TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.247

TEST REPORT

For

Ningbo Lumiaudio Electronic Technology LTD

22/F., Building 1,Lisi Plaza, Huifeng East Road, Ningbo, China 315100

FCC ID: 2AKKHWSP

Report Type:	**Product Type:**
Original Report	Speaker

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Report Number:	RSHA180413003-00A
Report Date:	2018-05-23
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	Ningbo Lumiaudio Electronic Technology LTD
Tested Model	WSP-6
Series Model	WSP-6-L, WSP-6-LA, WSP-6-NA, WSP-6S, WSP-6S-L, WSP-6S-LA, WSP-6S-NA
Model Difference	Model name
Product Type	Speaker
Dimension	225mm(L) × 225mm(W) × 98mm(H)
Power Supply	DC 24V from adapter

Adapter Information:
Model:TDX-2402500
Input: AC 100-240V,50/60Hz, 2A
Output: DC 24V, 2.5A

**All measurement and test data in this report was gathered from production sample serial number: 20180413003. (Assigned by BACL, Kunshan). The EUT was received on 2018-04-13.*

Objective

This report is prepared on behalf of *Ningbo Lumiaudio Electronic Technology LTD* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

No Related Submittal(s)/Grant(s).

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 and FCC KDB558074 D01 DTS Meas Guidance v04.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel List for 802.11b, 802.11g and 802.11n-HT20 mode:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

EUT was tested with Channel 1, 6 and 11.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

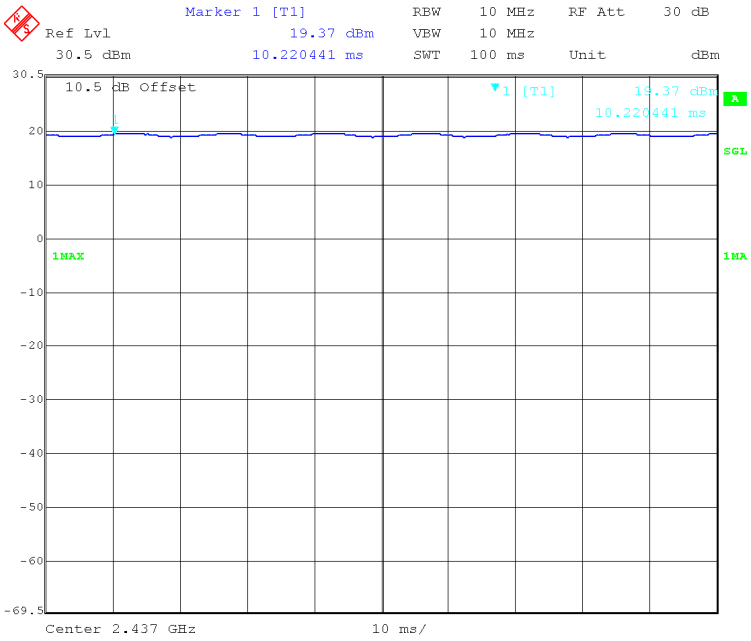
RF test tool: QATool_Dbg

Pre-scan with all the data rates, and the worst case was performed as below:

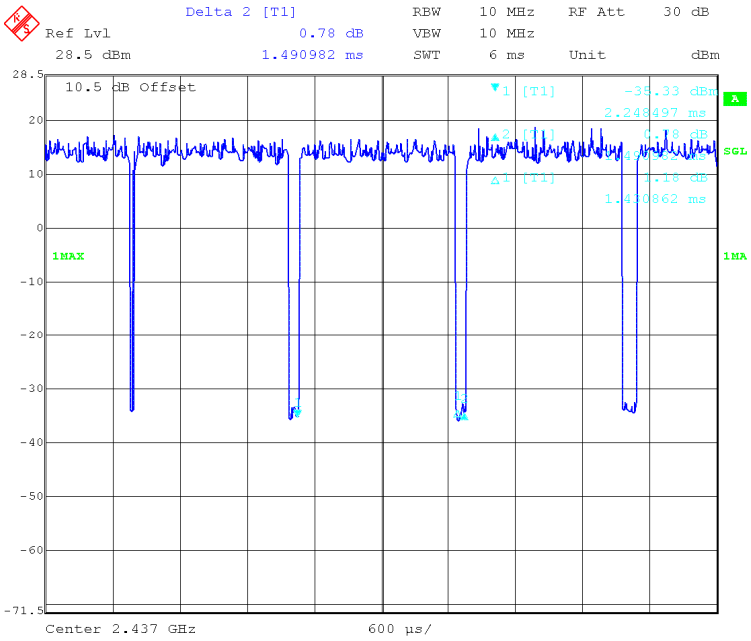
Mode	Data rate	Channel	Power level
802.11b	1 Mbps	Low	12.5
		Middle	6
		High	5
802.11g	6 Mbps	Low	12
		Middle	5
		High	4.5
802.11n-HT20	MCS0	Low	12.5
		Middle	6
		High	5

Duty Cycle:

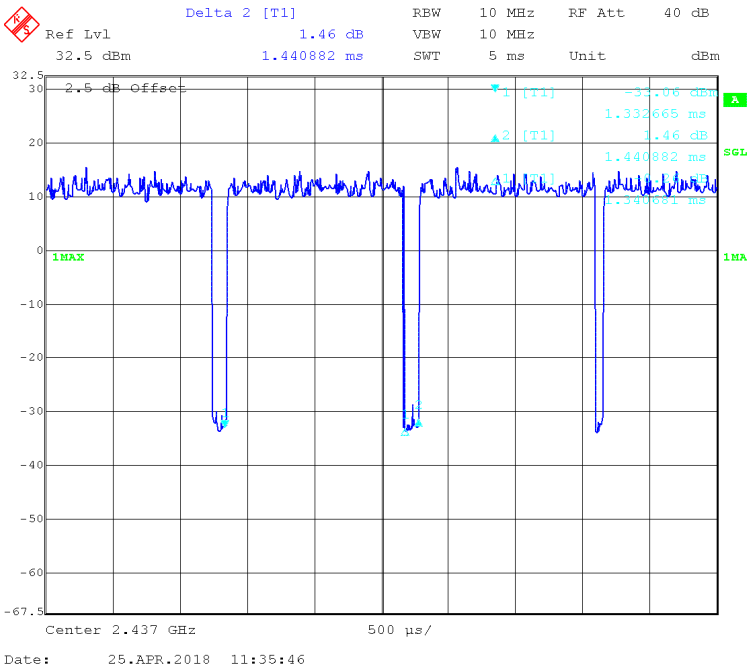
802.11b Mode Middle Channel



802.11g Mode Middle Channel



802.11n-HT20 Mode Middle Channel



Mode	Duty Cycle(%)	T(us)	1/T(kHz)	10log(1/x)
802.11b	100	/	/	0
802.11g	95.98	1431	0.70	0.18
802.11n-HT20	93.06	1341	0.75	0.31

Note:“x” means the Duty Cycle.

Support Equipment List and Details

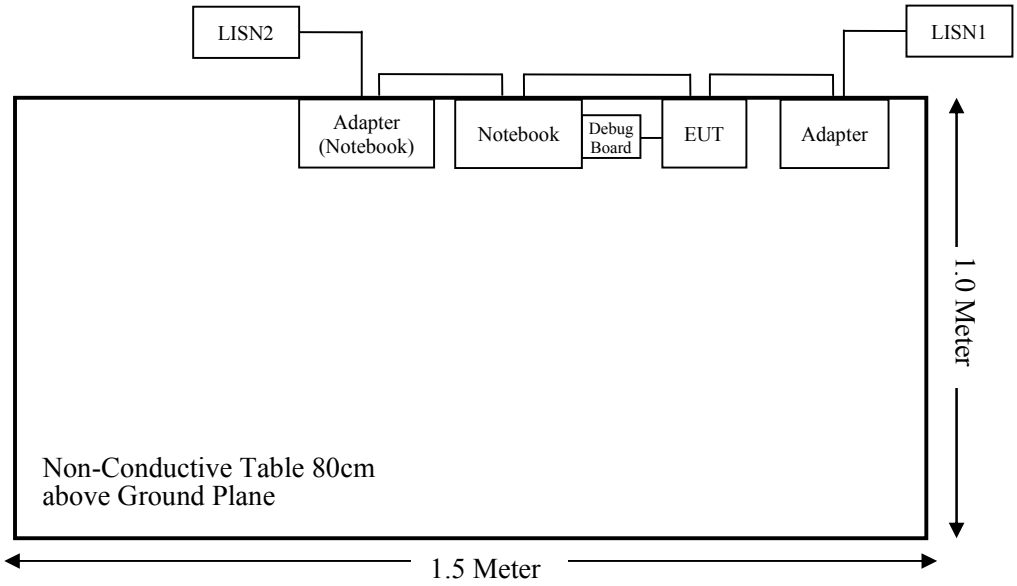
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
DELL	Adapter (Notebook)	LA65NS0-00	DF263
Ningbo Lumiaudio	Debug Board	/	/

External I/O Cable

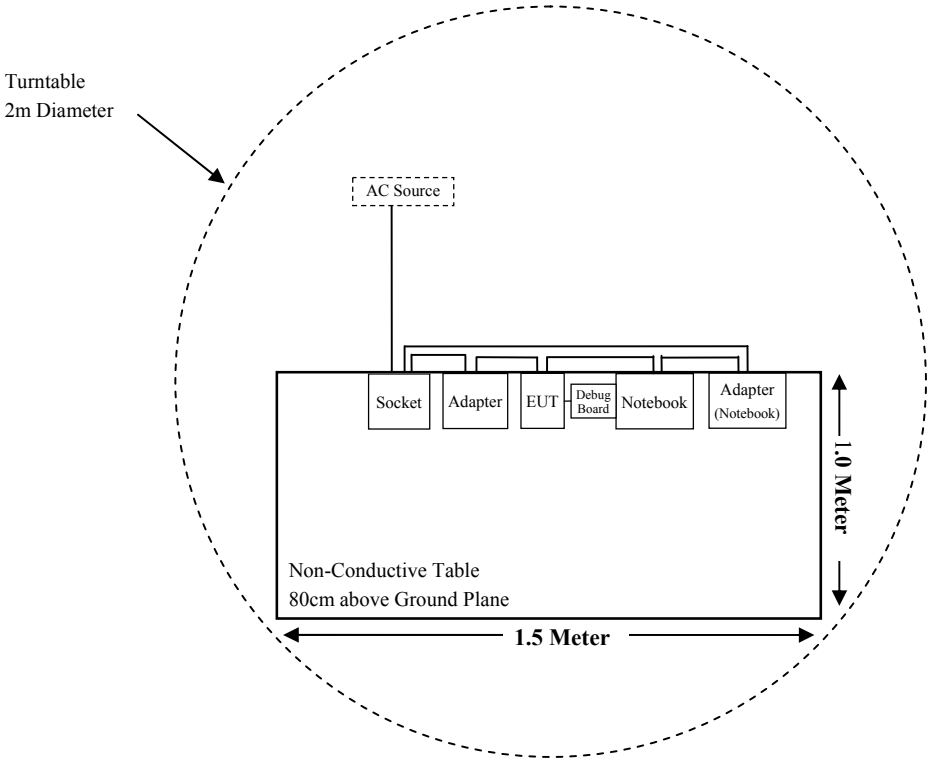
Cable Description	Shielding Type	Length (m)	From Port	To
RJ45 Cable	Un-shielding	1.0	Notebook	EUT
Data Cable	Un-shielding	0.2	Debug Board	EUT

Block Diagram of Test Setup

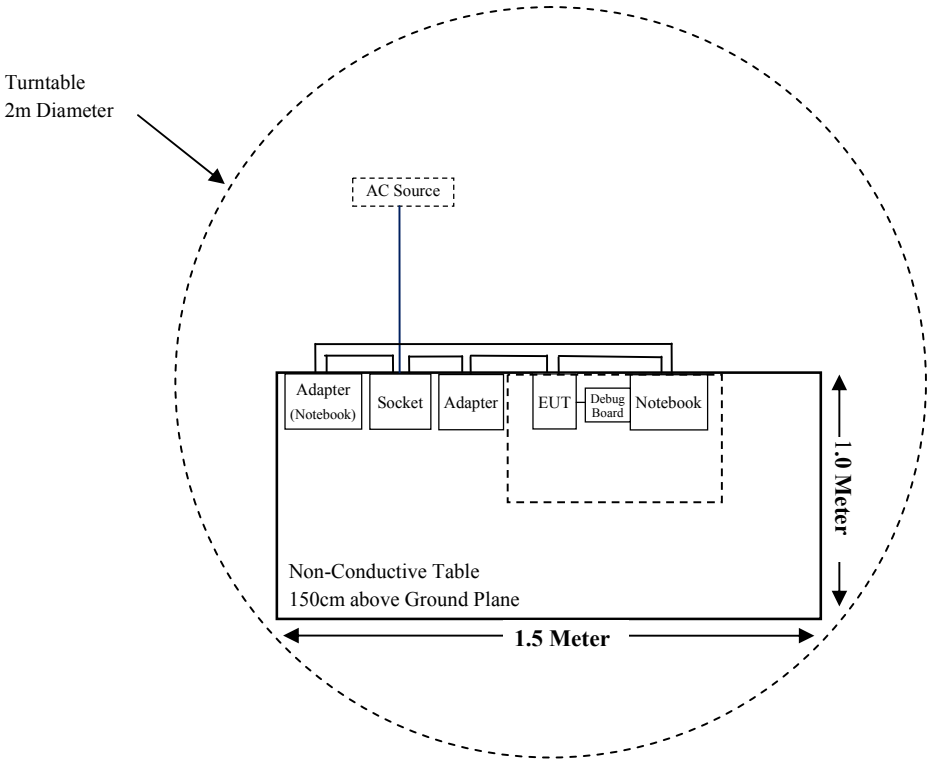
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.247(d)	Spurious Emissions at Antenna Port	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Conducted Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 1#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Sunol Sciences	Broadband Antenna	JB3	A040914-2	2016-01-09	2019-01-08
Sonoma Instrunent	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Narda	Pre-amplifier	AFS42-00101800	2001270	2017-12-12	2018-12-11
EM Electronics Corporation	Amplifier	EM18G40G	060726	2018-03-22	2019-03-21
MICRO-TRONICS	Band Reject Filter	BRM50702	/	2017-08-05	2018-08-04
Narda	Attenuator/10dB	10dB	/	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Narda	Attenuator/10dB	10dB	/	2017-08-15	2018-08-14
Agilent	Power Meter	N1912A	MY5000492	2017-11-18	2018-11-17
Agilent	Power Sensor	N1921A	MY54210024	2017-11-18	2018-11-17
Ningbo Lumiaudio	RF Cable	NA/	N/A	Each Time	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2017-11-12	2018-11-11
Rohde & Schwarz	LISN	ENV216	3560655016	2017-11-12	2018-11-11
BACL	Auto test Software	BACL-EMC	CE001	/	/
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2017-08-15	2018-08-14

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §1.1310& §2.1091 –MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm²)**	**Averaging Time (minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f²)	30
30-300	27.5	0.073	0.2	30
300-1500	/		f/1500	30
1500-100,000	/		1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Data:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = PG/4 π R² = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Mode	Frequency Range (MHz)	Antenna Gain		Output Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11b	2412~2462	2.00	1.58	21.0	125.89	20	0.0397	1.0
802.11g		2.00	1.58	16.0	39.81	20	0.0126	1.0
802.11n-HT20		2.00	1.58	15.0	31.62	20	0.0100	1.0

Note: The target output power were declared by the manufacturer.

