TEST REPORT

Applicant Name :	HDTELECOM
Address :	#708, E&C Venture Dream Tower 6th, 41, Digital-ro 31-gil, Guro-gu, Seoul, South Korea 08375
Report Number :	SZNS211118-59299E-RF-00B
FCC ID:	2ASQU-PHOENIXNOTE

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	Phoenix Note
Model No.:	PPS2022-P156
Multiple Model(s) No.:	1501A, 1502A, 1503A(Please refer to DOS for Model difference)
Trade Mark:	N/A
Date Received:	2021/11/18
Date of Test:	2021/12/02~2022/01/18
Report Date:	2022/01/24

Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Black Ding

EMC Engineer

Approved By:

Robert Li

EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".

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TABLE OF CONTENTS

GENERAL INFORMATION **4**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) 4
OBJECTIVE 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 7
SUPPORT EQUIPMENT LIST AND DETAILS 10
EXTERNAL I/O CABLE 10
BLOCK DIAGRAM OF TEST SETUP 11
SUMMARY OF TEST RESULTS **13**
TEST EQUIPMENT LIST **14**
FCC§15.247 (I), §1.1307 (B) (1) & §2.1093 – RF EXPOSURE **16**
APPLICABLE STANDARD 16
FCC §15.203 - ANTENNA REQUIREMENT **17**
APPLICABLE STANDARD 17
ANTENNA CONNECTOR CONSTRUCTION 17
FCC §15.207 (A) – AC LINE CONDUCTED EMISSIONS **18**
APPLICABLE STANDARD 18
EUT SETUP 18
EMI TEST RECEIVER SETUP 18
TEST PROCEDURE 18
TRANSD FACTOR & MARGIN CALCULATION 19
TEST DATA 19
FCC §15.209, §15.205 & §15.247(D) - SPURIOUS EMISSIONS **22**
APPLICABLE STANDARD 22
EUT SETUP 22
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP 23
TEST PROCEDURE 23
FACTOR & MARGIN CALCULATION 23
TEST DATA 23
FCC §15.247(A) (2) – 6 DB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH **33**
APPLICABLE STANDARD 33
TEST PROCEDURE 33
TEST DATA 33
FCC §15.247(B) (3) - MAXIMUM CONDUCTED OUTPUT POWER **51**
APPLICABLE STANDARD 51
TEST PROCEDURE 51
TEST DATA 51

FCC §15.247(D) – 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGE 53
APPLICABLE STANDARD 53
TEST PROCEDURE 53
TEST DATA 53
FCC §15.247(E) - POWER SPECTRAL DENSITY.....59
APPLICABLE STANDARD 59
TEST PROCEDURE 59
TEST DATA 59

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	BLE 1M/2M: 2402-2480MHz Wi-Fi: 2412-2472MHz
Maximum Conducted Peak Output Power	BLE: 5.84dBm Wi-Fi: 15.40dBm(802.11b), 13.76dBm(802.11g) 12.80dBm(802.11n20)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	Antenna: 2.0 dBi (provided by the applicant)
Voltage Range	DC 7.6V from battery or DC 5.0V/9.0V/12.0V/15.0V from adapter
Sample serial number	SZNS211118-59299E-RF-S1 for CE&RE SZNS211118-59299E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition
Adapter information	Model: FJ-SW360ARN Input: AC 100-240V, 50/60Hz, 1.2A Max Output: DC 5.0V, 3.0A, 15.0W Max or DC 9.0V, 3.0A, 27.0W Max or DC 12.0V, 3.0A, 36.0W Max or DC 15.0V, 2.4A, 36.0W Max

Objective

This test report is 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.

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 Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. 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 Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 802.11b, 802.11g, 802.11n-HT20, total 13 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	12	2467
6	2437	13	2472
7	2442	/	/

802.11b, 802.11g and 802.11n-HT20 mode was tested with Channel 1, 7 and 13.

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

"Command window" was used, power level as below:

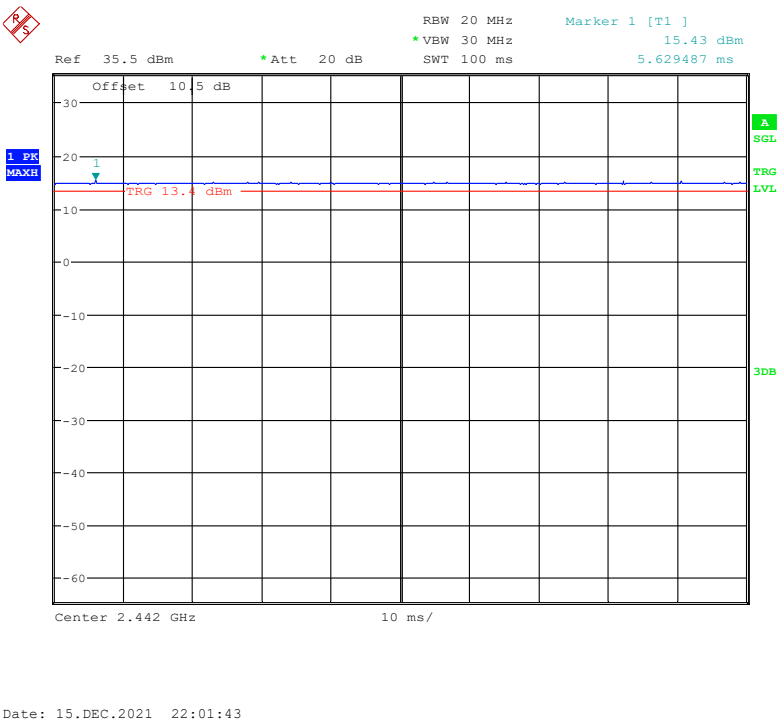
Item	Mode	Data Rate	Power Level*		
			Low	Middle	High
Wi-Fi	802.11 b	1Mbps	45	45	45
	802.11 g	6Mbps	23	23	23
	802.11 n20	MCS0	15	15	15
BLE	BLE-1M	1Mbps	Default	Default	Default
	BLE-2M	2Mbps	Default	Default	Default

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

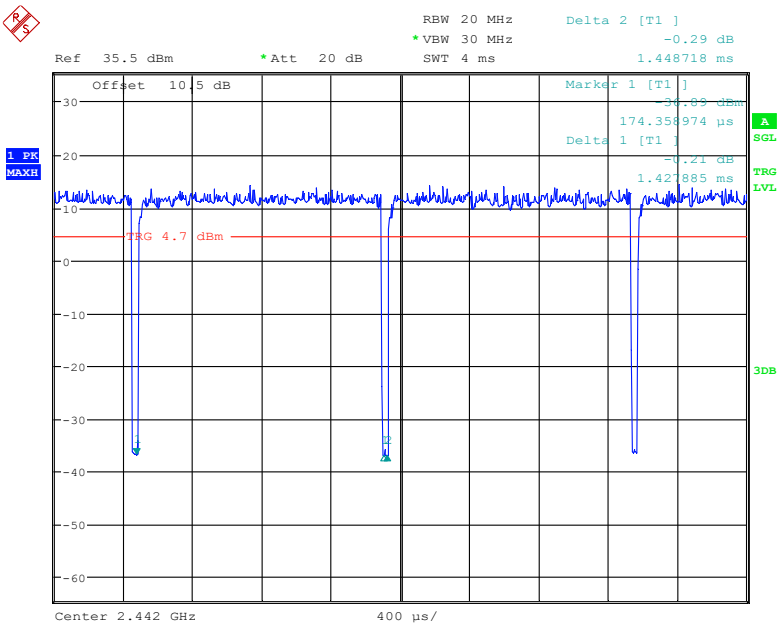
The power level was provided by the applicant.

Duty cycle

802.11b mode



802.11g mode



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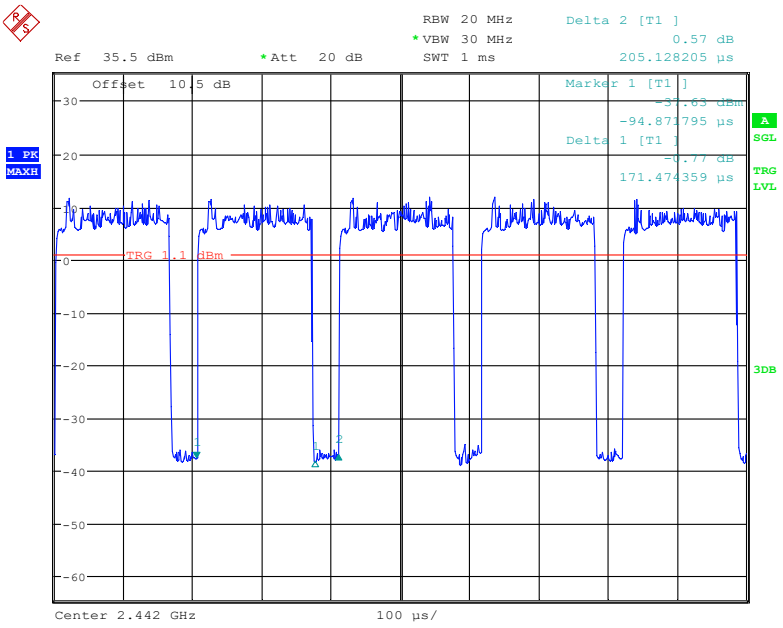
802.11n-HT20 Mode



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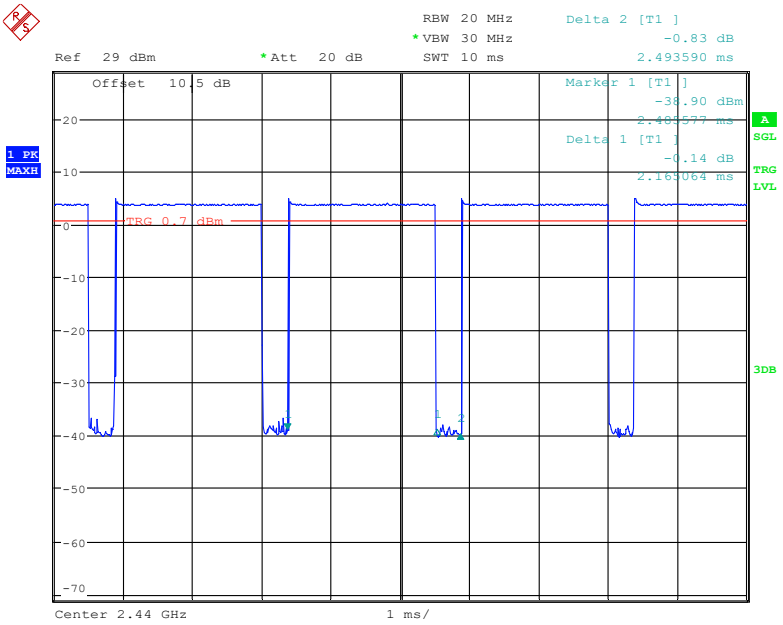
BLE-1M



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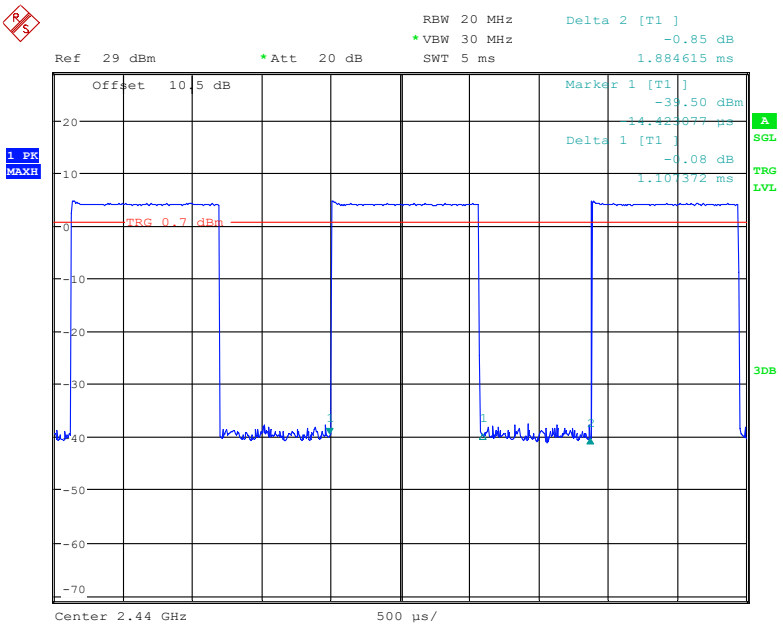
BLE-2M



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Mode	Ton (ms)	Ton+off (ms)	Duty Cycle (%)
802.11b	/	/	100
802.11g	1.428	1.449	98.55
802.11n-HT20	0.171	0.205	83.41
BLE 1M	2.165	2.494	86.81
BLE 2M	1.107	1.885	58.73

Support Equipment List and Details

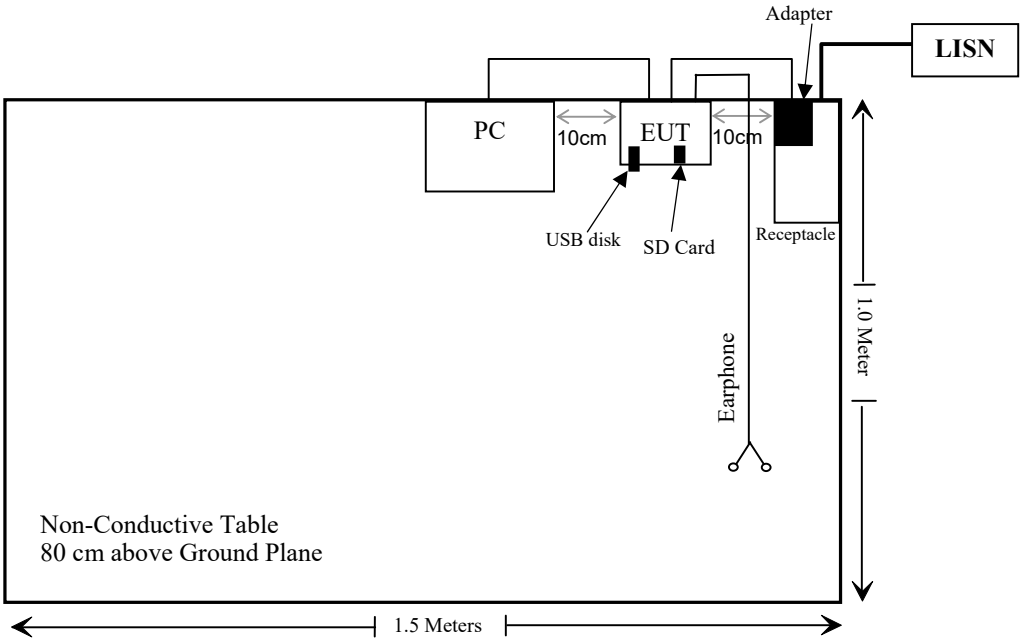
Manufacturer	Description	Model	Serial Number
Sandisk	USB disk	SDCZ38	BL210426179Z
DELL	PC	Latitude E5430	JG3NLV1
Sandisk	SD card	Unknown	SD card

External I/O Cable

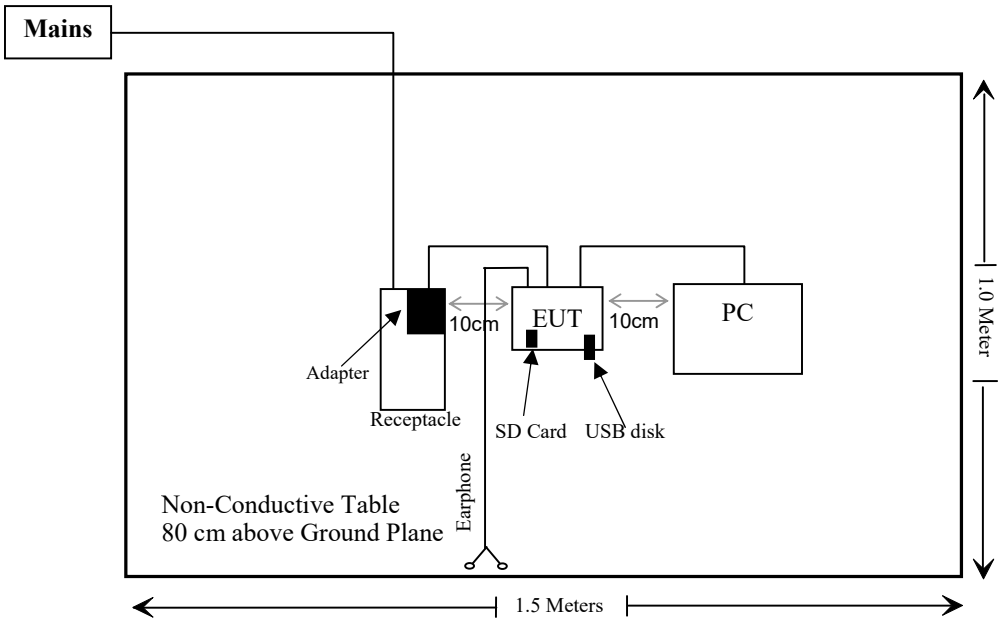
Cable Description	Length (m)	From Port	To
Un-shielding Detachable DC Cable	1.0	Adapter	EUT
Un-shielding Detachable Type-C to HDMI Cable	1.2	EUT	PC
Un-shielding Un-Detachable Audio Cable	1.0	Earphone	EUT

Block Diagram of Test Setup

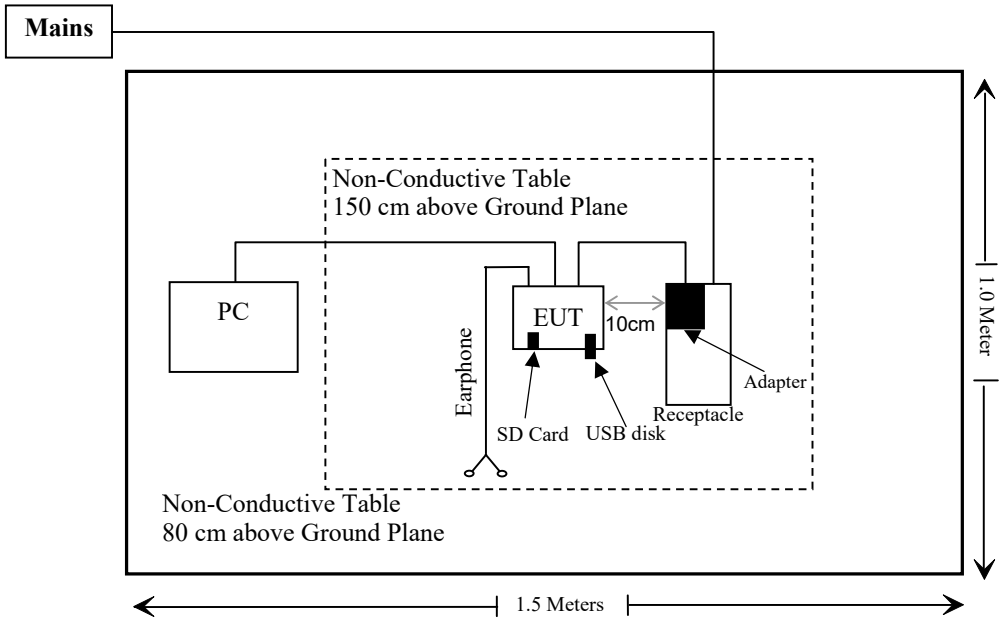
For Conducted Emissions



For Spurious Emissions(Below 1G)



For Spurious Emissions(Above 1G)



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §15.247 (i), §2.1093	RF EXPOSURE	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth & Occupied Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2020/12/13	2021/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2020/12/14	2021/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2020/12/14	2021/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2020/12/14	2021/12/13
Unknown	RF Coaxial Cable	No.16	N650	2020/12/14	2021/12/13
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2020/12/14	2021/12/13

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
SPECTRUM ANALYZER	Rohde & Schwarz	FSU26	200982	2021/07/06	2022/07/05
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. 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:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(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

For worst case:

Mode	Frequency (MHz)	Max tune-up conducted power (dBm)	Max tune-up conducted power (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
BLE	2480	6.0	3.98	5	1.3	3.0	Yes

Result: No SAR test is required.

