TEST REPORT

Dt&C

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1. Report No : DRTFCC1801-0013
2. Customer
   - Name : Bluebird Inc.
   - Address : (Dogok-dong, SEI Tower 13,14) 39, Eonjuro30-gil, Gangnam-gu, Seoul South Korea
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : Touch Mobile Computer / EF501R
   FCC ID : SS4EF501R
5. Test Method Used : KDB558074 D01v04
   Test Specification : FCC Part 15.247
6. Date of Test : 2017.12.22 ~ 2018.01.03
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by Name : JungWoo Kim (Signature)	Reviewed by Name : GeunKi Son (Signature)

2018 . 01 . 15 .

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
DRTFCC1801-0013	Jan. 15, 2018	Initial issue

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1. EUT DESCRIPTION

FCC Equipment Class	Digital Transmission System(DTS)
Product	Touch Mobile Computer
Model Name	EF501R
Add Model Name	NA
Power Supply	DC 3.8 V
Frequency Range	▪ 802.11b/g/n(20/40 MHz) : 2412 MHz ~ 2462 MHz
Max. RF Output Power	2.4GHz Band ▪ 802.11b : 19.36 dBm ▪ 802.11g : 21.73 dBm ▪ 802.11n (HT20) :20.21 dBm ▪ 802.11n (HT40) :20.41 dBm
Modulation Type	▪ 802.11b: CCK, DSSS ▪ 802.11g/n: OFDM
Antenna Specification	**Antenna type**: Internal Antenna **Antenna gain**: 1.108 dBi

. 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
TM 4	802.11n(HT40) MCS 0	2422	2437	2452

Note 1: The worst case data rate is determined as above test mode according to the power measurements.
Also radiated spurious emission was performed at lowest data rate.
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 ~ 24 °C
Relative humidity content	:	39 ~ 44 % R.H..
Details of power supply	:	DC 3.8 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	1.1 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 Section(s)	Parameter	Limit	Test Condition	Status Note 1
15.247(a)	6 dB Bandwidth	> 500 kHz	Conducted	C
15.247(b)	Transmitter Output Power	< 1 Watt		C
15.247(d)	Out of Band Emissions / Band Edge	20 dBc in any 100 kHz BW		C
15.247(e)	Transmitter Power Spectral Density	< 8 dBm/3 kHz		C
-	RSS-Gen [6.6]	Occupied Bandwidth (99 %)		NA
15.247(d) 15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	FCC 15.209 limits	Radiated	C Note 2, 3
15.207	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: This test item was performed in each axis and the worst case data was reported.
Note 3: For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.

4. TEST METHODOLOGY

Generally the tests were performed according to the KDB558074 D01v04, KDB662911 D01v02r01. 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 D01v04.
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 D01v04. 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 D01V04.
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. **- 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 attached on the main PCB using the special spring tension. (Refer to Internal Photo file.)
Therefore this E.U.T 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:

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB558074 D01V04**

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	9.056
	Middle	8.124
	Highest	8.611
TM 2	Lowest	16.420
	Middle	16.380
	Highest	16.400
TM 3	Lowest	17.590
	Middle	17.610
	Highest	17.620
TM 4	Lowest	35.160
	Middle	35.230
	Highest	35.390

▣ 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

6 dB Bandwidth

TM 4 & Lowest

6 dB Bandwidth

TM 4 & Middle

6 dB Bandwidth

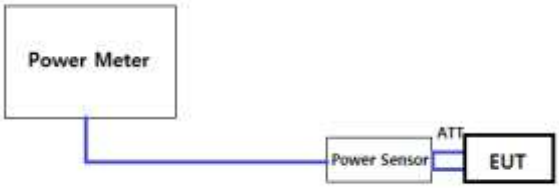
TM 4 & Highest

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 D01V04**
   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 D01V04**
   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.

   Note: The measure-and-sum technique is used for test mode with multiple transmitting.

▣ 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	19.13	19.05	19.01	18.94	-	-	-	-
	AV	16.88	16.83	16.75	16.71	-	-	-	-
2437	PK	19.24	19.20	19.14	19.09	-	-	-	-
	AV	16.83	16.79	16.74	16.70	-	-	-	-
2462	PK	**19.36**	19.30	19.24	19.20	-	-	-	-
	AV	16.95	16.90	16.82	16.74	-	-	-	-

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	21.13	21.09	21.02	20.95	20.87	20.74	20.69	20.55
	AV	14.87	14.85	14.79	14.71	14.66	14.58	14.53	14.47
2437	PK	21.52	21.48	21.39	21.32	21.27	21.21	21.14	21.09
	AV	14.93	14.90	14.88	14.82	14.77	14.76	14.74	14.70
2462	PK	**21.73**	21.68	21.64	21.57	21.48	21.39	21.34	21.26
	AV	14.94	14.93	14.90	14.86	14.84	14.82	14.78	14.75

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	20.10	20.04	19.96	19.87	19.84	19.77	19.71	19.65
	AV	11.83	11.79	11.73	11.65	11.57	11.52	11.46	11.42
2437	PK	20.11	20.07	19.95	19.87	19.75	19.72	19.64	19.56
	AV	11.82	11.78	11.71	11.64	11.58	11.52	11.47	11.38
2462	PK	**20.21**	20.17	20.11	20.05	19.96	19.89	19.84	19.79
	AV	11.87	11.84	11.79	11.73	11.64	11.61	11.56	11.49

Freq. (MHz)	Det.	Maximum Peak Conducted Output Power (dBm) for ***802.11n(HT40)***							
		Data Rate [MCS]							
		0	1	2	3	4	5	6	7
2422	PK	20.17	20.13	20.08	19.97	19.91	19.85	19.77	19.72
	AV	11.94	11.90	11.82	11.76	11.71	11.63	11.58	11.55
2437	PK	20.09	20.01	19.94	19.88	19.79	19.72	19.64	19.58
	AV	11.80	11.75	11.71	11.63	11.56	11.52	11.46	11.37
2452	PK	**20.41**	20.37	20.31	20.25	20.19	20.12	20.07	19.98
	AV	11.86	11.82	11.74	11.68	11.62	11.55	11.49	11.37

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

Method PKPSD of KDB558074 D01V04 is used.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW 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	-5.46
	Middle	3 kHz	-4.86
	Highest	3 kHz	-5.97
TM 2	Lowest	3 kHz	-9.83
	Middle	3 kHz	-10.24
	Highest	3 kHz	-10.21
TM 3	Lowest	3 kHz	-14.37
	Middle	3 kHz	-13.23
	Highest	3 kHz	-13.29
TM 4	Lowest	3 kHz	-16.15
	Middle	3 kHz	-15.34
	Highest	3 kHz	-16.12

