FCC TEST REPORT

Product Name:	GPON ONT
Trade Mark:	HALNy
Model No.:	HL-4GQV
Report Number:	200704006RFC-1
Test Standards:	FCC 47 CFR Part 15 Subpart C
FCC ID:	2AWIZHL4GQV
Test Result:	PASS
Date of Issue:	October 15, 2020

Prepared for:

FIBRAIN sp.zo.o.
Poland, Zaczernie 190F, 36-062

Prepared by:

Shenzhen UnionTrust Quality and Technology Co., Ltd.
16/F, Block A, Building 6, Baoneng Science and Technology Park,
Qingxiang Road No.1, Longhua New District, Shenzhen, China
TEL: +86-755-2823 0888
FAX: +86-755-2823 0886

Prepared by: Henry Lu, Team Leader

Reviewed by: Kevin Liang, Assistant Manager

Approved by: Billy Li, Technical Director

Date: October 15, 2020

Version

Version No.	Date	Description
V1.0	October 15, 2020	Original

CONTENTS

1. GENERAL INFORMATION 4
   1.1 CLIENT INFORMATION 4
   1.2 EUT INFORMATION 4
      1.2.1 GENERAL DESCRIPTION OF EUT 4
      1.2.2 DESCRIPTION OF ACCESSORIES 4
   1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD 5
   1.4 OTHER INFORMATION 5
   1.5 DESCRIPTION OF SUPPORT UNITS 6
   1.6 TEST LOCATION 6
   1.7 TEST FACILITY 6
   1.8 DEVIATION FROM STANDARDS 7
   1.9 ABNORMALITIES FROM STANDARD CONDITIONS 7
   1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER 7
   1.11 MEASUREMENT UNCERTAINTY 7
2. TEST SUMMARY 8
3. EQUIPMENT LIST 9
4. TEST CONFIGURATION 10
   4.1 ENVIRONMENTAL CONDITIONS FOR TESTING 10
      4.1.1 NORMAL OR EXTREME TEST CONDITIONS 10
      4.1.2 RECORD OF NORMAL ENVIRONMENT 10
   4.2 TEST CHANNELS 10
   4.3 EUT TEST STATUS 11
   4.4 PRE-SCAN 11
   4.5 TEST SETUP 12
      4.5.1 FOR RADIATED EMISSIONS TEST SETUP 12
      4.5.2 FOR CONDUCTED EMISSIONS TEST SETUP 13
      4.5.3 FOR CONDUCTED RF TEST SETUP 14
   4.6 SYSTEM TEST CONFIGURATION 14
   4.7 DUTY CYCLE 15
5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION 18
   5.1 REFERENCE DOCUMENTS FOR TESTING 18
   5.2 ANTENNA REQUIREMENT 18
   5.3 CONDUCTED PEAK OUTPUT POWER 19
   5.4 6 DB BANDWIDTH 20
   5.5 POWER SPECTRAL DENSITY 25
   5.6 CONDUCTED OUT OF BAND EMISSION 30
   5.7 RADIATED SPURIOUS EMISSIONS 47
   5.8 BAND EDGE MEASUREMENTS (RADIATED) 56
   5.9 CONDUCTED EMISSION 69

APPENDIX 1 PHOTOS OF TEST SETUP 72
APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS 72

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	FIBRAIN sp.zo.o.
Address of Applicant:	Poland, Zaczernie 190F, 36-062
Manufacturer:	FIBRAIN sp.zo.o.
Address of Manufacturer:	Poland, Zaczernie 190F, 36-062

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	GPON ONT		
Model No.:	HL-4GQV		
Trade Mark:	HALNy		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
Sample Received Date:	July 4, 2020		
Sample Tested Date:	July 4, 2020 to August 19, 2020		

1.2.2 Description of Accessories

Adapter	
Model No.:	BY-SKY120200U71L
Input:	100-240 V~50/60 Hz 0.7A
Output:	12.0 V ⎓ 2.0A
DC Cable:	1.50 Meter, Unshielded without ferrite
Manufacturer:	SHENZHEN TOPOW ELECTRONICS CO., LTD.

Cable	
Description:	Ethernet Cable
Cable Type:	Unshielded without ferrite
Length:	1.50 Meter, Unshielded without ferrite

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	2400 MHz to 2483.5 MHz	
Frequency Range:	2412 MHz to 2462 MHz	
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40	
Type of Modulation:	IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM(64-QAM, 16-QAM, QPSK, BPSK)	
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS15 IEEE 802.11n-HT40: Up to MCS15	
Number of Channels:	IEEE 802.11b: 11 IEEE 802.11g: 11 IEEE 802.11n-HT20: 11 IEEE 802.11n-HT40: 7	
Channel Separation:	5 MHz	
Antenna Type:	Chain 0	External Antenna
	Chain 1	External Antenna
Antenna Gain:	Chain 0	5 dBi
	Chain 1	5 dBi
Directional gain:	8.01 dBi	
Maximum Peak Power:	SISO_ Chain 0	IEEE 802.11b: 24.26dBm IEEE 802.11g: 24.74 dBm IEEE 802.11n-HT20: 23.77 dBm IEEE 802.11n-HT40: 23.50dBm
	SISO_ Chain 1	IEEE 802.11b: 24.19 dBm IEEE 802.11g: 24.76 dBm IEEE 802.11n-HT20: 23.28dBm IEEE 802.11n-HT40: 23.12 dBm
	MIMO_ Chain 0+1	IEEE 802.11n-HT20: 26.54 dBm IEEE 802.11n-HT40: 26.15 dBm
Normal Test Voltage:	120 Vac	

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20	**f = 2407 + 5k MHz, k = 1,…,11**
IEEE 802.11n-HT40	**f = 2407 + 5k MHz, k = 3,…,9**
Note: **f** is the operating frequency (MHz); **k** is the operating channel.	

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	Lenovo	E450	SL10G10780	UnionTrust
Wireless router	TP-Link	TL-WR886N	1169119003757	UnionTrust
mouse	DELL	MS111	CN-011D3V-738	UnionTrust
PLC Combiner	N/A	1/16 SCUPC	201604050002	Applicant
OLT	SKYWORTH	00320000623	00320000623	Applicant
PHONE	CHINO-E,	HCD6238P/TSDL	NA	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Ethernet Cable	RJ45	1.0 Unshielded without ferrite	Applicant
2	Ethernet Cable	RJ45	3.0 Unshielded without ferrite	UnionTrust
3	Ethernet Cable	RJ45	2.0 Unshielded without ferrite	UnionTrust
4	Optical fiber cable	Optical	2.9 Unshielded without ferrite	Applicant

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L9069
The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

IC-Registration No.: 21600-1
The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 21600-1.

A2LA-Lab Certificate No.: 4312.01
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the

identified field of testing.

FCC Accredited Lab.
Designation Number: CN1194
Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.2 dB
2	Conducted emission 150KHz-30MHz	±2.7 dB
3	Radiated emission 9KHz-30MHz	± 4.7 dB
4	Radiated emission 30MHz-1GHz	± 4.6 dB
5	Radiated emission 1GHz-18GHz	± 4.4 dB
6	Radiated emission 18GHz-26GHz	± 4.6 dB
7	Radiated emission 26GHz-40GHz	± 4.6 dB
8	Conducted spurious emissions	± 2.7 dB
9	RF Power, Conducted	± 0.9 dB
10	Occupied Bandwidth	± 1.86 %
11	Radio Frequency	2.4 GHz: ± 6.5 x 10^{-8}
12	Transmission Time	± 0.19 %

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)	N/A	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013 Clause 6.2	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013 Clause 11.9.1.3	PASS
6dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013 Clause 11.8.1	PASS
Power Spectral Density	FCC 47 CFR Part 15 Subpart C Section 15.247 (e)	ANSI C63.10-2013 Clause 11.10.2	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d)	ANSI C63.10-2013 Clause 11.11	PASS
Radiated Spurious Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Clause 11.11 & Clause 11.12	PASS
Band Edge Measurements (Radiated)	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Clause 11.13	PASS

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Dec. 03, 2018	Dec. 03, 2021
☒	Receiver	R&S	ESIB26	100114	Nov. 24, 2019	Nov. 23, 2020
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	Nov. 16, 2019	Nov. 15, 2020
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Nov. 16, 2019	Nov. 15, 2020
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	Nov. 16, 2019	Nov. 15, 2020
☒	Preamplifier	HP	8447F	2805A02960	Nov. 24, 2019	Nov. 23, 2020
☐	Broadband Antenna (Pre-amplifier)	ETS-LINDGREN	3142E-PA	00201891	Nov. 24, 2019	Nov. 23, 2020
☐	6dB Attenuator	Talent	RA6A5-N-18	18103002	Nov. 24, 2019	Nov. 23, 2020
☐	Horn Antenna	ETS-LINDGREN	3117	00164202	Nov. 16, 2019	Nov. 15, 2020
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	May 30, 2020	May 29, 2021
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	Jun 19, 2020	Jun 18, 2021
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Nov. 16, 2019	Nov. 15, 2020
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☒	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	Nov. 24, 2019	Nov. 23, 2020
☐	Band Rejection Filter (5150MHz~5880MHz)	Micro-Tronics	BRM50716	G1868	Nov. 24, 2019	Nov. 23, 2020
☒	Test Software	Audix	e3	Software Version: 9.160323		

Conducted Emission Test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	Receiver	R&S	ESR7	1316.3003K07 -101181-K3	Nov. 24, 2019	Nov. 23, 2020
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 24, 2019	Nov. 23, 2020
☒	LISN	R&S	ESH2-Z5	860014/024	Nov. 24, 2019	Nov. 23, 2020
☒	LISN	ETS-Lindgren	3816/2SH	00201088	Nov. 24, 2019	Nov. 23, 2020
☒	Test Software	Audix	e3	Software Version: 9.160323		

