# TEST REPORT

**DT&C Co., Ltd.**
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1904-0114
2. Customer
   - Name : HYUNDAI MOBIS CO., LTD.
   - Address : 203, Teheran-ro Gangnam-gu, Seoul, South Korea, 135-977
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : DIGITAL CAR AVN SYSTEM / ATC41GKAN
   FCC ID : TQ8-ATC41GKAN
5. Test Method Used : KDB558074 D01v05, ANSI C63.10-2013
   Test Specification : FCC Part 15.247
6. Date of Test : 2018.12.10 ~ 2019.01.23
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name : SunGeun Lee (Signature) | Reviewed by<br>Name : GeunKi Son (Signature) |

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

**2019 . 04 . 18 .**

**DT&C Co., Ltd.**

**If this report is required to confirmation of authenticity, please contact to report@dtnc.net**

# Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| DRTFCC1904-0114 | Apr. 18, 2019 | Initial issue |
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# Table of Contents

# 1. EUT DESCRIPTION

| | |
|---|---|
| **FCC Equipment Class** | Digital Transmission System(DTS) |
| **Product** | DIGITAL CAR AVN SYSTEM |
| **Model Name** | ATC41GKAN |
| **Add Model Name** | NA |
| **Hardware Version** | 1.0 |
| **Software Version** | 1.0 |
| **Power Supply** | DC 14.4 V |
| **Frequency Range** | ▪ 802.11b/g/n/(20 MHz) : 2412 MHz ~ 2462 MHz |
| **Max. RF Output Power** | 2.4GHz Band<br>▪ 802.11b : 10.48 dBm<br>▪ 802.11g : 18.46 dBm<br>▪ 802.11n (HT20) : 17.02 dBm |
| **Modulation Type** | ▪ 802.11b: CCK, DSSS<br>▪ 802.11g/n/ac: OFDM |
| **Antenna Specification** | **Antenna type**: Dual Band Antenna<br>**Antenna gain**: -0.7 dBi |

# 2. INFORMATION ABOUT TESTING

## 2.1 Test mode

| Test mode | Worst case data rate | Tested Frequency(MHz) | | |
|---|---|---|---|---|
| | | Lowest | Middle | Highest |
| **TM 1** | 802.11b<br>1 Mbps | 2412 | 2437 | 2462 |
| **TM 2** | 802.11g<br>6 Mbps | 2412 | 2437 | 2462 |
| **TM 3** | 802.11n(HT20)<br>MCS 0 | 2412 | 2437 | 2462 |

Note 1: The worst case data rate is determined as above test mode according to the power measurements.
Note 2: The power measurement results for all modes and data rate were reported.

## 2.2 Auxiliary equipment

| Equipment | Model No. | Serial No. | Manufacturer | Note |
|---|---|---|---|---|
| - | - | - | - | - |
| - | - | - | - | - |

## 2.3 Tested environment

| | | |
|---|---|---|
| **Temperature** | : | 20 ~ 25 ºC |
| **Relative humidity content** | : | 25 ~ 30 % |
| **Details of power supply** | : | DC 14.4 V |

## 2.4 EMI suppression Device(s) / Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

## 2.5 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C 63.4-2014 and ANSI C 63.10-2013. All measurement uncertainty values are shown with a coverage factor of *k* = 2 to indicate a 95 % level of confidence.

| Test items | Measurement uncertainty |
|---|---|
| Transmitter Output Power | 0.7 dB (The confidence level is about 95 %, k = 2) |
| Conducted spurious emission | 0.9 dB (The confidence level is about 95 %, k = 2) |
| AC conducted emission | 2.4 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (1 GHz Below) | 5.1 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (1 GHz ~ 18 GHz) | 5.4 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission (18 GHz Above) | 5.3 dB (The confidence level is about 95 %, k = 2) |

# 3. SUMMARY OF TESTS

| FCC Part | RSS Std. | Parameter | Limit | Test Condition | Status 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 |
| 15.247(d)<br>15.205<br>15.209 | RSS-247 [5.5]<br>RSS-GEN [8.9]<br>RSS-GEN [8.10] | 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 Note3 |
| 15.203 | RSS-Gen [8.3] | Antenna Requirements | FCC 15.203 | - | C |

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.

Note 3: This device is installed in a car. Therefore the power source is a battery of car.

# 4. TEST METHODOLOGY

The measurement procedures described in the ANSI C63.10-2013 and the guidance provided in KDB558074 D01v05 were used in measurement of the EUT.

The EUT was tested per the guidance of KDB558074 D01v05. 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.

## 4.1 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.

## 4.2 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.

## 4.3 General test procedures

### Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB558074 D01v05.

So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10-2013.

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 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector

### Radiated Emissions

Basically the radiated tests were performed with KDB558074 D01v05. 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 KDB558074 D01V05.

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 turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 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.

## 4.4 Description of test modes

The EUT has been tested with all modes of operating conditions to determine the worst case emission characteristics.

A test program is used to control the EUT for staying in continuous transmitting mode.

# 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.

# 6. FACILITIES AND ACCREDITATIONS

## 6.1 Facilities

| | | |
|---|---|---|
| **DT&C Co., Ltd.** | | |
| The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The site is constructed in conformance with the requirements.<br><br>**- FCC MRA Accredited Test Firm No. : KR0034** | | |
| www.dtnc.net | | |
| Telephone | : | + 82-31-321-2664 |
| FAX | : | + 82-31-321-1664 |

## 6.2 Equipment

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, loop, horn. Spectrum analyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements.
Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

# 7. ANTENNA REQUIREMENTS

## 7.1 According to FCC 47 CFR §15.203

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 internal antenna is printed on the PCB.**

# 8. TEST RESULT

## 8.1 6dB bandwidth

### ▣ Test Requirements and limit, §15.247(a)

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

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

### ▣ Test Configuration:

Refer to the APPENDIX I.

### ▣ Test Procedure:

- **KDB558074 D01v05 - Section 8.2**
- **ANSI C63.10-2013 – Section 11.8.2**

1. Set resolution bandwidth (RBW) = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x 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.

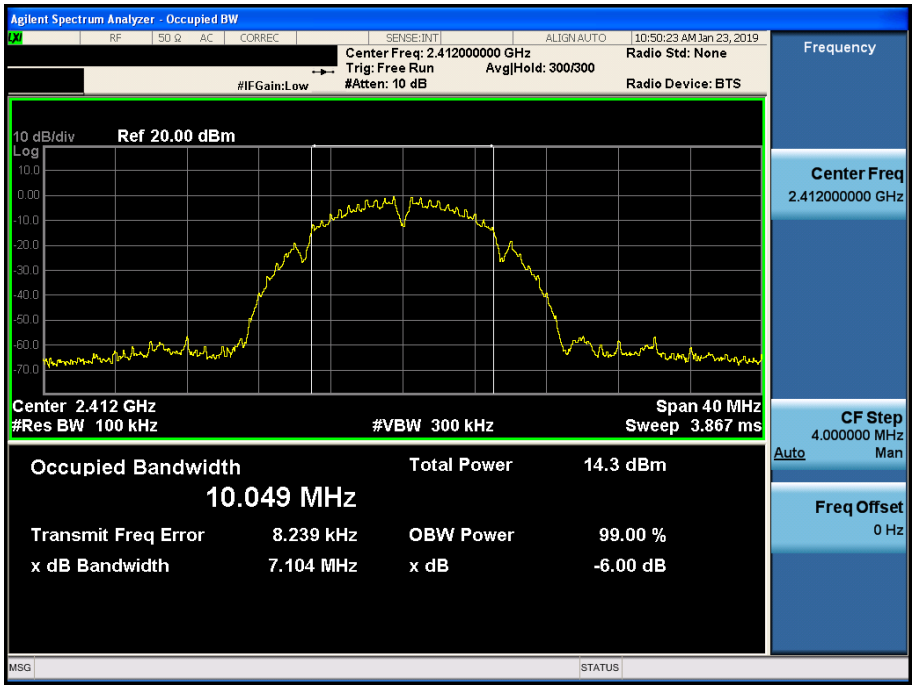
### ▣ Test Results: Comply

| Test Mode | Frequency | Test Results[MHz] |
|---|---|---|
| TM 1 | Lowest | 7.10 |
| | Middle | 7.09 |
| | Highest | 7.10 |
| TM 2 | Lowest | 16.31 |
| | Middle | 16.32 |
| | Highest | 16.34 |
| TM 3 | Lowest | 16.96 |
| | Middle | 16.91 |
| | Highest | 16.70 |

## ▣ RESULT PLOTS

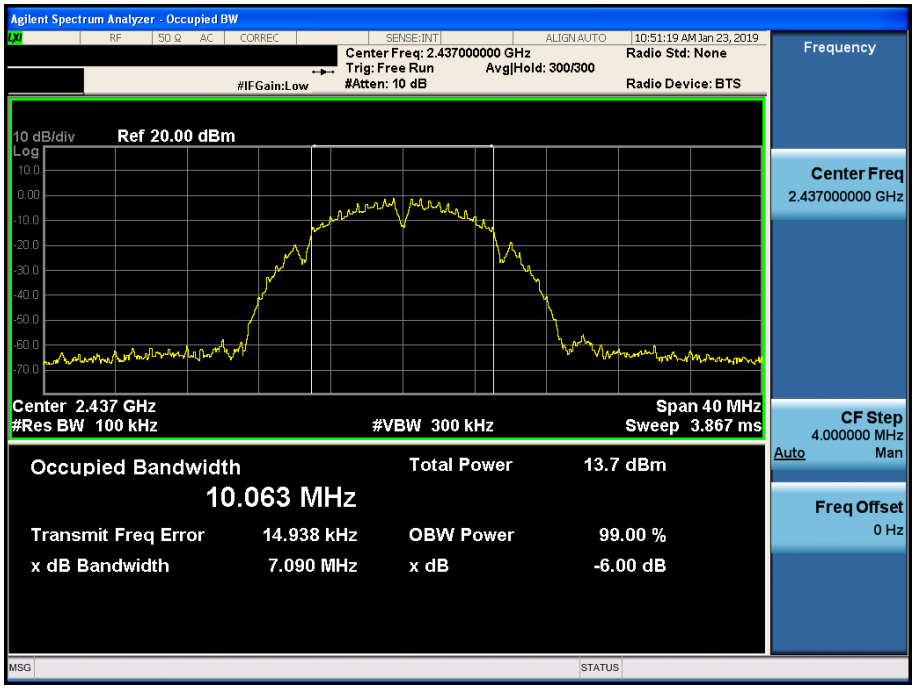
### 6 dB Bandwidth

TM 1 & Lowest



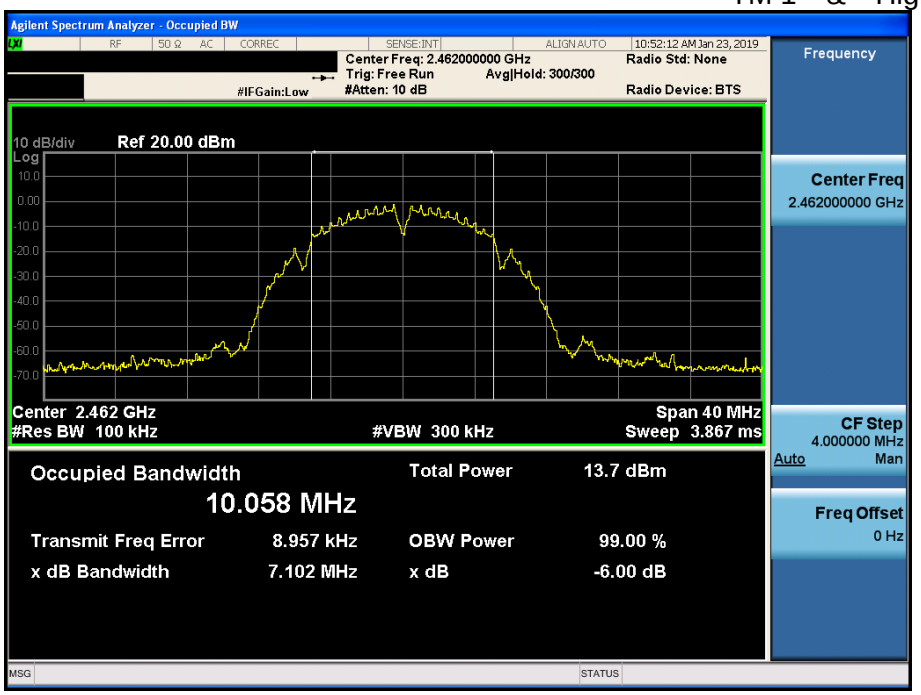

### 6 dB Bandwidth

TM 1 & Middle



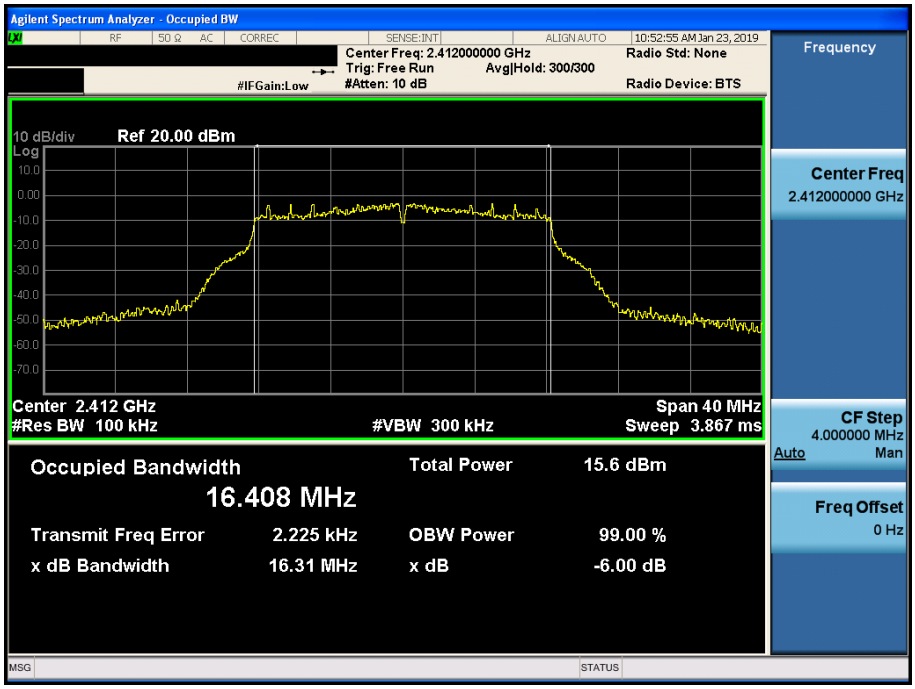
## 6 dB Bandwidth

TM 1 & Highest



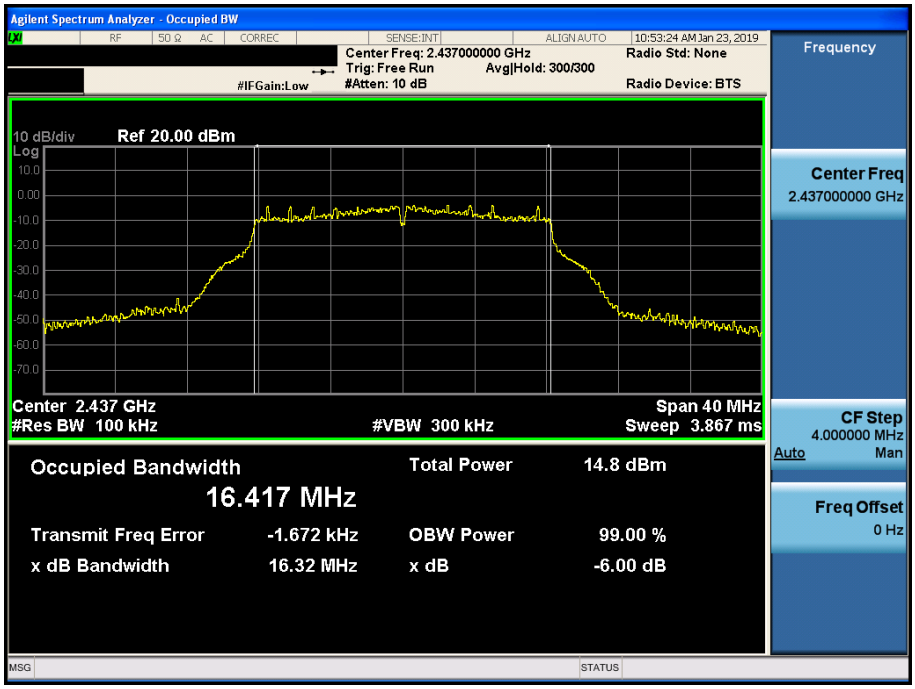
## 6 dB Bandwidth

TM 2 & Lowest




## 6 dB Bandwidth

TM 2 & Middle

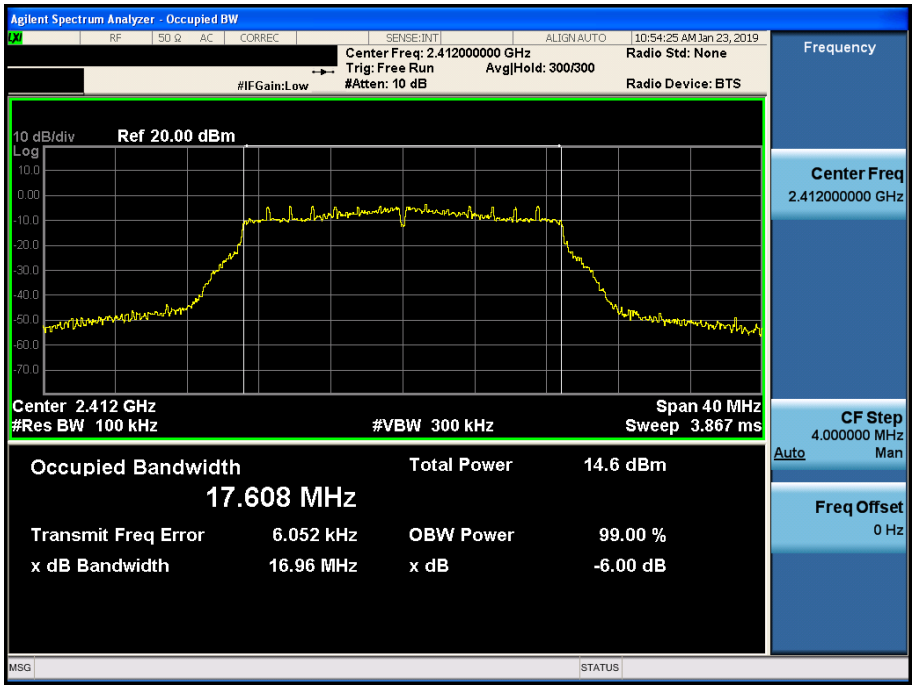


## 6 dB Bandwidth

TM 2 & Highest

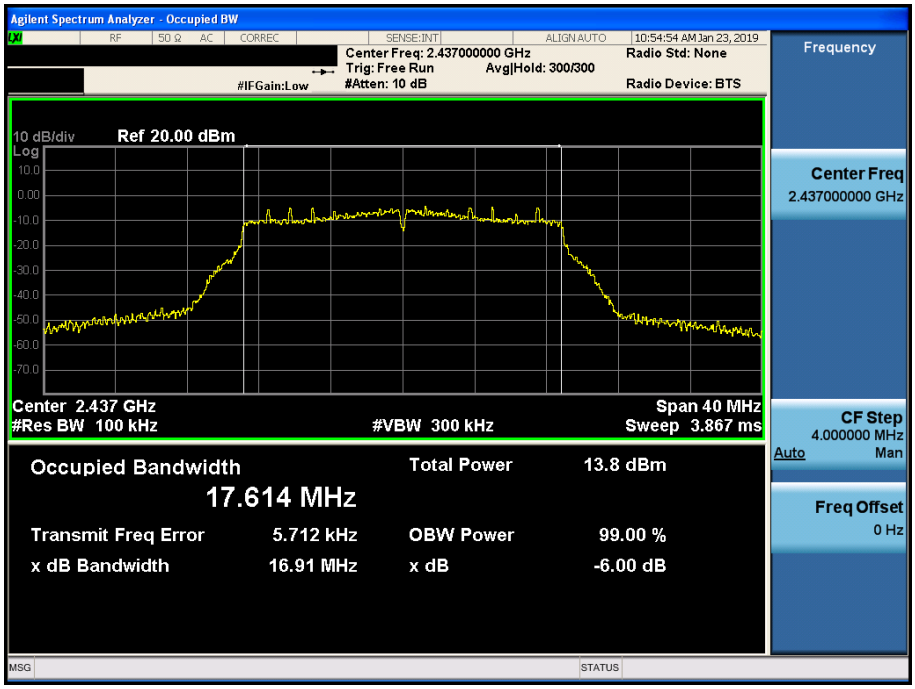
## 6 dB Bandwidth

TM 3 & Lowest



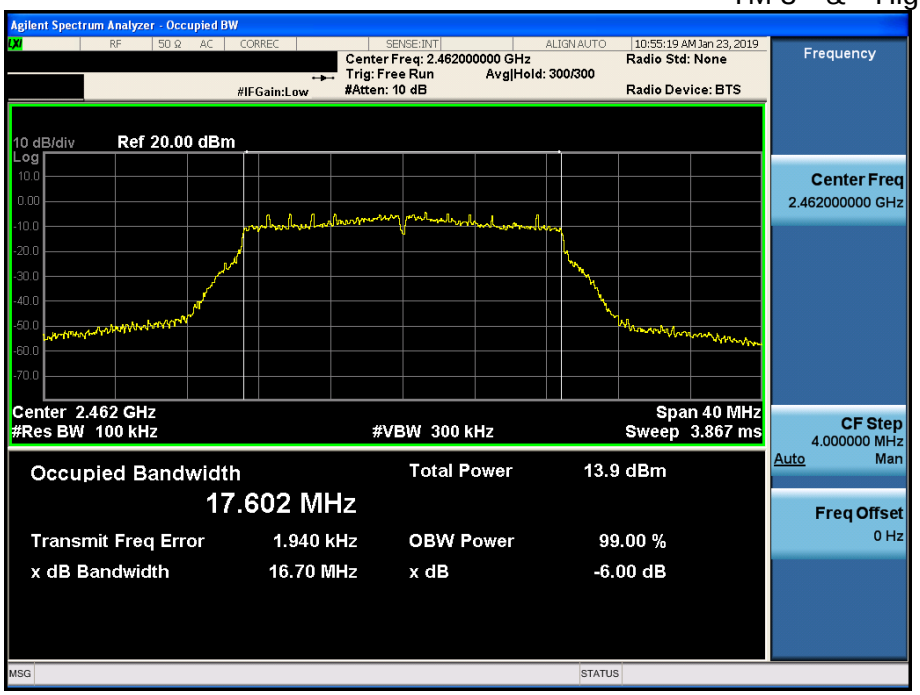

## 6 dB Bandwidth

TM 3 & Middle



## 6 dB Bandwidth

TM 3 & Highest

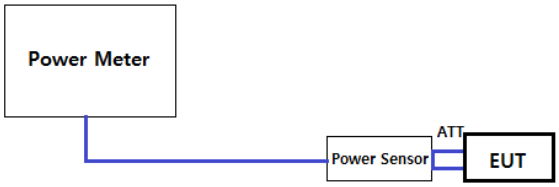


## 8.2 Maximum peak conducted output power

### ▣ Test Requirements and limit, §15.247(b)

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

### ▣ Test Configuration




### ▣ Test Procedure

1. **PKPM1 Peak power meter method of KDB558074 D01V05**
   The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.

