

FCC Part 15 Subpart B&C§15.247

RSS-247 ISSUE No.:1

Test Report

| | |
|----------------------|-----------------------------|
| Equipment Under Test | Bluetooth Module |
| Model Name | MB8811C1 |
| Applicant | Inkel Corporation. |
| FCC ID | VNH-MB8811C1 |
| IC Number | 10581A-MB8811C1 |
| Manufacturer | Inkel Corporation. |
| Date of Test(s) | 2017. 02. 14 ~ 2017. 02. 28 |
| Date of Issue | 2017. 02.28 |

In the configuration tested, the EUT complied with the standards specified above.

| Issue to | Issue by |
|---|---|
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Revision history

| Revision | Date of issue | Description | Revised by |
|----------|---------------|--|------------|
| -- | Feb 24, 2017 | Initial | -- |
| 1 | Feb 28, 2017 | AC Line Conducted Test add & Band-edge Compliance modify | Nanju.Yoo |

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1. Attestation of test result

1.1. Details of applicant

Applicant : Inkel Corporation.
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1.2. Manufacturer / Factory Information

Factory 1 : Inkel Vietnam Co., Ltd.
Address : Block 26, Quang Minh Industrial Zone, Quang Minh Town, Me Linh District, Hanoi City, 100000, Vietnam

Factory2 : Dongguan Inkel Electronics Co., Ltd.
Address : Shang qiao Industrial Road No.36, Dongcheng District, Dongguan City, Guangdong Province, 523111, People's Republic of China

1.3. Summary of test results

The EUT has been tested according to the following specifications;

| Section in FCC part 15 | Section in RSS-GEN, RSS-247 | Description | Result |
|----------------------------------|-----------------------------|---|--------|
| §15.205 §15.209 §15.247(d) | 5.5 | Transmitter radiated spurious emissions, Conducted spurious emission | C |
| §15.109(a) | RSS-Gen 7 | Receiver radiated spurious emission | C |
| §15.247(a)(2) | A8.2(a) | 6 dB Bandwidth and 99 % bandwidth | C |
| §15.247(b)(e) | A8.4(4) | Maximum Conducted Output Power | C |
| §15.247(e) | A8.2(b) | Transmitter Power Spectral Density | C |
| §1.1307(b)(1) | RSS-Gen 5.5 RSS-102 | RF exposure evaluation | C |
| §15.207(a) | RSS-Gen 8.8 | AC Conducted power line test | C |

The sample was tested according to the following specification:

FCC Parts 15.247; ANSI C63.4:2014, ANSI C63.10:2013

FCC Public Notice KDB 558074 D01v03r05

RSS-247 ISSUE No.: 1

RSS-GEN ISSUE 4

TEST SITE REGISTRATION NUMBER: FCC(KR0151), IC(6432B-3), IC(21313-1)

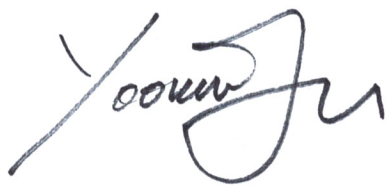
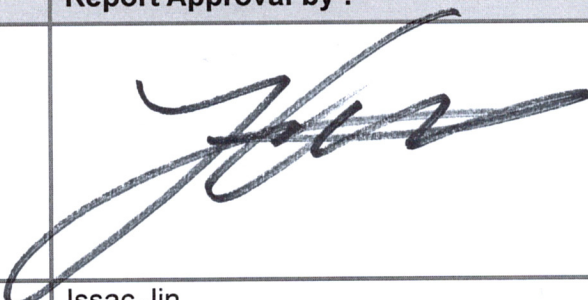
※ Abbreviation

C Complied

N/A Not applicable

F Fail

Approval Signatories

| Test and Report Completed by : | Report Approval by : |
|---|--|
|  |  |
| Nanju Yoo Test Engineer MOVON CORPORATION | Issac Jin Technical Manager MOVON CORPORATION |

2. EUT Description

| | |
|-------------------------------|---------------------------------------|
| Kind of product | Bluetooth Module |
| Model Name | MB8811C1 |
| FCC ID | VNH-MB8811C1 |
| IC Number | 10581A-MB8811C1 |
| Serial Number | N/A |
| Power supply | DC 3.0V |
| Frequency range | 2 402 MHz ~ 2 480 MHz |
| Modulation technique | GFSK |
| Number of channels | 40 |
| Antenna gain | 1.396 dB i (Max.) |
| Test Site Registration Number | FCC(KR0151), IC(6432B-3), IC(21313-1) |

2.1. Declarations by the manufacturer

None

2.2. Details of modification

None

3. Measurement equipment.

| Equipment | Manufacturer | Model | Serial number | Calibration Interval | Calibration due. |
|--------------------------------------|--------------|-----------------|----------------------|----------------------|------------------|
| Test Receiver | R&S | ESVS30 | 829673/015 | 1 year | 2017-12-09 |
| Signal Generator | R&S | SMA100A | 102188 | 1 year | 2017-12-09 |
| Spectrum Analyzer | R&S | FSV-40 | 100832 | 1 year | 2017-11-09 |
| Power Meter | Agilent | E4416A | GB41290645 | 1 year | 2017-06-28 |
| Power Sensor | Agilent | 9327A | US40441490 | 1 year | 2017-06-28 |
| Horn Antenna | R&S | HF906 | 100236 | 2 year | 2017-07-24 |
| Horn Antenna | R&S | HF906 | 100235 | 2 year | 2017-04-23 |
| Horn Antenna | AH Systems | SAS-572 | 269 | 2 year | 2017-09-07 |
| TRILOG Supper Broadband test Antenna | SCHWARZBECK | SAS-521-7 | 9161-4159 | 2 year | 2018-06-14 |
| Power Amplifier | MITEQ | AM-1431 | 1497315 | 1 year | 2017-06-28 |
| Power Amplifier | MITEQ | AFS43-01002600 | 1374382 | 1 year | 2017-11-03 |
| High Pass Filter | Wainwright | WHK3.0/18G-10SS | 508 | 1 year | 2017-06-29 |
| Controller | INNCO | CO2000 | co200/064/6961003/L | N/A | N/A |
| Antenna Master | INNCO | MA4000 | MA4000/038/6961003/L | N/A | N/A |
| Loop Antenna | ETS LINDGREN | 6502 | 00118166 | 2 year | 2018-02-23 |
| TWO LINE-V-NETWORK | R&S | ESH3-Z5 | 100296 | 1 year | 2017-12-09 |
| Power Amplifier | TESTEK | TK-PA6S | 140009 | 1 year | 2017-12-08 |

※Remark;

Support equipment

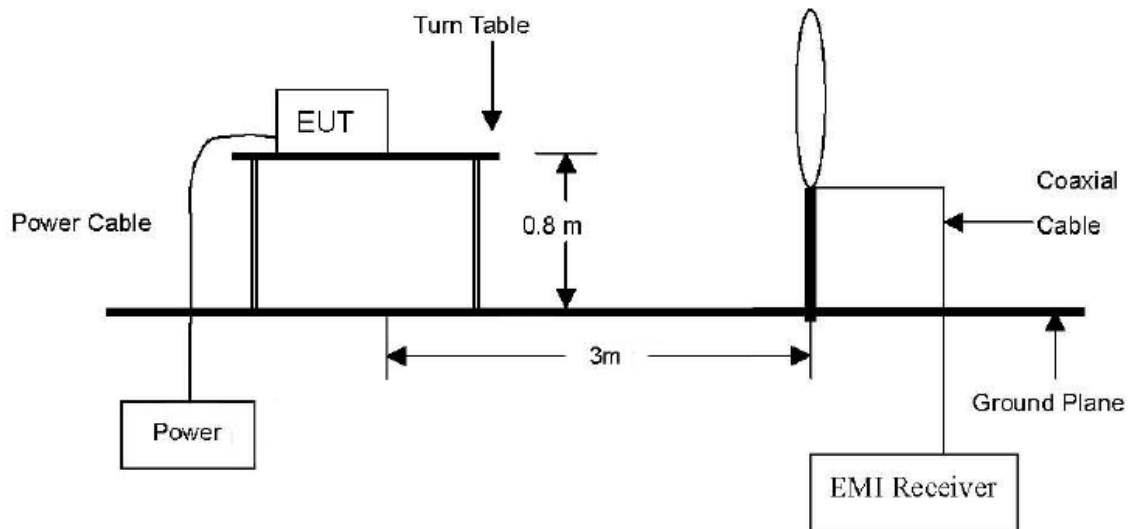
| Description | Manufacturer | Model | Serial number |
|-------------------|--------------|----------------|---------------|
| Notebook computer | DELL | Lattitude D510 | - |

