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 NUMBERS: A1633, A1688, A1691 AND A1700

FCC ID: BCG-E2946A
IC: 579C-E2946A

REPORT NUMBER: 15U20164-E4, REVISION B

ISSUE DATE: JULY 24, 2015

Prepared for
APPLE, INC.
1 INFINITE LOOP
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	07/15/2015	Initial Issue	M.Menkuria
A	07/22/2015	Addressed TCB's questions	E.Yu
B	07/24/2015	Addressed TCB's questions	E.Yu

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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

MODELS: A1633, A1688, A1691 AND A1700

SERIAL NUMBER: A1633:
C7JPQOFXGNPF(RADIATED); C7JPQOG1GNPF(CONDUCTED)
A1688:
C7JPR061GNPN (RADIATED); C7PPO46GNPV(CONDUCTED)

DATE TESTED: APRIL 15 – JULY 13, 2015

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
PROJECT LEADER
UL VERIFICATION SERVICES INC.

Tested By:

ERIC YU
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, 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
☐ Chamber A	☒ Chamber D
☐ Chamber B	☒ Chamber E
☐ Chamber C	☒ Chamber F
	☐ Chamber G
	☒ 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:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	± 3.52 dB
Radiated Disturbance, 30 to 1000 MHz	± 4.94 dB
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a mobile phone with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/CDMA/EVDO/LTE radio, IEEE 802.11a/b/g/n/ac, NFC, Bluetooth and GPS 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	22.39	173.38
	802.11g	Covered by HT20	
	802.11n HT20 1TX	23.88	244.34
	802.11n HT20 2TX	25.90	389.05

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band (GHz)	Antenna Gain	
	Chain 0	Chain 1
2.4	1.38	-0.95

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 7.15.239.6
The test utility software used during testing was wl 7.15.239.6

5.5. WORST-CASE CONFIGURATION AND MODE

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 Y-landscape orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in Y-landscape orientation.

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

802.11b mode: 1 Mbps
802.11g mode: 6 Mbps
802.11n HT20mode: MCS0

The target power for 802.11g and 802.11n HT20 1TX are the same and use the same modulation (OFDM).

802.11ac VHT20 and VHT40 mode are different from 802.11nHT20 and HT40 only in control messages and have the same power settings.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/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.

For simultaneous transmission of multiple channels from the same antenna in the 2.4 GHz and Cellular bands, tests were conducted for various configurations having the highest power, least separation in frequencies and widest operation bandwidths. No noticeable new emission was found.

Based on the manufacturer's statement Model A1688, A1700 and A1691 are exactly same, except for marketing reasons.

For WLAN/BT mode, all four models use the same WLAN/BT chipset. Therefore, conducted tests on Model A1633 was considered representative of Model A1688. Radiated testing was performed on both models A1633 and A1688.

Delta Items	A1633	A1688	A1691	A1700
Band 30	Yes	No	No	No

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop AC/DC adapter	Lenovo	92P1160	11S92P1160Z1ZBGH798B12	NA
Laptop	Lenovo	7659	L3-AL664 08/03	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
3	AC	1	AC	Un-shielded	3	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

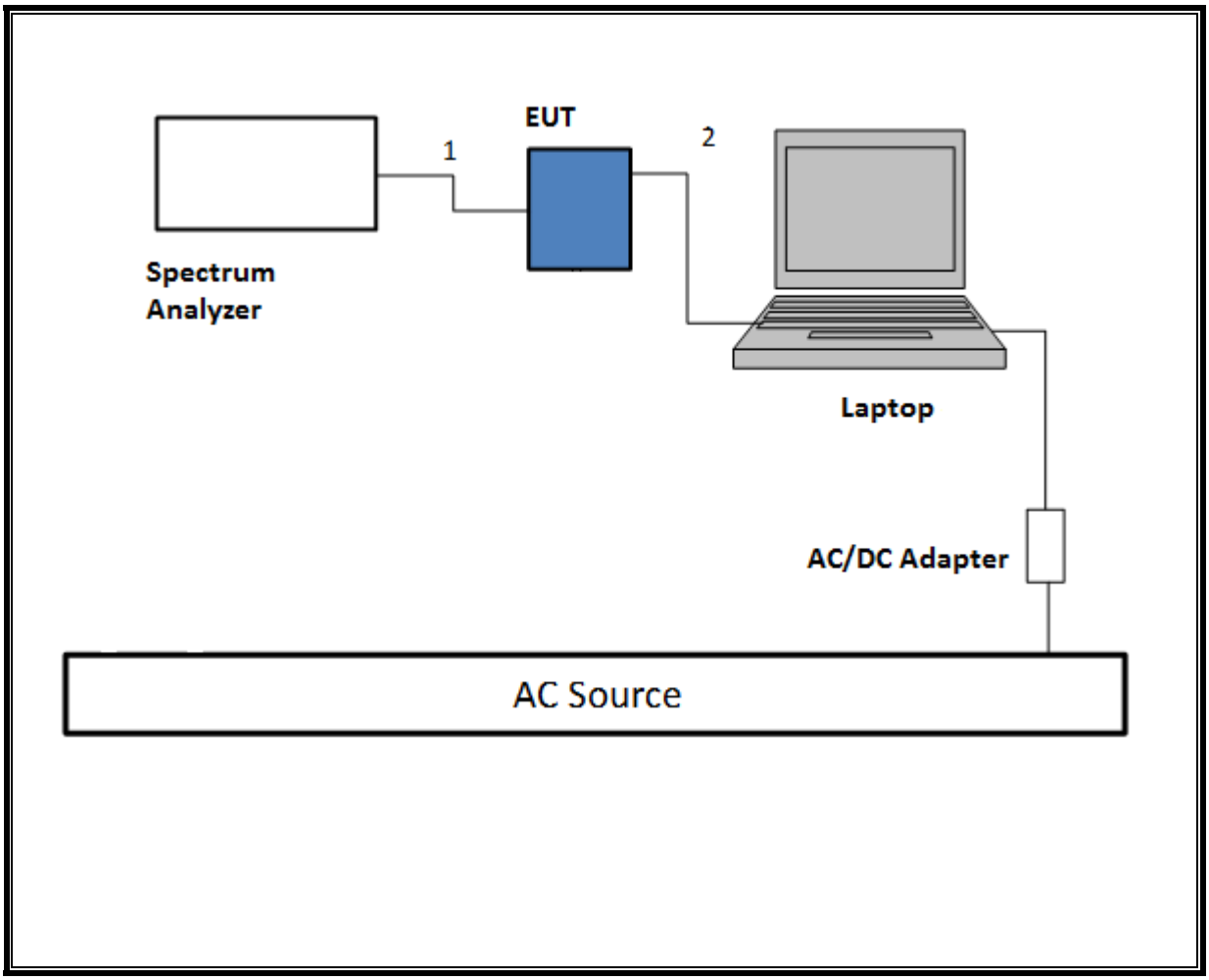
I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
None Used						

I/O CABLES (AC POWER CONDUCTED TEST AND 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

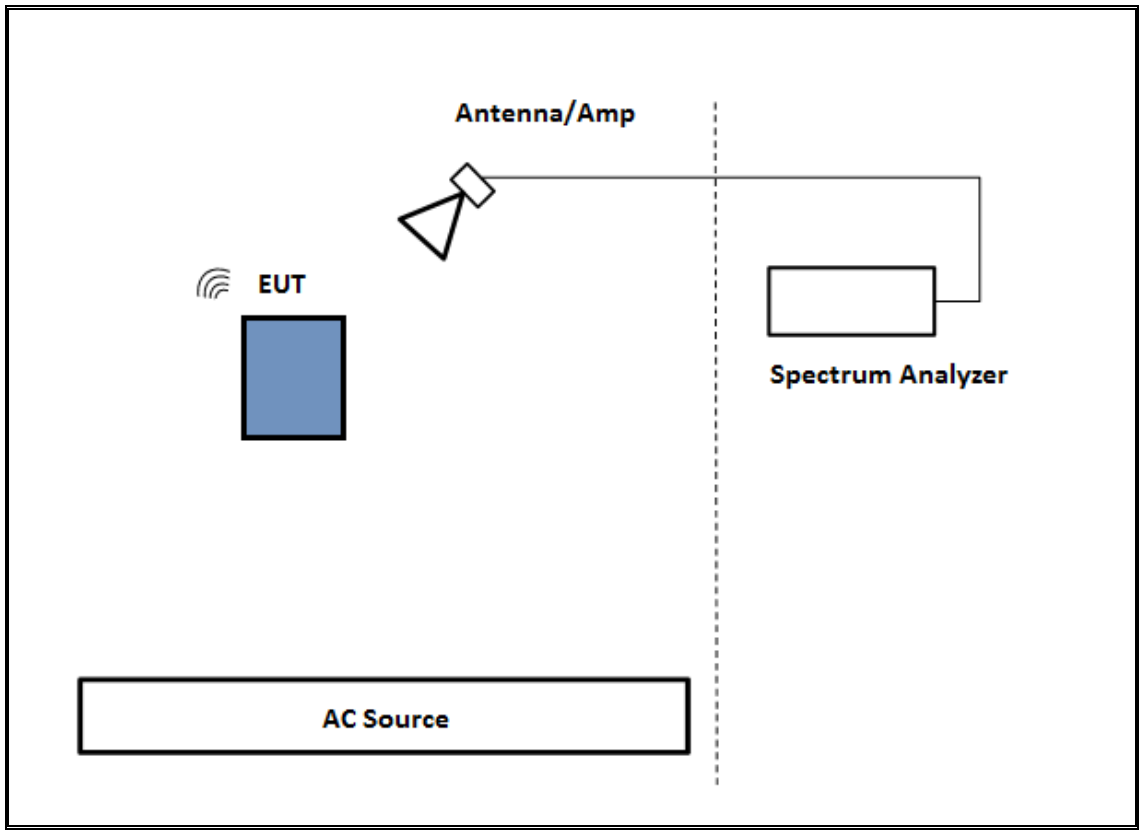
CONDUCTED TEST SETUP

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



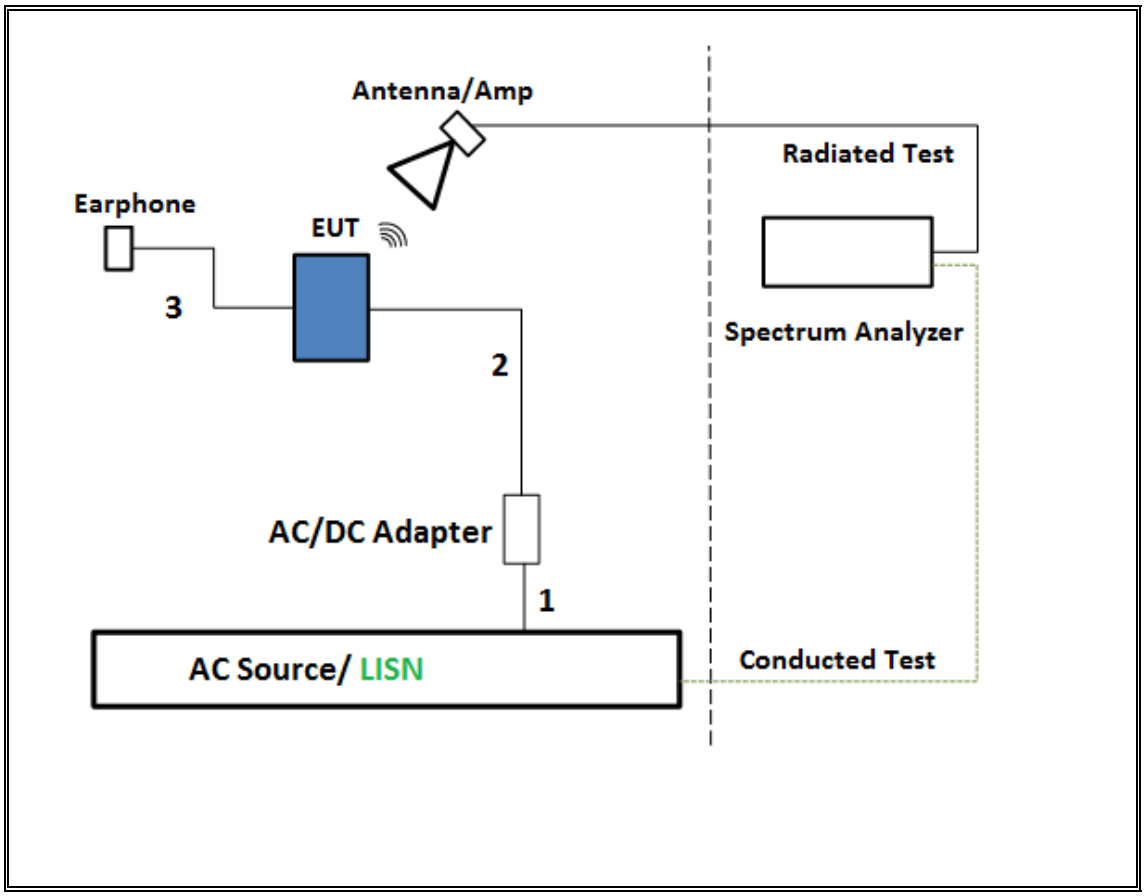
RADIATED TEST SETUP -ABOVE 1 GHZ

The EUT was tested battery powered. Test software exercised the EUT.



BELOW 1GHZ & AC LINE CONDUCTED TEST SETUP

The EUT was tested with earphone connected and powered by AC adapter. Test software exercised the EUT.



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	00143448	2/10/2016
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	A022813-1	1/14/2016
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	1782158	1/26/2016
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	171202	11/1/2015
Spectrum Analyzer, PXA, 3Hz to 50GHz	Agilent	N9030A	MY52350427	9/13/2015
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	325118	2/14/2016
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY52350675	3/16/2016
Power Meter, P-series single channel	Agilent	N1911A	GB45100212	10/9/2015
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Agilent	N1921A	MY53260010	7/12/2015
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826	1049	12/17/2015
Horn Antenna, 40GHz	ARA	MWH-2640/B	1029	7/15/2015
Spectrum Analyzer, 40 GHz	Agilent	8564E	3943A01643	8/6/2015
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Agilent	8449B	3008A01114	10/4/2015
Amplifier, 26 to 40GHz	Miteq	NSP4000-SP2	1029	9/3/2015
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	100935	9/16/2015
LISN for Conducted Emissions CISPR-16	FCC	50/250-25-2	114	1/16/2016
Power Cable, Line Conducted Emissions ANSI 63.4	U L	PG1	N/A	7/28/2015
UL SOFTWARE				
*Radiated Software	UL	UL EMC	Ver 9.5, July 22, 2014	
*Conducted Software	UL	UL EMC	Ver 2.2, March 31, 2015	
*AC Line Conducted Software	UL	UL EMC	Ver 9.5, April 3, 2015	

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

7. ANTENNA PORT TEST RESULTS (MODEL: A1633)

7.1. MEASUREMENT METHODS

6 dB BW: KDB 558074 D01 v03r03, Section 8.1.