2. **Method AVGPM-G (Measurement using a gated RF average power meter) of KDB558074 D01V05**
   The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

## ▣ Test Results: Comply

| Freq. (MHz) | Det. | Maximum Peak Conducted Output Power (dBm) for ***802.11b*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Data Rate [Mbps] | | | | | | | |
| | | 1 | 2 | 5.5 | 11 | - | - | - | - |
| 2412 | PK | **10.48** | 10.20 | 9.72 | 10.26 | - | - | - | - |
| | AV | 7.13 | 6.88 | 6.85 | 6.83 | - | - | - | - |
| 2437 | PK | 9.67 | 9.44 | 8.88 | 9.47 | - | - | - | - |
| | AV | 6.37 | 6.18 | 6.13 | 6.12 | - | - | - | - |
| 2462 | PK | 9.79 | 6.49 | 6.07 | 6.65 | - | - | - | - |
| | AV | 6.41 | 6.17 | 6.15 | 6.12 | - | - | - | - |

| Freq. (MHz) | Det. | Maximum Peak Conducted Output Power (dBm) for ***802.11g*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Data Rate [Mbps] | | | | | | | |
| | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 2412 | PK | **18.46** | 18.35 | 17.94 | 16.03 | 16.30 | 16.64 | 16.96 | 15.82 |
| | AV | 8.80 | 8.76 | 8.78 | 8.34 | 8.10 | 8.06 | 8.05 | 8.03 |
| 2437 | PK | 18.44 | 18.36 | 17.99 | 16.15 | 16.47 | 16.84 | 17.21 | 16.14 |
| | AV | 8.06 | 8.01 | 8.05 | 7.69 | 7.40 | 7.38 | 7.36 | 7.35 |
| 2462 | PK | 17.61 | 17.54 | 17.21 | 15.22 | 15.64 | 15.89 | 16.19 | 15.02 |
| | AV | 8.09 | 8.07 | 8.08 | 7.61 | 7.34 | 7.29 | 7.28 | 7.25 |

| Freq. (MHz) | Det. | Maximum Peak Conducted Output Power (dBm) for ***802.11n(HT20)*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Data Rate [MCS] | | | | | | | |
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2412 | PK | 16.70 | 16.49 | 16.69 | 15.97 | 16.48 | 15.94 | 15.89 | 15.63 |
| | AV | 7.22 | 7.13 | 7.16 | 6.85 | 7.15 | 7.10 | 7.01 | 6.81 |
| 2437 | PK | **17.02** | 16.85 | 17.01 | 16.33 | 16.81 | 16.35 | 16.32 | 16.11 |
| | AV | 6.40 | 6.35 | 6.39 | 6.05 | 6.39 | 6.31 | 6.27 | 6.10 |
| 2462 | PK | 15.51 | 15.28 | 15.54 | 14.89 | 17.37 | 16.80 | 16.72 | 16.43 |
| | AV | 6.33 | 6.26 | 6.28 | 6.01 | 6.28 | 6.26 | 6.21 | 6.07 |

## 8.3 Maximum power spectral density

### ▣ Test requirements and limit, §15.247(e)

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.

### ▣ Test Configuration:

Refer to the APPENDIX I.

### ▣ Test Procedure

- **KDB558074 D01v05 - Section 8.4**
- **ANSI C63.10-2013 – Section 11.10.2**

**Method PKPSD (peak PSD)**

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 to : **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.

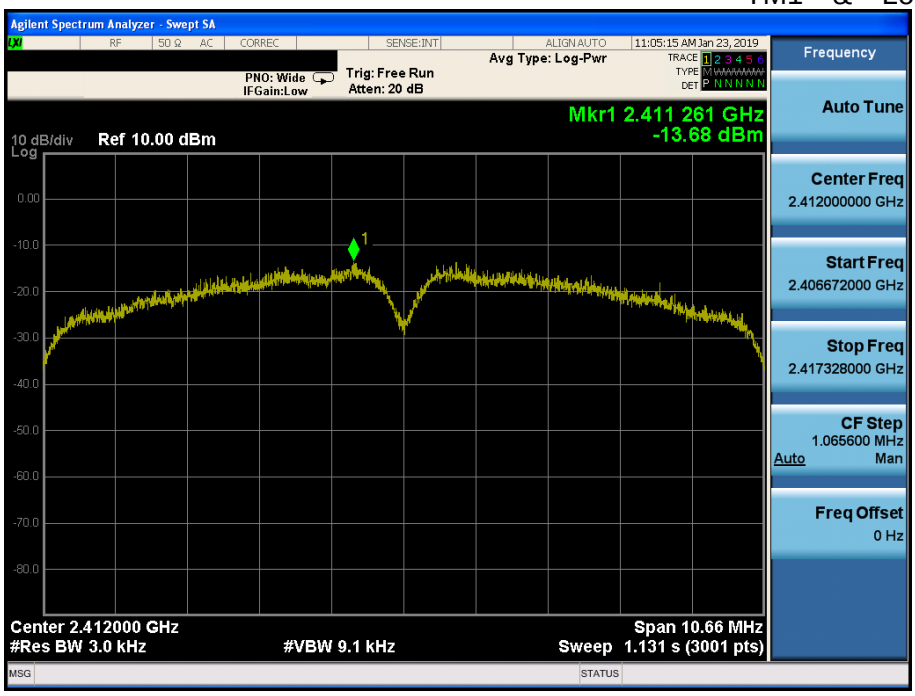
### ▣ Test Results: Comply

| Test Mode | Frequency | RBW | PKPSD [dBm] |
|---|---|---|---|
| TM 1 | Lowest | 3 kHz | -13.68 |
| | Middle | 3 kHz | -14.70 |
| | Highest | 3 kHz | -14.75 |
| TM 2 | Lowest | 3 kHz | -14.06 |
| | Middle | 3 kHz | -14.97 |
| | Highest | 3 kHz | -14.87 |
| TM 3 | Lowest | 3 kHz | -15.11 |
| | Middle | 3 kHz | -16.01 |
| | Highest | 3 kHz | -16.04 |

