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Report No.: GZEM170100015801  
Page: 1 of 54  
FCC ID: 2AKR8BTIN00

## **TEST REPORT**

The following sample(s) was/were submitted and identified on behalf of the client as:

|                             |                                                   |
|-----------------------------|---------------------------------------------------|
| <b>Application No.:</b>     | GZEM1701000158CR                                  |
| <b>Applicant:</b>           | Insigma Inc                                       |
| <b>Manufacturer:</b>        | Insigma Inc                                       |
| <b>Factory:</b>             | Insigma Inc                                       |
| <b>FCC ID:</b>              | 2AKR8BTIN00                                       |
| <b>Product Description:</b> | nRF52 Base BLE module                             |
| <b>Model No.:</b>           | BTIN0011                                          |
| <b>Trade Mark:</b>          | Insigma Inc                                       |
| <b>Standards:</b>           | CFR 47 FCC PART 15 Subpart C: 2016 section 15.247 |
| <b>Date of Receipt:</b>     | 2017-01-05                                        |
| <b>Date of Test:</b>        | 2017-01-11 to 2017-01-14                          |
| <b>Date of Issue:</b>       | 2017-02-22                                        |
| <b>Test Result :</b>        | <b>Pass*</b>                                      |

\* In the configuration tested, the EUT detailed in this report complied with the standards specified above.



The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards.

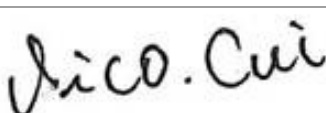
The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government. All test results in this report can be traceable to National or International Standards.

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## 2 Version

| Revision Record |         |            |          |                 |
|-----------------|---------|------------|----------|-----------------|
| Version         | Chapter | Date       | Modifier | Remark          |
| 00              |         | 2017-02-22 |          | Original Report |
|                 |         |            |          |                 |
|                 |         |            |          |                 |
|                 |         |            |          |                 |
|                 |         |            |          |                 |

|                          |                                                                                                                     |                                  |  |
|--------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------|--|
| Authorized for issue by: |                                                                                                                     |                                  |  |
| Tested By                | <br>(Vico Cui) /Project Engineer | 2017-01-11 to 2017-01-14<br>Date |  |
| Checked By               | <br>(Ricky Liu) / Reviewer       | 2017-01-22<br>Date               |  |



### 3 Test Summary

| Test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Test Requirement                                          | Test method                                               | Result |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|--------|
| Antenna Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | FCC PART 15 C<br>section 15.247 (c) and<br>Section 15.203 | FCC PART 15 C<br>section 15.247 (c) and<br>Section 15.203 | PASS   |
| 6 dB Bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | FCC PART 15 C<br>section 15.247 (a)(2)                    | ANSI C63.10: Clause<br>11.8                               | PASS   |
| Maximum Peak Output Power                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | FCC PART 15 C<br>section 15.247(b)(3)                     | ANSI C63.10: Clause<br>11.9                               | PASS   |
| Peak Power Spectral Density                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | FCC PART 15 C<br>section 15.247(e)                        | ANSI C63.10: Clause<br>11.10                              | PASS   |
| Conducted Spurious Emission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | FCC PART 15 C<br>section 15.209<br>&15.247(d)             | ANSI C63.10: Clause<br>11.11                              | PASS   |
| Radiated Spurious Emission                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | FCC PART 15 C<br>section 15.209                           | ANSI C63.10: Clause<br>11.12,6.3,6.5 and 6.6              | PASS   |
| Radiated Emissions which fall<br>in the restricted bands                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | FCC PART 15 C<br>section 15.209<br>&15.247(d)             | ANSI C63.10: Clause<br>11.12,6.3,6.5 and 6.6              | PASS   |
| Band Edges Measurement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | FCC PART 15 C<br>section 15.247 (d)<br>&15.205            | ANSI C63.10: Clause<br>11.13                              | PASS   |
| Conducted Emissions at Mains<br>Terminals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | FCC PART 15 C<br>section 15.207                           | ANSI C63.10: Clause 6.2                                   | PASS   |
| <b>Remark1:</b><br>N/A: not applicable. Refer to the relative section for the details.<br>EUT: In this whole report EUT means Equipment Under Test.<br>Tx: In this whole report Tx (or tx) means Transmitter.<br>Rx: In this whole report Rx (or rx) means Receiver.<br>RF: In this whole report RF means Radio Frequency.<br>ANSI C63.10: the detail version is ANSI C63.10:2013 in the whole report.<br>Conducted testing use a direct connection between the antenna port of the device and the spectrum analyzer, may through suitable attenuator, all the attenuation in the conducted RF path, include cable loss or external attenuation will be offset to the spectrum analyzer during testing. Detailed offset value, please refer to the corresponding test plot. |                                                           |                                                           |        |



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## **5 General Information**

### **5.1 Client Information**

|                          |                                                        |
|--------------------------|--------------------------------------------------------|
| Applicant:               | Insigma Inc                                            |
| Address of Applicant:    | 43490 Yukon Drive Suite #102 Ashburn, VA 20147, USA.   |
| Manufacturer:            | Insigma Inc                                            |
| Address of Manufacturer: | 43490 Yukon Drive, Suite #102, Ashburn, VA 20147, USA. |
| Factory:                 | Insigma Inc                                            |
| Address of Factory:      | 43490 Yukon Drive, Suite #102, Ashburn, VA 20147, USA. |

### **5.2 General Description of E.U.T.**

|                      |                       |
|----------------------|-----------------------|
| Product Description: | nRF52 Base BLE module |
| Model No.:           | BTIN0011              |

### **5.3 Details of E.U.T.**

|                     |                                                                                       |
|---------------------|---------------------------------------------------------------------------------------|
| Operating Frequency | 2402 MHz to 2480 MHz                                                                  |
| Type of Modulation: | GFSK<br>DSSS with Adaptive                                                            |
| Equipment types:    | (Only one adaptive mode is implemented and could not operate in a non-adaptive mode.) |
| Number of Channels  | 40 Channels                                                                           |
| Channel Separation: | 2 MHz                                                                                 |
| Duty Cycle:         | Continuous operation possible for testing purposes                                    |
| Antenna Type        | PCB antenna                                                                           |
| Antenna gain:       | 0 dBi                                                                                 |
| Speciality:         | Bluetooth 4.0 Smart (BLE mode)                                                        |
| Power Supply:       | DC 3V                                                                                 |
| Test software       | putty_V0.63.0.0.43510830                                                              |

## 5.4 Description of Support Units

The EUT has been tested with associated equipment as below:

| Description | Manufacturer | Model No. | SN/Certificate NO  |
|-------------|--------------|-----------|--------------------|
| Laptop      | Lenovo       | T430u     | REF.<br>No.SEA1800 |
| DC Power    | ZHAOXIN      | RXN-305D  | REF.<br>No.SEA2700 |

Using the special software and development board we can enter the product for engineer mode then we can control the EUT to select the wanted channel for test. The test board and PC are only to configure the engineer mode and not used to final test.

## 5.5 Deviation from Standards

Biconical and log periodic antennas were used instead of dipole antennas.

## 5.6 Abnormalities from Standard Conditions

None.

## 5.7 Other Information Requested by the Customer

None.

## 5.8 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd., Guangzhou Branch EMC Laboratory,  
198 Kezhu Road, Sciencetech Park, Guangzhou Economic & Technology Development District,  
Guangzhou, China 510663  
Tel: +86 20 82155555 Fax: +86 20 82075059

No tests were sub-contracted.

## 5.9 Measurement Uncertainty

| No. | Item               | Measurement uncertainty |
|-----|--------------------|-------------------------|
| 1   | Conducted emission | 1.02dB(9kHz to 150kHz)  |
|     |                    | 1.05dB(150kHz to 30MHz) |
| 2   | Radiated emission  | 5.06dB(30MHz to 1GHz)   |
|     |                    | 5.06dB(1GHz to 26GHz)   |

## 5.10 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **NVLAP (Lab Code: 200611-0)**

SGS-CSTC Standards Technical Services Co., Ltd., Guangzhou EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 200611-0.

The 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.

- **ACMA**

SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory can also perform testing for the Australian C-Tick mark as a result of our NVLAP accreditation.

- **SGS UK(Certificate No.: 32), SGS-TUV SAARLAND and SGS-FIMKO**

Have approved SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory as a supplier of EMC TESTING SERVICES and SAFETY TESTING SERVICES.

- **CNAS (Lab Code: L0167)**

SGS-CSTC Standards Technical Services Co., Ltd., EMC Laboratory has been assessed and in compliance with CNAS-CL01:2006 accreditation criteria for testing laboratories (identical to ISO/IEC 17025:2005 General Requirements) for the Competence of Testing Laboratories.

- **FCC (Registration No.: 282399)**

SGS-CSTC Standards Technical Services 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 282399, May 31, 2002.

- **Industry Canada (Registration No.: 4620B-1)**

The 3m/10m Alternate Semi-anechoic chamber of SGS-CSTC Standards Technical Services Co., Ltd., has been registered by Certification and Engineering of Industry Canada for radio equipment testing with Registration No. 4620B-1.

- **VCCI (Registration No.: R-2460, C-2584, G-449 and T-1179)**

The 10m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services Co. Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-2460, C-2584, G-449 and T-1179 respectively.

- **CBTL (Lab Code: TL129)**

SGS-CSTC Standards Technical Services Co., Ltd., E&E Laboratory has been assessed and fully comply with the requirements of ISO/IEC 17025:2005, the Basic Rules, IECEE 01 and Rules of procedure IECEE 02, and the relevant IECEE CB-Scheme Operational documents.



## 6 Equipment List

| RE in Chamber |                                            |                                   |             |            |              |              |
|---------------|--------------------------------------------|-----------------------------------|-------------|------------|--------------|--------------|
| No.           | Test Equipment                             | Manufacturer                      | Model No.   | Serial No. | Cal. date    | Cal.Due date |
|               |                                            |                                   |             |            | (YYYY-MM-DD) | (YYYY-MM-DD) |
| EMC0525       | Compact Semi-Anechoic Chamber              | ChangZhou ZhongYu                 | N/A         | N/A        | 2016-12-04   | 2019-12-03   |
| EMC0522       | EMI Test Receiver                          | Rohde & Schwarz                   | ESIB26      | 100283     | 2016-02-01   | 2017-01-31   |
| EMC0056       | EMI Test Receiver                          | Rohde & Schwarz                   | ESCI        | 100236     | 2016-02-01   | 2017-01-31   |
| EMC0528       | RI High frequency Cable                    | SGS                               | 20 m        | N/A        | 2016-04-19   | 2018-04-18   |
| EMC2025       | Trilog Broadband Antenna 30-1000MHz        | SCHWARZBECK MESS-ELEKTRONIK       | VULB 9160   | 9160-3372  | 2016-09-08   | 2019-09-07   |
| SEM003-18     | Trilog Broadband Antenna 25-2000MHz        | SCHWARZBECK MESS-ELEKTRONIK       | VULB 9168   | 665        | 2016-06-29   | 2019-06-28   |
| EMC0524       | Bi-log Type Antenna                        | Schaffner -Chase                  | CBL6112B    | 2966       | 2016-09-08   | 2019-09-07   |
| EMC0519       | Bilog Type Antenna                         | Schaffner -Chase                  | CBL6143     | 5070       | 2014-05-04   | 2017-05-03   |
| EMC2026       | Horn Antenna 1-18GHz                       | SCHWARZBECK MESS-ELEKTRONIK       | BBHA 9120D  | 9120D-841  | 2016-09-09   | 2019-09-08   |
| EMC0521       | 1-26.5 GHz Pre-Amplifier                   | Agilent                           | 8449B       | 3008A01649 | 2016-01-25   | 2017-01-24   |
| EMC2065       | Amplifier                                  | HP                                | 8447F       | N/A        | 2016-07-04   | 2017-07-03   |
| EMC2086       | PRE AMPLIFIER MH648A                       | ANRITSU CORP                      | MH648A      | N/A        | 2016-12-02   | 2017-12-01   |
| EMC2063       | Pre-amplifier 1GHz-26GHz                   | Compliance Direction Systems Lnc. | PAP-1G26-48 | 6279.628   | 2016-12-02   | 2017-12-01   |
| EMC0523       | Active Loop Antenna                        | EMCO                              | 6502        | 42963      | 2016-02-27   | 2018-02-26   |
| EMC2041       | Broad-Band Horn Antenna (14)15-26.5(40)GHz | SCHWARZBECK MESS-ELEKTRONIK       | BBHA 9170   | 9170-375   | 2014-05-26   | 2017-05-25   |
| EMC2079       | High Pass Filter(915MHz)                   | FSY MICROWAVE                     | HM1465-9SS  | 009        | 2016-01-25   | 2017-01-24   |
| EMC2069       | 2.4GHz Filter                              | Micro-Tronics                     | BRM 50702   | 149        | 2016-01-25   | 2017-01-24   |
| EMC0530       | 10m Semi-Anechoic Chamber                  | ETS                               | N/A         | N/A        | 2016-04-30   | 2018-04-29   |



**SGS-CSTC Standards Technical Services Co., Ltd.**  
**Guangzhou Branch**

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| General used equipment |                |              |           |            |              |              |
|------------------------|----------------|--------------|-----------|------------|--------------|--------------|
| No.                    | Test Equipment | Manufacturer | Model No. | Serial No. | Cal. date    | Cal.Due date |
|                        |                |              |           |            | (YYYY-MM-DD) | (YYYY-MM-DD) |
| EMC0006                | DMM            | Fluke        | 73        | 70681569   | 2016-09-01   | 2017-08-31   |
| EMC0007                | DMM            | Fluke        | 73        | 70671122   | 2016-08-22   | 2017-08-21   |



## 7 Test Results

### 7.1 E.U.T. test conditions

**Test Voltage:** DC 3.0V  
**Temperature:** 20.0 -25.0 °C  
**Humidity:** 38-50 % RH  
**Atmospheric Pressure:** 1000 -1010 mbar

**Requirements:** **15.31(e):** For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.  
**15.32:** Power supplies and CPU boards used with personal computers and for which separate authorizations are required to be obtained shall be tested as follows: Testing shall be in accordance with the procedures specified in Section 15.31 of this part.

**Test frequencies and frequency range:** According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

According to the 15.33 (a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in the following table:



**Number of fundamental frequencies to be tested in EUT transmit band**

| Frequency range in which device operates | Number of frequencies | Location in frequency range of operation    |
|------------------------------------------|-----------------------|---------------------------------------------|
| 1 MHz or less                            | 1                     | Middle                                      |
| 1 MHz to 10 MHz                          | 2                     | 1 near top and 1 near bottom                |
| More than 10 MHz                         | 3                     | 1 near top, 1 near middle and 1 near bottom |

**Frequency range of radiated emission measurements**

| Lowest frequency generated in the device | Upper frequency range of measurement                                                                        |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 9 kHz to below 10 GHz                    | 10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower                             |
| At or above 10 GHz to below 30 GHz       | 5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower                             |
| At or above 30 GHz                       | 5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified |

EUT channels and frequencies list:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0       | 2402            | 27      | 2456            |
| 1       | 2404            | 28      | 2458            |
| 2       | 2406            | 29      | 2460            |
| 3       | 2408            | 30      | 2462            |
| 4       | 2410            | 31      | 2464            |
| 5       | 2412            | 32      | 2466            |
| 6       | 2414            | 33      | 2468            |
| 7       | 2416            | 34      | 2470            |
| 8       | 2418            | 35      | 2472            |
| 9       | 2420            | 36      | 2474            |
| 10      | 2422            | 37      | 2476            |
| 11      | 2424            | 38      | 2478            |
| 12      | 2426            | 39      | 2480            |
| 13      | 2428            | 40      | /               |
| 14      | 2430            | 41      | /               |
| 15      | 2432            | 42      | /               |
| 16      | 2434            | 43      | /               |
| 17      | 2436            | 44      | /               |
| 18      | 2438            | 45      | /               |
| 19      | 2440            | 46      | /               |
| 20      | 2442            | 47      | /               |
| 21      | 2444            | 48      | /               |
| 22      | 2446            | 49      | /               |
| 23      | 2448            | 50      | /               |
| 24      | 2450            | 51      | /               |
| 25      | 2452            | 52      | /               |
| 26      | 2454            | 53      | /               |

Using the special software and development board we can enter the product for engineer mode then we can control the EUT to select the wanted channel for test as above list.