Output Power: KDB 558074 D01 v03r03, Section 9.1.2

Power Spectral Density: KDB 558074 D01 v03r03, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v03r03, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v03r03, Section 12.1.

Band-edge: KDB 558074 D01 v03r03, Section 12.1

7.2. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

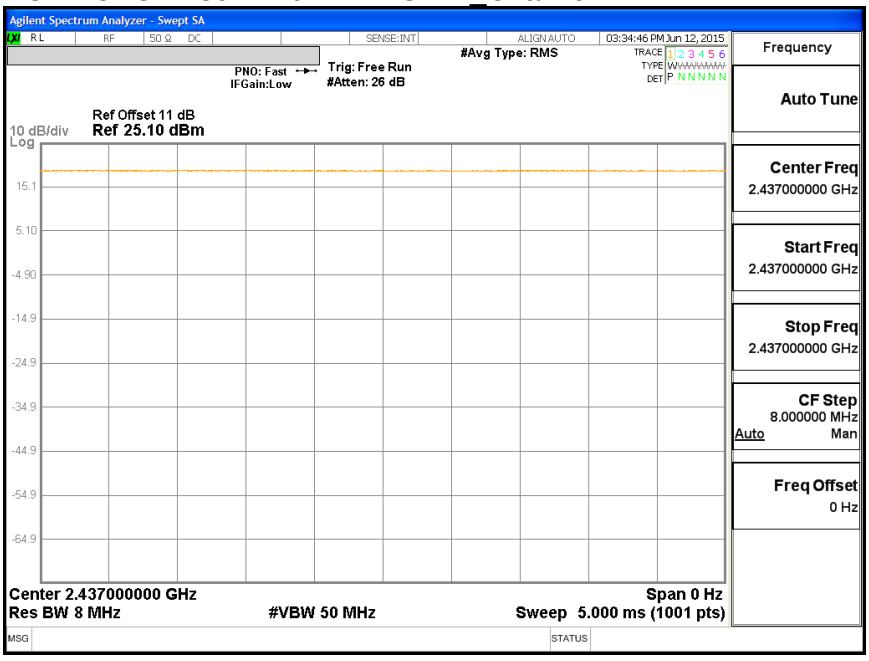
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

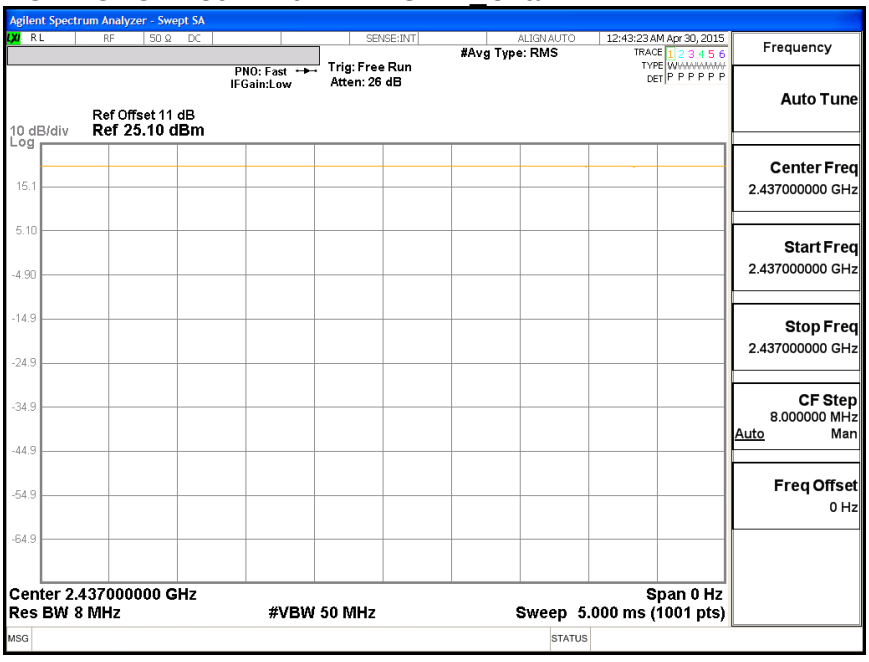
Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
802.11b 1TX_Chain 0	5.000	5.000	1.000	100.00%	0.00	0.010
802.11b 1TX_Chain 1	5.000	5.000	1.000	100.00%	0.00	0.010
802.11n HT20 1TX_Chain 0	1.920	1.941	0.989	98.92%	0.00	0.010
802.11n HT20 1TX_Chain 1	1.920	1.941	0.989	98.92%	0.00	0.010
802.11n HT20 CDD_Chain 0	1.920	1.941	0.989	98.92%	0.00	0.010
802.11n HT20 CDD_Chain 1	1.920	1.941	0.989	98.92%	0.00	0.010

DUTY CYCLE PLOTS

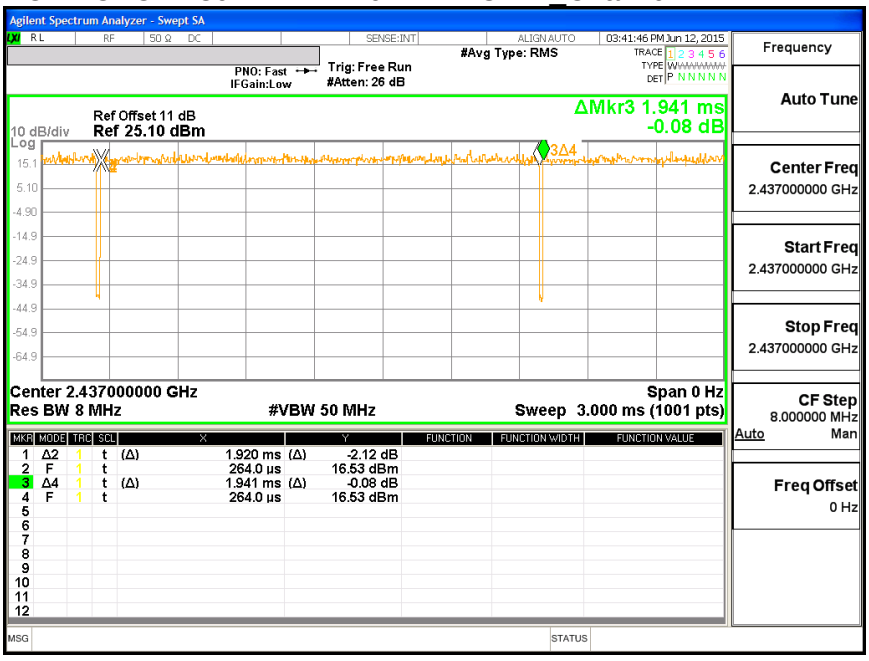
DUTY CYCLE 802.11b 1TX MODE_Chain 0



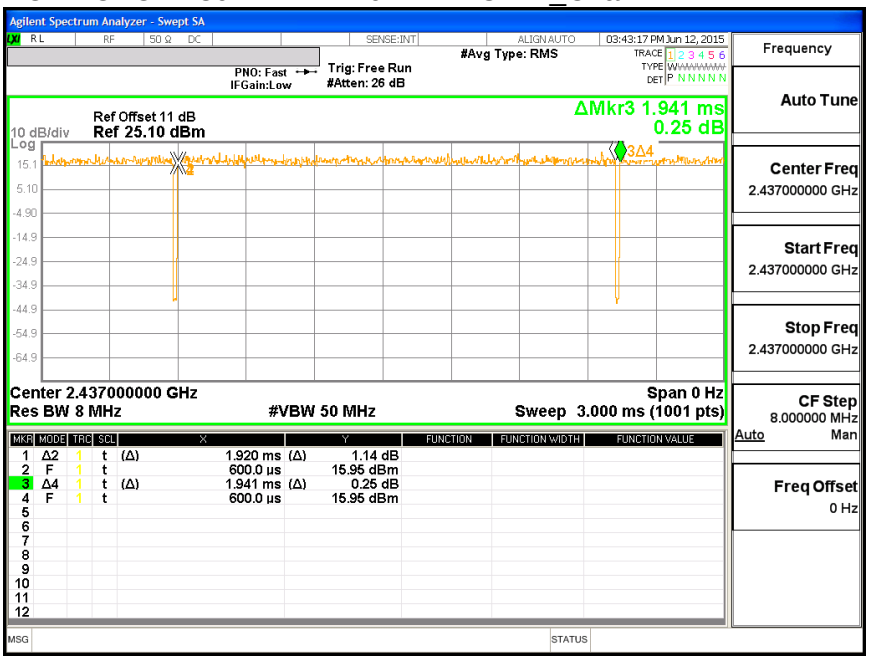
DUTY CYCLE 802.11b 1TX MODE_Chain 1



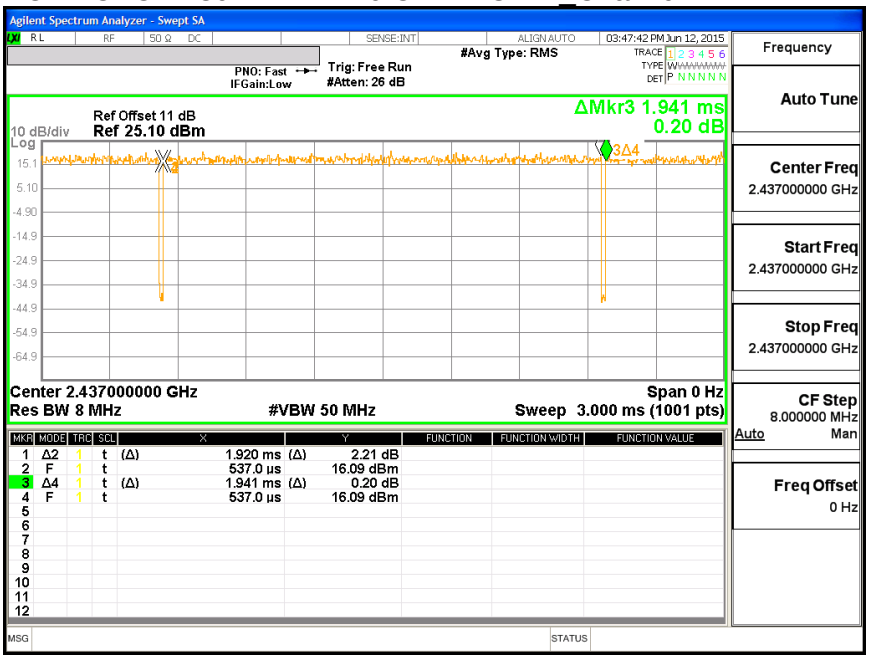
DUTY CYCLE 802.11n HT20 1TX MODE _Chain 0



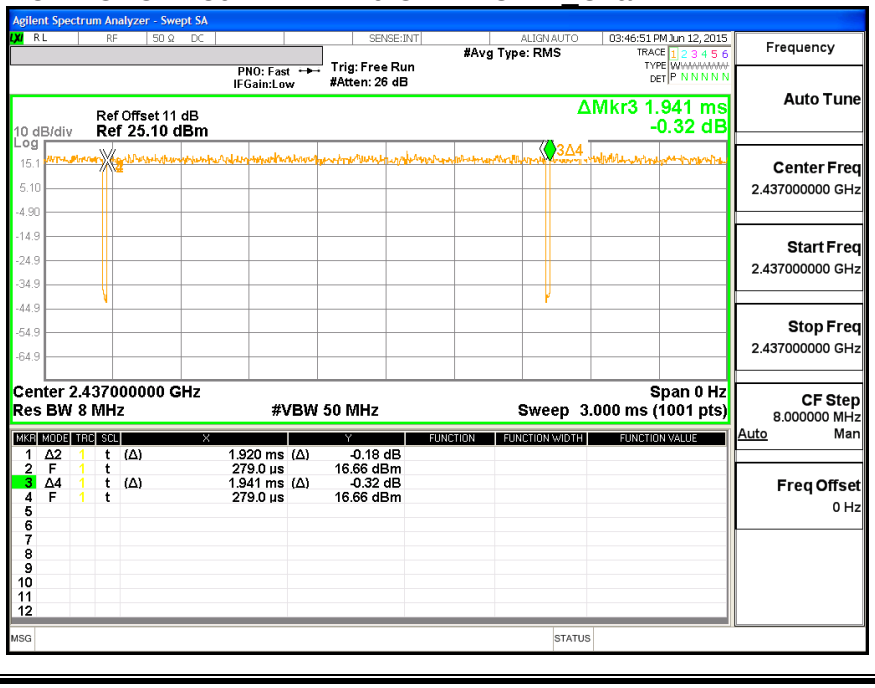
DUTY CYCLE 802.11n HT20 1TX MODE _Chain 1



DUTY CYCLE 802.11n HT20 CDD MODE _Chain 0



DUTY CYCLE 802.11n HT20 CDD MODE _Chain 1



7.3. 802.11b SISO MODE IN THE 2.4 GHz BAND

7.3.1. 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, Chain 0

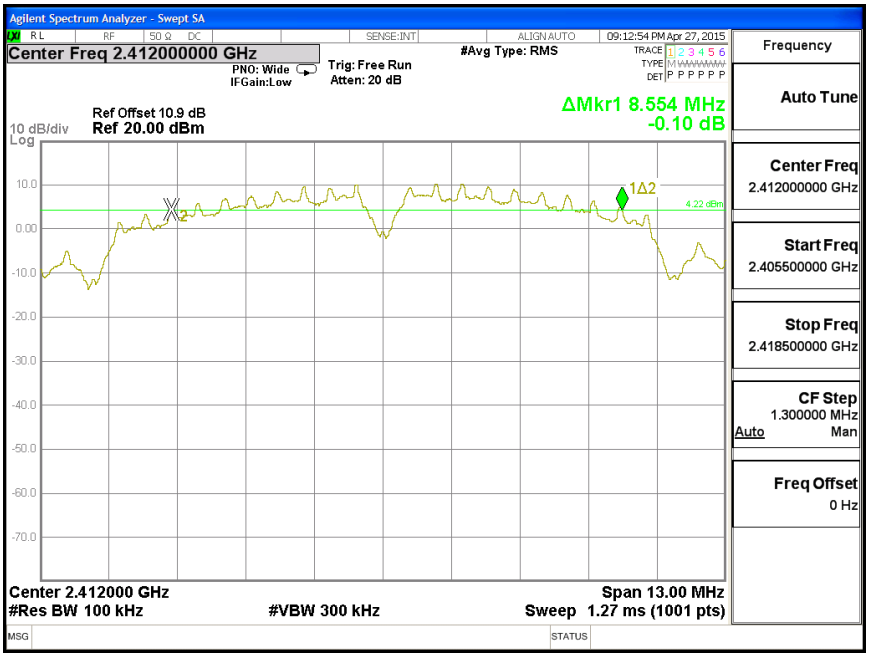
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2412	8.554	0.5
Mid	2437	9.058	0.5
High_11	2462	8.099	0.5
High_12	2467	8.567	0.5
High_13	2472	8.580	0.5

