

FCC TEST REPORT

For

Swift Info Technology Limited.

PC BOARD ASSY: WIFI MODULE

Model No.: 1002216-0000

Prepared for
Address

: Swift Info Technology Limited.
: R303, Building C, Future Plaza, No.6060, Qiaoxiang Road,
Nanshan Dist, Shenzhen China 518053

Prepared by
Address

: Shenzhen LCS Compliance Testing Laboratory Ltd.
: 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 : July 01, 2017

Number of tested samples : 1

Serial number : Prototype

Date of Test : July 01, 2017~ July 09, 2017

Date of Report : July 10, 2017

FCC TEST REPORT
FCC CFR 47 PART 15 C(15.247): 2015

Report Reference No. : LCS170707143AE

Date of Issue : July 10, 2017

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 : Swift Info Technology Limited.

Address : R303, Building C, Future Plaza, No.6060, Qiaoxiang Road,
Nanshan Dist, Shenzhen China 518053

Test Specification

Standard : FCC CFR 47 PART 15 C(15.247): 2016

Test Report Form No. : LCSEMC-1.0

TRF Originator : Shenzhen LCS Compliance Testing Laboratory Ltd.

Master TRF : Dated 2011-03

Shenzhen LCS Compliance Testing Laboratory Ltd. All rights reserved.

This publication may be reproduced in whole or in part for non-commercial purposes as long as the Shenzhen LCS Compliance Testing Laboratory Ltd. is acknowledged as copyright owner and source of the material. Shenzhen LCS Compliance Testing Laboratory Ltd. takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

EUT Description : PC BOARD ASSY: WIFI MODULE

Trade Mark : Swift Info

Model/ Type reference : 1002216-0000

Ratings : DC USB 5.0V

Result : Positive

Compiled by:

Chaz Liu

Chaz Liu / File administrators

Supervised by:

Dick Su

Dick Su / Technique principal

Approved by:

Gavin Liang

Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS170707143AE	<u>July 10, 2017</u> Date of issue
EUT.....	: PC BOARD ASSY: WIFI MODULE
Type / Model.....	: 1002216-0000
Applicant.....	: Swift Info Technology Limited. Address..... : R303, Building C, Future Plaza, No.6060, Qiaoxiang Road, Nanshan Dist, Shenzhen China 518053
Telephone.....	: /
Fax.....	: /
Manufacturer.....	: Swift Info Technology Limited. Address..... : R303, Building C, Future Plaza, No.6060, Qiaoxiang Road, Nanshan Dist, Shenzhen China 518053
Telephone.....	: /
Fax.....	: /
Factory.....	: Swift Info Technology Limited. Address..... : R303, Building C, Future Plaza, No.6060, Qiaoxiang Road, Nanshan Dist, Shenzhen China 518053
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
00	2017-07-10	Initial Issue	Gavin Liang

TABLE OF CONTENTS

1. GENERAL INFORMATION	6
1.1. DESCRIPTION OF DEVICE (EUT)	6
1.2. HOST SYSTEM CONFIGURATION LIST AND DETAILS	6
1.3. EXTERNAL I/O CABLE	6
1.4. DESCRIPTION OF TEST FACILITY	7
1.5. STATEMENT OF THE MEASUREMENT UNCERTAINTY	7
1.6. MEASUREMENT UNCERTAINTY	7
1.7. DESCRIPTION OF TEST MODES	8
2. TEST METHODOLOGY	9
2.1. EUT CONFIGURATION	9
2.2. EUT EXERCISE	9
2.3. GENERAL TEST PROCEDURES	9
3. SYSTEM TEST CONFIGURATION	10
3.1. JUSTIFICATION	10
3.2. EUT EXERCISE SOFTWARE	10
3.3. SPECIAL ACCESSORIES	10
3.4. BLOCK DIAGRAM/SCHEMATICS	10
3.5. EQUIPMENT MODIFICATIONS	10
3.6. TEST SETUP	10
4. SUMMARY OF TEST RESULTS.....	11
5. TEST RESULT	12
5.1. ON TIME AND DUTY CYCLE	12
5.2. MAXIMUM CONDUCTED OUTPUT POWER MEASUREMENT.....	14
5.3. POWER SPECTRAL DENSITY MEASUREMENT	16
5.4. 6 dB SPECTRUM BANDWIDTH MEASUREMENT	22
5.5. RADIATED EMISSIONS MEASUREMENT.....	28
5.6. CONDUCTED SPURIOUS EMISSIONS AND BAND EDGES TEST.....	39
5.7. POWER LINE CONDUCTED EMISSIONS	55
5.8 BAND-EDGE MEASUREMENTS FOR RADIATED EMISSIONS	58
5.9. ANTENNA REQUIREMENTS.....	69
6. LIST OF MEASURING EQUIPMENTS.....	71

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	: PC BOARD ASSY: WIFI MODULE
Hardware Version	: VER10
Software Version	: VER1.0
Model Number	: 1002216-0000
Power Supply	: DC USB 5.0V
Frequency Range	: 2412.00~2462.00MHz/2422.00~2452.00MHz; 5745.00-5825.00MHz
Channel Number	: 11 Channels for WIFI 20MHz Bandwidth(802.11b/g/n-HT20) 7 Channels for WIFI 40MHz Bandwidth(802.11n-HT40) 5 Channels for 5745.00-5825.00MHz(802.11a/n-HT20) 2 Channels for 5755.00-5795.00MHz(802.11n-HT40)
Modulation Technology	: IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK) IEEE 802.11a: OFDM (64QAM, 16QAM,QPSK,BPSK)
Data Rates	: IEEE 802.11b: 1-11Mbps IEEE 802.11g: 6-54Mbps IEEE 802.11n: MCS0-MCS15 IEEE 802.11a: 6-54Mbps
Antenna Type And Gain	: 2.4G WLAN Antenna Chain0 Internal antenna, 2.00 dBi (Max.) Chain1 Internal antenna, 2.00 dBi (Max.) 5G WLAN Antenna Chain0 Internal antenna, 2.00 dBi (Max.) Chain1 Internal antenna, 2.00 dBi (Max.)

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
--	--	--	--	--

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	1	N/A

1.4. Description of Test Facility

CNAS Registration Number. is L4595.
FCC Registration Number. is 899208.
Industry Canada Registration Number. is 9642A-1.
VCCI Registration Number. is C-4260 and R-3804.
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

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 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.

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.

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 that was determined to be IEEE 802.11b mode (High Channel).

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be IEEE 802.11b mode(High Channel).

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

IEEE 802.11b Mode: 1 Mbps, DSSS.

IEEE 802.11g Mode: 6 Mbps, OFDM.

IEEE 802.11n Mode HT20: MCS0, OFDM.

IEEE 802.11n Mode HT40: MCS8, OFDM.

Channel List & Frequency

IEEE 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	--	--

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 KDB558074 D01 DTS Meas. Guidance v03r05 and KDB 662911 are 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 RSS-247 Issue 1 and RSS-Gen Issue 4.

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

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 (rtl8192DU_linux_v4.0.3_10373.20140124_MP) provided by application.

3.3. Special Accessories

No.	Equipment	Manufacturer	Model No.	Serial No.	Length	shielded/unshielded	Notes
1	PC	Lenovo	Ideapad	A131101550	/	/	DOC
2	Power adapter	Lenovo	CPA-A090	36200414	1.00m	unshielded	DOC

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

Applicable Standards: FCC Part 15.247		
FCC Rules	Description of Test	Result
§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

5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

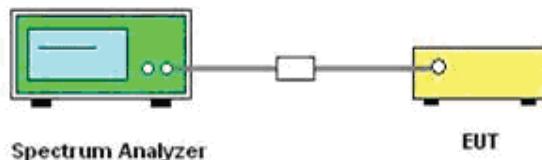
5.1.2. Measuring Instruments and Setting

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

5.1.3. Test Procedures

1. Set the centre frequency of the spectrum analyzer to the transmitting frequency;
2. Set the span=0MHz, RBW=8MHz, VBW=50MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

