



RF TEST REPORT

Applicant Quectel Wireless Solutions Co., Ltd.

FCC ID XMR202103FG50V

Product Wi-Fi & BT Module

Brand Quectel

Model FG50V

Report No. R2102A0150-R1

Issue Date May 25, 2021

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2020)**. 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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Summary of measurement results

Number	Test Case	Clause in FCC rules	Verdict
1	Maximum output power	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: March 1, 2021 ~ May 26, 2021			
Date of Sample Received: February 24, 2021			
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
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2. General Description of Equipment under Test

2.1. Applicant and Manufacturer Information

Applicant	Quectel Wireless Solutions Co., Ltd.
Applicant address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China, 200233
Manufacturer	Quectel Wireless Solutions Co., Ltd.
Manufacturer address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China, 200233

2.2. General information

EUT Description	
Model	FG50V
SN	P1Q20LJ4C000067
Hardware Version	R1.0
Software Version	FG50VAAMD
Power Supply	External power supply
Antenna Type	The EUT don't have standard Antenna. The Antenna used for testing in this report is the after-market accessory.
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	Max 5.38 dBi
additional beamforming gain	7 dBi
Test Mode	802.11b, 802.11g, 802.11n(HT20/HT40), 802.11ax(HE20/HE40) Bluetooth LE V5.1
Modulation Type	802.11b: DSSS 802.11g/n(HT20/HT40): OFDM 802.11ax(HE20/HE40): OFDMA Bluetooth LE: GFSK
Max. Conducted Power	Wi-Fi 2.4G: 22.04 dBm Bluetooth LE: 13.86 dBm
Operating Frequency Range(s)	802.11b/g/n(HT20)/ax(HE20): 2412 ~ 2462 MHz 802.11n(HT40)/ax(HE40): 2422 ~ 2452 MHz Bluetooth LE: 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 (2020) 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
Bluetooth (Low Energy)	125Kbps, 1Mbps, 2Mbps

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
802.11ax HE20	MCS0	MCS0	MCS8
802.11ax HE40	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

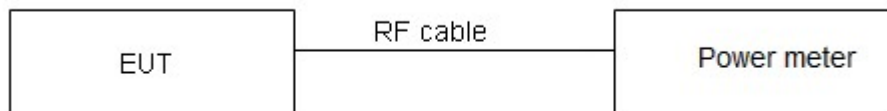
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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	$\leq 1\text{W}$ (30dBm)
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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

SISO Antenna Power Index								
Antenna	Channel	802.11b	802.11g	802.11n HT20	802.11ax HE20	Channel	802.11n HT40	802.11ax HE40
Antenna 1	CH1	20	18	18	17.5	CH3	18	17.5
	CH6	20	18	18	17.5	CH6	18	17.5
	CH11	20	18	18	17.5	CH9	18	17.5
Antenna 2	CH1	20	18	18	17.5	CH3	18	17.5
	CH6	20	18	18	17.5	CH6	18	17.5
	CH11	20	18	18	17.5	CH9	18	17.5
MIMO Antenna Power Index								
Antenna	Channel	802.11b	802.11g	802.11n HT20	802.11ax HE20	Channel	802.11n HT40	802.11ax HE40
Antenna 1	CH1	20	18	18	17.5	CH3	18	17.5
	CH6	20	18	18	17.5	CH6	18	17.5
	CH11	20	18	18	17.5	CH9	18	17.5
Antenna 2	CH1	20	18	18	17.5	CH3	18	17.5
	CH6	20	18	18	17.5	CH6	18	17.5
	CH11	20	18	18	17.5	CH9	18	17.5

Antenna	Test Mode	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
Antenna 1	802.11b	0.69	0.70	0.98	NA
	802.11g	1.97	1.99	0.99	NA
	802.11n HT20	1.00	1.00	1.00	NA
	802.11n HT40	1.00	1.00	1.00	NA
	802.11ax HE20	1.00	1.00	1.00	NA
	802.11ax HE40	1.00	1.00	1.00	NA
Antenna 2	802.11b	0.69	0.70	0.98	NA
	802.11g	1.00	1.00	1.00	NA
	802.11n HT20	1.00	1.00	1.00	NA
	802.11n HT40	1.00	1.00	1.00	NA
	802.11ax HE20	1.00	1.00	1.00	NA
	802.11ax HE40	1.00	1.00	1.00	NA
MIMO	802.11b	0.69	0.70	0.98	NA
	802.11g	1.00	1.00	1.00	NA
	802.11n HT20	1.00	1.00	1.00	NA
	802.11n HT40	1.00	1.00	1.00	NA
	802.11ax HE20	1.00	1.00	1.00	NA
	802.11ax HE40	1.00	1.00	1.00	NA



Bluetooth LE (125K)	0.39	0.62	0.620	2.075
Bluetooth LE (1M)	0.38	0.62	0.615	2.109
Bluetooth LE (2M)	0.20	0.62	0.322	4.920
Note: when Duty cycle ≥ 0.98 , Duty cycle correction Factor not required.				

