

TEST REPORT



CTK Co., Ltd.
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Report No.:
CTK-2024-02347
Page (1) / (66) Pages

1. Applicant

- Name : Samsung Electronics Co Ltd
- Address : 19 Chapin Rd, Building D. Pine Brook, New Jersey, United States
- Date of Receipt : 2024-07-29

2. Manufacturer

- Name : Samsung Electronics Co., Ltd.
- Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea

3. Factory

- Name #1: CHEMTRONICS CO.,LTD.
- Address #1: 35, Buk-ri, Namsa-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
- Name #2: Chengdu Xuguang Technology Co., Ltd.
- Address #2: No.86 2nd Section, Park Road, Longquanyi District, Chengdu City, Sichuan Province, P.R.China
- Name #3: CHEMTROVINA COMPANY LIMITED
- Address #3: Nhon Trach 2 - Loc Khang IZ, Hiep Phuoc Town, Nhon Trach District, Dong Nai Province, Vietnam
- Name #4: SJIT CO., LTD.
- Address #4: 54-11, Dongtanhana 1gil, Hwaseong-si, Gyeonggi-Do, Korea
- Name #5: SJIT VINA Co., Ltd
- Address #5: Lot X2, Ho Nai Industrial Zone, Ho Nai 3 Commune, Trang Bom District, Dong Nai Province, Vietnam
- Name #6: XUGUANG TECHNOLOGY (VIETNAM) COMPANY LIMITED
- Address #6: Factory No. 4, Lot CN1, An Duong Industrial Park, Hong Phong Commune, An Duong District, Hai Phong City, Vietnam

4. Use of Report : For FCC Conformance

5. Test Sample / Model: Wi-Fi Transceiver / WDF520M

6. Date of Test : 2024-08-16 to 2024-08-21

7. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247

8. Testing Environment: refer to 10 page



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9. Test Results : Compliance

10. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing

(Address : (Unhak-Dong) 5, Dongbu-ro 221beon-gil, Cheoin-gu, Yong-in-si,
Gyeonggi-do, Korea)

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This report cannot be reproduced or copied without the written consent of CTK.

Approval	Tested by	Technical Manager
	Su-jun Hwang: (Signature)	Won-Jae Hwang: (Signature)

Remark. This report is not related to KOLAS accreditation and relevant regulation.

2024-08-22

CTK Co., Ltd.

REPORT REVISION HISTORY

Date	Revision	Page No
2024-08-22	Issued (CTK-2024-02347)	all

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1. General Product Description

1.1 Applicant Information

Company	Samsung Electronics Co., Ltd.
Contact Point	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea
Contact Person	Name : Minhyung Cho E-mail : mh719.cho@samsung.com Tel : +82-31-277-2688 Fax : -

1.2 Product Information

FCC ID	A3LWDF520M
Product Description	Wi-Fi Transceiver
Model name	WDF520M
Variant Model name	-
Operating Frequency	2 412 MHz – 2 472 MHz (20 MHz_BW)
RF Output Power	802.11b : 19.13 dBm (81.85 mW) 802.11g : 16.46 dBm (44.26 mW) 802.11n_HT20 : 19.43 dBm (87.70 mW)
Antenna Specification	Antenna type : Metal Antenna Peak Gain : -1.51 dBi (ANT1), -0.71 dBi (ANT2)
Antenna Configurations	802.11b : SISO(ANT1, ANT2) 802.11g : SISO(ANT1, ANT2) 802.11n : SISO(ANT1, ANT2), MIMO(ANT1+ANT2)
Number of channels	13 (802.11b/g/n_HT20)
Type of Modulation	802.11b : DSSS 802.11g/n : OFDM
Data Rate	802.11b : 11 / 5.5 / 2 / 1 Mbps 802.11g : 54 / 48 / 36 / 24 / 18 / 12 / 9 / 6 Mbps 802.11n: up to 300 Mbps
Power Source	DC 5 V
Hardware Rev	WDF520M
Software Rev	v**.00(v04.00)

RF Power setting in Test SW

Mode	Frequency	Power Setting Value		
		ANT1	ANT2	ANT1+ANT2
802.11b	2 412 MHz	15.5	15.5	
	2 417 MHz	16	15.5	
	2 442 MHz	17	15	
	2 467 MHz	14.5	17	
	2 472 MHz	14	16.5	
802.11g	2 412 MHz – 2 467 MHz	15	15	
	2 472 MHz	11	12	
802.11n_HT20	2 412 MHz – 2 467 MHz	15	15	15
	2 472 MHz	11.5	11.5	11.5

1.3 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Note Computer	HP	15-bs563TU	CND772353R5S
AC/DC Adapter	HP	HSTNN-LA40	-
Note Computer	Samsung Electronics Co., Ltd.	NT560XBV	0Z8S91AM400511W
AC/DC Adapter	Samsung Electronics Co., Ltd.	A13-040N2A	-

1.4 Model Differences

Not applicable

2. Accreditations

2.1 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	CN : 8737A CAB ID : KR0025
KOREA	NRRA	KR0025

2.2 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

3. Test Specifications

3.1 Standards

FCC Part Section(s)	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	6 dB Bandwidth	C	Conducted
15.247(b)	Maximum Output Power	C	
15.247(d)	Conducted Spurious emission	C	
15.247(d)	Unwanted Emission(Conducted)	C	
15.247(e)	Transmitter Power Spectral Density	C	
15.209	Radiated Emissions	C	Radiated
15.207	AC Conducted Emissions	C	Line Conducted
Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
Note 2: The data in this test report are traceable to the national or international standards.			
Note 3: The sample was tested according to the following specification: FCC Part 15.247			
Note 4: The tests were performed according to the method of measurements prescribed in KDB No.558074, ANSI C63.10-2013			

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
 During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests.
 The results are only attached worst cases.

Test Frequency & Bandwidth

802.11b

Bandwidth	Lowest channel 1	Lowest channel 2	Middle channel	Highest channel 1	Highest channel 2
20 MHz	2 412 MHz	2 417 MHz	2 442 MHz	2 467 MHz	2 472 MHz

The other

Bandwidth	Lowest channel	Middle channel	Highest channel
20 MHz	2 412 MHz	2 442 MHz	2 472 MHz

Test mode & Worst case

Test mode	Modulation	Data rate (Worst case)	Duty Cycle	Duty Cycle Factor
802.11b	DSSS	1 Mbps	98.4 %	0.07 dB
802.11g	OFDM	6 Mbps	96.9 %	0.17 dB
802.11n_HT20	OFDM	MCS 0	90.0 %	0.46 dB

3.3 Device Modifications

The following modifications were necessary for compliance:

Not applicable

3.4 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
 Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	1.5 dB (C.L.: Approx. 95 %, $k = 2$)
Power Spectral Density	1.5 dB (C.L.: Approx. 95 %, $k = 2$)
Occupied Bandwidth	0.1 MHz (C.L.: Approx. 95 %, $k = 2$)
Unwanted Emission(conducted)	3.0 dB (C.L.: Approx. 95 %, $k = 2$)
Radiated Emissions ($f \leq 1$ GHz)	3.82 dB (C.L.: Approx. 95 %, $k = 2$)
Radiated Emissions ($f > 1$ GHz)	4.50 dB (C.L.: Approx. 95 %, $k = 2$)
Line Conducted Emission	2.00 dB (C.L.: Approx. 95 %, $k = 2$)

