RF TEST REPORT

Applicant	Xiaomi Communications Co., Ltd.
FCC ID	2AFZZJ20SG
Product	Mobile Phone
Brand	POCO
Model	M2102J20SG
Report No.	R2012A0844-R5
Issue Date	January 19, 2021

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2019)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Approved by: Kai Xu

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Summary of measurement results

Number	Test Case	Clause in FCC rules	Verdict
1	Maximum output powe	15.247(b)(3)	PASS
2	6 dB bandwidth	15.247(a)(2)	PASS
3	Power spectral density	15.247(e)	PASS
4	Band Edge	15.247(d)	PASS
5	Spurious RF Conducted Emissions	15.247(d)	PASS
6	Unwanted Emissions	15.247(d),15.205,15.209	PASS
7	Conducted Emissions	15.207	PASS
Date of Testing: December 19, 2020 ~January 12, 2021			
Date of Sample Received: December 14, 2020			
Note: All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

1. Test Laboratory

1.1. Notes of the test report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 3857.01)

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3. Testing Location

Company:	TA Technology (Shanghai) Co., Ltd.
Address:	No.145, Jintang Rd, Tangzhen Industry Park, Pudong
City:	Shanghai
Post code:	201201
Country:	P. R. China
Contact:	Xu Kai
Telephone:	+86-021-50791141/2/3
Fax:	+86-021-50791141/2/3-8000
Website:	http://www.ta-shanghai.com
E-mail:	xukai@ta-shanghai.com

2. General Description of Equipment under Test

2.1. Applicant and Manufacturer Information

Applicant	Xiaomi Communications Co., Ltd.
Applicant address	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085
Manufacturer	Xiaomi Communications Co., Ltd.
Manufacturer address	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085

2.2. General information

EUT Description			
Model	M2102J20SG		
IMEI	IMEI 1: 864460050025122 IMEI 2: 864460050025130		
Hardware Version	P1		
Software Version	MIUI12		
Power Supply	Battery / AC adapter		
Antenna Type	Internal Antenna		
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)		
Antenna Gain	Band	SISO Antenna 1	SISO Antenna 2
	BLE	-2.93dBi	/
	WIFI 2.4G	-2.93dBi	-3.14dBi
Directional Gain	Without Beamforming Mode for Power: -2.93dBi Without Beamforming Mode for PSD: 0.08dBi With Beamforming Mode for Power: 0.08dBi With Beamforming Mode for PSD: 0.08dBi		
Test Mode	802.11b, 802.11g, 802.11n(HT20/HT40) Bluetooth V5.0 LE		
Modulation Type	802.11b: DSSS 802.11g/n(HT20/HT40): OFDM BLE: GFSK		
Max. Conducted Power	Wi-Fi 2.4G:21.50dBm BLE:6.74dBm		
Operating Frequency Range(s)	802.11b/g/n(HT20): 2412 ~ 2462 MHz 802.11n(HT40): 2422 ~ 2452 MHz BLE: 2402 ~2480 MHz		

Note:1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards:

FCC CFR47 Part 15C (2019) Radio Frequency Devices

ANSI C63.10 (2013)

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

KDB 662911 D01 Multiple Transmitter Output v02r01

4. Test Configuration

Test Mode

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The radiated emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). The worst emission was found in lie-down position (X axis) and the loop antenna is vertical, the others are vertical and horizontal. and the worst case was recorded.

In order to find the worst case condition, Pre-tests are needed at the presence of different data rate. Preliminary tests have been done on all the configuration for confirming worst case. Data rate below means worst-case rate of each test item.

Worst-case data rates are shown as following table.

Test Mode	Data Rate		
	Antenna 1	Antenna 2	MIMO
802.11b	1 Mbps	1 Mbps	/
802.11g	6 Mbps	6 Mbps	/
802.11n HT20	MCS0	MCS0	MCS8
802.11n HT40	MCS0	MCS0	MCS8

The worst case Antenna mode for each of the following tests for Wi-Fi:

Test Cases	Antenna 1	Antenna 2	MIMO
Maximum conducted output power	O	O	O
6dB Bandwidth	--	--	O
Band Edge	--	--	O
Power Spectral Density	O	O	O
Spurious RF Conducted Emissions	--	--	O
Unwanted Emissions	--	--	O
Conducted Emission	--	--	O
Note: “O”: test all bands			

According to RF Output power results in chapter 5.1, MIMO was selected as the worst antenna.

5. Test Case Results

5.1. Maximum output power

Ambient condition

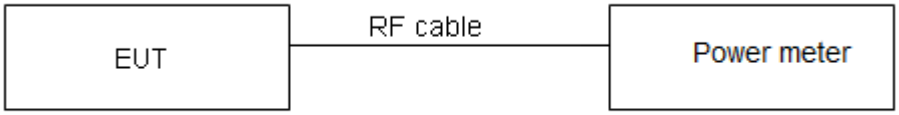
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

During the process of the testing, The EUT was connected to Power meter with a known loss. The EUT is max power transmission with proper modulation.

The conducted Power is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically.

Test Setup



Limits

Rule Part 15.247 (b) (3) specifies that " For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz: 1 Watt."

Average Output Power	≤ 1W (30dBm)

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.44 dB.

Test Results

Test Mode	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11b	12.21	12.30	0.99	NA
802.11g	2.03	2.08	0.98	NA
802.11n HT20	1.90	1.93	0.98	NA
802.11n HT40	0.93	0.98	0.95	0.25
BLE (1M)	0.38	0.62	0.62	2.07
BLE (2M)	0.22	0.63	0.34	4.66
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.				

Power Index							
Packet Type	Carrier frequency (MHz)	SISO Antenna		MIMO Antenna			
				Without Beamforming		With Beamforming	
		ANT1	ANT2	ANT1	ANT2	ANT1	ANT2
802.11b	2412	18.5	18.5	18.5	18.5	18.5	18.5
	2437	18.5	18.5	18.5	18.5	18.5	18.5
	2462	18.5	18.5	18.5	18.5	18.5	18.5
802.11g	2412	16	16	16	16	16	16
	2437	16	16	16	16	16	16
	2462	16	16	16	16	16	16
802.11n HT20	2412	13	13	13	13	13	13
	2437	13	13	13	13	13	13
	2462	13	13	13	13	13	13
802.11n HT40	2422	11	11	11	11	11	11
	2437	10	10	10	10	10	10
	2452	10	10	10	10	10	10

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy) (1M)	2402	2.86	4.93	30	PASS
	2440	3.12	5.19	30	PASS
	2480	4.67	6.74	30	PASS
Bluetooth (Low Energy) (2M)	2402	0.04	4.70	30	PASS
	2440	0.51	5.17	30	PASS
	2480	1.80	6.46	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

SISO Antenna 1:

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412	18.44	18.44	30	PASS
	2437	18.73	18.73	30	PASS
	2462	18.85	18.85	30	PASS
802.11g	2412	15.57	15.57	30	PASS
	2437	15.85	15.85	30	PASS
	2462	15.79	15.79	30	PASS
802.11n HT20	2412	12.68	12.68	30	PASS
	2437	13.06	13.06	30	PASS
	2462	12.97	12.97	30	PASS
802.11n HT40	2422	11.03	11.28	30	PASS
	2437	10.46	10.71	30	PASS
	2452	10.35	10.60	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

SISO Antenna 2:

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412	18.41	18.41	30	PASS
	2437	18.33	18.33	30	PASS
	2462	18.37	18.37	30	PASS
802.11g	2412	15.49	15.49	30	PASS
	2437	15.77	15.77	30	PASS
	2462	15.64	15.64	30	PASS
802.11n HT20	2412	12.48	12.48	30	PASS
	2437	12.61	12.61	30	PASS
	2462	12.82	12.82	30	PASS
802.11n HT40	2422	11.83	12.08	30	PASS
	2437	10.25	10.50	30	PASS
	2452	10.16	10.41	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

MIMO

Without Beamforming

Test Mode	Carrier frequency (MHz)	MIMO Antenna 1		MIMO Antenna 2		Total Power (dBm)	Limit (dBm)	Conclusion
		Average Power Measured (dBm)	Average Power with duty factor (dBm)	Average Power Measured (dBm)	Average Power with duty factor (dBm)			
802.11b	2412	18.35	18.35	18.25	18.25	21.31	30	PASS
	2437	18.63	18.63	18.26	18.26	21.46	30	PASS
	2462	18.66	18.66	18.31	18.31	21.50	30	PASS
802.11g	2412	15.52	15.52	15.46	15.46	18.50	30	PASS
	2437	15.78	15.78	15.71	15.71	18.76	30	PASS
	2462	15.61	15.61	15.52	15.52	18.58	30	PASS
802.11n HT20	2412	12.53	12.53	12.36	12.36	15.46	30	PASS
	2437	12.89	12.89	12.57	12.57	15.74	30	PASS
	2462	12.79	12.79	12.71	12.71	15.76	30	PASS
802.11n HT40	2422	11.84	12.09	10.63	10.88	14.53	30	PASS
	2437	10.34	10.59	10.02	10.27	13.44	30	PASS
	2452	10.21	10.46	9.98	10.23	13.35	30	PASS

Note: 1.Average Power with duty factor = Average Power Measured +Duty cycle correction factor

2. For Total Power, according to KDB 662911 D01 Multiple Transmitter Output v02r01 1),

The Total Power =$10\log(10^{(\text{Power antenna1 in dBm}/10)}+10^{(\text{Power antenna2 in dBm}/10)})$.

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{ss}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain,

Directional gain = G_{ANT} + Array Gain,

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;

Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};

Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less, for 20-MHz channel widths with $N_{ANT} \geq 5$.

4.If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

So directional gain = G_{ANT} + Array Gain =-2.93+0=-2.93dBi<6dBi. So the power limit is 30dBm

With Beamforming

Test Mode	Carrier frequency (MHz)	MIMO Antenna 1		MIMO Antenna 2		Total Power (dBm)	Limit (dBm)	Conclusion
		Average Power Measured (dBm)	Average Power with duty factor (dBm)	Average Power Measured (dBm)	Average Power with duty factor (dBm)			
802.11b	2412	18.33	18.33	18.23	18.23	21.29	30	PASS
	2437	18.61	18.61	18.25	18.25	21.44	30	PASS
	2462	18.63	18.63	18.30	18.30	21.48	30	PASS
802.11g	2412	15.51	15.51	15.44	15.44	18.49	30	PASS
	2437	15.76	15.76	15.70	15.70	18.74	30	PASS
	2462	15.57	15.57	15.51	15.51	18.55	30	PASS
802.11n HT20	2412	12.51	12.51	12.35	12.35	15.44	30	PASS
	2437	12.84	12.84	12.52	12.52	15.69	30	PASS
	2462	12.76	12.76	12.67	12.67	15.73	30	PASS
802.11n HT40	2422	10.82	11.07	10.62	10.87	13.98	30	PASS
	2437	10.33	10.58	10.01	10.26	13.43	30	PASS
	2452	10.20	10.45	9.95	10.20	13.33	30	PASS

Note: 1.Average Power with duty factor = Average Power Measured +Duty cycle correction factor

2. For Total Power, according to KDB 662911 D01 Multiple Transmitter Output v02r01 1),

The Total Power $=10\log(10^{(\text{Power antenna1 in dBm}/10)}+10^{(\text{Power antenna2 in dBm}/10)})$.

3. The manufacturer declared the transmitter output signals is CDD mode. And $N_{ss}=1$. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For power measurements on all devices, Array Gain=10log(Nant/Nss)dB.

4.If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

So directional gain=GANT+Array Gain=-2.93+10log(2/1)= 0.08<6dBi, so the power limit is 30dBm.

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient condition

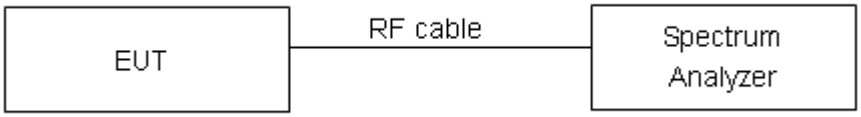
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable. RBW is set to 100 kHz; VBW is set to 300 kHz on spectrum analyzer.
Dector=Peak, Trace mode=max hold.

The EUT was connected to the spectrum analyzer through a known loss cable. The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

Test Setup



Limits

Rule Part 15.247 (a) (2) specifies that “Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.”

minimum 6 dB bandwidth	≥ 500 kHz

Measurement Uncertainty

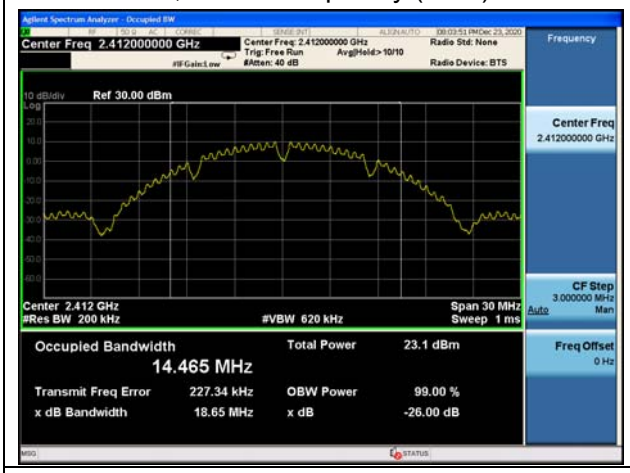
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 936 Hz.

Test Results:

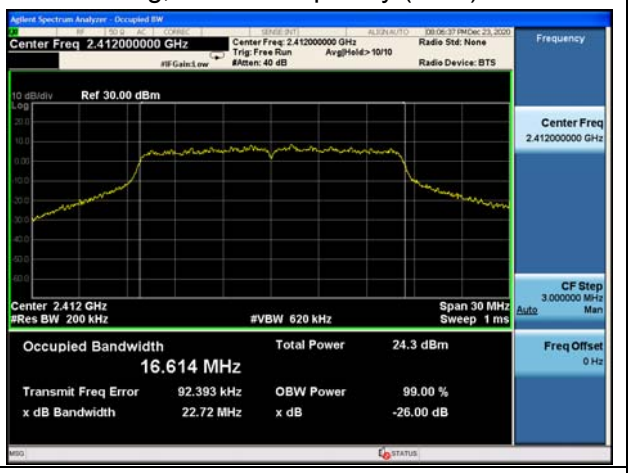
Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	14.465	9.094	500	PASS
	2437	14.889	9.084	500	PASS
	2462	15.041	9.580	500	PASS
802.11g	2412	16.614	15.47	500	PASS
	2437	16.691	15.68	500	PASS
	2462	16.685	15.51	500	PASS
802.11n HT20	2412	17.789	16.10	500	PASS
	2437	17.876	17.15	500	PASS
	2462	17.790	16.33	500	PASS
802.11n HT40	2422	36.059	35.11	500	PASS
	2437	36.290	36.08	500	PASS
	2452	36.132	35.50	500	PASS
Bluetooth (Low Energy) (1M)	2402	1.0185	0.661	500	PASS
	2440	1.0226	0.661	500	PASS
	2480	1.0206	0.659	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.0286	1.155	500	PASS
	2440	2.0280	1.112	500	PASS
	2480	2.0328	1.135	500	PASS

