FCC TEST REPORT

For

Ockel Computers BV

Sirius A

Test Model: OCSA-0812

List Model No.: OCSA-0412, OCSA-0411, OCSA-0811, OCSA-0408, OCSA-0808

Prepared for	:	Ockel Computers BV
Address	:	Wegastraat 33-35, 2516 AN, Den Haag, Netherlands
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Address	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Tel	:	(+86)755-82591330
Fax	:	(+86)755-82591332
Web	:	www.LCS-cert.com
Mail	:	webmaster@LCS-cert.com
Date of receipt of test sample	:	December 16, 2017
Number of tested samples	:	2
Serial number	:	Prototype
Date of Test	:	December 16, 2017~April 26, 2018
Date of Report	:	April 27, 2018

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FCC TEST REPORT
FCC CFR 47 PART 15 C(15.247): 2017

Report Reference No.	:	**LCS171127013AEC**
Date of Issue	:	April 27, 2018
Testing Laboratory Name	:	**Shenzhen LCS Compliance Testing Laboratory Ltd.**
Address.....	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Testing Location/ Procedure	:	Full application of Harmonised standards ■ Partial application of Harmonised standards □ Other standard testing method □
Applicant's Name	:	**Ockel Computers BV**
Address.....	:	Wegastraat 33-35, 2516 AN, Den Haag, Netherlands
Test Specification		
Standard	:	FCC CFR 47 PART 15 C(15.247): 2017
Test Report Form No.....	:	LCSEMC-1.0
TRF Originator.....	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF.....	:	Dated 2011-03

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EUT Description.....	:	**Sirius A**
Trade Mark	:	OCKEL
Test Model.....	:	OCSA-0812
Ratings.....	:	DC 3.8V by Rechargeable Li-ion Battery(3500mAh) Recharged by DC 5V/2.5A SWITCHING ADAPTOR
Result	:	**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Leo Lee	Dick Su	Gavin Liang
Leo Lee/ File administrators	Dick Su/ Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS171127013AEC	April 27, 2018 Date of issue

EUT.....	: Sirius A
Test Model.....	: OCSA-0812
Applicant.....	**: Ockel Computers BV**
Address.....	: Wegastraat 33-35, 2516 AN, Den Haag, Netherlands
Telephone.....	: /
Fax.....	: /
Manufacturer.....	**: Yuko Technology Co.,Ltd**
Address.....	: Floor 6th, Building A9, TianRui Industrial Park, Fuyuan 1st Road, Xinhe Village, Fuyong, Shenzhen, China
Telephone.....	: /
Fax.....	: /
Factory.....	**: Yuko Technology Co.,Ltd**
Address.....	: Floor 6th, Building A9, TianRui Industrial Park, Fuyuan 1st Road, Xinhe Village, Fuyong, Shenzhen, China
Telephone.....	: /
Fax.....	: /

Test Result	**Positive**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Revision History

Revision	Issue Date	Revisions	Revised By
000	April 27, 2018	Initial Issue	Gavin Liang

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1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	Sirius A
Model Number	:	OCSA-0412, OCSA-0812, OCSA-0411, OCSA-0811, OCSA-0408, OCSA-0808
Model Declaration	:	PCB board, structure and internal of these model(s) are the same, Only the model name, DDR, flash and shell color is different for these models.
Test Model	:	OCSA-0812
Power Supply	:	DC 3.8V by Rechargeable Li-ion Battery(3500mAh) Recharged by DC 5V/2.5A SWITCHING ADAPTOR
Hardware Version	:	CT600_MB_V1.1
Software Version	:	Windows10 RS3
Bluetooth	:	
Frequency Range	:	2402-2480MHz
Channel Number	:	79 channels for Bluetooth V4.0 (BDR/EDR) 40 channels for Bluetooth V4.0 (BT LE)
Channel Spacing	:	1MHz for Bluetooth V4.0 (BDR/EDR) 2MHz for Bluetooth V4.0 (BT LE)
Modulation Type	:	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth V4.0 (BDR/EDR) GFSK for Bluetooth V4.0 (BT LE)
Bluetooth Version	:	V4.0
WIFI(2.4G Band)	:	
Frequency Range	:	2412-2462MHz
Channel Spacing	:	5MHz
Channel Number	:	11 channels for 20MHz bandwidth(2412~2462MHz) 7 channels for 40MHz bandwidth(2422~2452MHz)
Modulation Type	:	802.11b: DSSS(CCK,DQPSK,DBPSK); 802.11g/n: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI(5.2G Band)	:	
Frequency Range	:	5180-5240MHz
Channel Number	:	4 channels for 20MHz bandwidth(5180-5240MHz) 2 channels for 40MHz bandwidth(5190~5230MHz) 1 channels for 80MHz bandwidth(5210MHz)
Modulation Type	:	802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI(5.8G Band)	:	
Frequency Range	:	5745-5825MHz
Channel Number	:	5 channels for 20MHz bandwidth(5745-5825MHz) 2 channels for 40MHz bandwidth(5755~5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	:	802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
Antenna Description	:	
		Two same Monopole Antenna; ANT0(MAIN) used for WIFI TX/RX, 3.0dBi(Max.) for 2.4G Band and 5.0dBi(Max.) for 5G Band ANT1(AUX) used for WIFI/Bluetooth TX/RX, 3.0dBi(Max.) for 2.4G Band and 5.0dBi(Max.) for 5G Band

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
SONY	TV Set	KDL-32W700B	2011083	DOC
SHENZHEN FUJIA APPLIANCE CO., LTD	SWITCHING ADAPTER (for TV Set)	FJ-SW1904000F	/	DOC
Shenzhen Fujia Appliance Co.,Ltd.	SWITCHING ADAPTOR	FJ-SW1260502500UN	/	VOC

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
Display Port	1	N/A
HDMI Port	1	N/A
USB 3.0 Port	2	N/A
Ethernet Port	1	N/A
USB Type C Port	1	N/A
DC Power In Port	1	2.0m, unshielded
3.5mm Audio Port	1	N/A
Micro SD Card Slot	1	N/A

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1.4. Description of Test Facility

FCC Registration Number. is 254912.
Industry Canada Registration Number. is 9642A-1.
ESMD Registration Number. is ARCB0108.
UL Registration Number. is 100571-492.
TUV SUD Registration Number. is SCN1081.
TUV RH Registration Number. is UA 50296516-001
NVLAP Registration Code is 600167-0

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.5. Statement of the Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the LCS quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.10dB	(1)
		30MHz~200MHz	±2.96dB	(1)
		200MHz~1000MHz	±3.10dB	(1)
		1GHz~26.5GHz	±3.80dB	(1)
		26.5GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±1.63dB	(1)
Power disturbance	:	30MHz~300MHz	±1.60dB	(1)

(1). This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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1.7. Description of Test Modes

The EUT has been tested under operating condition.

This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.

AC power line conducted emission pre-test at both at AC 120V/60Hz and AC 240V/60Hz modes, recorded worst case.
Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power, which was determined to be IEEE 802.11n HT40 mode (Middle Channel, Combined Antenna Chain0 and Antenna Chain1).

Worst-case mode and channel used for 9 KHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be IEEE 802.11n HT40 mode (Middle Channel, Combined Antenna Chain0 and Antenna Chain1).

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:
802.11b Mode: 1 Mbps, DSSS.
802.11g Mode: 6 Mbps, OFDM.
802.11n Mode HT20: MCS0, OFDM.
802.11n Mode HT40: MCS0, OFDM.

Antenna & Bandwidth

Antenna	Chain 0 (ANT0)		Chain 1 (ANT1)		Simultaneously
Bandwidth Mode	20MHz	40MHz	20MHz	40MHz	/
IEEE 802.11b	☑	☐	☑	☐	☐
IEEE 802.11g	☑	☐	☑	☐	☐
IEEE 802.11n	☑	☑	☑	☑	☑

Channel List & Frequency

802.11b/g/n(HT20)

Frequency Band	Channel No.	Frequency(MHz)	Channel No.	Frequency(MHz)
2412~2462MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437	--	--

IEEE 802.11n HT40

Frequency Band	Channel No.	Frequency(MHz)	Channel No.	Frequency(MHz)
2422~2452MHz	1	--	7	2442
	2	--	8	2447
	3	2422	9	2452
	4	2427	10	--
	5	2432	11	--
	6	2437	--	--

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2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd..

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure KDB 558074 D01 DTS Meas Guidance v04 and KDB 662911 D01 Multiple Transmitter Output v02r01 is required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3. General Test Procedures

2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013

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3. SYSTEM TEST CONFIGURATION

3.1. Justification

The system was configured for testing in a continuous transmits condition.

3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (DRTU.exe) provided by application.

3.3. Special Accessories

N/A.

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

Applied Standard: FCC Part 15 Subpart C		
FCC Rules	**Description of Test**	**Result**
/	On Time and Duty Cycle	Only reported
§15.247(b)	Maximum Conducted Output Power	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(a)(2)	6dB Bandwidth	Compliant
§15.247(a)	Occupied Bandwidth	Compliant
§15.209, §15.247(d)	Radiated and Conducted Spurious Emissions	Compliant
§15.205	Emissions at Restricted Band	Compliant
§15.207(a)	Conducted Emissions	Compliant
§15.203	Antenna Requirements	Compliant
§15.247(i)§2.1093	RF Exposure	Compliant

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5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

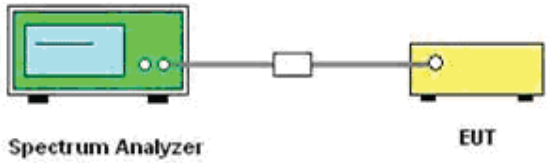
5.1.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of the spectrum analyser.

5.1.3. Test Procedures

1. Set the centre frequency of the spectrum analyser to the transmitting frequency;
2. Set the span=0MHz, RBW=8MHz, VBW=50MHz, Sweep time=20.27ms;
3. Detector = peak;
4. Trace mode = Single hold.

5.1.4. Test Setup Layout



5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.1.6. Test result

Mode	On Time B (ms)	Period (ms)	Duty Cycle x (Linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW(KHz)
802.11b	5	5	1	100	0	0.010
802.11g	5	5	1	100	0	0.010
802.11n -HT20	5	5	1	100	0	0.010
802.11n -HT40	5	5	1	100	0	0.010

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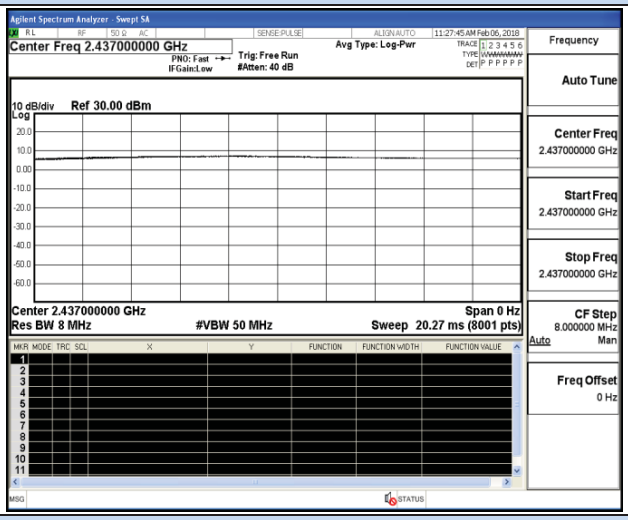
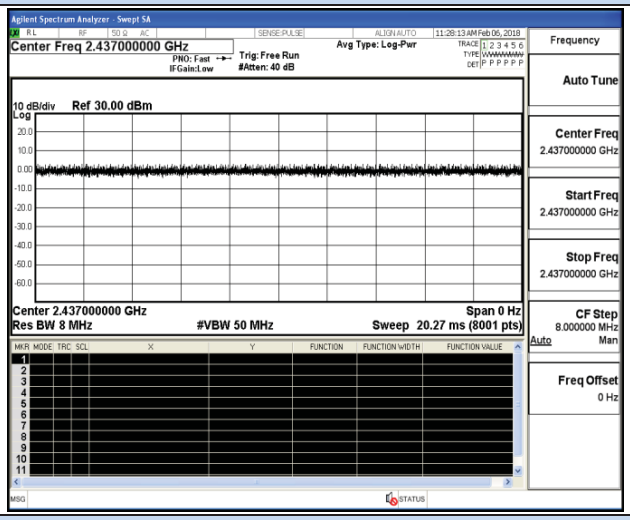
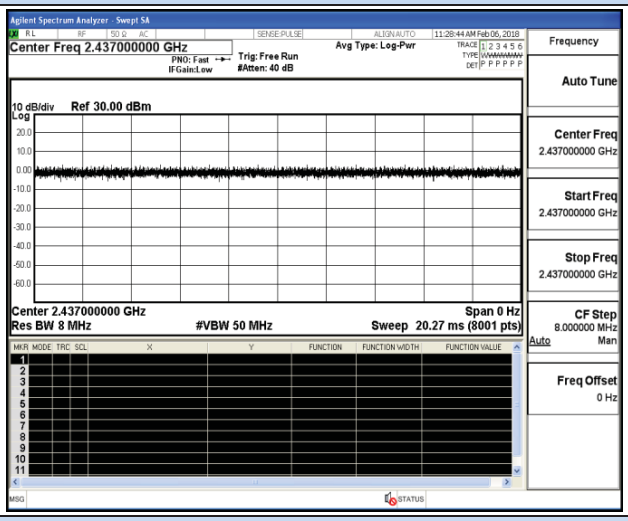
Test plot of On Time and Duty Cycle



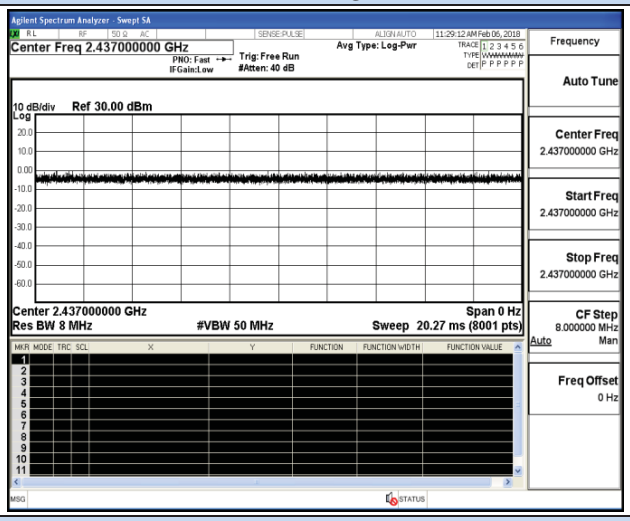
802.11b



802.11g



802.11n-HT20



802.11n-HT40

5.2. Maximum Conducted Output Power Measurement

5.2.1. Standard Applicable

According to §15.247(b): For systems using digital modulation in the 2400-2483.5 MHz and 5725-5850 MHz band, the limit for maximum peak conducted output power is 30dBm. The limited has to be reduced by the amount in dB that the gain of the antenna exceed 6dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi without any corresponding reduction in transmitter peak output power.

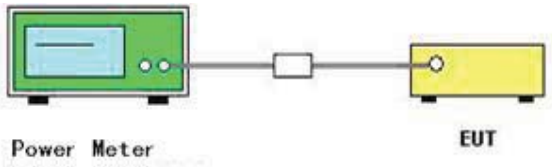
5.2.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of the power meter.

