



TESTING LABORATORY  
CERTIFICATE #4820.01



## FCC PART 15.247

## TEST REPORT

For

### Shenzhen Sonoff Technologies Co.,Ltd.

Room 1001, 10F, Building 8, Lianhua Industrial Park, Longyuan Road, Longhua District,  
Shenzhen, GD, China

**FCC ID: 2APN5RFR2**

<b>Report Type:</b> Original Report	<b>Product Name:</b> Wi-Fi Smart Switch with RF Control
<b>Report Number:</b>	RDG190905006-00A
<b>Report Date:</b>	2019-11-08
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FINAL

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

<b>EUT Name:</b>	Wi-Fi Smart Switch with RF Control
<b>EUT Model:</b>	RFR2
<b>Operation Frequency:</b>	2412-2462MHz
<b>Maximum Peak Output Power (Conducted):</b>	22.77 dBm
<b>Modulation Type:</b>	DSSS, OFDM
<b>Rated Input Voltage:</b>	100~240V
<b>External Dimension:</b>	88×39×24mm
<b>Serial Number:</b>	190905006
<b>EUT Received Date:</b>	2019.9.5
<b>EUT Received Status:</b>	Good

### Objective

This report is prepared on behalf of *Shenzhen Sonoff Technologies Co.,Ltd.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules.

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

### Related Submittal(s)/Grant(s)

FCC Part 15C DSC submissions with FCC ID: 2APN5RM433.

### 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 558074 D01 15.247 Meas Guidance v05r02

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

## Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Power Spectral Density, conducted	±0.61 dB
Unwanted Emissions, radiated	30M~200MHz: 4.55 dB,200M~1GHz: 5.92 dB,1G~6GHz: 4.98 dB, 6G~18GHz: 5.89 dB,18G~26.5G:5.47 dB,26.5G~40G:5.63 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1°C
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.12 dB (150 kHz to 30 MHz)

*Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.*

## Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0022.

## Declarations

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol “△”. Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

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## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in Engineering Mode, which was provided by the manufacturer.

For 2.4GHz band, total 11 channels are provided:

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

For 802.11b, 802.11g, and 802.11n ht20 modes were test with channel 1,6,11.

The worst-case data rates are determined to be as follows for each mode based upon investigations by measuring the average power and PSD across all data rates, bandwidths, and modulations.

### EUT Exercise Software

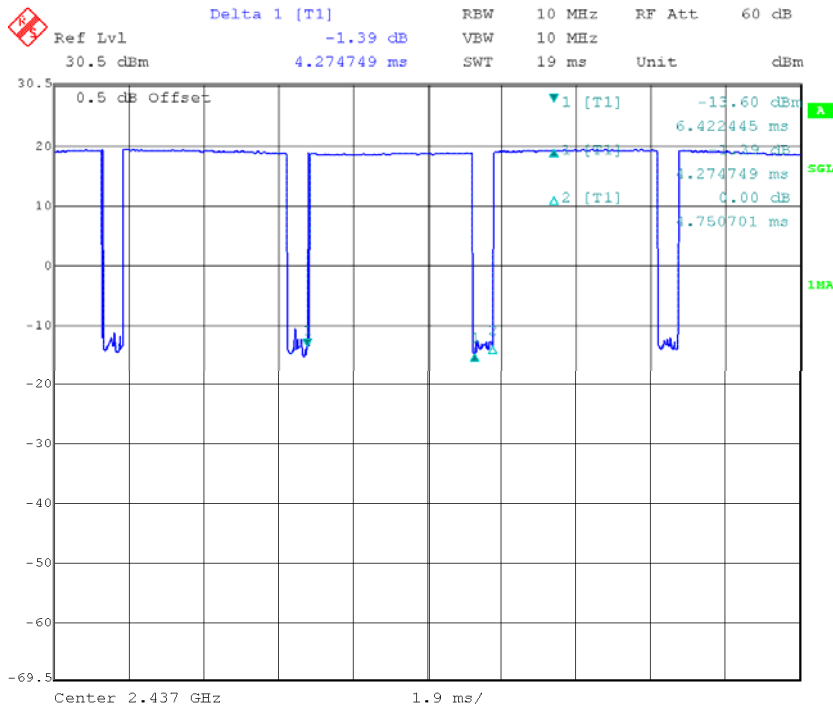
The software “SecureCRT” was used for testing, which was provided by manufacturer. The maximum power was configured as below table, that provided by the manufacturer:

Mode	Channel	Frequency (MHz)	Data rate	Power level Setting
802.11 b	Low	2412	1 Mbps	0
	Middle	2437	1 Mbps	0
	High	2462	1 Mbps	0
802.11 g	Low	2412	6 Mbps	0
	Middle	2437	6 Mbps	0
	High	2462	6 Mbps	0
802.11n ht20	Low	2412	MCS0	0
	Middle	2437	MCS0	0
	High	2462	MCS0	0

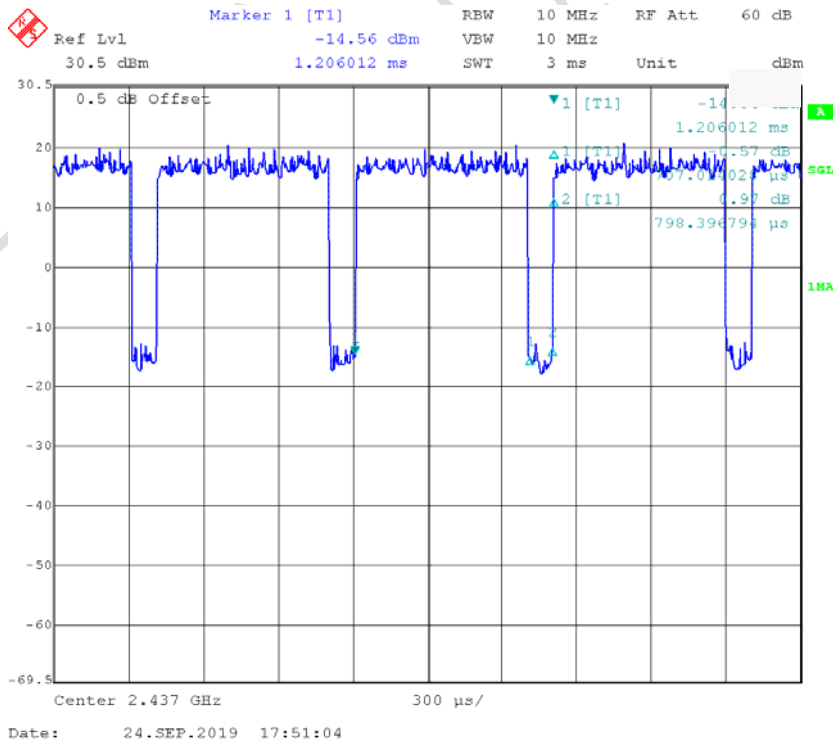
The maximum duty cycle as following table:

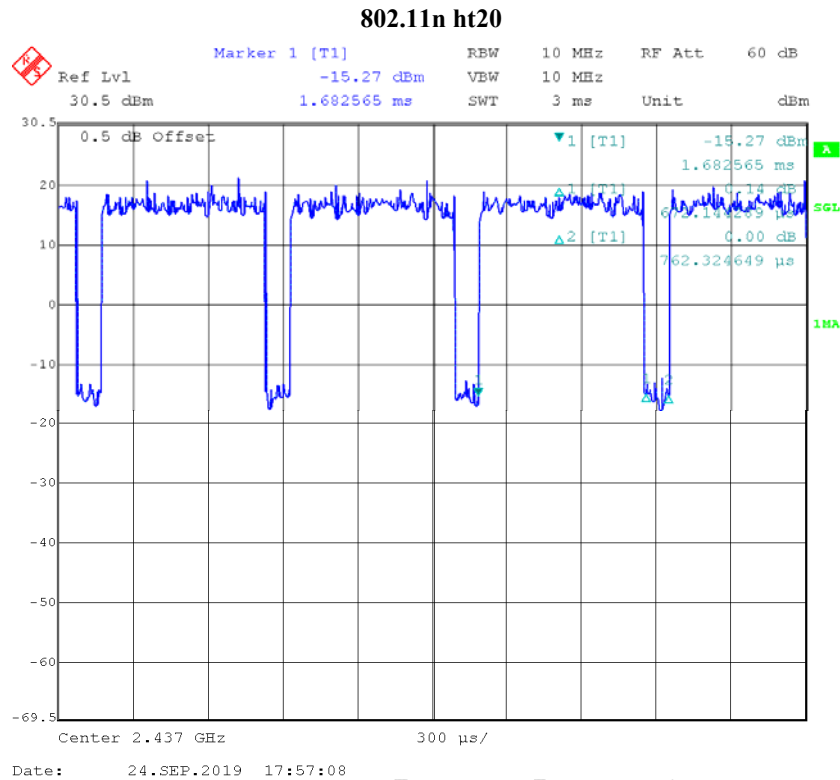
Test mode	T <sub>on</sub> (ms)	T <sub>on+off</sub> (ms)	Duty Cycle (%)
802.11b	4.27	4.75	89.89
802.11g	0.707	0.798	88.60
802.11n ht20	0.672	0.762	88.19

802.11b



802.11g





**Equipment Modifications**

No modification was made to the EUT.

**Support Equipment List and Details**

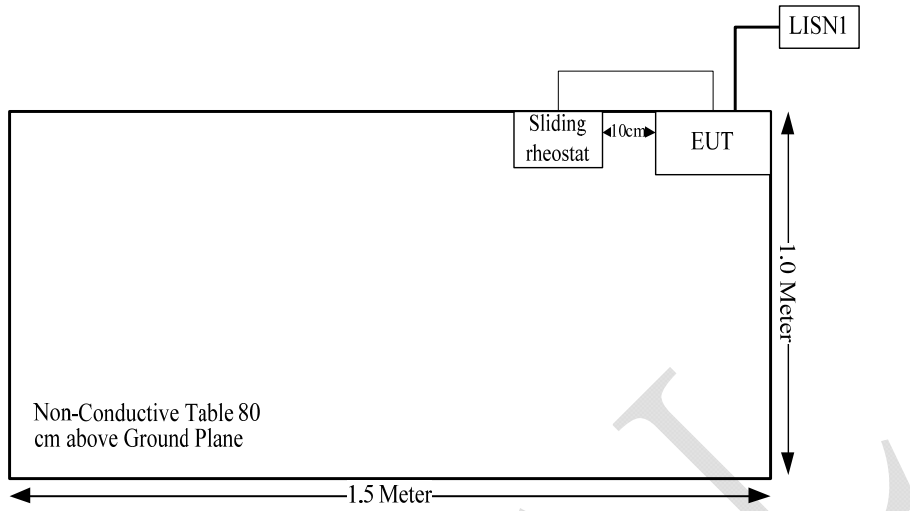
Manufacturer	Description	Model	Serial Number
Unknown	Sliding rheostat	Max 2000W	Unknown

**Support Cable List and Details**

Cable Description	Shielding Type	Ferrite Core	Length (m)	From To	
				From	To
Power Cable	No	No	1	EUT	Sliding rheostat



### Block Diagram of Test Setup



**SUMMARY OF TEST RESULTS**

FCC Rules	Description of Test	Result
FCC§15.247 (i) & §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB 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

**FCC §15.247 (i) & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

**Applicable Standard**

According to §15.247(i) and §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>(B) Limits for General Population/Uncontrolled Exposure</b>				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minutes)
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f <sup>2</sup> )	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 Formulary:**

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$  = power density (in appropriate units, e.g. mW/cm<sup>2</sup>);

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);

**Calculated Data:**

Frequency Range (MHz)	Antenna Gain		Max. Target Power including Tolerance		Evaluation Distance (cm)	Power Density (W/m <sup>2</sup> )	MPE Limit (W/m <sup>2</sup> )
	(dBi)	(numeric)	(dBm)	(mW)			
2412-2462	1	1.26	23	200	20.00	0.05	1.0

Note: the Max. Target Power including Tolerance was declared by manufacturer.

**Result: Compliance,** The device meets MPE requirement for Devices Used by the General Public (Uncontrolled Environment) at distance ≥20 cm.

