FCC / ISED RF Test Report

Report No.:	FCC_IC_RF_SL21022601-HAR-284_R1 EXT NA 2B_2.4G_Rev 1.0
FCC ID:	2AHPN-BE2860
ISED ID:	6434C-BE2860
Model:	R1 EXT NA 2B MY22
Received Date:	3/15/2021
Test Date:	4/15/2021-7/21/2021
Issued Date:	7/21/2021
Applicant:	HARMAN INTERNATIONAL
Address:	30001 Cabot Drive, Novi, MI 48377, USA
Manufacturer:	HARMAN INTERNATIONAL
Address:	30001 Cabot Drive, Novi, MI 48377, USA
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035
FCC Registration / Designation Number:	540430
ISED# / CAB identifier:	4842D

TESTING CERT # 2742-01

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Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL21022601-HAR-284_R1 EXT NA 2B_2.4G	Orignal Release	6/14/2021
FCC_IC_RF_SL21022601-HAR-284_R1 EXT NA 2B_2.4G_Rev 1.0	Update BW test	7/21/2021

1 Certificate of Conformity

Product: Automotive Infotainment Unit

Brand: HARMAN

Model: R1 EXT NA 2B MY22

Sample Status: Final Product

Applicant: Harman International

Test Date: 4/15/2021-5/23/2021

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
RSS 247 Issue 2, February 2017
ANSI C63.10: 2013
RSS Gen Issue 5, March 2019
KDB 558074 D01 15.247 Meas Guidance v05r02

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** *5/24/2021*

Jude Semana / Test Engineer

Approved by : _____ , **Date:** *7/21/2021*

Gary Chou/ Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247) / ISED RSS-247				
FCC Clause	RSS Section(s)	Test Item	Result	Remarks
15.207	RSS-Gen [8.8]	AC Power Conducted Emission	N/A	N/A
15.205 &15.209 & 15.247(d)	RSS-Gen [8.9] RSS-247 [5.5]	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit.
15.247(d)	RSS-247[5.5]	Antenna Port Emission	PASS	Meet the requirement of limit.
15.247(a)(2)	RSS-247[5.2]	6dB Bandwidth & 99% Bandwidth	PASS	Meet the requirement of limit.
15.247(b)	RSS-247 [5.4(4)]	Conducted power	PASS	Meet the requirement of limit.
15.247(e)	RSS-247 [5.2)]	Power Spectral Density	PASS	Meet the requirement of limit.
15.203		Antenna Requirement	PASS	Antenna connector is FAKRA. (The device is professionally installed)

Note: The EUT is DC powered.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Automotive Infotainment Unit
Brand	HARMAN
Model	R1 EXT NA 2B MY22
Status of EUT	Final Product
Power Supply Rating	12V, 20A
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS, OFDM
Transfer Rate	802.11b: up to 11Mbps 802.11g: up to 54Mbps 802.11n: up to 300Mbps
Operating Frequency	2412~2462MHz
Number of Channel	11 for 802.11b, 802.11g, 802.11n(HT20)
Output Power	101.15 mW (20.05dBm)
Antenna Type	External PCB Antenna, 1.43dBi
Antenna Connector	FAKRA

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

Power Settings:

MODE	CHANNEL	FREQUENCY	POWER SETTING
11b	1	2412MHz	1
	6	2437MHz	1
	11	2462MHz	1
11g	1	2412MHz	1
	6	2437MHz	1
	11	2462MHz	1
11n	1	2412MHz	1
	6	2437MHz	1
	11	2462MHz	1

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	N/A	√	-

Where RE≥1G: Radiated Emission above 1GHz & Bandedge Measurement **RE<1G:** Radiated Emission below 1GHz

PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane**.
NOTE: "-" means no effect.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (20MHz)	1 to 11	6	OFDM	BPSK	6.5

Power Line Conducted Emission Test:

☐ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☐ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (HT20)	1 to 11	6	OFDM	BPSK	6.5

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	12VDC	Jude Semana
RE<1G	25deg. C, 65%RH	12VDC	Jude Semana
PLC	25deg. C, 68%RH	12VDC	Jude Semana
APCM	21deg. C, 60%RH	12VDC	Jude Semana

3.3 Description of Support Units

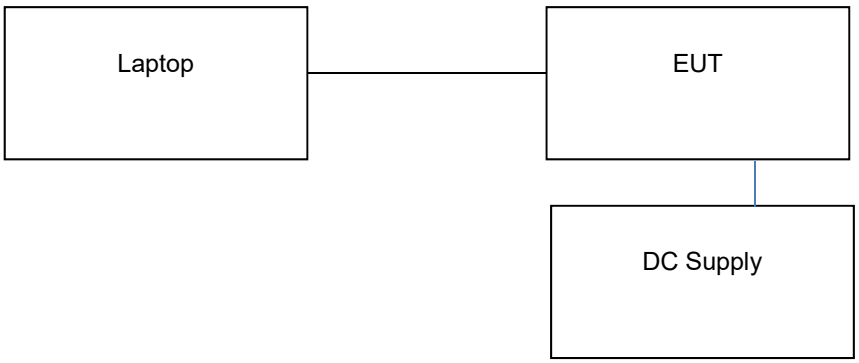
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Acer	Aspire 3	N/A	N/A	Provided by Lab

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB	1	1m	No	0	Connect from EUT to Laptop

Note: The core(s) is (are) originally attached to the cable(s).

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

47 CFR FCC Part 15, Subpart C (Section 15.247)
RSS 247 Issue2, February 2017
ANSI C63.10: 2013
RSS Gen Issue5, March 2019
558074 D01 15.247 Meas Guidance v05r02

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Receiver , Rohde and Schwarz	ESW44	1328.4100K-101662-MH	10/23/2020	10/23/2021
Biconilog Antenna , Sunol	JB6	A111717	9/4/2020	9/4/2021
Horn Antenna , ETS-Lindgren	3117	218554	7/24/2020	7/24/2021
Pre-Amplifier , RF-Lambda	RAMP00M50GA	18040300055	10/1/2020	10/1/2021
Spectrum Analyzer, Keysight	N9030B	MY57140700	07/22/2020	07/22/2022

4.1.3 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

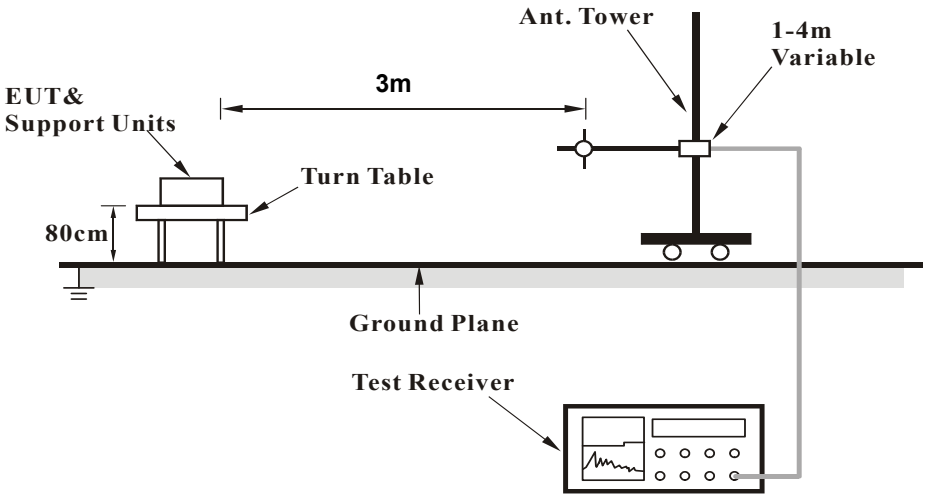
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

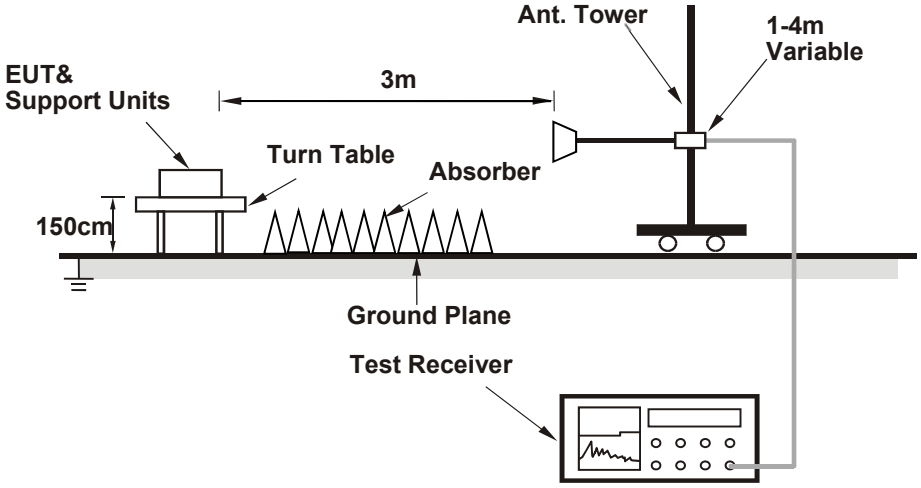
No deviation.

4.1.5 Test Setup

For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

a. Connected the EUT with the Notebook Computer which is placed on remote site.
b. Controlling software has been activated to set the EUT on specific status.

