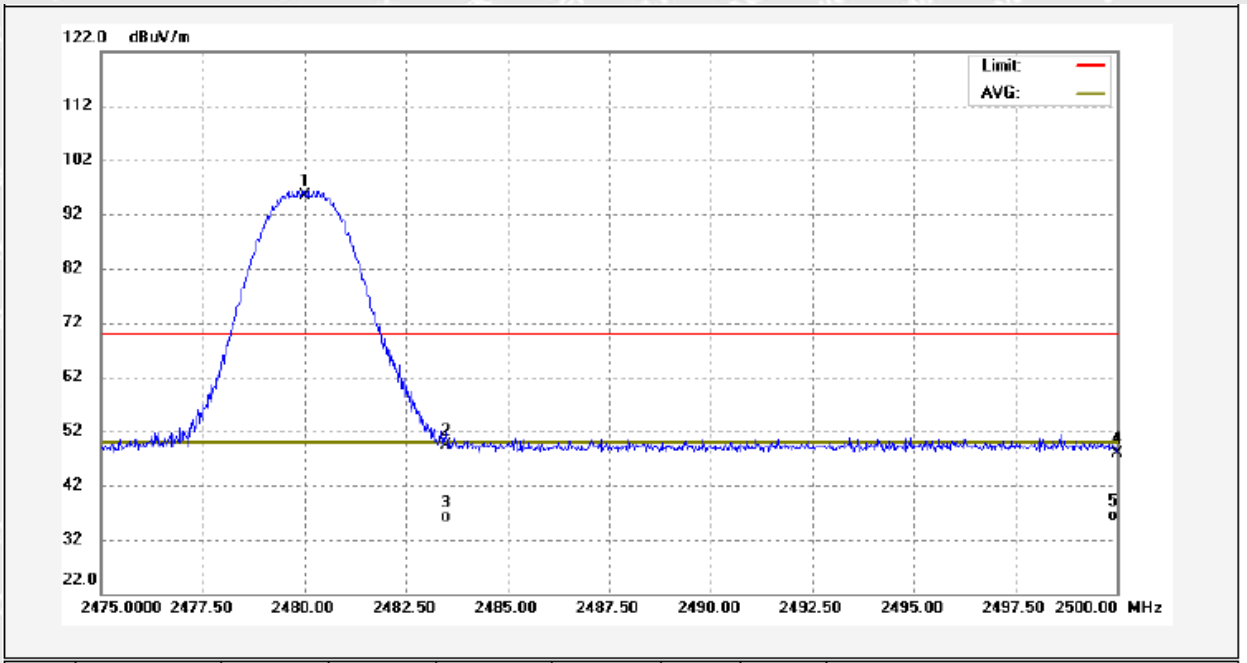
**1Mbps**

**Test Channel** Low Channel **Polarization** Vertical (worst case)




| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 2310.000 | 10.67 | 37.17 | 47.84 | 70.00 | -22.16 | peak | |
| 2 | 2310.000 | -2.15 | 37.17 | 35.02 | 50.00 | -14.98 | AVG | |
| 3 | 2390.000 | 10.55 | 37.57 | 48.12 | 70.00 | -21.88 | peak | |
| 4 | 2390.000 | -2.00 | 37.57 | 35.57 | 50.00 | -14.43 | AVG | |
| 5 | 2400.000 | 27.06 | 37.93 | 64.99 | 70.00 | -5.01 | peak | |
| 6 | 2400.000 | 7.16 | 37.93 | 45.09 | 50.00 | -4.91 | AVG | |
| 7 | 2402.000 | 56.82 | 37.93 | 94.75 | 70.00 | 24.75 | peak | |