For Wi-Fi mode, please refer to SAR report: SZNS211118-59299E-SA.

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 one internal antenna arrangement, which was permanently attached and the antenna gain is 2.0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

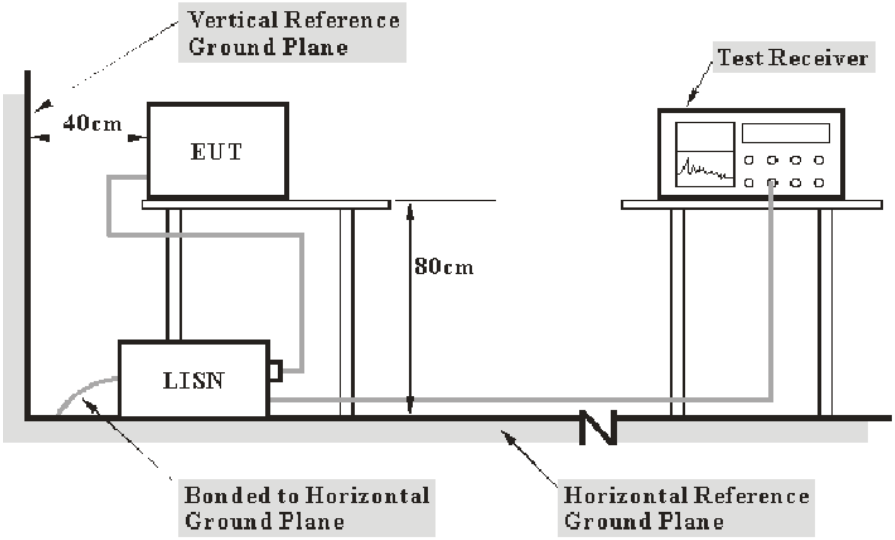
Result: Compliance.

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.

Transd Factor & Margin Calculation

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

Transd Factor = LISN VDF + Cable Loss

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

Over Limit = level – Limit
Level= reading level+ Transd Factor

Test Data

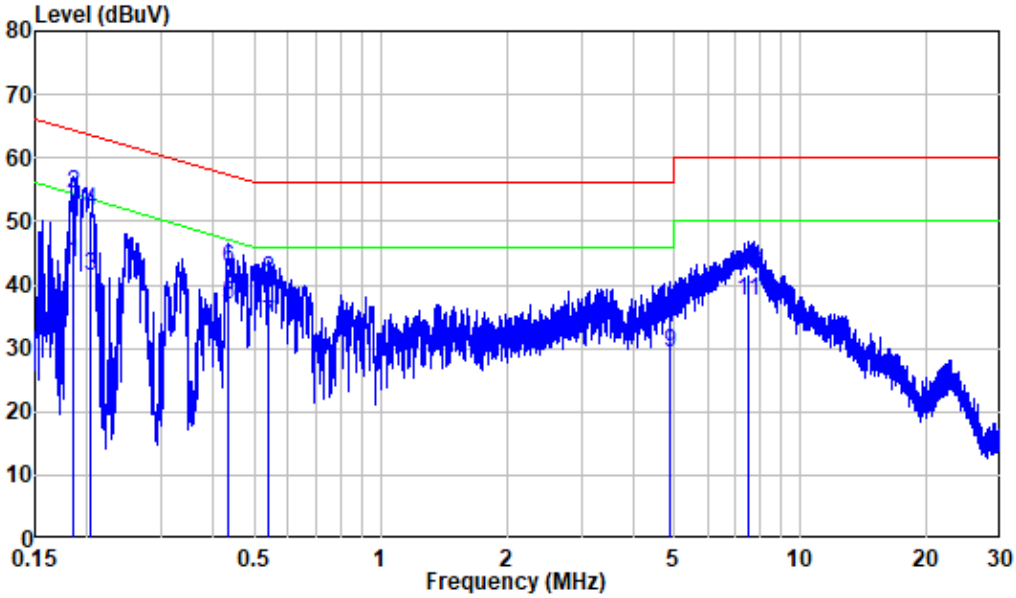
Environmental Conditions

Temperature:	22 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Bin Duan on 2022-01-18.

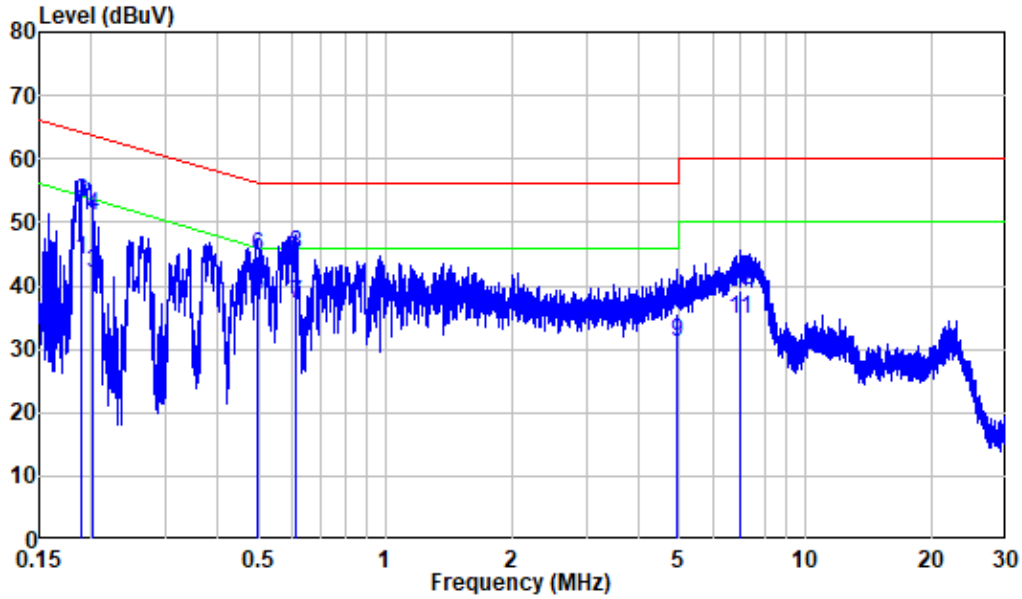
EUT operation mode: Transmitting (the worst case is 802.11b Mode, :Low channel)

AC 120V/60 Hz, Line



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.185	9.80	33.63	43.43	54.27	-10.84	Average
2	0.185	9.80	44.56	54.36	64.27	-9.91	QP
3	0.203	9.80	31.41	41.21	53.48	-12.27	Average
4	0.203	9.80	41.91	51.71	63.48	-11.77	QP
5	0.432	9.80	26.99	36.79	47.22	-10.43	Average
6	0.432	9.80	32.64	42.44	57.22	-14.78	QP
7	0.542	9.81	23.85	33.66	46.00	-12.34	Average
8	0.542	9.81	30.95	40.76	56.00	-15.24	QP
9	4.909	9.85	19.58	29.43	46.00	-16.57	Average
10	4.909	9.85	24.43	34.28	56.00	-21.72	QP
11	7.486	9.87	27.56	37.43	50.00	-12.57	Average
12	7.486	9.87	31.91	41.78	60.00	-18.22	QP

AC 120V/60 Hz, Neutral



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.190	9.80	34.27	44.07	54.05	-9.98	Average
2	0.190	9.80	43.45	53.25	64.05	-10.80	QP
3	0.201	9.80	32.19	41.99	53.56	-11.57	Average
4	0.201	9.80	41.28	51.08	63.56	-12.48	QP
5	0.495	9.80	28.53	38.33	46.08	-7.75	Average
6	0.495	9.80	34.80	44.60	56.08	-11.48	QP
7	0.611	9.81	27.37	37.18	46.00	-8.82	Average
8	0.611	9.81	35.04	44.85	56.00	-11.15	QP
9	4.955	9.89	21.24	31.13	46.00	-14.87	Average
10	4.955	9.89	25.72	35.61	56.00	-20.39	QP
11	6.951	9.97	24.88	34.85	50.00	-15.15	Average
12	6.951	9.97	29.30	39.27	60.00	-20.73	QP

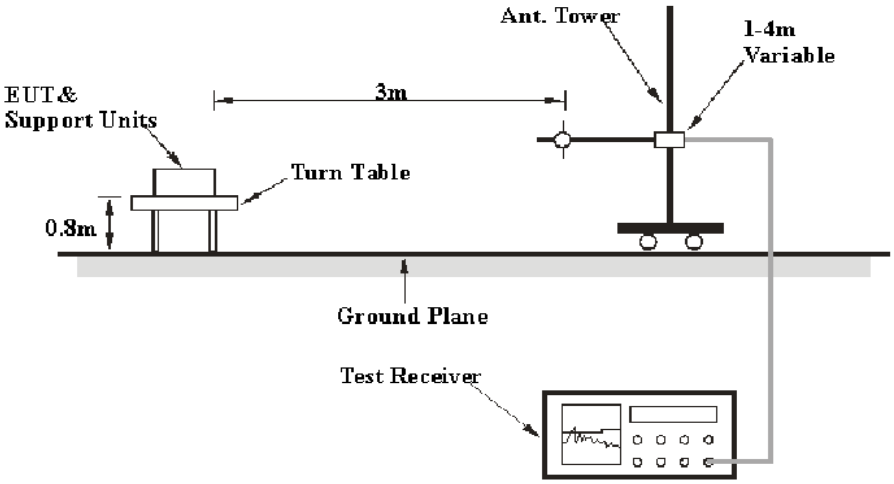
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

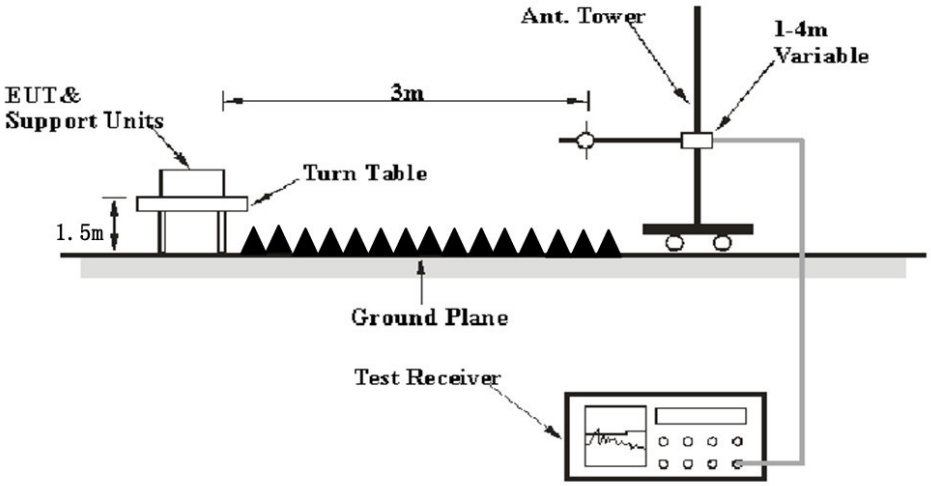
FCC §15.247 (d); §15.209; §15.205;

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

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.

Factor & Margin Calculation

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

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Margin/Over Limit = Corrected Amplitude/Level-Limit
Corrected Amplitude/Level = Reading + Corrected Factor

Test Data

Environmental Conditions

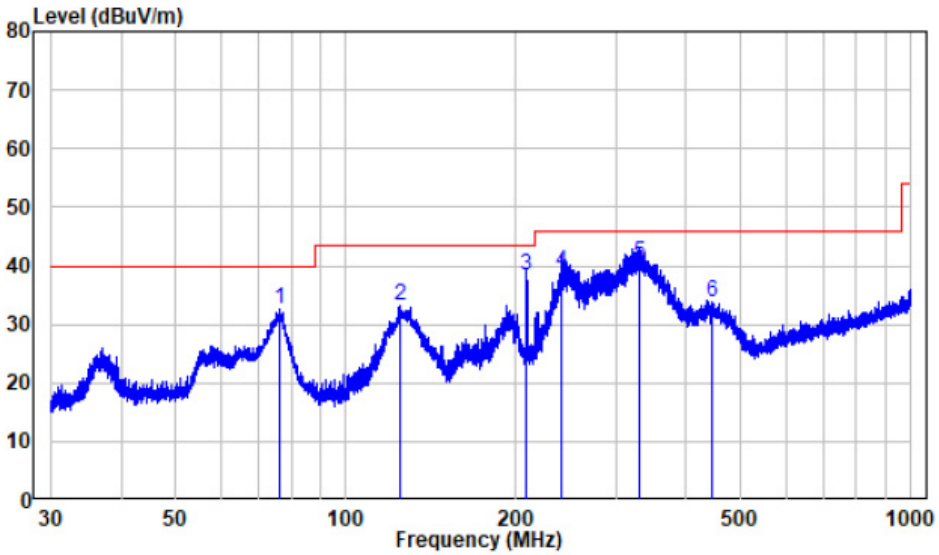
Temperature:	22.3~25 ℃
Relative Humidity:	60~64 %
ATM Pressure:	101.0 kPa

The testing was performed by Chao Mo on 2021-12-23 for below 1GHz and Bin Deng on 2021-12-02 for above 1GHz.

EUT operation mode: Transmitting(Pre-scan in the X, Y and Z axes of orientation, the worst case orientation was recorded)

30MHz-1GHz: *(the worst case is 802.1b Mode, Low channel)*

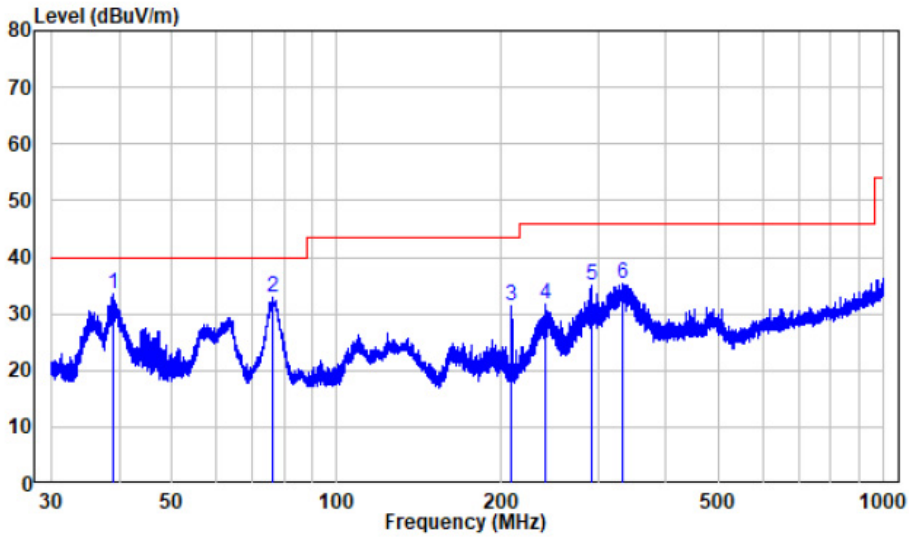
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS211118-59299E-RF
Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	76.18	-16.44	49.06	32.62	40.00	-7.38	Peak
2	125.12	-14.32	47.39	33.07	43.50	-10.43	Peak
3	208.76	-11.86	50.24	38.38	43.50	-5.12	QP
4	240.94	-10.84	49.80	38.96	46.00	-7.04	QP
5	330.92	-7.93	48.37	40.44	46.00	-5.56	QP
6	445.63	-5.63	39.51	33.88	46.00	-12.12	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS211118-59299E-RF
Test Mode: 2.4G WIFI

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	39.13	-10.55	43.97	33.42	40.00	-6.58	Peak
2	76.24	-16.44	49.32	32.88	40.00	-7.12	Peak
3	208.85	-11.86	43.22	31.36	43.50	-12.14	Peak
4	241.04	-10.84	42.62	31.78	46.00	-14.22	Peak
5	292.31	-9.29	44.46	35.17	46.00	-10.83	Peak
6	332.37	-7.81	43.05	35.24	46.00	-10.76	Peak

1-25 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/AV		Height (m)	Polar (H/V)				
BLE 1M, Low Channel									
2310	67.86	PK	91	2.2	H	-7.24	60.62	74	-13.38
2310	53.94	AV	91	2.2	H	-7.24	46.70	54	-7.30
2310	67.90	PK	254	2.4	V	-7.24	60.66	74	-13.34
2310	53.58	AV	254	2.4	V	-7.24	46.34	54	-7.66
2390	68.55	PK	245	1.1	H	-7.22	61.33	74	-12.67
2390	54.84	AV	245	1.1	H	-7.22	47.62	54	-6.38
2390	68.56	PK	311	2.2	V	-7.22	61.34	74	-12.66
2390	54.70	AV	311	2.2	V	-7.22	47.48	54	-6.52
4804	54.15	PK	238	2.3	H	-3.51	50.64	74	-23.36
4804	54.73	PK	57	2.3	V	-3.51	51.22	74	-22.78
BLE 1M, Middle Channel									
4880	55.17	PK	211	2.1	H	-3.38	51.79	74	-22.21
4880	54.75	PK	36	2.1	V	-3.38	51.37	74	-22.63
BLE 1M, High Channel									
2483.5	68.50	PK	10	1.3	H	-7.20	61.3	74	-12.70
2483.5	55.45	AV	10	1.3	H	-7.20	48.25	54	-5.75
2483.5	68.57	PK	104	2.1	V	-7.20	61.37	74	-12.63
2483.5	55.99	AV	104	2.1	V	-7.20	48.79	54	-5.21
2500	93.55	PK	159	1.6	H	-7.18	86.37	74	12.37
2500	54.88	AV	159	1.6	H	-7.18	47.7	54	-6.30
2500	69.29	PK	354	1.9	V	-7.18	62.11	74	-11.89
2500	55.02	AV	354	1.9	V	-7.18	47.84	54	-6.16
4960	54.10	PK	156	1.7	H	-3.01	51.09	74	-22.91
4960	54.29	PK	210	1.7	V	-3.01	51.28	74	-22.72

