



FCC PART 15.247 TEST REPORT

For

Vuzix Corporation

25 Hendrix Rd, West Henrietta, New York, United States 14586

FCC ID: 2AA9D-472

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TABLE OF CONTENTS

GENERAL INFORMATION.....	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
RELATED SUBMITTAL(S)/GRANT(S).....	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
SYSTEM TEST CONFIGURATION	6
DESCRIPTION OF TEST CONFIGURATION	6
EQUIPMENT MODIFICATIONS	7
EUT EXERCISE SOFTWARE	7
DUTY CYCLE	8
SUPPORT EQUIPMENT LIST AND DETAILS	11
EXTERNAL I/O CABLE.....	11
BLOCK DIAGRAM OF TEST SETUP	11
SUMMARY OF TEST RESULTS	12
TEST EQUIPMENT LIST	13
FCC§15.247 (i), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE	15
APPLICABLE STANDARD	15
FCC §15.203 - ANTENNA REQUIREMENT.....	16
APPLICABLE STANDARD	16
ANTENNA CONNECTOR CONSTRUCTION	16
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	17
APPLICABLE STANDARD	17
EUT SETUP	17
EMI TEST RECEIVER SETUP.....	17
TEST PROCEDURE	17
CORRECTED FACTOR & MARGIN CALCULATION	18
TEST RESULTS SUMMARY	18
TEST DATA	18
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS.....	23
APPLICABLE STANDARD	23
EUT SETUP	23
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	24
TEST PROCEDURE	24
CORRECTED AMPLITUDE & MARGIN CALCULATION	24
TEST RESULTS SUMMARY	24
TEST DATA	25
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH&99% OCCUPIED BANDWIDTH.....	37
APPLICABLE STANDARD	37
TEST PROCEDURE	37
TEST DATA	37

FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER.....	54
APPLICABLE STANDARD	54
TEST PROCEDURE	54
TEST DATA	54
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE.....	56
APPLICABLE STANDARD	56
TEST PROCEDURE	56
TEST DATA	56
FCC §15.247(e) - POWER SPECTRAL DENSITY	63
APPLICABLE STANDARD	63
TEST PROCEDURE	63
TEST DATA	63

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	M400
Tested Model	472
Frequency Range	Bluetooth LE: 2402~2480MHz Wi-Fi: 2412~2462MHz
Conducted Peak Power	Bluetooth LE 1M: 6.37dBm; LE 2M: 6.49dBm; Wi-Fi: 802.11b:20.58dBm, 802.11G:23.87dBm, 802.11N20: 22.85dBm, 802.11N40: 23.83dBm
Modulation Technique	Bluetooth LE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification	Bluetooth/Wi-Fi: -4.1dBi@2.4GHz
Voltage Range	DC 3.7 V from battery
Date of Test	2019-08-09 to 2019-09-19
Sample serial number	190723001(Assigned by BACL, Shenzhen)
Received date	2019-07-23
Sample/EUT Status	Good condition

Objective

This report is prepared on behalf of *Vuzix Corporation* 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 15.247 DSS and Part 15.407 NII submissions with FCC ID: 2AA9D-472.

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 °C
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

“QRCT.exe” exercise software was used.

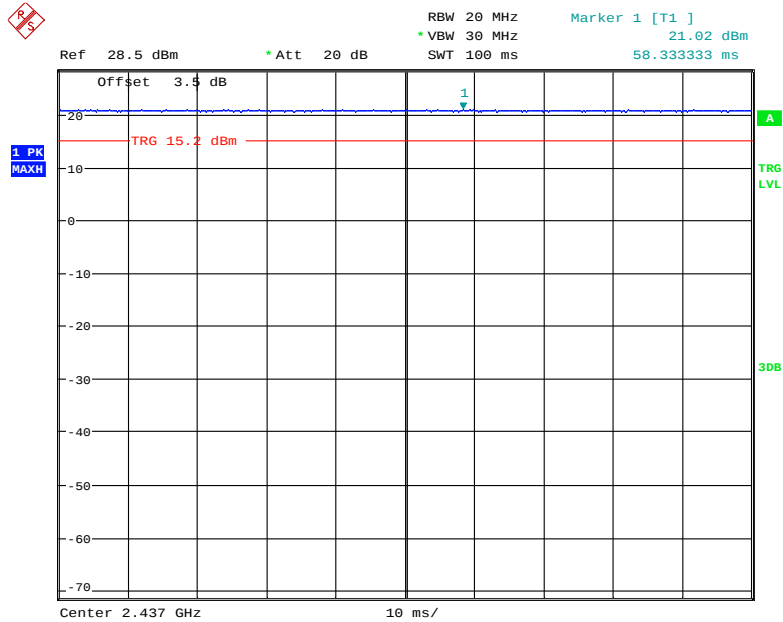
The device was tested with the worst case was performed as below:

Mode	Data rate	Power level		
		Low channel	Middle channel	High channel
802.11b	1 Mbps	18	18	18
802.11g	6 Mbps	16.5	16.5	16.5
802.11n-HT20	MCS0	16.5	16.5	16.5
802.11n-HT40	MCS0	16	16	16
BLE	1 Mbps	Default	Default	Default
BLE	2 Mbps	Default	Default	Default

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

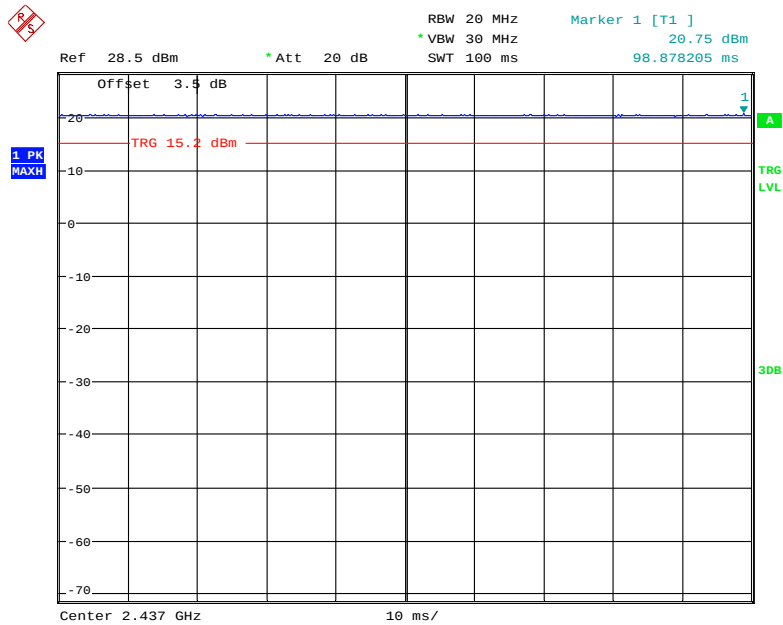
Duty cycle

802.11b mode



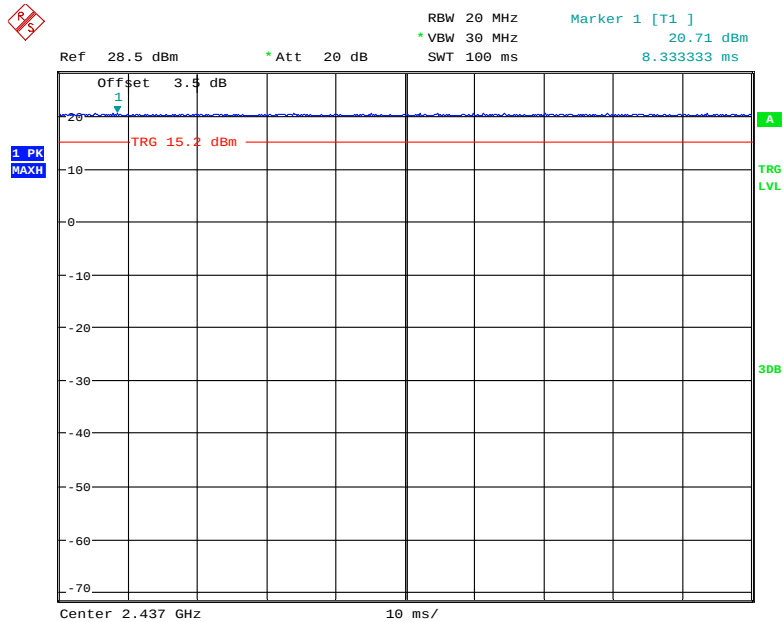
Date: 21.AUG.2019 13:11:10

802.11g mode



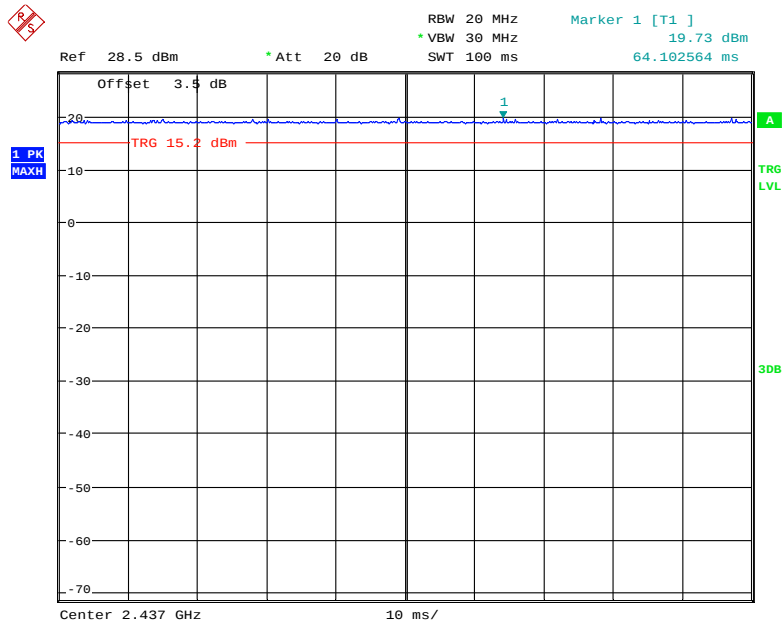
Date: 21.AUG.2019 13:12:45

802.11n-HT20 Mode



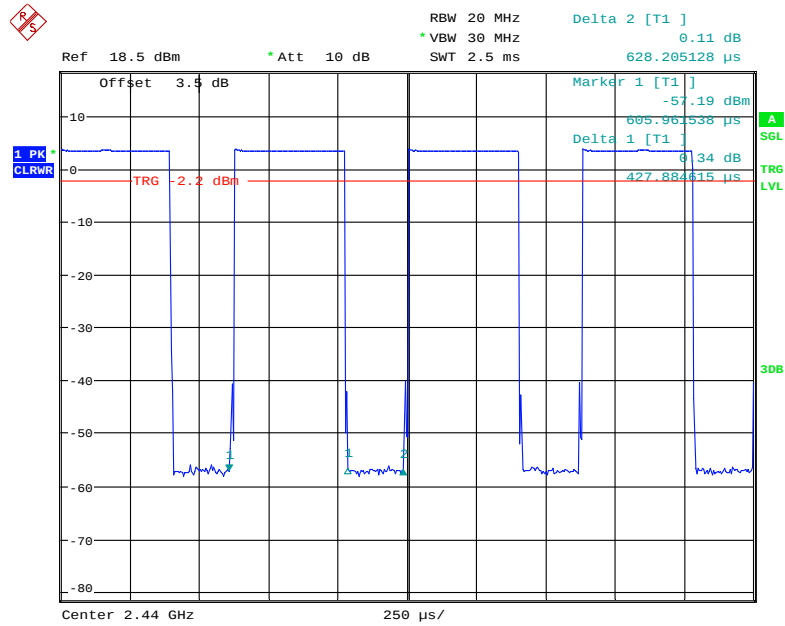
Date: 21.AUG.2019 13:13:36

802.11n-HT40 Mode



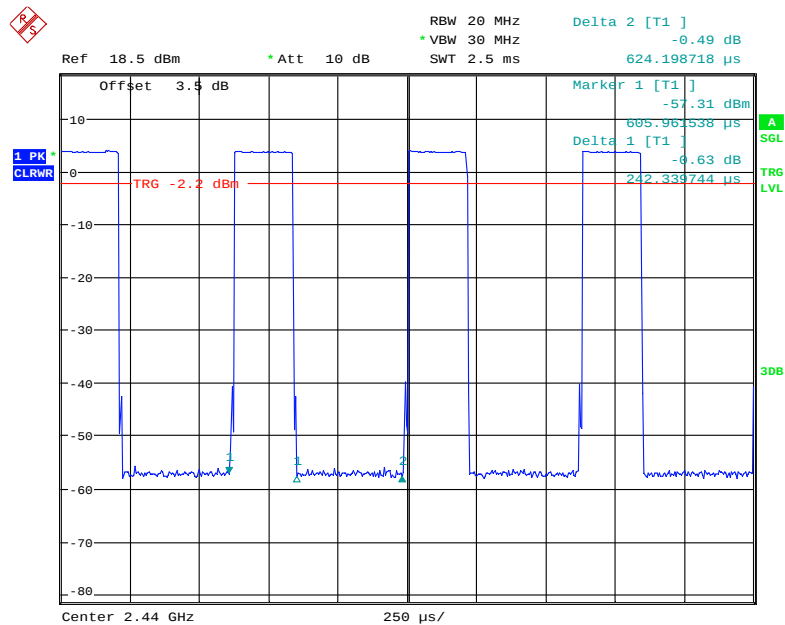
Date: 21.AUG.2019 13:14:25

BLE Mode, 1M



Date: 17.SEP.2019 13:52:31

BLE Mode, 2M



Date: 17.SEP.2019 13:54:01

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(1M)	68.15	428	2.34	3kHz	1.67
BLE(2M)	38.78	242	4.13	5kHz	4.11

Support Equipment List and Details

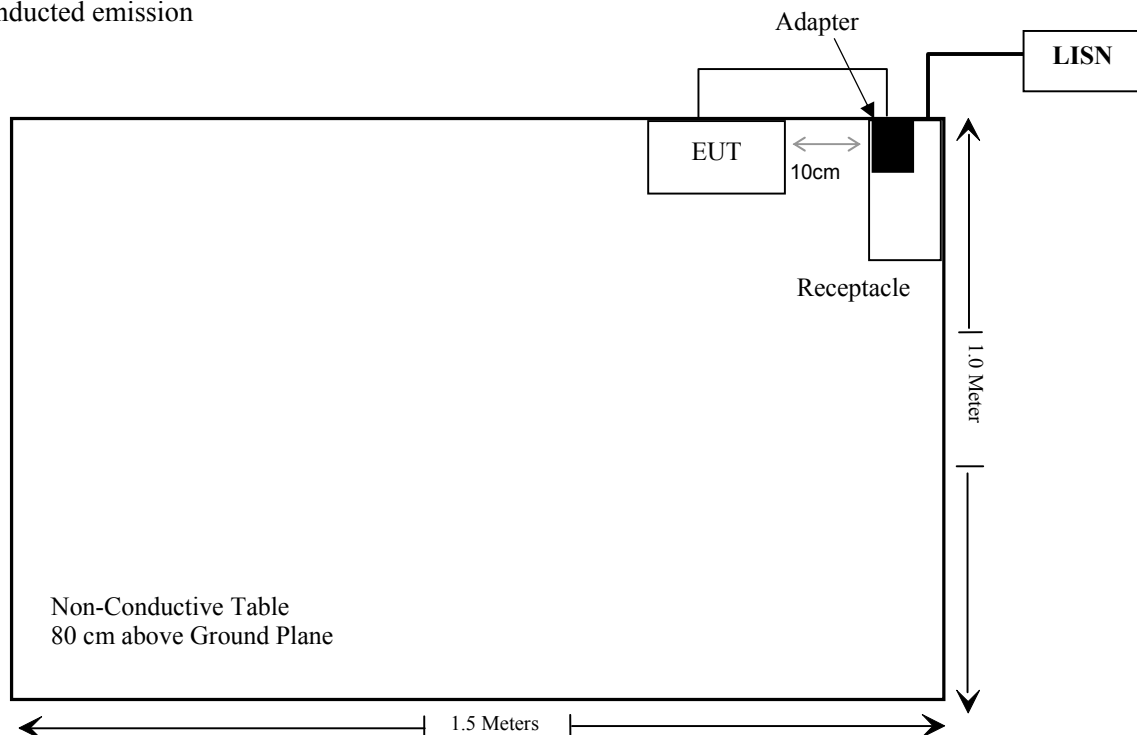
Manufacturer	Description	Model	Serial Number
Dongguan Aohai Power Technology Co.,Ltd	Adapter	A8-501000	/

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielded detachable USB Cable	1.0	Adapter	EUT

Block Diagram of Test Setup

For conducted emission



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1093	RF Exposure	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	2019-07-11	2020-07-11
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2019-01-25	2020-01-25
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2019-03-02	2020-03-01
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	Spectrum Analyzer	FSV40-N	102259	2019-07-22	2020-07-21
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	ESR3	102455	2019-07-09	2020-07-08
UTiFLEX MICRO-C0AX	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	Band Reject 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	2019-07-10	2020-07-09
WEINSCHL	3dB Attenuator	6231	666	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) & §2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), 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 KDB 447498 D01 General RF Exposure Guidance

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

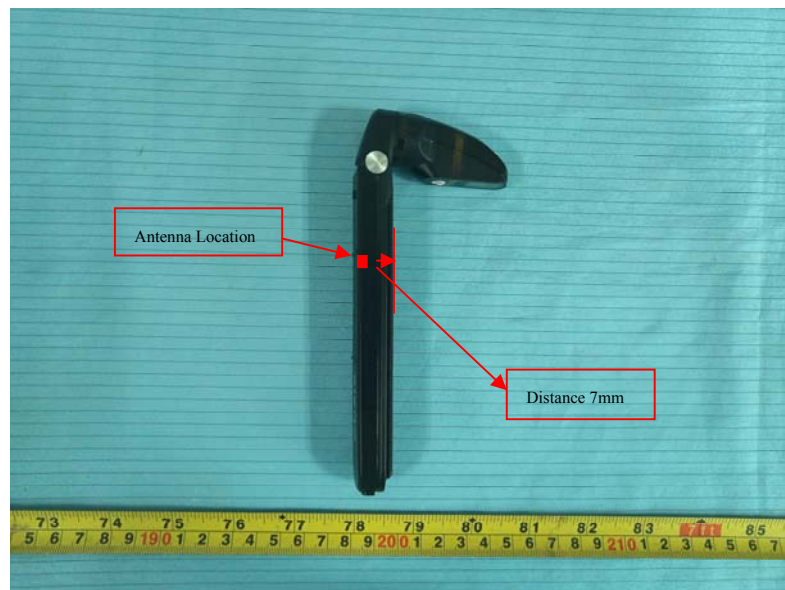
1. $f(\text{GHz})$ is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Measurement Result

BLE:

Mode	Frequency (MHz)	Max Tune-up Conducted Power (dBm)	Max Tune-up Conducted Power (mW)	Calculated Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
BLE	2480	6.8	4.79	7	1.08	3.0	Yes

Wi-Fi: Please refer to the SAR report: RSZ190723002-SAA.



