TESTING LABORATORY
CERTIFICATE # 4821.01

FCC PART 15.247

TEST REPORT

For

Grandstream Networks, Inc.

126 Brookline Ave., 3rd Floor Boston, MA 02215, USA

FCC ID: YZZGSC3510

Report Type:	**Product Type:**
Original Report	SIP Two-Way Intercom Speaker

Report Number: RSZ190401001-00B

Report Date: 2019-06-28

Reviewed By: Nancy Wang, RF Engineer

Prepared By: Bay Area Compliance Laboratories Corp. (Shenzhen)
6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China
Tel: +86-755-33320018
Fax: +86-755-33320008
www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	SIP Two-Way Intercom Speaker
Tested Model	GSC3510
Multiple Model#	GSC3505
Frequency Range	Bluetooth LE: 2402~2480MHz WI-FI: 2412~2472MHz
Transmit Power	Bluetooth LE: 1.24dBm WIFI: 802.11b: 22.49dBm, 802.11G: 23.42dBm, 802.11N20: 23.38dBm, 802.11N40: 20.81dBm
Modulation Technique	Bluetooth LE: GFSK WIFI: DSSS, OFDM
Antenna Specification	PCB Antenna Bluetooth/WIFI: 5.0dBi@2.4GHz
Voltage Range	DC 48V from POE
Date of Test	2019/05/14~2019/06/28
Sample serial number	190401001
Received date	2019/04/01
Sample/EUT Status	Good condition

Notes: This series products model: GSC3505 and GSC3510 are identical schematics, Model GSC3510 was selected for fully testing, the detailed information can be referred to the declaration which was stated and guaranteed by the applicant.

Objective

This report is prepared on behalf of *Grandstream Networks, Inc.* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's 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)

FCC Part 15B JAB, FCC Part 15.247 DSS and Part 15.407 NII submissions with FCC ID: YZZGSC3510.

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 15.247 Meas Guidance v05r02.

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

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1℃
Humidity		±6%
Supply voltages		±0.4%

Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, 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.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 802.11b, 802.11g and 802.11n-HT20 mode, 11 channels are provided to testing:

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	/	/

For 802.11b, 802.11g, 802.11n-HT20 mode, EUT was tested with Channel 1, 6 and 11

For 802.11n-HT40 mode, 7 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2422	6	2447
2	2427	7	2452
3	2432	/	/
4	2437	/	/
5	2442	/	/

EUT was tested with Channel 1, 4 and 7.

For BLE mode, 40 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

"Vysor-win32-ia32.exe" was used in the test.

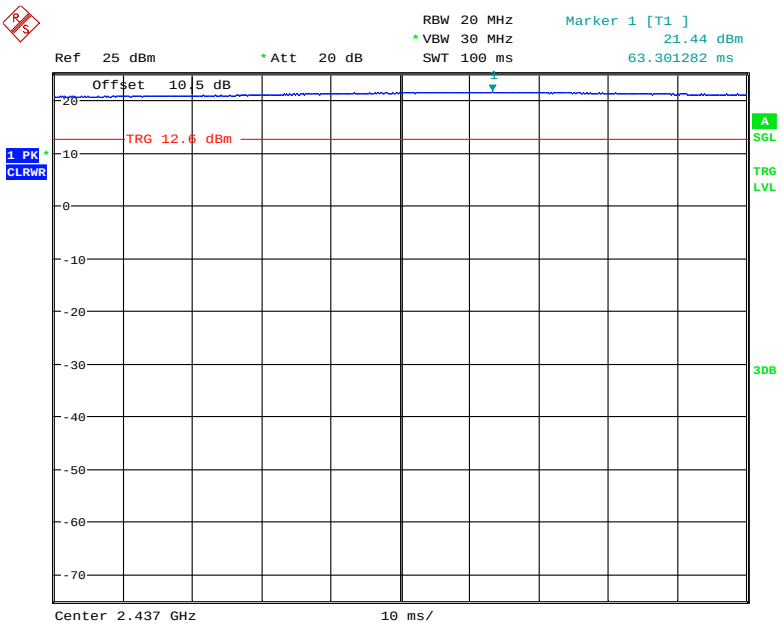
The device was tested with the worst case was performed as below:

Mode	Data rate	Power level		
		Low channel	Middle channel	High channel
802.11b	1 Mbps	19	19	19
802.11g	6 Mbps	17	17	17
802.11n-HT20	MCS0	17	17	17
802.11n-HT40	MCS0	14.5	14.5	14.5
BLE	/	Default	Default	Default

Pre-scan with all the data rates, the above data rate is the worst case for Wi-Fi test.

Duty cycle

802.11b mode



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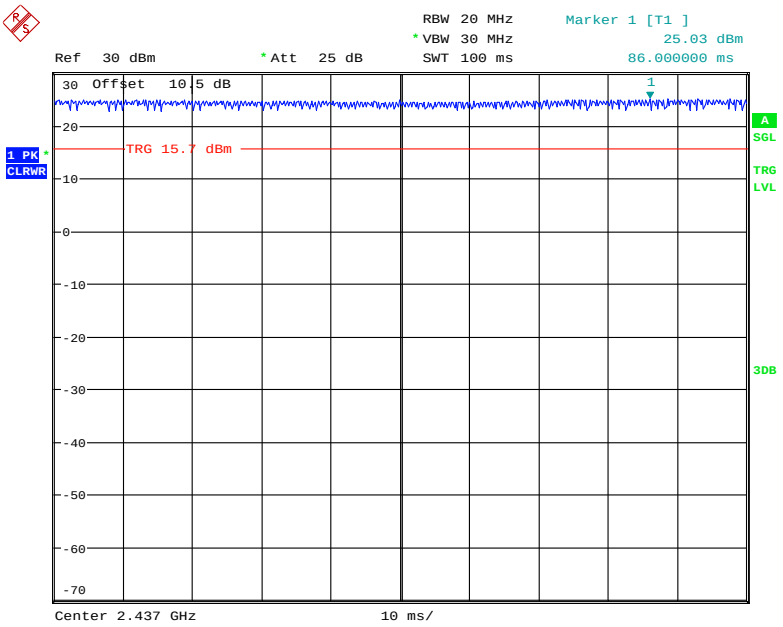
802.11g mode



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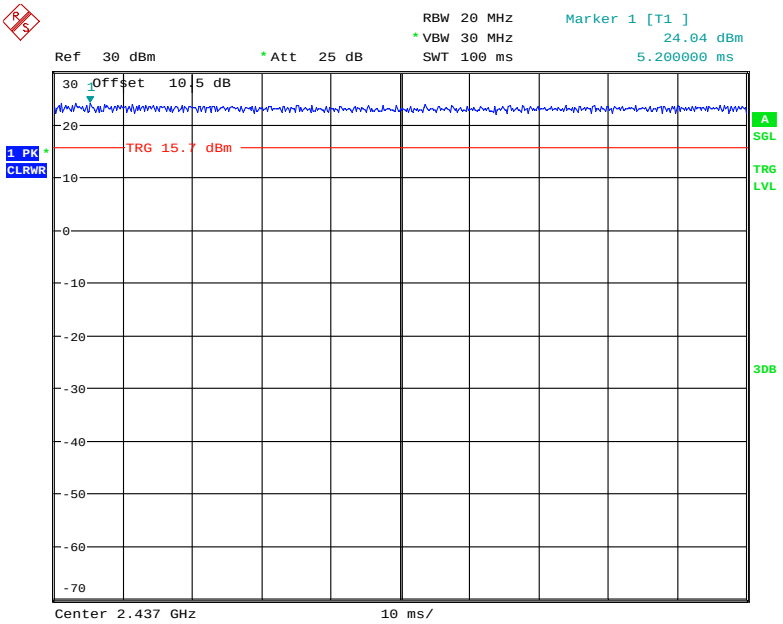
802.11n-HT20 Mode



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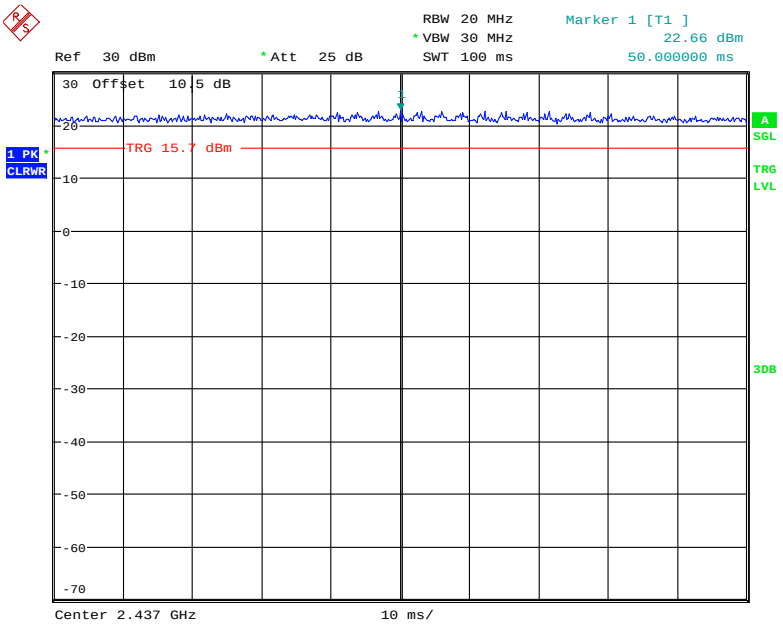
802.11n-HT40 Mode



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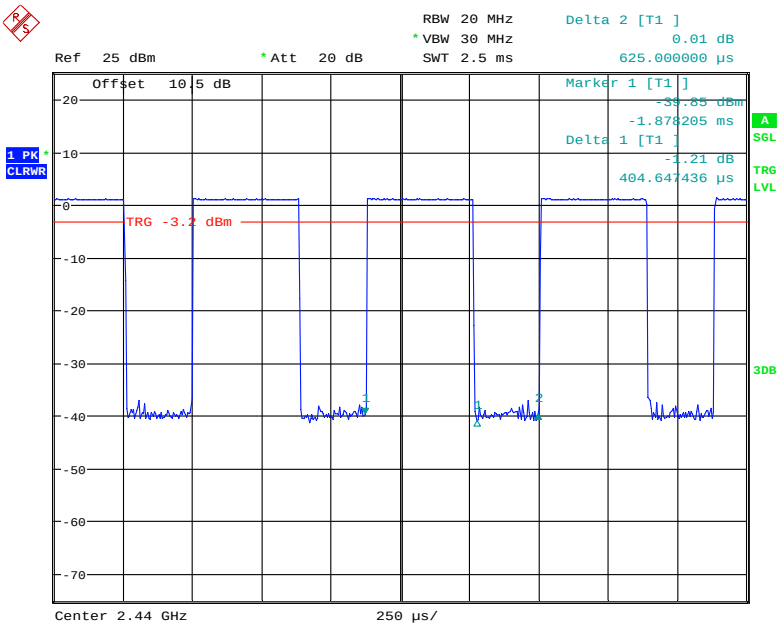
BLE Mode



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Mode	Duty Cycle (%)	T(us)	1/T(kHz)	VBW Setting	10log(1/ Duty Cycle)
802.11b	100	-	-	10Hz	-
802.11g	100	-	-	10Hz	-
802.11n-HT20	100	-	-	10Hz	-
802.11n-HT40	100	-	-	10Hz	-
BLE	64.8	405	2.47	3kHz	1.88

Support Equipment List and Details

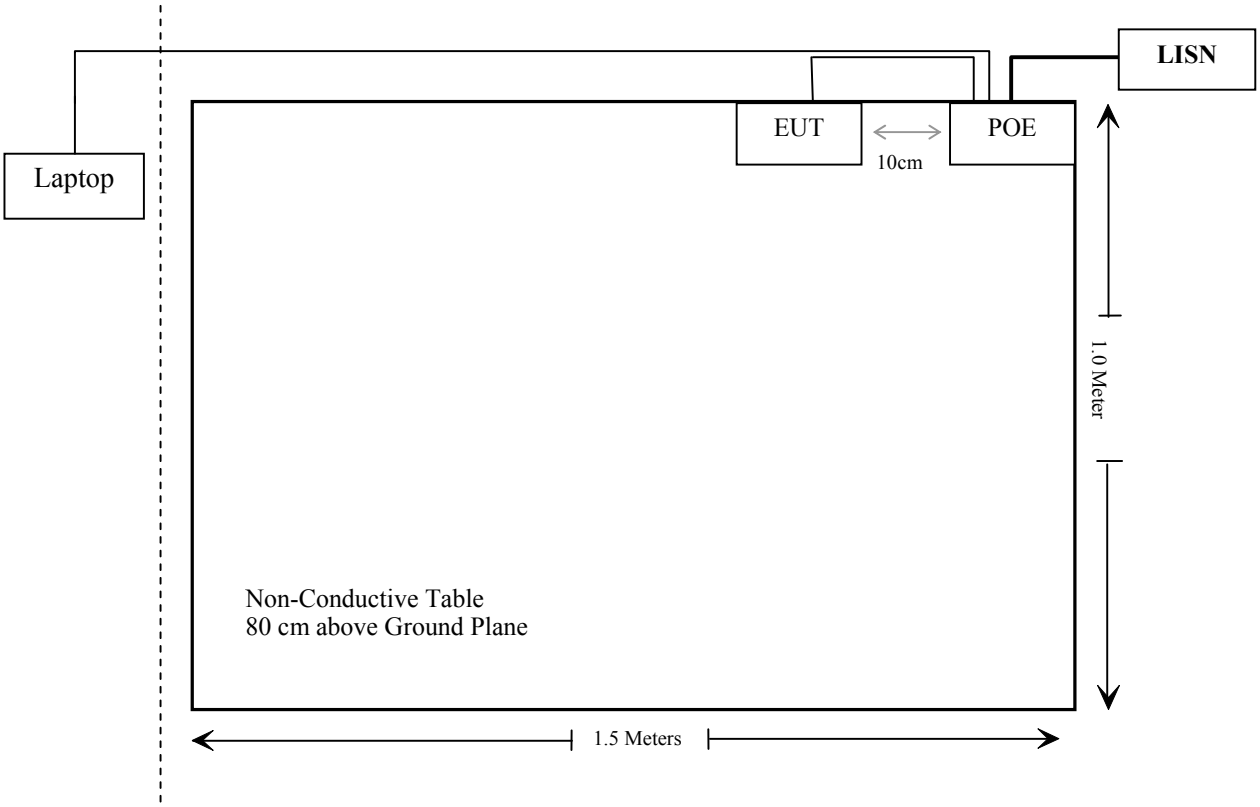
Manufacturer	Description	Model	Serial Number
Dcoma	POE	PSE801G	N/A
HP	Laptop	Compaq CQ45	5CG33407QL

External I/O Cable

Cable Description	Length (m)	From Port	To
Unshielded detachable AC Cable	1.0	LISN	POE
Unshielded detachable RJ45 Cable	1.2	POE	EUT
Unshielded detachable RJ45 Cable	8.0	POE	Laptop

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §15.247 (i) & §1.1307 (b) (1) & §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 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
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2018-07-11	2019-07-11
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2019-01-25	2020-01-25
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2019-03-02	2020-03-02
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Unknown	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-11-12	2019-11-12
Radiated Emission Test					
A.H. System	Horn Antenna	SAS-200/571	135	2018-09-01	2021-08-31
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
COM-POWER	Pre-amplifier	PA-122	181919	2018-11-12	2019-11-12
Sonoma Instrument	Amplifier	310N	186238	2018-11-12	2019-11-12
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2018-07-11	2019-07-11
Ducommun technologies	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	104PEA	218124002	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	RG-214	1	2019-05-21	2019-11-19
Ducommun technologies	RF Cable	RG-214	2	2018-11-12	2019-11-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-11-12	2019-11-12
Sinoscite	Notch Filter	BSF2402-2480MN-0898-001	99632	2018-11-12	2019-11-12
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Agilent	USB wideband power meter	U2021XA	MY54250003	2018-06-23	2019-06-23
WEINSCHEL	10dB Attenuator	5324	AU 3842	Each Time	
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2019-03-02	2020-03-01
Ducommun technologies	RF Cable	RG-214	3	Each Time	

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

FCC §15.247 (i) & §1.1307 (b) (1) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 1.1307 (b)(1), 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (Minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	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

Result

Calculated Formulary:

Predication of MPE limit at a given distance

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

S = power density (in appropriate units, e.g. mW/cm2)
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)

Frequency (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	5	3.16	1.5	1.41	20	0.001	1
2412-2462	5	3.16	23.5	223.87	20	0.141	1

Note: To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

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 antenna arrangement, which was permanently attached and the antenna gain is 5.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

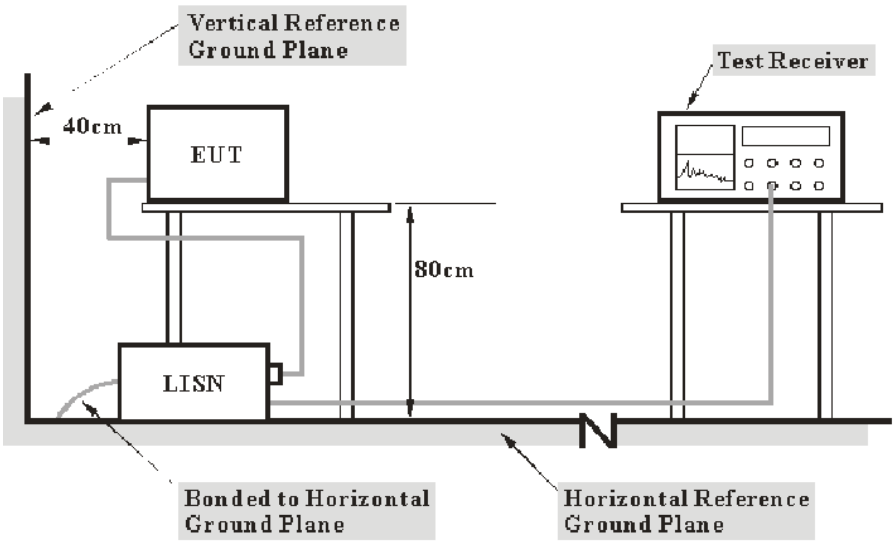
Result: Compliance.

