



FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-247 ISSUE 1

CERTIFICATION TEST REPORT

FOR

CELLULAR PHONE WITH BLUETOOTH AND WLAN RADIOS

MODEL NUMBER: A1784

FCC ID: BCG-E3092A
IC: 579C-E3092A

REPORT NUMBER: 16U23366-E3V2

ISSUE DATE: AUGUST 01, 2016

Prepared for
APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP[®]

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	7/21/2016	Initial Issue	Chin Pang
V2	8/01/2016	Address TCB's Questions	Chin Pang

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS	5
2. TEST METHODOLOGY	6
3. FACILITIES AND ACCREDITATION	6
4. CALIBRATION AND UNCERTAINTY	6
4.1. <i>MEASURING INSTRUMENT CALIBRATION</i>	6
4.2. <i>SAMPLE CALCULATION</i>	6
4.3. <i>MEASUREMENT UNCERTAINTY</i>	7
5. EQUIPMENT UNDER TEST	8
5.1. <i>DESCRIPTION OF EUT</i>	8
5.2. <i>MAXIMUM OUTPUT POWER</i>	8
5.3. <i>DESCRIPTION OF AVAILABLE ANTENNAS</i>	8
5.4. <i>SOFTWARE AND FIRMWARE</i>	8
5.5. <i>WORST-CASE CONFIGURATION AND MODE</i>	9
5.6. <i>DESCRIPTION OF TEST SETUP</i>	10
6. TEST AND MEASUREMENT EQUIPMENT	16
7. MEASUREMENT METHODS	17
8. ANTENNA PORT TEST RESULTS	18
8.1. <i>ON TIME AND DUTY CYCLE</i>	18
8.2. <i>802.11b SISO MODE IN THE 2.4 GHz BAND, CHAIN 0</i>	21
8.2.1. 6 dB BANDWIDTH	21
8.2.2. 99% BANDWIDTH	25
8.2.3. AVERAGE POWER	29
8.2.4. OUTPUT POWER LIMITS	30
8.2.5. POWER SPECTRAL DENSITY	32
8.2.6. OUT-OF-BAND EMISSIONS	36
8.3. <i>802.11b SISO MODE IN THE 2.4 GHz BAND, CHAIN 1</i>	42
8.3.1. 6 dB BANDWIDTH	42
8.3.2. 99% BANDWIDTH	46
8.3.3. AVERAGE POWER	50
8.3.4. OUTPUT POWER	51
8.3.5. POWER SPECTRAL DENSITY	53
8.3.6. OUT-OF-BAND EMISSIONS	57
8.4. <i>802.11g SISO MODE IN THE 2.4 GHz BAND</i>	63
8.5. <i>802.11n HT20 SISO MODE IN THE 2.4 GHz BAND, CHAIN 0</i>	64
8.5.1. 6 dB BANDWIDTH	64
8.5.2. 99% BANDWIDTH	69
8.5.3. AVERAGE POWER	74

8.5.4. OUTPUT POWER	75
8.5.5. POWER SPECTRAL DENSITY	77
8.5.6. OUT-OF-BAND EMISSIONS	82
8.6. 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND, CHAIN 1.....	90
8.6.1. 6 dB BANDWIDTH.....	90
8.6.2. 99% BANDWIDTH.....	95
8.6.3. AVERAGE POWER	100
8.6.4. OUTPUT POWER	101
8.6.5. POWER SPECTRAL DENSITY	103
8.6.6. OUT-OF-BAND EMISSIONS	108
8.7. 802.11n HT20 2Tx CDD MODE IN THE 2.4 GHz BAND.....	116
8.7.1. 6 dB BANDWIDTH.....	116
8.7.2. 99% BANDWIDTH.....	124
8.7.3. AVERAGE POWER	132
8.7.4. OUTPUT POWER	133
8.7.5. POWER SPECTRAL DENSITY	135
8.7.6. OUT-OF-BAND EMISSIONS	143
9. RADIATED TEST RESULTS.....	158
9.1. <i>LIMITS AND PROCEDURE</i>	158
9.2. TRANSMITTER ABOVE 1 GHz.....	159
9.2.1. 802.11b 1Tx MODE IN THE 2.4 GHz BAND CHAIN 0	159
9.2.2. 802.11b 1Tx MODE IN THE 2.4 GHz BAND CHAIN 1	177
9.2.3. 802.11n HT20 1Tx MODE IN THE 2.4 GHz BAND CHAIN 0	195
9.2.4. 802.11n HT20 1Tx MODE IN THE 2.4 GHz BAND CHAIN 1	221
9.2.5. 802.11n HT20 2Tx MODE IN THE 2.4 GHz BAND (CHAIN 0 + CHAIN 1)	245
9.3. <i>WORST-CASE BELOW 1 GHz.....</i>	271
9.4. <i>WORST-CASE 18 to 26 GHz.....</i>	273
9.5. <i>WORST-CASE CO-LOCATION.....</i>	275
10. AC POWER LINE CONDUCTED EMISSIONS	277
10.1. <i>EUT POWERED BY AC/DC ADAPTER VIA USB CABLE.....</i>	278
10.2. <i>EUT POWERED BY HOST PC VIA USB CABLE.....</i>	280
11. SETUP PHOTOS	282

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: CELLULAR PHONE WITH BLUETOOTH AND WLAN RADIOS

MODEL: A1784

SERIAL NUMBER: C39RV054HFPQ (CONDUCTED); C39RV064HFPQ (RADIATED)

DATE TESTED: MARCH 1, 2016 – JULY 12, 2016

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-247 Issue 1	Pass
INDUSTRY CANADA RSS-GEN Issue 4	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:

Mengistu Mekuria

Prepared By:

Joe Vang

MENGISTU MEKURIA
PROJECT LEADER
UL VERIFICATION SERVICES INC.

JOE VANG
EMC ENGINEER
UL VERIFICATION SERVICES INC.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, KDB 558074 D01 v03r05, ANSI C63.10-2013, RSS-GEN Issue 4, and RSS-247 Issue 1.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
<input type="checkbox"/> Chamber A	<input checked="" type="checkbox"/> Chamber D
<input type="checkbox"/> Chamber B	<input checked="" type="checkbox"/> Chamber E
<input type="checkbox"/> Chamber C	<input checked="" type="checkbox"/> Chamber F
	<input type="checkbox"/> Chamber G
	<input checked="" type="checkbox"/> Chamber H

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through H are covered under Industry Canada company address code 2324B with site numbers 2324B -1 through 2324B-8, respectively.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://ts.nist.gov/standards/scopes/2000650.htm>.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT, Model A1784 is a mobile phone with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE-radio, IEEE 802.11a/b/g/n/ac, NFC and Bluetooth radio. The rechargeable battery is not user accessible.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2412 - 2472	802.11b 1TX	21.35	136.46
2412 - 2472	802.11g 1TX		Covered by HT20 1TX
2412 - 2472	802.11g 2TX		Covered by HT20 2TX CDD
2412 - 2472	802.11n HT20 1TX	25.63	365.59
2412 - 2472	802.11n HT20 2TX CDD	28.85	767.36

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band (GHz)	Antenna Gain (dBi)	
	Upper Antenna	Lower Antenna
2.4	-1.85	-1.35

5.4. SOFTWARE AND FIRMWARE

The firmware version installed in the EUT during testing was 9.44.11.27
The test utility software used during testing was wl 1.359 RC65.0.

5.5. WORST-CASE CONFIGURATION AND MODE

For below 1G radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The fundamental of the EUT was investigated in three orthogonal orientations X/Y/Z, it was determined that X orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in X orientation.

Worst-case data rates as provided by the client were:

802.11b mode: 1 Mbps
802.11g mode: 6 Mbps
802.11n HT20 mode: MCS0

The following modes have the same target power and use the same modulation (OFDM). Therefore, 802.11g 1TX and 802.11n HT20 1TX CDD mode.

For simultaneous transmission of multiple channels from the same antenna in the 2.4GHz and WWAN, tests were conducted for various configurations having the highest power. It was determined that (11b mode and GSM 1900) configuration was worst-case configuration.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The WiFi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	MacBook Pro	W885200F70K	NA
Laptop AC/DC adapter	Apple	A1343	C0420640G9KDJ92BD	NA
AC Adaptor	Apple	A1385	D293093W069DHLHCM	NA

I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
No Used						

I/O CABLES (BELOW 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	3	N/A

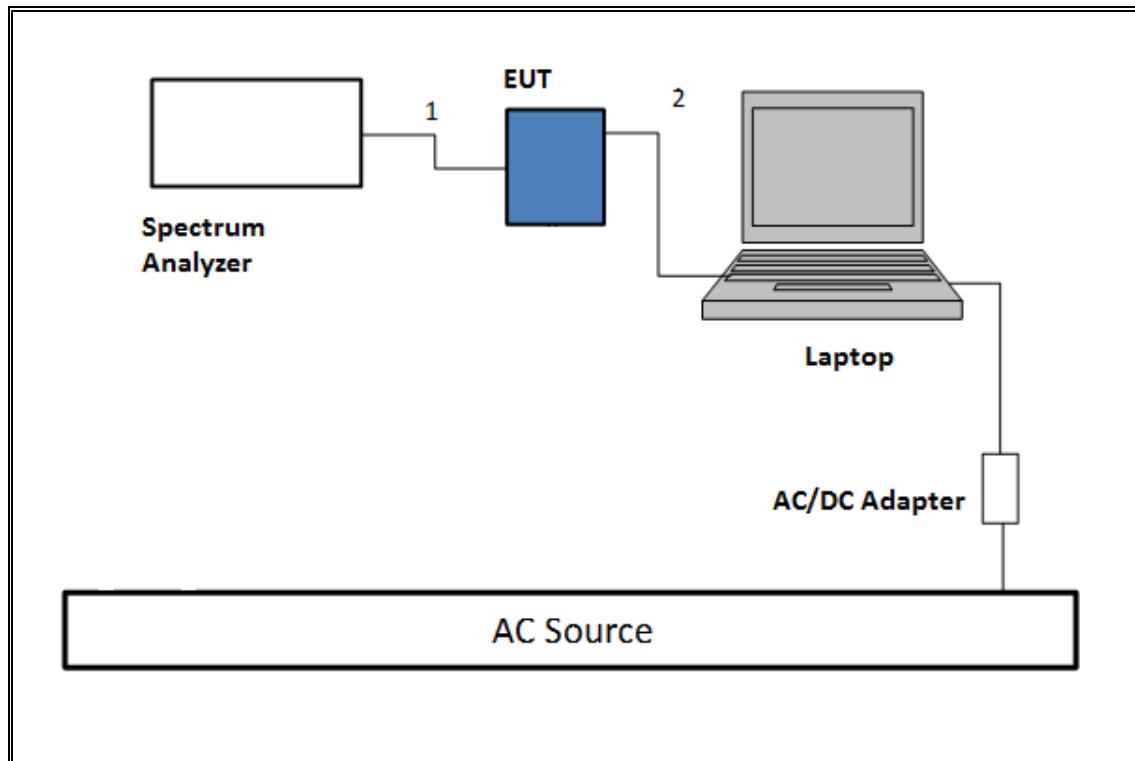
I/O CABLES (AC LINE CONDUCTED: AC/DC ADAPTER &LAPTOP CONFIGURATION)

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	3	N/A
2	Power Adapter	1	AC	Un-shielded	3	N/A

TEST SETUP - CONDUCTED

The EUT was connected to a host Laptop via USB cable and to spectrum analyzer via antenna port. Test software exercised the EUT.

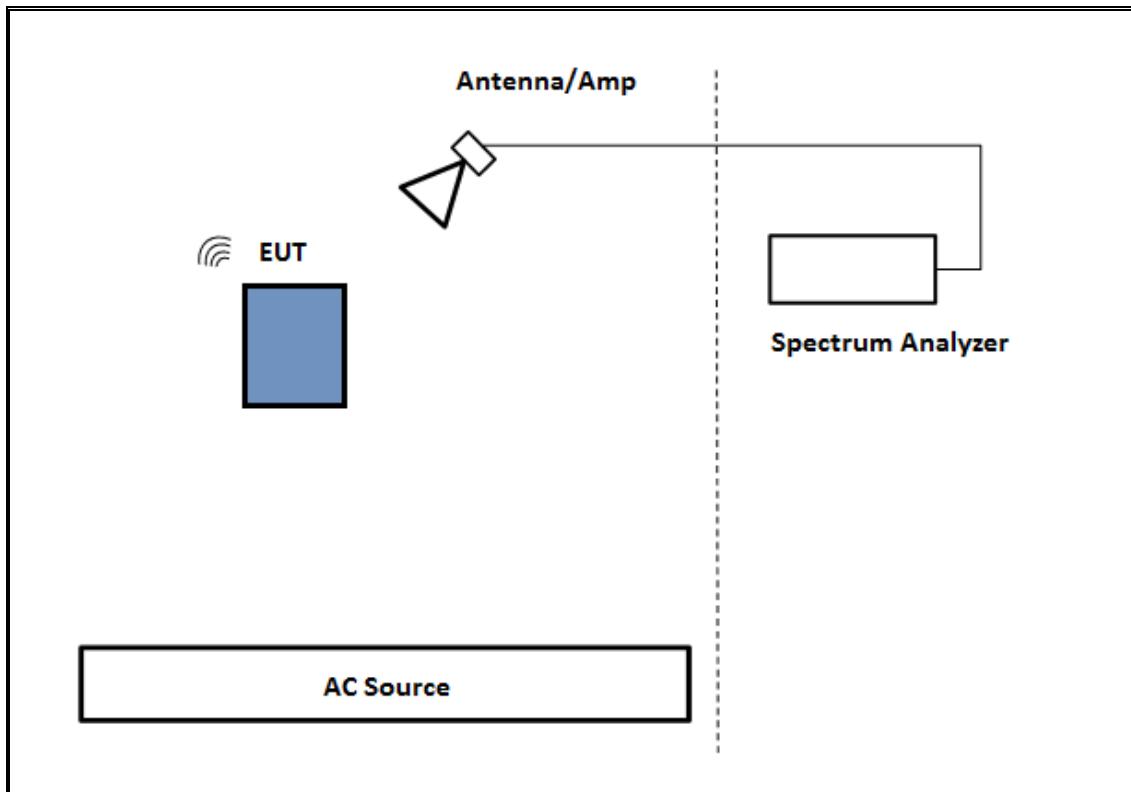
SETUP DIAGRAM



TEST SETUP- RADIATED-ABOVE 1 GHZ

The battery powered EUT was tested as a standalone unit. Test software exercised the EUT.

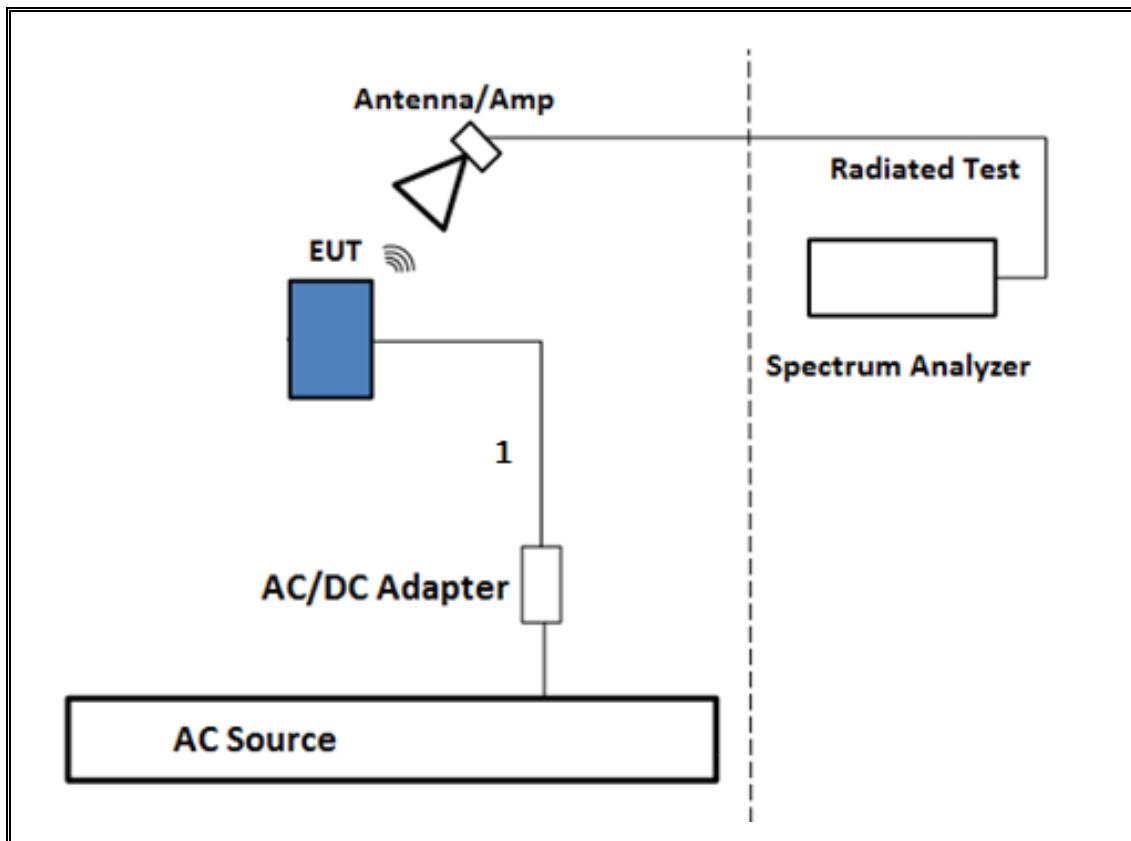
SETUP DIAGRAM



TEST SETUP- BELOW 1GHZ

The EUT was tested with powered by AC/DC adapter via USB cable. Test software exercised the EUT.

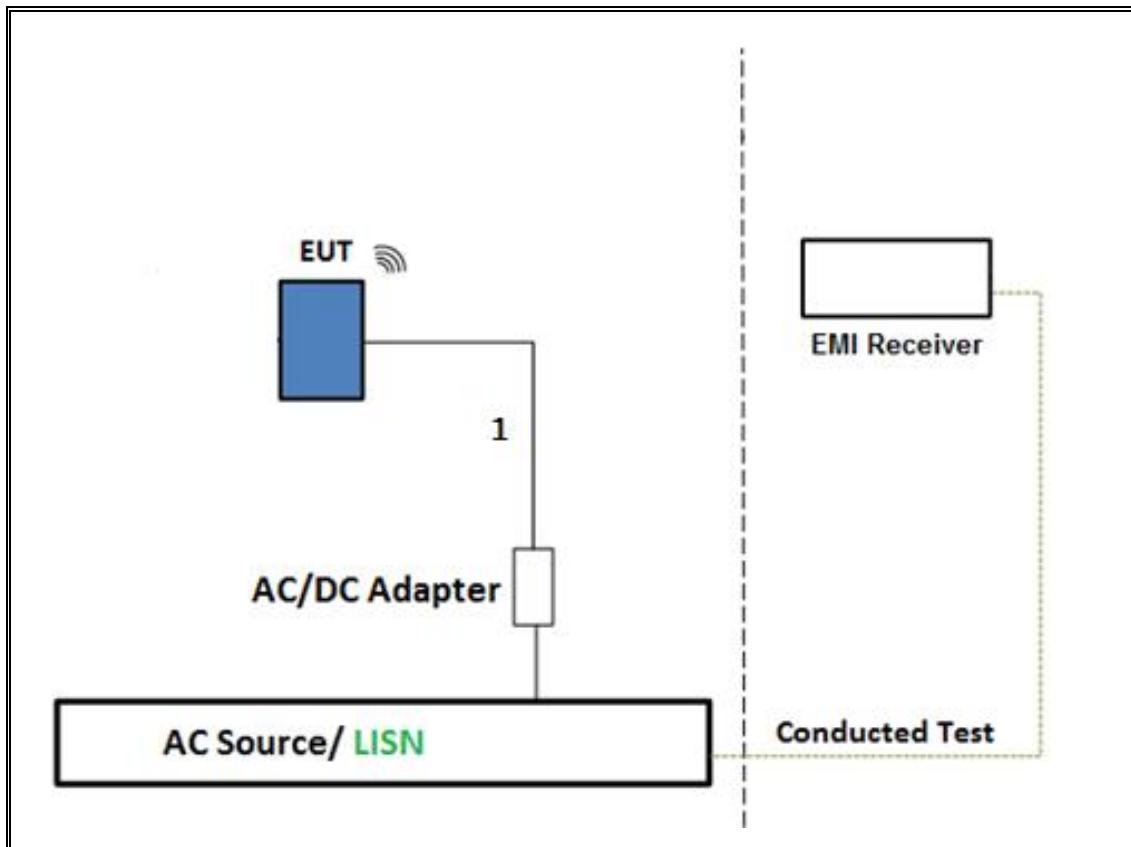
SETUP DIAGRAM



TEST SETUP- AC LINE CONDUCTED: AC/DC ADAPTER

The EUT was tested with powered by AC/DC adapter via USB cable. Test software exercised the EUT.

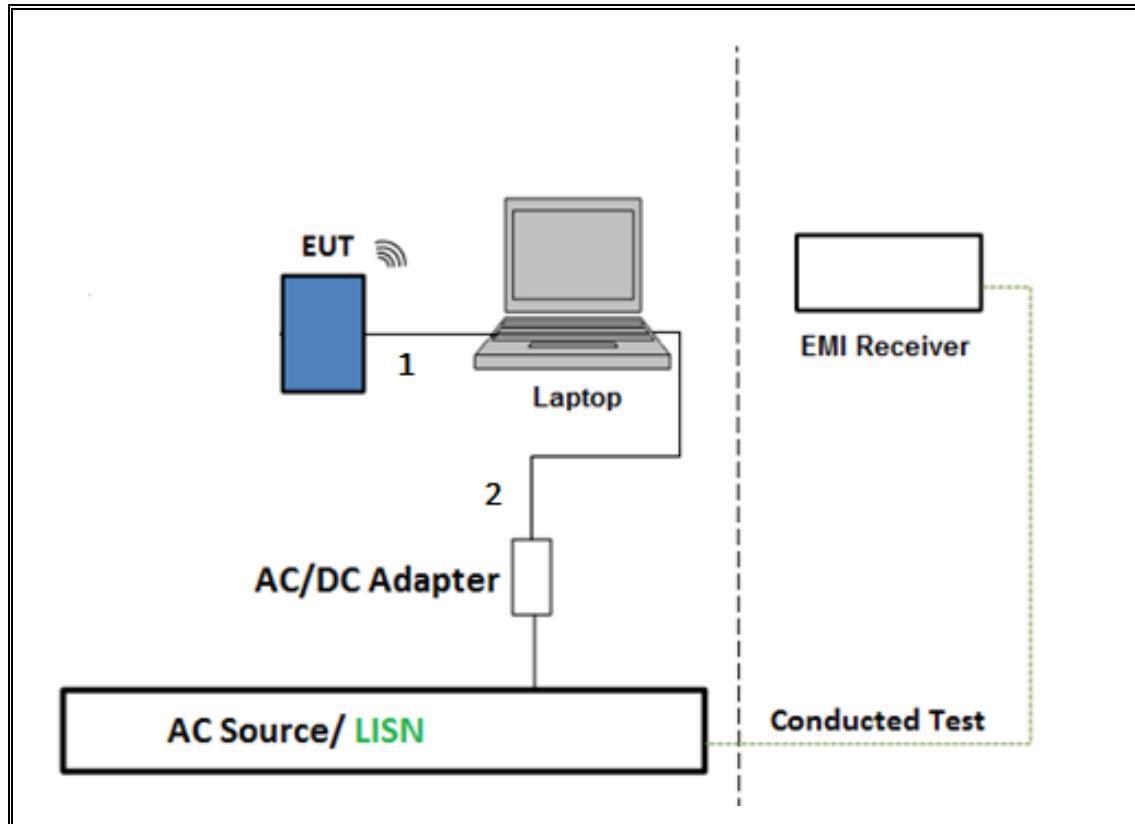
SETUP DIAGRAM



TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION

The EUT was tested with powered by host PC via USB cable. Test software exercised the EUT.

SETUP DIAGRAM



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	Manufacturer	Model	Asset	Cal Due
Antenna, Horn 1-18GHz	ETS Lindgren	3117	00154522	1/12/2017
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	A022813-1	10/28/2016
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	1782158	1/25/2017
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	323562	5/4/2017
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY52350675	11/15/2016
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY51380911	10/15/2016
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T136	3/14/2017
Power Meter, P-series single channel	Agilent	N1911A	GB45100212	9/25/2016
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Agilent	N1921A	MY53260010	7/8/2017
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826	209336	5/26/2017
Spectrum Analyzer, 40 GHz	Agilent	8564E	3943A01643	8/14/2016
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Keysight	8449B	3008A04710	7/5/2017
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	100935	9/10/2016
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2	161124	9/16/2016
Power Cable, Line Conducted Emissions	UL	PG1	N/A	7/28/2017
UL SOFTWARE				
* Radiated Software	UL	UL EMC	Ver 9.5, June 24, 2015	
* Conducted Software	UL	UL EMC	Ver 5.0, June 22, 2016	

Note: * indicates automation software version used in the compliance certification testing

7. MEASUREMENT METHODS

6 dB BW: KDB 558074 D01 v03r05, Section 8.1.

Output Power: KDB 558074 D01 v03r05, Section 9.1.2.

Power Spectral Density: KDB 558074 D01 v03r05, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v03r05, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v03r05, Section 12.1.

Band-edge: KDB 558074 D01 v03r05, Section 12.1.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

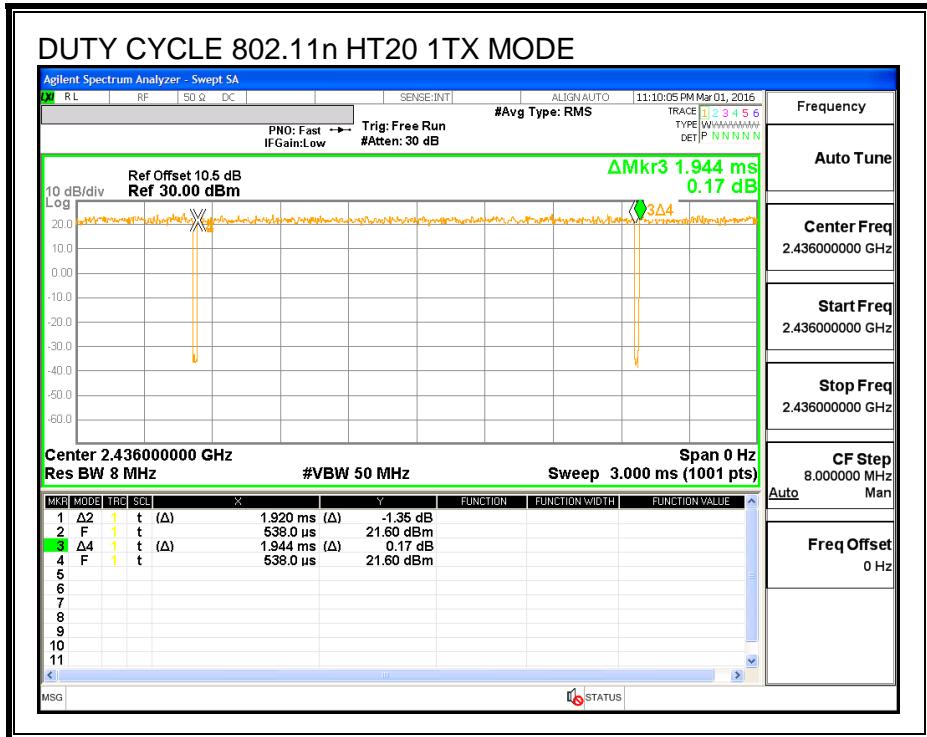
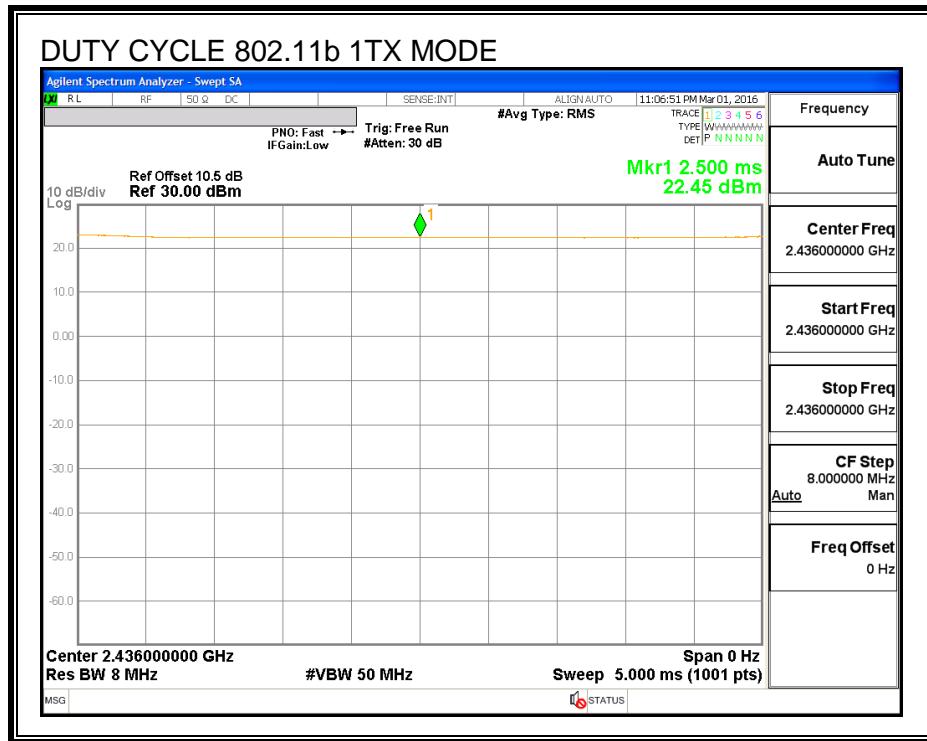
PROCEDURE

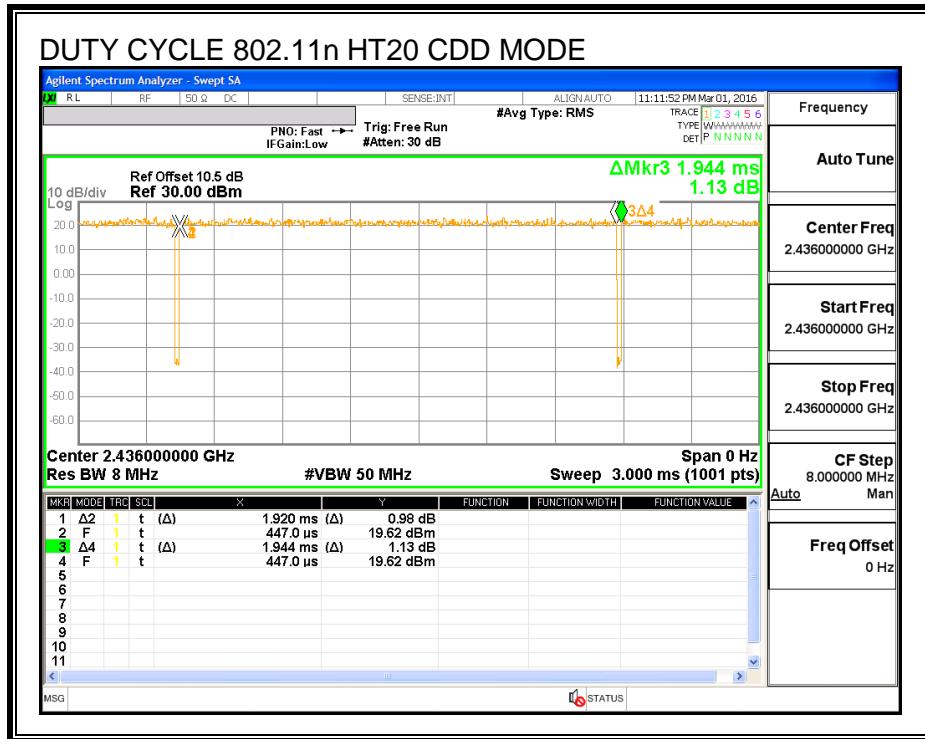
KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
802.11b 1TX	1.000	1.000	1.000	100.00%	0.00	0.010
802.11n HT20 1TX	1.920	1.944	0.988	98.77%	0.00	0.010
802.11n HT20 CDD	1.920	1.944	0.988	98.77%	0.00	0.010

