

TEST REPORT

Report No.: SHE21110074-02AE

Date: 2022-06-16

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Applicant : NATHER Ventilation System Co.,Ltd.
Address of Applicant : No. 2688, Xingping 1st Road, Pinghu
Economic-Technological Development Zone, Jiaxing City,
Zhejiang Province, China.

Product Name : Wireless Communication Modules
Model No. : TCM-F401-W4
Sample No. : E21110074-02#03
FCC ID : 2A3VE-TCM-F401-W4S
ISED Number : 28014-TCMF401W4S

Standards : FCC CFR47 Part 15, Subpart C
RSS-Gen (Issue 5, Amd.2-Feb 2021)
RSS-247 (Issue 2, February 2017)

Date of Receipt : 2021-12-14
Date of Test : 2021-12-20 ~ 2022-05-10
Date of Issue : 2022-06-16

Remark:

This report details the results of the testing carried out on one sample, the results contained in this report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

Prepared by:



(Erik Yang)

Reviewed by:



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Approved by:



(Authorized signatory: Guoyou Chi)

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1 General Information

1.1 Testing Laboratory

Company Name	ICAS Testing Technology Service (Shanghai) Co., Ltd.
Address	No.1298, Pingan Road, Minhang District, Shanghai, China
Telephone	0086 21-51682999
Fax	0086 21-54711112
Homepage	www.icasiso.com

1.2 Details of Application

Applicant Company Name	NATHER Ventilation System Co.,Ltd.
Address	No.2688, Xingping 1st Road, Pinghu Economic-Technological Development Zone, Jiaxing City, Zhejiang Province, China.
Contact Person	WANG xiaomei
Telephone	+86-21-64345163
Email	wxm@nather.com.cn
Manufacturer Company Name	Tiitang Information System (Shanghai) Co., LTD
Address	Room 308, Building 1, No. 3888, Humin Road, Minhang District, Shanghai

1.3 Details of EUT

Product Name	Wireless Communication Modules
Brand Name	N/A
Test Model No.	TCM-F401-W4
FCC ID	2A3VE-TCM-F401-W4S
ISED Number	28014-TCMF401W4S
Mode of Operation	WLAN 802.11b/g/n(HT20)
Frequency Range	2400MHz ~ 2483.5MHz
Channel Separation	5 MHz
Modulation Type	DSSS, OFDM
Antenna Type	PCB Antenna
Antenna Gain	2dBi
Test Voltage	DC 3.3V
Hardware version	V1.0
Software version	0102010801
Test SW Version	BL410_R;BL410_E
RF power setting in TEST SW	AiThinker Serial Tool V1.2.3

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1.4 Test Methodology

47 CFR Part 15, Subpart C	Telecommunication-Radio Frequency Devices-Intentional Radiators
KDB Publication 558074 D01 v05r02	15.247 Meas Guidance.
RSS-Gen (Issue 5, Amd.2-Feb 2021)	General Requirements for Compliance of Radio Apparatus
RSS-247 (Issue 2, February 2017)	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Note(s):

All test items were verified and recorded according to the standards and without any addition/deviation/exclusion during the test.

1.5 Test Summary

Test Item	FCC Rules	ISED RULES	Result
Antenna Requirement	FCC Part 15.247(b)(4), Part 15.203	RSS-247 5.4(6)	PASS
Peak Output Power and E.I.R.P	FCC Part 15.247(b)(3)	RSS-247 5.4(4)	PASS
6dB Bandwidth and 99% Bandwidth	FCC Part 15.247(a)(2)	RSS-247 5.2(1) RSS-Gen 6.7	PASS
Power Spectral Density	FCC Part 15.247(e)	RSS-247 5.2(2)	PASS
Conducted Spurious Emission & Authorized-band band-edge	FCC Part 15.247(d)	RSS-247 5.5 RSS-Gen 8.9	PASS
Radiated Spurious Emission	FCC Part 15.247(d), 15.205, 15.209	RSS-247 5.5	PASS
Band Edge (Restricted-band band-edge)	FCC Part 15.247(d), 15.205, 15.209	RSS-247 5.5	PASS
Conducted Emission on AC Mains	FCC Part 15.207(a)	RSS-Gen 8.8	PASS

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2 Test Condition

2.1 Environmental conditions

Temperature (°C)	18-25
Humidity (%RH)	40-65
Barometric Pressure (mbar)	960-1060

2.2 Equipment List

Name of Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due Date
Spectrum Analyzer	Keysight	N9020B	MY59260184	2021-08-17	2022-08-16
Spectrum Analyzer	Rohde & Schwarz	FSV40N	101450	2021-06-10	2022-06-09
EMI Test Receiver	Rohde & Schwarz	ESPI3	100173	2021-06-10	2022-06-09
EMI Test Receiver	Rohde & Schwarz	ESR 7	101911	2021-06-10	2022-06-09
V-network	SCHWARZBECK	NSLK 8127	8127-902	2021-06-10	2022-06-09
Wideband Radio Communication Tester	Rohde & Schwarz	CMW 500	100687	2021-08-13	2022-08-12
Broadband Antenna	SCHWARZBECK	VULB9163	9163-1037	2021-06-08	2022-06-07
Horn Antenna-18G	SCHWARZBECK	BBHA9120D	9120D-1775	2021-06-08	2022-06-07
Horn Antenna-40G	YINGLIAN	LB-180400-KF	N/A	2021-06-12	2022-06-11
EMC chamber 9*6*6 (L*W*H)	CHANGNING	966	N/A	2020-06-09	2023-06-08
Shielded Enclosure 8*5*4 (L*W*H)	CHANGNING	854	N/A	2020-06-09	2023-06-08
Test Software	BL	BL410_E	N/A	N/A	N/A
Test Software	BL	BL410_R	N/A	N/A	N/A

2.3 Measurement Uncertainty

The uncertainty is calculated using the methods suggested in the “Guide to the Expression of Uncertainty in measurement” (GUM) published by CISPR and ANSI.

Parameter	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	± 1.5 dB
	> 1GHz	± 1.5 dB
Radiated Emission	30 MHz – 1 GHz	± 3.42 dB
	> 1GHz	± 4.20 dB
Conducted Emission on AC Mains	9 kHz to 30 MHz	± 1.71 dB

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3 Test Set-up and Operation Modes

3.1 Details of Test Mode

Using test software was control EUT work in continuous transmitter and receiver mode. Select test channel as below:
For 802.11b/g/n (HT20)

Channel	Frequency
The lowest channel(CH1)	2412MHz
The middle channel(CH6)	2437MHz
The Highest channel(CH11)	2462MHz

Through Pre-scan under all rate at lowest channel, the data rate as below table described is the worst case, so we choose these data rate for test.

Type	Data rate
802.11b	5.5Mbps
802.11g	18Mbps
802.11n(20M)	MCS4

The basic operation modes are:

- A. On
 - 1. WLAN mode
 - a. Transmitting
 - i. Low Channel
 - ii. Middle Channel
 - iii. High Channel
 - b. Receiving
- B. Standby
- C. Off

3.2 Special Accessories and Auxiliary Equipment

Description	Manufacturer	Model No.	Serial No.
Laptop	HP	HP ZHAN 66 Pro G1	N/A
USB-Cable	N/A	N/A	N/A

3.3 Support Software

Description	Manufacturer	Software Name
Software	N/A	AiThinker Serial Tool V1.2.3

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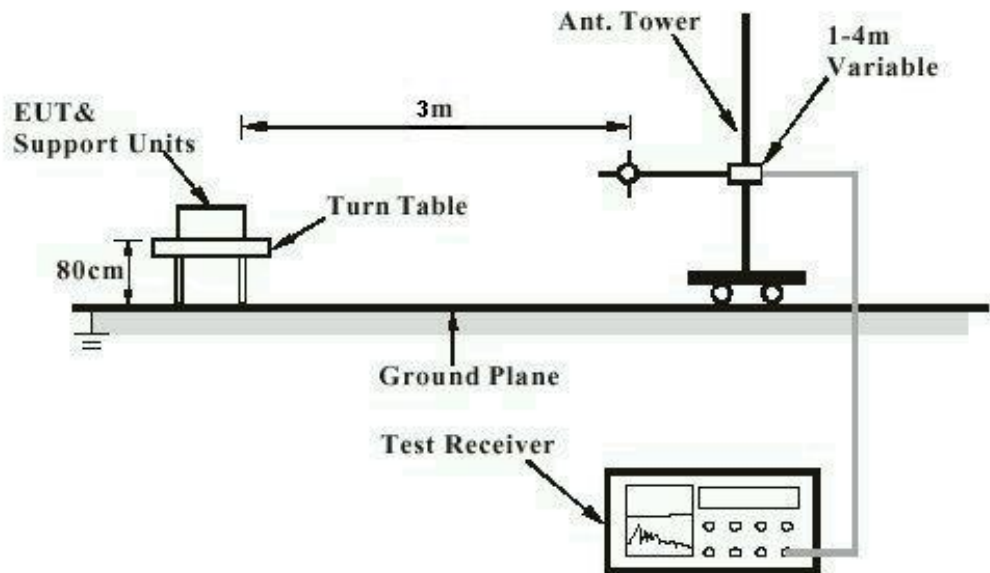
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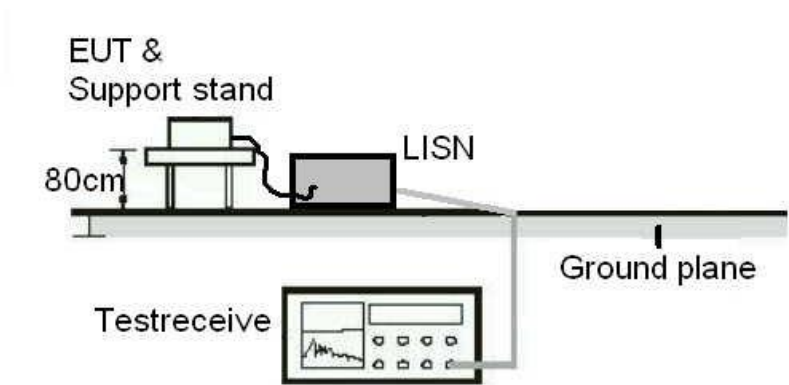
3.4 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Emission Measurement



Note: Measurements above 1GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Configuration for Conduction Emission Measurement



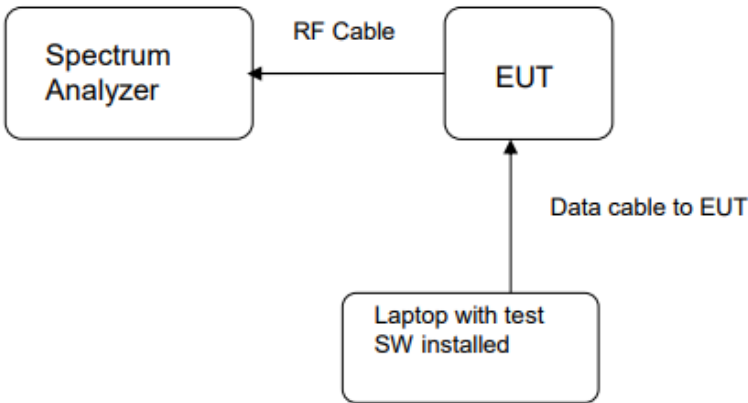
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Diagram of Measurement Configuration for Transmitter Measurement



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4 Test Results

4.1 Transmitter Requirement & Test Suites

4.1.1 Antenna Requirement

RESULT:

PASS

Test standard : FCC Part 15.247(b)(4), Part 15.203
RSS-247 5.4(6)

Requirement : The use of approved antennas only with directional
gains that do not exceed 6dBi

According to the manufacturer declaration, the EUT has an antenna with a directional gain of 2dBi. The antenna is an internal antenna with no possibility of replacement with a non-approved antenna by the end-user.

Therefore, the EUT is considered to comply with this provision.