RESULTS, Chain 1

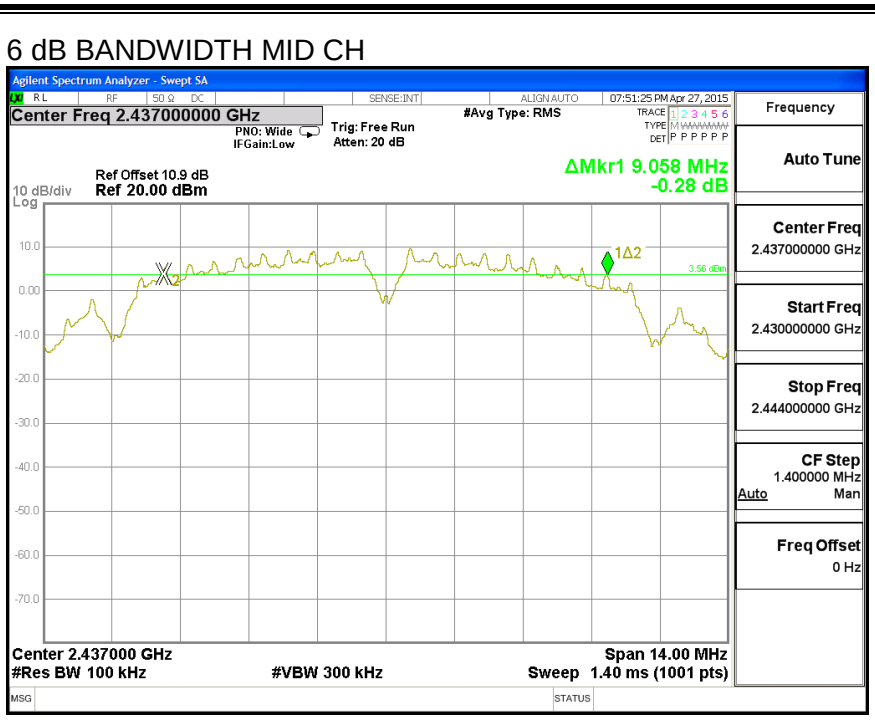
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2412	8.580	0.5
Mid	2437	9.072	0.5
High_11	2462	9.048	0.5
High_12	2467	8.596	0.5
High_13	2472	8.610	0.5

