

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant: Murata Manufacturing Co., Ltd.
10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan

Product Name: Communication Module

Brand Name: muRata

FCC Model No.: LBEE5XV1XA, LBEE5XV2BA, LBEE5XV1ZA
LBEE5XV1XA_3ANT, LBEE5XV1XA_2ANT,
IC Model No.: LBEE5XV2BA_3ANT, LBEE5XV2BA_2ANT,
LBEE5XV1ZA_3ANT, LBEE5XV1ZA_2ANT

Model Difference: Please refer to the tables on page 5 for further details.

Report Number: ER/2020/90108

FCC ID: VPYLBEE5XV1XA

IC: 772C-LBEE5XV1XA

FCC Rule Part: §15.247, Cat: DTS

IC RSS: RSS-247 issue 2 Feb 2017

Issue Date: Jan. 07, 2021

Date of Test: Sep. 22, 2020 ~ Oct. 29, 2020

Date of EUT Received: Sep. 22, 2020

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Approved By: _____



Jim Chang / Manager



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Revision History

Report Number	Revision	Description	Issue Date	Remark
ER/2020/90108	Rev.00	Original.	Jan. 07, 2021	Revised By: Violetta Tang

Note:

- 1、Multiple Model numbers or Trademarks
The variant model numbers are assessed as identical in hardware and software to each other, hence all variants are fully covered by the test results in this test report without further verification test.
- 2、Disclaimer
Variant information among model numbers is provided by the applicant, test results of this report are applicable to the sample EUT received.
- 3、Disclaimer
Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.

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1 GENERAL INFORMATION

1.1 Product description

Product Name:	Communication Module
Brand Name:	muRata
FCC Model No.:	LBEE5XV1XA, LBEE5XV2BA, LBEE5XV1ZA
IC Model No.:	LBEE5XV1XA_3ANT, LBEE5XV1XA_2ANT, LBEE5XV2BA_3ANT, LBEE5XV2BA_2ANT, LBEE5XV1ZA_3ANT, LBEE5XV1ZA_2ANT
Model Difference:	Please refer to the tables on page 5 for further details.
Hardware Version:	1.0
Software Version:	CYW4359D0_004.001.016.0200.0000_Generic_UART_37_4MHz_wlbga_BU_dLNA_test_build_20200910.hcd CYW4359D0_004.001.016.0200.0000_Generic_UART_37_4MHz_wlbga_BU_sLNA_test_build_20200909.hcd
EUT Series No.:	63_3A (Conducted) / 50 (Radiated)
Power Supply:	3.3Vdc

Wi-Fi 802.11	Frequency Range	Channels	Rated Power (dBm)	Modulation Technology
b	2412-2462	11	22.23	DSSS
g			25.68	OFDM
n_HT20			28.30 (MIMO)	
Modulation type:	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM			
Transission Rate:	802.11 b: 1/2/5.5/11 Mbps 802.11 g: 6/9/12/18/24/36/48/54 Mbps 802.11 n_20MHz: 6.5 – 144.4Mbps			

1.2 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)	Worst Antenna Gain
Dipole	Molex	146153	2402-2480	3.2	
	Molex	146187	2402-2480	3.4	V

Note: Pre-scanned was done on the above 2 antennas, the 146187 results higher emission at 2.4GHz. Therefore, the completed set of measurement was done on the antenna to be presented on this test report.

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Product Diversity Description Table
Difference for module

Number	Main model 1	2	5	6	9	10
Model Name	LBEE5XV1XA_3 ANT	LBEE5XV1XA_2 ANT	LBEE5XV2BA_3 ANT	LBEE5XV2BA_2 ANT	LBEE5XV1ZA_3 ANT	LBEE5XV1ZA_2 ANT
IC P/N	CYW54591	CYW54591	CYW54590	CYW54590	CYW88459	CYW88459
WiFi I/F	PCIe	PCIe	PCIe	PCIe	PCIe	PCIe
Antenna type/Gain	Dipole type	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT
Circuit Diagram	1XA	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT
Module PCB layout	1XA	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT
Internal Component	1XA	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT
Appearance Print	1XA	Same as 1XA_3ANT	Difference 1XA ->2BA	Difference 1XA ->2BA	Difference 1XA ->1ZA	Difference 1XA ->1ZA
Function/ Capability	1XA	Same as 1XA_3ANT	RSDB is de-sabled from 1XA_3ANT	RSDB is de-sabled from 1XA_3ANT	Same as 1XA_3ANT	Same as 1XA_3ANT
Other						

Difference for WLAN IC

Number	CYW54591	CYW54590	CYW88459
IC Size	5.155x7.698	Same as CYW54591	Same as CYW54591
Ball Number	194	Same as CYW54591	Same as CYW54591
Circuit Diagram	CYW54591	Same as CYW54591	Same as CYW54591
RF performance	CYW54591	Same as CYW54591	Same as CYW54591
Appearance	CYW54591	Difference ->Marking : CYW54590	Difference ->Marking : CYW88459
Function/Capability	CYW54591	RSDB doesn't support by Software	Same as CYW54591
Other	Consumer Grade	Same as CYW54591	Industrial Grade*

*IC vendor just want to control P/N for Consumer and Industrial. But IF fo Hardware/Software from point of view it is same.

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
FCC KDB 558074 D01 15.247 Meas Guidance v05r02
FCC KDB 662911 D01 Multiple Transmitter Output v02r01
RSS-247 issue 2 Feb. 2017
RSS-Gen. issue 5, Amendment 1, March 2019
ANSI C63.10:2013

1.4 Test Facility

SGS Taiwan Ltd. Central RF Lab (TAF code 3702)
No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803
FCC Designation number: TW0027
ISED CAB identifier: TW3702

1.5 Special Accessories

There are no special accessories used while test was conducted.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*9m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission

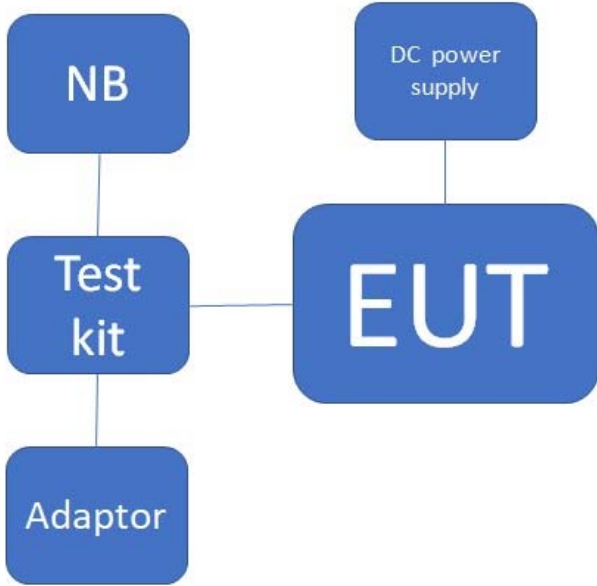


Fig. 2-2 Conducted Emission (AC Power Line)

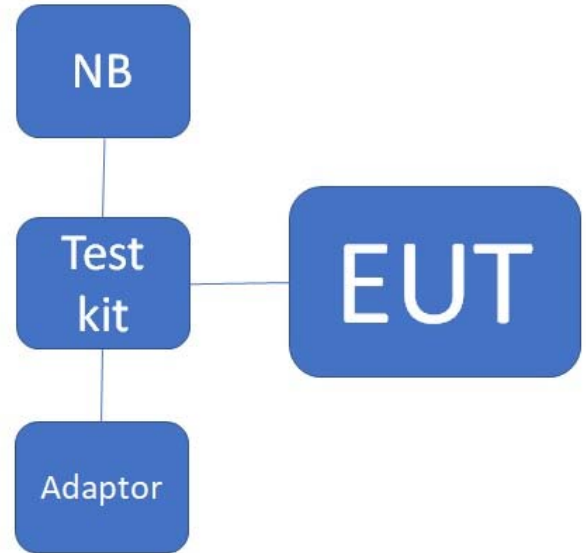


Fig. 2-2 Conducted (Antenna Port)

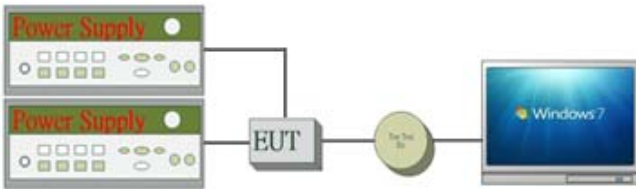


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1	WLAN Test Software	N/A	N/A	N/A	N/A	N/A
2	Notebook	Lenovo	X240	PF-00UH6D	N/A	N/A
3	Notebook	Lenovo	T440P	PB-02Y6RK	N/A	N/A
4	DC Power Supply	Agilent	E3640A	MY40000811	N/A	N/A
5	DC Power Supply	Agilent	E3640A	MY52410006	N/A	N/A
6	Test Kit	N/A	N/A	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	IC Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	RSS-247 §5.4 d	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.2 a RSS-Gen §6.7	6dB & 99% Emission Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5 RSS-Gen §8.10	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5 RSS-Gen §8.9 RSS-Gen §8.10 RSS-Gen §6.13	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	RSS-247 §5.2 b	Power Spectral Density	Compliant
§15.203 §15.247(b)	N/A	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

11 channels are provided for 802.11b/g/n 20M.

CHANNEL	FREQUENCY (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case.

The given UE is pre-scanned among below modes.

Modulation	Transmission Chain				Single Transmission Spatial	Multiple Transmission Spatial
<input checked="" type="checkbox"/> 802.11 b	<input checked="" type="checkbox"/> Ch0	<input checked="" type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> 2TX
<input checked="" type="checkbox"/> 802.11 g	<input checked="" type="checkbox"/> Ch0	<input checked="" type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> 2TX
<input checked="" type="checkbox"/> 802.11 n	<input checked="" type="checkbox"/> Ch0	<input checked="" type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input type="checkbox"/> SISO	<input checked="" type="checkbox"/> MIMO

4. Therefore, below summary is the modes of test configuration that yield the highest reading and generate the highest emission chosen to carry out the relevantly mandatory test items.

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4.3 Radiated Emission Test:

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
RADIATED EMISSION TEST (BELOW 1 GHz)					
802.11g	1 to 11	6	OFDM	6	Ch1
802.11n 20M	1 to 11	1, 6, 11	OFDM	MCS 8	MIMO
RADIATED EMISSION TEST (ABOVE 1 GHz)					
802.11b	1 to 11	1,2,3,6,9,10,11	DSSS	1	Ch1
802.11b	1 to 11	1,2,3,4,5,6,7,8,9,10,11	OFDM	6	Ch1
802.11n 20M	1 to 11	1,2,3,4,5,6,7,8,9,10,11	OFDM	MCS 8	MIMO
Note: The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for 802.11b/g/n WLAN Transmitter for channel Low, Mid and High, the worst case E1 position was reported.					

4.4 Antenna Port Conducted Measurement:

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11b	1 to 11	1,2,3,6,9,10,11	DSSS	1	Ch1
802.11b	1 to 11	1,2,3,4,5,6,7,8,9,10,11	OFDM	6	Ch1
802.11n 20M	1 to 11	1,2,3,4,5,6,7,8,9,10,11	OFDM	MCS 8	MIMO

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
6dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Peak Power Density	+/- 1.3 dB
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission Measurement Uncertainty	
Polarization: Vertical	9kHz~30MHz: +2.3dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB
Polarization: Horizontal	9kHz~30MHz: +2.3dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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6 CONDUCTED EMISSION TEST

6.1 Standard Applicable

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- The lower limit shall apply at the transition frequencies
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
PXA Spectrum Analyzer	Agilent	N9030A	MY53120760	04/21/2020	04/20/2021
EMI Test Receiver	R&S	ESCI 7	100759	07/13/2020	07/12/2021
LISN	SCHWARZBECK	NSLK 8127	8127-465	04/09/2020	04/08/2021
Coaxial Cables	N/A	Coaxial Cable	161207	12/07/2019	12/06/2020
Test Software	audix	e3	Ver. 6.11-20180413	N.C.R	N.C.R

NOTE: N.C.R refers to Not Calibrated Required.

6.3 EUT Setup

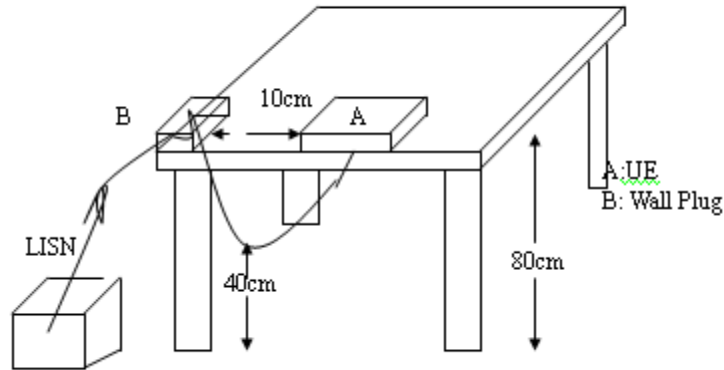
- The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
- The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
- The LISN was connected with 120Vac/60Hz power source.

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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

6.6 Measurement Result

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit.

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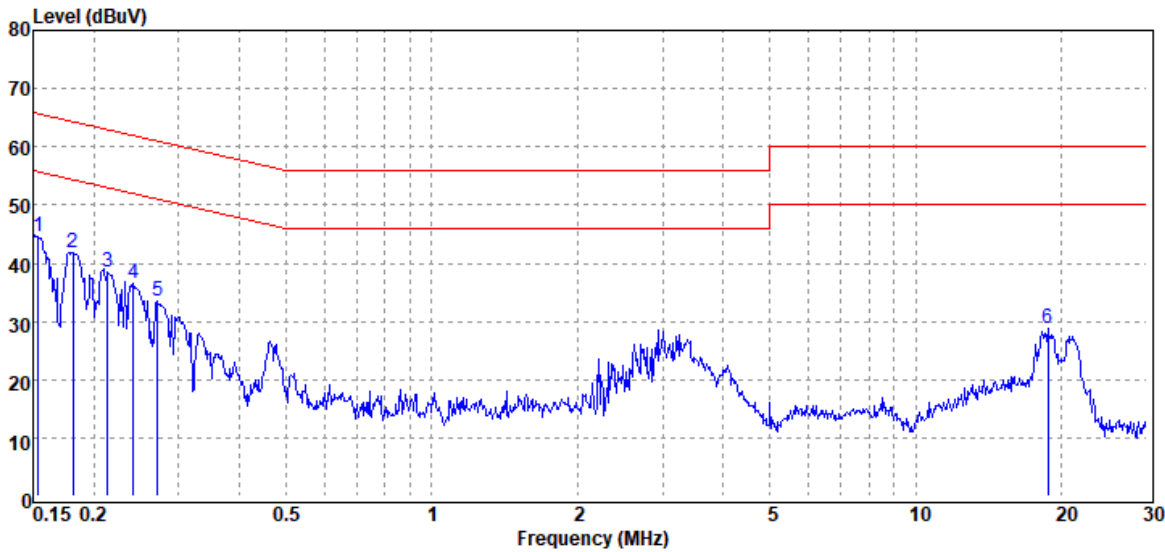
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number :ER-2020-90108
 Test Mode :WLAN 2.4G
 Power :AC 120V/60Hz
 Probe :L
 Note :

Test Site :Conduction 6F
 Test Date :2020-10-28
 Temp./Humi. :24.0/57
 Engineer :Neo



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.15	Peak	42.42	2.14	44.56	65.78	-21.22
0.18	Peak	39.55	2.14	41.69	64.42	-22.73
0.21	Peak	36.22	2.14	38.36	63.05	-24.69
0.24	Peak	34.34	2.14	36.48	62.04	-25.56
0.27	Peak	31.28	2.14	33.42	61.07	-27.65
18.72	Peak	25.71	3.06	28.77	60.00	-31.23

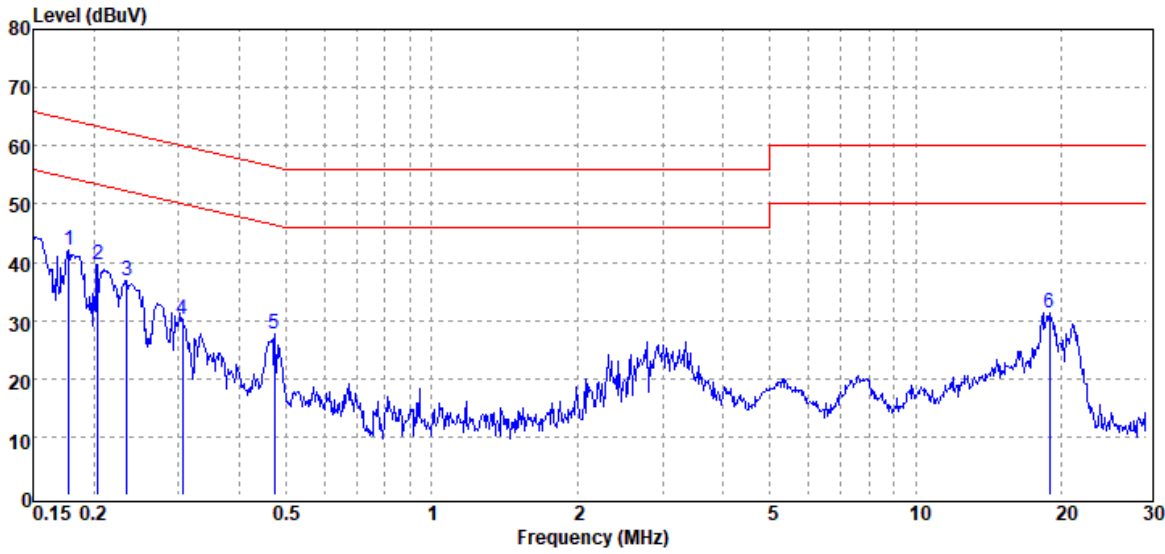
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Report Number :ER-2020-90108
 Test Mode :WLAN 2.4G
 Power :AC 120V/60Hz
 Probe :N
 Note: :

Test Site :Conduction 6F
 Test Date :2020-10-28
 Temp./Humi. :24.0/57
 Engineer :Neo



Freq. MHz	Detector Mode	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V	Limit dB μ V	Margin dB
0.18	Peak	39.74	2.21	41.95	64.59	-22.64
0.20	Peak	37.40	2.21	39.61	63.45	-23.84
0.23	Peak	34.70	2.21	36.91	62.30	-25.39
0.31	Peak	27.99	2.21	30.20	60.10	-29.90
0.47	Peak	25.35	2.22	27.57	56.45	-28.88
18.92	Peak	28.24	3.04	31.28	60.00	-28.72

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7 DUTY CYCLE OF TEST SIGNAL

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle. All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

7.1 Measurement Procedure:

1. Set span = Zero
2. RBW = 8MHz
3. VBW = 8MHz,
4. Detector = Peak

7.2 Duty Cycle:

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
802.11b	98.90	0.00	0.00	0.01
802.11g	93.33	0.30	0.70	1.00
802.11n_20	92.91	0.32	0.75	1.00

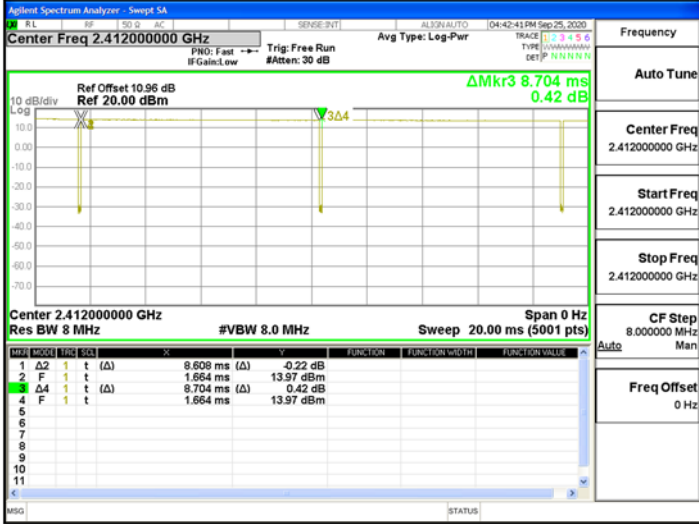
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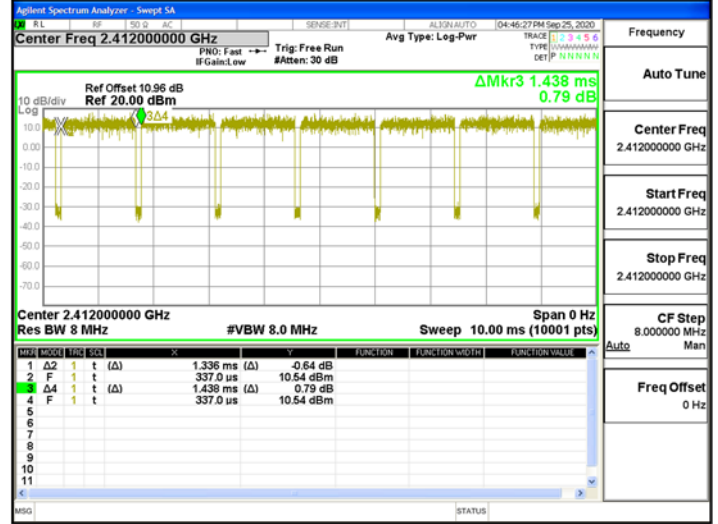
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7.3 Duty Cycle test plots

