

FCC TEST REPORT

Product Name: Promethean WIFI Module (Titanium)
Trade Mark: Promethean
Model No.: AP-WIFI-BC
Add. Model No.: N/A
Report Number: 181126027RFC-3
Test Standards: FCC 47 CFR Part 15 Subpart C
FCC ID: QAM-AP-WIFI-BC
Test Result: PASS
Date of Issue: January 18, 2019

Prepared for:

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Version

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V1.0	January 18, 2019	Original

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Promethean Ltd
Address of Applicant:	Promethean House, Lower Philips Rd Whitebirk, Blackburn, BB1 5TH, United Kingdom
Manufacturer:	Guangzhou Lango Electronics Technology Co., Ltd
Address of Manufacturer:	4/f, NO.136, Gaopu Road, Tianhe District, Guangzhou, 510663, P.R. China

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	Promethean WIFI Module (Titanium)		
Model No.:	AP-WIFI-BC		
Add. Model No.:	N/A		
Trade Mark:	Promethean		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
		Bluetooth V4.2	
	5 GHz RLAN Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
	5.8 GHz Band:	5 725 MHz to 5 875 MHz	IEEE 802.11a/n/ac
Software Version:	v5.2.21.1_27105.20180315_COEX20180112-5959		
Hardware Version:	XF.WIFI.E-4-V0		
Sample Received Date:	December 10, 2018		
Sample Tested Date:	December 20, 2018 to January 16, 2019		

1.2.2 Description of Accessories

None

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	4.58 dBi
	Chain 1	4.58 dBi
Directional gain:	7.59 dBi	

Maximum Peak Power:	SISO_ Chain 0	IEEE 802.11b: 15.8 dBm IEEE 802.11g: 19.8 dBm
	SISO_ Chain 1	IEEE 802.11b: 15.64 dBm IEEE 802.11g: 19.87 dBm
	MIMO_ Chain 0+1	IEEE 802.11n-HT20: 20.50 dBm IEEE 802.11n-HT40: 19.98 dBm
Normal Test Voltage:	120V~60Hz	

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20	$f = 2407 + 5k \text{ MHz}, k = 1, \dots, 11$
IEEE 802.11n-HT40	$f = 2407 + 5k \text{ MHz}, k = 3, \dots, 9$
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
Mainboard	Promethean	XM.H811.D-②-V0	N/A	Promethean
Power board	Promethean	PV01-180828-C09	N/A	Promethean
Adapter	SOY	SUN-1200400-039-I	N/A	Promethean
Display	DELL	P2416Db	N/A	UnionTrust
Mouse	Dell	MOCZUL	CN-0V7623-73826-65K-00XR	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.30 Meter	UnionTrust
2	HDMI Cable	HDMI-A	1.5 Meter Shielded with two ferrite	UnionTrust
3	Ethernet Cable	RJ45	2 Meter Unshielded without ferrite	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

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1.7 TEST FACILITY

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

Shenzhen UnionTrust Quality and Technology Co., Ltd.

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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	±3.8 dB
2	Conducted emission 150KHz-30MHz	±3.4 dB
3	Radiated emission 9KHz-30MHz	±4.9 dB
4	Radiated emission 30MHz-1GHz	±4.7 dB
5	Radiated emission 1GHz-18GHz	±5.1 dB
6	Radiated emission 18GHz-26GHz	±5.2 dB
7	Radiated emission 26GHz-40GHz	±5.2 dB

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, 2018	Nov. 24, 2019
☐	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2018	Nov. 24, 2019
☒	Loop Antenna	ETS-LINDGREN	6502	00202525	Dec. 03, 2018	Dec. 03, 2019
☒	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Dec. 08, 2018	Dec. 08, 2019
☒	6dB Attenuator	Talent	RA6A5-N-18	18103001	Dec. 08, 2018	Dec. 08, 2019
☒	Preamplifier	HP	8447F	2805A02960	Nov. 24, 2018	Nov. 24, 2019
☐	Broadband Antenna (Pre-amplifier)	ETS-LINDGREN	3142E-PA	00201891	May 19, 2018	May 19, 2019
☐	6dB Attenuator	Talent	RA6A5-N-18	18103002	Nov. 24, 2018	Nov. 24, 2019
☐	Horn Antenna	ETS-LINDGREN	3117	00164202	Dec. 08, 2018	Dec. 08, 2019
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	May 22, 2018	May 22, 2019
☐	Horn Antenna	ETS-LINDGREN	3116C	00200180	May 20, 2018	May 20, 2019
☒	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Jan. 05, 2019	Jan. 05, 2020
☒	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☒	Band Rejection Filter (2400MHz~2500MHz)	Micro-Tronics	BRM50702	G248	Jun. 06, 2018	Jun. 06, 2019
☐	Band Rejection Filter (5150MHz~5880MHz)	Micro-Tronics	BRM50716	G1868	Jun. 06, 2018	Jun. 06, 2019
☒	Test Software	Audix	e3	Software Version: 9.160333		

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, 2018	Nov. 24, 2019
☒	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	Nov. 24, 2018	Nov. 24, 2019
☒	LISN	R&S	ESH2-Z5	860014/024	Nov. 24, 2018	Nov. 24, 2019
☐	LISN	ETS-Lindgren	3816/2SH	00201088	Nov. 24, 2018	Nov. 24, 2019
☒	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	N9010B	MY57110211	Nov. 24, 2018	Nov. 24, 2019
☐	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Nov. 24, 2018	Nov. 24, 2019
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Nov. 24, 2018	Nov. 24, 2019
☒	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Nov. 24, 2018	Nov. 24, 2019

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	Relative Humidity (%)
NT/NV	+15 to +35	120V~60Hz	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	23.3	63	99.8	Gemini Huang
Conducted Peak Output Power	24.3	48	100.01	Tony Kang
6dB Bandwidth	24.3	48	100.01	Tony Kang
Power Spectral Density	24.3	48	100.01	Tony Kang
Conducted Out of Band Emission	24.3	48	100.01	Tony Kang
Radiated Spurious Emissions	25.4	51	99.8	Andy Lin
Band Edge Measurements (Radiated)	25.4	51	99.8	Andy Lin

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	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.

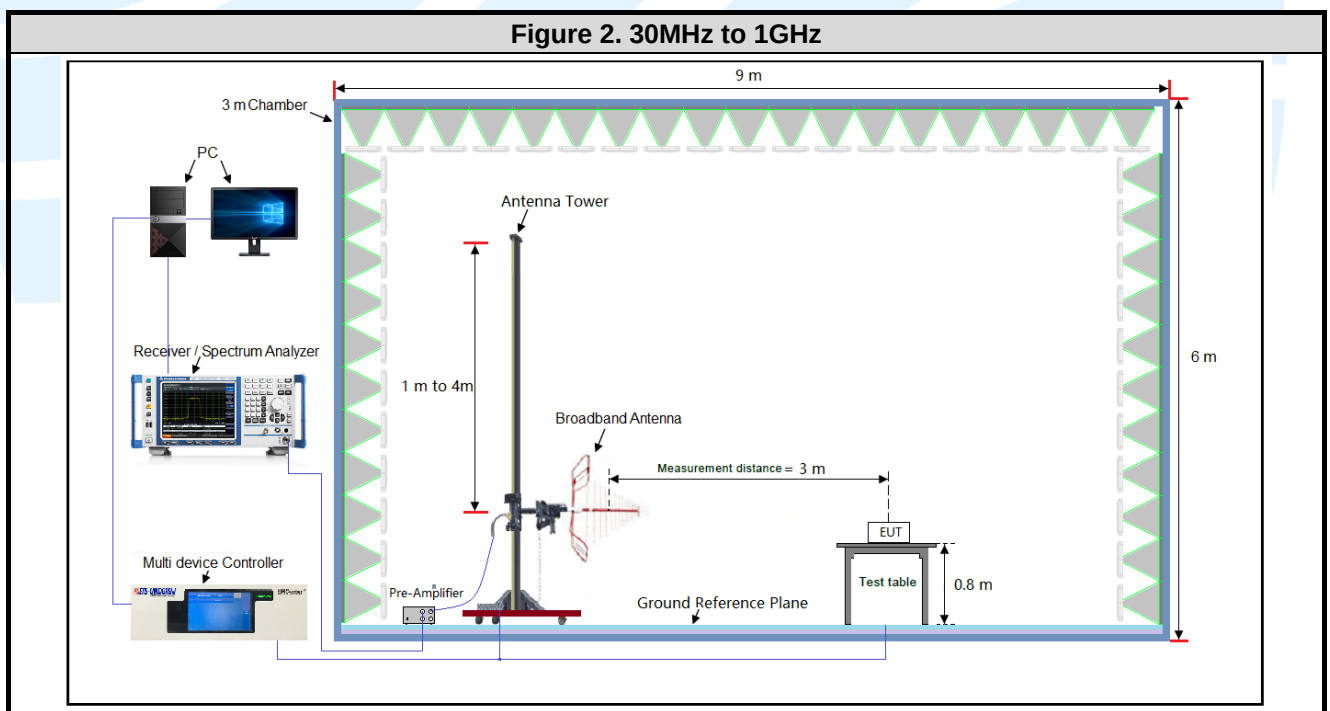
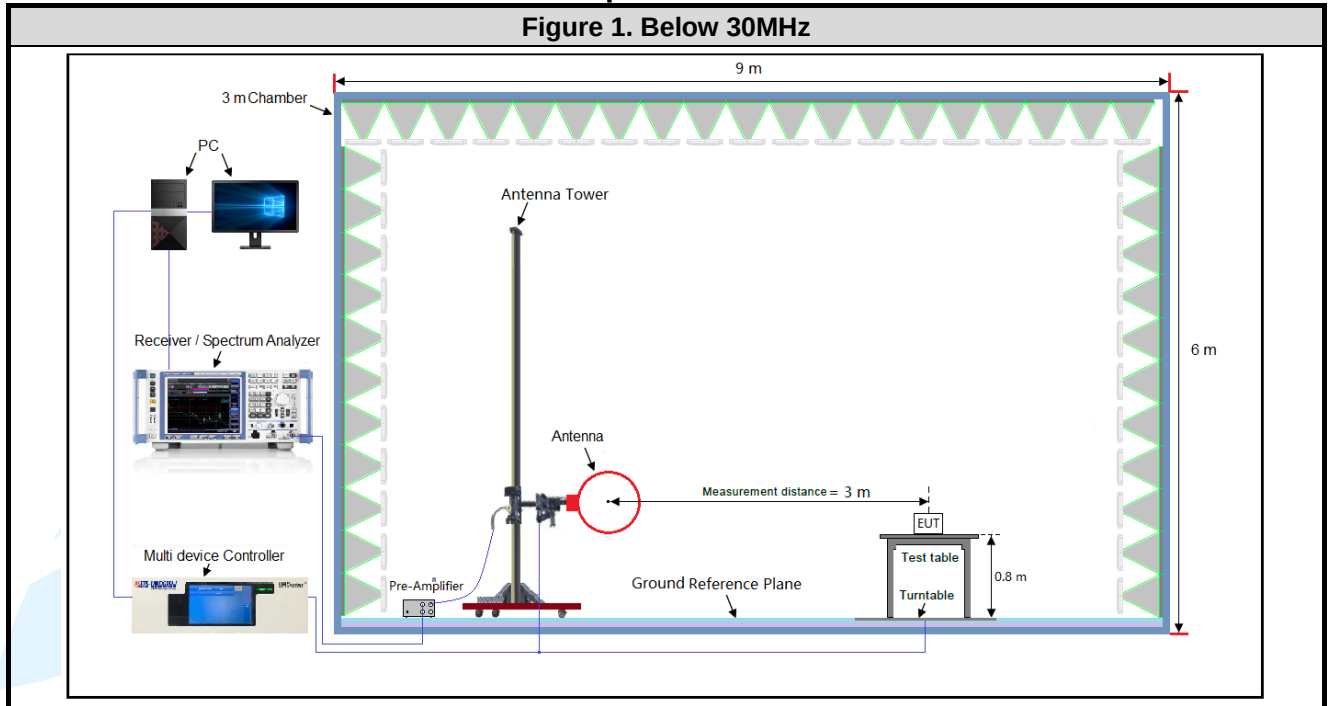
2.4 GHz Wi-Fi Power Setting						
Mode	Channel 1		Channel 6		Channel 11	
	Chain 0	Chain 1	Chain 0	Chain 1	Chain 0	Chain 1
IEEE 802.11b	38	36	38	36	38	36
IEEE 802.11g	38	36	38	36	38	36
IEEE 802.11n-HT20	37	36	37	36	37	36
IEEE 802.11n-HT40	36	35	36	35	36	35
2.4 GHz Wi-Fi Test Software						
Test software name: WLAN Test Tool (Version:2.3.0)						