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 -4.1 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:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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:

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

Test Results Summary

According to the EUT complied with the FCC Part 15.207,

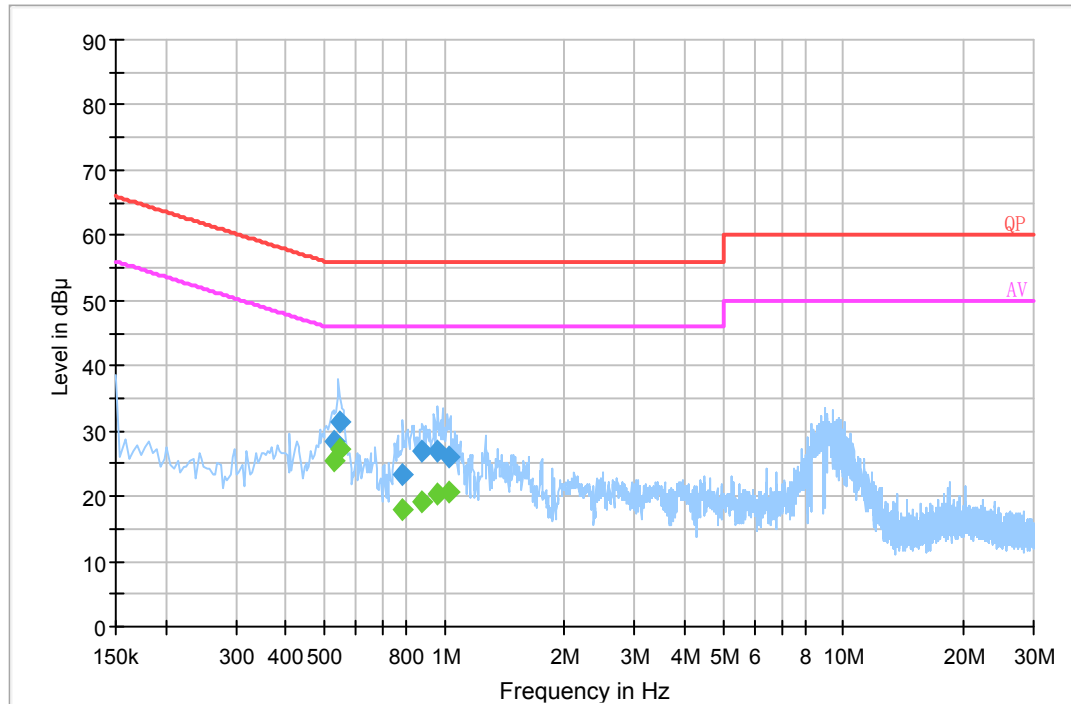
Test Data

Environmental Conditions

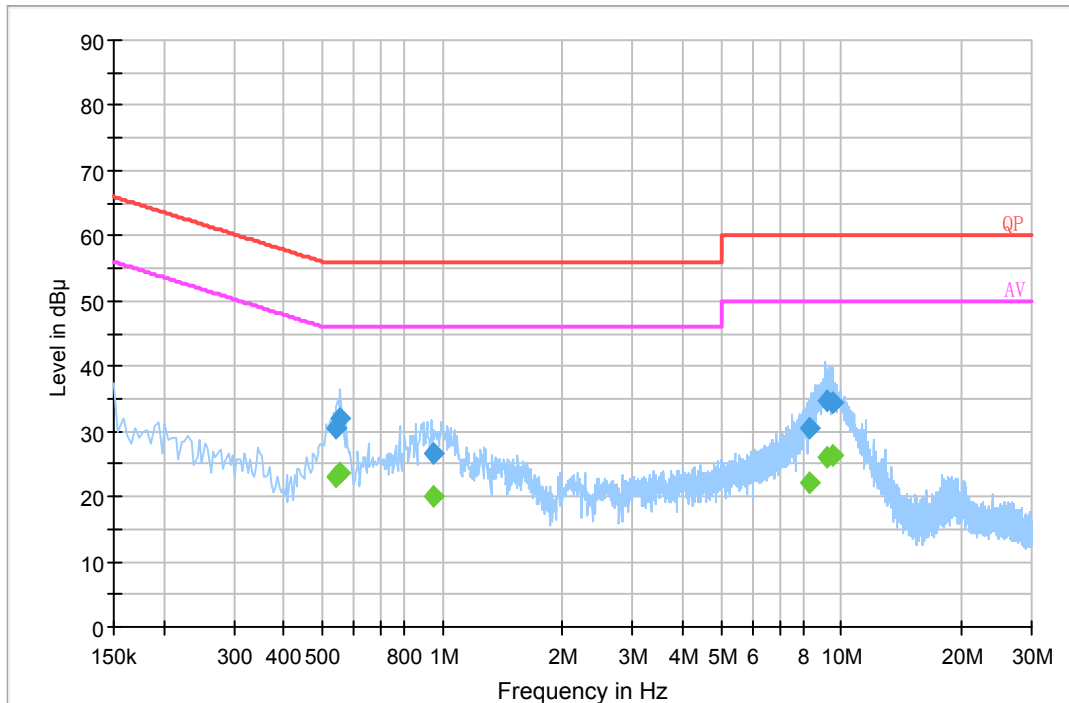
Temperature:	25 °C
Relative Humidity:	51 %
ATM Pressure:	101.0 kPa

The testing was performed by Kiki Geng on 2019-08-14.

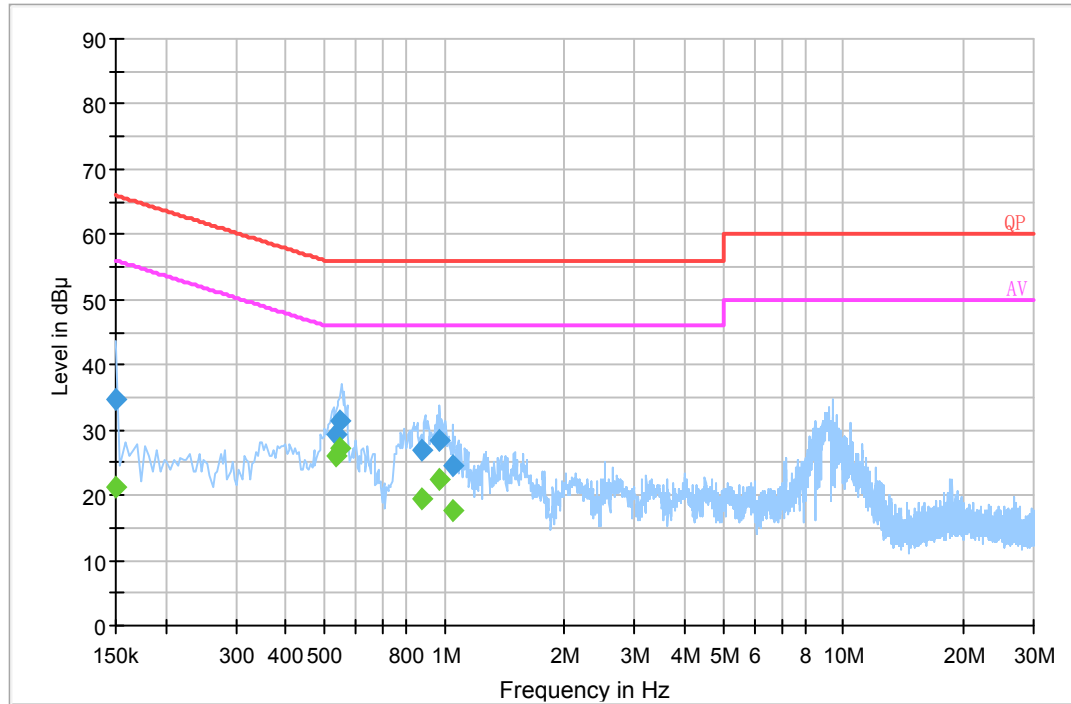
EUT operation mode: Transmitting (Worst case at High channel)

BLE Mode:**AC 120V/60 Hz, Line**

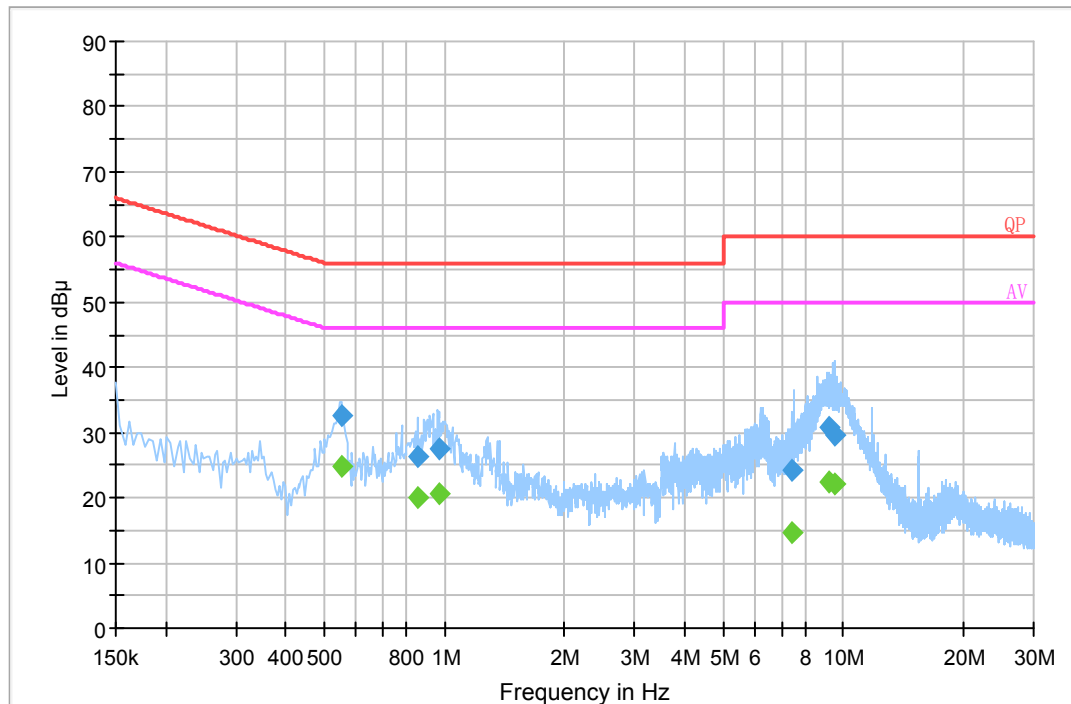
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.526110	28.5	19.8	56.0	27.5	QP
0.549870	31.3	19.8	56.0	24.7	QP
0.786210	23.3	19.8	56.0	32.7	QP
0.880770	26.8	19.8	56.0	29.2	QP
0.955570	27.0	19.8	56.0	29.0	QP
1.022730	25.9	19.9	56.0	30.1	QP
0.526110	25.3	19.8	46.0	20.7	Ave.
0.549870	27.1	19.8	46.0	18.9	Ave.
0.786210	17.9	19.8	46.0	28.1	Ave.
0.880770	19.1	19.8	46.0	26.9	Ave.
0.955570	20.4	19.8	46.0	25.6	Ave.
1.022730	20.7	19.9	46.0	25.3	Ave.

AC 120V/60 Hz, Neutral

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.541990	30.6	19.8	56.0	25.4	QP
0.553690	31.9	19.8	56.0	24.1	QP
0.947930	26.7	19.8	56.0	29.3	QP
8.348210	30.4	19.9	60.0	29.6	QP
9.213410	34.8	19.9	60.0	25.2	QP
9.528190	34.4	19.9	60.0	25.6	QP
0.541990	22.9	19.8	46.0	23.1	Ave.
0.553690	23.6	19.8	46.0	22.4	Ave.
0.947930	20.0	19.8	46.0	26.0	Ave.
8.348210	22.0	19.9	50.0	28.0	Ave.
9.213410	25.9	19.9	50.0	24.1	Ave.
9.528190	26.2	19.9	50.0	23.8	Ave.

Wi-Fi Mode:**AC 120 V/60 Hz, Line: (Worst case at 802.11b mode, High channel)**

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.150000	34.7	19.8	66.0	31.3	QP
0.533890	29.2	19.8	56.0	26.8	QP
0.549690	31.5	19.8	56.0	24.5	QP
0.880590	27.0	19.8	56.0	29.0	QP
0.971390	28.4	19.9	56.0	27.6	QP
1.054250	24.6	19.9	56.0	31.4	QP
0.150000	21.3	19.8	56.0	34.7	Ave.
0.533890	26.0	19.8	46.0	20.0	Ave.
0.549690	27.2	19.8	46.0	18.8	Ave.
0.880590	19.6	19.8	46.0	26.4	Ave.
0.971390	22.3	19.9	46.0	23.7	Ave.
1.054250	17.5	19.9	46.0	28.5	Ave.

AC 120V/ 60 Hz, Neutral:

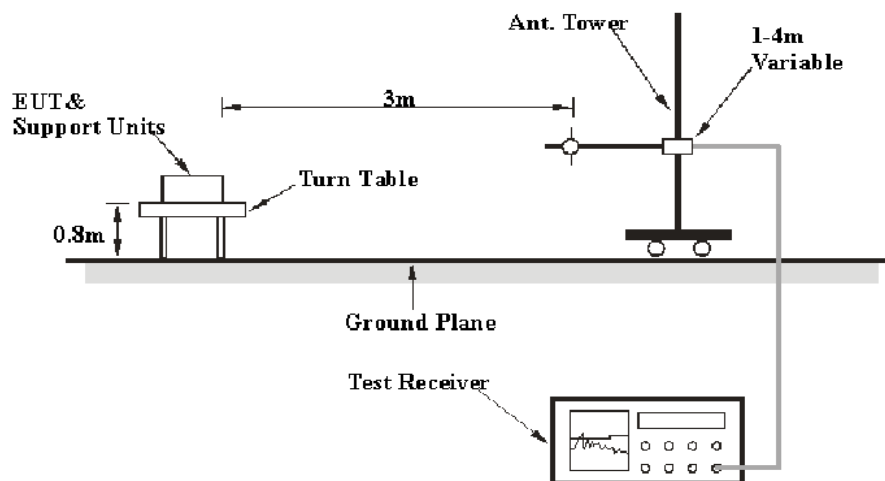
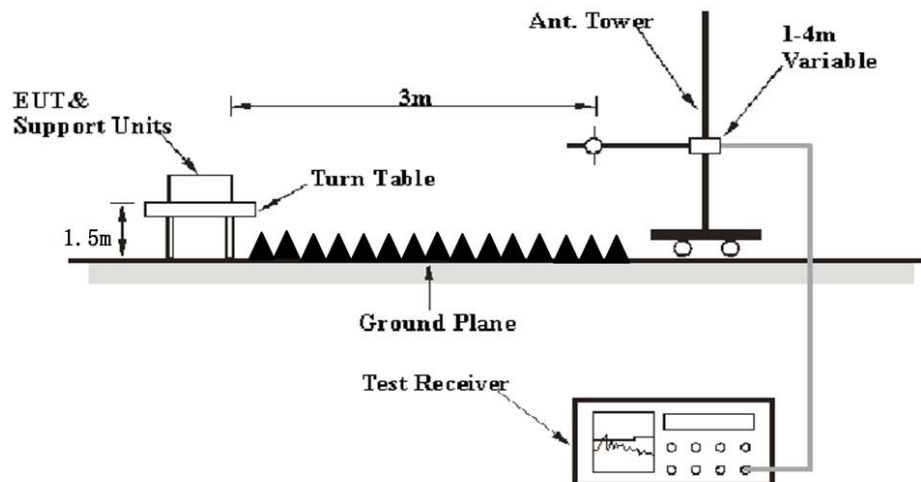
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.553810	32.7	19.8	56.0	23.3	QP
0.861130	26.3	19.8	56.0	29.7	QP
0.971570	27.4	19.8	56.0	28.6	QP
7.425530	24.2	19.9	60.0	35.8	QP
9.240870	30.7	19.9	60.0	29.3	QP
9.534570	29.7	19.9	60.0	30.3	QP
0.553810	24.7	19.8	46.0	21.3	Ave.
0.861130	19.9	19.8	46.0	26.1	Ave.
0.971570	20.6	19.8	46.0	25.4	Ave.
7.425530	14.6	19.9	50.0	35.4	Ave.
9.240870	22.3	19.9	50.0	27.7	Ave.
9.534570	22.2	19.9	50.0	27.8	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:

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

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 Results Summary

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

Test Data**Environmental Conditions**

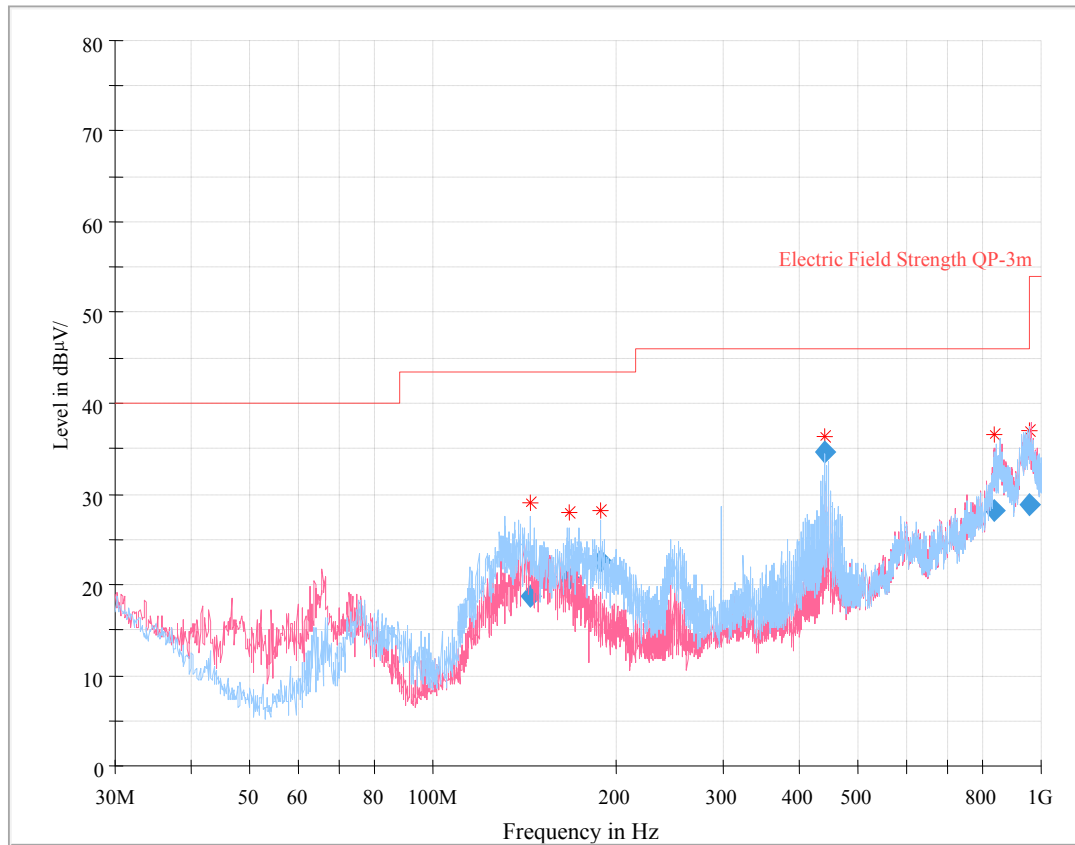
Temperature:	25 °C
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Charlie Cha on 2019-08-15 for below 1G and Curry Xiang on 2019-08-21 and 2019-08-22 for above 1G.