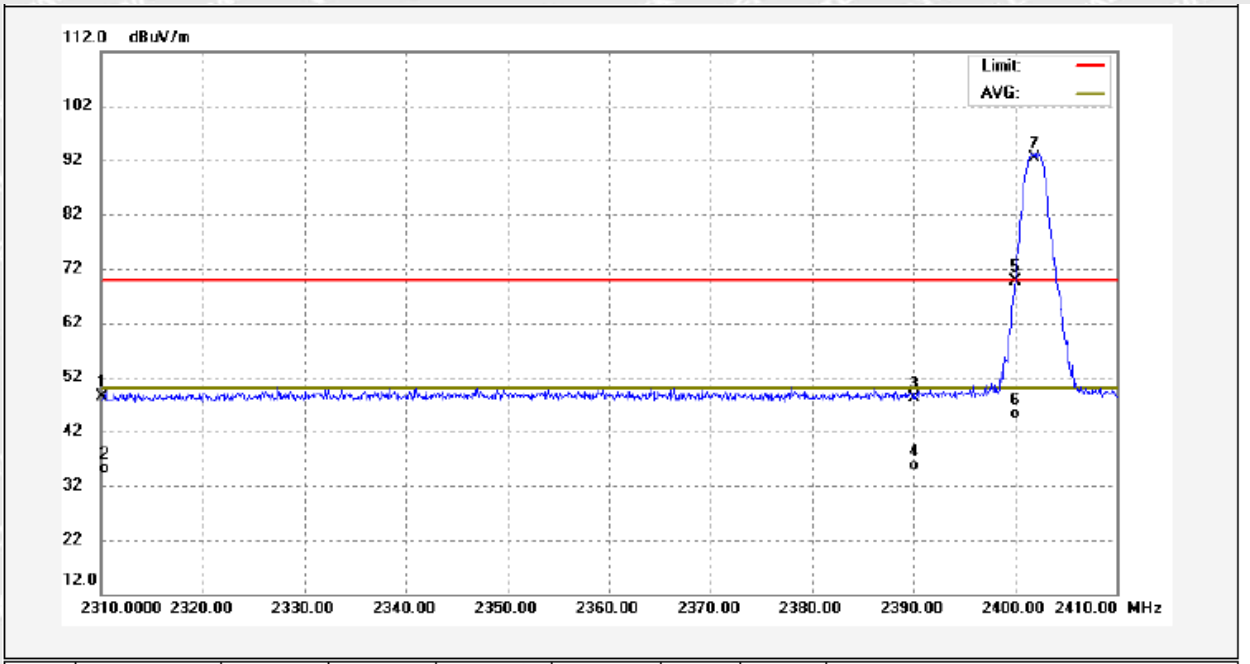
**Test Channel** High Channel **Polarization** Vertical (worst case)




| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 2480.000 | 57.43 | 37.93 | 95.36 | 70.00 | 25.36 | peak | |
| 2 | 2483.500 | 11.33 | 37.96 | 49.29 | 70.00 | -20.71 | peak | |
| 3 | 2483.500 | -1.93 | 37.96 | 36.03 | 50.00 | -13.97 | AVG | |
| 4 | 2500.000 | 9.81 | 38.15 | 47.96 | 70.00 | -22.04 | peak | |
| 5 | 2500.000 | -1.77 | 38.15 | 36.38 | 50.00 | -13.62 | AVG | |