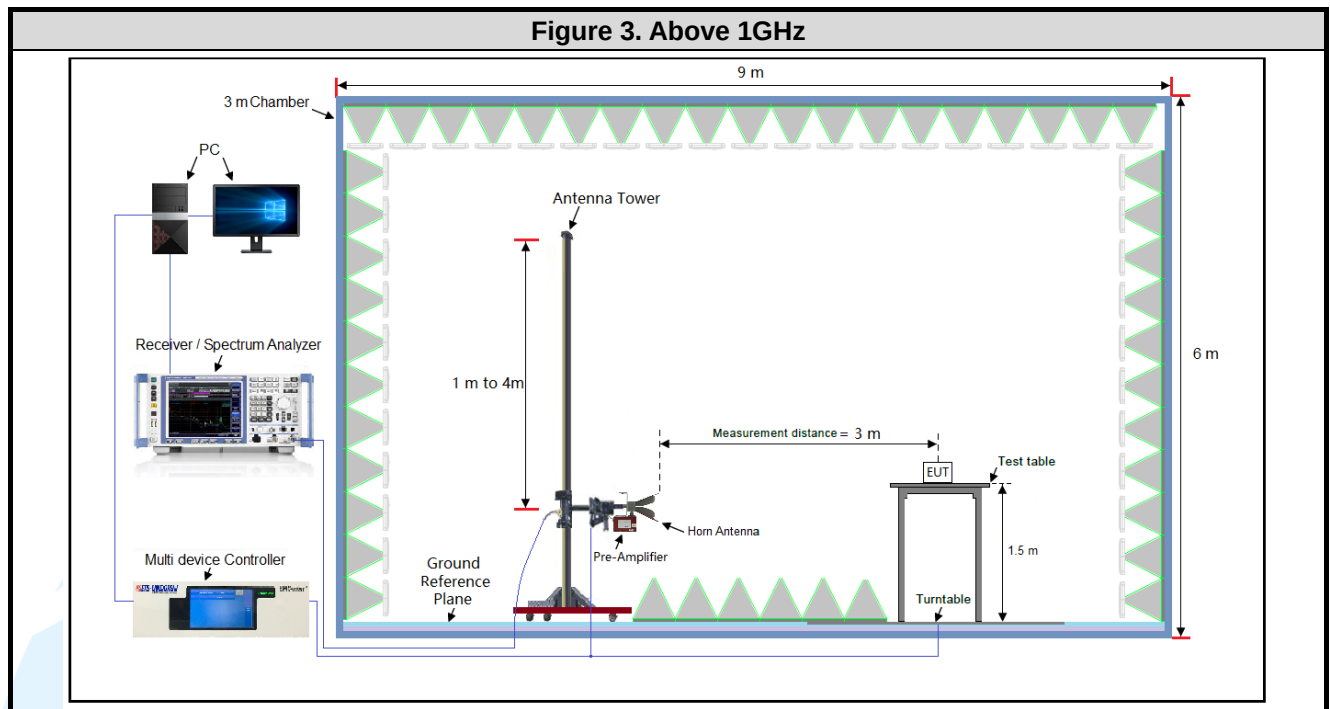
4.4 WORST-CASE DATA RATES

Mode	Worst-case data rates
IEEE 802.11b	1 Mbps
IEEE 802.11g	6 Mbps
IEEE 802.11n-HT20	MCS0
IEEE 802.11n-HT40	MCS0

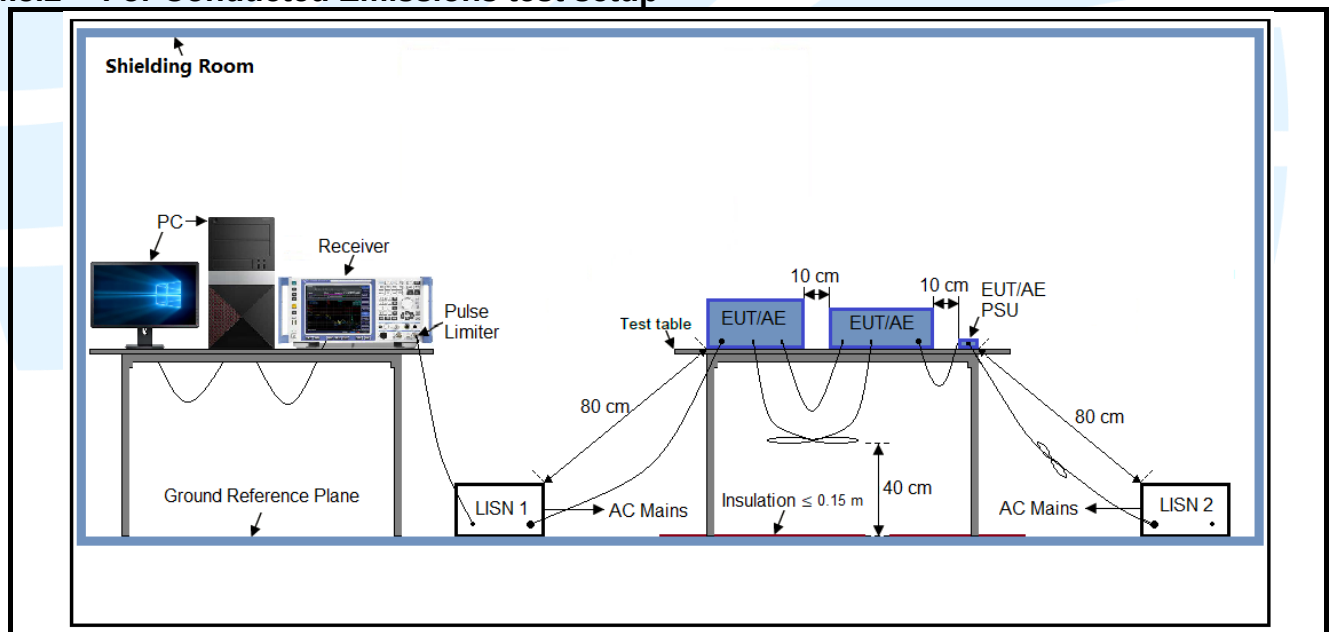
4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