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4.1.2 Peak Output Power and E.I.R.P

RESULT:

PASS

Test standard : FCC Part 15.247(b)(3)
RSS-247 5.4(4)
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 22.5°C
Relative humidity : 54%

Table 1: Peak Output Power

Test Mode	Test Channel (MHz)	Measured Conducted Peak Power	Peak Output Power		Limit (W)
		(dBm)	(dBm)	(mW)	
802.11b	2412	-17.81	-17.81	0.02	≤1
	2437	-18.96	-18.96	0.01	
	2462	-18.77	-18.77	0.01	
802.11g	2412	-19.75	-19.55	0.01	
	2437	-20.08	-19.88	0.01	
	2462	-22.94	-22.74	0.01	
802.11n(HT20)	2412	-19.52	-19.14	0.01	
	2437	-20.94	-20.56	0.01	
	2462	-20.46	-20.08	0.01	

Table 2: E.I.R.P

Test Mode	Test Channel (MHz)	E.I.R.P		Limit (W)
		(dBm)	(mW)	
802.11b	2412	-15.81	0.03	≤4
	2437	-16.96	0.02	
	2462	-16.77	0.02	
802.11g	2412	-17.55	0.02	
	2437	-17.88	0.02	
	2462	-20.74	0.01	
802.11n(HT20)	2412	-17.14	0.02	
	2437	-18.56	0.01	
	2462	-18.08	0.02	

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Notes:

Peak Output Power = Measured Conducted peak power +duty cycle factor

EIRP = Peak Output Power + Antenna Gain(2dBi)

Duty cycle factor = $10 \cdot \log(1/\text{duty cycle})$

Figure 1: 802.11b > 98%

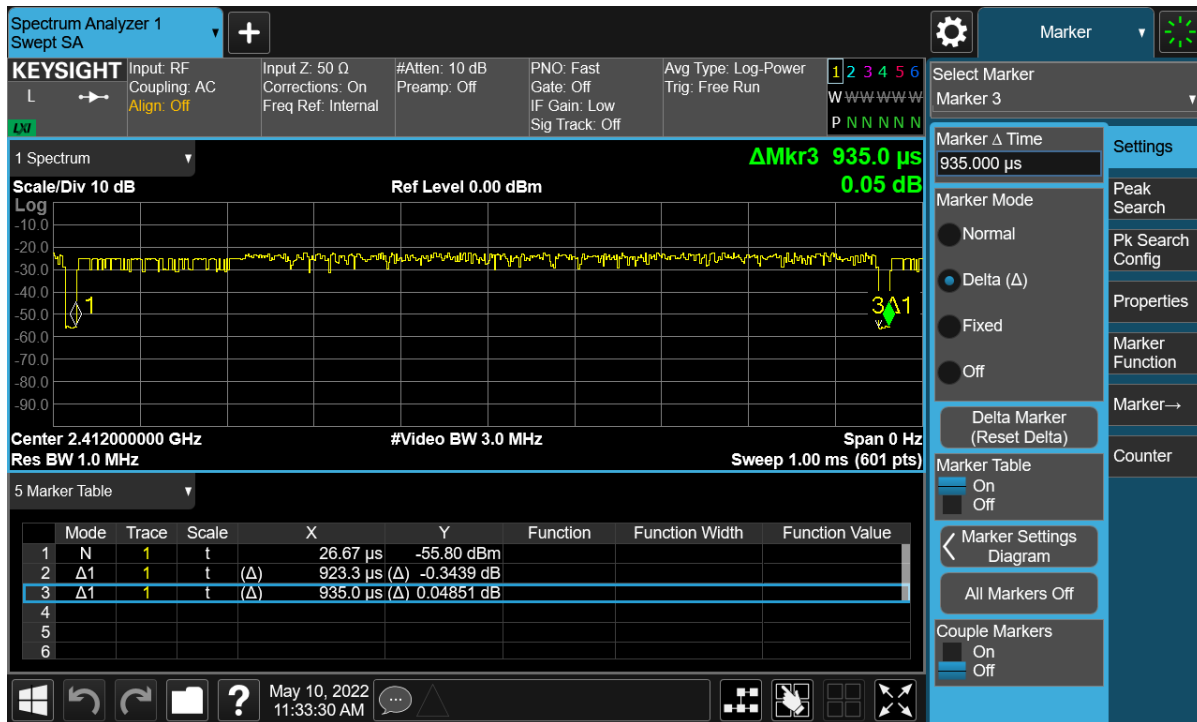
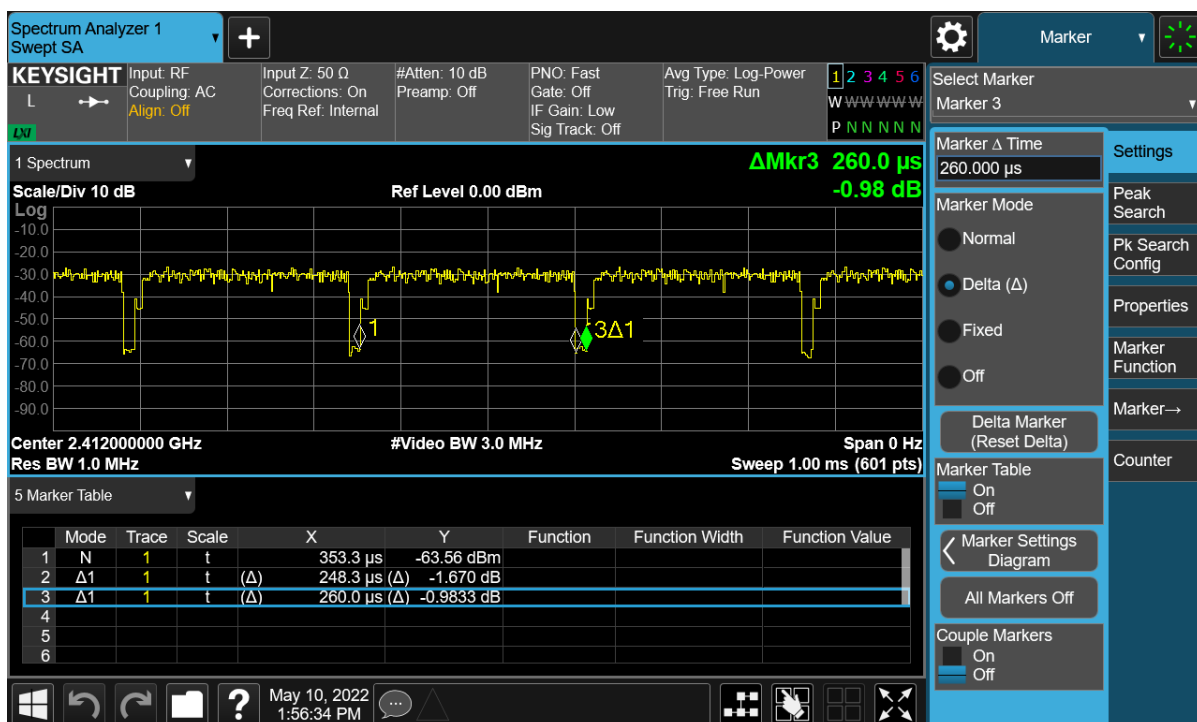


Figure 2: 802.11g < 98%, Duty cycle factor= $10 \cdot \log(1/\text{duty cycle})=0.20$



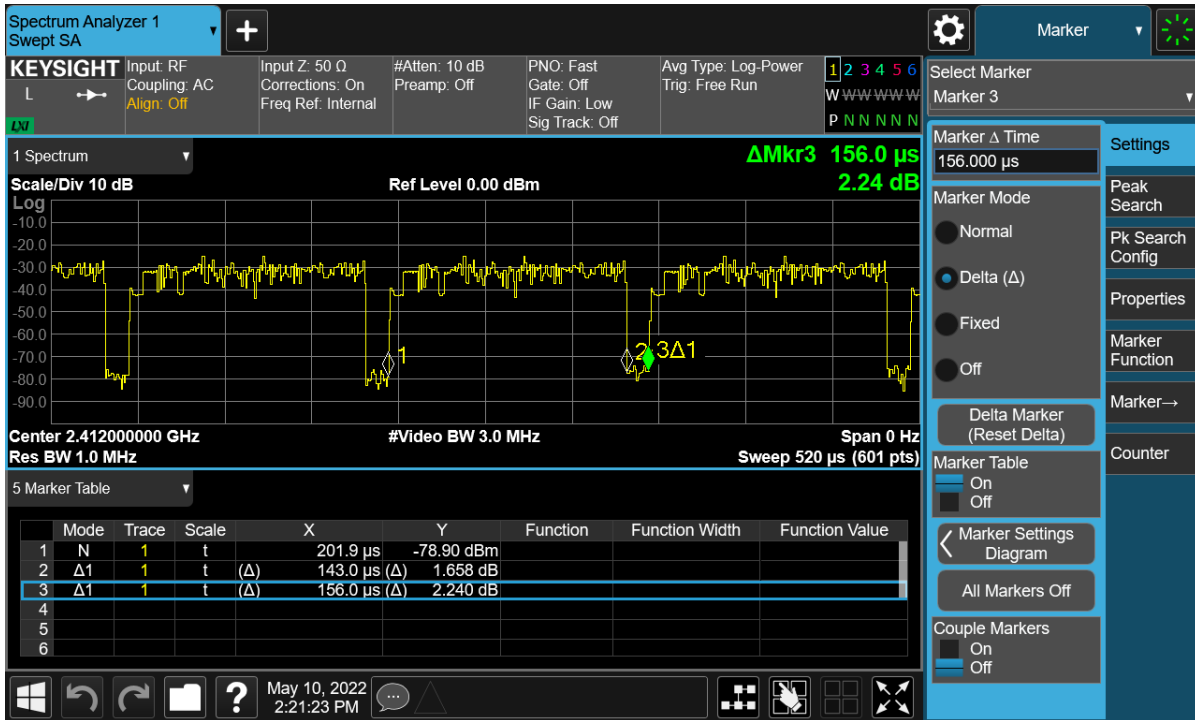
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Figure 3: 802.11n20 < 98%, Duty cycle factor = $10 \cdot \log(1/\text{duty cycle}) = 0.38$



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4.1.3 6dB Bandwidth and 99% Bandwidth

RESULT:

PASS

Test standard : FCC Part 15.247(a)(2)
RSS-247 5.2(1)
RSS-Gen 6.7
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 22.5°C
Relative humidity : 54%

Table 3: 6dB Bandwidth and 99% Bandwidth

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit (MHz)
802.11b	2412	8.036	11.812	≥0.5
	2437	8.100	12.319	
	2462	7.872	11.947	
802.11g	2412	15.710	17.341	
	2437	16.050	19.783	
	2462	15.990	16.838	
802.11n(HT20)	2412	17.620	19.274	
	2437	17.640	19.853	
	2462	17.570	19.889	

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Figure 4: 6dB Bandwidth 802.11b, 2412MHz