4. Transmitter radiated spurious emissions and conducted spurious emissions

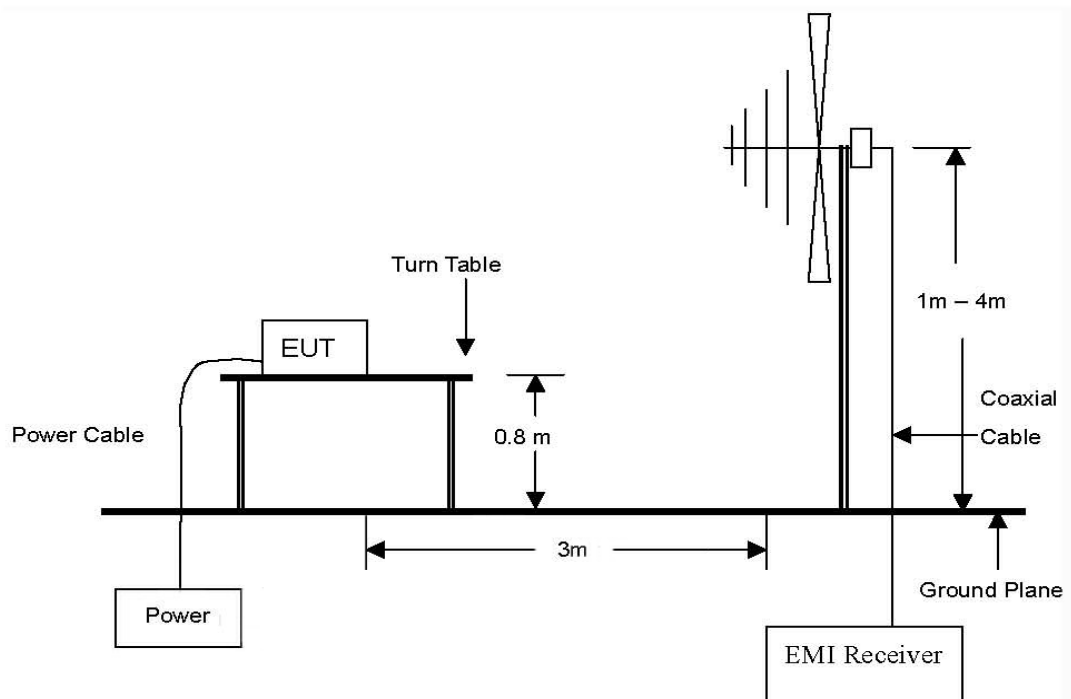
4.1. Test setup

4.1.1. Transmitter radiated spurious emissions

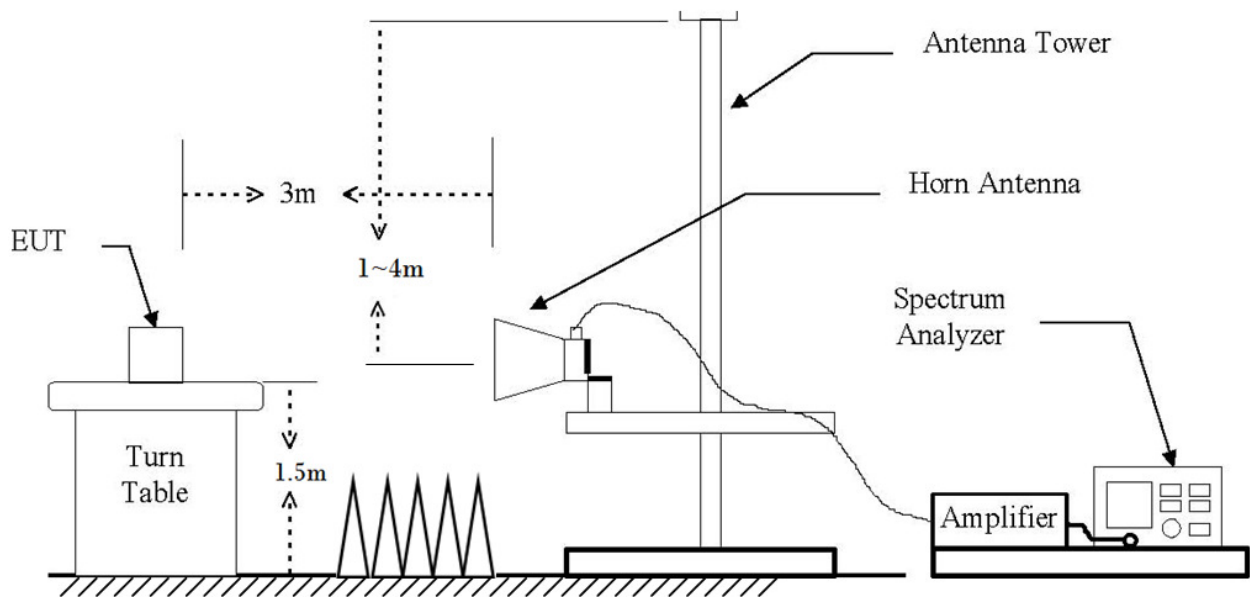
The diagram below shows the test setup that is utilized to make the measurements for emission from 9kHz to 30MHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to 40 GHz emissions.



4.2. Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

According to § 15.109(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

| Frequency (MHz) | Distance (Meters) | Radiated at 3M (dBμV/m) | Radiated (μV/m) |
|--------------------|----------------------|----------------------------|--------------------|
| 0.009–0.490 | 300 | See the remark | 2400/F(kHz) |
| 0.490–1.705 | 30 | | 24000/F(kHz) |
| 1.705–30.0 | 30 | | 30 |
| 30 - 88 | 3 | 40.0 | 100 |
| 88 – 216 | 3 | 43.52 | 150 |
| 216 – 960 | 3 | 46.02 | 200 |
| Above 960 | 3 | 53.97 | 500 |

*Remark

1. Emission level in dB uV/m= $20 \log (\mu\text{V/m})$
2. Measurement was performed at an antenna to the closed point of EUT distance of meters.
3. Distance extrapolation factor = $40 \log (\text{Specific distance/ test distance})(\text{dB})$
Limit line=Specific limits(dB uV) + distance extrapolation factor.

4.3. Test procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10:2013. In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately.

4.3.1. Test procedures for radiated spurious emissions

1. The EUT is placed on a turntable, which is 0.8 m (Below 1 GHz)/ 1.5 m (Above 1 GHz) above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

※ **Remark;**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for Peak detection (PK) at frequency below 30 MHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 GHz.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
4. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz for Average detection (AV) at frequency above 1 GHz.

4.3.2. Test procedures for conducted spurious emissions

All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

Per the guidance of KDB 558074, section 5.4.1.1, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 kHz. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 4.4.4. The limit for out of band spurious emission at the band edge is 30 dB below the fundamental emission level measured in a 100 kHz bandwidth.

4.4. Test result

Ambient temperature: 20°C

Relative humidity: 45% R.H.

4.4.1. Spurious radiated emission

The frequency spectrum from 9kHz to 30MHz was investigated. Emission levels are not reported much lower than the limits by over 20 dB. All reading values are peak values.

To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|----------------|---------------|------|--------------------|---------|-----------------|----------------|-------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

B. Middle channel (2 440 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|----------------|---------------|------|--------------------|---------|-----------------|----------------|-------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

C. High channel (2 480 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|----------------|---------------|------|--------------------|---------|-----------------|----------------|-------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

※ Remark

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBμV) + Distance extrapolation factor
4. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

4.4.2. Spurious radiated emission

The frequency spectrum from 30 MHz to 1 000 MHz was investigated. Emission levels are not reported much lower than the limits by over 20 dB. All reading values are peak values.