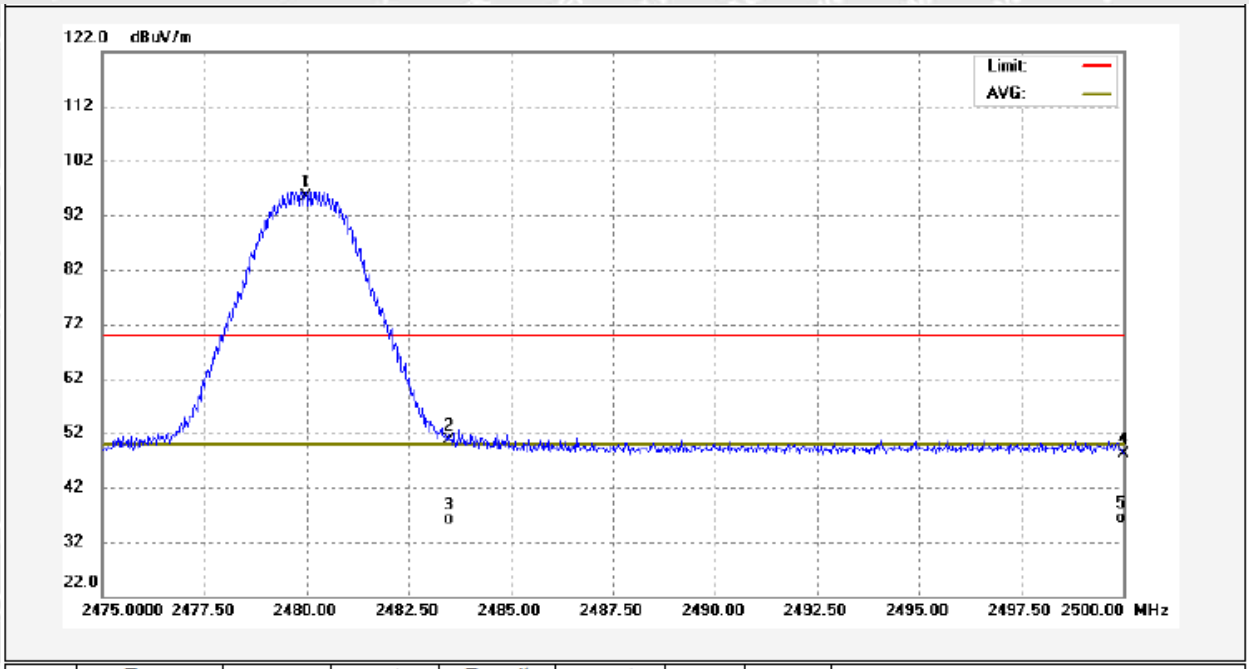
**2Mbps**

**Test Channel** Low Channel **Polarization** Vertical (worst case)




| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 2310.000 | 11.12 | 37.17 | 48.29 | 70.00 | -21.71 | peak | |
| 2 | 2310.000 | -2.10 | 37.17 | 35.07 | 50.00 | -14.93 | AVG | |
| 3 | 2390.000 | 10.58 | 37.57 | 48.15 | 70.00 | -21.85 | peak | |
| 4 | 2390.000 | -1.99 | 37.57 | 35.58 | 50.00 | -14.42 | AVG | |
| 5 | 2400.000 | 31.65 | 37.93 | 69.58 | 70.00 | -0.42 | peak | |
| 6 | 2400.000 | 7.09 | 37.93 | 45.02 | 50.00 | -4.98 | AVG | |
| 7 | 2402.000 | 54.57 | 37.93 | 92.50 | 70.00 | 22.50 | peak | |