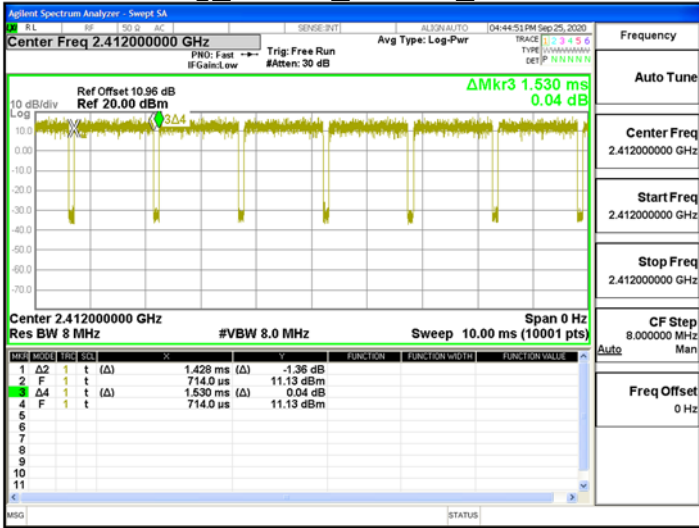
802.11b_20MHz_Chain1_2412MHz



802.11n_20MHz_Chain0_2412MHz



802.11g_20MHz_Chain1_2412MHz



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8 PEAK OUTPUT POWER MEASUREMENT

8.1 Standard Applicable

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

Note:

As per section F. 2). e). (ii) of FCC KDB 662911 D01

If antenna gains are not equal and each transmit antenna is driven by only one spatial stream, directional gain may be calculated by either of the following formulas.

$$DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

where

Each antenna is driven by no more than one spatial stream;

NSS = the number of independent spatial streams of data;

NANT = the total number of antennas

$g_{j,k}$ = / 20 10Gk if the kth antenna is being fed by spatial stream j, or zero if it is not;

G_k is the gain in dBi of the kth antenna.

The antenna gain is grater than 6 dBi , therefore the limit needs to be reduced as below:

Frequency (MHz)	Antenna Gain (dBi)	Conducted Power Limit (dBm)
2412~2462	6.41	29.59

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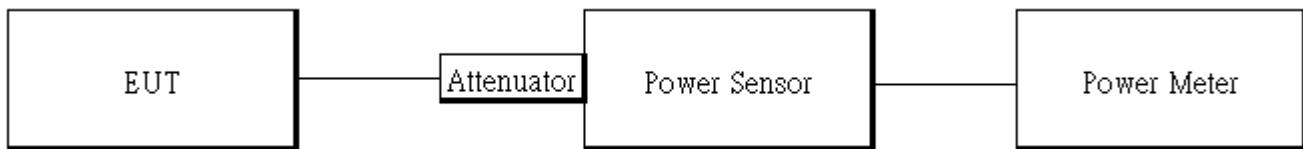
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8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1804001	02/20/2020	02/19/2021
Power Sensor	Anritsu	MA2411B	1726104	02/20/2020	02/19/2021
Power Sensor	Anritsu	MA2411B	1726107	02/20/2020	02/19/2021
DC Power Supply	Agilent	E3640A	MY40000811	12/23/2019	12/22/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/10/2019	12/09/2020
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2020	01/01/2021

8.3 Test Set-up

Power Meter:



8.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

Power Meter:

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Spectrum or Power Meter.

*** Note: The duty cycle factor is compensated to obtain the maximum value of measurement in average.**

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8.5 Measurement Result

Peak & Avg.

802.11b Ch1					
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	1	20.36	30.00	PASS
2	2417	1	20.18	30.00	PASS
3	2422	1	22.17	30.00	PASS
6	2437	1	22.21	30.00	PASS
9	2452	1	22.23	30.00	PASS
10	2457	1	20.75	30.00	PASS
11	2462	1	20.91	30.00	PASS
802.11b Ch1					
CH	Freq. (MHz)	Data Rate	Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
1	2412	1	16.98	30.00	PASS
2	2417	1	17.06	30.00	PASS
3	2422	1	19.21	30.00	PASS
6	2437	1	19.19	30.00	PASS
9	2452	1	19.26	30.00	PASS
10	2457	1	17.30	30.00	PASS
11	2462	1	17.85	30.00	PASS

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802.11g Ch1					
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	6	24.53	30.00	PASS
2	2417	6	25.51	30.00	PASS
3	2422	6	25.38	30.00	PASS
4	2427	6	25.43	30.00	PASS
5	2432	6	25.65	30.00	PASS
6	2437	6	25.53	30.00	PASS
7	2442	6	25.68	30.00	PASS
8	2447	6	25.57	30.00	PASS
9	2452	6	25.42	30.00	PASS
10	2457	6	25.43	30.00	PASS
11	2462	6	25.18	30.00	PASS
802.11g Ch1					
CH	Freq. (MHz)	Data Rate	Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
1	2412	6	14.68	30.00	PASS
2	2417	6	16.31	30.00	PASS
3	2422	6	16.34	30.00	PASS
4	2427	6	16.81	30.00	PASS
5	2432	6	16.99	30.00	PASS
6	2437	6	17.63	30.00	PASS
7	2442	6	18.73	30.00	PASS
8	2447	6	17.76	30.00	PASS
9	2452	6	17.19	30.00	PASS
10	2457	6	16.28	30.00	PASS
11	2462	6	14.92	30.00	PASS

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802.11n_HT20M MIMO							
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)		Total Peak Output Power (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1			
1	2412	MCS8	20.91	21.12	24.03	29.59	PASS
2	2417	MCS8	23.43	24.13	26.80	29.59	PASS
3	2422	MCS8	24.09	24.21	27.16	29.59	PASS
4	2427	MCS8	25.01	25.09	28.06	29.59	PASS
5	2432	MCS8	24.78	25.18	27.99	29.59	PASS
6	2437	MCS8	24.87	25.26	28.08	29.59	PASS
7	2442	MCS8	25.13	25.44	28.30	29.59	PASS
8	2447	MCS8	24.46	24.95	27.72	29.59	PASS
9	2452	MCS8	24.10	24.72	27.43	29.59	PASS
10	2457	MCS8	22.82	22.94	25.89	29.59	PASS
11	2462	MCS8	21.98	23.11	25.59	29.59	PASS
802.11n_HT20M MIMO							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)		Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1			
1	2412	MCS8	10.03	10.18	13.44	29.59	PASS
2	2417	MCS8	12.95	13.09	16.35	29.59	PASS
3	2422	MCS8	13.27	13.57	16.75	29.59	PASS
4	2427	MCS8	14.95	15.25	18.43	29.59	PASS
5	2432	MCS8	15.08	15.22	18.48	29.59	PASS
6	2437	MCS8	15.83	16.03	19.26	29.59	PASS
7	2442	MCS8	15.93	16.05	19.32	29.59	PASS
8	2447	MCS8	14.68	14.90	18.12	29.59	PASS
9	2452	MCS8	13.86	13.92	17.22	29.59	PASS
10	2457	MCS8	12.13	12.78	15.80	29.59	PASS
11	2462	MCS8	11.71	12.04	15.21	29.59	PASS

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EIRP

802.11b Ch1							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	1	16.98	3.40	20.38	36	PASS
2	2417	1	17.06	3.40	20.46	36	PASS
3	2422	1	19.21	3.40	22.61	36	PASS
6	2437	1	19.19	3.40	22.59	36	PASS
9	2452	1	19.26	3.40	22.66	36	PASS
10	2457	1	17.30	3.40	20.70	36	PASS
11	2462	1	17.85	3.40	21.25	36	PASS

802.11g Ch1							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	6	14.68	3.40	18.08	36	PASS
2	2417	6	16.31	3.40	19.71	36	PASS
3	2422	6	16.34	3.40	19.74	36	PASS
4	2427	6	16.81	3.40	20.21	36	PASS
5	2432	6	16.99	3.40	20.39	36	PASS
6	2437	6	17.63	3.40	21.03	36	PASS
7	2442	6	18.73	3.40	22.13	36	PASS
8	2447	6	17.76	3.40	21.16	36	PASS
9	2452	6	17.19	3.40	20.59	36	PASS
10	2457	6	16.28	3.40	19.68	36	PASS
11	2462	6	14.92	3.40	18.32	36	PASS

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802.11n_HT20M MIMO									
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)		Total Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1					
1	2412	MCS8	10.03	10.18	13.44	6.41	19.85	36	PASS
2	2417	MCS8	12.95	13.09	16.35	6.41	22.76	36	PASS
3	2422	MCS8	13.27	13.57	16.75	6.41	23.16	36	PASS
4	2427	MCS8	14.95	15.25	18.43	6.41	24.84	36	PASS
5	2432	MCS8	15.08	15.22	18.48	6.41	24.89	36	PASS
6	2437	MCS8	15.83	16.03	19.26	6.41	25.67	36	PASS
7	2442	MCS8	15.93	16.05	19.32	6.41	25.73	36	PASS
8	2447	MCS8	14.68	14.90	18.12	6.41	24.53	36	PASS
9	2452	MCS8	13.86	13.92	17.22	6.41	23.63	36	PASS
10	2457	MCS8	12.13	12.78	15.80	6.41	22.21	36	PASS
11	2462	MCS8	11.71	12.04	15.21	6.41	21.62	36	PASS

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9 6DB & 99% BANDWIDTH MEASUREMENT

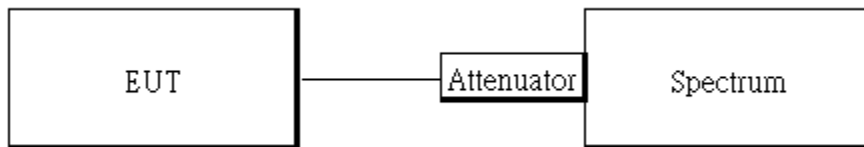
9.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz.