4.1.7 Test Results

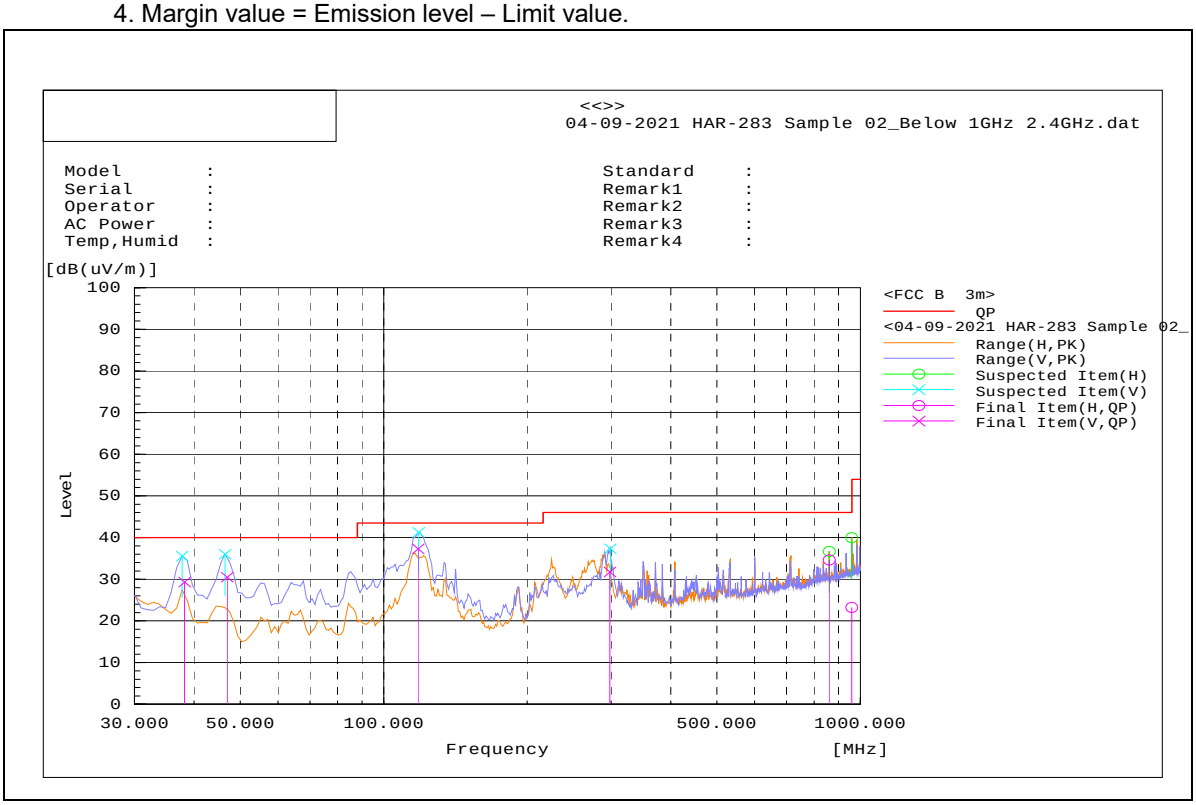
BELOW 1GHz WORST-CASE DATA:

CHANNEL	802.11g Channel 6	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	38.199	V	9.7	19.7	29.4	40	-10.6	101.2	284.1	Pass
2	46.932	V	16.2	14.3	30.5	40	-9.5	102.6	234	Pass
3	118.058	V	18	19.3	37.3	43.5	-6.2	101.2	249.8	Pass
4	298.255	V	11.6	20.2	31.8	46	-14.2	100.8	6.3	Pass
5	959.29	H	-8.2	31.4	23.2	46	-22.8	127.2	34.4	Pass
6	860.163	H	4.4	30.2	34.6	46	-11.4	273.1	75.4	Pass

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



ABOVE 1GHz TEST DATA:

WLAN 2.4GHz

802.11b

Above 1GHz-25GHz – 802.11b – 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2990.907	H	41.1	-9.6	Average	31.5	54	-22.5	378.1	258
4986.751	V	37.9	-7	Average	30.9	54	-23.1	128.5	139.1
3196.044	V	40.5	-8.9	Average	31.6	54	-22.4	173.6	225.1
2990.907	H	58.4	-9.6	Peak	48.8	74	-25.2	378.1	258
4986.751	V	62.1	-7	Peak	55.1	74	-18.9	128.5	139.1
3196.044	V	56.3	-8.9	Peak	47.4	74	-26.6	173.6	225.1

Above 1GHz-25GHz- 802.11b - 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3188.353	V	28.6	-8.9	Average	19.7	54	-34.3	102	122.8
4994.222	V	26.5	-6.9	Average	19.6	54	-34.4	228.5	209.7
6992.628	V	22.3	-2.6	Average	19.7	54	-34.3	295	181.1
3188.353	V	50.4	-8.9	Peak	41.5	74	-32.5	102	122.8
4994.222	V	50.7	-6.9	Peak	43.8	74	-30.2	228.5	209.7
6992.628	V	33.8	-2.6	Peak	31.2	74	-42.8	295	181.1

Above 1GHz-25GHz – 802.11b – 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3190.189	V	21.3	-8.9	Average	12.4	54	-41.6	356.4	0
4995.493	V	23.9	-6.9	Average	17	54	-37	306.1	147.1
2986.971	V	38.9	-9.6	Average	29.3	54	-24.7	270.6	0
3190.189	V	34.1	-8.9	Peak	25.2	74	-48.8	356.4	0
4995.493	V	39.2	-6.9	Peak	32.3	74	-41.7	306.1	147.1
2986.971	V	59.8	-9.6	Peak	50.2	74	-23.8	270.6	0

802.11g

Above 1GHz-25GHz- 802.11g - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3186.618	V	40.8	-8.9	Average	31.9	54	-22.1	371.3	0
2125.458	H	43.5	-10.9	Average	32.6	54	-21.4	185.5	318.2
4992.418	H	37.6	-6.9	Average	30.7	54	-23.3	395.7	193.4
3186.618	V	54.1	-8.9	Peak	45.2	74	-28.8	371.3	0
2125.458	H	59.5	-10.9	Peak	48.6	74	-25.4	185.5	318.2
4992.418	H	49.6	-6.9	Peak	42.7	74	-31.3	395.7	193.4

Above 1GHz-25GHz – 802.11g – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3197.549	V	43	-8.9	Average	34.1	54	-19.9	102	185.5
2127.879	V	45.8	-10.9	Average	34.9	54	-19.1	315.2	173.2
4997.861	H	38.7	-6.9	Average	31.8	54	-22.2	379.1	108.2
3197.549	V	63.3	-8.9	Peak	54.4	74	-19.6	102	185.5
2127.879	V	60.8	-10.9	Peak	49.9	74	-24.1	315.2	173.2
4997.861	H	49.6	-6.9	Peak	42.7	74	-31.3	379.1	108.2

Above 1GHz-25GHz- 802.11g - 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3192.006	V	40.2	-8.9	Average	31.3	54	-22.7	102	320.5
2128.961	V	45.3	-10.9	Average	34.4	54	-19.6	174	0
4993.669	V	37.8	-6.9	Average	30.9	54	-23.1	162.6	242.1
3192.006	V	54.7	-8.9	Peak	45.8	74	-28.2	102	320.5
2128.961	V	63.7	-10.9	Peak	52.8	74	-21.2	174	0
4993.669	V	59.4	-6.9	Peak	52.5	74	-21.5	162.6	242.1

802.11n-HT20

Above 1GHz-25GHz- 802.11n20 - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2127.783	V	27.5	-10.9	Average	16.6	54	-37.4	108.6	356.3
3196.489	V	25.5	-8.9	Average	16.6	54	-37.4	199.4	165.1
4250.019	V	28.2	-8.5	Average	19.7	54	-34.3	105.1	236
2127.783	V	47.1	-10.9	Peak	36.2	74	-37.8	108.6	356.3
3196.489	V	49.7	-8.9	Peak	40.8	74	-33.2	199.4	165.1
4250.019	V	46.2	-8.5	Peak	37.7	74	-36.3	105.1	236

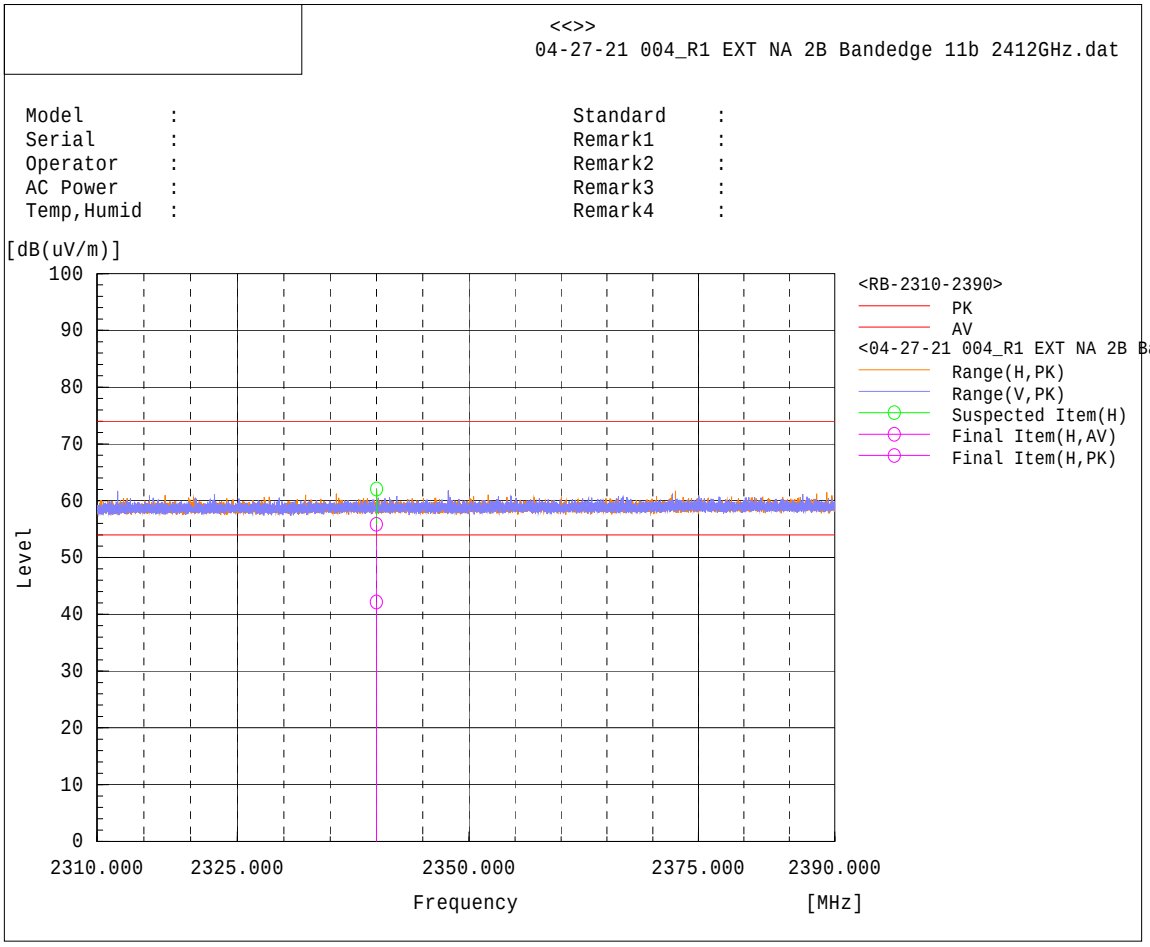
Above 1GHz-25GHz – 802.11n20 – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4989.254	V	26.7	-6.9	Average	19.8	54	-34.2	111.4	157.7
2992.419	V	25.8	-9.6	Average	16.2	54	-37.8	104.3	356.3
6969.126	V	25	-2.6	Average	22.4	54	-31.6	111.5	289.9
4989.254	V	49.3	-6.9	Peak	42.4	74	-31.6	111.4	157.7
2992.419	V	42.9	-9.6	Peak	33.3	74	-40.7	104.3	356.3
6969.126	V	37.2	-2.6	Peak	34.6	74	-39.4	111.5	289.9