Test frequencies are the lowest channel: 0 channel(2402MHz), middle channel: 19 channel(2440 MHz) and highest channel: 39 channel(2480 MHz)

## 7.2 Antenna Requirement

### Standard requirement

15.203 requirement:

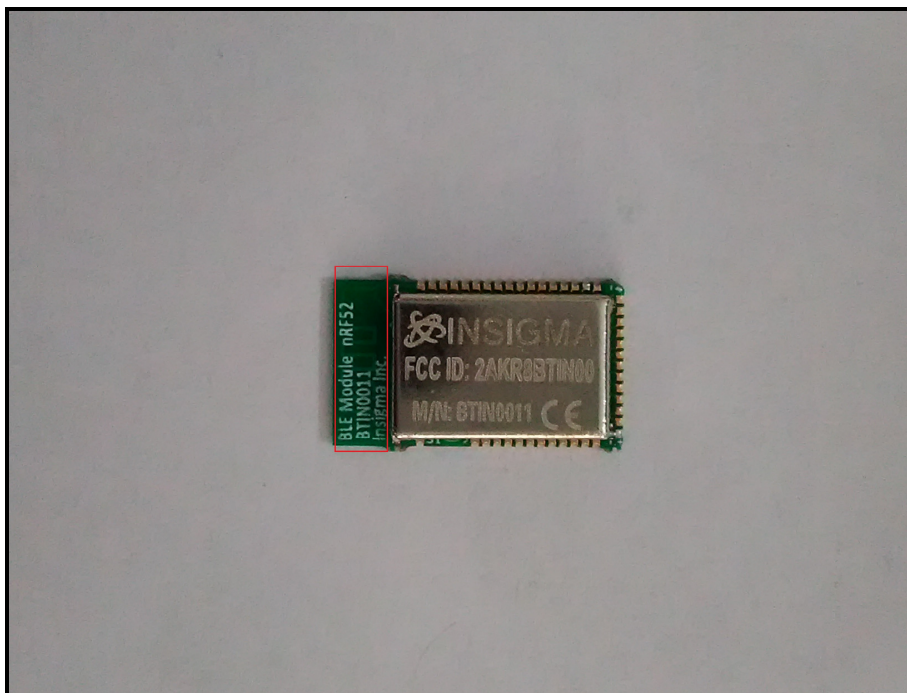
For intentional device. According to 15.203, an intentional radiator shall be designed to Ensure that no antenna other than that furnished by the responsible party shall be used with the device.

15.247(c) (1)(i) requirement:

(i) Systems operating in the 2400-2483.5 MHz bands that are used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

### EUT Antenna

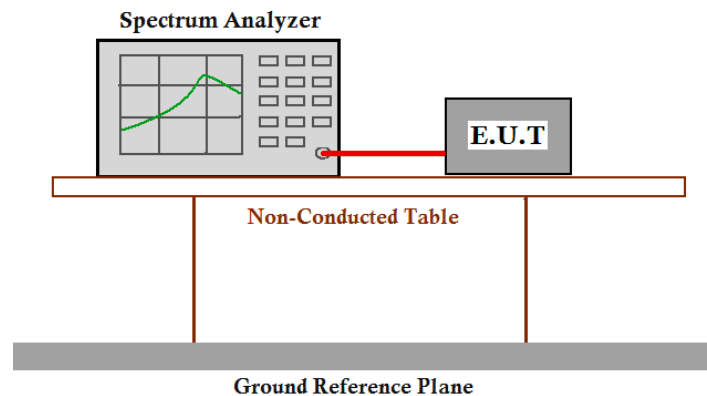
The antenna is PCB Layout antenna and no consideration of replacement. The best case gain of the antenna is 0dBi.



**Test result: The unit does meet the FCC requirements.**

### 7.3 6 dB Bandwidth

|                     |                                                                                                                                                                                                                       |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Requirement:   | FCC Part 15 C section 15.247<br><br>(a)(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz. |
| Test Method:        | ANSI C63.10: Clause 11.8                                                                                                                                                                                              |
| Test Status:        | Enter test mode for the product. Test in Channel lowest (2402MHz), middle (2442MHz) and highest (2480MHz), keep in continuously transmitting status.                                                                  |
| Test Configuration: |                                                                                                                                                                                                                       |



#### Test Procedure:

1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW=100 kHz. VBW = 300 kHz. Sweep = auto; Detector Function = Peak. Trace = Max Hold, Set span to encompass the entire emission bandwidth of the signal.
3. Mark the peak power frequency and -6dB (upper and lower) power frequency.
4. Repeat until all the test status is investigated.
5. Report the worse case.

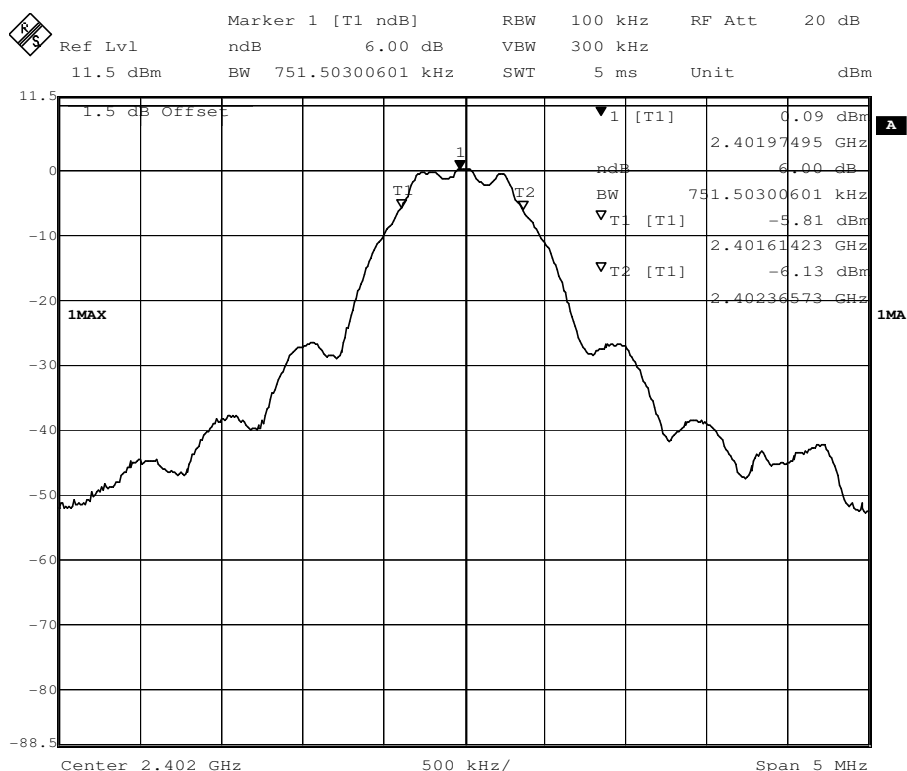


|    |      |      |           |         |      |
|----|------|------|-----------|---------|------|
| 0  | 2402 | GFSK | 751.5KHz  | ≥500KHz | Pass |
| 19 | 2440 |      | 711.4 KHz |         | Pass |
| 39 | 2480 |      | 731.4 KHz |         | Pass |

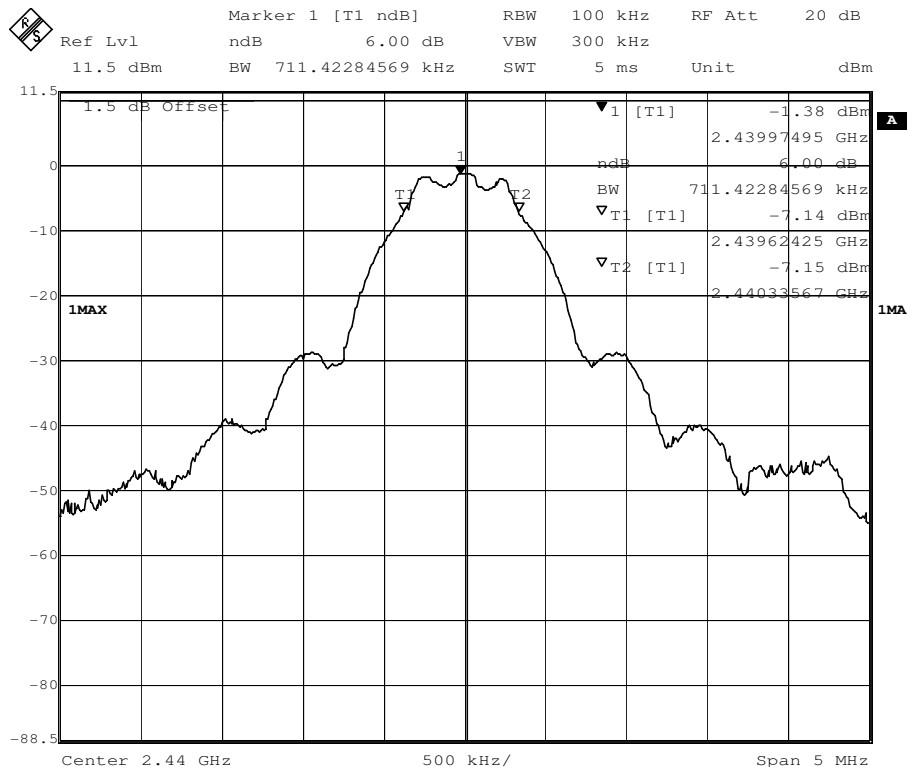
Test result: The unit does meet the FCC requirements.

Result plot as follows:

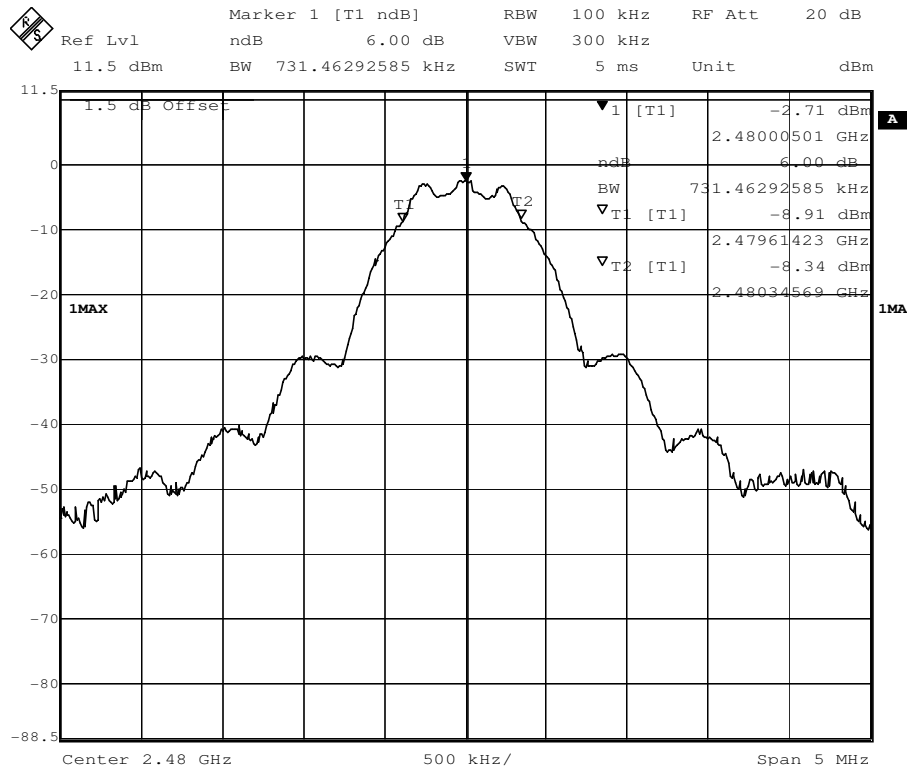
Channel 0:2.402GHz:



Channel 19:2.440GHz:

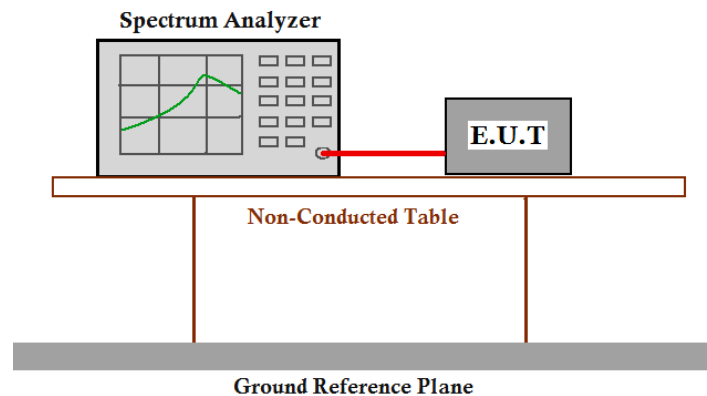


Channel 39:2.480GHz:



## 7.4 Maximum Peak Output Power

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Requirement:   | FCC Part 15 C section 15.247<br>(b)(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.<br>Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b) (1), (b) (2), and (b) (3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi. |
| Test Method:        | ANSI C63.10: Clause 11.9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Test Status:        | Enter test mode for the product. Test in Channel lowest (2402MHz), middle (2442MHz) and highest (2480MHz), keep in continuously transmitting status.                                                                                                                                                                                                                                                                                                                                                                                        |
| Test Configuration: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |





Test Procedure:

1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable from the antenna port to the spectrum.
2. Set the RBW  $\geq$  DTS. bandwidth.
3. Set the VBW  $\geq 3 \times$  RBW
4. Set the span  $\geq 3 \times$  RBW
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. . Use peak marker function to determine the peak amplitude level.

Report the worse case.

Test result:

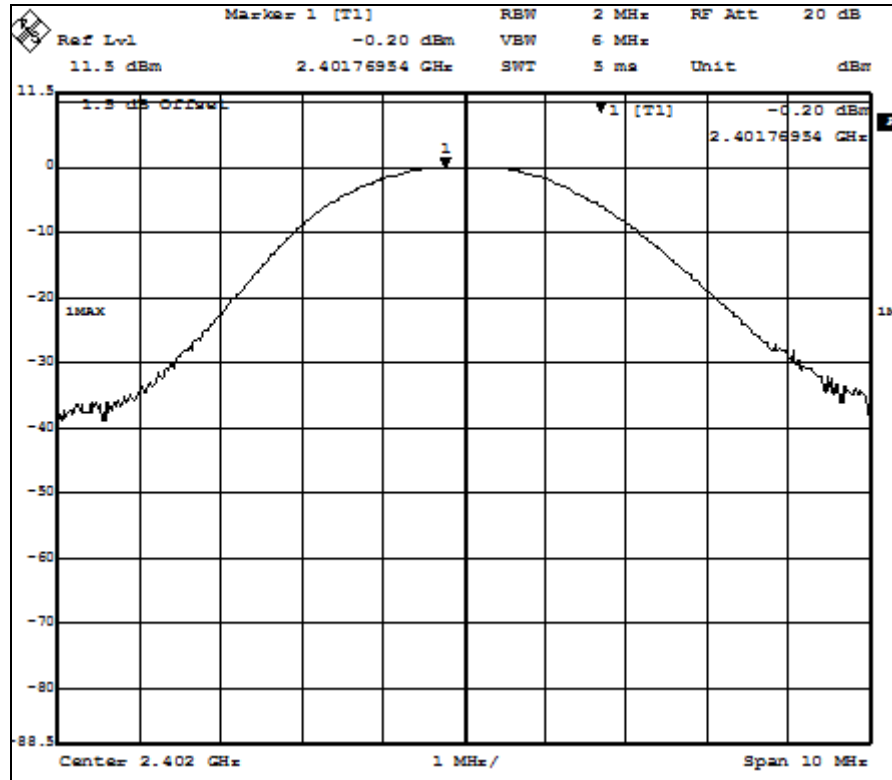
| Channel No. | Frequency<br>(MHz) | Mode | Data Rate | Measured Channel Power<br>(dBm) | Limit     | Result |
|-------------|--------------------|------|-----------|---------------------------------|-----------|--------|
| 0           | 2402               | GFSK | 1Mbps     | -0.20                           | 1W(30dBm) | Pass   |
| 19          | 2440               |      | 1Mbps     | -1.65                           |           | Pass   |
| 39          | 2480               |      | 1Mbps     | -2.88                           |           | Pass   |

Remark: Level = Read Level + Cable Loss

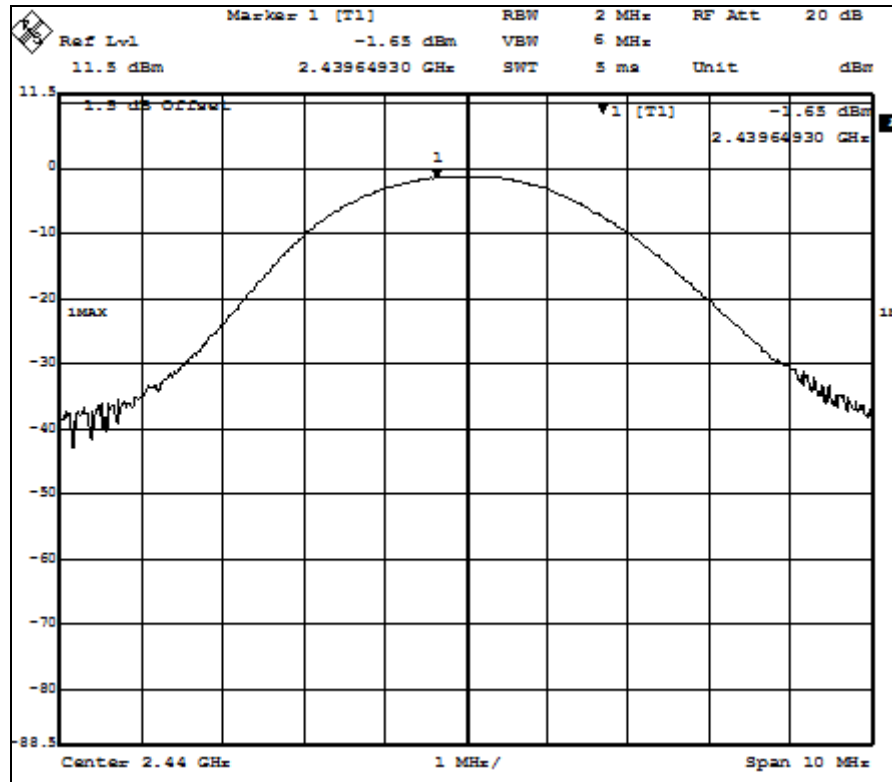
The unit does meet the FCC requirements.



