



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 15.247 TEST REPORT

For

Raymarine UK Ltd.

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FCC ID: PJ5-RAY90W

Report Type: Original Report	Product Name: Ray90/91 Wireless Handset
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Report Date: 2018-06-21	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	Ray90/91 Wireless Handset
EUT Model:	R70616
FCC ID:	PJ5-RAY90W
Rated Input Voltage:	DC 3.7V
External Dimension:	152.68mm(L)*67.56mm(W)*35.91mm(H)
Serial Number:	180212002
EUT Received Date:	2018.02.12

Objective

This report is prepared on behalf of *Raymarine UK 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 DSS submissions with FCC ID: PJ5-RAY90W.
Submitted with the part of a system with FCC ID: PJ5-RAYCGR

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 KDB 558074 D01 DTS Meas Guidance v04.

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)

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 test site has been approved by the FCC 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 test site has been registered with ISED Canada under ISED Canada Registration Number 3062D.

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 mode was 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.

For Bluetooth LE mode, 40 channels are provided for testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	...	...
...	...	...	...
...	...	...	...
..	...	38	2478
19	2440	39	2480

EUT was tested with channel 0, 19 and 39.

EUT Exercise Software

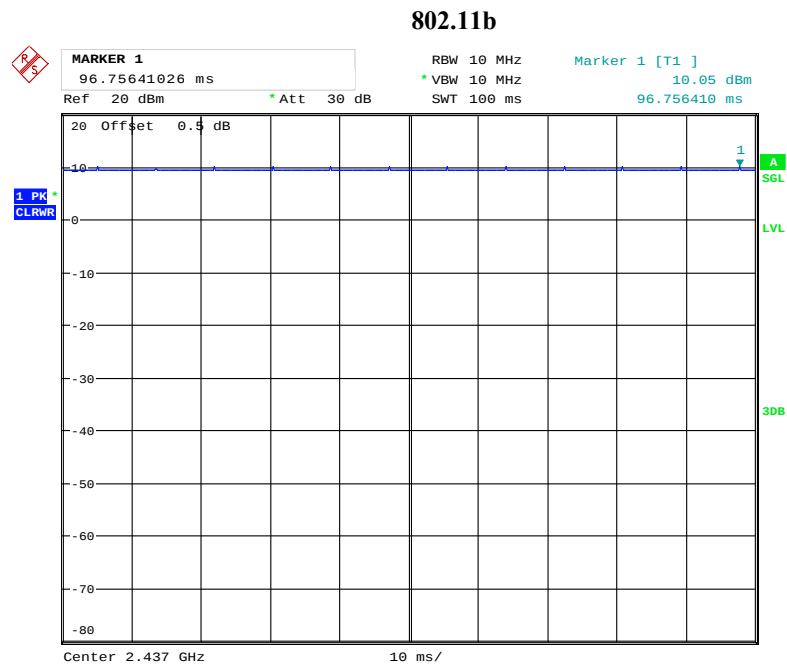
The software "esp RFTTool.exe" as used for testing, which was provided by manufacturer. The maximum power was configured as below table, that provided by the manufacturer:

Mode	Channel	Frequency (MHz)	Data Rate	Power level
802.11b	Low	2412	1 Mbps	default
	Middle	2437	1 Mbps	default
	High	2462	1 Mbps	default

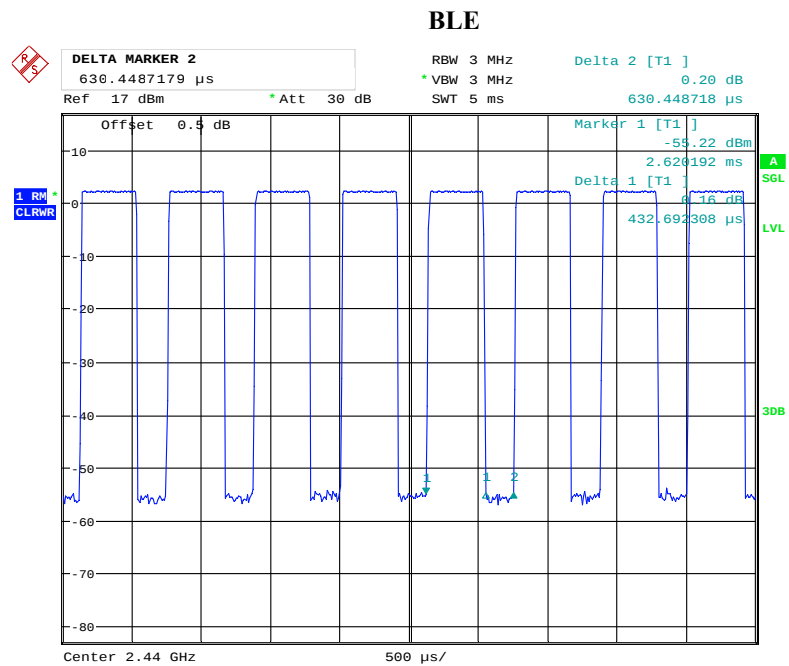
Bluetooth LE mode was configured by software "CSR BlueSuite 2.5.0.exe" default setting

The maximum duty cycle as following table:

Test mode	T _{on} (ms)	T _{on+off} (ms)	Duty Cycle (%)
802.11b	100	100	100
BLE	0.432	0.630	68.57



Date: 21.JUN.2018 09:16:54



Date: 1.JUN.2018 15:50:00

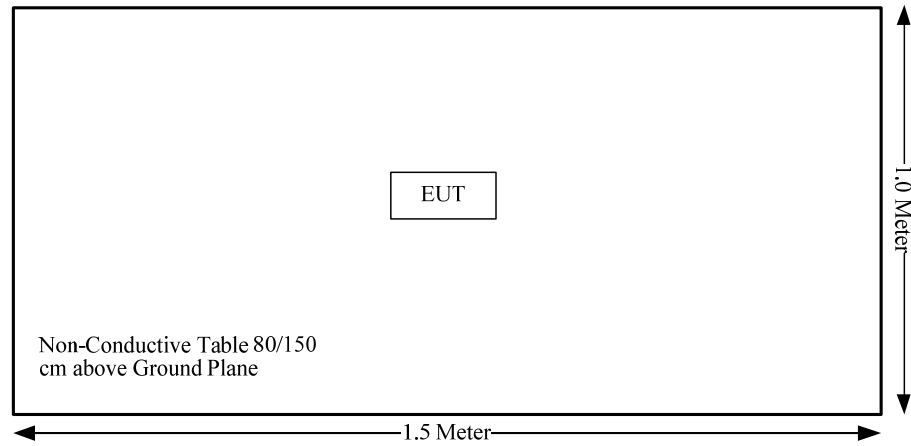
Equipment Modifications

No modification was made to the EUT.

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From	To
/	/	/	/	/	/

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i) & §1.1310 & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Not Applicable
§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

Not Applicable: The EUT is powered by DC.

FCC §15.247 (i) & §1.1310 & §2.1093- RF EXPOSURE

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 ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB447498 D01 General RF Exposure Guidance v06:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria: $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$, for test separation distances ≤ 50 mm; where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

Measurement Result

The EUT is hand portable.

BLE: The max conducted power including tune-up tolerance is 4.0 dBm (2.51 mW).

$[(\text{max. power of channel, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$
 $= 2.51 / 5 \cdot (\sqrt{2.480}) = 0.8 < 7.5$

BT: The max conducted power including tune-up tolerance is 7.0 dBm (5.01 mW).

$[(\text{max. power of channel, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$
 $= 5.01 / 5 \cdot (\sqrt{2.480}) = 1.6 < 7.5$

Wi-Fi: The max conducted power including tune-up tolerance is 12.0 dBm (15.85 mW).

$[(\text{max. power of channel, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$
 $= 15.85 / 5 \cdot (\sqrt{2.462}) = 4.97 < 7.5$

So the stand-alone SAR evaluation is not necessary.

