FCC TEST REPORT

For

HKC Corporation limited

Laptop

Model No.: DTLAPC14-1

Additional Model No.: /

Prepared for	:	HKC Corporation limited
Address	:	Building 1,2,3, Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, Shenzhen, China
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
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Date of receipt of test sample	:	July 03, 2017
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	September 14, 2017~ September 22, 2017
Date of Report	:	September 22, 2017

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

Report Reference No. ..... :	**LCS170713090AE**
Date of Issue ..... :	September 22, 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 ..... :	**HKC Corporation limited**
Address ..... :	Building 1,2,3, Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, Shenzhen, China
Test Specification	
Standard..... :	FCC CFR 47 PART 15 C(15.247)
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. ..... :	**Laptop**
Trade Mark..... :	DIREKT-TEK
Model/ Type reference ..... :	DTLAPC14-1
Ratings ..... :	DC 3.7V by Li-ion Battery(10000mAh) Charging parameter: Input: 100~240V AC, 50/60Hz, 0.8A; Output: DC 5V, 3A
Result ..... :	**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Calvin Weng	Dick Su	Gavin Liang
Calvin Weng/ Administrators	Dick Su/ Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : **LCS170713090AE**	September 22, 2017 Date of issue

EUT.....	:	Laptop
Type / Model.....	:	DTLAPC14-1
Applicant.....	**:**	**HKC Corporation limited**
Address.....	:	Building 1,2,3, Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, Shenzhen, China
Telephone.....	:	
Fax.....	:	
Manufacturer.....	**:**	**HKC Corporation limited**
Address.....	:	Building 1,2,3, Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, Shenzhen, China
Telephone.....	:	
Fax.....	:	
Factory.....	**:**	**HKC Corporation limited**
Address.....	:	Building 1,2,3, Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, 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	September 22, 2017	Initial Issue	Gavin Liang

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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 7
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 21
5.5. RADIATED EMISSIONS MEASUREMENT 26
5.6. CONDUCTED SPURIOUS EMISSIONS AND BAND EDGES TEST 38
5.7. POWER LINE CONDUCTED EMISSIONS 49
5.8. RESTRICT-BAND BAND-EDGE MEASUREMENTS FOR RADIATED EMISSIONS 51
5.9. ANTENNA REQUIREMENTS 57
6. LIST OF MEASURING EQUIPMENTS 59
7. TEST SETUP PHOTOGRAPHS OF EUT 60
8. EXTERIOR PHOTOGRAPHS OF THE EUT 60
9. INTERIOR PHOTOGRAPHS OF THE EUT 60

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	Laptop
Test Model	:	DTLAPC14-1
Power Supply	:	DC 3.70V by Li-ion Battery (10000mAh) Charging parameter: Input: 100~240V AC, 50/60Hz, 0.8A; Output: DC 5V, 3A
Hardware Version	:	Z8350
Software Version	:	1703
Bluetooth	:	
Frequency Range	:	2402 – 2480 MHz
Channel Number	:	79 channels for Bluetooth V3.0 (BT Classics) 40 channels for Bluetooth V4.0 (BT LE)
Channel Spacing	:	1MHz for Bluetooth V3.0 (BT Classics) 2MHz for Bluetooth V4.0 (BT LE)
Modulation Type	:	GFSK, π/4-DQPSK, 8-DPSK for Bluetooth V3.0 (BT Classics) GFSK for Bluetooth V4.0 (BT LE)
Bluetooth Version	:	V4.0
Antenna Description	:	PIFA Antenna, 3dBi (Max.)
WIFI(2.4G Band)	:	
WLAN	:	Supports IEEE 802.11b/802.11g/802.11n
WLAN FCC Operation Frequency	:	IEEE 802.11b: 2412 – 2462 MHz IEEE 802.11g: 2412 – 2462 MHz IEEE 802.11n HT20: 2412 – 2462 MHz IEEE 802.11n HT40: 2422 – 2452 MHz
Channel Spacing	:	5MHz
WLAN Channel Number	:	11 Channels for WIFI 20MHz Bandwidth(IEEE 802.11b/g/n HT20) 7 Channels for WIFI 40MHz Bandwidth(IEEE 802.11n HT40)
Modulation Type	:	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK)
Antenna Description	:	PIFA Antenna, 3dBi (Max.)

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
DIREKT-TEK	Power Adapter	BI18-050300-AdU	---	FCC VoC

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	2	N/A
Earphone	1	N/A
HDMI Port	1	N/A
TF Card Port	1	N/A
DC in Port	1	1.5m, unshielded cable

1.4. Description of Test Facility

CNAS Registration Number is L4595.
FCC Registration Number is 899208.
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 C63.4:2014 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 worst 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 (Mid Channel).

AC conducted emission pre-test at both at AC 120V/60Hz and AC 240V/50Hz modes, recorded worst case;

AC conducted emission pre-test power adapter modes, recorded worst case;

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 802.11b mode (Mid 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: MCS0, OFDM.
BT LE: 1Mbps, GFSK.

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)
2412~2462MHz	--	--	7	2442
	--	--	8	2447
	3	2422	9	2452
	4	2427	--	--
	5	2432	--	--
	6	2437	--	--

Bluetooth V4.0 (BT Classics)

Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	2402	20	2442
1	2404	---	---
2	2406	---	---
---	---	37	2476
---	---	38	2478
18	2438	39	2480
19	2440		

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 v04 and ANSI C63.10 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 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 sample will be controlled by DRTU.exe to enter RF test mode to control sample change channel, modulation and so on;

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
§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.

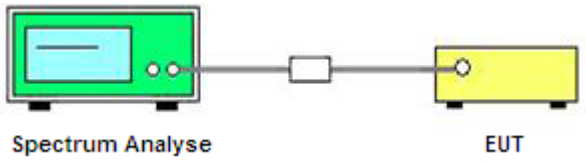
5.1.2. Measuring Instruments and Setting

Please refer to equipment 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



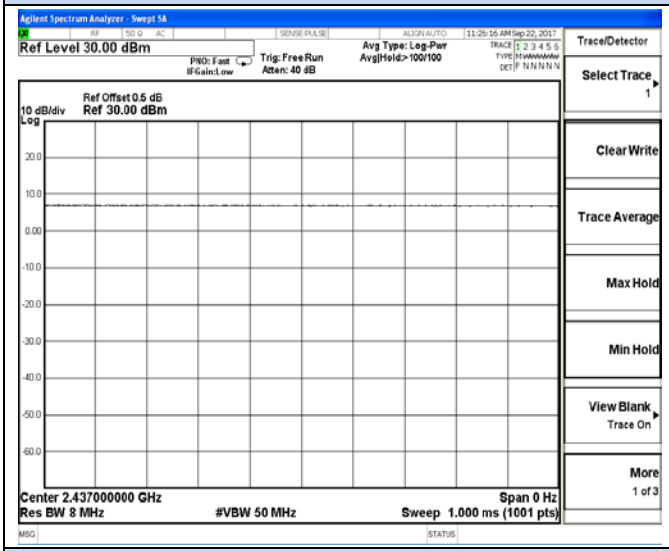
5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

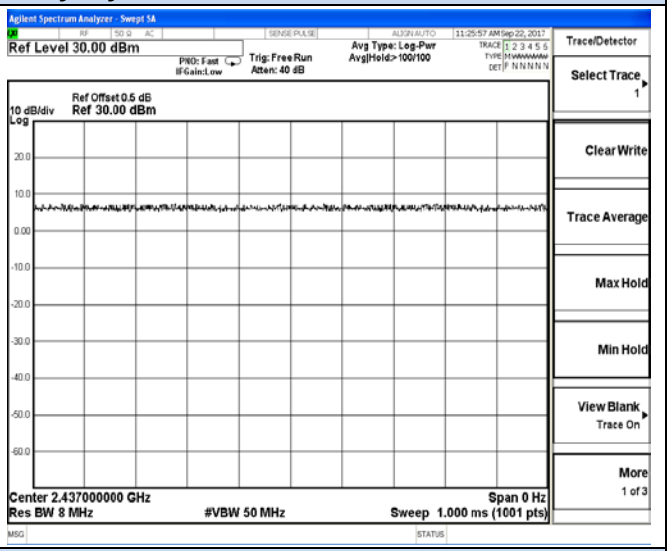
5.1.6. Test result

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

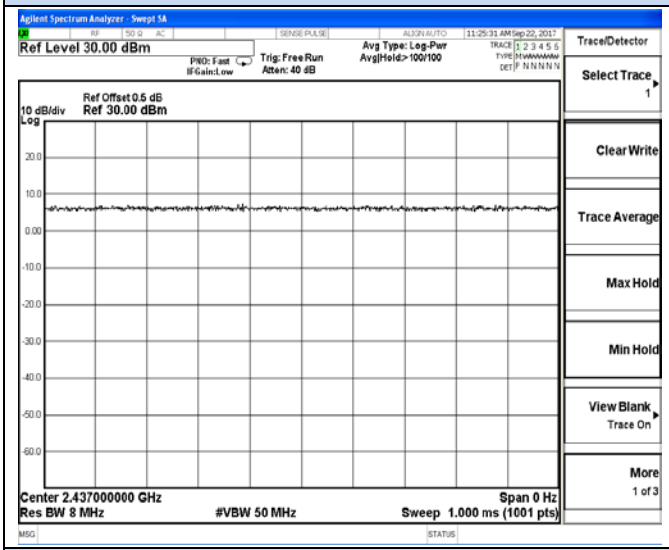
On Time and Duty Cycle



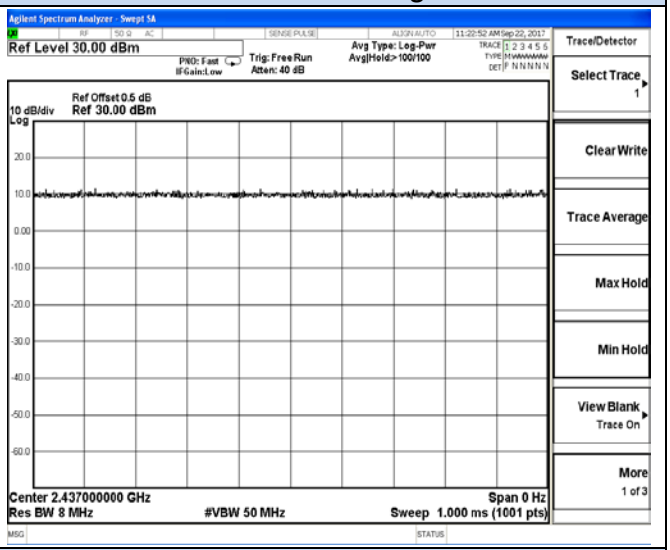
IEEE 802.11b



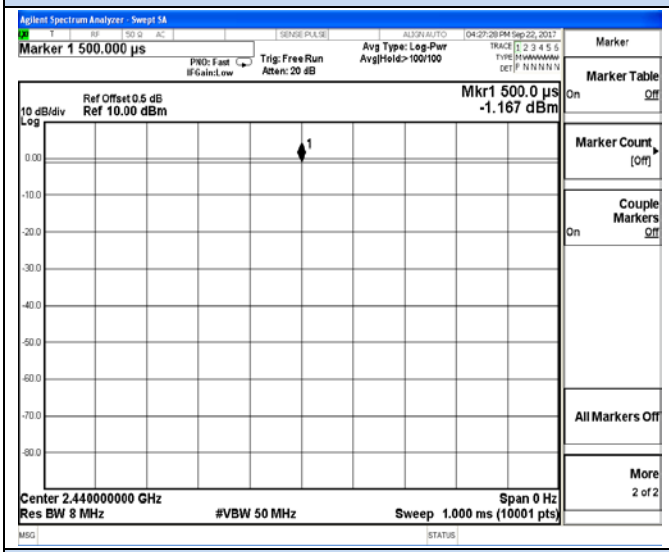
IEEE 802.11g



IEEE 802.11n-HT20



IEEE 802.11n-HT40



BT LE

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 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 equipment list in this report. The following table is the setting of the power meter.

5.2.3. Test Procedures

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.

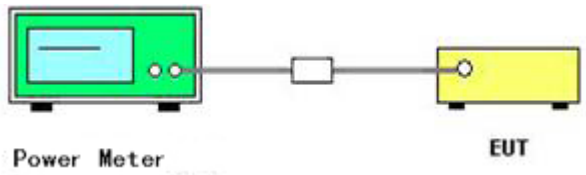
3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(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 10log (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 ℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b/g/n & BT LE

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Measured Average Output Power (dBm)	Limits (dBm)	Verdict
IEEE 802.11b	1	2412	10.50	8.91	30	PASS
	6	2437	10.68	9.14		
	11	2462	10.33	8.79		
IEEE 802.11g	1	2412	10.60	8.47	30	PASS
	6	2437	11.14	8.86		
	11	2462	10.80	8.71		
IEEE 802.11n HT20	1	2412	10.33	8.12	30	PASS
	6	2437	10.45	8.42		
	11	2462	10.27	7.98		
IEEE 802.11n HT40	3	2422	10.68	7.45	30	PASS
	6	2437	10.80	7.58		
	9	2452	10.70	7.48		
BT – LE	0	2402	-1.54	-2.12	30	PASS
	19	2440	-1.18	-1.77		
	39	2480	-1.21	-1.78		

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;*
4. *Average power is for report only;*

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.

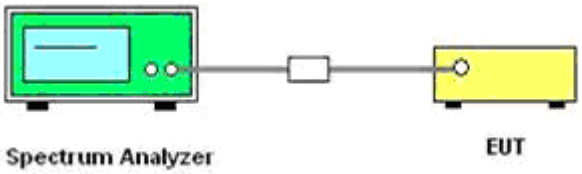
5.3.2. Measuring Instruments and Setting

Please refer to equipment 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 ≥ 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.
11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

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℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b/g/n & BT LE

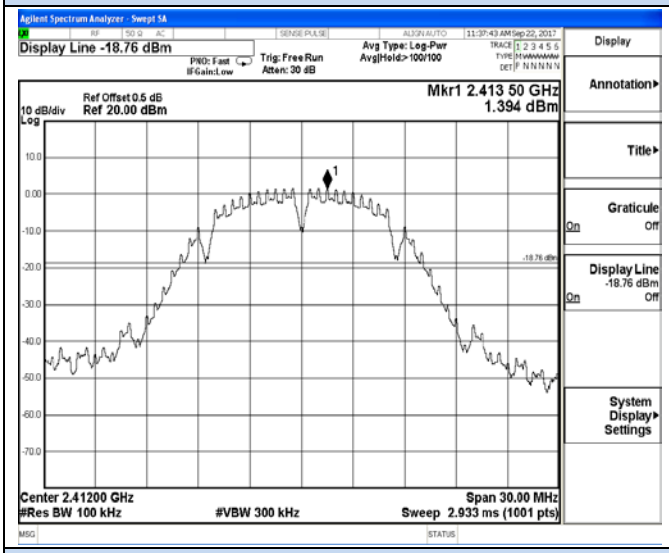
Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectral Density (dBm/100KHz)	Limits (dBm/3KHz)	Verdict
IEEE 802.11b	1	2412	1.394	8	PASS
	6	2437	1.871		
	11	2462	1.855		
IEEE 802.11g	1	2412	-3.749	8	PASS
	6	2437	-1.733		
	11	2462	-1.478		
IEEE 802.11n HT20	1	2412	-3.576	8	PASS
	6	2437	-2.353		
	11	2462	-1.412		
IEEE 802.11n HT40	3	2422	-5.780	8	PASS
	6	2437	-5.775		
	9	2452	-5.611		
BT – LE	0	2402	-2.561	8	PASS
	19	2440	-2.370		
	39	2480	-2.201		

Remark:

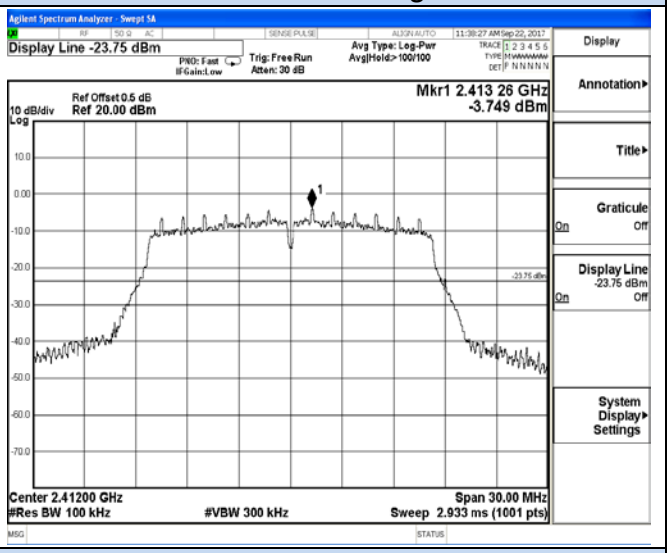
1. *Measured peak power spectrum density at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *Please refer to following plots;*