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.

The spacing between the peripherals was 10 cm.

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 adapter was connected to the outlet of the LISN.

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

All final 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 – Corrected Amplitude

Test Results Summary

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

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cispr}$$

In BACL, $U_{(Lm)}$ is less than U_{cispr}, if L_m is less than L_{lim}, it implies that the EUT complies with the limit.

Test Data

Environmental Conditions

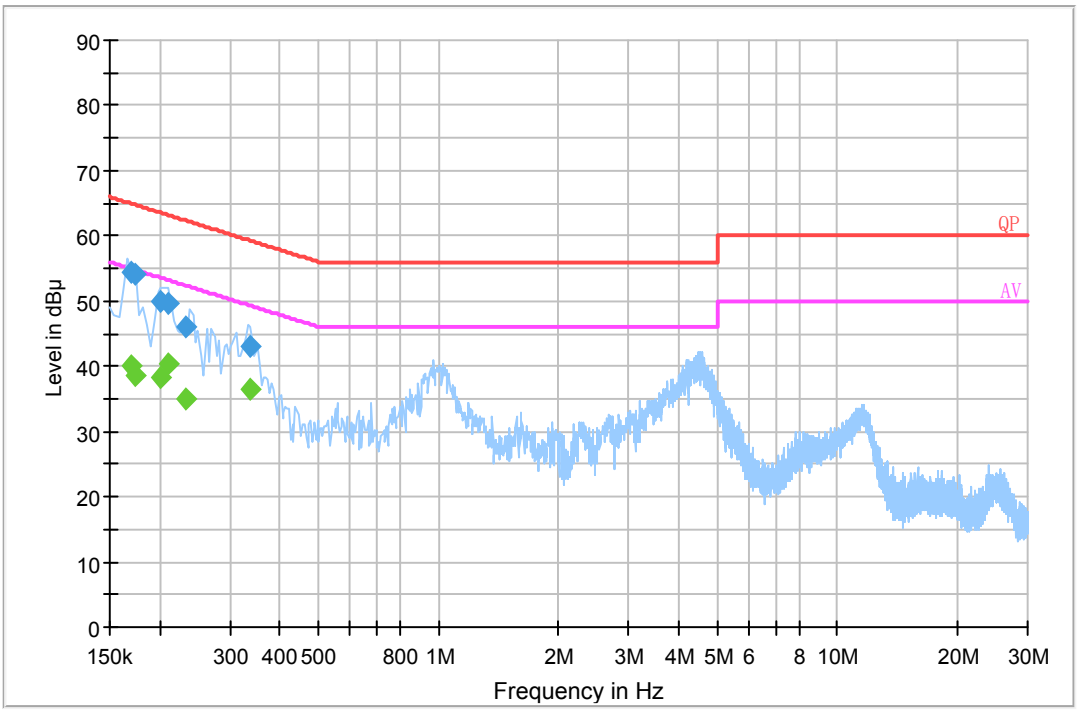
Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2019-06-07.

EUT operation mode: Transmitting

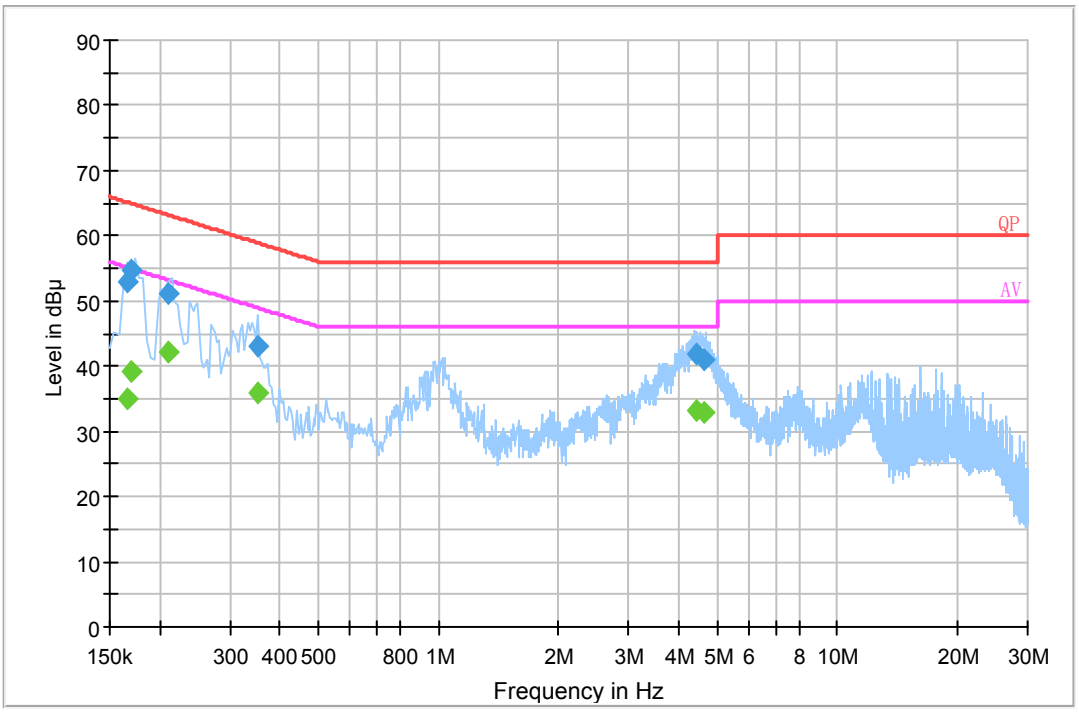
BLE Mode:

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.170501	54.4	19.9	64.9	10.5	QP
0.173500	54.0	19.9	64.8	10.8	QP
0.201500	50.0	19.8	63.5	13.5	QP
0.209500	49.7	19.8	63.2	13.5	QP
0.233500	46.1	19.8	62.3	16.2	QP
0.339010	43.0	19.9	59.2	16.2	QP
0.170501	39.9	19.9	54.9	15.0	Ave.
0.173500	38.7	19.9	54.8	16.1	Ave.
0.201500	38.4	19.8	53.5	15.1	Ave.
0.209500	40.5	19.8	53.2	12.7	Ave.
0.233500	35.1	19.8	52.3	17.2	Ave.
0.339010	36.5	19.9	49.2	12.7	Ave.

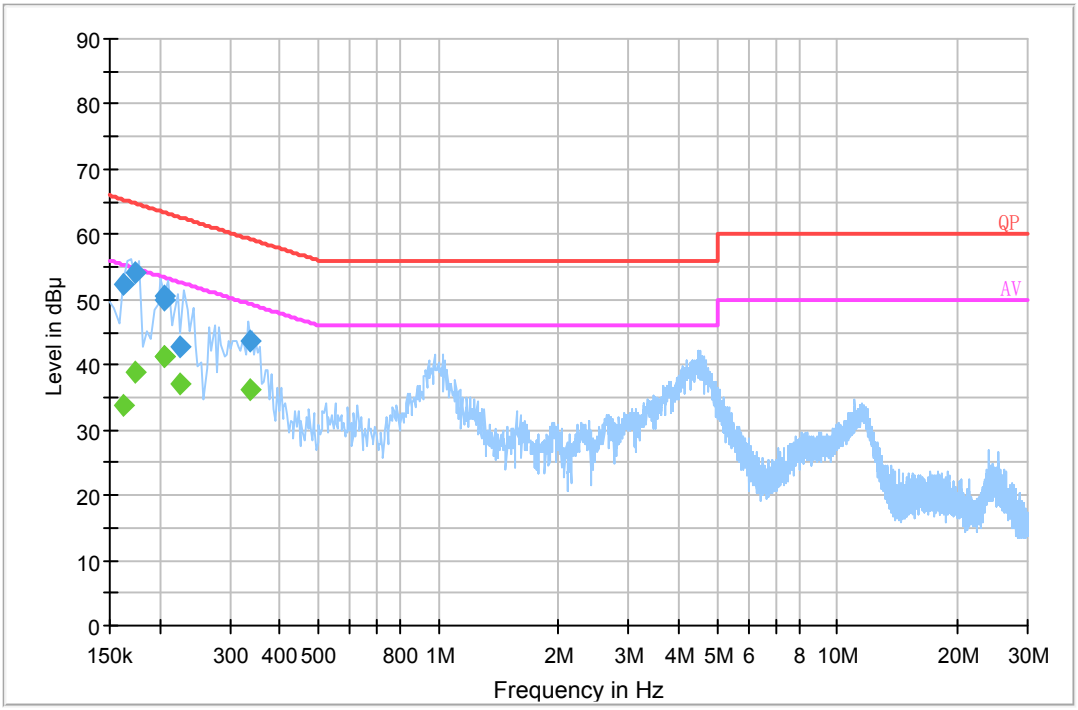
AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.165500	53.0	19.8	65.2	12.2	QP
0.169500	54.7	19.8	65.0	10.3	QP
0.209500	51.2	19.8	63.2	12.0	QP
0.352690	43.1	19.9	58.9	15.8	QP
4.411910	41.8	19.9	56.0	14.2	QP
4.655530	41.0	19.9	56.0	15.0	QP
0.165500	34.9	19.8	55.2	20.3	Ave.
0.169500	39.2	19.8	55.0	15.8	Ave.
0.209500	42.3	19.8	53.2	10.9	Ave.
0.352690	35.9	19.9	48.9	13.0	Ave.
4.411910	33.3	19.9	46.0	12.7	Ave.
4.655530	32.8	19.9	46.0	13.2	Ave.

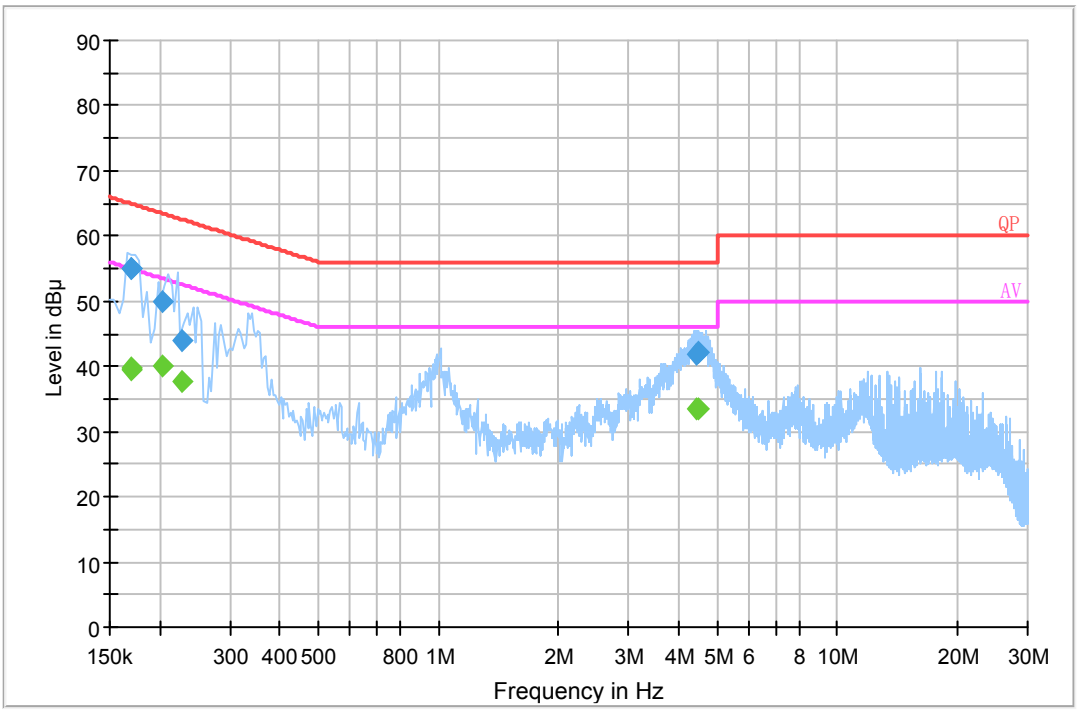
Wi-Fi Mode:

AC 120 V/60 Hz, Line:



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.161500	52.4	19.9	65.4	13.0	QP
0.173500	54.2	19.9	64.8	10.6	QP
0.205500	50.0	19.8	63.4	13.4	QP
0.206500	50.6	19.8	63.3	12.7	QP
0.225500	42.9	19.8	62.6	19.7	QP
0.336990	43.6	19.8	59.3	15.7	QP
0.161500	33.7	19.9	55.4	21.7	Ave.
0.173500	38.8	19.9	54.8	16.0	Ave.
0.205500	41.2	19.8	53.4	12.2	Ave.
0.206500	41.3	19.8	53.3	12.0	Ave.
0.225500	37.1	19.8	52.6	15.5	Ave.
0.336990	36.3	19.8	49.3	13.0	Ave.

AC 120V/ 60 Hz, Neutral:



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.169500	54.9	19.8	65.0	10.1	QP
0.170501	54.9	19.8	64.9	10.0	QP
0.202500	50.0	19.8	63.5	13.5	QP
0.226500	43.9	19.8	62.6	18.7	QP
4.447970	41.9	19.9	56.0	14.1	QP
4.498890	42.1	19.9	56.0	13.9	QP
0.169500	39.5	19.8	55.0	15.5	Ave.
0.170501	39.9	19.8	54.9	15.0	Ave.
0.202500	40.2	19.8	53.5	13.3	Ave.
0.226500	37.7	19.8	52.6	14.9	Ave.
4.447970	33.4	19.9	46.0	12.6	Ave.
4.498890	33.5	19.9	46.0	12.5	Ave.

Note:
1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
2) Corrected Amplitude = Reading + Correction Factor
3) Margin = Limit – Corrected Amplitude

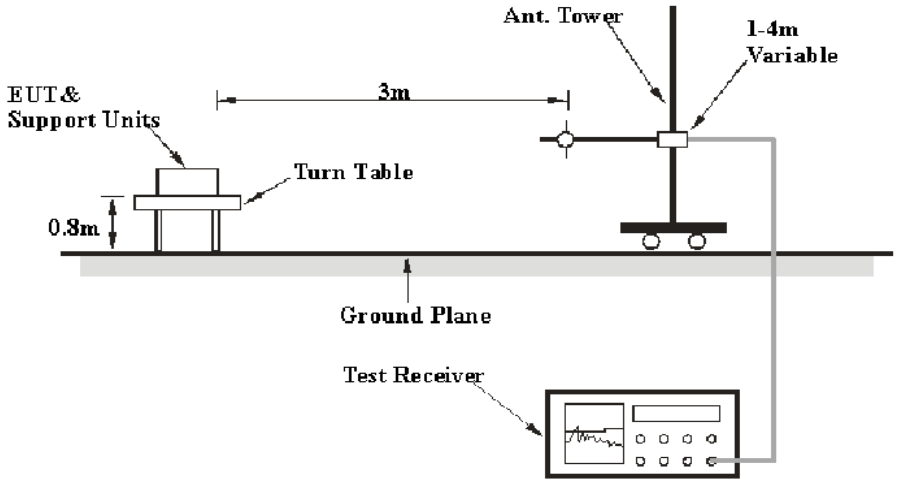
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

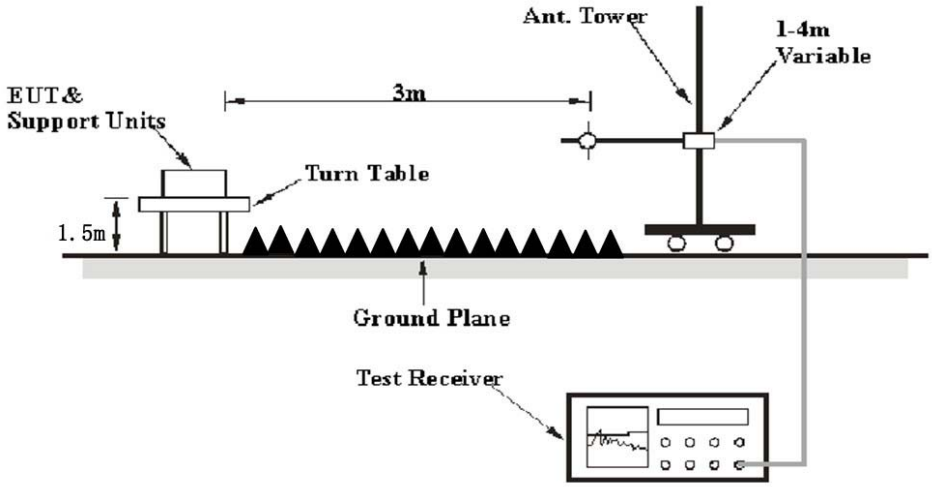
FCC §15.247 (d); §15.209; §15.205;

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 & 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:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz Note 1	/	Average
	1MHz	＞1/T Note 2	/	Average

Note 1: when duty cycle is no less than 98%
Note 2: when duty cycle is less than 98%

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:

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.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cispr}$$

In BACL, $U_{(Lm)}$ is less than U_{cispr}, if L_m is less than L_{lim}, it implies that the EUT complies with the limit.