5.1.4. Test Setup Layout



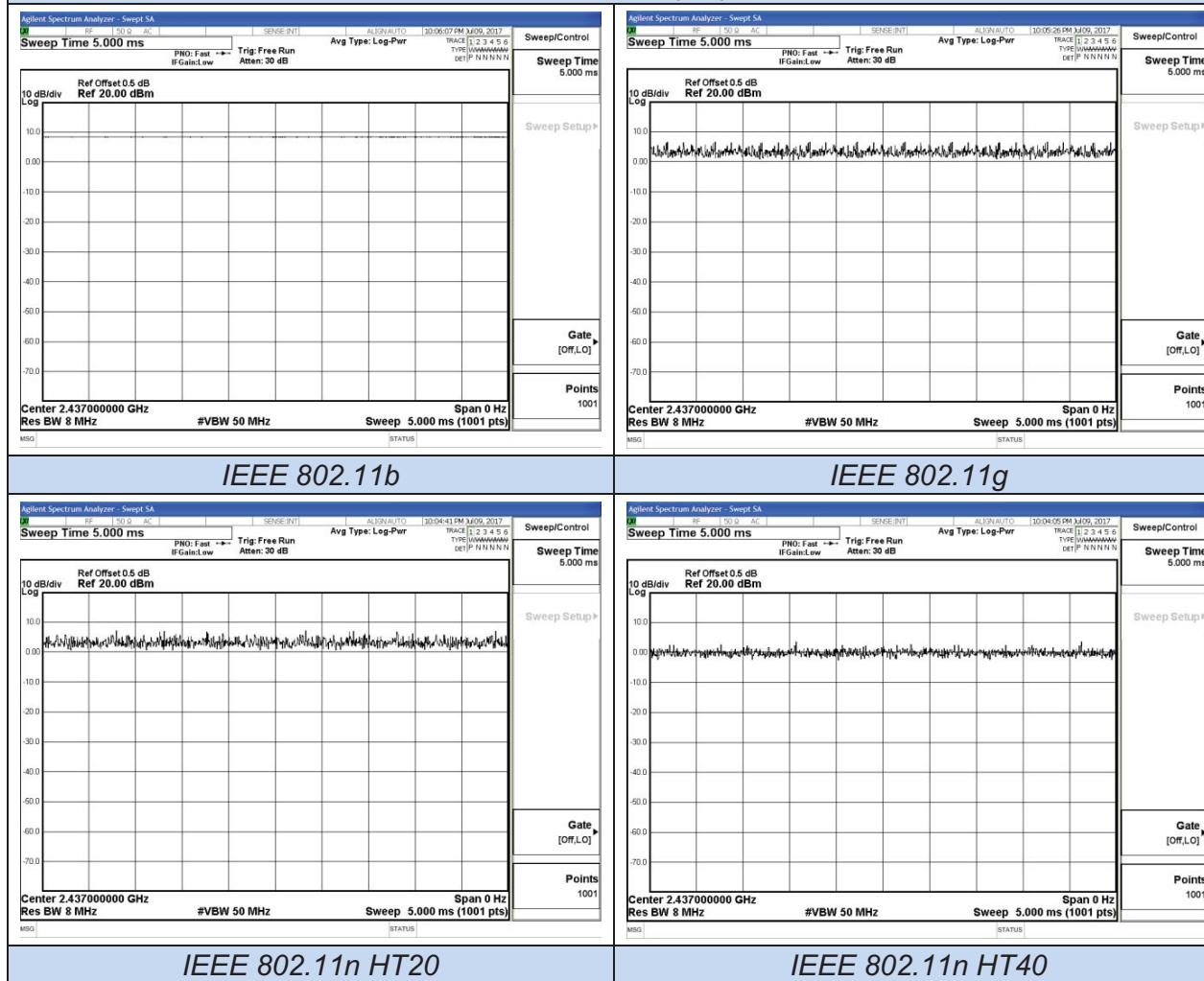
5.1.5. EUT Operation during Test

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)
IEEE 802.11b	5.00	5.00	1	100.00%	0	0.010
IEEE 802.11g	5.00	5.00	1	100.00%	0	0.010
IEEE 802.11n HT20	5.00	5.00	1	100.00%	0	0.010
IEEE 802.11n HT40	5.00	5.00	1	100.00%	0	0.010

On Time and Duty Cycle



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 limit has to be reduced by the amount in dB that the gain of the antenna exceeds 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.

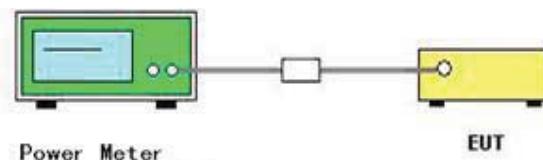
According to KDB558074 D01 DTS Measurement Guidance Section 9.1 Maximum peak conducted output power, 9.1.2 the maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

According to KDB558074 D01 DTS Measurement Guidance Section 9.2 Maximum average conducted output power, 9.2.3.1 Method AVGPM (Measurement using an RF average power meter)

(a) As an alternative to spectrum analyzer or EMI receiver measurements, measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

- 1) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.
 - 2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
 - 3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
- (b) If the transmitter does not transmit continuously, measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.
- (c) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
- (d) Adjust the measurement in dBm by adding $10\log(1/x)$, where x is the duty cycle to the measurement result.

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	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 802.11b/g/n

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)			Limits (dBm)	Verdict
			Antenna 0	Antenna 1	Sum		
IEEE 802.11b	1	2412	8.48	8.31	/	30	PASS
	6	2437	8.10	8.06	/		
	11	2462	8.24	8.12	/		
IEEE 802.11g	1	2412	7.56	7.58	/	30	PASS
	6	2437	7.42	7.39	/		
	11	2462	7.81	7.19	/		
IEEE 802.11n HT20	1	2412	5.42	5.38	8.41	30	PASS
	6	2437	5.39	5.41	8.41		
	11	2462	5.31	5.29	8.31		
IEEE 802.11n HT40	3	2422	5.37	5.33	8.36	30	PASS
	6	2437	5.34	5.24	8.30		
	9	2452	5.36	5.40	8.41		

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;
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;

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.

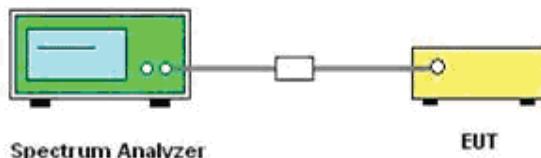
5.3.2. Measuring Instruments and Setting

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.
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 = 3 kHz~100 kHz.
4. Set the VBW \geq 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.

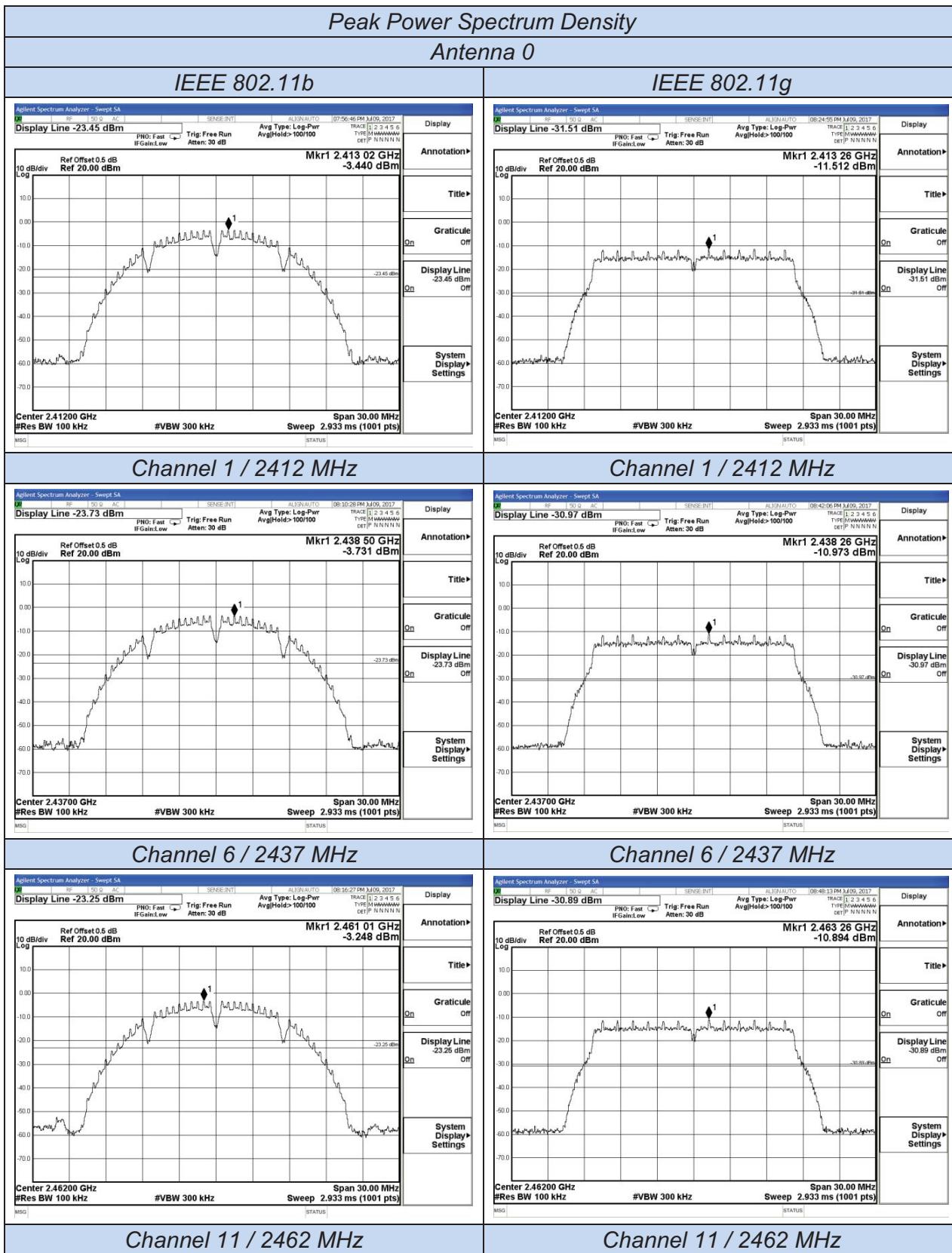
5.3.6. Test Result of Power Spectral Density