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
BLE 2M, Low Channel									
2310	67.31	PK	259	1.9	H	-7.24	60.07	74	-13.93
2310	53.81	AV	259	1.9	H	-7.24	46.57	54	-7.43
2310	68.01	PK	226	1.2	V	-7.24	60.77	74	-13.23
2310	54.12	AV	226	1.2	V	-7.24	46.88	54	-7.12
2390	68.69	PK	20	2.4	H	-7.22	61.47	74	-12.53
2390	54.88	AV	20	2.4	H	-7.22	47.66	54	-6.34
2390	67.90	PK	14	2.3	V	-7.22	60.68	74	-13.32
2390	54.91	AV	14	2.3	V	-7.22	47.69	54	-6.31
4804	54.97	PK	148	1.5	H	-3.51	51.46	74	-22.54
4804	54.59	PK	148	1.5	V	-3.51	51.08	74	-22.92
BLE 2M, Middle Channel									
4880	54.52	PK	42	1.4	H	-3.38	51.14	74	-22.86
4880	54.24	PK	42	1.4	V	-3.38	50.86	74	-23.14
BLE 2M, High Channel									
2483.5	69.03	PK	260	1.5	H	-7.20	61.83	74	-12.17
2483.5	55.76	AV	260	1.5	H	-7.20	48.56	54	-5.44
2483.5	68.80	PK	278	1.5	V	-7.20	61.6	74	-12.40
2483.5	55.67	AV	278	1.5	V	-7.20	48.47	54	-5.53
2500	68.63	PK	28	2	H	-7.18	61.45	74	-12.55
2500	55.21	AV	28	2	H	-7.18	48.03	54	-5.97
2500	68.57	PK	197	1	V	-7.18	61.39	74	-12.61
2500	55.16	AV	197	1	V	-7.18	47.98	54	-6.02
4960	53.90	PK	289	1.7	H	-3.01	50.89	74	-23.11
4960	54.12	PK	176	1.7	V	-3.01	51.11	74	-22.89

Wi-Fi:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11B, Low Channel									
2310	68.54	PK	318	2.1	H	-7.24	61.30	74	-12.70
2310	53.40	AV	318	2.1	H	-7.24	46.16	54	-7.84
2310	67.61	PK	34	1.7	V	-7.24	60.37	74	-13.63
2310	52.95	AV	34	1.7	V	-7.24	45.71	54	-8.29
2390	69.67	PK	199	2.4	H	-7.22	62.45	74	-11.55
2390	56.58	AV	199	2.4	H	-7.22	49.36	54	-4.64
2390	68.04	PK	189	1.7	V	-7.22	60.82	74	-13.18
2390	54.56	AV	189	1.7	V	-7.22	47.34	54	-6.66
4824	54.83	PK	206	1.7	H	-3.52	51.31	74	-22.69
4824	54.36	PK	21	1.7	V	-3.52	50.84	74	-23.16
802.11B, Middle Channel									
4884	55.02	PK	237	2.1	H	-3.36	51.66	74	-22.34
4884	55.23	PK	105	2.1	V	-3.36	51.87	74	-22.13
802.11B, High Channel									
2483.5	78.14	PK	227	1.8	H	-7.20	70.94	74	-3.06
2483.5	58.19	AV	227	1.8	H	-7.20	50.99	54	-3.01
2483.5	74.65	PK	94	2.4	V	-7.20	67.45	74	-6.55
2483.5	55.90	AV	94	2.4	V	-7.20	48.7	54	-5.30
2500	74.33	PK	55	1.5	H	-7.18	67.15	74	-6.85
2500	57.06	AV	55	1.5	H	-7.18	49.88	54	-4.12
2500	71.00	PK	306	1.5	V	-7.18	63.82	74	-10.18
2500	54.28	AV	306	1.5	V	-7.18	47.1	54	-6.90
4944	54.04	PK	184	1.7	H	-3.07	50.97	74	-23.03
4944	54.65	PK	126	1.7	V	-3.07	51.58	74	-22.42

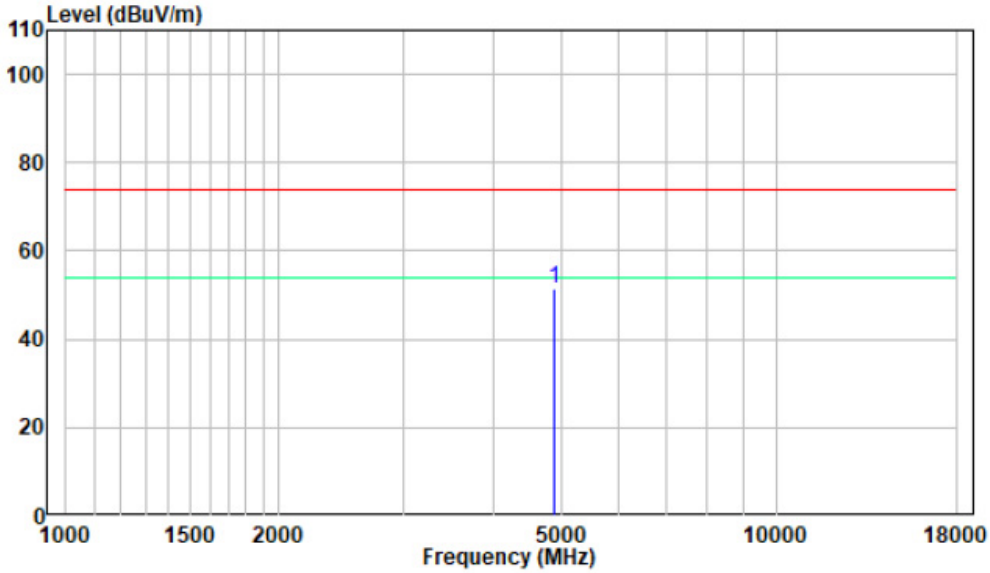
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11G, Low Channel									
2310	67.81	PK	186	1.9	H	-7.24	60.57	74	-13.43
2310	53.82	AV	186	1.9	H	-7.24	46.58	54	-7.42
2310	67.75	PK	264	2.5	V	-7.24	60.51	74	-13.49
2310	53.81	AV	264	2.5	V	-7.24	46.57	54	-7.43
2390	68.29	PK	300	1	H	-7.22	61.07	74	-12.93
2390	55.04	AV	300	1	H	-7.22	47.82	54	-6.18
2390	68.26	PK	8	2.2	V	-7.22	61.04	74	-12.96
2390	55.10	AV	8	2.2	V	-7.22	47.88	54	-6.12
4824	55.23	PK	290	1	H	-3.52	51.71	74	-22.29
4824	54.65	PK	174	1	V	-3.52	51.13	74	-22.87
802.11G, Middle Channel									
4884	54.85	PK	346	1.7	H	-3.36	51.49	74	-22.51
4884	54.71	PK	168	1.7	V	-3.36	51.35	74	-22.65
802.11G, High Channel									
2483.5	76.69	PK	11	2.5	H	-7.20	69.49	74	-4.51
2483.5	57.87	AV	11	2.5	H	-7.20	50.67	54	-3.33
2483.5	71.45	PK	235	1.8	V	-7.20	64.25	74	-9.75
2483.5	53.55	AV	235	1.8	V	-7.20	46.35	54	-7.65
2500	68.84	PK	53	1.4	H	-7.18	61.66	74	-12.34
2500	55.19	AV	53	1.4	H	-7.18	48.01	54	-5.99
2500	68.67	PK	14	2.2	V	-7.18	61.49	74	-12.51
2500	55.16	AV	14	2.2	V	-7.18	47.98	54	-6.02
4944	53.84	PK	323	1.7	H	-3.07	50.77	74	-23.23
4944	54.08	PK	212	1.7	V	-3.07	51.01	74	-22.99

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
802.11N20, Low Channel									
2310	68.85	PK	330	2.2	H	-7.24	61.61	74	-12.39
2310	57.13	AV	330	2.2	H	-7.24	49.89	54	-4.11
2310	68.85	PK	153	2.1	V	-7.24	61.61	74	-12.39
2310	56.99	AV	153	2.1	V	-7.24	49.75	54	-4.25
2390	70.14	PK	240	2	H	-7.22	62.92	74	-11.08
2390	57.50	AV	240	2	H	-7.22	50.28	54	-3.72
2390	69.14	PK	235	2.3	V	-7.22	61.92	74	-12.08
2390	57.68	AV	235	2.3	V	-7.22	50.46	54	-3.54
4824	54.74	PK	121	2	H	-3.52	51.22	74	-22.78
4824	55.02	PK	241	2	V	-3.52	51.50	74	-22.50
802.11N20, Middle Channel									
4884	54.81	PK	290	2.1	H	-3.36	51.45	74	-22.55
4884	54.90	PK	57	2.1	V	-3.36	51.54	74	-22.46
802.11N20, High Channel									
2483.5	73.24	PK	26	1.9	H	-7.20	66.04	74	-7.96
2483.5	58.45	AV	26	1.9	H	-7.20	51.25	54	-2.75
2483.5	69.34	PK	173	1.2	V	-7.20	62.14	74	-11.86
2483.5	58.05	AV	173	1.2	V	-7.20	50.85	54	-3.15
2500	68.51	PK	107	2.5	H	-7.18	61.33	74	-12.67
2500	57.79	AV	107	2.5	H	-7.18	50.61	54	-3.39
2500	68.60	PK	53	1.6	V	-7.18	61.42	74	-12.58
2500	57.30	AV	53	1.6	V	-7.18	50.12	54	-3.88
4944	53.91	PK	206	1.7	H	-3.07	50.84	74	-23.16
4944	54.40	PK	231	1.7	V	-3.07	51.33	74	-22.67

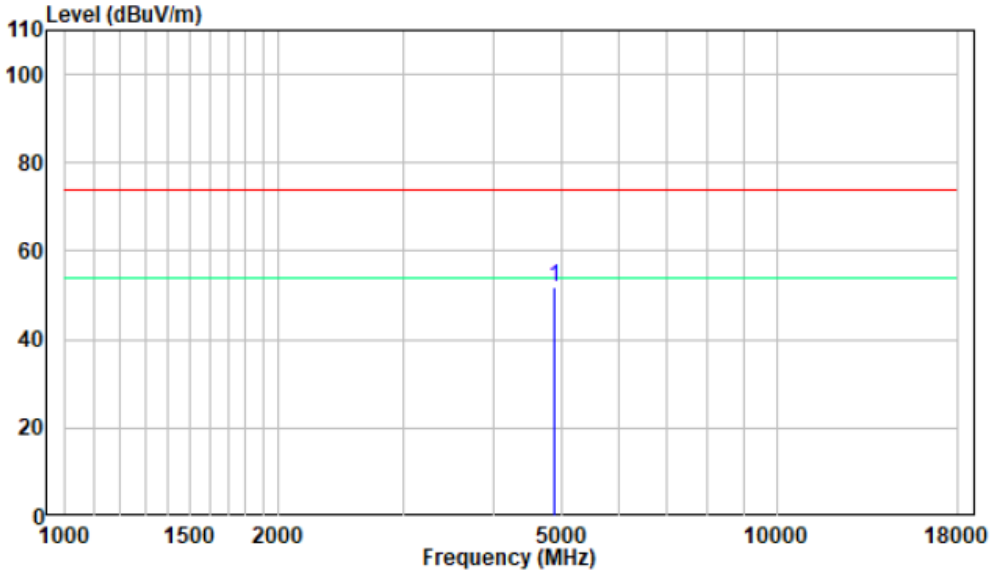
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is 20dB to the limit or in noise floor was not recorded.
The test result of peak was less than the limit of average, so just peak values were recorded.

1-18 GHz:

Pre-scan for 802.11 B Middle Channel
Horizontal

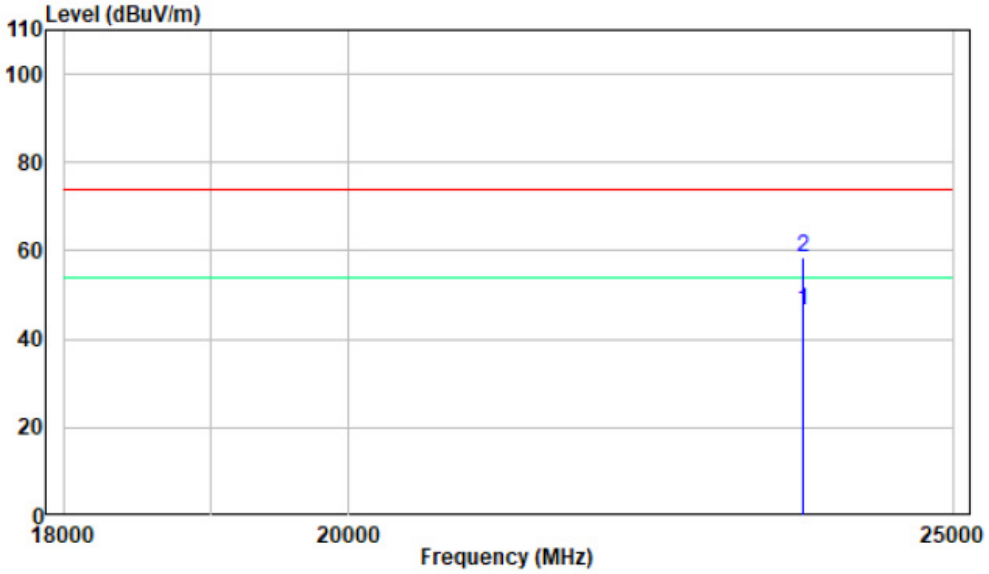


Vertical

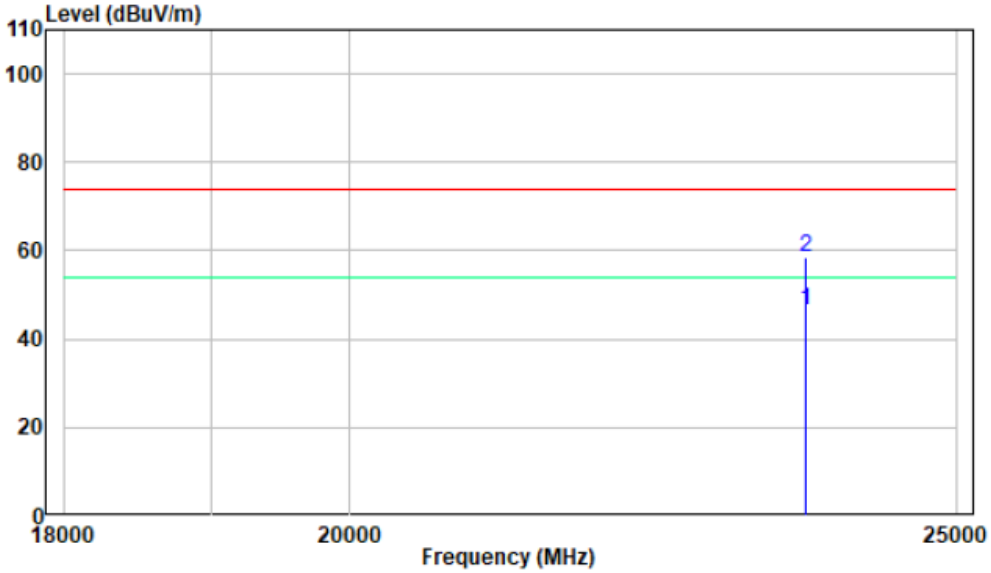


18 -25GHz:

Pre-scan for 802.11 B Middle Channel
Horizontal



Vertical



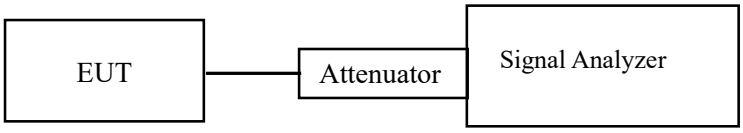
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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

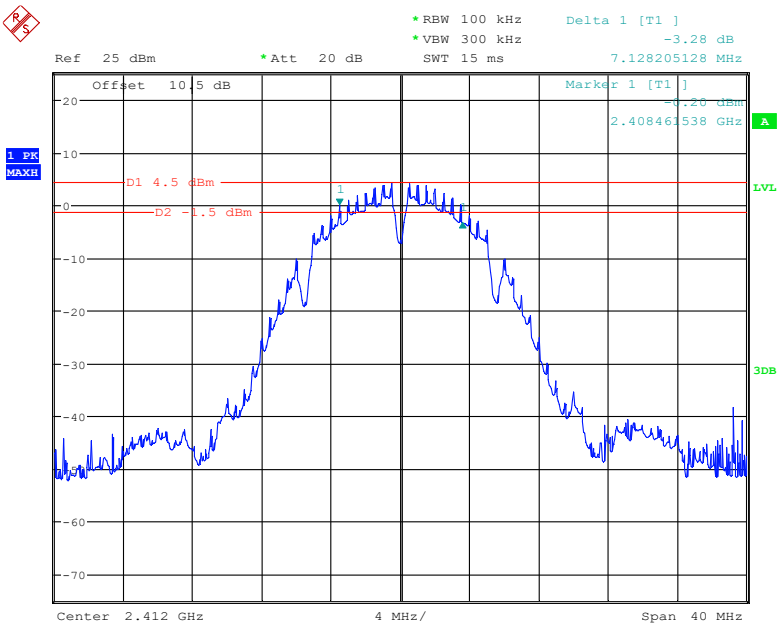
Temperature:	28.5~28.7 ℃
Relative Humidity:	46~48 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2021-12-14 to 2021-12-15.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)	Limit (kHz)
802.11b mode				
Low	2412	7.128	11.795	≥500
Middle	2442	7.051	11.795	≥500
High	2472	7.179	11.795	≥500
802.11g mode				
Low	2412	16.423	16.667	≥500
Middle	2442	16.410	16.731	≥500
High	2472	16.410	16.667	≥500
802.11n-HT20 mode				
Low	2412	17.821	17.885	≥500
Middle	2442	17.821	17.885	≥500
High	2472	17.821	17.885	≥500
BLE 1M				
Low	2402	0.673	1.045	≥500
Middle	2440	0.667	1.045	≥500
High	2480	0.670	1.045	≥500
BLE 2M				
Low	2402	1.237	2.051	≥500
Middle	2440	1.244	2.051	≥500
High	2480	1.247	2.045	≥500

