# RADIO TEST REPORT

Report No:STS1809094W01

Issued for

Fortin Auto Radio Inc.

9855 Rue Colbert, Anjou, QC H1J 1Z9, Canada

| | |
|---|---|
| **Product Name:** | EVO LORA-BT |
| **Brand Name:** | FORTIN |
| **Model Name:** | ANT900-BT |
| **Series Model:** | N/A |
| **FCC ID:** | 2ACKU-ANT900-BT |
| **IC:** | 12084A-ANT900BT |
| **Test Standard:** | FCC Part 15.247<br>RSS-247 ISSUE 2 FEB 2017<br>RSS-GEN ISSUE 5 Apr 2018 |

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# TEST RESULT CERTIFICATION

| | |
|---|---|
| **Applicant's name** ..... | Fortin Auto Radio Inc. |
| Address ..... | 9855 Rue Colbert, Anjou, QC H1J 1Z9, Canada |
| **Manufacture's Name**..... | Fortin Auto Radio Inc. |
| Address ..... | 9855 Rue Colbert, Anjou, QC H1J 1Z9, Canada |

**Product description**

| | |
|---|---|
| Product Name..... | EVO LORA-BT |
| Brand Name ..... | FORTIN |
| Model Name ..... | ANT900-BT |
| Series Model..... | N/A |
| **Test Standards**..... | FCC Part 15.247 |
| | RSS-247 Issue 2, February 2017 |
| Test procedure……..: | ANSI C63.10-2013 |

This device described above has been tested by STS, the test results show that the equipment under test (EUT) is in compliance with the FCC/IC requirements. And it is applicable only to the tested sample identified in the report.
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| | |
|---|---|
| **Date of Test** ..... | |
| Date (s) of performance of tests ..... | 28 Aug. 2018~ 08 Oct. 2018 |
| Date of Issue..... | 10 Oct. 2018 |
| Test Result..... | **Pass** |

Testing Engineer : Chris chen

( Chris chen )

Technical Manager : Sean She

( Sean she )

Authorized Signatory : Vita Li

(Vita Li)

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## Revision History

| Rev. | Issue Date | Report NO. | Effect Page | Contents |
|---|---|---|---|---|
| 00 | 10 Oct. 2018 | STS1809094W01 | ALL | Initial Issue |
| | | | | |

# 1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:
558074 D01 15.247 Meas Guidance v05

| FCC Part 15.247,Subpart C<br>RSS-247 Issue 2 | | | |
|---|---|---|---|
| Standard Section | Test Item | Judgment | Remark |
| 15.207<br>RSS-Gen 8.8 | Conducted Emission | PASS | -- |
| 15.247 (a)(2)<br>RSS-247 5.2 a)<br>RSS-Gen 6.7 | 6dB&99% Bandwidth | PASS | -- |
| 15.247 (b)(3)<br>RSS-247 5.4 d) | Output Power | PASS | -- |
| 15.247(d)/ 15.209/15.205<br>RSS-247 5.5<br>RSS-GEN 8.9 8.10 | Radiated Spurious Emission | PASS | -- |
| 15.247 (d)<br>RSS-247 Issue 2 5.5 | Conducted Spurious & Band Edge Emission | PASS | -- |
| 15.247 (e)<br>RSS-247 5.2 b) | Power Spectral Density | PASS | -- |
| 15.203<br>RSS-Gen 6.8 | Antenna Requirement | PASS | -- |
| RSS-Gen 6.11 8.11 | Frequency Stability | PASS | -- |

NOTE:

(1) "N/A" denotes test is not applicable in this Test Report

(2) All tests are according to ANSI C63.10-2013

1.1 TEST FACTORY

Shenzhen STS Test Services Co., Ltd.
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CNAS Registration No.: L7649; FCC Registration No.: 625569
IC Registration No.: 12108A; A2LA Certificate No.: 4338.01;

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y** ± **U**，where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**，providing a level of confidence of approximately **95** %。

| No. | Item | Uncertainty |
|---|---|---|
| 1 | Conducted Emission (9KHz-150KHz) | ±2.88dB |
| 2 | Conducted Emission (150KHz-30MHz) | ±2.67dB |
| 3 | RF power,conducted | ±0.71dB |
| 4 | Spurious emissions,conducted | ±0.63dB |
| 5 | All emissions,radiated (9KHz-30MHz) | ±3.02dB |
| 6 | All emissions,radiated (30MHz-200MHz) | ±3.80dB |
| 7 | All emissions,radiated (200MHz-1000MHz) | ±3.97dB |
| 8 | All emissions,radiated(>1G) | ±3.03dB |

# 2. GENERAL INFORMATION

## 2.1 GENERAL DESCRIPTION OF THE EUT

<table>
<tr><td>Product Name</td><td>EVO LORA-BT</td></tr>
<tr><td>Trade Name</td><td>FORTIN</td></tr>
<tr><td>Model Name</td><td>ANT900-BT</td></tr>
<tr><td>Series Model</td><td>N/A</td></tr>
<tr><td>Model Difference</td><td>N/A</td></tr>
<tr><td>Product Description</td><td>The EUT is a EVO LORA-BT
<table>
<tr><td>Operation Frequency:</td><td>2402~2480 MHz</td></tr>
<tr><td>Modulation Type:</td><td>GFSK</td></tr>
<tr><td>Radio Technology:</td><td>BLE</td></tr>
<tr><td>Buletooth Version:</td><td>5.0 LE(Support 1M PHY)</td></tr>
<tr><td>Number Of Channel:</td><td>40</td></tr>
<tr><td>Antenna Designation:</td><td>Please see Note 3.</td></tr>
<tr><td>Antenna Gain (dBi)</td><td>0 dBi</td></tr>
</table></td></tr>
<tr><td>Channel List</td><td>Please refer to the Note 2.</td></tr>
<tr><td>Power Rating</td><td>Input:DC 12V</td></tr>
<tr><td>Hardware version number</td><td>X1</td></tr>
<tr><td>Software version number</td><td>V1</td></tr>
<tr><td>Radio Hardware version</td><td>MPLY.LR9.W1444,MD.LWTG.MP.V79.P4</td></tr>
<tr><td>Radio Software version</td><td>SC6531_W13.04.05_Release</td></tr>
<tr><td>Test Software</td><td>3.18.19</td></tr>
<tr><td>RF Power Setting TEST Software (power class)</td><td>2.4 GHz:GFSK(1Mbps):-6.5</td></tr>
<tr><td>Connecting I/O Port(s)</td><td>Please refer to the User's Manual</td></tr>
</table>

Note:

1. For a more detailed features description, please refer to the manufacturer’s specifications or the User's Manual.

2.

| Channel List | | | | | | | |
|---|---|---|---|---|---|---|---|
| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| 37 | 2402 | 09 | 2422 | 18 | 2442 | 28 | 2462 |
| 00 | 2404 | 10 | 2424 | 19 | 2444 | 29 | 2464 |
| 01 | 2406 | 38 | 2426 | 20 | 2446 | 30 | 2466 |
| 02 | 2408 | 11 | 2428 | 21 | 2448 | 31 | 2468 |
| 03 | 2410 | 12 | 2430 | 22 | 2450 | 32 | 2470 |
| 04 | 2412 | 13 | 2432 | 23 | 2452 | 33 | 2472 |
| 05 | 2414 | 14 | 2434 | 24 | 2454 | 34 | 2474 |
| 06 | 2416 | 15 | 2436 | 25 | 2456 | 35 | 2476 |
| 07 | 2418 | 16 | 2438 | 26 | 2458 | 36 | 2478 |
| 08 | 2420 | 17 | 2440 | 27 | 2460 | 39 | 2480 |

3.

Table for Filed Antenna

| Ant. | Brand | Model Name | Antenna Type | Connector | Gain (dBi) | NOTE |
|---|---|---|---|---|---|---|
| 1 | FORTIN | ANT900-BT | Integral Antenna | N/A | 0 | BLE ANT. |

## 2.2 DESCRIPTION OF THE TEST MODES

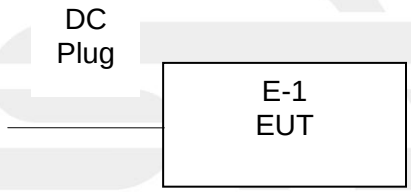
For conducted test items and radiated spurious emissions
Each of these EUT operation mode(s) or test configuration mode(s) mentioned below was evaluated respectively..

| Worst Mode | Description | Data/Modulation |
|---|---|---|
| Mode 1 | TX CH37(2402MHz) | 1 MHz/GFSK |
| Mode 2 | TX CH17(2440MHz) | 1 MHz/GFSK |
| Mode 3 | TX CH39(2480MHz) | 1 MHz/GFSK |

Note:
The measurements are performed at all Bit Rate of Transmitter, the worst data was reported

## 2.3 BLOCK DIGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious Emission Test



## 2.4 DESCRIPTION OF SUPPORT UNITS(CONDUCTED MODE)

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| Item | Equipment | Mfr/Brand | Model/Type No. | Serial No. | Note |
|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| Item | Shielded Type | Ferrite Core | Length | Note |
|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A |
| | | | | |
| | | | | |
| | | | | |

Note:

(1) The support equipment was authorized by Declaration of Confirmation.
(2) For detachable type I/O cable should be specified the length in cm in『Length』column.
(3) “YES” is means “shielded” “with core”; “NO” is means “unshielded” “without core”.

## 2.5 EQUIPMENTS LIST

Radiation Test equipment

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| EMI Test Receiver | R&S | ESCI | 102086 | 2017.10.15 | 2018.10.14 |
| Bilog Antenna | TESEQ | CBL6111D | 34678 | 2017.11.02 | 2018.11.01 |
| Horn Antenna | Schwarzbeck | BBHA 9120D | 9120D-1343 | 2017.10.27 | 2018.10.26 |
| SHF-EHF Horn Antenna (18G-40GHz) | A-INFO | LB-180400-KF | N/A | 2018.03.11 | 2019.03.10 |
| Temperature & Humitidy | HH660 | Mieo | N/A | 2017.10.15 | 2018.10.14 |
| Temperature & Humitidy | HH660 | Mieo | N/A | 2017.10.15 | 2018.10.14 |
| Pre-mplifier (0.1M-3GHz) | EM | EM330 | 60538 | 2018.03.11 | 2019.03.10 |
| PreAmplifier (1G-26.5GHz) | Agilent | 8449B | 60538 | 2017.10.15 | 2018.10.14 |
| Passive Loop (9K--30MHz) | ZHNAN | ZN3090C | 16035 | 2018.03.11 | 2019.03.10 |
| Low frequency cable | EM | R01 | N/A | 2018.03.11 | 2019.03.10 |
| Low frequency cable | EM | R06 | N/A | 2018.03.11 | 2019.03.10 |
| High frequency cable | SCHWARZBECK | R04 | N/A | 2018.03.11 | 2019.03.10 |
| High frequency cable | SCHWARZBECK | R02 | N/A | 2018.03.11 | 2019.03.10 |
| Semi-anechoic chamber | Changling | 966 | N/A | 2017.10.15 | 2018.10.14 |
| trun table | EM | SC100_1 | 60531 | N/A | N/A |
| Antnna mast | EM | SC100 | N/A | N/A | N/A |
| Max-full Antenna Corp | MF | MFA-440H | N/A | N/A | N/A |
| Programmable power supply | Agilent | E3642A | MY40002025 | 2017.10.13 | 2018.10.12 |
| Temperature& Humidity test chamber | Safety test | AG80L | 171200018 | 2018.03.09 | 2019.03.08 |