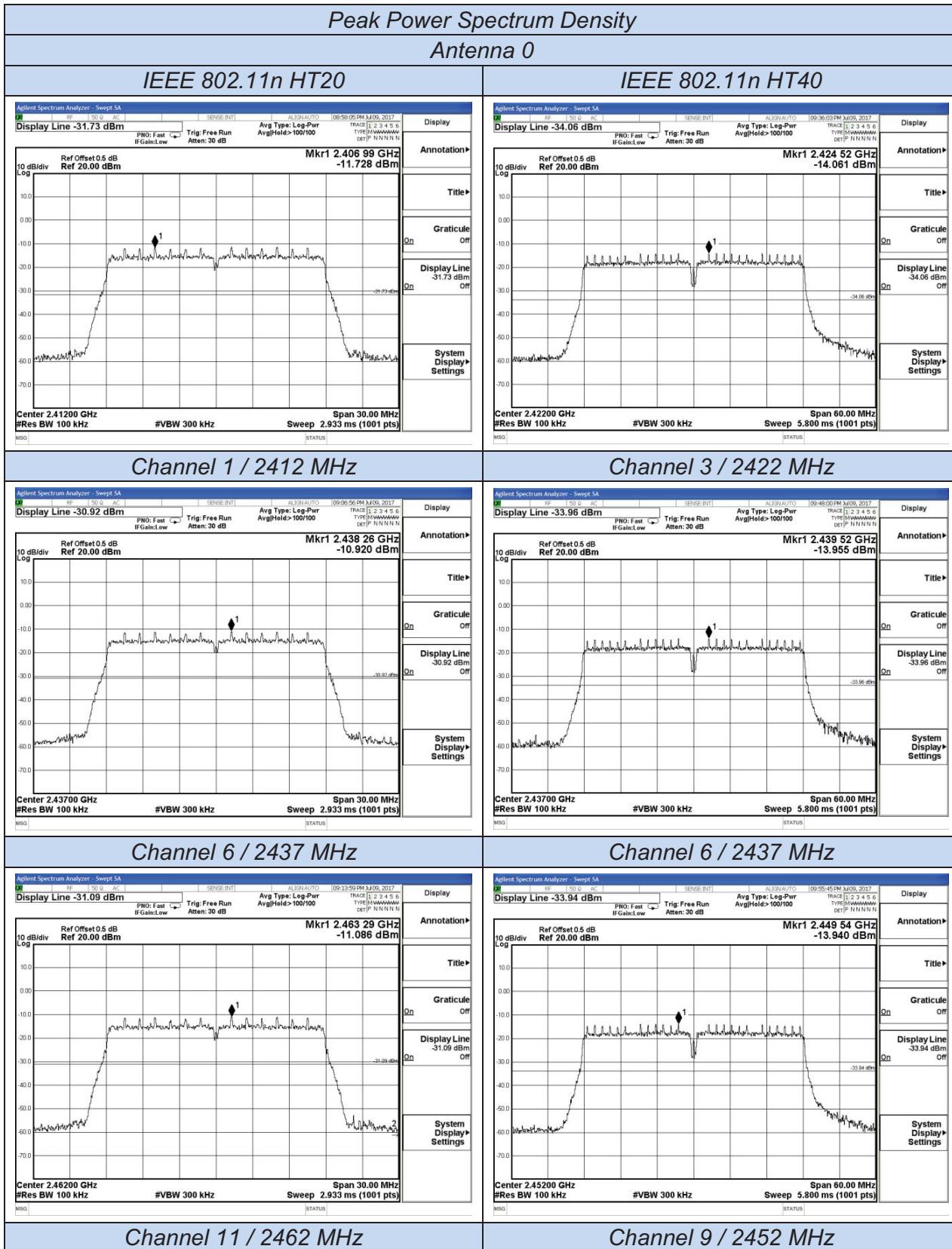
Temperature	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 802.11b/g/n

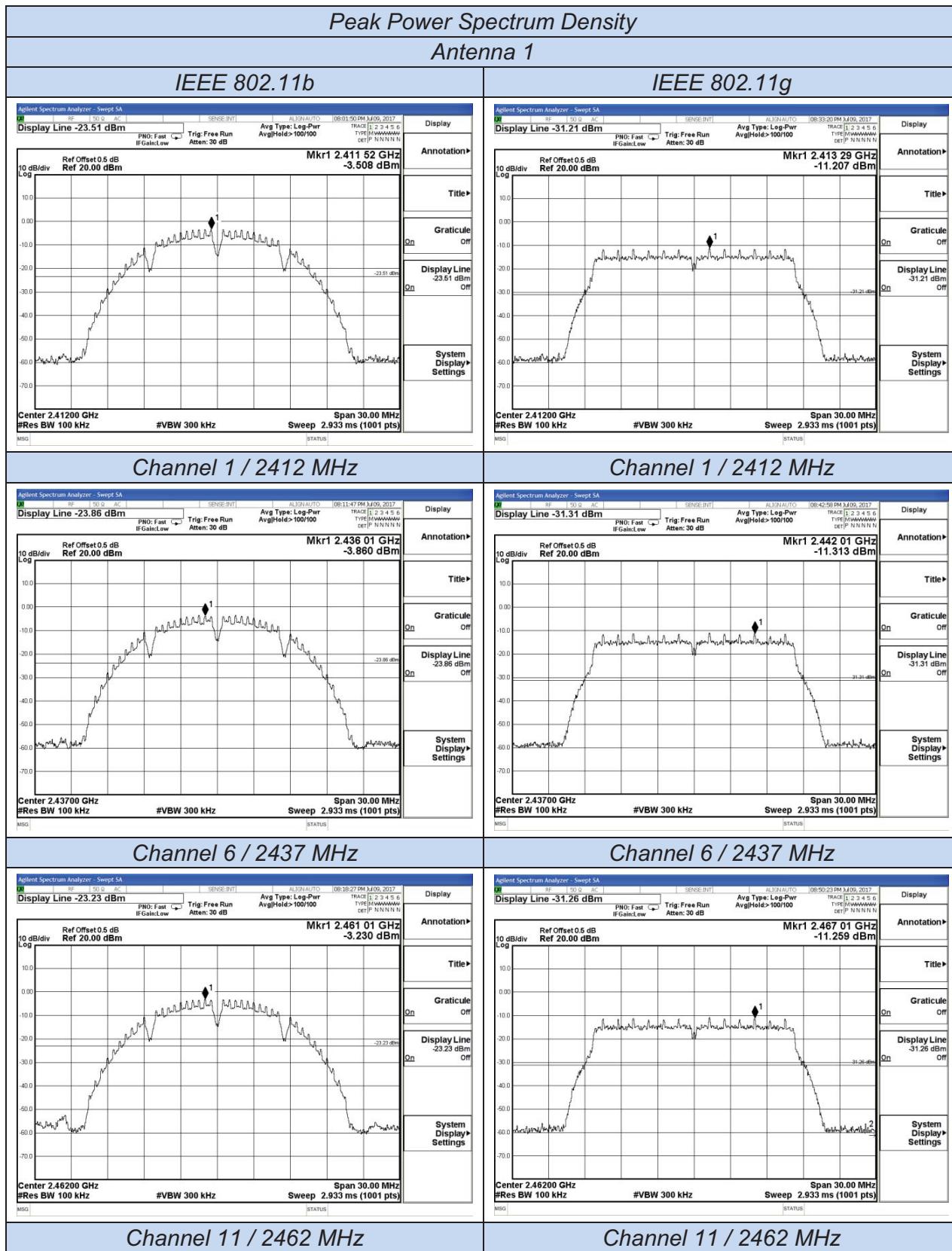
Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectrum Density (dBm/3KHz)			Limits (dBm/3KHz)	Verdict
			Antenna 0	Antenna 1	Sum		
IEEE 802.11b	1	2412	-3.440	-3.508	/	8	PASS
	6	2437	-3.731	-3.860	/		
	11	2462	-3.248	-3.230	/		
IEEE 802.11g	1	2412	-11.512	-11.207	/	8	PASS
	6	2437	-10.973	-11.313	/		
	11	2462	-10.894	-11.259	/		
IEEE 802.11n HT20	1	2412	-11.728	-11.233	-8.463	4.990*	PASS
	6	2437	-10.920	-10.913	-7.906		
	11	2462	-11.086	-10.853	-7.958		
IEEE 802.11n HT40	3	2422	-14.061	-14.181	-11.110	4.990*	PASS
	6	2437	-13.955	-14.122	-11.027		
	9	2452	-13.940	-13.886	-10.903		