Conducted RF test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
☒	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2019	Nov. 23, 2020
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 24, 2019	Nov. 23, 2020
☐	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Nov. 24, 2019	Nov. 23, 2020

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage (V)	Relative Humidity (%)
NT/NV	+15 to +35	12	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment

Test Item	Temperature (°C)	Relative Humidity (%)	Pressure (kPa)	Tested by
AC Power Line Conducted Emission	25.6	60	99.40	Tripp Jiang
Conducted Peak Output Power	25.3	51	99.80	Swift Liu
6dB Bandwidth	25.3	51	99.80	Swift Liu
Power Spectral Density	25.3	51	99.80	Swift Liu
Conducted Out of Band Emission	25.3	51	99.80	Swift Liu
Radiated Spurious Emissions	25.3	53	100.26	Asia Yan
Band Edge Measurements (Radiated)	25.3	53	100.26	Asia Yan

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
IEEE 802.11b	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11g	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11n-HT20	2412 MHz to 2462 MHz	Channel 1	Channel 7	Channel 11
		2412 MHz	2437 MHz	2462 MHz
IEEE 802.11n-HT40	2422 MHz to 2452 MHz	Channel 3	Channel 7	Channel 9
		2422 MHz	2437 MHz	2452 MHz

4.3 EUT TEST STATUS

Mode	Tx Function	Description
IEEE 802.11b IEEE 802.11g IEEE 802.11n-HT20 IEEE 802.11n-HT40	1Tx	1. Keep the EUT in continuously transmitting with modulation test single.
IEEE 802.11n-HT20 IEEE 802.11n-HT40	2Tx	2. Keep the EUT in continuously transmitting with modulation test single.

Power Setting		
	Channel 1 -11	
	Chain 0	Chain 1
IEEE 802.11b	1A	19
IEEE 802.11g	0C	0B
IEEE 802.11n-HT20	0A	0A
IEEE 802.11n-HT40	0B	0B

Test Software
Test software name: Engineering mode*#*#3646633#*#*;

4.4 PRE-SCAN

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate. Following data rate was (were) selected for the final test as listed below

Mode	Worst-case data rates
IEEE 802.11b	1 Mbps
IEEE 802.11g	6 Mbps
IEEE 802.11n-HT20	MCS8
IEEE 802.11n-HT40	MCS8

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

Figure 1. Below 30MHz

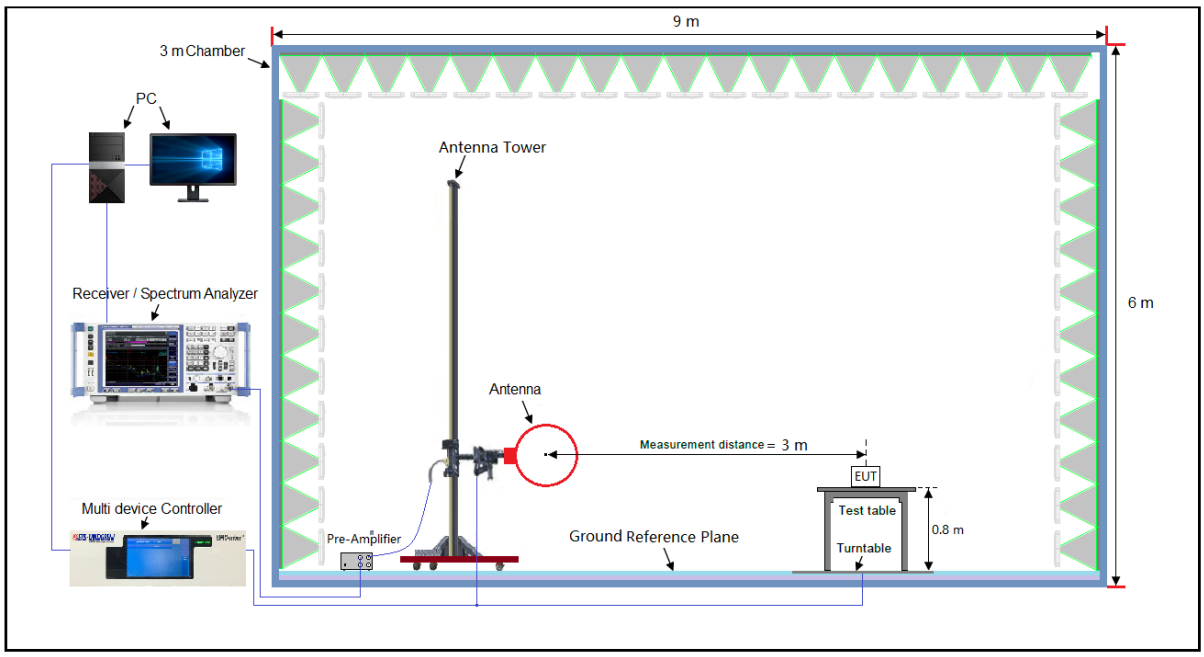


Figure 2. 30MHz to 1GHz

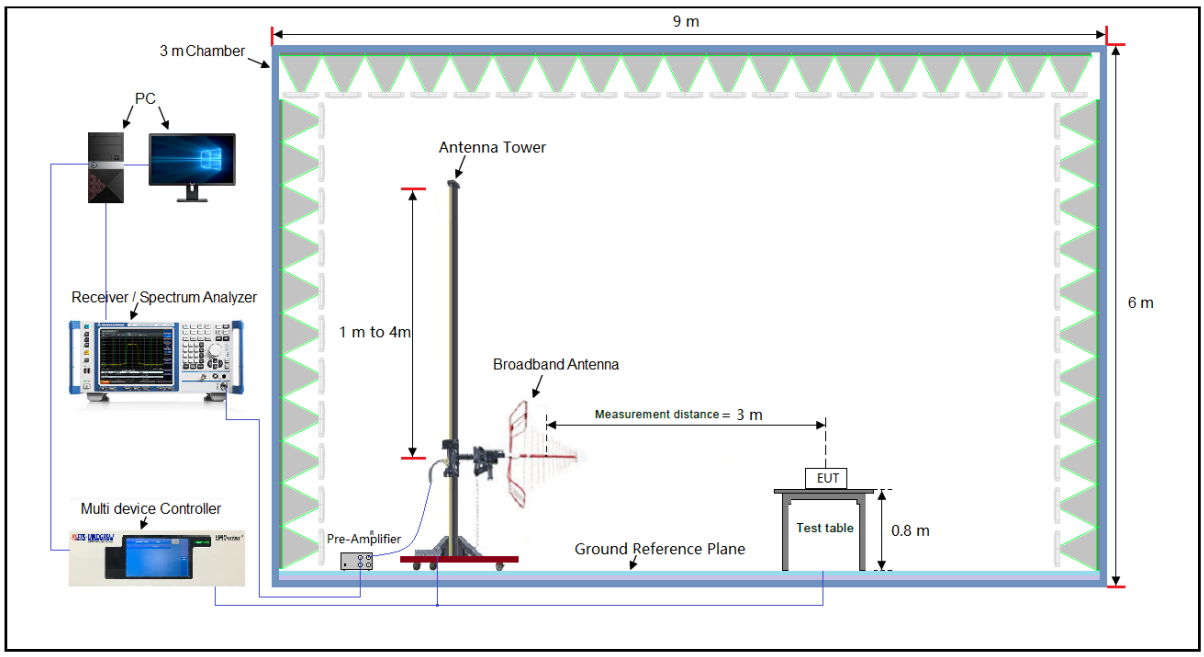
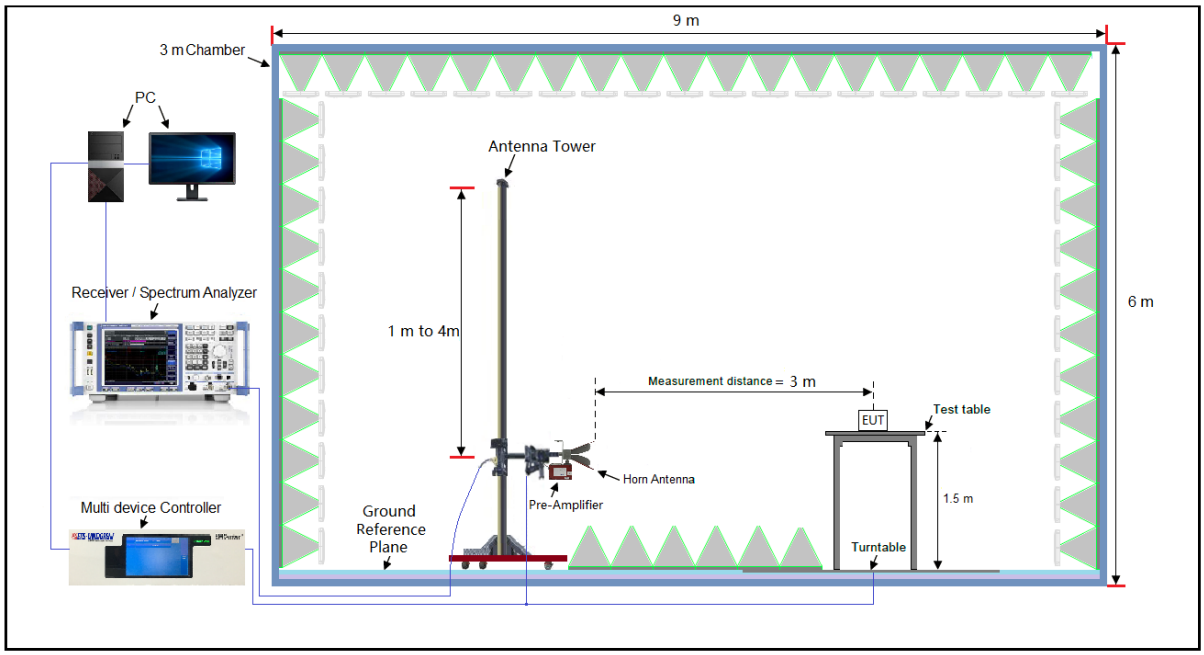
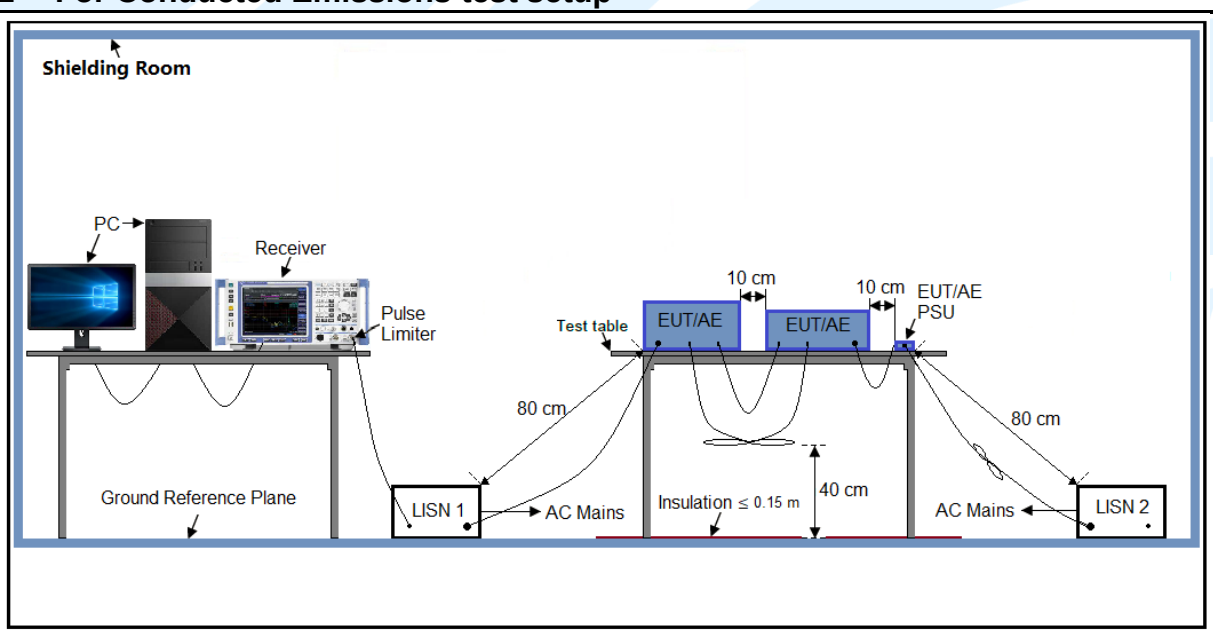