6dB Bandwidth, 802.11b Low Channel



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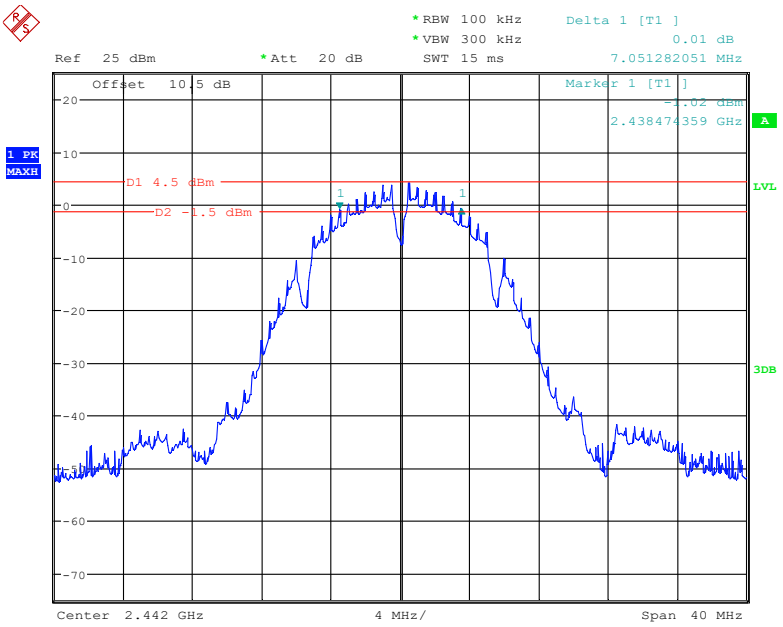
6dB Bandwidth, 802.11b Middle Channel



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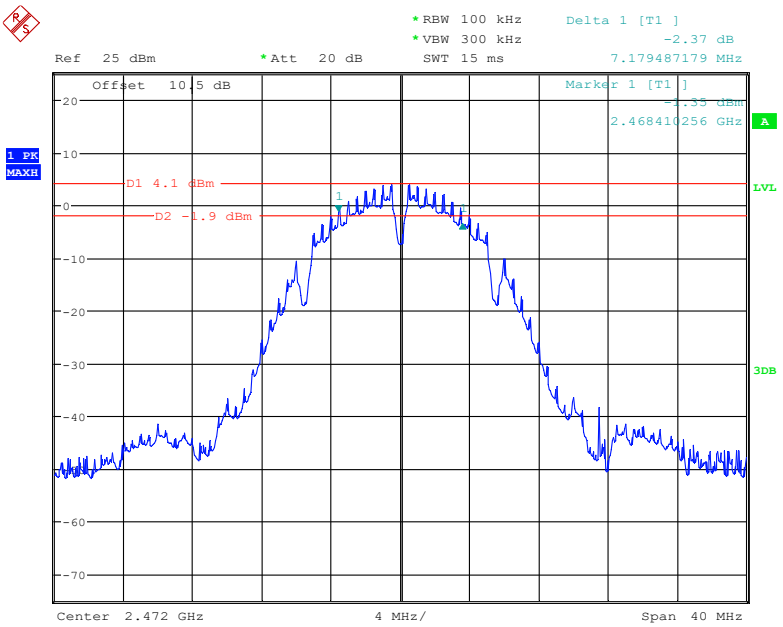
6dB Bandwidth, 802.11b High Channel



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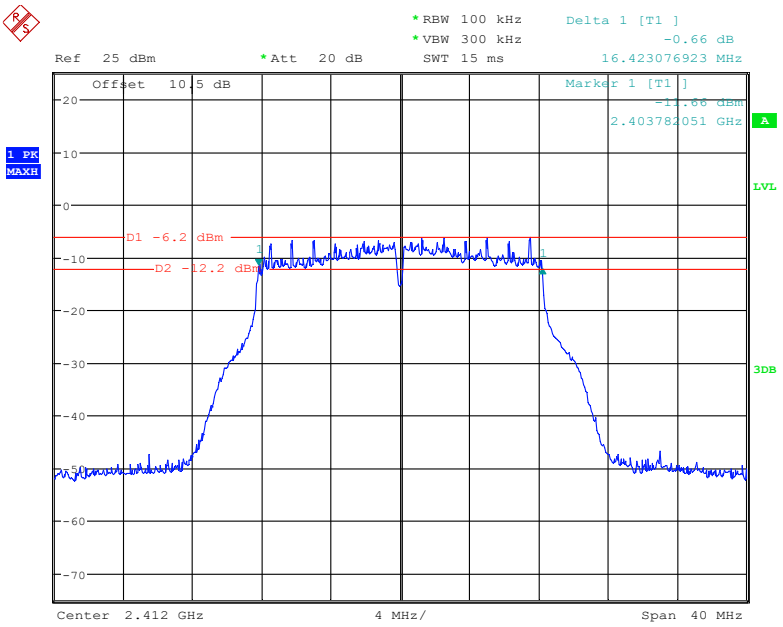
6dB Bandwidth, 802.11g Low Channel



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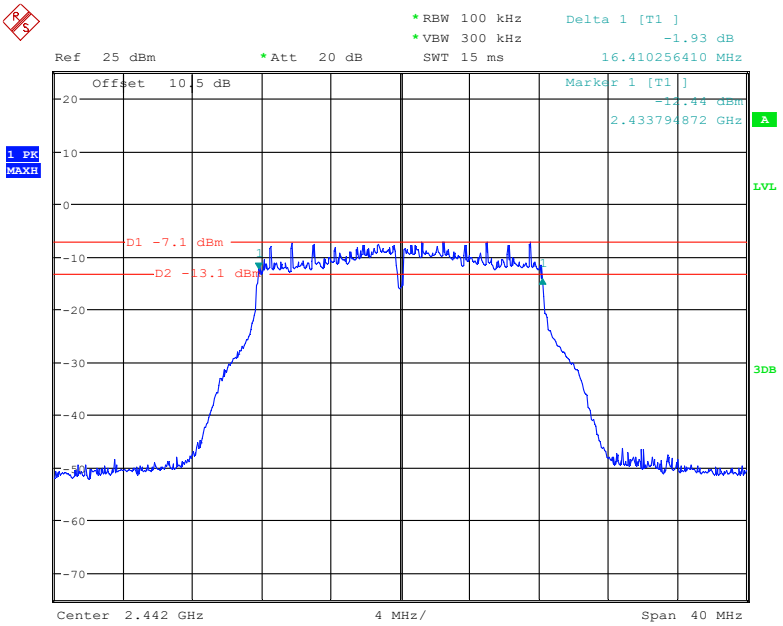
6dB Bandwidth, 802.11g Middle Channel



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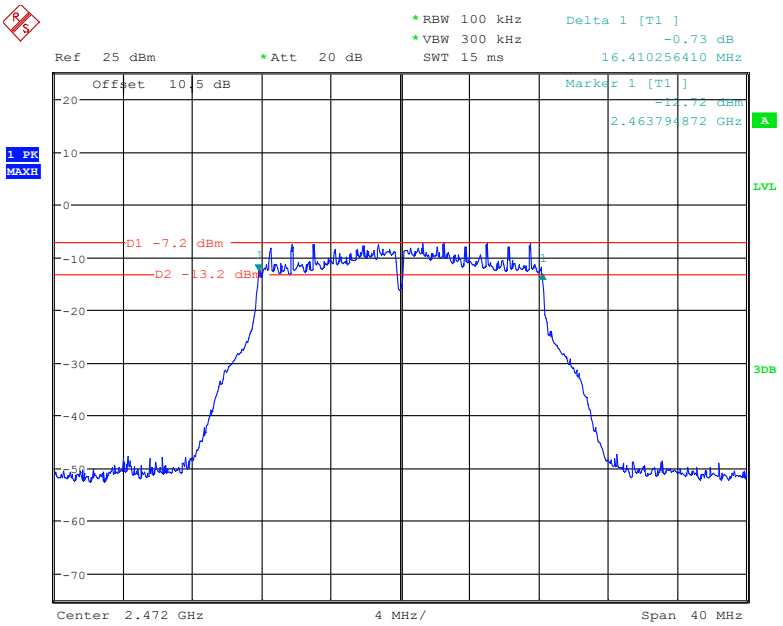
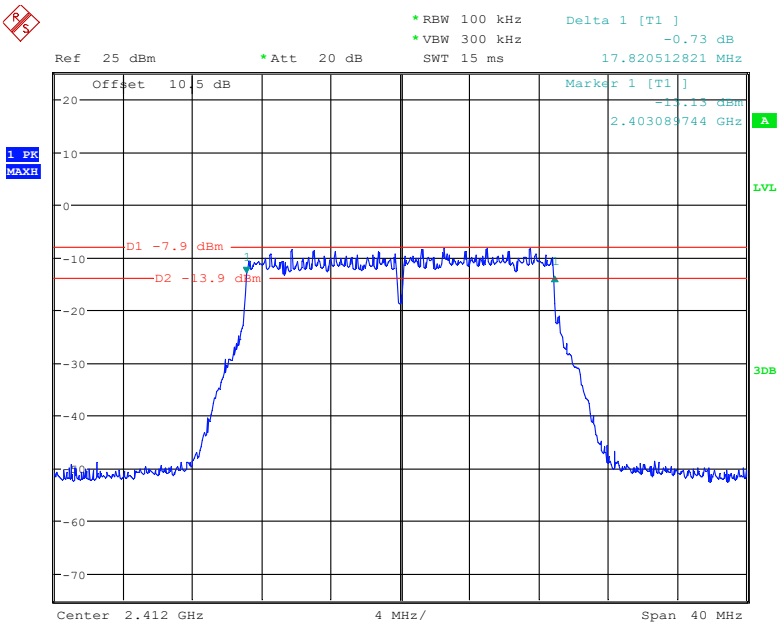
6dB Bandwidth, 802.11g High Channel



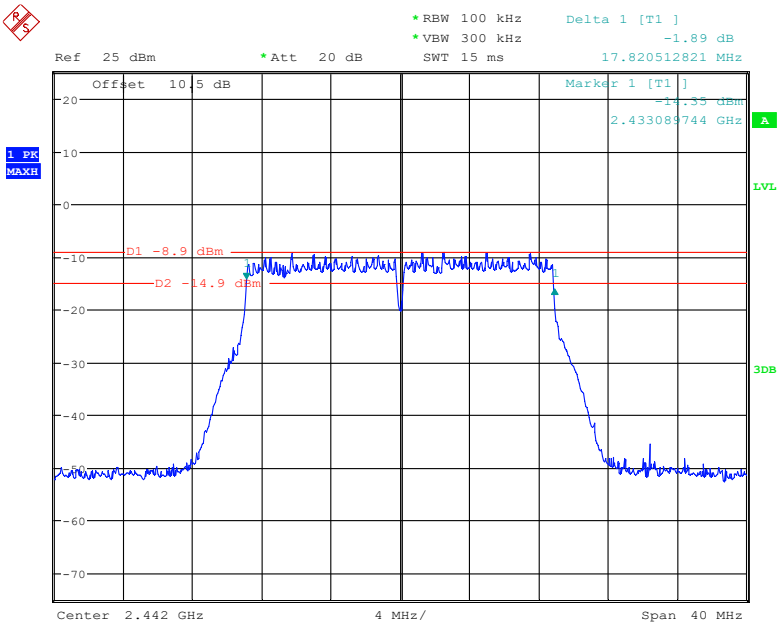
Date: 15.DEC.2021 21:51:41

6dB Bandwidth, 802.11n-HT20 Low Channel



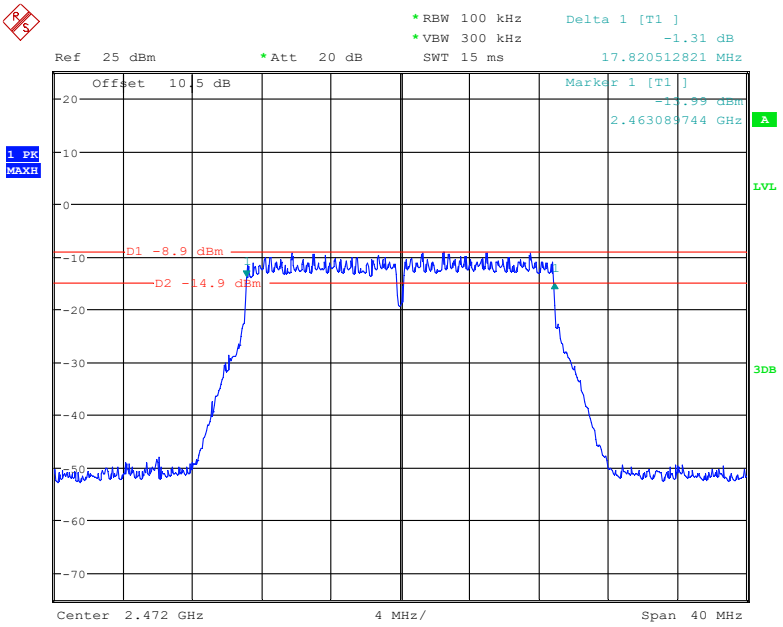
Date: 15.DEC.2021 21:53:09

6dB Bandwidth, 802.11n-HT20 Middle Channel



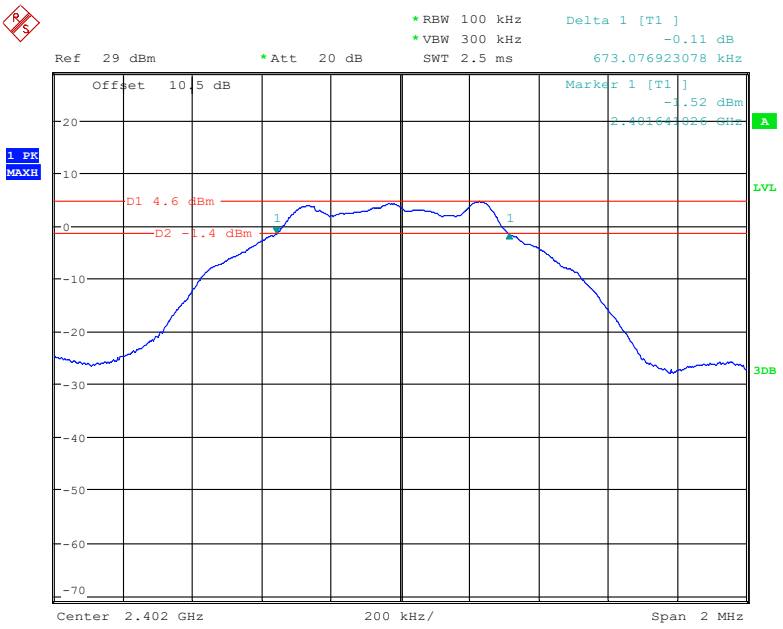
Date: 15.DEC.2021 21:54:31

6dB Bandwidth, 802.11n-HT20 High Channel



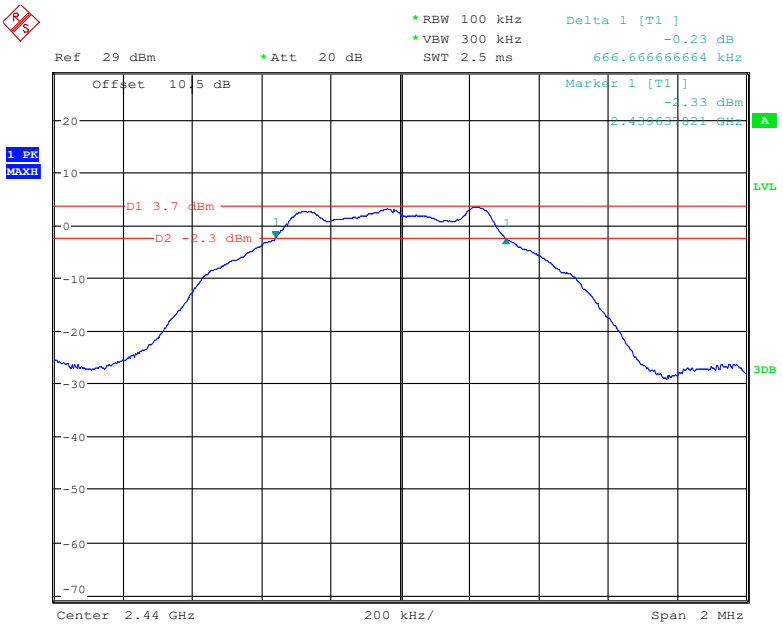
Date: 15.DEC.2021 21:56:11

6dB Bandwidth, BLE-1M Low Channel



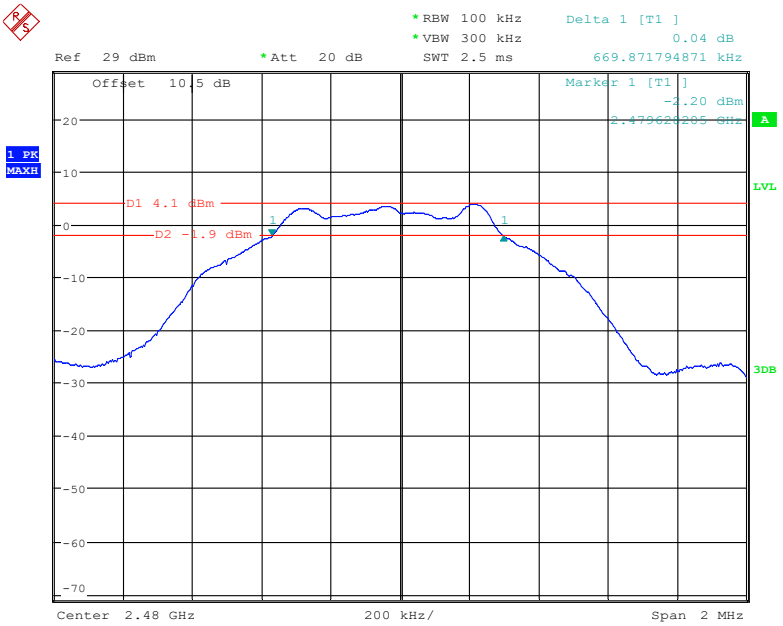
Date: 14.DEC.2021 23:48:03

6dB Bandwidth, BLE-1M Middle Channel



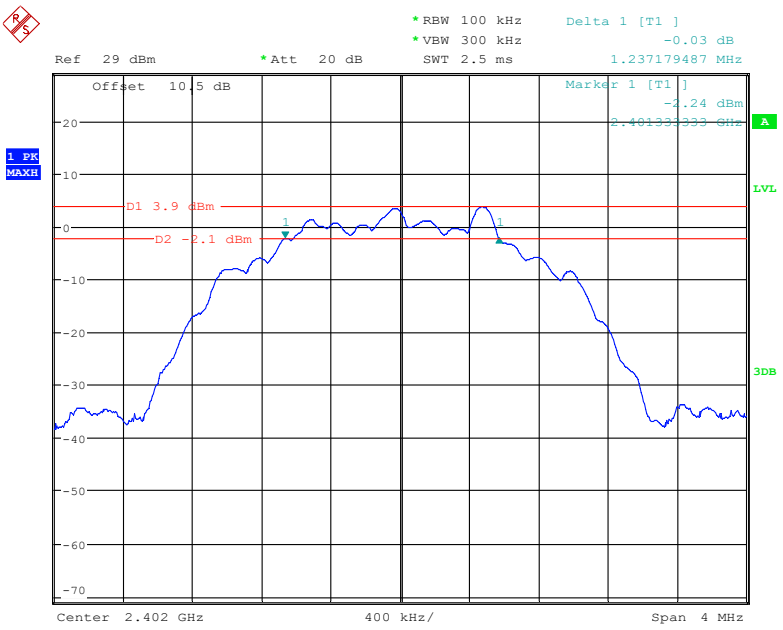
Date: 14.DEC.2021 23:49:24

6dB Bandwidth, BLE-1M High Channel



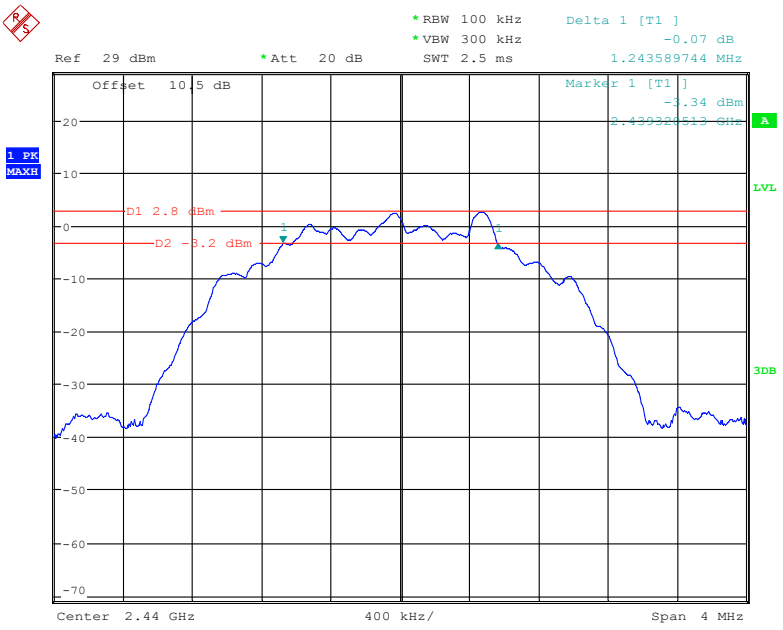
Date: 14.DEC.2021 23:50:48

6dB Bandwidth, BLE-2M Low Channel



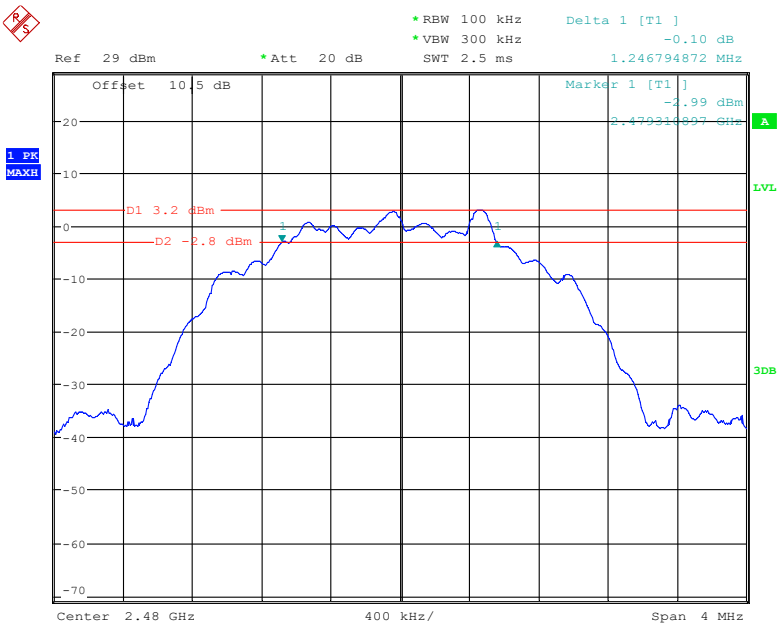
Date: 14.DEC.2021 23:46:36

6dB Bandwidth, BLE-2M Middle Channel



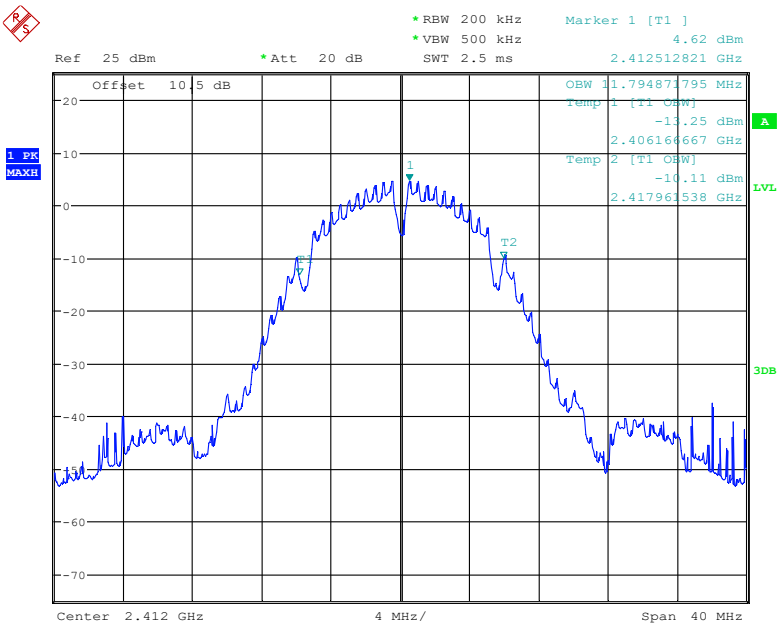
Date: 14.DEC.2021 23:45:03

6dB Bandwidth, BLE-2M High Channel



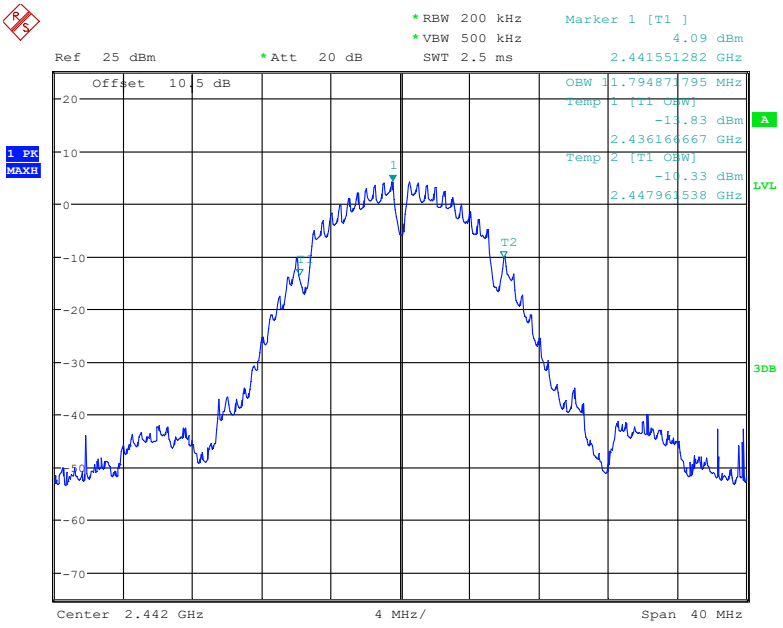
Date: 14.DEC.2021 23:43:33

99% Emission Bandwidth, 802.11b Low Channel



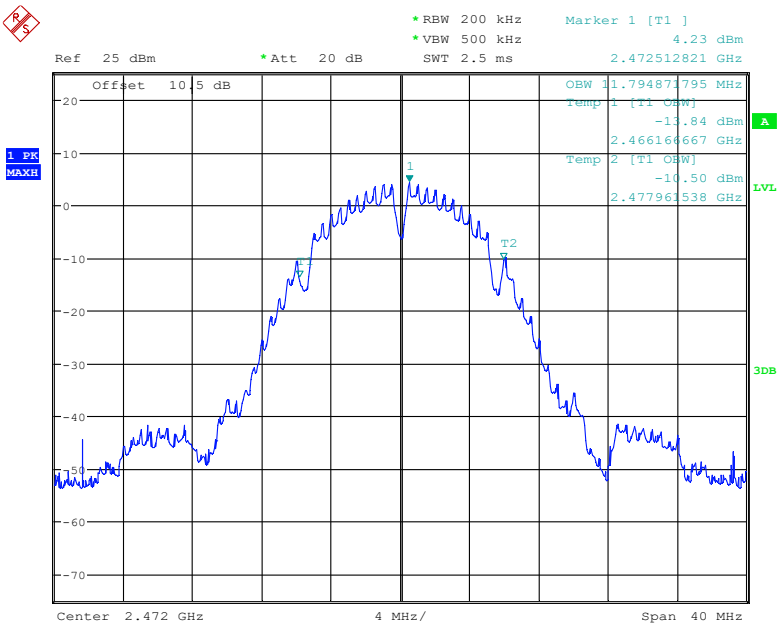
Date: 15.DEC.2021 21:16:58

99% Emission Bandwidth, 802.11b Middle Channel



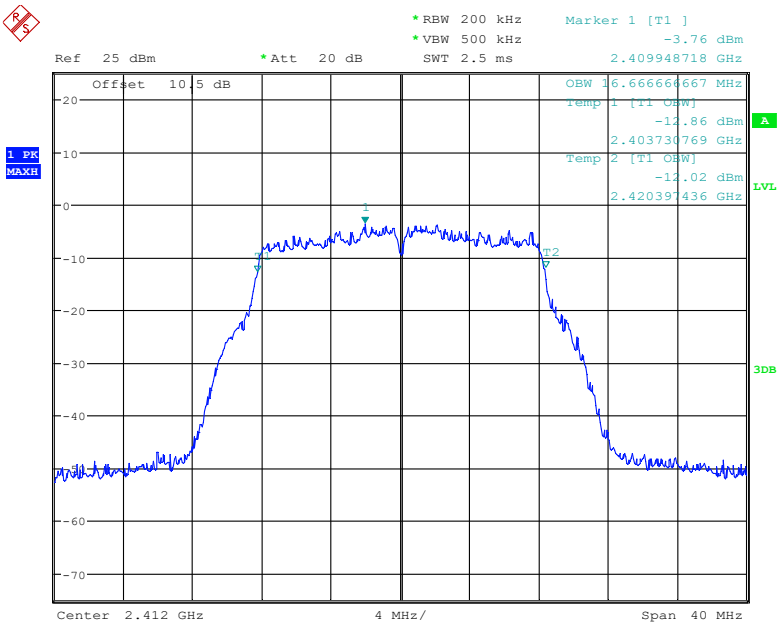
Date: 15.DEC.2021 21:15:26

99% Emission Bandwidth, 802.11b High Channel



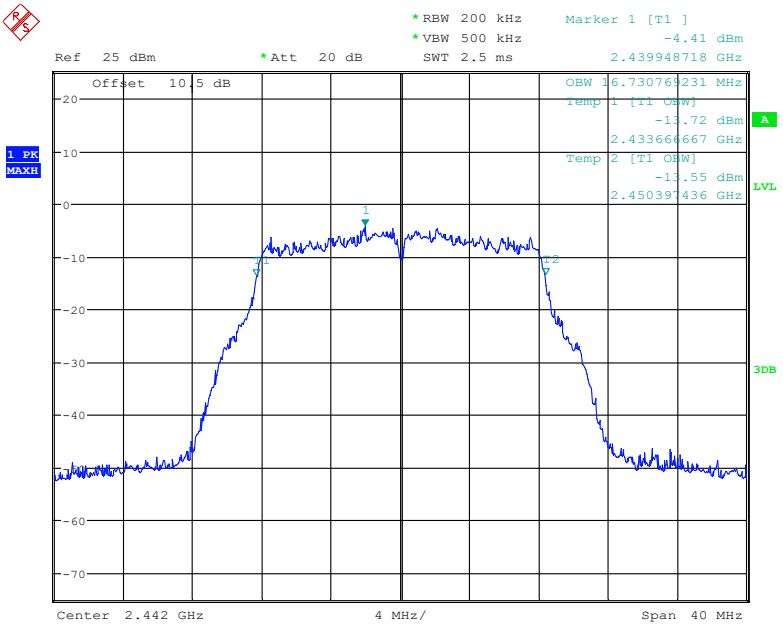
Date: 15.DEC.2021 21:17:43

99% Emission Bandwidth, 802.11g Low Channel



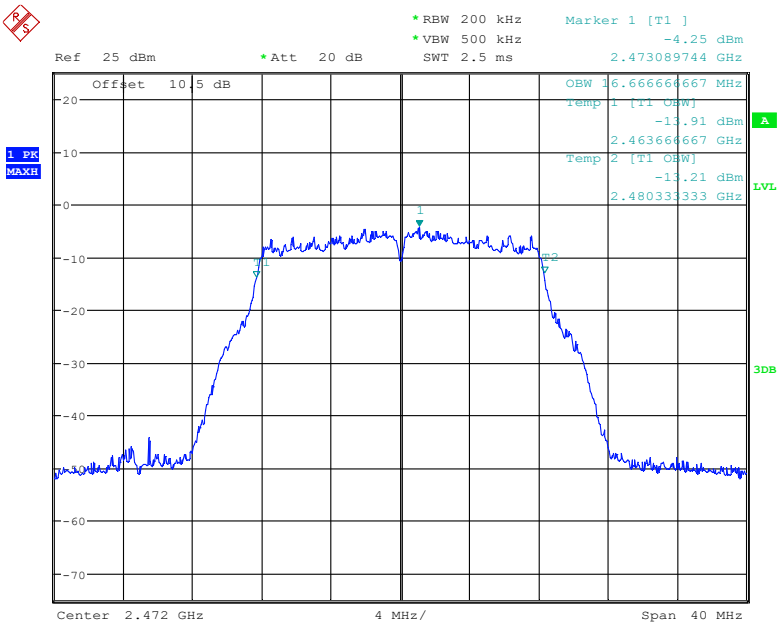
Date: 15.DEC.2021 21:13:17

99% Emission Bandwidth, 802.11g Middle Channel



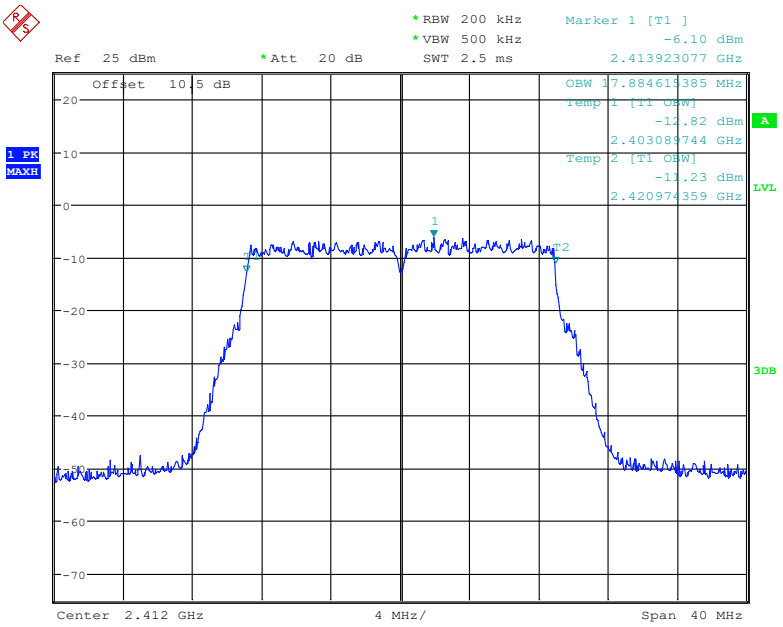
Date: 15.DEC.2021 21:12:18

99% Emission Bandwidth, 802.11g High Channel



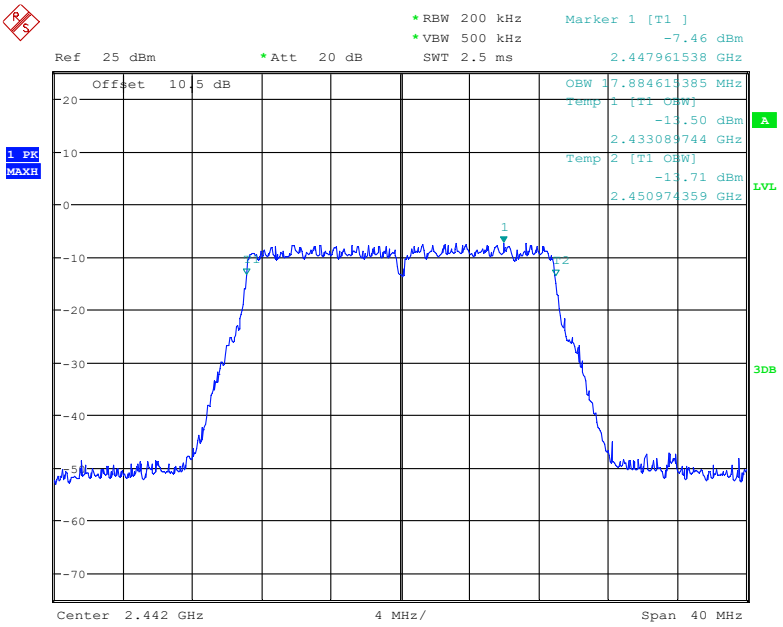
Date: 15.DEC.2021 21:11:13

99% Emission Bandwidth, 802.11n-HT20 Low Channel



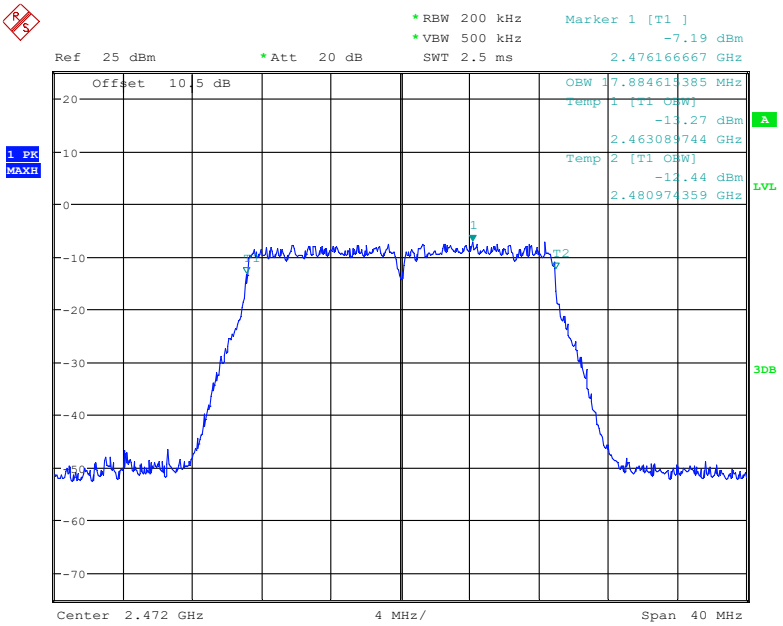
Date: 15.DEC.2021 21:09:22

99% Emission Bandwidth, 802.11n-HT20 Middle Channel



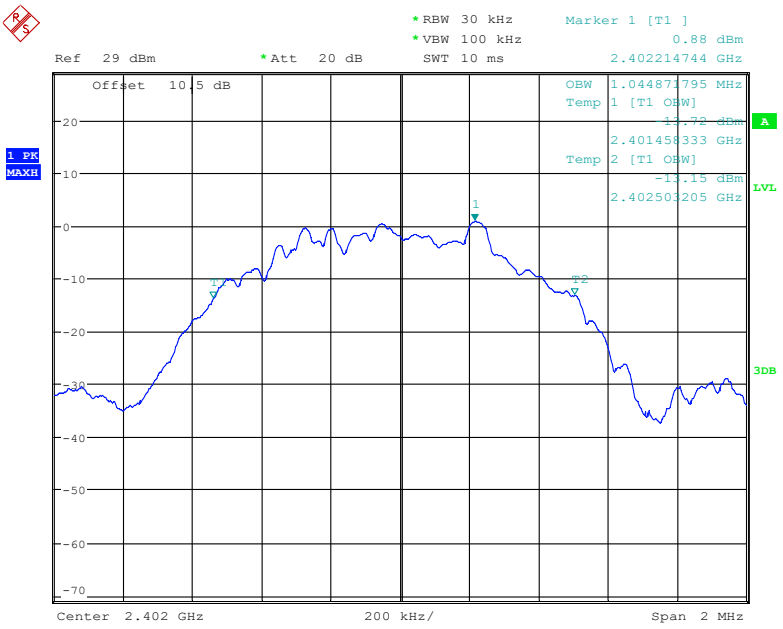
Date: 15.DEC.2021 21:08:37

99% Emission Bandwidth, 802.11n-HT20 High Channel