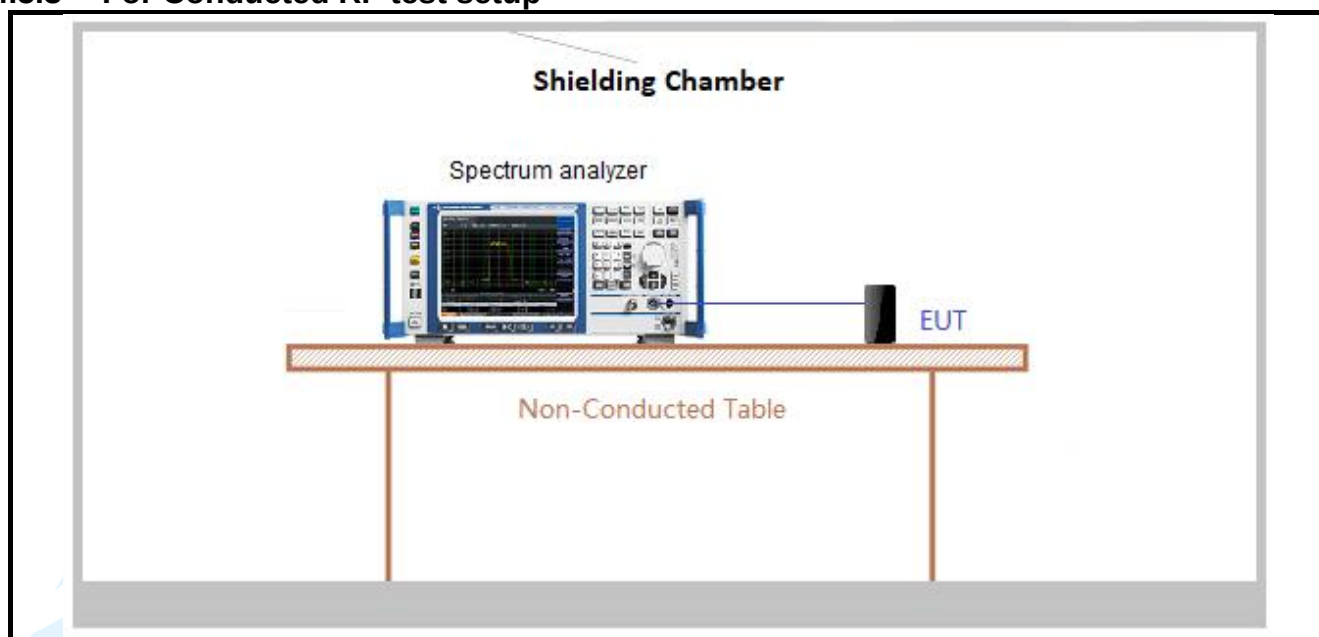




4.5.2 For Conducted Emissions test setup



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. It was powered by 120V~60Hz. 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.

