

# TEST REPORT

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                      |                                                                                             |             |                                             |                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------|---------------------------------------------|-----------------------------------------------------|
| <b>DT&amp;C Co., Ltd.</b><br>42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si,<br>Gyeonggi-do, Korea<br>Tel : 031-321-2664, Fax : 031-321-1664                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Report No : DRTFCC1511-0239<br>Pages:(1) / (39) page | <br>Dt&C |             |                                             |                                                     |
| <p>1. Customer</p> <ul style="list-style-type: none"><li>• Name : SOLUM CO.,LTD.</li><li>• Address : 150, Maeyeong-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea</li></ul> <p>2. Use of Report : FCC Original Grant</p> <p>3. Product Name (Model): ESL Graphic TAG (ST-GM16XX2)</p> <p>4. Date of Test : 2015-10-12 ~ 2015-11-04</p> <p>5. Test Method Used: FCC Part 15 Subpart C.247</p> <p>6. Testing Environment : See appended test report</p> <p>7. Test Result : <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail</p> <p>The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.</p> <table border="1"><tr><td>Affirmation</td><td>Tested by<br/>Name : HoonPyo Lee (Signature)</td><td>Technical Manager<br/>Name : WonJung Lee (Signature)</td></tr></table> <p style="text-align: center;"><b>2015. 11. 17</b><br/><b>DT&amp;C Co., Ltd.</b></p> |                                                      |                                                                                             | Affirmation | Tested by<br>Name : HoonPyo Lee (Signature) | Technical Manager<br>Name : WonJung Lee (Signature) |
| Affirmation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Tested by<br>Name : HoonPyo Lee (Signature)          | Technical Manager<br>Name : WonJung Lee (Signature)                                         |             |                                             |                                                     |

## Test Report Version

| Test Report No. | Date          | Description   |
|-----------------|---------------|---------------|
| DRTFCC1511-0239 | Nov. 17, 2015 | Initial issue |
|                 |               |               |
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# 1. General Information

## 1.1 Testing Laboratory

| DT&C Co., Ltd.                                 |                                            |                                                                                     |
|------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------|
| Standard                                       | Site number                                | Address                                                                             |
| FCC                                            | <input checked="" type="checkbox"/> 165783 | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 804488            | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 596748            | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 678747            | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| IC                                             | <input type="checkbox"/> 5740A-3           | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|                                                | <input type="checkbox"/> 5740A-2           | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| <a href="http://www.dtnc.net">www.dtnc.net</a> |                                            |                                                                                     |
| Telephone                                      | :                                          | + 82-31-321-2664                                                                    |
| FAX                                            | :                                          | + 82-31-321-1664                                                                    |

## 1.2 Details of Applicant

Applicant : SOLUM CO.,LTD.  
 Address : 150, Maeyeong-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea  
 Contact person : Ki Dong Lee

### 1.3 Description of EUT

|                              |                                                        |
|------------------------------|--------------------------------------------------------|
| <b>EUT</b>                   | ESL Graphic TAG                                        |
| <b>Model Name</b>            | ST-GM16XX2                                             |
| <b>Add Model Name</b>        | NA                                                     |
| <b>Serial Number</b>         | Identical prototype                                    |
| <b>Power Supply</b>          | DC 3.0 V (Not rechargeable battery)                    |
| <b>Frequency Range</b>       | 2405 ~ 2480 MHz (16 channels)                          |
| <b>Max. RF Output Power</b>  | -2.32 dBm                                              |
| <b>Modulation Technique</b>  | GFSK                                                   |
| <b>Antenna Specification</b> | Antenna Type: Internal Antenna<br>Gain: -3.43 dBi (PK) |

### 1.4 Declaration by the applicant / manufacturer

NA

### 1.5 Test Conditions

| Ambient Condition   |              |
|---------------------|--------------|
| ▪ Temperature       | +24 ~ +25 °C |
| ▪ Relative Humidity | 43 % ~ 45 %  |

## 1.6 Test Equipment List

| Type                                   | Manufacturer              | Model                           | Cal.Date<br>(yy/mm/dd) | Next.Cal.Date<br>(yy/mm/dd) | S/N                |
|----------------------------------------|---------------------------|---------------------------------|------------------------|-----------------------------|--------------------|
| MXA Signal Analyzer                    | Agilent Technologies      | N9020A                          | 15/03/26               | 16/03/26                    | MY50200828         |
| MXA Signal Analyzer                    | Agilent Technologies      | N9020A                          | 15/01/19               | 16/01/19                    | MY46471096         |
| Signal Generator                       | Rohde Schwarz             | SMF100A                         | 15/06/29               | 16/06/29                    | 102341             |
| Dynamic Measurement<br>DC Source       | Agilent Technologies      | 66332A                          | 14/10/20               | 15/10/20                    | MY43000394         |
|                                        |                           |                                 | 15/10/19               | 16/10/19                    |                    |
| Power Meter & Wide<br>Bandwidth Sensor | Anritsu                   | ML2495A<br>MA2490A              | 15/03/26               | 16/03/26                    | 1306007<br>1249001 |
| Multimeter                             | HP                        | 34401A                          | 15/02/25               | 16/02/25                    | 3146A13475         |
| Thermohygrometer                       | BODYCOM                   | BJ5478                          | 15/05/08               | 16/05/08                    | 120612-1           |
| Loop Antenna                           | Schwarzbeck               | FMZB1513                        | 14/04/29               | 16/04/29                    | 1513-128           |
| BILOG ANTENNA                          | SCHWARZBECK               | VULB9160                        | 14/06/24               | 16/06/24                    | 3358               |
| Horn Antenna                           | ETS-LINDGREN              | 3115                            | 15/02/09               | 17/02/09                    | 9202-3820          |
| Horn Antenna                           | A.H.Systems Inc.          | SAS-574                         | 15/04/30               | 17/04/30                    | 154                |
| Highpass Filter                        | Wainwright<br>Instruments | WHKX12-2580-<br>3000-18000-80SS | 15/09/23               | 16/09/23                    | 3                  |
| Highpass Filter                        | Wainwright<br>Instruments | WHNX6-6320-8000-<br>26500-40CC  | 15/09/23               | 16/09/23                    | 7                  |
| PreAmplifier                           | Agilent                   | 8449B                           | 15/02/26               | 16/02/26                    | 3008A00370         |
| EMI TEST RECEIVER                      | R&S                       | ESR7                            | 14/10/21               | 15/10/21                    | 101109             |
|                                        |                           |                                 | 15/10/19               | 16/10/19                    |                    |
| Low Noise Pre Amplifier                | tsj                       | MLA-010K01-B01-27               | 15/04/09               | 16/04/09                    | 1844539            |

## 1.7 Summary of Test Results

| FCC Part                                                                                                                                              | RSS Std.      | Parameter                                                                     | Limit                    | Test Condition    | Status<br>Note 1 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------------------------------------------|--------------------------|-------------------|------------------|
| 15.247(a)                                                                                                                                             | RSS-247 [5.2] | 6 dB Bandwidth                                                                | > 500 kHz                | Conducted         | C                |
| 15.247(b)                                                                                                                                             | RSS-247 [5.4] | Transmitter Output Power                                                      | < 1 Watt                 |                   | C                |
| 15.247(d)                                                                                                                                             | RSS-247 [5.5] | Out of Band Emissions / Band Edge                                             | 20 dBc in any 100 kHz BW |                   | C                |
| 15.247(e)                                                                                                                                             | RSS-247 [5.2] | Transmitter Power Spectral Density                                            | < 8 dBm/3 kHz            |                   | C                |
| -                                                                                                                                                     | RSS-Gen [6.6] | Occupied Bandwidth (99 %)                                                     | RSS-Gen(6.6)             |                   | NA               |
| 15.205<br>15.209                                                                                                                                      | RSS-247 [5.5] | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | FCC 15.209 limits        | Radiated          | C                |
| 15.207                                                                                                                                                | RSS-Gen [8.8] | AC Line Conducted Emissions                                                   | FCC 15.207 limits        | AC Line Conducted | NA<br>Note 2     |
| 15.203                                                                                                                                                | RSS-Gen [6.7] | Antenna Requirements                                                          | FCC 15.203               | -                 | C                |
| Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable<br>Note 2: The supplying power of this device is batteries which are not rechargeable. |               |                                                                               |                          |                   |                  |

## 2. Test Methodology

Generally the tests were performed according to the [KDB558074 D01 v03r03](#). And [ANSI C63.10-2013](#) was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

### 2.2 EUT Exercise

The EUT was operated in the test mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

### 2.3 General Test Procedures

#### Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB 558074.

So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15MHz and 30MHz using CISPR Quasi-peak and Average detector.

#### Radiated Emissions

Basically the radiated tests were performed with KDB 558074. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10 as stated on section 12.1 of the KDB 558074.

The EUT is placed on a non-conductive table, which is above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 1 or 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the highest emission, the relative positions of the EUT were rotated through three orthogonal axes.

### 2.4 Description of Test Modes

The EUT has been tested with the operating condition for maximizing the emission characteristics. A test program is used to control the EUT for staying in continuous transmitting. The lowest, middle and highest channels were tested and reported.

|      | Test Mode | Frequency [MHz] |                |                 |
|------|-----------|-----------------|----------------|-----------------|
|      |           | Lowest channel  | Middle channel | Highest channel |
| TM 1 | ZIGBEE    | 2405            | 2440           | 2480            |
| TM 2 | -         | -               | -              | -               |
| TM 3 | -         | -               | -              | -               |
| TM 4 | -         | -               | -              | -               |

### 2.5 Instrument Calibration

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

### 3. Test Result

#### 3.1 Maximum Peak Conducted Output Power

##### ■ Test Requirements and limit, §15.247(b) & RSS-247 [5.4]

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.

**The maximum permissible conducted output power is 1 Watt.**

##### 3.1.1 Test Setup

Refer to the APPENDIX I.

##### 3.1.2 Test Procedures

Maximum Peak Conducted Output Power is measured using Measurement Procedure Option 1 of **KDB558074**

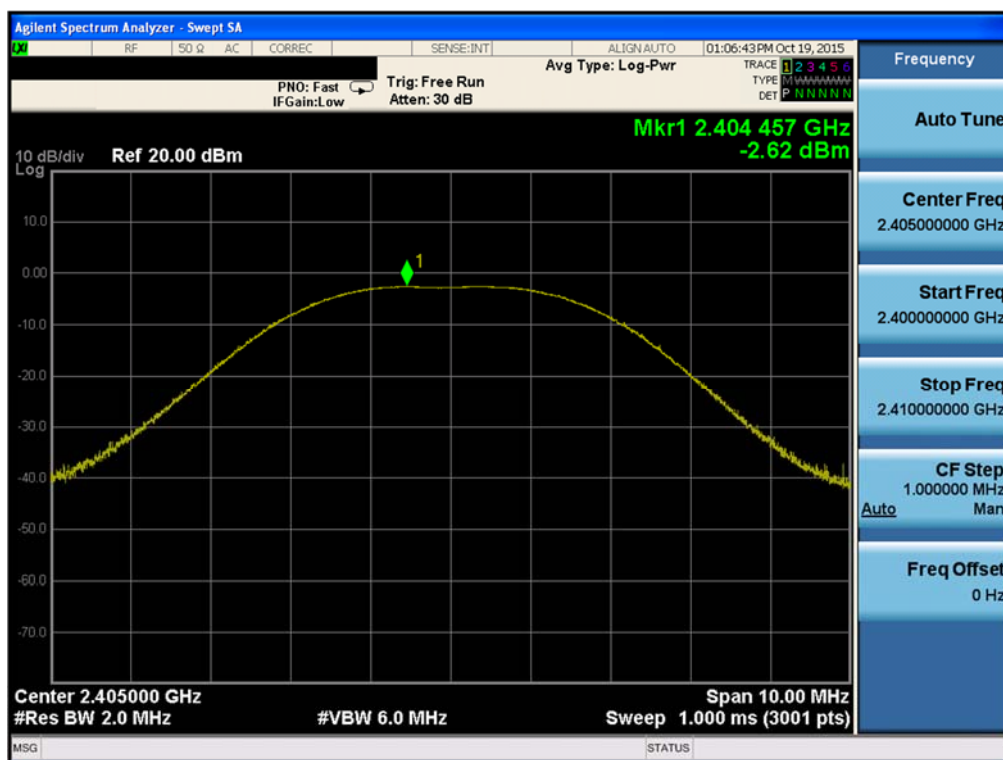
1. Set the RBW  $\geq$  DTS bandwidth. **Actual RBW = 2 MHz**
2. Set VBW  $\geq 3 \times$  RBW. **Actual VBW = 6 MHz**
3. Set span  $\geq 3 \times$  RBW.
4. Sweep time = **auto couple**
5. Detector = **peak**
6. Trace mode = **max hold**
7. Allow trace to fully stabilize
8. Use peak marker function to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