Above 1GHz-25GHz- 802.11n20 - 2462MHz

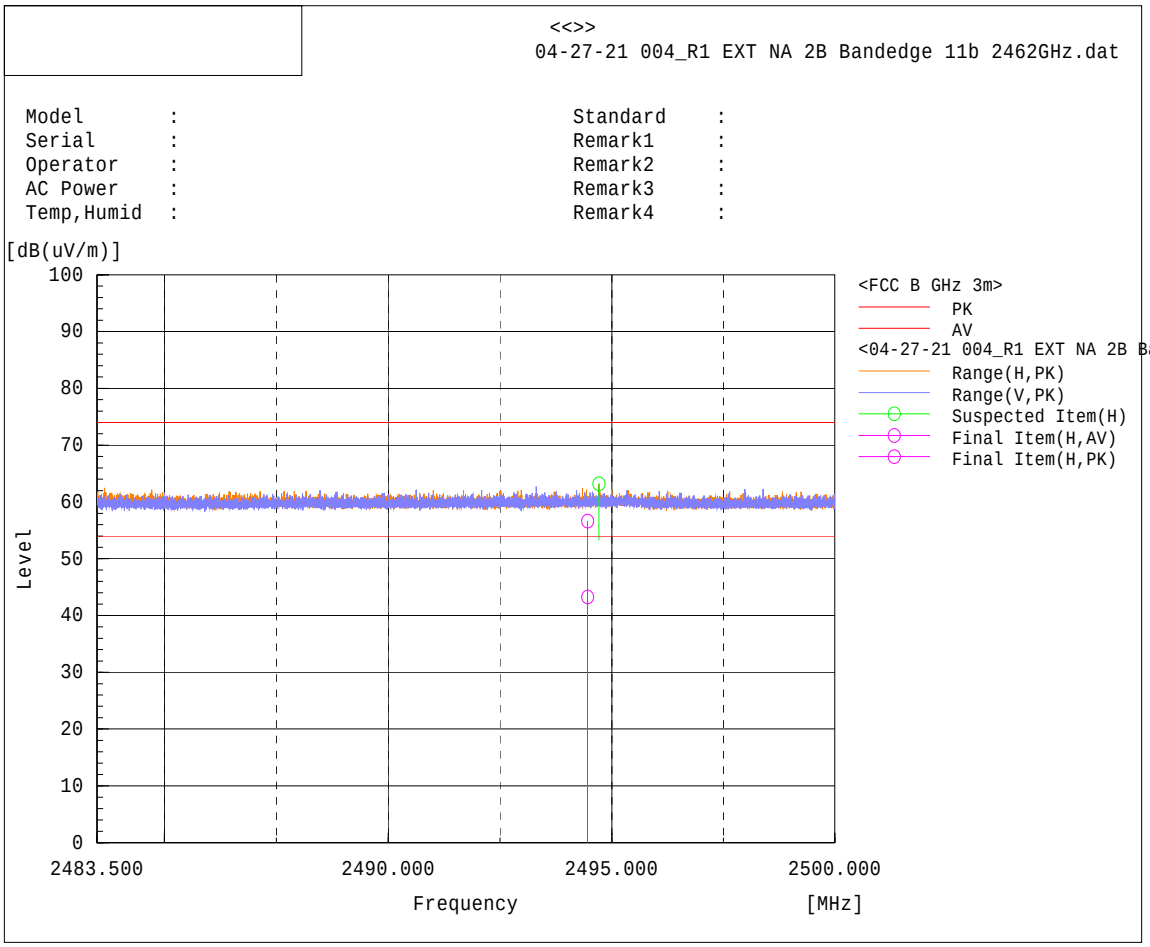
ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
6995.129	V	25.8	-2.6	Average	23.2	54	-30.8	100	146.8
4994.555	V	36.9	-6.9	Average	30	54	-24	214.8	274
2993.622	H	25.5	-9.6	Average	15.9	54	-38.1	111.7	84.2
6995.129	V	48.6	-2.6	Peak	46	74	-28	100	146.8
4994.555	V	53.3	-6.9	Peak	46.4	74	-27.6	214.8	274
2993.622	H	46.4	-9.6	Peak	36.8	74	-37.2	111.7	84.2

RESTRICTED BAND (802.11b LOW CHANNEL)



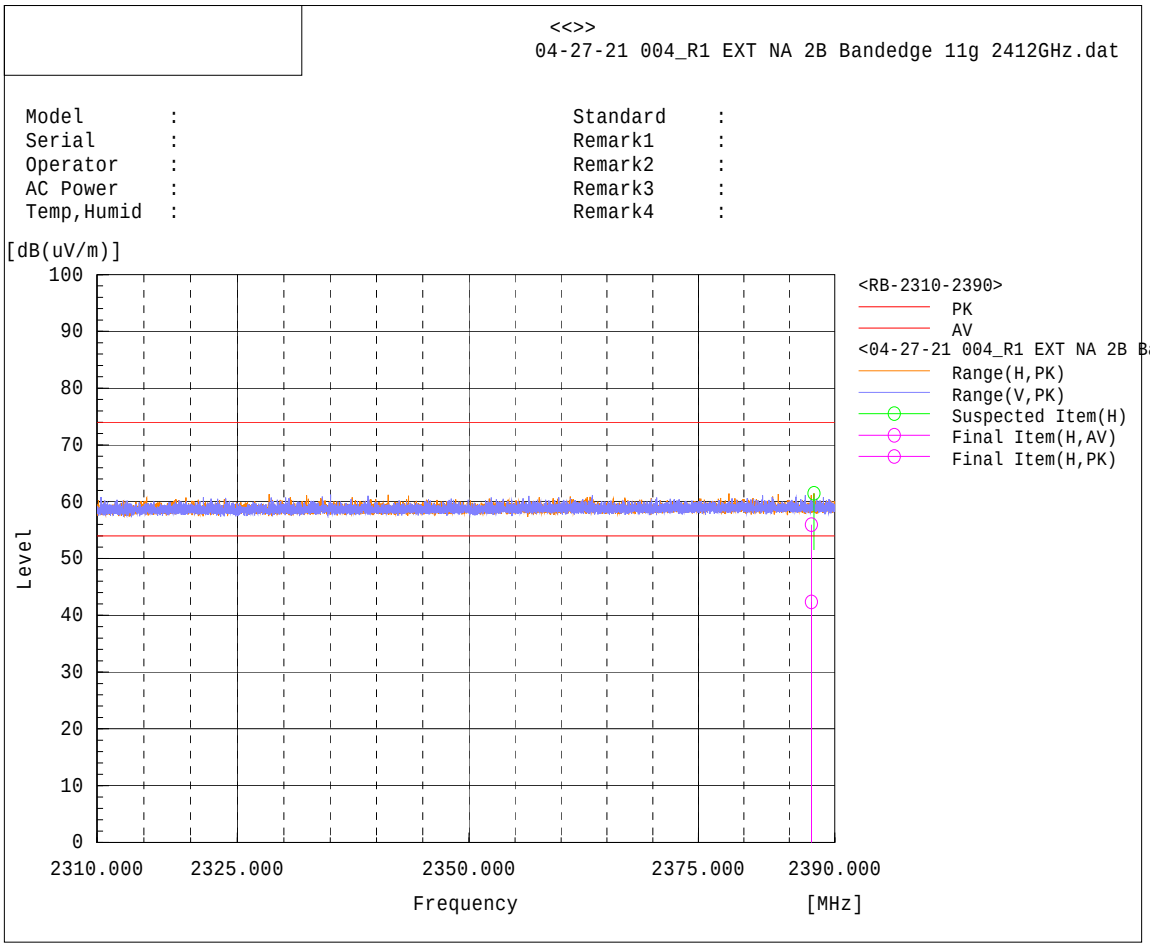
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2339.965	H	7.4	Average	34.8	42.2	54	-11.8	142.6	173.6
2339.965	H	21	Peak	34.8	55.8	74	-18.2	142.6	173.6

RESTRICTED BAND (802.11b High CHANNEL)