Result: The device meet FCC MPE at 20 cm distance.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

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. 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 replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has an internal integrated antenna for Wi-Fi and the antenna gain is 2dBi, which uses a unique coupling to the intentional radiator, fulfill the requirement of this section. Please refer to the EUT photos.

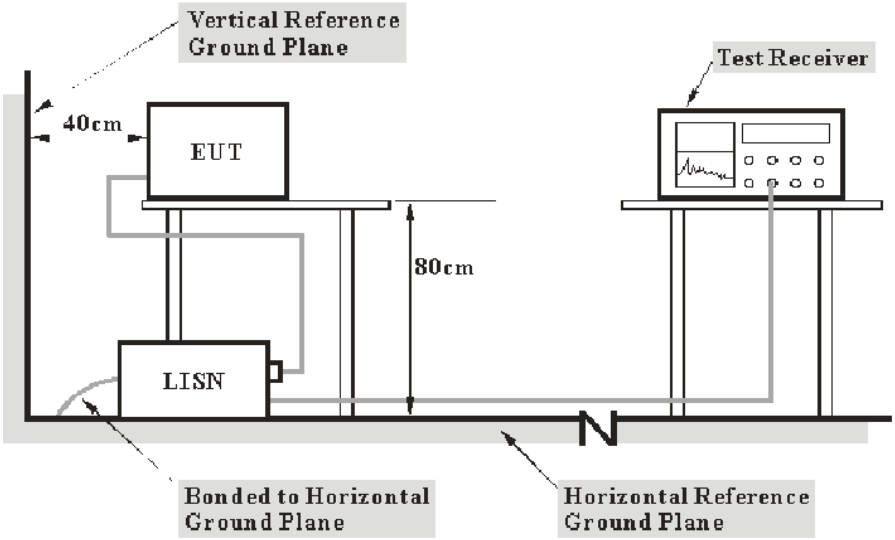
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

ANSI C63.10-2013 clause 6.2

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Limit –Reading

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

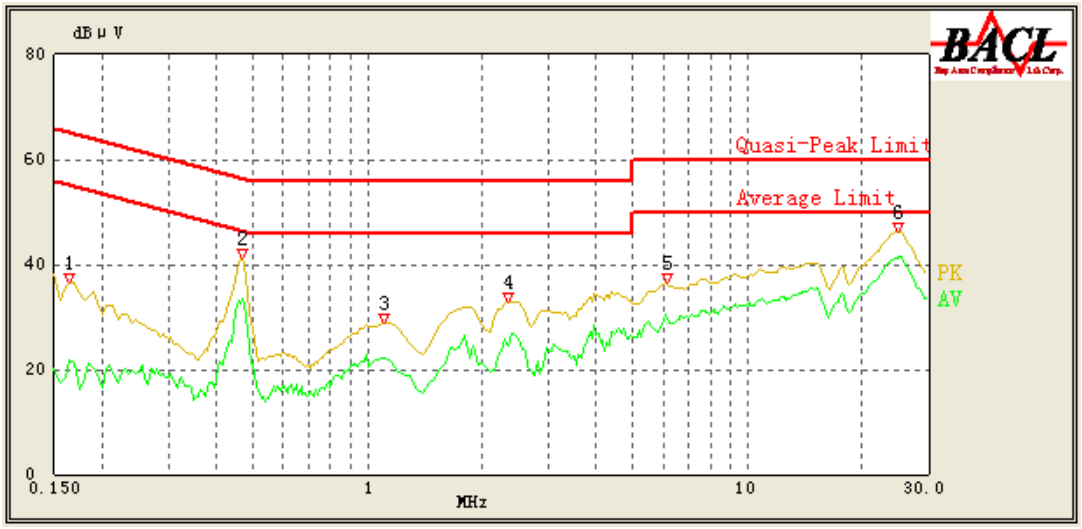
Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.1 kPa

The testing was performed by Mark Yu on 2018-04-27.

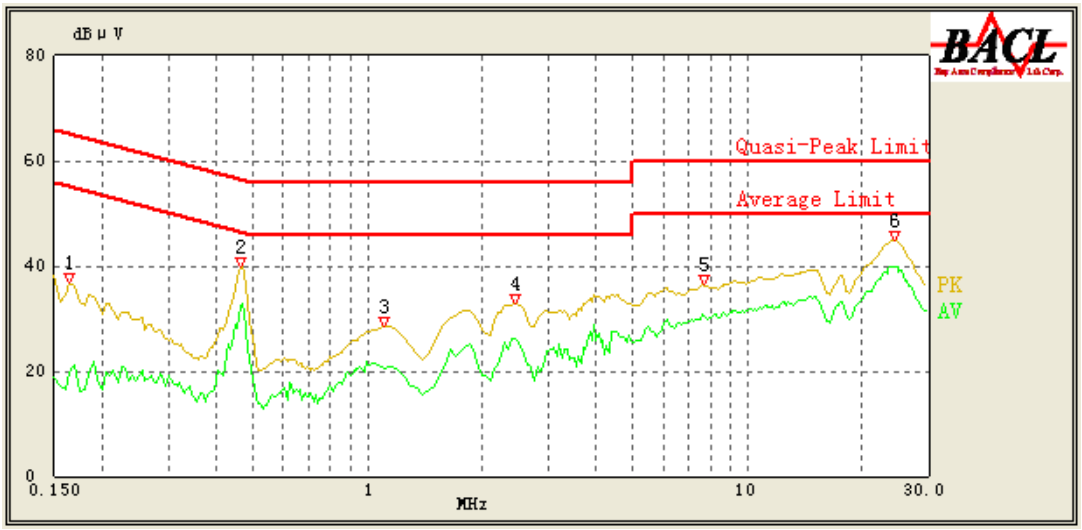
EUT operation mode: Transmitting in 802.11b mode middle channel (worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	Reading (dBμV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Comment
0.165	36.58	QP	9.000	L1	16.06	65.57	28.99	Compliance
0.165	21.83	AV	9.000	L1	16.06	55.57	33.74	Compliance
0.470	41.19	QP	9.000	L1	16.10	56.86	15.67	Compliance
0.470	33.66	AV	9.000	L1	16.10	46.86	13.20	Compliance
1.100	29.00	QP	9.000	L1	15.94	56.00	27.00	Compliance
1.100	22.03	AV	9.000	L1	15.94	46.00	23.97	Compliance
2.350	32.92	QP	9.000	L1	15.91	56.00	23.08	Compliance
2.350	24.51	AV	9.000	L1	15.91	46.00	21.49	Compliance
6.150	36.37	QP	9.000	L1	15.90	60.00	23.63	Compliance
6.150	29.91	AV	9.000	L1	15.90	50.00	20.09	Compliance
24.950	46.32	QP	9.000	L1	16.24	60.00	13.68	Compliance
24.950	41.42	AV	9.000	L1	16.24	50.00	8.58	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	Reading (dBμV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Comment
0.165	36.79	QP	9.000	N	16.06	65.57	28.78	Compliance
0.165	19.90	AV	9.000	N	16.06	55.57	35.67	Compliance
0.465	39.87	QP	9.000	N	16.10	57.00	17.13	Compliance
0.465	32.59	AV	9.000	N	16.10	47.00	14.41	Compliance
1.100	28.44	QP	9.000	N	15.94	56.00	27.56	Compliance
1.100	20.59	AV	9.000	N	15.94	46.00	25.41	Compliance
2.450	32.98	QP	9.000	N	15.90	56.00	23.02	Compliance
2.450	26.06	AV	9.000	N	15.90	46.00	19.94	Compliance
7.650	36.50	QP	9.000	N	15.94	60.00	23.50	Compliance
7.650	30.80	AV	9.000	N	15.93	50.00	19.20	Compliance
24.300	44.86	QP	9.000	N	16.23	60.00	15.14	Compliance
24.300	39.98	AV	9.000	N	16.23	50.00	10.02	Compliance

Note:
1) Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation
2) Margin = Limit – Reading

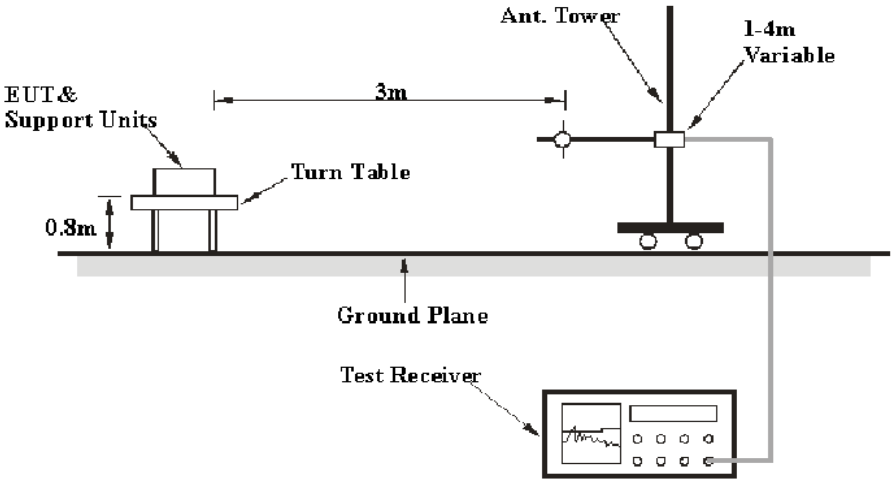
FCC §15.209, §15.205 & §15.247(D) - SPURIOUS EMISSIONS & RESTRICTED FREQUENCY BANDS

Applicable Standard

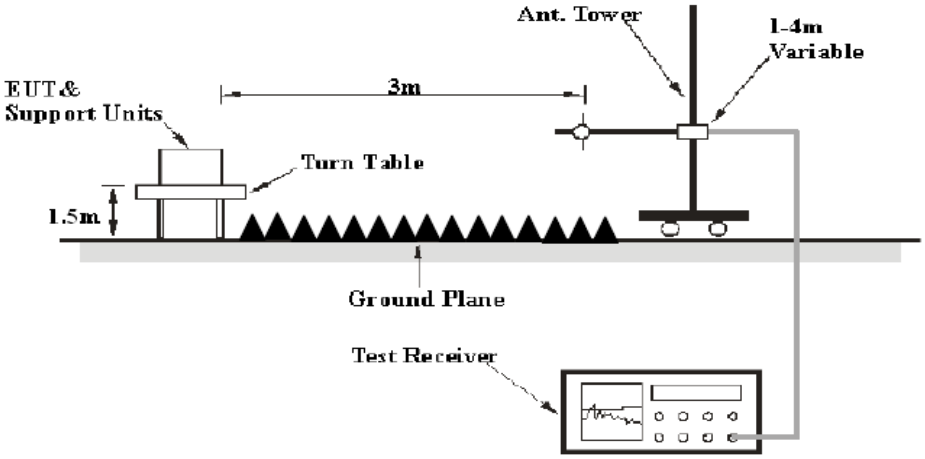
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	PK
	1MHz	3 MHz	/	Ave

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 12.1 and 12.2. and ANSI C63.10-2013 clause 6.5, 6.6 and 6.7.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

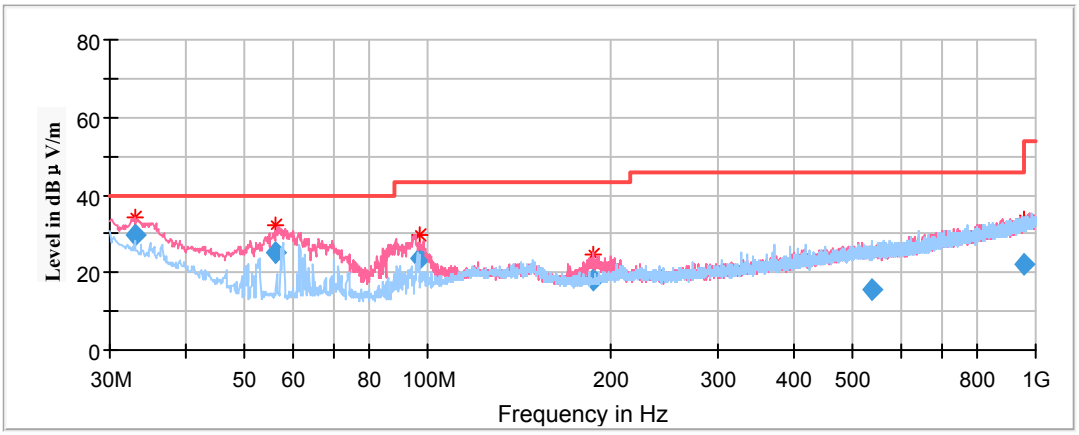
The testing was performed by Mark Yu from 2018-04-07 to 2018-05-08.