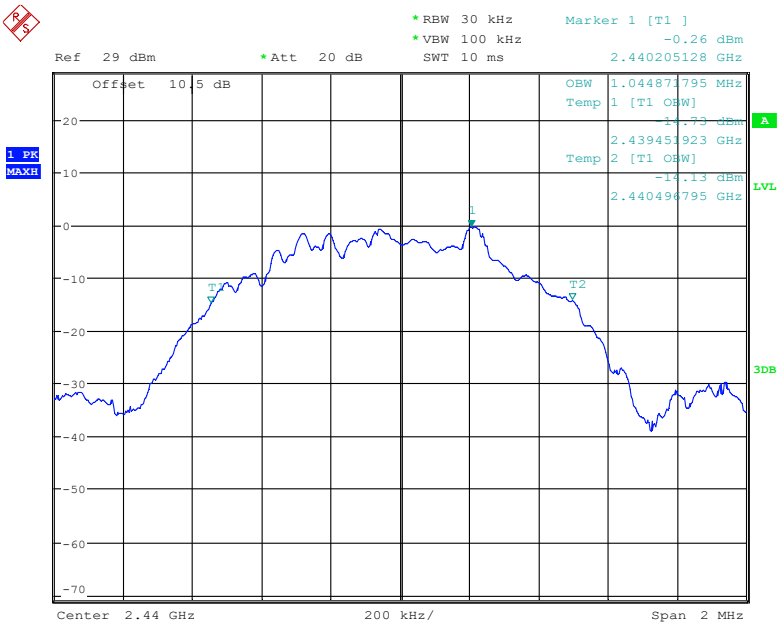
Date: 15.DEC.2021 21:07:01

99% Emission Bandwidth, BLE-1M Low Channel



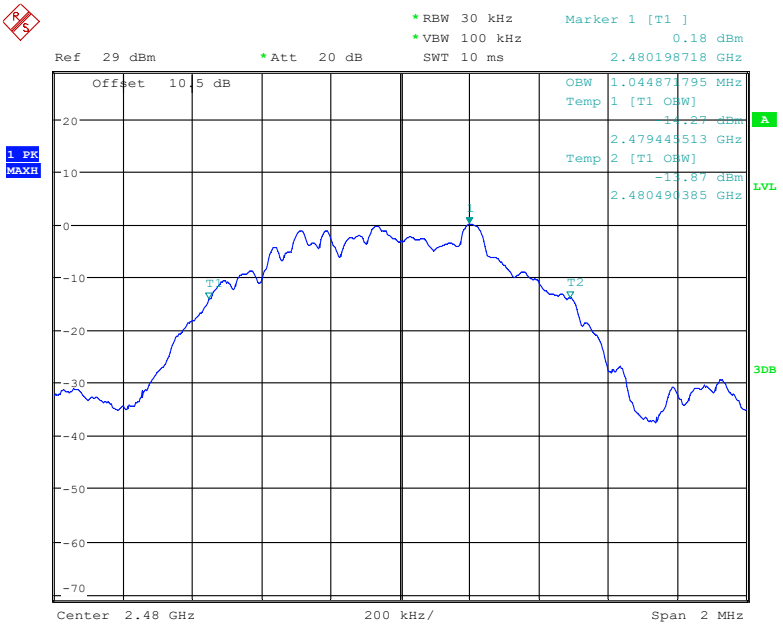
Date: 14.DEC.2021 23:55:22

99% Emission Bandwidth, BLE-1M Middle Channel



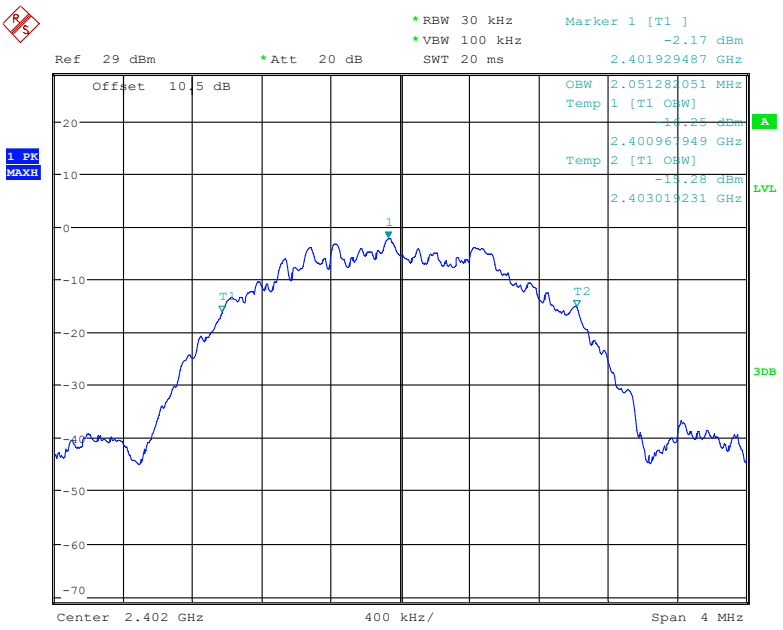
Date: 14.DEC.2021 23:54:27

99% Emission Bandwidth, BLE-1M High Channel



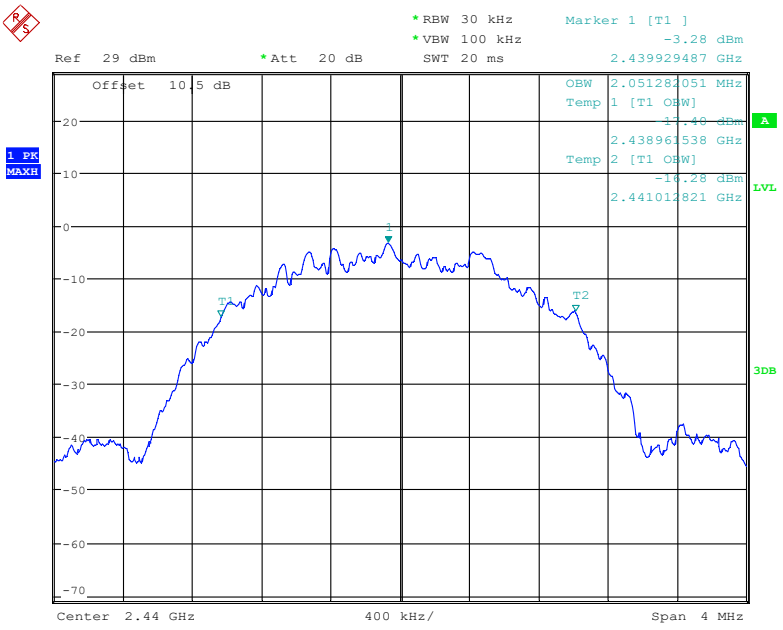
Date: 14.DEC.2021 23:53:25

99% Emission Bandwidth, BLE-2M Low Channel



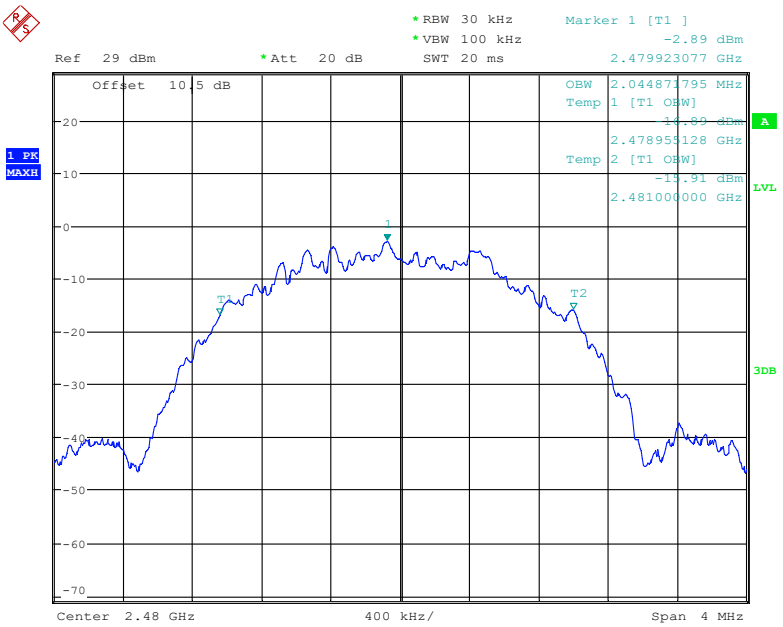
Date: 14.DEC.2021 23:56:52

99% Emission Bandwidth, BLE-2M Middle Channel



Date: 14.DEC.2021 23:59:35

99% Emission Bandwidth, BLE-2M High Channel



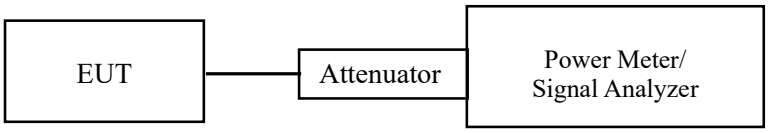
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

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

Test Procedure

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:	28.5~28.7 ℃
Relative Humidity:	46~48 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu from 2021-12-14 to 2021-12-15.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Max Conducted Average Output Power (dBm)	Limit (dBm)
802.11b mode				
Low	2412	15.40	12.71	30
Middle	2442	14.89	12.14	30
High	2472	14.95	12.23	30
802.11g mode				
Low	2412	13.76	8.00	30
Middle	2442	13.11	7.21	30
High	2472	12.85	7.10	30
802.11n HT20 mode				
Low	2412	12.80	6.75	30
Middle	2442	11.48	5.92	30
High	2472	11.65	6.03	30
BLE 1M				
Low	2402	5.84	/	30
Middle	2440	4.56	/	30
High	2480	4.90	/	30
BLE 2M				
Low	2402	5.37	/	30
Middle	2440	4.30	/	30
High	2480	4.75	/	30

Note: the duty cycle factor has added into average output power.

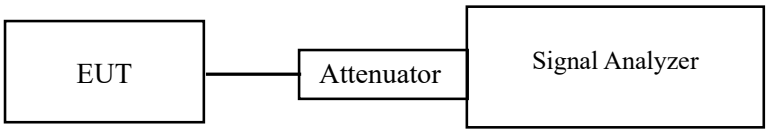
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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:	28.7 ℃
Relative Humidity:	46 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-12-15.

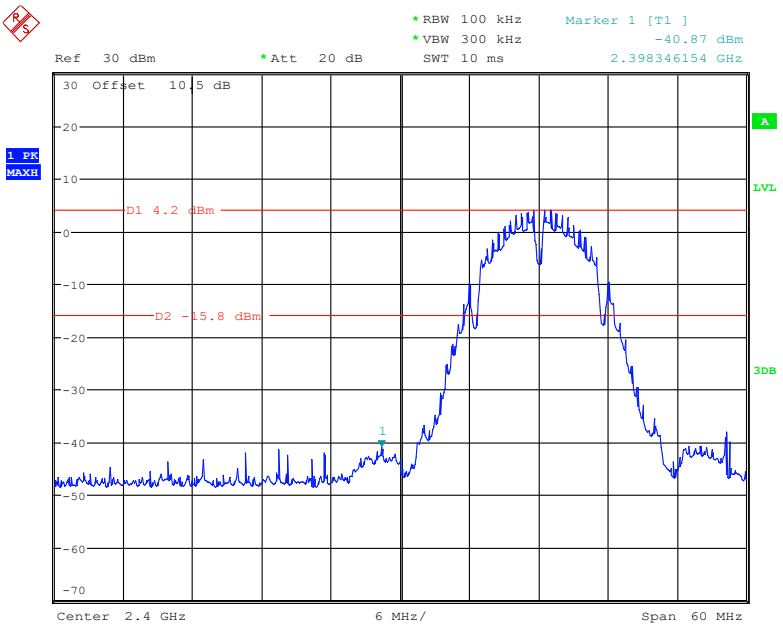
EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

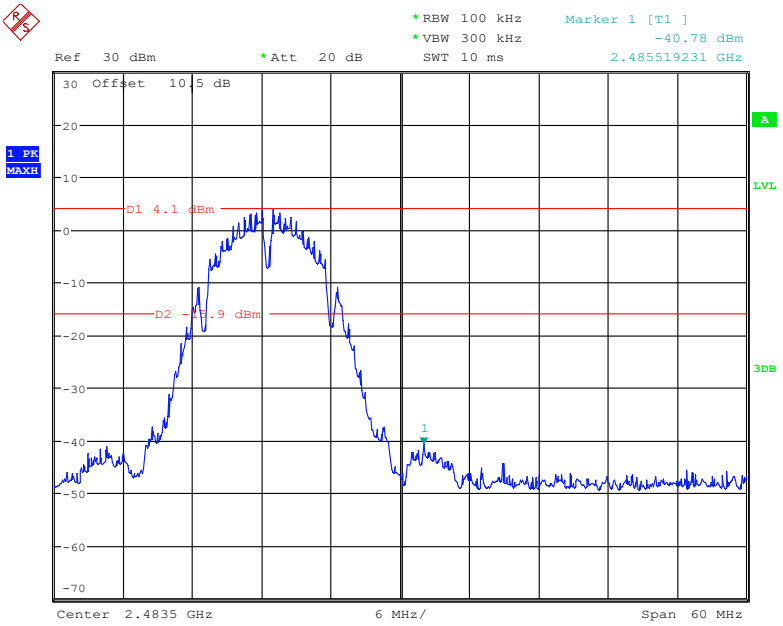
Please refer to the following plots.