6 dB BANDWIDTH, Chain 0

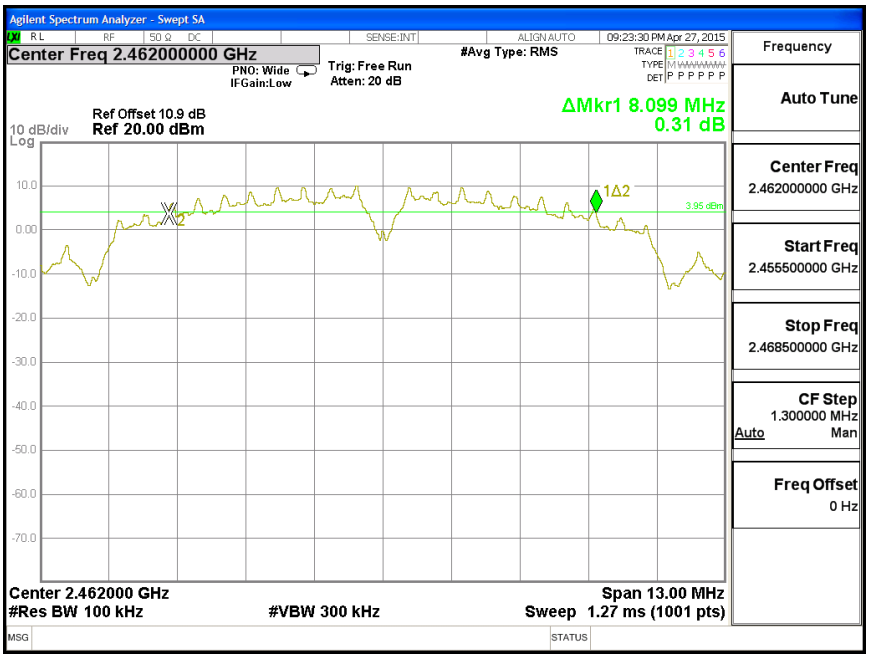
6 dB BANDWIDTH LOW CH



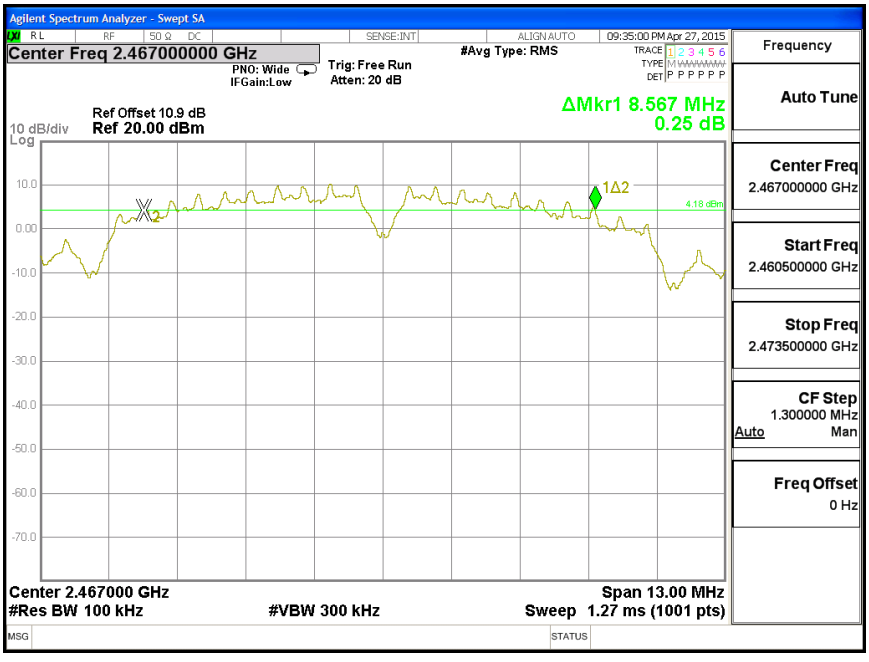
6 dB BANDWIDTH MID CH



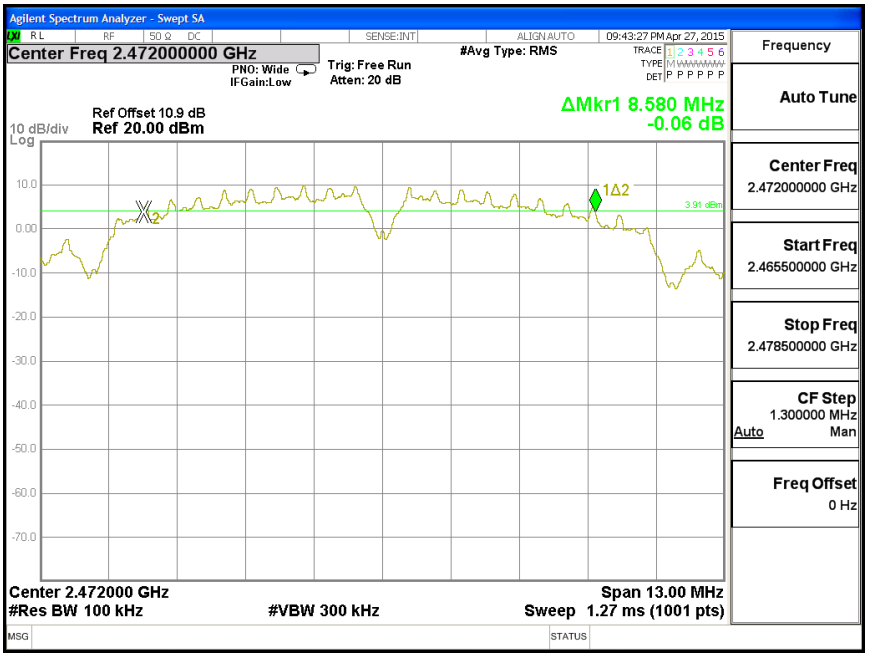
6 dB BANDWIDTH HIGH CH 11



6 dB BANDWIDTH HIGH CH 12

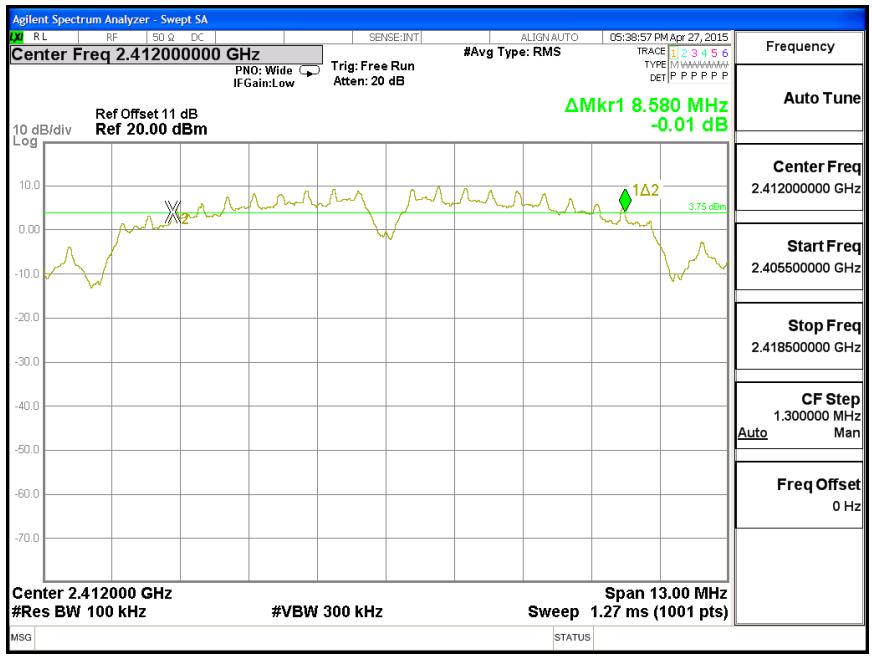


6 dB BANDWIDTH HIGH CH 13

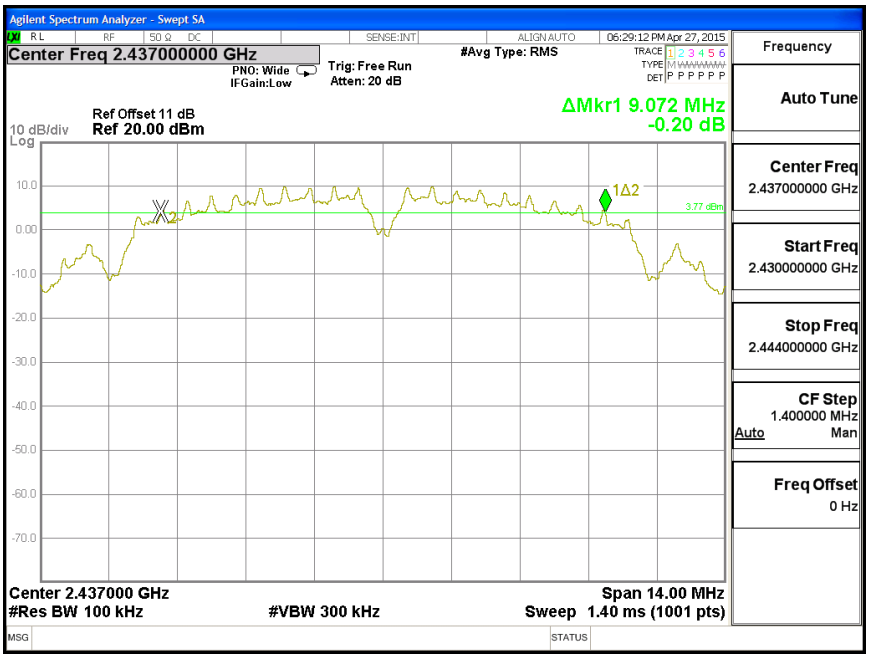


6 dB BANDWIDTH, Chain 1

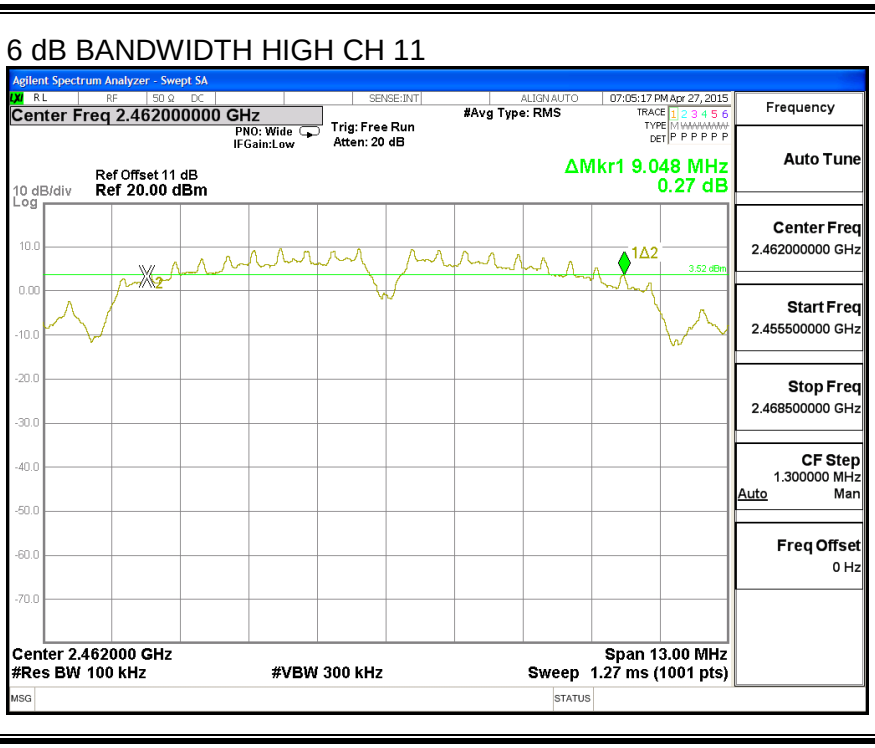
6 dB BANDWIDTH LOW CH



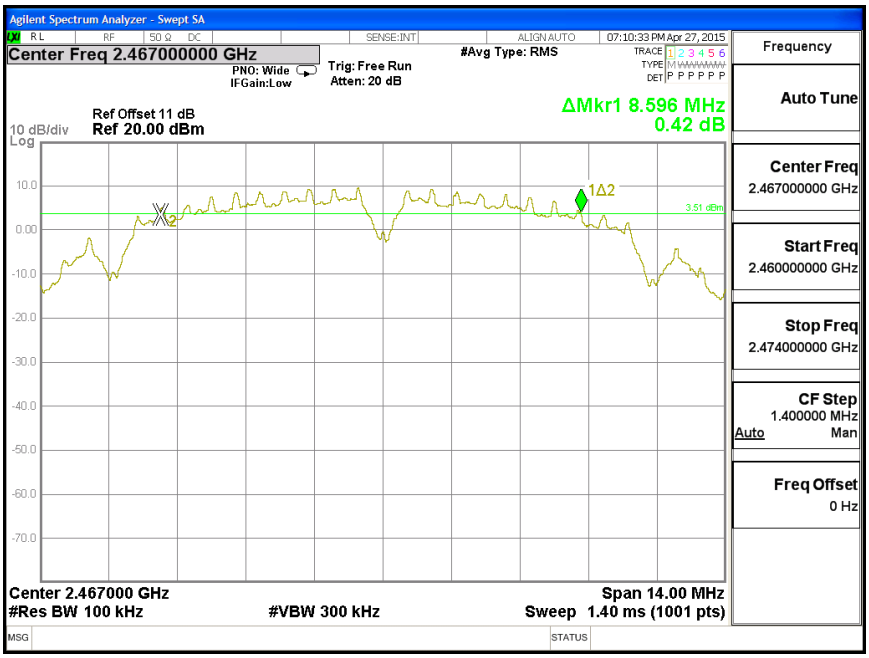
6 dB BANDWIDTH MID CH



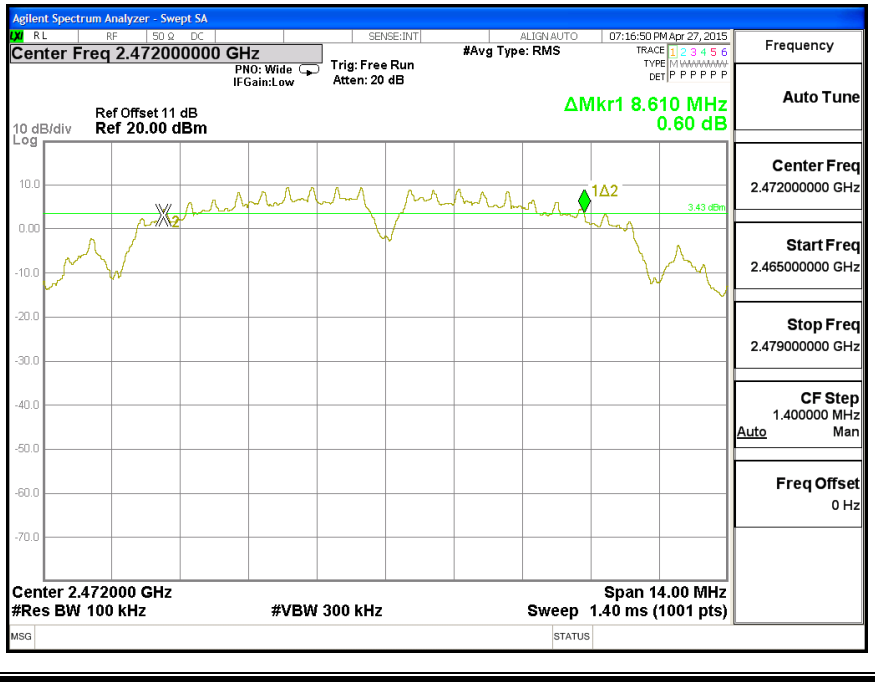
6 dB BANDWIDTH HIGH CH 11



6 dB BANDWIDTH HIGH CH 12



6 dB BANDWIDTH HIGH CH 13



7.3.2. **99% BANDWIDTH**

LIMITS

None; for reporting purposes only.

RESULTS, Chain 0

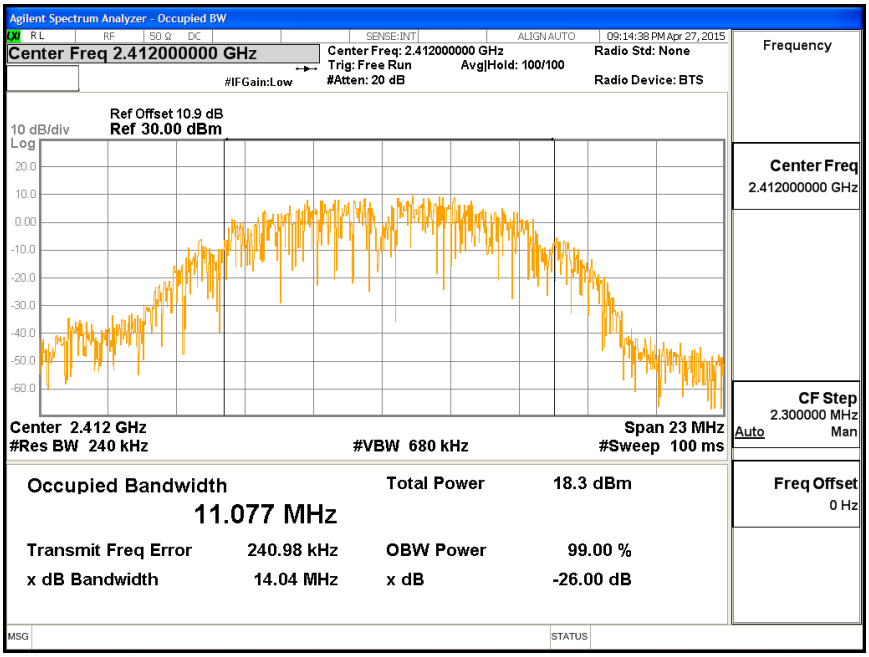
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low_1	2412	11.077
Mid	2437	11.612
High_11	2462	10.801
High_12	2467	11.342
High_13	2472	11.309

RESULTS, Chain 1

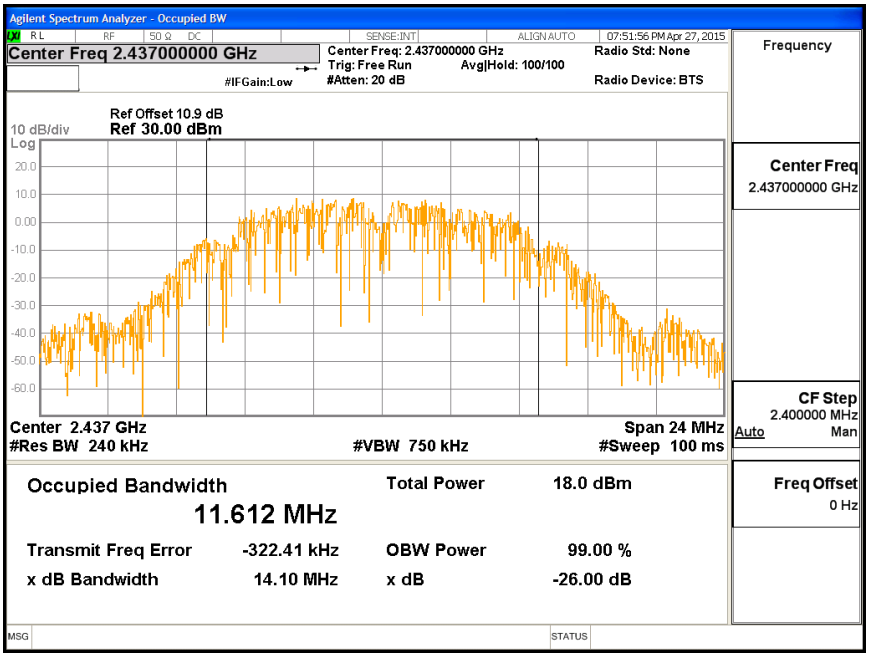
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low_1	2412	11.377
Mid	2437	11.487
High_11	2462	11.384
High_12	2467	11.602
High_13	2472	11.855

99% BANDWIDTH, Chain 0

BANDWIDTH LOW CH



BANDWIDTH MID CH



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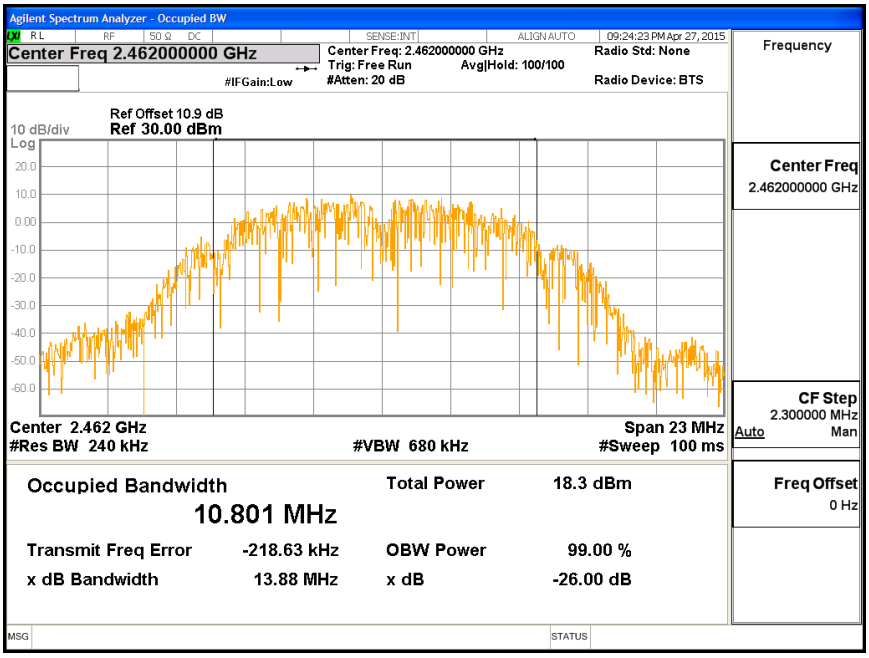

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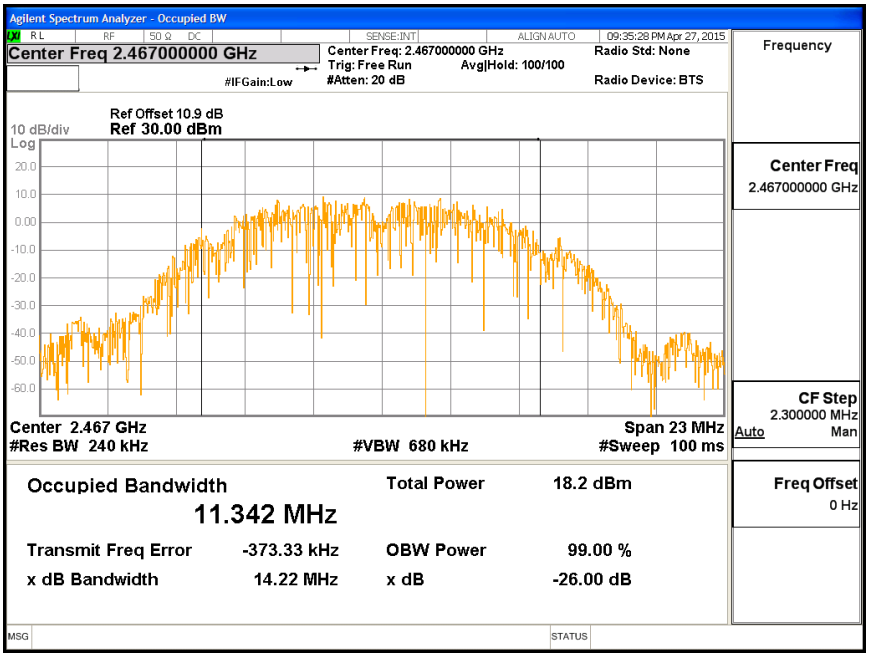
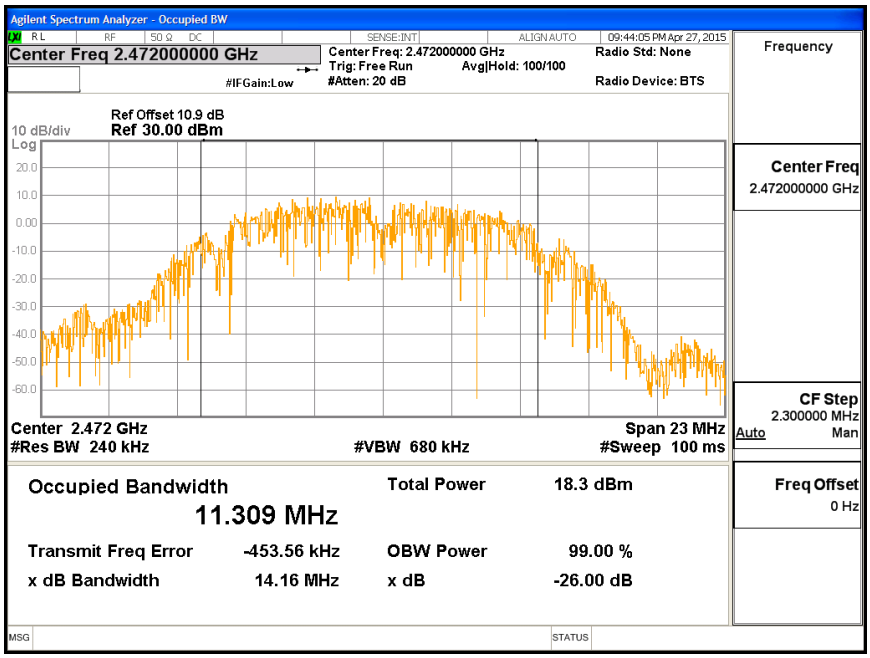
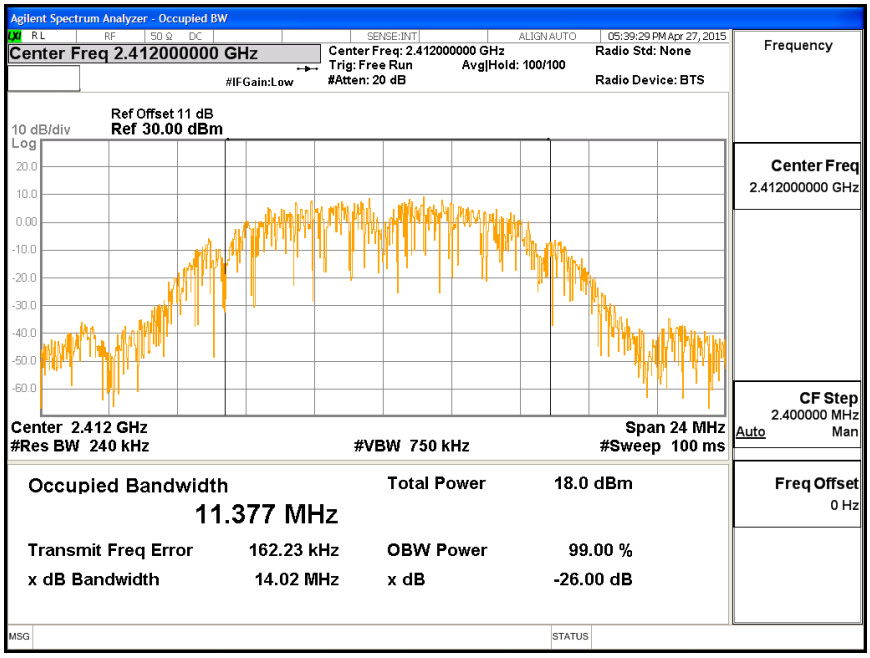


BANDWIDTH HIGH CH 13

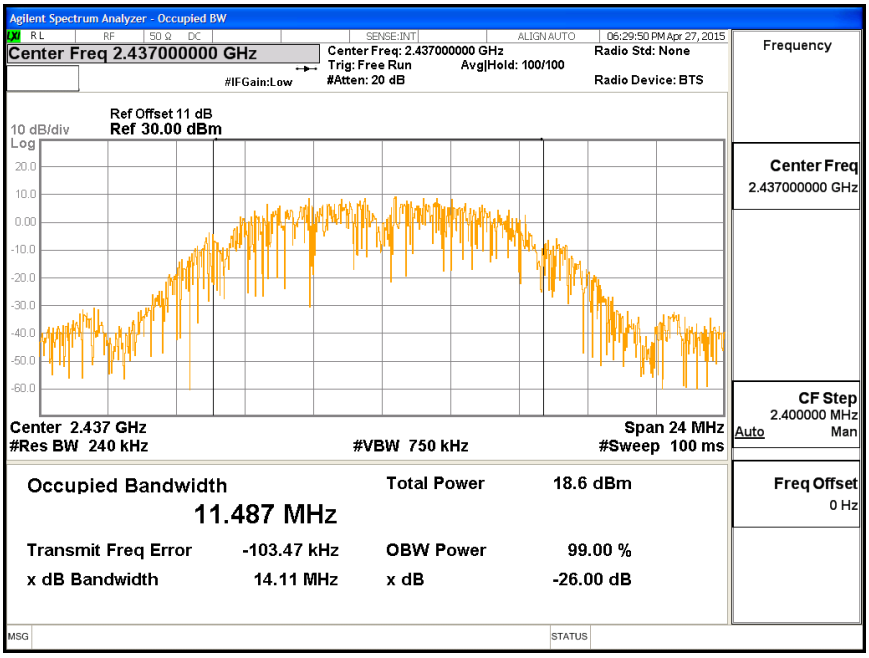


99% BANDWIDTH, Chain 1

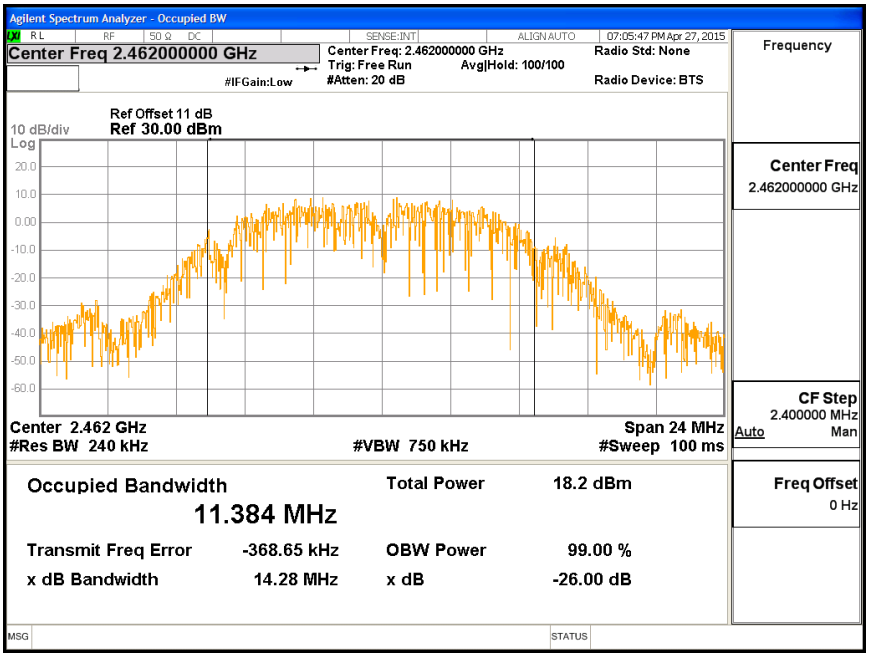
BANDWIDTH LOW CH



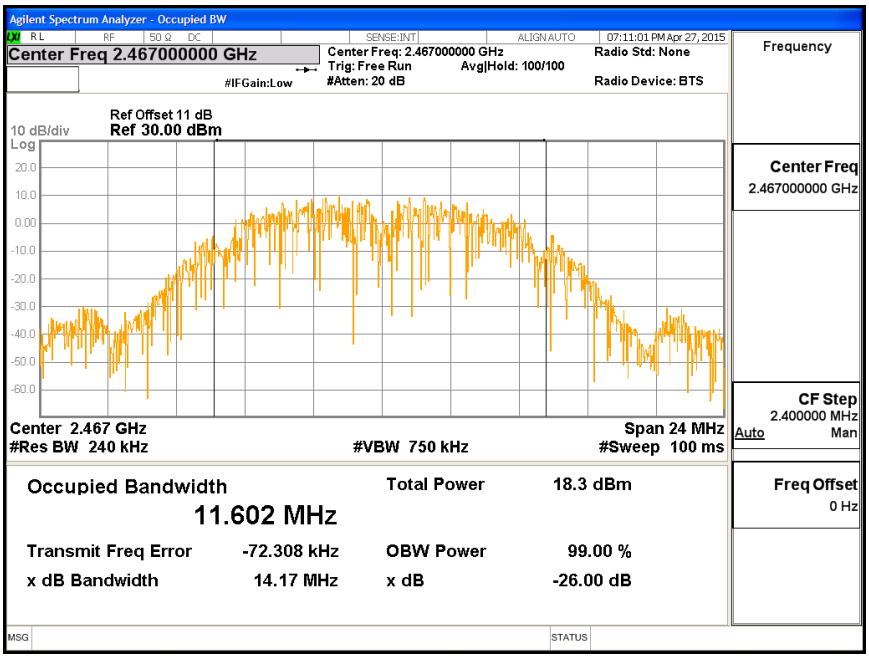
BANDWIDTH MID CH



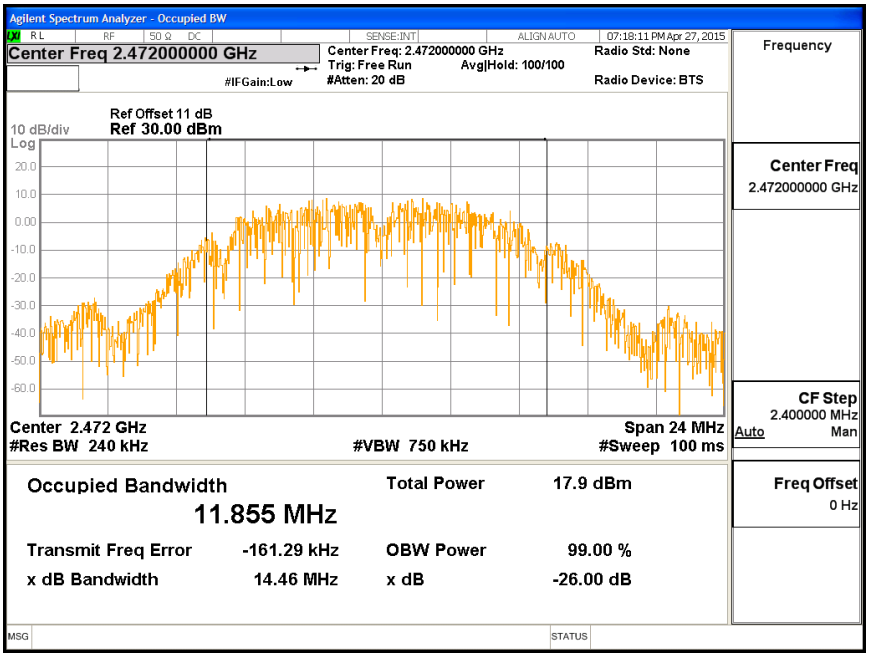
BANDWIDTH HIGH CH11



BANDWIDTH HIGH CH12



BANDWIDTH HIGH CH 13



7.3.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

RESULTS, Chain 0

Channel	Frequency (MHz)	Power (dBm)
Low	2412	18.46
Mid	2437	18.43
High_11	2462	18.38
High_12	2467	17.91
High_13	2472	14.89

RESULTS, Chain 1

Channel	Frequency (MHz)	Power (dBm)
Low_1	2412	18.36
Mid	2437	18.43
High_11	2462	18.42
High_12	2467	17.86
High_13	2472	14.93

7.3.4. 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, Chain 0

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low	2412	1.38	30.00	30	36	30.00
Mid	2437	1.38	30.00	30	36	30.00
High_11	2462	1.38	30.00	30	36	30.00
High_12	2467	1.38	30.00	30	36	30.00
High_13	2472	1.38	30.00	30	36	30.00

Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low	2412	22.15	22.15	30.00	-7.85
Mid	2437	22.39	22.39	30.00	-7.61
High_11	2462	22.23	22.23	30.00	-7.77
High_12	2467	21.05	21.05	30.00	-8.95
High_13	2472	18.72	18.72	30.00	-11.28

RESULTS, Chain 1

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low	2412	-0.95	30.00	30	36	30.00
Mid	2437	-0.95	30.00	30	36	30.00
High_11	2462	-0.95	30.00	30	36	30.00
High_12	2467	-0.95	30.00	30	36	30.00
High_13	2472	-0.95	30.00	30	36	30.00

Results

Channel	Frequency (MHz)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low	2412	22.18	22.18	30.00	-7.82
Mid	2437	22.40	22.40	30.00	-7.60
High_11	2462	21.31	21.31	30.00	-8.69
High_12	2467	20.98	20.98	30.00	-9.02
High_13	2472	18.86	18.86	30.00	-11.14

7.3.5. **POWER SPECTRAL DENSITY**

LIMITS

FCC §15.247

IC RSS-247 (5.2) (2)

For digitally modulated systems, the power spectral density conducted form 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, Chain 0

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-4.60	8.0	-12.6
Mid	2437	-4.55	8.0	-12.6
High_11	2462	-4.28	8.0	-12.3
High_12	2467	-5.11	8.0	-13.1
High_13	2472	-8.42	8.0	-16.4

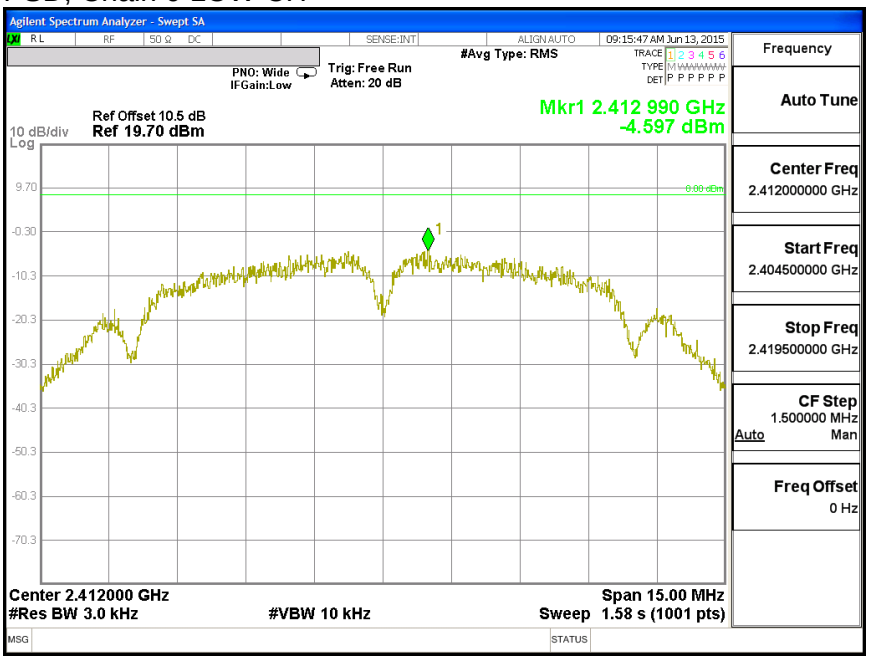
RESULTS, Chain 1

PSD Results

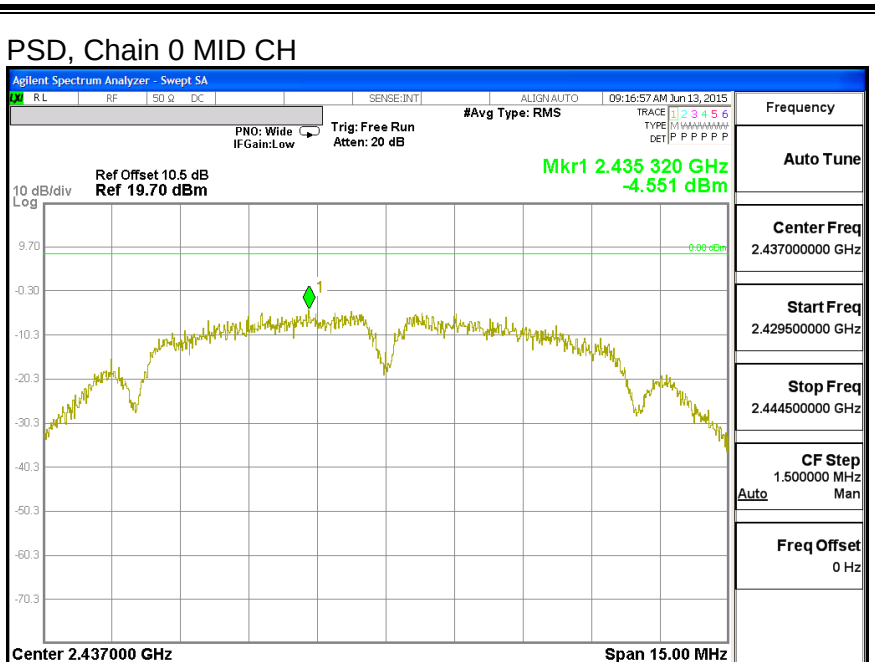
Channel	Frequency (MHz)	Chain 1 Meas (dBm)	Limit (dBm)	Margin (dB)
Low	2412	-4.38	8.0	-12.4
Mid	2437	-4.14	8.0	-12.1
High_11	2462	-4.16	8.0	-12.2
High_12	2467	-5.02	8.0	-13.0
High_13	2472	-8.22	8.0	-16.2