5.2.3. Test Procedures

The transmitter output (antenna port) was connected to the power meter.

5.2.4. Test Setup Layout



5.2.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.2.6. Test Result of Maximum Conducted Output Power

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11b/g/n

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)			Limits (dBm)	Verdict
			Chain0	Chain1	Sum		
IEEE 802.11b	1	2412	10.98	10.22	/	30	PASS
	6	2437	11.98	10.30	/		
	11	2462	10.69	10.22	/		
IEEE 802.11g	1	2412	11.17	11.38	/	30	PASS
	6	2437	11.20	10.53	/		
	11	2462	11.12	10.28	/		
IEEE 802.11n HT20	1	2412	11.64	10.17	13.98	29.99	PASS
	6	2437	11.72	10.97	14.37		
	11	2462	11.57	10.88	14.25		
IEEE 802.11n HT40	3	2422	11.04	11.14	14.10	29.99	PASS
	6	2437	11.92	11.23	14.60		
	9	2452	11.98	10.38	14.26		

Remark:
1). Measured output power at difference data rate for each mode and recorded worst case for each mode.
2). Test results including cable loss;
Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;
3). The EUT used two same monopole antenna for WIFI TX/RX,
*the directional gain=3.0+10*log(2)=6.01dBi.*
So the power limits of IEEE 802.11n HT20 and IEEE 802.11 n HT40 for MIMO with CDD technology should be reduced.

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5.3. Power Spectral Density Measurement

5.3.1. Standard Applicable

According to §15.247(e): 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 transmission.

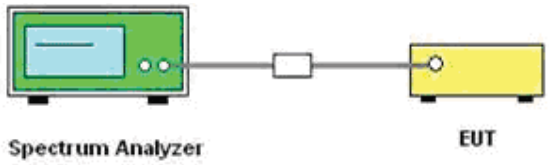
5.3.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of Spectrum Analyzer.

5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer through a directional couple.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 30kHz
4. Set the VBW ≥ 3*RBW
5. Set the span to 1.5 times the DTS channel bandwidth.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum power level in any 3 kHz band segment within the fundamental EBW.

5.3.4. Test Setup Layout



5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

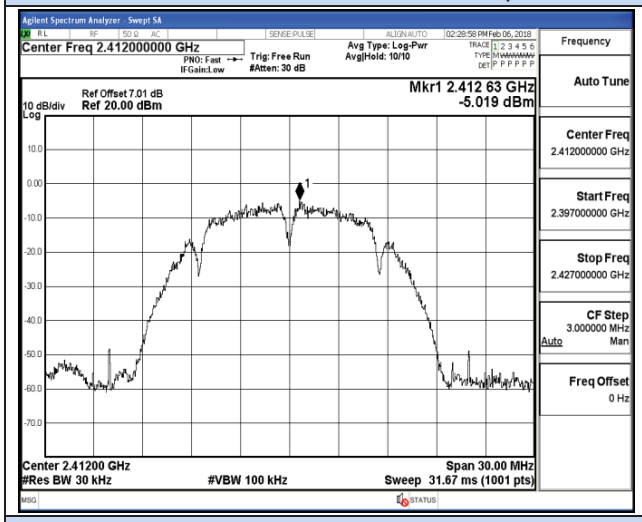
5.3.6. Test Result of Power Spectral Density

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11b/g/n

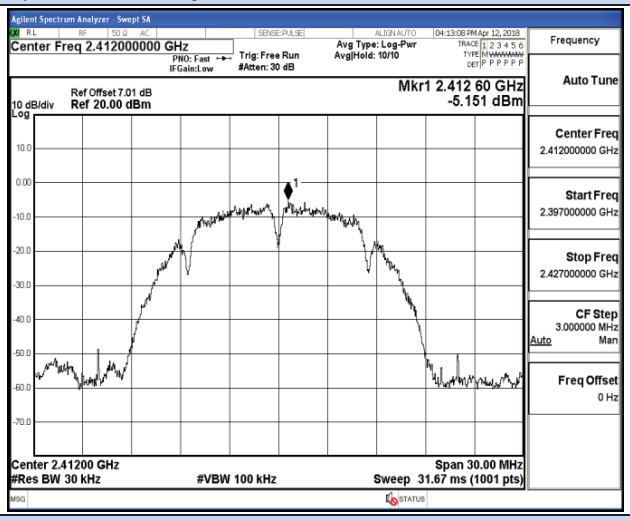
Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectrum Density (dBm/30KHz)			Limits (dBm/3KHz)	Verdict
			Chain0	Chain1	Sum		
IEEE 802.11b	1	2412	-5.019	-5.151	/	8	PASS
	6	2437	-4.884	-5.775	/		
	11	2462	-5.226	-5.439	/		
IEEE 802.11g	1	2412	-11.207	-10.978	/	8	PASS
	6	2437	-10.549	-12.088	/		
	11	2462	-10.852	-12.246	/		
IEEE 802.11n HT20	1	2412	-11.455	-12.901	-9.108	7.99	PASS
	6	2437	-10.916	-12.162	-8.484		
	11	2462	-11.431	-12.140	-8.761		
IEEE 802.11n HT40	3	2422	-14.936	-14.953	-11.934	7.99	PASS
	6	2437	-14.427	-14.495	-11.451		
	9	2452	-14.509	-14.905	-11.692		

Remark:
1). Measured peak power spectrum density at difference data rate for each mode and recorded worst case for each mode.
2). Test results including cable loss;
3). Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;
4.) Please refer to following plots;
*5). The EUT used two same monopole antenna for WIFI TX/RX, the directional gain=3.0+10*log(2)=6.01dBi. So the PSD limits of IEEE 802.11n HT20 and IEEE 802.11 n HT40 for MIMO with CDD technology should not be reduced.*
6). For MIMO with CCD technology device, The Directional Gain= Gain of individual transmit antennas (dBi) + Array gain;
Array gain = 10 log (N_{ant}), where Nant is the number of transmit antennas.