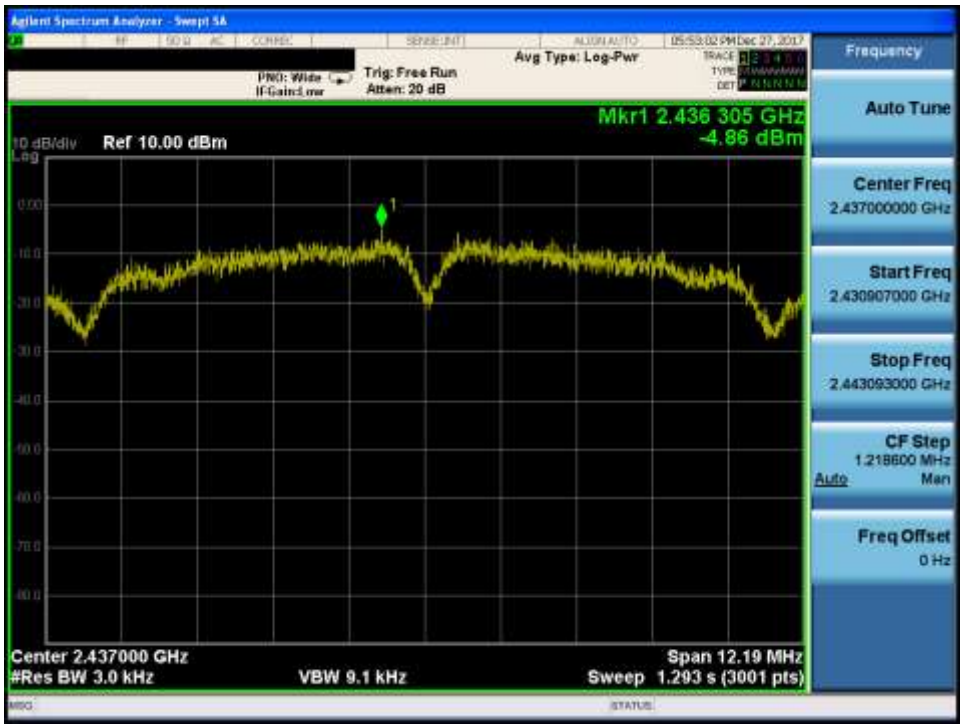
▣ RESULT PLOTS

Maximum PPSD

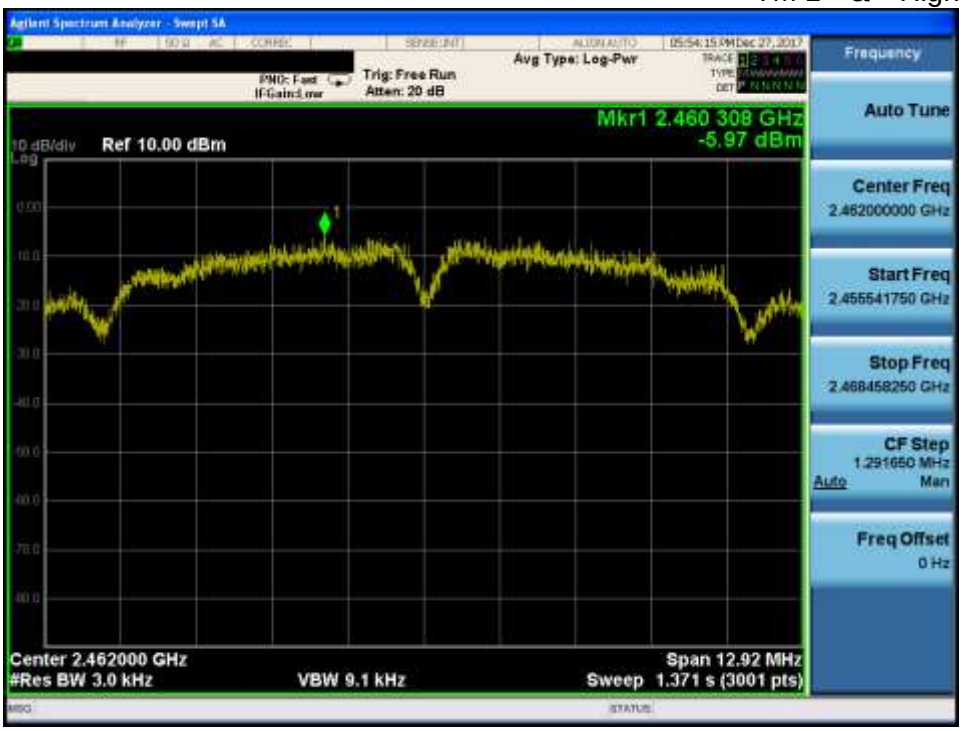
TM1 & Lowest

Maximum PPSD

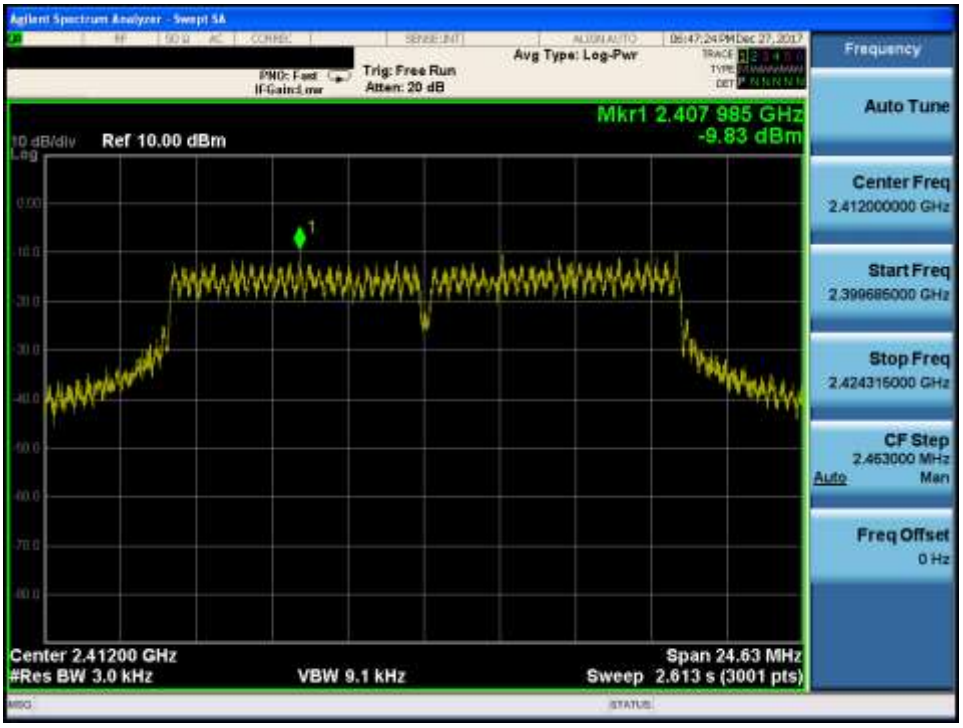
TM 1 & Middle



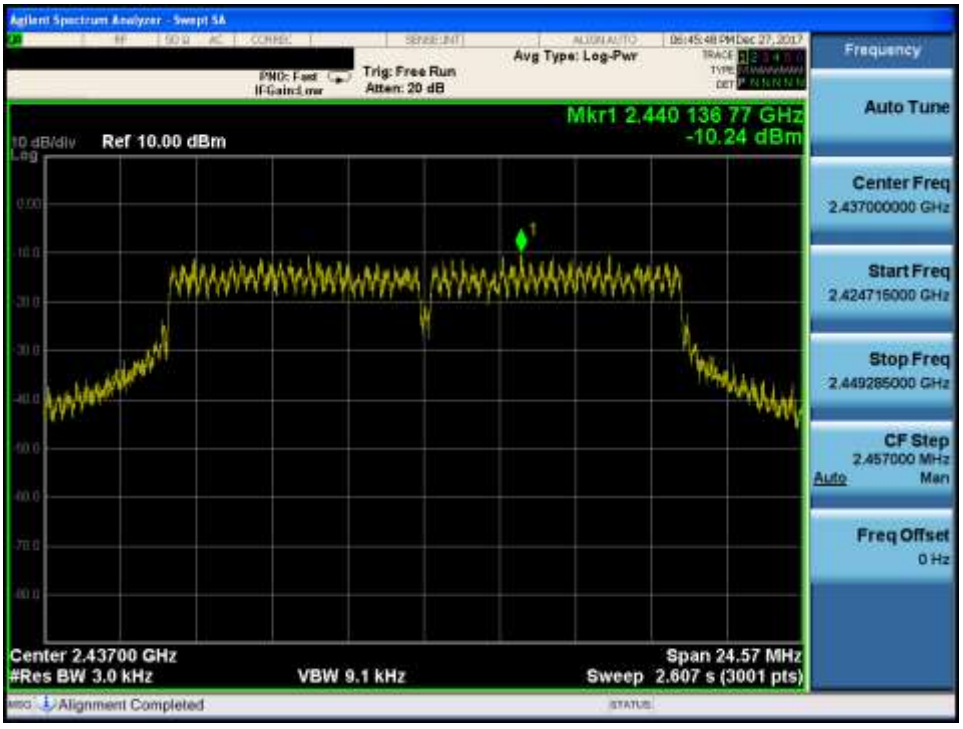
Maximum PPSD TM 1 & Highest



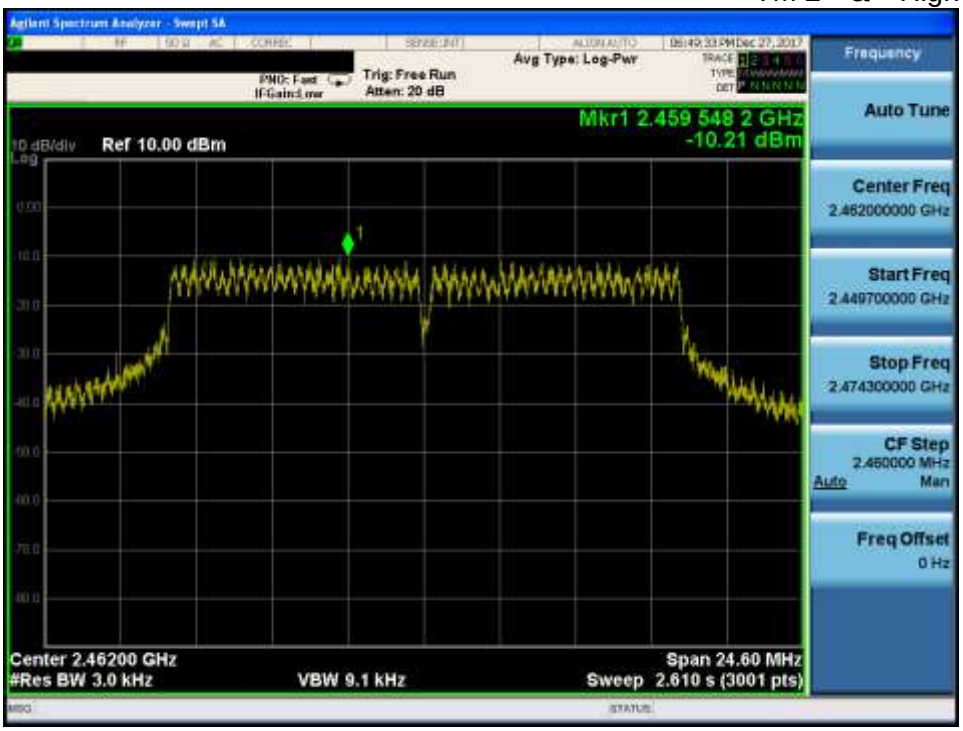
Maximum PPSD TM 2 & Lowest



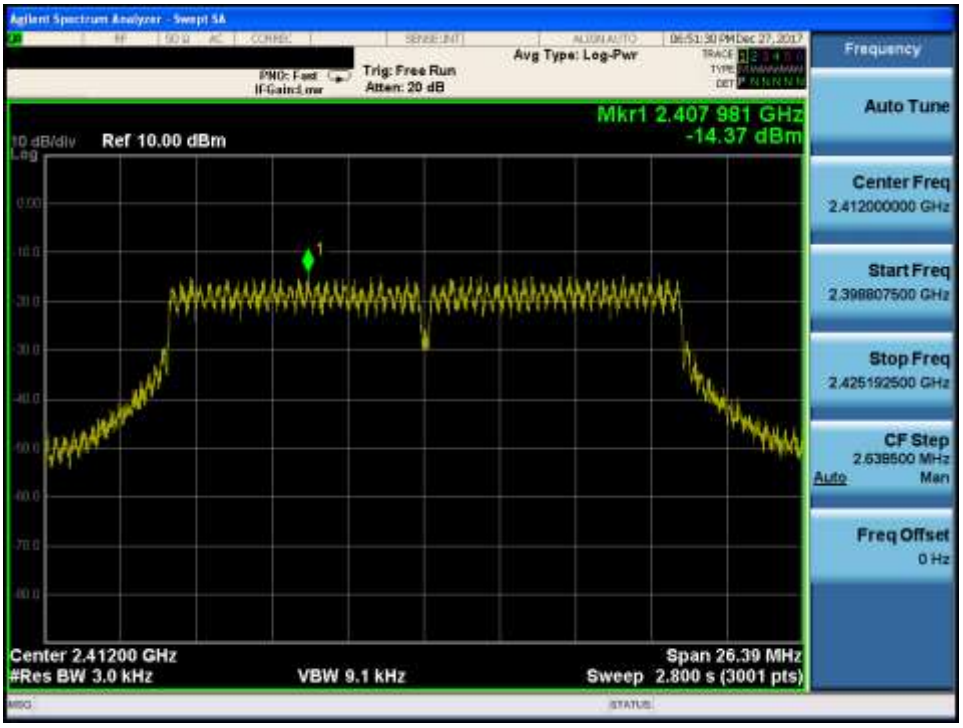
Maximum PPSD TM2 & Middle



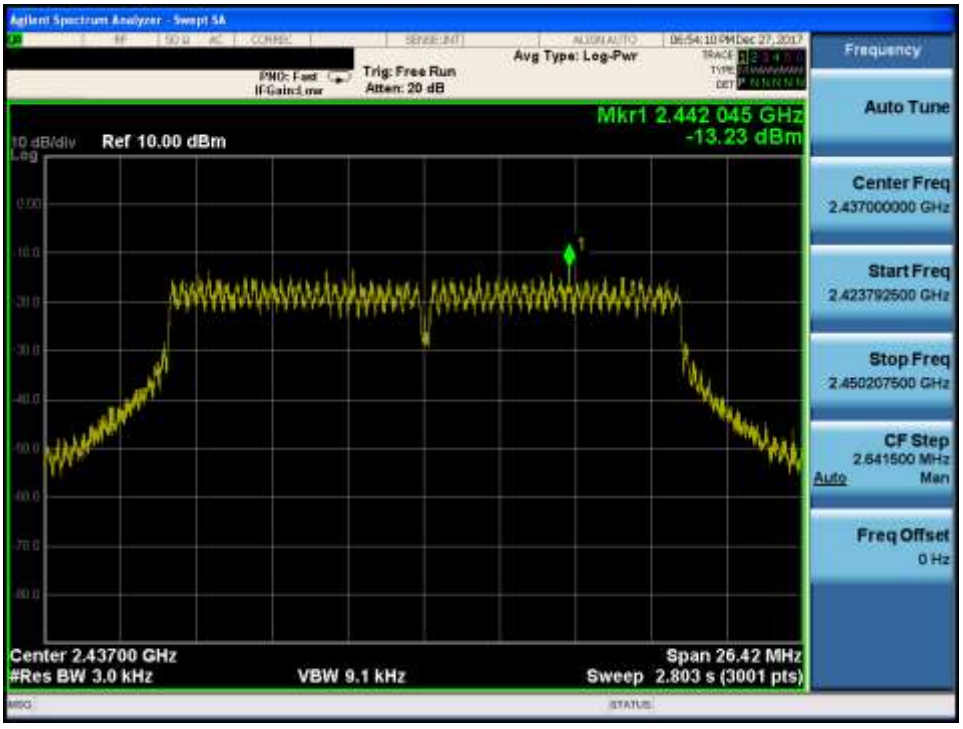
Maximum PPSD TM 2 & Highest



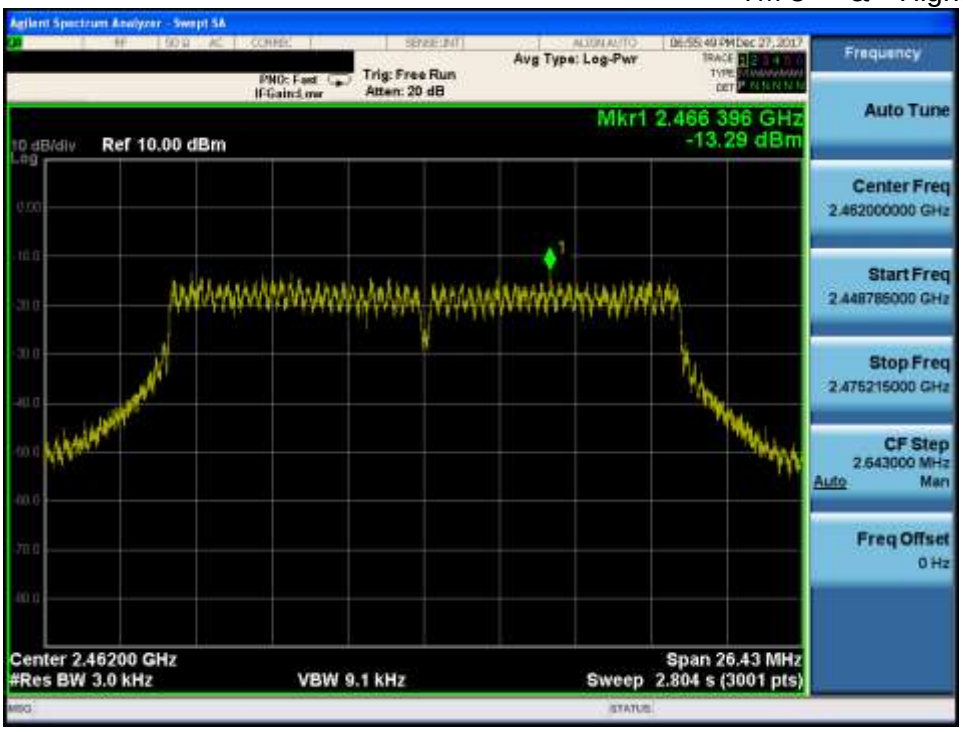
Maximum PPSD TM 3 & Lowest



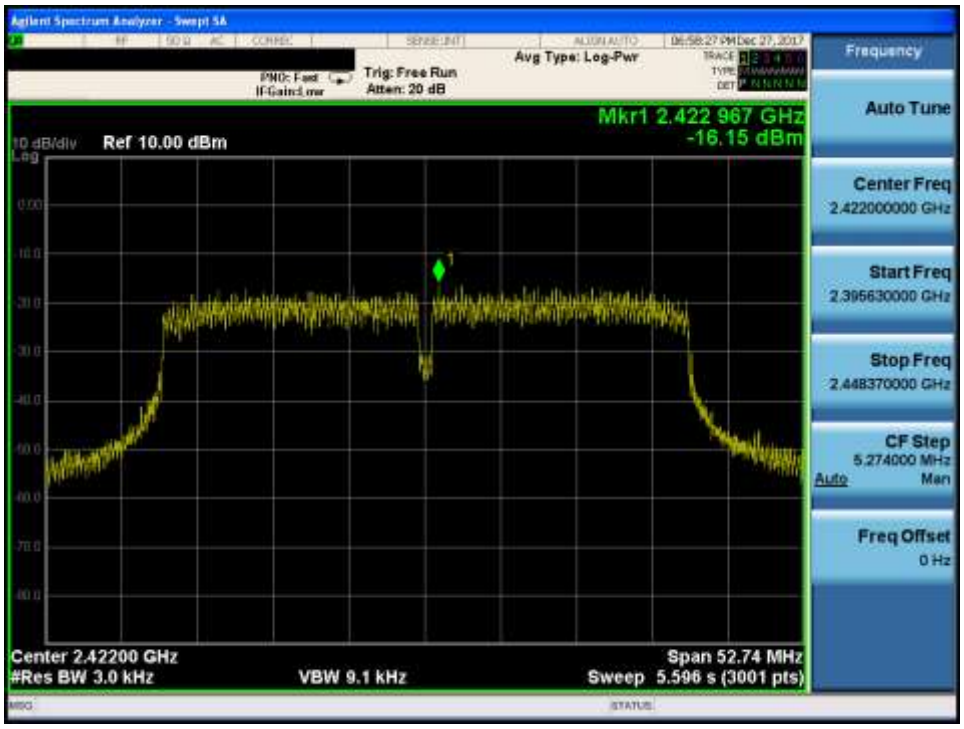
Maximum PPSD TM3 & Middle



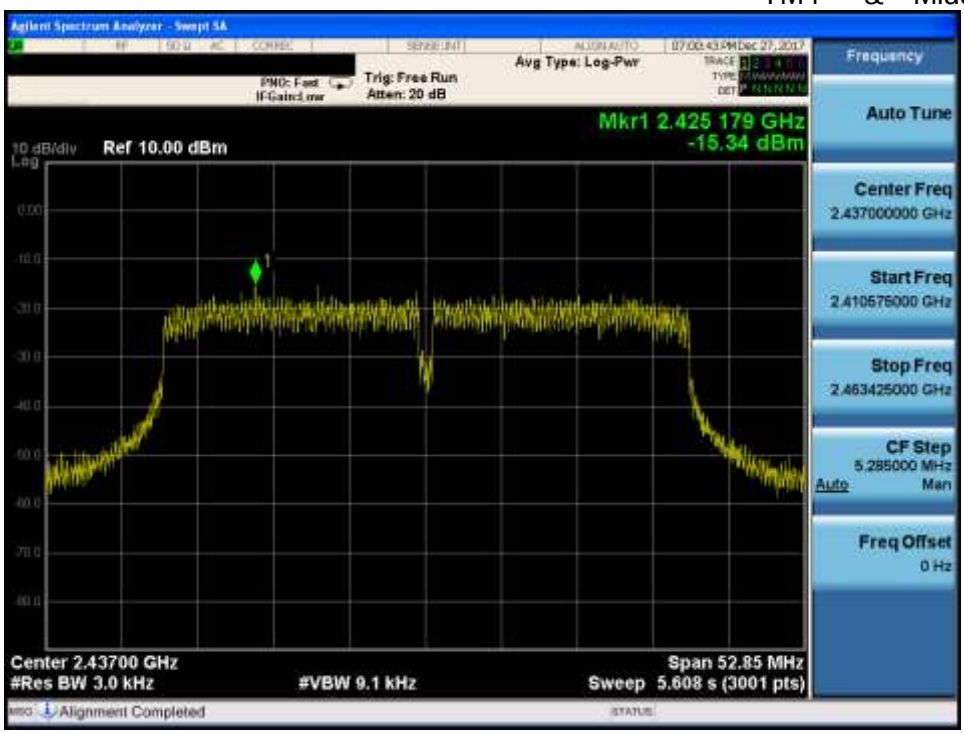
Maximum PPSD TM 3 & Highest



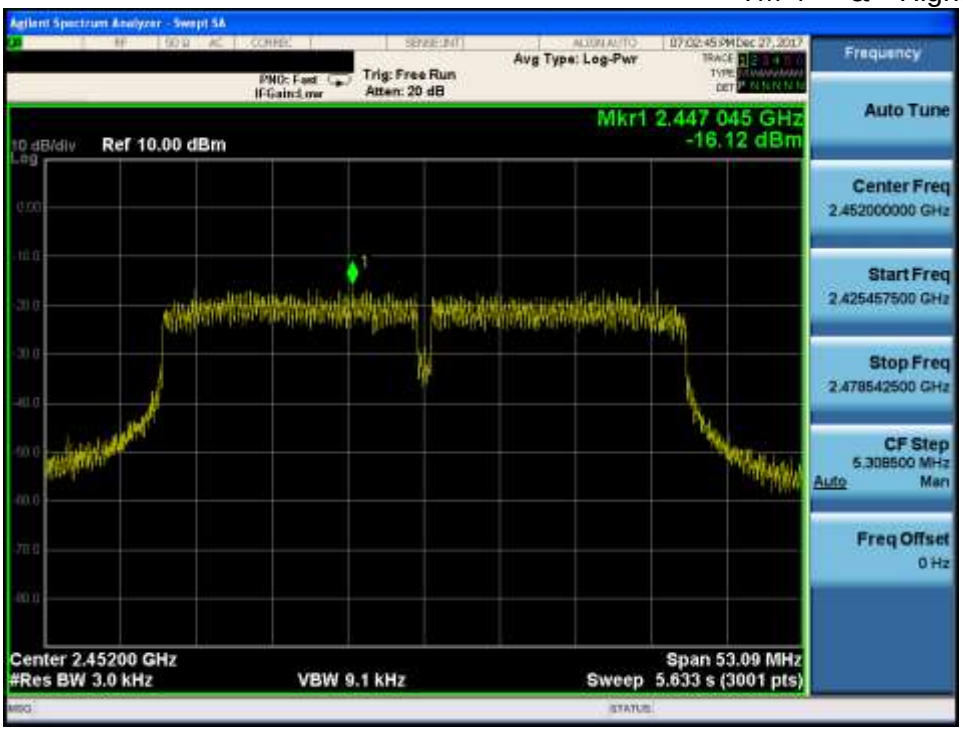
Maximum PPSD TM 4 & Lowest



Maximum PPSD TM4 & Middle



Maximum PPSD TM 4 & 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

The transmitter output is connected to a spectrum analyzer.

- Measurement Procedure 1 – Reference Level of KDB558074 D01v04

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.

- Measurement Procedure 2 - Unwanted Emissions of KDB558074 D01v04

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

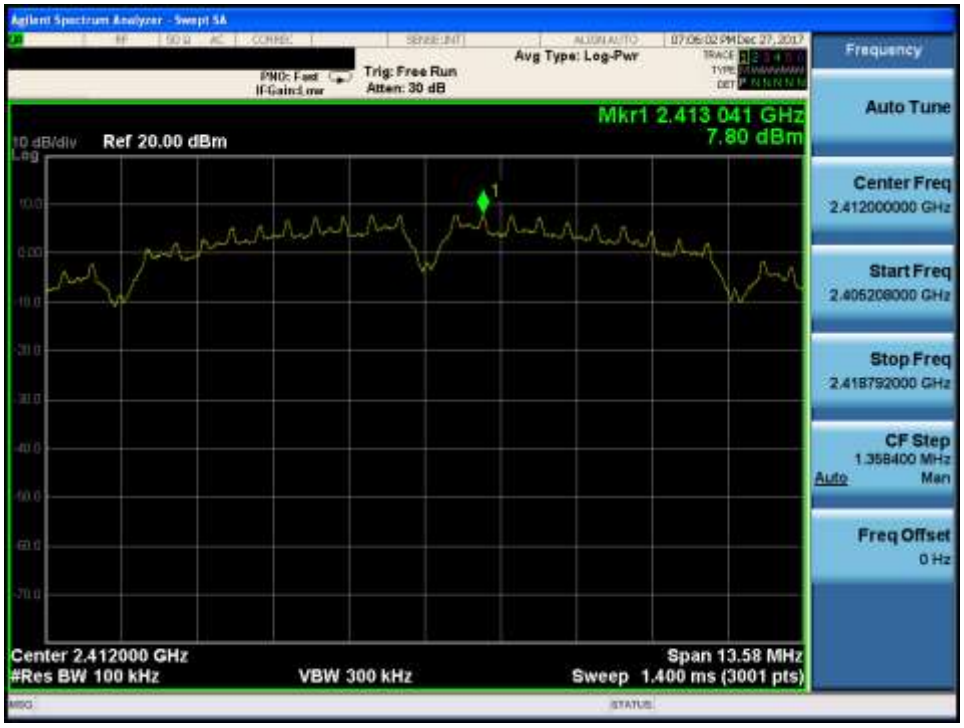
LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)

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

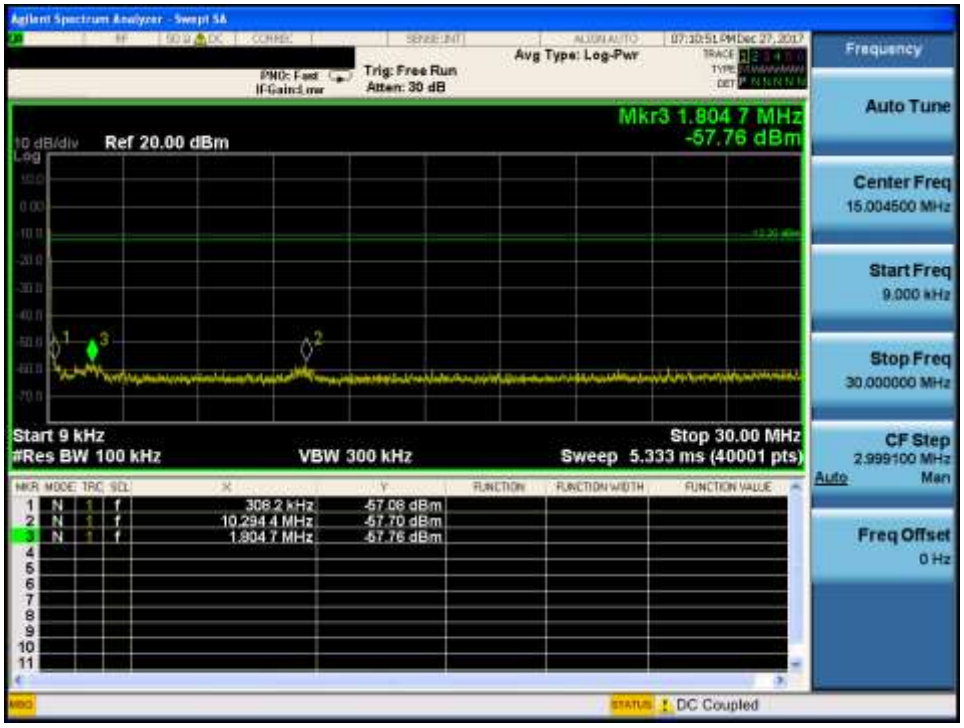
TM 1 & Lowest

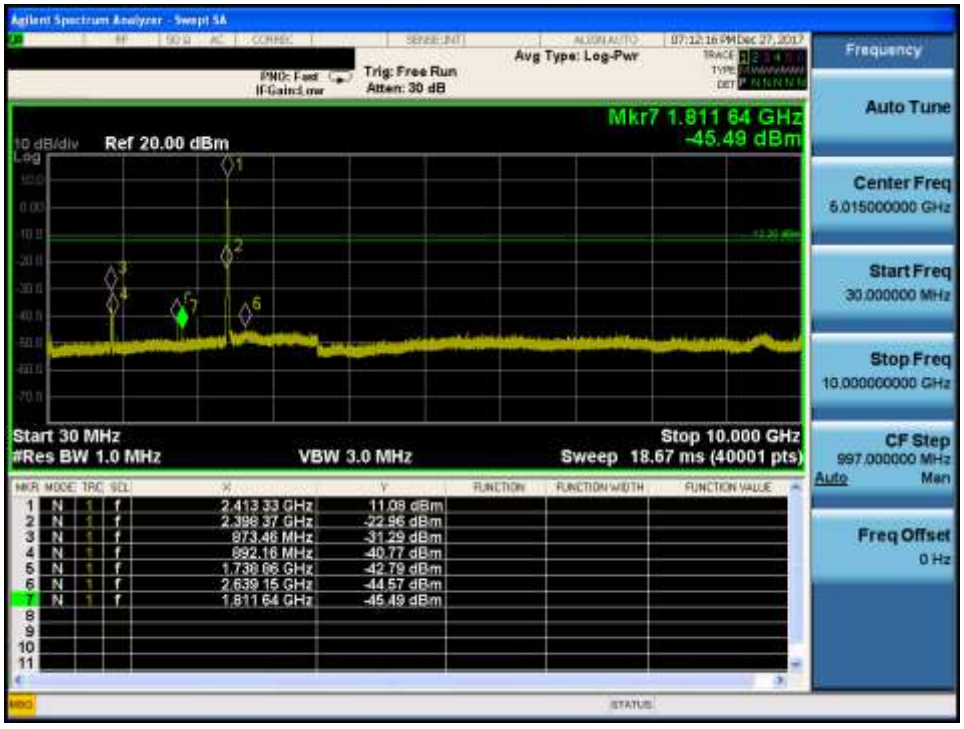
Reference



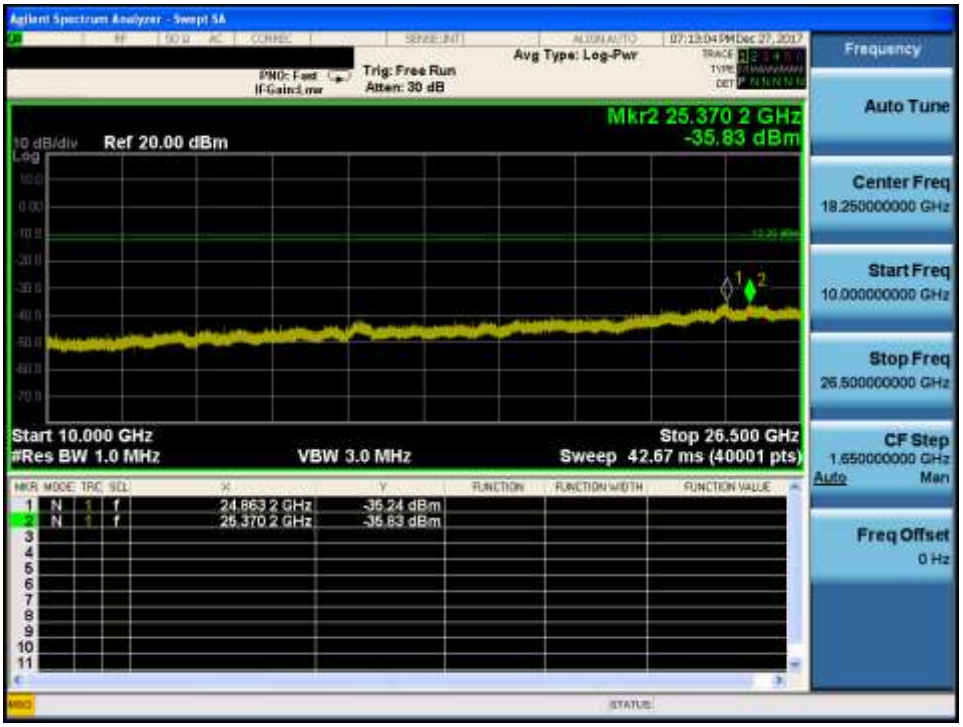
Low Band-edge

Conducted Spurious Emissions



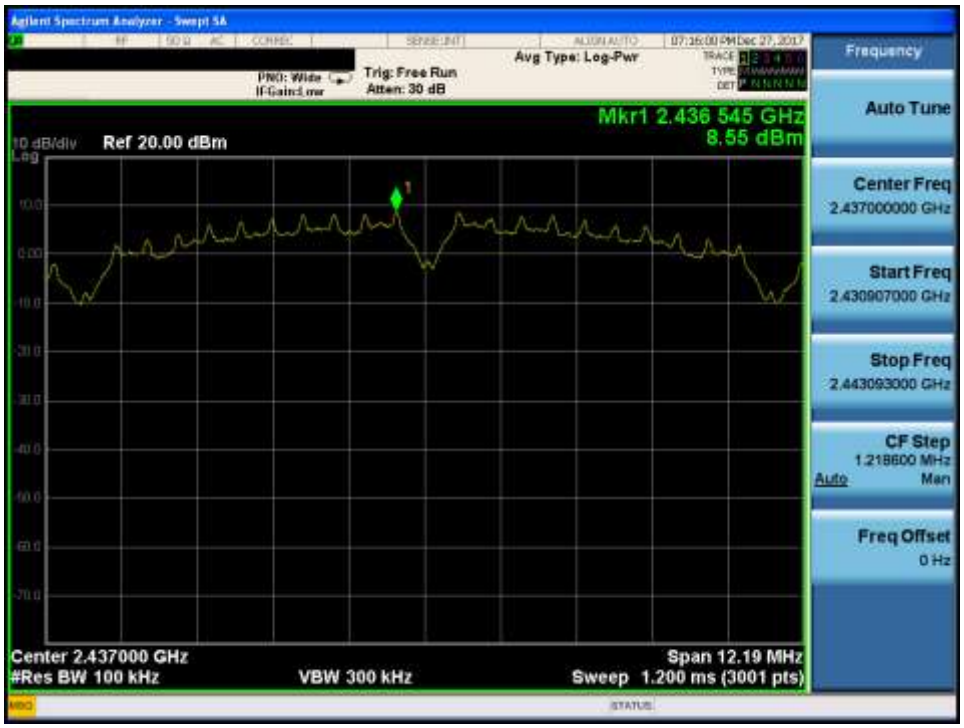


Conducted Spurious Emissions



TM 1 & Middle

Reference



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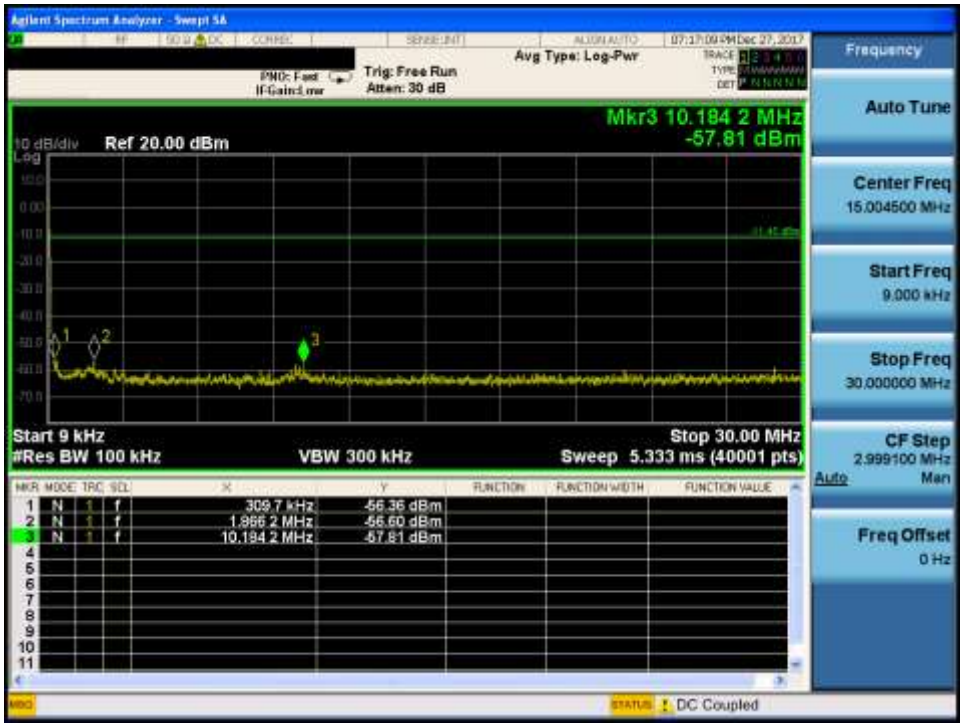