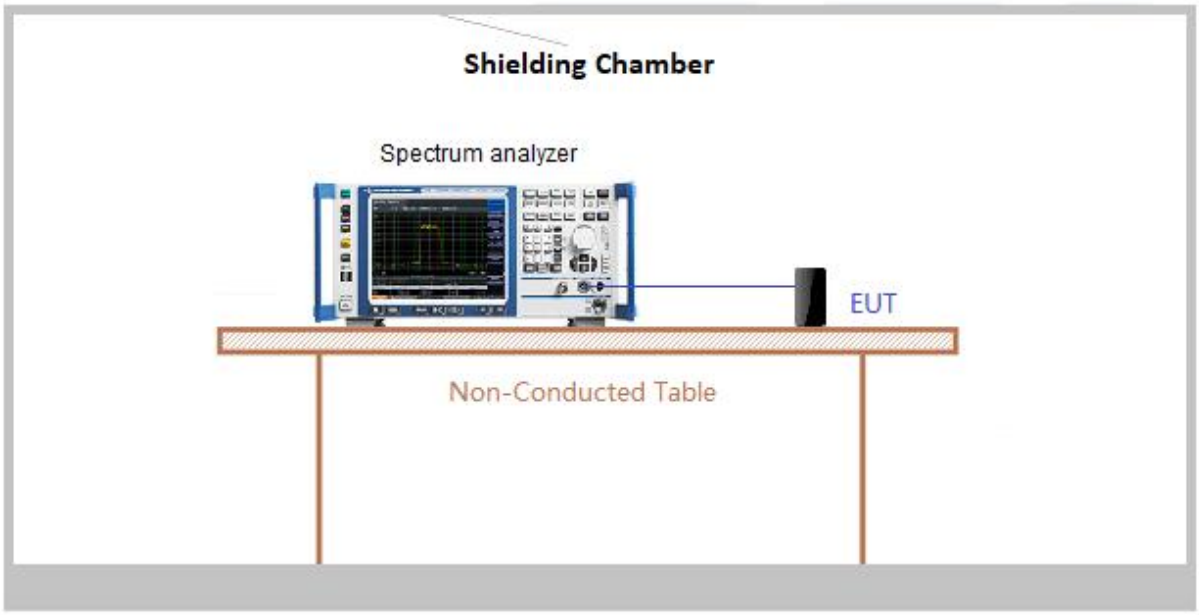
Figure 3. Above 1GHz



4.5.2 For Conducted Emissions test setup



4.5.3 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency	Mode	Antenna Port	Worst-case axis positioning
Above 1GHz	1TX	Chain 0	Y axis
	1TX	Chain 1	Y axis
	2TX	Chain 0+1	Y axis

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

4.7 DUTY CYCLE

Test Procedure: ANSI C63.10-2013 Clause 11.6.

Test Results

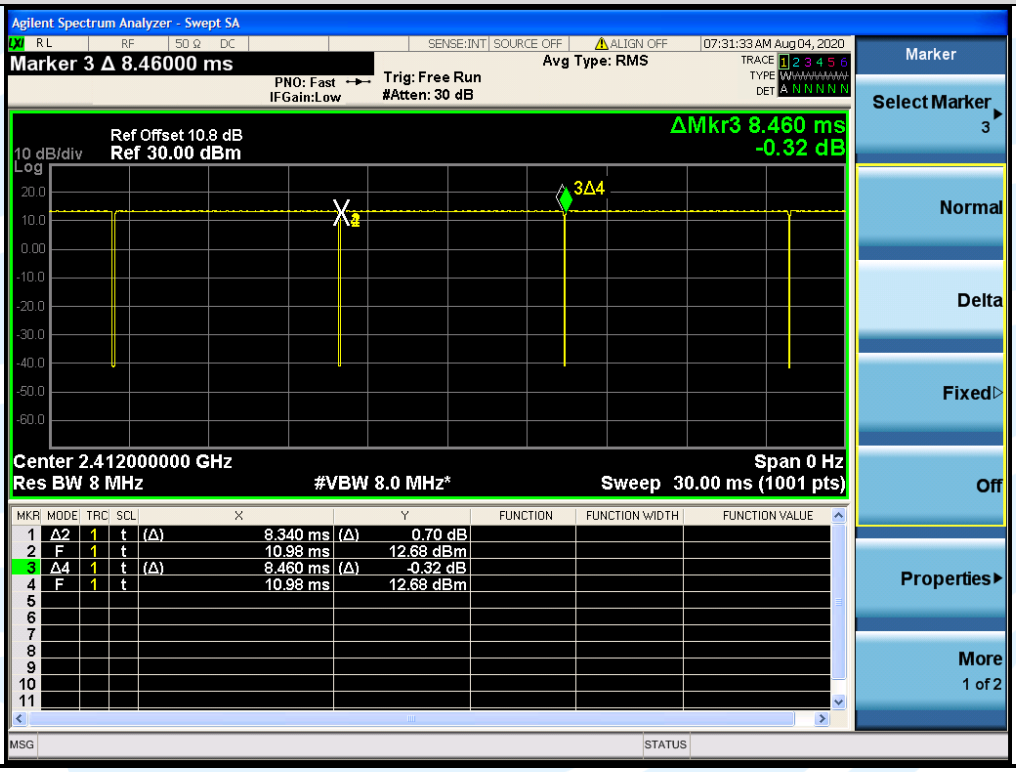
Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11b	1	8.3400	8.4600	0.99	98.58	0.00	0.01	-0.12
IEEE 802.11g	6	1.3900	1.5200	0.91	91.45	0.39	0.72	-0.78
IEEE 802.11n-HT20	MCS0	0.6720	0.7470	0.90	89.96	0.46	1.49	-0.92
IEEE 802.11n-HT40	MCS0	0.3420	0.4710	0.73	72.61	1.39	2.92	-2.78

Remark:

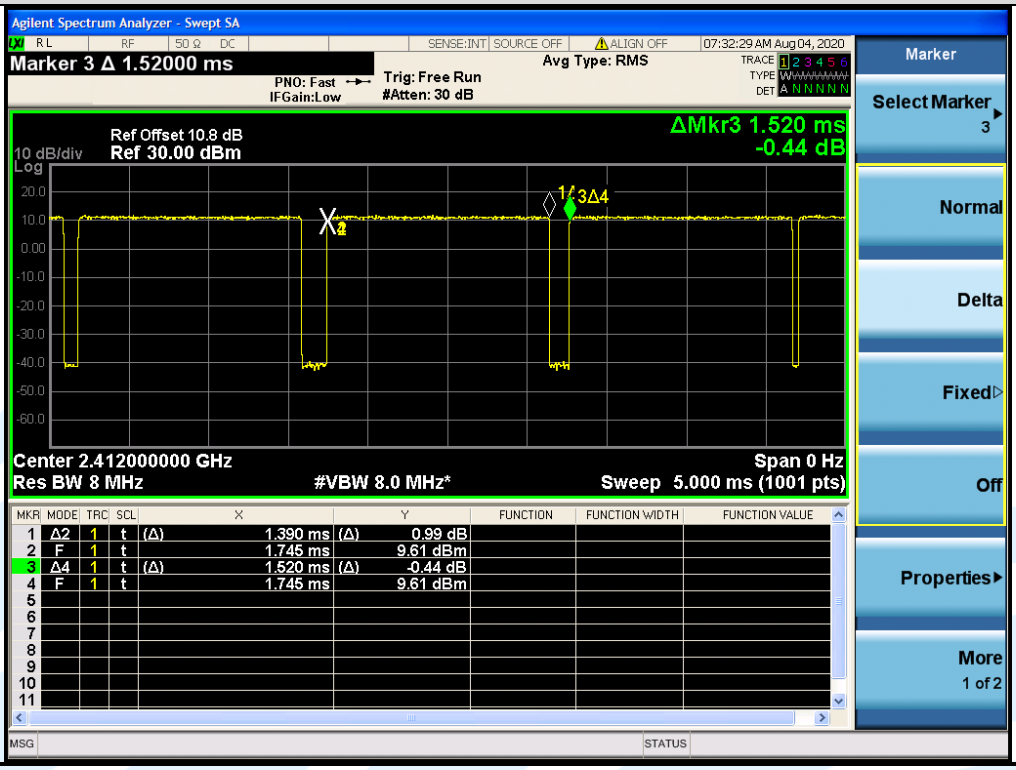
1) Duty cycle= On Time/ Period;
2) Duty Cycle factor = 10 * log(1/ Duty cycle);
3) Average factor = 20 $\log_{10}$ Duty Cycle.