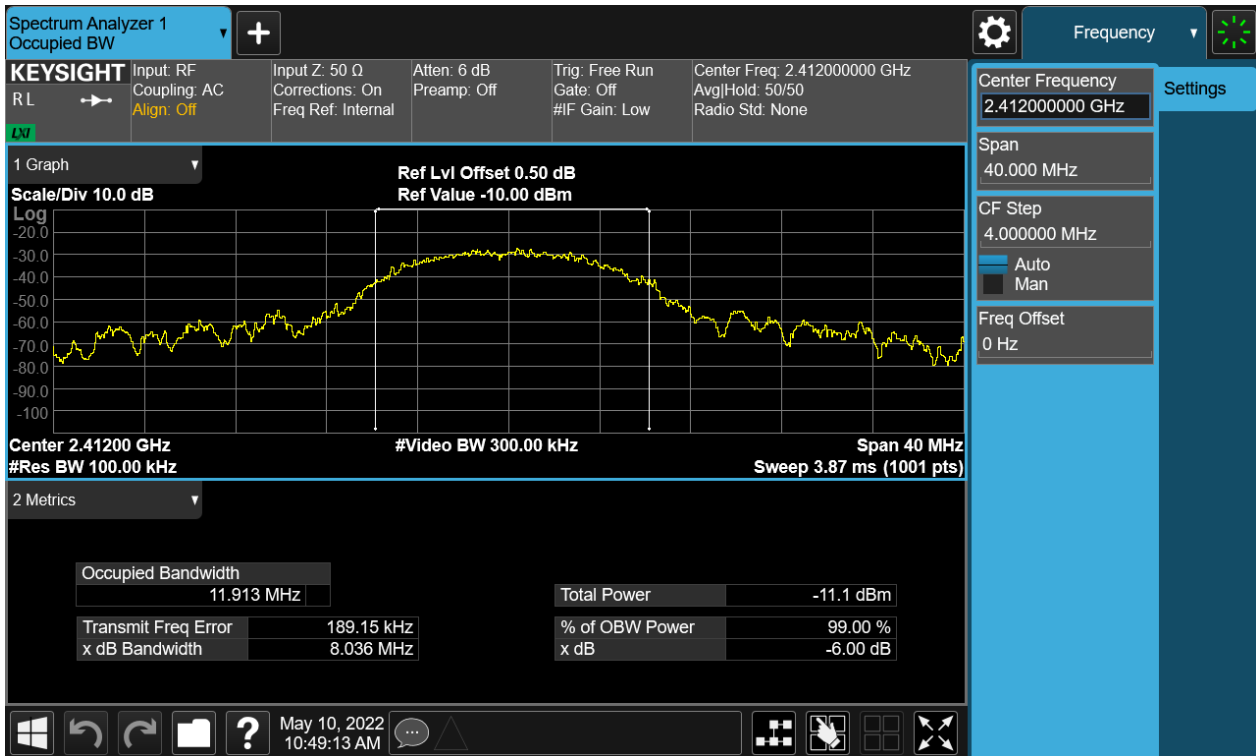
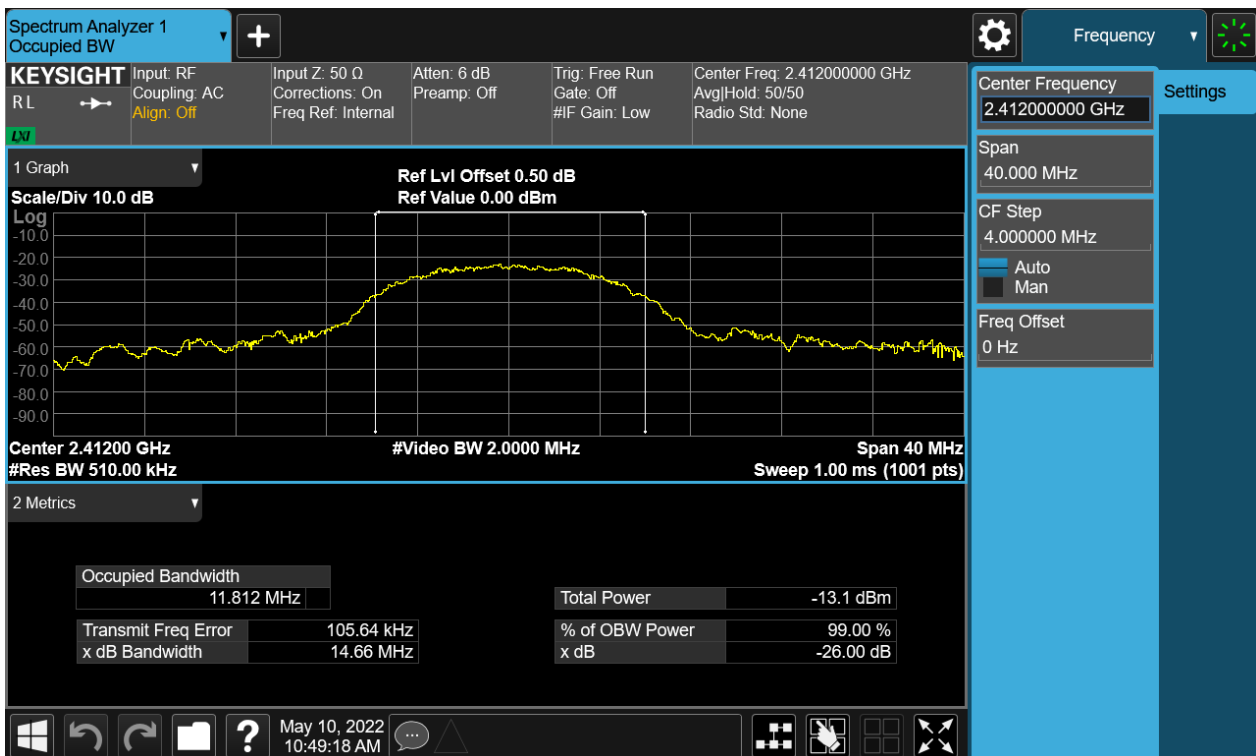


Figure 5: 99% Bandwidth, 802.11b, 2412MHz



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Figure 6: 6dB Bandwidth, 802.11b, 2437MHz

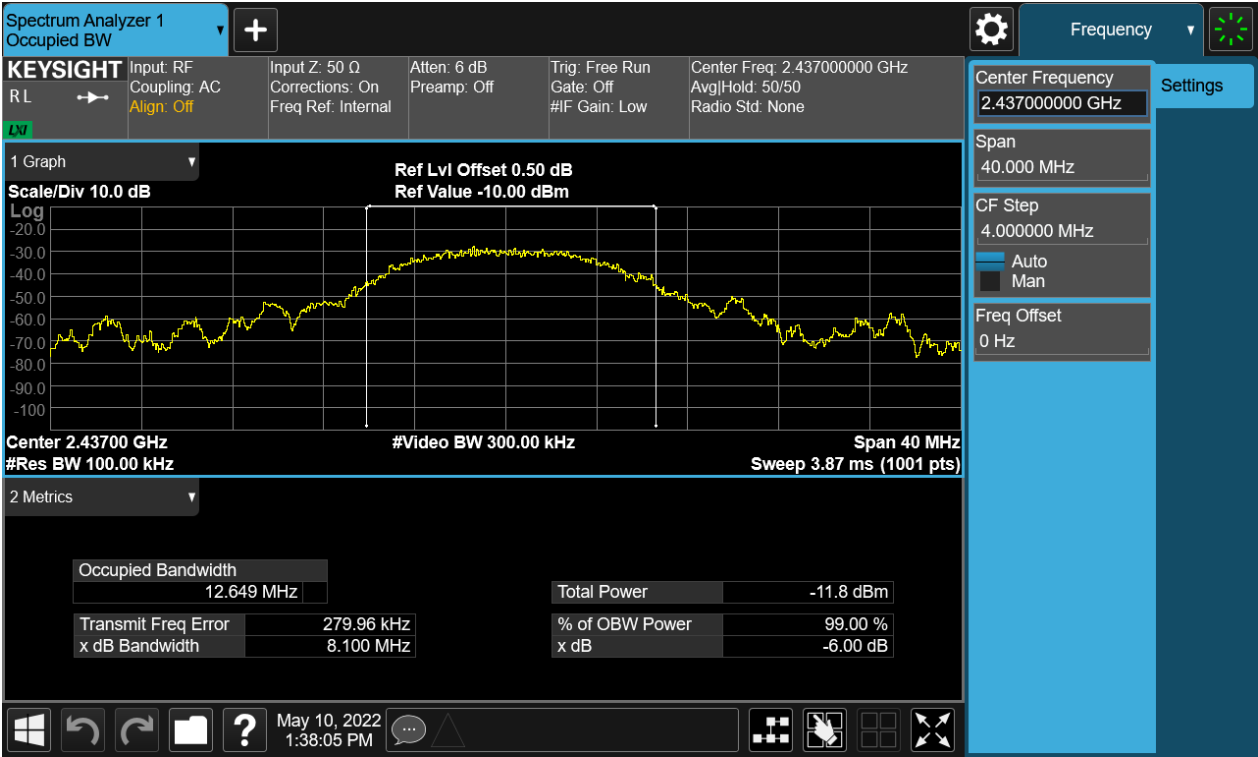


Figure 7: 99% Bandwidth, 802.11b, 2437MHz



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Figure 8: 6dB Bandwidth, 802.11b, 2462MHz

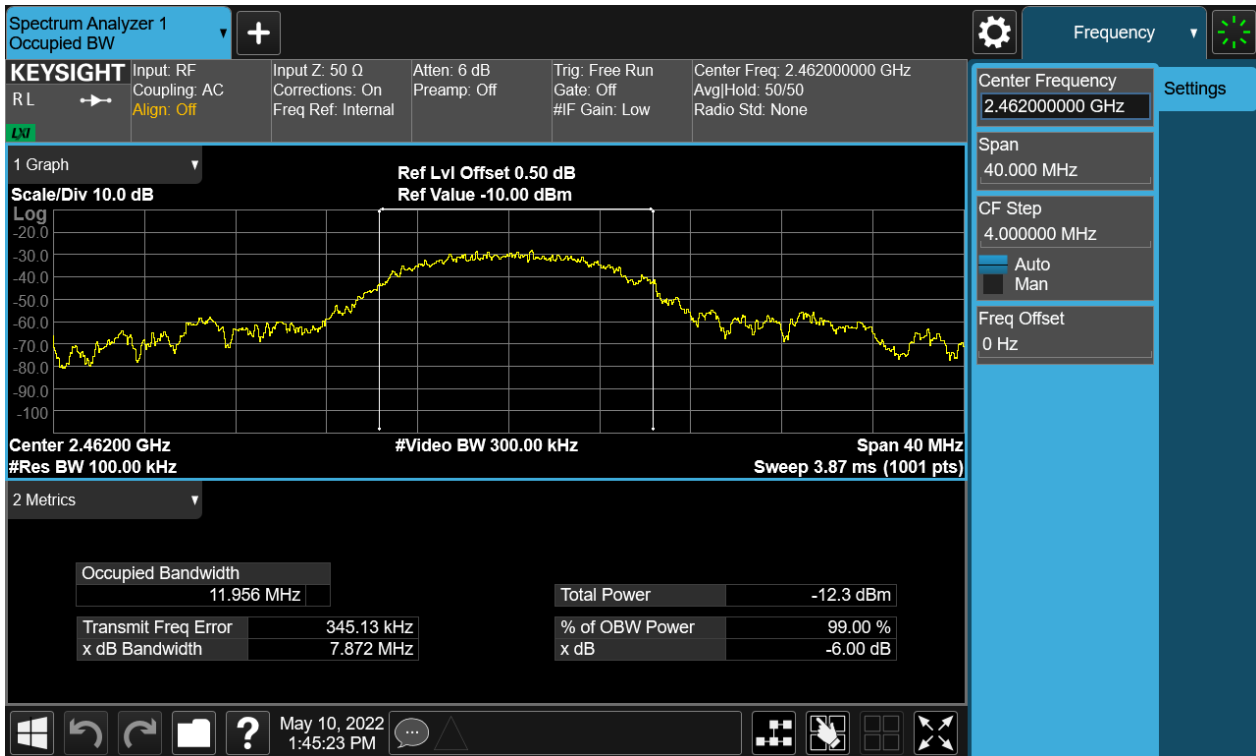
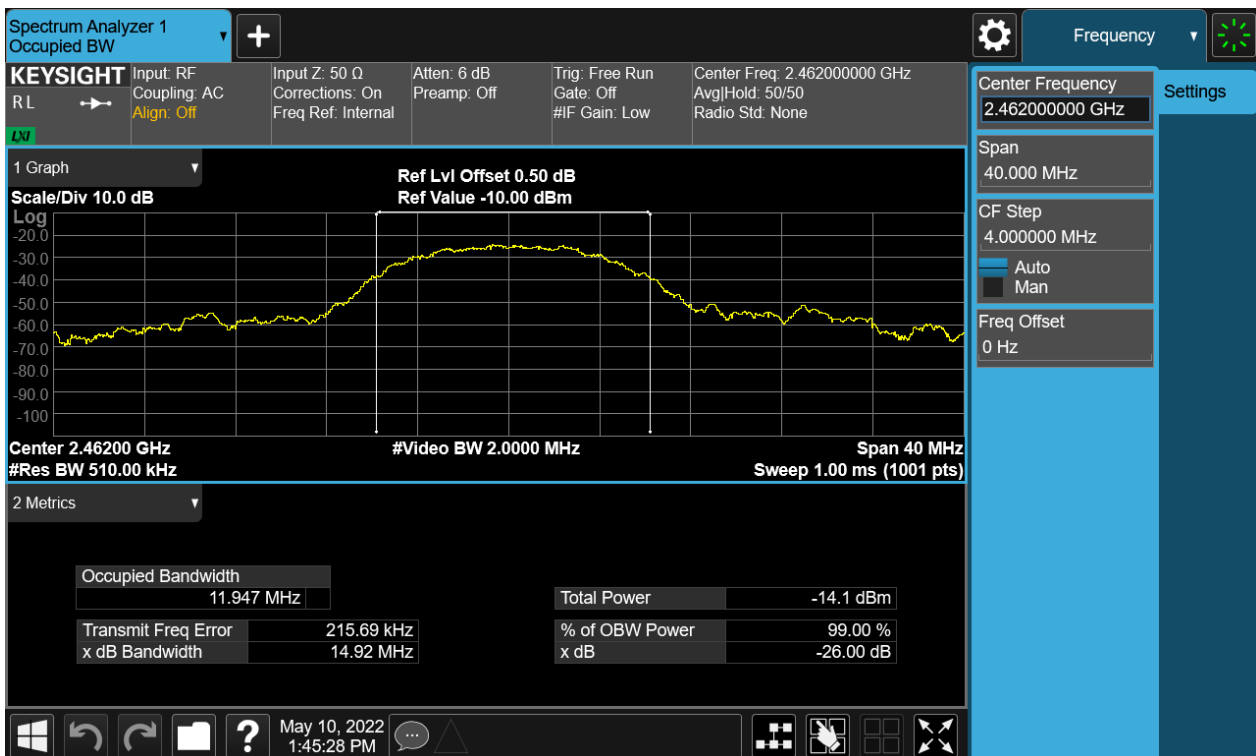


Figure 9: 99% Bandwidth, 802.11b, 2462MHz



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Figure 10: 6dB Bandwidth, 802.11g, 2412MHz