Simultaneous transmitting consideration:

When the standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas,

BLE: The max conducted power including tune-up tolerance is 4.0 dBm (2.51 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][$\sqrt{f(\text{GHz})/18.75}$] W/kg
 $=2.51/5*(\sqrt{2.480/18.75}) = 0.04 \text{ W/kg}$

BT: The max conducted power including tune-up tolerance is 7.0 dBm (5.01 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][$\sqrt{f(\text{GHz})/18.75}$] W/kg
 $=5.01/5*(\sqrt{2.480/18.75}) = 0.08 \text{ W/kg}$

Wi-Fi: The max conducted power including tune-up tolerance is 12.0 dBm (15.85 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][$\sqrt{f(\text{GHz})/18.75}$] W/kg
 $=15.85/5*(\sqrt{2.462/18.75}) = 0.27 \text{ W/kg}$

BT and BLE use the same antenna, and power of BT is higher than BLE.

So, Estimated SAR value (BT)+ Estimated SAR value (Wi-Fi)=0.35 W/kg <4.0 W/kg

So the SAR test is not necessary.

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:

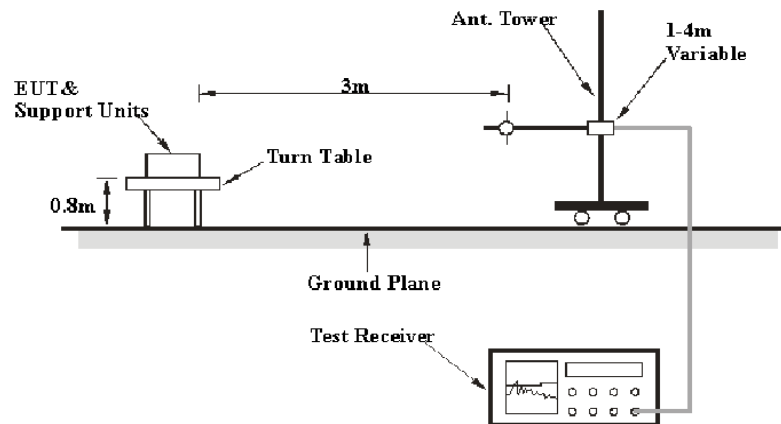
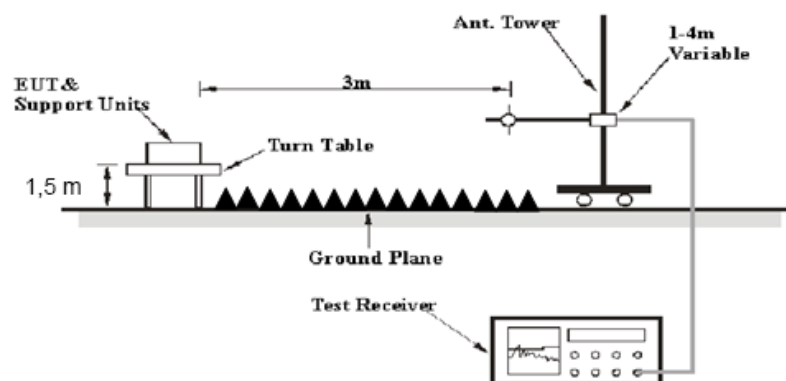
- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.
- c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

Antenna Connector Construction

Manufacture	Manufacture	Antenna Type	Antenna Gain	Result
Raymarine UK Limited	Wi-Fi	PCB	2 dBi	Compliance
	BLE	Monopole	2 dBi	Compliance

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 test site 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

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
R&S	EMI Test Receiver	ESCI	100035	2017-08-04	2018-08-04
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2019-07-21
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2017-09-05	2018-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-02	2017-09-05	2018-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-2200-01	2017-09-05	2018-09-05
HP	Amplifier	8447F	2443A01912	2017-09-05	2018-09-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-01-04	2019-01-04
ETS-Lindgren	Horn Antenna	3115	000 527 35	2016-01-05	2019-01-04
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	2017-09-05	2018-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2017-06-27	2018-06-27
MITEQ	Amplifier	AFS42-00101800- 25-S-42	2001271	2017-09-05	2018-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2017-06-27	2018-06-27
E-Microwave	Band-stop Filters	OBSF-2400-2483.5- S	OE01601525	2017-06-16	2018-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2017-06-16	2018-06-16

* **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**

Temperature:	28.9 °C
Relative Humidity:	39 %
ATM Pressure:	101.3 kPa

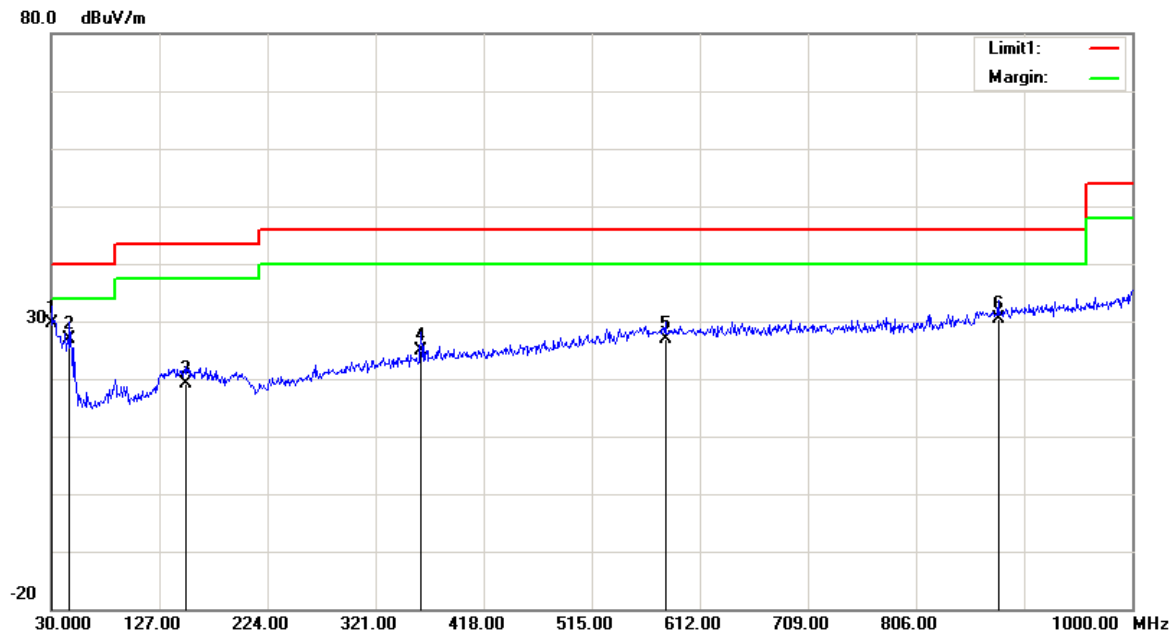
* The testing was performed by Tylay Pan on 2018-06-06.

Test Result: Compliance, please Refer to the following data

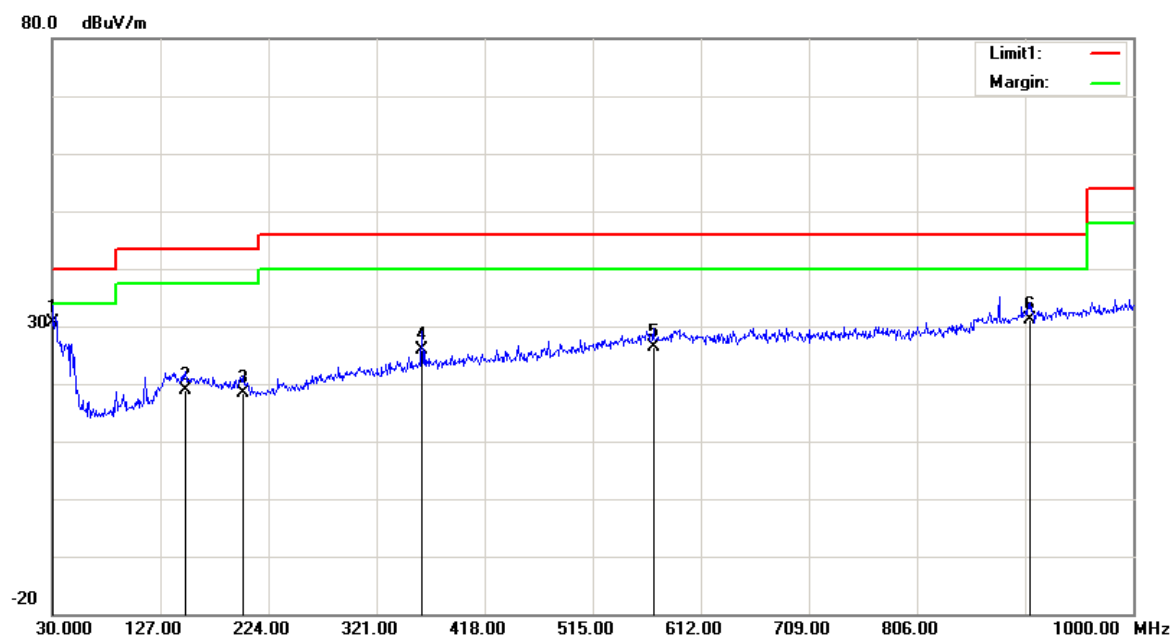
Test Mode: Transmitting

1) 30MHz-1GHz (802.11b mode Low 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	31.59	QP	-1.99	29.60	40.00	10.40
46.4900	37.84	QP	-10.94	26.90	40.00	13.10
150.2800	26.10	QP	-6.90	19.20	43.50	24.30
361.7400	28.19	QP	-3.19	25.00	46.00	21.00
580.9600	24.42	QP	2.48	26.90	46.00	19.10
879.7200	23.30	QP	7.20	30.50	46.00	15.50