99%bandwidth

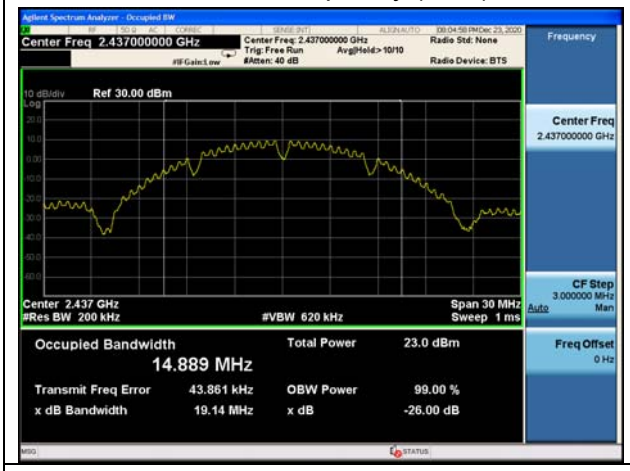
802.11b, Carrier frequency (MHz): 2412



802.11g, Carrier frequency (MHz): 2412

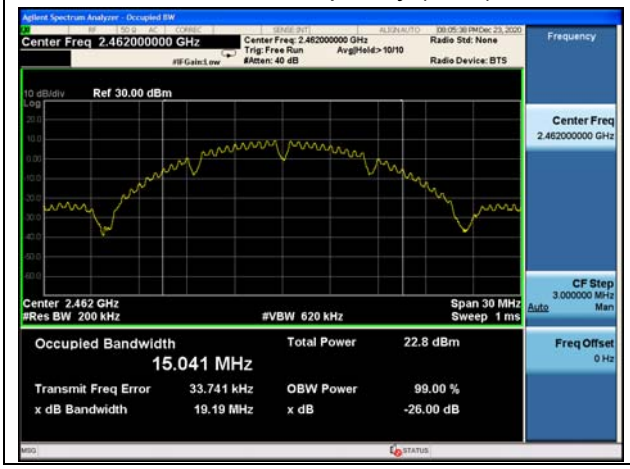


802.11b, Carrier frequency (MHz): 2437



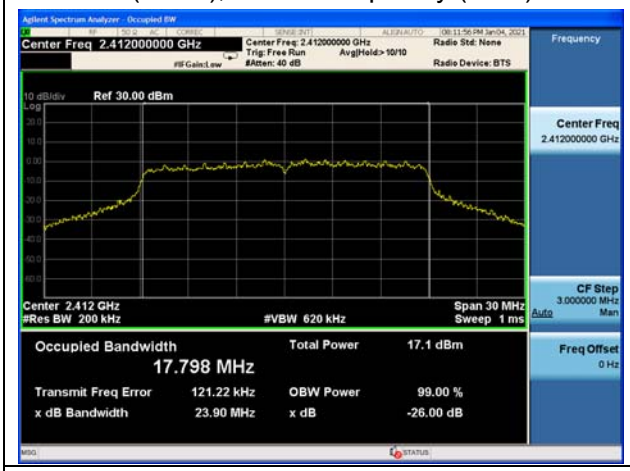
802.11g, Carrier frequency (MHz): 2437

802.11b, Carrier frequency (MHz):2462

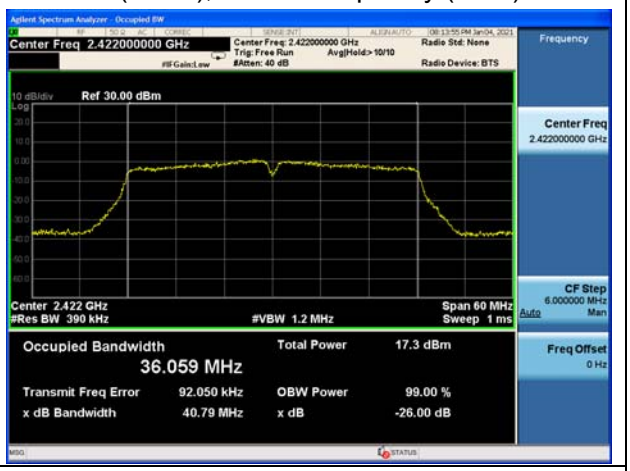


802.11g, Carrier frequency (MHz):2462

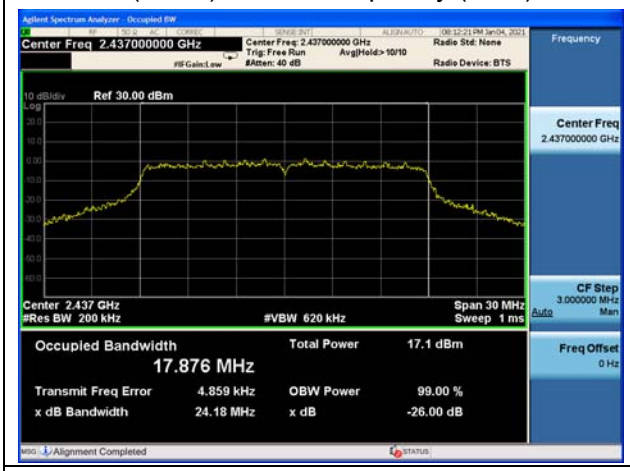
802.11n(HT20), Carrier frequency (MHz): 2412



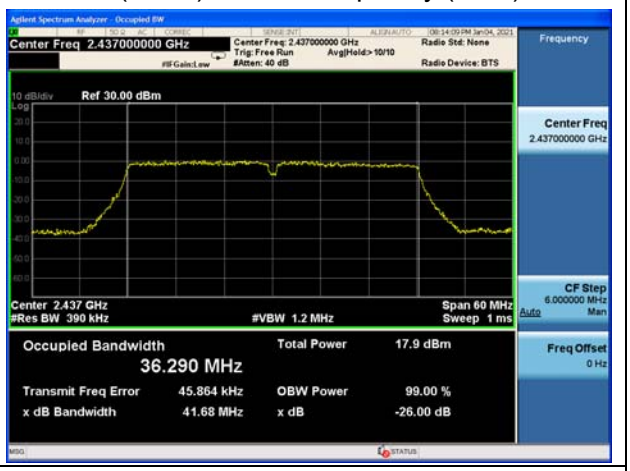
802.11n(HT40), Carrier frequency (MHz): 2422



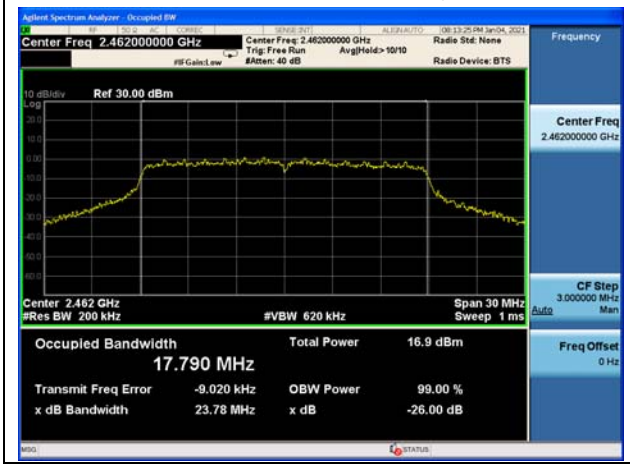
802.11n(HT20), Carrier frequency (MHz): 2437



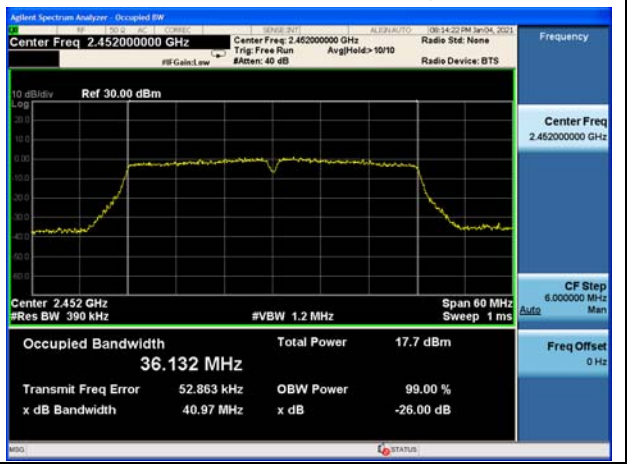
802.11n(HT40), Carrier frequency (MHz): 2437



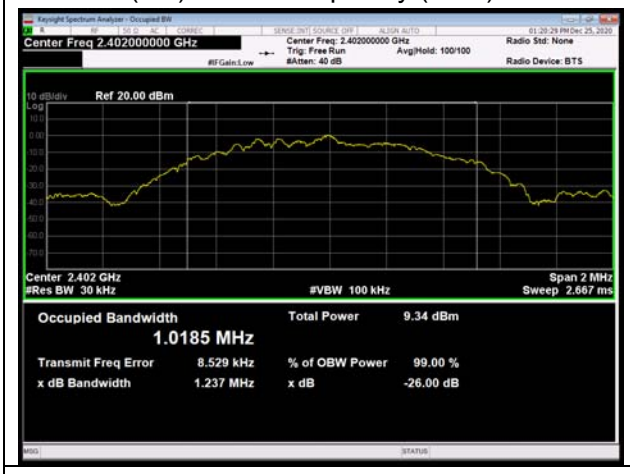
802.11n(HT20), Carrier frequency (MHz):2462



802.11n(HT40), Carrier frequency (MHz):2452

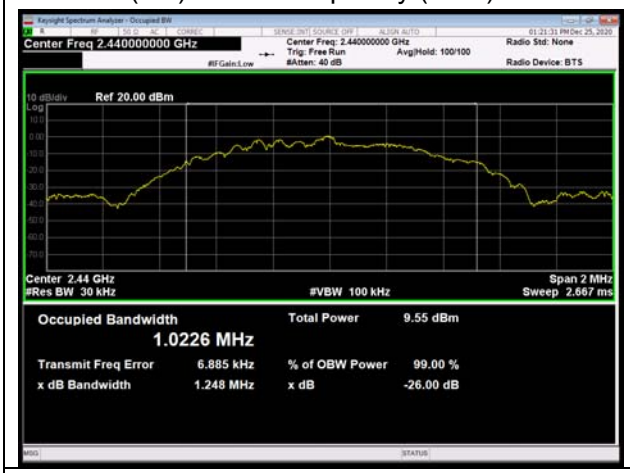


BLE (1M) Carrier frequency (MHz): 2402

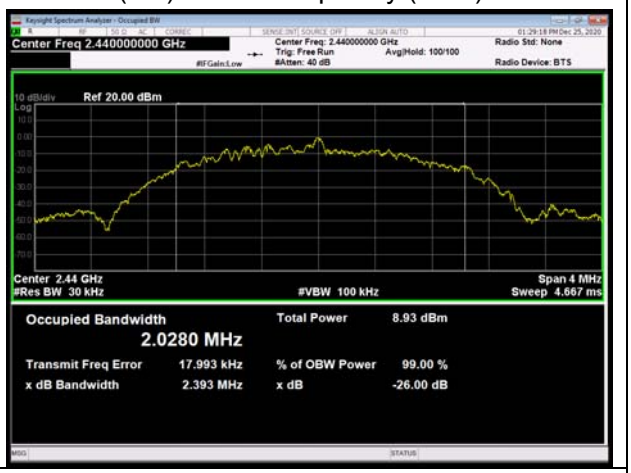


BLE (2M) Carrier frequency (MHz): 2402

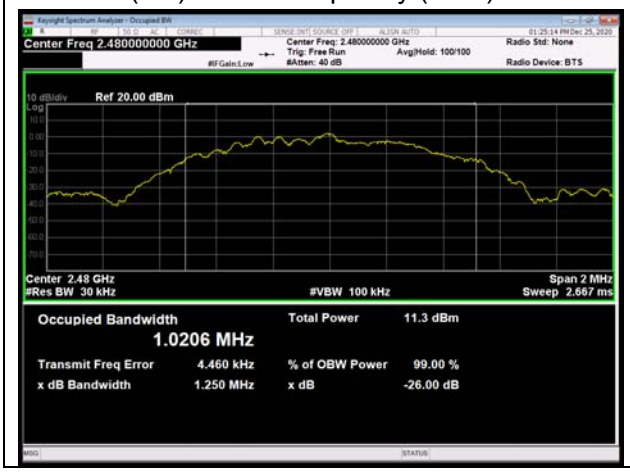
BLE (1M) Carrier frequency (MHz): 2440



BLE (2M) Carrier frequency (MHz): 2440



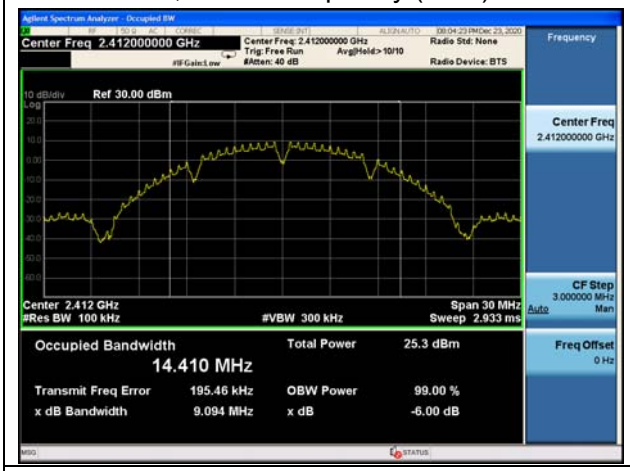
BLE (1M) Carrier frequency (MHz): 2480



BLE (2M) Carrier frequency (MHz): 2480

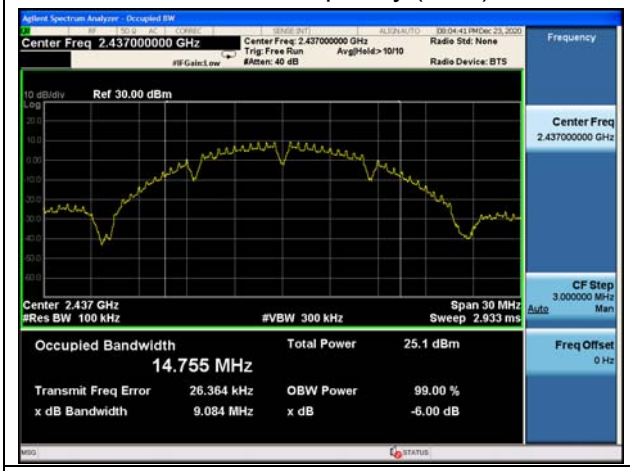
6 dB bandwidth

802.11b, Carrier frequency (MHz): 2412



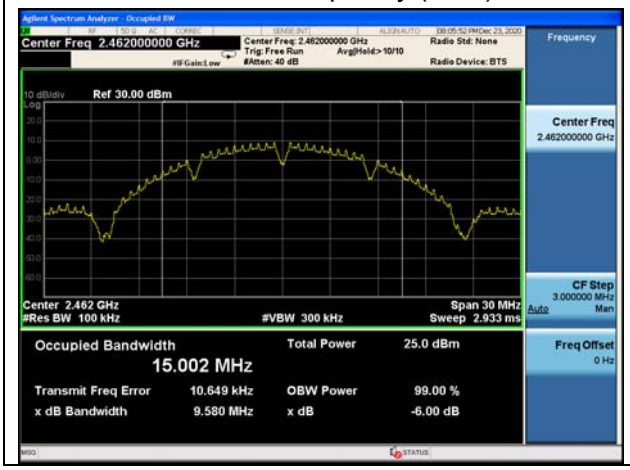
802.11g, Carrier frequency (MHz): 2412

802.11b, Carrier frequency (MHz): 2437



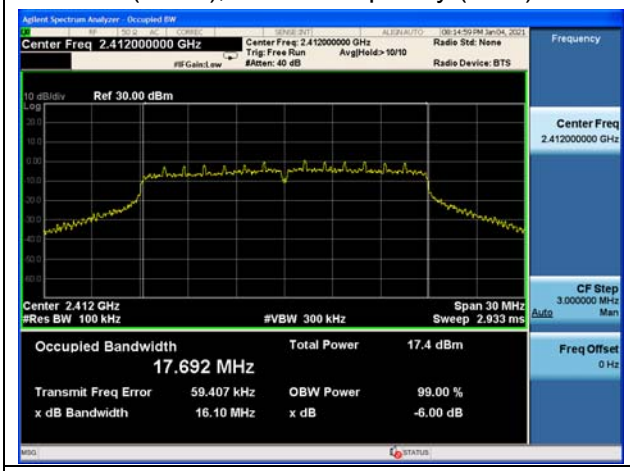
802.11g, Carrier frequency (MHz): 2437

802.11b, Carrier frequency (MHz):2462

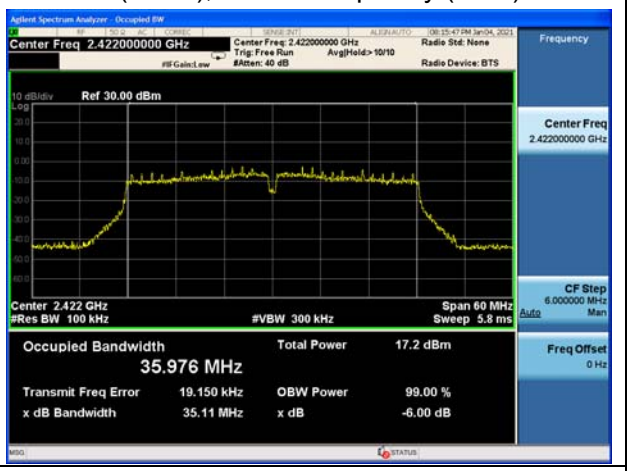


802.11g, Carrier frequency (MHz):2462

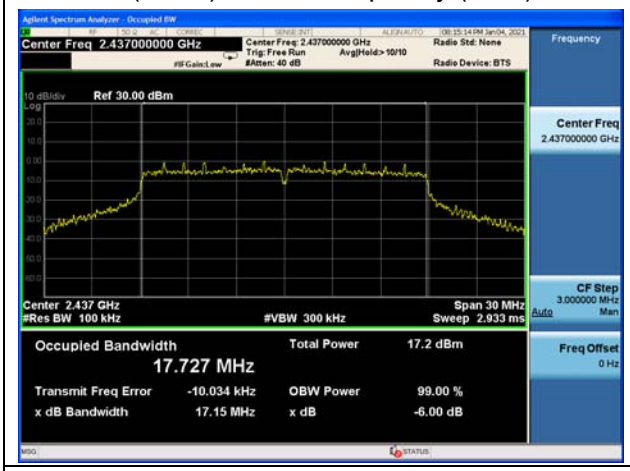
802.11n(HT20), Carrier frequency (MHz): 2412



