Electromagnetic Compatibility Test Report

Tests Performed on a Dwyer Instruments, Inc

Air Flow Hood Transciever, Model SAH-22

Radiometrics Document RP-8295

ACCREDITED
TESTING CERT #1495.01

Product Detail:
FCC ID: Z7KSAH0116 IC: 9525A-SAH0116 Equipment type: DTS 2.4 GHz
Test Standards:
US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2016 Innovation, Science, and Economic Development Canada RSS-247, Issue 1: 2015 as required for Category I Equipment This report concerns: Original Grant for Certification FCC Part 15.247

Tests Performed For:	*Test Facility:*
Dwyer Instruments, Inc 102 IN Hwy. 212 Michigan City, IN 46360-1956	**Radiometrics Midwest Corporation** 12 Devonwood Avenue Romeoville, IL 60446-1349 (815) 293-0772

Test Date(s): (Month-Day-Year)
February 24 to March 10, 2016

Document RP-8295 Revisions:

Rev.	Issue Date	Affected Sections	Revised By
0	March 11, 2016		
1	March 11, 2016	Cover, 2.0, 5.0	Joseph Strzelecki
2	March 21, 2016	3.1.1, 4.2, 11.3, 11.4 &11.5	Joseph Strzelecki

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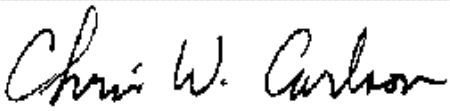
1.0 ADMINISTRATIVE DATA

Equipment Under Test: A Dwyer Instruments, Inc, Air Flow Hood Model: SAH-22 Serial Number: 0004 This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year) February 24, 2016	*Test Date(s): (Month-Day-Year)* February 24 to March 10, 2016
Test Report Written By: Joseph Strzelecki Senior EMC Engineer	*Test Witnessed By:* Neal Syverson Dwyer Instruments, Inc
Radiometrics' Personnel Responsible for Test:  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	*Test Report Approved By*  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is an Air Flow Hood, Model SAH-22, manufactured by Dwyer Instruments, Inc. The detailed test results are presented in a separate section. The following is a summary of the test results.

Spread Spectrum Transmitter Requirements

Environmental Phenomena	Frequency Range	FCC Section	RSS- Section	Test Result
RF AC Mains Conducted Emissions	0.15 - 30 MHz	15.207	GEN; 7.2.2	Pass
RF Radiated Emissions (Unintential Radiation Receive mode)	30-25,000 MHz	15.209	GEN; 7.2.5	Pass
6 dB Bandwidth Test	2400 to 2483 MHz	15.247 a	247; 5.2 (1)	Pass
20 dB Bandwidth Test	2400 to 2483 MHz	15.247 a	GEN	Pass
Peak Output Power	2400 to 2483 MHz	15.247 b	247; 5.4	Pass
Band-edge Compliance of RF Conducted Emissions	2400 to 2483 MHz	15.247 d	247; 5.5	Pass
Spurious Radiated Emissions	30 MHz to 25 GHz	15.247 d	247; 5.5	Pass
Power Spectral Density	2400 to 2483 MHz	15.247 e	247; 5.2 (2)	Pass
RF Radiated Emissions (Unintential Radiation Receive mode)	30-25,000 MHz	15.209	GEN; 7.2.5	Pass

Note: The RSS-247 specification is not currently covered in Radiometrics' Scope of Accreditation. This is technically very similar to FCC, CFR 47 Part 15 which is on Radiometrics scope.

2.1 RF Exposure Compliance Requirements

The EUT meets the FCC requirement for RF exposure and it is exempt from RSS-102 SAR and RF exposure evaluations because the power output is less than 200 mW. There are no power level adjustments available to the end user. The detailed calculations for RF Exposure are presented in a separate document. This is not used within 20 cm of personnel.

3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is an Air Flow Hood, Model SAH-22, manufactured by Dwyer Instruments, Inc. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is a monopole. The antenna has an MMCX connector type that is not readily available to the general public. The connector is internal to the product. Therefore, it meets the 15.203 Requirements. The antenna gain is 5 dBi.

3.2 Related Submittals

Dwyer Instruments, Inc is not submitting any other products simultaneously for equipment authorization related to the EUT.

4.0 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. The EUT was tested as a stand-alone device. Power was supplied at 115 VAC, 60 Hz single-phase to its external power supply.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Air Flow Hood	E	Dwyer Instruments, Inc	SAH-22	0004
2	USB power Supply	P	Apple	A1385	D292034F1QYDHLHAE

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

List of System Cables

QTY	Length (m)	Cable Description	Connected to (Item #)	Shielded?
1	1.8	USB Charging Cable	#1 Power input	No

4.2 EUT Operating Modes

Environmental Phenomena	Channels Tested	Mode	Data Mbps	Notes
Bandwidth Test	1, 6, 11	802.11b	1.0	
Bandwidth Test	1, 6, 11	802.11g	6.0	
Bandwidth Test	1, 6, 11	802.11n	6.5	
Peak Output Power	1, 6, 11	802.11b	1.0	
Peak Output Power	1, 6, 11	802.11g	6.0	
Peak Output Power	1, 6, 11	802.11n	6.5	
Band-edge Compliance of RF Conducted Emissions	1, 6, 11	802.11b	1.0	
Band-edge	1, 6, 11	802.11g	6.0	
Band-edge	1, 6, 11	802.11n	6.5	
RF Conducted Emissions	1, 6, 11	802.11b	1.0	
RF Conducted Emissions	1, 6, 11	802.11g	6.0	
RF Conducted Emissions	1, 6, 11	802.11n	6.5	
Radiated Emissions	1, 6, 11	802.11b	1.0	
Radiated Emissions	1, 6, 11	802.11g	6.0	
Radiated Emissions	1, 6, 11	802.11n	6.5	
Power Spectral Density	1, 6, 11	802.11b	1.0	
Power Spectral Density	1, 6, 11	802.11g	6.0	
Power Spectral Density	1, 6, 11	802.11n	6.5	
Conducted Emissions, AC Mains	6	802.11b	1.0	Note 1

Note 1: During preliminary testing, 802.11b mode Channel 6 was found to be worst case for this test.

The transmit mode for all tests was continuous. The continuous mode produces a Duty cycle of at least 98%.

4.3 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.4 Equipment Modifications

The following modifications were made prior to the start of compliance testing:

A ferrite P/N 0431167281 was added to the coaxial cable
Conducted coating was applied to the housing around the main PCB.

5.0 TEST SPECIFICATIONS

Document	Date	Title
FCC CFR Title 47	2015	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-247 Issue 1	2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
IC RSS-Gen Issue 4	2014	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

Document	Date	Title
ANSI C63.4-2014	2014	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	2013	American National Standard for Testing Unlicensed Wireless Devices
558074 D01 DTS Meas Guidance	2016	Guidance for Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under §15.247; v03r04

7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with Innovation, Science, and Economic Development Canada as site number IC 8727A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

10.0 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	10/06/15
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	01/05/16
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	01/05/16
AMP-29	HP / Agilent	Amplifier	11975A	2304A00158	2-8 GHz	12 Mo.	01/09/15
ANT-03	Tensor	Biconical Antenna	4104	2231	20-250MHz	24 Mo.	12/07/15
ANT-04	Tensor	Biconical Antenna	4104	2246	20-250MHz	24 Mo.	05/15/14
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	24 Mo.	11/25/15
ANT-08	RMC	Log-Periodic Ant.	LP1000	1002	200-1000MHz	24 Mo.	08/26/14
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	12/01/14
ANT-36	Ailtech (Eaton)	Horn Antenna	96001	2013	1.0-18GHz	24 Mo.	10/20/14
ANT-44	Imp Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	01/19/16
ANT-48	RMC	Std Gain Horn	HW2020	1001	18-26 GHz	24 Mo.	12/15/15
ANT-53	EMCO	Loop Antenna	6507	1453	1 kHz-30 MHz	24 Mo	12/17/15
HPF-06	Mini-Circuits	High Pass Filter	VHF-3800+	31035	4-11 GHz	12 Mo.	03/03/14
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	06/23/15
MXR-02	HP / Agilent	Harmonic Mixer	11970K	2332A00489	18-26.5GHz	12 Mo.	01/09/15
REC-08	HP / Agilent	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	24 Mo.	12/21/15
REC-20	HP / Agilent	Spectrum Analyzer	85460A/84562A	33330A00135 3410A00178	30Hz-6GHz	24 Mo.	06/26/15
REC-21	Agilent	Spectrum Analyzer	E7405A	MY45118341	9Hz-26.5 GHz	12 Mo.	12/22/15
THM-02	Fluke	Temp/Humid Meter	971	93490471	N/A	24 Mo.	08/03/15
THM-03	Fluke	Temp/Humid Meter	971	95850465	N/A	12 Mo.	01/11/16

Note: All calibrated equipment is subject to periodic checks.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	EN550XX0	06.09.15	RF Conducted Emissions (FCC Part 15 & EN 55011/22) REC-10
Radiometrics	REREC11D	12.04.15	RF Radiated Emissions (FCC Part 15 & EN 55011/22)
Agilent	PSA/ESA-E/L/EMC	2.4.0.42	Bandwidth and screen shots

11.0 TEST SECTIONS

11.1 AC Conducted Emissions

The tests and limits are in accordance with FCC section 15.207 and RSS Gen section 7.2.2.

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

FCC Limits of Conducted Emissions at the AC Mains Ports

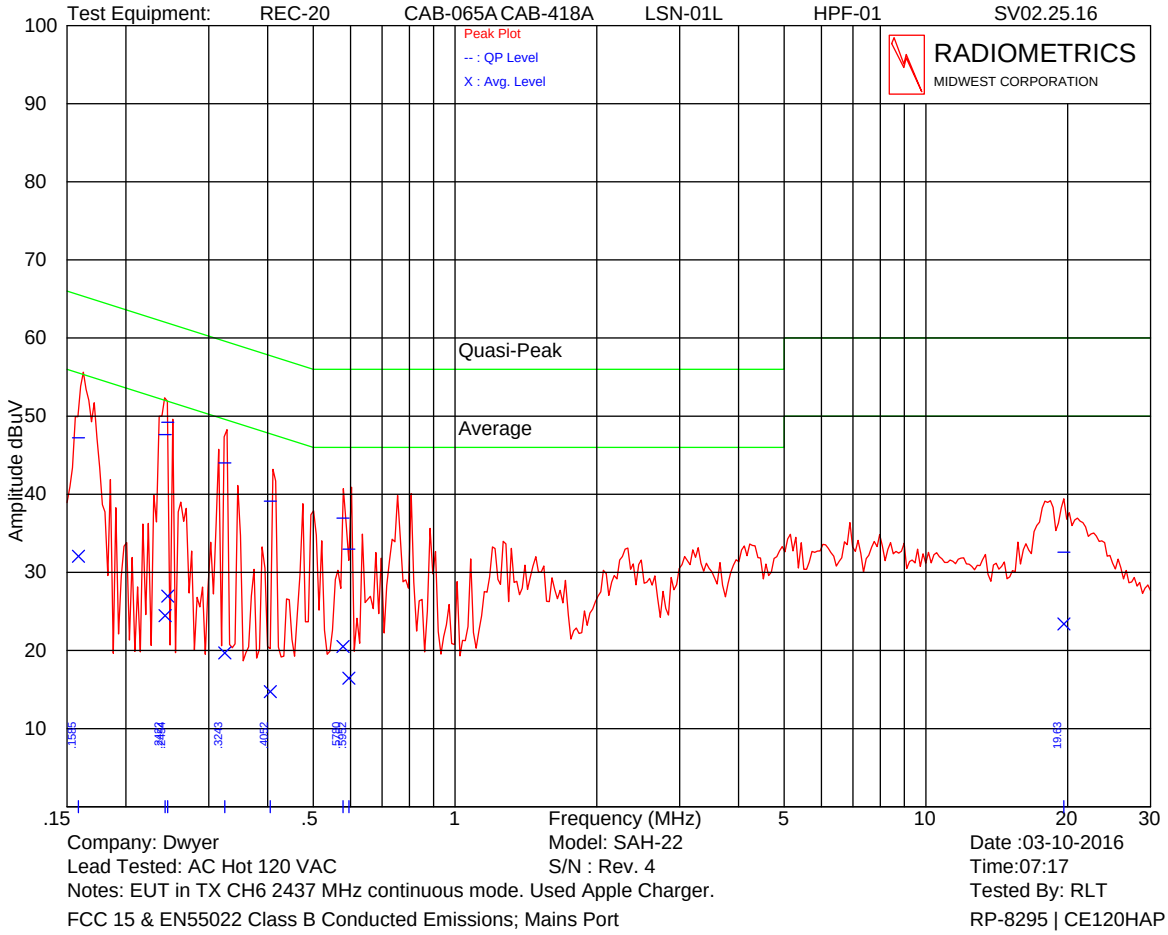
Frequency Range (MHz)	Class B Limits (dBuV)	
	Quasi-Peak	Average
0.150 - 0.50*	66 - 56	56 - 46
0.5 – 5.0	56	46
5.0 - 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from the external USB charger (with the EUT connected) power cord, after testing all modes of operation.

Test Date : March 10, 2016
The Amplitude is the final corrected value with cable and LISN Loss.
QP readings are quasi-peak with a 9 kHz bandwidth and no video filter.

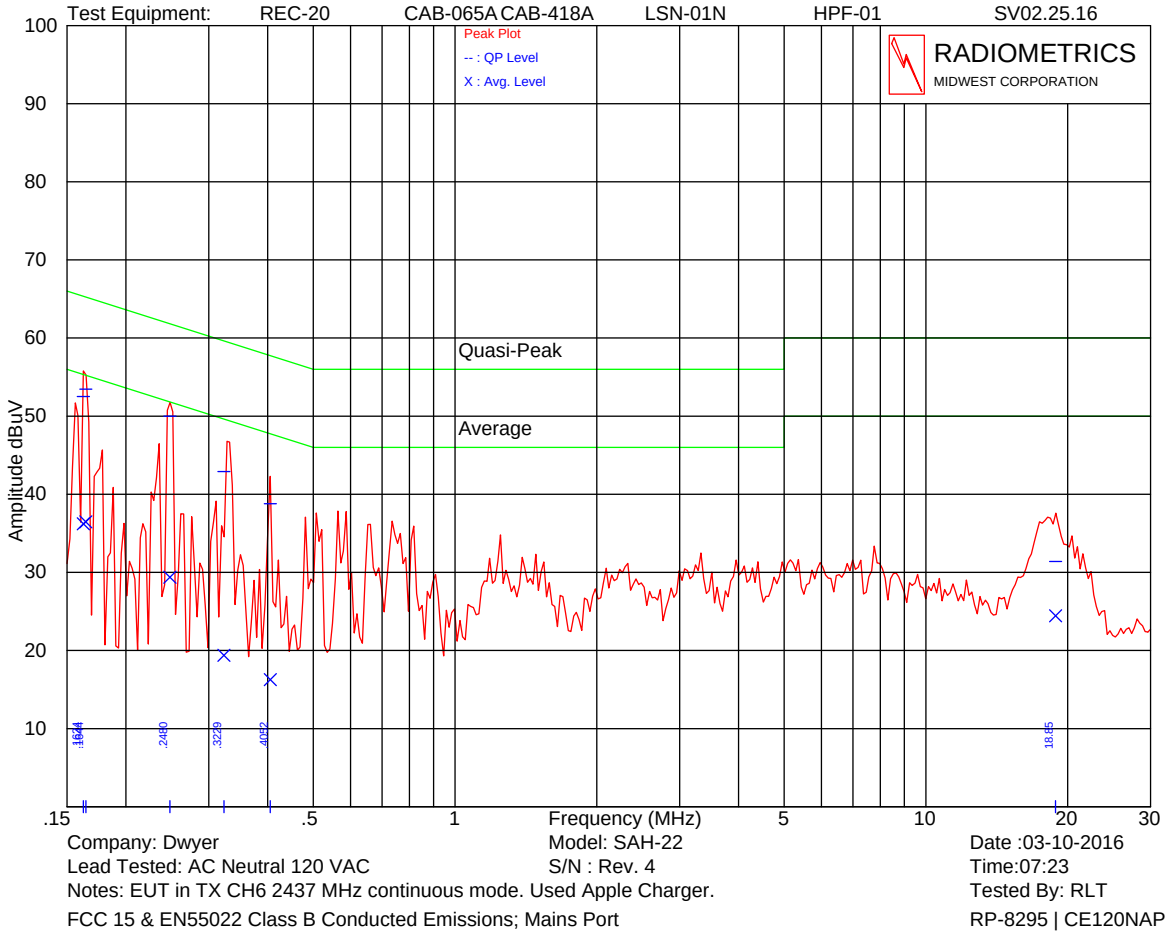
Judgment: Passed by at least 6 dB

Testing of the Dwyer Instruments, Inc, Model SAH-22, Air Flow Hood



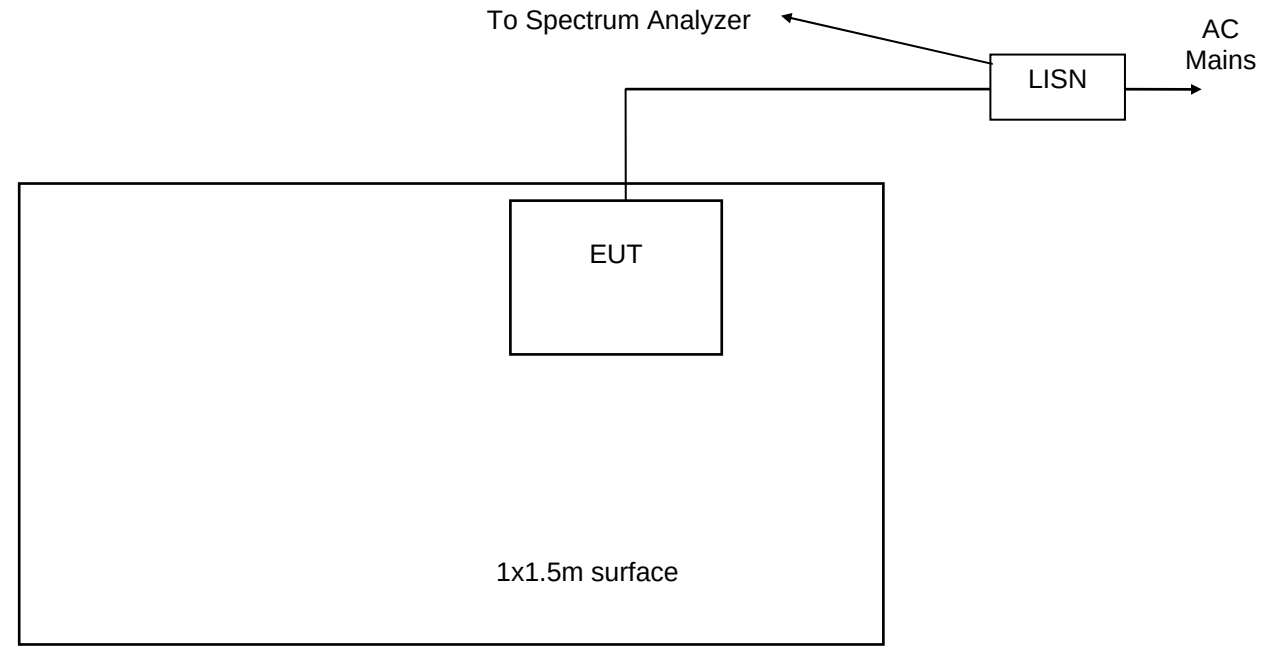
Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.159	47.2	65.5	32.1	55.5	18.3
0.242	47.6	62.0	24.5	52.0	14.4
0.245	49.2	61.9	27.0	51.9	12.7
0.324	44.0	59.6	19.7	49.6	15.6
0.405	39.1	57.7	14.7	47.7	18.6
0.578	36.9	56.0	20.5	46.0	19.1
0.595	33.0	56.0	16.4	46.0	23.0
19.633	32.6	60.0	23.4	50.0	26.6