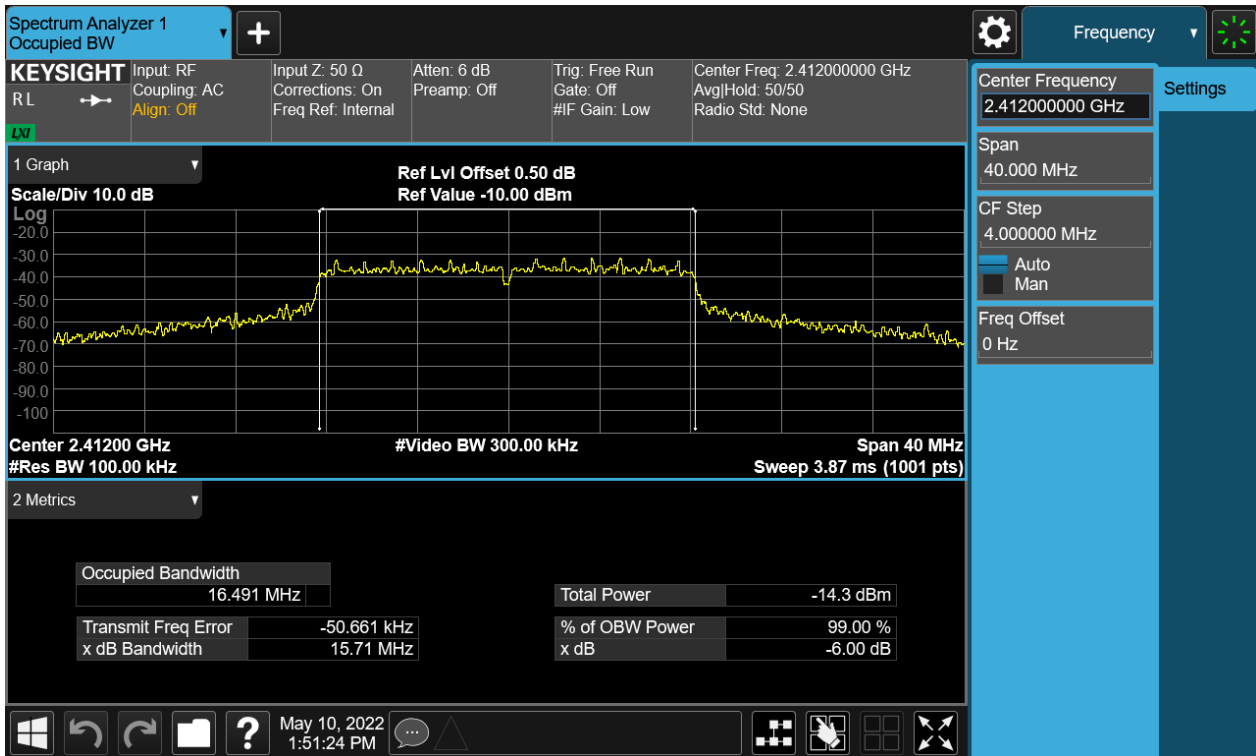
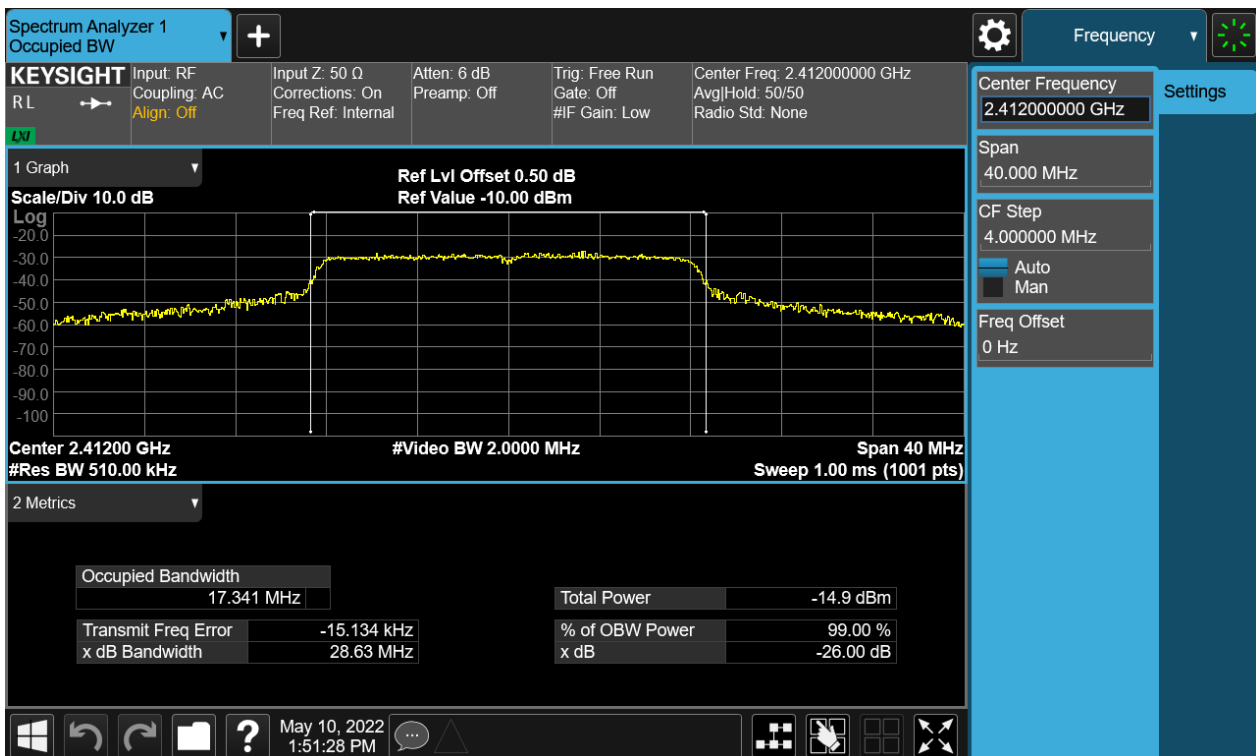


Figure 11: 99% Bandwidth, 802.11g, 2412MHz



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Figure 12: 6dB Bandwidth, 802.11g, 2437MHz

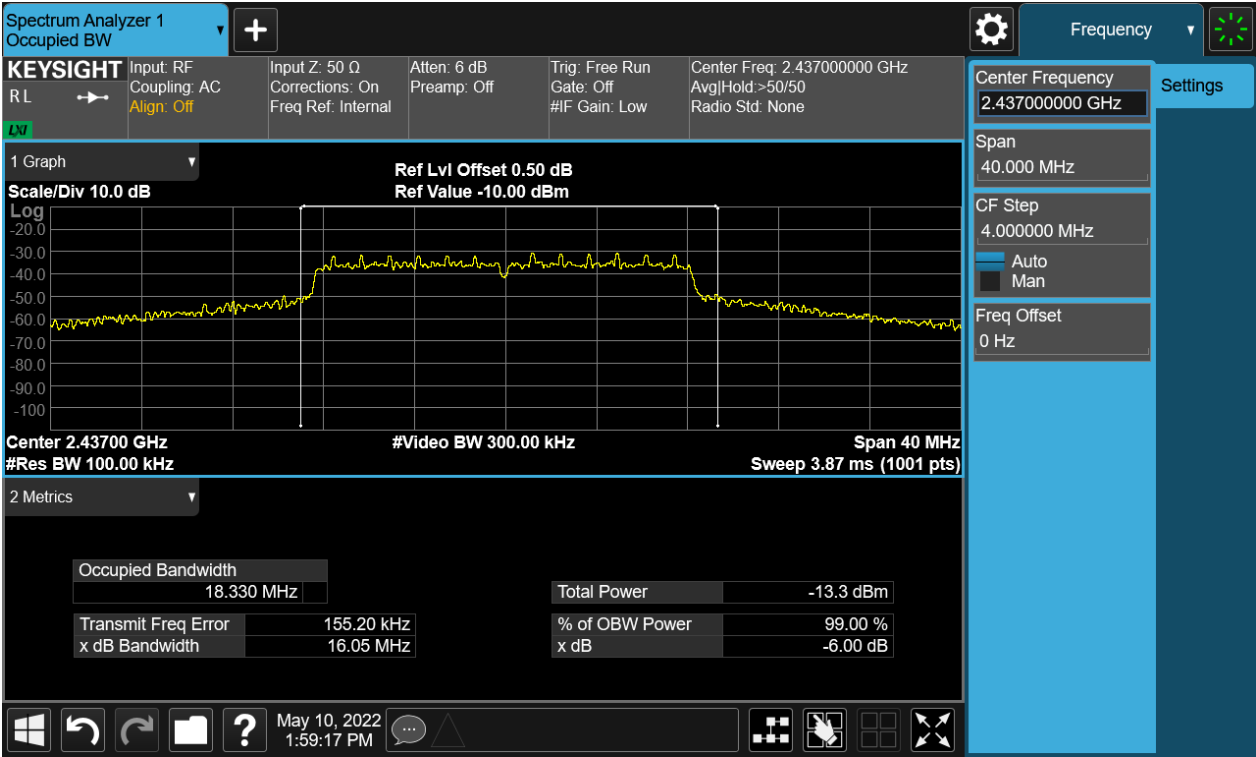


Figure 13: 99% Bandwidth, 802.11g, 2437MHz



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Figure 14: 6dB Bandwidth, 802.11g, 2462MHz

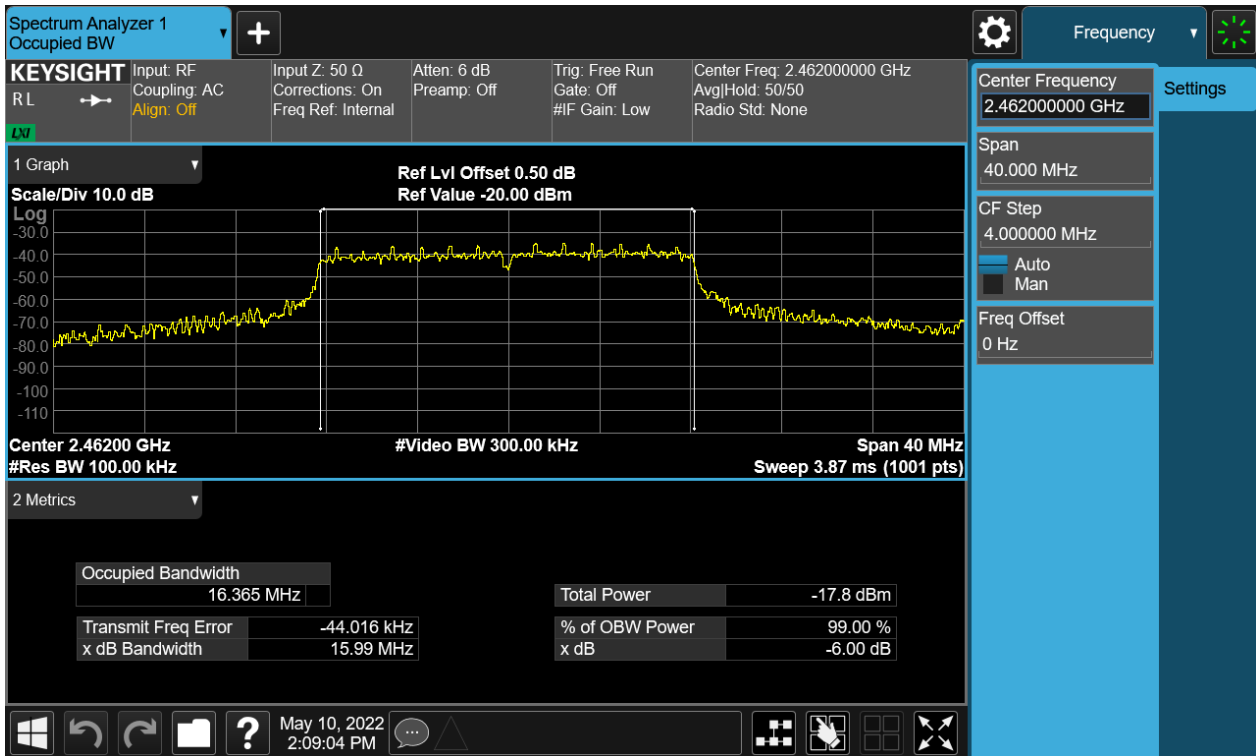
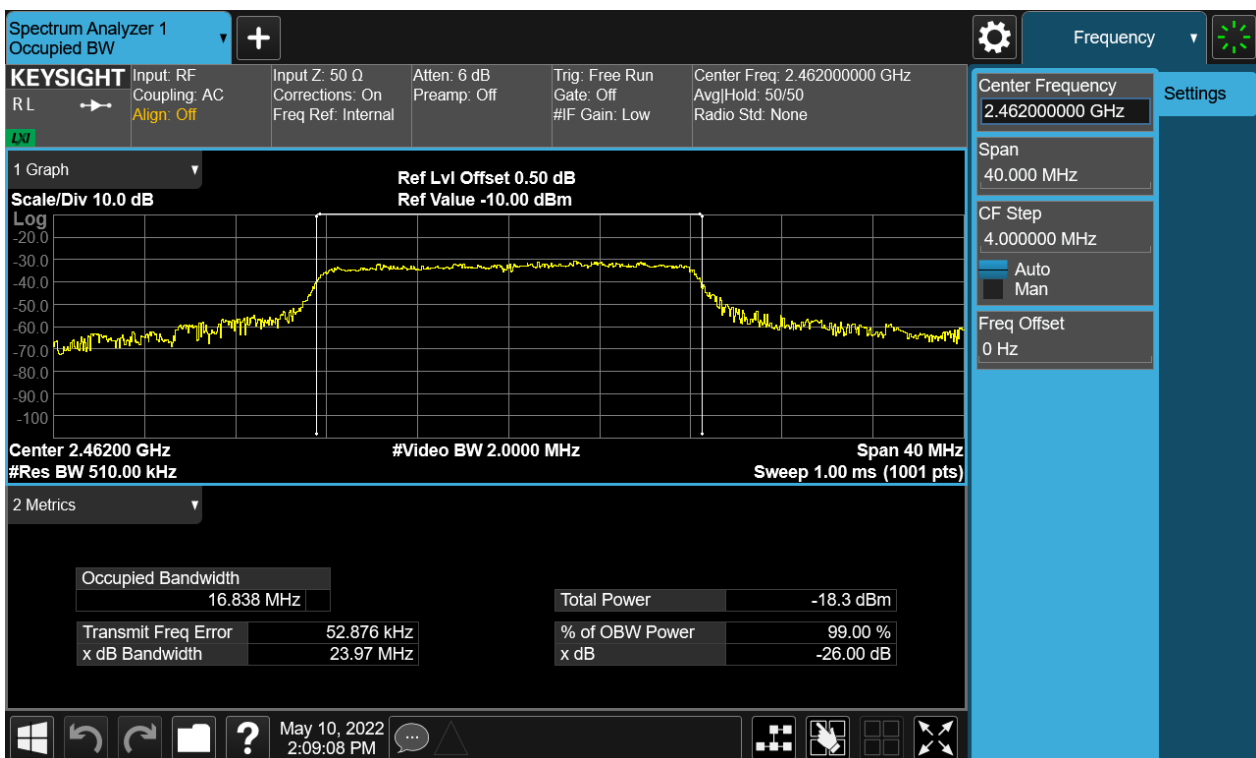