Test Data

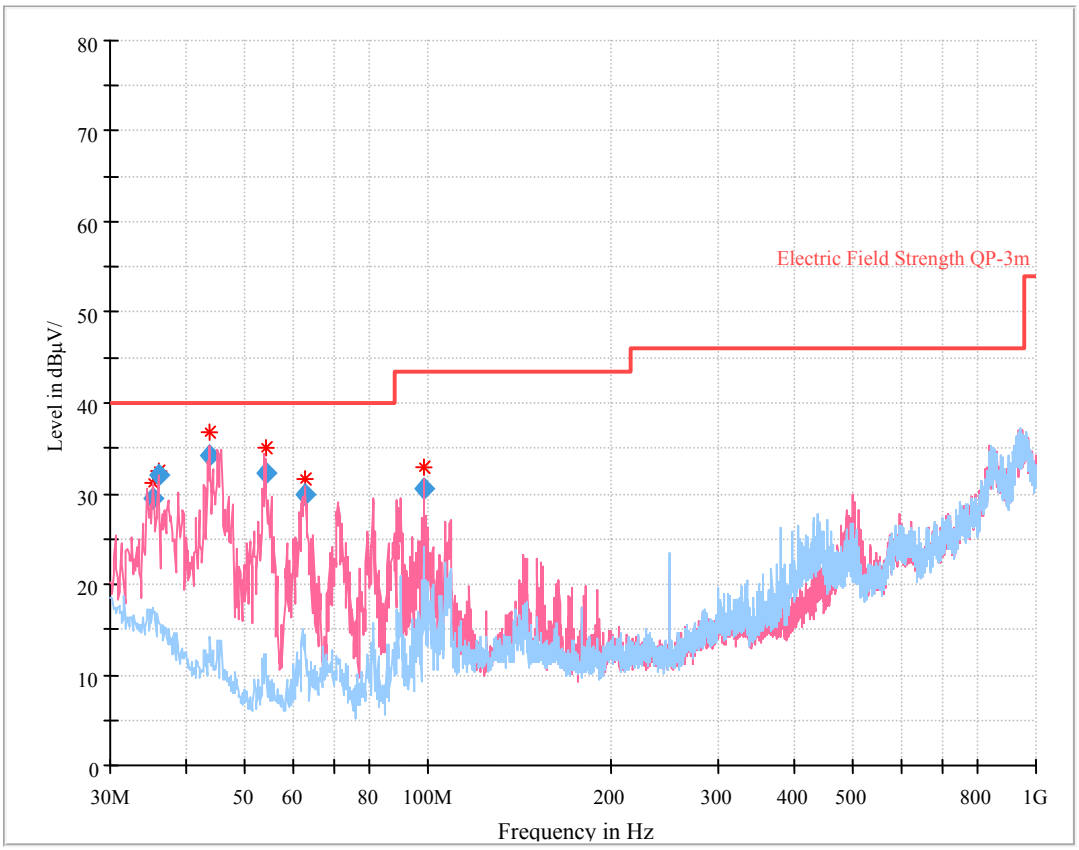
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Alen He and Andy Yu from 2019-05-14 to 2019-06-05.

EUT operation mode: Transmitting

30 MHz~1 GHz: Worst case at 802.11b mode, Low channel



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
35.343500	29.40	105.0	V	356.0	-10.7	40.00	10.60
36.138625	32.02	324.0	V	247.0	-11.3	40.00	7.98
43.805625	34.18	105.0	V	352.0	-16.4	40.00	5.82
54.187875	32.32	133.0	V	0.0	-19.9	40.00	7.68
62.756750	29.83	106.0	V	350.0	-20.3	40.00	10.17
98.436250	30.58	112.0	V	107.0	-17.5	43.50	12.92

1 GHz-25 GHz(BLE):

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2374.12	27.86	PK	117	1.4	H	31.87	59.73	74	14.27
2374.12	14.96	Ave.	117	1.4	H	31.87	46.83	54	7.17
2486.07	27.03	PK	118	1.4	H	32.13	59.16	74	14.84
2486.07	14.35	Ave.	118	1.4	H	32.13	46.48	54	7.52
4804.00	43.71	PK	228	1.8	H	6.28	49.99	74	24.01
4804.00	30.64	Ave.	228	1.8	H	6.28	36.92	54	17.08
Middle Channel (2440 MHz)									
4880.00	43.96	PK	192	1.7	H	6.76	50.72	74	23.28
4880.00	30.93	Ave.	192	1.7	H	6.76	37.69	54	16.31
High Channel (2480 MHz)									
2360.82	27.64	PK	168	1.2	H	31.77	59.41	74	14.59
2360.82	14.86	Ave.	168	1.2	H	31.77	46.63	54	7.37
2483.50	28.26	PK	24	1.2	H	32.13	60.39	74	13.61
2483.50	20.38	Ave.	24	1.2	H	32.13	52.51	54	1.49
4960.00	43.63	PK	139	2.0	H	6.80	50.43	74	23.57
4960.00	30.51	Ave.	139	2.0	H	6.80	37.31	54	16.69

1 GHz-25 GHz(WIFI):

802.11b Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2387.65	29.39	PK	195	2.3	H	31.87	61.26	74	12.74
2387.65	15.46	Ave.	195	2.3	H	31.87	47.33	54	6.67
2484.46	27.79	PK	206	2.4	H	32.13	59.92	74	14.08
2484.46	14.24	Ave.	206	2.4	H	32.13	46.37	54	7.63
4824.00	48.06	PK	98	2.2	H	6.28	54.34	74	19.66
4824.00	39.95	Ave.	98	2.2	H	6.28	46.23	54	7.77
Middle Channel (2437MHz)									
4874.00	46.39	PK	72	2.1	H	6.76	53.15	74	20.85
4874.00	37.76	Ave.	72	2.1	H	6.76	44.52	54	9.48
High Channel (2462 MHz)									
2389.43	28.42	PK	345	1.6	H	31.87	60.29	74	13.71
2389.43	14.63	Ave.	345	1.6	H	31.87	46.50	54	7.50
2484.36	29.12	PK	140	2.0	H	32.13	61.25	74	12.75
2484.36	15.86	Ave.	140	2.0	H	32.13	47.99	54	6.01
4924.00	46.27	PK	213	1.6	H	6.76	53.03	74	20.97
4924.00	37.92	Ave.	213	1.6	H	6.76	44.68	54	9.32

802.11g Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2390.00	34.41	PK	217	2.1	H	31.87	66.28	74	7.72
2390.00	18.66	Ave.	217	2.1	H	31.87	50.53	54	3.47
2483.79	28.68	PK	317	2.1	H	32.13	60.81	74	13.19
2483.79	15.43	Ave.	317	2.1	H	32.13	47.56	54	6.44
4824.00	44.96	PK	22	1.1	H	6.28	51.24	74	22.76
4824.00	29.66	Ave.	22	1.1	H	6.28	35.94	54	18.06
Middle Channel (2437MHz)									
4874.00	44.57	PK	14	1.2	H	6.76	51.33	74	22.67
4874.00	30.73	Ave.	14	1.2	H	6.76	37.49	54	16.51
High Channel (2462 MHz)									
2389.77	28.43	PK	107	2.4	H	31.87	60.30	74	13.70
2389.77	14.62	Ave.	107	2.4	H	31.87	46.49	54	7.51
2483.57	38.84	PK	336	1.4	H	32.13	70.97	74	3.03
2483.57	17.56	Ave.	336	1.4	H	32.13	49.69	54	4.31
4924.00	44.55	PK	233	1.6	H	6.76	51.31	74	22.69
4924.00	29.62	Ave.	233	1.6	H	6.76	36.38	54	17.62

802.11n-HT20 Mode:

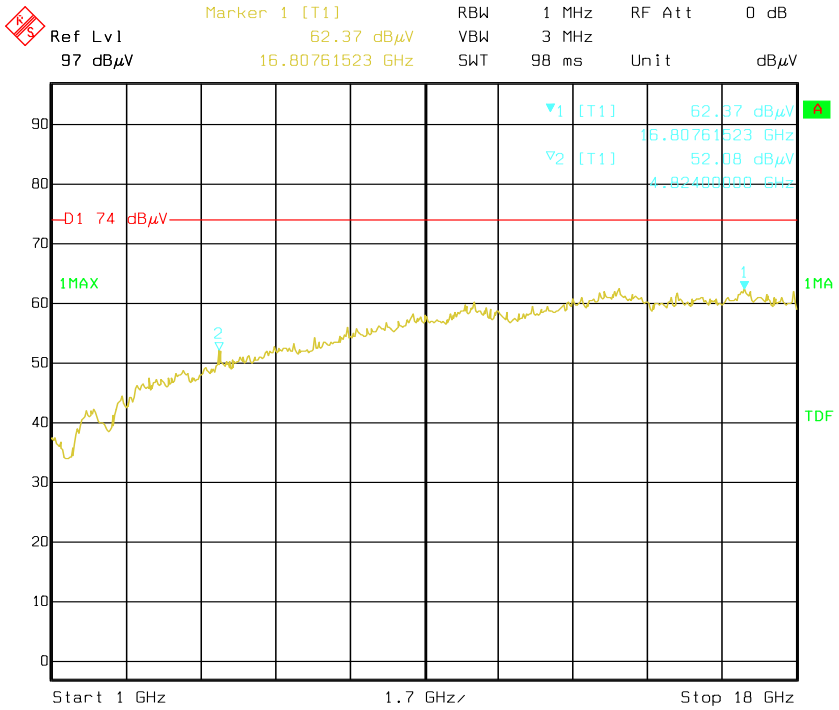
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2389.84	39.82	PK	21	2.3	H	31.87	71.69	74	2.31
2389.84	19.55	Ave.	21	2.3	H	31.87	51.42	54	2.58
2483.62	28.73	PK	135	1.4	H	32.13	60.86	74	13.14
2483.62	14.52	Ave.	135	1.4	H	32.13	46.65	54	7.35
4824.00	44.86	PK	27	1.8	H	6.28	51.14	74	22.86
4824.00	29.59	Ave.	27	1.8	H	6.28	35.87	54	18.13
Middle Channel (2437MHz)									
4874.00	44.17	PK	183	2.0	H	6.76	50.93	74	23.07
4874.00	30.57	Ave.	183	2.0	H	6.76	37.33	54	16.67
High Channel (2462 MHz)									
2388.76	28.62	PK	66	2.2	H	31.87	60.49	74	13.51
2388.76	14.71	Ave.	66	2.2	H	31.87	46.58	54	7.42
2483.57	35.22	PK	142	1.4	H	32.13	67.35	74	6.65
2483.57	17.55	Ave.	142	1.4	H	32.13	49.68	54	4.32
4924.00	44.80	PK	106	1.2	H	6.76	51.56	74	22.44
4924.00	29.55	Ave.	106	1.2	H	6.76	36.31	54	17.69

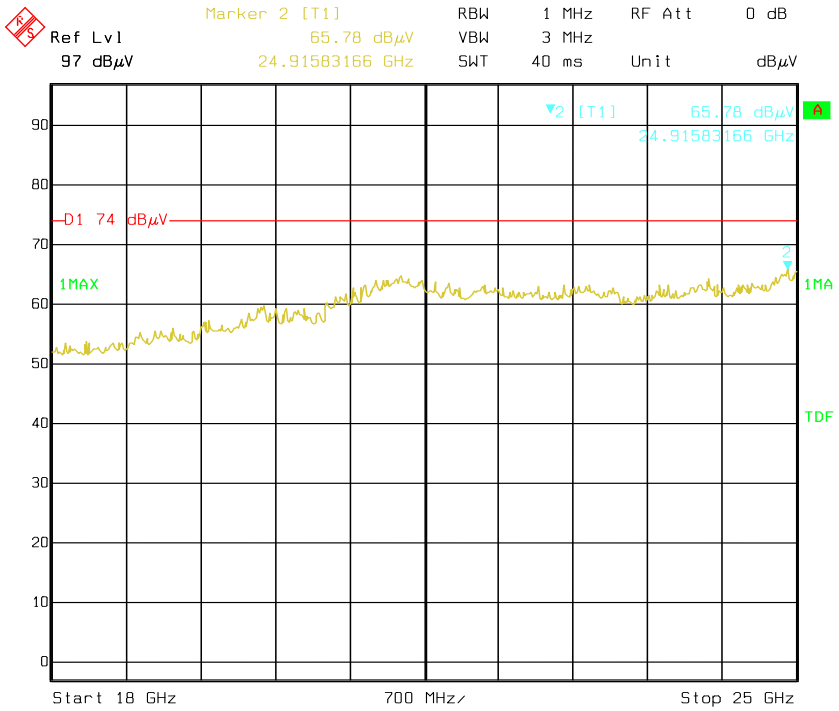
802.11n-HT40 Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2422 MHz)									
2388.56	34.64	PK	228	1.4	H	31.87	66.51	74	7.49
2388.56	18.45	Ave.	228	1.4	H	31.87	50.32	54	3.68
2483.54	28.43	PK	71	2.3	H	32.13	60.56	74	13.44
2483.54	14.26	Ave.	71	2.3	H	32.13	46.39	54	7.61
4844.00	44.61	PK	152	1.6	H	6.28	50.89	74	23.11
4844.00	29.63	Ave.	152	1.6	H	6.28	35.91	54	18.09
Middle Channel (2437MHz)									
4874.00	43.94	PK	196	1.6	H	6.76	50.70	74	23.30
4874.00	30.99	Ave.	196	1.6	H	6.76	37.75	54	16.25
High Channel (2452 MHz)									
2388.67	28.43	PK	315	2.5	H	31.87	60.30	74	13.70
2388.67	14.21	Ave.	315	2.5	H	31.87	46.08	54	7.92
2483.64	30.58	PK	135	1.8	H	32.13	62.71	74	11.29
2483.64	15.94	Ave.	135	1.8	H	32.13	48.07	54	5.93
4904.00	45.57	PK	263	1.9	H	6.76	52.33	74	21.67
4904.00	29.96	Ave.	263	1.9	H	6.76	36.72	54	17.28