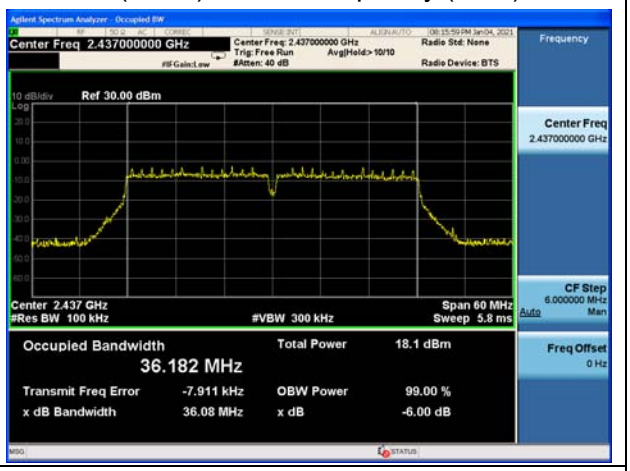
802.11n(HT40), Carrier frequency (MHz): 2422



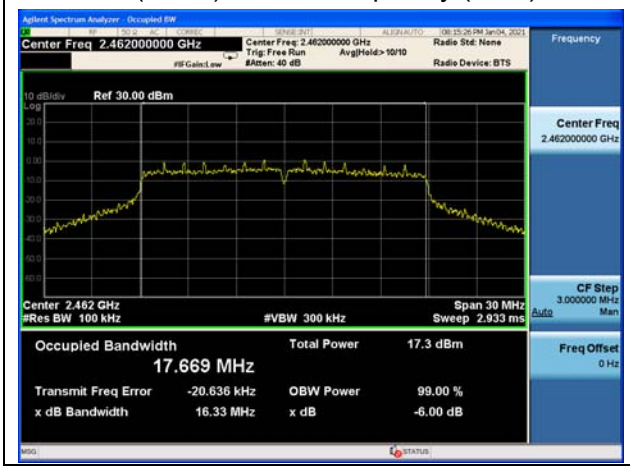
802.11n(HT20), Carrier frequency (MHz): 2437



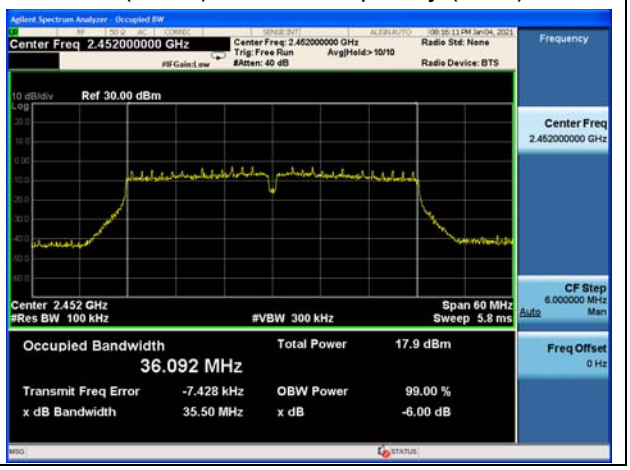
802.11n(HT40), Carrier frequency (MHz): 2437



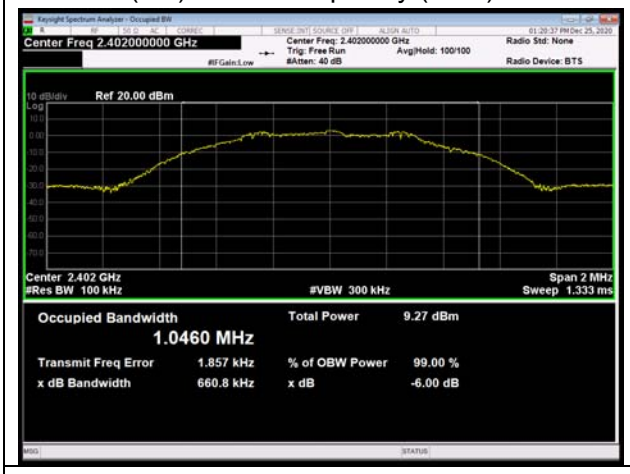
802.11n(HT20), Carrier frequency (MHz):2462



802.11n(HT40), Carrier frequency (MHz):2452

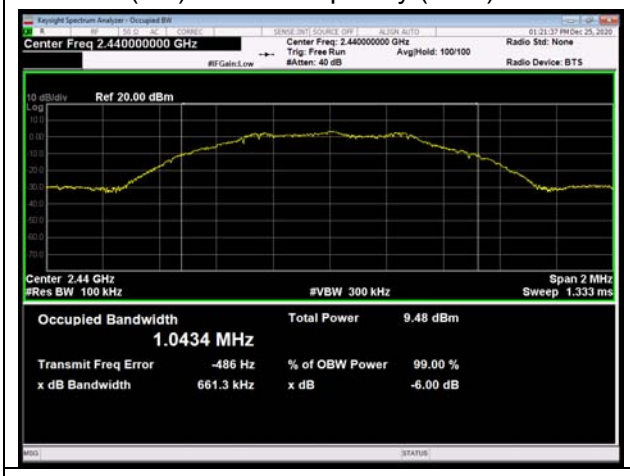


BLE (1M) Carrier frequency (MHz): 2402

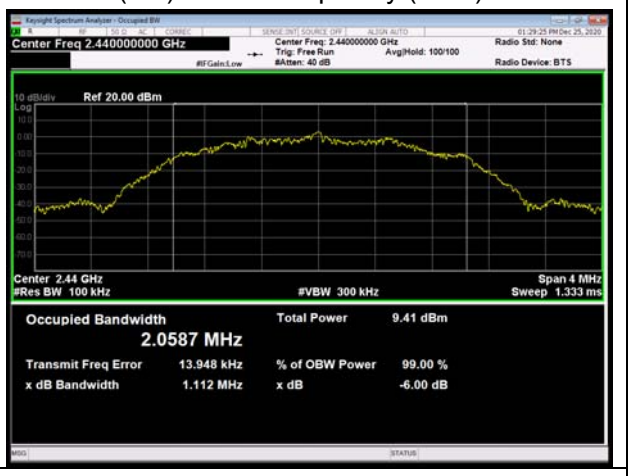


BLE (2M) Carrier frequency (MHz): 2402

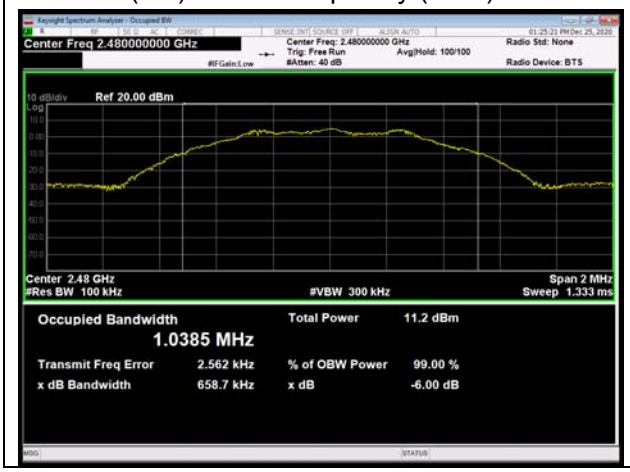
BLE (1M) Carrier frequency (MHz): 2440



BLE (2M) Carrier frequency (MHz): 2440



BLE (1M) Carrier frequency (MHz): 2480



BLE (2M) Carrier frequency (MHz): 2480

5.3. Band Edge

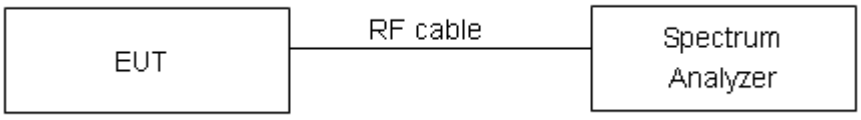
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

Rule Part 15.247(d) specifies that “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.”

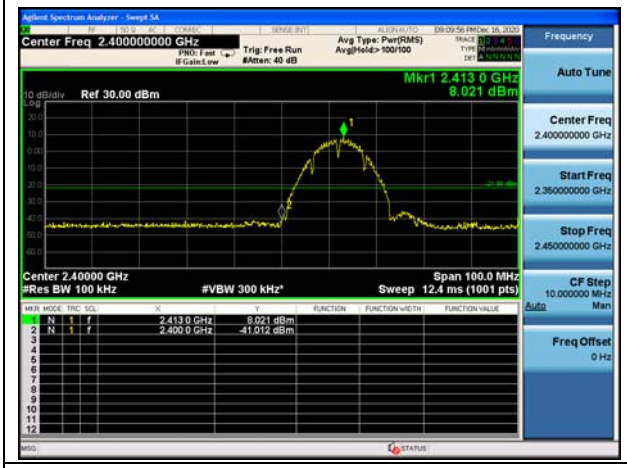
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

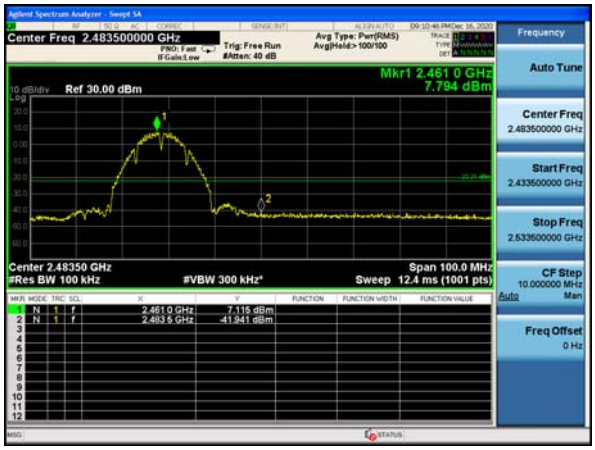
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

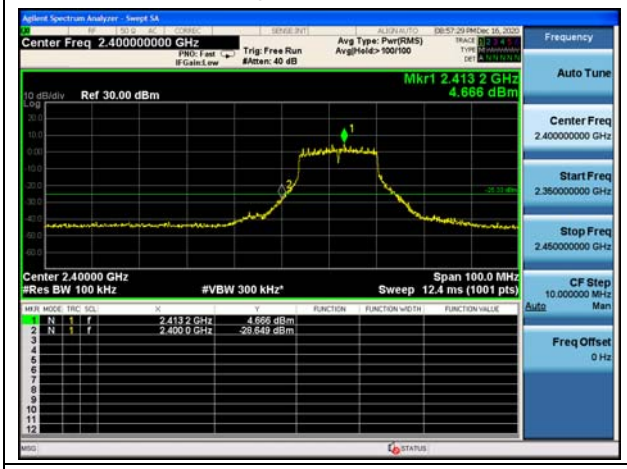
802.11b, Channel No.: 1



802.11b, Channel No.: 11

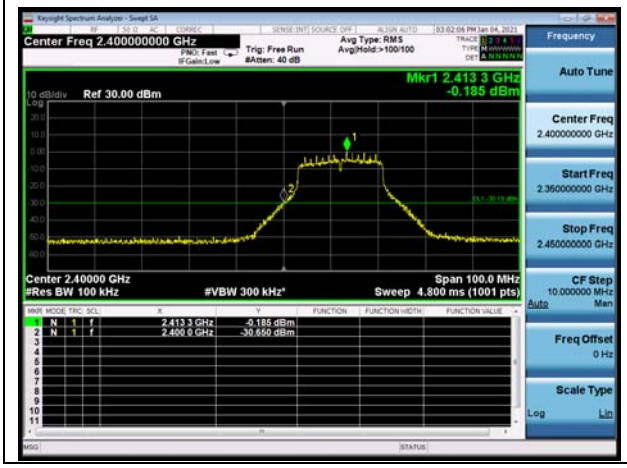


802.11g, Channel No.: 1

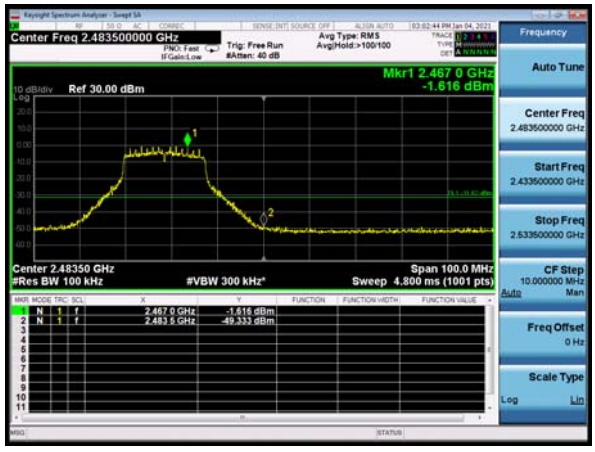


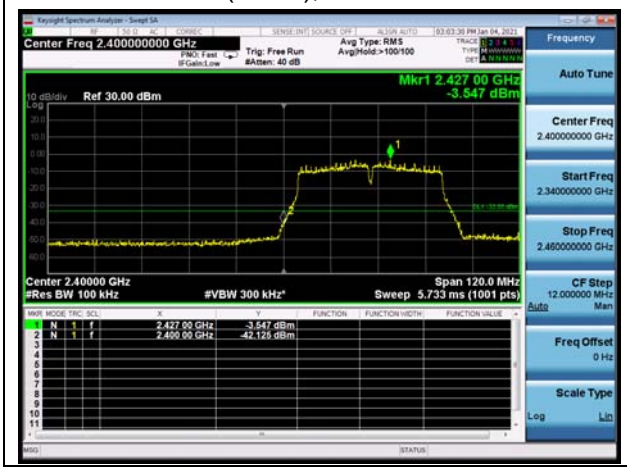
802.11g, Channel No.: 11

802.11n(HT20), Channel No.: 1

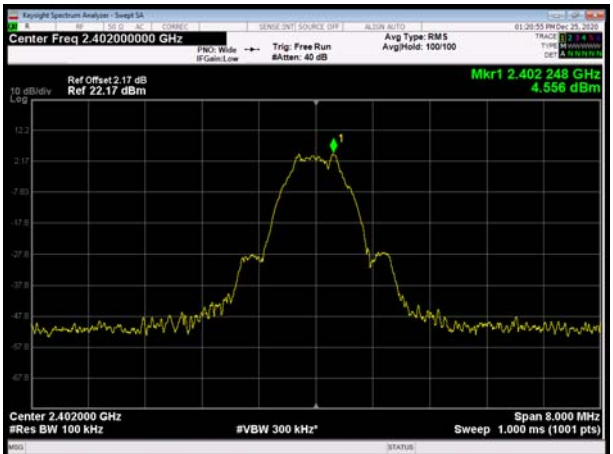


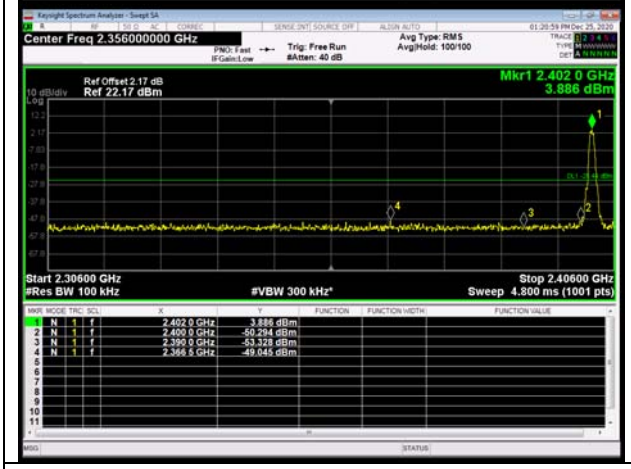
802.11n(HT20), Channel No.: 11



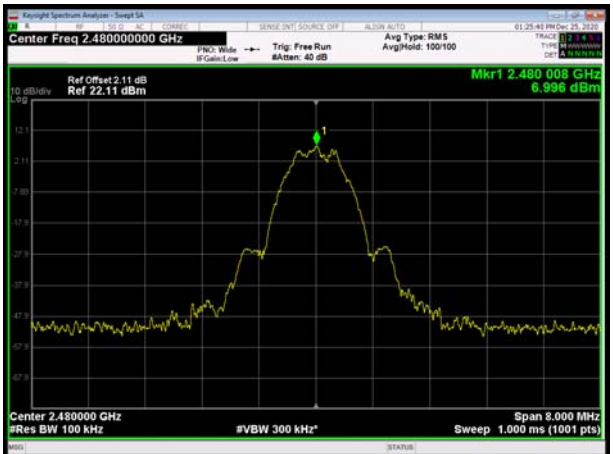
802.11n(HT40), Channel No.: 3	802.11n(HT40), Channel No.: 9
	