Conduction Test equipment

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| Test Receiver | R&S | ESCI | 101427 | 2017.10.15 | 2018.10.14 |
| LISN | R&S | ENV216 | 101242 | 2017.10.15 | 2018.10.14 |
| conduction Cable | EM | C01 | N/A | 2018.03.11 | 2019.03.10 |
| Temperature & Humitidy | Mieo | HH660 | N/A | 2017.10.15 | 2018.10.14 |

RF Connected Test

| Kind of Equipment | Manufacturer | Type No. | Serial No. | Last calibration | Calibrated until |
|---|---|---|---|---|---|
| USB RF power sensor | DARE | RPR3006W | 15I00041SNO03 | 2017.10.15 | 2018.10.14 |
| Power Meter | R&S | NRP | 100510 | 2017.10.15 | 2018.10.14 |
| Spectrum Analyzer | Agilent | N9020A | MY51110105 | 2018.03.08 | 2019.03.07 |
| Signal Analyzer | Agilent | N9020A | MY49100060 | 2017.10.15 | 2018.10.14 |

# 3. EMC EMISSION TEST

## 3.1 CONDUCTED EMISSION MEASUREMENT

### 3.1.1 POWER LINE CONDUCTED EMISSION LIMITS

operating frequency band. In case the emission fall within the restricted band specified on Part 207(a) and RSS-Gen Issue 5 limit in the table below has to be followed.

| FREQUENCY (MHz) | Conducted Emission limit (dBuV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 -0.5 | 66 - 56 * | 56 - 46 * |
| 0.50 -5.0 | 56.00 | 46.00 |
| 5.0 -30.0 | 60.00 | 50.00 |

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

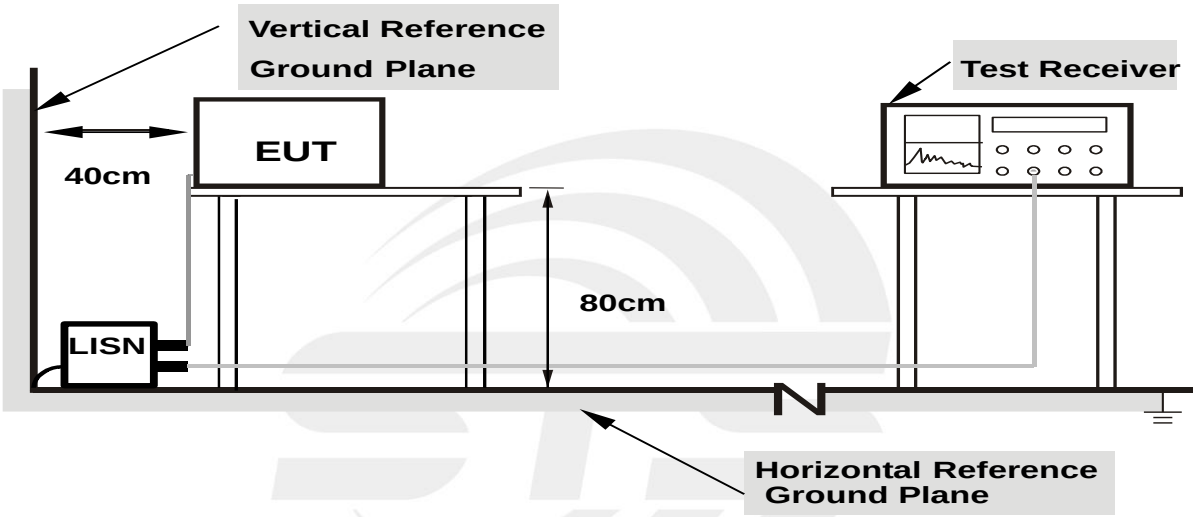
The following table is the setting of the receiver

| Receiver Parameters | Setting |
|---|---|
| Attenuation | 10 dB |
| Start Frequency | 0.15 MHz |
| Stop Frequency | 30 MHz |
| IF Bandwidth | 9 kHz |

3.2 TEST PROCEDURE

a. The EUT was 0.8 meters from the horizontal ground plane and 0.4 meters from the vertical ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN at least 80 cm from nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.3 TEST SETUP




**Note: 1.Support units were connected to second LISN.**
**2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes**

3.4 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

3.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 26 ℃ | Relative Humidity: | 64% |
| Test Voltage: | N/A | Phase: | L/N |
| Test Mode: | N/A | | |

Note: The EUT is power by DC, this test item is not apply.

# 4. RADIATED EMISSION MEASUREMENT

## 4.1 RADIATED EMISSION LIMITS

in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the Restricted band specified on Part15.205(a)&209(a) and RSS-247 Issue 2 limit in the table and according to ANSI C63.10-2013 below has to be followed.

LIMITS OF RADIATED EMISSION MEASUREMENT (Frequency Range 9kHz-1000MHz)

| Frequencies (MHz) | Field Strength (micorvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009~0.490 | 2400/F(KHz) | 300 |
| 0.490~1.705 | 24000/F(KHz) | 30 |
| 1.705~30.0 | 30 | 30 |
| 30~88 | 100 | 3 |
| 88~216 | 150 | 3 |
| 216~960 | 200 | 3 |
| Above 960 | 500 | 3 |

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

| FREQUENCY (MHz) | (dBuV/m) (at 3M) | |
|---|---|---|
| | PEAK | AVERAGE |
| Above 1000 | 74 | 54 |

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

For Radiated Emission

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Detector | Peak |
| Start Frequency | 1000 MHz(Peak/RMS) |
| Stop Frequency | 10th carrier hamonic(Peak/RMS) |
| RB / VB (emission in restricted band) | 1 MHz / 3 MHz |

For Band edge

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak /RMS |
| Start/Stop Frequency | Lower Band Edge: 2300 to 2403 MHz<br>Upper Band Edge: 2479 to 2500 MHz |
| RB / VB (emission in restricted band) | 1 MHz / 3 MHz |

| Receiver Parameter | Setting |
|---|---|
| Start ~ Stop Frequency | 9kHz~90kHz / RB 200Hz for PK & AV |
| Start ~ Stop Frequency | 90kHz~110kHz / RB 200Hz for QP |
| Start ~ Stop Frequency | 110kHz~490kHz / RB 200Hz for PK & AV |
| Start ~ Stop Frequency | 490kHz~30MHz / RB 9kHz for QP |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 120kHz for QP |

4.2 TEST PROCEDURE

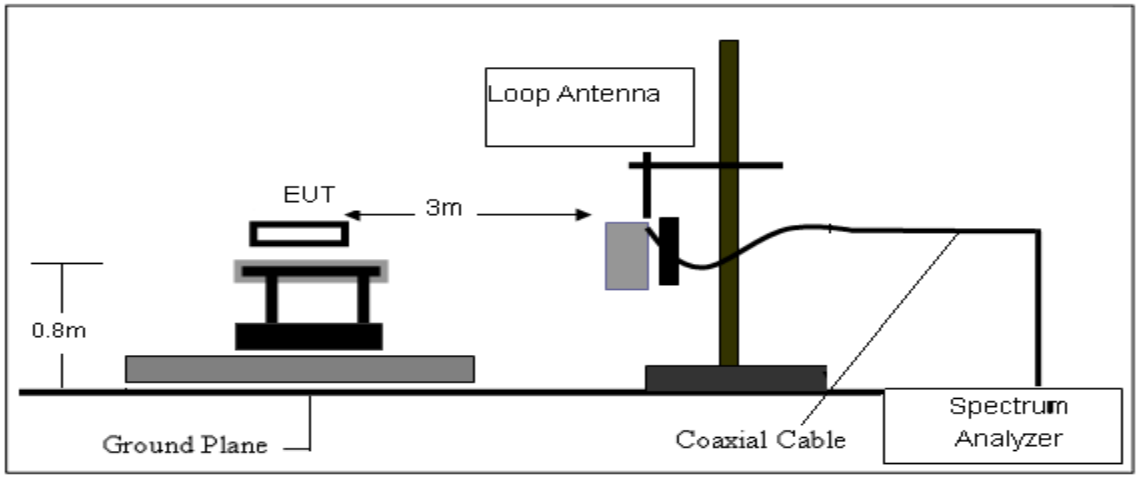
a. The measuring distance of at 3 m shall be used for measurements at frequency 0.009MHz up to 1GHz, and above 1GHz.
b. The EUT was placed on the top of a rotating table 0.8 meters(above 1GHz is 1.5 m) above the ground at a 3 meter anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
c. The height of the equipment shall be 0.8 m(above 1GHz is 1.5 m); the height of the test antenna shall vary between 1 m to 4 m. Horizontal and vertical polarizations of the antenna are set to make the measurement
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
e. If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

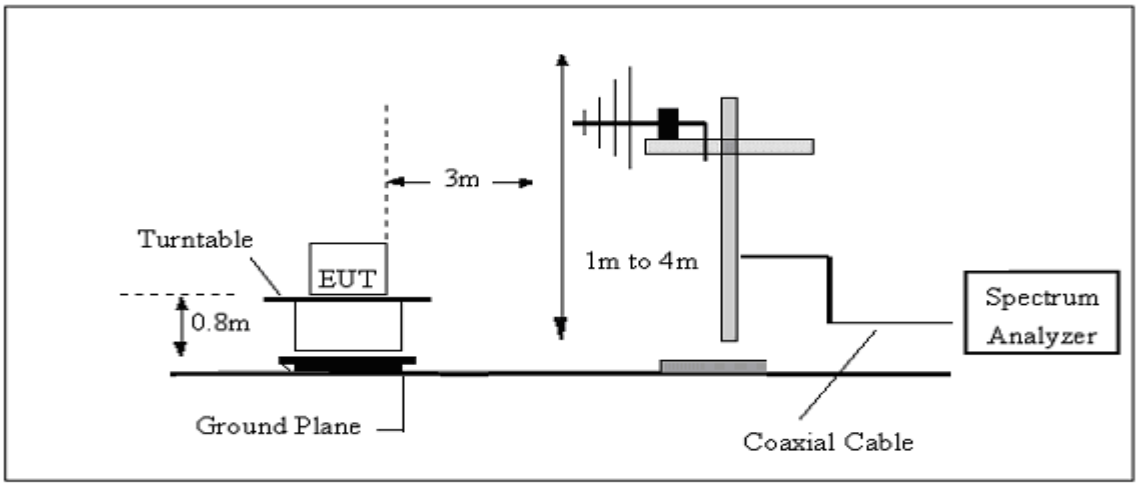
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

4.3 TEST SETUP

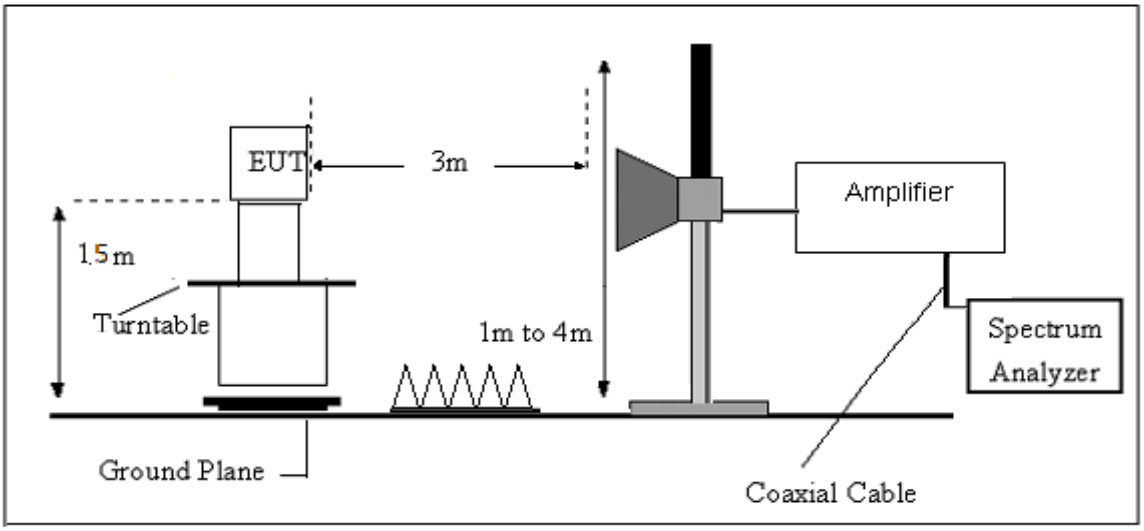
（A）Radiated Emission Test-Up Frequency Below 30MHz




