TEST REPORT

Reference No.	:	WTD23D03043940W001
FCC ID	:	QCV-BTSU1
Applicant.....	:	Budderfly INC
Address.....	:	2 Trap Falls Rd. Ste. 310, Shelton, CT 06484, USA
Manufacturer	:	BB CONTROLS LIMITED
Address.....	:	Room 101, Building 4-4, Number 18, Jingxing Street Nanshao, Changping District, Beijing, China
Product.....	:	Budderfly Thermostat
Model(s).	:	BTS-U1
Standards.....	:	FCC 47CFR Part 15.247
Date of Receipt sample	:	2023-03-09
Date of Test	:	2023-03-09 to 2023-03-31
Date of Issue.....	:	2023-04-20
Test Result.....	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

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3 Revision History

Test Report No.	Date of Receipt Sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTD23D03043940W001	2023-03-09	2023-03-09 to 2023-03-31	2023-04-20	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	Budderfly Thermostat
Model(s):	BTS-U1
Model Description:	N/A
Wi-Fi Specification:	2.4G-802.11b/g/n HT20/n HT40
Bluetooth Version:	V4.2
Hardware Version:	V1.0
Software Version:	V1.14
Remark:	The BTS-U1 model comes in two different colors of enclosure, white and black. The structure, circuit and PCB board all are same.Please refer to appendix for more details.

4.2 Details of E.U.T.

Operation Frequency:	2.4G Wi-Fi: 802.11b/g/n HT20: 2412~2462MHz 802.11n HT40: 2422~2452MHz BLE: 2402-2480MHz
Max. RF output power:	2.4G Wi-Fi: 21.04dBm BLE: 8.793dBm
Type of Modulation:	2.4G Wi-Fi: 802.11b: DBPSK, DQPSK, CCK 802.11g: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11n: OFDM (BPSK, QPSK, 16QAM, 64QAM) BLE: GFSK
Antenna installation:	PCB Antenna
Antenna Gain:	3.71dBi
Ratings:	24VAC, 1A

4.3 Channel List

2.4G Wi-Fi

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2412	2	2417	3	2422	4	2427
5	2432	6	2437	7	2442	8	2447
9	2452	10	2457	11	2462	12	-

BLE

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	1	2404	2	2406	3	2408
4	2410	5	2412	6	2414	7	2416
8	2418	9	2420	10	2422	11	2424
12	2426	13	2428	14	2430	15	2432
16	2434	17	2436	18	2438	19	2440
20	2442	21	2444	22	2446	23	2448
24	2450	25	2452	26	2454	27	2456
28	2458	29	2460	30	2462	31	2464
32	2466	33	2468	34	2470	35	2472
36	2474	37	2476	38	2478	39	2480

4.4 Test Facility

The test facility has a test site registered with the following organizations:

ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

Waltek Testing Group Co., Ltd. Has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration number 7760A, October 15, 2016.

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.

Waltek Testing Group Co., Ltd. EMC Laboratory `has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration number 523476, September 10, 2019.

4.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test Lab: N/A

Lab address: N/A

Test items: N/A

4.6 Abnormalities from Standard Conditions

None.

4.7 Test Mode

Table 1 Tests Carried Out Under FCC part 15.247

Test Items	Mode	Data Rate	Channel	TX/RX
Maximum Peak Output Power	802.11b	1 Mbps	1/6/11	TX
	802.11g	6 Mbps	1/6/11	TX
	802.11n HT20	MCS0	1/6/11	TX
	802.11n HT40	MCS0	3/6/9	TX
Power Spectral Density	802.11b	1 Mbps	1/6/11	TX
	802.11g	6 Mbps	1/6/11	TX
	802.11n HT20	MCS0	1/6/11	TX
	802.11n HT40	MCS0	3/6/9	TX
6dB Bandwidth	802.11b	1 Mbps	1/6/11	TX
	802.11g	6 Mbps	1/6/11	TX
	802.11n HT20	MCS0	1/6/11	TX
	802.11n HT40	MCS0	3/6/9	TX
Band Edge	802.11b	1 Mbps	1/6/11	TX
	802.11g	6 Mbps	1/6/11	TX
	802.11n HT20	MCS0	1/6/11	TX
	802.11n HT40	MCS0	3/6/9	TX
Transmitter Spurious Emissions	802.11b	1 Mbps	1/6/11	TX
	802.11g	6 Mbps	1/6/11	TX
	802.11n HT20	MCS0	1/6/11	TX
	802.11n HT40	MCS0	3/6/9	TX

Table 2 Tests Carried Out Under FCC part 15.247

Test Items	Mode	Data Rate	Channel	TX/RX
Maximum Peak Output Power	BT BLE	1 Mbps	0/19/39	TX
Power Spectral Density	BT BLE	1 Mbps	0/19/39	TX
6dB Bandwidth	BT BLE	1 Mbps	0/19/39	TX
Band Edge	BT BLE	1 Mbps	0/19/39	TX
Transmitter Spurious Emissions	BT BLE	1 Mbps	0/19/39	TX

Note: Parameters set by test software during channel & power tests, the software provided by the customer was used to set the operating channels as well as the output power level. The RF output power set is the power expected by the manufacturer and is going to be fixed on the firmware of the final product.

5 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.247(d) 15.205(a) 15.209(a)	PASS
Conducted Spurious Emissions	15.247(d)	PASS
Conducted Emissions	15.207(a)	N/A
6dB Bandwidth	15.247(a)(2)	PASS
Maximum Peak Output Power	15.247(b)(3),(4)	PASS
Power Spectral Density	15.247(e)	PASS
Band Edge	15.247(d)	PASS
Antenna Requirement	15.203	PASS
RF Exposure	1.1307(b)(1)	PASS
Note: PASS=Compliance; NC=Not Compliance; NT=Not Tested; N/A=Not Applicable.		

6 Equipment Used during Test

6.1 Equipments List

3m Semi-anechoic Chamber for Radiation Emissions Test site 1#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1	Spectrum Analyzer	R&S	FSP30	100091	2022-04-28	2023-04-27
2	Amplifier	Agilent	8447D	2944A10178	2022-08-01	2023-07-31
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2022-08-07	2023-08-06
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2022-04-28	2023-04-27
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2022-04-28	2023-04-27
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2022-07-29	2023-07-28
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2022-08-08	2023-08-07
8	Coaxial Cable (above 1GHz)	ZT26-NJ-NJ-8M/FA	1GHz-18GHz	NA	2022-04-28	2023-04-27
3m Semi-anechoic Chamber for Radiation Emissions Test site 2#						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No**	**Last Calibration Date**	**Calibration Due Date**
1	Test Receiver	R&S	ESCI	101296	2022-04-28	2023-04-27
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2022-10-30	2023-10-29
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2022-05-02	2023-05-01
4	Amplifier	ANRITSU	MH648A	M43381	2022-04-28	2023-04-27
5	Cable	HUBER+SUHNER	CBL2	525178	2022-04-28	2023-04-27
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	Spectrum Analyzer	R&S	FSP40	100501	2022-08-01	2023-07-31
2.	EXA Signal Analyzer	Malaysia Keysight	N9010A	MY50520207	2022-04-28	2023-04-27

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
/	/	/	/

6.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	± 3.64 dB(AC mains 150KHz~30MHz)
Radiated Spurious Emissions	± 5.08 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)
Radio Frequency	± 1 x 10^{-7}Hz
RF Power	± 0.42 dB
RF Power Density	± 0.7dB
Conducted Spurious Emissions	± 2.76 dB (9kHz~26500MHz)
Confidence interval：95%. Confidence factor:k=2	

7 Radiated Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.209 & 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019; ANSI C63.10:2013

Test Result: PASS

Measurement Distance: 3m

Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

7.1 EUT Operation

Operating Environment:

Temperature: 23.5 °C

Humidity: 52.1 % RH

Atmospheric Pressure: 101.2kPa

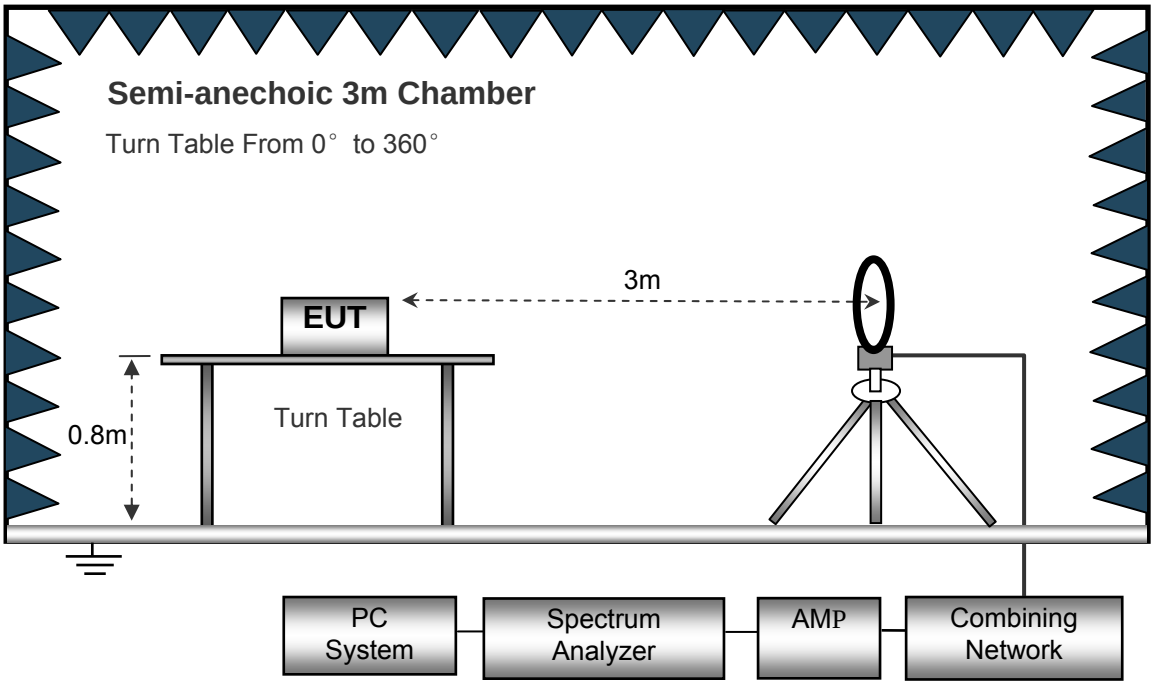
EUT Operation:

The test was performed in TX transmitting mode, the test data were shown in the report.

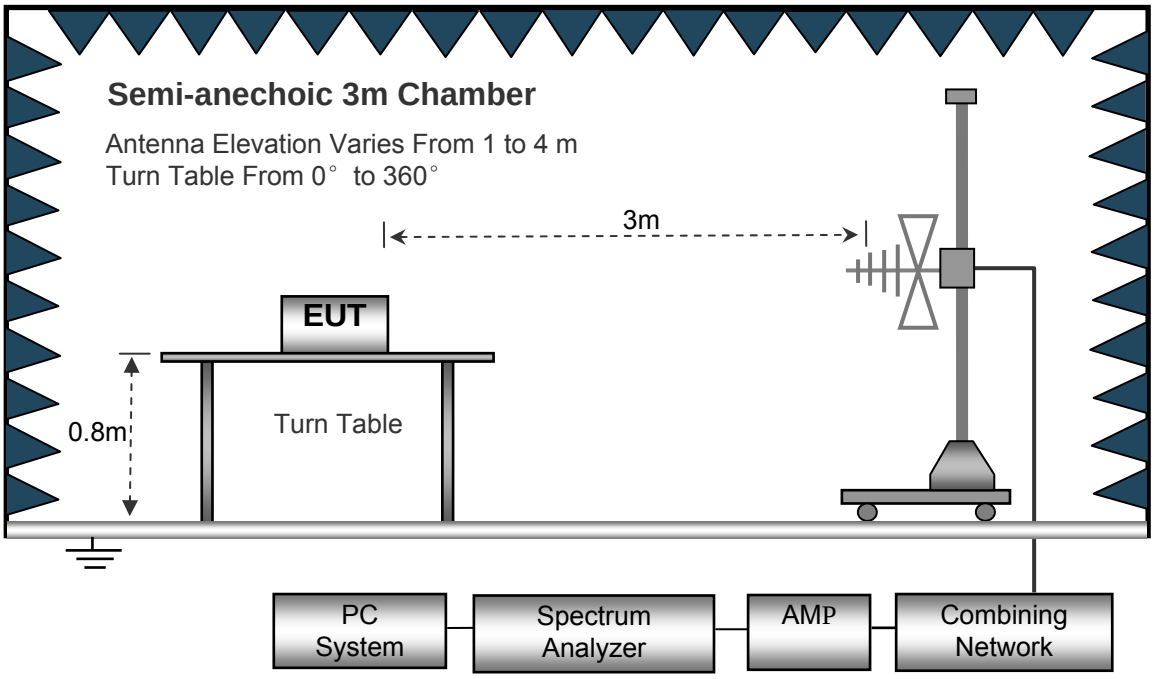
7.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10.

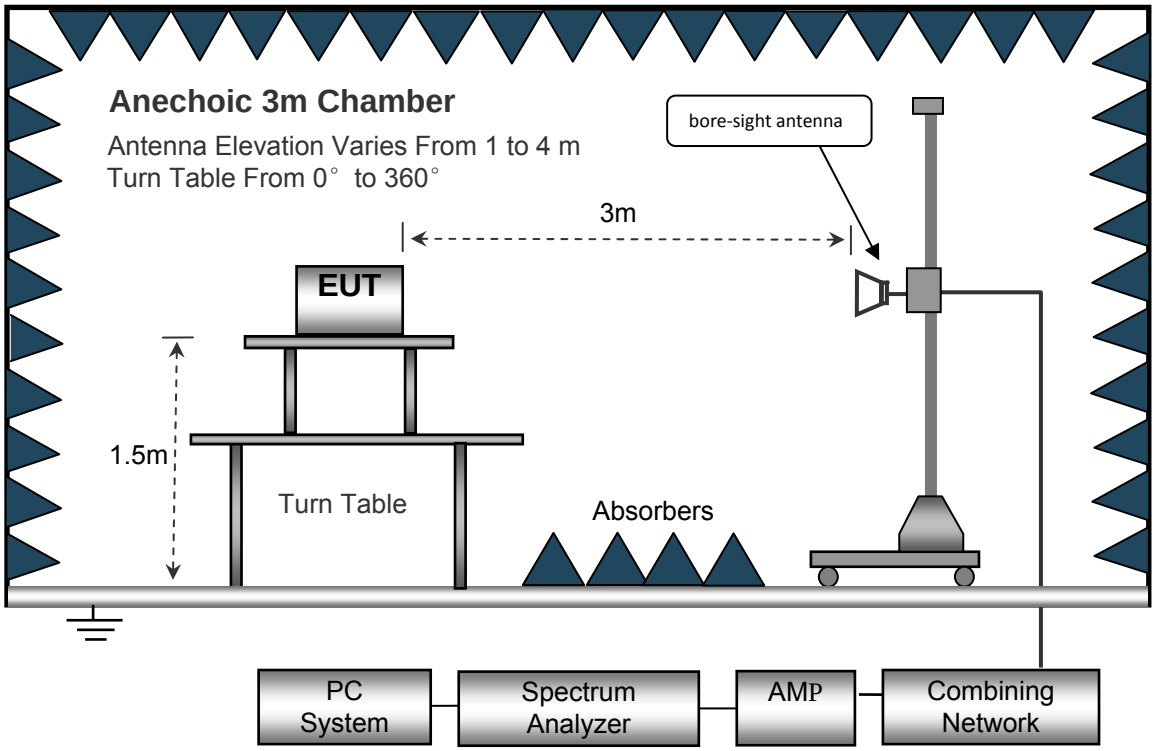
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.



7.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz
Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 100kHz
Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 3MHz
Detector ..... Ave.
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 10Hz

7.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are performed in X,Y and Z axis positioning(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand),the worst condition was tested putting the eut in Z axis,so the worst data were shown as follow.
8. A 2.4GHz high –pass filter is used druing radiated emissions above 1GHz measurement.

7.5 Corrected Amplitude & Margin Calculation

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

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - 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 maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

7.6 Summary of Test Results

Wi-Fi:
Test Frequency: 9kHz~30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 8GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11b: Low Channel 2412MHz									
315.08	46.81	QP	95	1.8	H	-11.95	34.86	46.00	-11.14
315.08	49.08	QP	5	1.3	V	-11.95	37.13	46.00	-8.87
4824.00	53.76	PK	205	1.4	V	-1.06	52.70	74.00	-21.30
4824.00	42.20	Ave	205	1.4	V	-1.06	41.14	54.00	-12.86
7236.00	46.13	PK	258	1.4	H	1.33	47.46	74.00	-26.54
7236.00	36.88	Ave	258	1.4	H	1.33	38.21	54.00	-15.79
2340.38	48.74	PK	136	1.9	V	-13.19	35.55	74.00	-38.45
2340.38	39.26	Ave	136	1.9	V	-13.19	26.07	54.00	-27.93
2361.76	43.76	PK	192	1.1	H	-13.14	30.62	74.00	-43.38
2361.76	36.45	Ave	192	1.1	H	-13.14	23.31	54.00	-30.69
2493.56	44.19	PK	245	2.0	V	-13.08	31.11	74.00	-42.89
2493.56	38.84	Ave	245	2.0	V	-13.08	25.76	54.00	-28.24

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11b: Middle Channel 2437MHz									
315.08	45.36	QP	60	1.5	H	-11.95	33.41	46.00	-12.59
315.08	49.23	QP	247	1.4	V	-11.95	37.28	46.00	-8.72
4874.00	55.14	PK	267	1.9	V	-0.62	54.52	74.00	-19.48
4874.00	43.18	Ave	267	1.9	V	-0.62	42.56	54.00	-11.44
7311.00	47.21	PK	339	1.5	H	2.21	49.42	74.00	-24.58
7311.00	35.57	Ave	339	1.5	H	2.21	37.78	54.00	-16.22
2320.48	45.37	PK	205	1.2	V	-13.19	32.18	74.00	-41.82
2320.48	38.07	Ave	205	1.2	V	-13.19	24.88	54.00	-29.12
2386.34	42.34	PK	73	1.1	H	-13.14	29.20	74.00	-44.80
2386.34	36.00	Ave	73	1.1	H	-13.14	22.86	54.00	-31.14
2489.89	44.41	PK	115	1.4	V	-13.08	31.33	74.00	-42.67
2489.89	36.81	Ave	115	1.4	V	-13.08	23.73	54.00	-30.27

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11b: High Channel 2462MHz									
315.08	46.35	QP	297	1.5	H	-11.95	34.40	46.00	-11.60
315.08	49.96	QP	1	1.6	V	-11.95	38.01	46.00	-7.99
4924.00	54.25	PK	359	1.9	V	-0.24	54.01	74.00	-19.99
4924.00	40.63	Ave	359	1.9	V	-0.24	40.39	54.00	-13.61
7386.00	46.93	PK	344	1.5	H	2.84	49.77	74.00	-24.23
7386.00	35.63	Ave	344	1.5	H	2.84	38.47	54.00	-15.53
2323.46	45.39	PK	7	1.1	V	-13.19	32.20	74.00	-41.80
2323.46	39.79	Ave	7	1.1	V	-13.19	26.60	54.00	-27.40
2361.22	42.22	PK	62	1.6	H	-13.14	29.08	74.00	-44.92
2361.22	37.11	Ave	62	1.6	H	-13.14	23.97	54.00	-30.03
2483.83	43.03	PK	127	1.5	V	-13.08	29.95	74.00	-44.05
2483.83	37.38	Ave	127	1.5	V	-13.08	24.30	54.00	-29.70