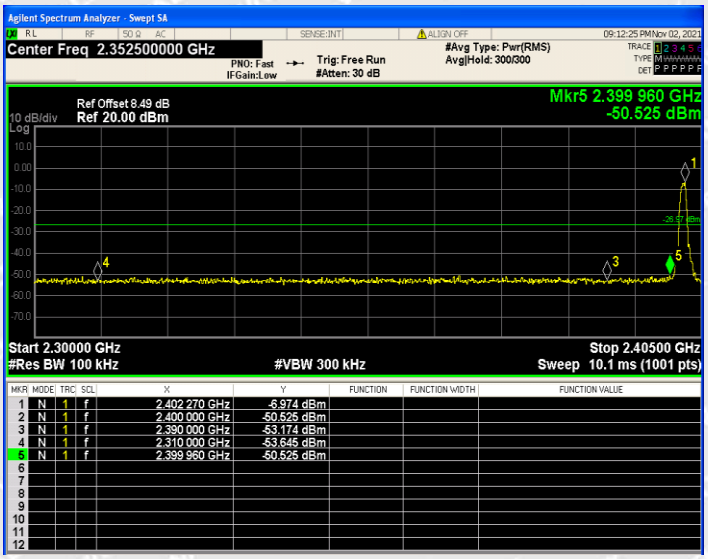
**Test Channel** High Channel **Polarization** Vertical (worst case)



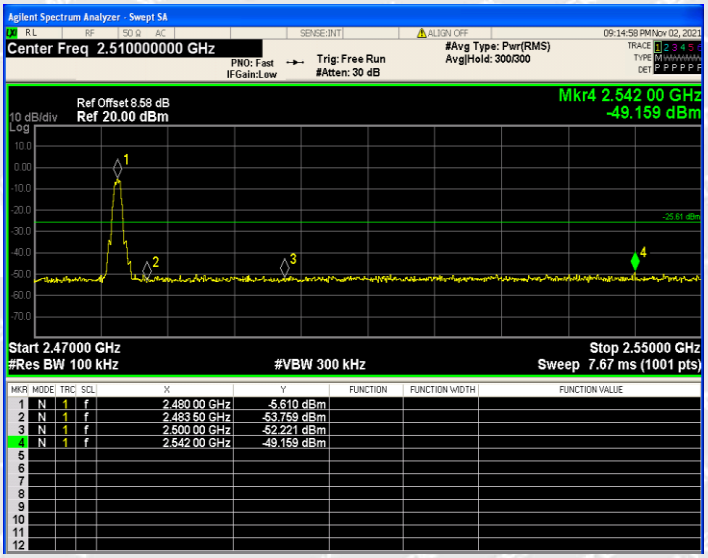

| No. | Freq. (MHz) | Reading (dBuV/m) | Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 2480.000 | 57.46 | 37.93 | 95.39 | 70.00 | 25.39 | peak | |
| 2 | 2483.500 | 12.77 | 37.96 | 50.73 | 70.00 | -19.27 | peak | |
| 3 | 2483.500 | -1.92 | 37.96 | 36.04 | 50.00 | -13.96 | AVG | |
| 4 | 2500.000 | 10.07 | 38.15 | 48.22 | 70.00 | -21.78 | peak | |
| 5 | 2500.000 | -1.78 | 38.15 | 36.37 | 50.00 | -13.63 | AVG | |