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy) (125K)	2402	9.79	11.86	30	PASS
	2440	11.35	13.42	30	PASS
	2480	7.73	9.80	30	PASS
Bluetooth (Low Energy) (1M)	2402	9.74	11.85	30	PASS
	2440	11.42	13.53	30	PASS
	2480	7.56	9.67	30	PASS
Bluetooth (Low Energy) (2M)	2402	7.13	12.05	30	PASS
	2440	8.94	13.86	30	PASS
	2480	5.45	10.37	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	19.49	19.49	30	PASS
	2437	18.57	18.57	30	PASS
	2462	17.83	17.83	30	PASS
802.11g	2412	16.92	16.92	30	PASS
	2437	16.17	16.17	30	PASS
	2462	15.72	15.72	30	PASS
802.11n HT20	2412	16.76	16.76	30	PASS
	2437	16.03	16.03	30	PASS
	2462	15.76	15.76	30	PASS
802.11n HT40	2422	16.43	16.43	30	PASS
	2437	16.28	16.28	30	PASS
	2452	16.06	16.06	30	PASS
802.11ax HE20	2412	18.34	18.34	30	PASS
	2437	17.54	17.54	30	PASS
	2462	17.22	17.22	30	PASS
802.11ax HE40	2422	18.01	18.01	30	PASS
	2437	17.62	17.62	30	PASS
	2452	17.45	17.45	30	PASS

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

Antenna 2

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412	19.10	19.10	30	PASS
	2437	18.95	18.95	30	PASS
	2462	18.13	18.13	30	PASS
802.11g	2412	16.87	16.87	30	PASS
	2437	16.74	16.74	30	PASS
	2462	16.09	16.09	30	PASS
802.11n	2412	16.68	16.68	30	PASS



HT20	2437	16.60	16.60	30	PASS
	2462	15.91	15.91	30	PASS
802.11n HT40	2422	16.66	16.66	30	PASS
	2437	16.63	16.63	30	PASS
	2452	16.34	16.34	30	PASS
802.11ax HE20	2412	17.75	17.75	30	PASS
	2437	17.77	17.77	30	PASS
	2462	17.36	17.36	30	PASS
802.11ax HE40	2422	17.68	17.68	30	PASS
	2437	17.62	17.62	30	PASS
	2452	17.55	17.55	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	19.27	19.27	18.78	18.78	22.04	30	PASS
	2437	18.26	18.26	18.47	18.47	21.38	30	PASS
	2462	17.71	17.71	17.66	17.66	20.70	30	PASS
802.11g	2412	16.67	16.67	16.75	16.75	19.72	30	PASS
	2437	16.02	16.02	16.61	16.61	19.34	30	PASS
	2462	15.67	15.67	15.92	15.92	18.81	30	PASS
802.11n HT20	2412	16.48	16.48	16.53	16.53	19.52	30	PASS
	2437	15.68	15.68	16.37	16.37	19.05	30	PASS
	2462	15.59	15.59	15.69	15.69	18.65	30	PASS
802.11n HT40	2422	16.27	16.27	16.48	16.48	19.39	30	PASS
	2437	16.21	16.21	16.38	16.38	19.31	30	PASS
	2452	16.01	16.01	16.06	16.06	19.05	30	PASS
802.11ax HE20	2412	17.98	17.98	17.46	17.46	20.74	30	PASS
	2437	17.21	17.21	17.47	17.47	20.35	30	PASS
	2462	16.88	16.88	17.13	17.13	20.02	30	PASS
802.11ax HE40	2422	17.69	17.69	17.35	17.35	20.53	30	PASS
	2437	17.36	17.36	17.32	17.32	20.35	30	PASS
	2452	17.08	17.08	17.30	17.30	20.20	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 = $G_{ANT} + \text{Array Gain}$,
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 $N_{ANT} \geq 5$.
So directional gain = $G_{ANT} + \text{Array Gain} < 6\text{dBi}$. 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	19.21	19.21	18.74	18.74	21.99	27.61	PASS
	2437	18.22	18.22	18.42	18.42	21.33	27.61	PASS
	2462	17.65	17.65	17.65	17.65	20.66	27.61	PASS
802.11g	2412	16.57	16.57	16.63	16.63	19.61	27.61	PASS
	2437	16.01	16.01	16.57	16.57	19.31	27.61	PASS
	2462	15.59	15.59	15.84	15.84	18.73	27.61	PASS
802.11n HT20	2412	16.44	16.44	16.46	16.46	19.46	27.61	PASS
	2437	15.61	15.61	16.33	16.33	19.00	27.61	PASS
	2462	15.56	15.56	15.62	15.62	18.60	27.61	PASS
802.11n HT40	2422	16.22	16.22	16.44	16.44	19.34	27.61	PASS
	2437	16.16	16.16	16.32	16.32	19.25	27.61	PASS
	2452	16.00	16.00	16.02	16.02	19.02	27.61	PASS
802.11ax HE20	2412	17.86	17.86	17.33	17.33	20.61	27.61	PASS
	2437	17.09	17.09	17.34	17.34	20.23	27.61	PASS
	2462	16.76	16.76	17.03	17.03	19.91	27.61	PASS
802.11ax HE40	2422	17.57	17.57	17.22	17.22	20.41	27.61	PASS
	2437	17.24	17.24	17.19	17.19	20.23	27.61	PASS
	2452	16.96	16.96	17.17	17.17	20.08	27.61	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. Direction gain calculation according to KDB662911 D01 Multiple Transmitter Output v02r01 F) 2) e) (i), If all antennas have the same gain, directional gain = $G_{ANT} + 10 \log(N_{ANT}/N_{ss}) = G_{ANT} + 10 \log(2/N_{ss}) = 8.39 \text{ dBi} > 6\text{dBi}$.

So the limit is $30 + 6 - \text{Max}(\text{directional gain}, 6) = 27.61\text{dBm}$.