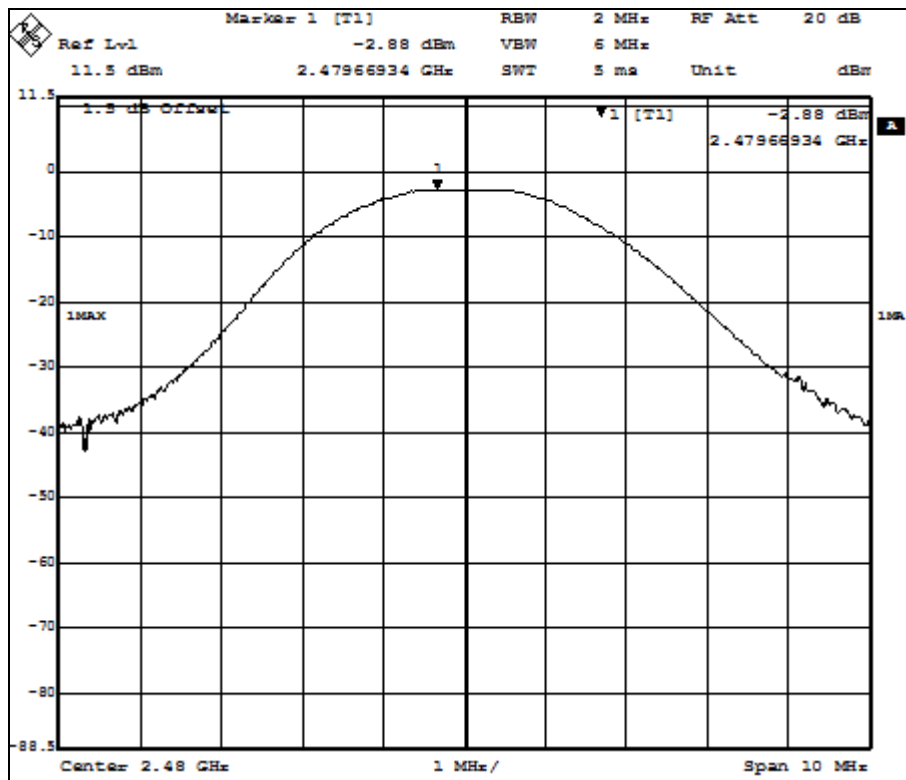
Result plot as follows:  
Channel 0:2.402GHz:



Channel 19:2.440GHz:

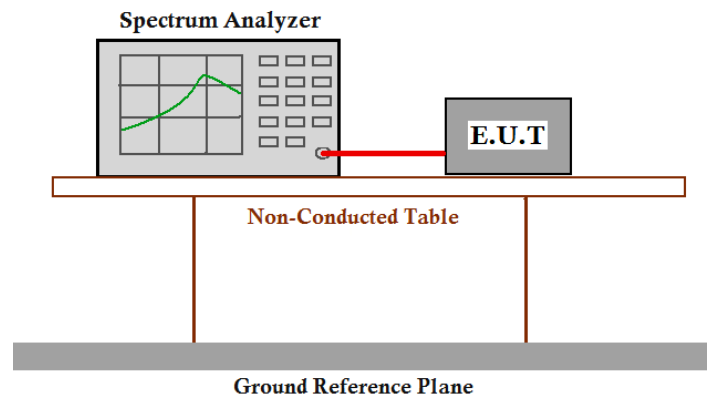


Channel 39:2.480GHz:



## 7.5 Peak Power Spectral Density

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Requirement:   | <p>FCC Part 15 C section 15.247</p> <p>(e) 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.</p> <p>This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.</p> |
| Test Method:        | ANSI C63.10: Clause 11.10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Test Status:        | Enter test mode for the product. Test in lowest Channel 2402MHz, middle Channel 2442MHz and highest Channel 2480MHz, keep in continuously transmitting status.                                                                                                                                                                                                                                                                                                                                                       |
| Test Configuration: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



### Test Procedure:

1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable from the antenna port to the spectrum analyzer or power meter.
2. Set the spectrum analyzer: RBW=3 kHz.
3. VBW  $\geq 3 \times$  RBW sweep= Auto couple; Set the span to 1.5 times the DTS bandwidth.
4. Detector Function = Peak. Trace = Max Hold, Centre = the Peak Power of the signal.
5. Measure the Power Spectral Density of the test frequency with special test status.
6. Repeat until all the test status is investigated.
7. Report the worse case.



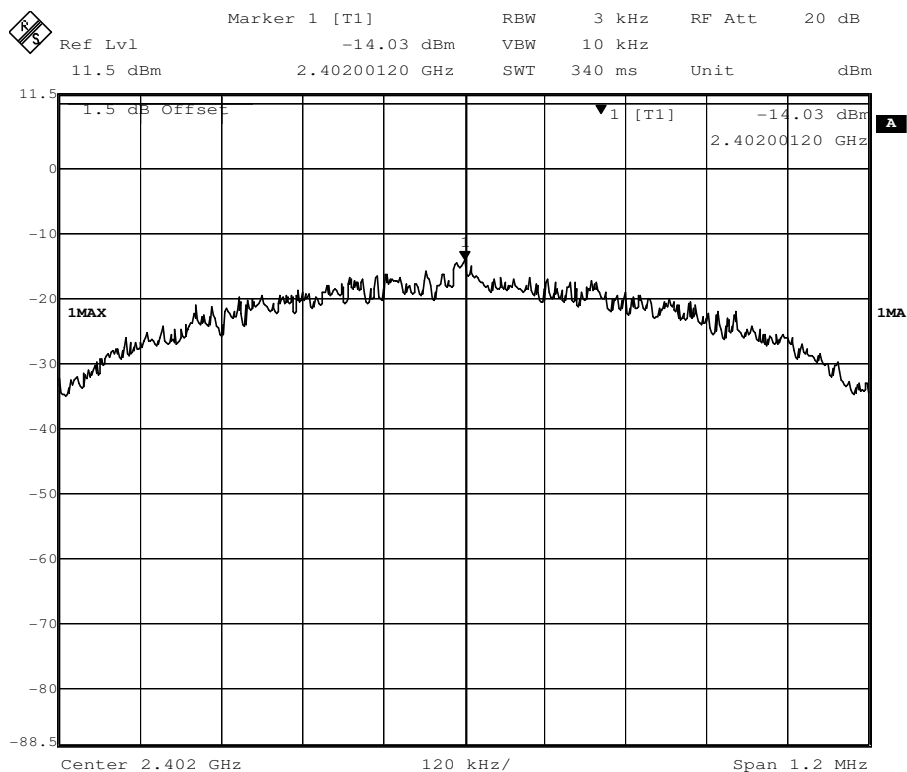
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| Channel No. | Frequency (MHz) | Mode | Data Rate | Measured Peak Power Spectral Density (dBm/3KHz) | Limit     | Result |
|-------------|-----------------|------|-----------|-------------------------------------------------|-----------|--------|
| 0           | 2402            | GFSK | 1 Mbps    | -14.03                                          | 8dBm/3KHz | Pass   |
| 19          | 2440            |      | 1 Mbps    | -15.09                                          |           | Pass   |
| 39          | 2480            |      | 1 Mbps    | -17.13                                          |           | Pass   |

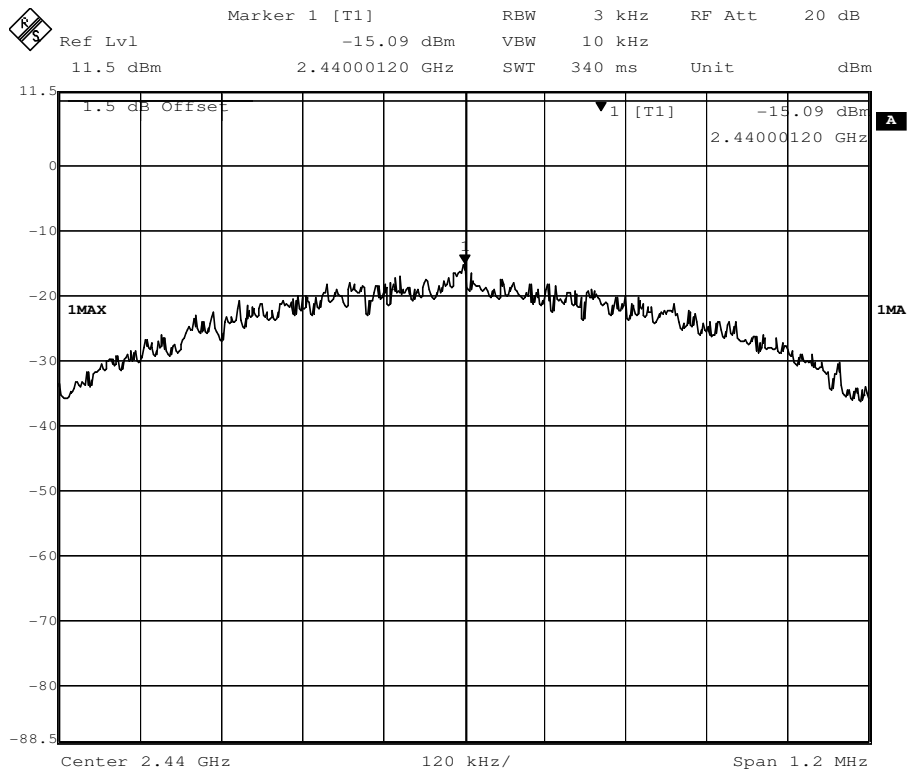
Test result: Level = Read Level + Cable Loss.  
The unit does meet the FCC requirements.

Result plot as follows:  
Channel 0:2.402 GHz:

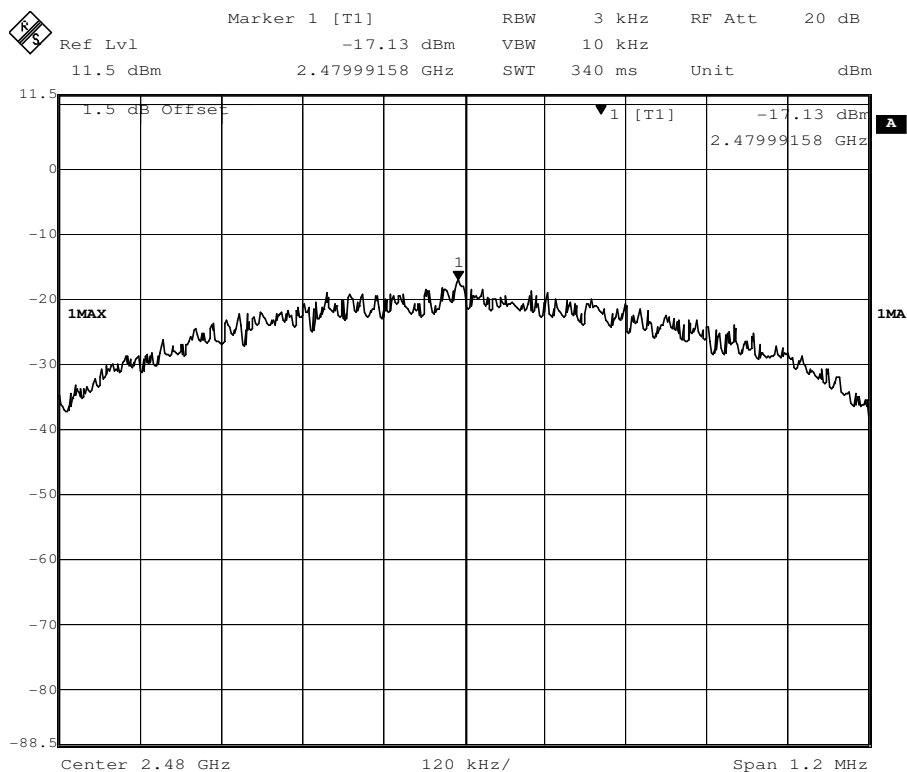




Channel 19:2.440 GHz:



Channel 39:2.480 GHz:



## 7.6 Conducted Spurious Emissions

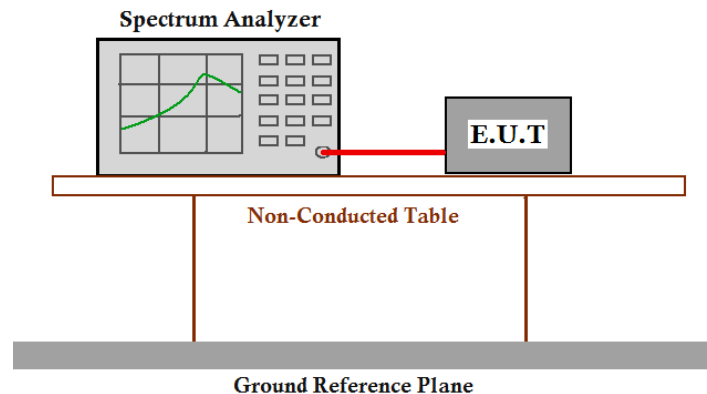
Test Requirement: FCC Part 15 C section 15.247

(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.

Test Method: ANSI C63.10: Clause 11.11

Test Status: Enter test mode for the product. Test in lowest Channel 2402MHz, middle Channel 2442MHz and highest Channel 2480MHz, keep in continuously transmitting status.