802.11b: Band Edge, Left Side



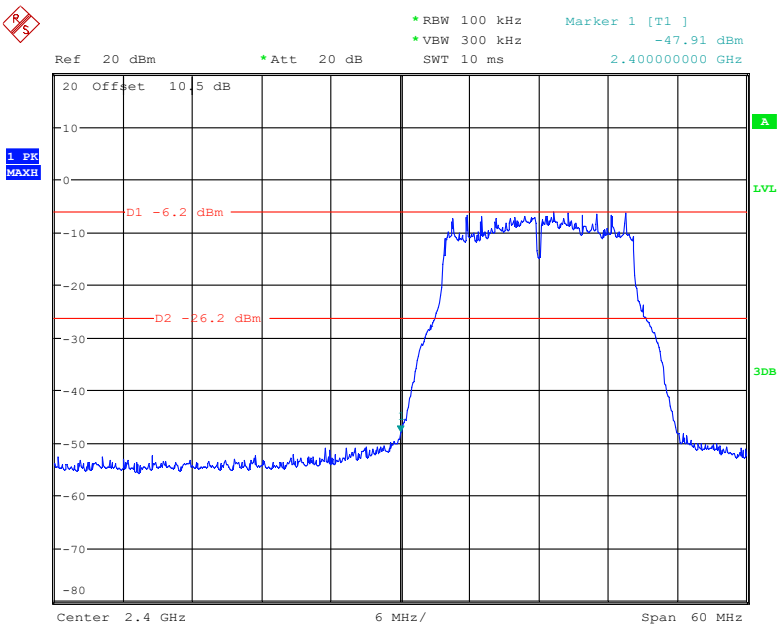
Date: 15.DEC.2021 22:03:52

802.11b: Band Edge, Right Side



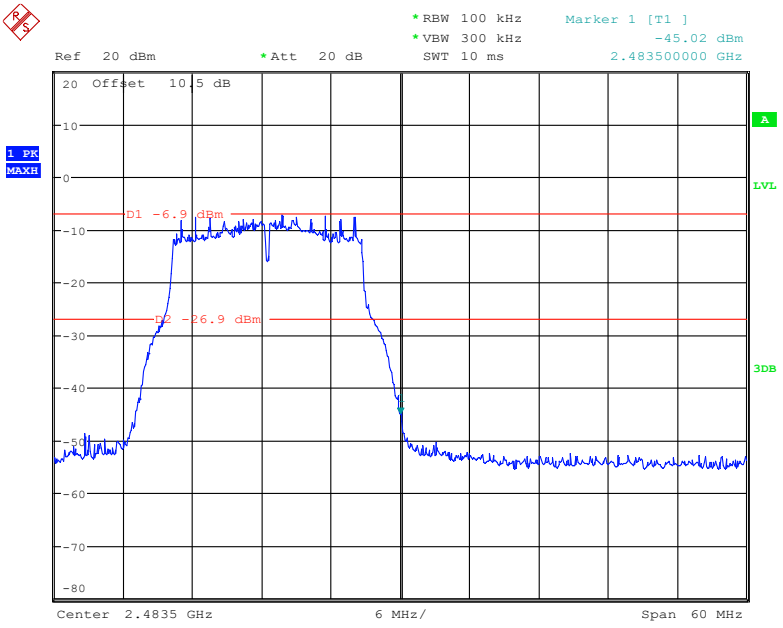
Date: 15.DEC.2021 22:06:44

802.11g: Band Edge, Left Side



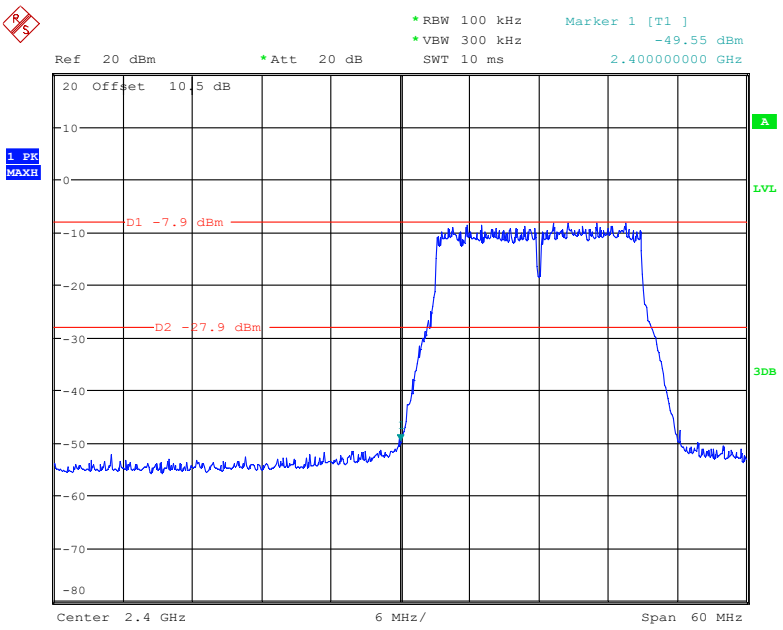
Date: 15.DEC.2021 22:09:33

802.11g: Band Edge, Right Side



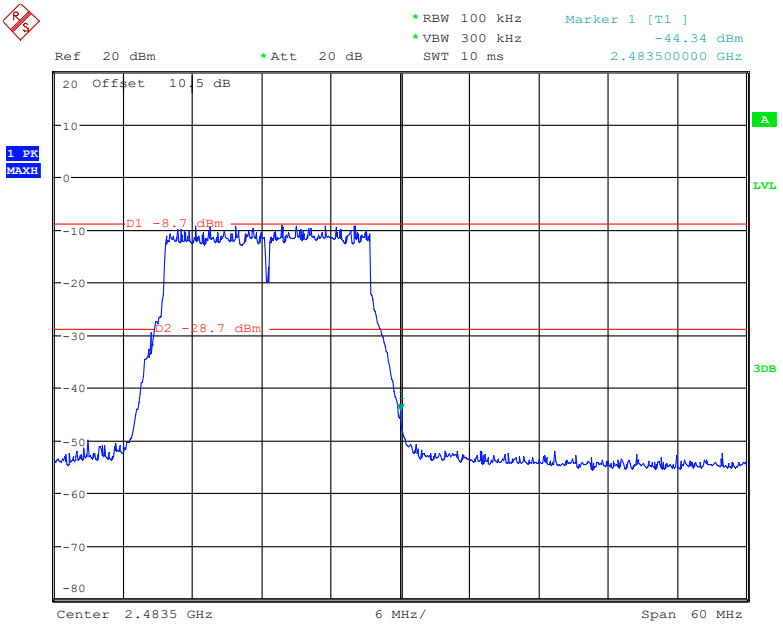
Date: 15.DEC.2021 22:08:18

802.11n-HT20: Band Edge, Left Side



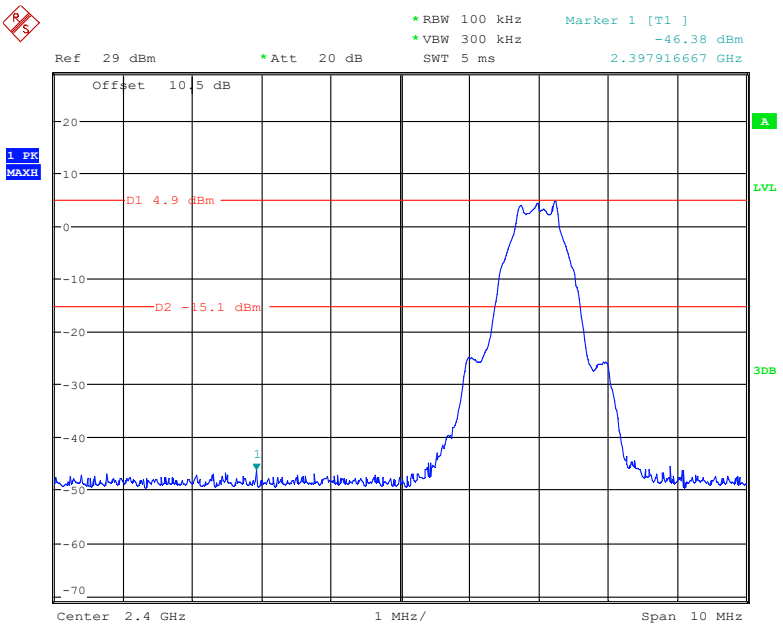
Date: 15.DEC.2021 22:10:38

802.11n-HT20: Band Edge, Right Side



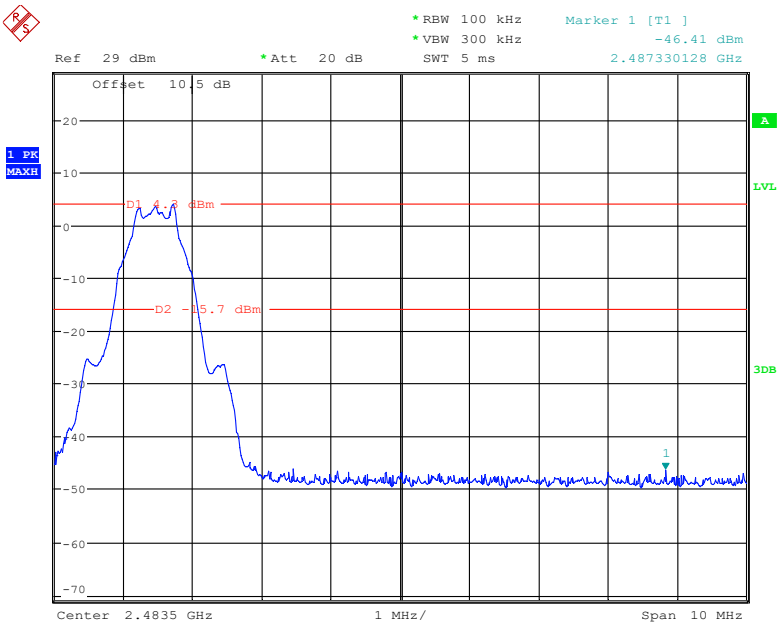
Date: 15.DEC.2021 22:11:50

BLE 1M: Band Edge, Left Side



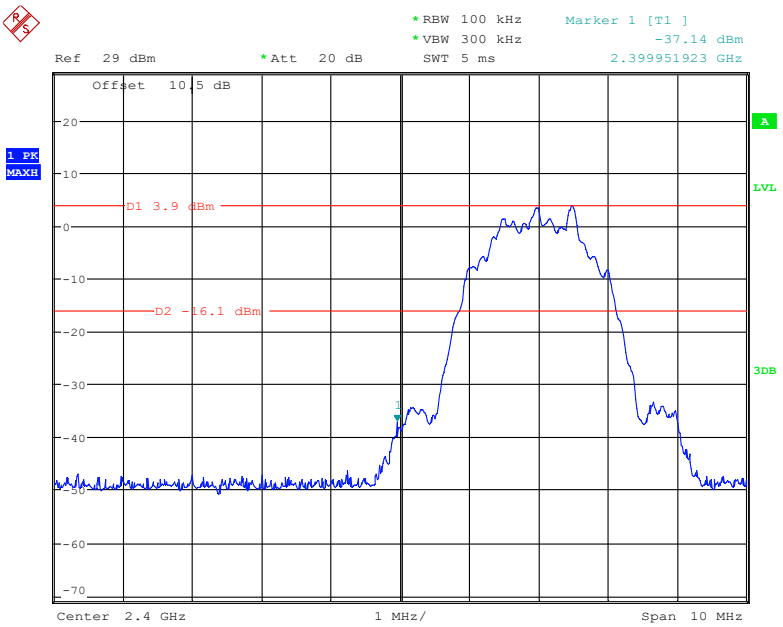
Date: 15.DEC.2021 00:06:13

BLE 1M: Band Edge, Right Side



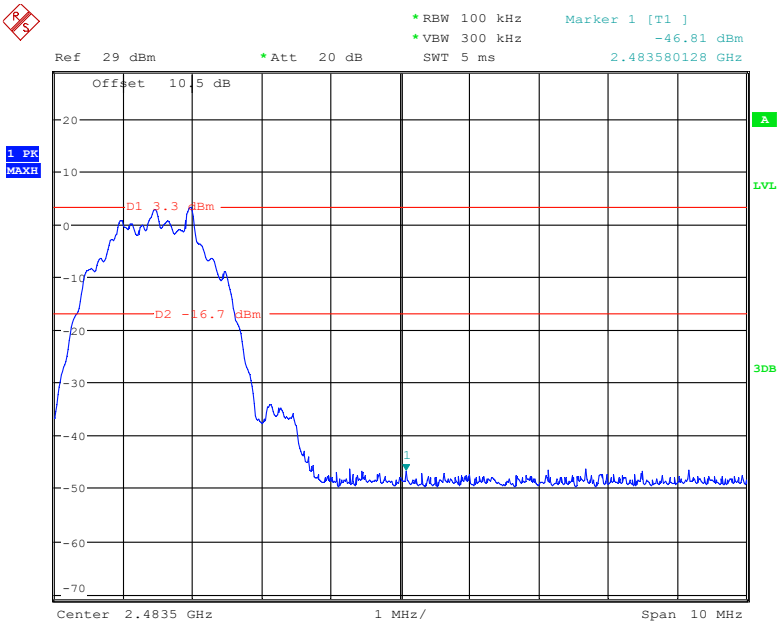
Date: 15.DEC.2021 00:07:37

BLE 2M: Band Edge, Left Side



Date: 15.DEC.2021 00:09:49

BLE 2M: Band Edge, Right Side



Date: 15.DEC.2021 00:08:41

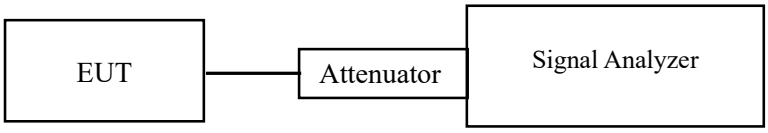
FCC §15.247(e) - POWER SPECTRAL DENSITY

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

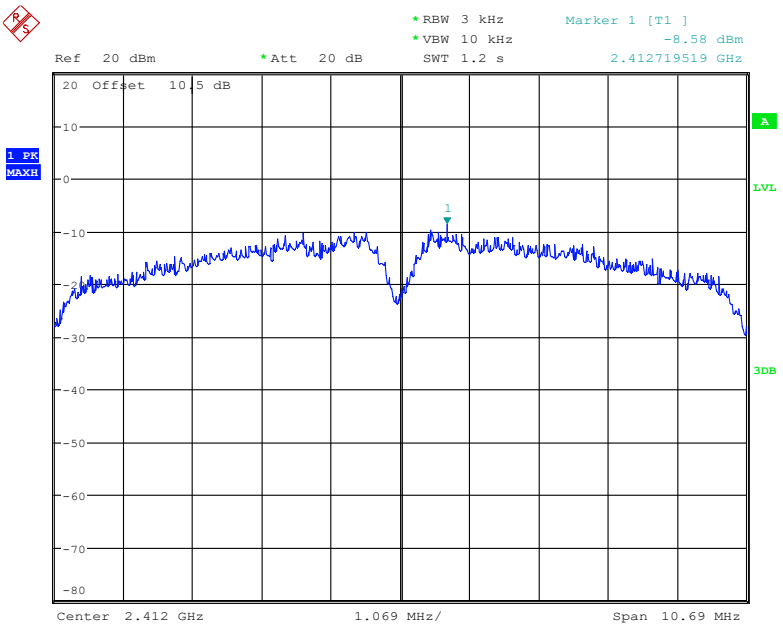
Temperature:	28.7 ℃
Relative Humidity:	46 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-12-15.

EUT operation mode: Transmitting

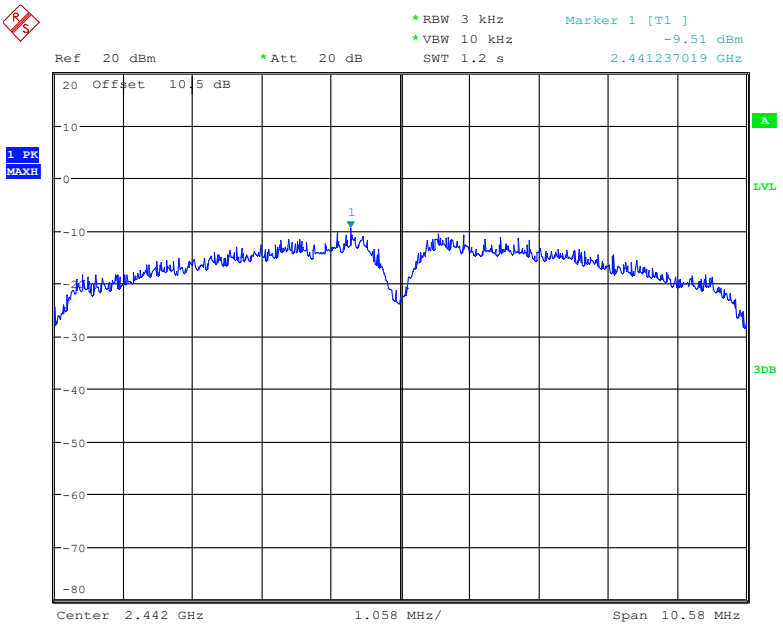
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode			
Low	2412	-8.58	≤8
Middle	2442	-9.51	≤8
High	2472	-9.57	≤8
802.11g mode			
Low	2412	-18.64	≤8
Middle	2442	-19.53	≤8
High	2472	-19.47	≤8
802.11n-HT20 mode			
Low	2412	-22.40	≤8
Middle	2442	-23.45	≤8
High	2472	-23.32	≤8
BLE 1M			
Low	2402	-12.04	≤8
Middle	2440	-13.08	≤8
High	2480	-12.58	≤8
BLE 2M			
Low	2402	-15.04	≤8
Middle	2440	-16.33	≤8
High	2480	-15.78	≤8