## 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.
- c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

### Antenna Connector Construction

The EUT has one internal PCB antenna arrangement, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	input impedance (Ohm)	Antenna Gain /Frequency Range
PCB	50	1.0 dBi/2.4~2.5GHz

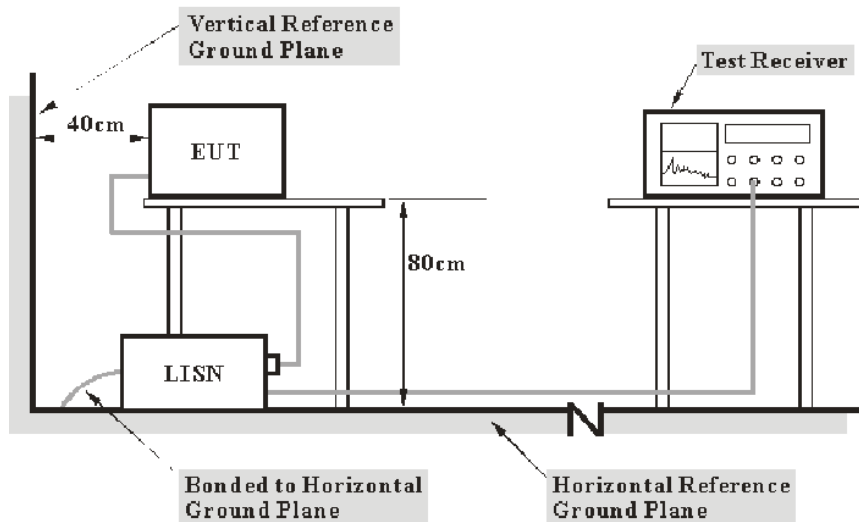
**Result:** Compliance.

**FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS**

**Applicable Standard**

FCC§15.207(a).

**EUT Setup**



- Note: 1. Support units were connected to second LISN.  
 2. Both of LISNs (AMN) 80 cm from EUT and at the least 30 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.

The spacing between the peripherals was 10 cm.

The EUT was connected to the main lisn with a 120 V/60 Hz AC power source.

**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

During the conducted emission test, the EUT was connected to the first 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 Amplitude & Margin Calculation

The basic equation is as follows:

$$V_C = V_R + A_C + VDF$$

$$C_f = A_C + VDF$$

Herein,

$V_C$  (cord. Reading): corrected voltage amplitude

$V_R$ : reading voltage amplitude

$A_C$ : attenuation caused by cable loss

VDF: voltage division factor of AMN

$C_f$ : Correction Factor

The “**Margin**” column of the following data tables indicates the degree of compliance within 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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-01	2019-09-05	2020-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	Two-line V-network	ENV 216	101614	2018-12-10	2019-12-10
R&S	EMI Test Receiver	ESPI	100120	2019-05-09	2020-05-09

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

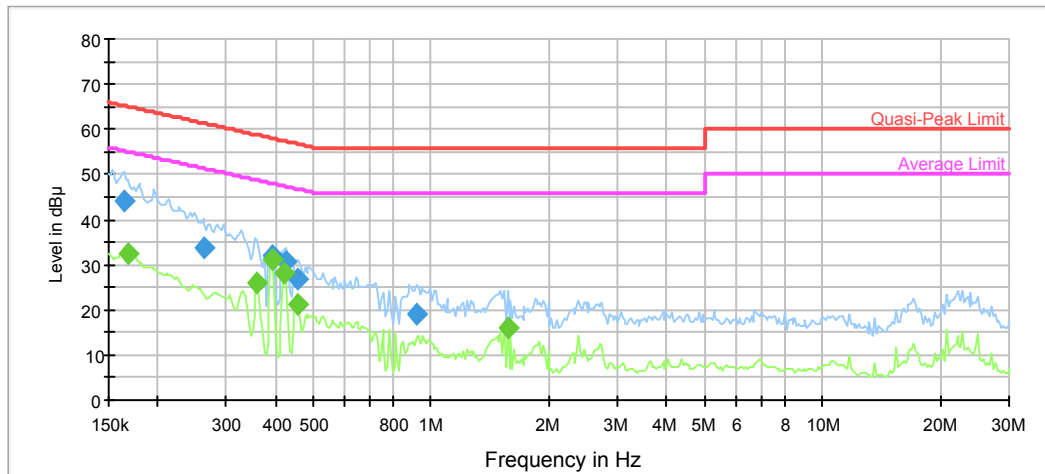
**Test Data**

**Environmental Conditions**

<b>Temperature:</b>	26.1°C
<b>Relative Humidity:</b>	54%
<b>ATM Pressure:</b>	101.5kPa
<b>Test by:</b>	Sem Xiang
<b>Test Date:</b>	2019-09-27

Test Mode: Transmitting

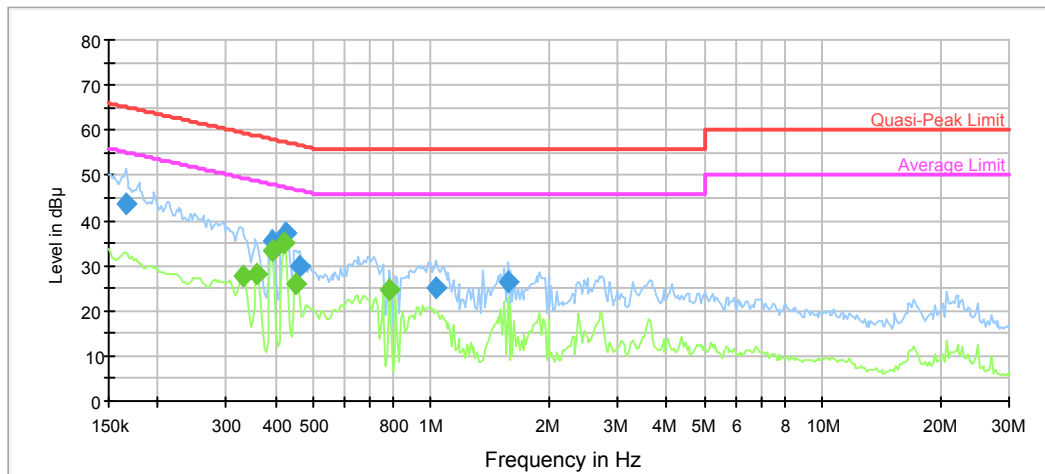
AC120 V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.164053	44.2	9.000	L1	11.0	21.1	65.3
0.261872	33.9	9.000	L1	10.3	27.5	61.4
0.393790	31.8	9.000	L1	10.0	26.2	58.0
0.426418	30.7	9.000	L1	9.9	26.6	57.3
0.457178	27.0	9.000	L1	9.9	29.7	56.7
0.917448	18.9	9.000	L1	9.8	37.1	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.167350	32.5	9.000	L1	10.9	22.6	55.1
0.360058	26.2	9.000	L1	10.0	22.5	48.7
0.393790	31.1	9.000	L1	10.0	16.9	48.0
0.422196	28.0	9.000	L1	9.9	19.4	47.4
0.457178	21.4	9.000	L1	9.9	25.3	46.7
1.570131	16.2	9.000	L1	9.7	29.8	46.0

**AC120 V, 60 Hz, Neutral:**



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.165693	43.7	9.000	N	10.9	21.5	65.2
0.393790	35.3	9.000	N	10.0	22.7	58.0
0.426418	37.0	9.000	N	9.9	20.3	57.3
0.461750	29.6	9.000	N	9.9	27.1	56.7
1.033804	25.1	9.000	N	9.8	30.9	56.0
1.570131	26.4	9.000	N	9.8	29.6	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.329215	27.6	9.000	N	10.1	21.9	49.5
0.360058	28.1	9.000	N	10.0	20.6	48.7
0.393790	33.2	9.000	N	10.0	14.8	48.0
0.422196	35.2	9.000	N	9.9	12.2	47.4
0.452652	25.9	9.000	N	9.9	20.9	46.8
0.782419	24.5	9.000	N	9.8	21.5	46.0



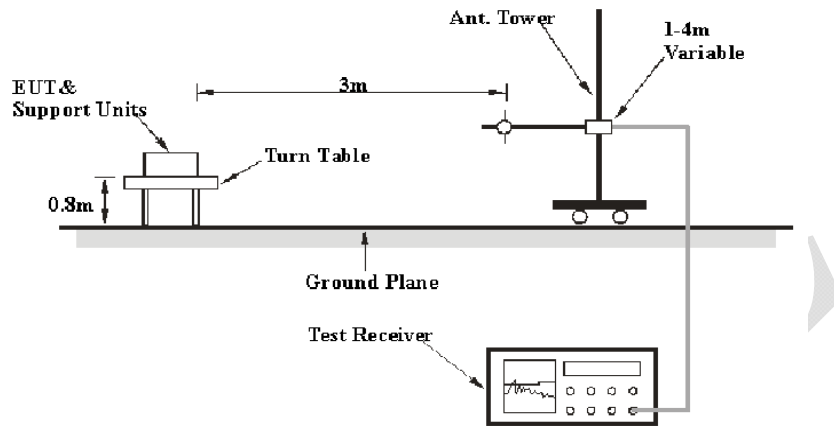
## FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

### Applicable Standard

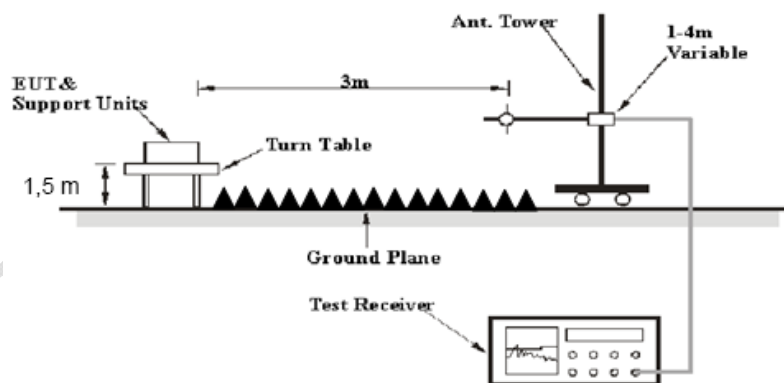
FCC §15.247 (d); §15.209; §15.205;

### EUT Setup

#### Below 1GHz:



#### Above 1GHz:



The radiated emission below 1GHz tests were performed in the 10 meters chamber, above 1GHz tests were performed in the 3 meters chamber B, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

The spacing between the peripherals was 10 cm.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

30MHz-1000MHz:

Measurement	RBW	Video B/W	IF B/W
QP	120 kHz	300 kHz	120kHz

1GHz- 25GHz:

Measurement	Duty cycle	RBW	Video B/W
PK	Any	1MHz	3 MHz
AV	>98%	1MHz	10 Hz
	<98%	1MHz	1/T

Note: T is minimum transmission duration

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

## Test Procedure

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:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation Below 1GHz					
R&S	EMI Test Receiver	ESCI	100035	2019-08-03	2020-08-03
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-2	2017-08-25	2020-08-25
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2019-09-24	2020-09-24
Sonoma	Amplifier	310N	185914	2018-10-13	2019-10-13
Radiation Above 1GHz					
Agilent	Spectrum Analyzer	E4440A	SG43360054	2019-05-09	2020-05-09
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2019-06-27	2020-06-27
MITEQ	Amplifier	AFS42-00101800- 25-S-42	2001271	2019-09-05	2020-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2019-06-27	2020-06-27
E-Microwave	Band-stop Filters	OBSF-2400-2483.5- S	OE01601525	2019-06-16	2020-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2019-06-16	2020-06-16

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

**Test Data****Environmental Conditions**

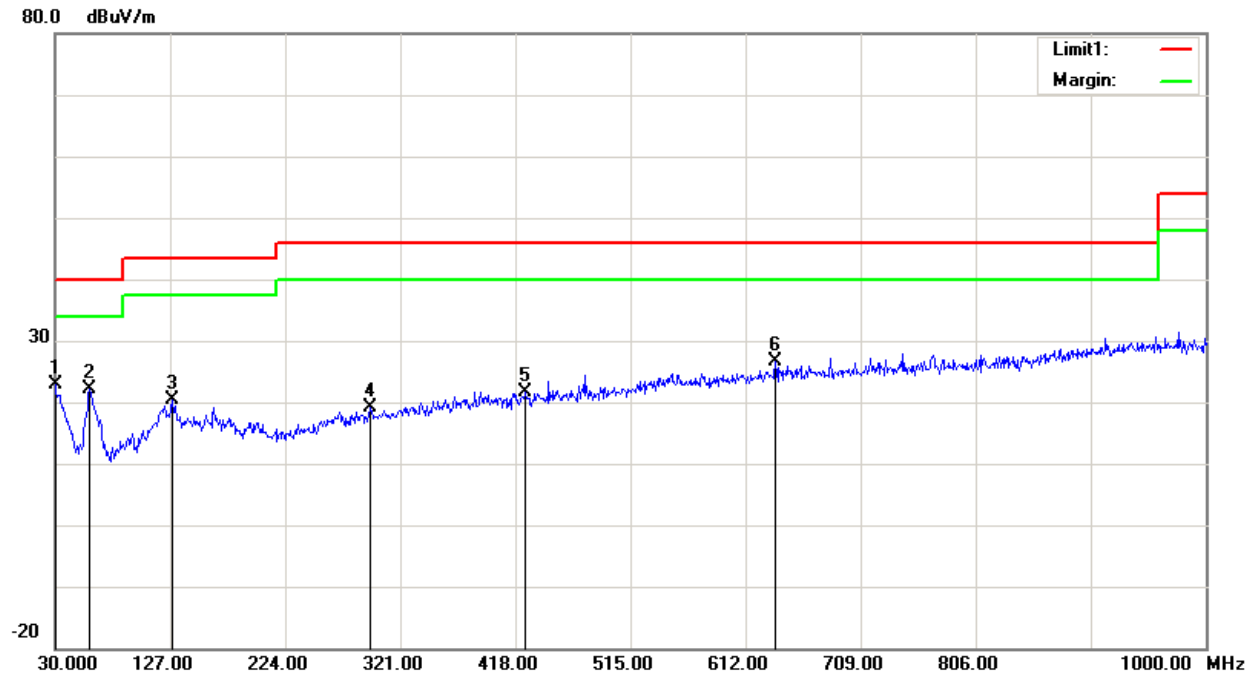
Test items:	Radiation Below 1GHz	Radiation Above 1GHz
<b>Temperature:</b>	26.2°C	26.4°C
<b>Relative Humidity:</b>	53%	47%
<b>ATM Pressure:</b>	101.1kPa	101.4kPa
<b>Test by:</b>	Ade Xiao	Tyler Pan
<b>Test Date:</b>	2019-09-24	2019-09-25

*Test Result: Compliance, please Refer to the following data*

*Test Mode: Transmitting*

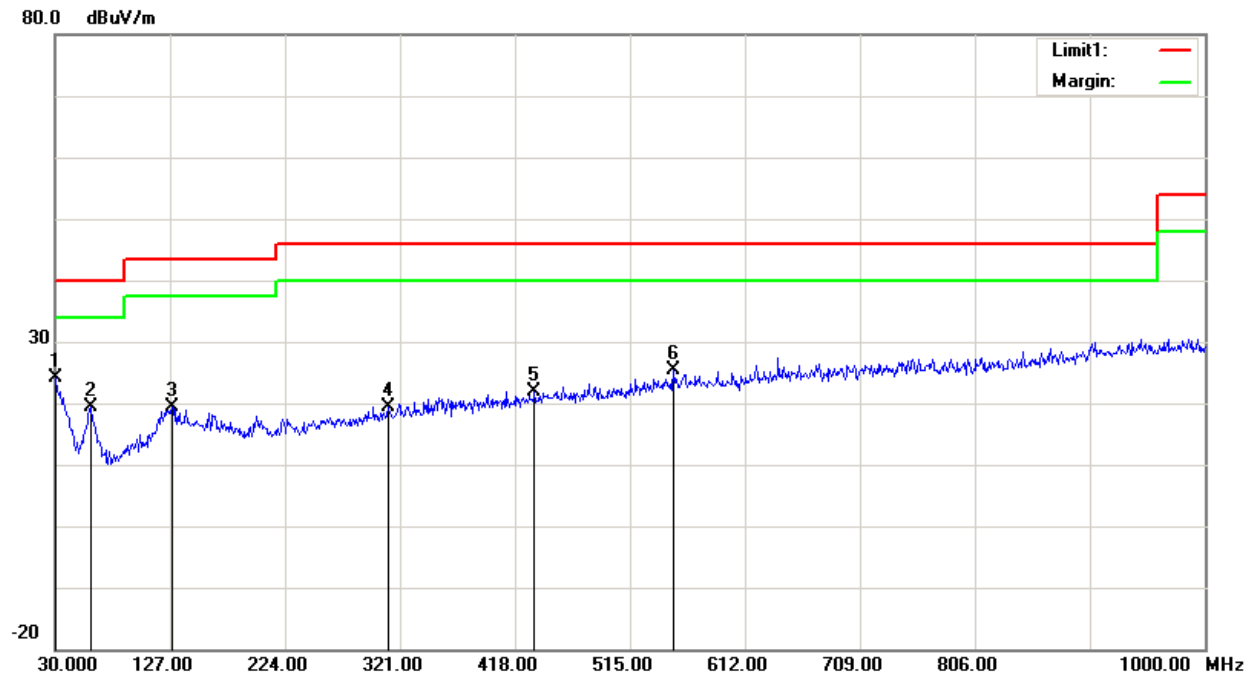
1) 30MHz-1GHz(802.11b,middle channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBuV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.0000	27.27	peak	-4.33	22.94	40.00	17.06
59.1000	38.85	peak	-16.64	22.21	40.00	17.79
128.9400	30.50	peak	-10.16	20.34	43.50	23.16
295.7800	26.92	peak	-7.78	19.14	46.00	26.86
426.7300	26.48	peak	-4.75	21.73	46.00	24.27
637.2200	27.30	peak	-0.73	26.57	46.00	19.43

**Vertical:**



Frequency (MHz)	Receiver Reading (dBuV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.9700	29.09	peak	-4.88	24.21	40.00	15.79
60.0700	35.98	peak	-16.57	19.41	40.00	20.59
128.9400	29.64	peak	-10.16	19.48	43.50	24.02
311.3000	26.36	peak	-7.06	19.30	46.00	26.70
434.4900	26.51	peak	-4.53	21.98	46.00	24.02
551.8600	27.03	peak	-1.75	25.28	46.00	20.72

**2) 1-25GHz:  
802.11b Mode:**

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
	Reading (dB $\mu$ V)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2412 MHz									
2412.00	64.50	PK	H	28.12	1.81	0.00	94.43	N/A	N/A
2412.00	61.32	AV	H	28.12	1.81	0.00	91.25	N/A	N/A
2412.00	70.15	PK	V	28.12	1.81	0.00	100.08	N/A	N/A
2412.00	66.86	AV	V	28.12	1.81	0.00	96.79	N/A	N/A
2390.00	26.66	PK	V	28.08	1.80	0.00	56.54	74.00	17.46
2390.00	13.51	AV	V	28.08	1.80	0.00	43.39	54.00	10.61
4824.00	53.67	PK	V	32.95	3.19	37.20	52.61	74.00	21.39
4824.00	49.77	AV	V	32.95	3.19	37.20	48.71	54.00	5.29
7236.00	46.37	PK	V	35.81	4.77	37.27	49.68	74.00	24.32
7236.00	33.65	AV	V	35.81	4.77	37.27	36.96	54.00	17.04
Middle Channel: 2437 MHz									
2437.00	66.12	PK	H	28.17	1.82	0.00	96.11	N/A	N/A
2437.00	62.89	AV	H	28.17	1.82	0.00	92.88	N/A	N/A
2437.00	72.22	PK	V	28.17	1.82	0.00	102.21	N/A	N/A
2437.00	69.08	AV	V	28.17	1.82	0.00	99.07	N/A	N/A
4874.00	54.54	PK	V	33.05	3.26	37.21	53.64	74.00	20.36
4874.00	51.10	AV	V	33.05	3.26	37.21	50.20	54.00	3.80
7311.00	46.74	PK	V	36.01	4.64	37.36	50.03	74.00	23.97
7311.00	34.23	AV	V	36.01	4.64	37.36	37.52	54.00	16.48
High Channel: 2462 MHz									
2462.00	64.74	PK	H	28.22	1.83	0.00	94.79	N/A	N/A
2462.00	61.37	AV	H	28.22	1.83	0.00	91.42	N/A	N/A
2462.00	71.13	PK	V	28.22	1.83	0.00	101.18	N/A	N/A
2462.00	67.89	AV	V	28.22	1.83	0.00	97.94	N/A	N/A
2483.50	26.45	PK	V	28.27	1.84	0.00	56.56	74.00	17.44
2483.50	13.54	AV	V	28.27	1.84	0.00	43.65	54.00	10.35
4924.00	54.19	PK	V	33.15	3.27	37.22	53.39	74.00	20.61
4924.00	50.67	AV	V	33.15	3.27	37.22	49.87	54.00	4.13
7386.00	46.58	PK	V	36.20	4.51	37.46	49.83	74.00	24.17
7386.00	34.10	AV	V	36.20	4.51	37.46	37.35	54.00	16.65

**802.11g Mode:**

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2412 MHz									
2412.00	64.88	PK	H	28.12	1.81	0.00	94.81	N/A	N/A
2412.00	55.76	AV	H	28.12	1.81	0.00	85.69	N/A	N/A
2412.00	70.61	PK	V	28.12	1.81	0.00	100.54	N/A	N/A
2412.00	61.48	AV	V	28.12	1.81	0.00	91.41	N/A	N/A
2390.00	32.66	PK	V	28.08	1.80	0.00	62.54	74.00	11.46
2390.00	19.64	AV	V	28.08	1.80	0.00	49.52	54.00	4.48
4824.00	53.46	PK	V	32.95	3.19	37.20	52.40	74.00	21.60
4824.00	41.28	AV	V	32.95	3.19	37.20	40.22	54.00	13.78
7236.00	46.77	PK	V	35.81	4.77	37.27	50.08	74.00	23.92
7236.00	34.25	AV	V	35.81	4.77	37.27	37.56	54.00	16.44
Middle Channel: 2437 MHz									
2437.00	66.41	PK	H	28.17	1.82	0.00	96.40	N/A	N/A
2437.00	57.20	AV	H	28.17	1.82	0.00	87.19	N/A	N/A
2437.00	72.13	PK	V	28.17	1.82	0.00	102.12	N/A	N/A
2437.00	62.98	AV	V	28.17	1.82	0.00	92.97	N/A	N/A
4874.00	54.07	PK	V	33.05	3.26	37.21	53.17	74.00	20.83
4874.00	41.79	AV	V	33.05	3.26	37.21	40.89	54.00	13.11
7311.00	46.37	PK	V	36.01	4.64	37.36	49.66	74.00	24.34
7311.00	34.25	AV	V	36.01	4.64	37.36	37.54	54.00	16.46
High Channel: 2462 MHz									
2462.00	64.56	PK	H	28.22	1.83	0.00	94.61	N/A	N/A
2462.00	55.49	AV	H	28.22	1.83	0.00	85.54	N/A	N/A
2462.00	71.74	PK	V	28.22	1.83	0.00	101.79	N/A	N/A
2462.00	62.64	AV	V	28.22	1.83	0.00	92.69	N/A	N/A
2483.50	33.43	PK	V	28.27	1.84	0.00	63.54	74.00	10.46
2483.50	19.53	AV	V	28.27	1.84	0.00	49.64	54.00	4.36
4924.00	53.28	PK	V	33.15	3.27	37.22	52.48	74.00	21.52
4924.00	41.37	AV	V	33.15	3.27	37.22	40.57	54.00	13.43
7386.00	45.98	PK	V	36.20	4.51	37.46	49.23	74.00	24.77
7386.00	33.77	AV	V	36.20	4.51	37.46	37.02	54.00	16.98

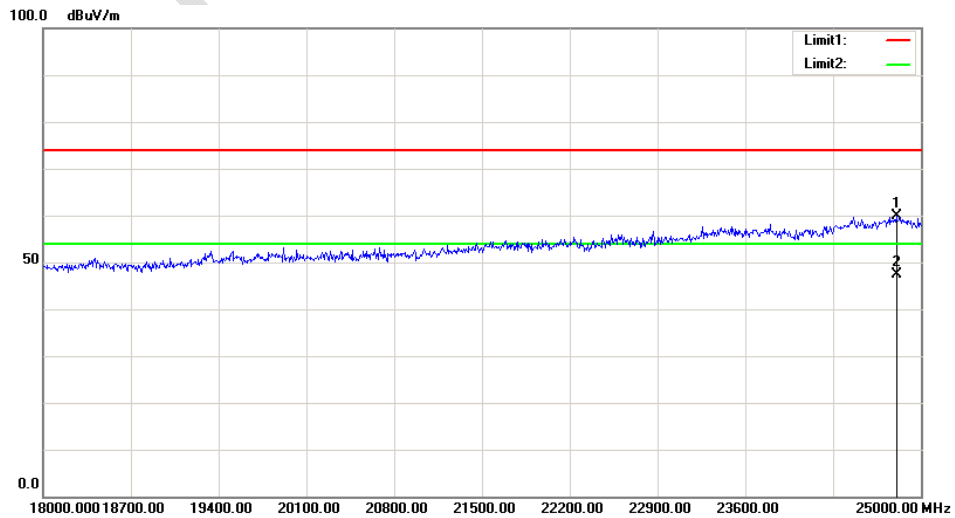
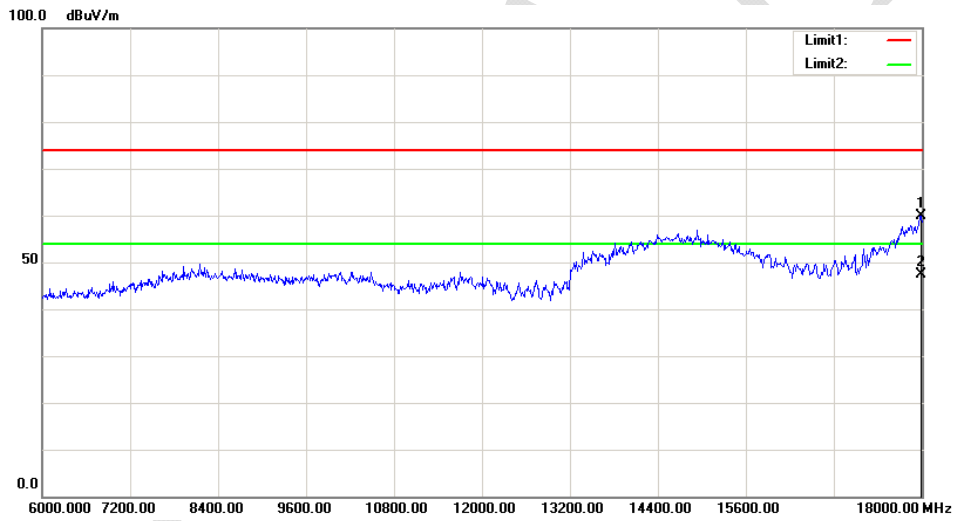
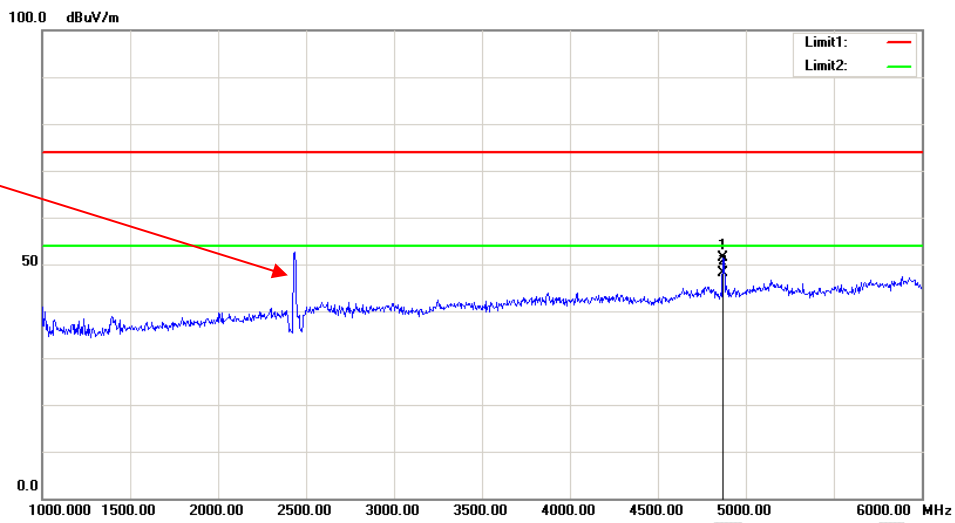
**802.11n20 Mode:**

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2412 MHz									
2412.00	65.10	PK	H	28.12	1.81	0.00	95.03	N/A	N/A
2412.00	56.21	AV	H	28.12	1.81	0.00	86.14	N/A	N/A
2412.00	70.78	PK	V	28.12	1.81	0.00	100.71	N/A	N/A
2412.00	61.66	AV	V	28.12	1.81	0.00	91.59	N/A	N/A
2390.00	32.85	PK	V	28.08	1.80	0.00	62.73	74.00	11.27
2390.00	17.93	AV	V	28.08	1.80	0.00	47.81	54.00	6.19
4824.00	53.30	PK	V	32.95	3.19	37.20	52.24	74.00	21.76
4824.00	41.07	AV	V	32.95	3.19	37.20	40.01	54.00	13.99
7236.00	45.87	PK	V	35.81	4.77	37.27	49.18	74.00	24.82
7236.00	33.47	AV	V	35.81	4.77	37.27	36.78	54.00	17.22
Middle Channel: 2437 MHz									
2437.00	66.80	PK	H	28.17	1.82	0.00	96.79	N/A	N/A
2437.00	57.74	AV	H	28.17	1.82	0.00	87.73	N/A	N/A
2437.00	72.24	PK	V	28.17	1.82	0.00	102.23	N/A	N/A
2437.00	63.31	AV	V	28.17	1.82	0.00	93.30	N/A	N/A
4874.00	53.96	PK	V	33.05	3.26	37.21	53.06	74.00	20.94
4874.00	41.65	AV	V	33.05	3.26	37.21	40.75	54.00	13.25
7311.00	46.58	PK	V	36.01	4.64	37.36	49.87	74.00	24.13
7311.00	34.10	AV	V	36.01	4.64	37.36	37.39	54.00	16.61
High Channel: 2462 MHz									
2462.00	65.57	PK	H	28.22	1.83	0.00	95.62	N/A	N/A
2462.00	56.45	AV	H	28.22	1.83	0.00	86.50	N/A	N/A
2462.00	71.49	PK	V	28.22	1.83	0.00	101.54	N/A	N/A
2462.00	62.86	AV	V	28.22	1.83	0.00	92.91	N/A	N/A
2483.50	35.34	PK	V	28.27	1.84	0.00	65.45	74.00	8.55
2483.50	20.89	AV	V	28.27	1.84	0.00	51.00	54.00	3.00
4924.00	53.63	PK	V	33.15	3.27	37.22	52.83	74.00	21.17
4924.00	41.29	AV	V	33.15	3.27	37.22	40.49	54.00	13.51
7386.00	46.58	PK	V	36.20	4.51	37.46	49.83	74.00	24.17
7386.00	34.12	AV	V	36.20	4.51	37.46	37.37	54.00	16.63



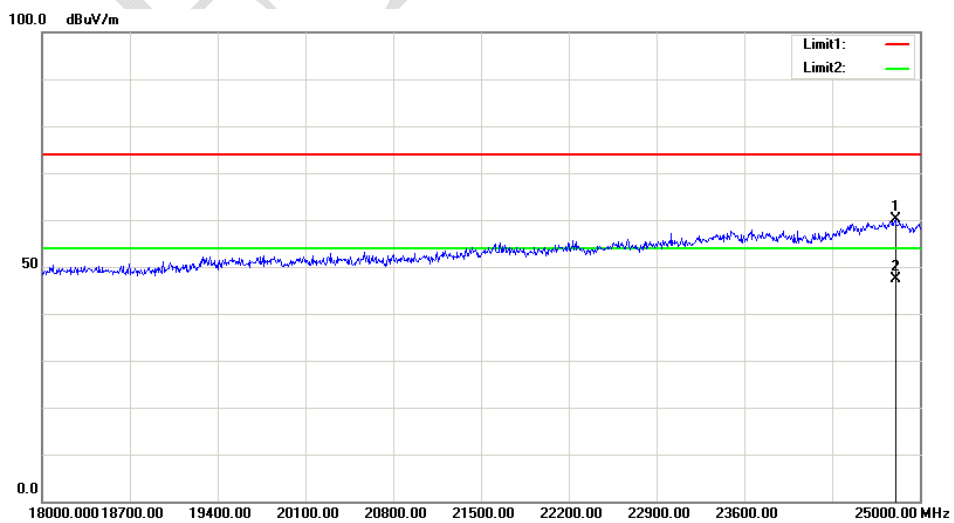
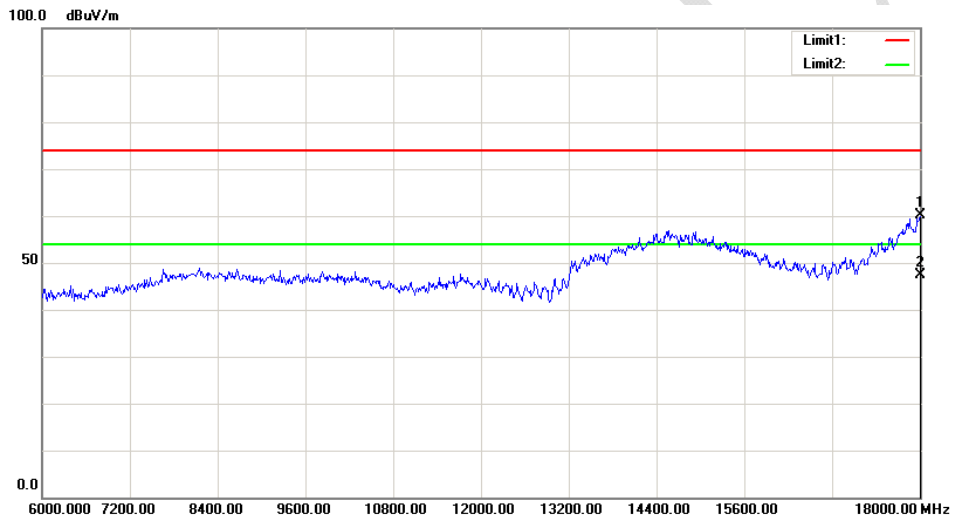
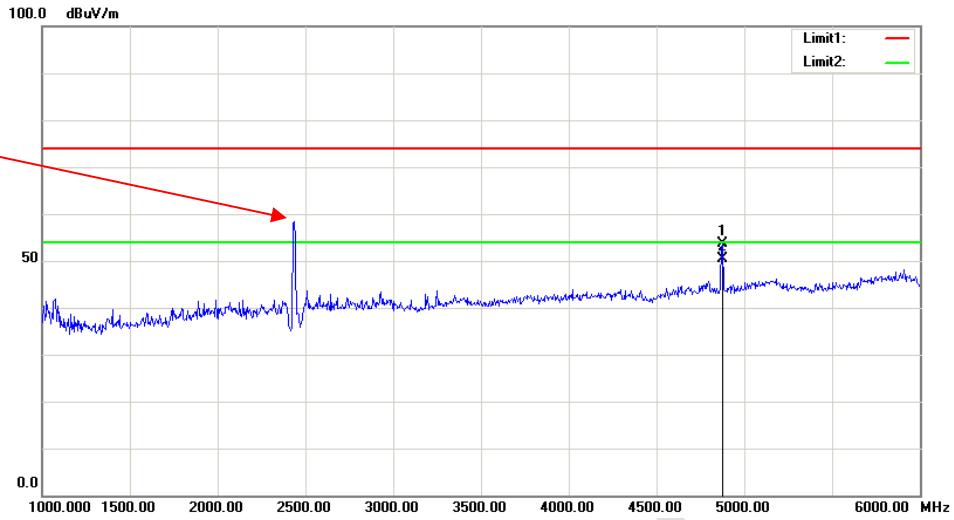
**Test plots(802.11b middle channel was the worst)  
Horizontal:**

Fundamental  
Test with Band  
Rejection Filter



Vertical:

Fundamental Test with Band Rejection Filter



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

### Applicable Standard

According to FCC §15.247(a) (2)

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

- a) Set RBW = 100 kHz.
- b) Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- c) Detector = Peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-08-03	2020-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

### Test Data

#### Environmental Conditions

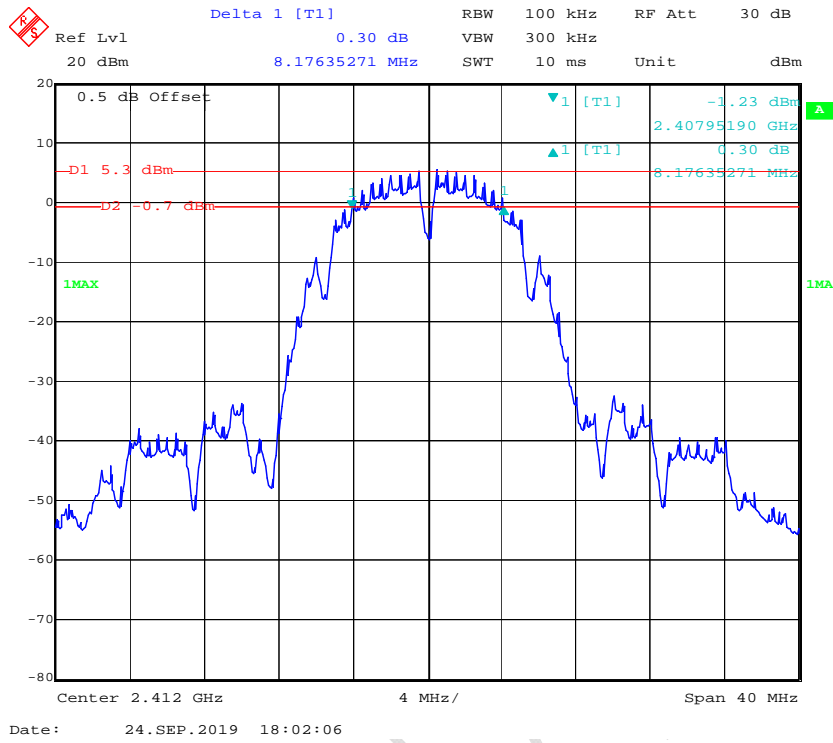
Temperature:	23.4°C
Relative Humidity:	51%
ATM Pressure:	101.1kPa
Test by:	Severn Zhu
Test Date:	2019-09-24

