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 : DRTFCC1904-0125
2. Customer
   - Name (FCC) : Canon Korea Business Solutions Inc.
   - Name (IC) : CANON KOREA BUSINESS SOLUTIONS INC.
   - Address (FCC) : 575, Sihwabencheo-ro, Danwon-gu, Ansan-si, Gyeonggi-do, South Korea
   - Address (IC) : 575, Sihwabencheo-ro, Danwon-gu, Ansan-si, Gyeonggi-do Korea (Republic Of)
3. Use of Report : FCC & IC Original Grant
4. Product Name / Model Name : Projector / Rayo S1
   FCC ID : 2AR9TRAYOS1 / IC : 498G-RAYOS1
5. Test Method Used : KDB558074 D01v05, ANSI C63.10-2013
   Test Specification : FCC Part 15.247
   RSS-247 Issue 2 (2017-02), RSS-GEN Issue 5 (2018-04)
6. Date of Test : 2018.12.28 ~ 2019.02.14
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by Name : InHee Bae (Signature)	Reviewed by 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 . 22 .

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
DRTFCC1904-0125	Apr. 22, 2019	Initial issue

Table of Contents

1. EUT DESCRIPTION 4
2. INFORMATION ABOUT TESTING 5
2.1 Test mode 5
2.2 Auxiliary equipment 5
2.3 Tested environment 6
2.4 EMI suppression Device(s) / Modifications 6
2.5 Measurement Uncertainty 6
3. SUMMARY OF TESTS 7
4. TEST METHODOLOGY 8
4.1 EUT configuration 8
4.2 EUT exercise 8
4.3 General test procedures 8
4.4 Description of test modes 8
5. INSTRUMENT CALIBRATION 9
6. FACILITIES AND ACCREDITATIONS 9
6.1 Facilities 9
6.2 Equipment 9
7. ANTENNA REQUIREMENTS 9
8. TEST RESULT 10
8.1 6dB bandwidth 10
8.2 Maximum peak conducted output power 17
8.3 Maximum power spectral density 19
8.4 Out of band emissions at the band edge / conducted spurious emissions 26
8.5 Radiated spurious emissions 51
8.6 Power-line conducted emissions 57
8.7 Occupied Bandwidth 60
9. LIST OF TEST EQUIPMENT 67
APPENDIX I 68
APPENDIX II 69
APPENDIX III 71

1. EUT DESCRIPTION

FCC Equipment Class	Digital Transmission System(DTS)
Product	Projector
Model Name(HVIN)	Rayo S1
Add Model Name	NA
FVIN	3.10.X
Power Supply	DC 3.7 V
Frequency Range	▪ 802.11b/g/n(20 MHz) : 2412 MHz ~ 2462 MHz
Max. RF Output Power	2.4GHz Band ▪ 802.11b : 12.90 dBm ▪ 802.11g : 19.57 dBm ▪ 802.11n (HT20) : 19.16 dBm
Modulation Type	▪ 802.11b: CCK, DSSS ▪ 802.11g/n: OFDM
Antenna Specification	**Antenna type**: FPC Antenna **Antenna gain**: 2.03 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 1 Mbps	2412	2437	2462
TM 2	802.11g 6 Mbps	2412	2437	2462
TM 3	802.11n(HT20) 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	:	22 ~ 25 °C
Relative humidity content	:	43 ~ 48 % R.H..
Details of power supply	:	DC 3.7 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	0.9 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 [6.7]	Occupied Bandwidth (99 %)	NA		C
15.247(d) 15.205 15.209	RSS-247 [5.5] RSS-GEN [8.9] RSS-GEN [8.10]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	FCC 15.209 limits	Radiated	C Note 3
15.207	RSS-Gen [8.8]	AC Line Conducted Emissions	FCC 15.207 limits	AC Line Conducted	C
15.203	-	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 test item was performed in each axis and the worst case data was reported.

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 test site complies with the requirements of § 2.948 according to ANSI C63.4-2014. **- FCC MRA Accredited Test Firm No. : KR0034** **- IC Test site No. : 5740A**		
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 antenna is permanently attached. (Refer to Internal Photo file.)
Therefore this EUT complies with the requirement of §15.203.

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.

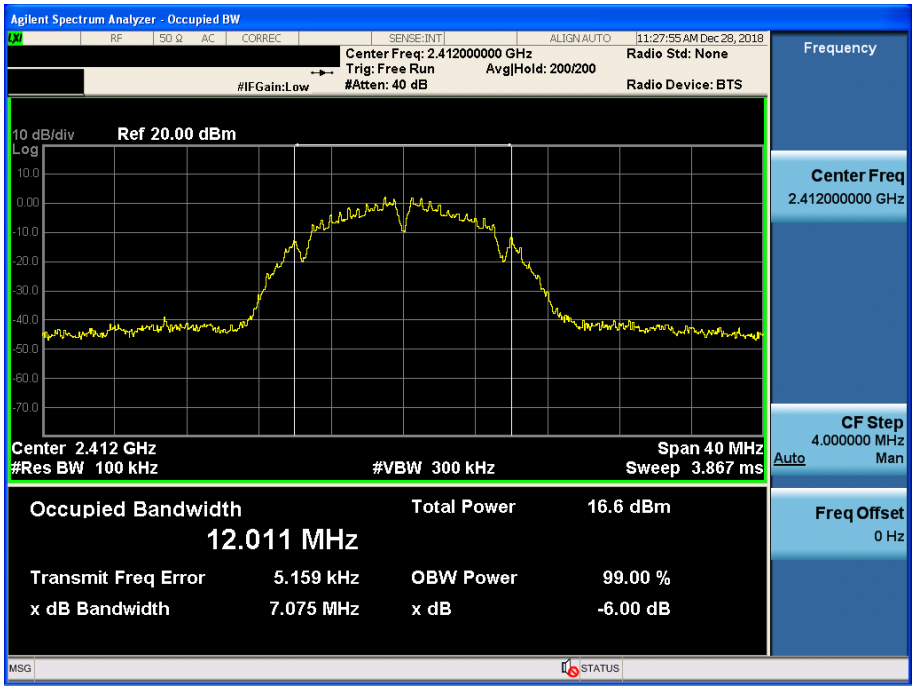
▣ Test Results: Comply

Test Mode	Frequency	Test Results[MHz]
TM 1	Lowest	7.08
	Middle	7.10
	Highest	7.09
TM 2	Lowest	15.16
	Middle	14.05
	Highest	15.06
TM 3	Lowest	16.11
	Middle	15.33
	Highest	16.99

▣ RESULT PLOTS

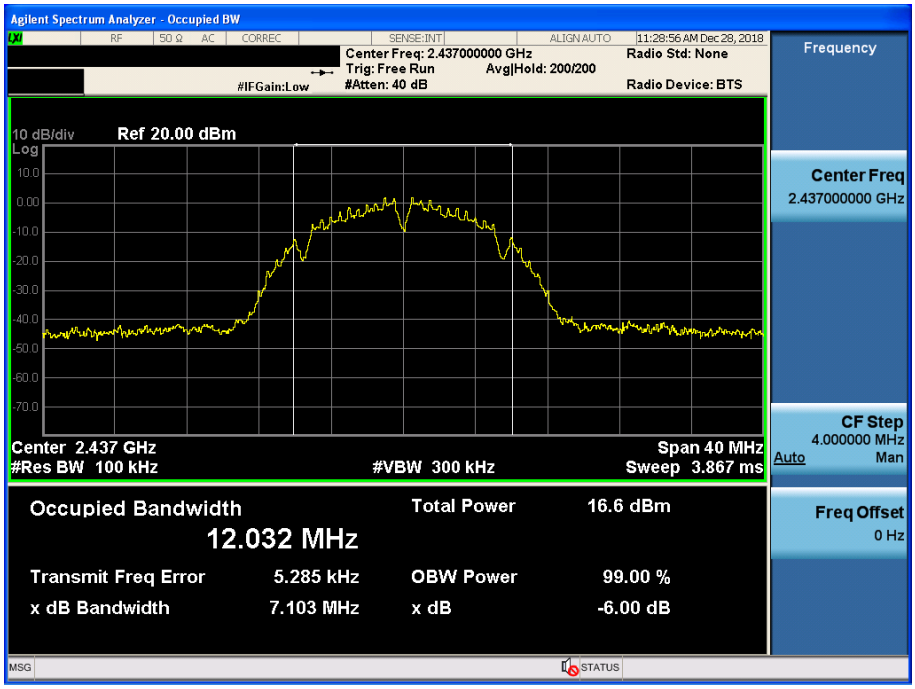
6 dB Bandwidth

TM 1 & Lowest



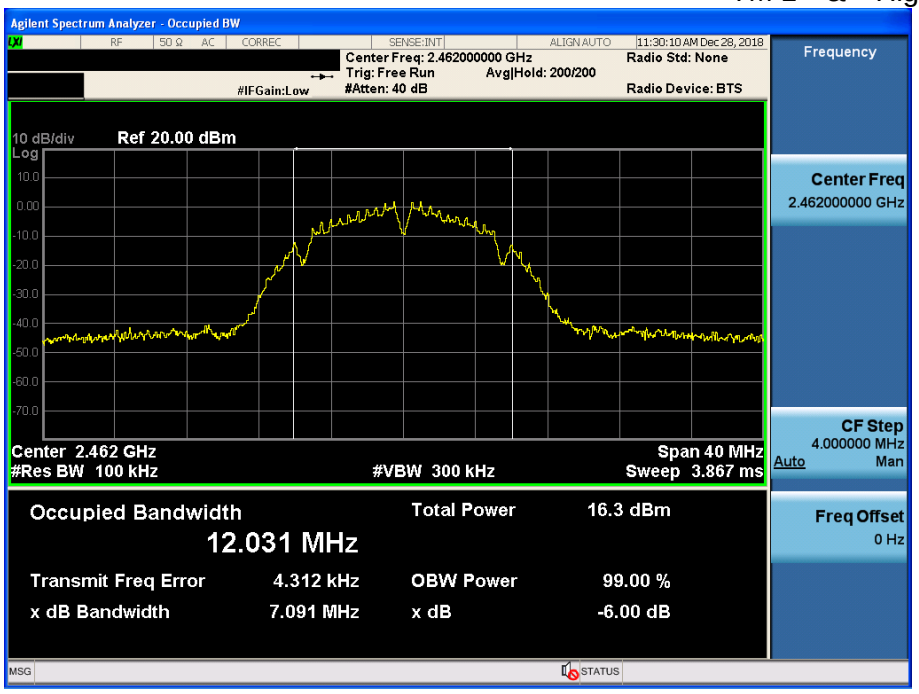
6 dB Bandwidth

TM 1 & Middle



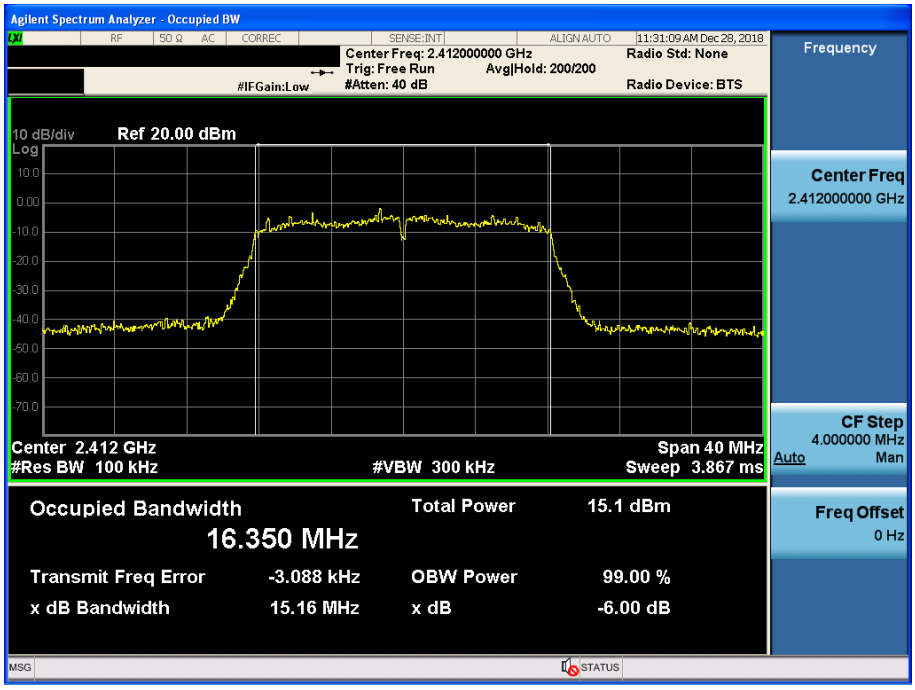
6 dB Bandwidth

TM 1 & Highest



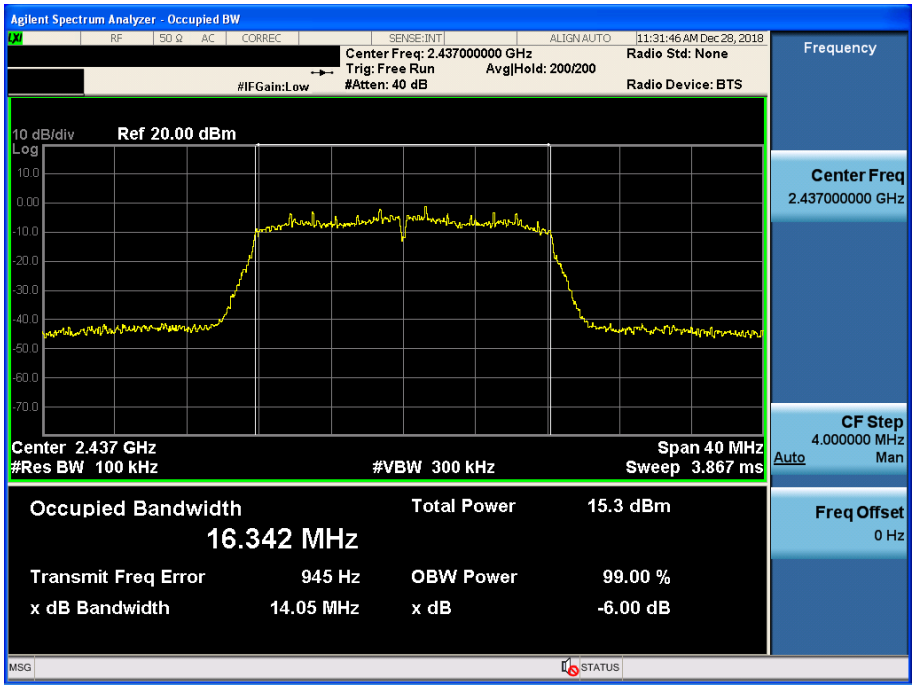
6 dB Bandwidth

TM 2 & Lowest



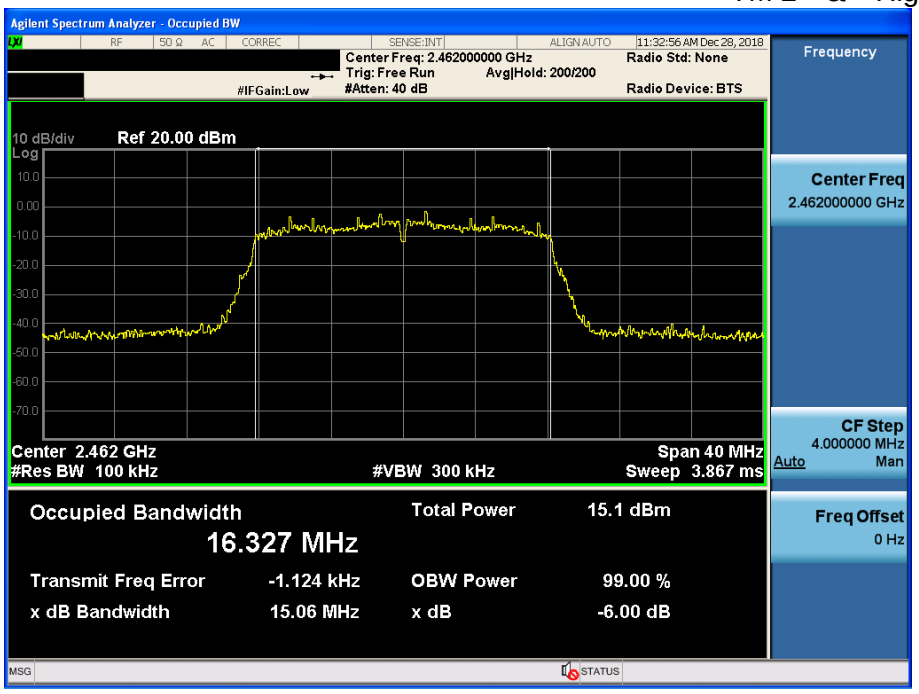
6 dB Bandwidth

TM 2 & Middle



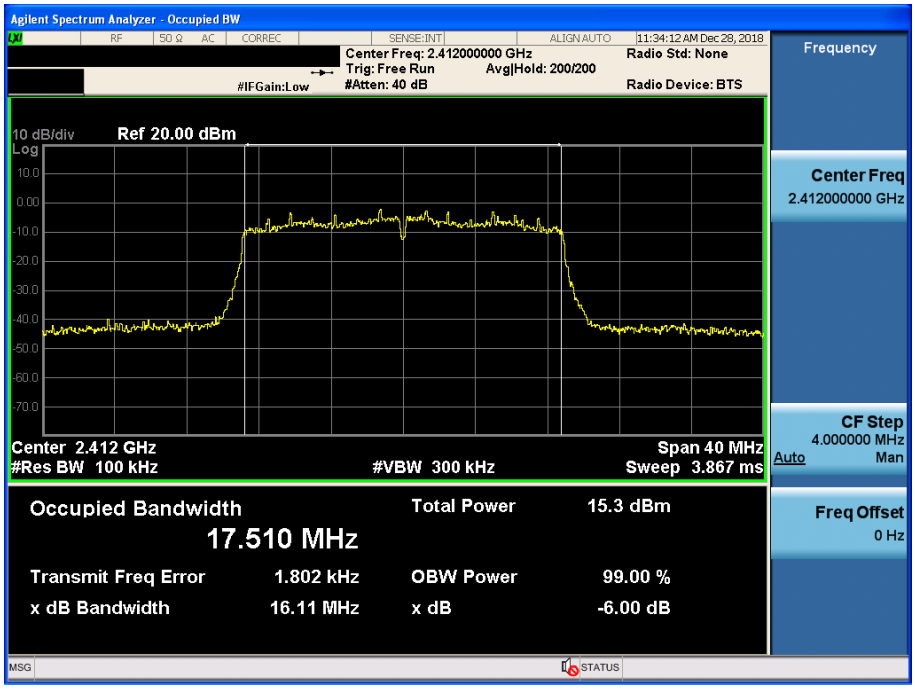
6 dB Bandwidth

TM 2 & Highest



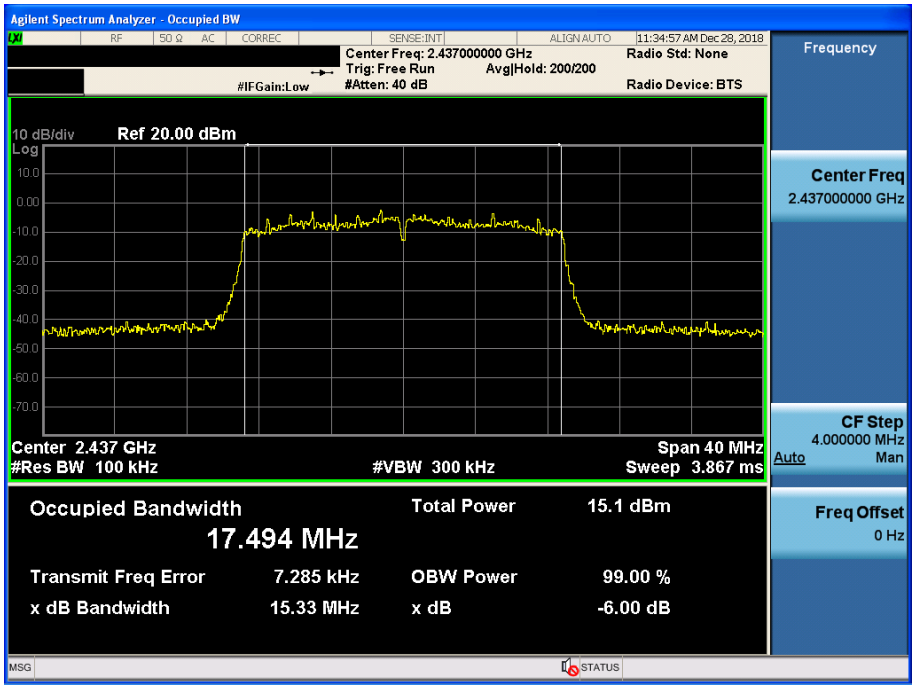
6 dB Bandwidth

TM 3 & Lowest



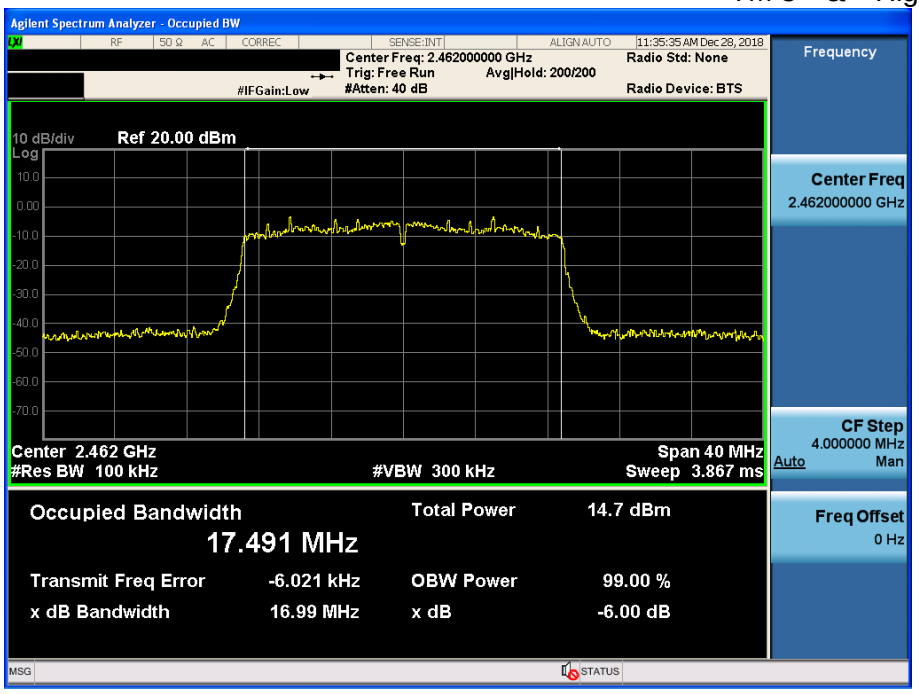
6 dB Bandwidth

TM 3 & Middle



6 dB Bandwidth

TM 3 & Highest

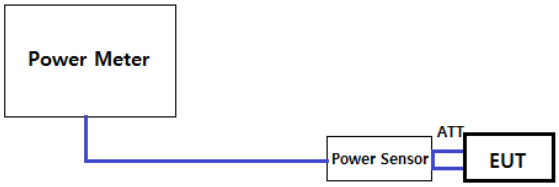


8.2 Maximum peak conducted output power

▣ Test Requirements and limit, §15.247(b)

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

▣ Test Configuration



▣ Test Procedure

- **KDB558074 D01v05 - Section 8.3.1.3**
- **ANSI C63.10-2013 – Section 11.9.1.3**

PKPM1 Peak power meter method

1. 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.