EUT operation mode: Transmitting

Spurious Emission Test:

30MHz-1GHz:

Pre-scan with 802.11b, 802.11g and 802.11n-HT20 modes of operation in the X,Y and Z axes of orientation, the worst case ***802.11b mode(middle channel:2437MHz) in X-axis of orientation*** *was recorded*



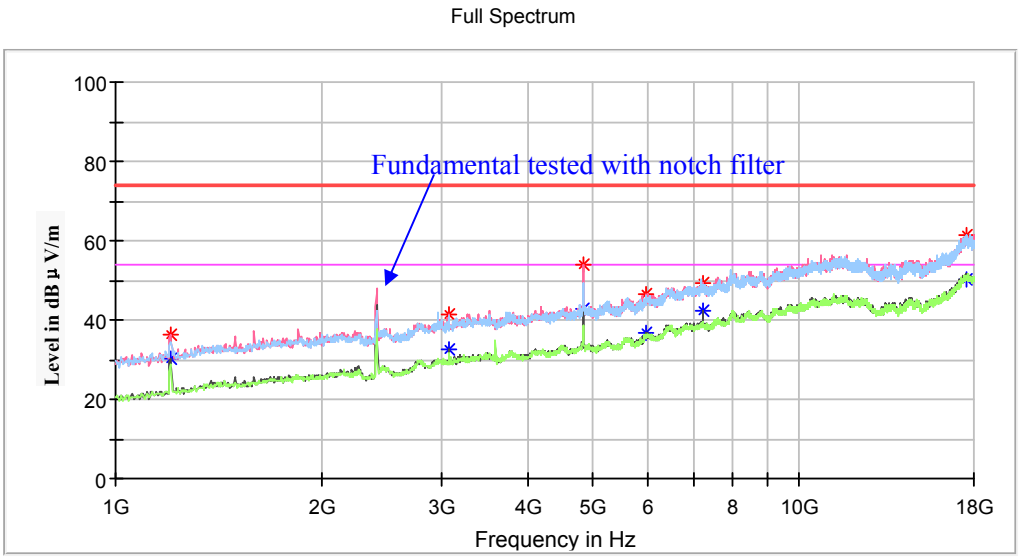
Frequency (MHz)	Corrected Amplitude QuasiPeak (dBµV/m)	Rx Antenna Height (cm)	Rx Antenna Polar (H/V)	Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
33.112800	34.10	100.0	V	103.0	-6.4	40.00	5.90
56.264250	32.03	100.0	V	150.0	-18.2	40.00	7.97
96.992600	29.75	100.0	V	0.0	-15.8	43.50	13.75
187.097750	24.82	100.0	V	21.0	-13.6	43.50	18.68
536.990500	25.87	100.0	H	118.0	-5.9	46.00	20.13
954.527300	33.49	100.0	H	347.0	1.3	46.00	12.51

1GHz-18GHz:

802.11b Mode:
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded)*

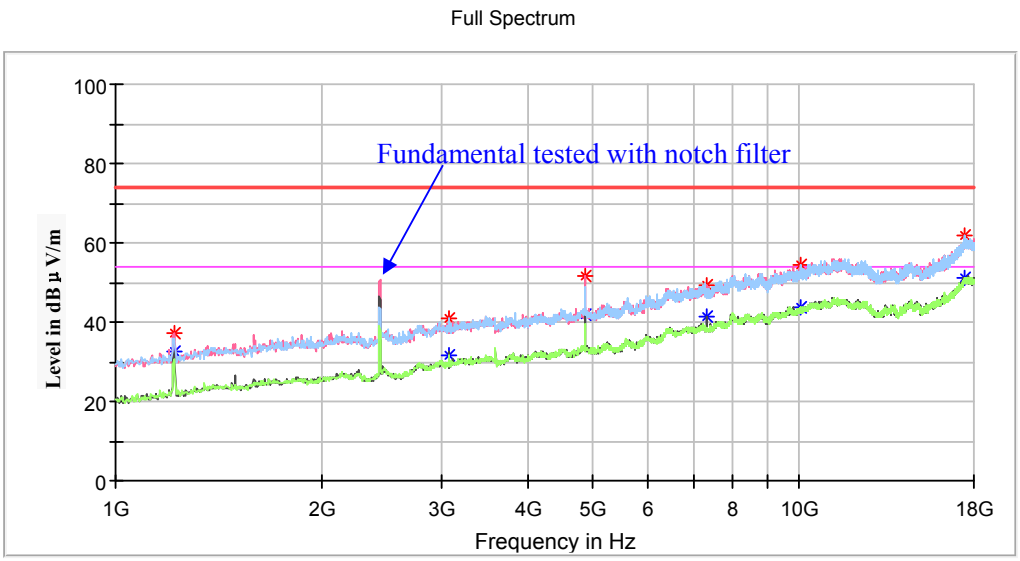
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

Low Channel: 2412MHz



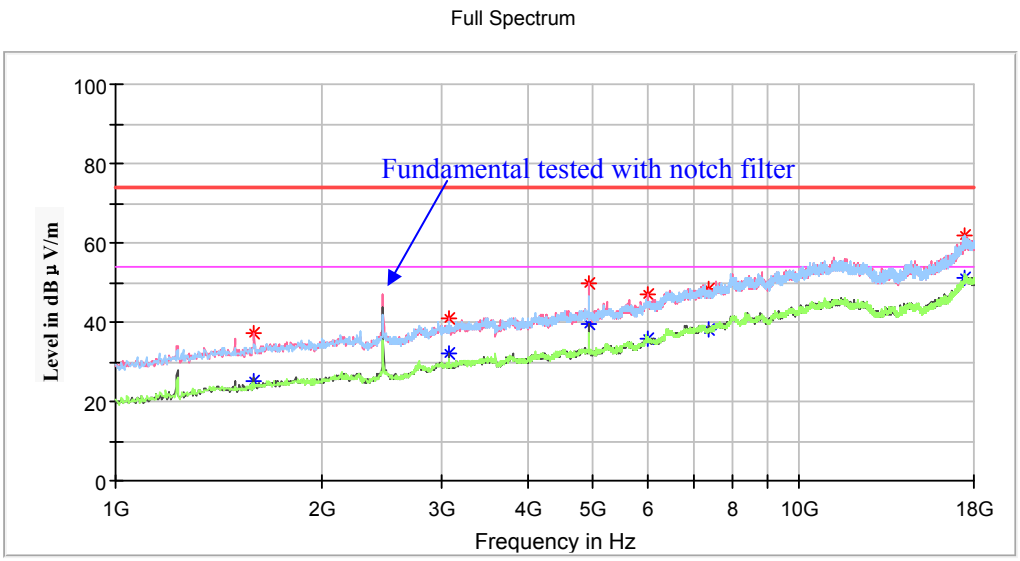
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1204.000000	---	30.20	100.0	V	34.0	-10.3	54.00	23.80
1204.000000	36.20	---	100.0	V	34.0	-10.3	74.00	37.80
3070.600000	---	32.57	100.0	V	108.0	-1.9	54.00	21.43
3070.600000	41.51	---	100.0	V	108.0	-1.9	74.00	32.49
4824.000000	---	42.62	250.0	V	123.0	2.5	54.00	11.38
4824.000000	53.87	---	250.0	V	123.0	2.5	74.00	20.13
5981.000000	---	36.55	100.0	V	238.0	5.6	54.00	17.45
5984.400000	46.65	---	100.0	V	238.0	5.6	74.00	27.35
7236.000000	---	42.14	250.0	V	212.0	9.8	54.00	11.86
7236.000000	49.32	---	250.0	V	212.0	9.8	74.00	24.68
17547.800000	---	50.35	150.0	H	148.0	23.7	54.00	3.65
17547.800000	61.57	---	150.0	H	148.0	23.7	74.00	12.43

Middle Channel: 2437MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1217.600000	37.16	---	200.0	V	323.0	-10.2	74.00	36.84
1217.600000	---	32.47	200.0	V	323.0	-10.2	54.00	21.53
3070.600000	41.10	---	150.0	H	262.0	-1.9	74.00	32.90
3070.600000	---	31.73	150.0	H	262.0	-1.9	54.00	22.27
4874.000000	51.71	---	100.0	V	197.0	2.6	74.00	22.29
4874.000000	---	41.70	100.0	V	197.0	2.6	54.00	12.30
7311.000000	49.49	---	200.0	V	169.0	10.0	74.00	24.51
7311.000000	---	41.52	200.0	V	169.0	10.0	54.00	12.48
10047.400000	---	43.62	100.0	H	150.0	15.1	54.00	10.38
10047.400000	54.63	---	100.0	H	150.0	15.1	74.00	19.37
17459.400000	62.02	---	250.0	H	67.0	23.5	74.00	11.98
17459.400000	---	51.37	250.0	H	67.0	23.5	54.00	2.63

High Channel: 2462MHz

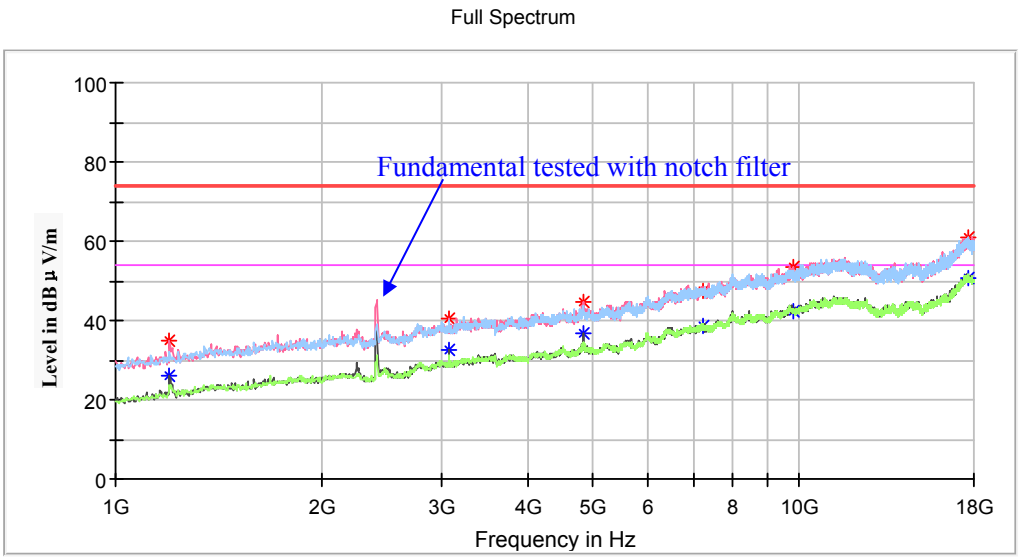


Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1595.000000	---	25.31	100.0	V	78.0	-7.6	54.00	28.69
1595.000000	37.14	---	100.0	V	78.0	-7.6	74.00	36.86
3070.600000	---	31.90	100.0	V	334.0	-1.9	54.00	22.10
3070.600000	41.15	---	100.0	V	334.0	-1.9	74.00	32.85
4924.000000	---	39.53	250.0	V	181.0	2.7	54.00	14.47
4924.000000	49.55	---	250.0	V	181.0	2.7	74.00	24.45
5998.000000	---	35.82	100.0	V	290.0	5.7	54.00	18.18
5998.000000	46.80	---	100.0	V	290.0	5.7	74.00	27.20
7386.000000	---	37.95	200.0	V	245.0	10.1	54.00	16.05
7386.000000	48.31	---	200.0	V	245.0	10.1	74.00	25.69
17445.800000	---	51.04	100.0	H	172.0	23.4	54.00	2.96
17445.800000	61.72	---	100.0	H	172.0	23.4	74.00	12.28

802.11g Mode:
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded)*

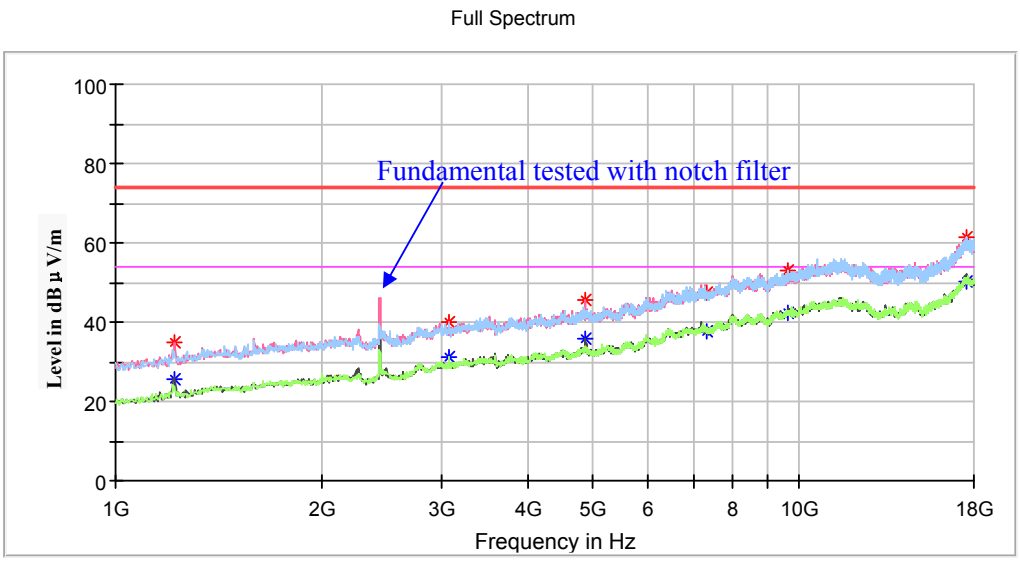
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

Low Channel: 2412MHz



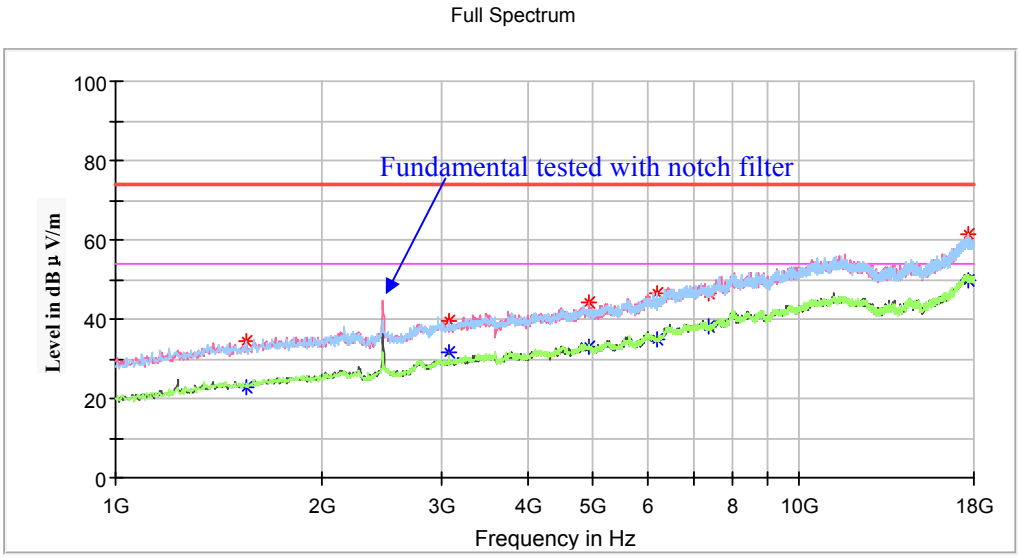
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1200.600000	---	26.16	100.0	V	333.0	-10.4	54.00	27.84
1200.600000	35.00	---	100.0	V	333.0	-10.4	74.00	39.00
3070.600000	---	32.40	100.0	V	166.0	-1.9	54.00	21.60
3070.600000	40.33	---	100.0	V	166.0	-1.9	74.00	33.67
4824.000000	---	36.70	250.0	V	223.0	2.5	54.00	17.30
4824.000000	44.55	---	250.0	V	223.0	2.5	74.00	29.45
7236.000000	---	38.73	100.0	V	213.0	9.8	54.00	15.27
7236.000000	47.53	---	100.0	V	213.0	9.8	74.00	26.47
9816.200000	---	42.38	250.0	V	358.0	14.9	54.00	11.62
9816.200000	53.66	---	250.0	V	358.0	14.9	74.00	20.34
17660.000000	---	50.72	150.0	V	212.0	23.6	54.00	3.28
17660.000000	61.02	---	150.0	V	212.0	23.6	74.00	12.98