DUTY CYCLE PLOTS





8.2. 802.11b SISO MODE IN THE 2.4 GHz BAND, CHAIN 0

8.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

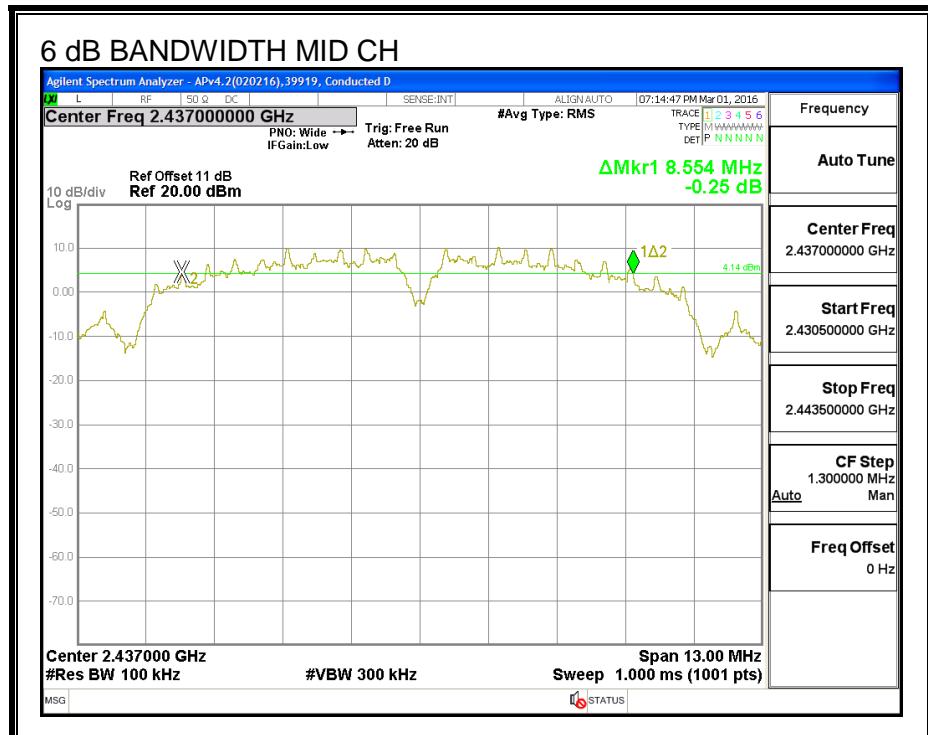
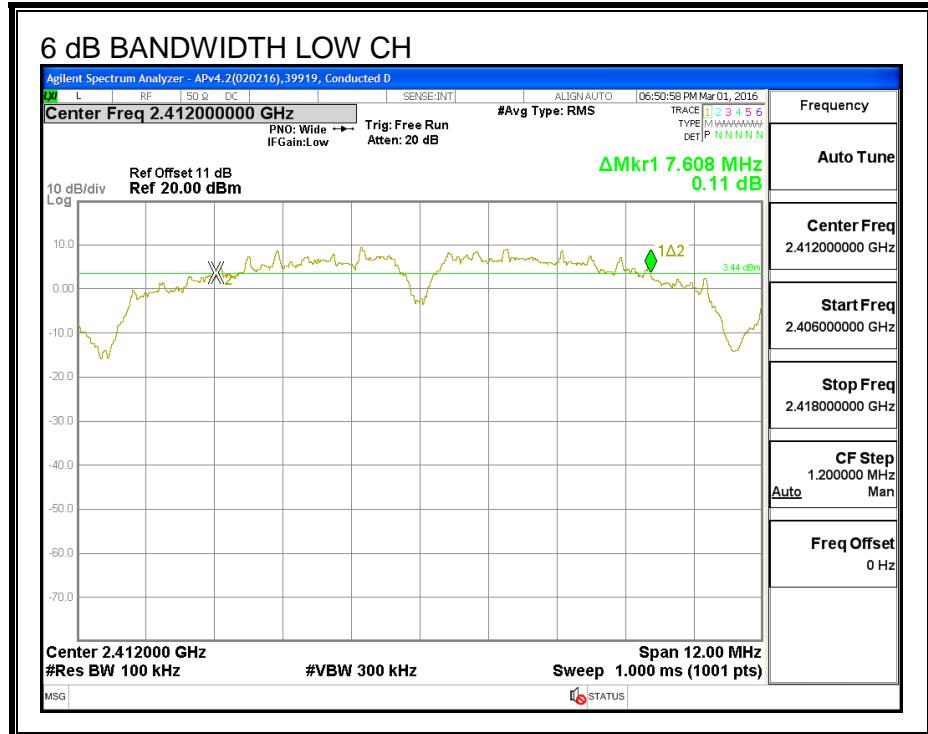
IC RSS-247 (5.2) (1)

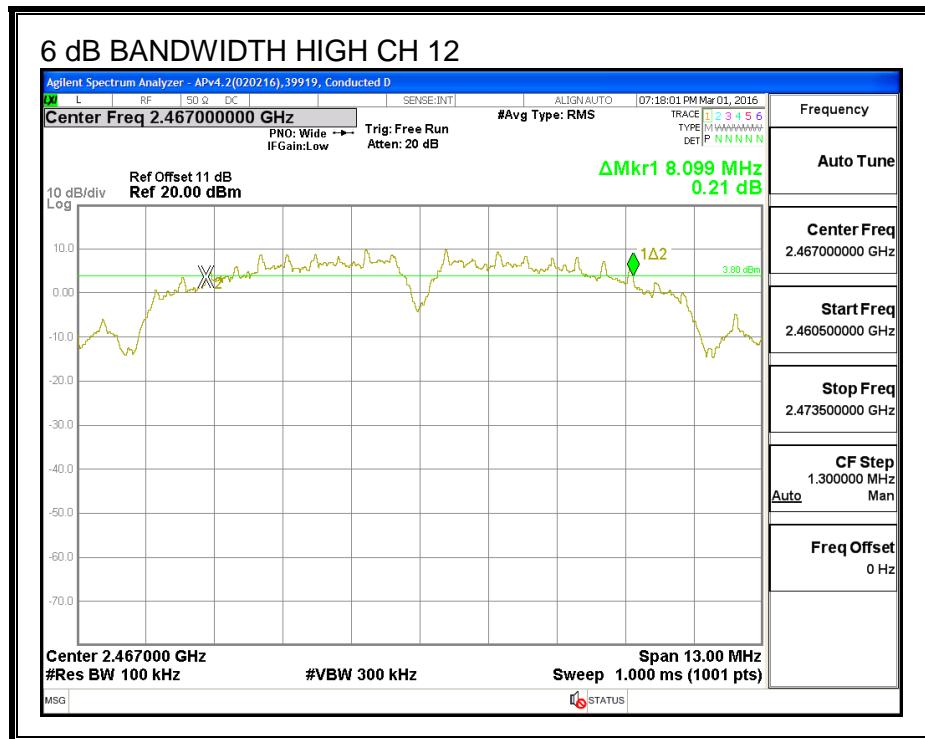
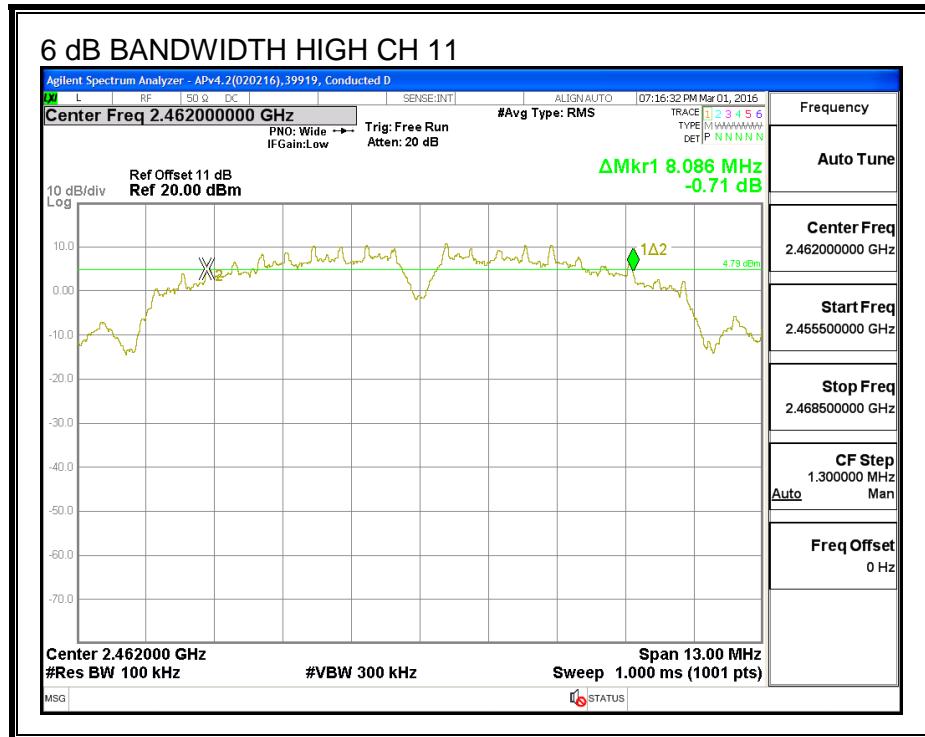
The minimum 6 dB bandwidth shall be at least 500 kHz.

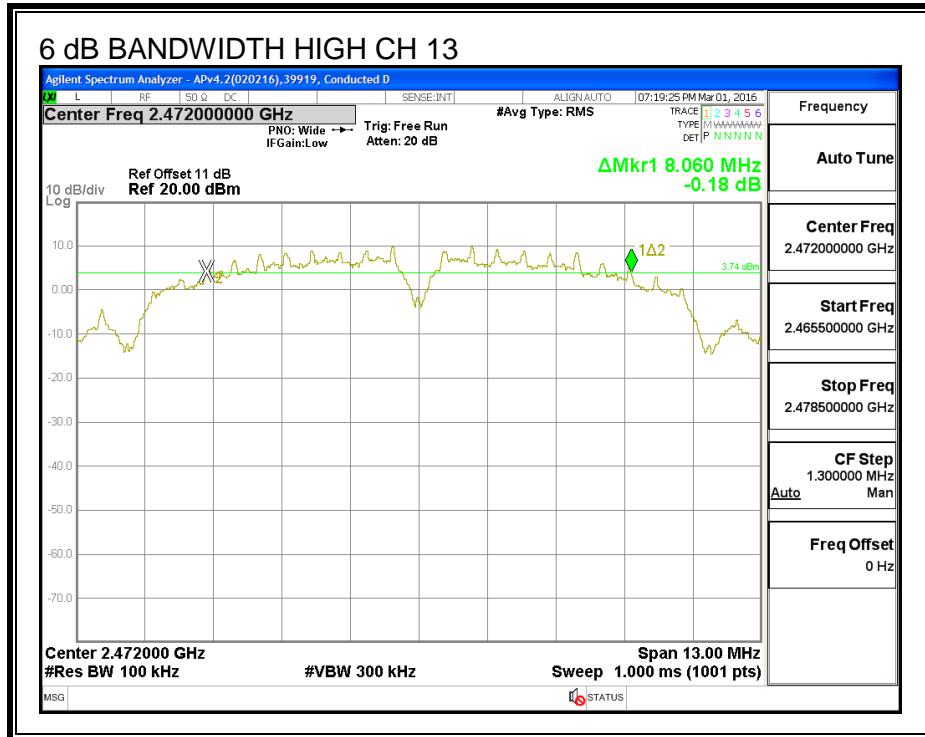
RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2412	7.608	0.5
Mid	2437	8.554	0.5
High_11	2462	8.086	0.5
High_12	2467	8.099	0.5
High_13	2472	8.060	0.5

6 dB BANDWIDTH







8.2.2. 99% BANDWIDTH

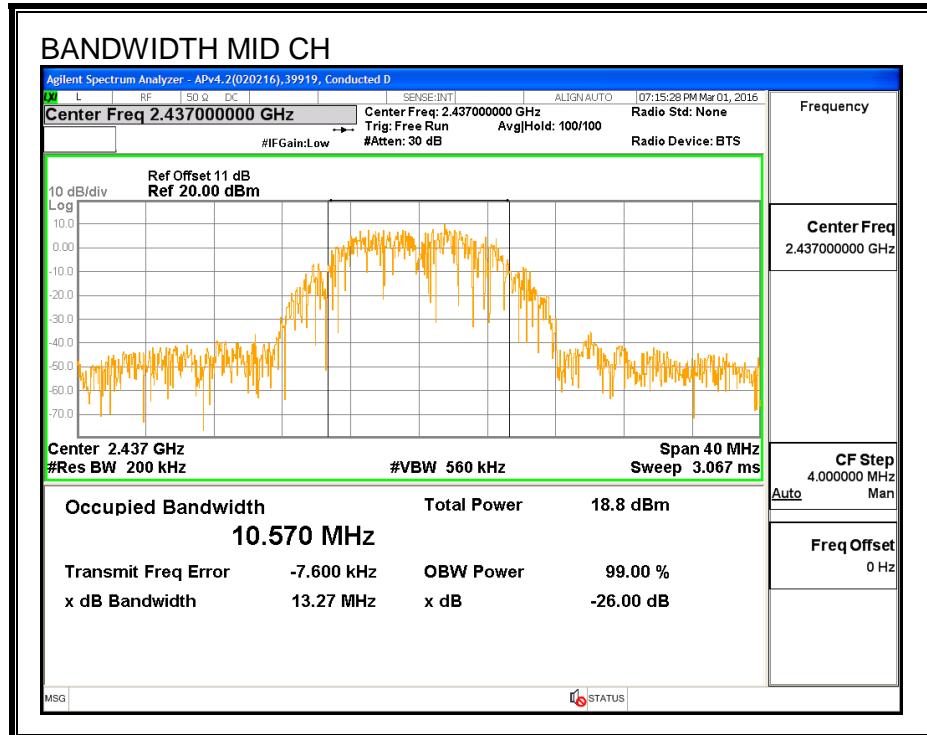
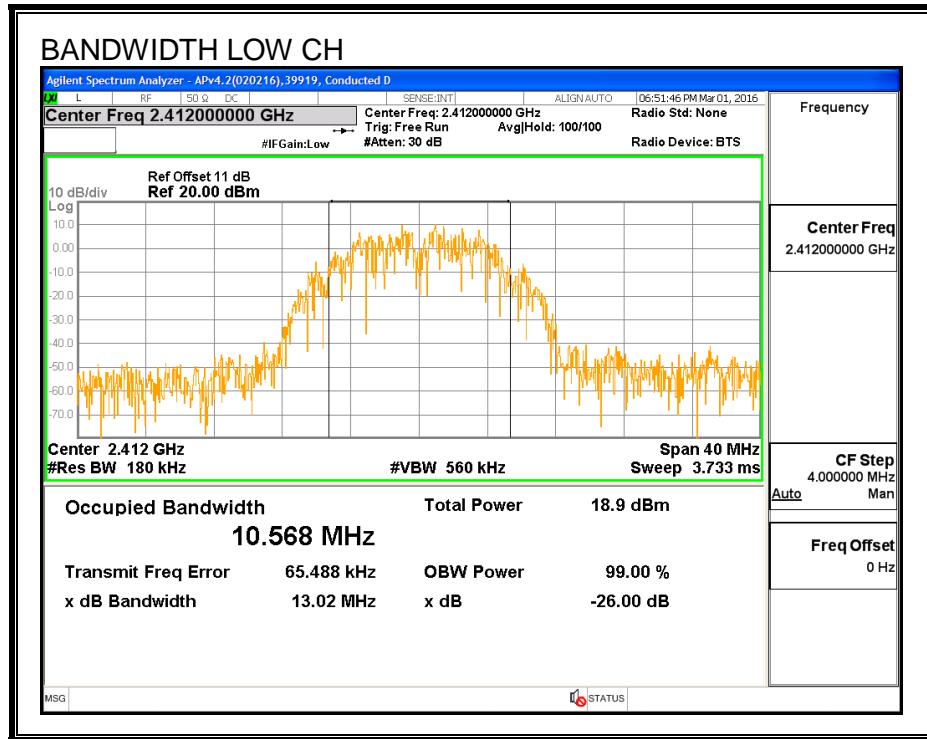
LIMITS

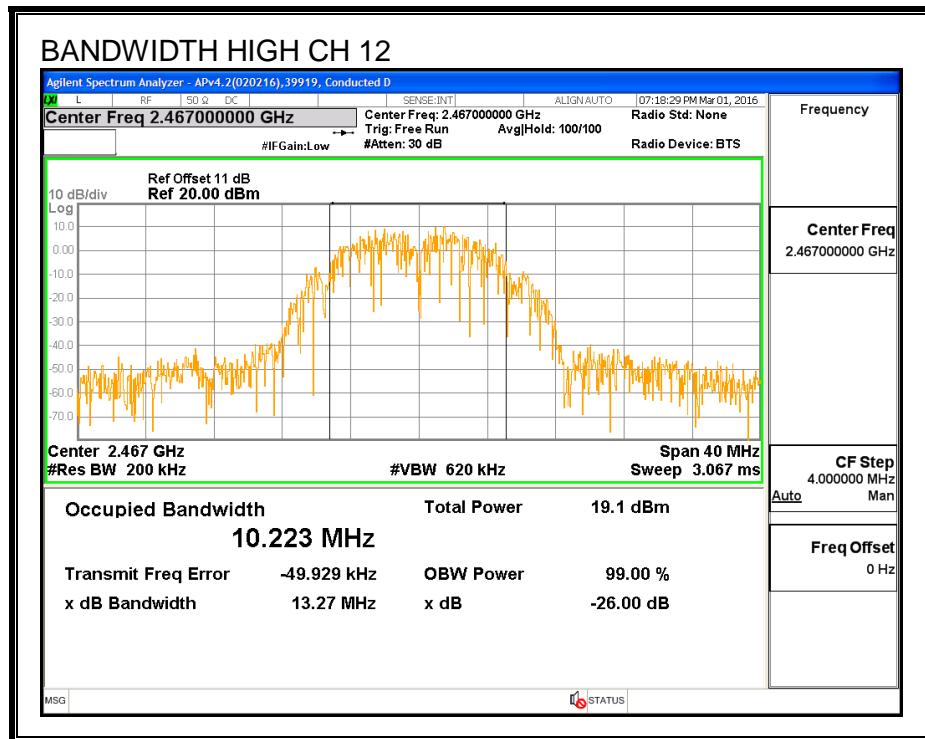
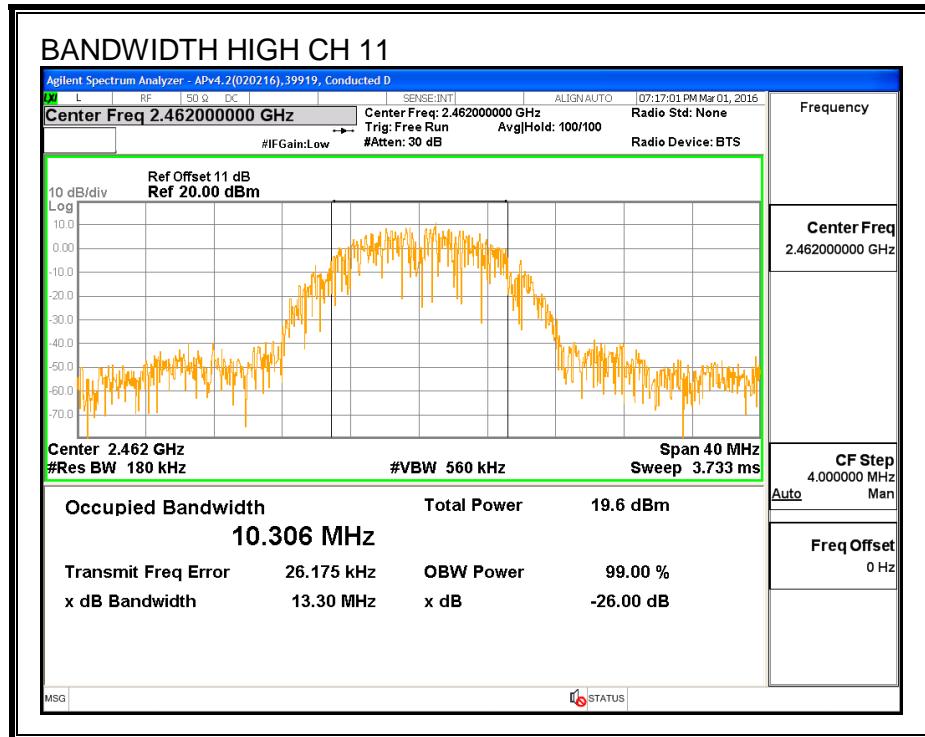
None; for reporting purposes only.

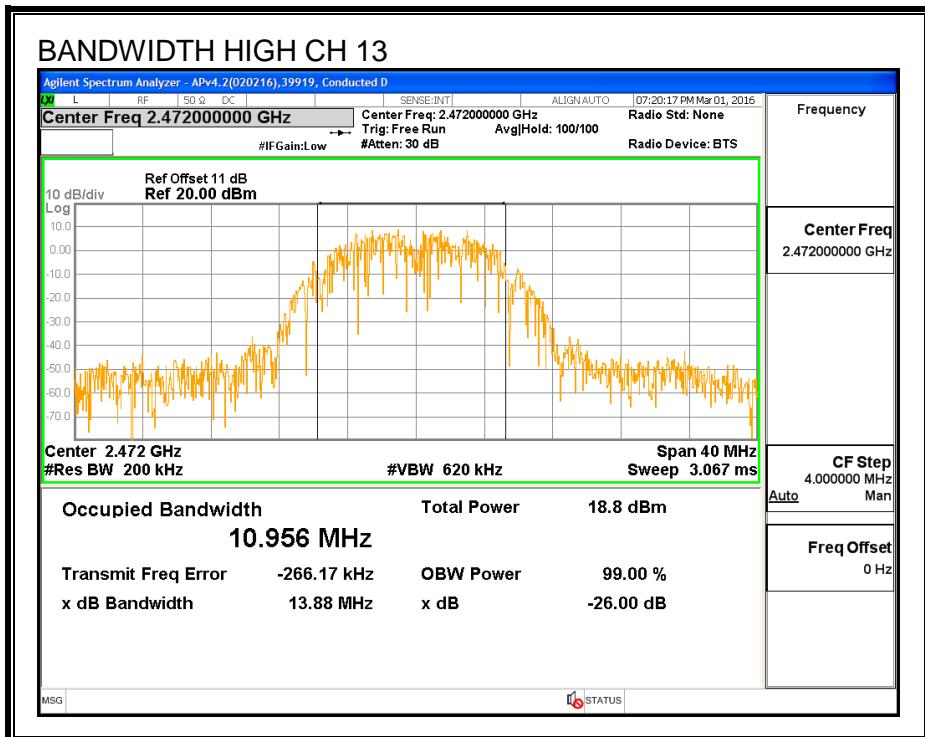
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	10.568
Mid	2437	10.570
High_11	2462	10.306
High_12	2467	10.223
High_13	2472	10.956

99% BANDWIDTH







8.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

RESULTS

ID:	39919	Date:	7/10/16
-----	-------	-------	---------

Channel	Frequency (MHz)	Power (dBm)
Low	2412	18.96
Mid	2437	19.00
High_11	2462	18.91
High_12	2467	17.45
High_13	2472	13.47

8.2.4. OUTPUT POWER LIMITS

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

RESULTS

ID:	39919	Date:	7/10/16
------------	-------	--------------	---------

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low	2412	-1.85	30.00	30	36	30.00
Mid	2437	-1.85	30.00	30	36	30.00
High_11	2462	-1.85	30.00	30	36	30.00
High_12	2467	-1.85	30.00	30	36	30.00
High_13	2472	-1.85	30.00	30	36	30.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
---------------------------	------	---

Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low	2412	21.31	21.31	30.00	-8.69
Mid	2437	21.35	21.35	30.00	-8.65
High_11	2462	21.25	21.25	30.00	-8.75
High_12	2467	19.85	19.85	30.00	-10.15
High_13	2472	15.89	15.89	30.00	-14.11

8.2.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

IC RSS-247 (5.2) (2)

For digitally modulated systems, 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 transmissions.

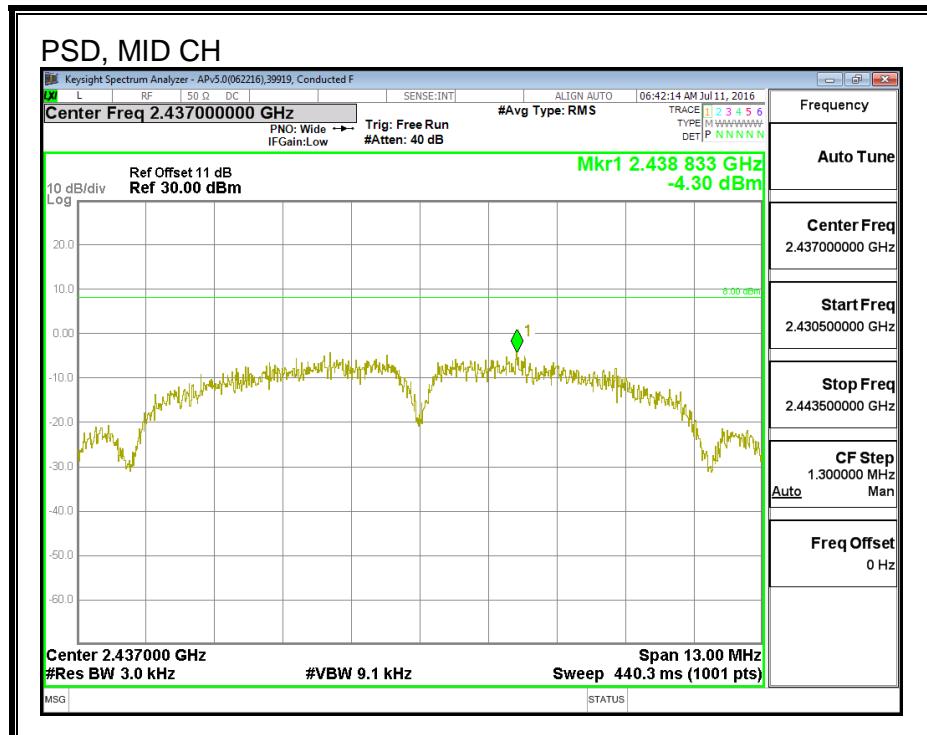
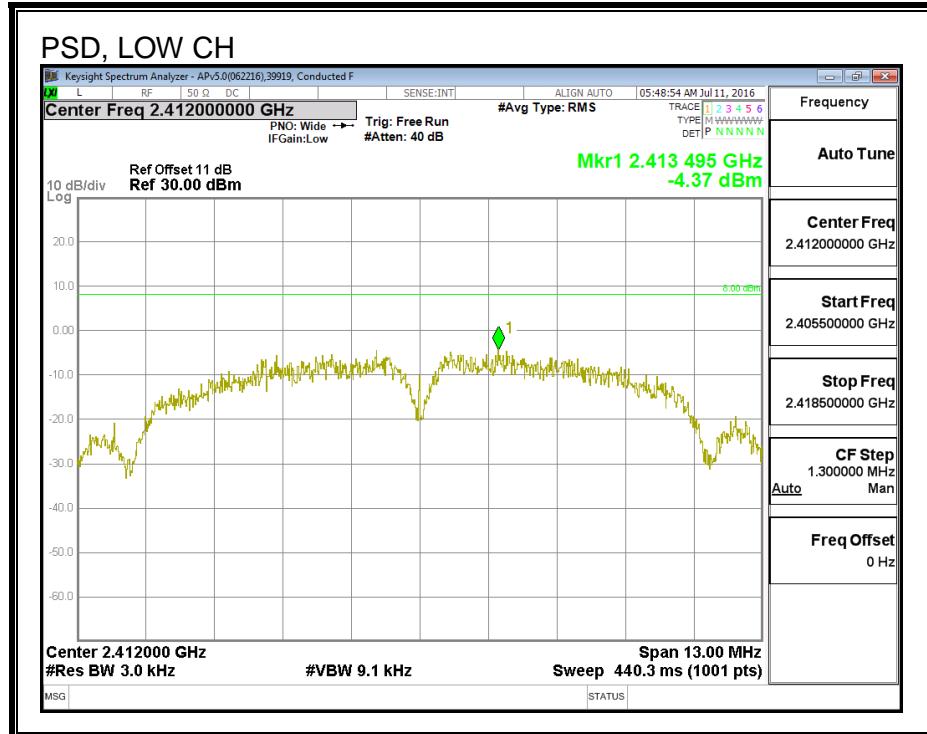
RESULTS

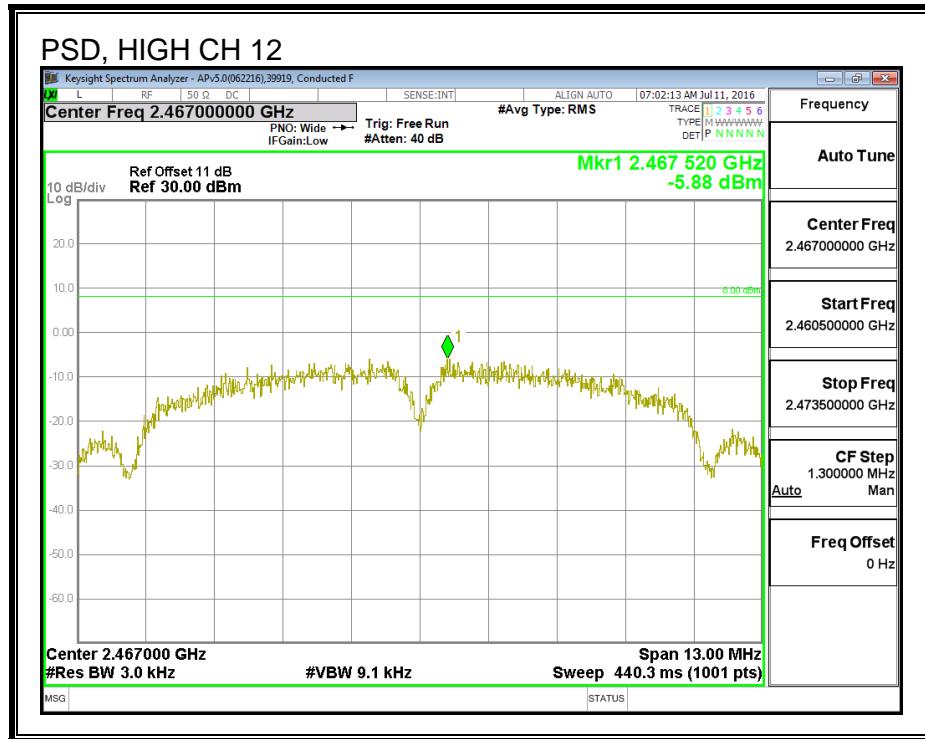
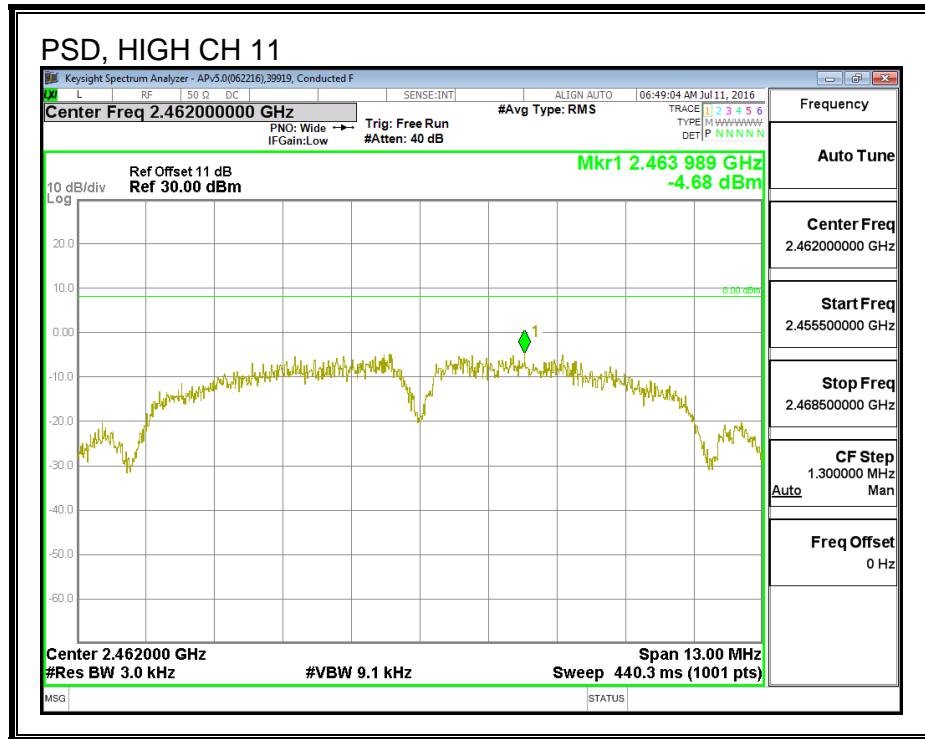
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
--------------------	------	--