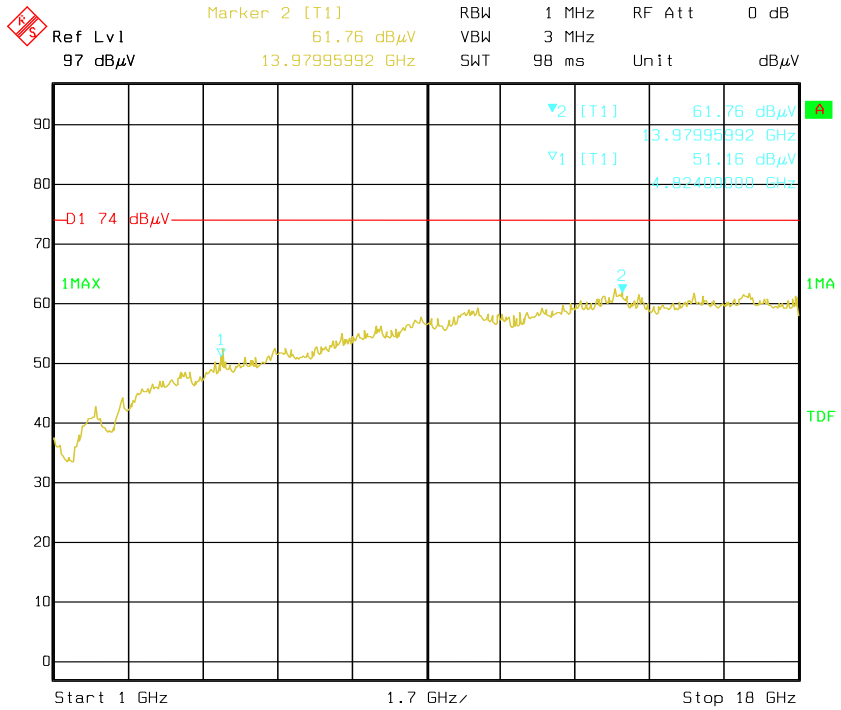
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

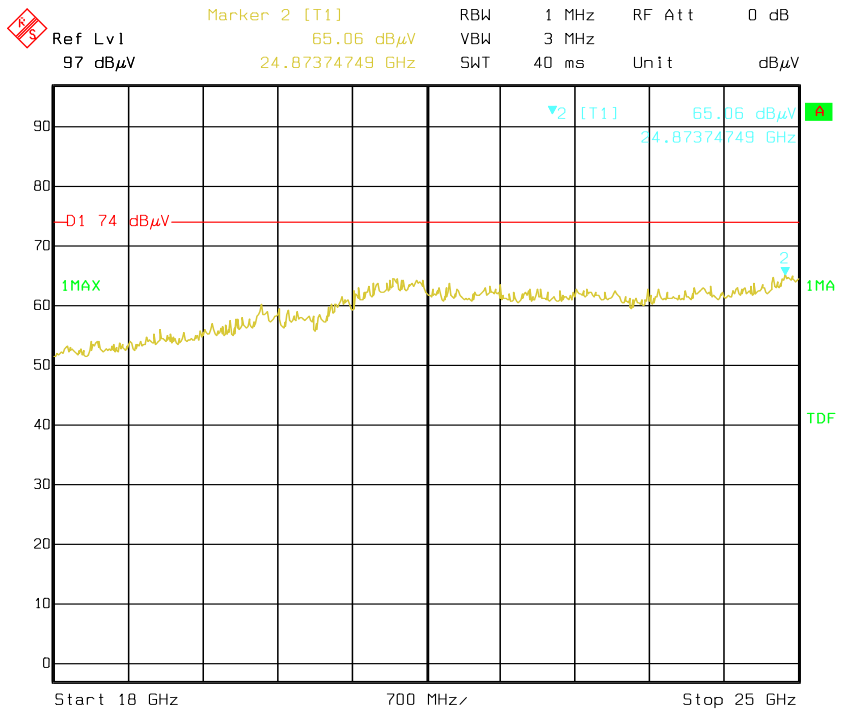
Pre-scan with 802.11B Mode, Low channel
Horizontal



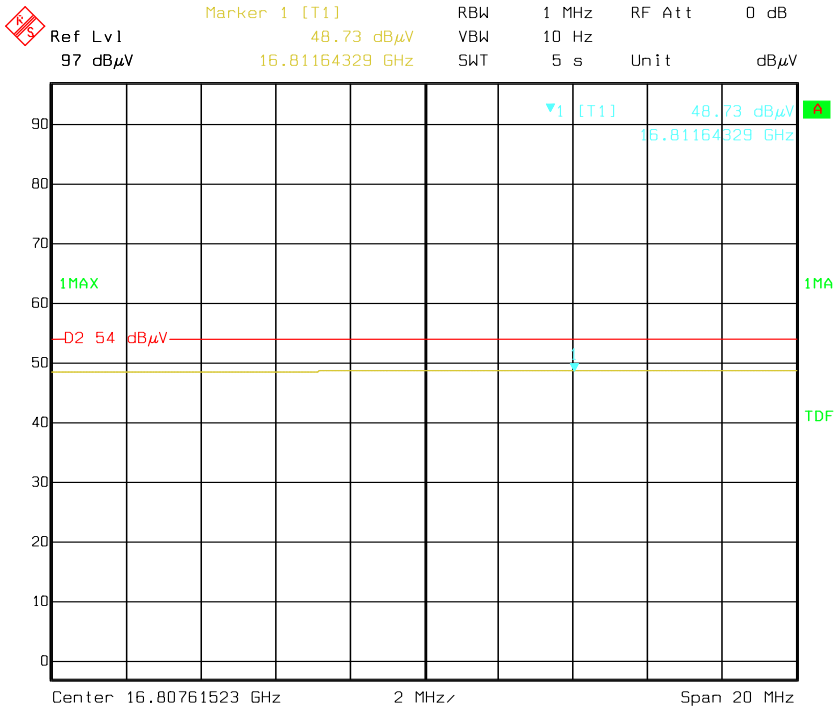


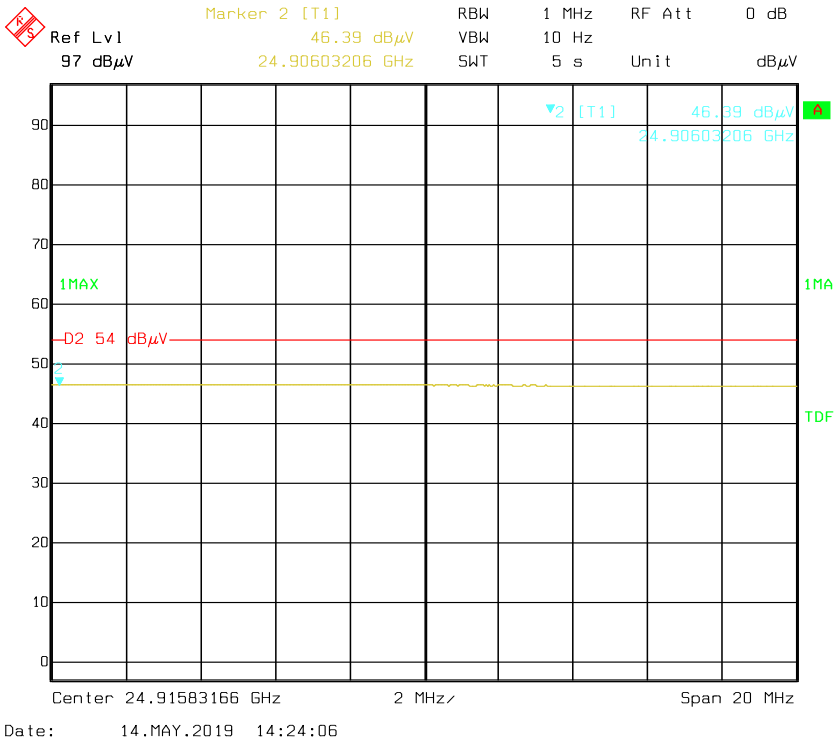
Vertical


Marker 2 [T1]
Ref Lvl
97 dBµV
61.76 dBµV
13.97995992 GHz
RBW 1 MHz
VBW 3 MHz
SWT 98 ms
RF Att 0 dB
Unit dBµV
▼2 [T1] 61.76 dBµV
13.97995992 GHz
▽1 [T1] 51.16 dBµV
4.82408908 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 1 GHz
1.7 GHz/
Stop 18 GHz
Date: 14.MAY.2019 13:43:48

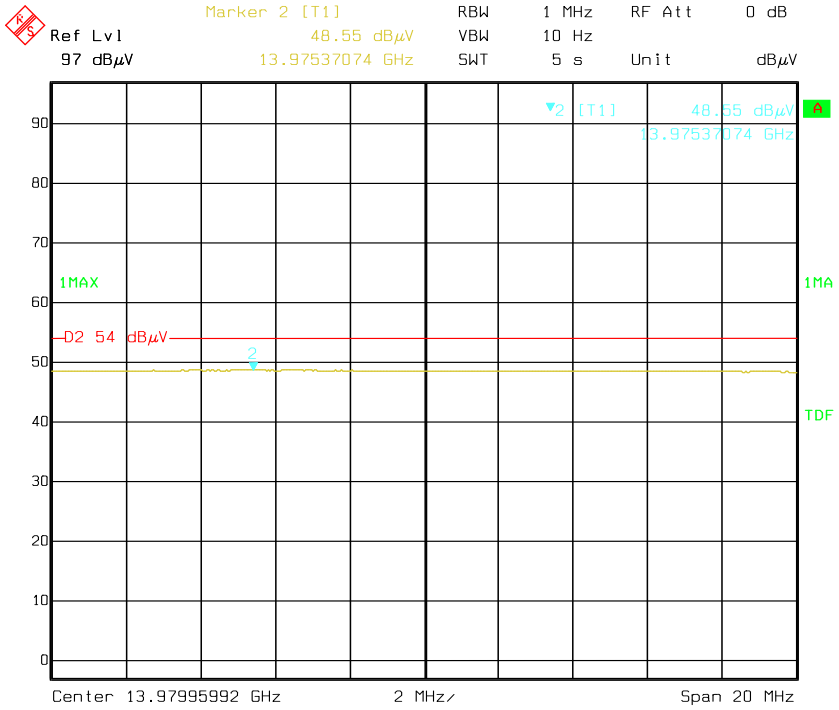

Marker 2 [T1]
Ref Lvl
97 dBµV
65.06 dBµV
24.87374749 GHz
RBW 1 MHz
VBW 3 MHz
SWT 40 ms
RF Att 0 dB
Unit dBµV
▼2 [T1] 65.06 dBµV
24.87374749 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 18 GHz
700 MHz/
Stop 25 GHz
Date: 14.MAY.2019 14:16:36

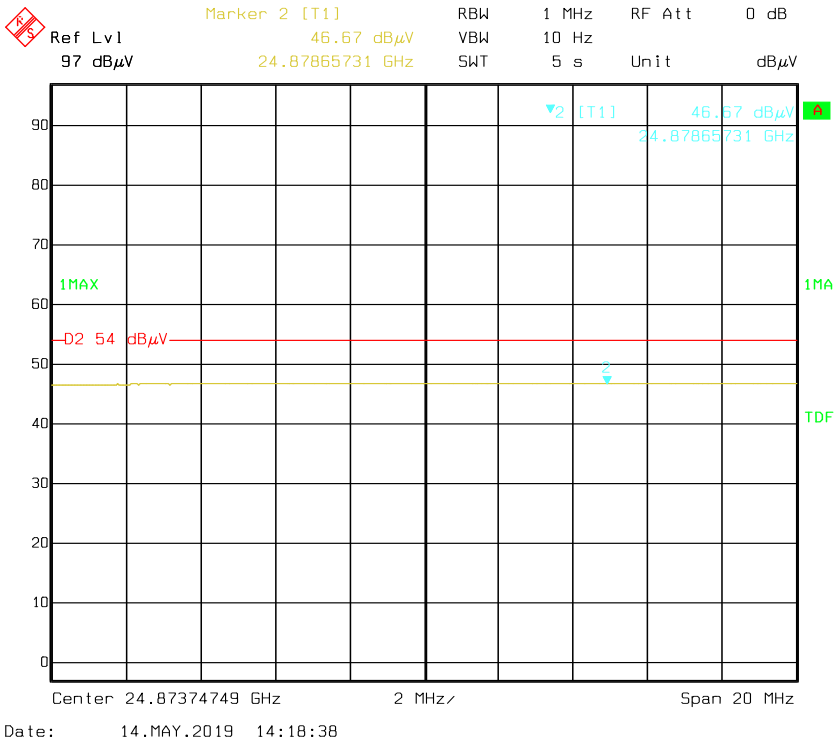
Pre-scan for Average
Horizontal





Vertical


Marker 2 [T1]
48.55 dBμV
13.97537074 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼2 [T1] 48.55 dBμV
13.97537074 GHz
A
1MAX
1MA
D2 54 dBμV
TDF
Center 13.97995992 GHz
2 MHz/
Span 20 MHz
Date: 14.MAY.2019 13:46:08


Marker 2 [T1]
46.67 dBμV
24.87865731 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼2 [T1] 46.67 dBμV
24.87865731 GHz
A
1MAX
1MA
D2 54 dBμV
TDF
Center 24.87374749 GHz
2 MHz/
Span 20 MHz
Date: 14.MAY.2019 14:18:38

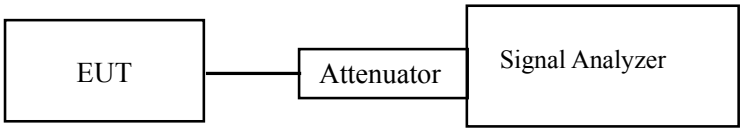
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

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

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 it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



Test Data

Environmental Conditions

Temperature:	24~25 ℃
Relative Humidity:	52~56 %
ATM Pressure:	100.9~101.0 kPa

The testing was performed by Kieroy Luo from 2019-06-01 to 2019-06-18.

Test Result: Pass.

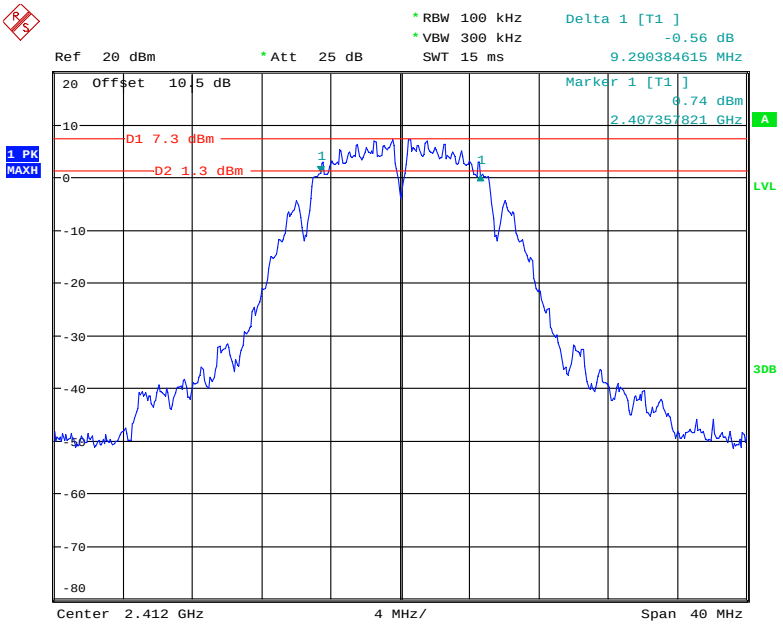
Please refer to the following table and plots.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)
802.11b mode			
Low	2412	9.290	≥500
Middle	2437	9.140	≥500
High	2462	9.264	≥500
802.11g			
Low	2412	16.474	≥500
Middle	2437	16.410	≥500
High	2462	16.459	≥500
802.11n-HT20 mode			
Low	2412	17.677	≥500
Middle	2437	17.625	≥500
High	2462	17.684	≥500
802.11n-HT40 mode			
Low	2422	36.556	⩾500
Middle	2437	36.567	⩾500
High	2452	36.655	⩾500

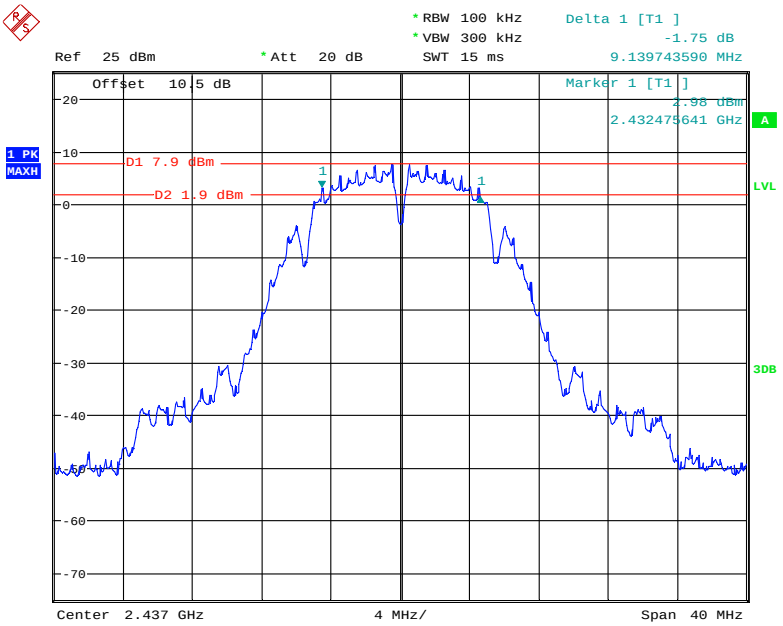
Channel	Frequency (MHz)	6 dB Emission Bandwidth(MHz)	Limit (kHz)
BLE mode			
Low	2402	0.715	≥500
Middle	2440	0.708	≥500
High	2480	0.724	≥500