3.5 Test Software automation program

Conducted Test	Ics Pro Ver. 6.0.3
Radiated Test	EP5RE Ver. 6.0.10, ES10 Ver. 2022.04.000
Line Conducted Test	EMC32 Ver. 10.50.00

Test program

Conducted Test, Radiated Test, Line Conducted Test	QATool_Dbg(0.0.1.85)
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3.6 Testing Environment

Test Item	Test Date	Temperature (℃)	Relative Humidity (%)
6 dB Bandwidth	2024-08-19	23	59
Maximum Output Power	2024-08-19	23	59
Conducted Spurious emission	2024-08-19	23	59
Unwanted Emission(Conducted)	2024-08-19	23	59
Transmitter Power Spectral Density	2024-08-19	23	59
Radiated Emissions (f > 1GHz)	2024-08-16 ~ 2024-08-19	23 ~ 24	57 ~ 59
Radiated Emissions (f < 1GHz)	2024-08-20	25	49
AC Conducted Emissions	2024-08-21	25	48

4. Technical Characteristic Test

4.1 6dB Bandwidth

Test Procedures

KDB 558074 - Section 8.2
 ANSI C63.10-2013 - Section 11.8.2

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Procedures

ANSI C63.10-2013 - Section 6.9

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- | | |
|--|----------------------------|
| a) RBW = 100 kHz | b) VBW $\geq 3 \times$ RBW |
| c) Detector = peak | d) Trace mode = Max hold |
| e) Sweep = auto couple | |
| f) Allow trace to fully stabilize | |
| g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. | |

Minimum Standard :

6 dB Bandwidth > 500kHz

Test Data :

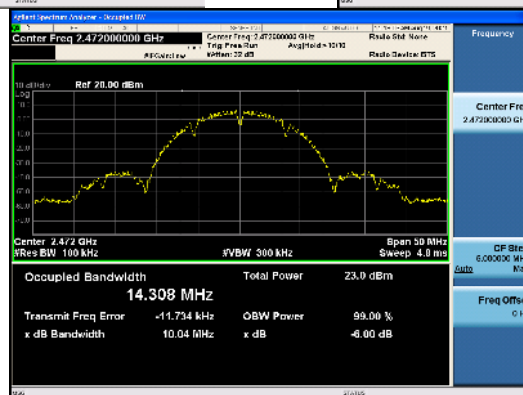
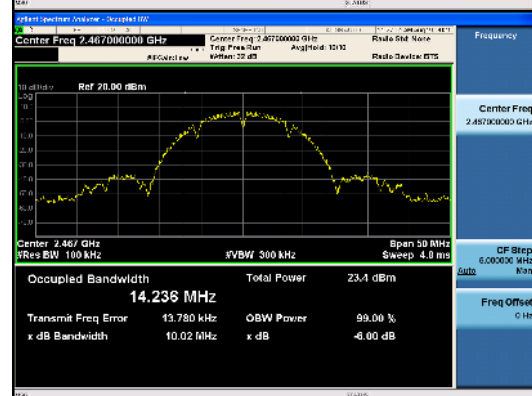
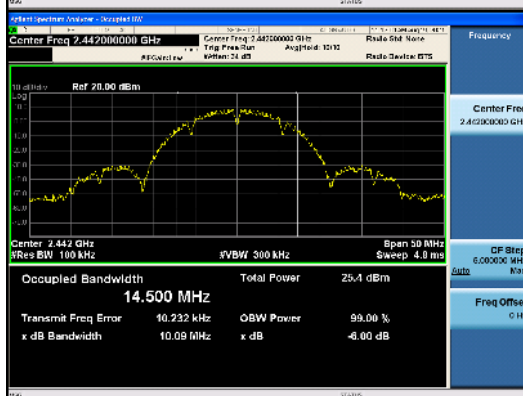
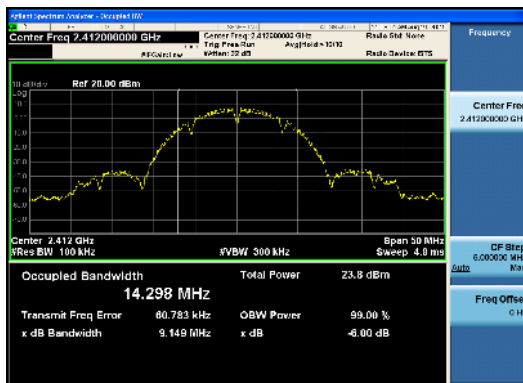
ANT1

Mode	6 dB Bandwidth and 99 % Bandwidth (MHz)					
	802.11b		802.11g		802.11n_HT20	
Frequency	6 dB	99 %	6 dB	99 %	6 dB	99 %
2 412 MHz	9.15	14.30	15.15	16.33	15.16	17.53
2 417 MHz	10.04	14.34	-	-	-	-
2 442 MHz	10.09	14.50	15.15	16.34	15.16	17.53
2 467 MHz	10.02	14.24	-	-	-	-
2 472 MHz	10.04	14.31	15.15	16.30	15.15	17.52

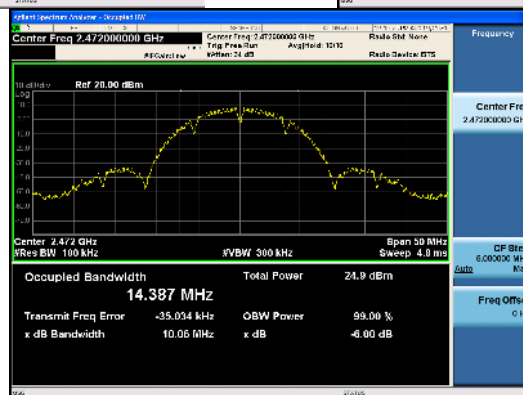
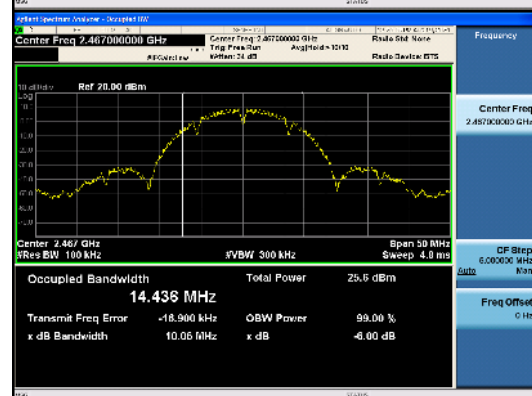
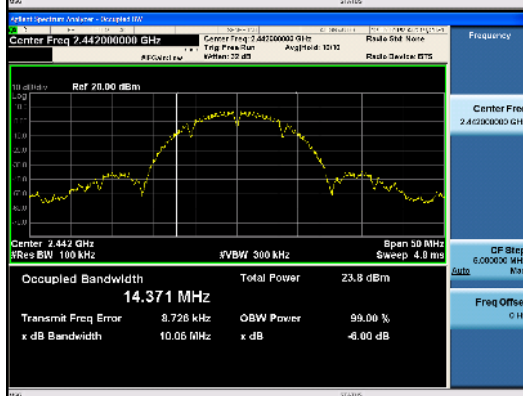
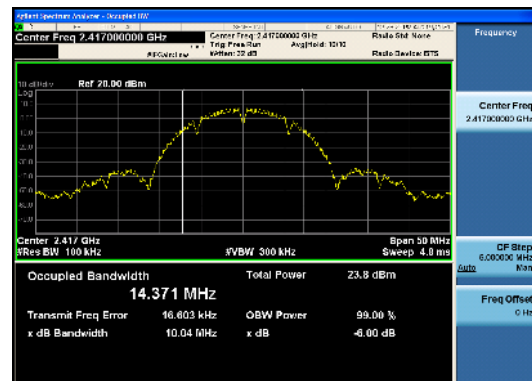
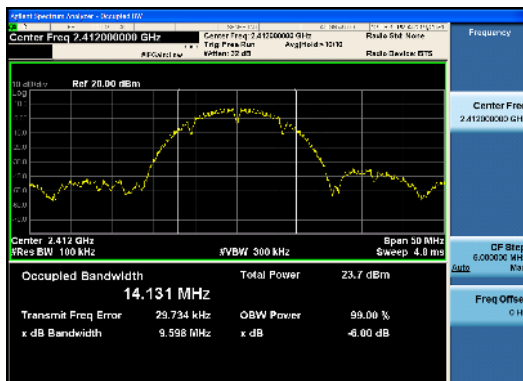
ANT2