9.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/06/2020	05/05/2021
DC Power Supply	Agilent	E3640A	MY40000811	12/23/2019	12/22/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/10/2019	12/09/2020
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2020	01/01/2021
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2020	01/01/2021

9.3 Test Set-up



9.4 Measurement Procedure

- Place the EUT on the table and set it in transmitting mode.
- The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
- Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- Set the spectrum analyzer as
RBW= 1 % to 5% of OBW ,
VBW = 3 X RBW,
Span= 2 to 5 times of the OBW,
Sweep=auto,
Detector = Peak, and Max hold for 20dB Bandwidth test.
- Mark the peak frequency and -20dB (upper and lower) frequency
- Set the spectrum analyzer as
RBW= 1 % to 5% of 99% Bandwidth ,
VBW ≥ 3 X RBW,
Span= large enough to capture all products of the modulation process,
Sweep=auto,
Detector = Peak, and Max hold for 99% Bandwidth test.
- Turn on the 99% bandwidth function, max reading.
- Repeat above procedures until all test default channel is completed

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9.5 6dB Bandwidth

802.11b Ch1

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	7088.00	> 500	PASS
2437	7099.00	> 500	PASS
2462	7088.00	> 500	PASS

802.11g Ch1

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	16090.00	> 500	PASS
2437	16310.00	> 500	PASS
2462	16310.00	> 500	PASS

802.11_n_HT20 Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	17330.00	> 500	PASS
2437	17570.00	> 500	PASS
2462	17330.00	> 500	PASS

802.11_n_HT20 Ch1

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	17580.00	> 500	PASS
2437	17580.00	> 500	PASS
2462	17580.00	> 500	PASS

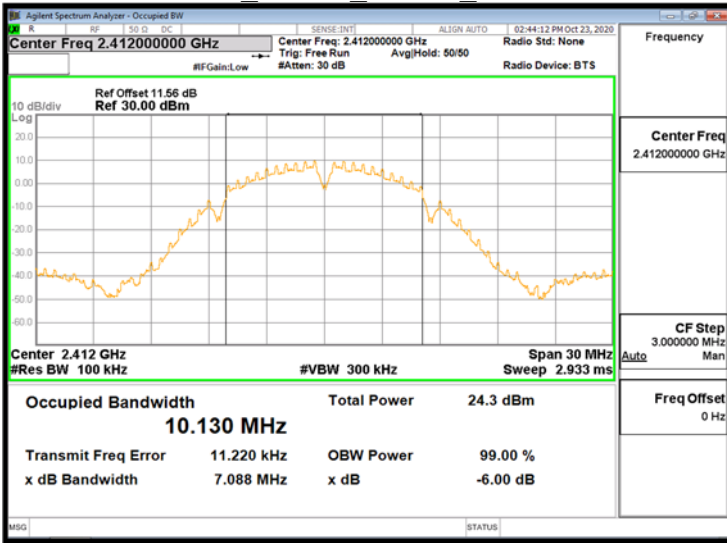
**Refer to next page for plots*

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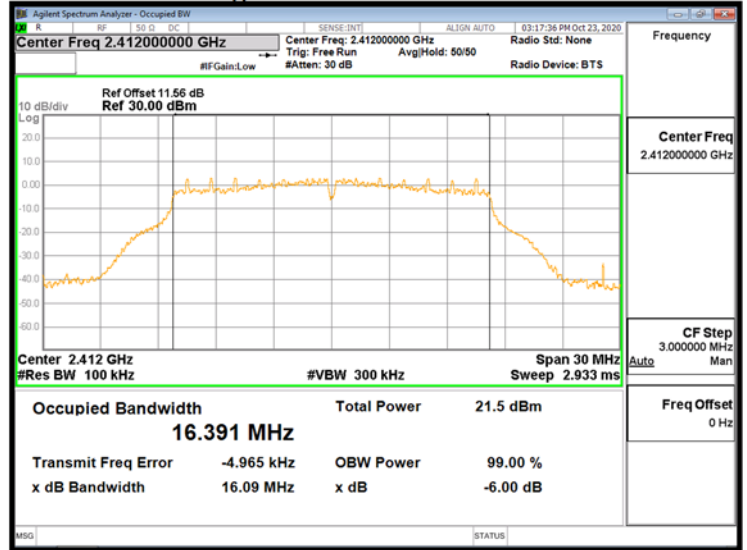
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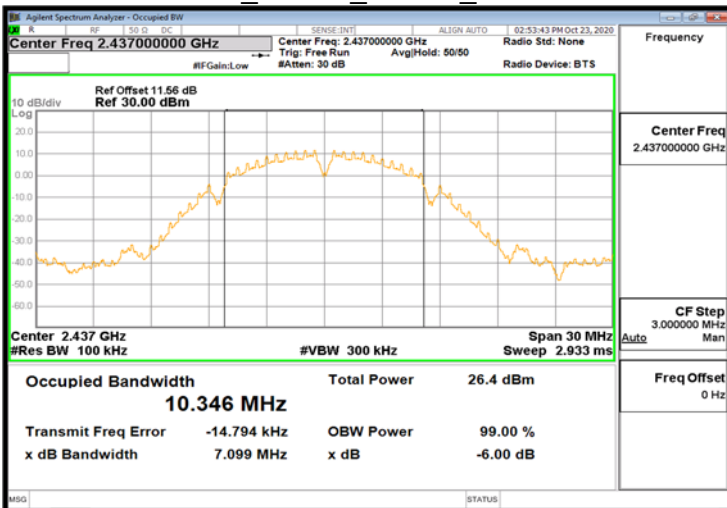
802.11b_20MHz_Chain1_2412MHz



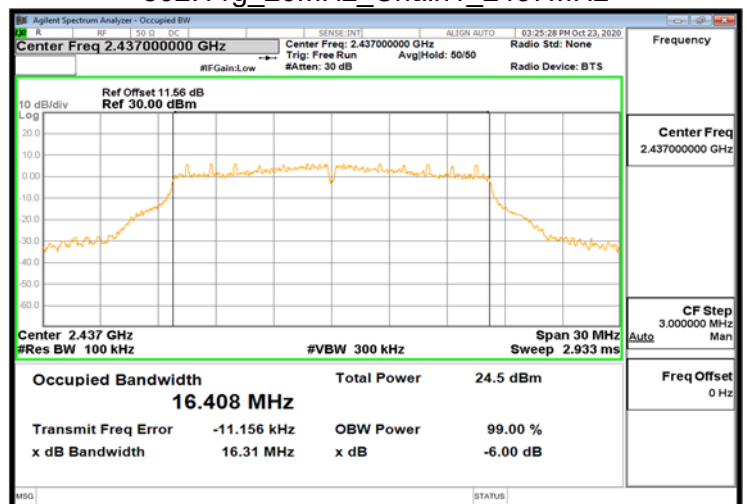
802.11g_20MHz_Chain1_2412MHz



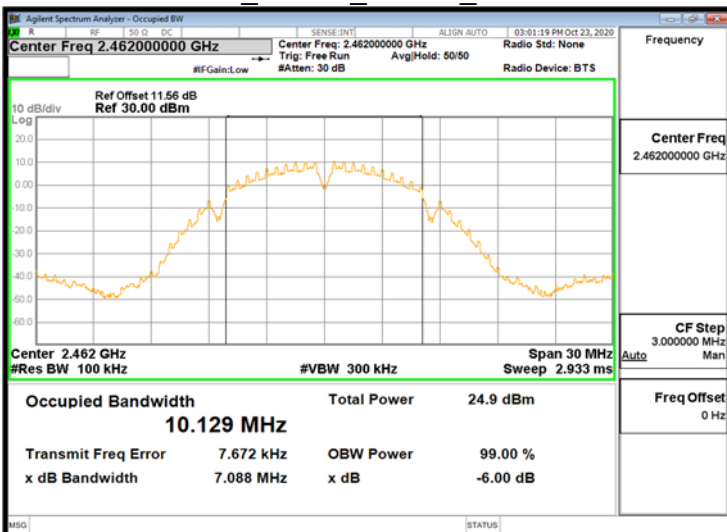
802.11b_20MHz_Chain1_2437MHz



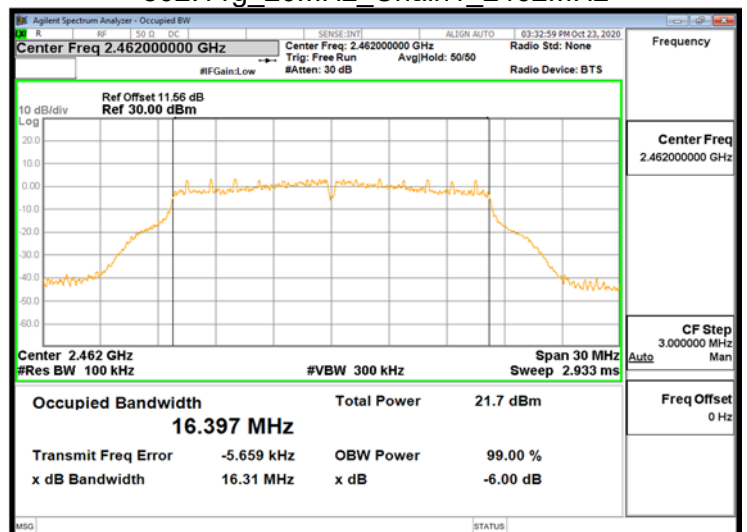
802.11g_20MHz_Chain1_2437MHz



802.11b_20MHz_Chain1_2462MHz



802.11g_20MHz_Chain1_2462MHz

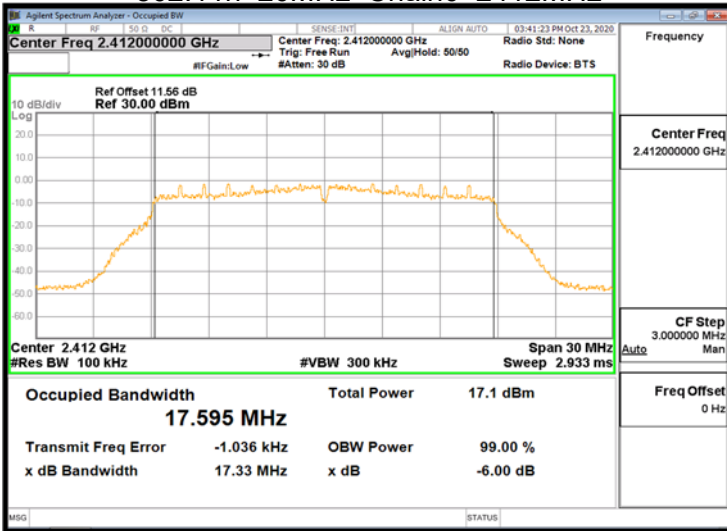


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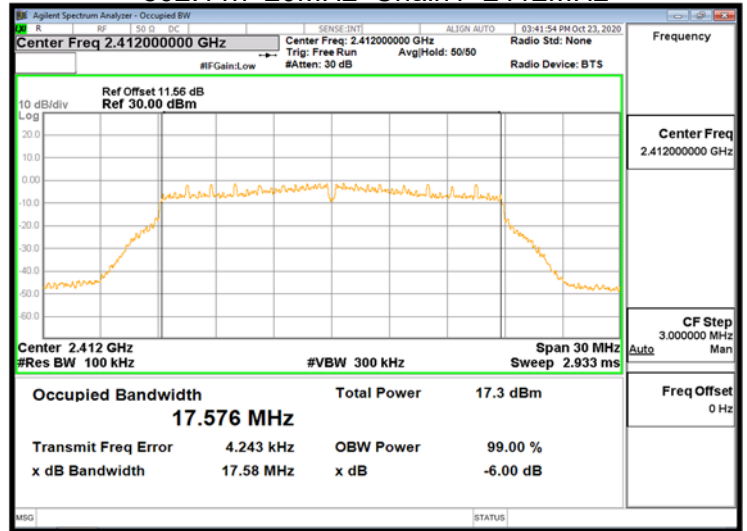
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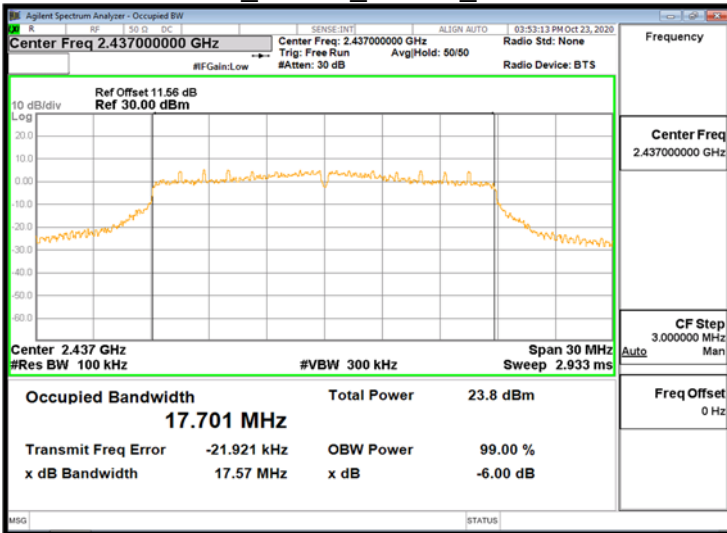
802.11n 20MHz Chain0 2412MHz