802.11b Low Channel



Date: 1.JUN.2019 13:44:37

802.11b Middle Channel



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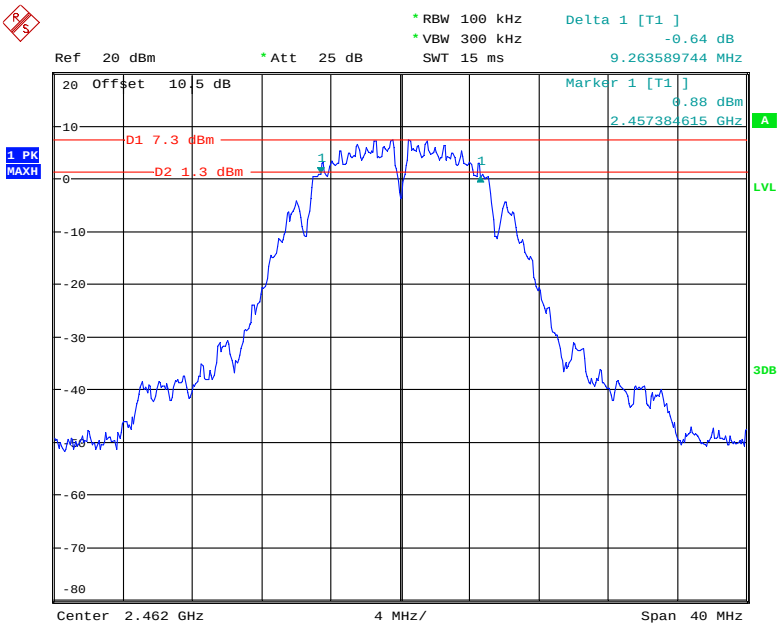
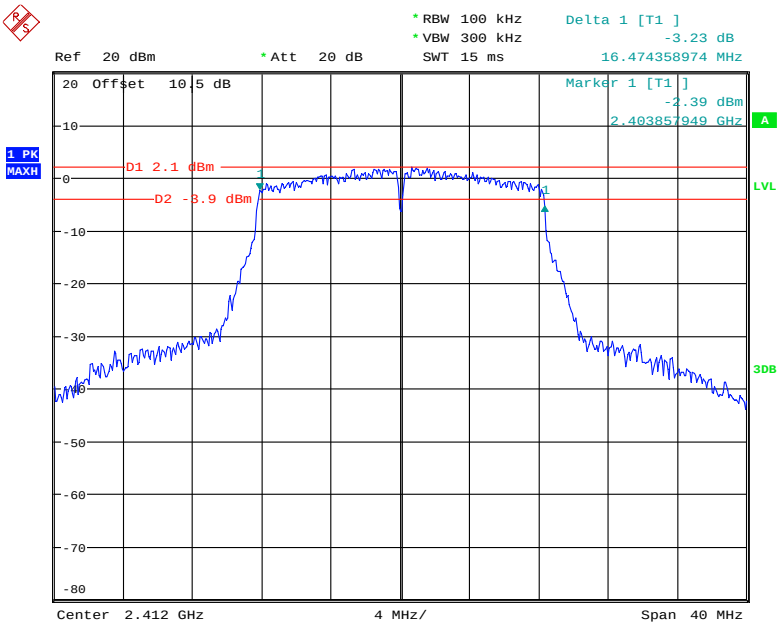
802.11b High Channel