The test plots as follows

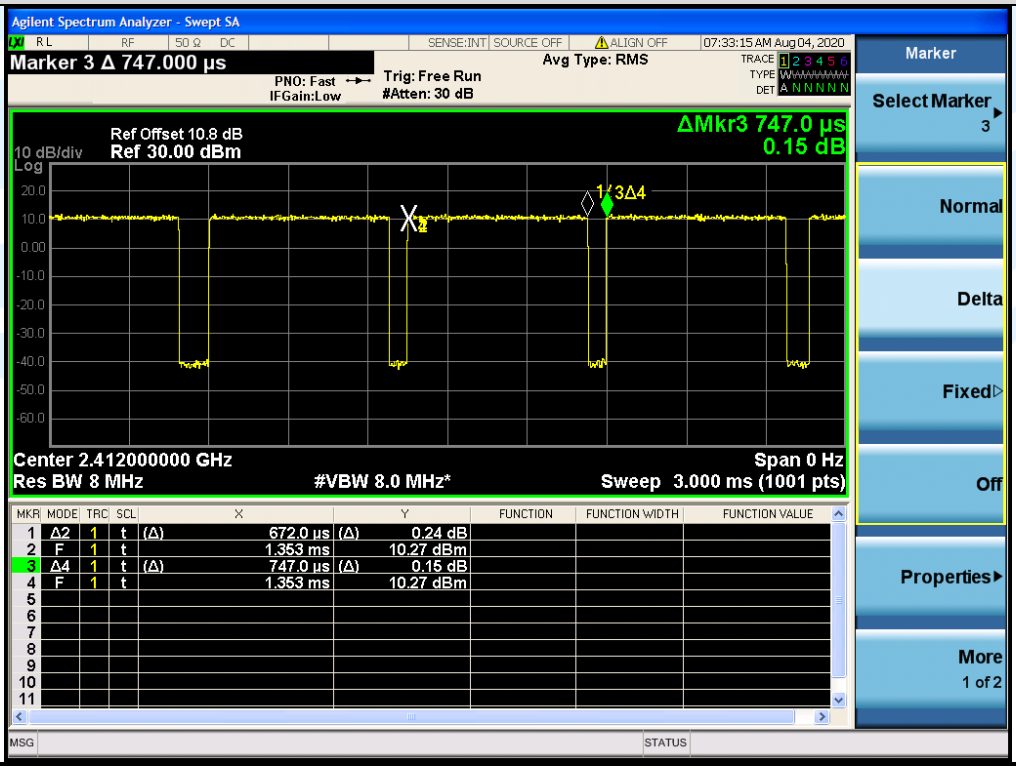
IEEE 802.11b



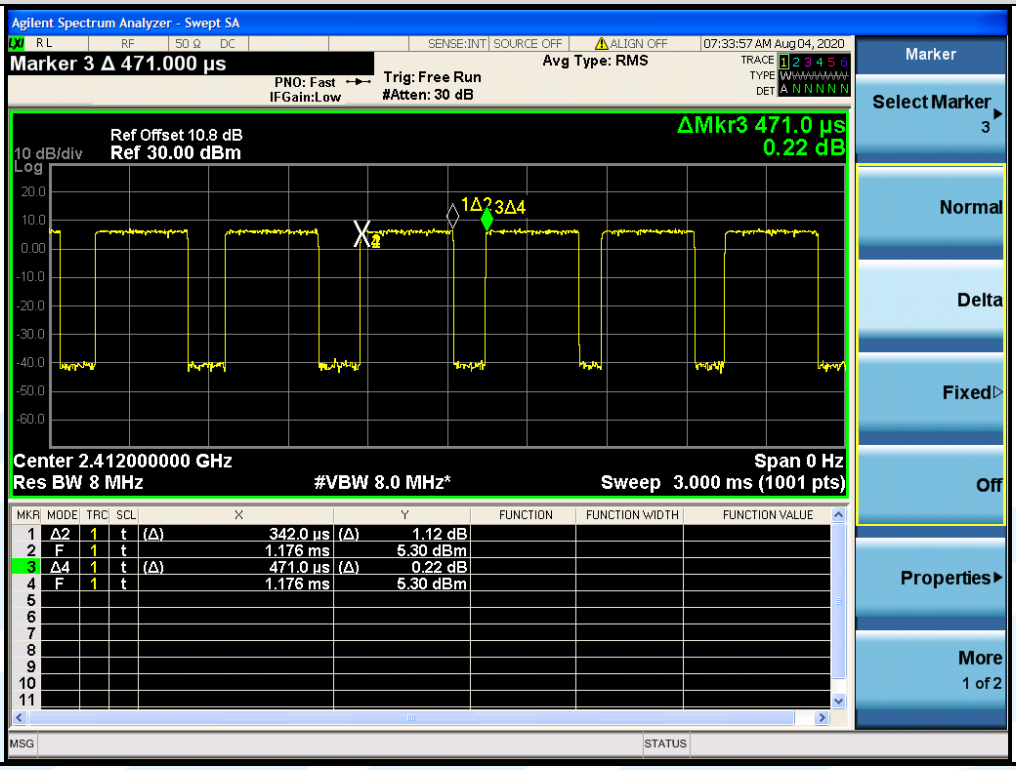
IEEE 802.11g



IEEE 802.11n-HT20



IEEE 802.11n-HT40



5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices
4	KDB 558074 D01 15.247 Meas Guidance v05	Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules
5	KDB 662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. **15.247(b) (4) requirement:** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
EUT Antenna:
The antenna has a special interface and no consideration of replacement. The transmit signals are correlated with each other and the antenna gain of both chains is completely consistent, the best case directional gain of the antenna is 8.01 dBi (See section 5.3).

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section15.247 (b)(3)

Test Method: ANSI C63.10-2013 Clause 11.9.1.3

Limit: For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

Test Procedure:
1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
2. Measure out each test modes' peak or average output power, record the power level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results: Pass

Mode	Channel/ Frequency (MHz)	Maximum Conducted Peak Output Power (dBm)				
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit (dBm)	Pass / Fail
IEEE 802.11b	1(2412)	23.50	23.33	---	30	Pass
	6(2437)	23.74	23.24	---	30	Pass
	11(2462)	24.26	24.19	---	30	Pass
IEEE 802.11g	1(2412)	24.22	24.06	---	30	Pass
	6(2437)	24.47	23.84	---	30	Pass
	11(2462)	24.74	24.76	---	30	Pass
IEEE 802.11n-HT20	1(2412)	23.17	22.39	25.81	27.99	Pass
	6(2437)	22.96	22.30	25.65	27.99	Pass
	11(2462)	23.77	23.28	**26.54**	27.99	Pass
IEEE 802.11n-HT40	3(2422)	23.10	23.12	26.12	27.99	Pass
	6(2437)	23.50	22.75	26.15	27.99	Pass
	9(2452)	22.79	22.63	25.72	27.99	Pass

Remark:
1. Total (Chain 0+1) = $10*\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]$
2. Directional gain and the maximum conducted output power limit see table below:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	5.00	5.00	8.01	27.99
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:				
If *any* transmit signals are *correlated* with each other,				
Directional gain = $G_{ANT} + 10\log(N_{ANT})$ dBi				

5.46 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)

Test Method: ANSI C63.10-2013 Clause 11.8.1

Limit: For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:
a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 x RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to 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.
Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
Chain 0					
IEEE 802.11b	1(2412)	9.581	14.126	> 500 kHz	Pass
	6(2437)	9.569	14.141	> 500 kHz	Pass
	11(2462)	9.595	14.089	> 500 kHz	Pass
IEEE 802.11g	1(2412)	15.14	16.308	> 500 kHz	Pass
	6(2437)	15.15	16.302	> 500 kHz	Pass
	11(2462)	15.14	16.309	> 500 kHz	Pass
IEEE 802.11n-HT20	1(2412)	15.11	17.478	> 500 kHz	Pass
	6(2437)	15.10	17.473	> 500 kHz	Pass
	11(2462)	15.15	17.480	> 500 kHz	Pass
IEEE 802.11n-HT40	3(2422)	35.11	35.724	> 500 kHz	Pass
	6(2437)	34.14	35.714	> 500 kHz	Pass
	9(2452)	35.12	35.701	> 500 kHz	Pass
Chain 1					
IEEE 802.11b	1(2412)	10.02	14.133	> 500 kHz	Pass
	6(2437)	9.575	14.122	> 500 kHz	Pass
	11(2462)	9.568	14.094	> 500 kHz	Pass
IEEE 802.11g	1(2412)	15.12	16.309	> 500 kHz	Pass
	6(2437)	15.14	16.314	> 500 kHz	Pass
	11(2462)	15.14	16.312	> 500 kHz	Pass
IEEE 802.11n-HT20	1(2412)	15.14	17.476	> 500 kHz	Pass
	6(2437)	15.14	17.479	> 500 kHz	Pass
	11(2462)	15.14	17.475	> 500 kHz	Pass
IEEE 802.11n-HT40	3(2422)	35.13	35.752	> 500 kHz	Pass
	6(2437)	35.13	35.758	> 500 kHz	Pass