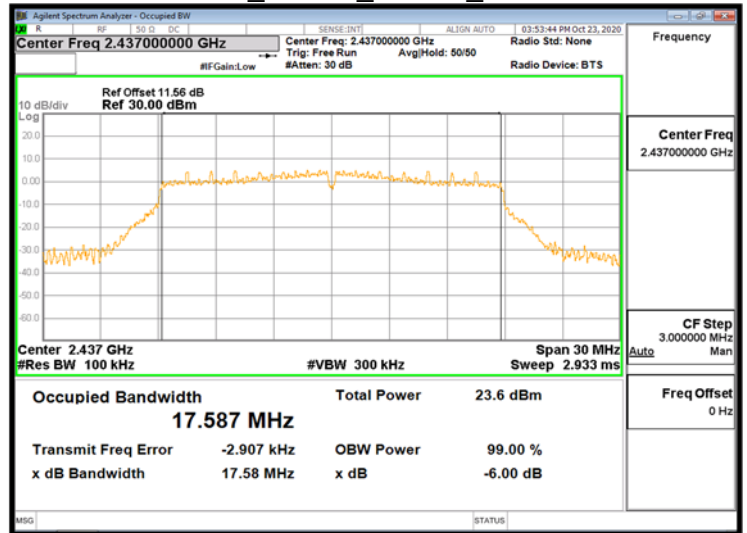
802.11n 20MHz Chain1 2412MHz



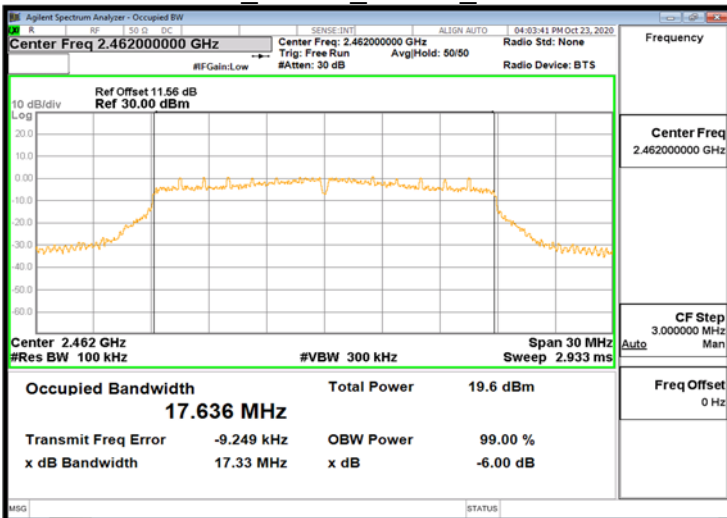
802.11n_20MHz_Chain0_2437MHz



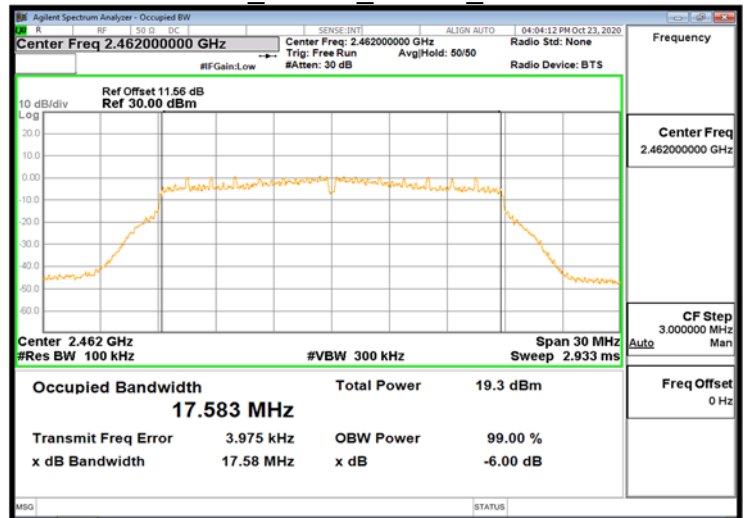
802.11n_20MHz_Chain1_2437MHz



802.11n_20MHz_Chain0_2462MHz



802.11n_20MHz_Chain1_2462MHz



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9.6 99% Bandwidth

802.11b Ch1	
Freq. (MHz)	99% BW (MHz)
2412	10.276
2437	10.575
2462	10.282

802.11g Ch1	
Freq. (MHz)	99% BW (MHz)
2412	16.823
2437	16.856
2462	16.847

802.11n_HT20M Ch0	
Freq. (MHz)	99% BW (MHz)
2412	17.914
2437	18.06
2462	17.972

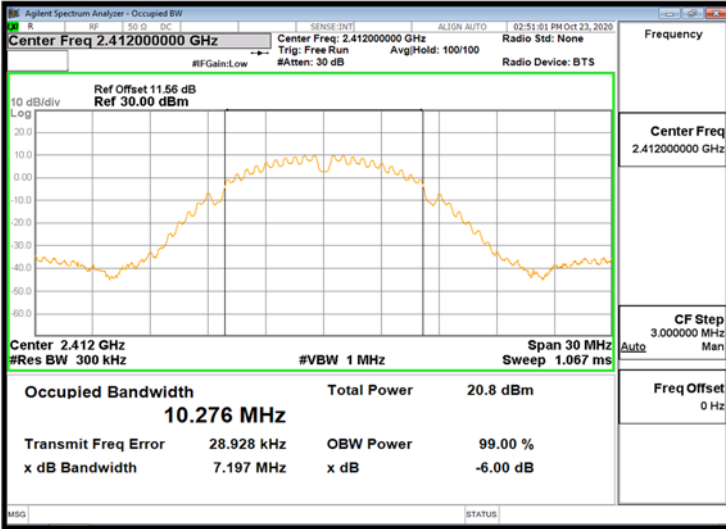
802.11n_HT20M Ch1	
Freq. (MHz)	99% BW (MHz)
2412	17.729
2437	17.751
2462	17.706

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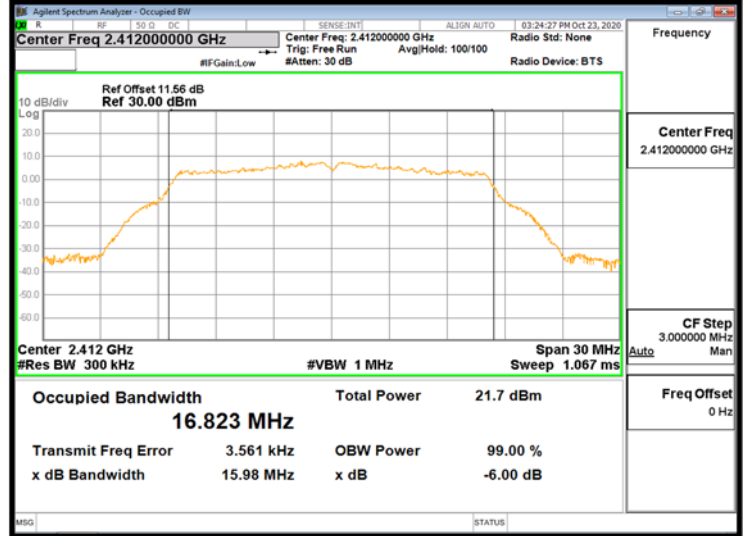
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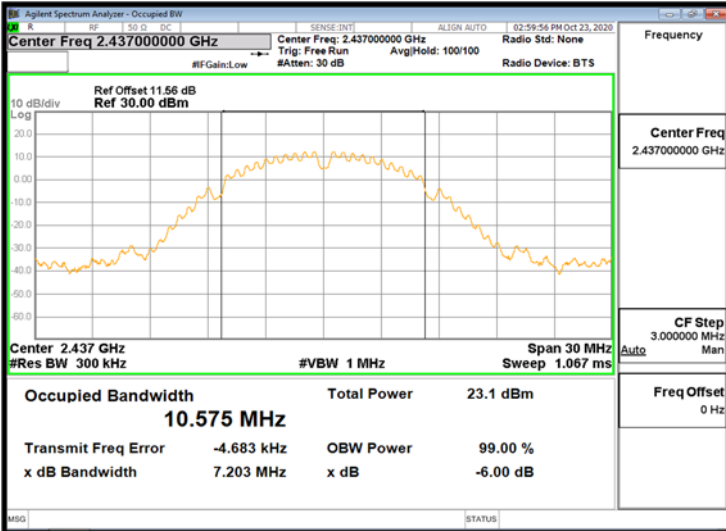
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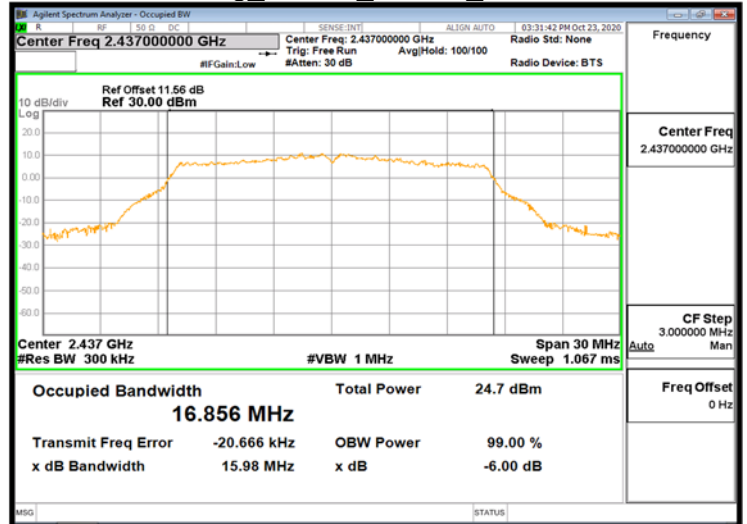
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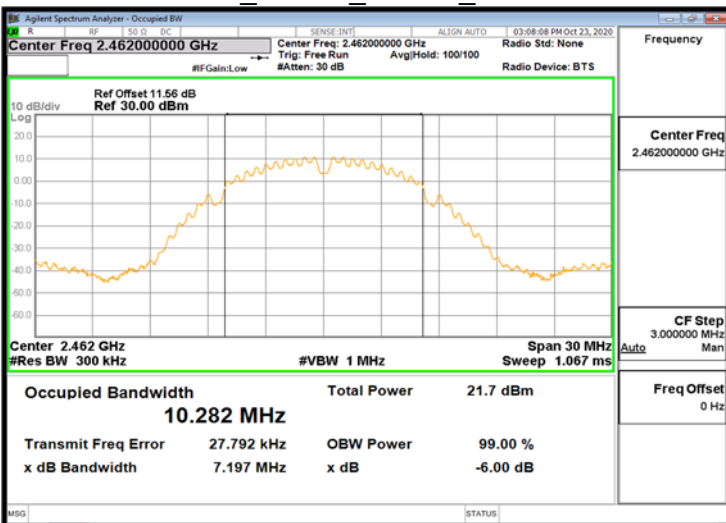
802.11b_20MHz_Chain1_2437MHz