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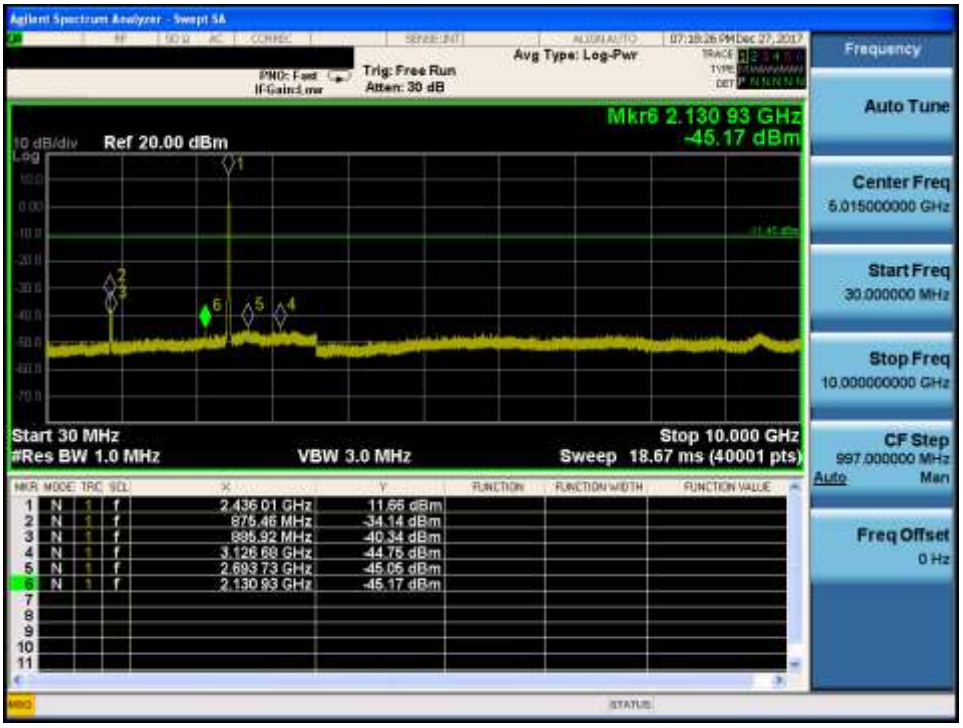
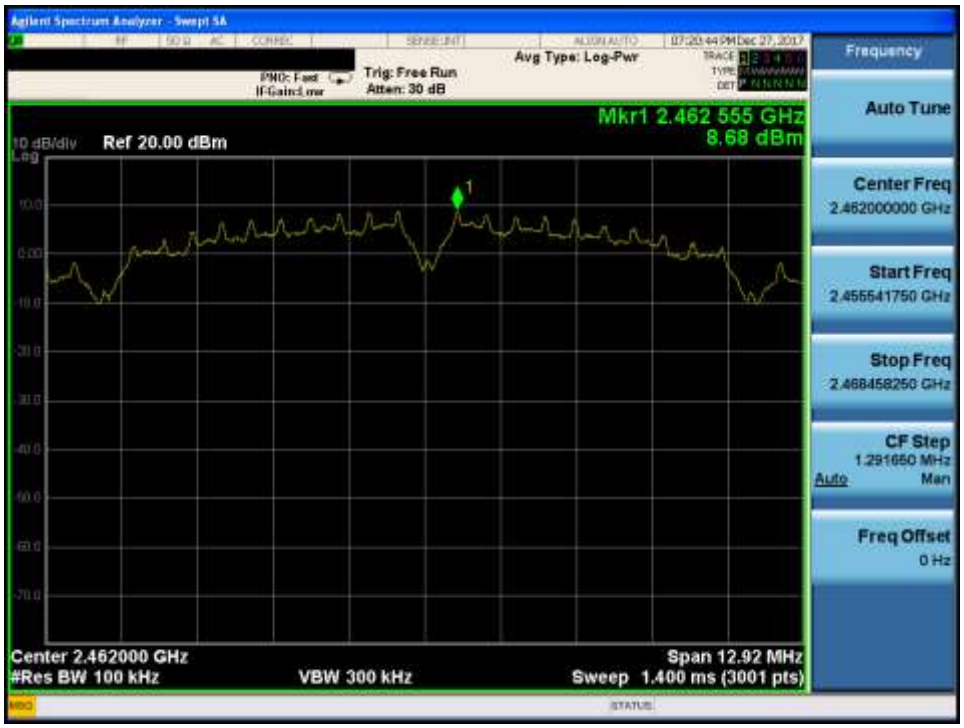