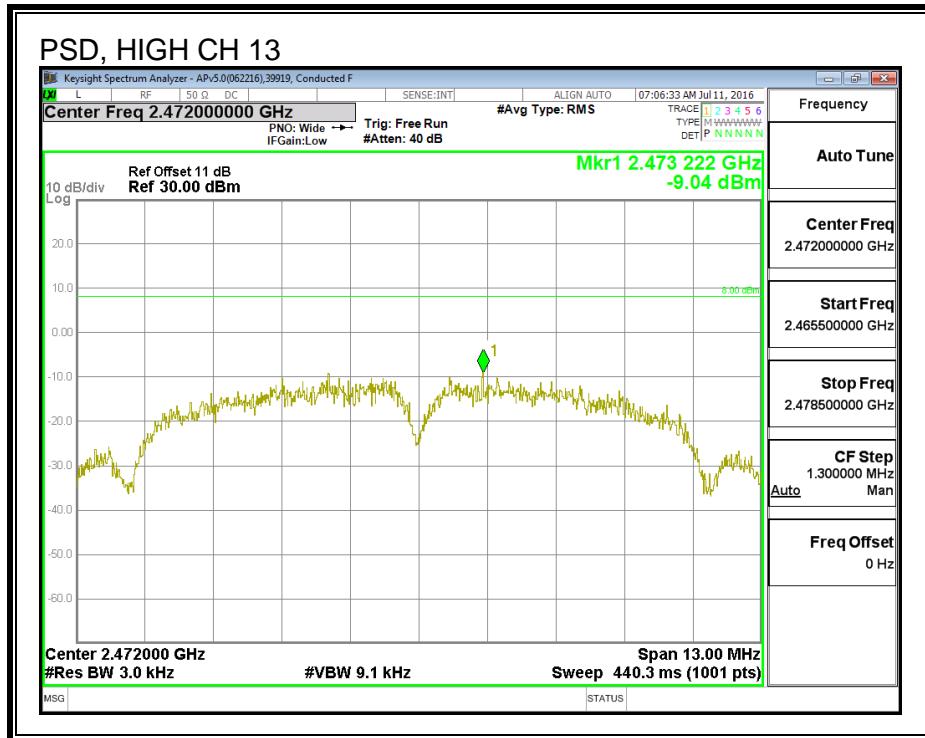
PSD Results

Channel	Frequency (MHz)	Meas (dBm)	Total Corr'd PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-4.37	-4.37	8.0	-12.4
Mid	2437	-4.30	-4.30	8.0	-12.3
High_11	2462	-4.68	-4.68	8.0	-12.7
High_12	2467	-5.88	-5.88	8.0	-13.9
High_13	2472	-9.04	-9.04	8.0	-17.0

PSD







8.2.6. OUT-OF-BAND EMISSIONS

LIMITS

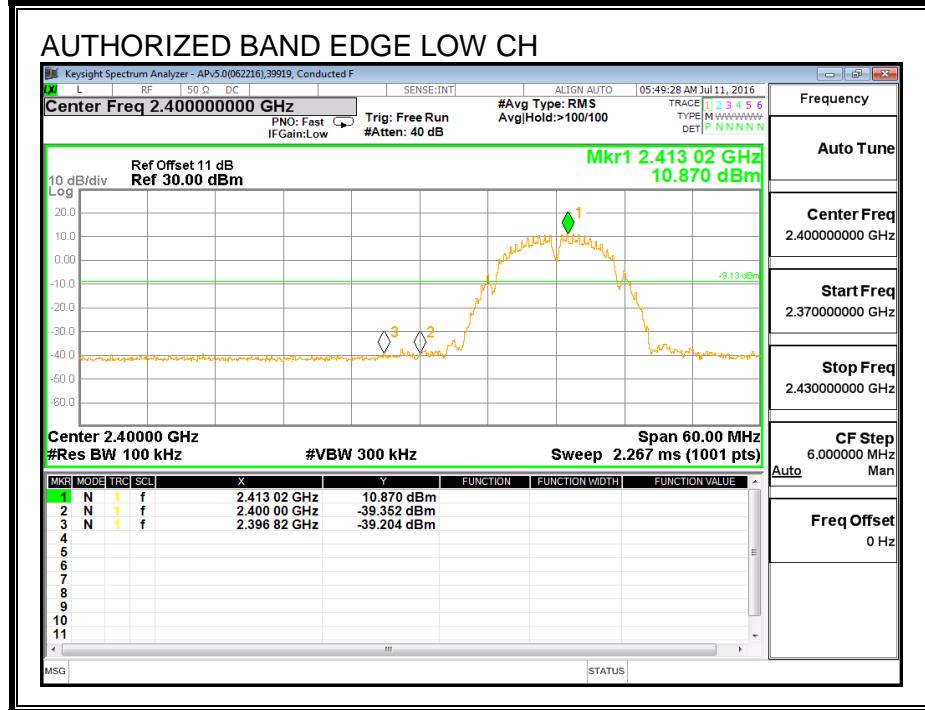
FCC §15.247 (d)

IC RSS-247 (5.5)

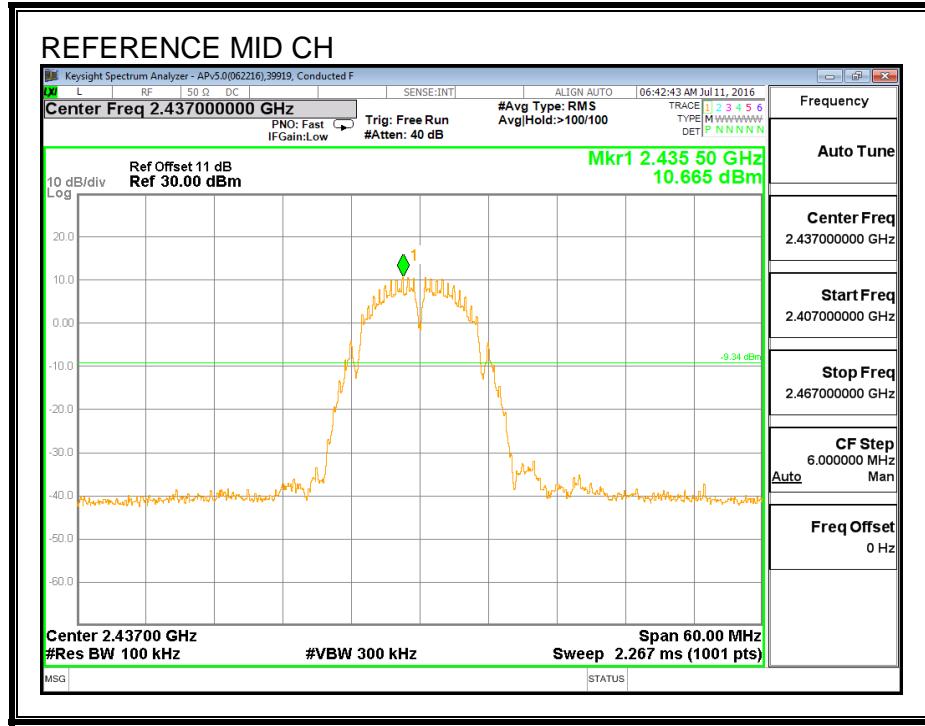
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

RESULTS

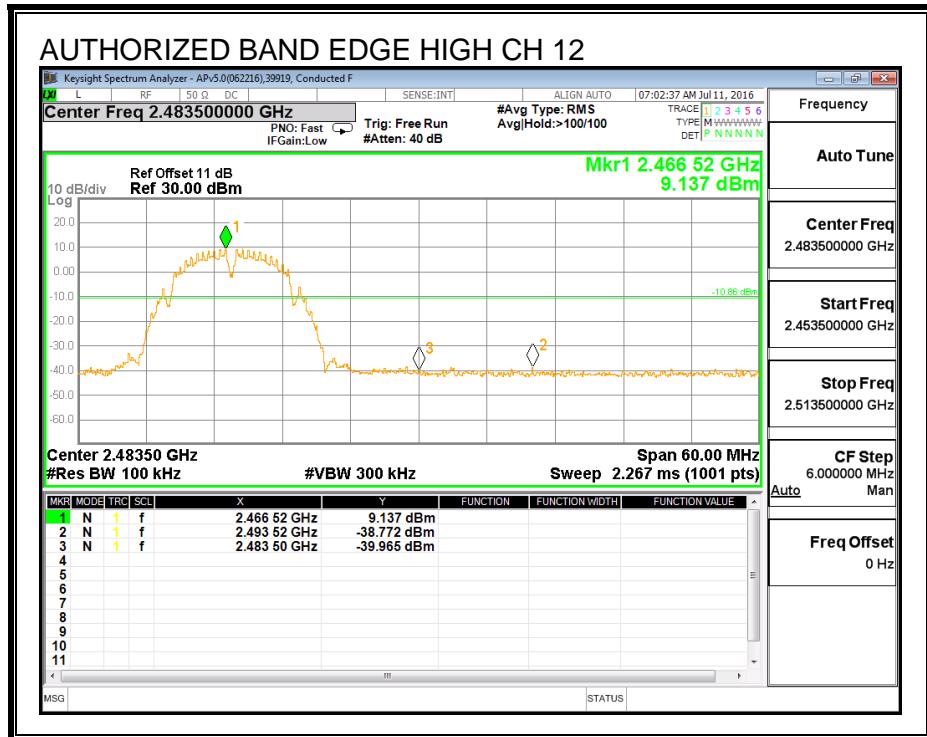
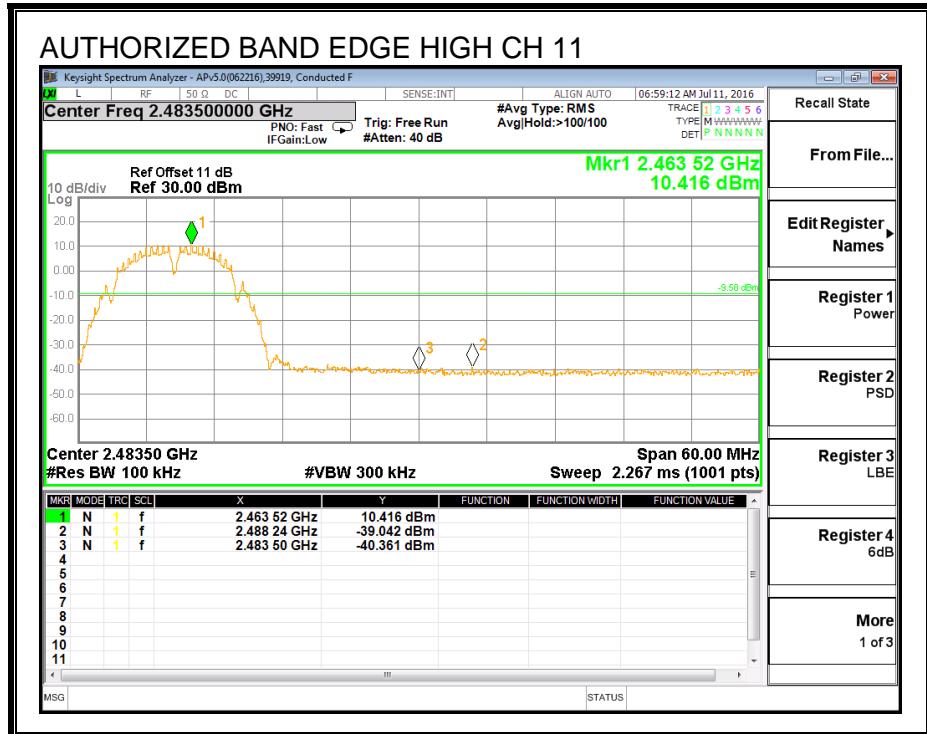
LOW CHANNEL BANDEDGE

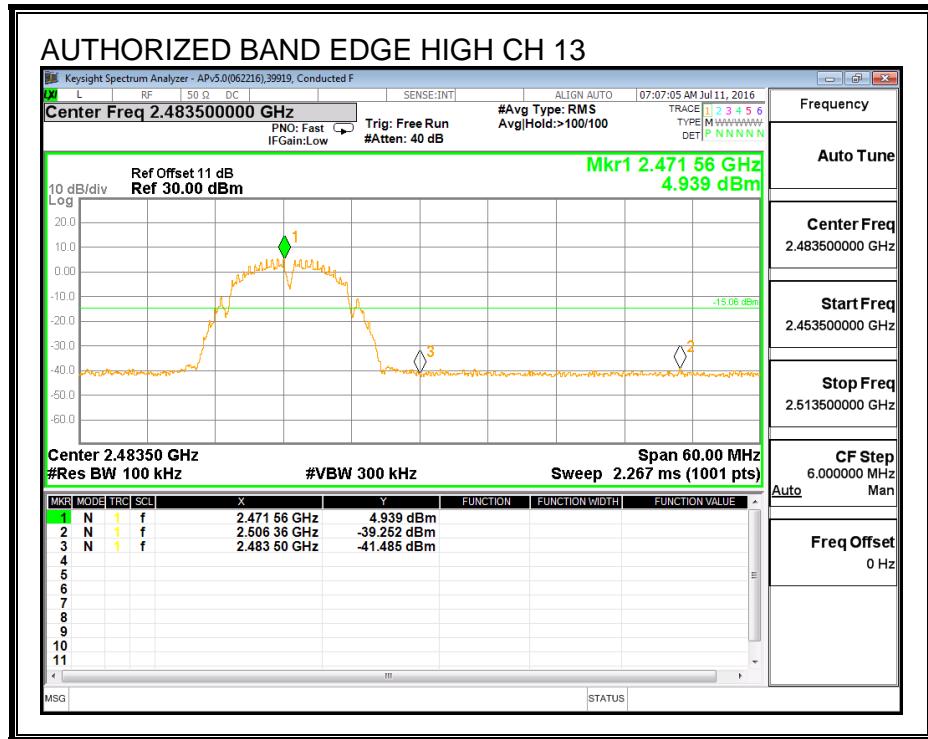


MID CHANNEL REFERENCE

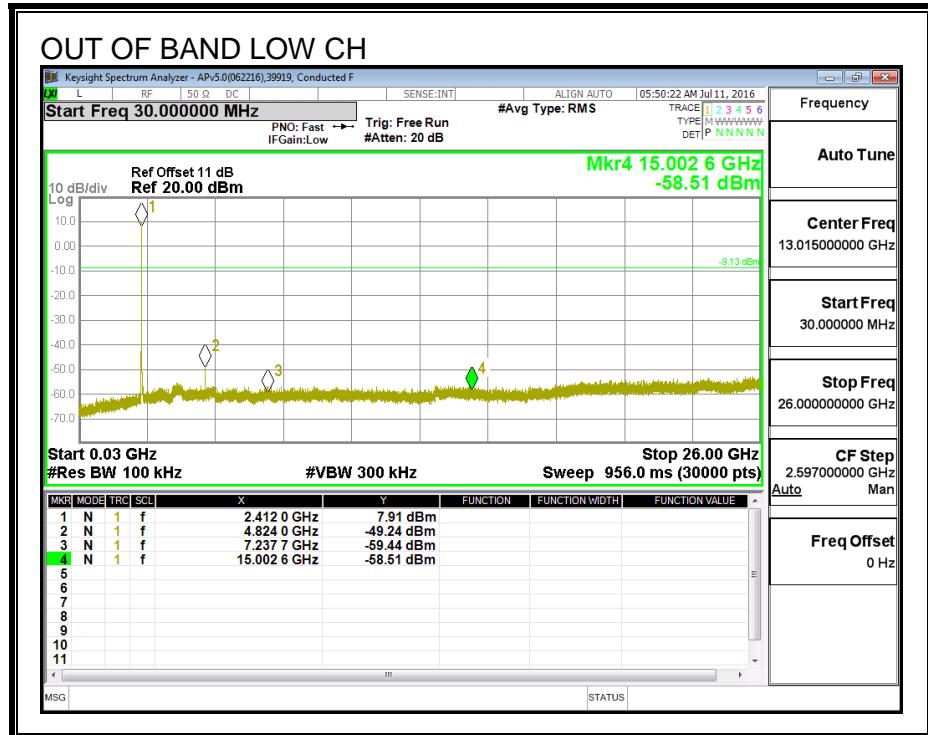


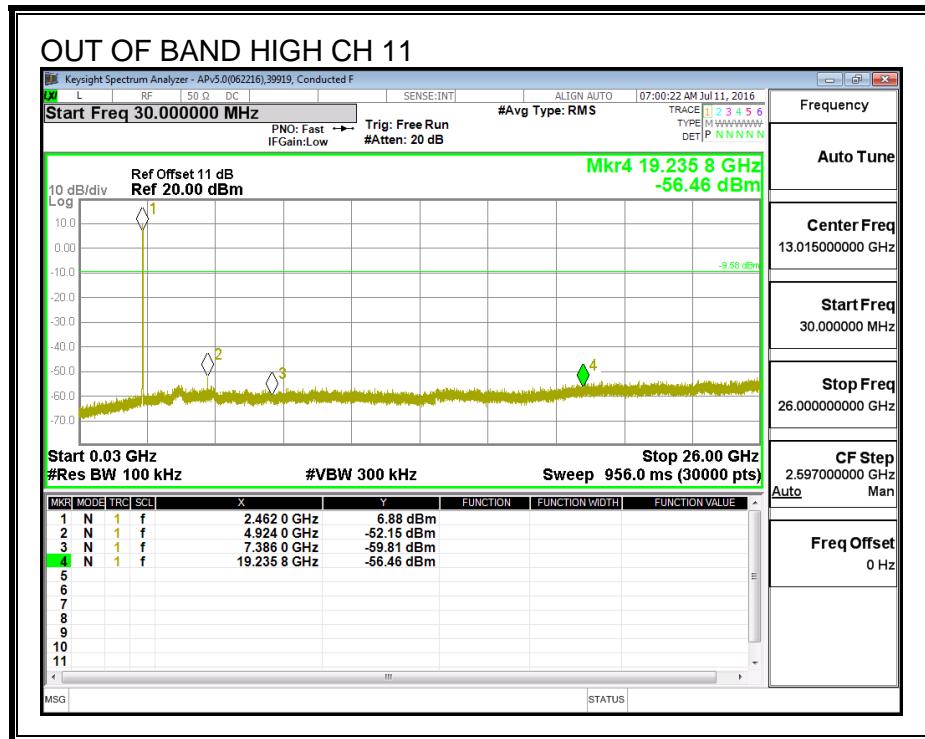
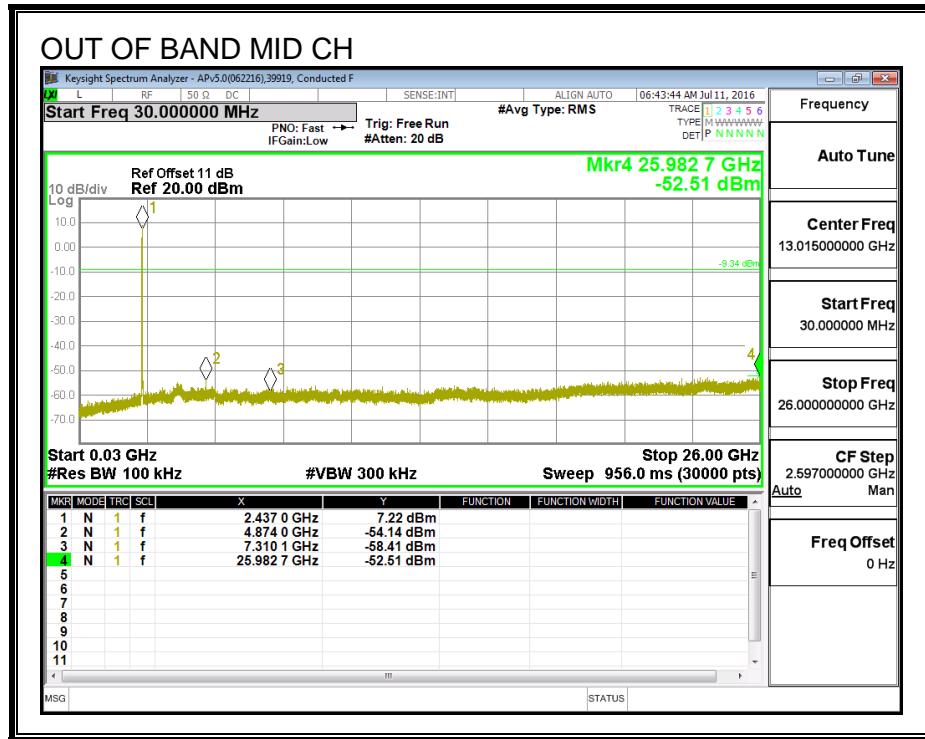
HIGH CHANNEL BANDEDGE

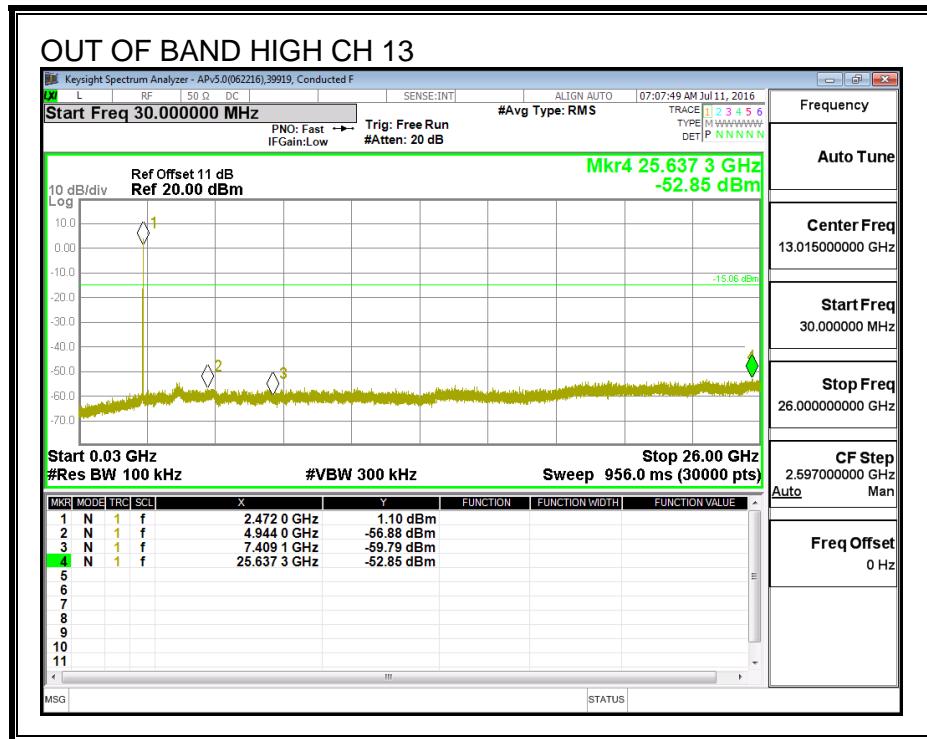
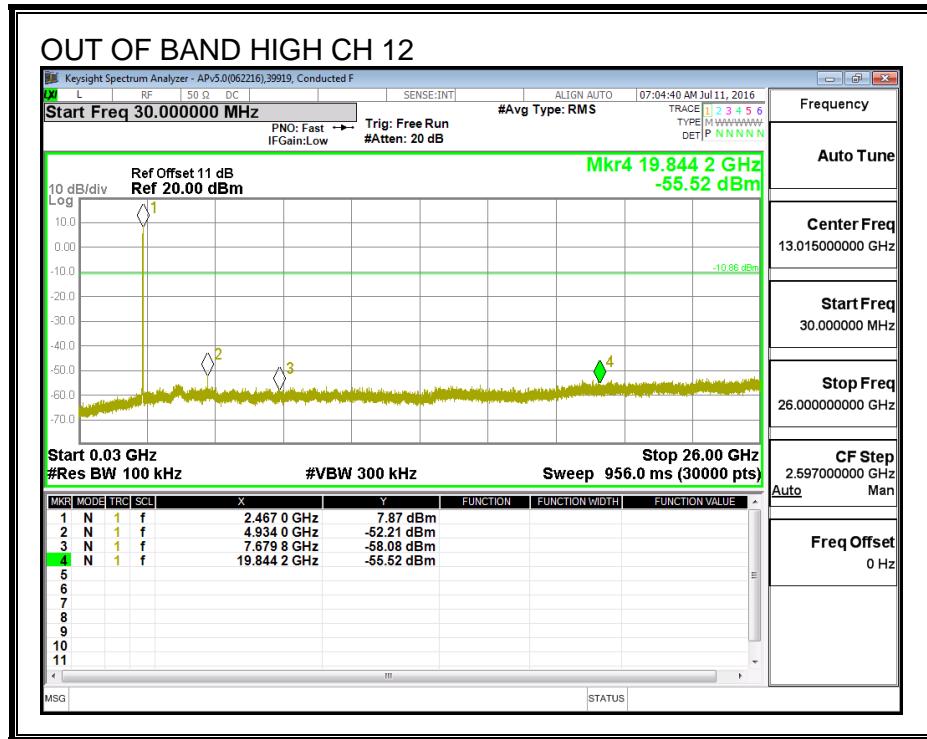




OUT-OF-BAND EMISSIONS







8.3. 802.11b SISO MODE IN THE 2.4 GHz BAND, CHAIN 1

8.3.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

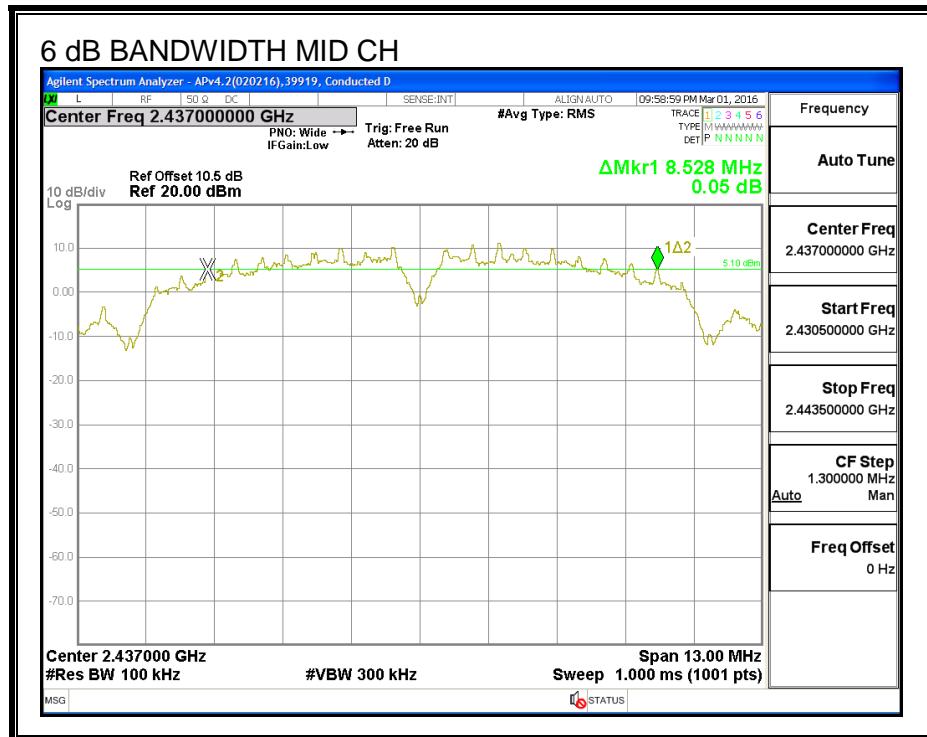
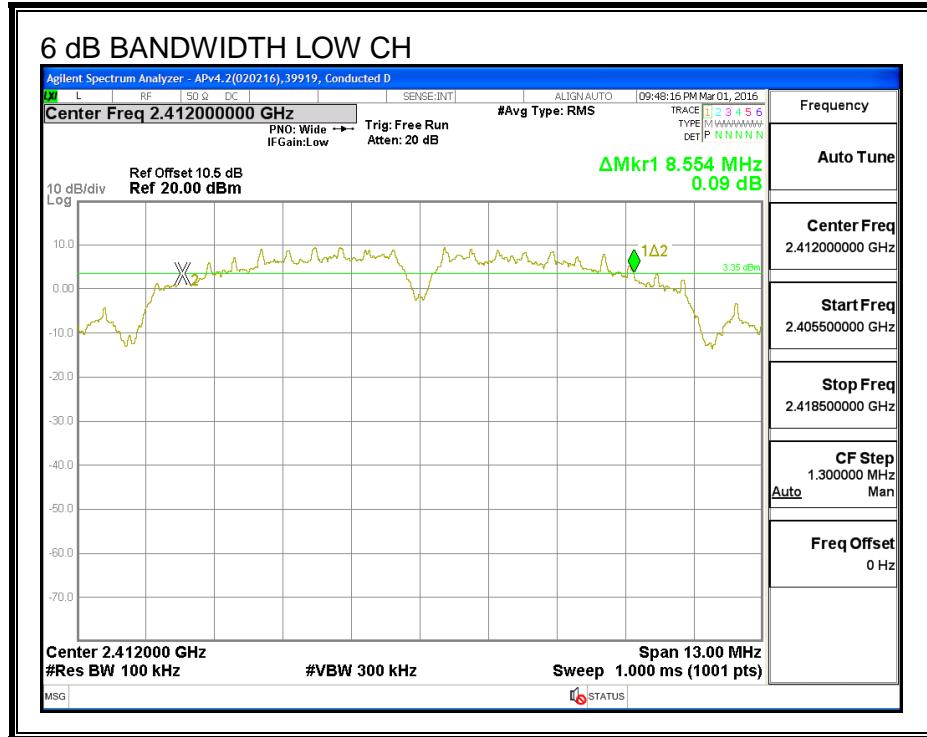
IC RSS-247 (5.2) (1)

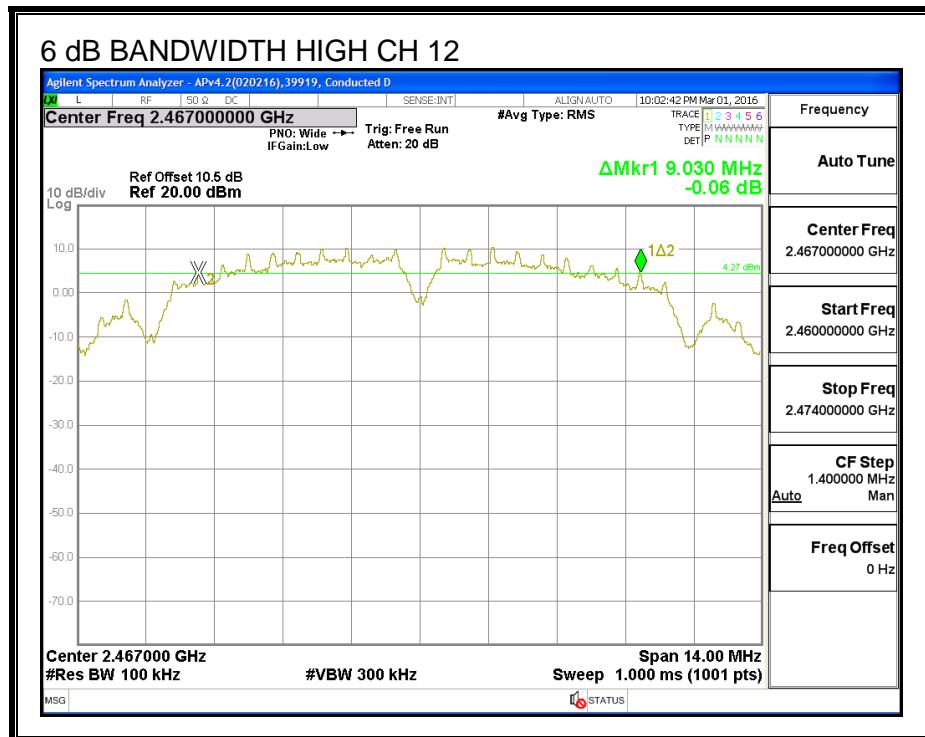
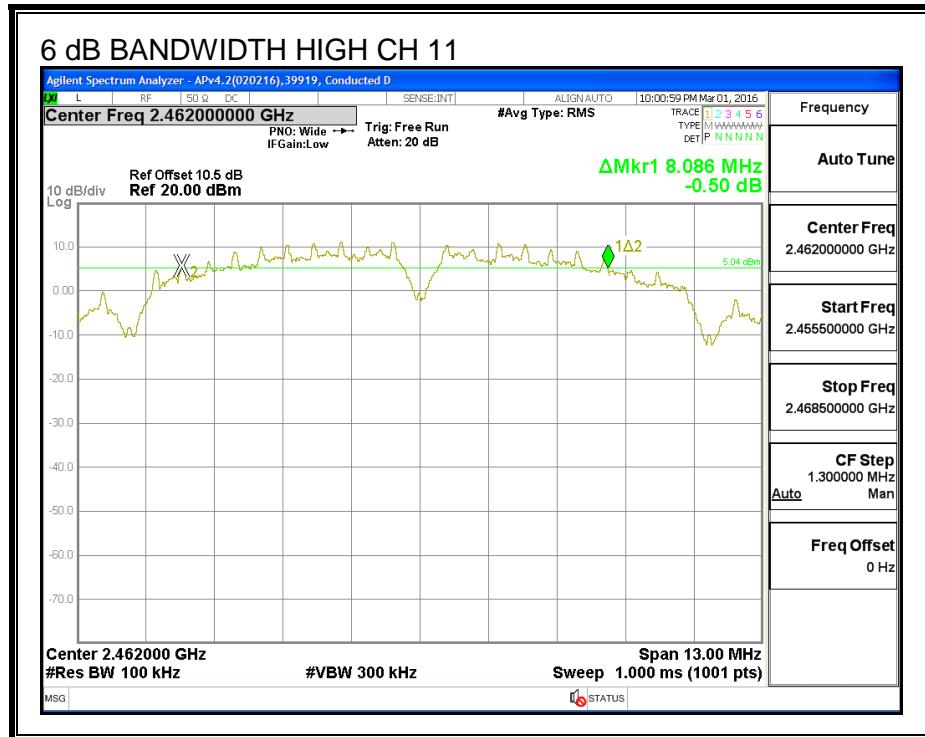
The minimum 6 dB bandwidth shall be at least 500 kHz.