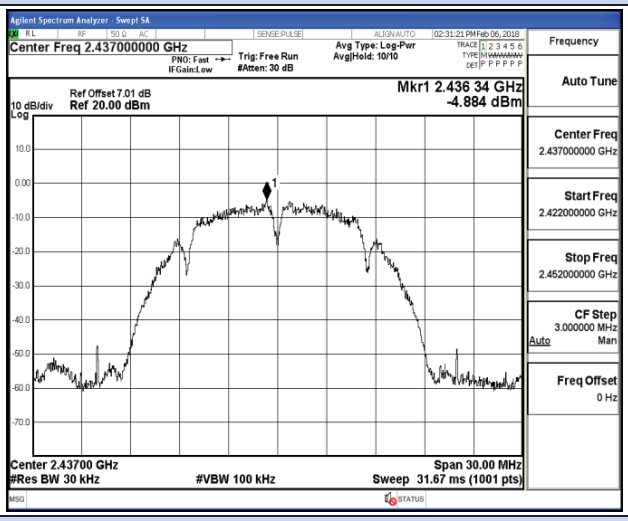
Test plot of Power Spectral Density



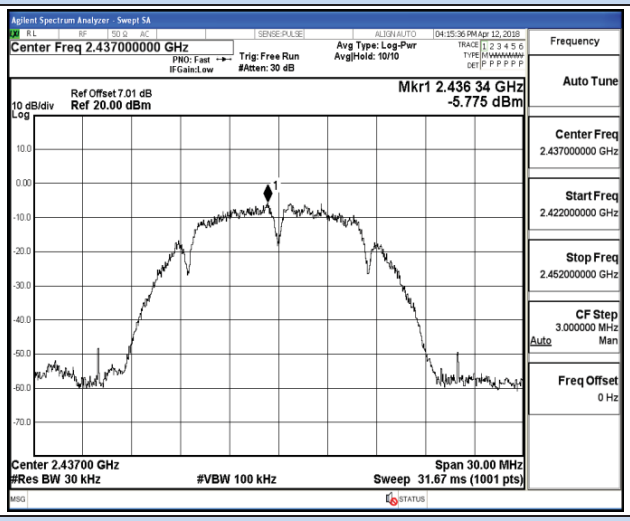
802.11b Chain 0-Low channel



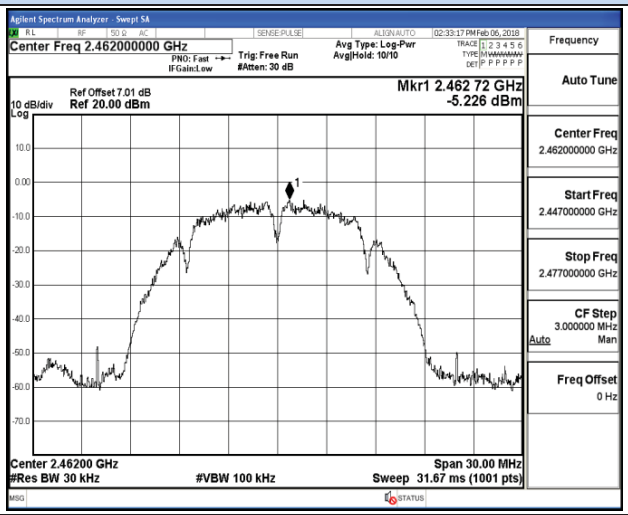
802.11b Chain 1-Low channel



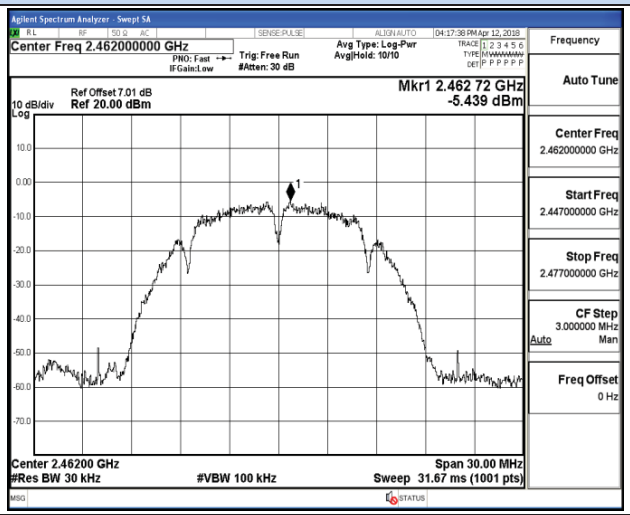
802.11b Chain 0-Middle channel



802.11b Chain 1-Middle channel

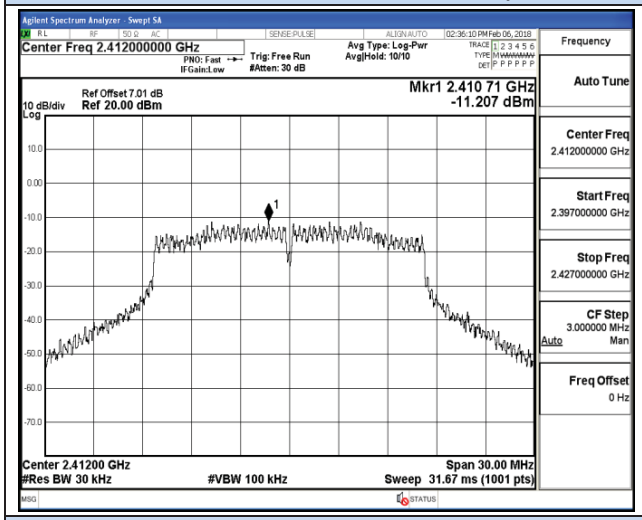


802.11b Chain 0-High channel

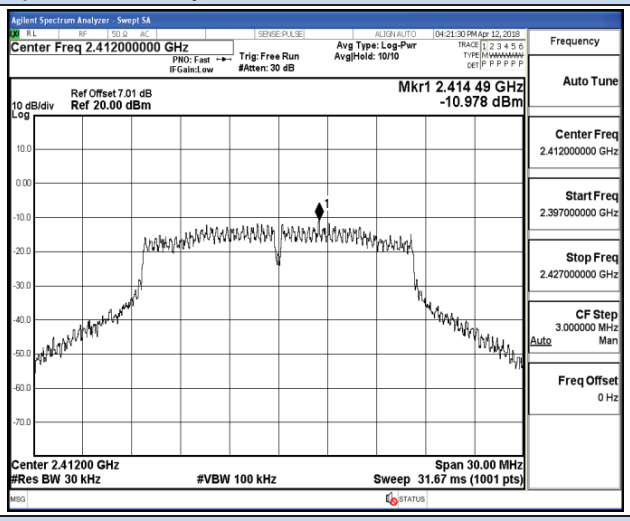


802.11b Chain 1-High channel

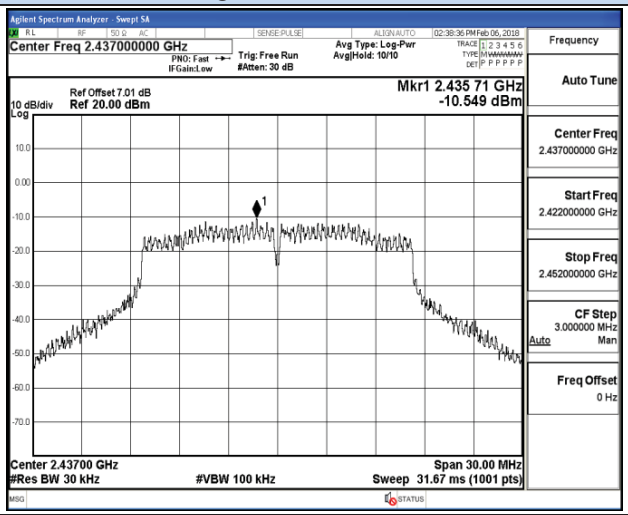
Test plot of Power Spectral Density



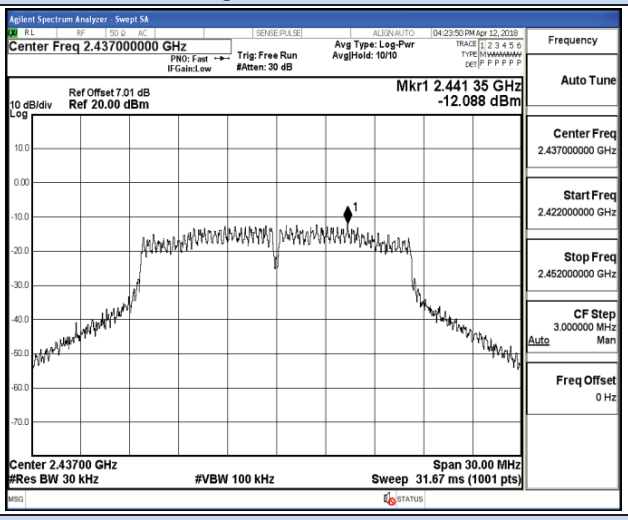
802.11g Chain 0-Low channel



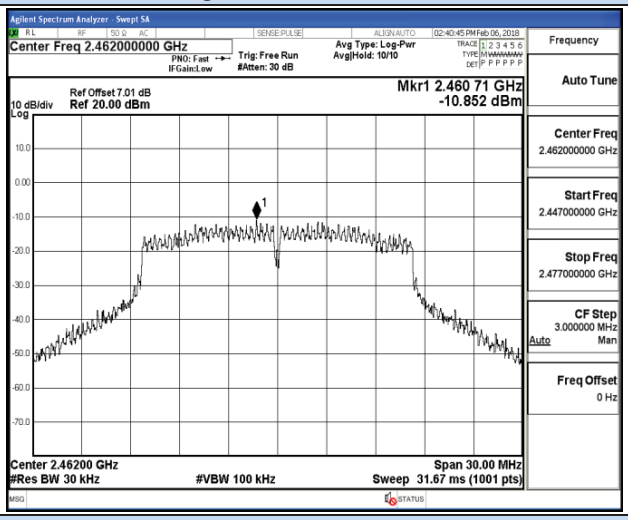
802.11g Chain 1-Low channel



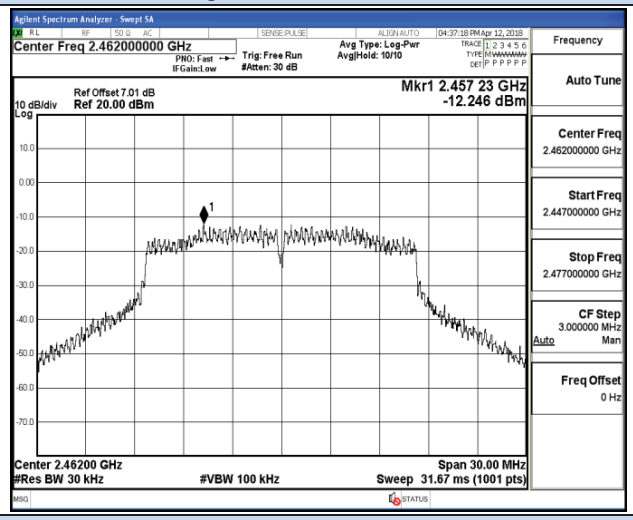
802.11g Chain 0-Middle channel



802.11g Chain 1-Middle channel

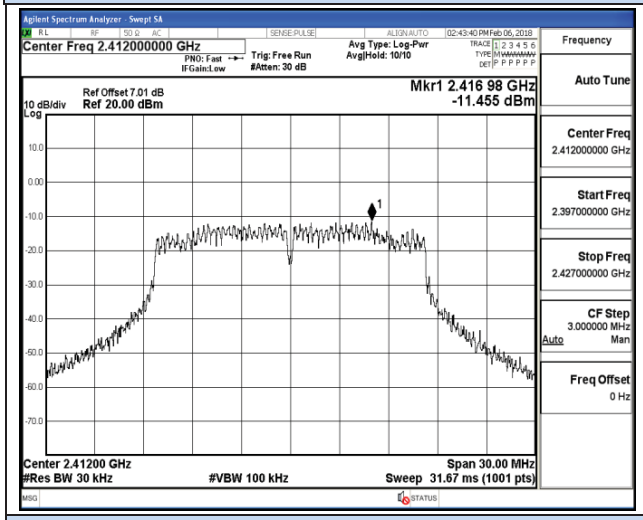


802.11g Chain 0-High channel

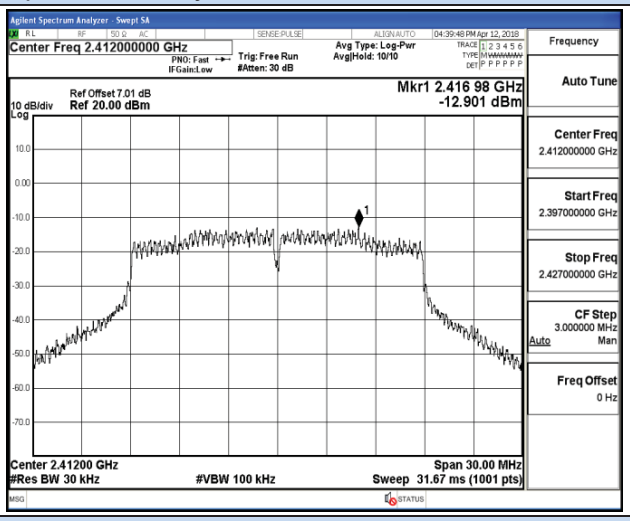


802.11g Chain 1-High channel

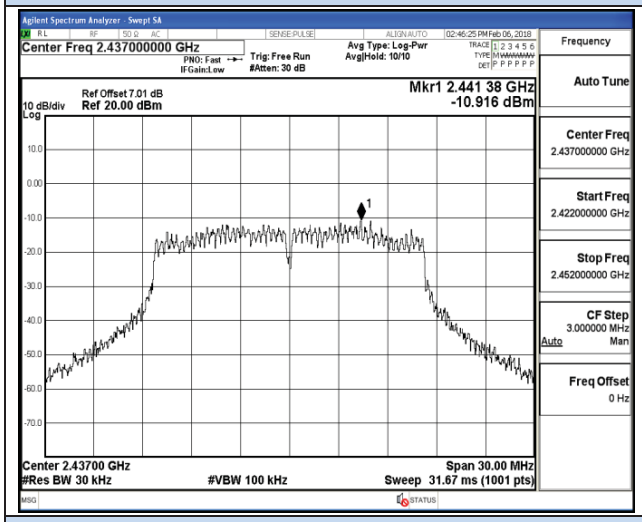
Test plot of Power Spectral Density



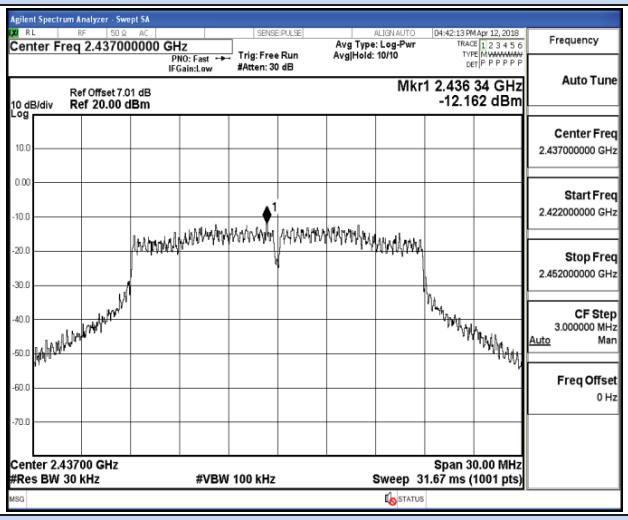
802.11n-HT20 Chain 0-Low channel



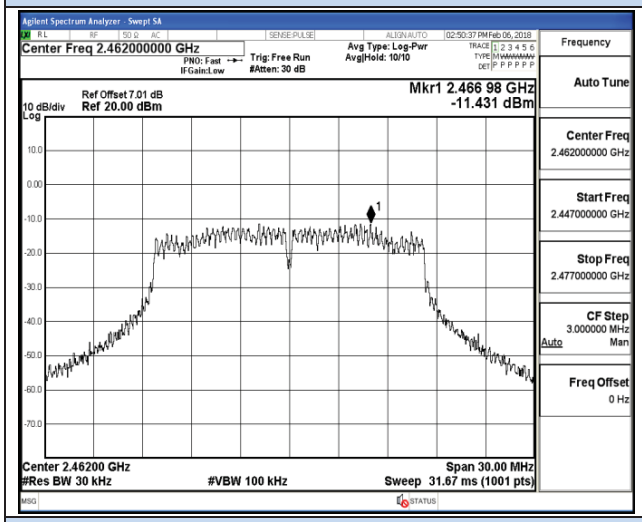
802.11n-HT20 Chain 1-Low channel



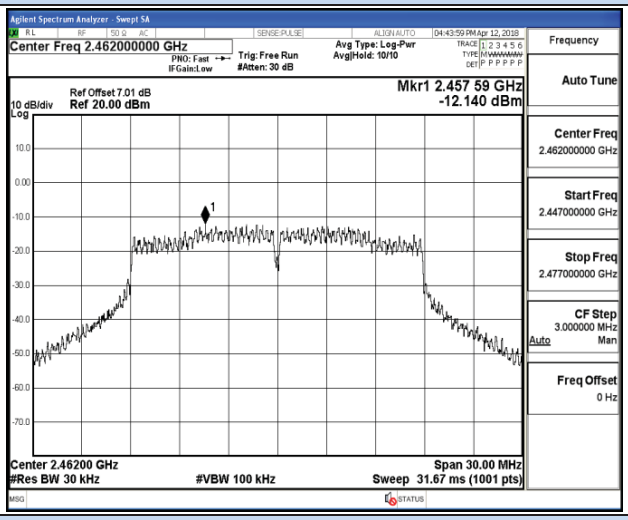
802.11n-HT20 Chain 0-Middle channel



802.11n-HT20 Chain 1-Middle channel

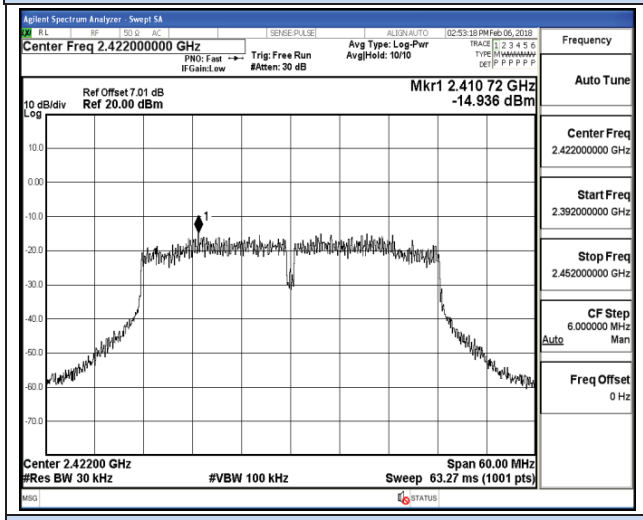


802.11n-HT20 Chain 0-High channel

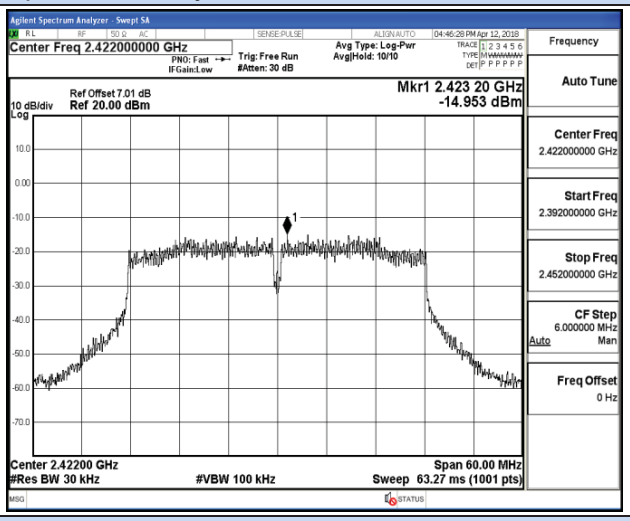


802.11n-HT20 Chain 1-High channel

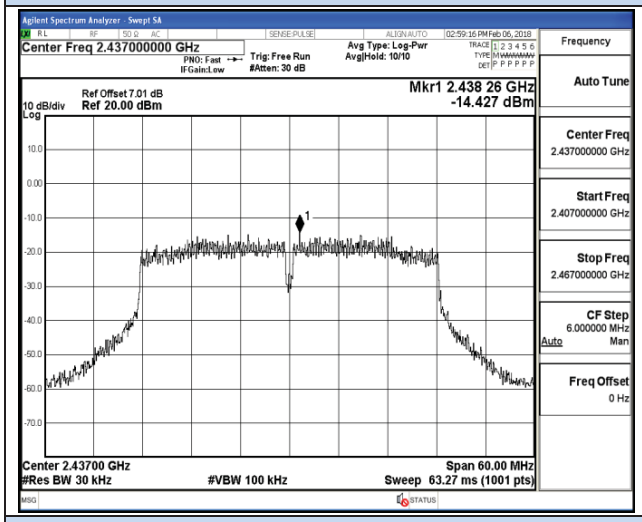
Test plot of Power Spectral Density



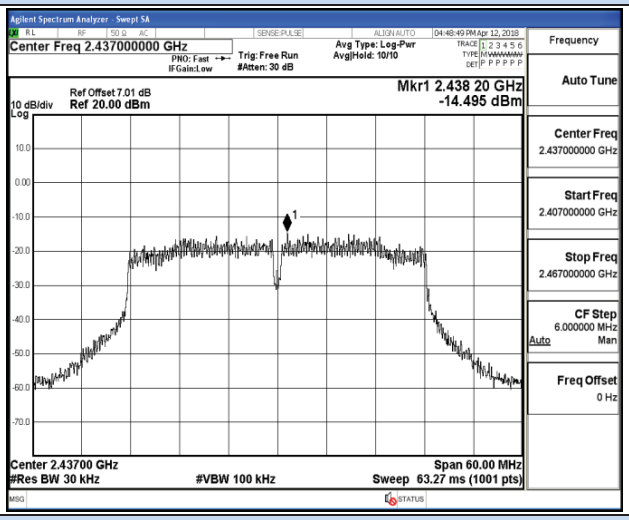
802.11n-HT40 Chain 0-Low channel



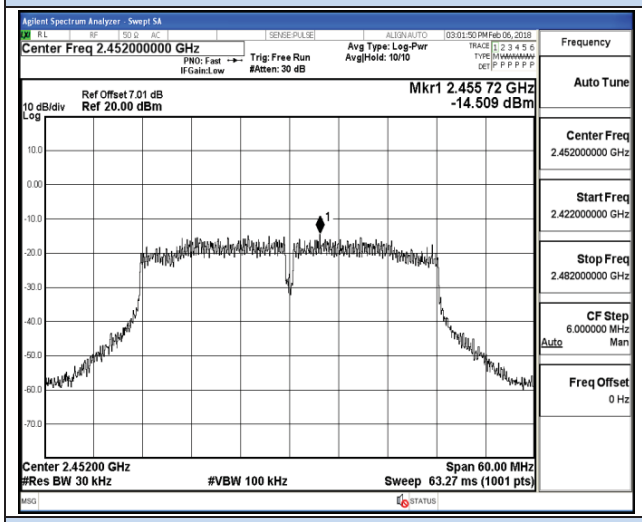
802.11n-HT40 Chain 1-Low channel



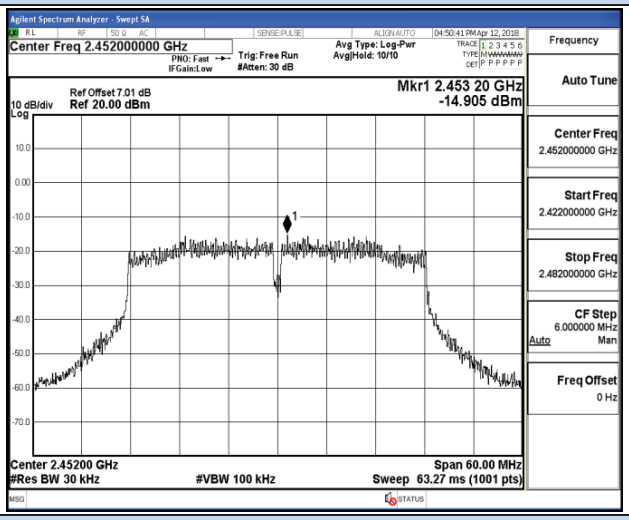
802.11n-HT40 Chain 0-Middle channel



802.11n-HT40 Chain 1-Middle channel



802.11n-HT40 Chain 0-High channel



802.11n-HT40 Chain 1-High channel

5.4. 6 dB Spectrum Bandwidth Measurement

5.4.1. Standard Applicable

According to §15.247(a)(2): For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.4.2. Measuring Instruments and Setting

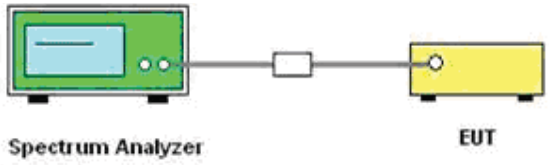
Please refer to section 6 of equipments list in this report. The following table is the setting of the Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> RBW
Detector	Peak
Trace	Max Hold
Sweep Time	100ms

5.4.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.
2. The resolution bandwidth and the video bandwidth were set according to KDB558074.
3. Measured the spectrum width with power higher than 6dB below carrier.