**Conducted Test**

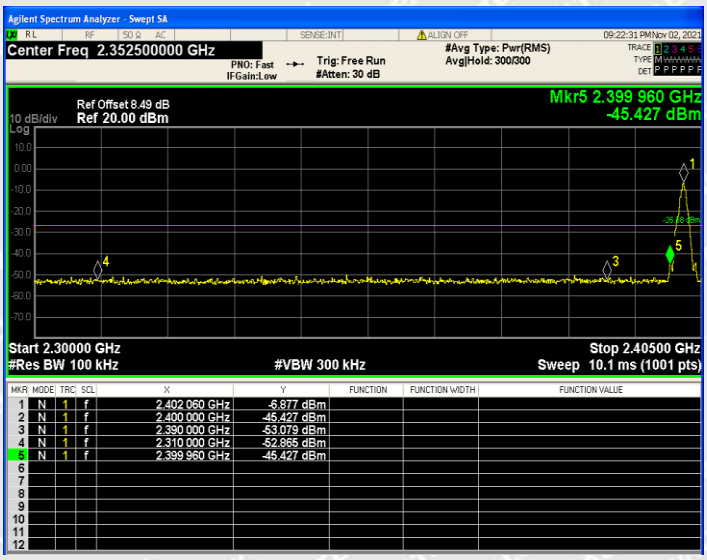
**BLE (1Mbps)_Low Channel**



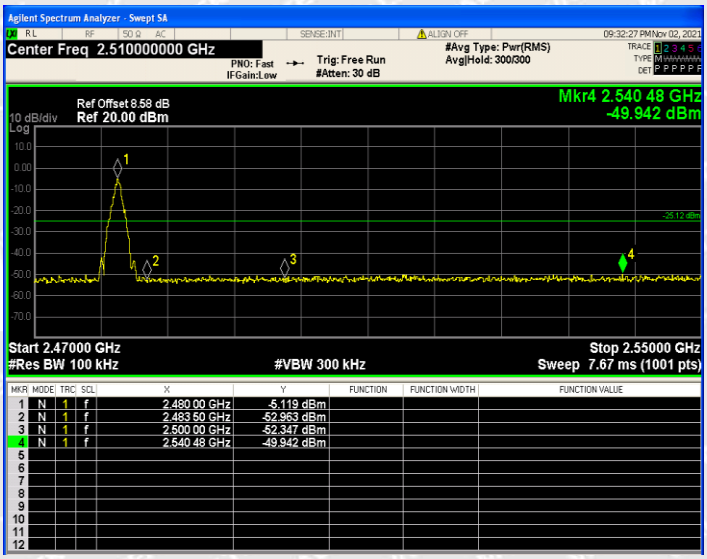

**BLE (1Mbps)_High Channel**



**BLE (2Mbps)_Low Channel**




**BLE (2Mbps)_High Channel**



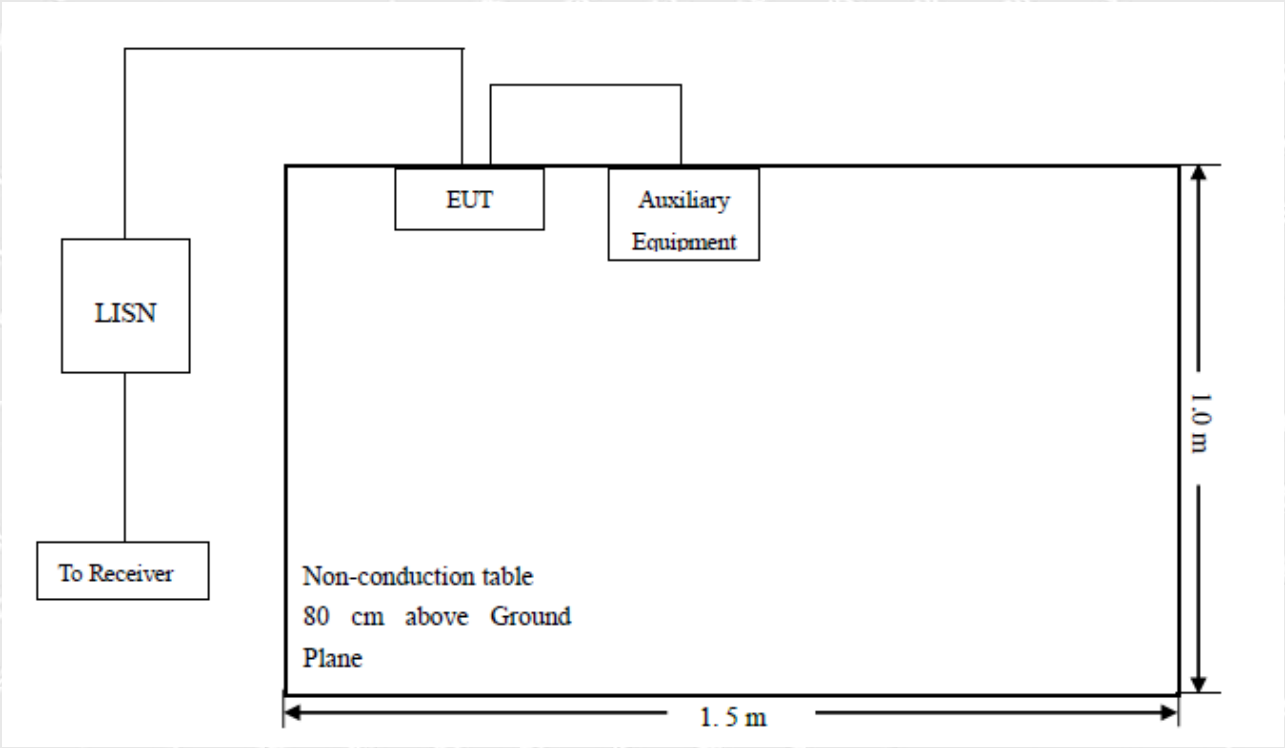
## 6.8 Conducted Emissions

### 6.8.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013measurement procedure. The specification used was with the FCC Part 15.207Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in themiddle. The spacing between the peripherals was 10 cm.

### 6.8.2 Basic Test Setup Block Diagram




### 6.8.3 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency.....150 kHz
Stop Frequency.....30 MHz
Sweep Speed.....Auto
IF Bandwidth.....10 kHz
Quasi-Peak Adapter Bandwidth.....9 kHz
Quasi-Peak Adapter Mode.....Normal

### 6.8.4 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

### 6.8.5 Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF(Voltage Division Facotr), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Measurement=Reading Level+Correct Factor