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11g: Low Channel 2412MHz									
315.08	45.84	QP	214	1.1	H	-11.95	33.89	46.00	-12.11
315.08	50.92	QP	110	1.5	V	-11.95	38.97	46.00	-7.03
4824.00	54.21	PK	352	1.9	V	-1.06	53.15	74.00	-20.85
4824.00	43.01	Ave	352	1.9	V	-1.06	41.95	54.00	-12.05
7236.00	44.09	PK	108	1.8	H	1.33	45.42	74.00	-28.58
7236.00	39.25	Ave	108	1.8	H	1.33	40.58	54.00	-13.42
2349.39	46.49	PK	128	1.1	V	-13.19	33.30	74.00	-40.70
2349.39	37.11	Ave	128	1.1	V	-13.19	23.92	54.00	-30.08
2374.27	44.02	PK	1	1.4	H	-13.14	30.88	74.00	-43.12
2374.27	38.96	Ave	1	1.4	H	-13.14	25.82	54.00	-28.18
2491.14	44.13	PK	26	1.4	V	-13.08	31.05	74.00	-42.95
2491.14	36.70	Ave	26	1.4	V	-13.08	23.62	54.00	-30.38

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11g: Middle Channel 2437MHz									
315.08	44.81	QP	70	1.3	H	-11.95	32.86	46.00	-13.14
315.08	48.60	QP	91	1.5	V	-11.95	36.65	46.00	-9.35
4874.00	51.71	PK	44	1.4	V	-0.62	51.09	74.00	-22.91
4874.00	47.23	Ave	44	1.4	V	-0.62	46.61	54.00	-7.39
7311.00	48.10	PK	203	1.5	H	2.21	50.31	74.00	-23.69
7311.00	35.33	Ave	203	1.5	H	2.21	37.54	54.00	-16.46
2331.73	46.92	PK	276	1.8	V	-13.19	33.73	74.00	-40.27
2331.73	38.67	Ave	276	1.8	V	-13.19	25.48	54.00	-28.52
2381.80	44.49	PK	260	1.9	H	-13.14	31.35	74.00	-42.65
2381.80	38.03	Ave	260	1.9	H	-13.14	24.89	54.00	-29.11
2497.99	44.62	PK	201	1.0	V	-13.08	31.54	74.00	-42.46
2497.99	36.31	Ave	201	1.0	V	-13.08	23.23	54.00	-30.77

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11g: High Channel 2462MHz									
315.08	44.93	QP	271	1.1	H	-11.95	32.98	46.00	-13.02
315.08	47.10	QP	158	1.8	V	-11.95	35.15	46.00	-10.85
4924.00	52.35	PK	250	1.3	V	-0.24	52.11	74.00	-21.89
4924.00	48.09	Ave	250	1.3	V	-0.24	47.85	54.00	-6.15
7386.00	47.71	PK	289	1.1	H	2.84	50.55	74.00	-23.45
7386.00	34.36	Ave	289	1.1	H	2.84	37.20	54.00	-16.80
2346.99	46.56	PK	194	1.6	V	-13.19	33.37	74.00	-40.63
2346.99	37.44	Ave	194	1.6	V	-13.19	24.25	54.00	-29.75
2378.42	44.50	PK	263	1.7	H	-13.14	31.36	74.00	-42.64
2378.42	37.00	Ave	263	1.7	H	-13.14	23.86	54.00	-30.14
2490.12	42.23	PK	8	1.4	V	-13.08	29.15	74.00	-44.85
2490.12	38.18	Ave	8	1.4	V	-13.08	25.10	54.00	-28.90

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n20: Low Channel 2412MHz									
315.08	44.76	QP	26	1.7	H	-11.95	32.81	46.00	-13.19
315.08	47.20	QP	52	1.8	V	-11.95	35.25	46.00	-10.75
4824.00	51.65	PK	17	1.0	V	-1.06	50.59	74.00	-23.41
4824.00	48.30	Ave	17	1.0	V	-1.06	47.24	54.00	-6.76
7236.00	47.84	PK	60	1.6	H	1.33	49.17	74.00	-24.83
7236.00	35.24	Ave	60	1.6	H	1.33	36.57	54.00	-17.43
2341.75	45.91	PK	344	1.3	V	-13.19	32.72	74.00	-41.28
2341.75	39.18	Ave	344	1.3	V	-13.19	25.99	54.00	-28.01
2379.48	42.10	PK	356	1.9	H	-13.14	28.96	74.00	-45.04
2379.48	38.30	Ave	356	1.9	H	-13.14	25.16	54.00	-28.84
2499.01	44.38	PK	108	2.0	V	-13.08	31.30	74.00	-42.70
2499.01	37.65	Ave	108	2.0	V	-13.08	24.57	54.00	-29.43

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n20: Middle Channel 2437MHz									
315.08	43.44	QP	62	1.2	H	-11.95	31.49	46.00	-14.51
315.08	45.93	QP	132	1.7	V	-11.95	33.98	46.00	-12.02
4874.00	51.82	PK	340	1.6	V	-0.62	51.20	74.00	-22.80
4874.00	47.79	Ave	340	1.6	V	-0.62	47.17	54.00	-6.83
7311.00	47.90	PK	117	2.0	H	2.21	50.11	74.00	-23.89
7311.00	36.34	Ave	117	2.0	H	2.21	38.55	54.00	-15.45
2349.44	45.24	PK	241	1.6	V	-13.19	32.05	74.00	-41.95
2349.44	39.95	Ave	241	1.6	V	-13.19	26.76	54.00	-27.24
2380.45	42.94	PK	209	1.5	H	-13.14	29.80	74.00	-44.20
2380.45	38.01	Ave	209	1.5	H	-13.14	24.87	54.00	-29.13
2484.21	42.18	PK	279	1.2	V	-13.08	29.10	74.00	-44.90
2484.21	36.22	Ave	279	1.2	V	-13.08	23.14	54.00	-30.86

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n20: High Channel 2462MHz									
315.08	43.97	QP	308	1.6	H	-11.95	32.02	46.00	-13.98
315.08	45.57	QP	128	1.4	V	-11.95	33.62	46.00	-12.38
4924.00	53.23	PK	74	1.3	V	-0.24	52.99	74.00	-21.01
4924.00	48.25	Ave	74	1.3	V	-0.24	48.01	54.00	-5.99
7386.00	48.61	PK	289	1.4	H	2.84	51.45	74.00	-22.55
7386.00	36.13	Ave	289	1.4	H	2.84	38.97	54.00	-15.03
2335.85	46.20	PK	226	1.9	V	-13.19	33.01	74.00	-40.99
2335.85	38.47	Ave	226	1.9	V	-13.19	25.28	54.00	-28.72
2388.28	42.79	PK	64	1.7	H	-13.14	29.65	74.00	-44.35
2388.28	37.48	Ave	64	1.7	H	-13.14	24.34	54.00	-29.66
2489.39	44.99	PK	353	1.2	V	-13.08	31.91	74.00	-42.09
2489.39	37.12	Ave	353	1.2	V	-13.08	24.04	54.00	-29.96

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n40: Low Channel 2422MHz									
315.08	44.19	QP	138	1.4	H	-11.95	32.24	46.00	-13.76
315.08	49.71	QP	112	1.2	V	-11.95	37.76	46.00	-8.24
4844.00	50.20	PK	100	1.1	V	-1.06	49.14	74.00	-24.86
4844.00	37.95	Ave	100	1.1	V	-1.06	36.89	54.00	-17.11
7266.00	43.07	PK	167	1.0	H	1.33	44.40	74.00	-29.60
7266.00	33.76	Ave	167	1.0	H	1.33	35.09	54.00	-18.91
2347.74	46.59	PK	294	1.5	V	-13.19	33.40	74.00	-40.60
2347.74	38.97	Ave	294	1.5	V	-13.19	25.78	54.00	-28.22
2374.22	42.24	PK	52	2.0	H	-13.14	29.10	74.00	-44.90
2374.22	38.81	Ave	52	2.0	H	-13.14	25.67	54.00	-28.33
2487.51	42.73	PK	234	1.3	V	-13.08	29.65	74.00	-44.35
2487.51	37.32	Ave	234	1.3	V	-13.08	24.24	54.00	-29.76

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n40: Middle Channel 2437MHz									
315.08	45.16	QP	22	1.9	H	-11.95	33.21	46.00	-12.79
315.08	48.92	QP	15	1.6	V	-11.95	36.97	46.00	-9.03
4874.00	51.09	PK	44	1.4	V	-0.62	50.47	74.00	-23.53
4874.00	37.21	Ave	44	1.4	V	-0.62	36.59	54.00	-17.41
7311.00	44.05	PK	110	1.3	H	2.21	46.26	74.00	-27.74
7311.00	34.21	Ave	110	1.3	H	2.21	36.42	54.00	-17.58
2340.88	45.60	PK	180	2.0	V	-13.19	32.41	74.00	-41.59
2340.88	38.98	Ave	180	2.0	V	-13.19	25.79	54.00	-28.21
2370.39	42.94	PK	228	1.1	H	-13.14	29.80	74.00	-44.20
2370.39	38.35	Ave	228	1.1	H	-13.14	25.21	54.00	-28.79
2486.38	43.00	PK	198	1.9	V	-13.08	29.92	74.00	-44.08
2486.38	37.43	Ave	198	1.9	V	-13.08	24.35	54.00	-29.65

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
11n40: High Channel 2452MHz									
315.08	44.77	QP	38	1.5	H	-11.95	32.82	46.00	-13.18
315.08	48.21	QP	318	1.2	V	-11.95	36.26	46.00	-9.74
4904.00	50.13	PK	355	1.2	V	-0.24	49.89	74.00	-24.11
4904.00	37.77	Ave	355	1.2	V	-0.24	37.53	54.00	-16.47
7356.00	44.37	PK	296	1.7	H	2.84	47.21	74.00	-26.79
7356.00	34.98	Ave	296	1.7	H	2.84	37.82	54.00	-16.18
2316.77	45.66	PK	27	1.3	V	-13.19	32.47	74.00	-41.53
2316.77	39.52	Ave	27	1.3	V	-13.19	26.33	54.00	-27.67
2389.89	42.64	PK	275	1.6	H	-13.14	29.50	74.00	-44.50
2389.89	37.00	Ave	275	1.6	H	-13.14	23.86	54.00	-30.14
2486.18	44.13	PK	266	1.6	V	-13.08	31.05	74.00	-42.95
2486.18	37.26	Ave	266	1.6	V	-13.08	24.18	54.00	-29.82

Test Frequency: 8GHz~25GHz

The measurements were more than 20 dB below the limit and not reported.

BLE:

Test Frequency: 9kHz~30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 18GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
309.25	40.71	QP	56	1.5	H	-11.88	28.83	46.00	-17.17
309.25	45.45	QP	37	1.7	V	-11.88	33.57	46.00	-12.43
4804.00	50.90	PK	180	1.1	V	-1.06	49.84	74.00	-24.16
4804.00	38.58	Ave	180	1.1	V	-1.06	37.52	54.00	-16.48
7206.00	44.35	PK	54	1.3	H	1.33	45.68	74.00	-28.32
7206.00	35.20	Ave	54	1.3	H	1.33	36.53	54.00	-17.47
2327.18	45.33	PK	319	1.3	V	-13.19	32.14	74.00	-41.86
2327.18	39.76	Ave	319	1.3	V	-13.19	26.57	54.00	-27.43
2387.80	43.52	PK	104	1.8	H	-13.14	30.38	74.00	-43.62
2387.80	36.33	Ave	104	1.8	H	-13.14	23.19	54.00	-30.81
2495.93	42.82	PK	58	2.0	V	-13.08	29.74	74.00	-44.26
2495.93	38.91	Ave	58	2.0	V	-13.08	25.83	54.00	-28.17

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Middle Channel 2440MHz									
309.25	40.60	QP	89	1.1	H	-13.35	27.25	46.00	-18.75
309.25	46.50	QP	271	1.3	V	-13.35	33.15	46.00	-12.85
4880.00	51.67	PK	331	1.3	V	-0.62	51.05	74.00	-22.95
4880.00	39.42	Ave	331	1.3	V	-0.62	38.80	54.00	-15.20
7320.00	45.68	PK	355	1.1	H	2.21	47.89	74.00	-26.11
7320.00	35.33	Ave	355	1.1	H	2.21	37.54	54.00	-16.46
2316.10	45.39	PK	162	1.6	V	-13.19	32.20	74.00	-41.80
2316.10	38.95	Ave	162	1.6	V	-13.19	25.76	54.00	-28.24
2369.95	44.16	PK	318	1.3	H	-13.14	31.02	74.00	-42.98
2369.95	36.96	Ave	318	1.3	H	-13.14	23.82	54.00	-30.18
2491.12	42.80	PK	278	1.4	V	-13.08	29.72	74.00	-44.28
2491.12	36.15	Ave	278	1.4	V	-13.08	23.07	54.00	-30.93

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK High Channel 2480MHz									
309.25	40.99	QP	185	1.9	H	-13.35	27.64	46.00	-18.36
309.25	38.46	QP	245	1.7	V	-13.35	25.11	46.00	-20.89
4960.00	51.74	PK	220	1.7	V	-0.24	51.50	74.00	-22.50
4960.00	38.36	Ave	220	1.7	V	-0.24	38.12	54.00	-15.88
7440.00	44.60	PK	195	1.9	H	2.84	47.44	74.00	-26.56
7440.00	37.13	Ave	195	1.9	H	2.84	39.97	54.00	-14.03
2318.60	45.23	PK	82	1.9	V	-13.19	32.04	74.00	-41.96
2318.60	38.62	Ave	82	1.9	V	-13.19	25.43	54.00	-28.57
2388.34	42.07	PK	279	2.0	H	-13.14	28.93	74.00	-45.07
2388.34	38.22	Ave	279	2.0	H	-13.14	25.08	54.00	-28.92
2489.99	44.73	PK	296	1.6	V	-13.08	31.65	74.00	-42.35
2489.99	37.55	Ave	296	1.6	V	-13.08	24.47	54.00	-29.53

Test Frequency: 18GHz~25GHz

The measurements were more than 20 dB below the limit and not reported.

8 Duty Cycle

2.4G Wi-Fi

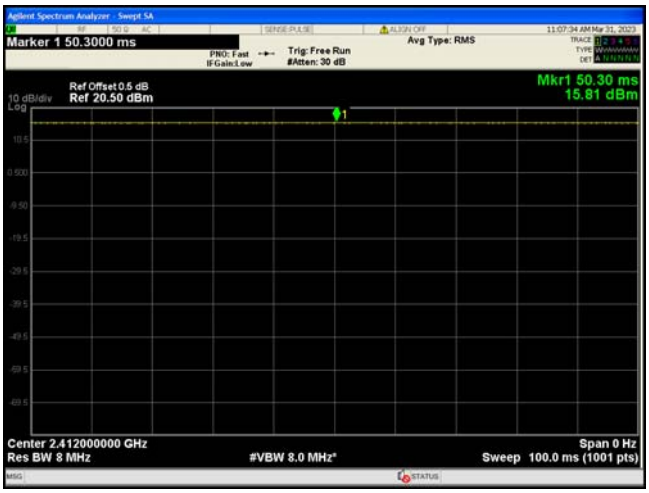
Modulation	On time(ms)	Period(ms)	Duty Cycle(%)	Duty Cycle Factor(dB)	Average Factor(dB)
802.11b	100	100	100	0	0
802.11g	100	100	100	0	0
802.11n20	100	100	100	0	0
802.11n40	100	100	100	0	0

Remark:

1) Duty Cycle=On Time/Period
2) Duty Cycle Factor=10*log(1/Duty cycle)
3) Average Factor=20 $\log_{10}$ Duty Cycle

Test Plot

802.11b



802.11g

802.11n HT20

802.11n HT40

9 Conducted Spurious Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019;
ANSI C63.10:2013

Test Result: PASS

Limit:

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

9.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:
   a) Set instrument center frequency to DTS channel center frequency.
   b) Set the span to _ 1.5 times the DTS bandwidth.
   c) Set the RBW = 100 kHz.
   d) Set the VBW _ [3 × RBW].
   e) Detector = peak.
   f) Sweep time = auto couple.
   g) Trace mode = max hold.
   h) Allow trace to fully stabilize.
   i) Use the peak marker function to determine the maximum PSD level.
   Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