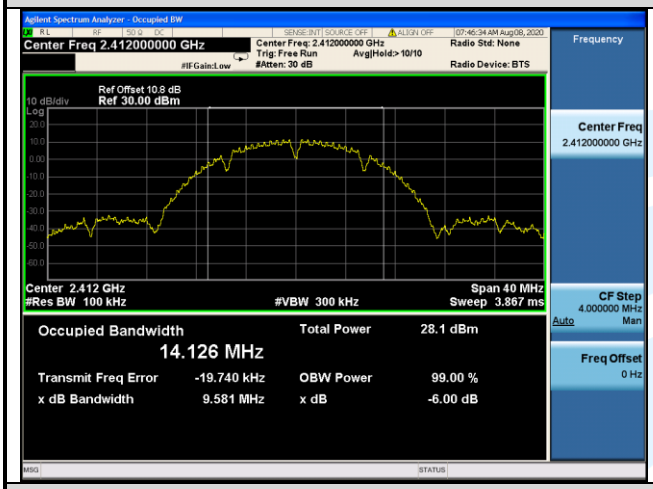
	9(2452)	35.13	35.780	> 500 kHz	Pass

The test plots as follows:

IEEE 802.11b

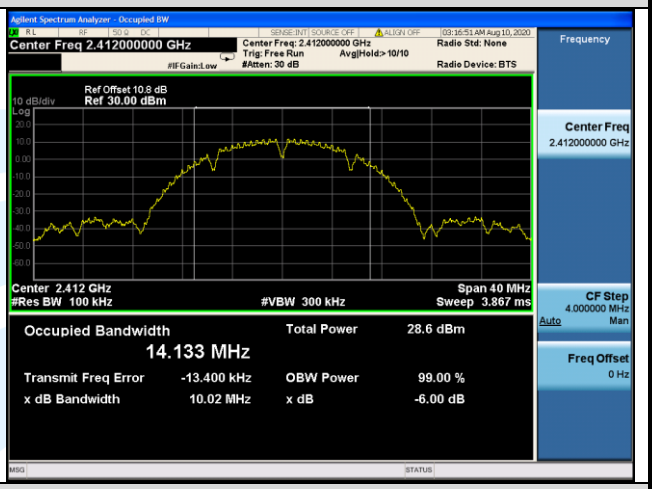
SISO_ Chain 0

Channel 1

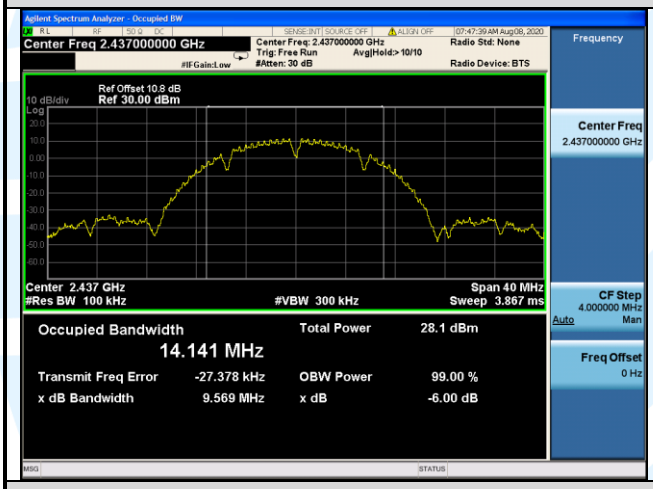


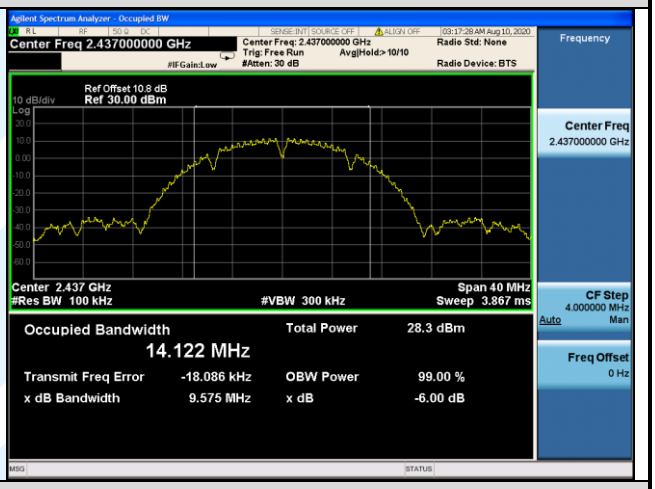
SISO_ Chain 1

Channel 1

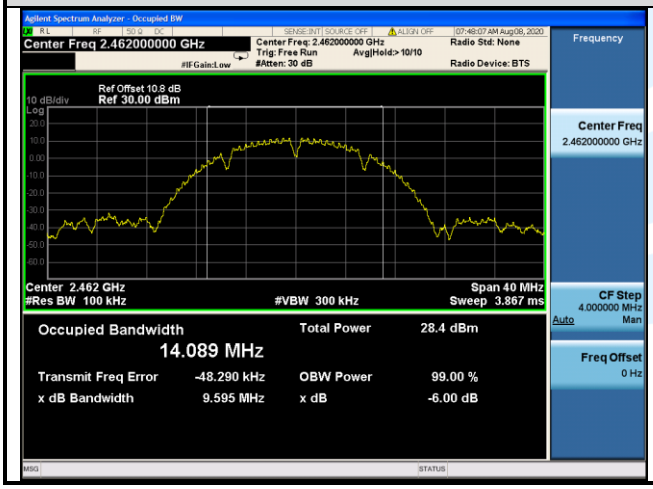


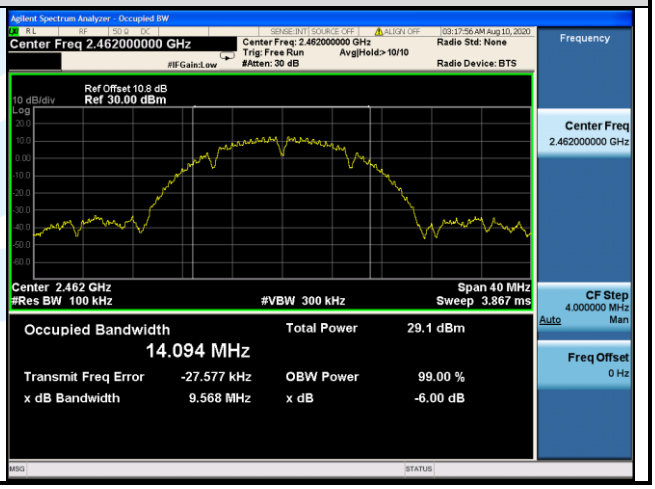
Channel 6

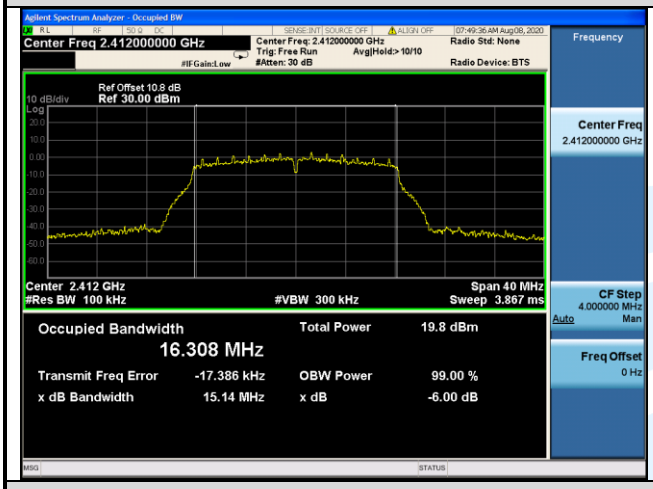