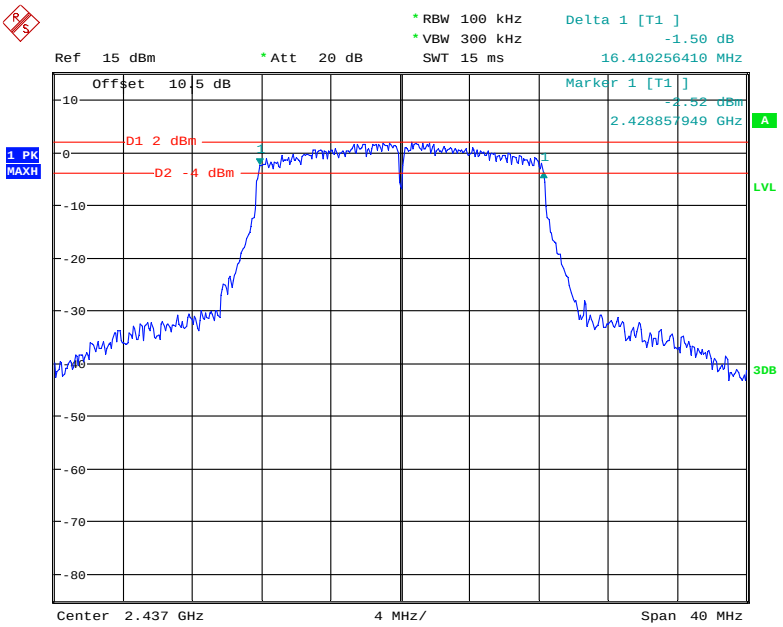
Date: 1.JUN.2019 13:48:37

802.11g Low Channel



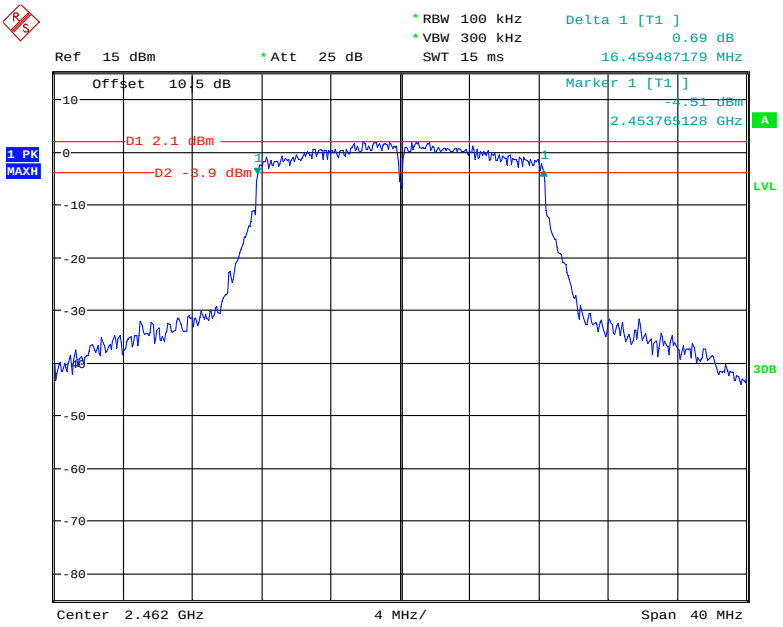
Date: 18.JUN.2019 15:38:00

802.11g Middle Channel



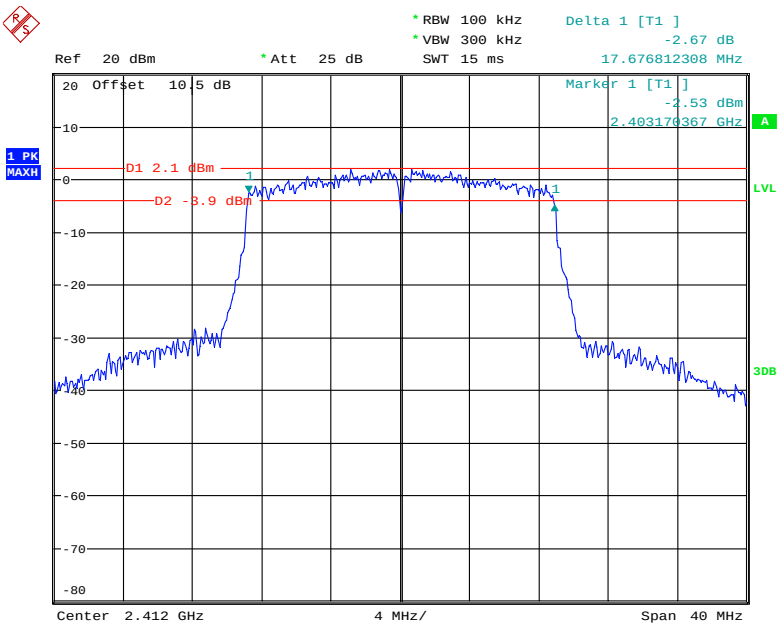
Date: 18.JUN.2019 15:41:02

802.11g High Channel



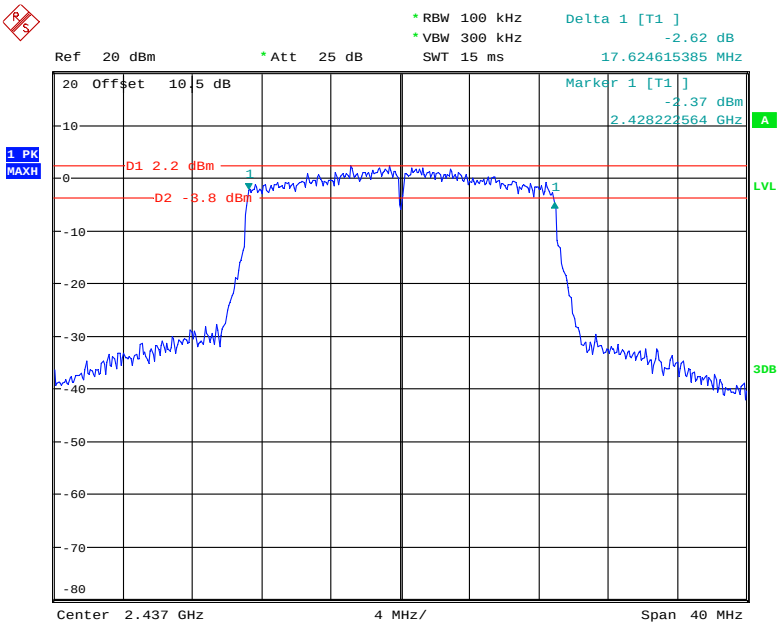
Date: 1.JUN.2019 13:37:03

802.11n-HT20 Low Channel



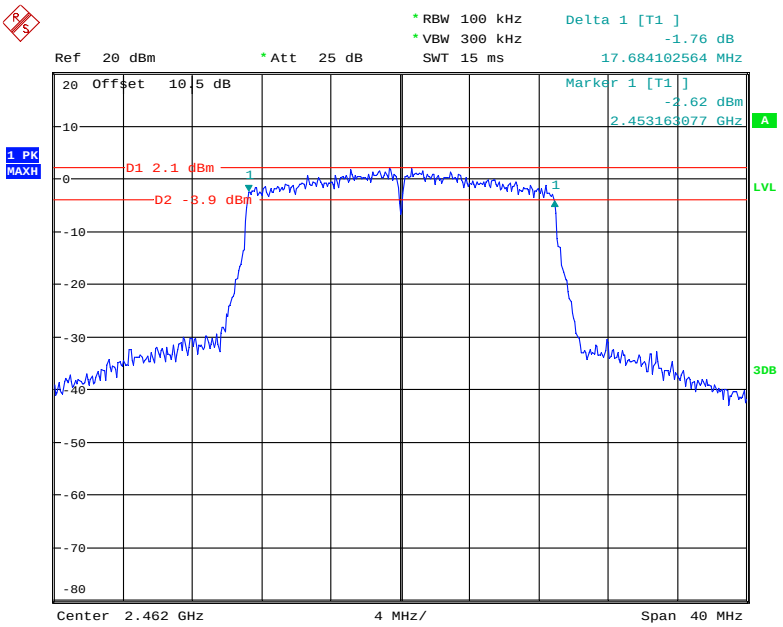
Date: 1.JUN.2019 12:04:01

802.11n-HT20 Middle Channel



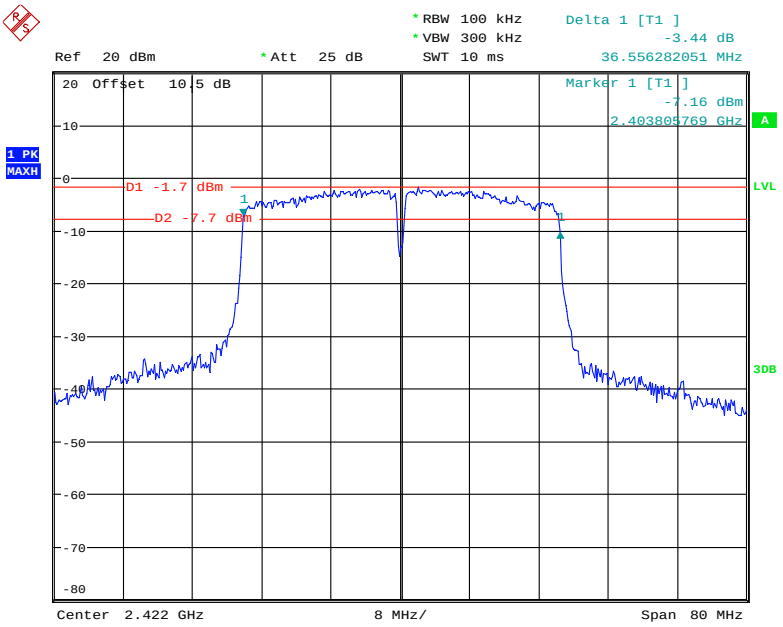
Date: 1.JUN.2019 13:21:47

802.11n-HT20 High Channel



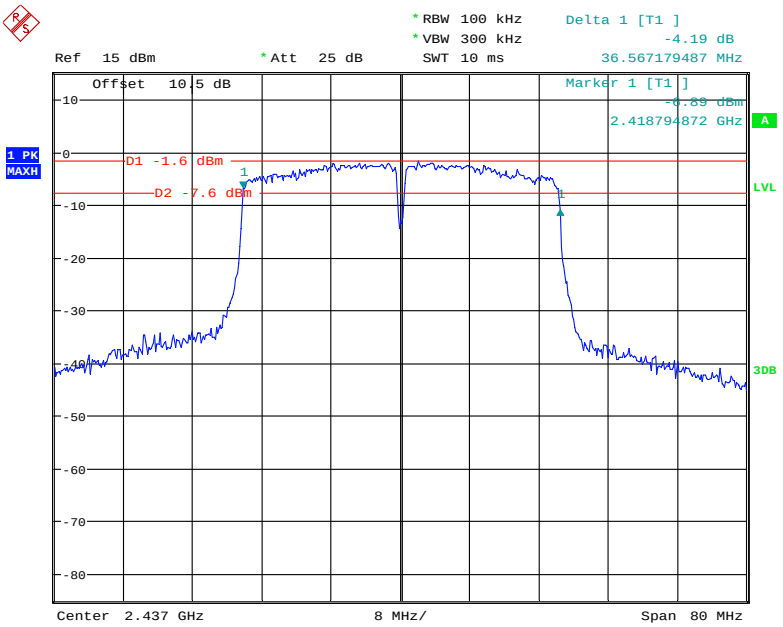
Date: 1.JUN.2019 12:09:08

802.11n-HT40 Low Channel



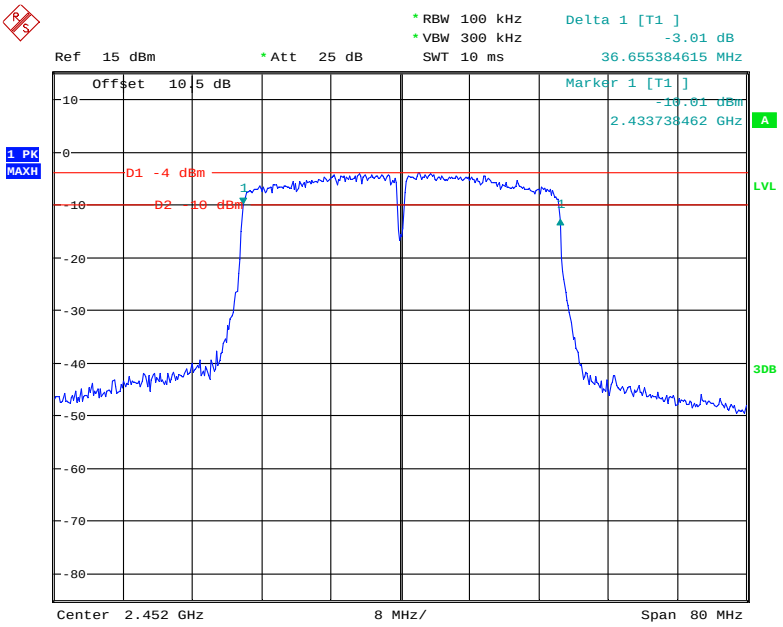
Date: 1.JUN.2019 11:59:51

802.11n-HT40 Middle Channel



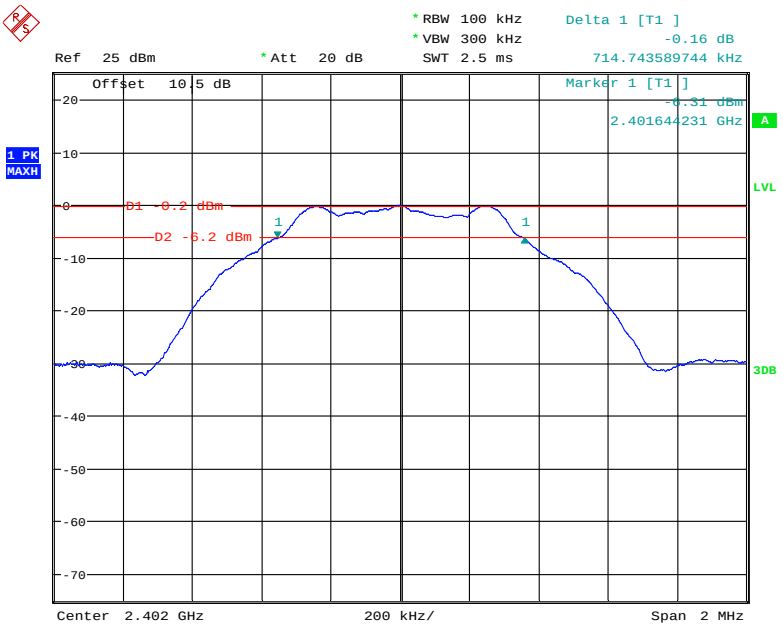
Date: 1.JUN.2019 11:56:14

802.11n-HT40 High Channel



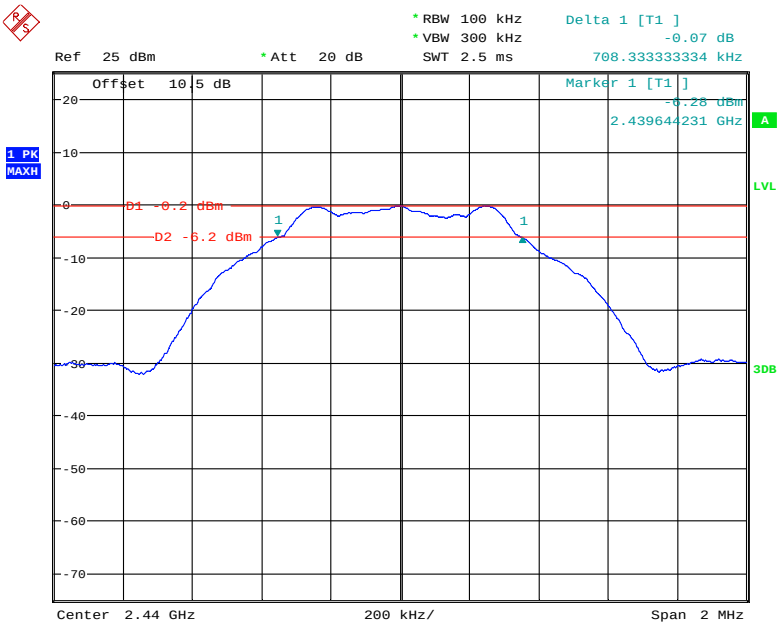
Date: 1.JUN.2019 11:48:25

BLE Low Channel



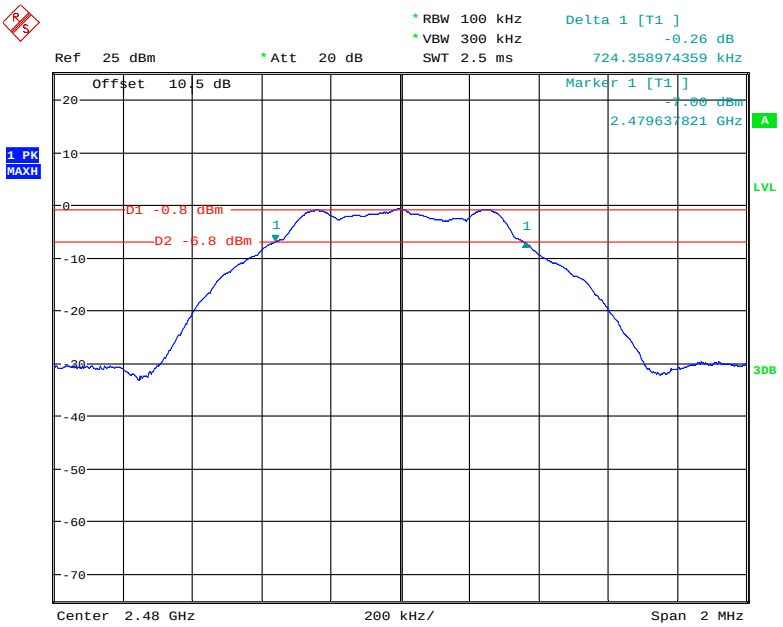
Date: 1.JUN.2019 18:21:23

BLE Middle Channel



Date: 1.JUN.2019 18:22:14

BLE High Channel



Date: 1.JUN.2019 18:18:37

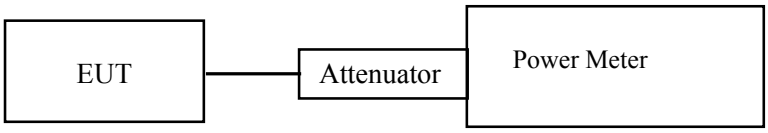
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

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

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 one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Kieroy Luo on 2019-06-01.

EUT operation mode: Transmitting

Wi-Fi mode

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Max Conducted Average Output Power (dBm)	Limit (dBm)
802.11b				
Low	2412	22.49	18.99	30
Middle	2437	21.96	18.32	30
High	2462	21.77	18.20	30
802.11g				
Low	2412	23.42	17.74	30
Middle	2437	23.38	17.33	30
High	2462	23.04	17.09	30
802.11n HT20				
Low	2412	23.28	17.29	30
Middle	2437	23.36	17.47	30
High	2462	23.38	17.37	30
802.11n HT40				
Low	2422	20.75	14.92	30
Middle	2437	20.81	15.01	30
High	2452	20.73	14.99	30

BLE mode

Channel	Frequency (MHz)	Max Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	1.24	30	Pass
Middle	2440	1.04	30	Pass
High	2480	0.58	30	Pass

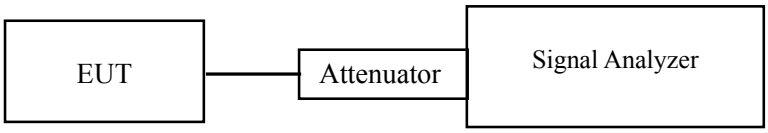
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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

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:	24~25 ℃
Relative Humidity:	51~52 %
ATM Pressure:	101.0 kPa

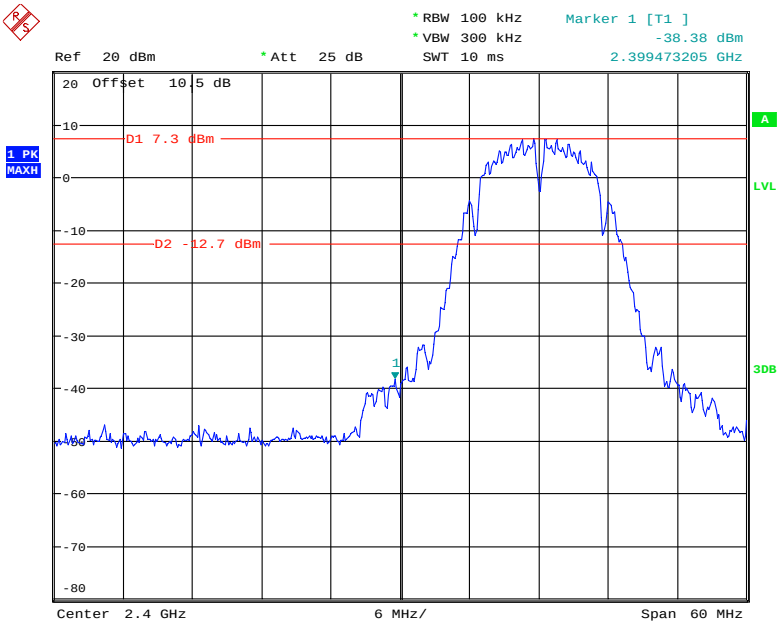
The testing was performed by Kieroy Luo on 2019-06-01 and 2019-06-28.

EUT operation mode: Transmitting

Test Result: Compliance

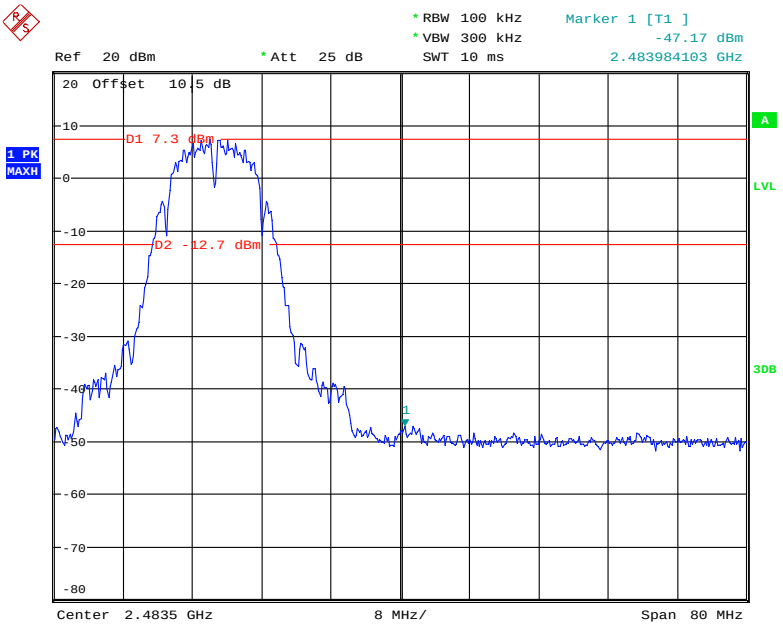
Please refer to the following plots.

