

# Test Report

## 1. Client

- Name : Sena Technologies Co., Ltd.
- Address : 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Republic of Korea

2. Use of Report : FCC & IC Approval

## 3. Sample Description

- Product Name : X-COM 3 PRO
- Model Name : SP146

4. Date of Receipt : 2023-10-19

5. Date of Test : 2023-11-03 ~ 2023-11-13

6. Test Method : FCC Part 15 Subpart C 15.247  
RSS-247 Issue 2(2017-02), RSS-GEN Issue 5(2019-03)

7. Test Results : Refer to the test results

This test report must not be reproduced or reproduced in any way.

The results shown in this test report are the results of testing the samples provided.

This test report is prepared according to the requirements of ISO / IEC 17025.

|             |                 |                                                                                                    |                   |                                                                                                      |
|-------------|-----------------|----------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------|
| Affirmation | Tested by       | <br>(signature) | Technical Manager | <br>(signature) |
|             | Dae-Seong, Choi |                                                                                                    | Jong-Myoung, Shin |                                                                                                      |

Nov 22, 2023

EMC Labs Co., Ltd.



# Contents

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| 1. Applicant & Manufacturer & Test Laboratory Information.....        | 4  |
| 2. Equipment under Test(EUT) Information.....                         | 5  |
| 3. Test Summary.....                                                  | 6  |
| 4. Used equipment on test.....                                        | 7  |
| 5. Antenna Requirement.....                                           | 7  |
| 6. 6 dB Bandwidth.....                                                | 9  |
| 7. Maximum Peak Output Power.....                                     | 13 |
| 8. Peak Power Spectral Density.....                                   | 16 |
| 9. TX Radiated Spurious Emission and Conducted Spurious Emission..... | 19 |
| 10. Conducted Emission.....                                           | 35 |

## APPENDIX

|                              |    |
|------------------------------|----|
| APPENDIX I TEST SETUP.....   | 38 |
| APPENDIX II UNCERTAINTY..... | 40 |

# Version

| TEST REPORT NO.   | DATE         | DESCRIPTION   |
|-------------------|--------------|---------------|
| KR0140-RF2311-003 | Nov 22, 2023 | Initial Issue |
|                   |              |               |
|                   |              |               |



## 1. Applicant & Manufacturer & Test Laboratory Information

### 1.1 Applicant Information

|                   |                                                                |
|-------------------|----------------------------------------------------------------|
| Applicant         | Sena Technologies Co., Ltd.                                    |
| Applicant Address | 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Republic of Korea |
| Contact Person    | Seunghyun Kim                                                  |
| Telephone No.     | +82-2-573-7772                                                 |
| Fax No.           | +82-2-573-7710                                                 |
| E-mail            | shkim77@sena.com                                               |

### 1.2. Manufacturer Information

|                      |                                                    |
|----------------------|----------------------------------------------------|
| Manufacturer         | Sena Technologies Co., Ltd.                        |
| Manufacturer Address | 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, Korea |

### 1.3 Test Laboratory Information

|                          |                                                                            |
|--------------------------|----------------------------------------------------------------------------|
| Laboratory               | EMC Labs Co., Ltd.                                                         |
| Laboratory Address       | 100, Jangjateo-ro, Hobeop-myeon, Icheon-si, Gyeonggi-do, Republic of Korea |
| Contact Person           | Jong-Myoung, Shin                                                          |
| Telephone No.            | +82-31-637-8895                                                            |
| Fax No.                  | +82-505-116-8895                                                           |
| FCC Designation No.      | KR0140                                                                     |
| FCC Registration No.     | 580000                                                                     |
| IC Site Registration No. | 28751                                                                      |



## 2. Equipment under Test(EUT) Information

### 2.1 General Information

|              |             |
|--------------|-------------|
| Product Name | X-COM 3 PRO |
| Model Name   | SP146       |
| FCC ID       | S7A-SP146   |
| IC           | 8154A-SP146 |
| Power Supply | DC 3.8 V    |

### 2.2 Additional Information

|                     |                       |
|---------------------|-----------------------|
| Operating Frequency | 2 410 MHz ~ 2 475 MHz |
| Number of channel   | 14                    |
| Modulation Type     | OQPSK                 |
| Antenna Type        | Dipole Antenna        |
| Antenna Gain        | 0.94 dBi              |
| Firmware Version    | 1.0                   |
| Hardware Version    | 1.0                   |
| Test software       | CMD v10.0.19044.1889  |

### 2.3 Test Frequency

| Test mode | Test Frequency (MHz) |                  |                |
|-----------|----------------------|------------------|----------------|
|           | Low Frequency        | Middle Frequency | High Frequency |
| MESH      | 2 410                | 2 445            | 2 475          |

### 2.4 Used Test Software Setting Value

| Test Mode | Setting Item |
|-----------|--------------|
|           | Power        |
| MESH      | 13           |

### 2.5 Mode of operation during the test

- The EUT continuous transmission mode during the test with set at Low Channel, Middle Channel, and High Channel. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, YZ, XZ planes.

### 2.6 Modifications of EUT

- None



### 3. Test Summary

| Applied                             | FCC Rule                        | IC Rule                                  | Test Items                  | Test Condition       | Result |
|-------------------------------------|---------------------------------|------------------------------------------|-----------------------------|----------------------|--------|
| <input checked="" type="checkbox"/> | 15.203                          | –                                        | Antenna Requirement         | Conducted            | C      |
| <input checked="" type="checkbox"/> | 15.247(a)                       | RSS-247 (5.2)                            | 6 dB Bandwidth              |                      | C      |
| <input checked="" type="checkbox"/> | –                               | RSS GEN (6.7)                            | Occupied Bandwidth (99%)    |                      | C      |
| <input checked="" type="checkbox"/> | 15.247(b)                       | RSS-247 (5.4)                            | Maximum Peak Output Power   |                      | C      |
| <input checked="" type="checkbox"/> | 15.247(e)                       | RSS-247 (5.2)                            | Peak Power Spectral Density |                      | C      |
| <input checked="" type="checkbox"/> | 15.247(d)                       | RSS-247 (5.5)                            | Conducted Spurious Emission |                      | C      |
| <input checked="" type="checkbox"/> | 15.247(d)<br>15.205 &<br>15.209 | RSS-247 (5.5)<br>RSS-GEN<br>(8.9 & 8.10) | Radiated Spurious Emission  | Radiated             | C      |
| <input checked="" type="checkbox"/> | 15.207                          | RSS-GEN (8.8)                            | Conducted Emissions         | AC Line<br>Conducted | C      |

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

The sample was tested according to the following specification: ANSI C63.10:2013.

Compliance was determined by specification limits of the applicable standard according to customer requirements.



## 4. Used equipment on test

|   | Description                  | Manufacturer      | Model Name            | Serial Name     | Next Cal.  |
|---|------------------------------|-------------------|-----------------------|-----------------|------------|
| ■ | TEMP & HUMID CHAMBER         | JFM               | JFMA-001              | 20200929-01     | 2023.12.15 |
| ■ | CONTROLLER                   | AMWON TECHNOLOGY  | TEMI2500              | S7800VK191 0707 | 2023.12.15 |
| ■ | PSA SERIES SPECTRUM ANALYZER | AGILENT           | E4440A                | MY45304057      | 2023.12.15 |
| ■ | MXG ANALOG SIGNAL GENERATOR  | AGILENT           | N5183A                | MY50141890      | 2023.12.14 |
| ■ | SYSTEM DC POWER SUPPLY       | AGILENT           | 6674A                 | MY53000118      | 2023.12.14 |
| □ | VECTOR SIGNAL GENERATOR      | ROHDE & SCHWARZ   | SMBV100A              | 257524          | 2023.12.14 |
| □ | BLUETOOTH TESTER             | TESCOM            | TC-3000A              | 3000A480088     | 2023.12.14 |
| □ | DIRECTIONAL COUPLER          | AGILENT           | 773D                  | 2839A01855      | 2023.12.14 |
| □ | ATTENUATOR                   | AGILENT           | 8493C                 | 73193           | 2023.12.14 |
| □ | TERMINATION                  | HEWLETT PACKARD   | 909D                  | 07492           | 2023.12.14 |
| □ | POWER DIVIDER                | HEWLETT PACKARD   | 11636A                | 06916           | 2023.12.14 |
| □ | SLIDE-AC                     | DAEKWANG TECH     | SV-1023               | NONE            | 2024.11.10 |
| □ | DIGITAL MULTIMETER           | HUMANTECHSTORE    | 15B+                  | 50561541WS      | 2023.12.14 |
| ■ | ATTENUATOR                   | ACE RF COMM       | ATT SMA 20W 20dB 8GHz | A-0820.SM20.2   | 2024.04.04 |
| ■ | DC POWER SUPPLY              | AGILENT           | E3634A                | MY40012120      | 2024.02.23 |
| □ | USB Peak Power Sensor        | Anritsu           | MA24408A              | 12321           | 2024.11.09 |
| □ | High Pass Filter             | WT Microwave INC. | WT-A3314-HS           | WT22111804-1    | 2023.12.14 |
| ■ | High Pass Filter             | WT Microwave INC. | WT-A1935-HS           | WT22111804-2    | 2023.12.14 |
| □ | SPECTRUM ANALYZER            | ROHDE & SCHWARZ   | FSU26                 | 200444          | 2024.02.22 |
| ■ | ACTIVE LOOP ANTENNA          | TESEQ             | HLA 6121              | 55685           | 2024.12.22 |
| ■ | Biconilog ANT                | Schwarzbeck       | VULB 9160             | 3260            | 2025.01.09 |
| □ | Biconilog ANT                | Schwarzbeck       | VULB9168              | 902             | 2024.11.30 |
| ■ | Horn ANT                     | Schwarzbeck       | BBHA9120D             | 974             | 2023.11.29 |
| □ | Horn ANT                     | Schwarzbeck       | BBHA9120D             | 1497            | 2024.01.09 |
| ■ | Amplifier                    | TESTEK            | TK-PA18H              | 200104-L        | 2024.03.14 |
| ■ | Horn ANT                     | Schwarzbeck       | BBHA9170              | 01188           | 2024.03.16 |
| □ | Horn ANT                     | Schwarzbeck       | BBHA9170              | 01189           | 2024.03.16 |
| ■ | AMPLIFIER                    | TESTEK            | TK-PA1840H            | 220105-L        | 2024.03.14 |
| ■ | EMI TEST RECEIVER            | ROHDE & SCHWARZ   | ESW44                 | 101952          | 2024.03.14 |
| ■ | Test Receiver                | ROHDE & SCHWARZ   | ESR7                  | 101616          | 2024.06.27 |
| ■ | LISN                         | ROHDE & SCHWARZ   | ENV216                | 100409          | 2024.01.09 |
| ■ | PULSE LIMITER                | lignex1           | EPL-30                | NONE            | 2024.01.09 |

## 5. Antenna Requirement

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

According to §15.247(b)(4) e conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. 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.

### 5.1 Result

Complies

(The transmitter has a Dipole Antenna. The directional peak gain of the antenna is 0.94 dBi.)



## 6. 6 dB Bandwidth

### 6.1 Test Setup

Refer to the APPENDIX I.