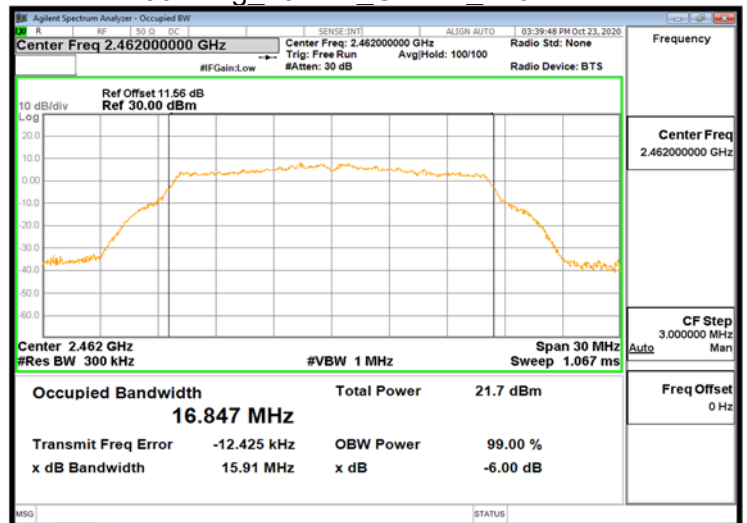
802.11g_20MHz_Chain1_2437MHz



802.11b_20MHz_Chain1_2462MHz



802.11g_20MHz_Chain1_2462MHz

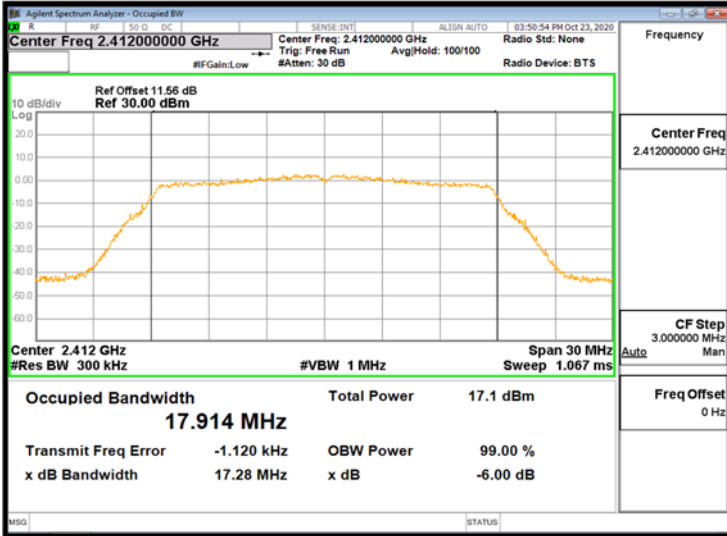


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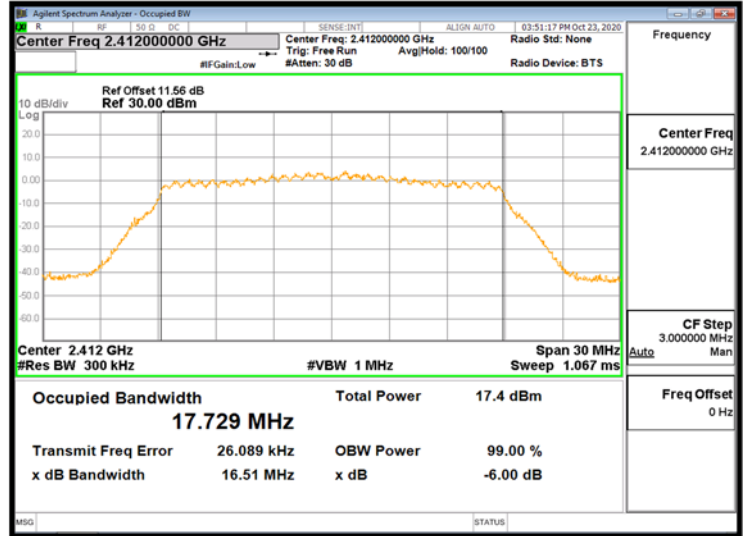
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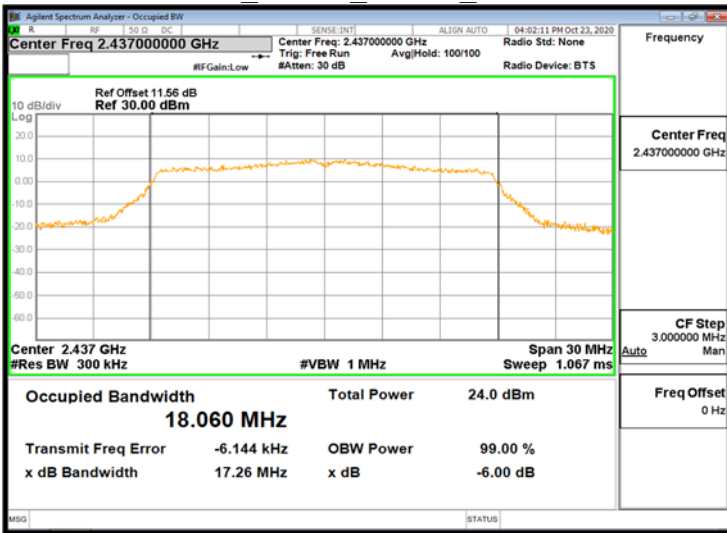
802.11n 20MHz Chain0 2412MHz



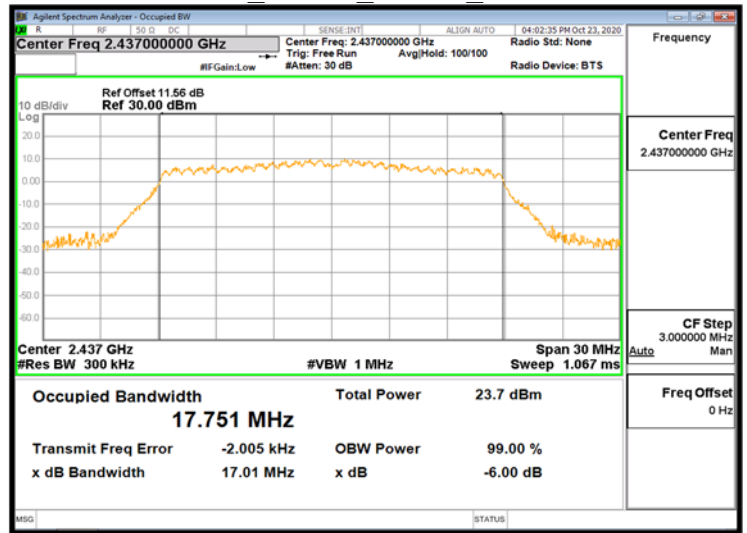
802.11n 20MHz Chain1 2412MHz



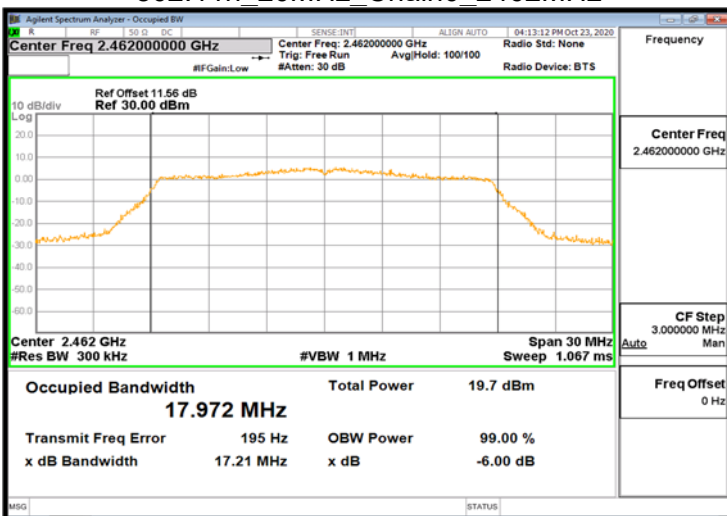
802.11n_20MHz_Chain0_2437MHz



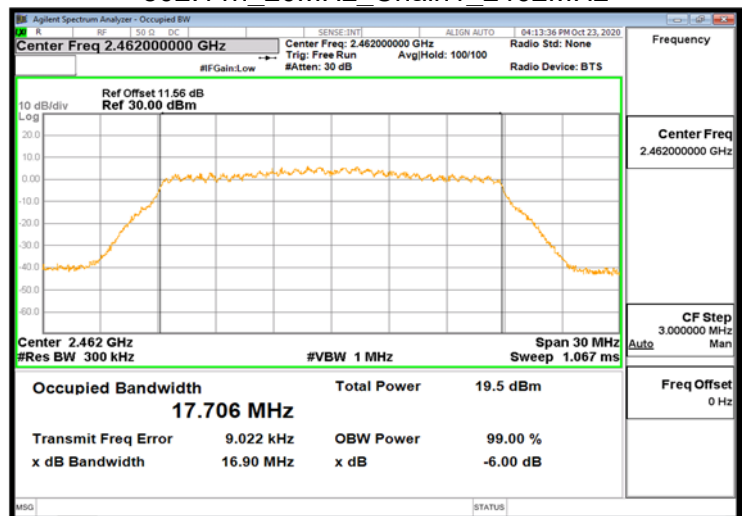
802.11n_20MHz_Chain1_2437MHz



802.11n_20MHz_Chain0_2462MHz



802.11n_20MHz_Chain1_2462MHz



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10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

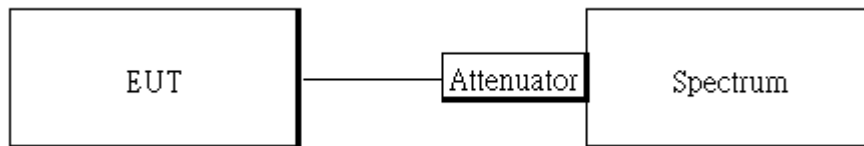
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

10.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	05/06/2020	05/05/2021
DC Power Supply	Agilent	E3640A	MY40000811	12/23/2019	12/22/2020
DC Power Supply	Agilent	E3640A	MY52410006	12/10/2019	12/09/2020
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2020	01/01/2021
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2020	01/01/2021

10.3 Test SET-UP



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10.4 Measurement Procedure

Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. MIMO mode: offset is set following “measure and add 10 Log (N)” on spectrum to measure for MIMO mode. Offset = cable loss + 10 log (N), where N is number of transmitting antenna.

Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker 1 – 20dBm
8. Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 kHz immediately outside the authorized (2400~2483.5) be attenuated by 20dB at least relative to the maximum emission of power.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.
10. MIMO mode: offset is set following “measure and add 10 Log (N)” on spectrum to measure for MIMO mode. Offset = cable loss + 10 log (N), where N is number of transmitting antenna.

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Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Set RBW = 100 kHz & VBW= 300 kHz, Detector =Peak, Sweep = Auto.
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.
7. MIMO mode: offset is set following “measure and add 10 Log (N)” on spectrum to measure for MIMO mode. Offset = cable loss + 10 log (N), where N is number of transmitting antenna.

Note:

For test of MIMO mode, the highest emission of worst case employing Measure and add 10 log (N) technical is reported on this report after the comparison between Main Antenna at single transmitting mode and Aux that yields the higher value. The MIMO transmitting mode produces higher value of outcome.

10.5 Measurement Result

Reference Level of Limit 802.11b mode		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	9.68	-10.32
2437	11.93	-8.07
2462	10.39	-9.61

Reference Level of Limit 802.11g mode		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	2.98	-17.02
2437	6.00	-14.00
2462	3.04	-16.96

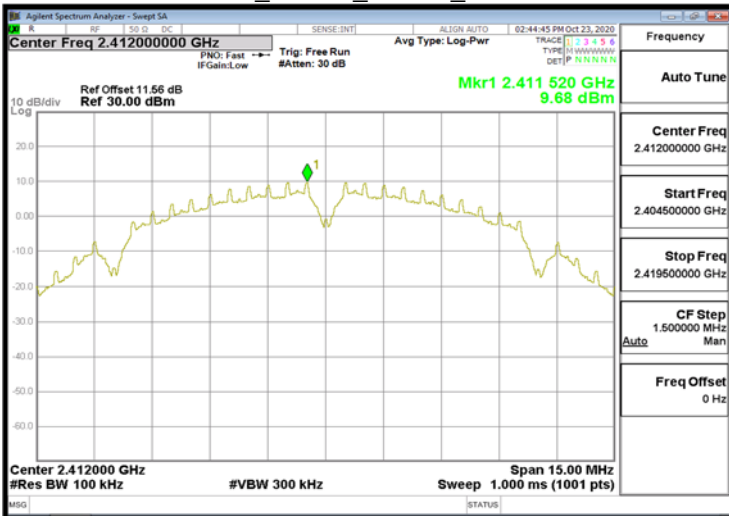
Reference Level of Limit 802.11n20 mode		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	1.51	-18.49
2437	8.05	-11.95
2462	3.55	-16.45

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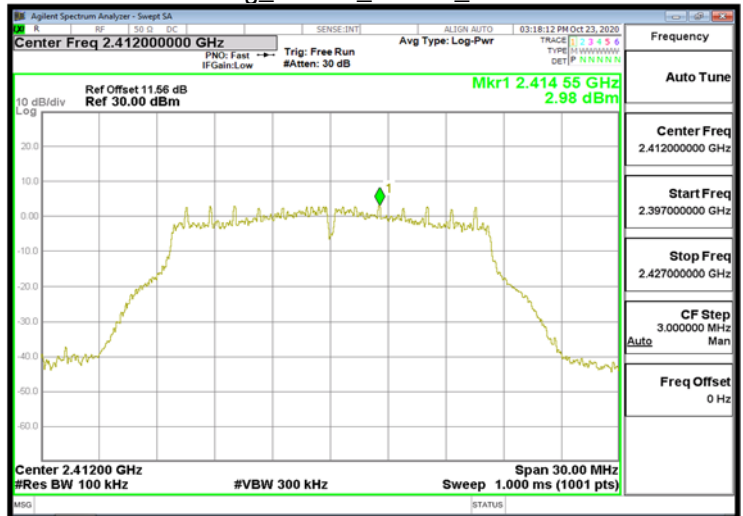
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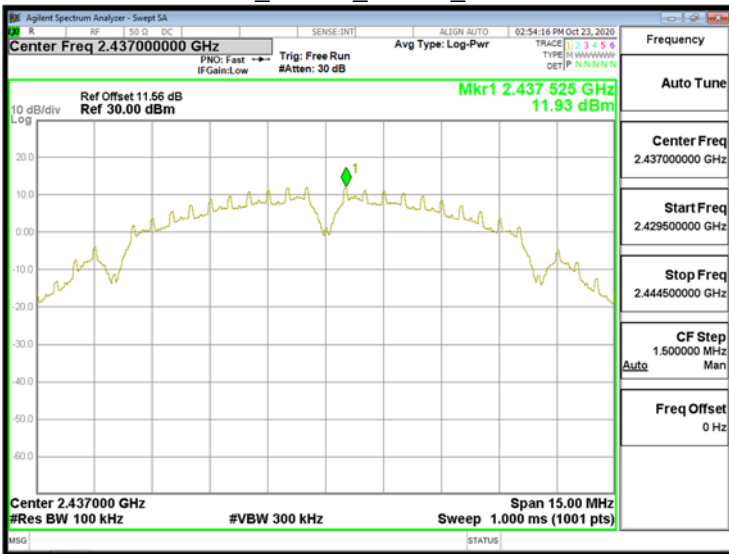
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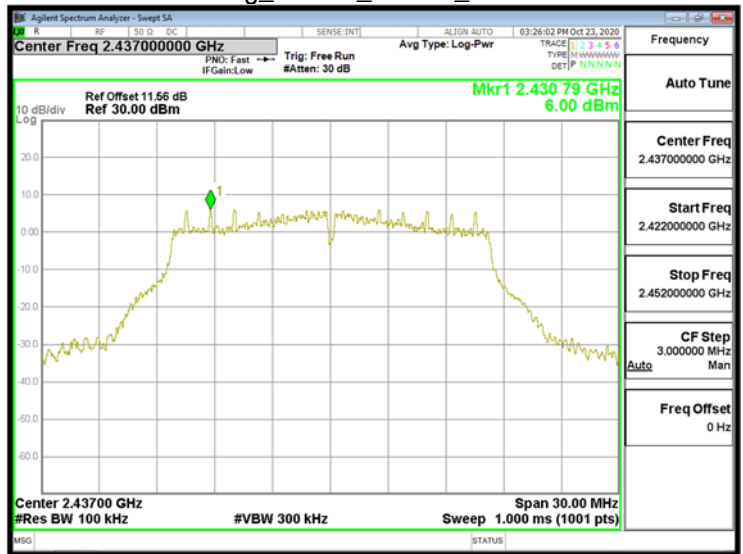
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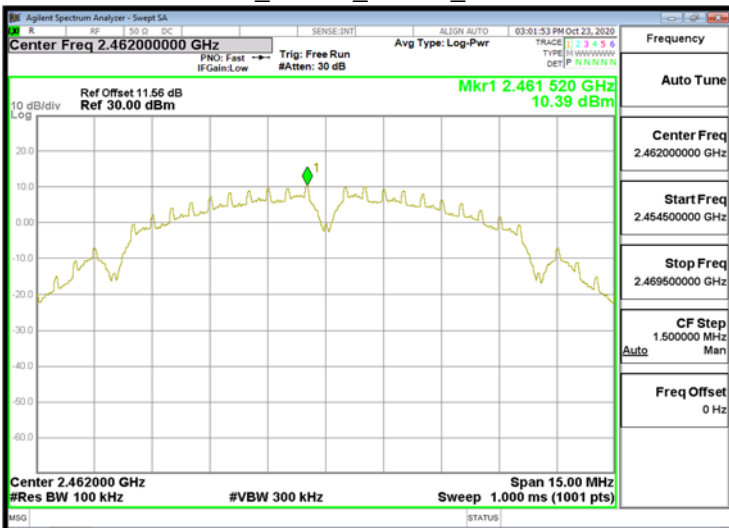
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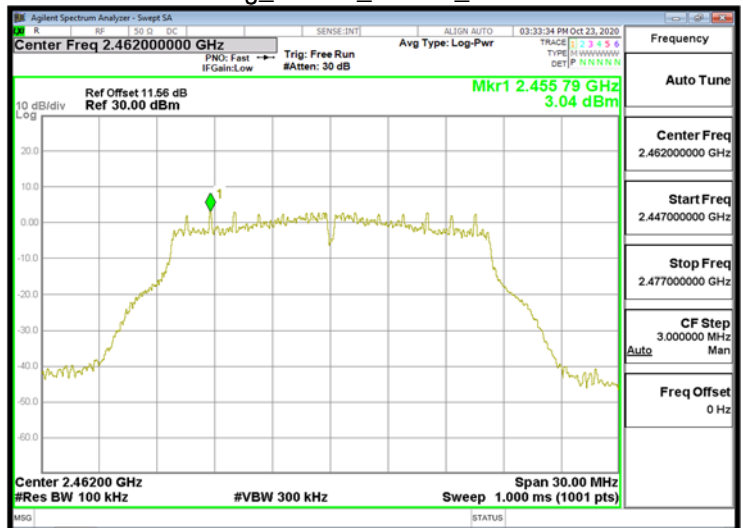
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802.11b_20MHz_Chain1_2462MHz