5.4.4. Test Setup Layout



5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.4.6. Test Result of 6dB Spectrum Bandwidth

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11b/g/n

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Limits (MHz)	Verdict
			Chain 0	Chain 1		
IEEE 802.11b	1	2412	9.167	9.153	0.500	PASS
	6	2437	9.162	9.141		
	11	2462	9.138	9.331		
IEEE 802.11g	1	2412	15.16	15.08	0.500	PASS
	6	2437	15.14	15.14		
	11	2462	15.17	15.15		
IEEE 802.11n HT20	1	2412	16.32	15.15	0.500	PASS
	6	2437	16.36	15.09		
	11	2462	16.14	15.12		
IEEE 802.11n HT40	3	2422	35.18	35.14	0.500	PASS
	6	2437	35.16	35.17		
	9	2452	35.17	35.17		

Remark:
1). Measured 6dB Bandwidth at difference data rate for each mode and recorded worst case for each mode.
2). Test results including cable loss;
3). Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;

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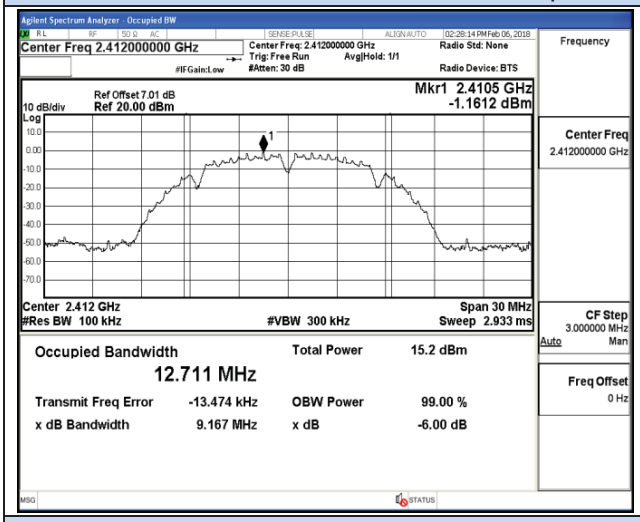
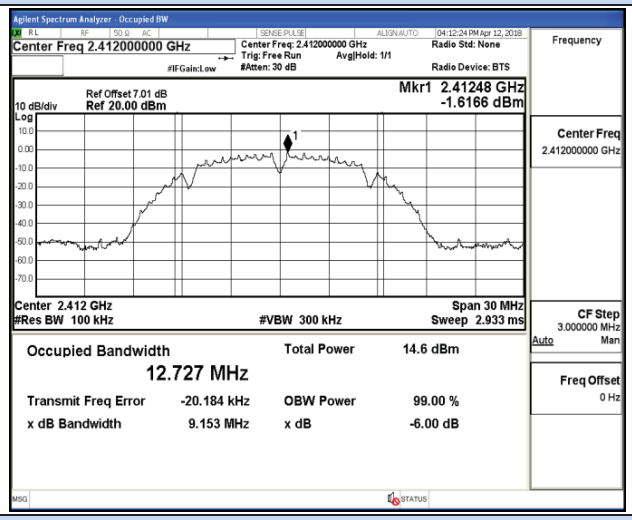
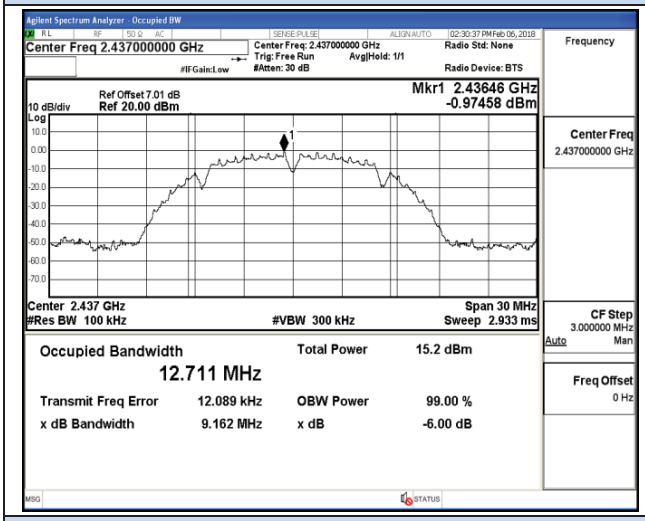
Test plot of 6 dB Bandwidth