##### 3.1.3 Test Results

| Test Mode | Tested Channel | Test Results (dBm) |
|-----------|----------------|--------------------|
| TM 1      | Lowest         | -2.62              |
|           | Middle         | -3.02              |
|           | Highest        | -2.32              |

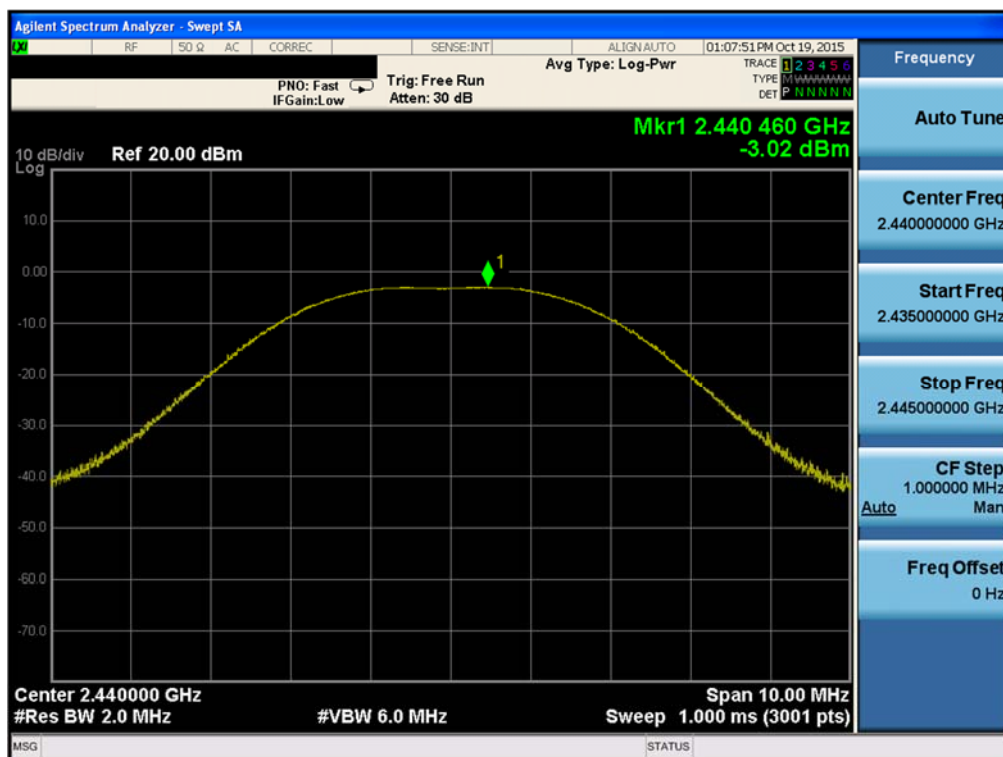
### Peak Output Power

Test Channel : Lowest



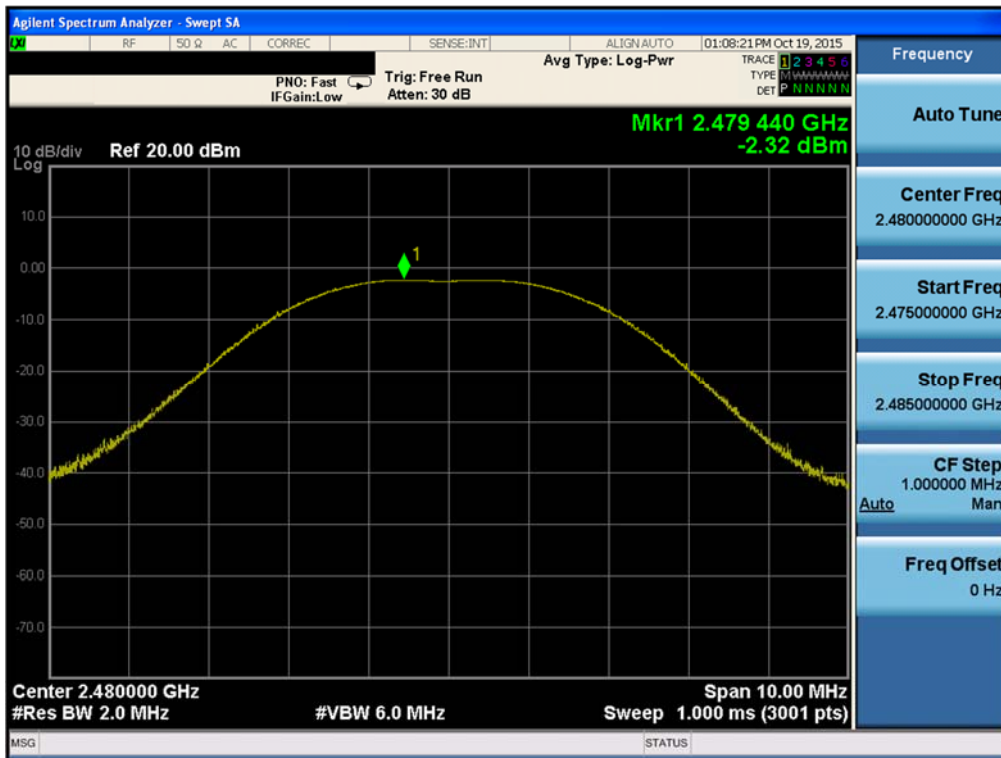
### Peak Output Power

Test Channel : Middle



## Peak Output Power

Test Channel : Highest



### 3.2 6 dB Bandwidth Measurement

#### ■ Test Requirements and limit, §15.247(a) & RSS-247 [5.2]

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.

**The minimum permissible 6 dB bandwidth is 500 kHz.**

#### 3.2.1 Test Setup

Refer to the APPENDIX I.

#### 3.2.2 Test Procedures

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB558074**

1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.

**(RBW : 100 kHz / VBW : 300 kHz)**

3. Detector = **Peak**.
4. Trace mode = **max hold**.
5. Sweep = **auto couple**.
6. Allow the trace to stabilize.
7. 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.

#### 3.2.3 Test Results

| Test Mode | Tested Channel | Test Results [MHz] |
|-----------|----------------|--------------------|
| TM 1      | Lowest         | 1.636              |
|           | Middle         | 1.617              |
|           | Highest        | 1.586              |

## 6 dB Bandwidth

Test Channel : Lowest



## 6 dB Bandwidth

Test Channel : Middle



## 6 dB Bandwidth

Test Channel : Highest



### 3.3 Maximum Power Spectral Density.

#### ■ Test requirements and limit, §15.247(e) & RSS-247 [5.2]

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.

#### Minimum Standard

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

#### 3.3.1 Test Setup

Refer to the APPENDIX I.

#### 3.3.2 Test Procedures

Method PKPSD of KDB558074 is used.

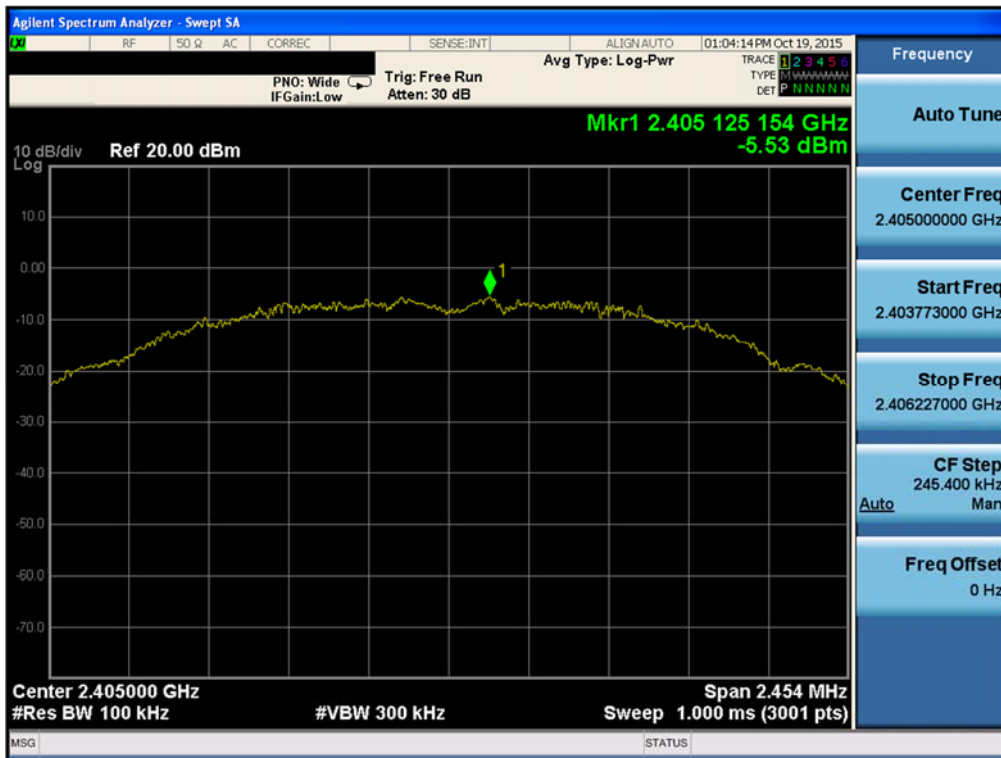
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW : **3 kHz ≤ RBW ≤ 100 kHz**.
4. Set the VBW ≥ **3 x RBW**.
5. Detector = **peak**.
6. Sweep time = **auto couple**.
7. Trace mode = **max hold**.
8. Allow trace to fully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

#### 3.3.3 Test Results

| Test Mode | Tested Channel | PKPSD [dBm] |
|-----------|----------------|-------------|
| TM 1      | Lowest         | -5.53       |
|           | Middle         | -6.27       |
|           | Highest        | -5.35       |