Power Spectral Density

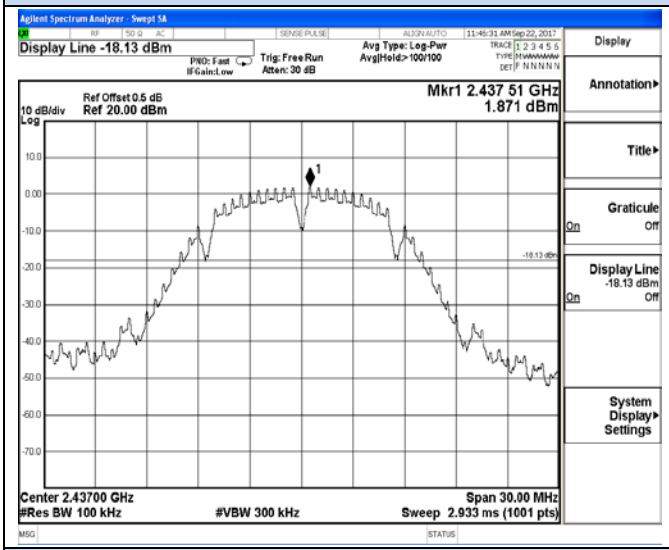
IEEE 802.11b



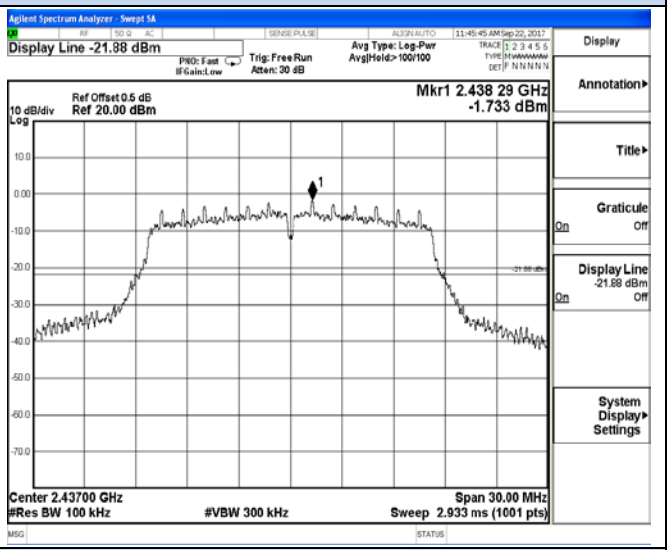
IEEE 802.11g



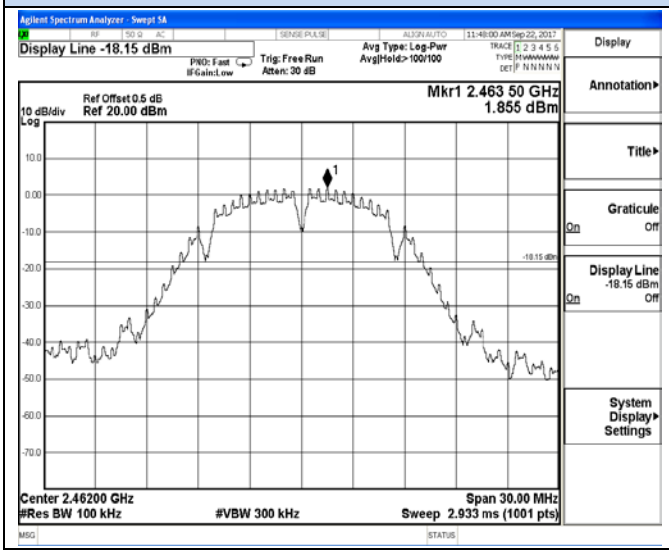
Channel 1 / 2412 MHz



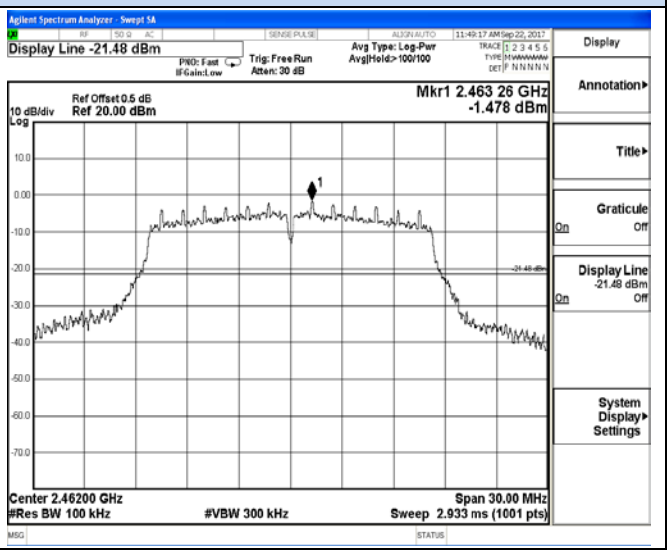
Channel 1 / 2412 MHz



Channel 6 / 2437 MHz



Channel 6 / 2437 MHz

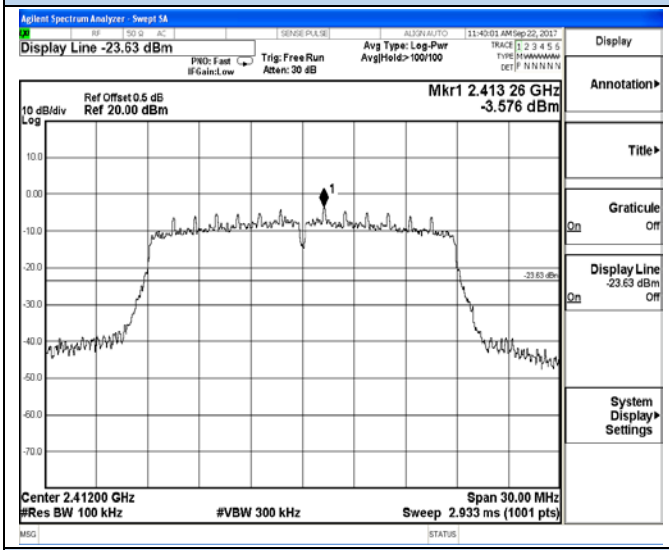


Channel 11 / 2462 MHz

Channel 11 / 2462 MHz

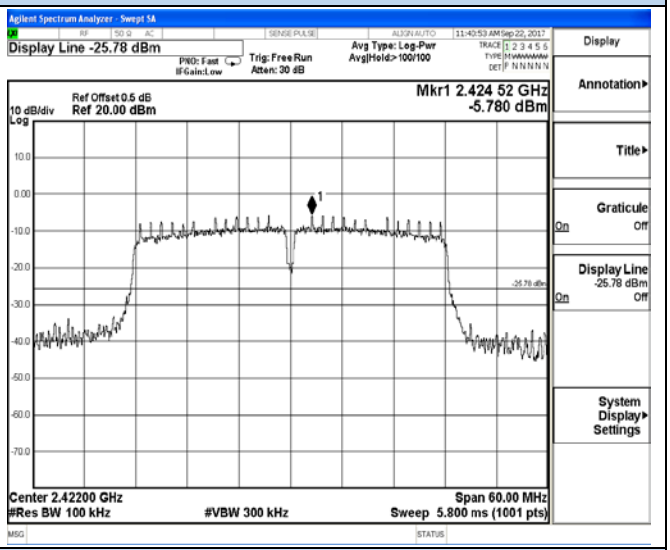
Power Spectral Density

IEEE 802.11n HT20

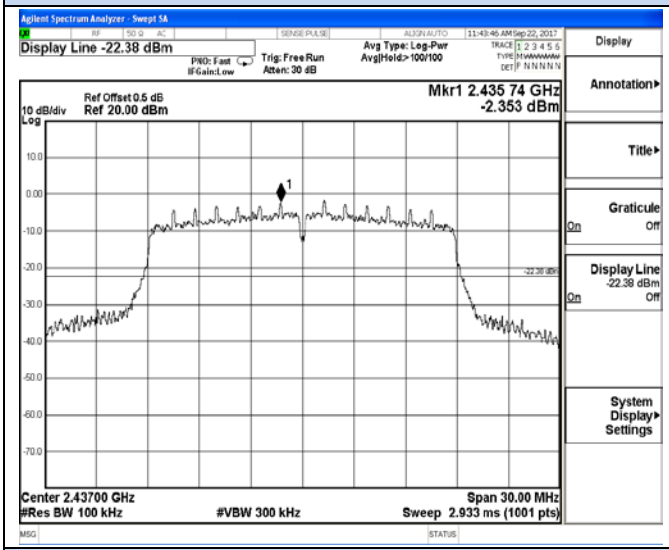


Channel 1 / 2412 MHz

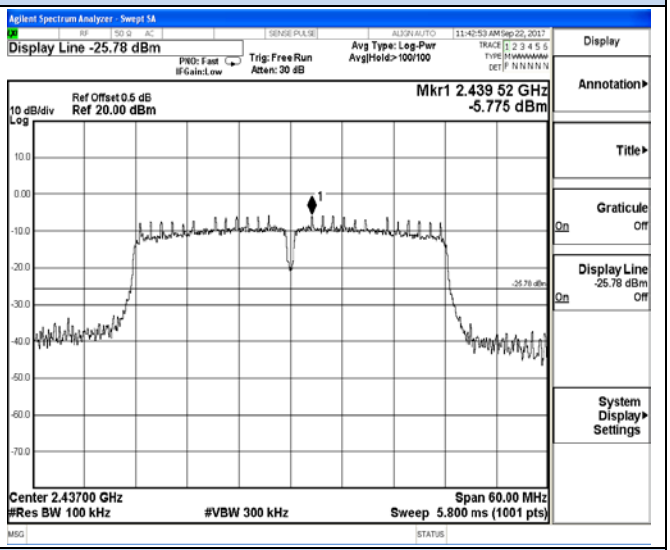
IEEE 802.11n HT40



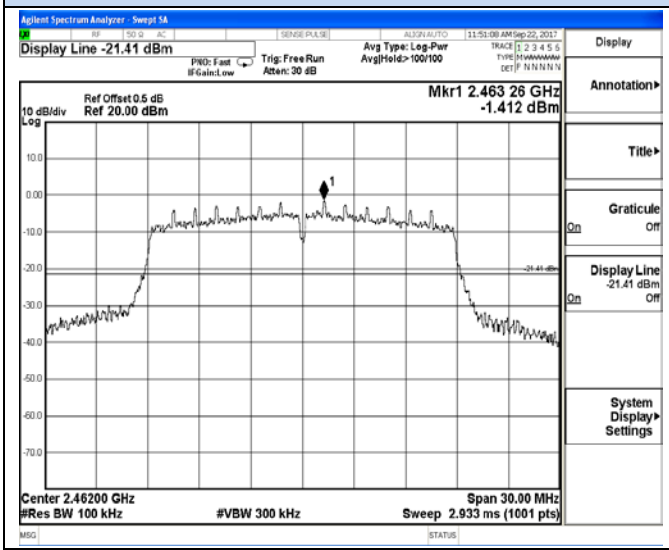
Channel 3 / 2422 MHz



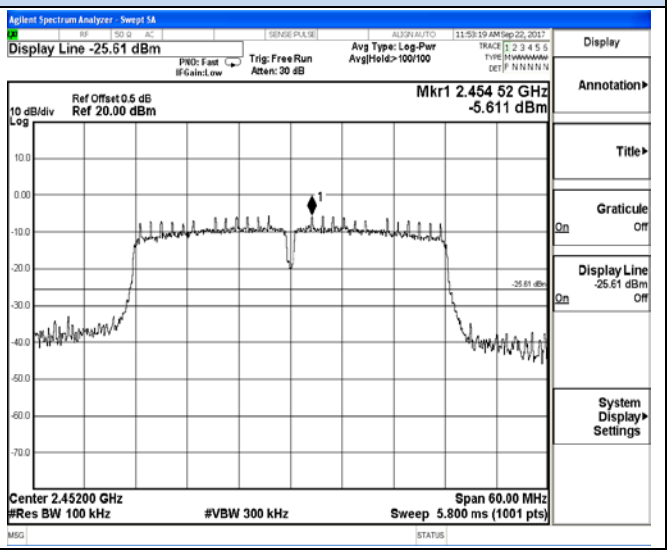
Channel 6 / 2437 MHz



Channel 6 / 2437 MHz



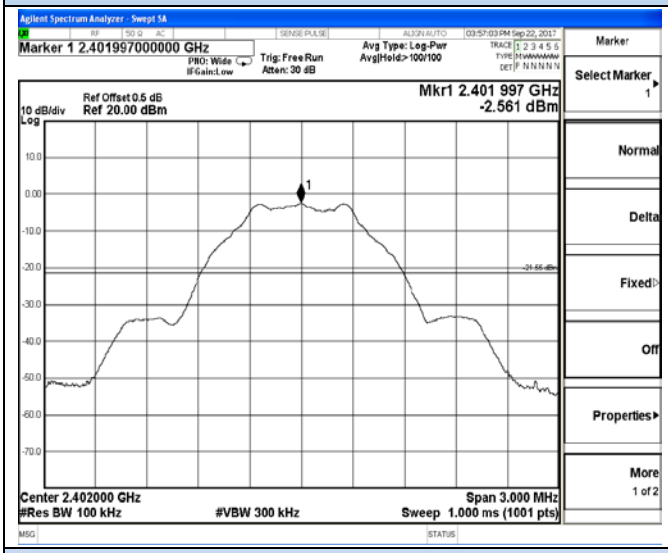
Channel 11 / 2462 MHz



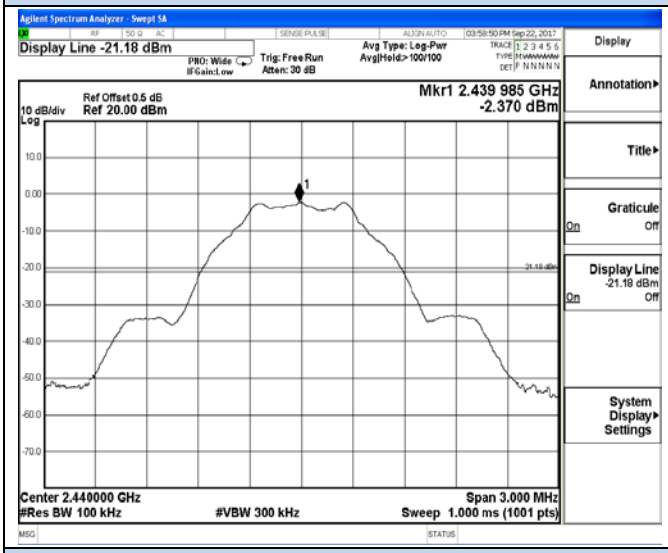
Channel 9 / 2452 MHz

Power Spectral Density

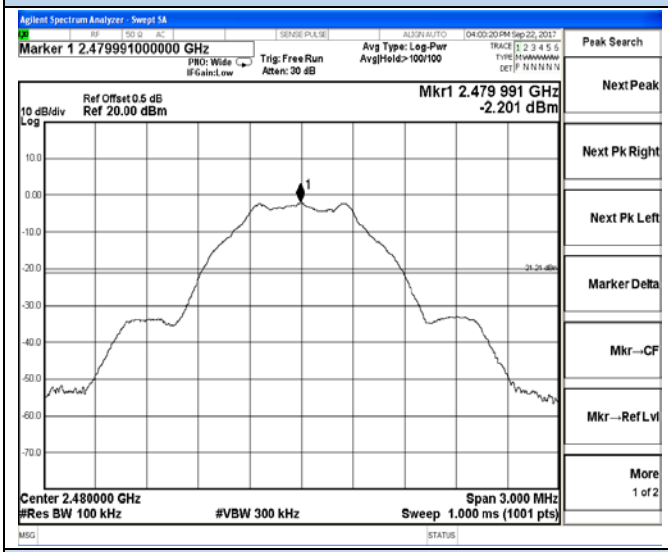
BT – LE



Channel 0 / 2402 MHz



Channel 19 / 2440 MHz



Channel 39 / 2480 MHz

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

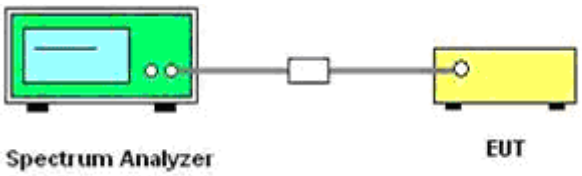
Please refer to equipment's list in this report. The following table is the setting of the Spectrum Analyzer.

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℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b/g/n & BT LE

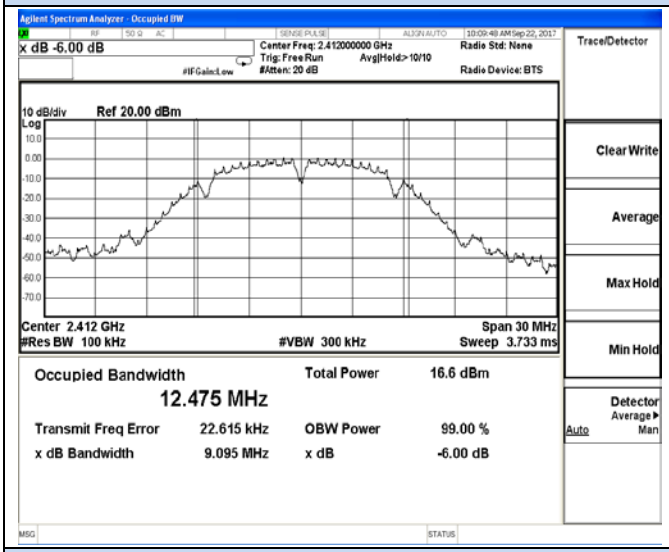
Test Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limits (MHz)	Verdict
IEEE 802.11b	1	2412	9.095	0.500	PASS
	6	2437	9.562		
	11	2462	9.110		
IEEE 802.11g	1	2412	16.380	0.500	PASS
	6	2437	16.370		
	11	2462	16.380		
IEEE 802.11n HT20	1	2412	17.610	0.500	PASS
	6	2437	17.590		
	11	2462	17.600		
IEEE 802.11n HT40	3	2422	36.320	0.500	PASS
	6	2437	36.330		
	9	2452	36.340		
BT - LE	0	2402	0.6763	0.500	PASS
	19	2440	0.6876		
	39	2480	0.6160		

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;*
4. *Please refer to following plots;*