Figure 15: 99% Bandwidth, 802.11g, 2462MHz



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Figure 16: 6dB Bandwidth, 802.11n(HT20), 2412MHz

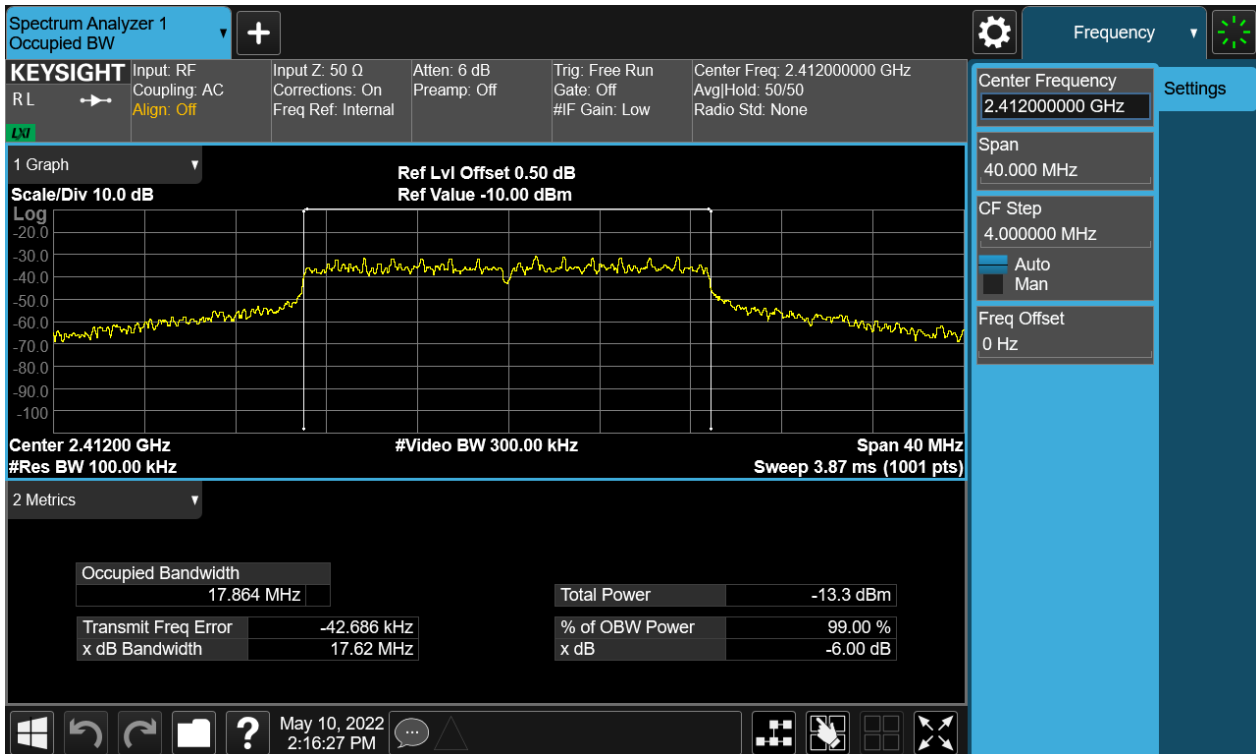
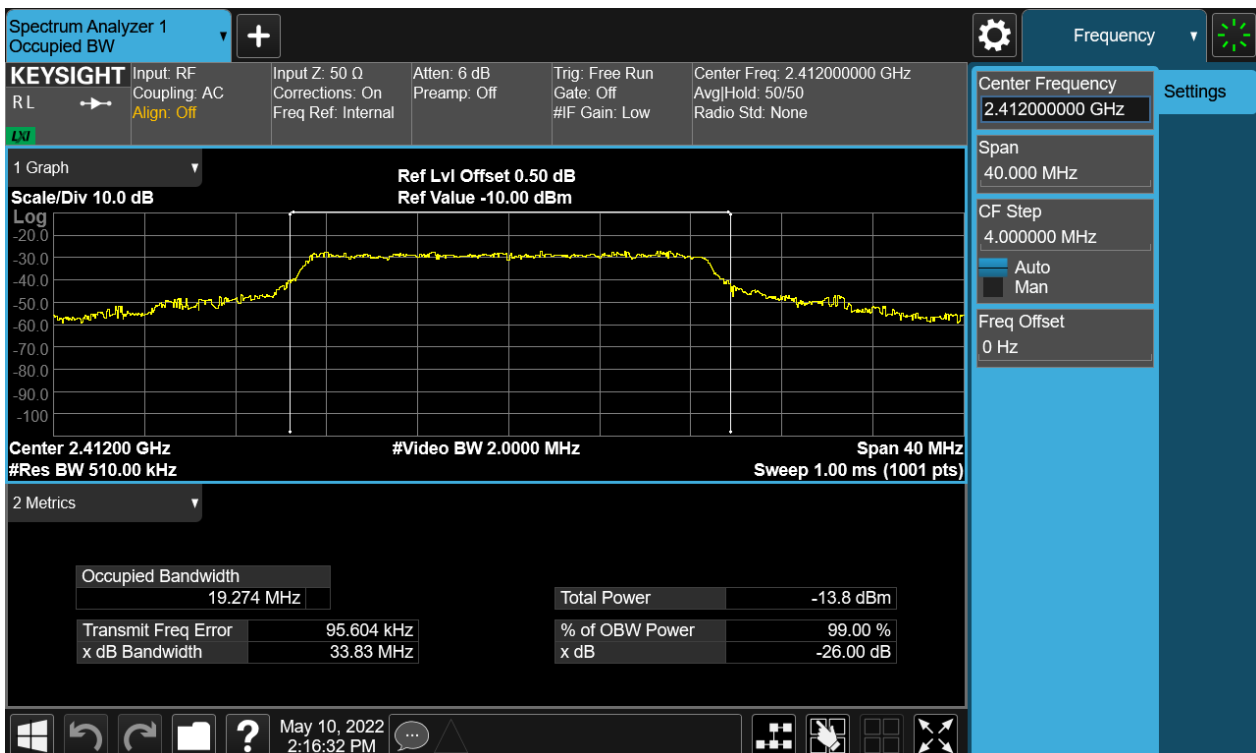


Figure 17: 99% Bandwidth, 802.11n(HT20), 2412MHz



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Figure 12: 6dB Bandwidth, 802.11n(HT20), 2437MHz

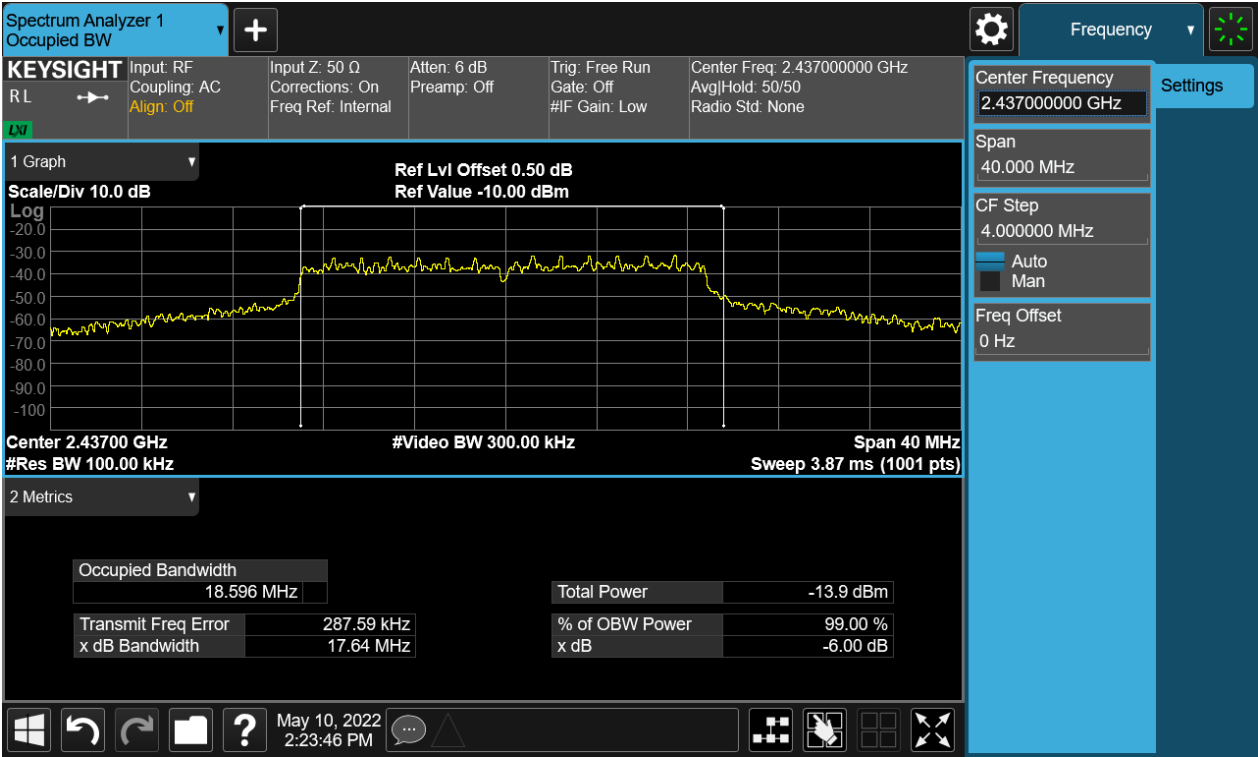
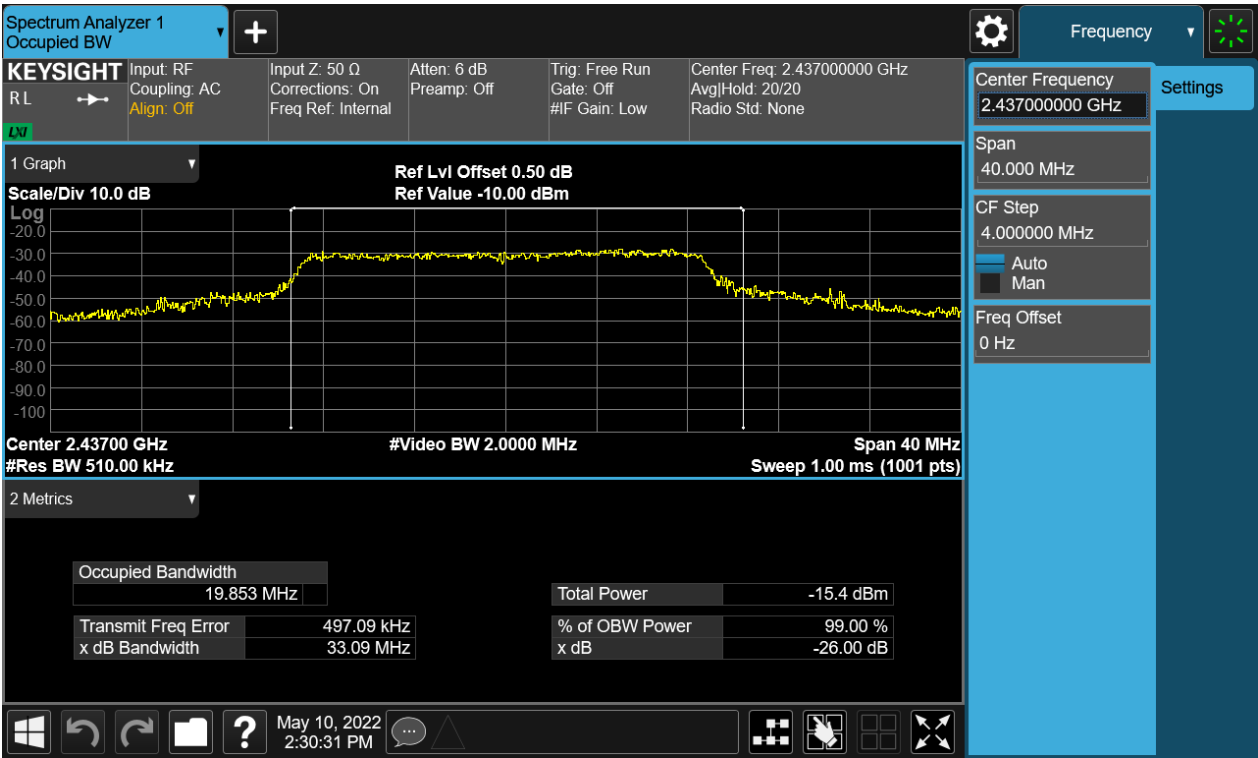