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient condition

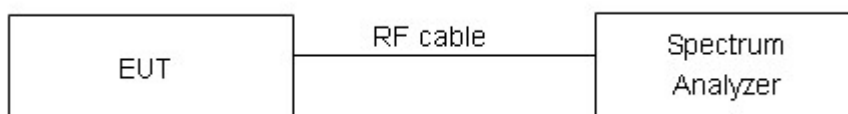
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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
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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	12.8880	7.6340	500	PASS
	2437	13.4930	8.5690	500	PASS
	2462	13.6250	8.5950	500	PASS
802.11g	2412	16.2800	15.7100	500	PASS
	2437	16.3740	16.1600	500	PASS
	2462	16.3930	15.7700	500	PASS
802.11n HT20	2412	17.4350	16.1100	500	PASS
	2437	17.5470	17.1700	500	PASS
	2462	17.5500	16.6800	500	PASS
802.11n HT40	2422	35.8260	35.1500	500	PASS
	2437	36.0540	36.3300	500	PASS
	2452	35.8110	33.9300	500	PASS
802.11ax HE20	2412	18.8170	18.4500	500	PASS
	2437	18.9230	18.8200	500	PASS
	2462	18.9150	18.6900	500	PASS
802.11ax HE40	2422	37.5150	33.9200	500	PASS
	2437	37.6600	37.9300	500	PASS
	2452	37.6300	34.0000	500	PASS
Bluetooth (Low Energy) (125K)	2402	1.02560	0.2485	500	PASS
	2440	1.02560	0.0156	500	PASS
	2480	1.02550	0.0203	500	PASS
Bluetooth (Low Energy) (1M)	2402	1.02630	0.6952	500	PASS
	2440	1.02560	0.6937	500	PASS
	2480	1.02550	0.6972	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.0108	1.1800	500	PASS
	2440	2.0104	1.1760	500	PASS
	2480	2.0083	1.1800	500	PASS