EUT operation mode: Transmitting

Wi-Fi Mode: (Worst case at 802.11b mode, High channel)

30 MHz~1 GHz:



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
144.213875	18.63	319.0	H	71.0	-14.2	43.50	24.87
167.133625	20.73	153.0	H	272.0	-14.8	43.50	22.77
189.165000	22.55	119.0	H	273.0	-15.2	43.50	20.95
441.599625	34.57	108.0	H	118.0	-8.6	46.00	11.43
837.998125	28.19	274.0	V	0.0	5.7	46.00	17.81
955.220625	28.86	262.0	H	17.0	9.6	46.00	17.14

1 GHz-25GHz (Wi-Fi):**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)									
2385.31	28.42	PK	353	1.9	H	31.87	60.29	74	13.71
2385.31	14.58	Ave.	353	1.9	H	31.87	46.45	54	7.55
2491.08	28.06	PK	225	1.9	H	32.13	60.19	74	13.81
2491.08	14.22	Ave.	225	1.9	H	32.13	46.35	54	7.65
4824.00	43.13	PK	21	2.0	H	6.28	49.41	74	24.59
4824.00	28.87	Ave.	21	2.0	H	6.28	35.15	54	18.85
Middle Channel (2437MHz)									
4874.00	43.45	PK	247	2.1	H	6.76	50.21	74	23.79
4874.00	28.27	Ave.	247	2.1	H	6.76	35.03	54	18.97
High Channel (2462 MHz)									
2350.81	28.49	PK	236	1.9	H	31.77	60.26	74	13.74
2350.81	14.42	Ave.	236	1.9	H	31.77	46.19	54	7.81
2497.07	28.15	PK	7	1.2	H	32.13	60.28	74	13.72
2497.07	14.23	Ave.	7	1.2	H	32.13	46.36	54	7.64
4924.00	43.93	PK	58	1.1	H	6.76	50.69	74	23.31
4924.00	28.58	Ave.	198	2.2	H	6.76	35.34	54	18.66

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)									
2337.15	28.78	PK	56	2.1	H	31.64	60.42	74	13.58
2337.15	14.69	Ave.	56	2.1	H	31.64	46.33	54	7.67
2497.07	28.34	PK	31	1.9	H	32.13	60.47	74	13.53
2497.07	14.52	Ave.	31	1.9	H	32.13	46.65	54	7.35
4824.00	42.98	PK	29	1.8	H	6.28	49.26	74	24.74
4824.00	28.25	Ave.	29	1.8	H	6.28	34.53	54	19.47
Middle Channel (2437MHz)									
4874.00	43.69	PK	84	1.7	H	6.76	50.45	74	23.55
4874.00	28.42	Ave.	84	1.7	H	6.76	35.18	54	18.82
High Channel (2462 MHz)									
2331.48	27.78	PK	273	1.7	H	31.64	59.42	74	14.58
2331.48	13.62	Ave.	273	1.7	H	31.64	45.26	54	8.74
2489.95	28.36	PK	230	2.2	H	32.13	60.49	74	13.51
2489.95	14.28	Ave.	230	2.2	H	32.13	46.41	54	7.59
4924.00	43.65	PK	277	2.4	H	6.76	50.41	74	23.59
4924.00	28.36	Ave.	277	2.4	H	6.76	35.12	54	18.88

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)									
2389.83	29.01	PK	148	2.2	H	31.87	60.88	74	13.12
2389.83	15.10	Ave.	148	2.2	H	31.87	46.97	54	7.03
2488.95	28.34	PK	243	2.2	H	32.13	60.47	74	13.53
2488.95	14.48	Ave.	243	2.2	H	32.13	46.61	54	7.39
4824.00	43.16	PK	189	1.6	H	6.28	49.44	74	24.56
4824.00	28.35	Ave.	189	1.6	H	6.28	34.63	54	19.37
Middle Channel (2437MHz)									
4874.00	43.08	PK	69	2.4	H	6.76	49.84	74	24.16
4874.00	28.57	Ave.	69	2.4	H	6.76	35.33	54	18.67
High Channel (2462 MHz)									
2311.45	28.25	PK	300	1.8	H	31.64	59.89	74	14.11
2311.45	14.30	Ave.	300	1.8	H	31.64	45.94	54	8.06
2484.25	28.54	PK	313	2.4	H	32.13	60.67	74	13.33
2484.25	14.63	Ave.	313	2.4	H	32.13	46.76	54	7.24
4924.00	43.85	PK	310	1.9	H	6.76	50.61	74	23.39
4924.00	28.67	Ave.	292	1.8	H	6.76	35.43	54	18.57

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)									
2389.94	28.73	PK	93	1.7	H	31.87	60.60	74	13.40
2389.94	14.86	Ave.	93	1.7	H	31.87	46.73	54	7.27
2499.41	28.47	PK	272	1.8	H	32.13	60.60	74	13.40
2499.41	14.65	Ave.	272	1.8	H	32.13	46.78	54	7.22
4844.00	43.40	PK	85	2.4	H	6.28	49.68	74	24.32
4844.00	28.30	Ave.	85	2.4	H	6.28	34.58	54	19.42
Middle Channel (2437MHz)									
4874.00	42.73	PK	336	1.5	H	6.76	49.49	74	24.51
4874.00	28.17	Ave.	336	1.5	H	6.76	34.93	54	19.07
High Channel (2452 MHz)									
2312.84	28.63	PK	207	1.2	H	31.64	60.27	74	13.73
2312.84	14.77	Ave.	207	1.2	H	31.64	46.41	54	7.59
2498.93	28.45	PK	227	1.0	H	32.13	60.58	74	13.42
2498.93	14.62	Ave.	227	1.0	H	32.13	46.75	54	7.25
4904.00	43.05	PK	328	1.1	H	6.76	49.81	74	24.19
4904.00	28.12	Ave.	328	1.1	H	6.76	34.88	54	19.12

1GHz-25GHz (BLE):**1M**

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)									
2327.08	28.01	PK	49	1.4	H	31.64	59.65	74	14.35
2327.08	15.58	Ave.	49	1.4	H	31.64	47.22	54	6.78
2491.82	27.91	PK	43	1.6	H	32.13	60.04	74	13.96
2491.82	14.36	Ave.	43	1.6	H	32.13	46.49	54	7.51
4804.00	43.03	PK	120	2.1	H	6.28	49.31	74	24.69
4804.00	30.58	Ave.	120	2.1	H	6.28	36.86	54	17.14
Middle Channel (2440 MHz)									
4880.00	43.16	PK	348	1.6	H	6.76	49.92	74	24.08
4880.00	30.67	Ave.	348	1.6	H	6.76	37.43	54	16.57
High Channel (2480 MHz)									
2364.70	28.19	PK	205	1.2	H	31.87	60.06	74	13.94
2364.70	15.32	Ave.	205	1.2	H	31.87	47.19	54	6.81
2497.60	28.26	PK	261	1.7	H	32.13	60.39	74	13.61
2497.60	15.49	Ave.	261	1.7	H	32.13	47.62	54	6.38
4960.00	43.28	PK	340	2.0	H	6.80	50.08	74	23.92
4960.00	30.74	Ave.	340	2.0	H	6.80	37.54	54	16.46

2M

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)									
2327.77	28.45	PK	353	1.3	H	31.64	60.09	74	13.91
2327.77	15.62	Ave.	353	1.3	H	31.64	47.26	54	6.74
2495.33	28.17	PK	35	2.3	H	32.13	60.30	74	13.70
2495.33	14.93	Ave.	35	2.3	H	32.13	47.06	54	6.94
4804.00	43.15	PK	119	1.1	H	6.28	49.43	74	24.57
4804.00	29.86	Ave.	119	1.1	H	6.28	36.14	54	17.86
Middle Channel (2440 MHz)									
4880.00	43.22	PK	221	1.6	H	6.76	49.98	74	24.02
4880.00	30.24	Ave.	221	1.6	H	6.76	37.00	54	17.00
High Channel (2480 MHz)									
2365.51	28.79	PK	356	1.9	H	31.87	60.66	74	13.34
2365.51	15.54	Ave.	356	1.9	H	31.87	47.41	54	6.59
2496.33	28.46	PK	226	1.0	H	32.13	60.59	74	13.41
2496.33	15.57	Ave.	226	1.0	H	32.13	47.70	54	6.30
4960.00	43.69	PK	356	1.5	H	6.80	50.49	74	23.51
4960.00	30.32	Ave.	356	1.5	H	6.80	37.12	54	16.88

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

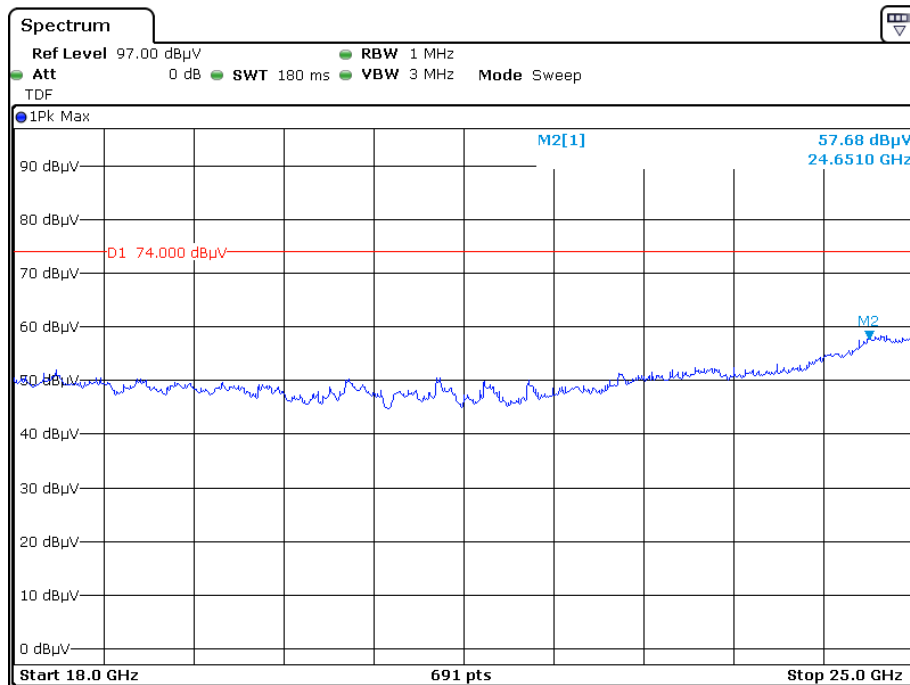
The other spurious emission which is 20dB to the limit was not recorded.

And for the pre-scan is performed with the 2400-2483.5MHz band filter.

**Pre-scan with 802.11b Mode, High channel
Horizontal**

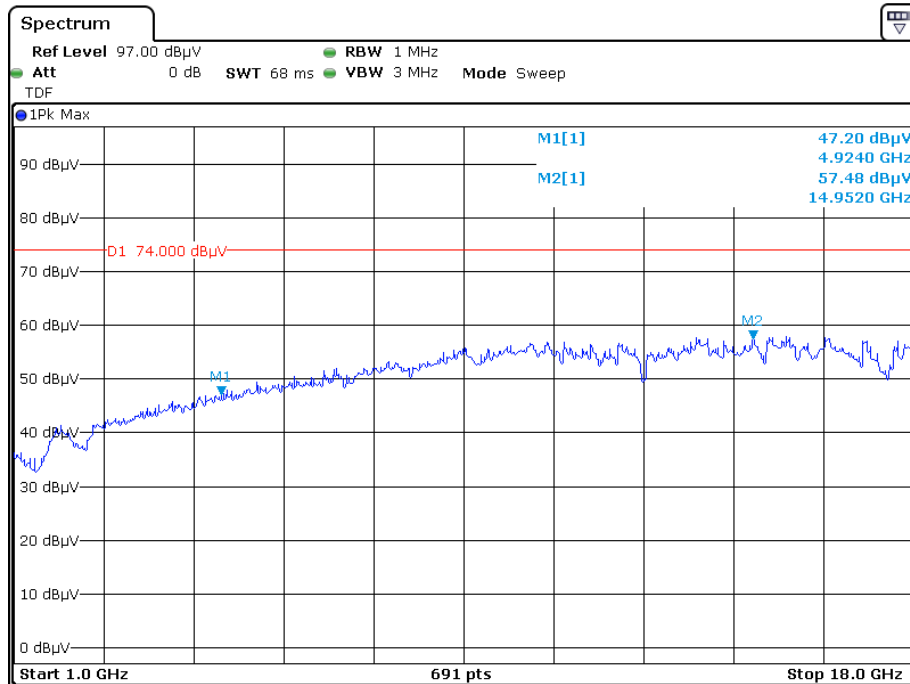


Date: 21.AUG.2019 23:36:47

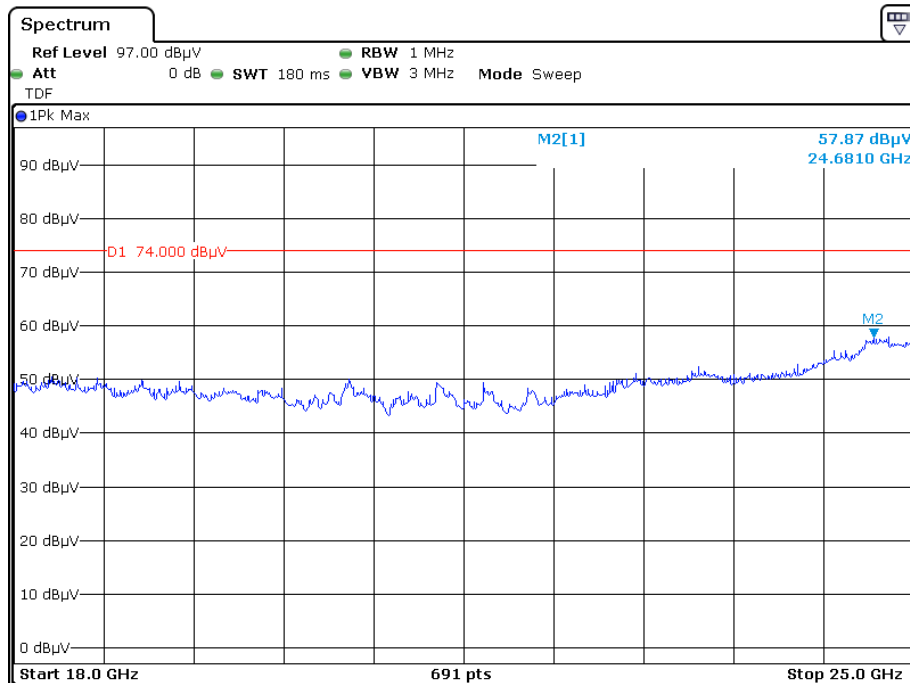


Date: 22.AUG.2019 00:26:27

Vertical

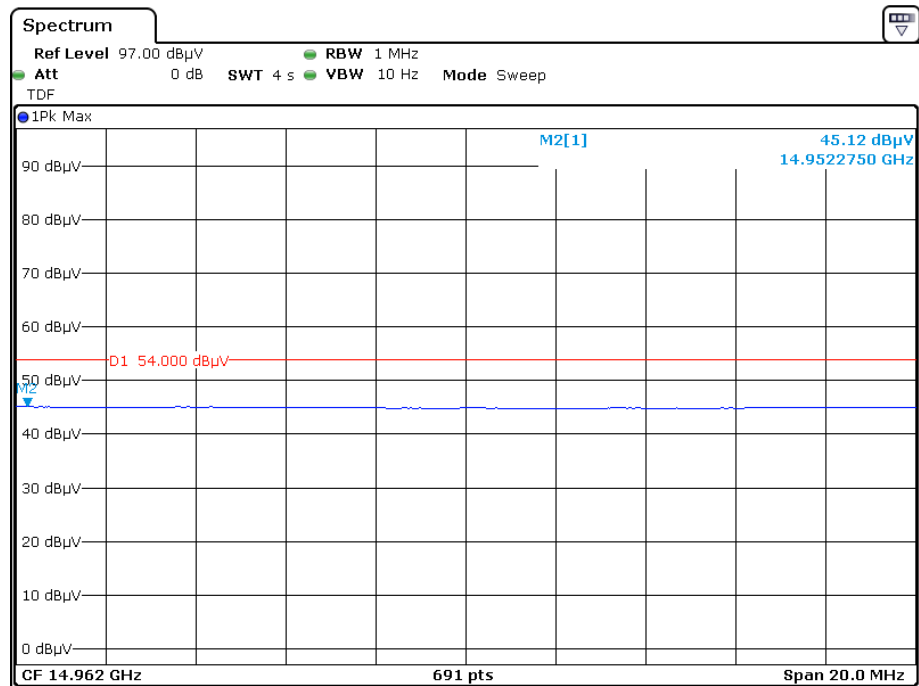


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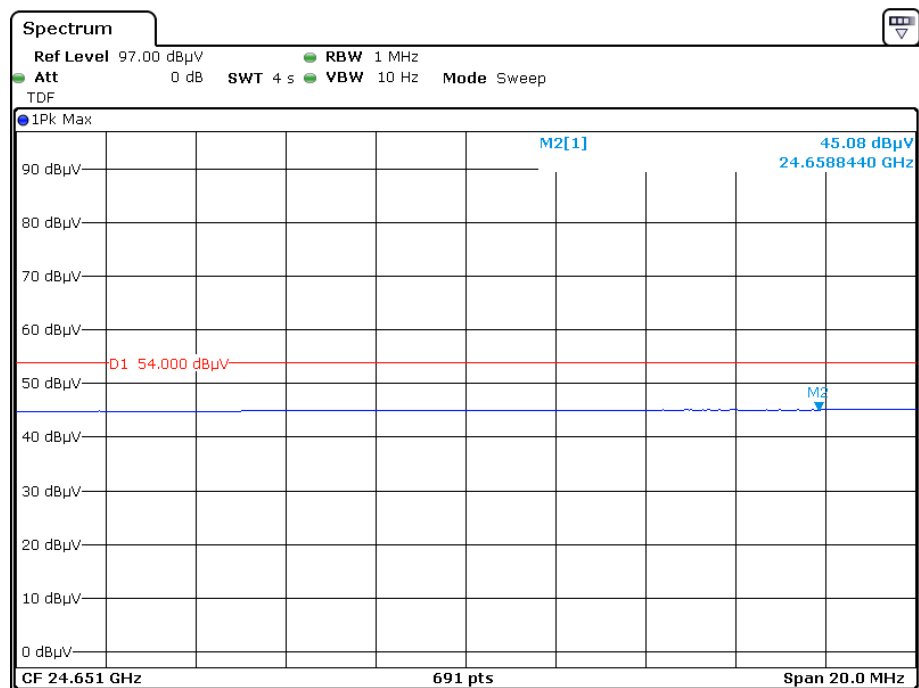


Date: 22.AUG.2019 00:33:52

Pre-scan for Average Horizontal

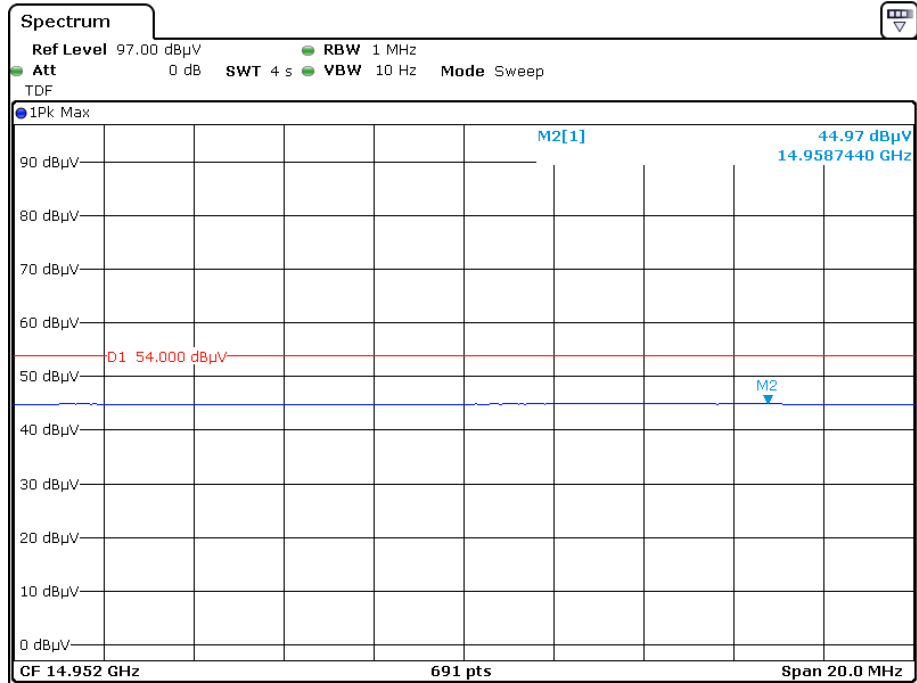


Date: 21.AUG.2019 23:40:59

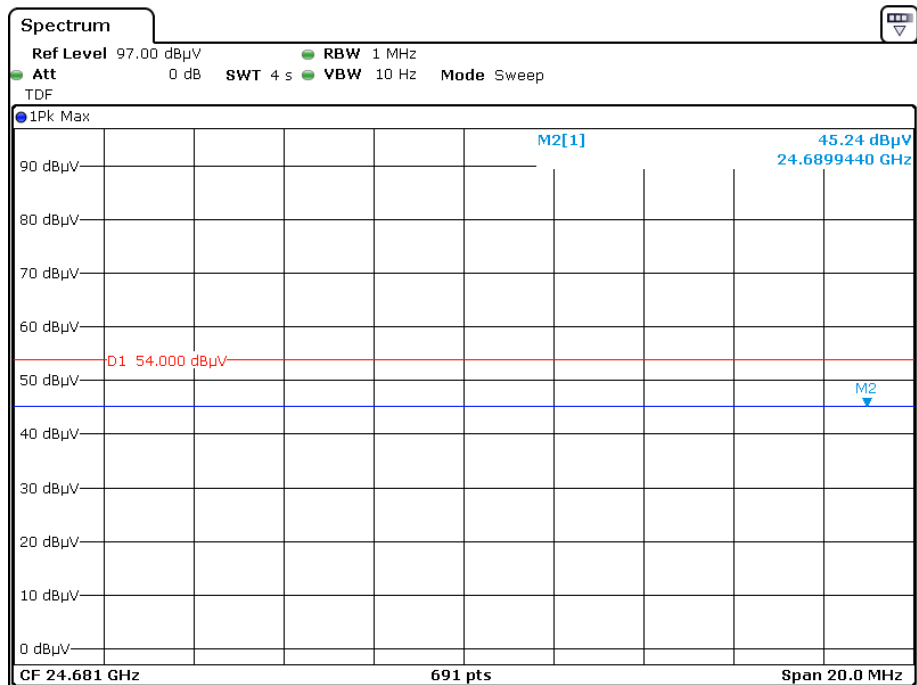


Date: 22.AUG.2019 00:30:20

Vertical



Date: 21.AUG.2019 23:47:26



Date: 22.AUG.2019 00:38:23

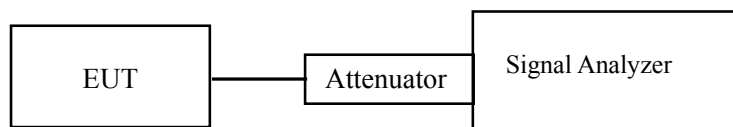
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH&99% OCCUPIED BANDWIDTH

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:	25~26 °C
Relative Humidity:	52~56 %
ATM Pressure:	100.0~101.0 kPa

The testing was performed by Leo Huang from 2019-08-09 to 2019-09-18.