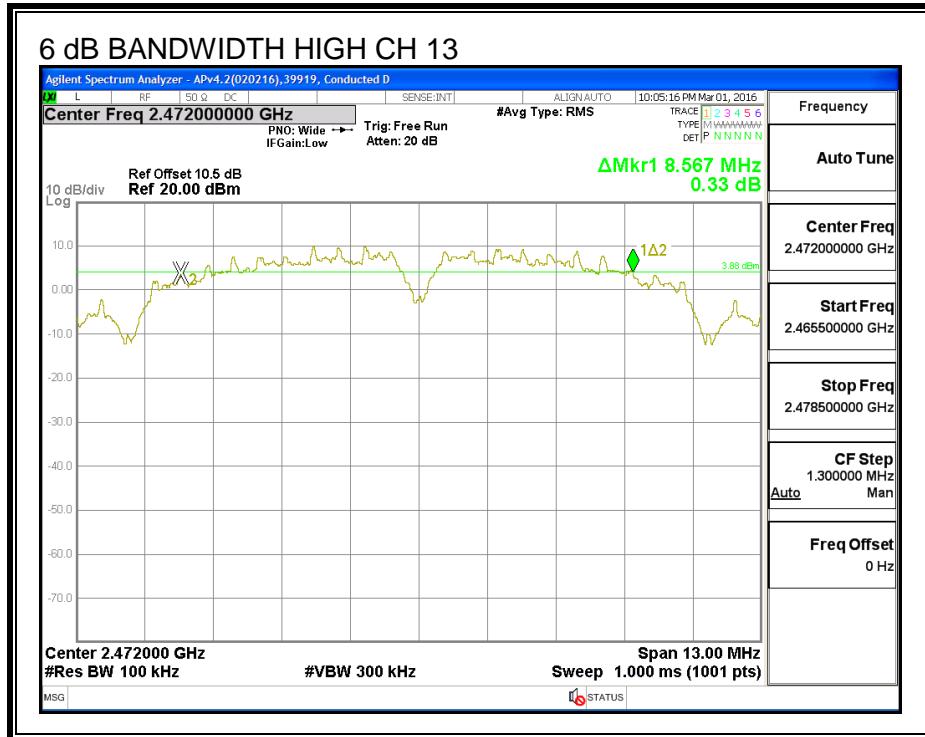
RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2412	8.554	0.5
Mid	2437	8.528	0.5
High_11	2462	8.086	0.5
High_12	2467	9.030	0.5
High_13	2472	8.567	0.5

6 dB BANDWIDTH







8.3.2. 99% BANDWIDTH

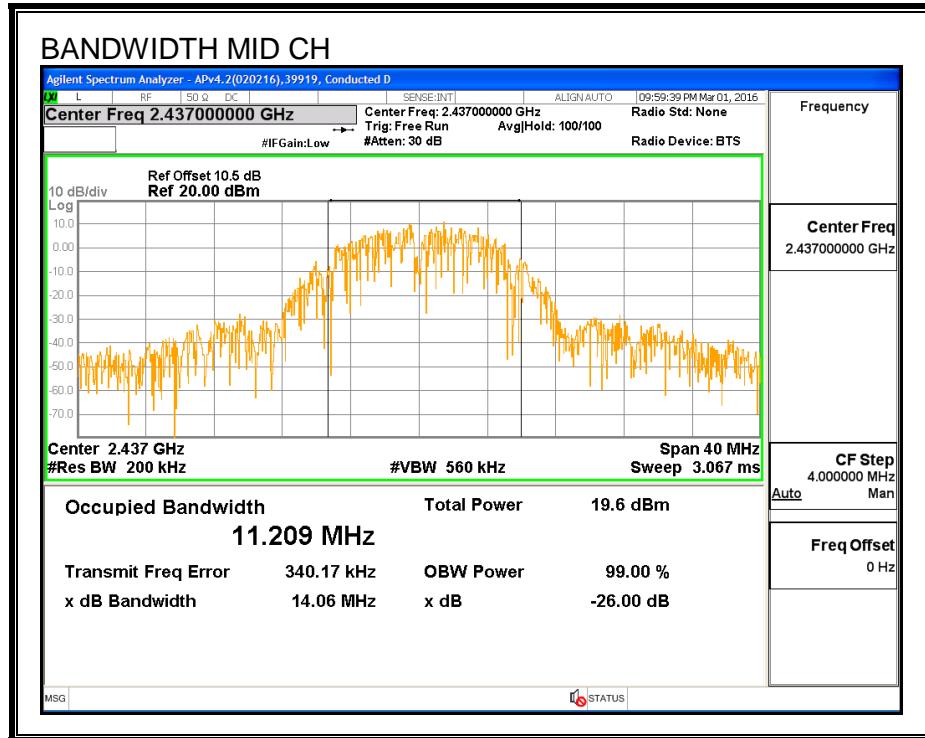
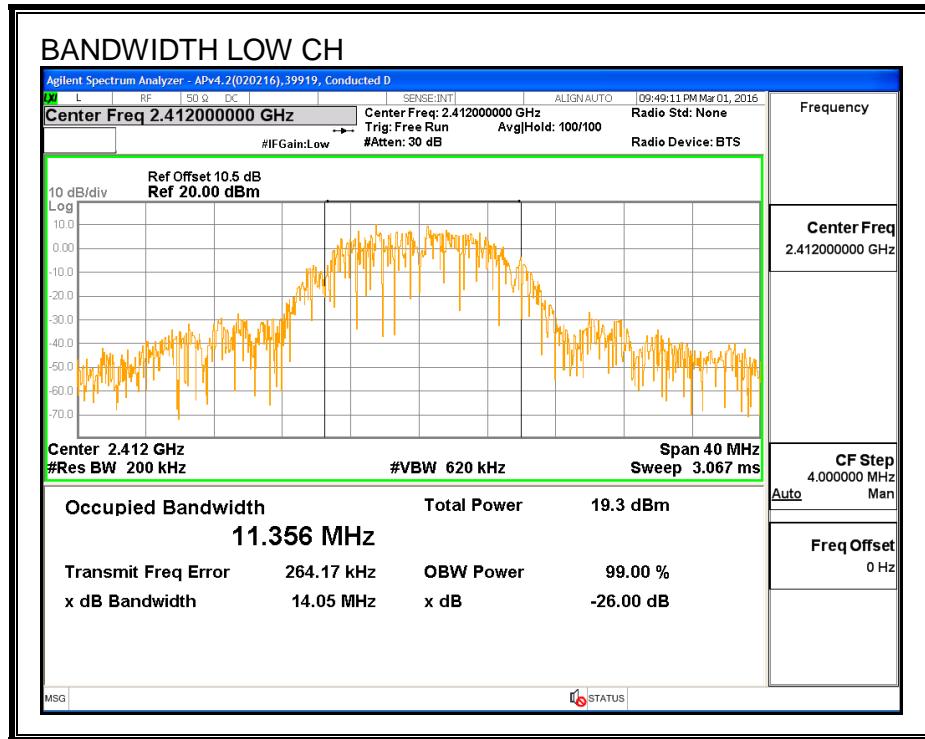
LIMITS

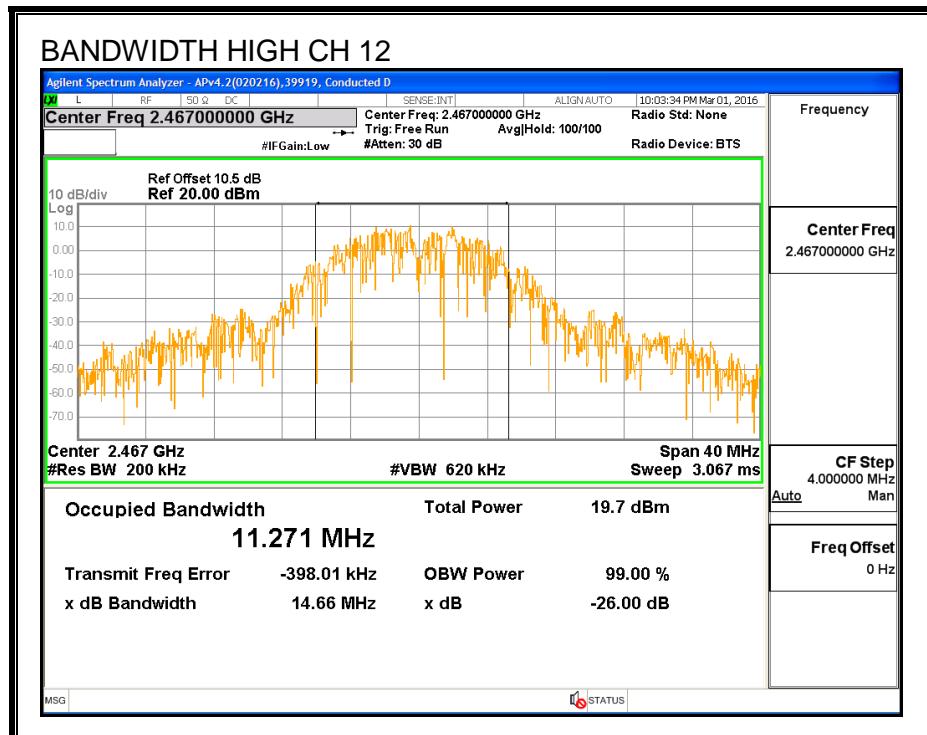
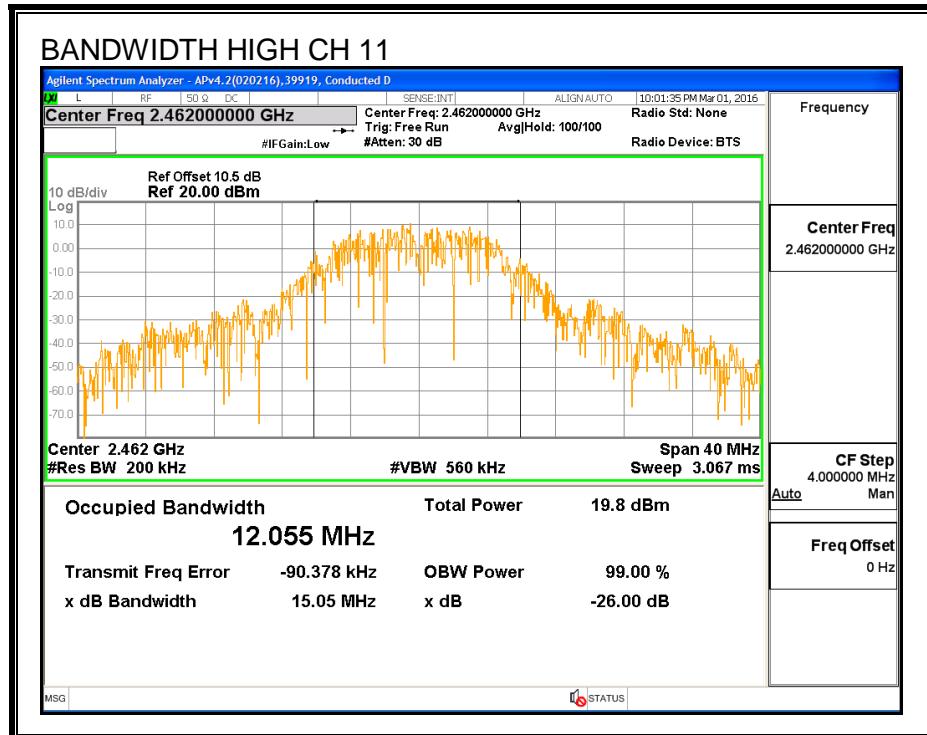
None; for reporting purposes only.

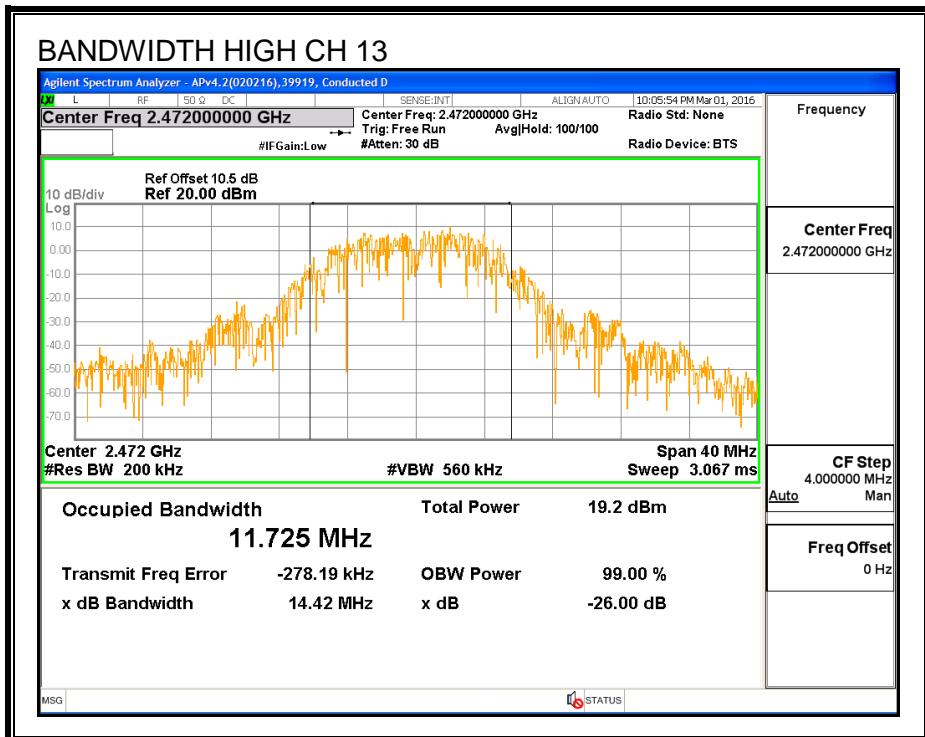
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2412	11.356
Mid	2437	11.209
High_11	2462	12.055
High_12	2467	11.271
High_13	2472	11.725

99% BANDWIDTH







8.3.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

RESULTS

ID:	39919	Date:	7/10/16
-----	-------	-------	---------

Channel	Frequency (MHz)	Power (dBm)
Low	2412	18.90
Mid	2437	18.96
High_11	2462	18.94
High_12	2467	17.42
High_13	2472	13.42

8.3.4. OUTPUT POWER

LIMITS

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

RESULTS

ID:	39919	Date:	7/10/16
------------	-------	--------------	---------

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low	2412	-1.35	30.00	30	36	30.00
Mid	2437	-1.35	30.00	30	36	30.00
High_11	2462	-1.35	30.00	30	36	30.00
High_12	2467	-1.35	30.00	30	36	30.00
High_13	2472	-1.35	30.00	30	36	30.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
---------------------------	------	---

Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low	2412	21.23	21.23	30.00	-8.77
Mid	2437	21.32	21.32	30.00	-8.68
High_11	2462	21.27	21.27	30.00	-8.73
High_12	2467	19.92	19.92	30.00	-10.08
High_13	2472	15.75	15.75	30.00	-14.25

8.3.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

IC RSS-247 (5.2) (2)

For digitally modulated systems, 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 transmissions.

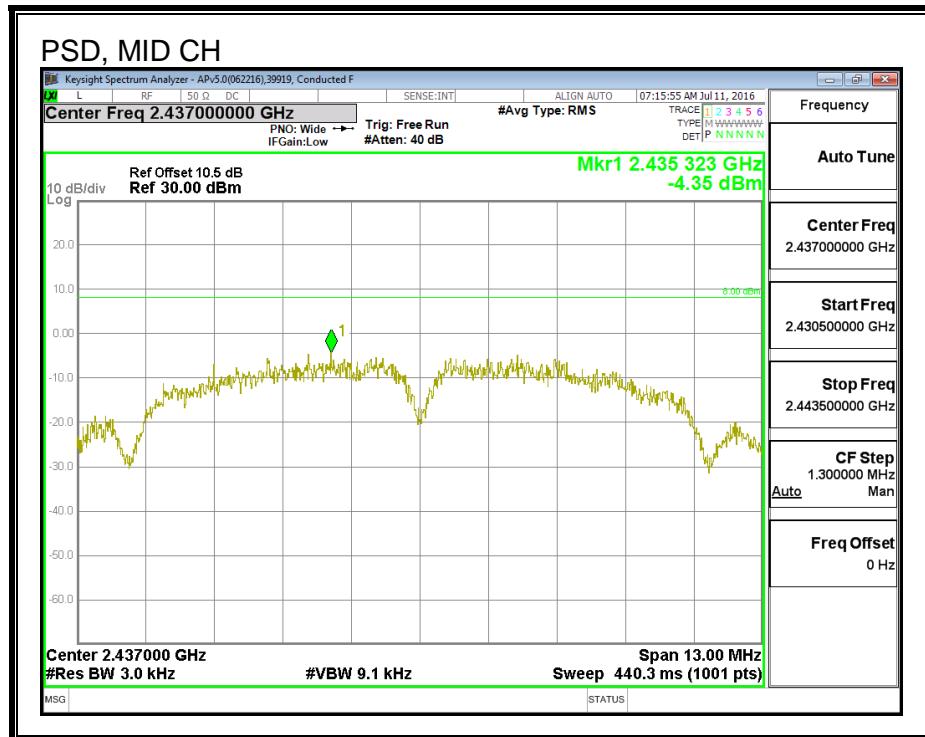
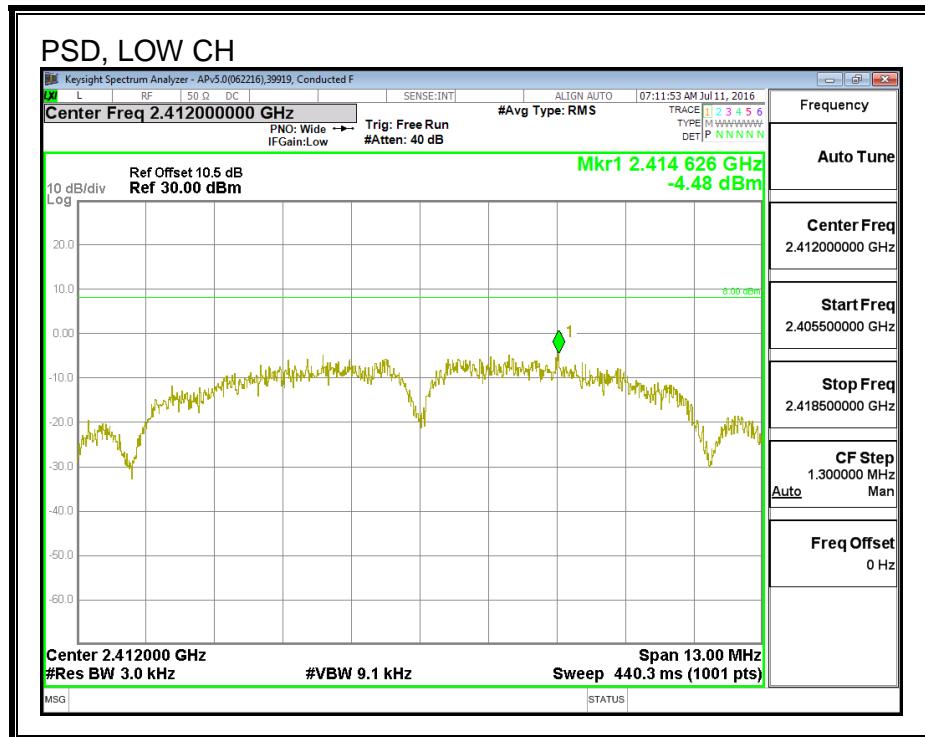
RESULTS

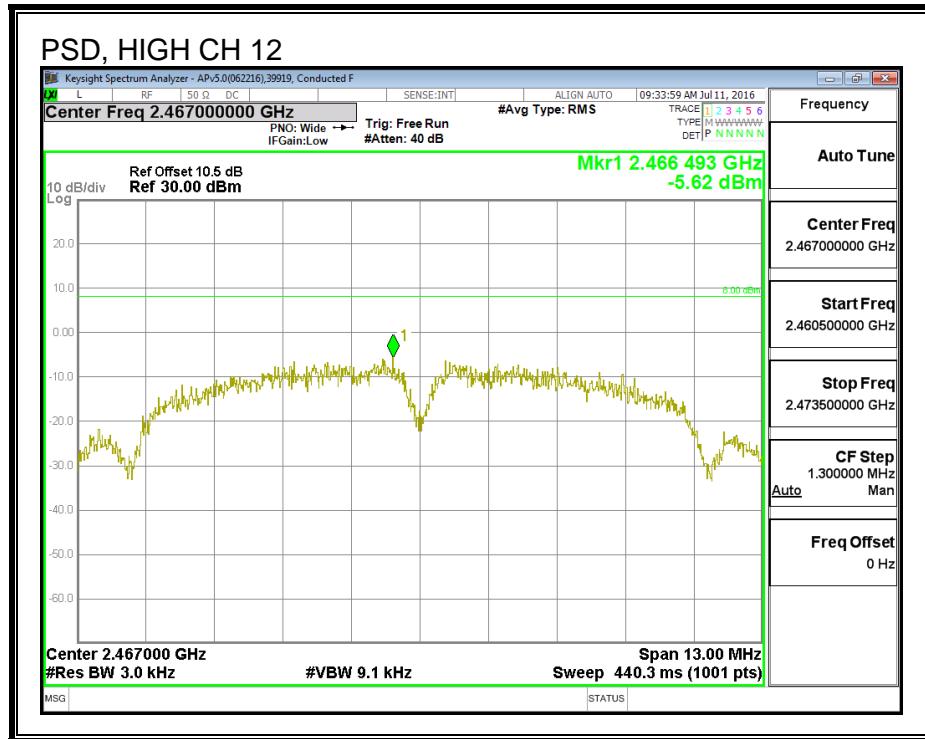
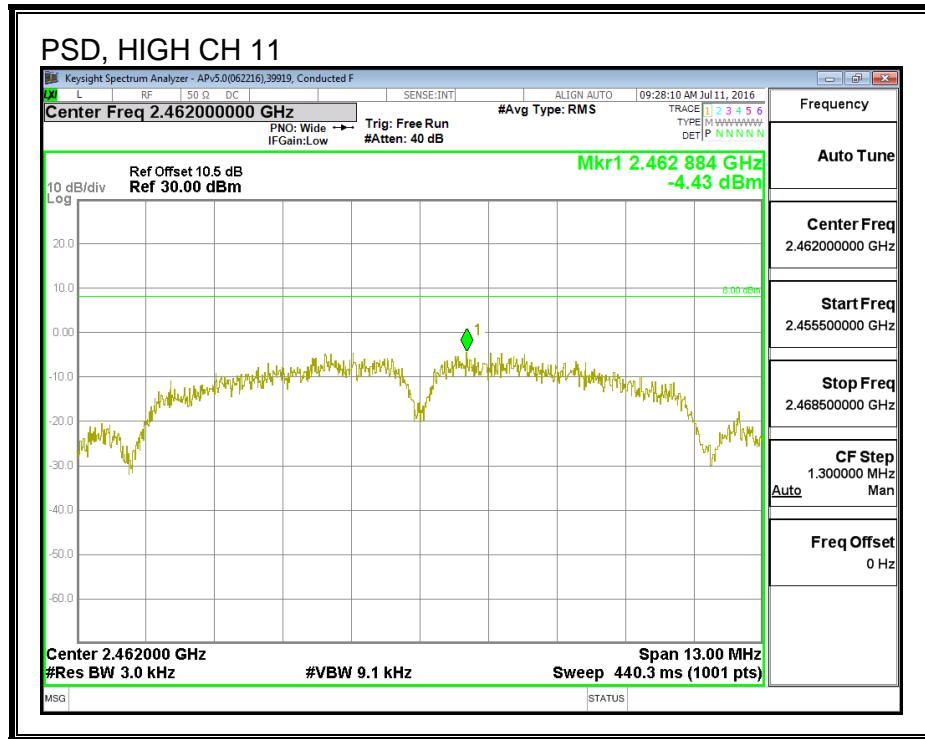
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
--------------------	------	--

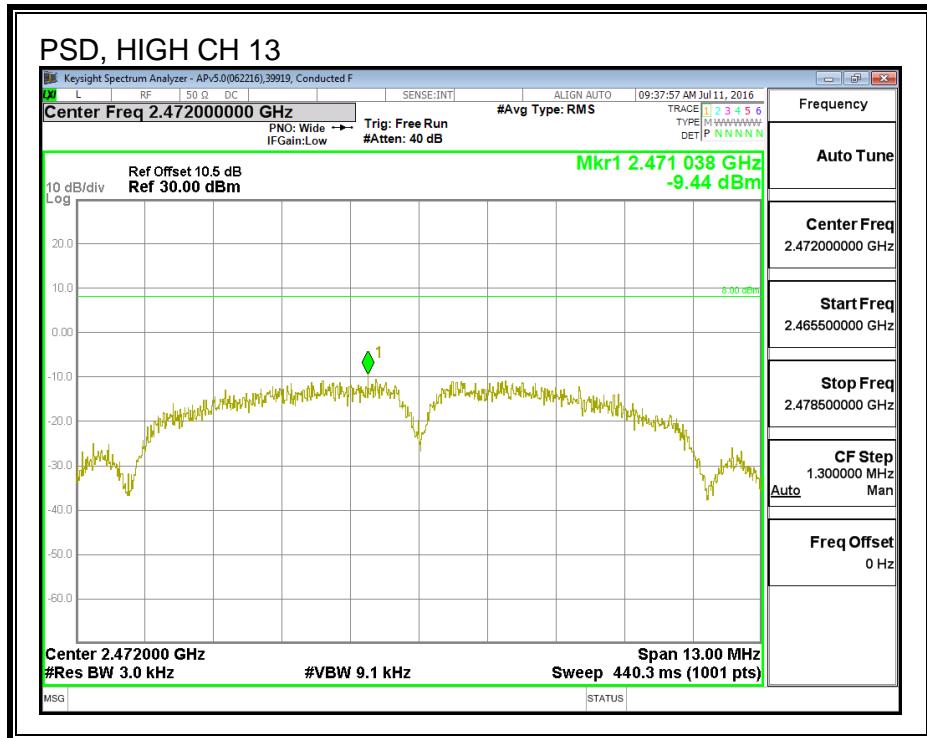
PSD Results

Channel	Frequency (MHz)	Meas (dBm)	Total Corr'd PSD (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-4.48	-4.48	8.0	-12.5
Mid	2437	-4.35	-4.35	8.0	-12.4
High_11	2462	-4.43	-4.43	8.0	-12.4
High_12	2467	-5.62	-5.62	8.0	-13.6
High_13	2472	-9.44	-9.44	8.0	-17.4

PSD







8.3.6. OUT-OF-BAND EMISSIONS

LIMITS

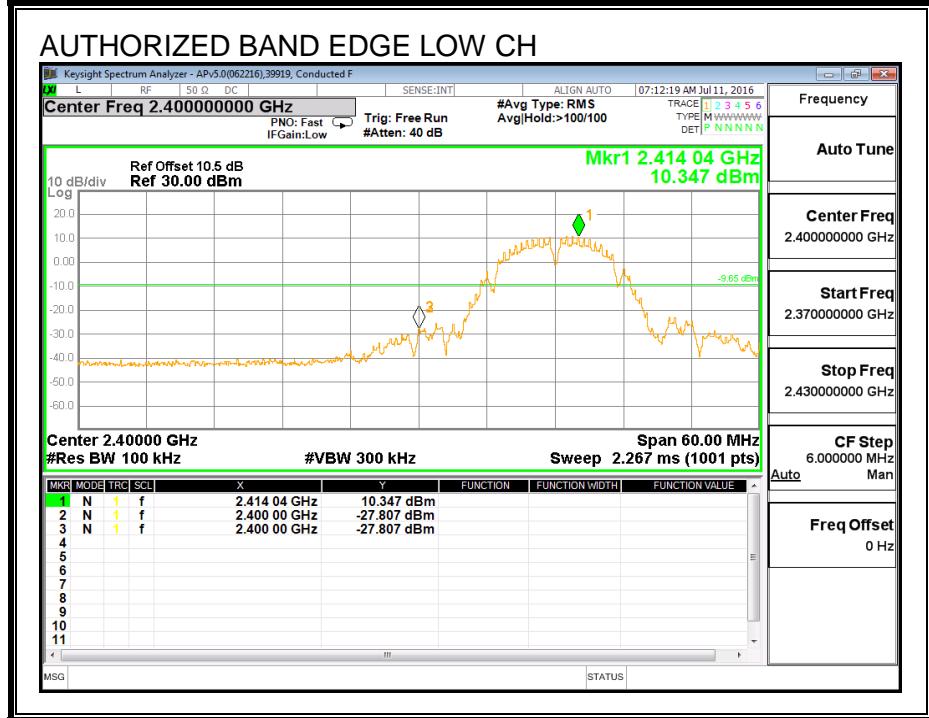
FCC §15.247 (d)

IC RSS-247 (5.5)

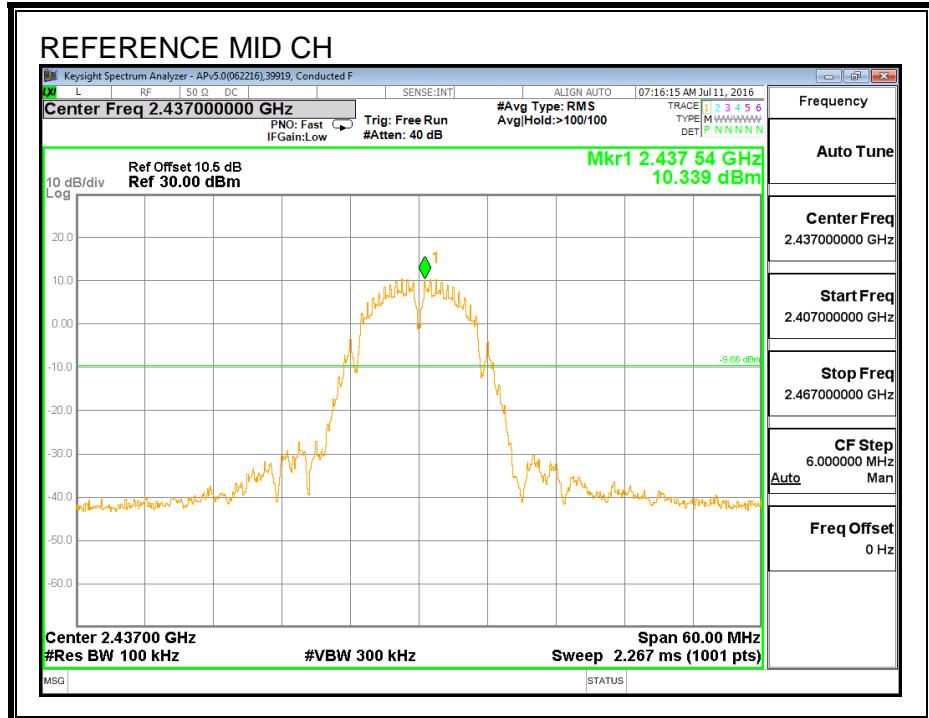
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

RESULTS

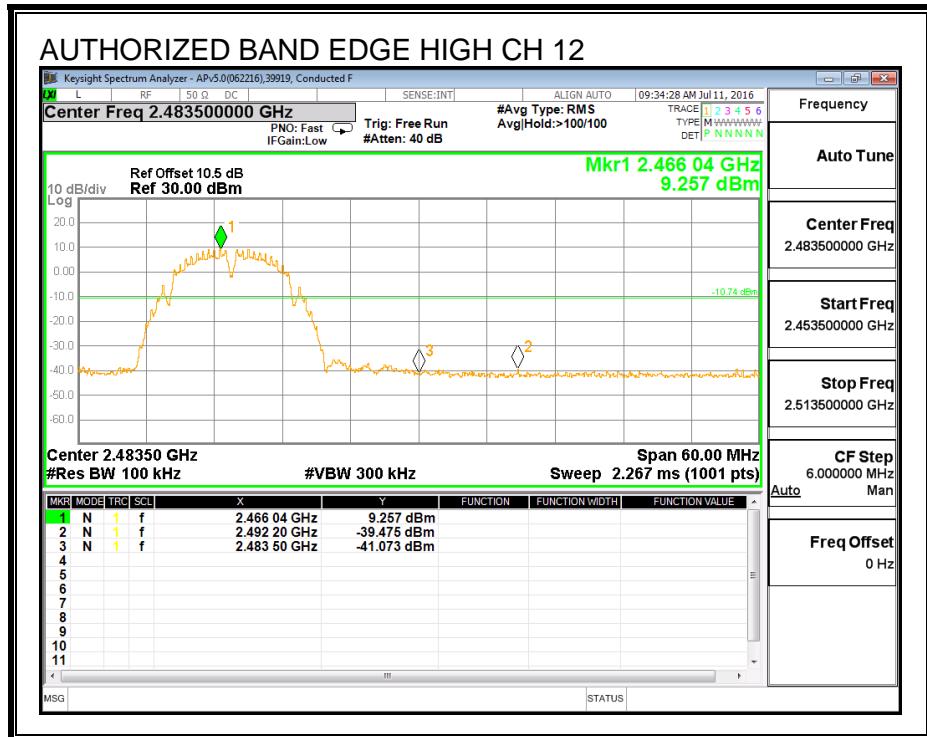
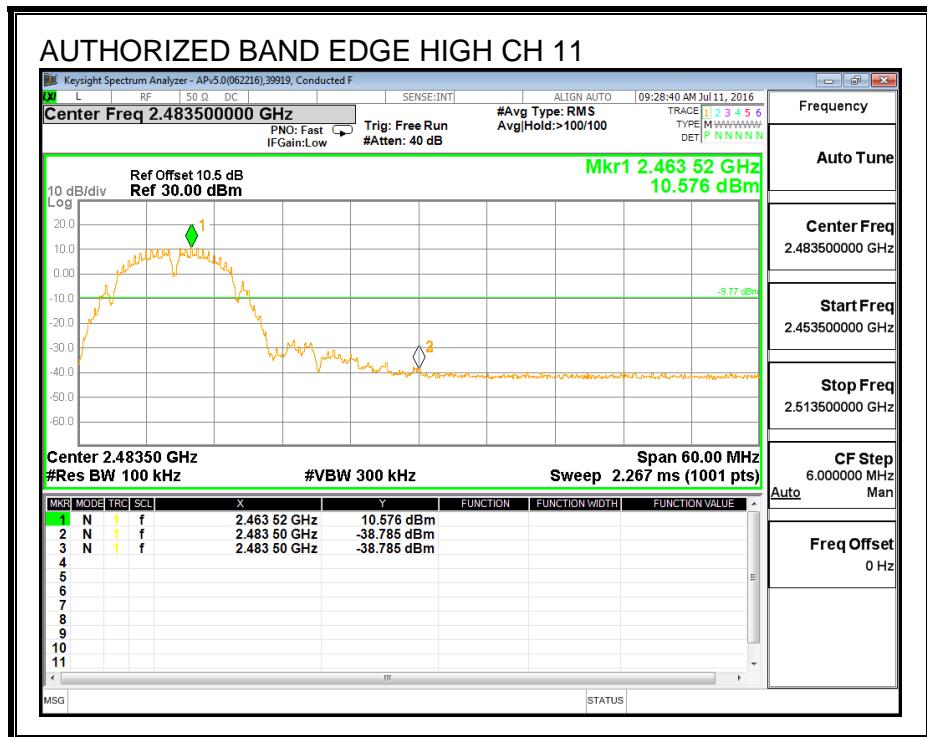
LOW CHANNEL BANDEDGE

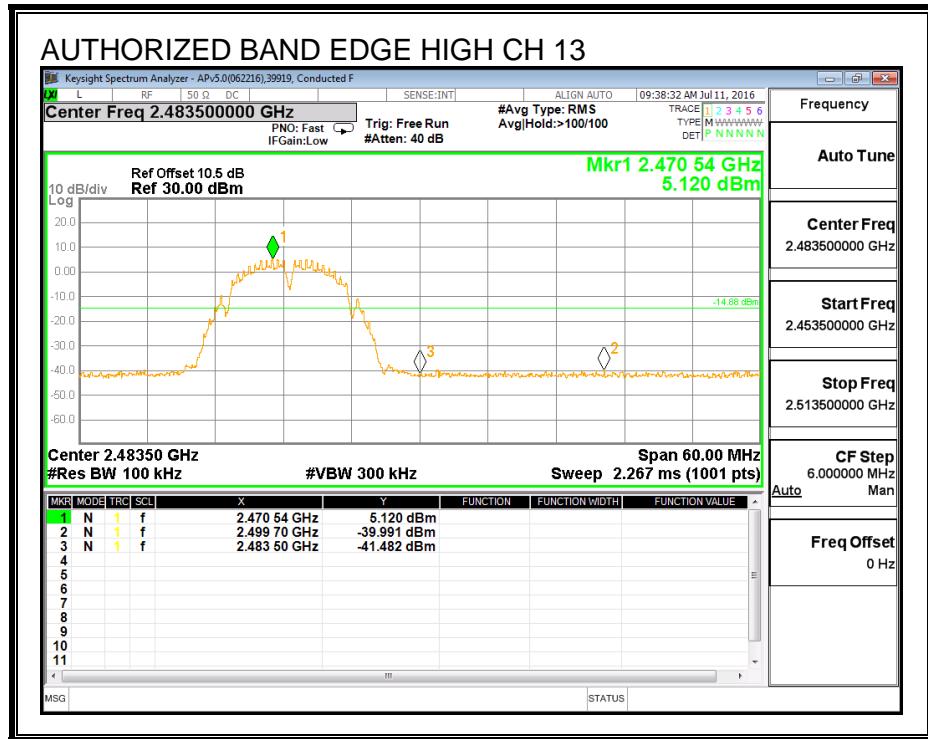


MID CHANNEL REFERENCE

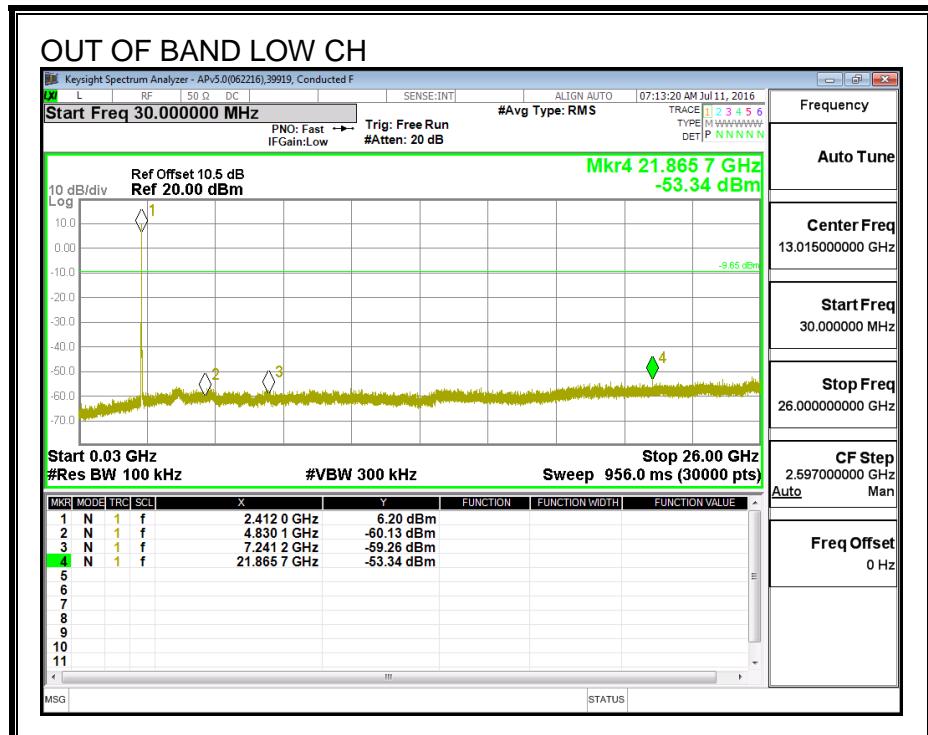


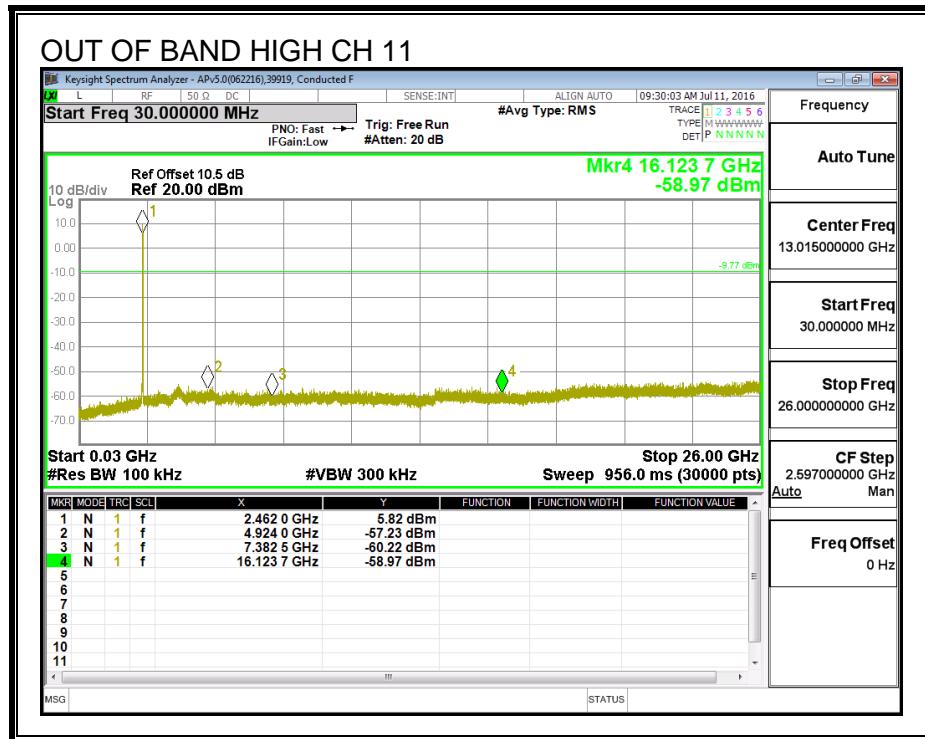
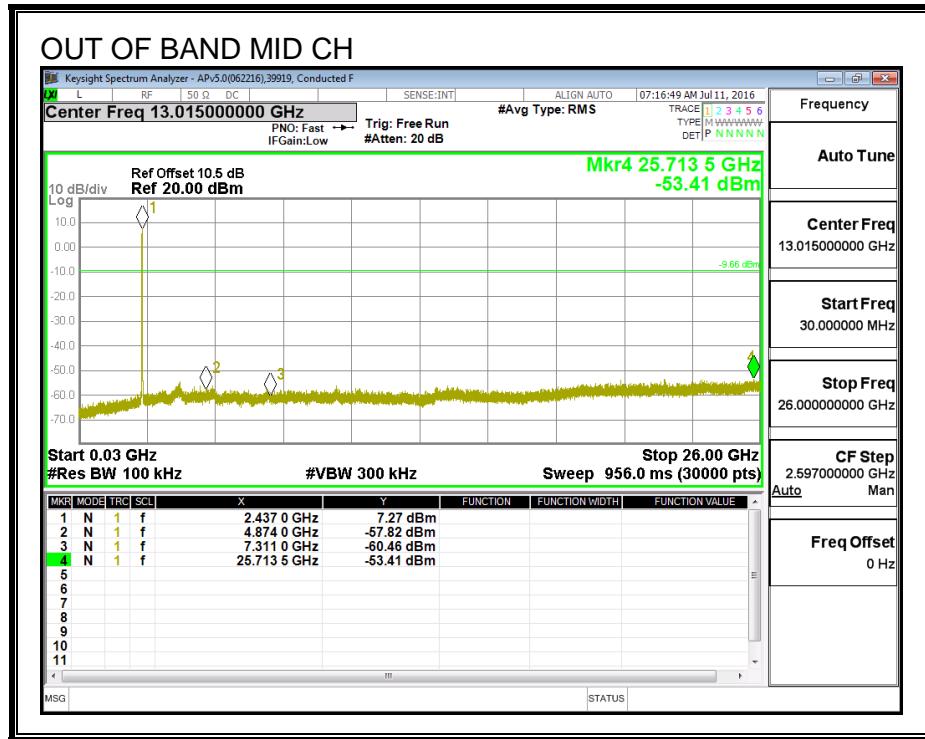
HIGH CHANNEL BANDEDGE

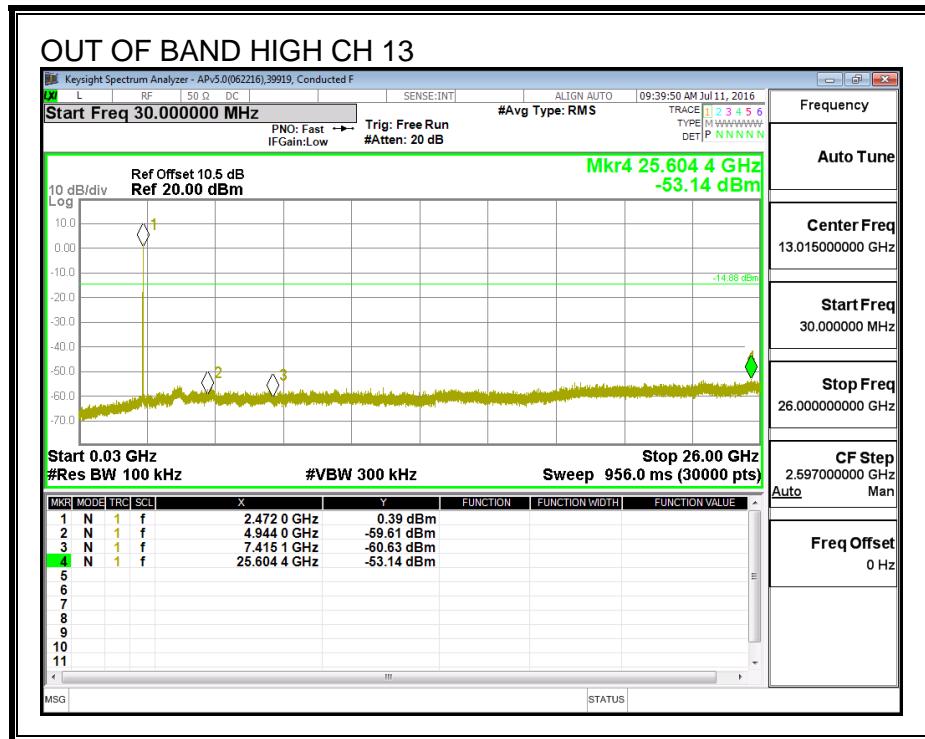
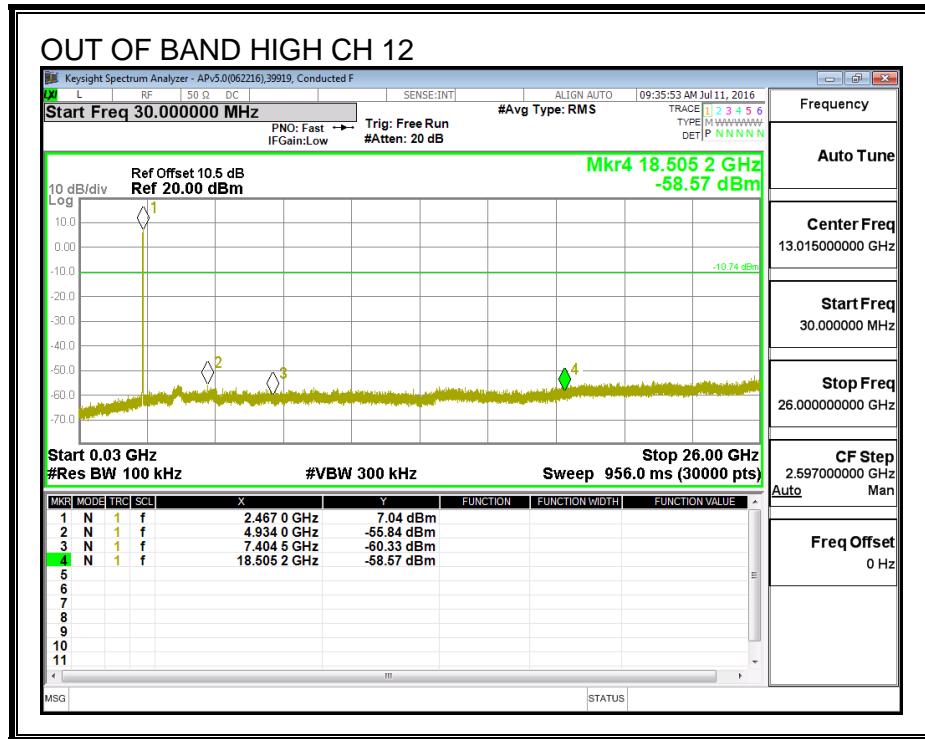




OUT-OF-BAND EMISSIONS







8.4. 802.11g SISO MODE IN THE 2.4 GHz BAND

Noted: Covered by 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND

8.5. 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND, CHAIN 0

8.5.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

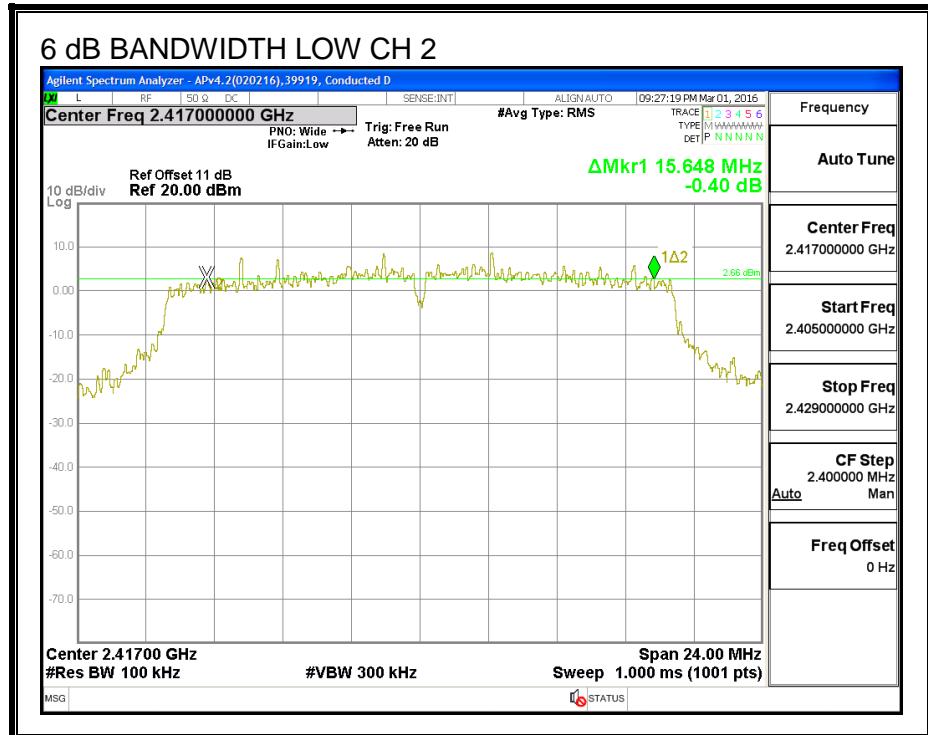
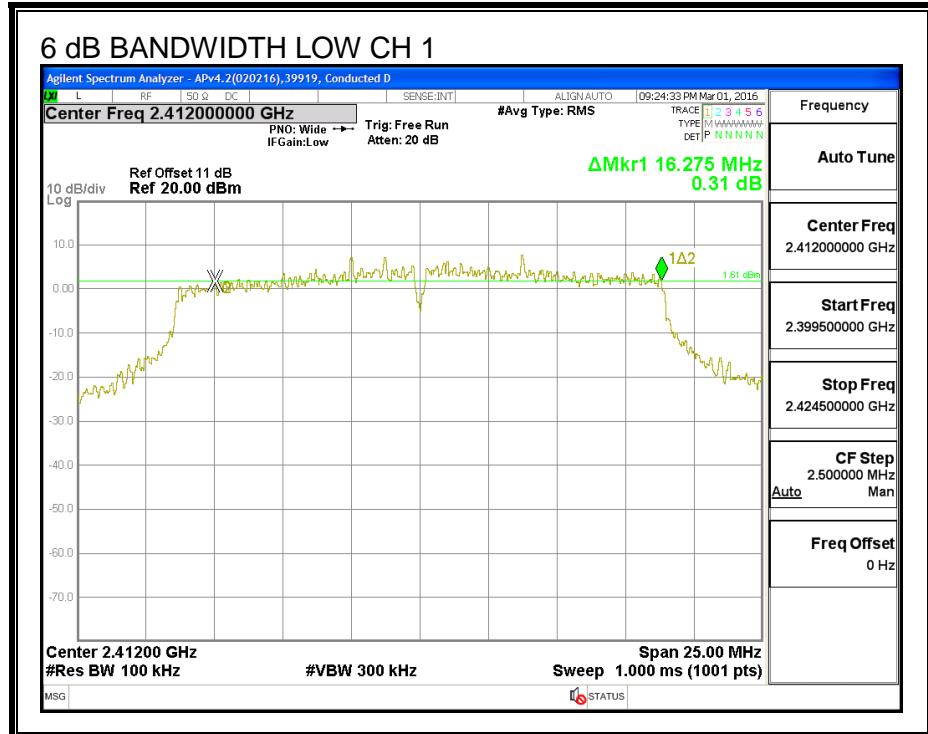
IC RSS-247 (5.2) (1)

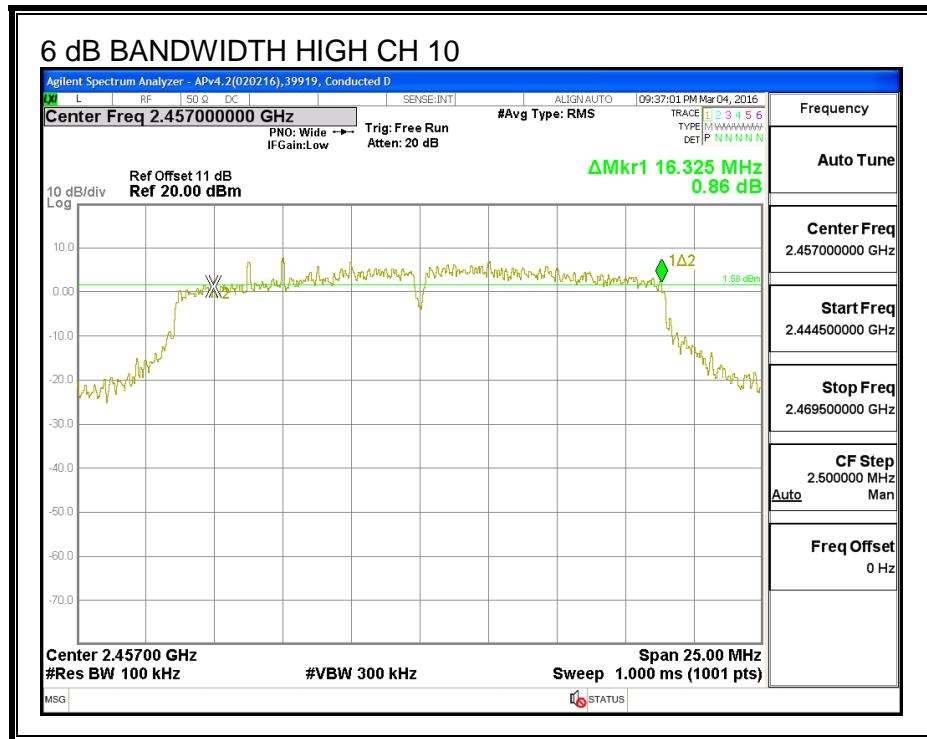
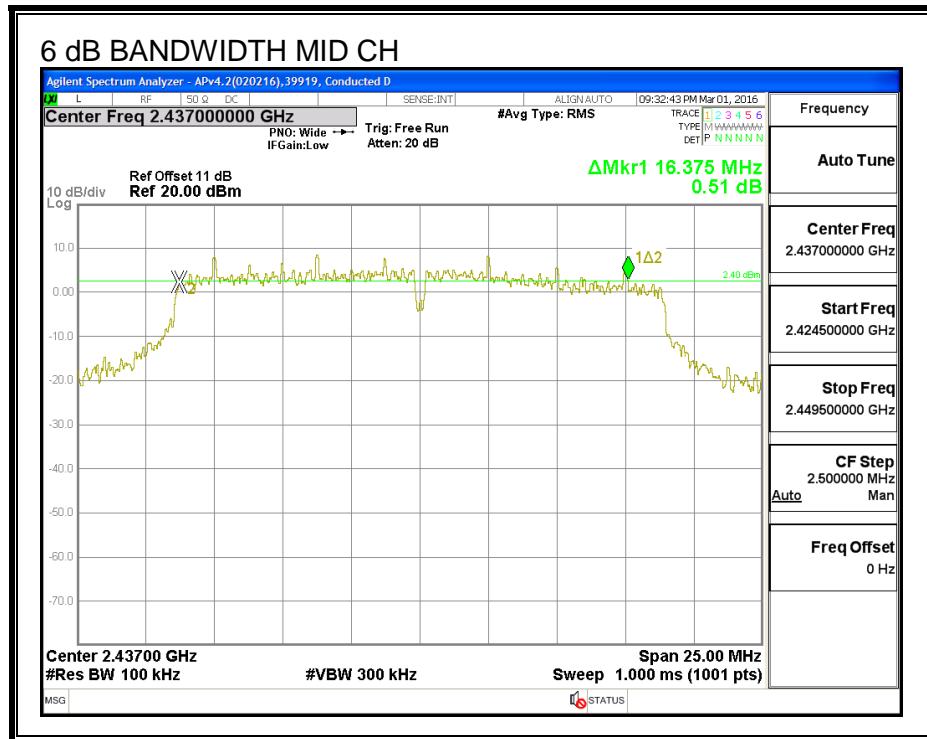
The minimum 6 dB bandwidth shall be at least 500 kHz.

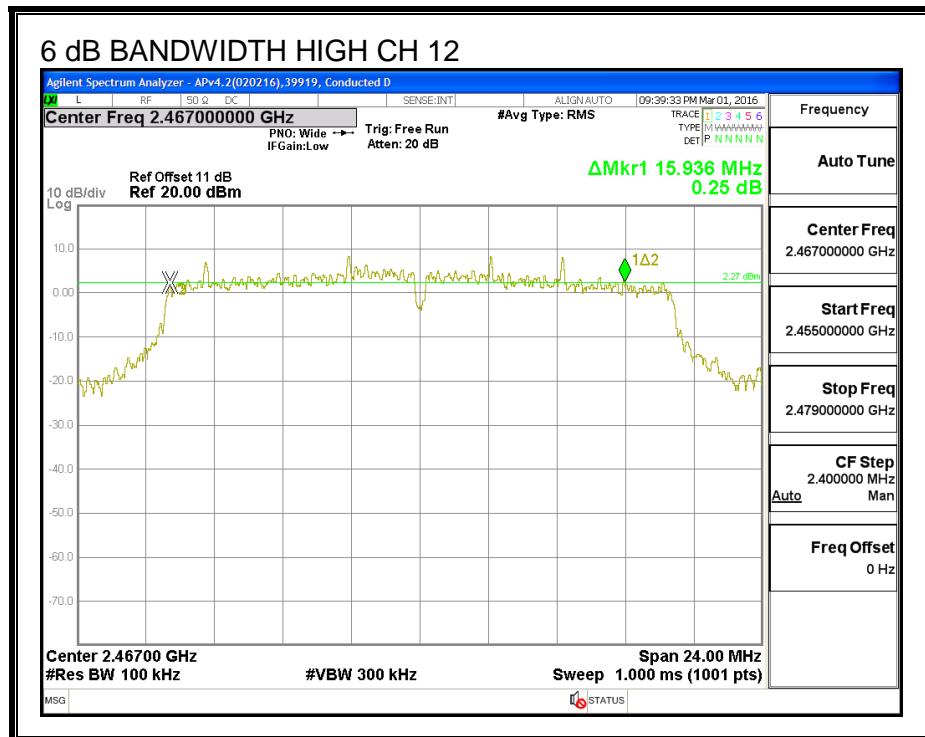
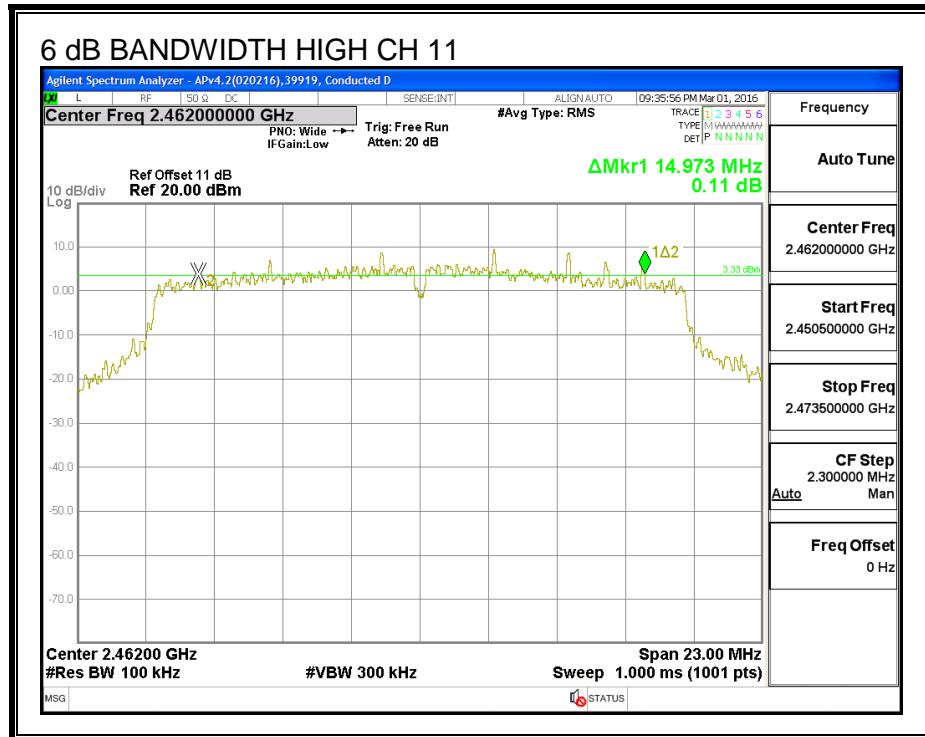
RESULTS

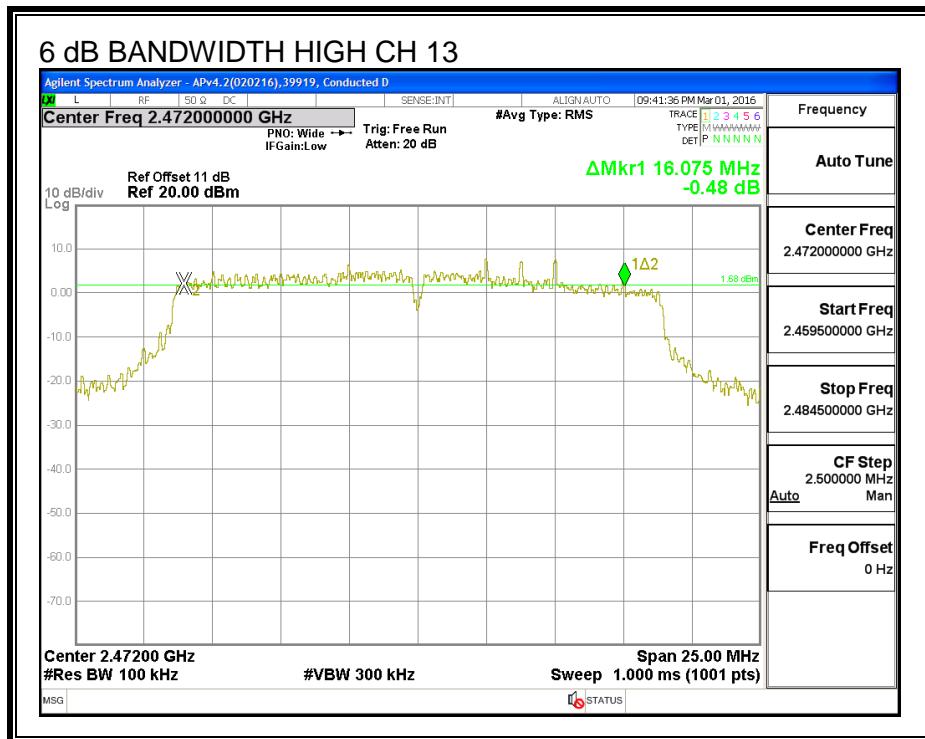
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low_1	2412	16.28	0.5
Low_2	2417	15.65	0.5
Mid_6	2437	16.38	0.5
High_10	2457	16.33	0.5
High_11	2462	14.97	0.5
High_12	2467	15.94	0.5
High_13	2472	16.08	0.5