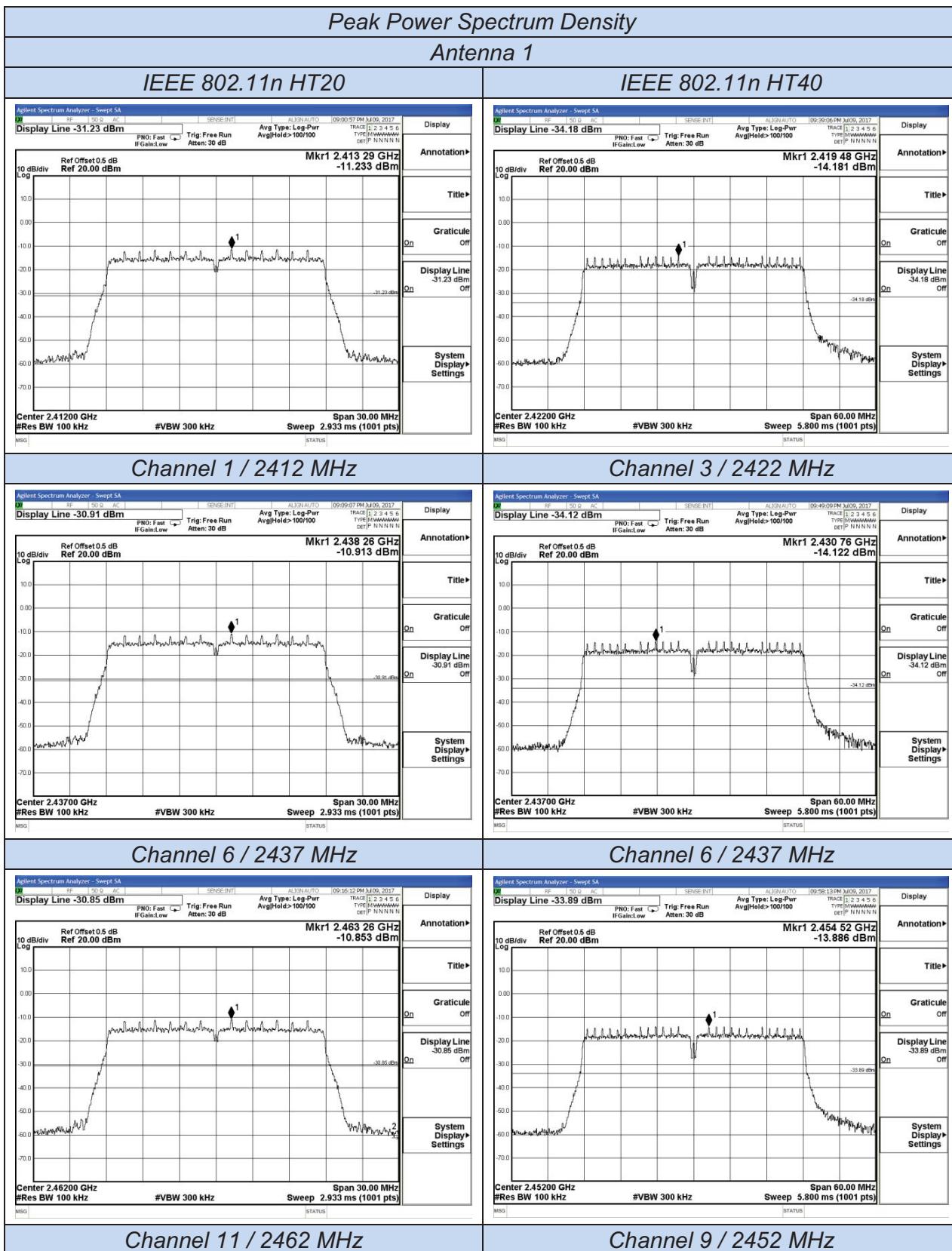
Remark:

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 PSD limits of IEEE 802.11n HT20 and IEEE 802.11 n HT40 for MIMO with CDD technology should be reduce (10*log(2) = 3.010dB according to KDB662911D01);
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 N_{ant} is the number of transmit antennas.









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

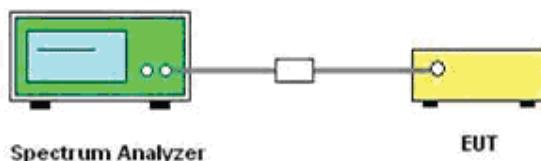
Please refer to section 6 of equipments list in this report. The following table is the setting of the Spectrum Analyzer.

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 analyzer 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.

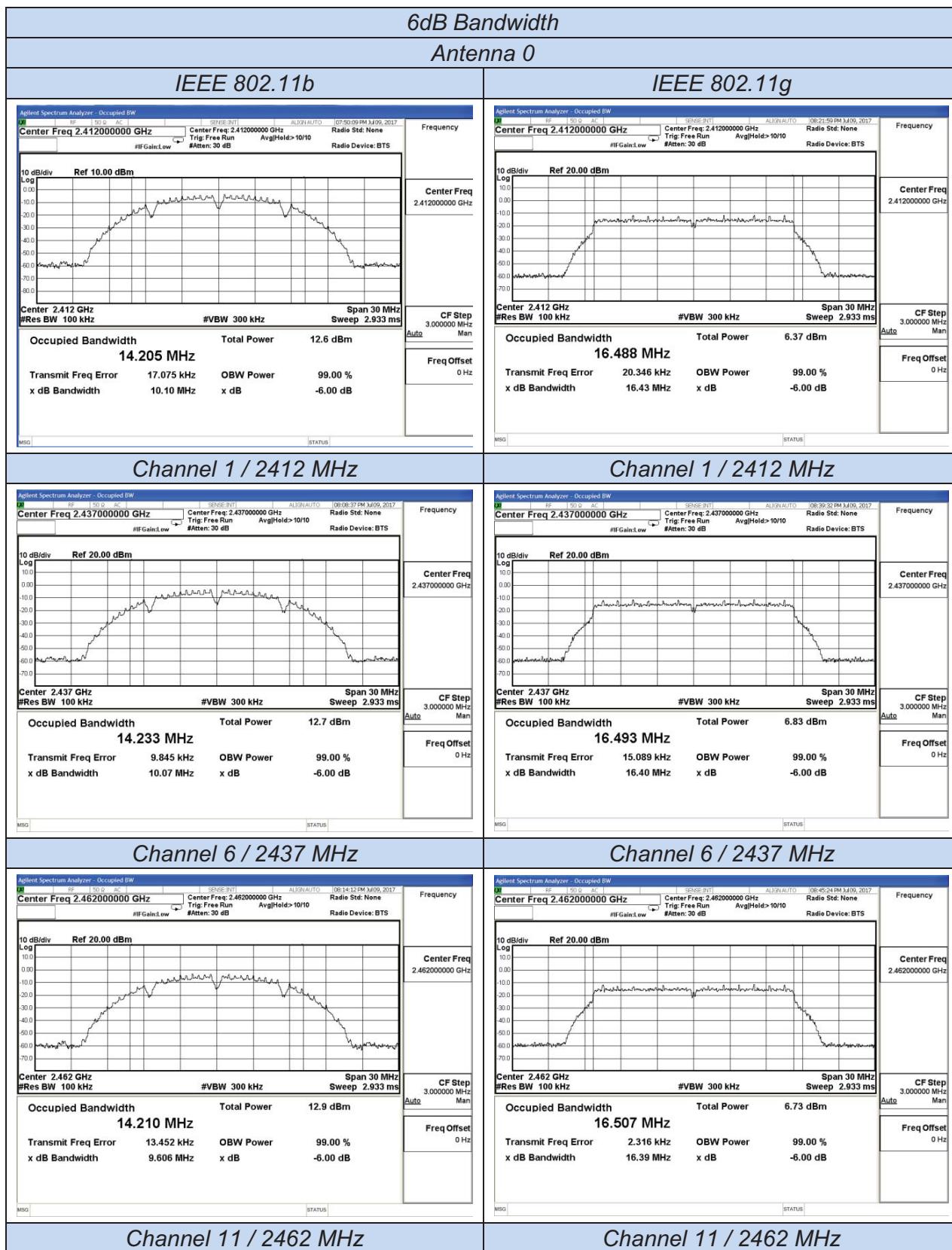
5.4.6. Test Result of 6dB Spectrum Bandwidth