Middle Channel: 2437MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1221.000000	---	25.43	200.0	V	40.0	-10.2	54.00	28.57
1221.000000	34.79	---	200.0	V	40.0	-10.2	74.00	39.21
3070.600000	---	31.15	100.0	V	145.0	-1.9	54.00	22.85
3070.600000	40.21	---	100.0	V	145.0	-1.9	74.00	33.79
4874.000000	---	35.85	100.0	V	92.0	2.6	54.00	18.15
4874.000000	45.56	---	100.0	V	92.0	2.6	74.00	28.44
7311.000000	---	37.70	250.0	V	27.0	10.0	54.00	16.30
7311.000000	47.59	---	250.0	V	27.0	10.0	74.00	26.41
9629.200000	---	42.27	150.0	H	46.0	14.9	54.00	11.73
9629.200000	53.22	---	150.0	H	46.0	14.9	74.00	20.78
17517.200000	---	50.17	250.0	H	120.0	23.7	54.00	3.83
17517.200000	61.62	---	250.0	H	120.0	23.7	74.00	12.38

High Channel: 2462MHz

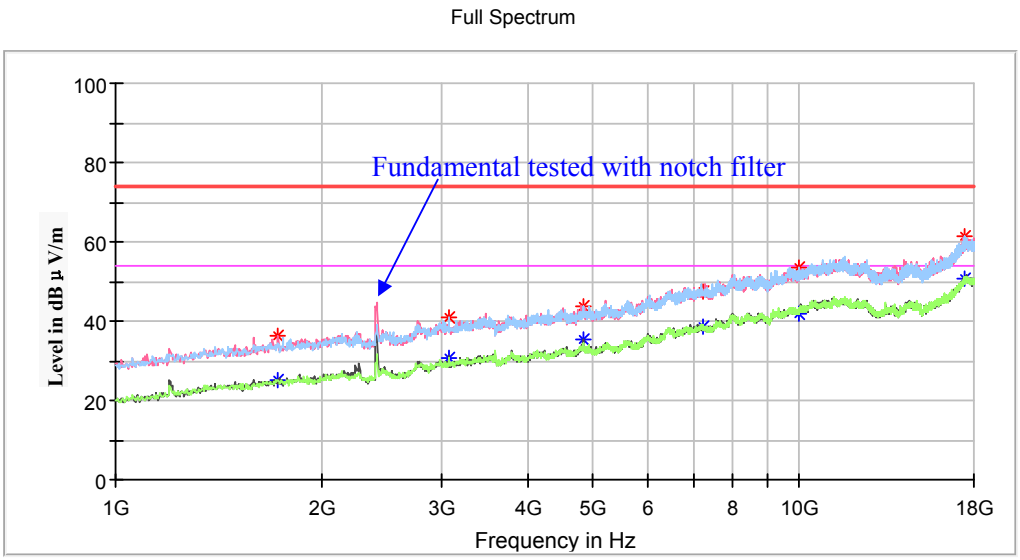


Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1550.800000	34.54	---	150.0	H	218.0	-7.8	74.00	39.46
1550.800000	---	22.92	150.0	H	218.0	-7.8	54.00	31.08
3070.600000	---	31.42	100.0	V	26.0	-1.9	54.00	22.58
3070.600000	39.52	---	100.0	V	26.0	-1.9	74.00	34.48
4924.000000	44.12	---	250.0	V	258.0	2.8	74.00	29.88
4924.000000	---	33.25	250.0	V	258.0	2.8	54.00	20.75
6188.400000	---	34.70	100.0	H	320.0	6.7	54.00	19.30
6188.400000	46.55	---	100.0	H	320.0	6.7	74.00	27.45
7386.000000	---	38.08	250.0	V	273.0	10.1	54.00	15.92
7386.000000	46.74	---	250.0	V	273.0	10.1	74.00	27.26
17660.000000	---	49.97	100.0	H	64.0	23.6	54.00	4.03
17660.000000	61.34	---	100.0	H	64.0	23.6	74.00	12.66

802.11n-HT20 Mode:
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded)*

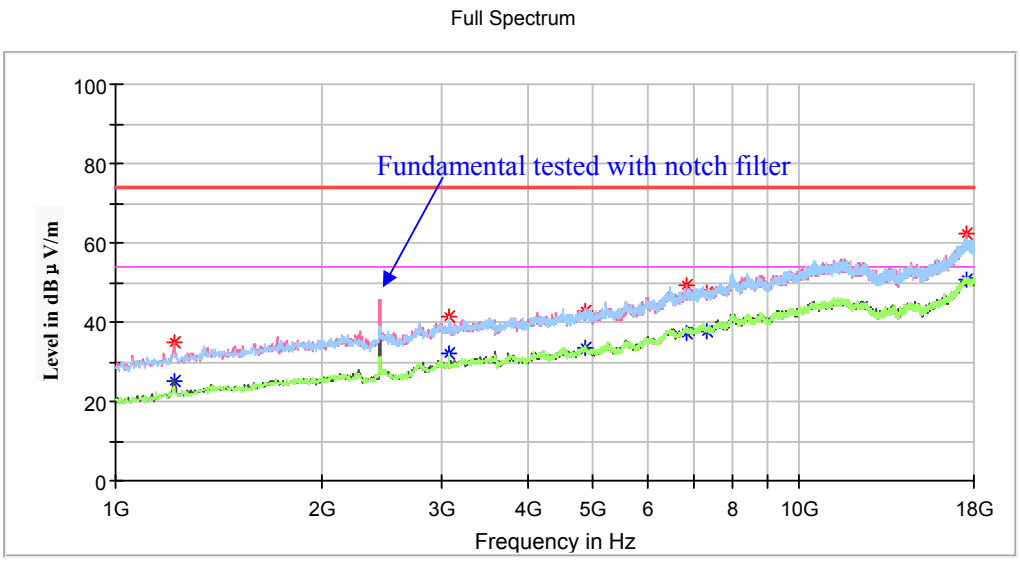
Note:
1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

Low Channel: 2412MHz



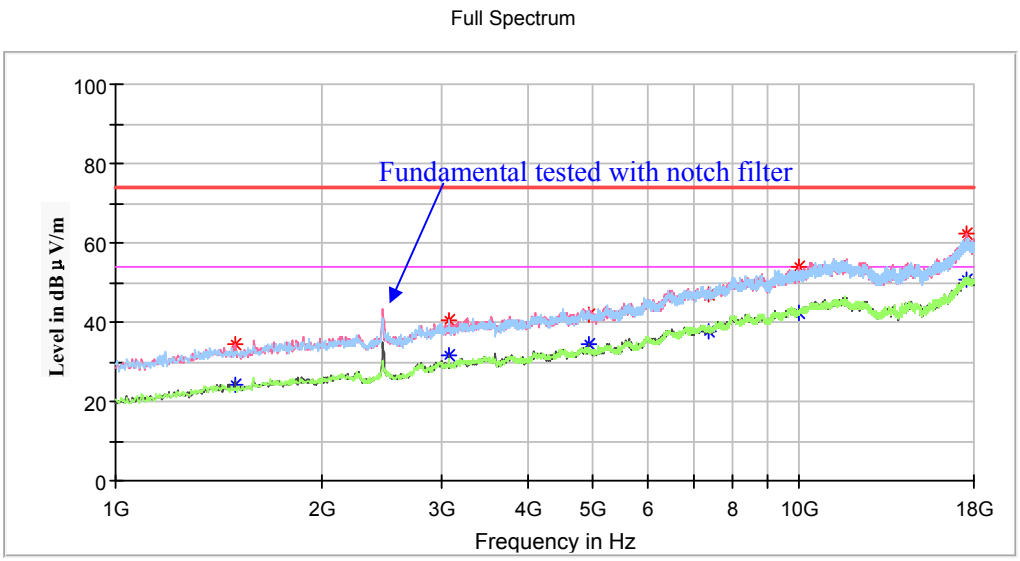
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1731.000000	---	25.31	100.0	V	216.0	-7.0	54.00	28.69
1731.000000	36.51	---	100.0	V	216.0	-7.0	74.00	37.49
3070.600000	---	30.83	100.0	H	132.0	-1.9	54.00	23.17
3070.600000	40.87	---	100.0	H	132.0	-1.9	74.00	33.13
4824.000000	---	35.32	200.0	V	199.0	2.5	54.00	18.68
4824.000000	43.89	---	200.0	V	199.0	2.5	74.00	30.11
7236.000000	---	38.47	100.0	V	190.0	9.8	54.00	15.53
7236.000000	47.40	---	100.0	V	190.0	9.8	74.00	26.60
9962.400000	---	41.82	200.0	V	106.0	14.9	54.00	12.18
9962.400000	53.54	---	200.0	V	106.0	14.9	74.00	20.46
17445.800000	---	50.48	100.0	H	201.0	23.4	54.00	3.52
17445.800000	61.51	---	100.0	H	201.0	23.4	74.00	12.49

Middle Channel: 2437MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1217.600000	34.80	---	100.0	V	215.0	-10.2	74.00	39.20
1217.600000	---	25.18	100.0	V	215.0	-10.2	54.00	28.82
3070.600000	41.53	---	100.0	H	353.0	-1.9	74.00	32.47
3070.600000	---	31.94	100.0	H	353.0	-1.9	54.00	22.06
4874.000000	43.02	---	200.0	V	155.0	2.6	74.00	30.98
4874.000000	---	33.64	200.0	V	155.0	2.6	54.00	20.36
6844.600000	---	37.33	100.0	V	327.0	9.1	54.00	16.67
6844.600000	49.52	---	100.0	V	327.0	9.1	74.00	24.48
7311.000000	---	37.59	200.0	V	66.0	10.0	54.00	16.41
7311.000000	47.37	---	200.0	V	66.0	10.0	74.00	26.63
17527.400000	---	50.47	100.0	V	61.0	23.7	54.00	3.53
17527.400000	62.13	---	100.0	V	61.0	23.7	74.00	11.87

High Channel: 2462MHz

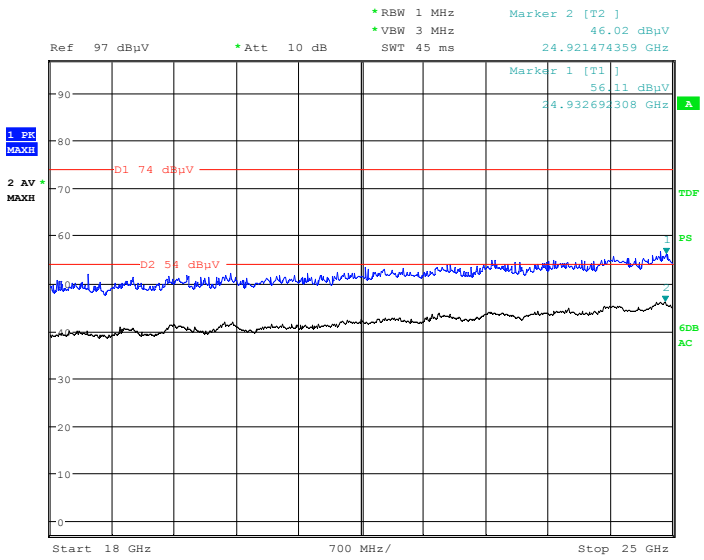


Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1493.000000	34.49	---	150.0	V	193.0	-8.1	74.00	39.51
1493.000000	---	24.14	150.0	V	193.0	-8.1	54.00	29.86
3070.600000	40.49	---	200.0	V	87.0	-1.9	74.00	33.51
3070.600000	---	31.65	200.0	V	87.0	-1.9	54.00	22.35
4924.000000	41.66	---	150.0	V	193.0	2.7	74.00	32.34
4924.000000	---	34.19	150.0	V	193.0	2.7	54.00	19.81
7386.000000	---	37.62	200.0	V	51.0	10.1	54.00	16.38
7386.000000	47.07	---	200.0	V	51.0	10.1	74.00	26.93
9993.000000	---	42.28	200.0	V	21.0	14.9	54.00	11.72
9993.000000	53.85	---	200.0	V	21.0	14.9	74.00	20.15
17581.800000	---	50.73	200.0	H	33.0	23.7	54.00	3.27
17581.800000	62.10	---	200.0	H	33.0	23.7	74.00	11.90

18GHz-25GHz:

*Pre-scan with 802.11b, 802.11g and 802.11n-HT20 modes of operation in the X,Y and Z axes of orientation, the worst case **802.11b mode(middle channel:2437MHz) in X-axis of orientation** was recorded*

Horizontal



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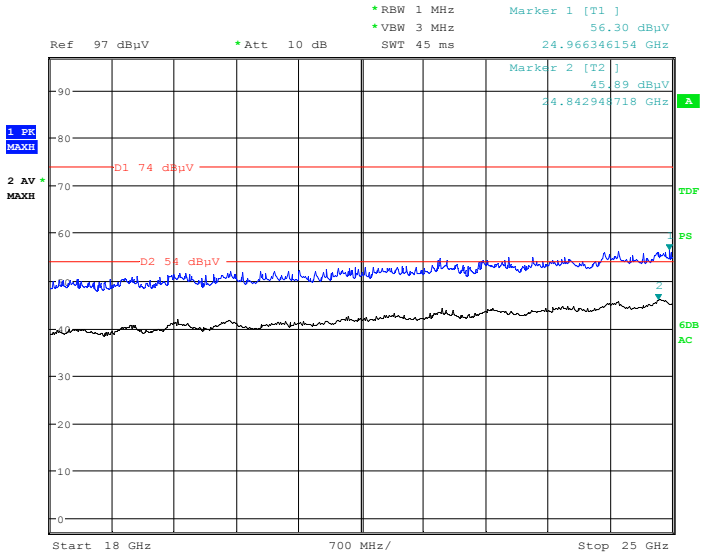
Vertical



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Fundamental Test & Restricted Bands Emissions Test:

Note:
1. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
2.Corrected Amplitude = Corrected Factor + Reading
3.Margin = Limit - Corrected. Amplitude

802.11b Mode: *(Pre-scan in the X,Y and Z axes of orientation, the worst case* ***X-axis of orientation*** *was recorded)*