Testing of the Dwyer Instruments, Inc, Model SAH-22, Air Flow Hood



Frequency (MHz)	QP Amp. (dBuV)	QP Limit (dBuV)	Average Amp. (dBuV)	Average Limit (dBuV)	Margin Under Limit (dB)
0.162	52.5	65.3	36.2	55.3	12.8
0.164	53.5	65.2	36.5	55.2	11.8
0.248	50.0	61.8	29.4	51.8	11.8
0.323	42.9	59.6	19.4	49.6	16.7
0.405	38.8	57.7	16.3	47.7	19.0
18.856	31.4	60.0	24.4	50.0	25.6

Figure 1. Conducted Emissions Test Setup



Notes:
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top

11.2 Occupied Bandwidth

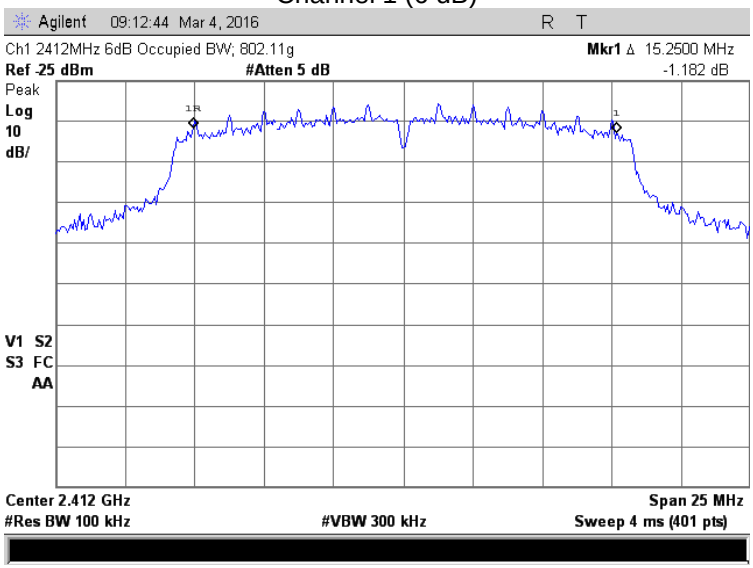
The test procedures were in accordance to FCC DTS Measurement Guideline 558074 D01, Section 8.1.

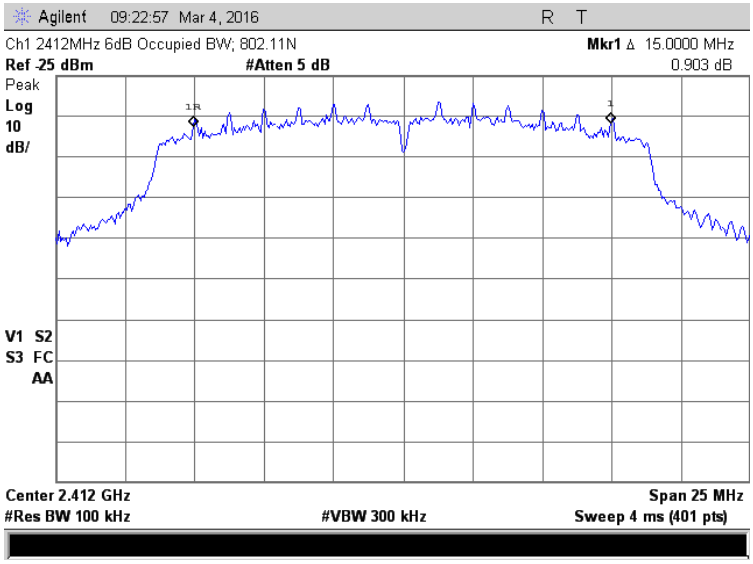
The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize.
The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 6 or 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the bandwidth of the emission.

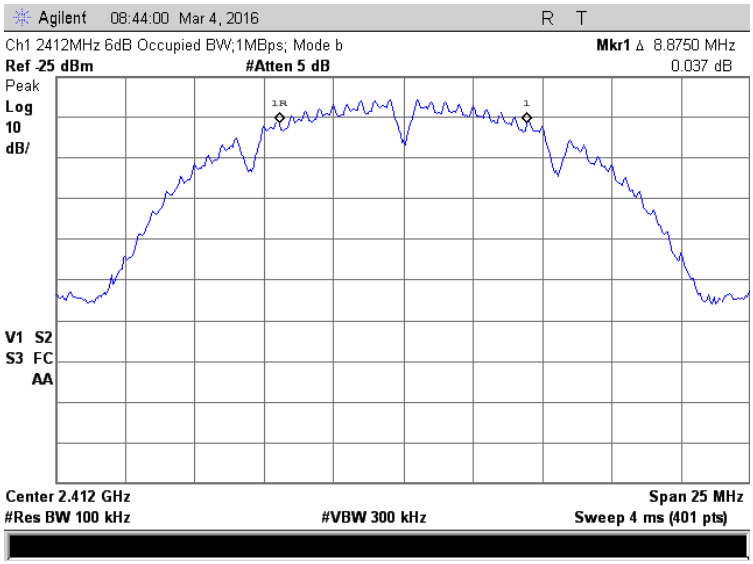
BW Type	Mode	EUT MHz	BW MHz	EUT MHz	BW MHz	EUT MHz	BW MHz
6 dB	b	2412	8.88	2437	9.06	2462	9.13
6 dB	g	2412	15.25	2437	15.00	2462	15.56
6 dB	N	2412	15.00	2437	15.19	2462	15.00
20 dB	b	2412	16.30	2437	16.69	2462	16.30
20 dB	g	2412	19.25	2437	21.00	2462	19.30
20 dB	N	2412	20.12	2437	21.90	2462	20.10

The 6 dB bandwidth is greater than 500 kHz
Judgement: Pass
Tested by: Richard Tichgelaar
Test Date: March 4 and 10, 2016

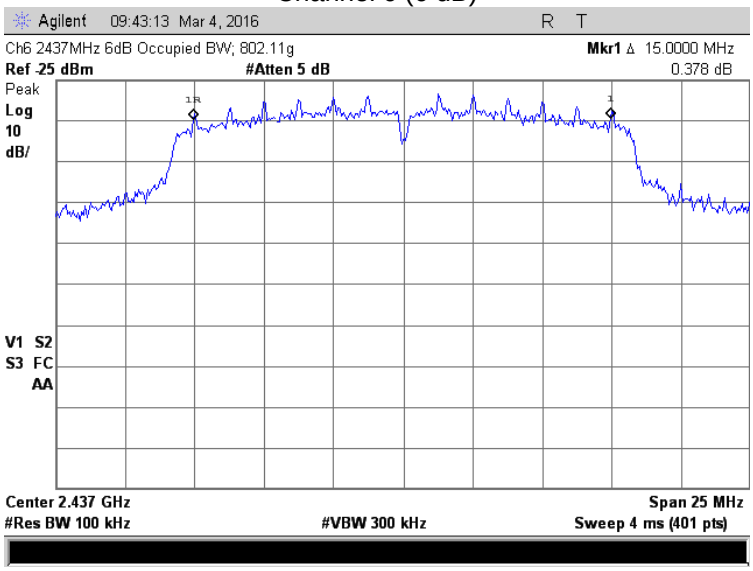
Channel 1 (6 dB)

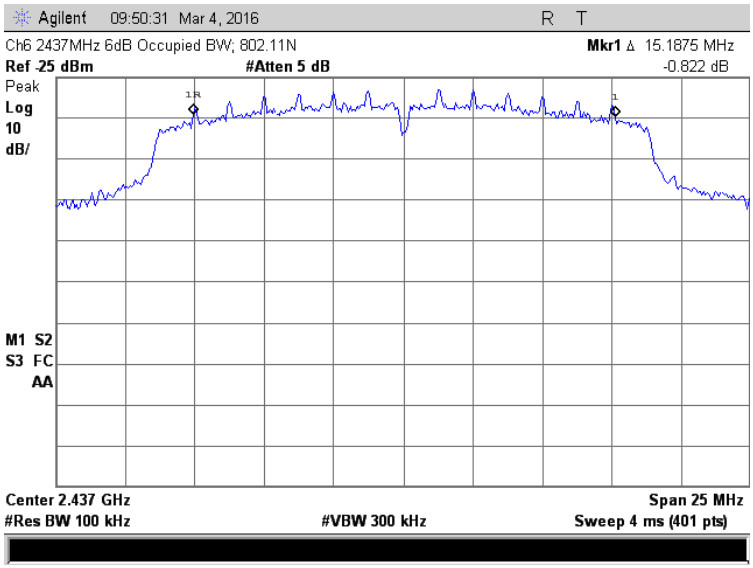


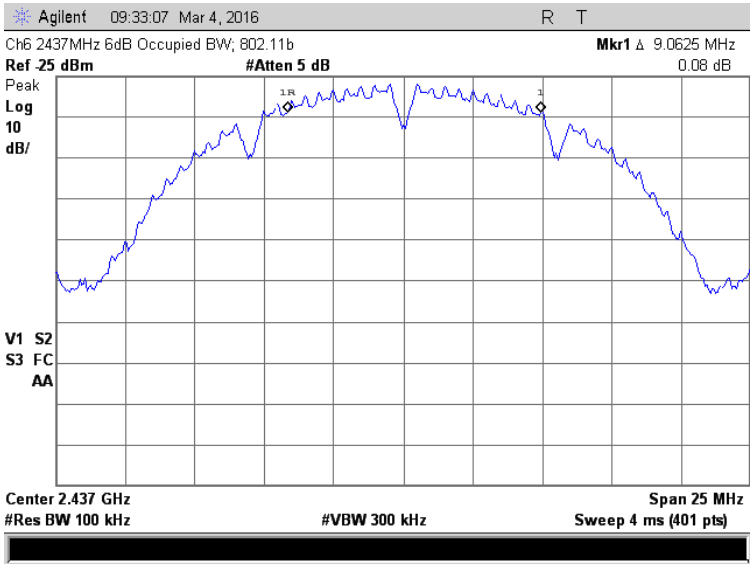




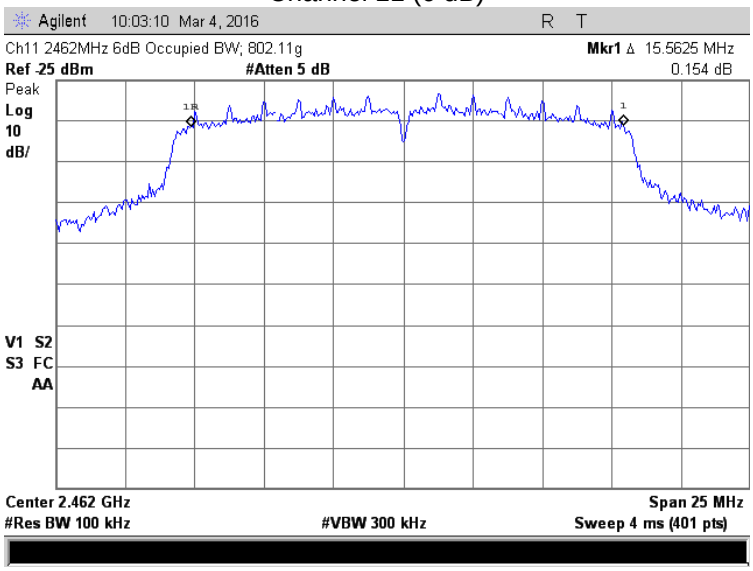
Channel 6 (6 dB)

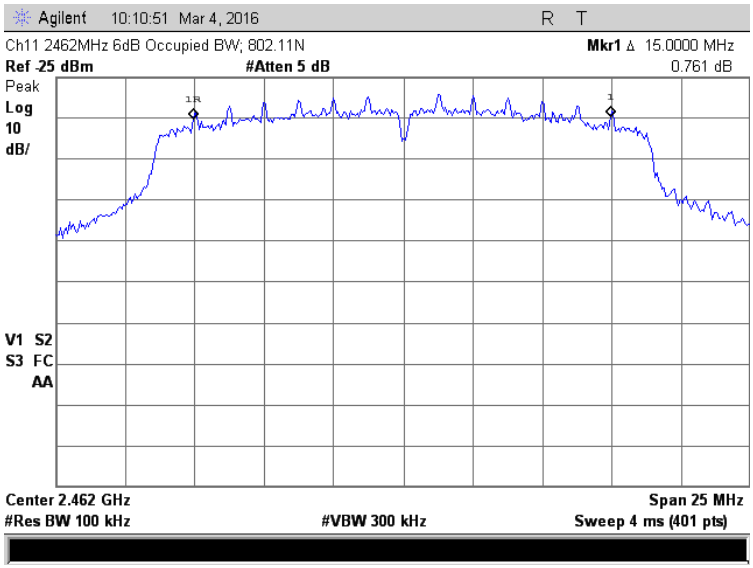


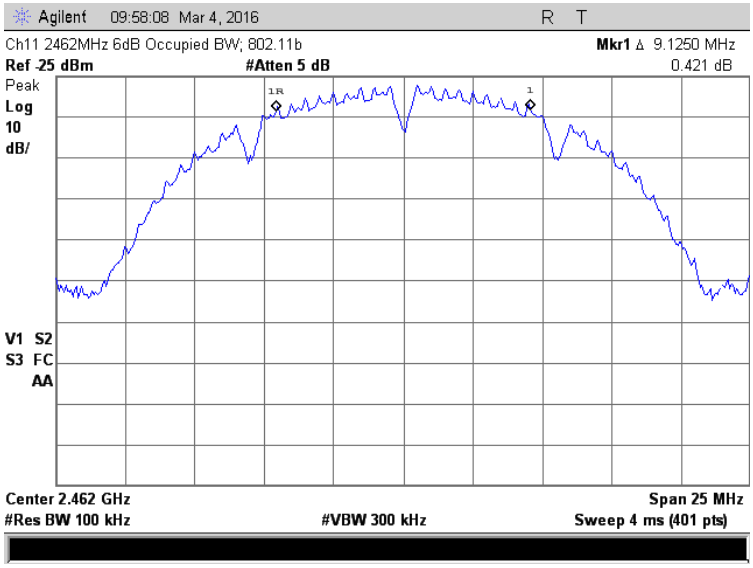




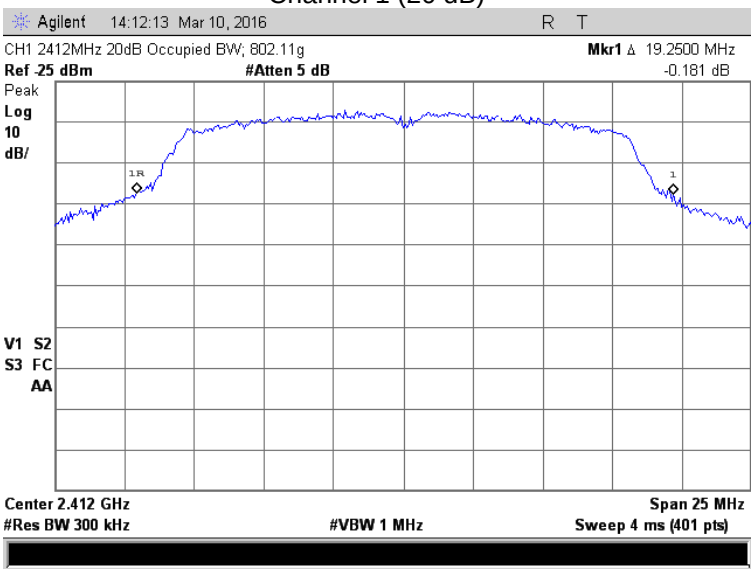
Channel 11 (6 dB)

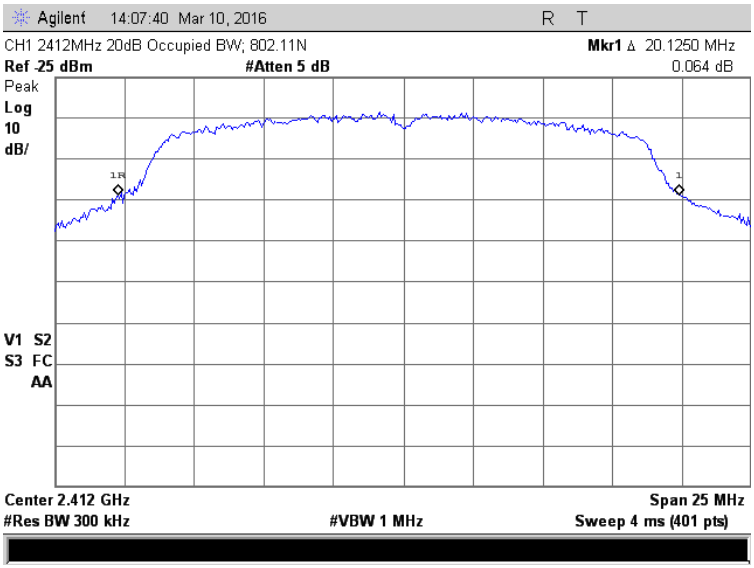


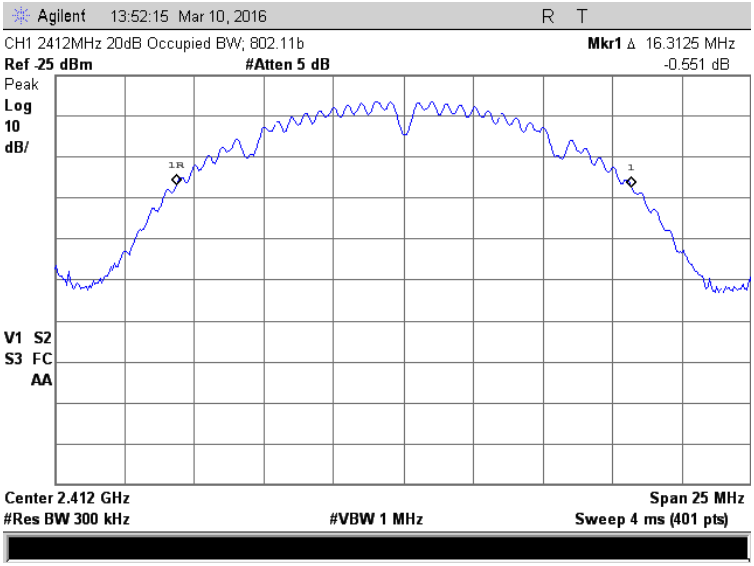




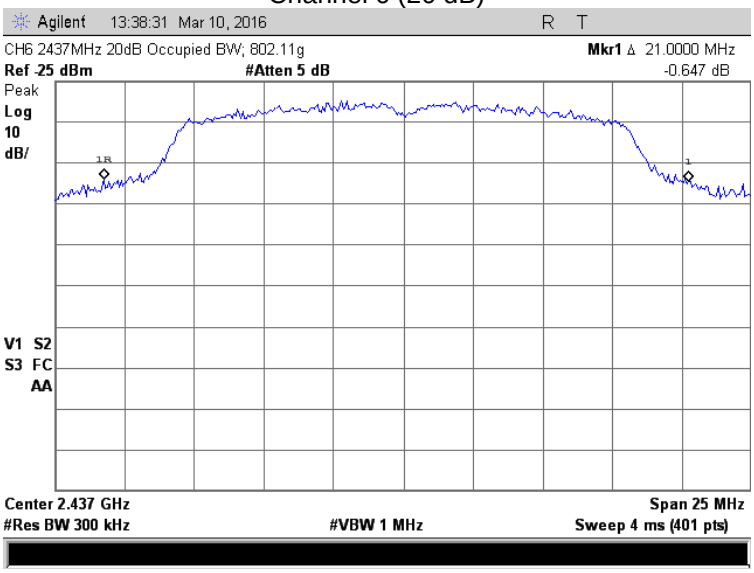
Channel 1 (20 dB)