- **KDB558074 D01v05 - Section 8.3.2.3**
- **ANSI C63.10-2013 – Section 11.9.2.3.2**

Method AVGPM-G

1. 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	**12.90**	12.86	12.83	12.69	-	-	-	-
	AV	9.70	9.80	9.64	9.52	-	-	-	-
2437	PK	12.68	12.57	12.36	12.23	-	-	-	-
	AV	9.52	9.44	9.15	8.95	-	-	-	-
2462	PK	12.51	12.37	12.19	12.08	-	-	-	-
	AV	9.28	9.20	8.96	8.83	-	-	-	-

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	**19.57**	19.11	18.84	18.79	18.87	18.51	18.80	18.49
	AV	8.80	8.73	8.80	8.81	8.87	8.84	8.79	8.86
2437	PK	19.41	19.22	18.93	18.82	18.84	18.57	18.68	18.53
	AV	8.45	8.67	8.86	8.82	8.81	8.77	8.73	8.82
2462	PK	19.34	19.18	18.86	18.73	18.82	18.54	18.76	18.55
	AV	8.22	8.32	8.88	8.84	8.77	8.73	8.69	8.85

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	**19.16**	18.50	18.58	18.49	18.43	18.33	18.18	18.15
	AV	8.54	8.59	8.72	8.70	8.68	8.67	8.65	8.63
2437	PK	19.10	18.42	18.55	18.51	18.44	18.31	18.16	18.11
	AV	8.48	8.44	8.63	8.67	8.61	8.58	8.60	8.53
2462	PK	18.86	18.32	18.44	18.38	18.34	18.22	18.13	18.02
	AV	8.11	8.06	8.46	8.57	8.52	8.43	8.54	8.49

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.

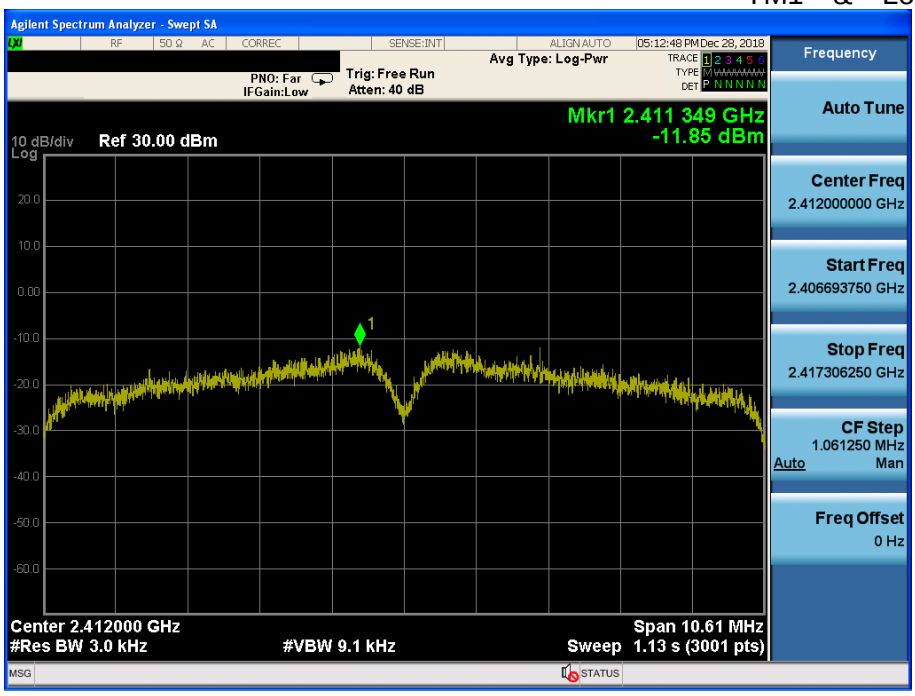
▣ Test Results: Comply

Test Mode	Frequency	RBW	PKPSD [dBm]
TM 1	Lowest	3 kHz	-11.85
	Middle	3 kHz	-11.36
	Highest	3 kHz	-12.81
TM 2	Lowest	3 kHz	-15.73
	Middle	3 kHz	-15.26
	Highest	3 kHz	-15.65
TM 3	Lowest	3 kHz	-15.97
	Middle	3 kHz	-15.66
	Highest	3 kHz	-16.36

▣ RESULT PLOTS

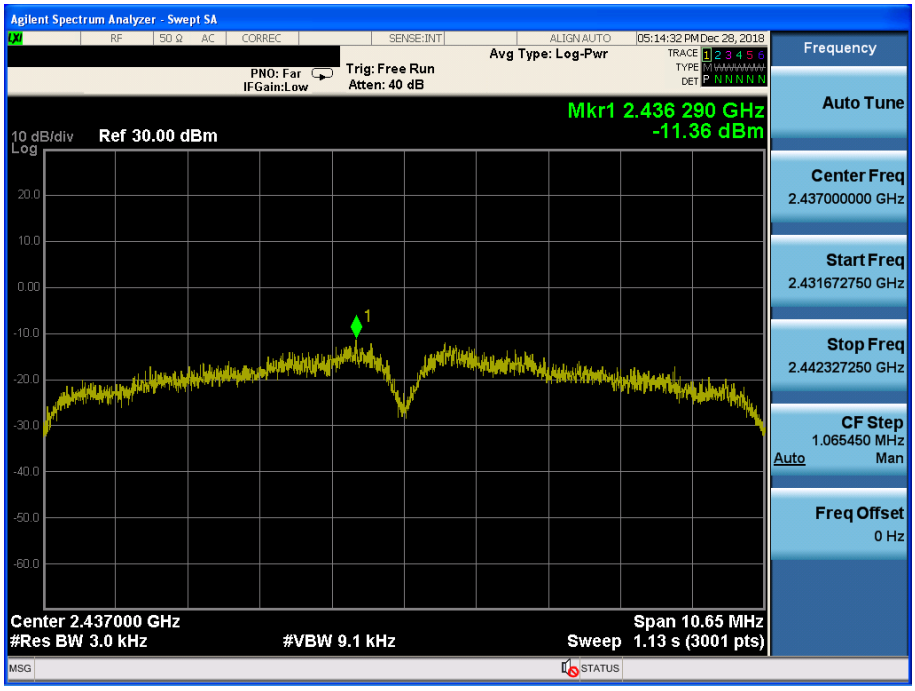
Maximum PPSD

TM1 & Lowest



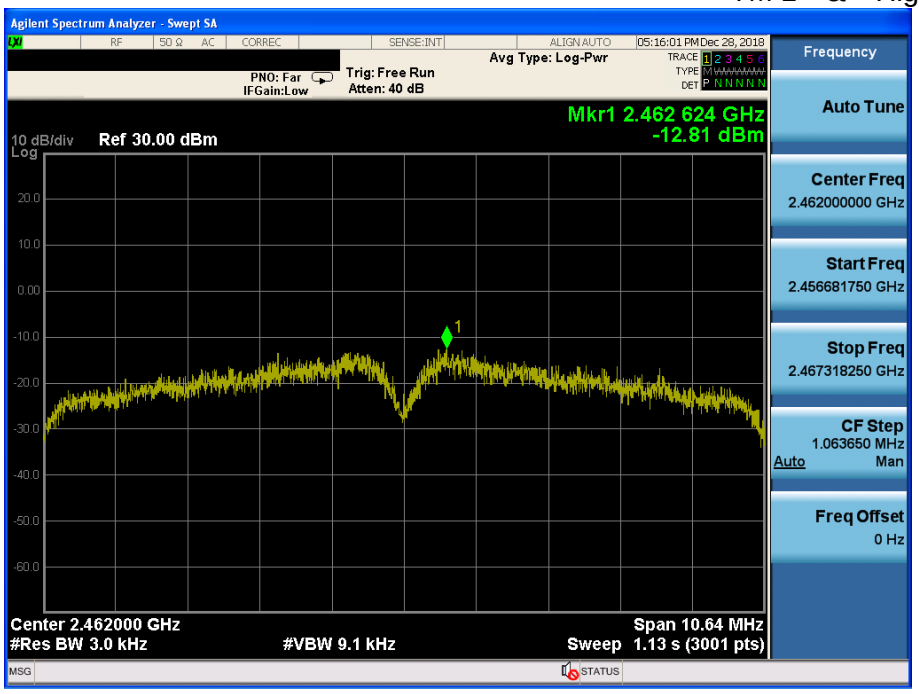
Maximum PPSD

TM 1 & Middle



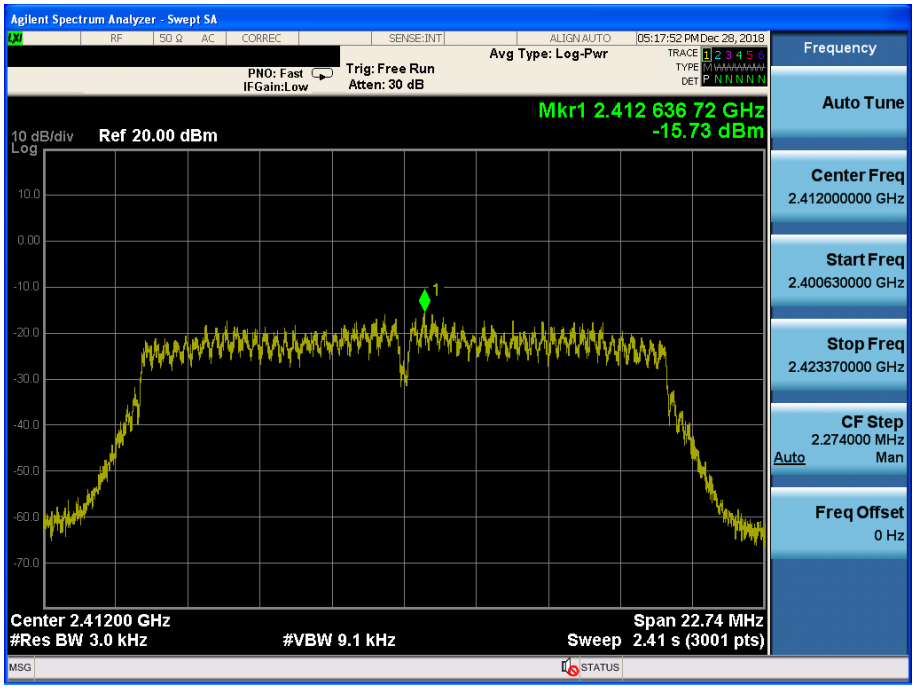
Maximum PPSD

TM 1 & Highest



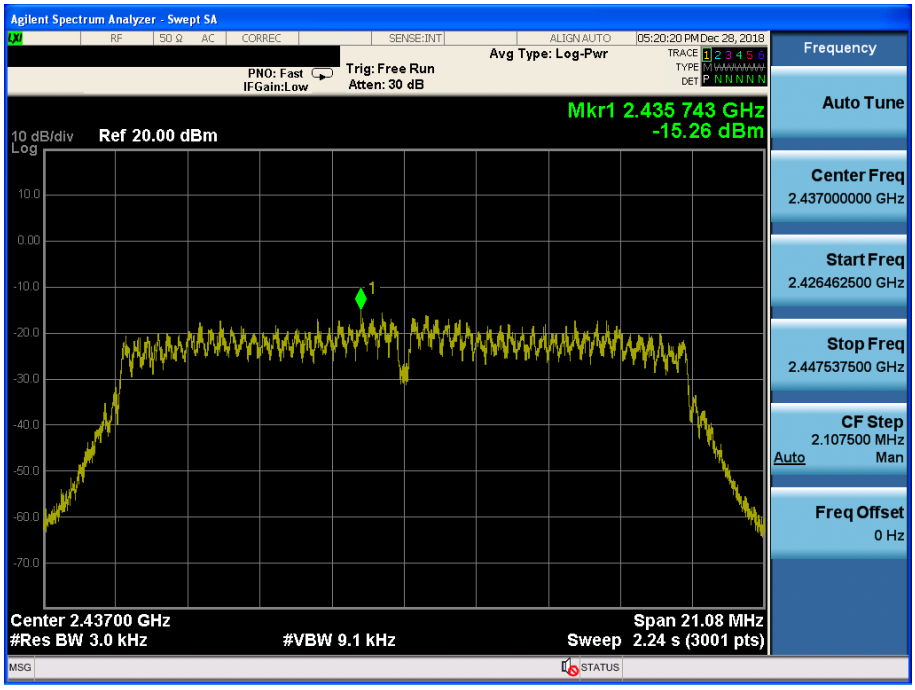
Maximum PPSD

TM 2 & Lowest



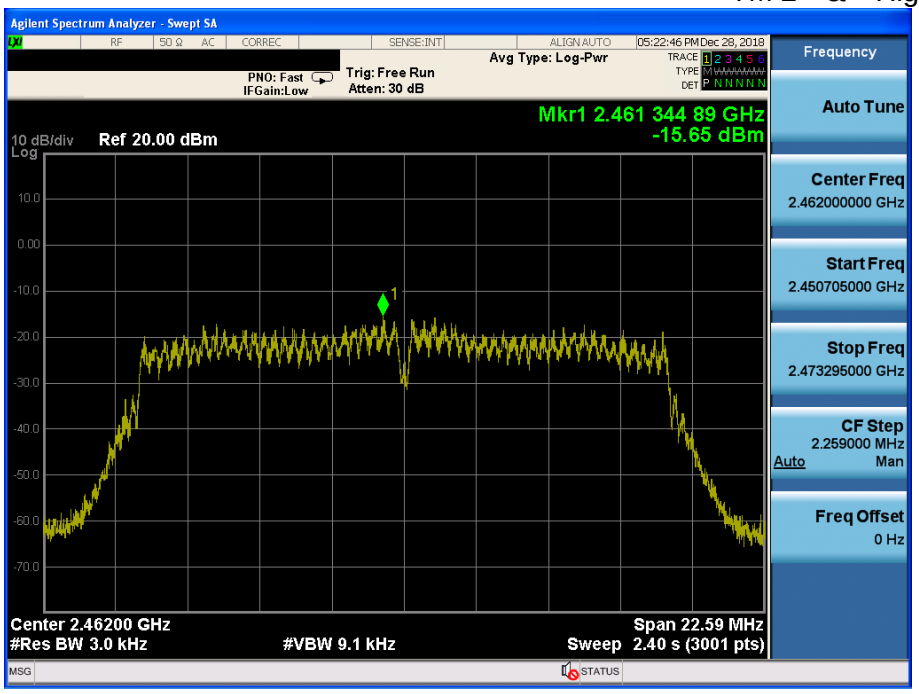
Maximum PPSD

TM2 & Middle



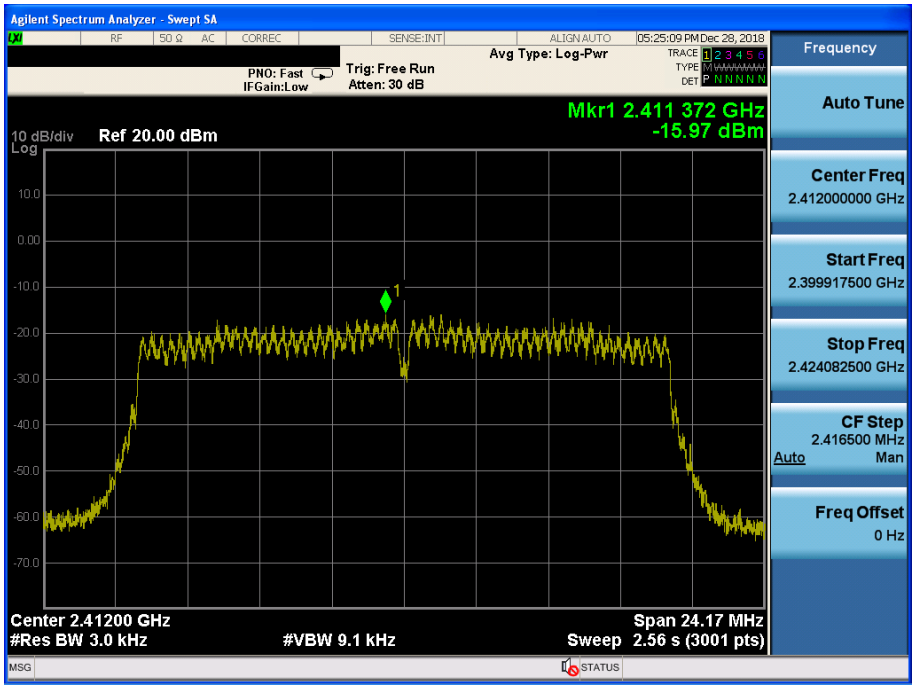
Maximum PPSD

TM 2 & Highest



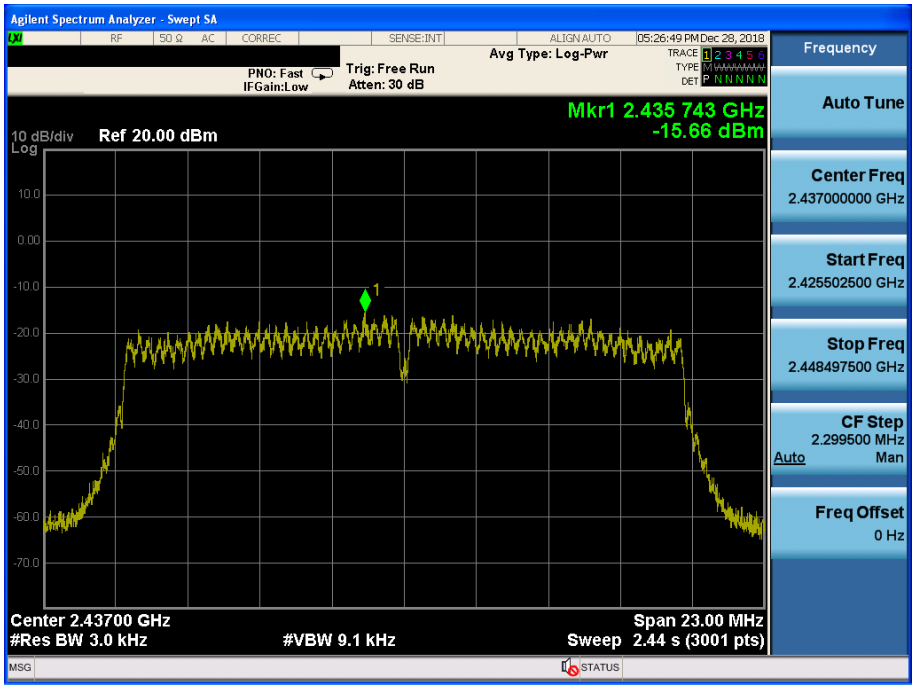
Maximum PPSD

TM 3 & Lowest



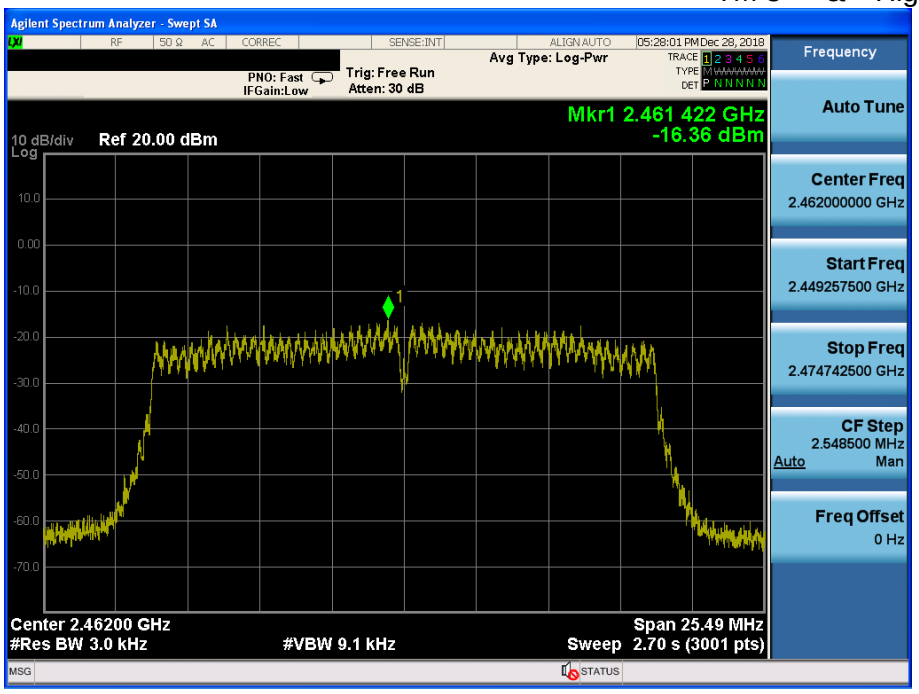
Maximum PPSD

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

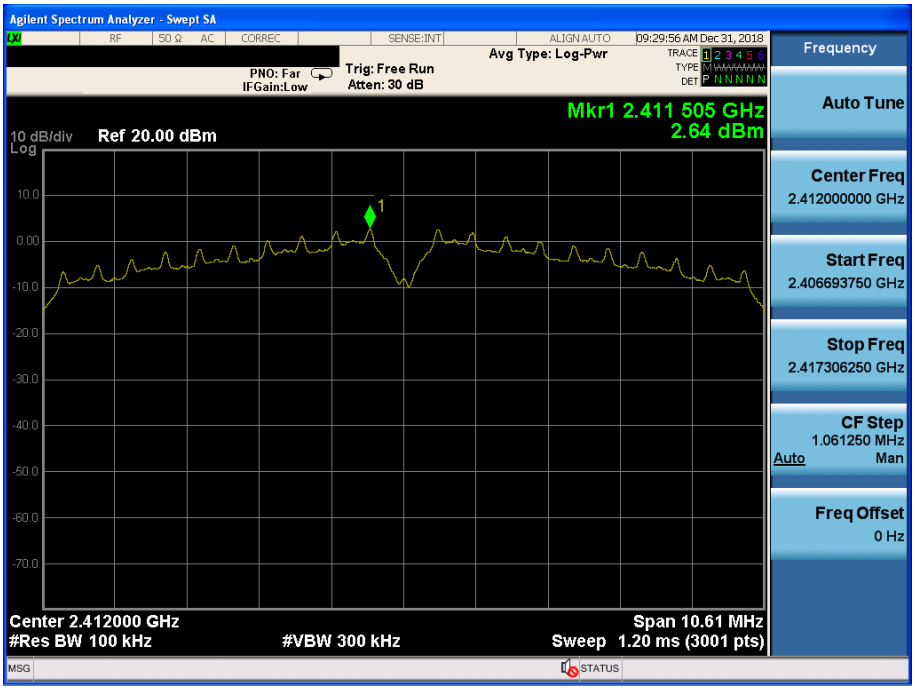
LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

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.