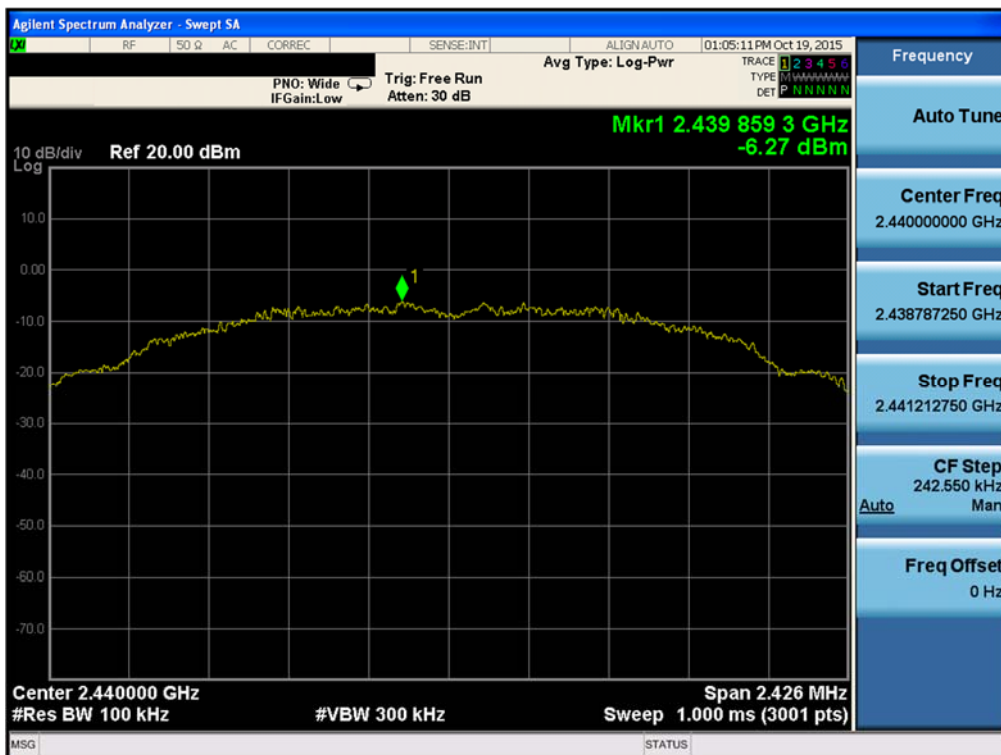
## Maximum PKPSD

Test Channel : Lowest



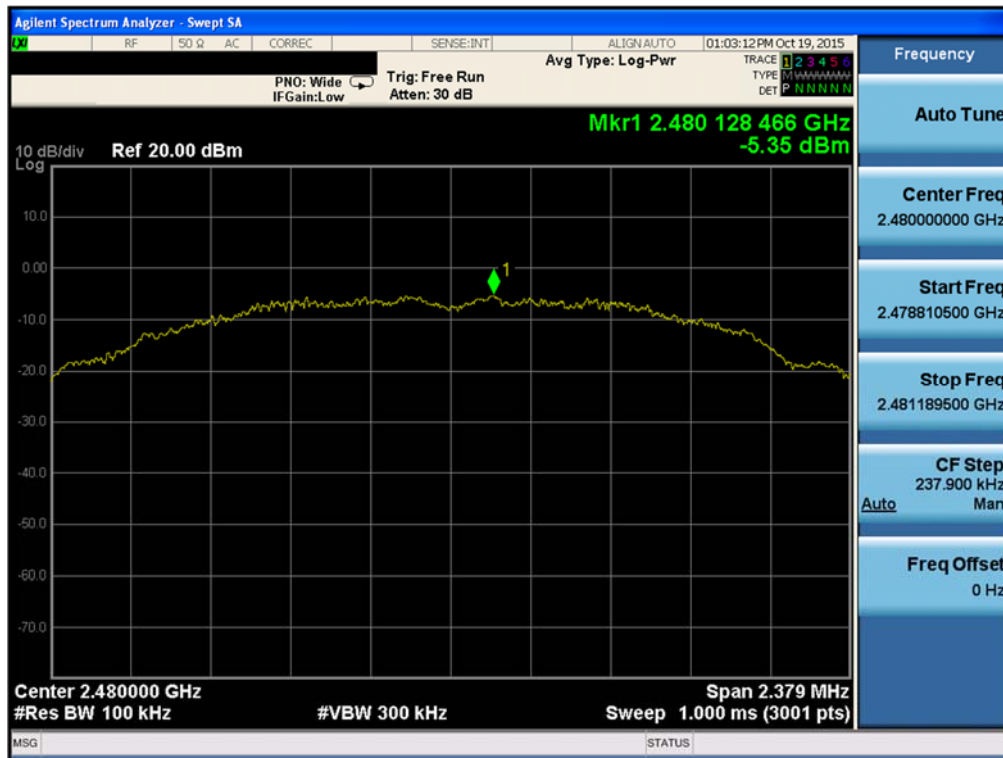
## Maximum PKPSD

Test Channel : Middle



## Maximum PKPSD

Test Channel : Highest



### 3.4 Unwanted Emissions (Conducted)

#### ■ Test requirements and limit, §15.247(d) & RSS-247 [5.5]

§15.247(d) specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

If **the peak output power procedure** is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated **by at least 20 dB** relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured in-band average PSD level.

In either case, attenuation to levels below the general emission limits specified in **§15.209(a)** is not required.

#### 3.4.1 Test Setup

Refer to the APPENDIX I

#### 3.4.2 Test Procedures

The transmitter output is connected to a spectrum analyzer.

##### - Measurement Procedure 1 – Reference Level

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to  $\geq 1.5$  times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW  $\geq 3 \times$  RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum PSD level

**LIMIT LINE = 20 dB below of the reference level.**

##### - Measurement Procedure 2 - Unwanted Emissions

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = **100 kHz.(Actual 1 MHz , See below note)**
3. Set the VBW  $\geq 3 \times$  RBW.(Actual 3 MHz, See below note)
4. Detector = **peak**.
5. Ensure that the number of measurement points  $\geq$  span / RBW
6. Sweep time = **auto couple**.
7. Trace mode = **max hold**.
8. **Allow the trace to stabilize** (this may take some time, depending on the extent of the span).
9. Use the peak marker function to determine the maximum amplitude level.

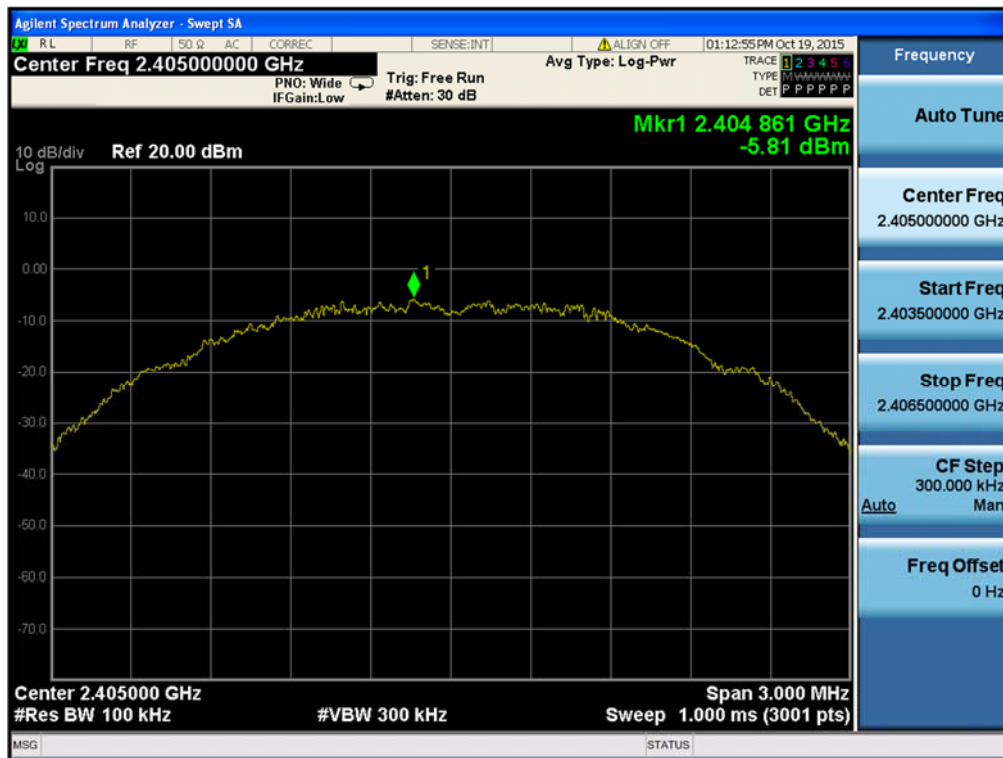
**Note :** The conducted spurious emission was tested with below settings.

| Frequency range | RBW     | VBW     | Detector | Trace    | Sweep Point |
|-----------------|---------|---------|----------|----------|-------------|
| 9 kHz ~ 30 MHz  | 100 kHz | 300 kHz | Peak     | Max Hold | 40001       |
| 30 MHz ~ 10 GHz | 1 MHz   | 3 MHz   |          |          |             |
| 10 GHz ~ 25 GHz | 1 MHz   | 3 MHz   |          |          |             |

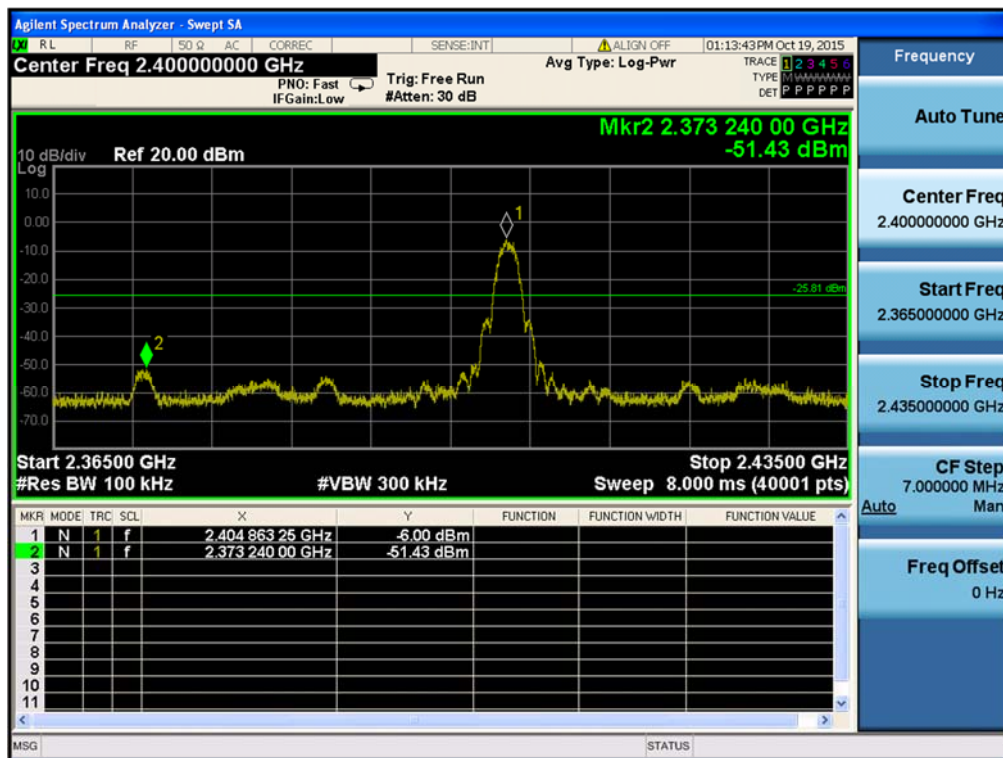
If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

### 3.4.3 Test Results

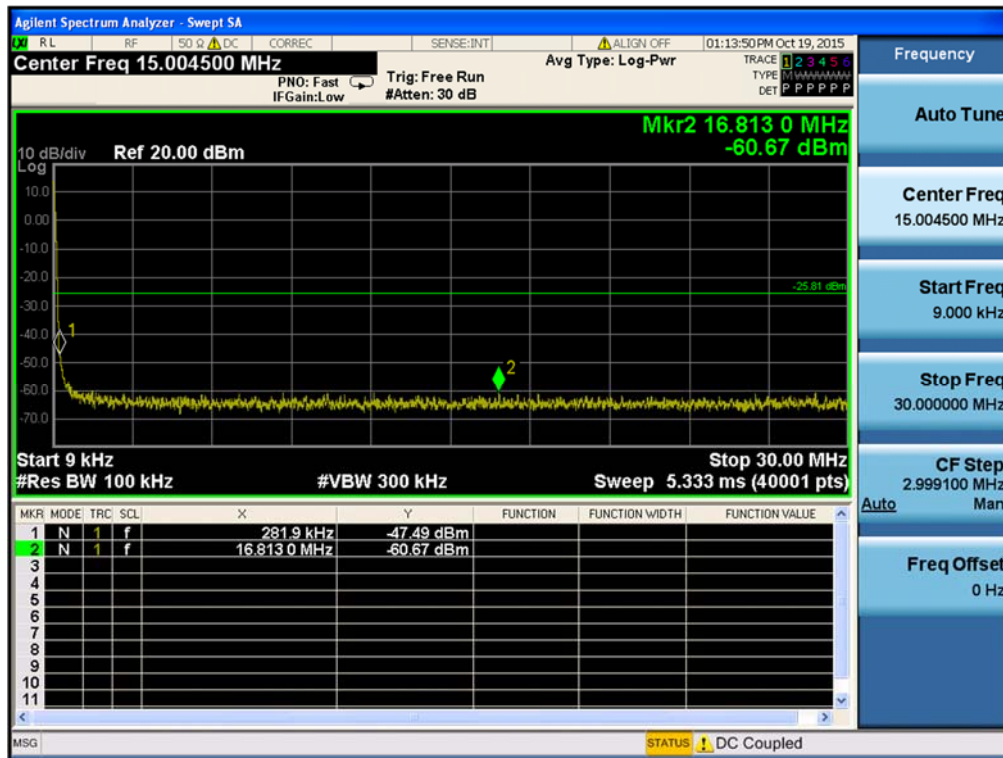
#### Reference (Test Channel : Lowest)