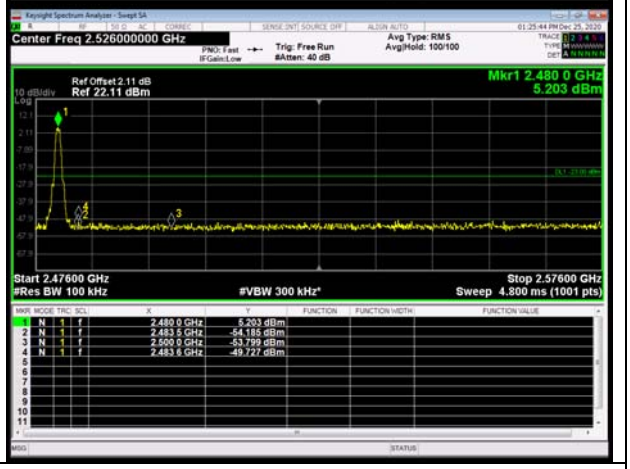
BLE (1M), Channel No.: 0



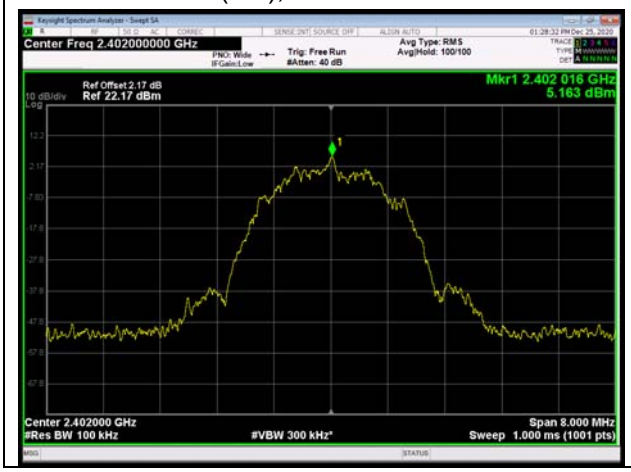


BLE (1M), Channel No.: 39

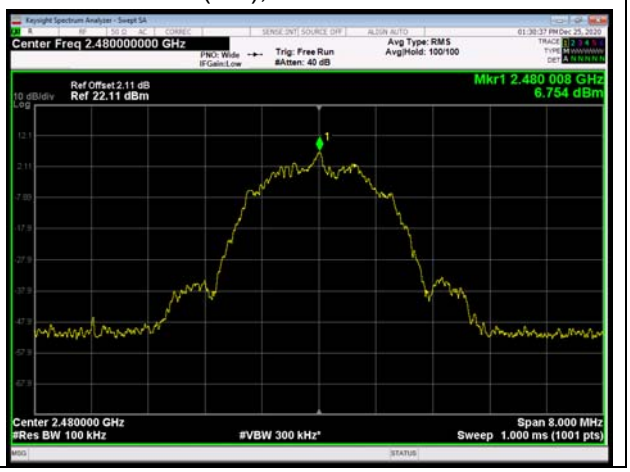


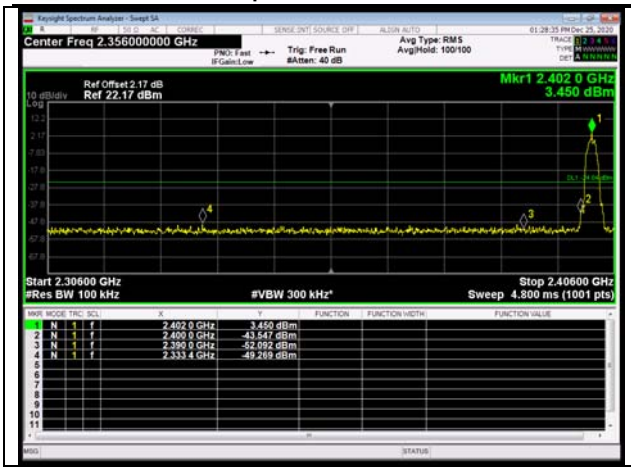


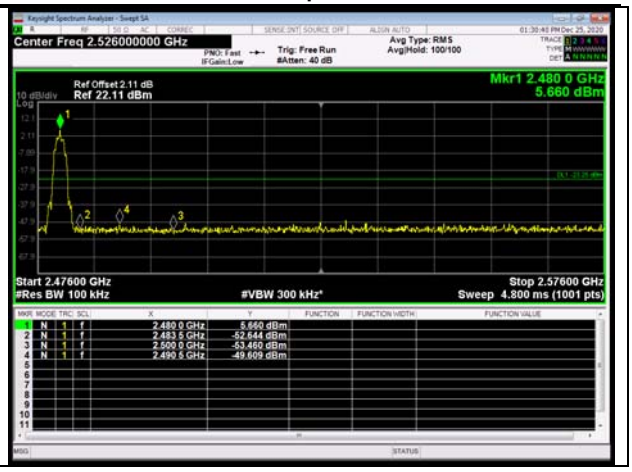
BLE (2M), Channel No.: 0



BLE (2M), Channel No.: 39







5.4. Power Spectral Density

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation.

Method AVGPSD-1 was used for this test.

a) Set instrument center frequency to DTS channel center frequency

b) Set span to at least 1.5 times the OBW

c) Set RBW to:3kHz≤RBW≤100kHz

d) Set VBW≥[3x RBW]

e) Detector=power averaging(rms) or sample detector(when rms not available)

f) Ensure that the number of measurement points in the sweep 2[2 X span/RBWT]

g)Sweep time auto couple

h) Employ trace averaging(rms) mode over a minimum of 100 traces

i) Use the peak marker function to determine the maximum amplitude level.

j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat(note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

Method AVGPSD-2 was used for this test.

a) Measure the duty cycle(D)of the transmitter output signal as described in 11.6

b) Set instrument center frequency to DTS channel center frequency

c)Set span to at least 1.5 times the OBW

d) Set RBW to:3kHz≤RBW≤100Kh

e) Set VBW≥[3x RBW]

f)Detector= power averaging(rms) or sample detector (when rms not available)

g) Ensure that the number of measurement points in the sweep 2[2 X span/RBW]

h) Sweep time =auto couple

i) Do not use sweep triggering; allow sweep to "free run”

j) Employ trace averaging(rms) mode over a minimum of 100 traces

k) Use the peak marker function to determine the maximum amplitude level

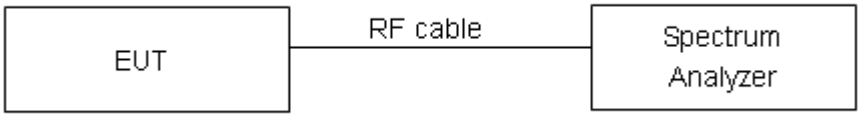
l) Add [10 log(1/ D)], where D is the duty cycle measured in step a), to the measured PSD to

compute the average PSD during the actual transmission time

m) If measured value exceeds requirement specified by regulatory agency then reduce RBW(but o less than 3 kHz) and repeat(note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

The conducted Power is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically.

Test setup



Limits

Rule Part 15.247(e) specifies that" 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. ''

Limits	≤ 8 dBm / 3kHz

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.75dB.

Test Results:

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy) (1M)	0	-13.02	-10.95	8	PASS
	19	-12.22	-10.15	8	PASS
	39	-10.83	-8.77	8	PASS
Bluetooth (Low Energy) (2M)	0	-17.72	-13.06	8	PASS
	19	-17.98	-13.33	8	PASS
	39	-14.82	-10.16	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

SISO Antenna 1:

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-14.31	-14.31	8	PASS
	6	-14.17	-14.17	8	PASS
	11	-14.06	-14.06	8	PASS
802.11g	1	-17.82	-17.82	8	PASS
	6	-17.37	-17.37	8	PASS
	11	-17.18	-17.18	8	PASS
802.11n HT20	1	-25.15	-25.15	8	PASS
	6	-24.67	-24.67	8	PASS
	11	-24.44	-24.44	8	PASS
802.11n HT40	3	-26.47	-26.22	8	PASS
	6	-27.08	-26.84	8	PASS
	9	-26.76	-26.51	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

SISO Antenna 1:

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-14.78	-14.78	8	PASS
	6	-14.83	-14.83	8	PASS
	11	-15.04	-15.04	8	PASS
802.11g	1	-17.65	-17.65	8	PASS
	6	-17.91	-17.91	8	PASS
	11	-17.52	-17.52	8	PASS
802.11n HT20	1	-25.19	-25.19	8	PASS
	6	-24.53	-24.53	8	PASS
	11	-24.28	-24.28	8	PASS
802.11n HT40	3	-27.09	-26.85	8	PASS
	6	-26.92	-26.67	8	PASS
	9	-27.13	-26.88	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

MIMO

Without Beamforming

Test Mode	Channel Number	Power Spectral Density				Total PSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)			
802.11b	1	-14.98	-14.98	-15.00	-15.00	-11.98	8.00	PASS
	6	-14.96	-14.96	-15.28	-15.28	-12.10	8.00	PASS
	11	-15.94	-15.94	-15.20	-15.20	-12.55	8.00	PASS
802.11g	1	-18.07	-18.07	-17.98	-17.98	-15.02	8.00	PASS
	6	-17.88	-17.88	-18.28	-18.28	-15.06	8.00	PASS
	11	-17.81	-17.81	-17.95	-17.95	-14.87	8.00	PASS
802.11n HT20	1	-25.48	-25.48	-25.52	-25.52	-22.49	8.00	PASS
	6	-25.05	-25.05	-24.95	-24.95	-21.99	8.00	PASS
	11	-25.10	-25.10	-24.49	-24.49	-21.77	8.00	PASS
802.11n HT40	3	-26.85	-26.60	-27.20	-26.95	-23.76	8.00	PASS
	6	-27.76	-27.51	-27.11	-26.87	-24.17	8.00	PASS
	9	-27.29	-27.04	-27.11	-26.87	-23.94	8.00	PASS

Note: 1.Power Spectral Density =Read Value+Duty cycle correction factor

2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=$10\log(10^{(\text{PSD antenna1 in dBm/10})}+10^{(\text{PSD antenna2 in dBm/10})})$

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{ss}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB.

4.If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

So directional gain=GANT+Array Gain=-2.93+10log(2/1)= 0.08<6dBi, so the PSD limit is 8dBm.

With Beamforming

Test Mode	Channel Number	Power Spectral Density				Total PSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)			
802.11b	1	-14.95	-14.95	-15.04	-15.04	-11.99	8.00	PASS
	6	-14.84	-14.84	-15.21	-15.21	-12.01	8.00	PASS
	11	-14.64	-14.64	-15.39	-15.39	-11.99	8.00	PASS
802.11g	1	-18.00	-18.00	-18.14	-18.14	-15.06	8.00	PASS
	6	-17.89	-17.89	-18.11	-18.11	-14.98	8.00	PASS
	11	-17.82	-17.82	-18.00	-18.00	-14.90	8.00	PASS
802.11n HT20	1	-25.47	-25.47	-25.45	-25.45	-22.45	8.00	PASS
	6	-26.07	-26.07	-25.02	-25.02	-22.50	8.00	PASS
	11	-25.03	-25.03	-24.98	-24.98	-22.00	8.00	PASS
802.11n HT40	3	-26.99	-26.74	-27.00	-26.75	-23.74	8.00	PASS
	6	-27.79	-27.55	-27.77	-27.52	-24.52	8.00	PASS
	9	-27.46	-27.22	-27.44	-27.20	-24.20	8.00	PASS

Note: 1.Power Spectral Density =Read Value+Duty cycle correction factor

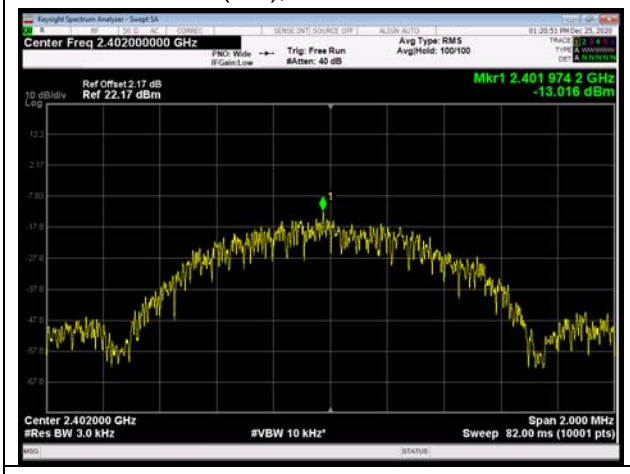
2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=$10\log(10^{(\text{PSD antenna1 in dBm/10})}+10^{(\text{PSD antenna2 in dBm/10})})$

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{ss}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB.

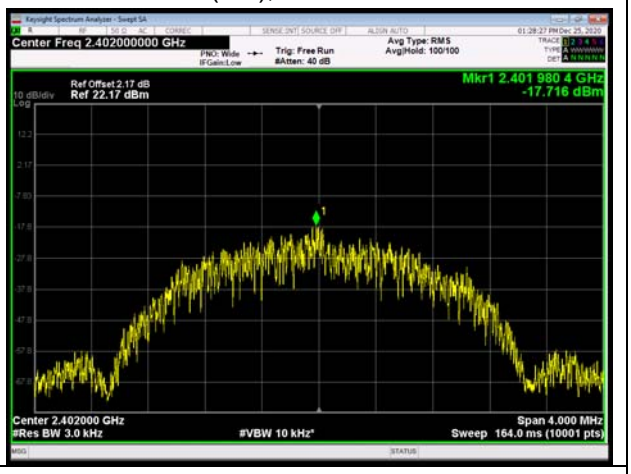
4.If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

So directional gain=GANT+Array Gain=-2.93+10log(2/1)= 0.08<6dBi, so the PSD limit is 8dBm.