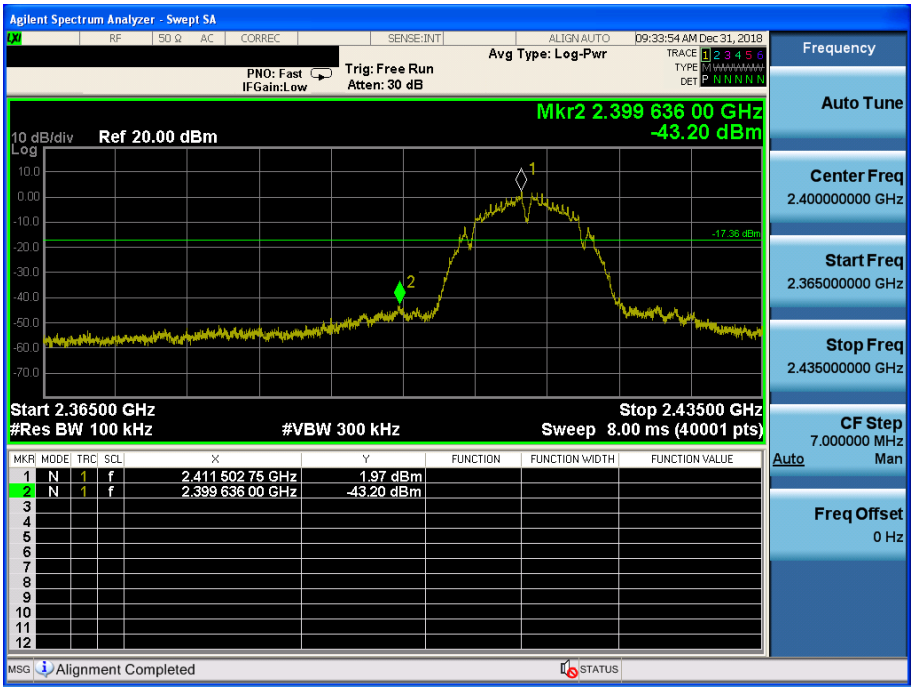
▣ RESULT PLOTS

TM 1 & Lowest

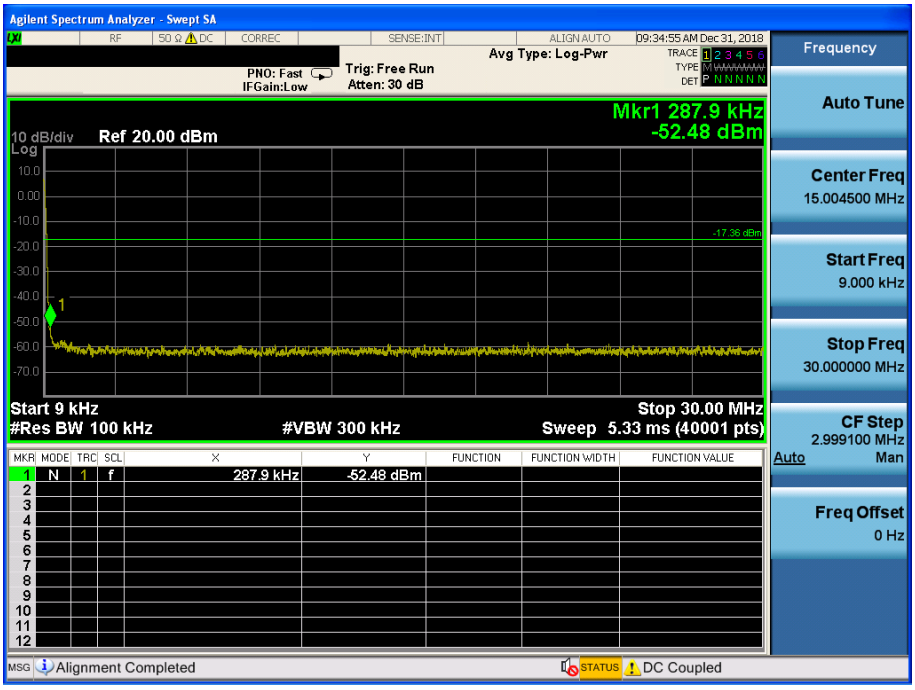
Reference

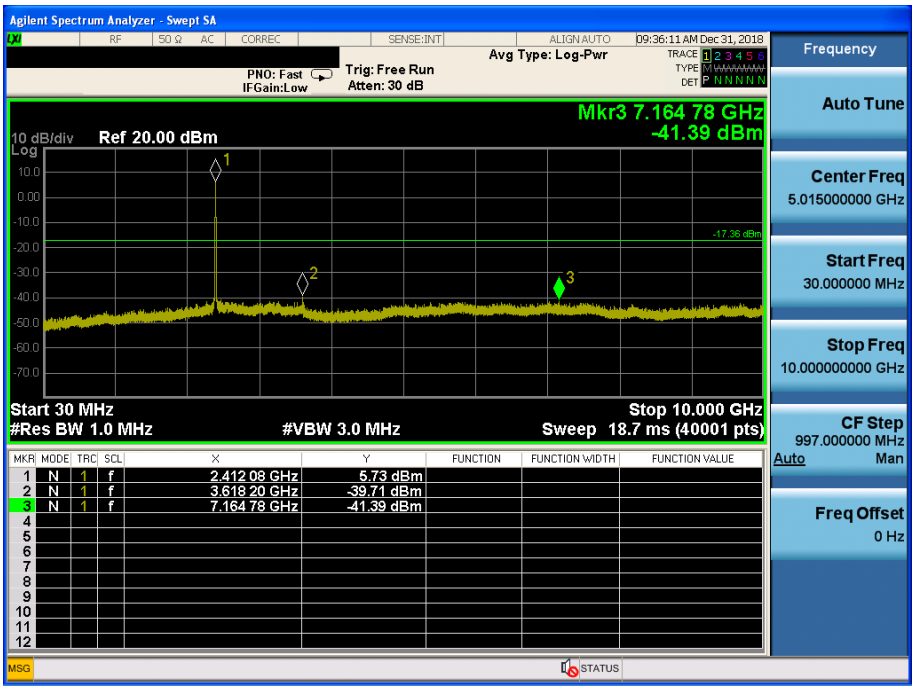


Low Band-edge

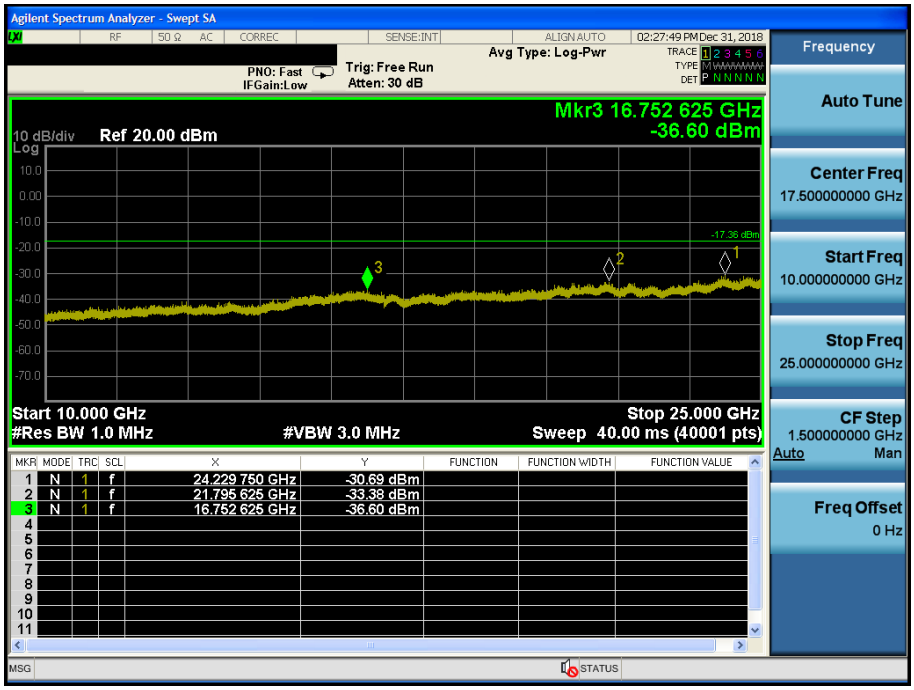


Conducted Spurious Emissions



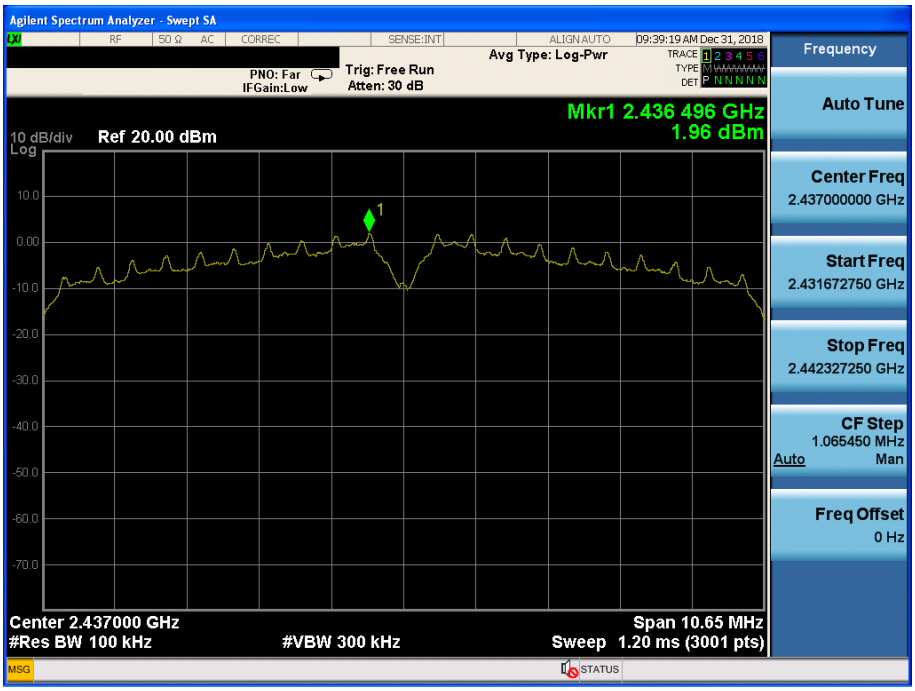


Conducted Spurious Emissions

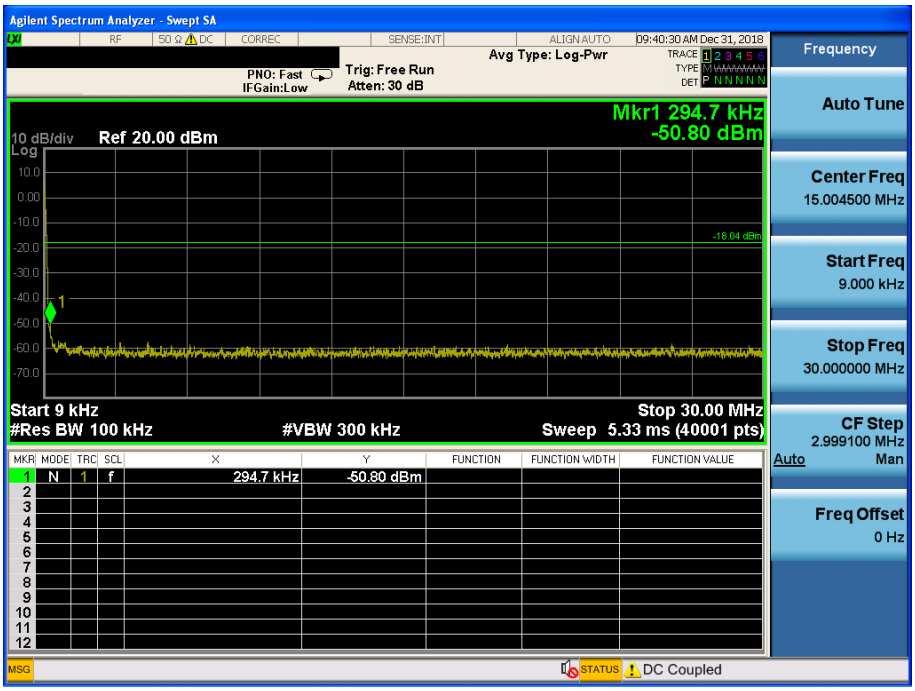


TM 1 & Middle

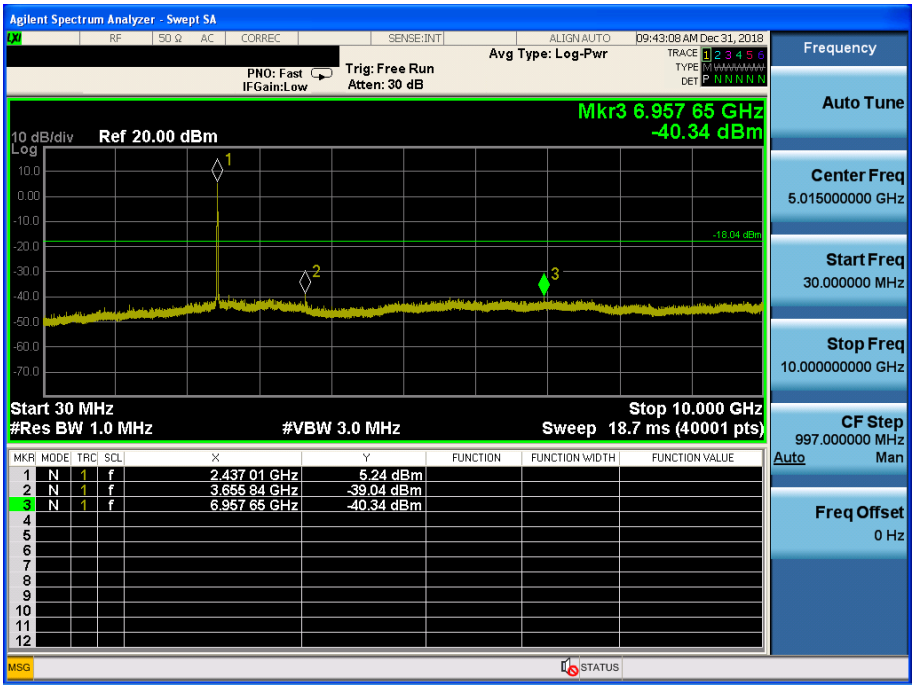
Reference

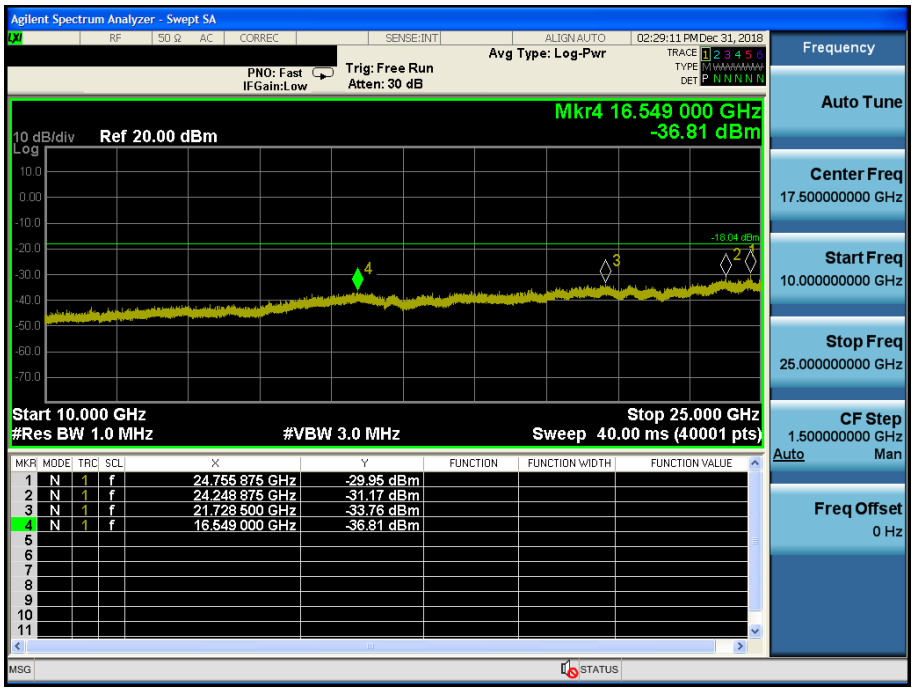


Conducted Spurious Emissions



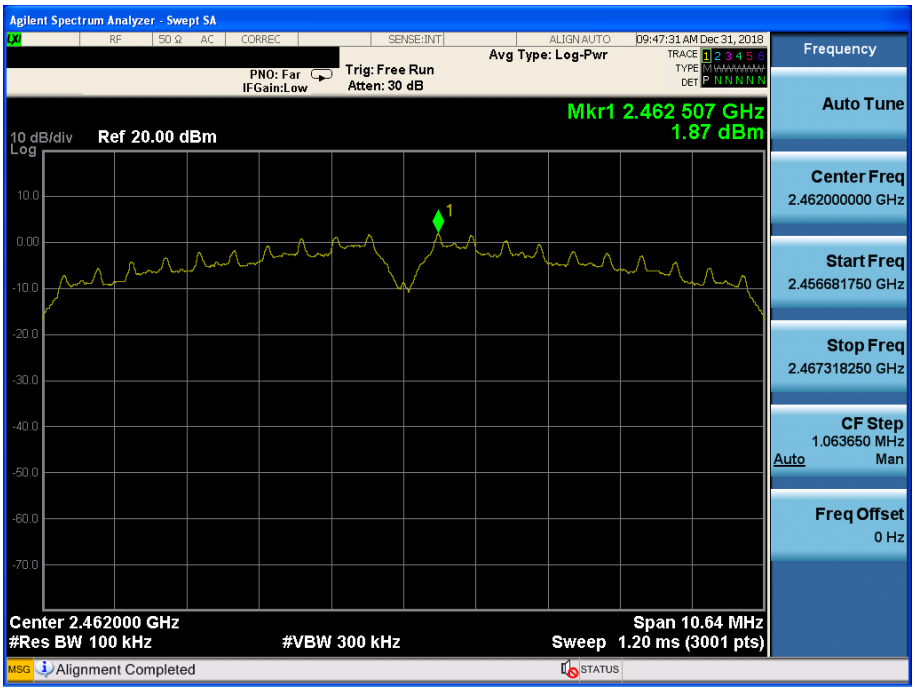
Conducted Spurious Emissions



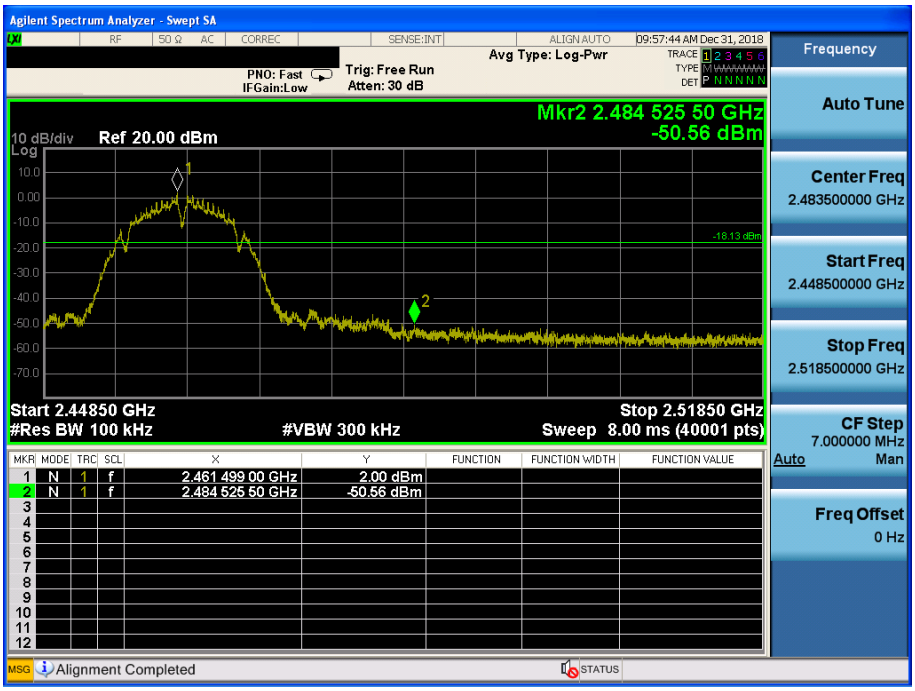


TM 1 & Highest

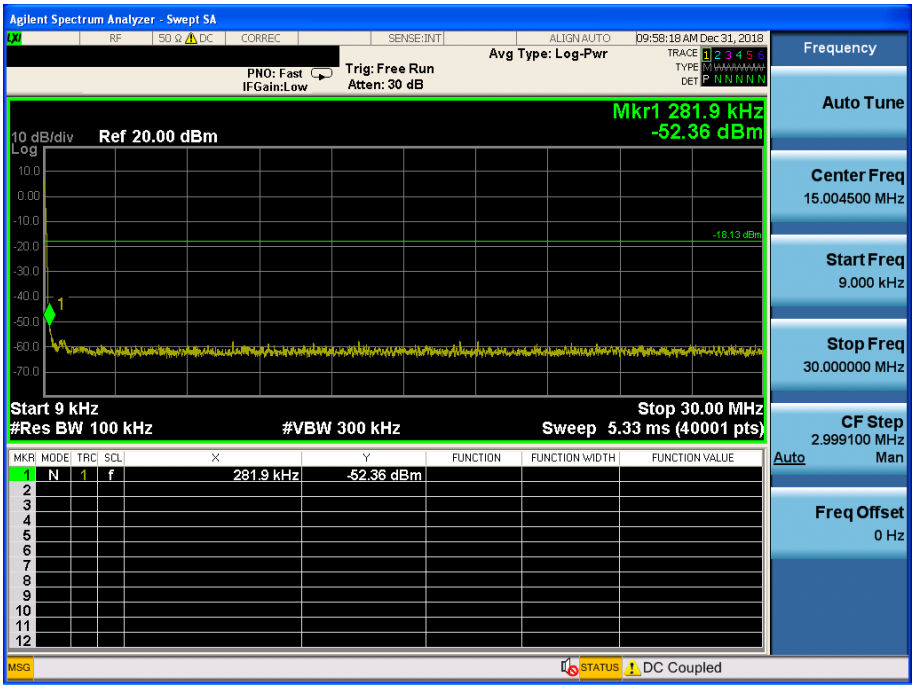
Reference

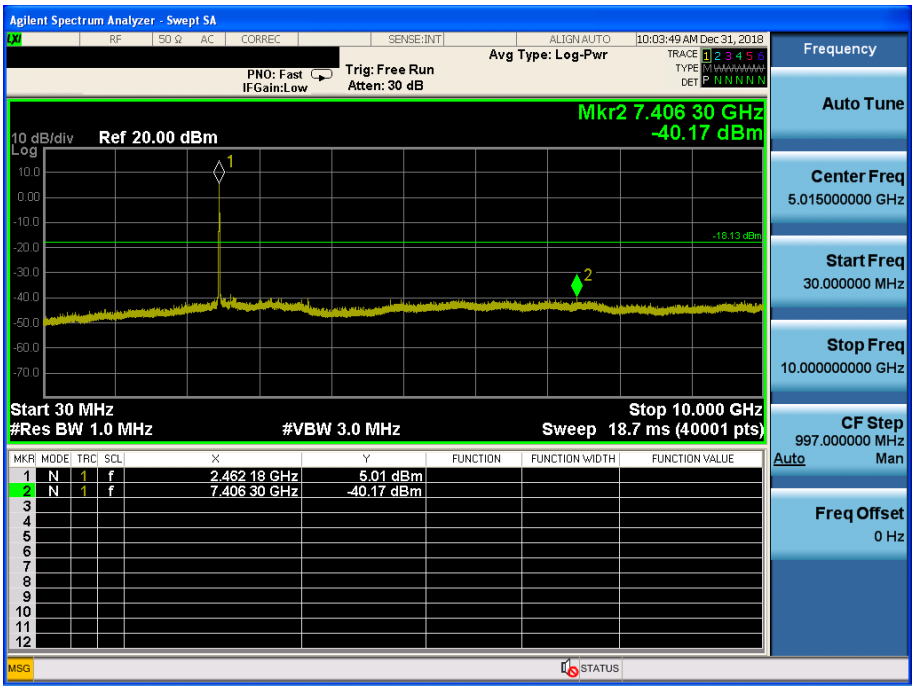


High Band-edge



Conducted Spurious Emissions

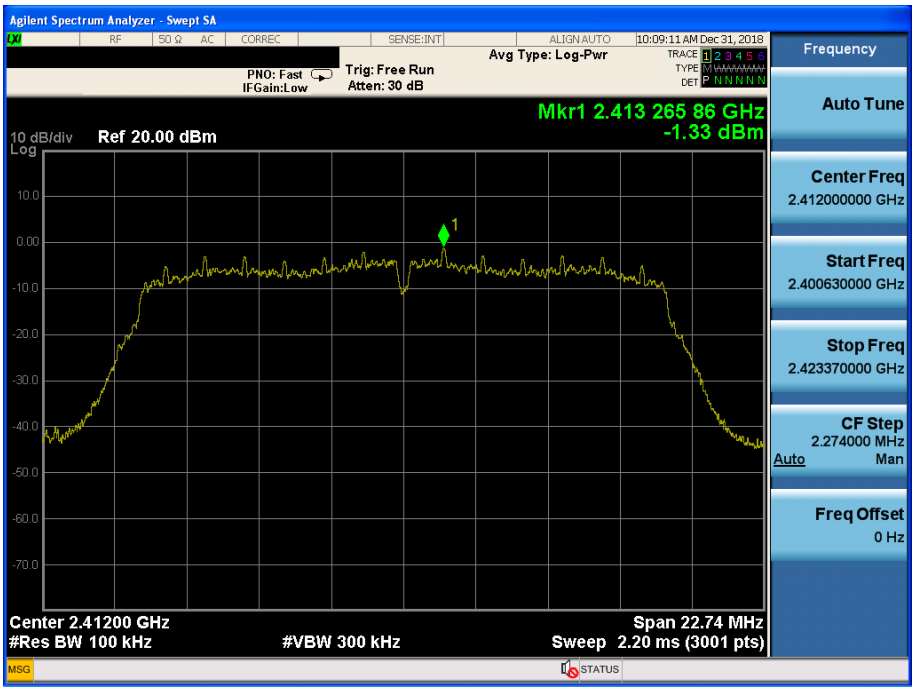




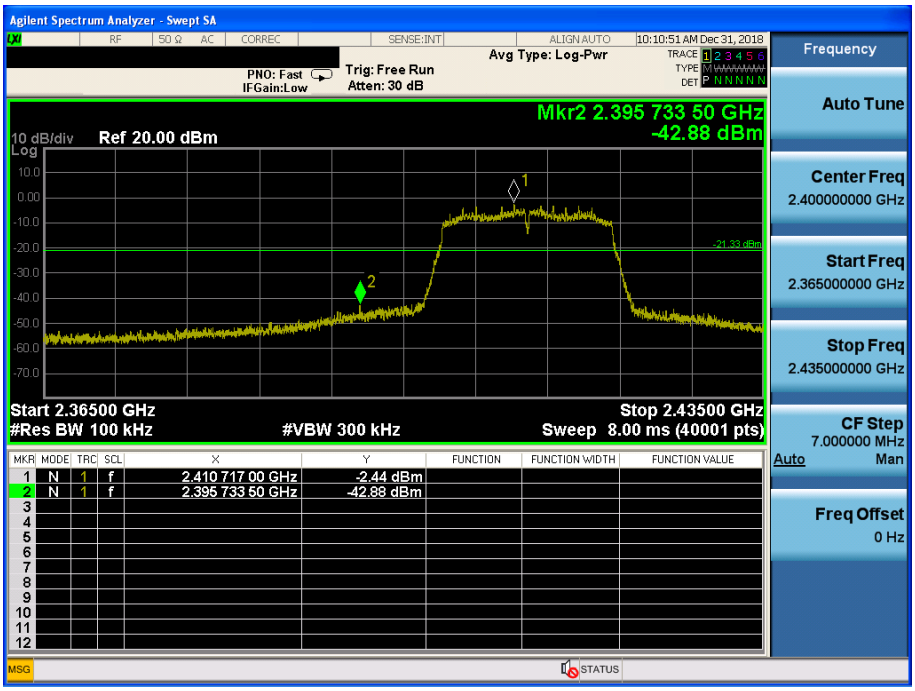
Conducted Spurious Emissions

TM 2 & Lowest

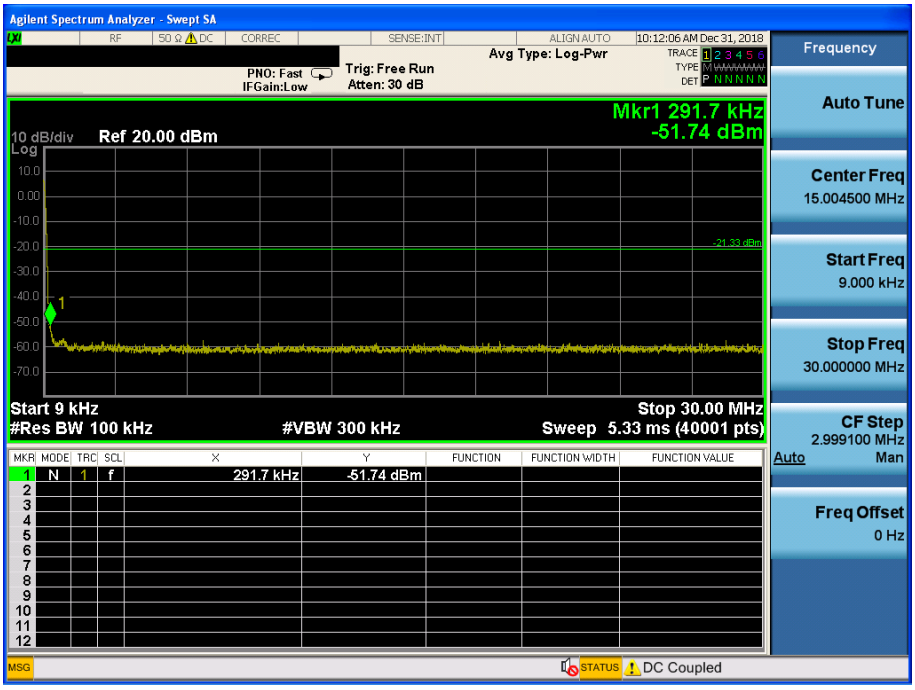
Reference

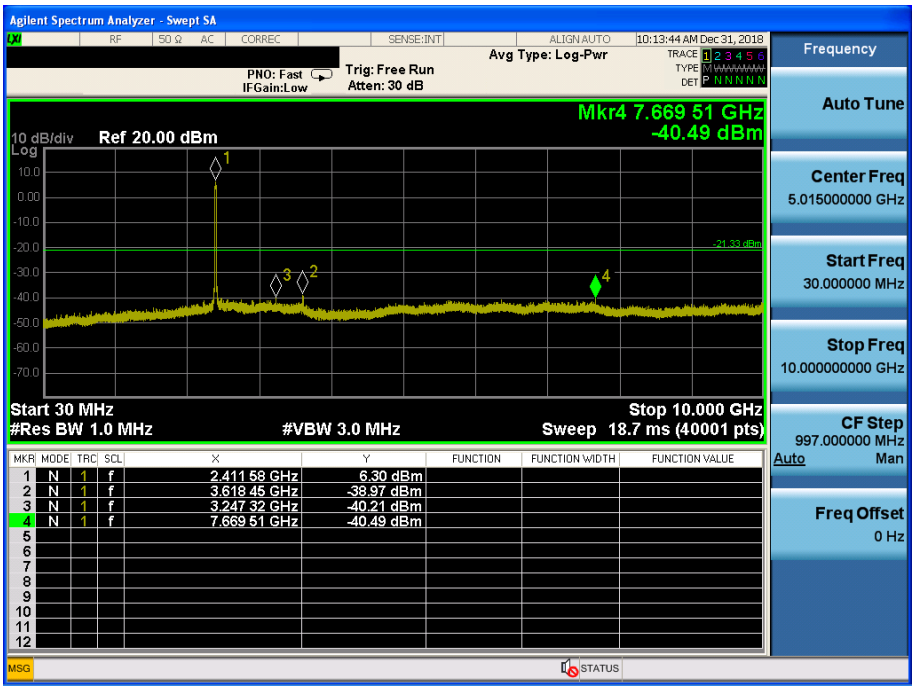


Low Band-edge

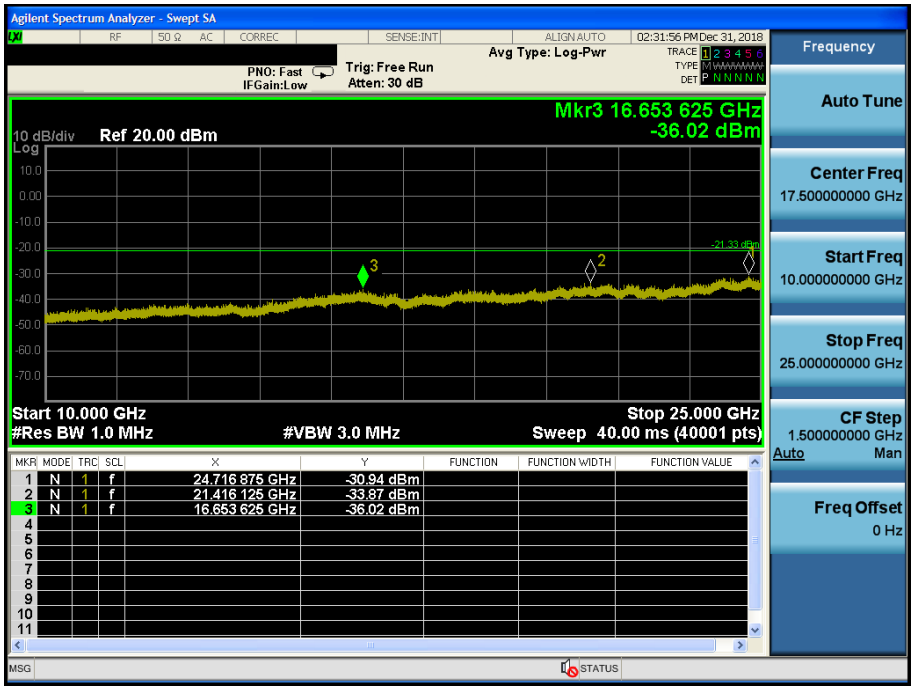


Conducted Spurious Emissions



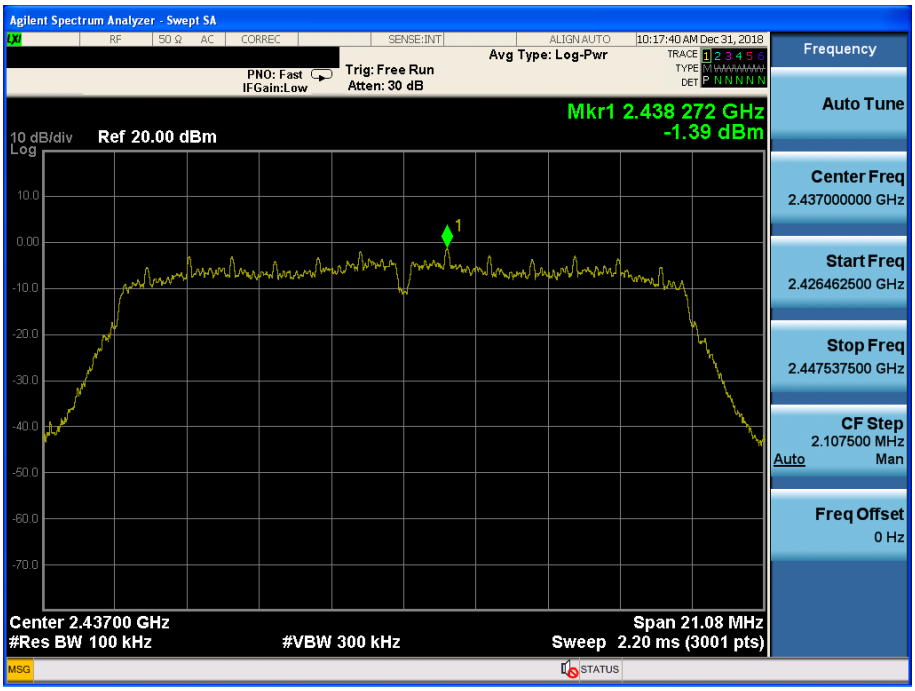


Conducted Spurious Emissions

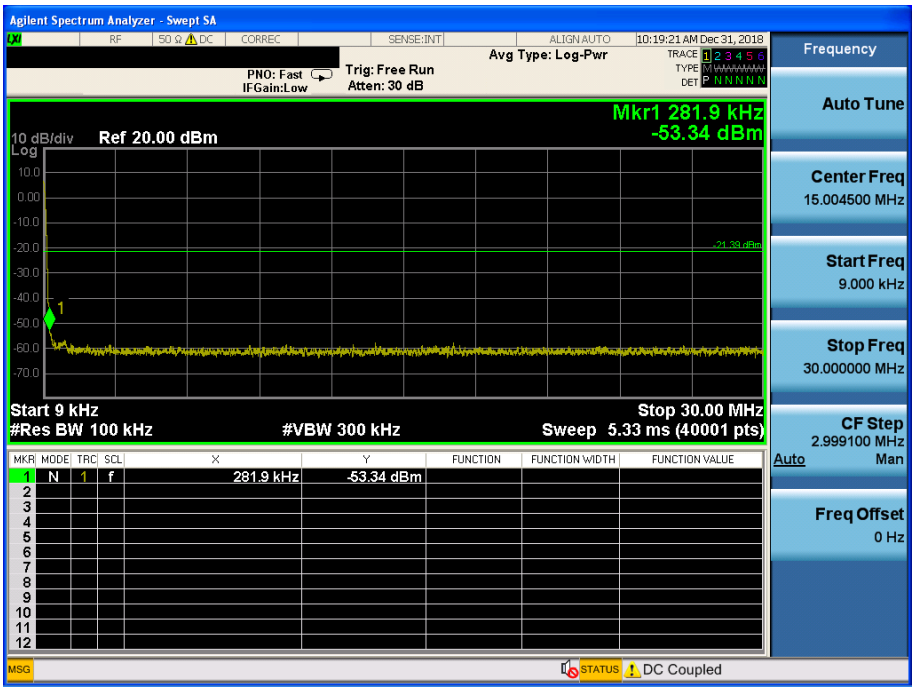


TM 2 & Middle

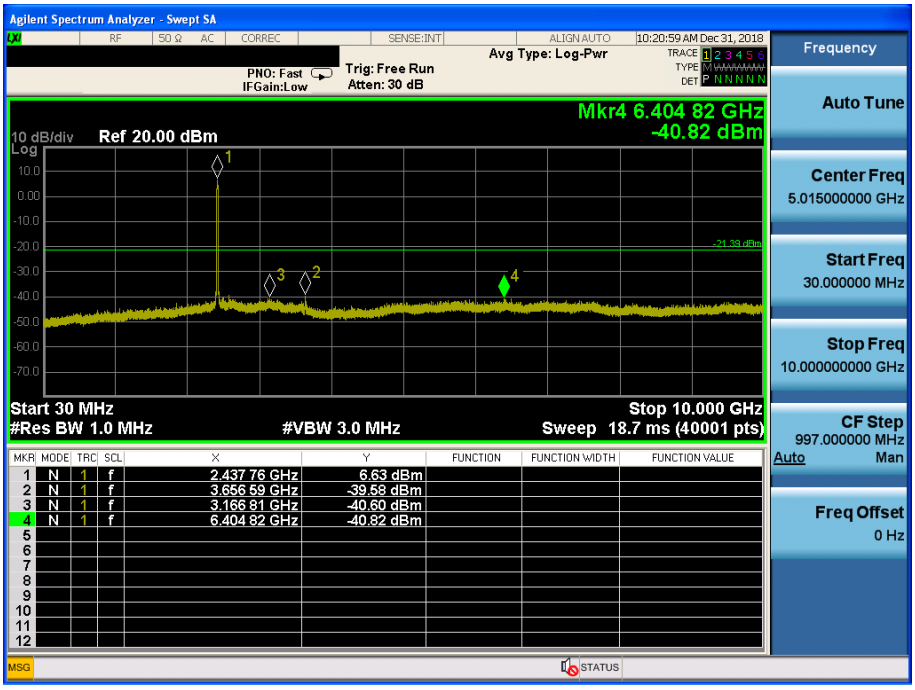
Reference



Conducted Spurious Emissions

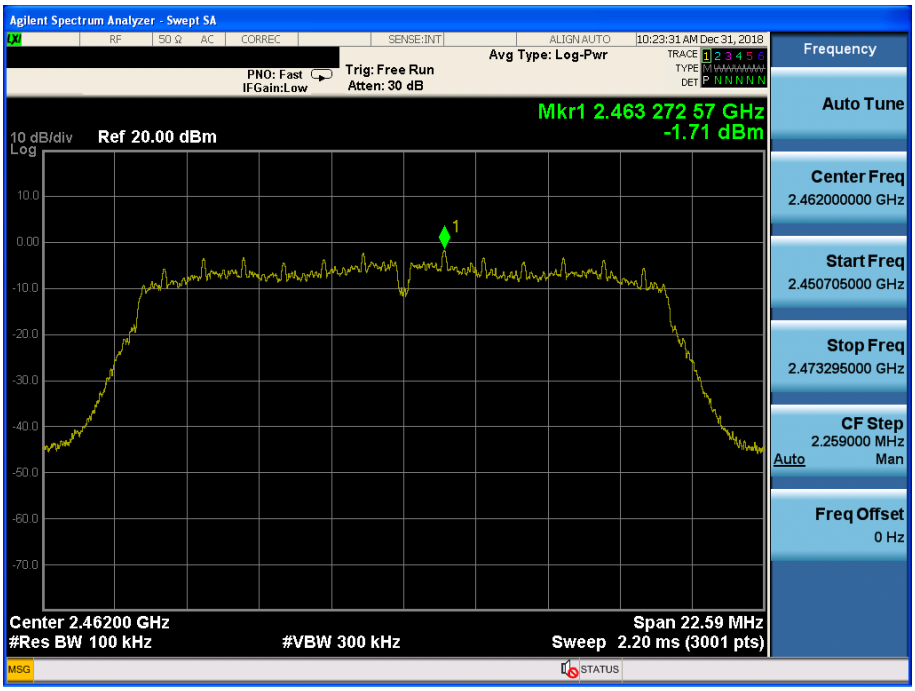


Conducted Spurious Emissions

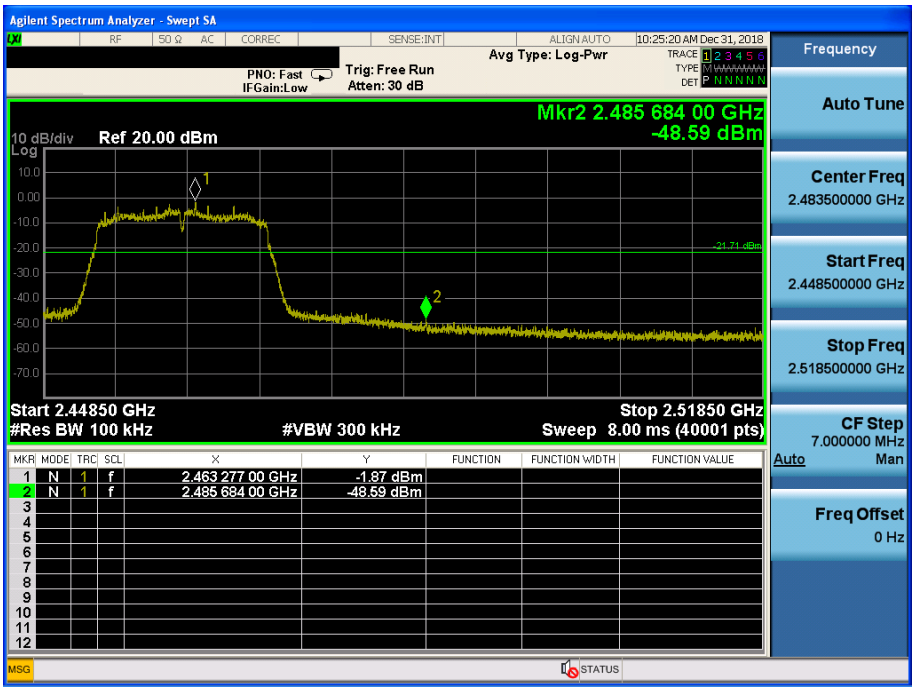


TM 2 & Highest

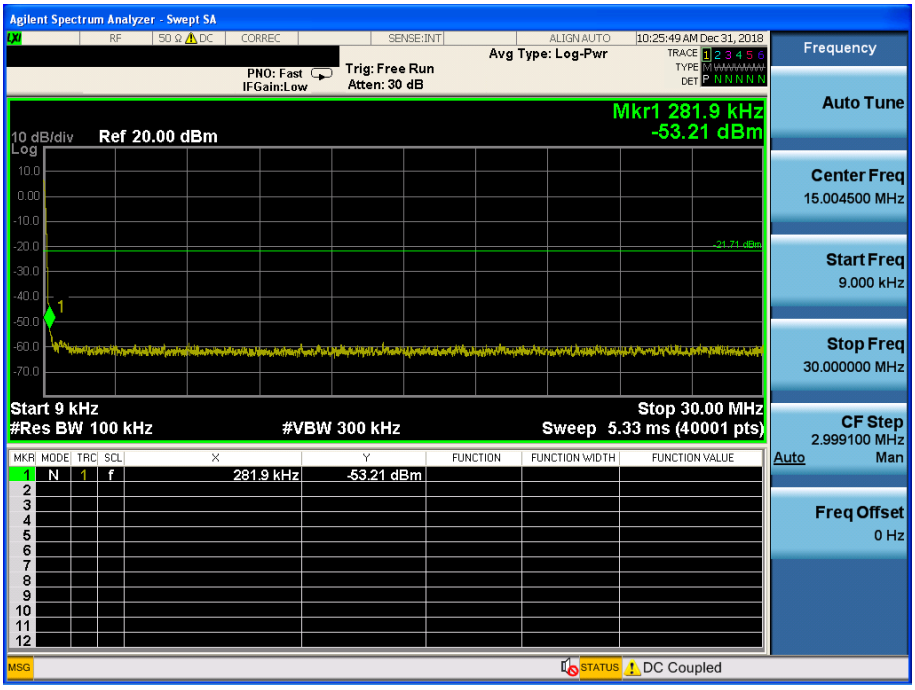
Reference

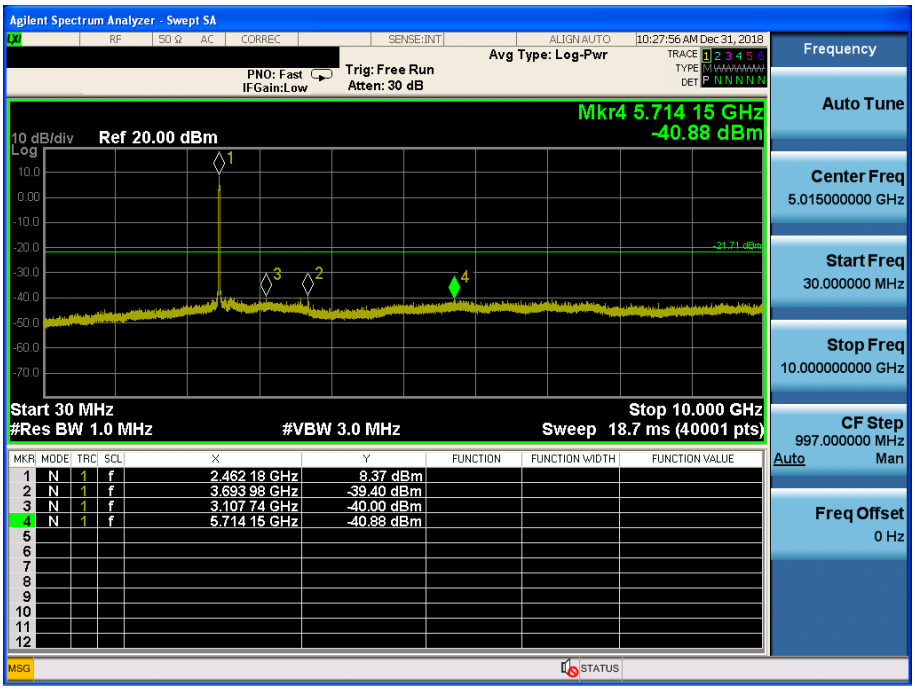


High Band-edge

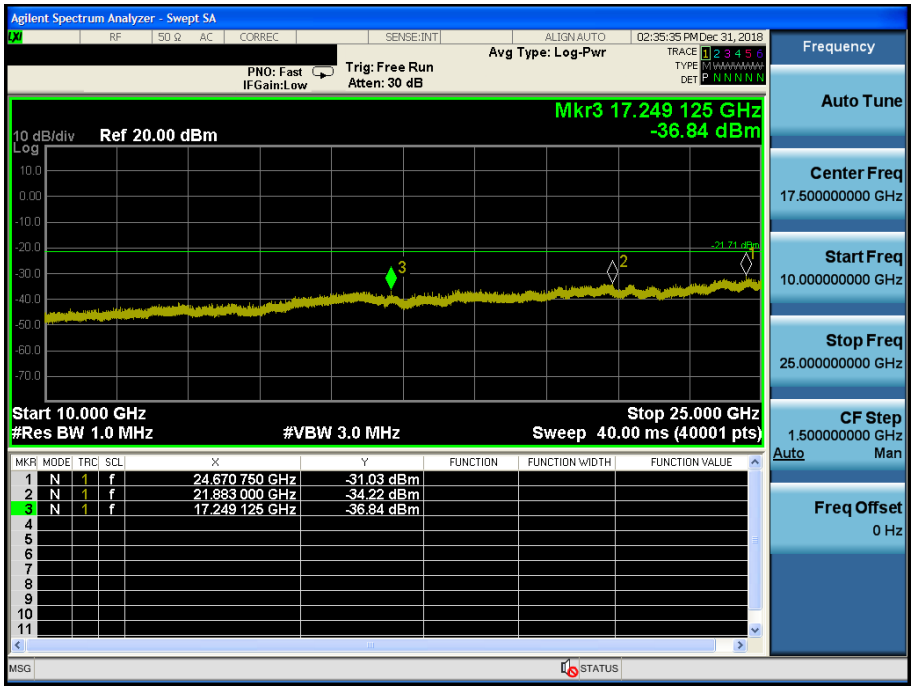


Conducted Spurious Emissions



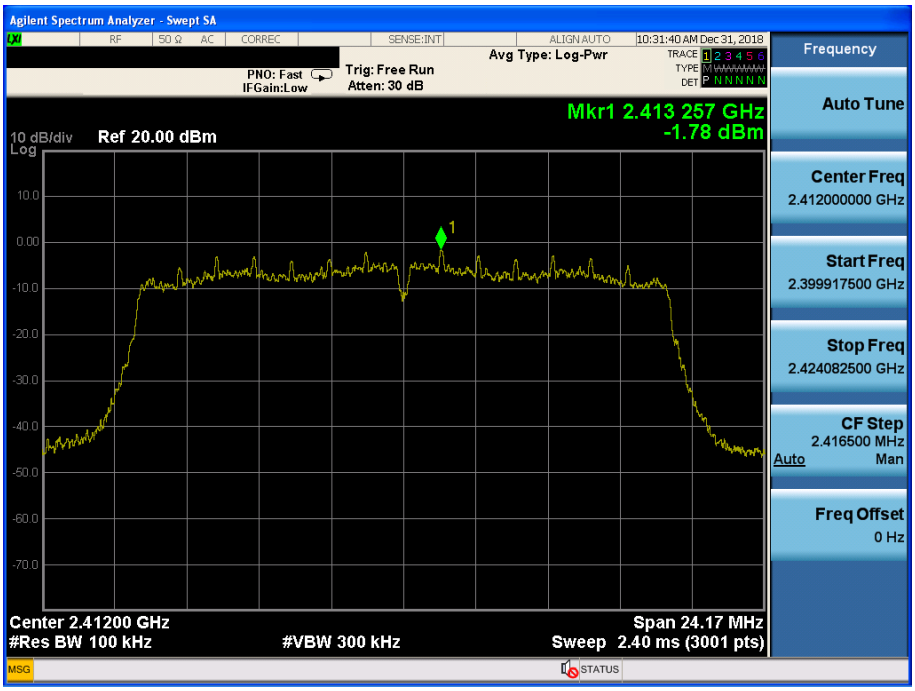


Conducted Spurious Emissions

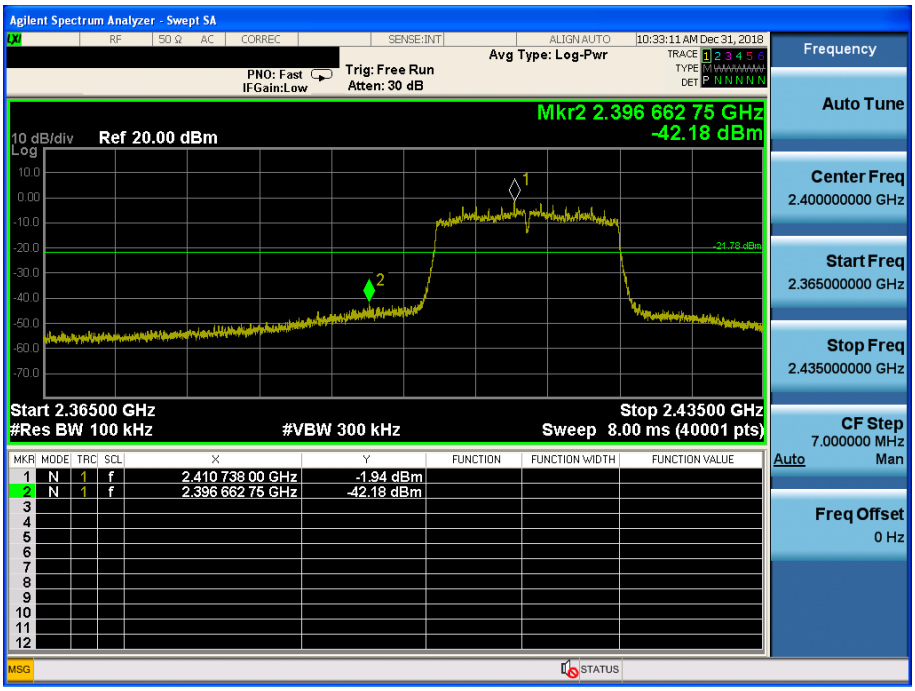


TM 3 & Lowest

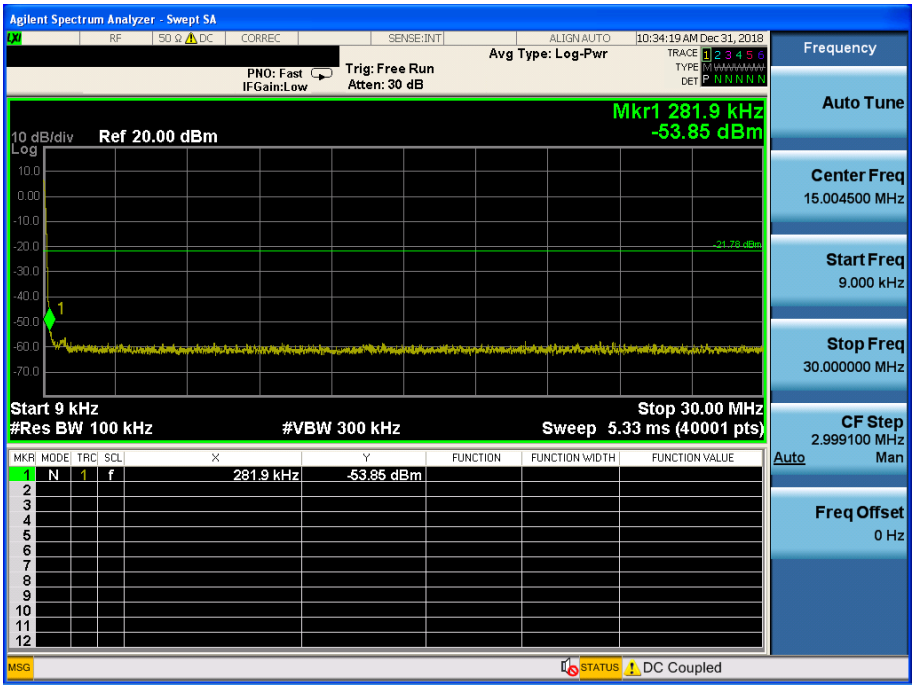
Reference

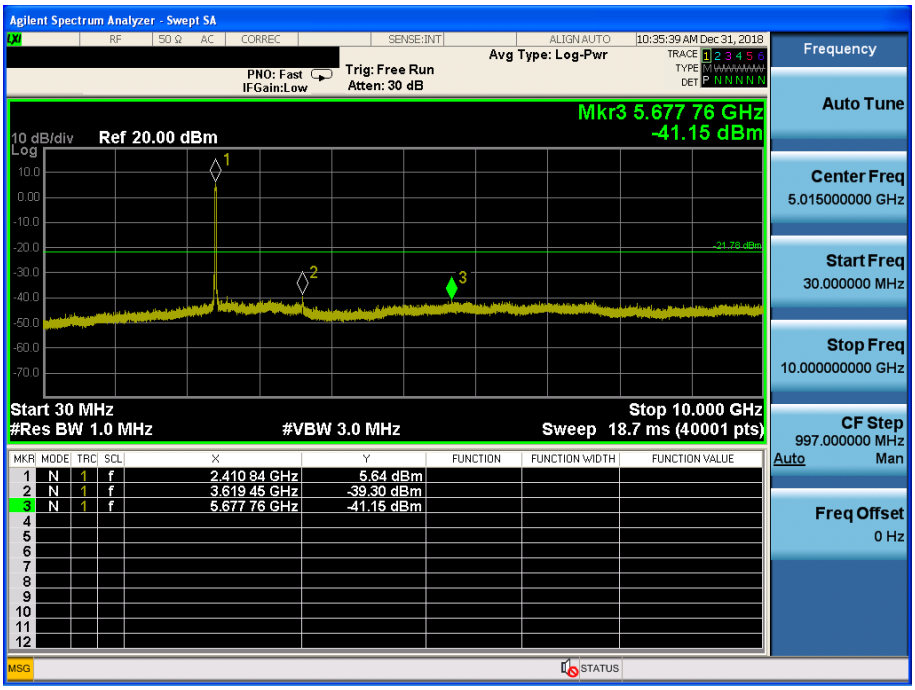


Low Band-edge

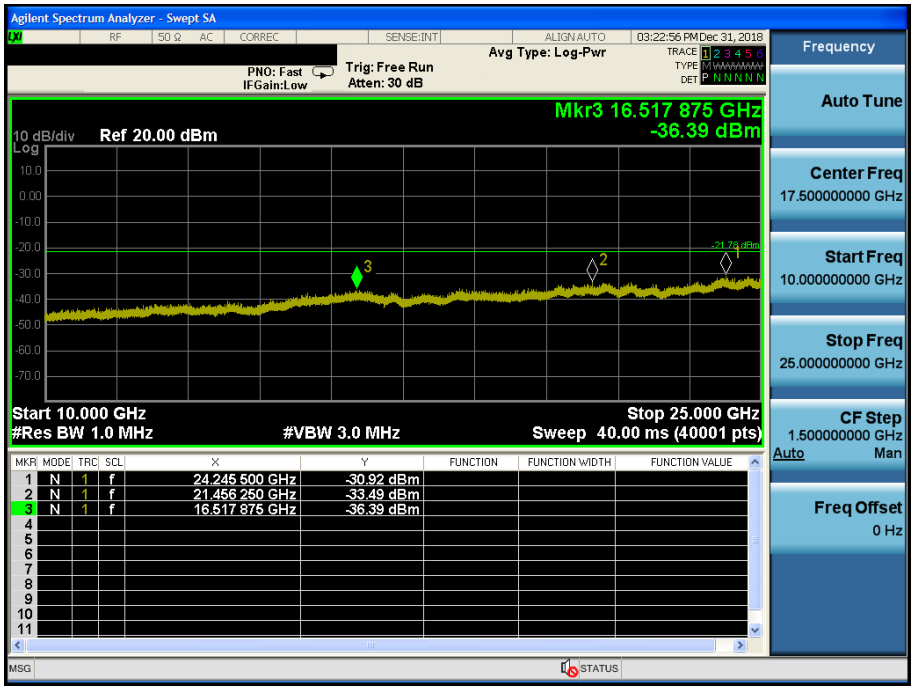


Conducted Spurious Emissions



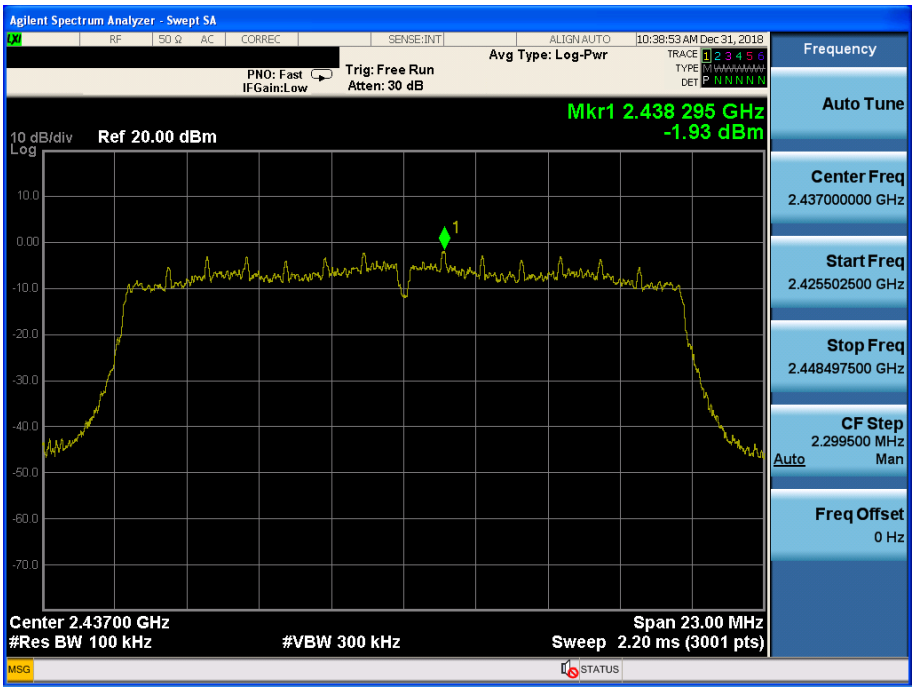


Conducted Spurious Emissions

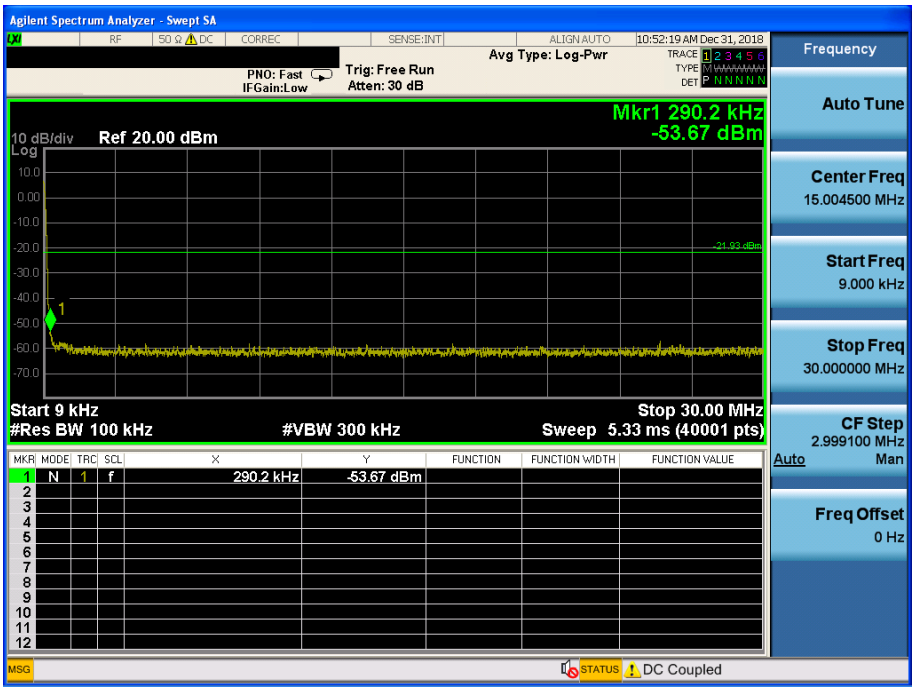


TM 3 & Middle

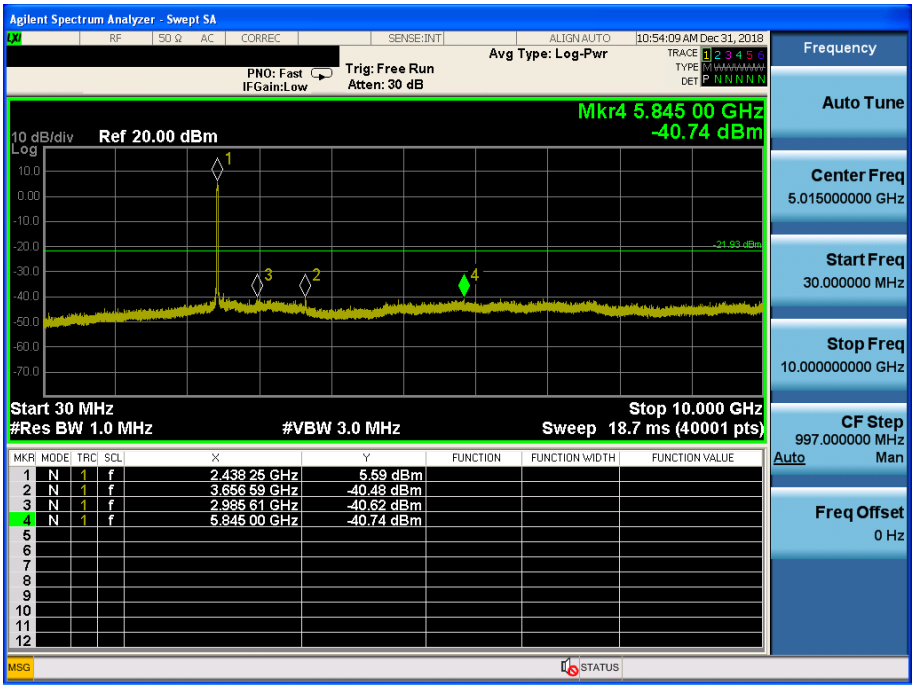
Reference

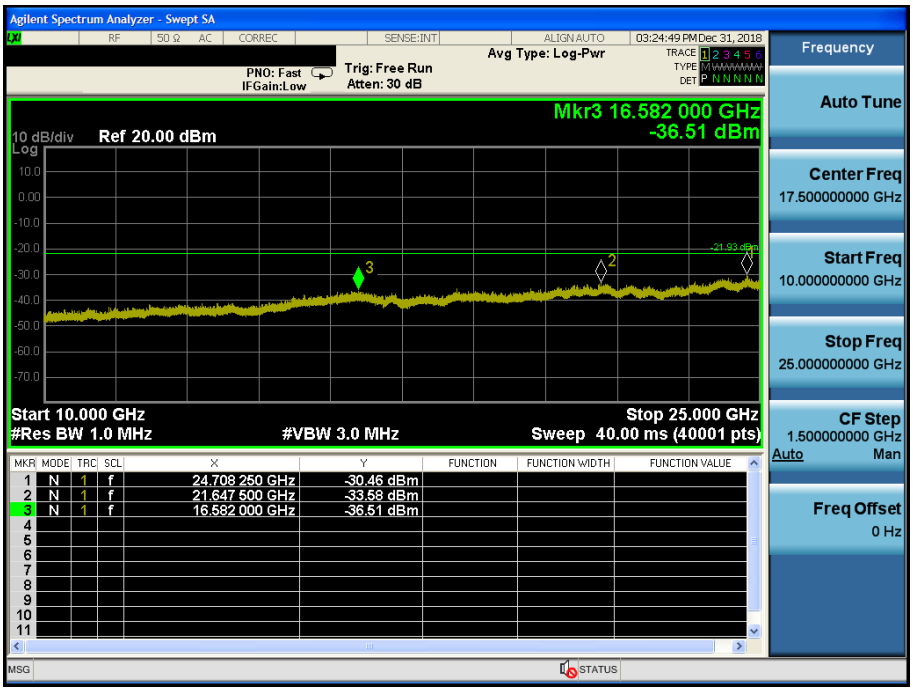