PSD, Chain 0

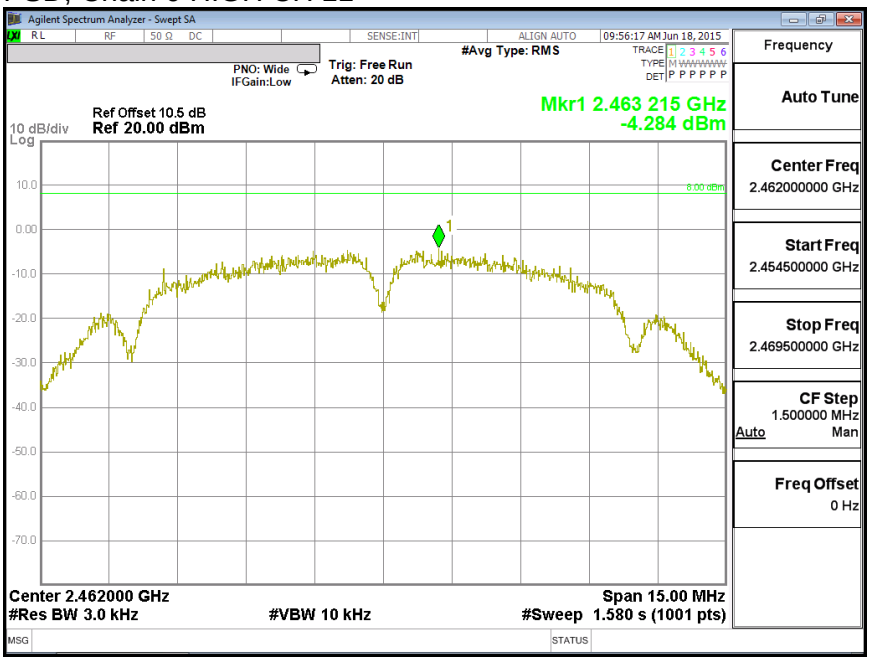
PSD, Chain 0 LOW CH



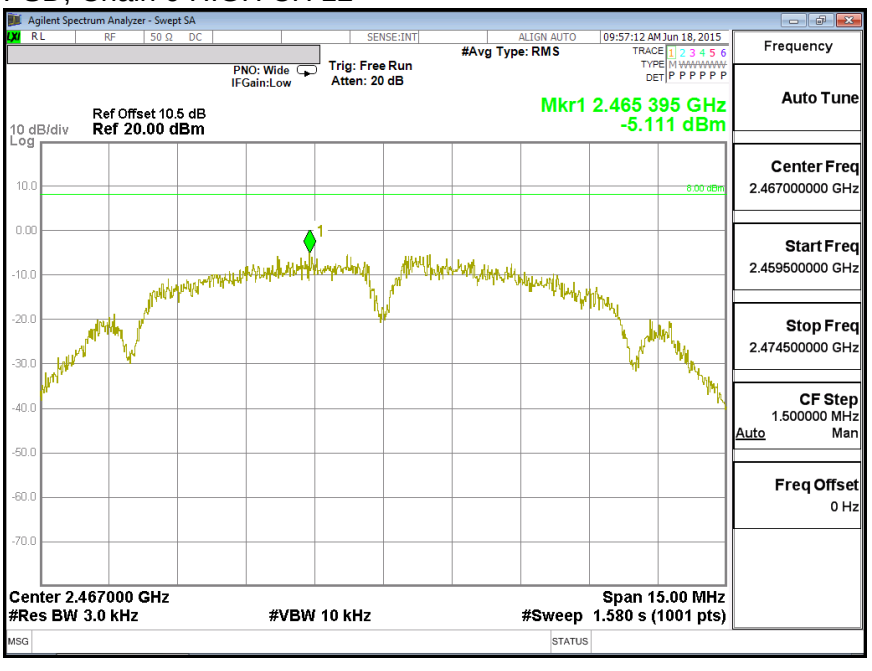
PSD, Chain 0 MID CH



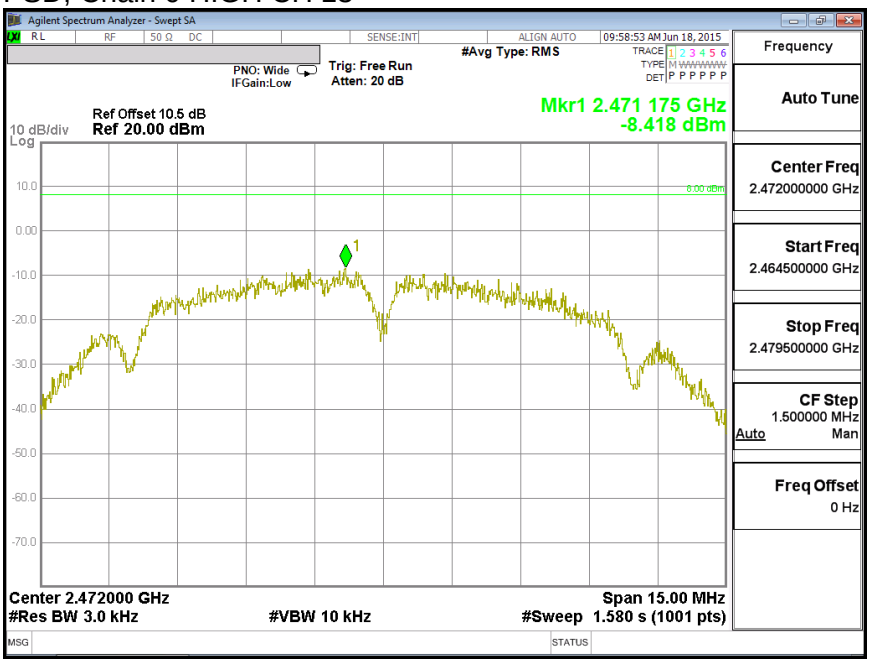
PSD, Chain 0 HIGH CH 11



PSD, Chain 0 HIGH CH 12

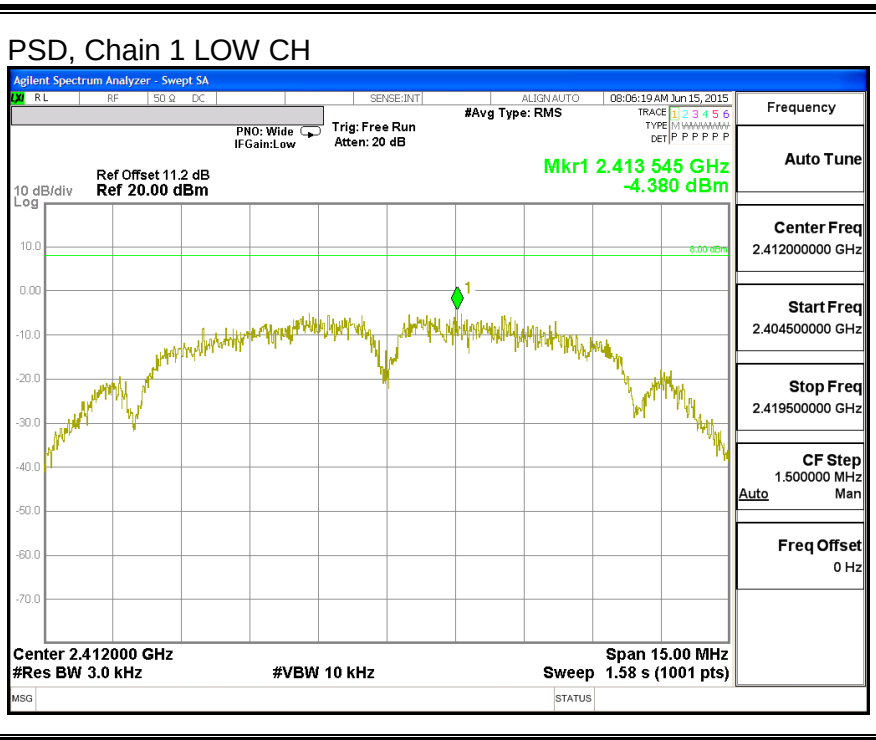


PSD, Chain 0 HIGH CH 13

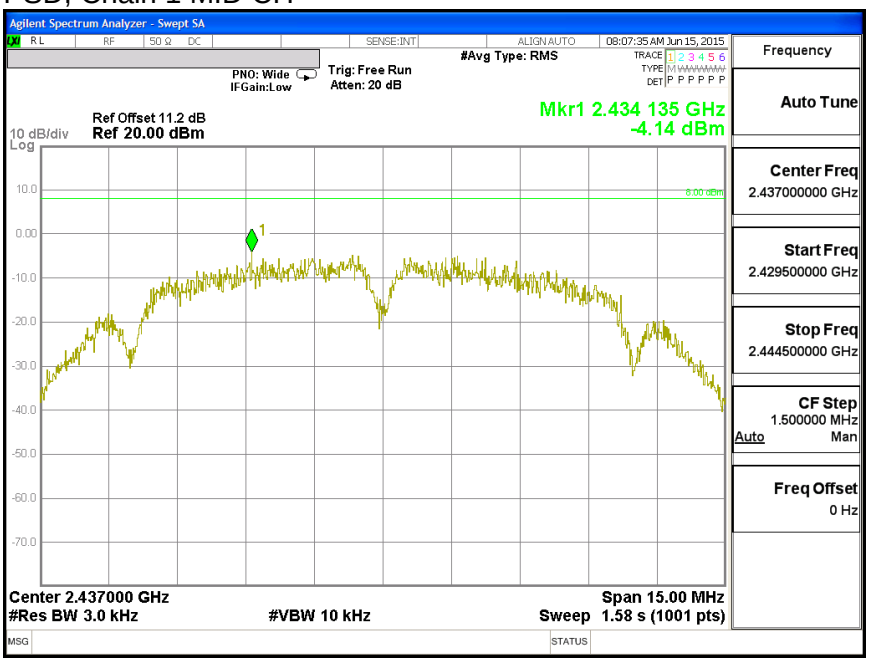


PSD, Chain 1

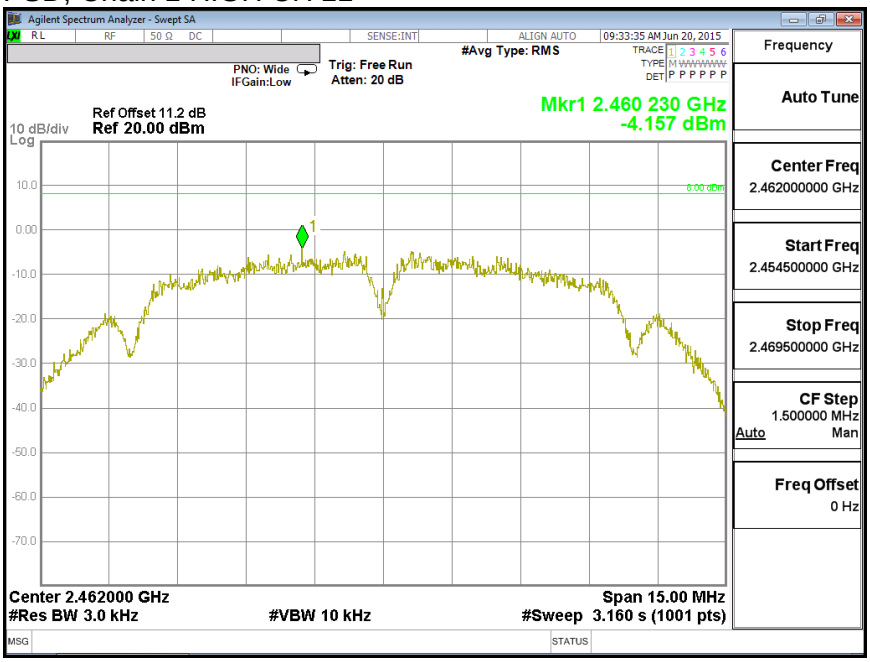
PSD, Chain 1 LOW CH



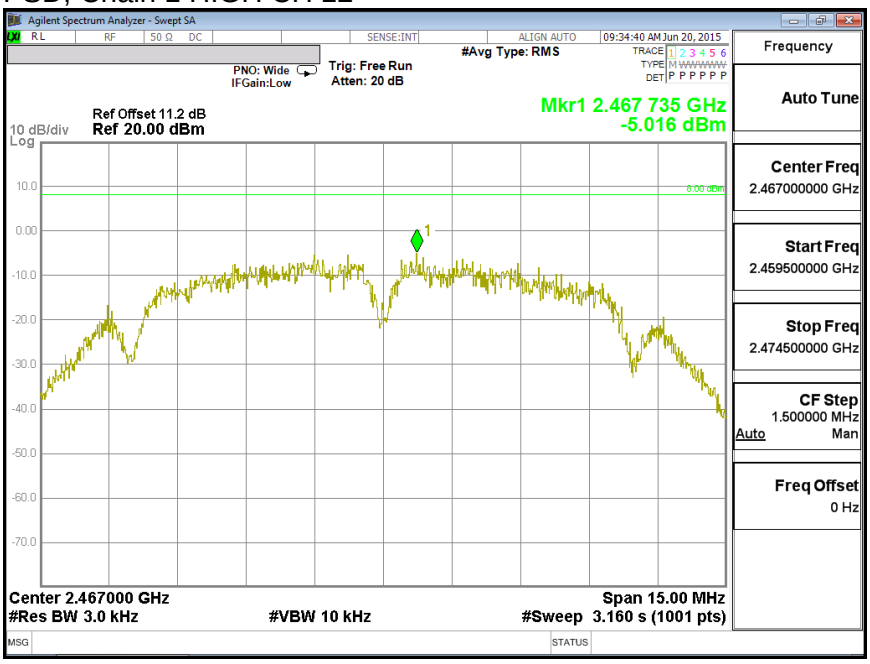
PSD, Chain 1 MID CH



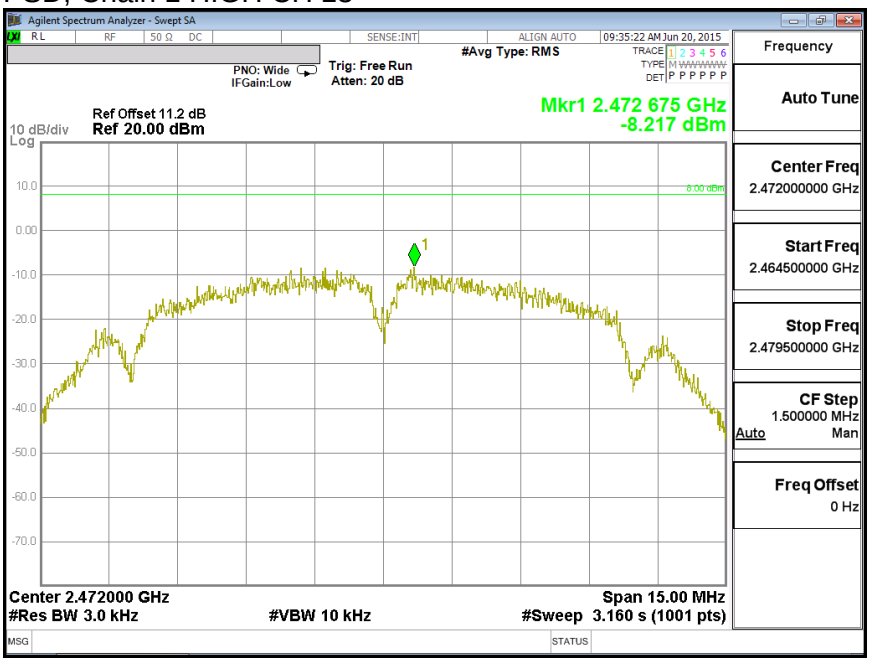
PSD, Chain 1 HIGH CH 11



PSD, Chain 1 HIGH CH 12



PSD, Chain 1 HIGH CH 13



7.3.6. OUT-OF-BAND EMISSIONS

LIMITS

FCC §15.247 (d)