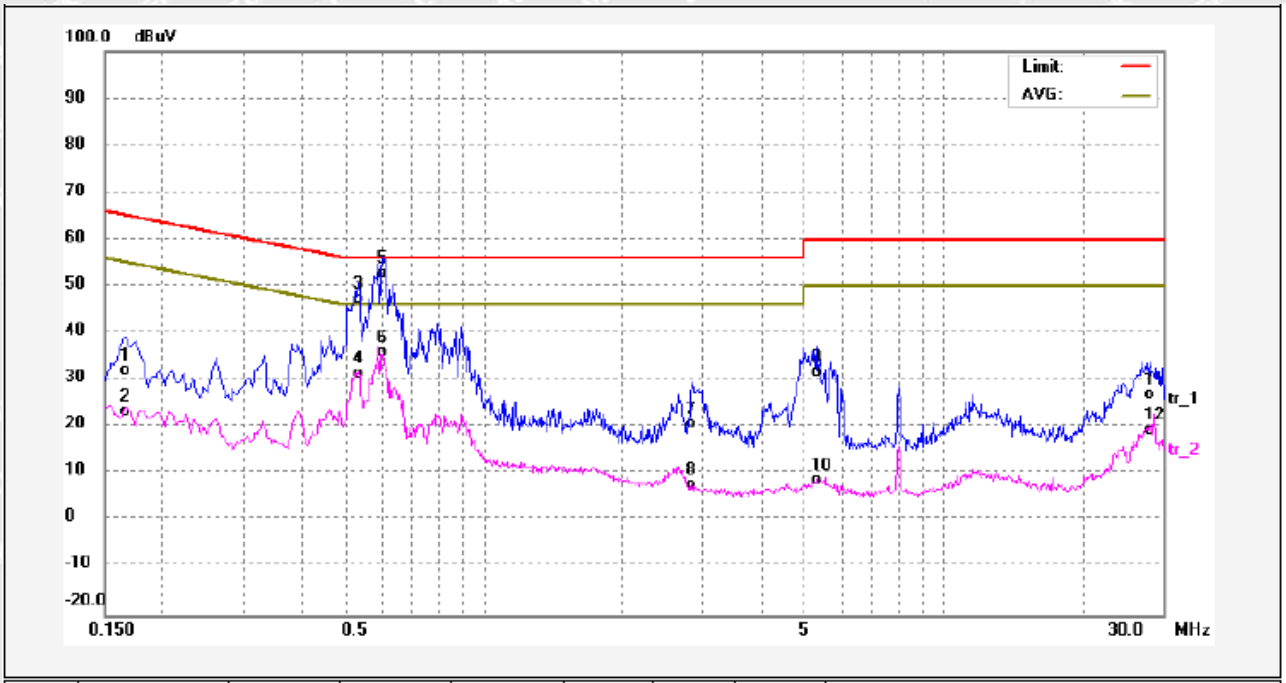
Correct Facotor=LISN VDF+Cable Loss

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin=Limit-Measurement

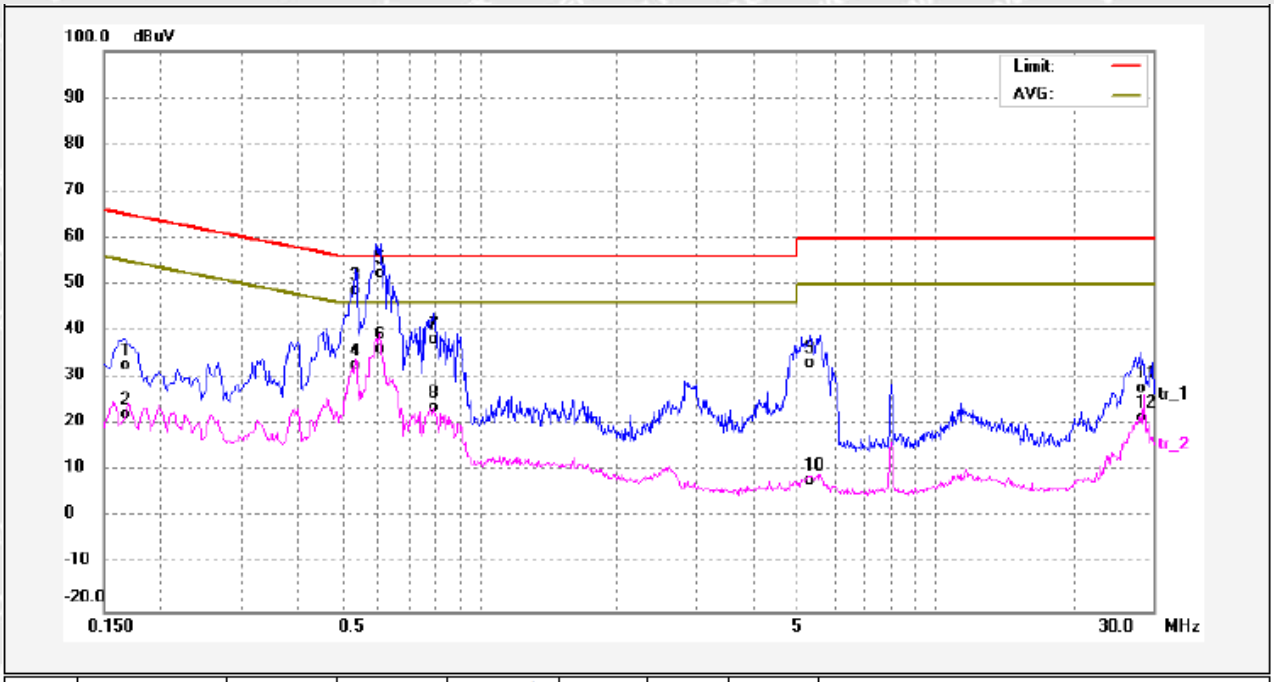
### 6.8.6 Test Result

**Test Mode** Communication mode (DC 3.3V) **Polarity** Line




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1660 | 30.85 | 0.03 | 30.88 | 65.15 | -34.27 | QP | |
| 2 | 0.1660 | 22.09 | 0.03 | 22.12 | 55.15 | -33.03 | AVG | |
| 3 | 0.5340 | 46.19 | 0.07 | 46.26 | 56.00 | -9.74 | QP | |
| 4 | 0.5340 | 30.05 | 0.07 | 30.12 | 46.00 | -15.88 | AVG | |
| 5 | 0.6020 | 51.60 | 0.07 | 51.67 | 56.00 | -4.33 | QP | |
| 6 | 0.6020 | 34.60 | 0.07 | 34.67 | 46.00 | -11.33 | AVG | |
| 7 | 2.8300 | 19.26 | 0.13 | 19.39 | 56.00 | -36.61 | QP | |
| 8 | 2.8300 | 6.54 | 0.13 | 6.67 | 46.00 | -39.33 | AVG | |
| 9 | 5.2780 | 30.35 | 0.17 | 30.52 | 60.00 | -29.48 | QP | |
| 10 | 5.2780 | 7.30 | 0.17 | 7.47 | 50.00 | -42.53 | AVG | |
| 11 | 28.1100 | 25.31 | 0.42 | 25.73 | 60.00 | -34.27 | QP | |