Conducted Spurious Emissions



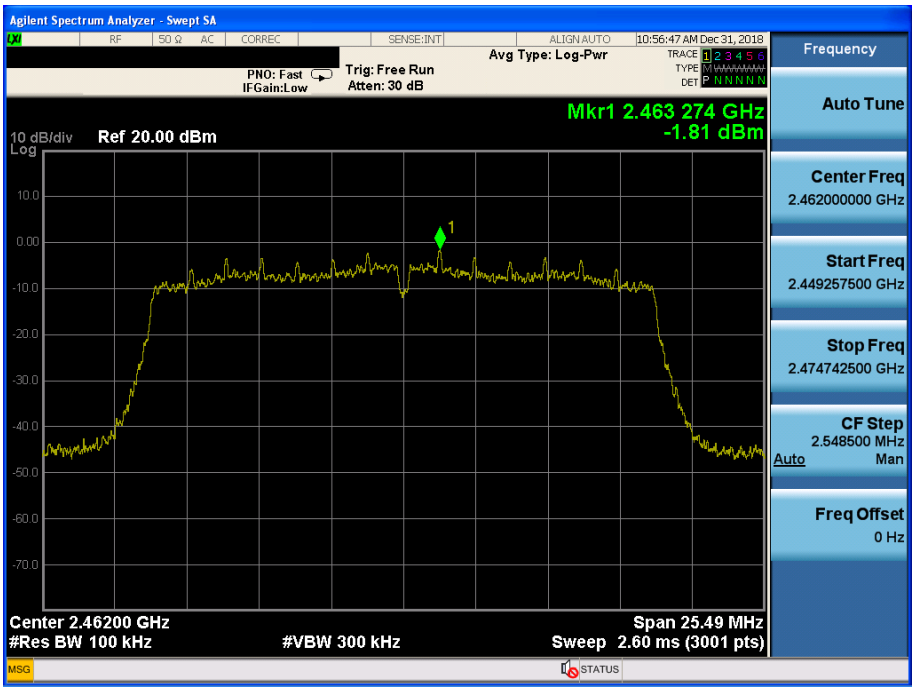
Conducted Spurious Emissions



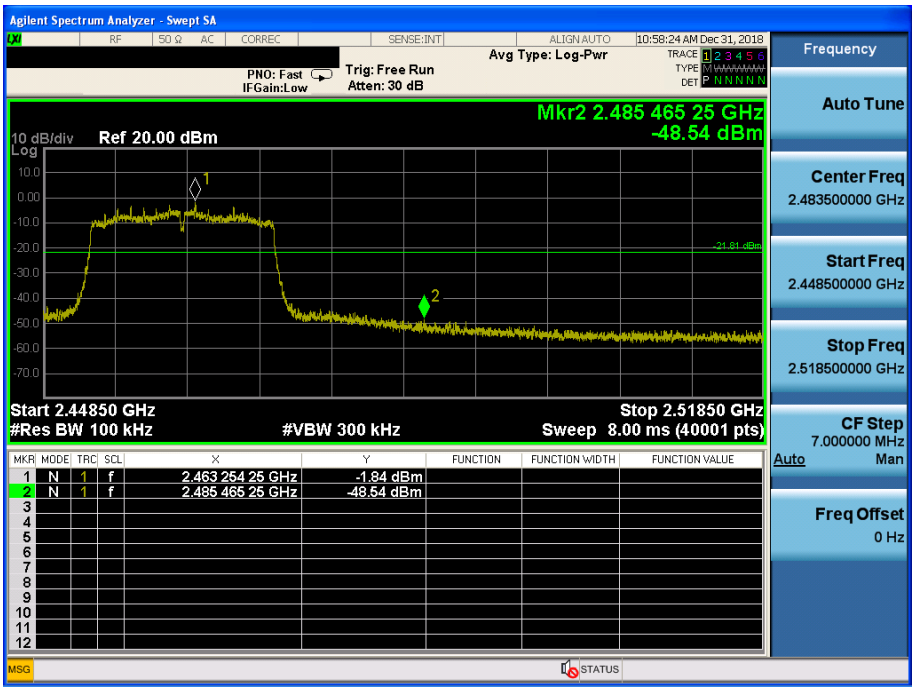


TM 3 & Highest

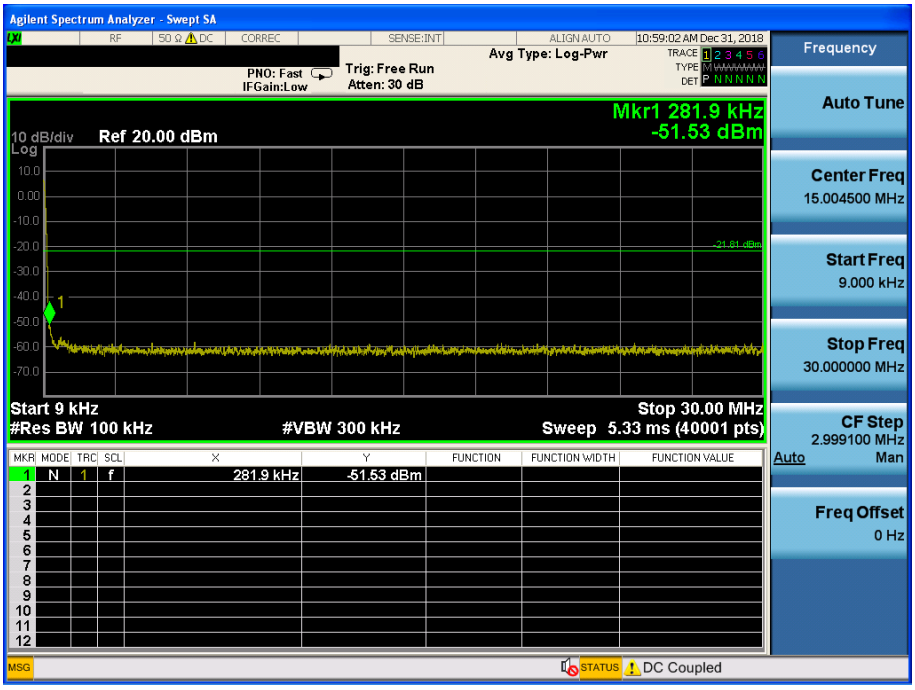
Reference

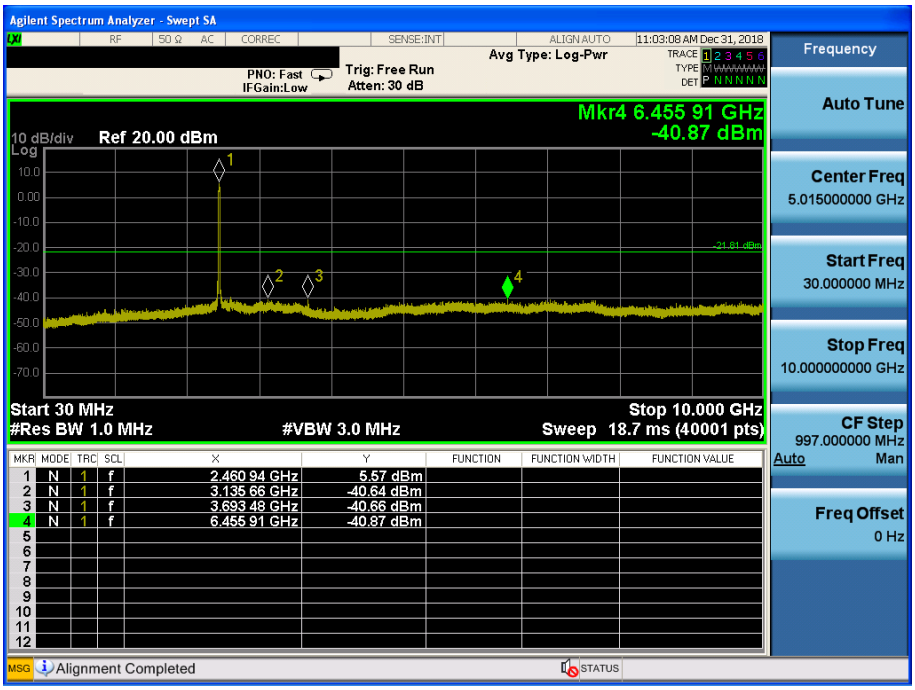


High Band-edge

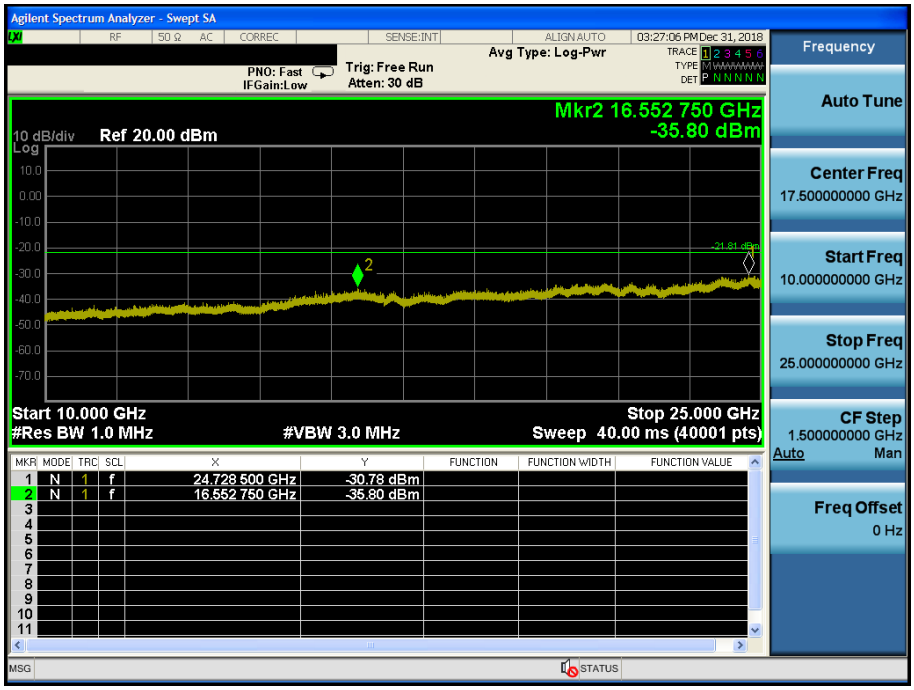


Conducted Spurious Emissions





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.

- **KDB558074 D01v05 - Section 8.6**
- **ANSI C63.10-2013 – Section 11.12**

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	99.48	-
TM 2	6Mbps	96.81	0.15
TM 3	MCS0	95.45	0.21

Note: Refer to the APPENDIX II.

▣ Test Results: Comply

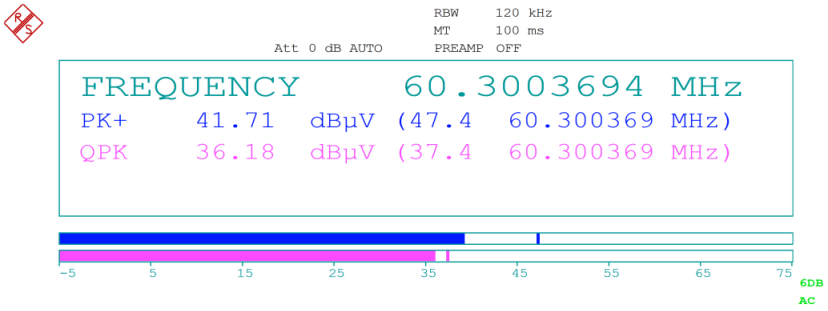
Radiated Spurious Emissions data(9 kHz ~ 1 GHz) : *TM 2*

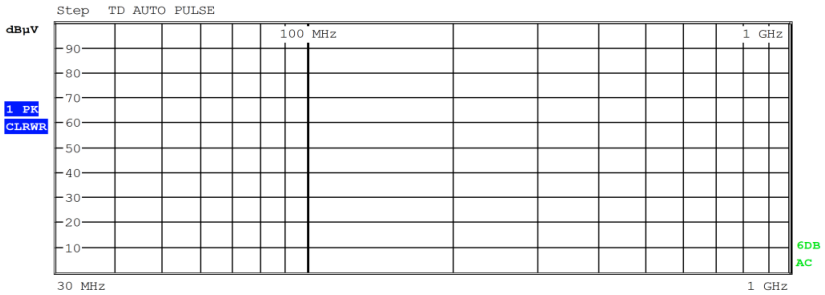
Tested Frequency	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Lowest	60.30	H	X	QP	37.40	-7.10	N/A	N/A	30.30	40.00	9.70
	61.04	V	X	QP	38.50	-7.30	N/A	N/A	31.20	40.00	8.80
	304.46	H	X	QP	36.60	-5.60	N/A	N/A	31.00	46.00	15.00
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-

Note.

1. Exploratory testing has been performed to determine the emissions characteristic of this EUT.
   And low channel of 802.11g(TM2) was selected for final testing and reported.
2. No other unwanted emissions were found above listed frequencies.
3. Information of Distance Factor
   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor (-9.54 dB) is applied to the result.
   - Calculation of distance factor = 20 log(applied distance / required distance) = 20 log(1 m / 3 m) = -9.54 dB
   When distance factor is "N/A", the distance is 3 m and distance factor is not applied.
4. 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

TM 2 & Lowest & X axis & Hor **Detector Mode : QP**





Radiated Spurious Emissions data(1 ~ 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	2387.98	H	Z	PK	53.37	2.30	N/A	N/A	55.67	74.00	18.33
	2388.86	H	Z	AV	44.36	2.30	N/A	N/A	46.66	54.00	7.34
	4823.96	V	Y	PK	50.48	0.84	N/A	N/A	51.32	74.00	22.68
	4824.16	V	Y	AV	39.71	0.84	N/A	N/A	40.55	54.00	13.45
Middle	4873.27	V	Y	PK	50.02	0.87	N/A	N/A	50.89	74.00	23.11