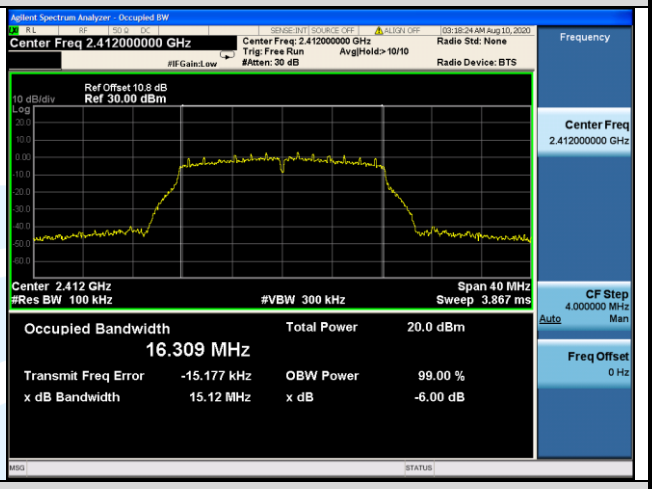
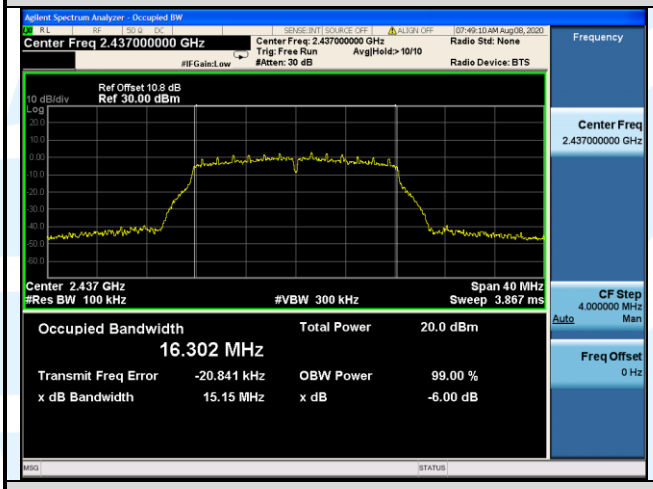
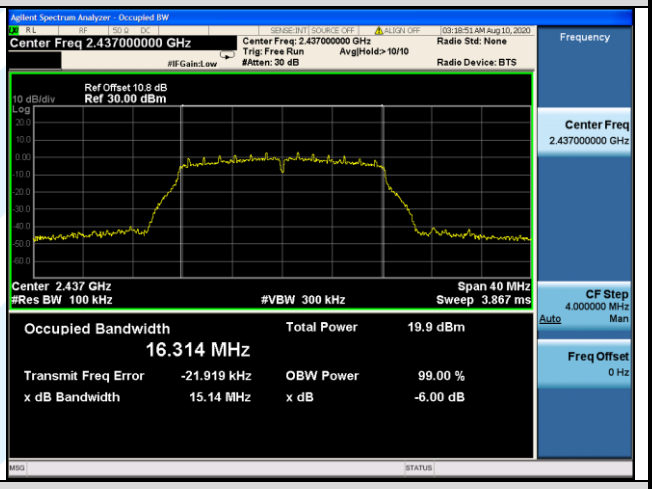
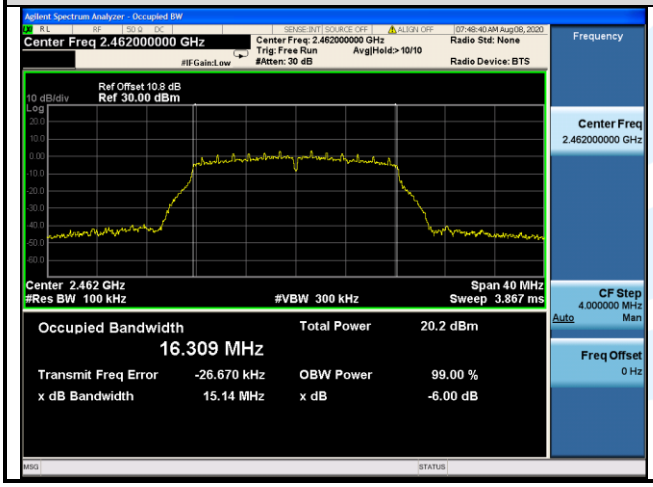
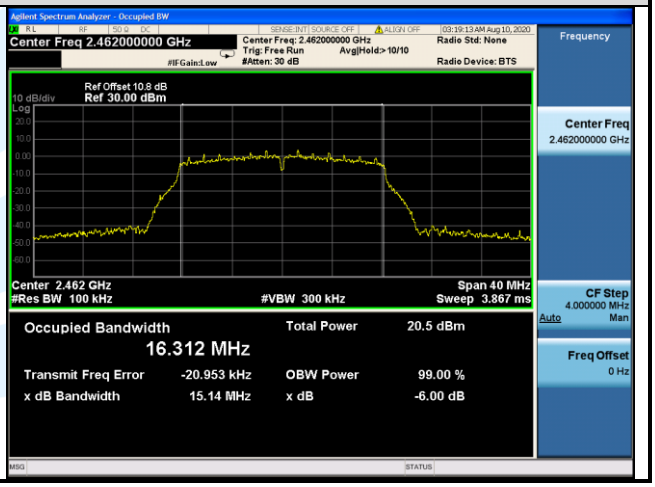


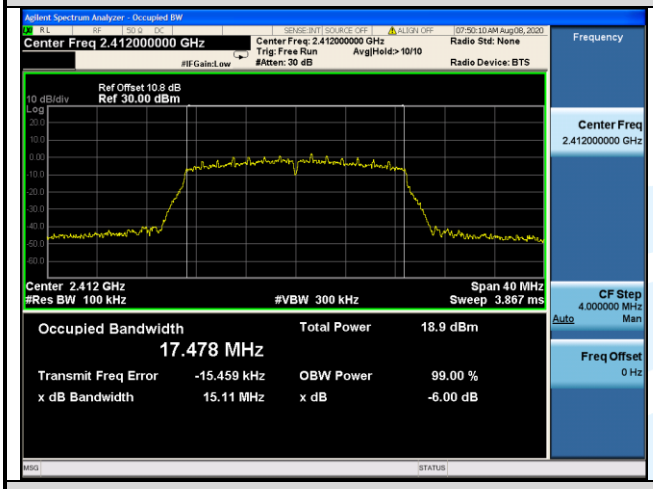
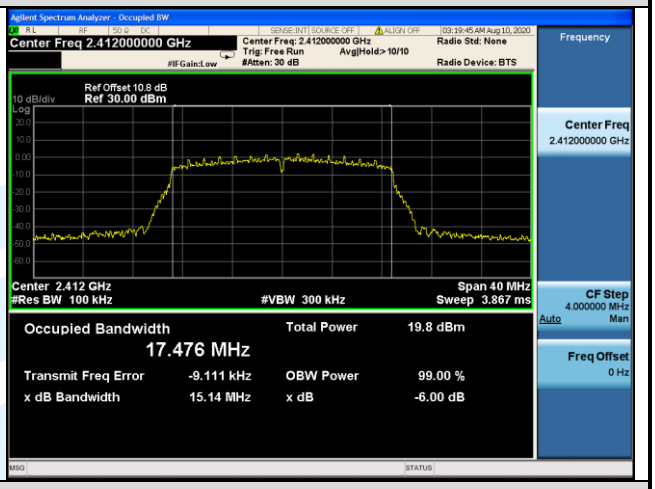
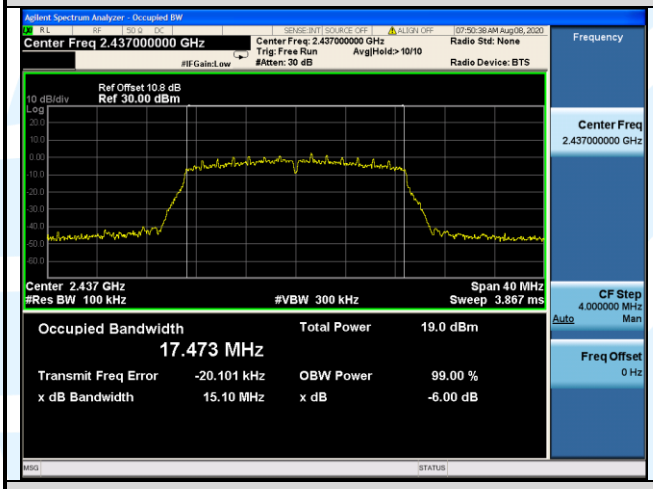
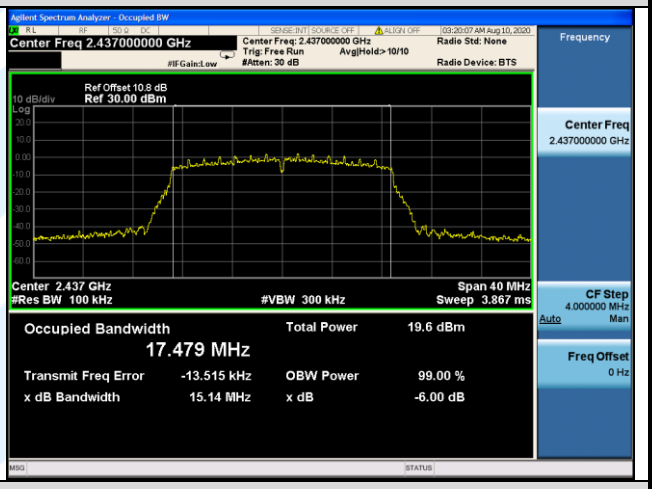
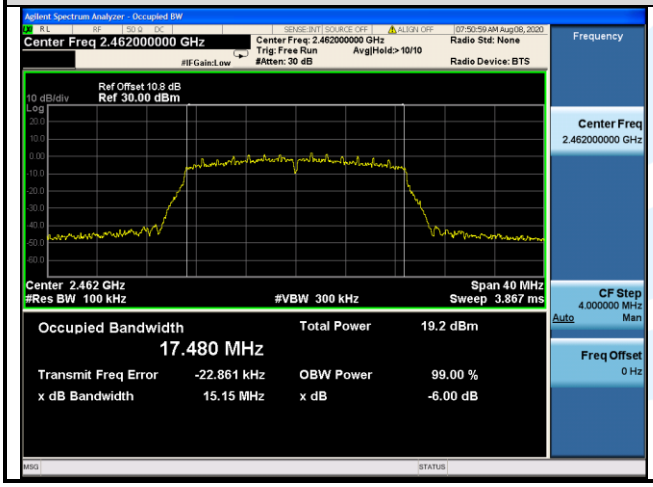
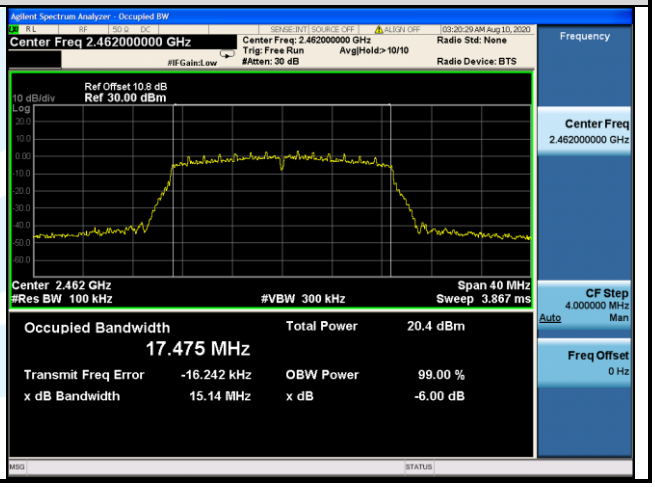