Mode	6 dB Bandwidth and 99 % Bandwidth (MHz)					
	802.11b		802.11g		802.11n_HT20	
Frequency	6 dB	99 %	6 dB	99 %	6 dB	99 %
2 412 MHz	9.60	14.13	15.15	16.34	15.15	17.50
2 417 MHz	10.04	14.37	-	-	-	-
2 442 MHz	10.06	14.37	15.15	16.36	15.16	17.54
2 467 MHz	10.06	14.44	-	-	-	-
2 472 MHz	10.06	14.39	15.15	16.31	15.16	17.50

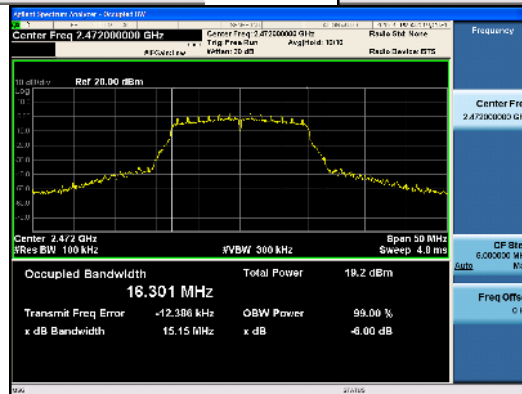
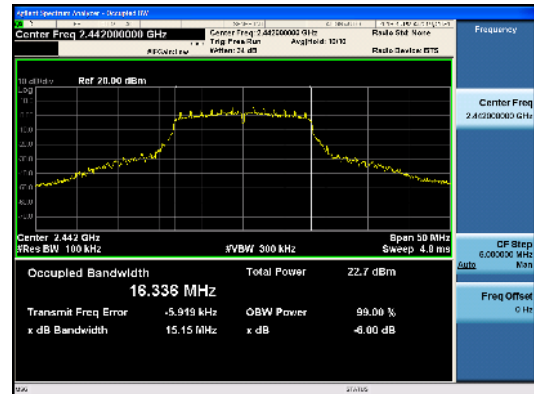
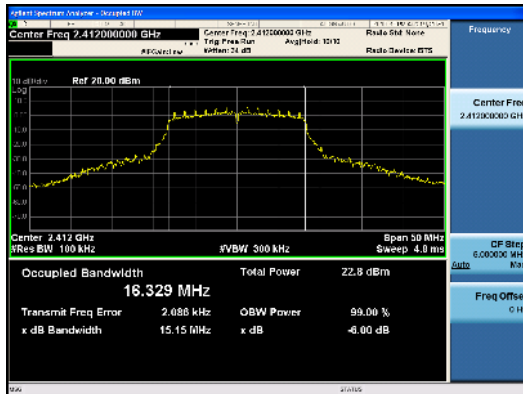
See next pages for actual measured spectrum plots.



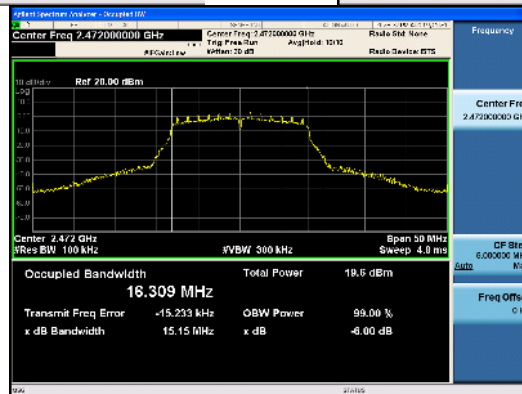
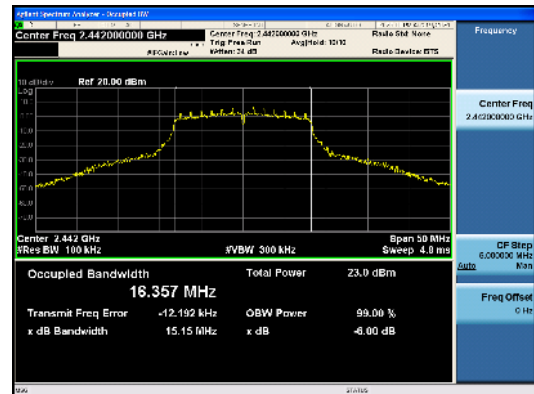
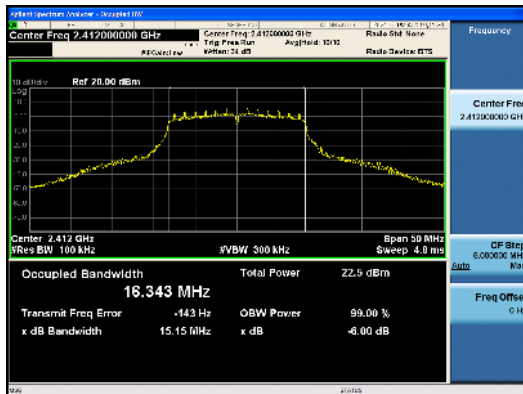
ANT1, 802.11b



ANT2, 802.11b



ANT1, 802.11g

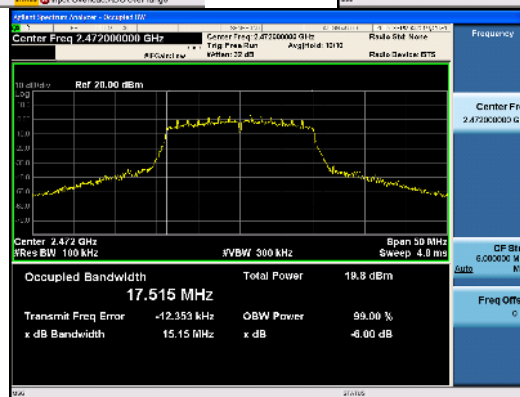
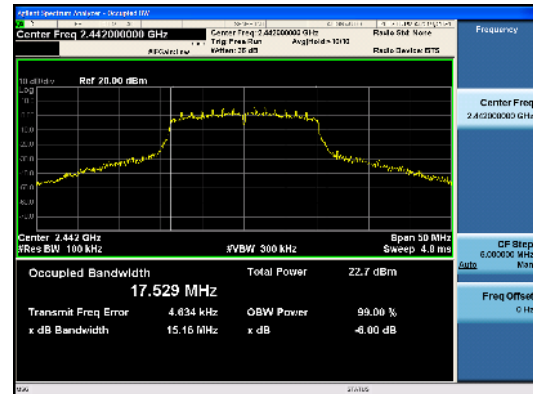
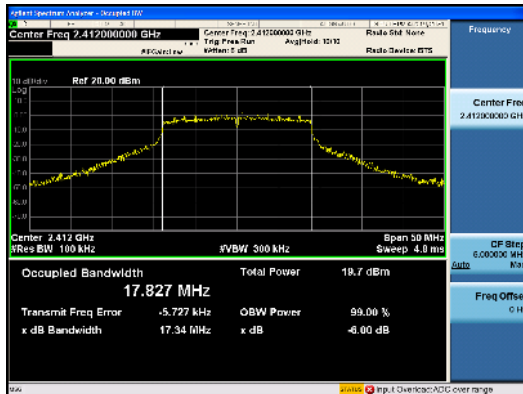