Test Configuration:



Test Procedure:

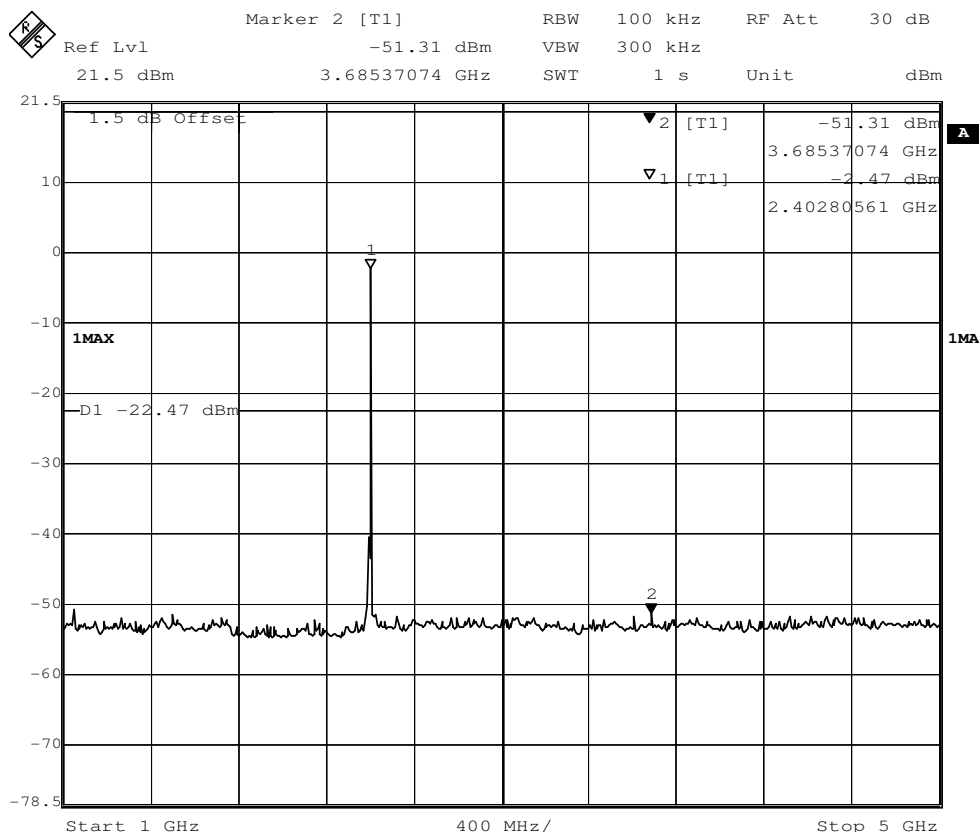
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer or power meter.
2. Set the spectrum analyzer: RBW=100 KHz, VBW = 300KHz. Sweep = auto; Detector Function = Peak. Trace = Max Hold, Scan up through 10th harmonic.
3. Measure the Conducted Spurious Emissions of the test frequency with special test status.
4. Repeat until all the test status is investigated.
5. Report the worse case.



Result plot as follows:

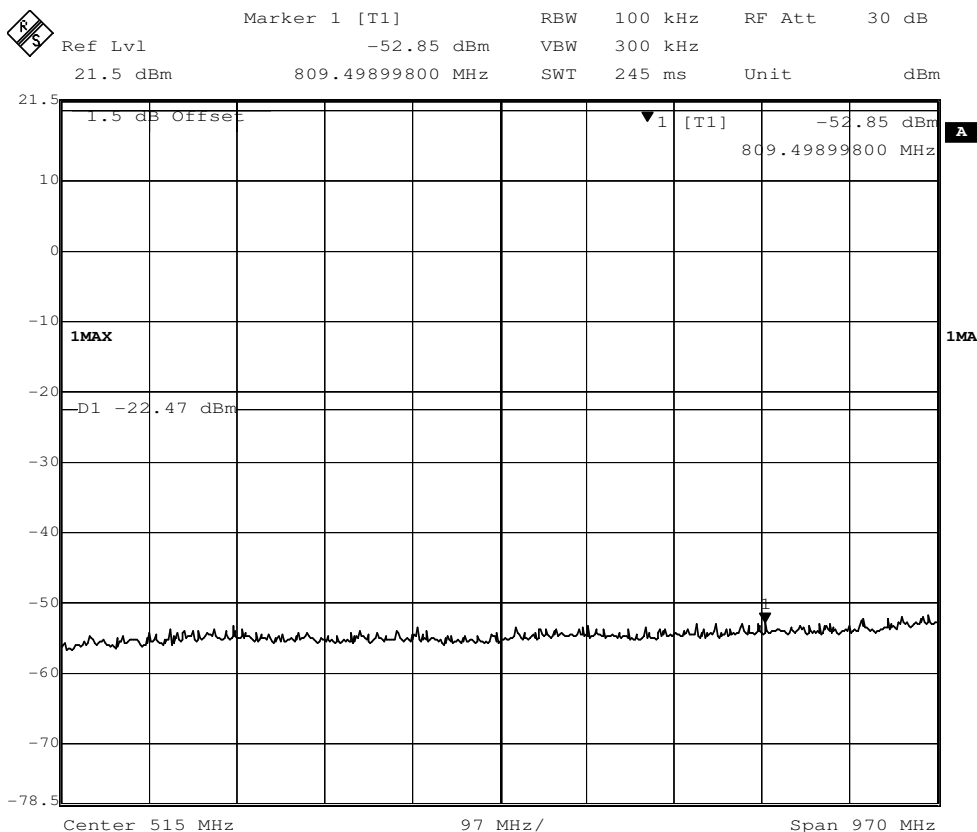
Channel 0: 2.402 GHz

1GHz to 5GHz



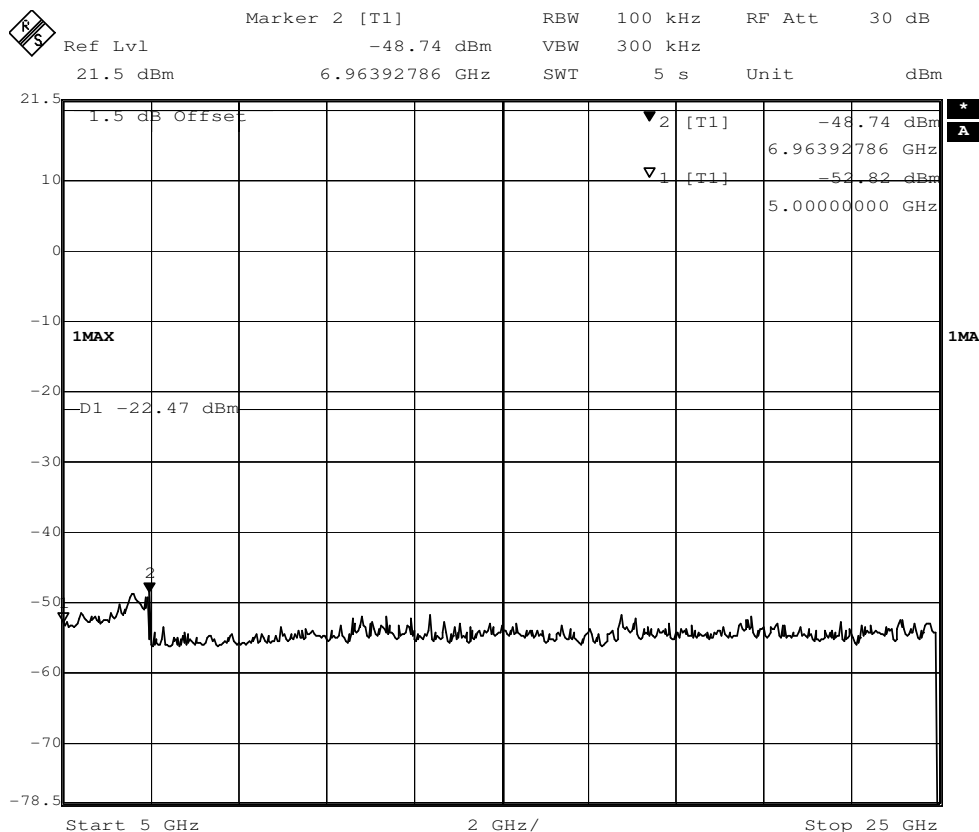


30 MHz to 1GHz





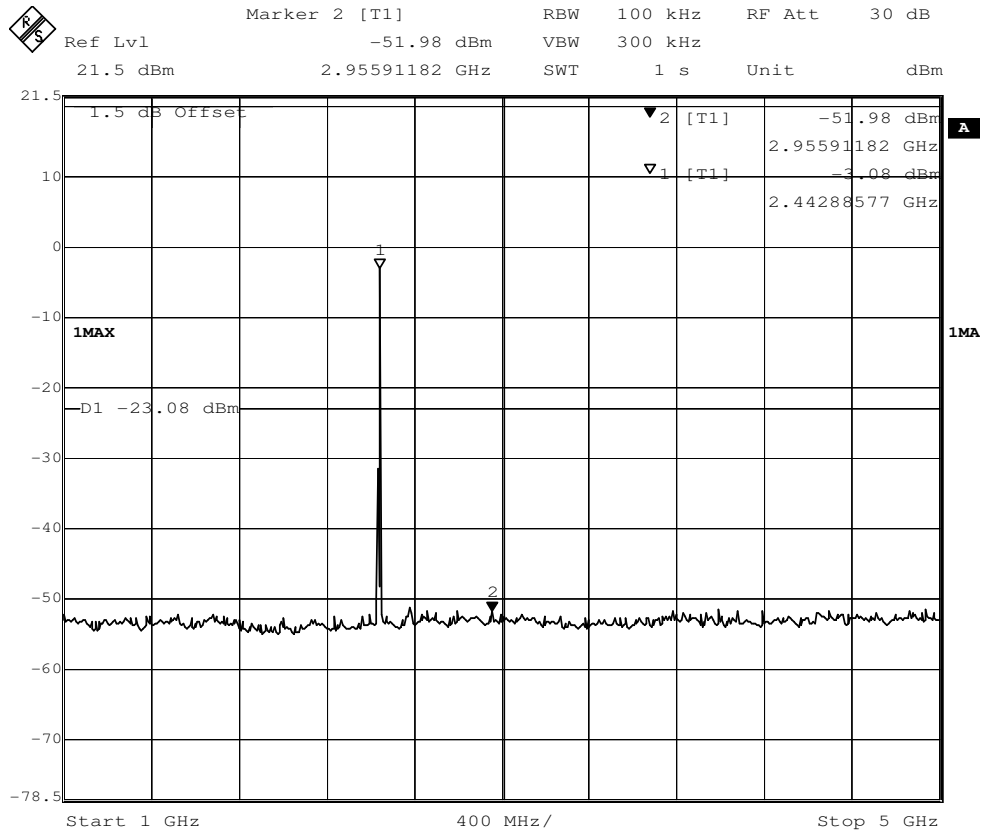
5GHz to 25GHz





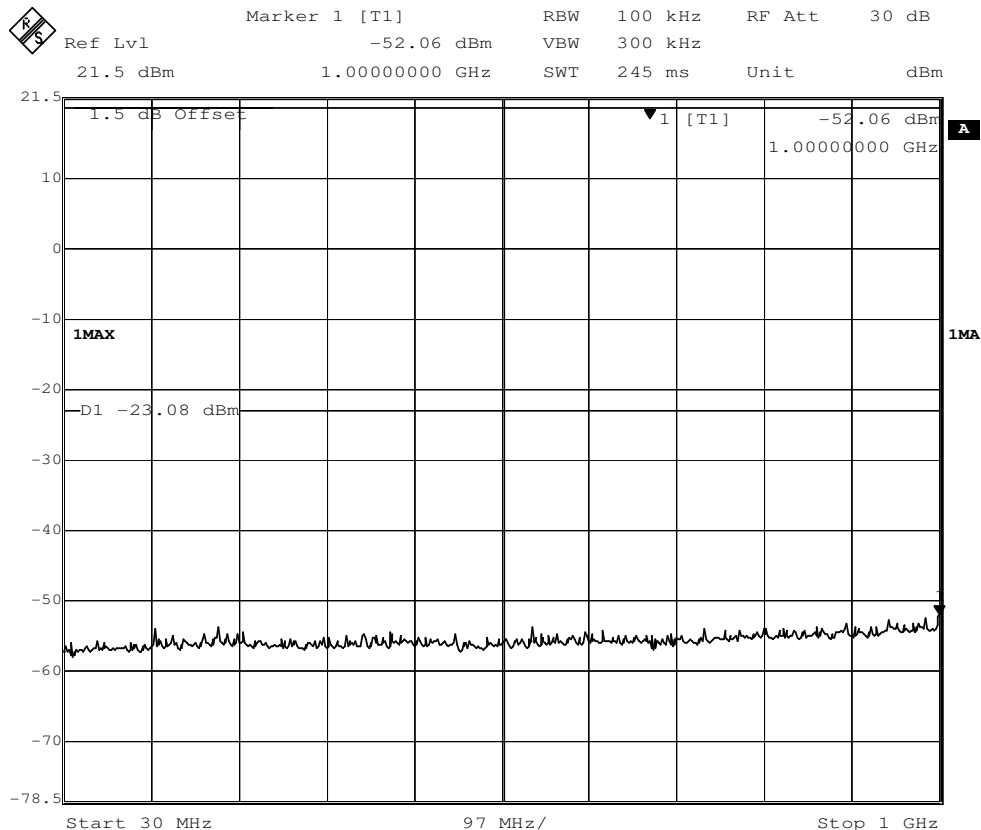
Channel 19:2.440GHz

1GHz to 5GHz



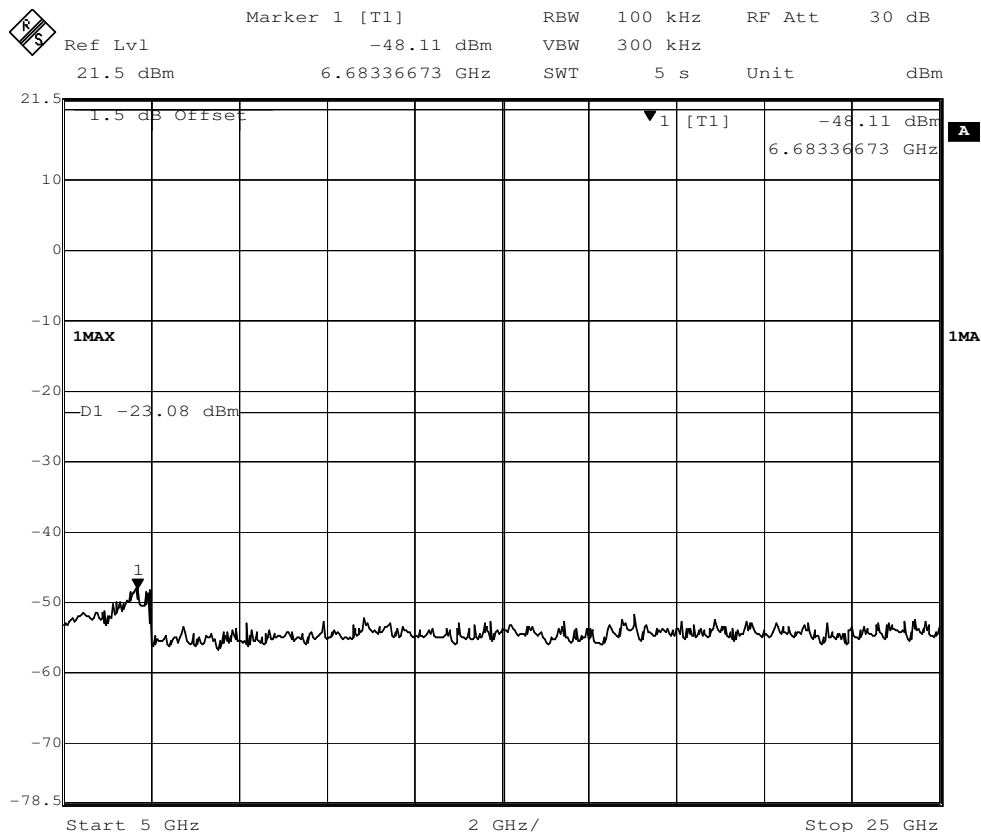


30 MHz to 1GHz





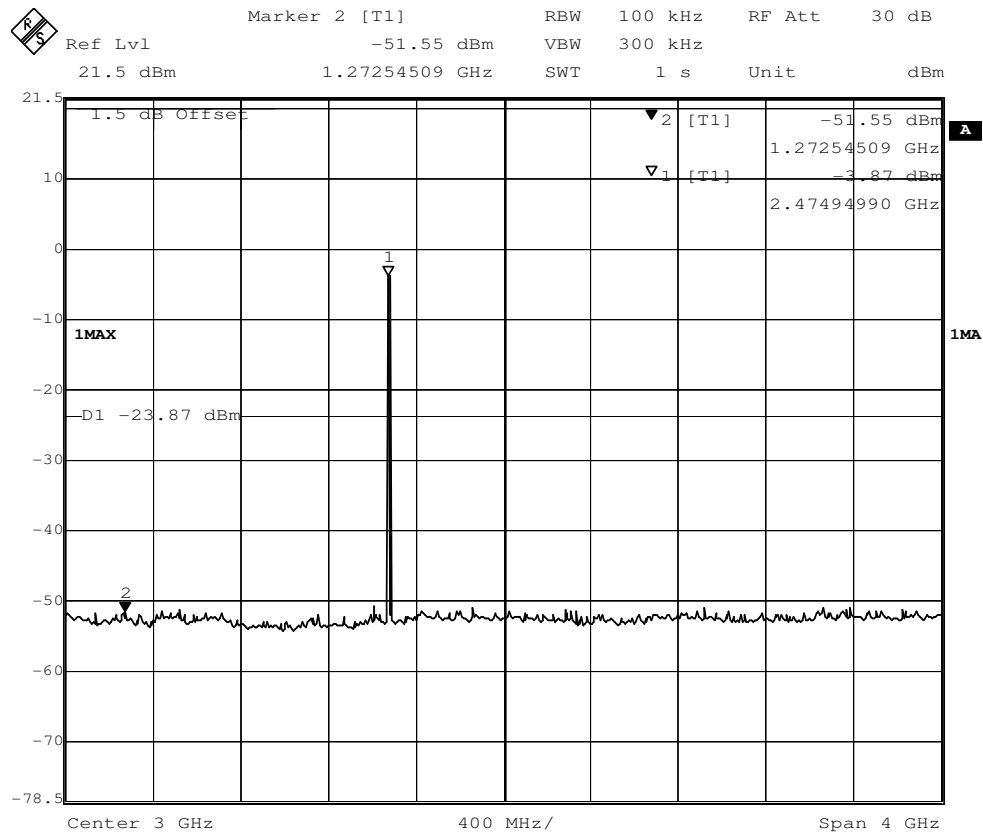
5GHz to 25GHz





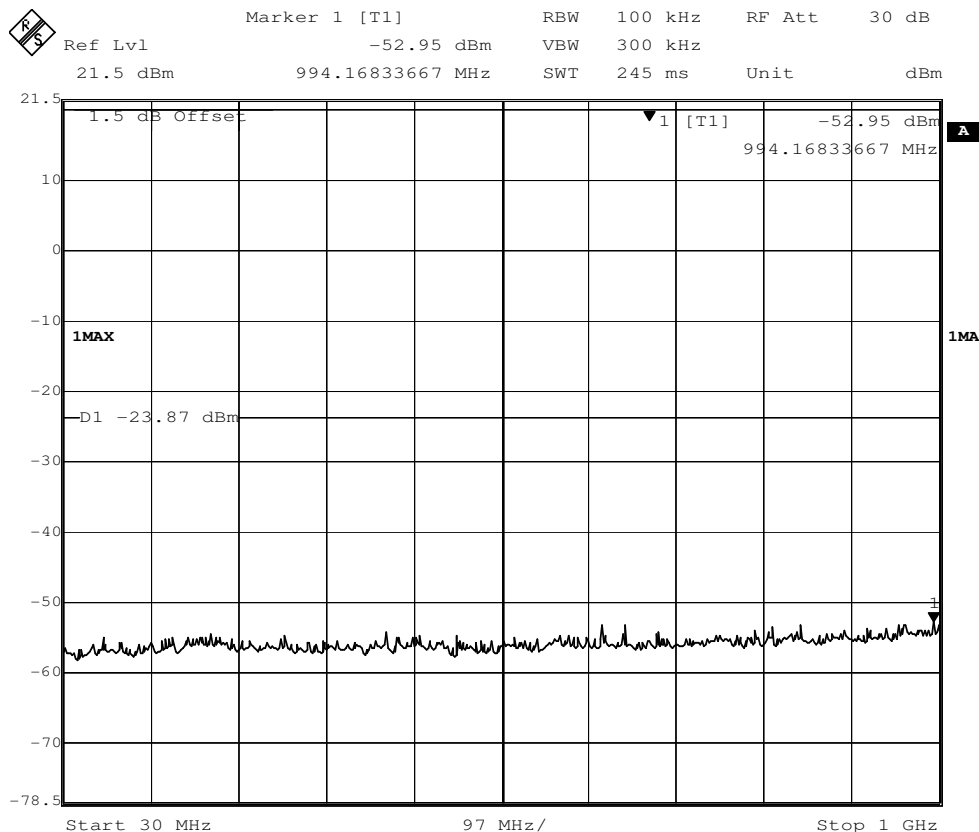
Channel 39:2.480GHz

1GHz to 5GHz



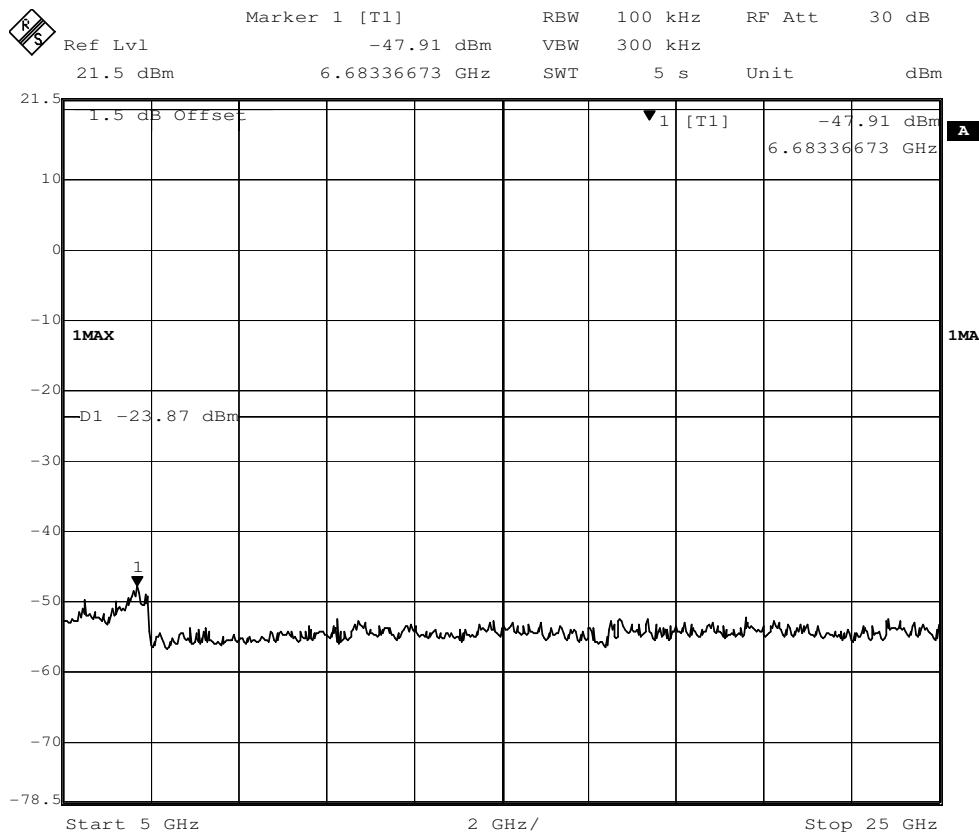


30 MHz to 1GHz





5GHz to 25GHz





## 7.7 Radiated Spurious Emissions

Test 47 CFR Part 15C Section 15.209 and 15.205

Requirement:

Test Method: ANSI C63.10: 2013

Test Site: Measurement Distance: 3m

(Semi-Anechoic Chamber below 1GHz, Full Anechoic Chamber above 1GHz)

Receiver

Setup:

| Frequency         | Detector   | RBW     | VBW    | Remark     |
|-------------------|------------|---------|--------|------------|
| 0.009MHz-0.090MHz | Peak       | 10kHz   | 30kHz  | Peak       |
| 0.009MHz-0.090MHz | Average    | 10kHz   | 30kHz  | Average    |
| 0.090MHz-0.110MHz | Quasi-peak | 10kHz   | 30kHz  | Quasi-peak |
| 0.110MHz-0.490MHz | Peak       | 10kHz   | 30kHz  | Peak       |
| 0.110MHz-0.490MHz | Average    | 10kHz   | 30kHz  | Average    |
| 0.490MHz -30MHz   | Quasi-peak | 10kHz   | 30kHz  | Quasi-peak |
| 30MHz-1GHz        | Quasi-peak | 100 kHz | 300kHz | Quasi-peak |
| Above 1GHz        | Peak       | 1MHz    | 3MHz   | Peak       |
|                   | Peak       | 1MHz    | 10Hz   | Average    |

Limit:

| Frequency         | Field strength<br>(microvolt/meter) | Limit<br>(dBuV/m) | Remark     | Measurement<br>distance (m) |
|-------------------|-------------------------------------|-------------------|------------|-----------------------------|
| 0.009MHz-0.490MHz | 2400/F(kHz)                         | -                 | -          | 300                         |
| 0.490MHz-1.705MHz | 24000/F(kHz)                        | -                 | -          | 30                          |
| 1.705MHz-30MHz    | 30                                  | -                 | -          | 30                          |
| 30MHz-88MHz       | 100                                 | 40.0              | Quasi-peak | 3                           |
| 88MHz-216MHz      | 150                                 | 43.5              | Quasi-peak | 3                           |
| 216MHz-960MHz     | 200                                 | 46.0              | Quasi-peak | 3                           |
| 960MHz-1GHz       | 500                                 | 54.0              | Quasi-peak | 3                           |
| Above 1GHz        | 500                                 | 54.0              | Average    | 3                           |

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Test Setup:

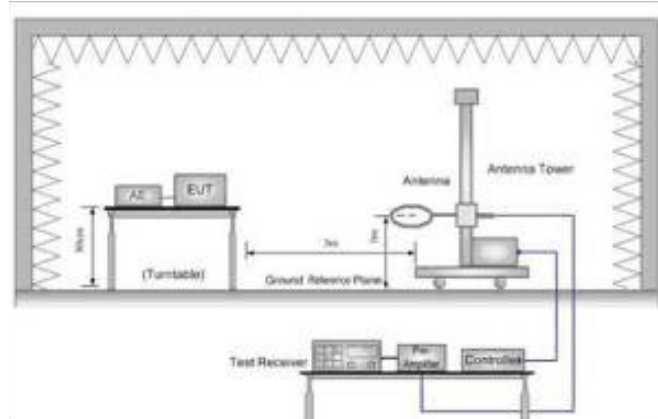


Figure 1. Below 30MHz

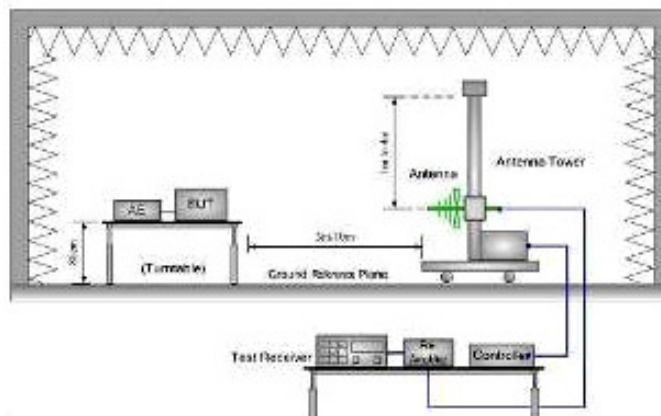


Figure 2. 30MHz to 1GHz

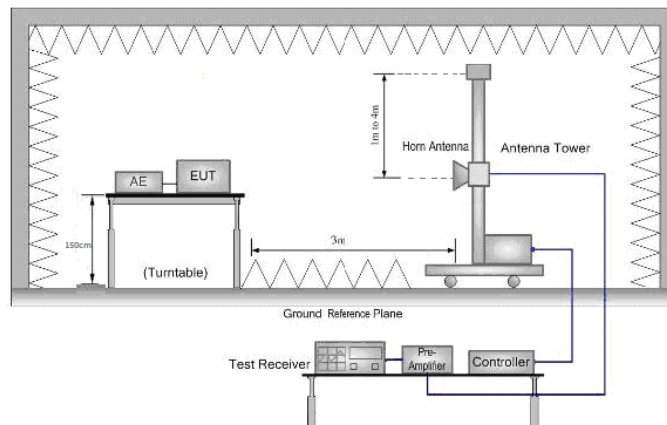


Figure 3. Above 1 GHz



|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Procedure:        | <p>a) For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 and 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.</p> <p>b) For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.</p> <p>c) The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.</p> <p>d) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.</p> <p>e) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degree to 360 degrees to find the maximum reading.</p> <p>f) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.</p> <p>g) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.</p> <p>h) Test the EUT in the lowest channel (2402MHz), the middle channel (2442MHz), the Highest channel (2480MHz)</p> <p>i) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.</p> <p>j) Repeat above procedures until all frequencies measured was complete.</p> |
| Exploratory Test Mode: | <p>Transmitting with GFSK modulation.</p> <p>a. Transmitting mode.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Final Test Mode:       | <p>Transmitting with GFSK modulation.</p> <p>a. Transmitting mode.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Test Results:          | Pass                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

Measurement data

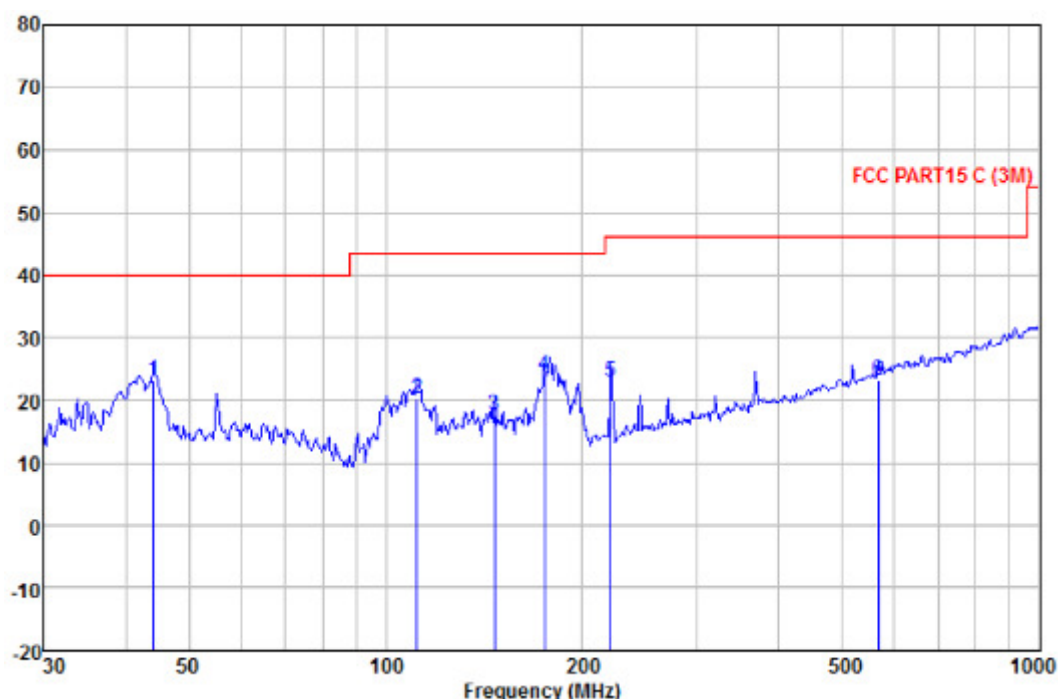
### 9KHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The **measurements** with Loop antenna and the amplitude of spurious emissions from the radiator are attenuated more than 20dB below the limit, so the test data were not recorded in the test report.

### 30MHz~1GHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

Pre-test the lowest, middle ,highest channel, find the worst case is lowest channel, therefore, only worst case was show.