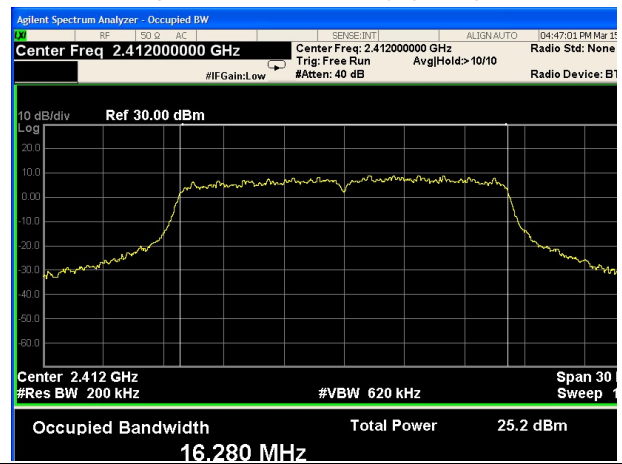


99%bandwidth

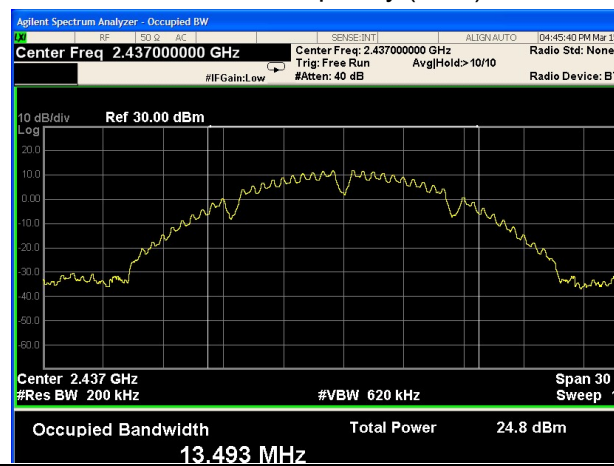
802.11b, Carrier frequency (MHz): 2412



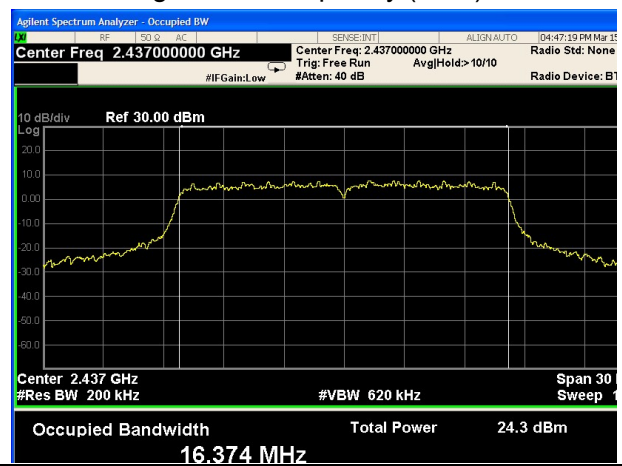
802.11g, Carrier frequency (MHz): 2412



802.11b, Carrier frequency (MHz): 2437



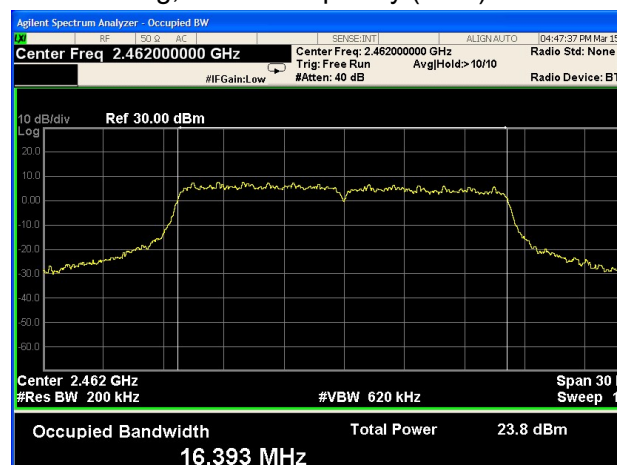
802.11g, Carrier frequency (MHz): 2437



802.11b, Carrier frequency (MHz): 2462

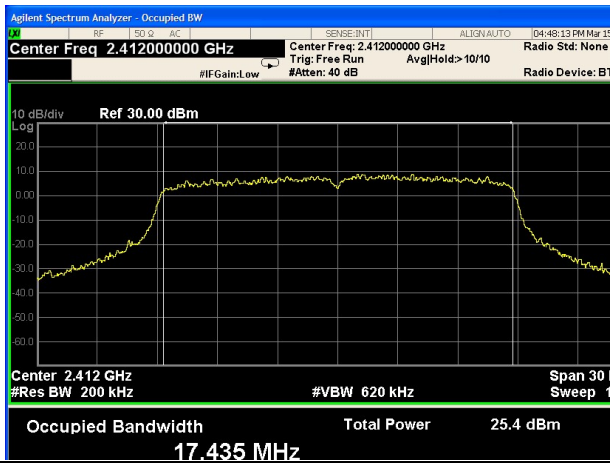


802.11g, Carrier frequency (MHz): 2462

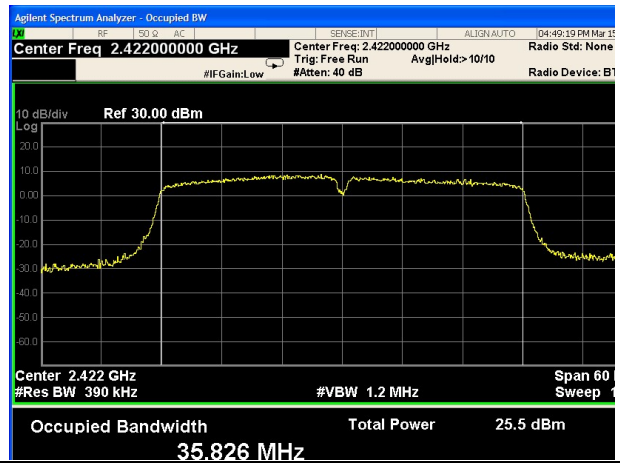




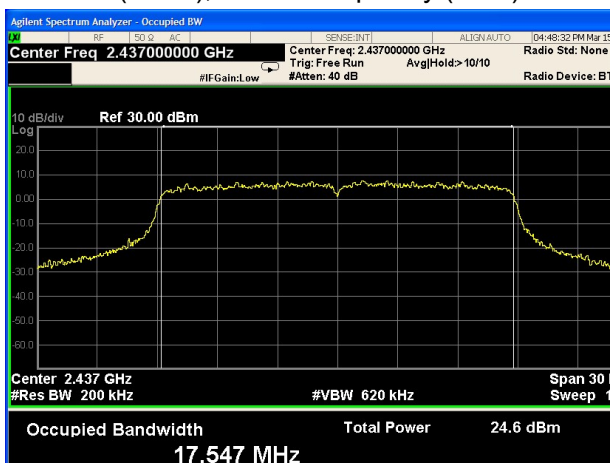
802.11n(HT20), Carrier frequency (MHz): 2412



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



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



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



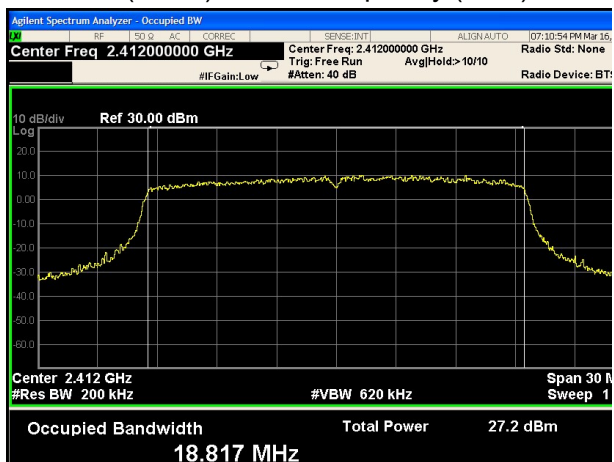
802.11n(HT20), Carrier frequency (MHz): 2462



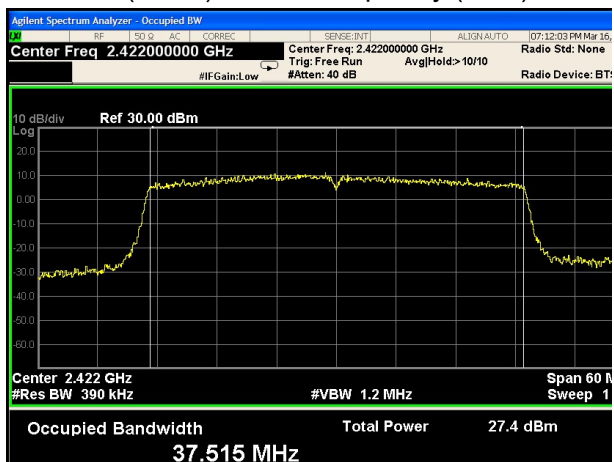
802.11n(HT40), Carrier frequency (MHz): 2452