Test Result: Pass.

Please refer to the following table and plots.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% OBW (MHz)	Limit (kHz)
802.11b mode				
Low	2412	9.615	14.103	≥500
Middle	2437	8.615	13.782	≥500
High	2462	9.090	13.718	≥500
802.11g				
Low	2412	16.141	17.372	≥500
Middle	2437	16.269	17.179	≥500
High	2462	15.231	17.115	≥500
802.11n-HT20 mode				
Low	2412	17.244	18.590	≥500
Middle	2437	16.026	18.333	≥500
High	2462	15.667	18.205	≥500
802.11n-HT40 mode				
Low	2422	35.872	36.667	≥500
Middle	2437	35.359	36.667	≥500
High	2452	36.051	36.795	≥500

1M

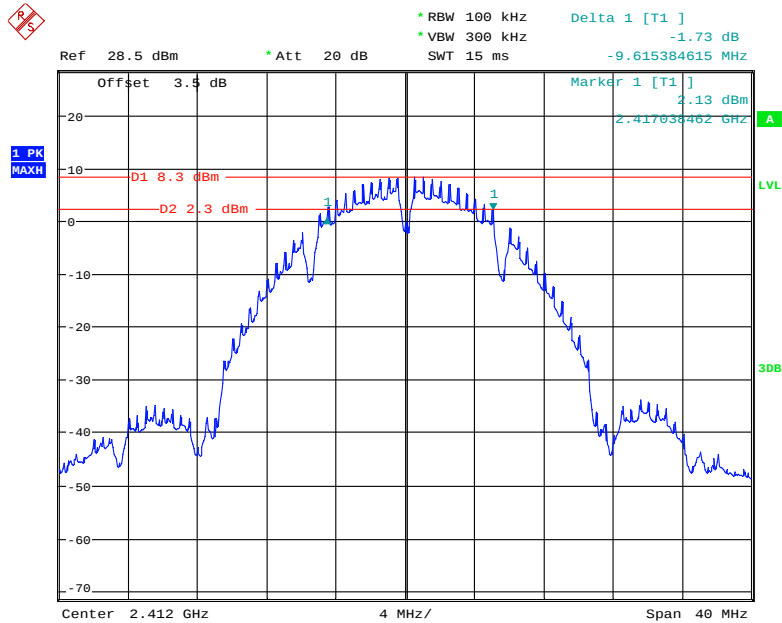
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)
BLE mode			
Low	2402	0.683	≥500
Middle	2440	0.685	≥500
High	2480	0.679	≥500

2M

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (kHz)
BLE mode			
Low	2402	1.177	≥500
Middle	2440	1.187	≥500
High	2480	1.150	≥500

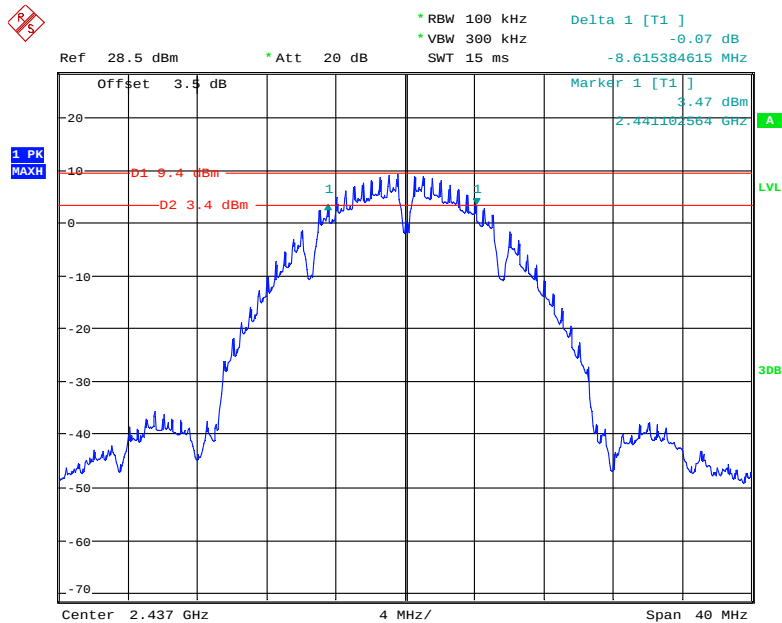
6dB Bandwidth

802.11b Low Channel



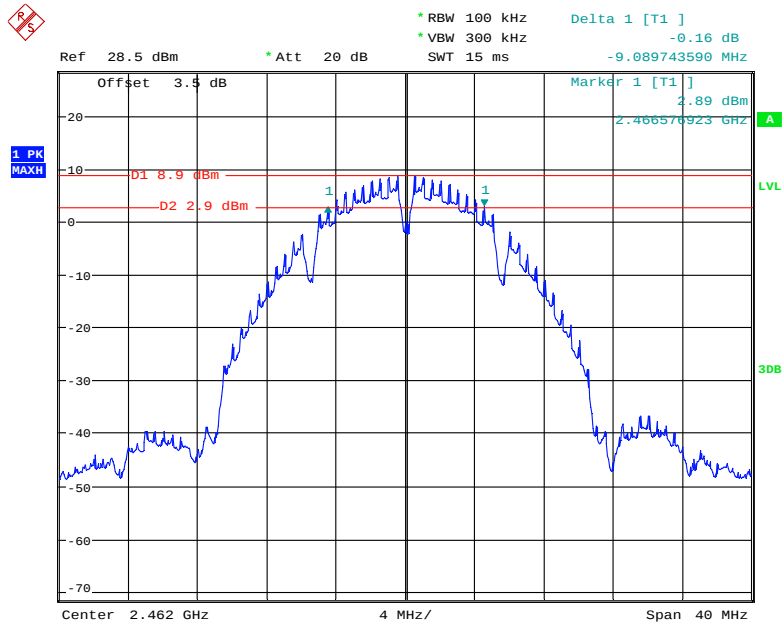
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802.11b Middle Channel



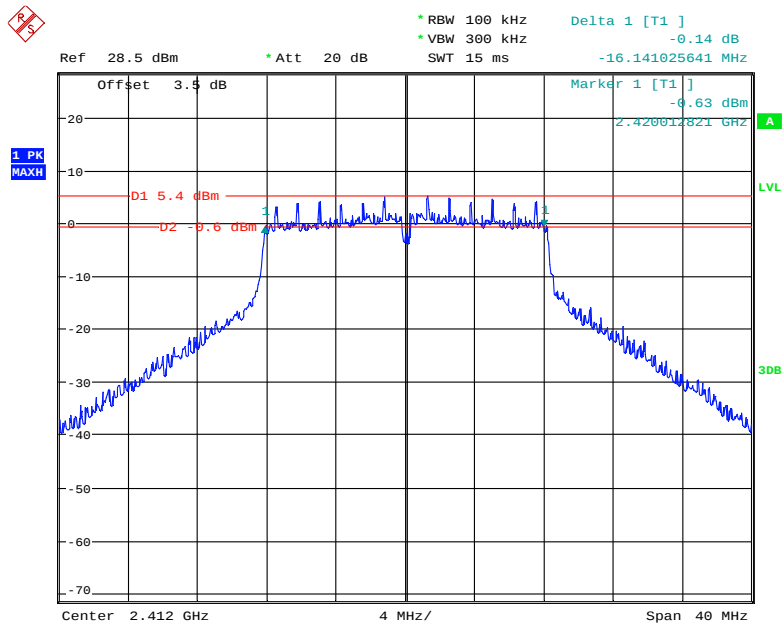
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802.11b High Channel