（B）Radiated Emission Test-Up Frequency 30MHz~1GHz




（C）Radiated Emission Test-Up Frequency Above 1GHz




4.4 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

## 4.5 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where

FS = Field Strength

CL = Cable Attenuation Factor (Cable Loss)

RA = Reading Amplitude

AG = Amplifier Gain

AF = Antenna Factor

For example

| Frequency | FS | RA | AF | CL | AG | Factor |
|---|---|---|---|---|---|---|
| (MHz) | (dBμV/m) | (dBμV/m) | (dB) | (dB) | (dB) | (dB) |
| 300 | 40 | 58.1 | 12.2 | 1.6 | 31.9 | -18.1 |

Factor=AF+CL-AG

4.6 TEST RESULTS

(Between 9KHz – 30 MHz)

| | | | |
|---|---|---|---|
| Temperature: | 25.7 ℃ | Relative Humidtity: | 54% |
| Test Voltage: | DC 12V | Polarization: | -- |
| Test Mode: | -- | | |

| Freq. | Reading | Limit | Margin | State |
|---|---|---|---|---|
| (MHz) | (dBuV/m) | (dBuV/m) | (dB) | P/F |
| -- | -- | -- | -- | PASS |
| -- | -- | -- | -- | PASS |

Note:

The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Distance extrapolation factor =40 log (specific distance/test distance)(dB);

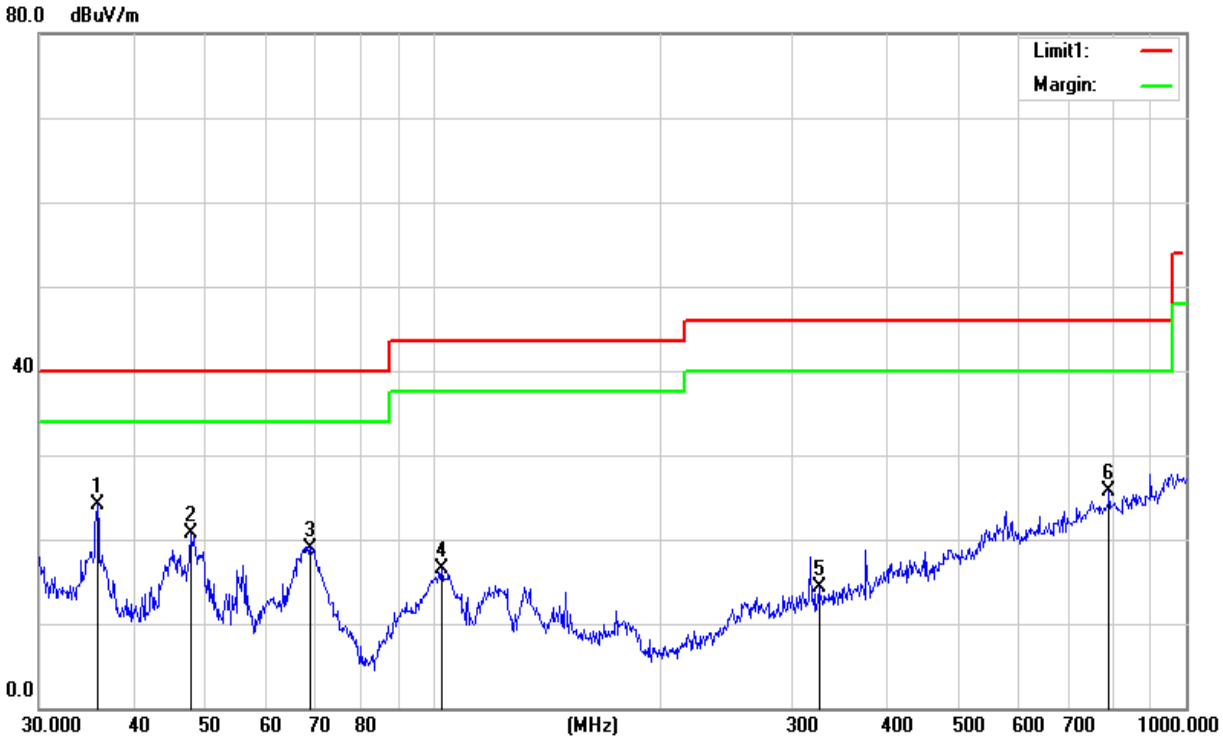
Limit line = specific limits(dBuv) + distance extrapolation factor.

(30MHz -1000MHz)

| | | | |
|---|---|---|---|
| Temperature: | 25.7 ℃ | Relative Humidity: | 54% |
| Test Voltage: | DC 12V | Phase: | Horizontal |
| Test Mode: | Mode1/2/3(Mode 1-1M worst mode) | | |

| Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|
| 35.8746 | 38.40 | -14.20 | 24.20 | 40.00 | -15.80 | QP |
| 47.6586 | 40.96 | -20.27 | 20.69 | 40.00 | -19.31 | QP |
| 68.8721 | 43.07 | -24.13 | 18.94 | 40.00 | -21.06 | QP |
| 102.7192 | 35.37 | -18.96 | 16.41 | 43.50 | -27.09 | QP |
| 325.5958 | 28.33 | -14.12 | 14.21 | 46.00 | -31.79 | QP |
| 790.6188 | 28.92 | -3.30 | 25.62 | 46.00 | -20.38 | QP |

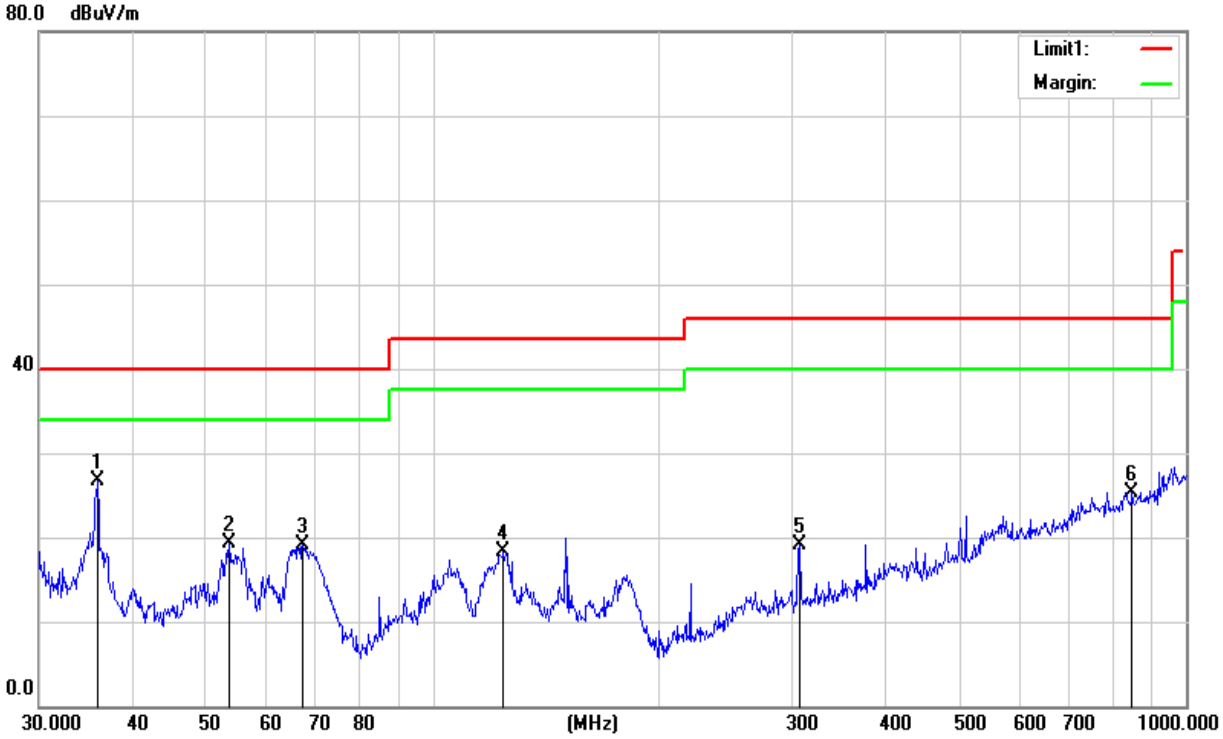
Remark:
1. Margin = Result (Result =Reading + Factor )–Limit



| Temperature: | 25.7 ℃ | Relative Humidity: | 54% |
|---|---|---|---|
| Test Voltage: | DC 12V | Phase: | Vertical |
| Test Mode: | Mode1/2/3(Mode 1-1M worst mode) | | |

| Frequency (MHz) | Reading (dBuV) | Correct Factor(dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|---|---|---|---|---|---|---|
| 35.8746 | 40.98 | -14.20 | 26.78 | 40.00 | -13.22 | QP |
| 53.6932 | 41.79 | -22.53 | 19.26 | 40.00 | -20.74 | QP |
| 67.2022 | 43.23 | -24.17 | 19.06 | 40.00 | -20.94 | QP |
| 124.1330 | 35.91 | -17.64 | 18.27 | 43.50 | -25.23 | QP |
| 306.7537 | 33.64 | -14.60 | 19.04 | 46.00 | -26.96 | QP |
| 848.0563 | 28.11 | -2.73 | 25.38 | 46.00 | -20.62 | QP |