## ▣ RESULT PLOTS

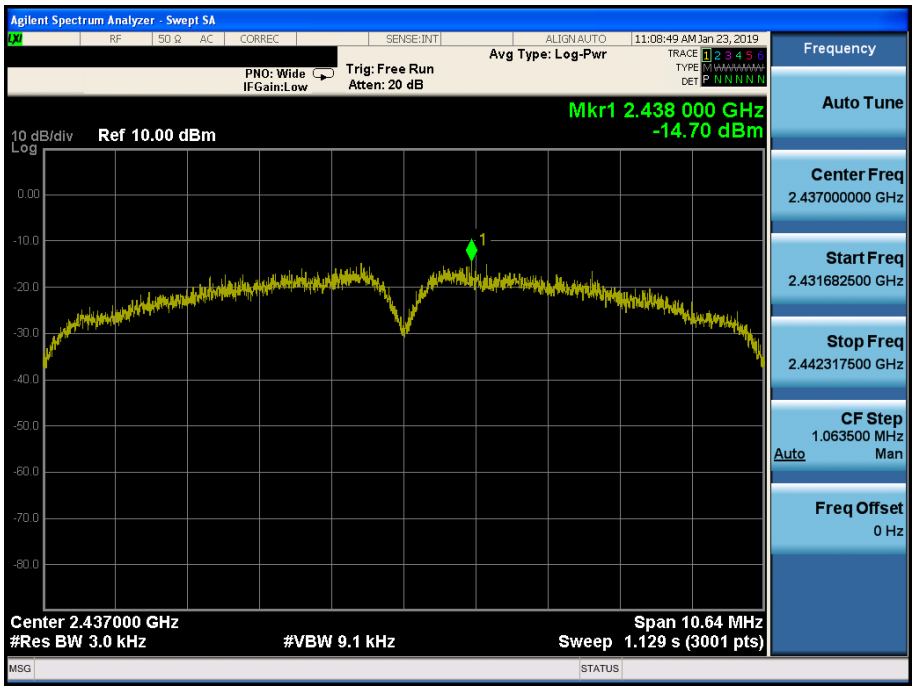
### Maximum PPSD

TM1 & Lowest

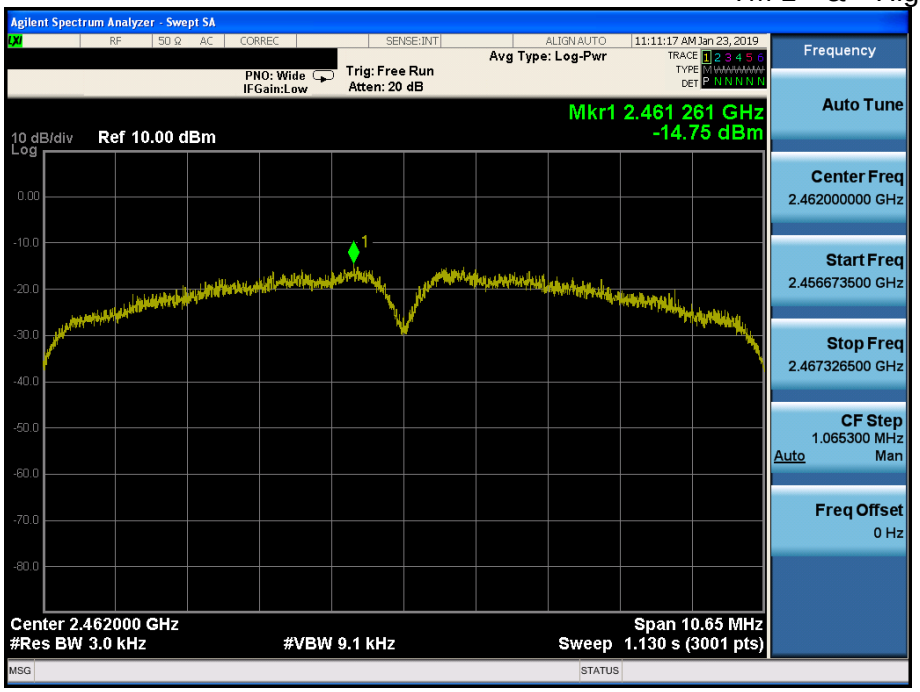



### Maximum PPSD

TM 1 & Middle

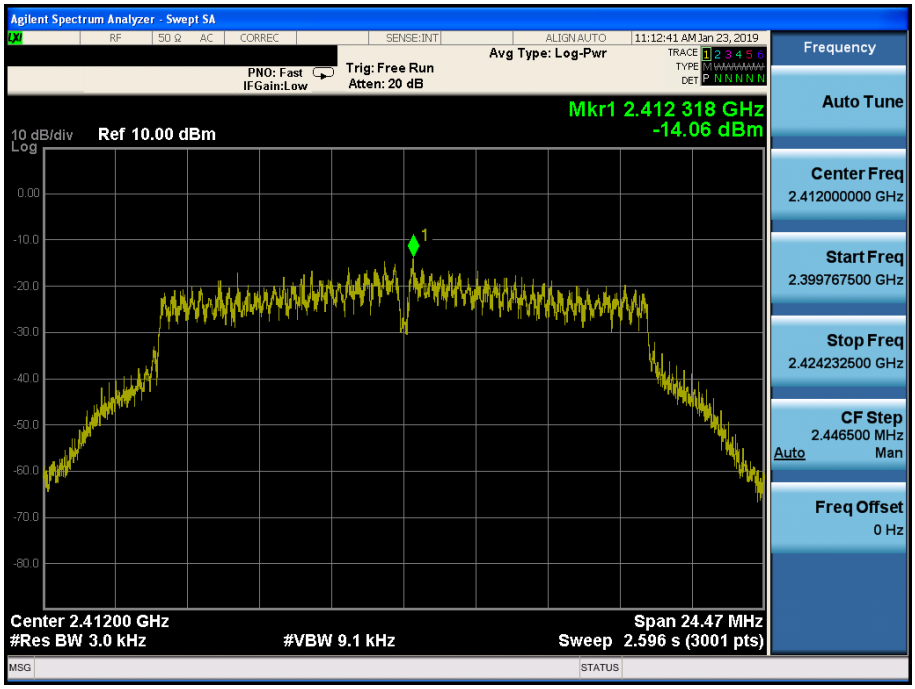


**Maximum PPSD** TM 1 & Highest



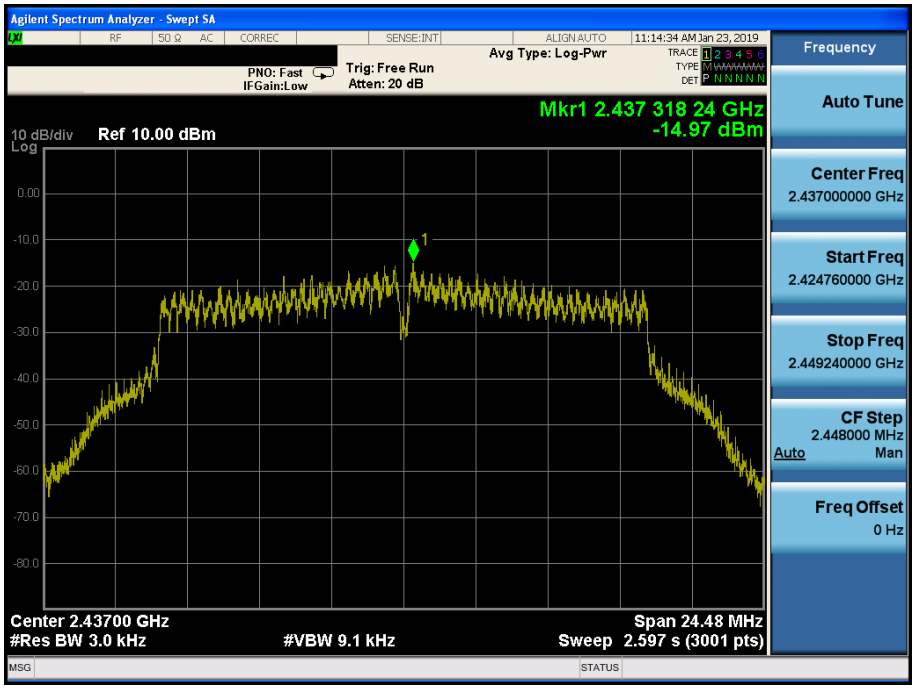
## Maximum PPSD

TM 2 & Lowest

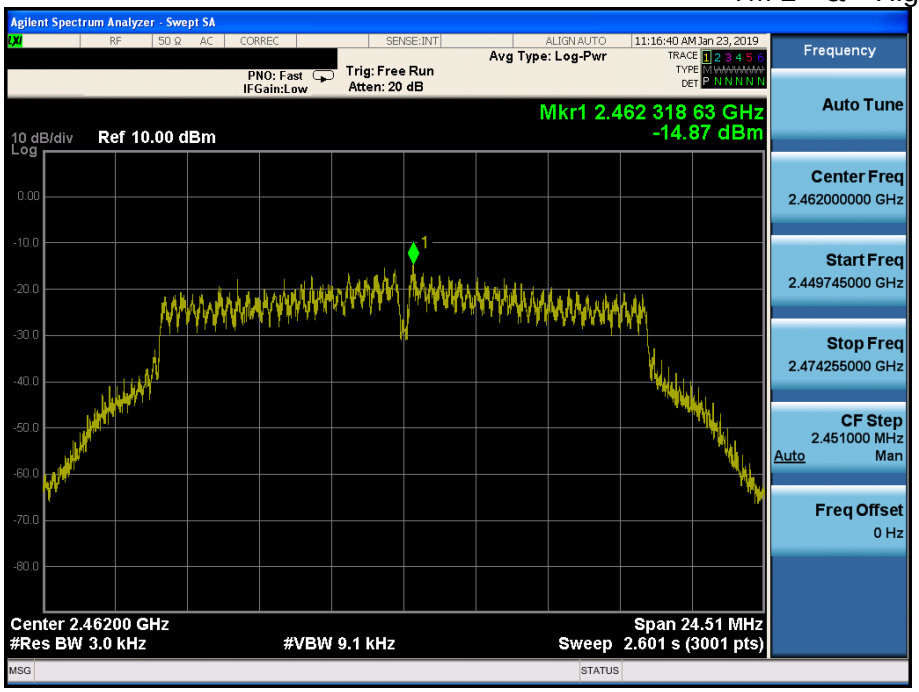



## Maximum PPSD

TM 2 & Middle

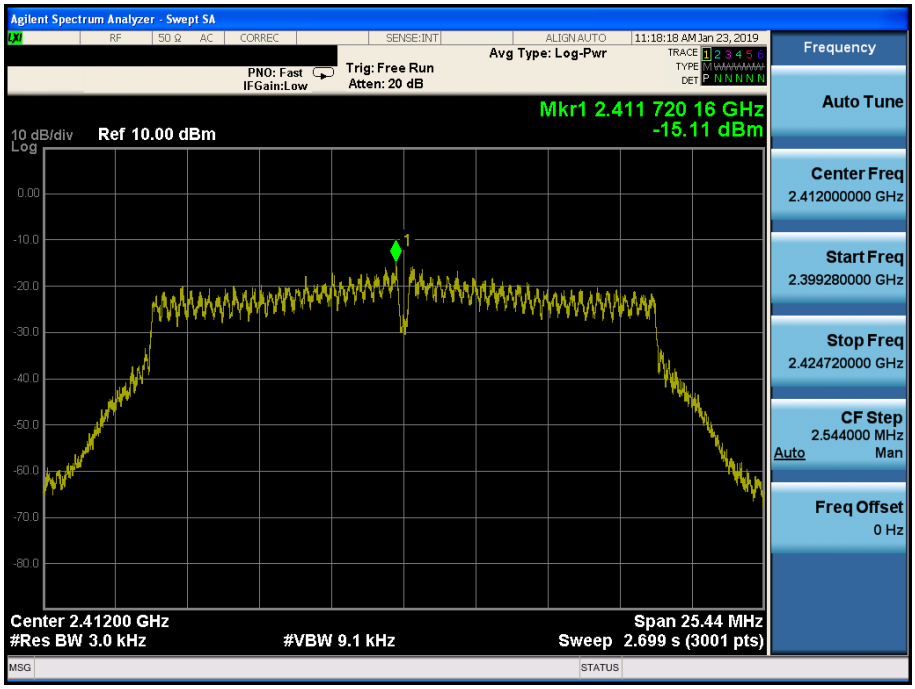


**Maximum PPSD** TM 2 & Highest



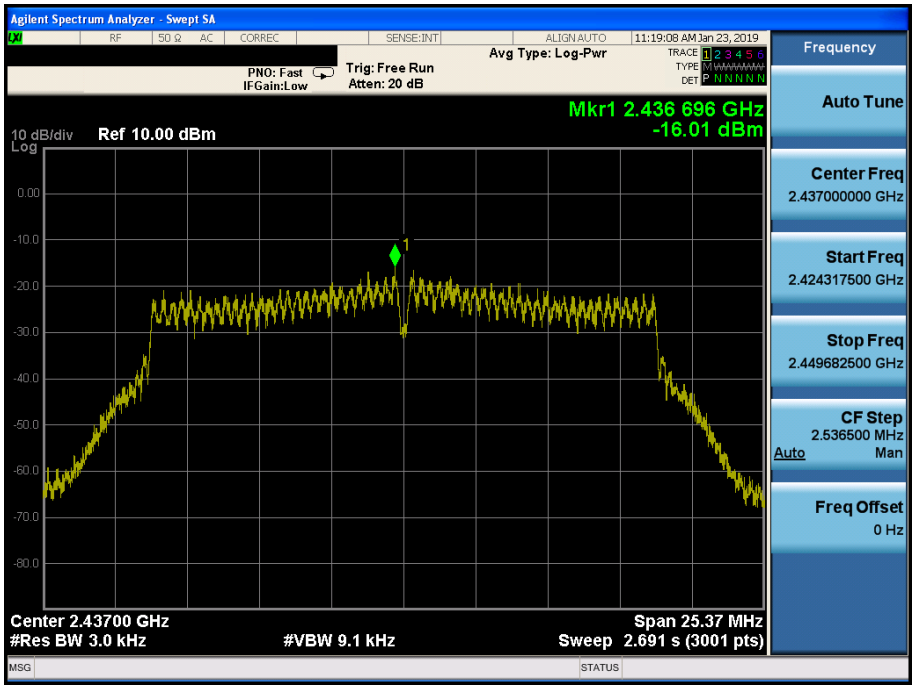
## Maximum PPSD

TM 3 & Lowest

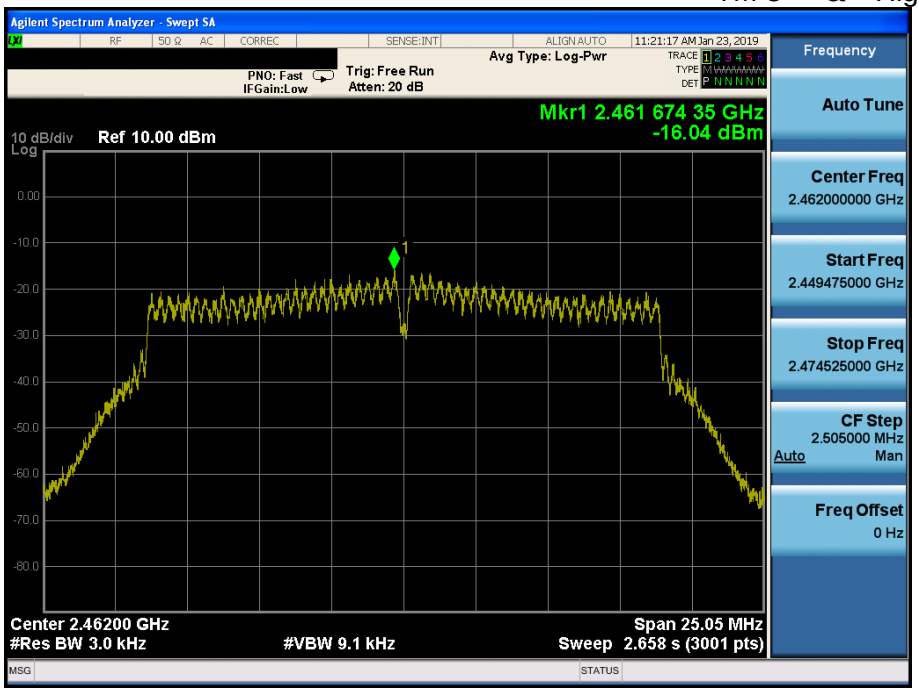



## Maximum PPSD

TM 3 & Middle



**Maximum PPSD** TM 3 & Highest



## 8.4 Out of band emissions at the band edge / conducted spurious emissions

### ▣ Test requirements and limit, §15.247(d)

**§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.

### ▣ Test Configuration:

Refer to the APPENDIX I.

### ▣ Test Procedure

- **KDB558074 D01v05 - Section 8.5**
- **ANSI C63.10-2013 – Section 11.11**

**- Reference level measurement**

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the 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 PSD level.

**- Emission level measurement**

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 ≥ **3 x RBW. (Actual 3 MHz, See below note)**
4. Detector = **Peak**.
5. Ensure that the number of measurement points ≥ 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: 9 kHz ~ 30 MHz**
**RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001**

**Frequency range: 30 MHz ~ 10 GHz, 10 GHz ~25 GHz**
**RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001**

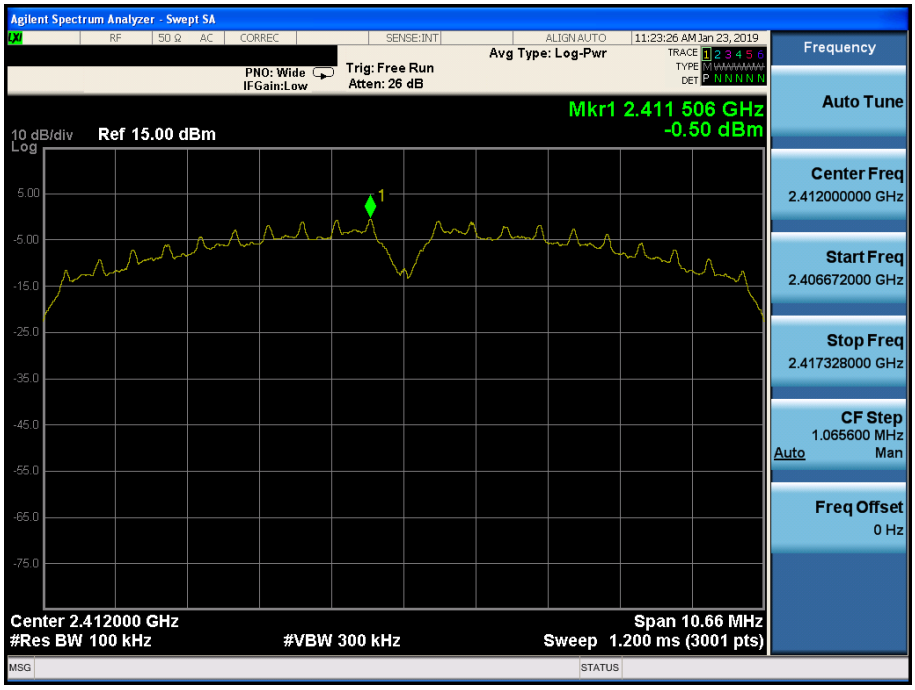
**LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)**

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.