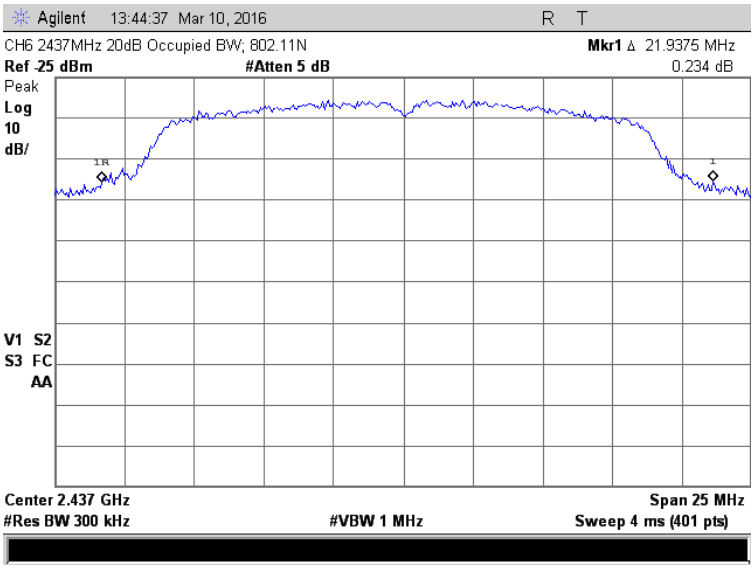


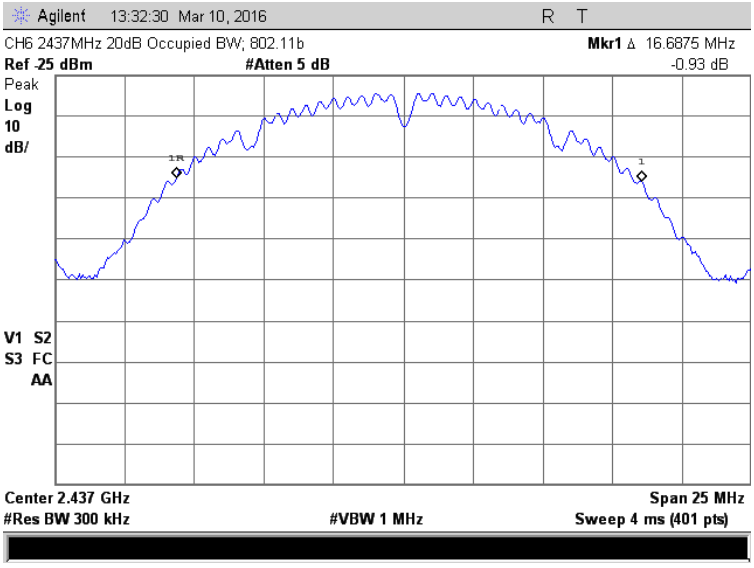




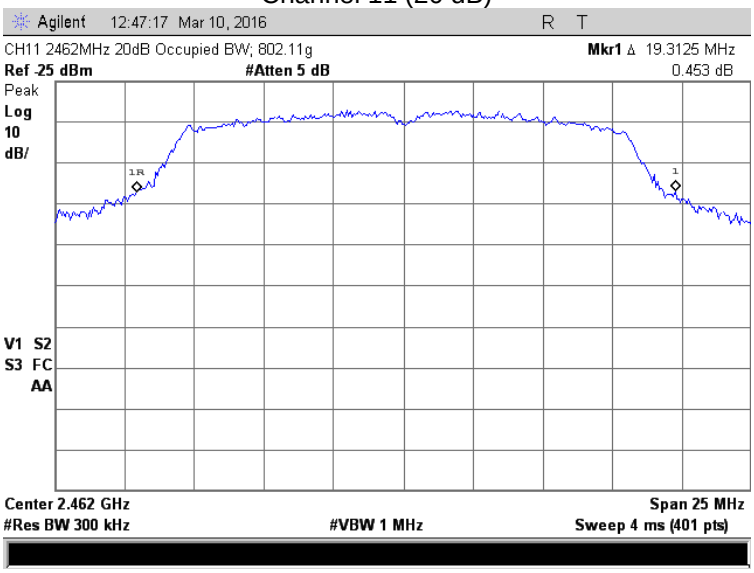
Channel 6 (20 dB)

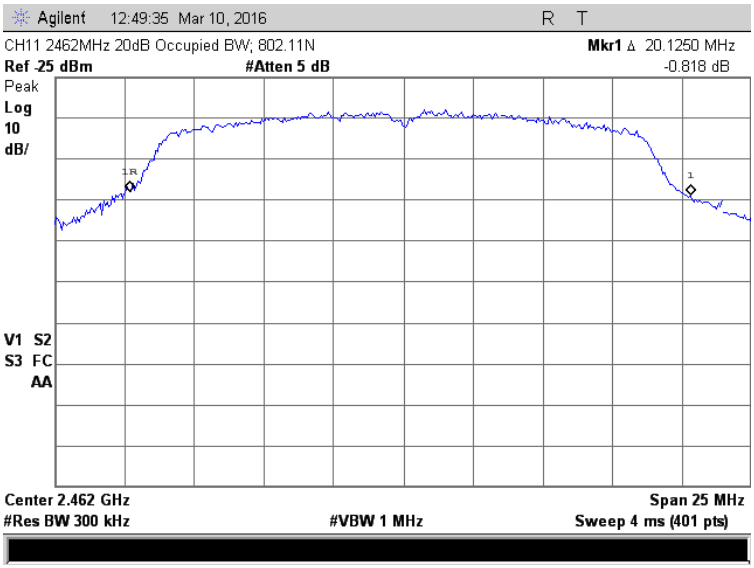


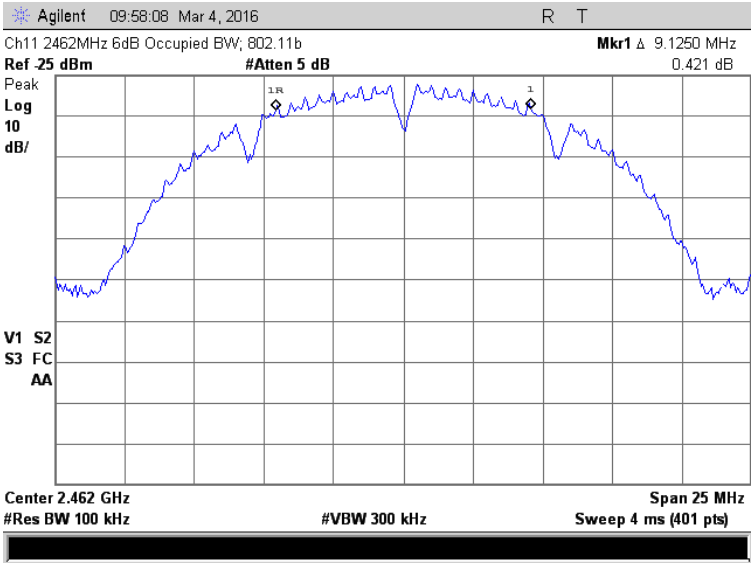




Channel 11 (20 dB)







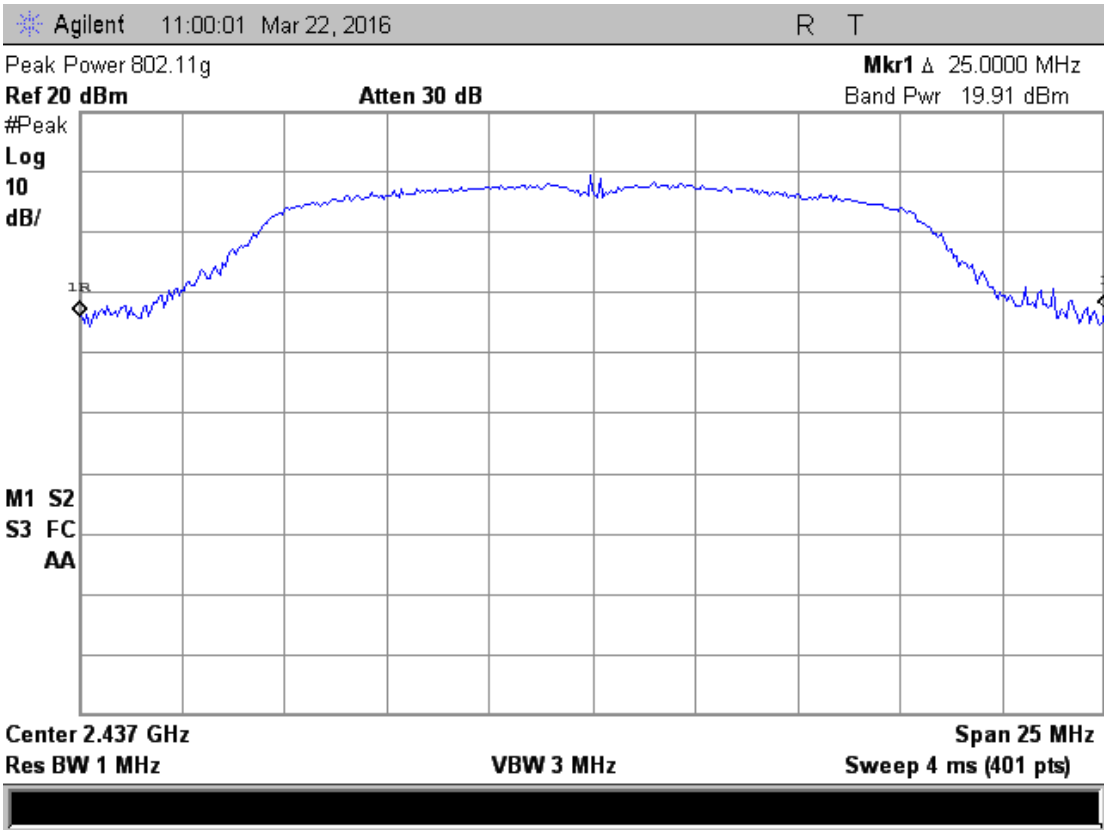
11.3 Peak Output Power

The power output test method from ANSI C63.10-2014 section 11.9.1.2 was used for this test. The spectrum analyzer was set to peak channel power with a span of 20 MHz. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable.
Span = 25 MHz; RBW = 1 MHz; VBW = 3 MHz

Tested by: Joseph Strzelecki/ Richard Tichgelaar
Test Date: March 9, 2016
Since the gain of the antenna is always less than 6 dB, the limit is not reduced. The antenna gain is 5 dBi.

Chan	Mode	EUT MHz	Peak Channel Power dBm	Cable Loss dB	Peak Power dBm	Limit dBm	Margin dB
1	802.11b	2412	14.5	0.6	15.1	30.0	14.9
1	802.11g	2412	18.3	0.6	18.9	30.0	11.1
1	802.11N	2412	17.6	0.6	18.2	30.0	11.8
6	802.11b	2437	17.0	0.6	17.6	30.0	12.4
6	802.11g	2437	19.9	0.6	20.5	30.0	9.5
6	802.11N	2437	19.7	0.6	20.3	30.0	9.7
11	802.11b	2462	15.5	0.6	16.1	30.0	13.9
11	802.11g	2462	18.7	0.6	19.3	30.0	10.7
11	802.11N	2462	17.9	0.6	18.5	30.0	11.5

Judgment: Passed by 9.5 dB



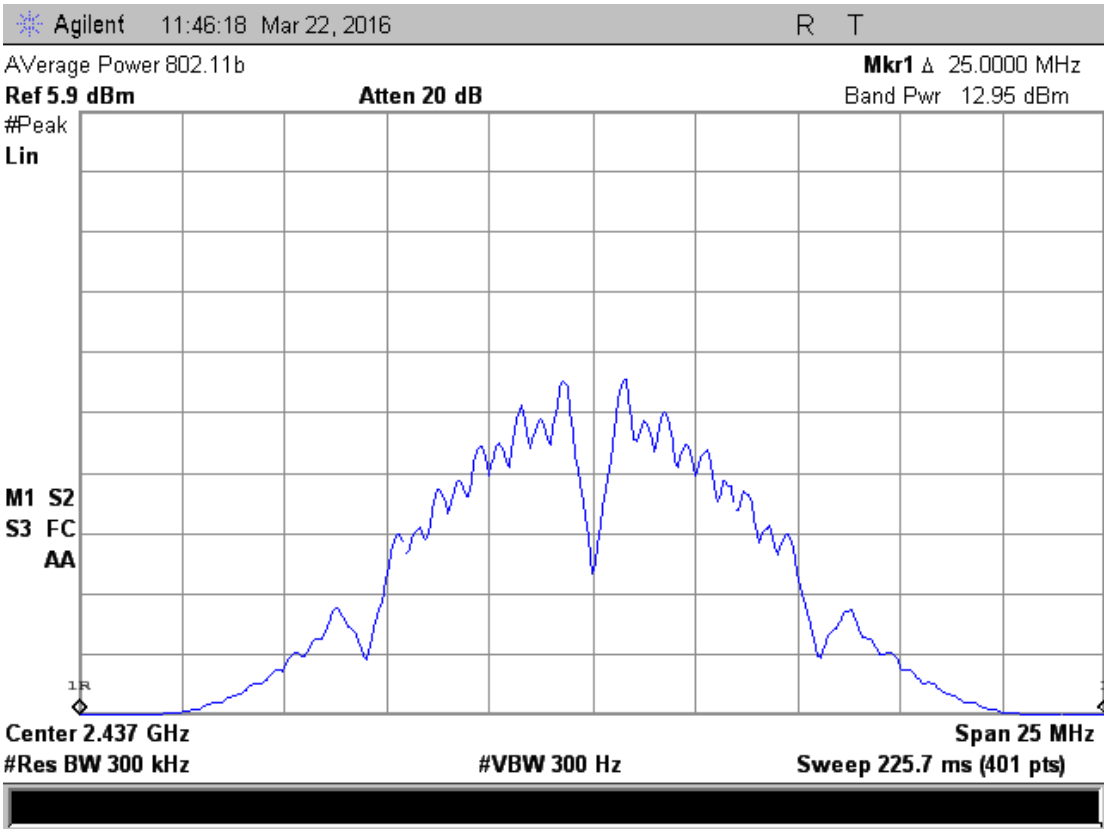
11.4 Average Output Power

The average power output test method from using 558074 D01, Section 9.2.2.7 was used for this test. The spectrum analyzer was set to channel power with a span of 20 MHz. The EUT antenna port was connected to the Spectrum analyzer Via a low loss coaxial cable.

Span = 25 MHz; RBW = 300 kHz; VBW = 300 Hz
Tested by: Richard Tichgelaar
Test Date: March 9, 2016

Chan	Mode	EUT MHz	Average Channel Power dBm	Cable Loss dB	Linear vs power factor dB	Ave power dBm	Power mW	Limit dBm
1	802.11b	2412	10.9	0.6	1.0	12.5	17.7	30.0
1	802.11g	2412	6.4	0.6	1.0	8.0	6.3	30.0
1	802.11N	2412	4.5	0.6	1.0	6.1	4.0	30.0
6	802.11b	2437	13.0	0.6	1.0	14.6	28.6	30.0
6	802.11g	2437	8.1	0.6	1.0	9.7	9.3	30.0
6	802.11N	2437	7.7	0.6	1.0	9.3	8.5	30.0
11	802.11b	2462	11.3	0.6	1.0	12.9	19.4	30.0
11	802.11g	2462	7.1	0.6	1.0	8.7	7.4	30.0
11	802.11N	2462	6.4	0.6	1.0	8.0	6.3	30.0

Judgment: Pass
This is used for RF exposure calculations



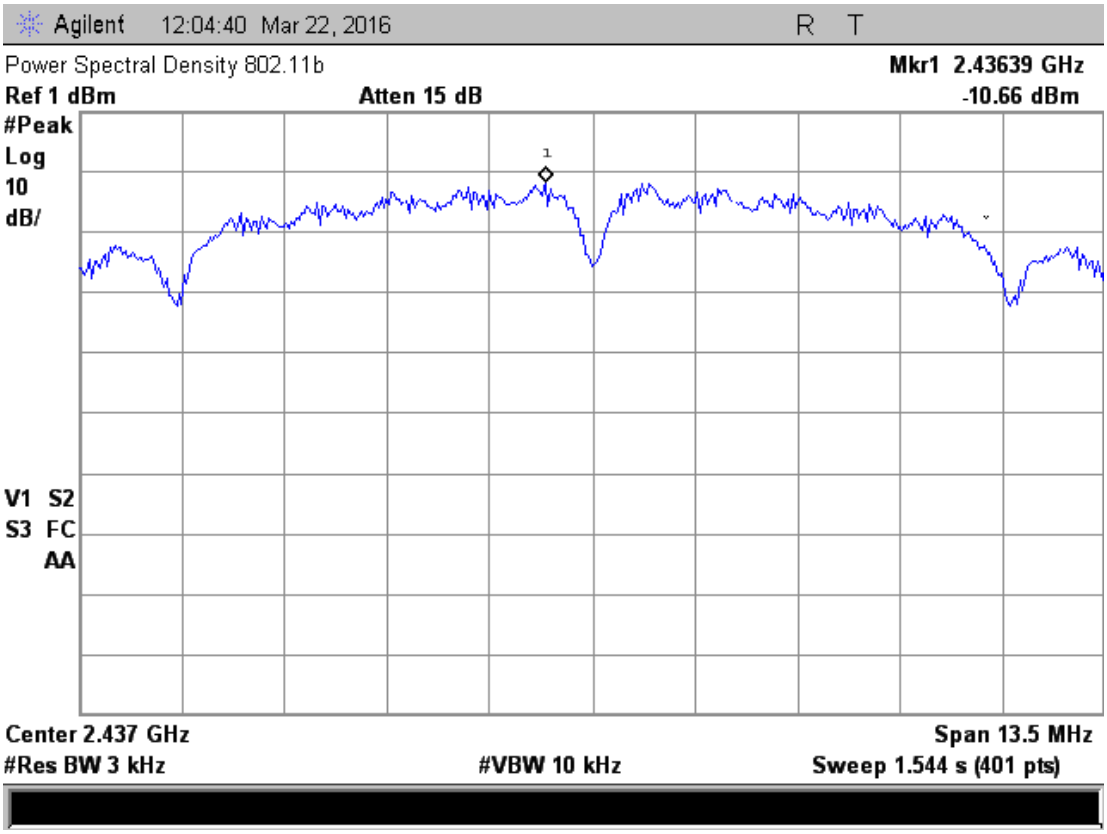
11.5 Power Spectral Density

The PSD test method from ANSI C63.10 section 11.10.2 and FCC DTS Measurement Guideline 558074 D01, Section 10.2. The spectrum analyzer was set to the following settings:

Tested by: Richard Tichgelaar
Test Date: March 8, 2016
Span = 1.5x DTS Bandwidth; RBW = 3 kHz; VBW = 10 kHz

Chan	Mode	EUT MHz	Analyzer reading dBm	Cable Loss dB	Peak 3 kHz PSD	Limit dBm	Margin dB
1	802.11b	2412	-12.7	0.6	-12.1	8.0	20.1
1	802.11g	2412	-14.2	0.6	-13.6	8.0	21.6
1	802.11N	2412	-13.9	0.6	-13.3	8.0	21.3
6	802.11b	2437	-10.7	0.6	-10.1	8.0	18.1
6	802.11g	2437	-12.7	0.6	-12.1	8.0	20.1
6	802.11N	2437	-11.7	0.6	-11.1	8.0	19.1
11	802.11b	2462	-11.8	0.6	-11.2	8.0	19.2
11	802.11g	2462	-14.3	0.6	-13.7	8.0	21.7
11	802.11N	2462	-14.6	0.6	-14.0	8.0	22.0

Judgment: Passed by 18.1 dB



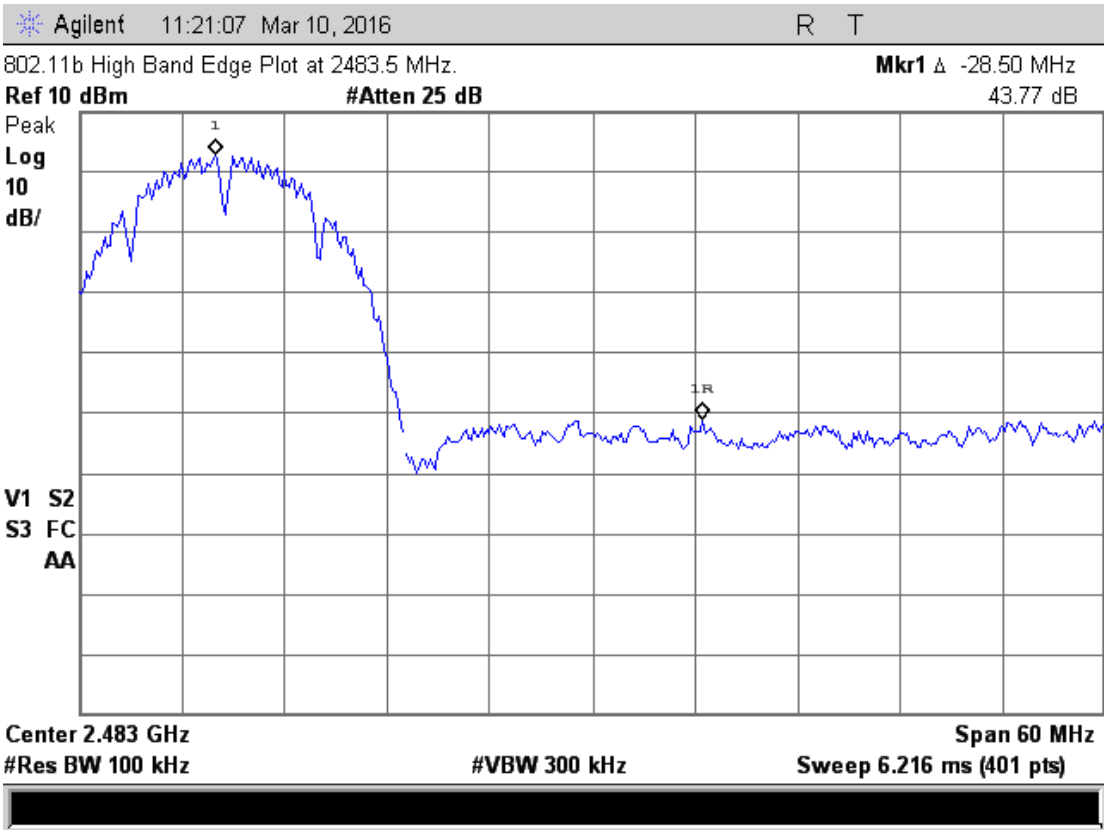
11.6 Band-edge Compliance of RF Conducted Emissions

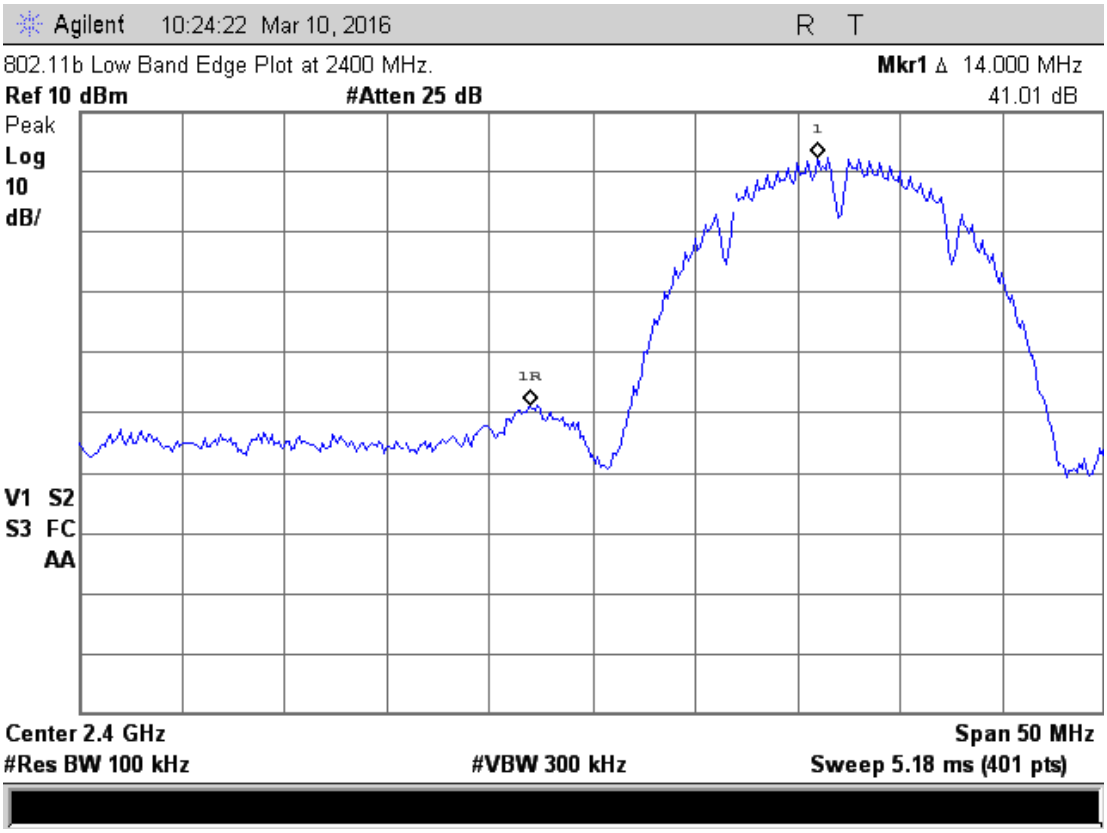
The Band Edge is in accordance to ANSI C63.10 sections 11.13.2. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

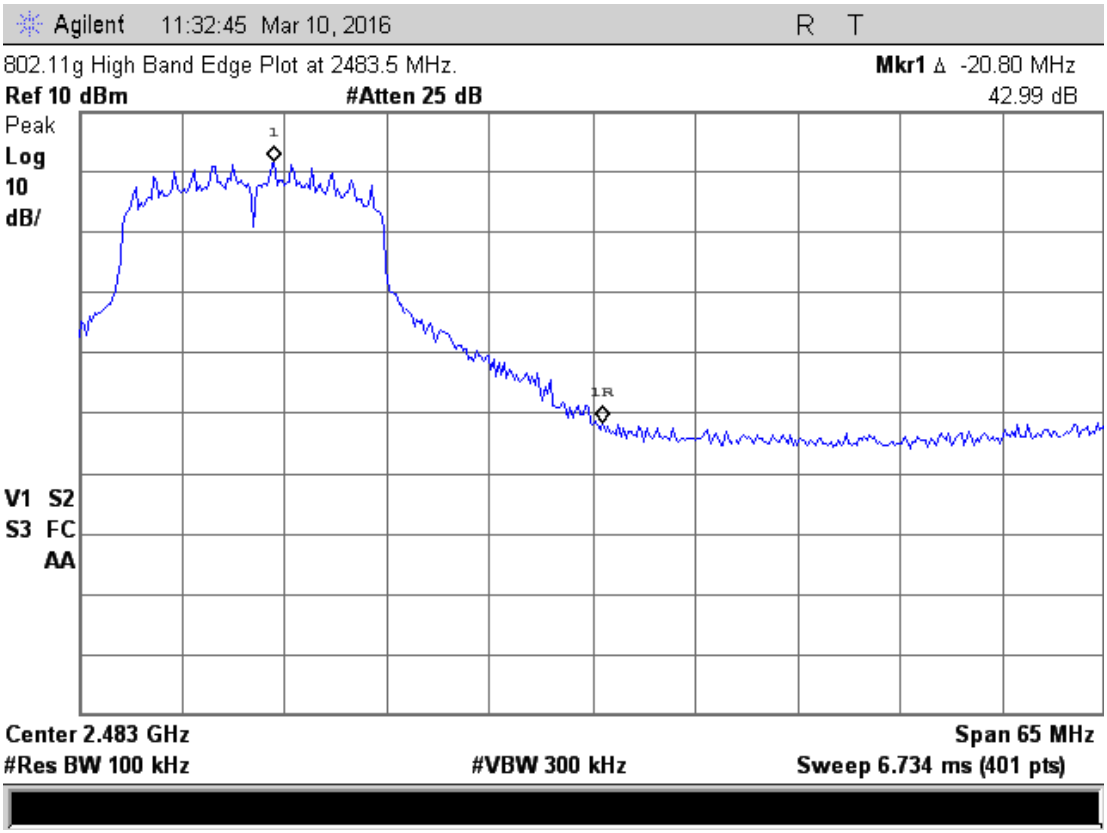
Tested by: Richard Tichgelaar
Test Date: March 10, 2016

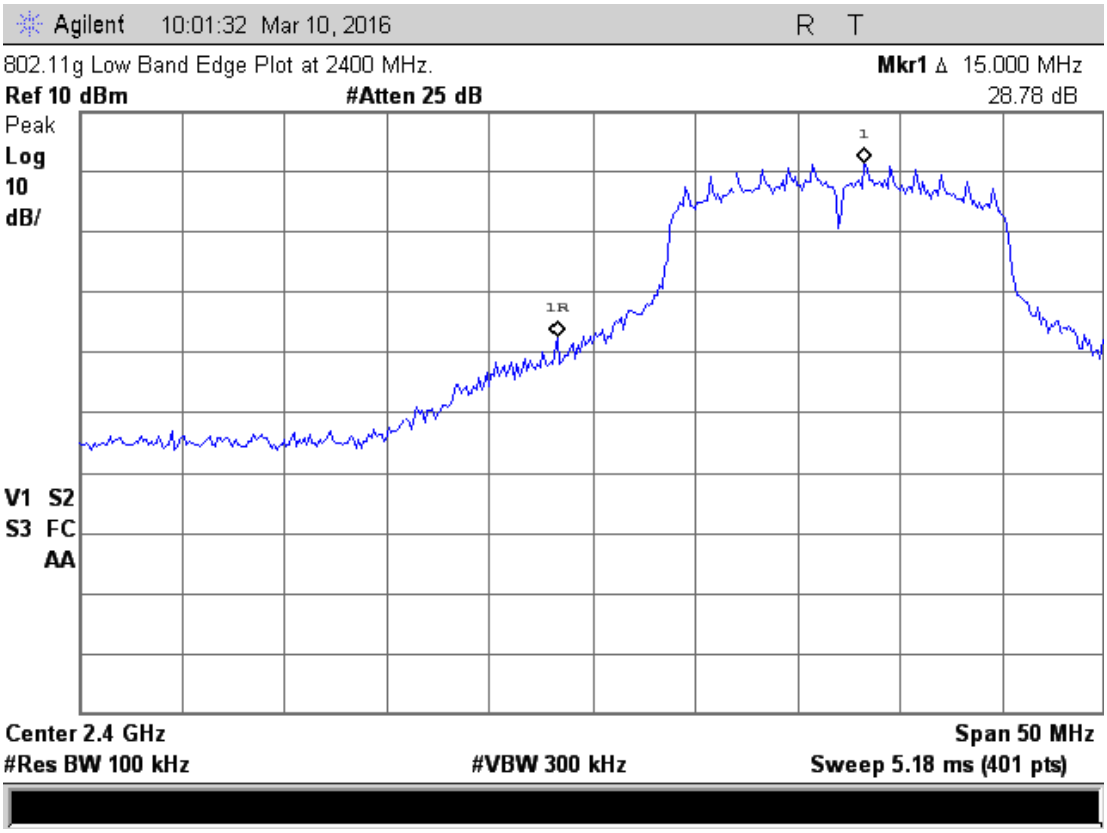
Channel	Band Edge Delta Readings in dB				
	Freq (MHz)	802.11b	802.11g	802.11N	Limit
2412 Lower Band edge	2400	41.0	28.8	30.7	20
2462 Upper Band edge	2483.5	43.8	43.0	43.2	20

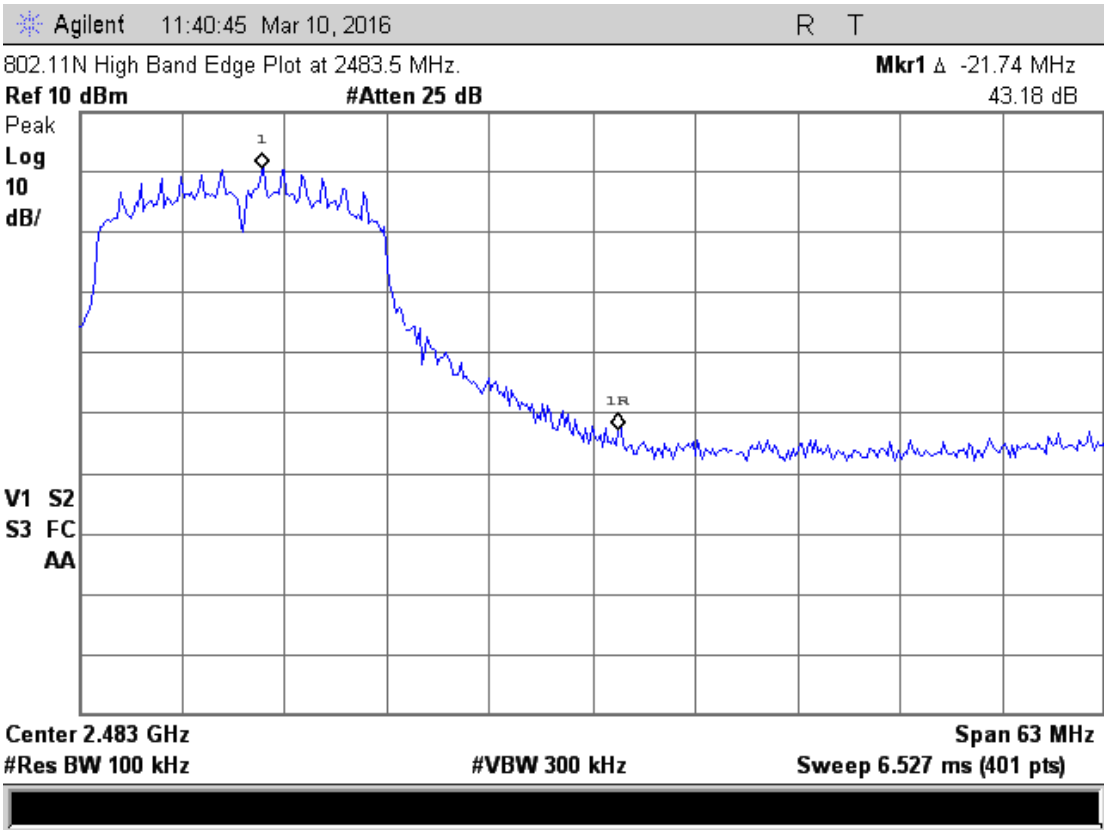
Judgment: Passed by 8.8 dB

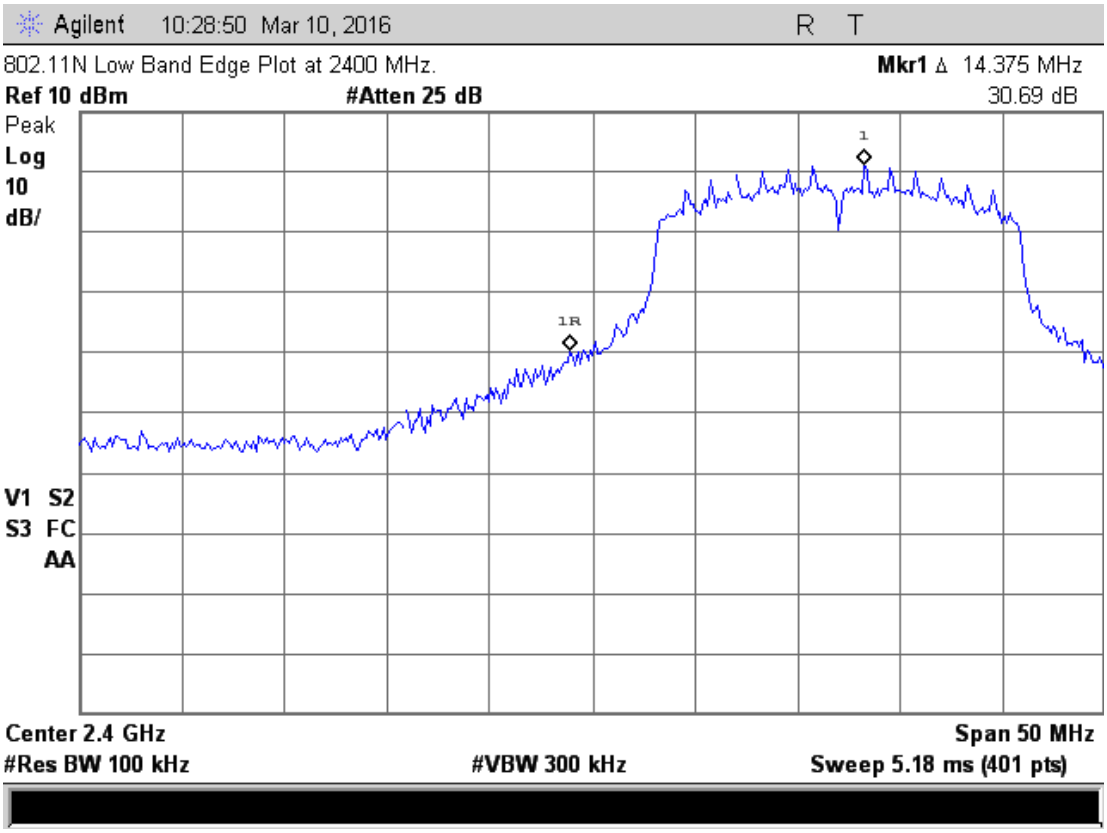



Agilent 10:24:22 Mar 10, 2016
R T
802.11b Low Band Edge Plot at 2400 MHz.
Mkr1 Δ 14.000 MHz
Ref 10 dBm
#Atten 25 dB
41.01 dB
Peak
Log
10
dB/
1
1R
V1 S2
S3 FC
AA
Center 2.4 GHz
Span 50 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 5.18 ms (401 pts)