Remark:
1. Margin = Result (Result =Reading + Factor )–Limit



(1GHz-25GHz)Restricted band and Spurious emission Requirements

## Low Channel

| Frequency (MHz) | Reading (dBμV) | Amplifier （dB） | Loss （dB） | Antenna Factor （dB/m） | Corrected Factor （dB） | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Low Channel (2402 MHz) | | | | | | | | | | |
| 3264.88 | 61.69 | 44.70 | 6.70 | 28.20 | -9.80 | 51.89 | 74.00 | -22.11 | PK | Vertical |
| 3264.88 | 50.97 | 44.70 | 6.70 | 28.20 | -9.80 | 41.17 | 54.00 | -12.83 | AV | Vertical |
| 3264.69 | 61.64 | 44.70 | 6.70 | 28.20 | -9.80 | 51.84 | 74.00 | -22.16 | PK | Horizontal |
| 3264.69 | 51.17 | 44.70 | 6.70 | 28.20 | -9.80 | 41.37 | 54.00 | -12.63 | AV | Horizontal |
| 4804.34 | 58.89 | 44.20 | 9.04 | 31.60 | -3.56 | 55.33 | 74.00 | -18.67 | PK | Vertical |
| 4804.34 | 49.30 | 44.20 | 9.04 | 31.60 | -3.56 | 45.74 | 54.00 | -8.26 | AV | Vertical |
| 4804.54 | 58.90 | 44.20 | 9.04 | 31.60 | -3.56 | 55.34 | 74.00 | -18.66 | PK | Horizontal |
| 4804.54 | 49.71 | 44.20 | 9.04 | 31.60 | -3.56 | 46.15 | 54.00 | -7.85 | AV | Horizontal |
| 5359.75 | 49.39 | 44.20 | 9.86 | 32.00 | -2.34 | 47.05 | 74.00 | -26.95 | PK | Vertical |
| 5359.75 | 39.30 | 44.20 | 9.86 | 32.00 | -2.34 | 36.96 | 54.00 | -17.04 | AV | Vertical |
| 5359.63 | 48.25 | 44.20 | 9.86 | 32.00 | -2.34 | 45.91 | 74.00 | -28.09 | PK | Horizontal |
| 5359.63 | 39.08 | 44.20 | 9.86 | 32.00 | -2.34 | 36.74 | 54.00 | -17.26 | AV | Horizontal |
| 7205.91 | 53.67 | 43.50 | 11.40 | 35.50 | 3.40 | 57.07 | 74.00 | -16.93 | PK | Vertical |
| 7205.91 | 44.01 | 43.50 | 11.40 | 35.50 | 3.40 | 47.41 | 54.00 | -6.59 | AV | Vertical |
| 7205.88 | 54.35 | 43.50 | 11.40 | 35.50 | 3.40 | 57.75 | 74.00 | -16.25 | PK | Horizontal |
| 7205.88 | 44.91 | 43.50 | 11.40 | 35.50 | 3.40 | 48.31 | 54.00 | -5.69 | AV | Horizontal |

# Mid Channel

| Frequency (MHz) | Reading (dBμV) | Amplifier （dB） | Loss （dB） | Antenna Factor （dB/m） | Corrected Factor （dB） | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Mid Channel (2440 MHz) | | | | | | | | | | |
| 3264.77 | 61.50 | 44.70 | 6.70 | 28.20 | -9.80 | 51.70 | 74.00 | -22.30 | PK | Vertical |
| 3264.77 | 49.96 | 44.70 | 6.70 | 28.20 | -9.80 | 40.16 | 54.00 | -13.84 | AV | Vertical |
| 3264.77 | 61.19 | 44.70 | 6.70 | 28.20 | -9.80 | 51.39 | 74.00 | -22.61 | PK | Horizontal |
| 3264.77 | 50.97 | 44.70 | 6.70 | 28.20 | -9.80 | 41.17 | 54.00 | -12.83 | AV | Horizontal |
| 4880.40 | 59.59 | 44.20 | 9.04 | 31.60 | -3.56 | 56.03 | 74.00 | -17.97 | PK | Vertical |
| 4880.40 | 49.91 | 44.20 | 9.04 | 31.60 | -3.56 | 46.35 | 54.00 | -7.65 | AV | Vertical |
| 4880.53 | 58.39 | 44.20 | 9.04 | 31.60 | -3.56 | 54.83 | 74.00 | -19.17 | PK | Horizontal |
| 4880.53 | 49.77 | 44.20 | 9.04 | 31.60 | -3.56 | 46.21 | 54.00 | -7.79 | AV | Horizontal |
| 5359.71 | 48.07 | 44.20 | 9.86 | 32.00 | -2.34 | 45.73 | 74.00 | -28.27 | PK | Vertical |
| 5359.71 | 40.09 | 44.20 | 9.86 | 32.00 | -2.34 | 37.75 | 54.00 | -16.25 | AV | Vertical |
| 5359.78 | 47.21 | 44.20 | 9.86 | 32.00 | -2.34 | 44.87 | 74.00 | -29.13 | PK | Horizontal |
| 5359.78 | 39.24 | 44.20 | 9.86 | 32.00 | -2.34 | 36.90 | 54.00 | -17.10 | AV | Horizontal |
| 7310.84 | 54.93 | 43.50 | 11.40 | 35.50 | 3.40 | 58.33 | 74.00 | -15.67 | PK | Vertical |
| 7310.84 | 44.11 | 43.50 | 11.40 | 35.50 | 3.40 | 47.51 | 54.00 | -6.49 | AV | Vertical |
| 7310.96 | 54.31 | 43.50 | 11.40 | 35.50 | 3.40 | 57.71 | 74.00 | -16.29 | PK | Horizontal |
| 7310.96 | 43.61 | 43.50 | 11.40 | 35.50 | 3.40 | 47.01 | 54.00 | -6.99 | AV | Horizontal |

# High Channel

| Frequency (MHz) | Reading (dBμV) | Amplifier （dB） | Loss （dB） | Antenna Factor （dB/m） | Corrected Factor （dB） | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| High Channel (2480 MHz) | | | | | | | | | | |
| 3264.75 | 61.13 | 44.70 | 6.70 | 28.20 | -9.80 | 51.33 | 74.00 | -22.67 | PK | Vertical |
| 3264.75 | 51.60 | 44.70 | 6.70 | 28.20 | -9.80 | 41.80 | 54.00 | -12.20 | AV | Vertical |
| 3264.76 | 61.32 | 44.70 | 6.70 | 28.20 | -9.80 | 51.52 | 74.00 | -22.48 | PK | Horizontal |
| 3264.76 | 50.63 | 44.70 | 6.70 | 28.20 | -9.80 | 40.83 | 54.00 | -13.17 | AV | Horizontal |
| 4960.32 | 58.59 | 44.20 | 9.04 | 31.60 | -3.56 | 55.03 | 74.00 | -18.97 | PK | Vertical |
| 4960.32 | 50.32 | 44.20 | 9.04 | 31.60 | -3.56 | 46.76 | 54.00 | -7.24 | AV | Vertical |
| 4960.42 | 58.29 | 44.20 | 9.04 | 31.60 | -3.56 | 54.73 | 74.00 | -19.27 | PK | Horizontal |
| 4960.42 | 50.06 | 44.20 | 9.04 | 31.60 | -3.56 | 46.50 | 54.00 | -7.50 | AV | Horizontal |
| 5359.73 | 48.65 | 44.20 | 9.86 | 32.00 | -2.34 | 46.31 | 74.00 | -27.69 | PK | Vertical |
| 5359.73 | 39.36 | 44.20 | 9.86 | 32.00 | -2.34 | 37.02 | 54.00 | -16.98 | AV | Vertical |
| 5359.83 | 47.84 | 44.20 | 9.86 | 32.00 | -2.34 | 45.50 | 74.00 | -28.50 | PK | Horizontal |
| 5359.83 | 39.12 | 44.20 | 9.86 | 32.00 | -2.34 | 36.78 | 54.00 | -17.22 | AV | Horizontal |
| 7439.77 | 53.81 | 43.50 | 11.40 | 35.50 | 3.40 | 57.21 | 74.00 | -16.79 | PK | Vertical |
| 7439.77 | 43.87 | 43.50 | 11.40 | 35.50 | 3.40 | 47.27 | 54.00 | -6.73 | AV | Vertical |
| 7439.83 | 53.55 | 43.50 | 11.40 | 35.50 | 3.40 | 56.95 | 74.00 | -17.05 | PK | Horizontal |
| 7439.83 | 43.58 | 43.50 | 11.40 | 35.50 | 3.40 | 46.98 | 54.00 | -7.02 | AV | Horizontal |

Note:

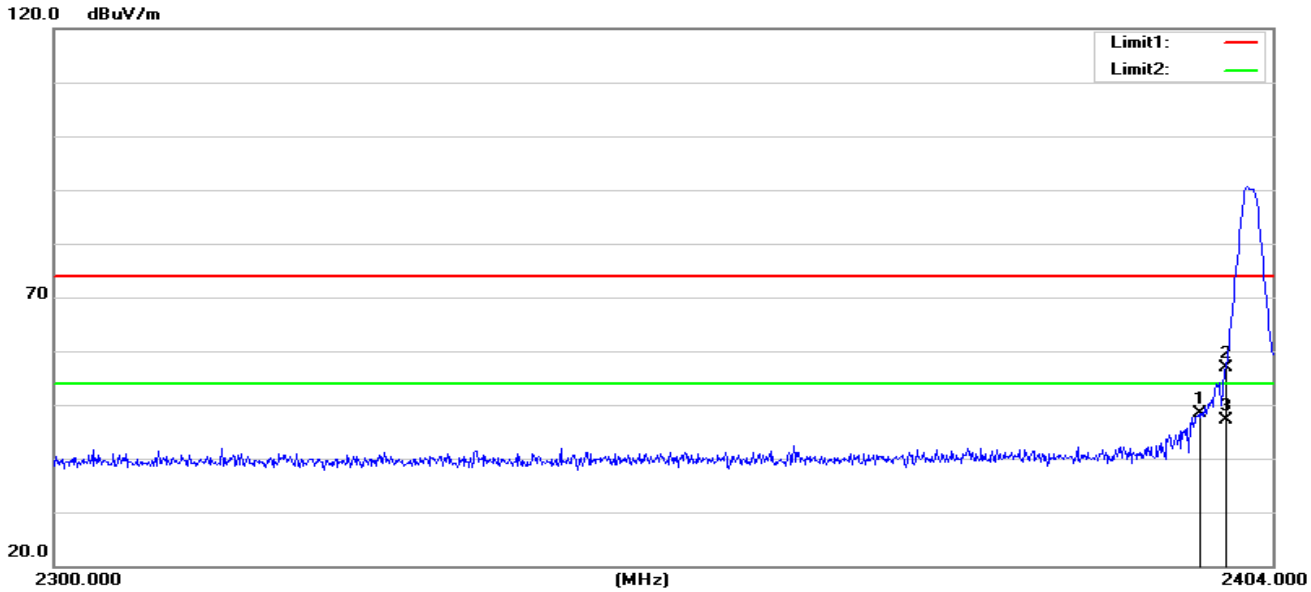
1) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
Emission Level = Reading + Factor

2) The frequency emission of peak points that did not show above the forms are at least 20dB below the limit, the frequency emission is mainly from the environment noise.