### 6.2 Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

### 6.3 Test Procedure

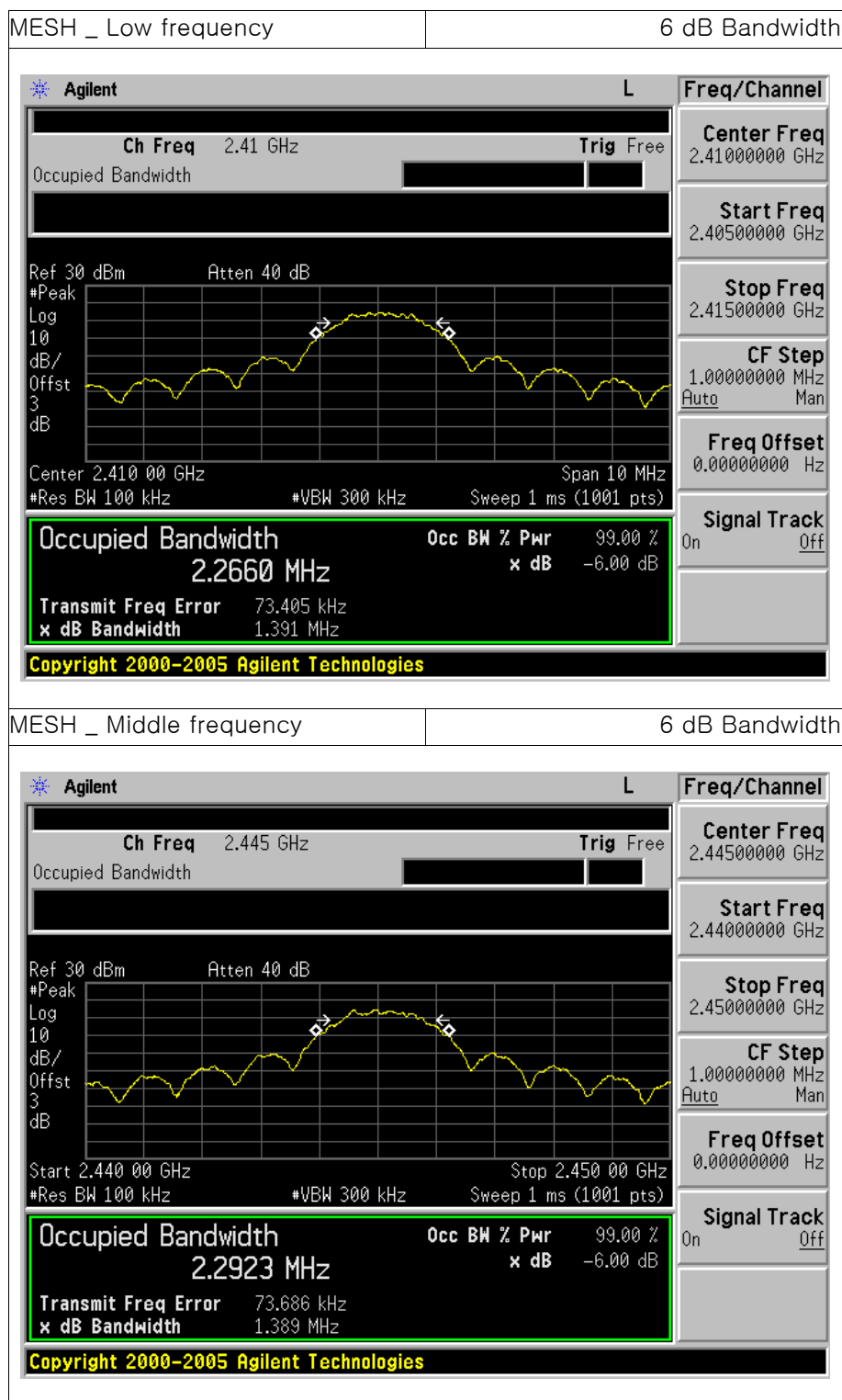
The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the EUT's antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

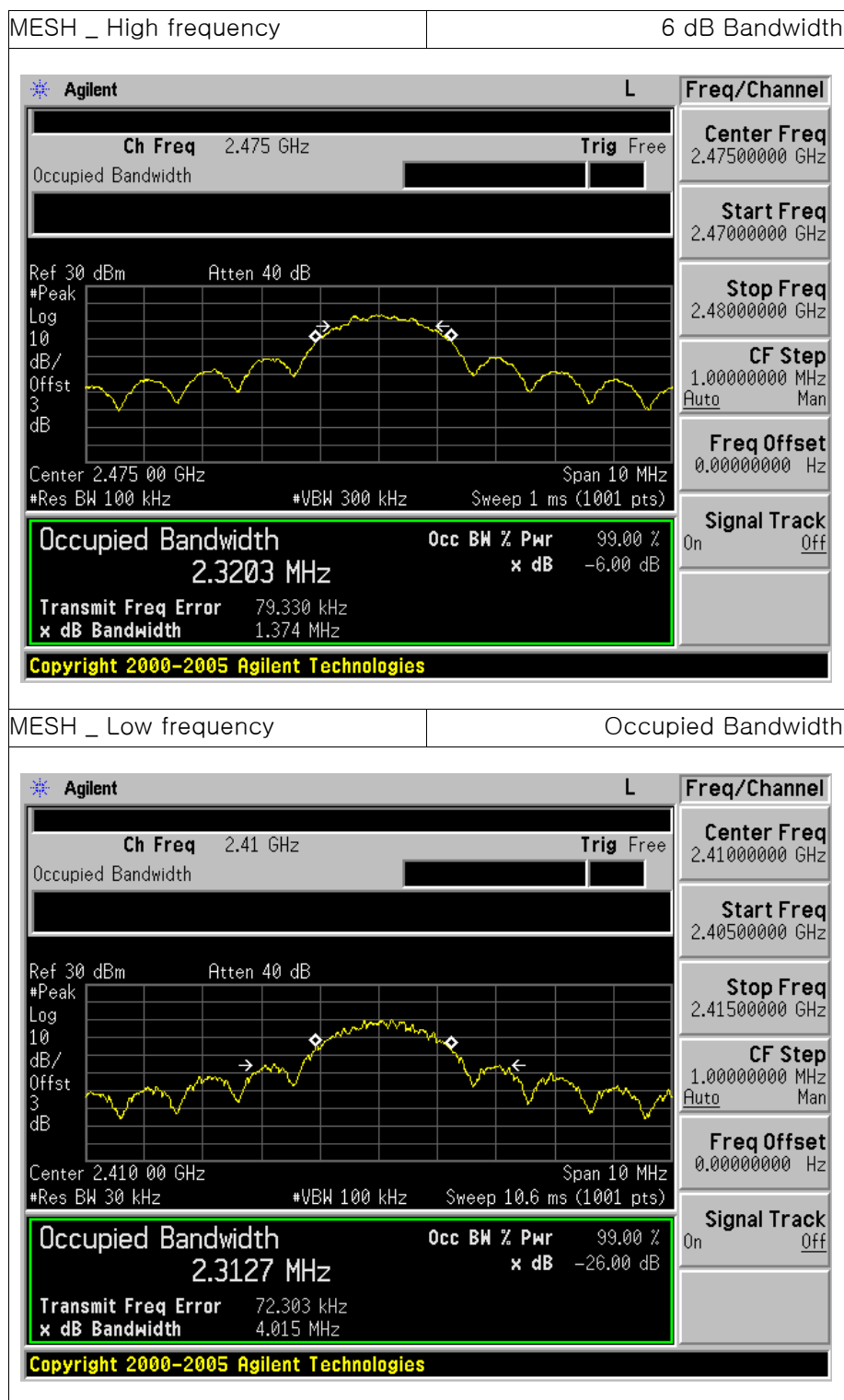
1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
3. Detector = Peak.
4. Trace mode = Max Hold.
5. Sweep = Auto
6. Allow the trace to stabilize.
7. Option 1 – Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.  
Option 2 – The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW  $\geq 3 \times$  RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq 6$  dB.

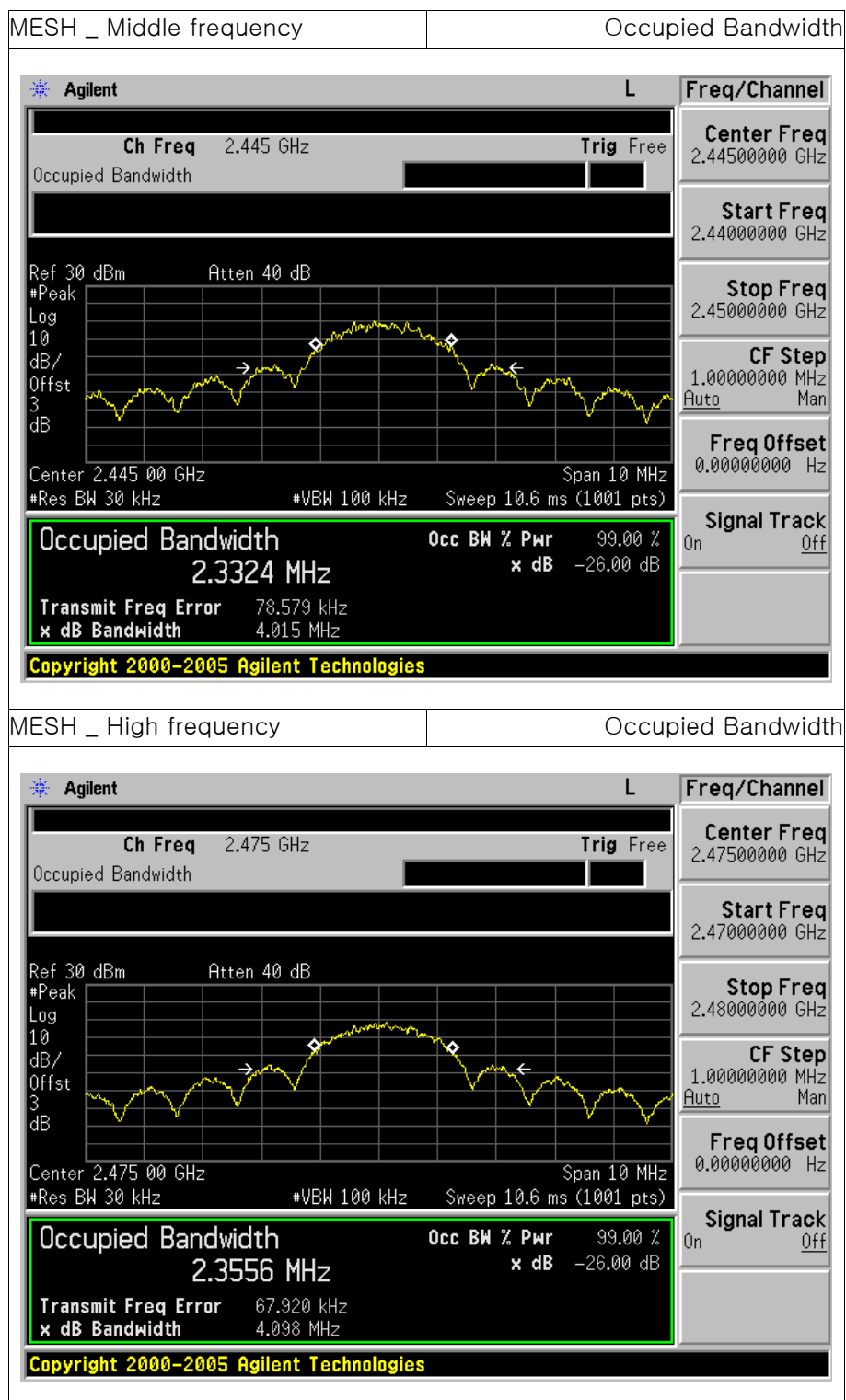
### 6.4 Test Result

| Test Mode | Test Frequency | 6 dB Bandwidth (MHz) | Occupied Bandwidth (MHz) |
|-----------|----------------|----------------------|--------------------------|
| MESH      | Low            | 1.391                | 2.313                    |
|           | Middle         | 1.389                | 2.332                    |
|           | High           | 1.374                | 2.356                    |

## 6.5 Test Plot









## 7. Maximum Peak Output Power

### 7.1 Test Setup

Refer to the APPENDIX I.