Figure 19: 99% Bandwidth, 802.11n(HT20), 2437MHz



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Figure 20: 6dB Bandwidth, 802.11n(HT20), 2462MHz

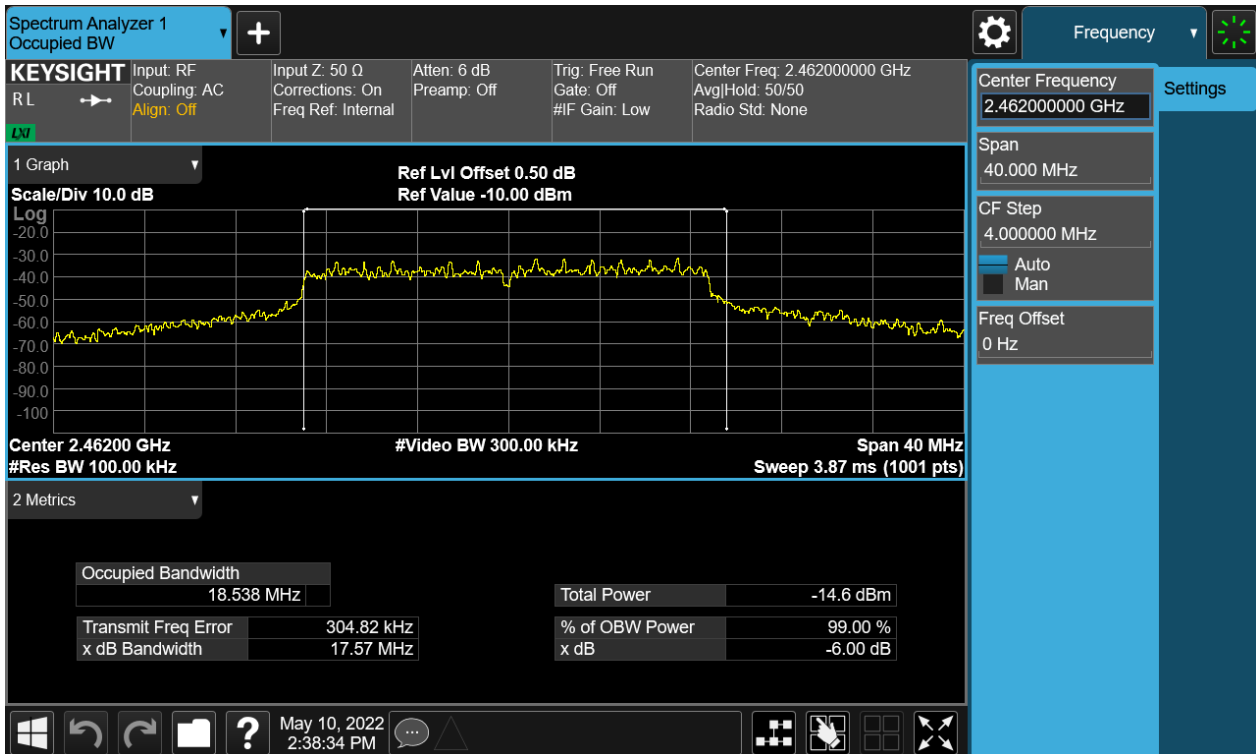
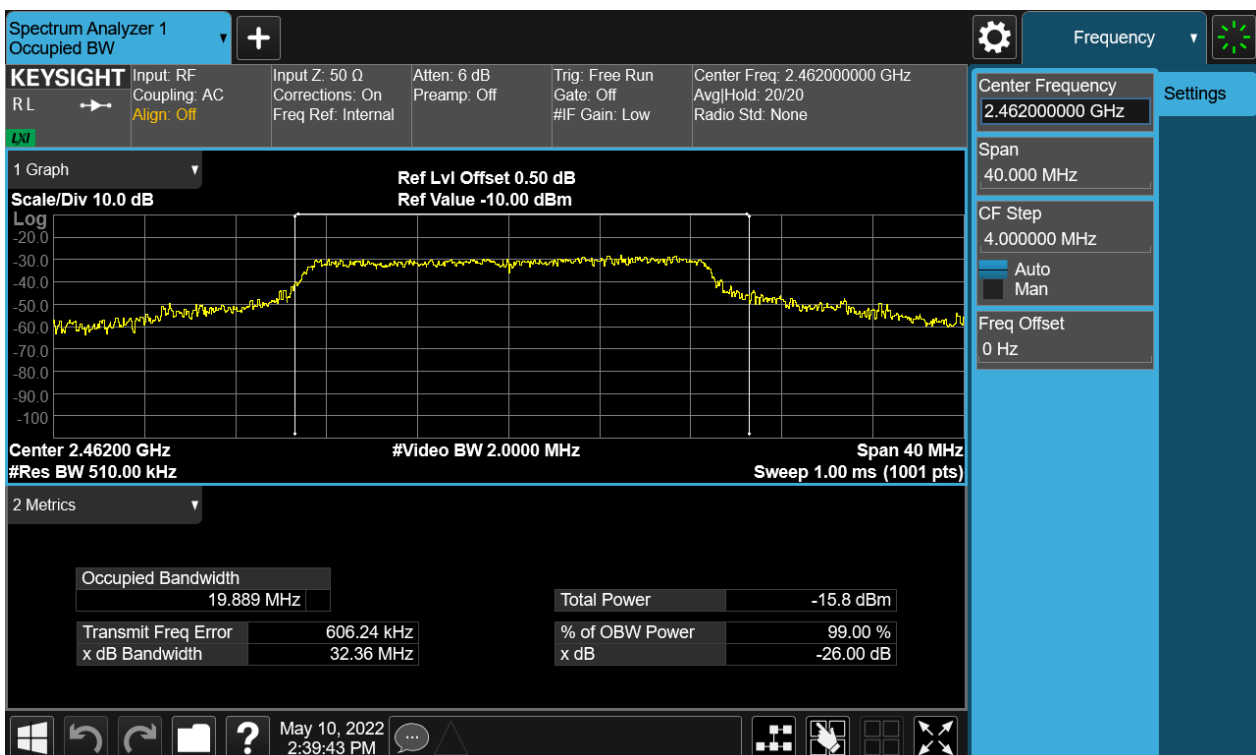


Figure 20: 99% Bandwidth, 802.11n(HT20), 2462MHz



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4.1.4 Power Spectral Density

RESULT:

PASS

Test standard : FCC Part 15.247(e)
RSS-247 5.2(2)
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 22.5°C
Relative humidity : 54%

Table 4: Power Spectral Density

Test Mode	Test Channel (MHz)	Measured Result (dBm/3kHz)	Limit (dBm/3kHz)
802.11b	2412	-41.83	≤ 8
	2437	-42.20	
	2462	-42.64	
802.11g	2412	-45.69	
	2437	-45.63	
	2462	-49.30	
802.11n(HT20)	2412	-44.43	
	2437	-45.78	
	2462	-46.19	

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Figure 21: Power Spectral Density, 802.11b, 2412MHz

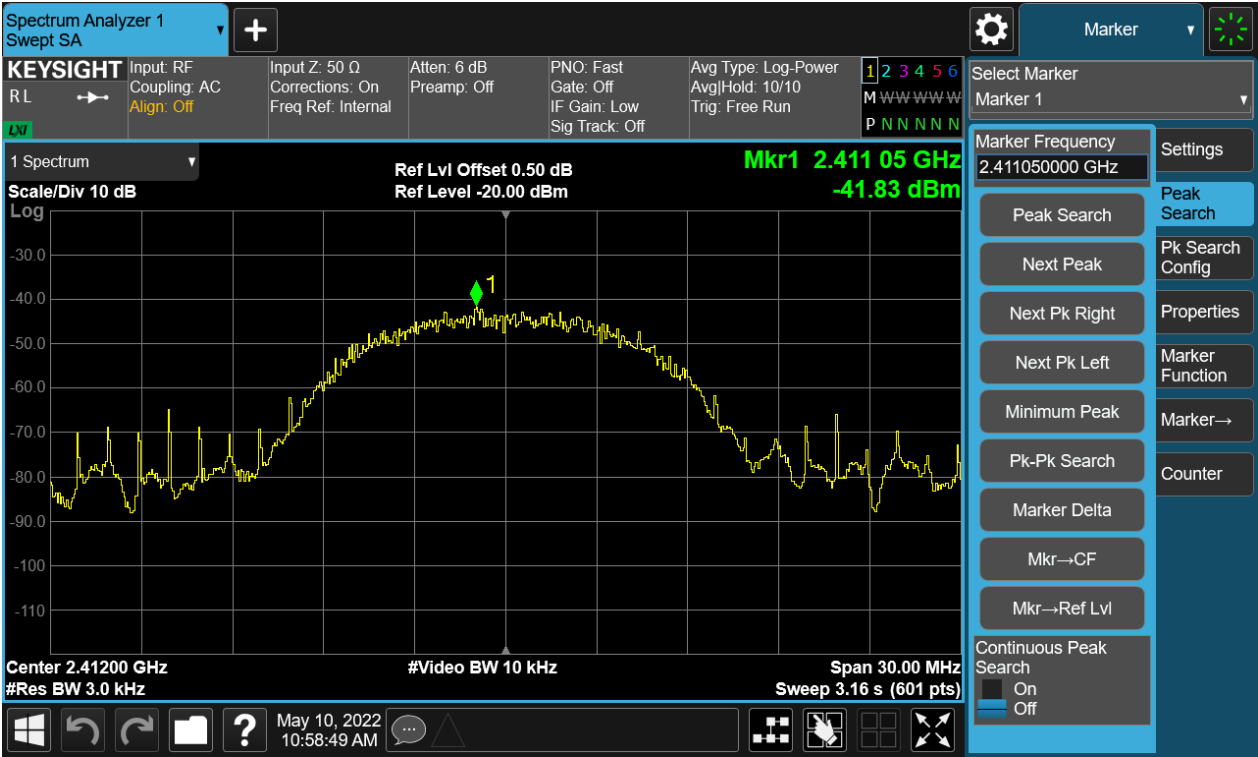


Figure 22: Power Spectral Density, 802.11b, 2437MHz



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Figure 3: Power Spectral Density, 802.11b, 2462MHz