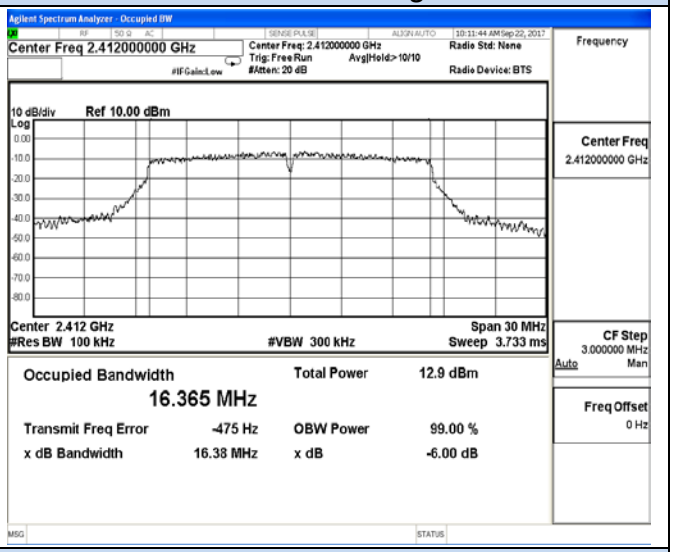
6 dB Bandwidth

IEEE 802.11b

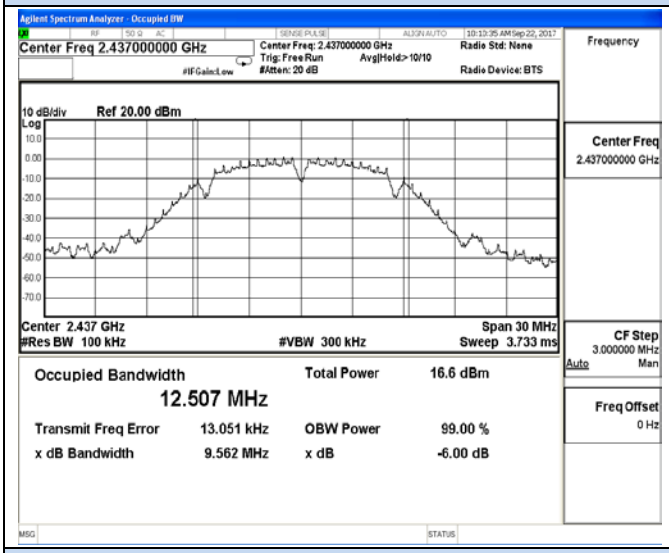


Channel 1 / 2412 MHz

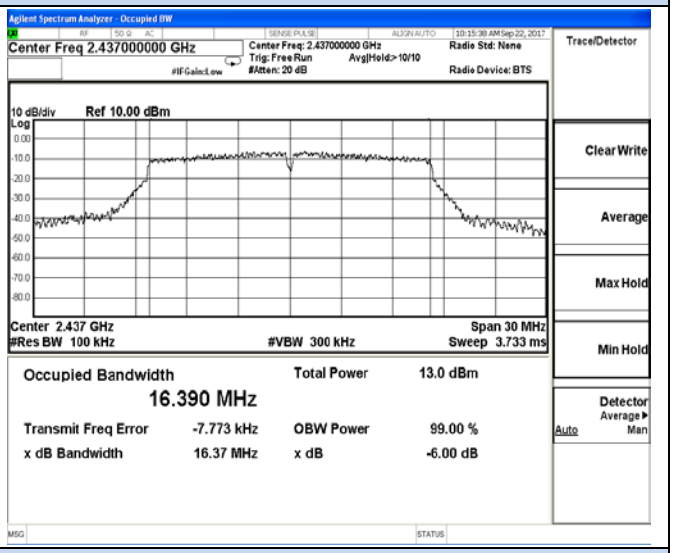
IEEE 802.11g



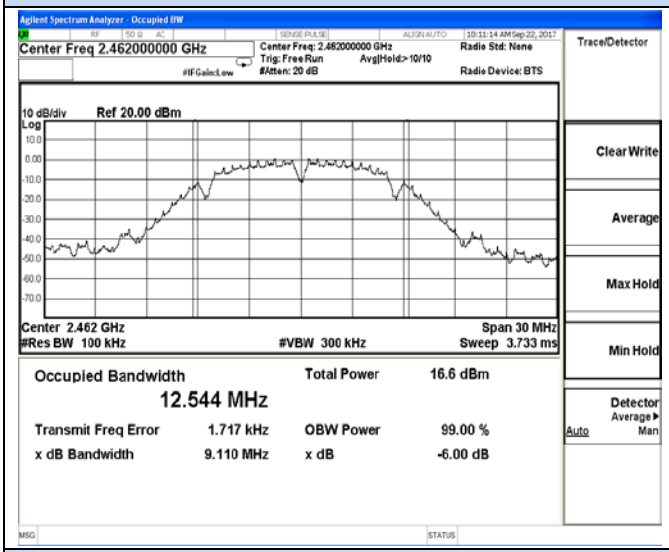
Channel 1 / 2412 MHz



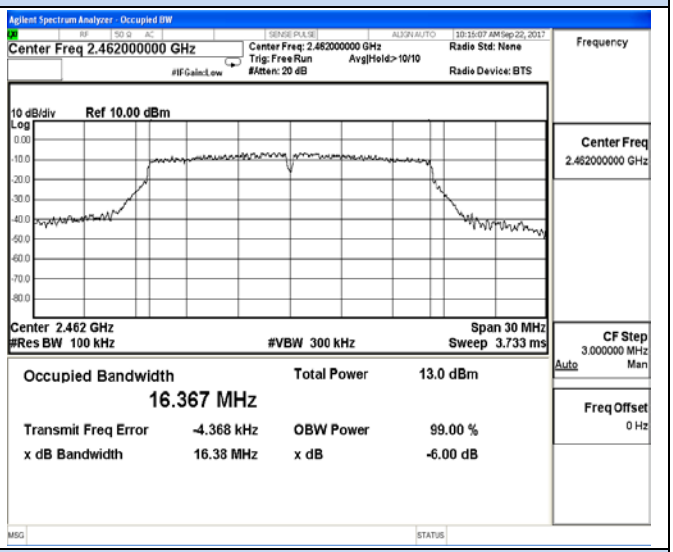
Channel 6 / 2437 MHz



Channel 6 / 2437 MHz



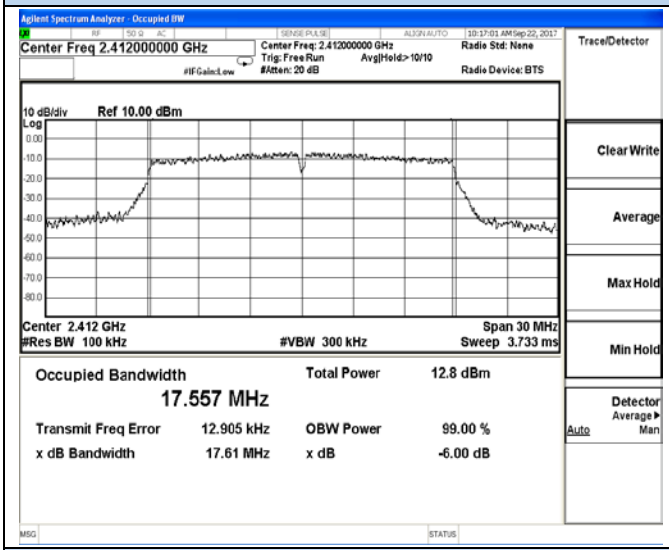
Channel 11 / 2462 MHz



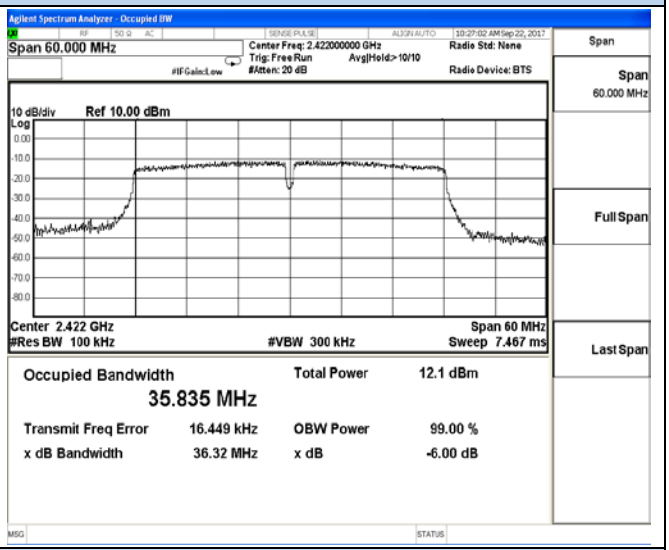
Channel 11 / 2462 MHz

6 dB Bandwidth

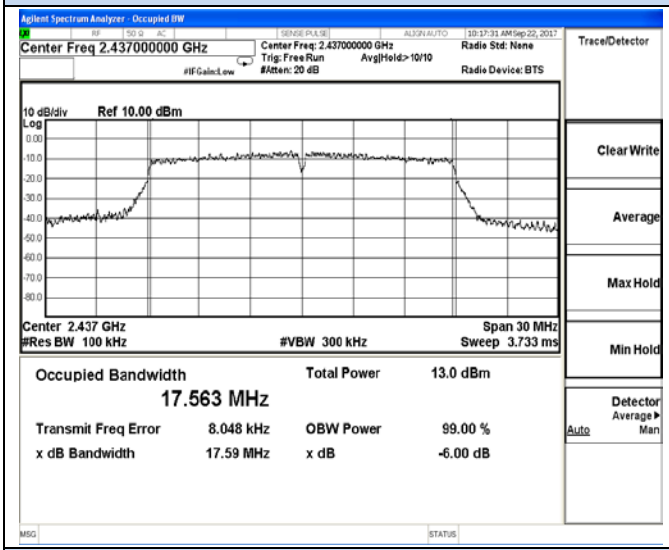
IEEE 802.11n HT20



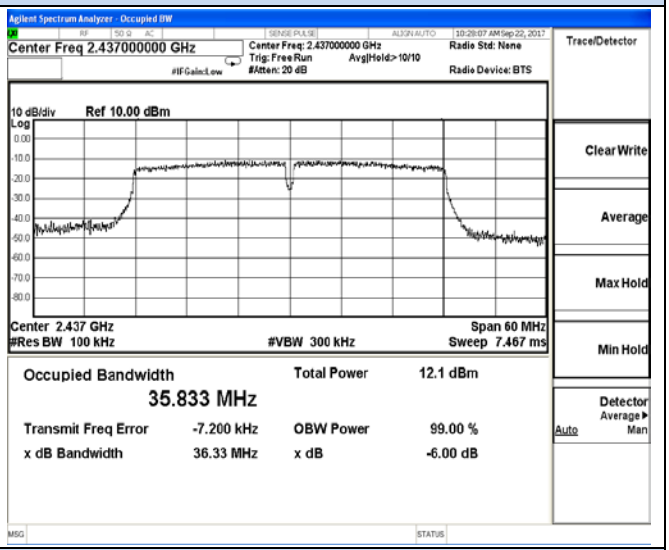
IEEE 802.11n HT40



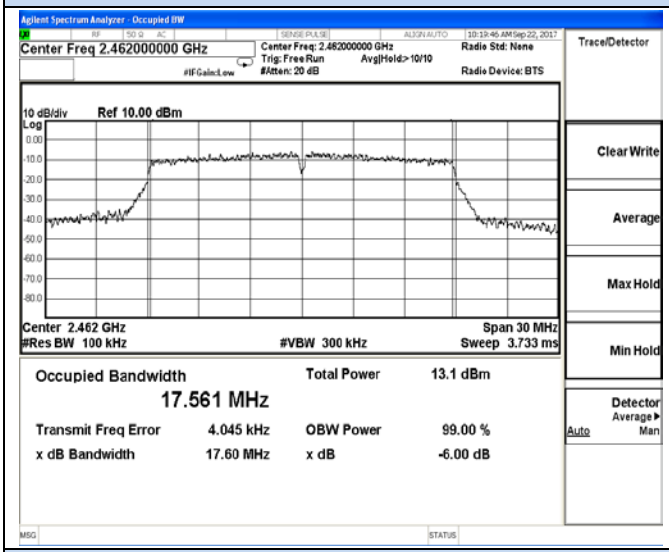
Channel 1 / 2412 MHz



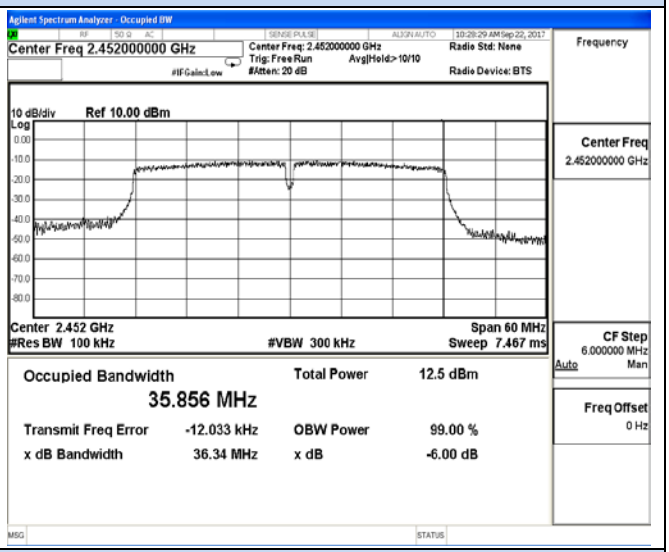
Channel 3 / 2422 MHz



Channel 6 / 2437 MHz



Channel 6 / 2437 MHz

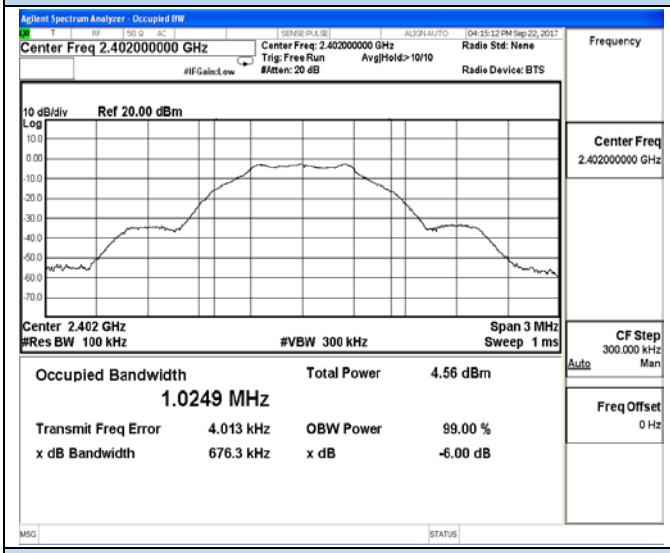


Channel 11 / 2462 MHz

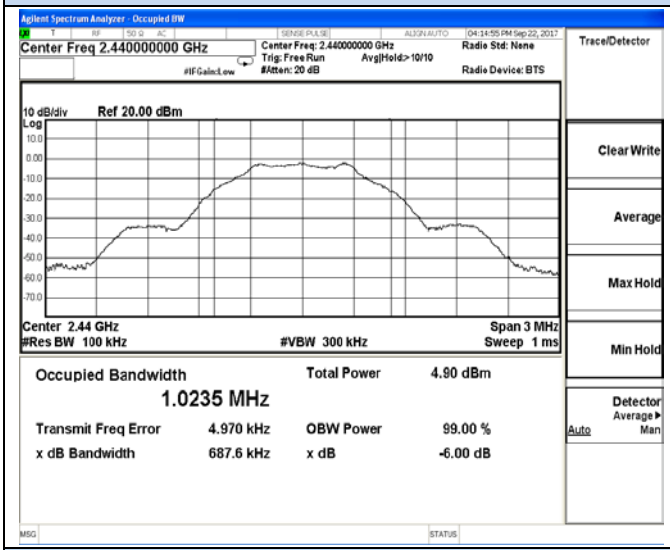
Channel 9 / 2452 MHz

6 dB Bandwidth

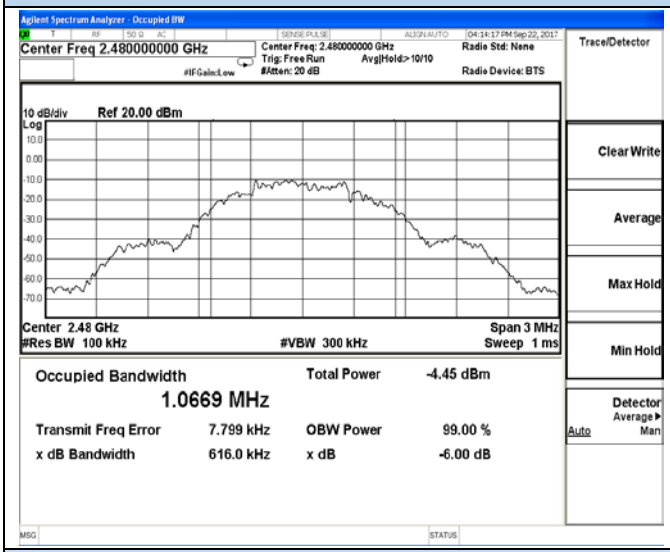
BT – LE



Channel 0 / 2402 MHz



Channel 19 / 2440 MHz



Channel 39 / 2480 MHz

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 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	10th 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 0.8 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 (± 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.

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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:

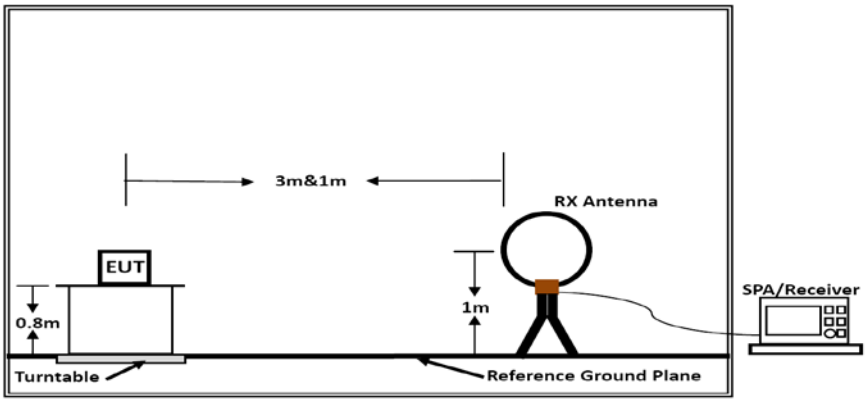
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

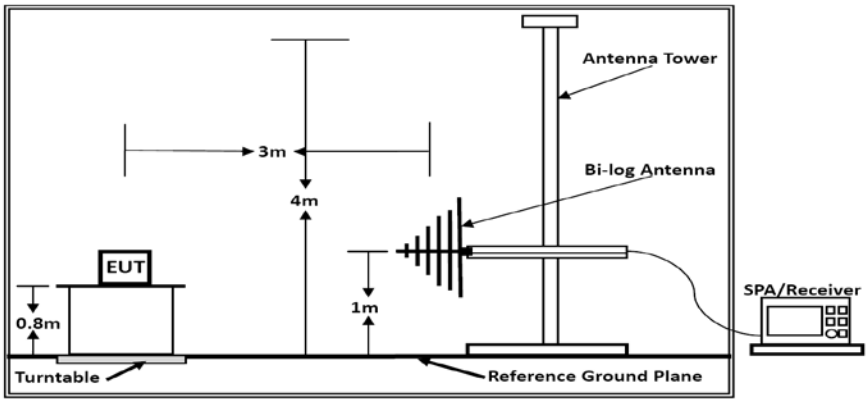
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- 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.

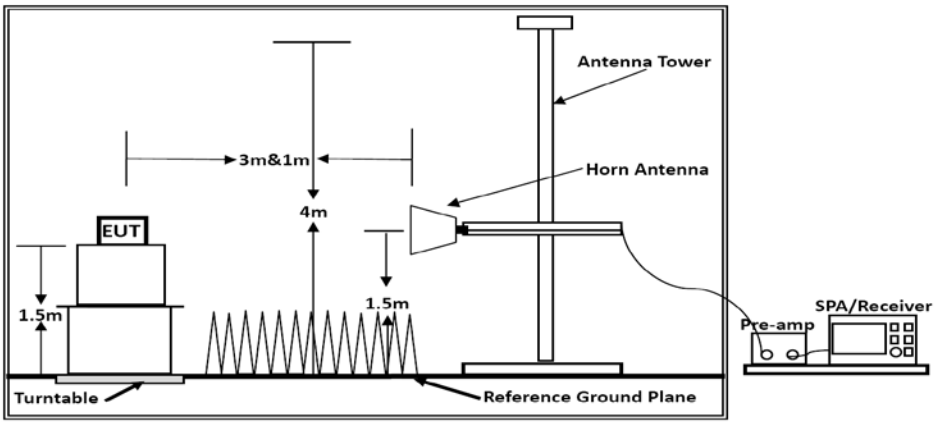
5.5.4. Test Setup Layout



Below 30MHz



Below 1GHz



Above 1GHz

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

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1m]) (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 ℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b/g/n & BT LE

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.

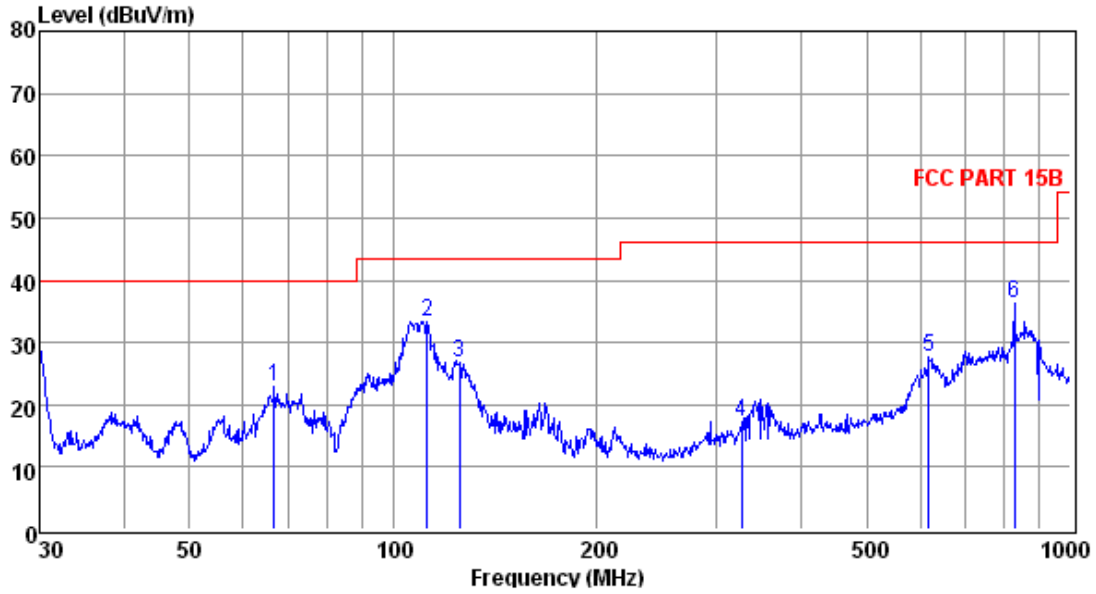
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

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

Temperature	25 ℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b (Mid CH)

Test result for IEEE 802.11b (Middle Channel)

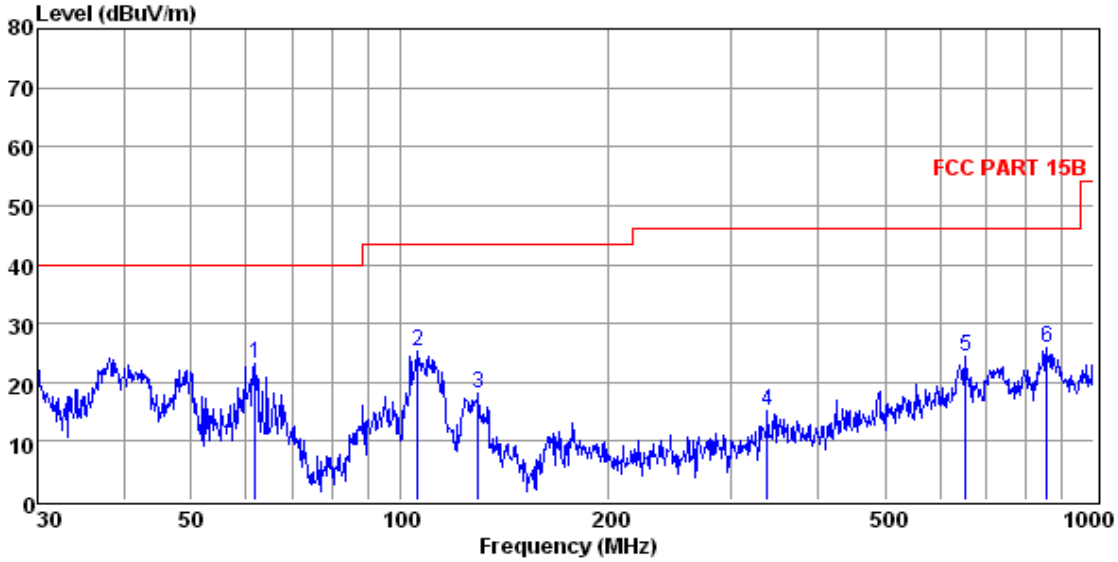
Vertical



	Freq MHz	Reading dBuV	CabLos dB	Antfac dB/m	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	66.73	12.50	0.52	10.00	23.02	40.00	-16.98	QP
2	112.13	20.91	0.65	11.87	33.43	43.50	-10.07	QP
3	125.01	16.33	0.71	9.70	26.74	43.50	-16.76	QP
4	326.74	2.68	1.04	13.60	17.32	46.00	-28.68	QP
5	618.54	7.60	1.51	18.52	27.63	46.00	-18.37	QP
6	827.49	14.30	1.67	20.34	36.31	46.00	-9.69	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

Horizontal



	Freq MHz	Reading dBuV	CabLos dB	Antfac dB/m	Measured dBuV/m	Limit dBuV/m	Over dB	Remark
1	61.78	10.59	0.48	11.99	23.06	40.00	-16.94	QP
2	106.01	12.05	0.68	12.61	25.34	43.50	-18.16	QP
3	129.47	8.33	0.67	9.01	18.01	43.50	-25.49	QP
4	338.40	-0.16	1.16	14.06	15.06	46.00	-30.94	QP
5	654.23	4.08	1.69	18.65	24.42	46.00	-21.58	QP
6	857.02	3.51	1.76	20.65	25.92	46.00	-20.08	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:

1). Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b (Middle Channel)). Emission level (dBuV/m) = 20 log Emission level (uV/m).
2). Corrected Reading: Antenna Factor + Cable Loss + Read Level = Level.