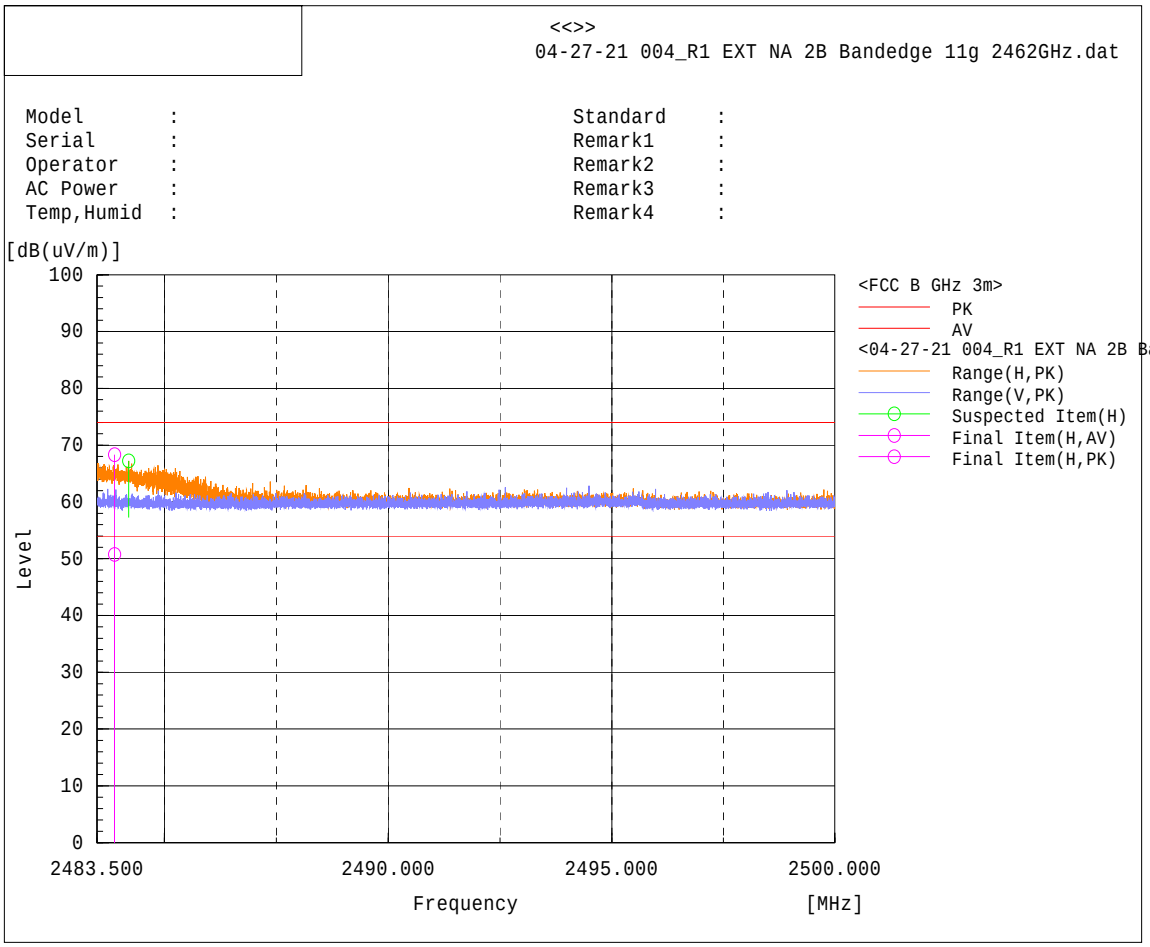
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2494.462	H	7.8	Average	35.5	43.3	54	-10.7	110.2	358.4
2494.462	H	21.1	Peak	35.5	56.6	74	-17.4	110.2	358.4

RESTRICTED BAND (802.11g LOW CHANNEL)



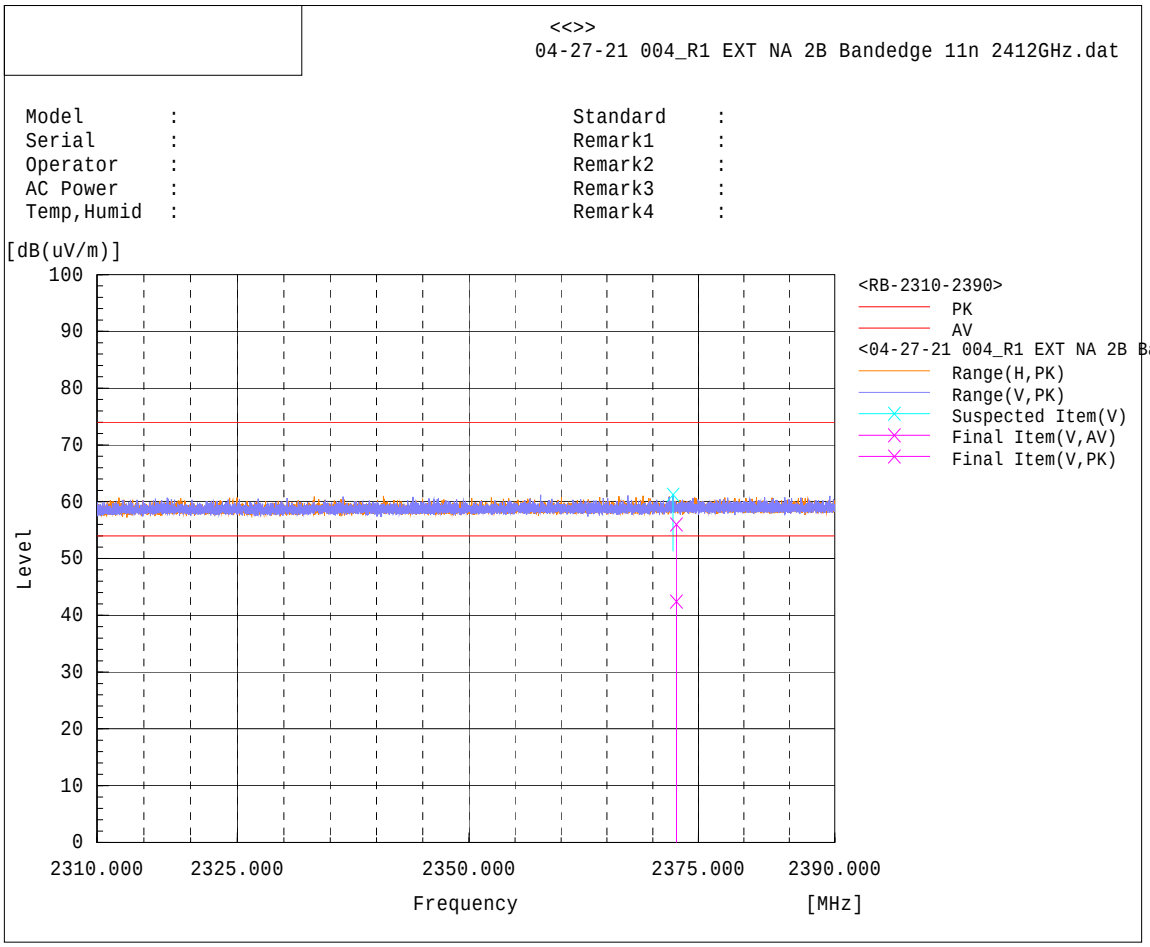
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2387.409	H	7.4	Average	35	42.4	54	-11.6	112.1	238
2387.409	H	21	Peak	35	56	74	-18	112.1	238

RESTRICTED BAND (802.11g High CHANNEL)



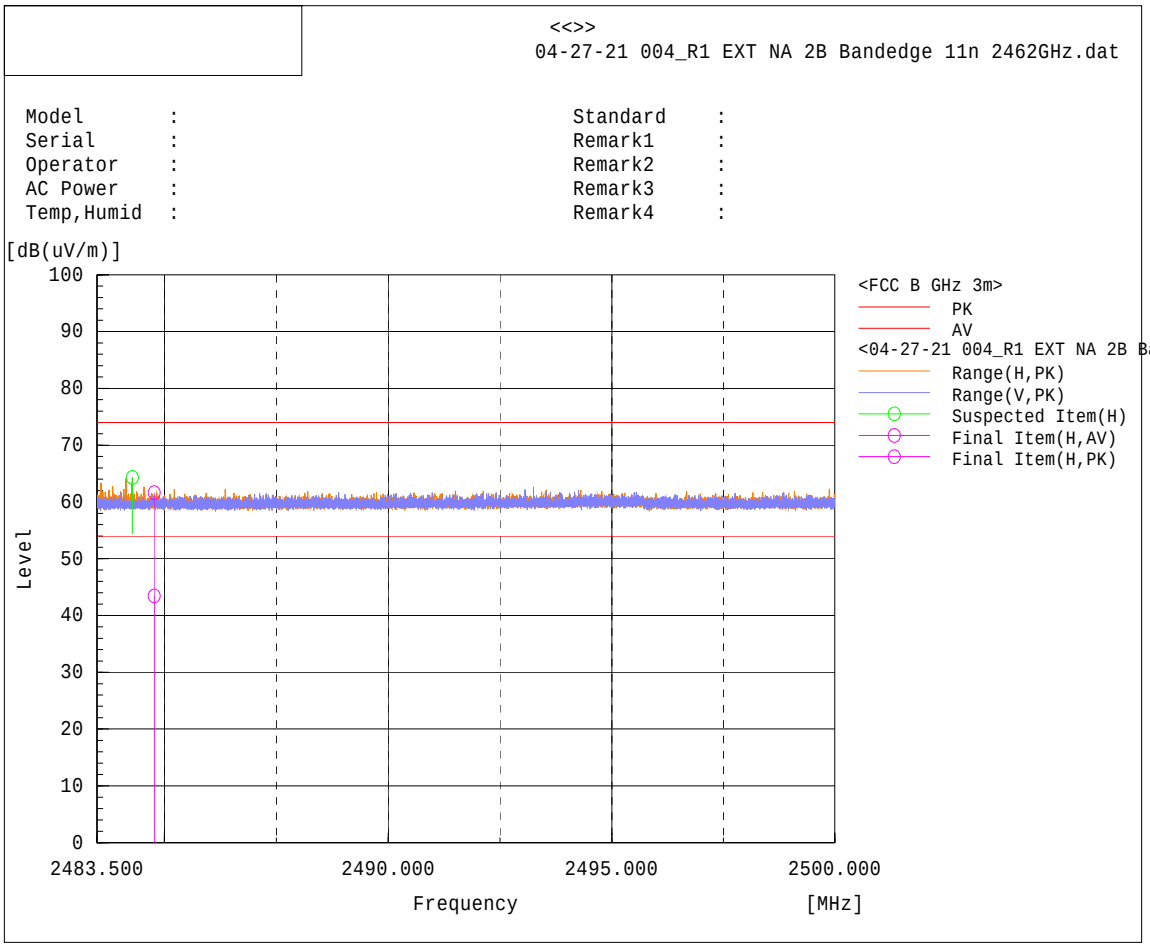
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.892	H	15.4	Average	35.4	50.8	54	-3.2	178.9	0.1
2483.892	H	32.9	Peak	35.4	68.3	74	-5.7	178.9	0.1

RESTRICTED BAND (802.11n LOW CHANNEL)



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2372.603	V	7.4	Average	35	42.4	54	-11.6	122.9	309
2372.603	V	21	Peak	35	56	74	-18	122.9	309

RESTRICTED BAND (802.11n High CHANNEL)



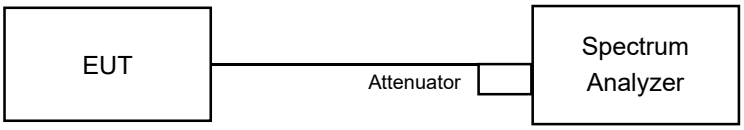
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2484.774	H	8.1	Average	35.4	43.5	54	-10.5	102.2	358
2484.774	H	26.2	Peak	35.4	61.6	74	-12.4	102.2	358

4.2 6dB Bandwidth & 99% Bandwidth Measurement

4.2.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 Test Procedure

a. Set resolution bandwidth (RBW) = 1% to 5% of OBW
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Span = 1.5 to 5 times the OBW
e. Sweep = auto couple.
f. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.2.5 Deviation fromTest Standard

No deviation.