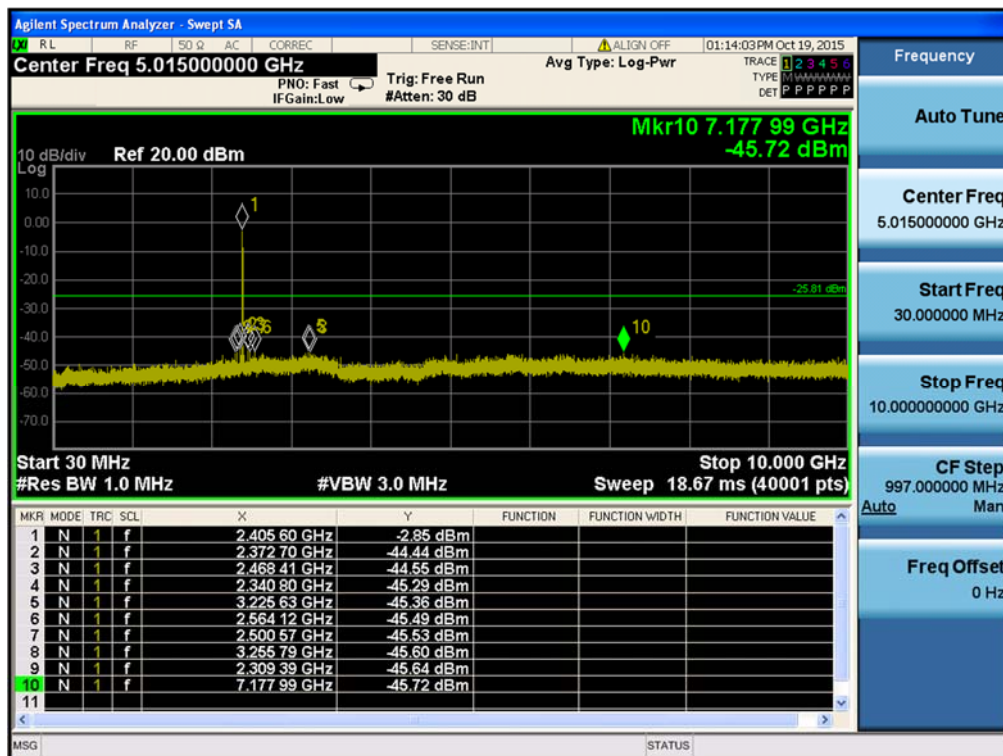
#### Low Band-edge

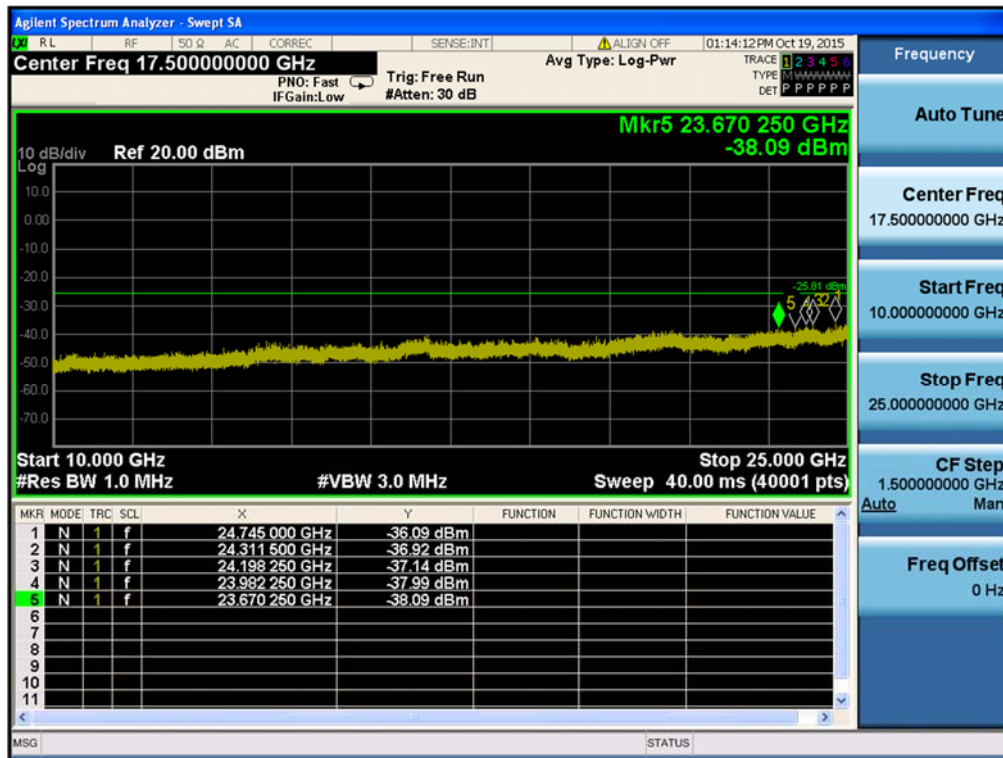


## Conducted Spurious Emissions 1 (Test Channel : Lowest)

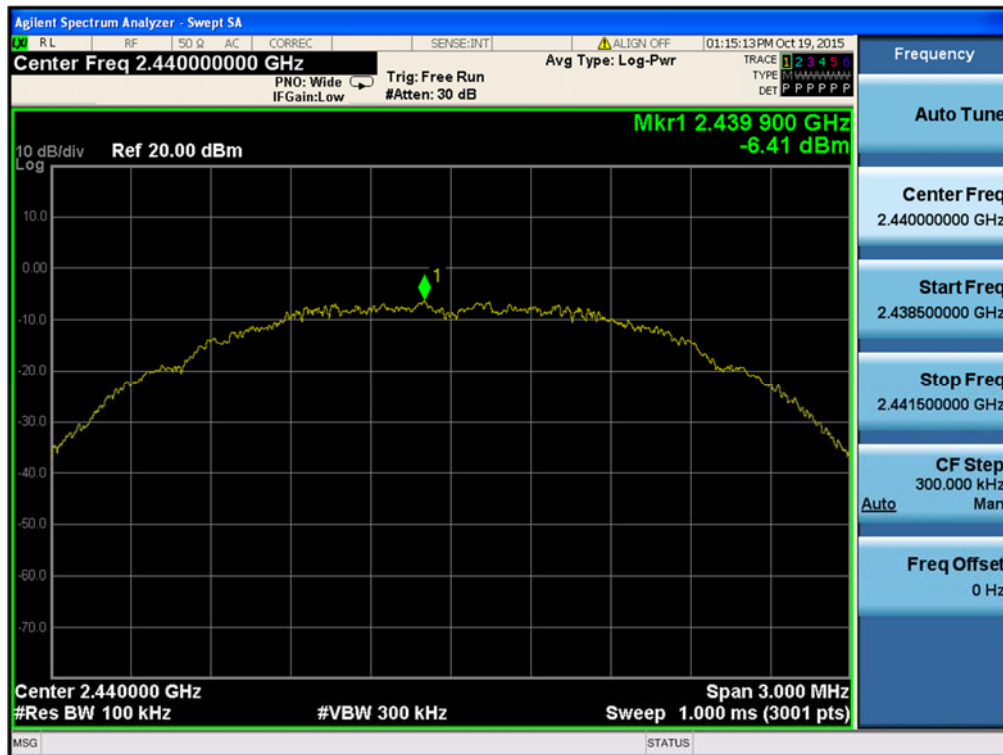


## Conducted Spurious Emissions 2 (Test Channel : Lowest)

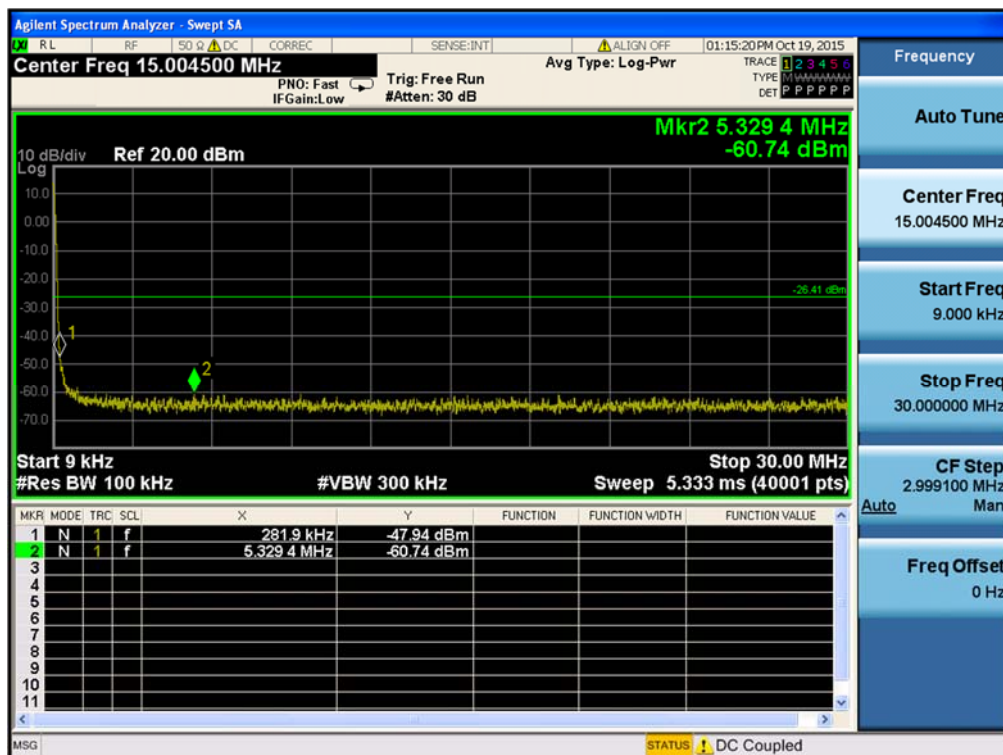


**Conducted Spurious Emissions 3 (Test Channel : Lowest)**

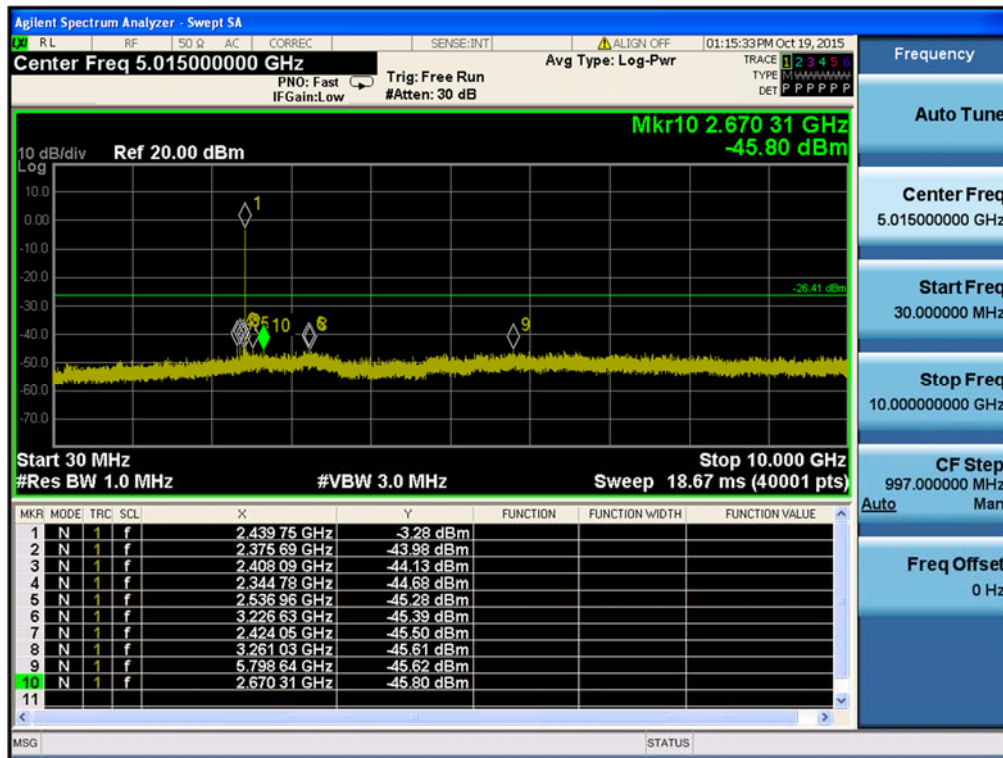
## Reference (Test Channel : Middle)



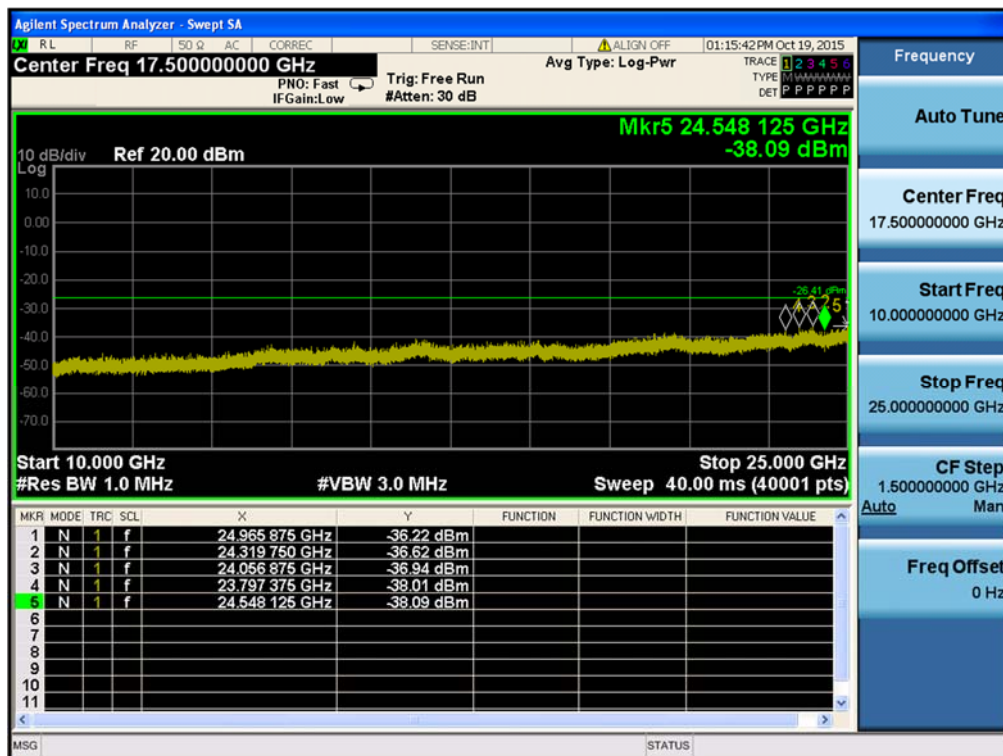
## Conducted Spurious Emissions 1 (Test Channel : Middle)



## Conducted Spurious Emissions 2 (Test Channel : Middle)



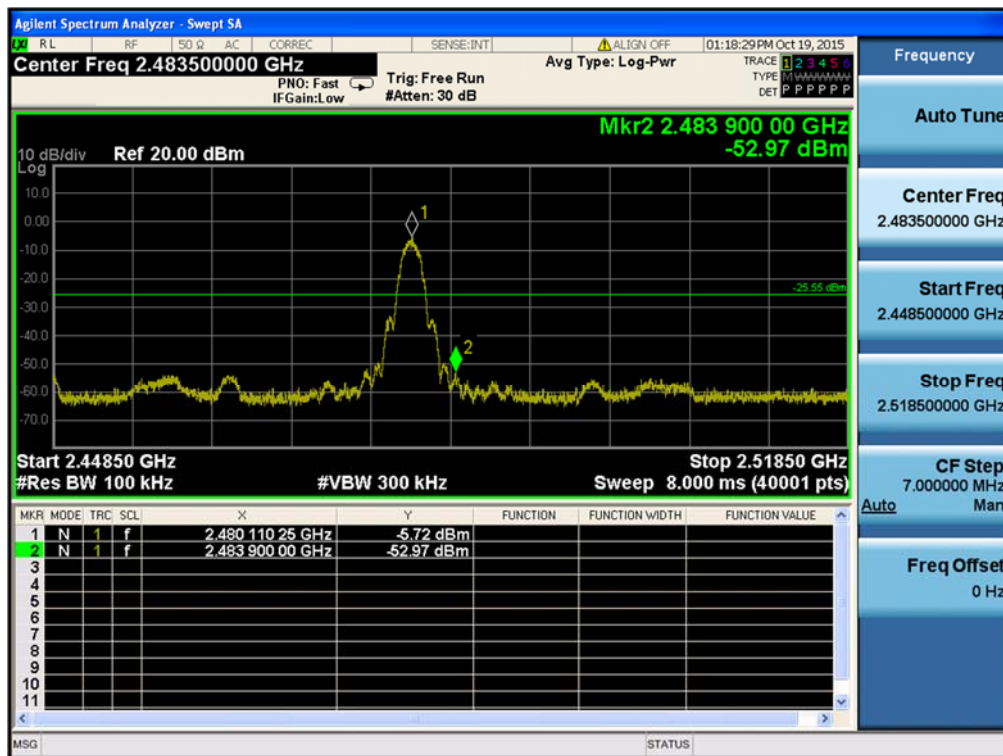
## Conducted Spurious Emissions 3 (Test Channel : Middle)



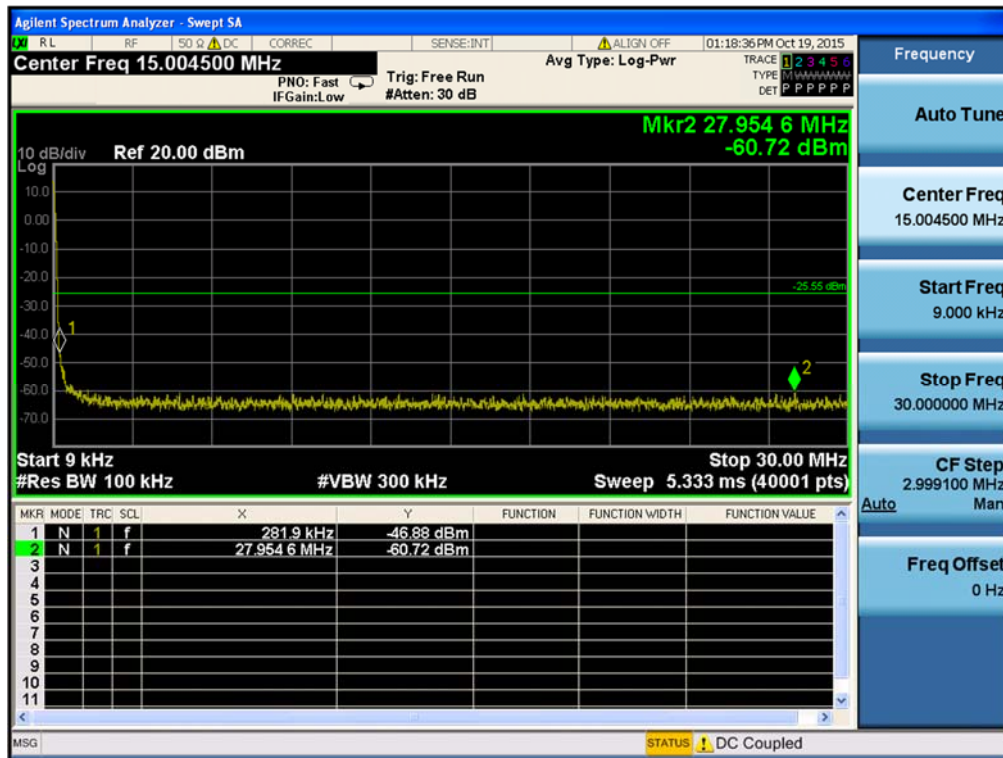
## Reference (Test Channel : Highest)



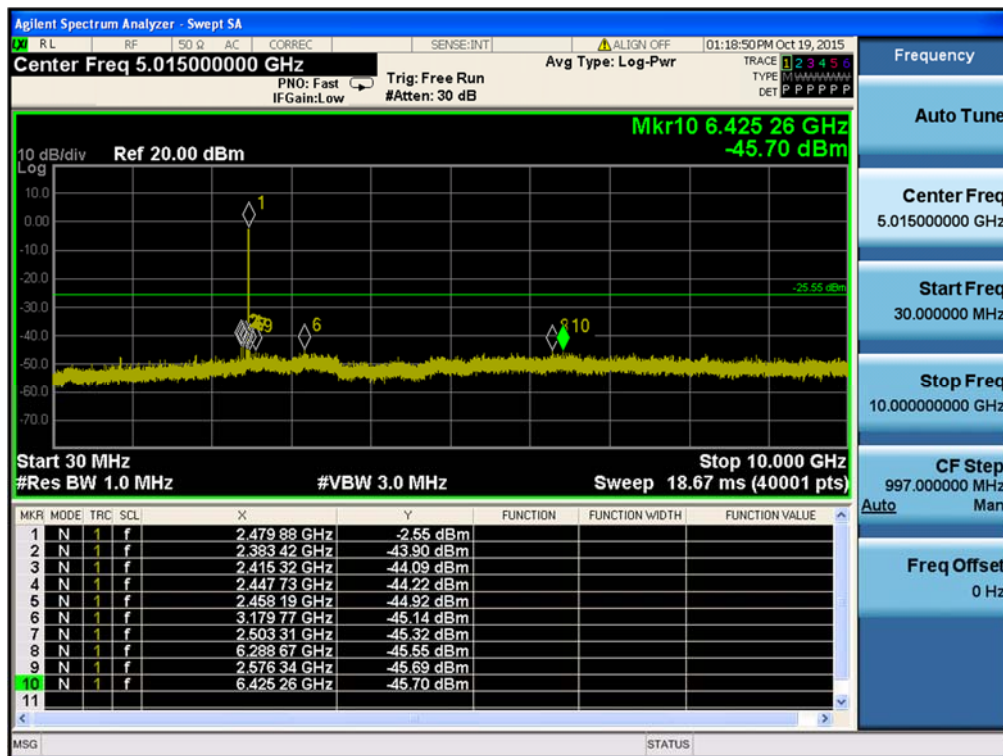
## High Band-edge (Test Channel : Highest)

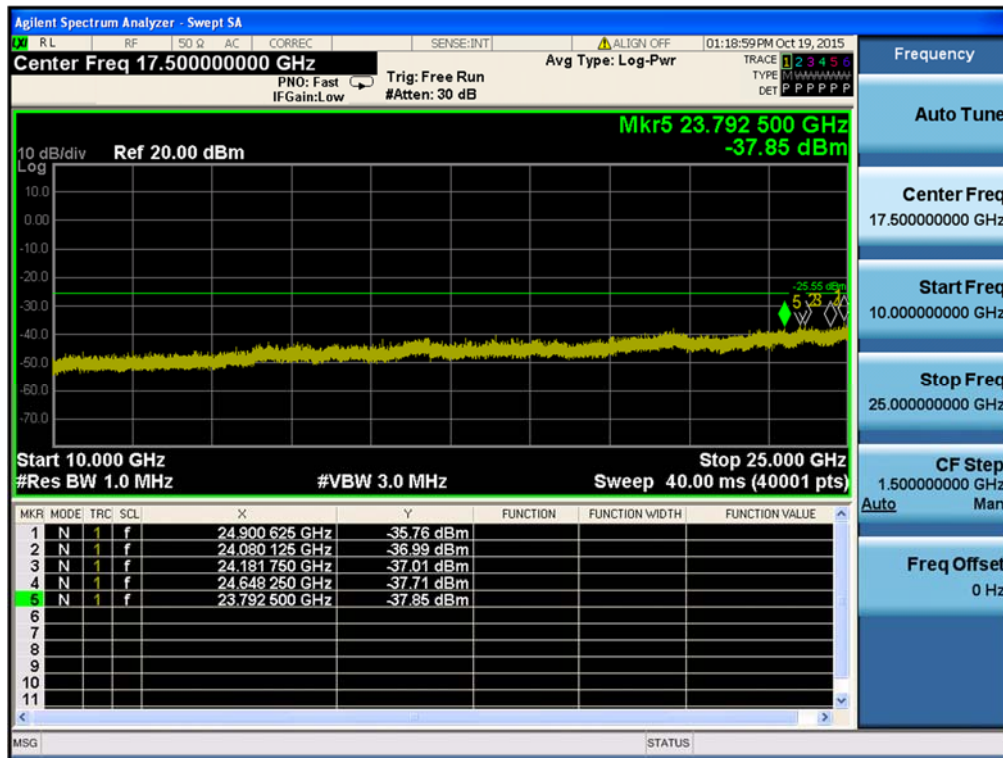


## Conducted Spurious Emissions 1 (Test Channel : Highest)



## Conducted Spurious Emissions 2 (Test Channel : Highest)



**Conducted Spurious Emissions 3 (Test Channel : Highest)**

### 3.5 Unwanted Emissions (Radiated)

#### ■ Test Requirements and limit,

#### §15.247(d), §15.205, §15.209 & RSS-247 [5.5], RSS-Gen [8.9], RSS-Gen [8.10]

In any 100 kHz bandwidth outside the operating frequency band, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed

#### • FCC Part 15.209(a) and (b)

| Frequency (MHz) | Limit (uV/m)  | Measurement Distance (meter) |
|-----------------|---------------|------------------------------|
| 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                            |

\*\* 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.

#### • FCC Part 15.205 (a) : Only spurious emissions are permitted in any of the frequency bands listed below :

| MHz               | MHz               | MHz               | MHz             | GHz          | GHz           |
|-------------------|-------------------|-------------------|-----------------|--------------|---------------|
| 0.009 ~ 0.110     | 8.41425 ~ 8.41475 | 108 ~ 121.94      | 1300 ~ 1427     | 4.5 ~ 5.15   | 14.47 ~ 14.5  |
| 0.495 ~ 0.505     | 12.29 ~ 12.293    | 123 ~ 138         | 1435 ~ 1626.5   | 5.35 ~ 5.46  | 15.35 ~ 16.2  |
| 2.1735 ~ 2.1905   | 12.51975 ~        | 149.9 ~ 150.05    | 1645.5 ~ 1646.5 | 7.25 ~ 7.75  | 17.7 ~ 21.4   |
| 4.125 ~ 4.128     | 12.52025          | 156.52475 ~       | 1660 ~ 1710     | 8.025 ~ 8.5  | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 12.57675 ~        | 156.52525         | 1718.8 ~ 1722.2 | 9.0 ~ 9.2    | 23.6 ~ 24.0   |
| 4.20725 ~ 4.20775 | 12.57725          | 156.7 ~ 156.9     | 2200 ~ 2300     | 9.3 ~ 9.5    | 31.2 ~ 31.8   |
| 6.215 ~ 6.218     | 13.36 ~ 13.41     | 162.0125 ~ 167.17 | 2310 ~ 2390     | 10.6 ~ 12.7  | 36.43 ~ 36.5  |
| 6.26775 ~ 6.26825 | 16.42 ~ 16.423    | 167.72 ~ 173.2    | 2483.5 ~ 2500   | 13.25 ~ 13.4 | Above 38.6    |
| 6.31175 ~ 6.31225 | 16.69475 ~        | 240 ~ 285         | 2655 ~ 2900     |              |               |
| 8.291 ~ 8.294     | 16.69525          | 322 ~ 335.4       | 3260 ~ 3267     |              |               |
| 8.362 ~ 8.366     | 16.80425 ~        | 399.90 ~ 410      | 3332 ~ 3339     |              |               |
| 8.37625 ~ 8.38675 | 16.80475          | 608 ~ 614         | 3345.8 ~ 3358   |              |               |
|                   | 25.5 ~ 25.67      | 960 ~ 1240        | 3600 ~ 4400     |              |               |
|                   | 37.5 ~ 38.25      |                   |                 |              |               |
|                   | 73 ~ 74.6         |                   |                 |              |               |
|                   | 74.8 ~ 75.2       |                   |                 |              |               |

• **FCC Part 15.205(b)** : 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.

### 3.5.1 Test Setup

Refer to the APPENDIX I.

### 3.5.2 Test Procedures

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.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 1 or 3 m away from the receiving antenna, which is varied from 1 m to 4 m 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.

#### **Note: Measurement Instrument Setting for Radiated Emission Measurements.**

##### **1. Frequency Range: $\leq 1$ GHz**

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

##### **2. Frequency Range: $> 1$ GHz**

###### **Peak Measurement**

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

###### **Average Measurement**

The result of Average measurement is calculated using PK result and duty correction factor.

### 3.5.3 Test Plot

Refer to the APPENDIX III

### 3.5.4 Test Results

#### 9 kHz ~ 25 GHz Data

##### ▪ Lowest Channel

| Tested band | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Det. Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-------------|-----------------|---------|---------------------|-----------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| RB          | 2340.78         | H       | X                   | PK        | 53.25          | -0.77      | N/A        | N/A                  | 52.48           | 74.00          | 21.52       |
| RB          | 2340.78         | H       | X                   | AV        | N/A            | N/A        | -28.18     | N/A                  | 24.30           | 54.00          | 29.70       |
| RB          | 2373.47         | V       | Z                   | PK        | 53.61          | -0.65      | N/A        | N/A                  | 52.96           | 74.00          | 21.04       |
| RB          | 2373.47         | V       | Z                   | AV        | N/A            | N/A        | -28.18     | N/A                  | 24.78           | 54.00          | 29.22       |
| RB          | 4811.11         | H       | X                   | PK        | 47.33          | 7.81       | N/A        | -9.54                | 45.60           | 74.00          | 28.40       |
| RB          | 4811.11         | H       | X                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 17.42           | 54.00          | 36.58       |
| RB          | 4810.77         | V       | Y                   | PK        | 47.32          | 7.81       | N/A        | -9.54                | 45.59           | 74.00          | 28.41       |
| RB          | 4810.77         | V       | Y                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 17.41           | 54.00          | 36.59       |

##### ▪ Middle Channel

| Tested band | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Det. Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-------------|-----------------|---------|---------------------|-----------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| RB          | 4878.88         | H       | X                   | PK        | 46.03          | 8.06       | N/A        | -9.54                | 44.55           | 74.00          | 29.45       |
| RB          | 4878.88         | H       | X                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 16.37           | 54.00          | 37.63       |
| RB          | 4881.34         | V       | X                   | PK        | 46.80          | 8.03       | N/A        | -9.54                | 45.29           | 74.00          | 28.71       |
| RB          | 4881.34         | V       | X                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 17.11           | 54.00          | 36.89       |

##### ▪ Highest Channel

| Tested band | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Det. Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-------------|-----------------|---------|---------------------|-----------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| RB          | 2483.58         | H       | Y                   | PK        | 55.74          | -0.62      | N/A        | N/A                  | 55.12           | 74.00          | 18.88       |
| RB          | 2483.58         | H       | Y                   | AV        | N/A            | N/A        | -28.18     | N/A                  | 26.94           | 54.00          | 27.06       |
| RB          | 2483.75         | V       | Z                   | PK        | 55.32          | -0.62      | N/A        | N/A                  | 54.70           | 74.00          | 19.30       |
| RB          | 2483.75         | V       | Z                   | AV        | N/A            | N/A        | -28.18     | N/A                  | 26.52           | 54.00          | 27.48       |
| RB          | 4958.96         | H       | Z                   | PK        | 46.94          | 8.22       | N/A        | -9.54                | 45.62           | 74.00          | 28.38       |
| RB          | 4958.96         | H       | Z                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 17.44           | 54.00          | 36.56       |
| RB          | 4959.13         | V       | X                   | PK        | 46.21          | 8.23       | N/A        | -9.54                | 44.90           | 74.00          | 29.10       |
| RB          | 4959.13         | V       | X                   | AV        | N/A            | N/A        | -28.18     | -9.54                | 16.72           | 54.00          | 37.28       |

##### ▪ Note.

- This test item was performed in each axis.  
And no other emissions were reported greater than listed emissions above table.
- The limit is applied as below,  
Non-Restricted Band(NRB) = Fundamental level – 20dB  
Restricted Band(RB) = FCC Part15. 209
- Description of tested band  
“F” = Fundamental signal / “NRB” = Emission in non-restricted band / “RB” = Emission in restricted Band
- Description of Distance Factor  
For finding emissions, the test distance might be reduced from 3m to 1m.  
In this case, the distance factor (-9.54 dB) is applied to the result.  
- Calculation of distance factor =  $20 \log(\text{applied distance} / \text{required distance}) = 20 \log(1\text{m} / 3\text{m}) = -9.54\text{dB}$   
When distance factor is “N/A”, the distance is 3m and distance factor is not applied.
- Sample Calculation  
Margin = Limit – Result / Result = Reading + T.F / T.F = AF + CL – AG  
Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
- The AV result was calculated using a duty correction factor (DCF).  
And the Duty cycle information is declared by manufacturer.  
DCF =  $20 \log(t / 100 \text{ ms})$ , t = Declared value of bursts on-time in 100 ms  
 $20 \log(3.9 \text{ ms} / 100 \text{ ms}) = -28.18 \text{ dB}$  / AV result = PK result + DCF

### 3.6 Power line Conducted Emissions

#### ■ Test Requirements and limit, §15.207 & RSS-Gen [8.8]

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 ohms line impedance stabilization network (LISN).

| 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

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

#### 3.6.1 Test Setup

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

#### 3.6.2 Test Procedures

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.

#### 3.6.3 Test Results

**Not Applicable**

Note : The power of this device is only DC(Not rechargeable Battery).

### 3.7 Occupied Bandwidth

#### ■ Test Requirements, RSS-Gen [6.6]

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.

#### 3.7.1 Test Setup

#### 3.7.2 Test Procedures

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately  $3 \times \text{RBW}$ .

Spectrum analyzer plots are included on the following pages.

#### 3.7.3 Test Results

**Not Applicable**

## 4. ANTENNA REQUIREMENTS

■ **According to FCC 47 CFR §15.203 & RSS-Gen [6.7]**

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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.”

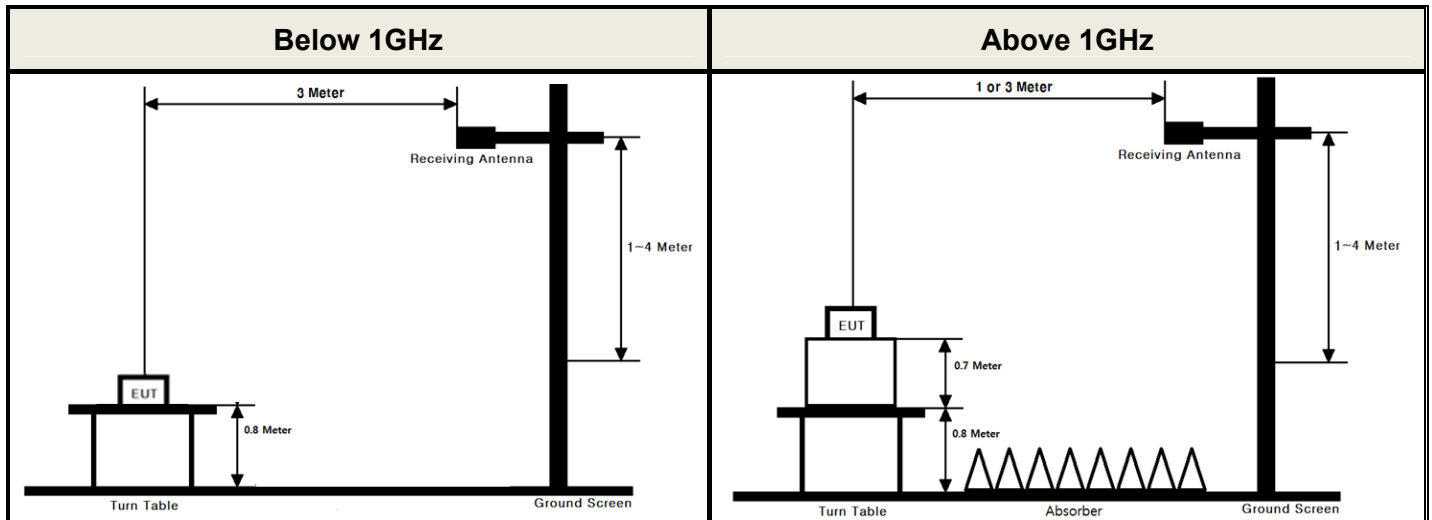
**The antenna uses a unique coupling to this device. (Please refer to internal photo.)**

**Therefore this E.U.T Complies with the requirement of §15.203**

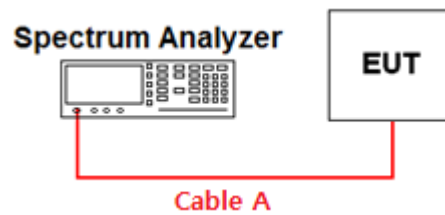
## APPENDIX I

### Test set up diagrams

#### ▪ Radiated Measurement



#### ▪ Conducted Measurement



Path loss information

| Frequency (GHz)    | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|--------------------|----------------|-----------------|----------------|
| 0.03               | 0.01           | 15              | 3.28           |
| 1                  | 0.11           | 20              | 4.45           |
| 2405 & 2440 & 2480 | 1.35           | 25              | 5.54           |
| 5                  | 1.98           | -               | -              |
| 10                 | 2.35           | -               | -              |

Note 1 : The path loss from EUT to Spectrum analyzer was measured and used for test.