To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 168.00 | 13.48 | PK | H | 18.31 | 2.72 | 34.51 | 43.52 | 9.01 |
| 323.00 | 19.55 | PK | H | 13.91 | 3.81 | 36.94 | 46.02 | 9.08 |
| 491.68 | 17.50 | PK | V | 17.76 | 4.77 | 40.01 | 46.02 | 6.01 |
| 796.10 | 10.11 | PK | V | 22.38 | 6.13 | 38.69 | 46.02 | 7.33 |
| 833.08 | 16.70 | PK | V | 22.80 | 6.28 | 41.70 | 46.02 | 4.32 |
| Above 900.00 | Not detected | - | - | - | - | - | - | - |

B. Middle channel (2 440 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 167.56 | 13.65 | PK | H | 18.31 | 2.72 | 34.68 | 43.52 | 8.84 |
| 326.13 | 19.73 | PK | H | 13.91 | 3.81 | 37.12 | 46.02 | 8.90 |
| 492.28 | 16.74 | PK | V | 17.76 | 4.77 | 39.25 | 46.02 | 6.77 |
| 795.41 | 10.13 | PK | V | 22.38 | 6.13 | 38.71 | 46.02 | 7.31 |
| 835.13 | 17.68 | PK | V | 22.80 | 6.28 | 42.68 | 46.02 | 3.34 |
| Above 900.00 | Not detected | - | - | - | - | - | - | - |

C. High channel (2 480 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 168.52 | 13.59 | PK | H | 18.31 | 2.72 | 34.62 | 43.52 | 8.90 |
| 321.26 | 19.74 | PK | H | 13.91 | 3.81 | 37.13 | 46.02 | 8.89 |
| 493.52 | 17.01 | PK | V | 17.76 | 4.77 | 39.52 | 46.02 | 6.50 |
| 797.46 | 8.98 | PK | V | 22.38 | 6.13 | 37.56 | 46.02 | 8.46 |
| 834.68 | 15.81 | PK | V | 22.80 | 6.28 | 40.81 | 46.02 | 5.21 |
| Above 900.00 | Not detected | - | - | - | - | - | - | - |

※ Remark

- Actual = Reading + Ant. factor + CL (Cable loss)
- 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

4.4.3. Spurious radiated emission

The frequency spectrum above 1 000 MHz was investigated. Emission levels are not reported much lower than the limits by over 20 dB.

To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | Amp + CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 4 803.75 | 62.33 | Peak | V | 32.89 | 33.72 | 61.50 | 74.00 | 12.50 |
| 4 803.97 | 50.54 | Average | V | 32.89 | 33.72 | 49.71 | 54.00 | 4.29 |
| 4 803.68 | 56.33 | Peak | H | 32.89 | 33.72 | 55.50 | 74.00 | 18.50 |
| 4 803.97 | 45.62 | Average | H | 32.89 | 33.72 | 44.79 | 54.00 | 9.21 |
| Above 5 000.00 | - | - | - | - | - | - | - | - |

B. Middle channel (2 440 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | Amp + CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 4 879.34 | 63.70 | Peak | V | 32.89 | 33.72 | 62.87 | 74.00 | 11.13 |
| 4 879.92 | 51.37 | Average | V | 32.89 | 33.72 | 50.54 | 54.00 | 3.46 |
| Above 5 000.00 | - | - | - | - | - | - | - | - |

※ Remark

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental Frequency.
2. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor - Amp + CL (Cable loss)
5. 15.31 Measurement standards.

C. High channel (2 480 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|---------------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | Amp + CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 4 959.49 | 59.85 | Peak | V | 32.89 | 33.72 | 59.02 | 74.00 | 14.98 |
| 4 960.00 | 46.77 | Average | V | 32.89 | 33.72 | 45.94 | 54.00 | 8.06 |
| Above 5 000.00 | - | - | - | - | - | - | - | - |

※ Remark

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental Frequency.
2. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor - Amp + CL (Cable loss)
5. 15.31 Measurement standards.

THE AMPLITUDE OF SPURIOUS EMISSIONS FROM INTENTIONAL RADIATORS AND EMISSIONS FROM UNINTENTIONAL RADIATORS WHICH ARE ATTENUATED MORE THAN 20 DB BELOW THE PERMISSIBLE VALUE NEED NOT BE REPORTED UNLESS SPECIFICALLY REQUIRED ELSEWHERE IN THIS PART.

4.5 Radiated Band Edge

4.5.1 Limit of Radiated Band Edges

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30dB instead of 20dB.

In addition, radiated emissions which fall in test restricted bands must also comply with the FCC section 15.209 limits as below.

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|-----------------|-----------------------------------|-------------------------------|
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

4.5.2 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement. For average measurement:
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.

4.5.3. Test Result

A. 2 310 - 2 390 MHz measurement (2 402MHz)

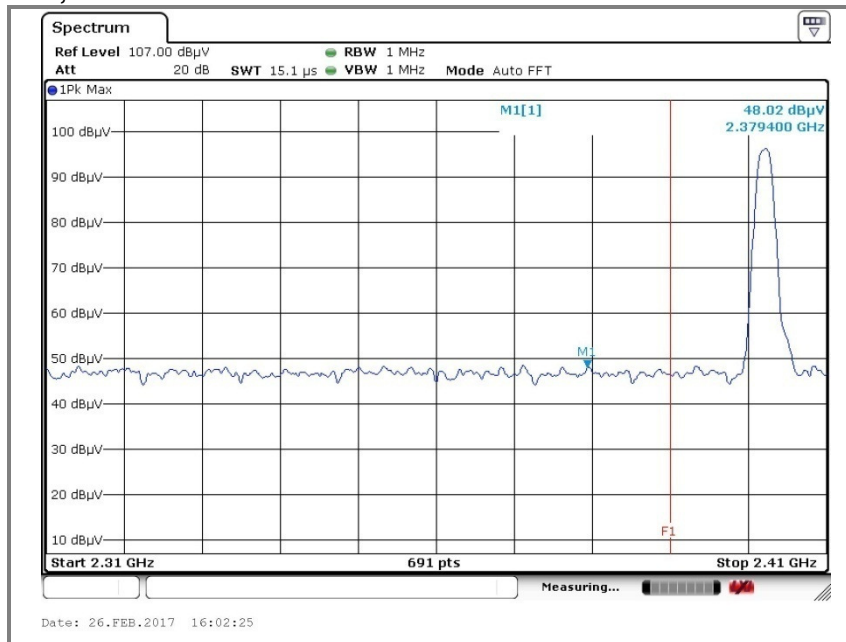
| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|-------------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | Amp+CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 2 379.40 | 48.02 | Peak | H | 28.21 | 36.64 | 39.59 | 74.00 | 34.41 |
| 2 384.60 | 35.16 | Average | H | 28.21 | 36.64 | 26.73 | 54.00 | 27.27 |
| 2 384.32 | 47.61 | Peak | V | 28.21 | 36.64 | 39.18 | 74.00 | 34.82 |
| 2 384.32 | 35.19 | Average | V | 28.21 | 36.64 | 26.76 | 54.00 | 27.24 |

B. 2 483.5 – 2 500 MHz measurement (2 480MHz)

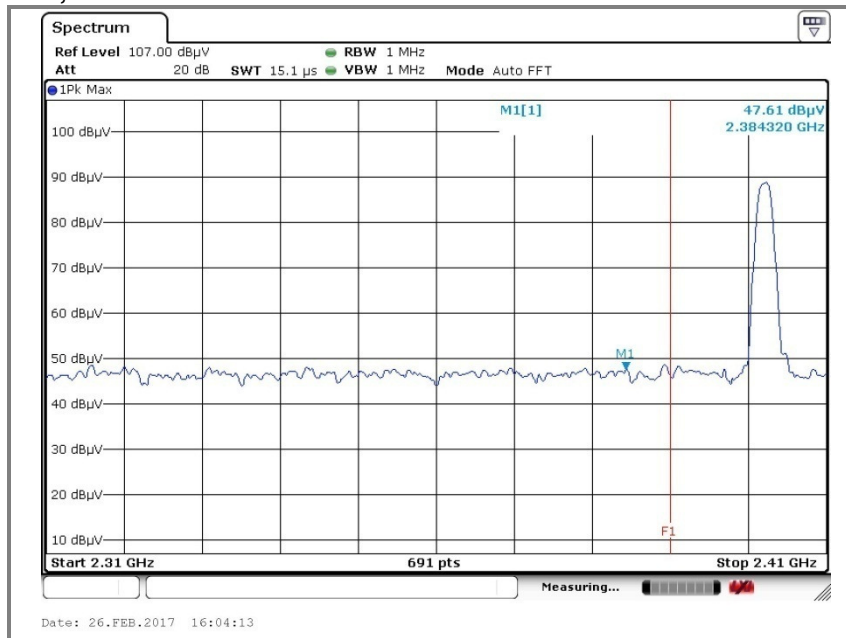
| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--------------------|----------------------|---------------|------|--------------------|-------------|-----------------------|----------------------|-------------|
| Frequency (MHz) | Reading (dB μ V) | Detector mode | Pol. | Ant. factor (dB/m) | Amp+CL (dB) | Actual (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
| 2 484.09 | 48.39 | Peak | V | 28.21 | 36.64 | 39.96 | 74.00 | 34.04 |
| 2 484.09 | 34.76 | Average | V | 28.21 | 36.64 | 26.33 | 54.00 | 27.67 |
| 2 492.38 | 47.86 | Peak | H | 28.21 | 36.64 | 39.43 | 74.00 | 34.57 |
| 2 492.58 | 32.18 | Average | H | 28.21 | 36.64 | 23.75 | 54.00 | 30.25 |