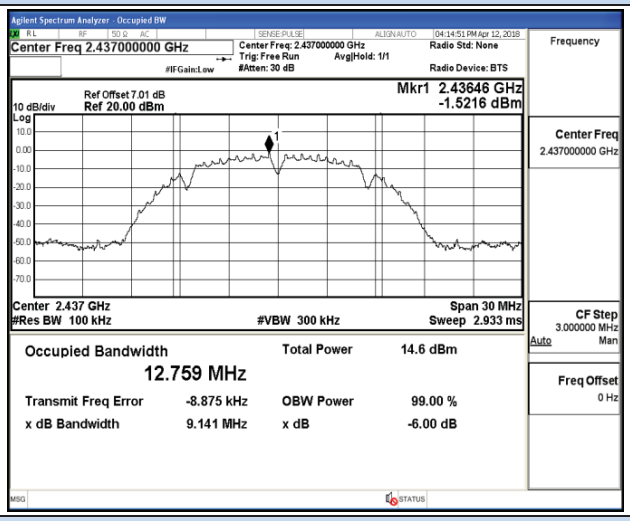
802.11b Chain 0-Low channel



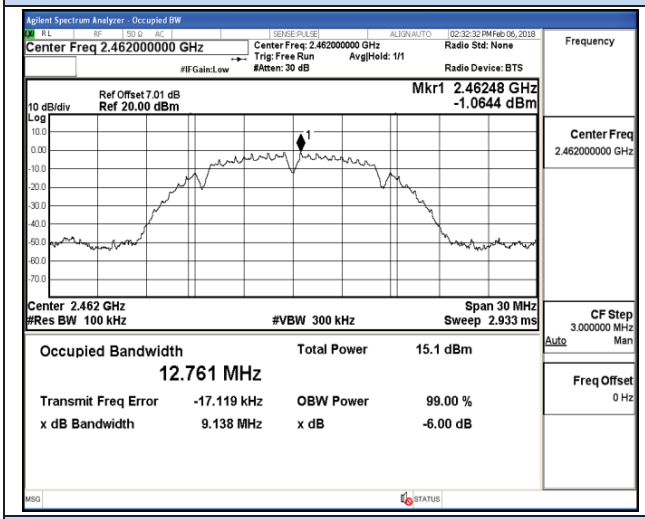
802.11b Chain 1-Low channel



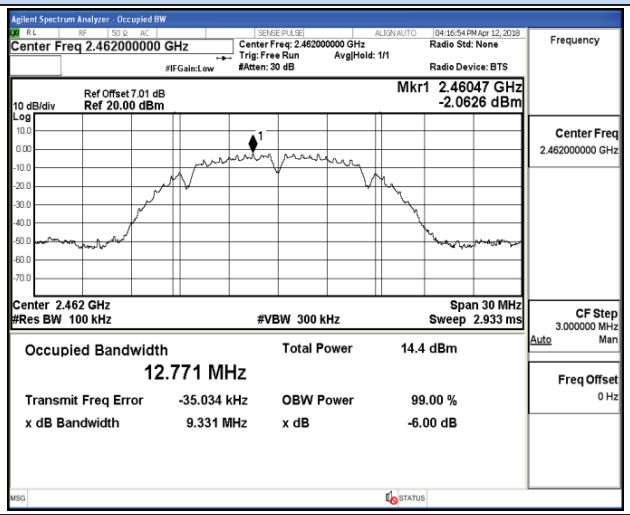
802.11b Chain 0-Middle channel



802.11b Chain 1-Middle channel

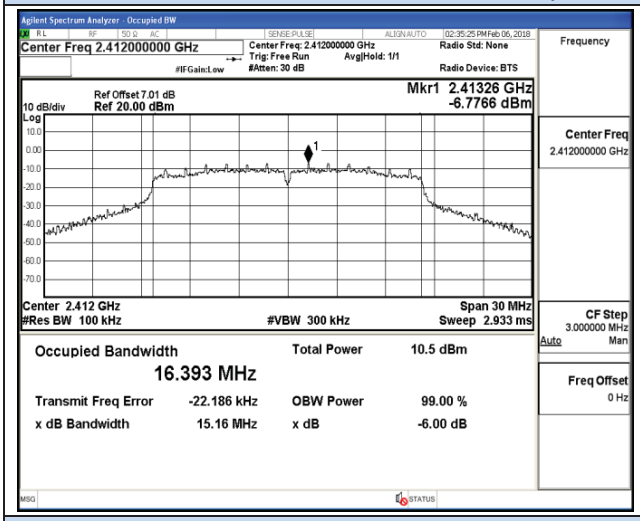


802.11b Chain 0-High channel

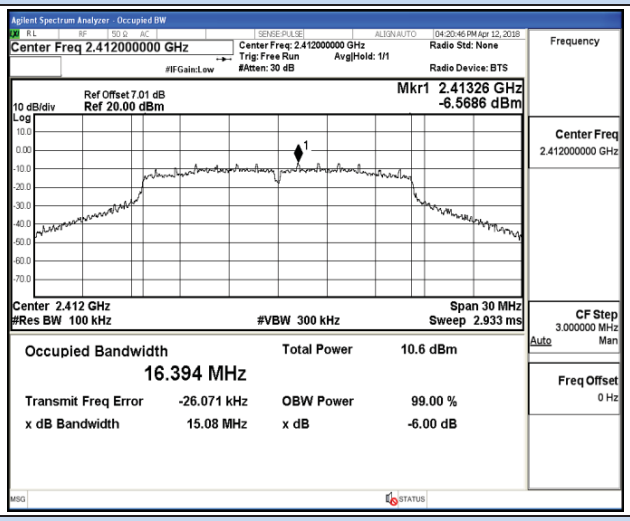


802.11b Chain 1-High channel

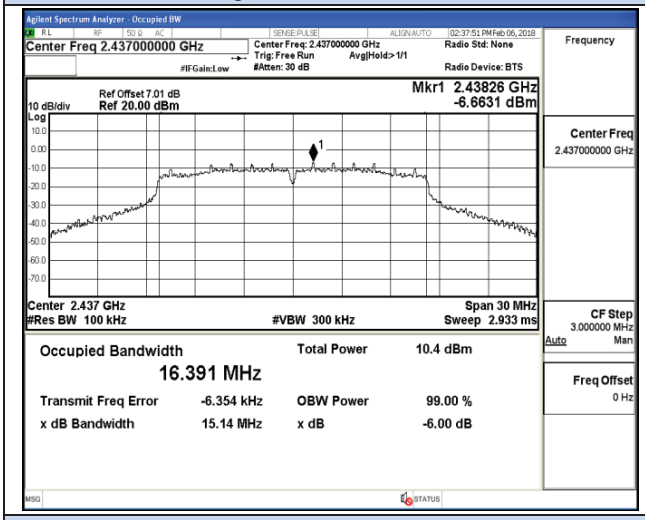
Test plot of 6 dB Bandwidth



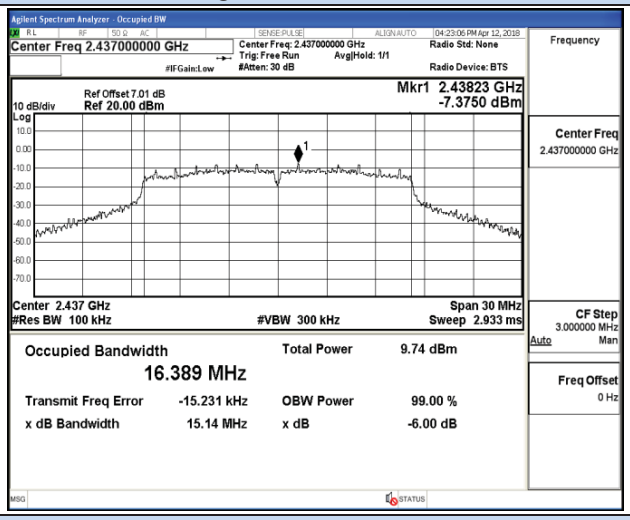
802.11g Chain 0-Low channel



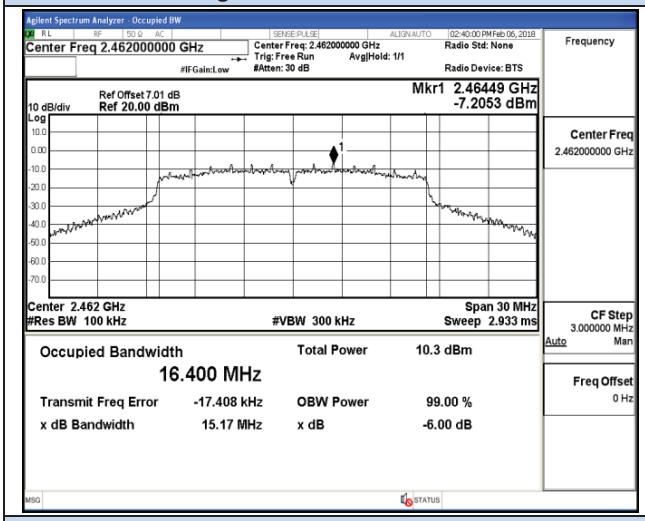
802.11g Chain 1-Low channel



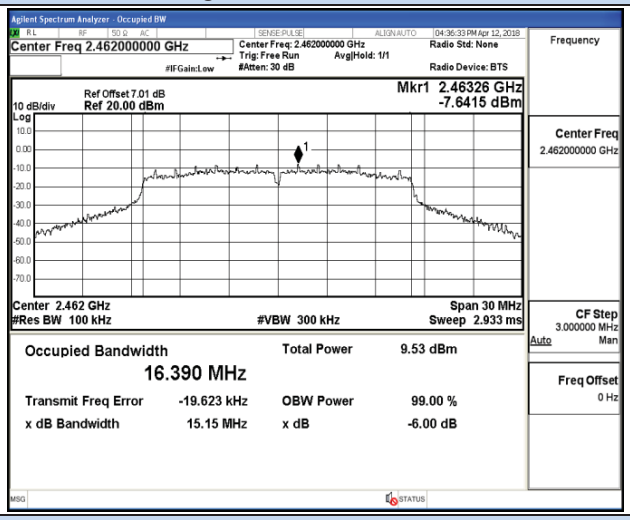
802.11g Chain 0-Middle channel



802.11g Chain 1-Middle channel

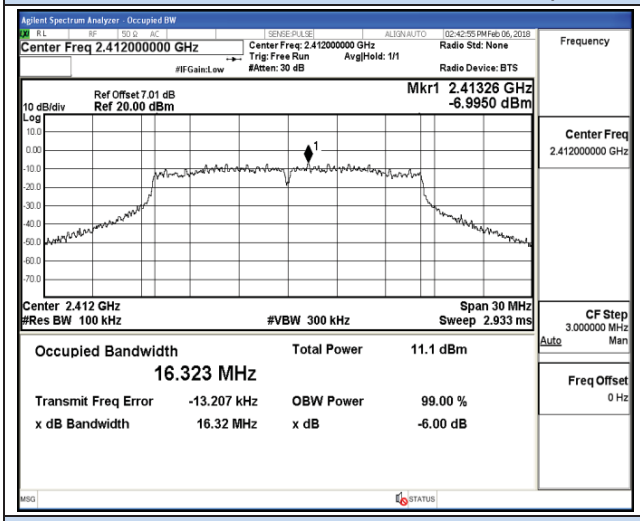


802.11g Chain 0-High channel

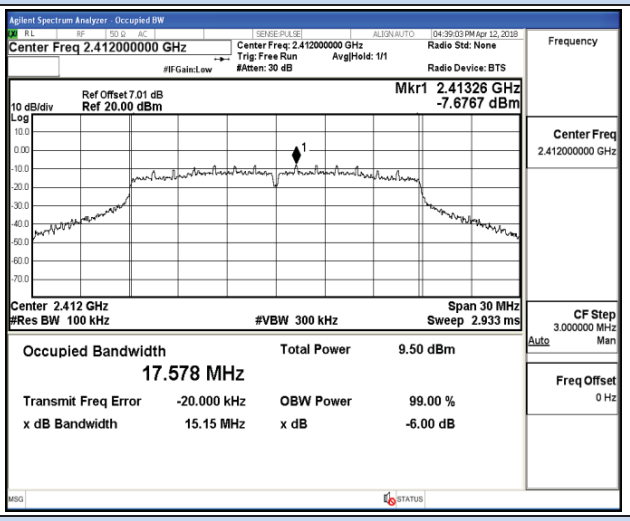


802.11g Chain 1-High channel

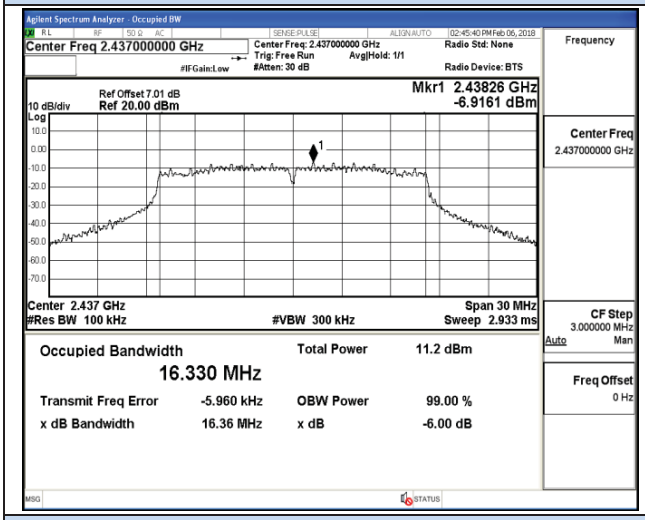
Test plot of 6 dB Bandwidth



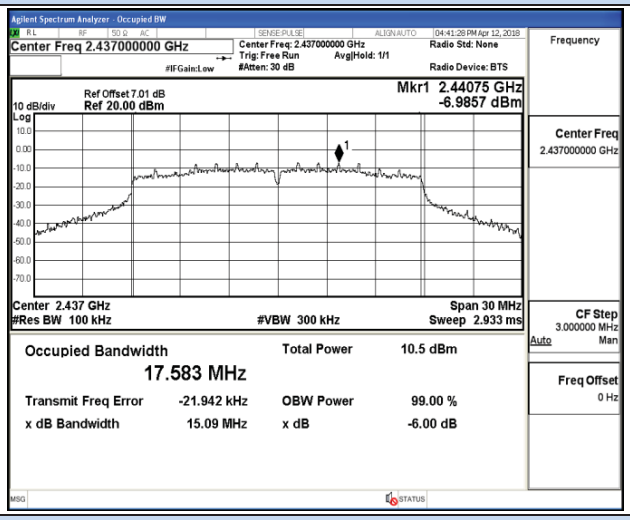
802.11n-HT20 Chain 0-Low channel



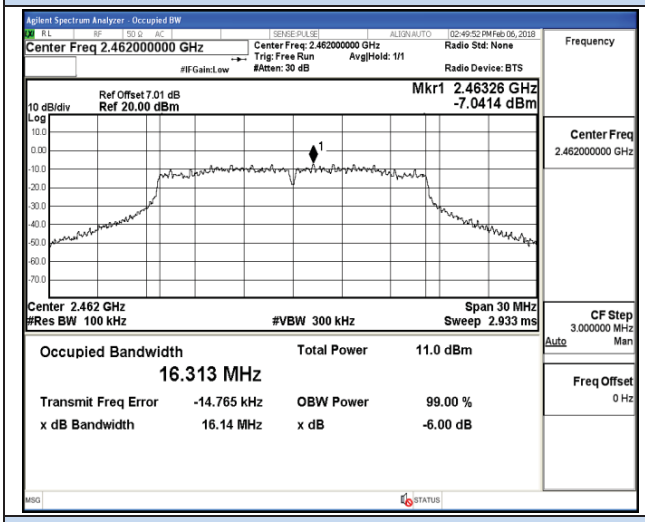
802.11n-HT20 Chain 1-Low channel



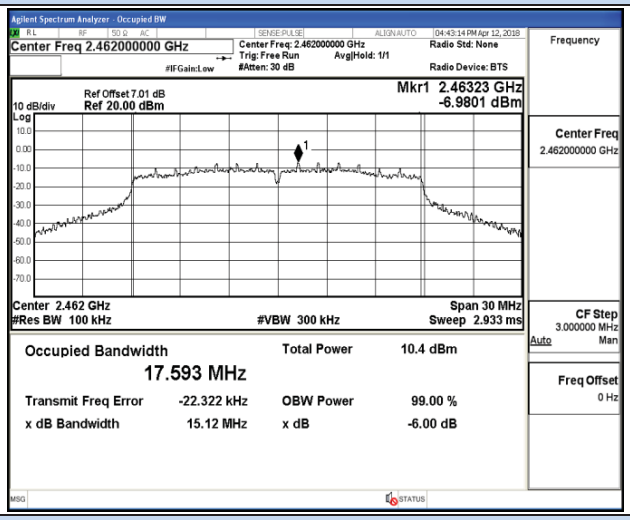
802.11n-HT20 Chain 0-Middle channel



802.11n-HT20 Chain 1-Middle channel

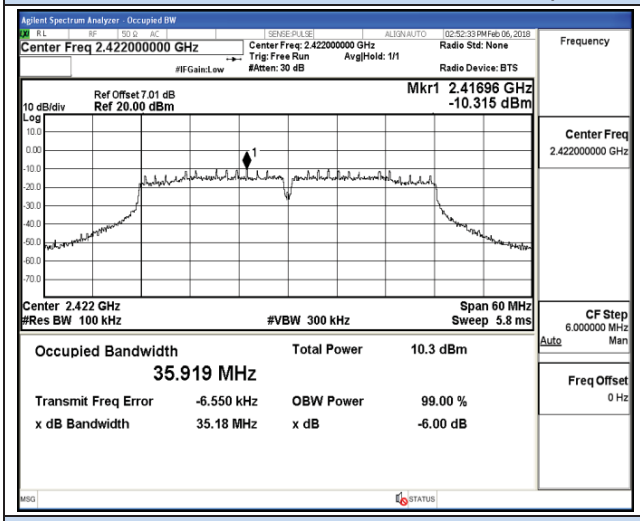


802.11n-HT20 Chain 0-High channel

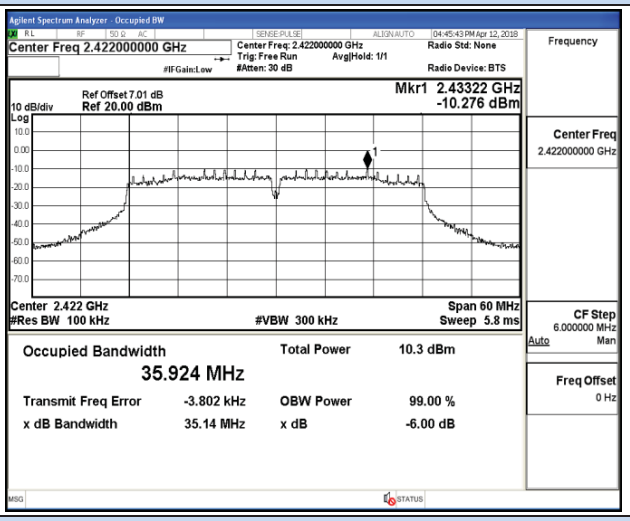


802.11n-HT20 Chain 1-High channel

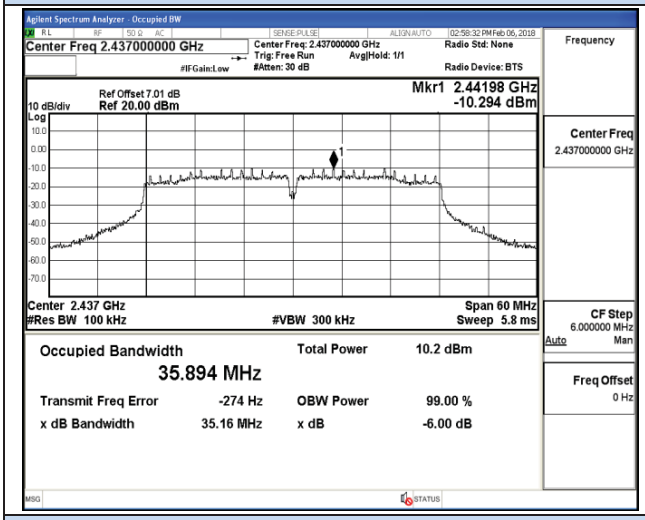
Test plot of 6 dB Bandwidth



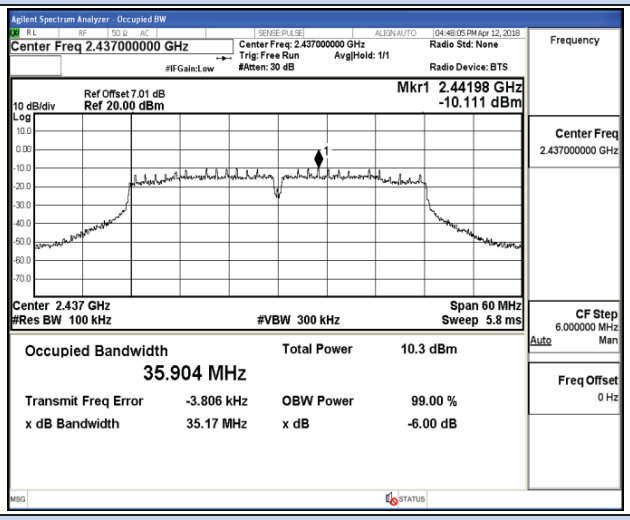
802.11n-HT40 Chain 0-Low channel



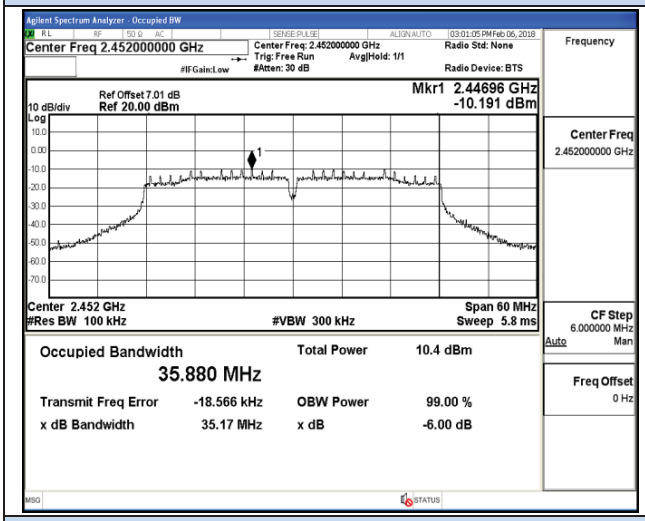
802.11n-HT40 Chain 1-Low channel



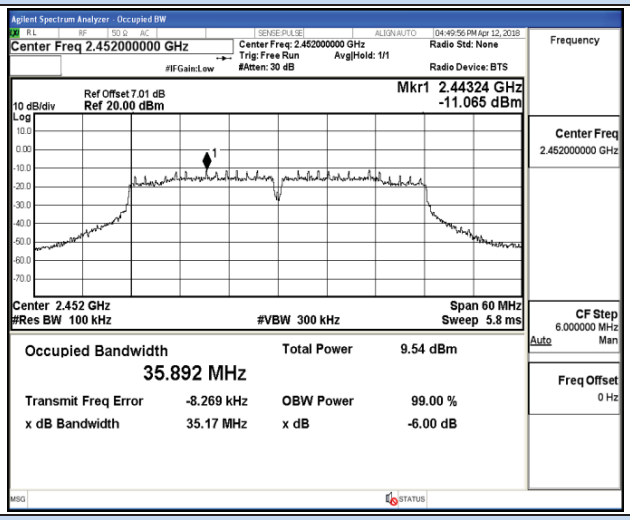
802.11n-HT40 Chain 0-Middle channel



802.11n-HT40 Chain 1-Middle channel



802.11n-HT40 Chain 0-High channel



802.11n-HT40 Chain 1-High channel

5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

5.5.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 10Hz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 10Hz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB 100kHz for QP/AVG

5.5.3. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 1.5 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarisations of the antenna.

Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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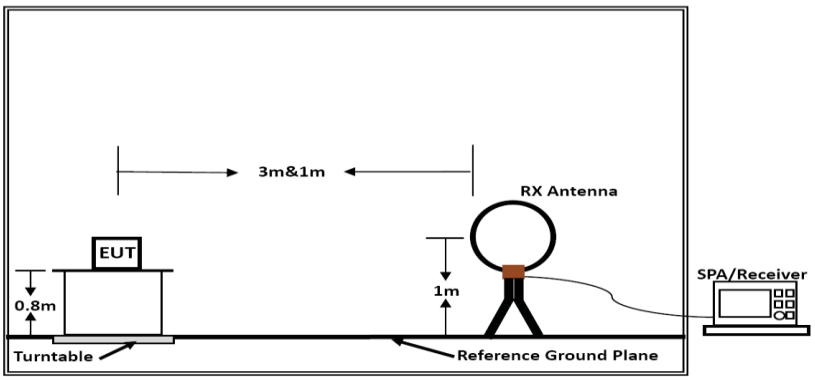
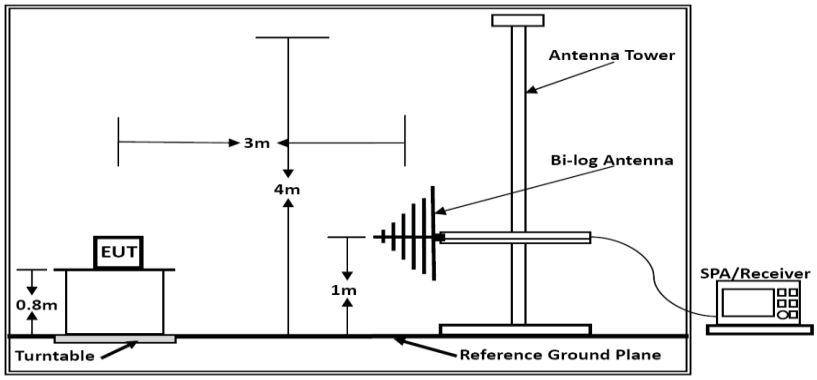
5.5.4. Test Setup Layout

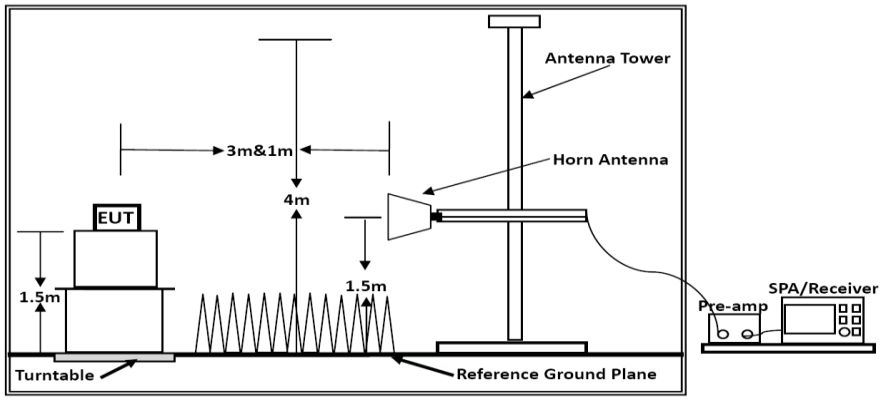
For radiated emissions below 30MHz



Below 30MHz



Below 1GHz



Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1.5m.

Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1.5m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9kHz~30MHz)

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11b/g/n

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

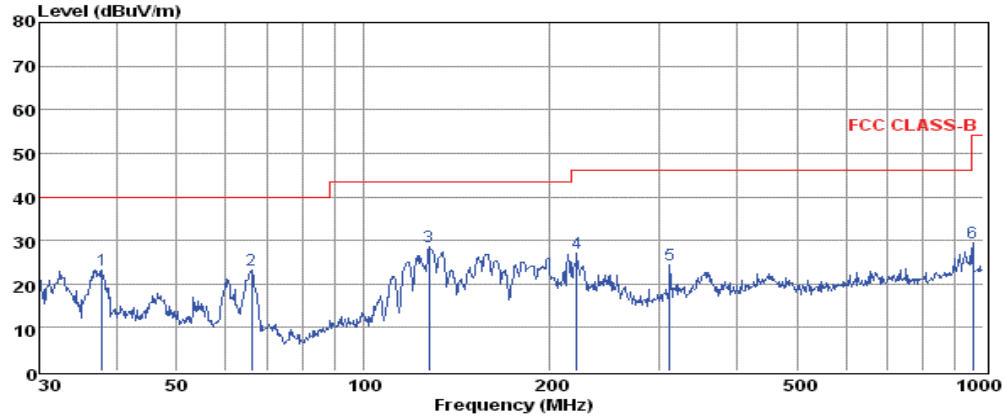
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11n HT40

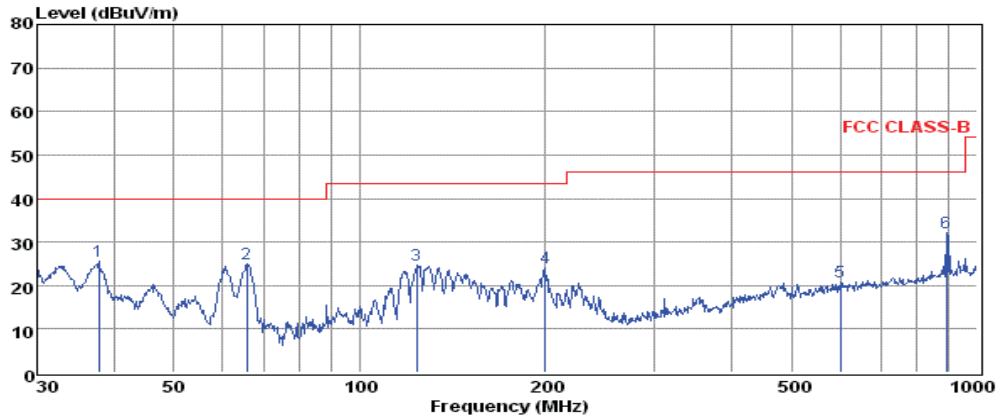
The worst test result for IEEE 802.11n HT40 mode (Middle Channel, Combined Antenna Chain0 and Antenna Chain1)



pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	37.94	9.85	0.38	13.05	23.28	40.00	-16.72	QP
2	66.03	12.35	0.52	10.28	23.15	40.00	-16.85	QP
3	127.66	18.73	0.67	9.29	28.69	43.50	-14.81	QP
4	220.62	14.78	0.95	11.23	26.96	46.00	-19.04	QP
5	312.18	9.93	1.09	13.22	24.24	46.00	-21.76	QP
6	962.16	6.08	2.01	21.49	29.58	54.00	-24.42	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported



pol: VERTICAL

	Freq MHz	Reading dBuV	CabLos dB	Antfac dB/m	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	37.81	12.24	0.38	13.02	25.64	40.00	-14.36	QP
2	65.57	13.99	0.52	10.47	24.98	40.00	-15.02	QP
3	123.70	13.95	0.71	9.91	24.57	43.50	-18.93	QP
4	199.99	12.56	0.84	10.57	23.97	43.50	-19.53	QP
5	601.43	1.01	1.43	18.46	20.90	46.00	-25.10	QP
6	890.73	9.40	1.86	20.99	32.25	46.00	-13.75	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Note:

Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11n HT40 mode (Middle Channel, Combined Antenna Chain0 and Antenna Chain1)).

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

5.5.8. Results for Radiated Emissions (Above 1GHz)

(Worst Case at Antenna Chain 0)

802.11b

Channel 1 / 2412 MHz

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	54.99	33.06	35.04	3.94	56.95	74.00	-17.05	Peak	Horizontal
4824.00	43.05	33.06	35.04	3.94	45.01	54.00	-8.99	Average	Horizontal
4824.00	52.93	33.06	35.04	3.94	54.89	74.00	-19.11	Peak	Vertical
4824.00	41.52	33.06	35.04	3.94	43.48	54.00	-10.52	Average	Vertical

Channel 6 / 2437 MHz

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	60.20	33.16	35.15	3.96	62.17	74.00	-11.83	Peak	Horizontal
4874.00	41.89	33.16	35.15	3.96	43.86	54.00	-10.14	Average	Horizontal
4874.00	55.02	33.16	35.15	3.96	56.99	74.00	-17.01	Peak	Vertical
4874.00	39.28	33.16	35.15	3.96	41.25	54.00	-12.75	Average	Vertical

Channel 11 / 2462 MHz

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	58.76	33.26	35.14	3.98	60.86	74.00	-13.14	Peak	Horizontal
4924.00	43.35	33.26	35.14	3.98	45.45	54.00	-8.55	Average	Horizontal
4924.00	53.96	33.26	35.14	3.98	56.06	74.00	-17.94	Peak	Vertical
4924.00	41.26	33.26	35.14	3.98	43.36	54.00	-10.64	Average	Vertical

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(Worst Case at Antenna Chain 0)

802.11g

Channel 1

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	57.14	33.06	35.04	3.94	59.10	74.00	-14.90	Peak	Horizontal
4824.00	40.27	33.06	35.04	3.94	42.23	54.00	-11.77	Average	Horizontal
4824.00	54.09	33.06	35.04	3.94	56.05	74.00	-17.95	Peak	Vertical
4824.00	41.00	33.06	35.04	3.94	42.96	54.00	-11.04	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	59.18	33.16	35.15	3.96	61.15	74.00	-12.85	Peak	Horizontal
4874.00	41.52	33.16	35.15	3.96	43.49	54.00	-10.51	Average	Horizontal
4874.00	54.67	33.16	35.15	3.96	56.64	74.00	-17.36	Peak	Vertical
4874.00	41.58	33.16	35.15	3.96	43.55	54.00	-10.45	Average	Vertical

Channel 11

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	56.39	33.26	35.14	3.98	58.49	74.00	-15.51	Peak	Horizontal
4924.00	41.67	33.26	35.14	3.98	43.77	54.00	-10.23	Average	Horizontal
4924.00	55.72	33.26	35.14	3.98	57.82	74.00	-16.18	Peak	Vertical
4924.00	39.31	33.26	35.14	3.98	41.41	54.00	-12.59	Average	Vertical

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(Combine with Antenna Chain 0 and Antenna Chain 1)

802.11n HT20

Channel 1

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	56.72	33.06	35.04	3.94	58.68	74.00	-15.32	Peak	Horizontal
4824.00	44.68	33.06	35.04	3.94	46.64	54.00	-7.36	Average	Horizontal
4824.00	58.41	33.06	35.04	3.94	60.37	74.00	-13.63	Peak	Vertical
4824.00	43.46	33.06	35.04	3.94	45.42	54.00	-8.58	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	60.58	33.16	35.15	3.96	62.55	74.00	-11.45	Peak	Horizontal
4874.00	45.47	33.16	35.15	3.96	47.44	54.00	-6.56	Average	Horizontal
4874.00	56.49	33.16	35.15	3.96	58.46	74.00	-15.54	Peak	Vertical
4874.00	42.16	33.16	35.15	3.96	44.13	54.00	-9.87	Average	Vertical

Channel 11

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	61.77	33.26	35.14	3.98	63.87	74.00	-10.13	Peak	Horizontal
4924.00	45.93	33.26	35.14	3.98	48.03	54.00	-5.97	Average	Horizontal
4924.00	57.65	33.26	35.14	3.98	59.75	74.00	-14.25	Peak	Vertical
4924.00	44.29	33.26	35.14	3.98	46.39	54.00	-7.61	Average	Vertical

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(Combine with Antenna Chain 0 and Antenna Chain 1)

802.11n HT40

Channel 3

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4844.00	56.88	33.06	35.04	3.94	58.84	74.00	-15.16	Peak	Horizontal
4844.00	44.27	33.06	35.04	3.94	46.23	54.00	-7.77	Average	Horizontal
4844.00	56.77	33.06	35.04	3.94	58.73	74.00	-15.27	Peak	Vertical
4844.00	43.98	33.06	35.04	3.94	45.94	54.00	-8.06	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	60.61	33.16	35.15	3.96	62.58	74.00	-11.42	Peak	Horizontal
4874.00	45.14	33.16	35.15	3.96	47.11	54.00	-6.89	Average	Horizontal
4874.00	58.93	33.16	35.15	3.96	60.90	74.00	-13.10	Peak	Vertical
4874.00	43.15	33.16	35.15	3.96	45.12	54.00	-8.88	Average	Vertical

Channel 9

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4904.00	60.62	33.26	35.14	3.98	62.72	74.00	-11.28	Peak	Horizontal
4904.00	46.13	33.26	35.14	3.98	48.23	54.00	-5.77	Average	Horizontal
4904.00	56.29	33.26	35.14	3.98	58.39	74.00	-15.61	Peak	Vertical
4904.00	44.21	33.26	35.14	3.98	46.31	54.00	-7.69	Average	Vertical

Notes:

1). Measuring frequencies from 9 KHz - 10th harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.

2). Radiated emissions measured in frequency range from 9k~10th harmonic or 26.5GHz (which is less) were made with an instrument using Peak detector mode.

3). Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

4). Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40.

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5.6. Conducted Spurious Emissions and Band Edges Test

5.6.1. Standard Applicable

According to §15.247 (d): 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

5.6.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Detector	Peak
Attenuation	Auto
RB / VB (Emission in restricted band)	100KHz/300KHz
RB / VB (Emission in non-restricted band)	100KHz/300KHz

5.6.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9 kHz to 26.5GHz is investigated with the transmitter set to the lowest,

middle, and highest channels.

5.6.4. Test Setup Layout

This test setup layout is the same as that shown in section 5.4.4.

5.6.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.6.6. Test Results of Conducted Spurious Emissions

Temperature	23.2℃	Humidity	52.3%
Test Engineer	Ryan Hu	Configurations	802.11b/g/n

Note: Not recorded test plots from 9 KHz to 30 MHz as emission levels 20dB lower than emission limit.

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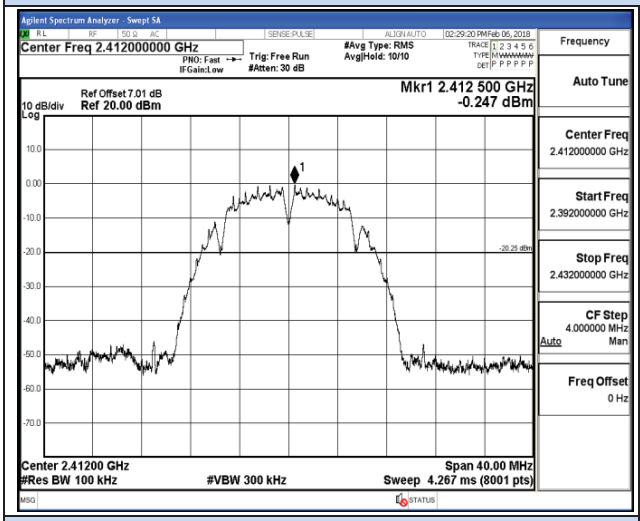
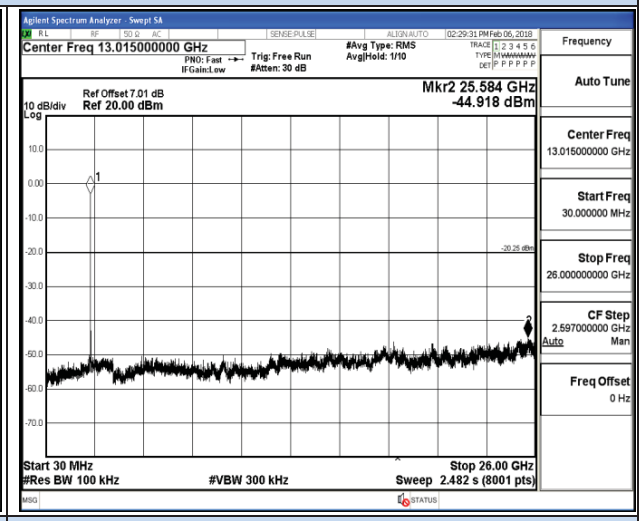
RF Conducted Spurious Emissions