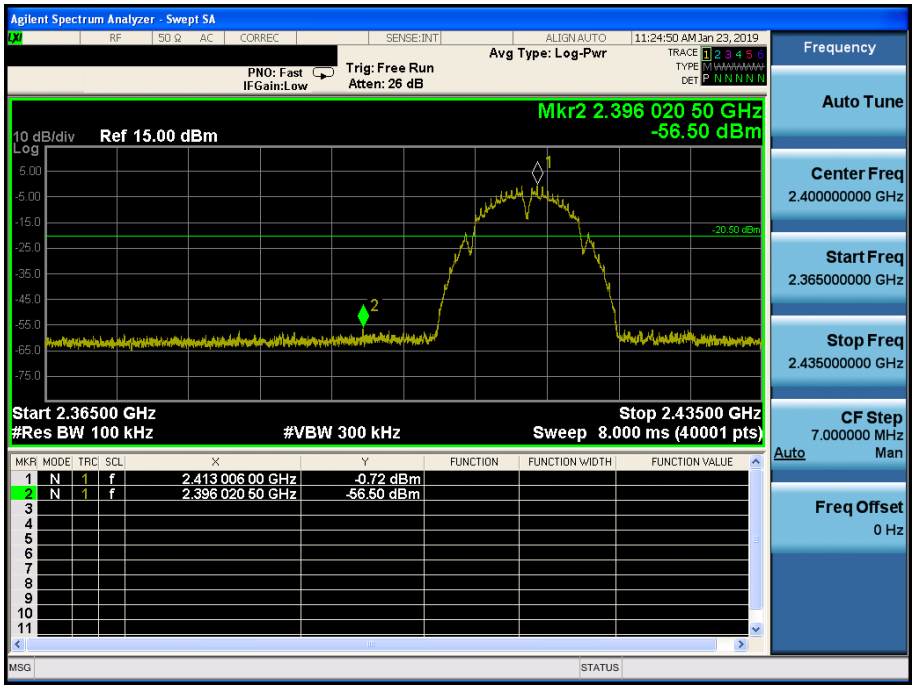
## ▣ RESULT PLOTS

### TM 1 & Lowest

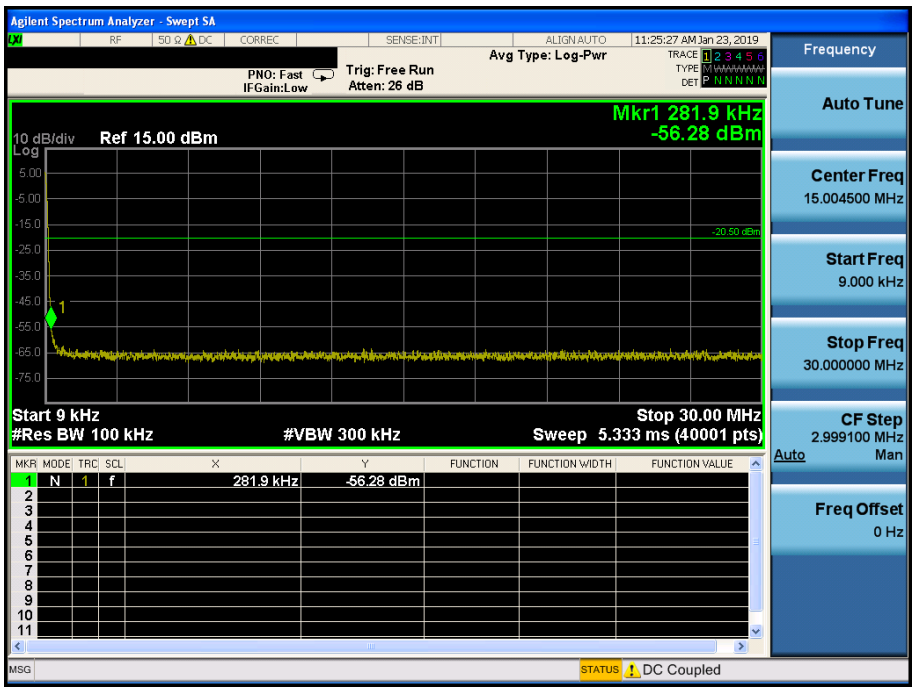
#### Reference

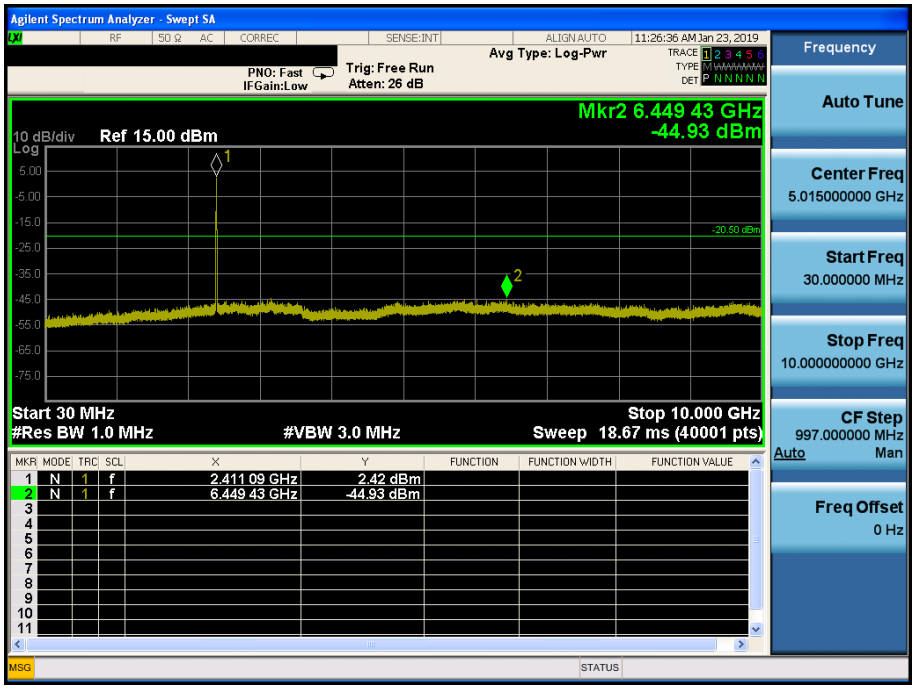



#### Low Band-edge



## Conducted Spurious Emissions

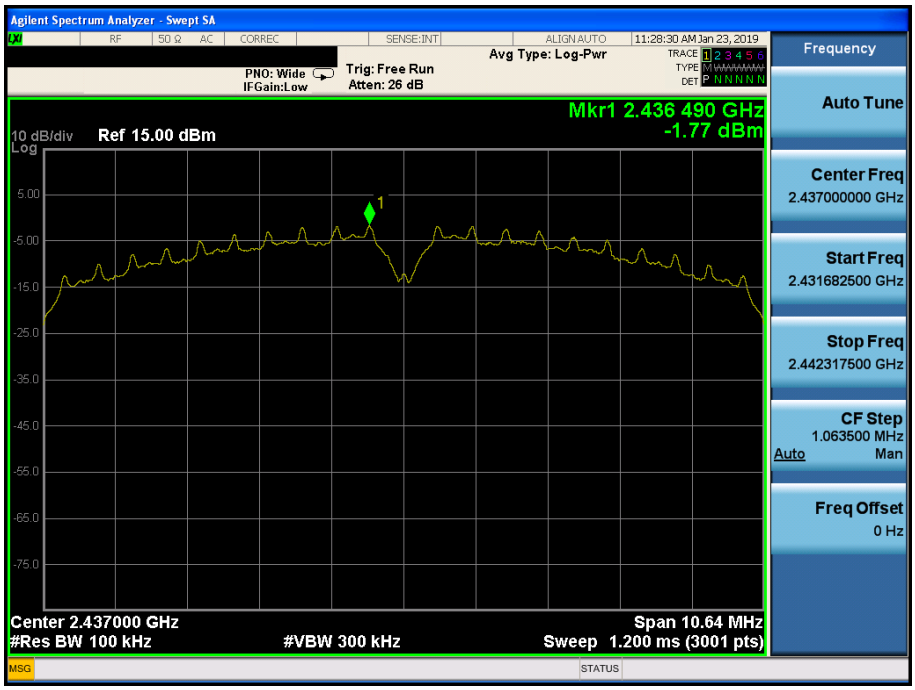


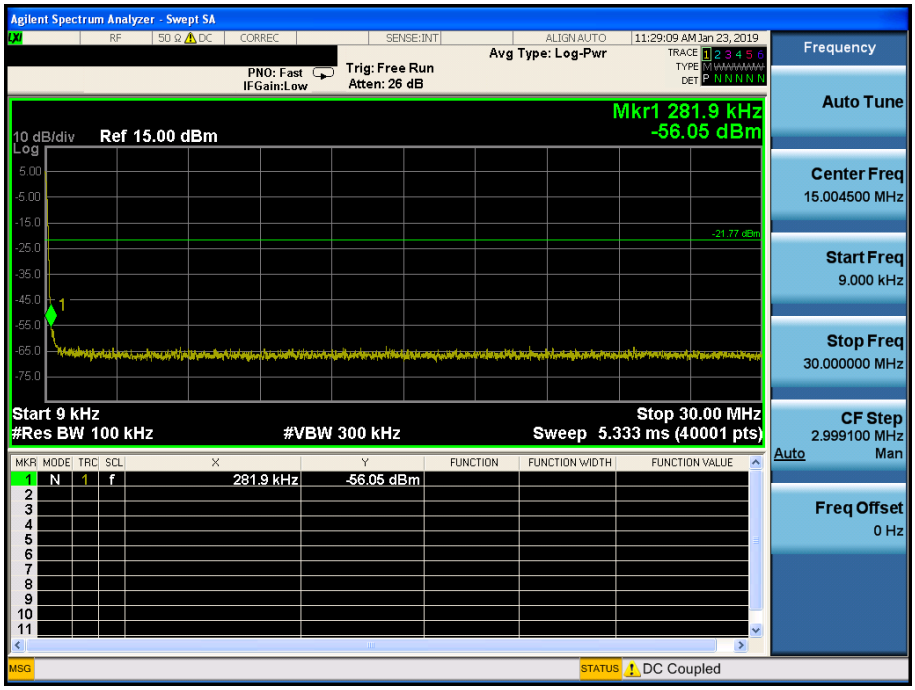
## Conducted Spurious Emissions

## TM 1 & Middle

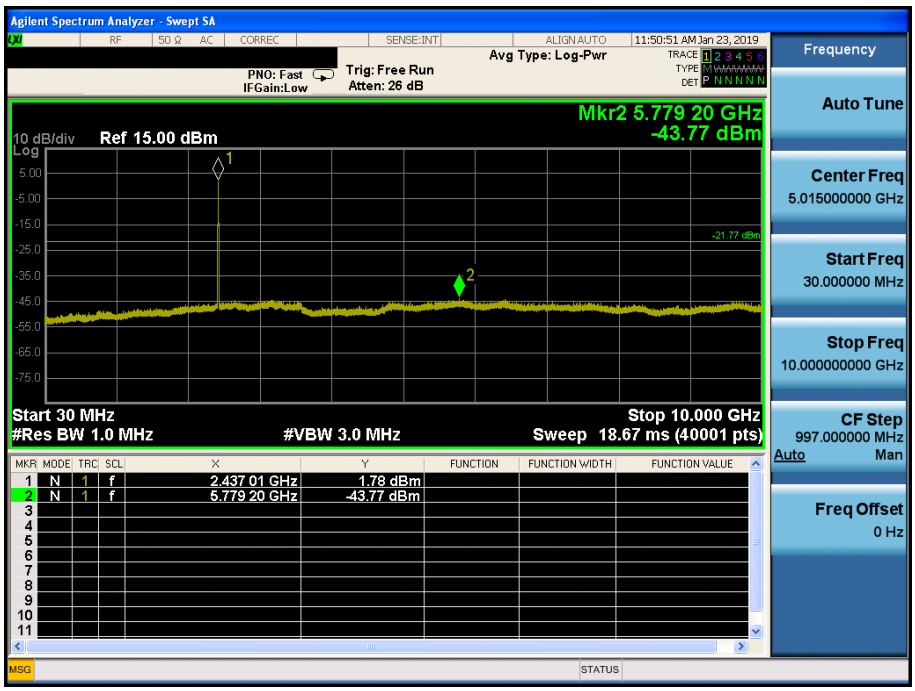
### Reference




### Conducted Spurious Emissions

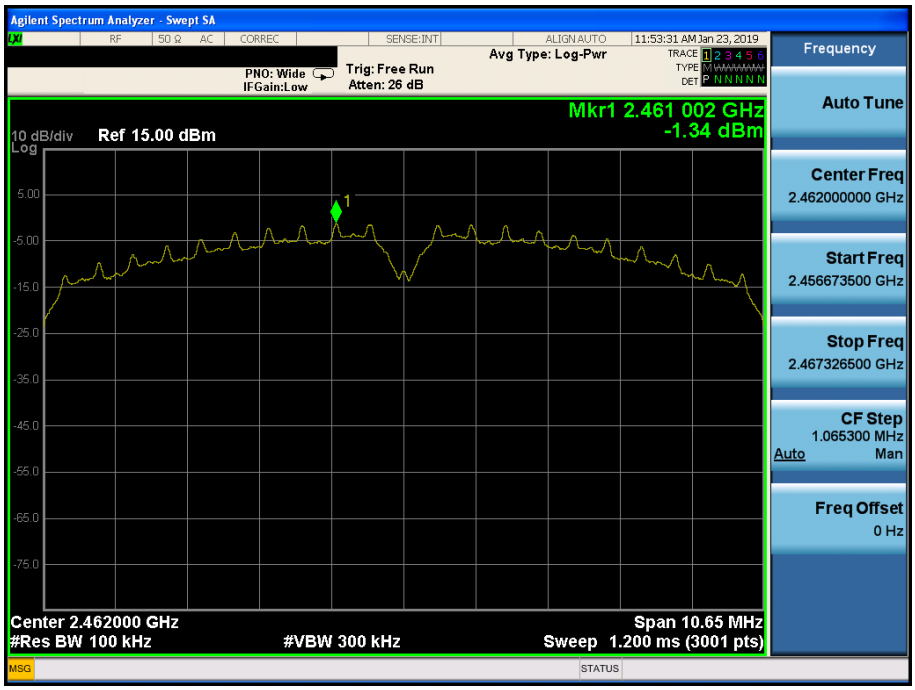


## Conducted Spurious Emissions

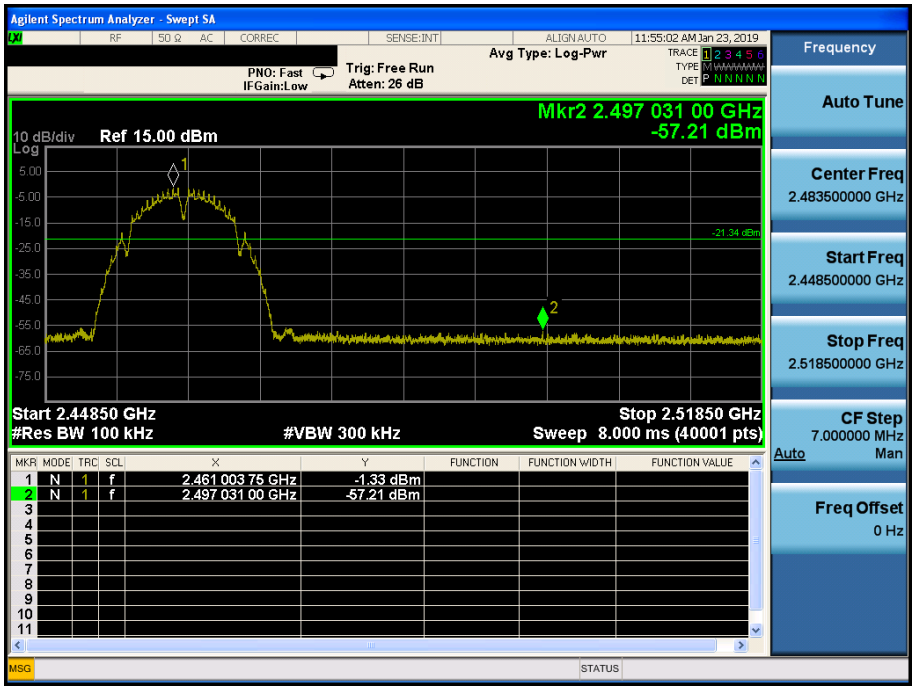



## TM 1 & Highest

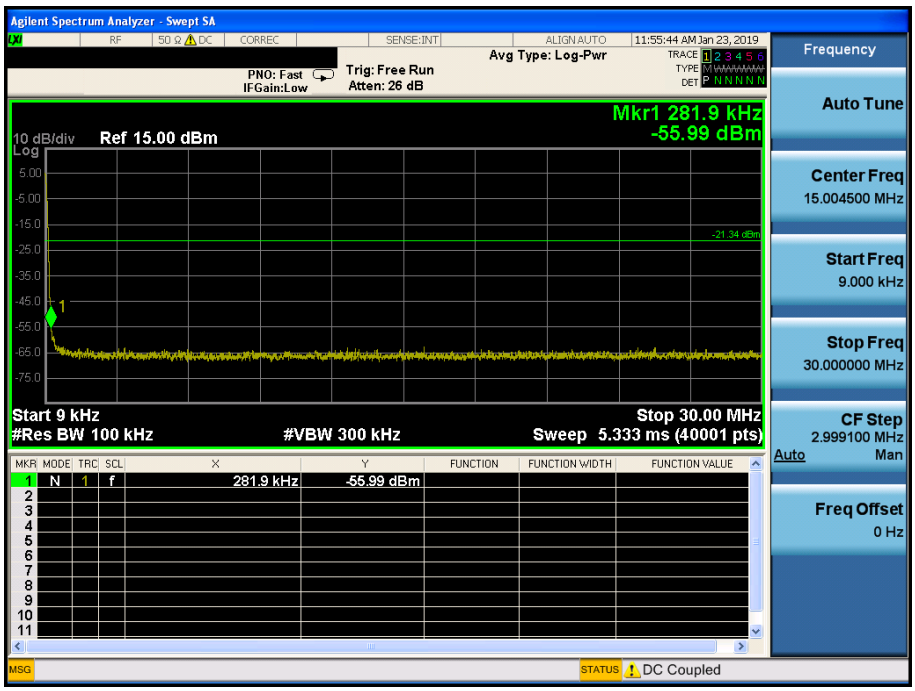
### Reference

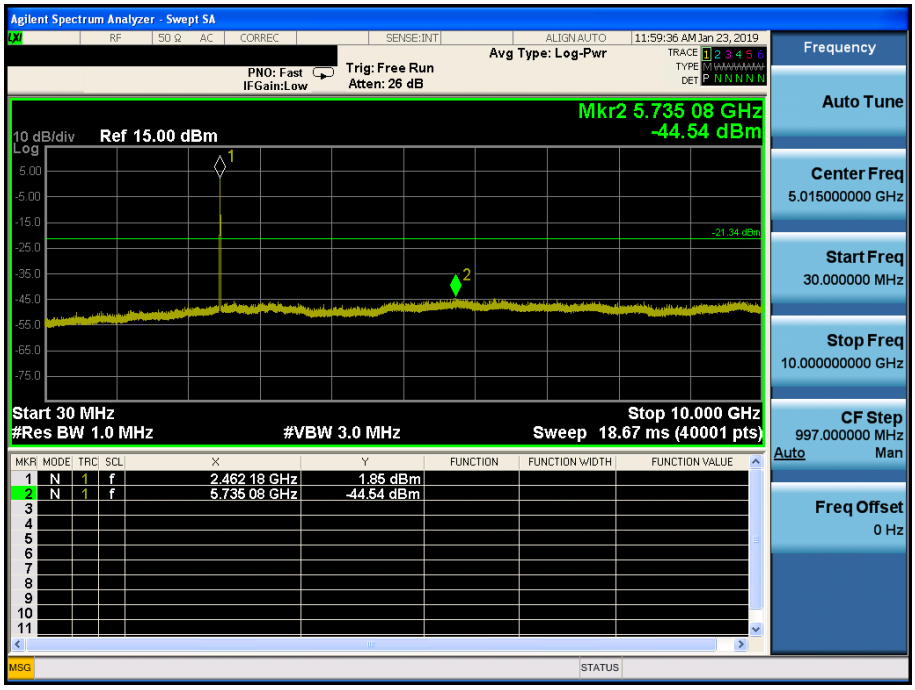



### High Band-edge

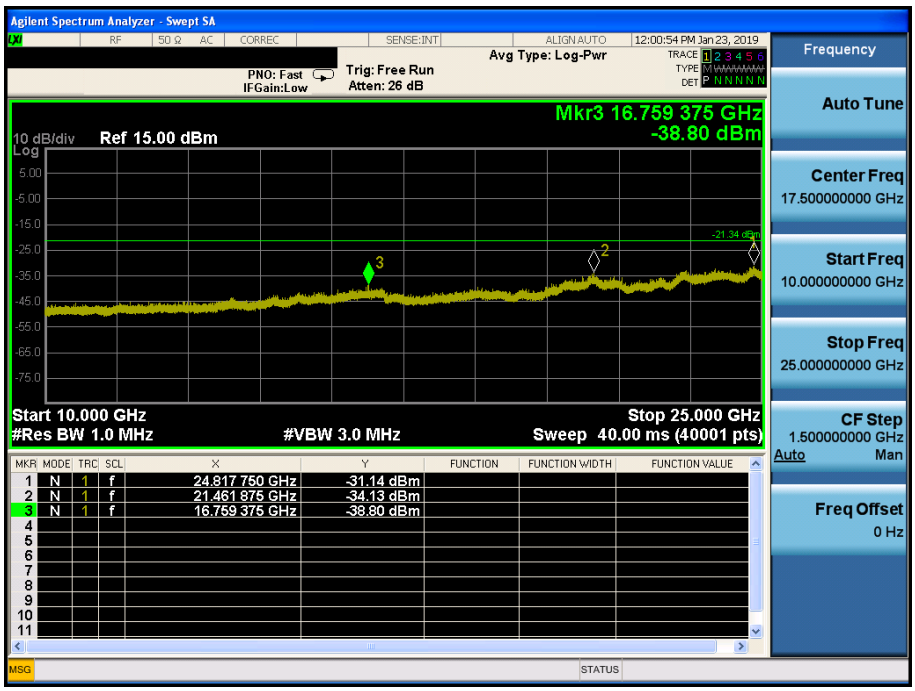


## Conducted Spurious Emissions



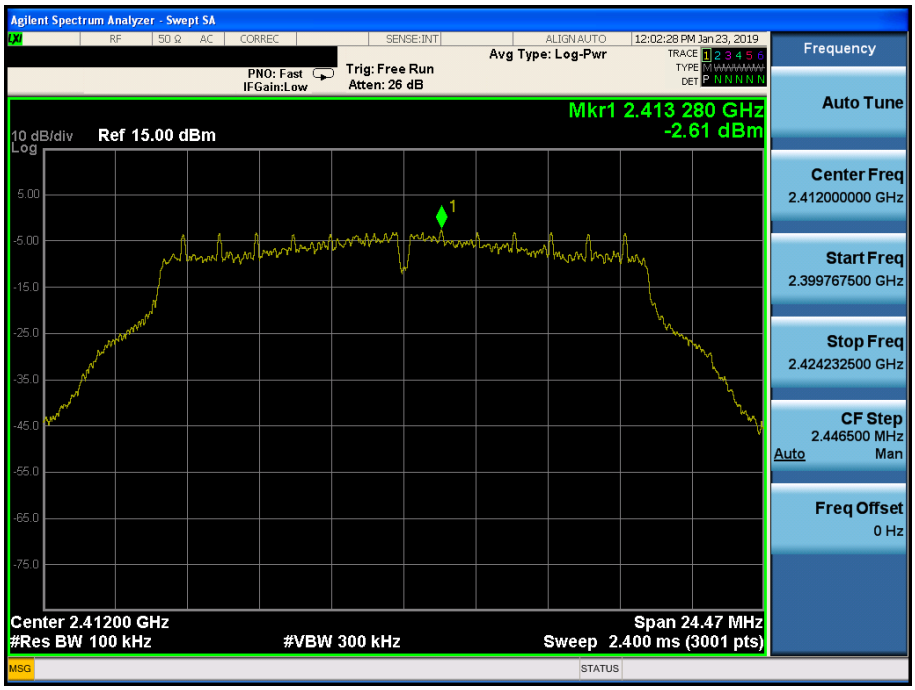



## Conducted Spurious Emissions

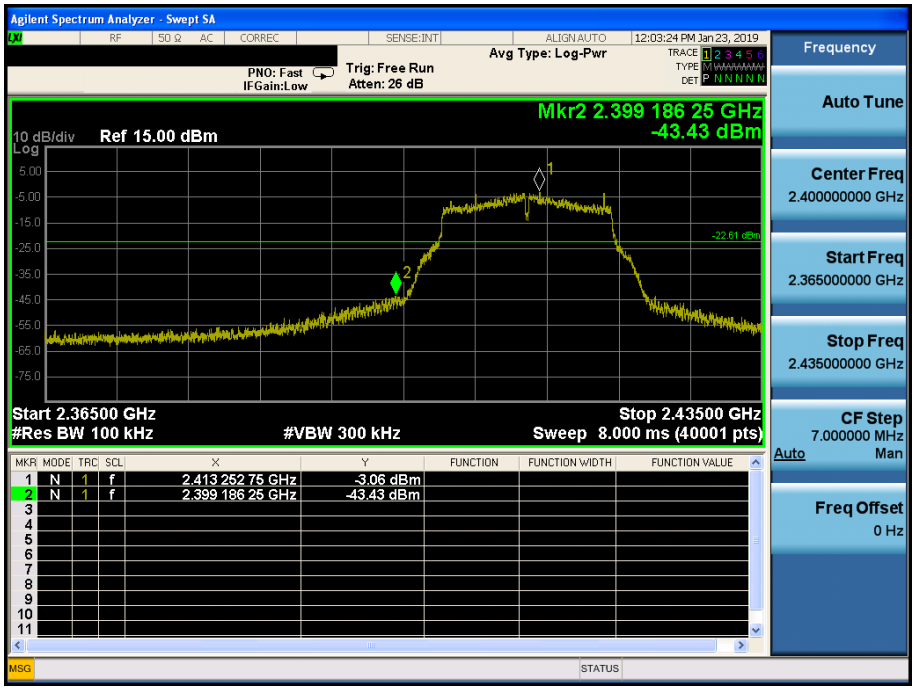


## TM 2 & Lowest

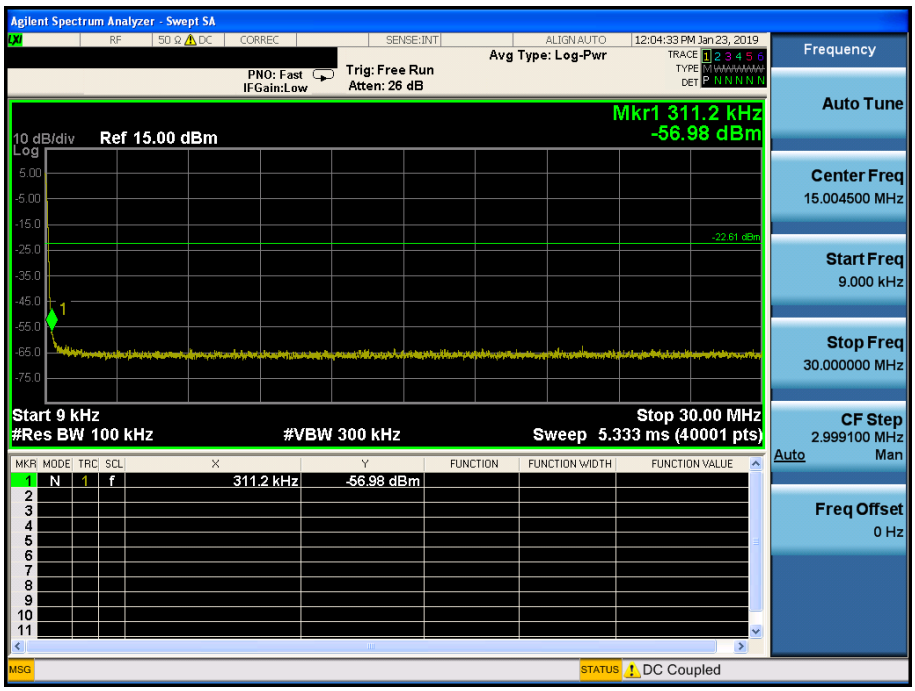
### Reference

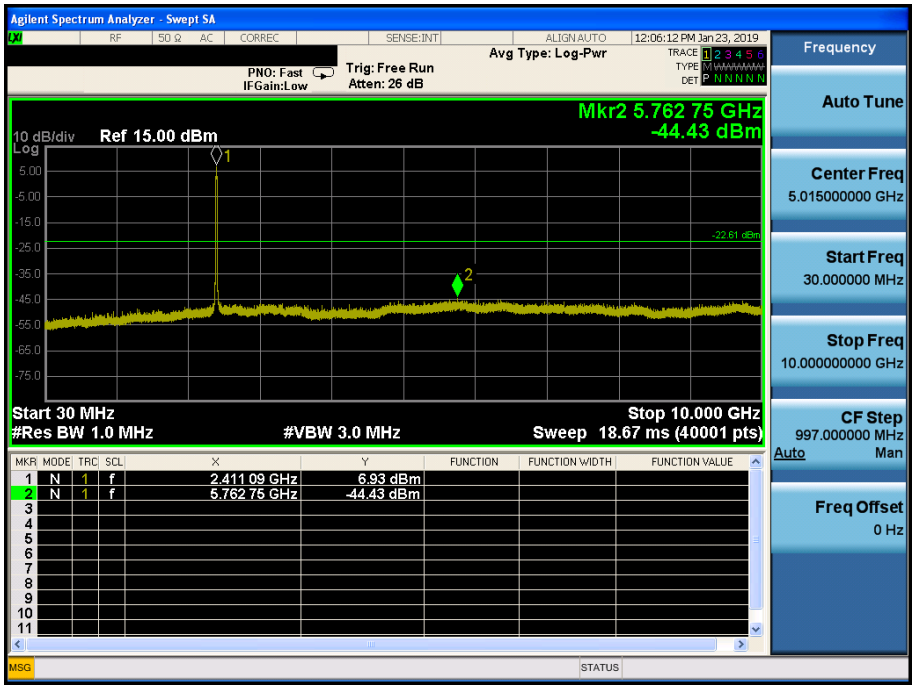



### Low Band-edge



## Conducted Spurious Emissions

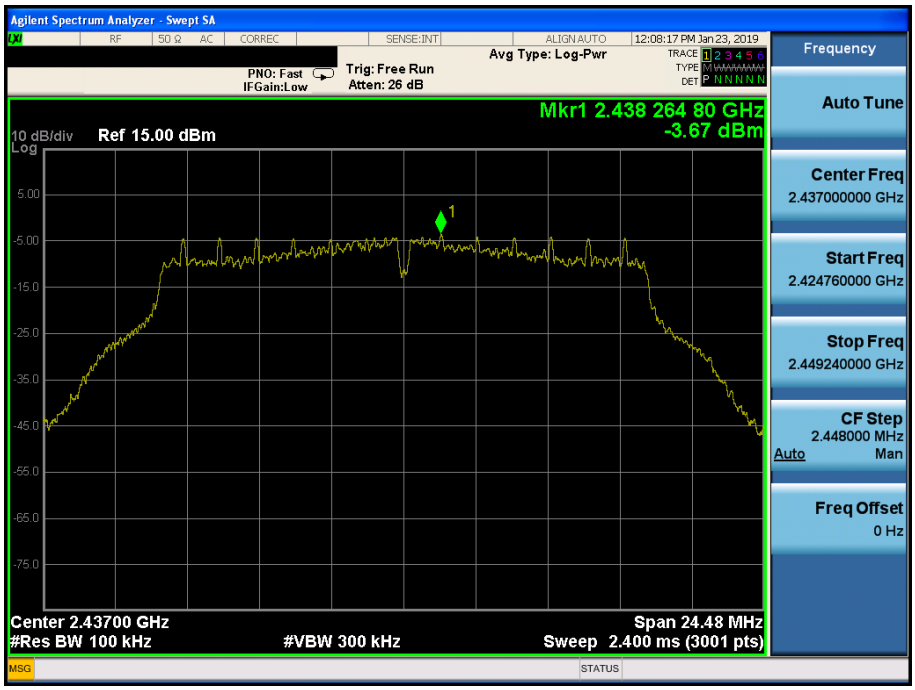


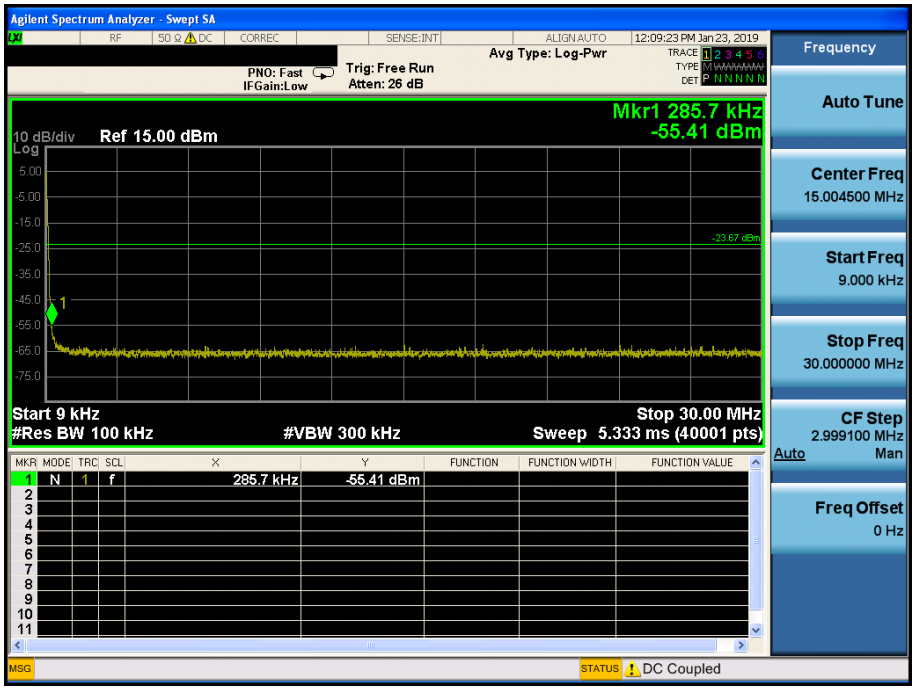
## Conducted Spurious Emissions

## TM 2 & Middle

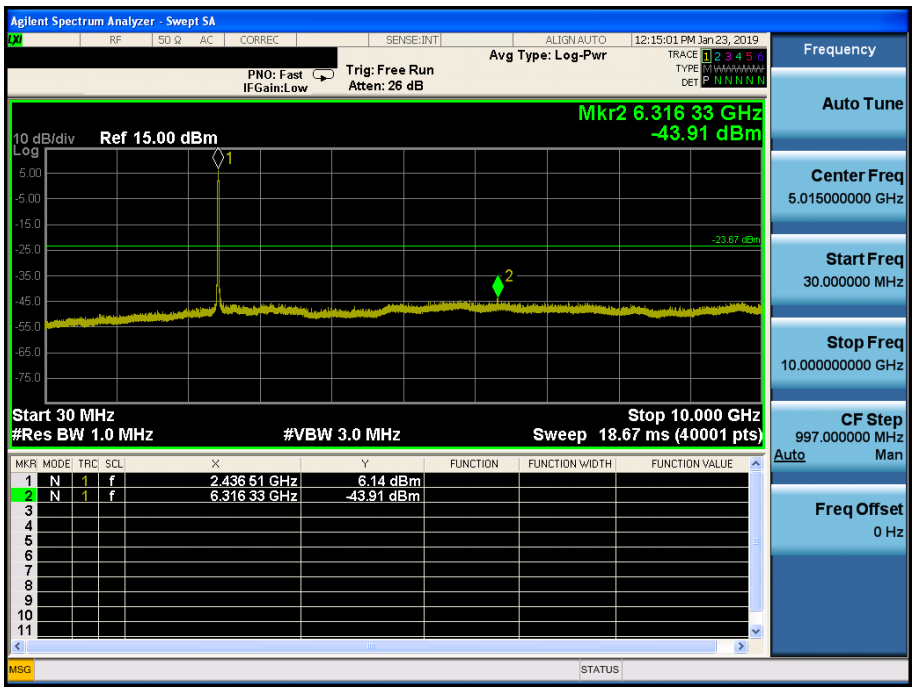
### Reference




### Conducted Spurious Emissions

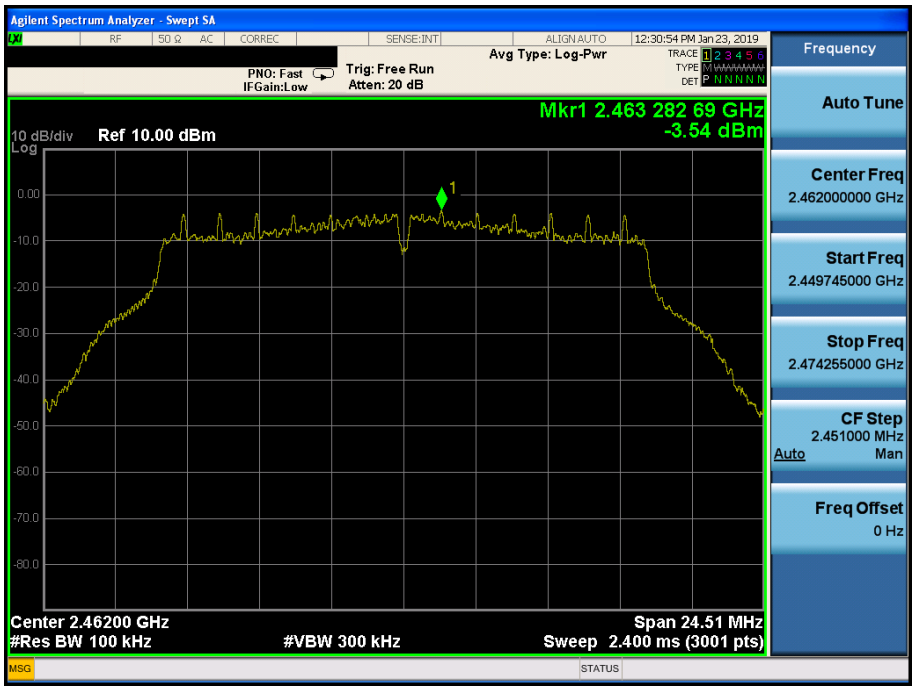


## Conducted Spurious Emissions

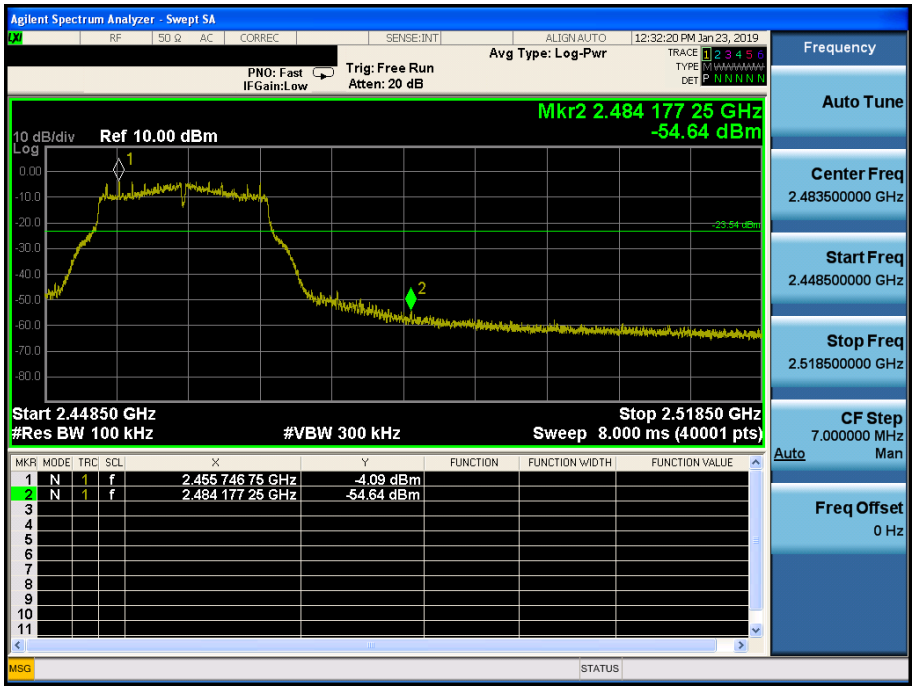



## TM 2 & Highest

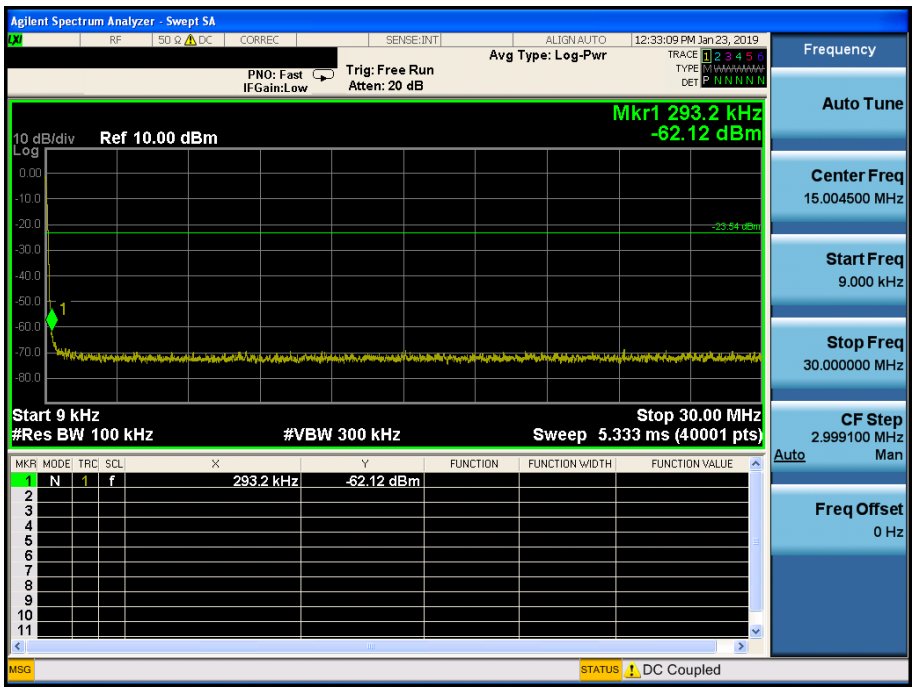
### Reference

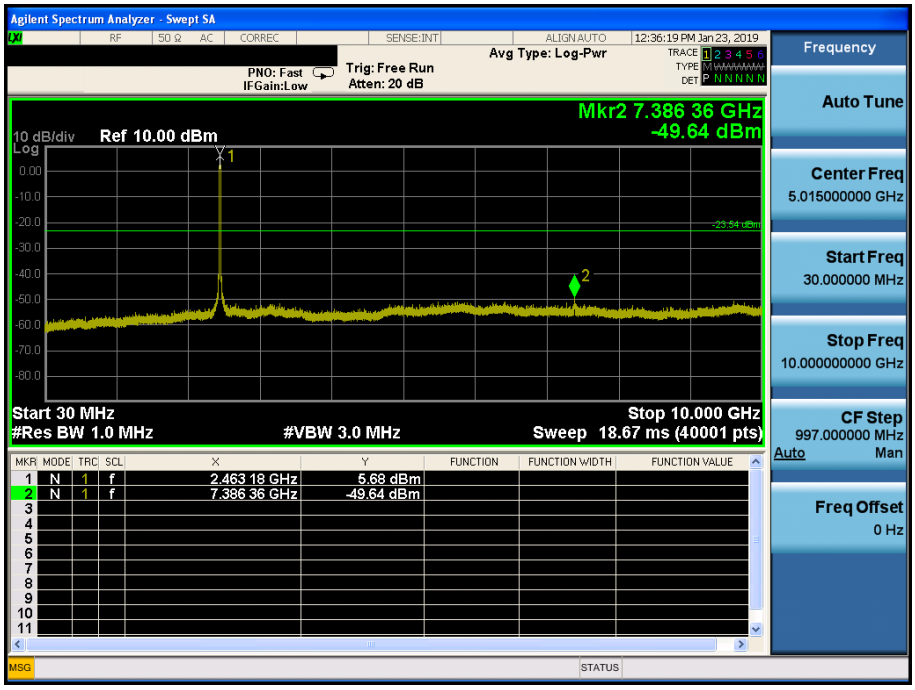



### High Band-edge



## Conducted Spurious Emissions

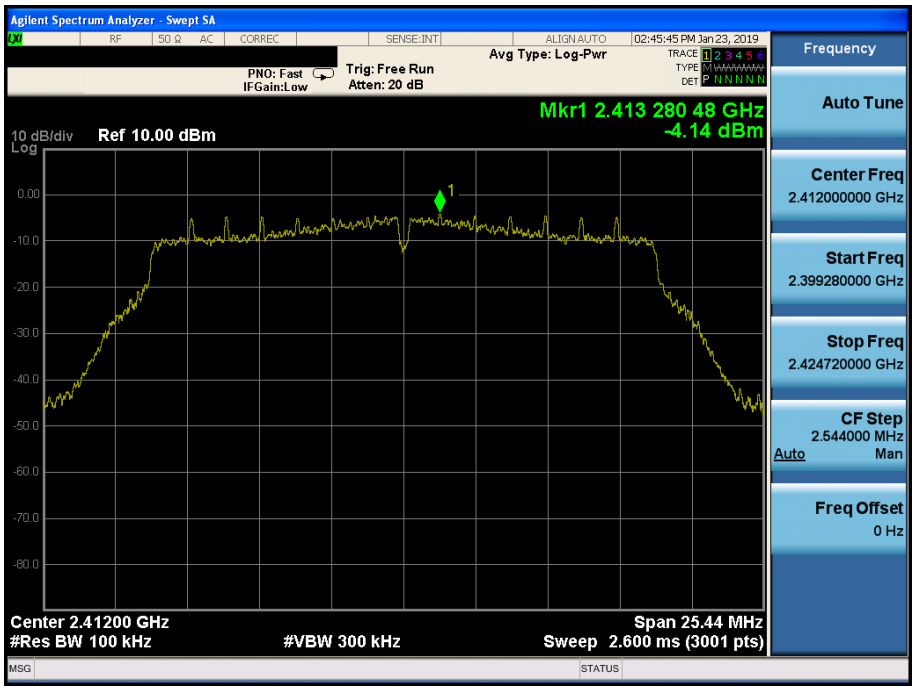


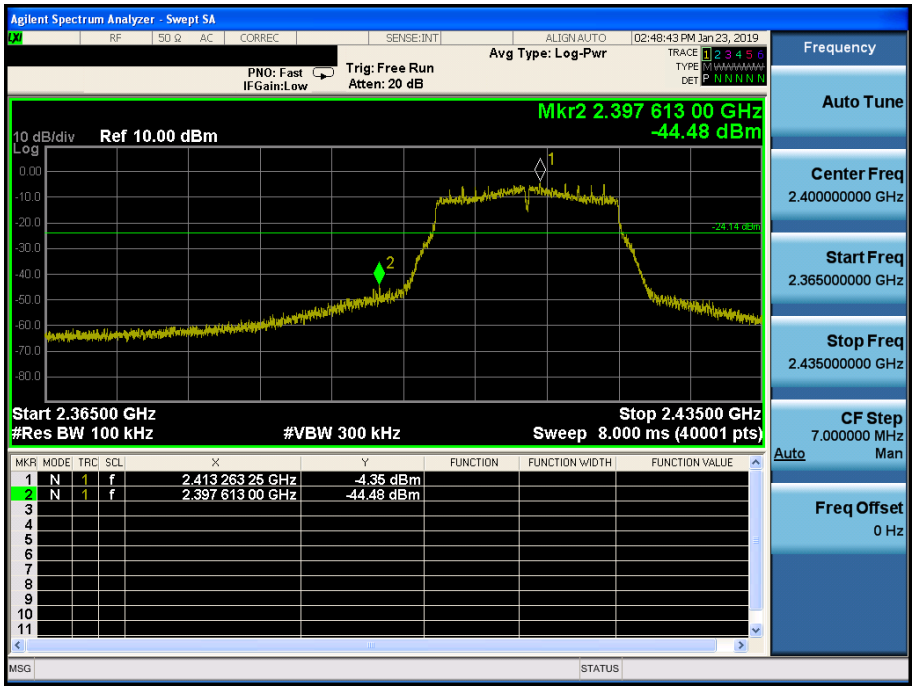
## Conducted Spurious Emissions

## TM 3 & Lowest

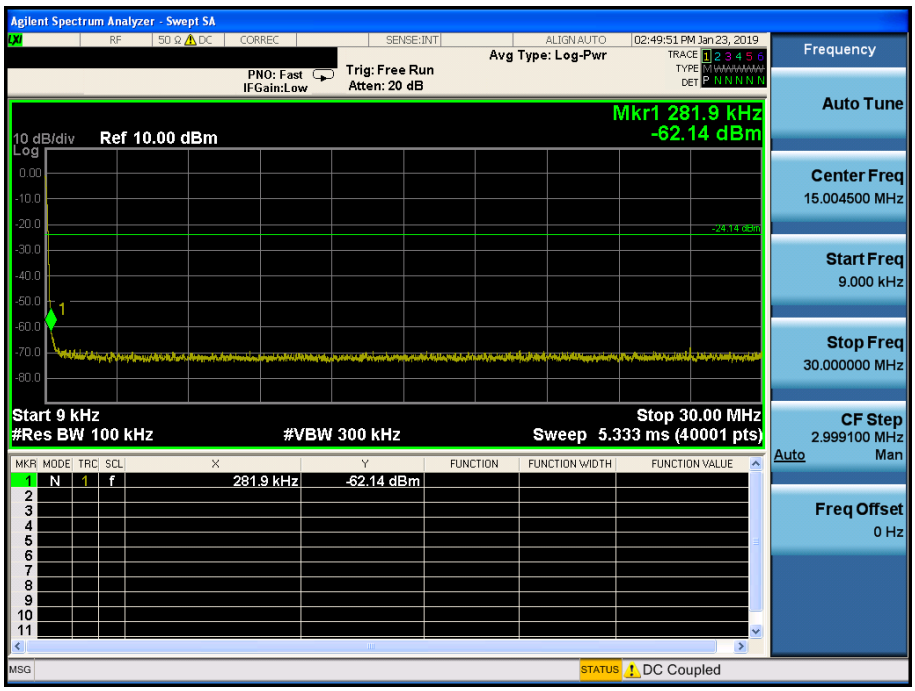
### Reference

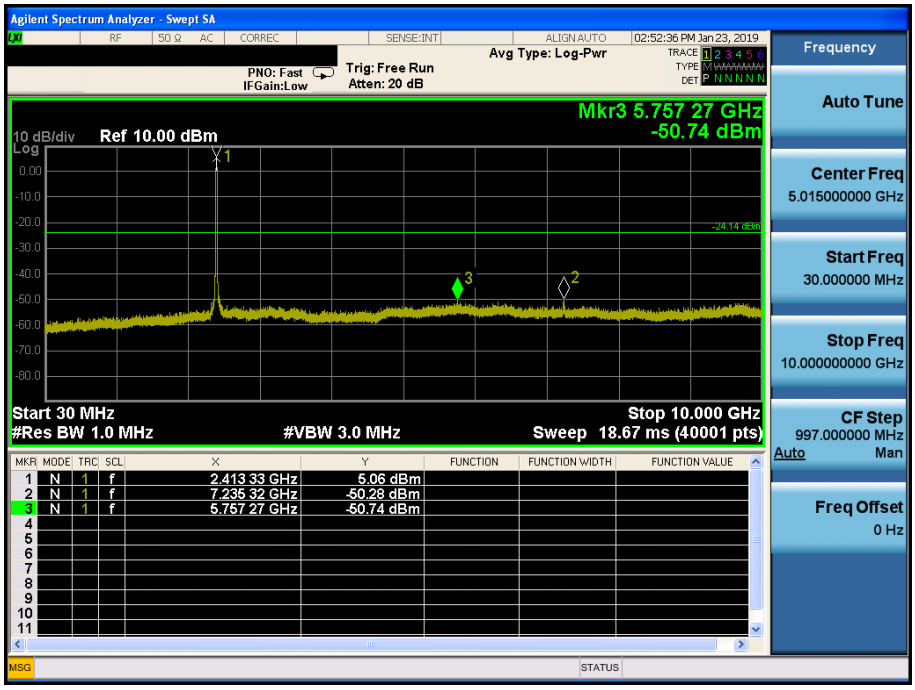



### Low Band-edge



## Conducted Spurious Emissions

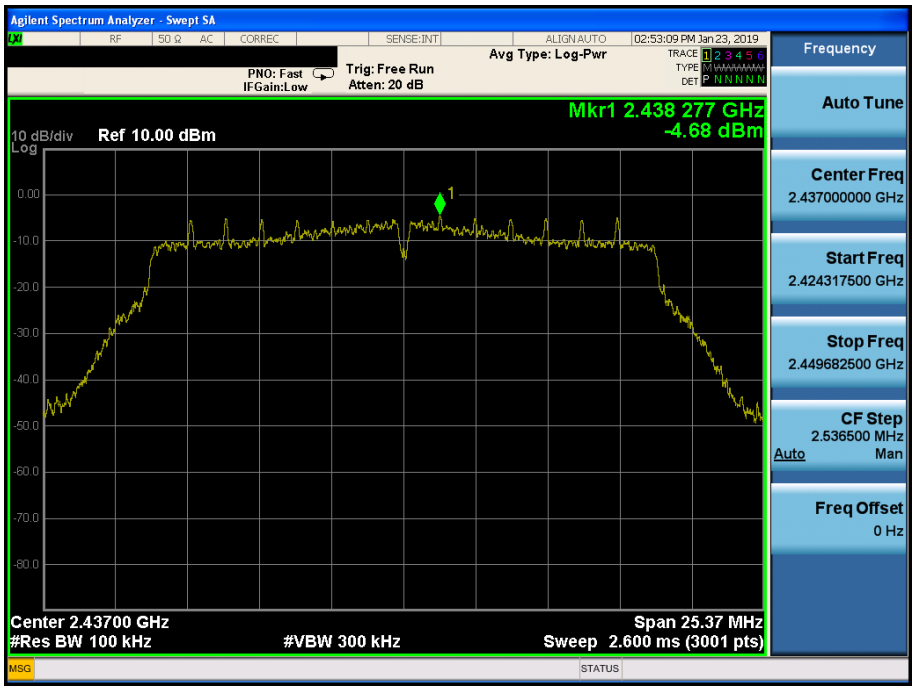


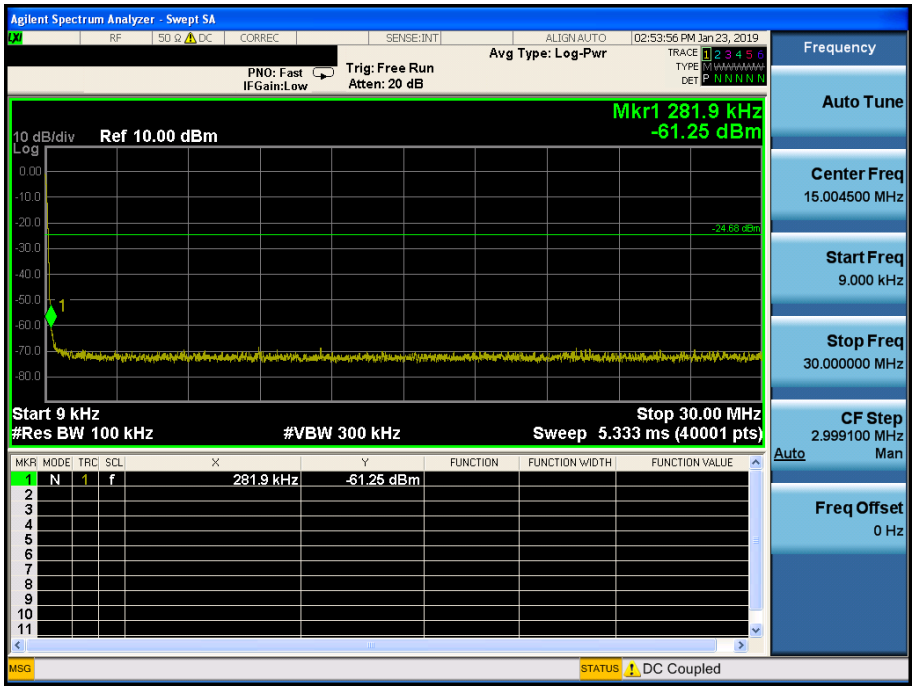
## Conducted Spurious Emissions

## TM 3 & Middle

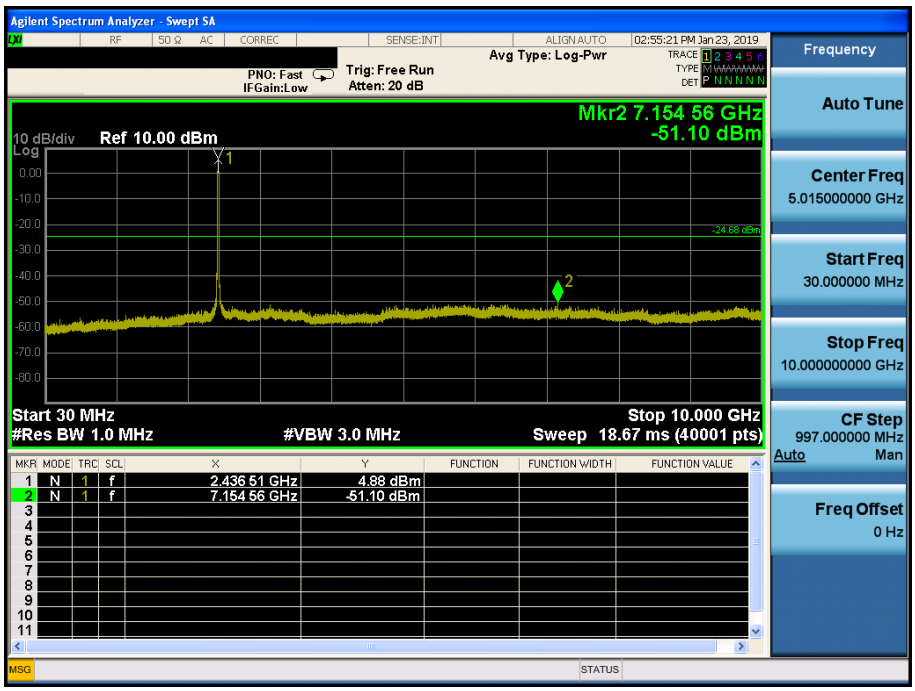
### Reference




### Conducted Spurious Emissions

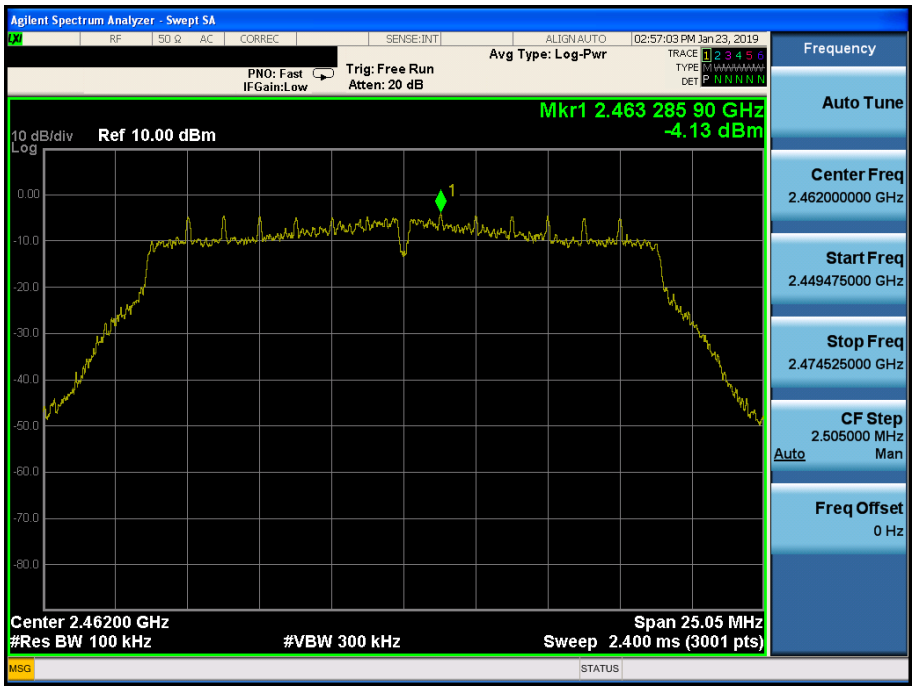


## Conducted Spurious Emissions

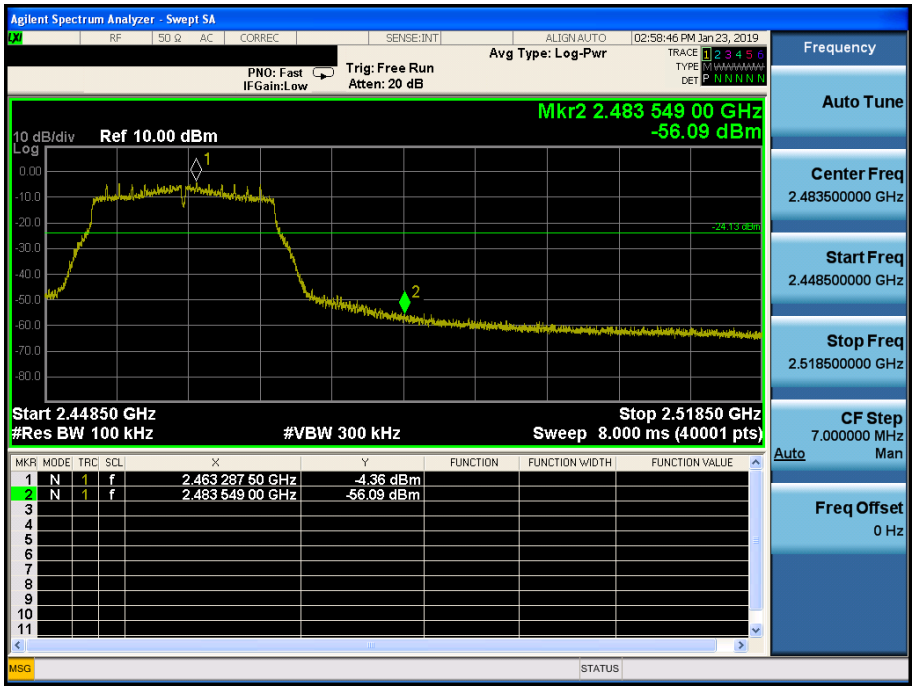



## TM 3 & Highest

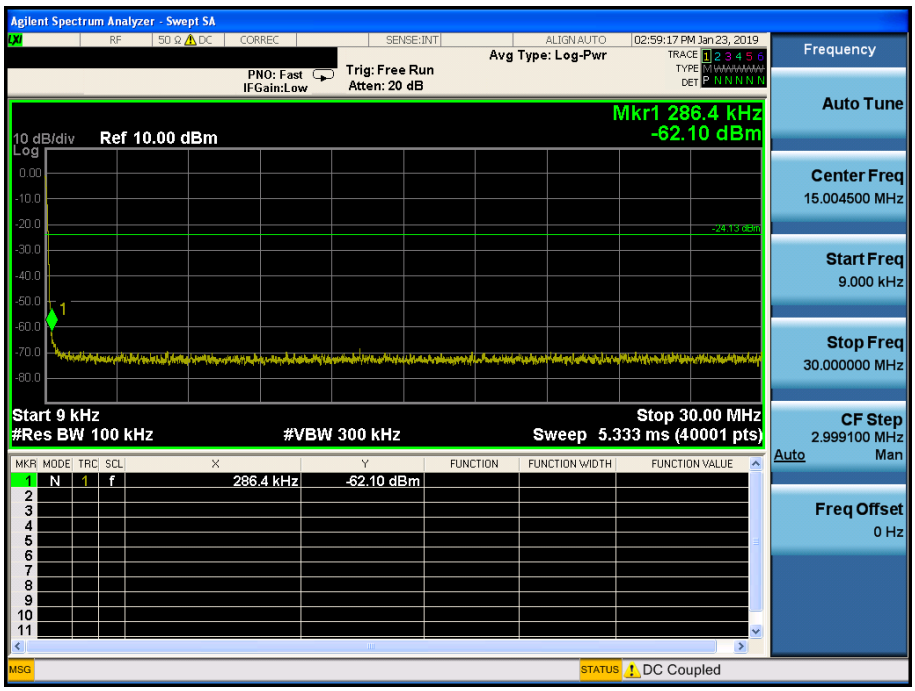
### Reference

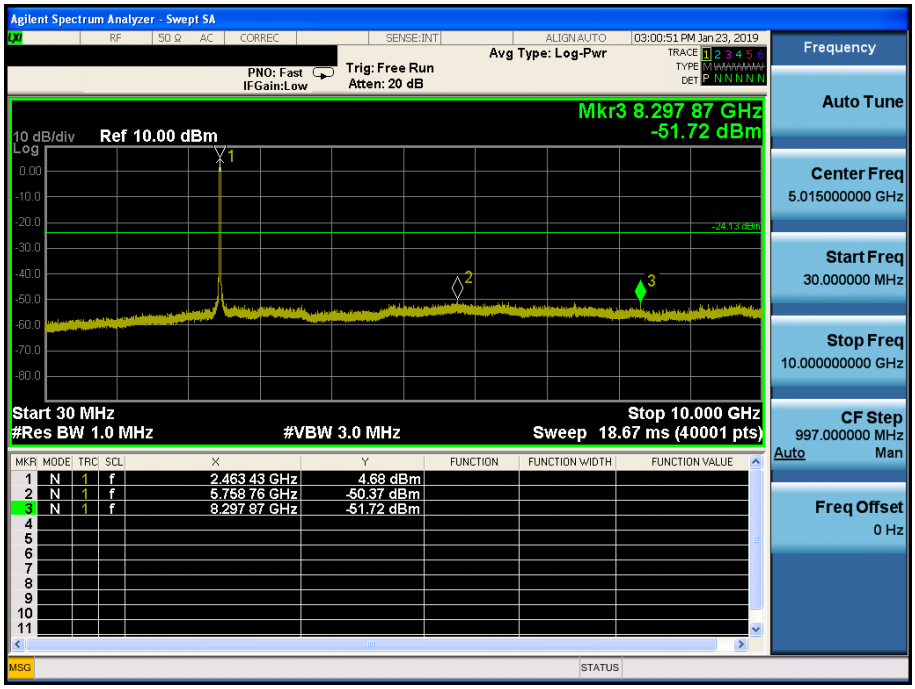



### High Band-edge



## Conducted Spurious Emissions



## Conducted Spurious Emissions

## 8.5 Radiated spurious emissions

▣ **Test Requirements and limit, §15.247(d), §15.205, §15.209**

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 20 dB below that in the 100 KHz bandwidth within the band. 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 ~ 12.52025 | 149.9 ~ 150.05 | 1645.5 ~ 1646.5 | 7.25 ~ 7.75 | 17.7 ~ 21.4 |
| 4.125 ~ 4.128 | 12.57675 ~ 12.57725 | 156.52475 ~ | 1660 ~ 1710 | 8.025 ~ 8.5 | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 13.36 ~ 13.41 | 156.52525 | 1718.8 ~ 1722.2 | 9.0 ~ 9.2 | 23.6 ~ 24.0 |
| 4.20725 ~ 4.20775 | 16.42 ~ 16.423 | 156.7 ~ 156.9 | 2200 ~ 2300 | 9.3 ~ 9.5 | 31.2 ~ 31.8 |
| 6.215 ~ 6.218 | 16.69475 ~ 16.69525 | 162.0125 ~ 167.17 | 2310 ~ 2390 | 10.6 ~ 12.7 | 36.43 ~ 36.5 |
| 6.26775 ~ 6.26825 | 16.80425 ~ 16.80475 | 167.72 ~ 173.2 | 2483.5 ~ 2500 | 13.25 ~ 13.4 | Above 38.6 |
| 6.31175 ~ 6.31225 | 25.5 ~ 25.67 | 240 ~ 285 | 2655 ~ 2900 | | |
| 8.291 ~ 8.294 | 37.5 ~ 38.25 | 322 ~ 335.4 | 3260 ~ 3267 | | |
| 8.362 ~ 8.366 | 73 ~ 74.6 | 399.90 ~ 410 | 3332 ~ 3339 | | |
| 8.37625 ~ 8.38675 | 74.8 ~ 75.2 | 608 ~ 614 | 3345.8 ~ 3358 | | |
| | | 960 ~ 1240 | 3600 ~ 4400 | | |

▪ **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.

## ▣ Test Configuration

Refer to the APPENDIX I.

## ▣ Test Procedure

1. The EUT is placed on a non-conductive table, emission measurements at below 1 GHz, the table height is 80 cm and 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.

## ▣ Measurement Instrument Setting for Radiated Emission Measurements.

The radiated emission was tested according to the section 6.3, 6.4, 6.5 and 6.6 of the ANSI C63.10-2013 with following settings.

### Peak Measurement

RBW = As specified in below table, VBW ≥ 3 x RBW, Sweep = Auto, Detector = Peak, Trace mode = Max Hold until the trace stabilizes.

| Frequency | RBW |
|---|---|
| 9-150 kHz | 200-300 Hz |
| 0.15-30 MHz | 9-10 kHz |
| 30-1000 MHz | 100-120 kHz |
| > 1000 MHz | 1 MHz |

### Average Measurement:

1. RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 3 x RBW.
3. Detector = RMS (Number of points ≥ 2 x Span / RBW)
4. Averaging type = power. (i.e., RMS)
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.
7. 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 (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

### Duty Cycle Correction factor

| Test Mode | Date rate | Duty Cycle (%) | Duty Cycle Correction Factor (dB) |
|---|---|---|---|
| TM 1 | 1Mbps | 98.90 | 0.05 |
| TM 2 | 6Mbps | 91.85 | 0.37 |
| TM 3 | MCS0 | 91.34 | 0.40 |

Note: Refer to the APPENDIX II.

## ▣ Test Results: Comply

Please refer to next page for data table and the appendix III for worst data plots.

## Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : *TM 1*

| Tested Frequency | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCCF (dB) | DCF (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lowest | 2389.64 | V | X | PK | 51.51 | 2.31 | N/A | N/A | 53.82 | 74.00 | 20.18 |
| | 2389.85 | V | X | AV | 42.13 | 2.31 | N/A | N/A | 44.44 | 54.00 | 9.56 |
| | 4824.26 | H | X | PK | 49.54 | 0.84 | N/A | N/A | 50.38 | 74.00 | 23.62 |
| | 4823.77 | H | X | AV | 39.33 | 0.84 | N/A | N/A | 40.17 | 54.00 | 13.83 |
| Middle | 4873.88 | H | X | PK | 50.13 | 0.87 | N/A | N/A | 51.00 | 74.00 | 23.00 |
| | 4874.09 | H | X | AV | 39.42 | 0.87 | N/A | N/A | 40.29 | 54.00 | 13.71 |
| Highest | 2483.77 | V | X | PK | 52.58 | 2.61 | N/A | N/A | 55.19 | 74.00 | 18.81 |
| | 2483.82 | V | X | AV | 42.23 | 2.61 | N/A | N/A | 44.84 | 54.00 | 9.16 |
| | 4924.44 | H | X | PK | 49.43 | 0.98 | N/A | N/A | 50.41 | 74.00 | 23.59 |
| | 4923.84 | H | X | AV | 39.20 | 0.98 | N/A | N/A | 40.18 | 54.00 | 13.82 |

**Note.**

1. The radiated emissions were investigated 9kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Information of Distance Factor.
   For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.
   - Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

## Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : *TM 2*

| Tested Frequency | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCCF (dB) | DCF (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lowest | 2389.21 | V | X | PK | 51.99 | 2.31 | N/A | N/A | 54.30 | 74.00 | 19.70 |
| | 2389.56 | V | X | AV | 42.60 | 2.31 | 0.37 | N/A | 45.28 | 54.00 | 8.72 |
| | 4824.50 | H | X | PK | 49.87 | 0.84 | N/A | N/A | 50.71 | 74.00 | 23.29 |
| | 4824.21 | H | X | AV | 39.53 | 0.84 | 0.37 | N/A | 40.74 | 54.00 | 13.26 |
| Middle | 4874.37 | H | X | PK | 50.13 | 0.87 | N/A | N/A | 51.00 | 74.00 | 23.00 |
| | 4874.38 | H | X | AV | 39.58 | 0.87 | 0.37 | N/A | 40.82 | 54.00 | 13.18 |
| Highest | 2483.73 | V | X | PK | 52.41 | 2.61 | N/A | N/A | 55.02 | 74.00 | 18.98 |
| | 2483.78 | V | X | AV | 42.12 | 2.61 | 0.37 | N/A | 45.10 | 54.00 | 8.90 |
| | 4924.27 | H | X | PK | 49.45 | 0.98 | N/A | N/A | 50.43 | 74.00 | 23.57 |
| | 4923.80 | H | X | AV | 39.39 | 0.98 | 0.37 | N/A | 40.74 | 54.00 | 13.26 |

**Note.**

1. The radiated emissions were investigated 9kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Information of Distance Factor.
   For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.
   - Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

## Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : *TM 3*

| Tested Frequency | Frequency (MHz) | ANT Pol | EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | DCCF (dB) | DCF (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lowest | 2389.49 | V | X | PK | 52.23 | 2.31 | N/A | N/A | 54.54 | 74.00 | 19.46 |
| | 2389.40 | V | X | AV | 42.37 | 2.31 | 0.40 | N/A | 45.08 | 54.00 | 8.92 |
| | 4824.35 | H | X | PK | 49.97 | 0.84 | N/A | N/A | 50.81 | 74.00 | 23.19 |
| | 4823.51 | H | X | AV | 39.42 | 0.84 | 0.40 | N/A | 40.66 | 54.00 | 13.34 |
| Middle | 4873.87 | H | X | PK | 49.86 | 0.87 | N/A | N/A | 50.73 | 74.00 | 23.27 |
| | 4874.31 | H | X | AV | 39.66 | 0.87 | 0.40 | N/A | 40.93 | 54.00 | 13.07 |
| Highest | 2483.94 | V | X | PK | 52.51 | 2.61 | N/A | N/A | 55.12 | 74.00 | 18.88 |
| | 2483.93 | V | X | AV | 42.15 | 2.61 | 0.40 | N/A | 45.16 | 54.00 | 8.84 |
| | 4923.54 | H | X | PK | 49.91 | 0.98 | N/A | N/A | 50.89 | 74.00 | 23.11 |
| | 4924.00 | H | X | AV | 39.34 | 0.98 | 0.40 | N/A | 40.72 | 54.00 | 13.28 |

**Note.**

1. The radiated emissions were investigated 9kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Information of Distance Factor.
   For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.
   - Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

## 8.6 Power-line conducted emissions

### ▣ Test Requirements and limit, §15.207

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

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.

### ▣ Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to the test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

### ▣ Test Results: NA

# 9. LIST OF TEST EQUIPMENT

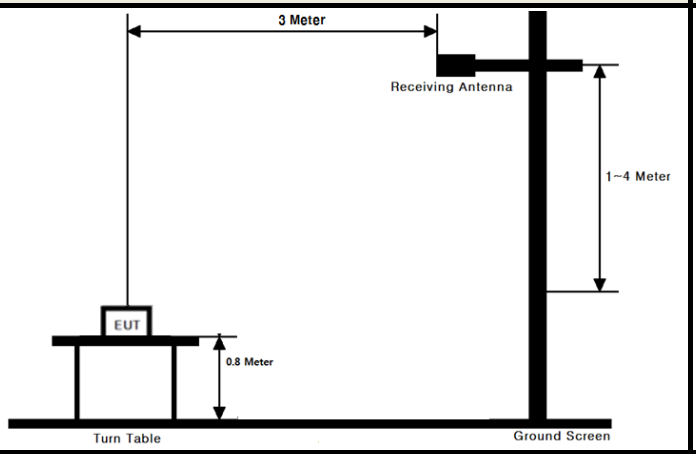
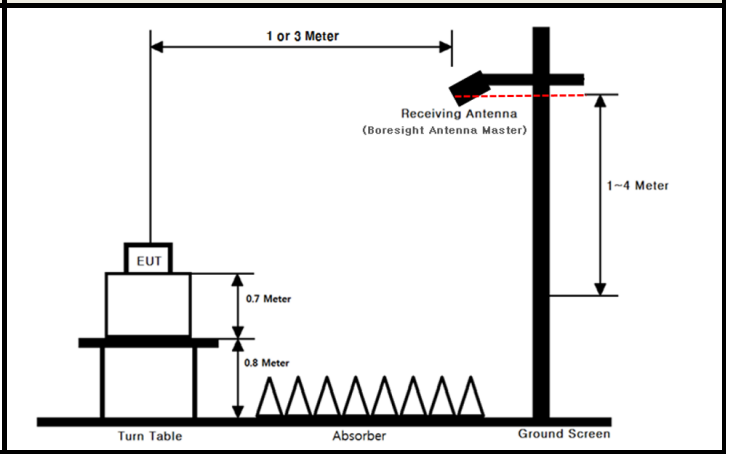
| Type | Manufacturer | Model | Cal.Date (yy/mm/dd) | Next.Cal.Date (yy/mm/dd) | S/N |
|---|---|---|---|---|---|
| Spectrum Analyzer | Agilent Technologies | N9020A | 18/07/06 | 19/07/06 | US47360812 |
| Spectrum Analyzer | Agilent Technologies | N9020A | 18/01/03 | 19/01/03 | MY48011700 |
| | | | 18/12/19 | 19/12/19 | |
| Attenuator | SMAJK | SMAJK-2-3 | 18/07/04 | 19/07/04 | 4 |
| DC Power Supply | Agilent Technologies | 66332A | 18/07/02 | 19/07/02 | US37473422 |
| DC Power Supply | SMtechno | SDP30-5D | 18/07/03 | 19/07/03 | 305DNF079 |
| Multimeter | FLUKE | 17B | 17/12/26 | 18/12/26 | 26030065WS |
| | | | 18/12/18 | 19/12/18 | |
| Signal Generator | Rohde Schwarz | SMBV100A | 17/12/27 | 18/12/27 | 255571 |
| | | | 18/12/19 | 19/12/19 | |
| Signal Generator | ANRITSU | MG3695C | 18/12/10 | 19/12/10 | 173501 |
| Thermohygrometer | BODYCOM | BJ5478 | 18/01/03 | 19/01/03 | 120612-1 |
| | | | 18/12/27 | 19/12/27 | |
| Thermohygrometer | BODYCOM | BJ5478 | 18/01/03 | 19/01/03 | 120612-2 |
| | | | 18/12/27 | 19/12/27 | |
| Thermohygrometer | BODYCOM | BJ5478 | 18/07/09 | 19/07/09 | N/A |
| HYGROMETER | TESTO | 608-H1 | 18/02/10 | 19/02/10 | 34862883 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 18/01/30 | 20/01/30 | 1513-128 |
| BILOG ANTENNA | Schwarzbeck | VULB 9160 | 18/07/13 | 20/07/13 | 3359 |
| Horn Antenna | ETS-Lindgren | 3115 | 18/01/30 | 20/01/30 | 6419 |
| Horn Antenna | Schwarzbeck | BBHA 9120C | 17/12/04 | 19/12/04 | 9120C-561 |
| Horn Antenna | A.H.Systems Inc. | SAS-574 | 17/07/31 | 19/07/31 | 155 |
| PreAmplifier | tsj | MLA-0118-J01-45 | 18/02/08 | 19/02/08 | 17138 |
| PreAmplifier | tsj | MLA-1840-J02-45 | 18/07/06 | 19/07/06 | 16966-10728 |
| PreAmplifier | H.P | 8447D | 17/12/26 | 18/12/26 | 2944A07774 |
| | | | 18/12/18 | 19/12/18 | |
| Attenuator | SMAJK | SMAJK-2-3 | 18/07/02 | 19/07/02 | 3 |
| Attenuator | Aeroflex/Weinschel | 56-3 | 18/07/02 | 19/07/02 | Y2370 |
| Attenuator | SRTechnology | F01-B0606-01 | 18/07/02 | 19/07/02 | 13092403 |
| Attenuator | Hefei Shunze | SS5T2.92-10-40 | 18/07/03 | 19/07/03 | 16012202 |
| High Pass Filter | Wainwright Instruments | WHNX8.0/26.5-6SS | 18/07/03 | 19/07/03 | 3 |
| High Pass Filter | Wainwright Instruments | WHKX12-935-1000-15000-40SS | 18/07/02 | 19/07/02 | 8 |
| High Pass Filter | Wainwright Instruments | WHKX10-2838-3300-18000-60SS | 18/07/02 | 19/07/02 | 1 |
| Power Meter & Wide Bandwidth Sensor | Anritsu | ML2495A MA2490A | 18/04/17 | 19/04/17 | 1306007 1249001 |
| EMI Test Receiver | Rohde Schwarz | ESR7 | 18/02/13 | 19/02/13 | 101061 |
| Cable | Radiall | TESTPRO3 | 18/07/06 | 19/07/06 | M-01 |
| Cable | Junkosha | MWX315 | 18/11/19 | 19/11/19 | M-05 |
| Cable | Junkosha | MWX221 | 18/11/19 | 19/11/19 | M-06 |
| Cable | Junkosha | MWX241 | 18/06/25 | 19/06/25 | G-04 |
| Cable | Junkosha | MWX241 | 18/06/25 | 19/06/25 | G-07 |
| Cable | DT&C | Cable | 18/07/06 | 19/07/06 | G-13 |
| Cable | DT&C | Cable | 18/07/06 | 19/07/06 | G-14 |
| Cable | HUBER+SUHNER | SUCOFLEX 104 | 18/07/06 | 19/07/06 | G-15 |
| Cable | DT&C | Cable | 18/06/25 | 19/06/25 | RF-18 |

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.
Note2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

# APPENDIX I

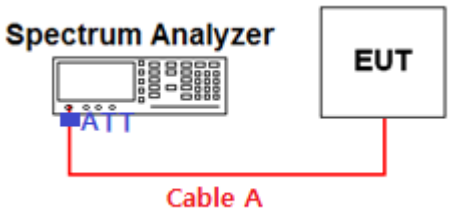
## Test set up diagrams

- **Radiated Measurement**

| Below 1GHz | Above 1GHz |
|---|---|
|  |  |



- **Conducted Measurement**




**Path loss information**

| Frequency (GHz) | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|---|---|---|---|
| 0.03 | 3.83 | 15 | 4.17 |
| 1 | 3.90 | 20 | 4.97 |
| 2.412 & 2.437 & 2.462 | 3.94 | 25 | 5.86 |
| 5 | 4.60 | - | - |
| 10 | 4.67 | - | - |

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

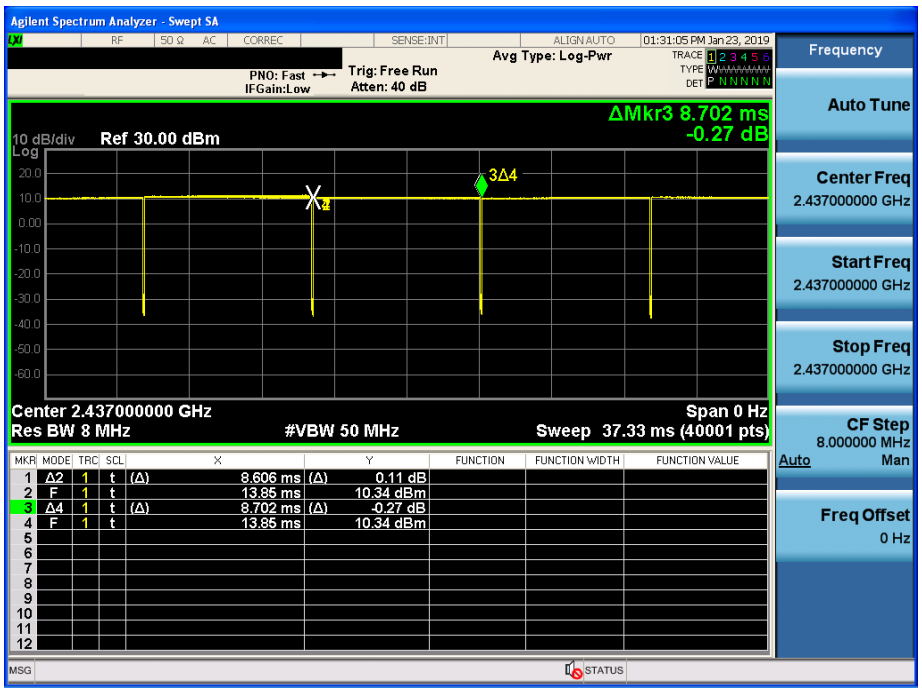
### ▪ Test Procedure

**Duty Cycle** was measured using **section 6.0 b) of KDB558074 D01V05 :**

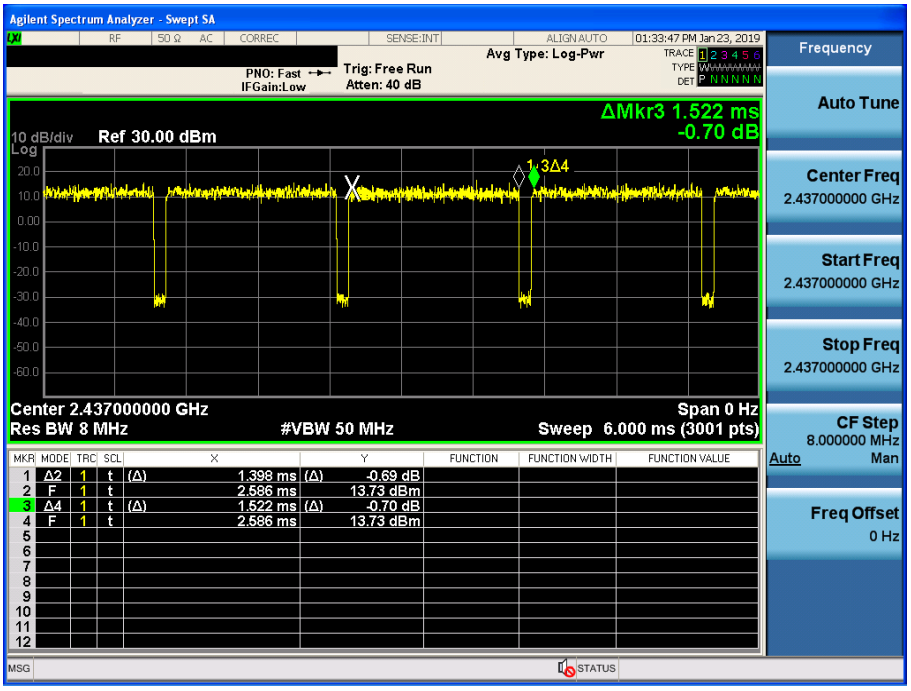
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ 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 ≤ 16.7 microseconds.)

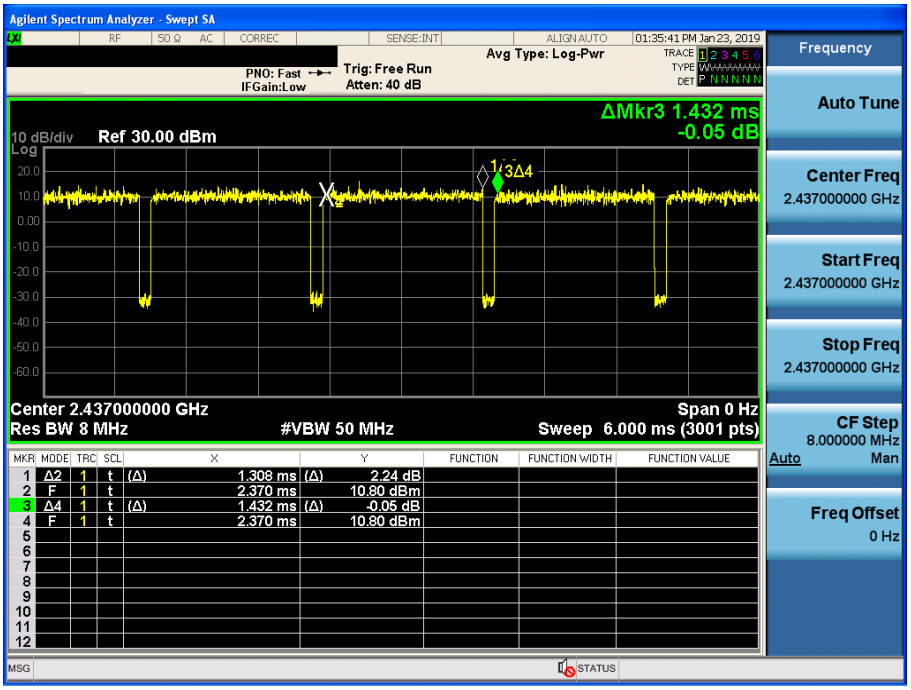
**Duty Cycle** TM 1 & Middle



**Duty Cycle** TM 2 & Middle



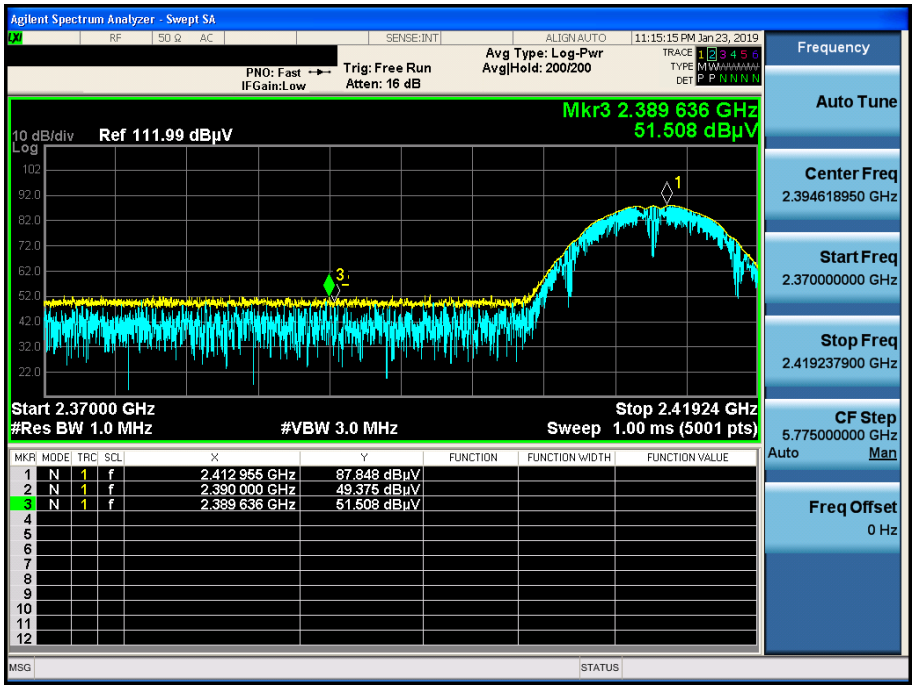

**Duty Cycle** TM 3 & Middle



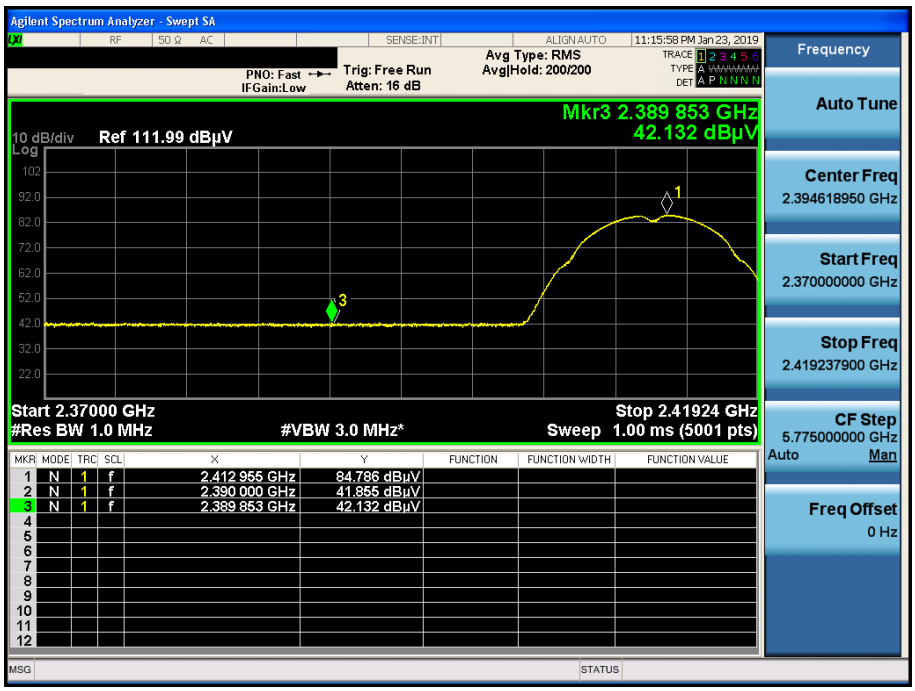
# APPENDIX III

## Unwanted Emissions (Radiated) Test Plot

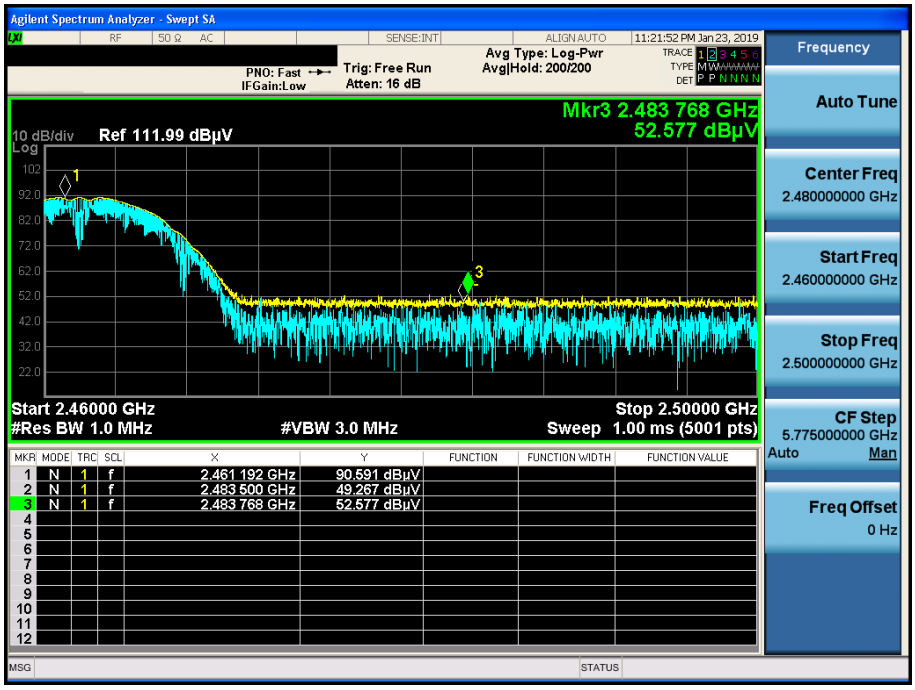
**TM 1 & Lowest & X axis & Ver** **Detector Mode : PK**



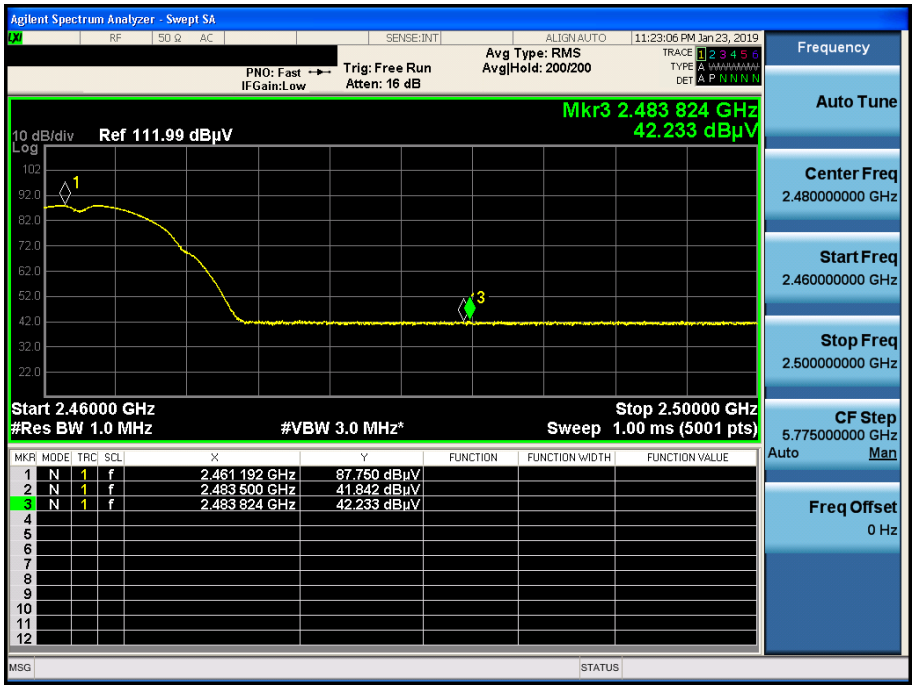

**TM 1 & Lowest & X axis & Ver** **Detector Mode : AV**



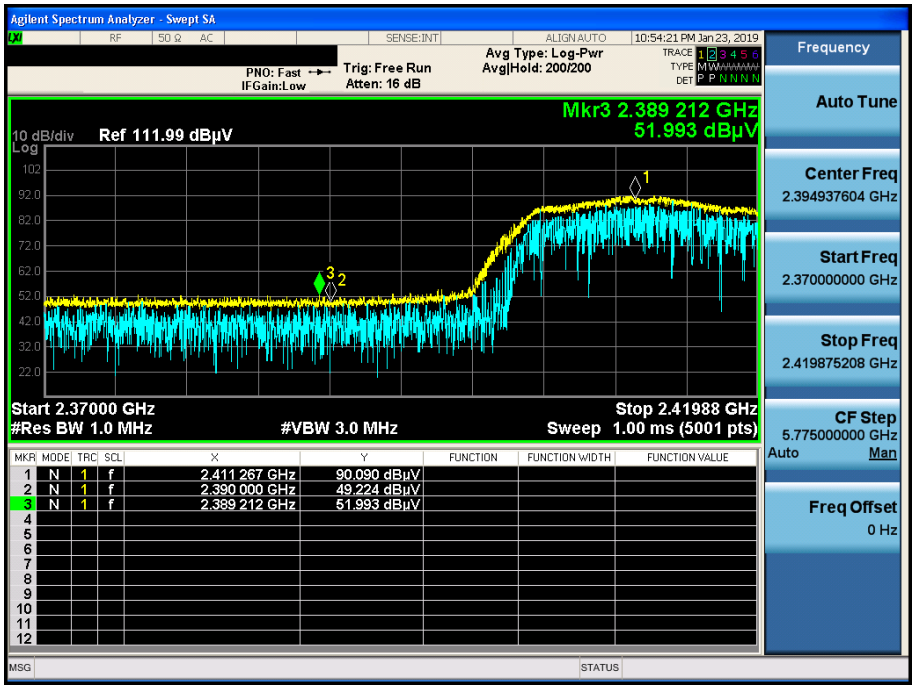
**TM 1 & Highest & X axis & Ver** **Detector Mode : PK**