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	107.79	---	166.0	V	23.0	5.1	/	/
2412.000000	---	105.06	166.0	V	23.0	5.1	/	/
2412.000000	105.64	---	214.0	H	302.0	5.1	/	/
2412.000000	---	102.92	214.0	H	302.0	5.1	/	/
2390.000000	---	50.19	250.0	V	83.0	5.1	54.00	3.81
2390.000000	58.58	---	250.0	V	83.0	5.1	74.00	15.42
Middle Channel: 2437MHz								
2437.000000	106.56	---	231.0	V	119.0	5.2	/	/
2437.000000	---	103.87	231.0	V	119.0	5.2	/	/
2437.000000	104.44	---	206.0	H	162.0	5.2	/	/
2437.000000	---	101.74	206.0	H	162.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	107.37	---	224.0	V	82.0	5.2	/	/
2462.000000	---	104.38	224.0	V	82.0	5.2	/	/
2462.000000	105.21	---	190.0	H	95.0	5.2	/	/
2462.000000	---	102.27	190.0	H	95.0	5.2	/	/
2483.500000	59.91	---	169.0	V	141.0	5.3	74.00	14.09
2483.500000	---	50.19	169.0	V	141.0	5.3	54.00	3.81

802.11g Mode: *(Pre-scan in the X,Y and Z axes of orientation, the worst case* ***X-axis of orientation*** *was recorded)*

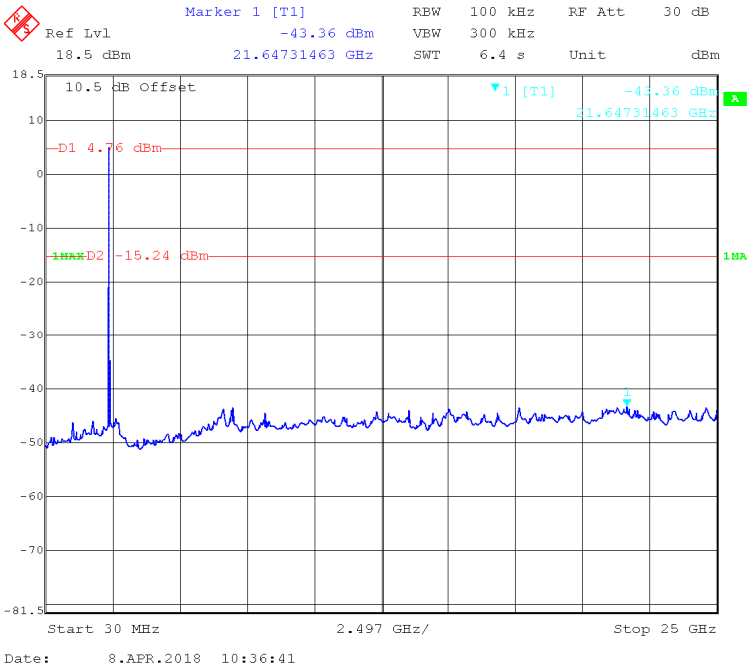
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	99.11	---	244.0	V	152.0	5.1	/	/
2412.000000	---	90.79	244.0	V	152.0	5.1	/	/
2412.000000	97.00	---	205.0	H	236.0	5.1	/	/
2412.000000	---	88.70	205.0	H	236.0	5.1	/	/
2390.000000	---	43.89	199.0	V	247.0	5.1	54.00	10.11
2390.000000	52.21	---	199.0	V	247.0	5.1	74.00	21.79
Middle Channel: 2437MHz								
2437.000000	98.49	---	200.0	V	139.0	5.2	/	/
2437.000000	---	91.30	200.0	V	139.0	5.2	/	/
2437.000000	96.37	---	221.0	H	275.0	5.2	/	/
2437.000000	---	89.16	221.0	H	275.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	97.88	---	201.0	V	262.0	5.2	/	/
2462.000000	---	90.72	201.0	V	262.0	5.2	/	/
2462.000000	95.76	---	206.0	H	227.0	5.2	/	/
2462.000000	---	88.63	206.0	H	227.0	5.2	/	/
2483.500000	51.39	---	181.0	V	125.0	5.3	74.00	22.61
2483.500000	---	43.77	181.0	V	125.0	5.3	54.00	10.23

802.11n-HT20 Mode: *(Pre-scan in the X,Y and Z axes of orientation, the worst case* ***X-axis of orientation*** *was recorded)*

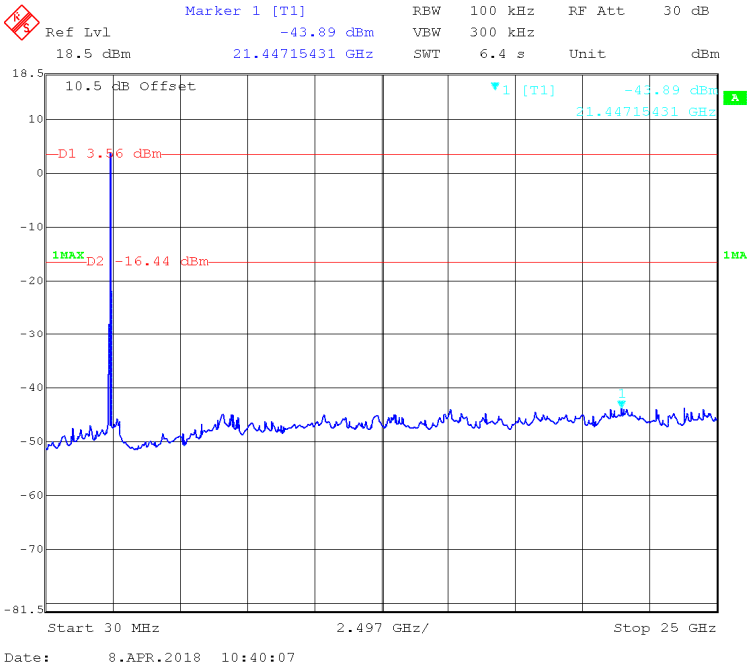
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	99.11	---	197.0	V	185.0	5.1	/	/
2412.000000	---	91.67	197.0	V	185.0	5.1	/	/
2412.000000	97.00	---	219.0	H	302.0	5.1	/	/
2412.000000	---	89.58	219.0	H	302.0	5.1	/	/
2390.000000	---	45.95	173.0	V	305.0	5.1	54.00	8.05
2390.000000	56.63	---	173.0	V	305.0	5.1	74.00	17.37
Middle Channel: 2437MHz								
2437.000000	97.99	---	250.0	V	39.0	5.2	/	/
2437.000000	---	90.24	250.0	V	39.0	5.2	/	/
2437.000000	95.87	---	236.0	H	355.0	5.2	/	/
2437.000000	---	88.09	236.0	H	355.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	99.76	---	196.0	V	186.0	5.2	/	/
2462.000000	---	91.87	196.0	V	186.0	5.2	/	/
2462.000000	97.63	---	181.0	H	27.0	5.2	/	/
2462.000000	---	89.78	181.0	H	27.0	5.2	/	/
2483.500000	55.99	---	210.0	V	29.0	5.3	74.00	18.01
2483.500000	---	46.07	210.0	V	29.0	5.3	54.00	7.93