### 7.2 Limit

The maximum permissible conducted output power is 1 Watt.

### 7.3 Test Procedure

A transmitter antenna terminal of EUT is connected to the input of a spectrum analyzer. Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

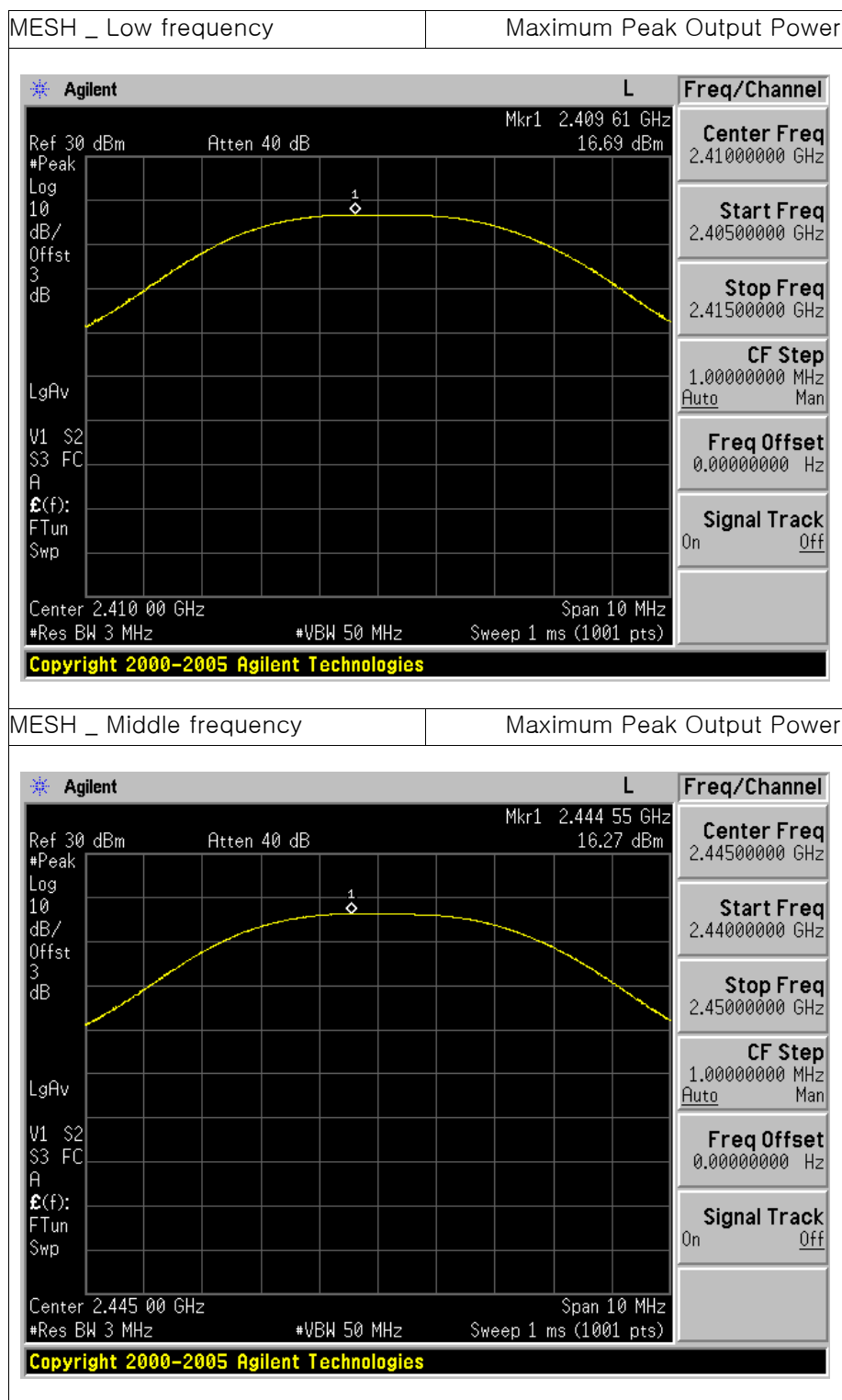
1. Set the RBW  $\geq$  DTS bandwidth
2. Set VBW  $\geq 3 \times$  RBW
3. Set span  $\geq 3 \times$  RBW.
4. Sweep time = auto couple
5. Detector = peak
6. Trace mode = max hold
7. Allow trace to fully stabilize
8. Use peak search function to determine the peak amplitude level.

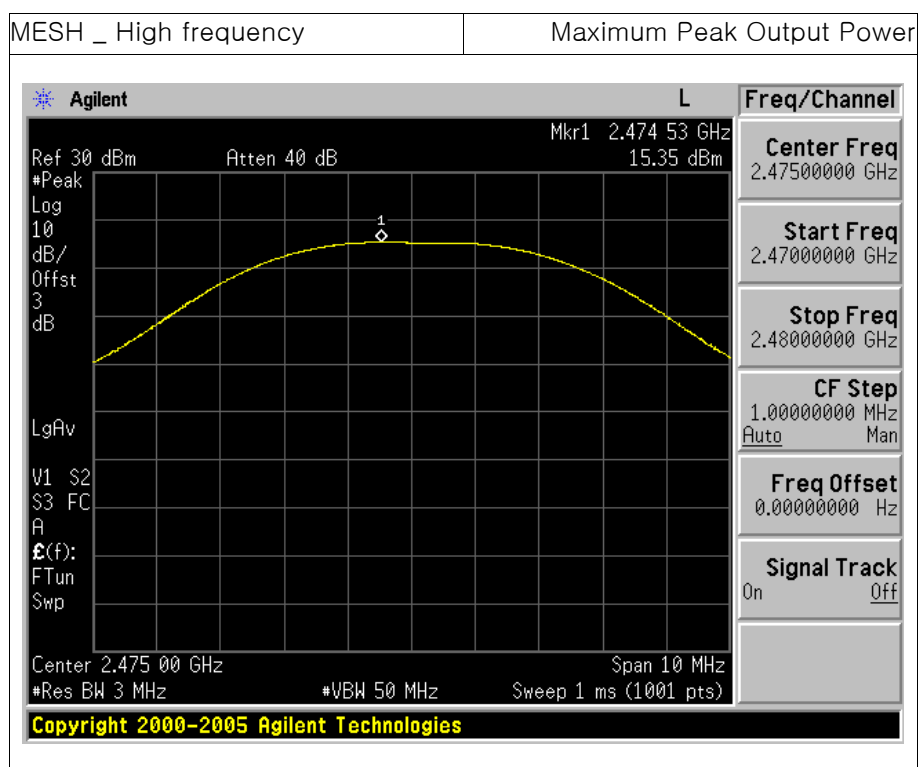
### 7.4 Test Result

| Test Mode | Test Frequency | Peak Output Power |       |
|-----------|----------------|-------------------|-------|
|           |                | dBm               | mW    |
| MESH      | Low            | 16.69             | 46.67 |
|           | Middle         | 16.27             | 42.36 |
|           | High           | 15.35             | 34.28 |

Note1: Frame Average Power was tested using an average power meter for reference only.

## 7.5 Test Plot





## 8. Peak Power Spectral Density

### 8.1 Test Setup

Refer to the APPENDIX I.

### 8.2 Limit

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

### 8.3 Test Procedure

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

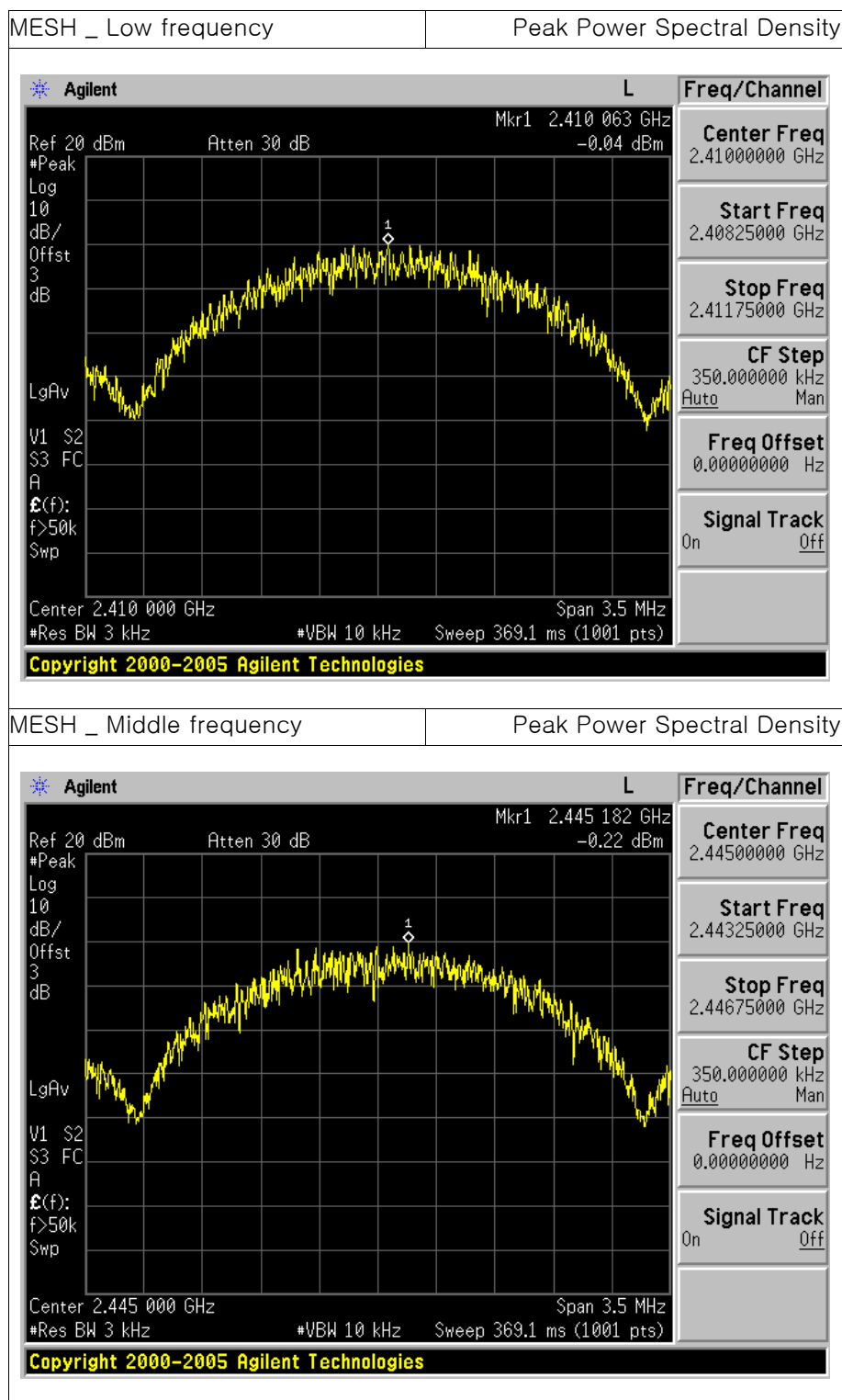
(ANSI C63.10–2013 \_ Section 11.10.2 – Method PKPSD)