	4873.88	V	Y	AV	40.34	0.87	N/A	N/A	41.21	54.00	12.79
Highest	2483.96	H	Z	PK	54.86	2.61	N/A	N/A	57.47	74.00	16.53
	2483.58	H	Z	AV	44.79	2.61	N/A	N/A	47.40	54.00	6.60
	4924.55	V	Y	PK	49.77	0.98	N/A	N/A	50.75	74.00	23.25
	4923.84	V	Y	AV	39.59	0.98	N/A	N/A	40.57	54.00	13.43

Note.

1. The radiated emissions were investigated up 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(1 ~ 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	2387.41	H	Z	PK	54.12	2.30	N/A	N/A	56.42	74.00	17.58
	2389.63	H	Z	AV	44.44	2.30	0.15	N/A	46.89	54.00	7.11
	4822.92	V	Y	PK	50.51	0.84	N/A	N/A	51.35	74.00	22.65
	4824.77	V	Y	AV	39.53	0.84	0.15	N/A	40.52	54.00	13.48
Middle	4877.03	V	Y	PK	50.02	0.87	N/A	N/A	50.89	74.00	23.11
	4875.98	V	Y	AV	39.36	0.87	0.15	N/A	40.38	54.00	13.62
Highest	2483.65	H	Z	PK	61.34	2.61	N/A	N/A	63.95	74.00	10.05
	2483.65	H	Z	AV	46.32	2.61	0.15	N/A	49.08	54.00	4.92
	4922.82	V	Y	PK	49.67	0.97	N/A	N/A	50.64	74.00	23.36
	4924.80	V	Y	AV	38.96	0.97	0.15	N/A	40.08	54.00	13.92

Note.

1. The radiated emissions were investigated up 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(1 ~ 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	2384.62	H	Z	PK	54.12	2.29	N/A	N/A	56.41	74.00	17.59
	2389.43	H	Z	AV	44.41	2.29	0.21	N/A	46.91	54.00	7.09
	4823.79	V	Y	PK	50.40	0.84	N/A	N/A	51.24	74.00	22.76
	4823.23	V	Y	AV	39.73	0.84	0.21	N/A	40.78	54.00	13.22
Middle	4875.04	V	Y	PK	49.91	0.87	N/A	N/A	50.78	74.00	23.22
	4873.05	V	Y	AV	39.80	0.87	0.21	N/A	40.88	54.00	13.12
Highest	2483.56	H	Z	PK	58.49	2.61	N/A	N/A	61.10	74.00	12.90
	2483.67	H	Z	AV	46.17	2.61	0.21	N/A	48.99	54.00	5.01
	4923.24	V	Y	PK	50.12	0.98	N/A	N/A	51.10	74.00	22.90
	4924.51	V	Y	AV	39.47	0.98	0.21	N/A	40.66	54.00	13.34

Note.

1. The radiated emissions were investigated up 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: Comply(Refer to next page.)

The worst data was reported.

▣ RESULT PLOTS

AC Line Conducted Emissions (Graph)

Test Mode: TM 2 & 2412 MHz

Results of Conducted Emission

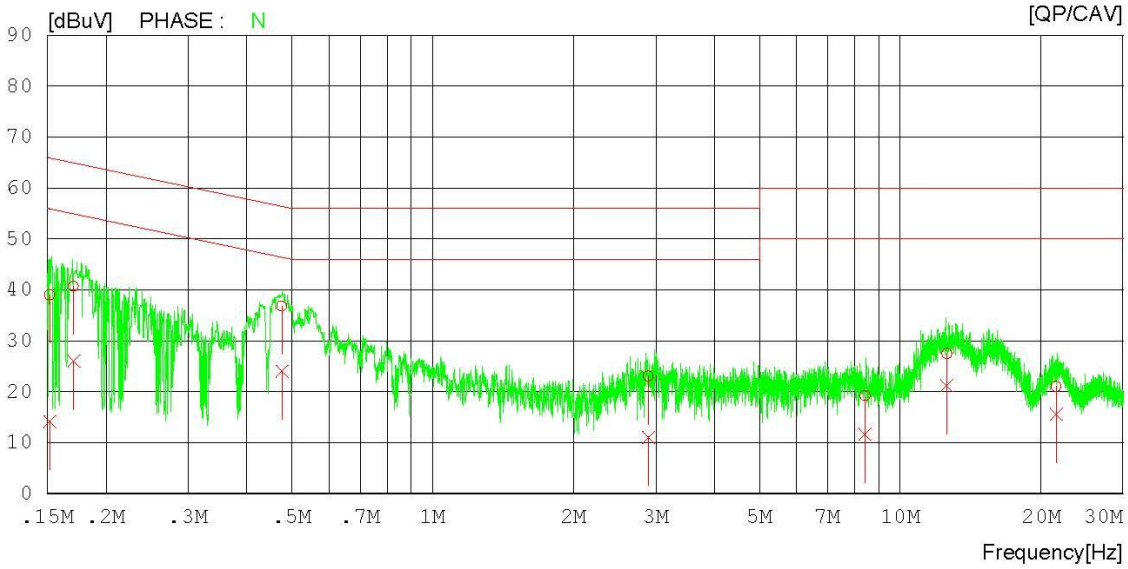
DTNC

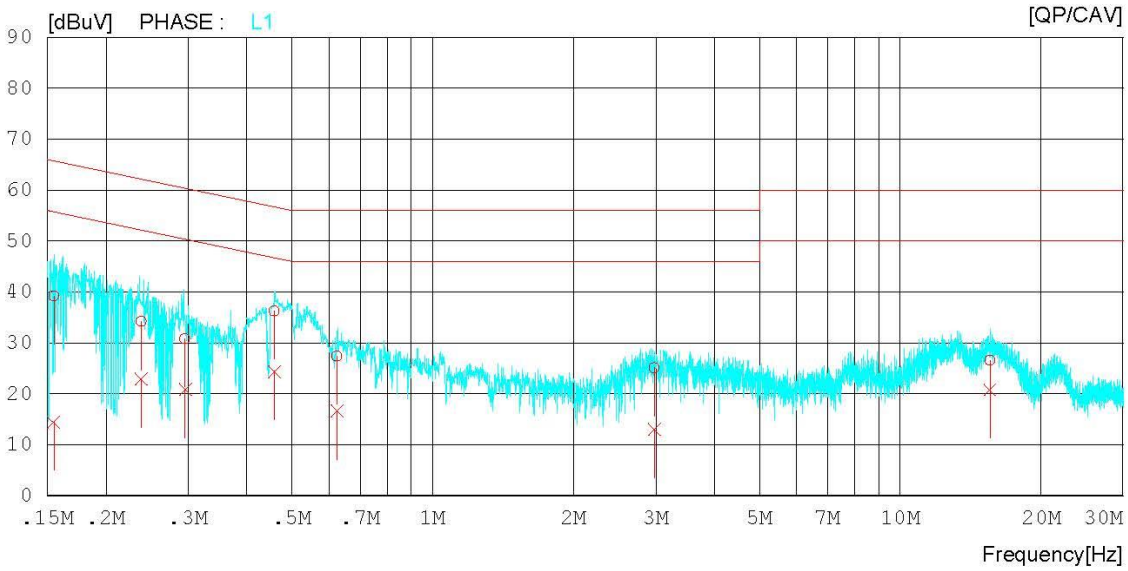
Date 2019-01-02

Order No.		Referrence No.	
Model No.	Rayo S1	Power Supply	120 V, 60 Hz
Serial No.		Temp/Humi.	23 'C / 45 %
Test Condition	2.4G (WLAN)	Operator	MyungHoon LEE

Memo

LIMIT : FCC P15.207 QP
FCC P15.207 AV





AC Line Conducted Emissions (List)

Test Mode: TM 2 & 2412 MHz

Results of Conducted Emission

DTNC

Date 2019-01-02

Order No.		Referrence No.	
Model No.	Rayo S1	Power Supply	120 V, 60 Hz
Serial No.		Temp/Humi.	23 'C / 45 %
Test Condition	2.4G (WLAN)	Operator	MyungHoon LEE

Memo

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ [MHz]	READING QP [dBuV]	READING CAV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT CAV [dBuV]	LIMIT QP [dBuV]	LIMIT CAV [dBuV]	MARGIN QP [dBuV]	MARGIN CAV [dBuV]	PHASE
1	0.15178	28.71	3.83	10.28	38.99	14.11	65.90	55.90	26.91	41.79	N
2	0.17075	30.56	15.85	10.17	40.73	26.02	64.92	54.92	24.19	28.90	N
3	0.47582	26.86	13.99	10.02	36.88	24.01	56.41	46.41	19.53	22.40	N
4	2.89520	12.98	0.96	10.14	23.12	11.10	56.00	46.00	32.88	34.90	N
5	8.40800	8.93	1.29	10.32	19.25	11.61	60.00	50.00	40.75	38.39	N
6	12.57980	17.01	10.76	10.45	27.46	21.21	60.00	50.00	32.54	28.79	N
7	21.54400	10.37	4.99	10.61	20.98	15.60	60.00	50.00	39.02	34.40	N
8	0.15471	28.93	4.15	10.23	39.16	14.38	65.74	55.74	26.58	41.36	L1
9	0.23804	24.15	12.85	9.97	34.12	22.82	62.16	52.16	28.04	29.34	L1
10	0.29539	20.80	10.86	9.98	30.78	20.84	60.37	50.37	29.59	29.53	L1
11	0.45882	26.26	14.35	10.00	36.26	24.35	56.71	46.71	20.45	22.36	L1
12	0.62448	17.32	6.55	10.01	27.33	16.56	56.00	46.00	28.67	29.44	L1
13	2.97920	14.93	2.88	10.11	25.04	12.99	56.00	46.00	30.96	33.01	L1
14	15.55000	16.01	10.26	10.48	26.49	20.74	60.00	50.00	33.51	29.26	L1

8.7 Occupied Bandwidth

Test Requirements, RSS-Gen [6.7]

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.

▣ TEST CONFIGURATION

Refer to the APPENDIX I.

▣ TEST PROCEDURE

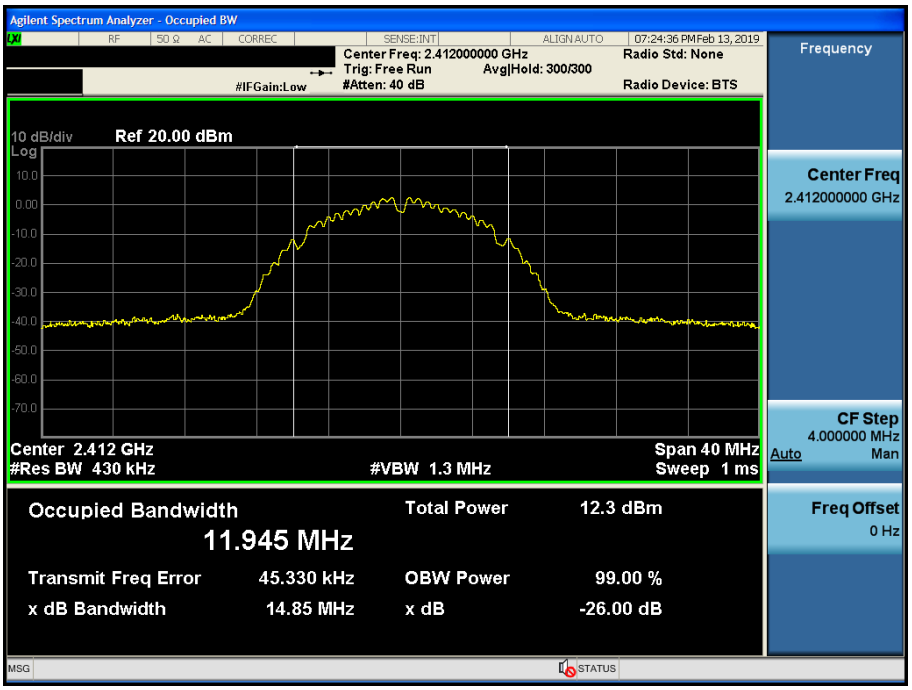
- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

▣ TEST RESULTS: Comply

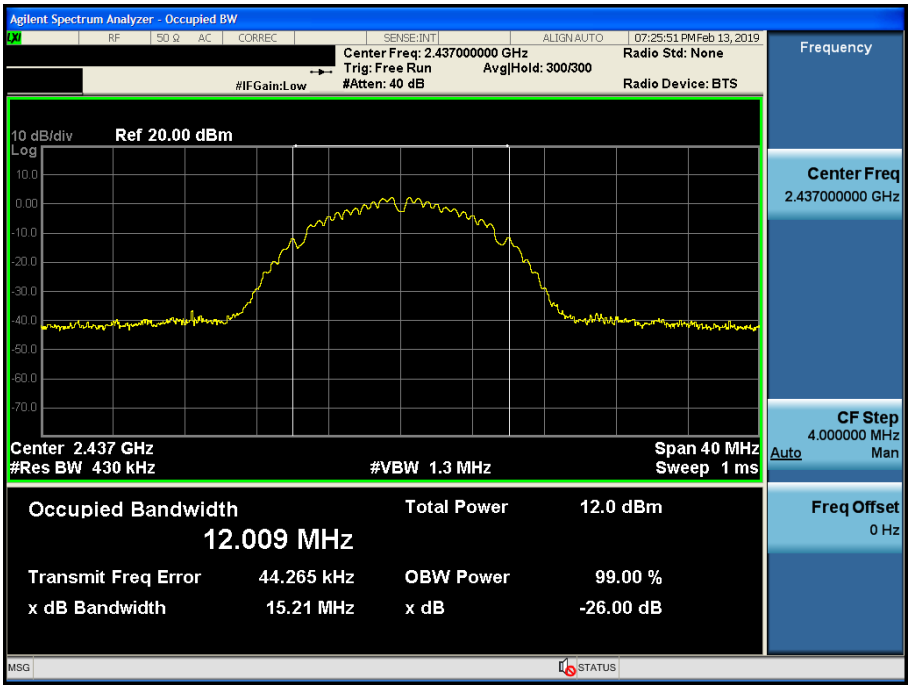
Test Mode	Frequency	Test Results[MHz]
TM 1	Lowest	11.95
	Middle	12.01
	Highest	12.08
TM 2	Lowest	16.58
	Middle	16.59
	Highest	16.64
TM 3	Lowest	17.50
	Middle	17.54
	Highest	17.55

▣ RESULT PLOTS

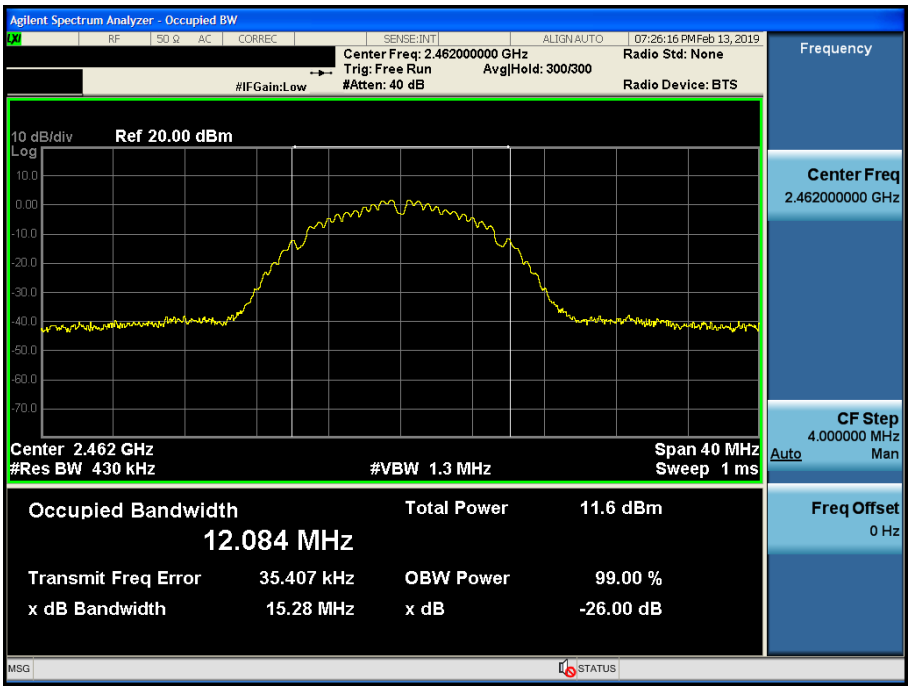
Occupied Bandwidth Test Mode: TM 1 & 2412 MHz