Vertical:

Frequency (MHz)	Receiver Reading (dBuV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.0000	32.59	QP	-1.99	30.60	40.00	9.40
149.3100	25.89	QP	-6.89	19.00	43.50	24.50
200.7200	25.49	QP	-6.99	18.50	43.50	25.00
361.7400	29.19	QP	-3.19	26.00	46.00	20.00
569.3200	24.18	QP	2.32	26.50	46.00	19.50
907.8500	23.43	QP	7.67	31.10	46.00	14.90

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

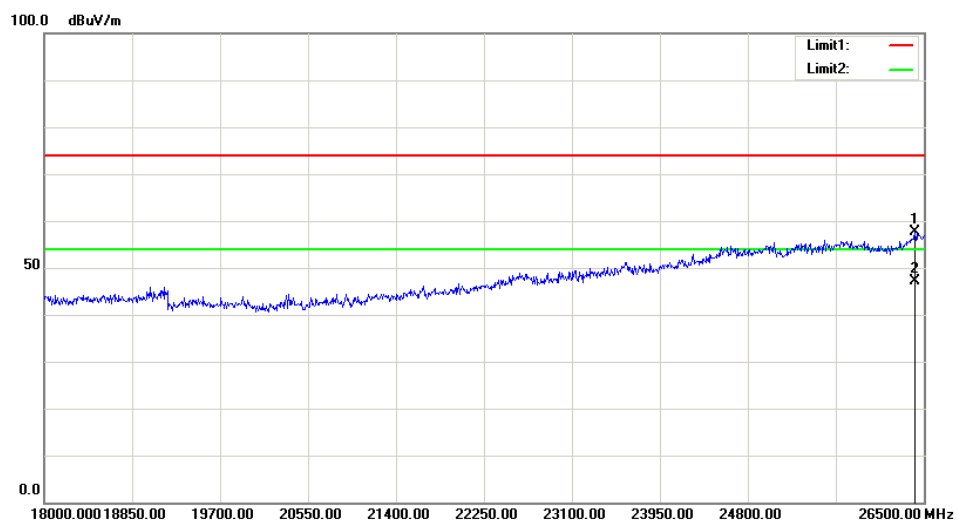
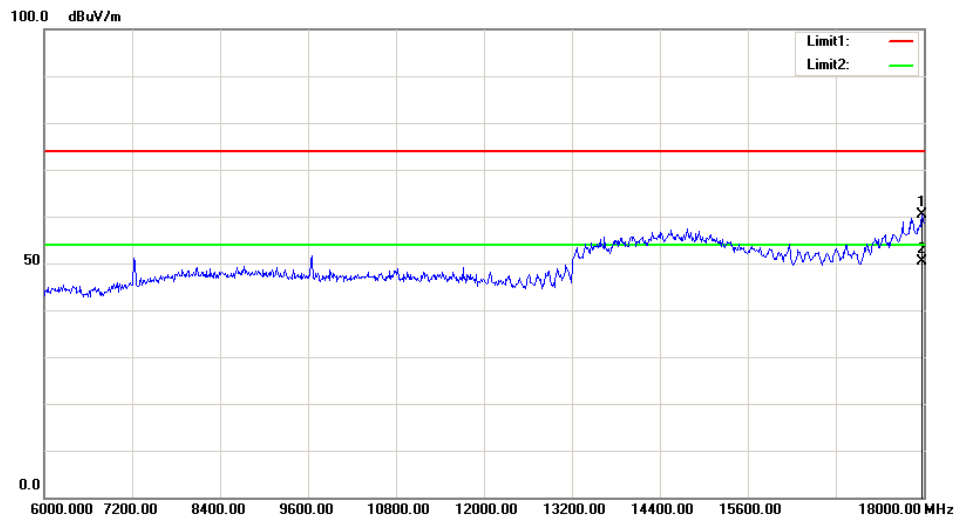
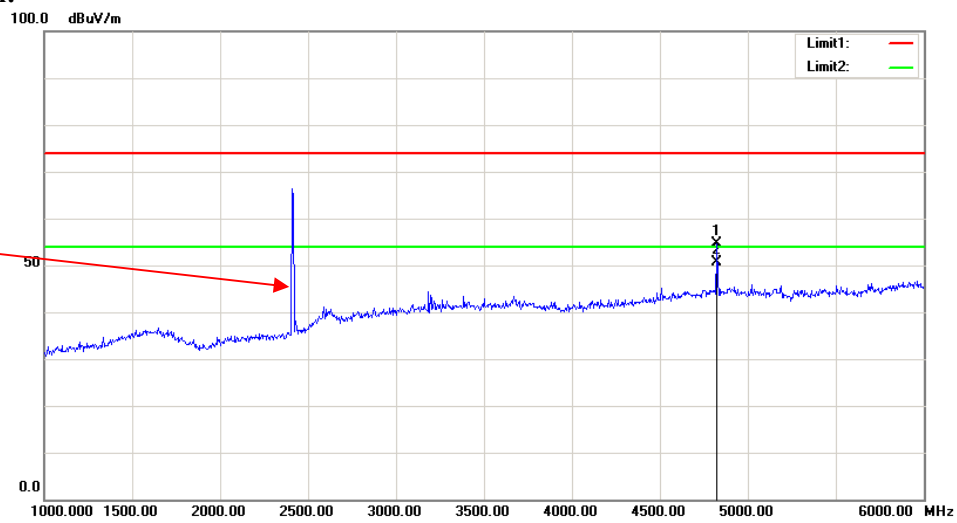
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Measurement	Polar (H/V)	Factor (dB/m)					
Low Channel: 2412 MHz									
2412.00	62.14	PK	H	28.12	1.81	0.00	92.07	N/A	N/A
2412.00	58.77	AV	H	28.12	1.81	0.00	88.70	N/A	N/A
2412.00	70.53	PK	V	28.12	1.81	0.00	100.46	N/A	N/A
2412.00	67.03	AV	V	28.12	1.81	0.00	96.96	N/A	N/A
2390.00	27.47	PK	V	28.08	1.80	0.00	57.35	74.00	16.65
2390.00	17.03	AV	V	28.08	1.80	0.00	46.91	54.00	7.09
4824.00	57.08	PK	V	32.95	3.19	37.20	56.02	74.00	17.98
4824.00	53.18	AV	V	32.95	3.19	37.20	52.12	54.00	1.88
7236.00	47.68	PK	V	35.81	4.77	37.27	50.99	74.00	23.01
7236.00	36.98	AV	V	35.81	4.77	37.27	40.29	54.00	13.71
Middle Channel: 2437 MHz									
2437.00	61.08	PK	H	28.17	1.82	0.00	91.07	N/A	N/A
2437.00	57.97	AV	H	28.17	1.82	0.00	87.96	N/A	N/A
2437.00	70.86	PK	V	28.17	1.82	0.00	100.85	N/A	N/A
2437.00	67.49	AV	V	28.17	1.82	0.00	97.48	N/A	N/A
4874.00	56.12	PK	V	33.05	3.26	37.21	55.22	74.00	18.78
4874.00	52.57	AV	V	33.05	3.26	37.21	51.67	54.00	2.33
7311.00	48.91	PK	V	36.01	4.64	37.36	52.20	74.00	21.80
7311.00	39.99	AV	V	36.01	4.64	37.36	43.28	54.00	10.72
High Channel: 2462 MHz									
2462.00	58.99	PK	H	28.22	1.83	0.00	89.04	N/A	N/A
2462.00	54.55	AV	H	28.22	1.83	0.00	84.60	N/A	N/A
2462.00	70.14	PK	V	28.22	1.83	0.00	100.19	N/A	N/A
2462.00	67.31	AV	V	28.22	1.83	0.00	97.36	N/A	N/A
2483.50	28.49	PK	V	28.27	1.84	0.00	58.60	74.00	15.40
2483.50	18.68	AV	V	28.27	1.84	0.00	48.79	54.00	5.21
4924.00	55.67	PK	V	33.15	3.27	37.22	54.87	74.00	19.13
4924.00	52.14	AV	V	33.15	3.27	37.22	51.34	54.00	2.66
7386.00	47.28	PK	V	36.20	4.51	37.46	50.53	74.00	23.47
7386.00	35.14	AV	V	36.20	4.51	37.46	38.39	54.00	15.61