Conducted Spurious Emissions at Antenna Port

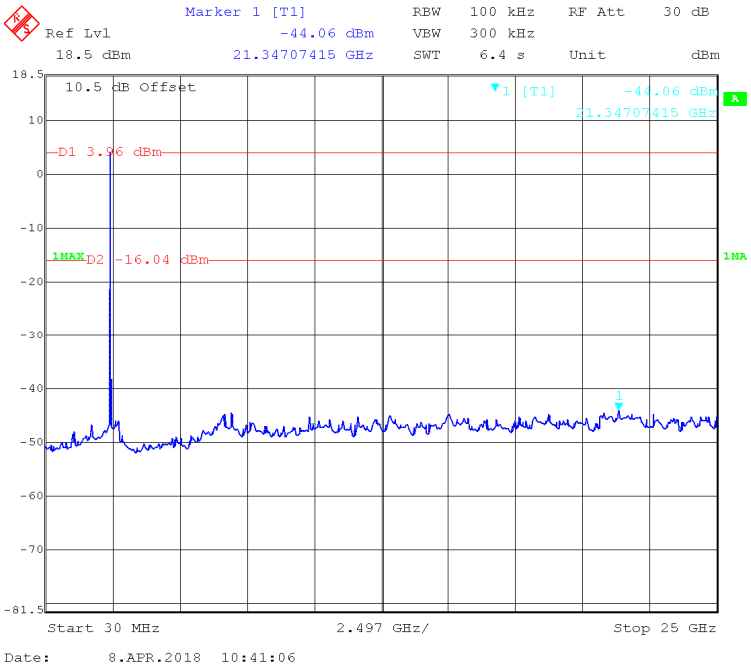
802.11b Low Channel



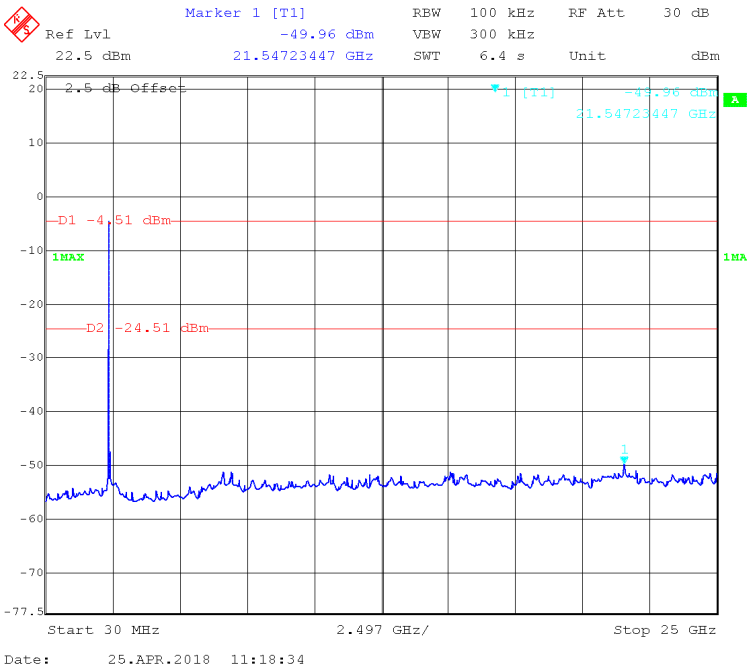
802.11b Middle Channel



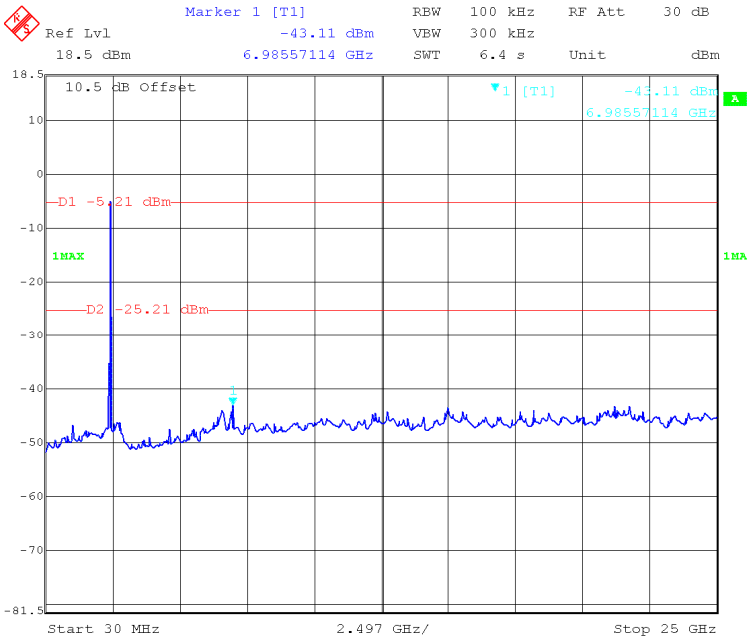
802.11b High Channel



802.11g Low Channel

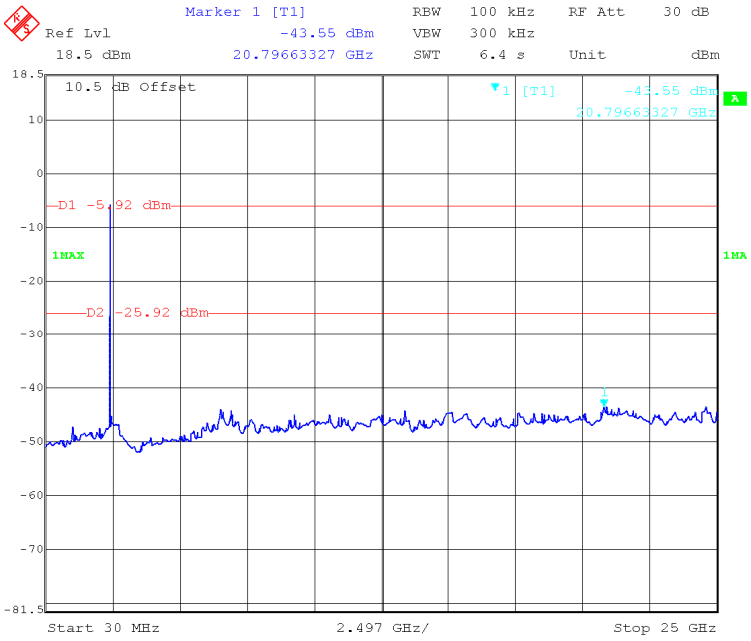


802.11g Middle Channel



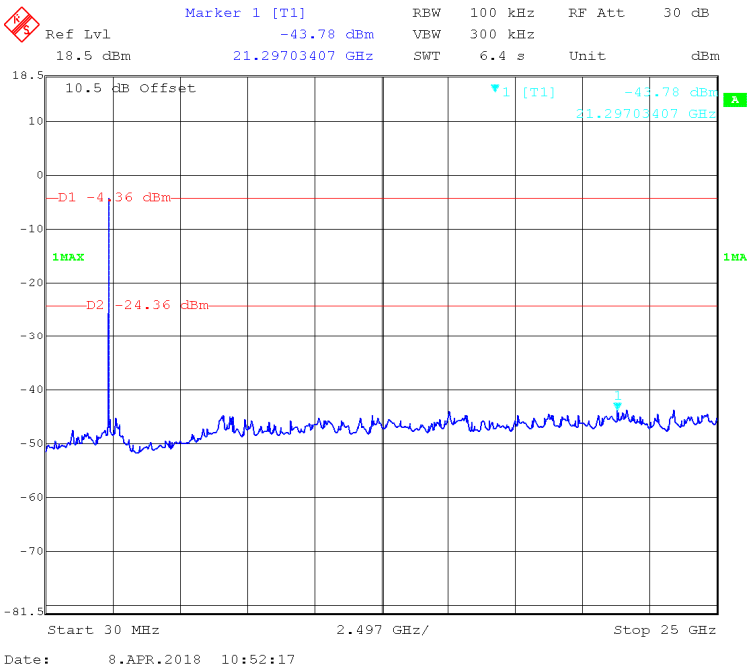
Date: 8.APR.2018 10:44:31

802.11g High Channel

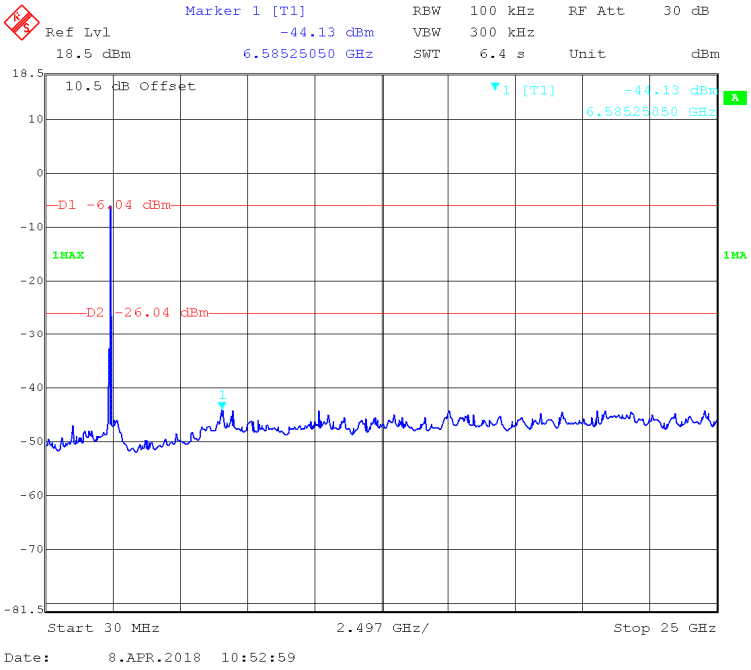


Date: 8.APR.2018 10:46:33

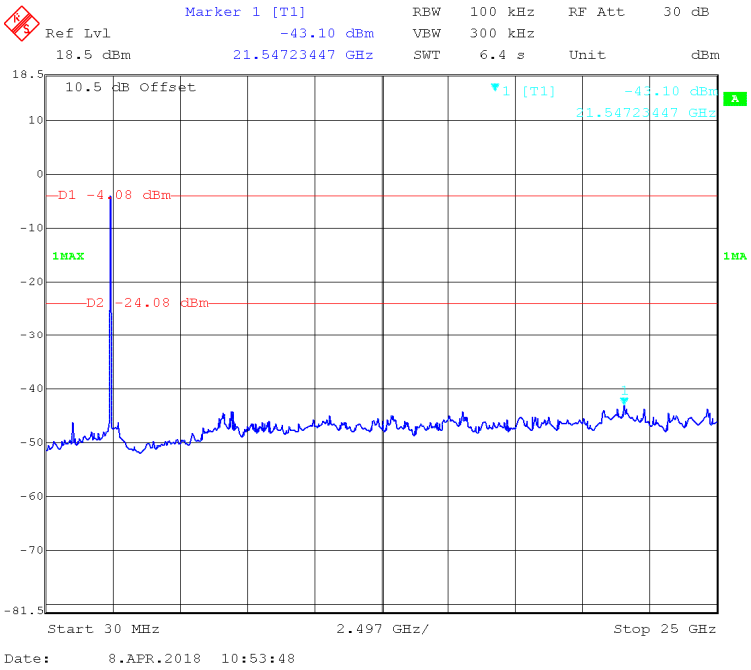
802.11n-HT20 Low Channel



802.11n-HT20 Middle Channel



802.11n-HT20 High Channel



FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

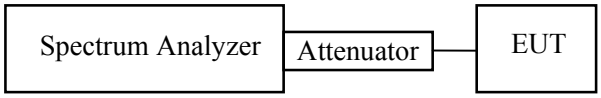
Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3xRBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.



Test Data

Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

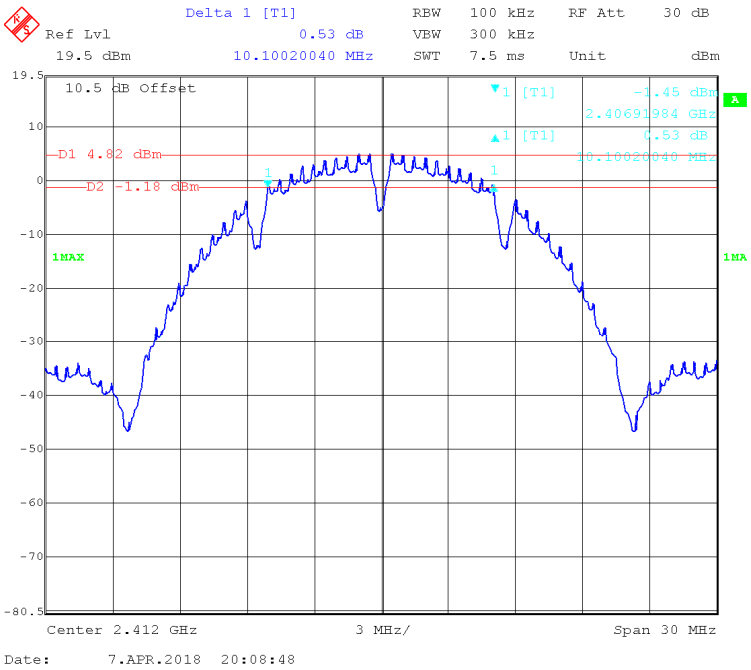
The testing was performed by Mark Yu on 2018-04-07& 2018-05-23.

Test Result: Pass.

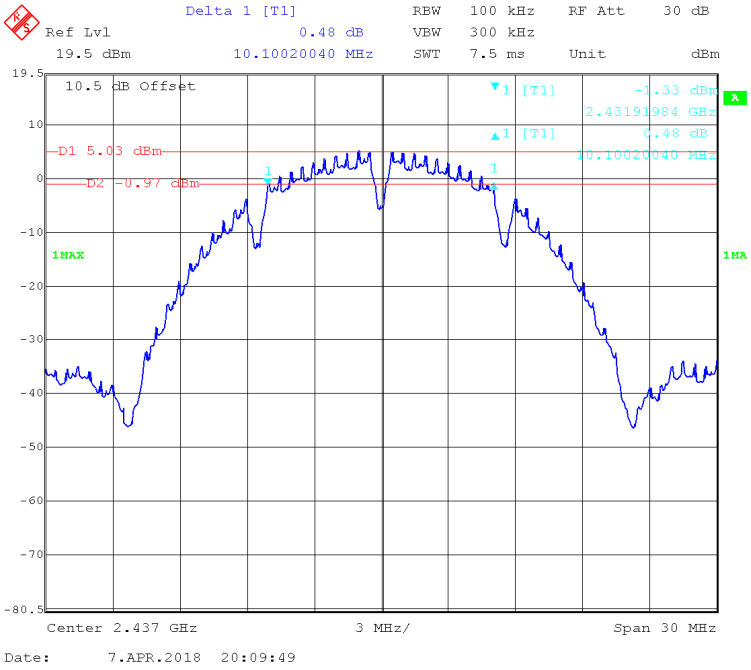
EUT operation mode: Transmitting

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
802.11b mode			
Low	2412	10.100	⩾0.5
Middle	2437	10.100	⩾0.5
High	2462	10.040	⩾0.5
802.11g mode			
Low	2412	16.413	⩾0.5
Middle	2437	16.423	⩾0.5
High	2462	16.413	⩾0.5
802.11n-HT20 mode			
Low	2412	17.315	⩾0.5
Middle	2437	17.435	⩾0.5
High	2462	17.375	⩾0.5