4.2.6 EUT Operating Conditions

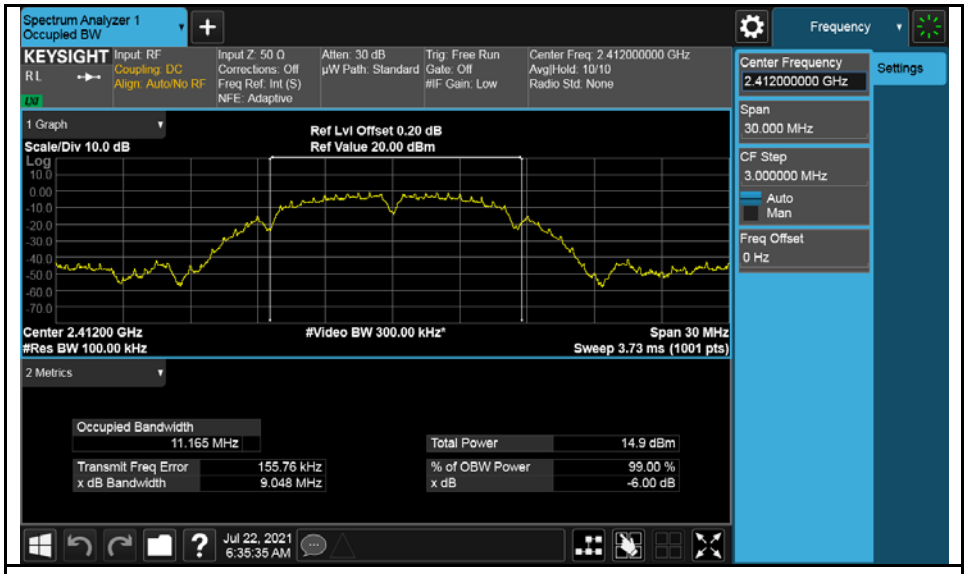
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.2.7 Test Result

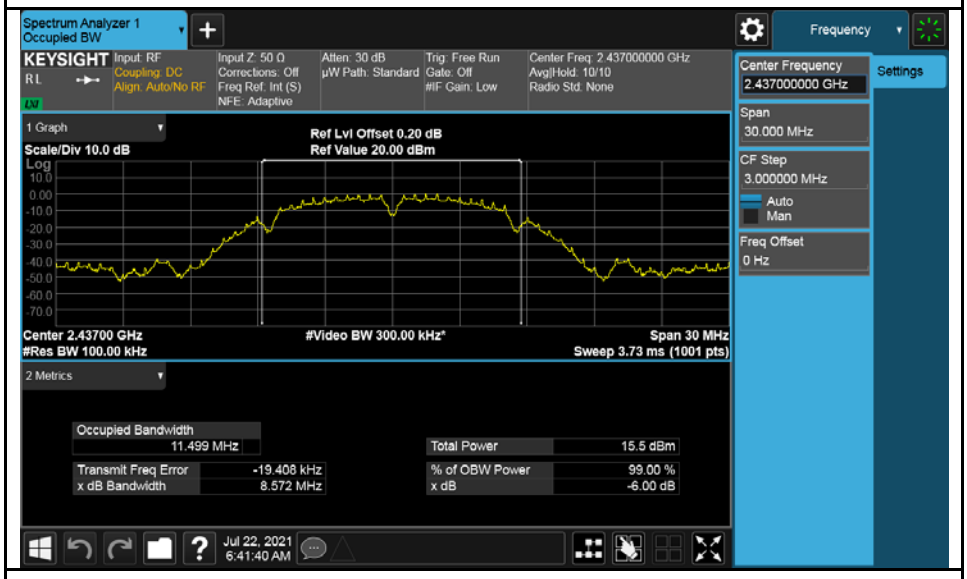
802.11b

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	9.05	11.16	0.5	PASS
6	2437	8.57	11.50	0.5	PASS
11	2462	8.56	11.53	0.5	PASS

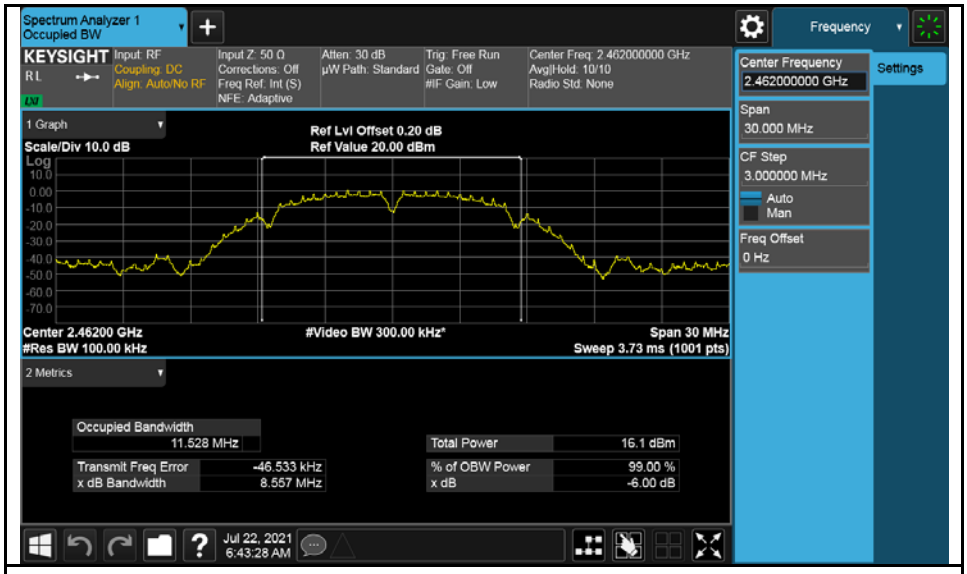
Test Plots:



2412MHz



2437MHz

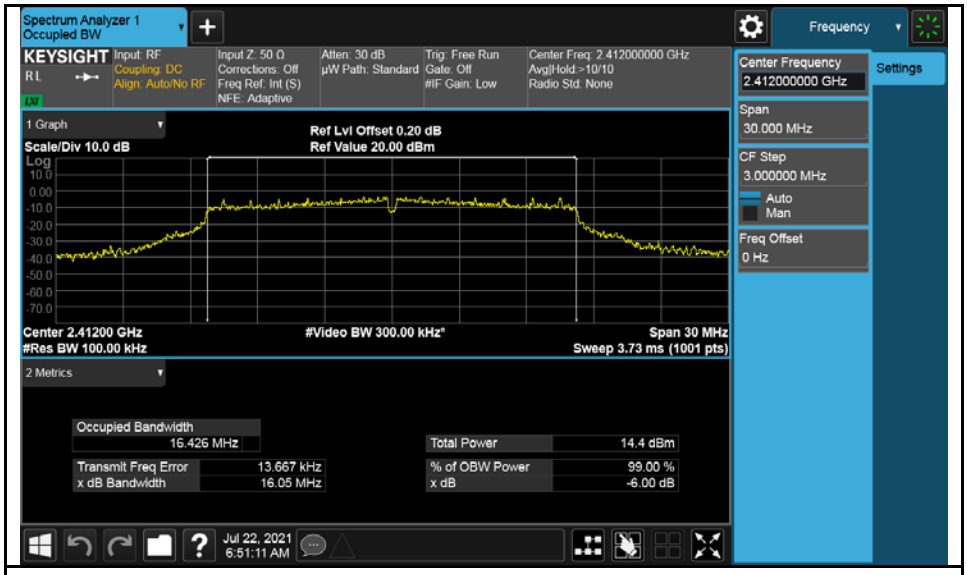

Spectrum Analyzer 1
Occupied BW
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 0.20 dB
Ref Value 20.00 dBm
Scale/Div 10.0 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
11.528 MHz
Total Power
16.1 dBm
Transmit Freq Error
-46.533 kHz
% of OBW Power
99.00 %
x dB Bandwidth
8.557 MHz
x dB
-6.00 dB
Jul 22, 2021
6:43:28 AM

2462MHz

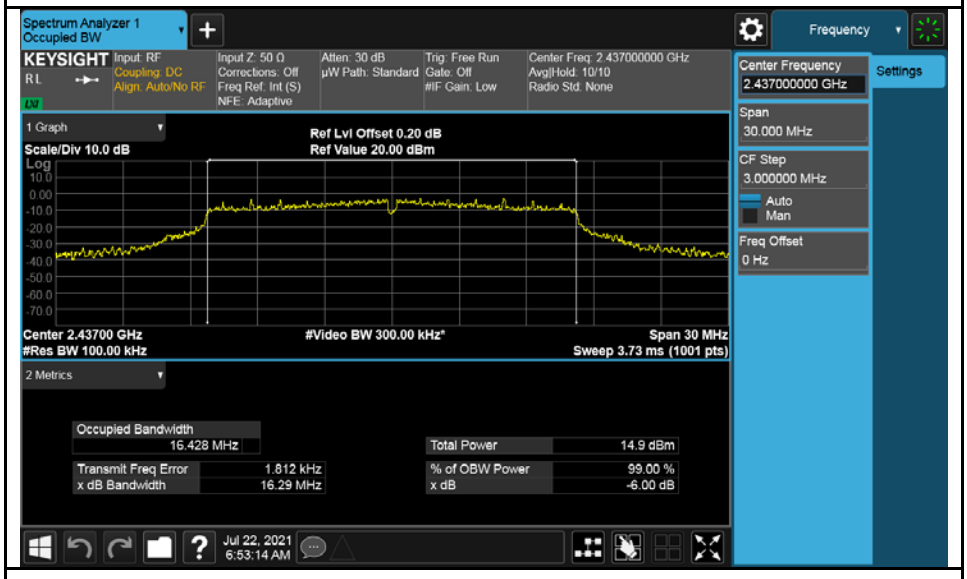
802.11g

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	16.05	16.43	0.5	PASS
6	2437	16.29	16.43	0.5	PASS
11	2462	15.73	16.44	0.5	PASS