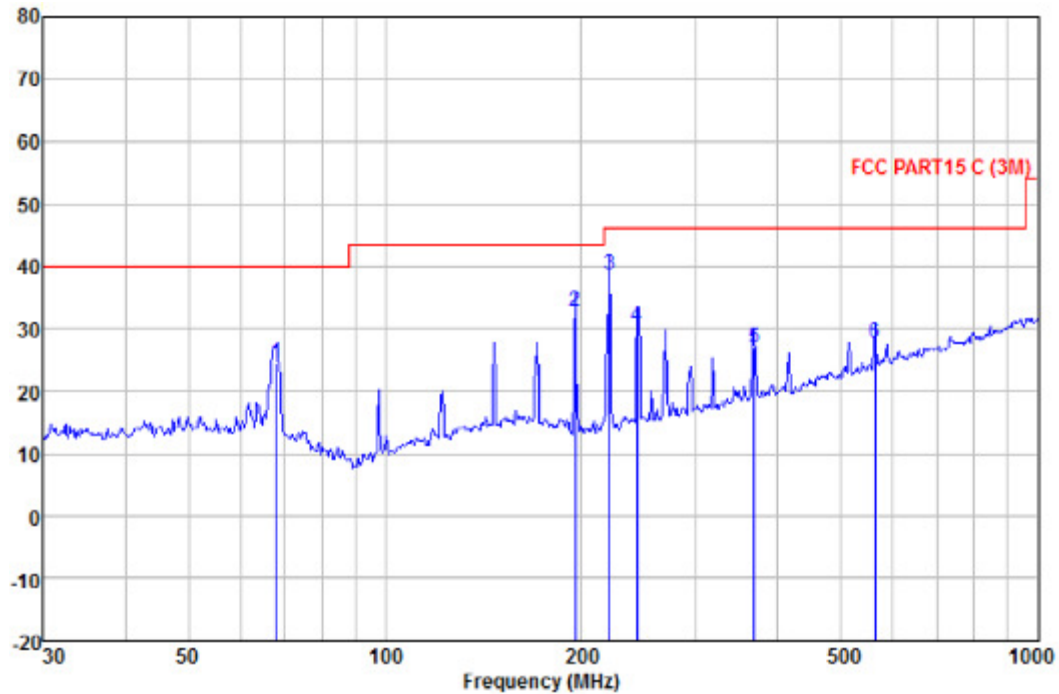
Vertical:



| Freq    | ReadAntenna | Cable | Preamp |       | Limit  | Over   |           |
|---------|-------------|-------|--------|-------|--------|--------|-----------|
| Level   | Factor      | Loss  | Factor | Level | Line   | Limit  | Remark    |
| MHz     | dBuV        | dB/m  | dB     | dB    | dBuV/m | dBuV/m | dB        |
| 44.120  | 34.94       | 14.01 | 1.18   | 27.00 | 23.13  | 40.00  | -16.87 QP |
| 111.738 | 34.83       | 10.43 | 1.97   | 26.90 | 20.33  | 43.50  | -23.17 QP |
| 146.888 | 29.00       | 13.22 | 2.28   | 26.81 | 17.69  | 43.50  | -25.81 QP |
| 175.037 | 35.31       | 12.88 | 2.52   | 26.68 | 24.03  | 43.50  | -19.47 QP |
| 220.617 | 35.48       | 11.24 | 2.84   | 26.52 | 23.04  | 46.00  | -22.96 QP |
| 566.622 | 26.66       | 19.80 | 4.66   | 28.00 | 23.12  | 46.00  | -22.88 QP |



Horizontal:



| Freq    | ReadAntenna Level | Antenna Factor | Cable Loss | Preamp Factor | Level  | Limit Line | Over Limit | Remark |
|---------|-------------------|----------------|------------|---------------|--------|------------|------------|--------|
| MHz     | dBuV              | dB/m           | dB         | dB            | dBuV/m | dBuV/m     | dB         |        |
| 68.151  | 37.14             | 12.87          | 1.50       | 27.00         | 24.51  | 40.00      | -15.49     | QP     |
| 195.822 | 45.39             | 11.42          | 2.69       | 26.61         | 32.89  | 43.50      | -10.61     | QP     |
| 220.617 | 51.14             | 11.24          | 2.84       | 26.52         | 38.70  | 46.00      | -7.30      | QP     |
| 243.377 | 41.31             | 12.44          | 2.99       | 26.47         | 30.27  | 46.00      | -15.73     | QP     |
| 368.112 | 34.35             | 15.83          | 3.76       | 26.94         | 27.00  | 46.00      | -19.00     | QP     |
| 562.662 | 31.33             | 19.70          | 4.66       | 28.00         | 27.69  | 46.00      | -18.31     | QP     |



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| Above 1GHz Field Strength of Unwanted Emissions. Peak & Average Measurement |                      |                        |                 |                    |                         |                |            |                      |
|-----------------------------------------------------------------------------|----------------------|------------------------|-----------------|--------------------|-------------------------|----------------|------------|----------------------|
| Lowest channel                                                              |                      | Peak Measurement:      |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4804.110                                                                    | 40.97                | 30.79                  | 9.95            | 40.21              | 41.50                   | 74.00          | -32.50     | V                    |
| 7206.320                                                                    | 38.35                | 35.45                  | 12.73           | 39.25              | 47.28                   | 74.00          | -26.72     | V                    |
| 9608.480                                                                    | 35.30                | 37.51                  | 14.48           | 37.97              | 49.32                   | 74.00          | -24.68     | V                    |
| 12010.530                                                                   | 34.15                | 39.50                  | 15.80           | 38.08              | 51.37                   | 74.00          | -22.63     | V                    |
| 4204.560                                                                    | 43.22                | 29.73                  | 9.23            | 40.11              | 42.07                   | 74.00          | -31.93     | H                    |
| 7206.830                                                                    | 34.23                | 35.45                  | 12.73           | 39.25              | 43.16                   | 74.00          | -30.84     | H                    |
| 9608.320                                                                    | 32.81                | 37.51                  | 14.48           | 37.97              | 46.83                   | 74.00          | -27.17     | H                    |
| 12010.480                                                                   | 33.67                | 39.50                  | 15.80           | 38.08              | 50.89                   | 74.00          | -23.11     | H                    |
| Lowest channel                                                              |                      | Average Measurement:   |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4804.110                                                                    | 31.44                | 30.79                  | 9.95            | 40.21              | 31.97                   | 54.00          | -22.03     | V                    |
| 7206.320                                                                    | 31.07                | 35.45                  | 12.73           | 39.25              | 40.00                   | 54.00          | -14.00     | V                    |
| 9608.480                                                                    | 25.95                | 37.51                  | 14.48           | 37.97              | 39.97                   | 54.00          | -14.03     | V                    |
| 12010.530                                                                   | 26.62                | 39.50                  | 15.80           | 38.08              | 43.84                   | 54.00          | -10.16     | V                    |
| 4204.560                                                                    | 33.39                | 29.73                  | 9.23            | 40.11              | 32.24                   | 54.00          | -21.76     | H                    |
| 7206.830                                                                    | 25.51                | 35.45                  | 12.73           | 39.25              | 34.44                   | 54.00          | -19.56     | H                    |
| 9608.320                                                                    | 23.75                | 37.51                  | 14.48           | 37.97              | 37.77                   | 54.00          | -16.23     | H                    |
| 12010.480                                                                   | 24.89                | 39.50                  | 15.80           | 38.08              | 42.11                   | 54.00          | -11.89     | H                    |



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| Above 1GHz Field Strength of Unwanted Emissions. Peak & Average Measurement |                      |                        |                 |                    |                         |                |            |                      |
|-----------------------------------------------------------------------------|----------------------|------------------------|-----------------|--------------------|-------------------------|----------------|------------|----------------------|
| Middle channel                                                              |                      | Peak Measurement:      |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4884.160                                                                    | 38.13                | 30.95                  | 10.02           | 40.22              | 38.88                   | 74.00          | -35.12     | V                    |
| 7326.580                                                                    | 31.55                | 35.74                  | 12.93           | 39.22              | 41.00                   | 74.00          | -33.00     | V                    |
| 9768.420                                                                    | 30.42                | 37.74                  | 14.44           | 37.90              | 44.70                   | 74.00          | -29.30     | V                    |
| 12210.250                                                                   | 35.47                | 39.21                  | 16.05           | 38.10              | 52.63                   | 74.00          | -21.37     | V                    |
| 4884.630                                                                    | 37.88                | 30.95                  | 10.02           | 40.22              | 38.63                   | 74.00          | -35.37     | H                    |
| 7326.520                                                                    | 32.44                | 35.74                  | 12.93           | 39.22              | 41.89                   | 74.00          | -32.11     | H                    |
| 9768.340                                                                    | 32.97                | 37.74                  | 14.44           | 37.90              | 47.25                   | 74.00          | -26.75     | H                    |
| 12210.530                                                                   | 31.11                | 39.21                  | 16.05           | 38.10              | 48.27                   | 74.00          | -25.73     | H                    |
| Middle channel                                                              |                      | Average Measurement:   |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4884.160                                                                    | 30.35                | 30.95                  | 10.02           | 40.22              | 31.10                   | 54.00          | -22.90     | V                    |
| 7326.580                                                                    | 22.72                | 35.74                  | 12.93           | 39.22              | 32.17                   | 54.00          | -21.83     | V                    |
| 9768.420                                                                    | 22.22                | 37.74                  | 14.44           | 37.90              | 36.50                   | 54.00          | -17.50     | V                    |
| 12210.250                                                                   | 23.54                | 39.21                  | 16.05           | 38.10              | 40.70                   | 54.00          | -13.30     | V                    |
| 4884.630                                                                    | 28.41                | 30.95                  | 10.02           | 40.22              | 29.16                   | 54.00          | -24.84     | H                    |
| 7326.520                                                                    | 24.24                | 35.74                  | 12.93           | 39.22              | 33.69                   | 54.00          | -20.31     | H                    |
| 9768.340                                                                    | 24.50                | 37.74                  | 14.44           | 37.90              | 38.78                   | 54.00          | -15.22     | H                    |
| 12210.530                                                                   | 22.54                | 39.21                  | 16.05           | 38.10              | 39.70                   | 54.00          | -14.30     | H                    |



| Above 1GHz Field Strength of Unwanted Emissions. Peak & Average Measurement |                      |                        |                 |                    |                         |                |            |                      |
|-----------------------------------------------------------------------------|----------------------|------------------------|-----------------|--------------------|-------------------------|----------------|------------|----------------------|
| Highest channel                                                             |                      | Peak Measurement:      |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4960.520                                                                    | 40.28                | 31.05                  | 10.07           | 40.23              | 41.17                   | 74.00          | -32.83     | V                    |
| 7440.830                                                                    | 35.41                | 35.92                  | 13.04           | 39.20              | 45.17                   | 74.00          | -28.83     | V                    |
| 9920.320                                                                    | 32.20                | 37.92                  | 14.41           | 37.84              | 46.69                   | 74.00          | -27.31     | V                    |
| 12400.130                                                                   | 33.38                | 38.93                  | 16.29           | 38.12              | 50.48                   | 74.00          | -23.52     | V                    |
| 4960.520                                                                    | 40.49                | 31.05                  | 10.07           | 40.23              | 41.38                   | 74.00          | -32.62     | H                    |
| 7440.380                                                                    | 31.48                | 35.92                  | 13.04           | 39.20              | 41.24                   | 74.00          | -32.76     | H                    |
| 9920.430                                                                    | 30.77                | 37.92                  | 14.41           | 37.84              | 45.26                   | 74.00          | -28.74     | H                    |
| 12400.620                                                                   | 31.60                | 38.93                  | 16.29           | 38.12              | 48.70                   | 74.00          | -25.30     | H                    |
| Highest channel                                                             |                      | Average Measurement:   |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                                             | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 4960.520                                                                    | 32.32                | 31.05                  | 10.07           | 40.23              | 33.21                   | 54.00          | -20.79     | V                    |
| 7440.830                                                                    | 26.14                | 35.92                  | 13.04           | 39.20              | 35.90                   | 54.00          | -18.10     | V                    |
| 9920.320                                                                    | 24.37                | 37.92                  | 14.41           | 37.84              | 38.86                   | 54.00          | -15.14     | V                    |
| 12400.130                                                                   | 22.84                | 38.93                  | 16.29           | 38.12              | 39.94                   | 54.00          | -14.06     | V                    |
| 4960.520                                                                    | 31.26                | 31.05                  | 10.07           | 40.23              | 32.15                   | 54.00          | -21.85     | H                    |
| 7440.380                                                                    | 24.11                | 35.92                  | 13.04           | 39.20              | 33.87                   | 54.00          | -20.13     | H                    |
| 9920.430                                                                    | 22.84                | 37.92                  | 14.41           | 37.84              | 37.33                   | 54.00          | -16.67     | H                    |
| 12400.620                                                                   | 23.54                | 38.93                  | 16.29           | 38.12              | 40.64                   | 54.00          | -13.36     | H                    |



## 7.8 Radiated Emissions which fall in the restricted bands

Test Requirement: FCC Part 15 C section 15.247

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

Test Method: ANSI C63.10.2013

Test Status: Enter test mode for the product. Test in lowest channel 2402 MHz and highest channel 2480 MHz, keep in continuously transmitting status with GFSK modulation.

Test site: Measurement Distance: 3m (Semi-Anechoic Chamber)

| Limit: | Frequency     | Limit (dBuV/m @3m) | Remark           |
|--------|---------------|--------------------|------------------|
|        | 30MHz-88MHz   | 40.0               | Quasi-peak Value |
|        | 88MHz-216MHz  | 43.5               | Quasi-peak Value |
|        | 216MHz-960MHz | 46.0               | Quasi-peak Value |
|        | 960MHz-1GHz   | 54.0               | Quasi-peak Value |
|        | Above 1GHz    | 54.0               | Average Value    |
|        |               | 74.0               | Peak Value       |

Detector: For PK value:

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 AV value:

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

VBW = 10Hz

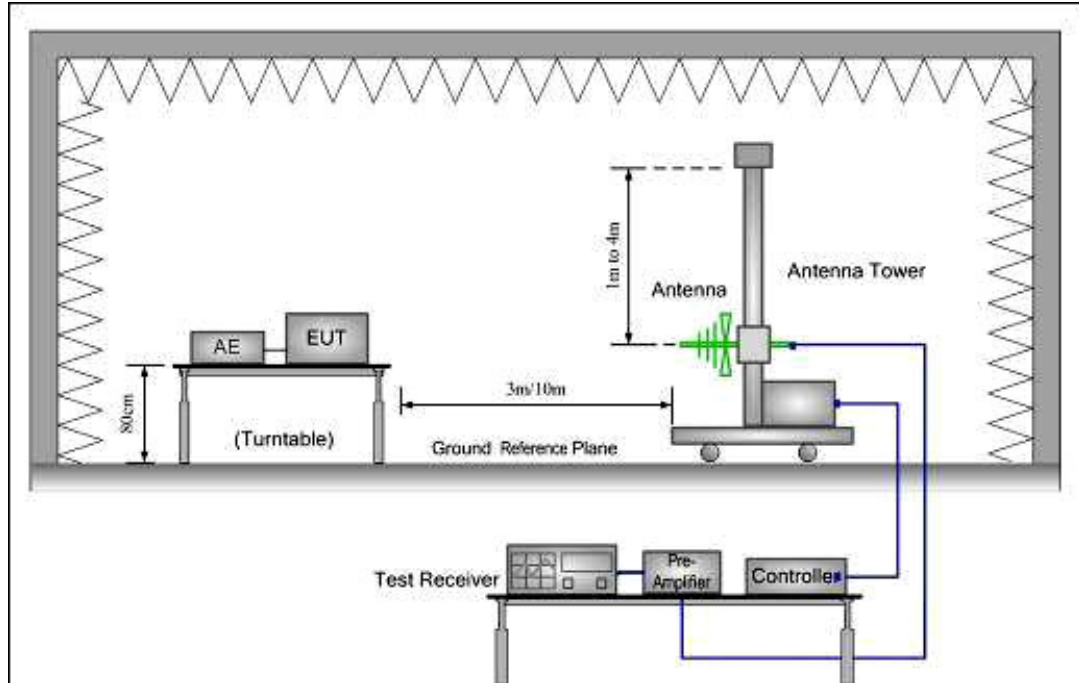
Sweep = auto

Detector function = peak

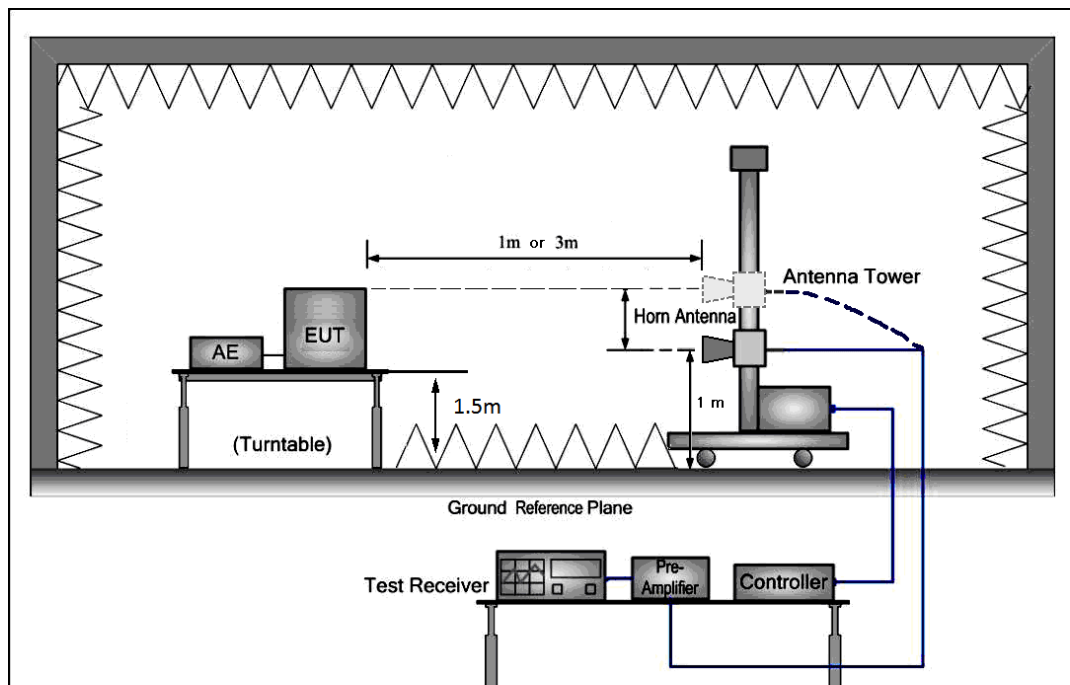
Trace = max hold

**Test Configuration:**

1). 30 MHz to 1 GHz emissions:



2). Above 1 GHz emissions:



**Test Procedure:**

Test site with RF absorbing material covering the ground plane that met the site validation criterion called



out in CISPR 16-1-4:2010 was used to perform radiated emission test above 1 GHz.