5.5.8. Results for Radiated Emissions (Above 1GHz)

IEEE 802.11b

Channel 1 / 2412MHz

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	55.47	33.06	35.14	3.98	57.37	74.00	-16.63	Peak	Horizontal
4824.00	38.35	33.06	35.14	3.98	40.25	54.00	-13.75	Average	Horizontal
4824.00	59.00	33.06	35.14	3.98	60.90	74.00	-13.10	Peak	Vertical
4824.00	41.76	33.06	35.14	3.98	43.66	54.00	-10.34	Average	Vertical

Channel 6 / 2437MHz

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	53.72	33.16	35.15	3.96	55.69	74.00	-18.31	Peak	Horizontal
4874.00	39.35	33.16	35.15	3.96	41.32	54.00	-12.68	Average	Horizontal
4874.00	59.23	33.16	35.15	3.96	61.20	74.00	-12.80	Peak	Vertical
4874.00	42.76	33.16	35.15	3.96	44.73	54.00	-9.27	Average	Vertical

Channel 11 / 2462MHz

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	54.48	33.26	35.14	3.98	56.58	74.00	-17.42	Peak	Horizontal
4924.00	39.53	33.26	35.14	3.98	41.63	54.00	-12.37	Average	Horizontal
4924.00	60.35	33.26	35.14	3.98	62.45	74.00	-11.55	Peak	Vertical
4924.00	42.44	33.26	35.14	3.98	44.54	54.00	-9.46	Average	Vertical

IEEE 802.11g

Channel 1 / 2412MHz

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	54.81	33.06	35.14	3.98	56.71	74.00	-17.29	Peak	Horizontal
4824.00	40.38	33.06	35.14	3.98	42.28	54.00	-11.72	Average	Horizontal
4824.00	57.84	33.06	35.14	3.98	59.74	74.00	-14.26	Peak	Vertical
4824.00	42.96	33.06	35.14	3.98	44.86	54.00	-9.14	Average	Vertical

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Channel 6 / 2437MHz

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	55.14	33.16	35.15	3.96	57.11	74.00	-16.89	Peak	Horizontal
4874.00	40.46	33.16	35.15	3.96	42.43	54.00	-11.57	Average	Horizontal
4874.00	58.25	33.16	35.15	3.96	60.22	74.00	-13.78	Peak	Vertical
4874.00	43.87	33.16	35.15	3.96	45.84	54.00	-8.16	Average	Vertical

Channel 11 / 2462MHz

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	56.08	33.26	35.14	3.98	58.18	74.00	-15.82	Peak	Horizontal
4924.00	38.84	33.26	35.14	3.98	40.94	54.00	-13.06	Average	Horizontal
4924.00	60.67	33.26	35.14	3.98	62.77	74.00	-11.23	Peak	Vertical
4924.00	43.56	33.26	35.14	3.98	45.66	54.00	-8.34	Average	Vertical

IEEE 802.11n HT20

Channel 1 / 2412MHz

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	51.52	33.06	35.14	3.98	53.42	74.00	-20.58	Peak	Horizontal
4824.00	34.92	33.06	35.14	3.98	36.82	54.00	-17.18	Average	Horizontal
4824.00	55.67	33.06	35.14	3.98	57.57	74.00	-16.43	Peak	Vertical
4824.00	36.36	33.06	35.14	3.98	38.26	54.00	-15.74	Average	Vertical

Channel 6 / 2437MHz

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	49.75	33.16	35.15	3.96	51.72	74.00	-22.28	Peak	Horizontal
4874.00	35.26	33.16	35.15	3.96	37.23	54.00	-16.77	Average	Horizontal
4874.00	54.02	33.16	35.15	3.96	55.99	74.00	-18.01	Peak	Vertical
4874.00	39.40	33.16	35.15	3.96	41.37	54.00	-12.63	Average	Vertical

Channel 11 / 2462MHz

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	49.94	33.26	35.14	3.98	52.04	74.00	-21.96	Peak	Horizontal
4924.00	34.28	33.26	35.14	3.98	36.38	54.00	-17.62	Average	Horizontal
4924.00	53.87	33.26	35.14	3.98	55.97	74.00	-18.03	Peak	Vertical
4924.00	36.36	33.26	35.14	3.98	38.46	54.00	-15.54	Average	Vertical

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IEEE 802.11n HT40

Channel 3 / 2422MHz

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	51.31	33.06	35.14	3.98	53.21	74.00	-20.79	Peak	Horizontal
4844.00	34.91	33.06	35.14	3.98	36.81	54.00	-17.19	Average	Horizontal
4844.00	56.17	33.06	35.14	3.98	58.07	74.00	-15.93	Peak	Vertical
4844.00	36.32	33.06	35.14	3.98	38.22	54.00	-15.78	Average	Vertical

Channel 6 / 2437MHz

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	51.72	33.16	35.15	3.96	53.69	74.00	-20.31	Peak	Horizontal
4874.00	33.59	33.16	35.15	3.96	35.56	54.00	-18.44	Average	Horizontal
4874.00	55.26	33.16	35.15	3.96	57.23	74.00	-16.77	Peak	Vertical
4874.00	39.72	33.16	35.15	3.96	41.69	54.00	-12.31	Average	Vertical

Channel 9 / 2452MHz

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	49.98	33.26	35.14	3.98	52.08	74.00	-21.92	Peak	Horizontal
4904.00	35.01	33.26	35.14	3.98	37.11	54.00	-16.89	Average	Horizontal
4904.00	55.37	33.26	35.14	3.98	57.47	74.00	-16.53	Peak	Vertical
4904.00	39.51	33.26	35.14	3.98	41.61	54.00	-12.39	Average	Vertical

BT LE

Channel 0 / 2402MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4804.00	48.45	33.06	35.04	3.94	50.41	74.00	-23.59	Peak	Horizontal
4804.00	32.92	33.06	35.04	3.94	34.88	54.00	-19.12	Average	Horizontal
4804.00	50.69	33.06	35.04	3.94	52.65	74.00	-21.35	Peak	Vertical
4804.00	33.72	33.06	35.04	3.94	35.68	54.00	-18.32	Average	Vertical

Channel 19 / 2440MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4880.00	47.39	33.16	35.15	3.96	49.36	74.00	-24.64	Peak	Horizontal
4880.00	33.89	33.16	35.15	3.96	35.86	54.00	-18.14	Average	Horizontal
4880.00	51.83	33.16	35.15	3.96	53.80	74.00	-20.20	Peak	Vertical
4880.00	35.56	33.16	35.15	3.96	37.53	54.00	-16.47	Average	Vertical

Channel 39 / 2480MHz

Freq. MHz	Reading dBuV	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4960.00	48.06	33.26	35.14	3.98	50.16	74.00	-23.84	Peak	Horizontal
4960.00	34.65	33.26	35.14	3.98	36.75	54.00	-17.25	Average	Horizontal
4960.00	48.84	33.26	35.14	3.98	50.94	74.00	-23.06	Peak	Vertical
4960.00	34.07	33.26	35.14	3.98	36.17	54.00	-17.83	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 9 KHz~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 equipment 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℃	Humidity	60%
Test Engineer	Jayden Zhuo	Configurations	IEEE 802.11b/g/n & BT LE

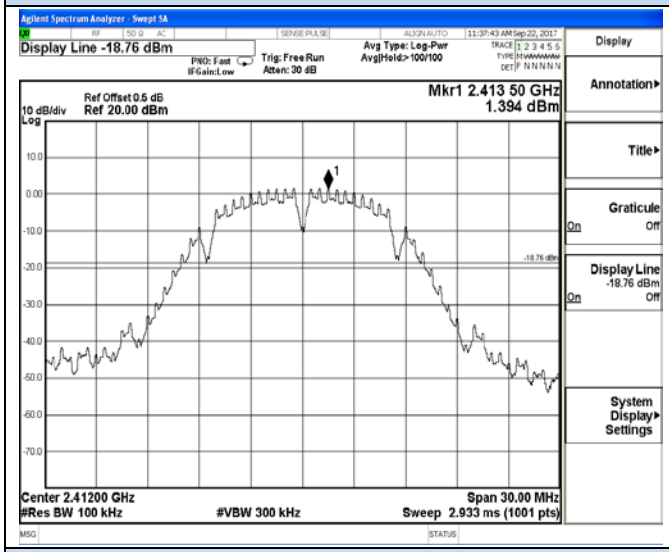
Test Mode	Channel	Frequency (MHz)	Measured Frequency Range	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
IEEE 802.11b	1	2412	9 KHz – 26.5 GHz	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20		
IEEE 802.11g	1	2412	9 KHz – 26.5 GHz	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20		
IEEE 802.11n HT20	1	2412	9 KHz – 26.5 GHz	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20		
	11	2462	9 KHz – 26.5 GHz	<-20		
IEEE 802.11n HT40	3	2412	9 KHz – 26.5 GHz	<-20	-20	PASS
	6	2437	9 KHz – 26.5 GHz	<-20		
	9	2452	9 KHz – 26.5 GHz	<-20		
BT – LE	0	2402	9 KHz – 26.5 GHz	<-20	-20	PASS
	19	2440	9 KHz – 26.5 GHz	<-20		
	39	2480	9 KHz – 26.5 GHz	<-20		

Remark:

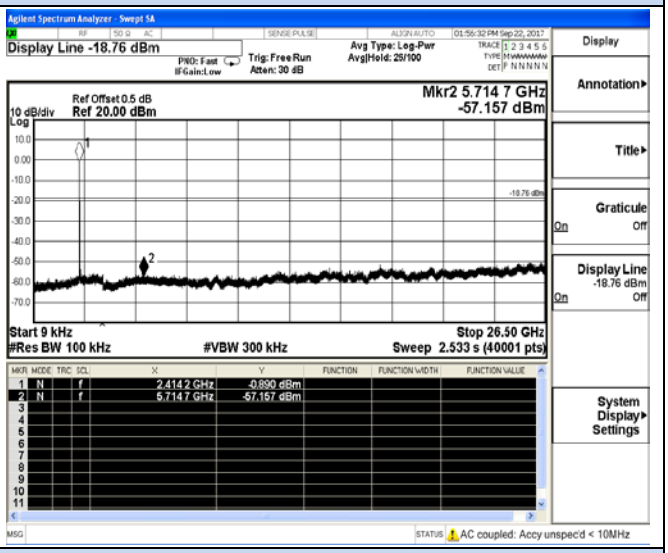
1. *Measured RF conducted spurious emission at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *"---"means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

RF Conducted Spurious Emission

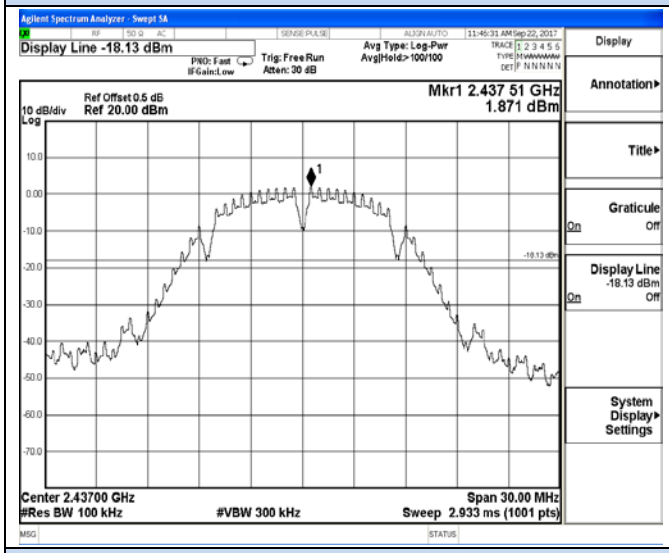
IEEE 802.11b



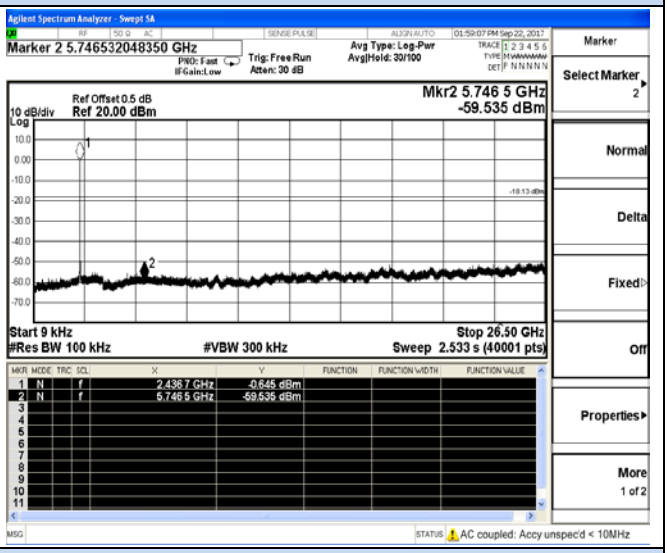
2397 MHz – 2427 MHz



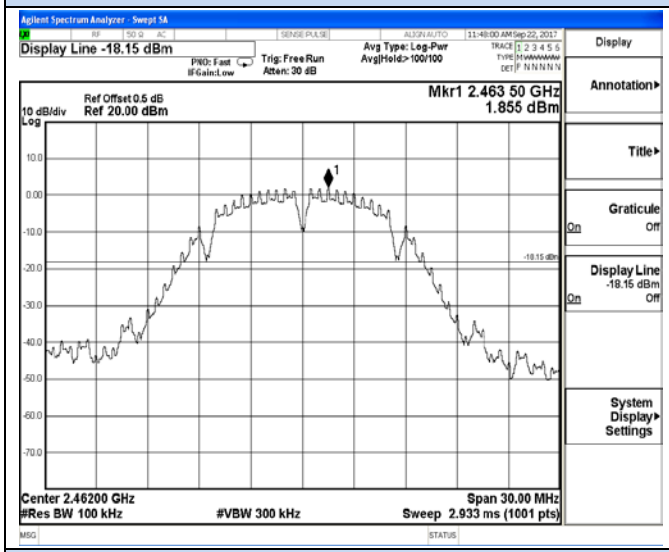
9 KHz – 26.5 GHz



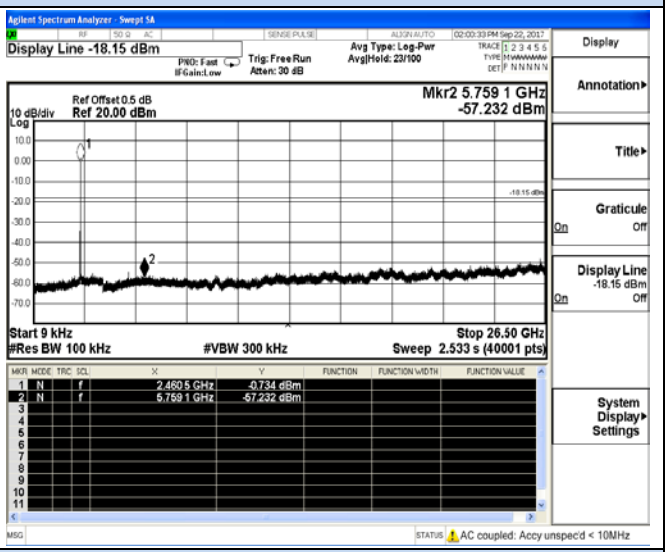
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



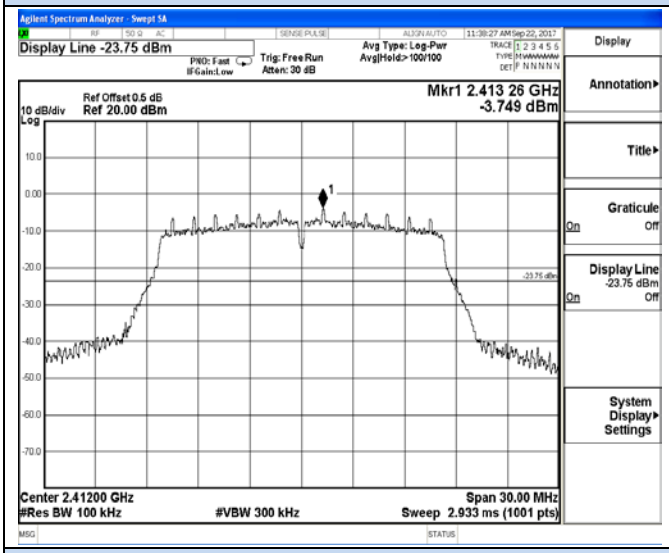
2447 MHz – 2477 MHz



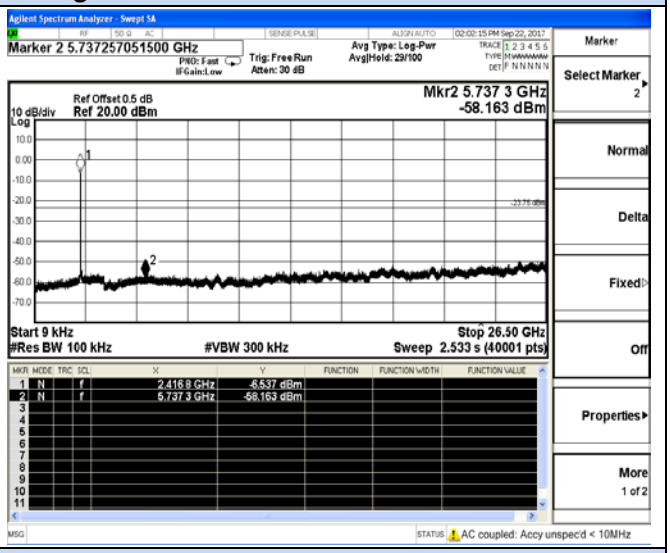
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

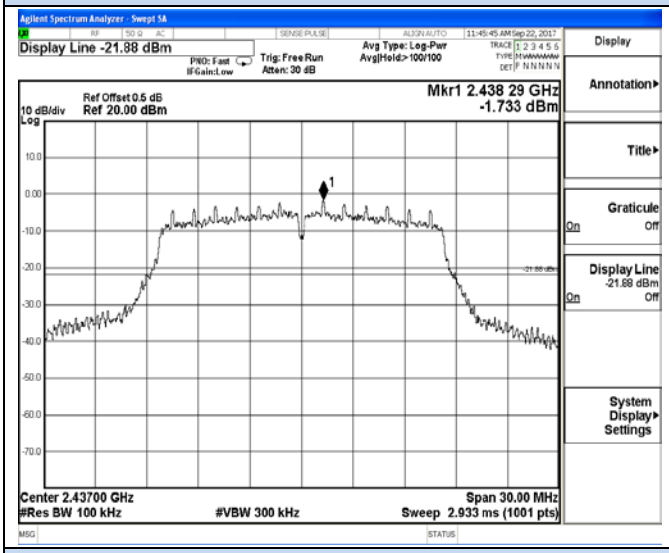
IEEE 802.11g



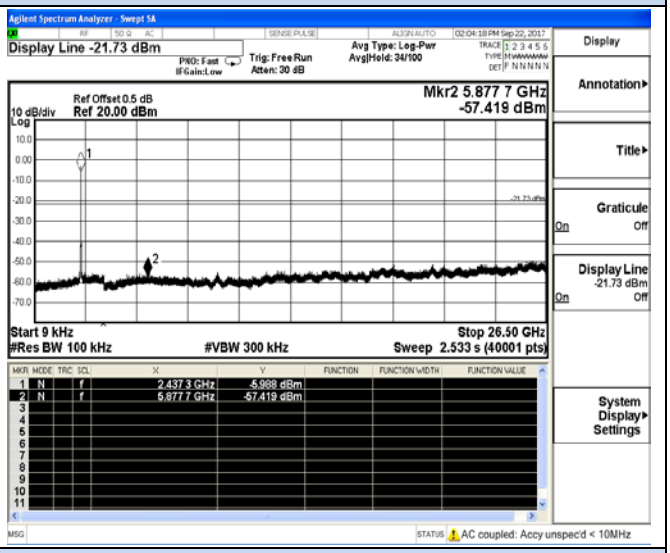
2397 MHz – 2427 MHz



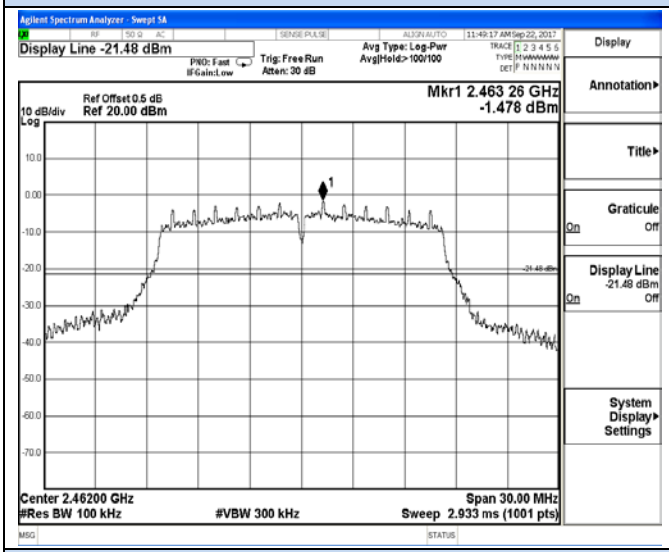
9 KHz – 26.5 GHz



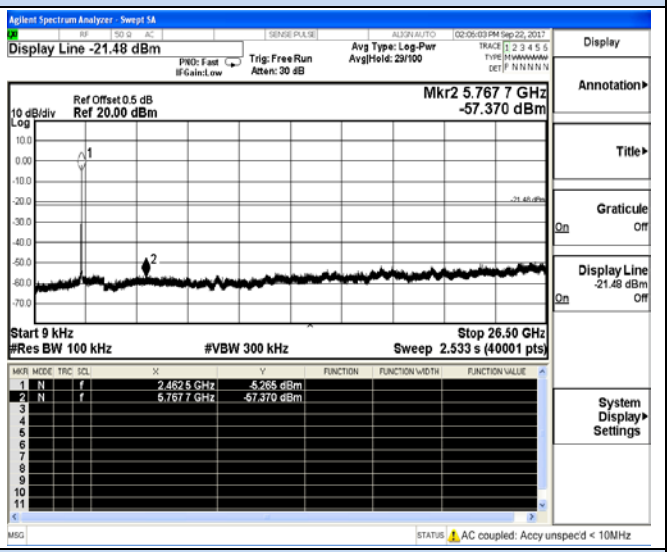
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