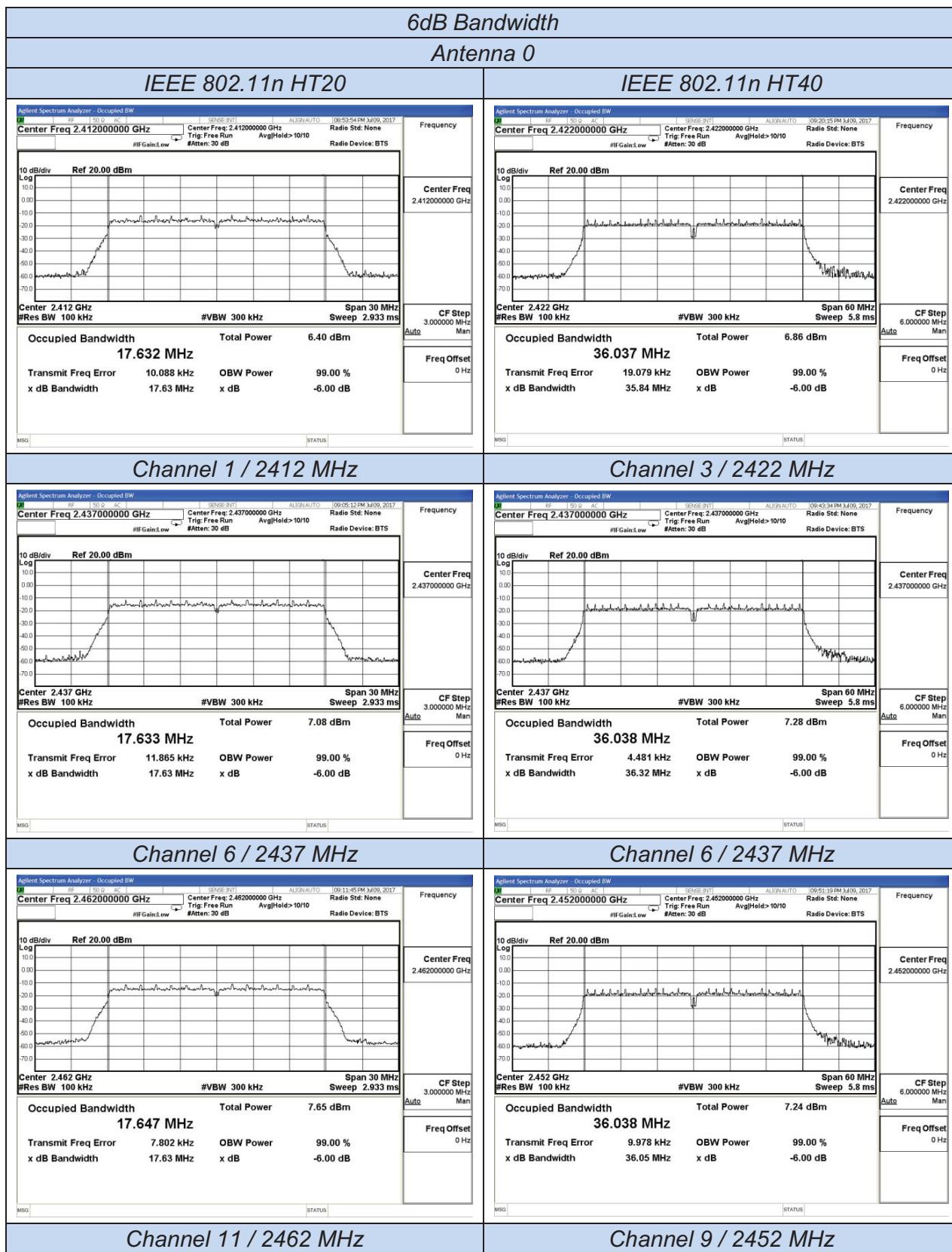
Temperature	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 802.11b/g/n

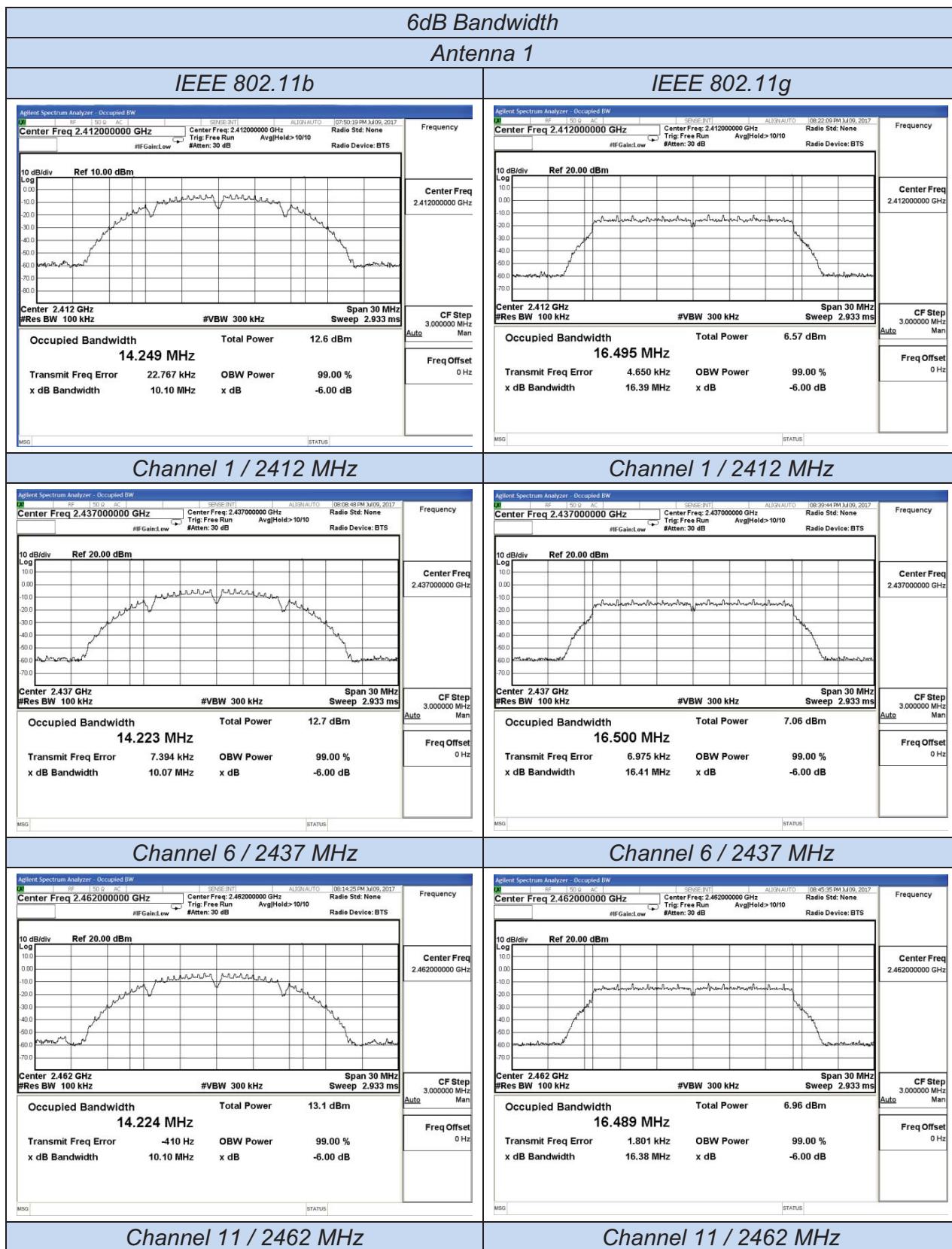
Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Limits (MHz)	Verdict
			Antenna 0	Antenna 2		
IEEE 802.11b	1	2412	10.10	10.10	0.500	PASS
	6	2437	10.07	10.07		
	11	2462	9.606	10.10		
IEEE 802.11g	1	2412	16.43	16.39	0.500	PASS
	6	2437	16.40	16.41		
	11	2462	16.39	16.38		
IEEE 802.11n HT20	1	2412	17.63	17.61	0.500	PASS
	6	2437	17.63	17.64		
	11	2462	17.63	15.140		
IEEE 802.11n HT40	3	2422	35.840	36.070	0.500	PASS
	6	2437	36.320	36.080		
	9	2452	36.050	36.100		