*Test Mode: Transmitting*

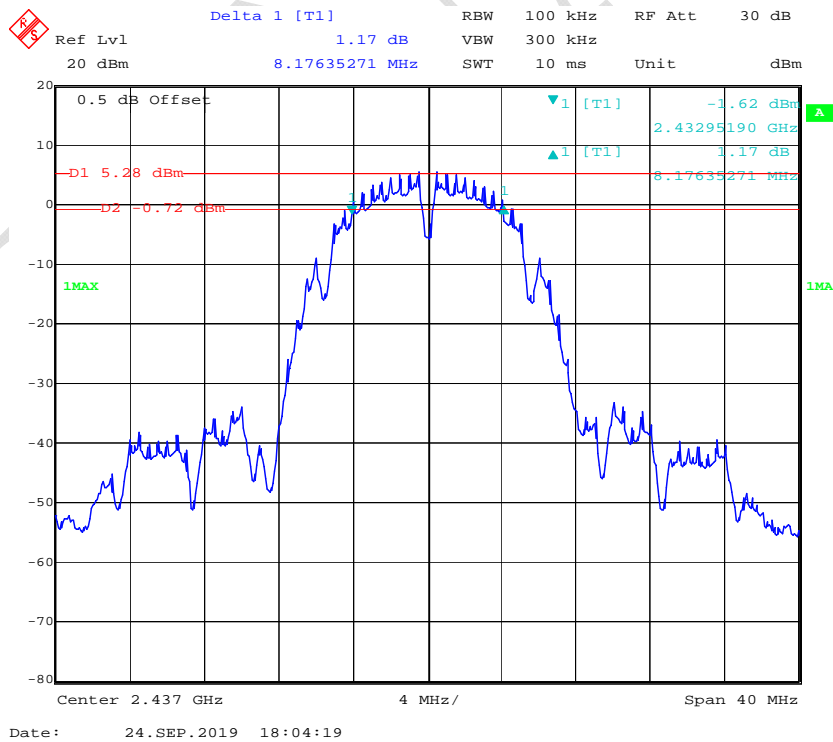
*Test Result: Compliance. Please refer to the following table and plots.*

Test mode	Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Limit (MHz)
802.11b	Low	2412	8.176	$\geq 0.5$
	Middle	2437	8.176	$\geq 0.5$
	High	2462	8.978	$\geq 0.5$
802.11g	Low	2412	16.273	$\geq 0.5$
	Middle	2437	16.112	$\geq 0.5$
	High	2462	16.353	$\geq 0.5$
802.11n20	Low	2412	16.192	$\geq 0.5$
	Middle	2437	16.353	$\geq 0.5$
	High	2462	16.353	$\geq 0.5$