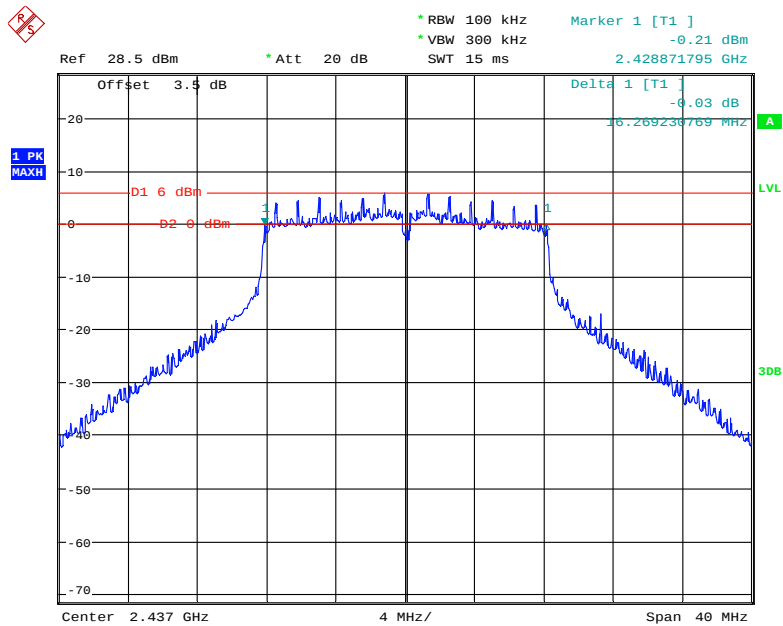
Date: 21.AUG.2019 10:46:02

802.11g Low Channel



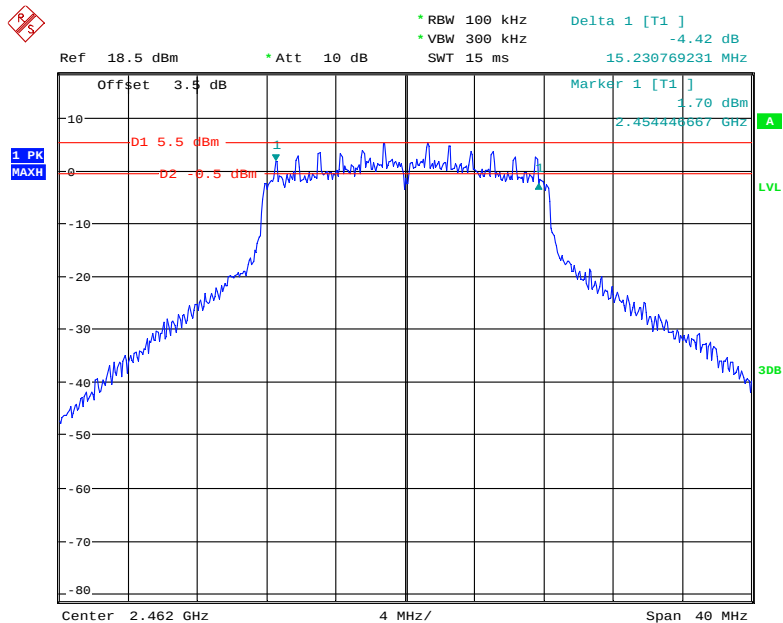
Date: 21.AUG.2019 10:39:01

802.11g Middle Channel



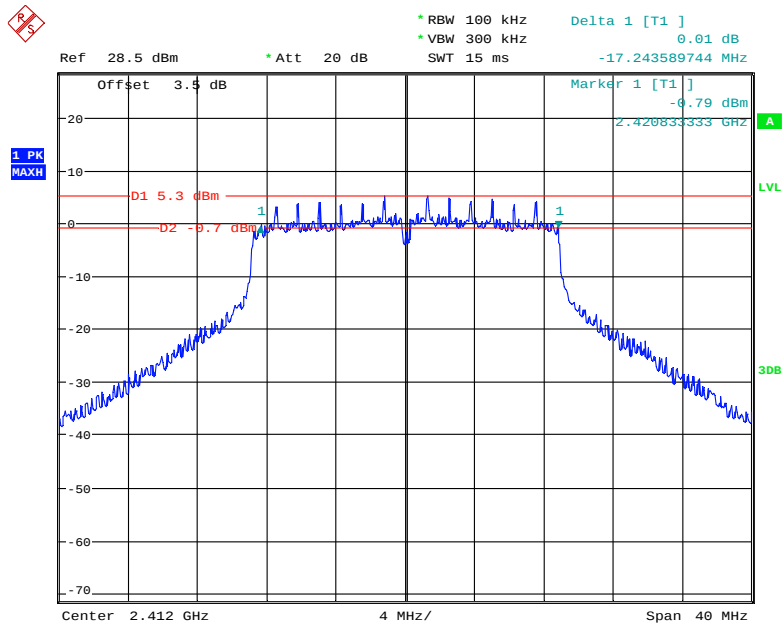
Date: 21.AUG.2019 10:36:35

802.11g High Channel



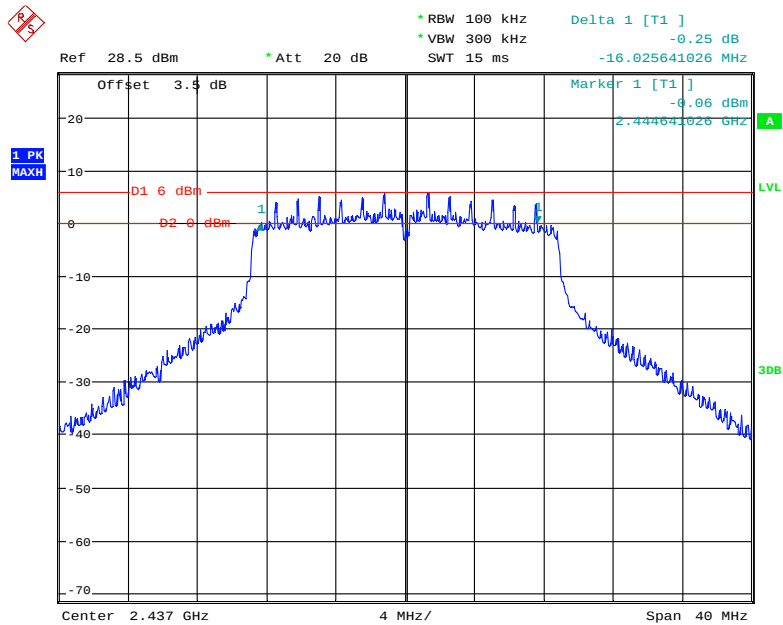
Date: 18.SEP.2019 17:53:18

802.11n-HT20 Low Channel



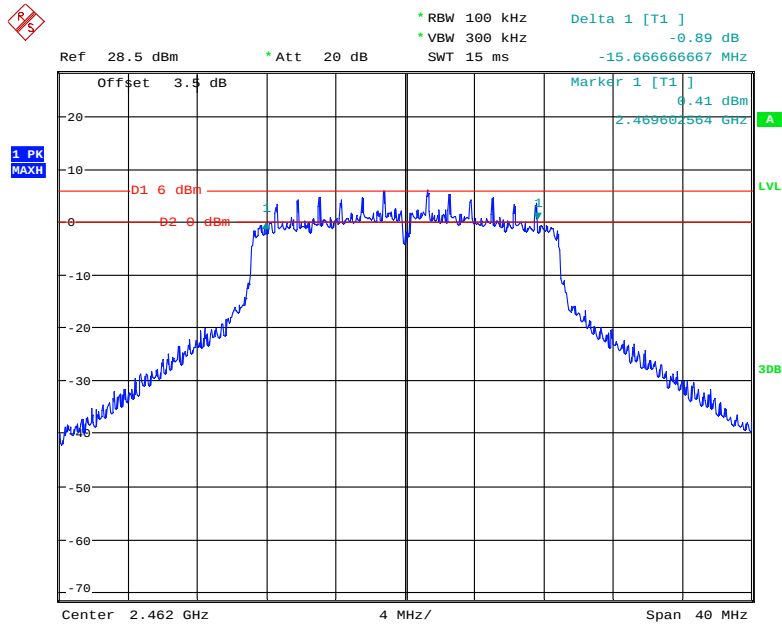
Date: 21.AUG.2019 10:30:02

802.11n-HT20 Middle Channel



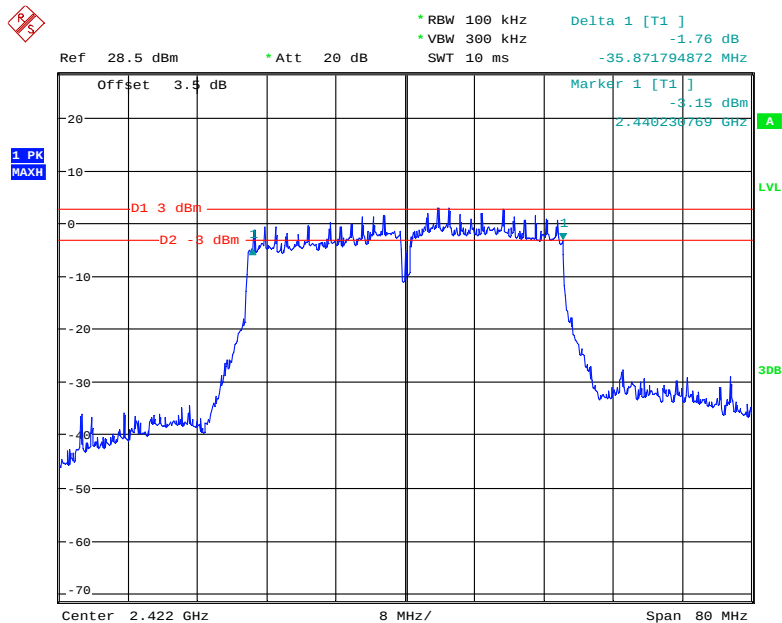
Date: 21.AUG.2019 10:31:50

802.11n-HT20 High Channel



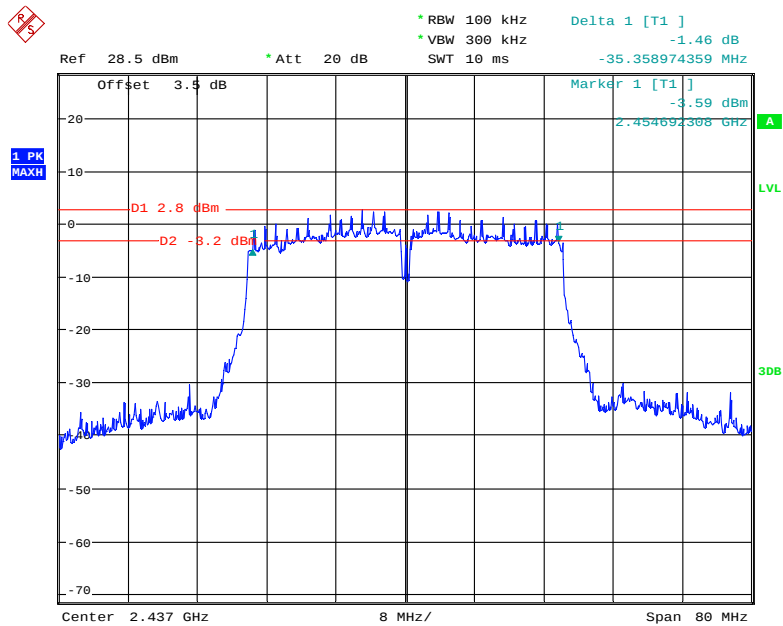
Date: 21.AUG.2019 10:33:01

802.11n-HT40 Low Channel



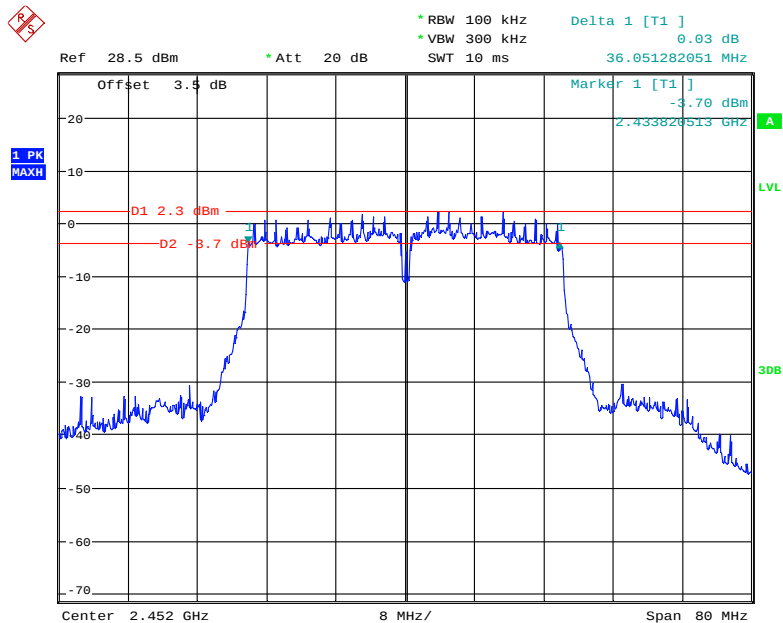
Date: 21.AUG.2019 10:24:36

802.11n-HT40 Middle Channel



Date: 21.AUG.2019 10:21:14

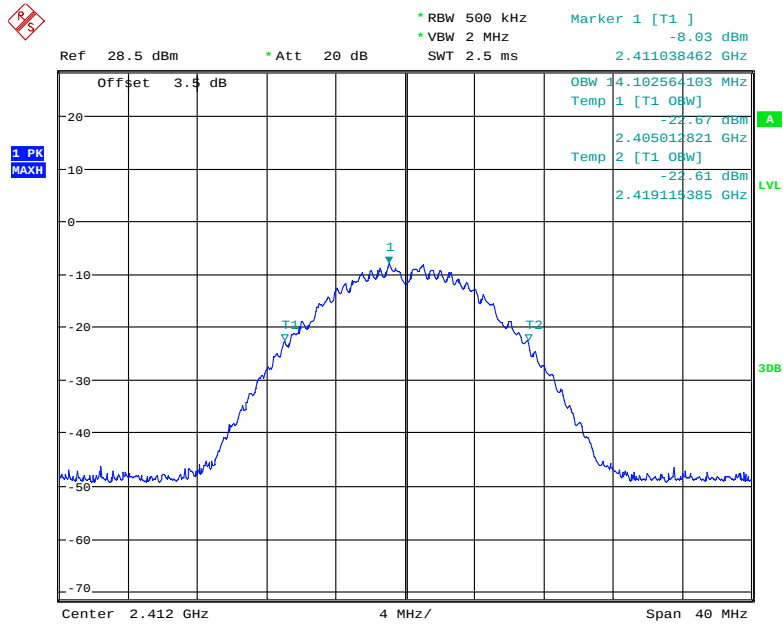
802.11n-HT40 High Channel



Date: 21.AUG.2019 10:18:30

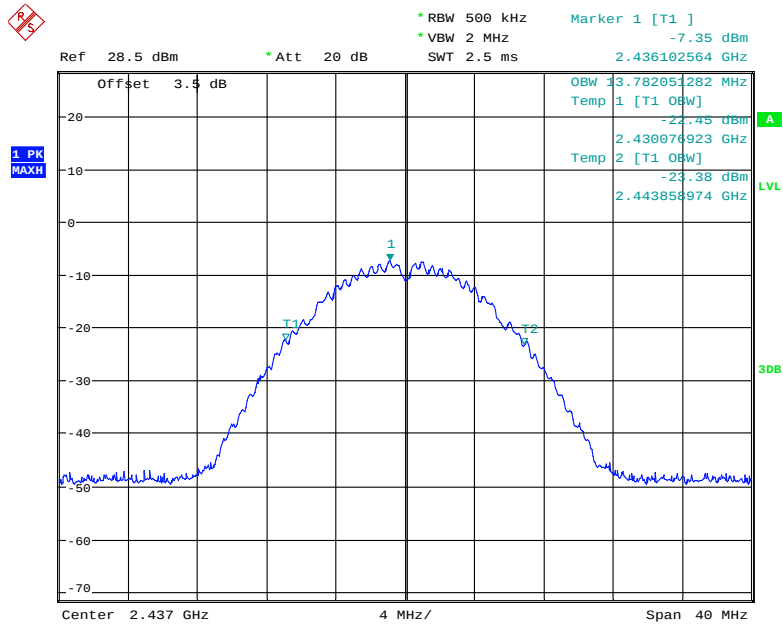
99% Occupied Bandwidth

802.11b Low Channel



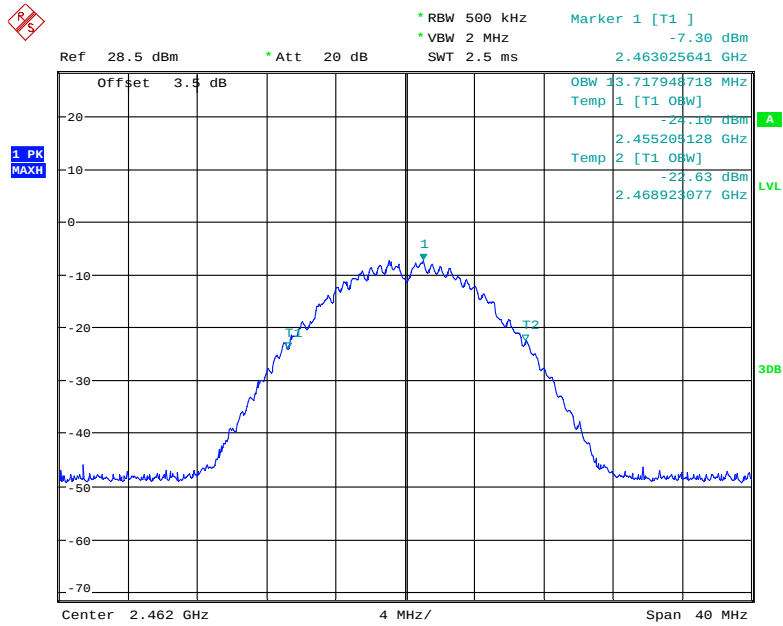
Date: 21.AUG.2019 13:47:40

802.11b Middle Channel



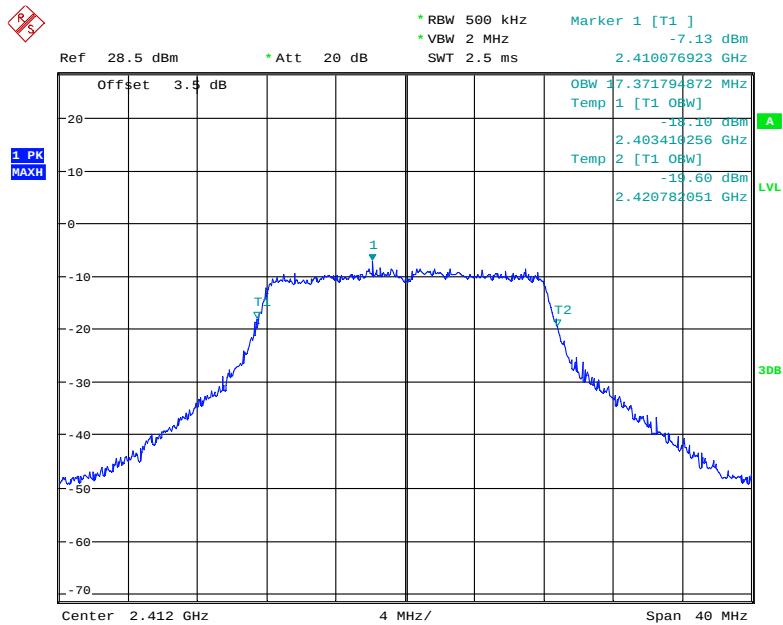
Date: 21.AUG.2019 13:46:50

802.11b High Channel



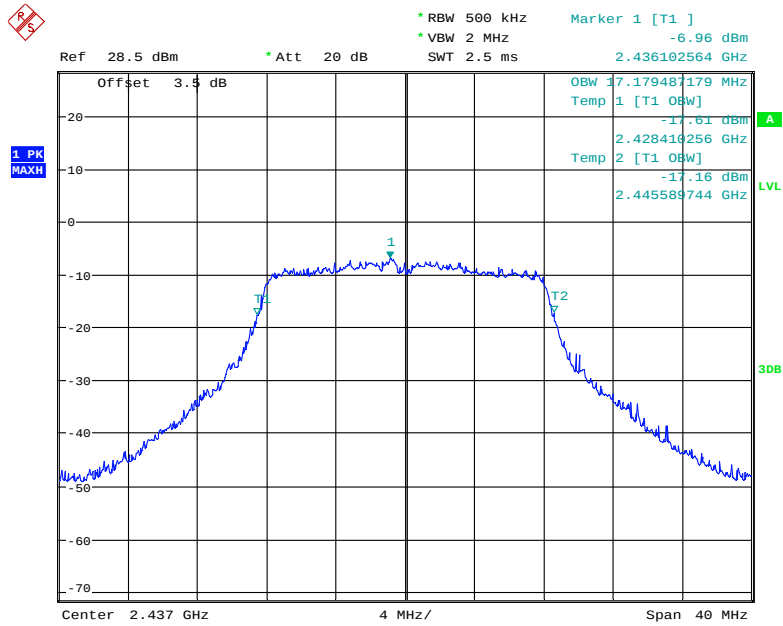
Date: 21.AUG.2019 13:45:51

802.11g Low Channel



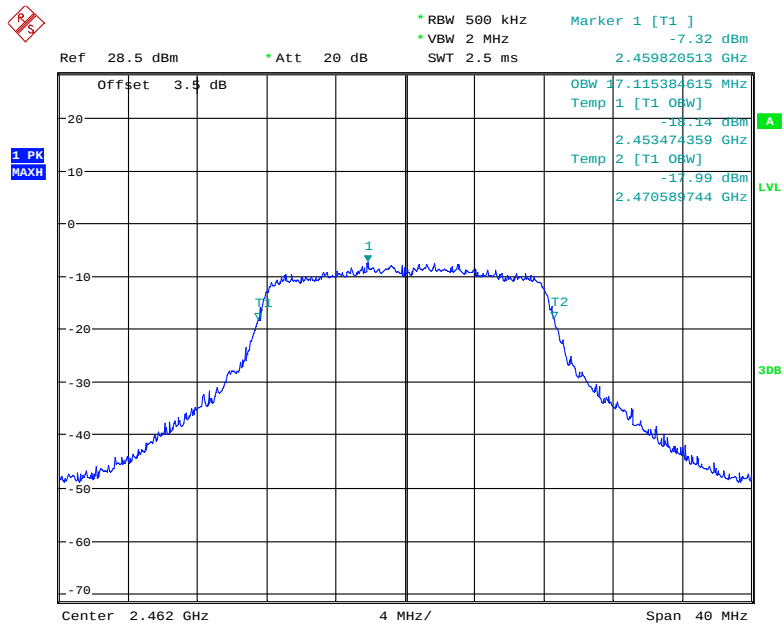
Date: 21.AUG.2019 13:43:00

802.11g Middle Channel



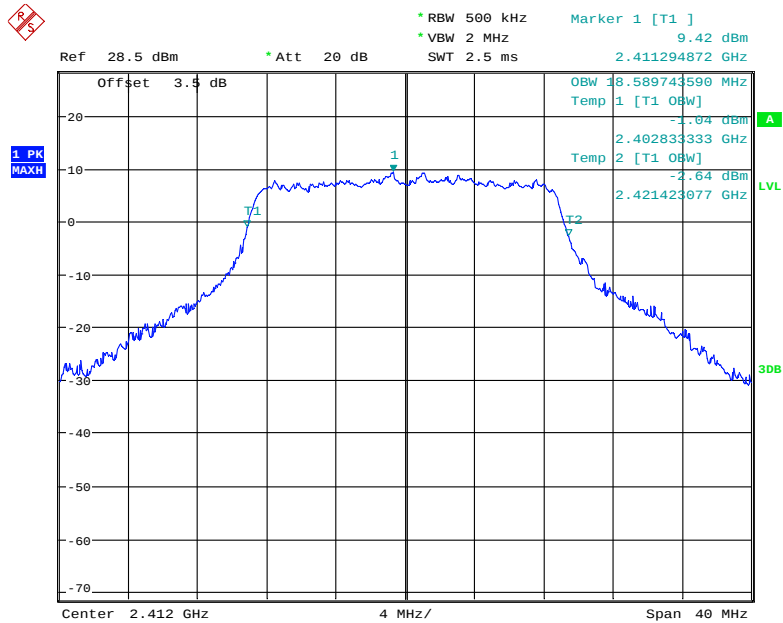
Date: 21.AUG.2019 13:43:55

802.11g High Channel



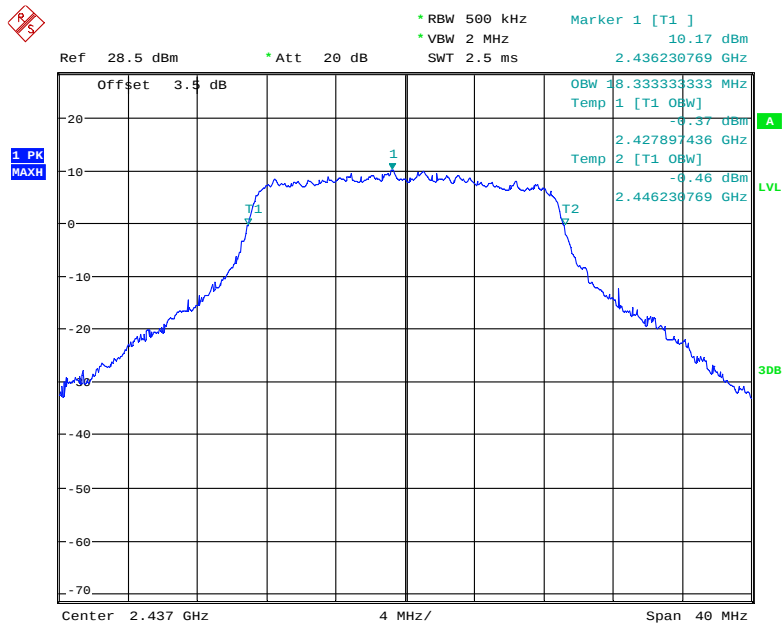
Date: 21.AUG.2019 13:44:49

802.11n-HT20 Low Channel



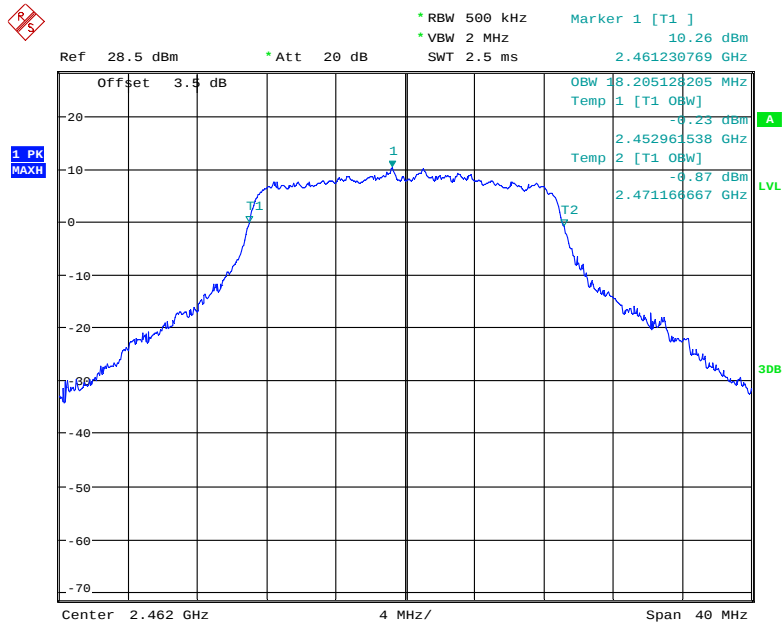
Date: 21.AUG.2019 13:39:41

802.11n-HT20 Middle Channel



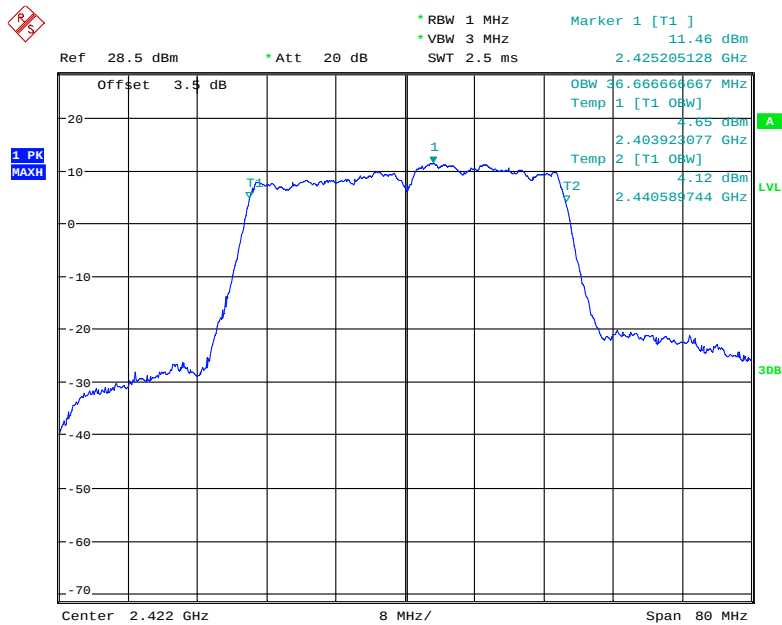
Date: 21.AUG.2019 13:38:45

802.11n-HT20 High Channel



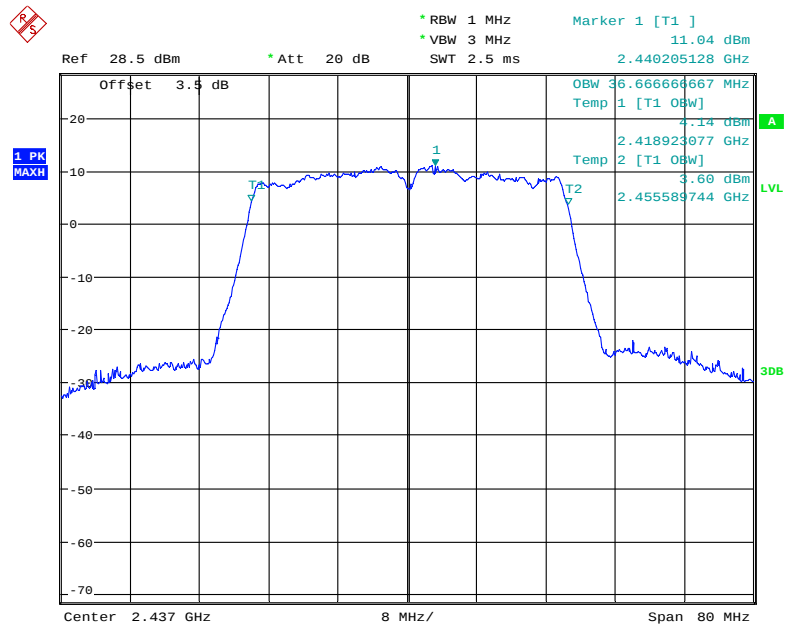
Date: 21.AUG.2019 13:40:45

802.11n-HT40 Low Channel



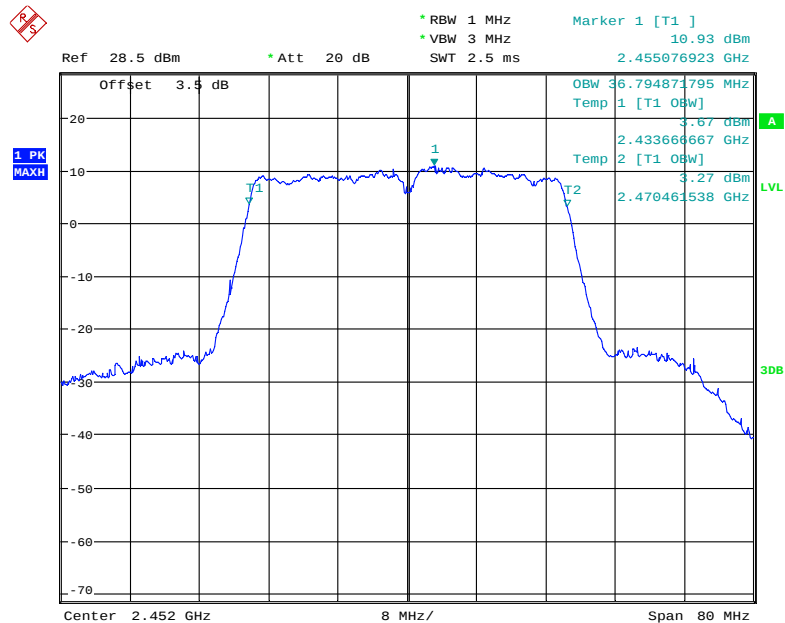
Date: 21.AUG.2019 13:28:57

802.11n-HT40 Middle Channel



Date: 21.AUG.2019 13:27:49

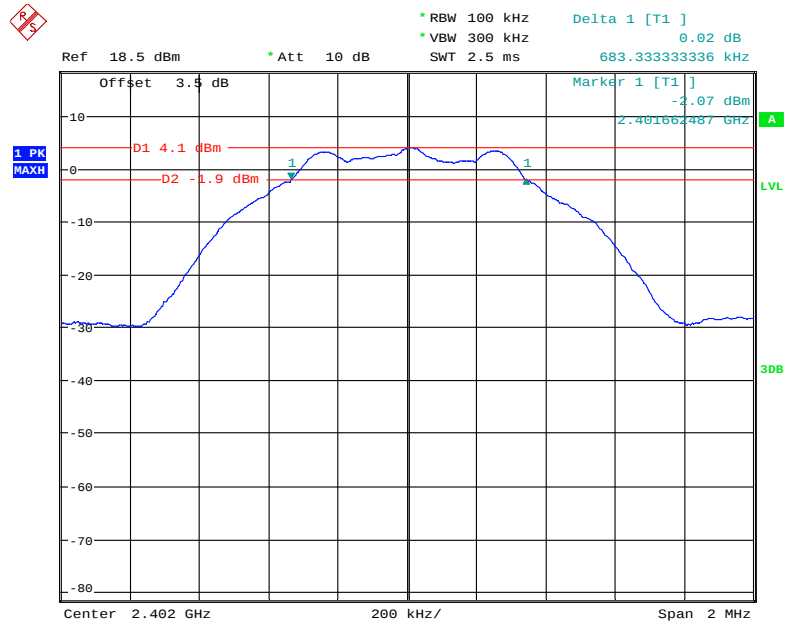