Agilent 11:32:45 Mar 10, 2016
R T
802.11g High Band Edge Plot at 2483.5 MHz.
Mkr1 Δ -20.80 MHz
Ref 10 dBm
#Atten 25 dB
42.99 dB
Peak
Log
10
dB/
1
1R
V1 S2
S3 FC
AA
Center 2.483 GHz
Span 65 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 6.734 ms (401 pts)


Agilent 10:01:32 Mar 10, 2016
R T
802.11g Low Band Edge Plot at 2400 MHz.
Mkr1 Δ 15.000 MHz
Ref 10 dBm
#Atten 25 dB
28.78 dB
Peak
Log
10
dB/
1
1R
V1 S2
S3 FC
AA
Center 2.4 GHz
Span 50 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 5.18 ms (401 pts)

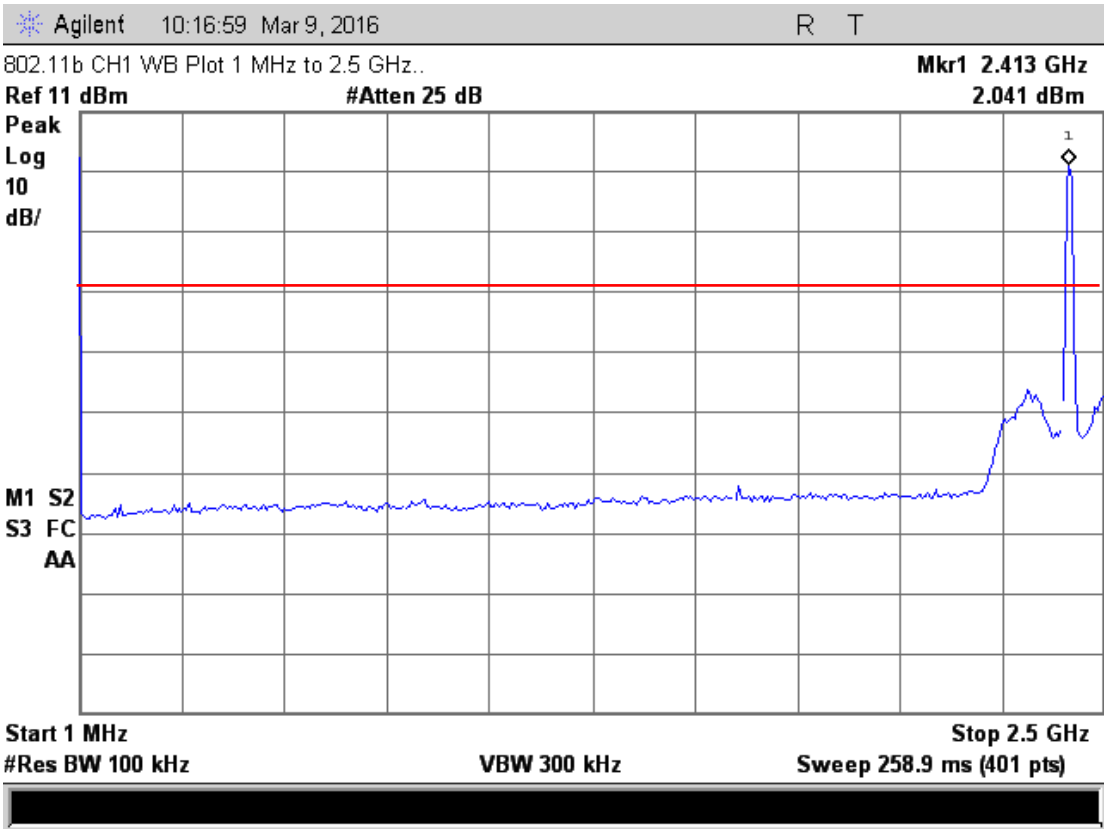

Agilent 11:40:45 Mar 10, 2016
R T
802.11N High Band Edge Plot at 2483.5 MHz.
Mkr1 Δ -21.74 MHz
Ref 10 dBm
#Atten 25 dB
43.18 dB
Peak
Log
10
dB/
1
1R
V1 S2
S3 FC
AA
Center 2.483 GHz
Span 63 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 6.527 ms (401 pts)

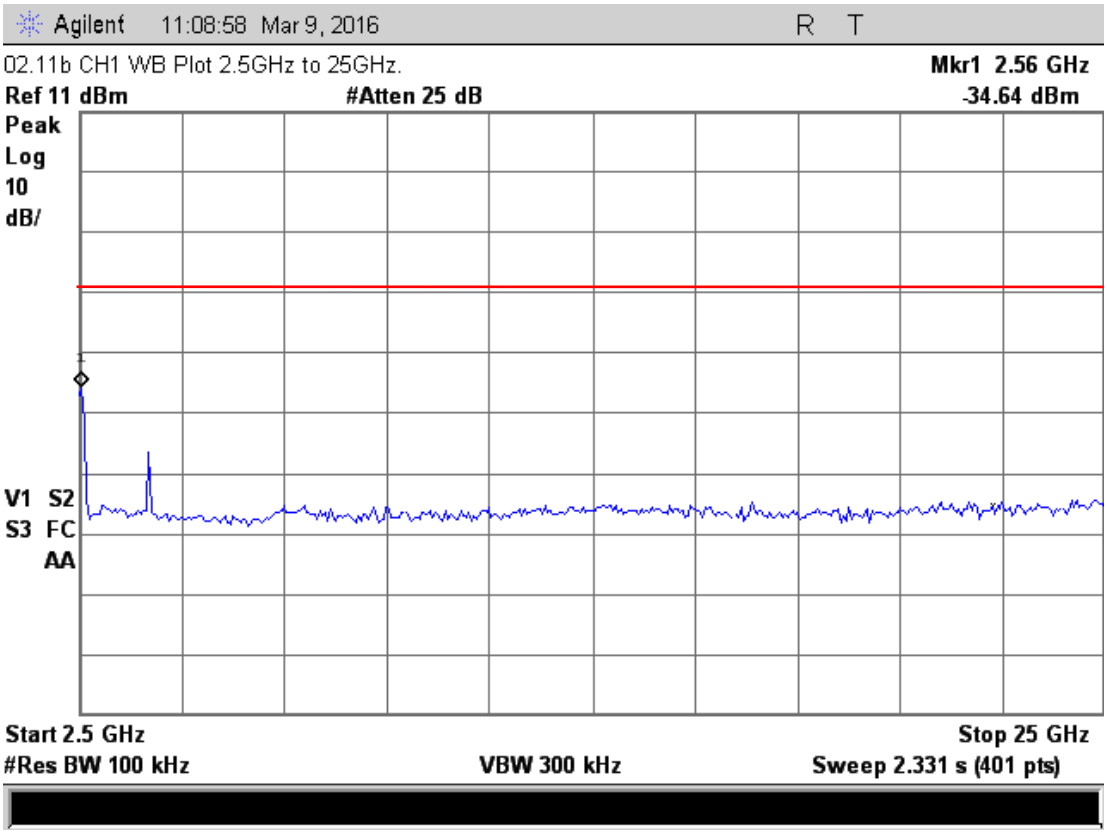


11.7 Spurious RF Conducted Emissions at Antenna Port

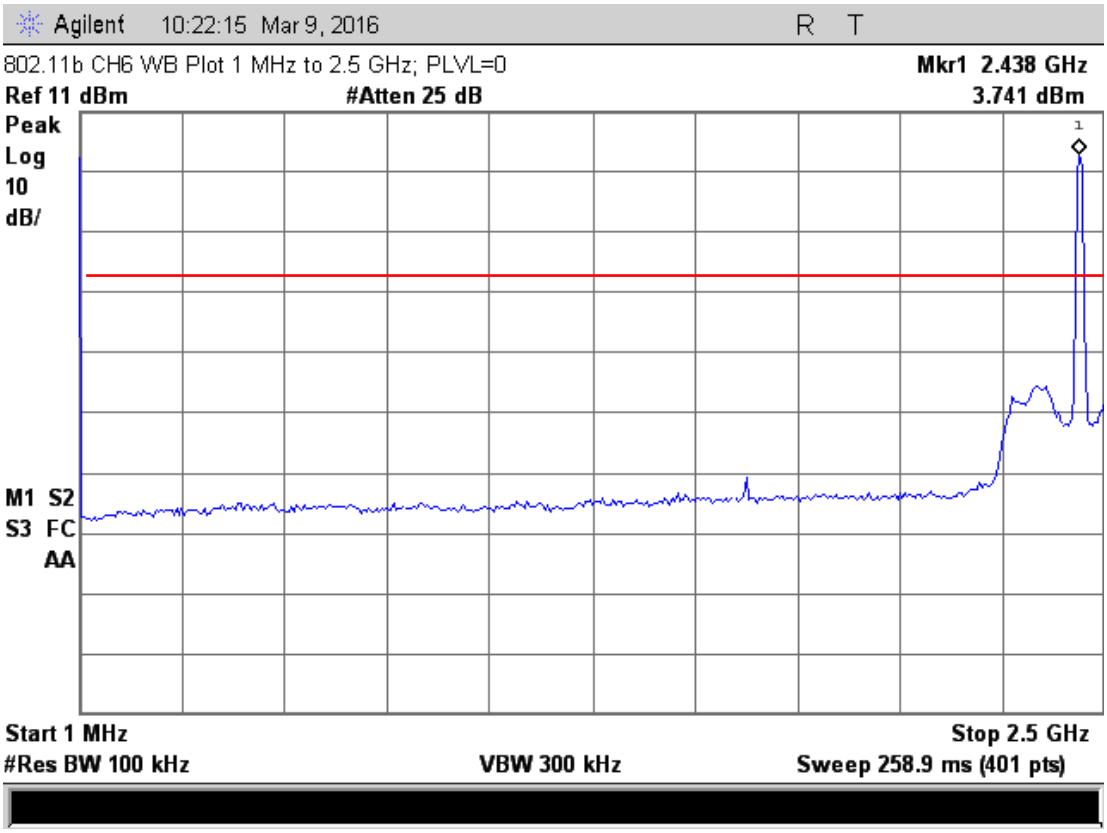
The spectrum analyzer was set to the MAX HOLD mode to record all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonic. The trace was allowed to stabilize. The first two plots were made while stepping through three frequencies (Low middle and high). Each frequency was on for 30 seconds.

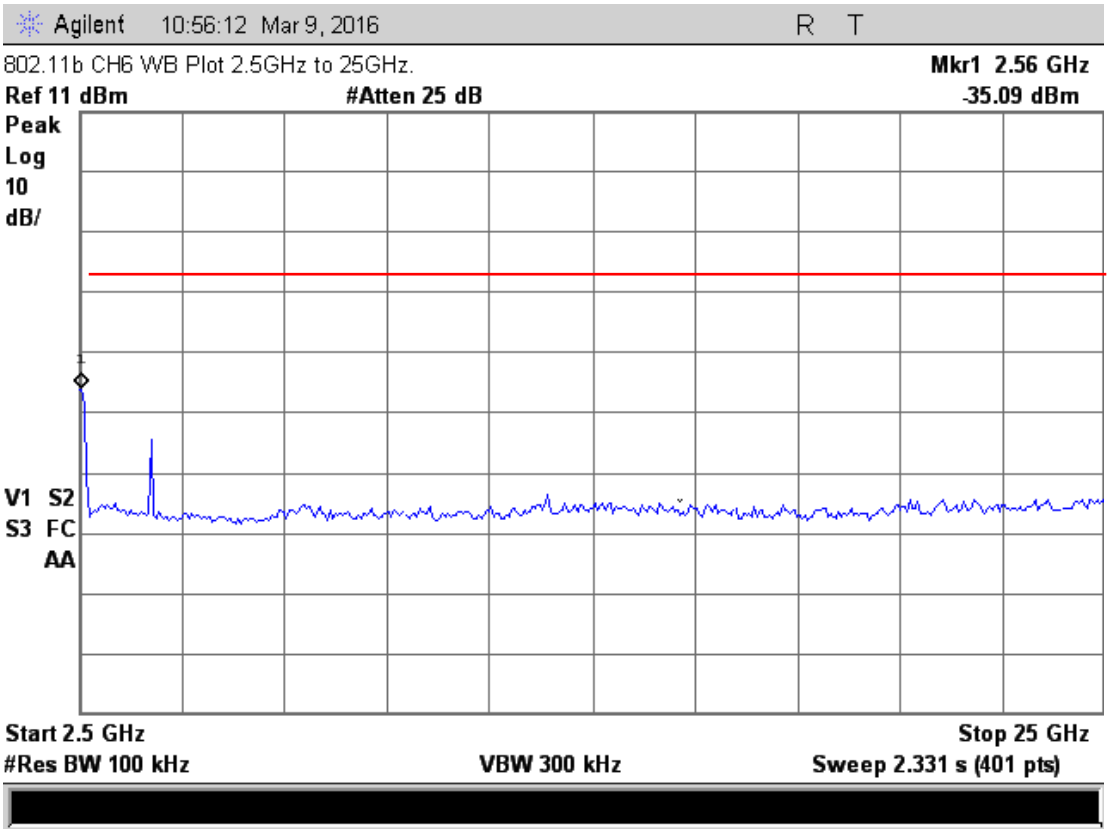
802.11b Chan 1


Agilent 10:16:59 Mar 9, 2016
R T
802.11b CH1 WB Plot 1 MHz to 2.5 GHz..
Mkr1 2.413 GHz
Ref 11 dBm
#Atten 25 dB
2.041 dBm
Peak
Log
10
dB/
M1 S2
S3 FC
AA
Start 1 MHz
Stop 2.5 GHz
#Res BW 100 kHz
VBW 300 kHz
Sweep 258.9 ms (401 pts)

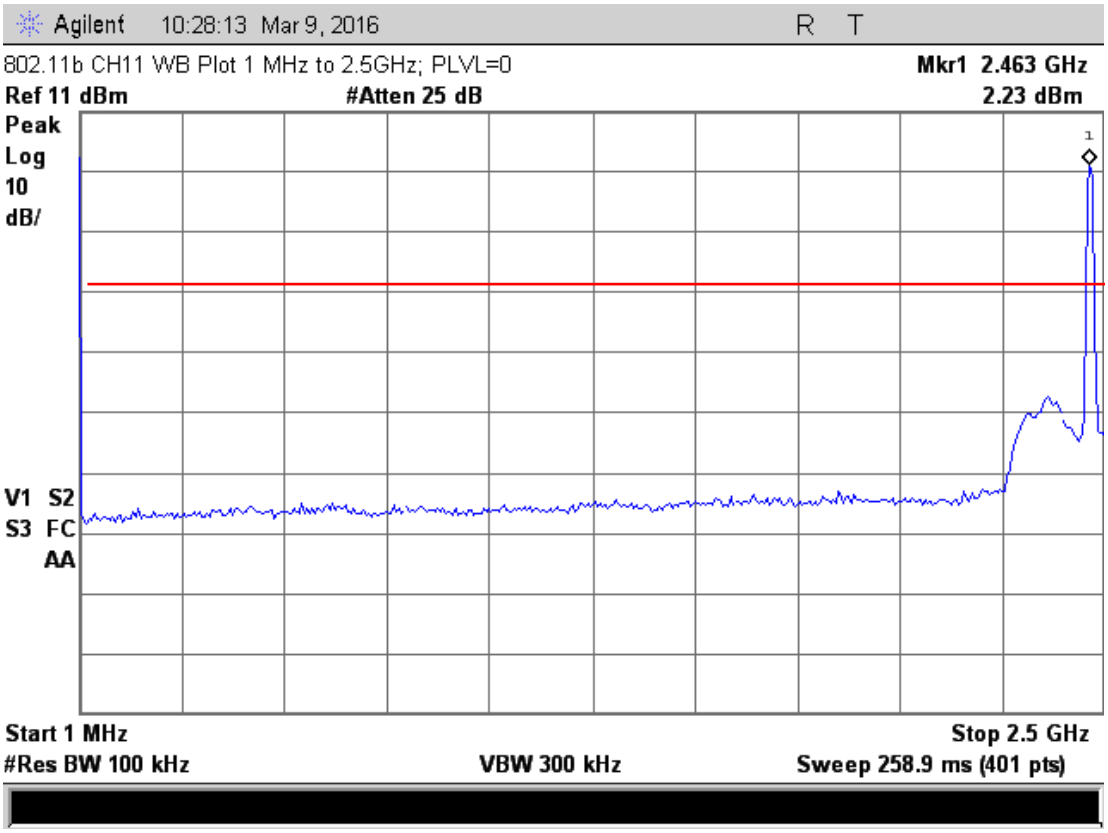

Agilent 11:08:58 Mar 9, 2016
R T
02.11b CH1 WB Plot 2.5GHz to 25GHz.
Mkr1 2.56 GHz
Ref 11 dBm
#Atten 25 dB
-34.64 dBm
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Start 2.5 GHz
Stop 25 GHz
#Res BW 100 kHz
VBW 300 kHz
Sweep 2.331 s (401 pts)