ANT2, 802.11g

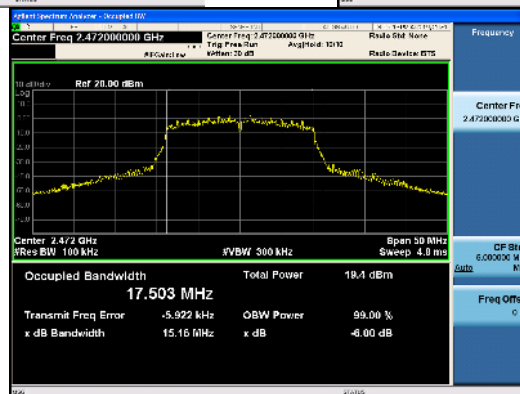
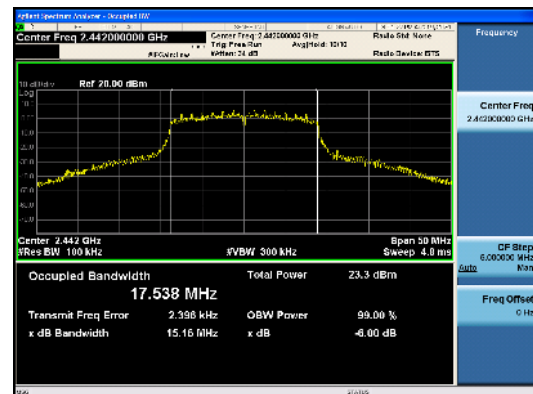
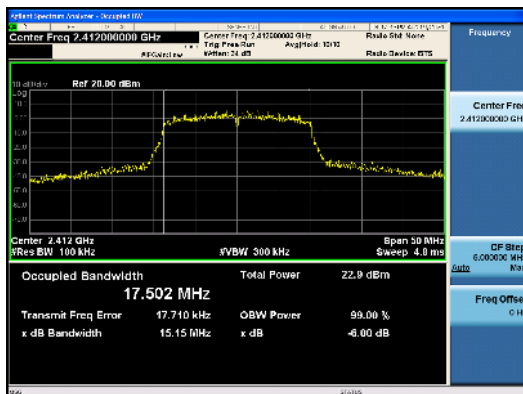


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ANT1, 802.11n_HT20



ANT2, 802.11n_HT20

4.2 OUTPUT POWER

Test Procedures

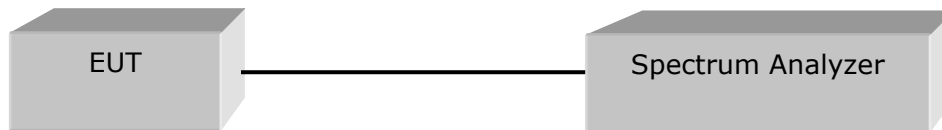
<802.11b/g/n mode>

KDB 558074 - Section 8.3.2.2 (Average Power)

ANSI C63.10-2013 - Section 11.9.2.2

KDB 662911 D01, D02 (Multiple Transmitter Output)

The transmitter output is connected to a spectrum analyzer and the analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth.



Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) span $\geq 1.5 \times \text{OBW}$
- b) RBW = 1 MHz
- c) VBW $\geq 3 \times \text{RBW}$
- d) Sweep time = auto
- e) Detector = RMS
- f) average at least 100
- g) Duty cycle factor = $10\log(1/x)$

Test mode	Duty Cycle Factor
802.11b	0.07 dB
802.11g	0.17 dB
802.11n_HT20	0.46 dB

Limit

Operating Mode	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
SISO	802.11b/g/n	ANT1	-1.51	30.00
SISO	802.11b/g/n	ANT2	-0.71	30.00
MIMO (2Tx)	802.11n	ANT1 + ANT2	1.91	30.00

Note :

Per KDB 662911, the MIMO directional gain is calculated using the following formula, Where G_N is the gain of the nth antenna and N_{ANT} , the total number of antennas used.

$$\text{Directional gain} = 10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{GN/20})^2 / N_{\text{ANT}}] \text{ dBi}$$

Test Data :

ANT1 (SISO)

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11b	2 412	17.35	0.07	17.42	30.00	12.58
	2 417	17.25	0.07	17.32	30.00	12.68
	2 442	18.87	0.07	18.94	30.00	11.06
	2 467	16.94	0.07	17.01	30.00	12.99
	2 472	16.47	0.07	16.54	30.00	13.46
802.11g	2 412	16.04	0.17	16.21	30.00	13.79
	2 442	15.96	0.17	16.13	30.00	13.87
	2 472	12.51	0.17	12.68	30.00	17.32
802.11n _HT20	2 412	16.05	0.46	16.51	30.00	13.49
	2 442	15.79	0.46	16.25	30.00	13.75
	2 472	13.02	0.46	13.48	30.00	16.52

ANT2 (SISO)

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11b	2 412	17.35	0.07	17.42	30.00	12.58
	2 417	17.47	0.07	17.54	30.00	12.46
	2 442	17.39	0.07	17.46	30.00	12.54
	2 467	19.06	0.07	19.13	30.00	10.87
	2 472	18.43	0.07	18.50	30.00	11.50
802.11g	2 412	15.68	0.17	15.85	30.00	14.15
	2 442	16.29	0.17	16.46	30.00	13.54
	2 472	12.95	0.17	13.12	30.00	16.88
802.11n _HT20	2 412	15.77	0.46	16.23	30.00	13.77
	2 442	16.13	0.46	16.59	30.00	13.41
	2 472	12.29	0.46	12.75	30.00	17.25