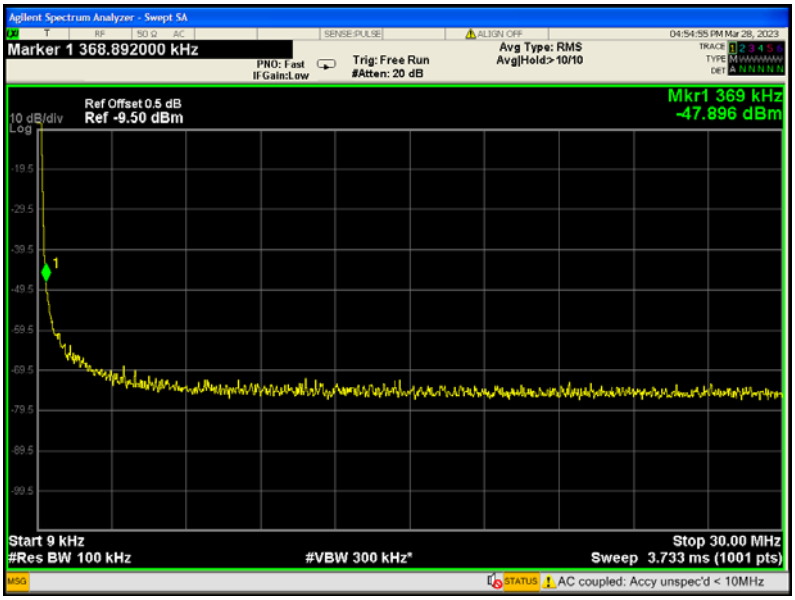
9.2 Test Result

9KHz – 30MHz

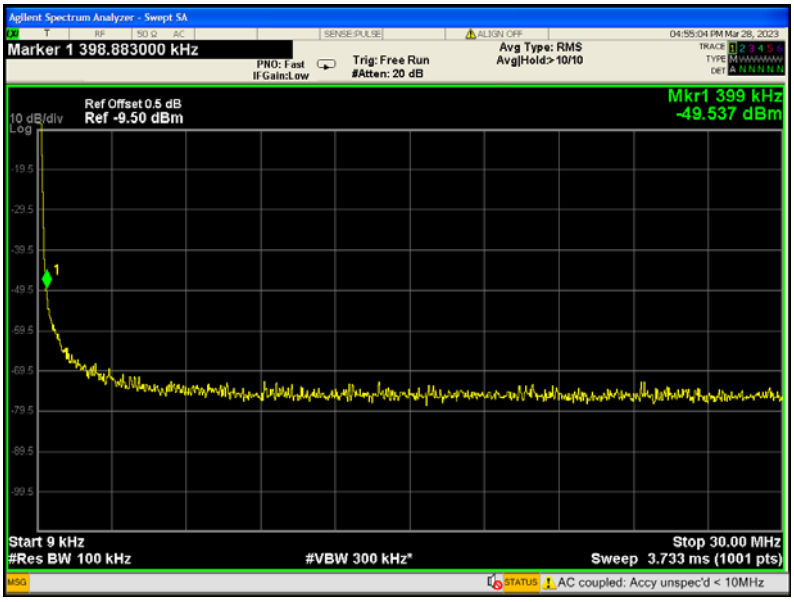
2.4G Wi-Fi

802.11b

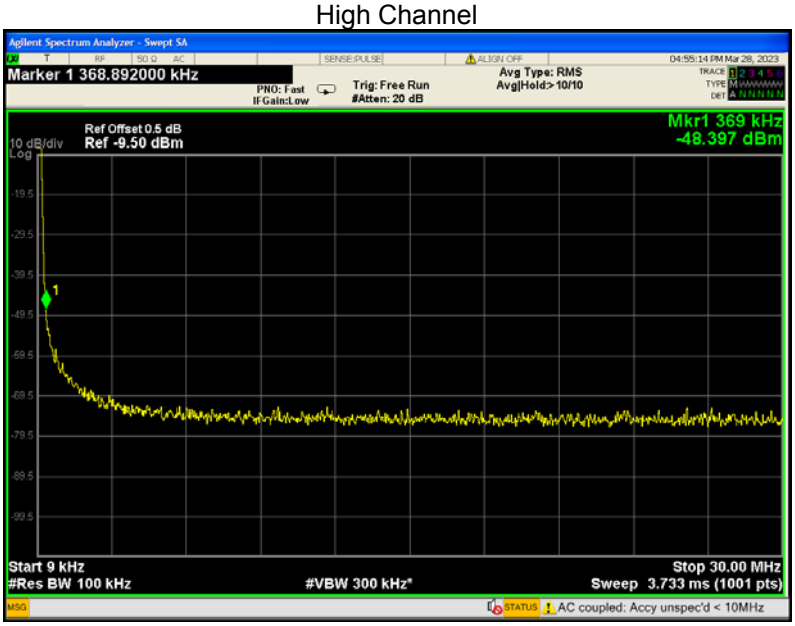
Low Channel



Middle Channel

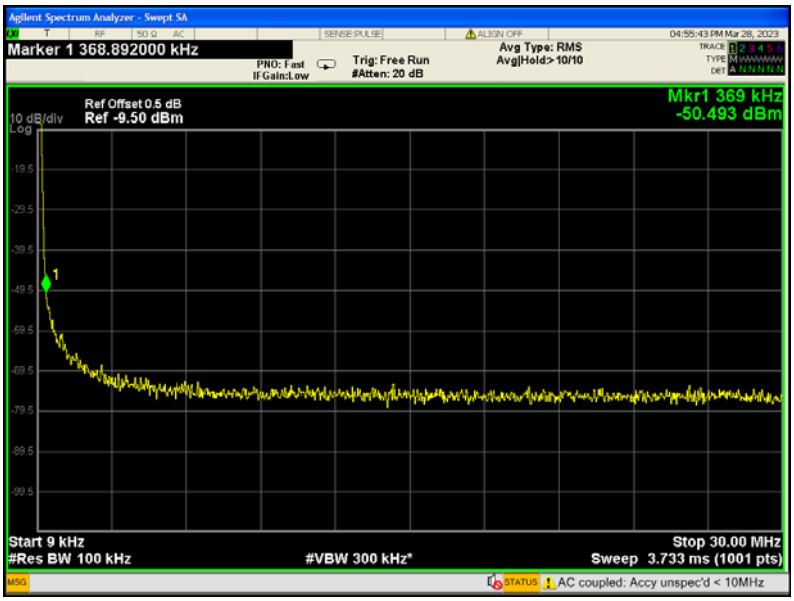


High Channel

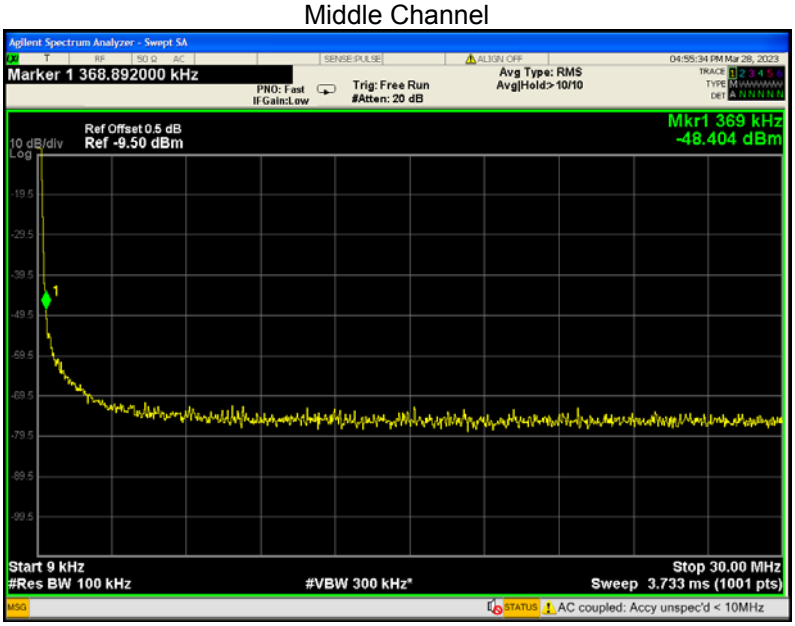


802.11g

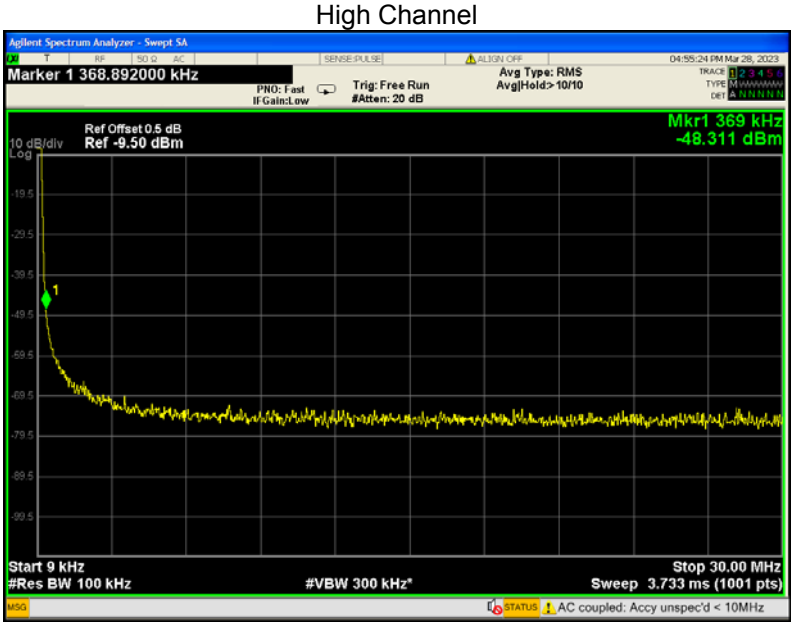
Low Channel



Middle Channel

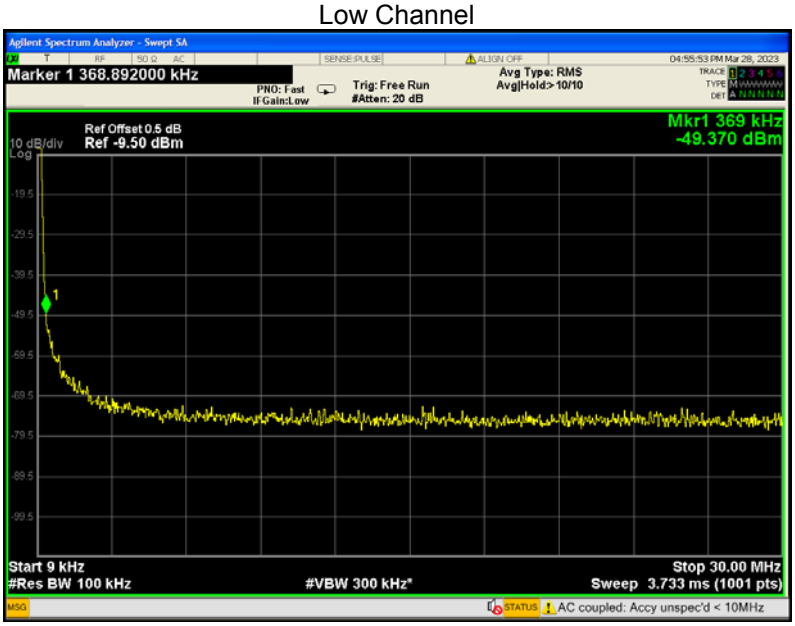


High Channel

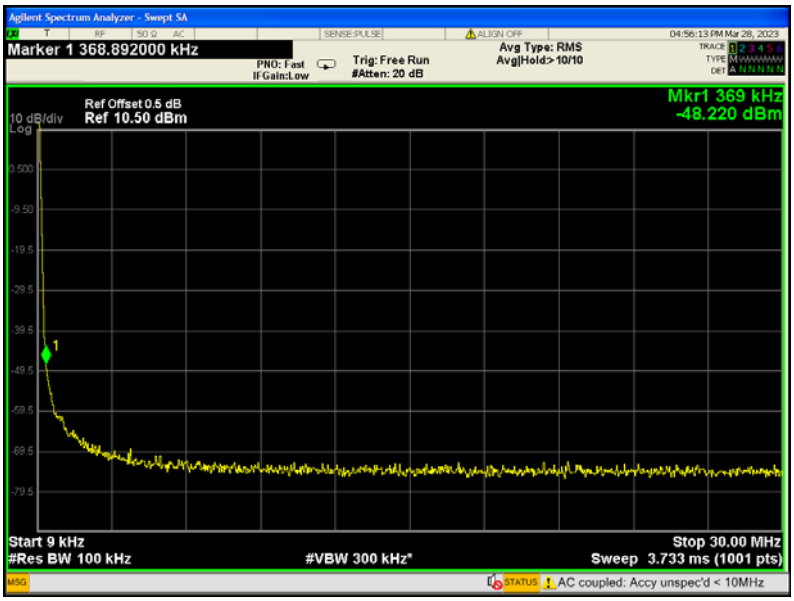


802.11n HT20

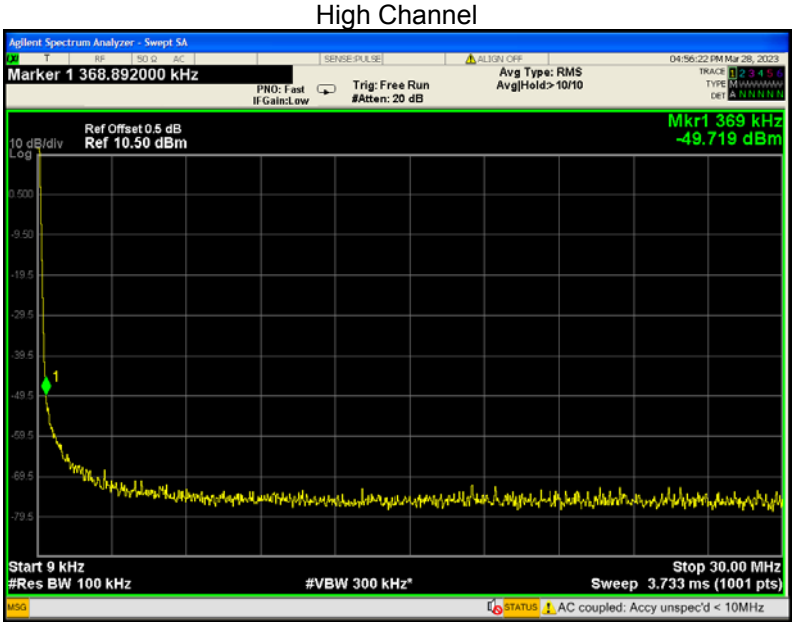
Low Channel



Middle Channel

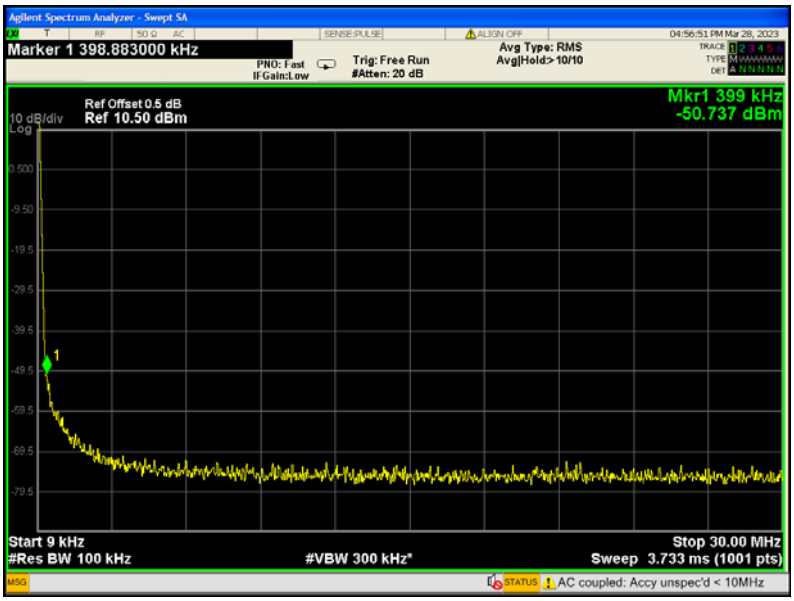


High Channel

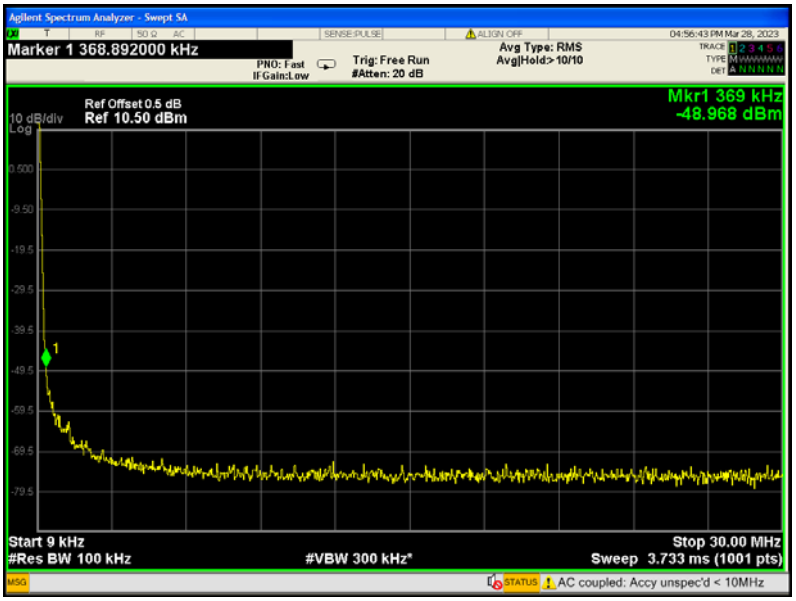


802.11n HT40

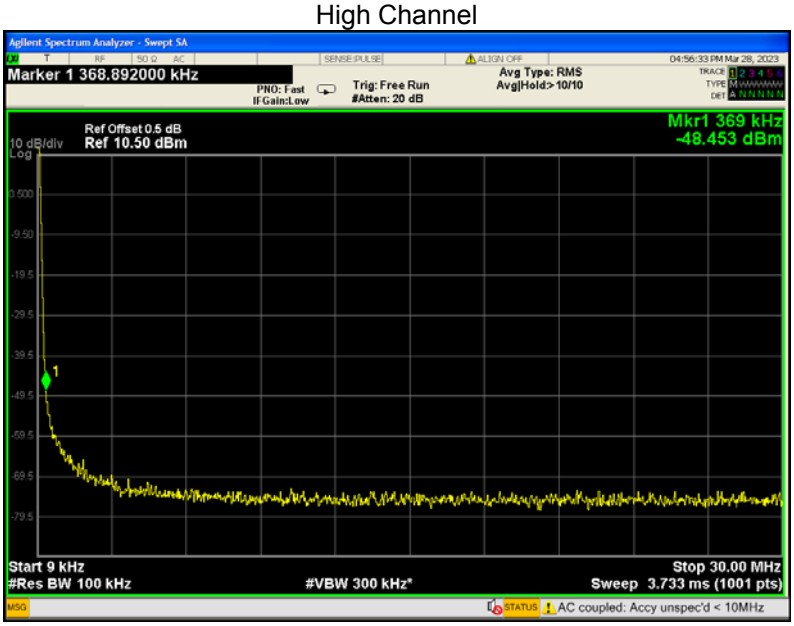
Low Channel



Middle Channel

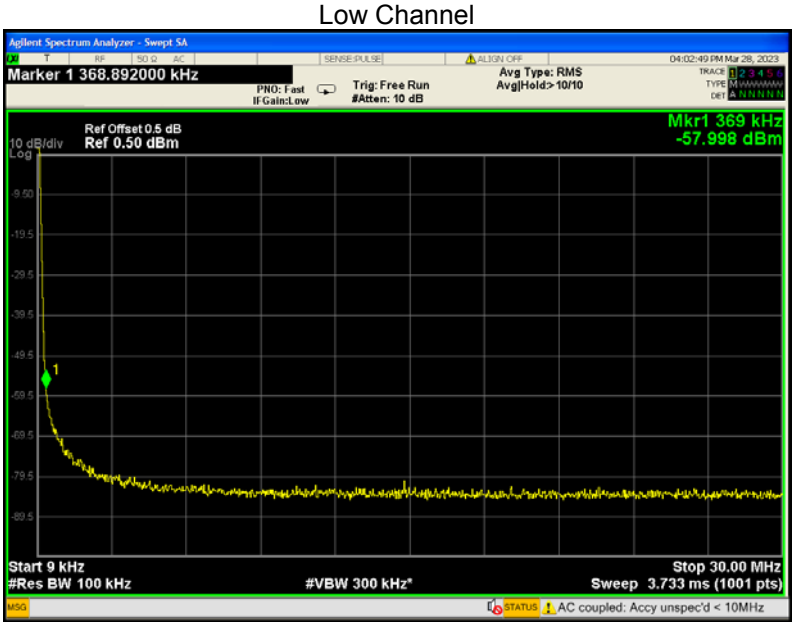


High Channel

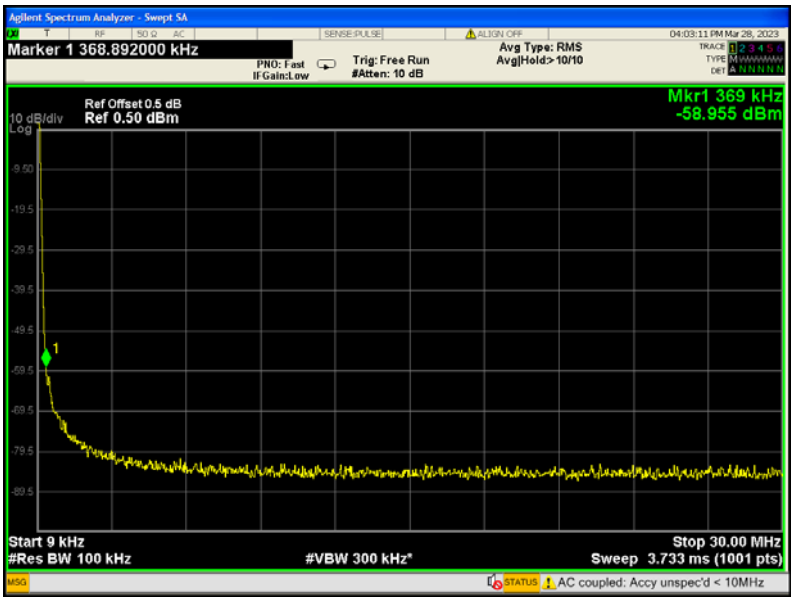


BLE

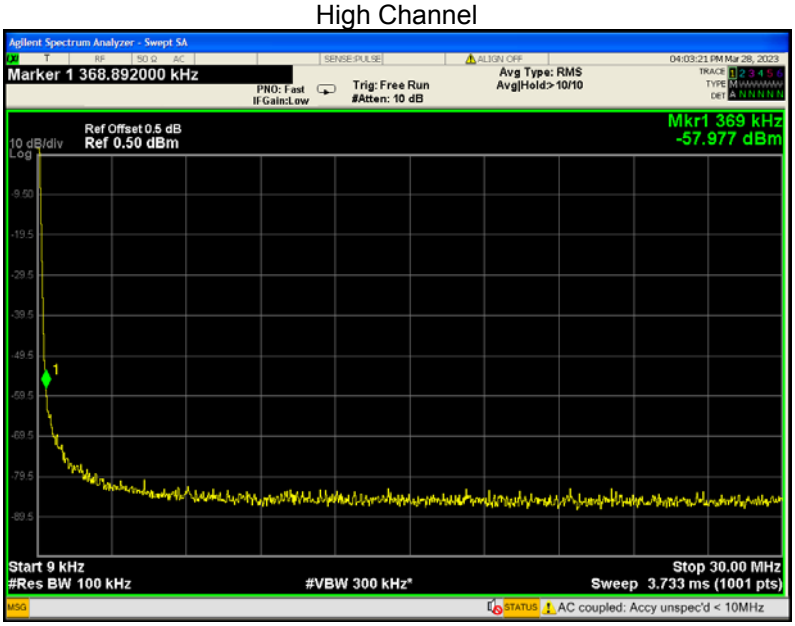