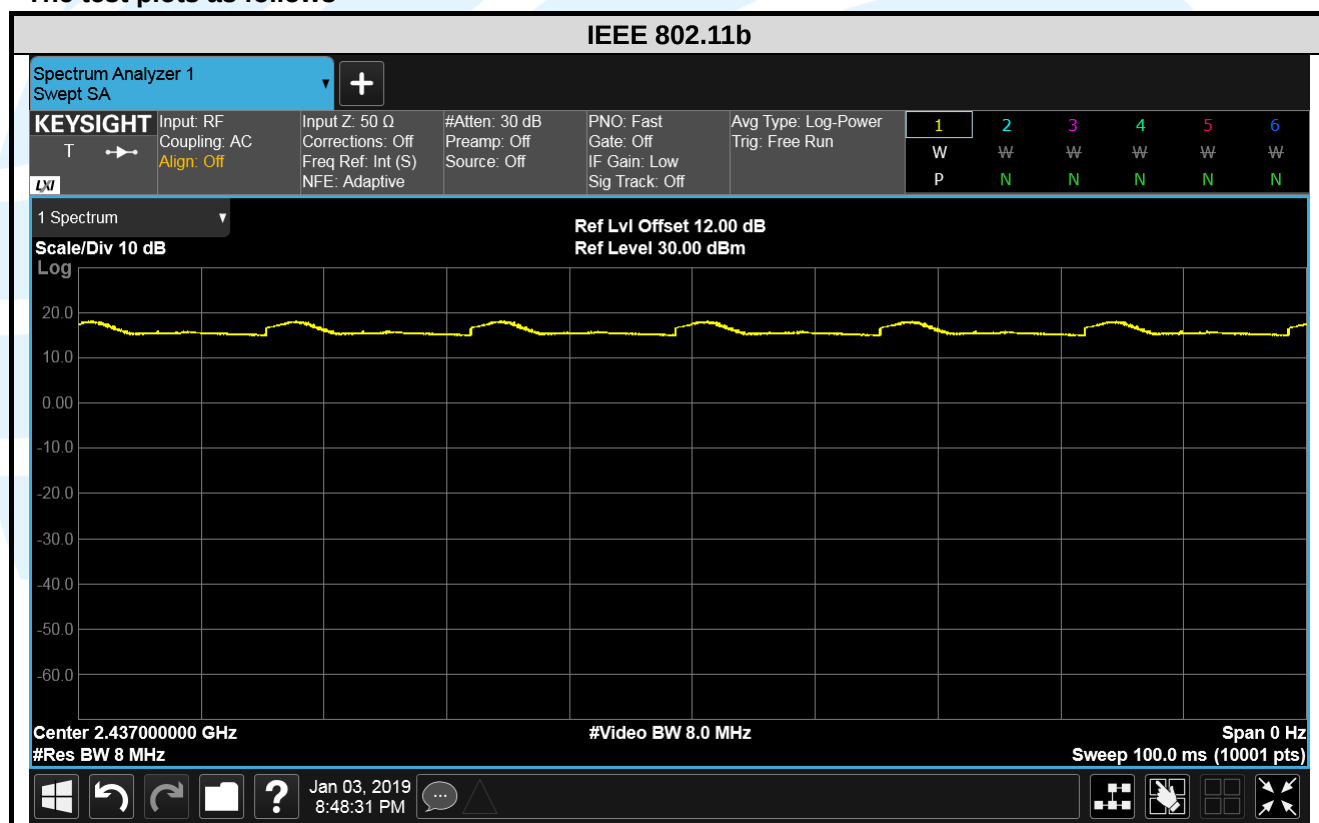
Test Results

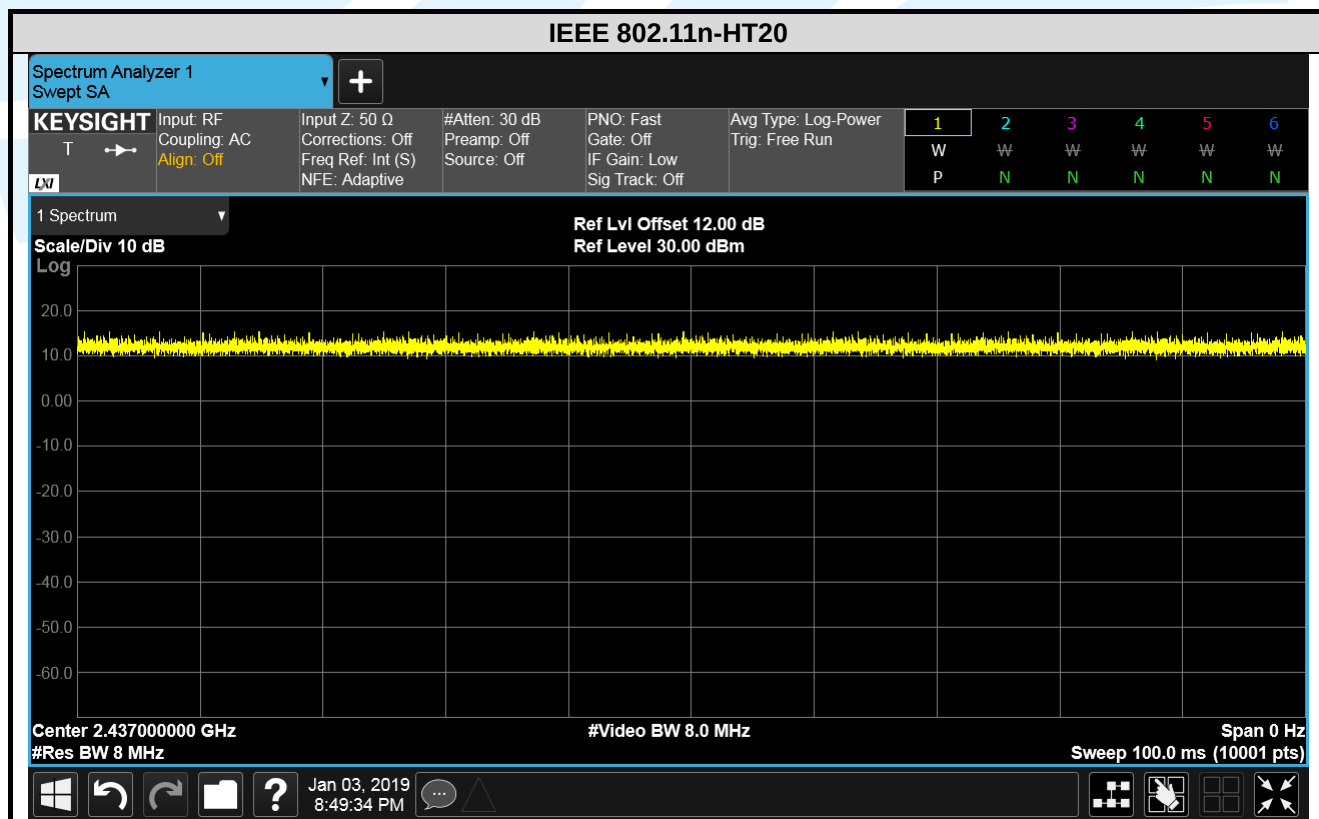
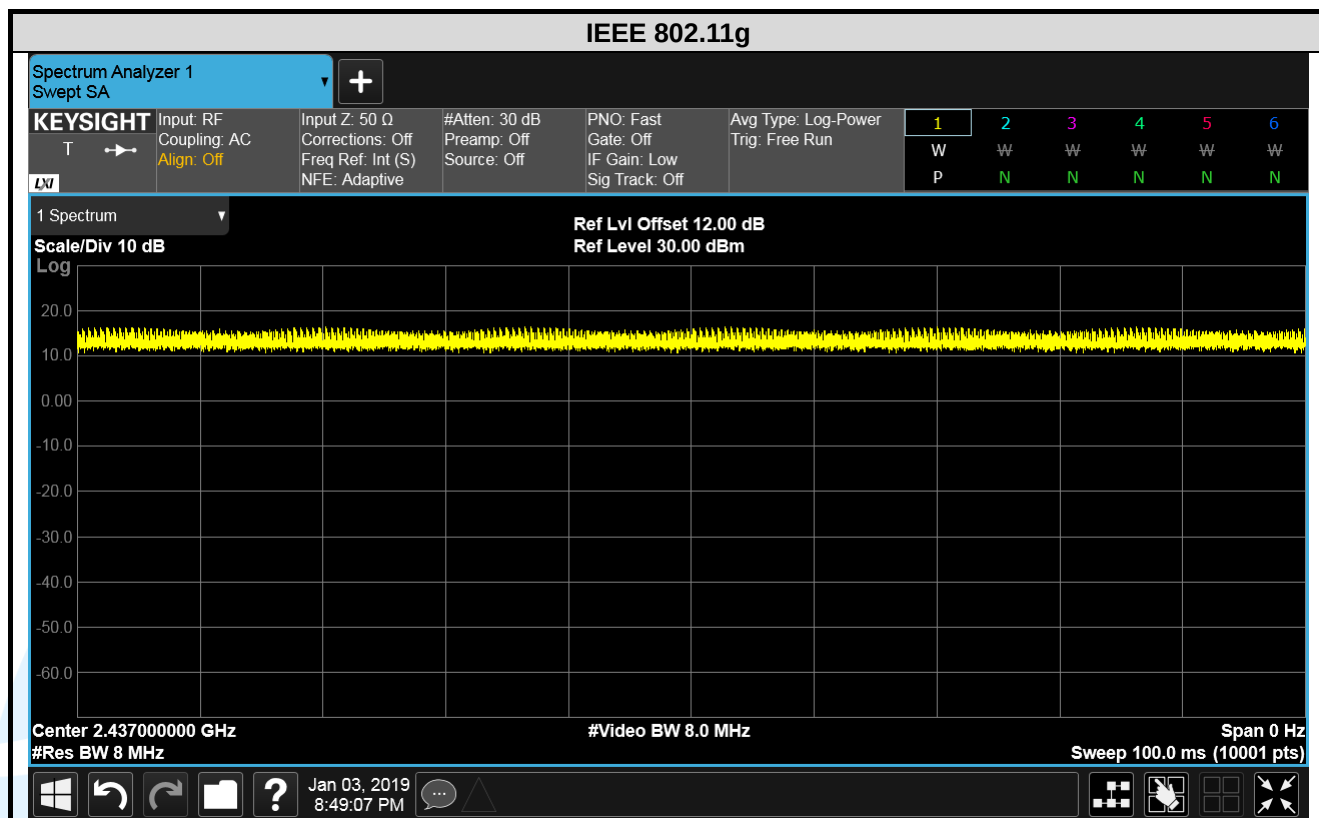
Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/ T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11b	1	1	1	1.00	100.00	0.00	0.01	0.00
IEEE 802.11g	6	1	1	1.00	100.00	0.00	0.01	0.00
IEEE 802.11n-HT20	MCS0	1	1	1.00	100.00	0.00	0.01	0.00
IEEE 802.11n-HT40	MCS0	1	1	1.00	100.00	0.00	0.01	0.00

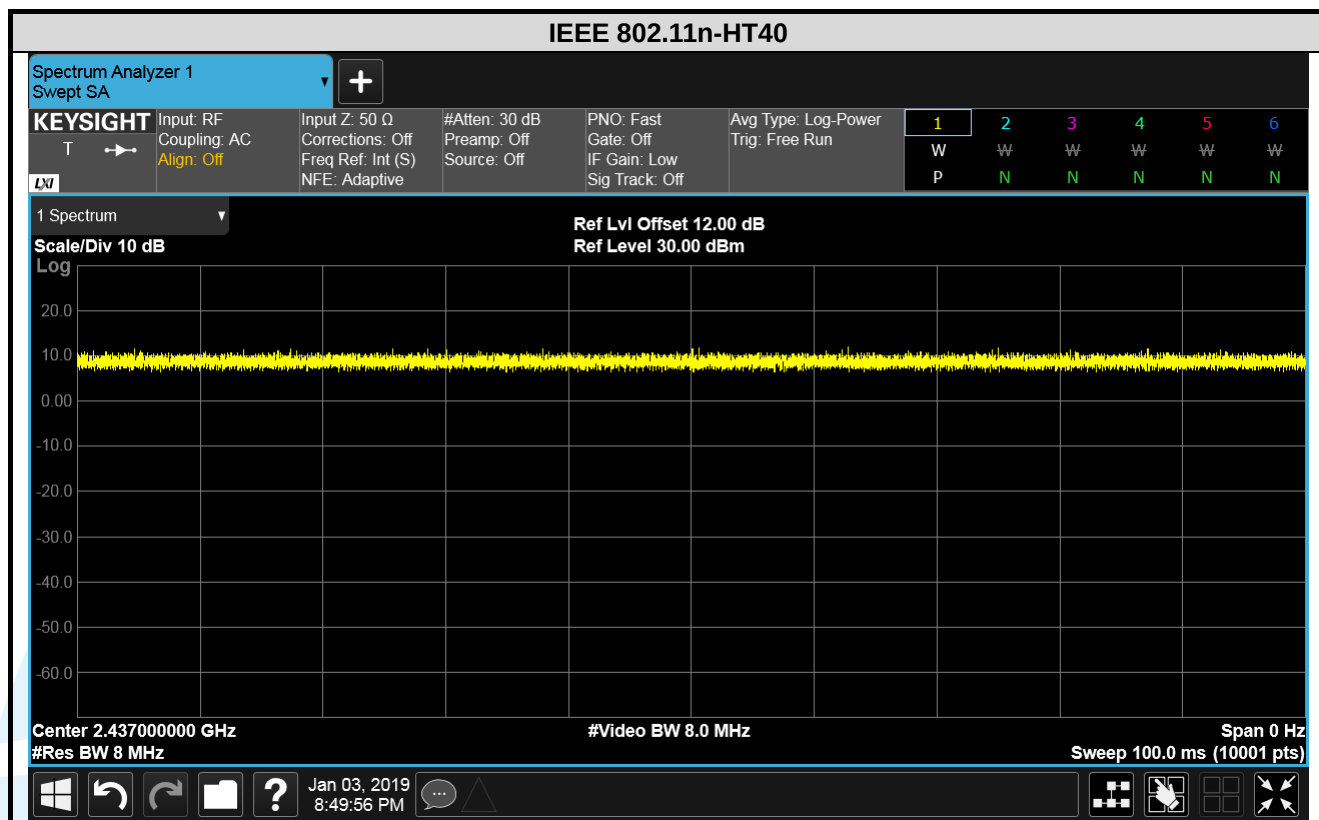
Remark:

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

The test plots as follows







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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 Unlicensed 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: Both antenna in the external of the equipment 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 7.59 dBi (See section 5.3).

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (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)				Pass / Fail
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit (dBm)	
IEEE 802.11b	1(2412)	15.80	15.32	---	30	Pass
	6(2437)	15.68	15.52	---	30	Pass
	11(2462)	15.50	15.64	---	30	Pass
IEEE 802.11g	1(2412)	19.80	19.71	---	30	Pass
	6(2437)	19.74	19.87	---	30	Pass
	11(2462)	19.52	19.82	---	30	Pass
IEEE 802.11n-HT20	1(2412)	17.64	17.34	20.50	28.41	Pass
	6(2437)	17.24	17.31	20.29	28.41	Pass
	11(2462)	17.58	17.27	20.44	28.41	Pass
IEEE 802.11n-HT40	3(2422)	16.77	17.00	19.90	28.41	Pass
	6(2437)	16.21	16.87	19.56	28.41	Pass
	9(2452)	16.72	17.21	19.98	28.41	Pass

Remark:

1. Total (Chain 0+1) = $10 \cdot \log[(10^{\text{Chain 0}/10}) + (10^{\text{Chain 1}/10})]$

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	4.58	4.58	7.59	28.41
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 <i>correlated</i> 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) $\geq 3 \times$ 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.