802.11b: Band Edge, Left Side



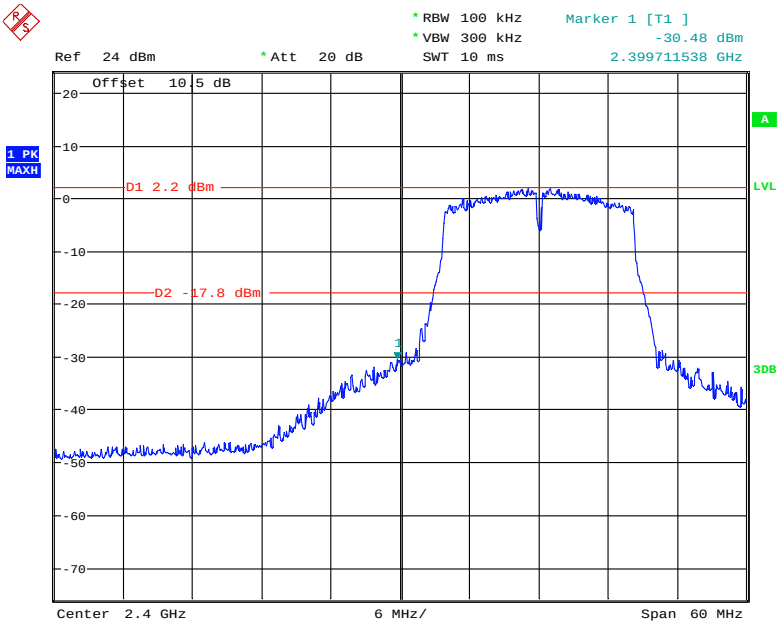
Date: 1.JUN.2019 13:45:46

802.11b: Band Edge, Right Side



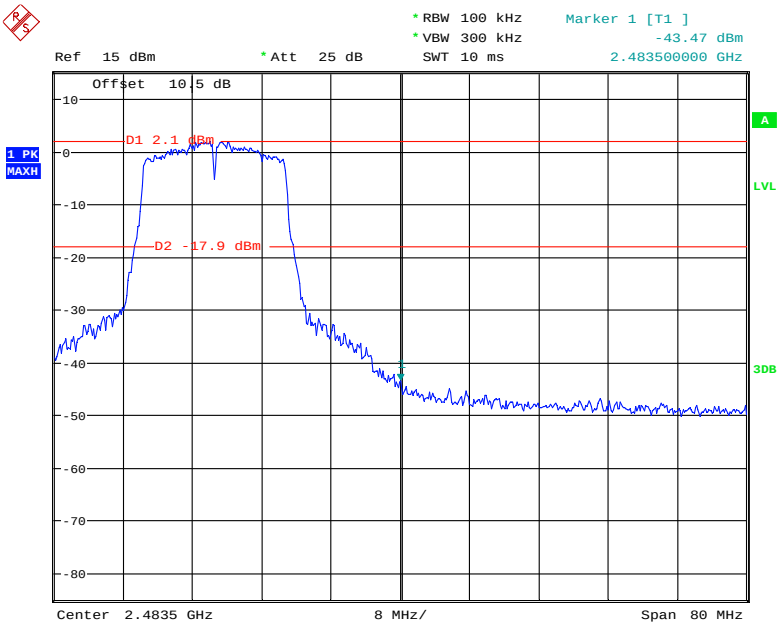
Date: 1.JUN.2019 13:49:40

802.11g: Band Edge, Left Side



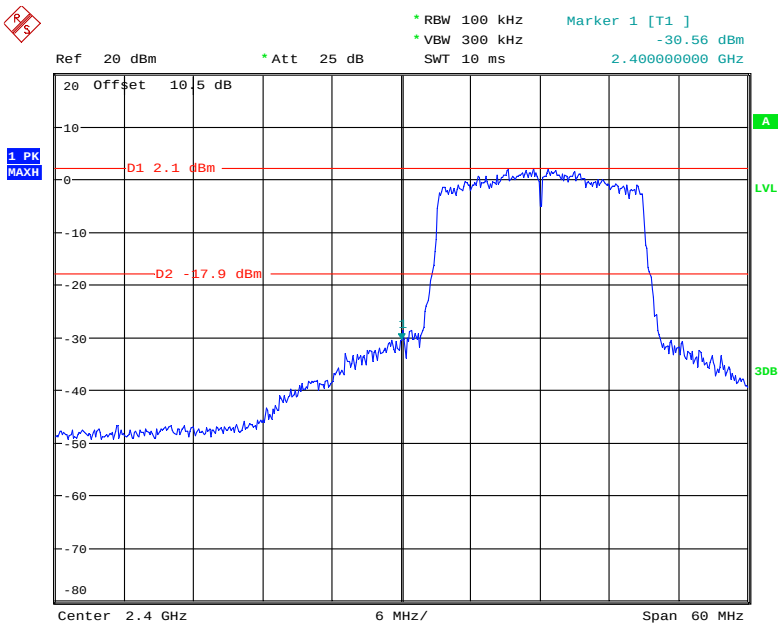
Date: 28.JUN.2019 09:30:11

802.11g: Band Edge, Right Side



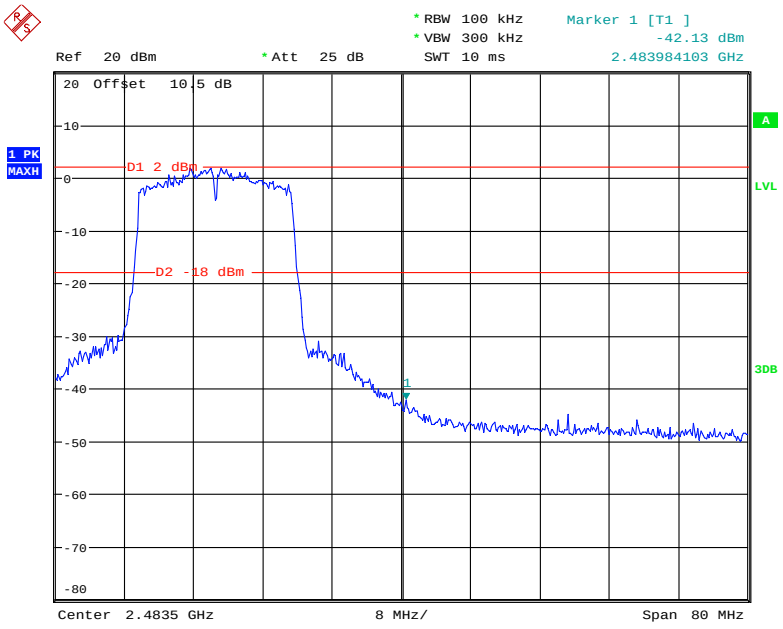
Date: 1.JUN.2019 13:41:32

802.11n-HT20: Band Edge, Left Side



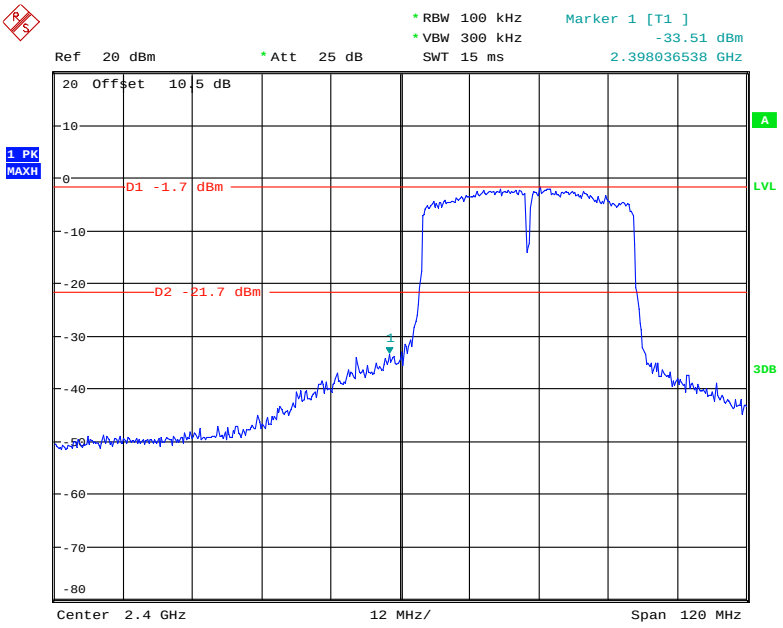
Date: 1.JUN.2019 12:05:07

802.11n-HT20: Band Edge, Right Side



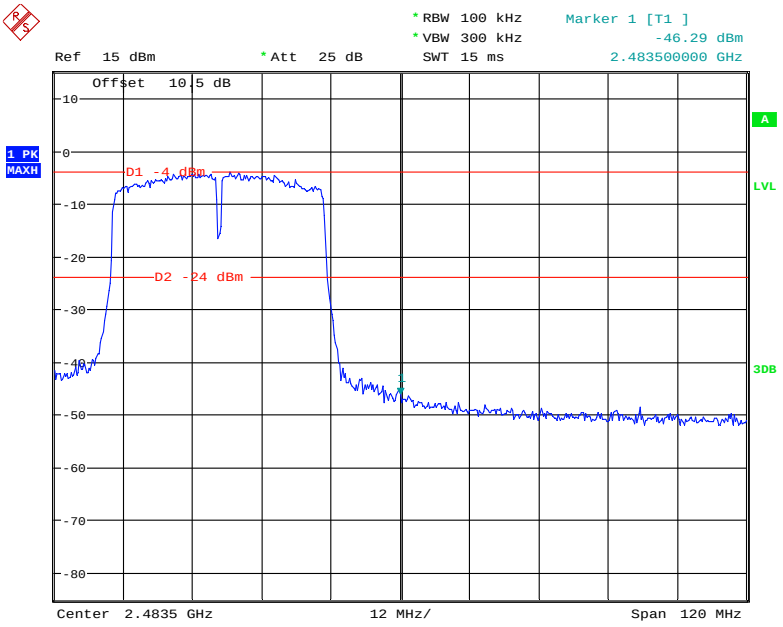
Date: 1.JUN.2019 12:11:05

802.11n-HT40: Band Edge, Left Side



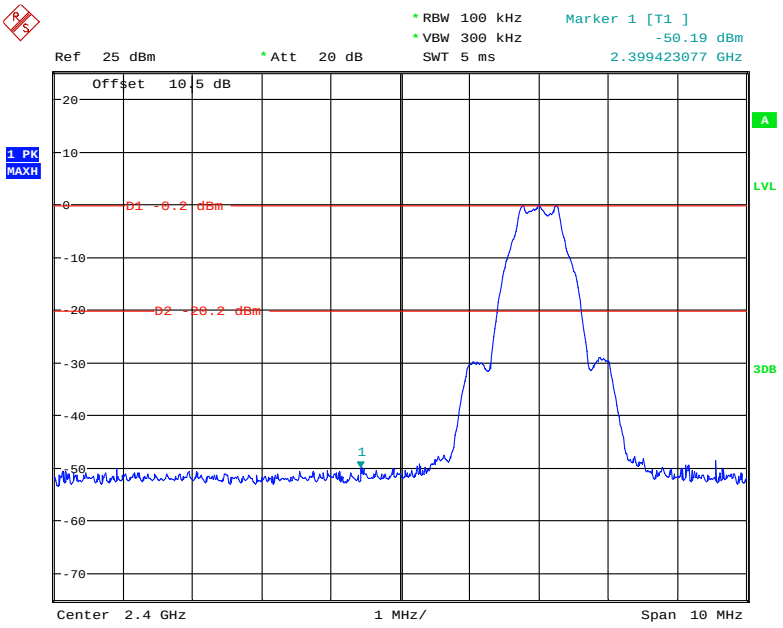
Date: 1.JUN.2019 12:00:51

802.11n-HT40: Band Edge, Right Side



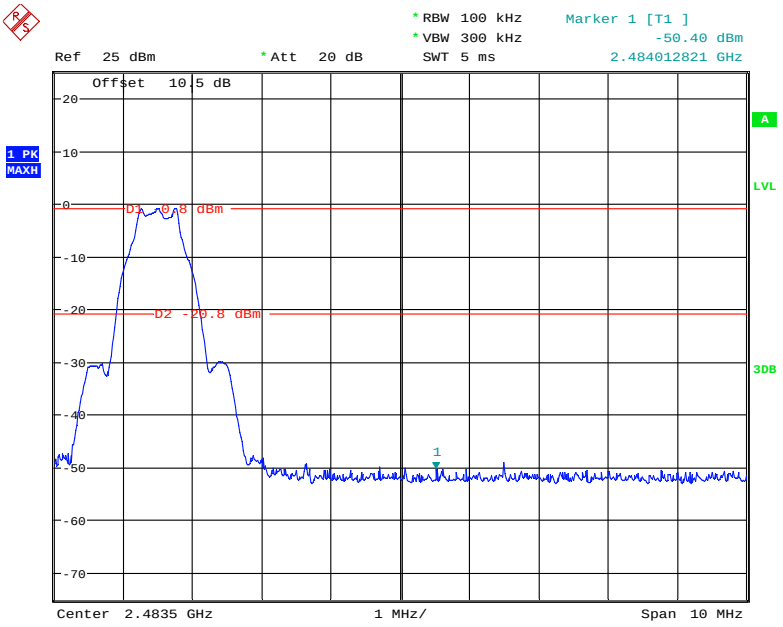
Date: 1.JUN.2019 11:51:35

BLE: Band Edge, Left Side



Date: 1.JUN.2019 18:20:49

BLE: Band Edge, Right Side



Date: 1.JUN.2019 18:19:23

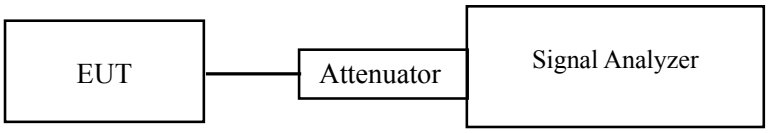
FCC §15.247(e) - POWER SPECTRAL DENSITY

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. 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:	24~25 ℃
Relative Humidity:	52~56 %
ATM Pressure:	100.9~101.0 kPa

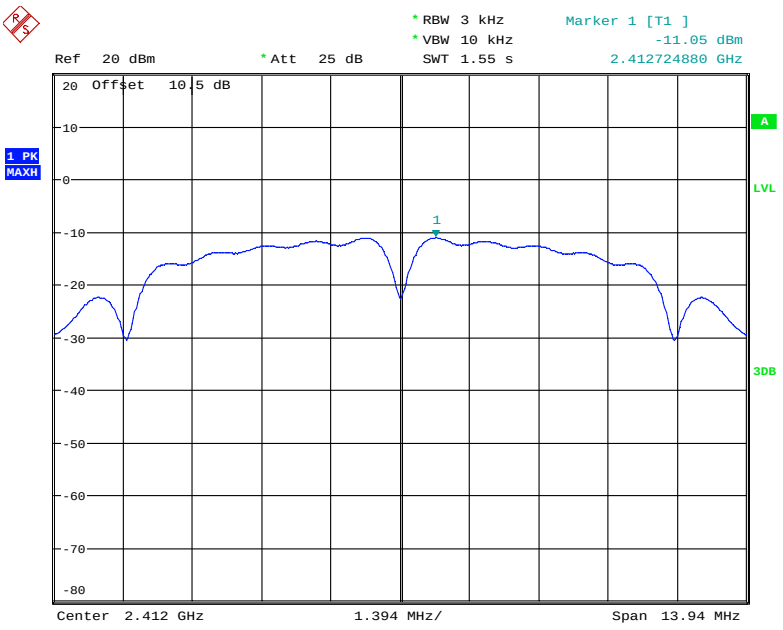
The testing was performed by Kieroy Luo from 2019-06-01 to 2019-06-18.

EUT operation mode: Transmitting

Test Result: Pass

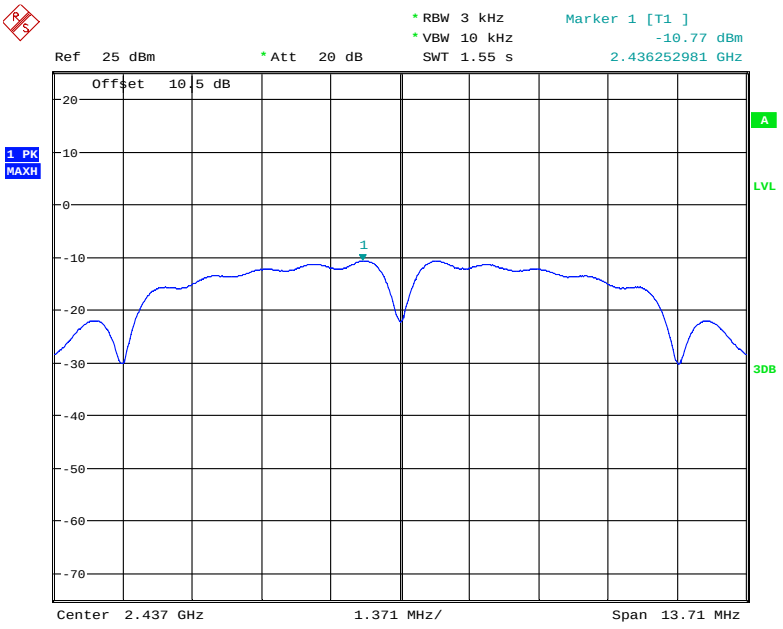
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode			
Low	2412	-11.05	≤8
Middle	2437	-10.77	≤8
High	2462	-10.98	≤8
802.11g mode			
Low	2412	-12.24	≤8
Middle	2437	-11.80	≤8
High	2462	-11.72	≤8
802.11n-HT20 mode			
Low	2412	-11.99	≤8
Middle	2437	-12.17	≤8
High	2462	-12.46	≤8
802.11n-HT40 mode			
Low	2422	-14.34	≤8
Middle	2437	-13.92	≤8
High	2452	-16.05	≤8
BLE mode			
Low	2402	-14.75	≤8
Middle	2440	-14.93	≤8
High	2480	-15.55	≤8