Low Channel



Middle Channel



High Channel

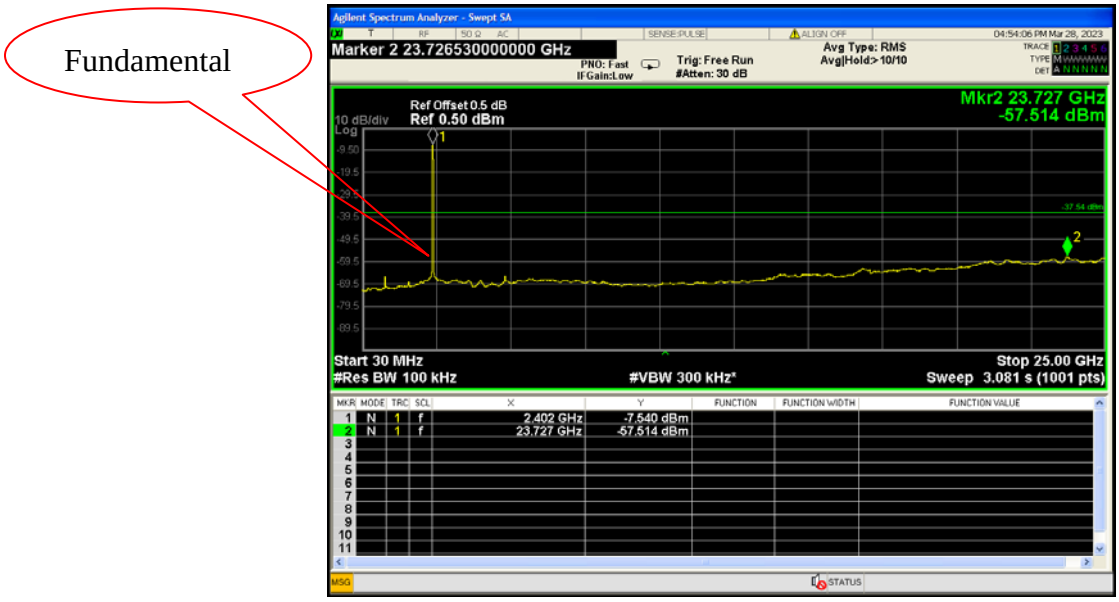


Above 30MHz

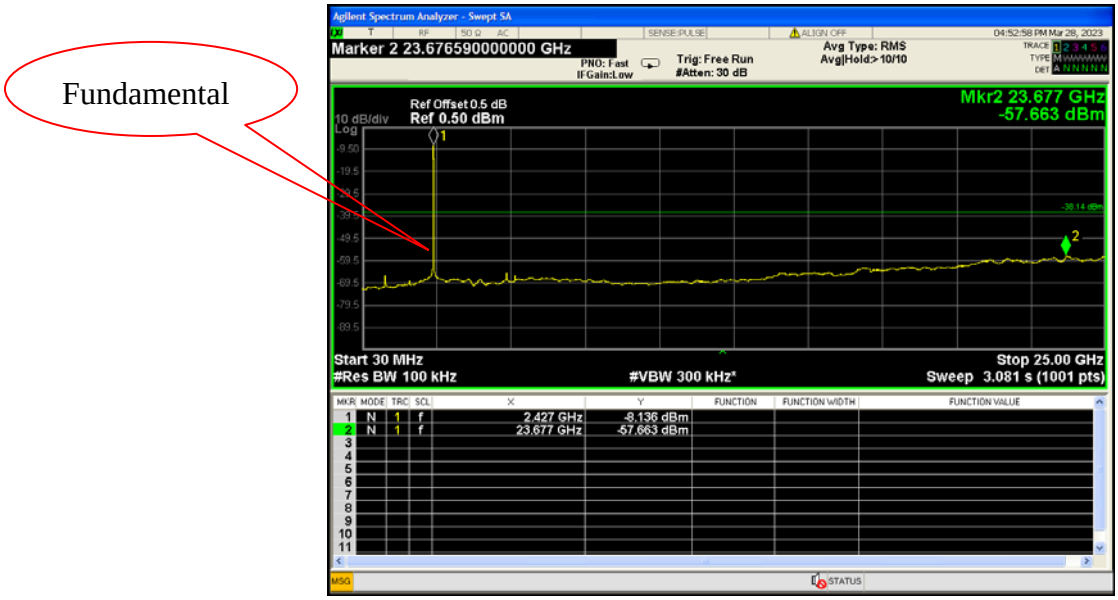
2.4G Wi-Fi

802.11b

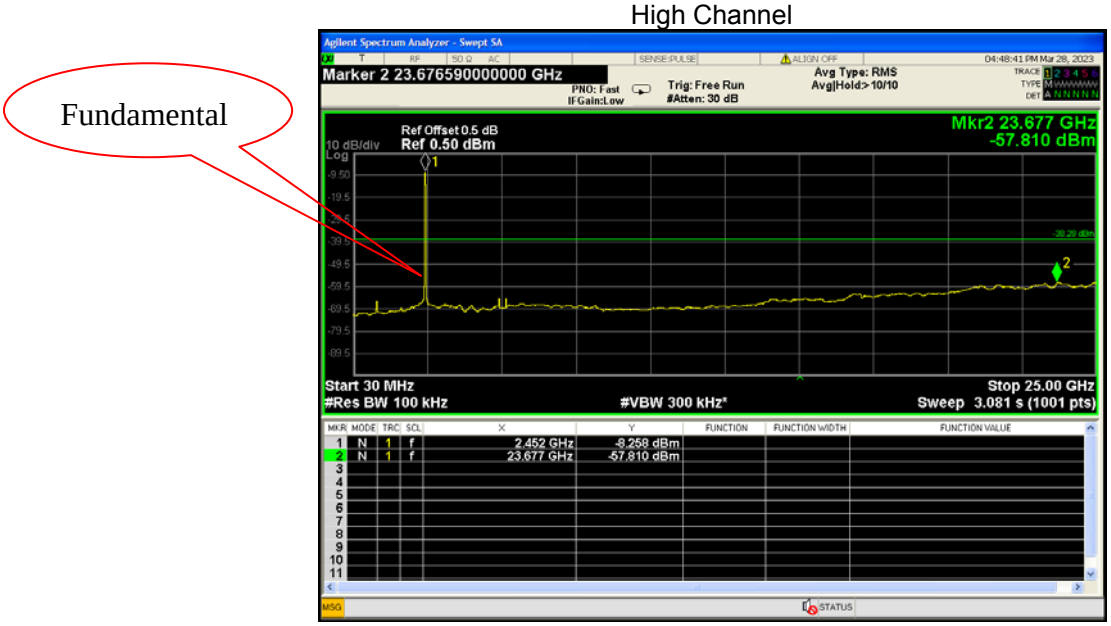
Low Channel



Middle Channel

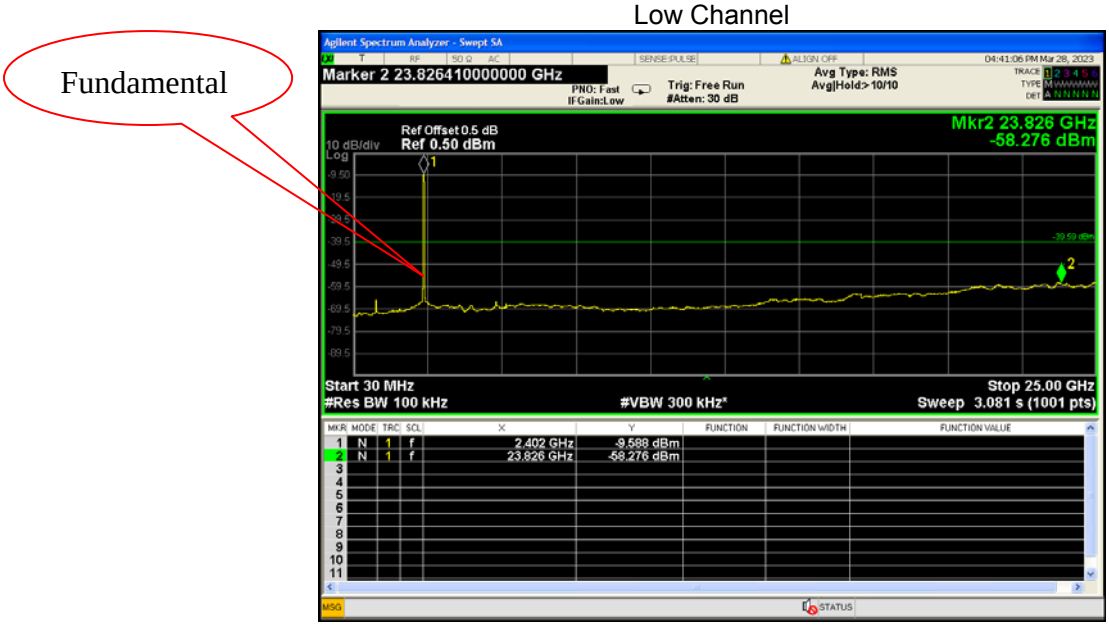


High Channel

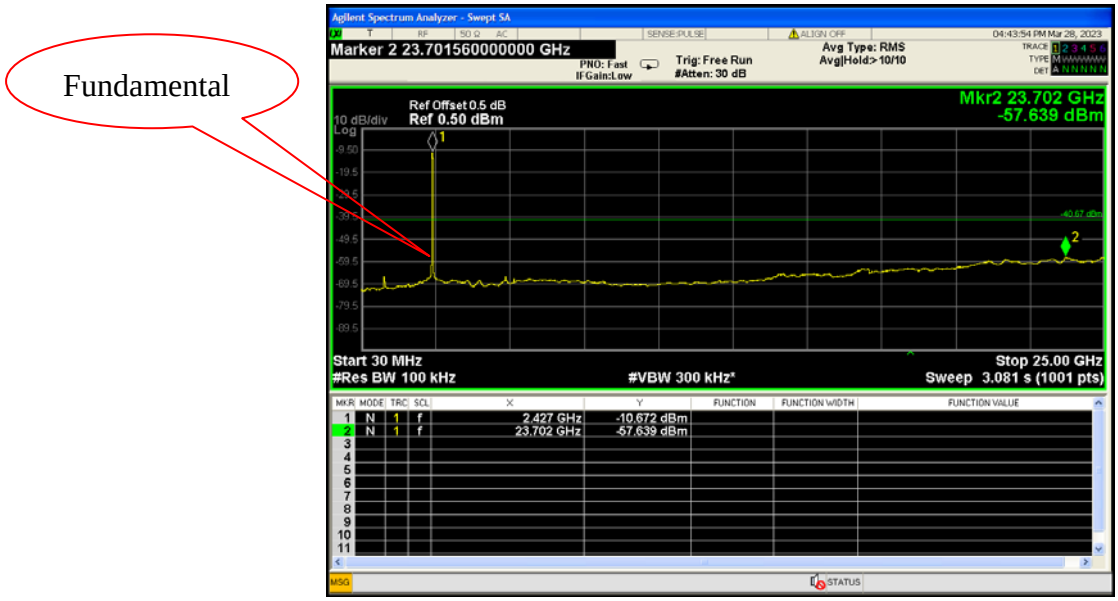


802.11g

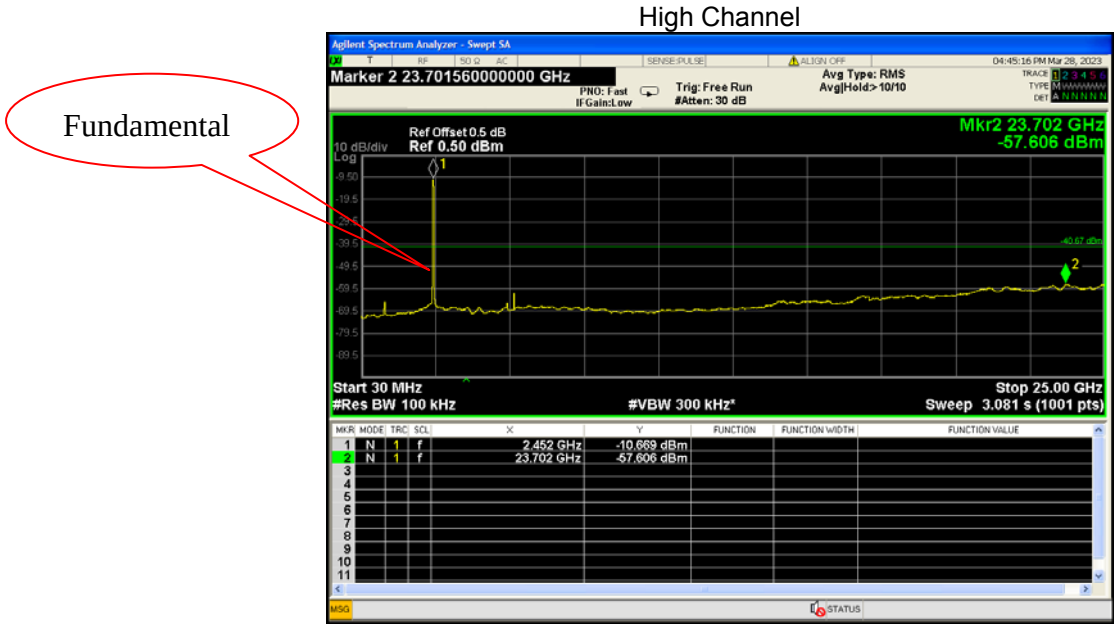
Low Channel



Middle Channel

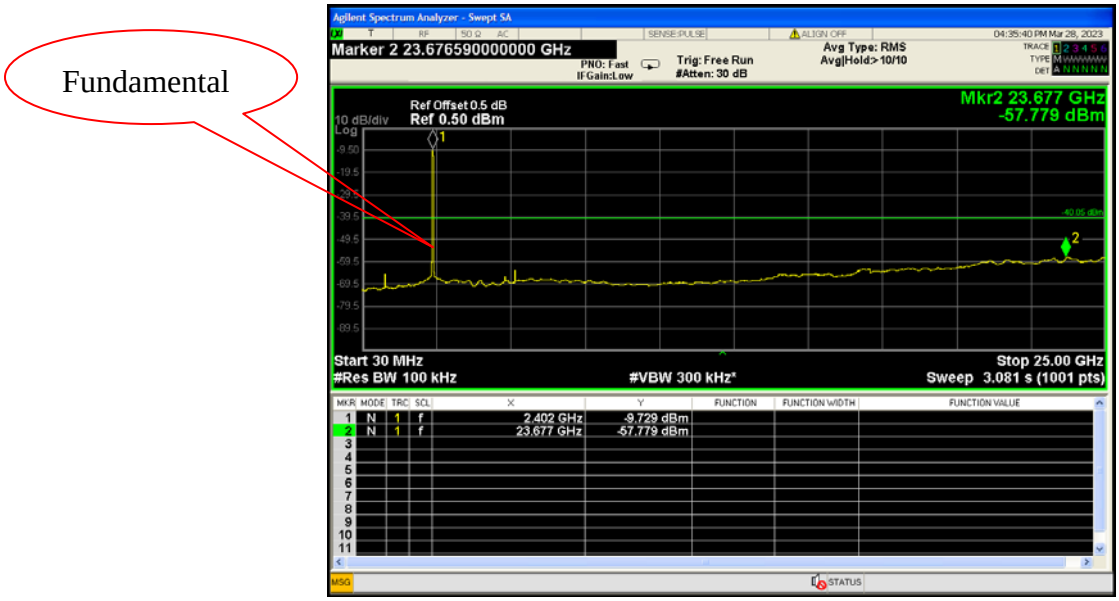


High Channel

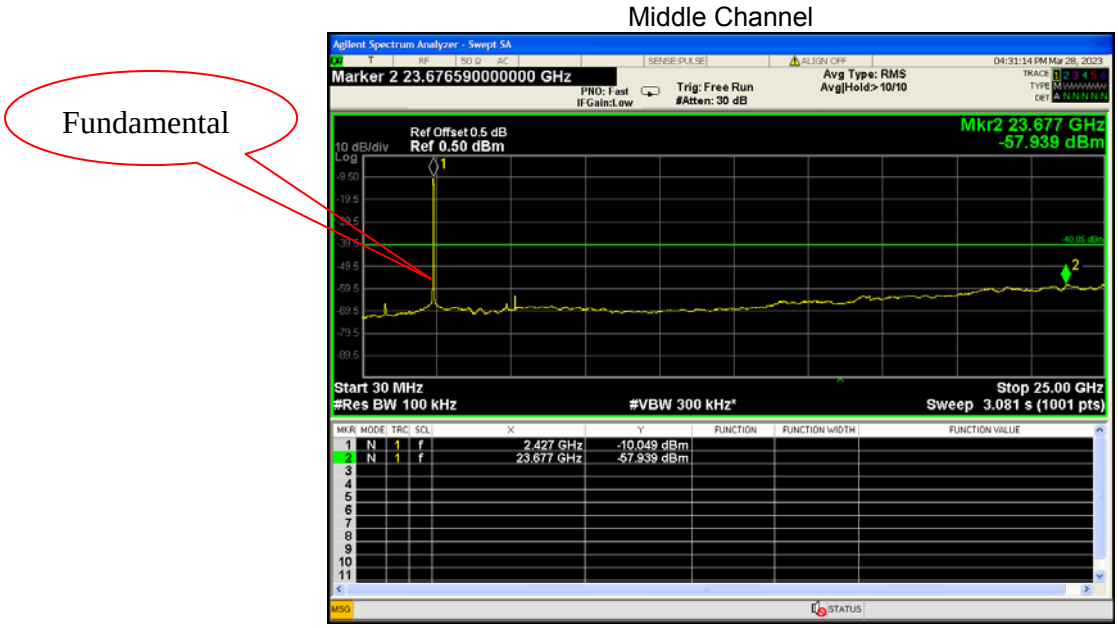


802.11n HT20

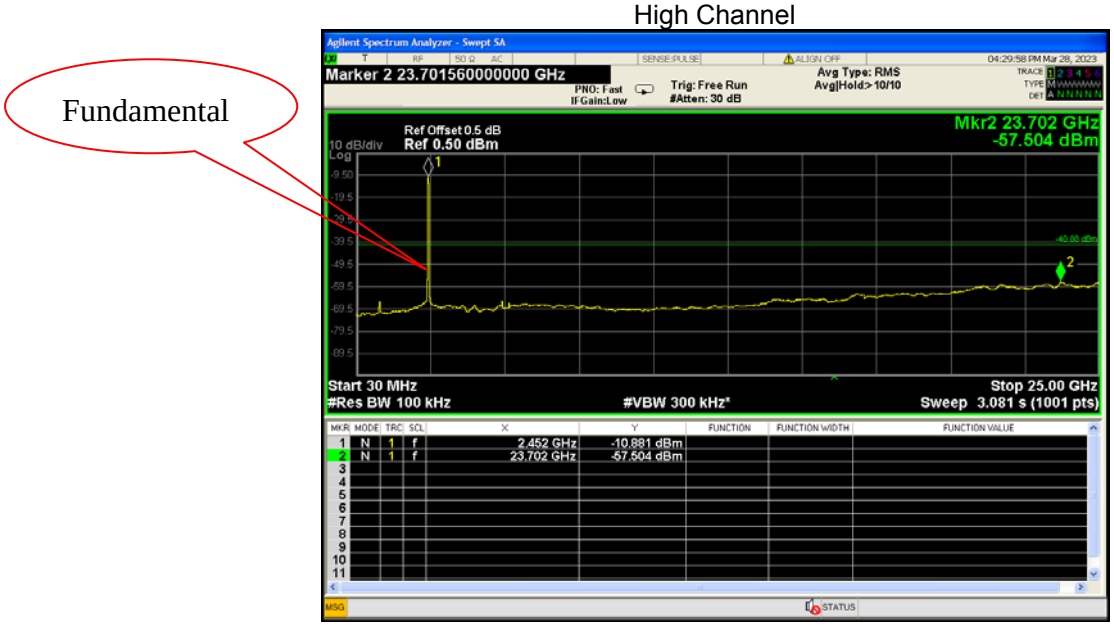
Low Channel



Middle Channel

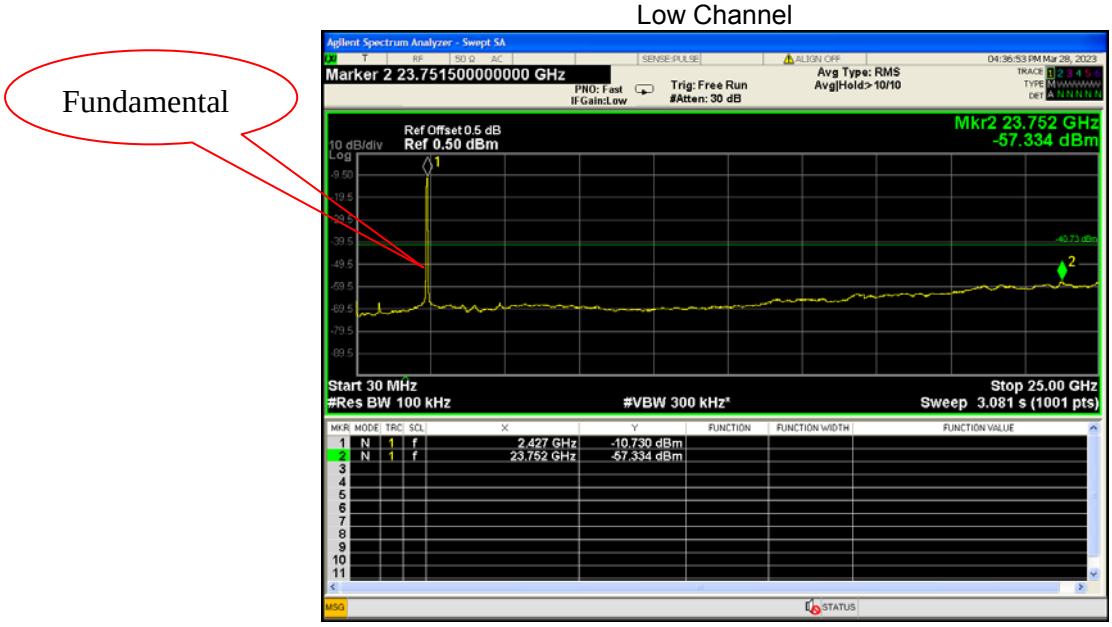


High Channel

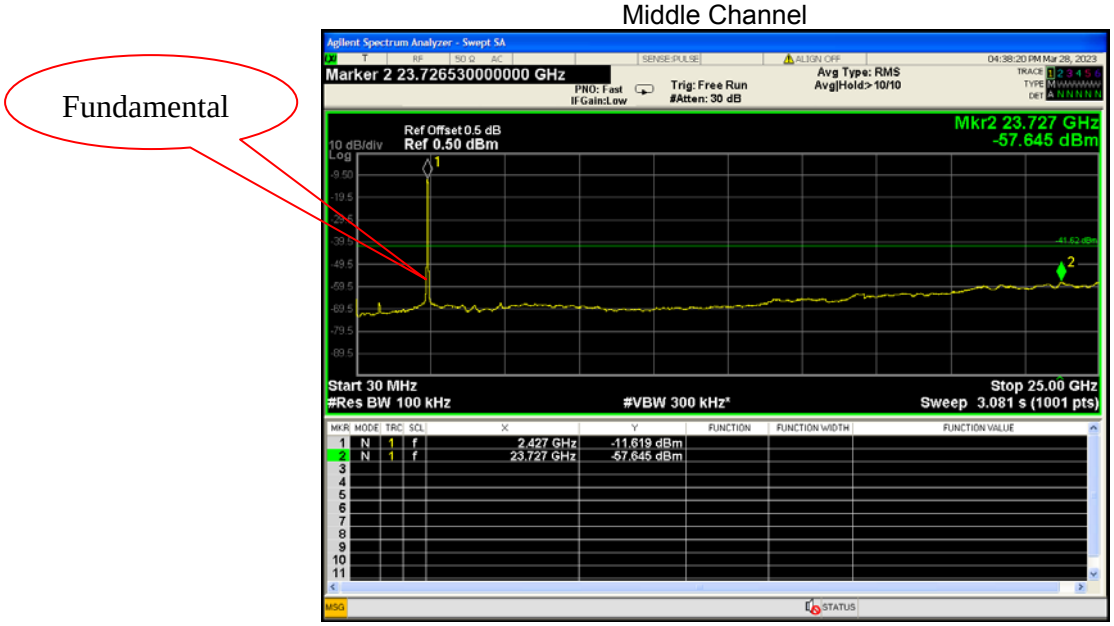


802.11n HT40

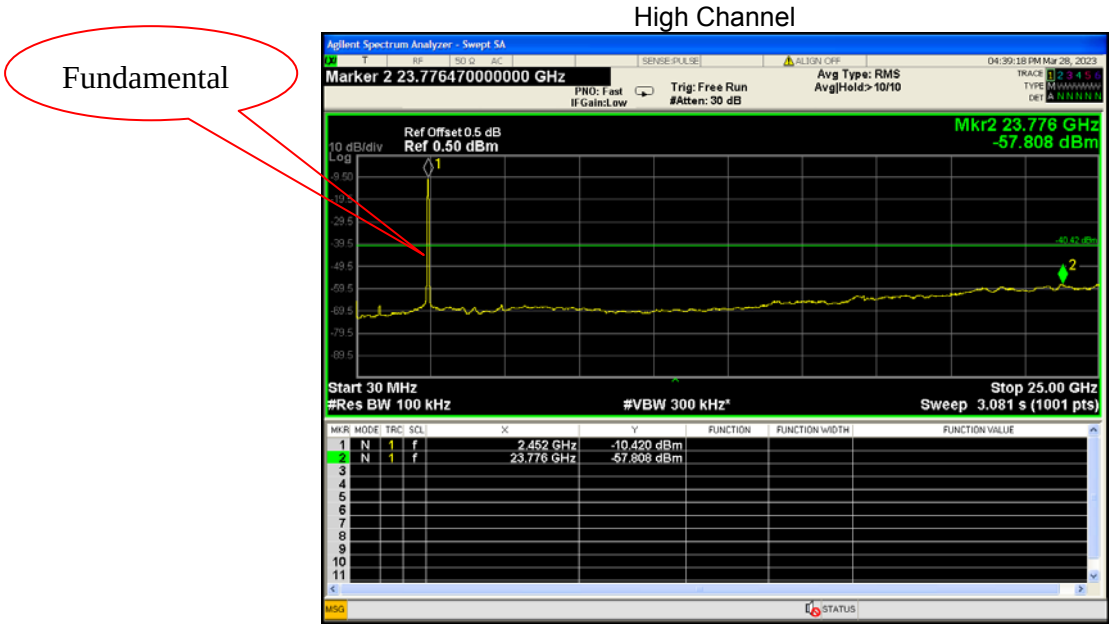
Low Channel



Middle Channel

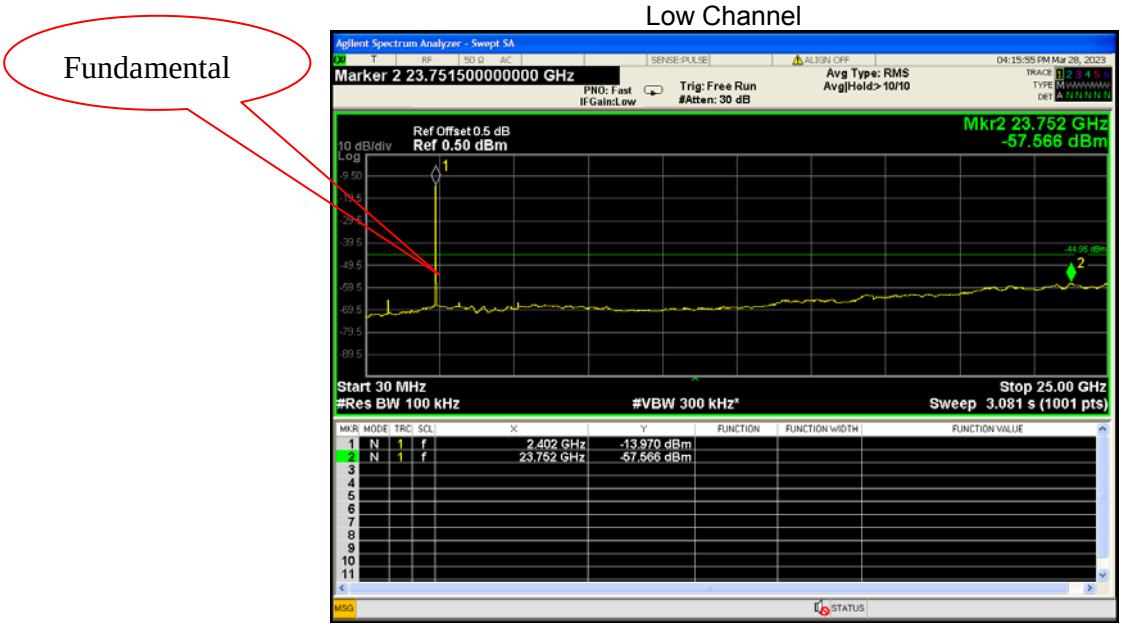


High Channel

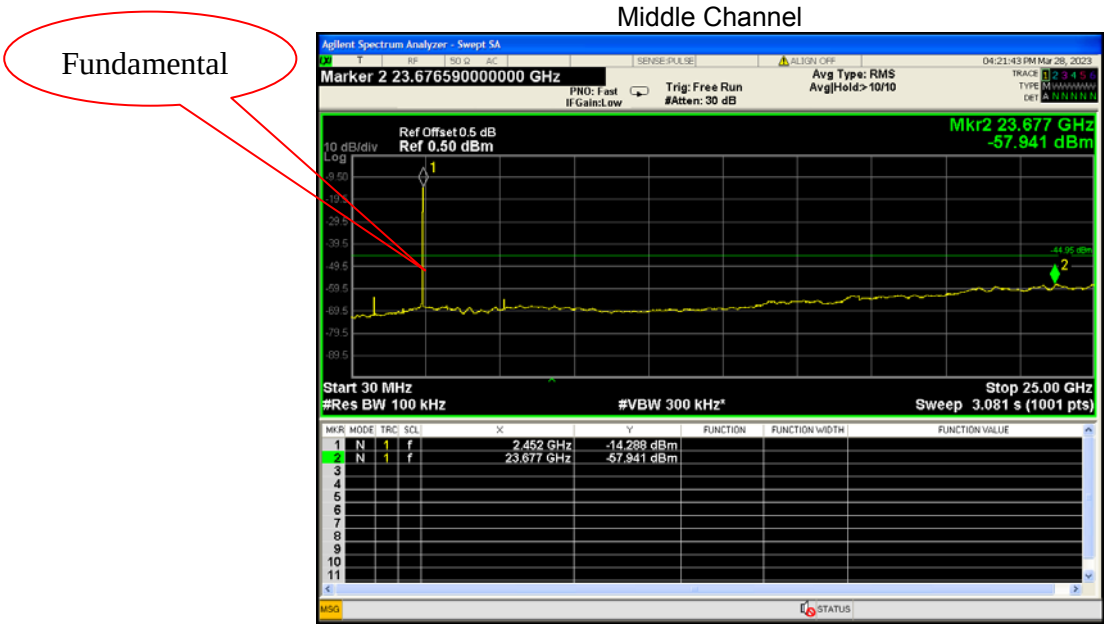