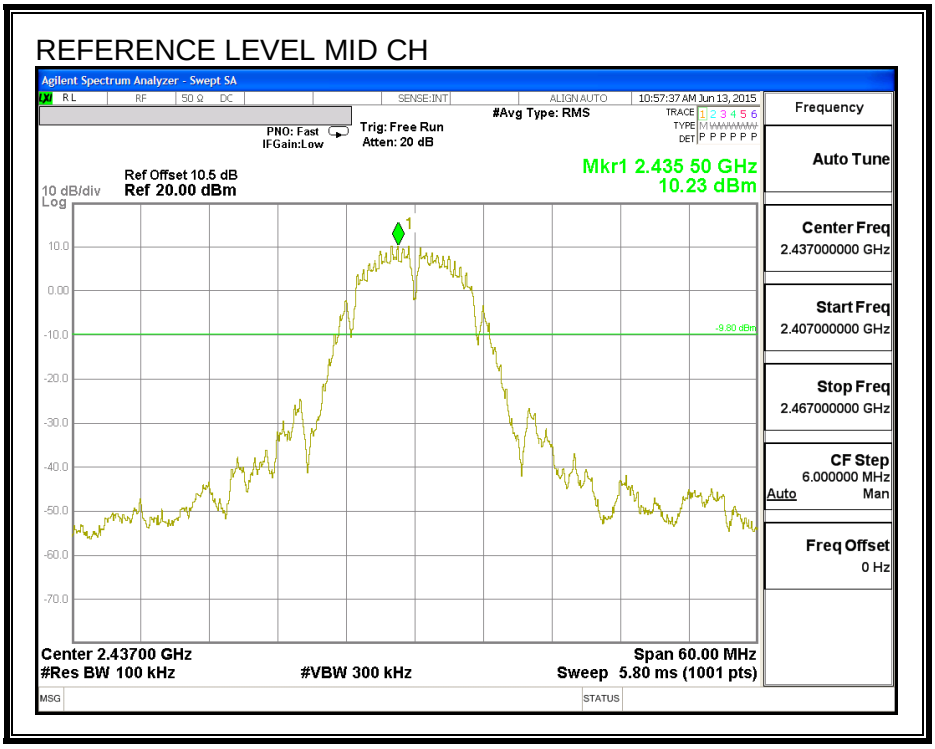
IC RSS-247 (5.5)

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.