BLE Mode:

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Measurement	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	57.86	PK	H	28.10	1.80	0.00	87.76	N/A	N/A
2402.00	54.38	AV	H	28.10	1.80	0.00	84.28	N/A	N/A
2402.00	63.25	PK	V	28.10	1.80	0.00	93.15	N/A	N/A
2402.00	58.81	AV	V	28.10	1.80	0.00	88.71	N/A	N/A
2390.00	26.09	PK	V	28.08	1.80	0.00	55.97	74.00	18.03
2390.00	14.35	AV	V	28.08	1.80	0.00	44.23	54.00	9.77
4804.00	55.16	PK	V	32.91	3.17	37.20	54.04	74.00	19.96
4804.00	48.04	AV	V	32.91	3.17	37.20	46.92	54.00	7.08
7206.00	50.55	PK	V	35.74	4.82	37.23	53.88	74.00	20.12
7206.00	42.72	AV	V	35.74	4.82	37.23	46.05	54.00	7.95
Middle Channel: 2440 MHz									
2440.00	57.63	PK	H	28.18	1.82	0.00	87.63	N/A	N/A
2440.00	54.41	AV	H	28.18	1.82	0.00	84.41	N/A	N/A
2440.00	62.53	PK	V	28.18	1.82	0.00	92.53	N/A	N/A
2440.00	58.16	AV	V	28.18	1.82	0.00	88.16	N/A	N/A
4880.00	58.43	PK	V	33.06	3.27	37.21	57.55	74.00	16.45
4880.00	50.66	AV	V	33.06	3.27	37.21	49.78	54.00	4.22
7320.00	51.95	PK	V	36.03	4.62	37.37	55.23	74.00	18.77
7320.00	43.03	AV	V	36.03	4.62	37.37	46.31	54.00	7.69
High Channel: 2480 MHz									
2480.00	57.67	PK	H	28.26	1.84	0.00	87.77	N/A	N/A
2480.00	53.12	AV	H	28.26	1.84	0.00	83.22	N/A	N/A
2480.00	61.85	PK	V	28.26	1.84	0.00	91.95	N/A	N/A
2480.00	57.04	AV	V	28.26	1.84	0.00	87.14	N/A	N/A
2483.50	25.65	PK	V	28.27	1.84	0.00	55.76	74.00	18.24
2483.50	13.92	AV	V	28.27	1.84	0.00	44.03	54.00	9.97
4960.00	57.31	PK	V	33.22	3.23	37.25	56.51	74.00	17.49
4960.00	49.52	AV	V	33.22	3.23	37.25	48.72	54.00	5.28
7440.00	51.18	PK	V	36.34	4.41	37.52	54.41	74.00	19.59
7440.00	42.96	AV	V	36.34	4.41	37.52	46.19	54.00	7.81

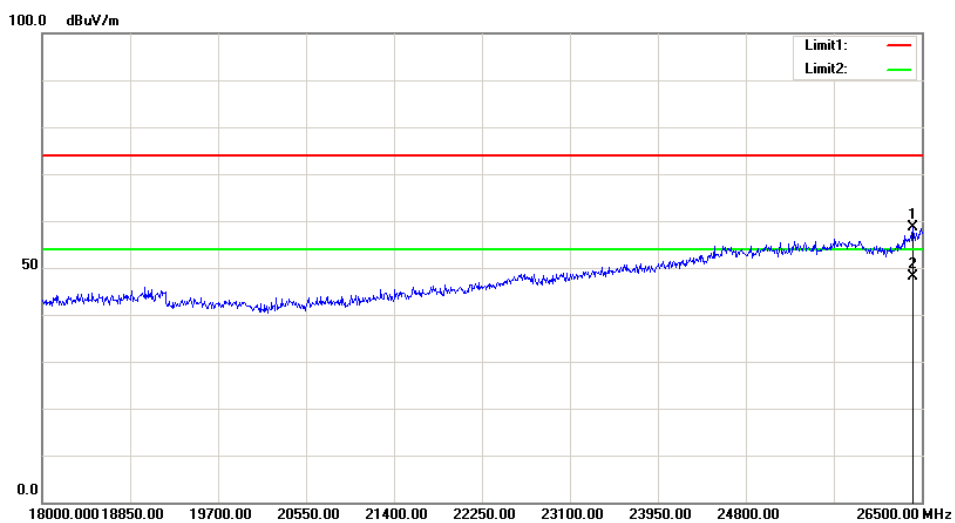
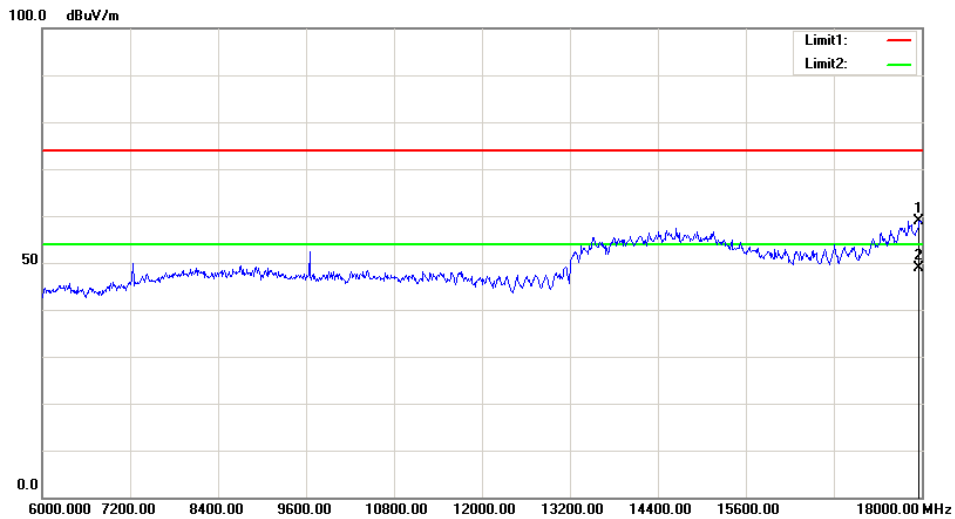
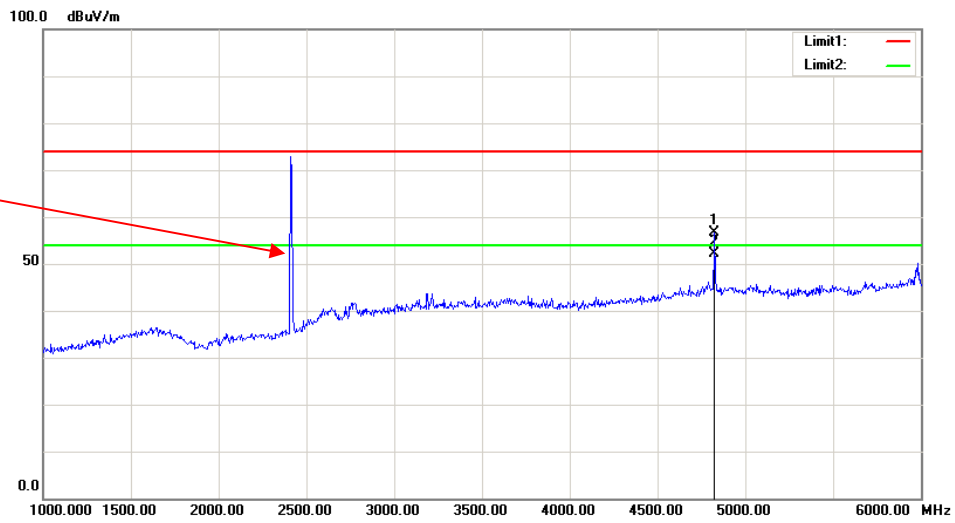
Test plots(802.11 b mode middle channel was the worst)
Horizontal:

Fundamental
Test with Band
Rejection Filter



Vertical:

Fundamental
Test with Band
Rejection Filter



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

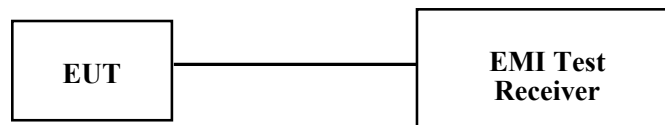
Applicable Standard

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

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- 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
R&S	EMI Test Receiver	ESPI	100120	2017-12-11	2018-12-11
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
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:	26.1 ~ 27.4 °C
Relative Humidity:	53 ~ 61 %
ATM Pressure:	101.2 ~ 101.9 kPa

* The testing was performed by Nami Quan on 2018-06-01 to 2018-06-14.

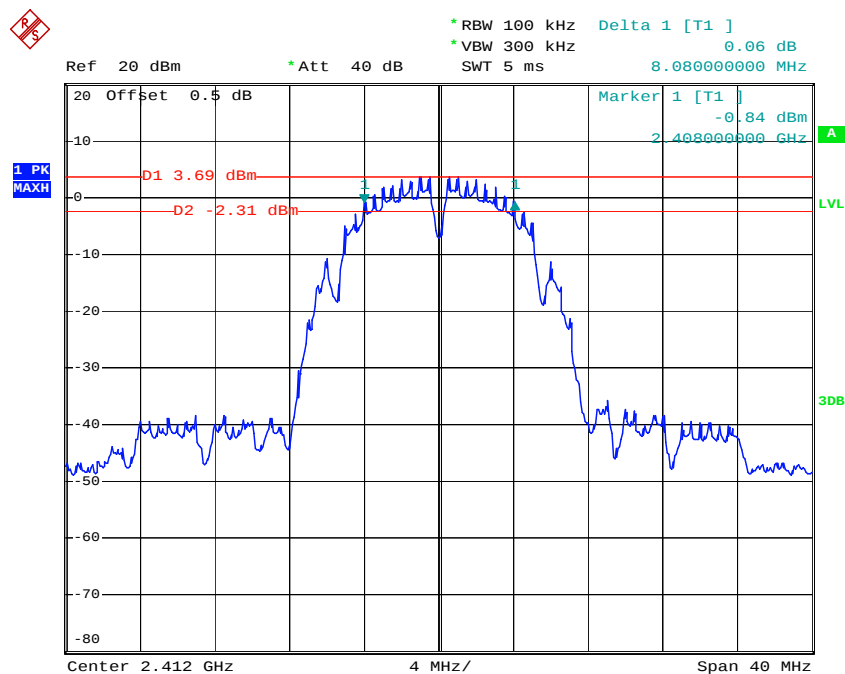
Test Mode: Transmitting

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	8.08	≥ 0.5
	Middle	2437	8.16	≥ 0.5
	High	2462	8.00	≥ 0.5
BLE	Low	2402	0.66	≥ 0.5
	Middle	2440	0.66	≥ 0.5
	High	2480	0.66	≥ 0.5

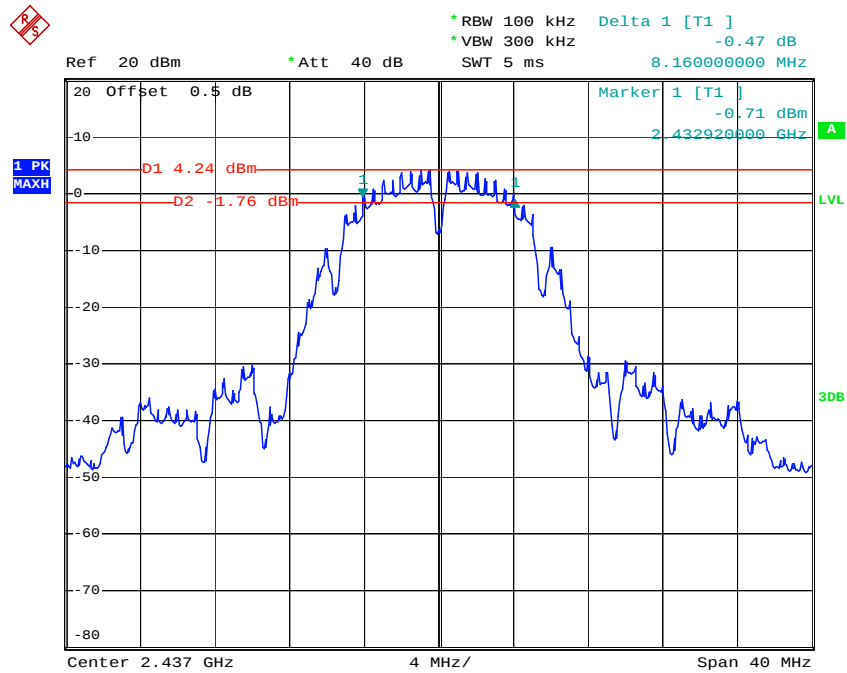
6dB bandwidth:

802.11b Low Channel



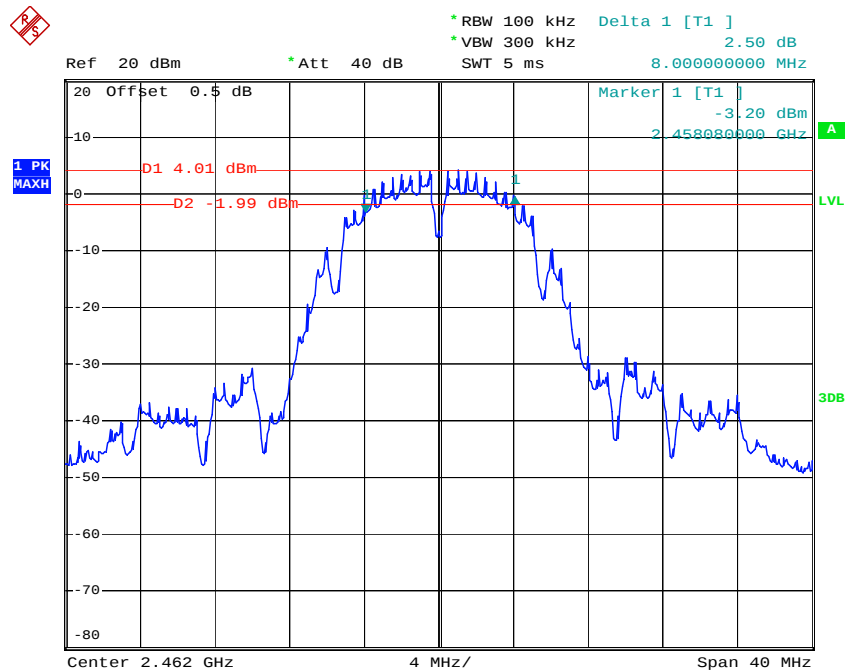
Date: 14.JUN.2018 15:55:43

802.11b Middle Channel



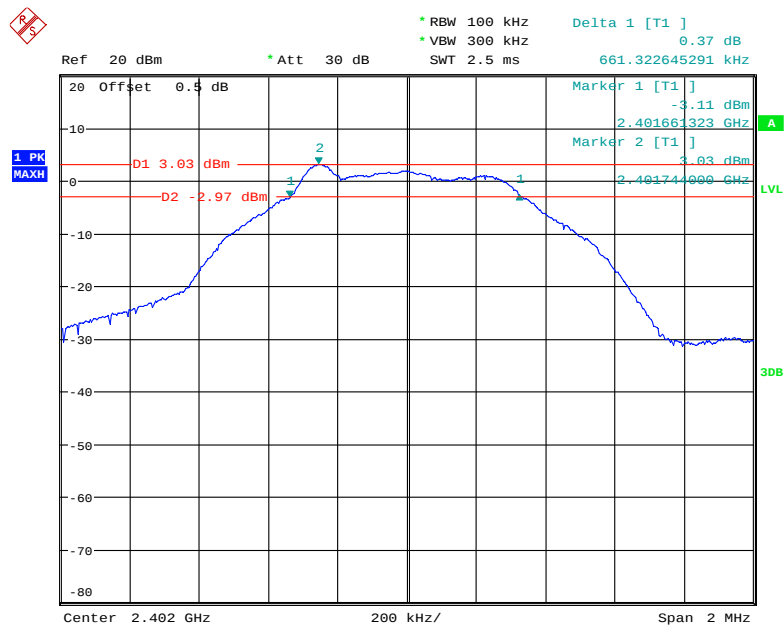
Date: 14.JUN.2018 16:04:42

802.11b High Channel



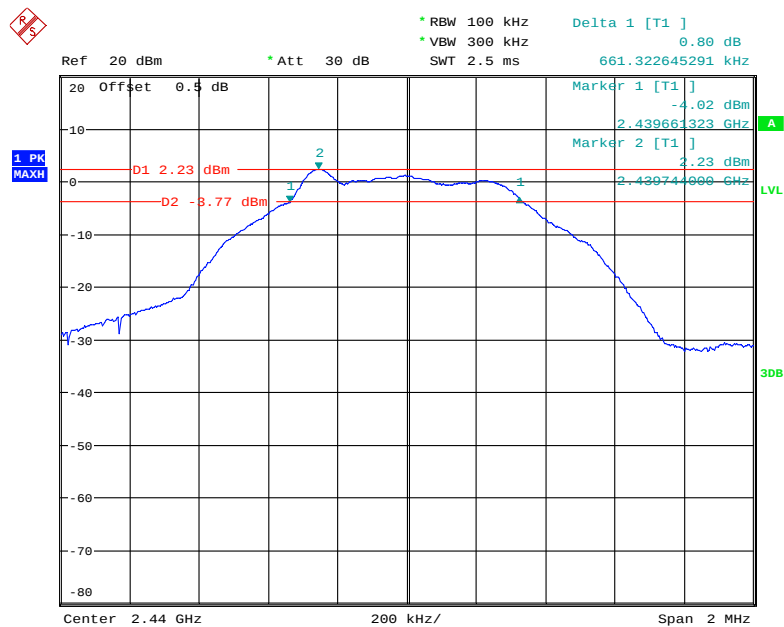
Date: 14.JUN.2018 16:07:45

BLE Low Channel



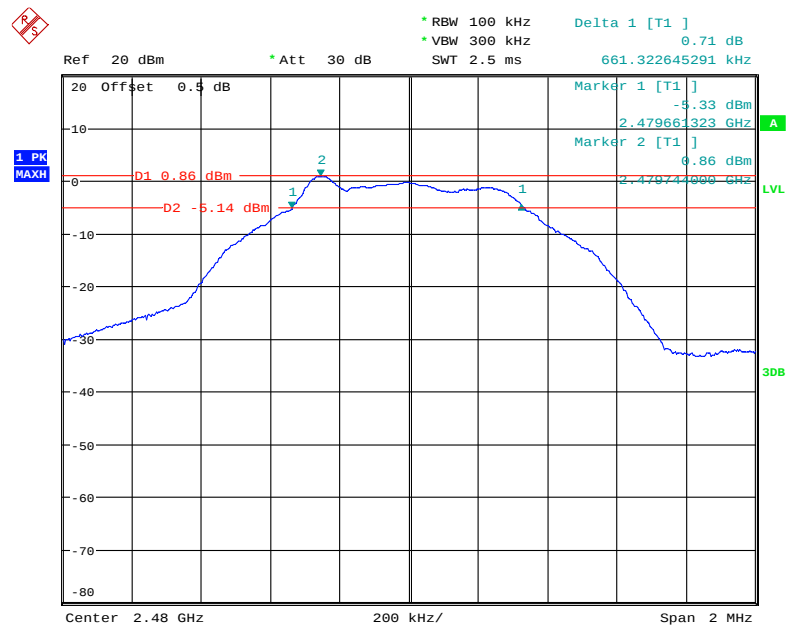
Date: 1.JUN.2018 16:10:21

BLE Middle Channel



Date: 1.JUN.2018 16:14:33

BLE High Channel



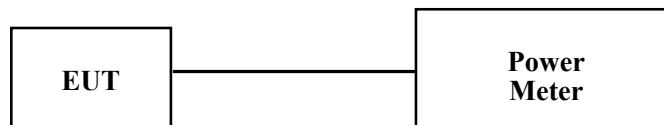
Date: 1.JUN.2018 16:19:21

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 Peak output power, record the result as peak power.
5. 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	2017-12-11	2018-12-11
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	/

* **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:	26.1 °C
Relative Humidity:	56 %
ATM Pressure:	101.4 kPa

* The testing was performed by Nami Quan on 2018-06-01.

Test Mode: Transmitting

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

Test mode	Channel	Frequency (MHz)	Max Peak Conducted Output Power (dBm)	Max Conducted Average Output Power (dBm)	Limit (dBm)
802.11b	Low	2412	14.70	11.46	30
	Middle	2437	15.27	11.96	30
	High	2462	14.82	11.53	30
BLE	Low	2402	3.40	/	30
	Middle	2440	2.57	/	30
	High	2480	1.18	/	30

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

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESPI	100120	2017-12-11	2018-12-11
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
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).

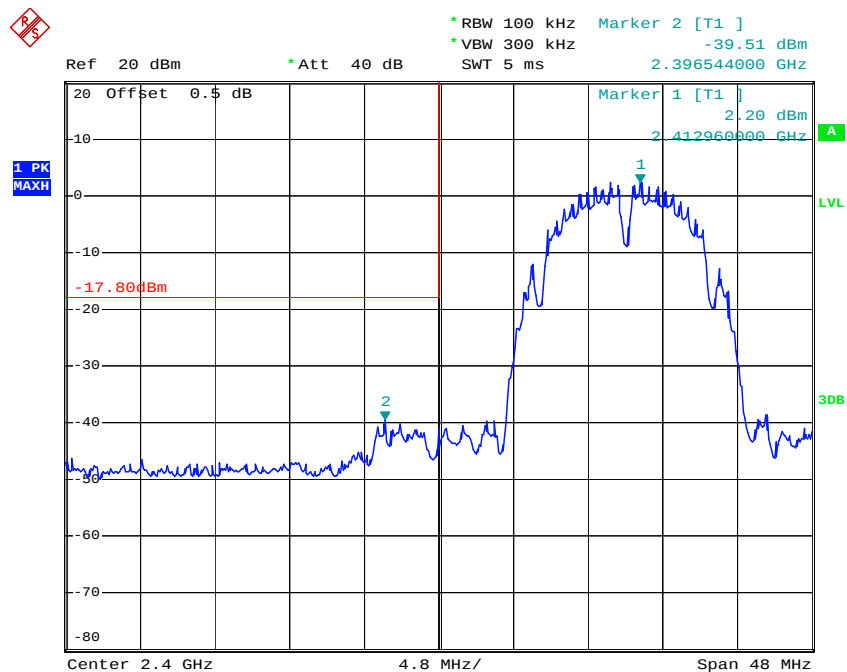
Test Data**Environmental Conditions**

Temperature:	26.1 ~ 27.4 °C
Relative Humidity:	53 ~ 61 %
ATM Pressure:	101.2 ~ 101.9 kPa

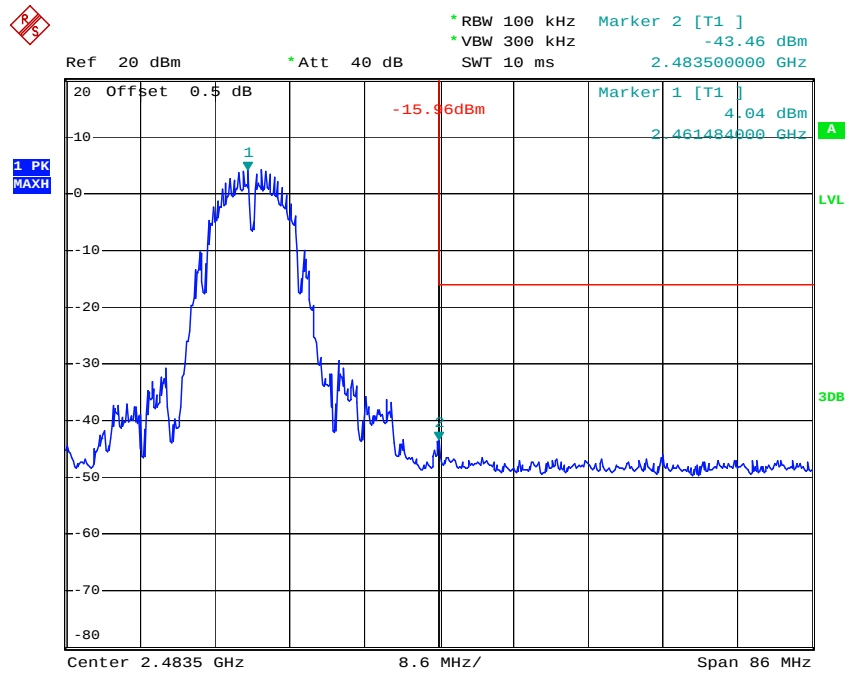
* The testing was performed by Nami Quan from 2018-06-01 to 2018-06-14.