A. Low channel(2 402 MHz) 2 310 - 2 390 MHz measurement

Detected Mode : Peak, Hor

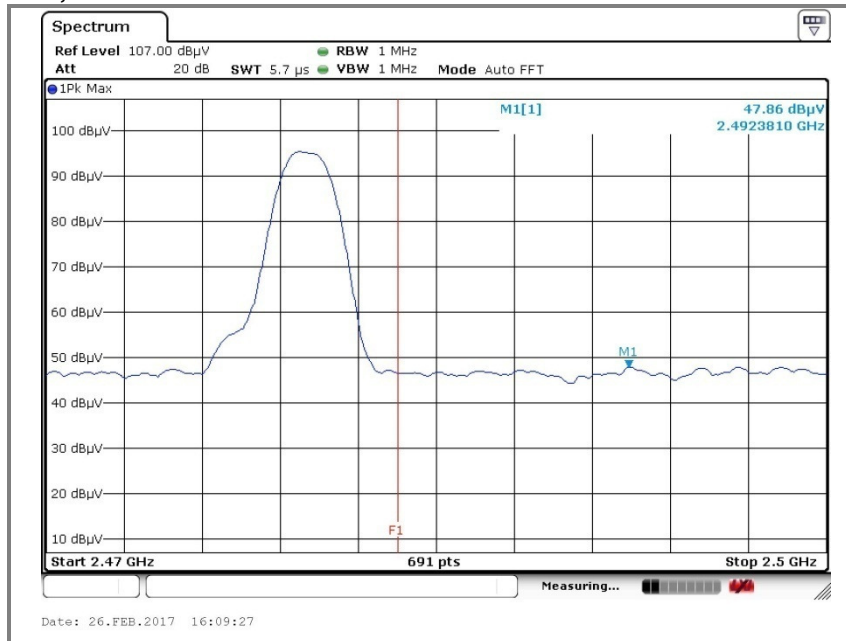


Detected Mode : Peak, Ver

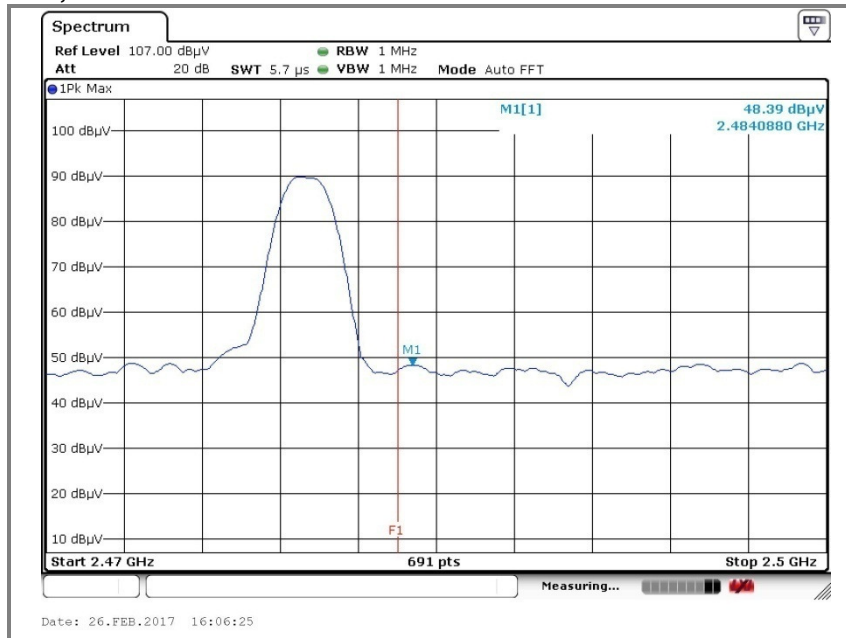


B. High channel(2 480 MHz) 2 483.5 – 2 500 MHz measurement

Detected Mode : Peak, Hor



Detected Mode : Peak, Ver



5. Receiver radiated spurious emissions

5.1. Test setup

Same as clause 5.1.

5.1.1. Receiver radiated spurious emissions

Same as clause 5.1.1

5.2. Limit

According to §15.109(a), Except for Class A digital devices, the field strength of radiated emission from unintentional radiator at a distance of 3 m shall not exceed the following values:

| Frequency (MHz) | Distance (Meters) | Radiated (dB μ V/m) | Radiated (μ V/m) |
|--------------------|----------------------|----------------------------|--------------------------|
| 0.009–0.490 | 300 | See the remark | 2400/F(kHz) |
| 0.490–1.705 | 30 | | 24000/F(kHz) |
| 1.705–30.0 | 30 | | 30 |
| 30 - 88 | 3 | 40.0 | 100 |
| 88 – 216 | 3 | 43.5 | 150 |
| 216 – 960 | 3 | 46.0 | 200 |
| Above 960 | 3 | 54.0 | 500 |

5.3. Test procedures

Same as clause 5.3.

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003. In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately.

5.3.1. Test procedures for radiated spurious emissions

Same as Clause 5.3.1.

5.4. Test results

Ambient temperature: 20 °C

Relative humidity: 45% R.H.

5.4.1. Spurious radiated emission.

The frequency spectrum from 30 MHz to 26GHz was investigated. Emission levels are not reported much lower than the limits by over 30 dB. All reading values are peak values.

A. Low channel (2 402 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|-------------------|------------------|------|-----------------------|------------|--------------------|-------------------|----------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

B. Middle channel (2 440 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|-------------------|------------------|------|-----------------------|------------|--------------------|-------------------|----------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

C. High channel (2 480 MHz)

| Radiated emissions | | | Ant. | Correction factors | | Total | Limit | |
|--|-------------------|------------------|------|-----------------------|------------|--------------------|-------------------|----------------|
| Frequency (MHz) | Reading (dBμV) | Detector mode | Pol. | Ant. factor (dB/m) | CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No other emissions were detected at a level greater than 20dB below limit. | | | | | | | | |

※ Remark

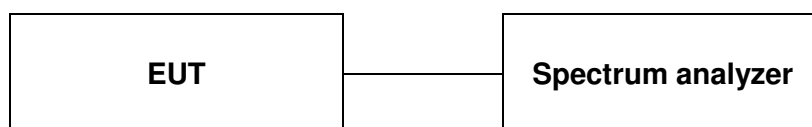
1. Actual = Reading + Ant. factor + CL (Cable loss)

2. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

6. 6 dB bandwidth& 99% bandwidth measurement

6.1. Test setup



6.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902~928 MHz, 2 400~2 483.5 MHz, and 5 725~5 825 MHz bands. The minimum of 6 dB Bandwidth shall be at least 500 kHz

6.3. Test procedure

1. The 6dB band width was measured with a spectrum analyzer connected to RF antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate centerfrequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.Display Line and Marker Delta functions, the 6dB band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100kHz, VBW ≥ 3 x RBW, Span= 2times the DTS bandwidth
Detector= peak, Trace = max hold, Sweep=auto couple