IEEE 802.11b

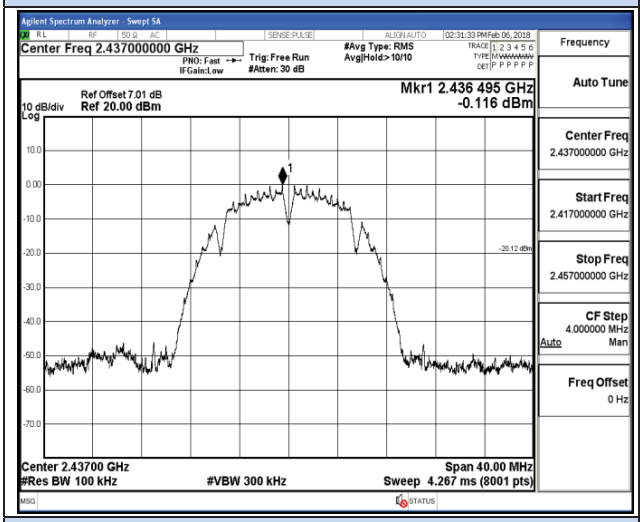
Chain 0



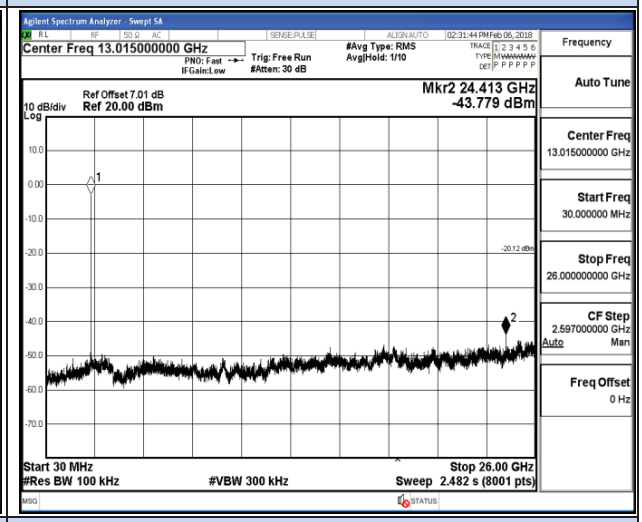
2397 MHz – 2427 MHz



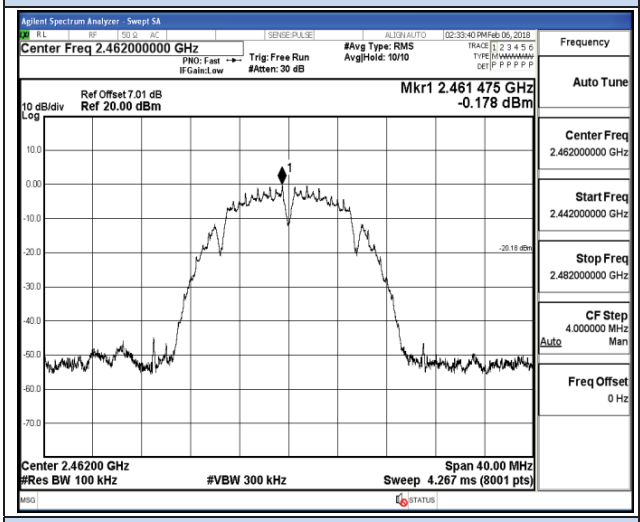
30 MHz – 26.5 GHz



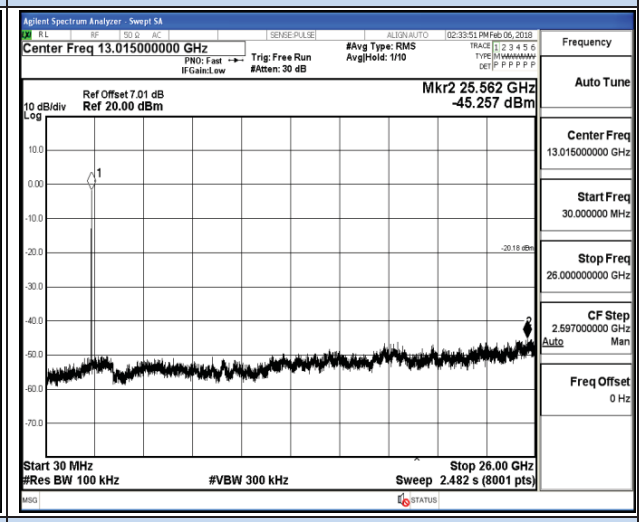
2422 MHz – 2452 MHz



30 MHz – 26.5 GHz



2447 MHz – 2477 MHz

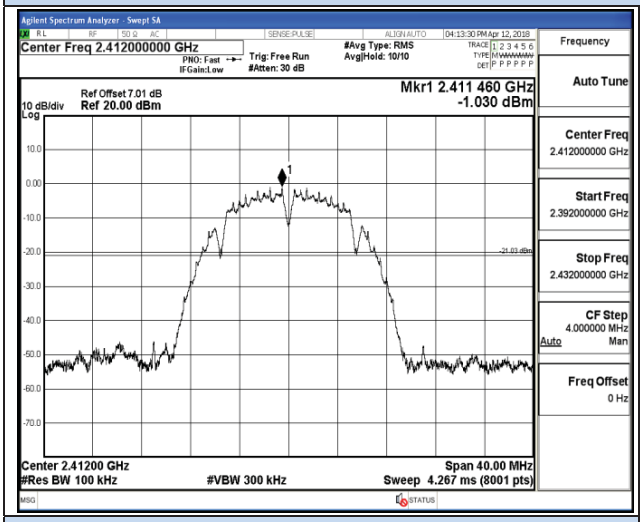


30 MHz – 26.5 GHz

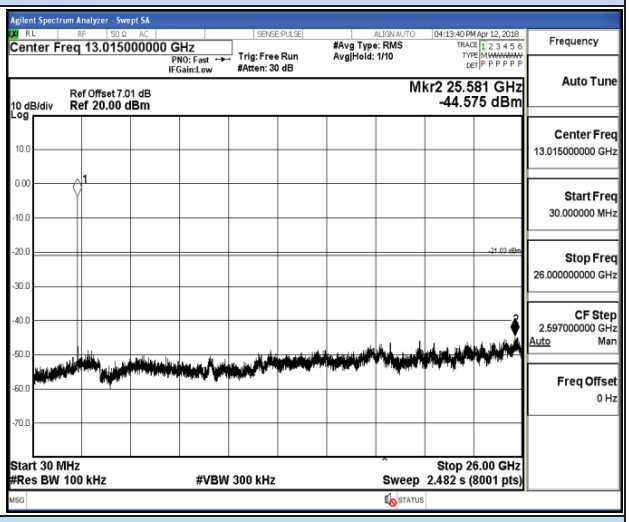
RF Conducted Spurious Emissions

IEEE 802.11b

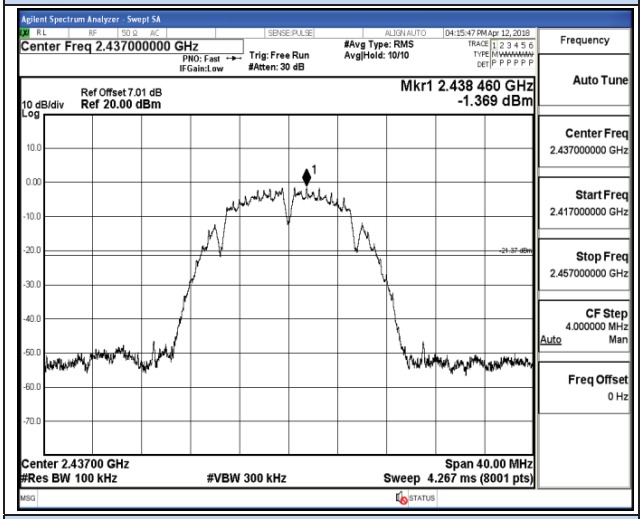
Chain 1



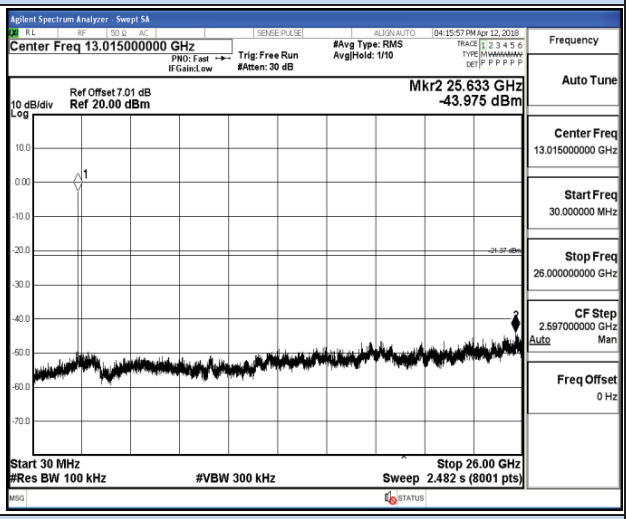
2397 MHz – 2427 MHz



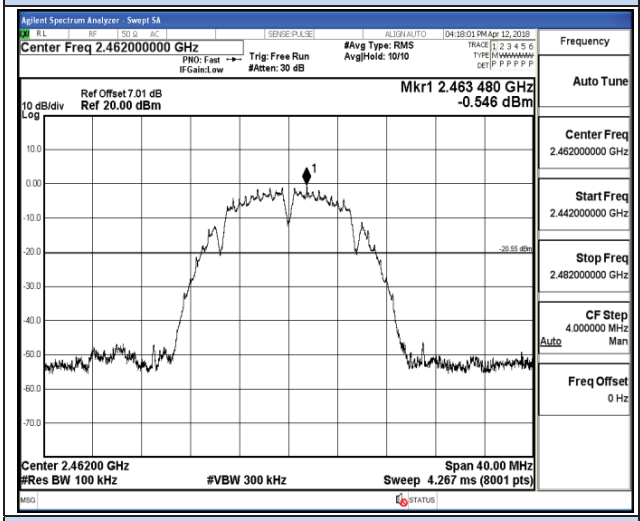
30 MHz – 26.5 GHz



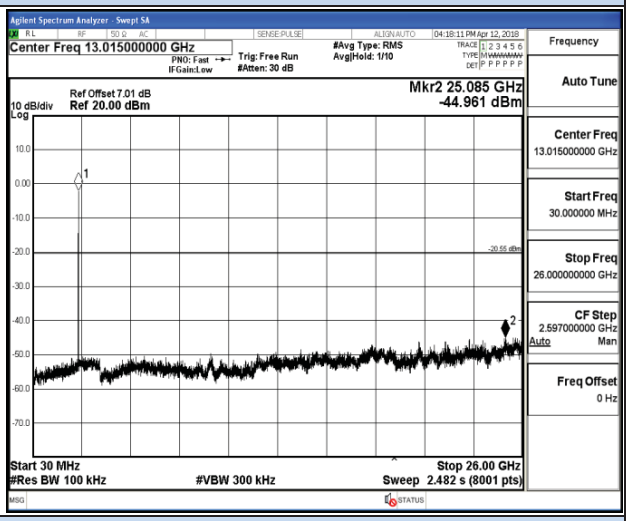
2422 MHz – 2452 MHz



30 MHz – 26.5 GHz



2447 MHz – 2477 MHz

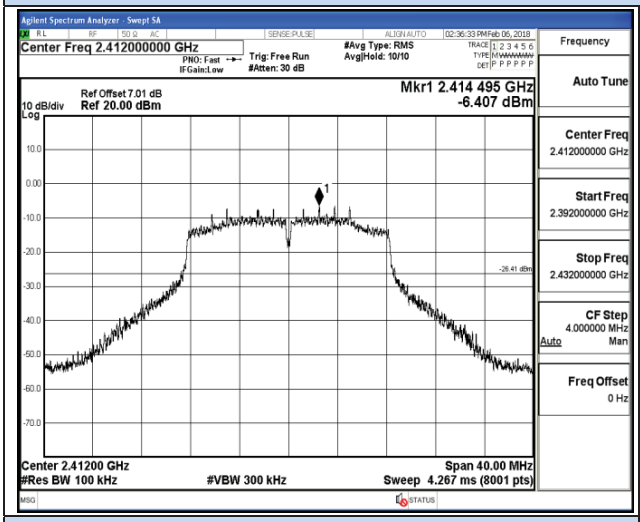


30 MHz – 26.5 GHz

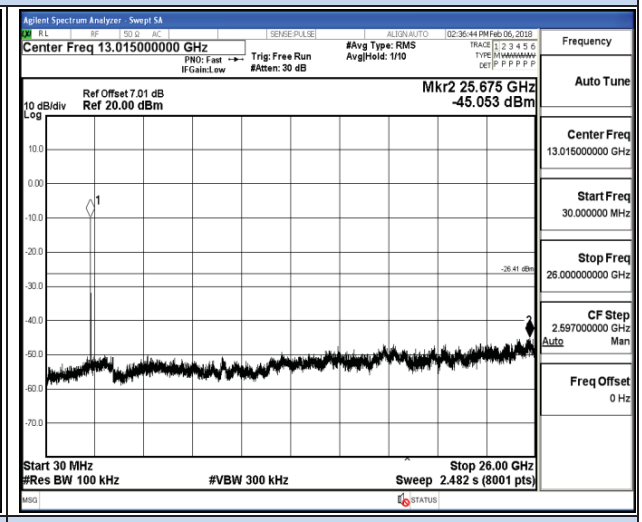
RF Conducted Spurious Emissions

IEEE 802.11g

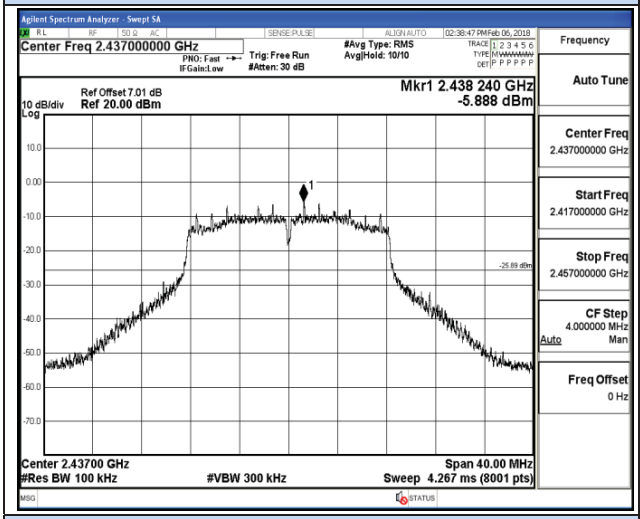
Chain 0



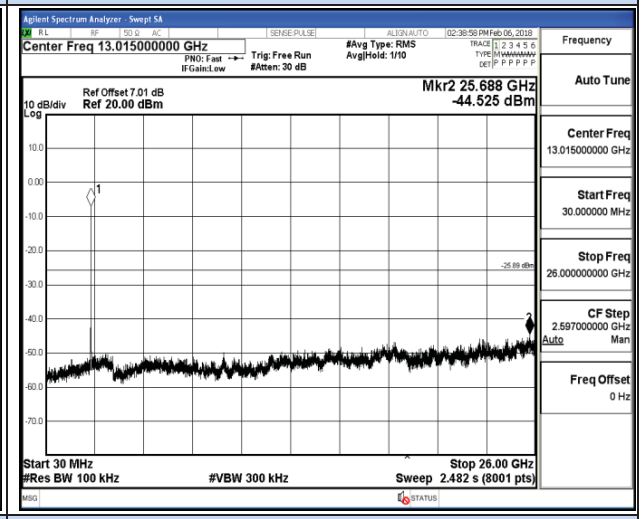
2397 MHz – 2427 MHz



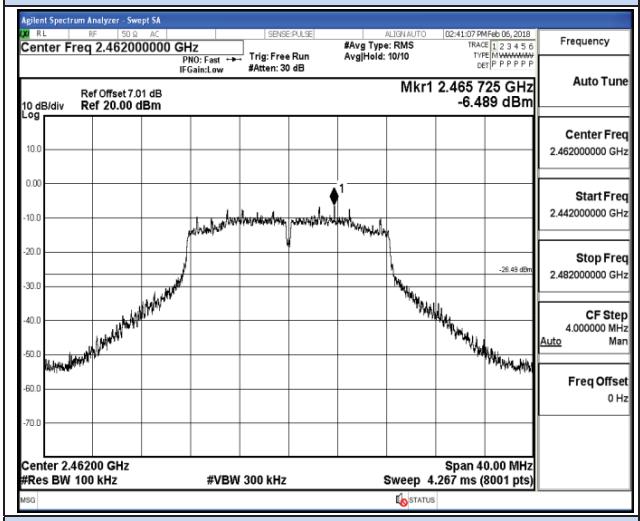