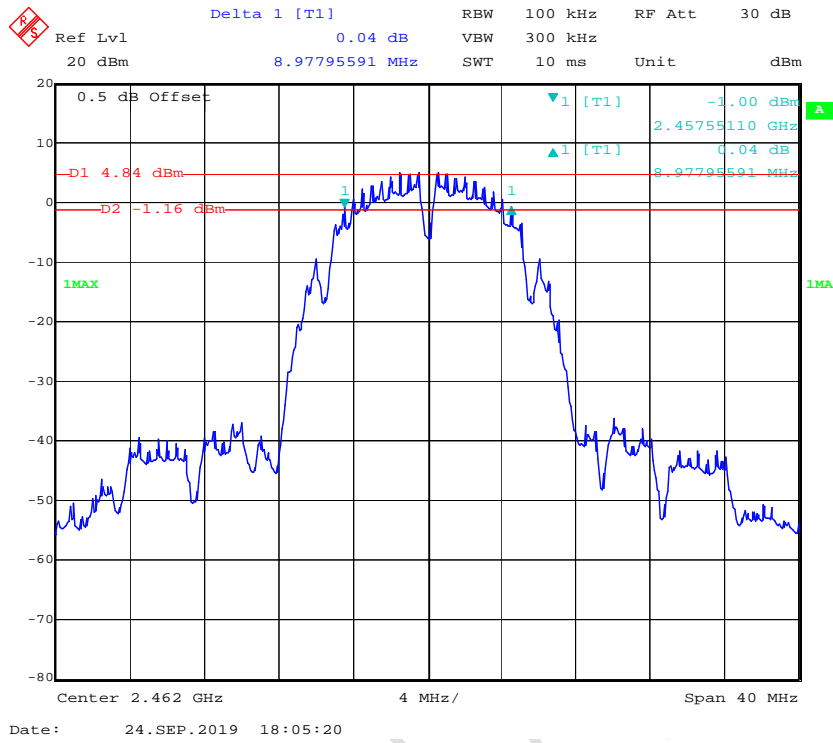
### 802.11b Low Channel



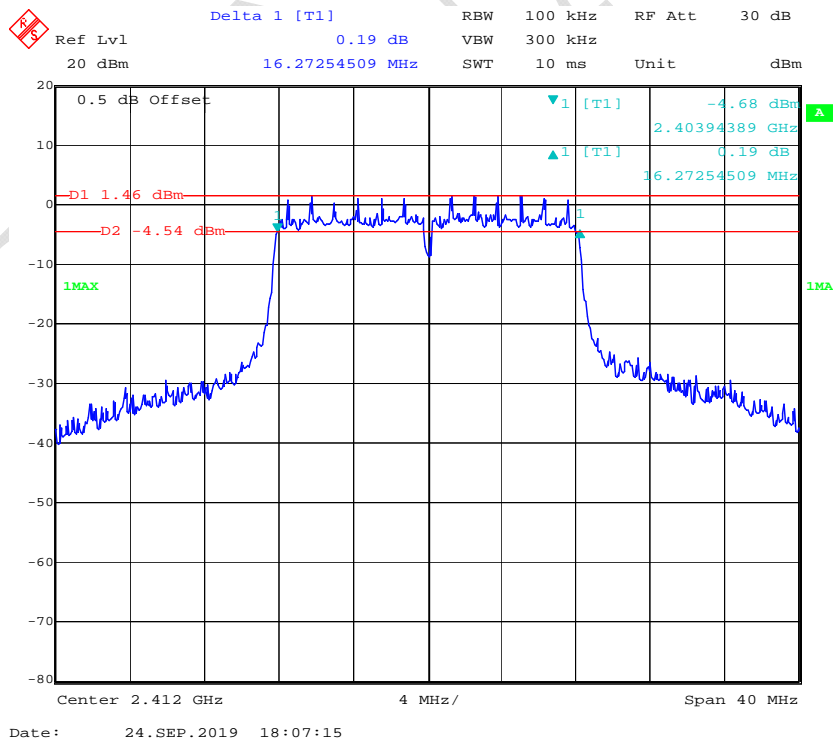
### 802.11b Middle Channel



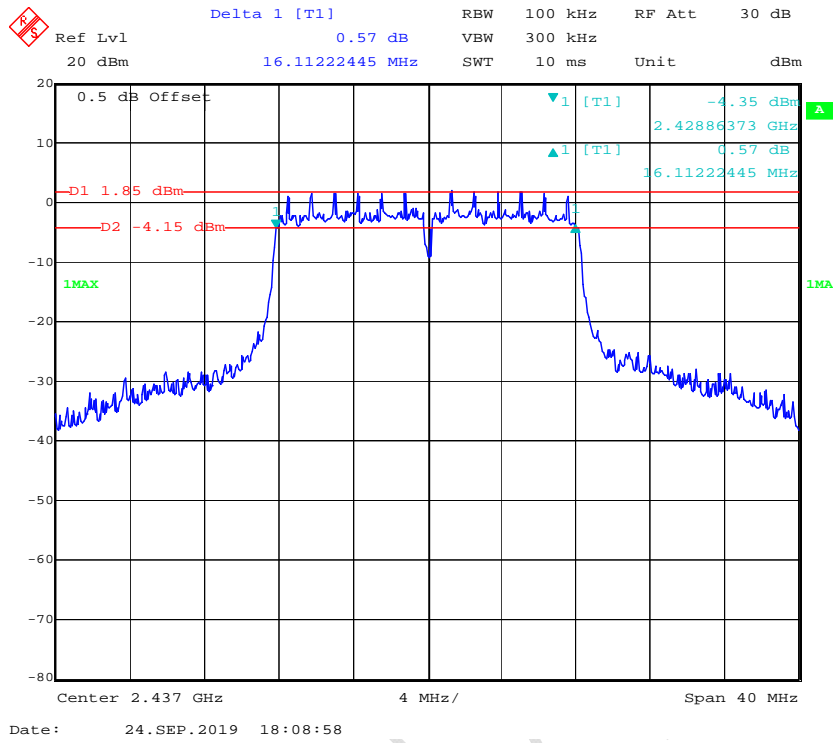
### 802.11b High Channel



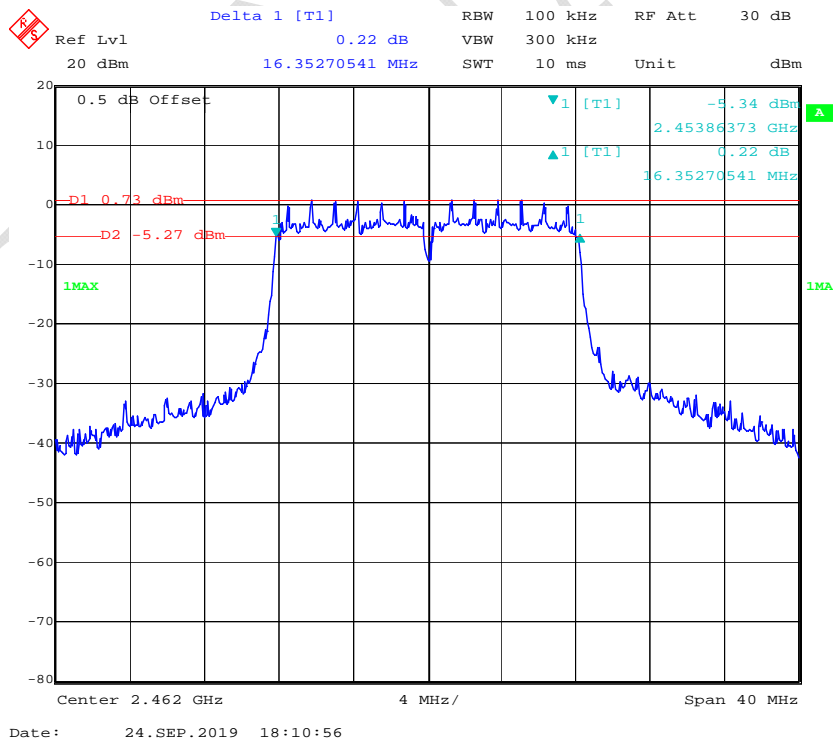
### 802.11g Low Channel



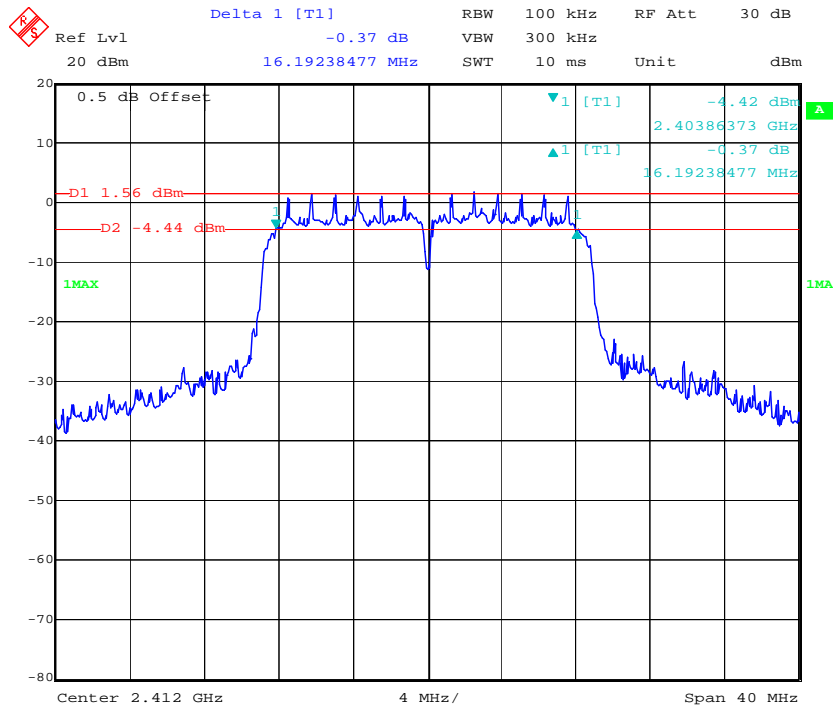
### 802.11g Middle Channel



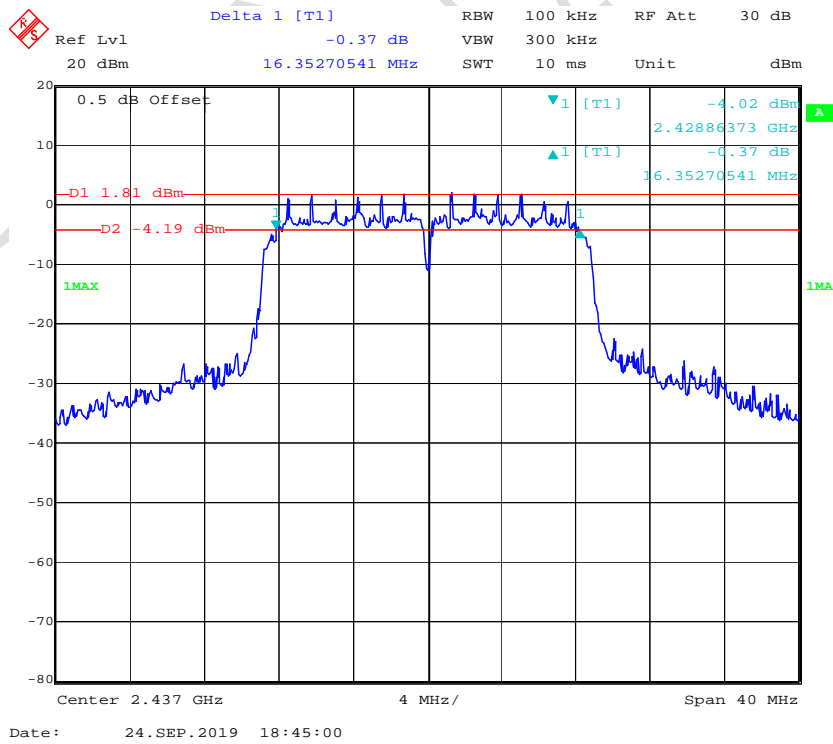
### 802.11g High Channel



### 802.11n20 Low Channel

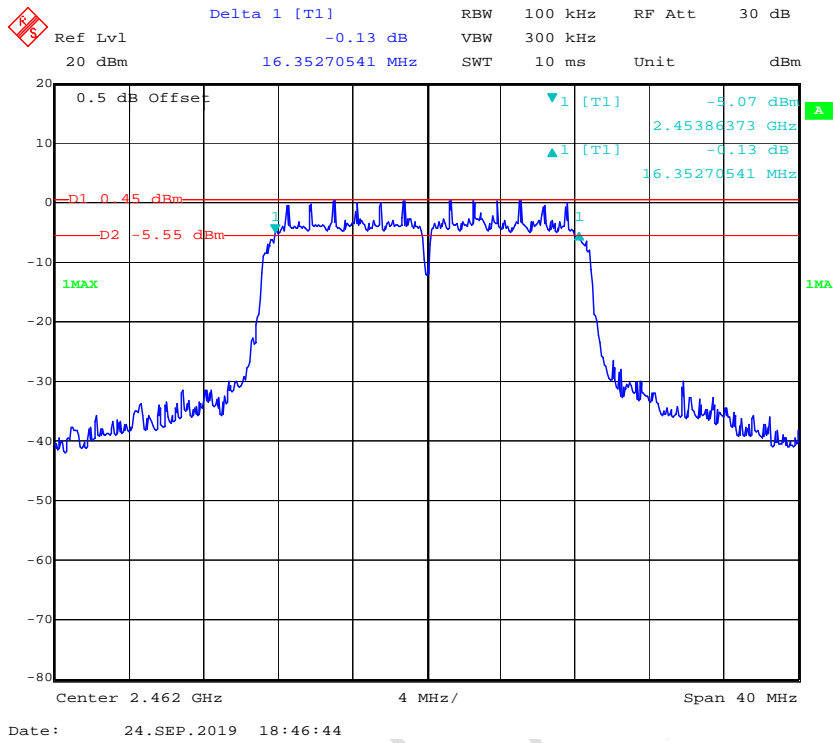


### 802.11n20 Middle Channel





### 802.11n20 High Channel



FEMN

## **FCC §15.247(b) (3) - MAXIMUM PEAK 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**

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to test equipment.
3. Add a correction factor to the display.
4. Set the power meter to test average output power, record the result as average power.



### **Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2018-12-10	2019-12-10
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

### **Test Data**

#### **Environmental Conditions**

<b>Temperature:</b>	23.4°C
<b>Relative Humidity:</b>	51%
<b>ATM Pressure:</b>	101.1kPa
<b>Test by:</b>	Severn Zhu
<b>Test Date:</b>	2019-09-24

*Test Mode: Transmitting*

*Test Result: Compliance. Please refer to the following table.*

<b>Mode</b>	<b>Frequency (MHz)</b>	<b>Maximum conducted Peak Output Power (dBm)</b>	<b>Limit (dBm)</b>
802.11 b	2412	20.01	30
	2437	21.19	30
	2462	22.37	30
802.11 g	2412	20.51	30
	2437	21.42	30
	2462	22.77	30
802.11n ht20	2412	21.34	30
	2437	21.51	30
	2462	22.05	30

FINAL

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

### **Applicable Standard**

According to FCC§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, 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**

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 Equipment List and Details**

<b>Manufacturer</b>	<b>Description</b>	<b>Model</b>	<b>Serial Number</b>	<b>Calibration Date</b>	<b>Calibration Due Date</b>
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-08-03	2020-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

**Test Data**

**Environmental Conditions**

<b>Temperature:</b>	23.4°C
<b>Relative Humidity:</b>	51%
<b>ATM Pressure:</b>	101.1kPa
<b>Test by:</b>	Severn Zhu
<b>Test Date:</b>	2019-09-24

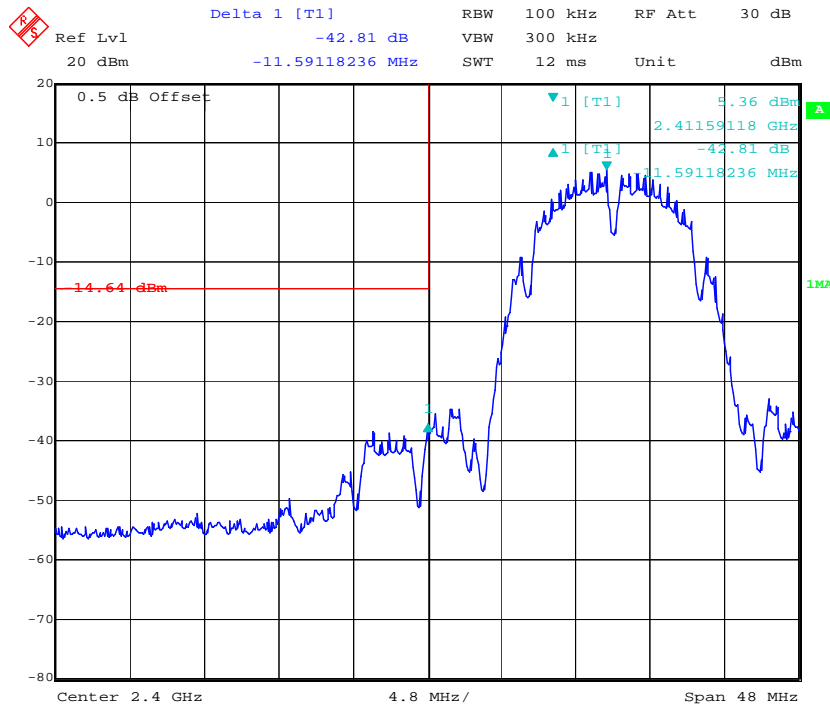
*Test mode: Transmitting*

*Test Result: Compliance. Please refer to following plots.*

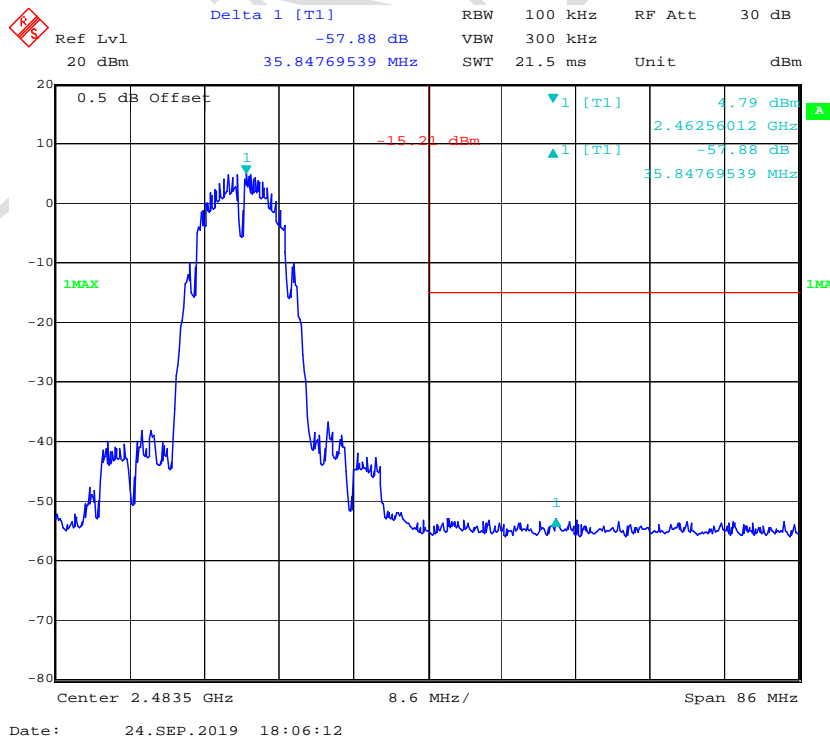
FUNIVAL

802.11b:

**Band Edge, Left Side**

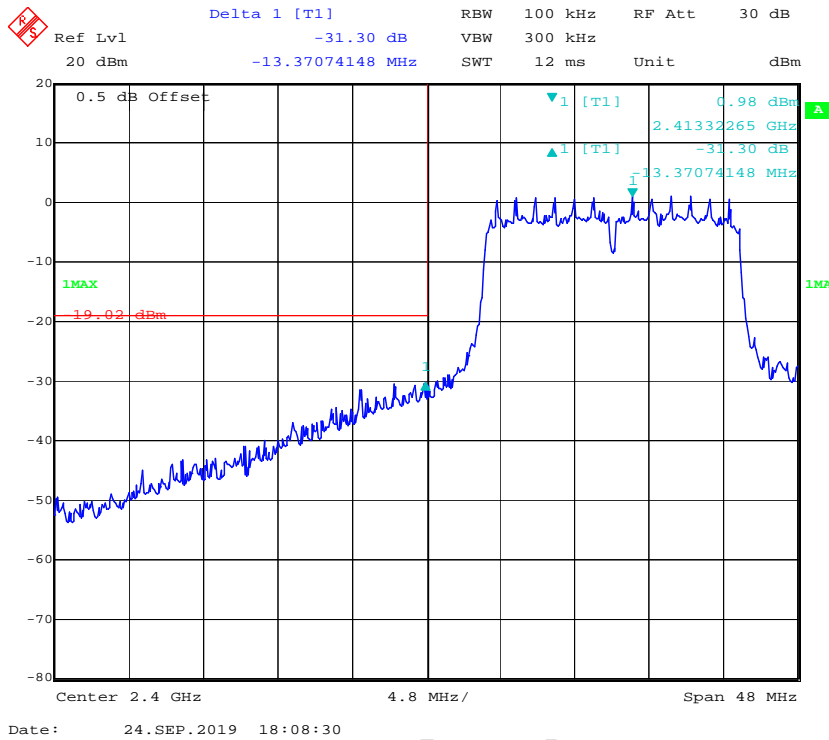


**Band Edge, Right Side**

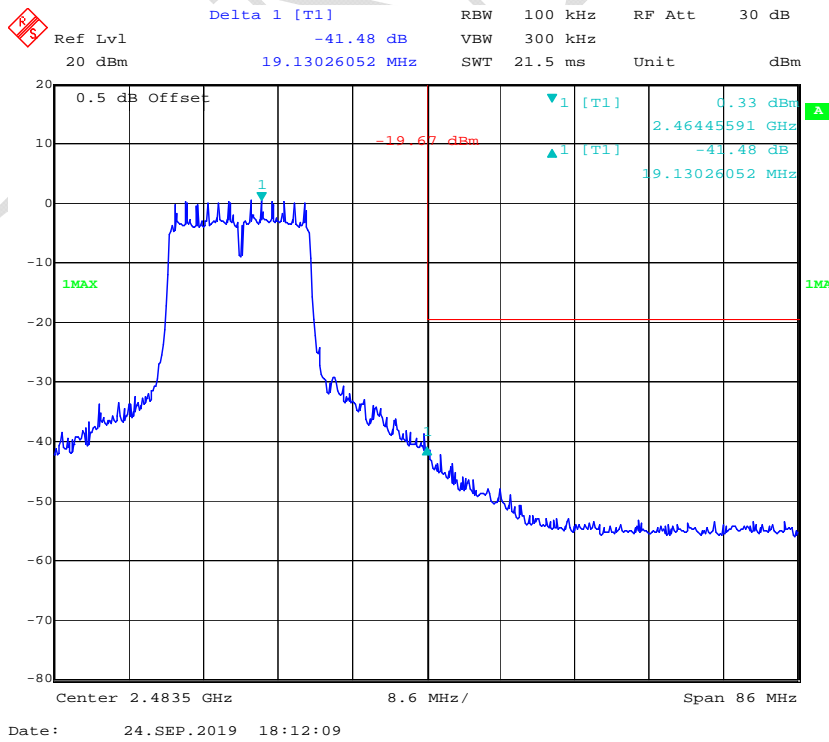


802.11g:

**Band Edge, Left Side**

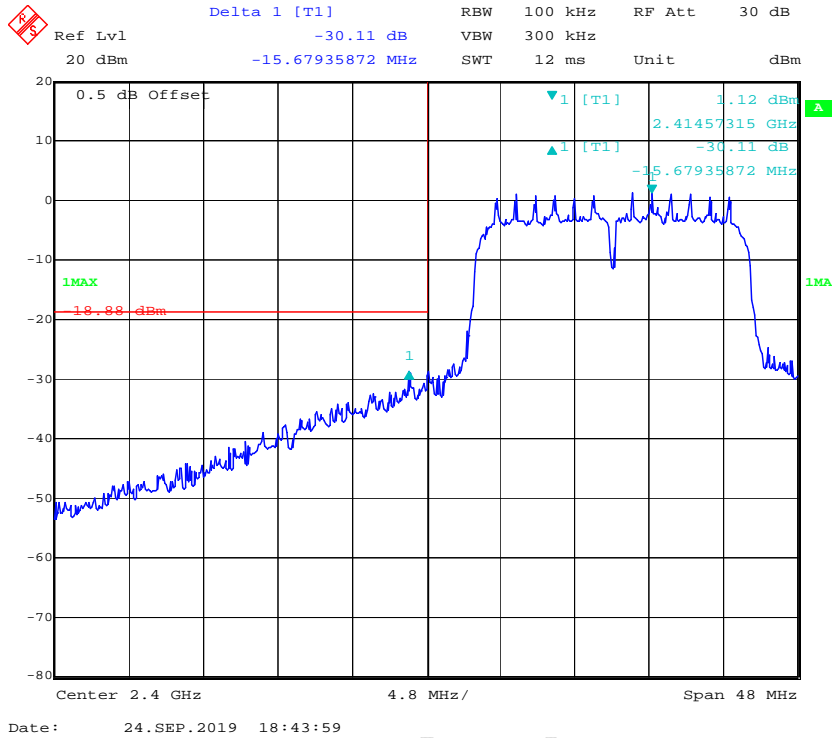


**Band Edge, Right Side**

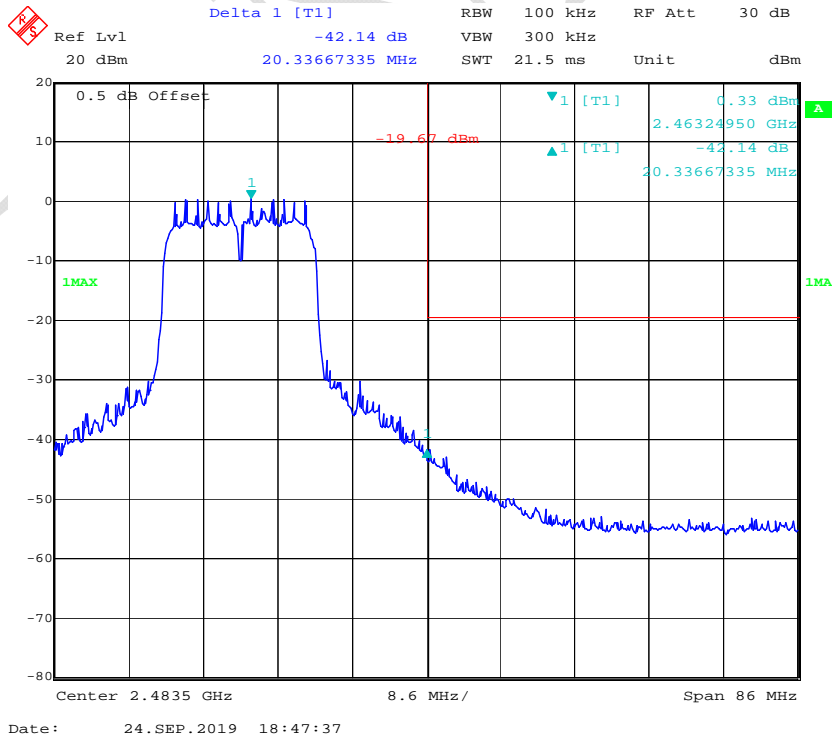


802.11n ht20:

Band Edge, Left Side



Band Edge, 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

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 was set 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 the RBW = 3 kHz, VBW = 10 kHz, Set the span to 1.5 times the DTS bandwidth.
4. Use the peak marker function to determine the maximum amplitude level.

### Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-08-03	2020-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

### Test Data

#### Environmental Conditions

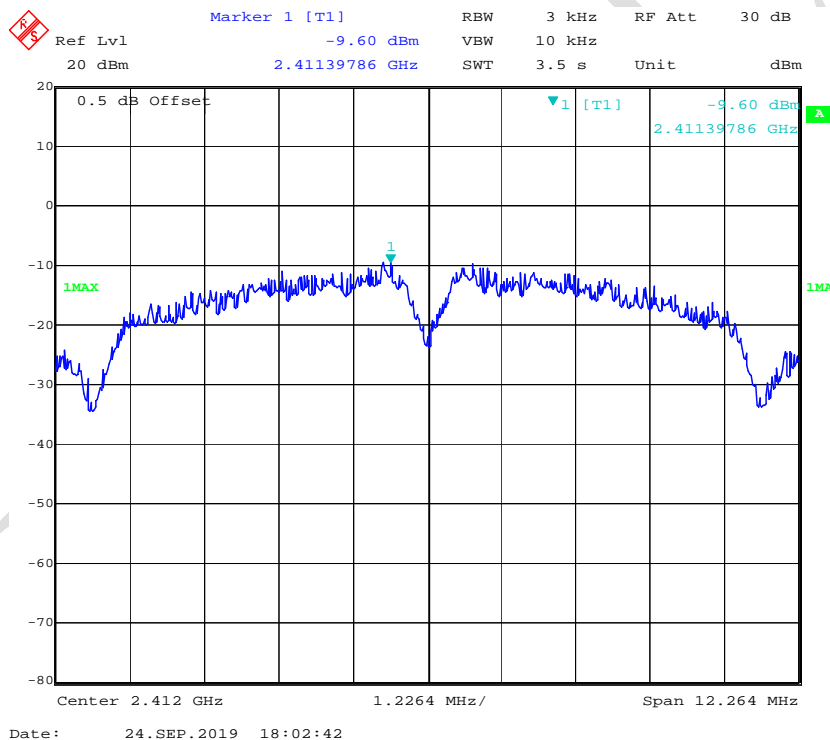
Temperature:	23.4°C
Relative Humidity:	51%
ATM Pressure:	101.1kPa
Test by:	Severn Zhu
Test Date:	2019-09-24

**Test Result:** Compliance, *Please refer to the following table and plots*

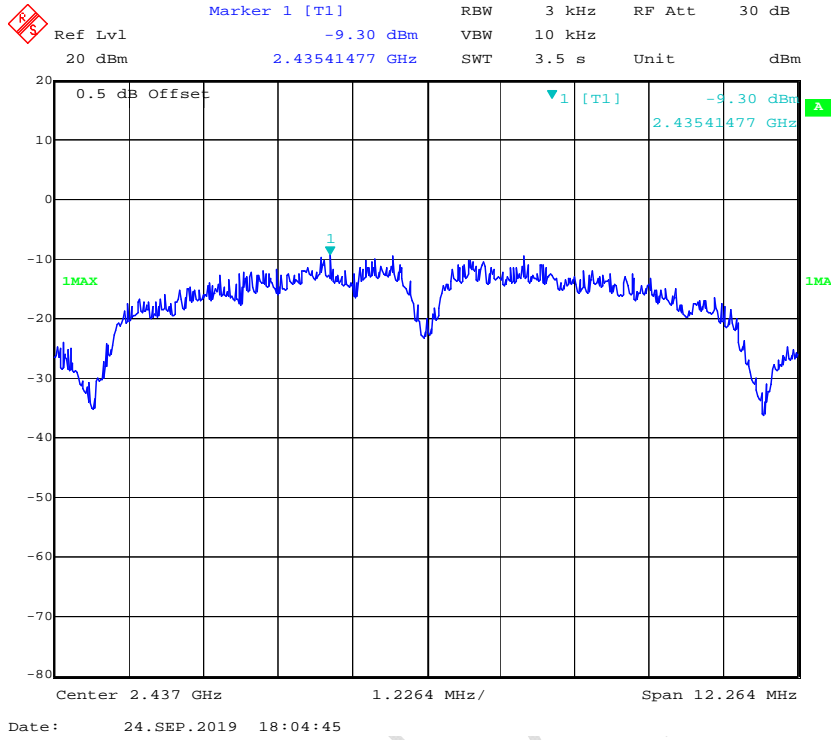
Test Mode: Transmitting

Test mode	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
802.11b	2412	-9.60	≤8
	2437	-9.30	≤8
	2462	-9.52	≤8
802.11g	2412	-13.61	≤8
	2437	-12.98	≤8
	2462	-14.13	≤8
802.11n20	2412	-13.70	≤8
	2437	-13.27	≤8
	2462	-14.46	≤8

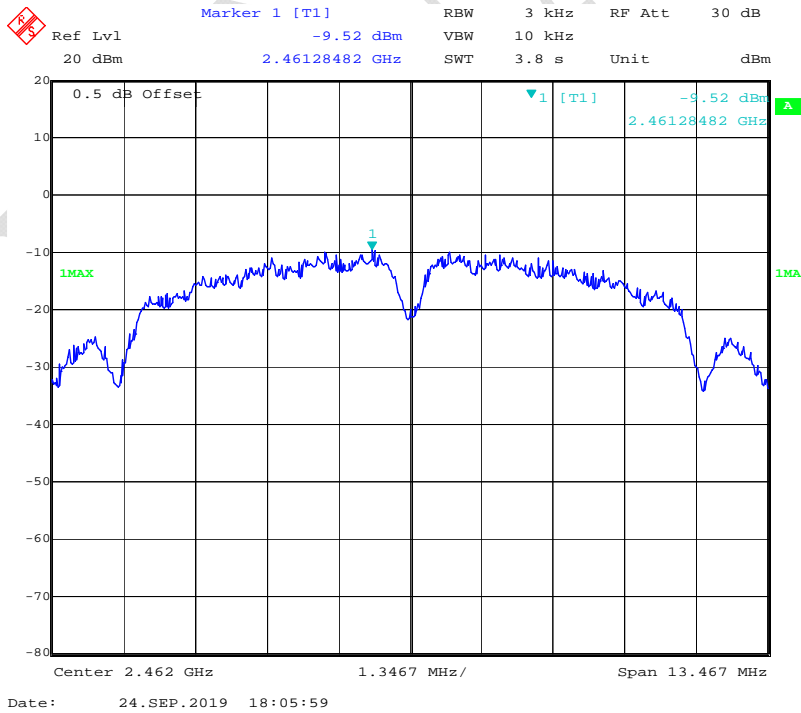
Power Spectral Density, 802.11b Low Channel