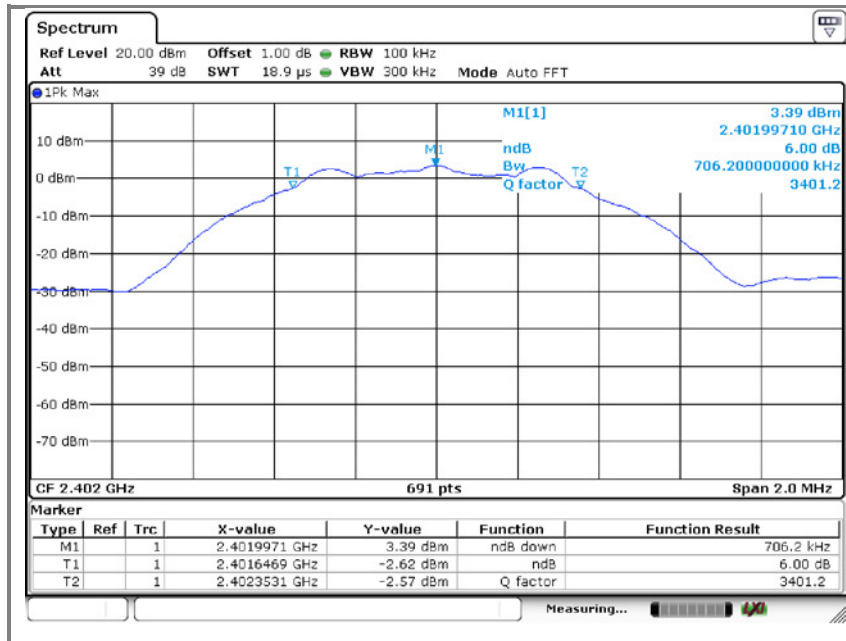
6.4. Test results

Ambient temperature: 22℃

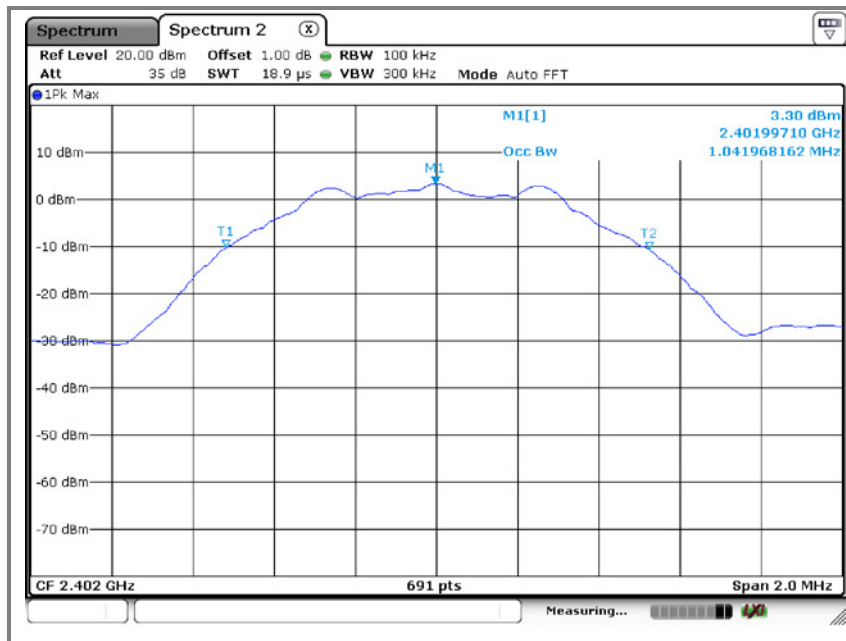
Relative humidity: 45% R.H.

| Frequency(MHz) | 6 dB bandwidth(MHz) | 99% bandwidth(MHz) |
|----------------|---------------------|--------------------|
| 2 402 | 0.706 | 1.042 |
| 2 440 | 0.703 | 1.039 |
| 2 480 | 0.700 | 1.039 |

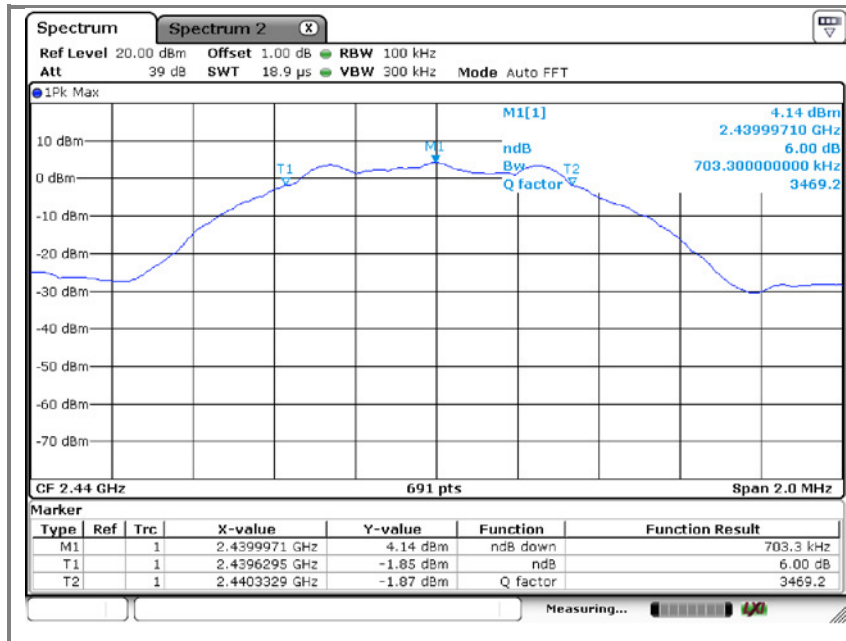
A. Low channel(2 402 MHz) - 6 dB bandwidth



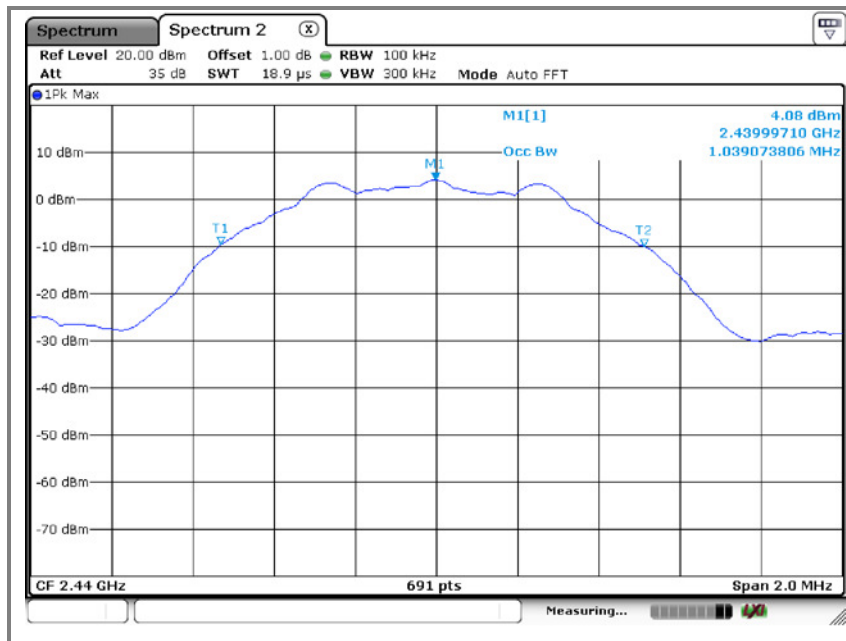
A. Low channel(2 402 MHz)–99 % bandwidth



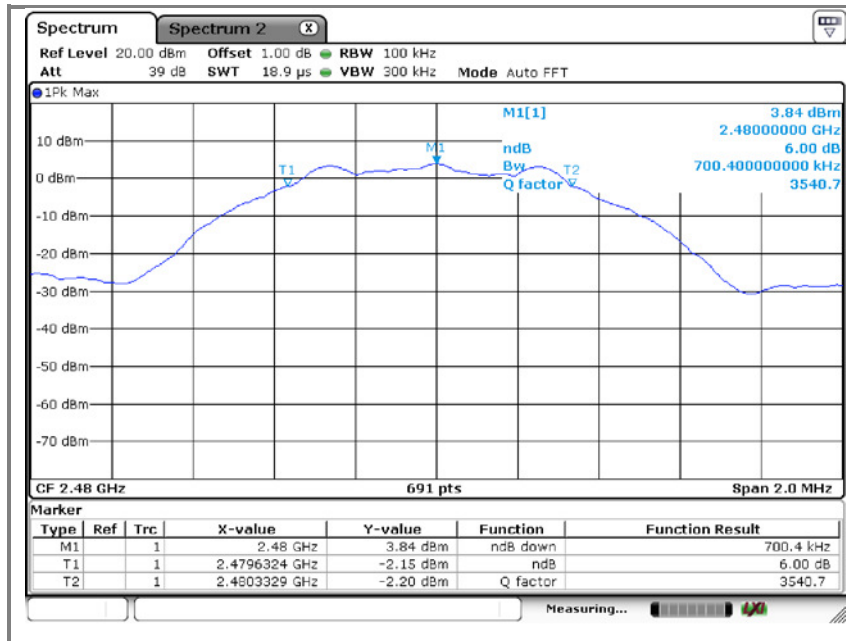
B. Middle channel(2 440 MHz)- 6 dB bandwidth