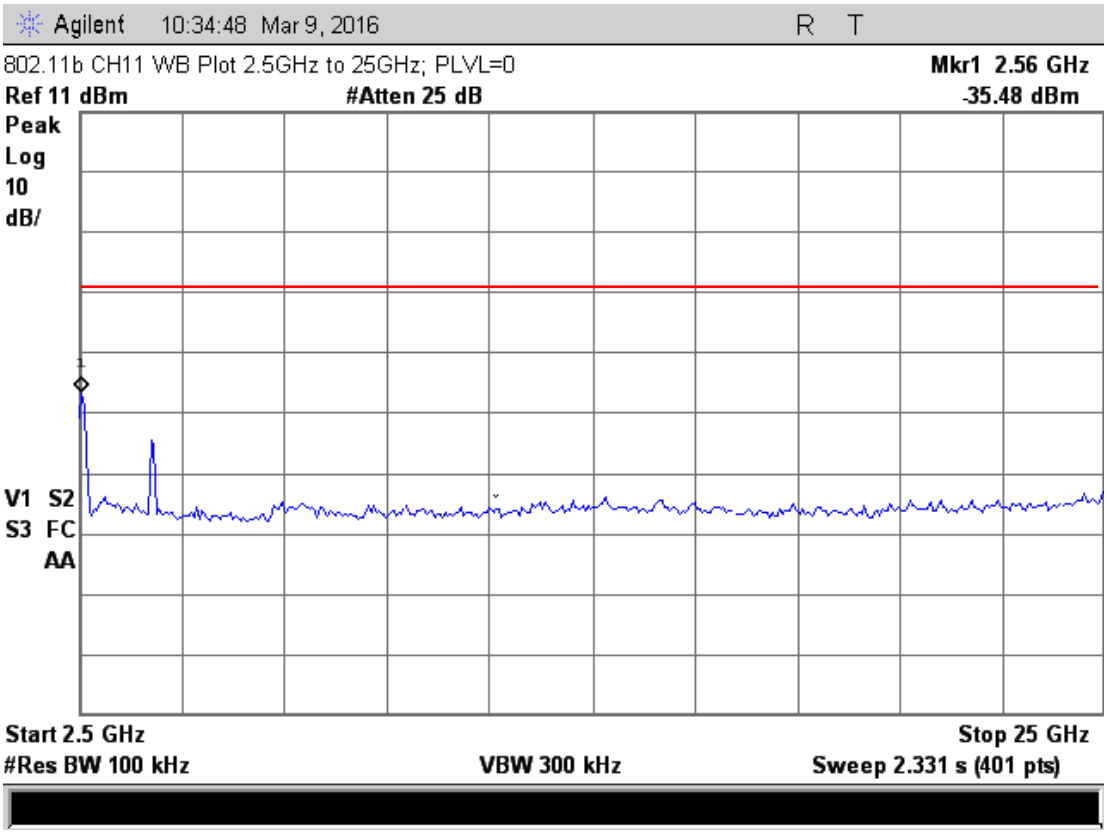
802.11b Channel 6



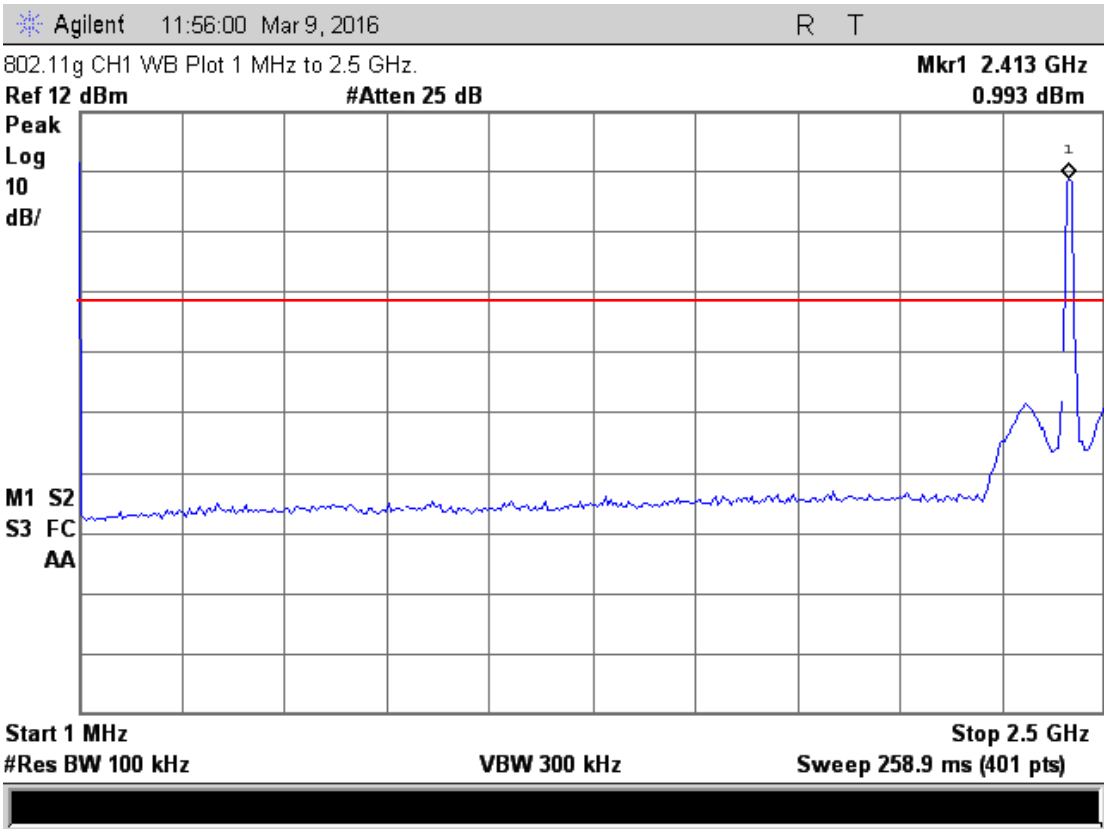


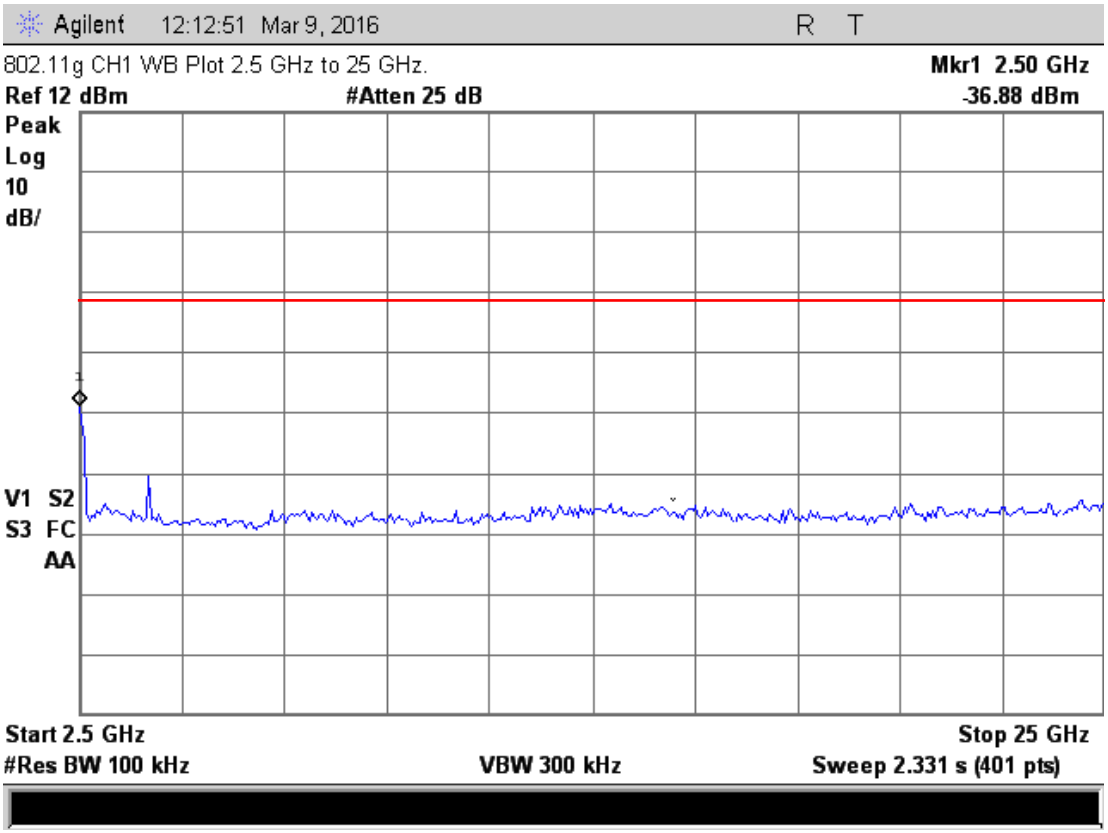
802.11b Channel 11



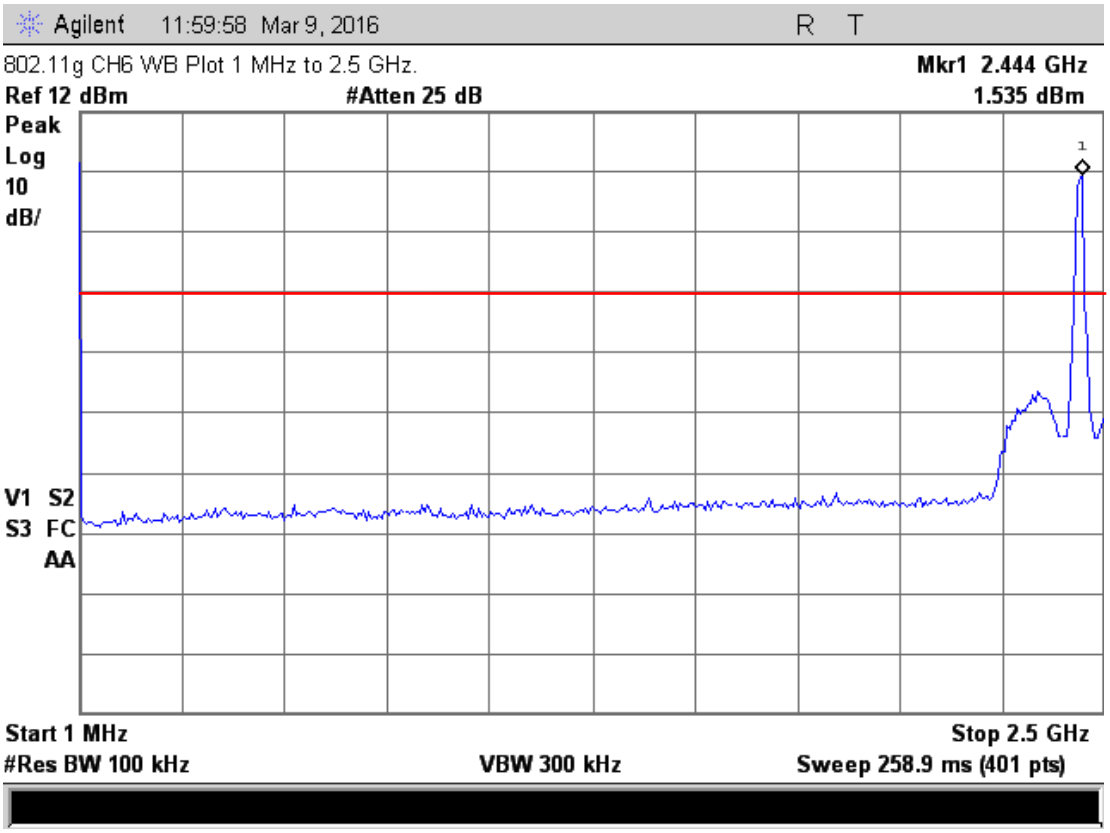


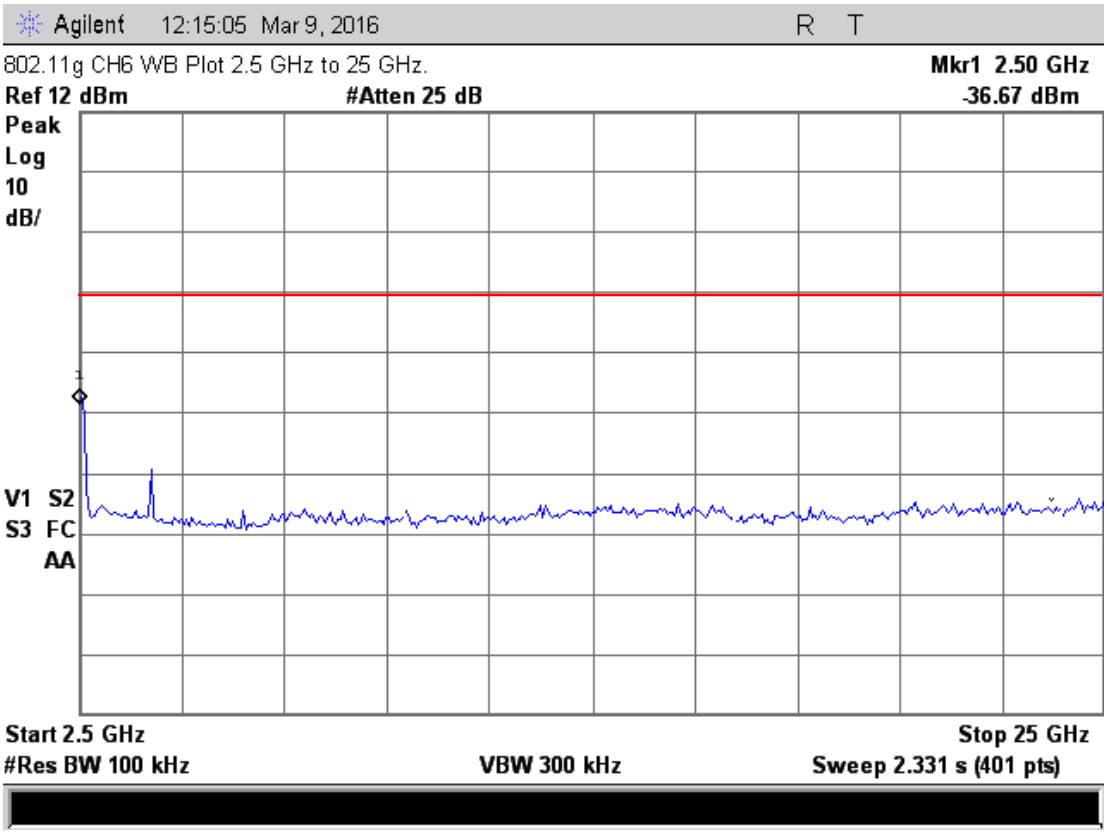
802.11g Channel 1



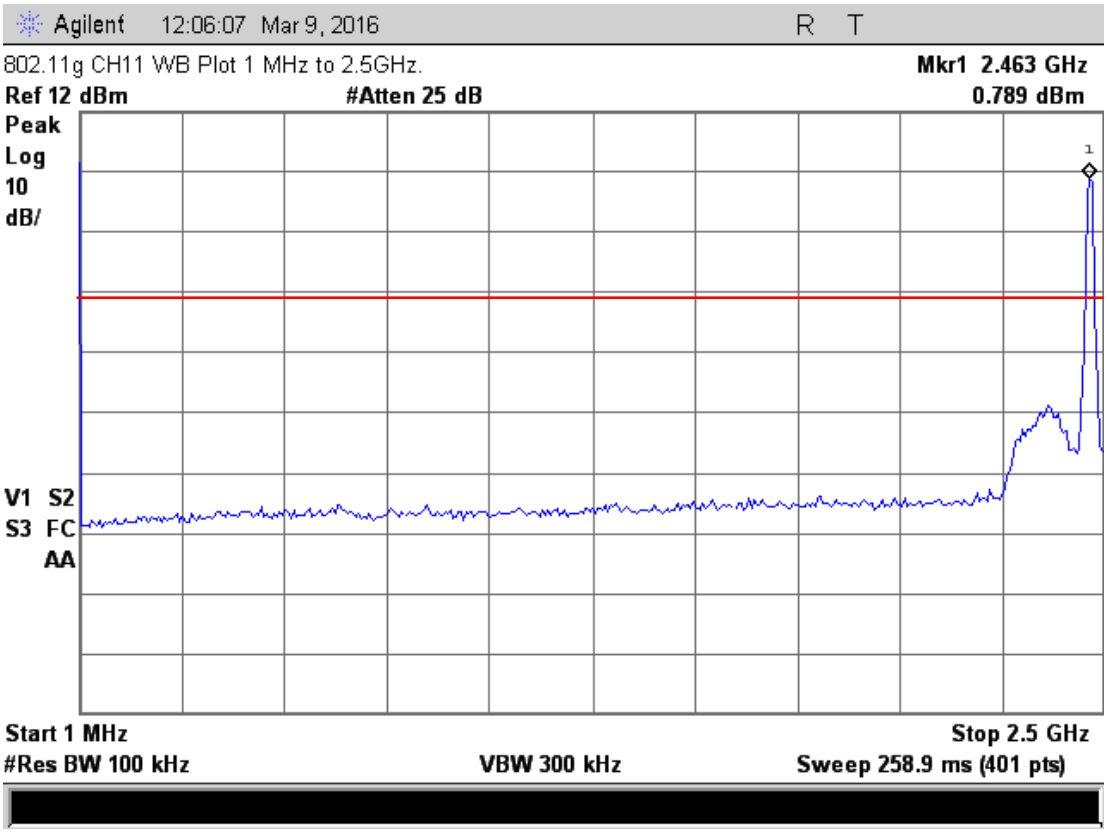


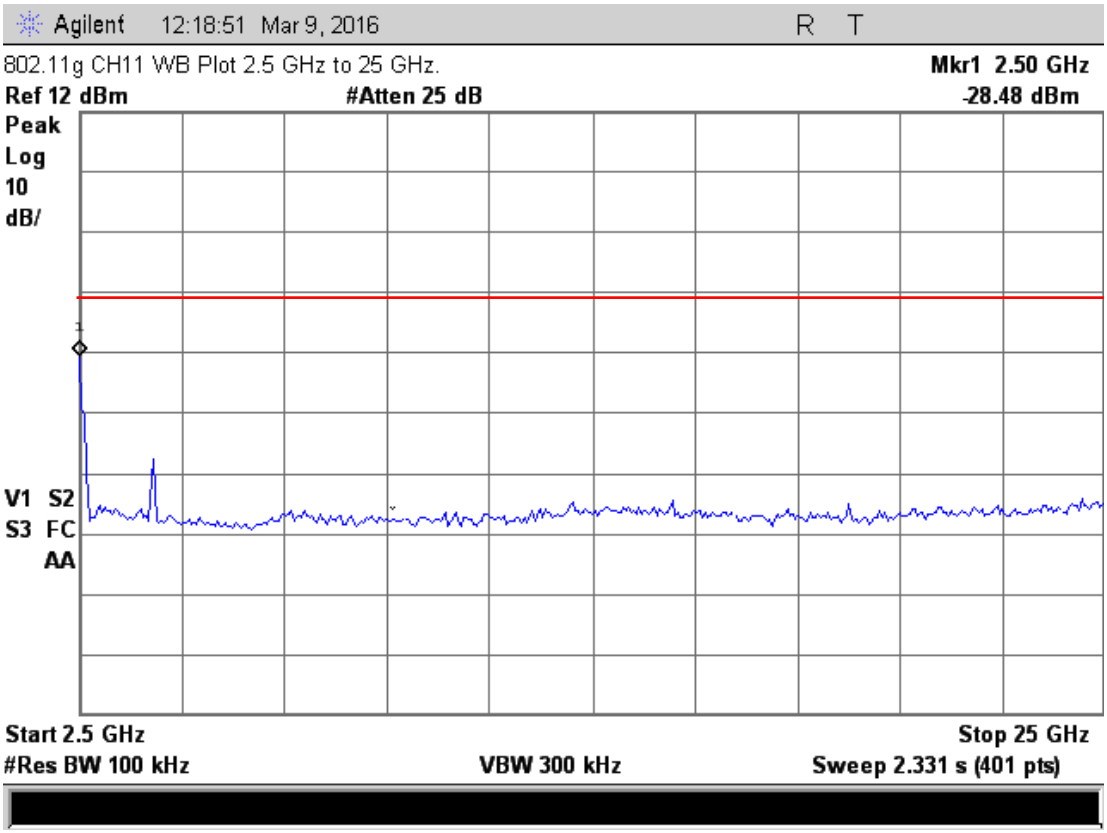
802.11g Channel 6

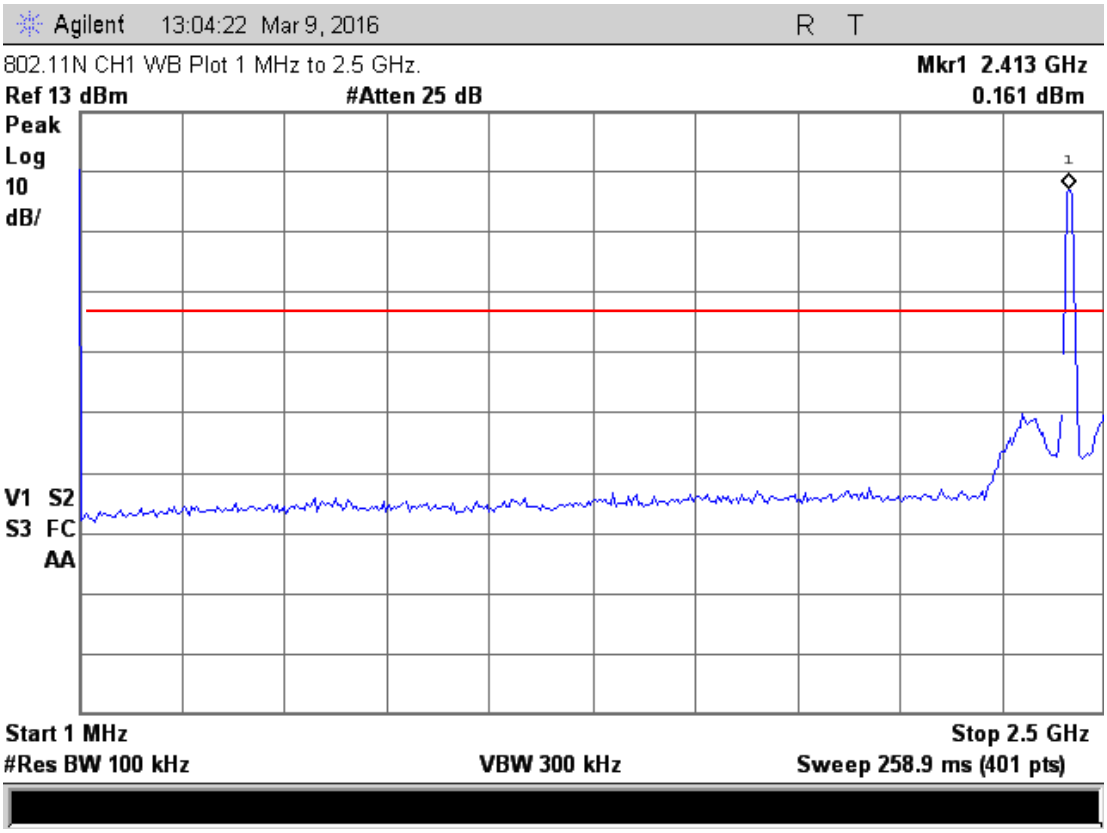




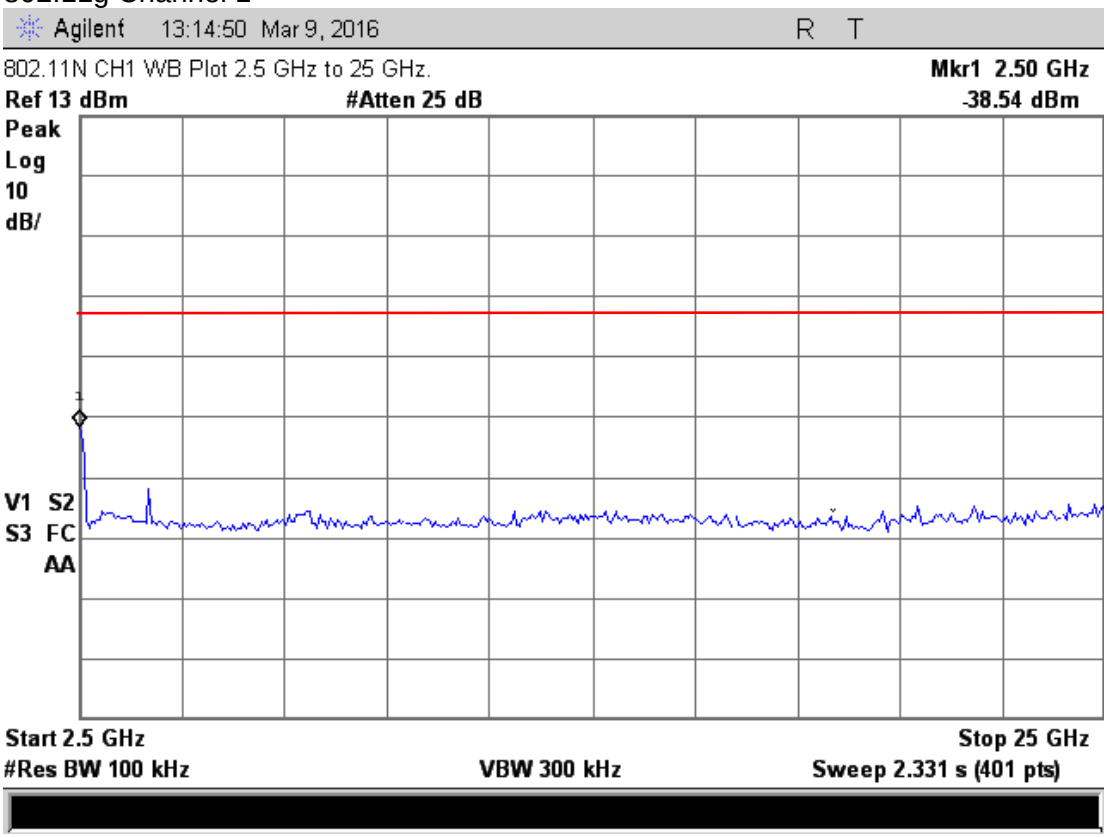
802.11g Channel 11

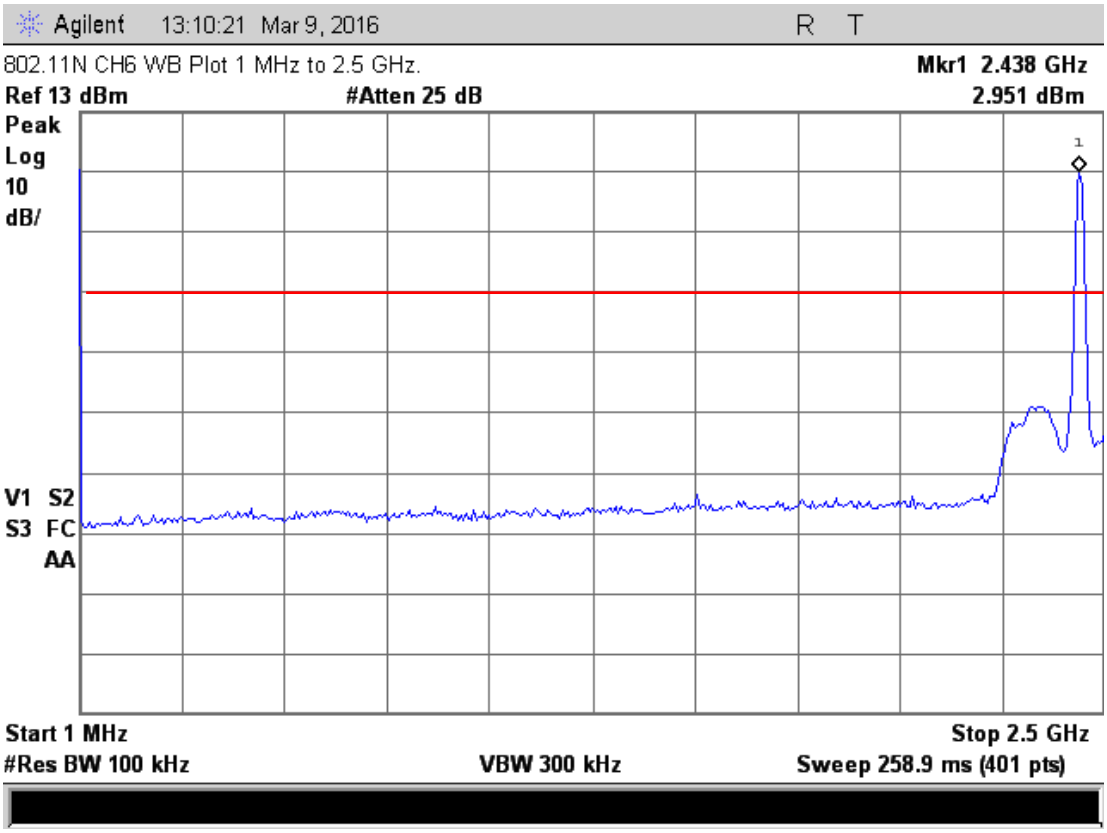

Agilent 12:06:07 Mar 9, 2016
R T
802.11g CH11 WB Plot 1 MHz to 2.5GHz.
Mkr1 2.463 GHz
Ref 12 dBm
#Atten 25 dB
0.789 dBm
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Start 1 MHz
Stop 2.5 GHz
#Res BW 100 kHz
VBW 300 kHz
Sweep 258.9 ms (401 pts)

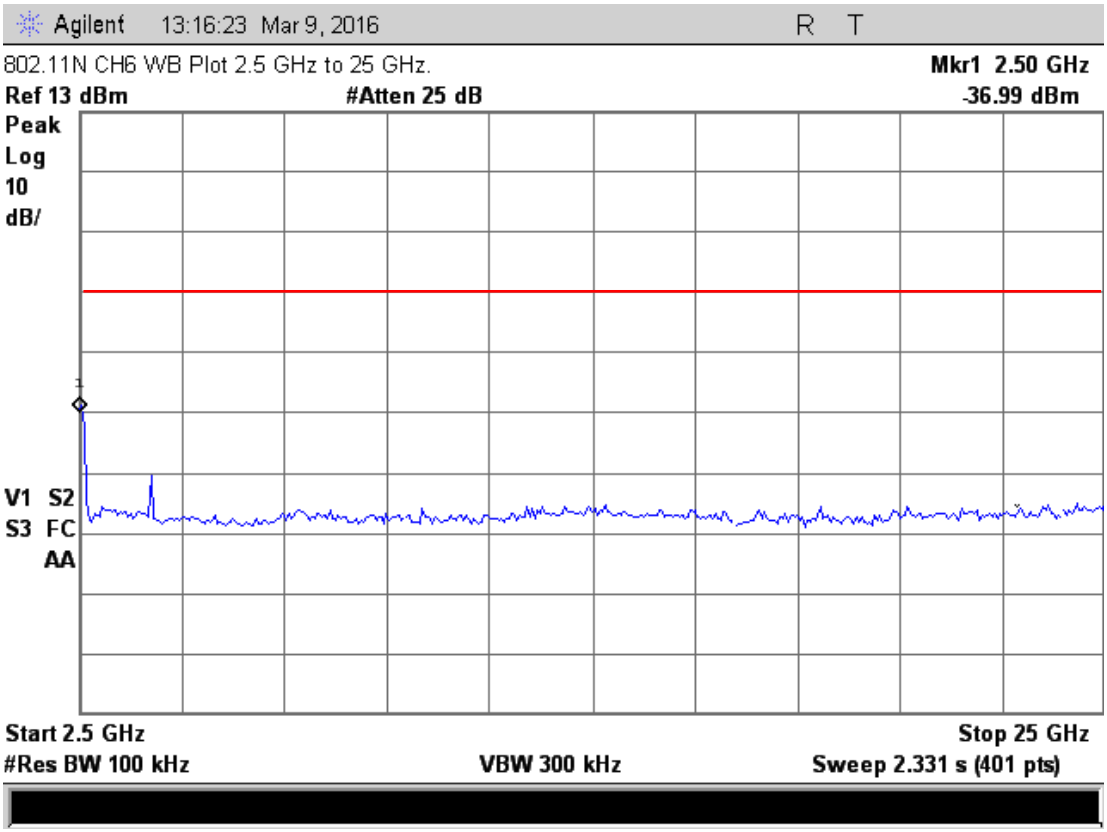

Agilent 12:18:51 Mar 9, 2016
R T
802.11g CH11 WB Plot 2.5 GHz to 25 GHz.
Mkr1 2.50 GHz
Ref 12 dBm
#Atten 25 dB
-28.48 dBm