4.6 TEST RESULTS (Restricted Bands Requirements)

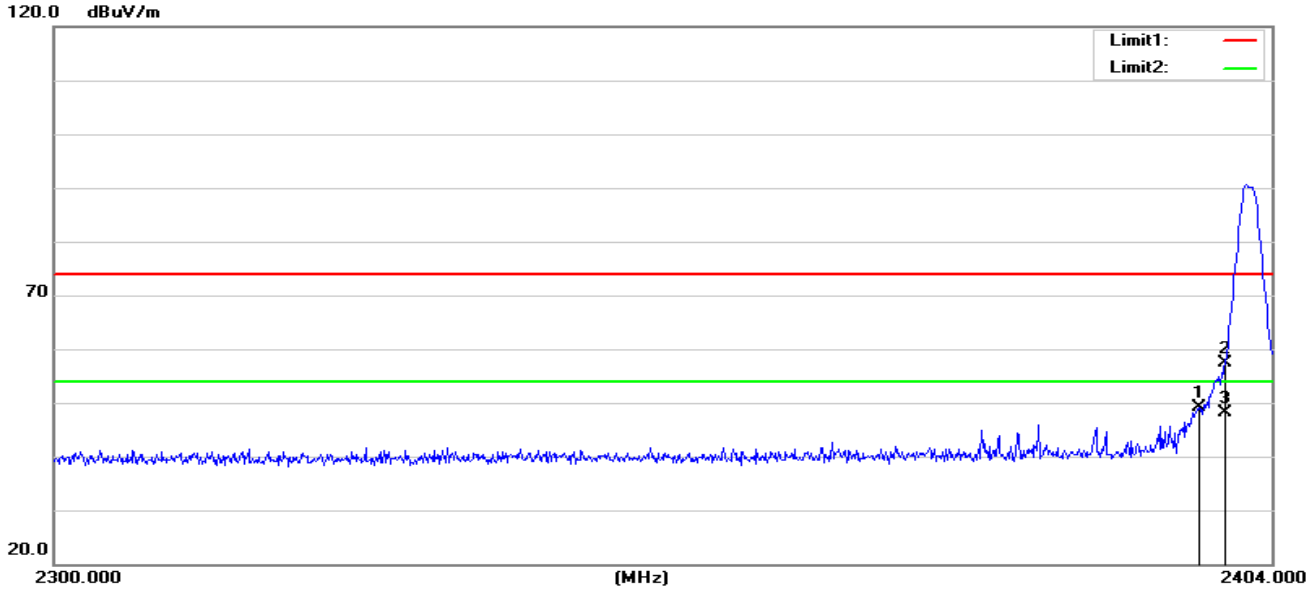
**GFSK-Low**

Horizontal




| No. | Frequency | Reading | Correct | Result | Limit | Margin | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBuV) | Factor(dB/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 1 | 2397.760 | 50.46 | -1.98 | 48.48 | 74.00 | -25.52 | peak |
| 2 | 2400.000 | 58.78 | -1.97 | 56.81 | 74.00 | -17.19 | peak |
| 3 | 2400.000 | 49.20 | -1.97 | 47.23 | 54.00 | -6.77 | AVG |

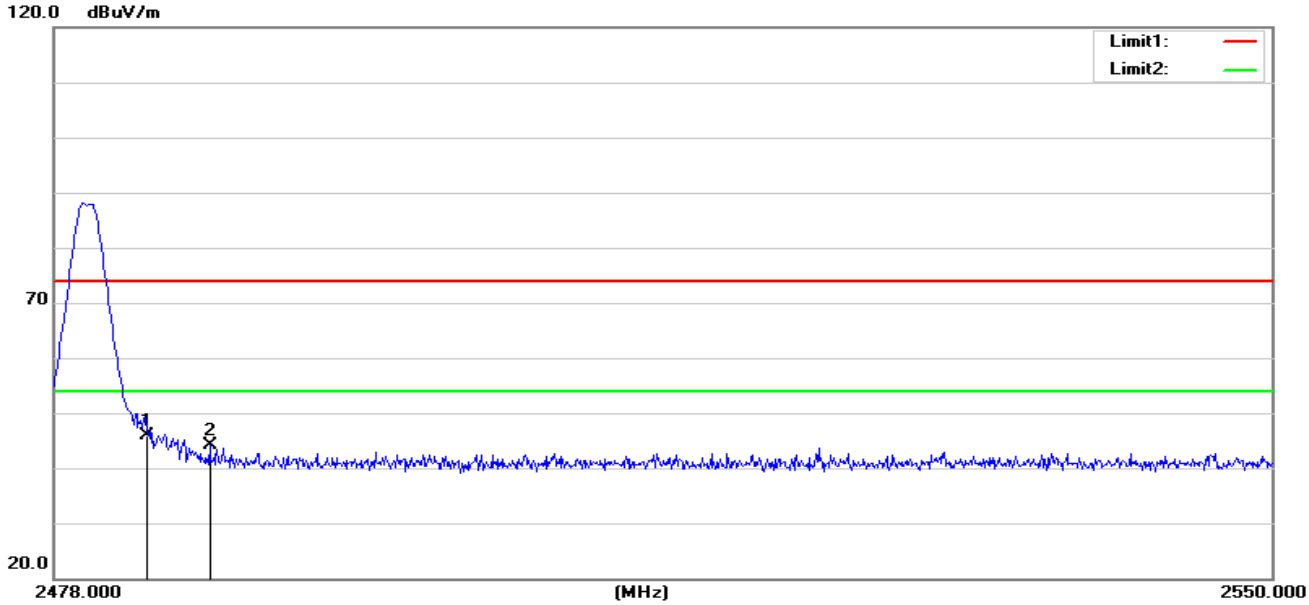
Vertical




| No. | Frequency | Reading | Correct | Result | Limit | Margin | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBuV) | Factor(dB/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 1 | 2397.656 | 51.03 | -1.98 | 49.05 | 74.00 | -24.95 | peak |
| 2 | 2400.000 | 59.26 | -1.97 | 57.29 | 74.00 | -16.71 | peak |
| 3 | 2400.000 | 50.12 | -1.97 | 48.15 | 54.00 | -5.85 | AVG |

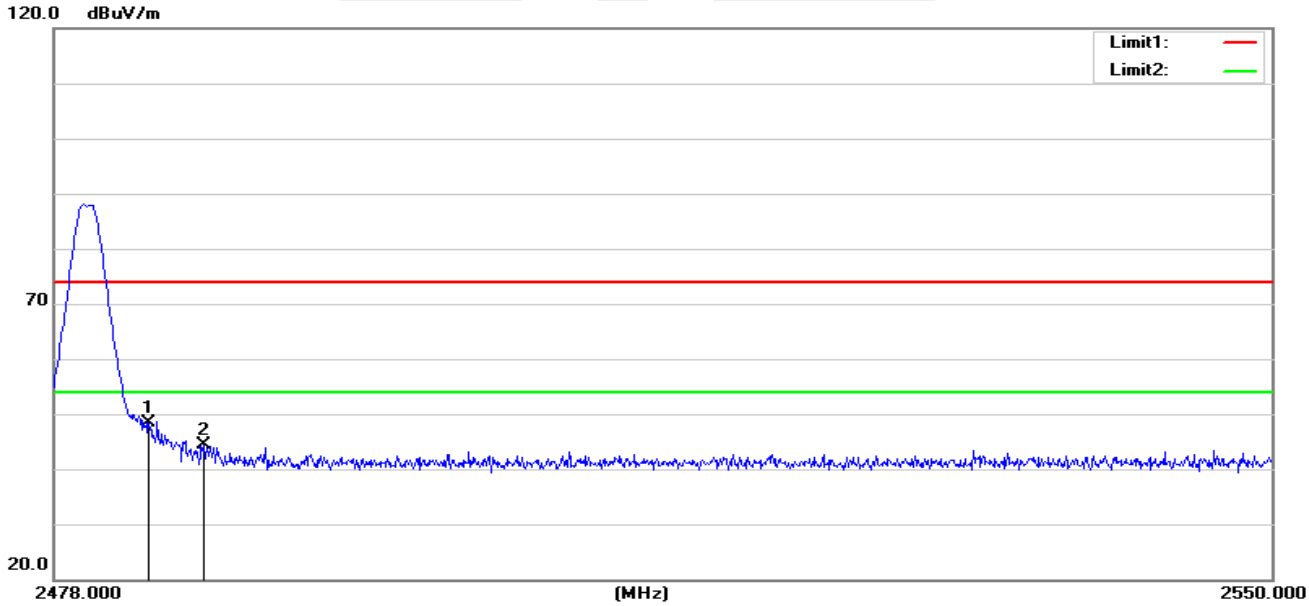
**GFSK-High**

Horizontal




| No. | Frequency | Reading | Correct | Result | Limit | Margin | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBuV) | Factor(dB/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 1 | 2483.500 | 47.19 | -1.20 | 45.99 | 74.00 | -28.01 | peak |
| 2 | 2487.144 | 45.22 | -1.19 | 44.03 | 74.00 | -29.97 | peak |

Vertical




| No. | Frequency | Reading | Correct | Result | Limit | Margin | Remark |
|---|---|---|---|---|---|---|---|
| | (MHz) | (dBuV) | Factor(dB/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 1 | 2483.500 | 49.55 | -1.20 | 48.35 | 74.00 | -25.65 | peak |
| 2 | 2486.784 | 45.55 | -1.19 | 44.36 | 74.00 | -29.64 | peak |

# 5. CONDUCTED SPURIOUS & BAND EDGE EMISSION

## 5.1 REQUIREMENT

According to FCC section 15.247(d) and RSS-247 Issue 2, in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

## 5.2 TEST PROCEDURE

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | 30 MHz to 10th carrier harmonic |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

.

For Band edge

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| Start/Stop Frequency | Lower Band Edge: 2300 – 2403 MHz<br>Upper Band Edge: 2479 – 2500 MHz |
| RB / VB (emission in restricted band) | 100 KHz/300 KHz |
| Trace-Mode: | Max hold |

## 5.3 TEST SETUP

The EUT which is powered by the Battery, is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading. Make the measurement with the spectrum analyzer's resolution bandwidth(RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW.

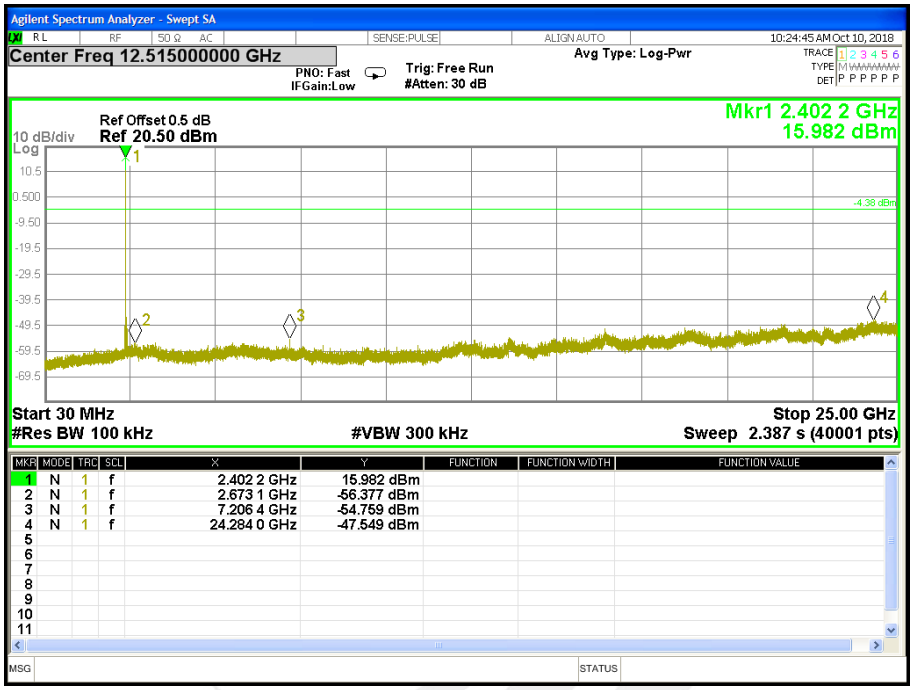
## 5.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