Path loss (S/A's correction factor) = Cable A (Attenuator, Applied only when it was used externally)

## APPENDIX II

## Duty cycle plots

- **Test Procedure**

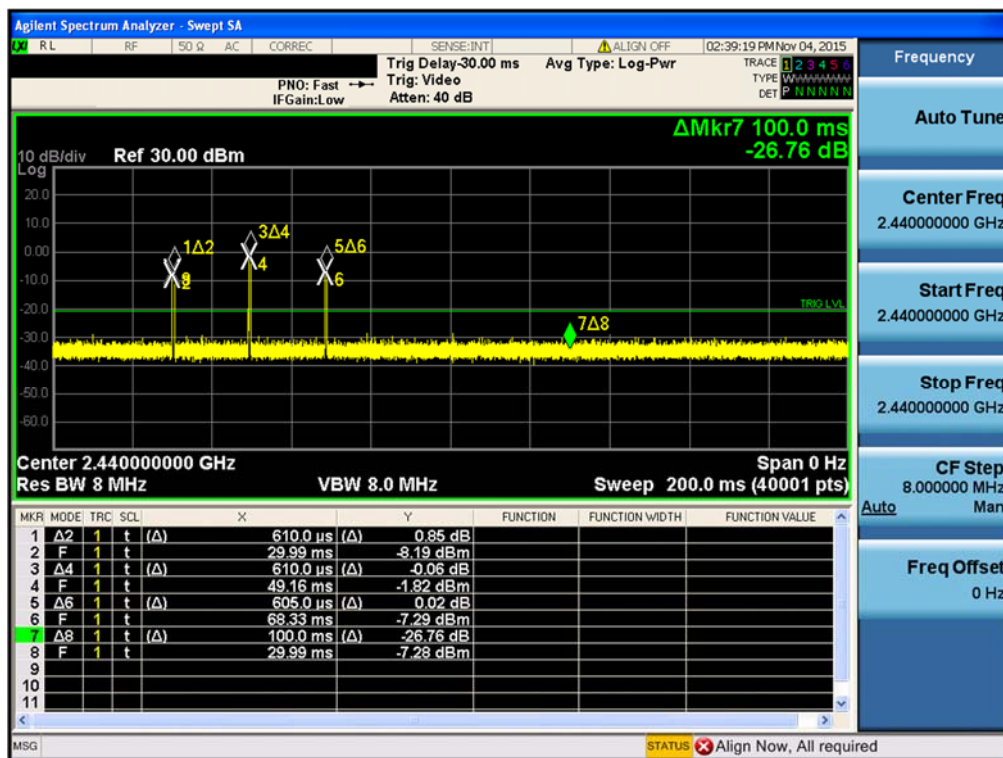
**Duty Cycle** was measured using **section 6.0 b) of KDB558074** :

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set  $RBW \geq OBW$  if possible; otherwise, set RBW to the largest available value. Set  $VBW \geq RBW$ . Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are  $> 50/T$  and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if  $T \leq 16.7$  microseconds.)

## Duty Cycle

**Test Channel : Middle**



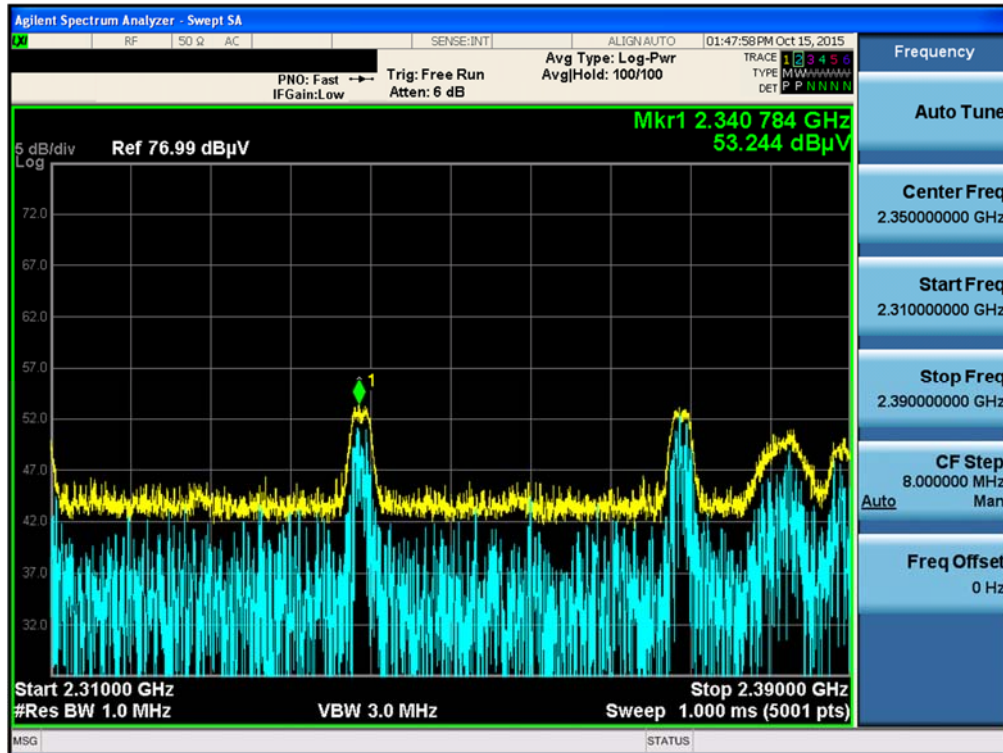
**Note : Measure Duty Cycle =  $T / 100 \text{ ms}$  (  $T$  = sum of the individual on-time in 100 ms )  
 = ( 0.610 ms + 0.610 ms + 0.605 ms ) / 100 ms = 1.825 %  
 Declared worst Duty Cycle = 3.9 %**