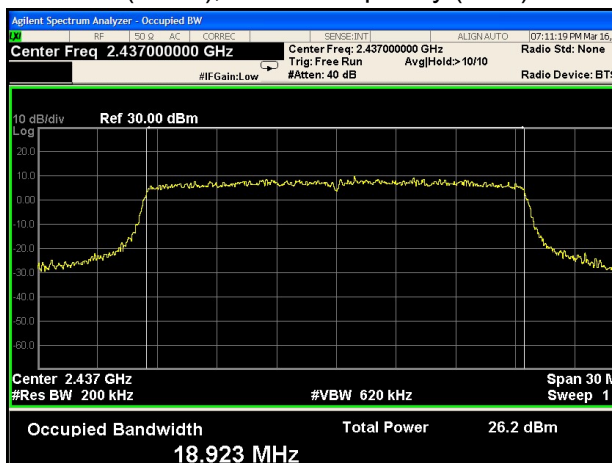
802.11ax(HE20), Carrier frequency (MHz): 2412



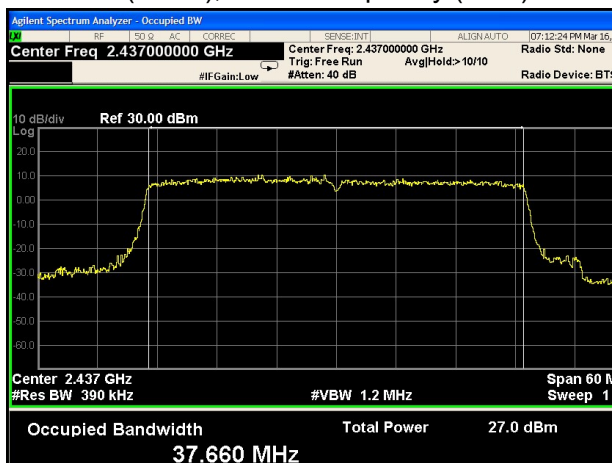
802.11ax(HE40), Carrier frequency (MHz): 2422



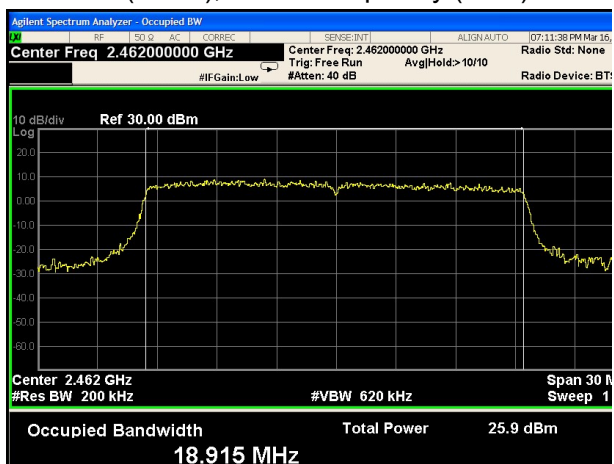
802.11ax(HE20), Carrier frequency (MHz): 2437



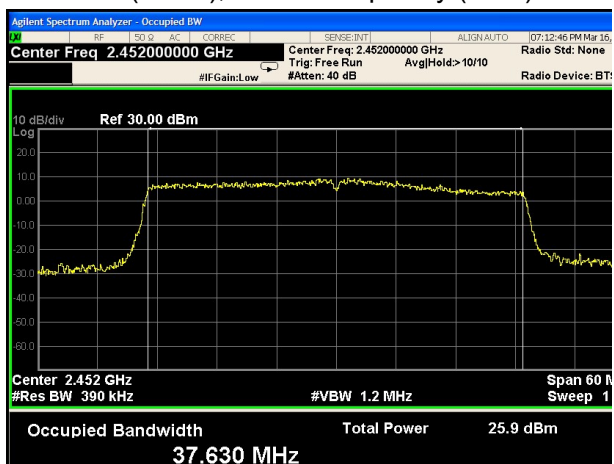
802.11ax(HE40), Carrier frequency (MHz): 2437

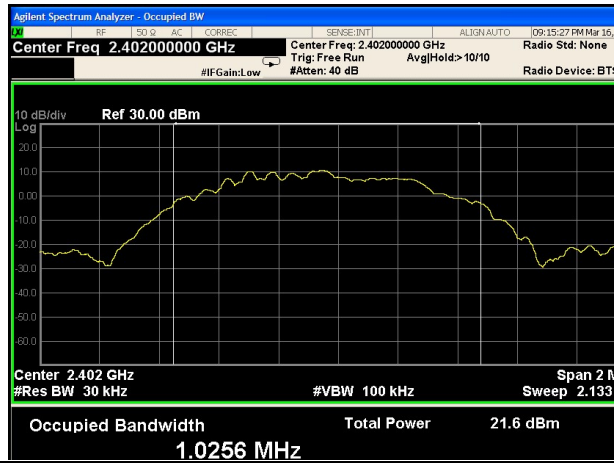
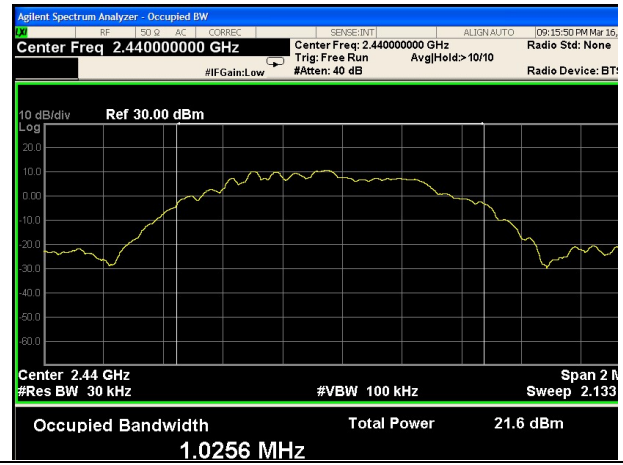