The receiver scanned from the lowest frequency generated within the EUT to 25GHz. When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test three orthogonal planes. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst case emissions were reported.

From 30MHz to 1GHz, read the Quasi-Peak field strength of the emissions with receiver QP detector RBW=120KHz.

Above 1GHz, read the Peak field strength and Average field strength.

Read the Peak field strength through RBW=1MHz, VBW=3MHz in spectrum analyzer setting;

Read the Average field strength through RBW=1MHz, VBW=10Hz in spectrum analyzer setting;

While maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the average field strength reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from  $20\log(\text{dwell time}/100 \text{ ms})$ , in an effort to demonstrate compliance with the 15.209 limit.

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section. only spurious emissions are permitted in any of the frequency bands listed below:

| MHz                        | MHz                 | MHz             | GHz          |
|----------------------------|---------------------|-----------------|--------------|
| 0.090 - 0.110              | 16.42 - 16.423      | 399.9 - 410     | 4.5 - 5.15   |
| <sup>1</sup> 0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614       | 5.35 - 5.46  |
| 2.1735 - 2.1905            | 16.80425 - 16.80475 | 960 - 1240      | 7.25 - 7.75  |
| 4.125 - 4.128              | 25.5 - 25.67        | 1300 - 1427     | 8.025 - 8.5  |
| 4.17725 - 4.17775          | 37.5 - 38.25        | 1435 - 1626.5   | 9.0 - 9.2    |
| 4.20725 - 4.20775          | 73 - 74.6           | 1645.5 - 1646.5 | 9.3 - 9.5    |
| 6.215 - 6.218              | 74.8 - 75.2         | 1660 - 1710     | 10.6 - 12.7  |
| 6.26775 - 6.26825          | 108 - 121.94        | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225          | 123 - 138           | 2200 - 2300     | 14.47 - 14.5 |
| 8.291 - 8.294              | 149.9 - 150.05      | 2310 - 2390     | 15.35 - 16.2 |
| 8.362 - 8.366              | 156.52475 -         | 2483.5 - 2500   | 17.7 - 21.4  |



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|                     |                   |               |               |
|---------------------|-------------------|---------------|---------------|
| 8.37625 - 8.38675   | 156.52525         | 2655 - 2900   | 22.01 - 23.12 |
| 8.41425 - 8.41475   | 156.7 - 156.9     | 3260 - 3267   | 23.6 - 24.0   |
| 12.29 - 12.293      | 162.0125 - 167.17 | 3332 - 3339   | 31.2 - 31.8   |
| 12.51975 - 12.52025 | 167.72 - 173.2    | 3345.8 - 3358 | 36.43 - 36.5  |
| 12.57675 - 12.57725 | 240 - 285         | 3600 - 4400   |               |
| 13.36 - 13.41       | 322 - 335.4       |               |               |

## Test Result:

### Above 1GHz Radiated Emissions. Peak & Average Measurement

| Lowest channel  |                      | Peak Measurement:      |                 |                    |                         |                |            |                      |
|-----------------|----------------------|------------------------|-----------------|--------------------|-------------------------|----------------|------------|----------------------|
| Frequency (MHz) | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 2310.000        | 48.06                | 26.25                  | 6.80            | 39.07              | 42.04                   | 74.00          | -31.96     | V                    |
| 2390.000        | 53.36                | 26.43                  | 6.87            | 39.10              | 47.56                   | 74.00          | -26.44     | V                    |
| 2483.500        | 50.76                | 26.58                  | 7.07            | 39.14              | 45.27                   | 74.00          | -28.73     | V                    |
| 2500.000        | 49.18                | 26.60                  | 7.10            | 39.14              | 43.74                   | 74.00          | -30.26     | V                    |
| 2310.000        | 41.36                | 26.25                  | 6.80            | 39.07              | 35.34                   | 74.00          | -38.66     | H                    |
| 2390.000        | 47.95                | 26.43                  | 6.87            | 39.10              | 42.15                   | 74.00          | -31.85     | H                    |
| 2483.500        | 45.30                | 26.58                  | 7.07            | 39.14              | 39.81                   | 74.00          | -34.19     | H                    |
| 2500.000        | 43.44                | 26.60                  | 7.10            | 39.14              | 38.00                   | 74.00          | -36.00     | H                    |
| Lowest channel  |                      | Average Measurement:   |                 |                    |                         |                |            |                      |
| Frequency (MHz) | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 2310.000        | 38.48                | 26.25                  | 6.80            | 39.07              | 32.46                   | 54.00          | -21.54     | V                    |
| 2390.000        | 43.98                | 26.43                  | 6.87            | 39.10              | 38.18                   | 54.00          | -15.82     | V                    |
| 2483.500        | 40.25                | 26.58                  | 7.07            | 39.14              | 34.76                   | 54.00          | -19.24     | V                    |
| 2500.000        | 39.55                | 26.60                  | 7.10            | 39.14              | 34.11                   | 54.00          | -19.89     | V                    |
| 2310.000        | 32.67                | 26.25                  | 6.80            | 39.07              | 26.65                   | 54.00          | -27.35     | H                    |
| 2390.000        | 36.98                | 26.43                  | 6.87            | 39.10              | 31.18                   | 54.00          | -22.82     | H                    |
| 2483.500        | 36.80                | 26.58                  | 7.07            | 39.14              | 31.31                   | 54.00          | -22.69     | H                    |
| 2500.000        | 34.20                | 26.60                  | 7.10            | 39.14              | 28.76                   | 54.00          | -25.24     | H                    |



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| Above 1GHz Radiated Emissions. Peak & Average Measurement |                                  |                              |                       |                          |                                     |                         |            |                         |
|-----------------------------------------------------------|----------------------------------|------------------------------|-----------------------|--------------------------|-------------------------------------|-------------------------|------------|-------------------------|
| Middle channel                                            |                                  | Peak Measurement:            |                       |                          |                                     |                         |            |                         |
| Frequency<br>(MHz)                                        | Reading<br>Level<br>(dB $\mu$ V) | Antenna<br>factors<br>(dB/m) | Cable<br>loss<br>(dB) | Preamp<br>factor<br>(dB) | Emission<br>Level<br>(dB $\mu$ V/m) | Limit<br>(dB $\mu$ V/m) | Over limit | Antenna<br>polarization |
| 2310.000                                                  | 41.21                            | 26.25                        | 6.80                  | 39.07                    | 35.19                               | 74.00                   | -38.81     | V                       |
| 2390.000                                                  | 43.45                            | 26.43                        | 6.87                  | 39.10                    | 37.65                               | 74.00                   | -36.35     | V                       |
| 2483.500                                                  | 42.84                            | 26.58                        | 7.07                  | 39.14                    | 37.35                               | 74.00                   | -36.65     | V                       |
| 2500.000                                                  | 43.26                            | 26.60                        | 7.10                  | 39.14                    | 37.82                               | 74.00                   | -36.18     | V                       |
| 2310.000                                                  | 42.12                            | 26.25                        | 6.80                  | 39.07                    | 36.10                               | 74.00                   | -37.90     | H                       |
| 2390.000                                                  | 44.23                            | 26.43                        | 6.87                  | 39.10                    | 38.43                               | 74.00                   | -35.57     | H                       |
| 2483.500                                                  | 45.09                            | 26.58                        | 7.07                  | 39.14                    | 39.60                               | 74.00                   | -34.40     | H                       |
| 2500.000                                                  | 43.39                            | 26.60                        | 7.10                  | 39.14                    | 37.95                               | 74.00                   | -36.05     | H                       |
| Middle channel                                            |                                  | Average Measurement:         |                       |                          |                                     |                         |            |                         |
| Frequency<br>(MHz)                                        | Reading<br>Level<br>(dB $\mu$ V) | Antenna<br>factors<br>(dB/m) | Cable<br>loss<br>(dB) | Preamp<br>factor<br>(dB) | Emission<br>Level<br>(dB $\mu$ V/m) | Limit<br>(dB $\mu$ V/m) | Over limit | Antenna<br>polarization |
| 2310.000                                                  | 32.05                            | 26.25                        | 6.80                  | 39.07                    | 26.03                               | 54.00                   | -27.97     | V                       |
| 2390.000                                                  | 32.52                            | 26.43                        | 6.87                  | 39.10                    | 26.72                               | 54.00                   | -27.28     | V                       |
| 2483.500                                                  | 31.46                            | 26.58                        | 7.07                  | 39.14                    | 25.97                               | 54.00                   | -28.03     | V                       |
| 2500.000                                                  | 34.23                            | 26.60                        | 7.10                  | 39.14                    | 28.79                               | 54.00                   | -25.21     | V                       |
| 2310.000                                                  | 32.07                            | 26.25                        | 6.80                  | 39.07                    | 26.05                               | 54.00                   | -27.95     | H                       |
| 2390.000                                                  | 34.56                            | 26.43                        | 6.87                  | 39.10                    | 28.76                               | 54.00                   | -25.24     | H                       |
| 2483.500                                                  | 35.19                            | 26.58                        | 7.07                  | 39.14                    | 29.70                               | 54.00                   | -24.30     | H                       |
| 2500.000                                                  | 36.40                            | 26.60                        | 7.10                  | 39.14                    | 30.96                               | 54.00                   | -23.04     | H                       |



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| Above 1GHz Radiated Emissions. Peak & Average Measurement |                      |                        |                 |                    |                         |                |            |                      |
|-----------------------------------------------------------|----------------------|------------------------|-----------------|--------------------|-------------------------|----------------|------------|----------------------|
| Highest channel                                           |                      | Peak Measurement:      |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                           | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 2310.000                                                  | 42.46                | 26.25                  | 6.80            | 39.07              | 36.44                   | 74.00          | -37.56     | V                    |
| 2390.000                                                  | 43.90                | 26.43                  | 6.87            | 39.10              | 38.10                   | 74.00          | -35.90     | V                    |
| 2483.500                                                  | 45.67                | 26.58                  | 7.07            | 39.14              | 40.18                   | 74.00          | -33.82     | V                    |
| 2500.000                                                  | 45.43                | 26.60                  | 7.10            | 39.14              | 39.99                   | 74.00          | -34.01     | V                    |
| 2310.000                                                  | 42.03                | 26.25                  | 6.80            | 39.07              | 36.01                   | 74.00          | -37.99     | H                    |
| 2390.000                                                  | 41.82                | 26.43                  | 6.87            | 39.10              | 36.02                   | 74.00          | -37.98     | H                    |
| 2483.500                                                  | 43.75                | 26.58                  | 7.07            | 39.14              | 38.26                   | 74.00          | -35.74     | H                    |
| 2500.000                                                  | 42.79                | 26.60                  | 7.10            | 39.14              | 37.35                   | 74.00          | -36.65     | H                    |
| Highest channel                                           |                      | Average Measurement:   |                 |                    |                         |                |            |                      |
| Frequency (MHz)                                           | Reading Level (dBμV) | Antenna factors (dB/m) | Cable loss (dB) | Preamp factor (dB) | Emission Level (dBμV/m) | Limit (dBμV/m) | Over limit | Antenna polarization |
| 2310.000                                                  | 32.04                | 26.25                  | 6.80            | 39.07              | 26.02                   | 54.00          | -27.98     | V                    |
| 2390.000                                                  | 33.09                | 26.43                  | 6.87            | 39.10              | 27.29                   | 54.00          | -26.71     | V                    |
| 2483.500                                                  | 35.92                | 26.58                  | 7.07            | 39.14              | 30.43                   | 54.00          | -23.57     | V                    |
| 2500.000                                                  | 34.94                | 26.60                  | 7.10            | 39.14              | 29.50                   | 54.00          | -24.50     | V                    |
| 2310.000                                                  | 33.10                | 26.25                  | 6.80            | 39.07              | 27.08                   | 54.00          | -26.92     | H                    |
| 2390.000                                                  | 33.08                | 26.43                  | 6.87            | 39.10              | 27.28                   | 54.00          | -26.72     | H                    |
| 2483.500                                                  | 34.10                | 26.58                  | 7.07            | 39.14              | 28.61                   | 54.00          | -25.39     | H                    |
| 2500.000                                                  | 31.17                | 26.60                  | 7.10            | 39.14              | 25.73                   | 54.00          | -28.27     | H                    |
| Test result: The unit does meet the FCC requirements.     |                      |                        |                 |                    |                         |                |            |                      |

## 7.9 Band Edges Requirement

Test Requirement: FCC Part 15 C section 15.247

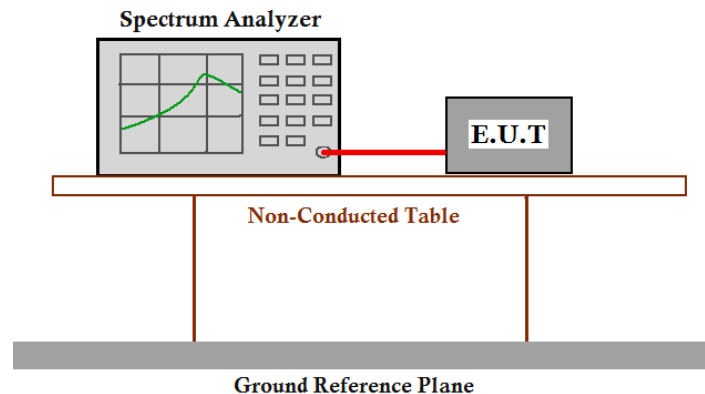
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating. The radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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.

Frequency Band: 2400 MHz to 2483.5 MHz

Test Method: ANSI C63.10: Clause 11.13

Test Status: Enter test mode for the product. Test in lowest channel 2402 MHz and highest channel 2480 MHz, keep in continuously transmitting status with GFSK modulation.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer or power meter.
2. Set instrument center frequency to the frequency of the emission to be measured (must be within 2MHz of the authorized band edge).
3. Set span (wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.),
4. RBW=100kHz,
5. VBW $\geq$ 3 $\times$ RBW
6. Detector=peak

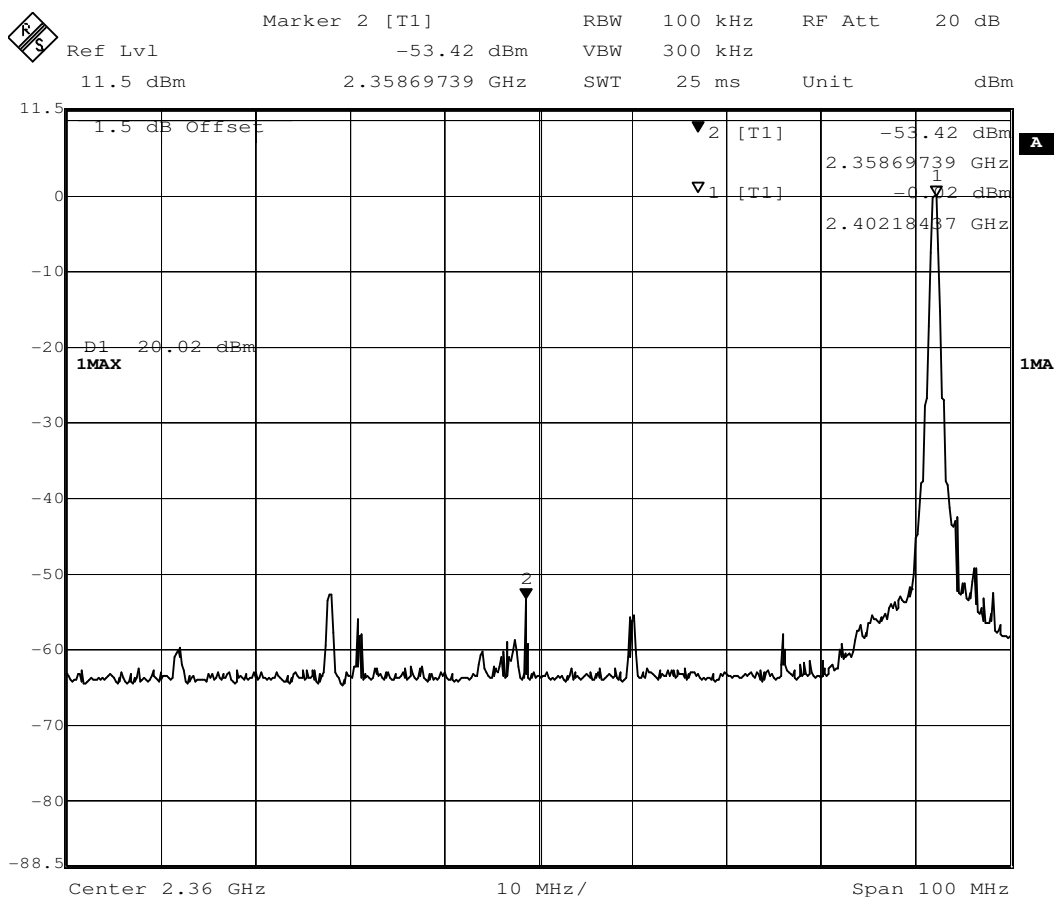
7. Sweep time =auto,
8. Trace mode=max hold.
9. Allow sweep to continue until the trace stabilizes(required measurement time may increase for low duty cycle applications)
10. Compute the power by integrating the spectrum over 1MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency( $f_{\text{emission}} \pm 0.5\text{MHz}$ ). If the instrument does not have a band power function, the sum the amplitude levels(in power units) at 100kHz intervals extending across the 1MHz spectrum defined by  $f_{\text{emission}} \pm 0.5\text{MHz}$ .