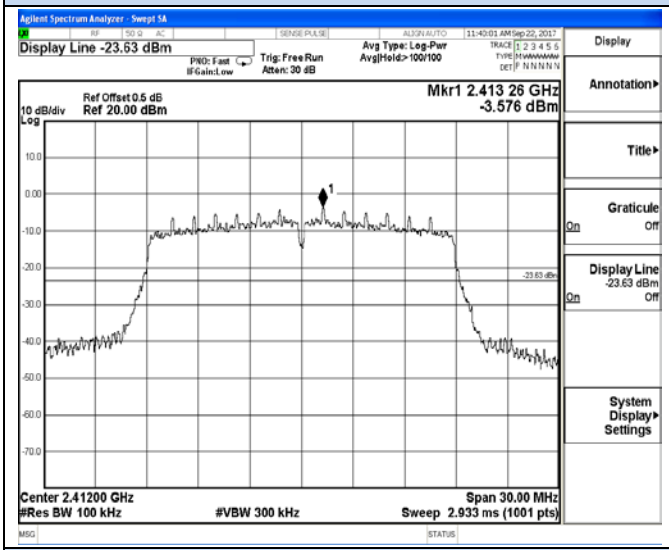
2447 MHz – 2477 MHz



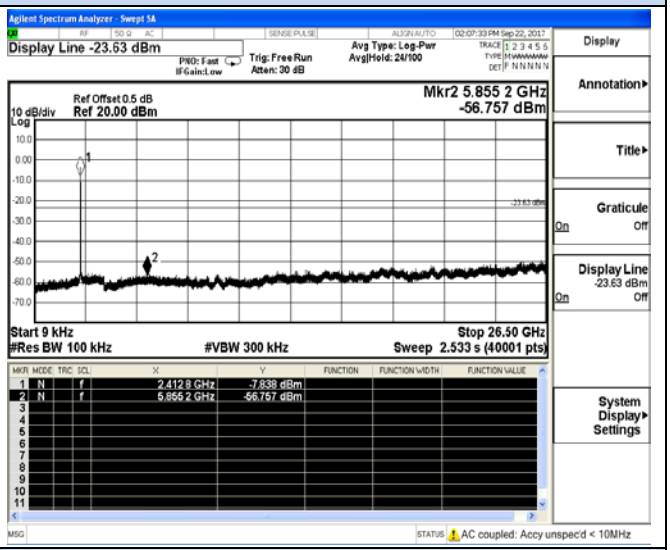
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

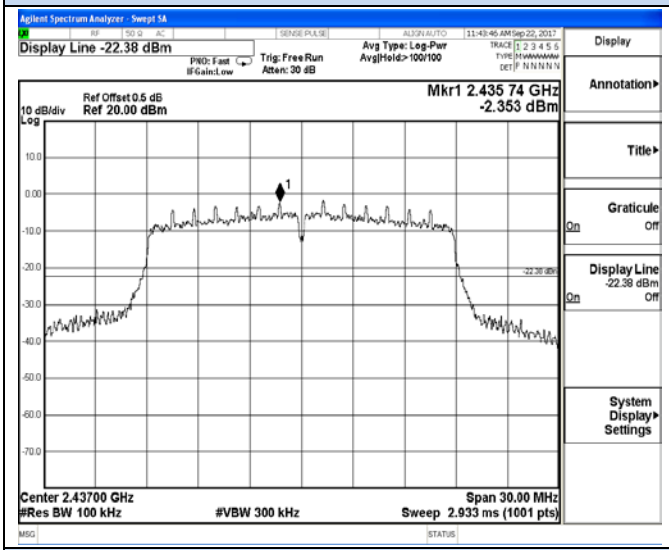
IEEE 802.11n HT20



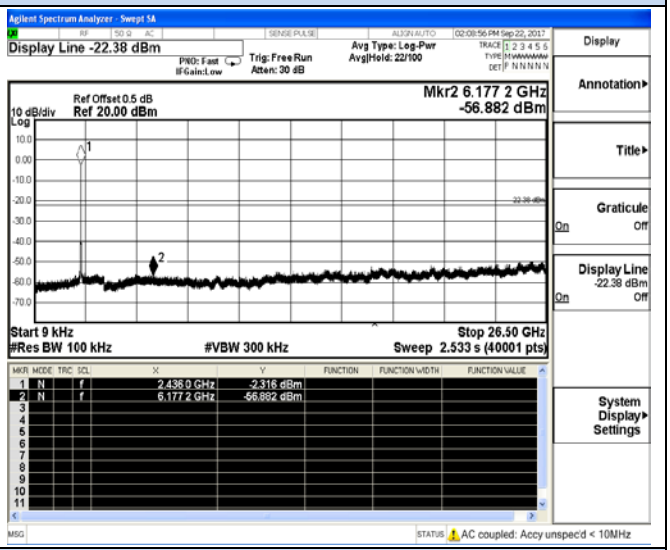
2397 MHz – 2427 MHz



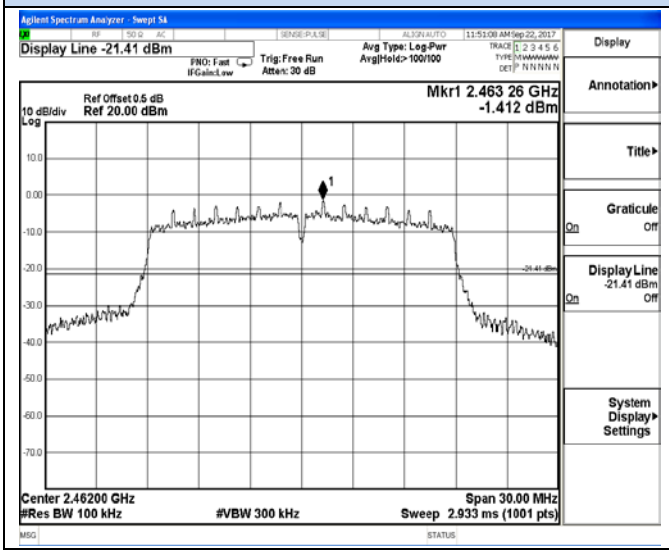
9 KHz – 26.5 GHz



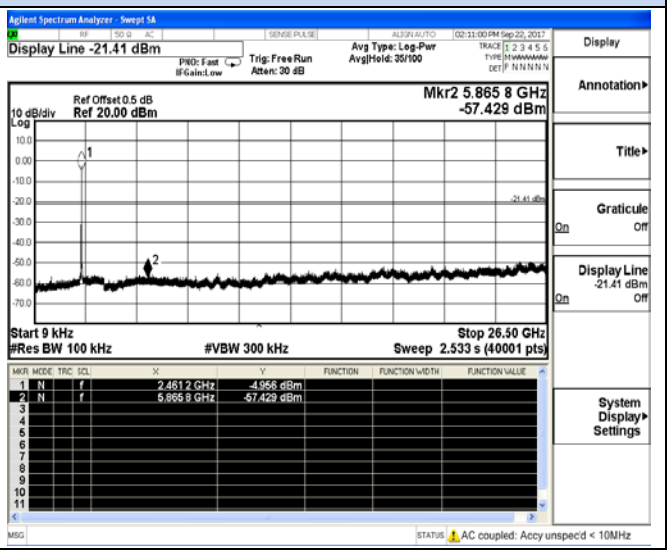
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



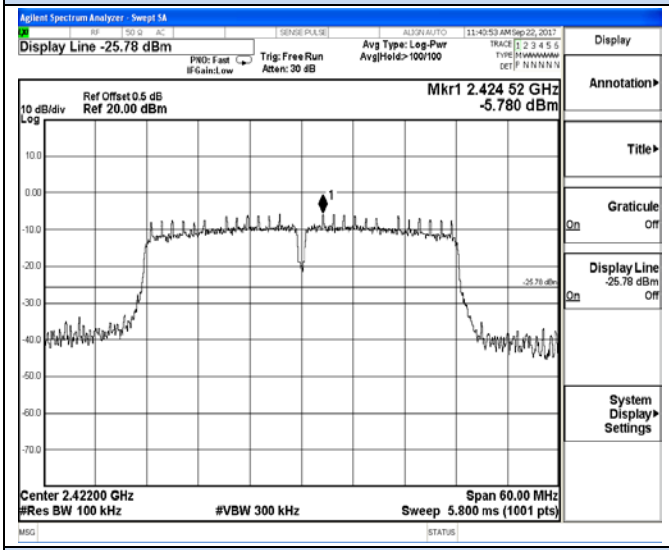
2447 MHz – 2477 MHz



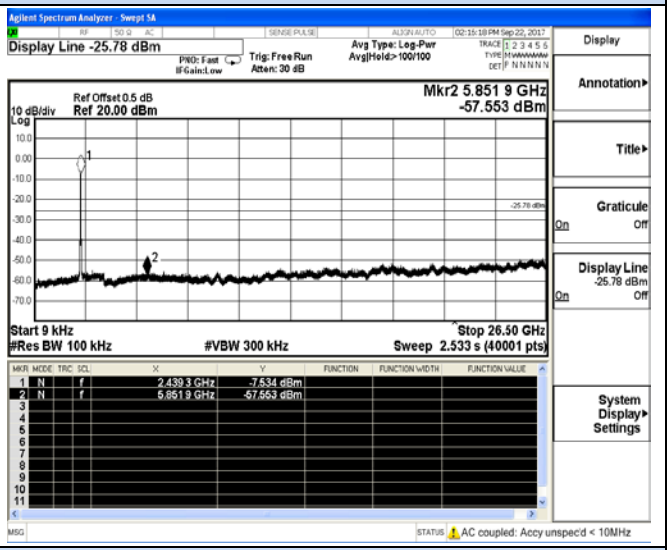
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

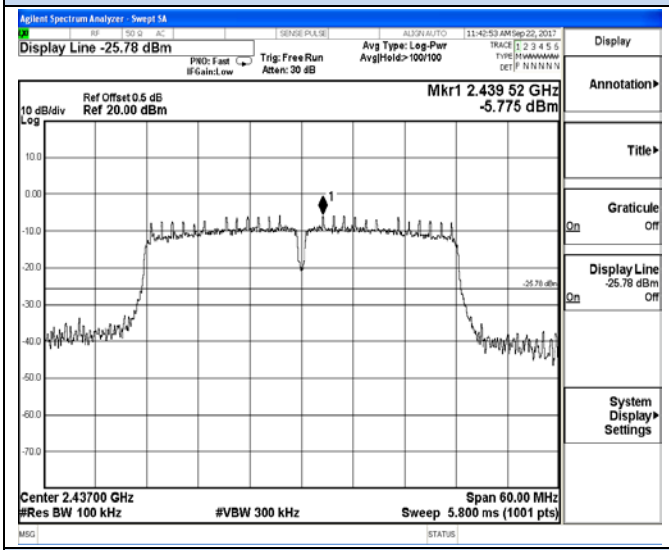
IEEE 802.11n HT40



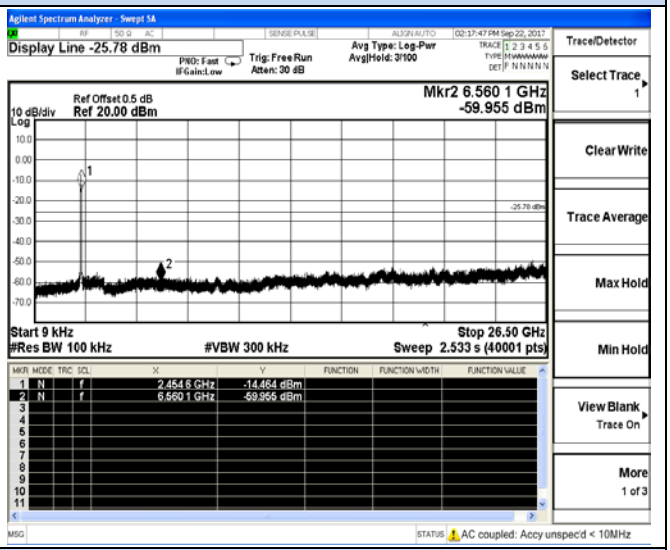
2392 MHz – 2452 MHz



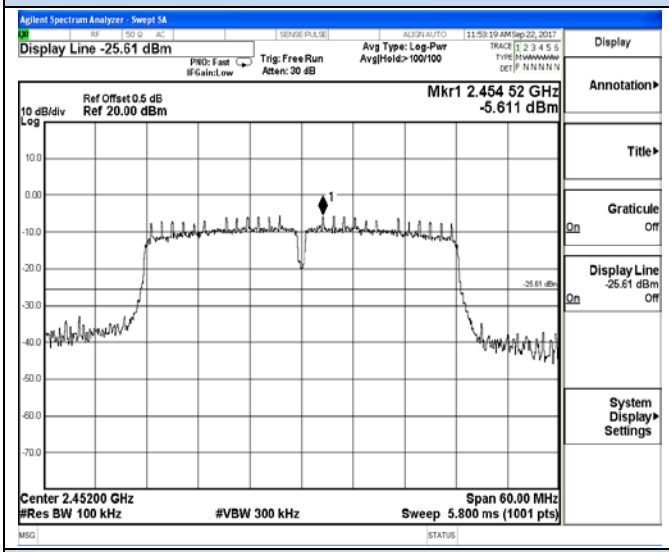
9 KHz – 26.5 GHz



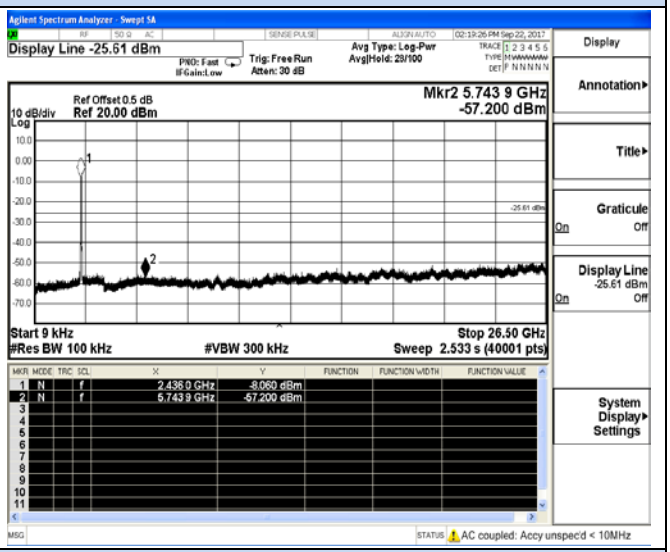
2407 MHz – 2467 MHz



9 KHz – 26.5 GHz



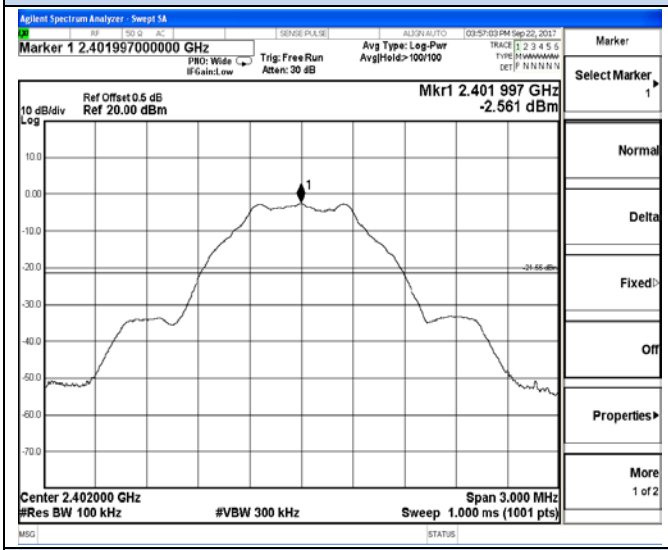
2422 MHz – 2482 MHz



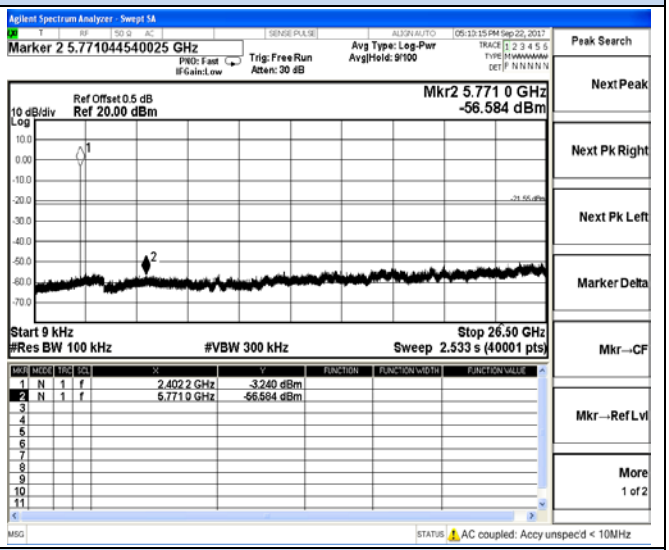
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