| 12 | 28.1100 | 17.95 | 0.42 | 18.37 | 50.00 | -31.63 | AVG | |

**Test Mode** Communication mode (DC 3.3V) **Polarity** Neutral



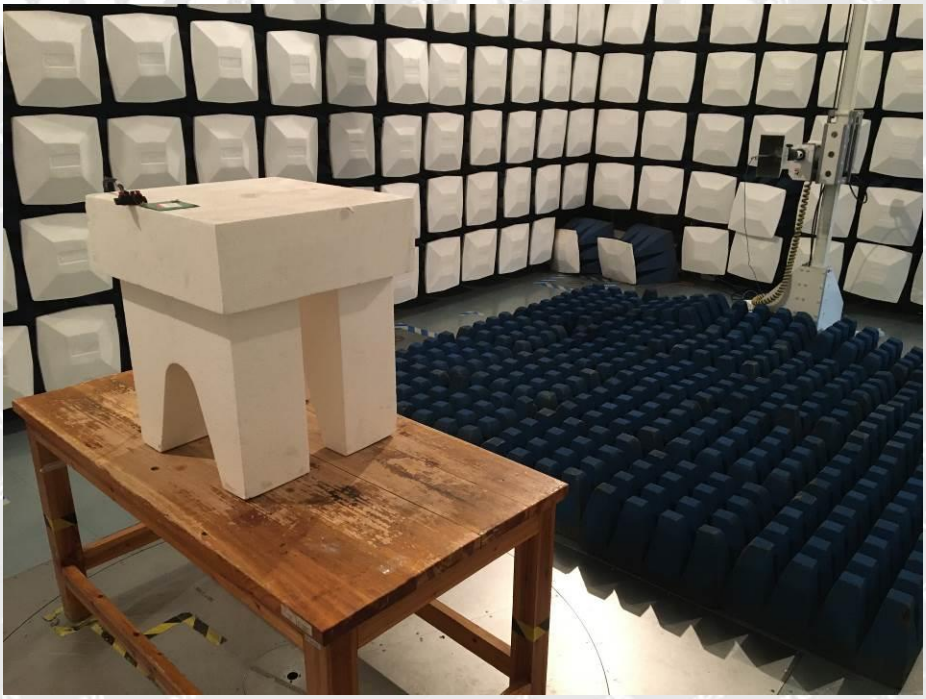

| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1660 | 31.50 | 0.03 | 31.53 | 65.15 | -33.62 | QP | |
| 2 | 0.1660 | 21.00 | 0.03 | 21.03 | 55.15 | -34.12 | AVG | |
| 3 | 0.5340 | 47.55 | 0.07 | 47.62 | 56.00 | -8.38 | QP | |
| 4 | 0.5340 | 31.41 | 0.07 | 31.48 | 46.00 | -14.52 | AVG | |
| 5 | 0.6060 | 51.14 | 0.07 | 51.21 | 56.00 | -4.79 | QP | |
| 6 | 0.6060 | 35.06 | 0.07 | 35.13 | 46.00 | -10.87 | AVG | |
| 7 | 0.7940 | 36.99 | 0.07 | 37.06 | 56.00 | -18.94 | QP | |
| 8 | 0.7940 | 22.35 | 0.07 | 22.42 | 46.00 | -23.58 | AVG | |
| 9 | 5.3260 | 31.75 | 0.17 | 31.92 | 60.00 | -28.08 | QP | |
| 10 | 5.3260 | 6.69 | 0.17 | 6.86 | 50.00 | -43.14 | AVG | |
| 11 | 28.0460 | 26.13 | 0.42 | 26.55 | 60.00 | -33.45 | QP | |
| 12 | 28.0460 | 20.00 | 0.42 | 20.42 | 50.00 | -29.58 | AVG | |