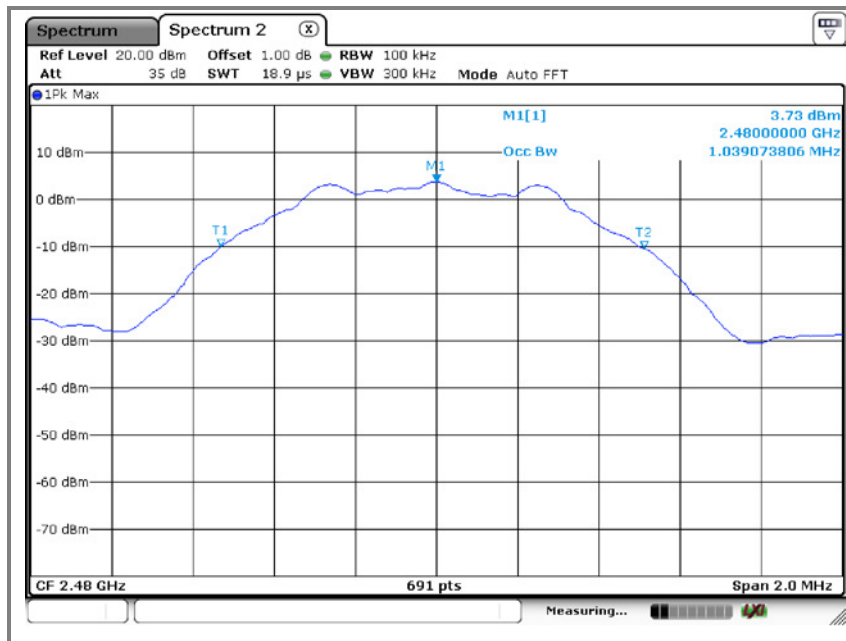
B. Middle channel(2 440 MHz)-99 % bandwidth



C. High channel(2 480 MHz) -6 dB bandwidth

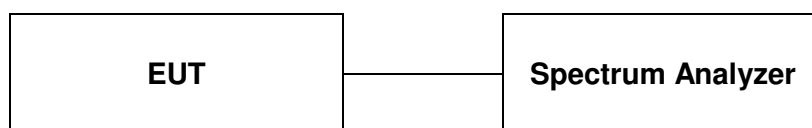


C. High channel(2 480 MHz)–99 % bandwidth



7. Maximum Output Power Measurement

7.1. Test setup.



7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following:

- §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 6 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW
- §15.247(b)(1), For frequency hopping systems operating in the 2400–2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5805 MHz band: 1 Watt.

7.3 Test procedure

Maximum Peak Conducted Output Power is measured using the following procedure (RBW ≥ DTS bandwidth).

- Set the RBW ≥ DTS bandwidth.
- Set VBW ≥ 3 x RBW. / Set span ≥ 3 x RBW.
- Sweep time = auto couple
- Detector = peak
- Trace mode = max hold
- Allow trace to fully stabilize
- Use peak marker function to determine the peak amplitude level.

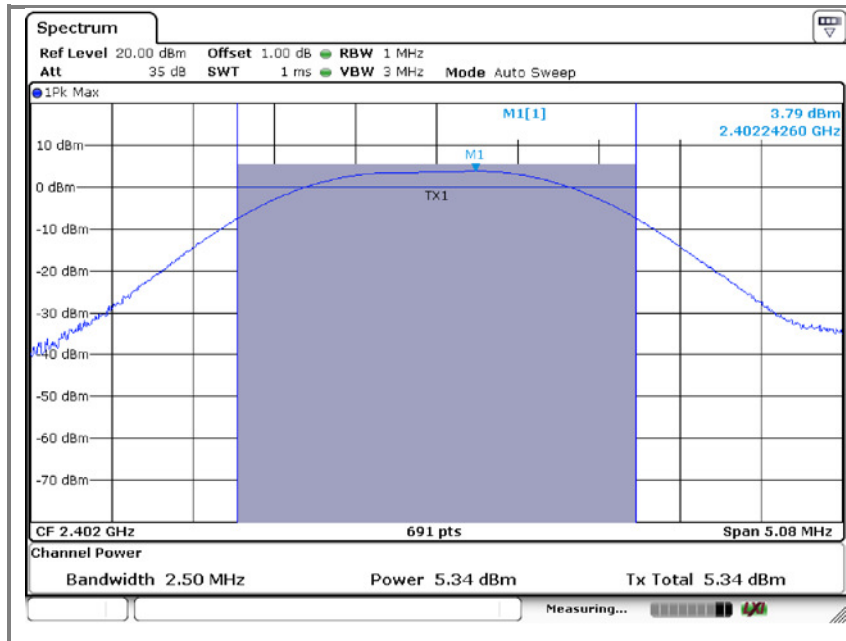
7.4 Test results

Ambient temperature: 22°C

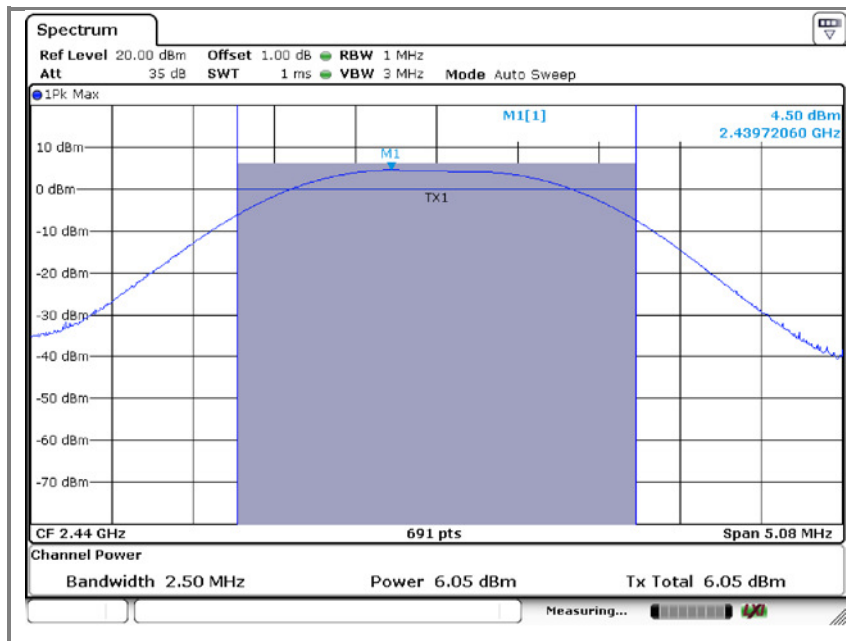
Relative humidity: 45% R.H.

| Frequency(MHz) | Conducted power (dBm) | Limit (dBm) |
|----------------|-----------------------|-------------|
| 2 402 | 5.34 | 30 |
| 2 440 | 6.05 | |
| 2 480 | 5.73 | |