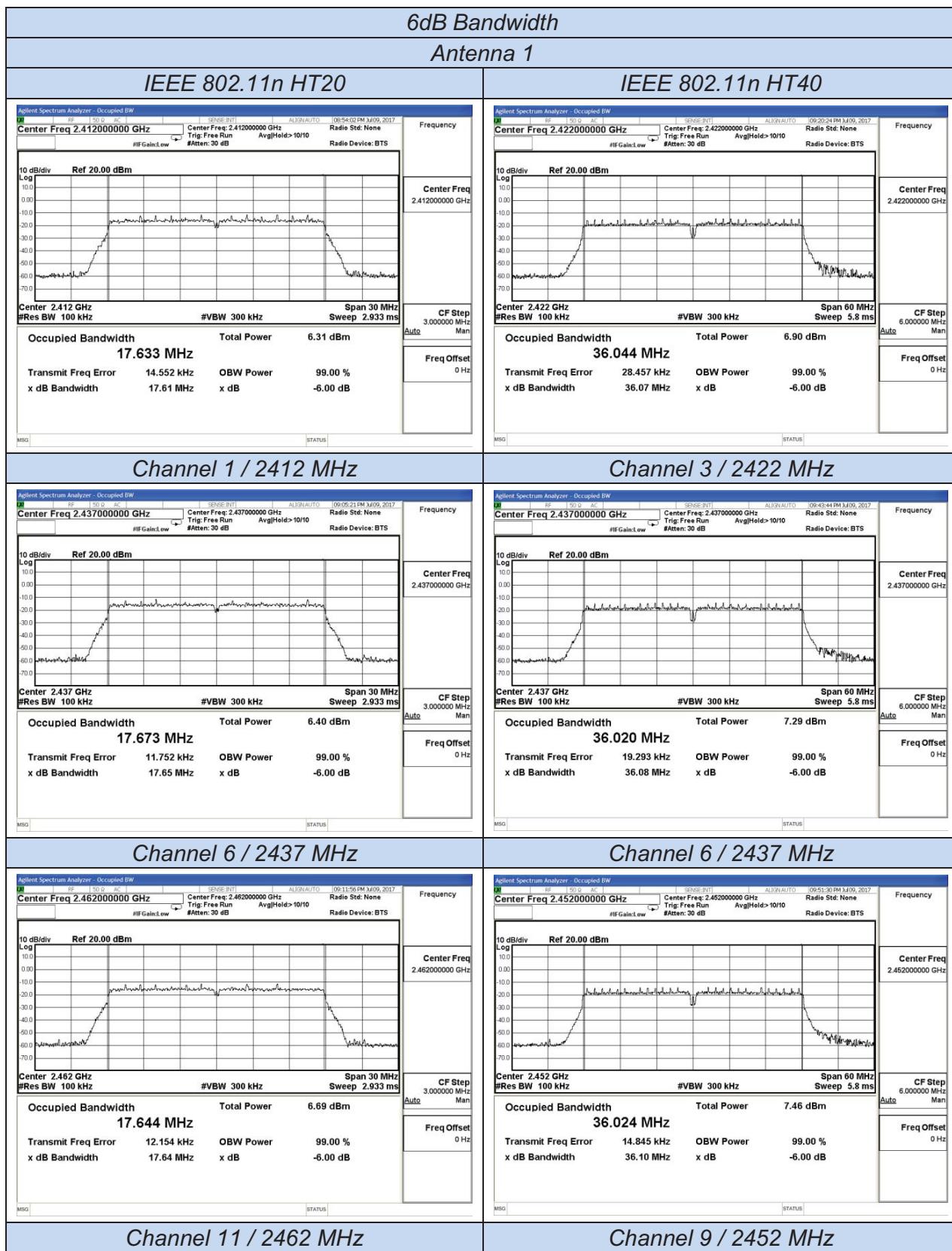
Remark:

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;









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 equipment 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	10 th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

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.

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 ($\pm 45^\circ$) 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 ($\pm 45^\circ$) 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.

Premereasurement:

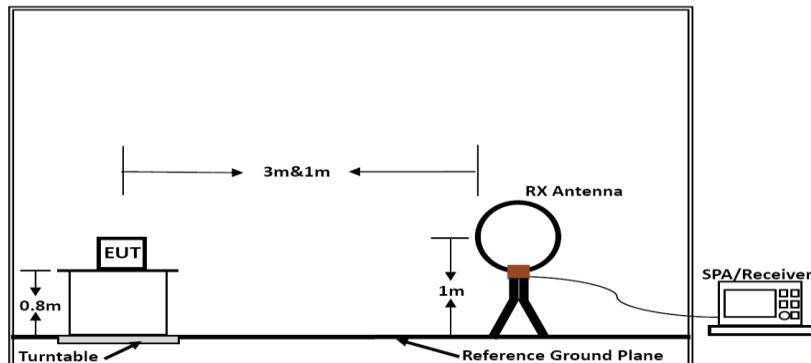
- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

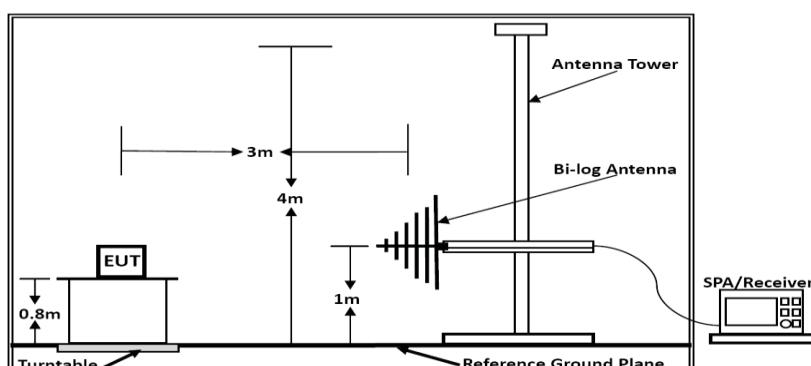
- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.4. Test Setup Layout

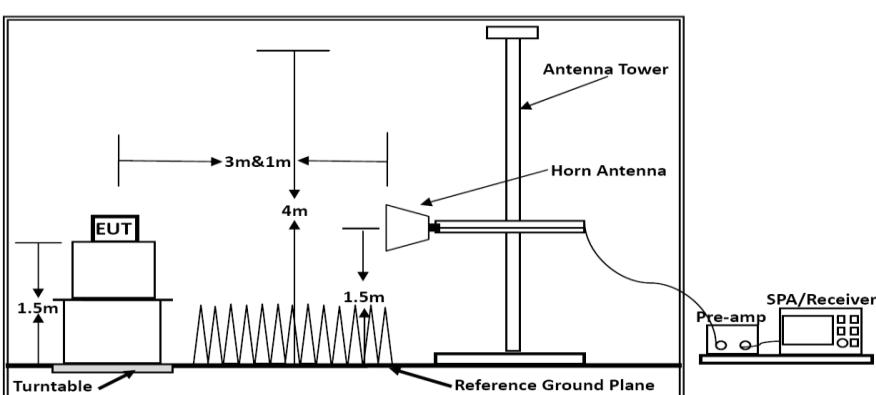
For radiated emissions below 30MHz



Below 30MHz



Below 1GHz



Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from 3m to 1m.

Distance extrapolation factor = $20 \log (\text{specific distanc [3m]} / \text{test distance [1.5m]})$ (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 (9 KHz~30MHz)

Temperature	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 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);

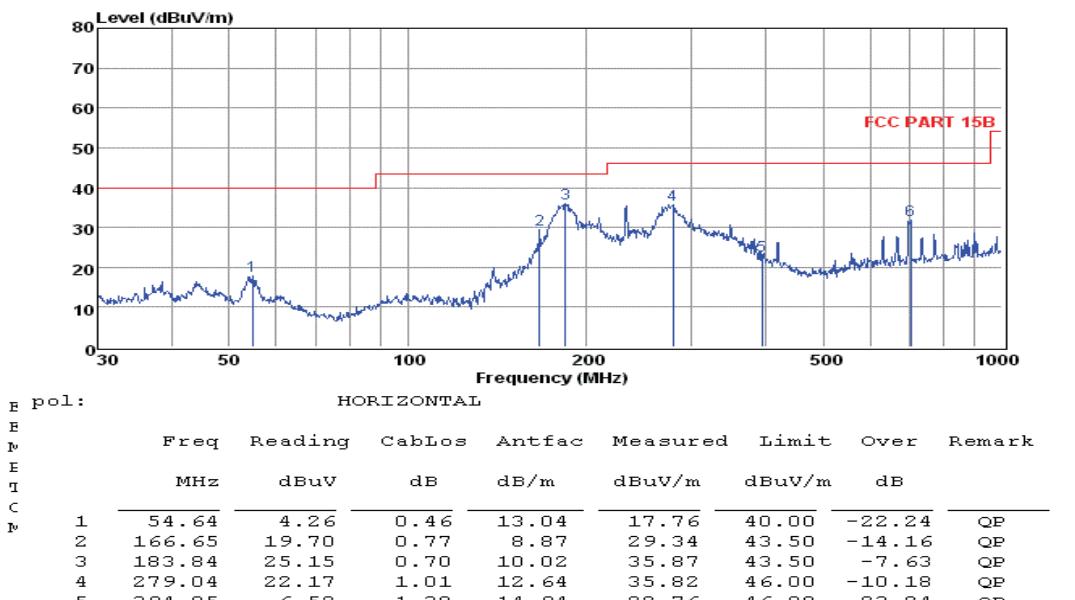
Limit line = specific limits (dBuV) + distance extrapolation factor.

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

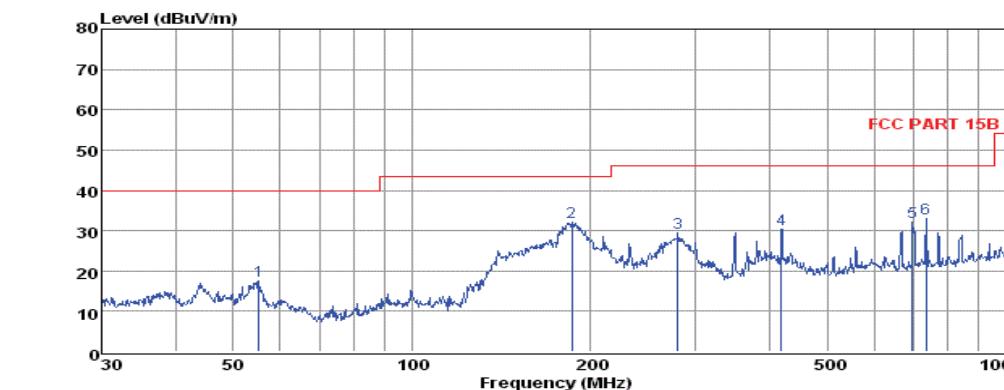
Temperature	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 802.11b (High CH)

Test result for IEEE 802.11b (High Channel) @Chain 0

Horizontal:



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

Vertical:

pol:

VERTICAL

Freq	Reading	CabLoss	Antfac	Measured	Limit	Over	Remark
MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	

1	55.22	4.14	0.46	13.01	17.61	40.00	-22.39	QP
2	185.79	21.24	0.70	10.19	32.13	43.50	-11.37	QP
3	280.02	15.84	1.01	12.67	29.52	46.00	-16.48	QP
4	419.11	13.58	1.32	15.45	30.35	46.00	-15.65	QP
5	696.86	11.85	1.59	18.80	32.24	46.00	-13.76	QP
6	734.49	12.01	1.74	19.24	32.99	46.00	-13.01	QP

Note: 1. All readings are Quasi-peak values.