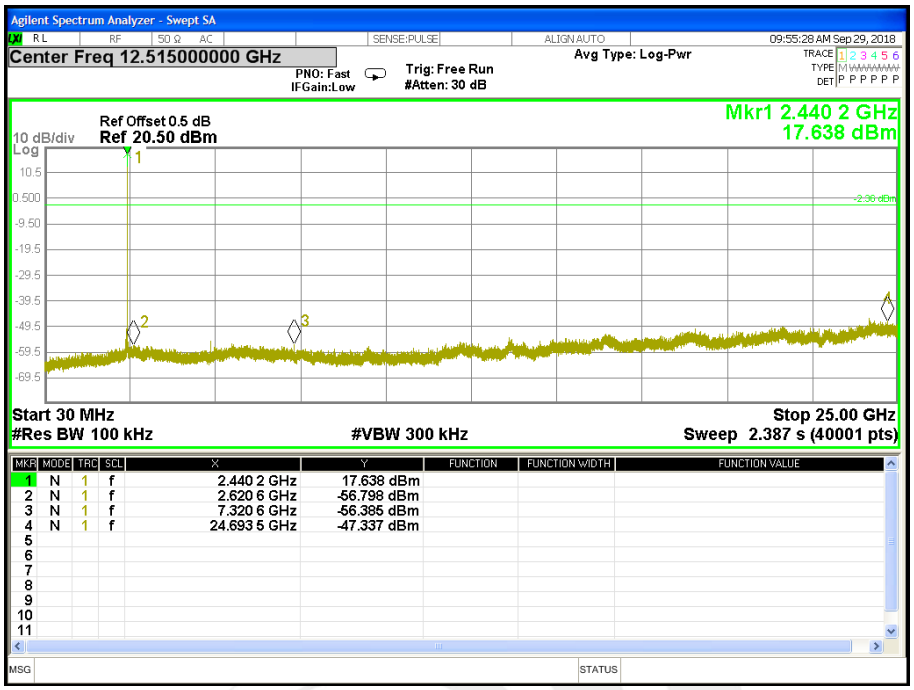
## 5.5 TEST RESULTS

| Temperature: | 25 ℃ | Relative Humidity: | 50% |
|---|---|---|---|
| Test Voltage: | DC 12V | Test Mode: | TX Mode /CH37, CH17, CH39 |

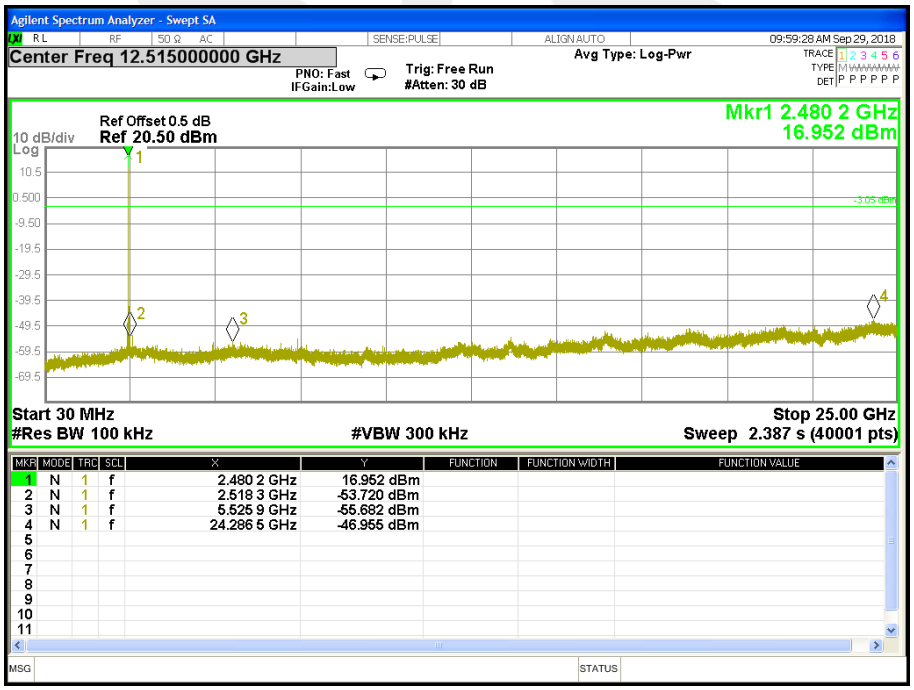
37 CH



17 CH

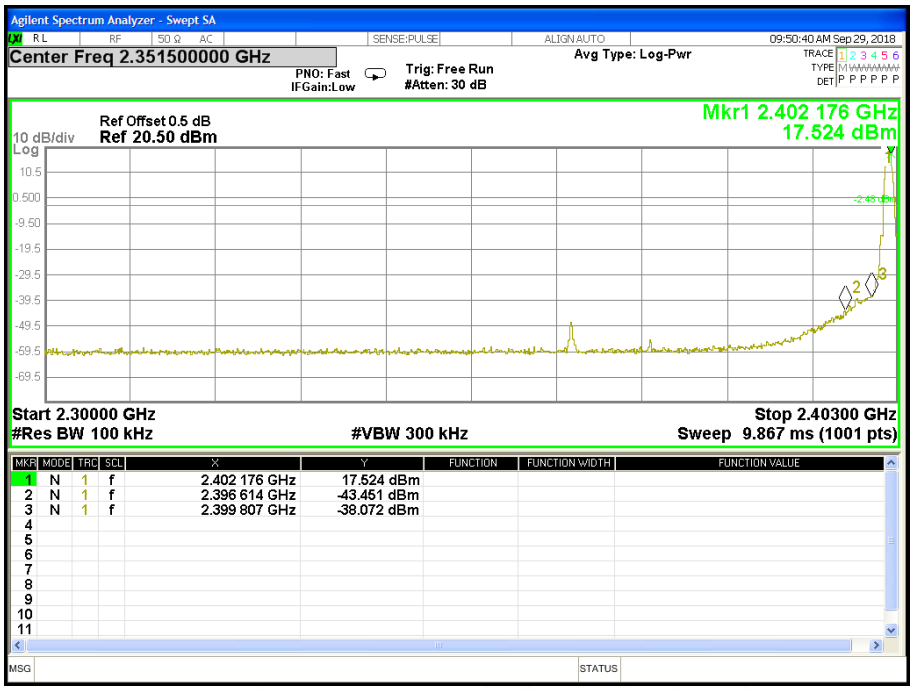

Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
09:55:28 AM Sep 29, 2018
Ref Offset 0.5 dB
10 dB/div
Ref 20.50 dBm
Mkr1 2.440 2 GHz
17.638 dBm
-2.36 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
1 N 1 f 2.440 2 GHz 17.638 dBm
2 N 1 f 2.620 6 GHz -56.798 dBm
3 N 1 f 7.320 6 GHz -56.385 dBm
4 N 1 f 24.693 5 GHz -47.337 dBm

39 CH

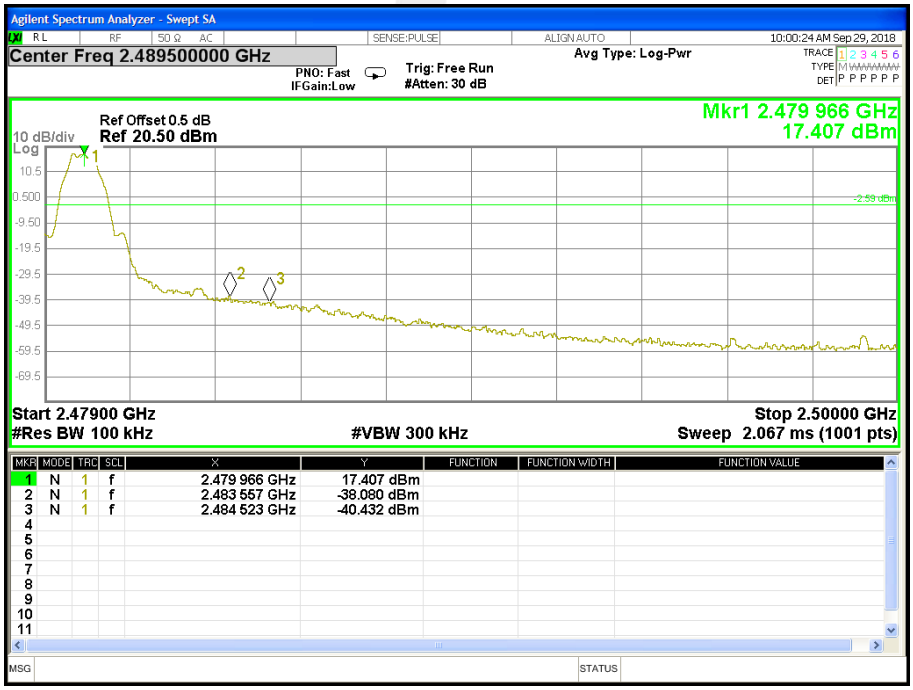

Agilent Spectrum Analyzer - Swept SA
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
09:59:28 AM Sep 29, 2018
Ref Offset 0.5 dB
10 dB/div
Ref 20.50 dBm
Mkr1 2.480 2 GHz
16.952 dBm
-3.05 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.387 s (40001 pts)
1 N 1 f 2.480 2 GHz 16.952 dBm
2 N 1 f 2.518 3 GHz -53.720 dBm
3 N 1 f 5.525 9 GHz -55.682 dBm
4 N 1 f 24.286 5 GHz -46.955 dBm

For Band edge

**37 CH**




**39 CH**



# 6. POWER SPECTRAL DENSITY TEST

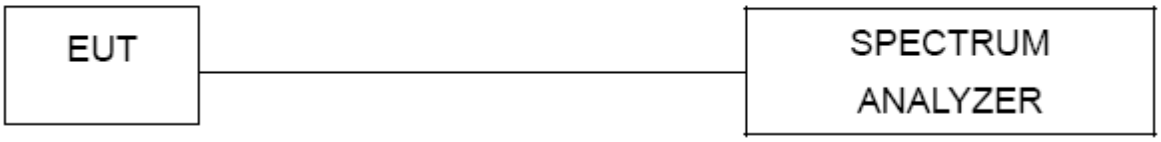
## 6.1 APPLIED PROCEDURES / LIMIT

| FCC Part 15.247,Subpart C<br>RSS-247 Issue 2 | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) | Result |
| 15.247(e)<br>RSS-247 Issue 2 | Power Spectral Density | ≤8 dBm<br>(RBW≥3KHz) | 2400-2483.5 | PASS |

## 6.2 TEST PROCEDURE

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW to: 100 kHz ≥ RBW ≥ 3 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

## 6.3 TEST SETUP




## 6.4 EUT OPERATION CONDITIONS

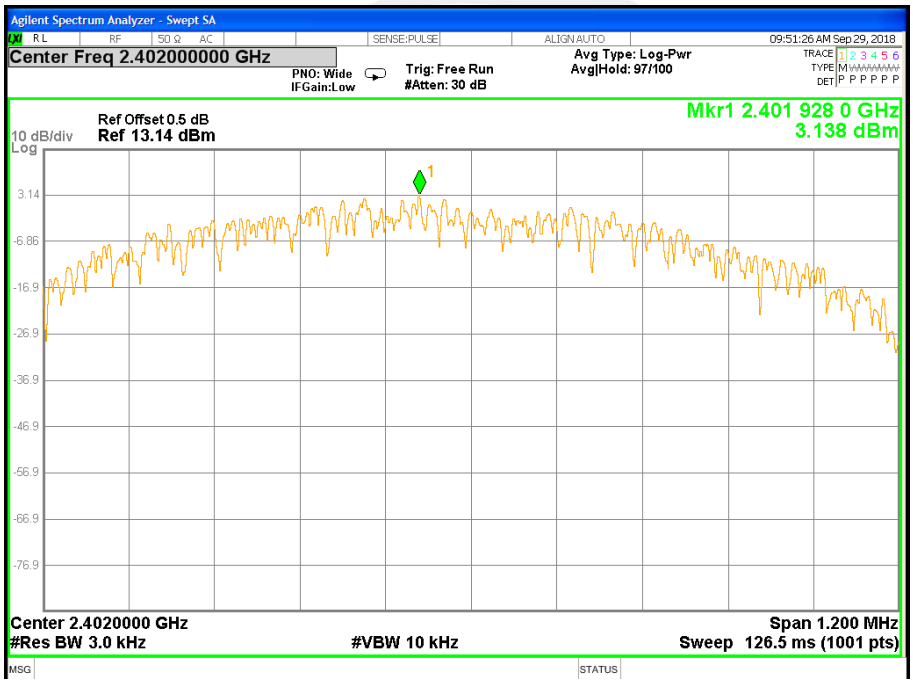
The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