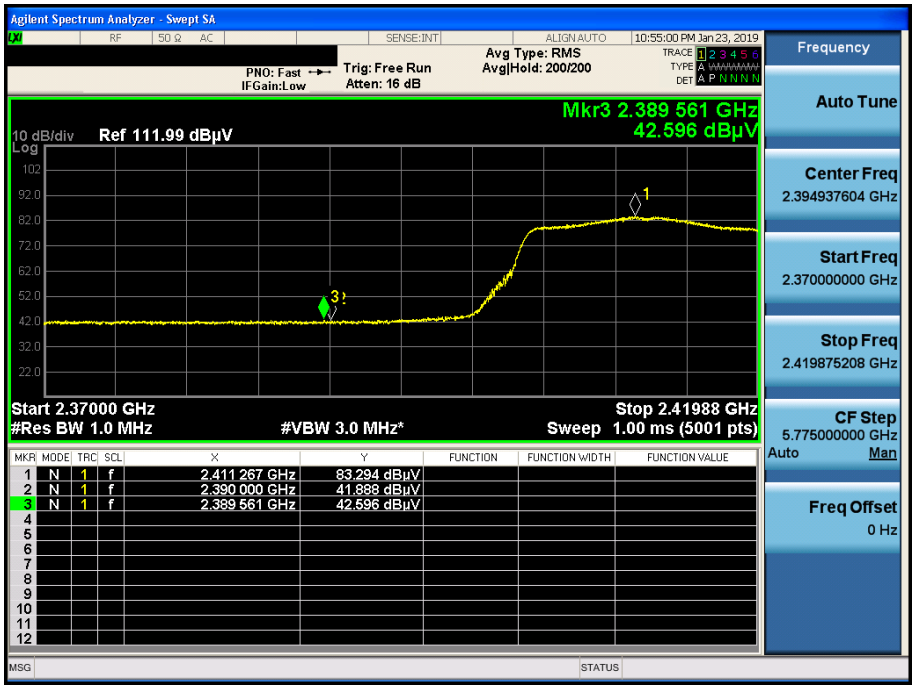

**TM 1 & Highest & X axis & Ver** **Detector Mode : AV**



**TM 2 & Lowest & X axis & Ver** **Detector Mode : PK**

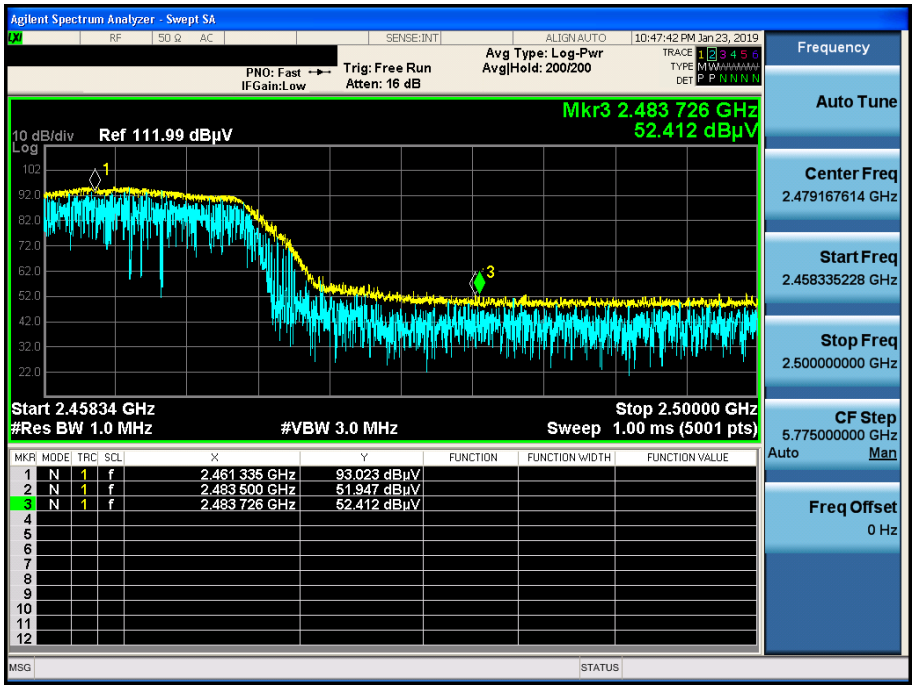



**TM 2 & Lowest & X axis & Ver** **Detector Mode : AV**

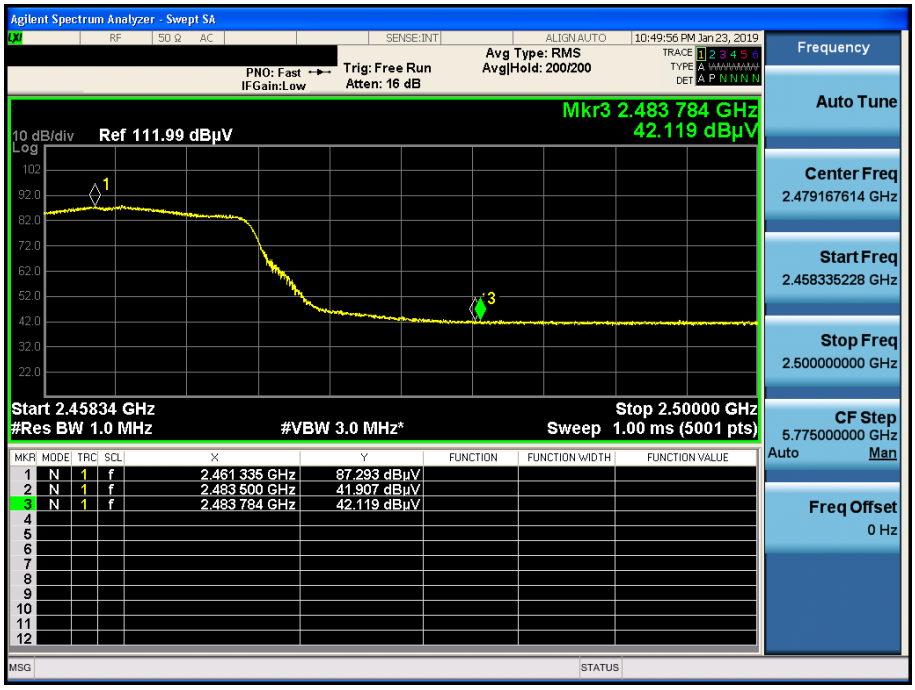


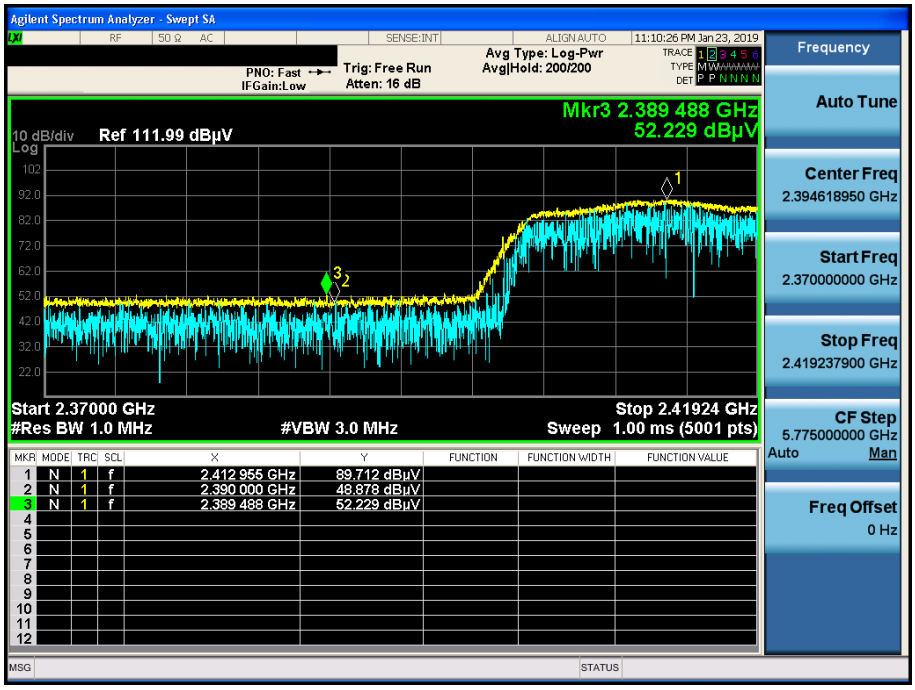
**TM 2 & Highest & X axis & Ver** **Detector Mode : PK**



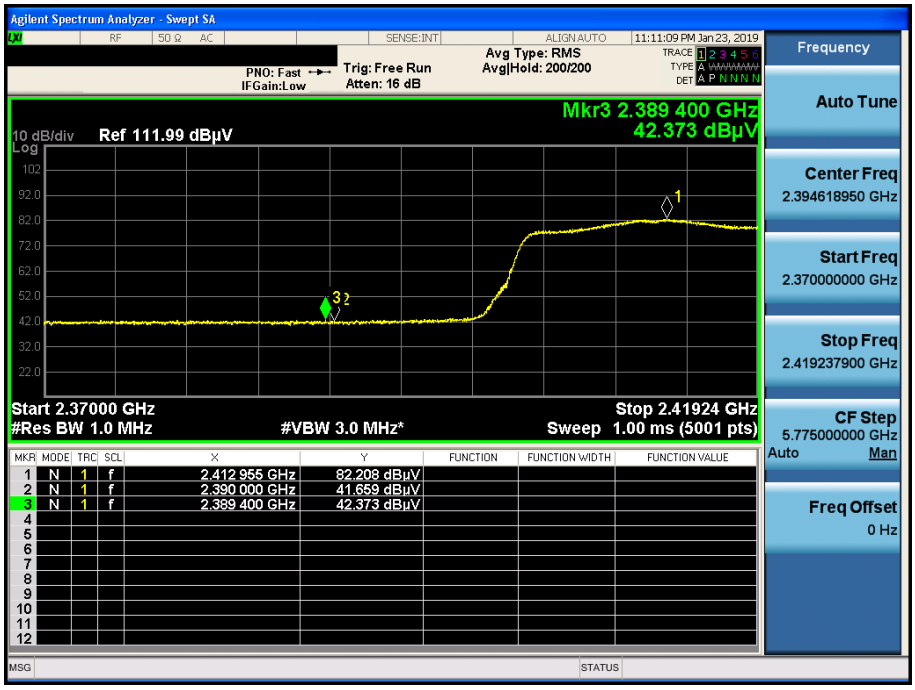

**TM 2 & Highest & X axis & Ver** **Detector Mode : AV**



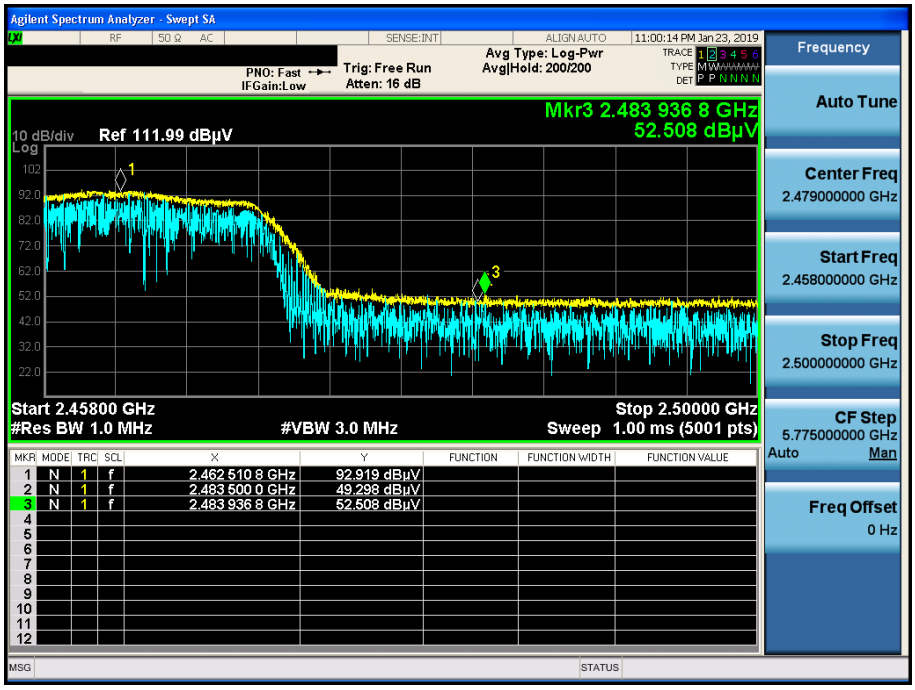
**TM 3 & Lowest & X axis & Ver** **Detector Mode : PK**



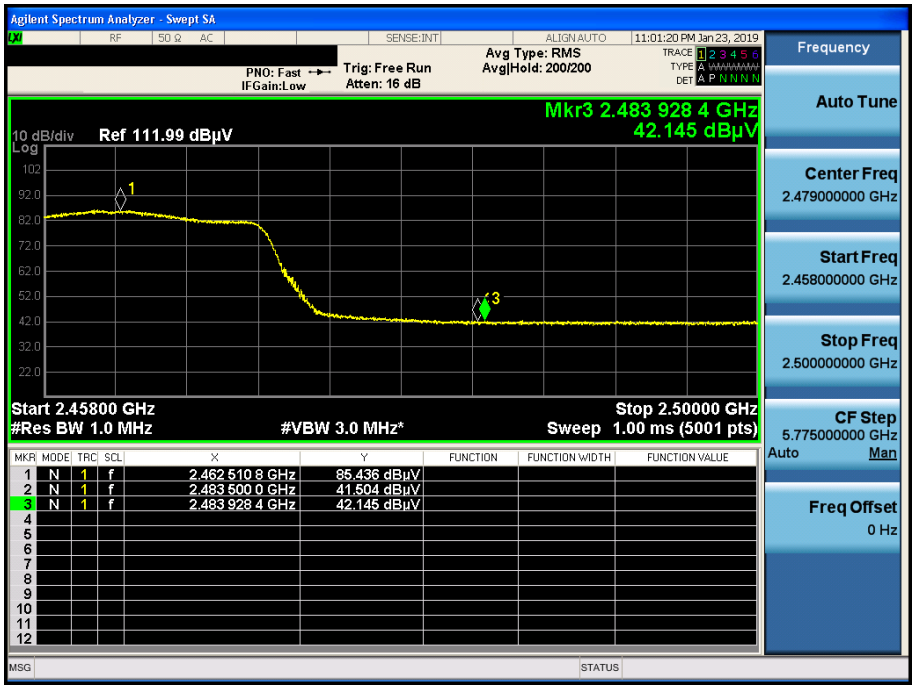

**TM 3 & Lowest & X axis & Ver** **Detector Mode : AV**



**TM 3 & Highest & X axis & Ver** **Detector Mode : PK**

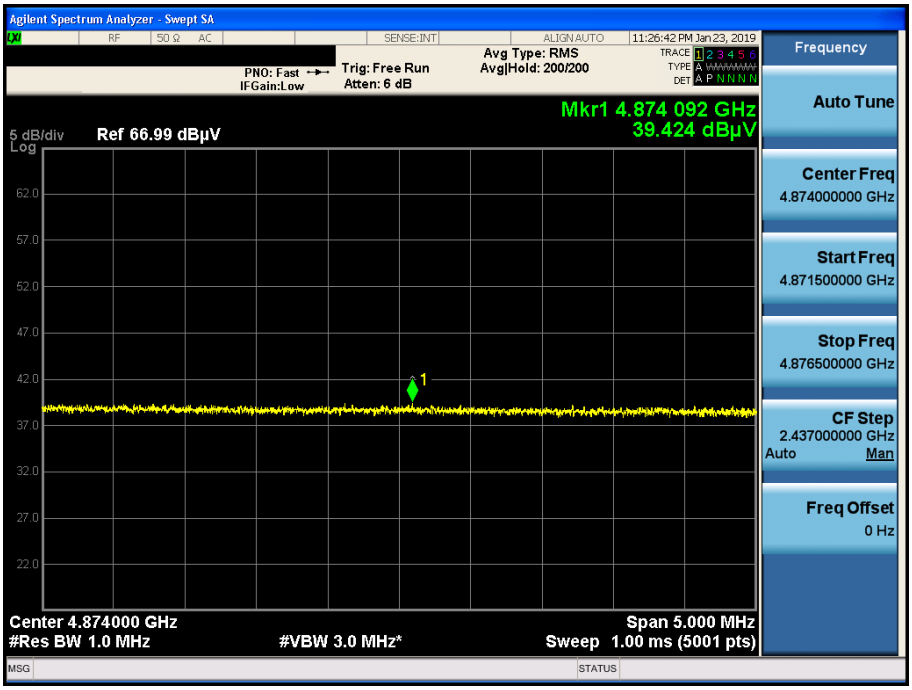



**TM 3 & Highest & X axis & Ver** **Detector Mode : AV**

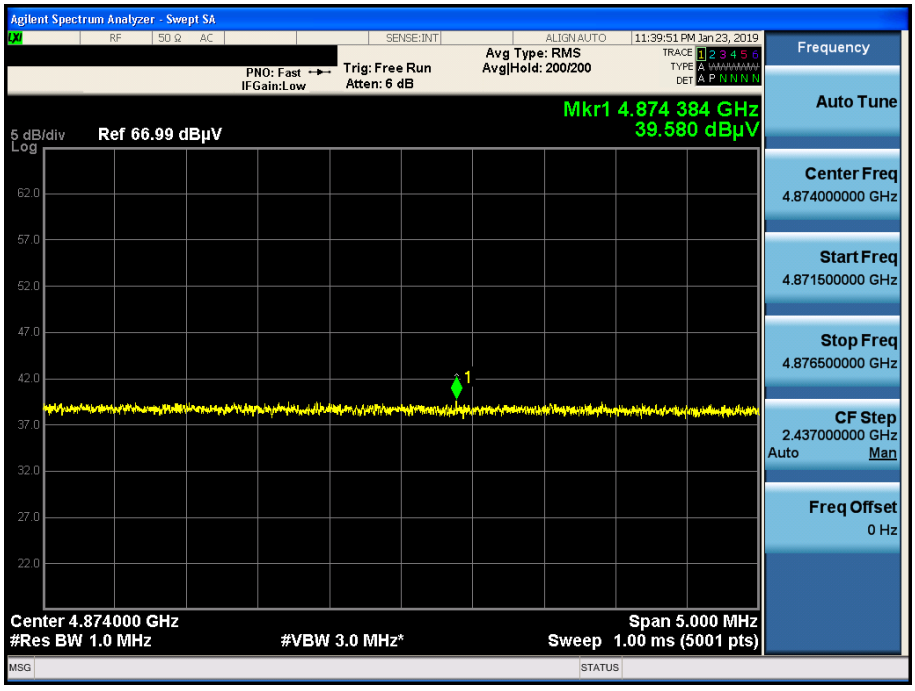


**TM 1 & Middle & X axis & Hor** **Detector Mode : AV**




**TM 2 & Middle & X axis & Hor** **Detector Mode : AV**



**TM 3 & Middle & X axis & Hor** **Detector Mode : AV**