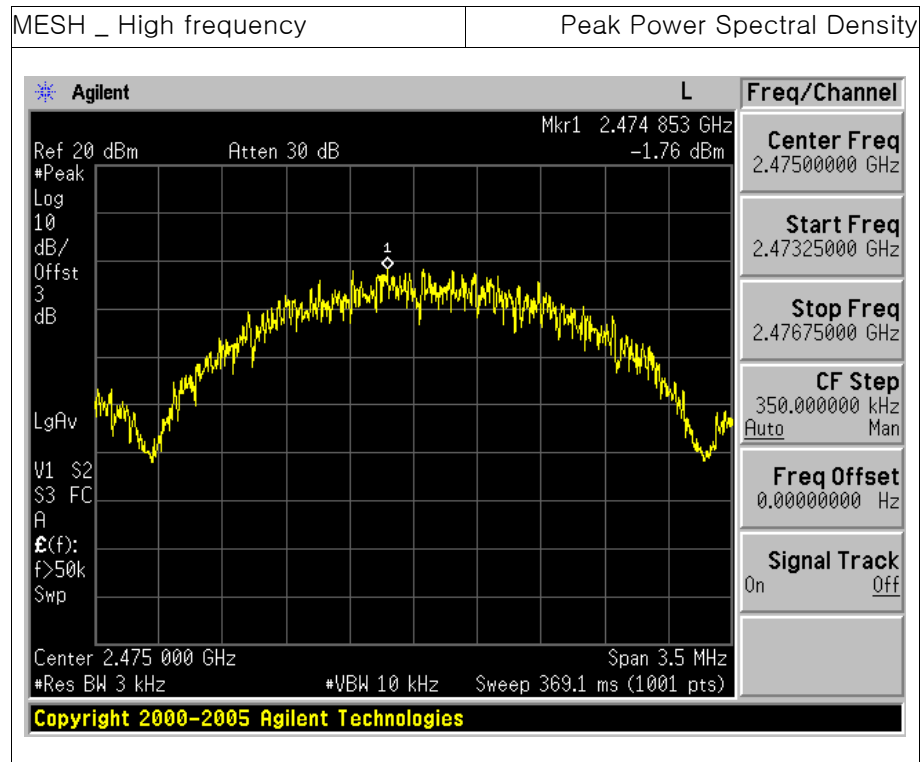
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW :  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
4. Set the VBW  $\geq 3 \times \text{RBW}$ .
5. Detector = Peak.
6. Sweep time = Auto
7. Trace mode = Max Hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 8.4 Test Result

| Test Mode | Test Frequency | Peak Power Spectral Density (dBm) |
|-----------|----------------|-----------------------------------|
| MESH      | Low            | -0.04                             |
|           | Middle         | -0.22                             |
|           | High           | -1.76                             |

## 8.5 Test Plot





## 9. TX Radiated Spurious Emission and Conducted Spurious Emission

### 9.1 Test Setup

Refer to the APPENDIX I.

### 9.2 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 § 15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

| Frequency (MHz) | Limit (uV/m)  | Measurement Distance (meter) |
|-----------------|---------------|------------------------------|
| 0.009 ~ 0.490   | 2400/F (kHz)  | 300                          |
| 0.490 ~ 1705    | 24000/F (kHz) | 30                           |
| 1705 ~ 30.0     | 30            | 30                           |
| 30 ~ 88         | 100 **        | 3                            |
| 88 ~ 216        | 150 **        | 3                            |
| 216 ~ 960       | 200 **        | 3                            |
| Above 960       | 500           | 3                            |

\*\* Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 – 72 MHz, 76 – 88 MHz, 174 – 216 MHz or 470 – 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.



According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

| MHz                 | MHz                   | MHz             | GHz           |
|---------------------|-----------------------|-----------------|---------------|
| 0.009 ~ 0.110       | 16.42 ~ 16.423        | 399.90 ~ 410    | 4.5 ~ 5.15    |
| 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.            | 1435 ~ 1626.5   | 9.0 ~ 9.2     |
| 4.20725 ~ 4.20775   | 25 73 ~ 74.6          | 1645.5 ~ 1646.5 | 9.3 ~ 9.5     |
| 4.17725 ~ 4.17775   | 74.8 ~ 75.2           | 1660 ~ 1710     | 10.6 ~ 12.7   |
| 6.215 ~ 6.218       | 108 ~ 121.94          | 1718.8 ~ 1722.2 | 13.25 ~ 13.4  |
| 6.26775 ~ 6.26825   | 149.9 ~ 150.05        | 2200 ~ 2300     | 14.47 ~ 14.5  |
| 6.31175 ~ 6.31225   | 156.52475 ~ 156.52525 | 2310 ~ 2390     | 15.35 ~ 16.2  |
| 8.291 ~ 8.294       | 156.7 ~ 156.9         | 2483.5 ~ 2500   | 17.7 ~ 21.4   |
| 8.362 ~ 8.366       | 162.0125 ~ 167.17     | 2690 ~ 2900     | 22.01 ~ 23.12 |
| 8.37625 ~ 8.38675   | 3345.8 ~ 3358         | 3260 ~ 3267     | 23.6 ~ 24.0   |
| 8.41425 ~ 8.41475   | 3600 ~ 4400           | 3332 ~ 3339     | 31.2 ~ 31.8   |
| 12.51975 ~ 12.52025 | 3345.8 ~ 3358         | 240 ~ 285       | 36.43 ~ 36.5  |
| 12.57675 ~ 12.57725 | 3600 ~ 4400           | 322 ~ 335.4     | Above 38.6    |
| 13.36 ~ 13.41       |                       |                 |               |

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

### 9.3 Test Procedure for Radiated Spurious Emission

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3.75 meter away from the interference-receiving antenna.
3. For measurements above 1 GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.
4. The antenna is a Broadband antenna, and its 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.
5. 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 and the table was turned from 0 degrees to 360 degrees to find the maximum reading.  
(The EUT was pre-tested with three axes (X, Y, Z) and the final test was performed at the worst case.)
6. Repeat above procedures until the measurements for all frequencies are complete.

#### Measurement Instrument Setting

1. Frequency Range: Below 1 GHz  
RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak
2. Frequency Range: Above 1 GHz  
Peak Measurement  
RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto,  
Trace mode = Max Hold until the trace stabilizes  
  
Average Measurement  
RBW = 1 MHz, VBW = 3 MHz, Detector = RMS (Number of points  $\geq 2 \times \text{Span} / \text{RBW}$ ),  
Trace Mode = Average (Averaging type = power(i.e. RMS)), Sweep Time = Auto,  
Sweep Count = at least 100 traces

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:



- 1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is  $10 \log(1/x)$ , where  $x$  is the duty cycle.
- 2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is  $20 \log(1/x)$ , where  $x$  is the duty cycle.
- 3) If a specific emission is demonstrated to be continuous ( $\geq 98$  percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

#### 9.4 Test Procedure for Conducted Spurious Emission

1. The transmitter output was connected to the spectrum analyzer.
2. The reference level of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 kHz, VBW = 300 kHz.
3. The conducted spurious emission was tested each ranges were set as below.  
Frequency range: 30 MHz ~ 26.5 GHz  
RBW = 100 kHz, VBW = 300 kHz, Sweep Time = Auto, Detector = Peak,  
Trace = Max Hold

LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

## 9.5 Test Result

### 9 kHz ~ 25 GHz Data for MESH

#### ● Low frequency

| Frequency | Reading   |       | Pol. | T.F<br>(dB) | DCCF<br>(dB) | Limits    |      | Result    |      | Margin    |      |
|-----------|-----------|-------|------|-------------|--------------|-----------|------|-----------|------|-----------|------|
|           | (dBuV/m)  |       |      |             |              | (dBuV/m)  |      | (dBuV/m)  |      | (dB)      |      |
| (MHz)     | AV / Peak |       |      |             |              | AV / Peak |      | AV / Peak |      | AV / Peak |      |
| 2 389.56  | N/A       | 39.84 | H    | 9.48        | −34.28       | 54.0      | 74.0 | 15.0      | 49.3 | 39.0      | 24.7 |
| 4 821.15  | N/A       | 55.23 | H    | −0.60       | −34.28       | 54.0      | 74.0 | 20.4      | 54.6 | 33.6      | 19.4 |
| 7 231.78  | N/A       | 52.30 | H    | 8.69        | −34.28       | 54.0      | 74.0 | 26.7      | 61.0 | 27.3      | 13.0 |
|           |           |       |      |             |              |           |      |           |      |           |      |
|           |           |       |      |             |              |           |      |           |      |           |      |

#### ● Middle frequency

| Frequency<br>(MHz) | Reading<br>(dBuV/m) |       | Pol. | T.F<br>(dB) | DCCF<br>(dB) | Limits<br>(dBuV/m) |      | Result<br>(dBuV/m) |      | Margin<br>(dB) |      |
|--------------------|---------------------|-------|------|-------------|--------------|--------------------|------|--------------------|------|----------------|------|
|                    |                     |       |      |             |              |                    |      |                    |      |                |      |
|                    | AV / Peak           |       |      |             |              | AV / Peak          |      | AV / Peak          |      | AV / Peak      |      |
| 4 891.32           | N/A                 | 54.54 | H    | −0.60       | −34.28       | 54.0               | 74.0 | 19.7               | 53.9 | 34.3           | 20.1 |
| 7 336.81           | N/A                 | 49.40 | H    | 8.80        | −34.28       | 54.0               | 74.0 | 23.9               | 58.2 | 30.1           | 15.8 |
|                    |                     |       |      |             |              |                    |      |                    |      |                |      |
|                    |                     |       |      |             |              |                    |      |                    |      |                |      |
|                    |                     |       |      |             |              |                    |      |                    |      |                |      |

#### ● High frequency

| Frequency<br>(MHz) | Reading   |       | Pol. | T.F<br>(dB) | DCCF<br>(dB) | Limits    |      | Result    |      | Margin    |      |
|--------------------|-----------|-------|------|-------------|--------------|-----------|------|-----------|------|-----------|------|
|                    | (dBuV/m)  |       |      |             |              | (dBuV/m)  |      | (dBuV/m)  |      | (dB)      |      |
|                    | AV / Peak |       |      |             |              | AV / Peak |      | AV / Peak |      | AV / Peak |      |
| 2 483.54           | N/A       | 51.44 | H    | 10.21       | -34.28       | 54.0      | 74.0 | 27.4      | 61.7 | 26.6      | 12.4 |
| 4 949.26           | N/A       | 53.61 | H    | -0.52       | -34.28       | 54.0      | 74.0 | 18.8      | 53.1 | 35.2      | 20.9 |
| 7 426.55           | N/A       | 48.93 | H    | 8.86        | -34.28       | 54.0      | 74.0 | 23.5      | 57.8 | 30.5      | 16.2 |
|                    |           |       |      |             |              |           |      |           |      |           |      |
|                    |           |       |      |             |              |           |      |           |      |           |      |

Note 1: The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: DCCF(Duty Cycle Correction Factor)

–  $T_{on} = 0.644 \text{ ms}$  /  $T_{off} = 39.54 \text{ ms}$

–  $DCCF = 20 \times \log(\text{The Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = 20 \times \log(1.932 / 100) \text{ dB} = -34.28 \text{ dB}$

Note 3: Sample Calculation.