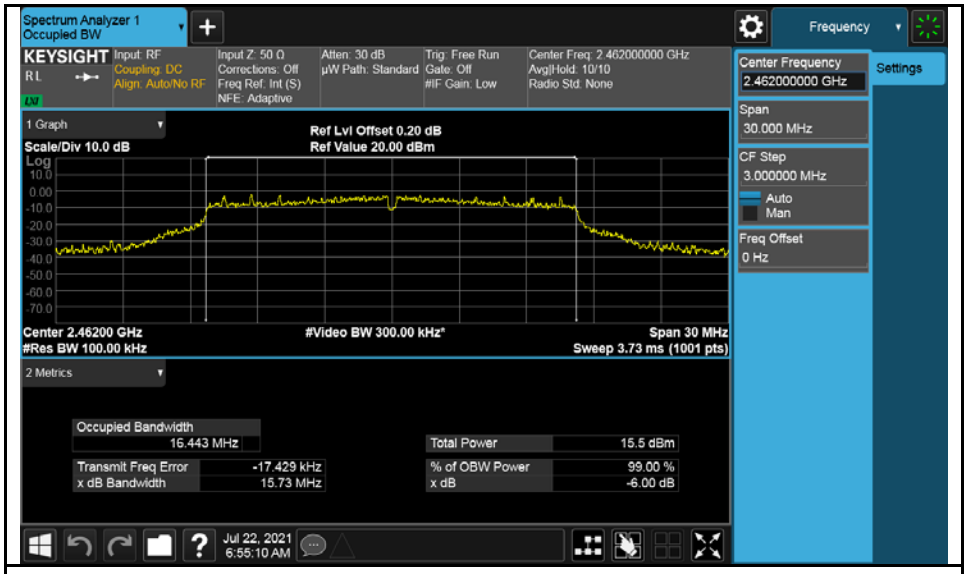
Test Plots:



2412MHz



2437MHz

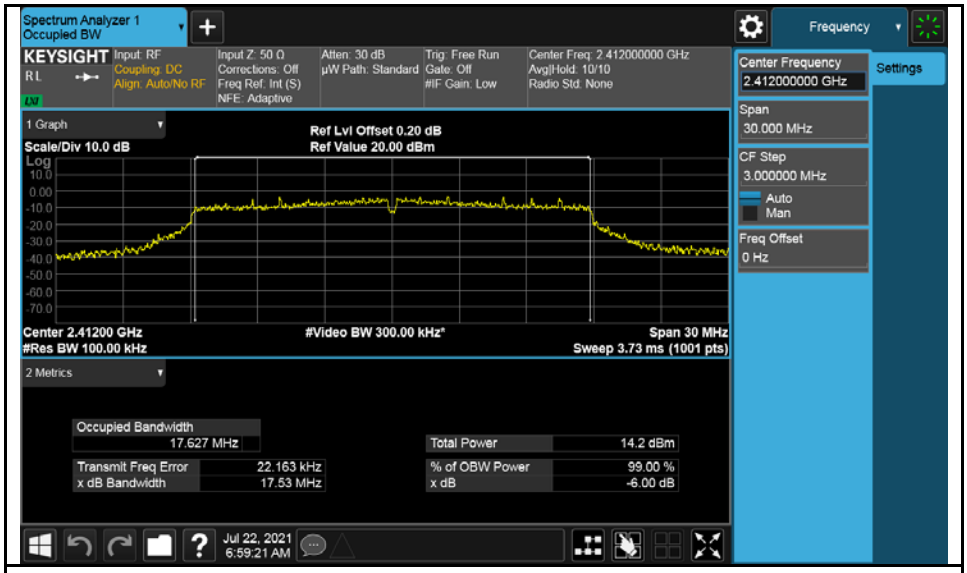

Spectrum Analyzer 1
Occupied BW
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 0.20 dB
Ref Value 20.00 dBm
Scale/Div 10.0 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
16.443 MHz
Total Power
15.5 dBm
Transmit Freq Error
-17.429 kHz
% of OBW Power
99.00 %
x dB Bandwidth
15.73 MHz
x dB
-6.00 dB
Jul 22, 2021
6:55:10 AM

2462MHz

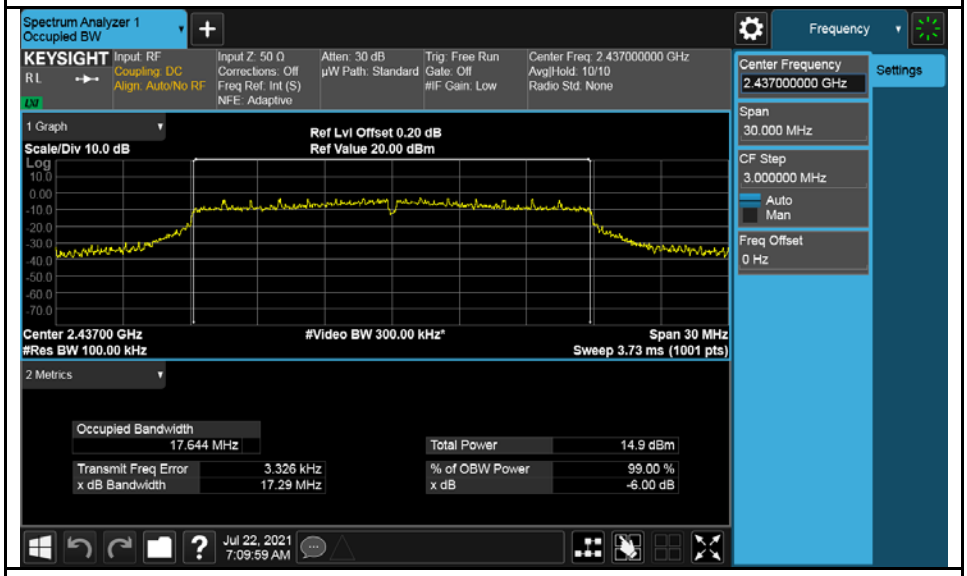
802.11n-HT20

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth	Minimum Limit (MHz)	Pass / Fail
1	2412	17.53	17.63	0.5	PASS
6	2437	17.29	17.64	0.5	PASS
11	2462	16.92	17.66	0.5	PASS

Test Plots:



2412MHz



2437MHz


Spectrum Analyzer 1
Occupied BW
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold: 10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.000 MHz
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 0.20 dB
Ref Value 20.00 dBm
Scale/Div 10.0 dB
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.46200 GHz
#Res BW 100.00 kHz
#Video BW 300.00 kHz*
Span 30 MHz
Sweep 3.73 ms (1001 pts)
2 Metrics
Occupied Bandwidth
17.657 MHz
Total Power
15.6 dBm
Transmit Freq Error
-8.425 kHz
% of OBW Power
99.00 %
x dB Bandwidth
16.92 MHz
x dB
-6.00 dB
Jul 22, 2021
7:26:44 AM

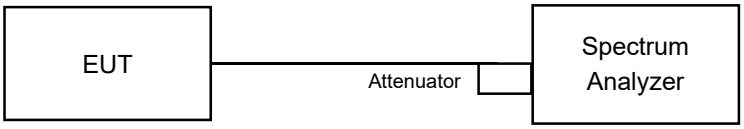
2462MHz

4.3 Conducted Output Power Measurement

4.3.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedures

a. Set the RBW ≥ DTS bandwidth.
b. Set VBW ≥ 3 × RBW.
c. Set span ≥ 3 x RBW
d. Sweep time = auto couple.
e. Detector = peak.
f. Trace mode = max hold.
g. Allow trace to fully stabilize.
h. Use peak marker function to determine the peak amplitude level.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

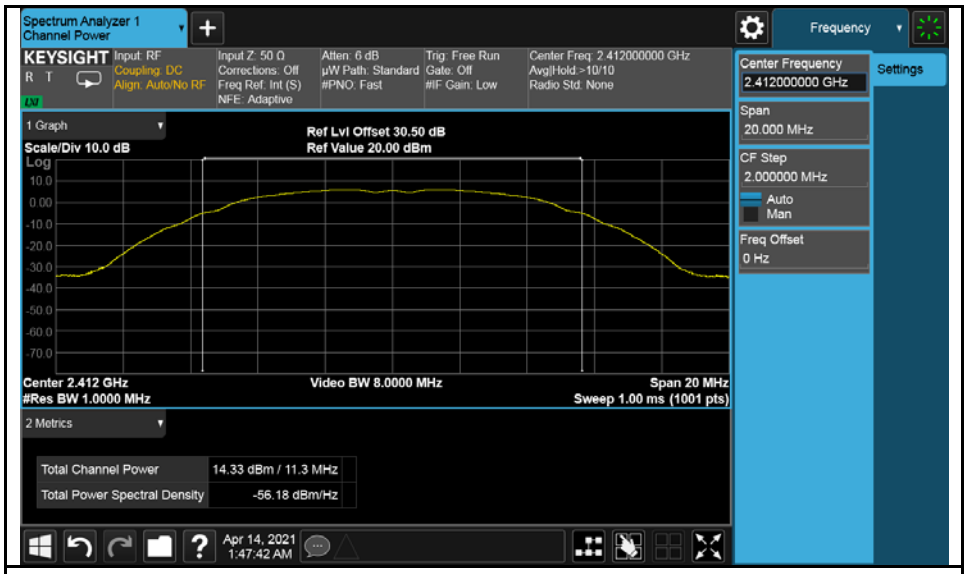
Same as Item 4.3.6.