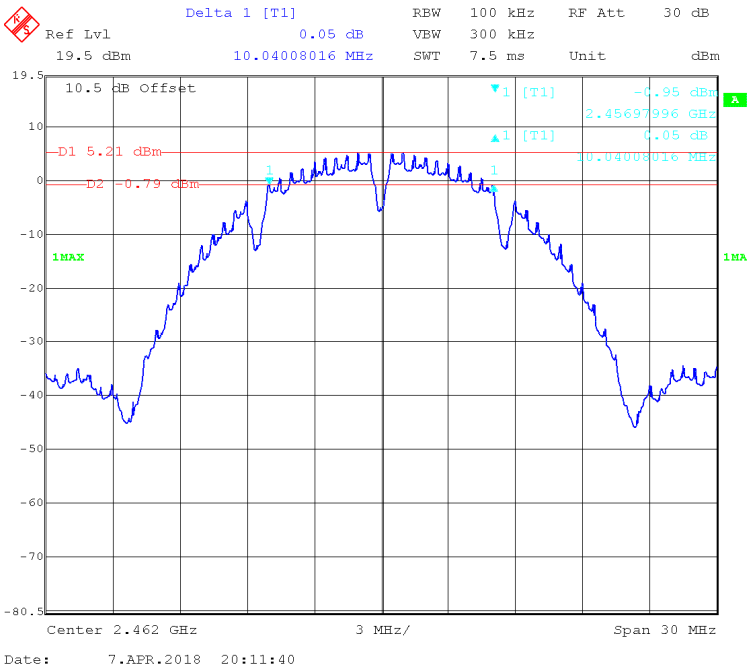
802.11b Low Channel



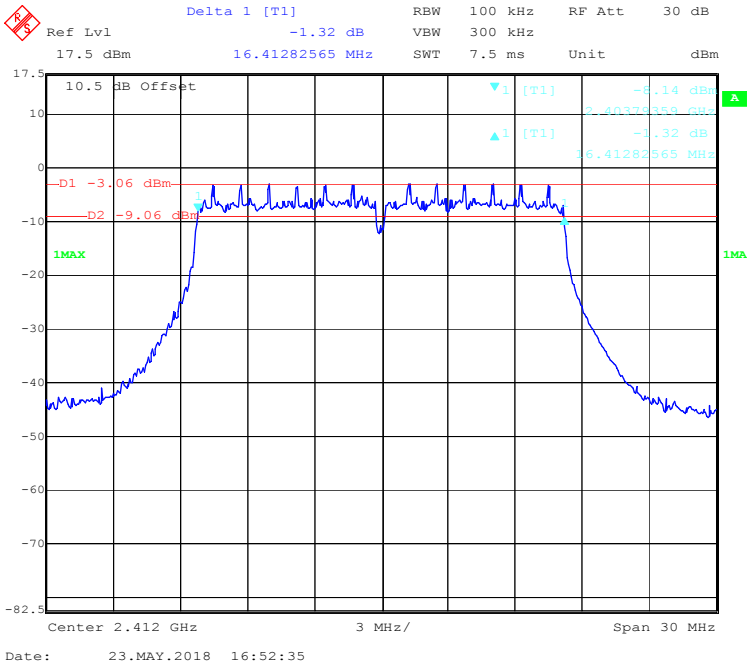
802.11b Middle Channel



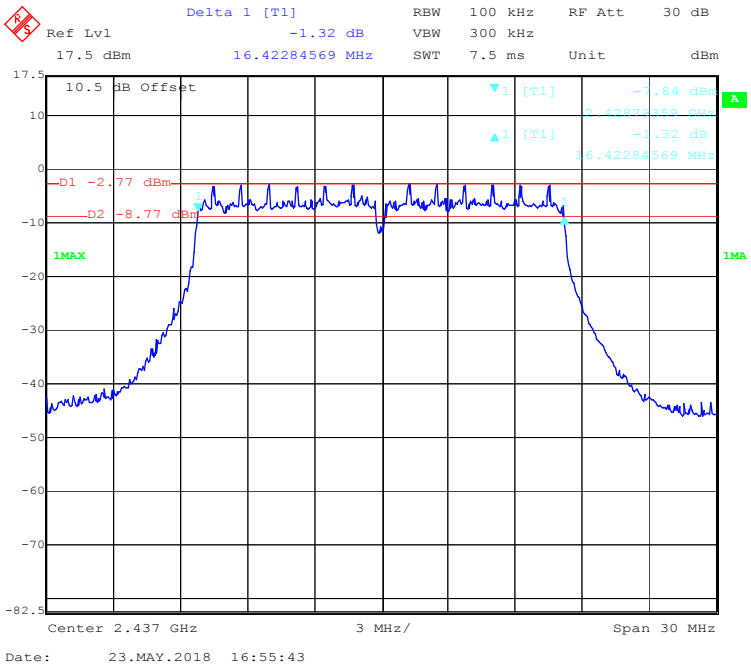
802.11b High Channel



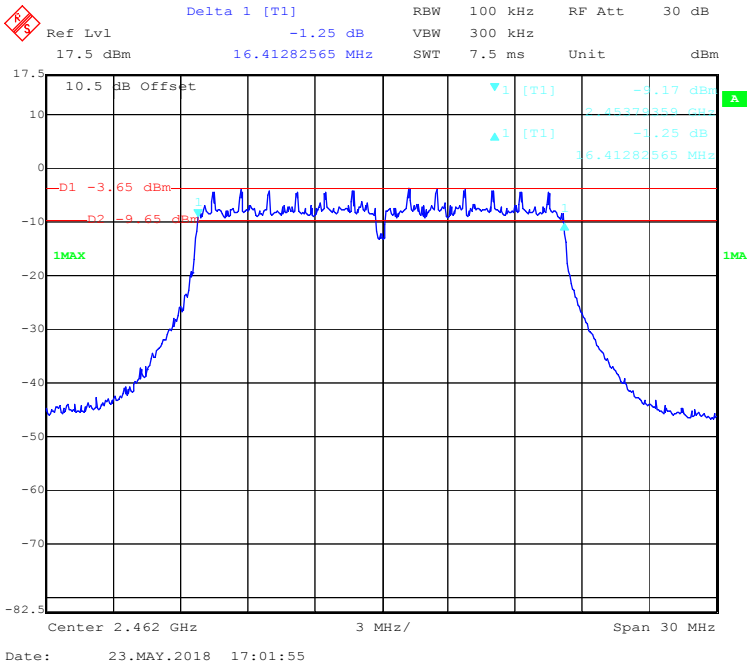
802.11g Low Channel



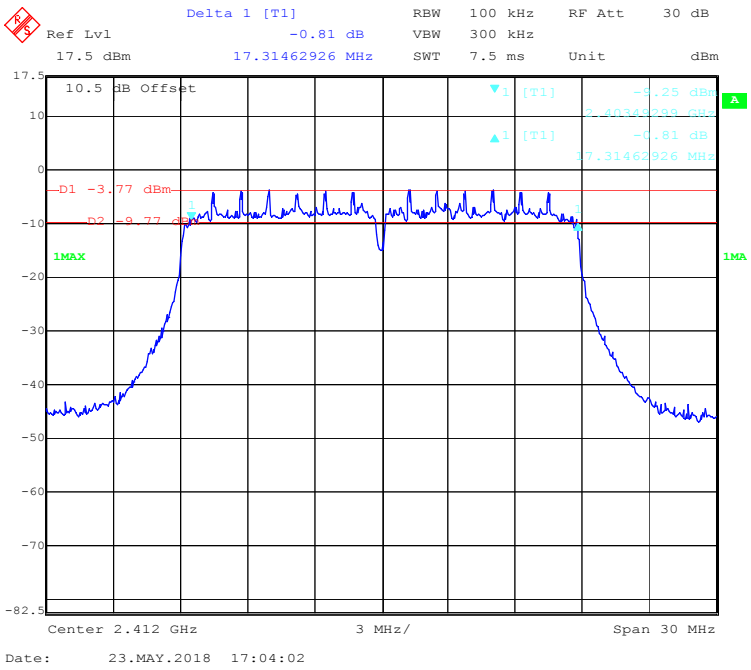
802.11g Middle Channel



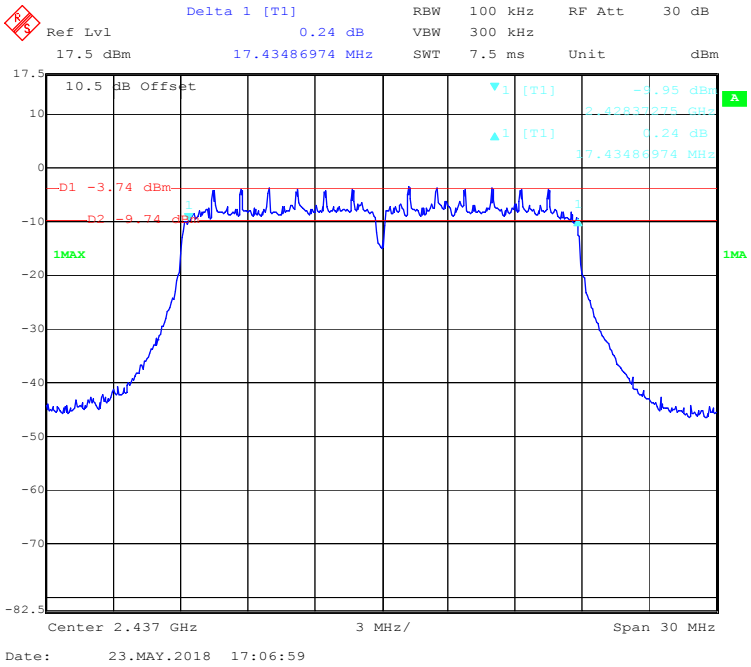
802.11g High Channel



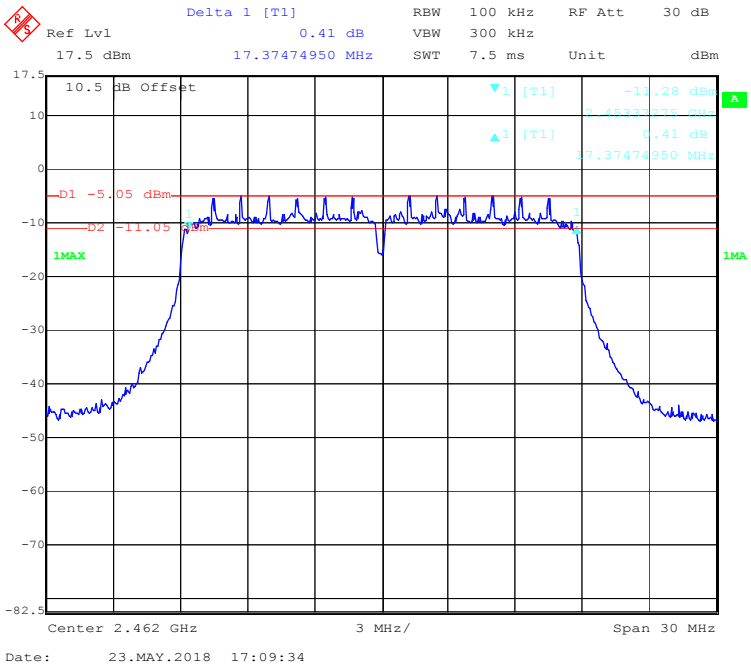
802.11n-HT20 Low Channel



802.11n-HT20 Middle Channel



802.11n-HT20 High Channel



FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

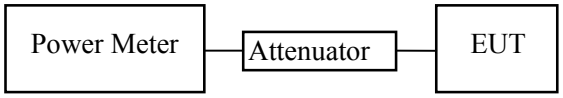
Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 9.1.3

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 use a fast-responding diode detector.



Test Data

Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Mark Yu on 2018-04-23.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
802.11b				
Low	2412	20.50	30	Pass
Middle	2437	20.68	30	Pass
High	2462	20.65	30	Pass
802.11g				
Low	2412	15.91	30	Pass
Middle	2437	15.42	30	Pass
High	2462	15.91	30	Pass
802.11n-HT20				
Low	2412	14.59	30	Pass
Middle	2437	14.71	30	Pass
High	2462	14.78	30	Pass

FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

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)).

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 13.2 and ANSI C63.10-2013 clause 6.10.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
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.

Test Data

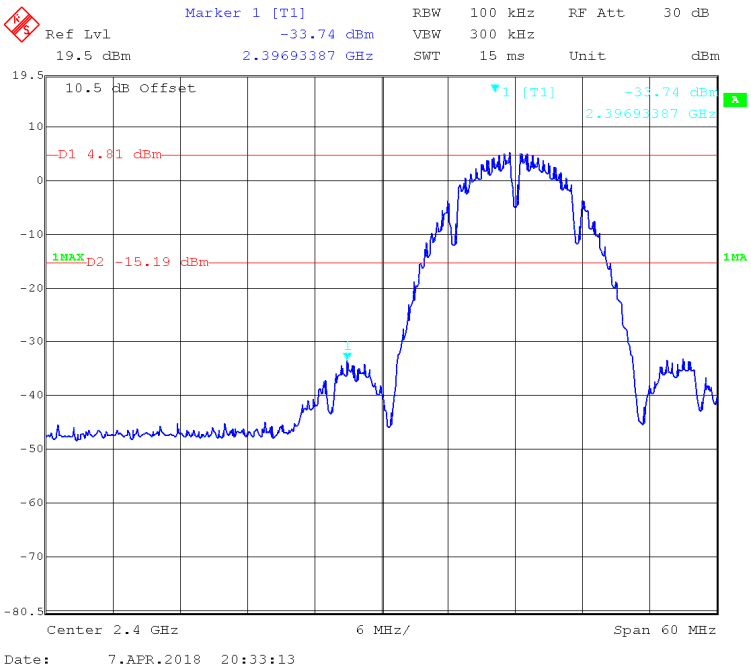
Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

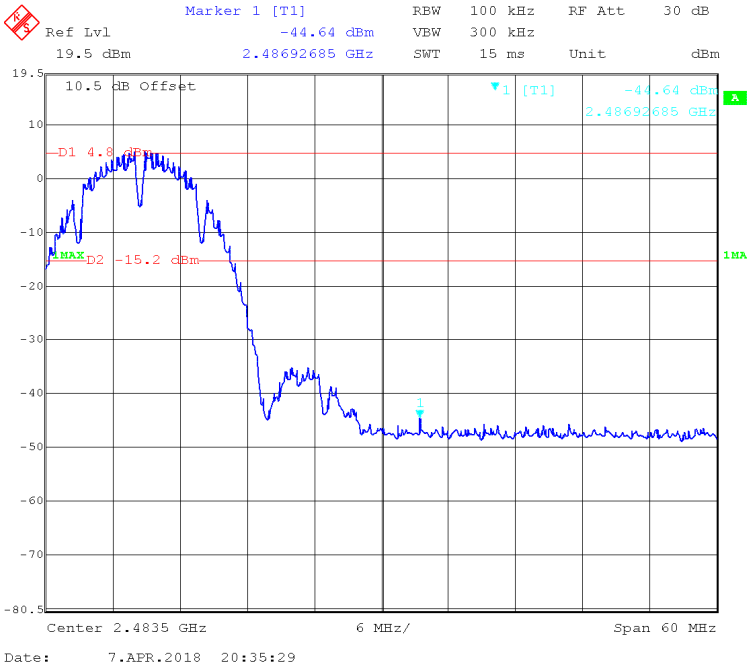
The testing was performed by Mark Yu on 2018-04-07.

Test Result: *Compliance*

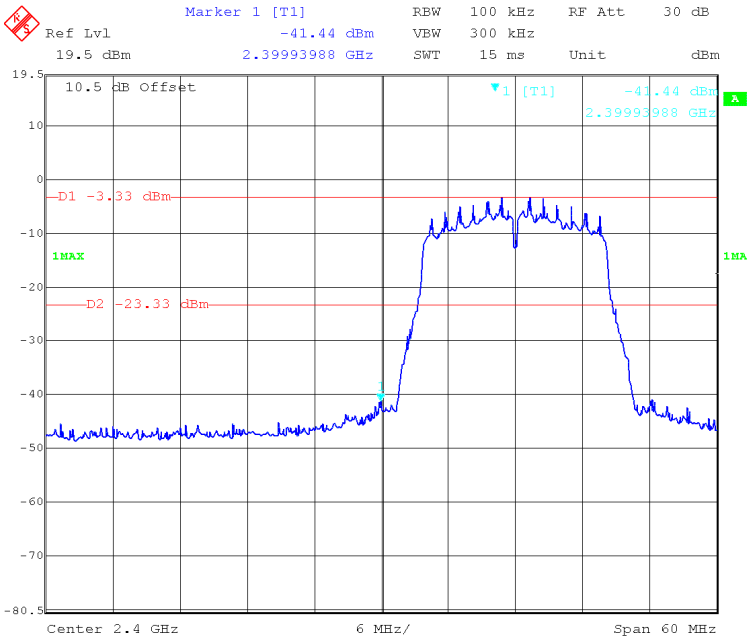
802.11b Mode Left Side



802.11b Mode Right Side



802.11g Mode Left Side



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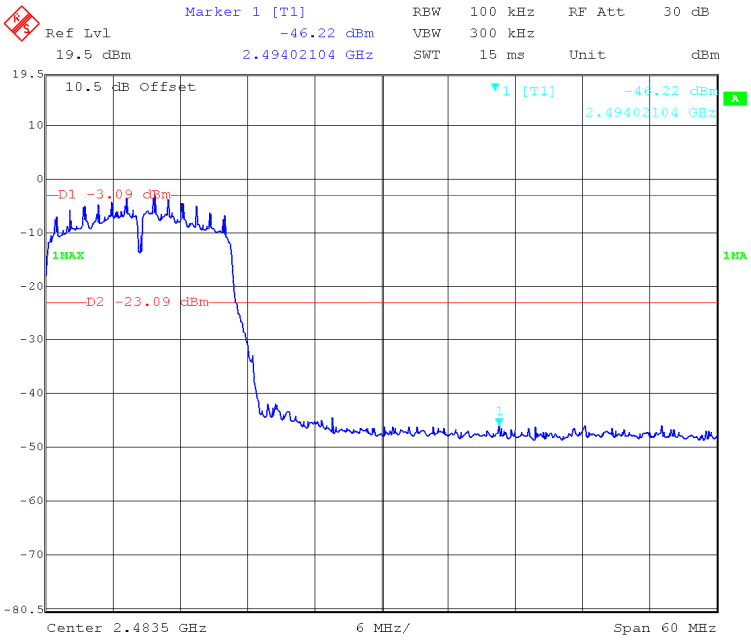
802.11g Mode Right Side



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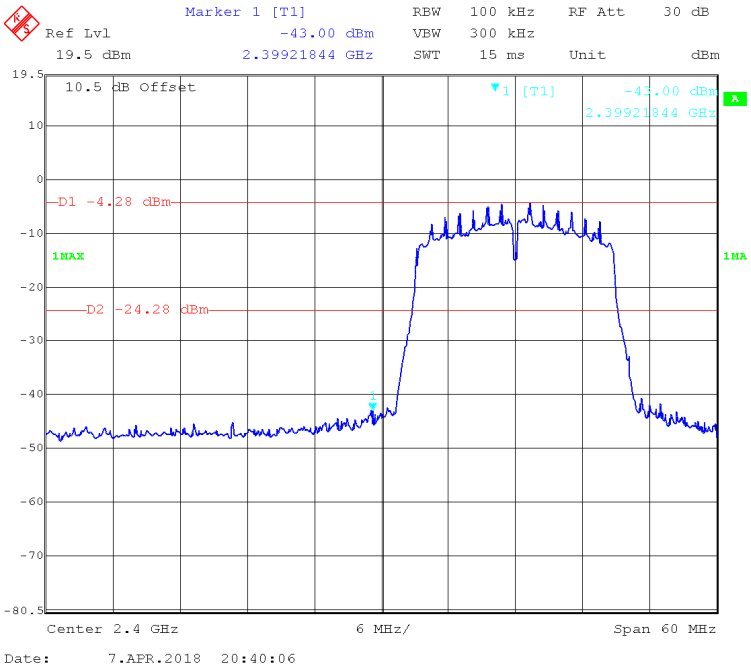
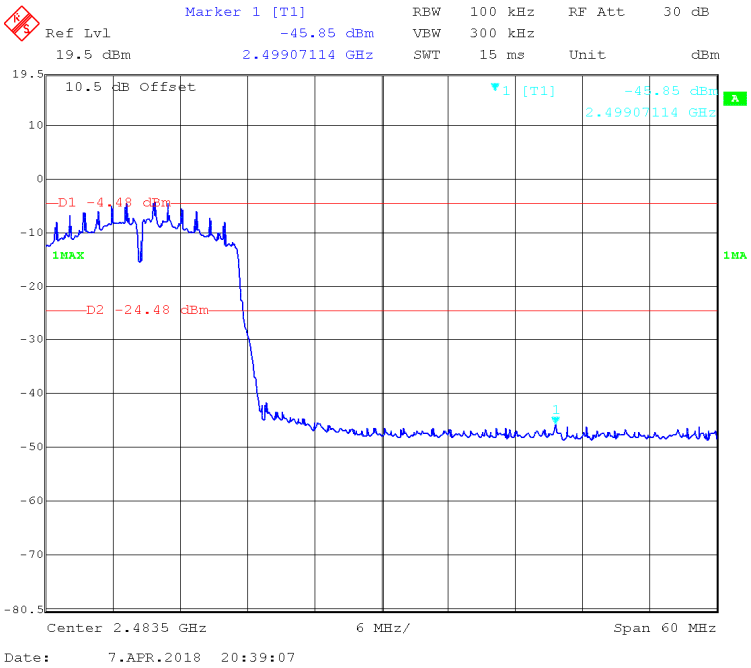
802.11n-HT20 Mode Left Side



802.11n-HT20 Mode Right Side



FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: 3kHz≤ RBW≤100 kHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Test Data

Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

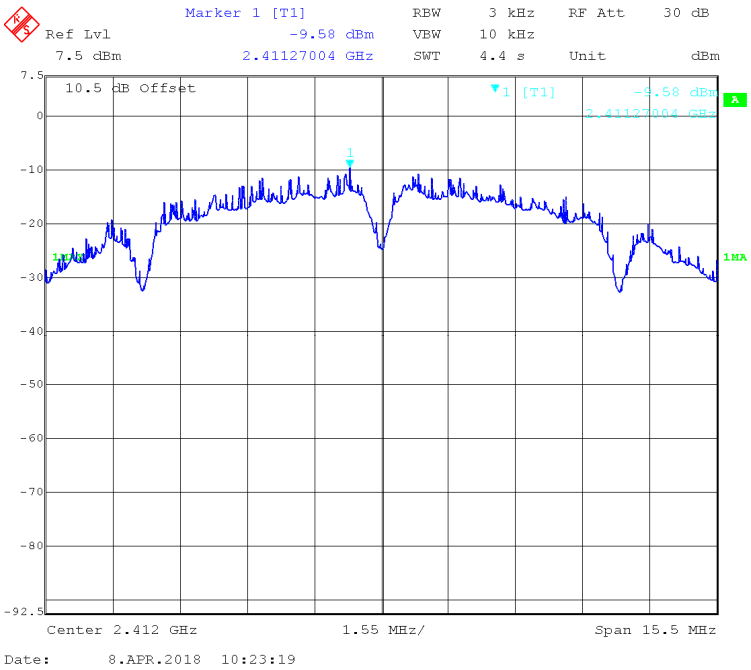
The testing was performed by Mark Yu on 2018-04-08.