2. Measured= Reading + Antenna Factor + Cable Loss

3. The emission that ate 20db blow the official limit are not reported

Note:

Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b (High Channel) @ Chain 0).

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 1)

IEEE 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	54.18	33.06	35.14	3.98	56.08	74.00	-17.92	Peak	Horizontal
4824.00	38.02	33.06	35.14	3.98	39.92	54.00	-14.08	Average	Horizontal
4824.00	59.65	33.06	35.14	3.98	61.55	74.00	-12.45	Peak	Vertical
4824.00	42.04	33.06	35.14	3.98	43.94	54.00	-10.06	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	55.61	33.16	35.15	3.96	57.58	74.00	-16.42	Peak	Horizontal
4874.00	39.42	33.16	35.15	3.96	41.39	54.00	-12.61	Average	Horizontal
4874.00	59.49	33.16	35.15	3.96	61.46	74.00	-12.54	Peak	Vertical
4874.00	41.22	33.16	35.15	3.96	43.19	54.00	-10.81	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	55.10	33.26	35.14	3.98	57.20	74.00	-16.80	Peak	Horizontal
4924.00	38.30	33.26	35.14	3.98	40.40	54.00	-13.60	Average	Horizontal
4924.00	59.62	33.26	35.14	3.98	61.72	74.00	-12.28	Peak	Vertical
4924.00	41.65	33.26	35.14	3.98	43.75	54.00	-10.25	Average	Vertical

(Worst Case at Antenna Chain 0)*IEEE 802.11g**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	55.35	33.06	35.14	3.98	57.25	74.00	-16.75	Peak	Horizontal
4824.00	39.09	33.06	35.14	3.98	40.99	54.00	-13.01	Average	Horizontal
4824.00	59.57	33.06	35.14	3.98	61.47	74.00	-12.53	Peak	Vertical
4824.00	42.61	33.06	35.14	3.98	44.51	54.00	-9.49	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	55.57	33.16	35.15	3.96	57.54	74.00	-16.46	Peak	Horizontal
4874.00	38.72	33.16	35.15	3.96	40.69	54.00	-13.31	Average	Horizontal
4874.00	59.99	33.16	35.15	3.96	61.96	74.00	-12.04	Peak	Vertical
4874.00	42.07	33.16	35.15	3.96	44.04	54.00	-9.96	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	54.24	33.26	35.14	3.98	56.34	74.00	-17.66	Peak	Horizontal
4924.00	39.56	33.26	35.14	3.98	41.66	54.00	-12.34	Average	Horizontal
4924.00	58.22	33.26	35.14	3.98	60.32	74.00	-13.68	Peak	Vertical
4924.00	42.48	33.26	35.14	3.98	44.58	54.00	-9.42	Average	Vertical

(Combine with Antenna Chain 0, Antenna Chain 1)

IEEE 802.11n HT20

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	54.46	33.06	35.14	3.98	56.36	74.00	-17.64	Peak	Horizontal
4824.00	38.55	33.06	35.14	3.98	40.45	54.00	-13.55	Average	Horizontal
4824.00	59.29	33.06	35.14	3.98	61.19	74.00	-12.81	Peak	Vertical
4824.00	41.45	33.06	35.14	3.98	43.35	54.00	-10.65	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	55.07	33.16	35.15	3.96	57.04	74.00	-16.96	Peak	Horizontal
4874.00	39.01	33.16	35.15	3.96	40.98	54.00	-13.02	Average	Horizontal
4874.00	59.75	33.16	35.15	3.96	61.72	74.00	-12.28	Peak	Vertical
4874.00	42.35	33.16	35.15	3.96	44.32	54.00	-9.68	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	54.57	33.26	35.14	3.98	56.67	74.00	-17.33	Peak	Horizontal
4924.00	38.30	33.26	35.14	3.98	40.40	54.00	-13.60	Average	Horizontal
4924.00	59.44	33.26	35.14	3.98	61.54	74.00	-12.46	Peak	Vertical
4924.00	41.40	33.26	35.14	3.98	43.50	54.00	-10.50	Average	Vertical

(Combine with Antenna Chain 0, Antenna Chain 1)

IEEE 802.11n HT40

Channel 3 / 2422 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.
4844.00	54.81	33.06	35.14	3.98	56.71	74.00	-17.29	Peak	Horizontal
4844.00	38.79	33.06	35.14	3.98	40.69	54.00	-13.31	Average	Horizontal
4844.00	59.28	33.06	35.14	3.98	61.18	74.00	-12.82	Peak	Vertical
4844.00	42.16	33.06	35.14	3.98	44.06	54.00	-9.94	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	54.17	33.16	35.15	3.96	56.14	74.00	-17.86	Peak	Horizontal
4874.00	38.37	33.16	35.15	3.96	40.34	54.00	-13.66	Average	Horizontal
4874.00	58.27	33.16	35.15	3.96	60.24	74.00	-13.76	Peak	Vertical
4874.00	42.83	33.16	35.15	3.96	44.80	54.00	-9.20	Average	Vertical

Channel 9 / 2452 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.
4904.00	55.64	33.26	35.14	3.98	57.74	74.00	-16.26	Peak	Horizontal
4904.00	38.95	33.26	35.14	3.98	41.05	54.00	-12.95	Average	Horizontal
4904.00	59.40	33.26	35.14	3.98	61.50	74.00	-12.50	Peak	Vertical
4904.00	41.42	33.26	35.14	3.98	43.52	54.00	-10.48	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;

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.

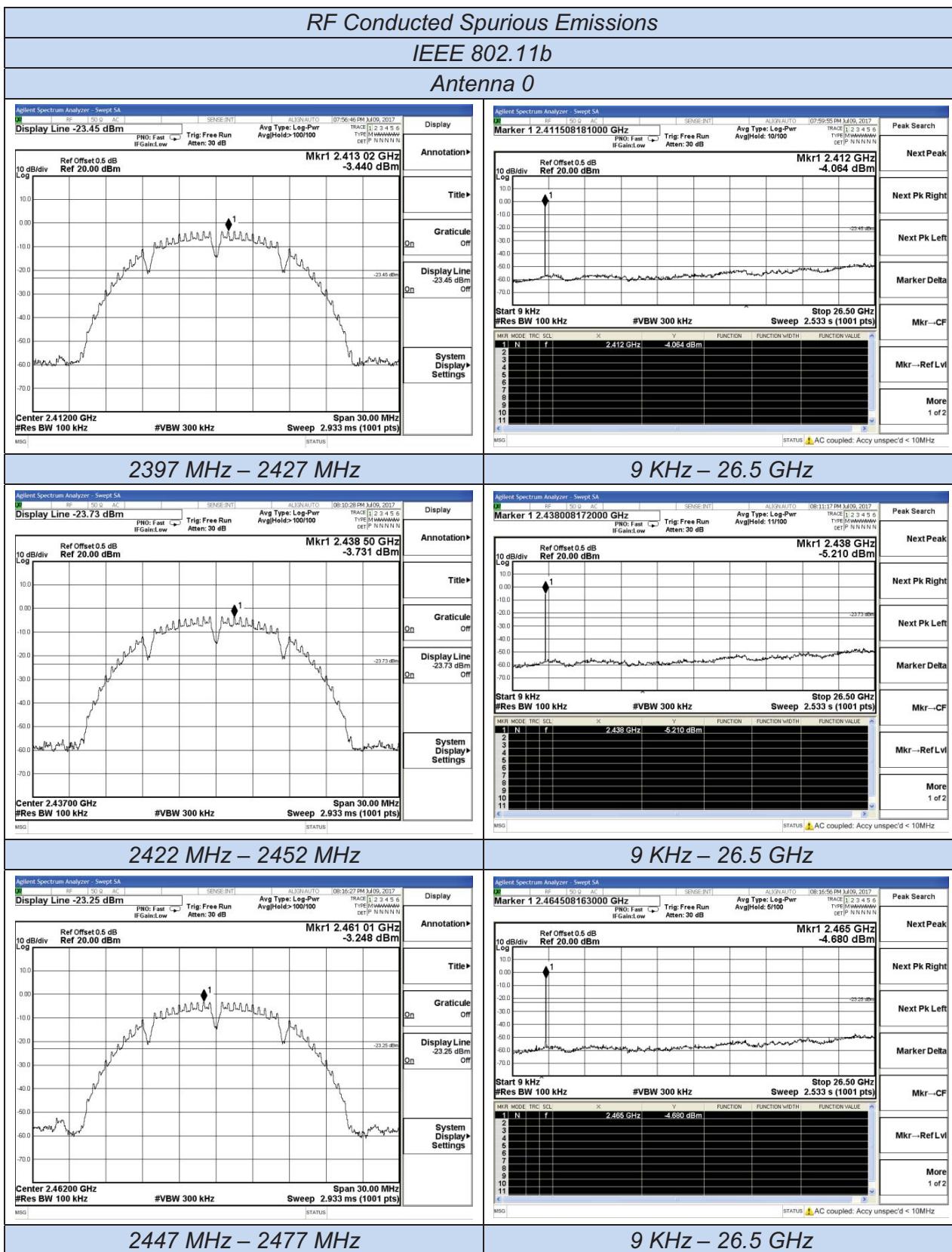
5.6.6. Test Results of Conducted Spurious Emissions