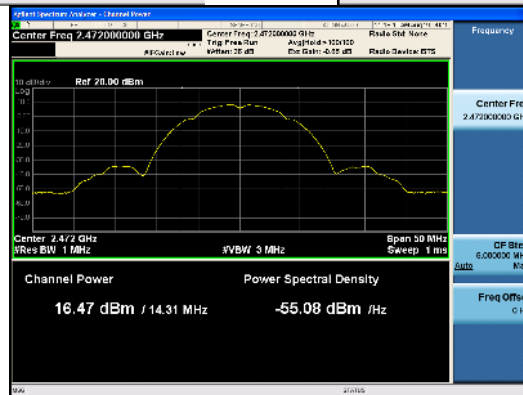
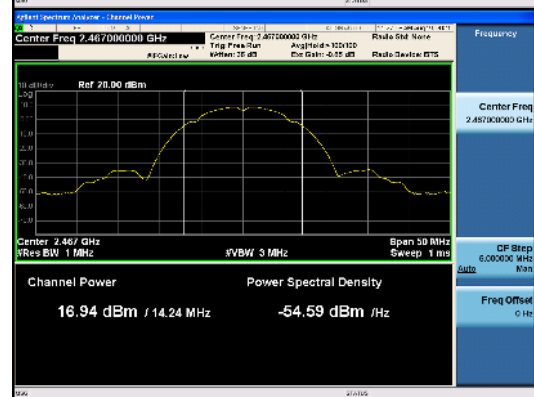
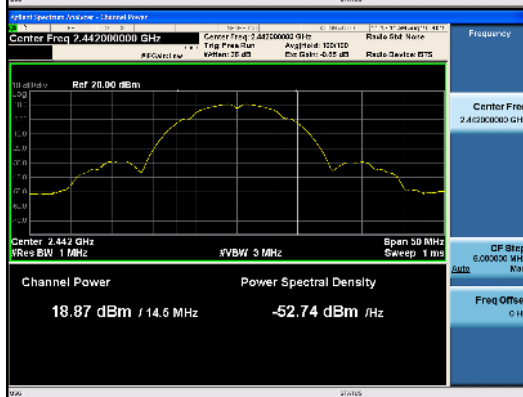
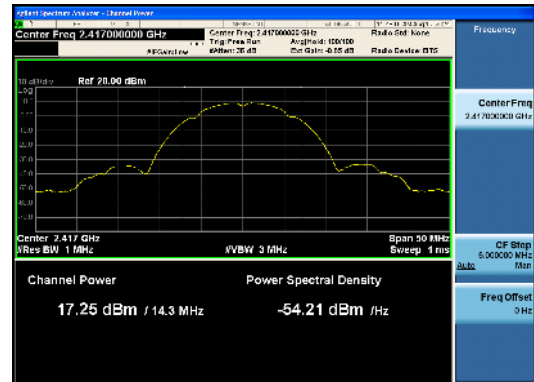
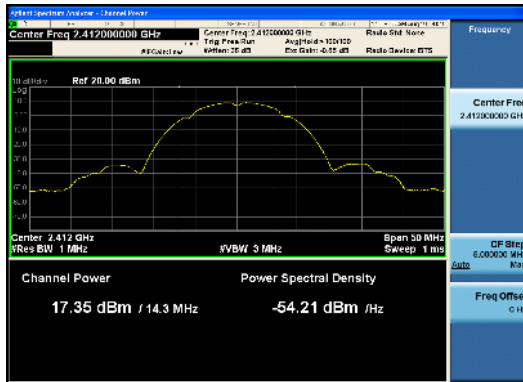
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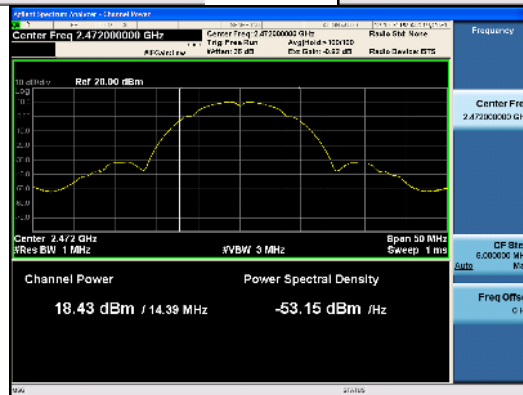
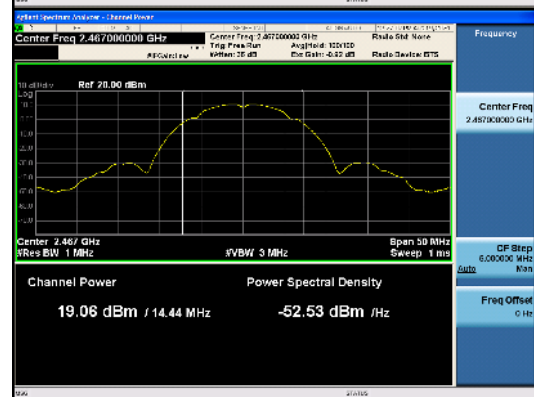
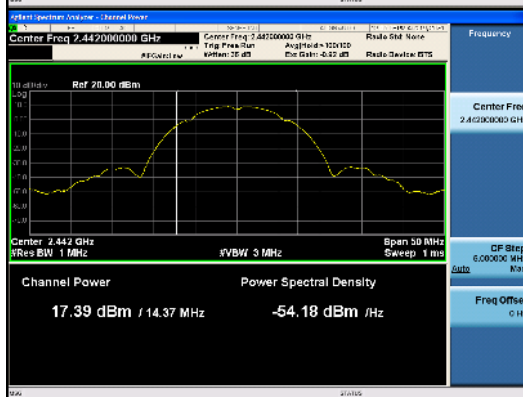
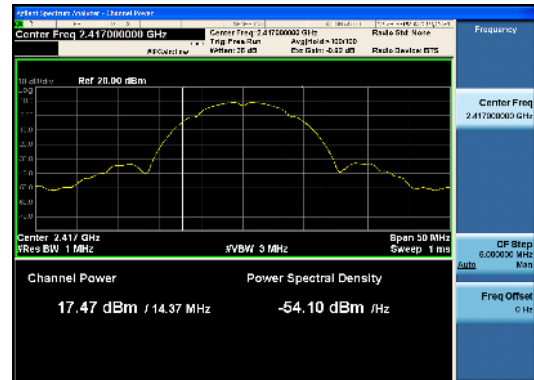
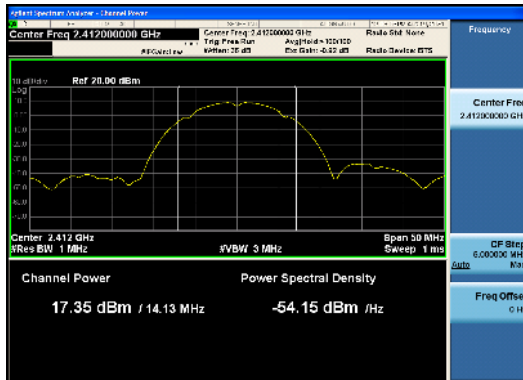
ANT1 + ANT2 (MIMO)

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11n_HT20	2 412	18.92	0.46	19.38	30.00	10.62
	2 442	18.97	0.46	19.43	30.00	10.57
	2 472	15.68	0.46	16.14	30.00	13.86

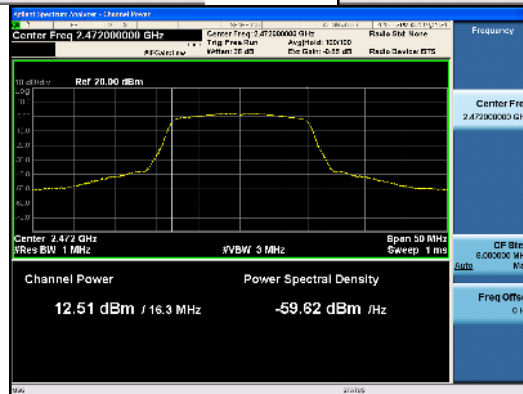
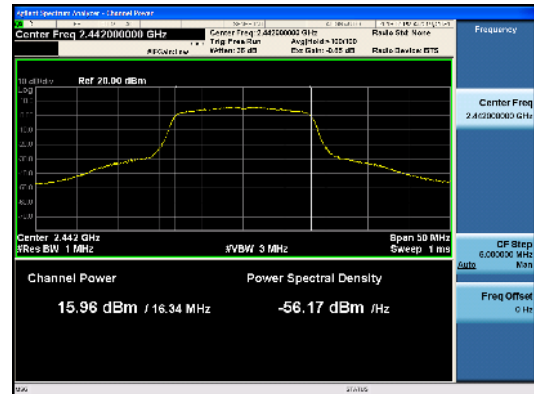
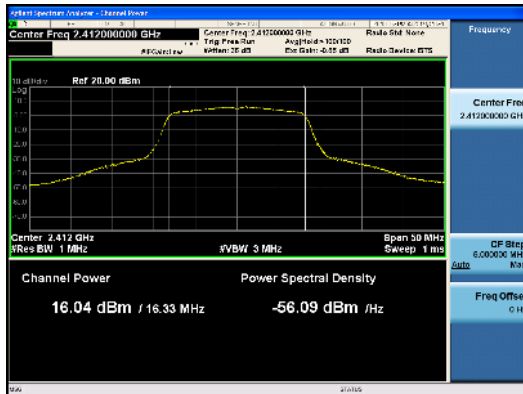
See next pages for actual measured spectrum plots.