Test mode: Transmitting

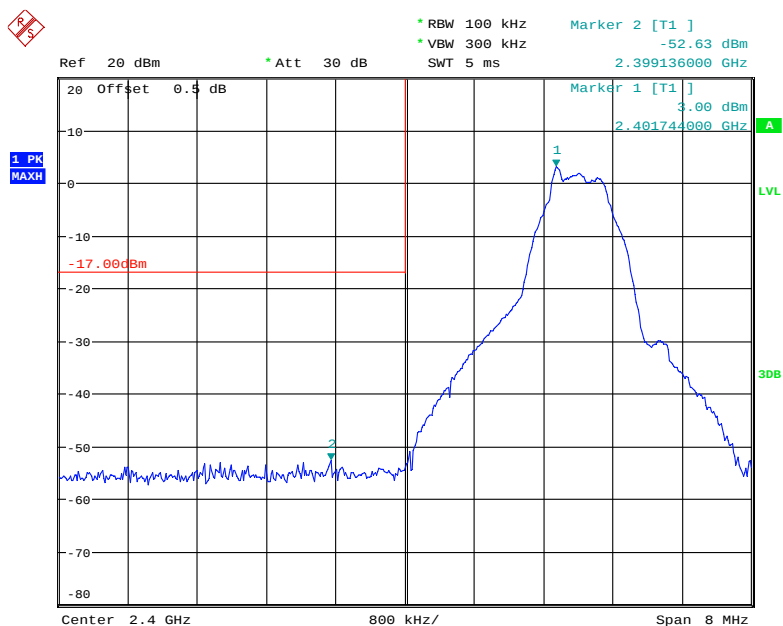
Test Result: Compliance. Please refer to following plots.

802.11b: Band Edge, Left Side

Date: 14. JUN. 2018 15:57:35

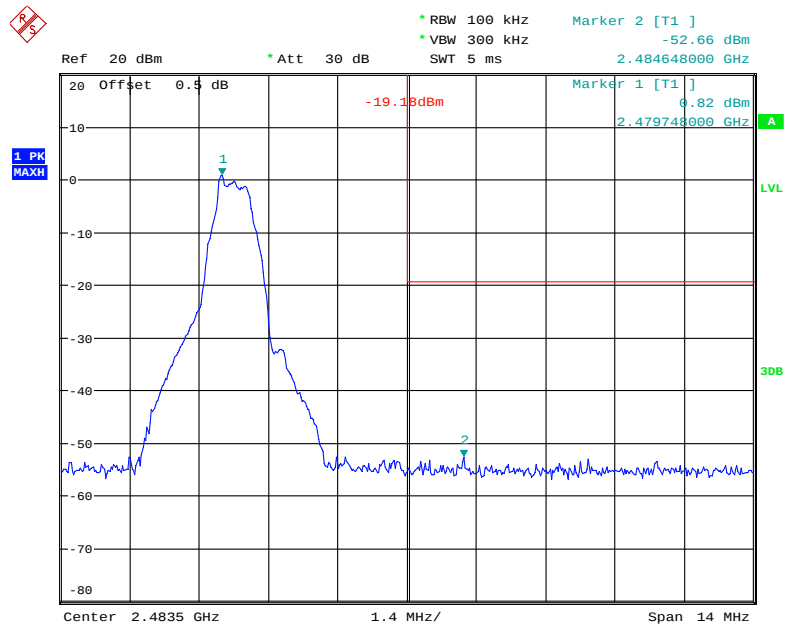
802.11b: Band Edge, Right Side

Date: 14.JUN.2018 16:09:33

BLE Band Edge, Left Side

Date: 1.JUN.2018 16:12:41

BLE Band Edge, Right Side



Date: 1.JUN.2018 16:22:10

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
R&S	EMI Test Receiver	ESPI	100120	2017-12-11	2018-12-11
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
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

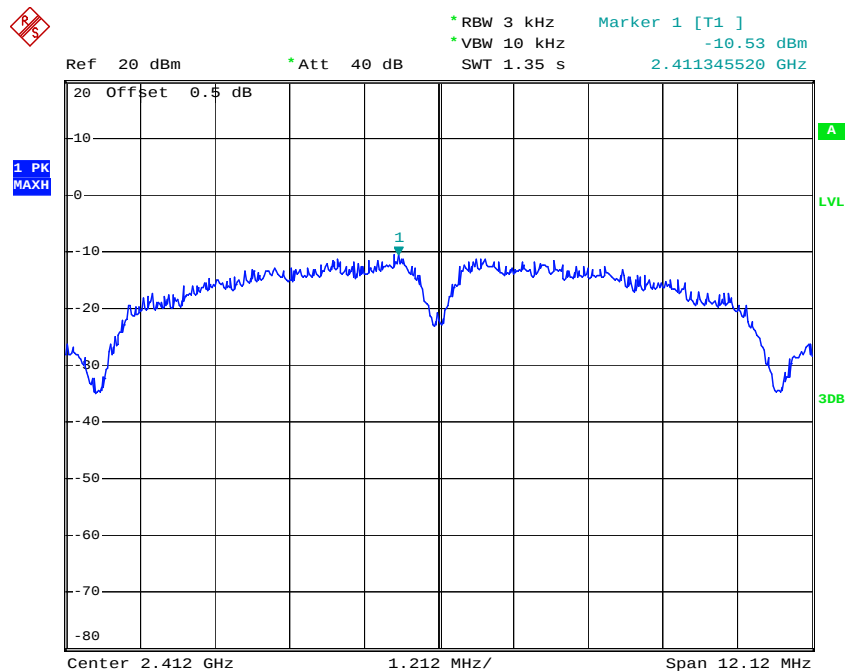
Environmental Conditions

Temperature:	26.1 ~ 27.4 °C
Relative Humidity:	53 ~ 61 %
ATM Pressure:	101.2 ~ 101.9 kPa

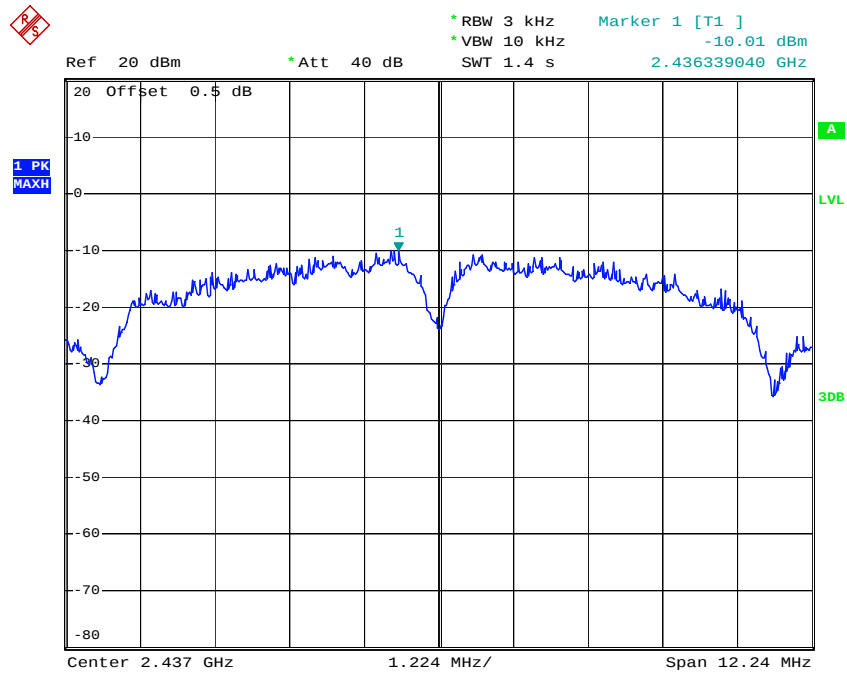
* The testing was performed by Nami Quan from 2018-06-01 to 2018-06-14.