**Test result with plots as follows:**

Compare with the output power of the lowest frequency, the Lower Edges attenuated more than 20dB  
Compare with the output power of the highest frequency, the Upper Edges attenuated more than 20dB.

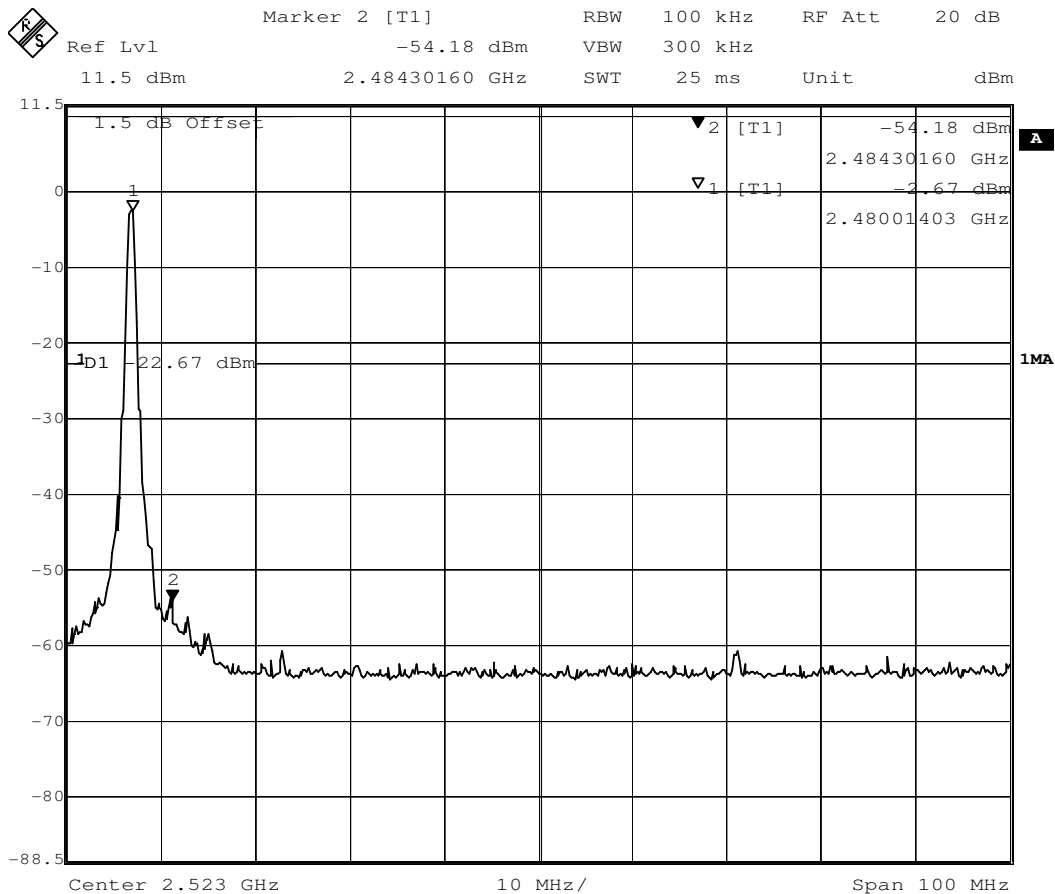
**Result plot as follows:**

Channel 0: 2.402 GHz





Channel 39: 2.480GHz





## 7.10 Conducted Emissions at Mains Terminals 150 kHz to 30 MHz

**Test Requirement:** FCC Part 15 C section 15.207  
**Test Method:** ANSI C63.10: Clause 6.2  
**Frequency Range:** 150 kHz to 30 MHz  
**Detector:** Peak for pre-scan (9 kHz Resolution Bandwidth)  
**Test Limit**

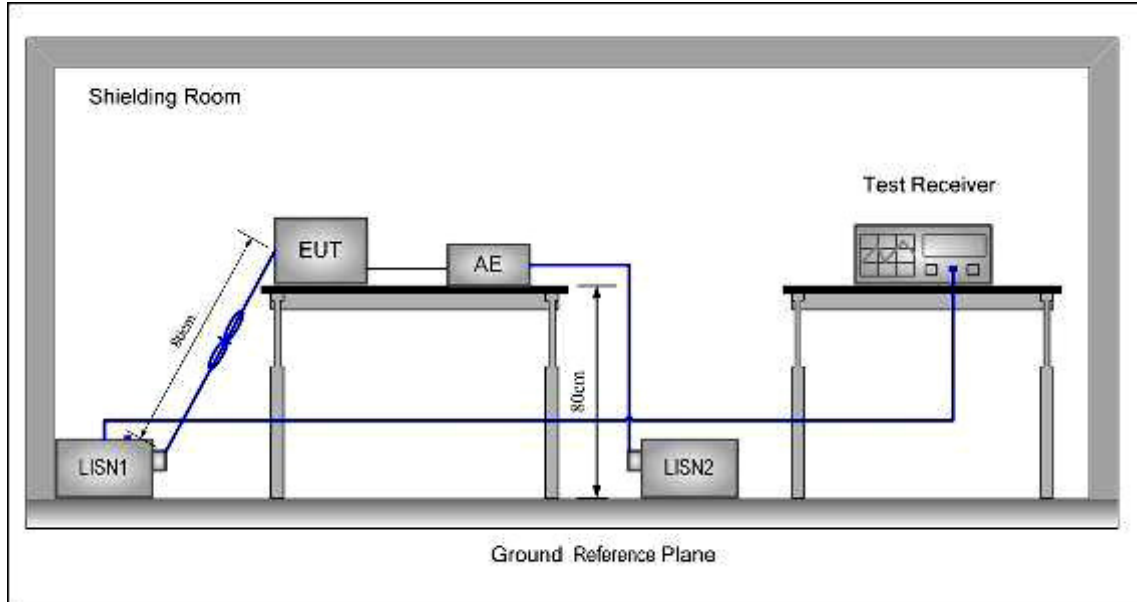
### Limits for conducted disturbance at the mains ports of class B

| Frequency Range<br>(MHz)                                                                                   | Class B Limit dB(μV) |          |
|------------------------------------------------------------------------------------------------------------|----------------------|----------|
|                                                                                                            | Quasi-peak           | Average  |
| 0.15 to 0.50                                                                                               | 66 to 56             | 56 to 46 |
| 0.50 to 5                                                                                                  | 56                   | 46       |
| 5 to 30                                                                                                    | 60                   | 50       |
| NOTE 1 The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz. |                      |          |

**EUT Operation:** Test in normal operating mode. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

### Test Configuration:



### Test procedure:

1. The mains terminal disturbance voltage test was conducted in a shielded room.
2. The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a  $50\Omega/50\mu\text{H} + 5\Omega$  linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, but separated from metallic contact with the ground reference plane by 0.1m of insulation.
4. The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

### Measurement Data

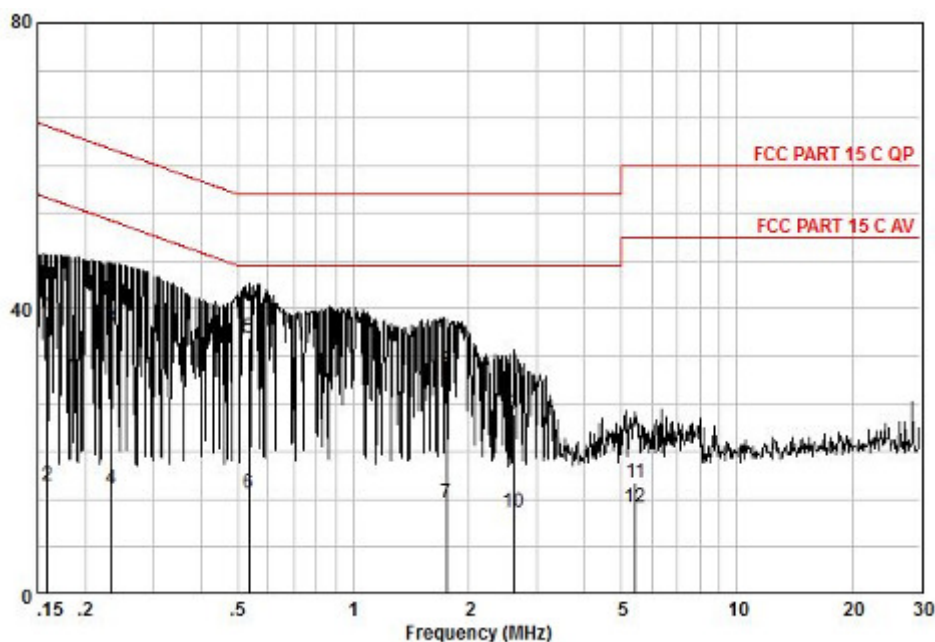
An initial pre-scan was performed on the live and neutral lines with peak detector. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected. For EUT the communicating was worst case mode.

**The following Quasi-Peak and Average measurements were performed on the EUT:**

#### Test Result:

##### 1. Neutral Line

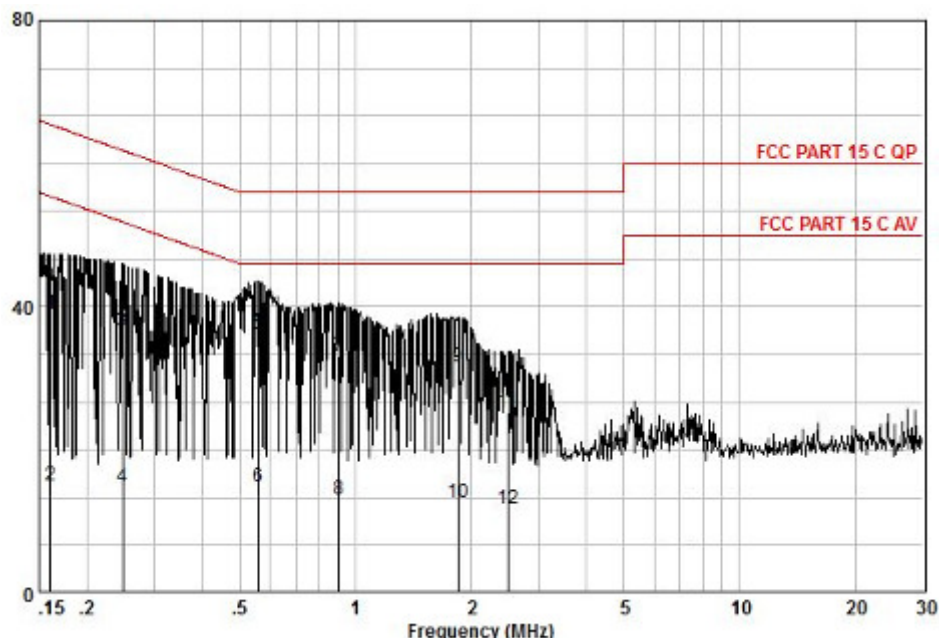
Level(dBμV)



#### Measure data:

| Frequency<br>MHz | read<br>level<br>dBμV | Cable<br>Loss<br>dB | LISN<br>Factor<br>dB | Measured<br>level<br>dBμV | Limit<br>Line<br>dBμV | Over<br>limit<br>dB | Remark  |
|------------------|-----------------------|---------------------|----------------------|---------------------------|-----------------------|---------------------|---------|
| 0,16             | 29,45                 | 0,10                | 9,56                 | 39,11                     | 65,52                 | -26,41              | QP      |
| 0,16             | 5,52                  | 0,10                | 9,56                 | 15,18                     | 55,52                 | -40,34              | AVERAGE |
| 0,23             | 27,58                 | 0,12                | 9,56                 | 37,25                     | 62,35                 | -25,09              | QP      |
| 0,23             | 5,17                  | 0,12                | 9,56                 | 14,84                     | 52,35                 | -37,50              | AVERAGE |
| 0,53             | 26,17                 | 0,21                | 9,54                 | 35,92                     | 56,00                 | -20,08              | QP      |
| 0,53             | 4,44                  | 0,21                | 9,54                 | 14,19                     | 46,00                 | -31,81              | AVERAGE |
| 1,74             | 2,97                  | 0,35                | 9,57                 | 12,89                     | 46,00                 | -33,11              | AVERAGE |
| 1,74             | 21,54                 | 0,35                | 9,57                 | 31,46                     | 56,00                 | -24,54              | QP      |
| 2,61             | 15,27                 | 0,49                | 9,58                 | 25,34                     | 56,00                 | -30,66              | QP      |
| 2,61             | 1,40                  | 0,49                | 9,58                 | 11,47                     | 46,00                 | -34,53              | AVERAGE |
| 5,45             | 5,37                  | 0,69                | 9,63                 | 15,69                     | 60,00                 | -44,31              | QP      |
| 5,45             | 1,84                  | 0,69                | 9,63                 | 12,16                     | 50,00                 | -37,84              | AVERAGE |

Live Line  
Level(dBμV)



Measure data:

| Frequency<br>MHz | read<br>level<br>dBμV | Cable<br>Loss<br>dB | LISN<br>Factor<br>dB | Measured<br>level<br>dBμV | Limit<br>Line<br>dBμV | Over<br>limit<br>dB | Remark  |
|------------------|-----------------------|---------------------|----------------------|---------------------------|-----------------------|---------------------|---------|
| 0.16             | 29.14                 | 0.10                | 9.69                 | 38.93                     | 65.43                 | -26.49              | QP      |
| 0.16             | 5.35                  | 0.10                | 9.69                 | 15.14                     | 55.43                 | -40.28              | AVERAGE |
| 0.25             | 26.81                 | 0.12                | 9.70                 | 36.63                     | 61.82                 | -25.19              | QP      |
| 0.25             | 5.05                  | 0.12                | 9.70                 | 14.87                     | 51.82                 | -36.95              | AVERAGE |
| 0.56             | 26.23                 | 0.22                | 9.70                 | 36.15                     | 56.00                 | -19.85              | QP      |
| 0.56             | 5.01                  | 0.22                | 9.70                 | 14.93                     | 46.00                 | -31.07              | AVERAGE |
| 0.90             | 23.05                 | 0.28                | 9.70                 | 33.03                     | 56.00                 | -22.97              | QP      |
| 0.90             | 3.01                  | 0.28                | 9.70                 | 12.99                     | 46.00                 | -33.01              | AVERAGE |
| 1.85             | 21.52                 | 0.37                | 9.71                 | 31.60                     | 56.00                 | -24.40              | QP      |
| 1.85             | 2.50                  | 0.37                | 9.71                 | 12.58                     | 46.00                 | -33.42              | AVERAGE |
| 2.49             | 15.10                 | 0.47                | 9.74                 | 25.31                     | 56.00                 | -30.69              | QP      |
| 2.49             | 1.46                  | 0.47                | 9.74                 | 11.67                     | 46.00                 | -34.33              | AVERAGE |

--End of Report--