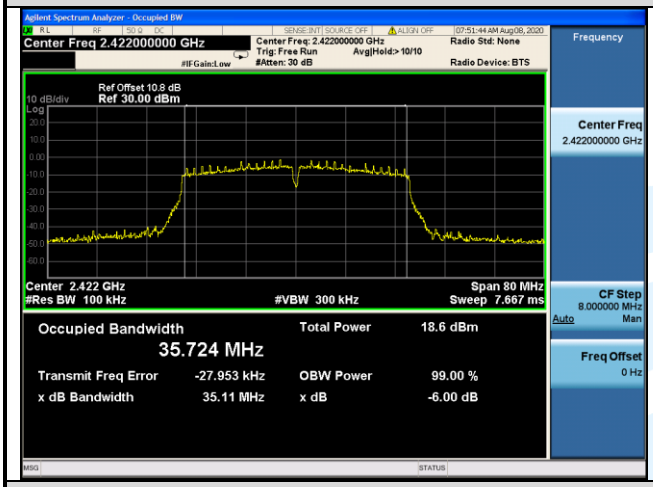
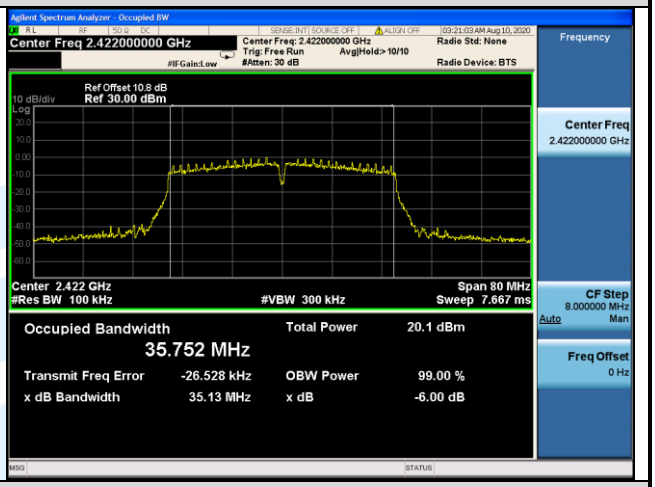
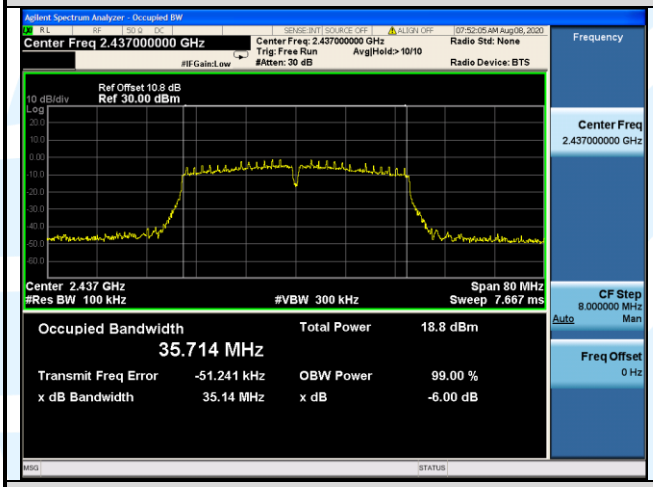
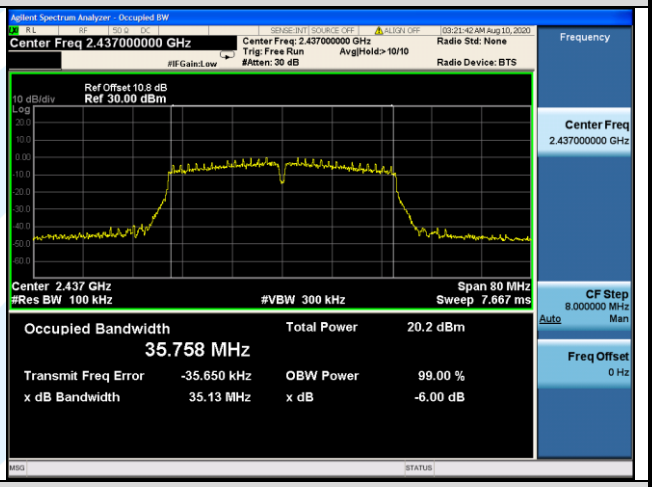
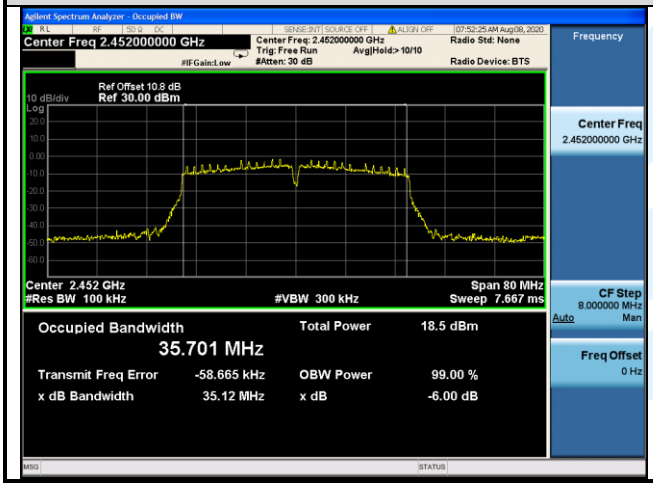
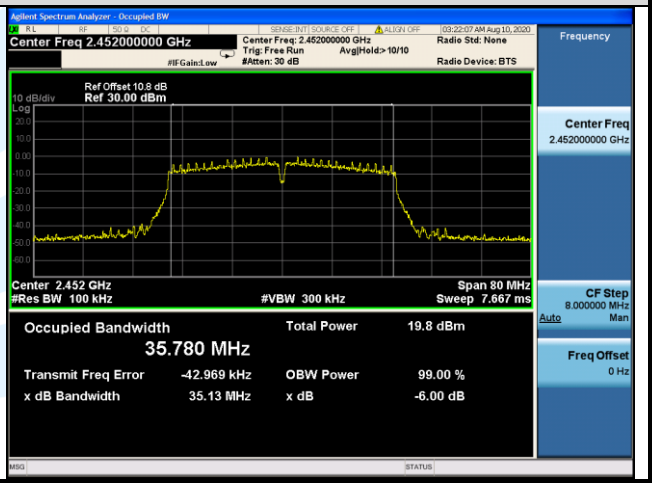
Channel 11





IEEE 802.11g	
SISO_ Chain 0	SISO_ Chain 1
Channel 1	
	
Channel 6	
	
Channel 11	
	

IEEE 802.11n-HT20	
MIMO_ Chain 0	MIMO_ Chain 1
Channel 1	
	
Channel 6	
	
Channel 11	
	

IEEE 802.11n-HT40	
MIMO_ Chain 0	MIMO_ Chain 1
Channel 3	
	
Channel 6	
	
Channel 9	
	

5.5 POWER SPECTRAL DENSITY

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (e)

Test Method: ANSI C63.10-2013 Clause 11.10.2

Limit: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

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 x 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.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm/3kHz)				
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit @3kHz (dBm)	Pass / Fail
IEEE 802.11b	1(2412)	-3.015	-3.182	---	8	Pass
	6(2437)	-1.880	-3.486	---	8	Pass
	11(2462)	-3.255	-3.615	---	8	Pass
IEEE 802.11g	1(2412)	-11.403	-13.235	---	8	Pass
	6(2437)	-12.051	-12.686	---	8	Pass
	11(2462)	-11.768	-11.126	---	8	Pass
IEEE 802.11n-HT20	1(2412)	-13.953	-12.598	-10.21	5.99	Pass
	6(2437)	-14.147	-12.828	-10.43	5.99	Pass
	11(2462)	-12.990	-11.660	**-9.26**	5.99	Pass
IEEE 802.11n-HT40	3(2422)	-14.823	-13.710	-11.22	5.99	Pass
	6(2437)	-15.184	-14.270	-11.69	5.99	Pass
	9(2452)	-15.371	-13.274	-11.19	5.99	Pass