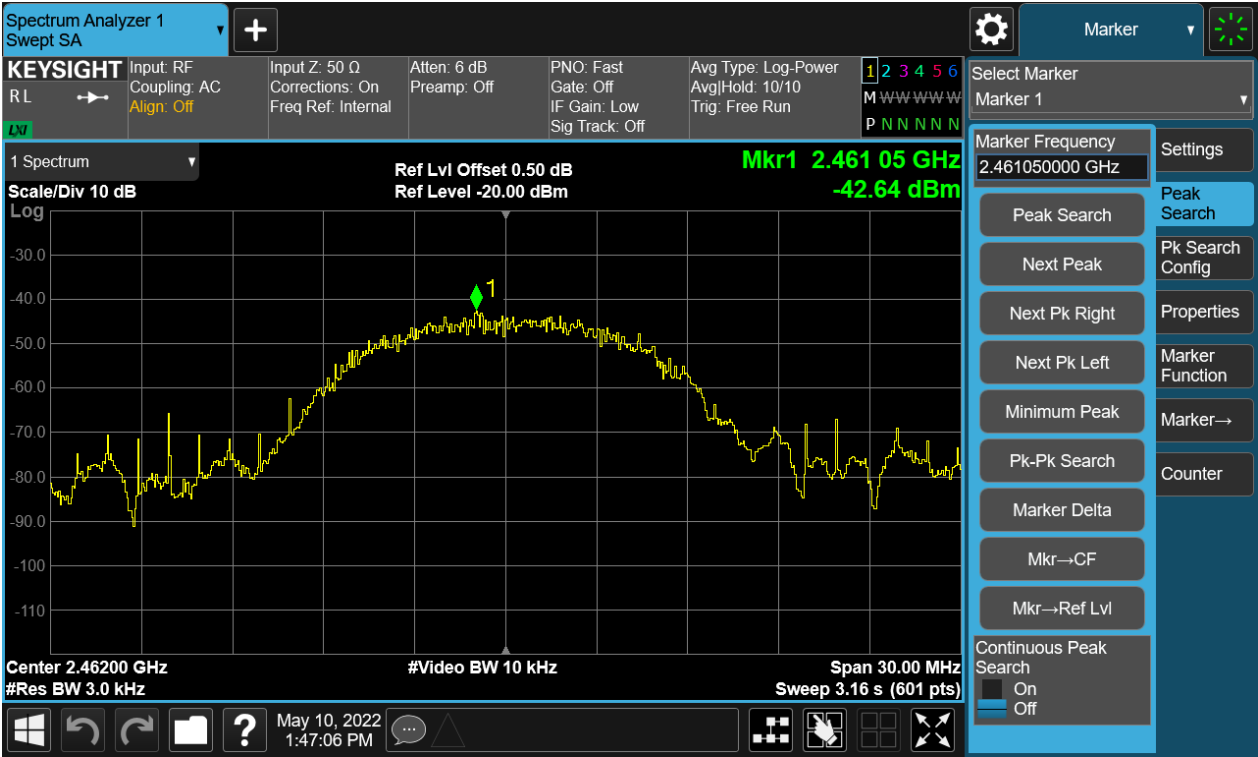
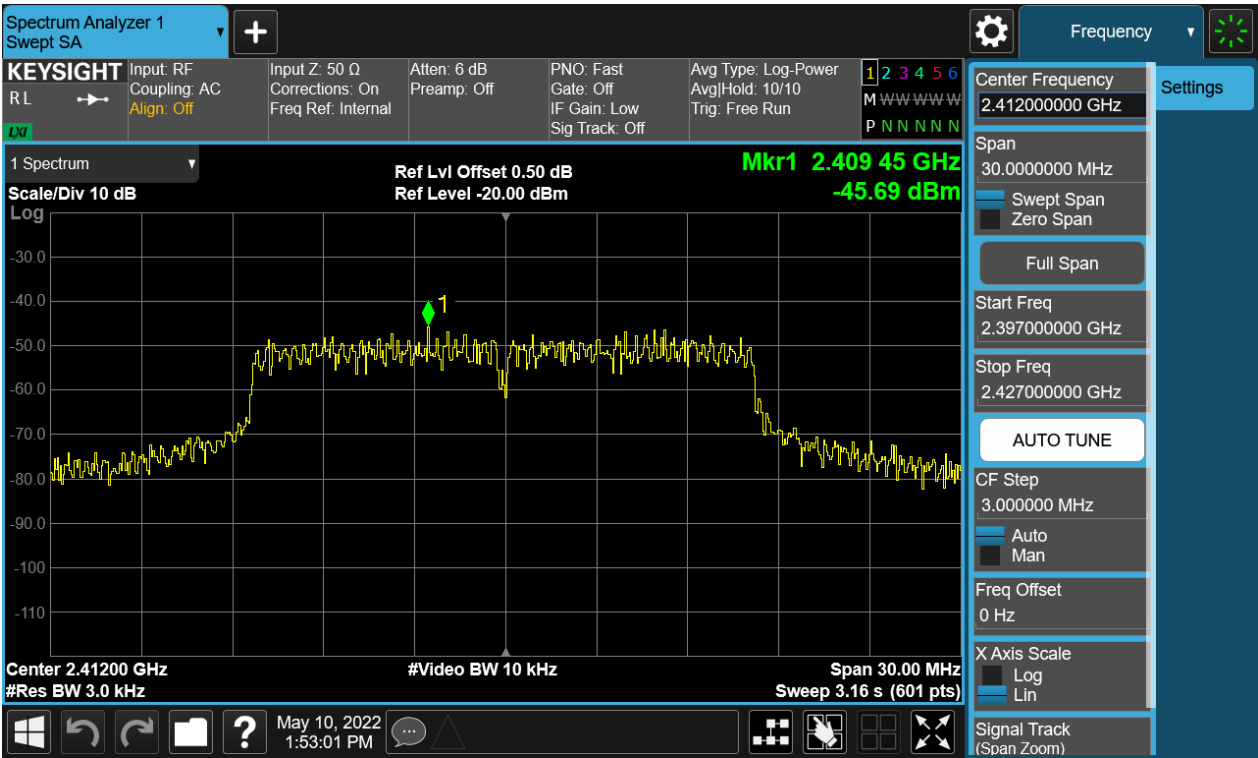


Figure 4: Power Spectral Density, 802.11g, 2412MHz



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Figure 25: Power Spectral Density, 802.11g, 2437MHz

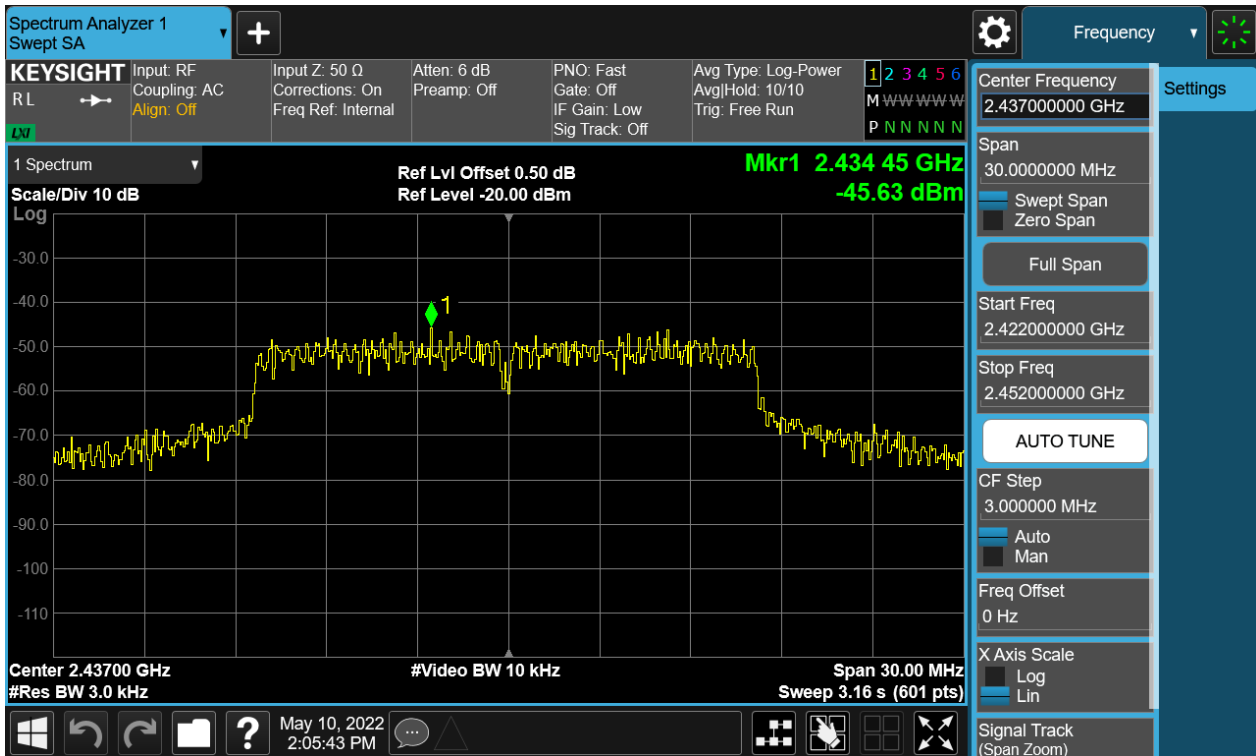
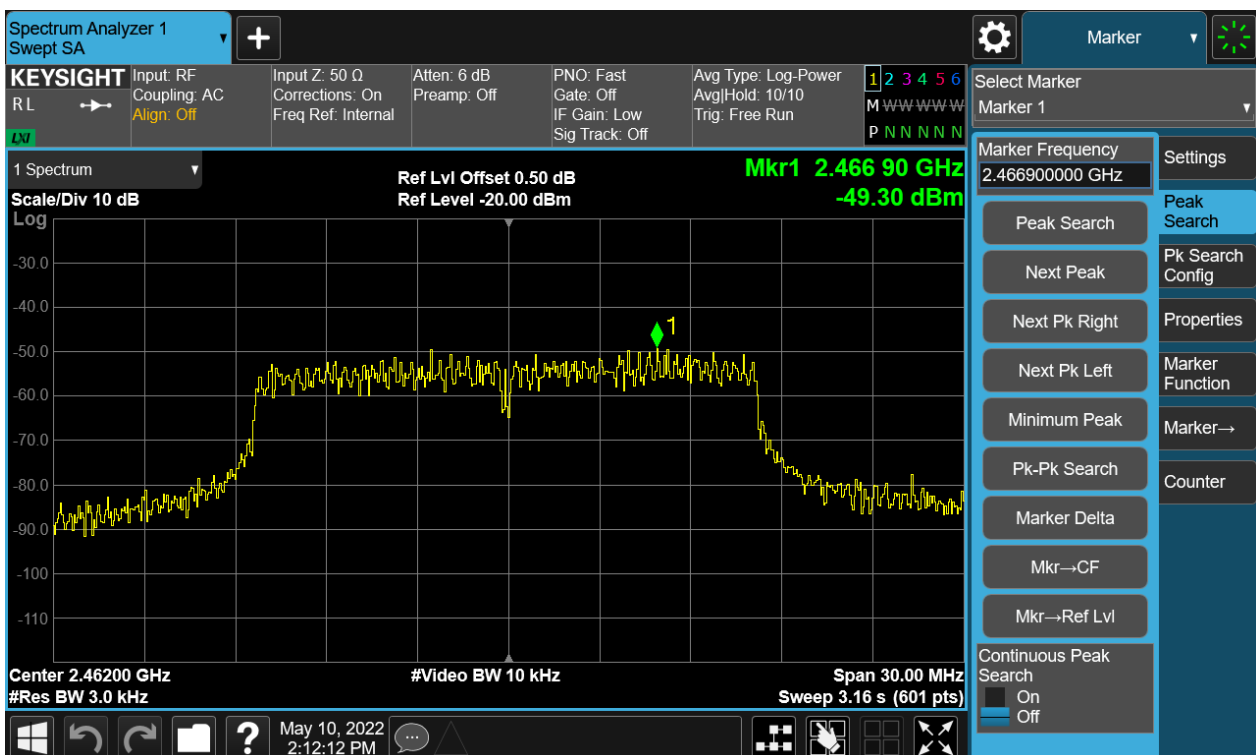


Figure 26: Power Spectral Density, 802.11g, 2462MHz



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Figure 27: Power Spectral Density, 802.11n(HT20), 2412MHz