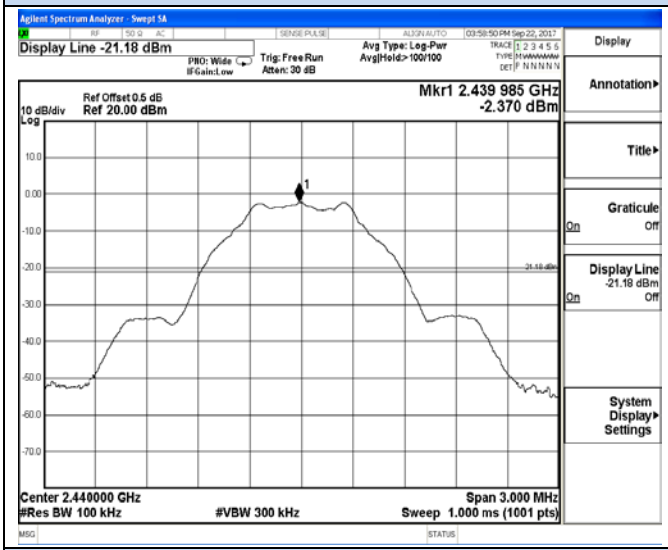
BT - LE



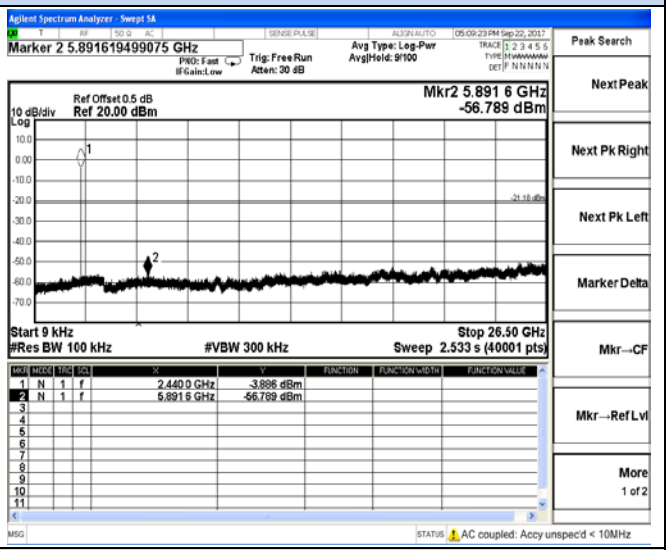
2400.5 MHz – 2403.5 MHz



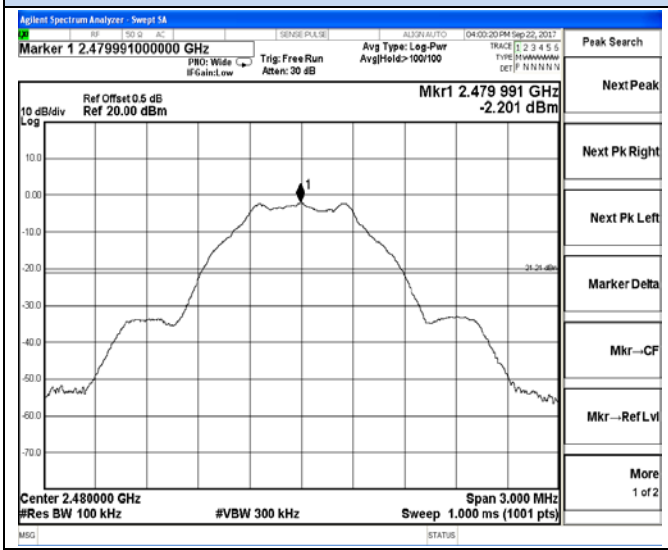
9 KHz – 26.5 GHz



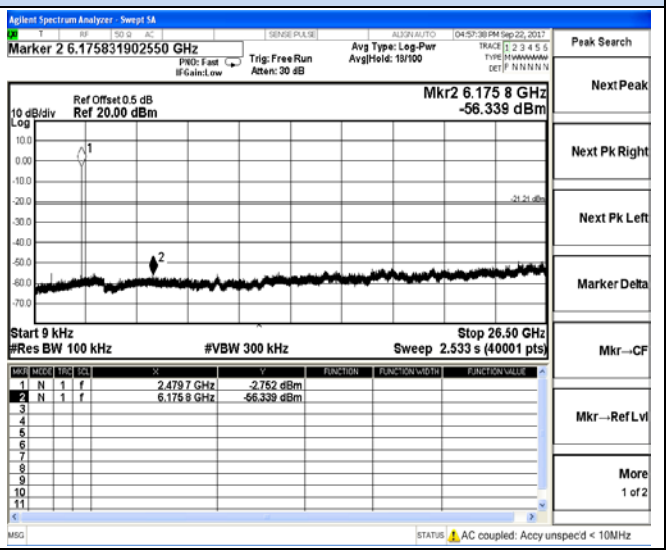
2438.5 MHz – 2441.5 MHz



9 KHz – 26.5 GHz



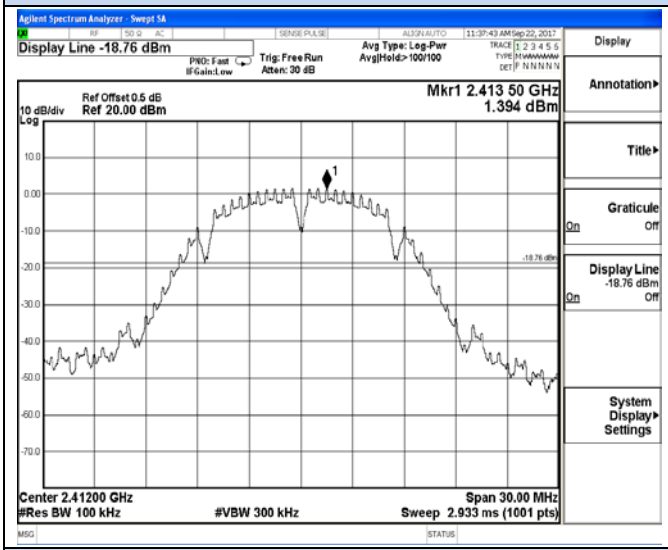
2478.5 MHz – 2481.5 MHz



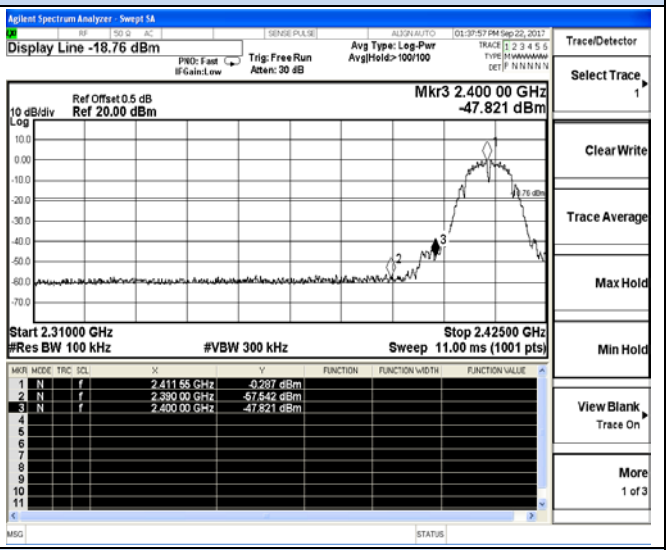
9 KHz – 26.5 GHz

Band-edge measurements for conducted emissions

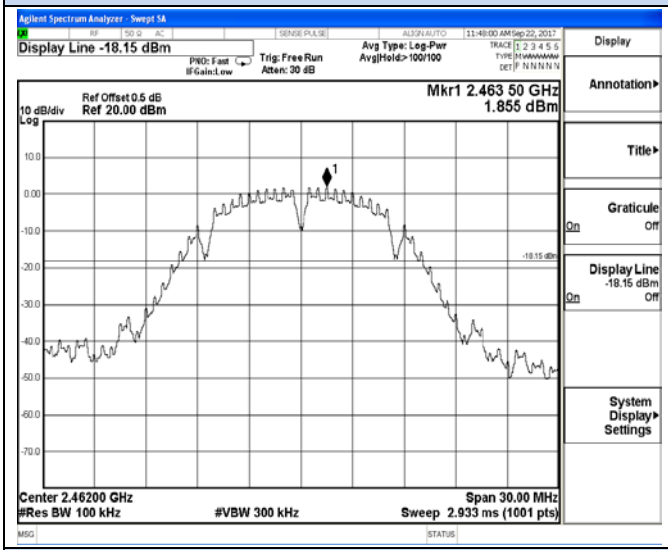
IEEE 802.11b



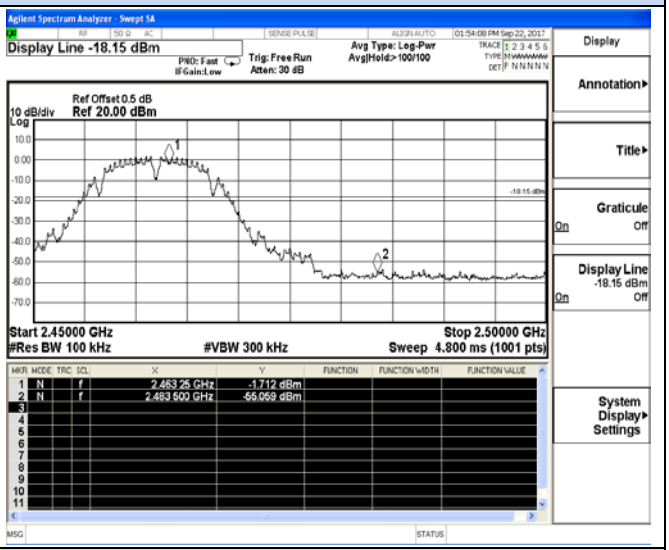
2397 MHz – 2427 MHz



Channel 1 / 2412 MHz

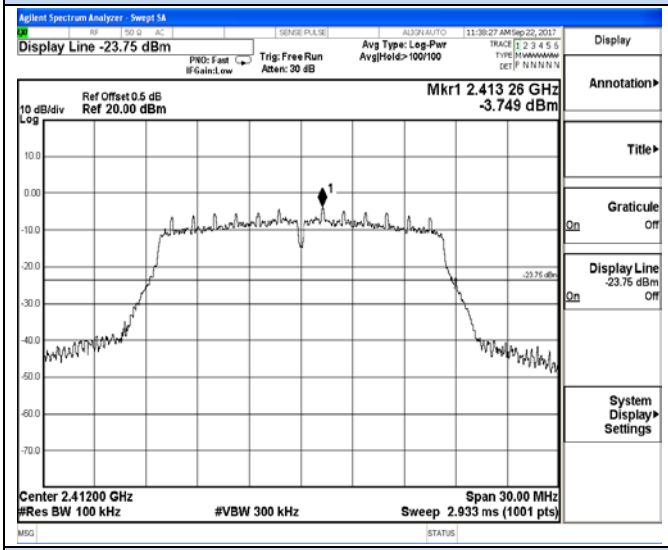


2447 MHz – 2477 MHz

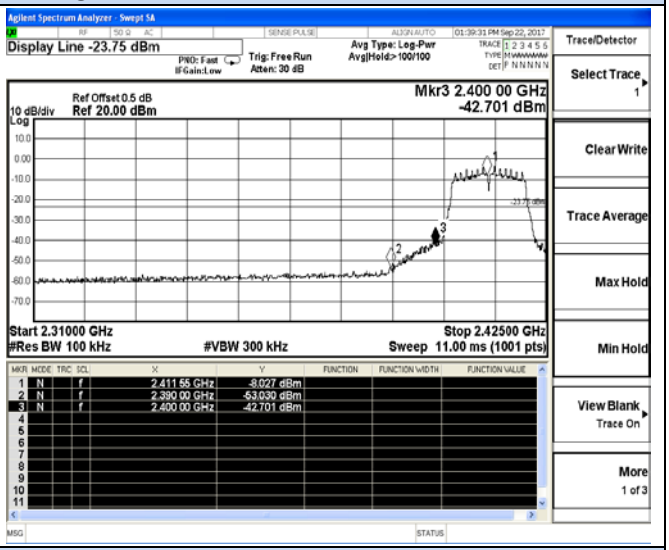


Channel 11 / 2462 MHz

IEEE 802.11g



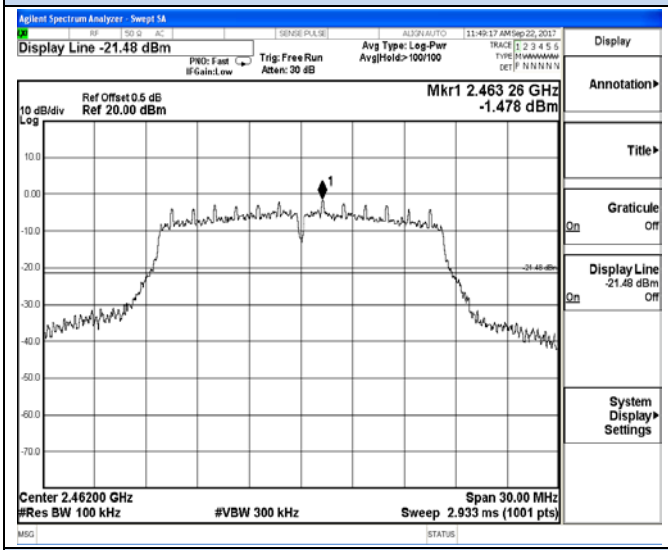
2397 MHz – 2427 MHz



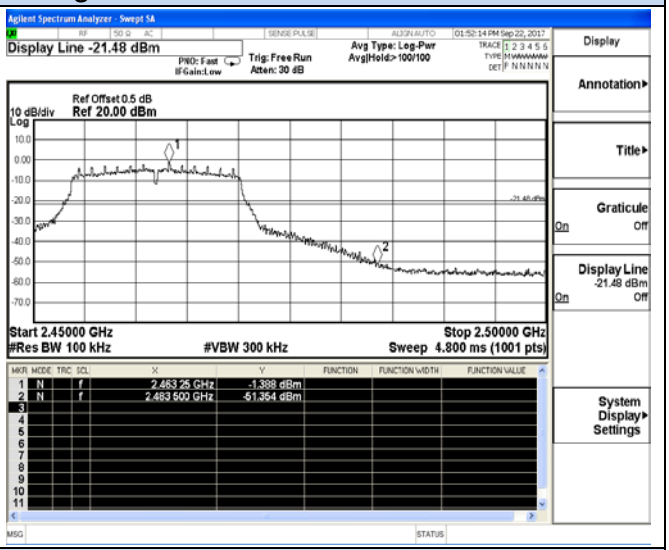
Channel 1 / 2412 MHz

Band-edge measurements for conducted emissions

IEEE 802.11g

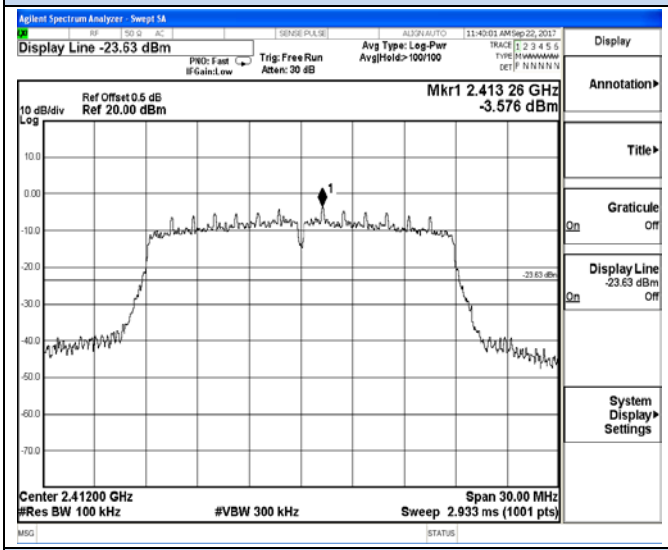


2447 MHz – 2477 MHz

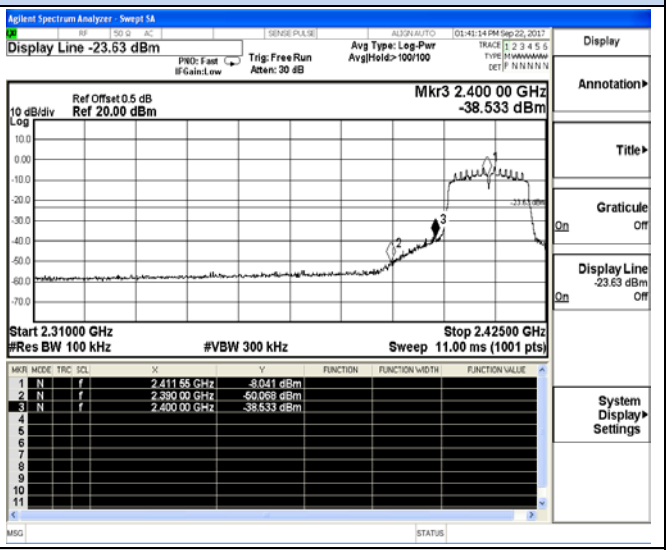


Channel 11 / 2462 MHz

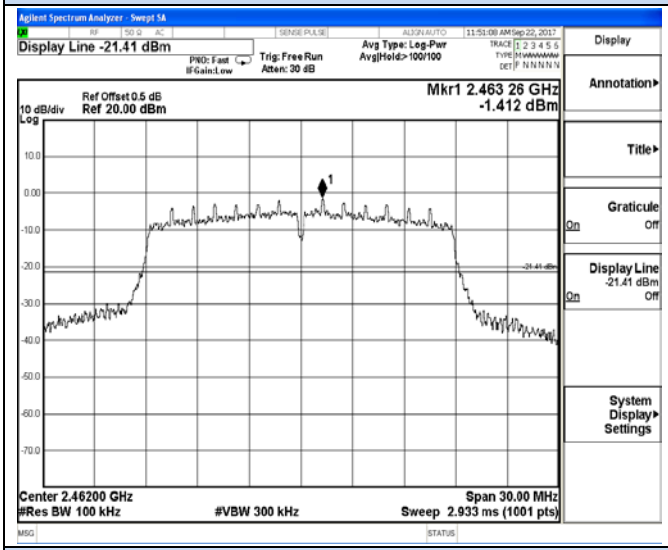
IEEE 802.11n HT20



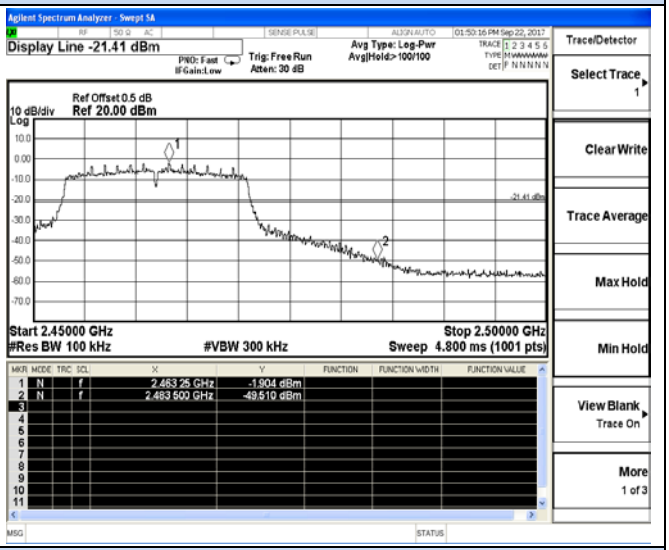
2397 MHz – 2427 MHz



Channel 1 / 2412 MHz



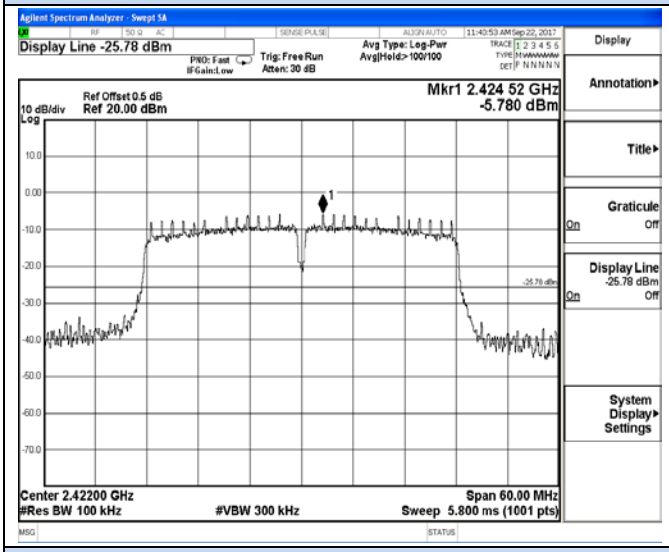
2447 MHz – 2477 MHz



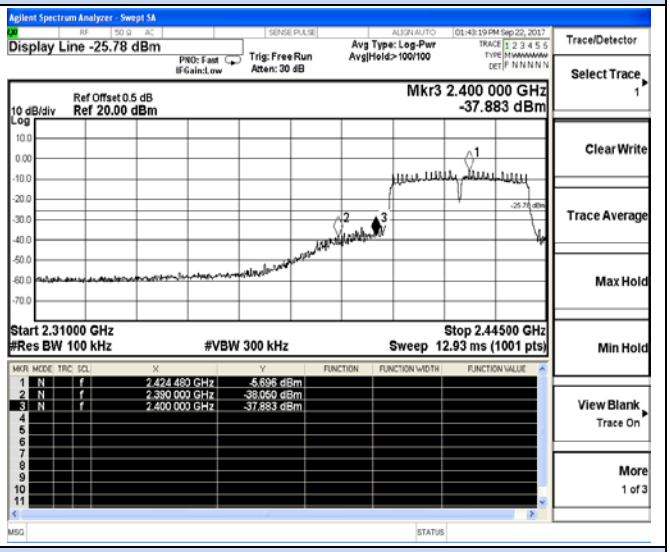
Channel 11 / 2462 MHz

Band-edge measurements for conducted emissions

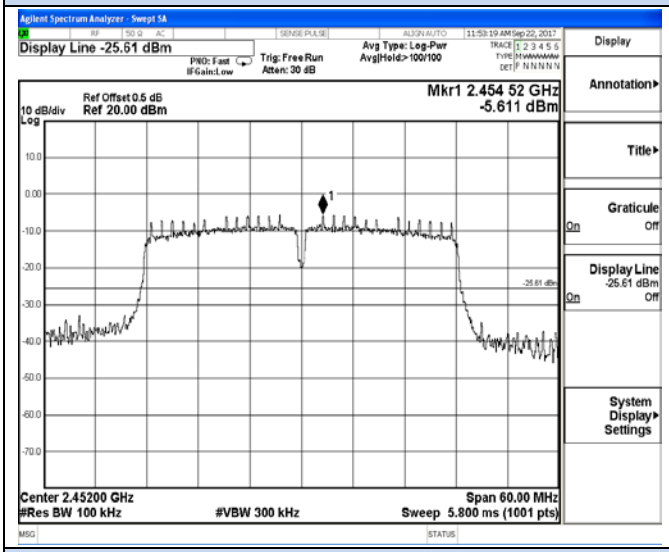
IEEE 802.11n HT40



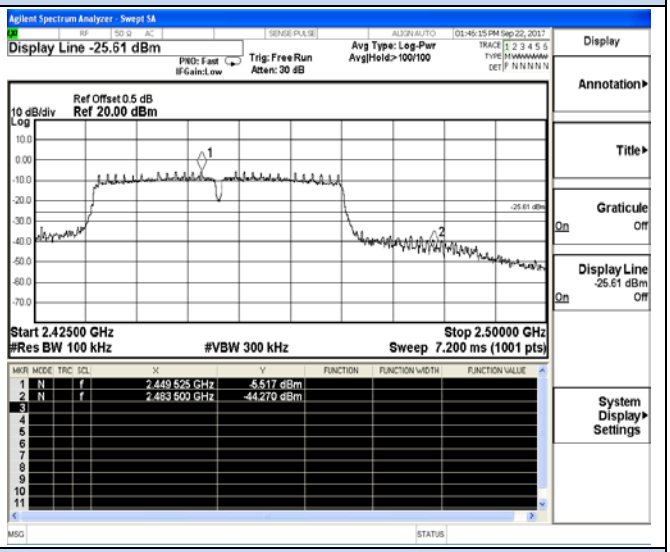
2392 MHz – 2452 MHz



Channel 3 / 2422 MHz



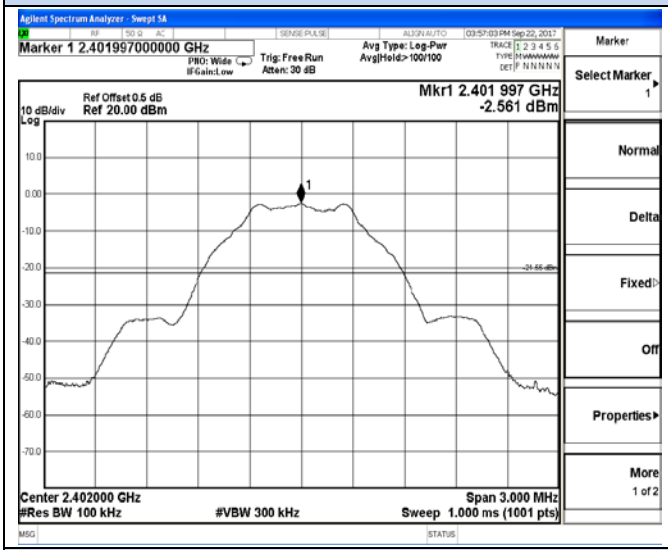
2422 MHz – 2482 MHz



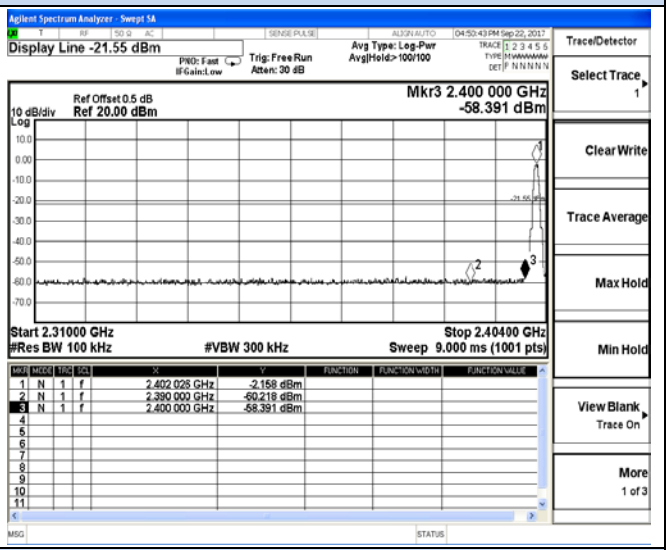
Channel 9 / 2452 MHz

Band-edge measurements for conducted emissions

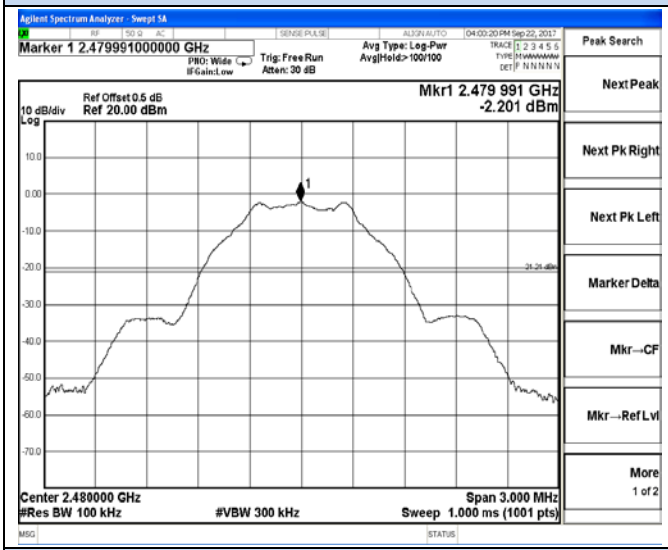
BT – LE



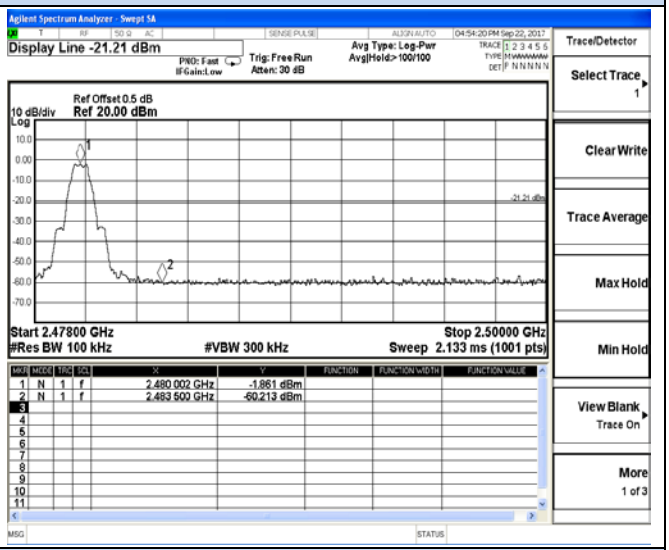
2400.5 MHz – 2403.5 MHz



Channel 0 / 2402 MHz



2478.5 MHz – 2481.5 MHz



Channel 39 / 2480 MHz

5.7. Power line conducted emissions

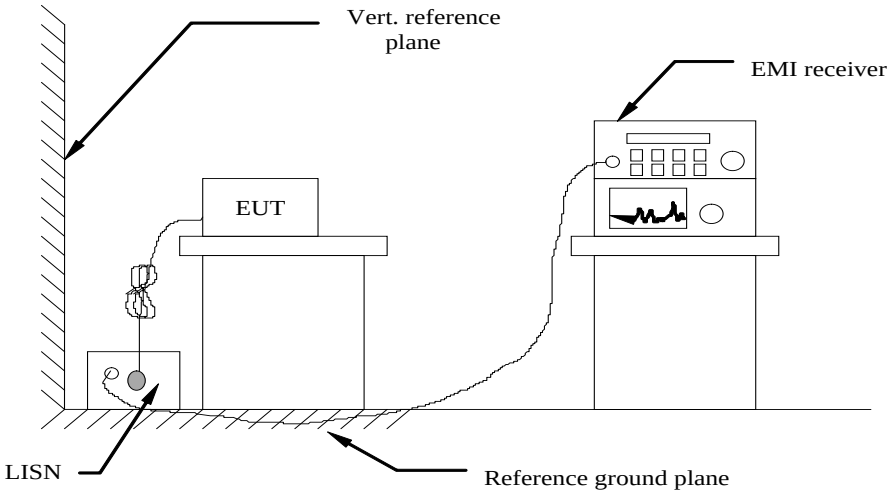
5.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



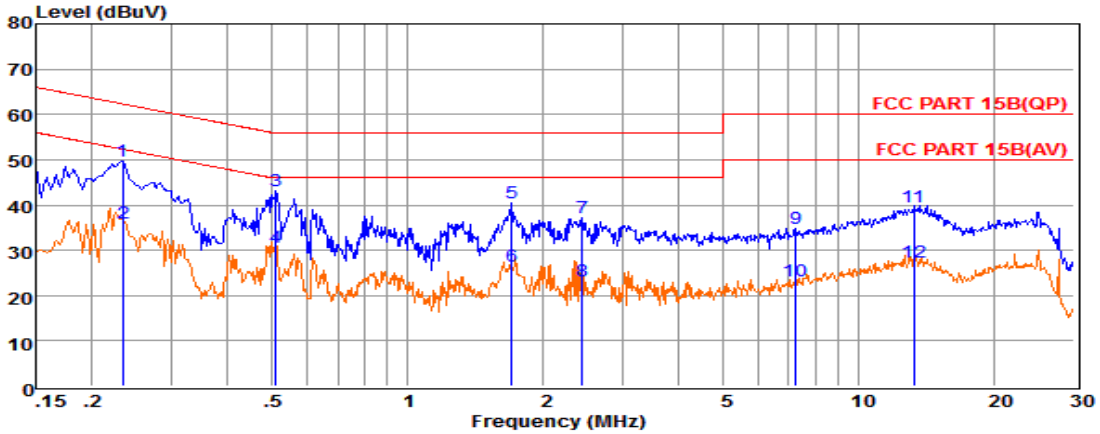
5.7.3 Test Results

PASS.

The test data please refer to following page.

AC Conducted Emission of power adapter @ AC 120V/60Hz @ IEEE 802.11b (worst case)

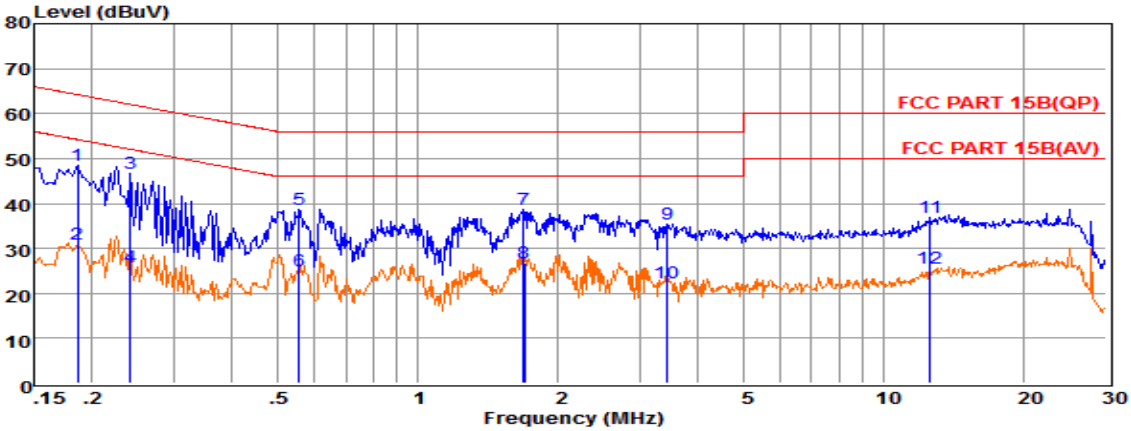
Line



	Freq MHz	Reading dBuV	LISNFac dB	CabLos dB	Aux2Fac dB	Measured dB	Limit dBuV	Over dBuV	Remark dB
1	0.23	29.99	9.63	0.03	10.00	49.65	62.30	-12.65	QP
2	0.23	16.41	9.63	0.03	10.00	36.07	52.30	-16.23	Average
3	0.51	23.49	9.62	0.04	10.00	43.15	56.00	-12.85	QP
4	0.51	10.93	9.62	0.04	10.00	30.59	46.00	-15.41	Average
5	1.70	20.71	9.64	0.05	10.00	40.40	56.00	-15.60	QP
6	1.70	6.74	9.64	0.05	10.00	26.43	46.00	-19.57	Average
7	2.43	17.50	9.64	0.05	10.00	37.19	56.00	-18.81	QP
8	2.44	3.43	9.64	0.05	10.00	23.12	46.00	-22.88	Average
9	7.25	15.05	9.68	0.07	10.00	34.80	60.00	-25.20	QP
10	7.25	3.59	9.68	0.07	10.00	23.34	50.00	-26.66	Average
11	13.27	19.61	9.70	0.10	10.00	39.41	60.00	-20.59	QP
12	13.27	7.45	9.70	0.10	10.00	27.25	50.00	-22.75	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Neutral



	Freq MHz	Reading dBuV	LISNFac dB	CabLos dB	Aux2Fac dB	Measured dB	Limit dBuV	Over dBuV	Remark dB
1	0.19	28.80	9.62	0.02	10.00	48.44	64.20	-15.76	QP
2	0.19	11.35	9.62	0.02	10.00	30.99	54.19	-23.20	Average
3	0.24	27.21	9.60	0.03	10.00	46.84	62.04	-15.20	QP
4	0.24	6.35	9.60	0.03	10.00	25.98	52.04	-26.06	Average
5	0.56	19.12	9.62	0.04	10.00	38.78	56.00	-17.22	QP
6	0.56	5.36	9.62	0.04	10.00	25.02	46.00	-20.98	Average
7	1.69	19.11	9.63	0.05	10.00	38.79	56.00	-17.21	QP
8	1.69	7.10	9.63	0.05	10.00	26.78	46.00	-19.22	Average
9	3.44	15.67	9.65	0.06	10.00	35.38	56.00	-20.62	QP
10	3.44	2.63	9.65	0.06	10.00	22.34	46.00	-23.66	Average
