**Korea Standard Testlab**
107-27, Jangdeokdong-gil, Namyang-eup, Hwaseong-si, Gyeonggi-do, Korea
Tel : +82-31-356-7333 FAX : +82-31-356-7303

# FCC TEST REPORT

| | |
|---|---|
| Applicant Name | : ST Electronics Co., Ltd. |
| Brand Name | : N/A |
| Applicant Address | : 234-1 Anajiro , Gyeyang-gu , Incheon , Republic of Korea |
| FCC ID | : 2AIMY-HN03MS |
| Products Name | : Electric Sterilizer |
| Model No. | : HN-03-MS |
| Variant Model No. | : HN-03-S, HN-03-BK, HN-03-B, HN-03-G, HN-03-P, HN-03-MS-N, HN-03-S-N, HN-03-BK-N, HN-03-B-N, HN-03-G-N, HN-03-P-N |
| Products Manufacturer | : ST Electronics Co., Ltd. |
| Test Standard | : FCC CFR 47 Part 15.247 Subpart C |
| Test Method | : KDB 558074 D01 v03r05 and ANSI C63.10:2013 |
| Test Result | : PASS |
| Dates of Test | : May 30, 2016 to June 03, 2016 |
| Date of Issue | : June 08, 2016 |
| Test Laboratory | : Korea Standard Testlab<br>FCC Registration No. : 251179 |

Tested by

Gyung-Nam Park
Test Engineer

Approved by

Eun-Hee Han
Technical Manager

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# 1. General Information

## 1.1. Client Information

| | | |
|---|---|---|
| Applicant | : | ST Electronics Co., Ltd. |
| Address of Applicant | : | 234-1 Anajiro , Gyeyang-gu , Incheon , Republic of Korea |

## 1.2. General Description of E.U.T.

| | | |
|---|---|---|
| Product Name | : | Electric Sterilizer |
| Model No. | : | HN-03-MS |

## 1.3. Details of E.U.T.

| | | |
|---|---|---|
| Operating Frequency | : | 2402 MHz to 2480 MHz |
| Type of Modulation | : | GFSK |
| Number of Channels | : | 40 Channels |
| Channel Separation | : | 2 MHz |
| Duty Cycle | : | Continuous operation possible for testing purposes |
| Antenna Type | : | Integral Antenna |
| Antenna gain | : | 4.8 dBi |
| Speciality | : | Bluetooth specification version 4.0 (BLE) |
| Power Supply | : | Working voltage |
| Normal Test Voltage | : | DC 12 V |

## 1.4. Test Facility

**-.Address**

Korea Standard Testlab
#107-27, Jangdeokdong-gil, Namyang-eup, Hwaseong-si, Gyeonggi-do, Korea
Tel : +82-31-356-7333
FAX : +82-31-356-7303

**-. Laboratory Acceditations and Listings**

KC Designation No. : KR0155
FCC Registration No. : 251179

## 2. Test Equipment and Ancillaries used for Tests

| No. | Test Equipment | Manufacturer | Model No. | Serial No. | Next Cal. Data | Used equipment |
|---|---|---|---|---|---|---|
| 1 | Spectrum Analyzer | Agilent | E4440A | MY45304715 | 16.11.10 | ■ |
| 2 | Frequency Counter | HP | 5350B | 3049A05530 | 17.06.02 | □ |
| 3 | DC Power Supply | ALINCO | DM-340MV | F001015 | 17.06.01 | ■ |
| 4 | Signal Generator | Leader Electronics | 3220 | 137231 | 17.06.01 | ■ |
| 5 | Synthesized CW Generator | HP | 83711B | US34490158 | 17.06.01 | ■ |
| 6 | SYNTHESIZED SWEEPER | HP | 8340B | 2804A00830 | 17.06.01 | □ |
| 7 | Function Generator | IWATSU | SG-4105 | 62372780 | 17.06.01 | □ |
| 8 | Modulation Analyzer | Agilent | 8901B | 3438A05099 | 17.06.01 | □ |
| 9 | Audio Analyaer | Agilent | 8903B | 3279A18576 | 17.06.01 | □ |
| 10 | Power Meter | Agilent | E4418B | GB43312894 | 17.06.02 | □ |
| 11 | Power Sensor | HP | 8485A | 3316A14708 | 17.06.02 | □ |
| 12 | Power Sensor | Agilent | 8482B | 2703703543 | 17.06.02 | □ |
| 13 | Pre Amplifier | GTC | GA-1825A | GT0929/003 | 17.06.01 | □ |
| 14 | Attenuator | Weinsche | 53-30-33 | MG906 | 17.06.01 | □ |
| 15 | Step Attenuator | Agilent | 8494B | MY41110204 | 17.06.01 | □ |
| 16 | Step Attenuator | Agilent | 8495B | 3308A17660 | 17.06.01 | □ |
| 17 | Step Attenuator | Agilent | 8496B | US40152183 | 17.06.01 | □ |
| 18 | Attenuator | HP | 30dB | N/A | 17.06.01 | □ |
| 19 | Attenuator | TAE SUNG | SMA-1 | N/A | 17.06.01 | □ |
| 20 | Attenuator | TAE SUNG | SMA-2 | N/A | 17.06.01 | □ |
| 21 | Termination | KWANG YEOK | KYTE-NJ-150W | 2040004 | 17.06.01 | □ |
| 22 | Spectrum Analyzer | LIG | ISA-265 | L0812M002 | 16.11.04 | □ |
| 23 | Bluetooth Tester | TESCOM | TC-3000A | 3000A590236 | 17.06.02 | □ |
| 24 | Loop ANT. | Com-Power | AL-130 | 121010 | 17.06.04 | ■ |

| | | | | | | |
|---|---|---|---|---|---|---|
| 25 | Horn ANT. | SCHWARZBECK | BBHA 9120D | 831 | 16.07.21 | ■ |
| 26 | Temp & Humidity Chamber | Seoksan Tech | SE-CT-02 | S7400JD5340618 | 17.06.01 | □ |
| 27 | Test Receiver | LIG Nex1 | LSA-265 | L07098033 | 16.12.06 | ■ |
| 28 | Test Receiver | ROHDE&SCHWARZ | ESPI | 101014 | 17.06.01 | ■ |
| 29 | Bi-log Antenna | SCHWARZBECK | VULB9160 | 3311 | 17.11.18 | ■ |

## 3. Summary of Test Results

| No | Test | Standard Sub-Class | Result |
|---|---|---|---|
| 0 | Antenna Requirement | §15.203,§15.247(c) | Compliant |
| 1 | Maximum Peak Output Power | §15.247(b) | Compliant |
| 2 | Peak Power Spectral Density | §15.247(e) | Compliant |
| 3 | Occupied 6dB Bandwidth | §15.247(a) | Compliant |
| 4 | Band Edges Compliance | §15.247(d) | Compliant |
| 5 | Conducted Spurious Emission | §15.247(d) | Compliant |
| 6 | Radiated Spurious Emission | §15.247, §15.205, §15.209 | Compliant |
| 7 | AC Powerline Conducted Emission | §15.107, §15.207 | Compliant |
| 8 | Radio Frequency Exposure Procedures | §2.1093 | Compliant |

# 4. Test Results

4.1. E.U.T. test conditions

| | |
|---|---|
| Test Voltage: | DC 12 V |
| Temperature: | 25 °C |
| Humidity: | 50 % RH |
| Atmospheric Pressure: | 1 006 mbar |
| 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:<br>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 |

4.1.1. EUT channels and frequencies list

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|
| 0 | 2 402 | 20 | 2 442 |
| 1 | 2 404 | 21 | 2 444 |
| 2 | 2 406 | 22 | 2 446 |
| 3 | 2 408 | 23 | 2 448 |
| 4 | 2 410 | 24 | 2 450 |
| 5 | 2 412 | 25 | 2 452 |
| 6 | 2 414 | 26 | 2 454 |
| 7 | 2 416 | 27 | 2 456 |
| 8 | 2 418 | 28 | 2 458 |
| 9 | 2 420 | 29 | 2 460 |
| 10 | 2 422 | 30 | 2 462 |
| 11 | 2 424 | 31 | 2 464 |
| 12 | 2 426 | 32 | 2 466 |
| 13 | 2 428 | 33 | 2 468 |
| 14 | 2 430 | 34 | 2 470 |
| 15 | 2 432 | 35 | 2 472 |
| 16 | 2 434 | 36 | 2 474 |
| 17 | 2 436 | 37 | 2 476 |
| 18 | 2 438 | 38 | 2 478 |
| 19 | 2 440 | 39 | 2 480 |

4.1.2. Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

| Test mode | Low channel | Middle channel | High channel |
|---|---|---|---|
| Transmitting | 2 402 MHz | 2 440 MHz | 2 480 MHz |

## 4.2. Antenna

### 4.2.1. Requirement

FCC Part 15 C section 15.203

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.

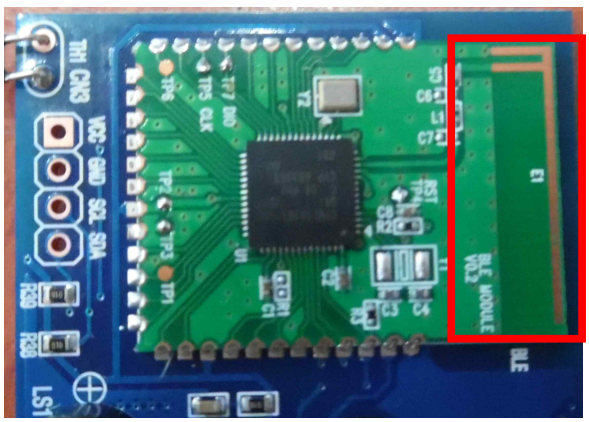
FCC Part 15 C section 15.247(c) (1)(i)

(i) Systems operating in the 2 400 ~ 2 483.5 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.

### 4.2.2. Test Result

The antenna is PCB Layout antenna and no consideration of replacement. The directional gain of the antenna is 4.8 dBi. Please refer to the EUT internal photos.




Test result : The unit does meet the FCC requirements.

## 4.3. Occupied 6 dB Bandwidth

4.3.1. Requirement

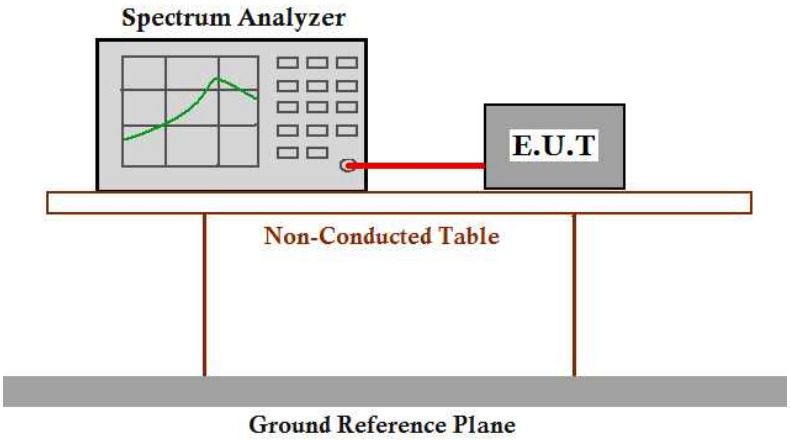
FCC Part 15 C section 15.247

(a)(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

4.3.2. Test method

KDB 558074 D01 v03r05 and ANSI C63.10

4.3.3. Test Configuration




4.3.4. Test Procedure

1) Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.

2) Set the spectrum analyzer :

a) Set RBW = 100 kHz.

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

c) Detector = Peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

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

4.3.5. Test result

BLE mode

| Test Channel | Frequency (MHz) | 6 dB Bandwidth (kHz) | Limit (kHz) | Result |
|---|---|---|---|---|
| Low | 2 402 | 720.98 | ≥500 | Pass |
| Middle | 2 440 | 758.27 | ≥500 | Pass |
| High | 2 480 | 724.37 | ≥500 | Pass |

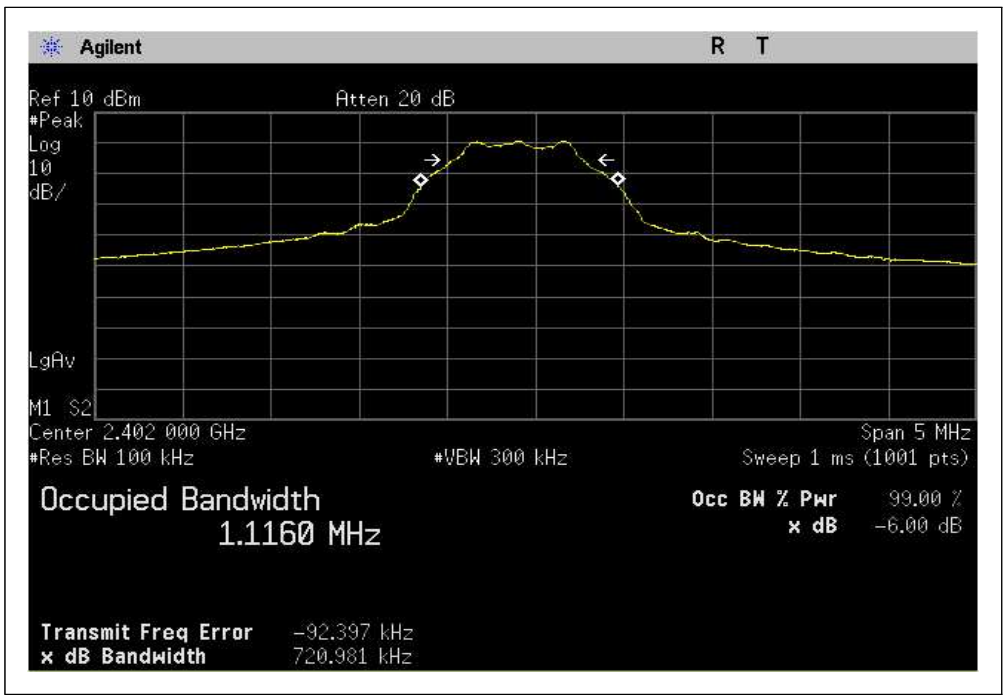
| Test Channel | Frequency (MHz) | 99% Bandwidth (kHz) | Limit (kHz) | Result |
|---|---|---|---|---|
| Low | 2 402 | 1 116.00 | N/A | N/A |
| Middle | 2 440 | 1 120.50 | N/A | N/A |
| High | 2 480 | 1 112.00 | N/A | N/A |

Test result : The unit does meet the FCC requirements.