# 7 Photographs Test Setup

## 7.1 Photographs - Radiated Emission Test Setup

**30MHz-1GHz**

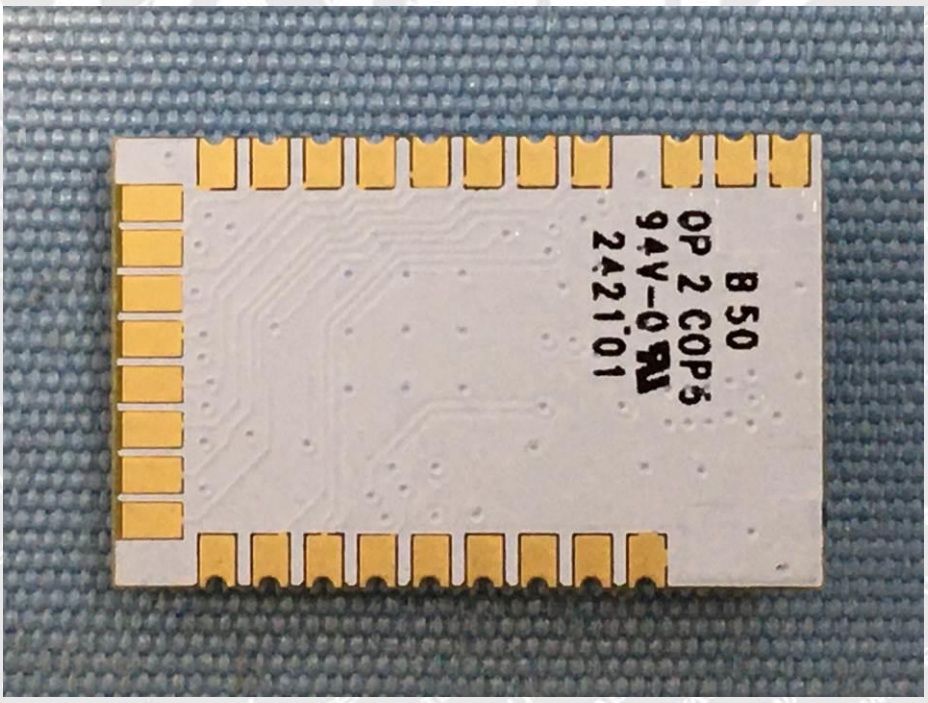
**Above 1GHz**

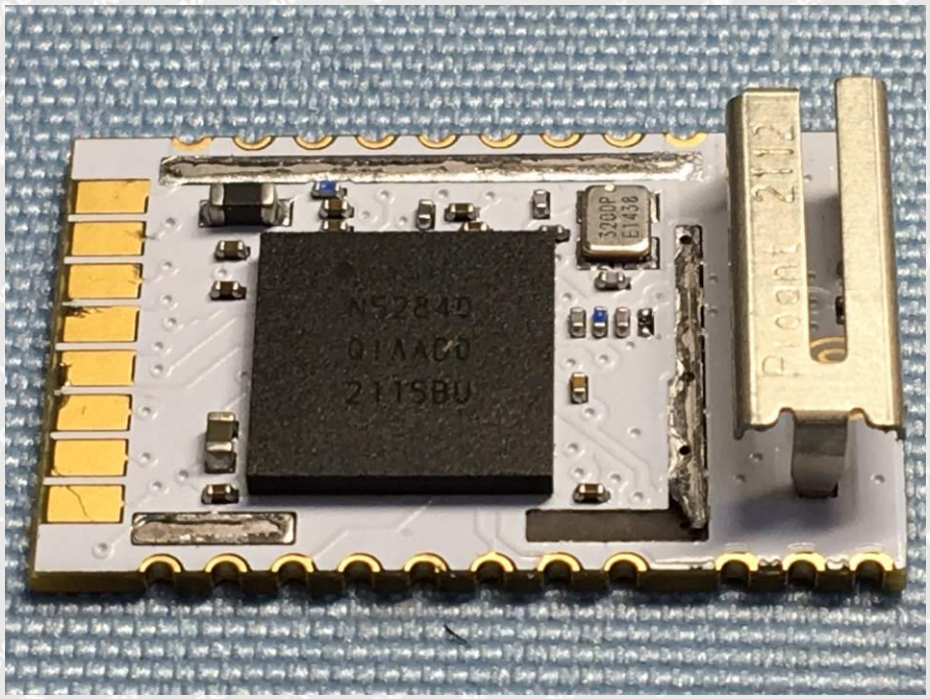


## 7.2 Photographs – Conducted Emission Test Setup

# 8 Photographs - Constructional Details

## 8.1 EUT - External Photos




======End of Report======