802.11ax(HE20), Carrier frequency (MHz): 2437

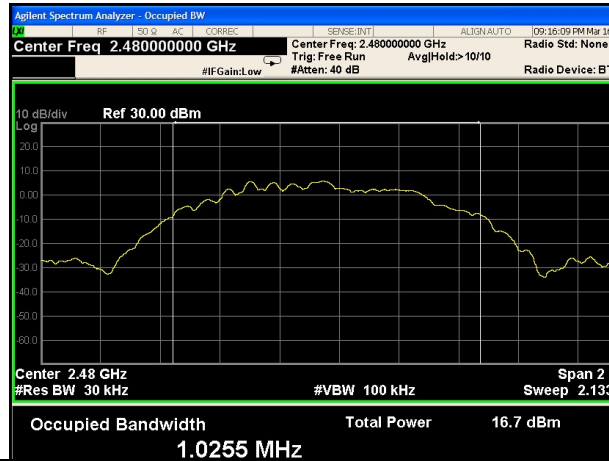


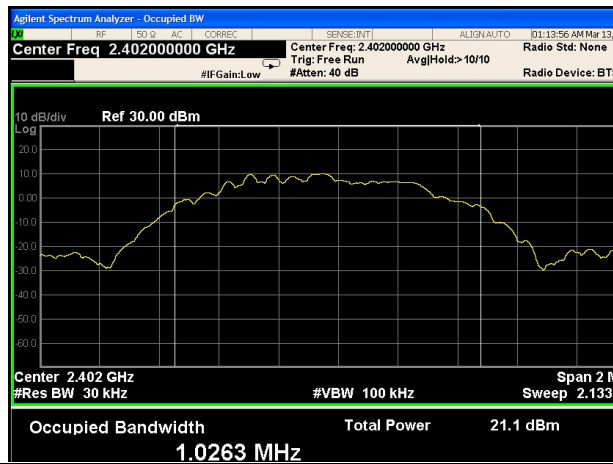
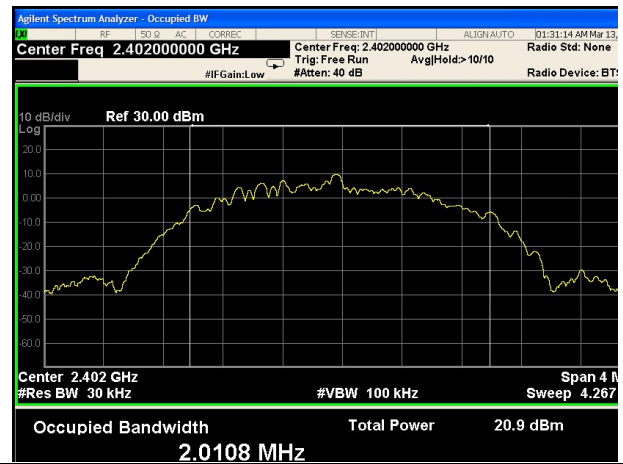
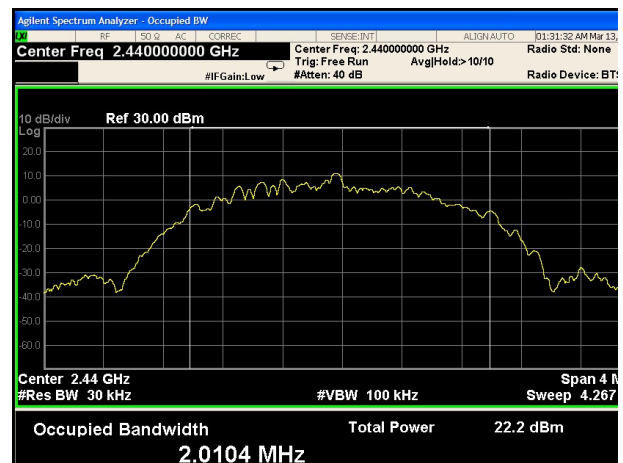
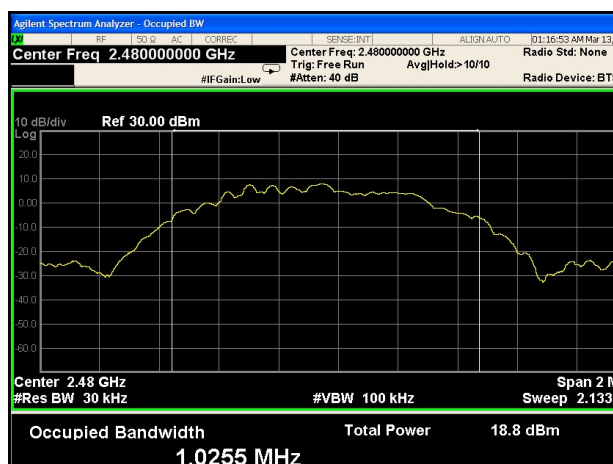
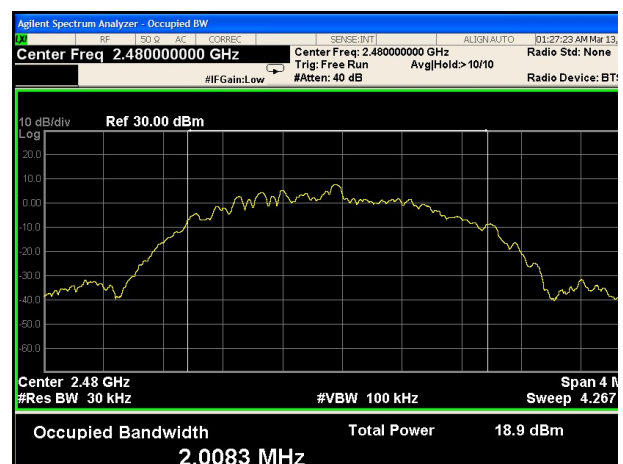
802.11ax(HE40), Carrier frequency (MHz):2452