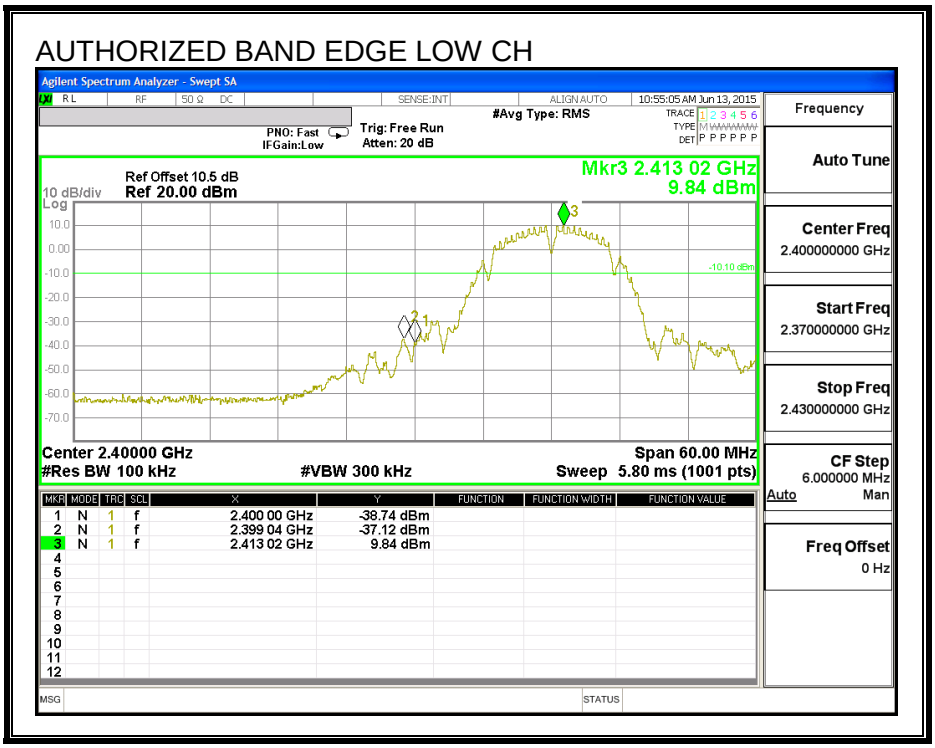
RESULTS

IN-BAND REFERENCE LEVEL, Chain 0

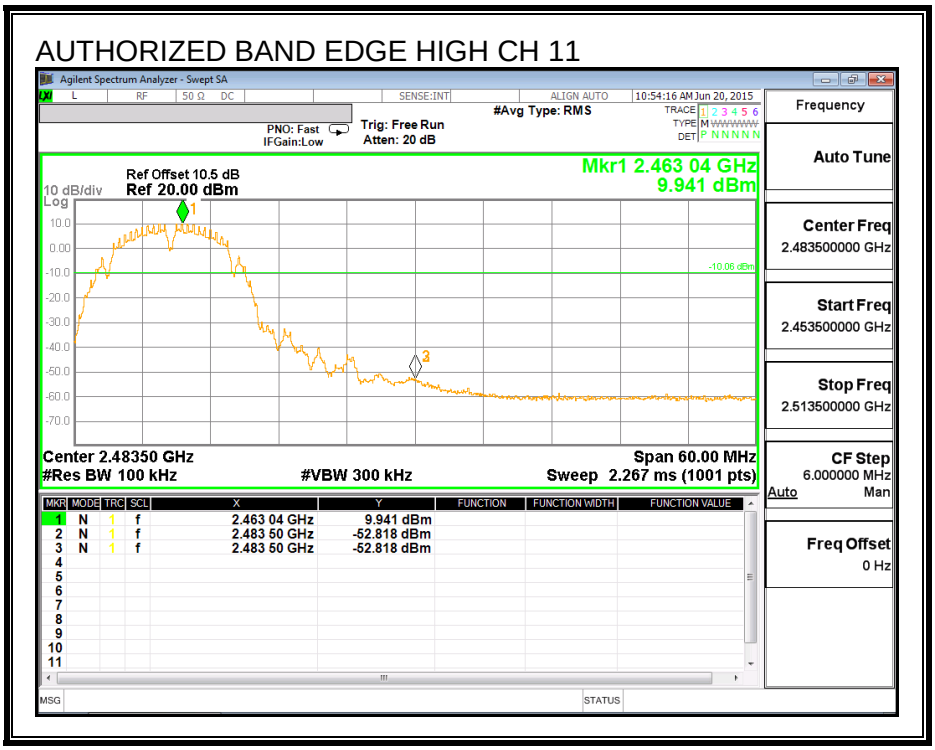
REFERENCE LEVEL MID CH



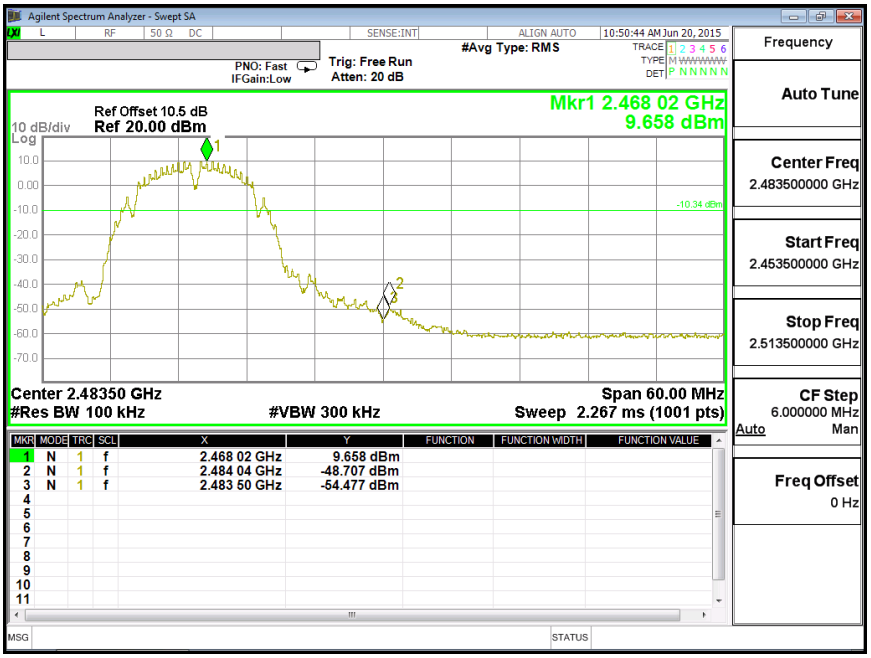
LOW CHANNEL BANDEDGE



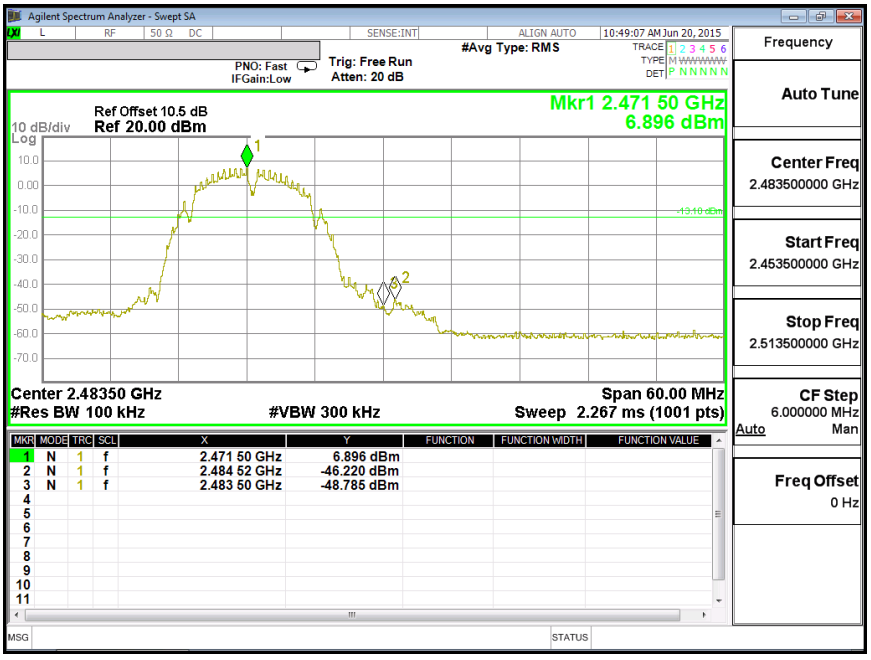
HIGH CHANNEL BANDEDGE



AUTHORIZED BAND EDGE HIGH CH 12

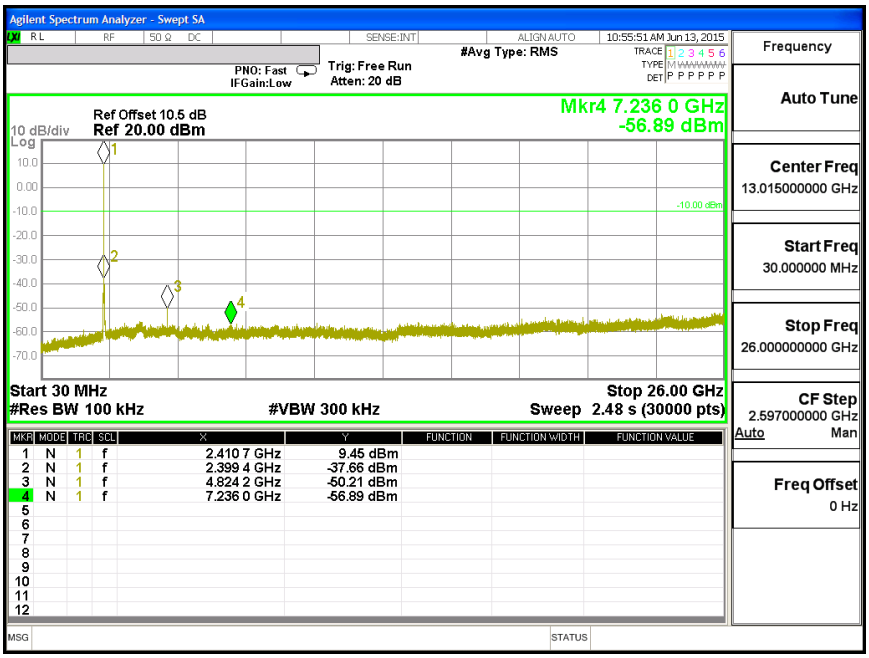


AUTHORIZED BAND EDGE HIGH CH 13

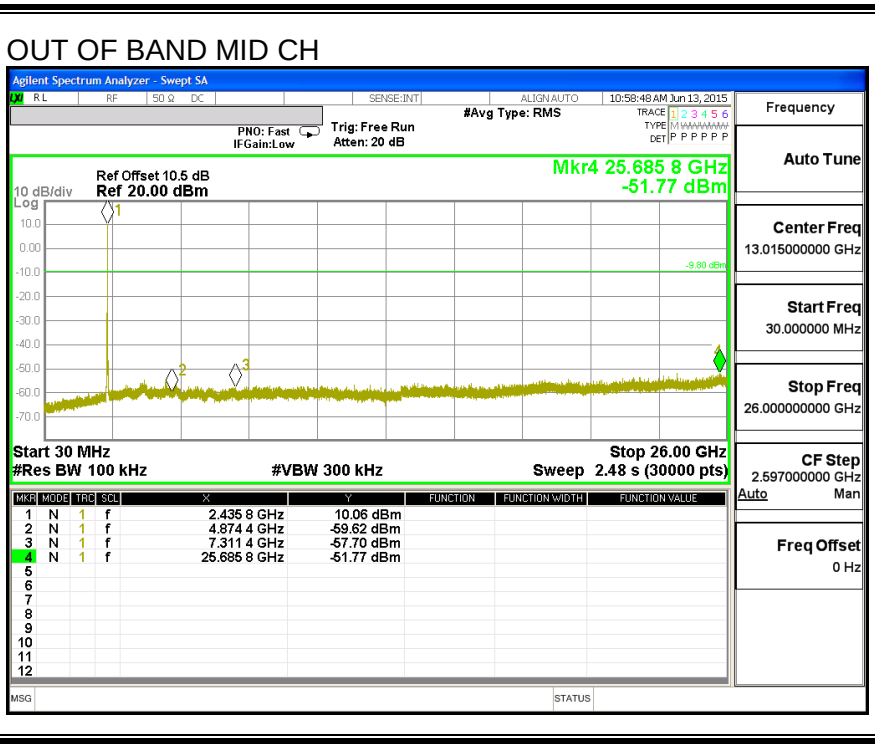


OUT-OF-BAND EMISSIONS

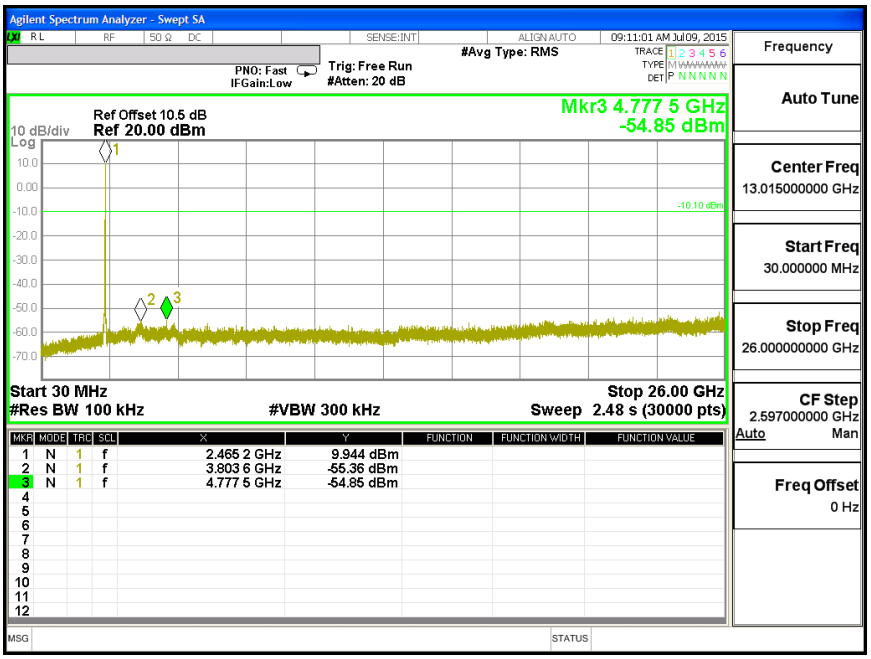
OUT OF BAND LOW CH



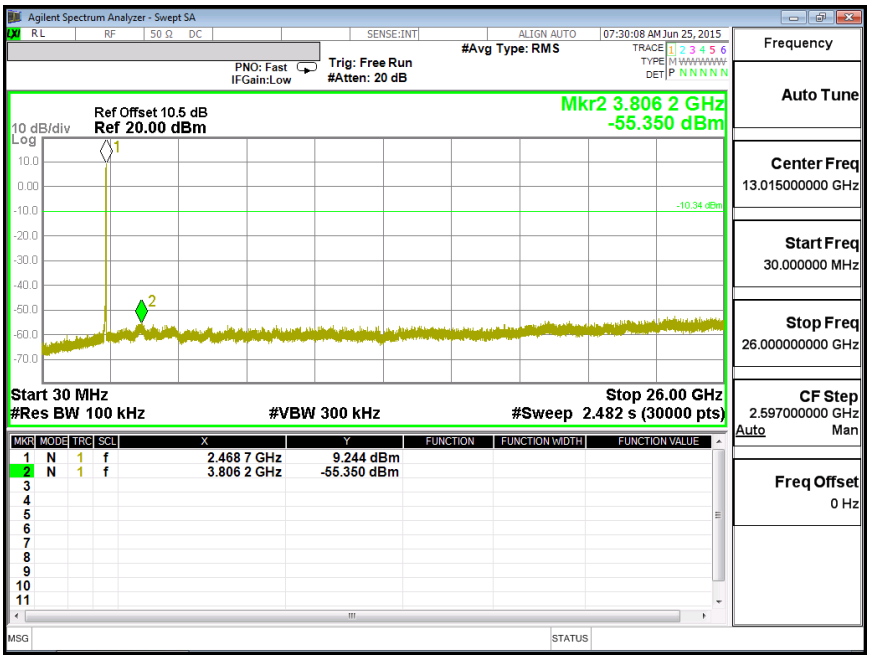
OUT OF BAND MID CH



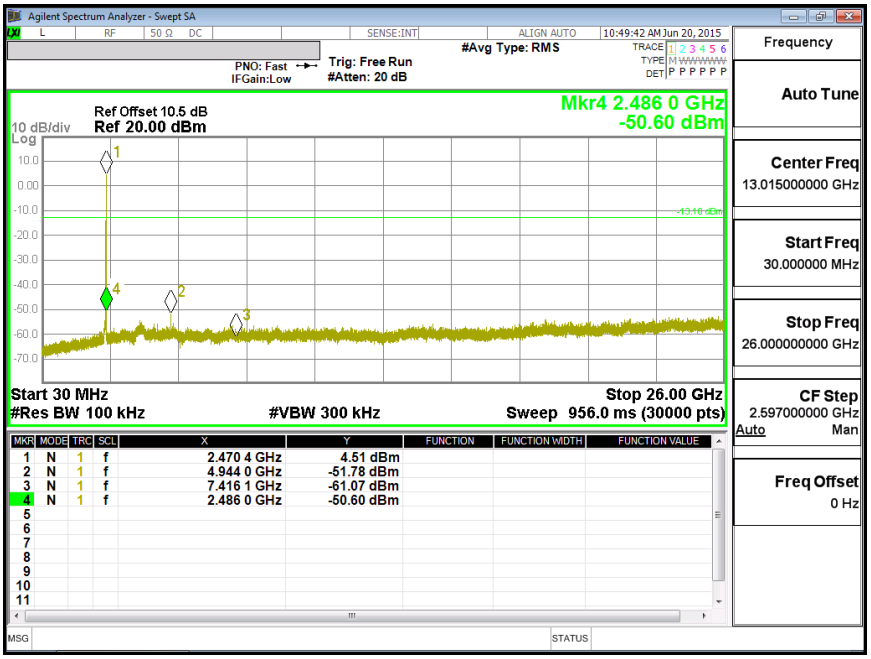
OUT OF BAND HIGH CH11



OUT OF BAND HIGH CH12

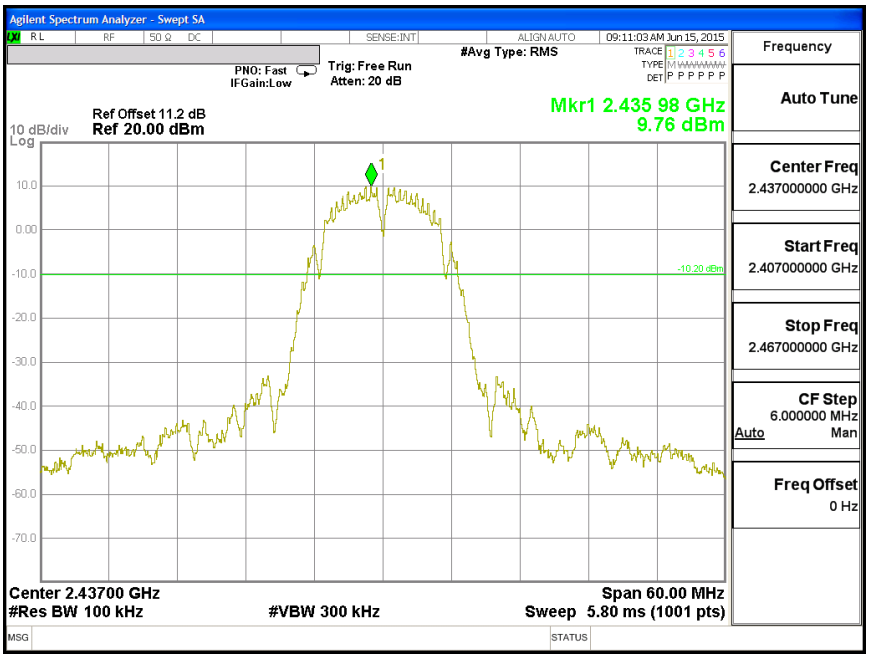


OUT OF BAND HIGH CH13



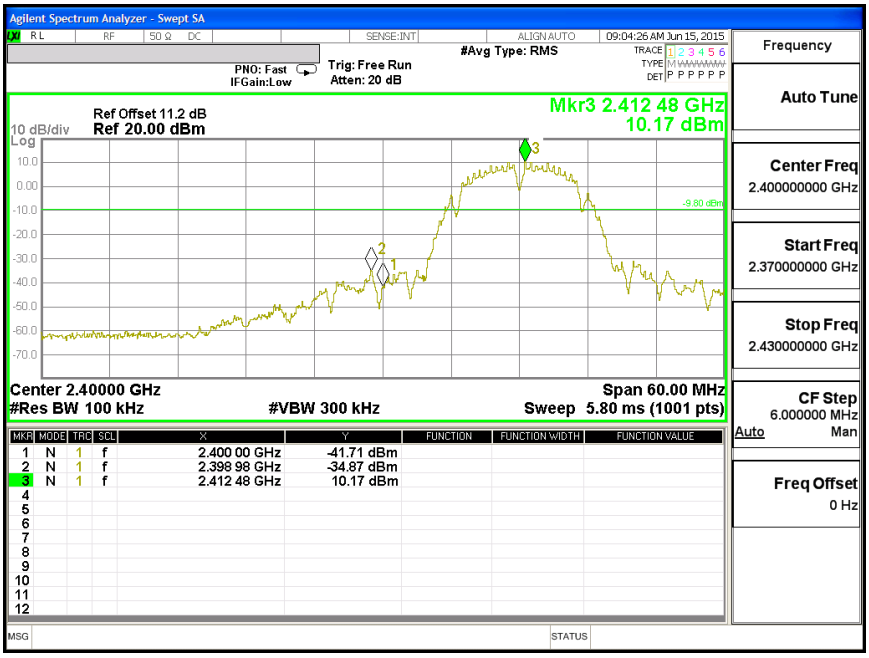
IN-BAND REFERENCE LEVEL, Chain 1

REFERENCE LEVEL MID CH



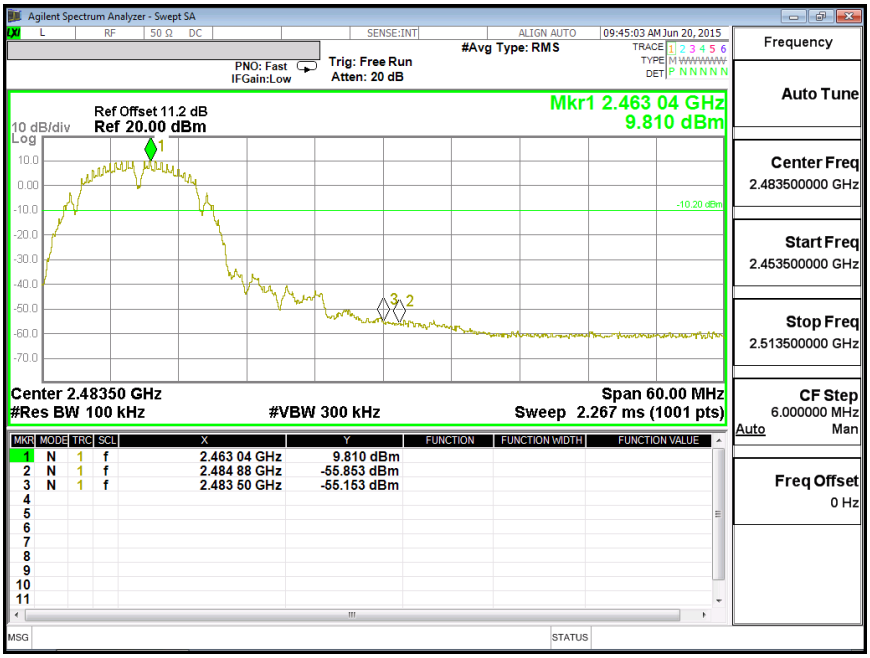
LOW CHANNEL BANDEDGE

AUTHORIZED BAND EDGE LOW CH

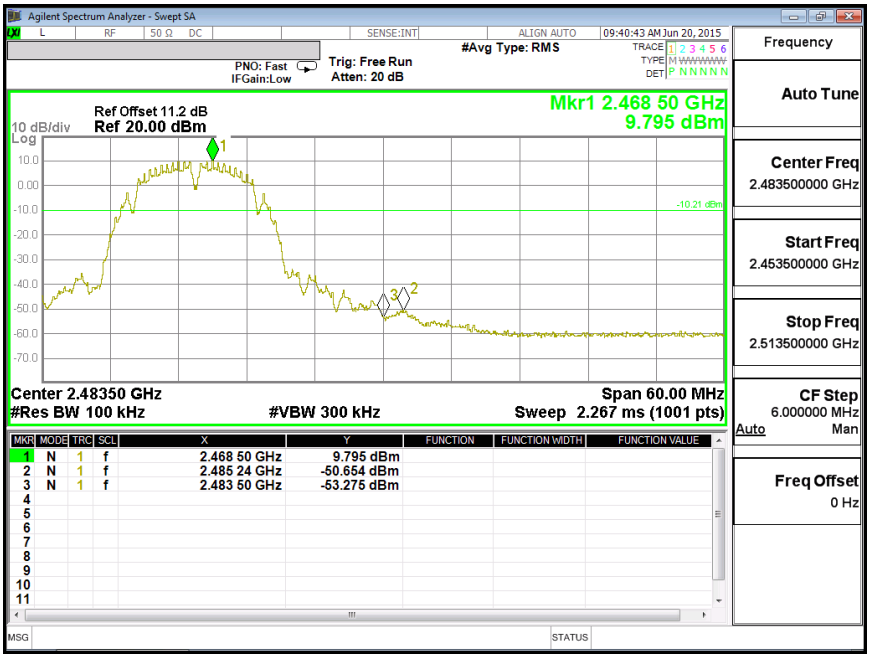


HIGH CHANNEL BANDEDGE

AUTHORIZED BAND EDGE HIGH CH 11



AUTHORIZED BAND EDGE HIGH CH 12



AUTHORIZED BAND EDGE HIGH CH 13