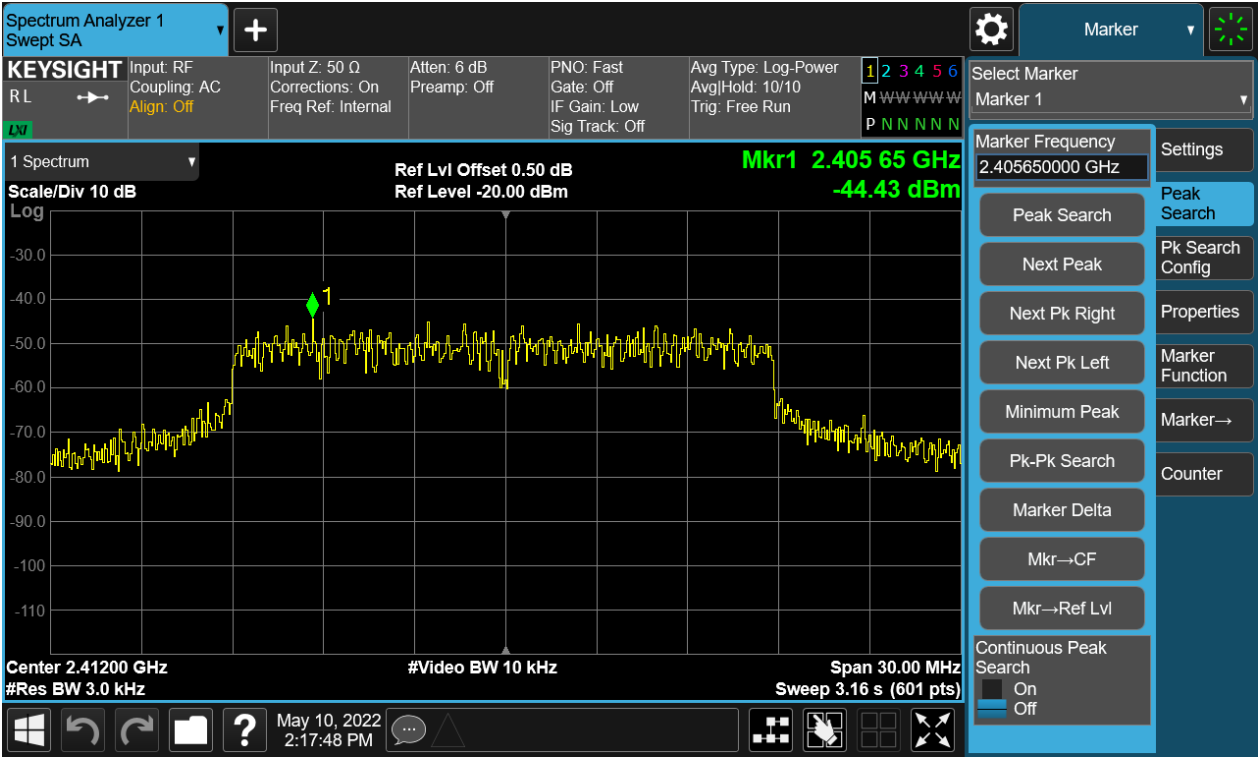
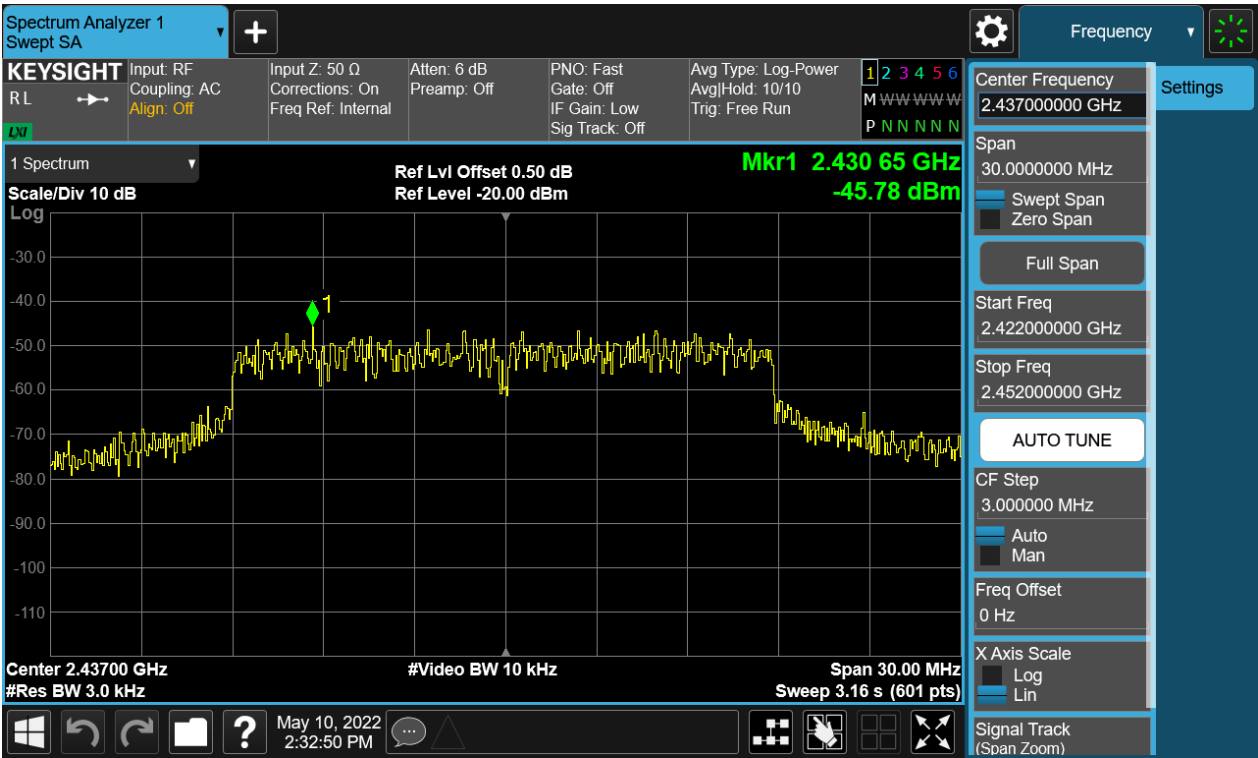


Figure 28: Power Spectral Density, 802.11n(HT20), 2437MHz



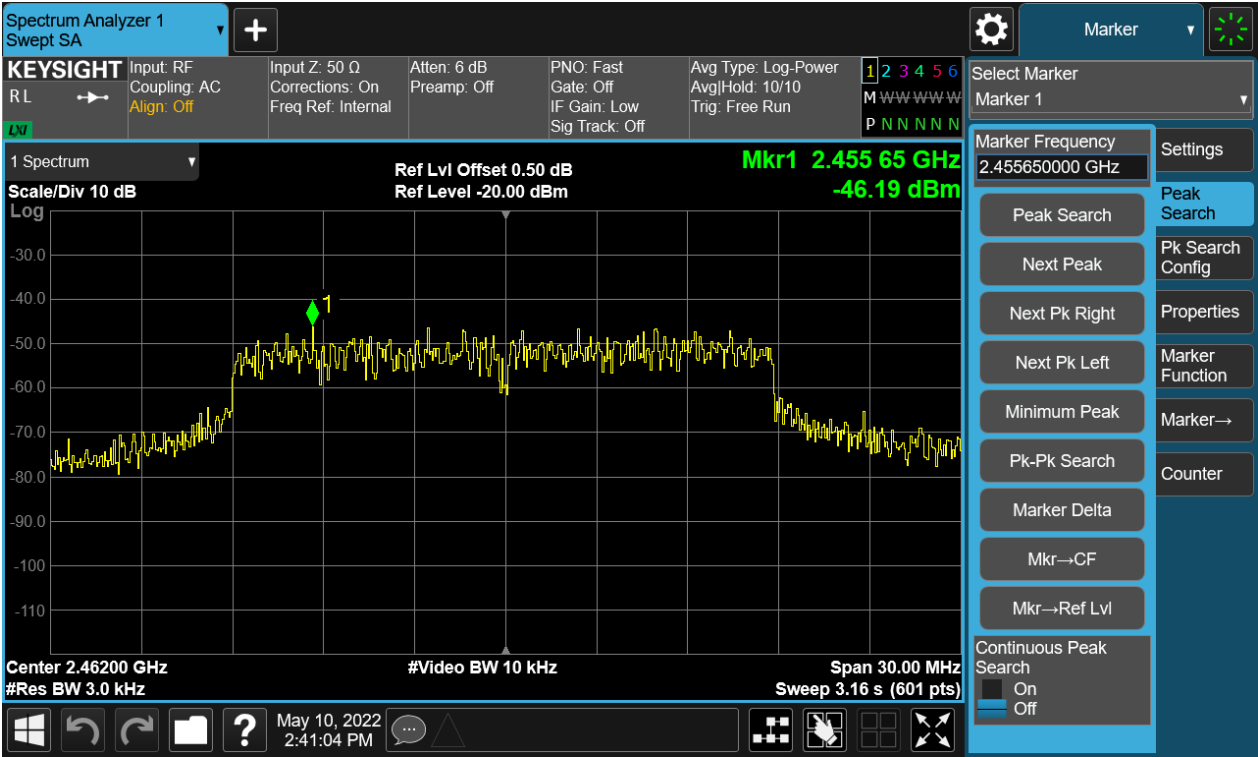
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Figure 29: Power Spectral Density, 802.11n(HT20), 2462MHz



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4.1.5 Conducted Spurious Emission & Authorized-band band-edge

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.209
RSS-247 5.5
RSS-Gen 8.9

Requirement : ANSI C63.10-2013, KDB 558074

Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High for spurious, Low/High for Band Edge

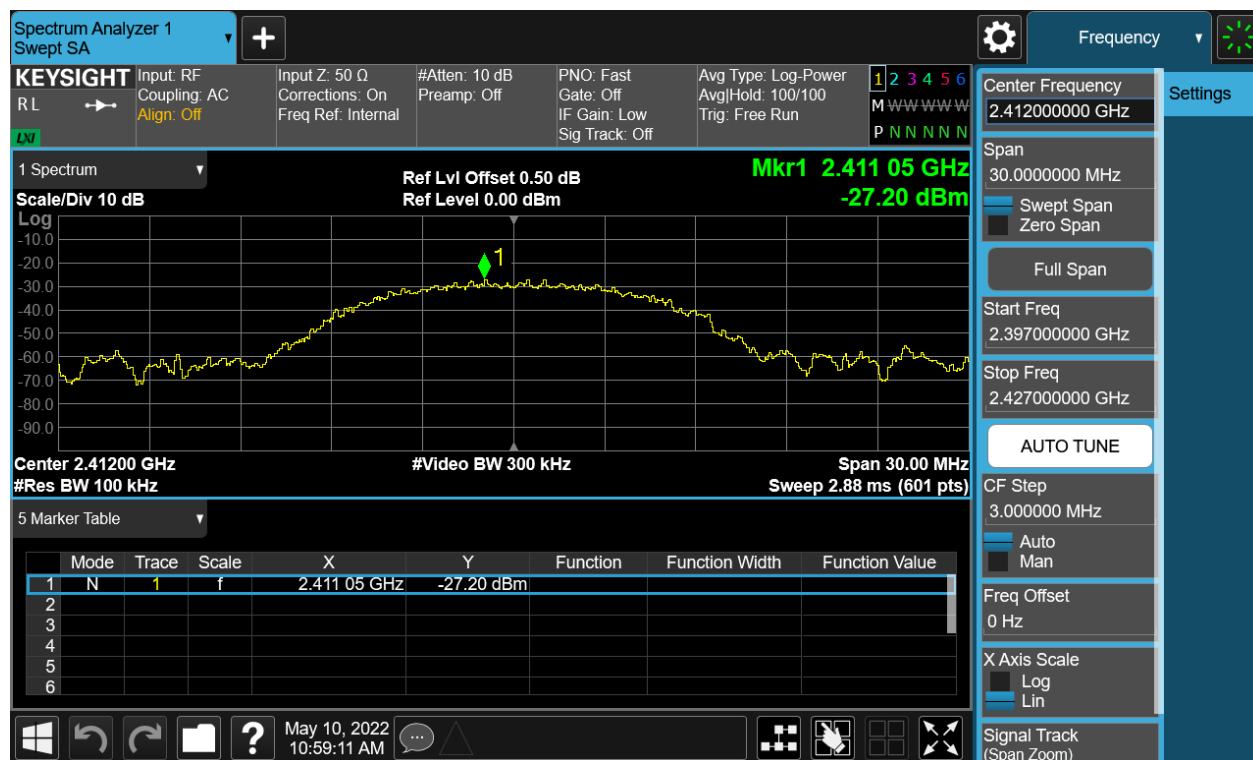
Operation Mode : A.1.a

Ambient temperature : 22.5°C

Relative humidity : 54%

For details refer to following test plot.

Figure 30: Conducted Spurious Emission & Authorized-band band-edge, 802.11b, 2412MHz
Carrier Level



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Band Edge



Conducted spurious emissions 30MHz-25GHz