11	12.58	17.03	9.73	0.09	10.00	36.85	60.00	-23.15	QP
12	12.58	5.77	9.73	0.09	10.00	25.59	50.00	-24.41	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

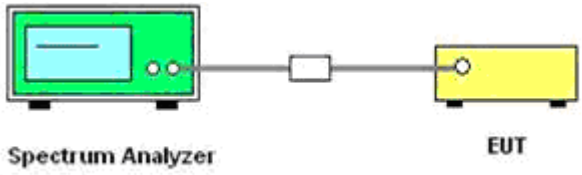
****Note: Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b).*

5.8. Restrict-band band-edge measurements for radiated emissions

5.8.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

5.8.2. Test Setup Layout



5.8.3. Measuring Instruments and Setting

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

5.8.4. Test Procedures

According to KDB 558074 D01 for Antenna-port conducted measurement. Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=1/B for Peak detector.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 12.2.2, 12.2.3, and 12.2.4 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10. Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$$E = EIRP - 20\log D + 104.8$$

Where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

11. Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
12. Compare the resultant electric field strength level to the applicable regulatory limit.
13. Perform radiated spurious emission test duress until all measured frequencies were complete.

5.8.5 Test Results

IEEE 802.11b							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-49.554	3.000	0.000	48.674	Peak	74.000	PASS
2310.000	-61.161	3.000	0.000	37.067	AV	54.000	PASS
2390.000	-46.194	3.000	0.000	52.034	Peak	74.000	PASS
2390.000	-59.035	3.000	0.000	39.193	AV	54.000	PASS
2483.500	-45.182	3.000	0.000	53.046	Peak	74.000	PASS
2483.500	-57.908	3.000	0.000	40.320	AV	54.000	PASS
2500.000	-47.533	3.000	0.000	50.695	Peak	74.000	PASS
2500.000	-59.553	3.000	0.000	38.675	AV	54.000	PASS

IEEE 802.11g							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-49.493	3.000	0.000	48.735	Peak	74.000	PASS
2310.000	-60.492	3.000	0.000	37.736	AV	54.000	PASS
2390.000	-43.925	3.000	0.000	54.303	Peak	74.000	PASS
2390.000	-53.691	3.000	0.000	44.537	AV	54.000	PASS
2483.500	-45.282	3.000	0.000	52.946	Peak	74.000	PASS
2483.500	-56.265	3.000	0.000	41.963	AV	54.000	PASS
2500.000	-46.301	3.000	0.000	51.927	Peak	74.000	PASS
2500.000	-57.382	3.000	0.000	40.846	AV	54.000	PASS

IEEE 802.11n HT20							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-48.994	3.000	0.000	49.234	Peak	74.000	PASS
2310.000	-60.881	3.000	0.000	37.347	AV	54.000	PASS
2390.000	-38.545	3.000	0.000	59.683	Peak	74.000	PASS
2390.000	-55.709	3.000	0.000	42.519	AV	54.000	PASS
2483.500	-45.326	3.000	0.000	52.902	Peak	74.000	PASS
2483.500	-57.369	3.000	0.000	40.859	AV	54.000	PASS
2500.000	-45.062	3.000	0.000	53.166	Peak	74.000	PASS
2500.000	-58.436	3.000	0.000	39.792	AV	54.000	PASS

IEEE 802.11n HT40							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-49.518	3.000	0.000	48.710	Peak	74.000	PASS
2310.000	-60.993	3.000	0.000	37.235	AV	54.000	PASS
2390.000	-32.843	3.000	0.000	65.385	Peak	74.000	PASS
2390.000	-54.392	3.000	0.000	43.836	AV	54.000	PASS
2483.500	-36.849	3.000	0.000	61.379	Peak	74.000	PASS
2483.500	-56.990	3.000	0.000	41.238	AV	54.000	PASS
2500.000	-45.968	3.000	0.000	52.260	Peak	74.000	PASS
2500.000	-58.488	3.000	0.000	39.740	AV	54.000	PASS

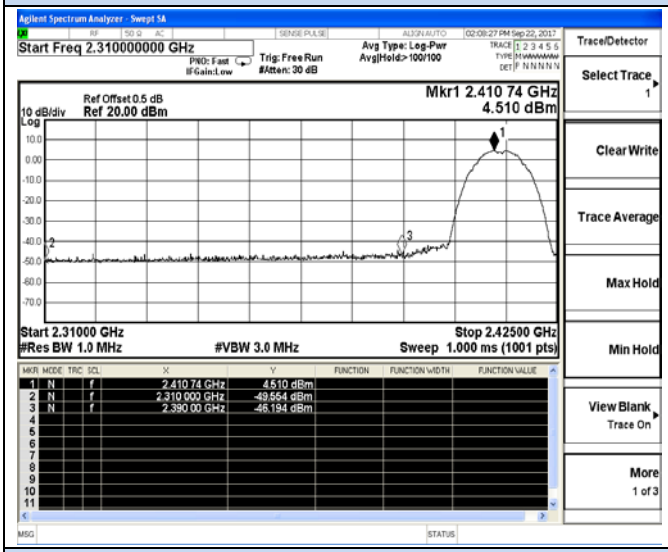
BT – LE							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-49.991	3.000	0.000	48.237	Peak	74.000	PASS
2390.000	-49.391	3.000	0.000	48.837	Peak	74.000	PASS
2483.500	-48.706	3.000	0.000	49.522	Peak	74.000	PASS
2500.000	-48.739	3.000	0.000	49.489	Peak	74.000	PASS

Remark:

1. *Measured Band edge measurement for radiated emission 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;*

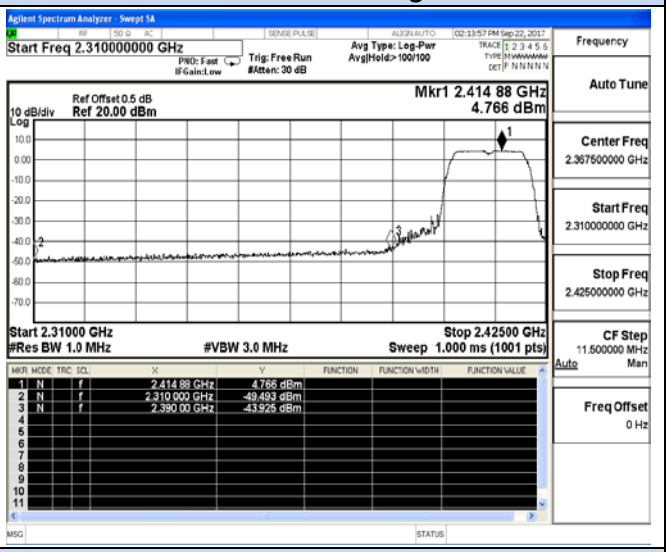
Restrict-band band-edge measurements for conducted emissions