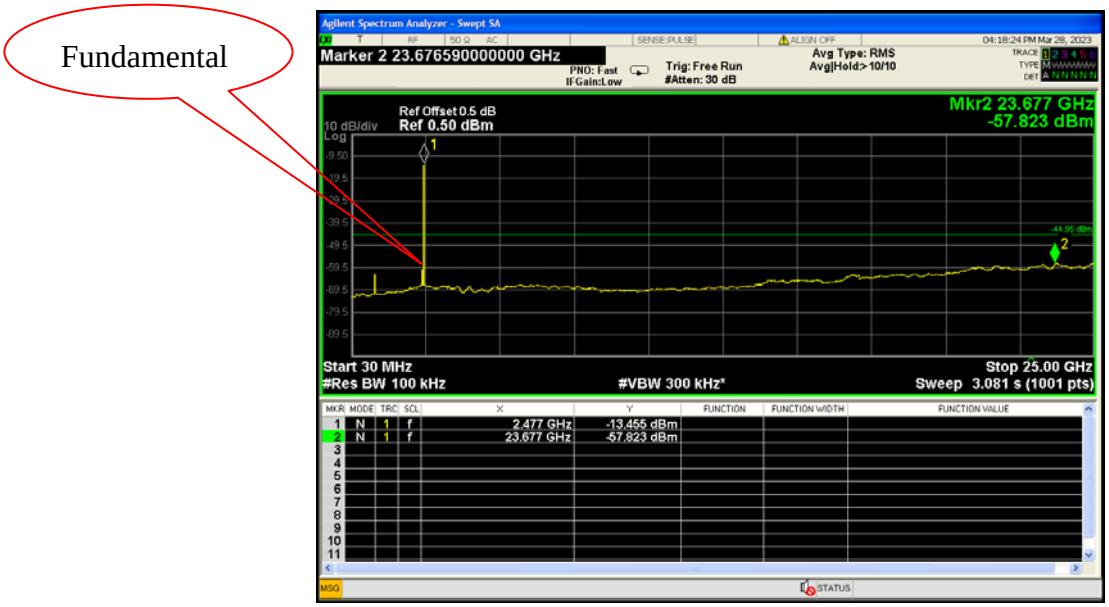
BLE

Low Channel



Middle Channel




Fundamental
Agilent Spectrum Analyzer - Swept SA
Marker 2 23.676590000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: RMS
Avg|Hold:>10/10
Ref Offset 0.5 dB
10 dB/div
Ref 0.50 dBm
Log
Mkr2 23.677 GHz
-57.823 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz*
Stop 25.00 GHz
Sweep 3.081 s (1001 pts)
1 N 1 f 2.477 GHz -13.455 dBm
2 N 1 f 23.677 GHz -57.823 dBm

10 Band Edge Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019;
ANSI C63.10:2013

Test Limit: Regulation 15.247 (d),In any 100 kHz bandwidth outside the frequency band 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 Mode: Transmitting

10.1 Test Produce

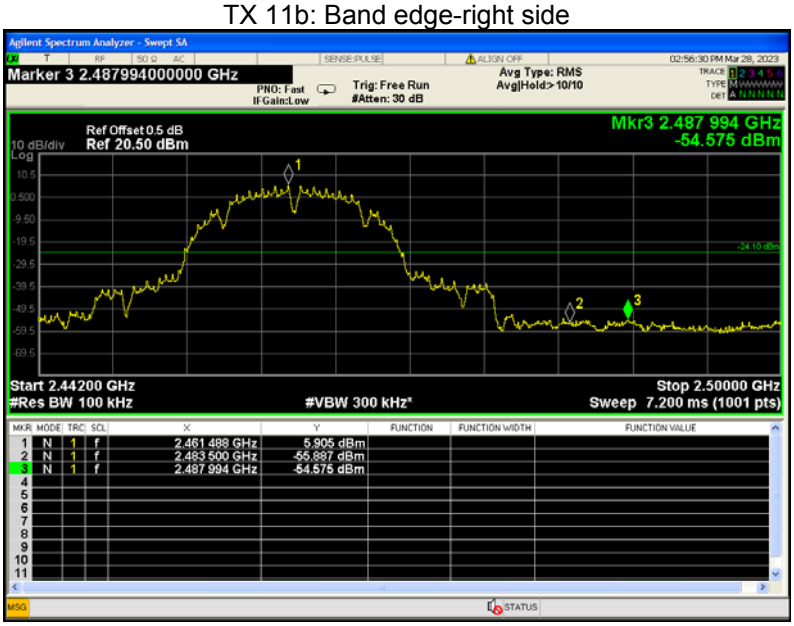
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then 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.