6 dB BANDWIDTH









8.5.2. 99% BANDWIDTH

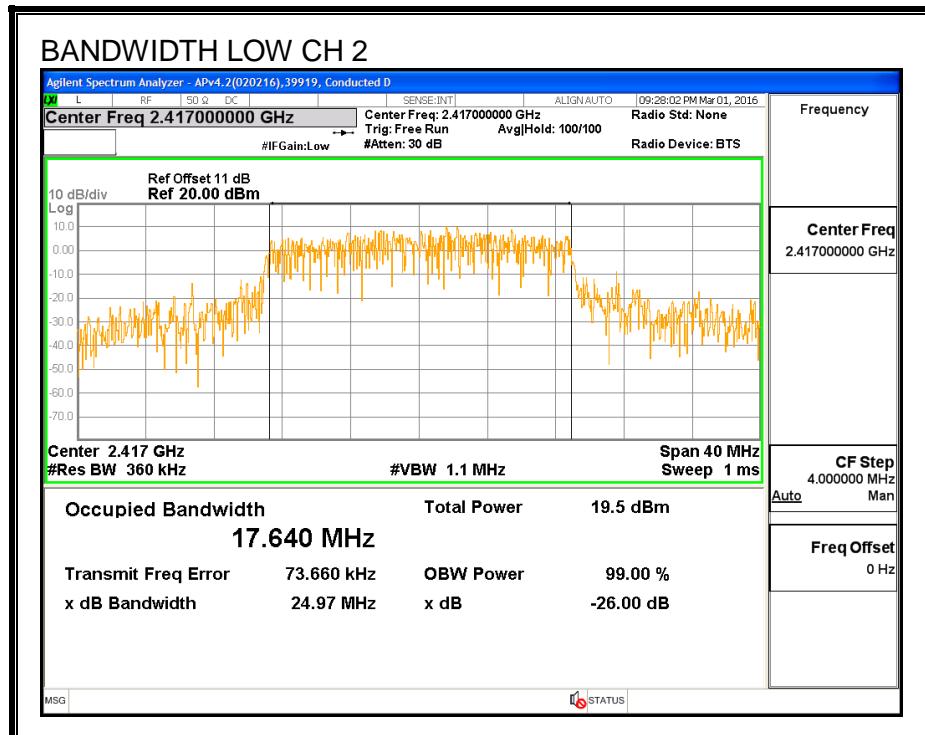
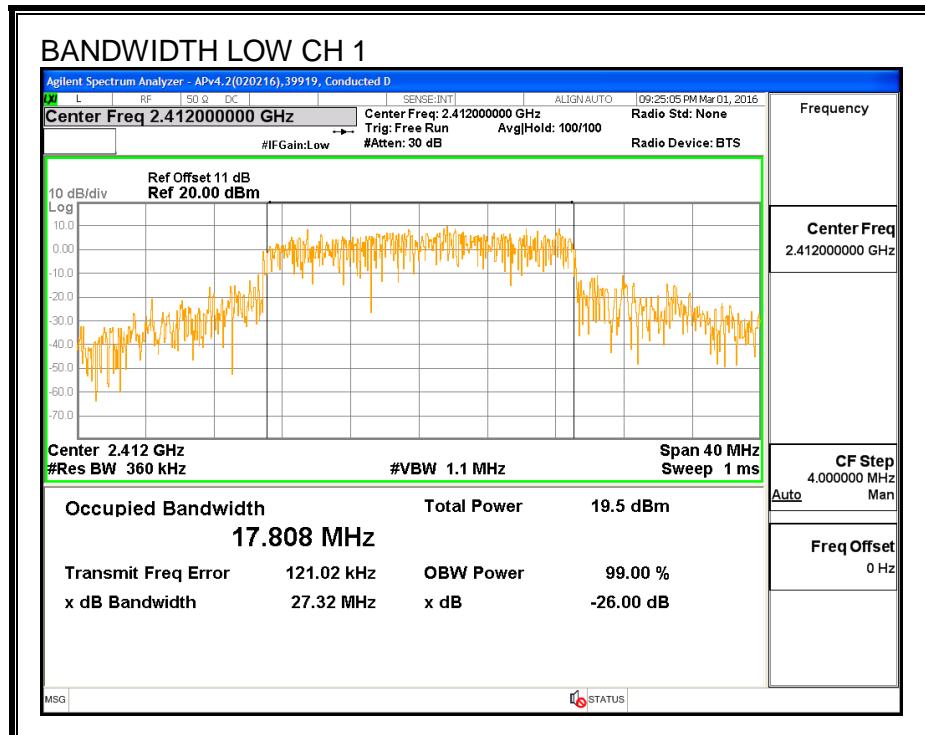
LIMITS

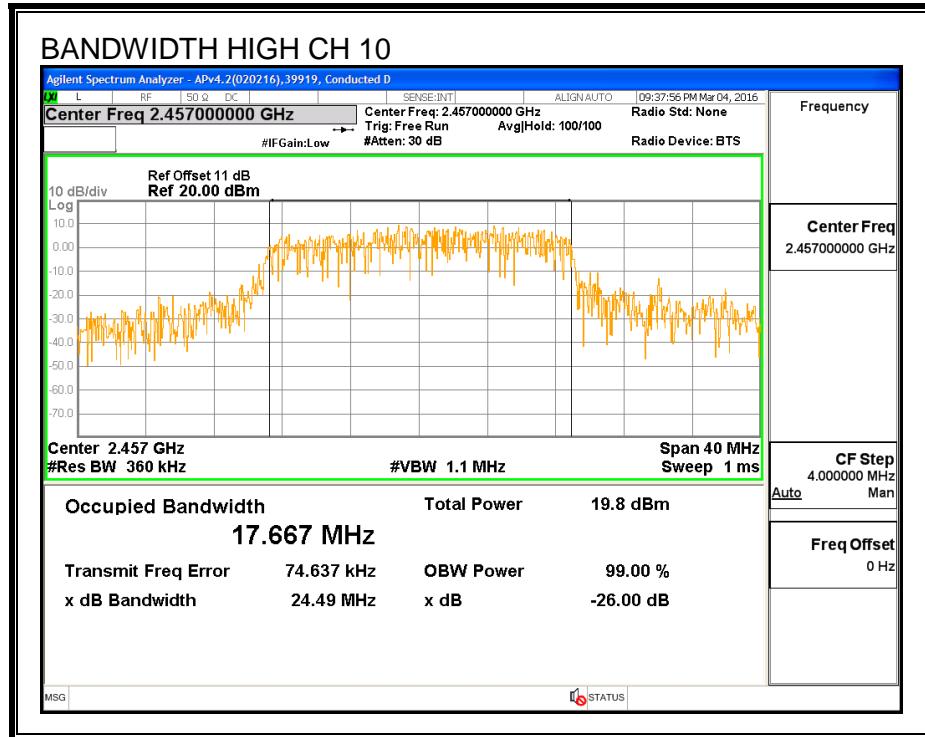
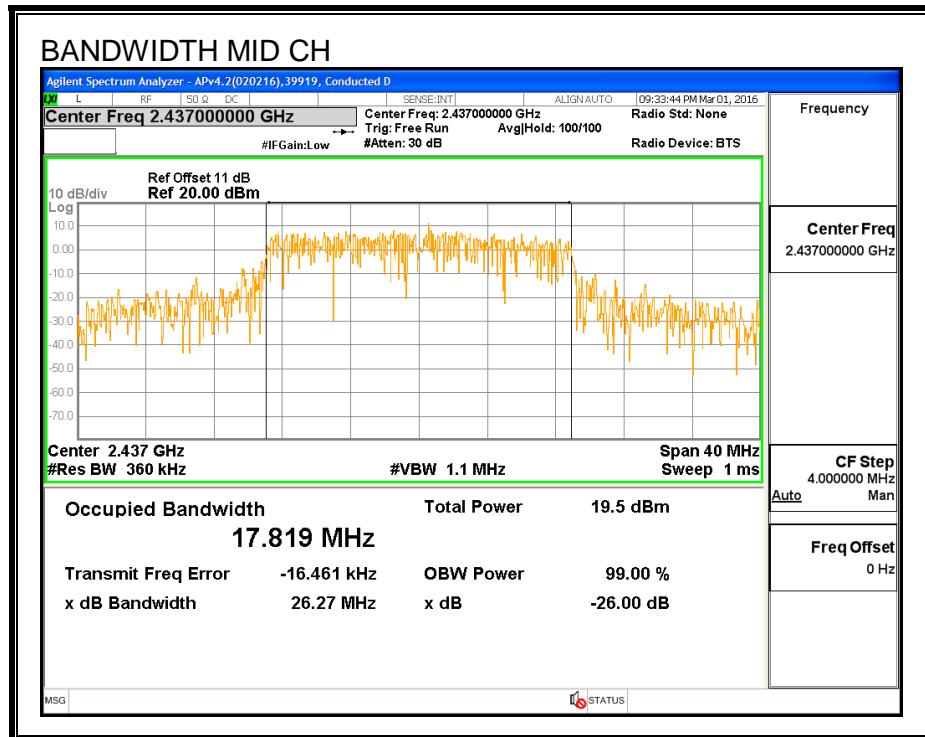
None; for reporting purposes only.

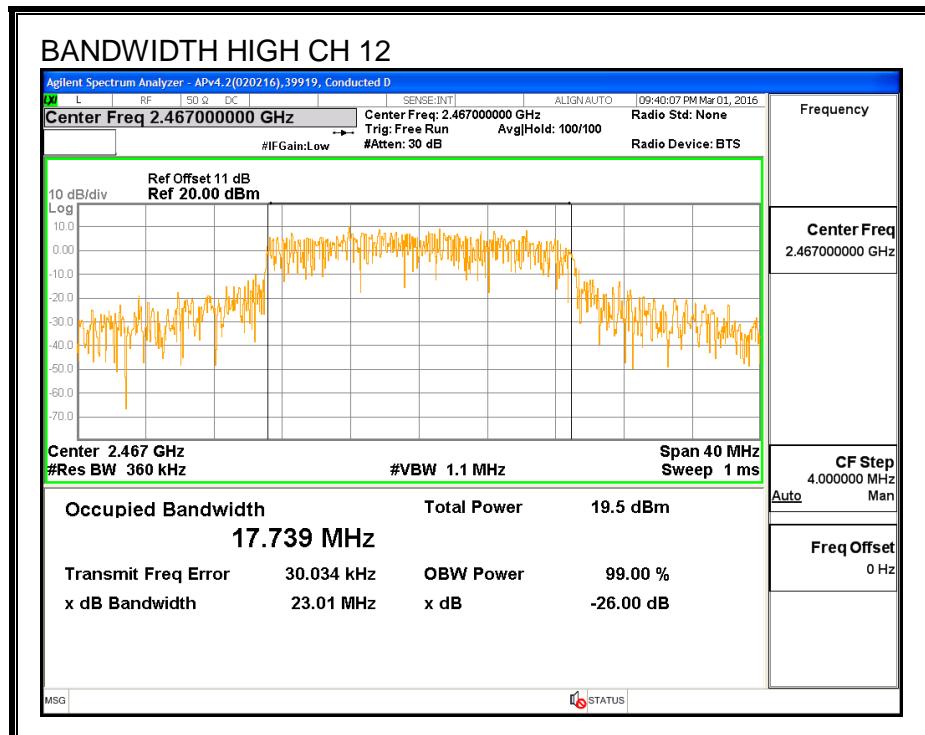
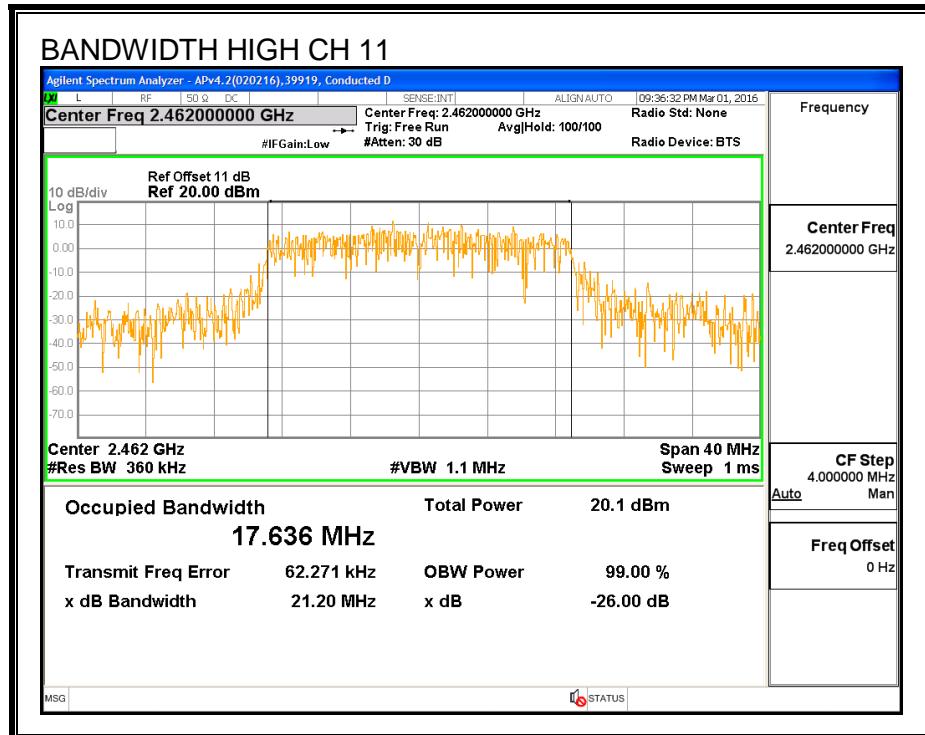
RESULTS

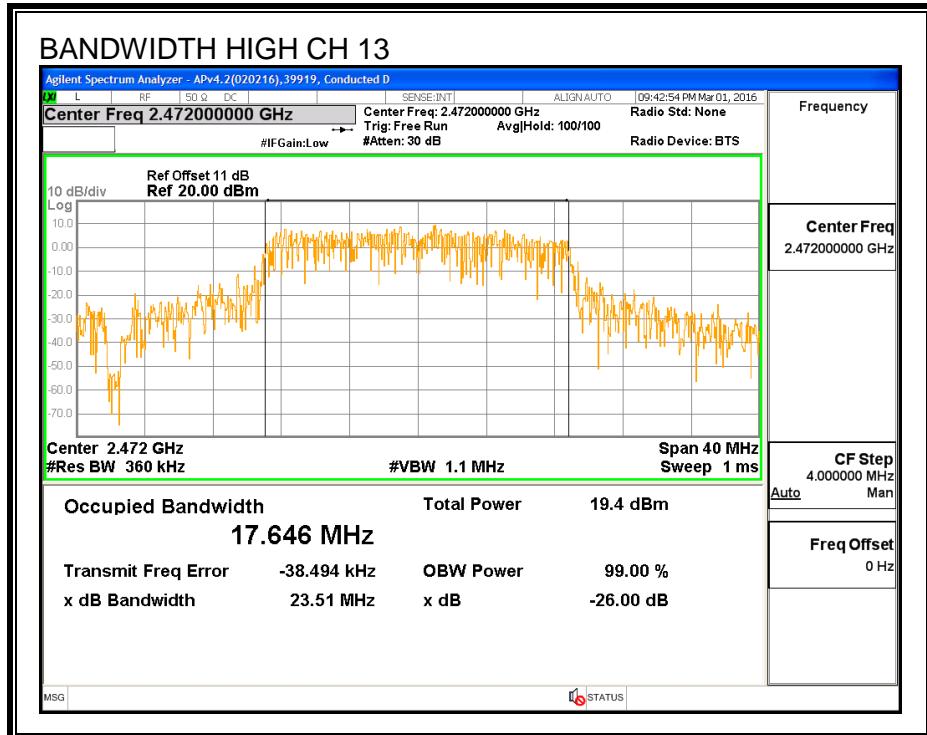
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low_1	2412	17.808
Low_2	2417	17.640
Mid_6	2437	17.819
High_10	2457	17.667
High_11	2462	17.636
High_12	2467	17.739
High_13	2472	17.646

99% BANDWIDTH









8.5.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

RESULTS

ID:	39919	Date:	7/10/16
-----	-------	-------	---------

Channel	Frequency (MHz)	Power (dBm)
Low_1	2412	14.99
Low_2	2417	17.48
Mid_6	2437	18.97
High_10	2457	15.95
High_11	2462	14.49
High_12	2467	12.50
High_13	2472	2.49

8.5.4. OUTPUT POWER

LIMITS

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

RESULTS

ID:	39919	Date:	7/10/16
------------	-------	--------------	---------

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-1.85	30.00	30	36	30.00
Low_2	2417	-1.85	30.00	30	36	30.00
Mid_6	2437	-1.85	30.00	30	36	30.00
High_10	2457	-1.85	30.00	30	36	30.00
High_11	2462	-1.85	30.00	30	36	30.00
High_12	2467	-1.85	30.00	30	36	30.00
High_13	2472	-1.85	30.00	30	36	30.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
---------------------------	------	---

Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low_1	2412	21.72	21.72	30.00	-8.28
Low_2	2417	23.21	23.21	30.00	-6.79
Mid_6	2437	25.63	25.63	30.00	-4.37
High_10	2457	21.67	21.67	30.00	-8.33
High_11	2462	20.23	20.23	30.00	-9.77
High_12	2467	18.28	18.28	30.00	-11.72
High_13	2472	8.26	8.26	30.00	-21.74

8.5.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

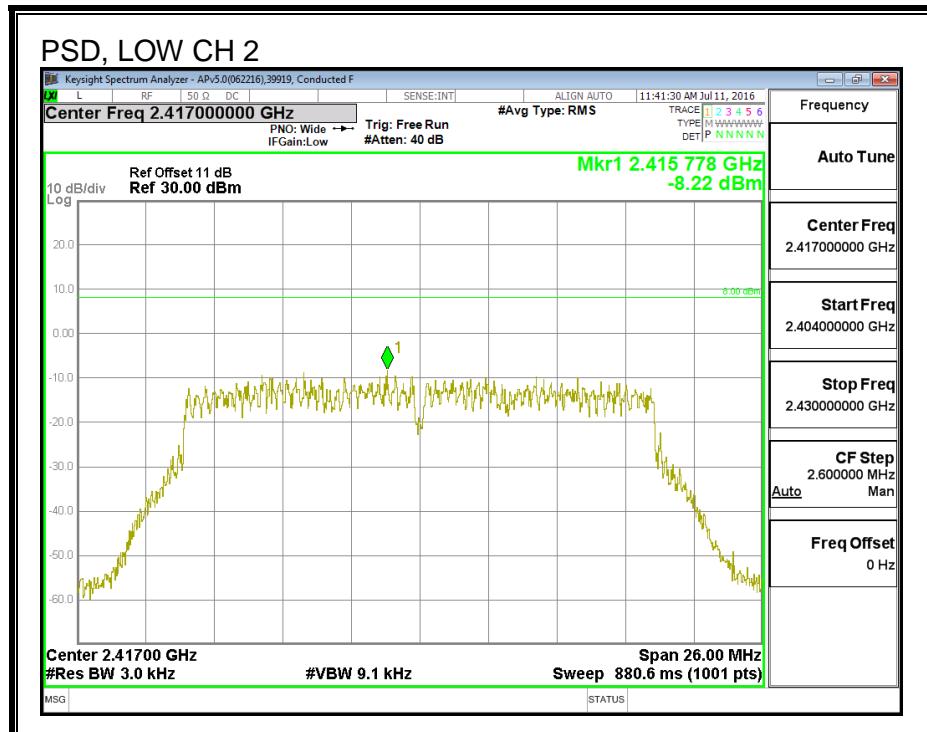
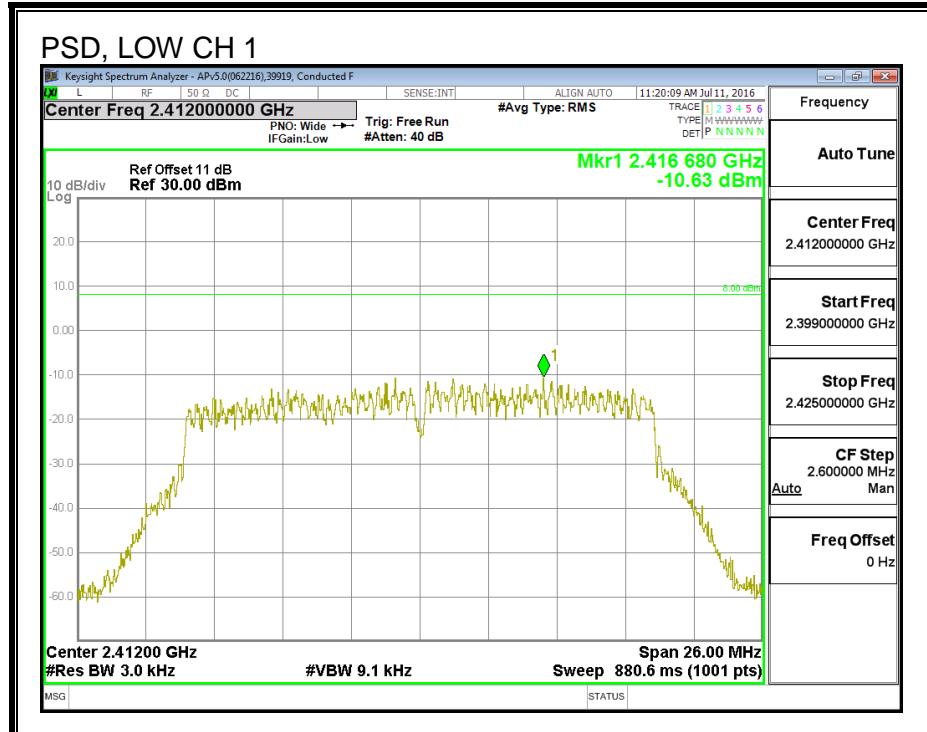
IC RSS-247 (5.2) (2)

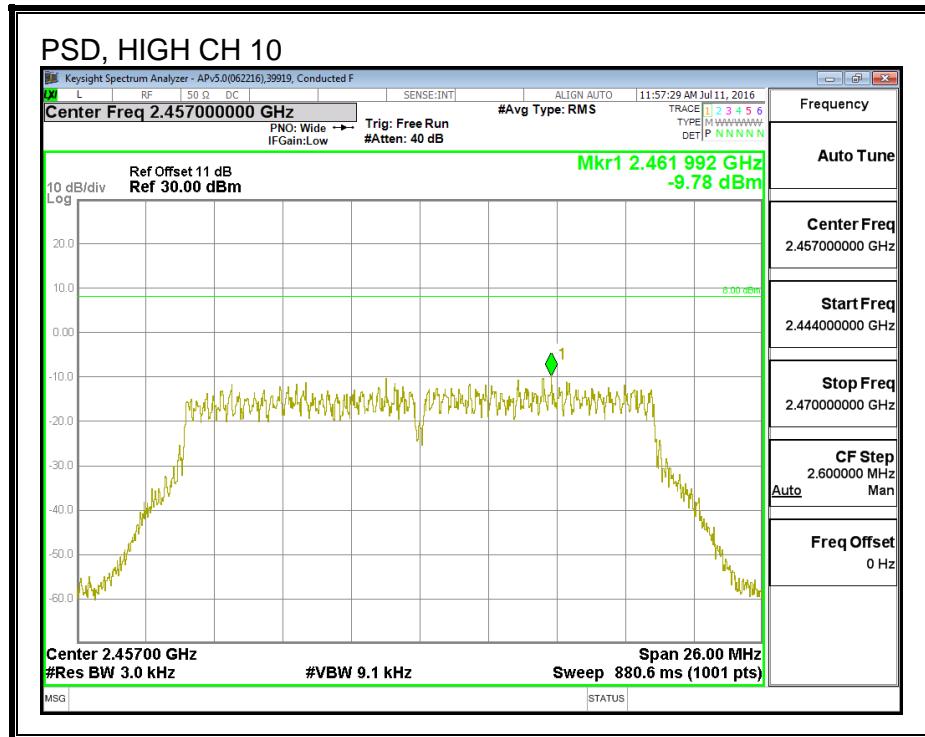
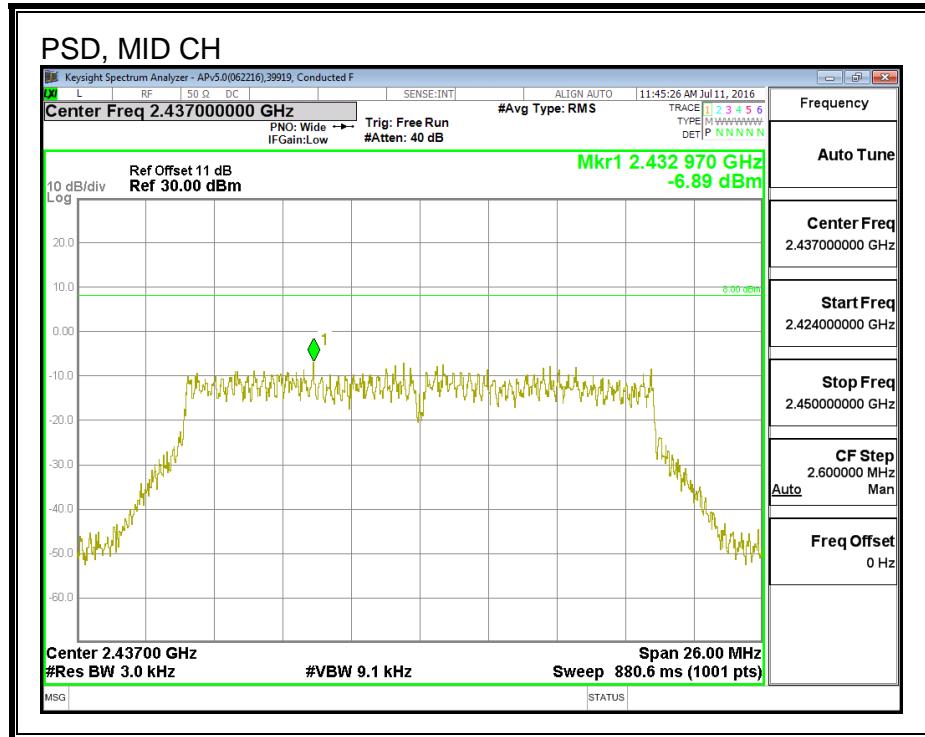
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

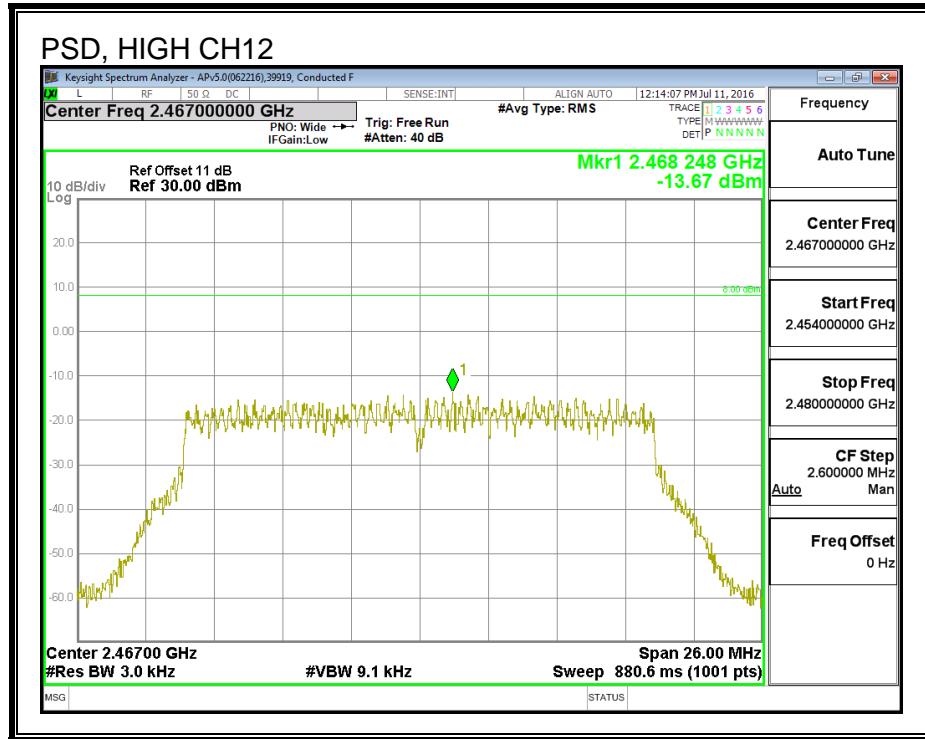
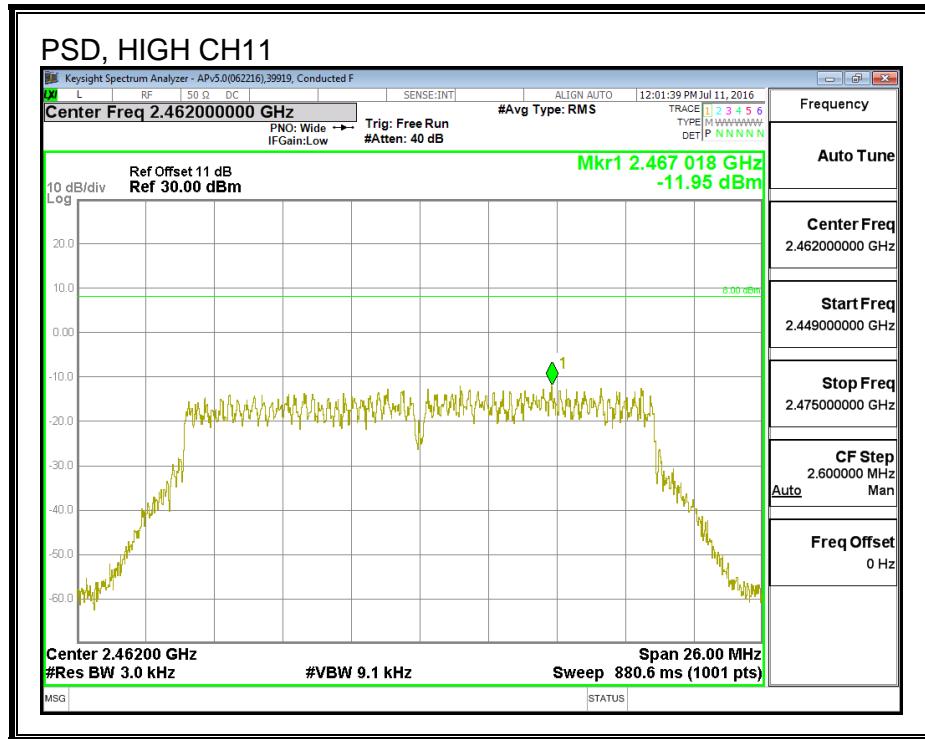
RESULTS