Bluetooth LE (125K) Carrier frequency (MHz):
2402Bluetooth LE (125K) Carrier frequency (MHz):
2440

Bluetooth LE (125K) Carrier frequency (MHz): 2480

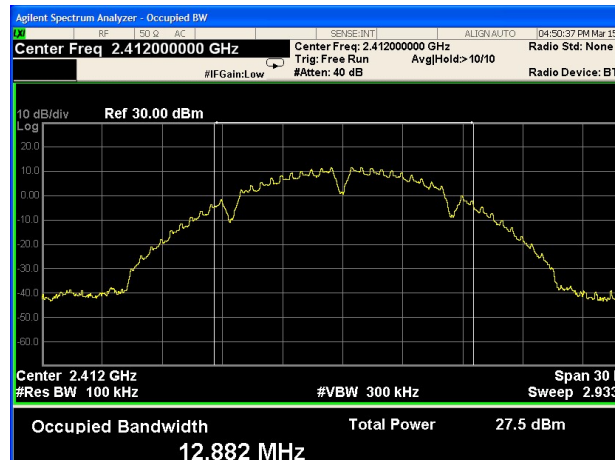


Bluetooth LE (1M) Carrier frequency (MHz):
2402Bluetooth LE (2M) Carrier frequency (MHz):
2402Bluetooth LE (1M) Carrier frequency (MHz):
2440Bluetooth LE (2M) Carrier frequency (MHz):
2440Bluetooth LE (1M) Carrier frequency (MHz):
2480Bluetooth LE (2M) Carrier frequency (MHz):
2480