802.11g_20MHz_Chain1_2462MHz

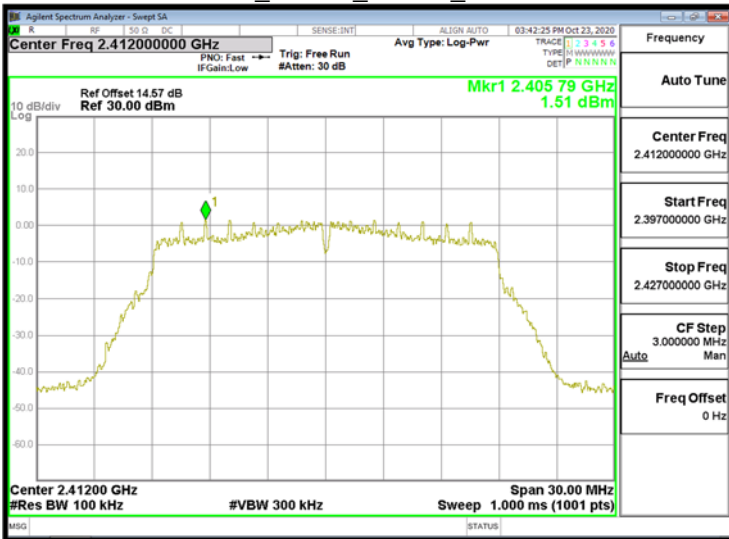


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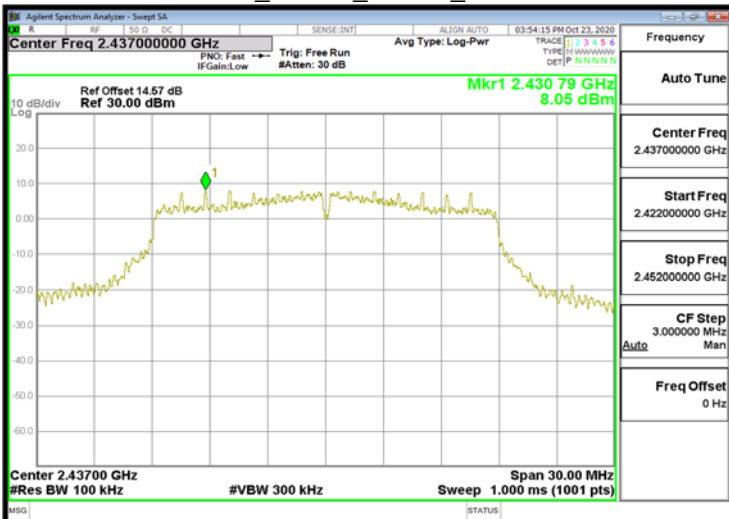
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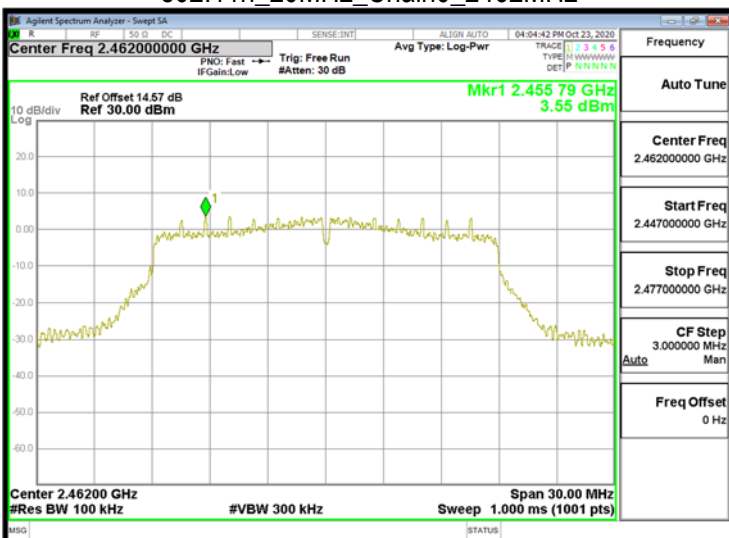
802.11n_20MHz_Chain0_2412MHz



802.11n_20MHz_Chain0_2437MHz



802.11n_20MHz_Chain0_2462MHz

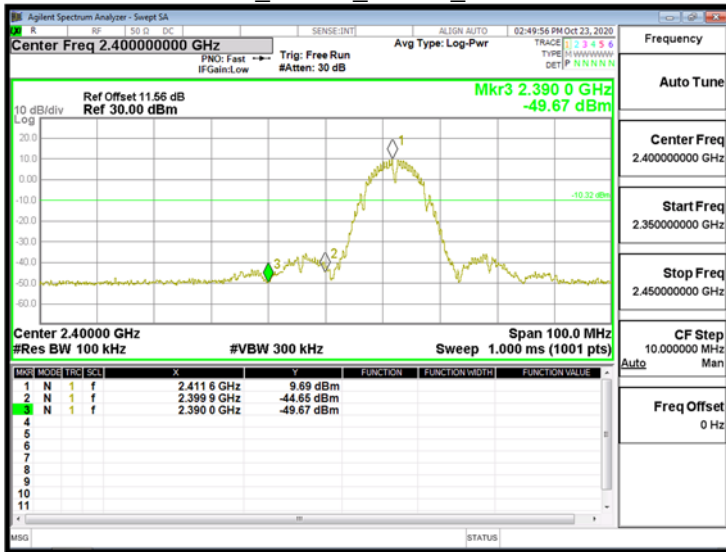


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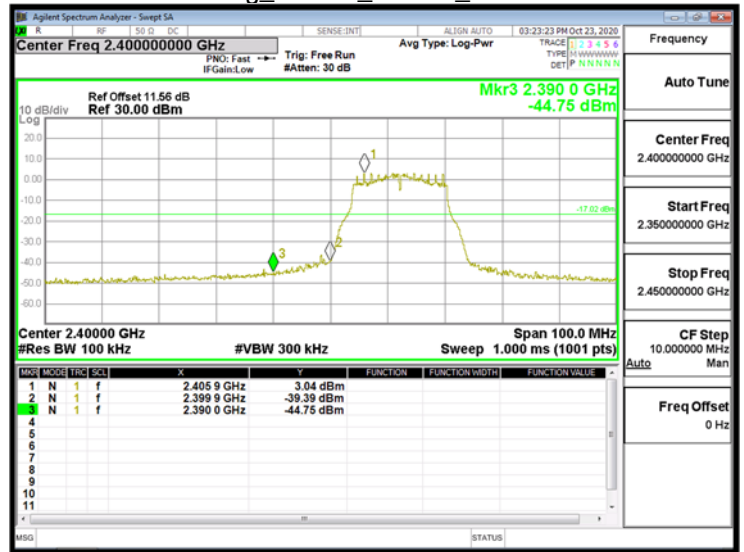
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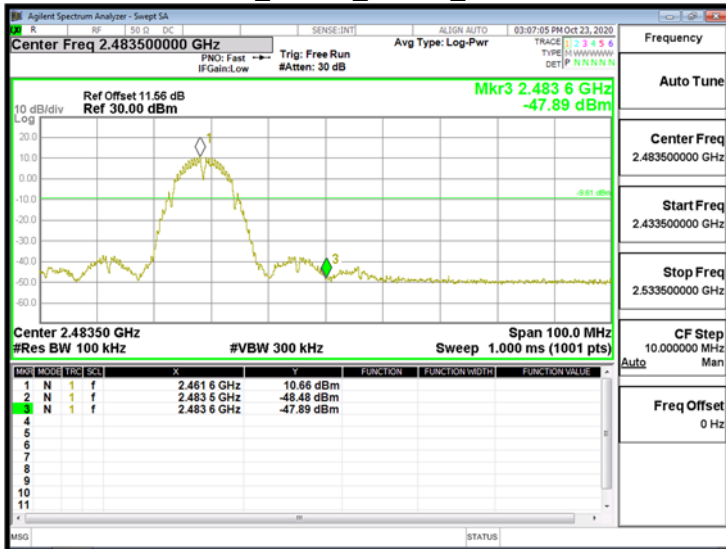
802.11b_20MHz_Chain1_2412MHz



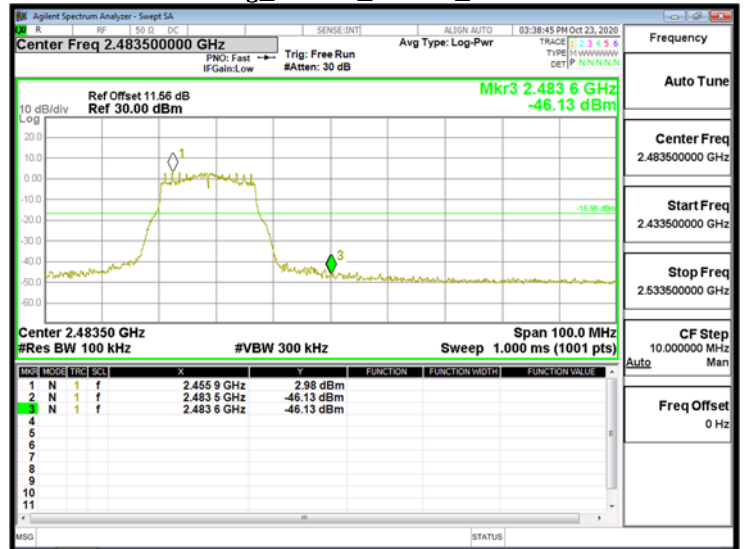
802.11g_20MHz_Chain1_2412MHz



802.11b_20MHz_Chain1_2462MHz



802.11g_20MHz_Chain1_2462MHz

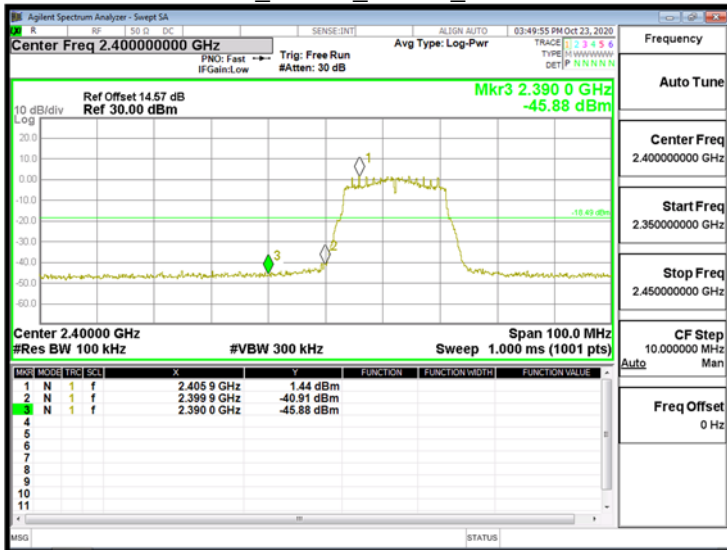


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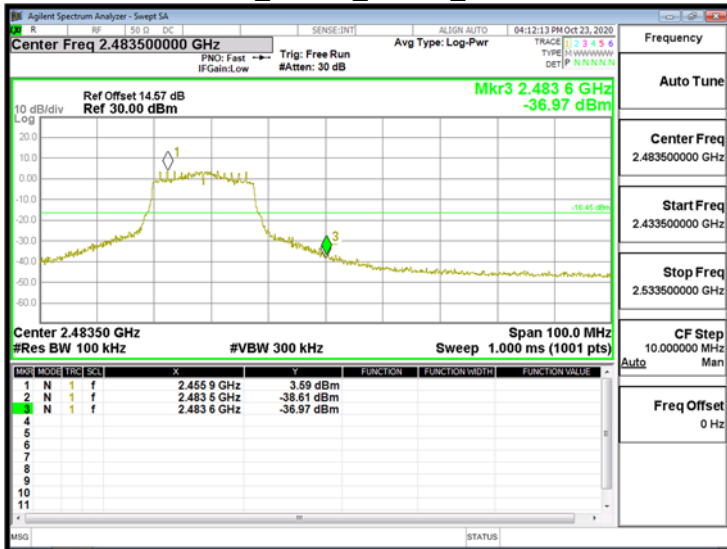
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