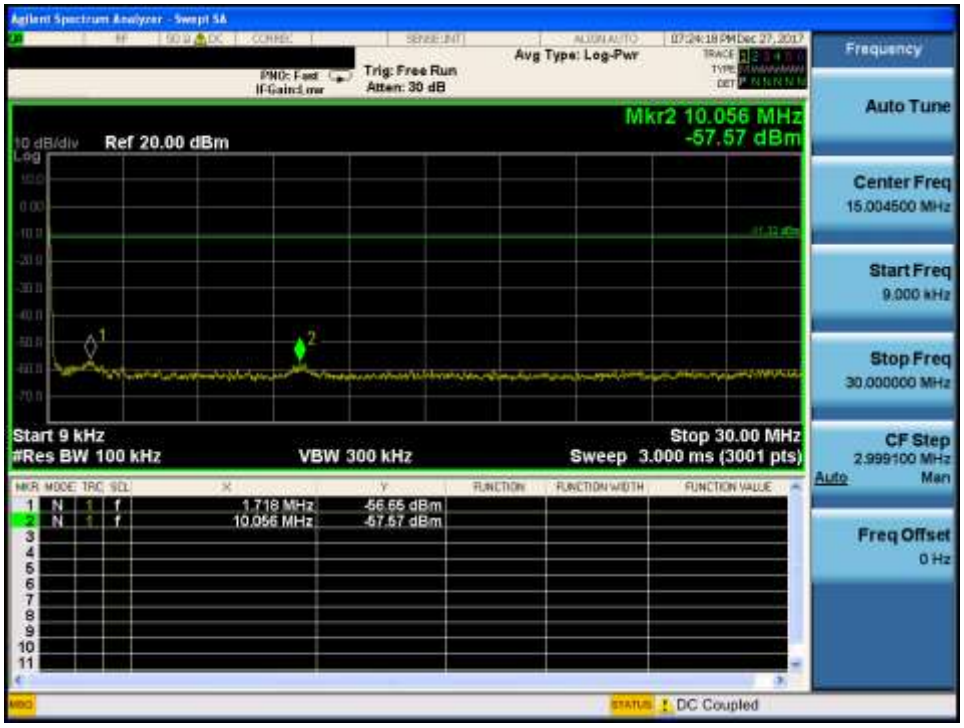
TM 1 & Highest

Reference

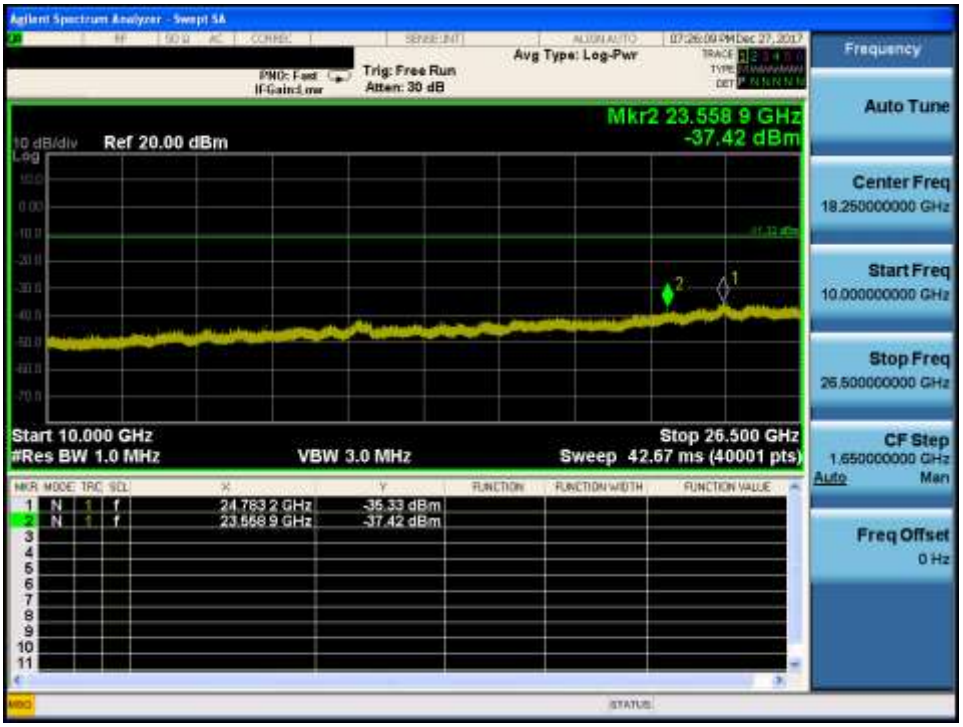


High Band-edge

Conducted Spurious Emissions

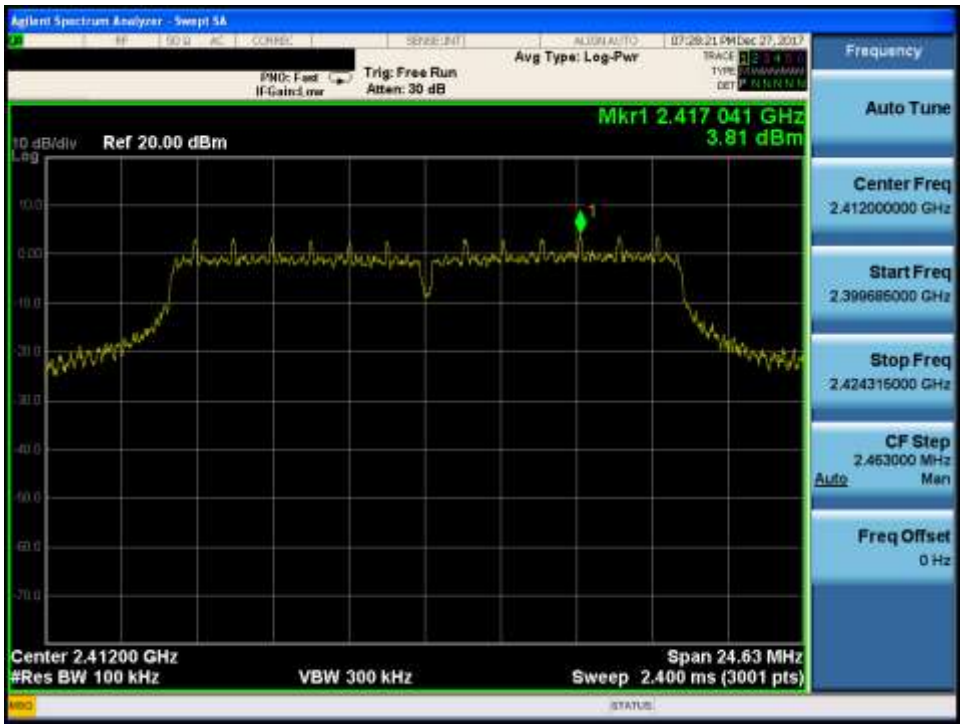


Conducted Spurious Emissions



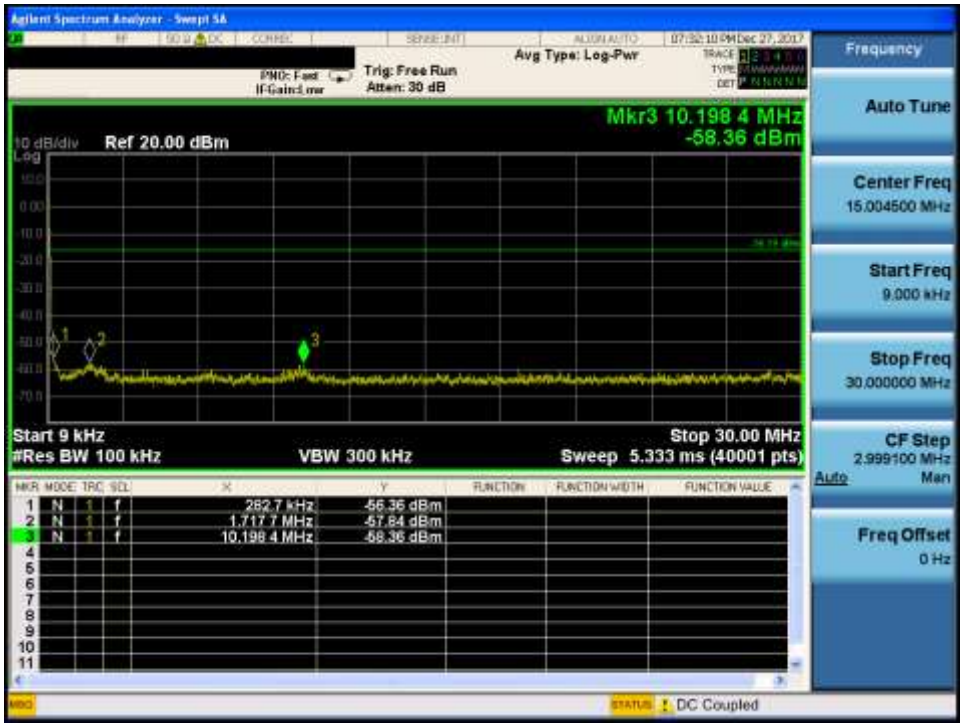
TM 2 & Lowest

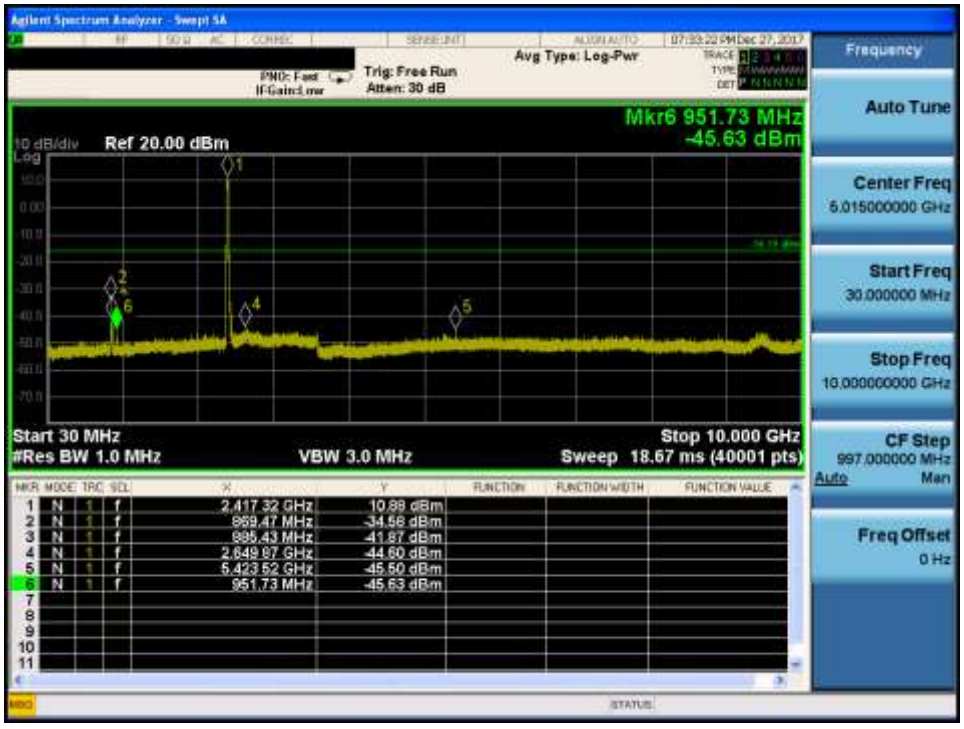
Reference



Low Band-edge

Conducted Spurious Emissions

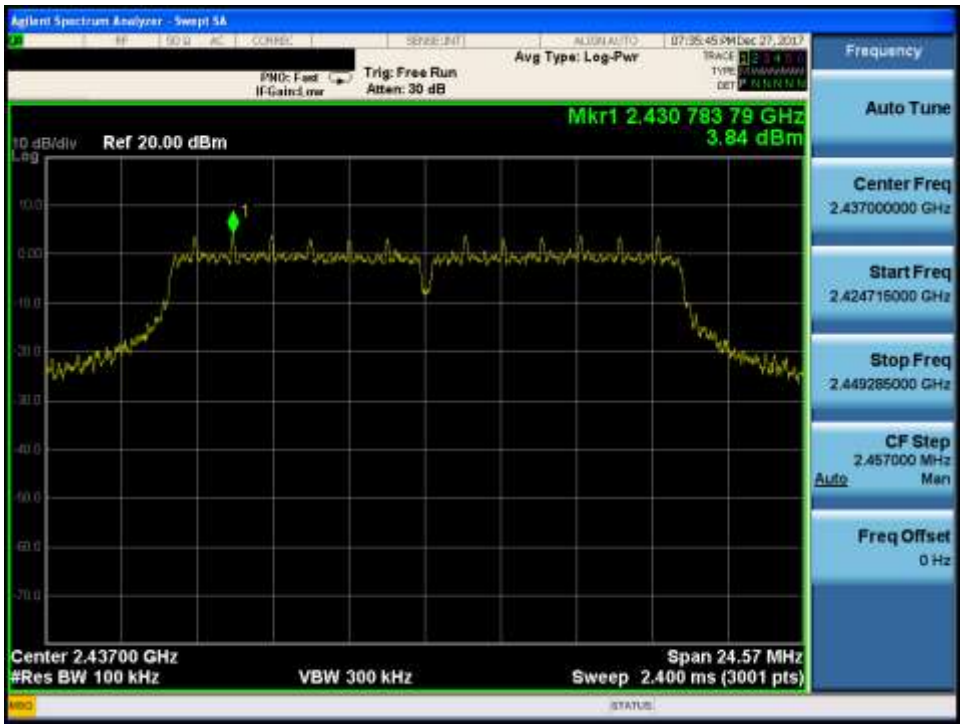




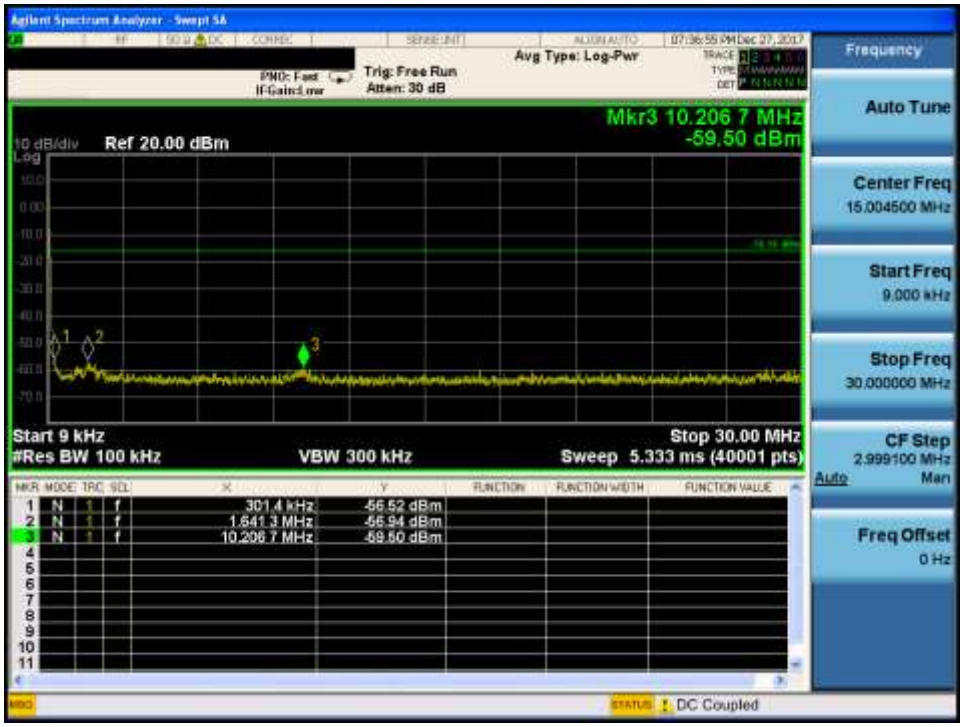
Conducted Spurious Emissions

TM 2 & Middle

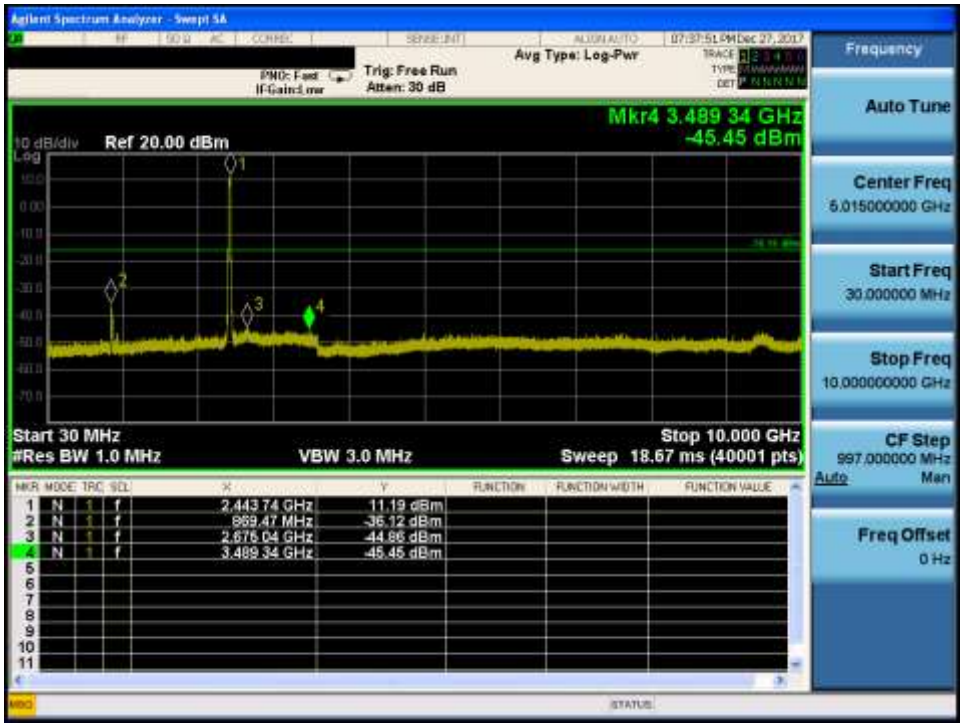
Reference

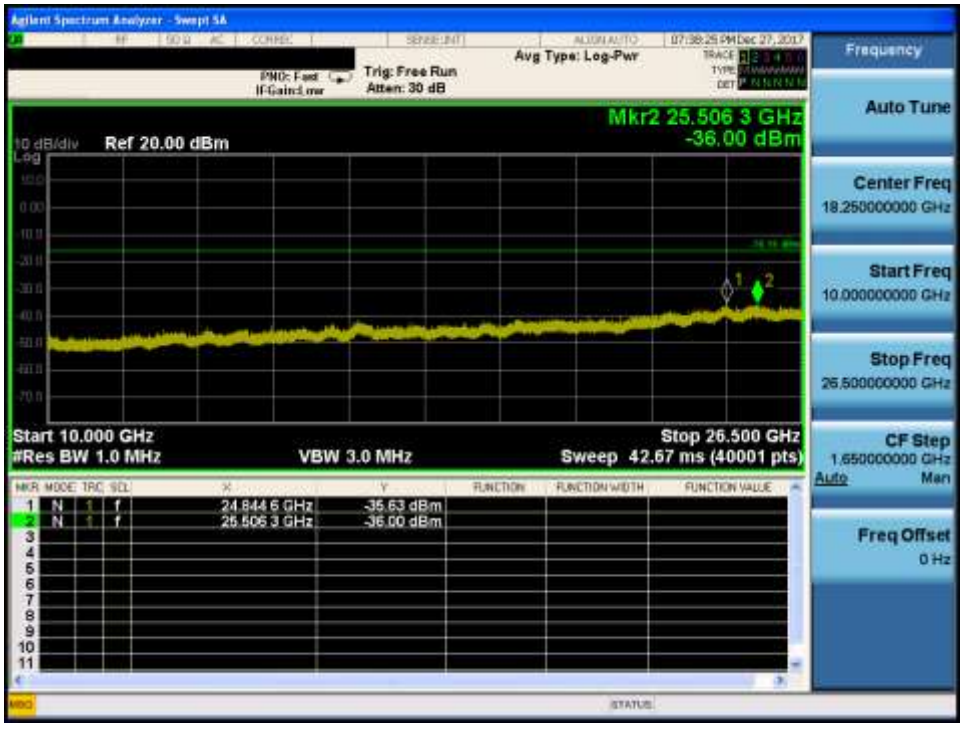


Conducted Spurious Emissions



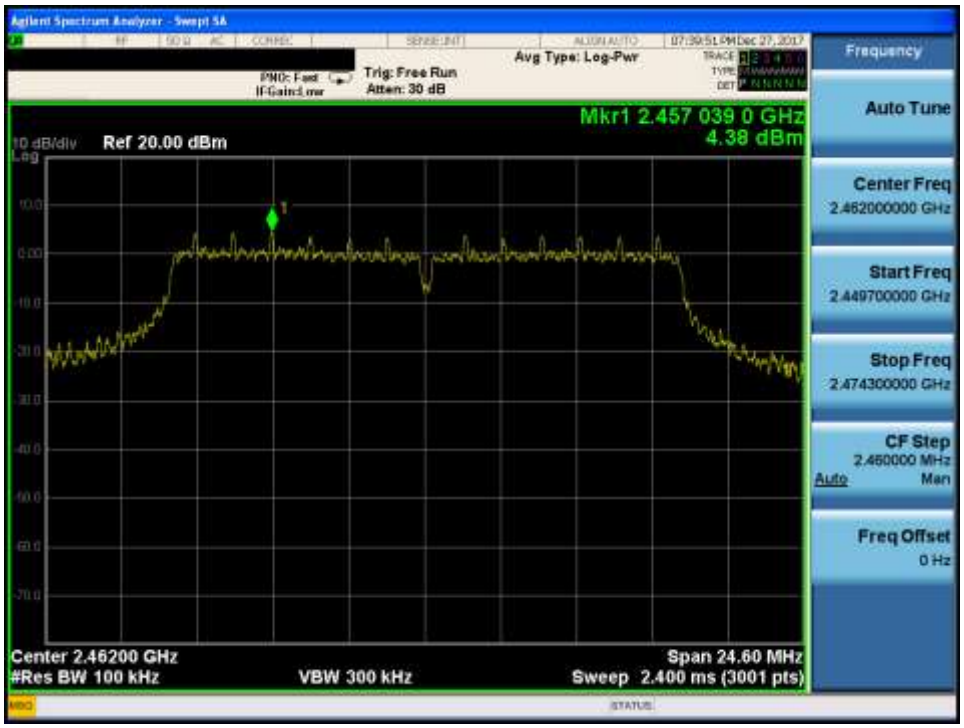
Conducted Spurious Emissions





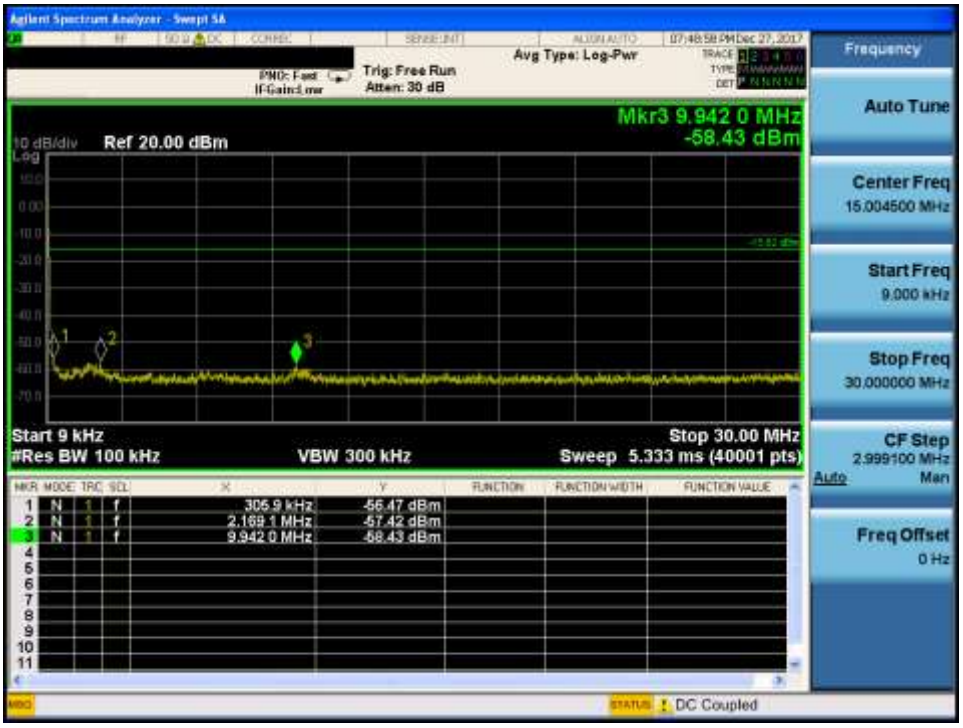
TM 2 & Highest

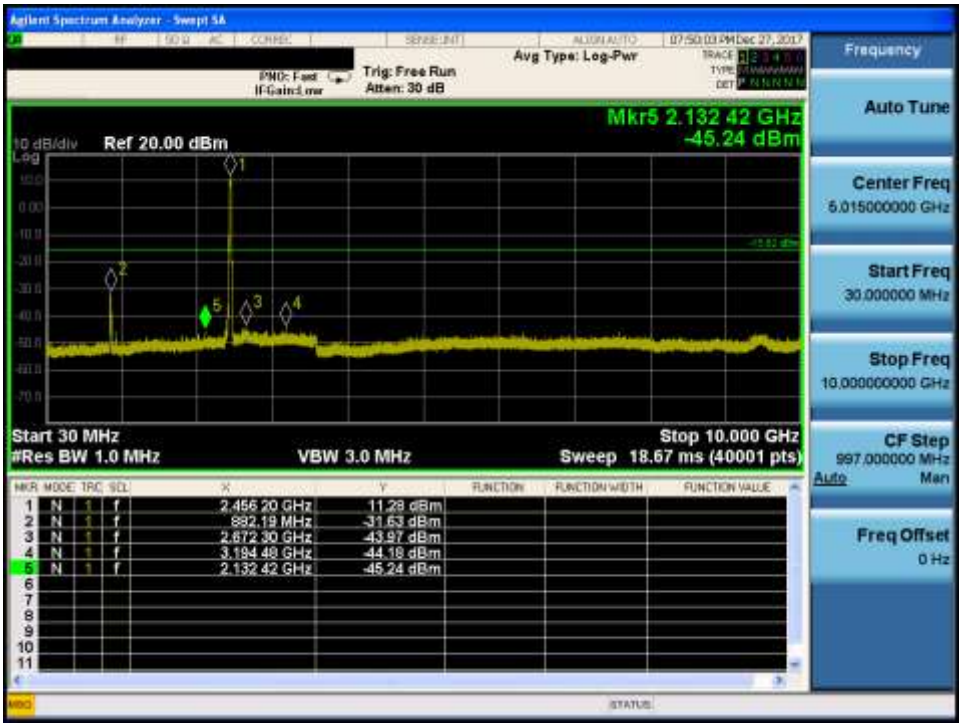
Reference



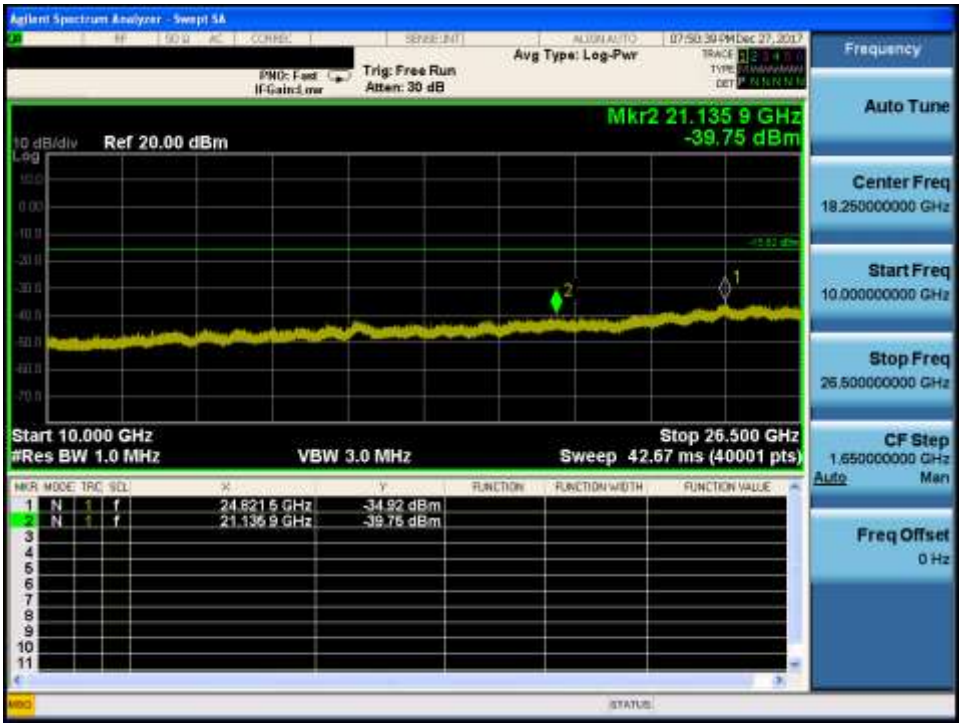
High Band-edge

Conducted Spurious Emissions





Conducted Spurious Emissions

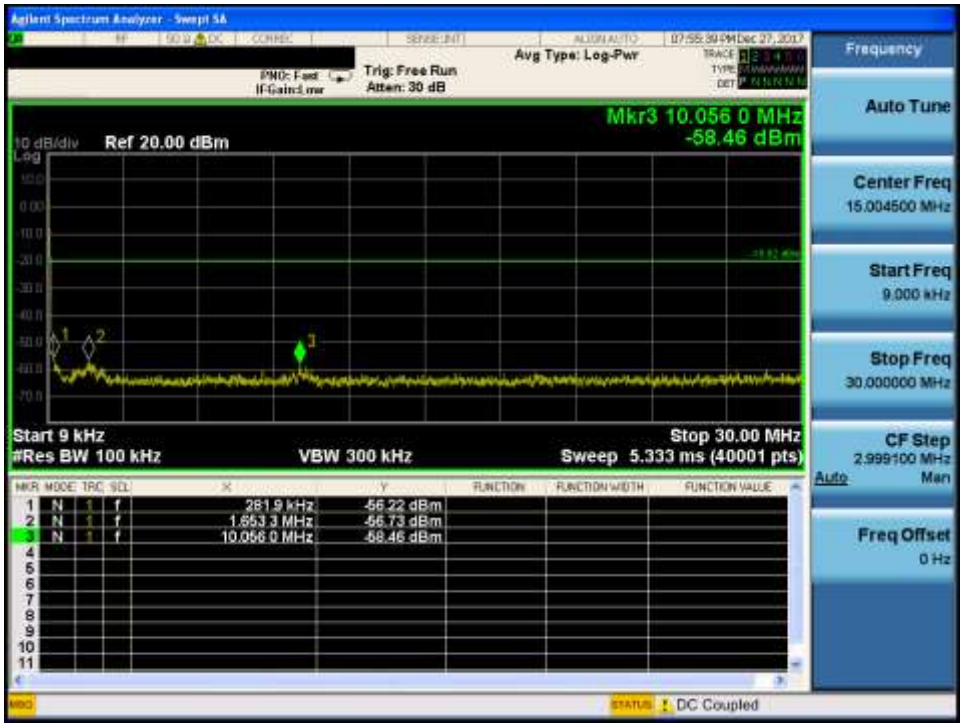


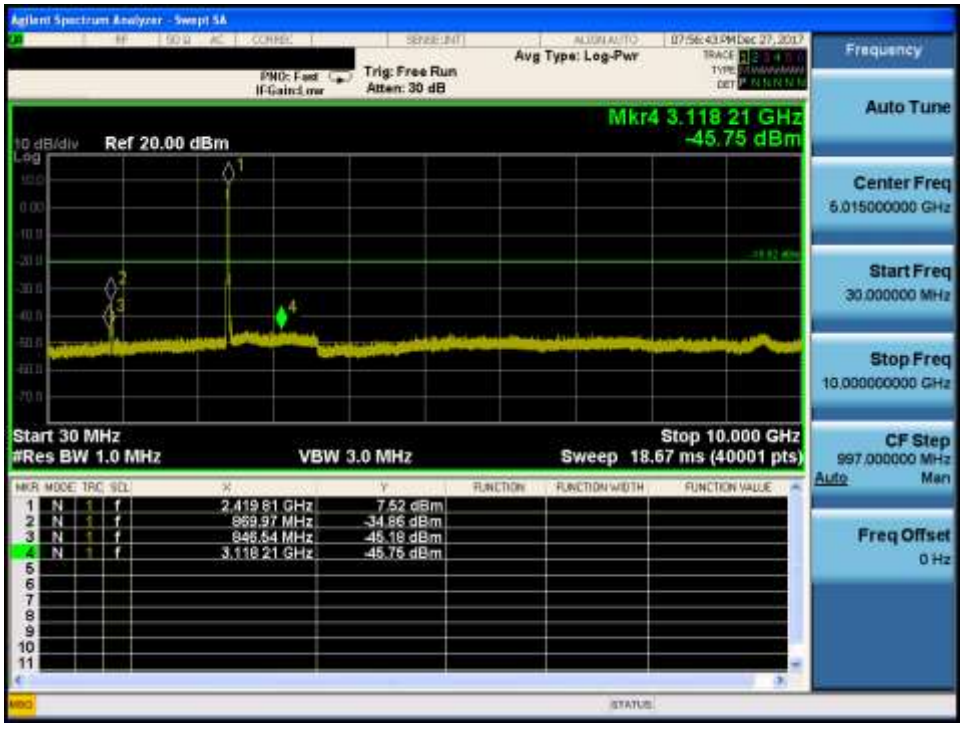
TM 3 & Lowest

Reference

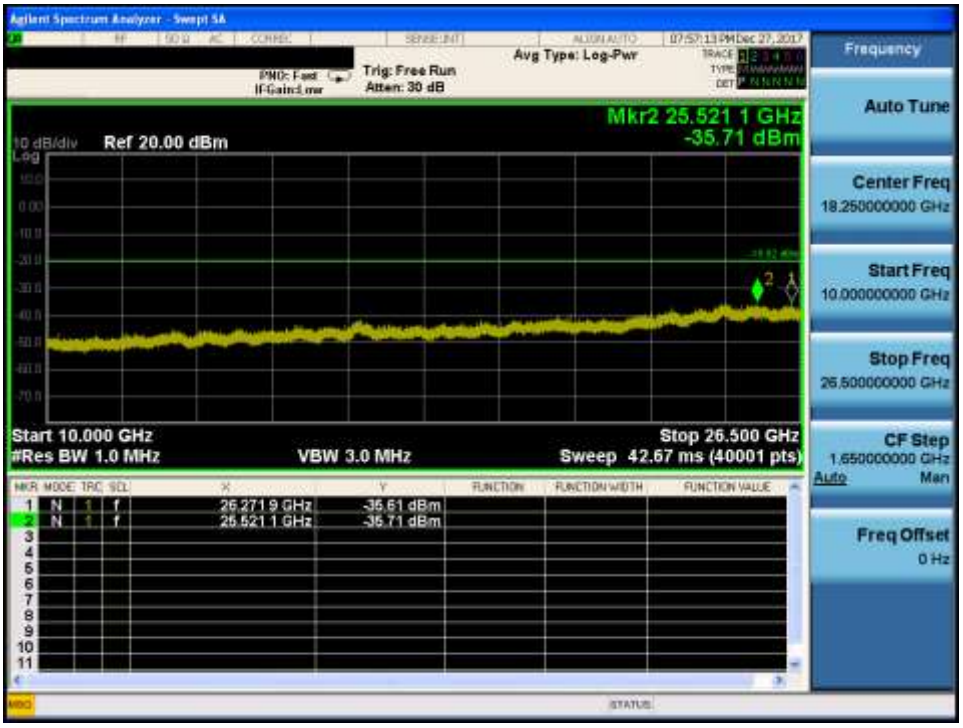
Low Band-edge

Conducted Spurious Emissions



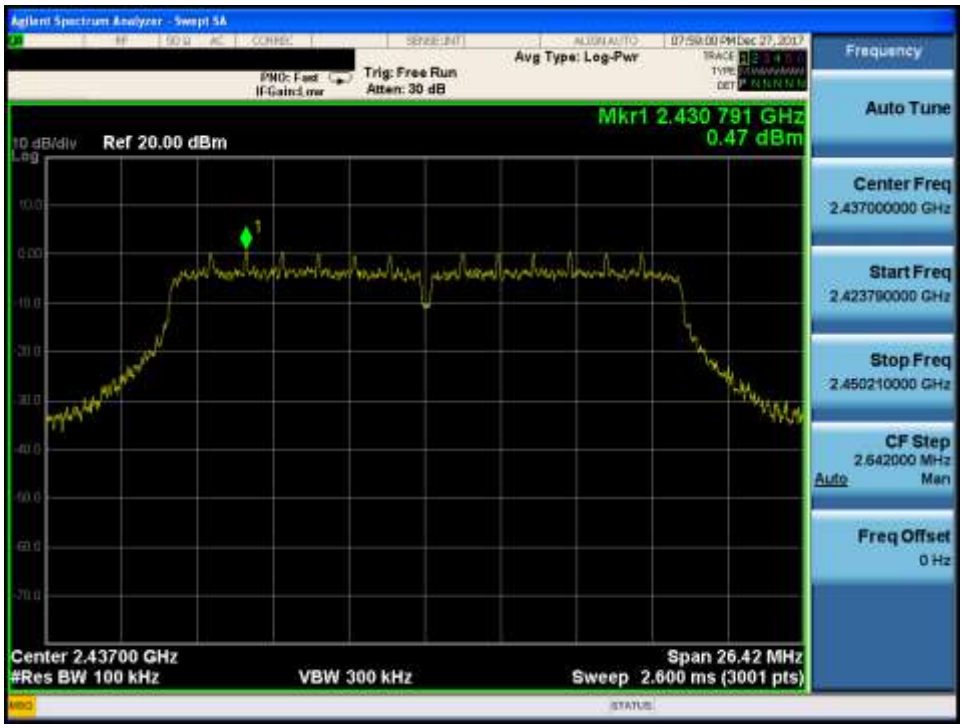


Conducted Spurious Emissions

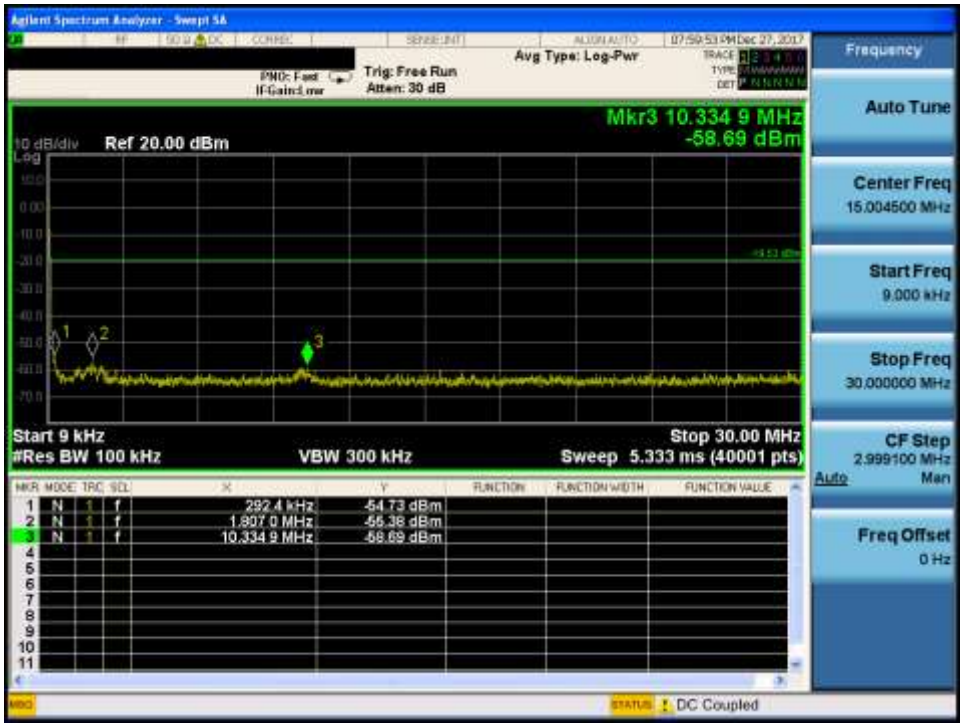


TM 3 & Middle

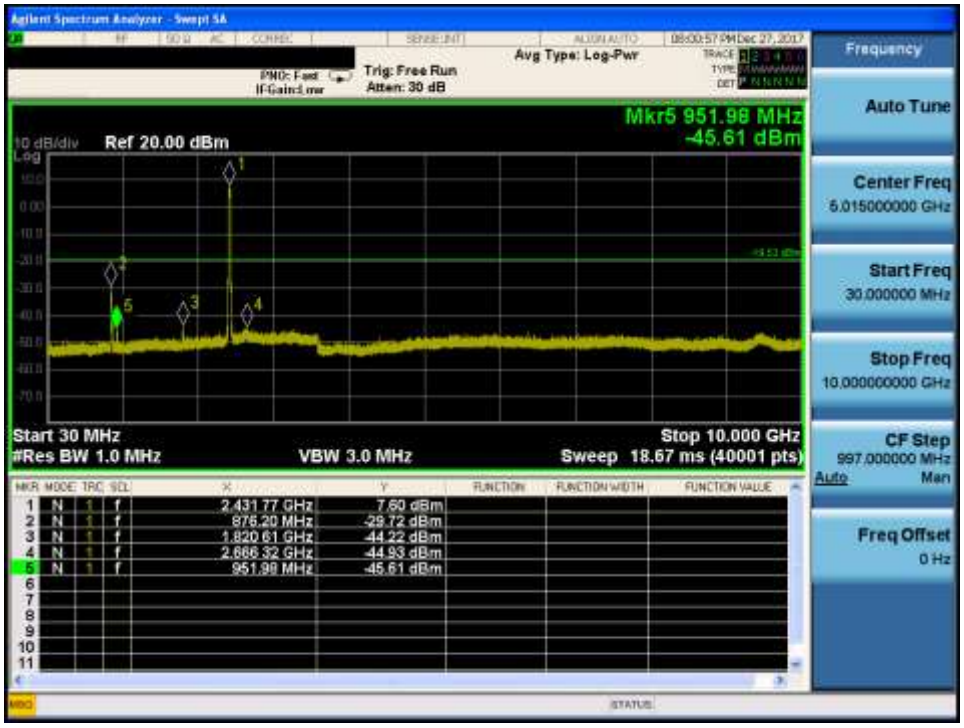
Reference

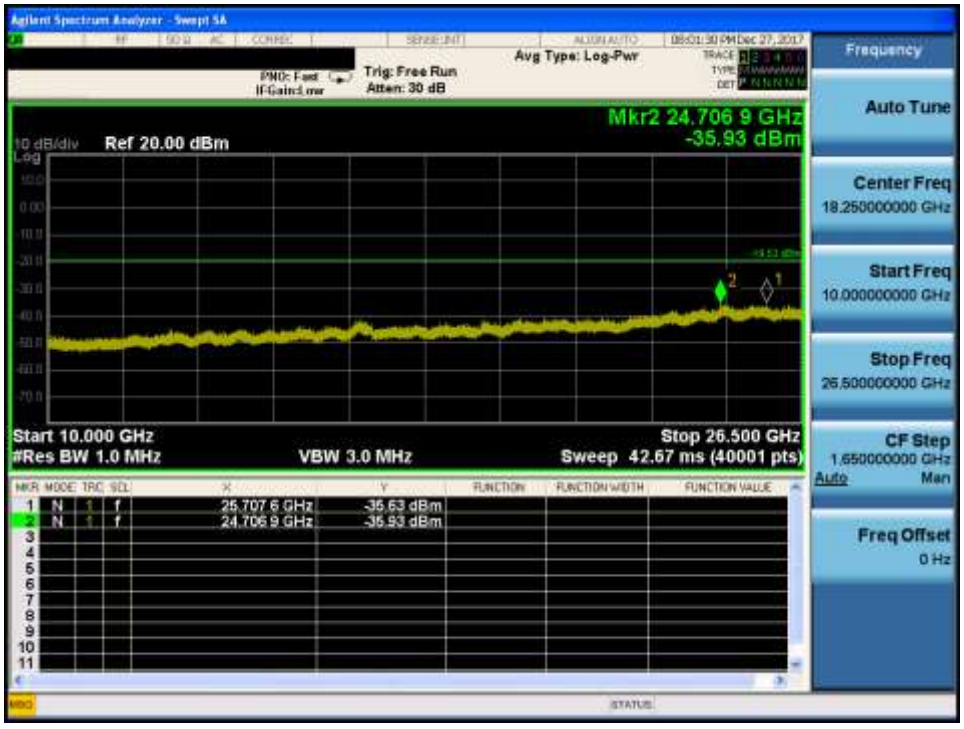


Conducted Spurious Emissions



Conducted Spurious Emissions



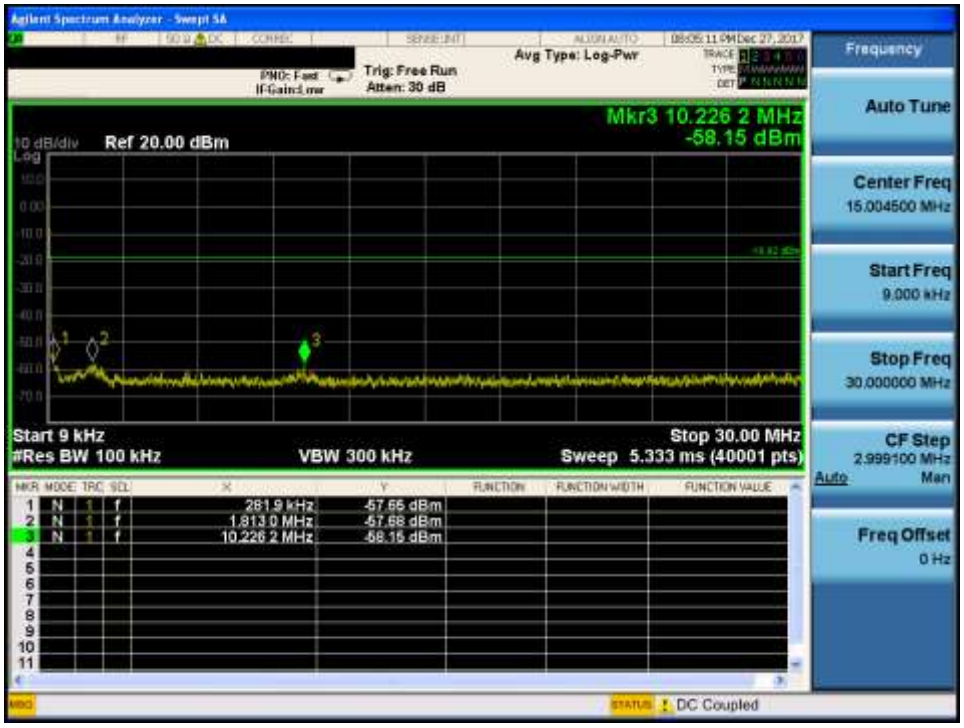


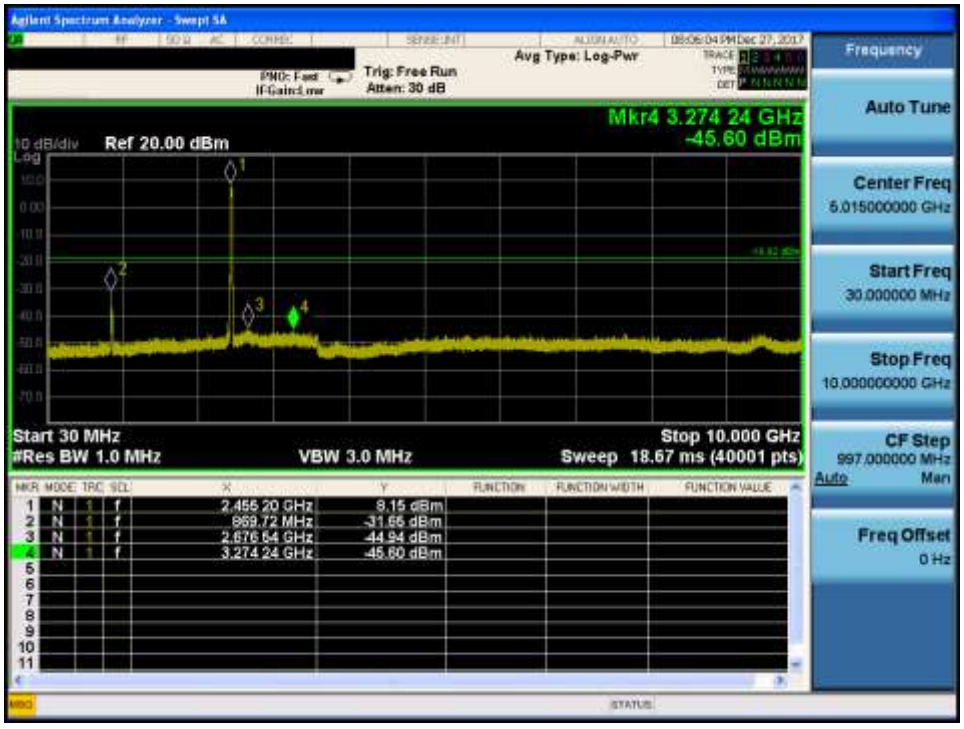
TM 3 & Highest

Reference

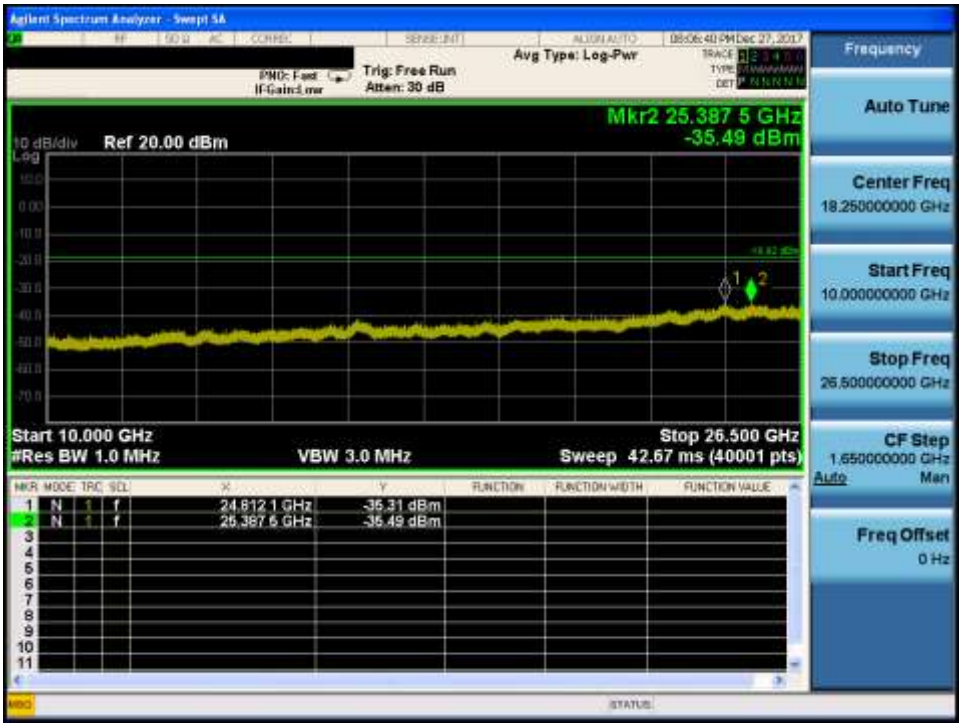
High Band-edge

Conducted Spurious Emissions



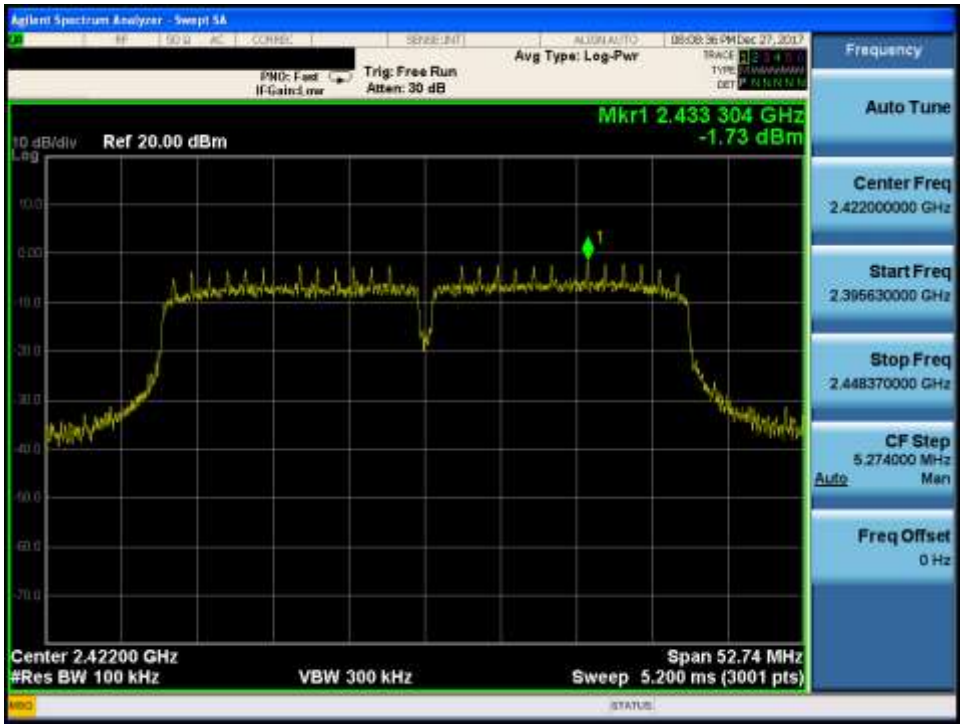


Conducted Spurious Emissions



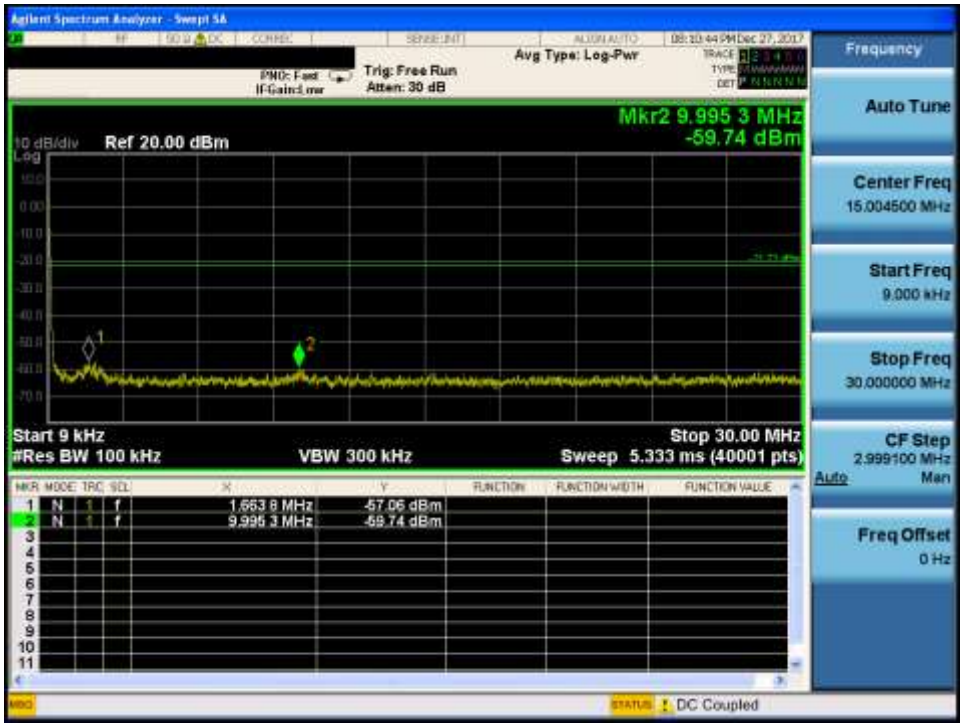
TM 4 & Lowest

Reference

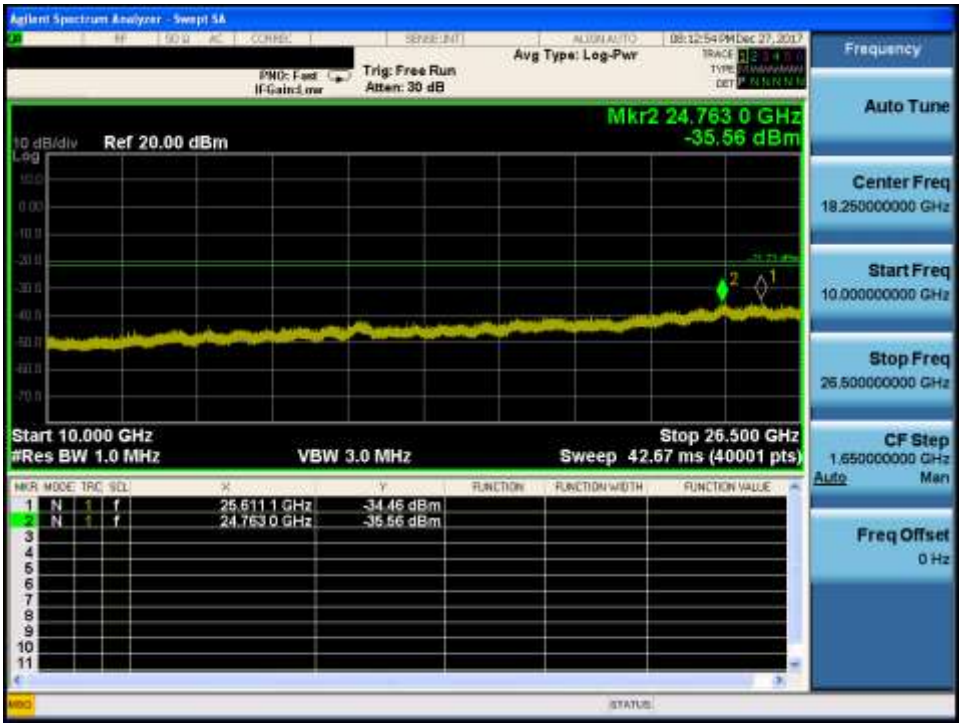


Low Band-edge

Conducted Spurious Emissions

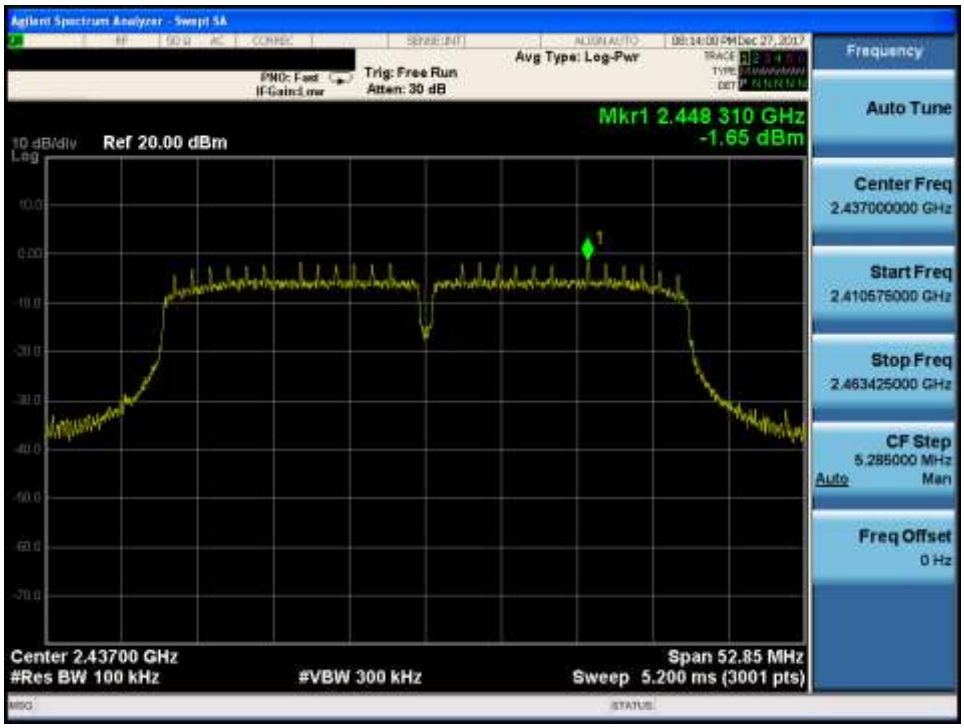


Conducted Spurious Emissions

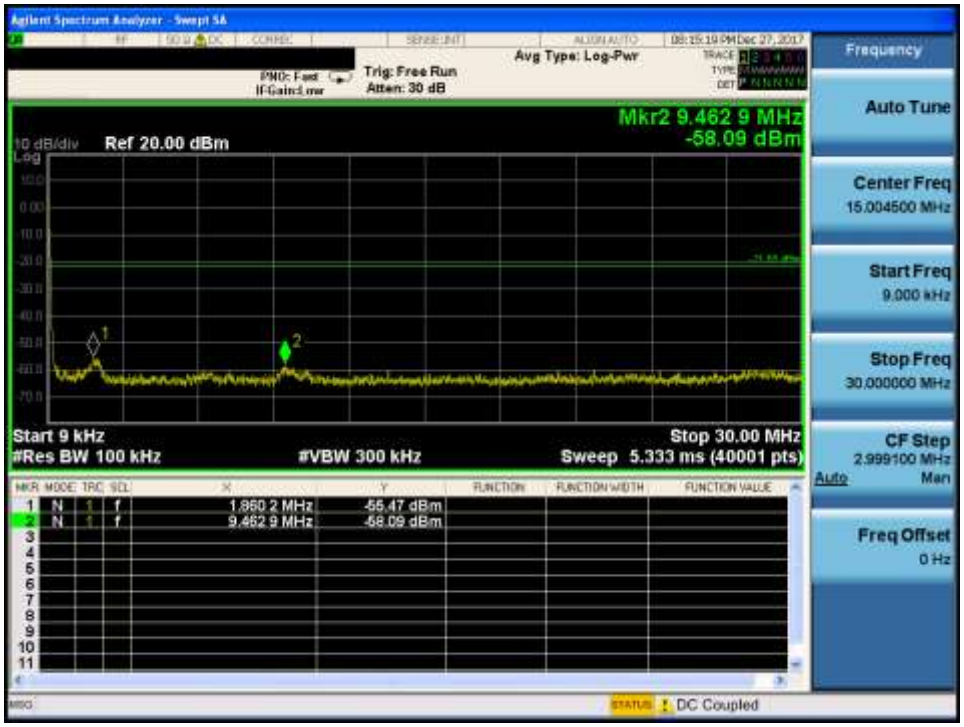


TM 4 & Middle

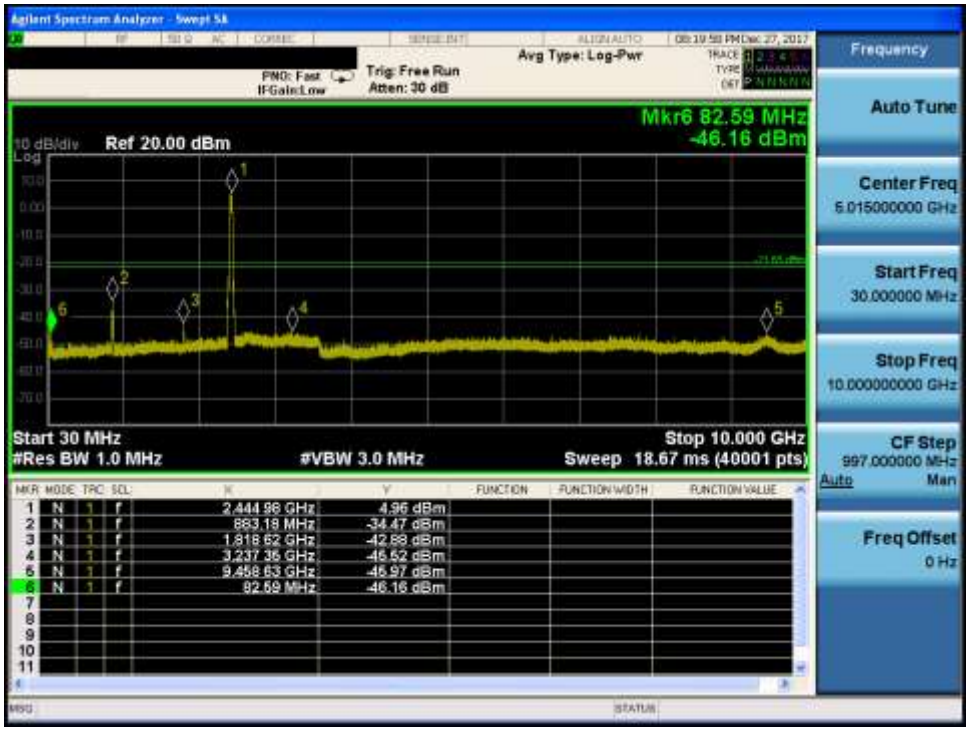
Reference



Conducted Spurious Emissions

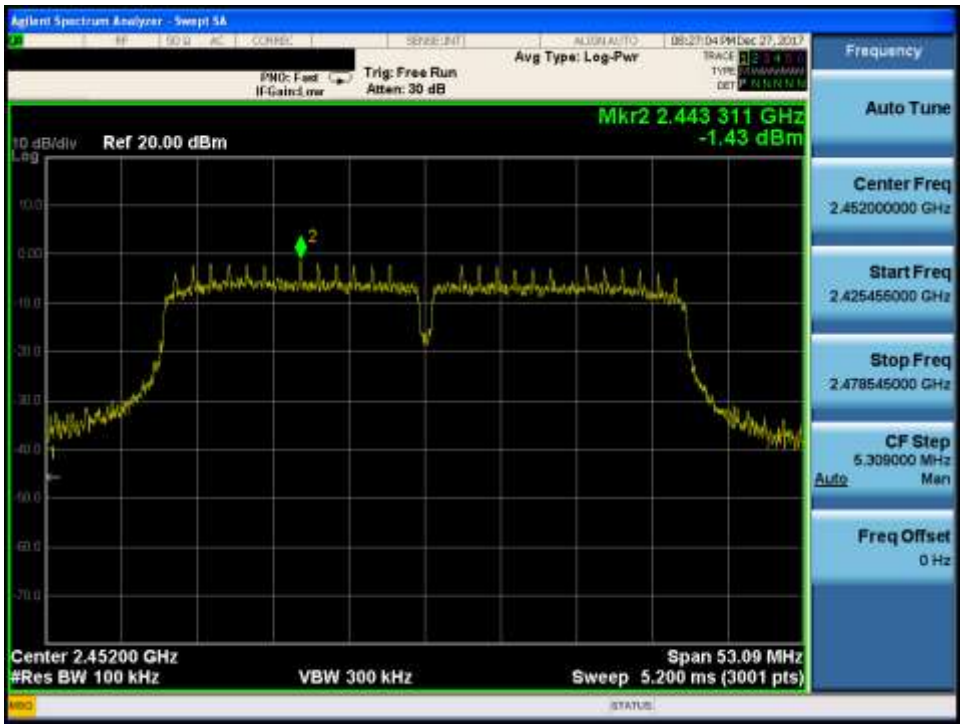


Conducted Spurious Emissions



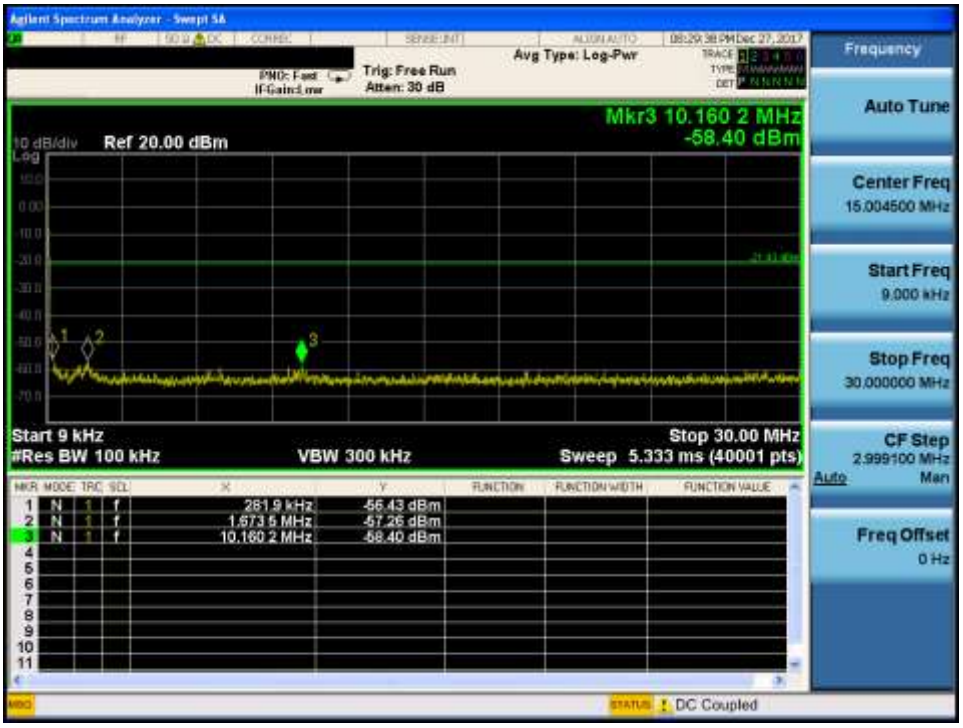
TM 4 & Highest

Reference

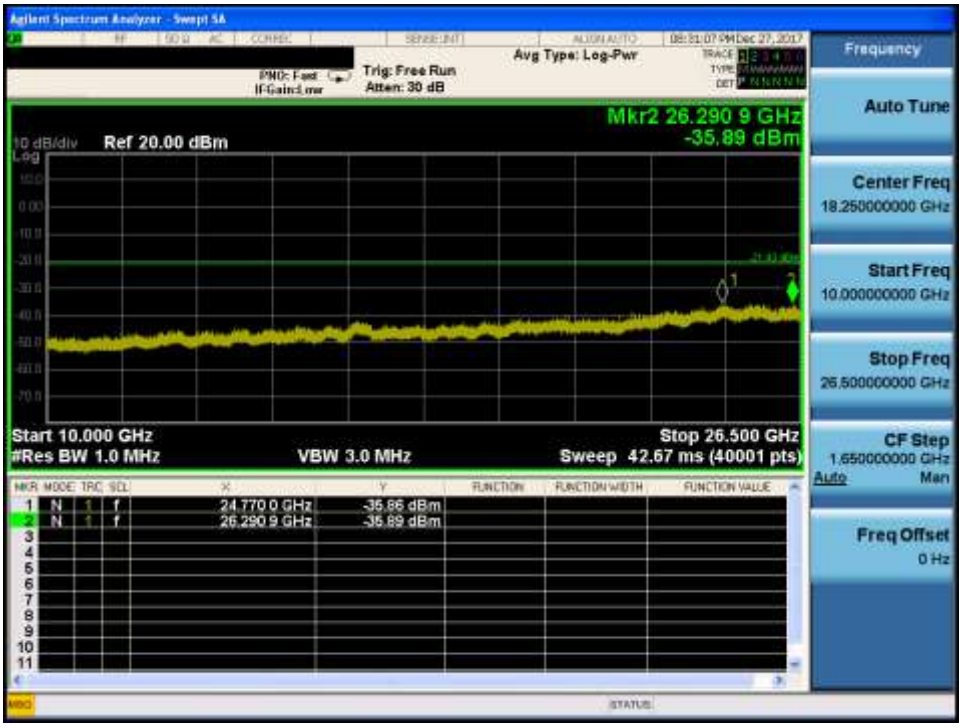


High Band-edge

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	96.91	0.14
TM 2	6Mbps	84.01	0.76
TM 3	MCS0	82.98	0.81
TM 4	MCS0	70.93	1.49

Note: Please refer to the test report of the granted module.

▣ 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) : ***Test Mode 1(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	2387.78	H	Z	PK	48.55	0.70	N/A	N/A	49.25	74.00	24.75
	2387.74	H	Z	AV	40.44	0.70	0.14	N/A	41.28	54.00	12.72
	4824.19	V	Z	PK	46.81	4.86	N/A	N/A	51.67	74.00	22.33
	4823.97	V	Z	AV	38.46	4.86	0.14	N/A	43.46	54.00	10.54
Middle	4874.05	V	Z	PK	47.01	5.07	N/A	N/A	52.08	74.00	21.92
	4873.94	V	Z	AV	37.22	5.07	0.14	N/A	42.43	54.00	11.57
Highest	2483.59	H	Z	PK	48.25	1.07	N/A	N/A	49.32	74.00	24.68