802.11n-HT40 High Channel



Date: 21.AUG.2019 13:29:56

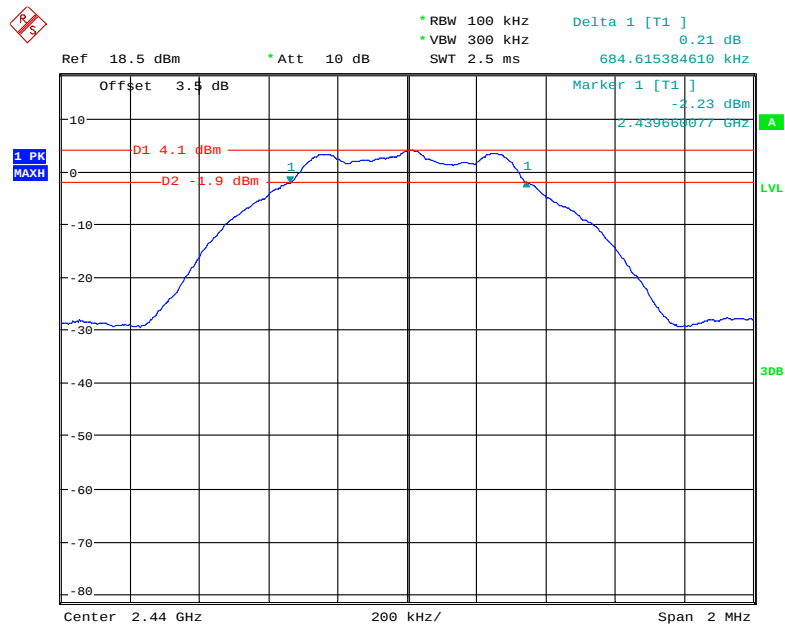
1M

BLE Low Channel



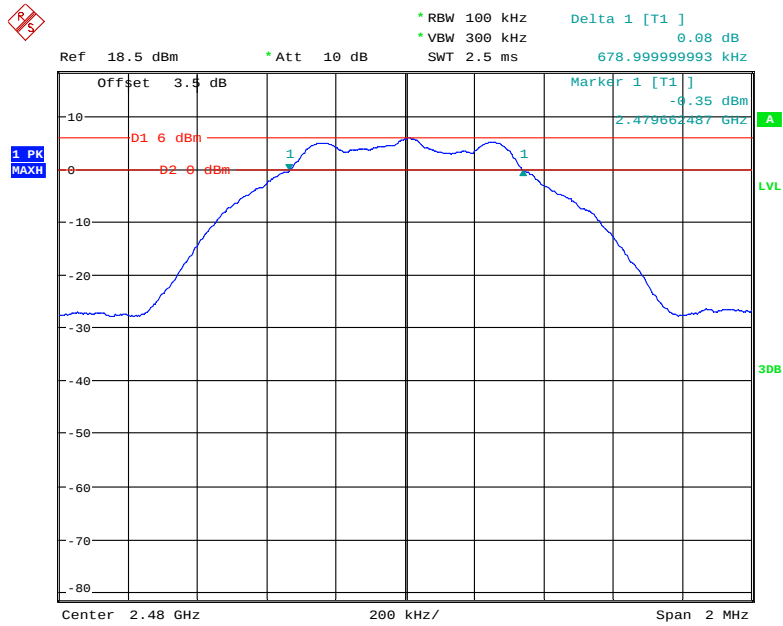
Date: 9.AUG.2019 11:05:03

BLE Middle Channel



Date: 9.AUG.2019 11:03:42

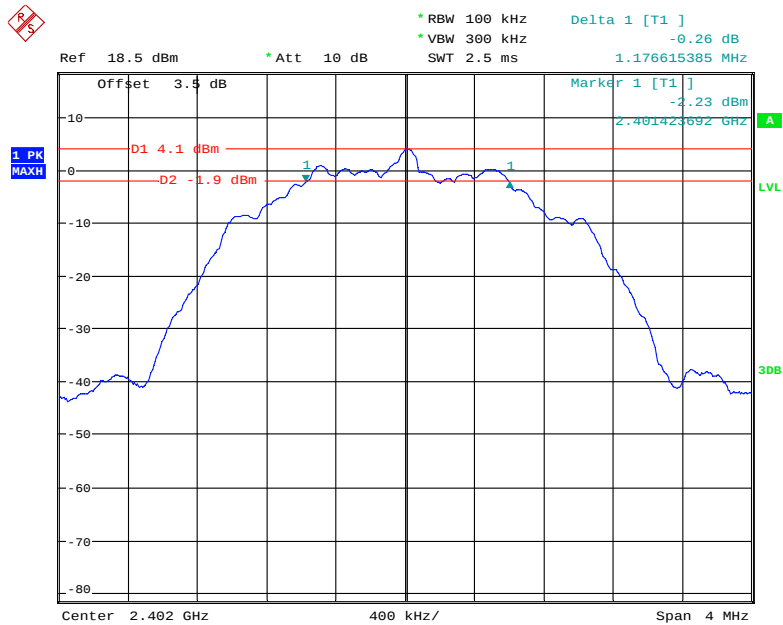
BLE High Channel



Date: 9.AUG.2019 10:59:08

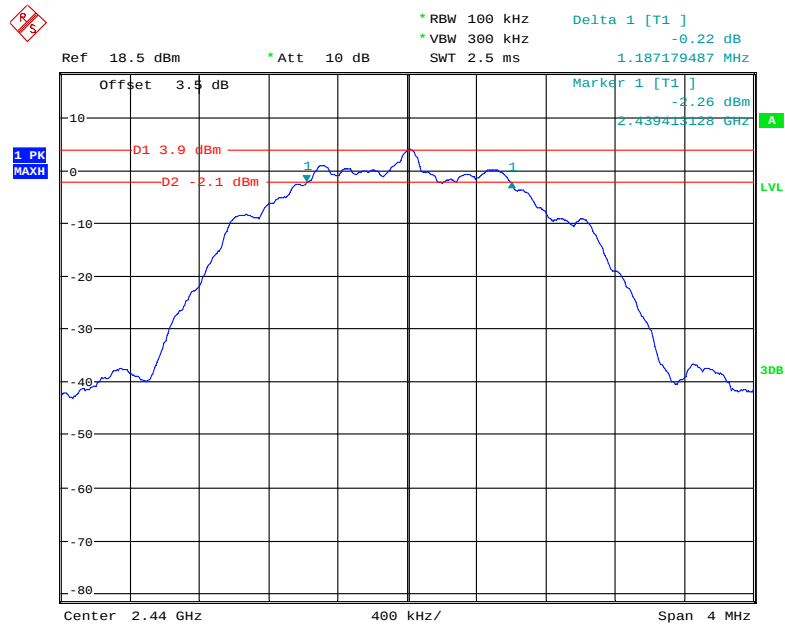
2M

BLE Low Channel



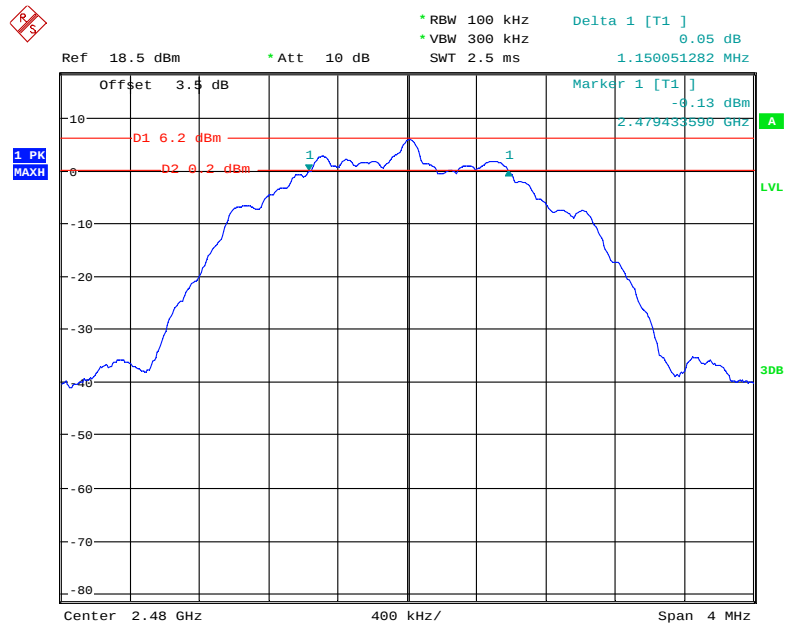
Date: 9.AUG.2019 11:30:32

BLE Middle Channel



Date: 9.AUG.2019 11:29:20

BLE High Channel



Date: 9.AUG.2019 11:28:08

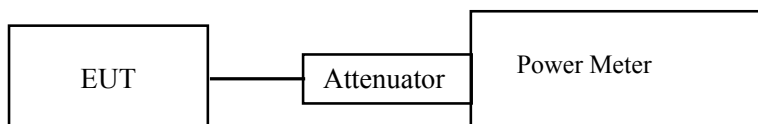
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

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:	25~26 °C
Relative Humidity:	52~56 %
ATM Pressure:	100.0~101.0 kPa

The testing was performed by Leo Huang from 2019-08-09 to 2019-08-21.

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	20.14	17.37	30
Middle	2437	20.58	17.78	30
High	2462	20.32	17.52	30
802.11g				
Low	2412	23.11	17.35	30
Middle	2437	23.68	17.81	30
High	2462	23.87	17.88	30
802.11n HT20				
Low	2412	22.29	16.78	30
Middle	2437	22.85	17.15	30
High	2462	22.71	17.03	30
802.11n HT40				
Low	2422	23.73	17.75	30
Middle	2437	23.73	17.68	30
High	2452	23.83	17.74	30

BLE mode, 1M

Channel	Frequency (MHz)	Max Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	4.52	30	Pass
Middle	2440	4.50	30	Pass
High	2480	6.37	30	Pass

BLE mode, 2M

Channel	Frequency (MHz)	Max Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	4.67	30	Pass
Middle	2440	4.62	30	Pass
High	2480	6.49	30	Pass

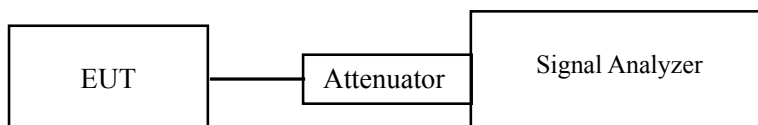
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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:	25~26 °C
Relative Humidity:	52~56 %
ATM Pressure:	100.0~101.0 kPa

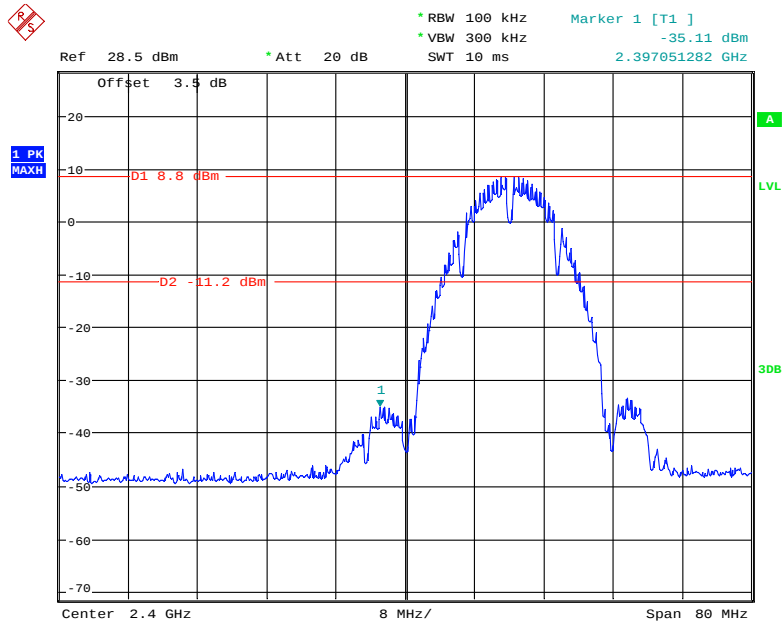
The testing was performed by Leo Huang from 2019-08-09 to 2019-08-21.

EUT operation mode: Transmitting

Test Result: Compliance

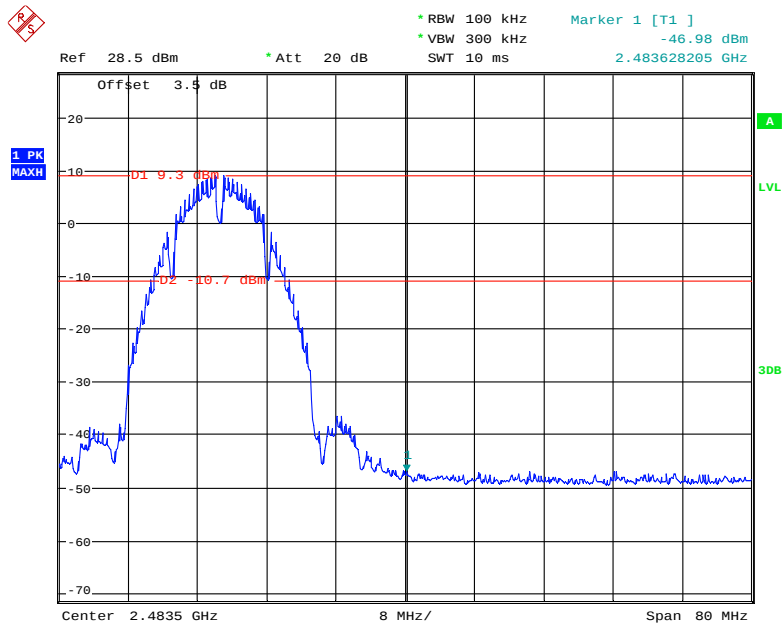
Please refer to the following plots.