4.3.7 Test Results

802.11b

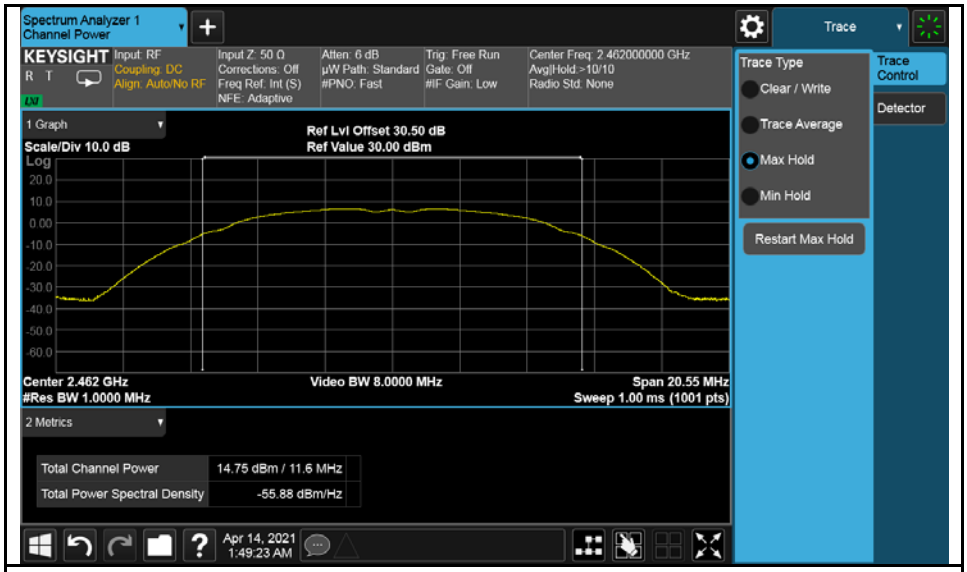
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	14.33	30	Pass
6	2437	14.55	30	Pass
11	2462	14.75	30	Pass

Test Plots:



2412MHz

2437MHz


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold:>10/10
Radio Std: None
Trace
Trace Type
Clear / Write
Trace Average
Max Hold
Min Hold
Restart Max Hold
Trace Control
Detector
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 30.00 dBm
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Center 2.462 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz
Span 20.55 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
14.75 dBm / 11.6 MHz
Total Power Spectral Density
-55.88 dBm/Hz
Apr 14, 2021
1:49:23 AM

2462MHz

802.11g

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	19.04	30	Pass
6	2437	19.59	30	Pass
11	2462	19.86	30	Pass

Test Plots:

2412MHz

2437MHz


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold:>10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
29.316 MHz
CF Step
2.931556 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Scale/Div 10.0 dB
Ref Value 30.00 dBm
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Center 2.462 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz
Span 29.32 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
19.86 dBm / 16.5 MHz
Total Power Spectral Density
-52.31 dBm/Hz
Apr 14, 2021
1:52:21 AM

2462MHz

802.11n-HT20

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	19.00	30	Pass
6	2437	19.59	30	Pass
11	2462	20.05	30	Pass

Test Plots:

2412MHz

2437MHz


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 2.462000000 GHz
Avg|Hold:>10/10
Radio Std: None
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
31.396 MHz
CF Step
3.139556 MHz
Auto
Man
Freq Offset
0 Hz
1 Graph
Ref Lvl Offset 30.50 dB
Ref Value 30.00 dBm
Scale/Div 10.0 dB
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Center 2.462 GHz
#Res BW 1.0000 MHz
Video BW 8.0000 MHz
Span 31.4 MHz
Sweep 1.00 ms (1001 pts)
2 Metrics
Total Channel Power
20.05 dBm / 17.7 MHz
Total Power Spectral Density
-52.42 dBm/Hz
Apr 14, 2021
1:54:41 AM

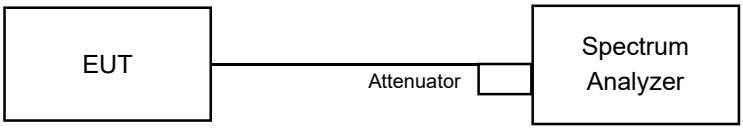
2462MHz

4.4 Power Spectral Density Measurement

4.4.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

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

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Condition

Same as Item 4.3.6

4.4.7 Test Results

802.11b

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-9.47	8	Pass
6	2437	-9.14	8	Pass
11	2462	-8.49	8	Pass

Test Plots:

2412MHz

2437MHz

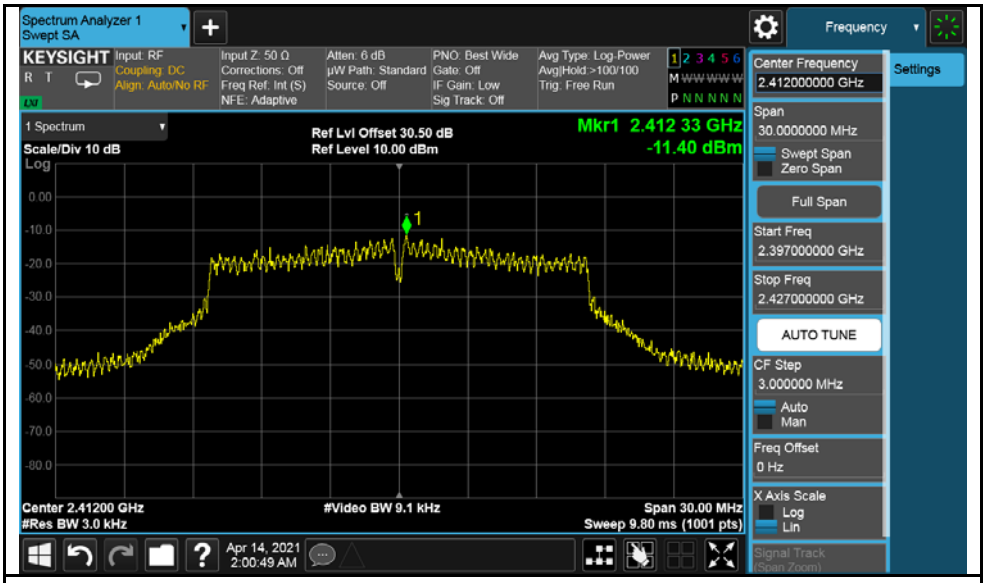

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Frequency
Center Frequency
2.462000000 GHz
Settings
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
1 Spectrum
Ref Lvl Offset 30.50 dB
Ref Level 10.00 dBm
Mkr1 2.461 22 GHz
-8.49 dBm
Scale/Div 10 dB
Log
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Center 2.46200 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 30.00 MHz
Sweep 9.80 ms (1001 pts)
Apr 14, 2021
2:00:04 AM

2462MHz

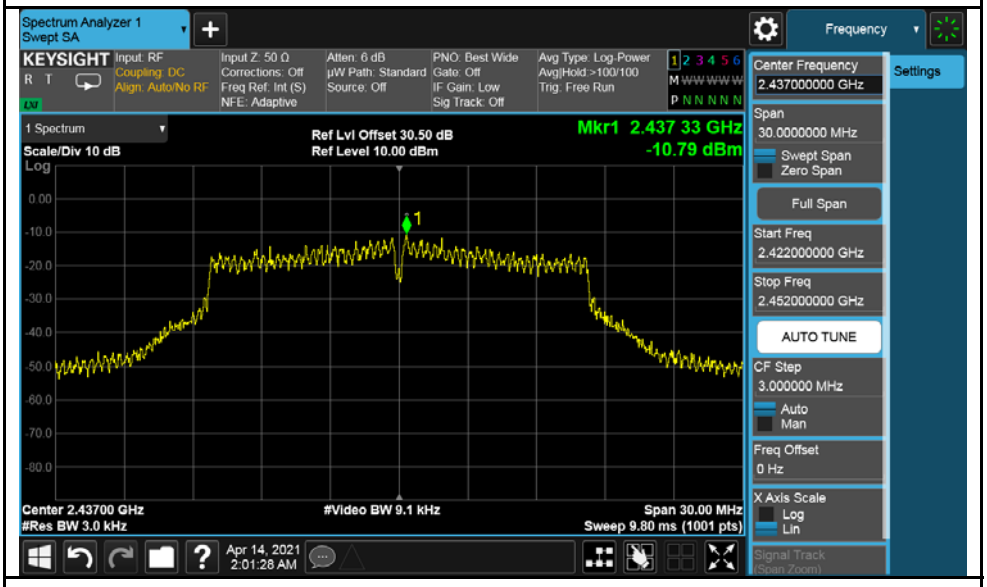
802.11g

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-11.40	8	Pass
6	2437	-10.79	8	Pass
11	2462	-10.64	8	Pass

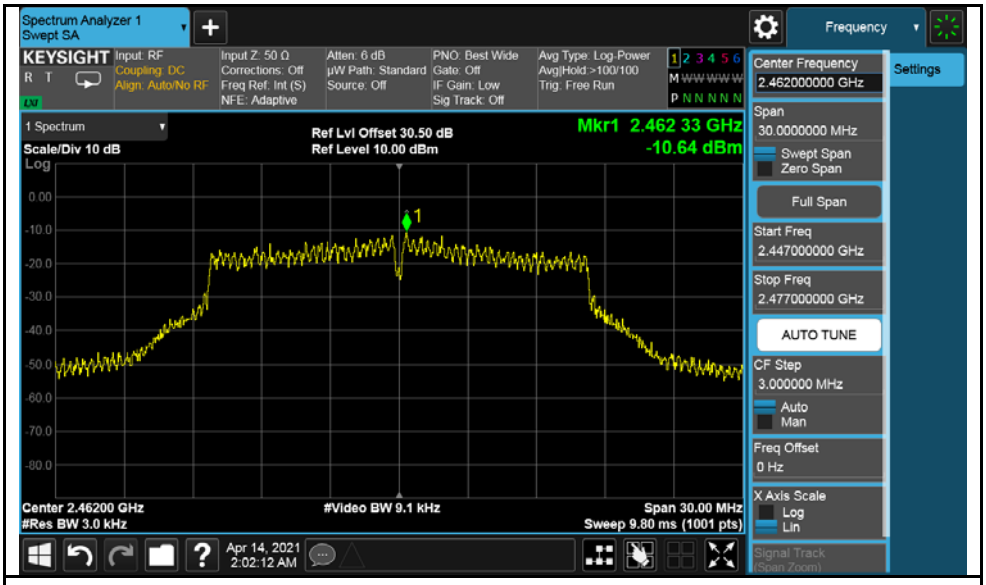
Test Plots:



2412MHz



2437MHz

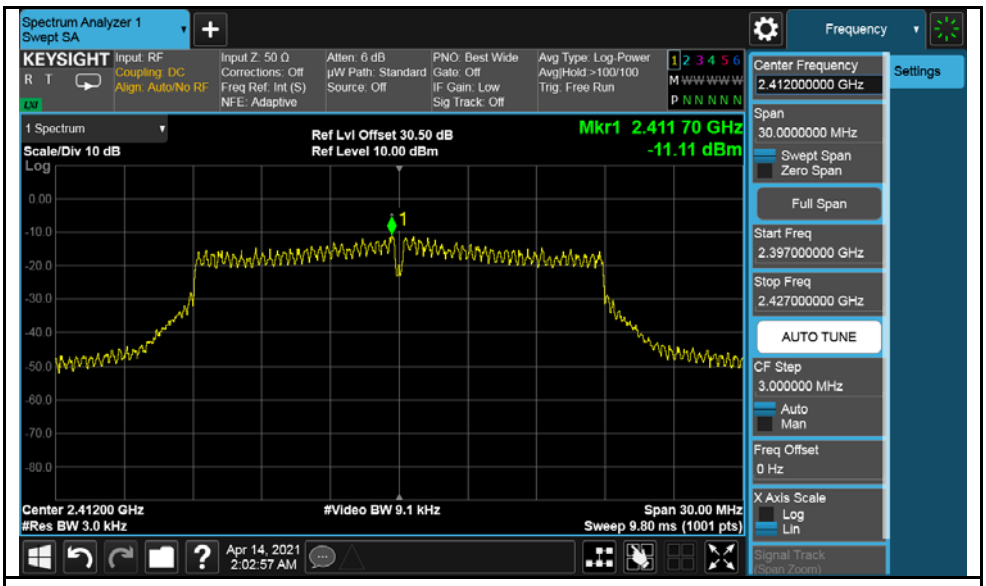

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Frequency
Settings
Center Frequency
2.462000000 GHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
1 Spectrum
Ref Lvl Offset 30.50 dB
Ref Level 10.00 dBm
Mkr1 2.462 33 GHz
-10.64 dBm
Scale/Div 10 dB
Log
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Center 2.46200 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 30.00 MHz
Sweep 9.80 ms (1001 pts)
Apr 14, 2021
2:02:12 AM