	2483.57	H	Z	AV	40.11	1.07	0.14	N/A	41.32	54.00	12.68
	4923.76	V	Z	PK	46.62	5.23	N/A	N/A	51.85	74.00	22.15
	4924.09	V	Z	AV	36.41	5.23	0.14	N/A	41.78	54.00	12.22

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. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)

Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : ***Test Mode 2(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	2389.89	H	Z	PK	64.13	0.70	N/A	N/A	64.83	74.00	9.17
	2389.96	H	Z	AV	48.28	0.70	0.76	N/A	49.74	54.00	4.26
	4822.87	V	Z	PK	44.45	4.86	N/A	N/A	49.31	74.00	24.69
	4822.70	V	Z	AV	34.13	4.86	0.76	N/A	39.75	54.00	14.25
Middle	4873.19	V	Z	PK	44.93	5.07	N/A	N/A	50.00	74.00	24.00
	4873.63	V	Z	AV	34.18	5.07	0.76	N/A	40.01	54.00	13.99
Highest	2483.67	H	Z	PK	62.47	1.07	N/A	N/A	63.54	74.00	10.46
	2483.57	H	Z	AV	49.00	1.07	0.76	N/A	50.83	54.00	3.17
	4924.39	V	Z	PK	44.94	5.23	N/A	N/A	50.17	74.00	23.83
	4924.42	V	Z	AV	34.35	5.23	0.76	N/A	40.34	54.00	13.66

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. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)

Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : *Test Mode 3(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	2389.77	H	Z	PK	57.52	0.70	N/A	N/A	58.22	74.00	15.78
	2389.96	H	Z	AV	42.56	0.70	0.81	N/A	44.07	54.00	9.93
	4823.46	V	Z	PK	44.83	4.86	N/A	N/A	49.69	74.00	24.31
	4823.37	V	Z	AV	33.94	4.86	0.81	N/A	39.61	54.00	14.39
Middle	4873.40	V	Z	PK	44.79	5.07	N/A	N/A	49.86	74.00	24.14
	4872.50	V	Z	AV	34.25	5.07	0.81	N/A	40.13	54.00	13.87
Highest	2484.20	H	Z	PK	58.57	1.07	N/A	N/A	59.64	74.00	14.36
	2483.73	H	Z	AV	42.48	1.07	0.81	N/A	44.36	54.00	9.64
	4923.53	V	Z	PK	45.58	5.23	N/A	N/A	50.81	74.00	23.19
	4924.40	V	Z	AV	34.32	5.23	0.81	N/A	40.36	54.00	13.64

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. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)

Radiated Spurious Emissions data(9 kHz ~ 25 GHz) : *Test Mode 4(TM 4)*

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	2389.91	H	Z	PK	59.57	0.70	N/A	N/A	60.27	74.00	13.73
	2389.81	H	Z	AV	45.38	0.70	1.49	N/A	47.57	54.00	6.43
	4842.83	V	Z	PK	44.70	4.94	N/A	N/A	49.64	74.00	24.36
	4842.69	V	Z	AV	34.26	4.94	1.49	N/A	40.69	54.00	13.31
Middle	4874.53	V	Z	PK	45.04	5.07	N/A	N/A	50.11	74.00	23.89
	4874.44	V	Z	AV	34.36	5.07	1.49	N/A	40.92	54.00	13.08
Highest	2484.11	H	Z	PK	58.17	1.07	N/A	N/A	59.24	74.00	14.76
	2484.57	H	Z	AV	43.22	1.07	1.49	N/A	45.78	54.00	8.22
	4903.25	V	Z	PK	44.88	5.17	N/A	N/A	50.05	74.00	23.95
	4902.56	V	Z	AV	34.40	5.17	1.49	N/A	41.06	54.00	12.94

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. Measurement Distance = 3 m for below 10 GHz, Measurement Distance = 1 m for above 10 GHz.
   Therefore Distance Correction Factor(DCF) : - 9.54 dB = 20*log(1m/3m)

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

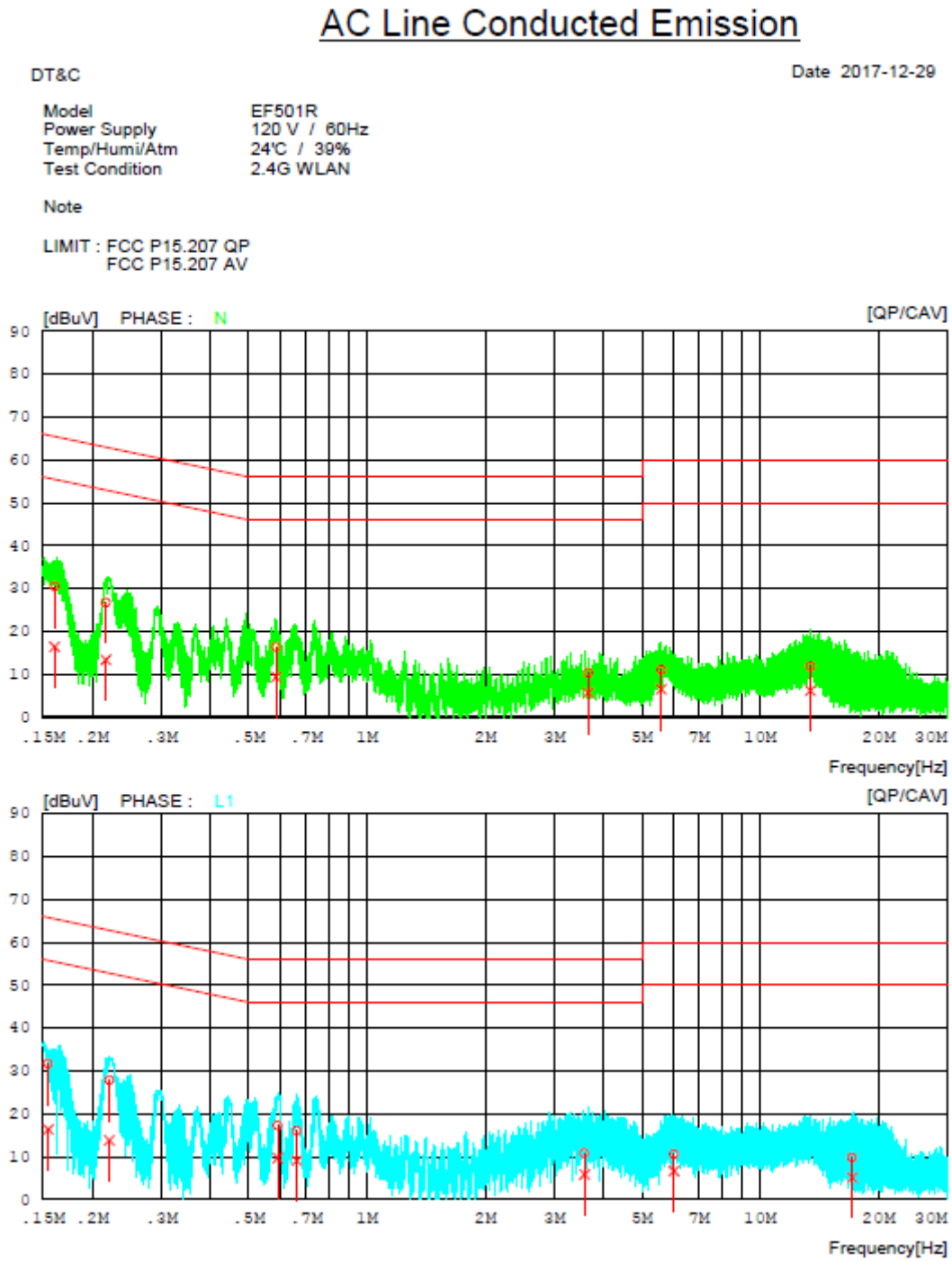
1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to the test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