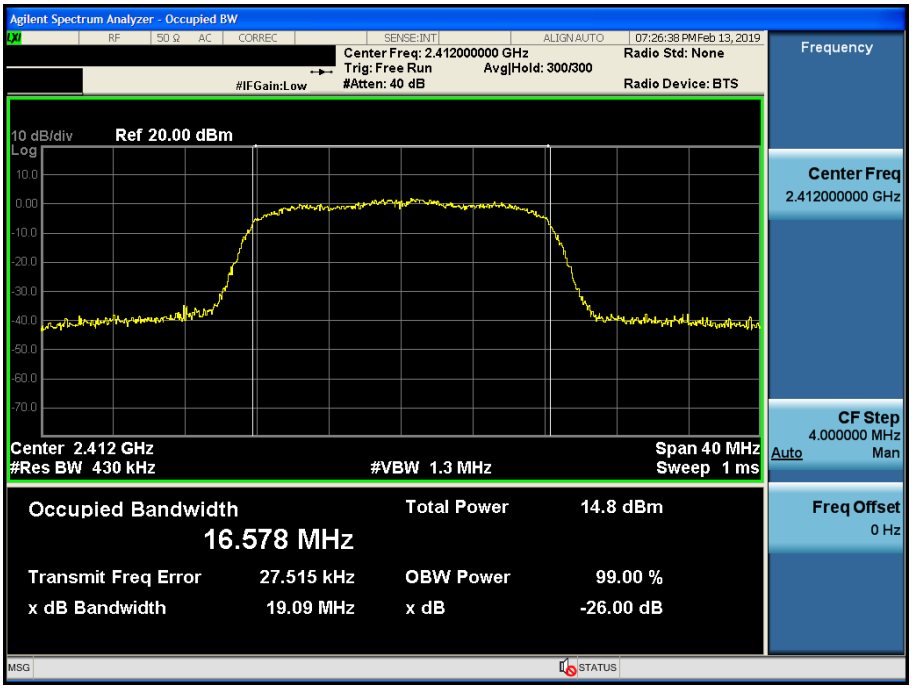
Occupied Bandwidth Test Mode: TM 1 & 2437 MHz



Occupied Bandwidth Test Mode: TM 1 & 2462 MHz

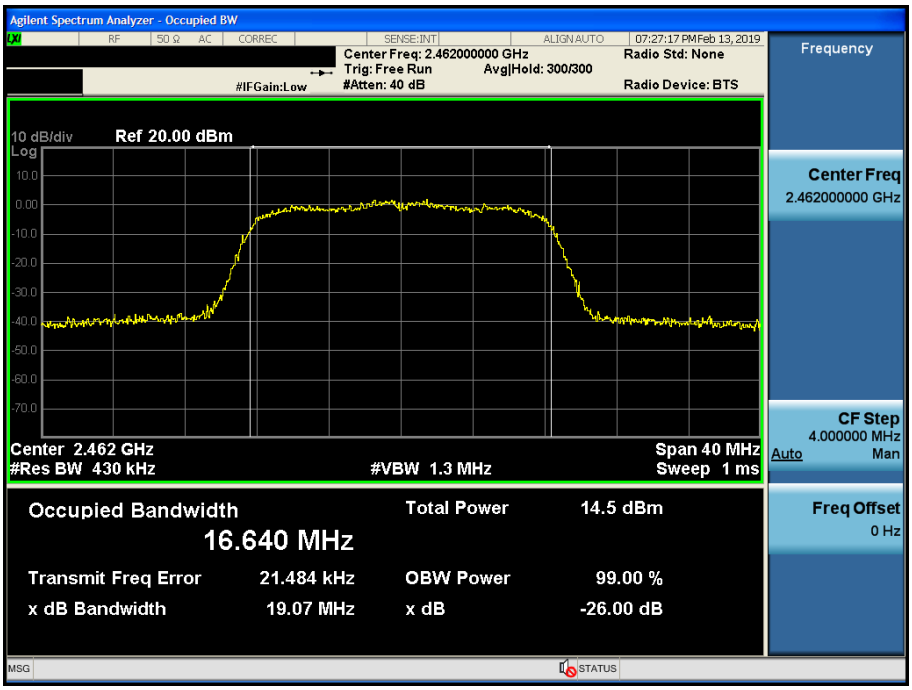


Occupied Bandwidth Test Mode: TM 2 & 2412 MHz

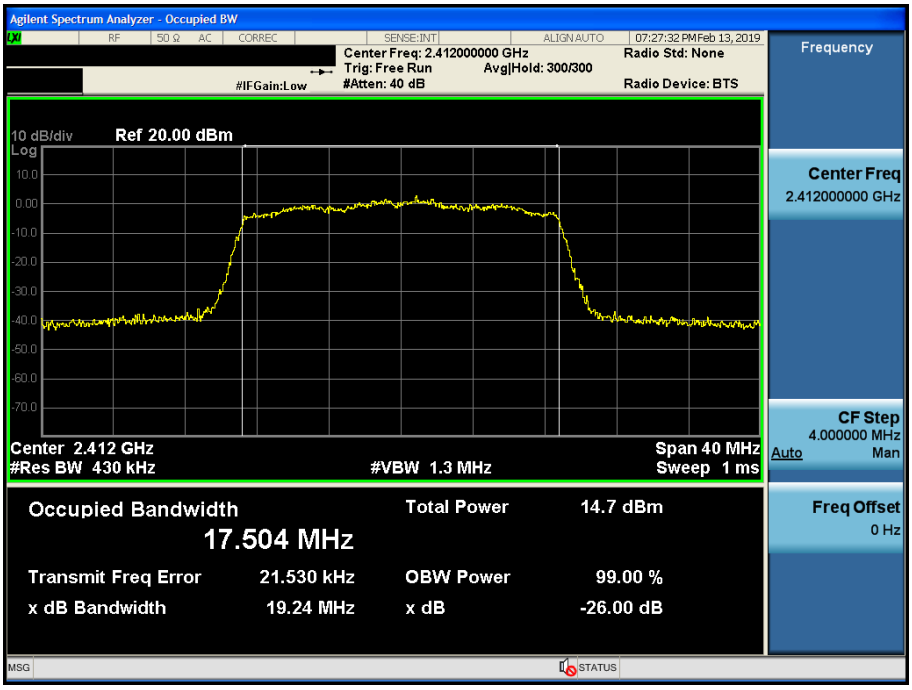


Occupied Bandwidth Test Mode: TM 2 & 2437 MHz

Occupied Bandwidth Test Mode: TM 2 & & 2462 MHz



Occupied Bandwidth Test Mode: TM 3 & 2412 MHz



Occupied Bandwidth Test Mode: TM 3 & 2437 MHz

Occupied Bandwidth Test Mode: TM 3 & 2462 MHz

9. LIST OF TEST EQUIPMENT

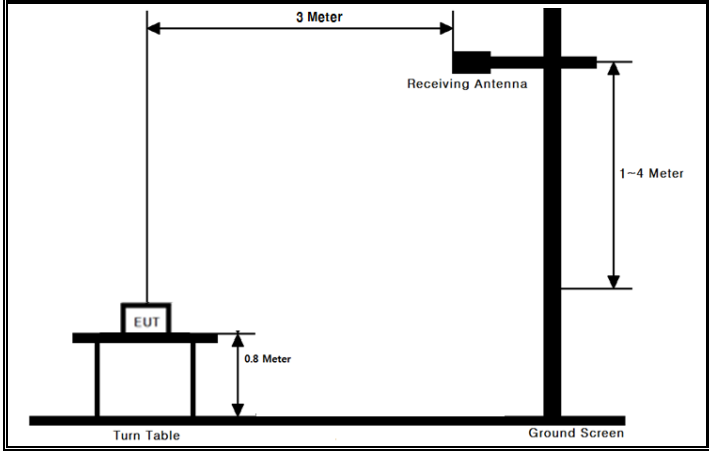
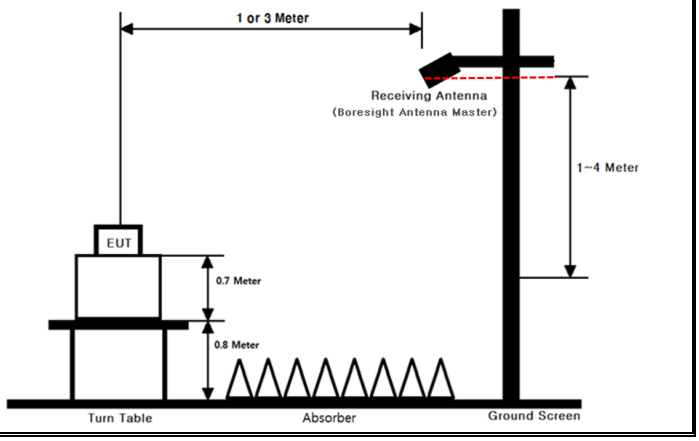
Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	18/12/19	19/12/19	MY48011700
Spectrum Analyzer	Agilent Technologies	N9020A	18/12/19	19/12/19	MY50410357
Horn Antenna	ETS-Lindgren	3115	18/01/30	20/01/30	6419
Horn Antenna	Schwarzbeck	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
Loop Antenna	Schwarzbeck	FMZB1513	18/01/30	20/01/30	1513-128
Biglog Antenna	Schwarzbeck	VULB 9160	18/07/13	20/07/13	3359
EMI Test Receiver	Rohde Schwarz	ESCI7	18/03/13	19/03/13	100364
EMI Test Receiver	Rohde Schwarz	ESCI7	18/02/12 19/01/30	19/02/12 20/01/30	100910
Multimeter	FLUKE	17B	18/12/18	19/12/18	26030065WS
Thermohygrometer	BODYCOM	BJ5478	18/07/09	19/07/09	NA
Thermohygrometer	BODYCOM	BJ5478	18/01/03 18/12/27	19/01/03 19/12/27	120612-1
Thermohygrometer	BODYCOM	BJ5478	18/01/03 18/12/27	19/01/03 19/12/27	120612-2
HYGROMETER	TESTO	608-H1	18/02/10 19/01/31	19/02/10 20/01/31	34862883
Signal Generator	Rohde Schwarz	SMBV100A	18/12/19	19/12/19	255571
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	18/09/27	19/09/27	101333
LISN	SCHWARZBECK	NNLK 8121	18/03/20	19/03/20	06183
PreAmplifier	H.P	8447D	18/12/18	19/12/18	2944A07774
PreAmplifier	tsj	MLA-0118-J01-45	18/12/19	19/12/19	17138
PreAmplifier	tsj	MLA-1840-J02-45	18/07/06	19/07/06	16966-10728
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	18/07/02	19/07/02	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	18/07/04	19/07/04	1338003 1249304
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-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-20
Cable	DT&C	Cable	18/07/05	19/07/05	RF-82

Note 1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.
Note 2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

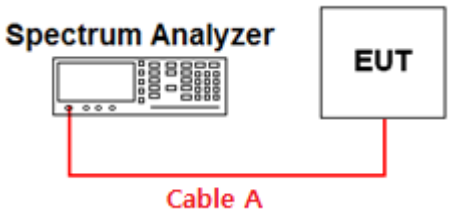
APPENDIX I

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	0.61	15	5.29
1	1.17	20	7.19
2.412 & 2.437 & 2.462	1.92	25	7.69
5	2.83	-	-
10	4.01	-	-

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

APPENDIX II

Duty cycle plots

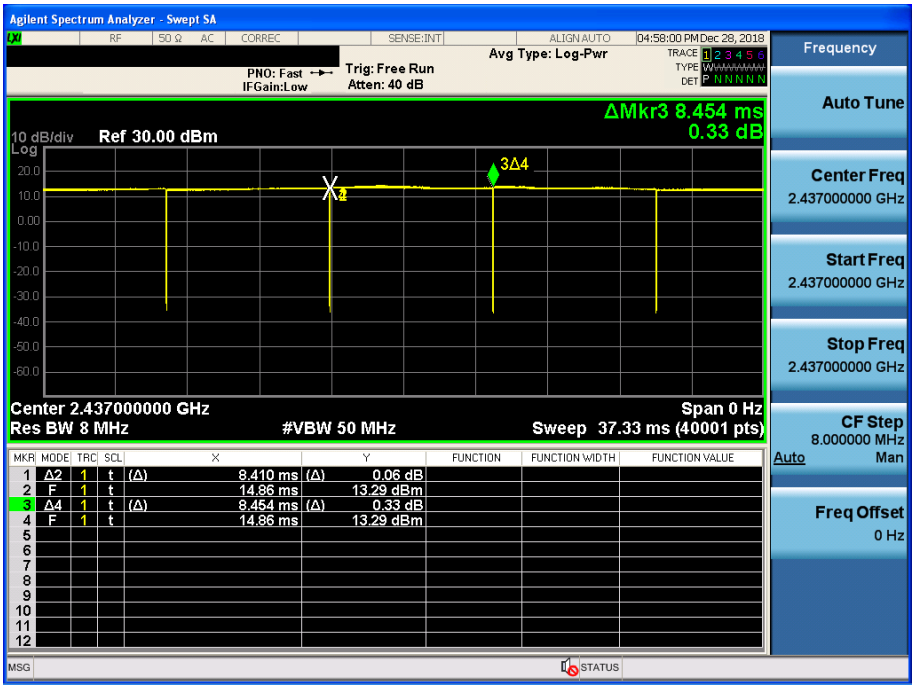
▪ Test Procedure

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

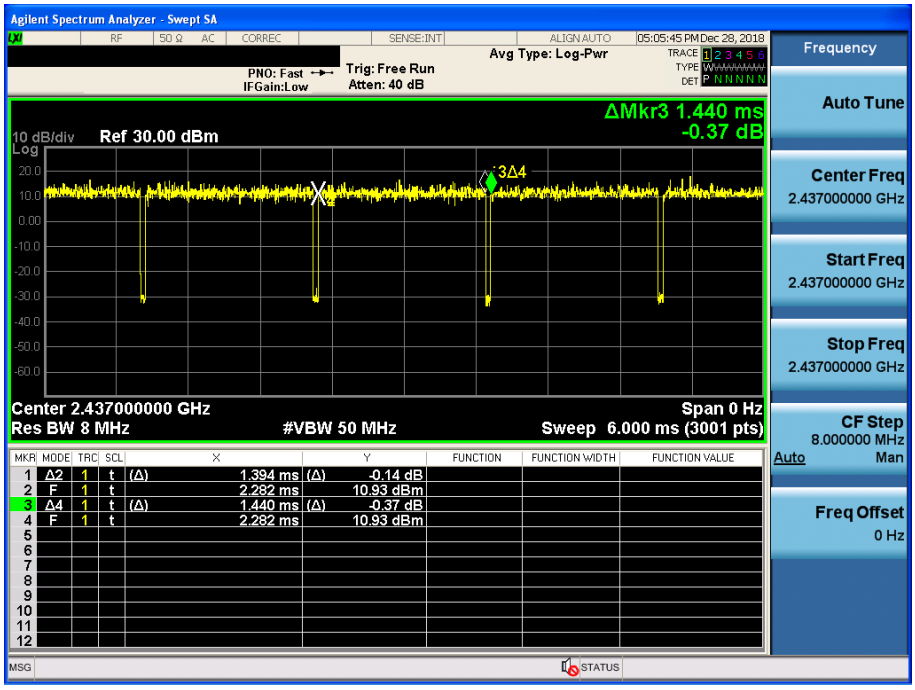
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. 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.)

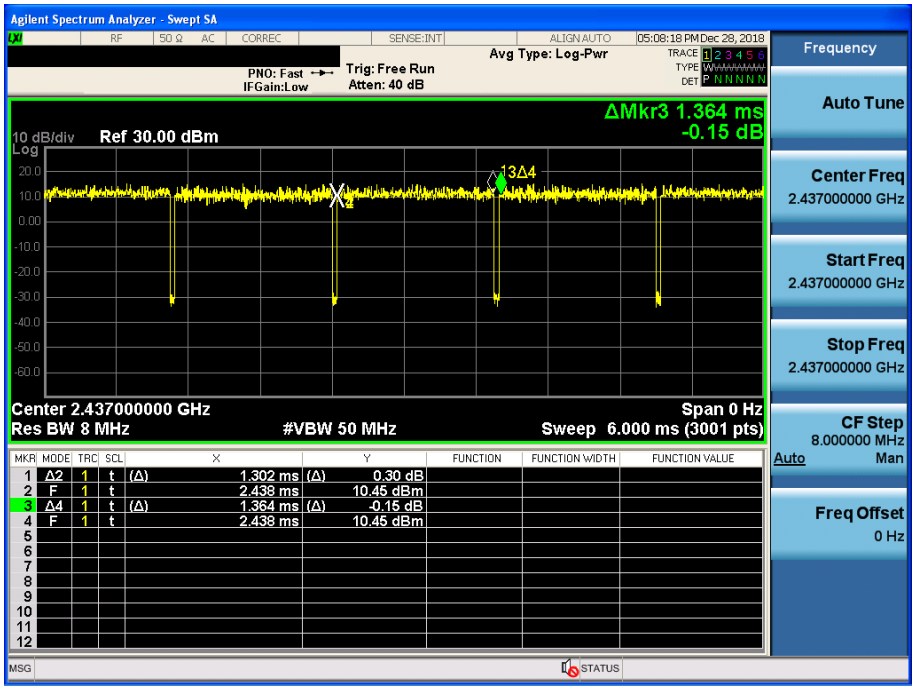
Duty Cycle TM 1 & Middle



Duty Cycle TM 2 & Middle



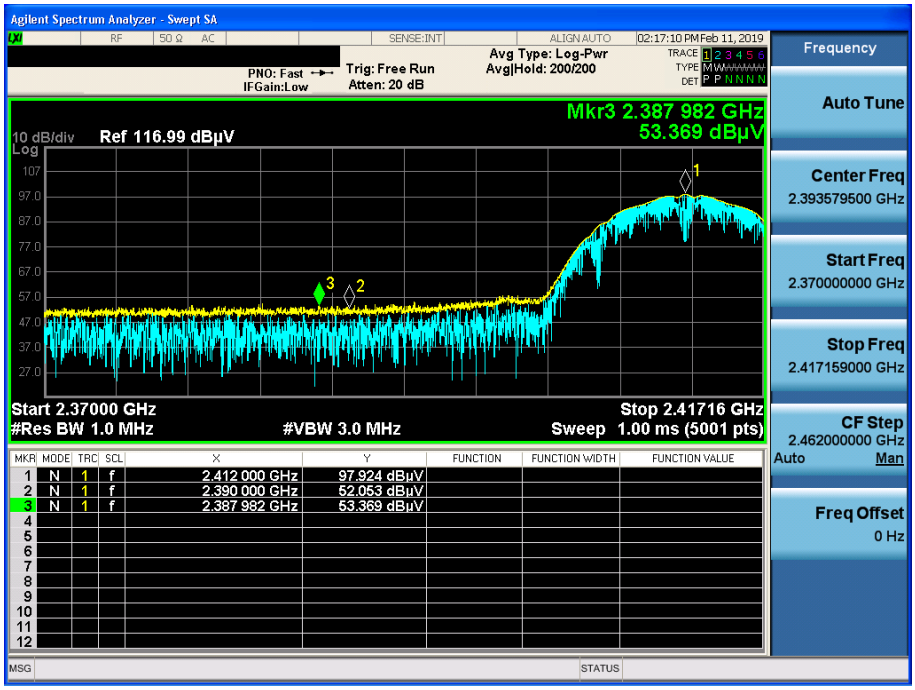
Duty Cycle TM 3 & Middle



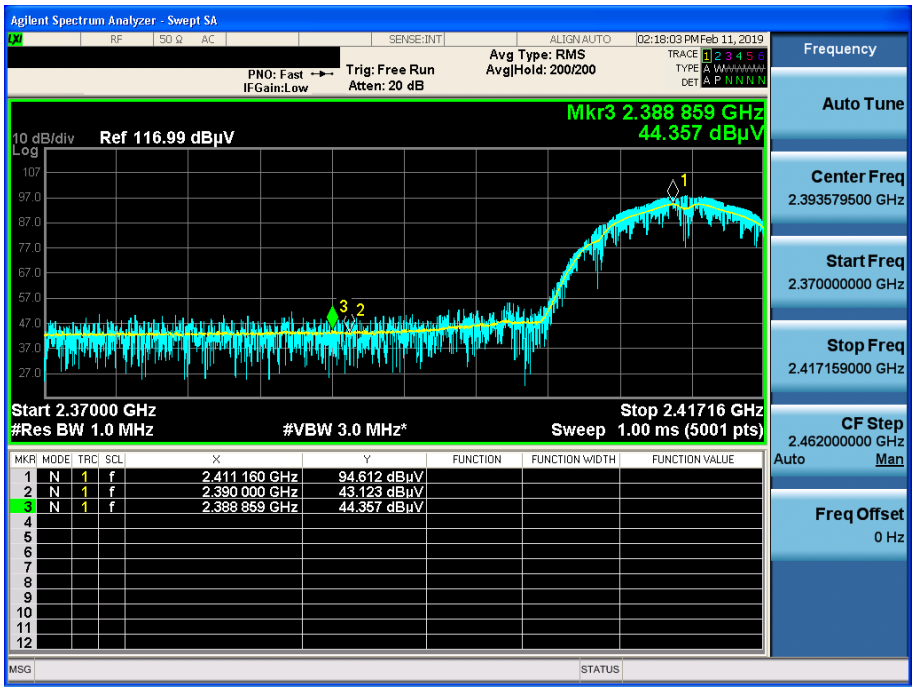
APPENDIX III

Unwanted Emissions (Radiated) Test Plot

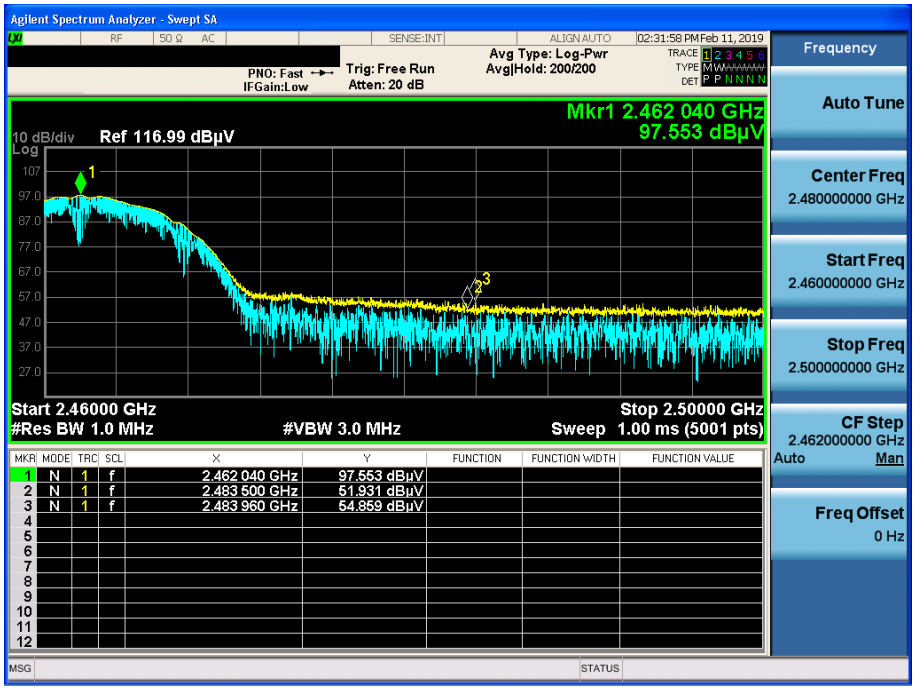
TM 1 & Lowest & Z axis & Hor **Detector Mode : PK**