## APPENDIX III

### Unwanted Emissions (Radiated) Test Plot

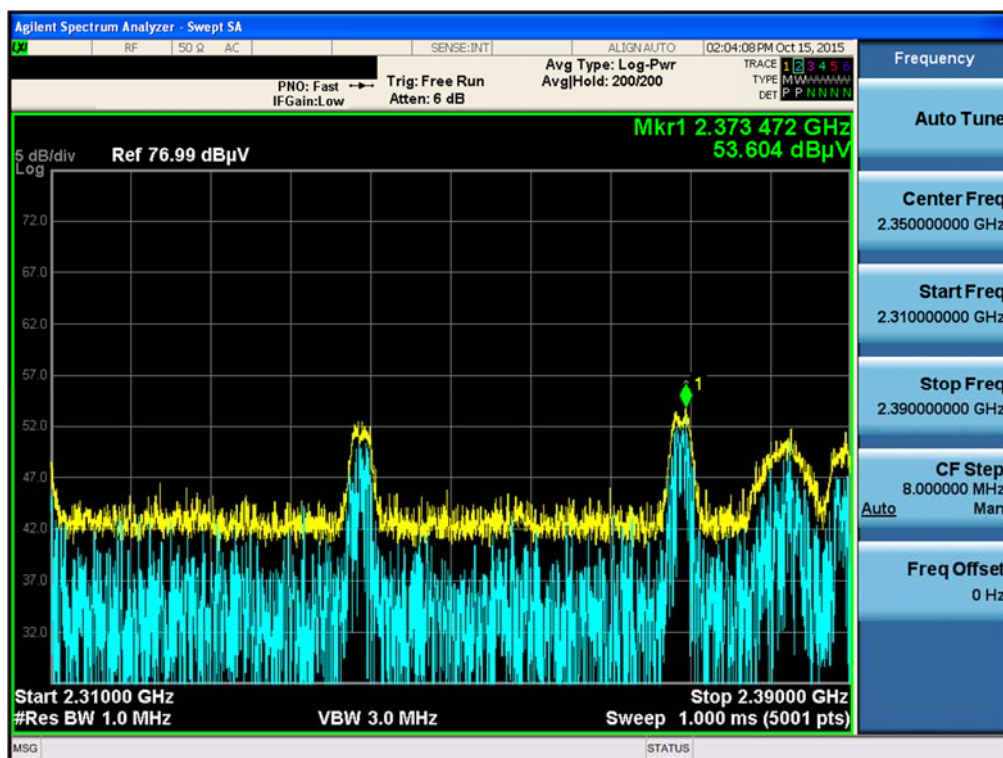
Lowest & X axis & Hor

Detector Mode : PK



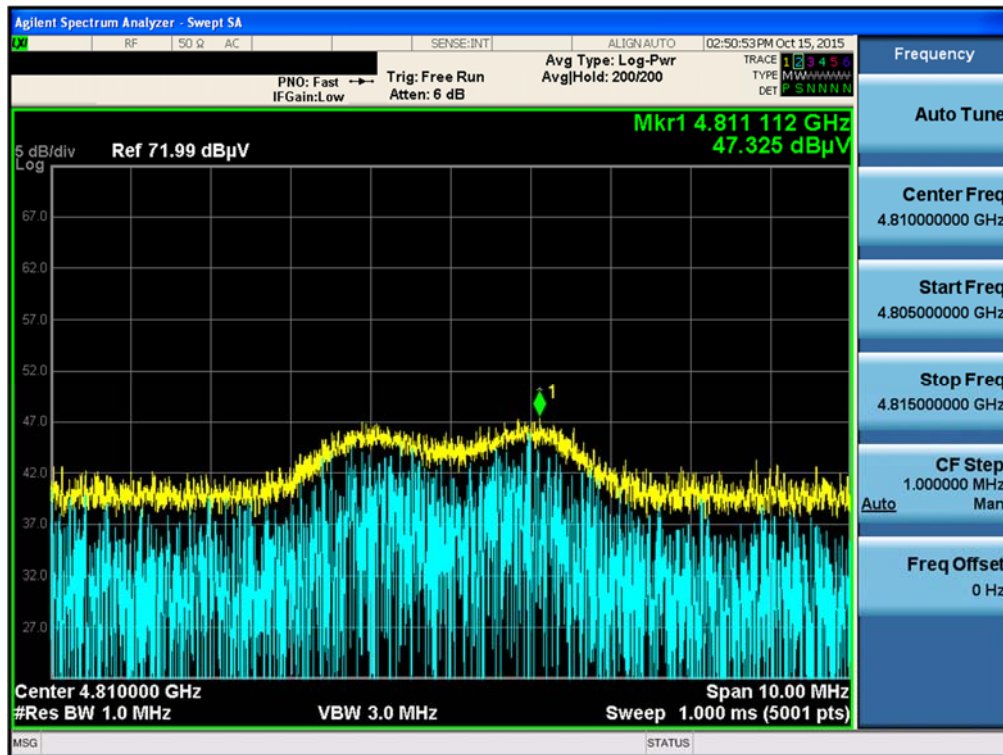
Lowest & Z axis & Ver

Detector Mode : PK



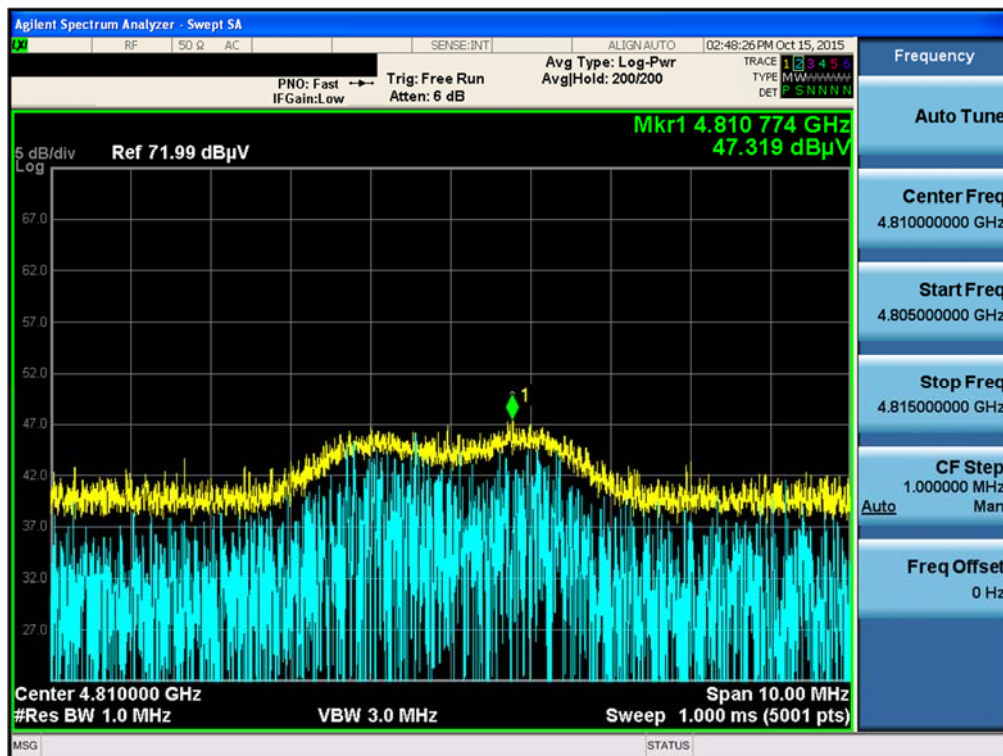
### Lowest & X axis & Hor

**Detector Mode : PK**



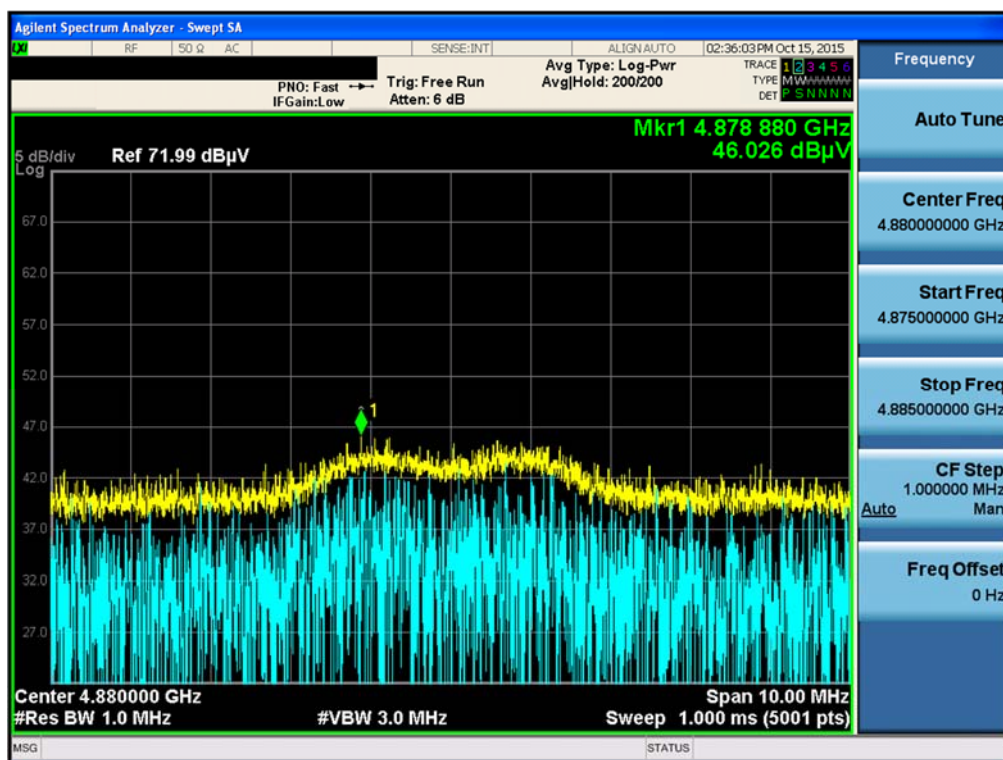
### Lowest & Y axis & Ver

**Detector Mode : PK**



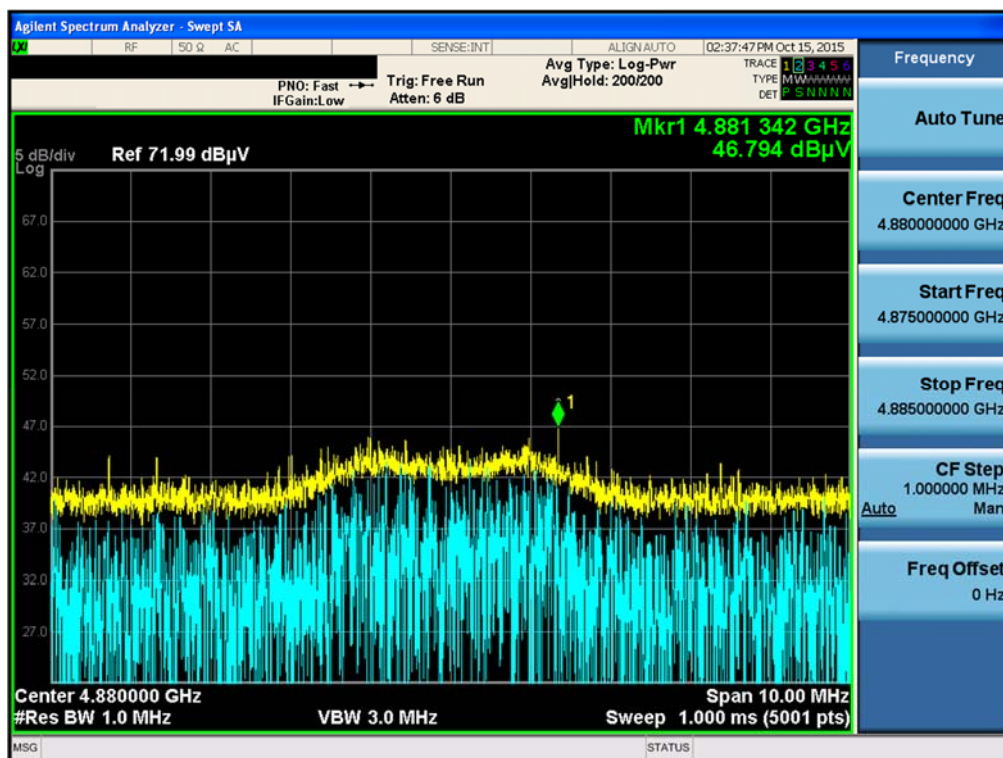
### Middle & X axis & Hor

**Detector Mode : PK**



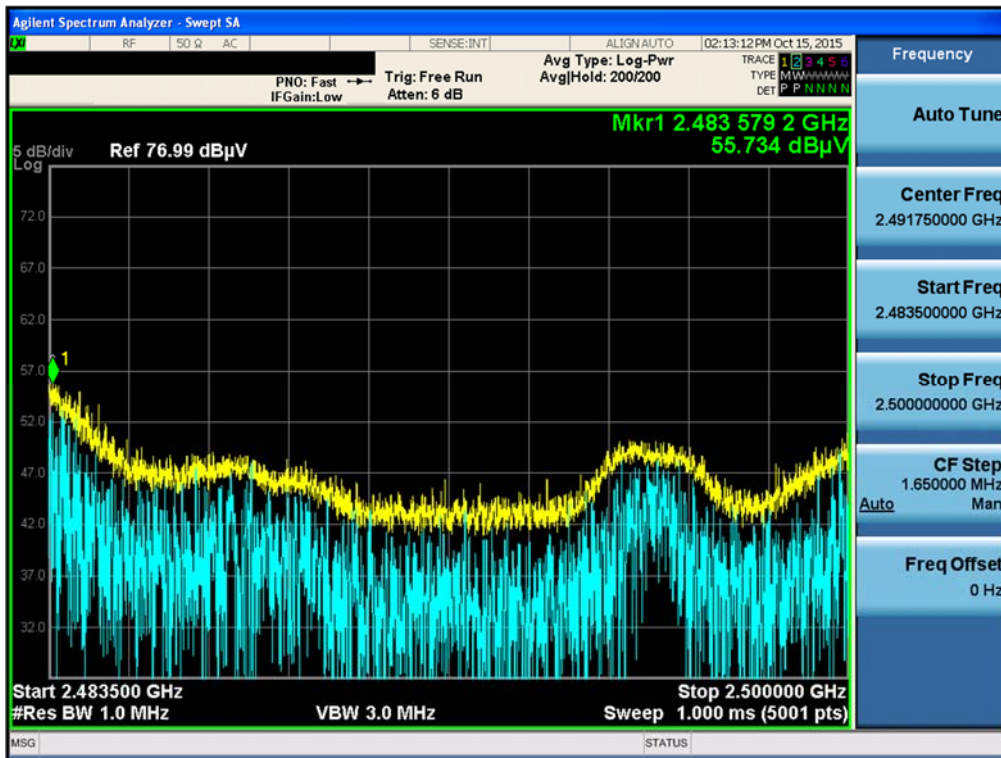
### Middle & X axis & Ver

**Detector Mode : PK**



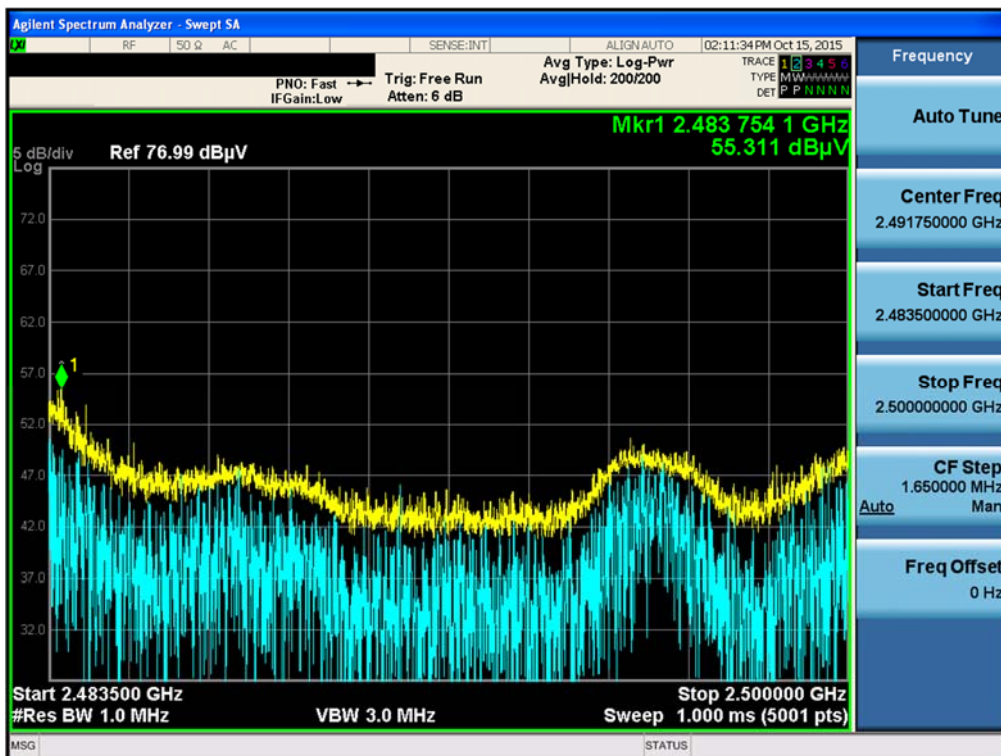
## Highest &amp; Y axis &amp; Hor

Detector Mode : PK



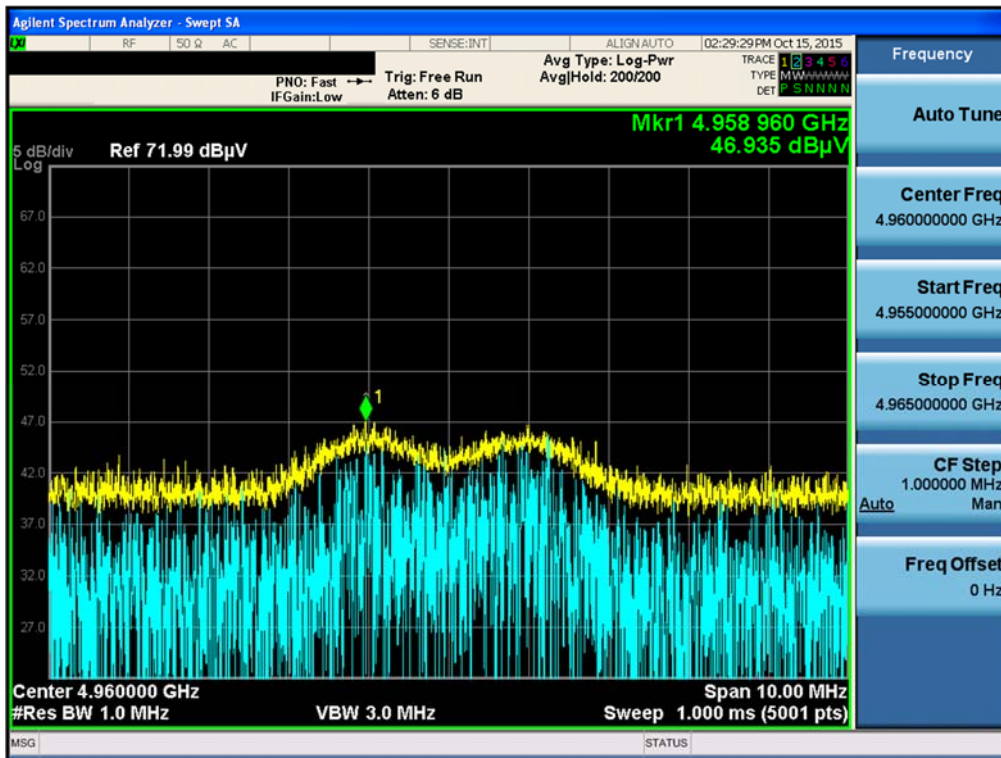
## Highest &amp; Z axis &amp; Ver

Detector Mode : PK



## Highest &amp; Z axis &amp; Hor

Detector Mode : PK



## Highest &amp; X axis &amp; Ver

Detector Mode : PK