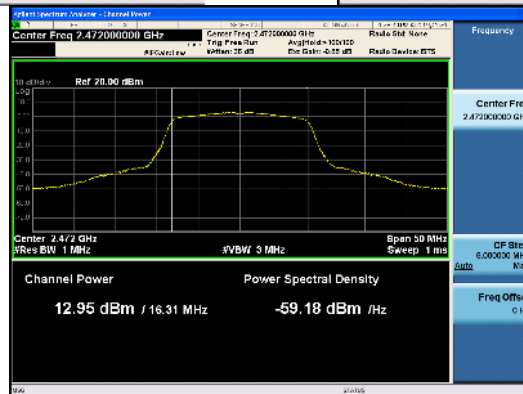
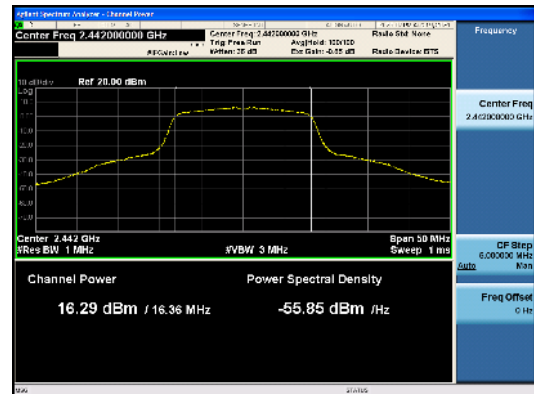
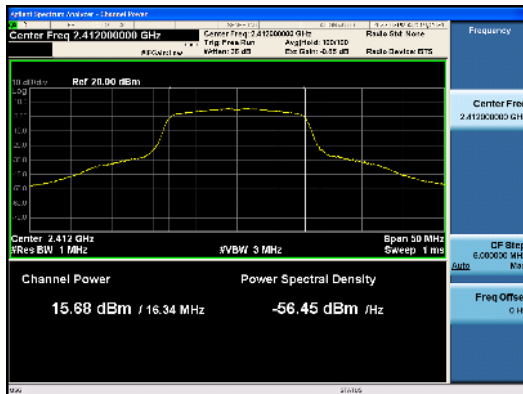
ANT1, 802.11b



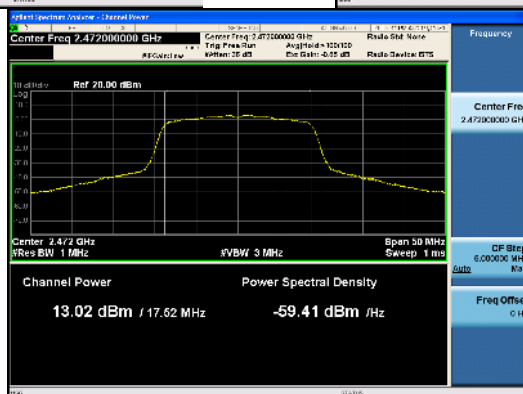
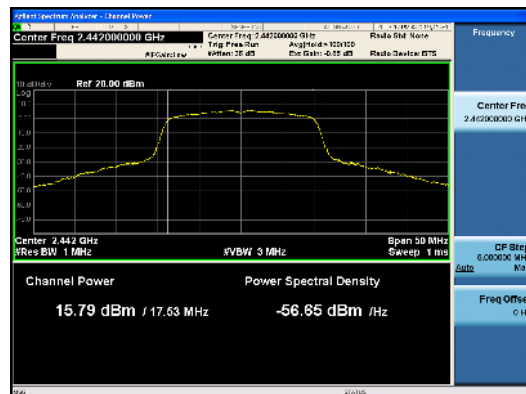
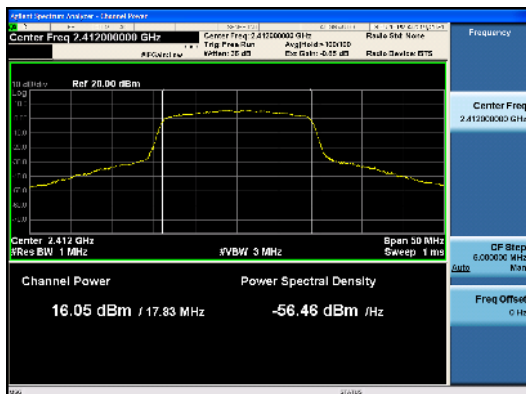
ANT2, 802.11b



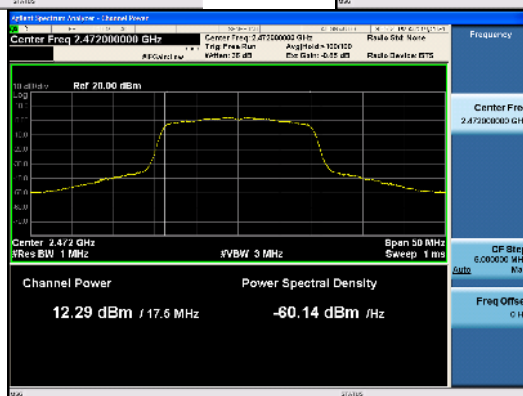
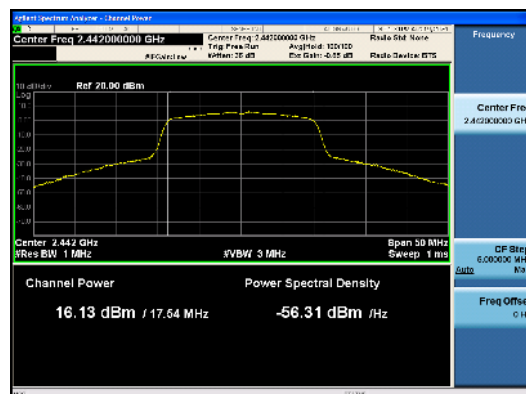
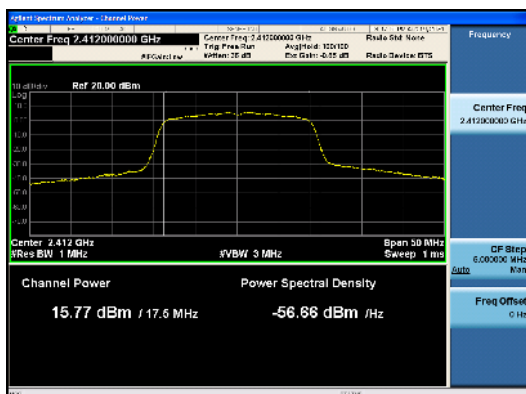
ANT1, 802.11g



ANT2, 802.11g



ANT1, 802.11n_HT20



ANT2, 802.11n_HT20

4.3 Transmitter Power Spectral Density

Test Procedures

KDB 558074 - Section 8.4
 ANSI C63.10-2013 - Section 11.10.2
 KDB 662911 D01, D02 (Multiple Transmitter Output)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) RBW : 3 kHz ≤ RBW ≤ 100 kHz
- b) VBW ≥ 3 × RBW
- c) span ≥ 1.5 × DTS bandwidth
- d) Sweep time = auto couple
- e) Detector = peak
- f) Trace mode= max hold
- g) Allow trace to fully stabilize
- h) Use the peak marker function to determine the maximum amplitude level within the RBW.