802.11b: Band Edge, Left Side



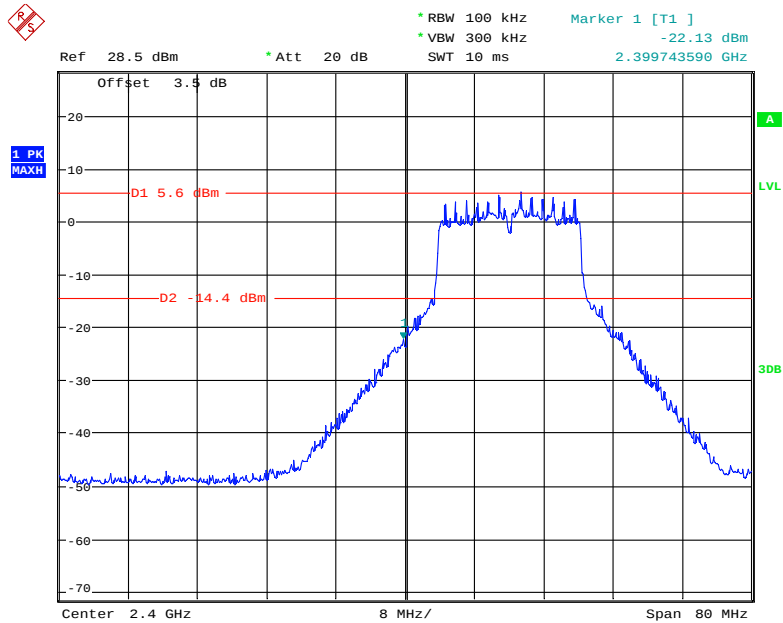
Date: 21.AUG.2019 11:01:33

802.11b: Band Edge, Right Side



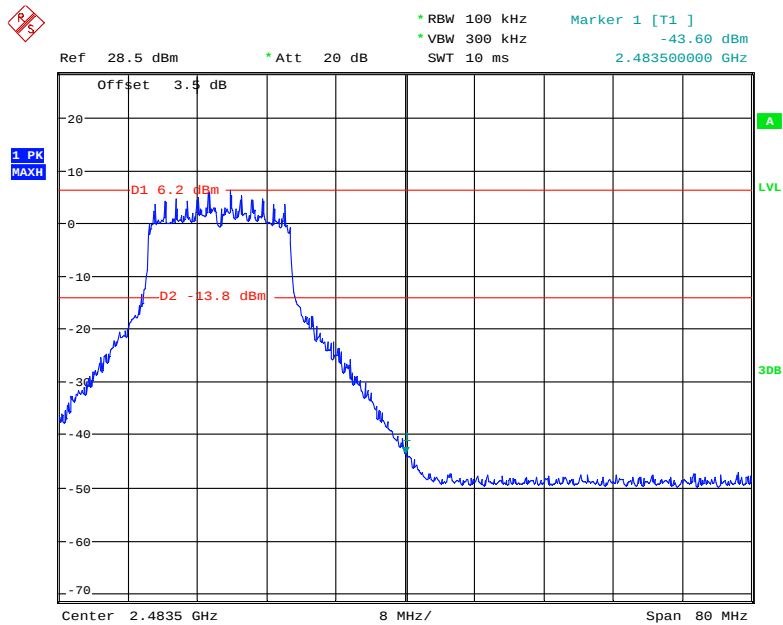
Date: 21.AUG.2019 10:57:04

802.11g: Band Edge, Left Side



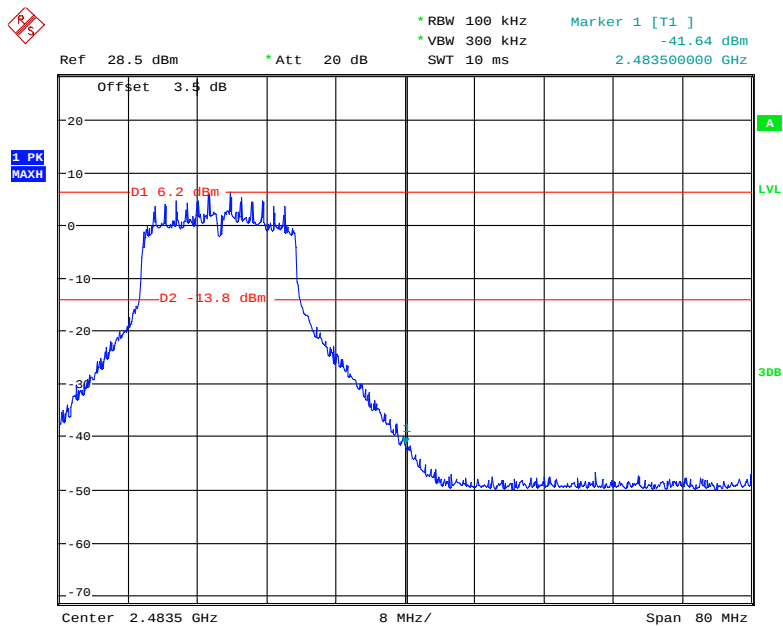
Date: 21.AUG.2019 11:03:50

802.11g: Band Edge, Right Side



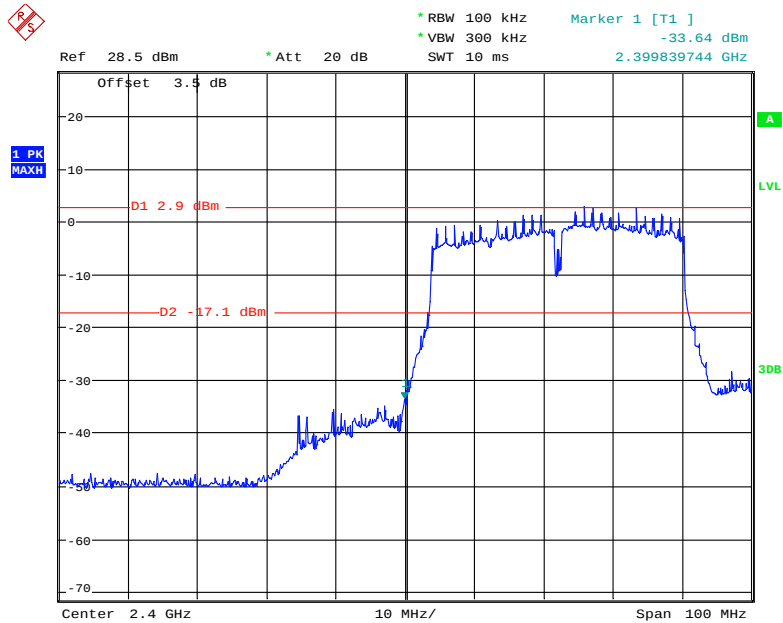
Date: 21.AUG.2019 11:05:42

802.11n-HT20: Band Edge, Right Side



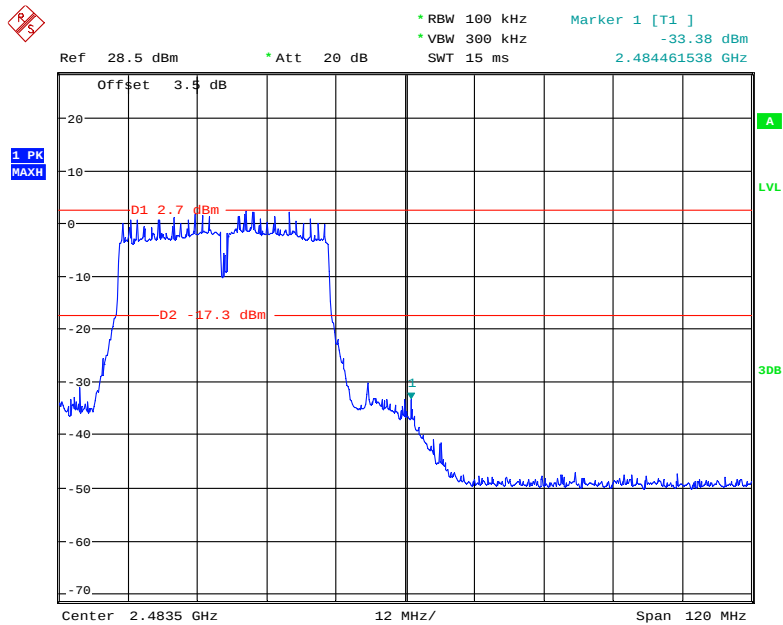
Page 59 of 73

802.11n-HT40: Band Edge, Left Side



Date: 21.AUG.2019 11:13:50

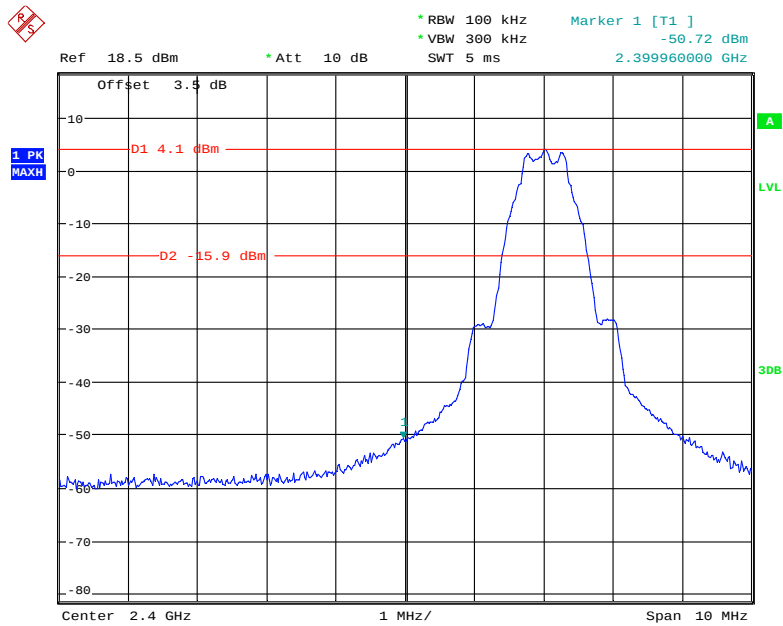
802.11n-HT40: Band Edge, Right Side



Date: 21.AUG.2019 11:18:07

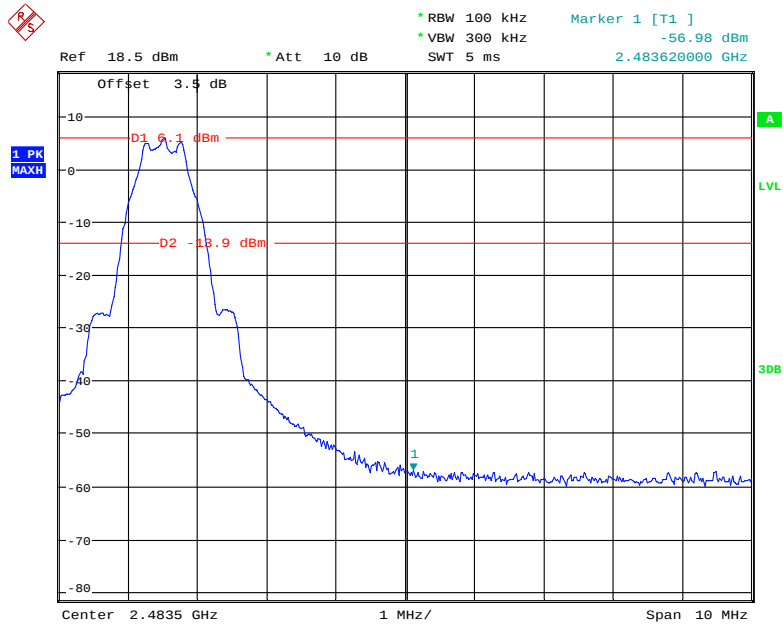
1M

BLE: Band Edge, Left Side



Date: 9.AUG.2019 11:06:35

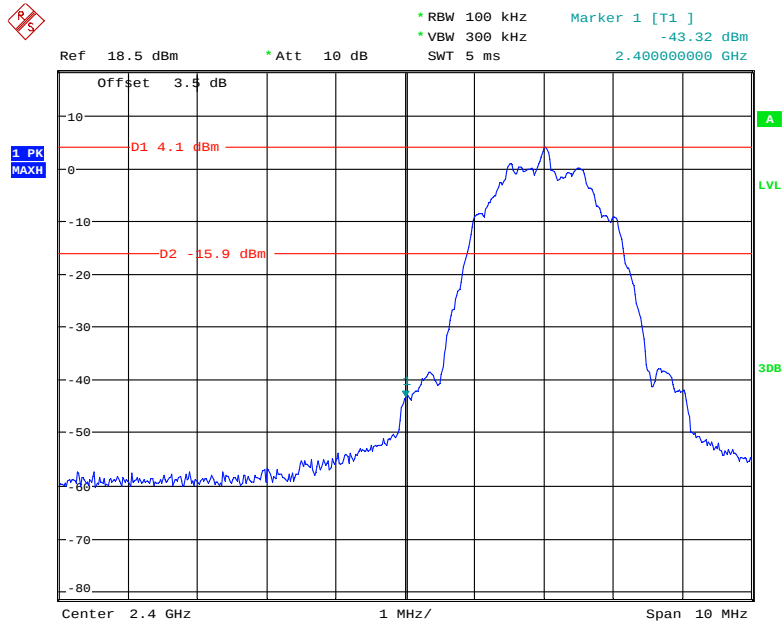
BLE: Band Edge, Right Side



Date: 9.AUG.2019 11:08:04

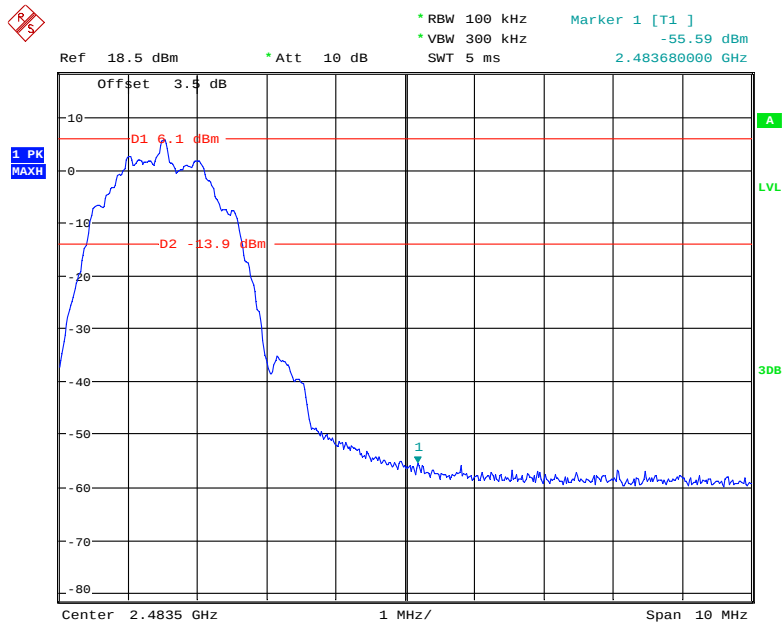
2M

BLE: Band Edge, Left Side



Date: 9.AUG.2019 11:31:30

BLE: Band Edge, Right Side



Date: 9.AUG.2019 11:32:38

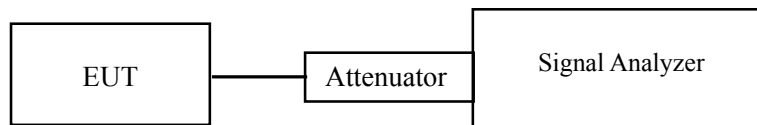
FCC §15.247(e) - POWER SPECTRAL DENSITY

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: $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
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:	25~26 °C
Relative Humidity:	52~56 %
ATM Pressure:	100.0~101.0 kPa

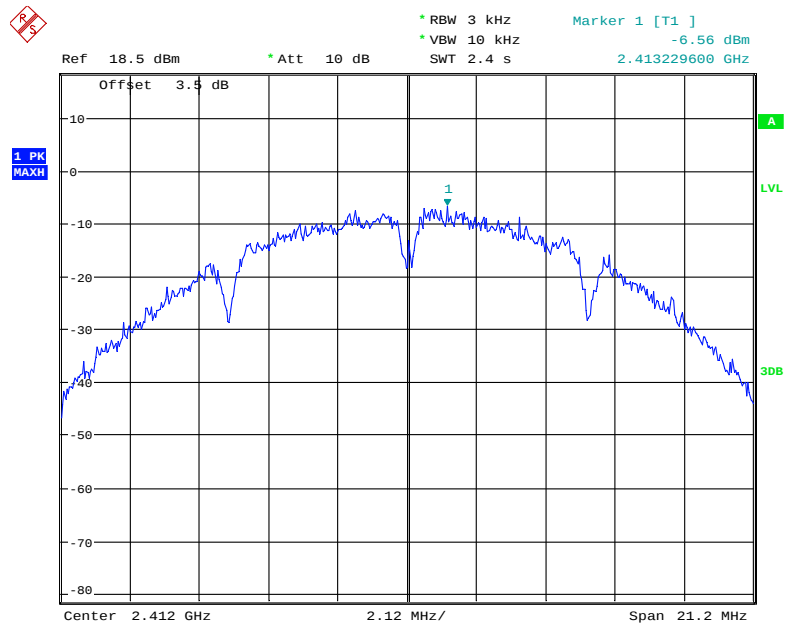
The testing was performed by Leo Huang from 2019-08-09 to 2019-09-19.

EUT operation mode: Transmitting

Test Result: Pass

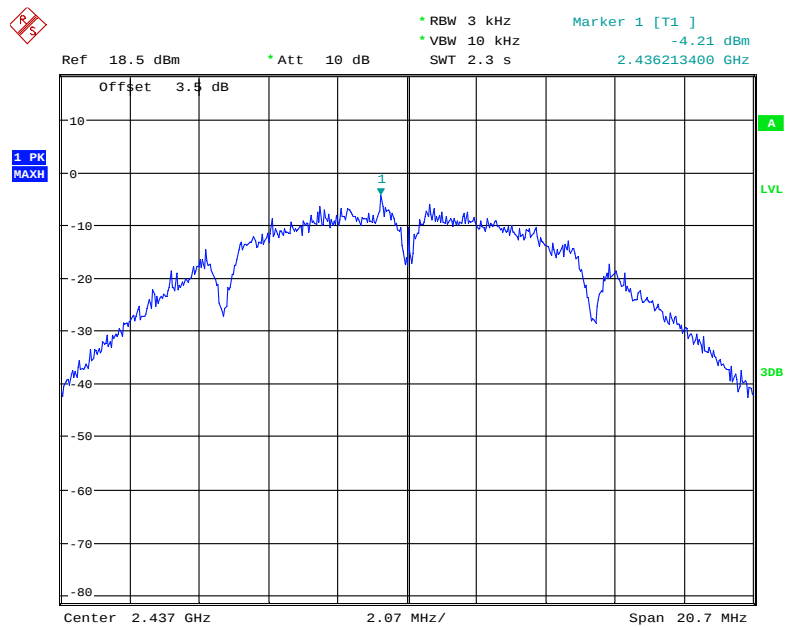
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode			
Low	2412	-6.56	≤ 8
Middle	2437	-4.21	≤ 8
High	2462	-6.92	≤ 8
802.11g mode			
Low	2412	-12.43	≤ 8
Middle	2437	-9.72	≤ 8
High	2462	-9.29	≤ 8
802.11n-HT20 mode			
Low	2412	-11.64	≤ 8
Middle	2437	-8.84	≤ 8
High	2462	-10.06	≤ 8
802.11n-HT40 mode			
Low	2422	-10.79	≤ 8
Middle	2437	-9.84	≤ 8
High	2452	-11.08	≤ 8
BLE mode, 1M			
Low	2402	-10.42	≤ 8
Middle	2440	-10.43	≤ 8
High	2480	-8.67	≤ 8
BLE mode, 2M			
Low	2402	-14.04	≤ 8
Middle	2440	-13.22	≤ 8
High	2480	-12.22	≤ 8