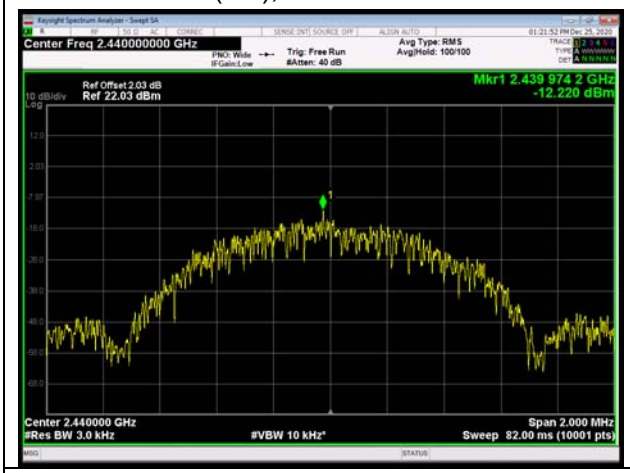
BLE (1M), Channel No.: 0



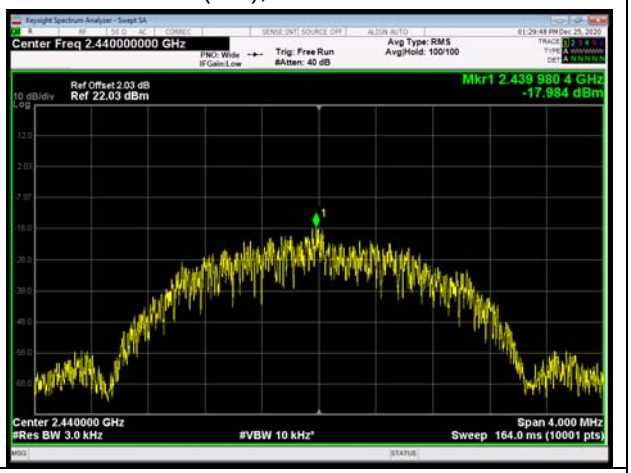
BLE (2M), Channel No.: 0



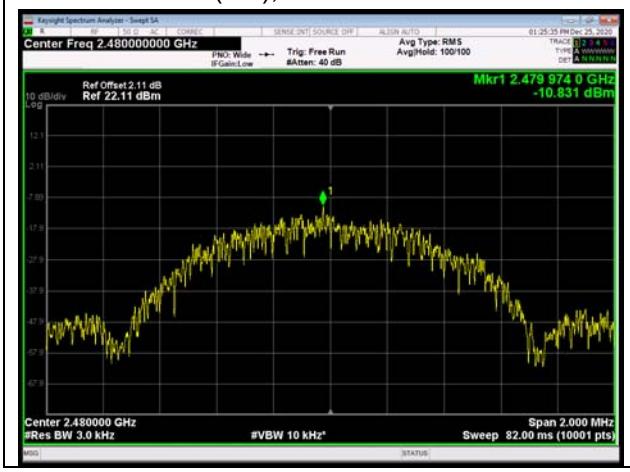
BLE (1M), Channel No.: 19



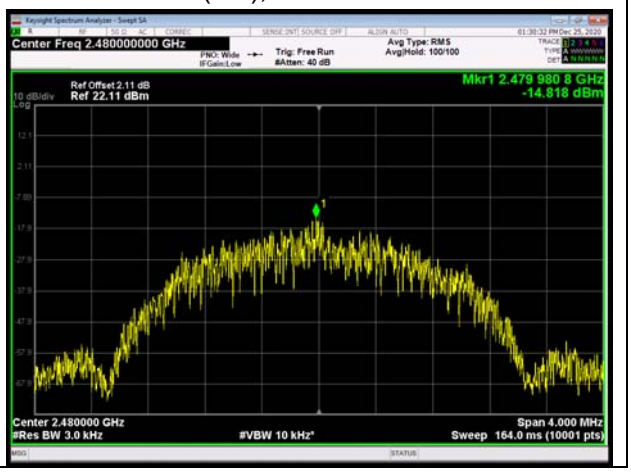
BLE (2M), Channel No.: 19



BLE (1M), Channel No.: 39



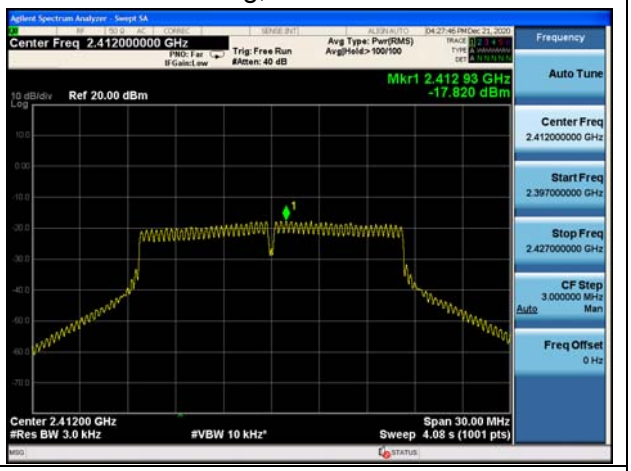
BLE (2M), Channel No.: 39



SISO Antenna 1:

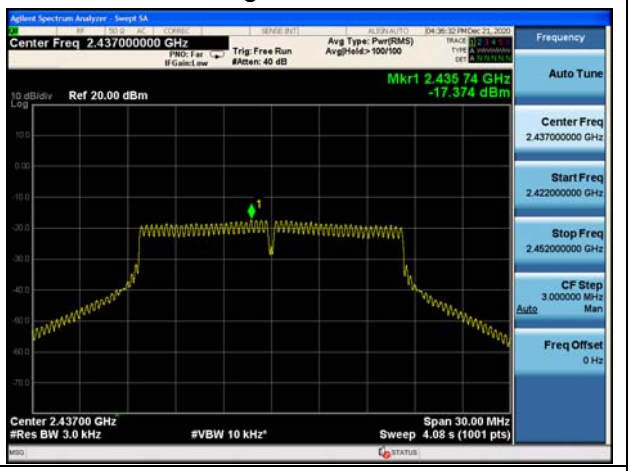
802.11b, Channel No.: 1

802.11g, Channel No.: 1



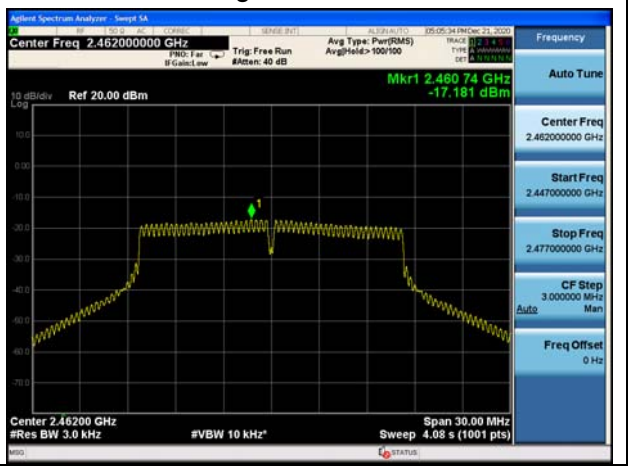
802.11b, Channel No.: 6

802.11g, Channel No.: 6

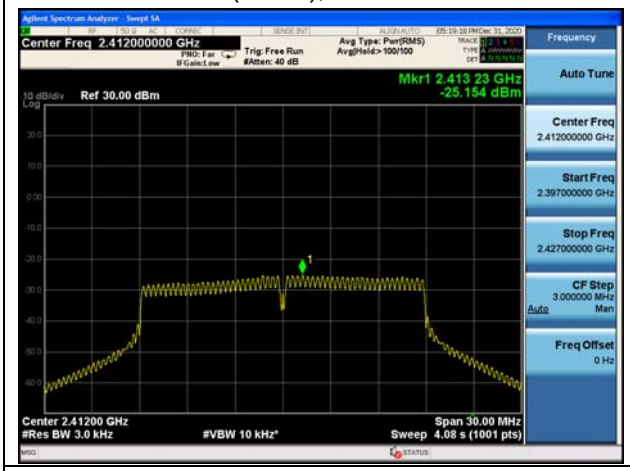


802.11b, Channel No.: 11

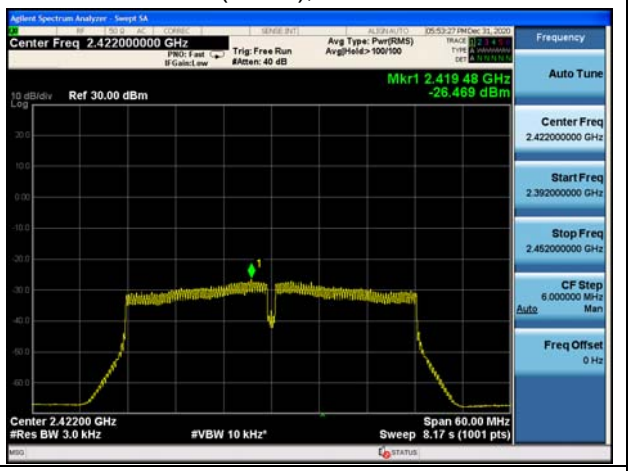
802.11g, Channel No.: 11



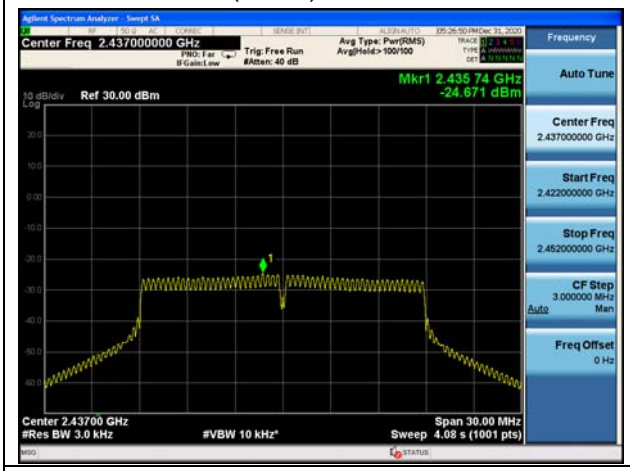
802.11n(HT20), Channel No. 1



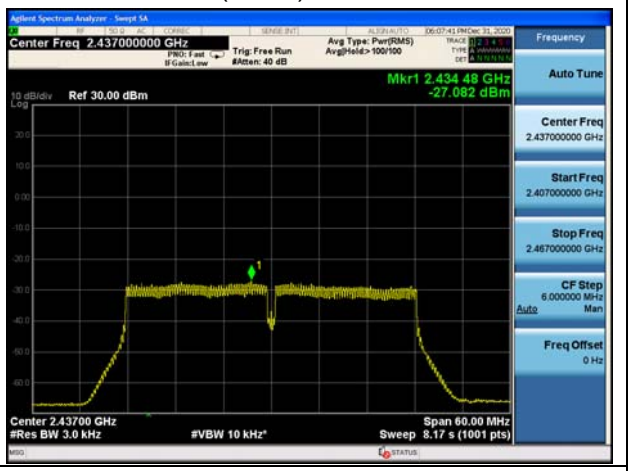
802.11n(HT40), Channel No. 3



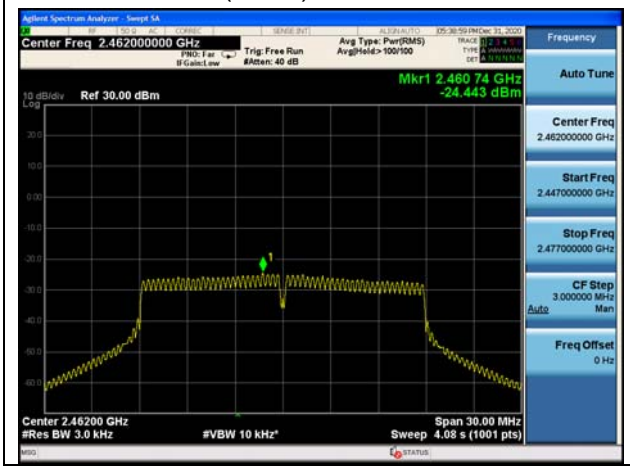
802.11n(HT20), Channel No. 6



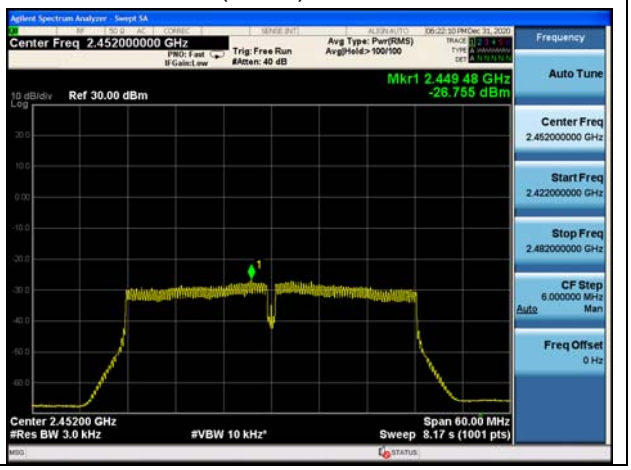
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



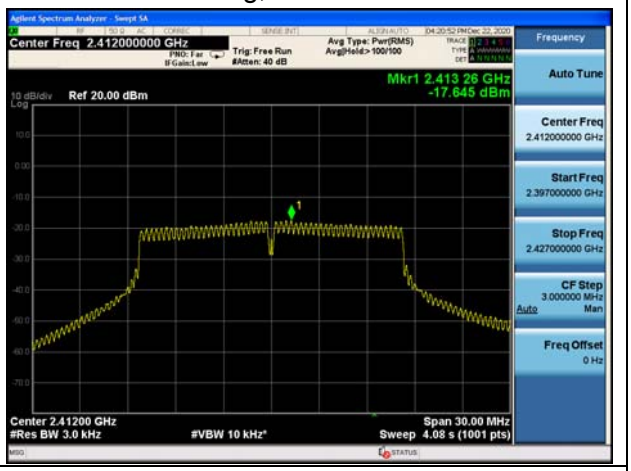
802.11n(HT40), Channel No. 9



SISO Antenna 2:

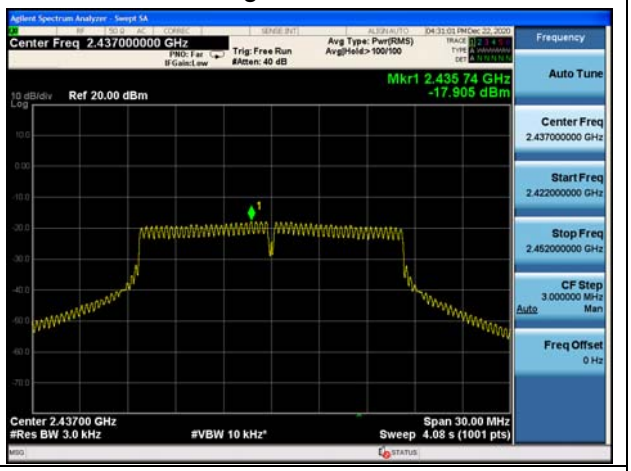
802.11b, Channel No.: 1

802.11g, Channel No.: 1



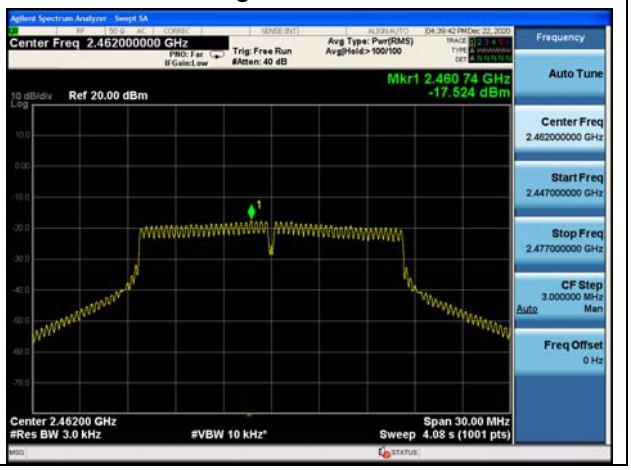
802.11b, Channel No.: 6

802.11g, Channel No.: 6

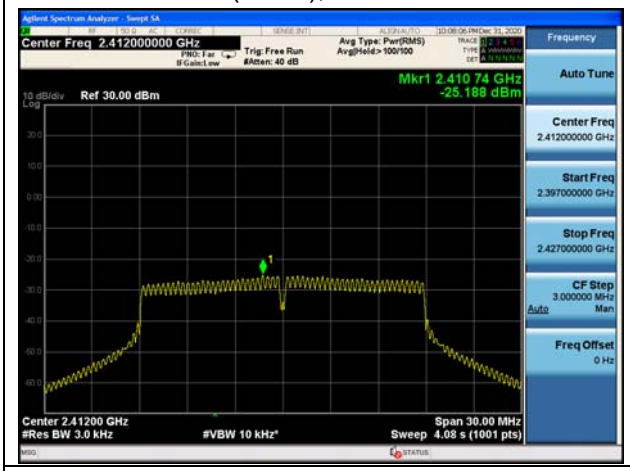


802.11b, Channel No.: 11

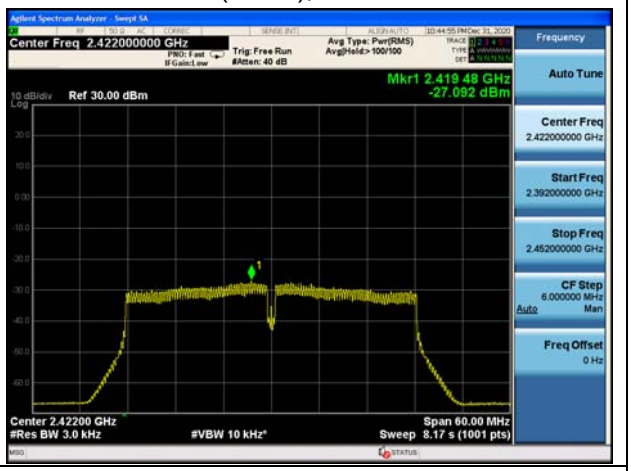
802.11g, Channel No.: 11



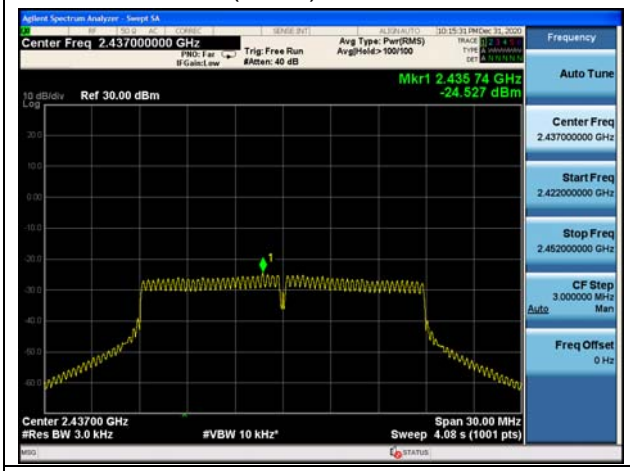
802.11n(HT20), Channel No. 1



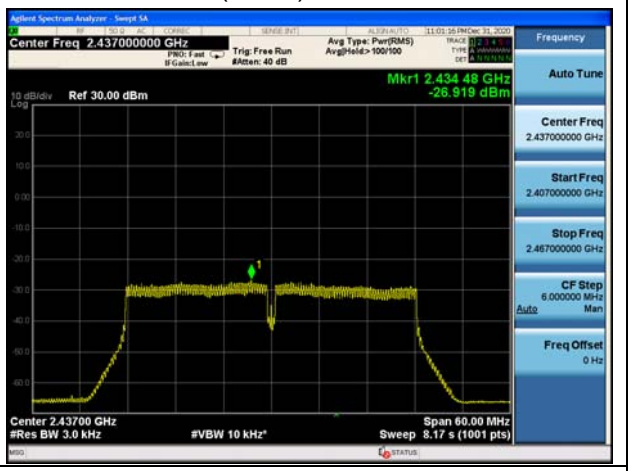
802.11n(HT40), Channel No. 3



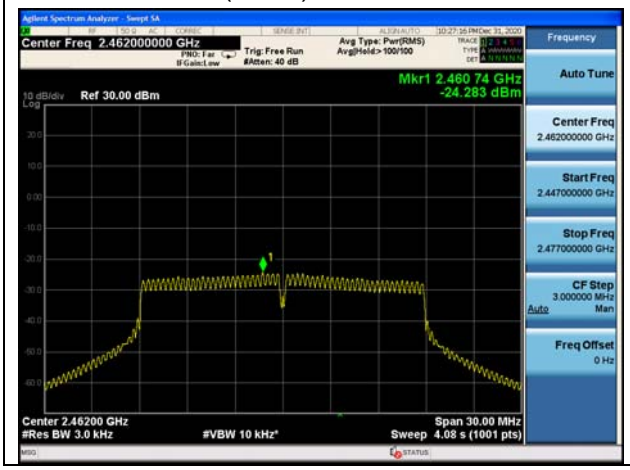
802.11n(HT20), Channel No. 6



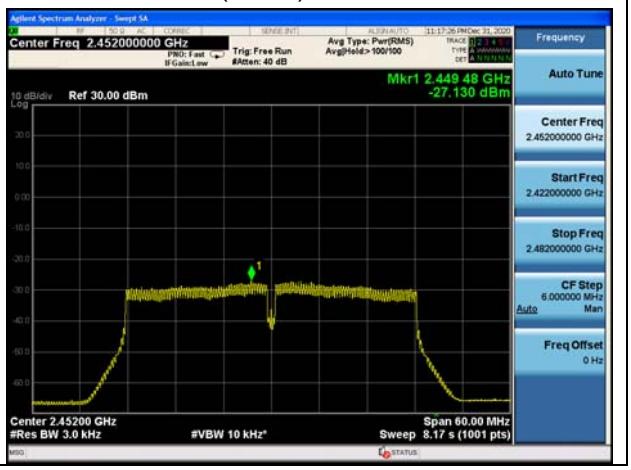
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 9

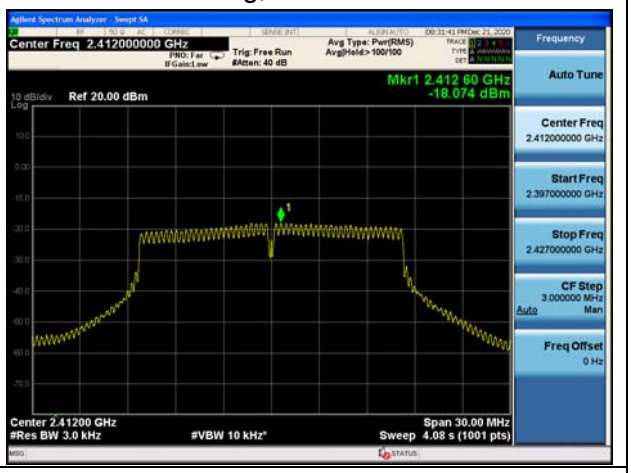


Without Beamforming

MIMO Antenna 1:

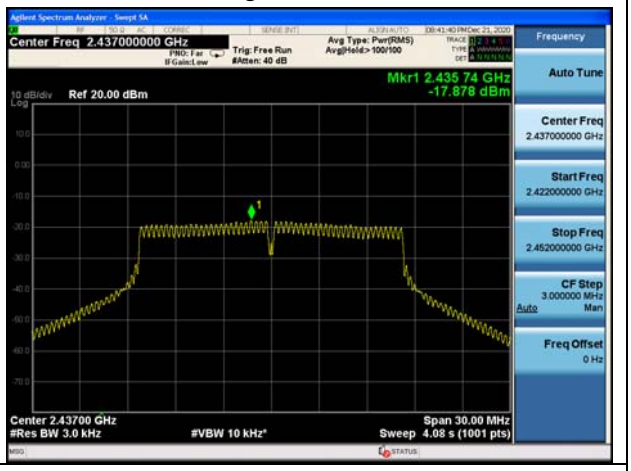
802.11b, Channel No.: 1

802.11g, Channel No.: 1



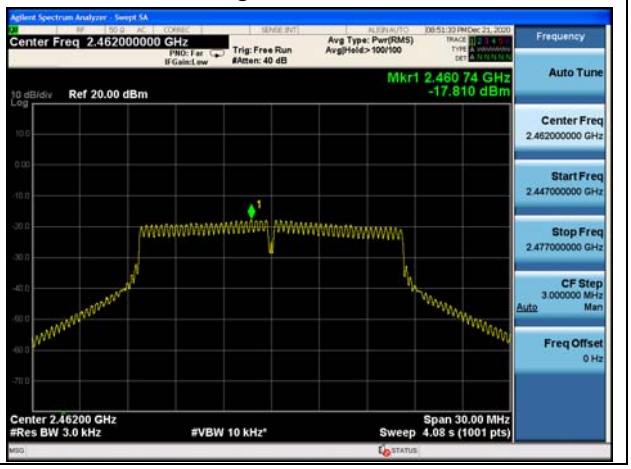
802.11b, Channel No.: 6

802.11g, Channel No.: 6

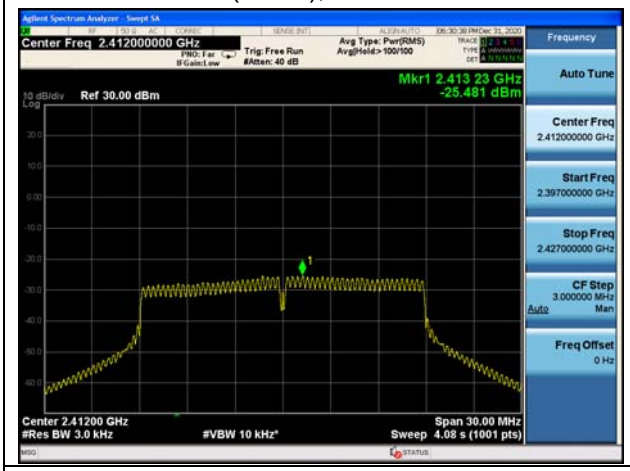


802.11b, Channel No.: 11

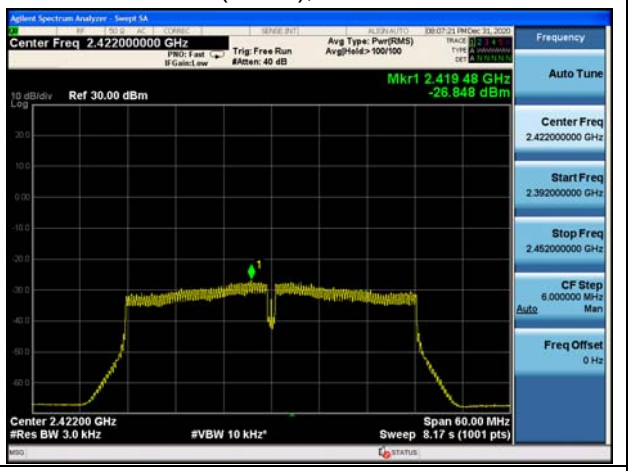
802.11g, Channel No.: 11



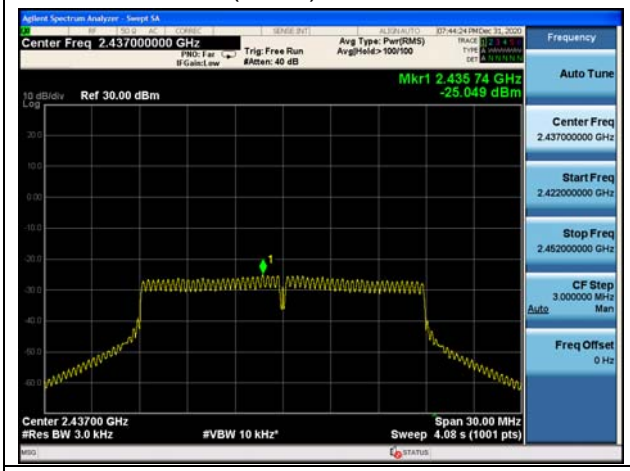
802.11n(HT20), Channel No. 1



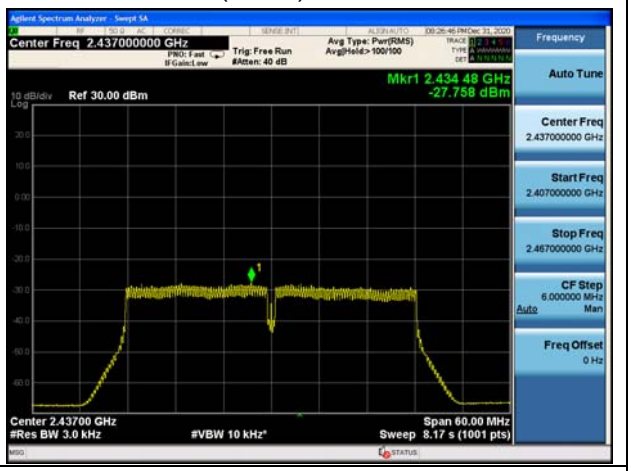
802.11n(HT40), Channel No. 3



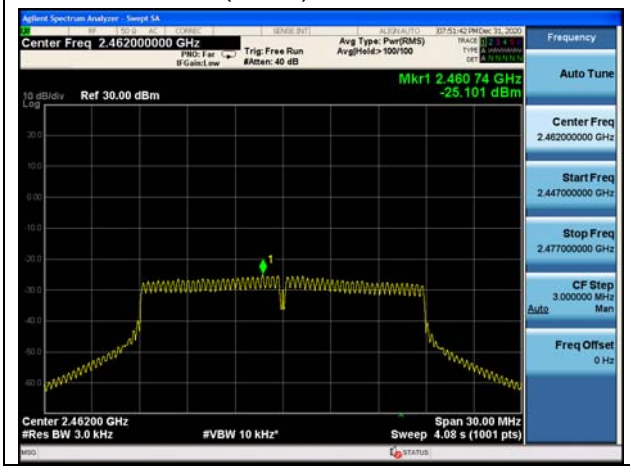
802.11n(HT20), Channel No. 6



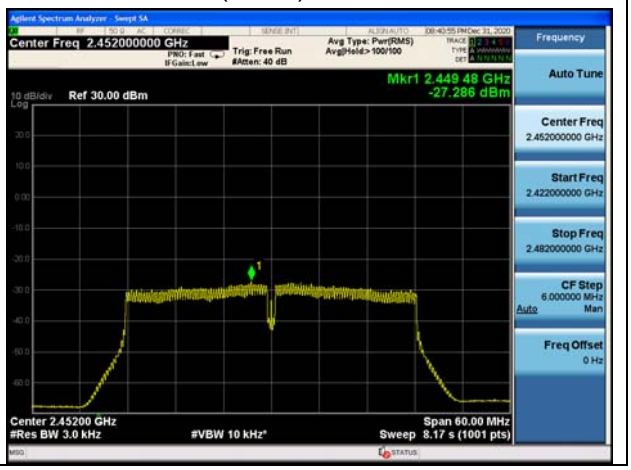
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



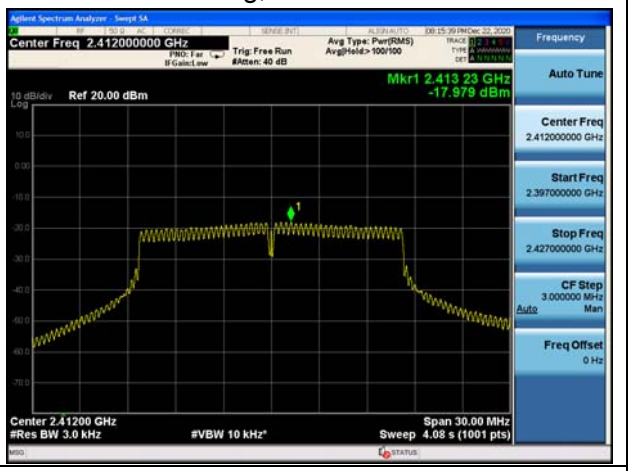
802.11n(HT40), Channel No. 9



MIMO Antenna 2:

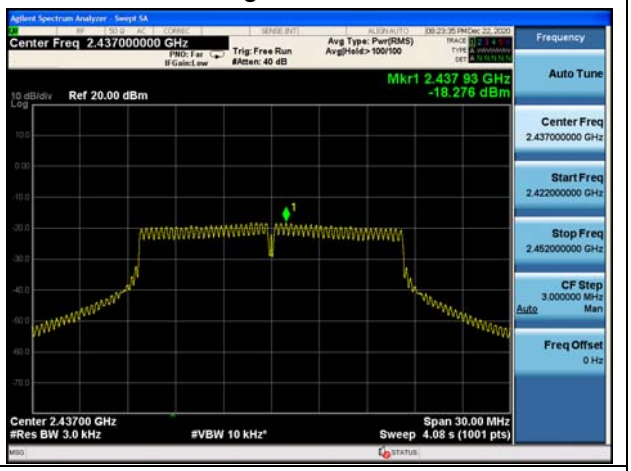
802.11b, Channel No.: 1

802.11g, Channel No.: 1



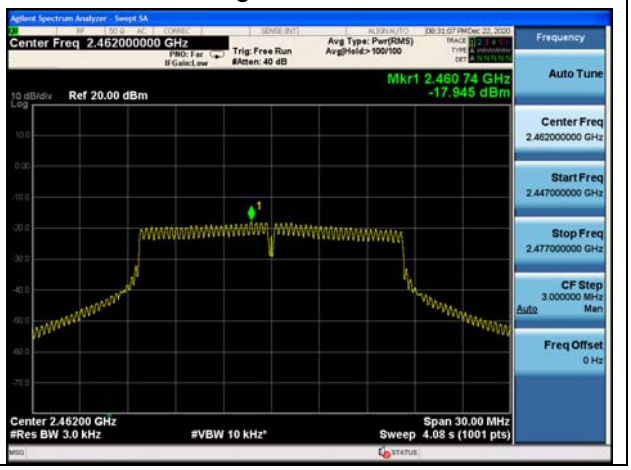
802.11b, Channel No.: 6

802.11g, Channel No.: 6

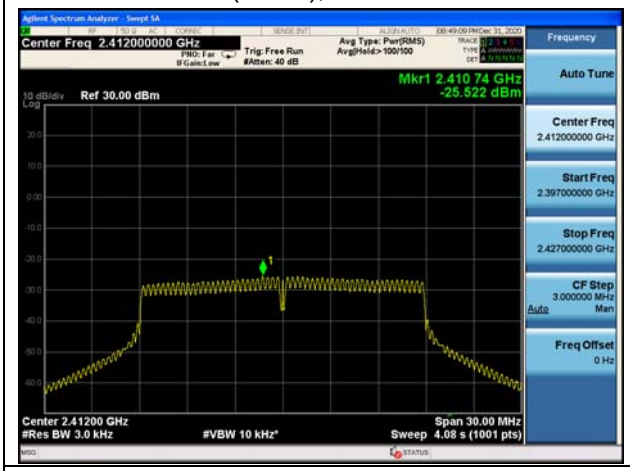


802.11b, Channel No.: 11

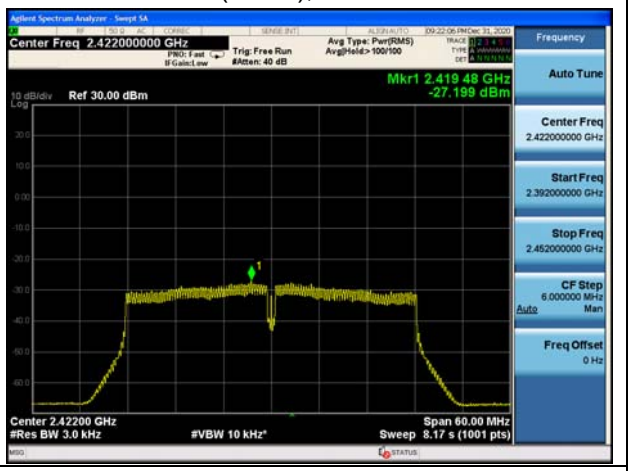
802.11g, Channel No.: 11



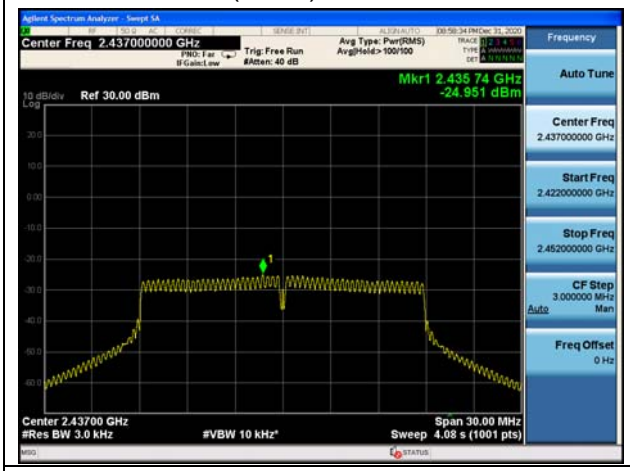
802.11n(HT20), Channel No. 1



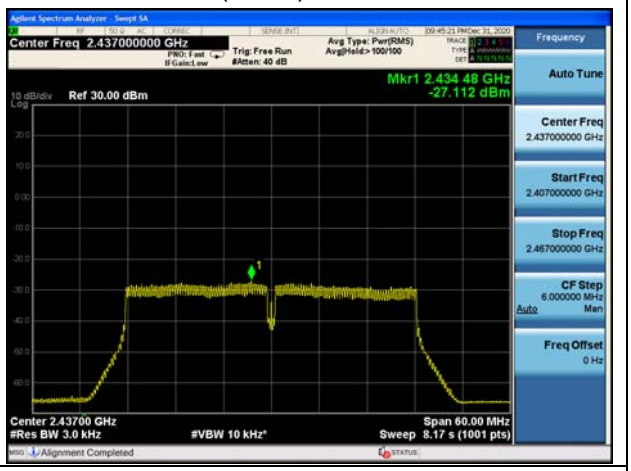
802.11n(HT40), Channel No. 3



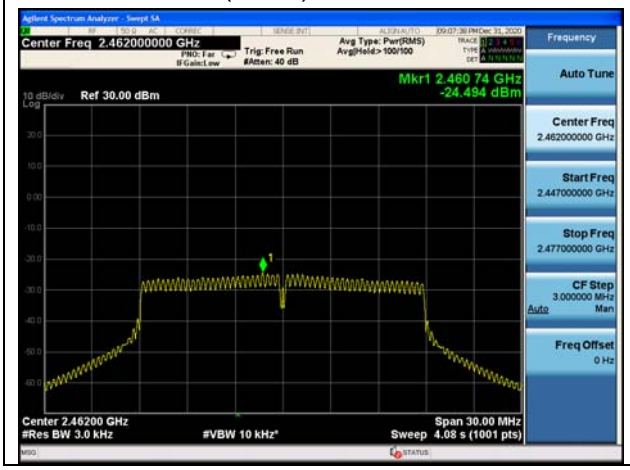
802.11n(HT20), Channel No. 6



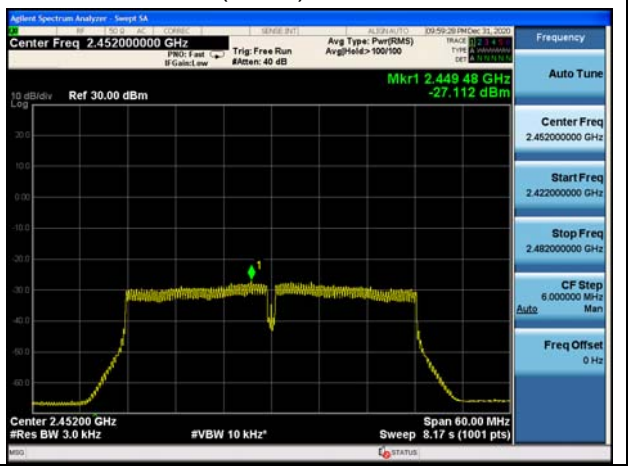
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 9

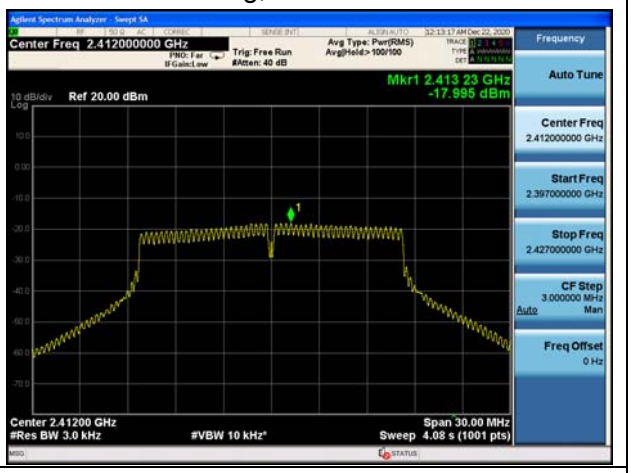


With Beamforming

MIMO Antenna 1:

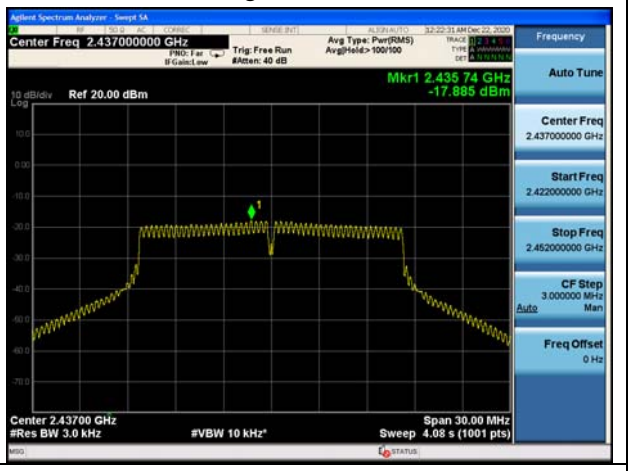
802.11b, Channel No.: 1

802.11g, Channel No.: 1



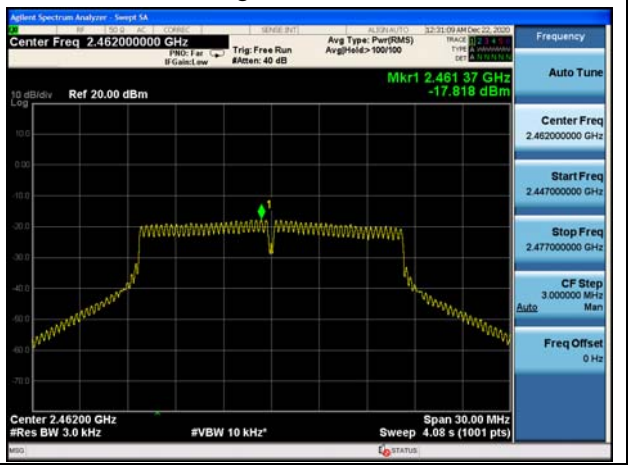
802.11b, Channel No.: 6

802.11g, Channel No.: 6

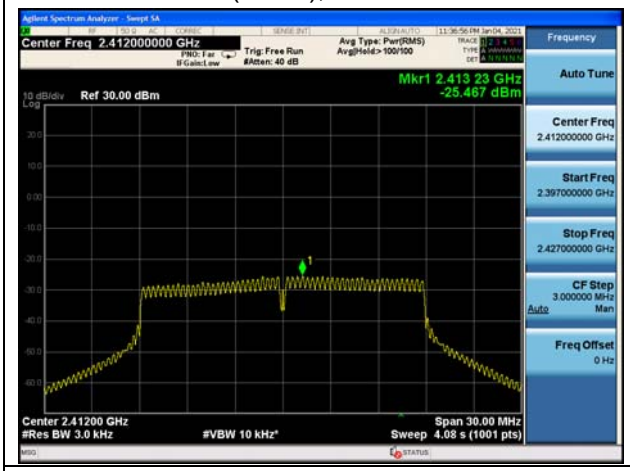


802.11b, Channel No.: 11

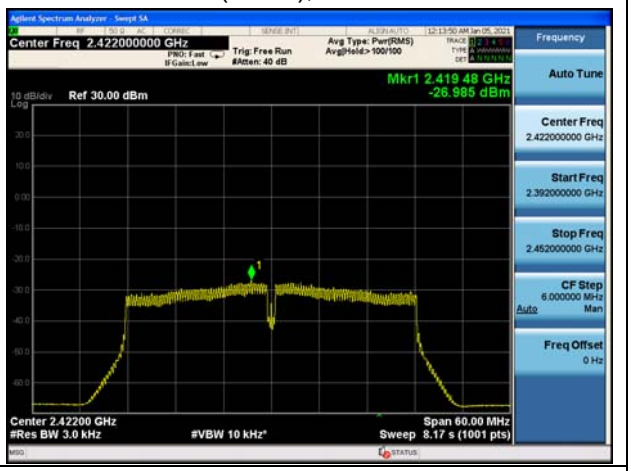
802.11g, Channel No.: 11



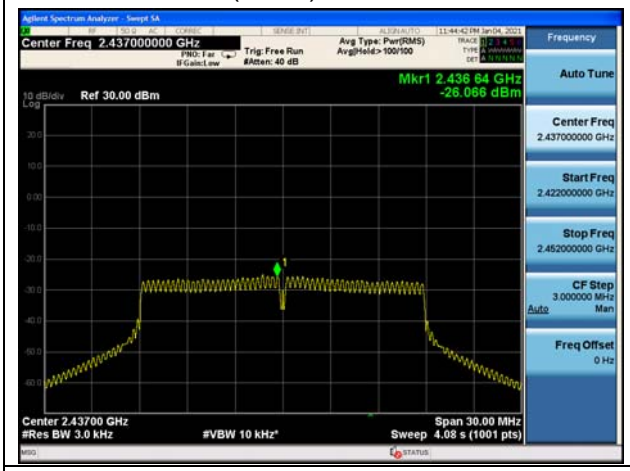
802.11n(HT20), Channel No. 1



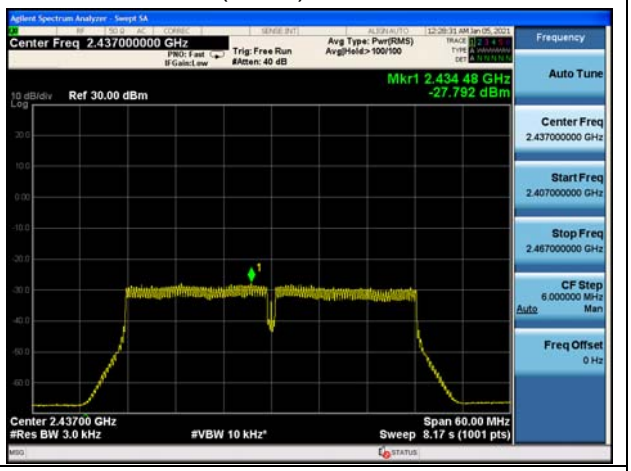
802.11n(HT40), Channel No. 3



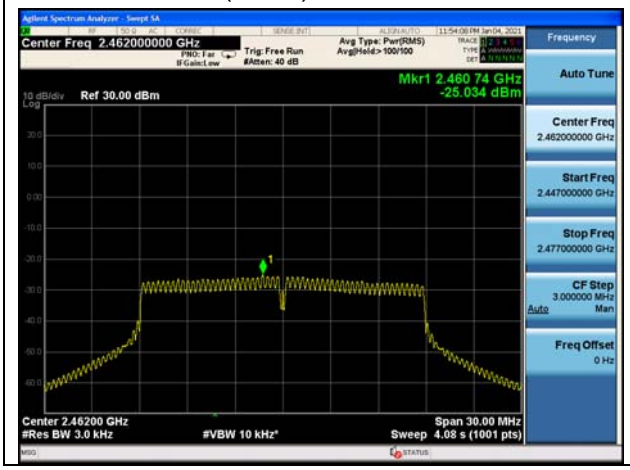
802.11n(HT20), Channel No. 6



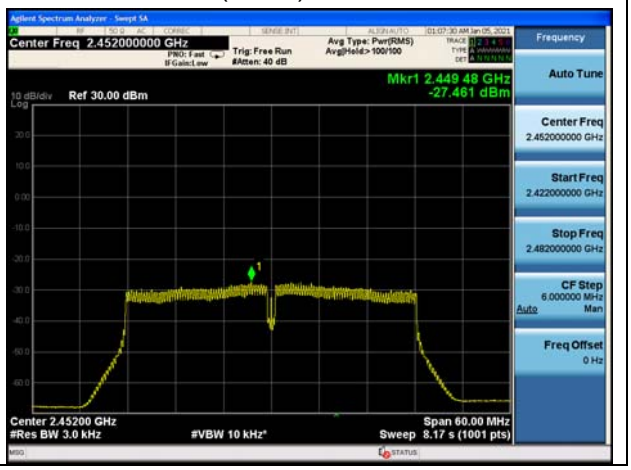
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



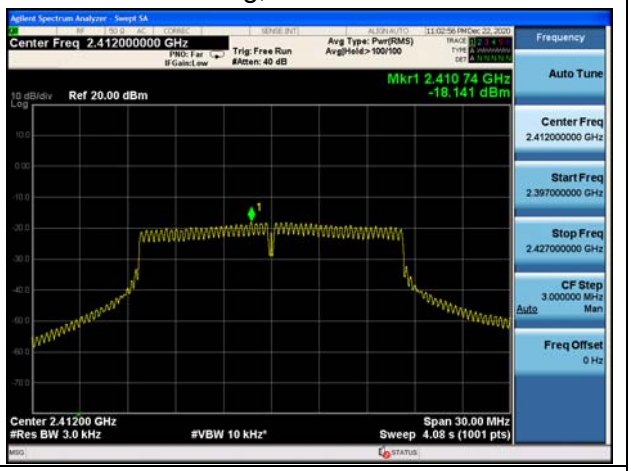
802.11n(HT40), Channel No. 9



MIMO Antenna 2:

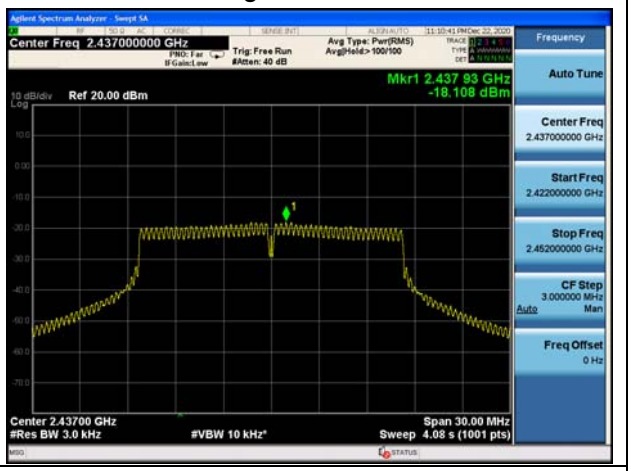
802.11b, Channel No.: 1

802.11g, Channel No.: 1



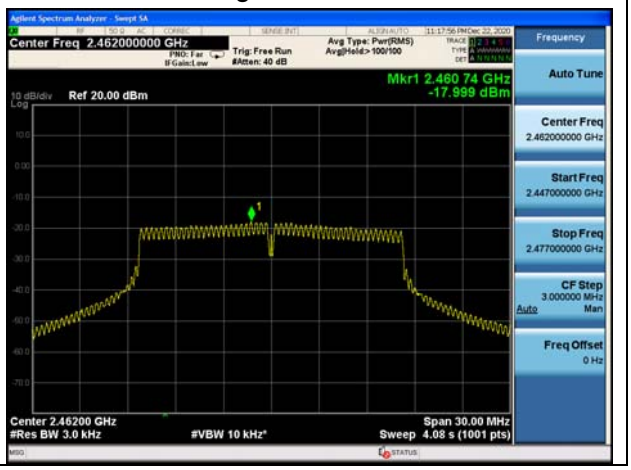
802.11b, Channel No.: 6

802.11g, Channel No.: 6

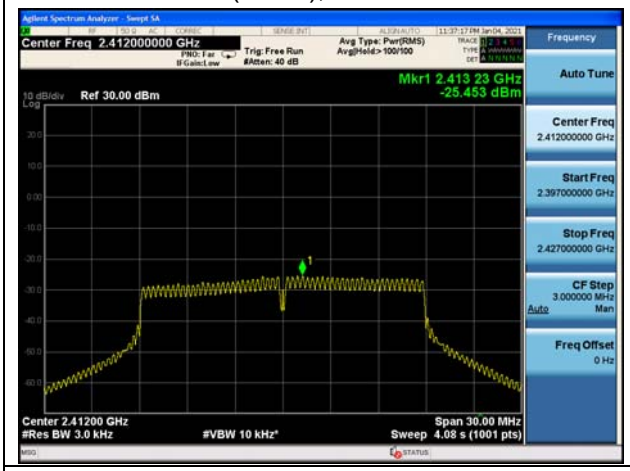


802.11b, Channel No.: 11

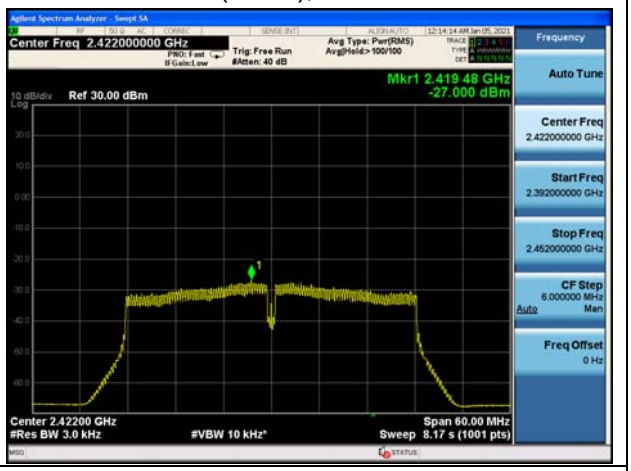
802.11g, Channel No.: 11



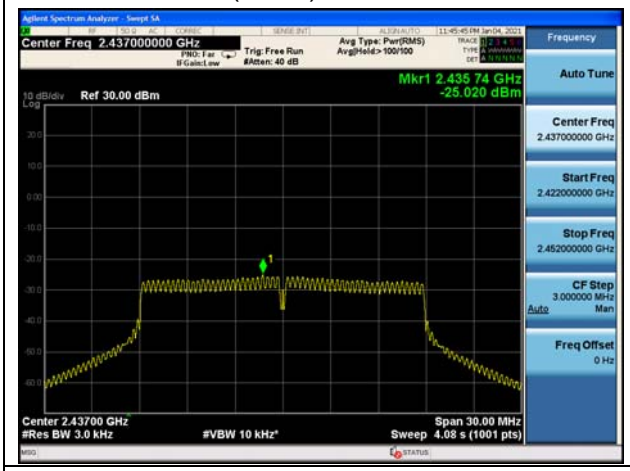
802.11n(HT20), Channel No. 1



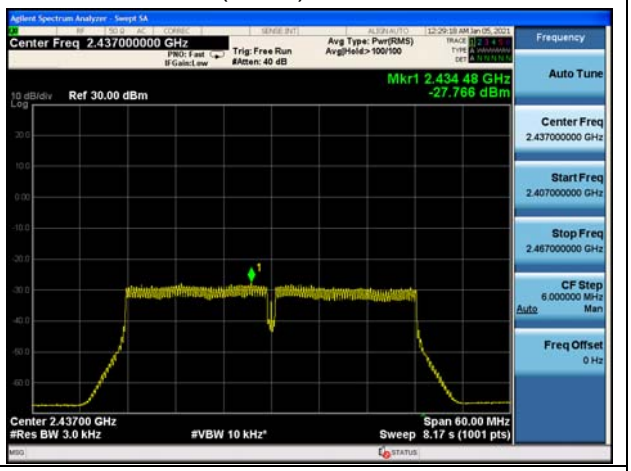
802.11n(HT40), Channel No. 3



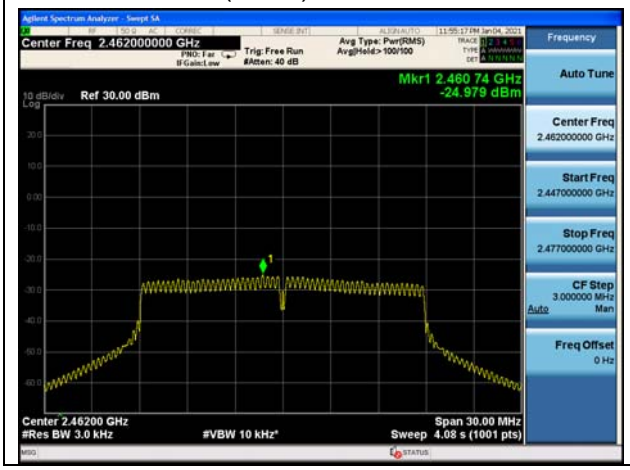
802.11n(HT20), Channel No. 6



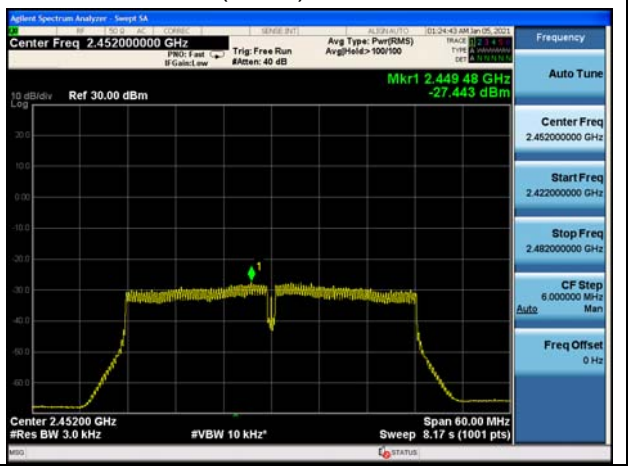
802.11n(HT40), Channel No. 6



802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 9



5.5. Spurious RF Conducted Emissions

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer with a known loss. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. Set RBW to 100 kHz and VBW to 300 kHz, Sweep is set to ATUO.
The test is in transmitting mode.

Test setup

Limits

Rule Part 15.247(d) pacifies that “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. ”

Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
802.11b	2412	-5.19	-35.19
	2437	-5.07	-35.07
	2462	-4.85	-34.85
802.11g	2412	-8.15	-38.15
	2437	-8.01	-38.01
	2462	-7.66	-37.66
802.11n HT20	2412	-13.70	-43.70
	2437	-13.39	-43.39
	2462	-13.46	-43.46
802.11n HT40	2422	-15.55	-45.55
	2437	-14.60	-44.60
	2452	-16.04	-46.04
Bluetooth (Low Energy) (1M)	2402	-16.09	-46.09
	2440	-16.32	-46.32
	2480	-15.28	-45.28
Bluetooth (Low Energy) (2M)	2402	-17.27	-47.27
	2440	-17.81	-47.81
	2480	-16.22	-46.22

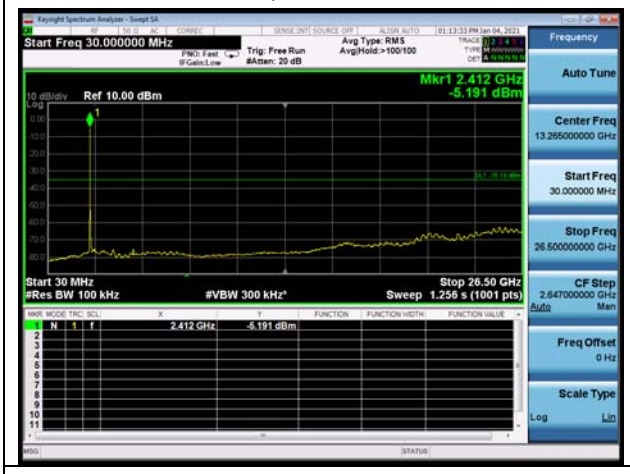
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

Frequency	Uncertainty
100kHz-2GHz	0.684 dB
2GHz-26GHz	1.407 dB

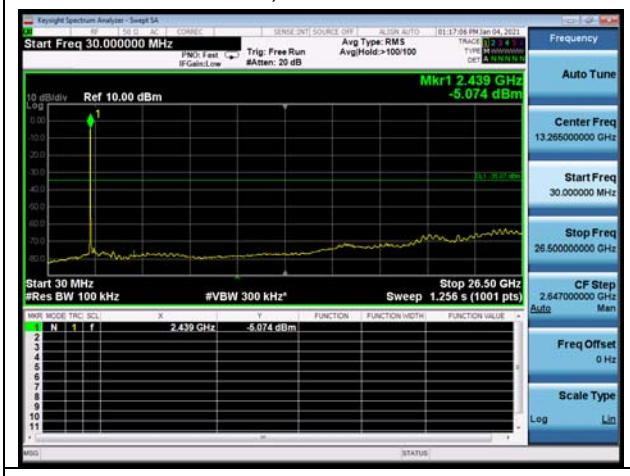
Test Results:

802.11b, Channel No.: 1



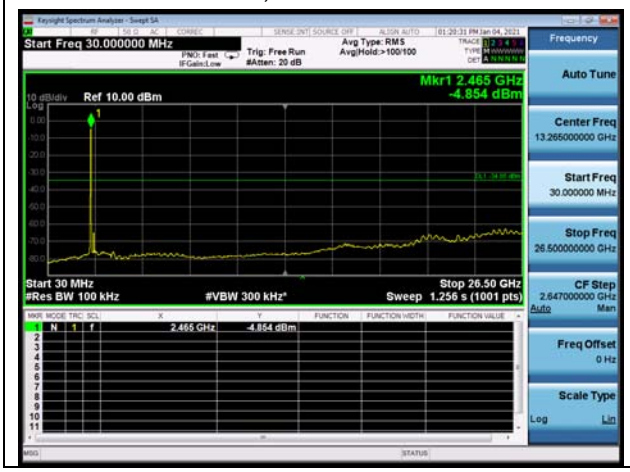
802.11g, Channel No.: 1

802.11b, Channel No.: 6



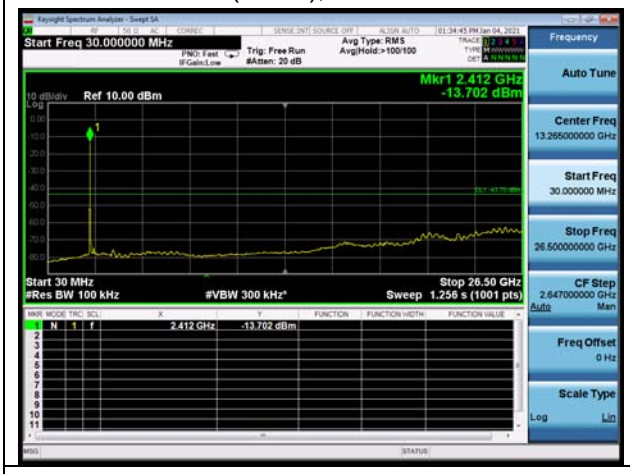
802.11g, Channel No.: 6

802.11b, Channel No.: 11



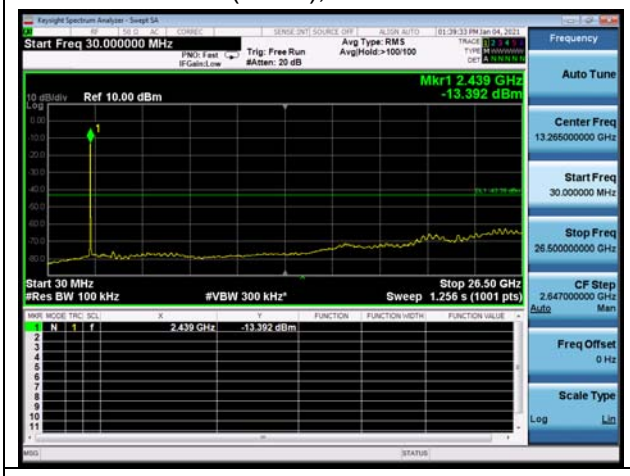
802.11g, Channel No.: 11

802.11n(HT20), Channel No. 1



802.11n(HT40), Channel No. 3

802.11n(HT20), Channel No. 6

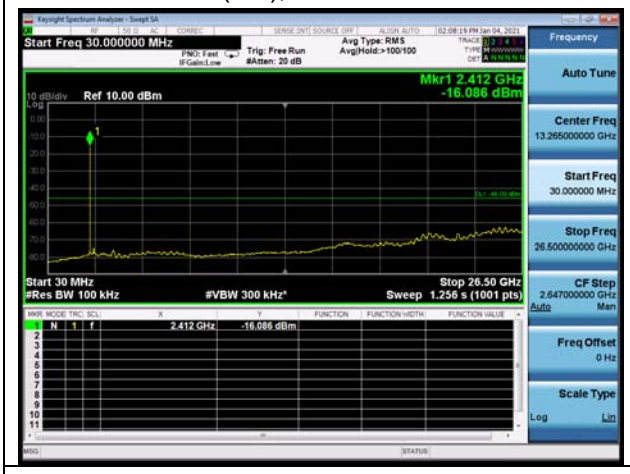


802.11n(HT40), Channel No. 6

802.11n(HT20), Channel No. 11

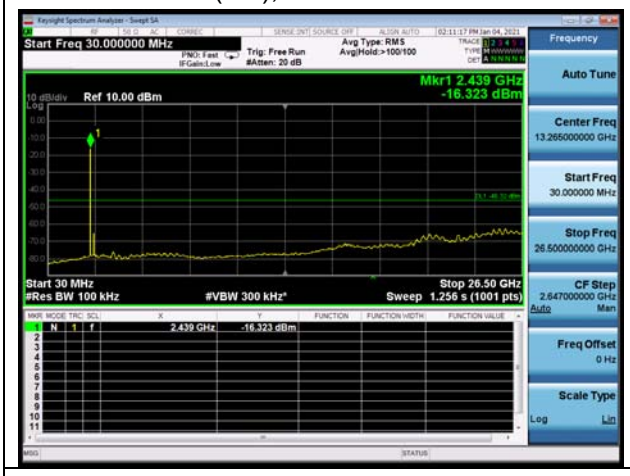
802.11n(HT40), Channel No. 9

BLE (1M), Channel No.: 0



BLE (2M), Channel No.: 0

BLE (1M), Channel No.: 19



BLE (2M), Channel No.: 19

BLE (1M), Channel No.: 39

BLE (2M), Channel No.: 39