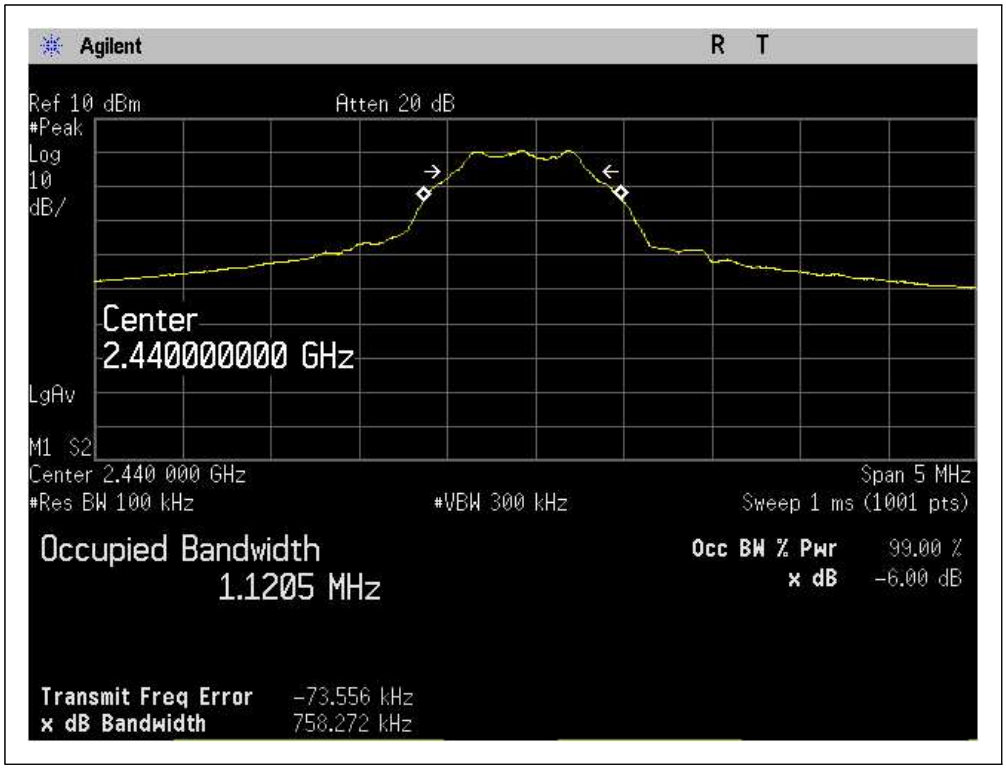
Please refer to the following test plots:

For BLE

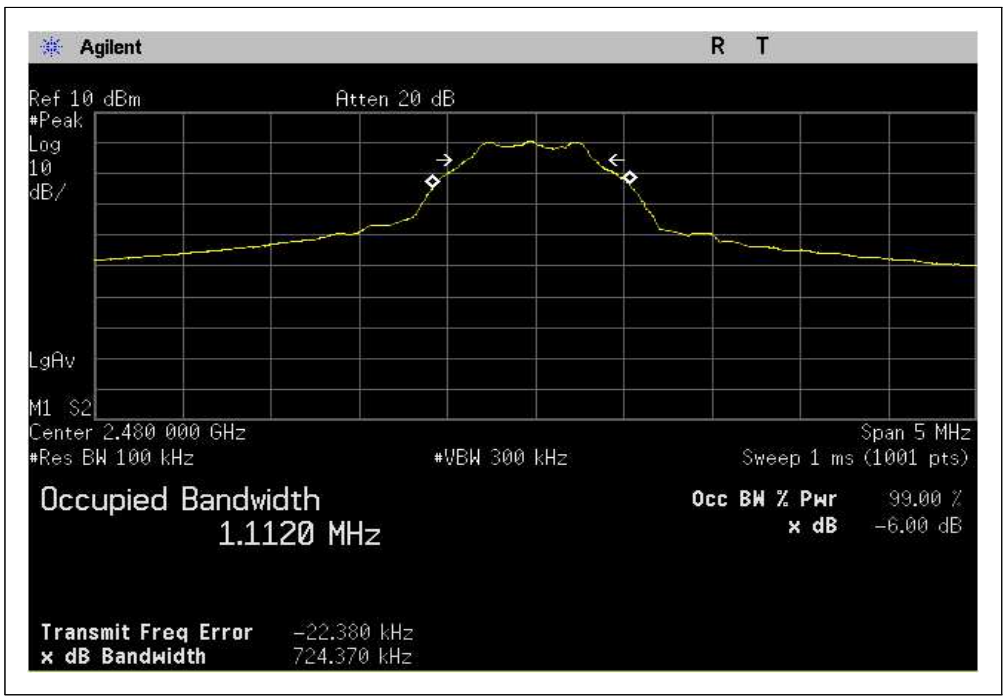
Low Channel(2 402 MHz):



Middle Channel(2 440 MHz):




High Channel(2 480 MHz):



## 4.4. Maximum Peak Output Power

4.4.1. Requirement

FCC Part 15 C section 15.247

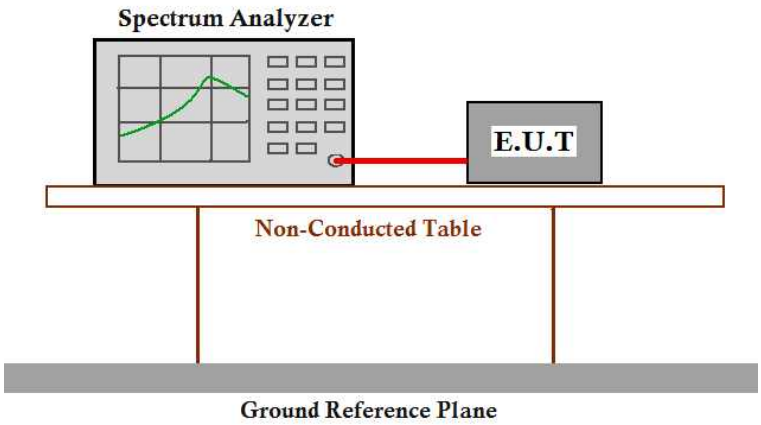
(b)(3) For systems using digital modulation in the 902 ~ 928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz bands: 1 Watt.

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 paragraph (b) (1), (b) (2), and (b) (3) of section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.4.2. Test Method

KDB 558074 D01 v03r05 and ANSI C63.10

4.4.3. Test Configuration




4.4.4. Test Procedure

1) Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2) Set the spectrum analyzer:
   a) Set RBW ≥ DTS bandwidth
   b) Set the video bandwidth (VBW) ≥ 3 × RBW.
   c) Set span ≥ 3 × RBW.
   d) Sweep time = auto couple.
   e) Detector = Peak.
   f) Trace mode = max hold.
   g) Allow the trace to stabilize.
   h) Use peak marker function to determine the peak amplitude level.

4.4.5. Test result

BLE mode

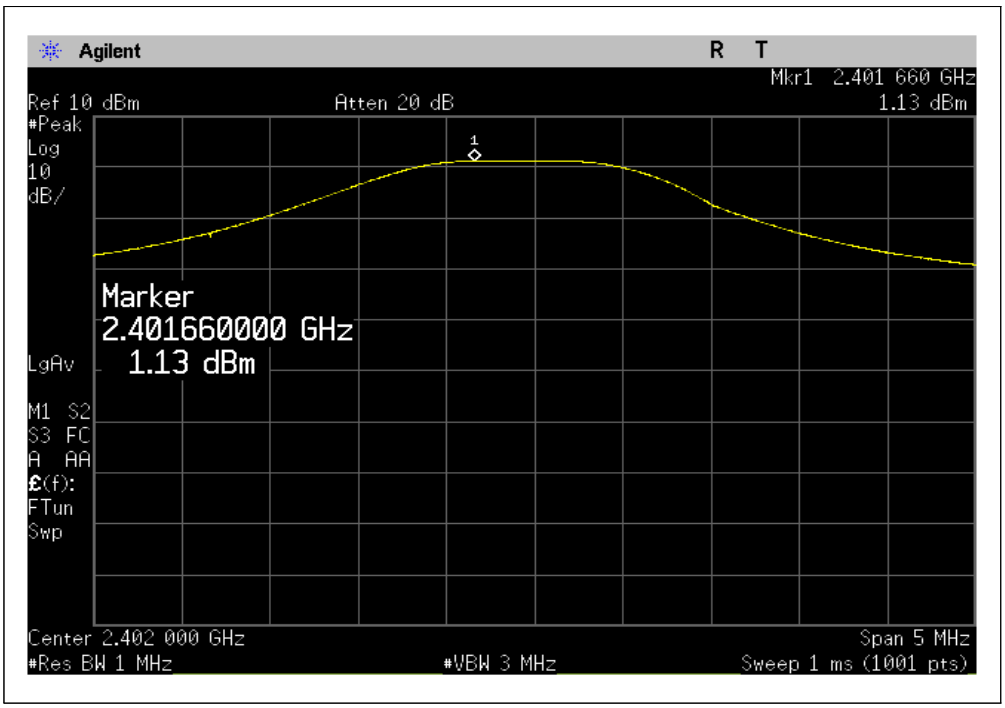
| Test Channel | Frequency (MHz) | Measured Channel Power (dBm) | Measured Channel Power (mW) | Limit (mW) | Result |
|---|---|---|---|---|---|
| Low | 2 402 | 1.13 | 1.30 | 1000.00 | Pass |
| Middle | 2 440 | 1.15 | 1.30 | 1000.00 | Pass |
| High | 2 480 | 0.96 | 1.25 | 1000.00 | Pass |

This unit does meet the FCC requirements.

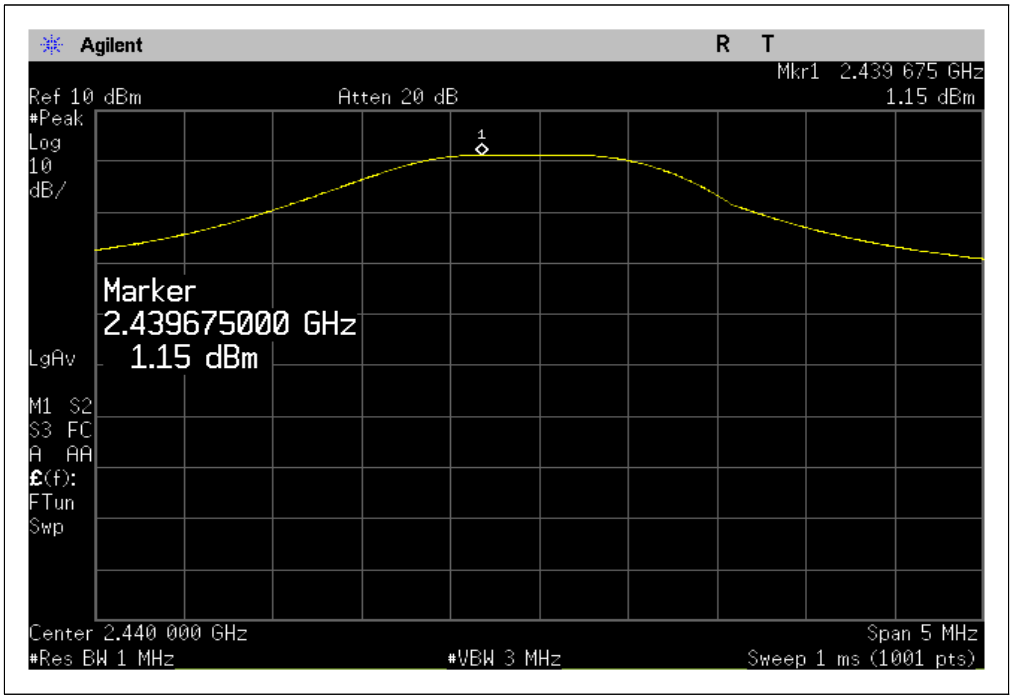
Please refer to the following test plots:

For BLE

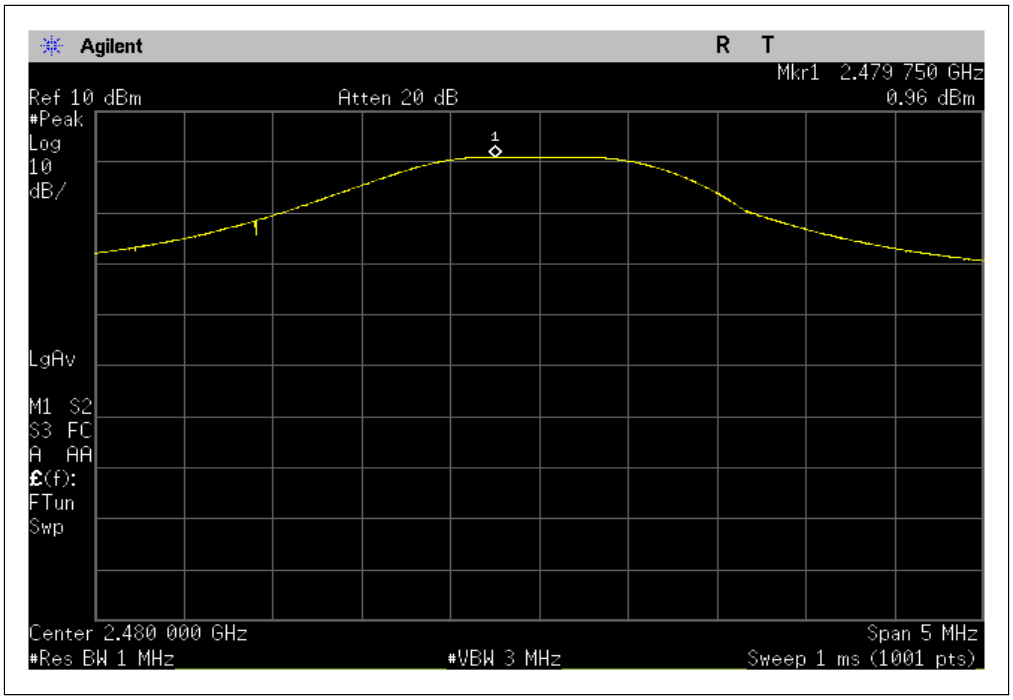
Low Channel(2 402 MHz):



Middle Channel(2 440 MHz):




High Channel(2 480 MHz):



## 4.5. Peak Power Spectral Density

4.5.1. Requirement

FCC Part 15 C section 15.247

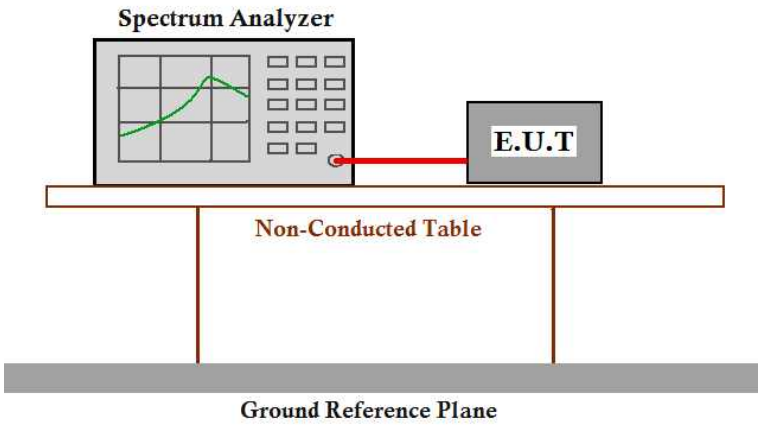
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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.

4.5.2. Test Method

KDB 558074 D01 v03r05 and ANSI C63.10

4.5.3. Test Configuration




4.5.4. Test Procedure

1) Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2) Set the spectrum analyzer:
   a) Set analyzer center frequency to DTS channel center frequency.
   b) Set the span to 1.5 times the DTS bandwidth.
   c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
   d) Set the VBW ≥ 3 × RBW.
   e) Detector = peak.
   f) Sweep time = auto couple.
   g) Trace mode = max hold.
   h) Allow trace to fully stabilize.
   i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.5.5. Test result

BLE mode:

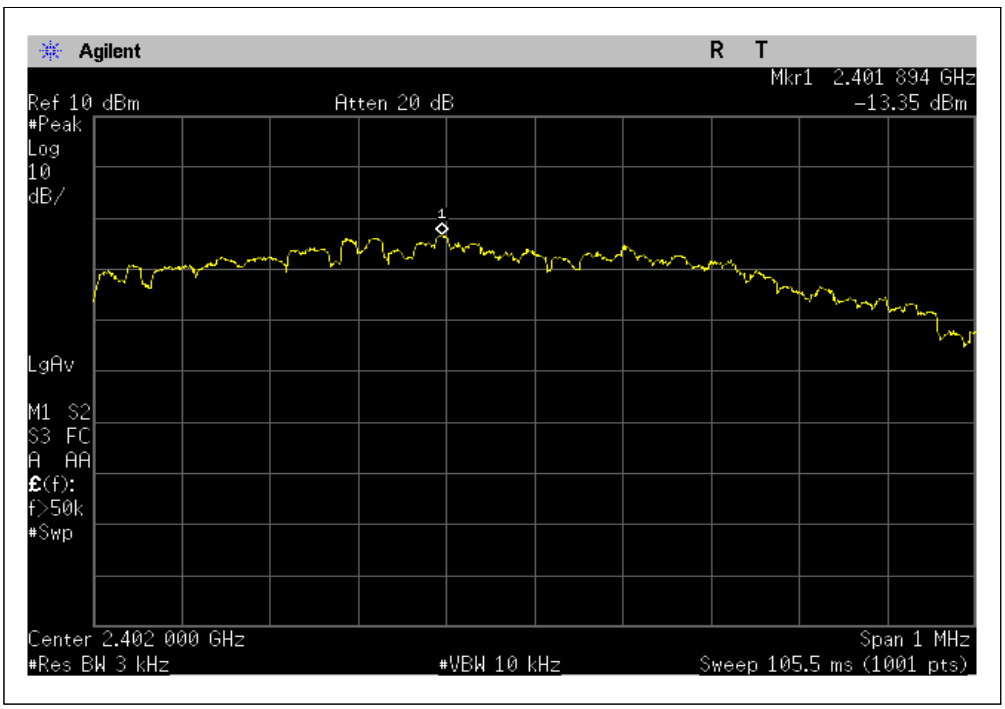
| Test Channel | Frequency (MHz) | Measured Peak Power Spectral Density (dBm/3 kHz) | Limit (dBm/3 kHz) | Result |
|---|---|---|---|---|
| Low | 2 402 | -13.35 | 8 | Pass |
| Middle | 2 441 | -13.95 | 8 | Pass |
| High | 2 480 | -13.36 | 8 | Pass |

This unit does meet the FCC requirements.

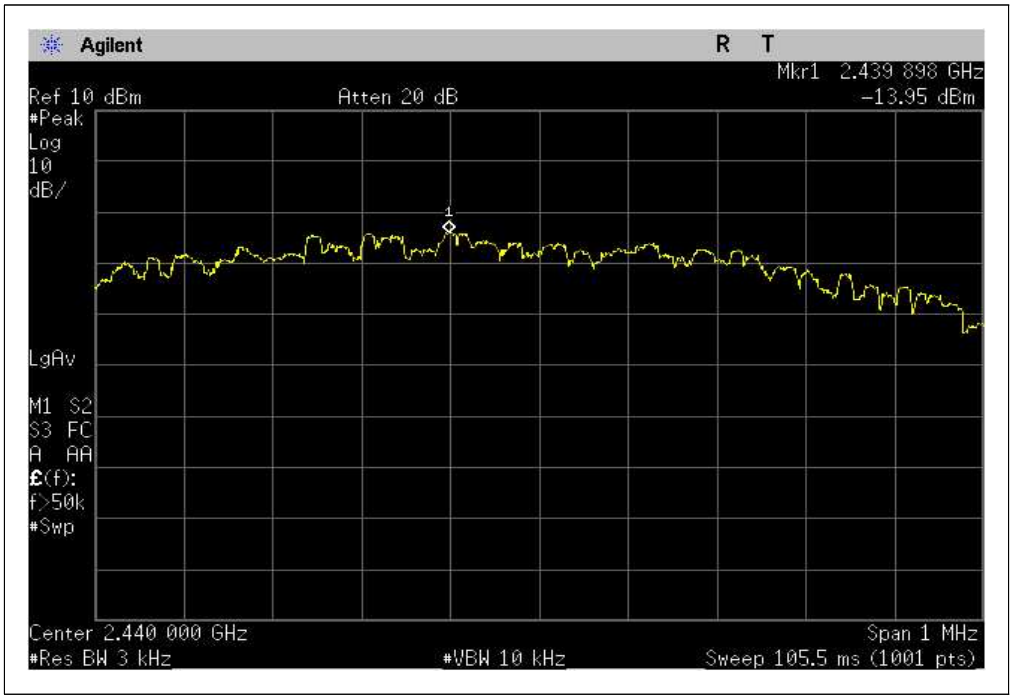
Please refer to the following test plots:

For BLE

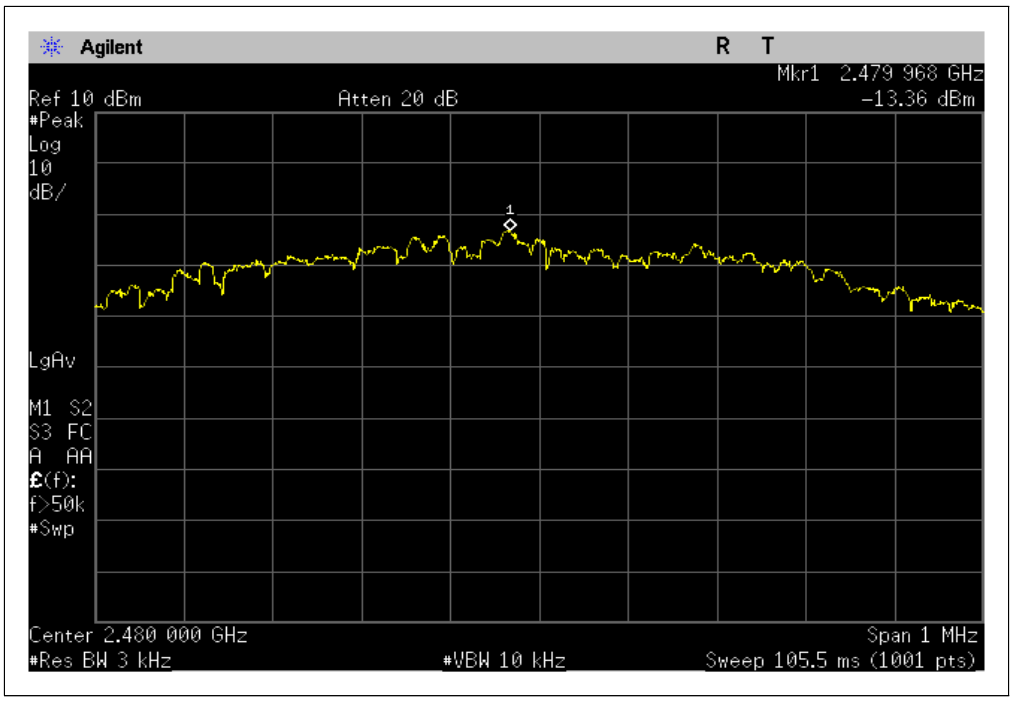
Low Channel(2 402 GHz):



Middle Channel(2 440 GHz):




High Channel(2 480 GHz):



## 4.6. Conducted Spurious Emissions

4.6.1. Requirement

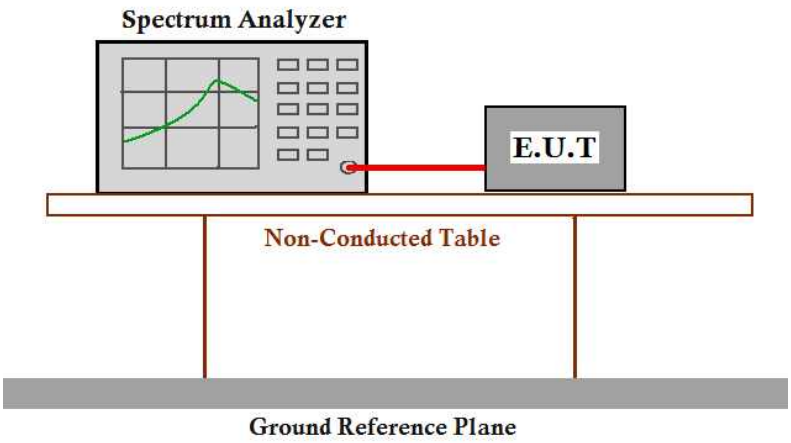
FCC Part15 C section 15.247

(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.

4.6.2. Test Method

KDB 558074 D01 v03r05 and ANSI C63.10

4.6.3. Test Configuration




4.6.4. Test Procedure

1) Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.

2) Set the spectrum analyzer:

a) Set the RBW = 100 kHz.

b) Set the VBW = 300 kHz.

c) Detector = peak.

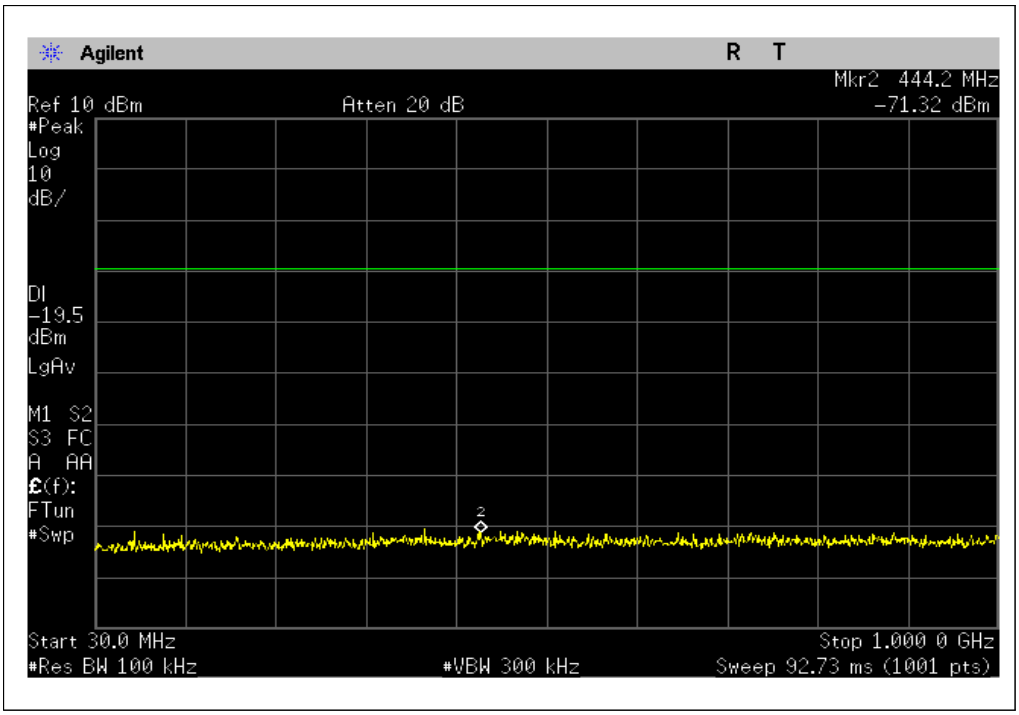
d) Sweep time = auto couple.

e) Trace mode = max hold.

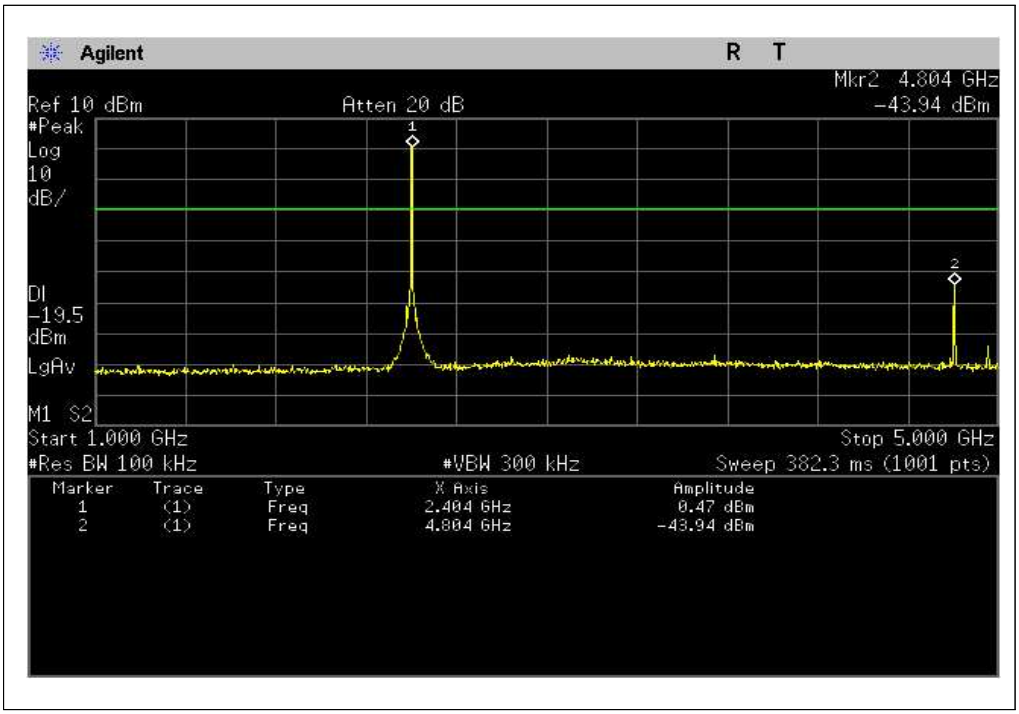
f) Scan up through 10th harmonic.

4.6.5. Test result

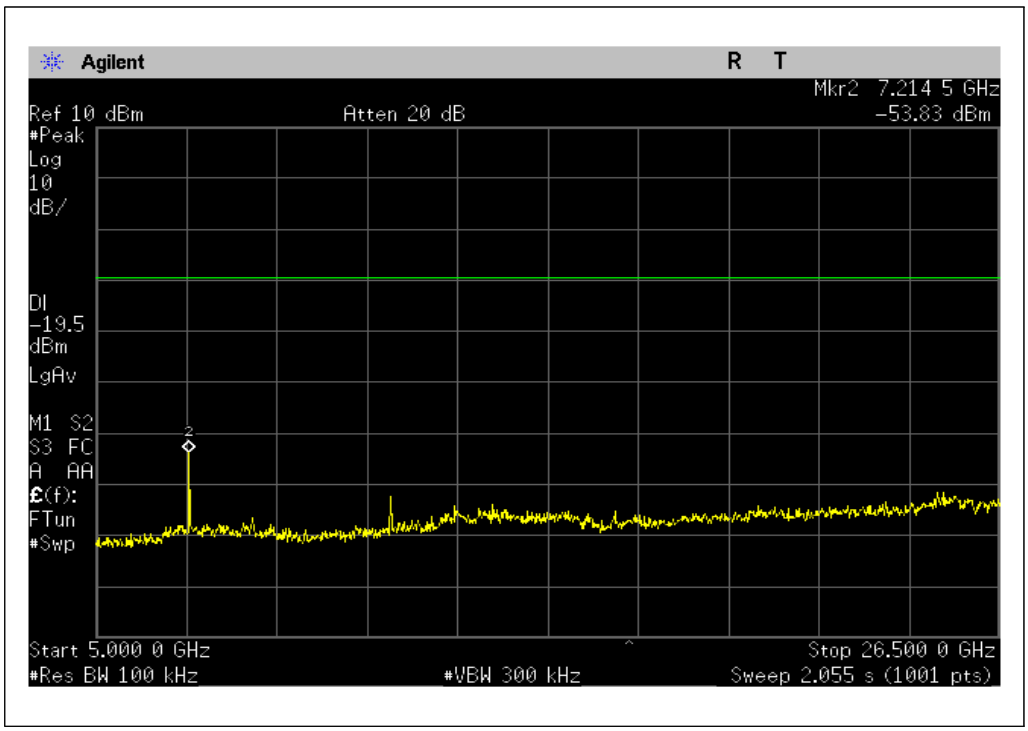
Low Channel(2 402 MHz) : 30 MHz to 1 GHz



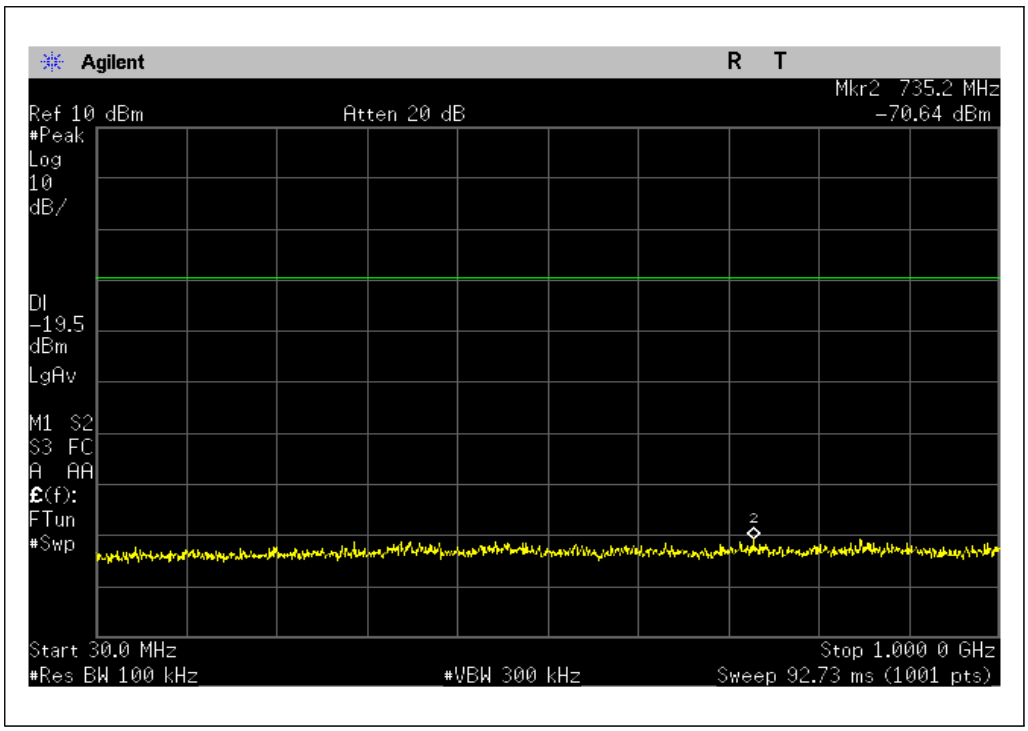

Low Channel(2 402 MHz) : 1 GHz to 5 GHz



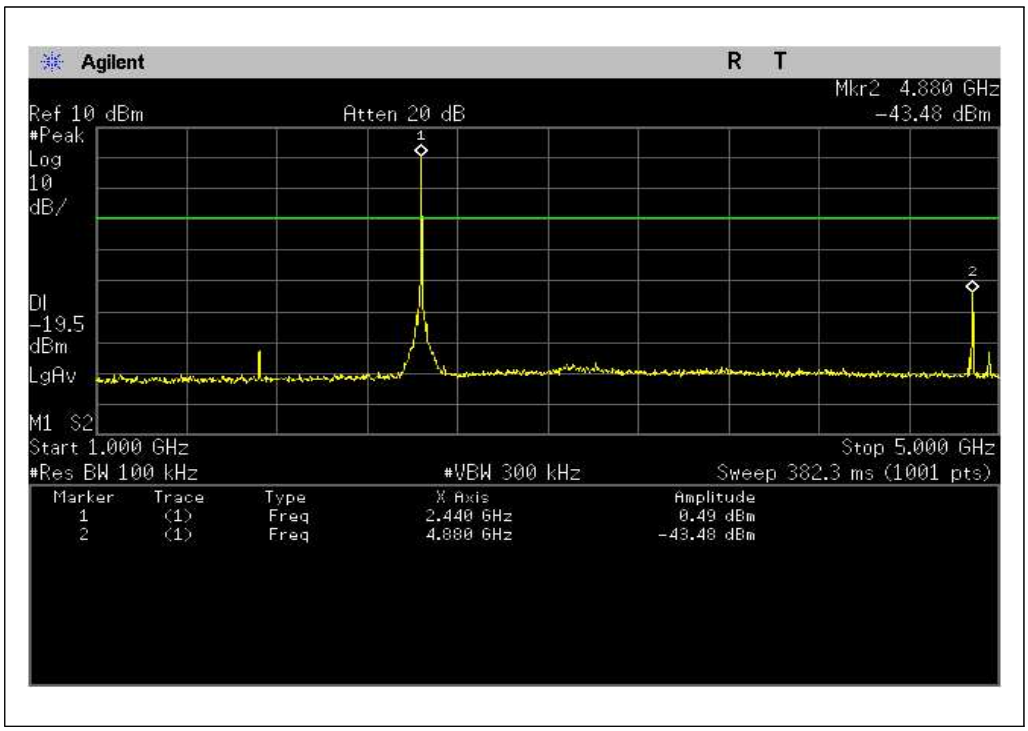
Low Channel(2 402 MHz) : 5 GHz to 26.5 GHz



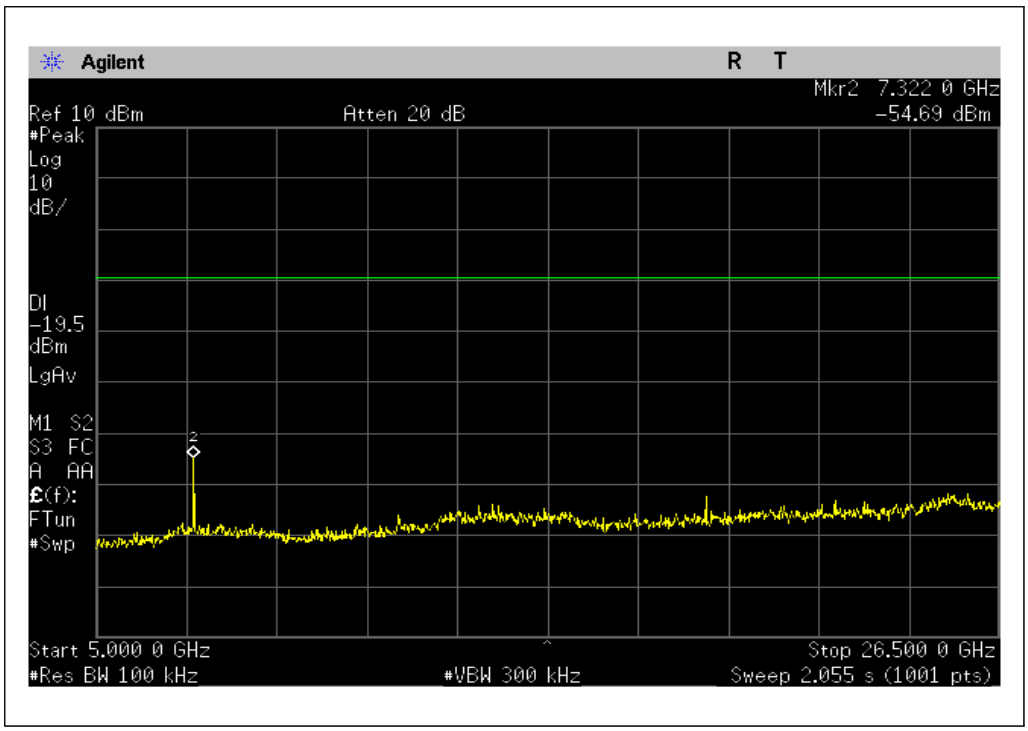

Middle Channel(2 440 MHz) : 30 MHz to 1 GHz



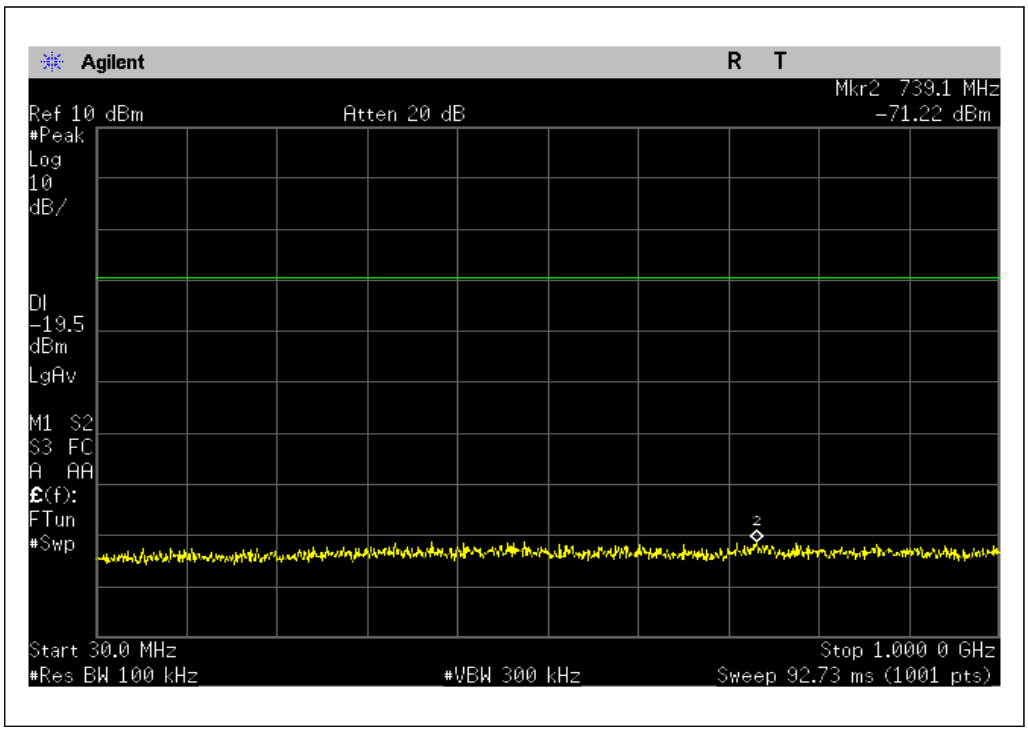
Middle Channel(2 440 MHz) : 1 GHz to 5 GHz



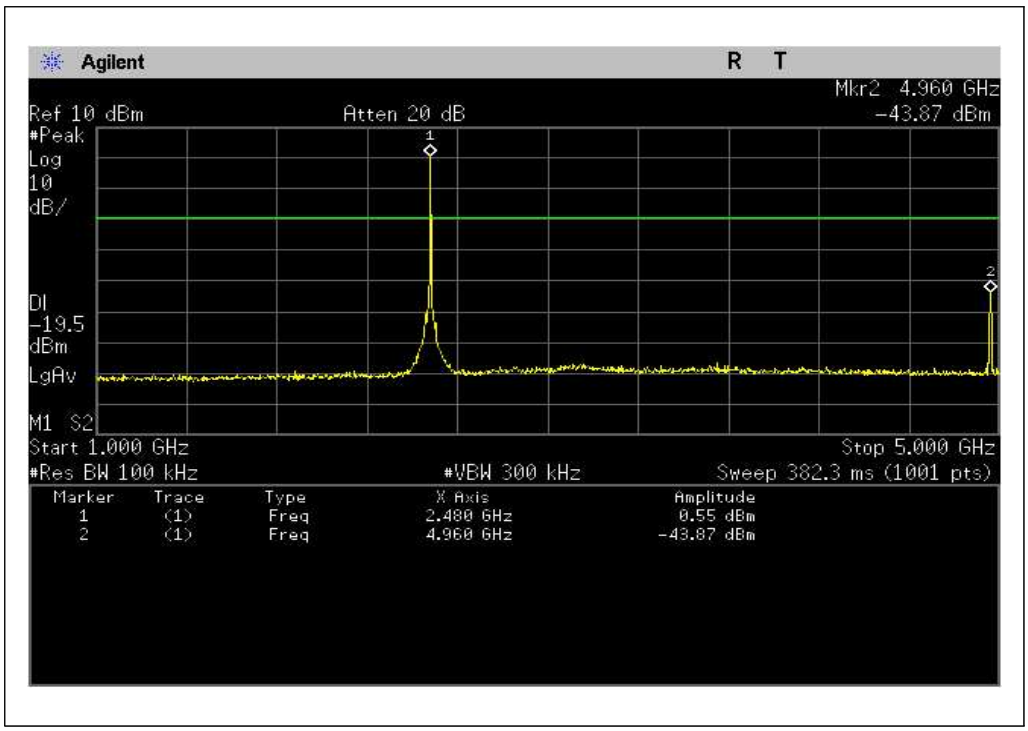

Middle Channel(2 440 MHz) : 5 GHz to 26.5 GHz



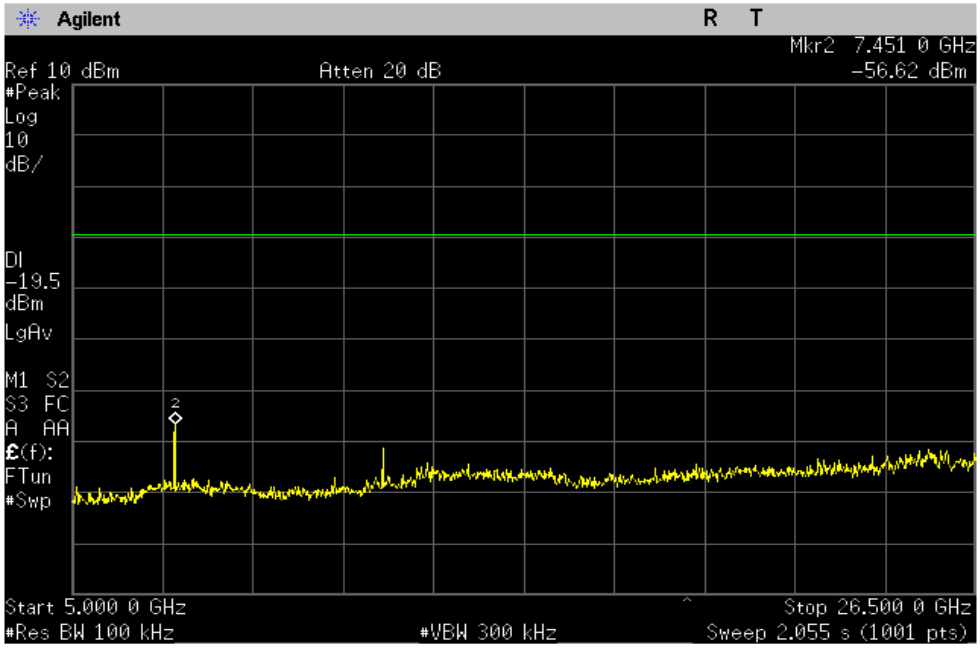
High Channel(2 480 MHz) : 30 MHz to 1 GHz




High Channel(2 480 MHz) : 1 GHz to 5 GHz



High Channel(2 480 MHz) : 5 GHz to 26.5 GHz



## 4.7. Radiated Spurious Emission

4.7.1. Requirement

FCC Part15 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 limited specified in Section 15.209(a) (see Section 15.205(c)).

4.7.2. Test Method

ANSI C63.10

1) Test site

Measurement Distance : 3 m (Semi-Anechoic Chamber)

2) Receiver setup

| Frequency | Detector | RBW | VBW | Remark |
|---|---|---|---|---|
| 30 MHz~1 GHz | Quasi-peak | 120 KHz | 300 KHz | Quasi-peak Value |
| Above 1 GHz | Peak | 1 MHz | 3 MHz | Peak Value |
| | RMS | 1 MHz | 3 MHz | Average Vaile |

3) Limit

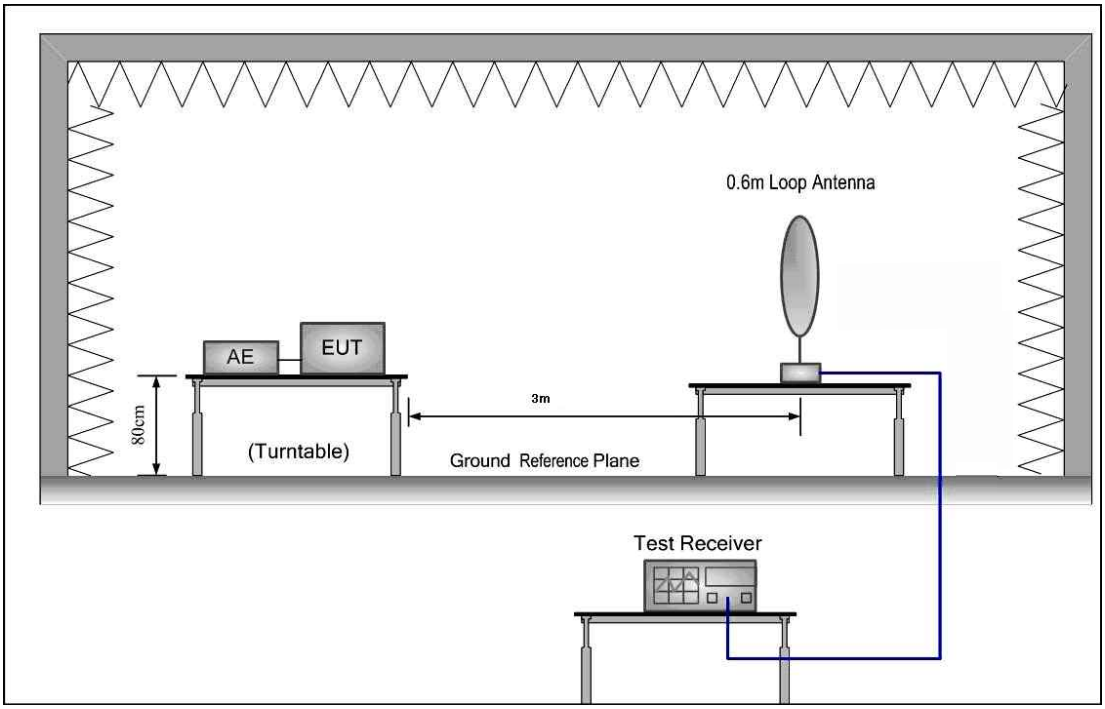
| Frequency | Limit(dB$\mu$V/m @ 3m) | Remark |
|---|---|---|
| 30 MHz ~ 88 MHz | 40.0 | Quasi-peak Vaule |
| 88 MHz ~ 216 MHz | 43.5 | Quasi-peak Vaule |
| 216 MHz ~ 960 MHz | 46.0 | Quasi-peak Vaule |
| 960 MHz ~ 1 GHz | 54.0 | Quasi-peak Vaule |
| Above 1 GHz | 54.0 | Average Value |
| | 74.0 | Peak Value |

4) Test Frequency Range

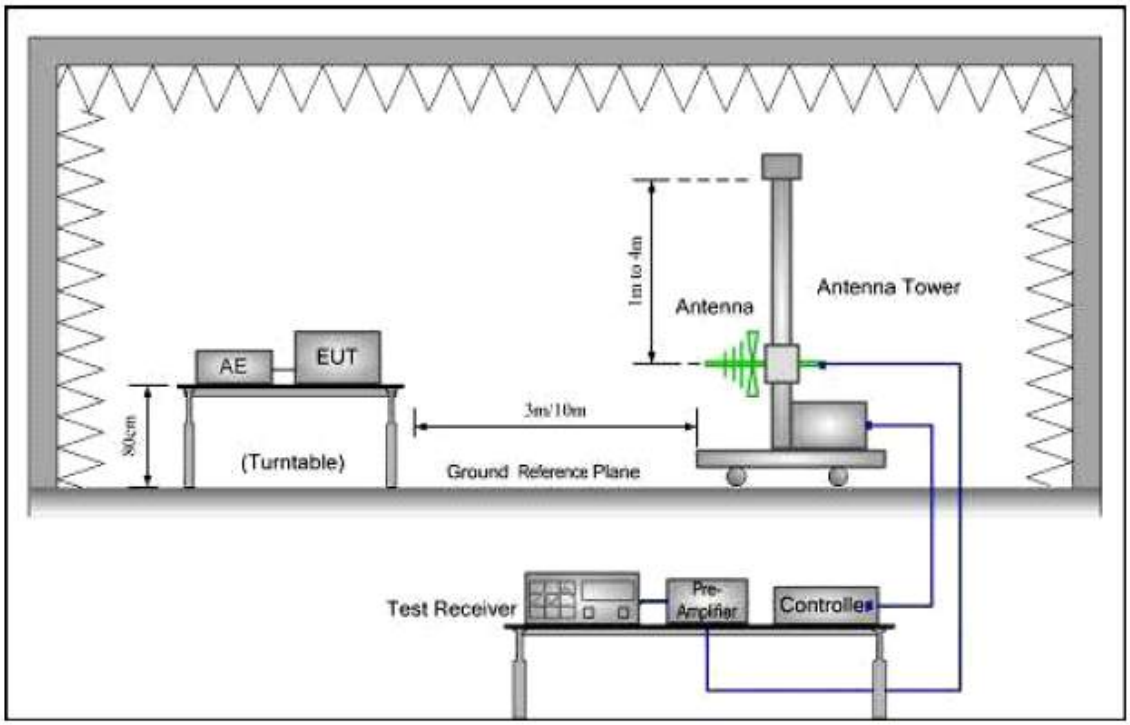
9 kHz ~ 26.5 GHz

4.7.3. Test Configuration

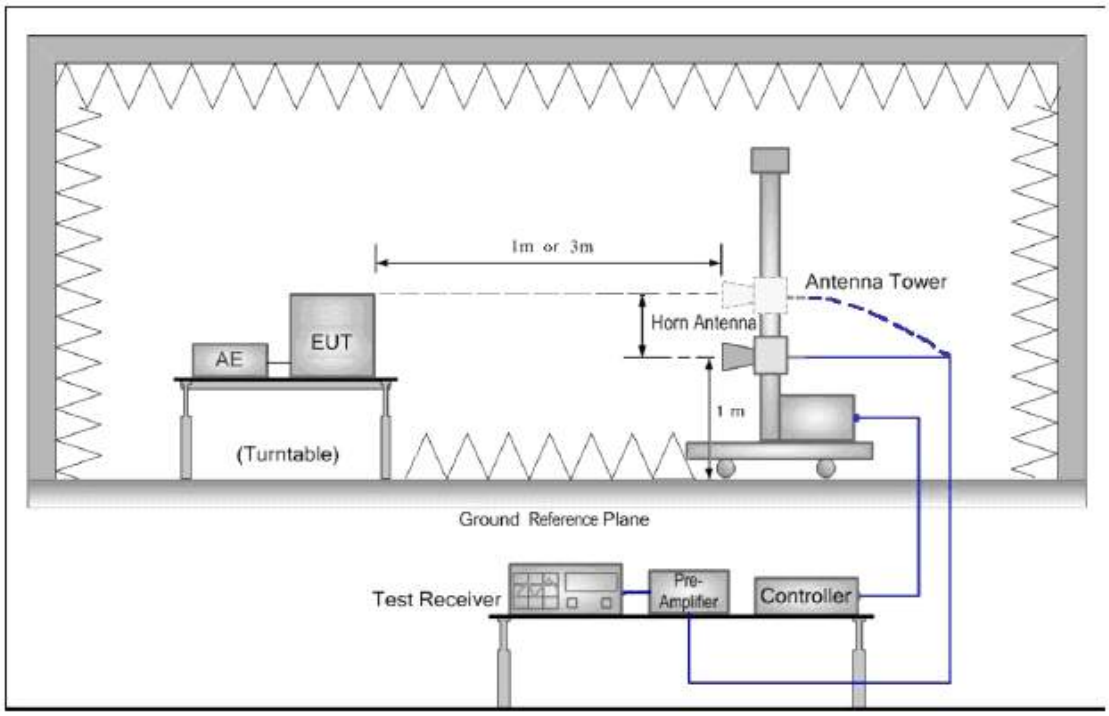
1) 9 kHz to 30 MHz emissions:




2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 26.5 GHz emissions:




4.7.4. Test Procedure

1) The EUT is placed on a turntable. For below 1 GHz, the EUT is 0.8 m above ground plane; For above 1 GHz, the EUT is 1.5m above ground plane.
2) The turn 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 move from 1m to 4 m to find out the maximum emissions. The spectrum was investigated from the lowest radio highest fundamental frequency or to 40 GHz, whichever is lower.
4) Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5) And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6) Repeat above procedures until the measurements for all frequencies are complete.

4.7.5. Test result

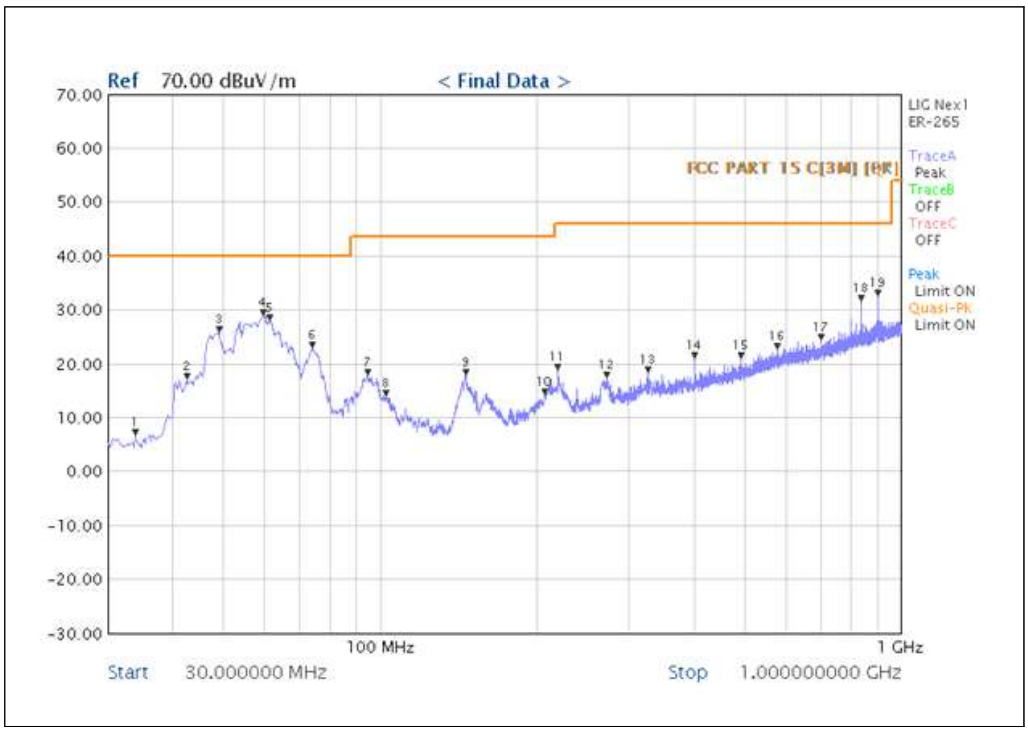
1) Test at low Channel (2 402 MHz) in transmitting status

a) 9 kHz ~ 30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20 dB below the limit, so the test data were not recorded in the test report.

b) 30 MHz~1 GHz Spurious Emissions. Quasi-Peak Measurement

Vertical: Level (dB$\mu$V/m)

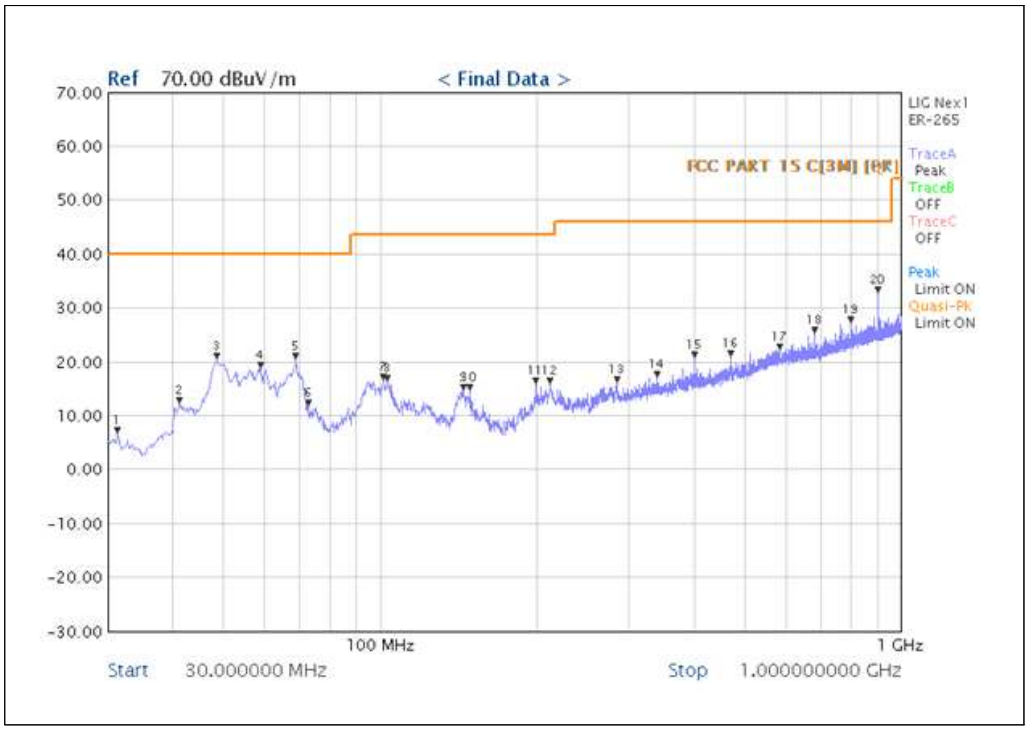



Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dB$\mu$V/m) | Limit (dB$\mu$V/m) | Margin (dB) |
|---|---|---|---|---|---|
| 48.95 | QP | V | 25.76 | 40.00 | 14.24 |
| 59.37 | QP | V | 28.76 | 40.00 | 11.24 |
| 61.38 | QP | V | 27.96 | 40.00 | 12.04 |
| 73.81 | QP | V | 22.72 | 40.00 | 17.28 |
| 700.51 | QP | V | 24.20 | 46.00 | 21.80 |
| 838.71 | QP | V | 31.54 | 46.00 | 14.46 |
| 900.52 | QP | V | 24.74 | 46.00 | 13.55 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”

Horizontal: Level (dBμV/m)




Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 48.36 | QP | H | 20.43 | 40.00 | 19.57 |
| 58.78 | QP | H | 18.71 | 40.00 | 21.29 |
| 68.61 | QP | H | 20.32 | 40.00 | 19.68 |
| 583.39 | QP | H | 22.10 | 46.00 | 23.90 |
| 680.97 | QP | H | 25.22 | 46.00 | 20.78 |
| 800.22 | QP | H | 27.23 | 46.00 | 18.77 |
| 900.52 | QP | H | 32.62 | 46.00 | 13.38 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”.

c) 1~26.5 GHz Harmonics & Spurious Emissions. Peak & Average Measurement

Peak Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 1319.50 | V | 41.75 | 74.00 | 32.25 |
| 1683.00 | H | 43.97 | 74.00 | 30.03 |
| 1731.50 | V | 45.02 | 74.00 | 28.98 |
| 2177.00 | H | 50.69 | 74.00 | 23.31 |
| 4327.00 | H | 47.72 | 74.00 | 26.28 |
| 4451.50 | V | 47.39 | 74.00 | 26.61 |
| 5777.00 | V | 50.52 | 74.00 | 23.48 |
| 5968.00 | H | 51.21 | 74.00 | 22.79 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

Average Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 2200.00 | H | 43.64 | 54.00 | 10.36 |
| 2200.00 | V | 43.58 | 54.00 | 10.42 |
| 2677.50 | H | 44.73 | 54.00 | 9.27 |
| 2678.50 | V | 44.75 | 54.00 | 9.25 |
| 4449.50 | H | 40.04 | 54.00 | 13.96 |
| 4451.50 | V | 40.09 | 54.00 | 13.91 |
| 5961.00 | H | 43.07 | 54.00 | 10.93 |
| 5964.50 | V | 43.23 | 54.00 | 10.77 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

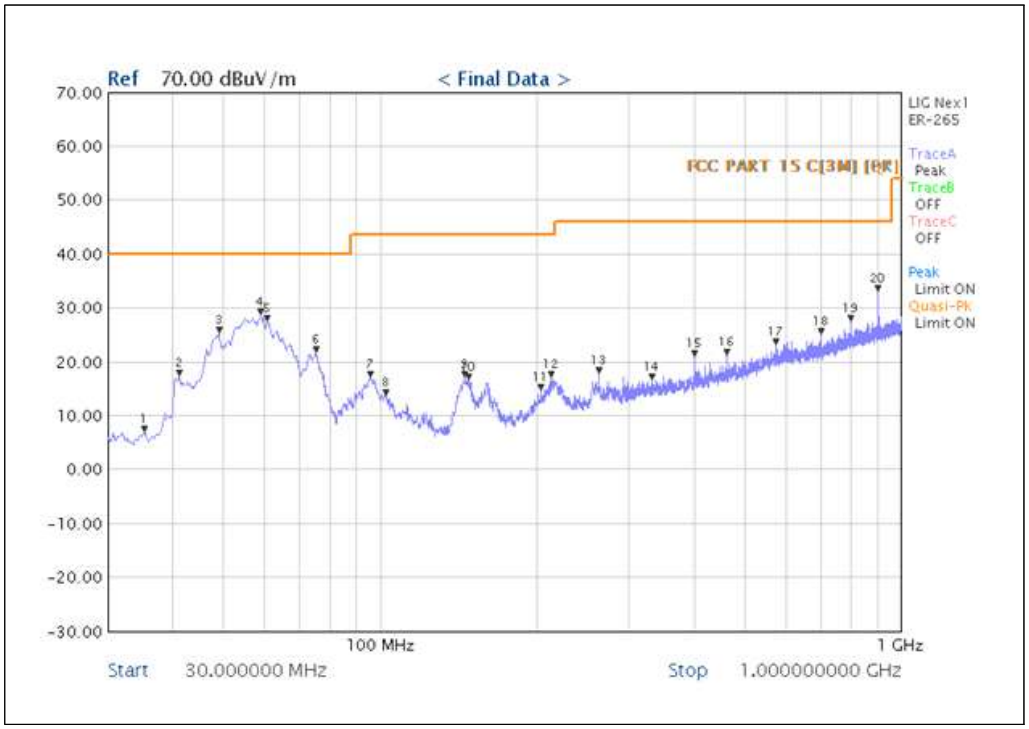
2) Test at middle Channel (2 440 MHz)in transmitting status

a) 9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20 dB below the limit, so the test data were not recorded in the test report.

b) 30 MHz ~ 1 GHz Spurious Emissions. Quasi-Peak Measurement

Vertical: Level (dB$\mu$V/m)

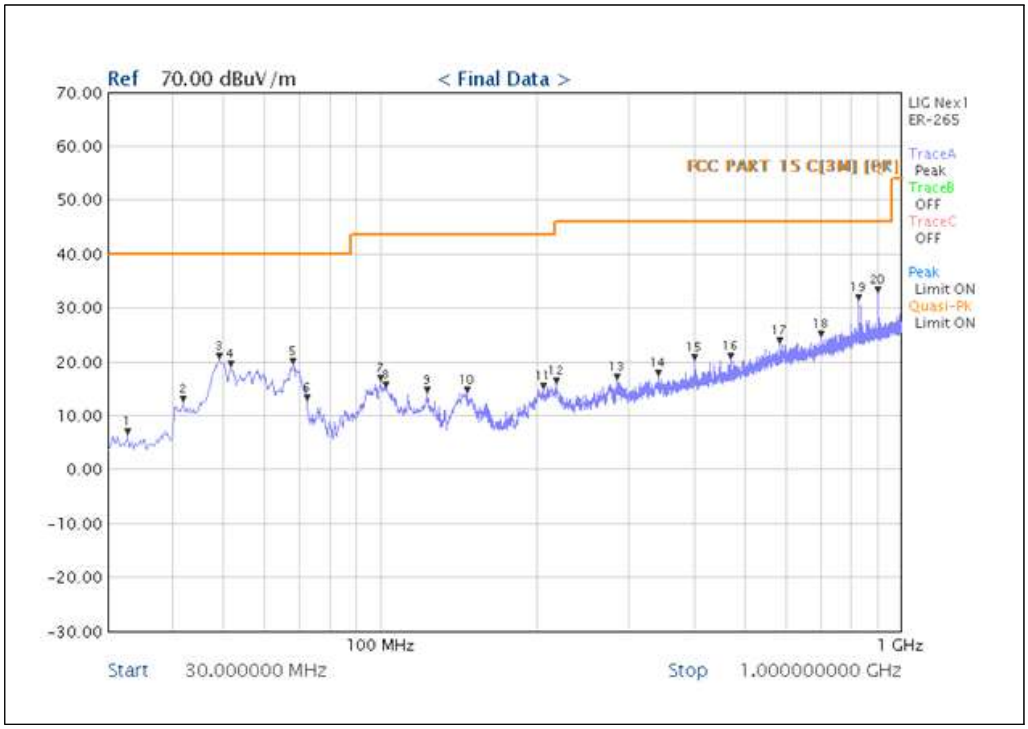



Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dB$\mu$V/m) | Limit (dB$\mu$V/m) | Margin (dB) |
|---|---|---|---|---|---|
| 48.95 | QP | V | 25.12 | 40.00 | 14.88 |
| 58.78 | QP | V | 28.46 | 40.00 | 11.54 |
| 60.67 | QP | V | 27.41 | 40.00 | 12.59 |
| 75.12 | QP | V | 21.49 | 40.00 | 18.51 |
| 701.22 | QP | V | 24.94 | 46.00 | 21.06 |
| 799.50 | QP | V | 27.36 | 46.00 | 18.64 |
| 900.52 | QP | V | 32.94 | 46.00 | 13.06 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”.

Horizontal: Level (dBμV/m)




Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 48.97 | QP | H | 20.36 | 40.00 | 19.64 |
| 51.55 | QP | H | 18.94 | 40.00 | 21.06 |
| 67.90 | QP | H | 19.32 | 40.00 | 20.68 |
| 583.98 | QP | H | 23.30 | 46.00 | 22.70 |
| 700.51 | QP | H | 24.52 | 46.00 | 21.48 |
| 830.18 | QP | H | 31.18 | 46.00 | 14.82 |
| 900.52 | QP | H | 32.67 | 46.00 | 13.33 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”.

c) 1~26.5 GHz Harmonics & Spurious Emissions. Peak & Average Measurement

Peak Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 1779.00 | V | 44.61 | 74.00 | 29.39 |
| 1816.50 | H | 45.19 | 74.00 | 28.81 |
| 2710.50 | H | 52.36 | 74.00 | 21.64 |
| 2714.00 | V | 51.77 | 74.00 | 22.23 |
| 4171.50 | V | 47.20 | 74.00 | 26.80 |
| 4344.00 | H | 47.18 | 74.00 | 26.82 |
| 5633.50 | H | 50.08 | 74.00 | 23.92 |
| 5957.50 | V | 51.24 | 74.00 | 22.76 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

Average Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 1733.00 | H | 37.39 | 54.00 | 16.61 |
| 1734.50 | V | 37.32 | 54.00 | 16.68 |
| 2679.00 | H | 44.78 | 54.00 | 9.22 |
| 2687.00 | V | 44.63 | 54.00 | 9.37 |
| 4449.00 | H | 40.00 | 54.00 | 14.00 |
| 4449.00 | V | 40.18 | 54.00 | 13.82 |
| 5789.50 | V | 43.11 | 54.00 | 10.89 |
| 5965.00 | H | 43.13 | 54.00 | 10.87 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

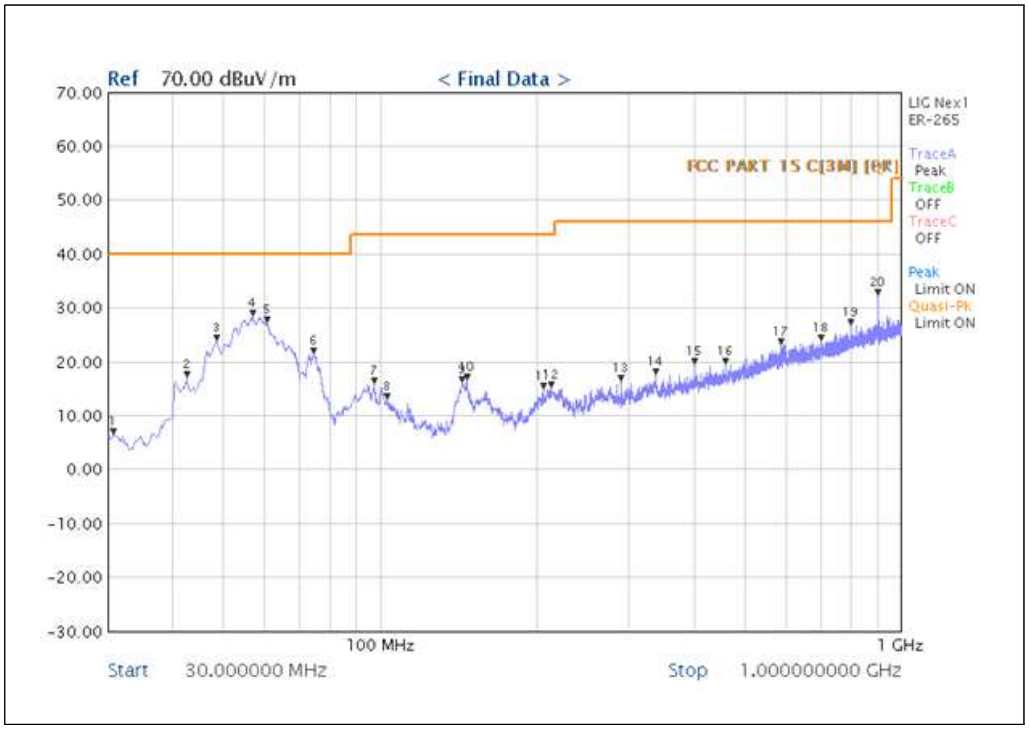
3) Test at high Channel (2 480 MHz) in transmitting status

a) 9 kHz ~ 30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20 dB below the limit, so the test data were not recorded in the test report.

b) 30 MHz ~ 1 GHz Spurious Emissions. Quasi-Peak Measurement

Vertical: Level (dB$\mu$V/m)

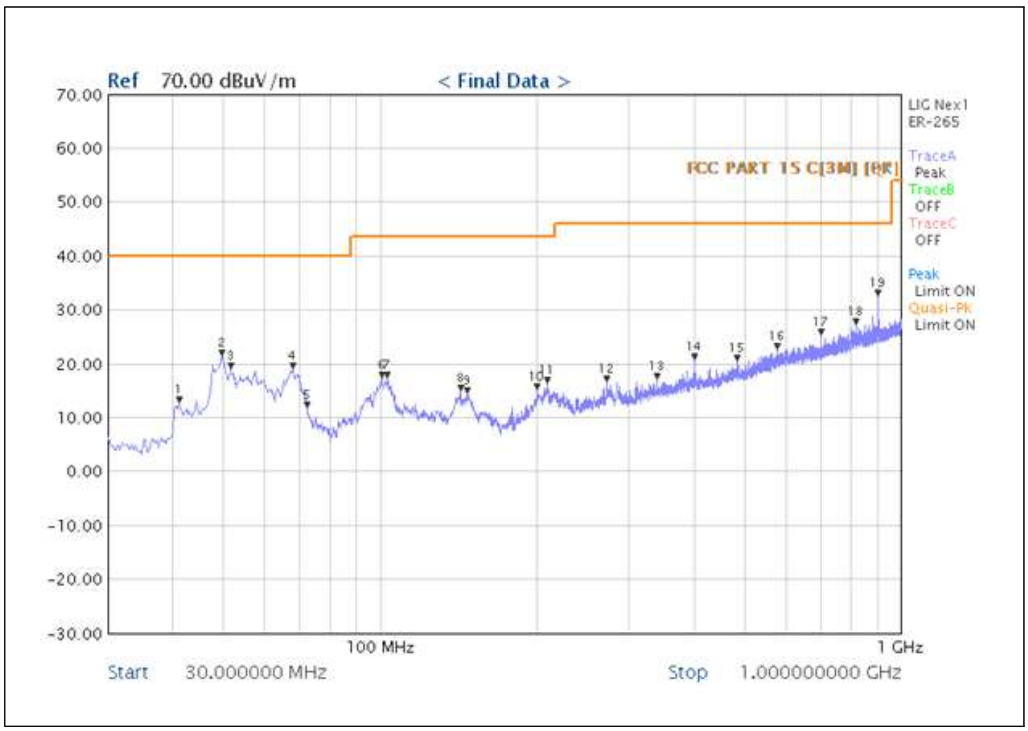



Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dB$\mu$V/m) | Limit (dB$\mu$V/m) | Margin (dB) |
|---|---|---|---|---|---|
| 48.36 | QP | V | 23.83 | 40.00 | 16.17 |
| 56.76 | QP | V | 28.22 | 40.00 | 11.78 |
| 60.67 | QP | V | 27.08 | 40.00 | 12.92 |
| 74.41 | QP | V | 21.30 | 40.00 | 18.70 |
| 700.51 | QP | V | 23.78 | 46.00 | 22.22 |
| 800.22 | QP | V | 26.66 | 46.00 | 19.34 |
| 900.52 | QP | V | 32.14 | 46.00 | 13.86 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”.

Horizontal: Level (dB$\mu$V/m)




Quasi-peak measurement

| Frequency (MHz) | Detect Mode | Polarization (V/H) | Emission Level (dB$\mu$V/m) | Limit (dB$\mu$V/m) | Margin (dB) |
|---|---|---|---|---|---|
| 49.66 | QP | H | 21.45 | 40.00 | 18.55 |
| 51.55 | QP | H | 18.88 | 40.00 | 21.12 |
| 67.90 | QP | H | 18.83 | 40.00 | 21.17 |
| 578.18 | QP | H | 22.53 | 46.00 | 23.47 |
| 700.51 | QP | H | 25.27 | 46.00 | 20.73 |
| 819.76 | QP | H | 27.02 | 46.00 | 18.98 |
| 900.52 | QP | H | 32.39 | 46.00 | 13.61 |

* Remark:
1) The Emission Level values are included “Correction Factor”
2) Correction Factor = “Antenna Factor” + “Cable Loss” - “Amp. Gain”.

c) 1~26.5 GHz Harmonics & Spurious Emissions. Peak & Average Measurement

Peak Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 1203.00 | H | 41.89 | 74.00 | 32.11 |
| 1778.00 | H | 44.25 | 74.00 | 29.75 |
| 1784.00 | V | 44.39 | 74.00 | 29.61 |
| 2696.00 | V | 52.30 | 74.00 | 21.70 |
| 4440.00 | H | 47.23 | 74.00 | 26.77 |
| 4444.50 | V | 47.67 | 74.00 | 26.33 |
| 5898.50 | V | 50.71 | 74.00 | 23.29 |
| 5944.00 | H | 50.77 | 74.00 | 23.23 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

Average Measurement:

| Frequency (MHz) | Polarization (V/H) | Emission Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 1732.00 | H | 37.48 | 54.00 | 16.52 |
| 2200.00 | H | 43.63 | 54.00 | 10.37 |
| 2200.00 | V | 43.89 | 54.00 | 10.11 |
| 2686.00 | V | 44.77 | 54.00 | 9.23 |
| 4442.00 | V | 40.18 | 54.00 | 13.82 |
| 4449.00 | H | 40.33 | 54.00 | 13.67 |
| 5799.50 | V | 43.20 | 54.00 | 10.80 |
| 5899.50 | H | 43.04 | 54.00 | 10.96 |

* Remark:
1) The Emission Level values are included "Correction Factor"
2) Correction Factor = "Antenna Factor" + "Cable Loss" - "Amp. Gain"
3) As shown in Section, for frequencies above 1 000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.
4) The test only perform the EUT in transmitting status since the test frequencies were over 1 GHz only required transmitting status.

## 4.8. Band Edges Compliance

4.8.1. Requirement

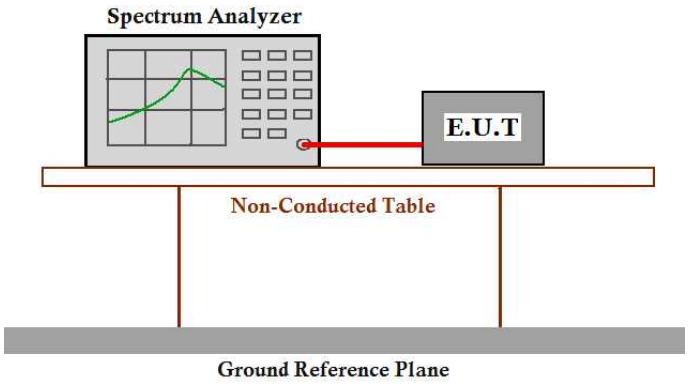
FCC Part15 C section 15.247

(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. 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 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)).

4.8.2. Test Method

KDB 558074 D01 v03r05 and ANSI C63.10

4.8.3. Test Configuration




4.8.4. Test Procedure

1)Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.

2) Set the spectrum analyzer:

a) Set start frequency to DTS channel edge frequency.

b) Set stop frequency so as to encompass the spectrum to be examined.

c) Set RBW = 100 kHz.

d) Set VBW ≥ 300 kHz.

e) Detector = peak.

f) Trace Mode = max hold.

g) Sweep = auto couple.

h) Allow the trace to stabilize (this may take some time, depending on the extent of the span).

i ) Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

4.8.5. Test result

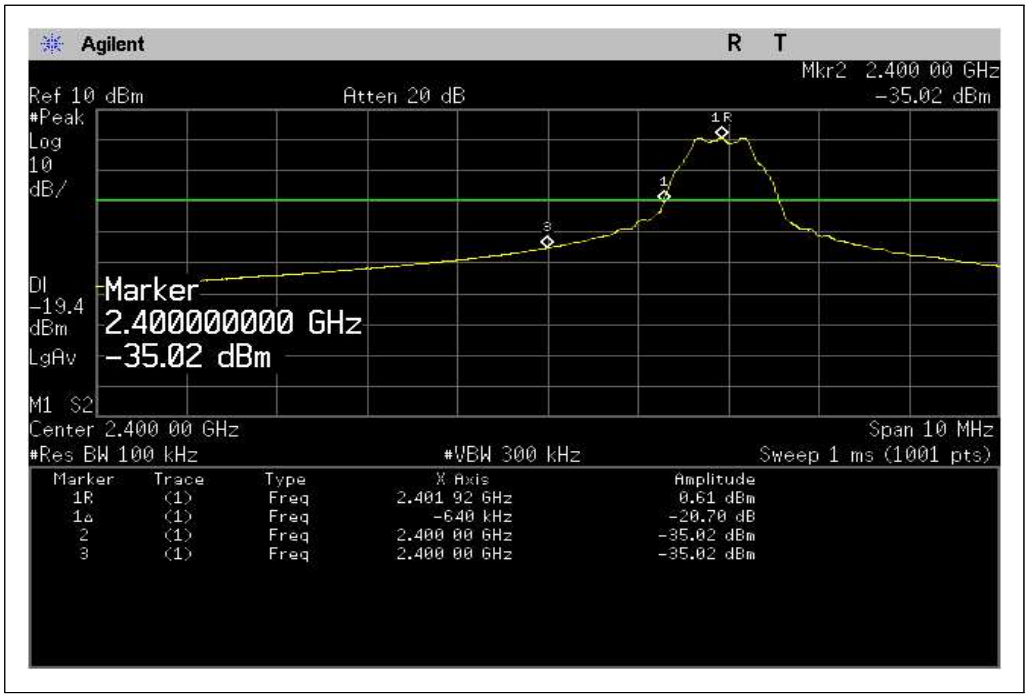
Compare with the output power of the lowest frequency, the Lower Edges attenuated more than 20 dB.

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

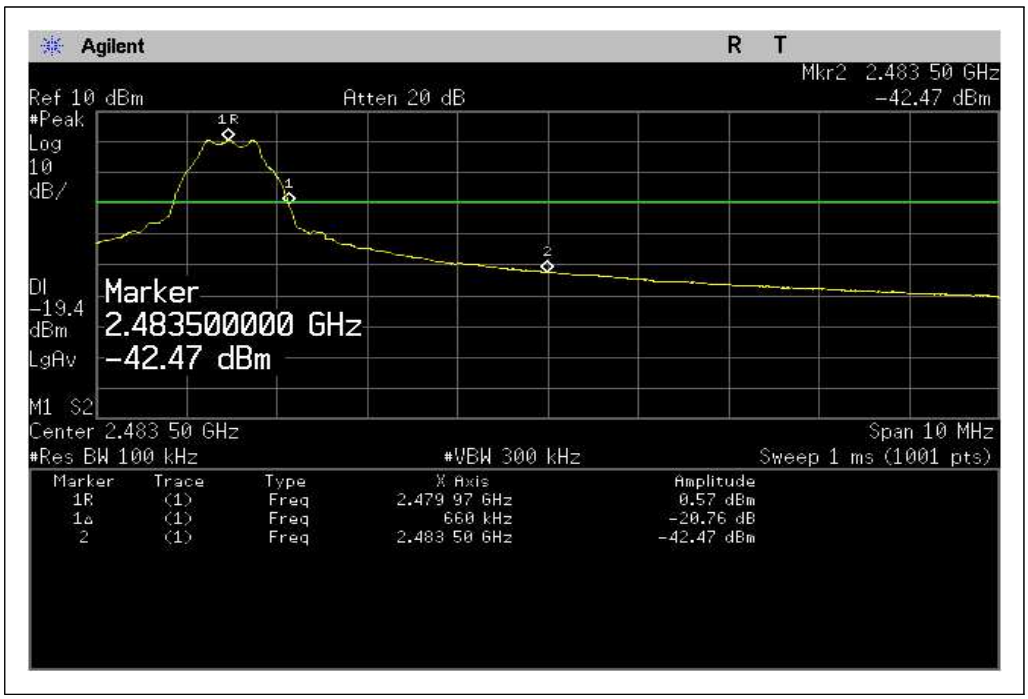
Result plot as follows:

BLE mode:

Low Channel(2 402 MHz):



Highest Channel(2 480 MHz):



## 4.9. AC Powerline Conducted Emission

4.9.1. Requirement

FCC Part 15 C section 15.207

4.9.2. Test Method

ANSI C63.4

1) Frequency Range

150 kHz to 30 MHz

2) Detector

Peak for pre-scan (9 kHz Resolution Bandwidth)

3) Test Limit

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

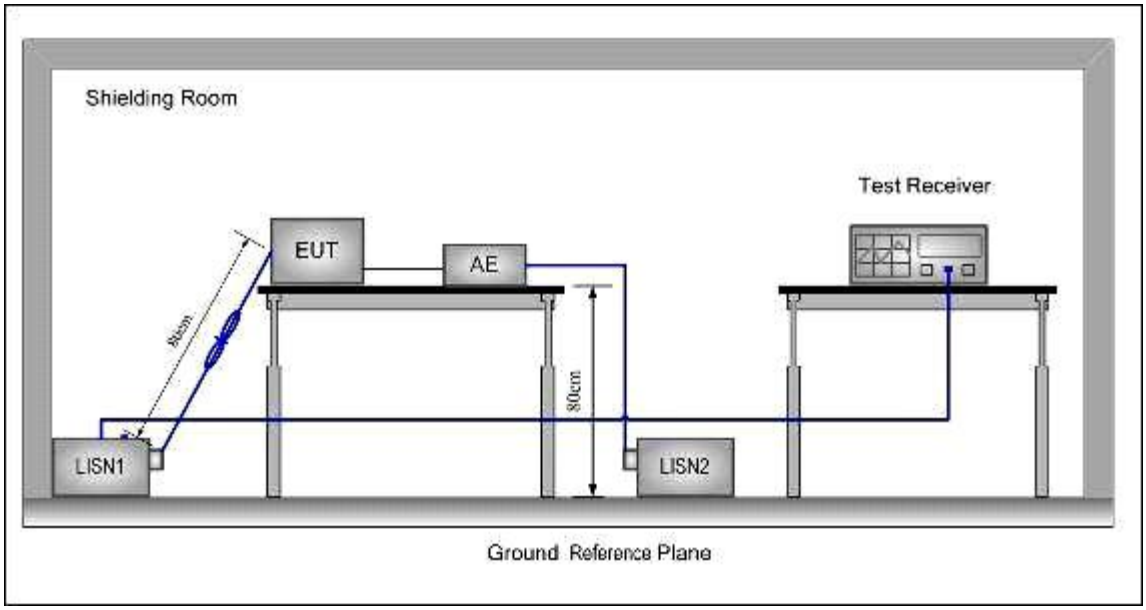
| Frequency Range (MHz) | Class B Limit dB(μV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |
| NOTE 1 The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz. | | |

4) 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).

4.9.3. Test Configuration




4.9.4. Test procedure

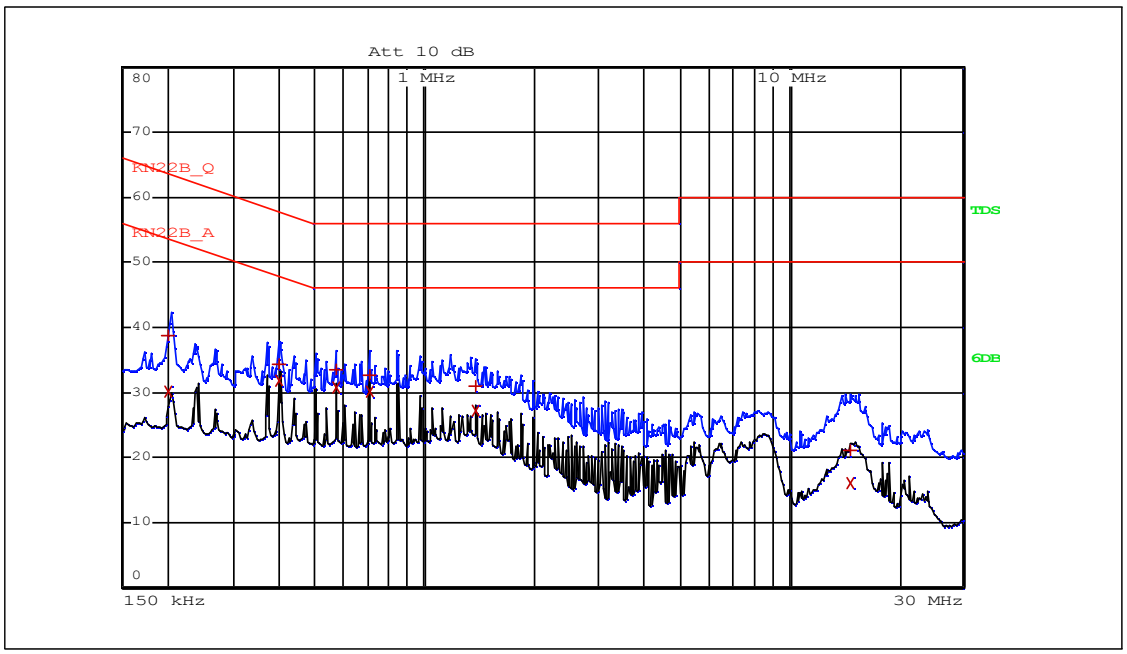
1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50/50µH + 5linear impedance. The power cables of all other units of the EUT were connected to a second 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.

4.9.5. Test result

Pre-scan was performed with peak detected on all ports, Quasi-peak & average measurements were performed at the frequencies at which maximum peak emission level were detected.

Please see the attached Quasi-peak and Average test results.

Hot Line – PE(Peak and Average detector used)

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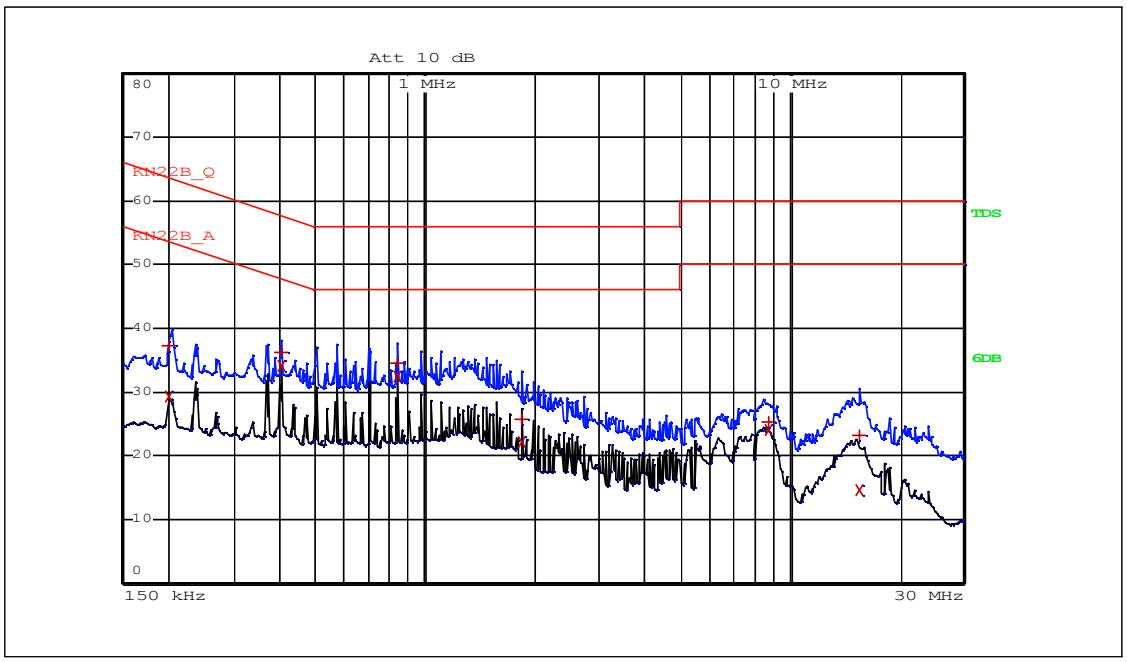
Neutral Line – PE(Peak and Average detector used)




Date: 2.JUN.2016 15:16:08

| Frequency (MHz) | Line (H/N) | Quasi-Peak | | | Average | | |
|---|---|---|---|---|---|---|---|
| | | Emission Level (dBμV) | Limit (dBμV) | Margin (dB) | Emission Level (dBμV) | Limit (dBμV) | Margin (dB) |
| 0.20 | N | 37.32 | 63.61 | 26.29 | 29.38 | 53.61 | 24.23 |
| 0.20 | H | 38.65 | 63.61 | 24.96 | 30.07 | 53.61 | 23.54 |
| 0.40 | N | 36.24 | 57.85 | 21.61 | 34.04 | 47.85 | 13.81 |
| 0.40 | H | 34.25 | 57.85 | 23.60 | 31.88 | 47.85 | 15.97 |
| 0.57 | H | 33.46 | 56.00 | 22.54 | 30.82 | 46.00 | 15.18 |
| 0.71 | H | 32.63 | 56.00 | 23.37 | 30.13 | 46.00 | 15.87 |
| 0.84 | N | 34.58 | 56.00 | 21.42 | 32.41 | 46.00 | 13.59 |
| 1.38 | H | 30.89 | 56.00 | 25.11 | 27.09 | 46.00 | 18.91 |
| 1.85 | N | 25.78 | 56.00 | 30.22 | 22.14 | 46.00 | 23.86 |
| 8.75 | N | 25.22 | 60.00 | 34.78 | 23.95 | 50.00 | 26.05 |
| 14.70 | H | 21.08 | 60.00 | 38.92 | 16.00 | 50.00 | 34.00 |
| 15.62 | N | 23.15 | 60.00 | 36.85 | 14.60 | 50.00 | 35.40 |

* Remark:
1) Margin (dB) = Limit − Emission Level
2) Emission Level = Measured Value + Antenna Factor + Cable Loss

## 4.10. Radio Frequency Exposure Procedures

4.10.1. Requirement

According to §15.247(i) and § 1.1307(b)(1) , systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

KDB 447498 D01: Approximate SAR test exclusion power thresholds at selected frequencies and test separation distances are illustrated in the following table:

| MHz | 5 | 10 | 15 | 20 | 25 | mm |
|---|---|---|---|---|---|---|
| 150 | 39 | 77 | 116 | 155 | 194 | SAR Test Exclusion Threshold (mW) |
| 300 | 27 | 55 | 82 | 110 | 137 | |
| 450 | 22 | 45 | 67 | 89 | 112 | |
| 835 | 16 | 33 | 49 | 66 | 82 | |
| 900 | 16 | 32 | 47 | 63 | 79 | |
| 1 500 | 12 | 24 | 37 | 49 | 61 | |
| 1 900 | 11 | 22 | 33 | 44 | 54 | |
| 2 450 | 10 | 19 | 29 | 38 | 48 | |
| 3 600 | 8 | 16 | 24 | 32 | 40 | |
| 5 200 | 7 | 13 | 20 | 26 | 33 | |
| 5 400 | 6 | 13 | 19 | 26 | 32 | |
| 5 800 | 6 | 12 | 19 | 25 | 31 | |

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: [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- f(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.

4.10.2. Conclusion

1) Maximum Measured Transmitter Power:

| Channel Frequency (MHz) | Maximum Peak Conducted Output Power | | Max Antenna Gain (dBi) | Numeric antenna gain (mW) |
|---|---|---|---|---|
| | (dBm) | (mW) | | |
| 2 440 | 1.15 | 1.30 | 4.8 | 3.02 |

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] = 1.30/25*√2.440 = 0.081 ≤ 3.0

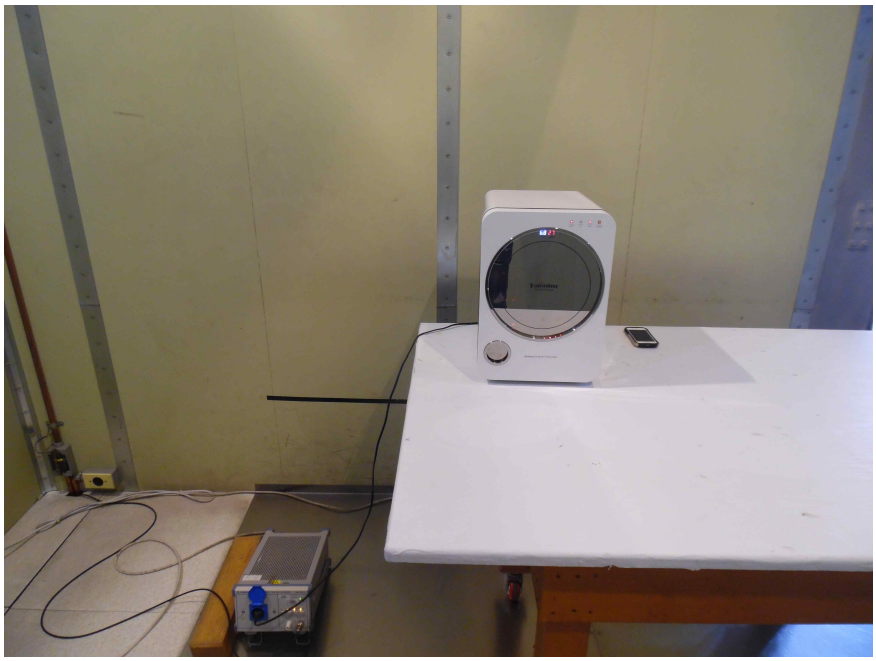
Threshold at which no SAR required is 48 mW and ≤ 3.0 for 1-g SAR, Separation distance is 25 mm.

2) Conclusion : The SAR measurement is exempt.

# APPENDIX A : Photographs of Test Setup

## 1. Radiated Spurious Emission

## 2. AC Powerline Conducted Emission



# APPENDIX B : Photographs of EUT

## 1. EUT photo