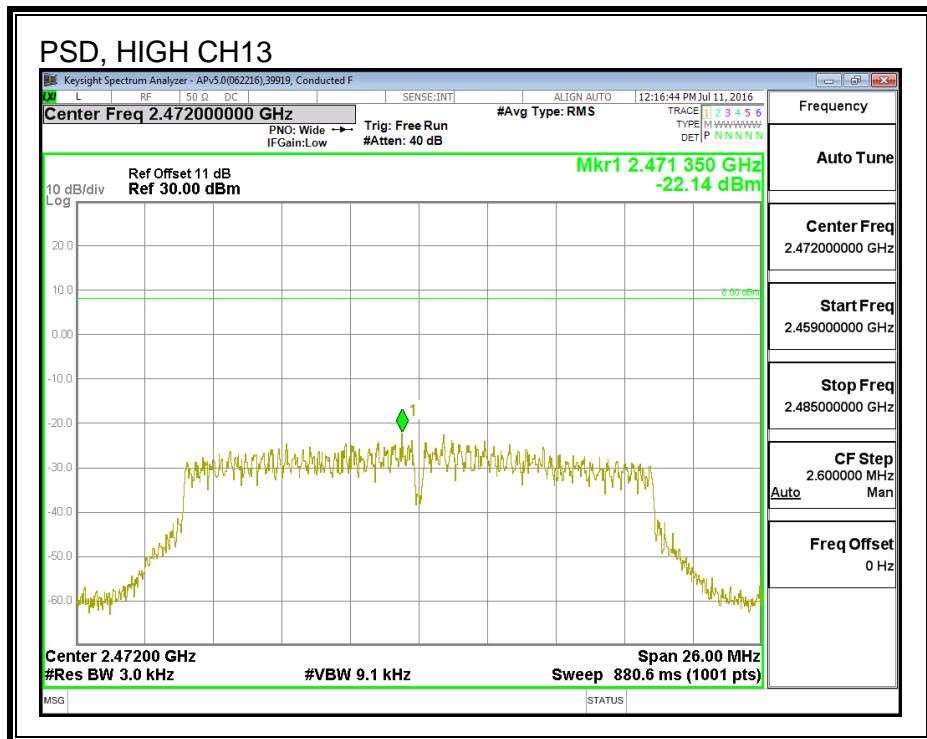
Duty Cycle CF (dB)		0.00	Included in Calculations of Corr'd PSD		
PSD Results					
Channel	Frequency (MHz)	Chain 0 Meas (dBm)	Total Corr'd PSD (dBm)	Limit (dBm)	Margin (dB)
Low_1	2412	-10.63	-10.63	8.0	-18.6
Low_2	2417	-8.22	-8.22	8.0	-16.2
Mid_6	2437	-6.89	-6.89	8.0	-14.9
High_10	2457	-9.78	-9.78	8.0	-17.8
High_11	2462	-11.95	-11.95	8.0	-20.0
High_12	2467	-13.67	-13.67	8.0	-21.7
High_13	2472	-22.14	-22.14	8.0	-30.1

PSD









8.5.6. OUT-OF-BAND EMISSIONS

LIMITS

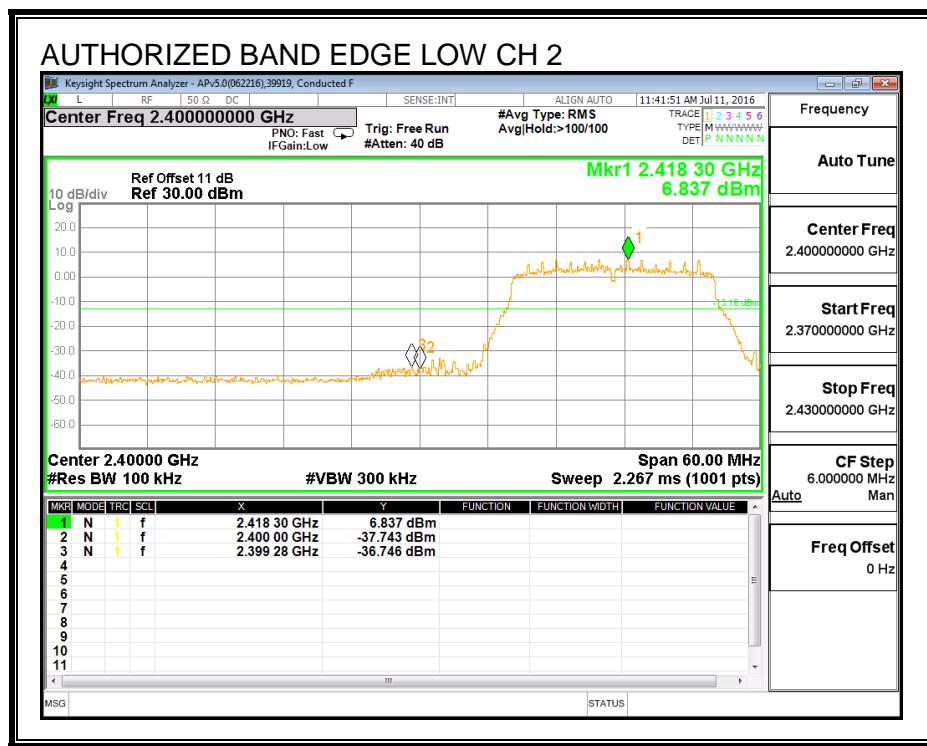
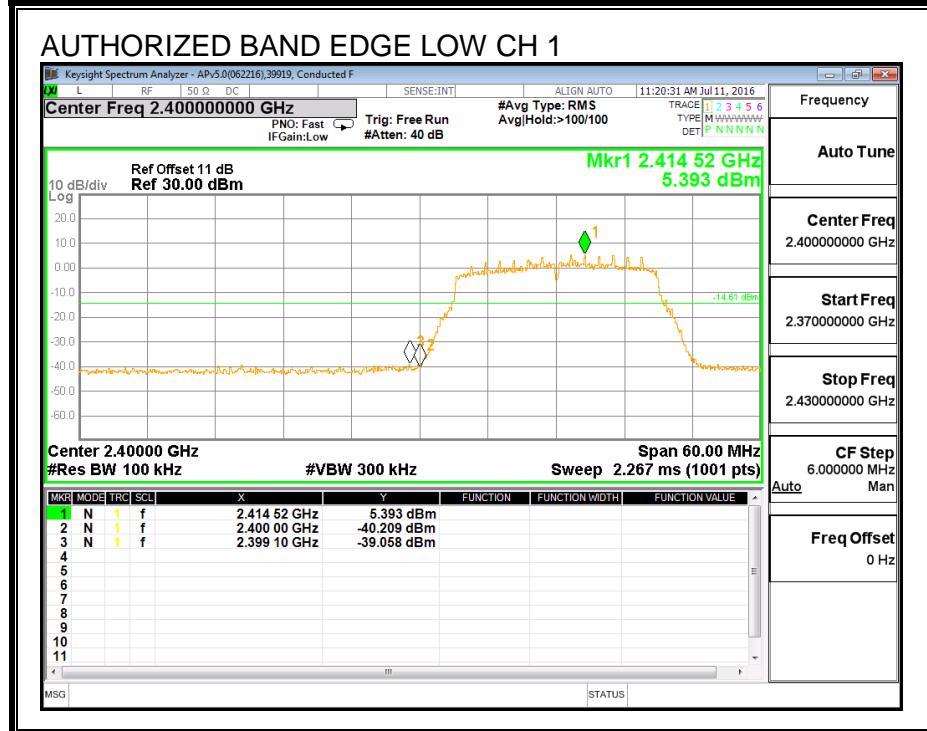
FCC §15.247 (d)

IC RSS-247 (5.5)

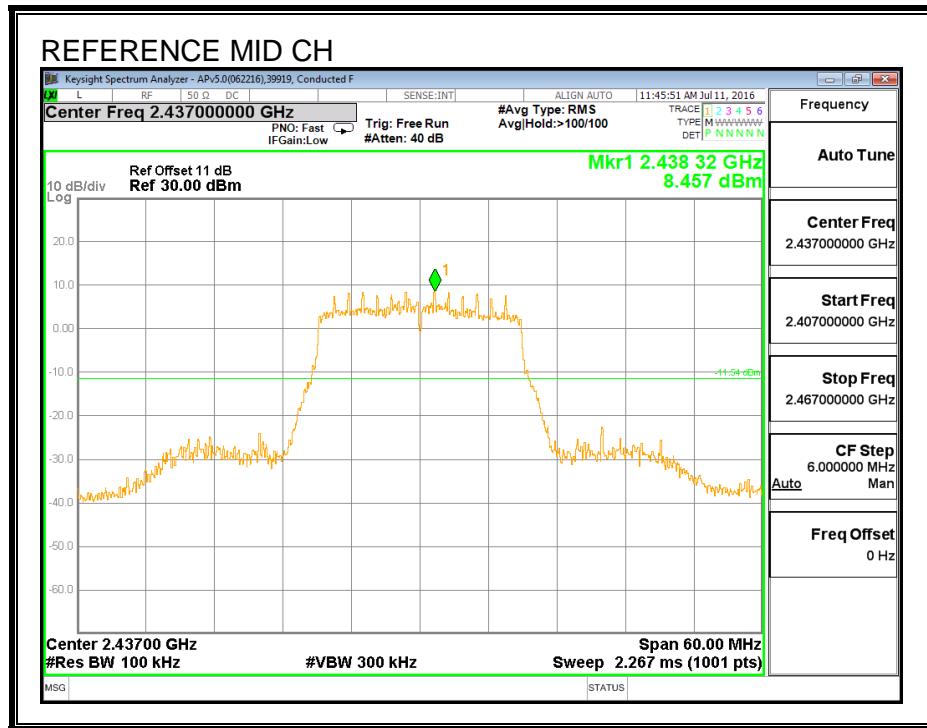
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

RESULTS

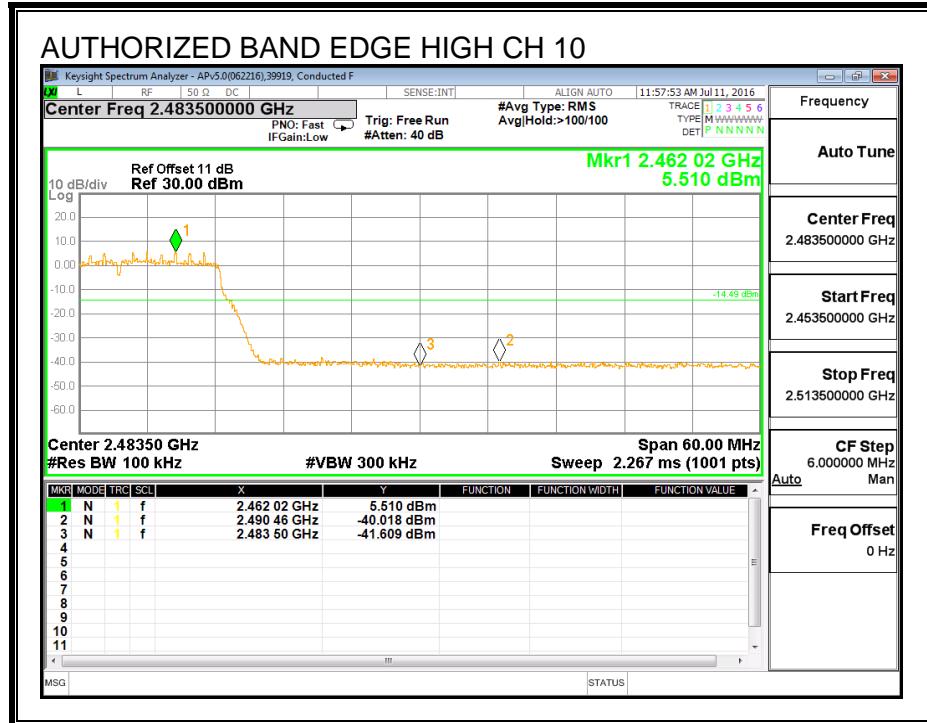
LOW CHANNEL BANDEDGE

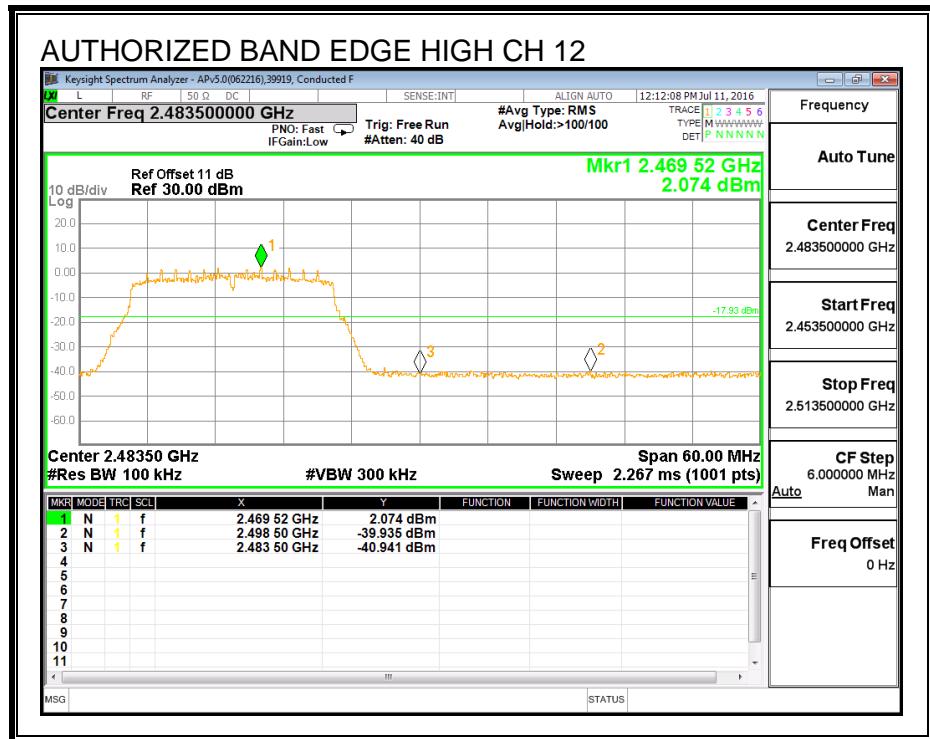
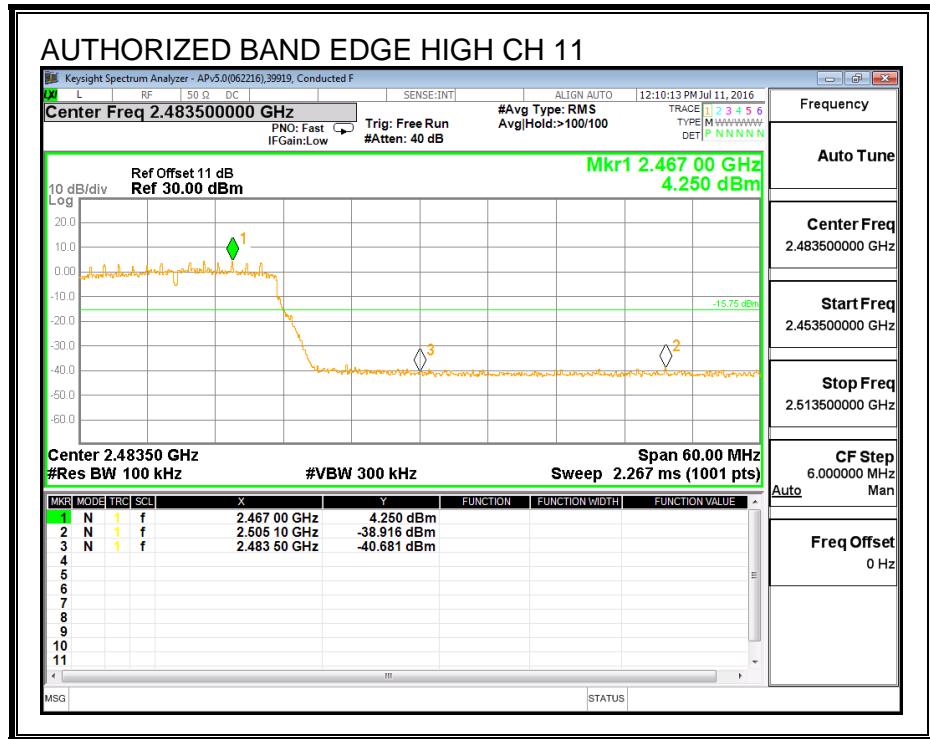


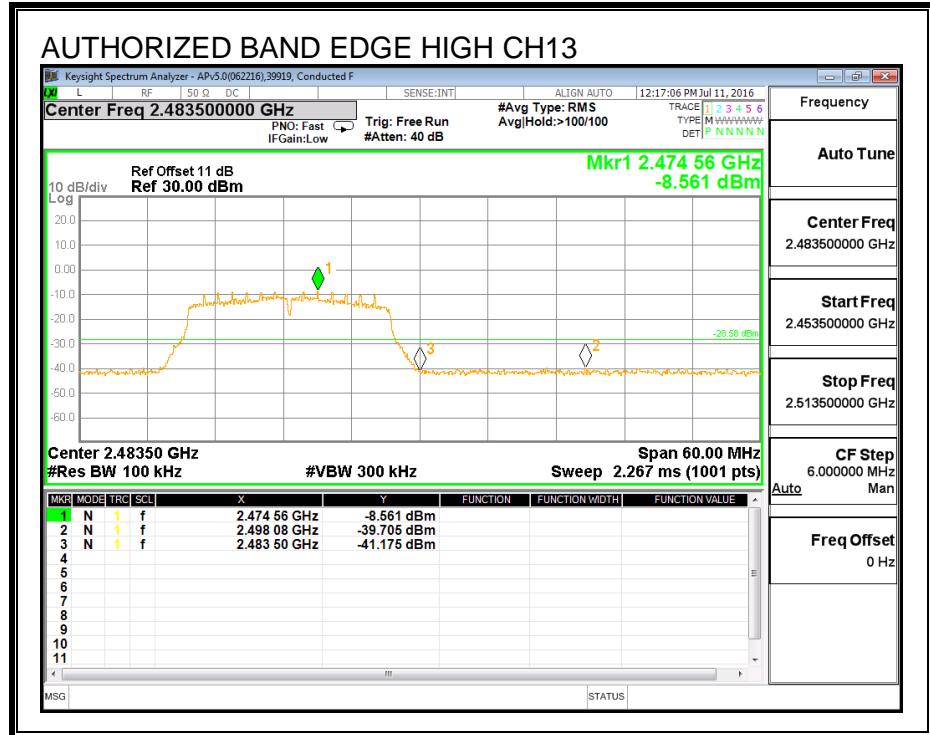
MID CHANNEL REFERENCE



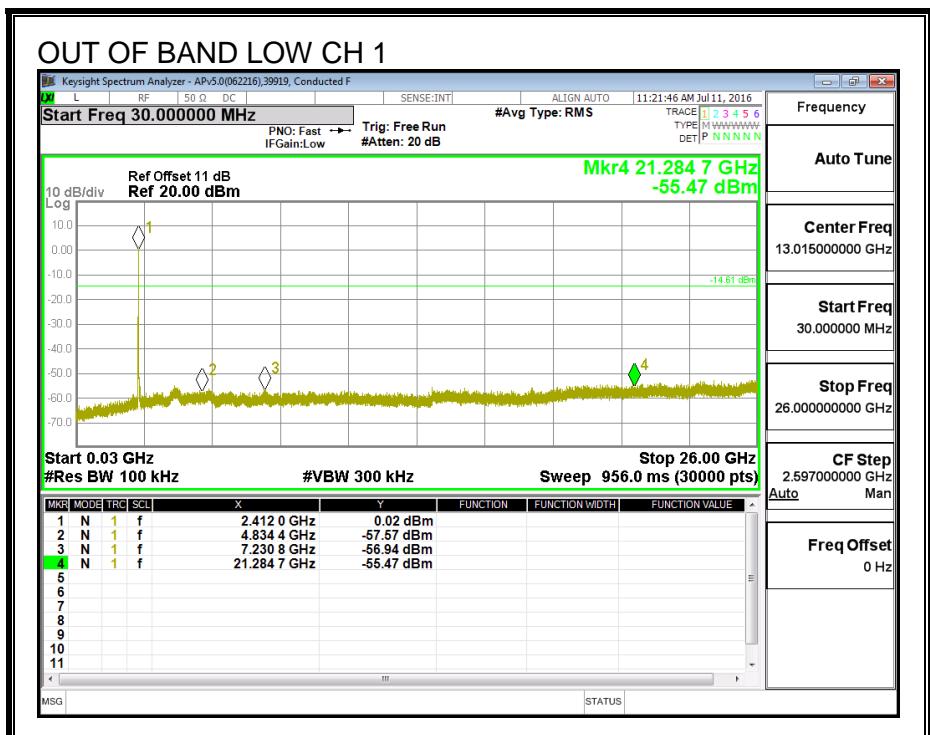
HIGH CHANNEL BANDEDGE

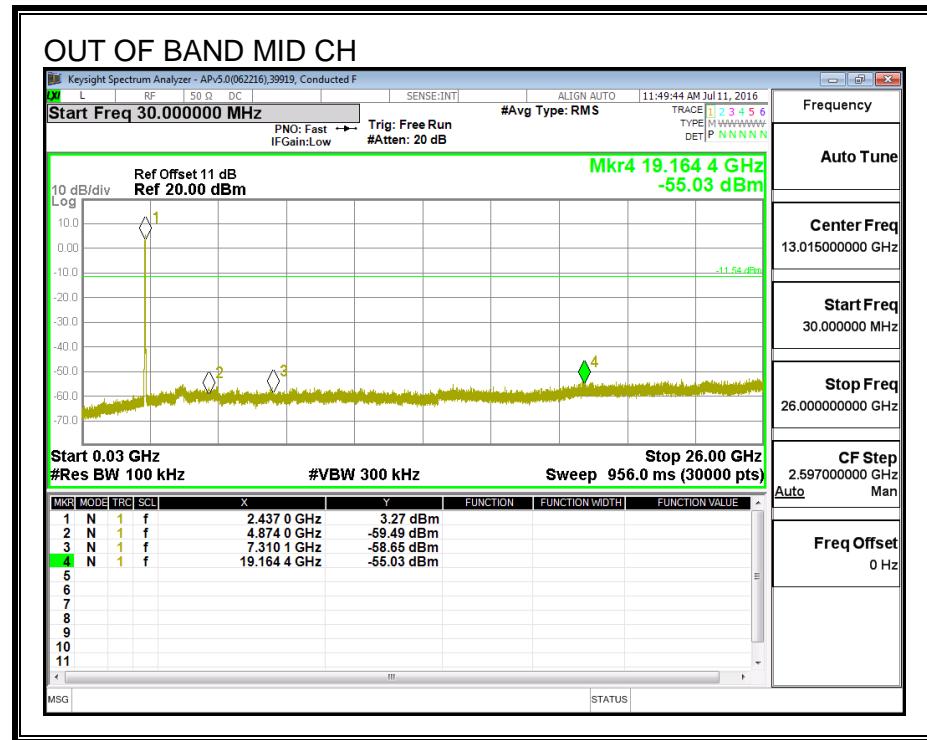
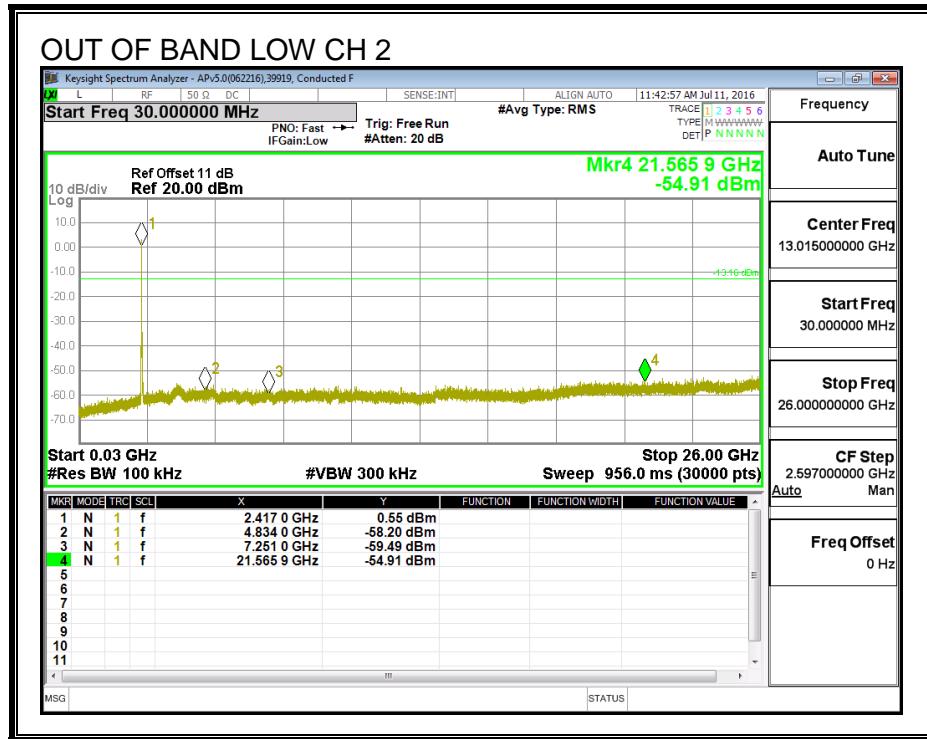


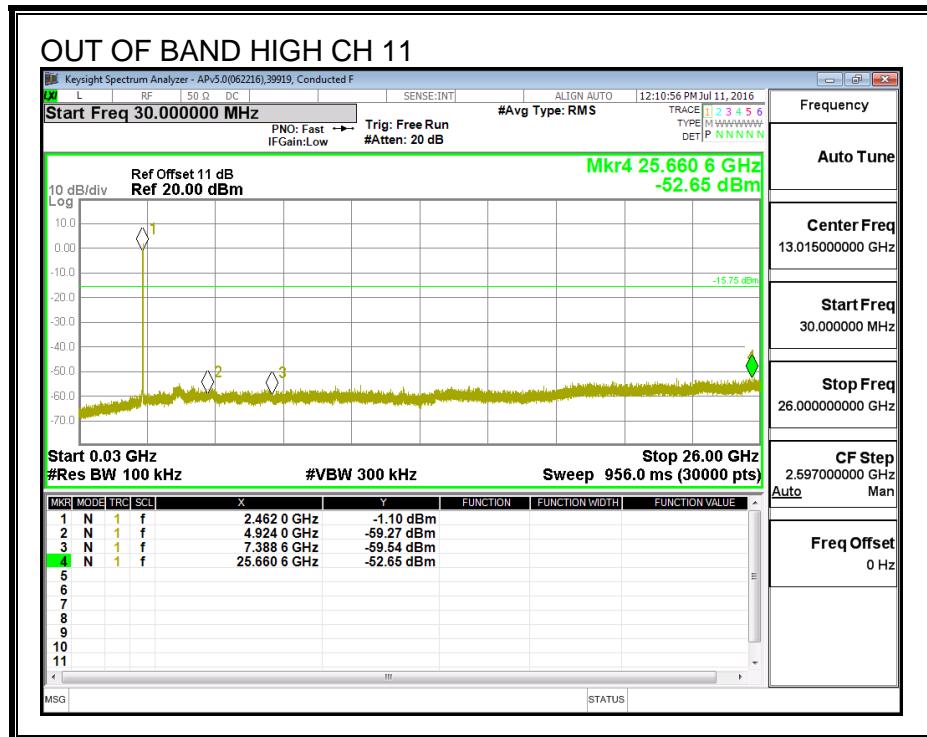
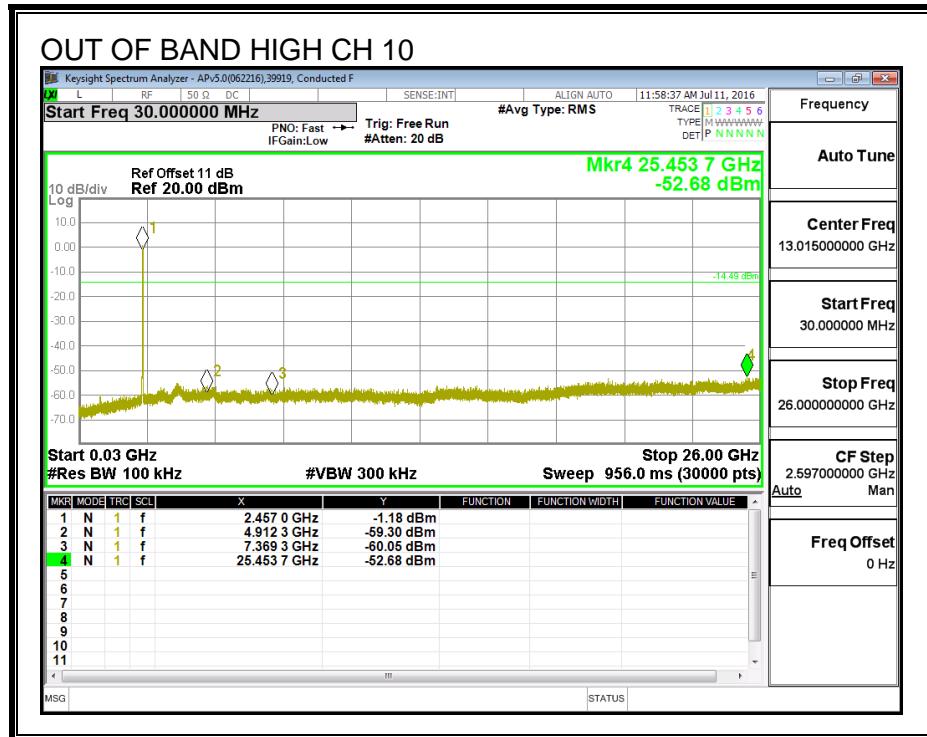


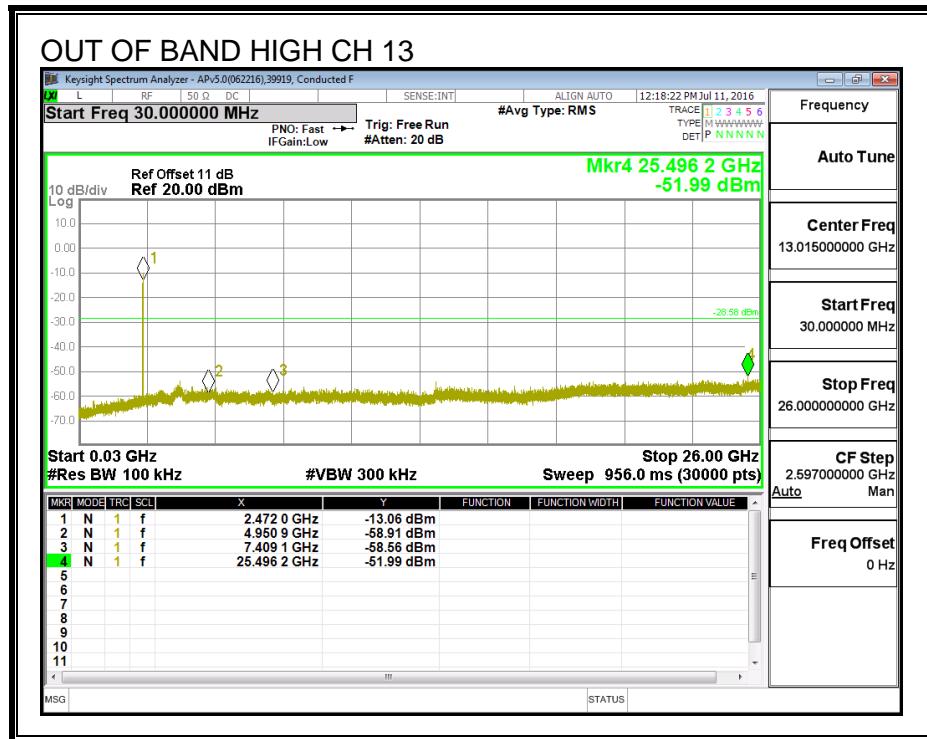
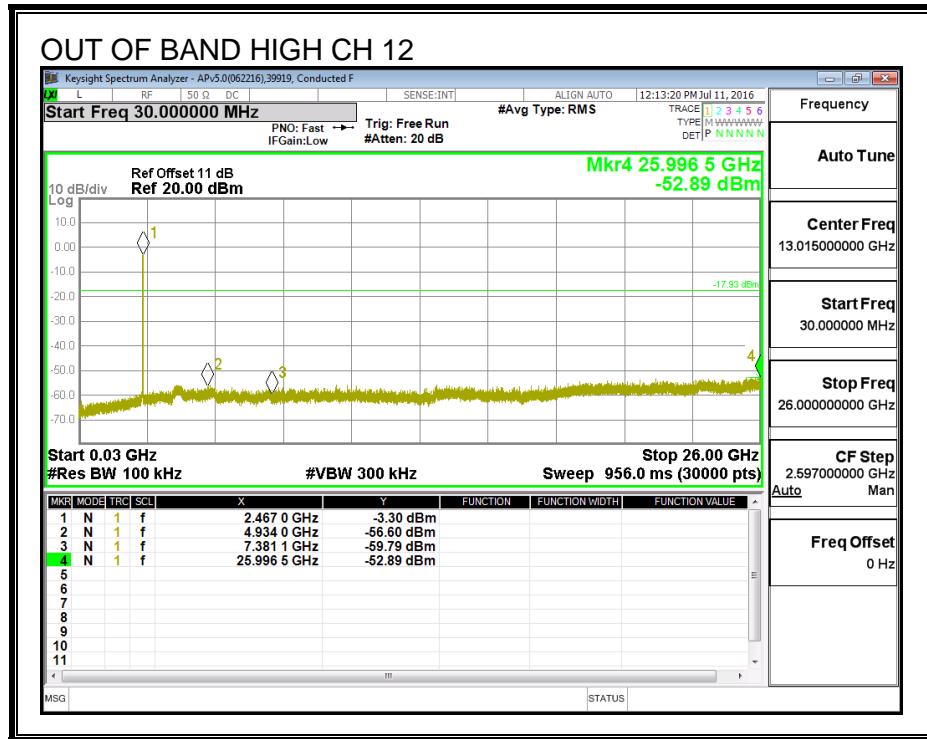