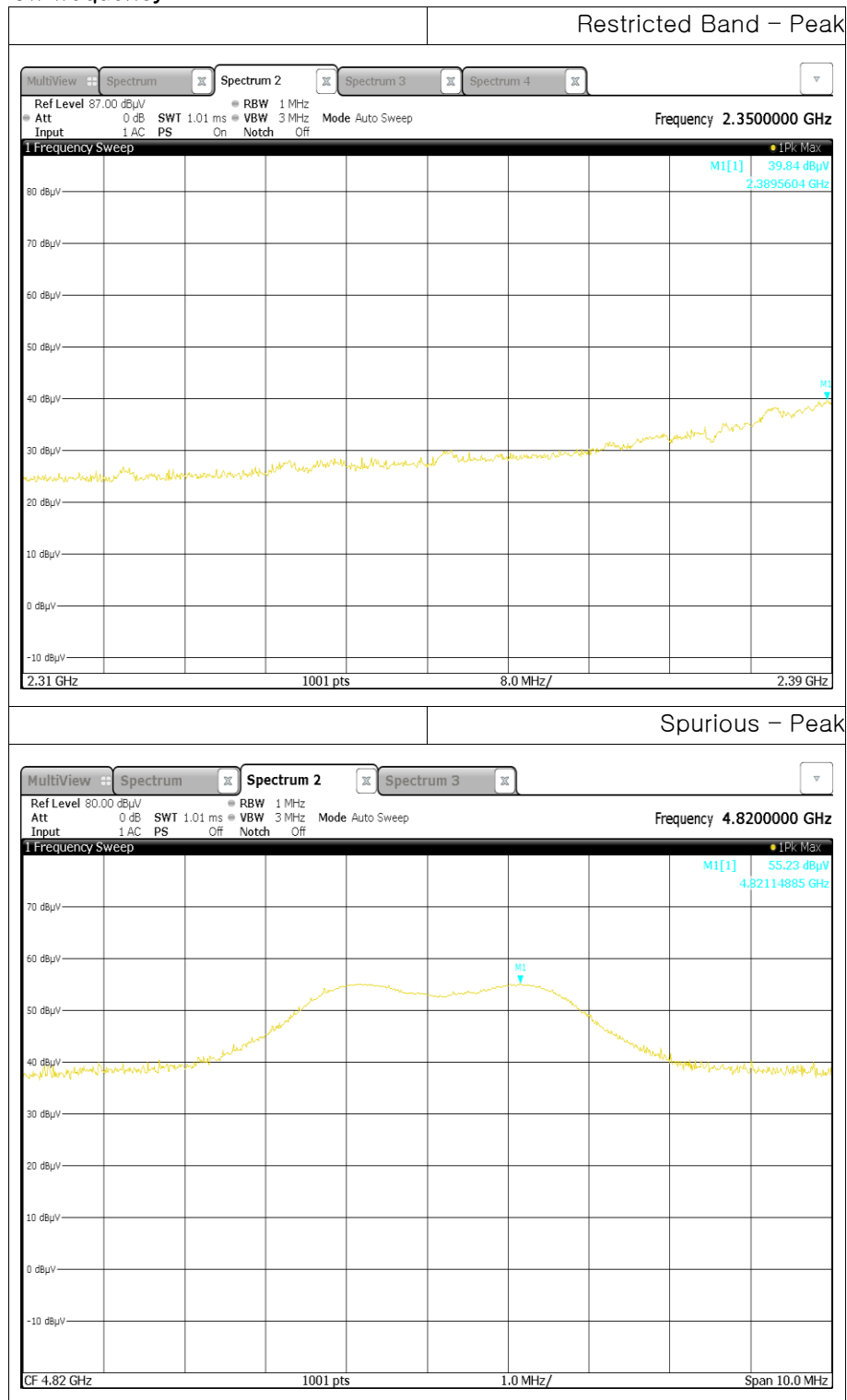
Margin = Limit – Result / Peak Result = Peak Reading + TF / Average Result = Peak Reading + TF + DCCF

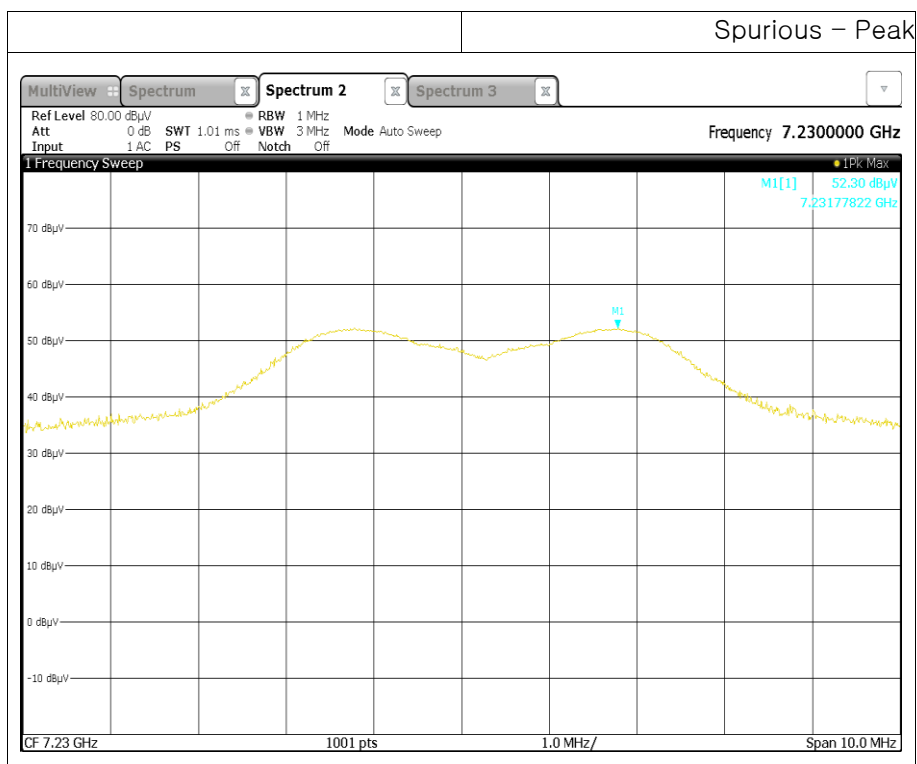
TF = Ant factor + Cable Loss + Filter Loss – Amp Gain + Distance Factor

Distance Factor =  $20\log(\text{applied distance}/\text{required distance}) = 20\log(3.75\text{m}/3\text{m}) = 1.94$

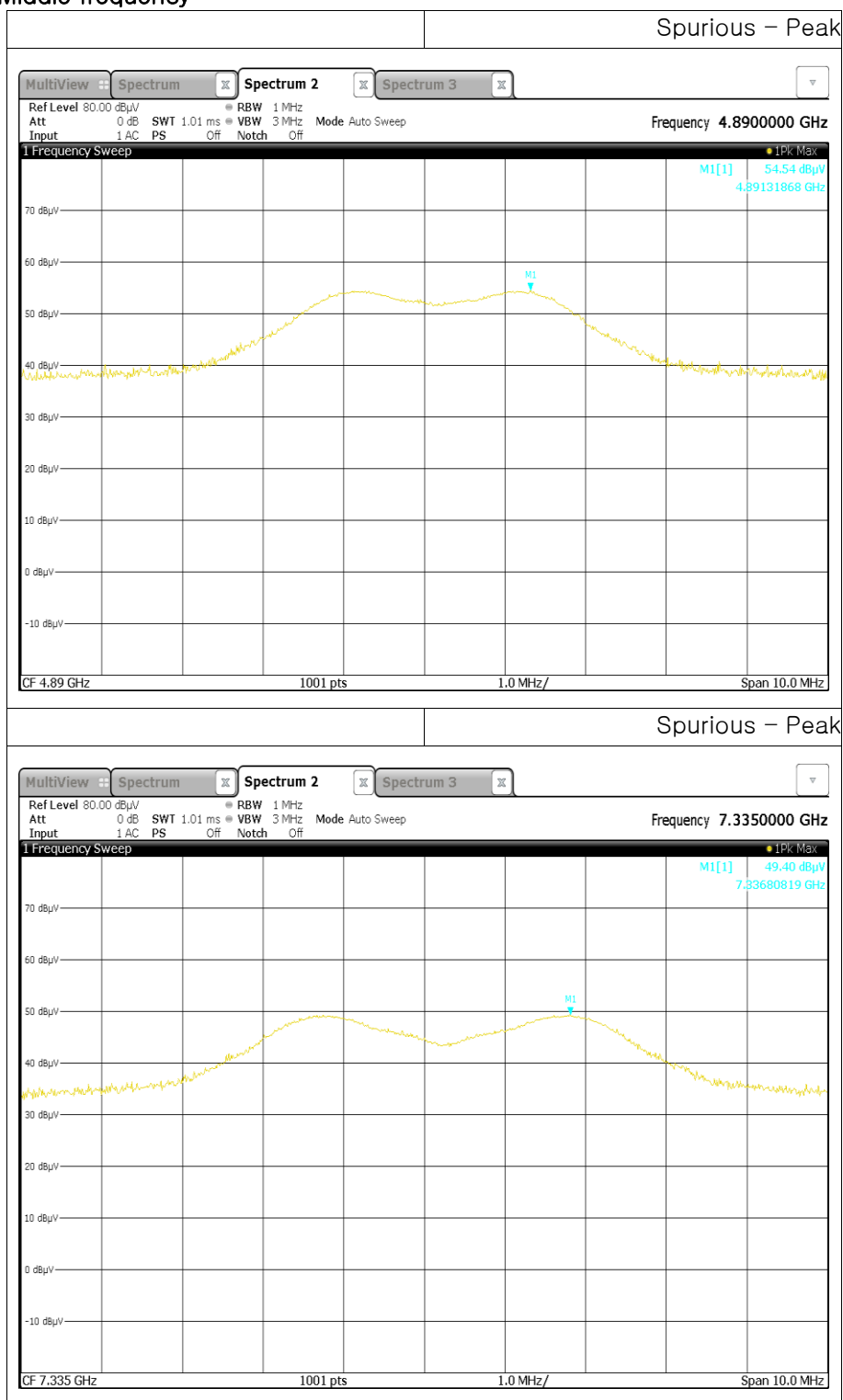
## 9.6 Test Plot for Radiated Spurious Emission MESH