Limit

Operating Mode	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
SISO	802.11b/g/n/ax	ANT1	-1.51	8.00
SISO	802.11b/g/n/ax	ANT2	-0.71	8.00
MIMO (2Tx)	802.11n/ax	ANT1 + ANT2	1.91	8.00

Note :

Per KDB 662911, the MIMO directional gain is calculated using the following formula, Where G_N is the gain of the nth antenna and N_{ANT} , the total number of antennas used.

$$\text{Directional gain} = 10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{GN/20})^2 / N_{ANT}] \text{ dBi}$$

Test Data

ANT1 (SISO)

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11b	2 412	4.94	8.00	3.06
	2 417	3.72	8.00	4.28
	2 442	7.77	8.00	0.23
	2 467	5.06	8.00	2.94
	2 472	4.61	8.00	3.39
802.11g	2 412	-7.49	8.00	15.49
	2 442	-9.39	8.00	17.39
	2 472	-12.94	8.00	20.94
802.11n _HT20	2 412	-9.58	8.00	17.58
	2 442	-9.65	8.00	17.65
	2 472	-11.89	8.00	19.89

ANT2 (SISO)

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11b	2 412	6.52	8.00	1.48
	2 417	4.77	8.00	3.23
	2 442	3.02	8.00	4.98
	2 467	6.11	8.00	1.89
	2 472	7.50	8.00	0.50
802.11g	2 412	-9.09	8.00	17.09
	2 442	-8.96	8.00	16.96
	2 472	-12.60	8.00	20.60
802.11n _HT20	2 412	-9.22	8.00	17.22
	2 442	-8.51	8.00	16.51
	2 472	-10.17	8.00	18.17

ANT1 + ANT2 (MIMO)

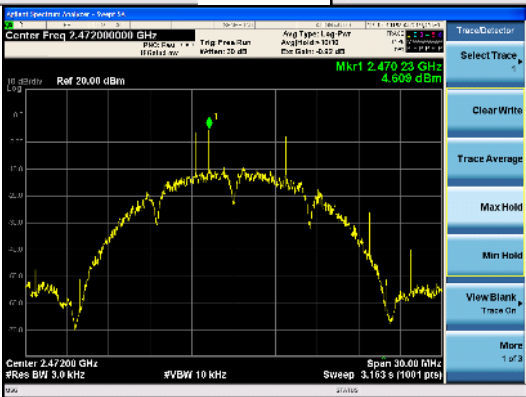
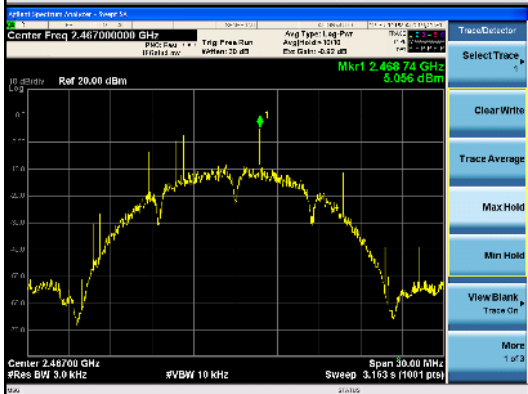
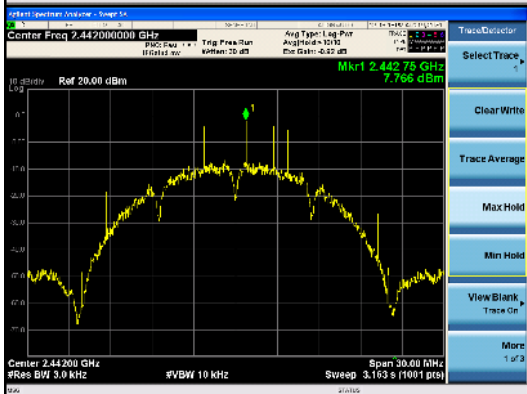
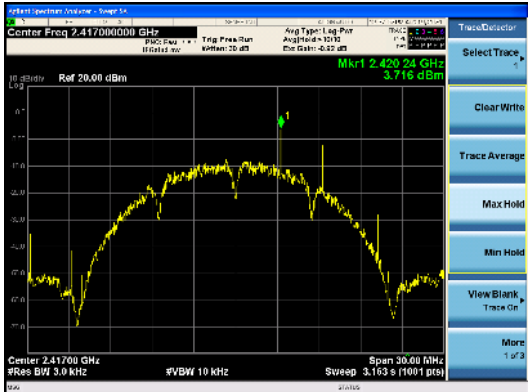
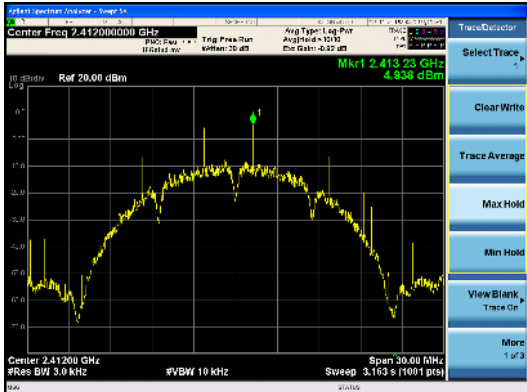
Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11n _HT20	2 412	-6.39	8.00	14.39
	2 442	-6.03	8.00	14.03
	2 472	-7.94	8.00	15.94

See next pages for actual measured spectrum plots.



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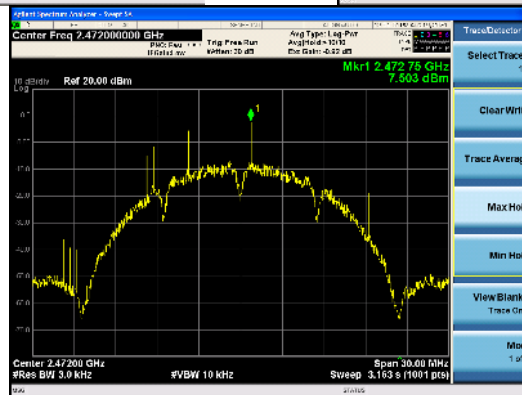
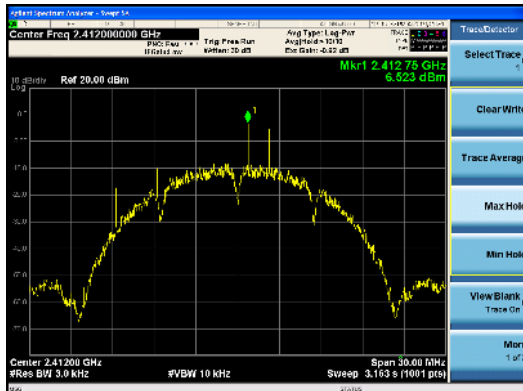