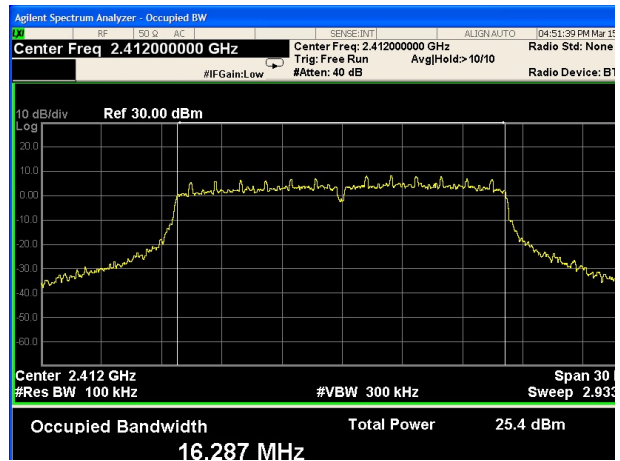


6 dB bandwidth

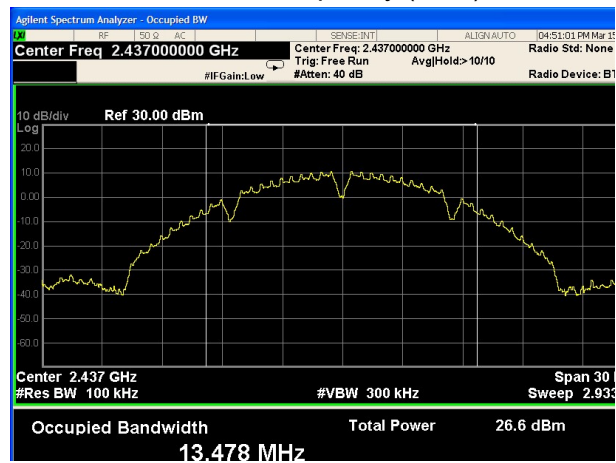
802.11b, Carrier frequency (MHz): 2412



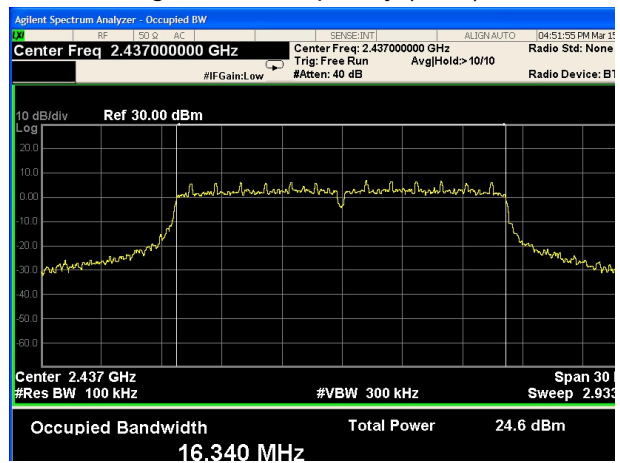
802.11g, Carrier frequency (MHz): 2412



802.11b, Carrier frequency (MHz): 2437



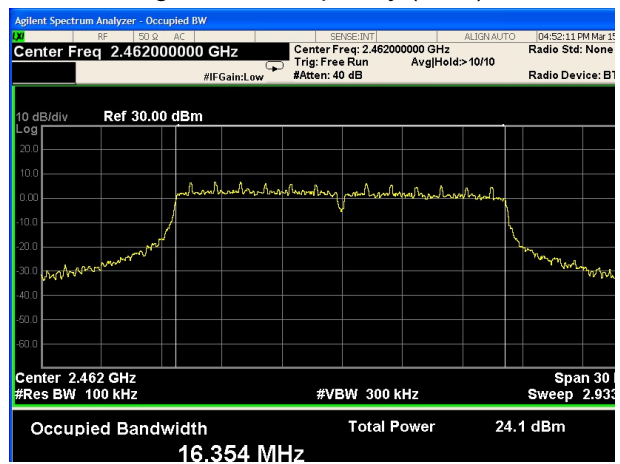
802.11g, Carrier frequency (MHz): 2437



802.11b, Carrier frequency (MHz): 2462

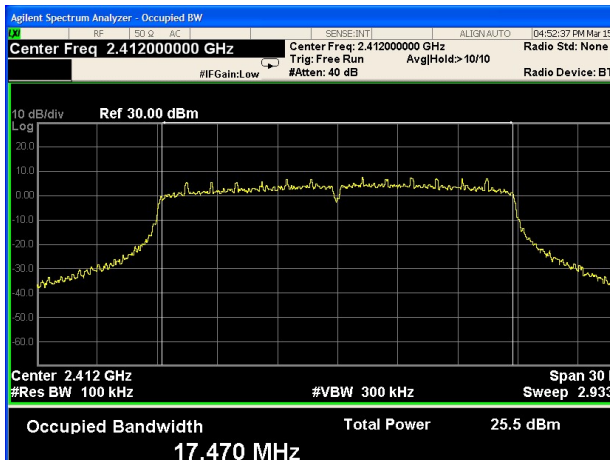


802.11g, Carrier frequency (MHz): 2462

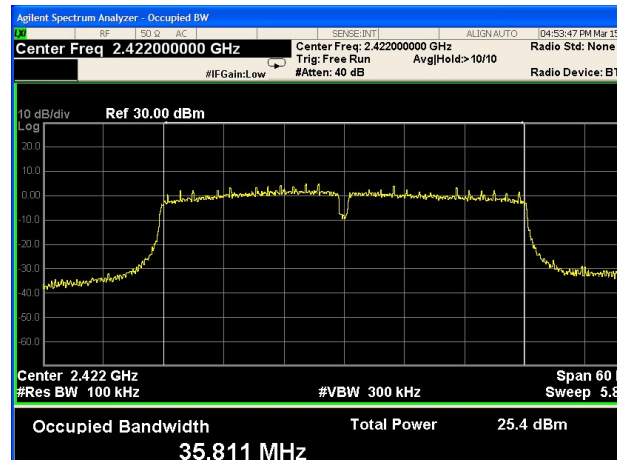




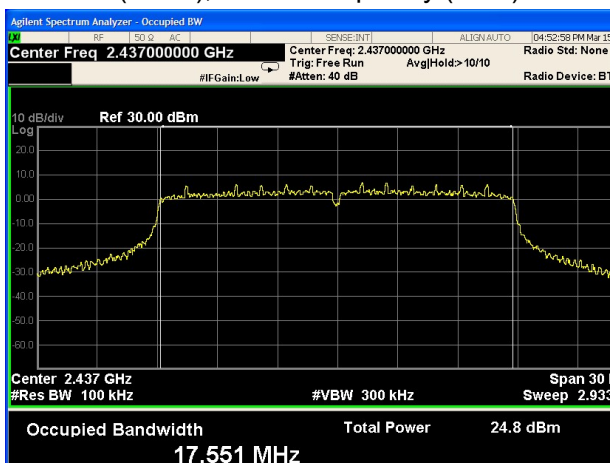
802.11n(HT20), Carrier frequency (MHz): 2412



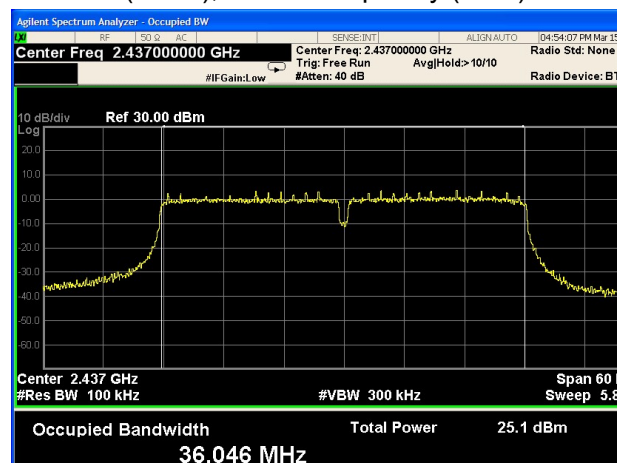
802.11n(HT40), Carrier frequency (MHz): 2422



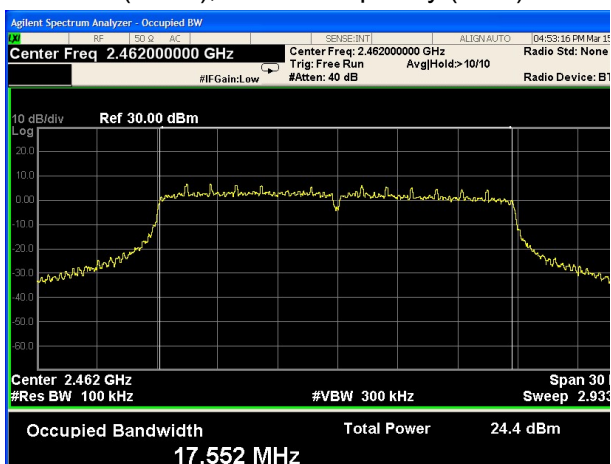
802.11n(HT20), Carrier frequency (MHz): 2437



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



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



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