2462MHz

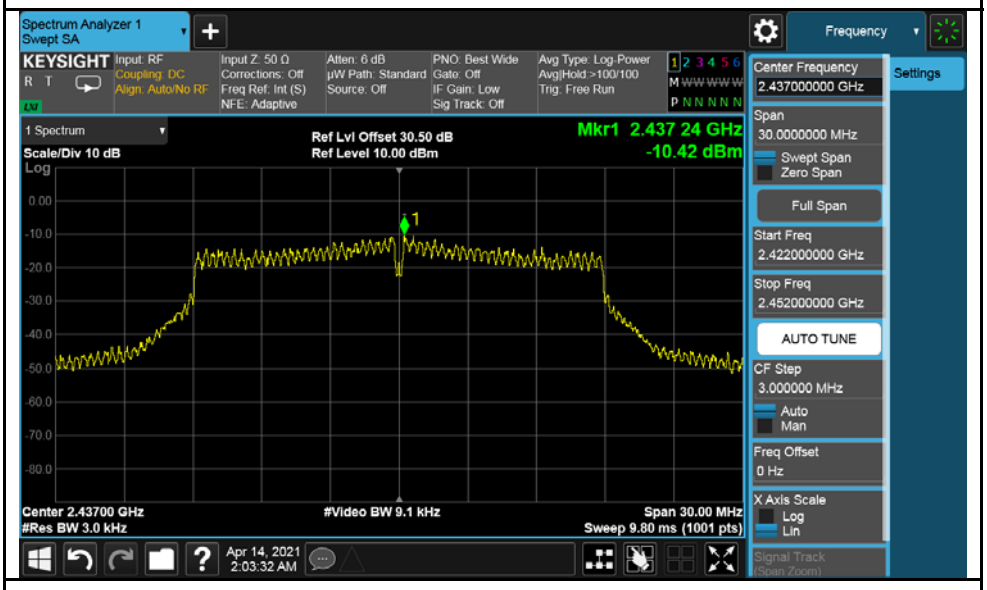
802.11n-HT20

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-11.11	8	Pass
6	2437	-10.42	8	Pass
11	2462	-10.24	8	Pass

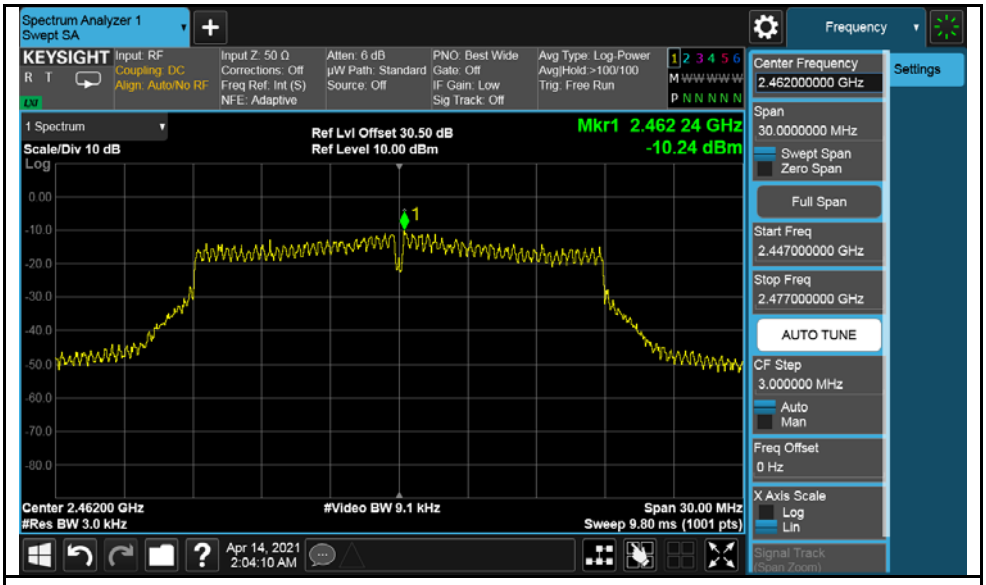
Test Plots:



2412MHz



2437MHz


Spectrum Analyzer 1
Swept SA
Frequency
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 30.50 dB
Ref Level 10.00 dBm
Mkr1 2.462 24 GHz
-10.24 dBm
Center 2.46200 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 30.00 MHz
Sweep 9.80 ms (1001 pts)
Apr 14, 2021
2:04:10 AM
Center Frequency
2.462000000 GHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
2.447000000 GHz
Stop Freq
2.477000000 GHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)
Settings

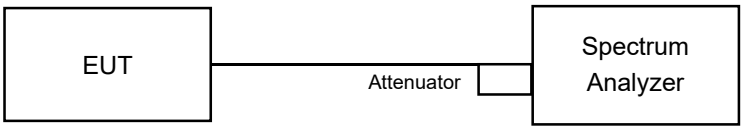
2462MHz

4.5 Conducted Out of Band Emission Measurement

4.5.1 Limits of Conducted Out of Band Emission Measurement

Below 20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

MEASUREMENT PROCEDURE REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

4.5.5 Deviation from Test Standard

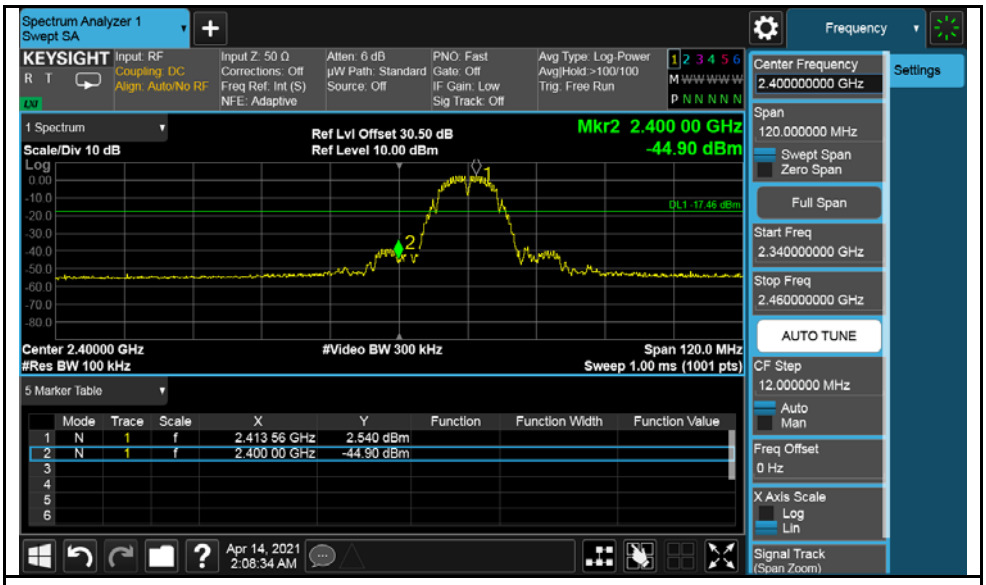
No deviation.

4.5.6 EUT Operating Condition

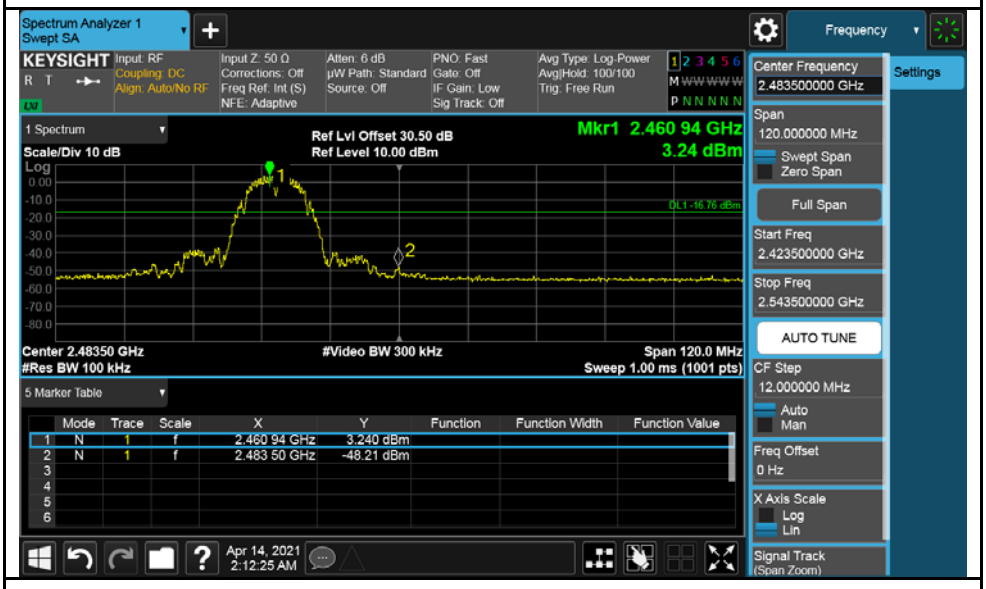
Same as Item 4.3.6

4.5.7 Test Results

802.11b



802.11b-2412MHz



802.11b-2462MHz

802.11g

802.11g-2412MHz

802.11g-2462MHz

802.11n-HT20

802.11n-HT20-2412MHz

802.11n-HT20-2462MHz

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

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Tel: +1 978 486 8880

Email: sales.eaw@us.bureauveritas.com
Web Site: www.cpsusa-bureauveritas.com

The address and road map of all our labs can be found in our web site also.

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