## 6.5 TEST RESULTS

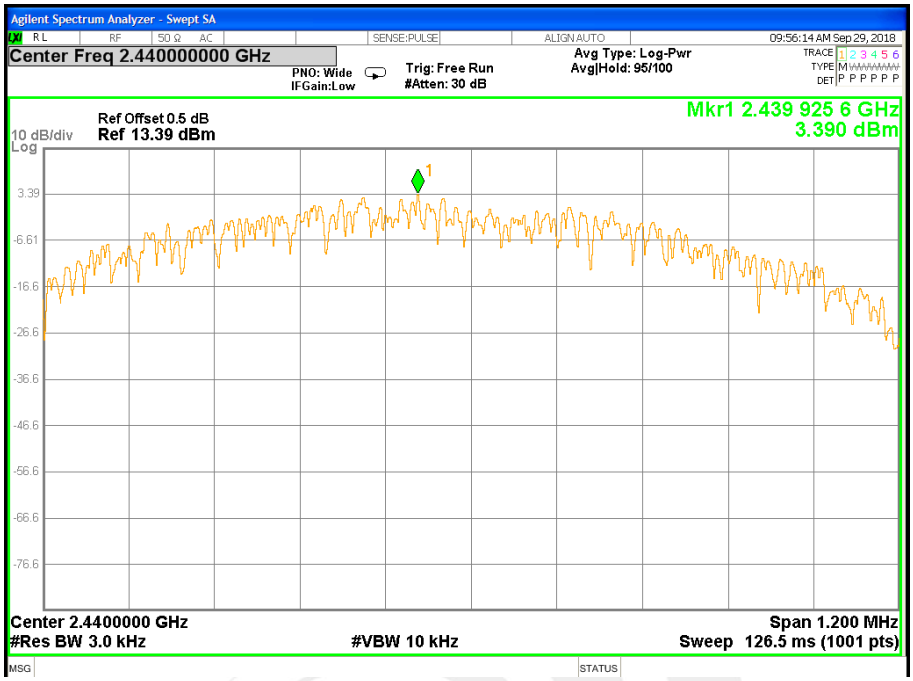
| Temperature: | 25 ℃ | Relative Humidity: | 60% |
|---|---|---|---|
| Test Voltage: | DC 12V | Test Mode: | TX Mode /CH37, CH17, CH39 |

| Frequency | Power Density (dBm/3kHz) | Limit (dBm/3KHz) | Result |
|---|---|---|---|
| 2402 MHz | 3.138 | ≤8 | PASS |
| 2440 MHz | 3.390 | ≤8 | PASS |
| 2480 MHz | 3.147 | ≤8 | PASS |

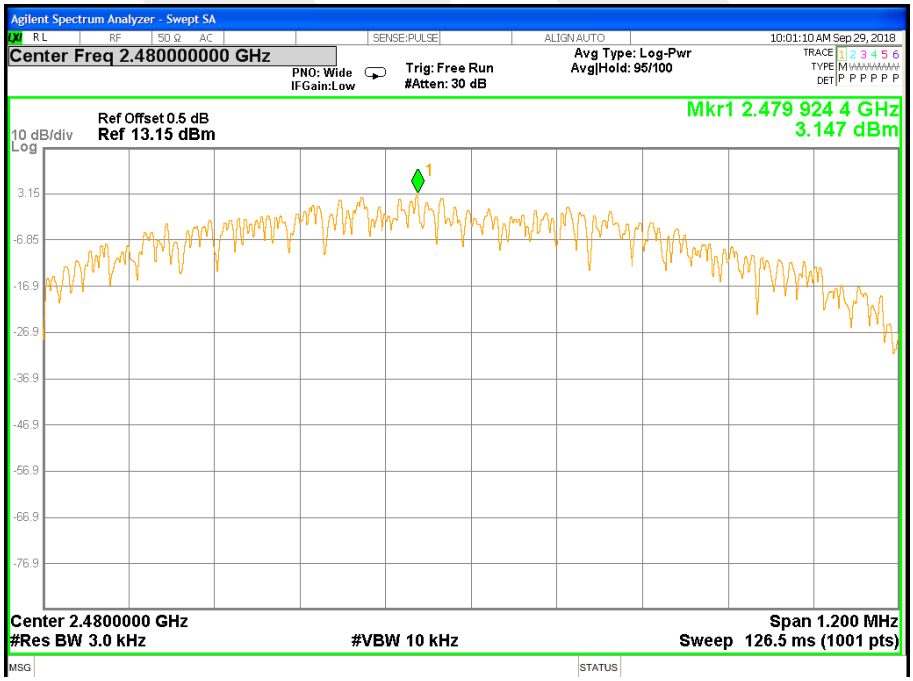
**TX CH37**



## TX CH17




## TX CH39



# 7. BANDWIDTH TEST

## 7.1 APPLIED PROCEDURES / LIMIT

| FCC Part 15.247,Subpart C<br>RSS-247 Issue 2 | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) | Result |
| 15.247(a)(2)<br>RSS-247 Issue 2 | 6dB Bandwidth | >= 500KHz | 2400-2483.5 | PASS |
| RSS-Gen Clause 6.7 | 99% Bandwidth | For reporting purposes only. | 2400-2483.5 | PASS |

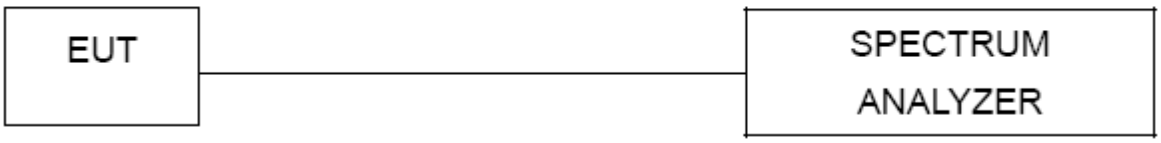
## 7.2 TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

| | |
|---|---|
| Center Frequency | The centre frequency of the channel under test |
| Detector | Peak |
| RBW | For 6 dB Bandwidth :100K<br>For 99% Bandwidth :1% to 5% of the occupied bandwidth |
| VBW | For 6dB Bandwidth : ≥3 × RBW<br>For 99% Bandwidth : approximately 3×RBW |
| Trace | Max hold |
| Sweep | Auto |

Allow the trace to stabilize and 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 and 99% relative to the maximum level measured in the fundamental emission.

## 7.3 TEST SETUP




## 7.4 EUT OPERATION CONDITIONS

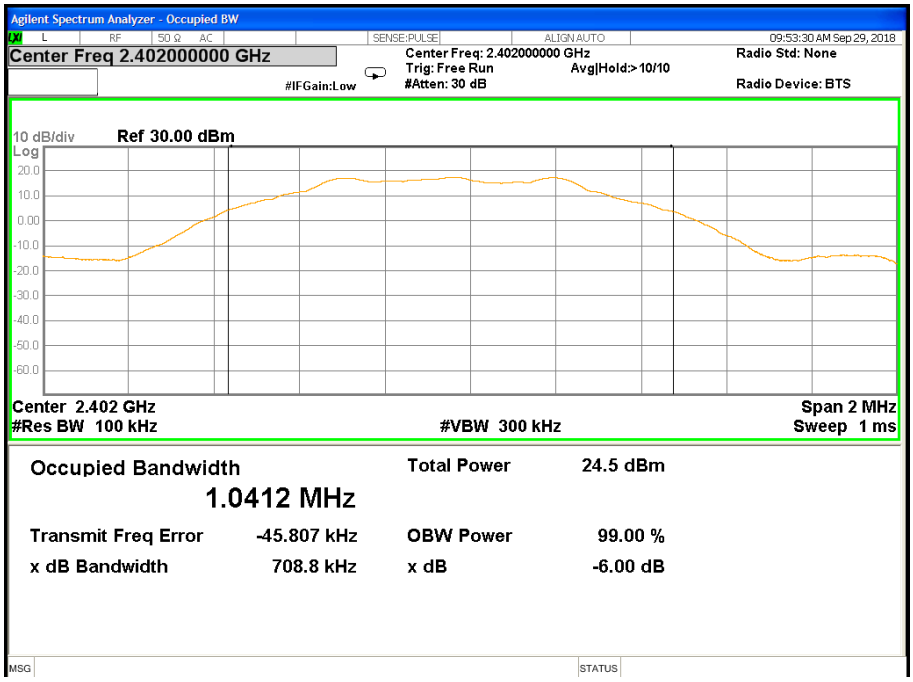
The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

7.5 TEST RESULTS

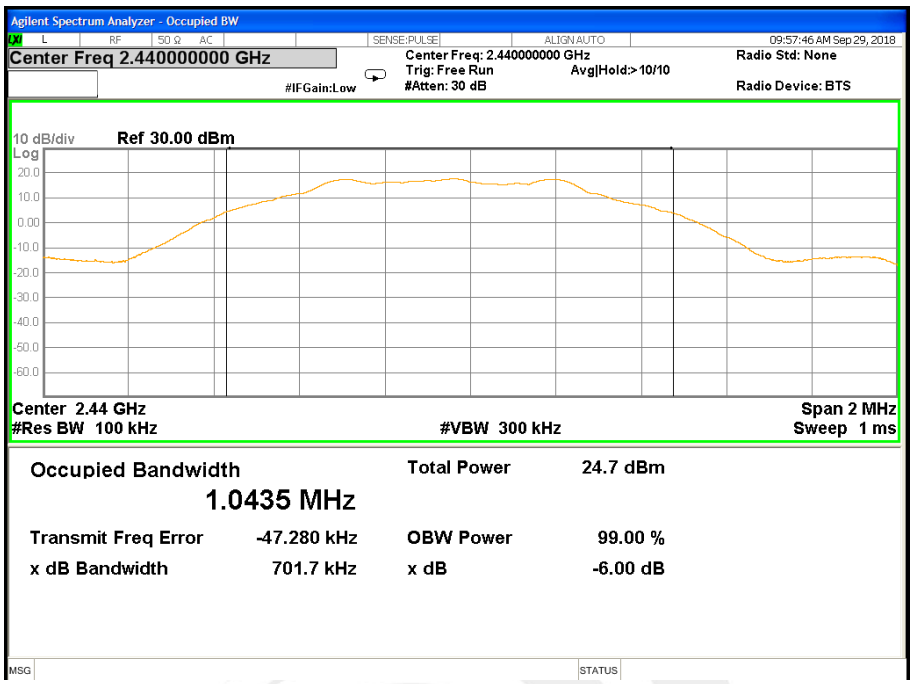
| Temperature: | 25 ℃ | Relative Humidity: | 60% |
|---|---|---|---|
| Test Voltage: | DC 12V | Test Mode: | TX Mode /CH37, CH17, CH39 |

| Frequency | 6dB Bandwidth (MHz) | 99% Bandwidth (MHz) | Channel Separation (MHz) | Result |
|---|---|---|---|---|
| 2402 MHz | 0.709 | 1.031 | >=500KHz | PASS |
| 2440 MHz | 0.702 | 1.031 | >=500KHz | PASS |
| 2480 MHz | 0.699 | 1.033 | >=500KHz | PASS |