EUT operation mode: Transmitting

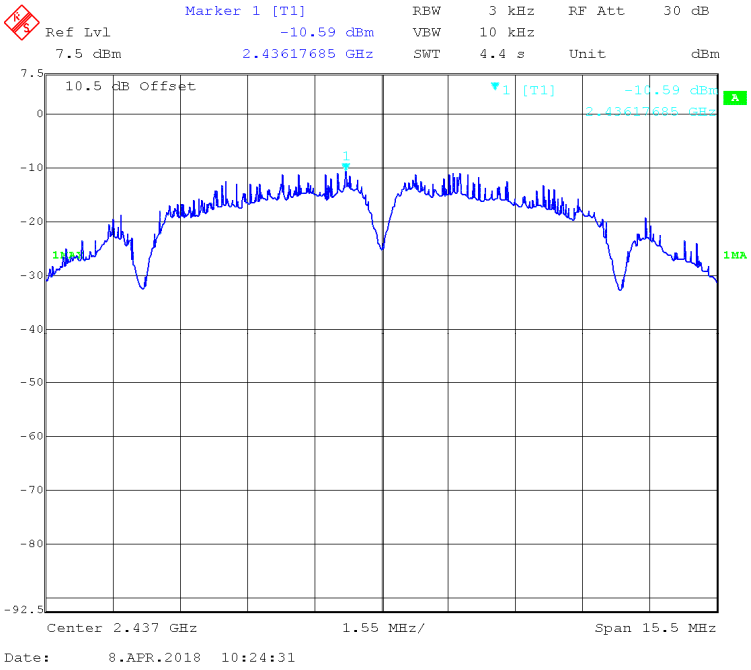
Test Result: Pass

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode			
Low	2412	-9.58	≤8
Middle	2437	-10.59	≤8
High	2462	-10.09	≤8
802.11g mode			
Low	2412	-18.10	≤8
Middle	2437	-19.31	≤8
High	2462	-18.02	≤8
802.11n-HT20 mode			
Low	2412	-19.88	≤8
Middle	2437	-20.13	≤8
High	2462	-20.32	≤8

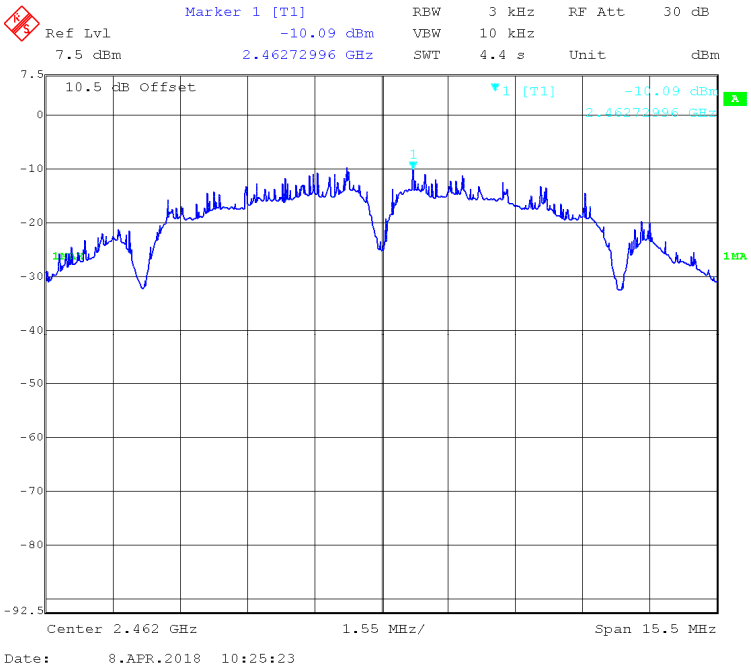
802.11b Low Channel



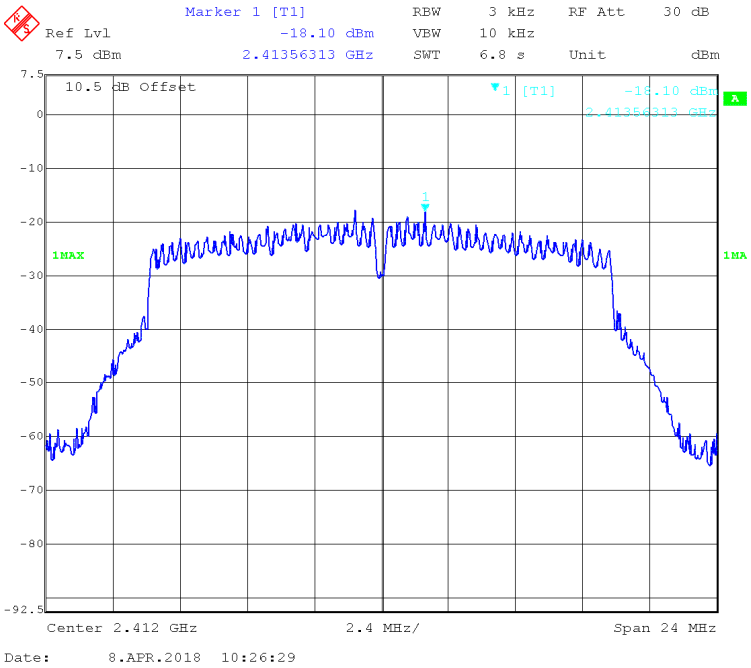
802.11b Middle Channel



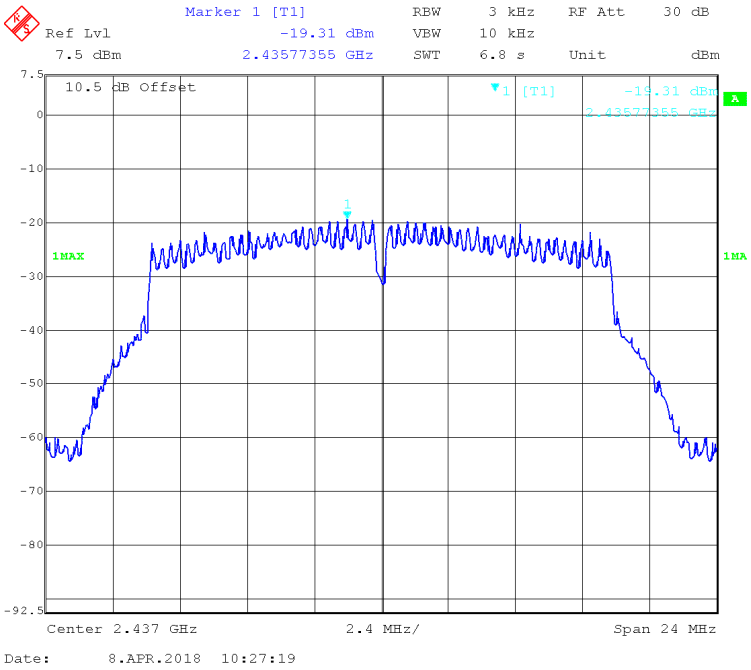
802.11b High Channel



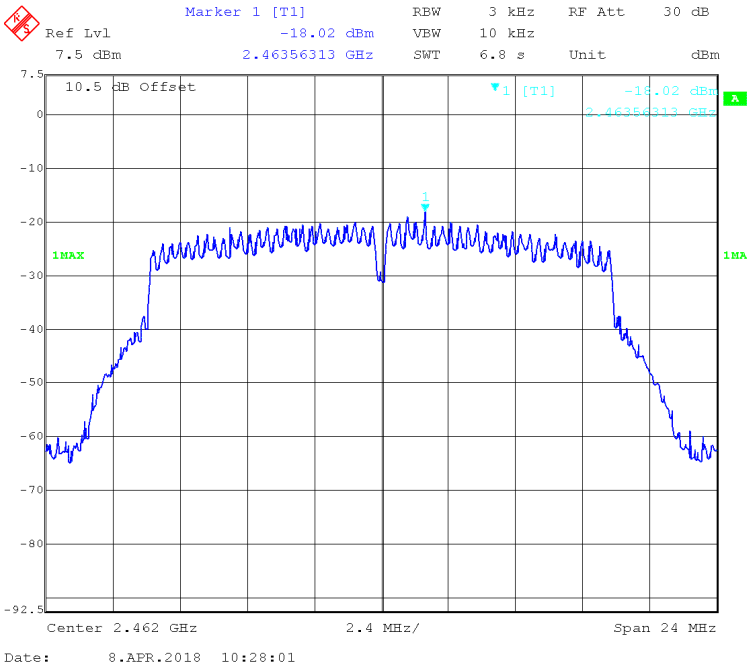
802.11g Low Channel



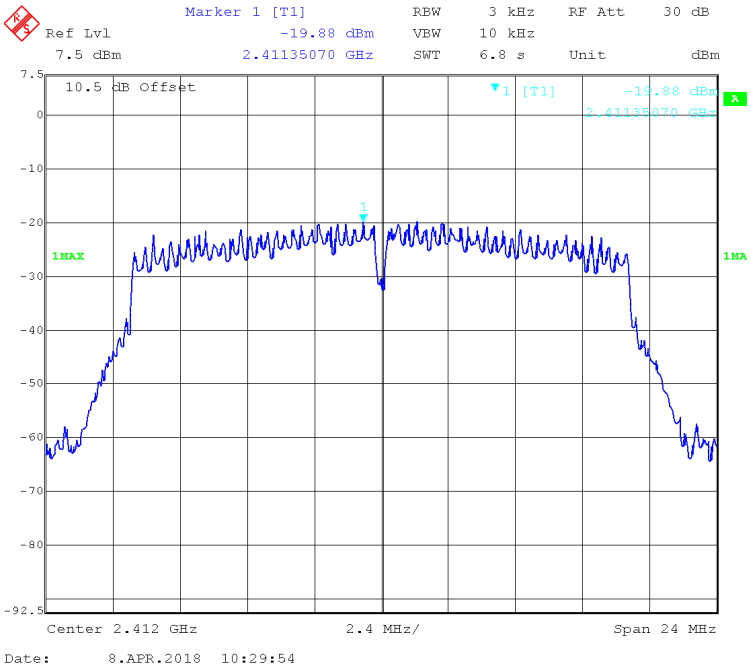
802.11g Middle Channel



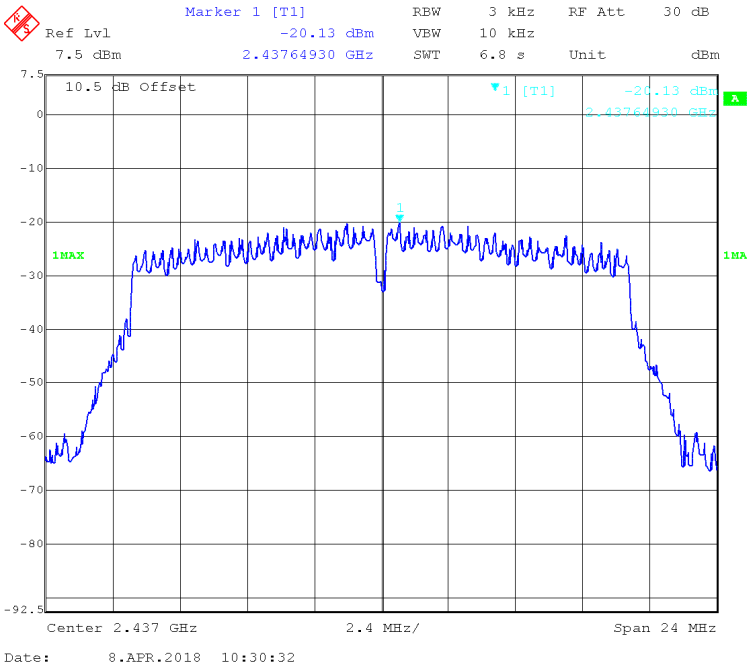
802.11g High Channel



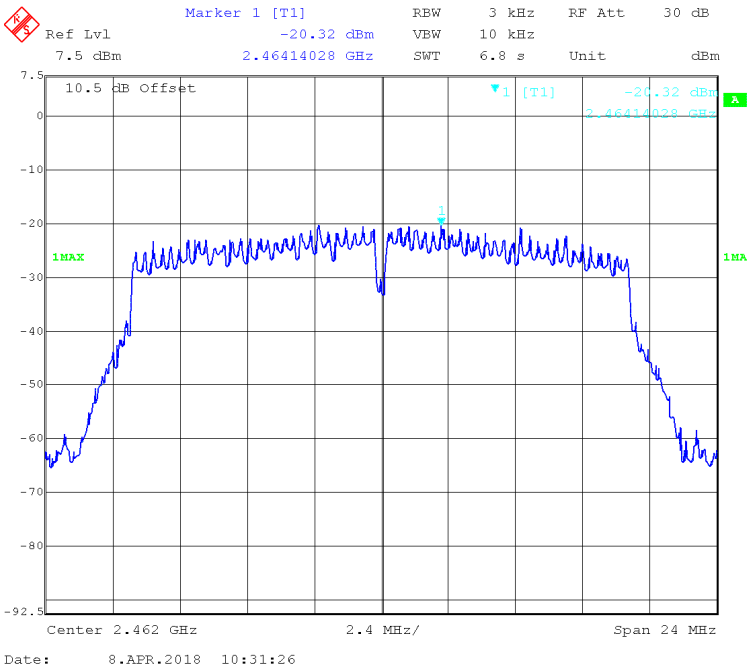
802.11n-HT20 Low Channel



802.11n-HT20 Middle Channel



802.11n-HT20 High Channel



******* END OF REPORT *******