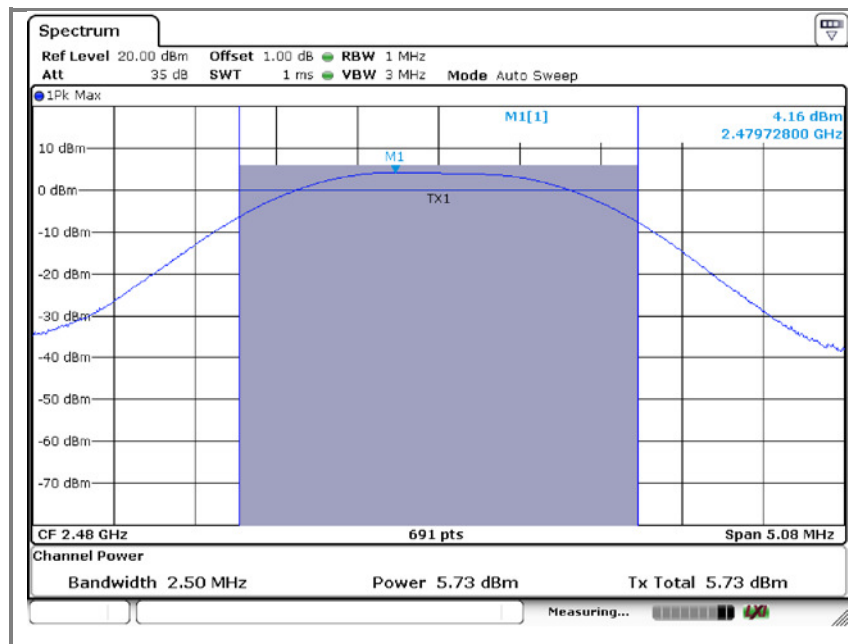
A. Low channel(2 402 MHz)



B. Middle channel(2 440 MHz)

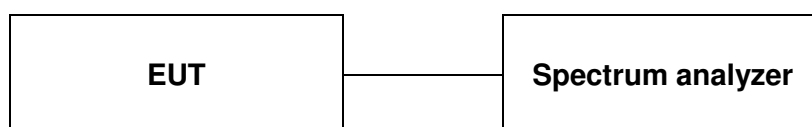


C. High channel(2 480 MHz)



8. Power Spectral Density Measurement

8.1. Test setup



8.2. Limit

< 8dBm @ 3kHz BW

8.3. Test procedure (PKPSD)

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency,A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using;
 Span = 1.5 times the DTS bandwidth
 $RBW = 3\text{kHz} \leq RBW \leq 100\text{kHz}$
 $VBW \geq 3 \times RBW$,Sweep = Auto couple
 Detectorfunction = peak, Trace = max hold

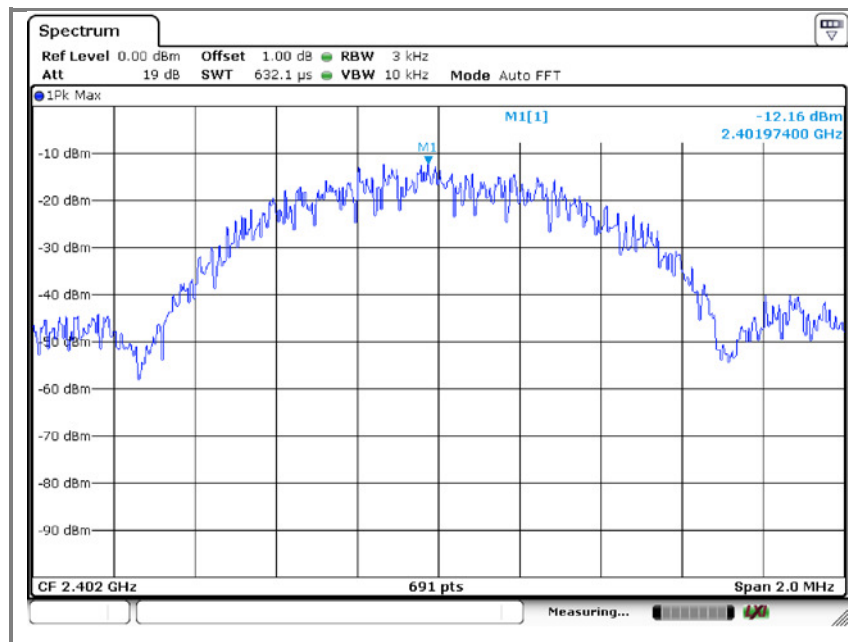
8.4. Test results

Ambient temperature: 22°C

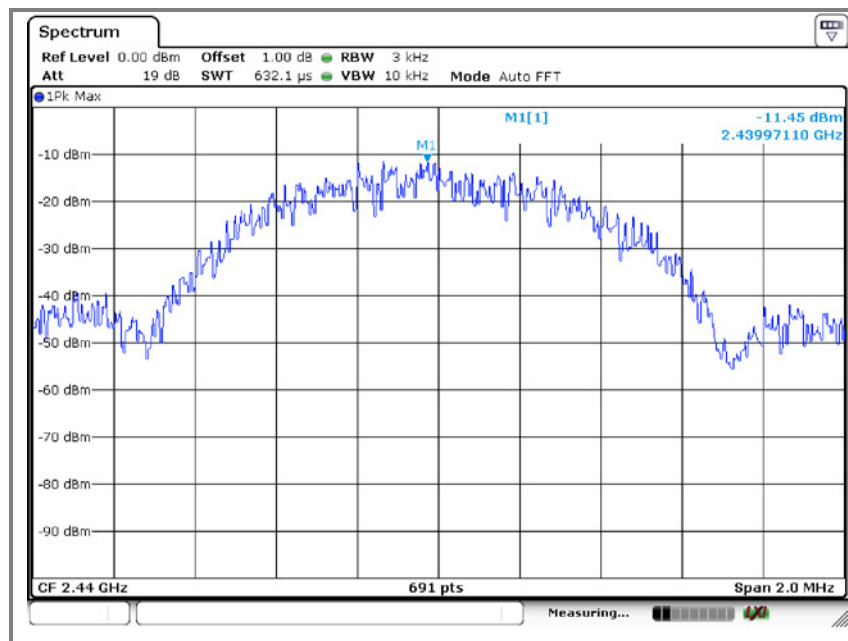
Relative humidity: 45% R.H.

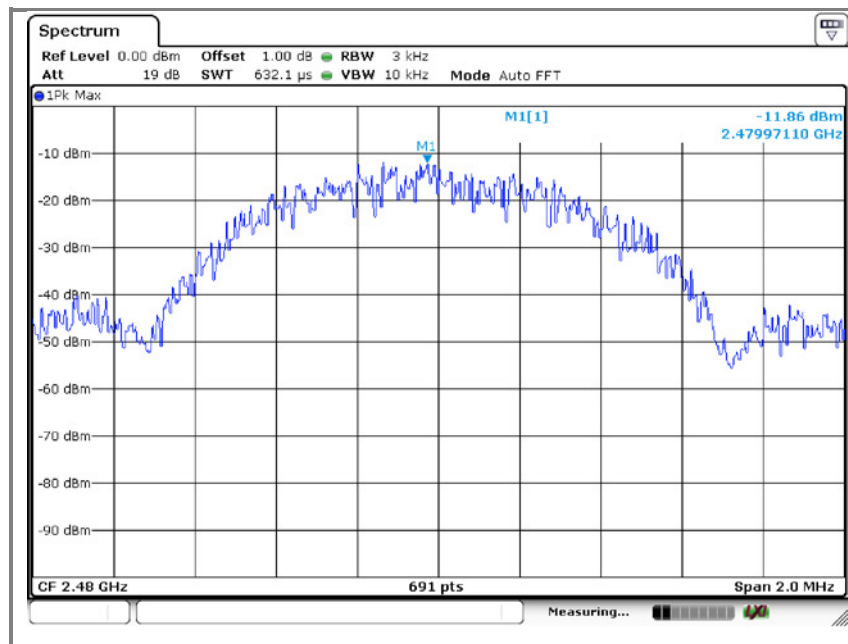
| Frequency(MHz) | Peak output power(dBm) | Limit (dBm) |
|----------------|------------------------|-------------|
| 2 402 | -12.16 | 8 |
| 2 440 | -11.45 | |
| 2 480 | -11.86 | |