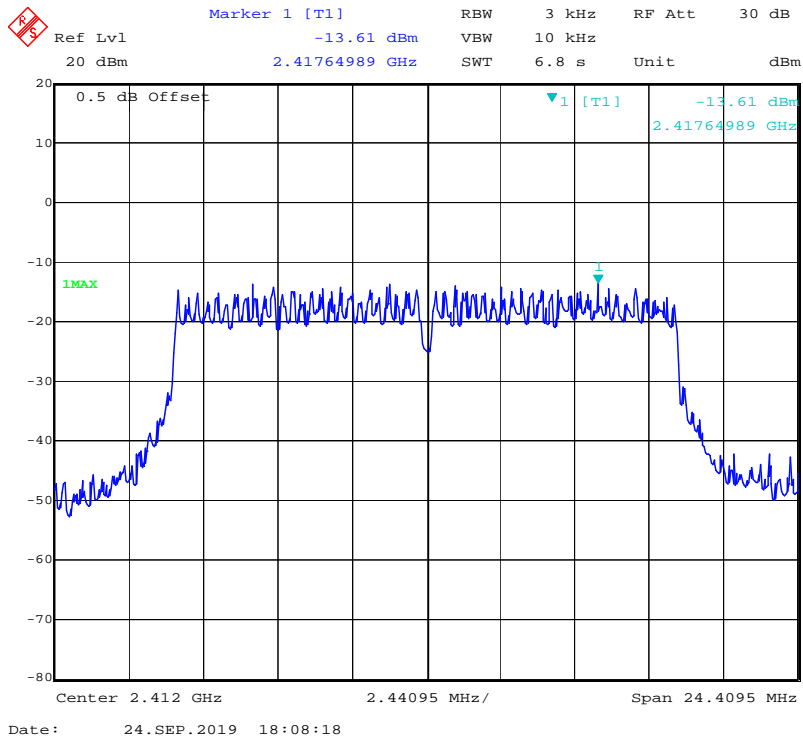
### Power Spectral Density, 802.11b Middle Channel



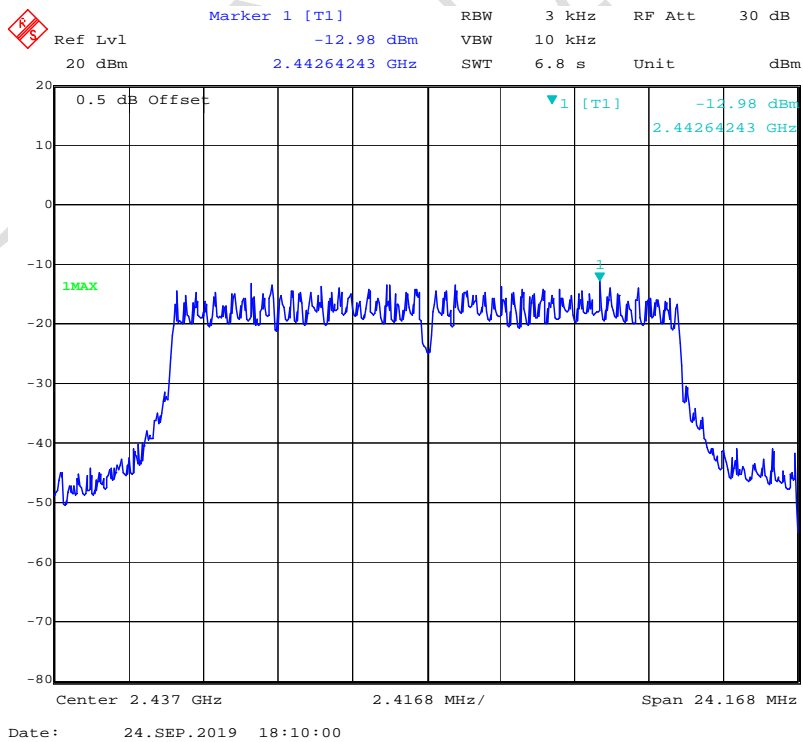
### Power Spectral Density, 802.11b High Channel



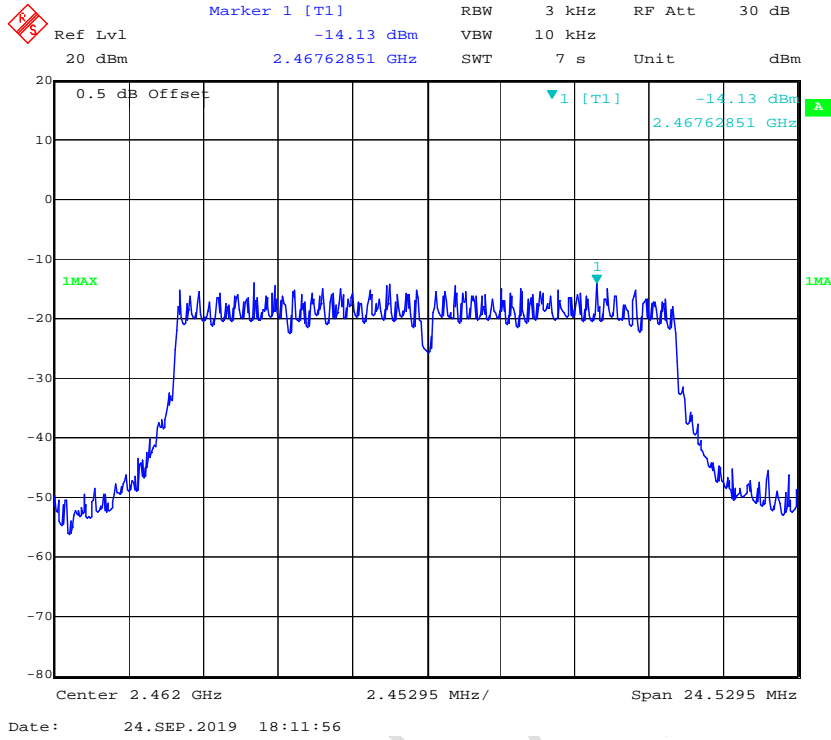
### Power Spectral Density, 802.11g Low Channel



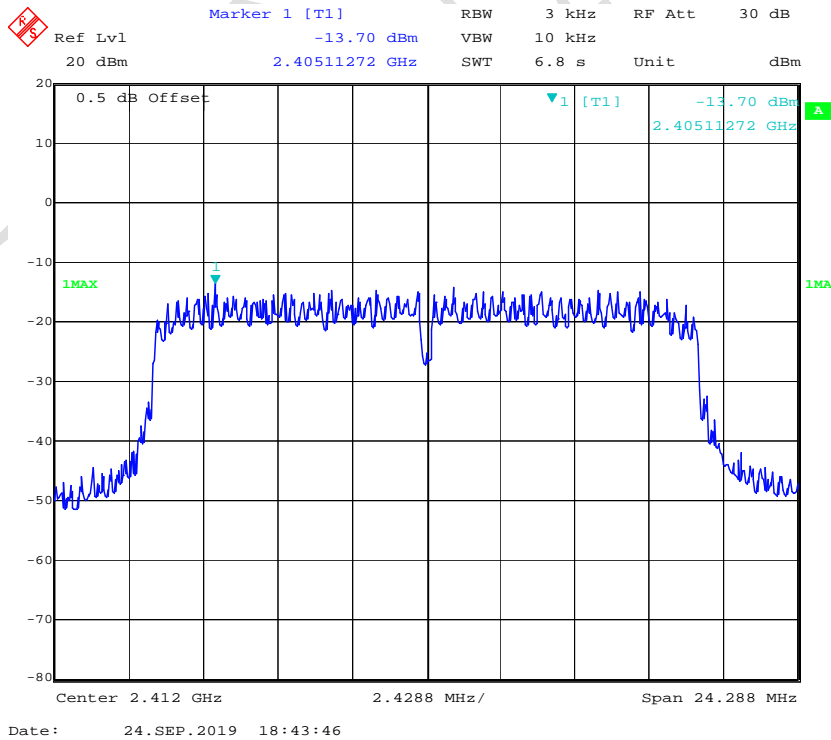
### Power Spectral Density, 802.11g Middle Channel



### Power Spectral Density, 802.11g High Channel

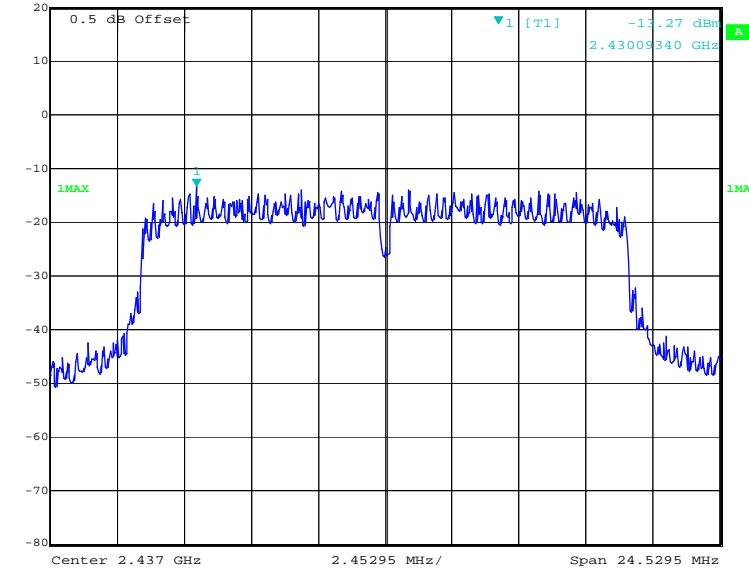


### Power Spectral Density, 802.11n20 Low Channel



**Power Spectral Density, 802.11n20 Middle Channel**

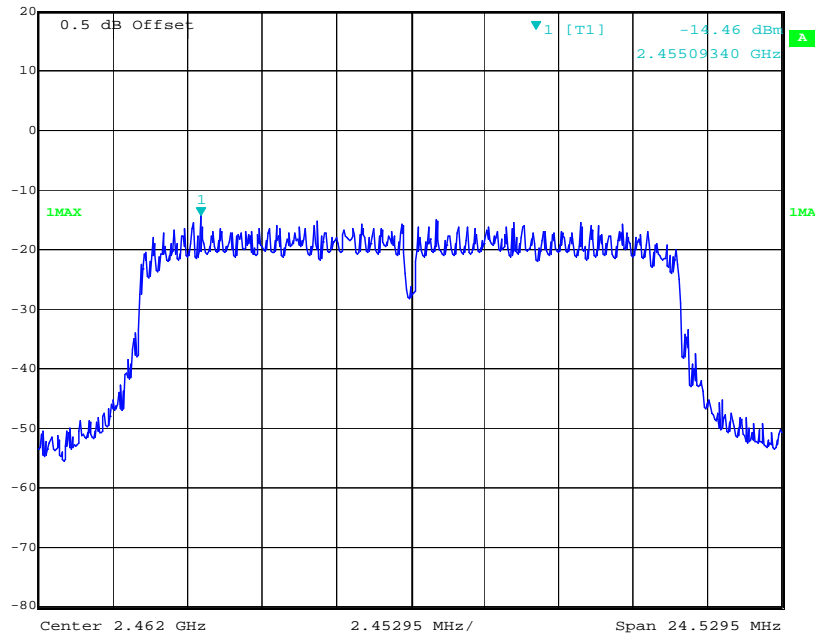
Marker 1 [T1] RBW 3 kHz RF Att 30 dB  
 Ref Lvl -13.27 dBm VBW 10 kHz  
 20 dBm 2.43009340 GHz SWT 7 s Unit dBm



Date: 24.SEP.2019 18:46:04

**Power Spectral Density, 802.11n20 High Channel**

Marker 1 [T1] RBW 3 kHz RF Att 30 dB  
 Ref Lvl -14.46 dBm VBW 10 kHz  
 20 dBm 2.45509340 GHz SWT 7 s Unit dBm



Date: 24.SEP.2019 18:47:24

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