OUT-OF-BAND EMISSIONS









8.6. 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND, CHAIN 1

8.6.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

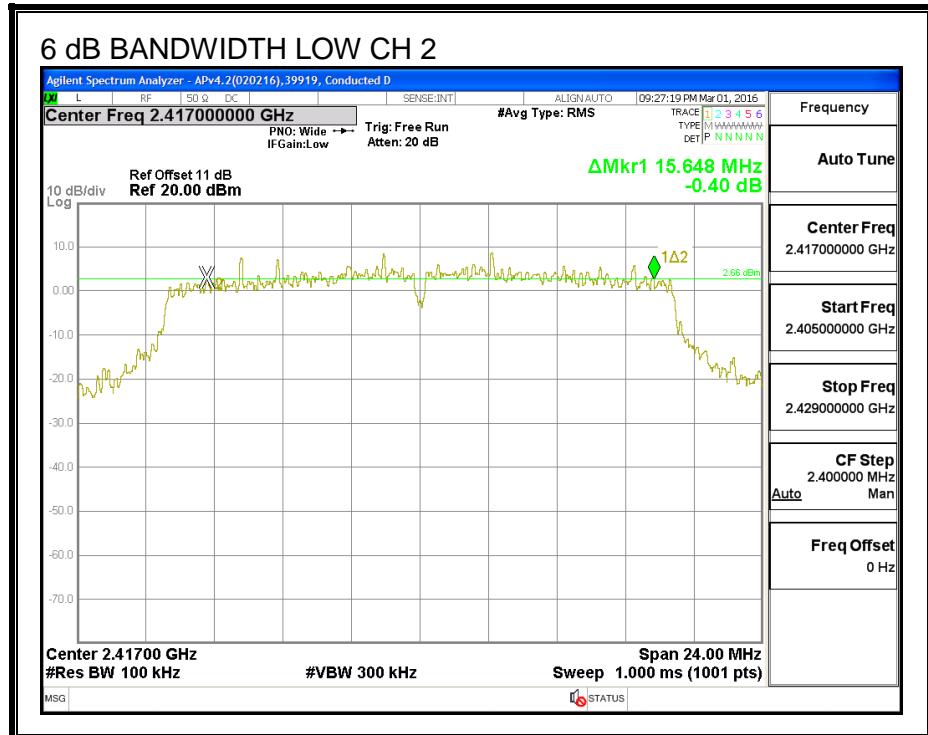
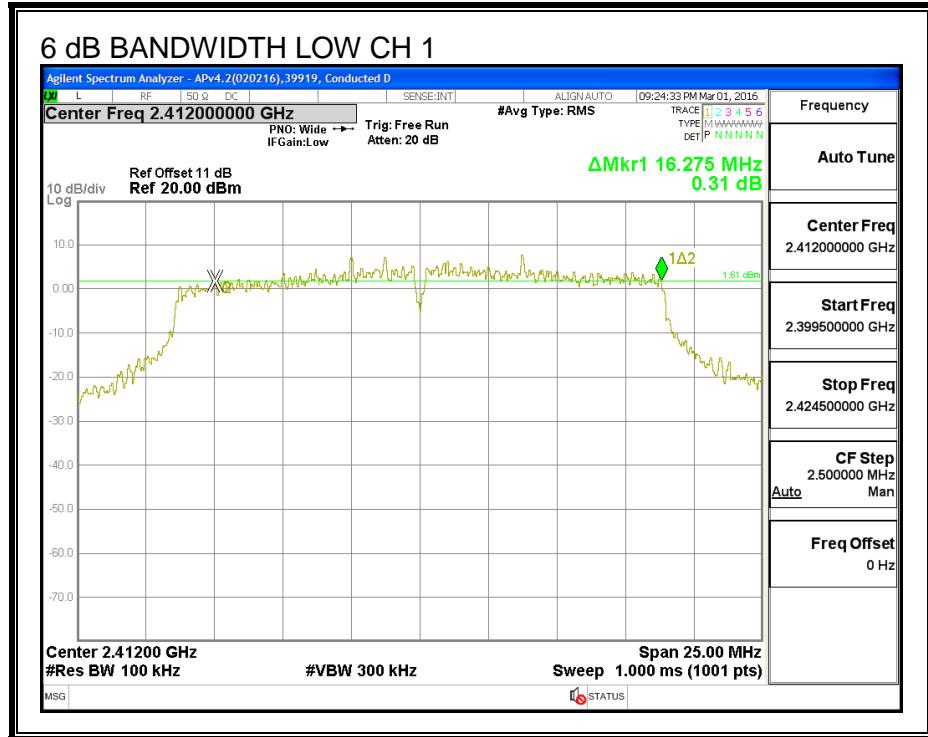
IC RSS-247 (5.2) (1)

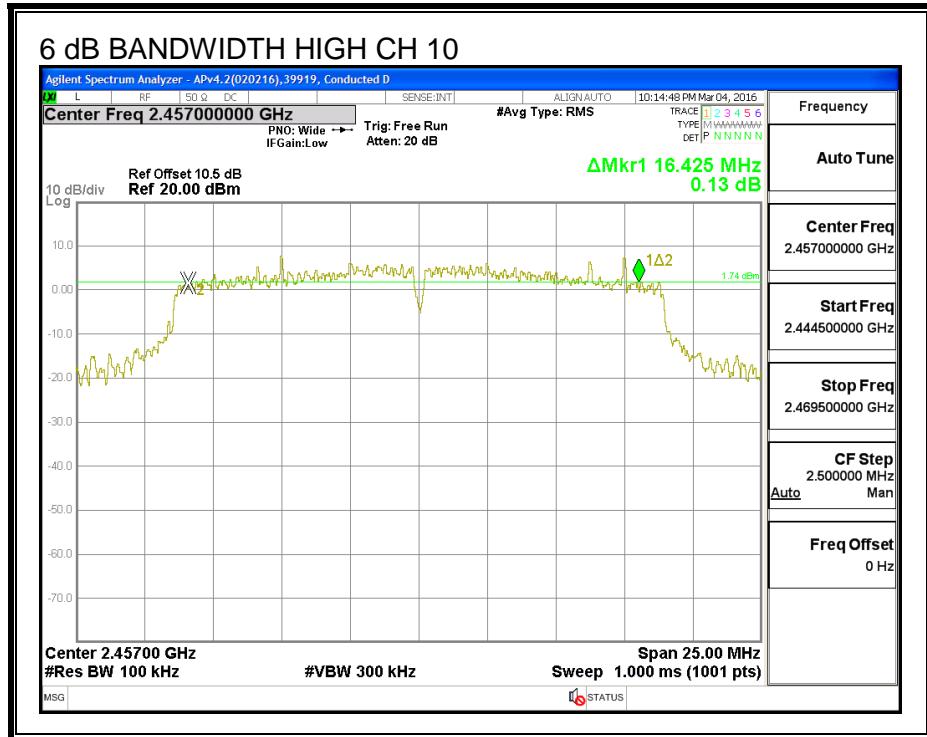
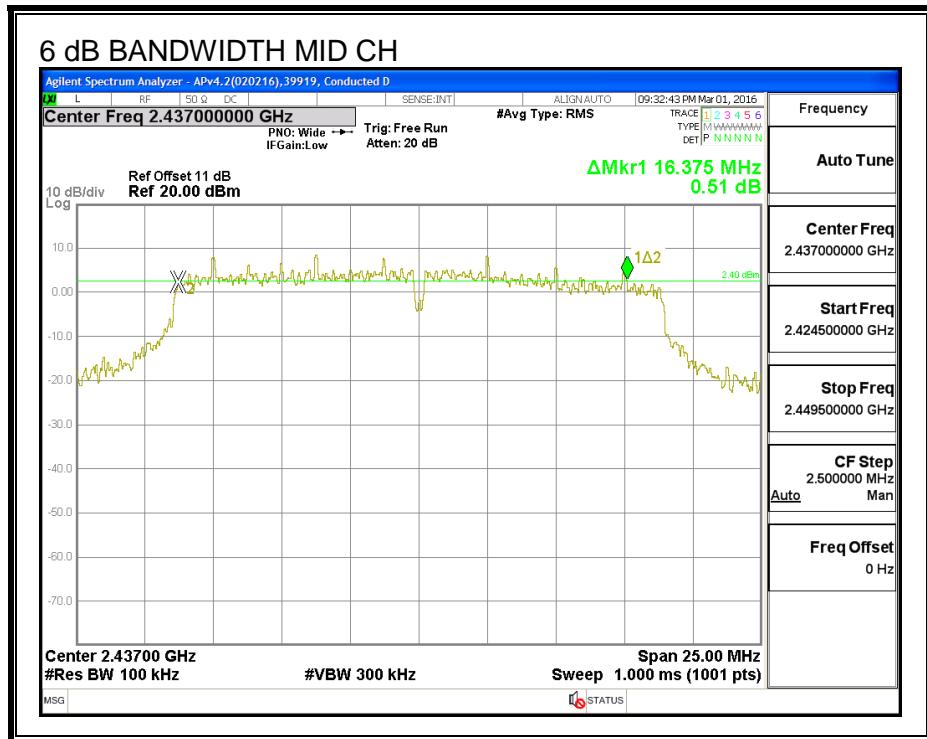
The minimum 6 dB bandwidth shall be at least 500 kHz.

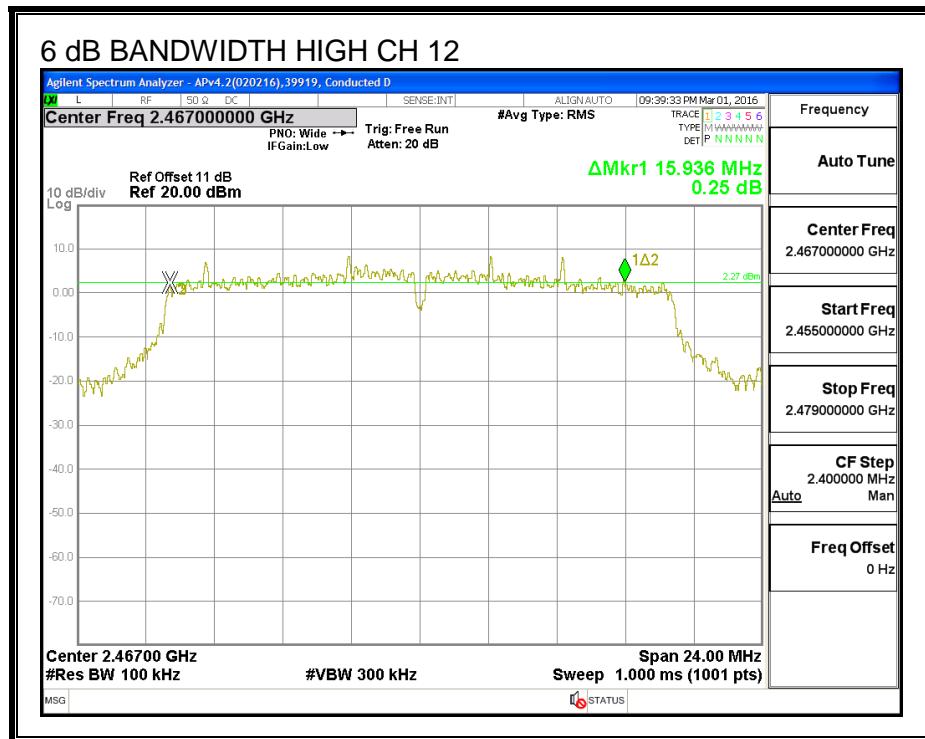
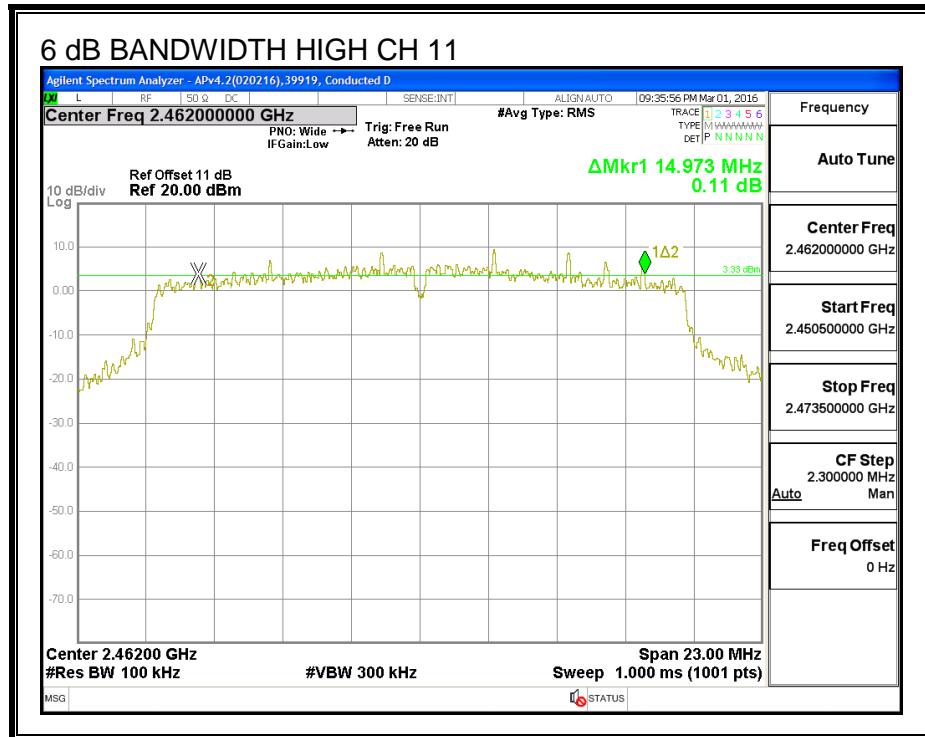
RESULTS

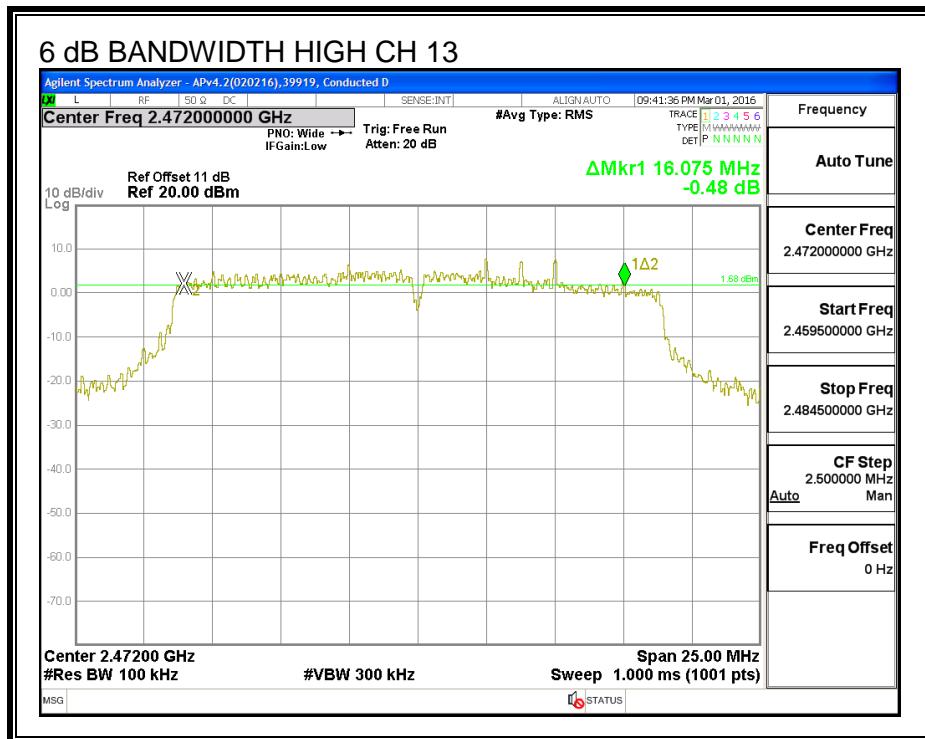
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low_1	2412	16.28	0.5
Low_2	2417	15.65	0.5
Mid_6	2437	16.38	0.5
High_10	2457	16.43	0.5
High_11	2462	14.97	0.5
High_12	2467	15.94	0.5
High_13	2472	16.08	0.5

6 dB BANDWIDTH









8.6.2. 99% BANDWIDTH

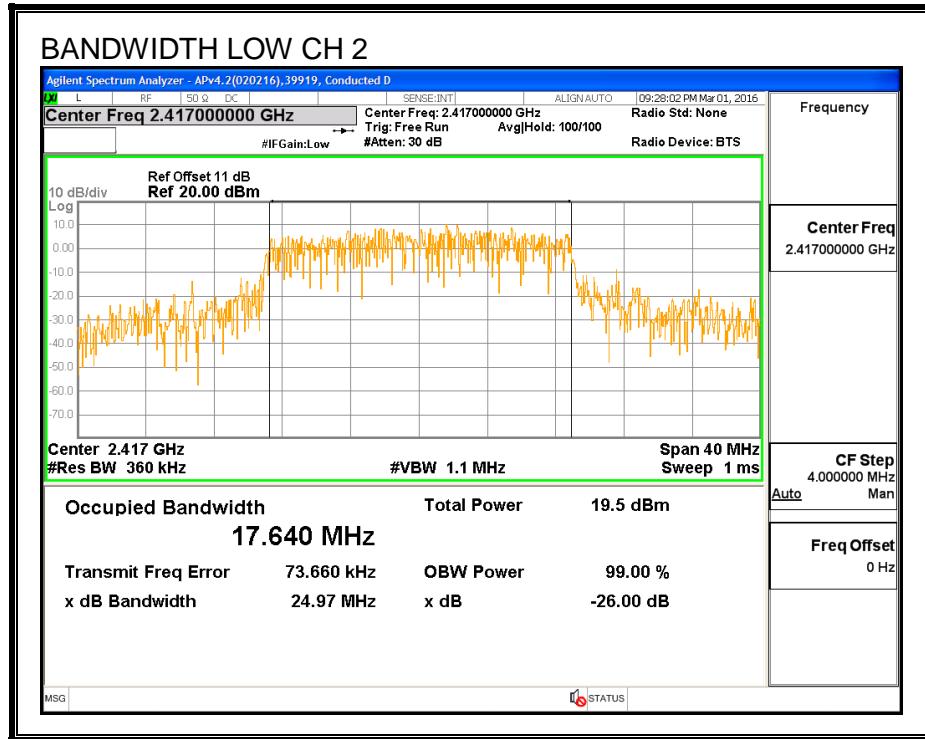
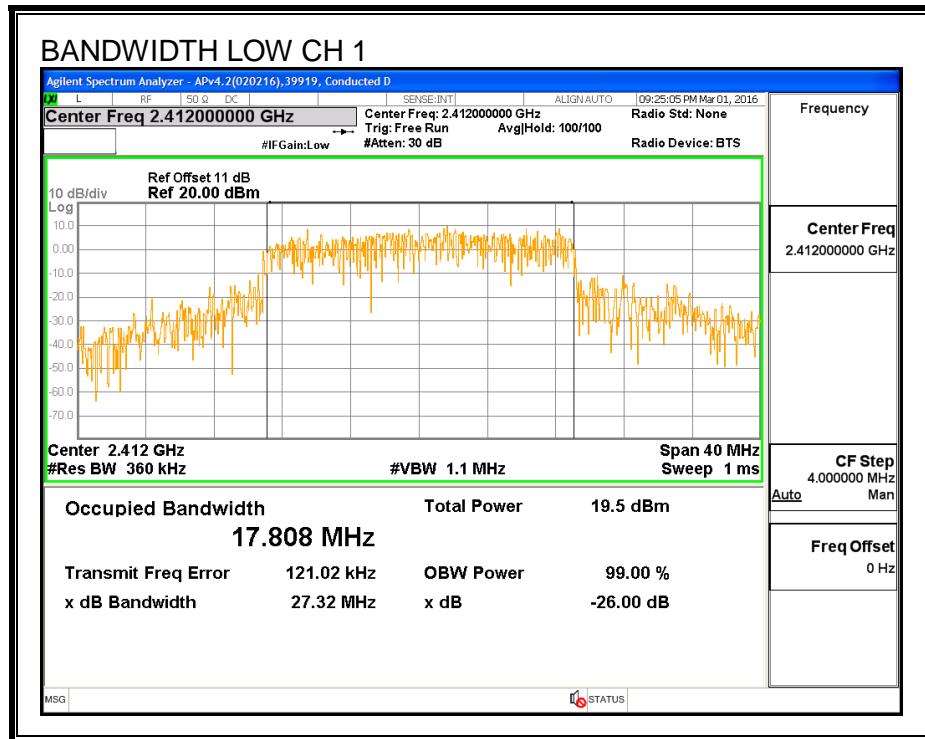
LIMITS

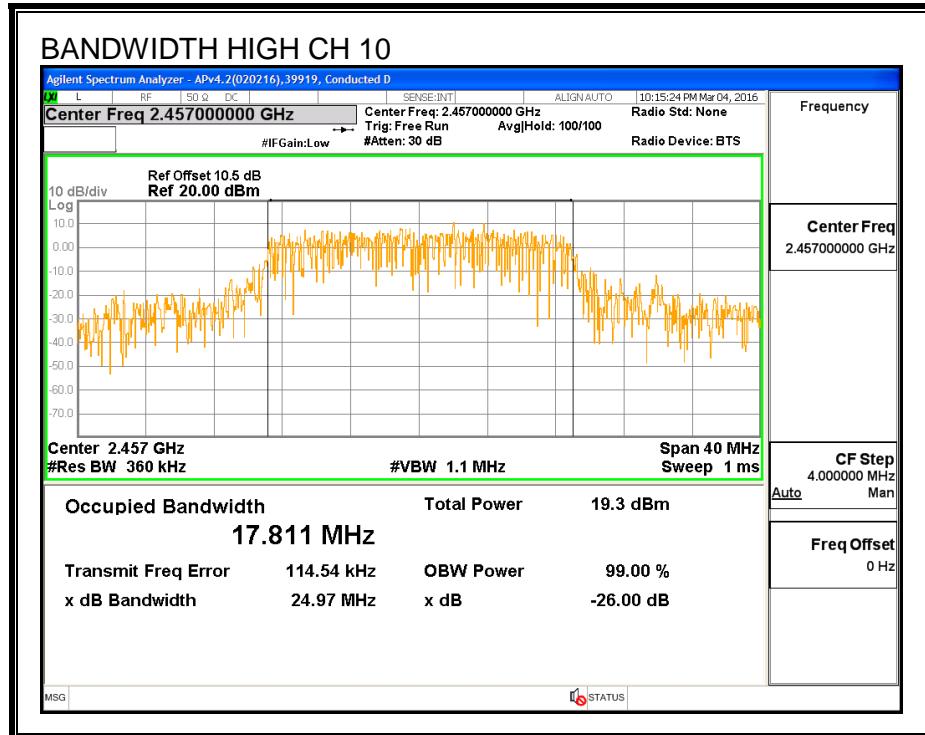
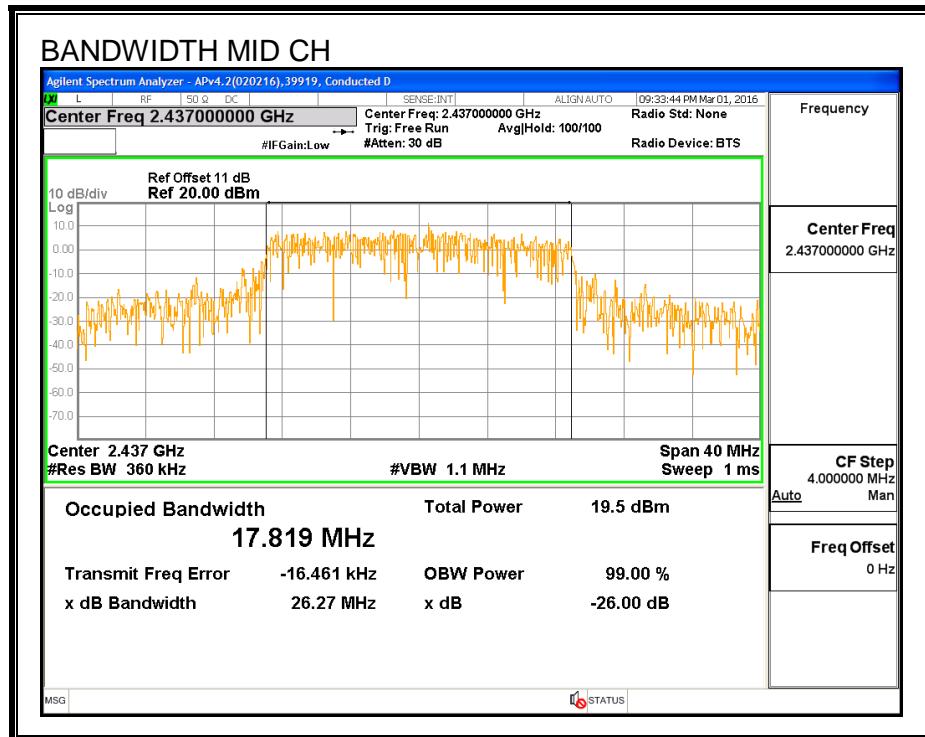
None; for reporting purposes only.

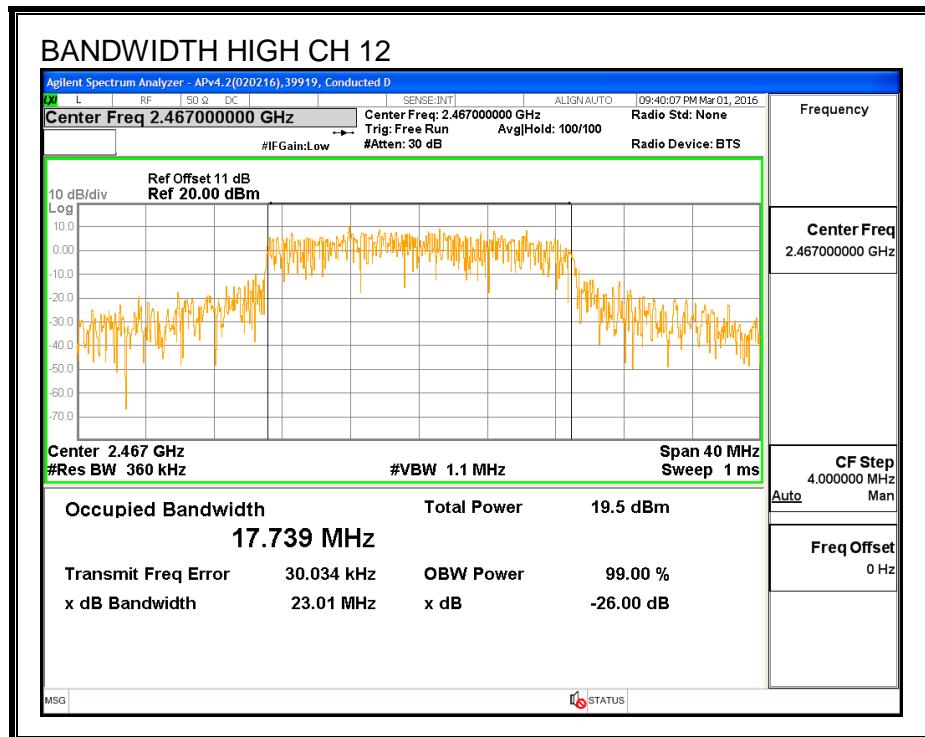
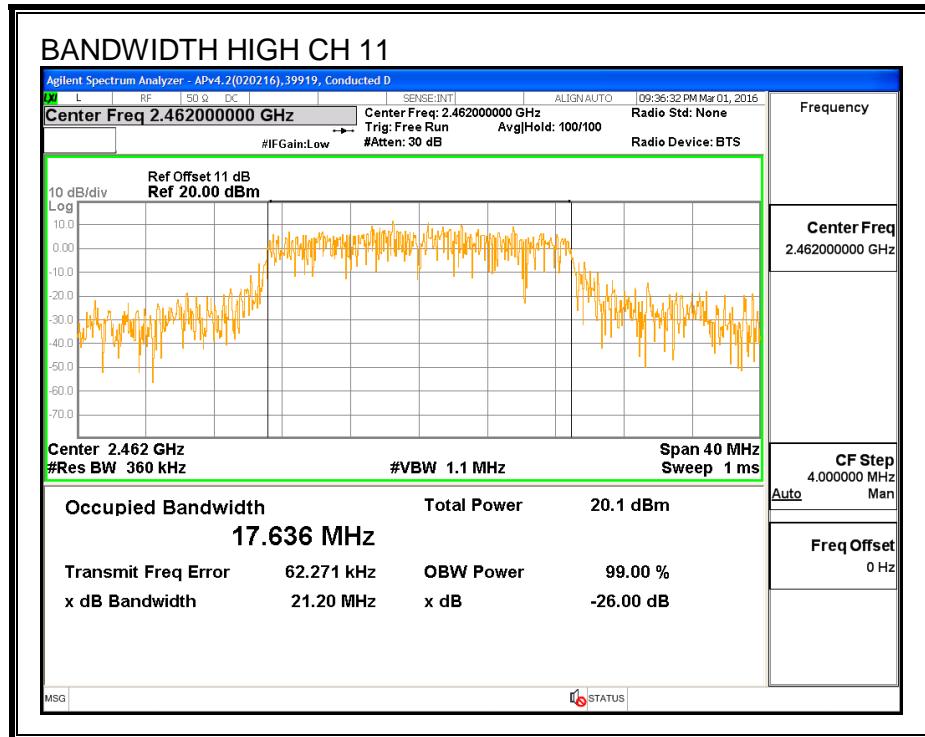
RESULTS

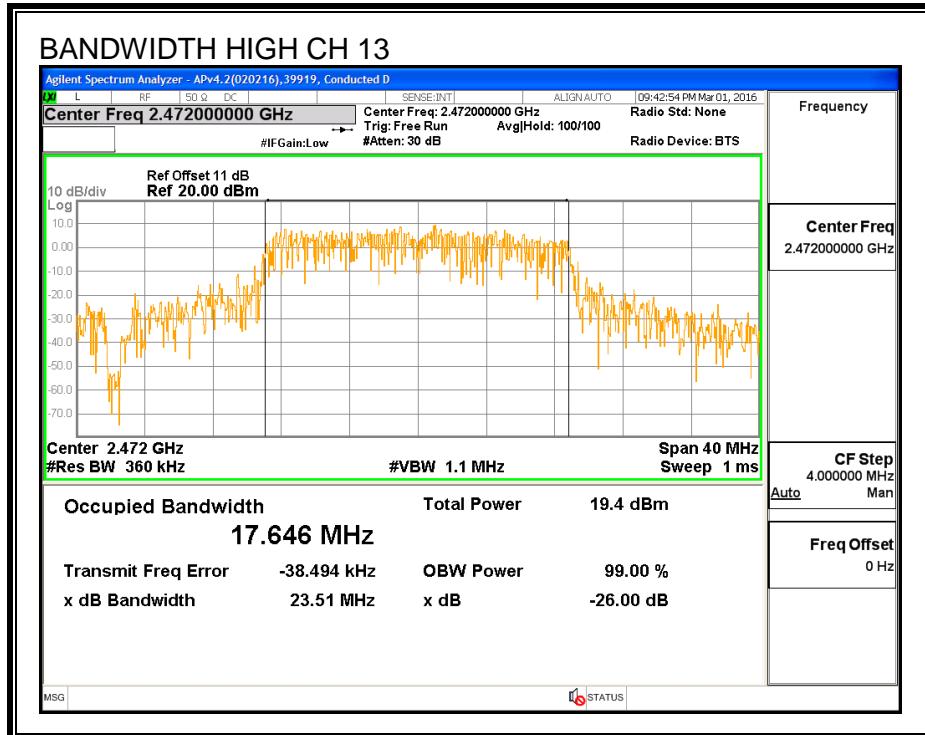
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low_1	2412	17.808
Low_2	2417	17.640
Mid_6	2437	17.819
High_10	2457	17.811
High_11	2462	17.636
High_12	2467	17.739
High_13	2472	17.646

99% BANDWIDTH









8.6.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

RESULTS

ID:	39919	Date:	7/10/16
-----	-------	-------	---------

Channel	Frequency (MHz)	Power (dBm)
Low_1	2412	14.98
Low_2	2417	17.44
Mid_6	2437	18.81
High_10	2457	15.90
High_11	2462	14.47
High_12	2467	12.37
High_13	2472	2.42