10.2 Test Result

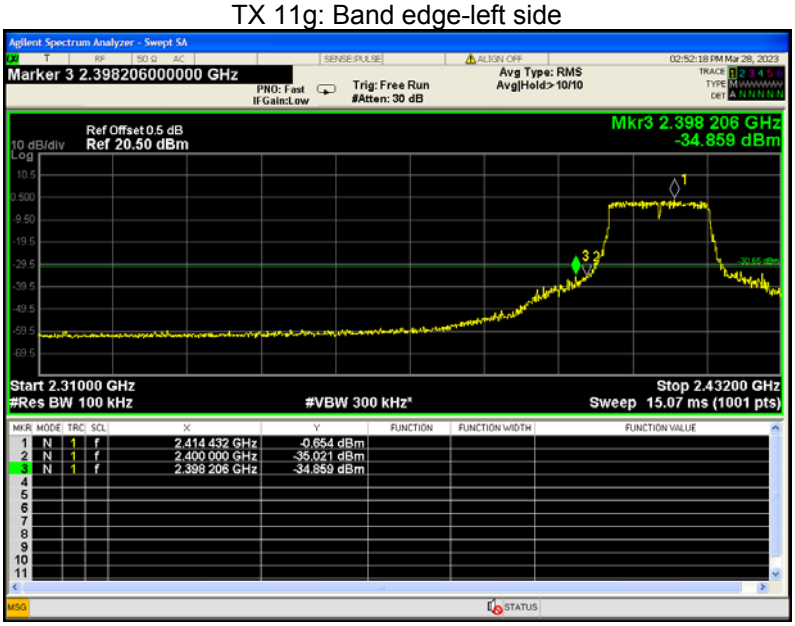
Test result plots shown as follows:

TX 11b: Band edge-left side

TX 11b: Band edge-right side

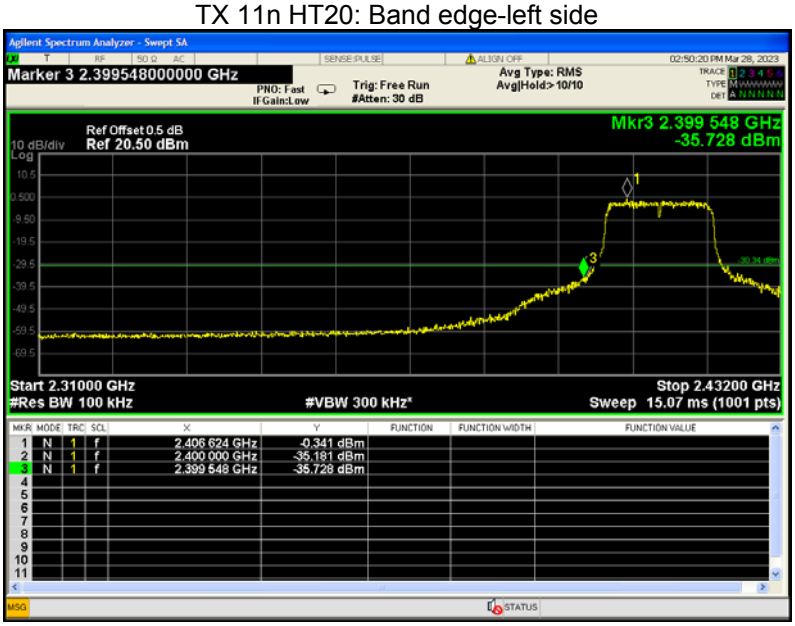


TX 11g: Band edge-left side

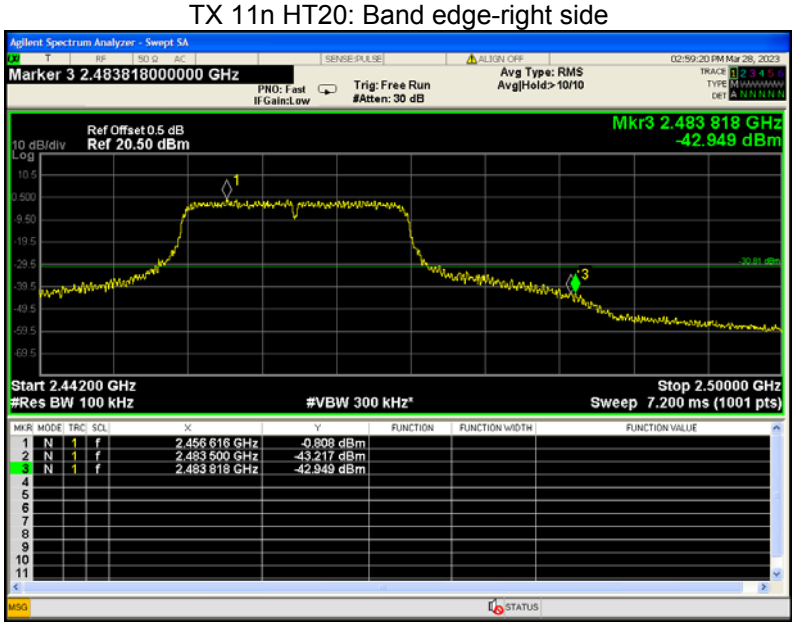


TX 11g: Band edge-right side

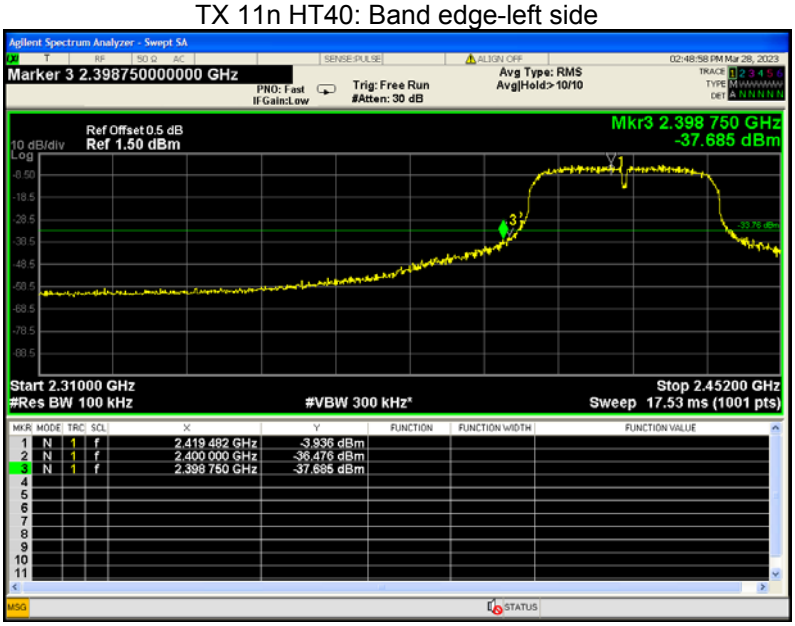
TX 11n HT20: Band edge-left side



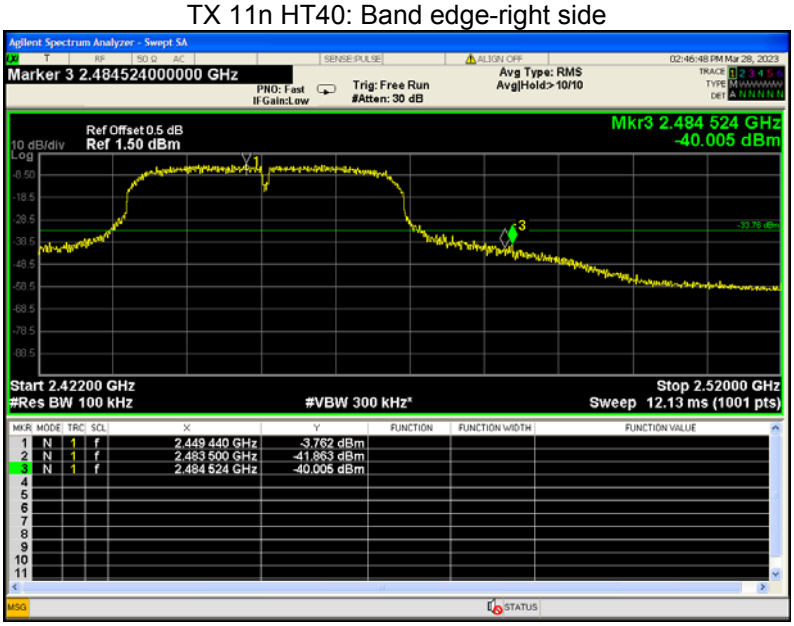
TX 11n HT20: Band edge-right side



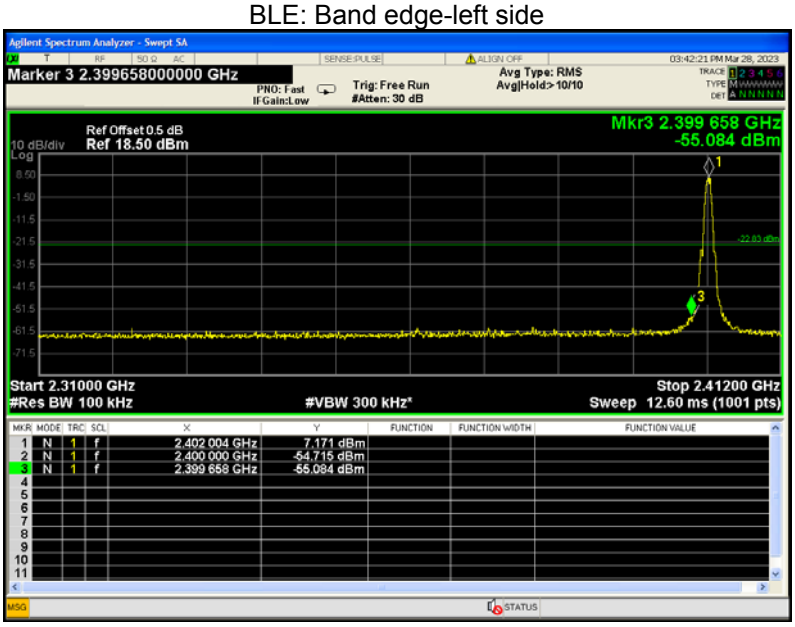
TX 11n HT40: Band edge-left side



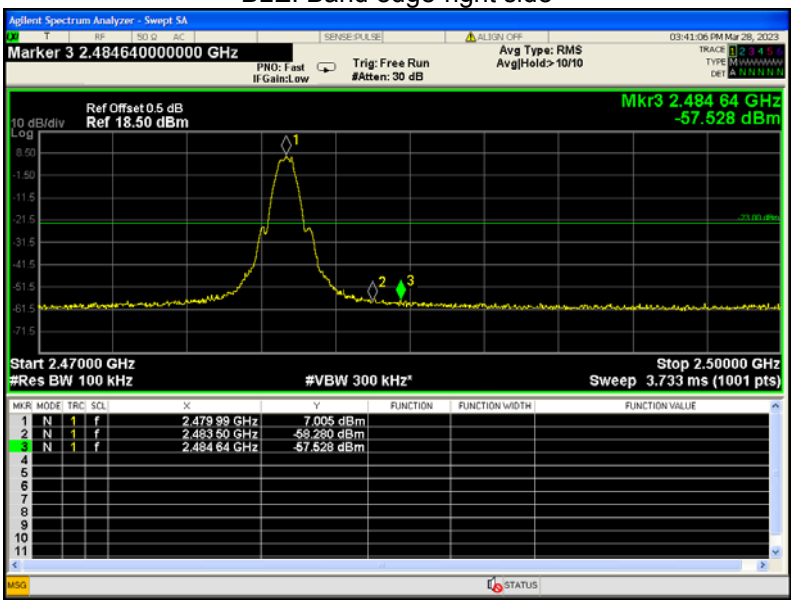
TX 11n HT40: Band edge-right side



BLE: Band edge-left side



BLE: Band edge-right side



11 6 dB Bandwidth and 99% Bandwidth Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019;
ANSI C63.10:2013

11.1 Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

2. 6dB Bandwidth Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz

99% Bandwidth Set the spectrum analyzer : RBW = 1~5% DTS OBW, VBW = 3 RBW

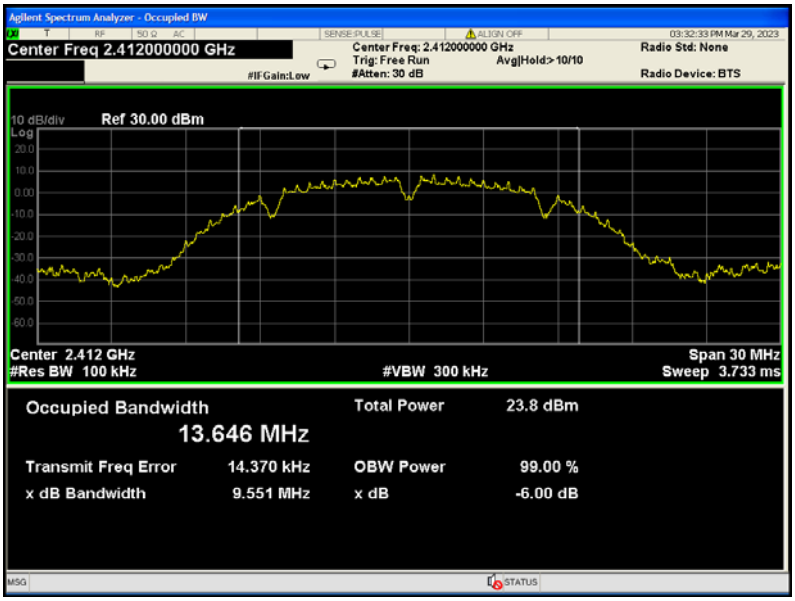
11.2 Test Result:

Operation mode	Test Channel	6dB Bandwidth (MHz)	99% Bandwidth (MHz)
TX 11b	Channel 1	9.551	13.371
	Channel 6	9.688	13.882
	Channel 11	10.04	14.096
TX 11g	Channel 1	16.35	17.197
	Channel 6	16.34	17.370
	Channel 11	16.35	17.468
TX 11n HT20	Channel 1	17.55	18.123
	Channel 6	17.61	18.215
	Channel 11	17.57	18.393
TX 11n HT40	Channel 3	36.37	37.934
	Channel 6	36.39	37.940
	Channel 9	36.39	37.608
BLE	Channel 0	0.646	1.016
	Channel 19	0.646	1.016
	Channel 39	0.649	1.016

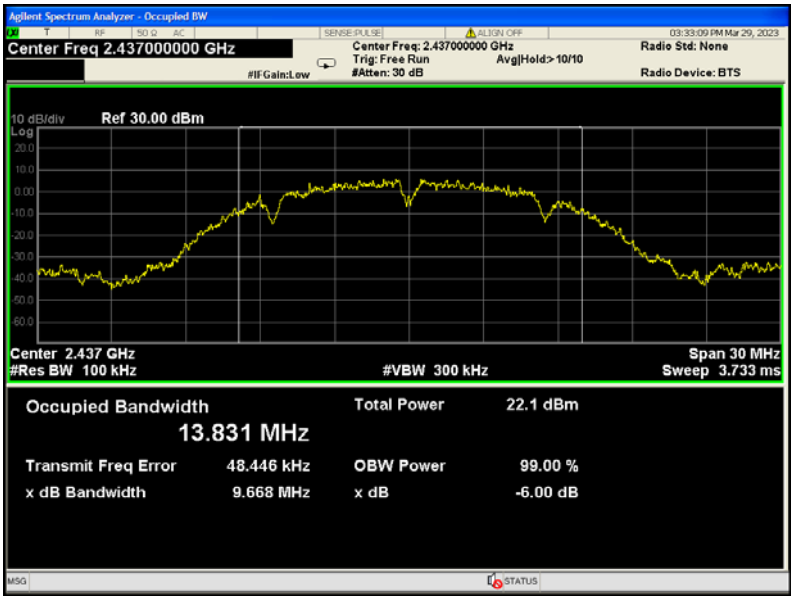
Test result plot:

6dB Bandwidth

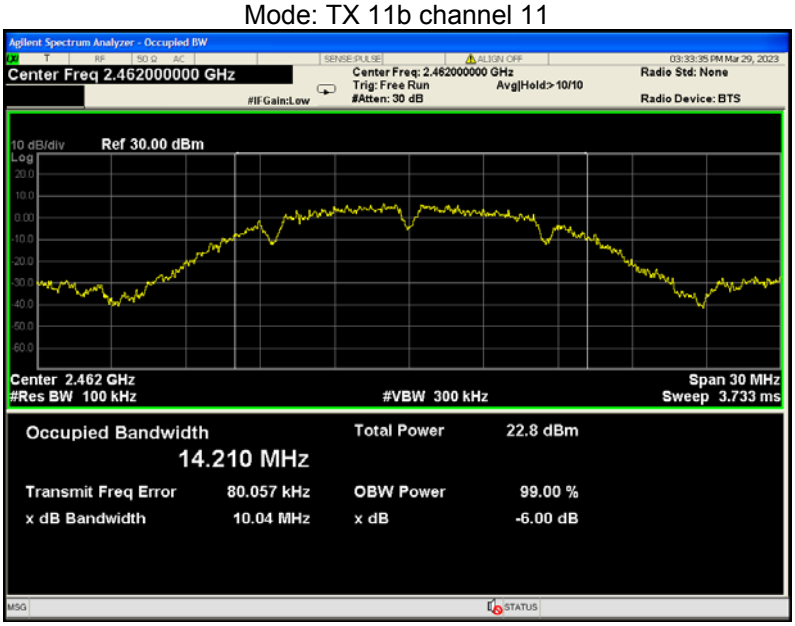
Mode: TX 11b channel 1



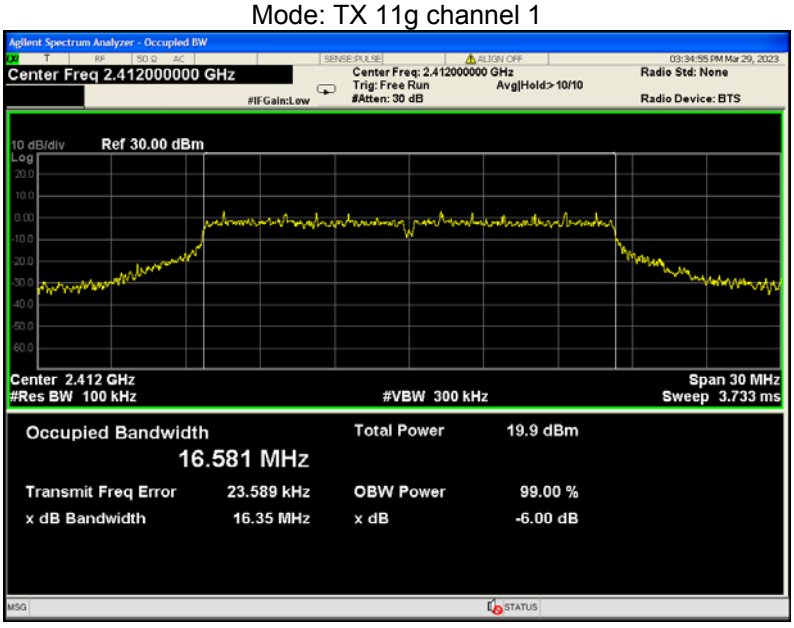
Mode: TX 11b channel 6



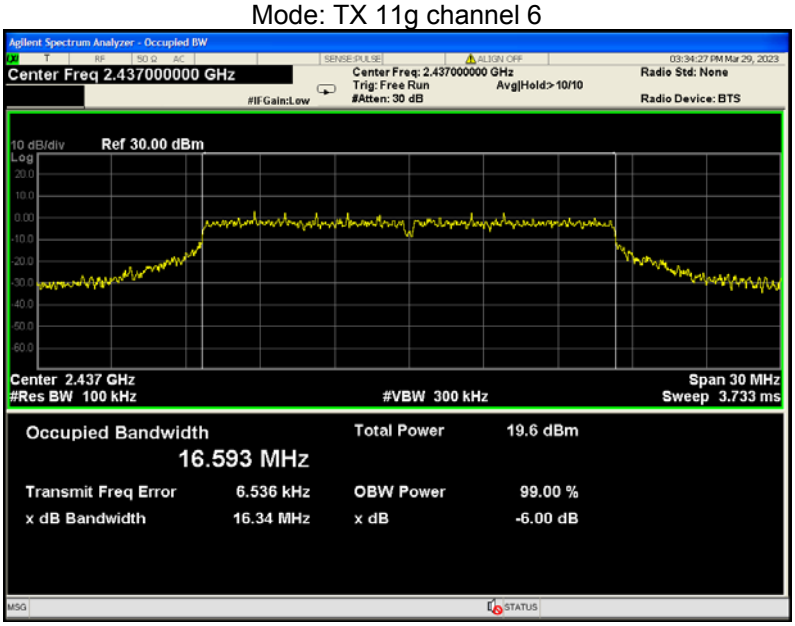
Mode: TX 11b channel 11



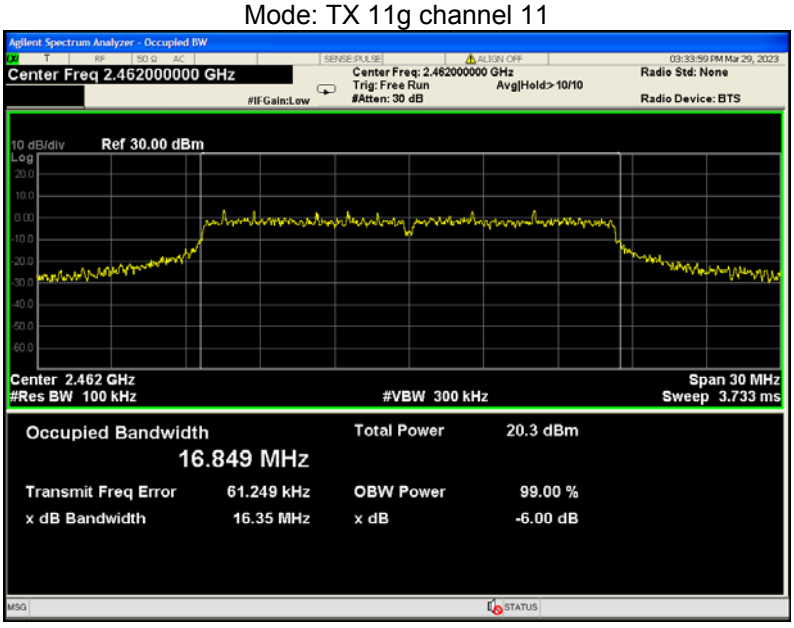
Mode: TX 11g channel 1



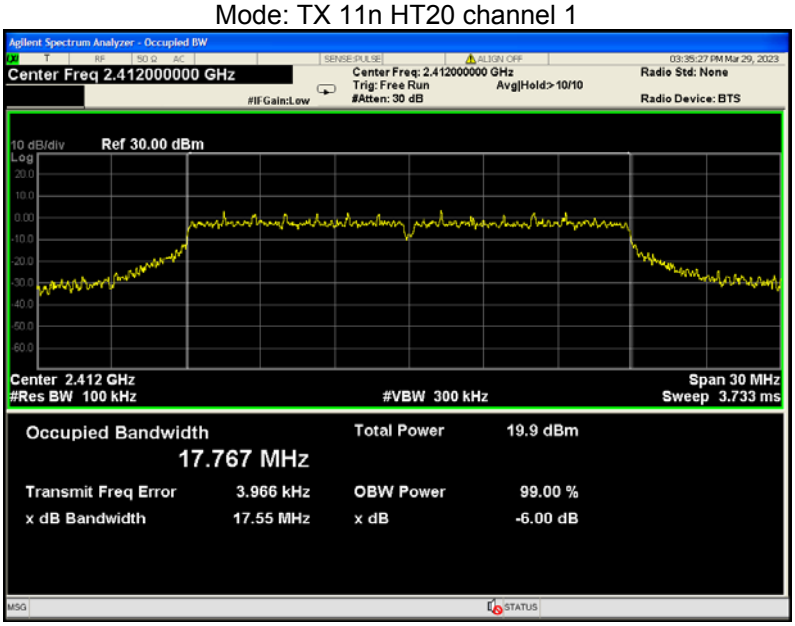
Mode: TX 11g channel 6



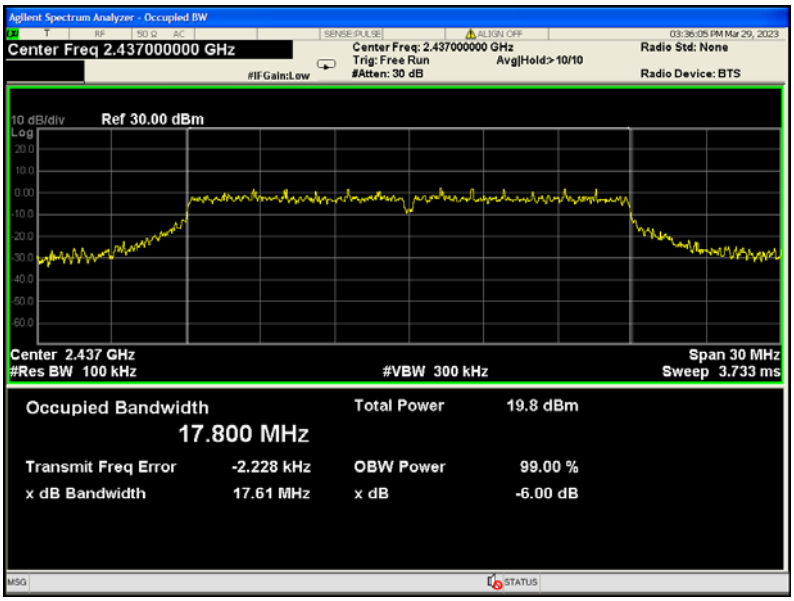
Mode: TX 11g channel 11



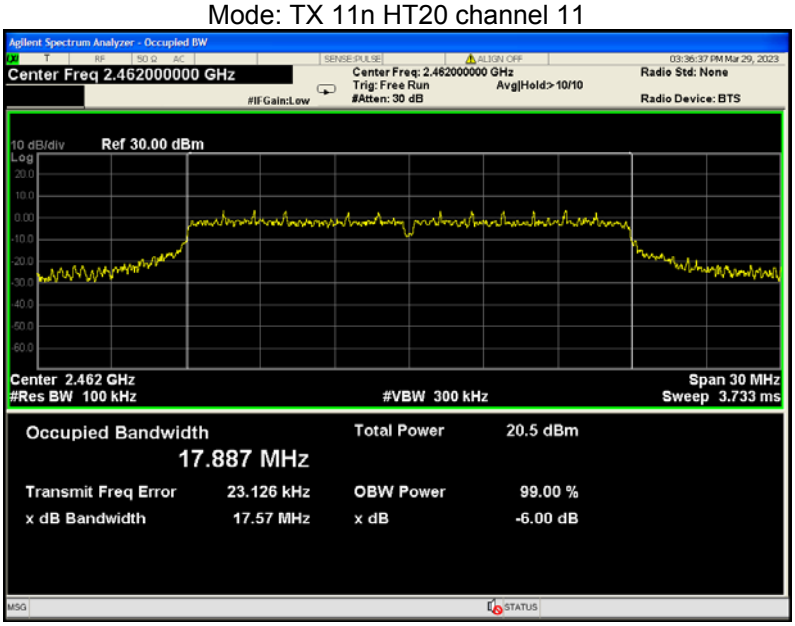
Mode: TX 11n HT20 channel 1



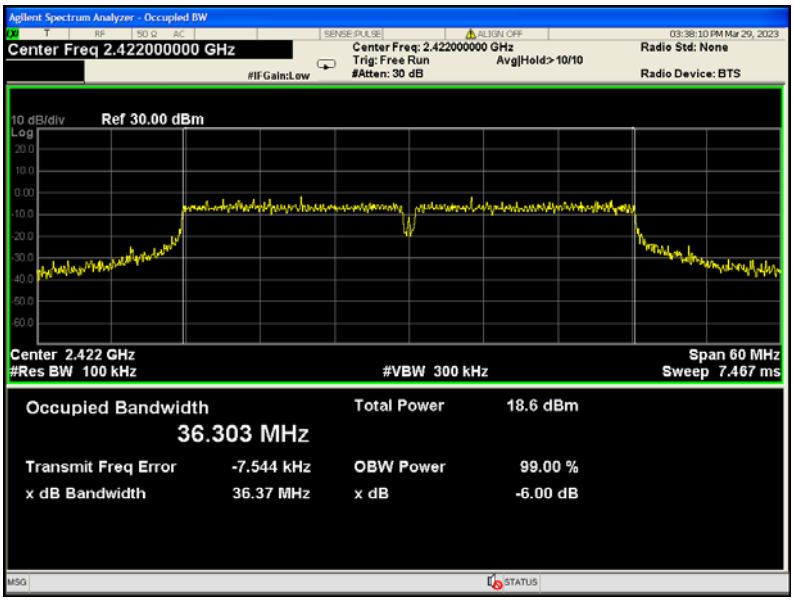
Mode: TX 11n HT20 channel 6



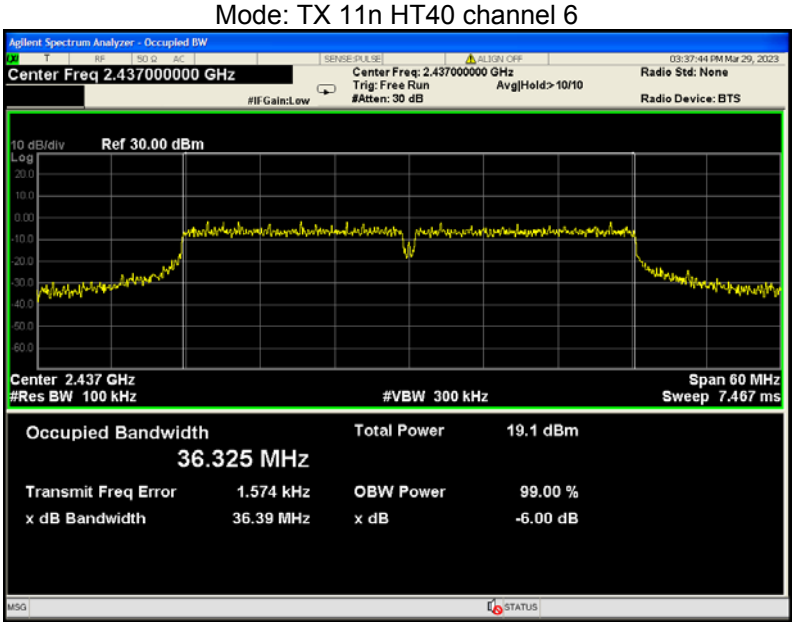
Mode: TX 11n HT20 channel 11



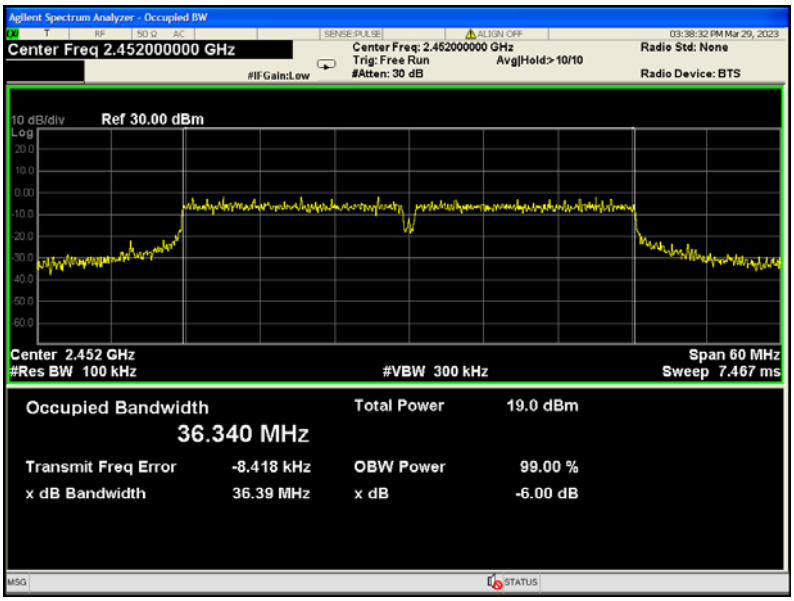
Mode: TX 11n HT40 channel 3



Mode: TX 11n HT40 channel 6

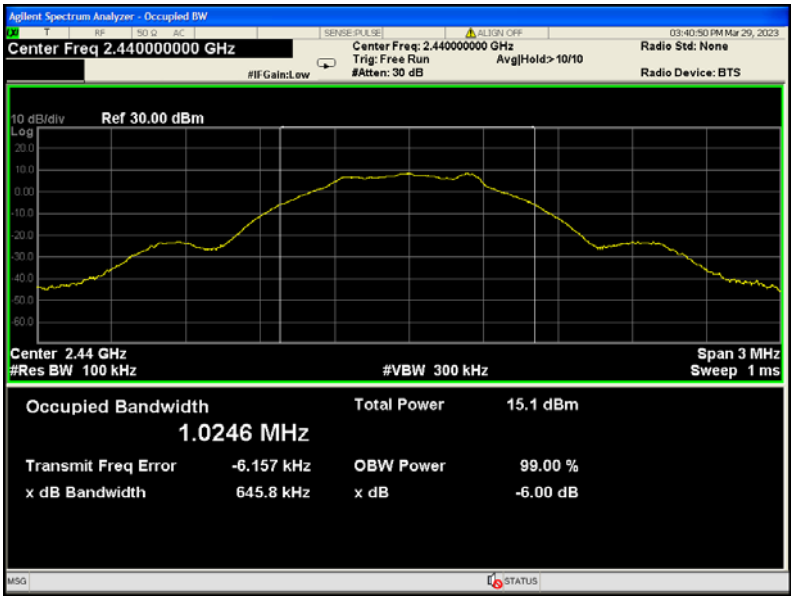


Mode: TX 11n HT40 channel 9

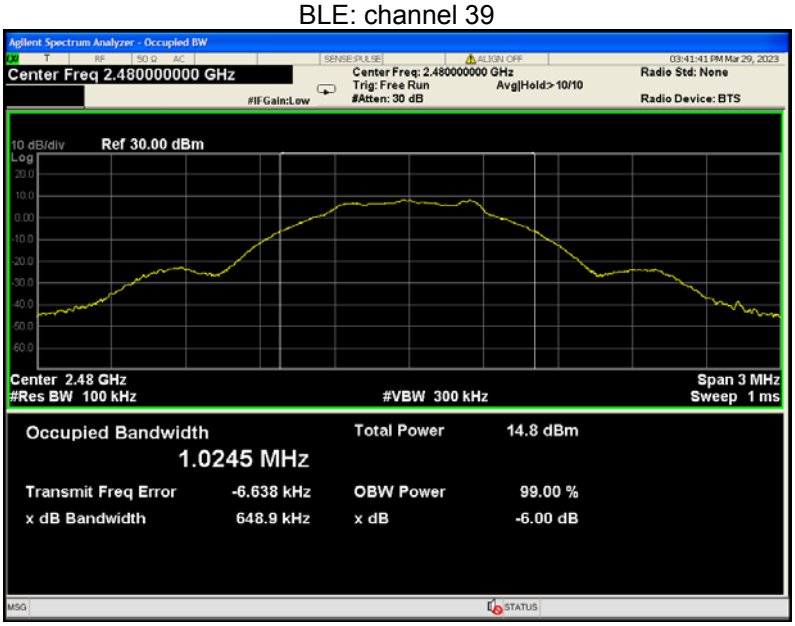


BLE: channel 0

BLE: channel 19

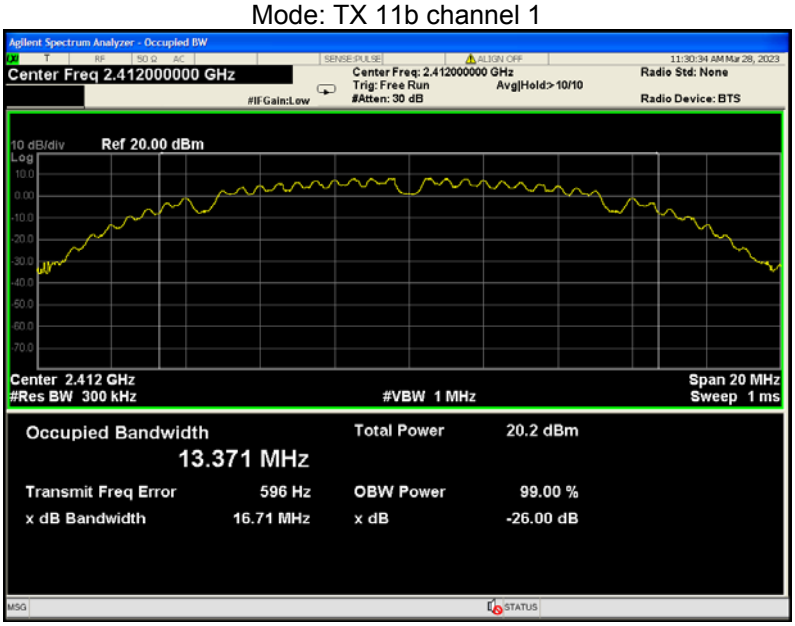


BLE: channel 39

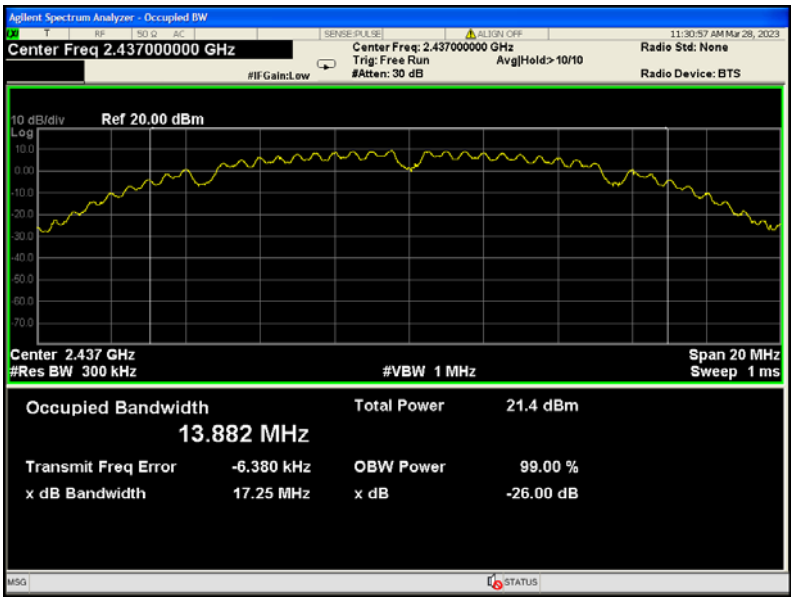


99% Bandwidth

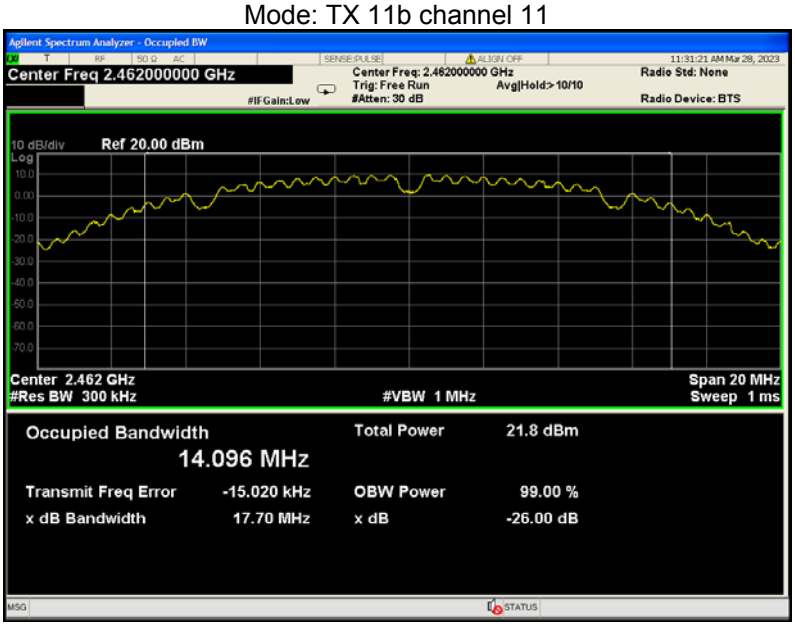
Mode: TX 11b channel 1



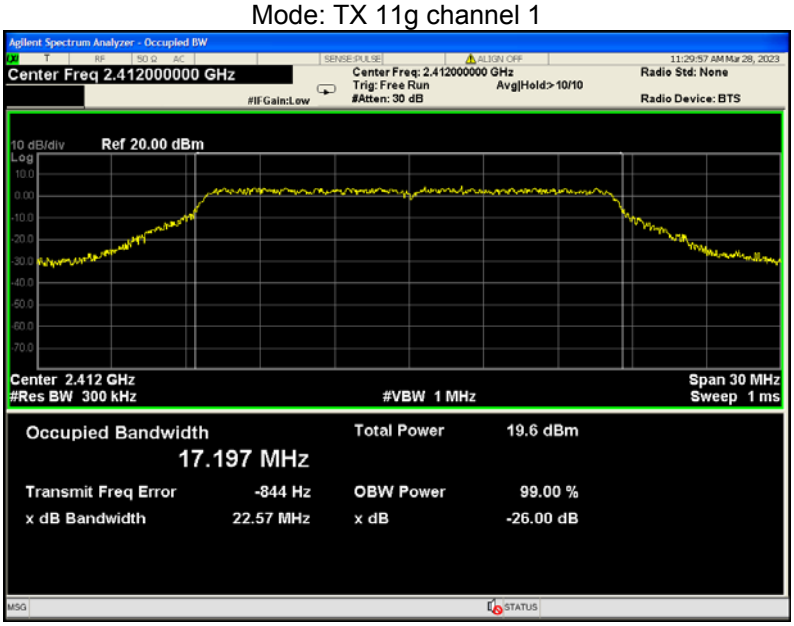
Mode: TX 11b channel 6



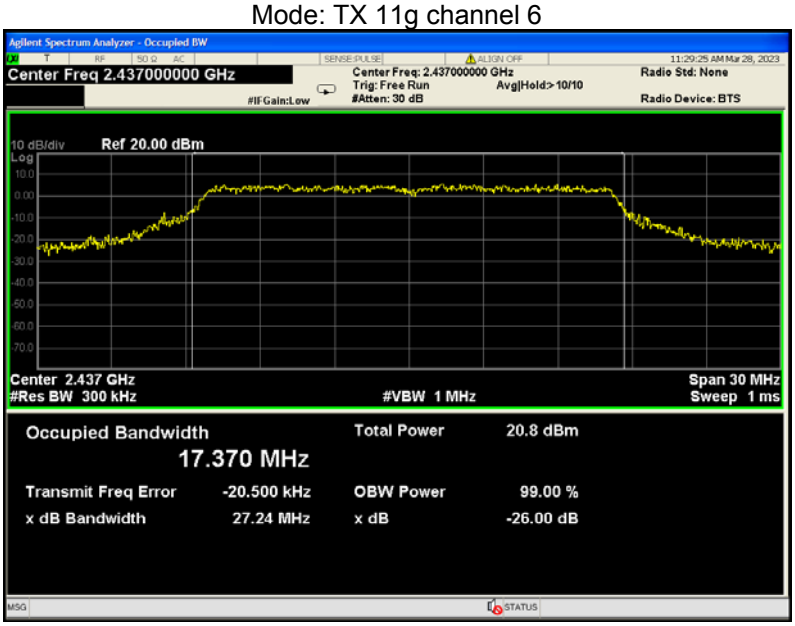
Mode: TX 11b channel 11



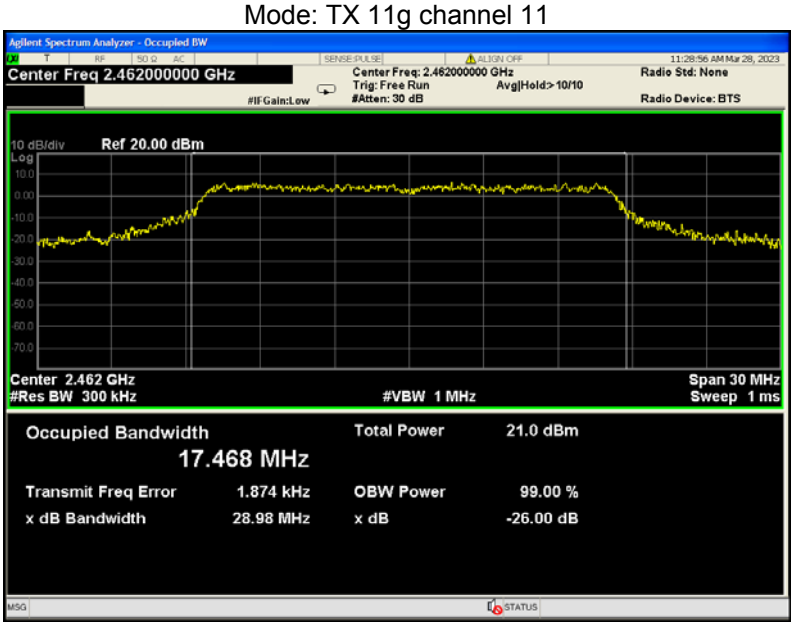
Mode: TX 11g channel 1



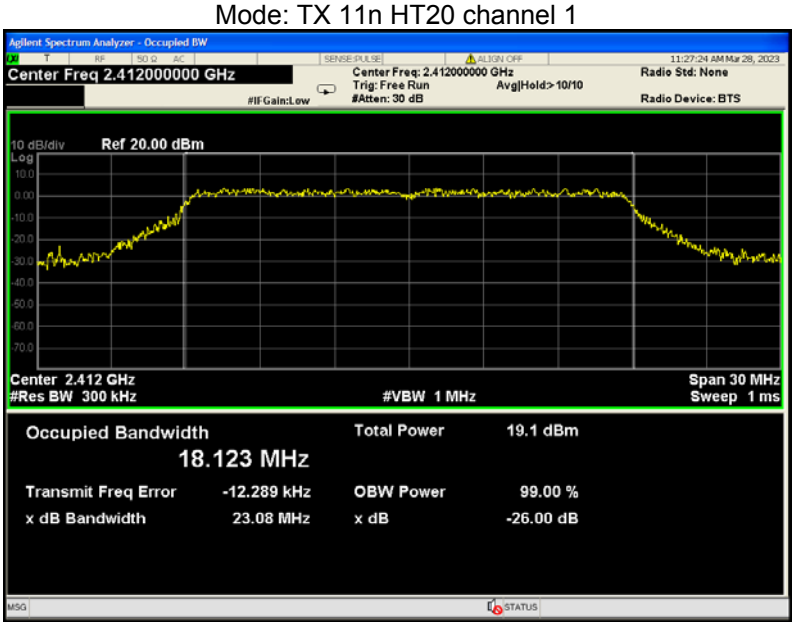
Mode: TX 11g channel 6



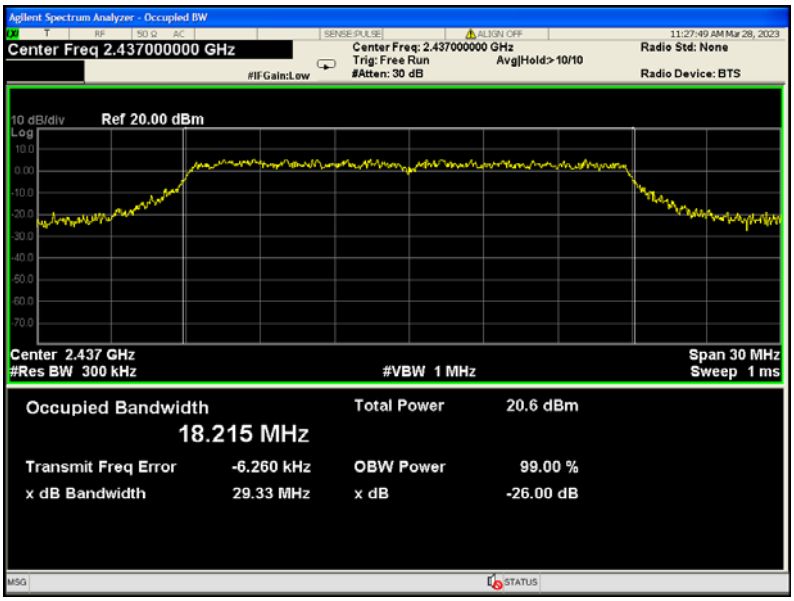
Mode: TX 11g channel 11



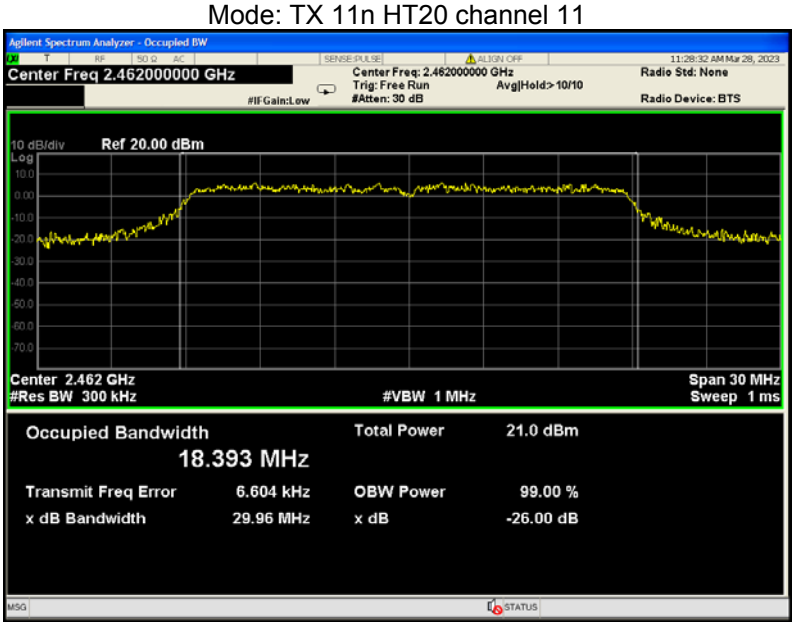
Mode: TX 11n HT20 channel 1



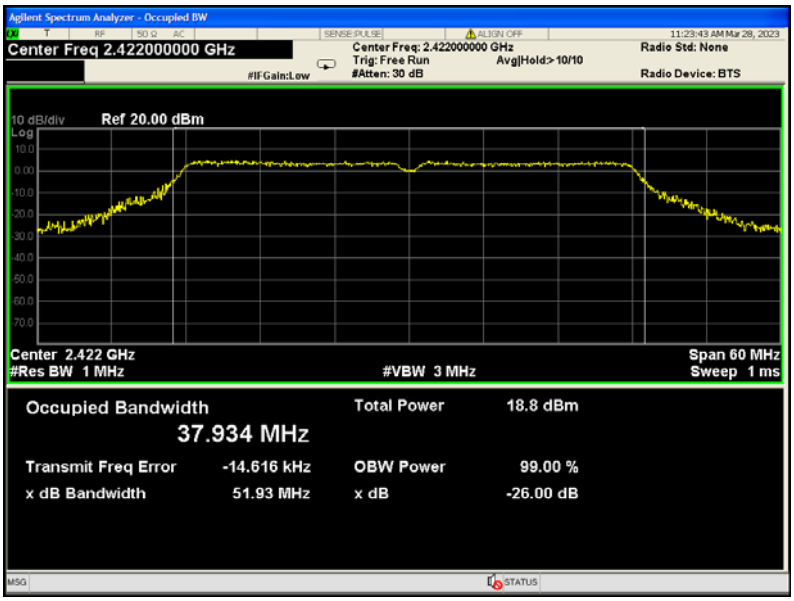
Mode: TX 11n HT20 channel 6



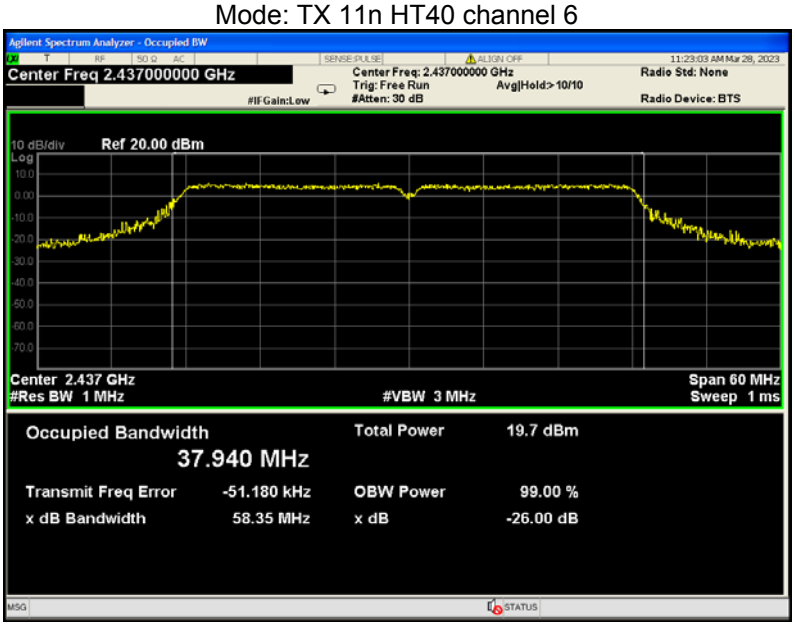
Mode: TX 11n HT20 channel 11



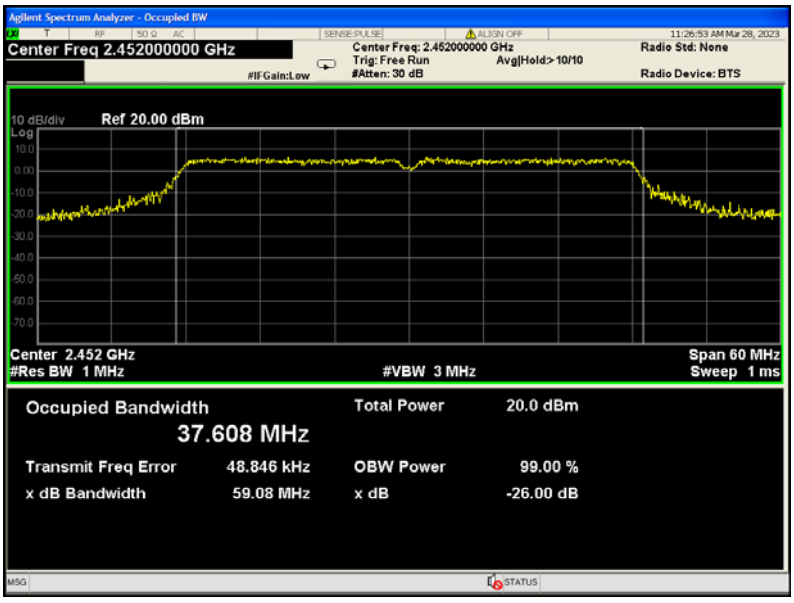
Mode: TX 11n HT40 channel 3



Mode: TX 11n HT40 channel 6

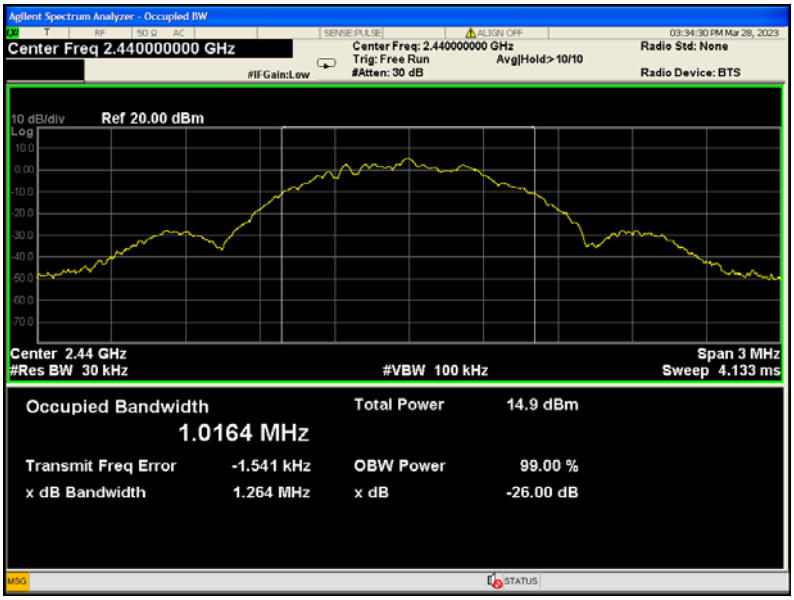


Mode: TX 11n HT40 channel 9



BLE: channel 0

BLE: channel 19



BLE: channel 39

12 Maximum Peak conducted Output Power