Power Spectral Density, 802.11b Low Channel



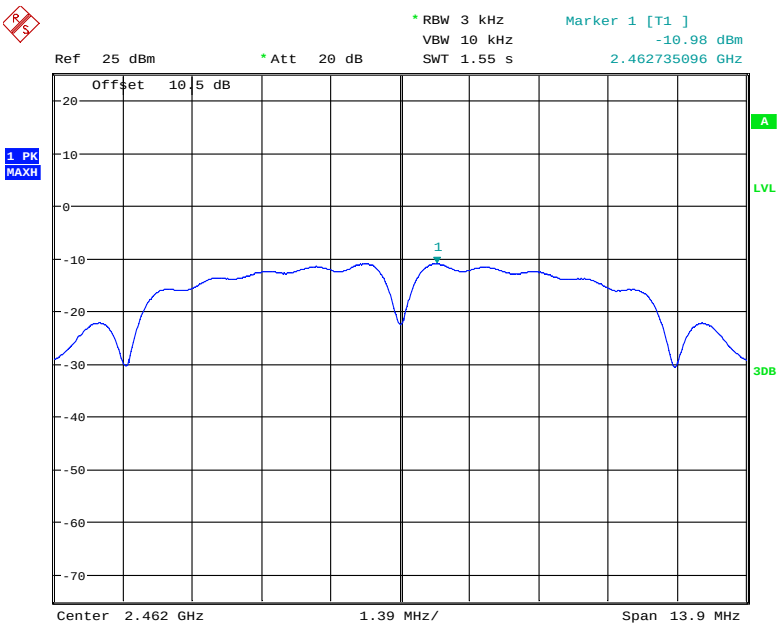
Date: 1.JUN.2019 13:46:26

Power Spectral Density, 802.11b Middle Channel



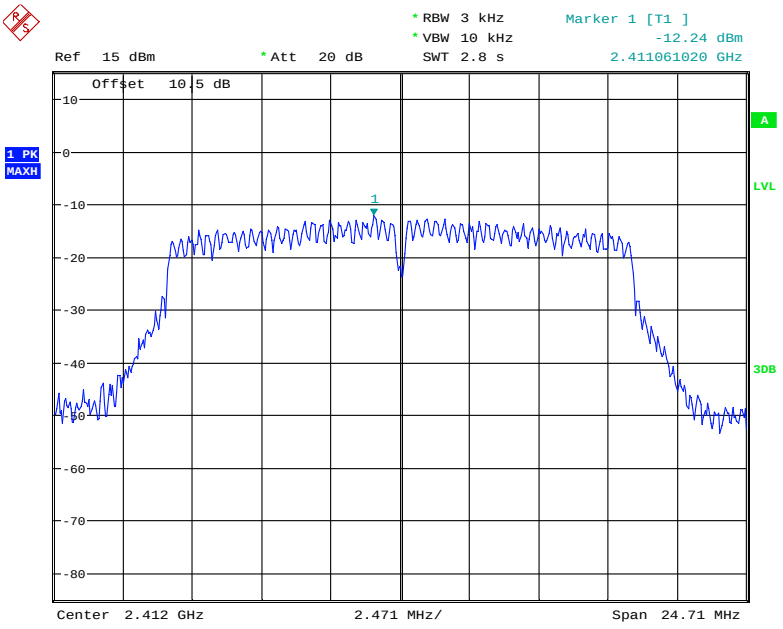
Date: 1.JUN.2019 13:57:02

Power Spectral Density, 802.11b High Channel



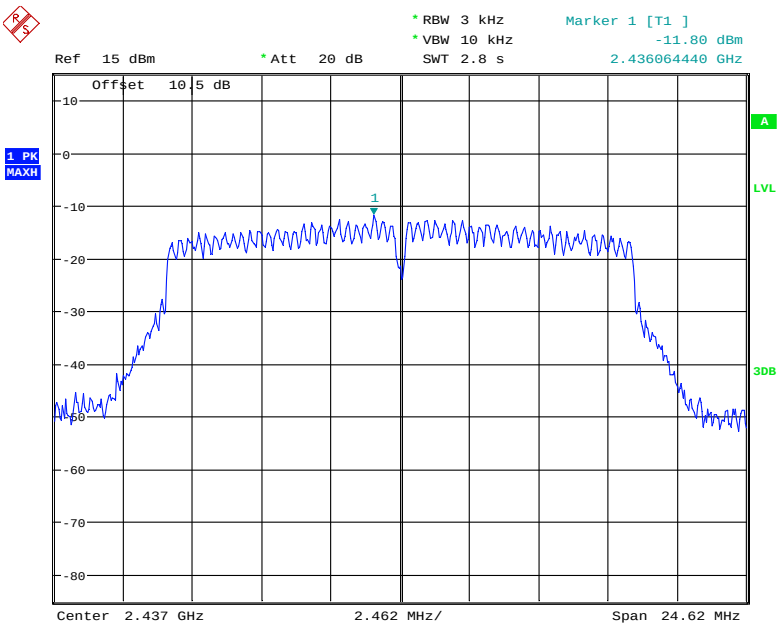
Date: 1.JUN.2019 13:54:54

Power Spectral Density, 802.11g Low Channel



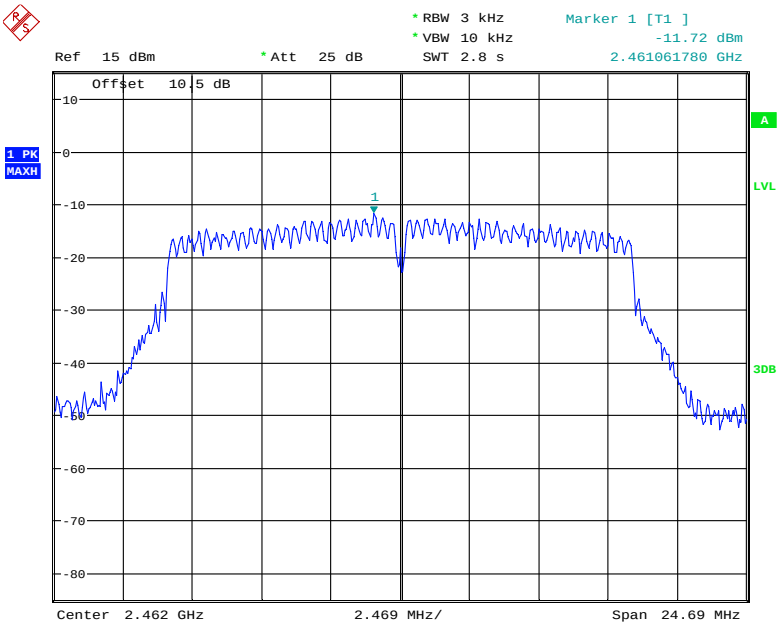
Date: 18.JUN.2019 15:39:49

Power Spectral Density, 802.11g Middle Channel



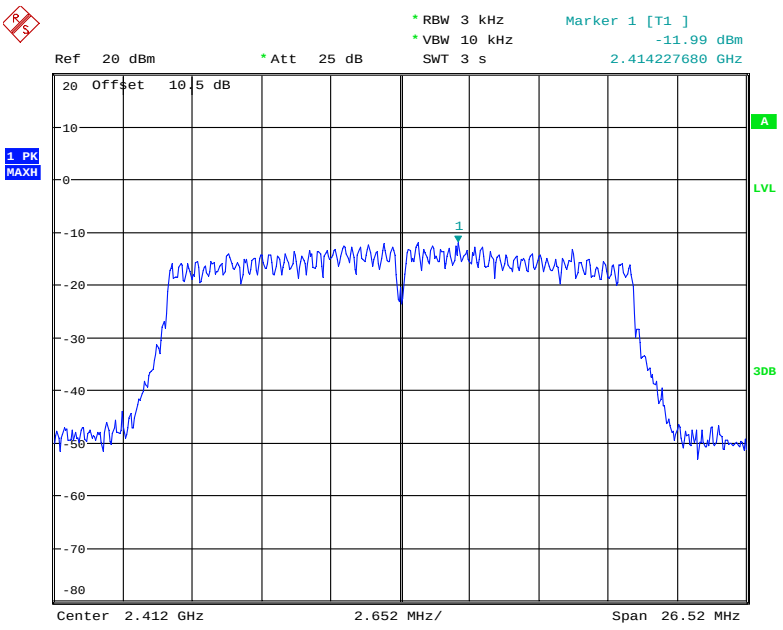
Date: 18.JUN.2019 15:42:04

Power Spectral Density, 802.11g High Channel



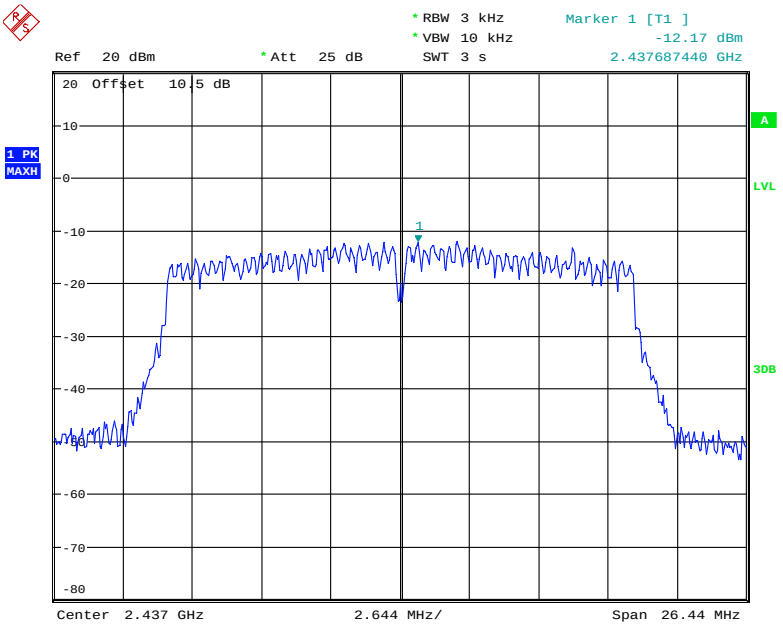
Date: 1.JUN.2019 13:43:04

Power Spectral Density, 802.11n-HT20 Low Channel



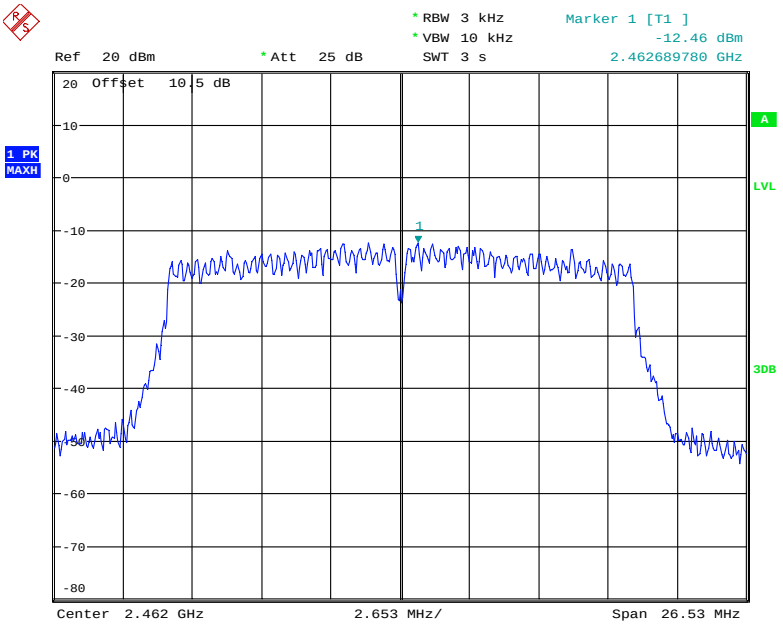
Date: 1.JUN.2019 12:06:28

Power Spectral Density, 802.11n-HT20 Middle Channel



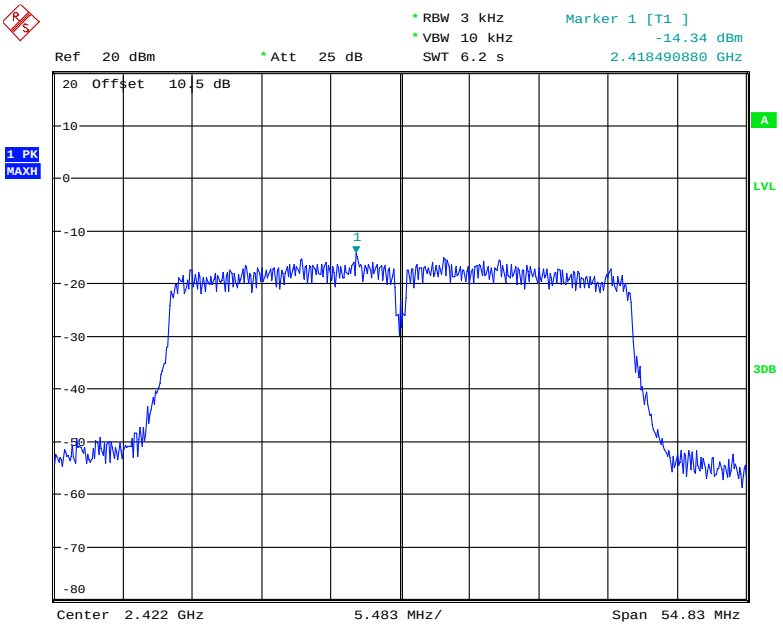
Date: 1.JUN.2019 13:24:44

Power Spectral Density, 802.11n-HT20 High Channel



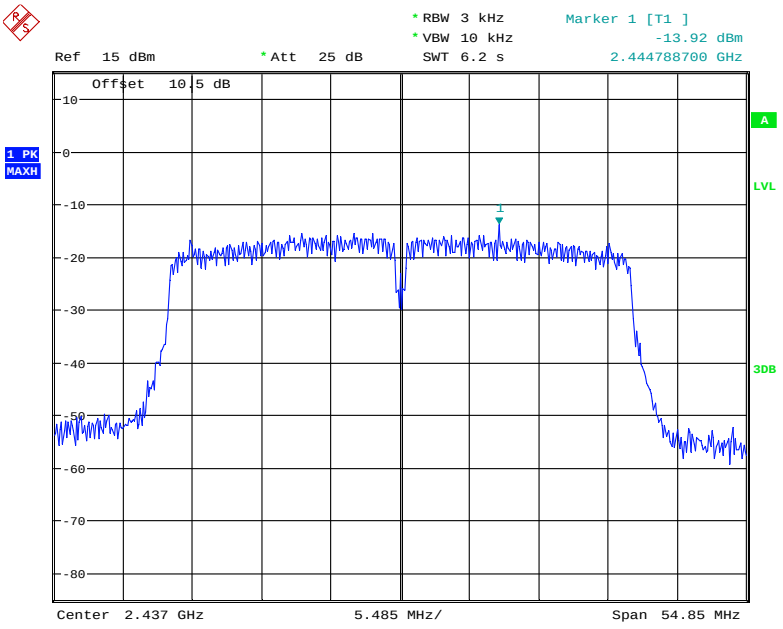
Date: 1.JUN.2019 12:11:51

Power Spectral Density, 802.11n-HT40 Low Channel



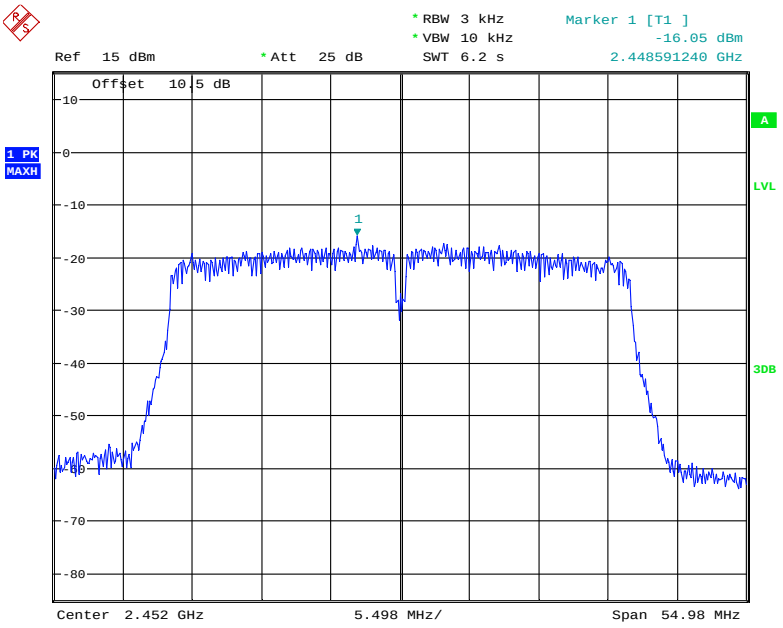
Date: 1.JUN.2019 12:01:59

Power Spectral Density, 802.11n-HT40 Middle Channel



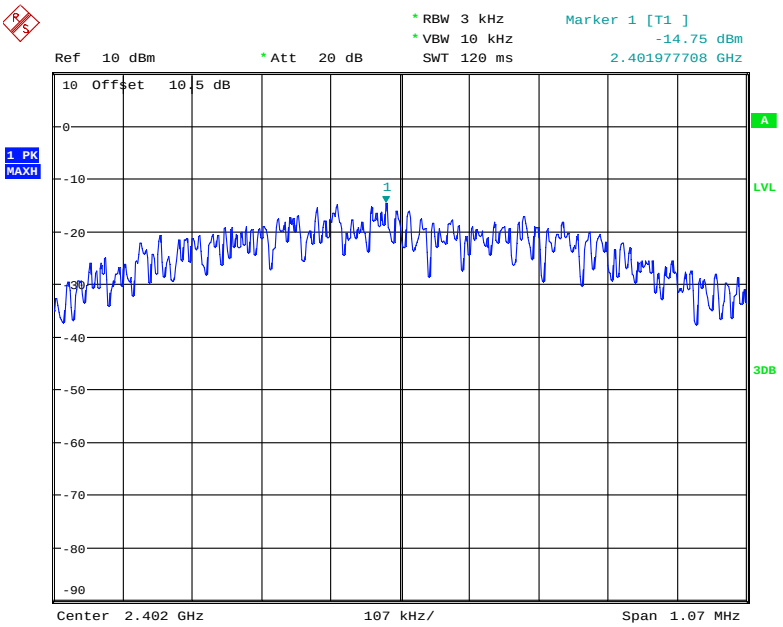
Date: 1.JUN.2019 11:57:15

Power Spectral Density, 802.11n-HT40 High Channel



Date: 1.JUN.2019 11:50:37

Power Spectral Density, BLE Low Channel



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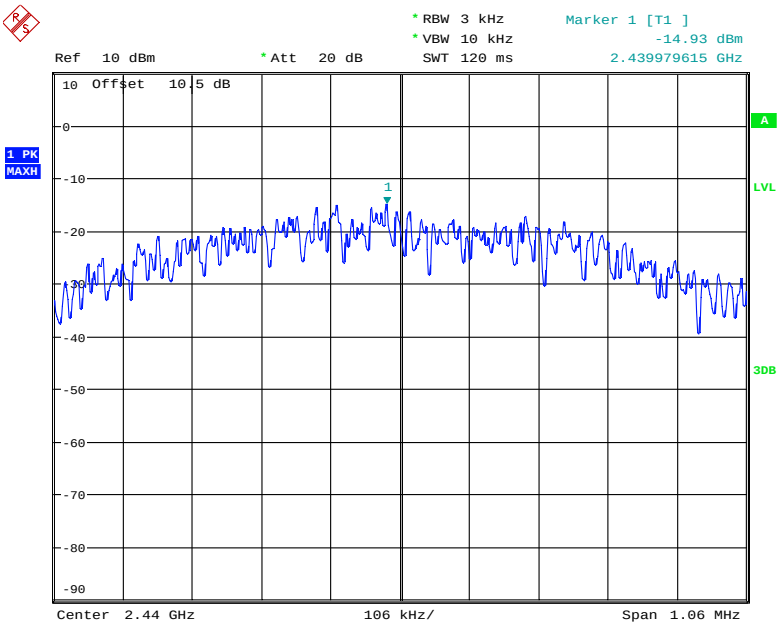
Power Spectral Density, BLE Middle Channel



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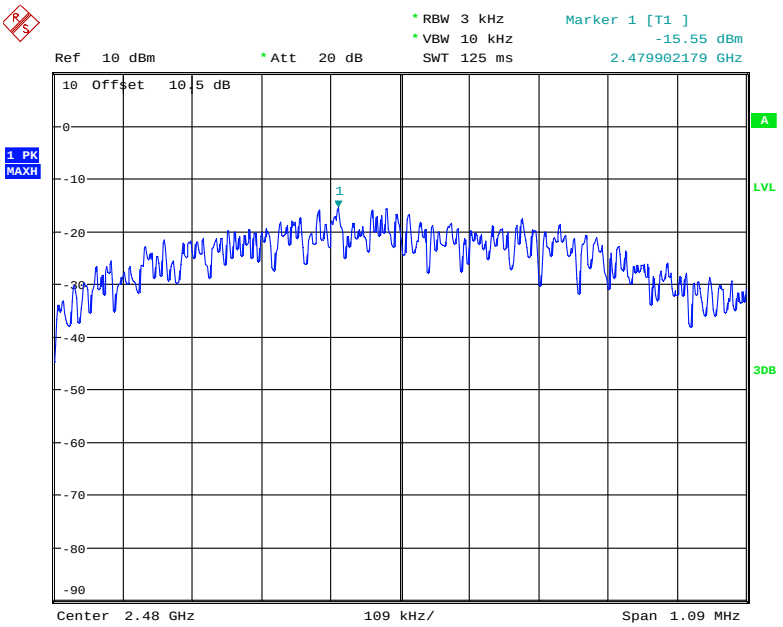
Power Spectral Density, BLE High Channel



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