Power Spectral Density, 802.11b Low Channel



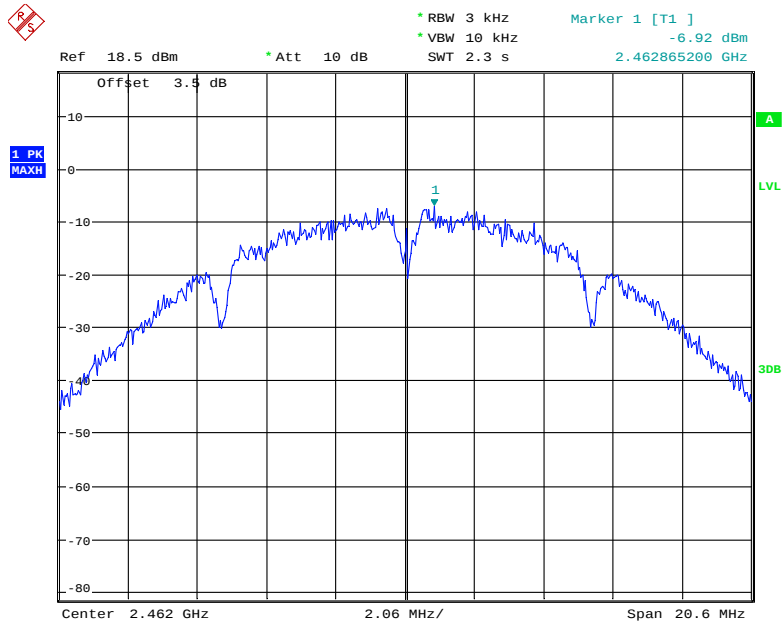
Date: 18.SEP.2019 17:59:06

Power Spectral Density, 802.11b Middle Channel



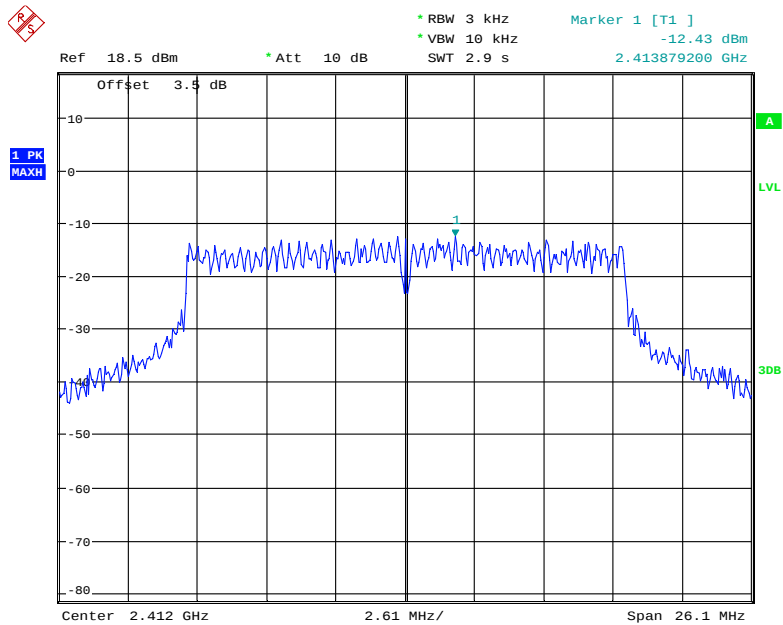
Date: 18.SEP.2019 18:01:20

Power Spectral Density, 802.11b High Channel



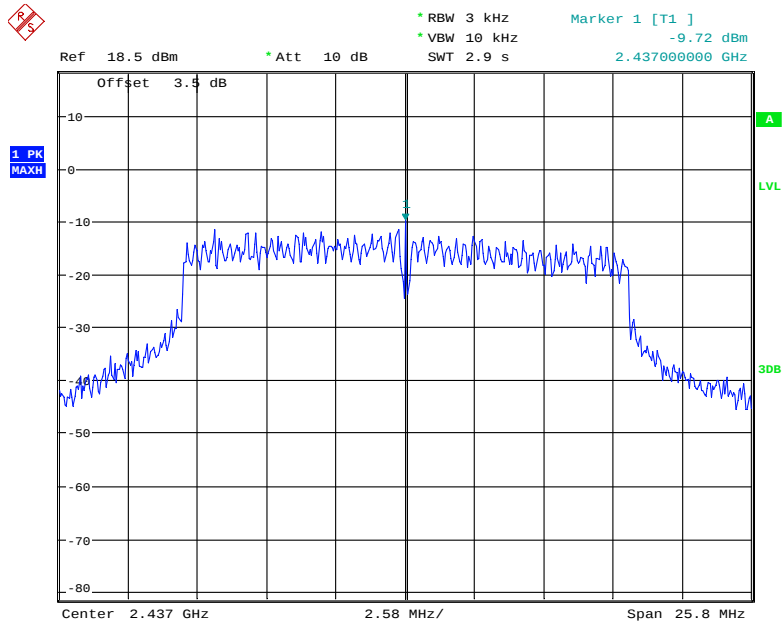
Date: 18.SEP.2019 18:01:54

Power Spectral Density, 802.11g Low Channel



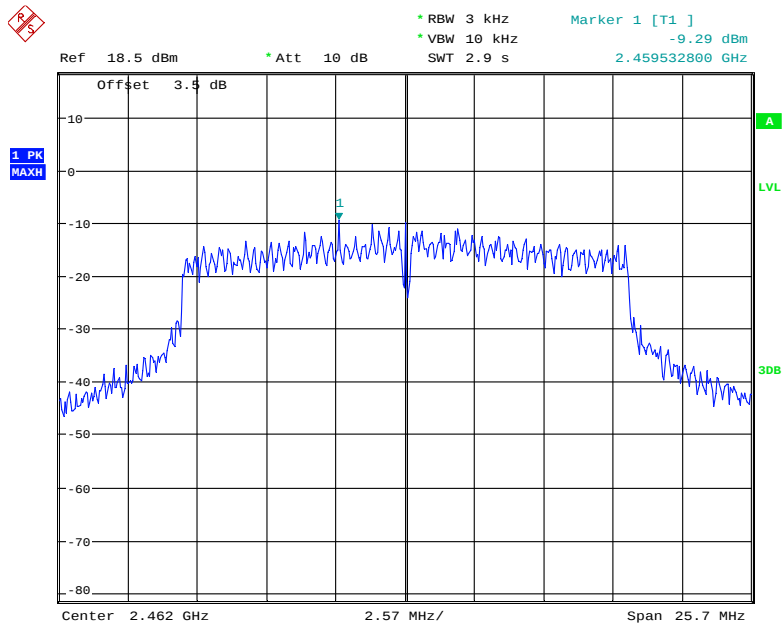
Date: 18.SEP.2019 18:08:05

Power Spectral Density, 802.11g Middle Channel



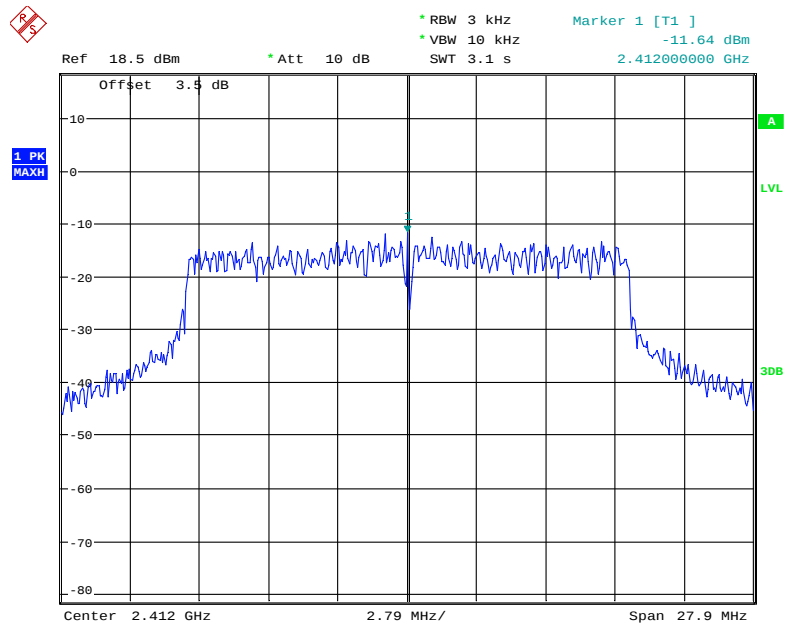
Date: 18.SEP.2019 18:06:44

Power Spectral Density, 802.11g High Channel



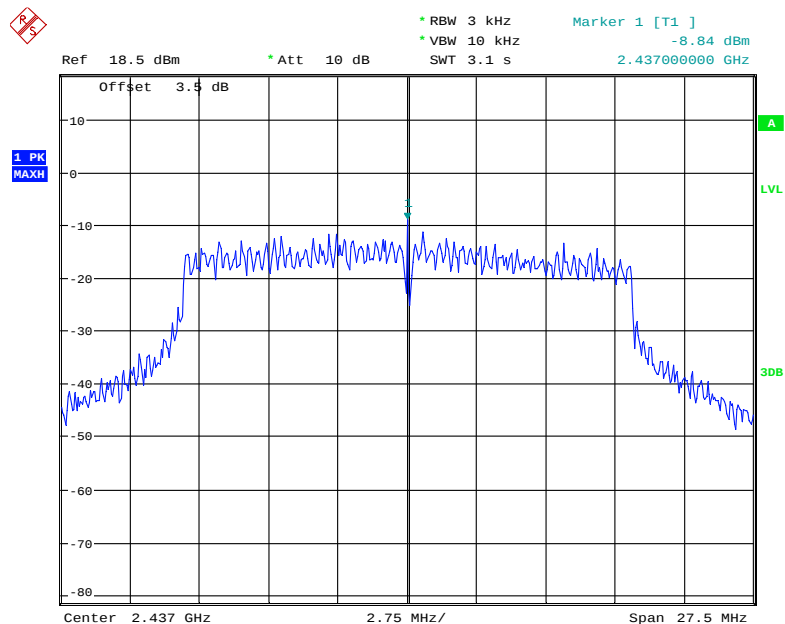
Date: 18.SEP.2019 18:03:59

Power Spectral Density, 802.11n-HT20 Low Channel



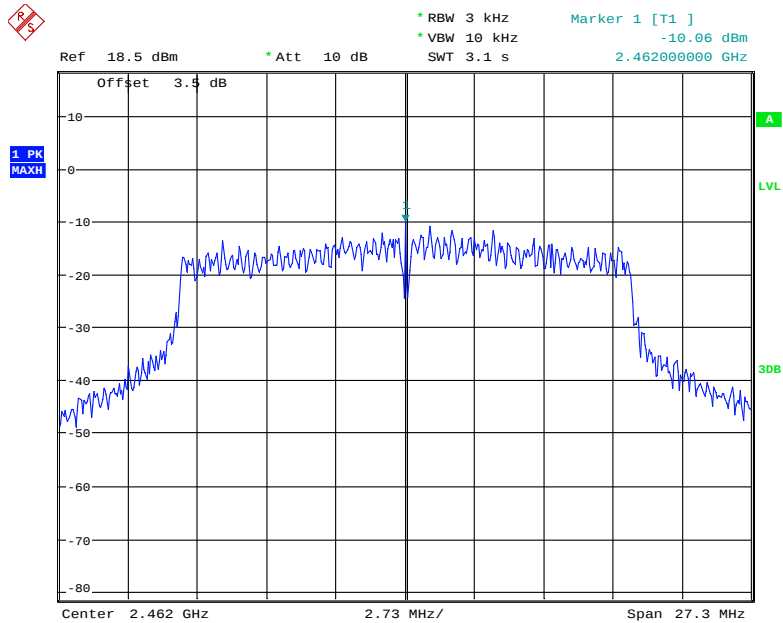
Date: 18.SEP.2019 18:09:13

Power Spectral Density, 802.11n-HT20 Middle Channel



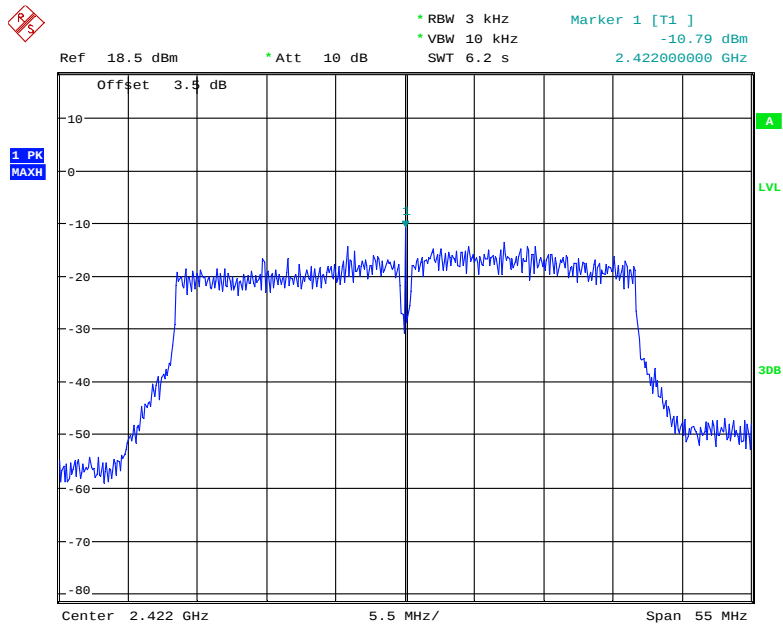
Date: 18.SEP.2019 18:10:10

Power Spectral Density, 802.11n-HT20 High Channel



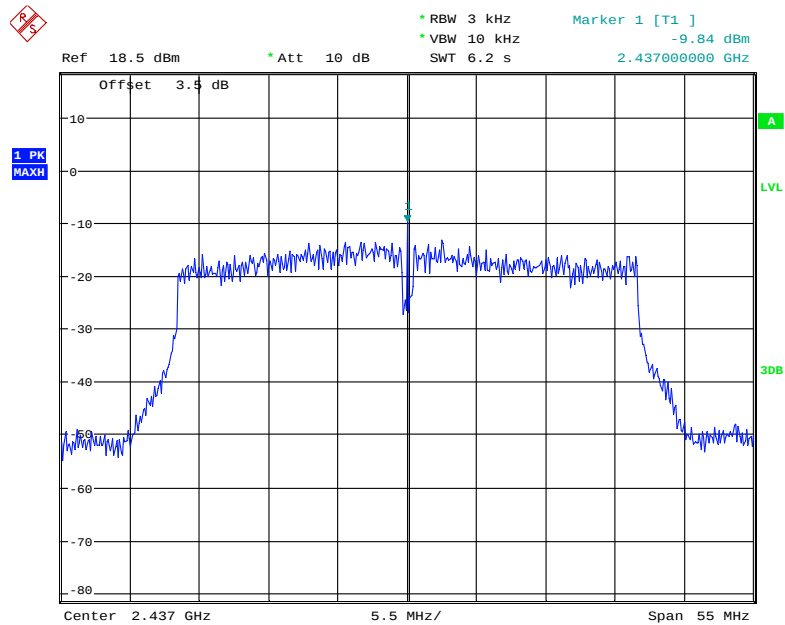
Date: 18.SEP.2019 18:11:17

Power Spectral Density, 802.11n-HT40 Low Channel



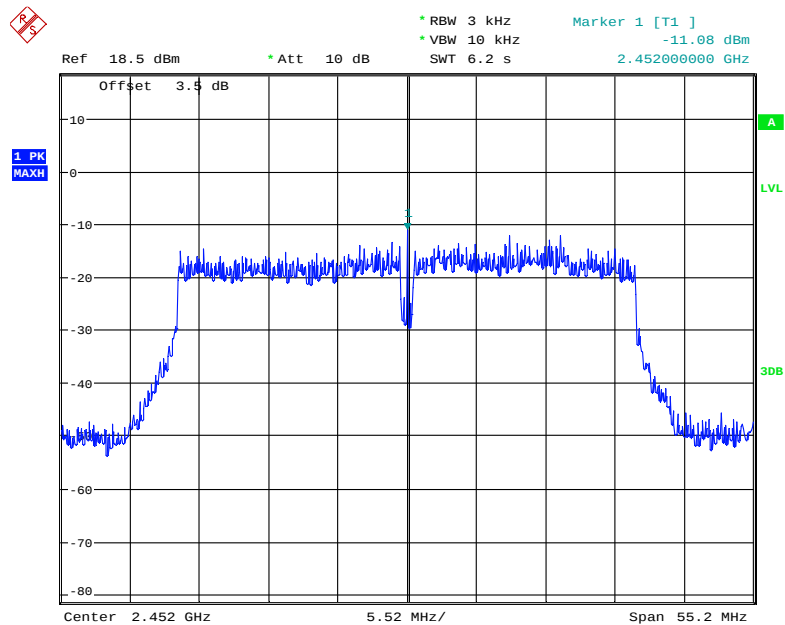
Date: 18.SEP.2019 18:14:42

Power Spectral Density, 802.11n-HT40 Middle Channel



Date: 18.SEP.2019 18:16:31

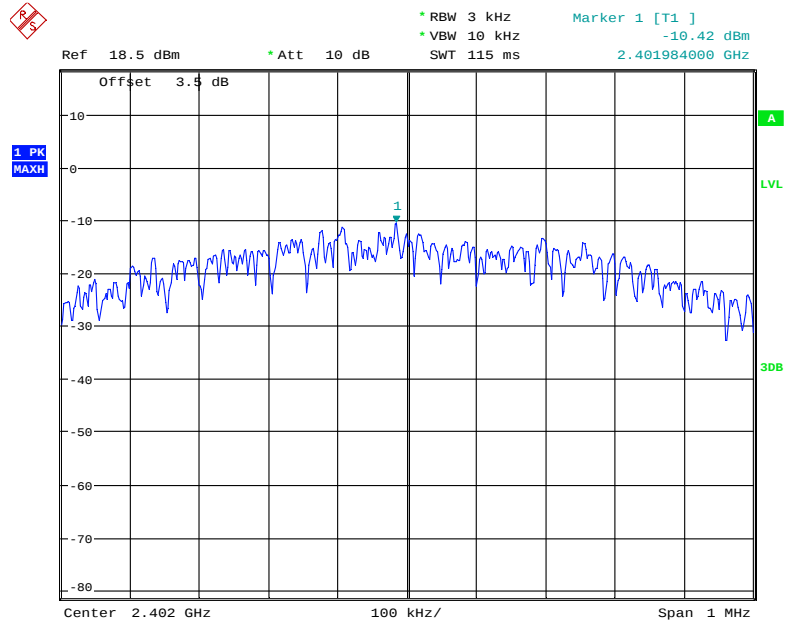
Power Spectral Density, 802.11n-HT40 High Channel



Date: 19.SEP.2019 08:37:15

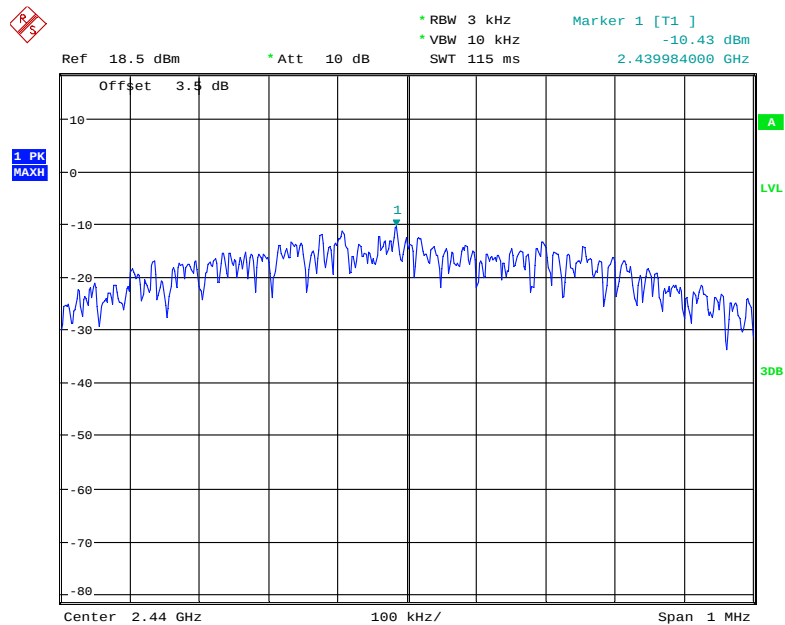
1M

Power Spectral Density, BLE Low Channel



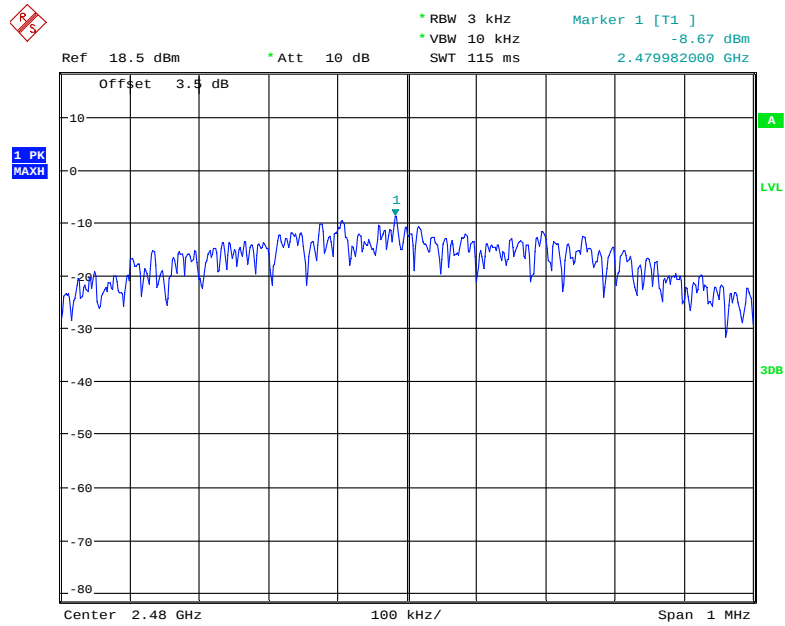
Date: 9.AUG.2019 11:12:23

Power Spectral Density, BLE Middle Channel



Date: 9.AUG.2019 11:11:58

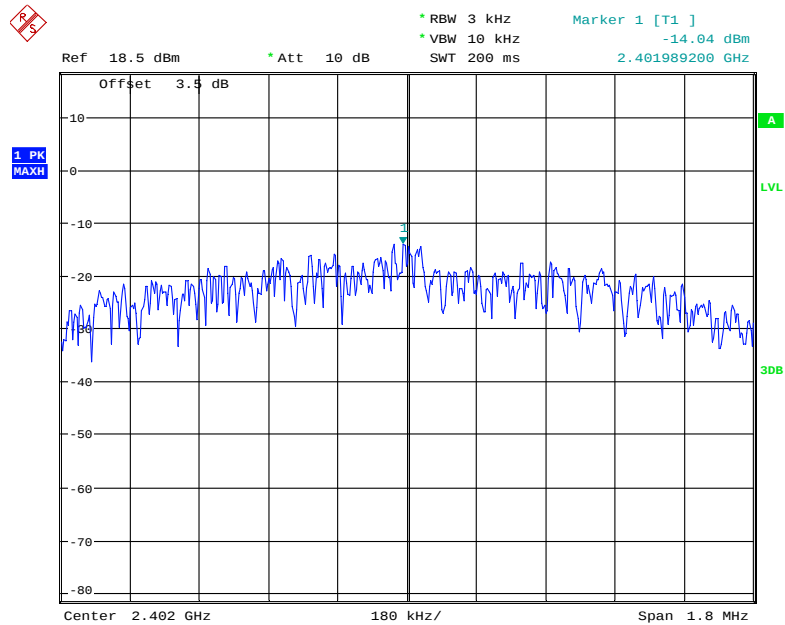
Power Spectral Density, BLE High Channel



Date: 9.AUG.2019 11:11:33

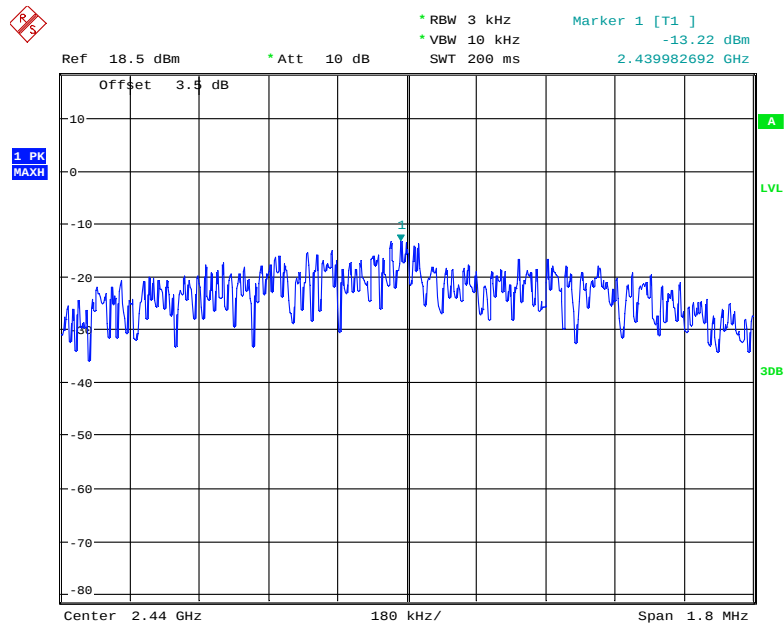
2M

Power Spectral Density, BLE Low Channel



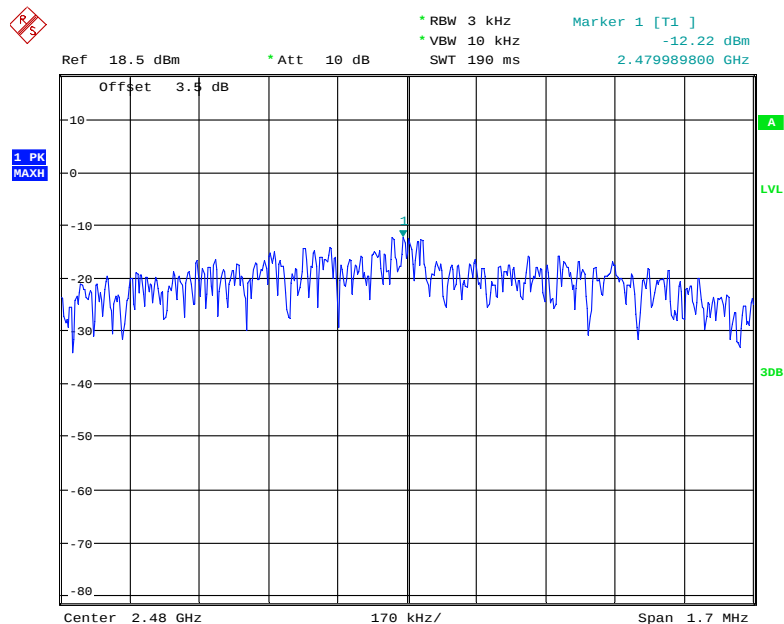
Date: 9.AUG.2019 11:43:11

Power Spectral Density, BLE Middle Channel



Date: 19.SEP.2019 09:01:50

Power Spectral Density, BLE High Channel



Date: 9.AUG.2019 11:41:52

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