Power Spectral Density, 802.11b Low Channel



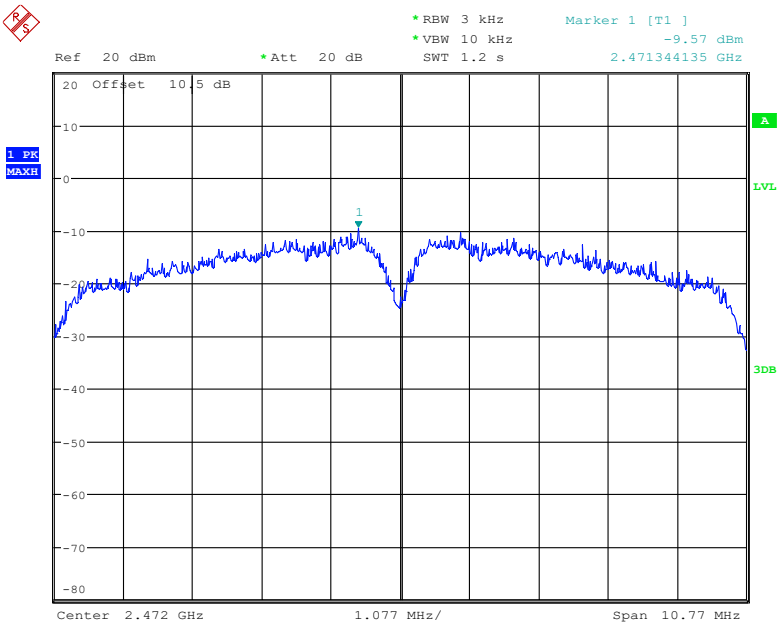
Date: 15.DEC.2021 22:22:08

Power Spectral Density, 802.11b Middle Channel



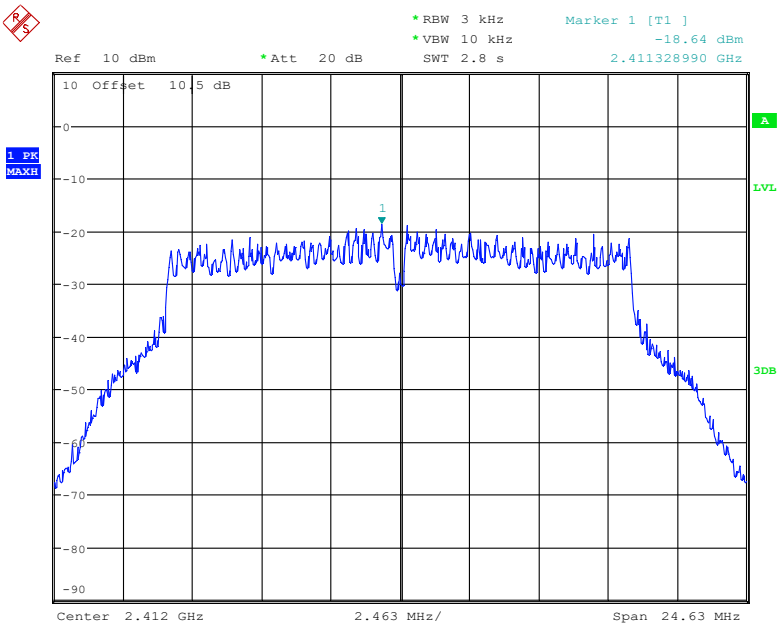
Date: 15.DEC.2021 22:23:35

Power Spectral Density, 802.11b High Channel



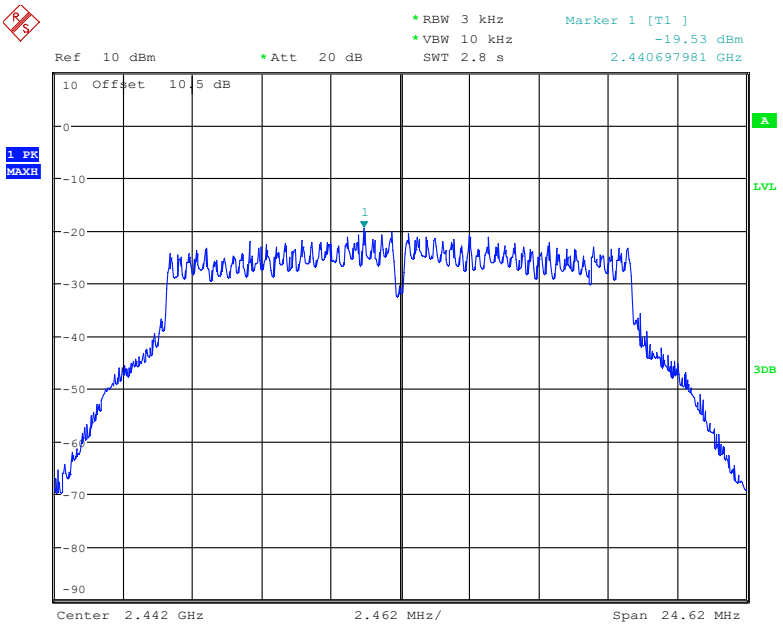
Date: 15.DEC.2021 22:25:11

Power Spectral Density, 802.11g Low Channel



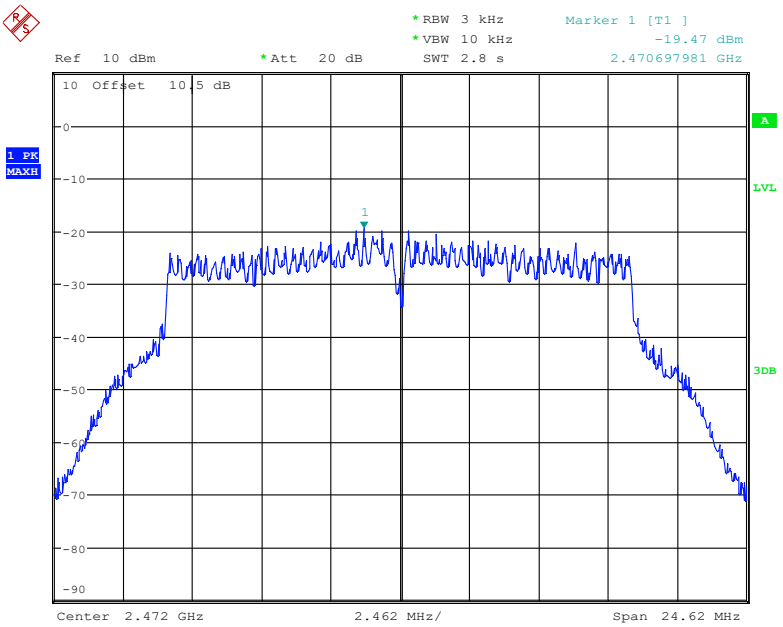
Date: 15.DEC.2021 22:18:54

Power Spectral Density, 802.11g Middle Channel



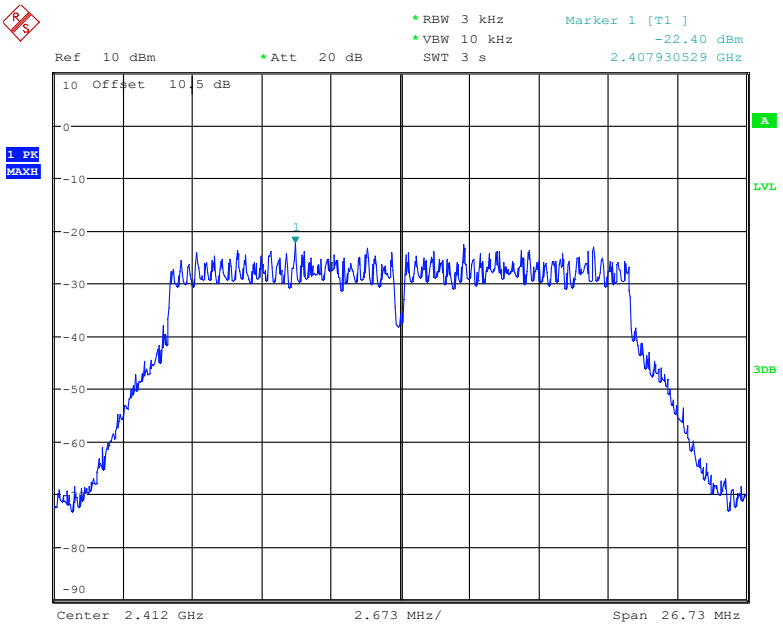
Date: 15.DEC.2021 22:19:45

Power Spectral Density, 802.11g High Channel



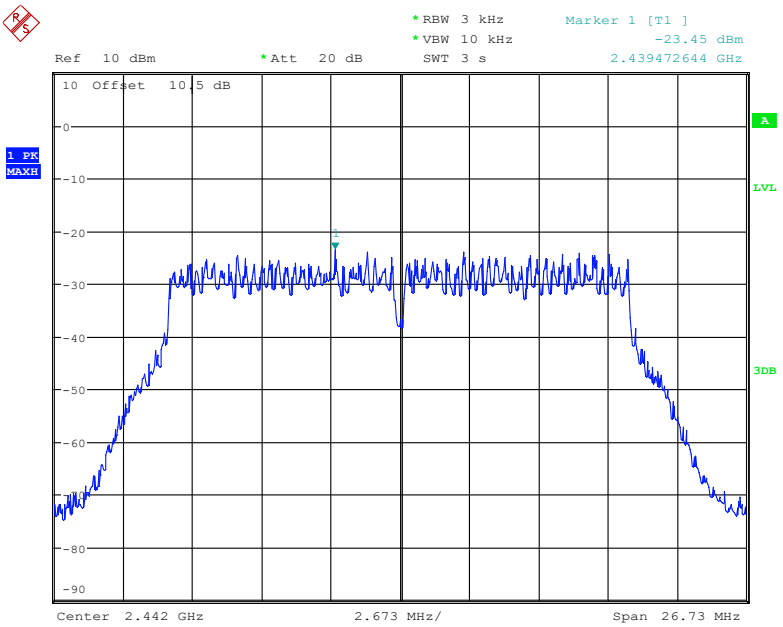
Date: 15.DEC.2021 22:20:35

Power Spectral Density, 802.11n-HT20 Low Channel



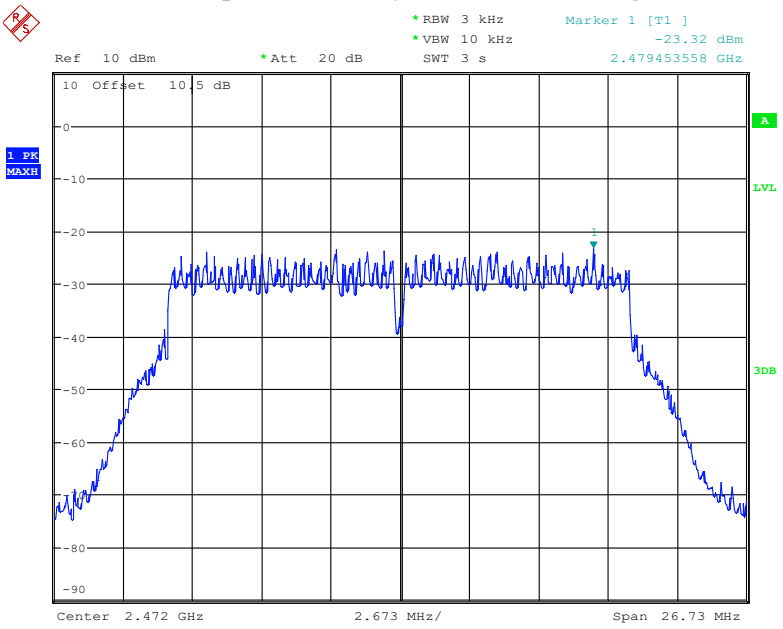
Date: 15.DEC.2021 22:17:51

Power Spectral Density, 802.11n-HT20 Middle Channel



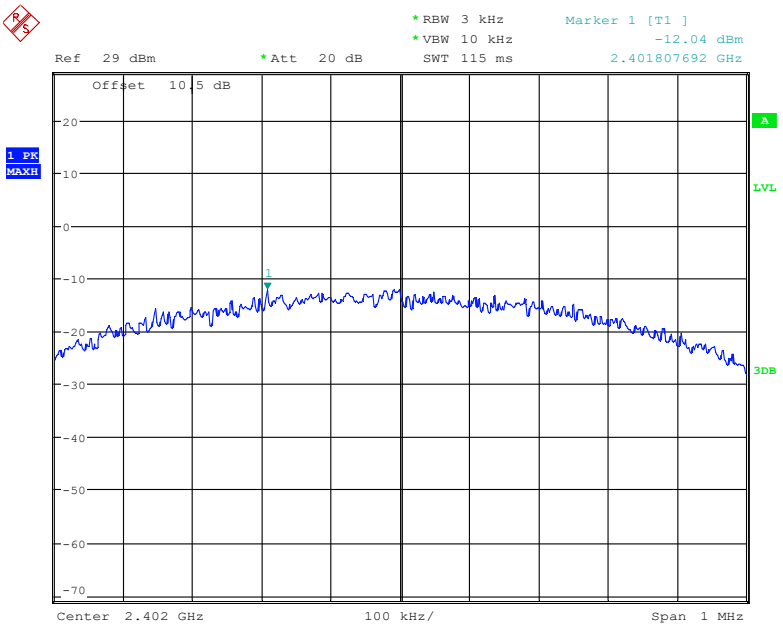
Date: 15.DEC.2021 22:16:54

Power Spectral Density, 802.11n-HT20 High Channel



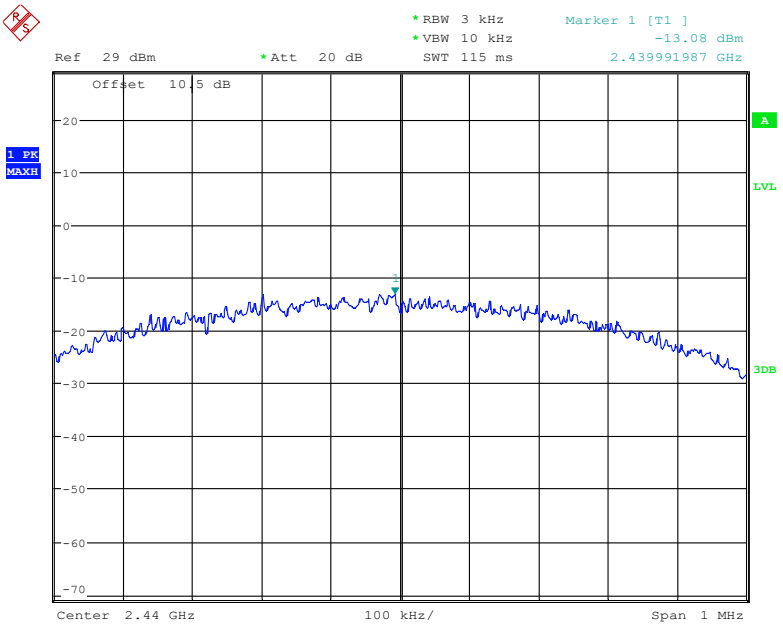
Date: 15.DEC.2021 22:15:54

Power Spectral Density, BLE 1M Low Channel



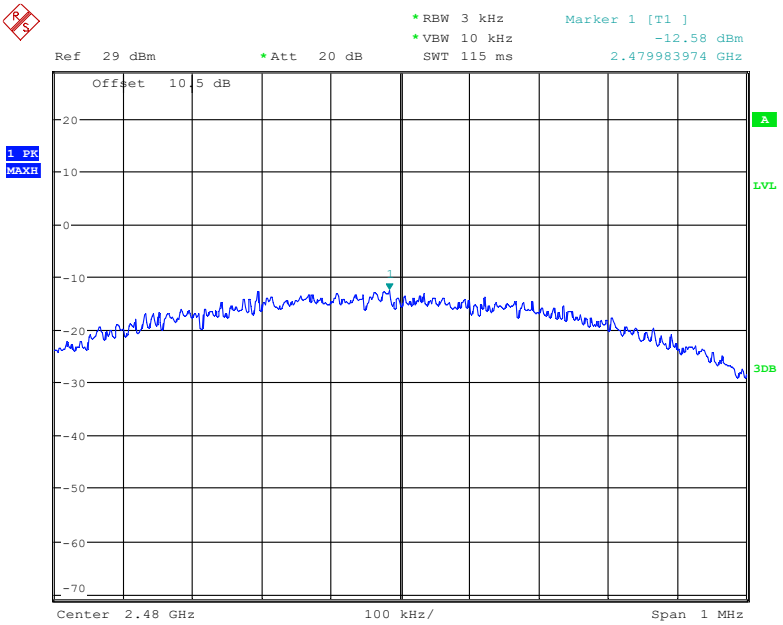
Date: 15.DEC.2021 00:17:06

Power Spectral Density, BLE 1M Middle Channel



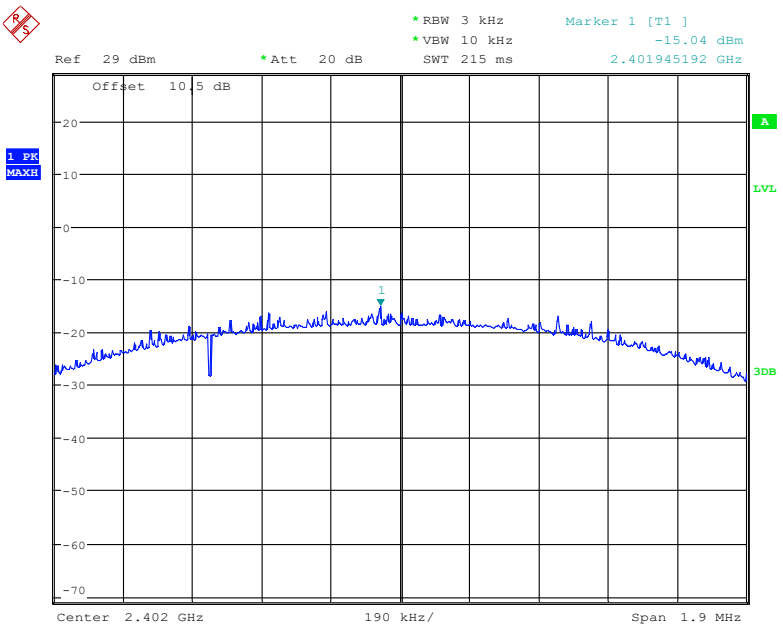
Date: 15.DEC.2021 00:16:24

Power Spectral Density, BLE 1M High Channel



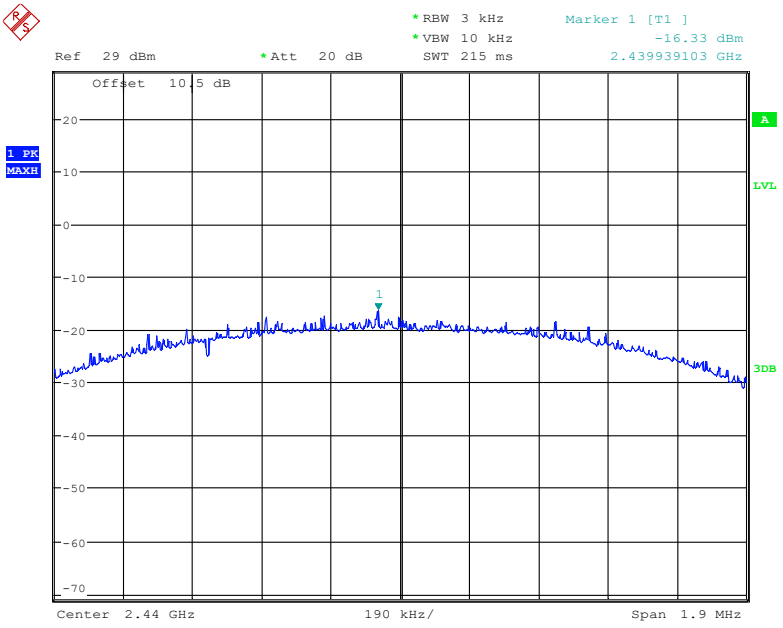
Date: 15.DEC.2021 00:15:47

Power Spectral Density, BLE 2M Low Channel



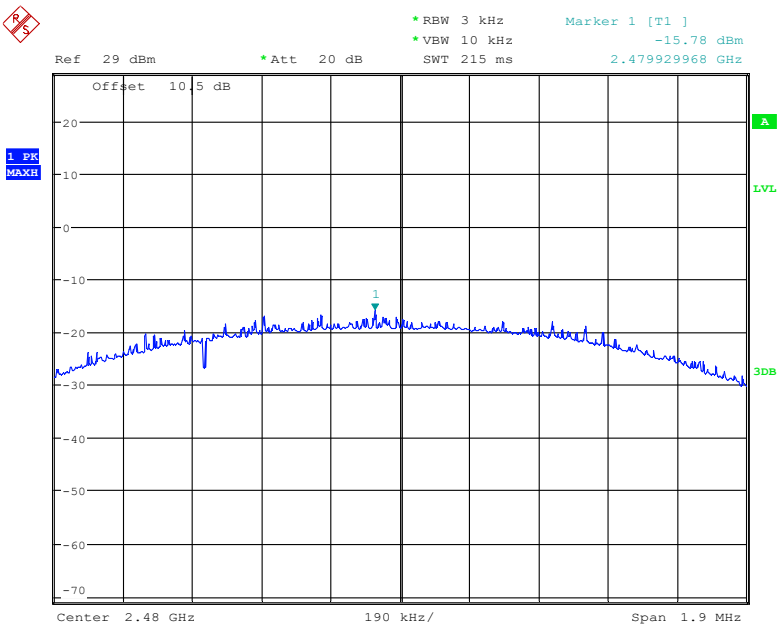
Date: 15.DEC.2021 00:13:51

Power Spectral Density, BLE 2M Middle Channel



Date: 15.DEC.2021 00:14:32

Power Spectral Density, BLE 2M High Channel



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