Temperature	25°C	Humidity	60%
Test Engineer	Chaz Liu	Configurations	IEEE 802.11b/g/n

Test Mode	Channel	Frequency (MHz)	Frequency Range (MHz)	Spurious RF Conducted Emission (dBc)				Limits (dBc)	Verdict
				Antenna 0	Antenna 1	Antenna 2	Sum		
IEEE 802.11b	1	2412	9 KHz- 26.5 GHz	<-20	<-20	<-20	/	-20	PASS
	6	2437	9 KHz- 26.5 GHz	<-20	<-20	<-20	/		
	11	2462	9 KHz- 26.5 GHz	<-20	<-20	<-20	/		
IEEE 802.11g	1	2412	9 KHz- 26.5 GHz	<-20	<-20	<-20	/	-20	PASS
	6	2437	9 KHz- 26.5 GHz	<-20	<-20	<-20	/		
	11	2462	9 KHz- 26.5 GHz	<-20	<-20	<-20	/		
IEEE 802.11n HT20	1	2412	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20		
	11	2462	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20		
IEEE 802.11n HT40	3	2412	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20	-20	PASS
	6	2437	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20		
	9	2452	9 KHz- 26.5 GHz	<-20	<-20	<-20	<-20		

Remark:

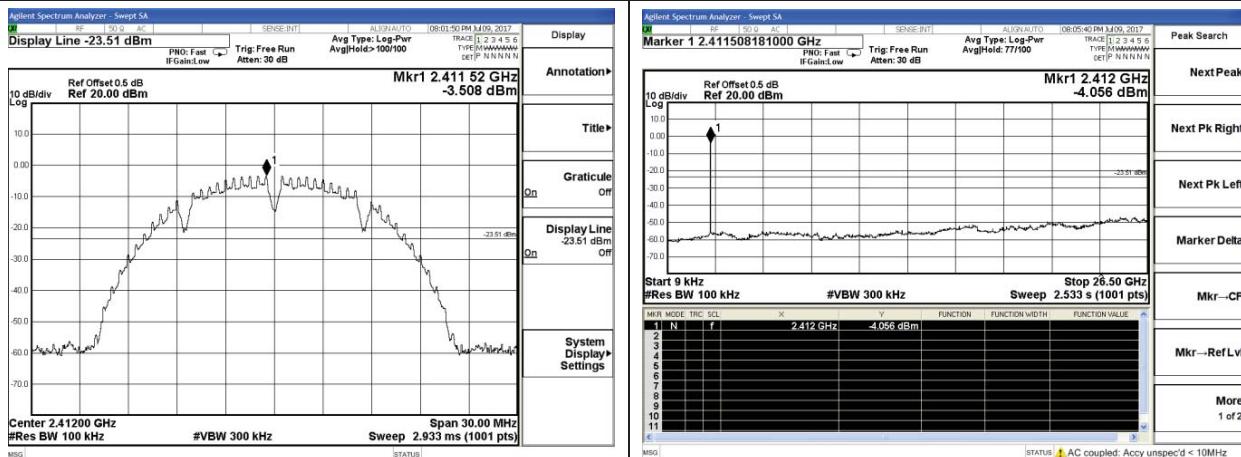
1. Measured RF conducted spurious at difference data rate for each mode and recorded worst case for each mode.
2. Test results including cable loss;
3. Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;
4. “--“means that the fundamental frequency not for 15.209 limits requirement.
5. Please refer to following plots;



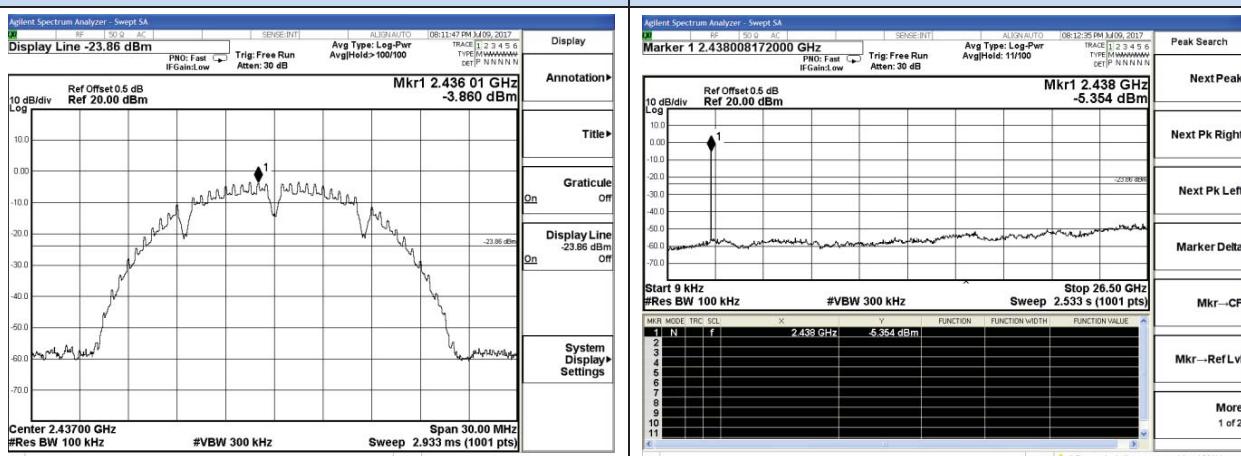
RF Conducted Spurious Emissions

IEEE 802.11b

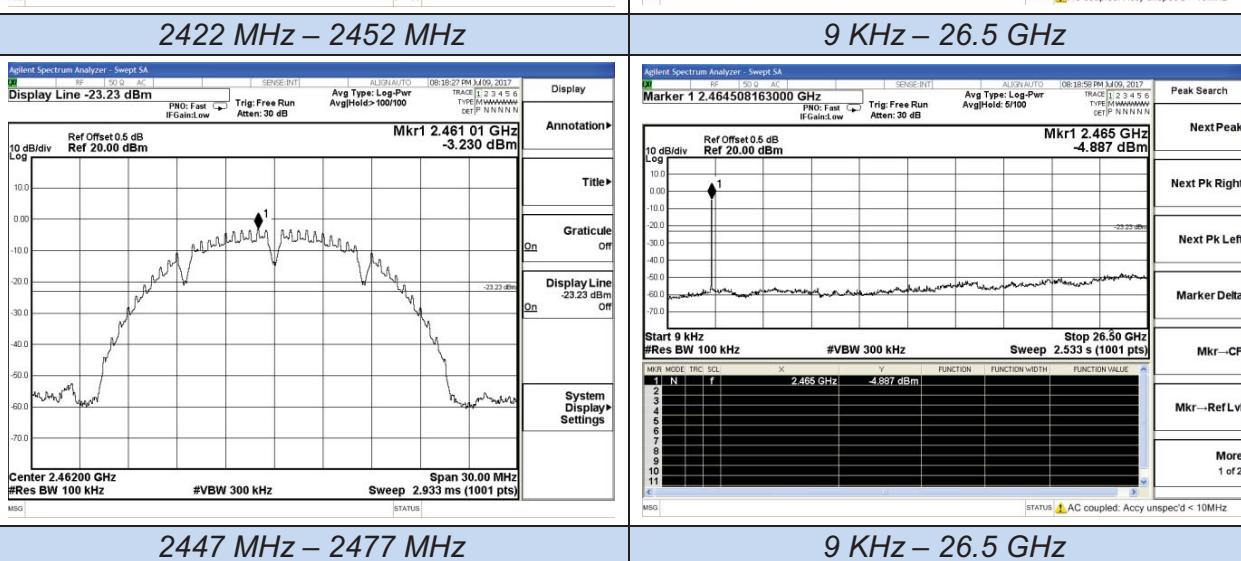
Antenna 1



2397 MHz – 2427 MHz



9 KHz – 26.5 GHz



2447 MHz – 2477 MHz

9 KHz – 26.5 GHz