30 MHz – 26.5 GHz



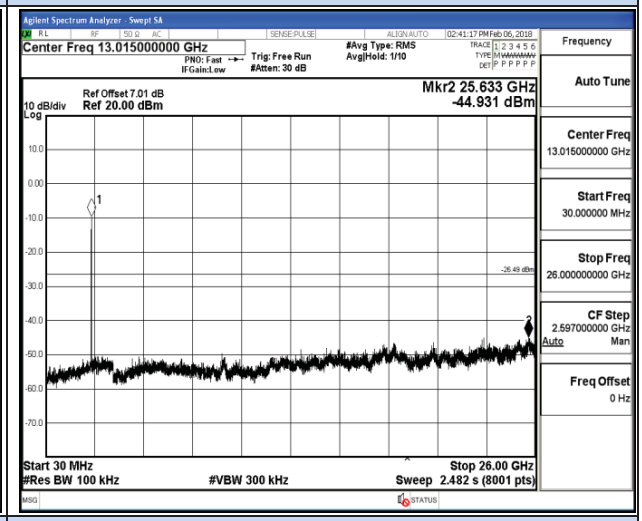
2422 MHz – 2452 MHz



30 MHz – 26.5 GHz



2447 MHz – 2477 MHz

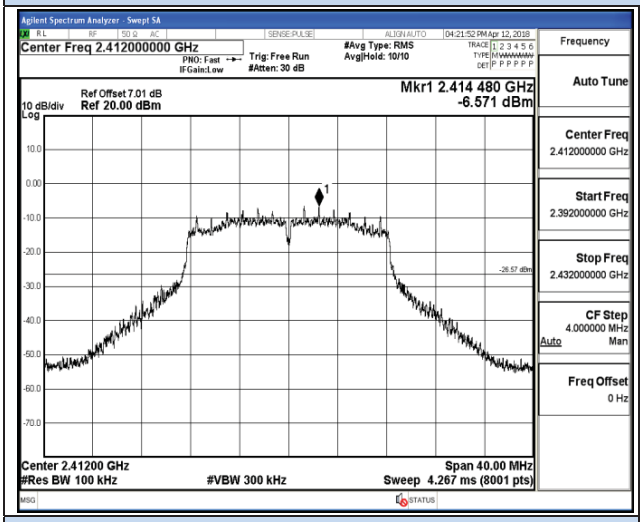


30 MHz – 26.5 GHz

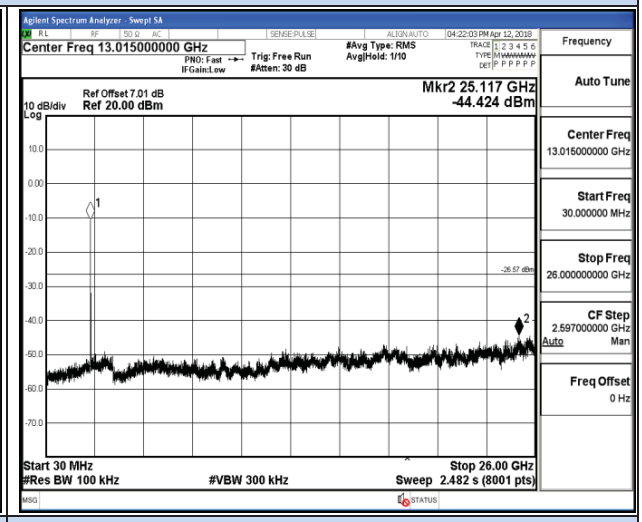
RF Conducted Spurious Emissions

IEEE 802.11g

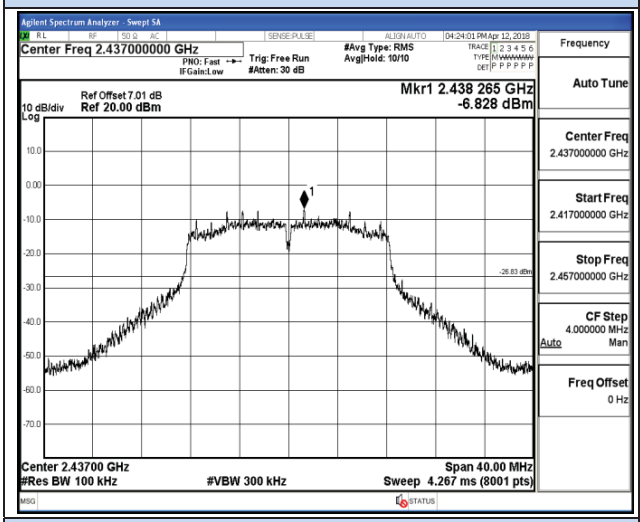
Chain 1



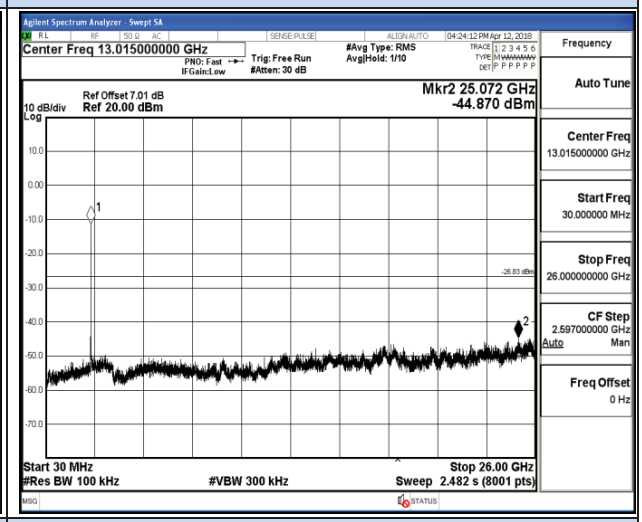
2397 MHz – 2427 MHz



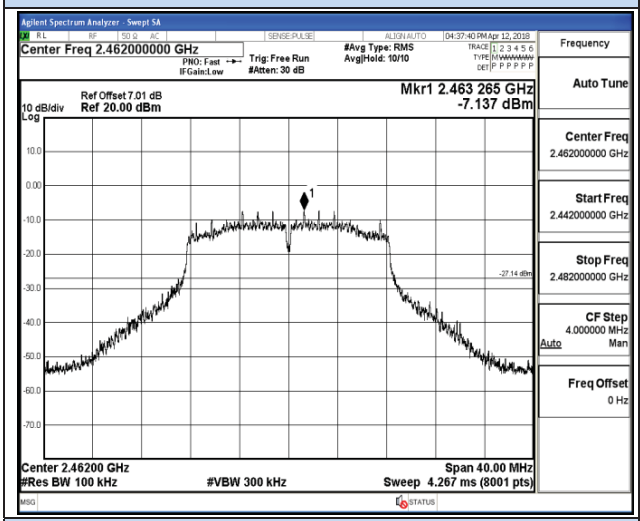
30 MHz – 26.5 GHz



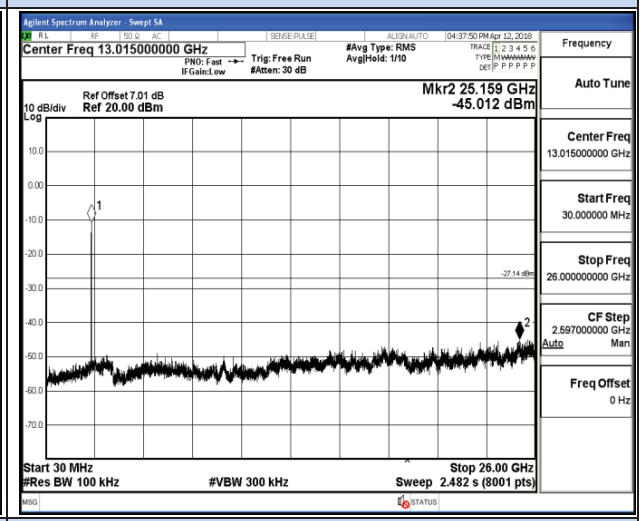
2422 MHz – 2452 MHz



30 MHz – 26.5 GHz



2447 MHz – 2477 MHz

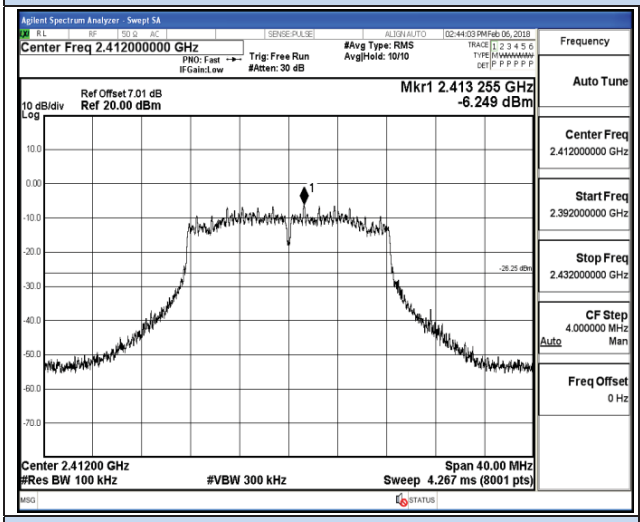


30 MHz – 26.5 GHz

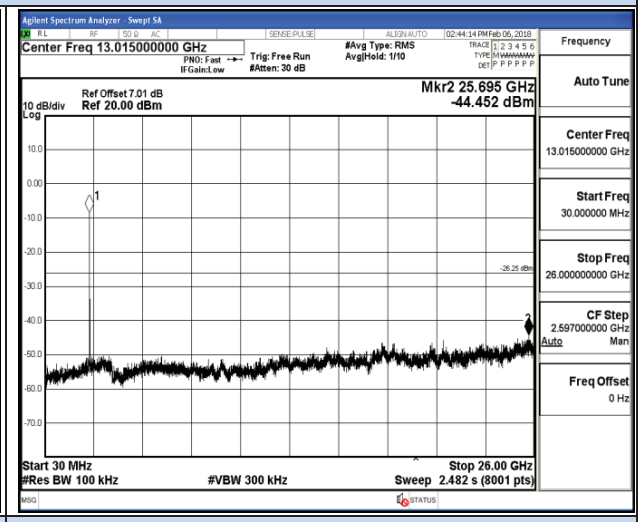
RF Conducted Spurious Emissions

IEEE 802.11n HT20

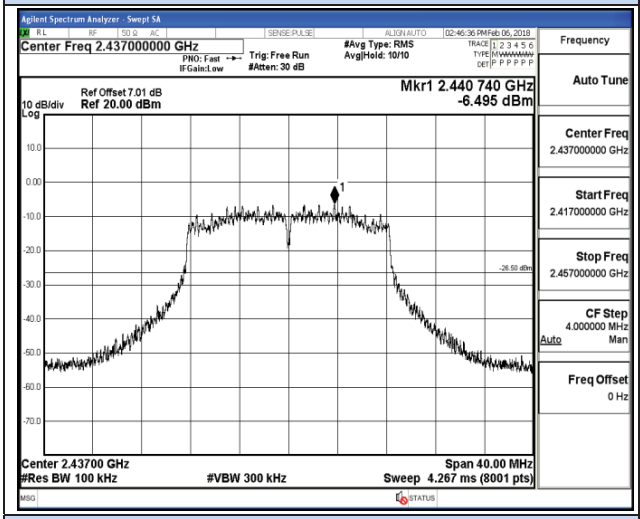
Chain 0



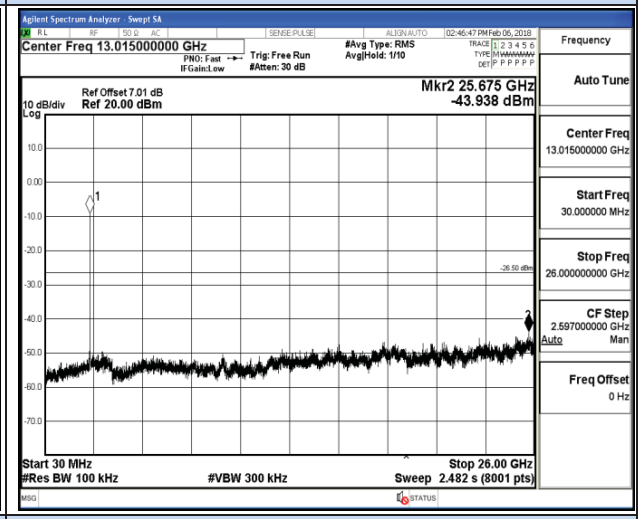
2397 MHz – 2427 MHz



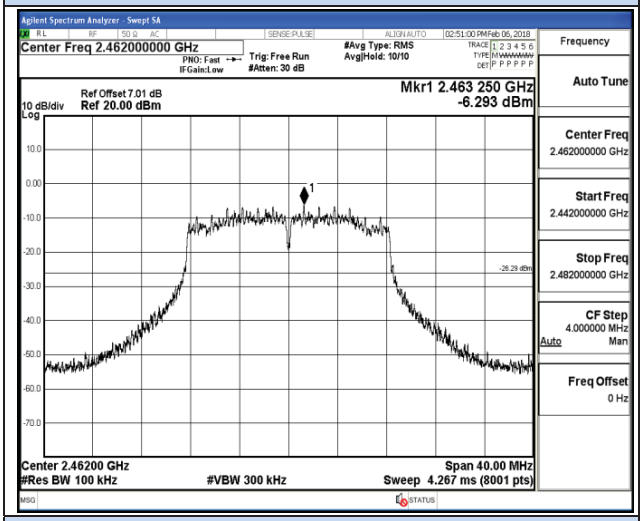
30 MHz – 26.5 GHz



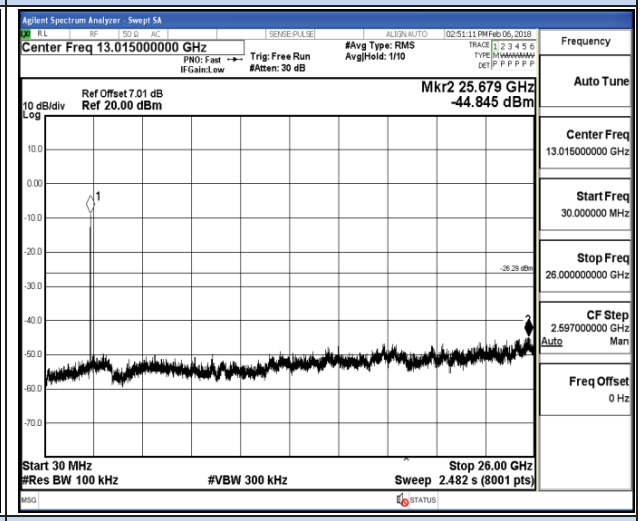
2422 MHz – 2452 MHz



30 MHz – 26.5 GHz



2447 MHz – 2477 MHz



30 MHz – 26.5 GHz