▣ Test Results: Comply(Refer to next page.)

The worst data was reported.

▣ RESULT PLOTS

AC Line Conducted Emissions (Graph)



AC Line Conducted Emissions (List)

AC Line Conducted Emission

DT&C Date 2017-12-29

Model	EF501R
Power Supply	120 V / 60Hz
Temp/Humi/Atm	24'C / 39%
Test Condition	2.4G WLAN

Note

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

NO	FREQ	READING QP	READING CAV	C.FACTOR	RESULT QP	RESULT CAV	LIMIT QP	LIMIT CAV	MARGIN QP	MARGIN CAV	PHASE
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	
1	0.16050	20.79	6.75	9.64	30.43	16.39	65.44	55.44	35.01	39.05	N
2	0.21650	17.12	3.70	9.64	26.76	13.34	62.95	52.95	36.19	39.61	N
3	0.58750	6.74	-0.28	9.64	16.38	9.36	56.00	46.00	39.62	36.64	N
4	3.64934	0.68	-3.99	9.69	10.37	5.70	56.00	46.00	45.63	40.30	N
5	5.60489	1.24	-3.24	9.75	10.99	6.51	60.00	50.00	49.01	43.49	N
6	13.43056	1.97	-3.68	9.87	11.84	6.19	60.00	50.00	48.16	43.81	N
7	0.15450	21.91	6.57	9.74	31.65	16.31	65.75	55.75	34.10	39.44	L1
8	0.22093	18.05	3.99	9.74	27.79	13.73	62.78	52.78	34.99	39.05	L1
9	0.59250	7.50	-0.10	9.74	17.24	9.64	56.00	46.00	38.76	36.36	L1
10	0.66250	6.24	-0.69	9.75	15.99	9.06	56.00	46.00	40.01	36.94	L1
11	3.57469	0.98	-4.00	9.79	10.77	5.79	56.00	46.00	45.23	40.21	L1
12	6.04015	0.70	-3.19	9.82	10.52	6.63	60.00	50.00	49.48	43.37	L1
13	17.15769	-0.19	-4.78	9.95	9.76	5.17	60.00	50.00	50.24	44.83	L1

9. LIST OF TEST EQUIPMENT

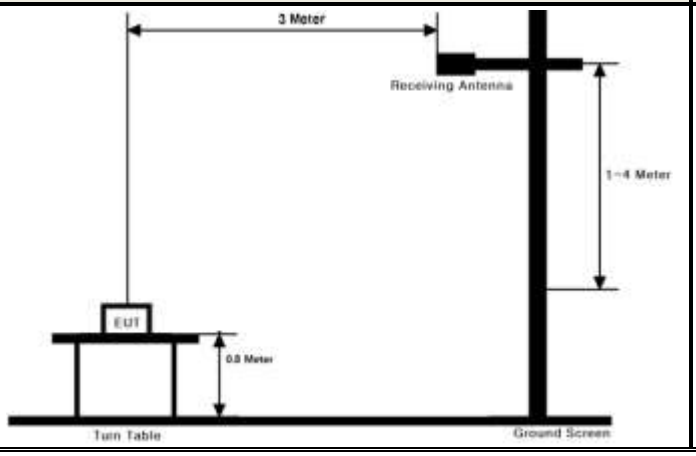
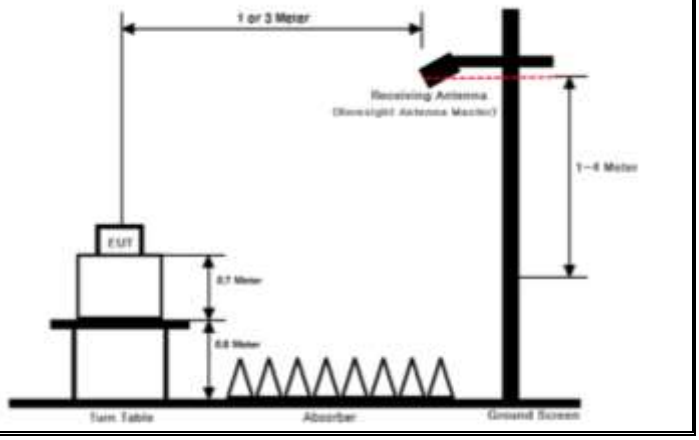
Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	17/09/06	18/09/06	MY48011075
Spectrum Analyzer	Agilent Technologies	N9020A	17/09/05	18/09/05	MY46471251
Multimeter	FLUKE	17B	17/04/12	18/04/12	26030065WS
DC Power Supply	SM techno	SDP30-5D	17/09/08	18/09/08	305DMG304
Signal Generator	Rohde Schwarz	SMBV100A	17/01/04	18/01/04	255571
Signal Generator	Rohde Schwarz	SMF100A	17/04/21	18/04/21	102341
Thermohygrometer	BODYCOM	BJ5478	17/04/11	18/04/11	120612-2
50W 10dB ATT	SMAJK	SMAJK-50-10	17/09/06	18/09/06	2-50-10
Loop Antenna	Schwarzbeck	FMZB1513	16/04/22	18/04/22	1513-128
BILOG ANTENNA	Schwarzbeck	VULB 9160	16/08/05	18/08/05	9160-3362
Horn Antenna	ETS-LINDGREN	3117	16/05/03	18/05/03	00140394
Horn Antenna	A.H.Systems Inc.	SAS-574	17/07/31	19/07/31	155
PreAmplifier	Agilent	8449B	17/09/05	18/09/05	3008A02108
PreAmplifier	TSJ	MLA-010K01-B01-27	17/03/06	18/03/06	1844539
EMI Test Receiver	Rohde Schwarz	ESR7	17/02/16	18/02/16	101061
EMI Test Receiver	Rohde Schwarz	ESR7	17/11/16	18/11/16	101109
High-pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	17/09/05	18/09/05	3
High-pass filter	Wainwright	WHNX6-6320-8000-26500-40CC	17/09/05	18/09/05	1
TRANSIENT LIMITER	EMCIS	TL-B0930A	17/09/07	18/09/07	11002
SINGLE-PHASE MASTER	NF	4420	17/09/01	18/09/01	3049354420023
TWO-LINE V-NETWORK	Rohde Schwarz	ENV216	17/10/10	18/10/10	101979
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A MA2411B	17/04/11	18/04/11	1338004 1306053

Note: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.