IEEE 802.11b

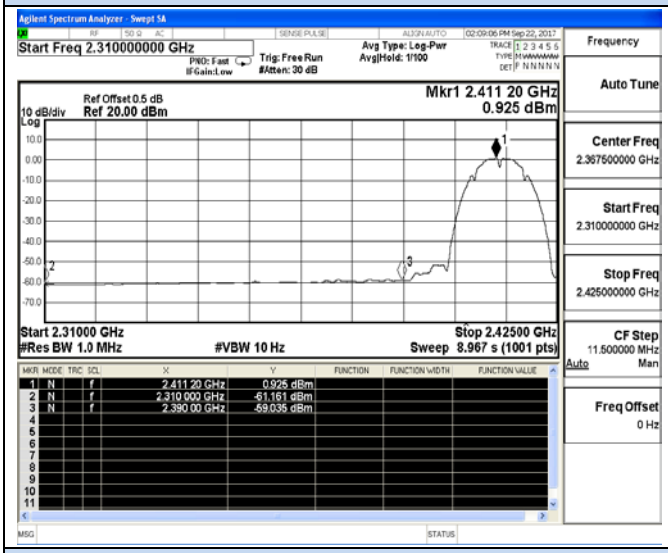


Channel 1 / 2412 MHz – Peak

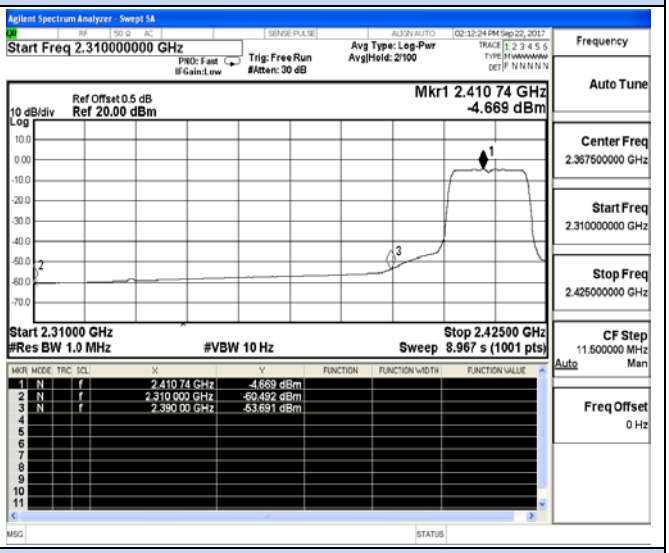
IEEE 802.11g



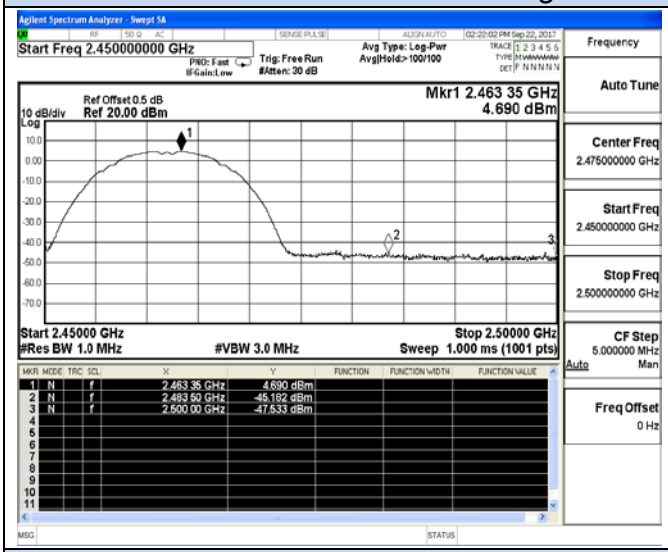
Channel 1 / 2412 MHz – Peak



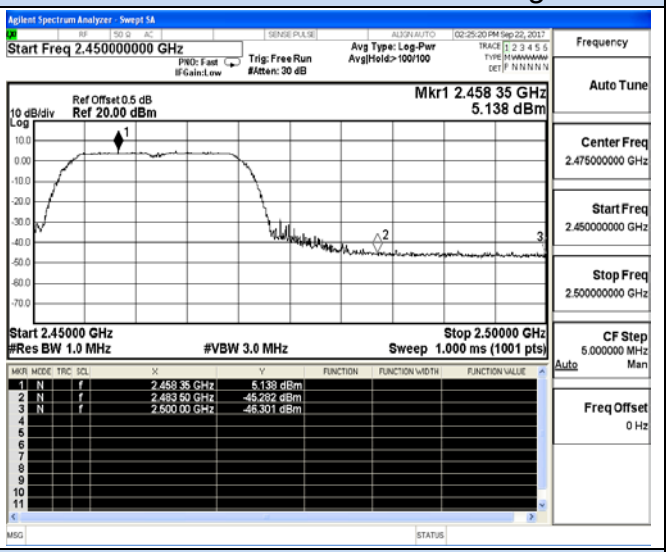
Channel 1 / 2412 MHz – Average



Channel 1 / 2412 MHz – Average



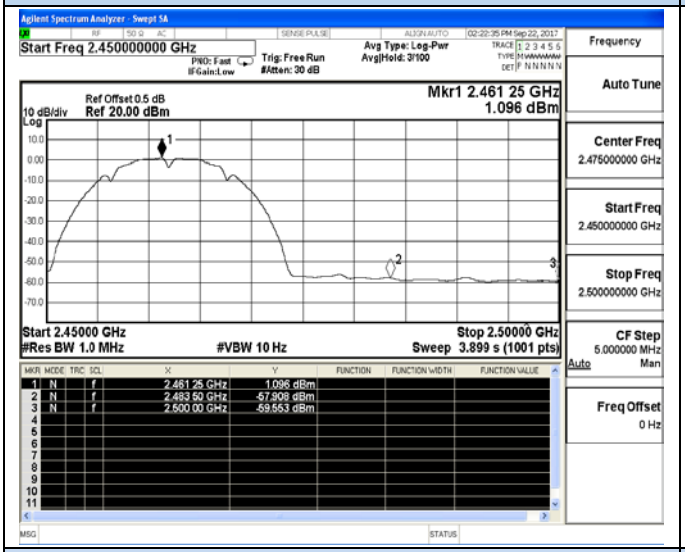
Channel 11 / 2412 MHz – Peak



Channel 11 / 2412 MHz – Peak

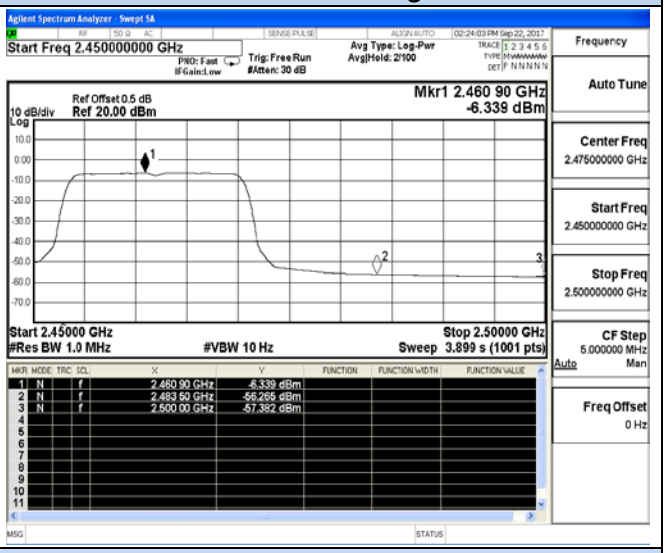
Restrict-band band-edge measurements for conducted emissions

IEEE 802.11b



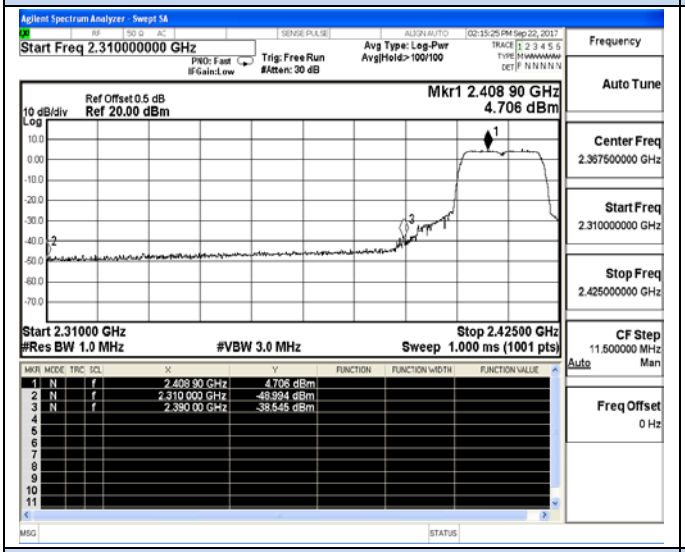
Channel 11 / 2412 MHz – Average

IEEE 802.11g



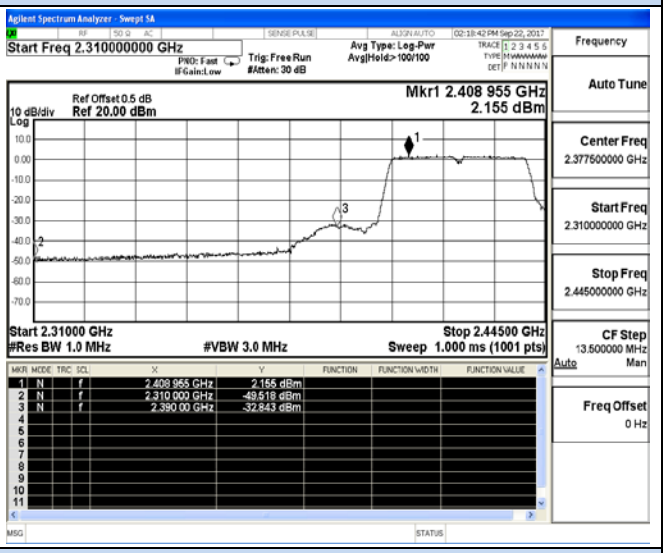
Channel 11 / 2412 MHz – Average

IEEE 802.11n HT20

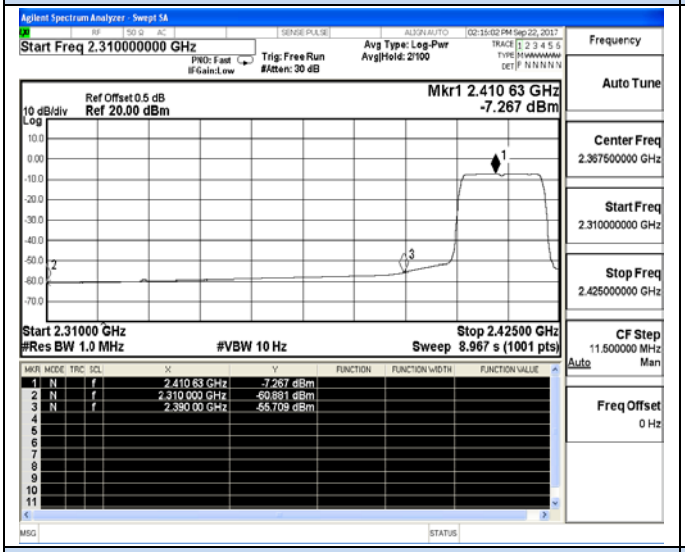


Channel 1 / 2412 MHz – Peak

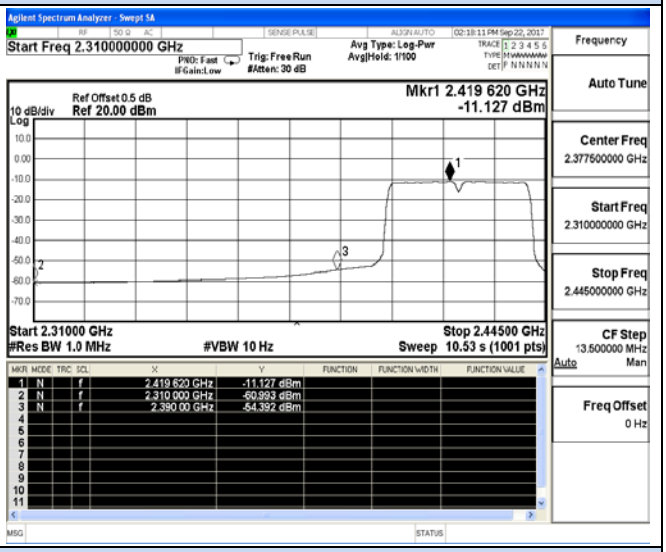
IEEE 802.11n HT40



Channel 3 / 2422 MHz – Peak



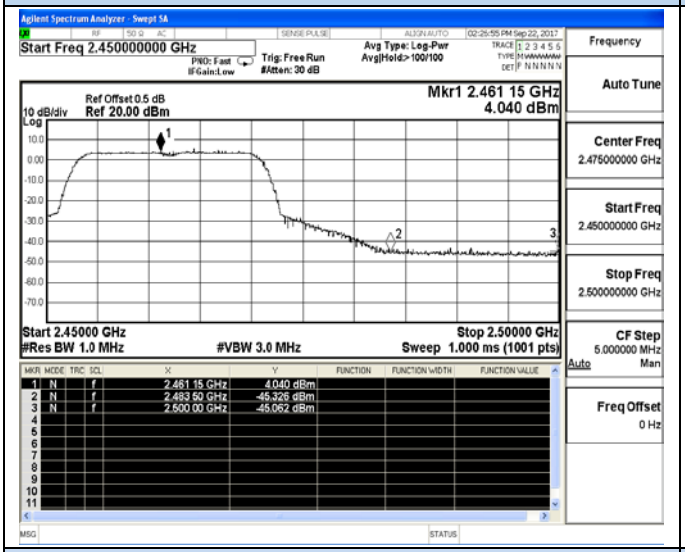
Channel 1 / 2412 MHz – Average



Channel 3 / 2422 MHz – Average

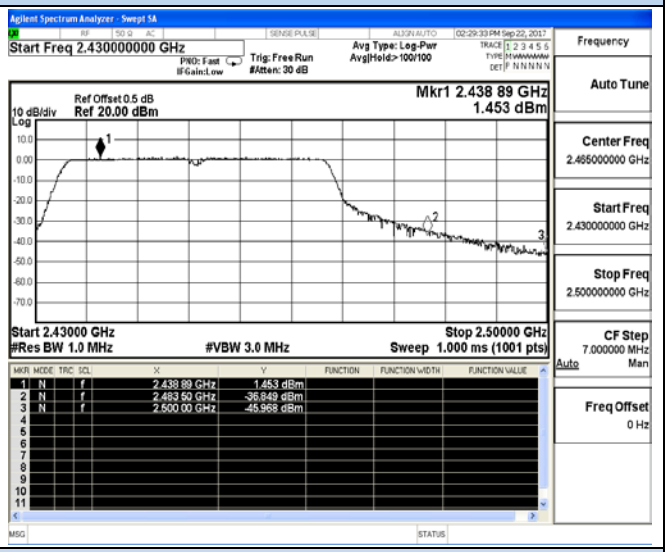
Restrict-band band-edge measurements for conducted emissions

IEEE 802.11n HT20

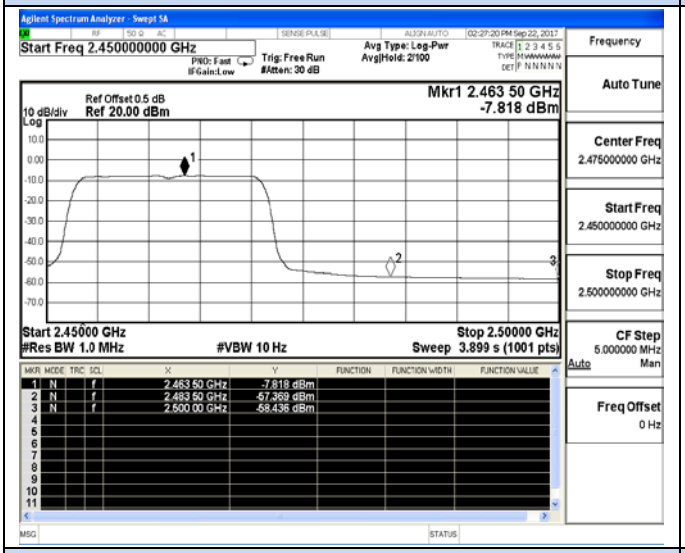


Channel 11 / 2462 MHz – Peak

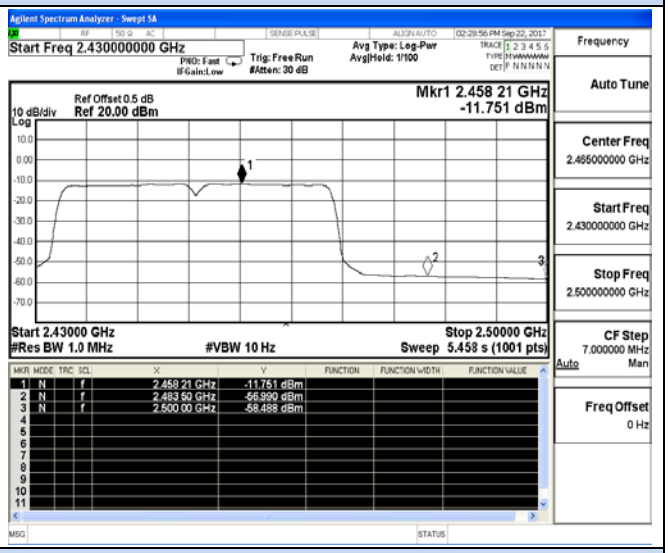
IEEE 802.11n HT40



Channel 9 / 2452 MHz – Peak

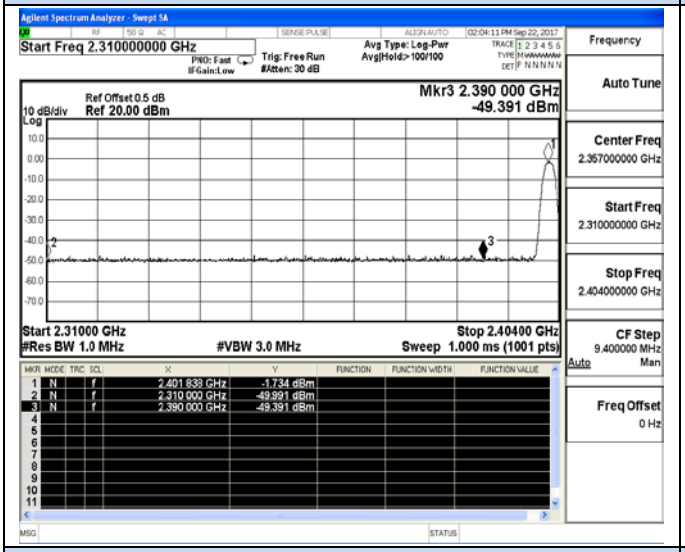


Channel 11 / 2462 MHz – Average



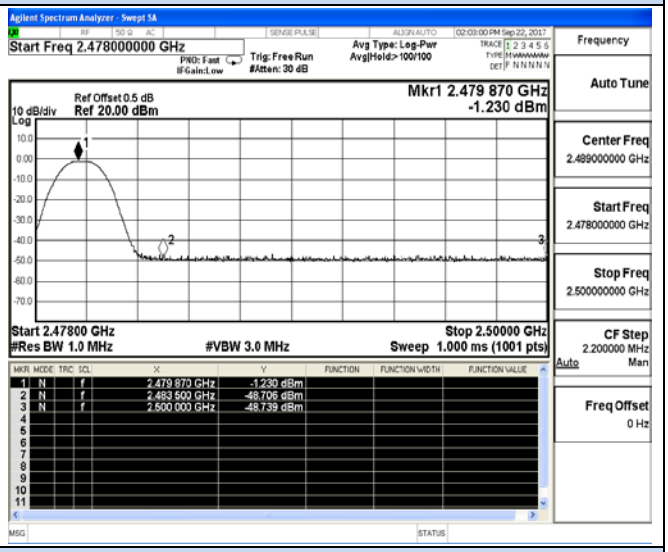
Channel 9 / 2452 MHz – Average

BT LE



Channel 0 / 2402 MHz – Peak

BT LE



Channel 39 / 2480 MHz – Peak

5.9. Antenna Requirements

5.9.1 Standard Applicable

According to antenna requirement of §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

5.9.2 Antenna Connected Construction

5.9.2.1. Standard Applicable

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

5.9.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 3.0dBi, it's a PIFA antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.
The WLAN and BT share same antenna;

5.9.2.3. Results: Compliance.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.
Conducted power refers ANSI C63.10:2013 Output power test procedure for DTS devices.
Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep Time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Limits

FCC	ISED
Antenna Gain	
6 dBi	

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For WLAN devices, the DSSS mode is used;

T_{nom}	V_{nom}	Lowest Channel 2412 MHz	Middle Channel 2437 MHz	Highest Channel 2462 MHz
Conducted power [dBm] Measured with DSSS modulation		4.510	4.922	4.690
Radiated power [dBm] Measured with DSSS modulation		6.494	7.778	7.112
Gain [dBi] Calculated		1.984	2.856	2.422
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

T_{nom}	V_{nom}	Lowest Channel 2402 MHz	Middle Channel 2440 MHz	Highest Channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		-1.734	-1.072	-1.230
Radiated power [dBm] Measured with GFSK modulation		-3.539	1.757	0.968
Gain [dBi] Calculated		-1.805	2.829	2.198
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

6. LIST OF MEASURING EQUIPMENTS

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
1	Power Sensor	R&S	NRV-Z81	100458	2017-06-18	2018-06-17
2	Power Sensor	R&S	NRV-Z32	10057	2017-06-18	2018-06-17
3	Power Meter	R&S	NRVS	100444	2017-06-18	2018-06-17
4	DC Filter	MPE	23872C	N/A	2017-06-18	2018-06-17
5	RF Cable	Harbour Industries	1452	N/A	2017-06-18	2018-06-17
6	SMA Connector	Harbour Industries	9625	N/A	2017-06-18	2018-06-17
7	Spectrum Analyzer	Agilent	N9020A	MY50510140	2016-10-27	2017-10-26
8	Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	2017-06-16	2018-06-15
9	RF Cable	Hubersuhner	Sucoflex104	FP2RX2	2017-06-18	2018-06-17
10	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2017-06-18	2018-06-17
11	Amplifier	SCHAFFNER	COA9231A	18667	2017-04-18	2018-04-17
12	Amplifier	Agilent	8449B	3008A02120	2017-04-18	2018-04-17
13	Amplifier	MITEQ	AMF-6F-260400	9121372	2017-04-18	2018-04-17
14	Loop Antenna	R&S	HFH2-Z2	860004/001	2017-04-18	2018-04-17
15	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2017-04-18	2018-04-17
16	Horn Antenna	EMCO	3115	6741	2017-04-18	2018-04-17
17	Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	2017-04-18	2018-04-17
18	RF Cable-R03m	Jye Bao	RG142	CB021	2017-06-18	2018-06-17
19	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2017-06-18	2018-06-17
20	EMI Test Receiver	R&S	ESCI	101142	2017-06-18	2018-06-17
21	Artificial Mains	R&S	ENV216	101288	2017-06-18	2018-06-17
22	EMI Test Software	AUDIX	E3	N/A	2017-06-18	2018-06-17

This report shall not be reproduced except in full, without the written approval of Shenzhen LCS Compliance Testing Laboratory Ltd.

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

----------THE END OF REPORT----------