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Start 2.5 GHz
Stop 25 GHz
#Res BW 100 kHz
VBW 300 kHz
Sweep 2.331 s (401 pts)

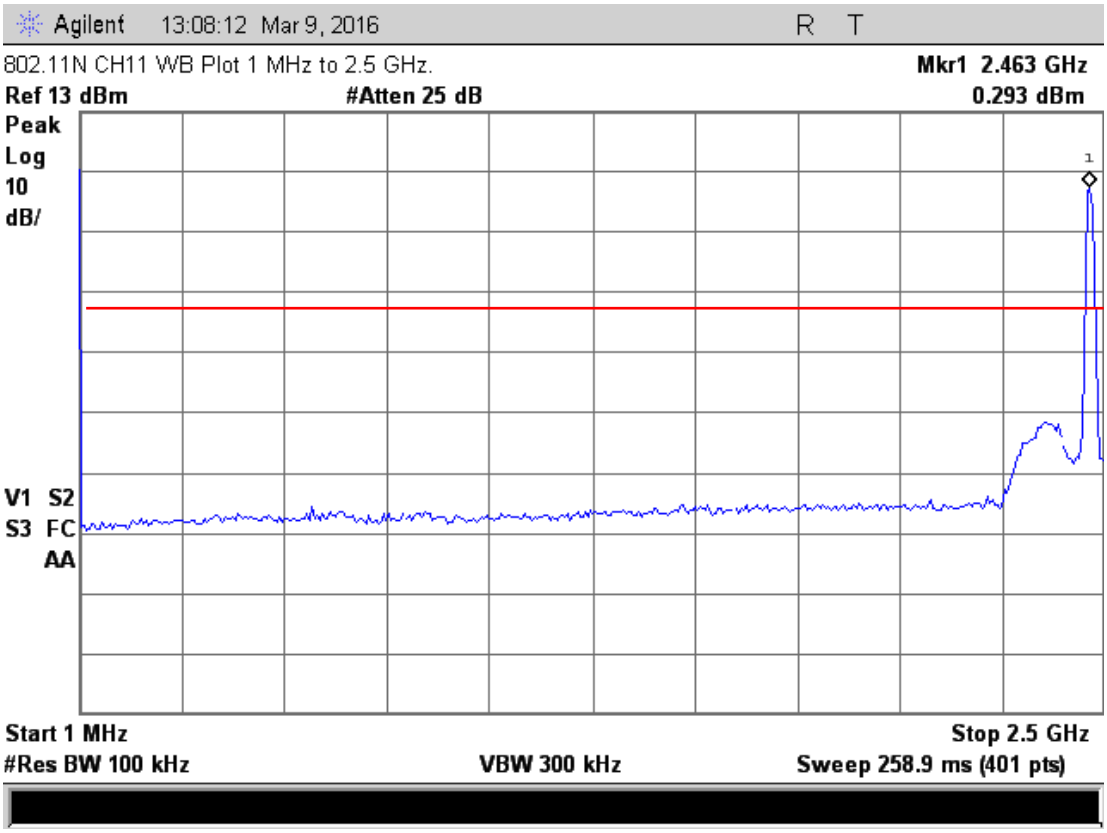


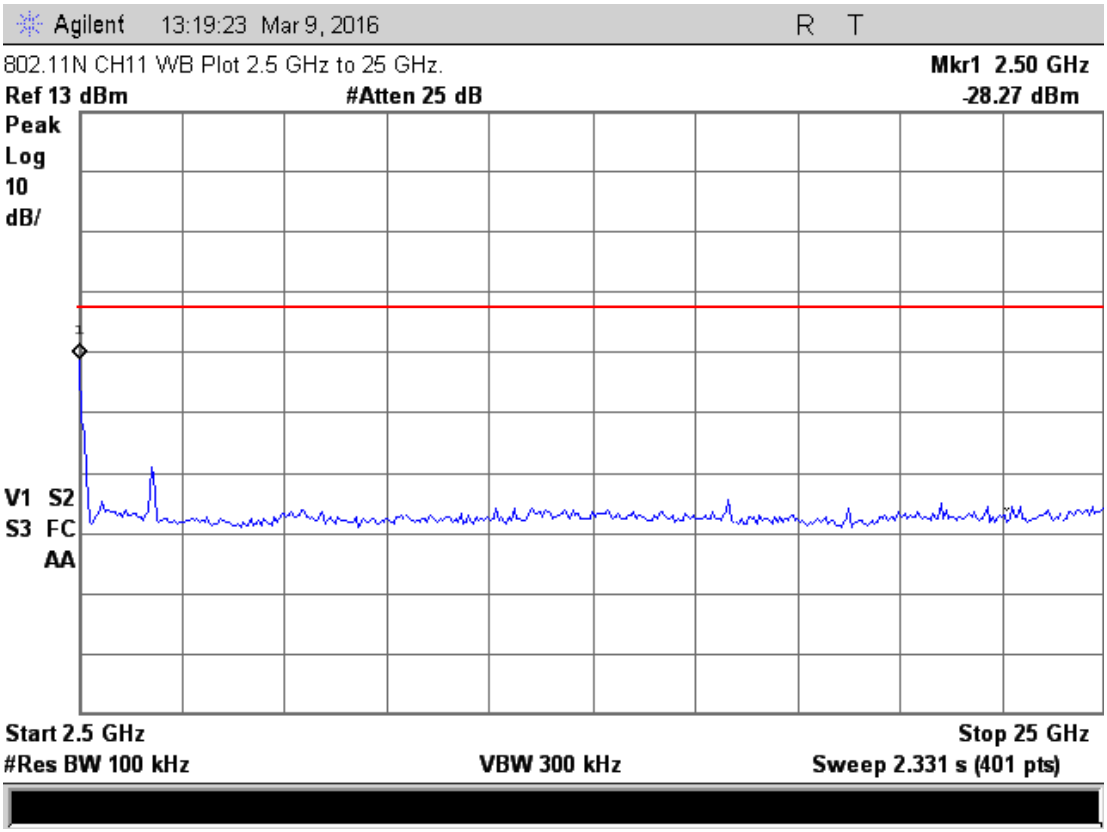
802.11g Channel 1




Agilent 13:10:21 Mar 9, 2016
R T
802.11N CH6 WB Plot 1 MHz to 2.5 GHz.
Mkr1 2.438 GHz
2.951 dBm
Ref 13 dBm
#Atten 25 dB
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Start 1 MHz
#Res BW 100 kHz
VBW 300 kHz
Stop 2.5 GHz
Sweep 258.9 ms (401 pts)


Agilent 13:16:23 Mar 9, 2016
R T
802.11N CH6 WB Plot 2.5 GHz to 25 GHz.
Mkr1 2.50 GHz
-36.99 dBm
Ref 13 dBm
#Atten 25 dB
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Start 2.5 GHz
#Res BW 100 kHz
VBW 300 kHz
Stop 25 GHz
Sweep 2.331 s (401 pts)





Judgement: Pass by at least 8 dB

11.8 Spurious Radiated Emissions (Restricted Band)

The procedures were in accordance to FCC DTS Measurement Guideline 558074 D01, Section 12.1 and ANSI C63.10.