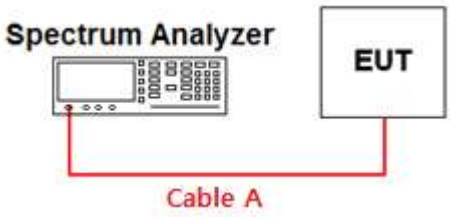
APPENDIX I

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	0.03	15	0.92
1	0.30	20	1.37
2.402 & 2.440 & 2.480	0.44	25	2.25
5	0.60	-	-
10	0.89	-	-

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

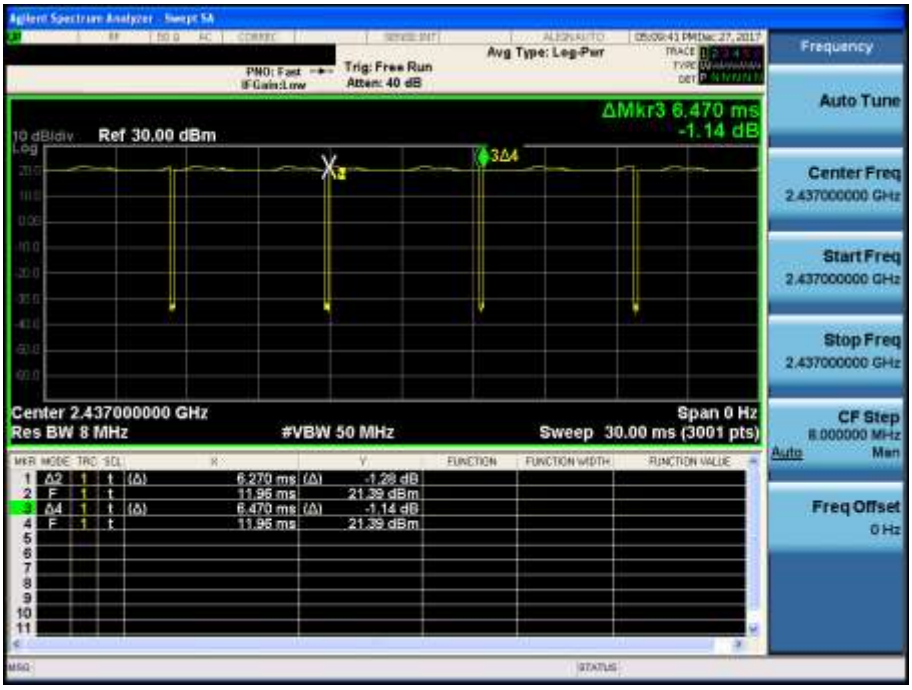
▪ Test Procedure

Duty Cycle was measured using **section 6.0 b) of KDB558074 D01V04 :**

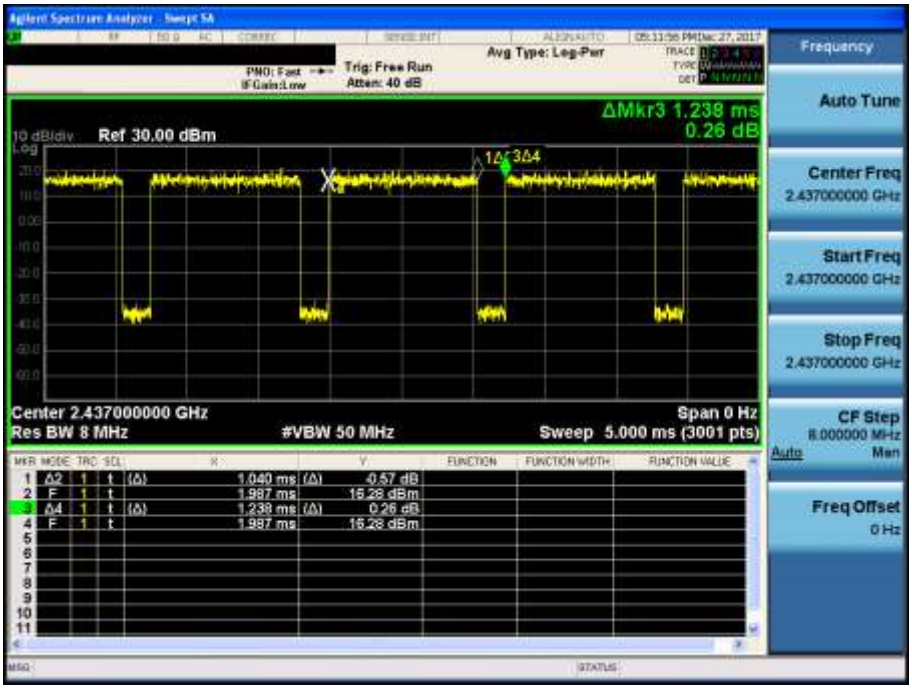
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission.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

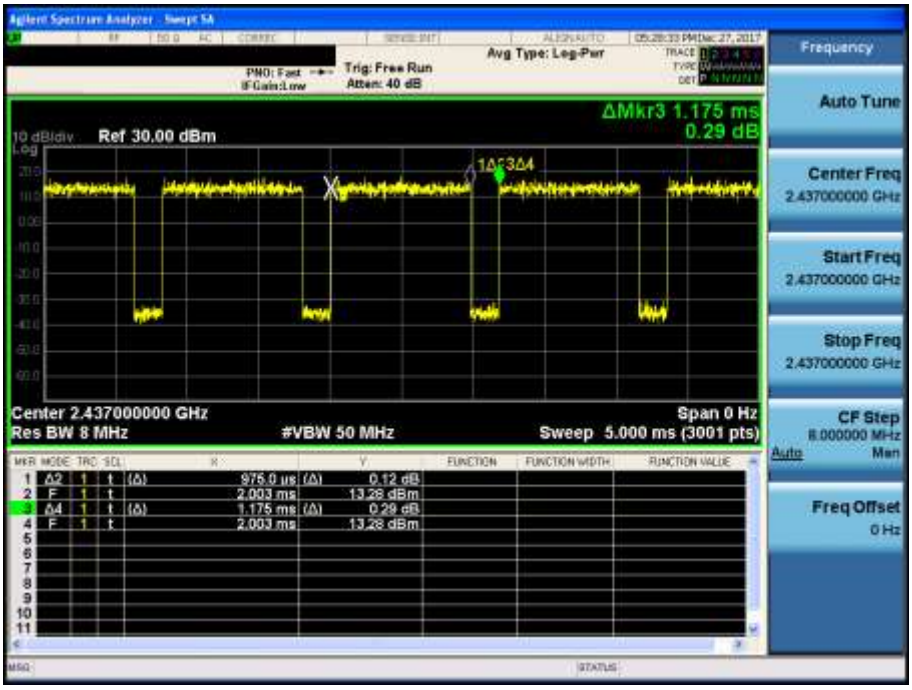
Duty Cycle TM 1 & Middle



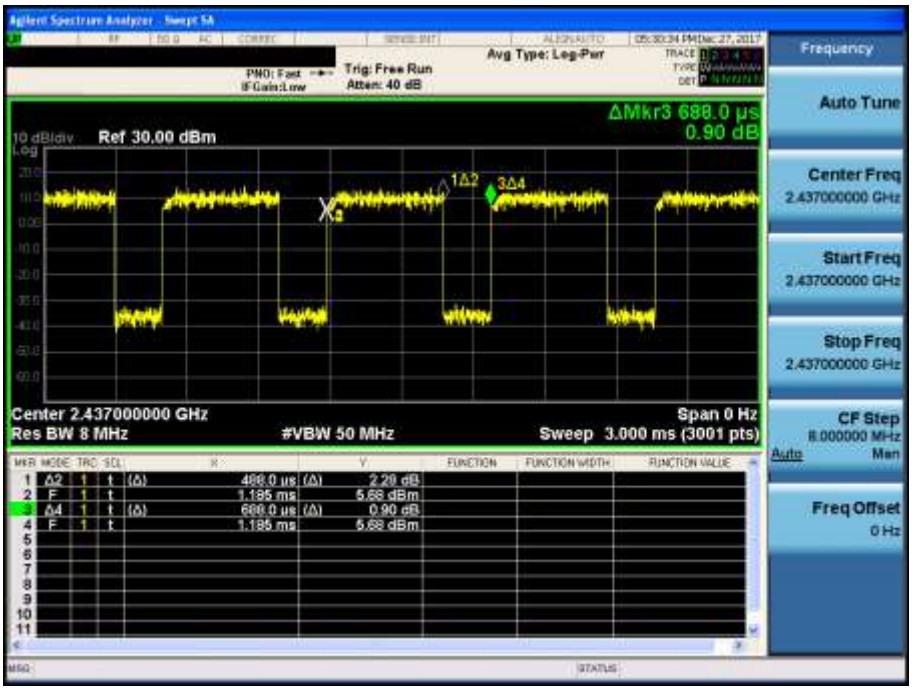
Duty Cycle TM 2 & Middle



Duty Cycle TM 3 & Middle



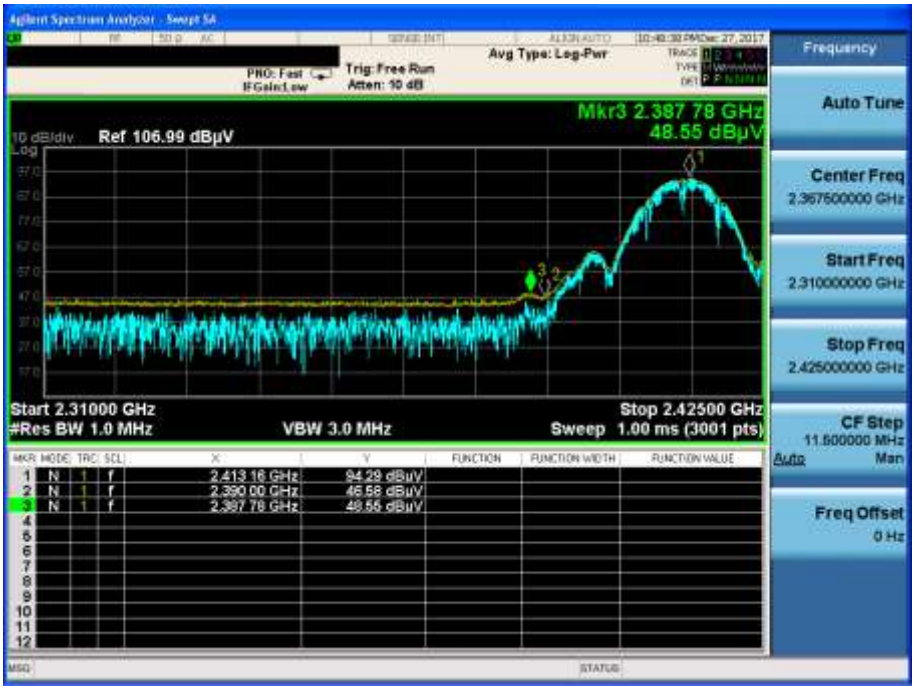
Duty Cycle TM 4 & Middle



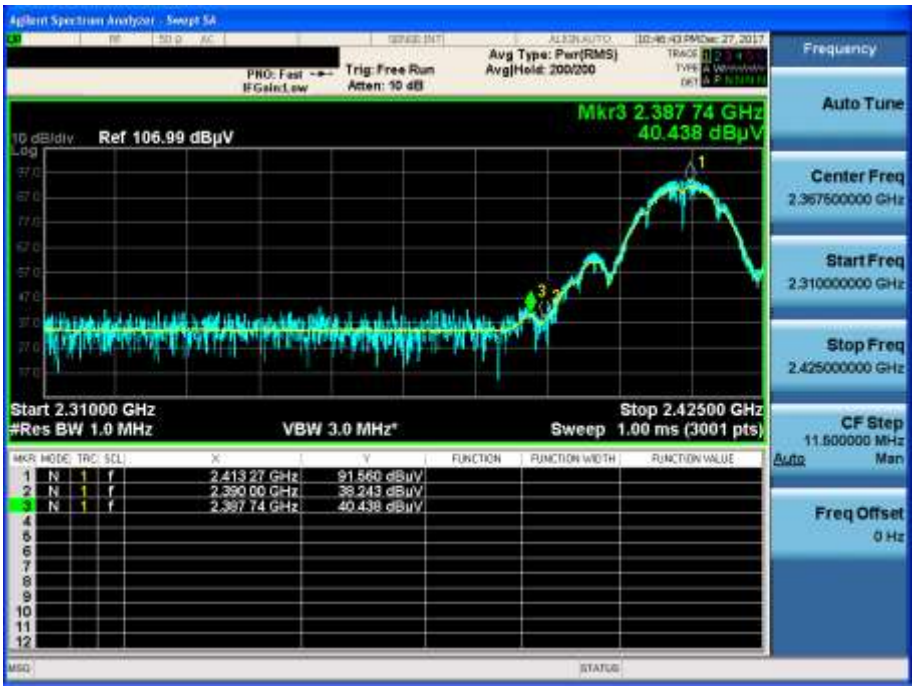
APPENDIX III

Unwanted Emissions (Radiated) Test Plot

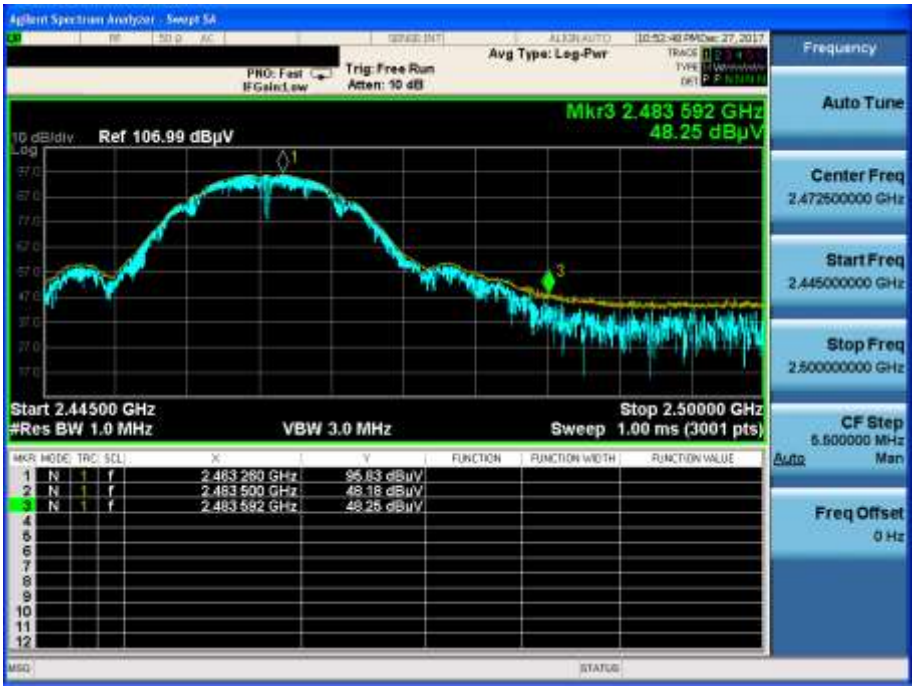
TM 1 & Lowest & Z axis & Hor **Detector Mode : PK**



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

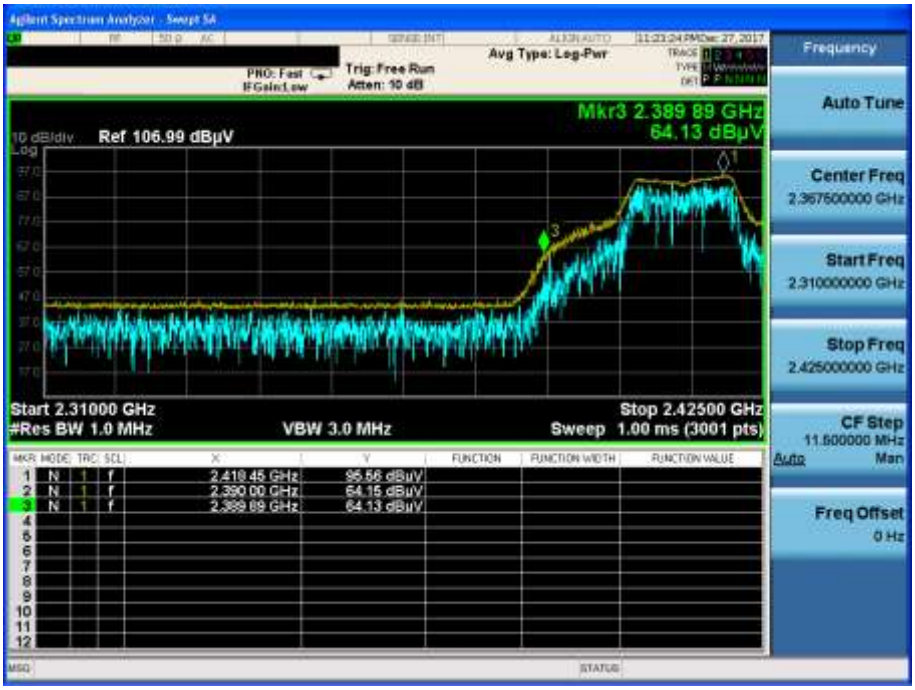


TM 1 & Highest & Z axis & Hor **Detector Mode : PK**

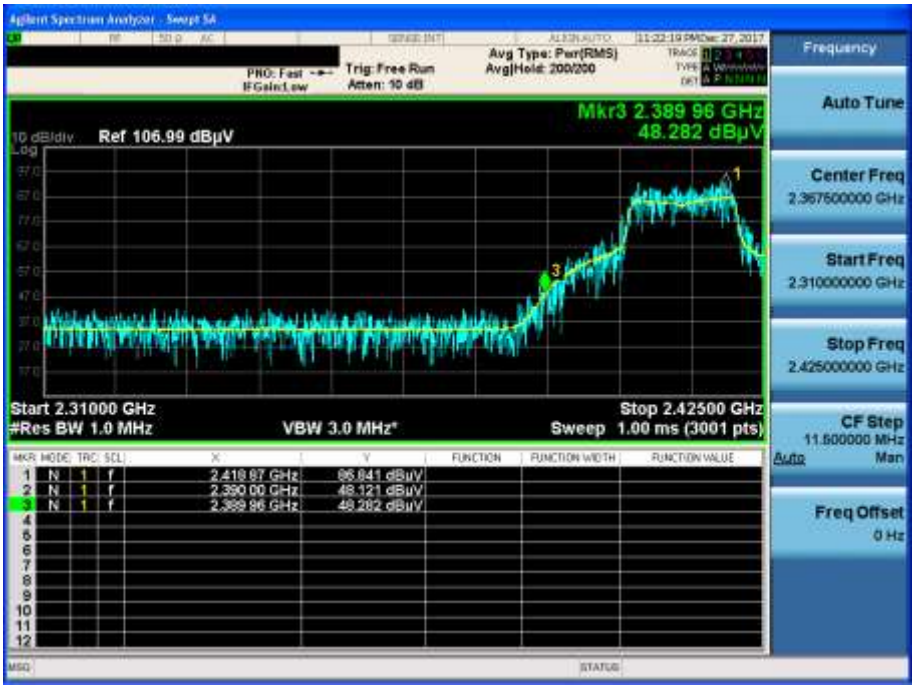


TM 1 & Highest & Z axis & Hor **Detector Mode : AV**

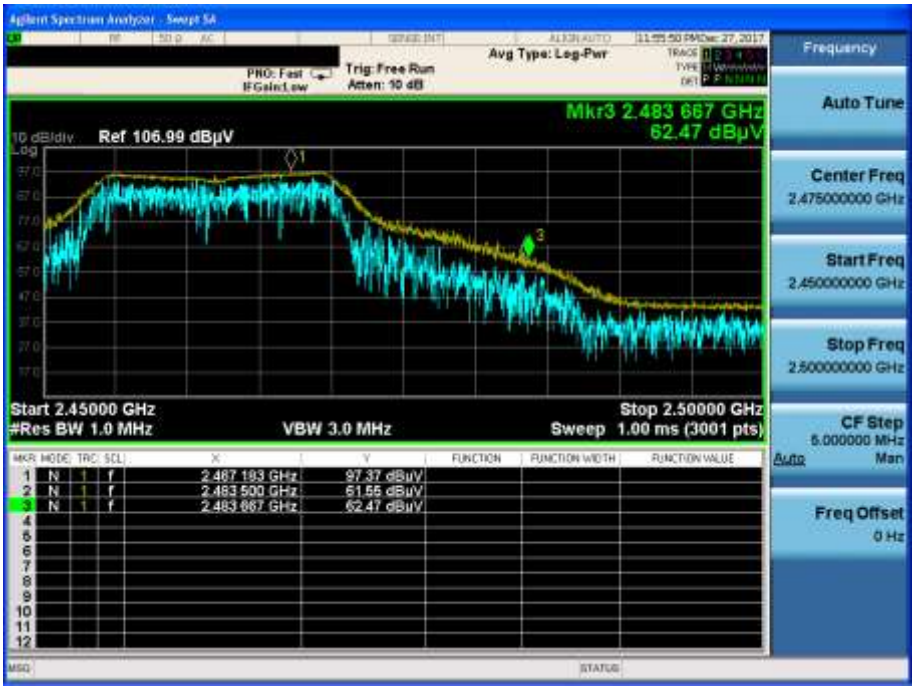
TM 2 & Lowest & Z axis & Hor **Detector Mode : PK**