A. Low channel(2 402 MHz)



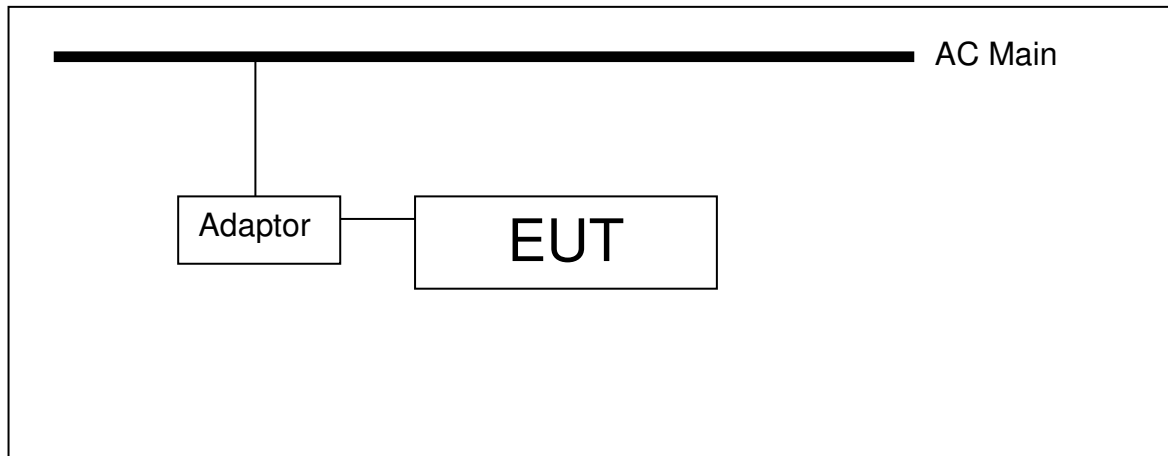
B. Middle channel(2 440 MHz)



C. High channel(2 480 MHz)

9. AC Conducted power line test

9.1 Test setup



9.2 Limit

According to §15.107(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50ohm line impedance stabilization network(LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

| Frequency of Emission (MHz) | Conducted limit (dBμV/m) | |
|-----------------------------|--------------------------|---------|
| | Quasi-peak | Average |
| 0.15 – 0.50 | 66-56* | 56-46* |
| 0.50 – 5.00 | 56 | 46 |
| 5.00 – 30.0 | 60 | 50 |

※ Remark

Decreases with the logarithm of the frequency.

9.3 Test procedures

The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L×W×H) shielded room. The EUT along with its peripherals were placed on a 1.0m(W)× 1.5m(L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.

The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

9.4 Test results

Ambient temperature: 26 °C

Relative humidity: 45 % R.H.

Frequency range: 0.15 MHz ~ 30 MHz

Measured bandwidth: 9 kHz

| Freq. (MHz) | Line | Q-Peak | | |
|-------------|------|---------------------|---------------------|------------|
| | | Level(dB μ V/m) | Limit(dB μ V/m) | Margin(dB) |
| 0.16 | H | 39.14 | 65.57 | 26.43 |
| 0.27 | N | 36.54 | 61.24 | 24.70 |
| 0.47 | H | 33.52 | 56.51 | 22.99 |
| 0.94 | H | 34.81 | 56.00 | 21.19 |
| 8.90 | H | 35.50 | 60.00 | 24.50 |
| 24.47 | H | 39.58 | 60.00 | 20.42 |

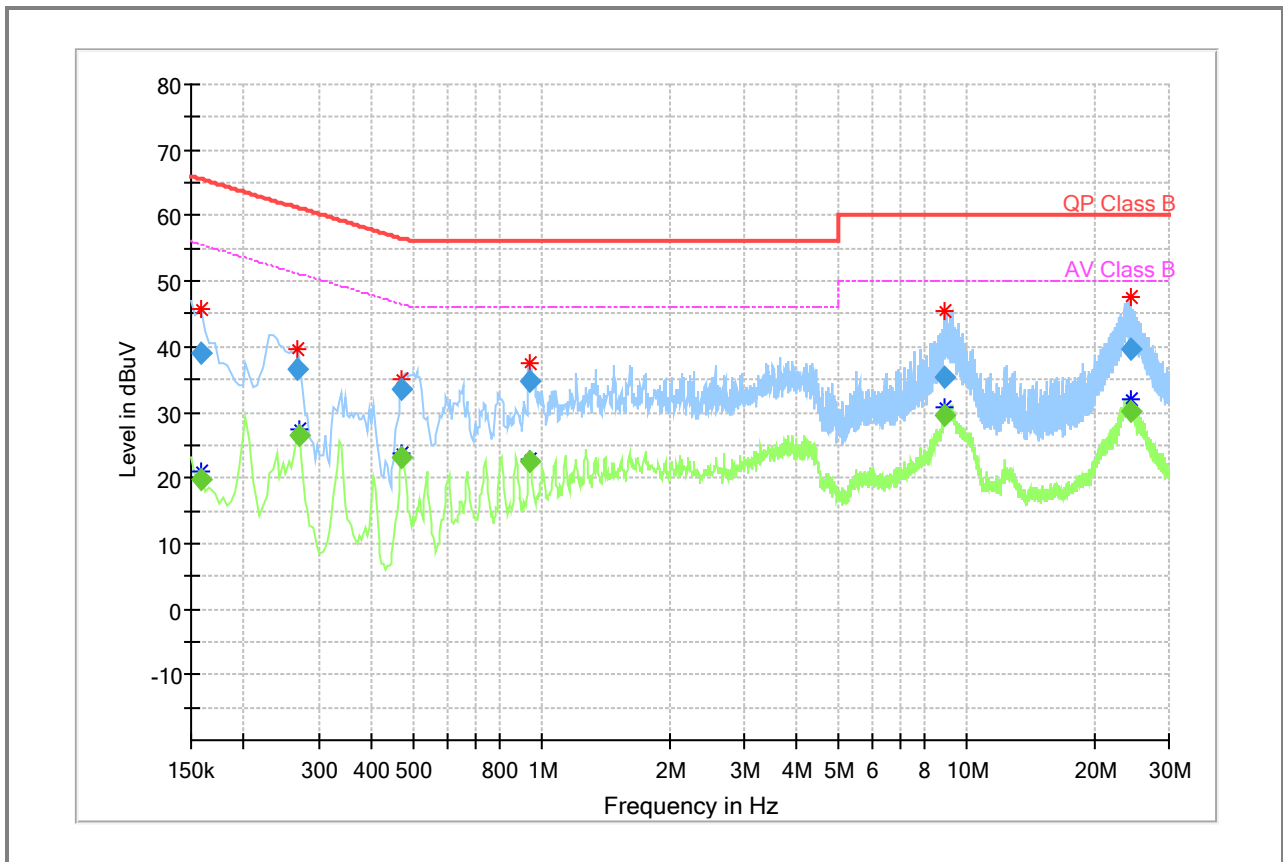
| Freq. (MHz) | Line | Average | | |
|-------------|------|---------------------|---------------------|------------|
| | | Level(dB μ V/m) | Limit(dB μ V/m) | Margin(dB) |
| 0.16 | H | 19.69 | 55.57 | 35.87 |
| 0.27 | N | 26.56 | 51.12 | 24.56 |
| 0.47 | N | 22.98 | 46.51 | 23.53 |
| 0.94 | N | 22.46 | 46.00 | 23.54 |
| 8.90 | H | 29.50 | 50.00 | 20.50 |
| 24.50 | H | 30.25 | 50.00 | 19.75 |

※ Remark

Line(H): Hot

Line(N): Neutral

Plot of conducted power line



10. Antenna requirement

10.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6dBi are used.

10.2. Antenna Connected Construction

Antenna used in this product is PCB antenna,
Antenna gain is 1.396 dBi.

11. RF exposure evaluation

11.1 RF Exposure Compliance Requirement

11.1.1 Standard Requirement

According to KDB447498 D01 General RF Exposure Guidance v06

4.3.1. Standalone SAR test exclusion considerations

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

11.1.2 Limits

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where $f(\text{GHz})$ is the RF channel transmit frequency in GHz

Power and distance are rounded to the nearest mW and mm before calculation

The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

11.1.3 EUT RF Exposure

The Max Conducted Peak Output Power is 6.05 dBm in Highest channel(2.441 GHz) ;

The best case gain of the antenna is 1.396dBi

EIRP= 6.05dBm + 1.396dBi = 7.446dBm

7.446 dBm logarithmic terms convert to numeric result is nearly 5.554 mW

According to the formula. calculate the EIRP test result:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$

General RF Exposure = $(5.554 \text{ mW} / 5 \text{ mm}) \times \sqrt{2.441 \text{ GHz}} = 1.735$ ①;

SAR requirement:

S= 3.0

② ;

① < ②.

So the SAR report is not required.

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