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019;
ANSI C63.10:2013

12.1 Test Procedure:

KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019

section 8.3.1.1 (For BLE)

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

a)Set the RBW ≥ DTS bandwidth.

b)Set VBW ≥ 3 RBW.

c)Set span ≥ 3 x RBW

d)Sweep time = auto couple.

e)Detector = peak.

f)Trace mode = max hold.

g)Allow trace to fully stabilize.

h)Use peak marker function to determine the peak amplitude level.

section 8.3.1.2 (For WIFI)

This procedure may be used when the maximum available RBW of the measurement instrument is less than the DTS bandwidth.

a)Set the RBW = 1% to 5% of the OBW, not to exceed 1 MHz..

b)Set the VBW ≥ 3 x RBW

c)Set the span ≥ 1.5 x OBW.

d)Detector = RMS.

e)Sweep time = auto couple.

f) trigger = free run..

g) Number of points in sweep _ [2 × span / RBW]. (This gives bin-to-bin spacing _ RBW / 2, so that narrowband signals are not lost between frequency bins.)

h) Trace average at least 100 traces in power averaging (rms) mode.

i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum..

12.2 Test Result:

2.4G Wi-Fi:

Operation mode	Channel Frequency (MHz)	Measurements (dBm)	Duty Cycle Factor (dB)	Conducted Output Power (dBm)	Limit
TX 11b	Low-2412	19.42	0	19.42	1W/30dBm
	Middle-2437	19.45		19.45	1W/30dBm
	High-2462	19.31		19.31	1W/30dBm
TX 11g	Low-2412	20.76	0	20.76	1W/30dBm
	Middle-2437	20.09		20.09	1W/30dBm
	High-2462	20.06		20.06	1W/30dBm
TX 11n HT20	Low-2412	20.75	0	20.75	1W/30dBm
	Middle-2437	20.16		20.16	1W/30dBm
	High-2462	20.27		20.27	1W/30dBm
TX 11n HT40	Low-2422	21.04	0	**21.04**	1W/30dBm
	Middle-2437	20.14		20.14	1W/30dBm
	High-2452	19.62		19.62	1W/30dBm

BLE:

Operation mode	Channel Frequency (MHz)	Maximum Peak Output Power (dBm)	Limit
BLE	Low-2402	**8.793**	1W/30dBm
	Middle-2440	8.362	1W/30dBm
	High-2480	7.696	1W/30dBm