ANT1, 802.11b

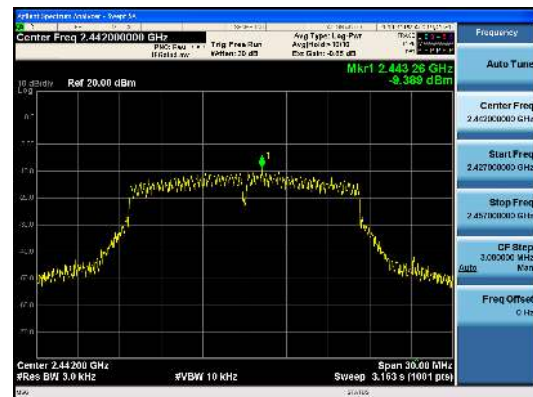
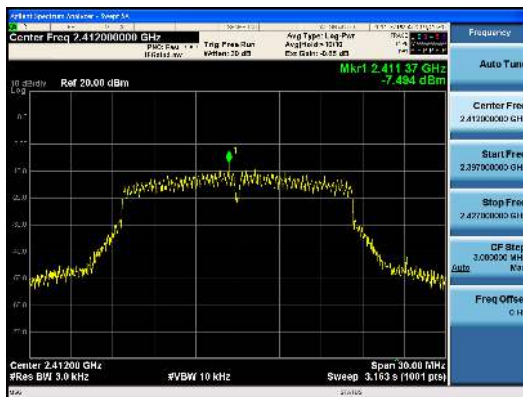


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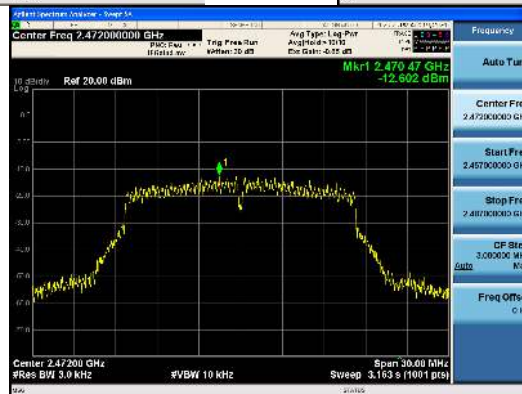
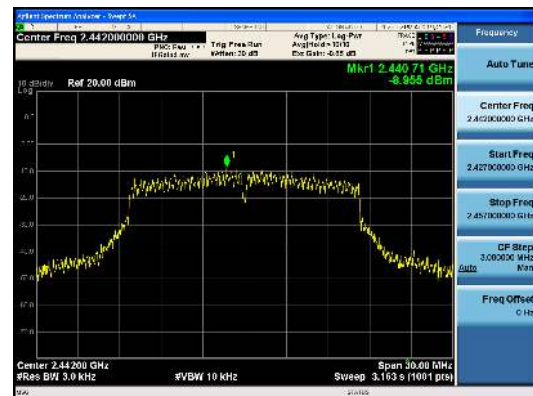
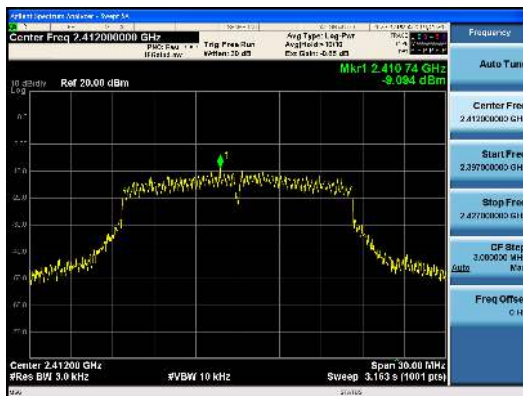
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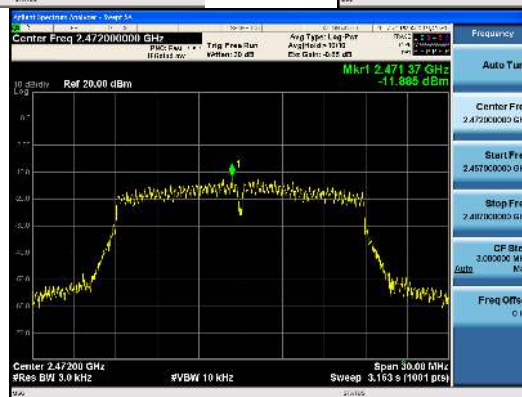
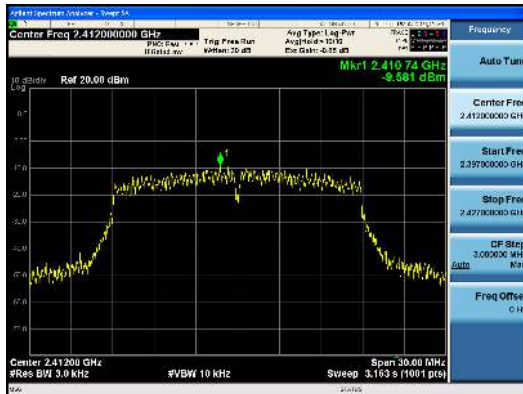
ANT2, 802.11b



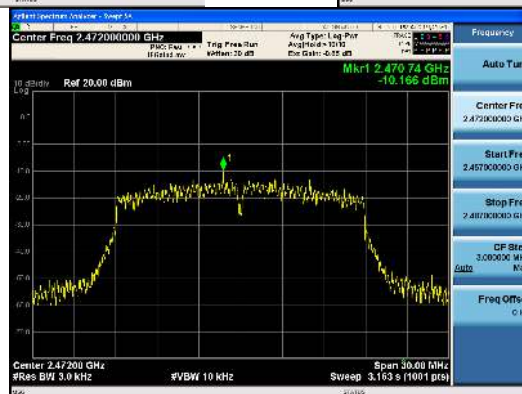
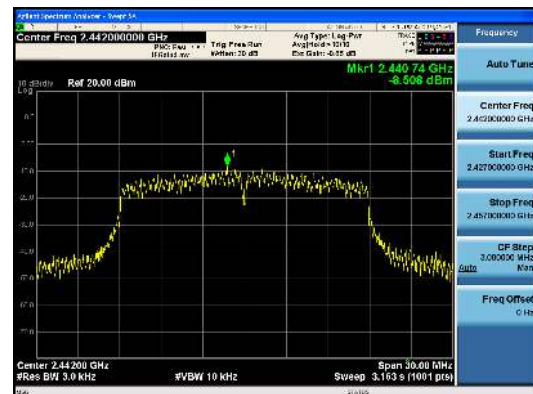
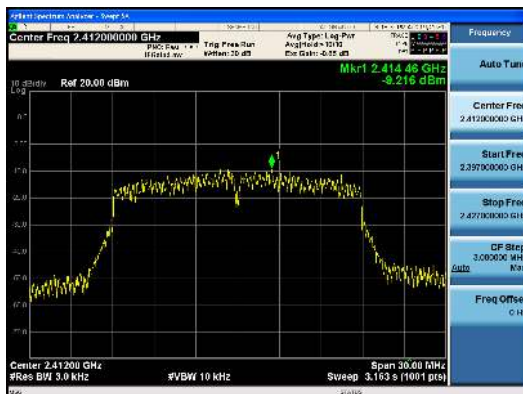
ANT1, 802.11g



ANT2, 802.11g



ANT1, 802.11n_HT20



ANT2, 802.11n_HT20