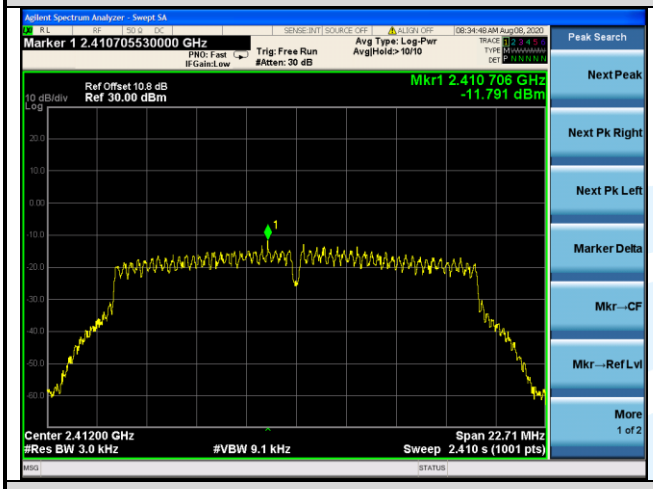
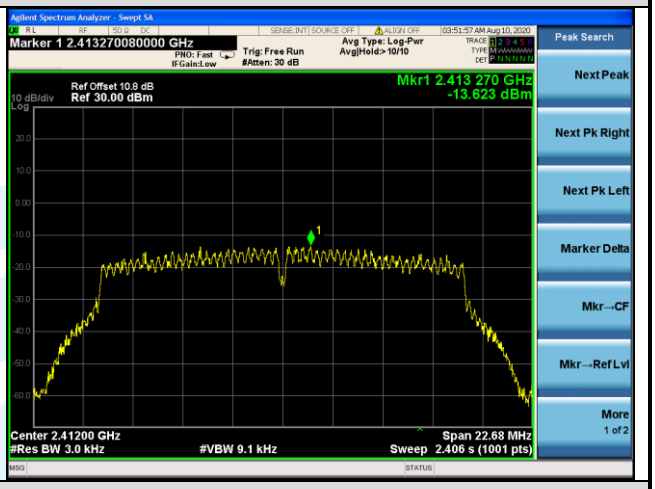
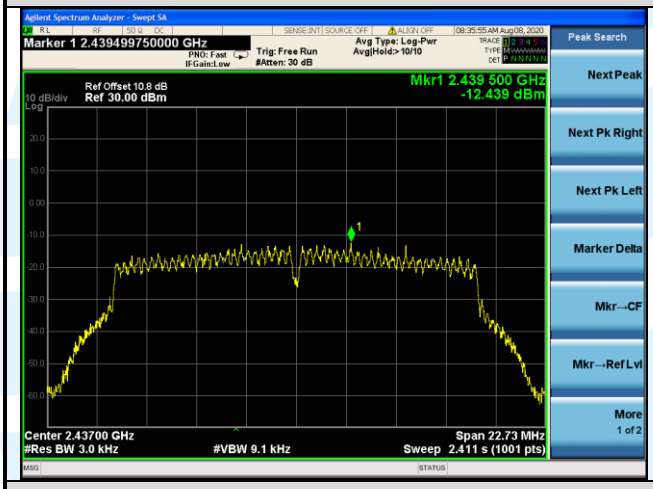
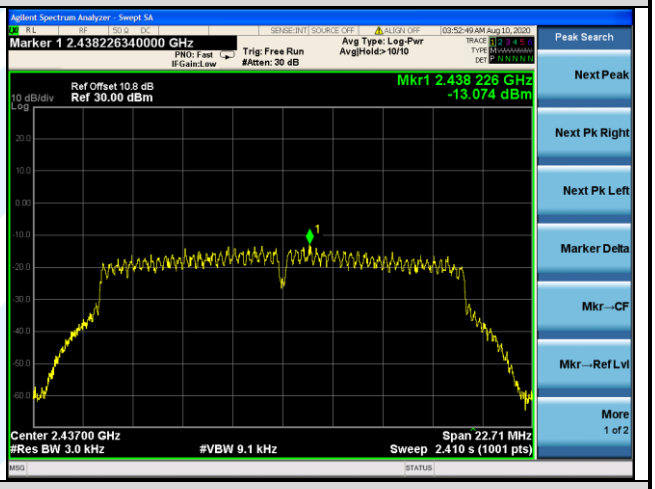
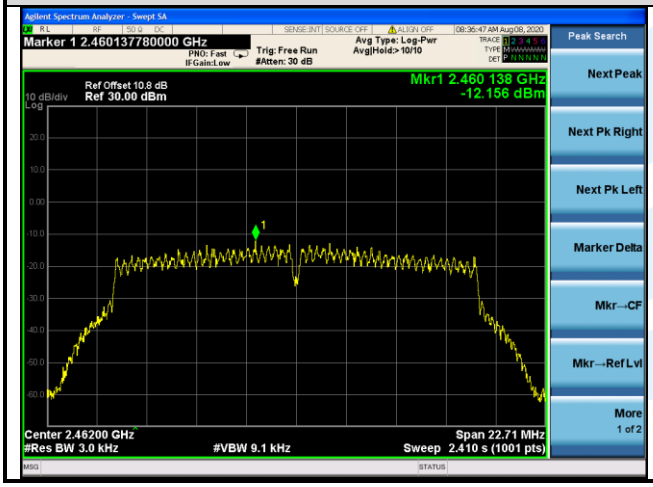
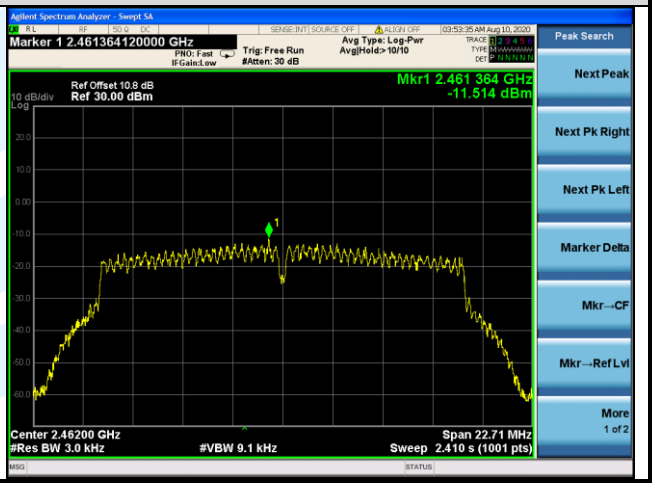
Remark:

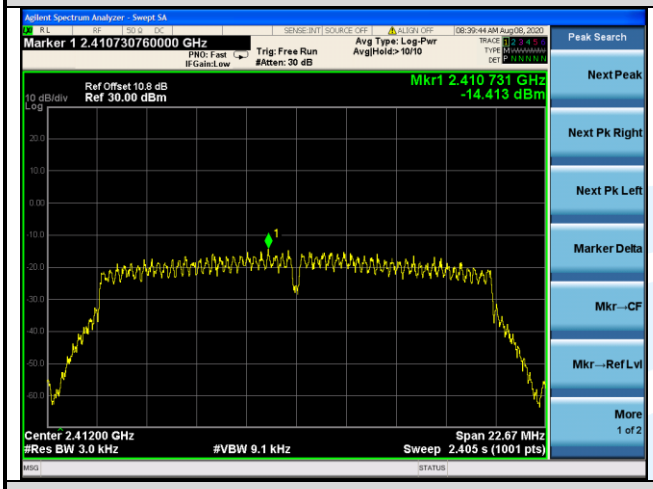
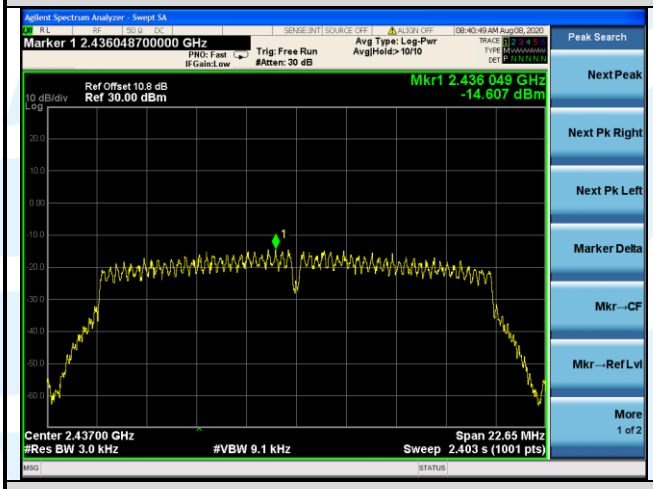
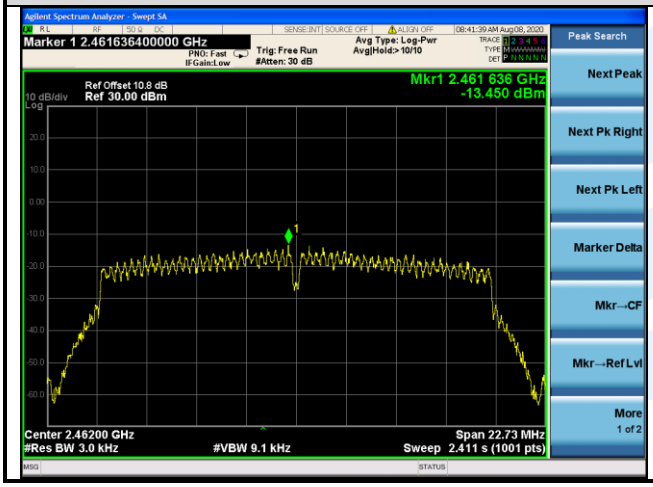
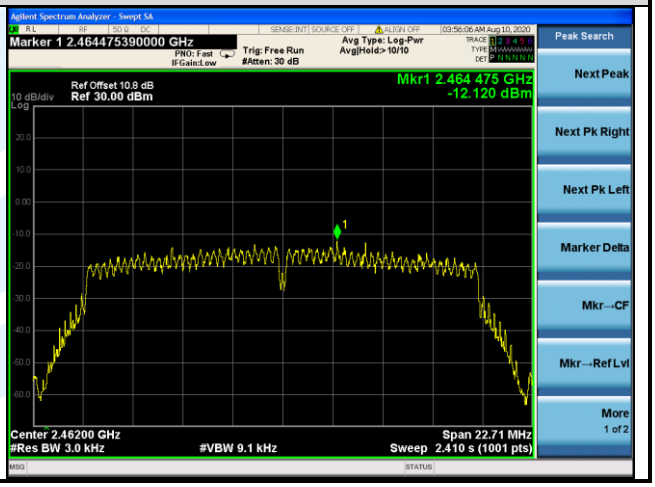
1. Total (Chain 0+1) = $10*\log[(10^{\text{Chain 0}/10})+(10^{\text{Chain 1}/10})]$
2. Directional gain and the maximum conducted power spectral density limit see table below:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	5.00	5.00	8.01	5.99
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:				
If *any* transmit signals are *correlated* with each other,				
Directional gain = $G_{ANT} + 10\log(N_{ANT})$ dBi				

The test plots as follows:

IEEE 802.11b	
SISO_ Chain 0	SISO_ Chain 1
Channel 1	
Channel 6	
Channel 11	

IEEE 802.11g	
SISO_ Chain 0	SISO_ Chain 1
Channel 1	
	
Channel 6	
	
Channel 11	
	

IEEE 802.11n-HT20	
MIMO_ Chain 0	MIMO_ Chain 1
Channel 1	
	
Channel 6	
	
Channel 11