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

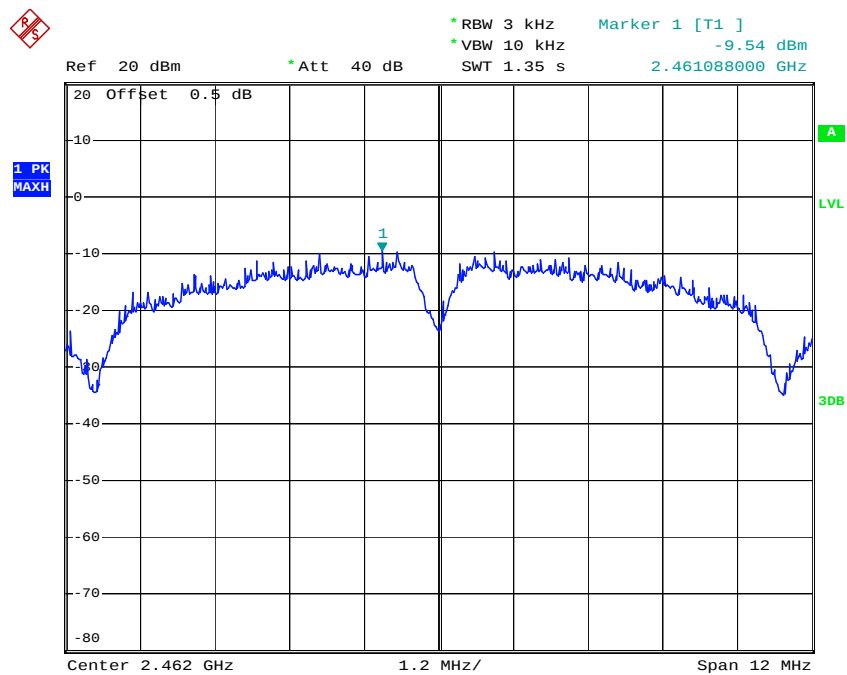
Test mode	Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b	Low	2412	-10.53	≤8
	Middle	2437	-10.01	≤8
	High	2462	-9.54	≤8
BLE	Low	2402	-12.50	≤8
	Middle	2440	-13.25	≤8
	High	2480	-14.70	≤8

Power Spectral Density, 802.11b Low Channel

Date: 14.JUN.2018 15:57:00

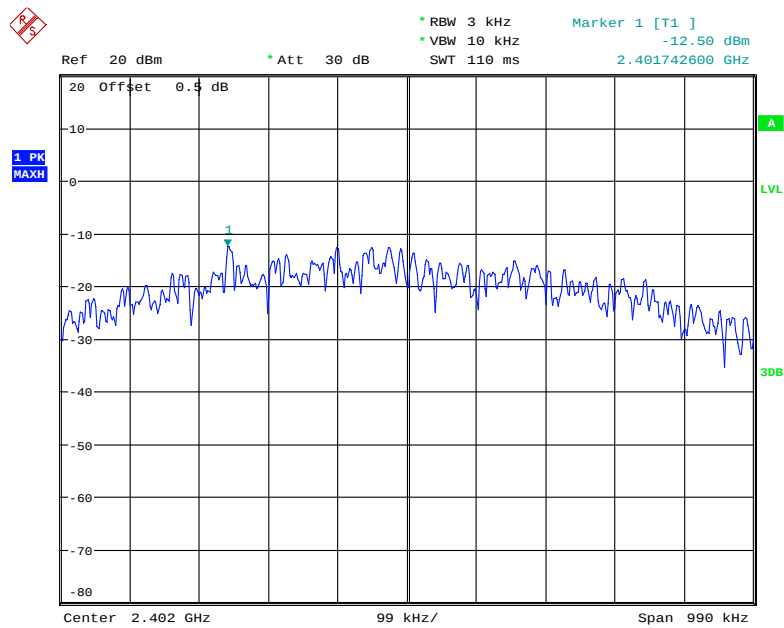
Power Spectral Density, 802.11b Middle Channel

Date: 14.JUN.2018 16:05:50

Power Spectral Density, 802.11b High Channel

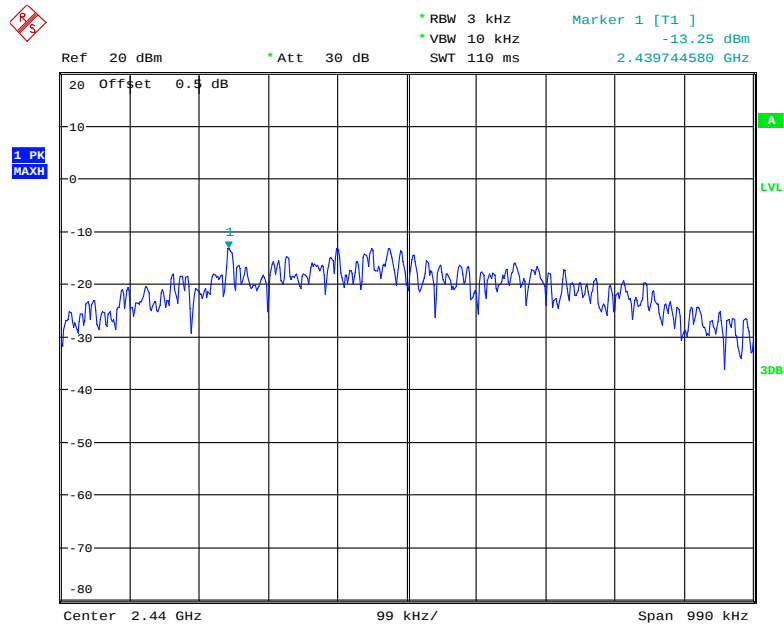
Date: 14.JUN.2018 16:09:03

Power Spectral Density, BLE Low Channel



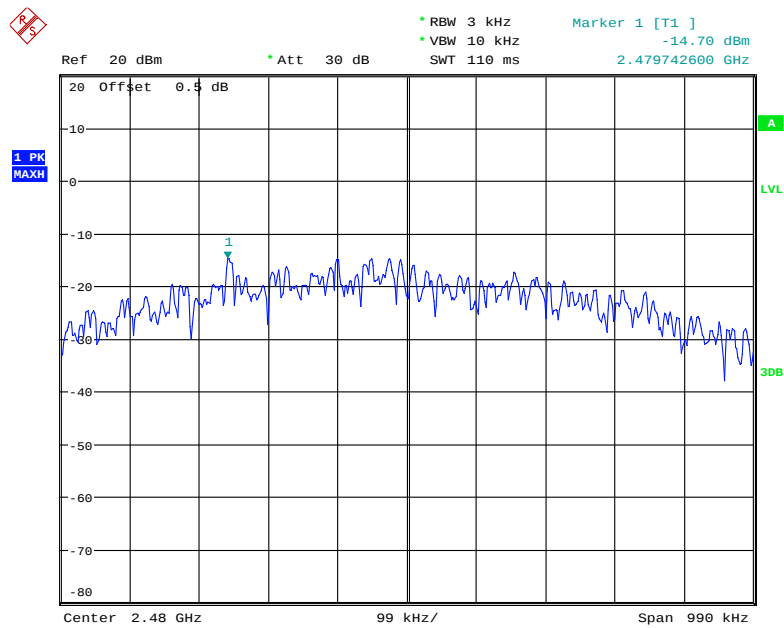
Date: 1.JUN.2018 16:12:24

Power Spectral Density, BLE Middle Channel



Date: 1.JUN.2018 16:23:29

Power Spectral Density, BLE High Channel



Date: 1.JUN.2018 16:24:05

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