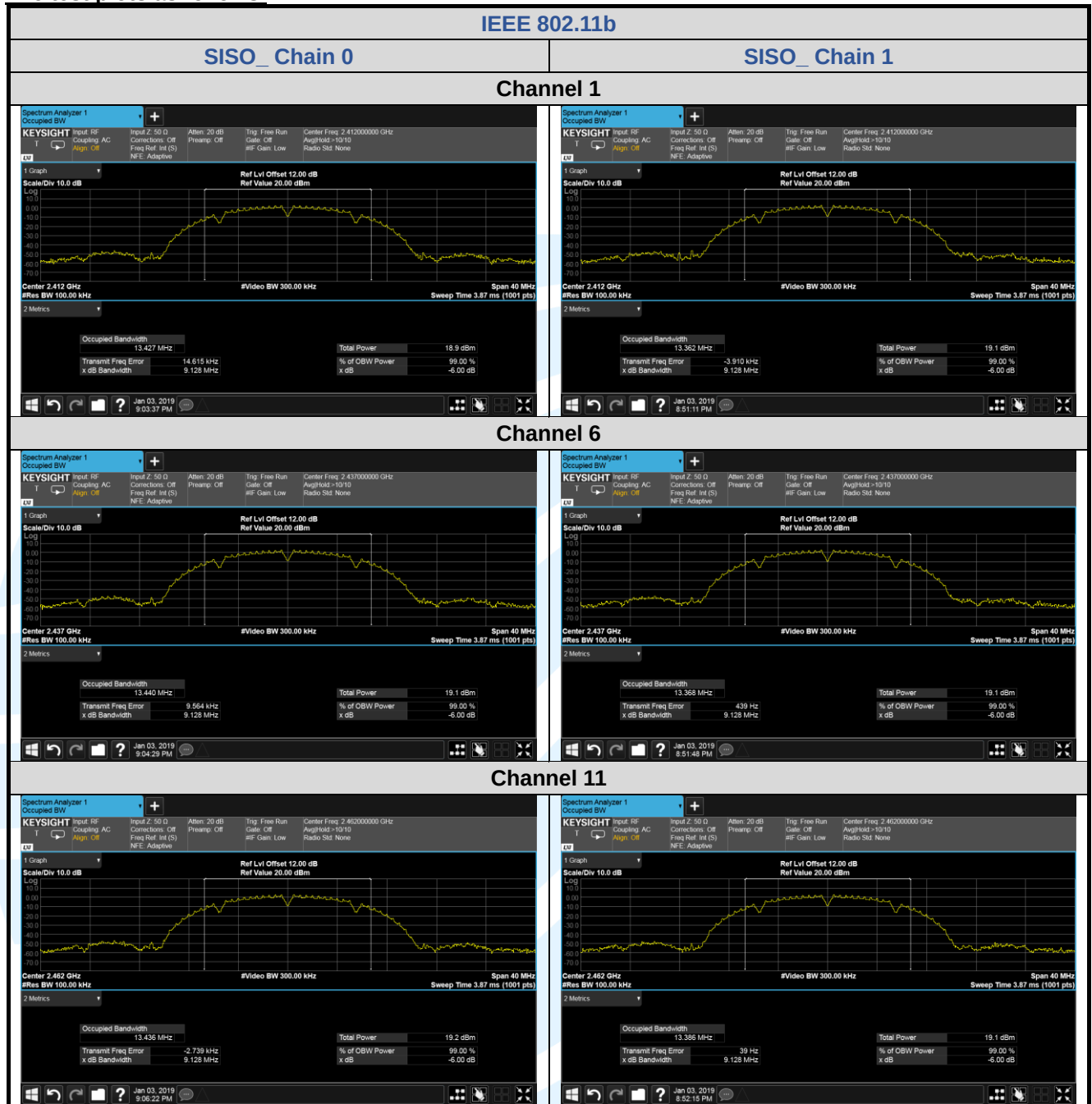
Test Setup: Refer to section 4.5.3 for details.

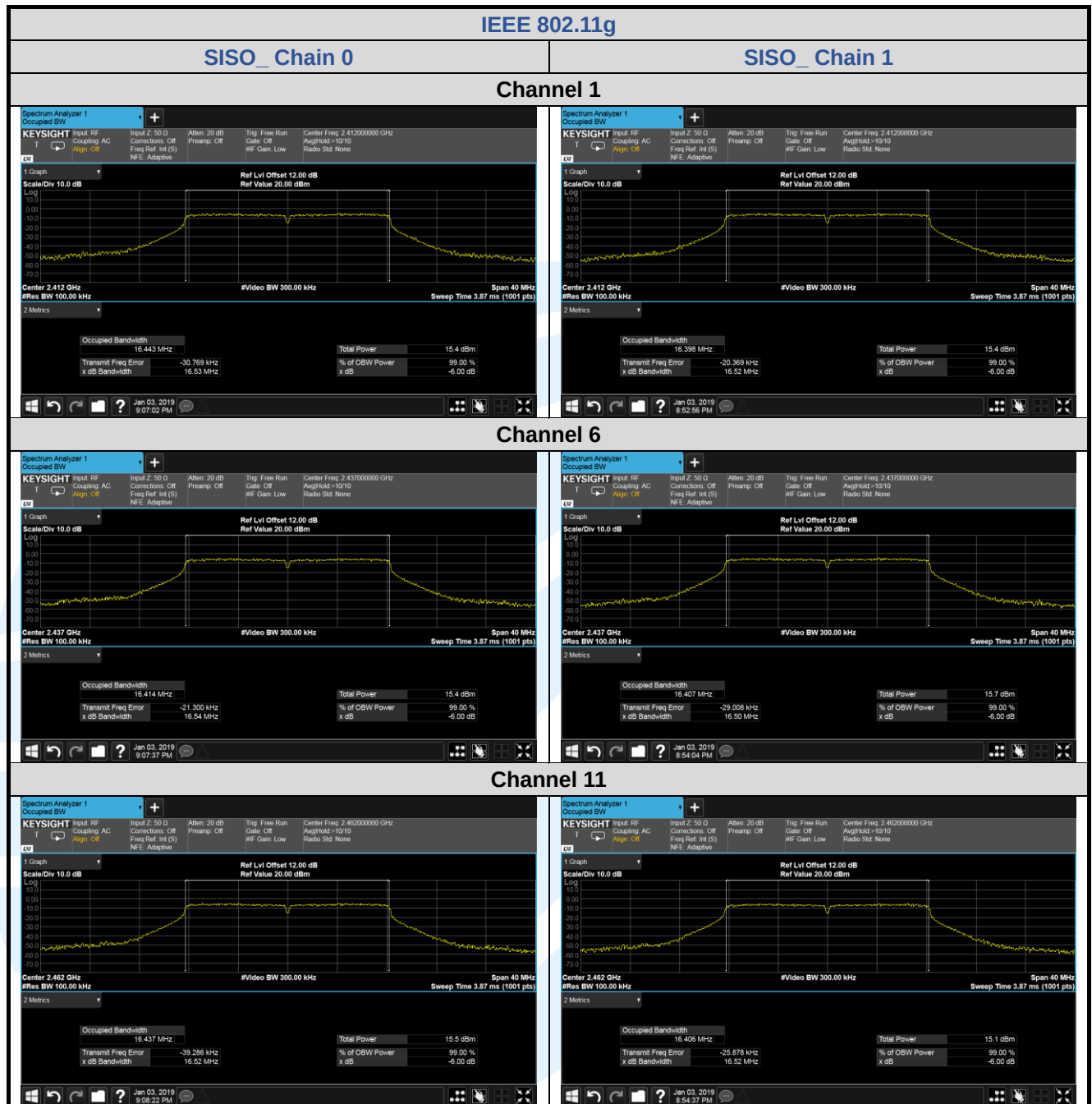
Instruments Used: Refer to section 3 for details

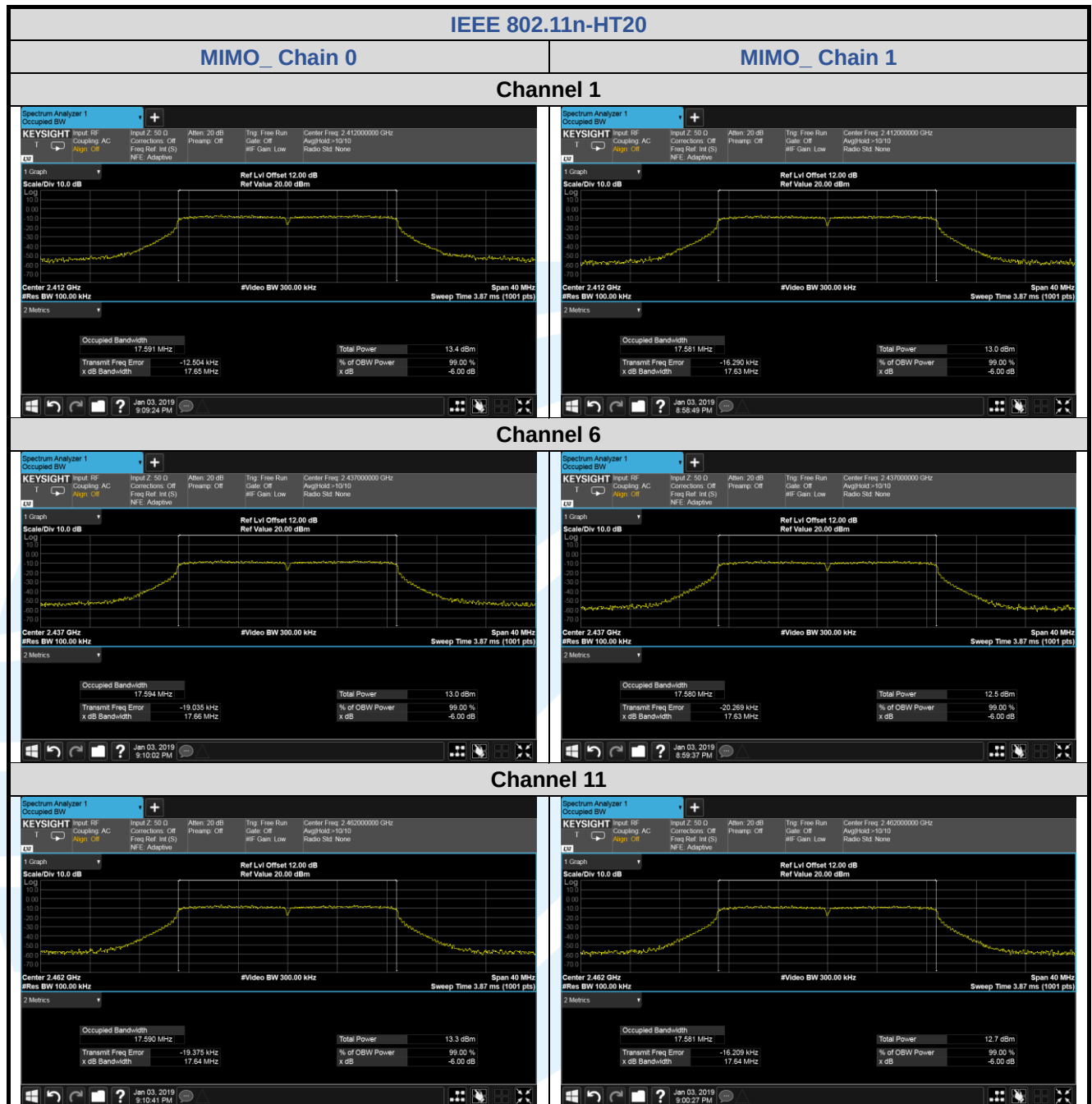
Test Results:

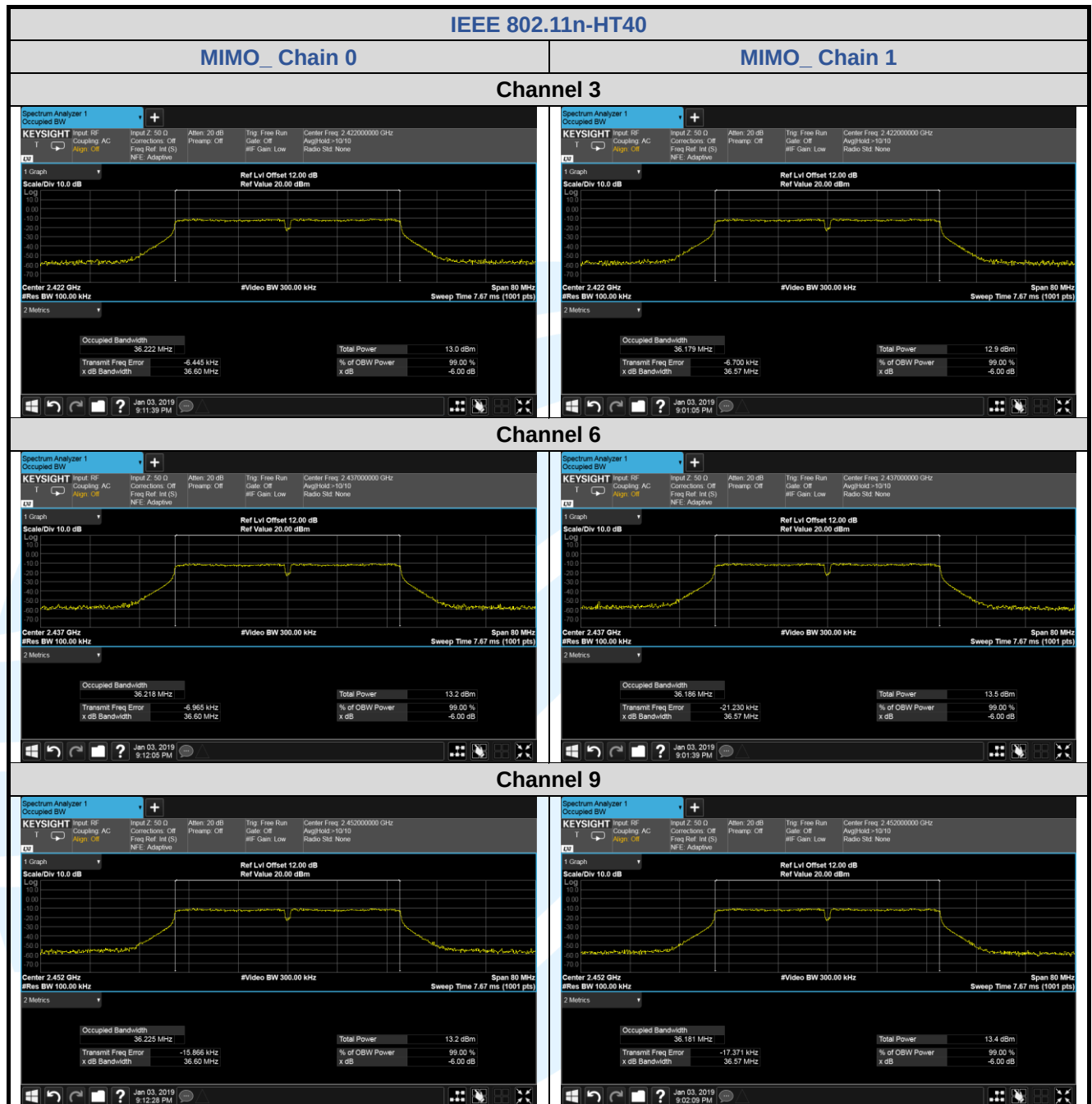
Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)		99% Bandwidth (MHz)		6 dB Bandwidth Limit	Pass / Fail
		Chain 0	Chain 1	Chain 0	Chain 1		
IEEE 802.11b	1(2412)	9.128	9.128	13.427	13.362	> 500 kHz	Pass
	6(2437)	9.128	9.128	13.440	13.368	> 500 kHz	Pass
	11(2462)	9.128	9.128	13.436	13.386	> 500 kHz	Pass
IEEE 802.11g	1(2412)	16.53	16.52	16.443	16.398	> 500 kHz	Pass
	6(2437)	16.54	16.50	16.414	16.407	> 500 kHz	Pass
	11(2462)	16.52	16.52	16.437	16.406	> 500 kHz	Pass
IEEE 802.11n- HT20	1(2412)	17.65	17.63	17.591	17.581	> 500 kHz	Pass
	6(2437)	17.66	17.63	17.594	17.580	> 500 kHz	Pass
	11(2462)	17.64	17.64	17.590	17.581	> 500 kHz	Pass
IEEE 802.11n- HT40	3(2422)	36.60	36.57	36.222	36.179	> 500 kHz	Pass
	6(2437)	36.60	36.57	36.218	36.186	> 500 kHz	Pass
	9(2452)	36.60	36.57	36.225	36.181	> 500 kHz	Pass

The test plots as follows:









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:

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- Set the VBW $\geq 3 \times \text{RBW}$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- 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)				Pass / Fail
		SISO_Chain 0	SISO_Chain 1	Total Power MIMO_Chain 0+1	Limit @3kHz (dBm)	
IEEE 802.11b	1(2412)	-18.1	-17.82	---	8	Pass
	6(2437)	-17.74	-17.86	---	8	Pass
	11(2462)	-17.52	-17.82	---	8	Pass
IEEE 802.11g	1(2412)	-20.11	-19.58	---	8	Pass
	6(2437)	-19.36	-19.79	---	8	Pass
	11(2462)	-19.19	-19.67	---	8	Pass
IEEE 802.11n-HT20	1(2412)	-20.1	-20.83	-17.44	6.41	Pass
	6(2437)	-20.51	-20.52	-17.50	6.41	Pass
	11(2462)	-20.47	-19.95	-17.19	6.41	Pass
IEEE 802.11n-HT40	3(2422)	-22.58	-21.84	-19.18	6.41	Pass
	6(2437)	-22.16	-23.55	-19.79	6.41	Pass
	9(2452)	-22.17	-22.69	-19.41	6.41	Pass

Remark:

1. Total (Chain 0+1) = $10 \cdot \log[(10^{\text{Chain 0/10}}) + (10^{\text{Chain 1/10}})]$

2. Directional gain and the maximum conducted power spectral density limit see table below:

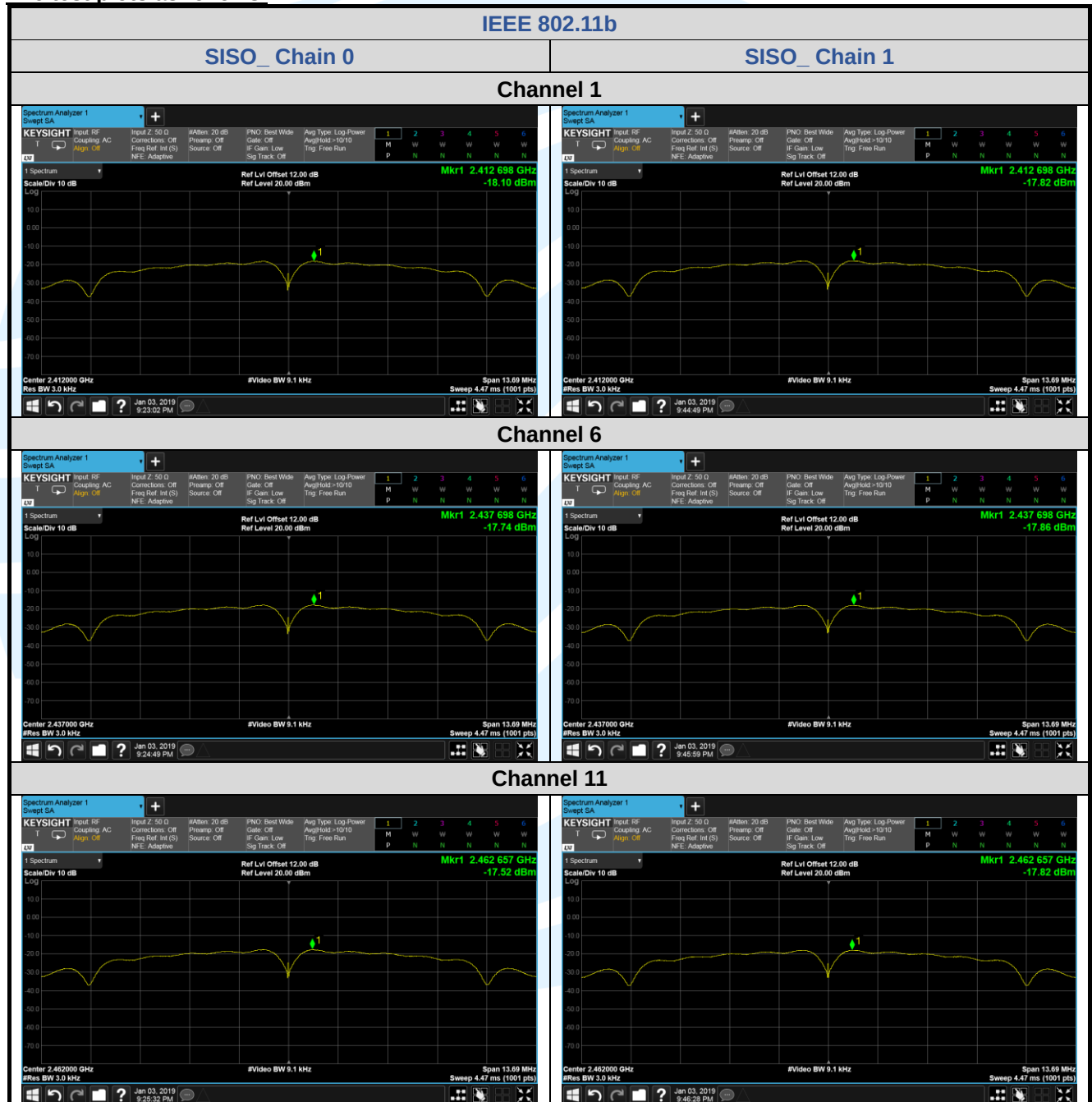
Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	4.58	4.58	7.59	6.41

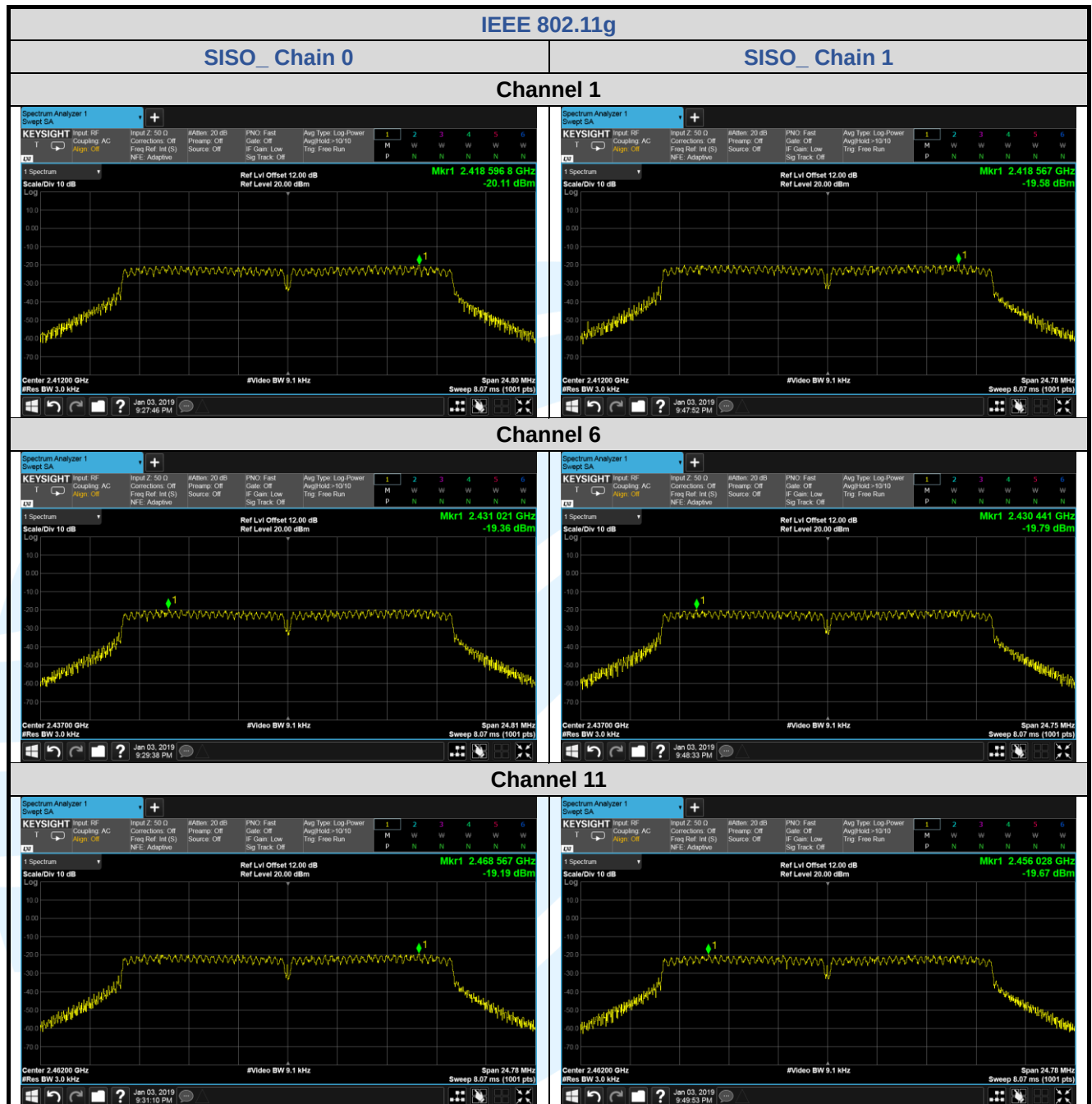
Basic methodology with N_{ANT} transmit antennas, each with the same directional gain G_{ANT} dBi, being driven by N_{ANT} transmitter outputs of equal power. Directional gain is to be computed as follows:

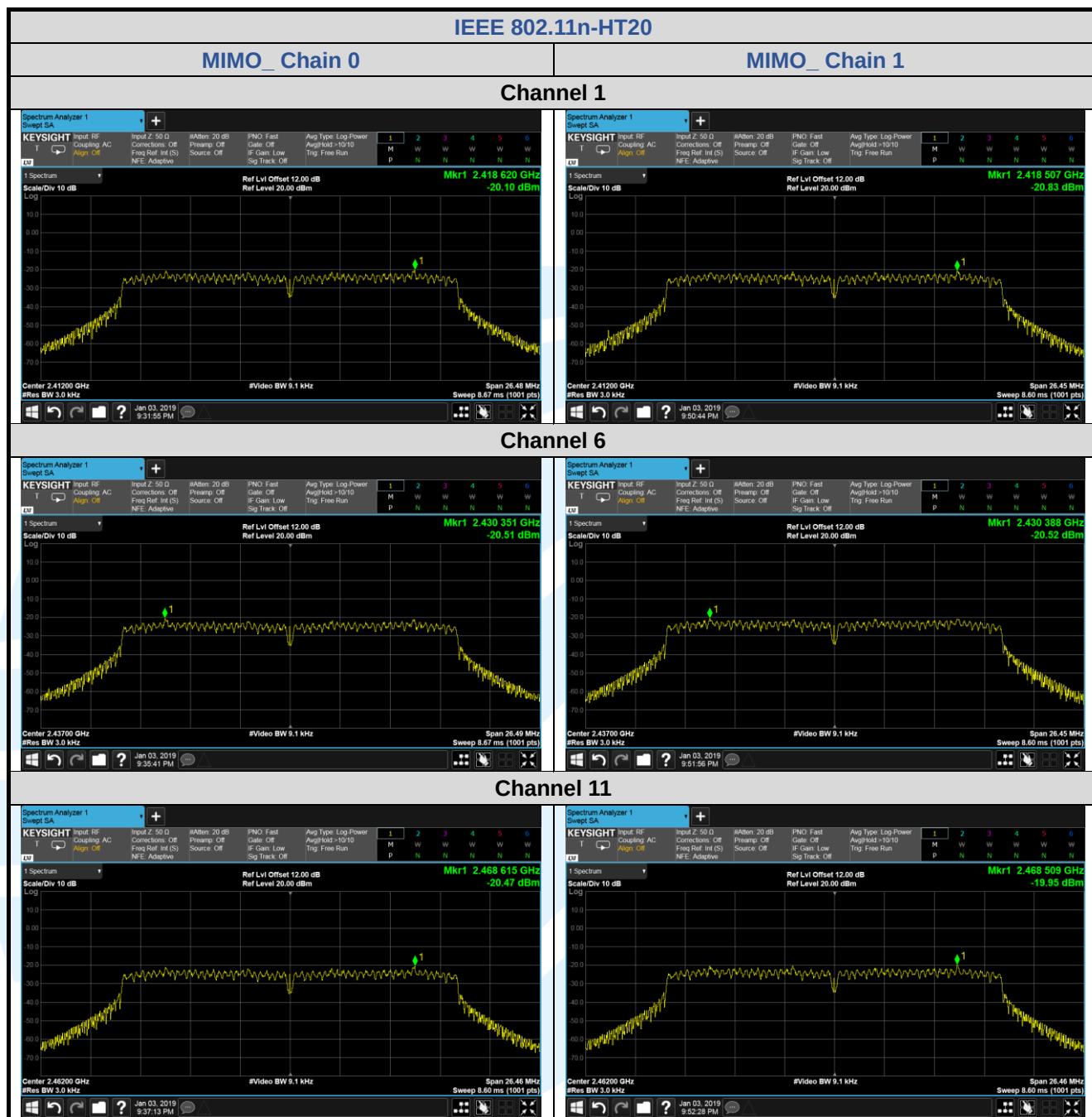
If any transmit signals are *correlated* with each other,