- MESH \_ Low frequency

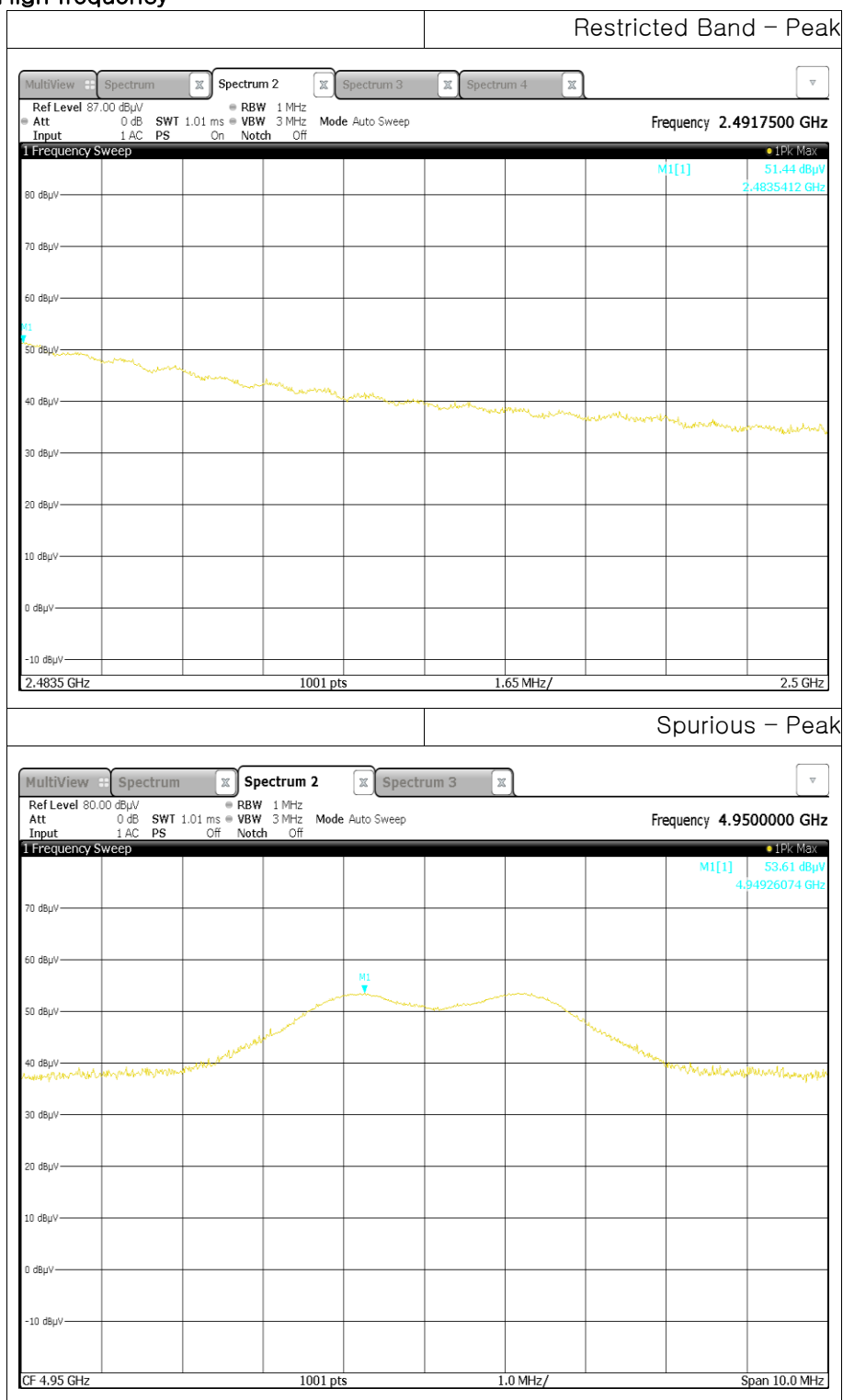


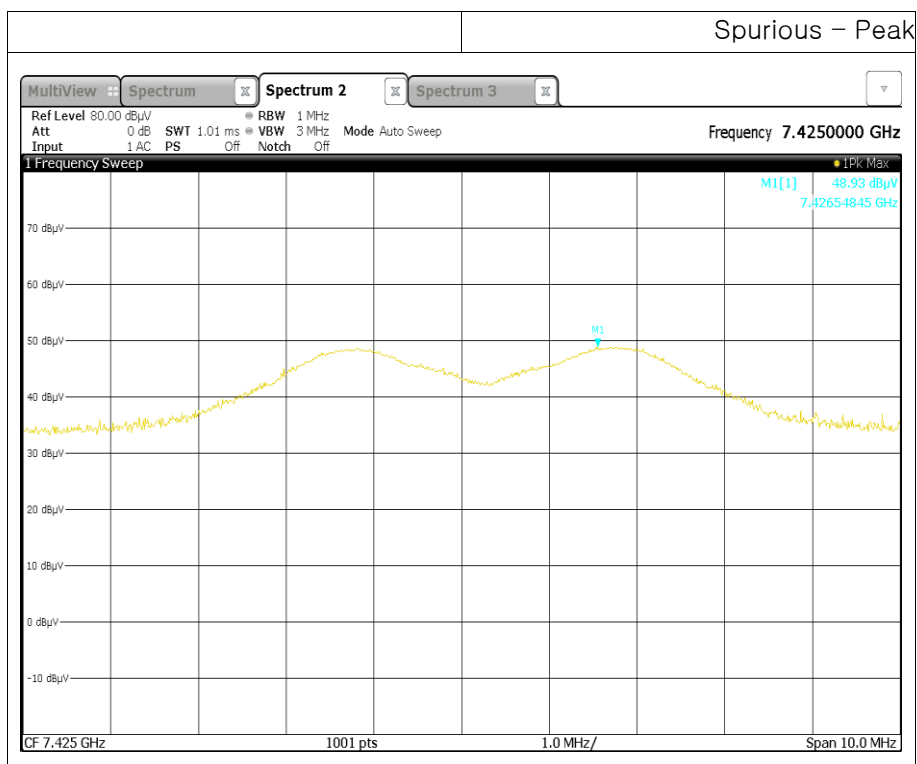


● MESH \_ Middle frequency



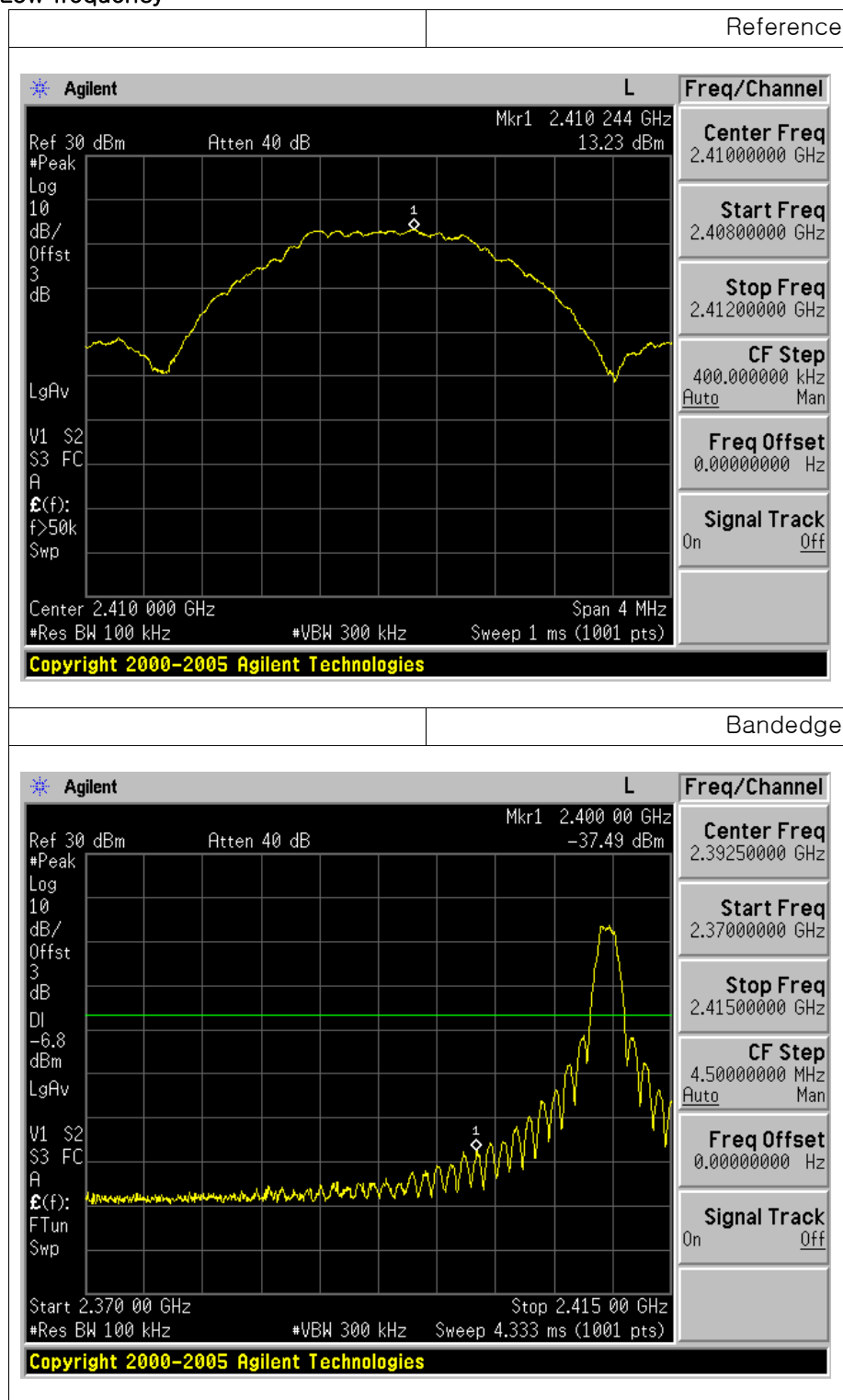
- MESH \_ High frequency

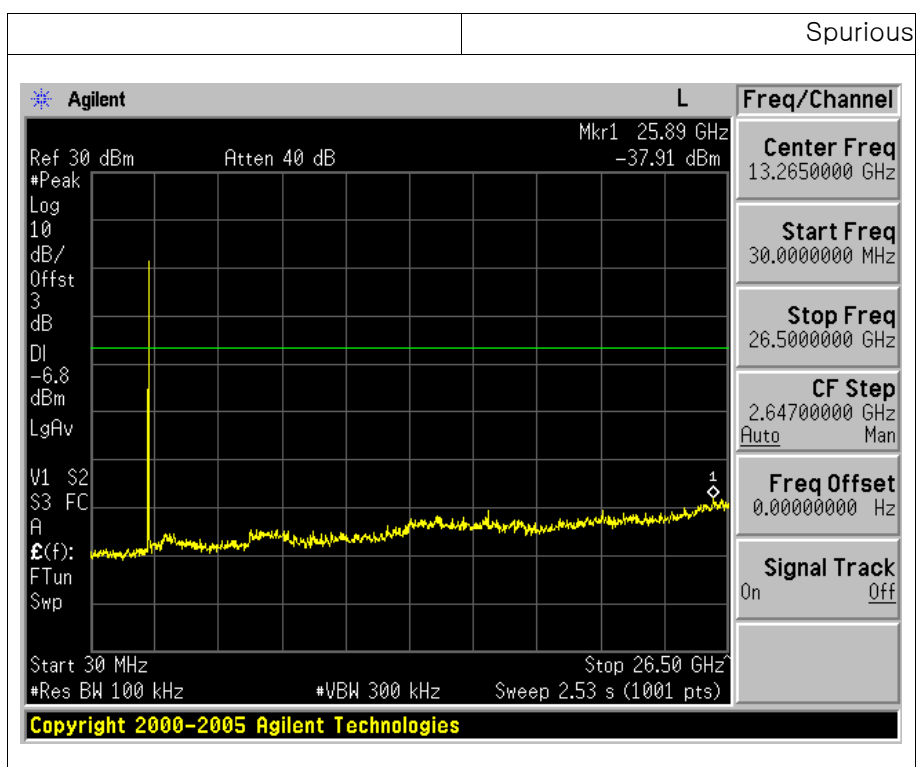




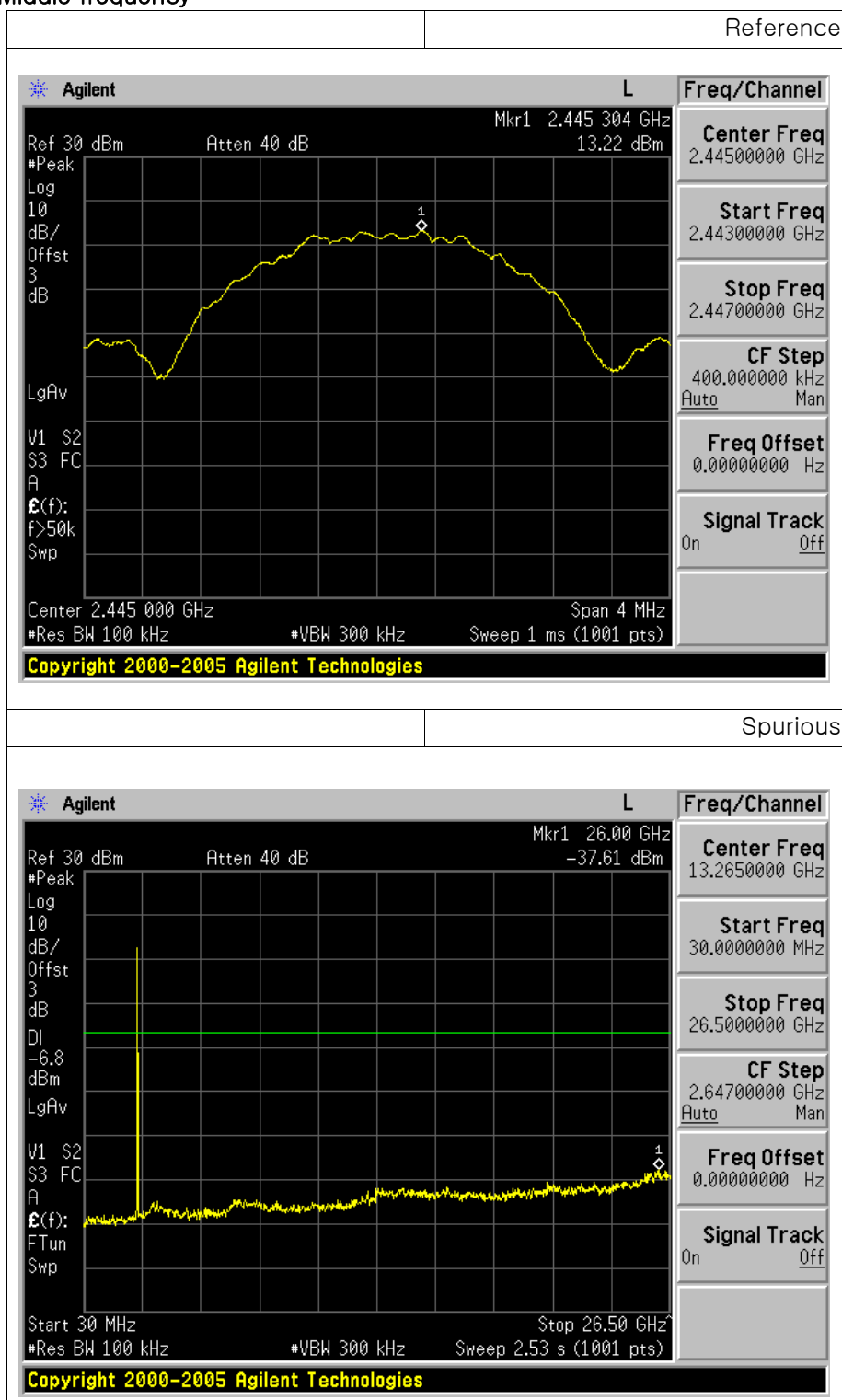
## 9.7 Test Plot for Conducted Spurious Emission

- MESH \_ Low frequency

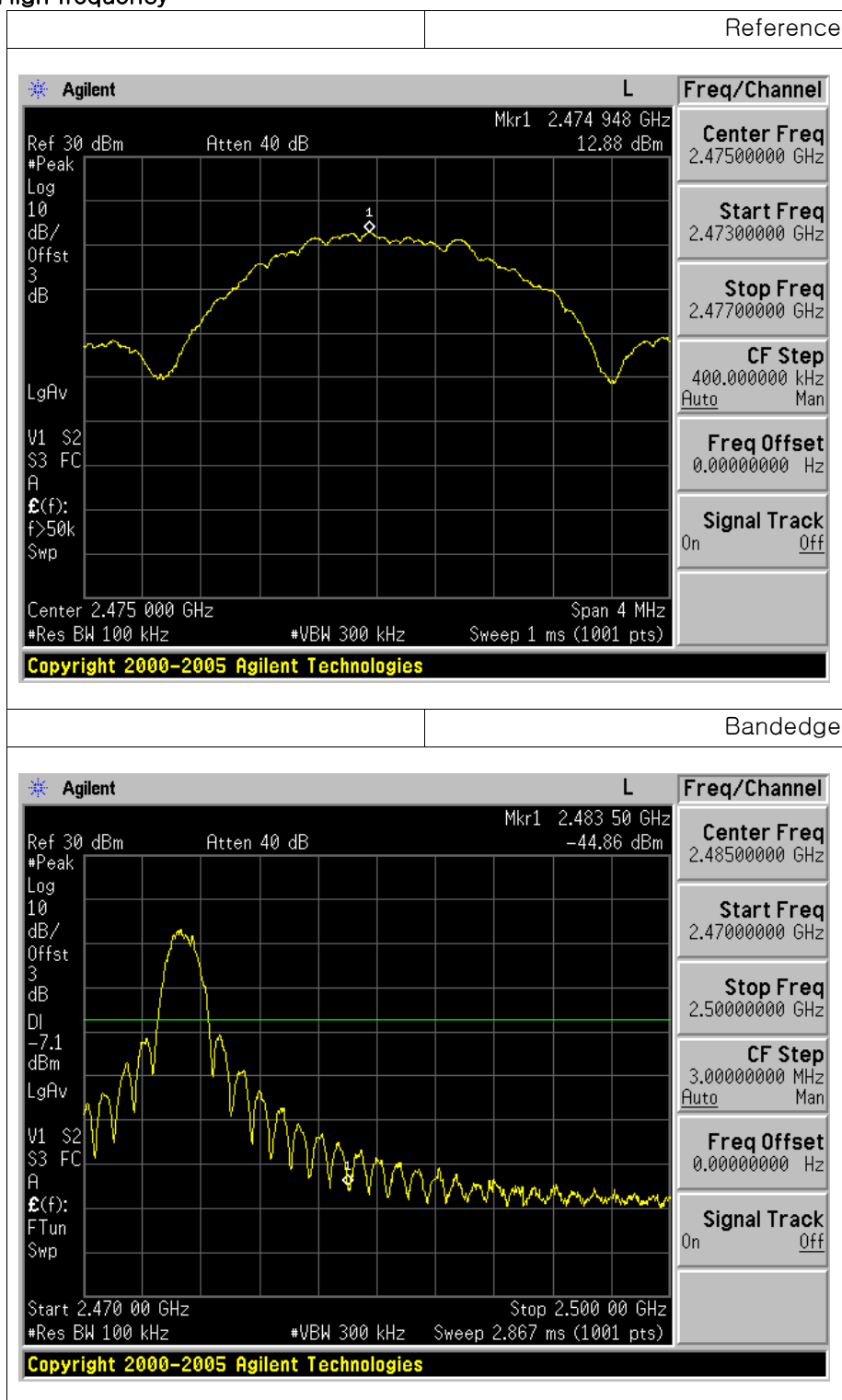


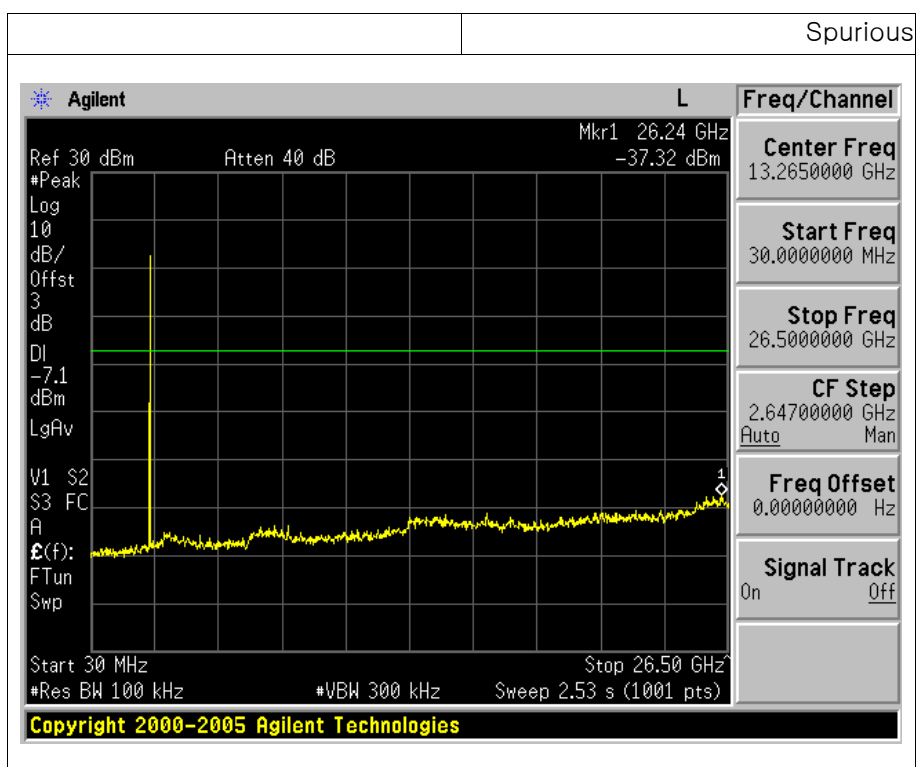


• MESH \_ Middle frequency

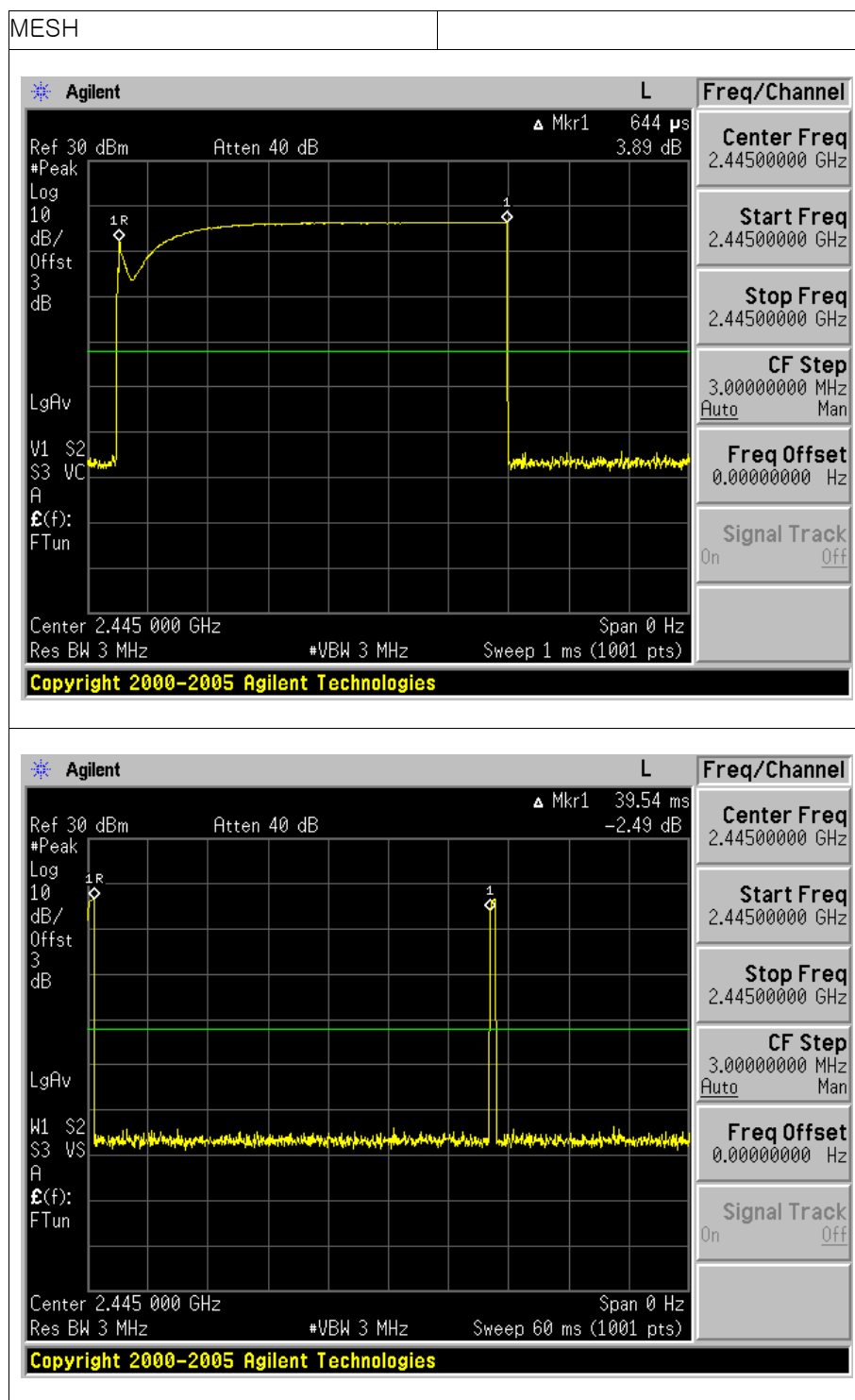


• MESH \_ High frequency





## 9.8 Test Plot for Duty Cycle





## 10. Conducted Emission

### 10.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

### 10.2 Limit

According to §15.207(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  $\mu$ H/50 ohm 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 frequency ranges.

| Frequency Range (MHz) | Conducted Limit (dBuV) |            |
|-----------------------|------------------------|------------|
|                       | Quasi-Peak             | Average    |
| 0.15 ~ 0.5            | 66 to 56 *             | 56 to 46 * |
| 0.5 ~ 5               | 56                     | 46         |
| 5 ~ 30                | 60                     | 50         |

\* Decreases with the logarithm of the frequency

### 10.3 Test Procedure

Conducted emissions from the EUT were measured according to the ANSI C63.10.