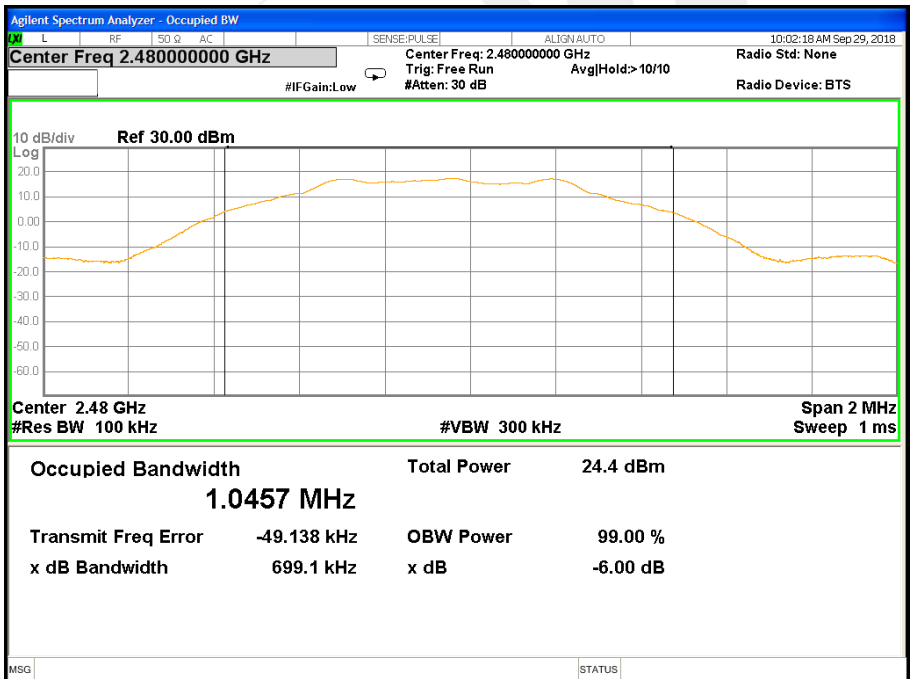
**6dB Bandwidth TX CH 37**



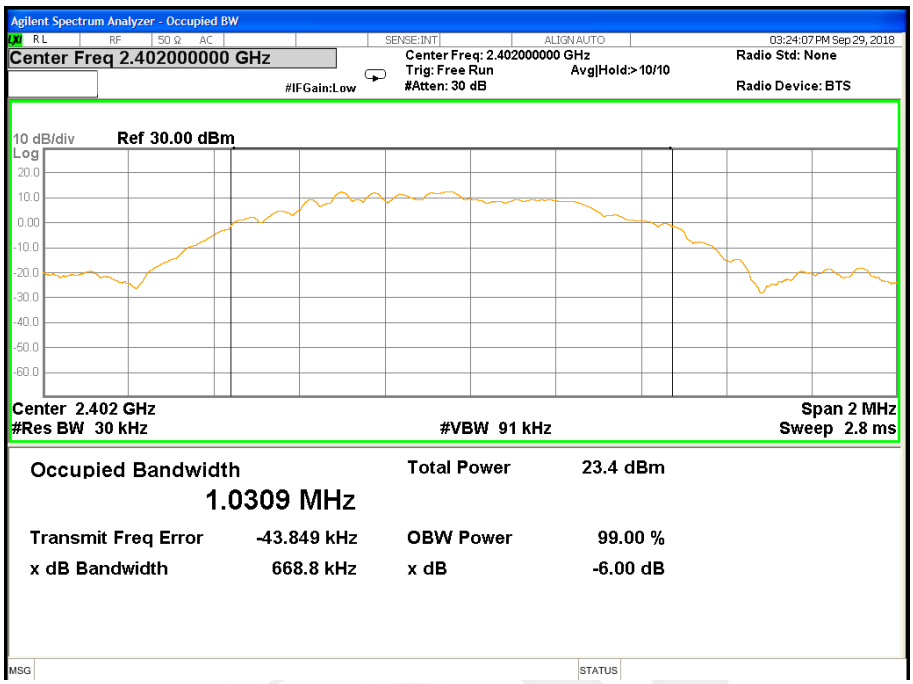
## 6dB Bandwidth TX CH 17



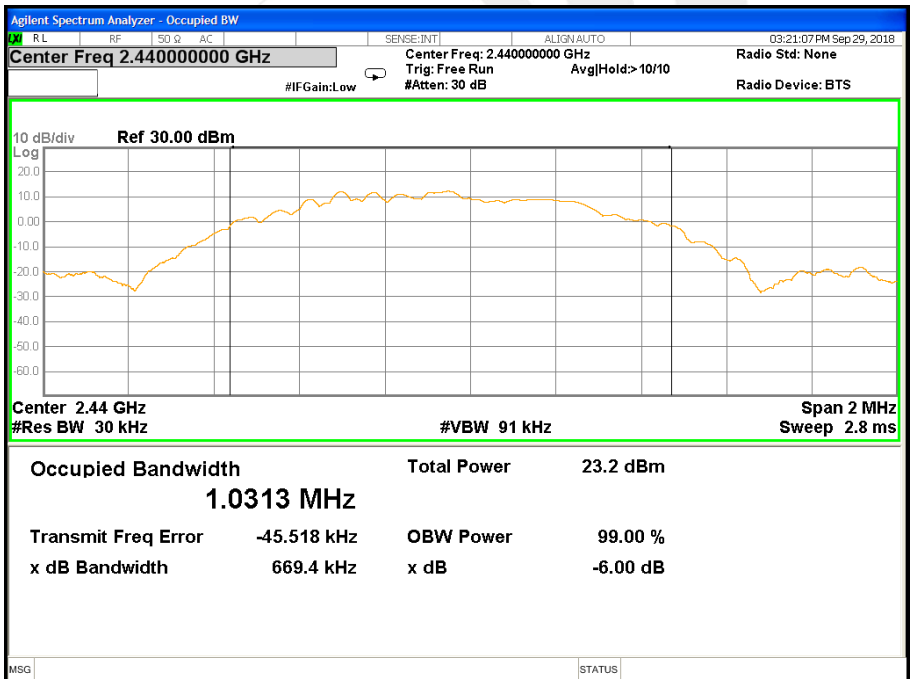

## 6dB Bandwidth TX CH 39



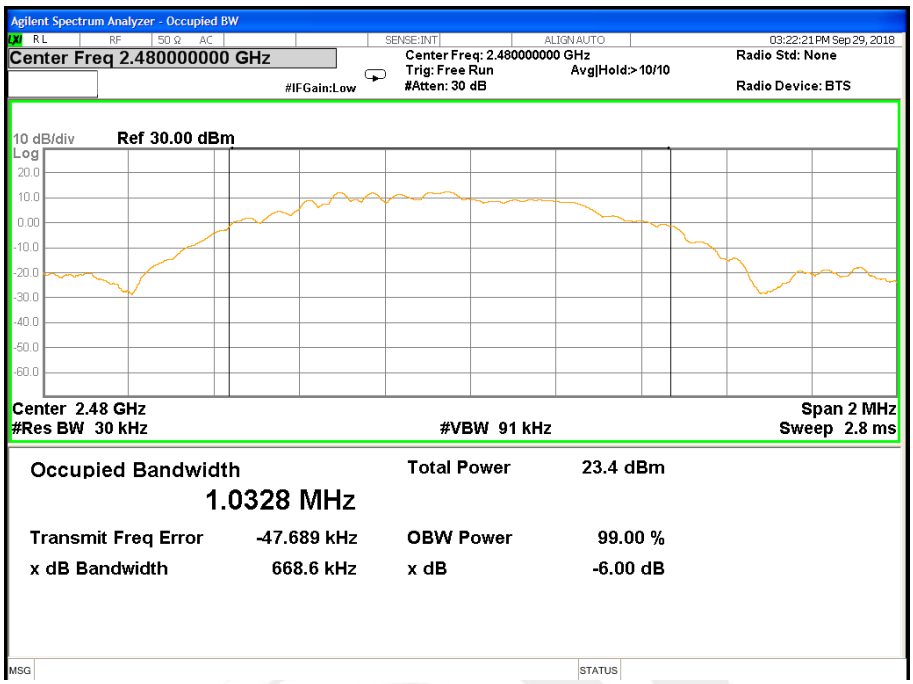
## 99% Bandwidth TX CH 37




## 99% Bandwidth TX CH 17



## 99% Bandwidth TX CH 39



# 8. PEAK OUTPUT POWER TEST

## 8.1 APPLIED PROCEDURES / LIMIT

| FCC Part 15.247,Subpart C<br>RSS-247 Issue 2 | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) | Result |
| 15.247(b)(3)<br>RSS 247 Issue 2 | Output Power | 1 watt or 30dBm | 2400-2483.5 | PASS |

## 8.2 TEST PROCEDURE

a. The EUT was directly connected to the Power Meter

## 8.3 TEST SETUP

## 8.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

8.5 TEST RESULTS

| | | | |
|---|---|---|---|
| Temperature: | 25 ℃ | Relative Humidity: | 60% |
| Test Voltage: | DC 12V | Test Mode: | TX Mode /CH37, CH17, CH39 |

| TX Mode | | | | |
|---|---|---|---|---|
| Test Channel | Frequency | Conducted Output Power | | LIMIT |
| | (MHz) | Peak (dBm) | AVG (dBm) | dBm |
| CH37 | 2402 | 20.36 | 18.48 | 30 |
| CH17 | 2440 | 19.92 | 18.03 | 30 |
| CH39 | 2480 | 20.15 | 18.06 | 30 |

# 9. ANTENNA REQUIREMENT

## 9.1 STANDARD REQUIREMENT

15.203 and RSS-Genlssue 5 requirement: For intentional device, according to 15.203 and RSS-Genlssue 5: 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.

## 9.2 EUT ANTENNA

The EUT antenna is Integral Antenna. It comply with the standard requirement.

# 10.FREQUENCY STABILITY

## 10.1 LIMITS

The frequency tolerance of the carrier signal shall be maintained within +/-0.02% of the operating frequency over a temperature variation of -30 degrees to 50 degrees C at normal supply voltage,and for a variation in primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees.

## 10.2 TEST PROCEDURE

1.The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
2.Turn the EUT on and couple its output to spectrum analyzer.
3.Turn the EUT off and set the chamber to the highest temperature specified.
4.Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize,turn the EUT on and measure the operating frequency after 2,5,and 10 minutes.
5.Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
6.The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes.The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

## 10.3 TEST RESULT

Channel 17 (2440MHz): Test at Modulation mode

Voltage vs. Frequency Stability

| Voltage vs. Frequency Stability Voltage(V) | Measurement Frequency(MHz) |
|---|---|
| 13.8 | 2439.9919 |
| 12 | 2439.9909 |
| 10.2 | 2439.9911 |
| Max.Deviation(MHz) | -0.0081 |
| Max.Deviation(ppm) | -3.32 |

Rated working voltage:DC 12V

Temperature vs. Frequency Stability

| Temperature(℃) | Measurement Frequency(MHz) |
|---|---|
| -30 | 2439.9917 |
| -20 | 2439.9916 |
| -10 | 2439.9907 |
| 0 | 2439.9911 |
| 10 | 2439.9916 |
| 20 | 2439.9912 |
| 30 | 2439.9917 |
| 40 | 2439.9913 |
| 50 | 2439.9917 |
| Max.Deviation(MHz) | -0.0083 |
| Max.Deviation(ppm) | -3.40 |

## 11. EUT TEST PHOTO

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

※※※※※END OF THE REPORT※※※※※