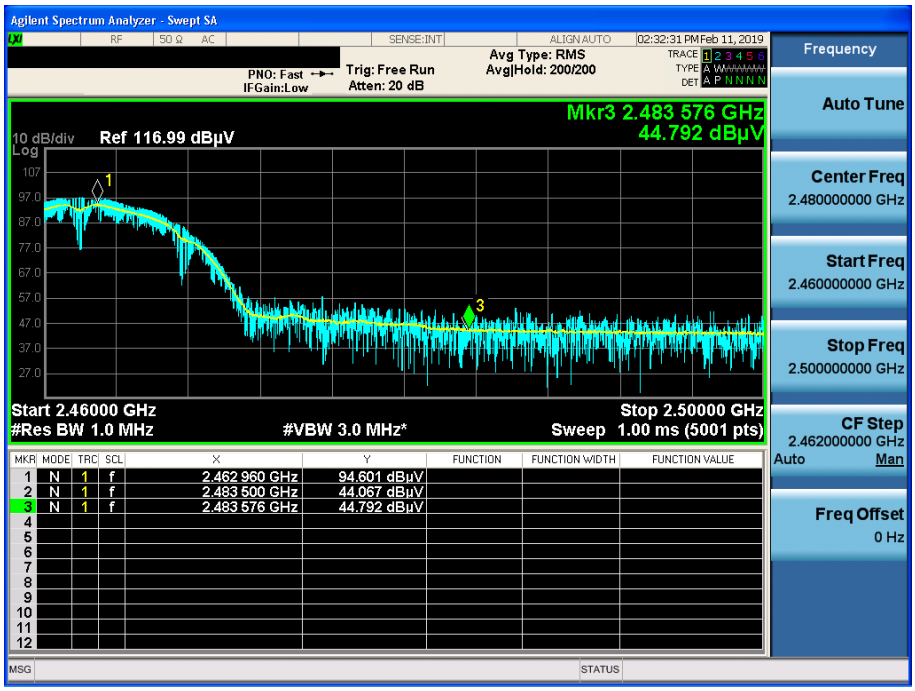
TM 1 & Lowest & Z axis & Hor **Detector Mode : AV**



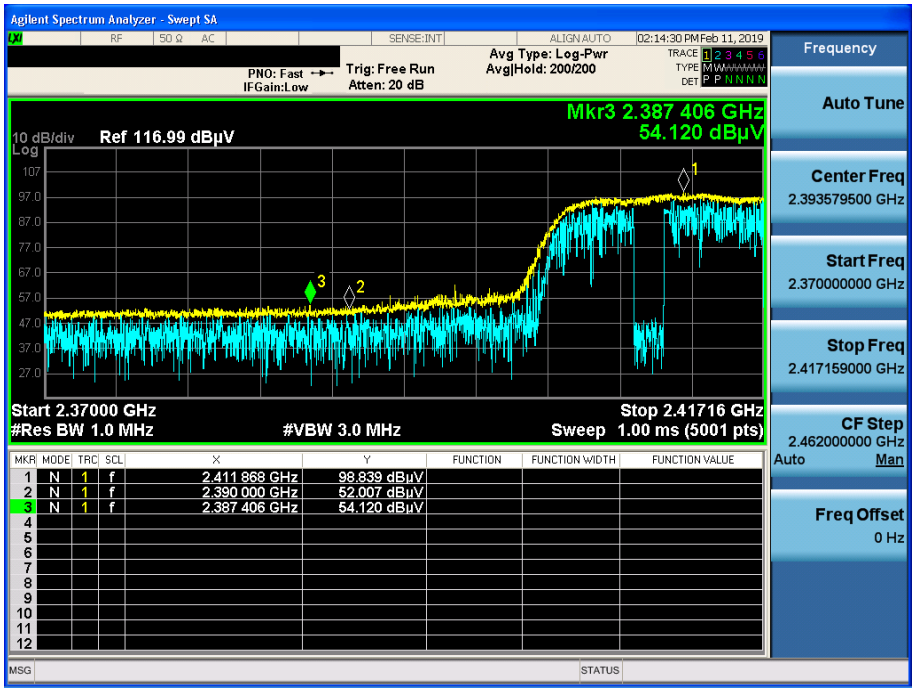
TM 1 & Highest & Z axis & Hor **Detector Mode : PK**



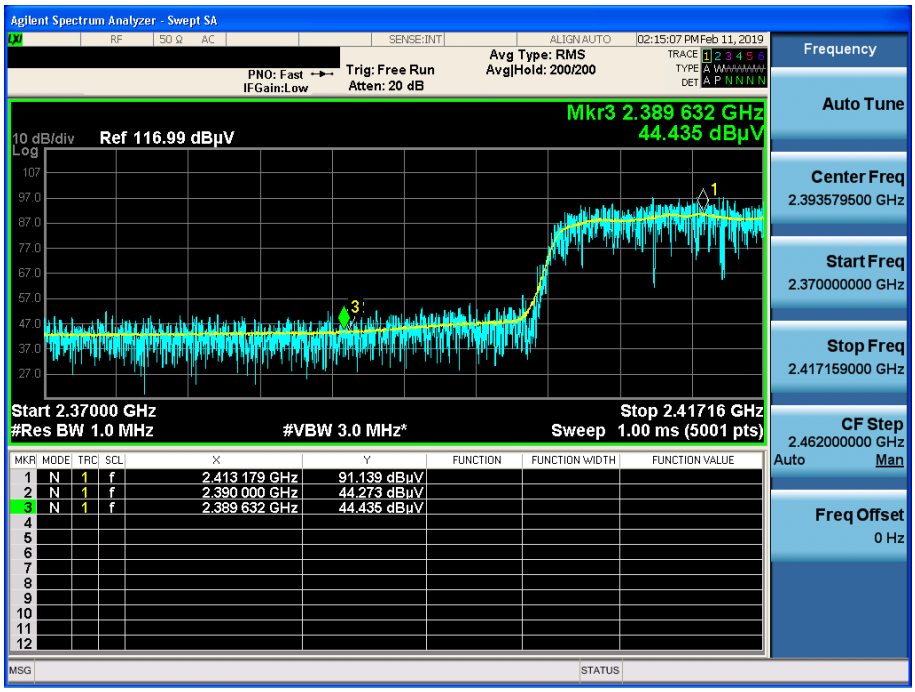
TM 1 & Highest & Z axis & Hor **Detector Mode : AV**



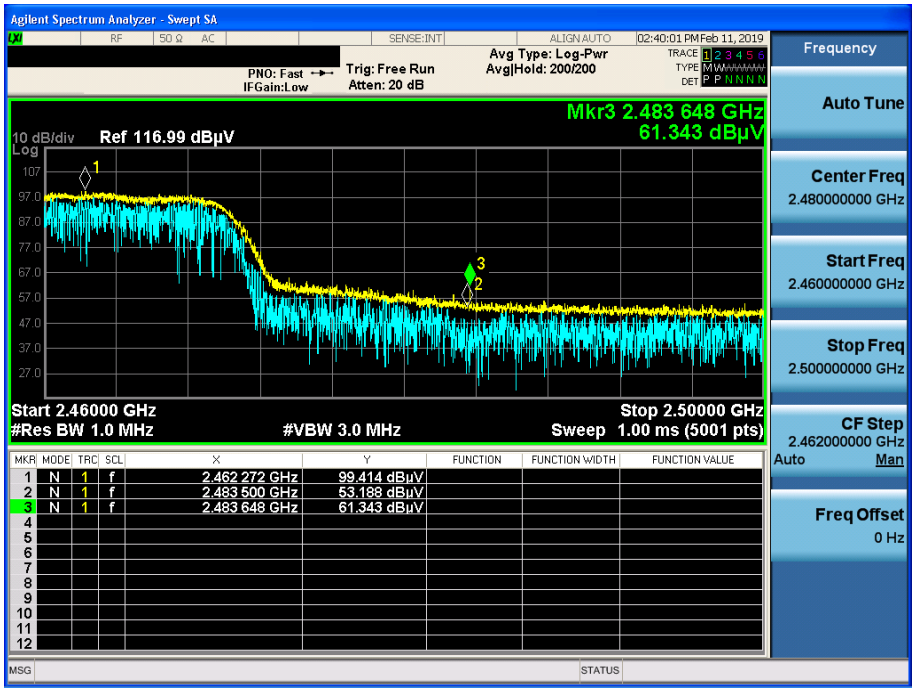
TM 2 & Lowest & Z axis & Hor **Detector Mode : PK**



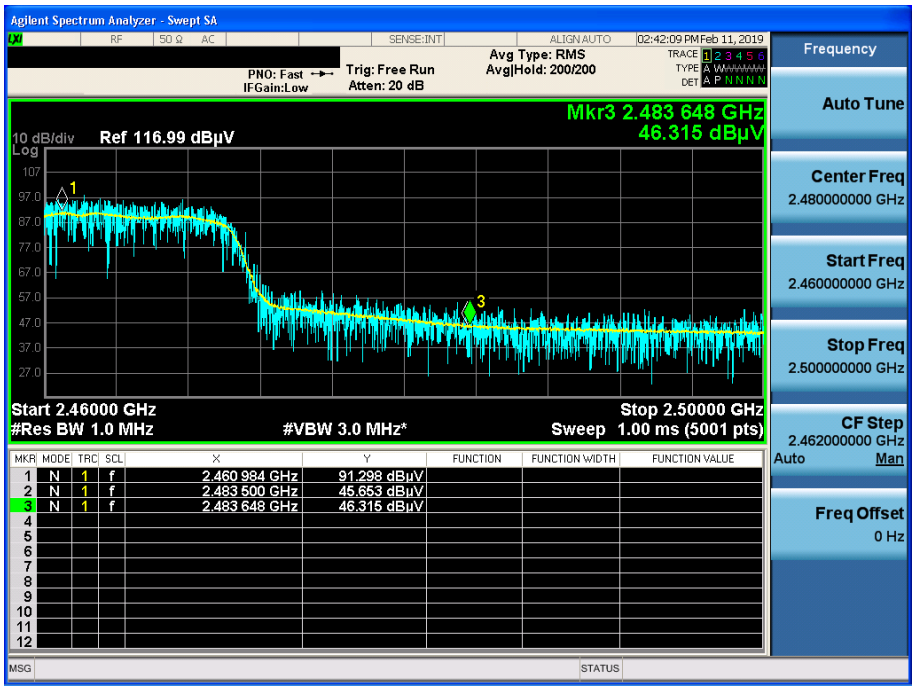
TM 2 & Lowest & Z axis & Hor **Detector Mode : AV**



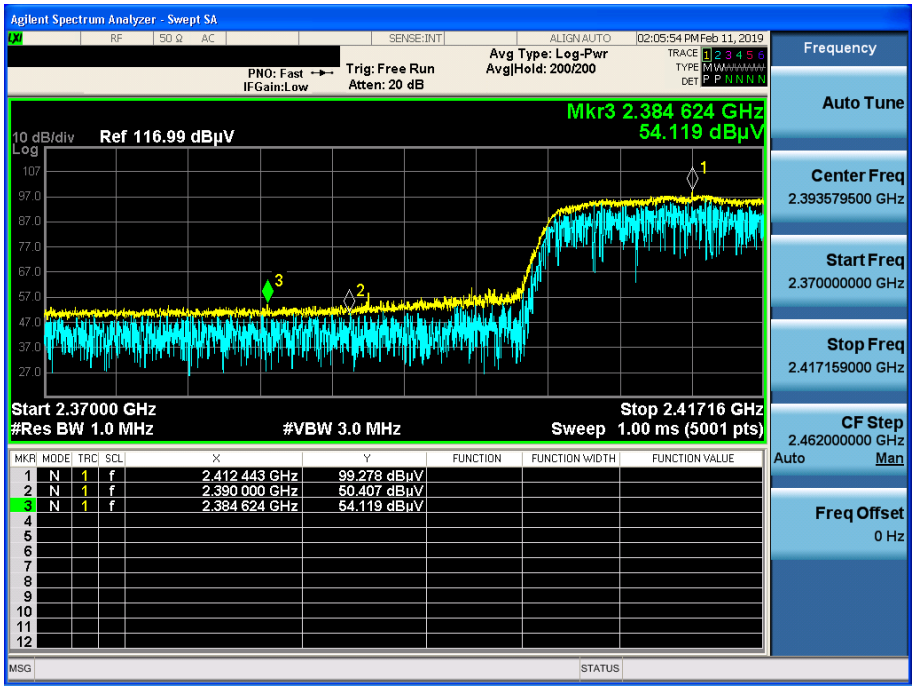
TM 2 & Highest & Z axis & Hor **Detector Mode : PK**



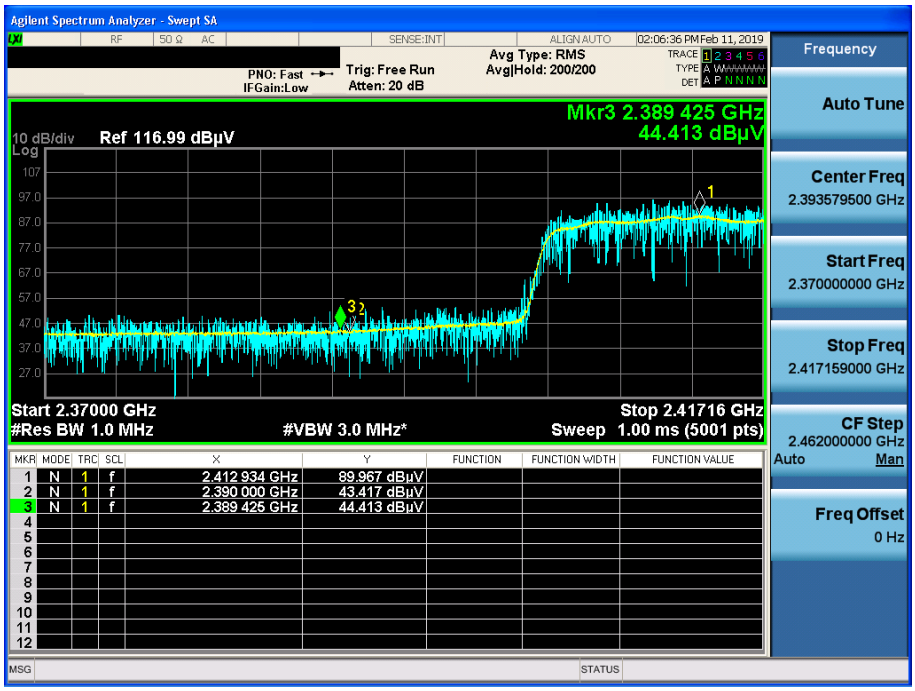
TM 2 & Highest & Z axis & Hor **Detector Mode : AV**



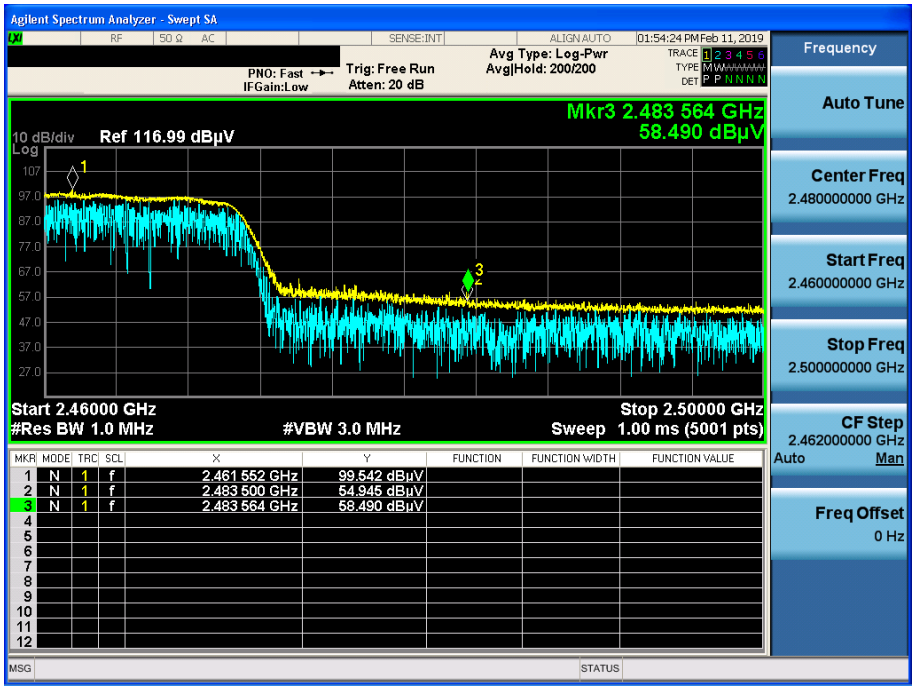
TM 3 & Lowest & Z axis & Hor **Detector Mode : PK**



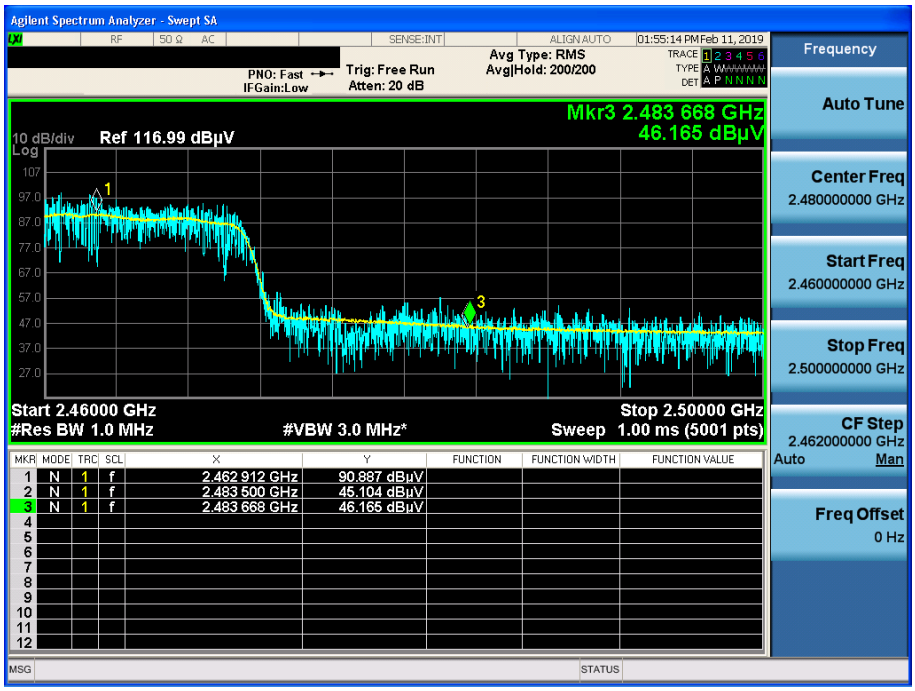
TM 3 & Lowest & Z axis & Hor **Detector Mode : AV**



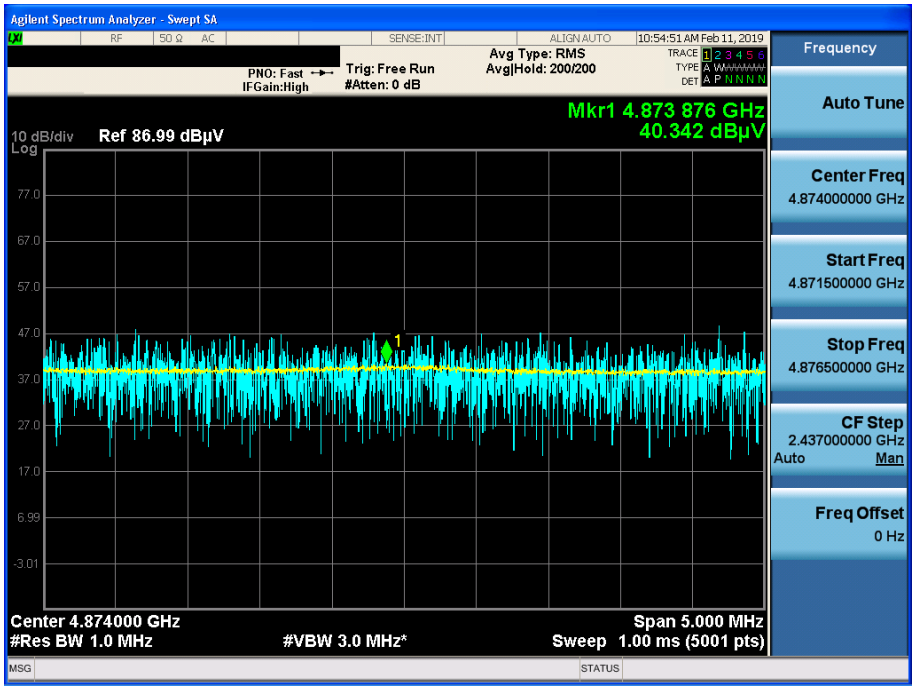
TM 3 & Highest & Z axis & Hor **Detector Mode : PK**



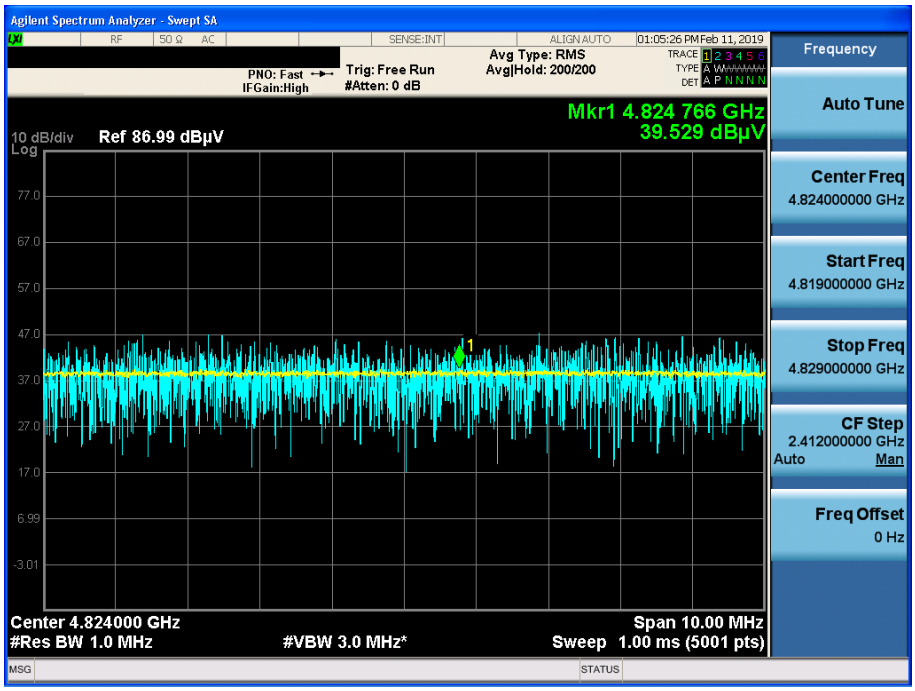
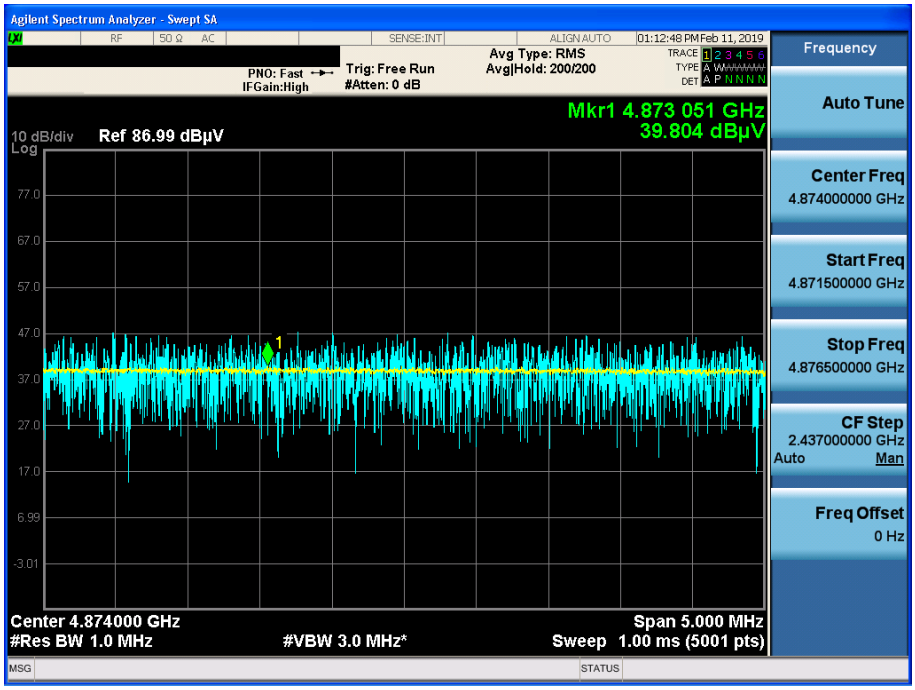
TM 3 & Highest & Z axis & Hor **Detector Mode : AV**



TM 1 & Middle & Y axis & Ver **Detector Mode : AV**



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



TM 3 & Middle & Y axis & Ver **Detector Mode : AV**