1. The test procedure is performed in a 6.5 m  $\times$  3.5 m  $\times$  3.5 m (L  $\times$  W  $\times$  H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W)  $\times$  1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. 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.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. 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.

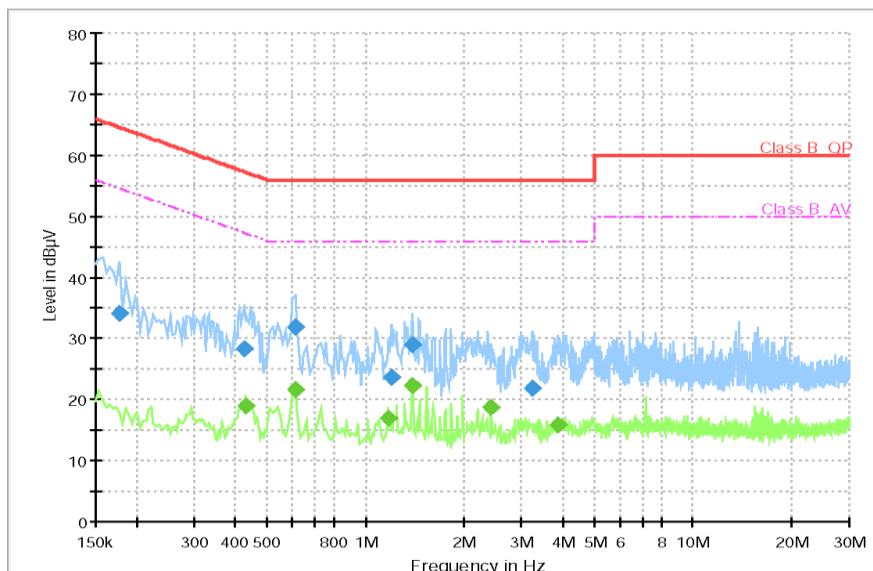


## 10.4 Test Result

- AC Line Conducted Emission (Graph)

SP146\_Charging\_L1

### Power Interference

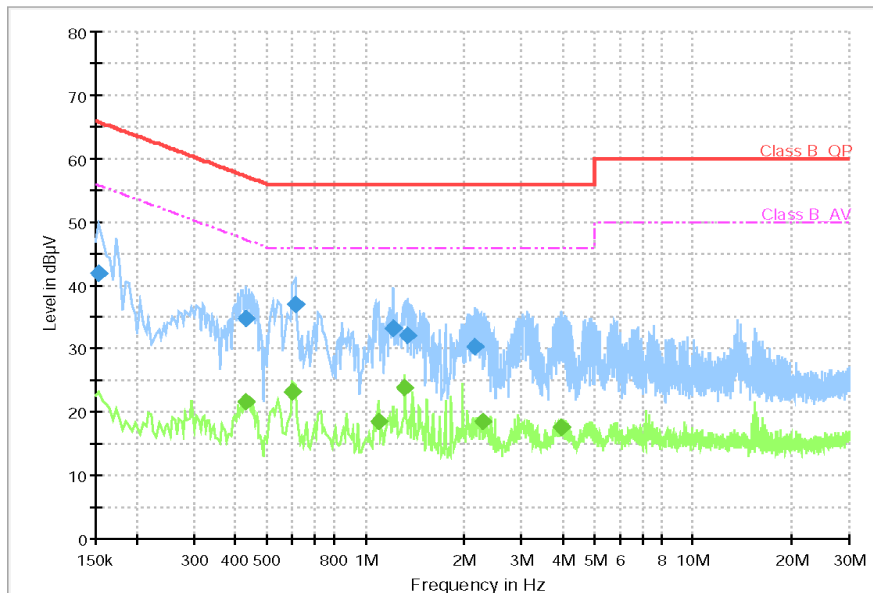


### Final Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Bandwidth (kHz) | Line | Filter |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|------|--------|
| 0.178           | 34.18            | ---             | 64.58        | 30.40       | 9               | L1   | ON     |
| 0.426           | 28.26            | ---             | 57.33        | 29.07       | 9               | L1   | ON     |
| 0.430           | ---              | 18.89           | 47.25        | 28.37       | 9               | L1   | ON     |
| 0.610           | ---              | 21.69           | 46.00        | 24.31       | 9               | L1   | ON     |
| 0.610           | 31.79            | ---             | 56.00        | 24.21       | 9               | L1   | ON     |
| 1.170           | ---              | 17.04           | 46.00        | 28.96       | 9               | L1   | ON     |
| 1.200           | 23.64            | ---             | 56.00        | 32.36       | 9               | L1   | ON     |
| 1.390           | ---              | 22.32           | 46.00        | 23.68       | 9               | L1   | ON     |
| 1.390           | 29.07            | ---             | 56.00        | 26.93       | 9               | L1   | ON     |
| 2.420           | ---              | 18.75           | 46.00        | 27.25       | 9               | L1   | ON     |
| 3.220           | 21.78            | ---             | 56.00        | 34.22       | 9               | L1   | ON     |
| 3.880           | ---              | 15.78           | 46.00        | 30.22       | 9               | L1   | ON     |

SP146\_Charging\_N

## Power Interference



## Final Result

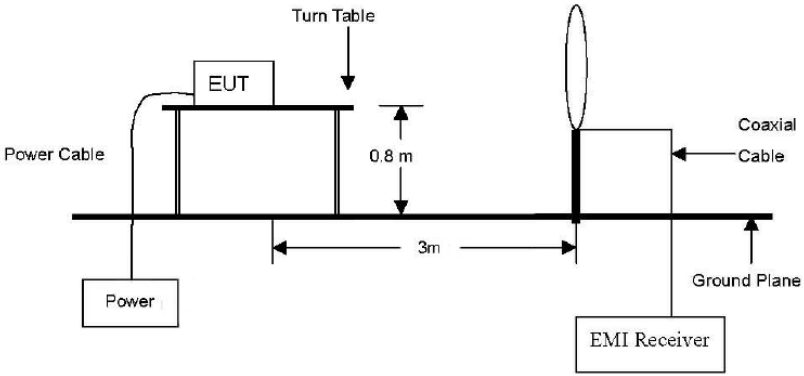
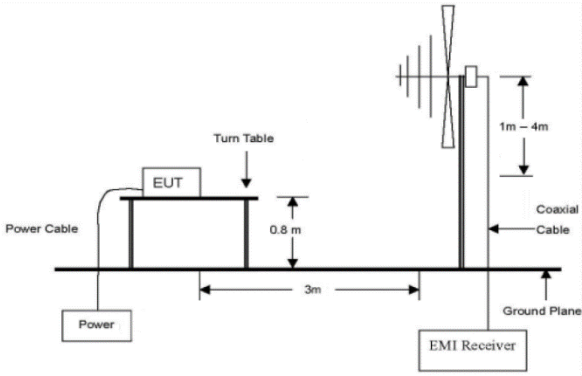
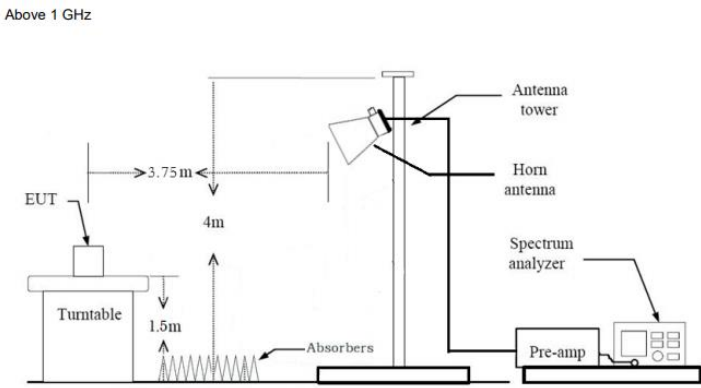
| Frequency (MHz) | QuasiPeak (dBμV) | CAverage (dBμV) | Limit (dBμV) | Margin (dB) | Bandwidth (kHz) | Line | Filter |
|-----------------|------------------|-----------------|--------------|-------------|-----------------|------|--------|
| 0.154           | 41.89            | ---             | 65.78        | 23.89       | 9               | N    | ON     |
| 0.430           | ---              | 21.53           | 47.25        | 25.73       | 9               | N    | ON     |
| 0.430           | 34.77            | ---             | 57.25        | 22.48       | 9               | N    | ON     |
| 0.600           | ---              | 23.24           | 46.00        | 22.76       | 9               | N    | ON     |
| 0.610           | 37.05            | ---             | 56.00        | 18.95       | 9               | N    | ON     |
| 1.100           | ---              | 18.49           | 46.00        | 27.51       | 9               | N    | ON     |
| 1.220           | 33.31            | ---             | 56.00        | 22.69       | 9               | N    | ON     |
| 1.320           | ---              | 23.85           | 46.00        | 22.15       | 9               | N    | ON     |
| 1.340           | 32.00            | ---             | 56.00        | 24.00       | 9               | N    | ON     |
| 2.160           | 30.27            | ---             | 56.00        | 25.73       | 9               | N    | ON     |
| 2.270           | ---              | 18.40           | 46.00        | 27.60       | 9               | N    | ON     |
| 3.950           | ---              | 17.56           | 46.00        | 28.44       | 9               | N    | ON     |

## APPENDIX I

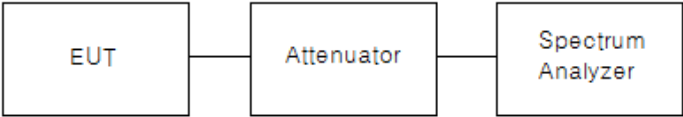
### TEST SETUP



- Radiated Measurement

|              |                                                                                      |
|--------------|--------------------------------------------------------------------------------------|
| below 30 MHz |    |
| below 1 GHz  |   |
| above 1 GHz  |  |

- Conducted Measurement

|           |                                                                                      |
|-----------|--------------------------------------------------------------------------------------|
| Conducted |  |
|-----------|--------------------------------------------------------------------------------------|

## APPENDIX II

### UNCERTAINTY

| Measurement Item             | Expanded Uncertainty<br>$U = kU_c (k=2)$ |
|------------------------------|------------------------------------------|
| Conducted RF power           | 0.32 dB                                  |
| Conducted Spurious Emissions | 0.32 dB                                  |
| Radiated Spurious Emissions  | 6.34 dB                                  |
| Conducted Emissions          | 1.74 dB                                  |