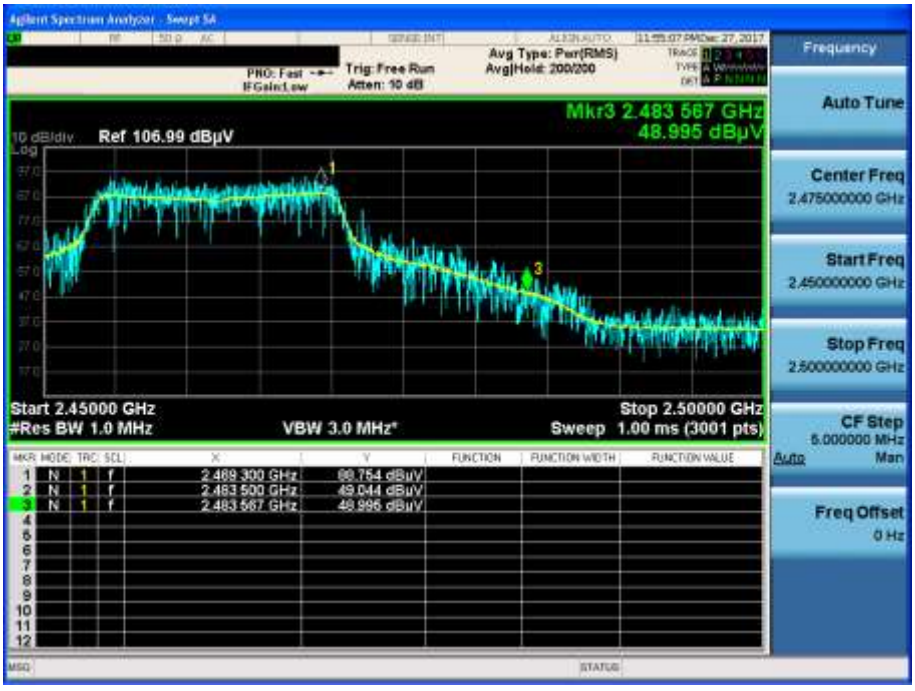
TM 2 & Lowest & Z axis & Hor **Detector Mode : AV**



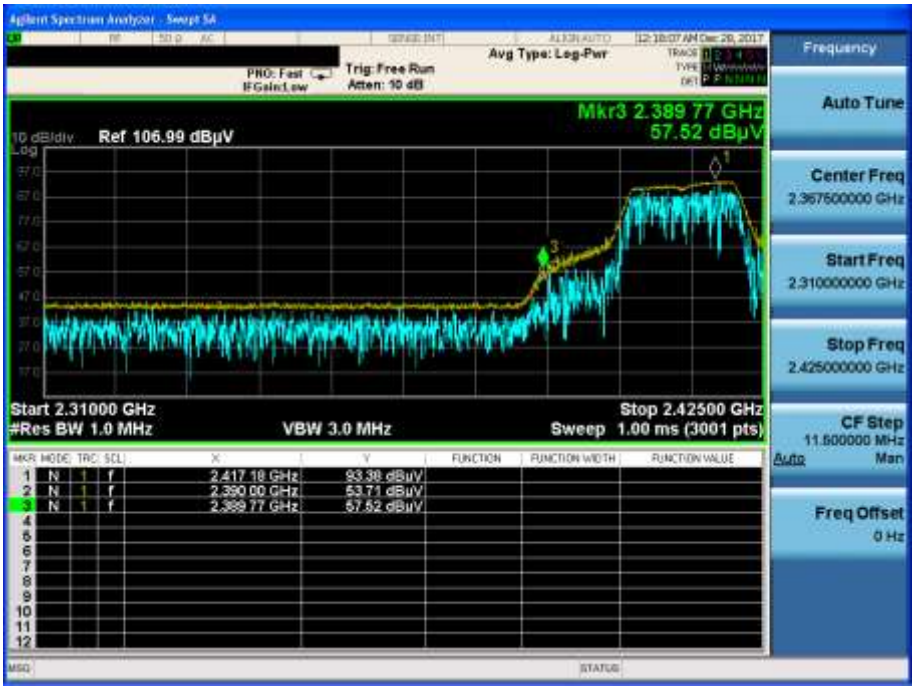
TM 2 & Highest & Z axis & Hor **Detector Mode : PK**



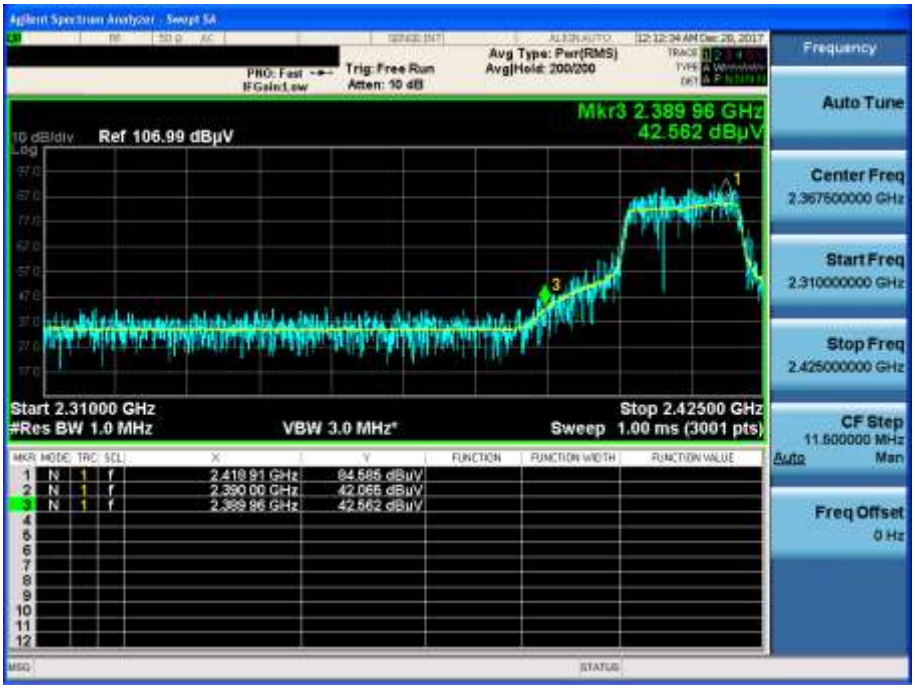
TM 2 & Highest & Z axis & Hor **Detector Mode : AV**



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

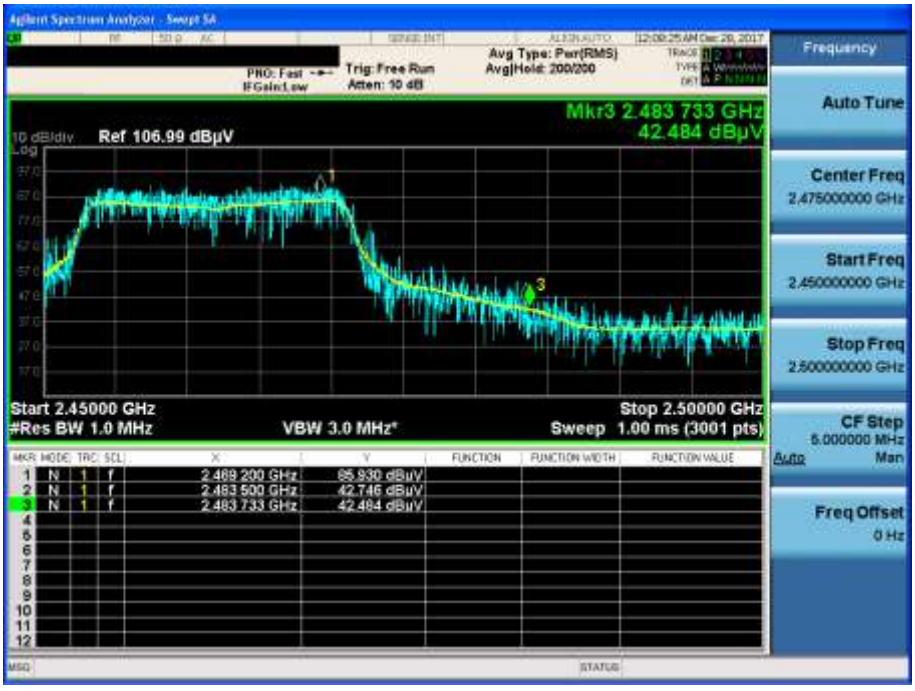


TM 3 & Lowest & Z axis & Hor **Detector Mode : AV**

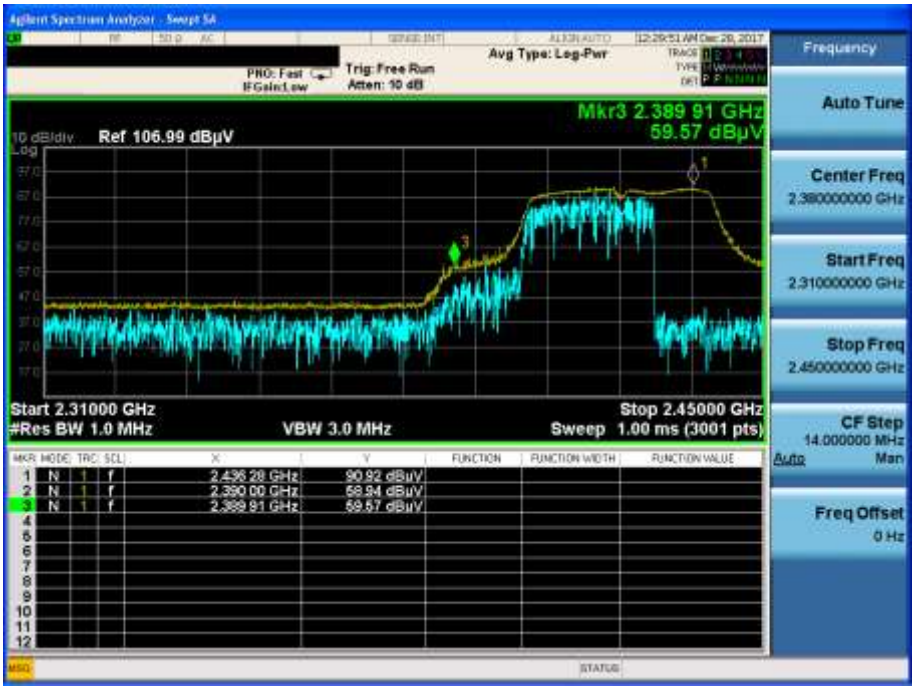


TM 3 & Highest & Z axis & Hor **Detector Mode : PK**

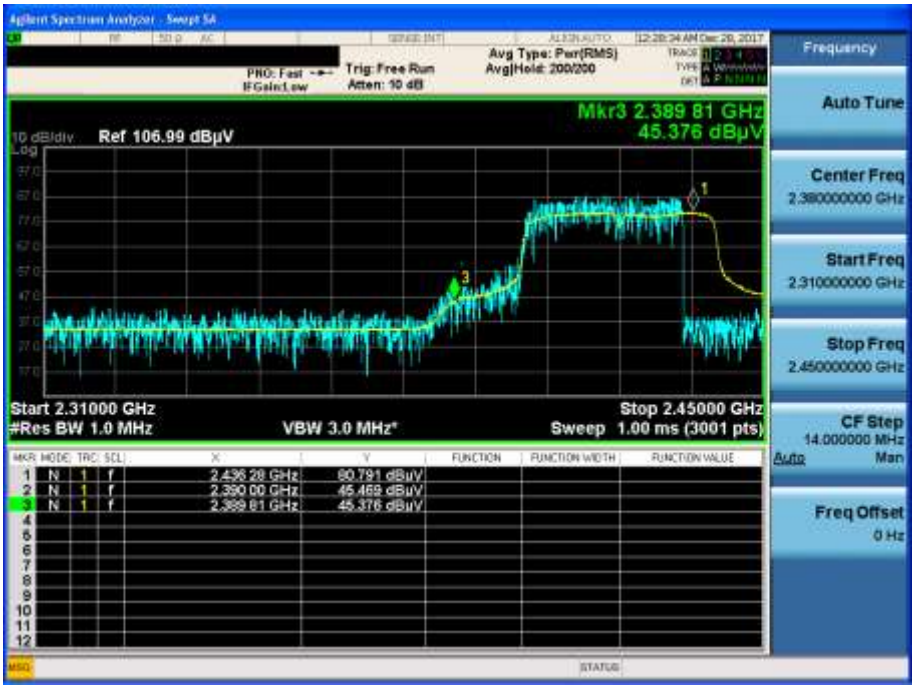
TM 3 & Highest & Z axis & Hor **Detector Mode : AV**



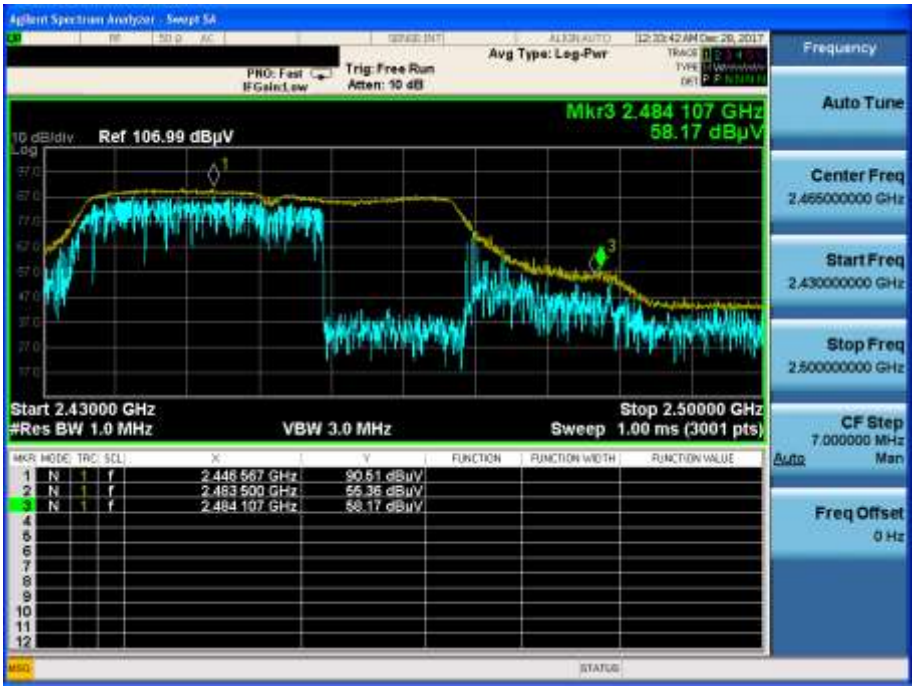
TM 4 & Lowest & Z axis & Hor **Detector Mode : PK**



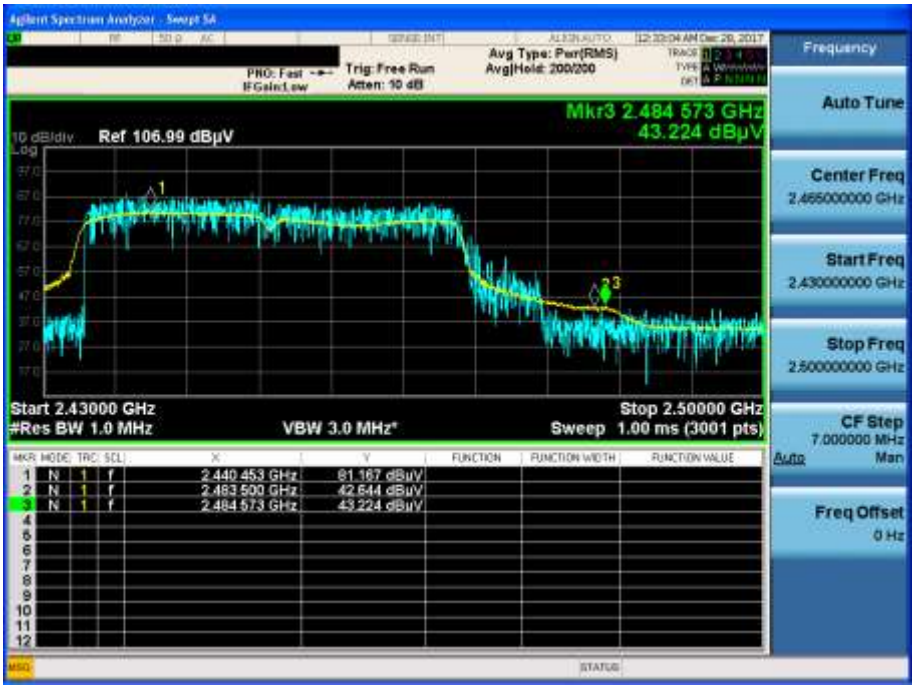
TM 4 & Lowest & Z axis & Hor **Detector Mode : AV**



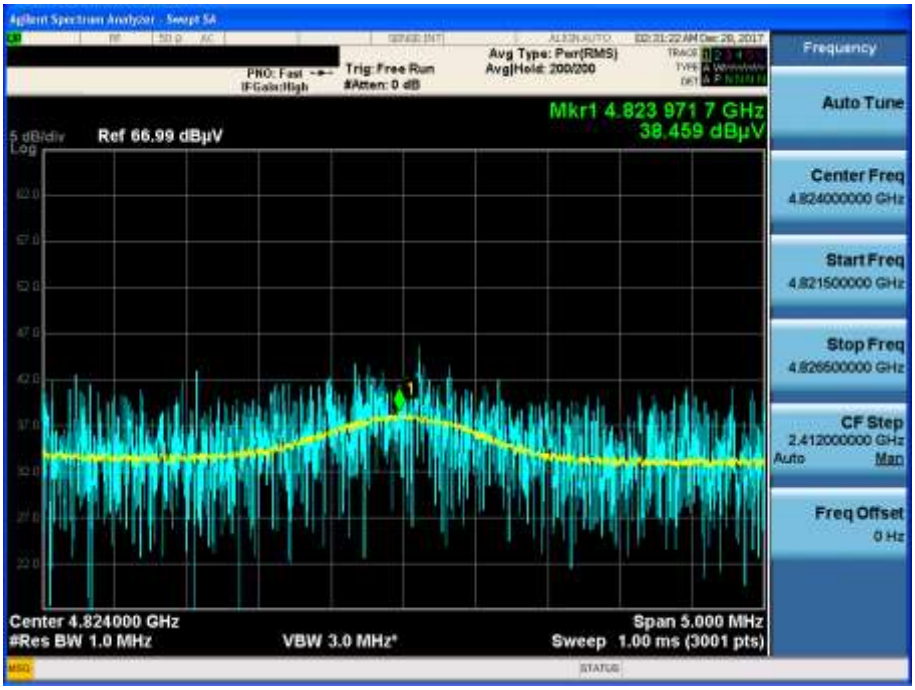
TM 4 & Highest & Z axis & Hor **Detector Mode : PK**



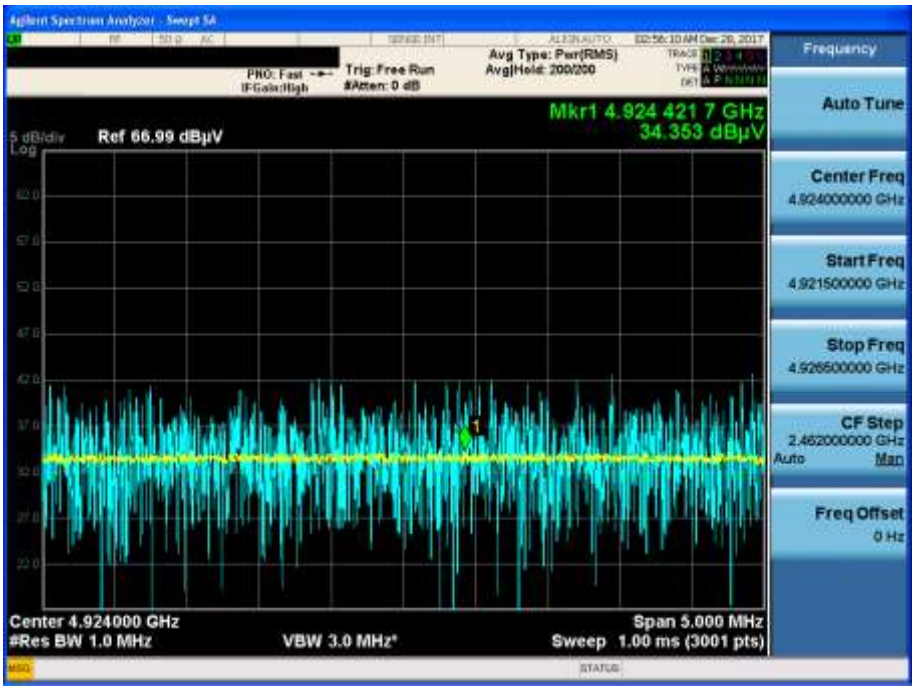
TM 4 & Highest & Z axis & Hor **Detector Mode : AV**



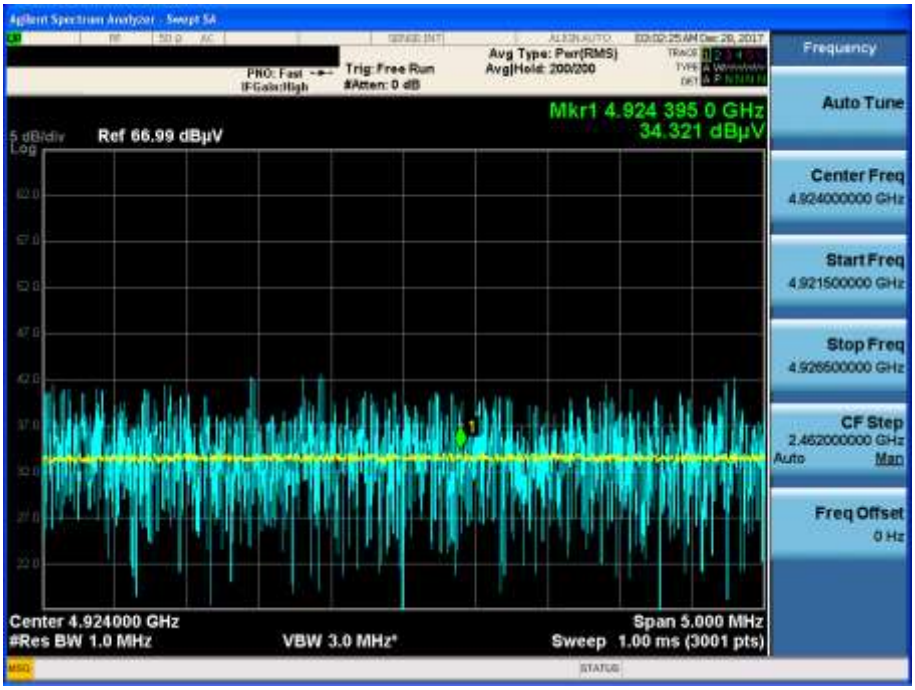
TM 1 & Lowest & Z axis & Ver **Detector Mode : AV**



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



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



TM 4 & Highest & Z axis & Ver **Detector Mode : AV**