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

For tests from 1 to 25 GHz, an E7405 spectrum analyzer was used. For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission. A harmonic mixer was used from 18 to 25 GHz. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

The was device was rotated through three orthogonal axis as per ANSI C63.10 during the radiated tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

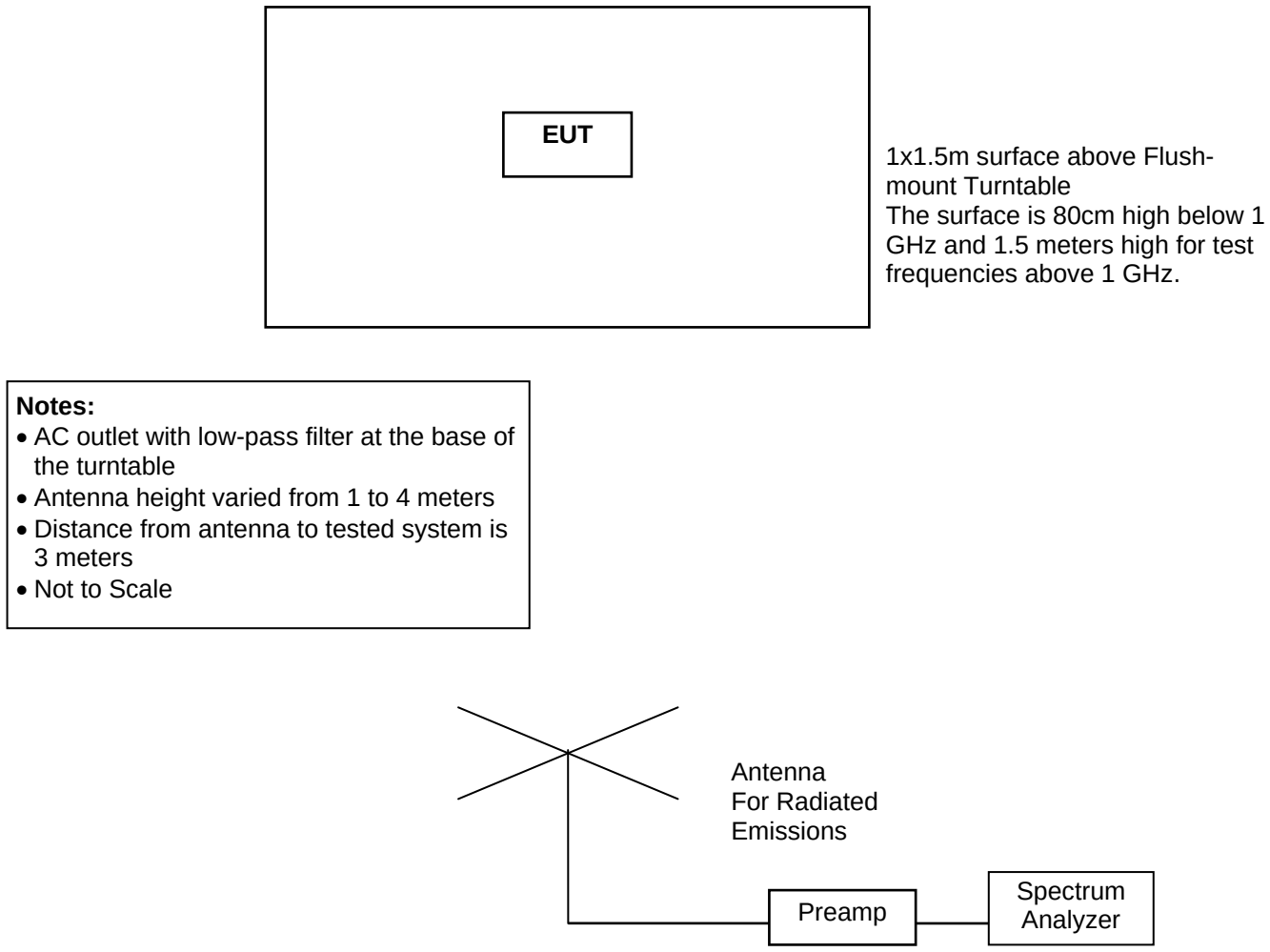
11.8.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF - AG

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
HPF = High pass Filter Loss

Figure 2. Drawing of Radiated Emissions Setup



11.8.2 Spurious Radiated Emissions Test Results (Restricted Band)

The following spectrum analyzer settings were used.

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

A Video Bandwidth of 10 Hz was used for Average measurements.

Testing of the Dwyer Instruments, Inc, Model SAH-22, Air Flow Hood

Manufacturer	Dwyer Instruments, Inc	Specification	FCC Part 15 Subpart C & RSS-210
Model	SAH-22	Test Date	3-4-16
Serial Number	0004	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP		
Tested by	Richard Tichgelaar		

Intentional Radiator emissions (30-1000 MHz Restricted bands)

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable Factors	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB
109.2	21.4	P	H	12.5	0.8	34.7	43.5	8.8
116.3	22.9	P	H	12.5	0.8	36.2	43.5	7.3
120.2	20.6	P	H	12.4	0.9	33.8	43.5	9.7
123.5	23.0	P	H	12.3	0.9	36.2	43.5	7.3
131.2	22.5	P	H	11.7	0.9	35.2	43.5	8.3
134.5	20.7	P	H	11.6	0.9	33.2	43.5	10.3
138.4	21.6	P	H	11.6	0.9	34.1	43.5	9.4
149.4	20.3	P	H	13.0	1.0	34.3	43.5	9.2
156.5	19.9	P	H	14.5	1.0	35.4	43.5	8.1
243.9	14.6	P	H	16.1	1.3	31.9	46.0	14.1
247.8	10.6	P	H	16.7	1.3	28.5	46.0	17.5
254.4	19.2	P	H	11.4	1.3	31.8	46.0	14.2
261.9	22.3	P	H	11.9	1.3	35.5	46.0	10.5
269.4	20.7	P	H	12.6	1.3	34.6	46.0	11.4
276.3	18.6	P	H	13.2	1.3	33.1	46.0	12.9
608.8	14.4	P	H	18.4	2.0	34.8	46.0	11.2
772.5	9.2	P	H	21.7	2.3	33.2	46.0	12.8
915.0	10.2	P	H	22.8	2.5	35.5	46.0	10.5
997.5	8.9	P	H	23.7	2.6	35.2	54.0	18.8
38.3	20.3	P	V	11.6	0.5	32.4	40.0	7.6
72.9	16.1	P	V	6.4	0.7	23.1	40.0	16.9
112.5	17.9	P	V	12.6	0.8	31.3	43.5	12.2
113.1	17.7	P	V	12.6	0.8	31.2	43.5	12.3
130.6	20.3	P	V	11.7	0.9	32.9	43.5	10.6
243.9	14.6	P	V	16.1	1.3	31.9	46.0	14.1
261.9	15.4	P	V	11.9	1.3	28.5	46.0	17.5
611.3	14.6	P	V	18.6	2.0	35.2	46.0	10.8

Judgement: Pass

Intentional Radiator emissions (1-25 GHz)
February 25 and 26, 2016
Tested by: Richard Tichgelaar

802.11b Mode

hrm #	Tx Freq MHz	Spectrum Analyzer Readings in dBuV				Corr. Fact dB	Emission Freq MHz	Field Strength				Margin Under Limit
		Vertical Polarization		Horizontal Polarization				EUT		Limit		
		Peak	Ave	Peak	Ave			dBuV/m				
1	2412	102.0	97.1	103.5	98.6	-3.1	2412.0	100.4	95.5	125	125	24.6
BE	2412	65.1	51.3	64.8	50.2	-3.4	2390.0	61.7	47.9	74	54	6.1
2	2412	48.3	43.4	48.3	43.4	6.3	4824.0	54.6	49.7	74	54	4.3
3	2412	42.7	37.8	43.3	38.4	12.0	7236.0	55.3	50.4	74	54	3.6
1	2437	101.9	97.0	102.6	97.7	-2.9	2437.0	99.7	94.8	125	125	25.3
2	2437	50.1	45.2	48.7	43.8	6.4	4874.0	56.5	51.6	74	54	2.4
3	2437	43.5	38.6	42.3	37.4	12.4	7311.0	55.9	51.0	74	54	3.0
1	2462	102.6	97.7	104.0	99.1	-2.9	2462.0	101.1	96.2	125	125	23.9
BE	2462	64.6	48.2	65.7	49.7	-3.0	2483.5	62.7	46.7	74	54	7.3
2	2462	49.5	44.6	48.5	43.6	6.5	4924.0	56.0	51.1	74	54	2.9
3	2462	42.9	38.0	42.4	37.5	12.5	7386.0	55.4	50.5	74	54	3.5
Column numbers (see below for explanations)												
1	2	3	4	5	6	7	8	9	10	11	12	13

The fundamental emissions are shown for information only. Compliance is based on conducted measurements.

Notes on Columns:
Column #1. hrm = Harmonic; BE = Band Edge emissions
Column #2. Frequency of Transmitter.
Column #3. Uncorrected Peak Vertical readings from spectrum analyzer. (Worst case from three axis rotation)
Column #4. Uncorrected Average reading; (Worst case from three axis rotation)
Column #5. Uncorrected Horizontal readings from the spectrum analyzer
Column #6. Uncorrected Horizontal Average reading; (Worst case from three axis rotation).
Column #7. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #8. Frequency of Tested Emission
Column #9. Highest peak field strength at listed frequency.
Column #10. Highest Average field strength at listed frequency.
Column #11. Peak Limit. All limits set to 74 dBuV/m.
Column #12. Average Limit. All limits set to 54 dBuV/m.
Column #13. The margin (last column) is the worst case margin under the peak or average limits for that row.

No other emissions were detected from 1 to 25 GHz, within 10 dB of the limits.

Judgment: Passed by 2.9 dB

February 25 and 26, 2016
Tested by: Richard Tichgelaar

802.11g Mode

hrm #	Tx Freq MHz	Spectrum Analyzer Readings in dBuV				Corr. Fact dB	Emission Freq MHz	Field Strength				Margin Under Limit
		Vertical Polarization		Horizontal Polarization				EUT		Limit		
		Peak	Ave	Peak	Ave			dBuV/m				
1	2412	104.0	96.0	105.0	97.0	-3.1	2412.0	101.9	93.9	125	125	23.1
BE	2412	68.6	51.1	69.5	52.7	-3.4	2390.0	66.1	49.3	74	54	4.7
2	2412	48.2	40.2	46.7	38.7	6.3	4824.0	54.5	46.5	74	54	7.5
3	2412	45.5	37.5	46.8	38.8	12.0	7236.0	58.8	50.8	74	54	3.2
1	2437	108.1	100.1	107.7	99.7	-2.9	2437.0	105.2	97.2	125	125	19.8
2	2437	49.2	41.2	49.9	41.9	6.4	4874.0	56.3	48.3	74	54	5.7
3	2437	46.5	38.1	45.0	37.0	12.4	7311.0	58.9	50.5	74	54	3.5
1	2462	106.5	98.5	107.7	99.7	-2.9	2462.0	104.8	96.8	125	125	20.2
BE	2462	69.8	51.4	70.6	53.8	-3.0	2483.5	67.6	50.8	74	54	3.2
2	2462	49.9	41.9	49.6	41.6	6.5	4924.0	56.4	48.4	74	54	5.6
3	2462	43.4	35.4	44.0	36.0	12.5	7386.0	56.5	48.5	74	54	5.5
Column numbers (see below for explanations)												
1	2	3	4	5	6	7	8	9	10	11	12	13

The fundamental emissions are shown for information only. Compliance is based on conducted measurements.

Notes on Columns:
Column #14. hrm = Harmonic; BE = Band Edge emissions
Column #15. Frequency of Transmitter.
Column #16. Uncorrected Peak Vertical readings from spectrum analyzer. (Worst case from three axis rotation)
Column #17. Uncorrected Average reading; (Worst case from three axis rotation)
Column #18. Uncorrected Horizontal readings from the spectrum analyzer
Column #19. Uncorrected Horizontal Average reading; (Worst case from three axis rotation).
Column #20. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #21. Frequency of Tested Emission
Column #22. Highest peak field strength at listed frequency.
Column #23. Highest Average field strength at listed frequency.
Column #24. Peak Limit. All limits set to 74 dBuV/m.
Column #25. Average Limit. All limits set to 54 dBuV/m.
Column #26. The margin (last column) is the worst case margin under the peak or average limits for that row.

No other emissions were detected from 1 to 25 GHz, within 10 dB of the limits.

Judgment: Passed by 3.2 dB

February 25 and 26, 2016
Tested by: Richard Tichgelaar

802.11N Mode

hrm #	Tx Freq MHz	Spectrum Analyzer Readings in dBuV				Corr. Fact dB	Emission Freq MHz	Field Strength				Margin Under Limit
		Vertical Polarization		Horizontal Polarization				EUT		Limit		
		Peak	Ave	Peak	Ave			dBuV/m				
1	2412	103.8	95.6	105.6	97.4	-3.1	2412.0	102.5	94.3	125	125	22.5
BE	2412	67.5	52.3	68.9	51.8	-3.4	2390.0	65.5	48.9	74	54	5.1
2	2412	48.3	40.1	47.2	39.0	6.3	4824.0	54.6	46.4	74	54	7.6
3	2412	45.5	37.3	46.1	37.9	12.0	7236.0	58.1	49.9	74	54	4.1
1	2437	109.3	101.1	106.9	98.7	-2.9	2437.0	106.4	98.2	125	125	18.6
2	2437	49.3	41.1	48.6	40.4	6.4	4874.0	55.7	47.5	74	54	6.5
3	2437	46.1	37.9	44.6	36.4	12.4	7311.0	58.5	50.3	74	54	3.7
1	2462	107.2	99.0	108.0	99.8	-2.9	2462.0	105.1	96.9	125	125	19.9
BE	2462	69.7	50.8	71.2	52.2	-3.0	2483.5	68.2	49.2	74	54	4.8
2	2462	48.3	40.1	50.0	41.8	6.5	4924.0	56.5	48.3	74	54	5.7
3	2462	44.1	35.9	43.2	35.0	12.5	7386.0	56.6	48.4	74	54	5.6
Column numbers (see below for explanations)												
1	2	3	4	5	6	7	8	9	10	11	12	13

The fundamental emissions are shown for information only. Compliance is based on conducted measurements.

Notes on Columns:
Column #27. hrm = Harmonic; BE = Band Edge emissions
Column #28. Frequency of Transmitter.
Column #29. Uncorrected Peak Vertical readings from spectrum analyzer. (Worst case from three axis rotation)
Column #30. Uncorrected Average reading; (Worst case from three axis rotation)
Column #31. Uncorrected Horizontal readings from the spectrum analyzer
Column #32. Uncorrected Horizontal Average reading; (Worst case from three axis rotation).
Column #33. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #34. Frequency of Tested Emission
Column #35. Highest peak field strength at listed frequency.
Column #36. Highest Average field strength at listed frequency.
Column #37. Peak Limit. All limits set to 74 dBuV/m.
Column #38. Average Limit. All limits set to 54 dBuV/m.
Column #39. The margin (last column) is the worst case margin under the peak or average limits for that row.

No other emissions were detected from 1 to 25 GHz, within 10 dB of the limits.

Judgment: Passed by 3.7 dB

11.9 Unintentional Emissions (Receive Mode)

Manufacturer	Dwyer Instruments, Inc	Specification	FCC Part 15.209 & RSS-210
Model	SAH-22	Test Date	March 4, 2016
Serial Number	0004	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP		
Tested by	Richard Tichgelaar		
Configuration	Receive mode		

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable Factors	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB
36.6	11.4	P	H	11.4	0.5	23.3	40.0	16.7
58.0	13.2	P	H	9.5	0.6	23.3	40.0	16.7
109.2	14.3	P	H	12.4	0.8	27.5	43.5	16.0
113.1	15.5	P	H	12.6	0.8	28.9	43.5	14.6
115.2	13.8	P	H	12.6	0.8	27.2	43.5	16.3
188.9	21.6	P	H	17.1	1.1	39.8	43.5	3.7
192.7	19.9	Q	H	16.8	1.1	37.8	43.5	5.7
196.4	22.3	Q	H	16.5	1.1	39.9	43.5	3.6
203.6	22.0	Q	H	15.9	1.1	39.0	43.5	4.5
210.9	21.9	Q	H	15.3	1.2	38.4	43.5	5.1
218.1	19.2	P	H	14.7	1.2	35.1	46.0	10.9
229.1	17.7	P	H	14.7	1.2	33.6	46.0	12.4
245.1	12.9	P	H	16.2	1.3	30.4	46.0	15.6
261.9	20.8	P	H	11.9	1.3	34.0	46.0	12.0
269.4	19.4	P	H	12.6	1.3	33.3	46.0	12.7
272.5	17.4	P	H	12.9	1.3	31.6	46.0	14.4
276.3	16.7	P	H	13.2	1.3	31.2	46.0	14.8
280.0	15.8	P	H	13.5	1.3	30.6	46.0	15.4
407.5	13.4	P	H	14.9	1.6	29.9	46.0	16.1
481.3	18.3	P	H	17.8	1.7	37.8	46.0	8.2
490.6	16.3	P	H	17.3	1.8	35.4	46.0	10.6
497.5	18.4	P	H	17.5	1.8	37.7	46.0	8.3
501.3	15.7	P	H	17.8	1.8	35.3	46.0	10.7
520.0	12.4	P	H	17.4	1.9	31.7	46.0	14.3
555.0	13.1	P	H	19.0	1.9	34.0	46.0	12.0
31.1	20.3	P	V	10.8	0.4	31.5	40.0	8.5
32.8	17.3	P	V	11.0	0.5	28.8	40.0	11.2
39.9	20.0	P	V	11.8	0.5	32.3	40.0	7.7
46.5	18.9	P	V	11.7	0.5	31.1	40.0	8.9
49.8	22.3	P	V	11.2	0.6	34.1	40.0	5.9
53.7	21.4	P	V	10.5	0.6	32.5	40.0	7.5
62.5	22.4	P	V	8.3	0.6	31.3	40.0	8.7
66.3	18.6	P	V	7.4	0.7	26.7	40.0	13.3
103.2	13.8	P	V	12.0	0.8	26.6	43.5	16.9
177.9	14.2	P	V	16.8	1.1	32.1	43.5	11.4
181.8	15.8	P	V	17.0	1.1	33.9	43.5	9.6
189.1	14.1	Q	V	17.1	1.1	32.3	43.5	11.2
196.6	18.5	P	V	16.5	1.1	36.1	43.5	7.4
203.8	19.4	P	V	15.8	1.1	36.3	43.5	7.2
210.9	17.7	Q	V	15.3	1.2	34.2	43.5	9.3

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable Factors	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB
225.8	14.3	P	V	14.6	1.2	30.1	46.0	15.9
342.5	14.1	P	V	13.9	1.5	29.5	46.0	16.5
446.3	12.5	P	V	16.1	1.7	30.3	46.0	15.7
495.6	16.9	P	V	17.4	1.8	36.1	46.0	9.9
500.0	15.6	P	V	17.8	1.8	35.2	46.0	10.8
507.5	16.4	P	V	17.9	1.8	36.1	46.0	9.9
608.8	13.7	P	V	18.4	2.0	35.1	46.0	10.9
751.3	10.9	P	V	20.2	2.2	35.3	46.0	10.7
761.3	11.0	P	V	20.4	2.2	36.6	46.0	9.4
891.3	11.3	P	V	21.1	2.5	38.9	46.0	7.1

No other emissions were detected from 30 MHz to 12.4 GHz within 10 dB of the limits.
Judgement: Pass