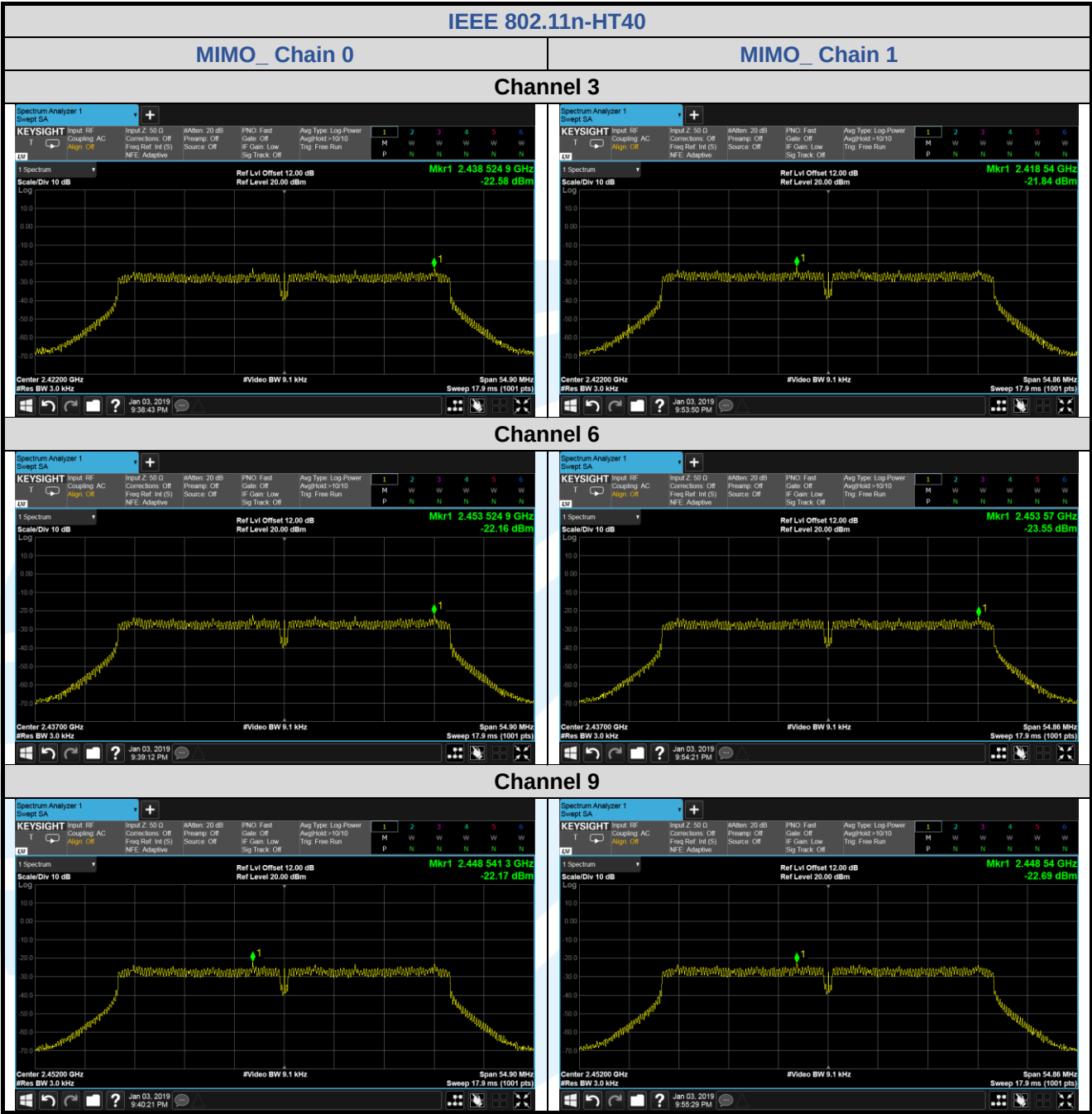
$$\text{Directional gain} = G_{ANT} + 10 \log(N_{ANT}) \text{ dBi}$$

The test plots as follows:









Channel 6

Spectrum Analyzer 1
Sweep SA

KEYSIGHT Input RF
Coupling AC
Align Off

Input Z: 50 Ω
Corrections Off
Freq Ref: Int (S)
NFE: Adaptive

#Att: 20 dB
Preamp Off
Source Off

PNO: Fast
Gate Off
IF Gain: Low
Sig Track Off

Avg Type: Log Power
AverHold: 10/10
Trig: Free Run

1 2 3 4 5 6
M W W W W W
P N N N N N

1 Spectrum
Scale/Div 10 dB
Log

Ref Lvl Offset 12.00 dB
Ref Level 20.00 dBm

Mkr1 2.453 524.9 GHz
-22.16 dBm

Center 2.43700 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 54.80 MHz
Sweep 17.9 ms (1001 pts)

Jan 03, 2019
9:39:12 PM

Spectrum Analyzer 1
Sweep SA

KEYSIGHT Input RF
Coupling AC
Align Off

Input Z: 50 Ω
Corrections Off
Freq Ref: Int (S)
NFE: Adaptive

#Att: 20 dB
Preamp Off
Source Off

PNO: Fast
Gate Off
IF Gain: Low
Sig Track Off

Avg Type: Log Power
AverHold: 10/10
Trig: Free Run

1 2 3 4 5 6
M W W W W W
P N N N N N

1 Spectrum
Scale/Div 10 dB
LogRef Lvl Offset 12.00 dB
Ref Level 20.00 dBmMkr1 2.453 57 GHz
-23.55 dBmCenter 2.43700 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 54.80 MHz
Sweep 17.9 ms (1001 pts)Jan 03, 2019
9:54:21 PM

Channel 9

Spectrum Analyzer 1
Sweep SA

KEYSIGHT Input RF
Coupling AC
Align Off

Input Z: 50 Ω
Corrections Off
Freq Ref: Int (S)
NFE: Adaptive

#Att: 20 dB
Preamp Off
Source Off

PNO: Fast
Gate Off
IF Gain: Low
Sig Track Off

Avg Type: Log Power
AverHold: 10/10
Trig: Free Run

1 2 3 4 5 6
M W W W W W
P N N N N N

1 Spectrum
Scale/Div 10 dB
Log

Ref Lvl Offset 12.00 dB
Ref Level 20.00 dBm

Mkr1 2.448 541.3 GHz
-22.17 dBm

Center 2.45200 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 54.80 MHz
Sweep 17.9 ms (1001 pts)

Jan 03, 2019
9:40:21 PM

Spectrum Analyzer 1
Sweep SA

KEYSIGHT Input RF
Coupling AC
Align Off

Input Z: 50 Ω
Corrections Off
Freq Ref: Int (S)
NFE: Adaptive

#Att: 20 dB
Preamp Off
Source Off

PNO: Fast
Gate Off
IF Gain: Low
Sig Track Off

Avg Type: Log Power
AverHold: 10/10
Trig: Free Run

1 2 3 4 5 6
M W W W W W
P N N N N N

1 Spectrum
Scale/Div 10 dB
LogRef Lvl Offset 12.00 dB
Ref Level 20.00 dBmMkr1 2.448 54 GHz
-22.69 dBmCenter 2.45200 GHz
#Res BW 3.0 kHz
#Video BW 9.1 kHz
Span 54.80 MHz
Sweep 17.9 ms (1001 pts)Jan 03, 2019
9:55:29 PM

5.6 CONDUCTED OUT OF BAND EMISSION

Test Requirement:	FCC 47 CFR Part 15 Subpart C Section 15.247(d)
Test Method:	ANSI C63.10-2013 Clause 11.11
Limit:	In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.
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: Step 1: Measurement Procedure REF a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 times the DTS bandwidth. c) Set the RBW = 100 kHz. d) Set the VBW $\geq 3 \times$ 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 PSD level. j) Note that the channel found to contain the maximum PSD level can be used to establish the reference level. Step 2: Measurement Procedure OOBE a) Set RBW = 100 kHz. b) Set VBW ≥ 300 kHz. c) Detector = peak. d) Sweep = auto couple. e) Trace Mode = max hold. f) Allow trace to fully stabilize. g) Use the peak marker function to determine the maximum amplitude 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

The test plots as follows:

