RF TEST REPORT

SIEMIC
A Bureau Veritas Group Company

Report No.: FCC_IC_RF_SL19041703-ROK-001 Rev 1.0
Supersede Report No.: FCC_IC_RF_SL19041703-ROK-001

Applicant	:	Roku, Inc.
Product Name	:	STB
Model No.	:	3930X, 3931X, 3932X
Test Standard	:	47 CFR 15.247 RSS 247 Issue 2, February 2017
Test Method	:	ANSI C63.10: 2013 RSS Gen Issue 5, April 2018 558074 D01 15.247 Meas Guidance v05r01
FCC ID	:	TC2-R1027
IC ID	:	5959A-R1025
Dates of test	:	05/24/2019-06/03/2019
Issue Date	:	07/25/2019
Test Result	:	☒ Pass ☐ Fail
Equipment complied with the specification [X] Equipment did not comply with the specification [ ]		

This Test Report is Issued Under the Authority of:	
Deon	Chen
Deon Dai	**Chen Ge**
Test Engineer	Engineer Reviewer

Issued By:
SIEMIC Laboratories
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ilac-MRA
ACCREDITED
TESTING CERT # 2742-01

Laboratory Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.

In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

Accreditations for Conformity Assessment

Country/Region	Accreditation Body	Scope
USA	FCC, A2LA	EMC, RF/Wireless, Telecom
Canada	IC, A2LA, NIST	EMC, RF/Wireless, Telecom
Taiwan	BSMI, NCC, NIST	EMC, RF, Telecom, Safety
Hong Kong	OFTA, NIST	RF/Wireless, Telecom
Australia	NATA, NIST	EMC, RF, Telecom, Safety
Korea	KCC/RRA, NIST	EMI, EMS, RF, Telecom, Safety
Japan	VCCI, JATE, TELEC, RFT	EMI, RF/Wireless, Telecom
Mexico	NOM, COFETEL, Caniety	Safety, EMC, RF/Wireless, Telecom
Europe	A2LA, NIST	EMC, RF, Telecom, Safety
Israel	MOC, NIST	EMC, RF, Telecom, Safety

Accreditations for Product Certifications

Country	Accreditation Body	Scope
USA	FCC TCB, NIST	EMC, RF, Telecom
Canada	IC FCB, NIST	EMC, RF, Telecom
Singapore	iDA, NIST	EMC, RF, Telecom
EU	NB	EMC & R&TTE Directive
Japan	MIC (RCB 208)	RF, Telecom
Hong Kong	OFTA (US002)	RF, Telecom

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1 Report Revision History

Report No.	Report Version	Description	Issue Date
FCC_IC_RF_SL19041703-ROK-001	None	Original	05/31/2019
FCC_IC_RF_SL19041703-ROK-001 Rev 1.0	Rev 1.0	Updated product name and antenna information	07/25/2019

2 Executive Summary

The purpose of this test program was to demonstrate compliance of following product

Company:	Roku, Inc.
Product:	STB
Model:	3930X, 3931X, 3932X

against the current Stipulated Standards. The specified model product stated above has demonstrated compliance with the Stipulated Standard listed on 1st page.

3 Customer information

Applicant Name	:	Roku, Inc.
Applicant Address	:	150 Winchester Circle, Los Gatos CA 95032
Manufacturer Name	:	Roku, Inc.
Manufacturer Address	:	150 Winchester Circle, Los Gatos CA 95032

4 Test site information

Lab performing tests	SIEMIC Laboratories
Lab Address	775 Montague Expressway, Milpitas, CA 95035
FCC Test Site No.	540430
IC Test Site No.	4842D
VCCI Test Site No.	A0133

5 Modification

Index	Item	Description	Note
-	-	-	-

6 EUT Information

6.1 EUT Description

Product Name	STB
Model No.	3930X, 3931X, 3932X
Trade Name	Roku
Serial No.	431806000043
Host Model No.	N/A
Input Power	120V-240V 50/60 Hz
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Date of EUT received	05/16/2019
Equipment Class/ Category	DTS

6.2 Radio Description

Radio Type	802.11b	802.11g	802.11n-20M
Operating Frequency	2412-2462MHz	2412-2462MHz	2412-2462MHz
Modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM)	OFDM (BPSK, QPSK, 16QAM, 64QAM)
Channel Spacing	5MHz	5MHz	5MHz
Number of Channels	11	11	11
Antenna Type	Chip Antenna		
Antenna Gain (Peak)	2.4G: 3.8 dBi		
Antenna Connector Type	N/A		
Note	N/A		

EUT Power level setting

Mode	Frequency (MHz)	Power setting
802.11-b	2412	60
802.11-b	2437	62
802.11-b	2462	62
802.11-g	2412	57
802.11-g	2437	62
802.11-g	2462	56
802.11-n-20	2412	55
802.11-n-20	2437	62
802.11-n-20	2462	53

7 Supporting Equipment/Software and cabling Description

7.1 Supporting Equipment

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
1	Laptop	PP01L Latitude E5440	F1WPF12	Dell	-
2					-

7.2 Cabling Description

Name	Connection Start		Connection Stop		Length / shielding Info		Note
	From	I/O Port	To	I/O Port	Length (m)	Shielding	
							-
							-

7.3 Test Software Description

Test Item	Software	Description
RF Testing	TeraTerm	Set the EUT to transmit continuously in diferent test mode

8 Test Summary

Test Item	Test standard		Test Method/Procedure		Pass / Fail
Restricted Band of Operation	FCC	15.205	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v05r01	☒ Pass ☐ N/A
	IC	RSS Gen 8.10	IC		
AC Conducted Emissions	FCC	15.207(a)	FCC	ANSI C63.10:2013	☒ Pass ☐ N/A
	IC	RSS Gen 8.8	IC	RSS Gen Issue 5: 2018	

DTS Band Requirement

Test Item	Test standard		Test Method/Procedure		Pass / Fail
99% Occupied Bandwidth	-	-	-	-	☒ Pass ☐ N/A
	IC	RSS Gen 6.7	IC	RSS Gen Issue 5: 2018	
6dB Bandwidth	FCC	15.247(a)(2)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v05r01	☒ Pass ☐ N/A
	IC	RSS247 (5.2.a)	IC		
Band Edge and Radiated Spurious Emissions	FCC	15.247(d)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v05r01	☒ Pass ☐ N/A
	IC	RSS247 (5.5)	IC		
Output Power	FCC	15.247(b)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v05r01	☒ Pass ☐ N/A
	IC	RSS247 (5.4.d)	IC		
Receiver Spurious Emissions	IC	RSS Gen (7.3)	IC	RSS Gen Issue 5: 2018	☐ Pass ☒ N/A
Antenna Gain > 6 dBi	FCC	15.247(e)	FCC	-	☐ Pass ☒ N/A
	IC	-	IC	-	
Power Spectral Density	FCC	15.247(e)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v05r01	☒ Pass ☐ N/A
	IC	RSS247 (5.2.b)	IC		
RF Exposure requirement	FCC	15.247(i)	FCC	-	☐ Pass ☒ N/A
	IC	RSS Gen(3.4)	IC	RSS Gen Issue 5: 2018	
Remark	1. All measurement uncertainties do not take into consideration for all presented test results. 2. The applicant shall ensure frequency stability by showing that an emission is maintained within the band of operation under all normal operating conditions as specified in the user's manual.				

9 Measurement Uncertainty

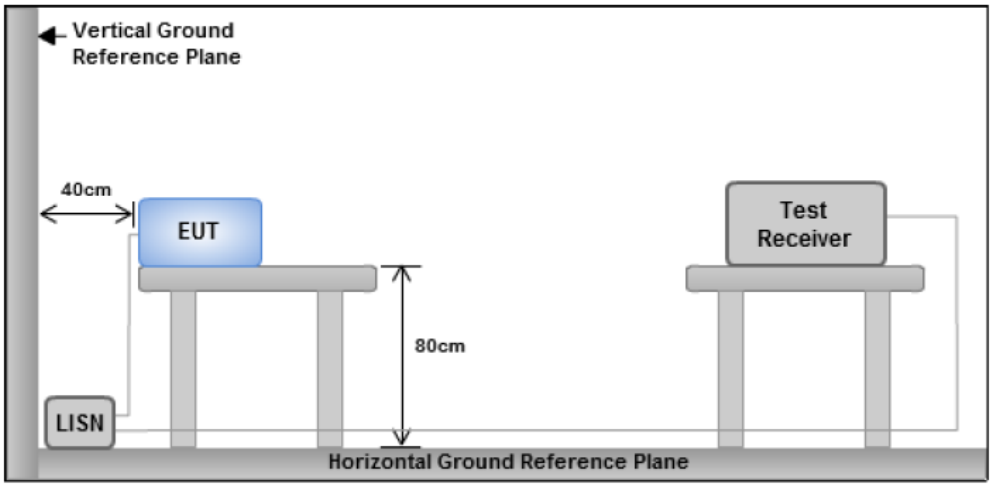
Emissions			
Test Item	**Frequency Range**	**Description**	**Uncertainty**
AC Conducted Emissions	150KHz – 30MHz	Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2	±3.5dB
RF conducted measurement	150KHz – 40GHz	Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2	±0.95dB
Radiated Spurious Emissions	30MHz – 1GHz	Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2 (for EUTs < 0.5m X 0.5m X 0.5m)	±6dB
Radiated Spurious Emissions	1GHz – 40GHz	Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2 (for EUTs < 0.5m X 0.5m X 0.5m)	±6dB

10 Measurements, Examination and Derived Results

10.1 Conducted Emissions

Conducted Emission Limit

Frequency ranges (MHz)	Limit (dBuV)	
	QP	Average
0.15 ~ 0.5	66 – 56	56 – 46
0.5 ~ 5	56	46
5 ~ 30	60	50

Spec	Item	Requirement	Applicable
RSS247(A8.1)	a)	For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.	☒
Test Setup	 Note: 1. Support units were connected to second LISN. 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes	
Procedure	- The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B. - The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains. - The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable. - All other supporting equipment was powered separately from another main supply.	
Remark	EUT was tested at 120VAC, 60Hz	
Result	☒ Pass ☐ Fail	

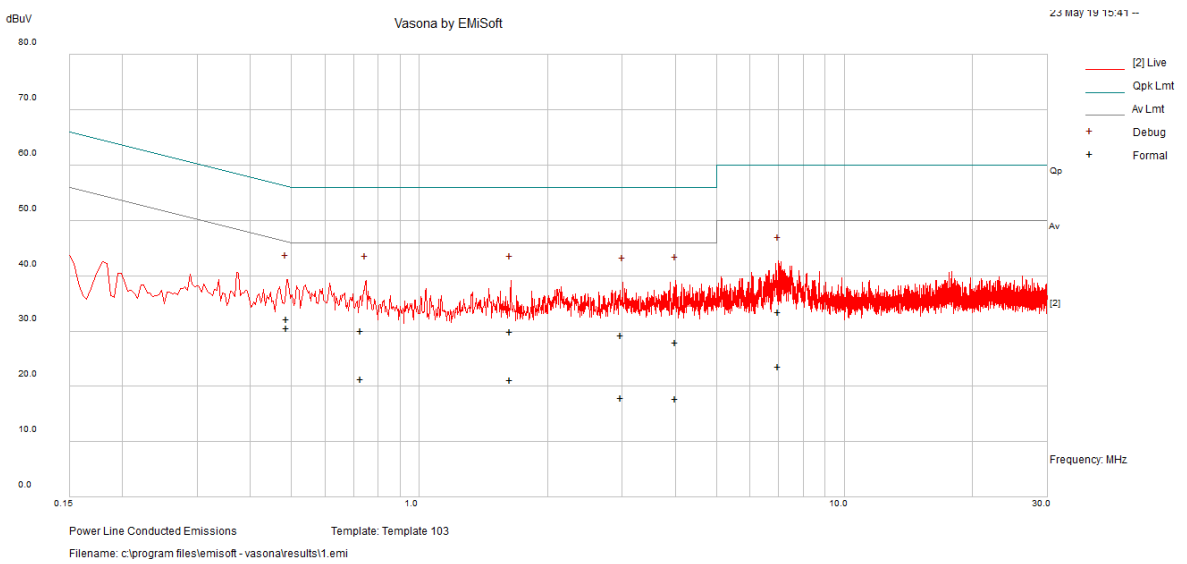
Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Deon Dai at Conducted Emission test site.

Conducted Emission Test Results

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass ☐ Fail
	Humidity (%):	42		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	Deon Dai			
Test Date:	05/23/2019			
Remarks	Live			

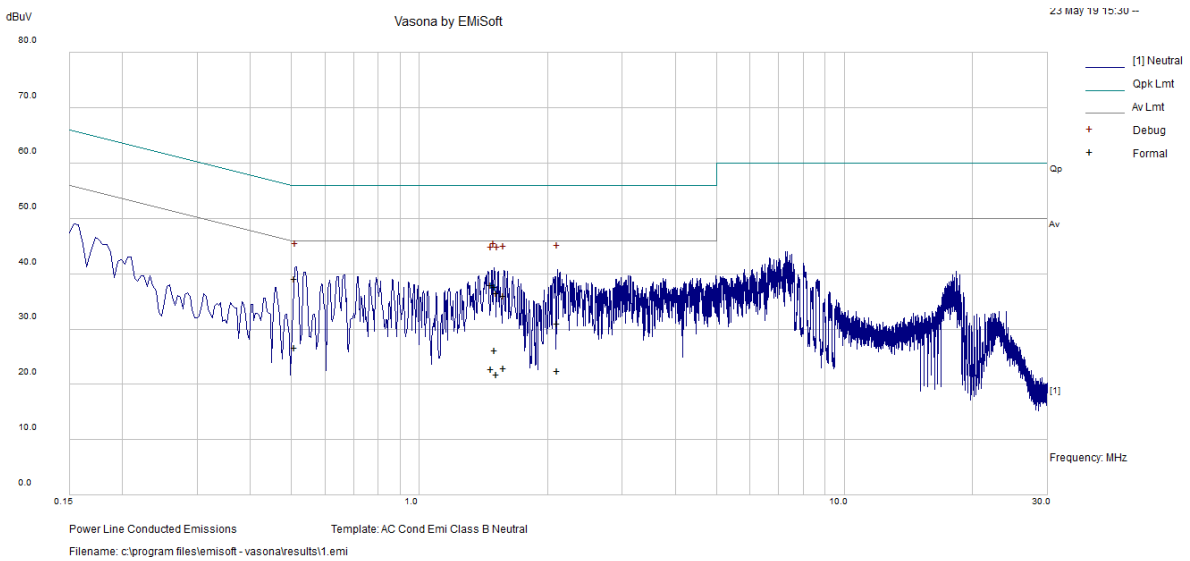


Live Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.731255	22.56	7.53	0.04	30.13	Quasi Peak	Live	56	-25.87	Pass
1.64216	22	7.83	0.06	29.89	Quasi Peak	Live	56	-26.11	Pass
0.488393	24.84	7.34	0.04	32.22	Quasi Peak	Live	56.2	-23.98	Pass
4.012411	19.83	8.03	0.07	27.93	Quasi Peak	Live	56	-28.07	Pass
2.994404	21.25	7.93	0.07	29.24	Quasi Peak	Live	56	-26.76	Pass
7.023328	25.13	8.25	0.11	33.49	Quasi Peak	Live	60	-26.51	Pass
0.731255	13.83	7.53	0.04	21.41	Average	Live	46	-24.59	Pass
1.64216	13.36	7.83	0.06	21.24	Average	Live	46	-24.76	Pass
0.488393	23.16	7.34	0.04	30.55	Average	Live	46.2	-15.65	Pass
4.012411	9.71	8.03	0.07	17.81	Average	Live	46	-28.19	Pass
2.994404	10	7.93	0.07	18	Average	Live	46	-28	Pass
7.023328	15.22	8.25	0.11	23.58	Average	Live	50	-26.42	Pass

Conducted Emission Test Results

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass ☐ Fail
	Humidity (%):	42		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	Deon Dai			
Test Date:	05/23/2019			
Remarks	Neutral			

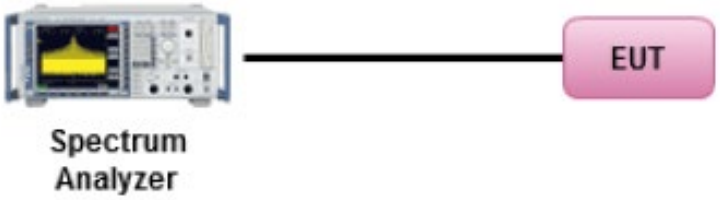


Neutral Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.510096	31.73	7.36	0.03	39.12	Quasi Peak	Neutral	56	-16.88	Pass
1.505687	29.75	7.8	0.05	37.6	Quasi Peak	Neutral	56	-18.4	Pass
2.12106	23.12	7.89	0.06	31.07	Quasi Peak	Neutral	56	-24.93	Pass
1.582978	28.14	7.82	0.05	36.01	Quasi Peak	Neutral	56	-19.99	Pass
1.47956	30.17	7.8	0.05	38.02	Quasi Peak	Neutral	56	-17.98	Pass
1.527222	28.62	7.81	0.05	36.48	Quasi Peak	Neutral	56	-19.52	Pass
0.510096	19.22	7.36	0.03	26.61	Average	Neutral	46	-19.39	Pass
1.505687	18.27	7.8	0.05	26.12	Average	Neutral	46	-19.88	Pass
2.12106	14.49	7.89	0.06	22.44	Average	Neutral	46	-23.56	Pass
1.582978	15.07	7.82	0.05	22.94	Average	Neutral	46	-23.06	Pass
1.47956	14.99	7.8	0.05	22.84	Average	Neutral	46	-23.16	Pass
1.527222	13.96	7.81	0.05	21.82	Average	Neutral	46	-24.18	Pass

10.2 6dB & 99% Bandwidth

Requirement(s):

Spec	Requirement	Applicable
§ 15.247 RSS247 (5.2.a)	6dB BW≥500KHz;	☒
RSS Gen 6.7	For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).	☒
Test Setup		
Test Procedure	558074 D01 DTS Meas Guidance v05r01, 8.2 DTS bandwidth ANSI C63.10, 11.8 Measurement procedure - Set RBW = 100 kHz. - Set the video bandwidth (VBW) ⩾ 3 x RBW. - Detector = Peak. - Trace mode = max hold. - Sweep = auto couple. - Allow the trace to stabilize. - Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.	

Test Date	05/23/2019	Environmental condition	Temperature 23ºC Relative Humidity 42% Atmospheric Pressure 1021mbar
Remark	N/A		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes ☐ N/A

Test was done by Deon Dai at RF test site.

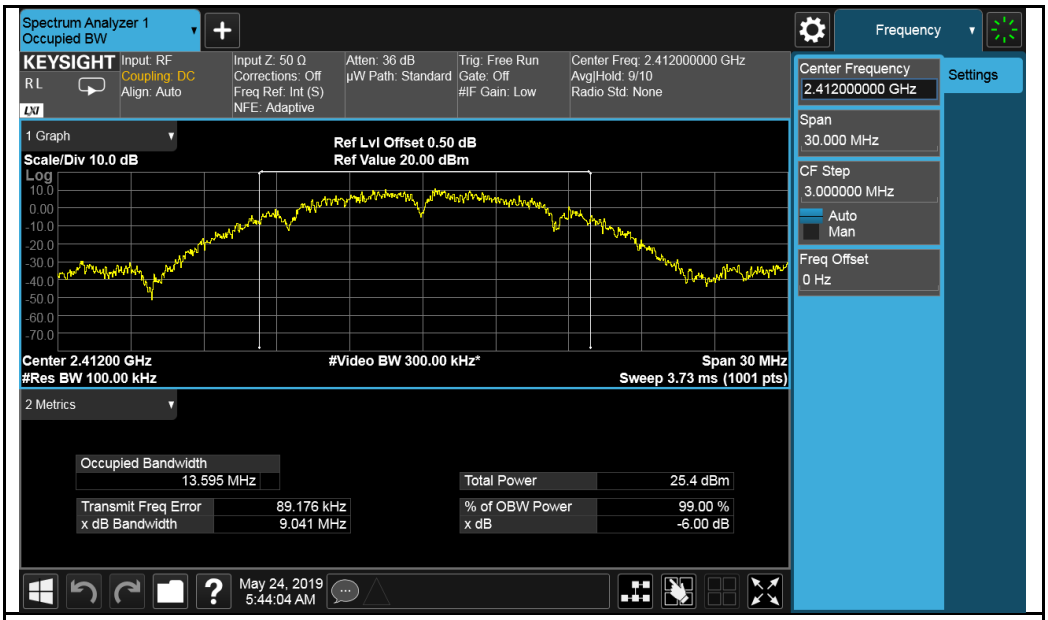
6dB Bandwidth measurement result for 2.4GHz

Type	Test mode	Freq (MHz)	CH	Result (MHz)	Limit (MHz)	Result
6dB BW	802.11b	2412	Low	9.04	≥0.5	Pass
		2437	Mid	7.81	≥0.5	Pass
		2462	High	8.52	≥0.5	Pass
	802.11g	2412	Low	16.53	≥0.5	Pass
		2437	Mid	16.53	≥0.5	Pass
		2462	High	16.53	≥0.5	Pass
	802.11n-20M	2412	Low	17.78	≥0.5	Pass
		2437	Mid	17.70	≥0.5	Pass
		2462	High	17.68	≥0.5	Pass

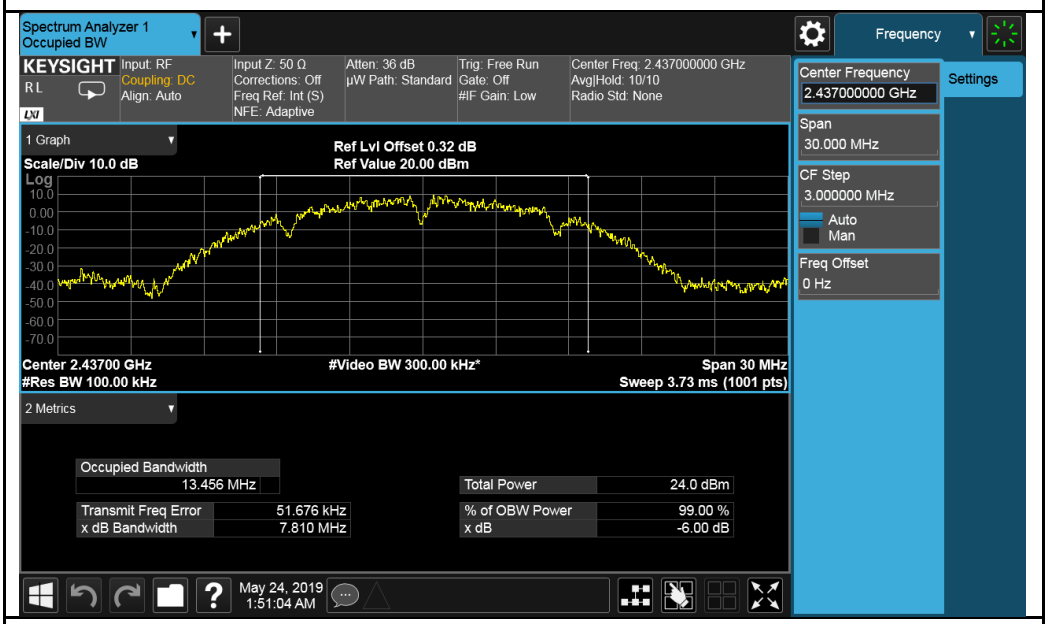
99% OBW measurement result for 2.4GHz

Type	Test mode	Freq (MHz)	CH	Result (MHz)
99% OBW	802.11b	2412	Low	13.59
		2437	Mid	13.45
		2462	High	13.48
	802.11g	2412	Low	16.44
		2437	Mid	16.46
		2462	High	16.44
	802.11n-20M	2412	Low	17.62
		2437	Mid	17.63
		2462	High	17.61

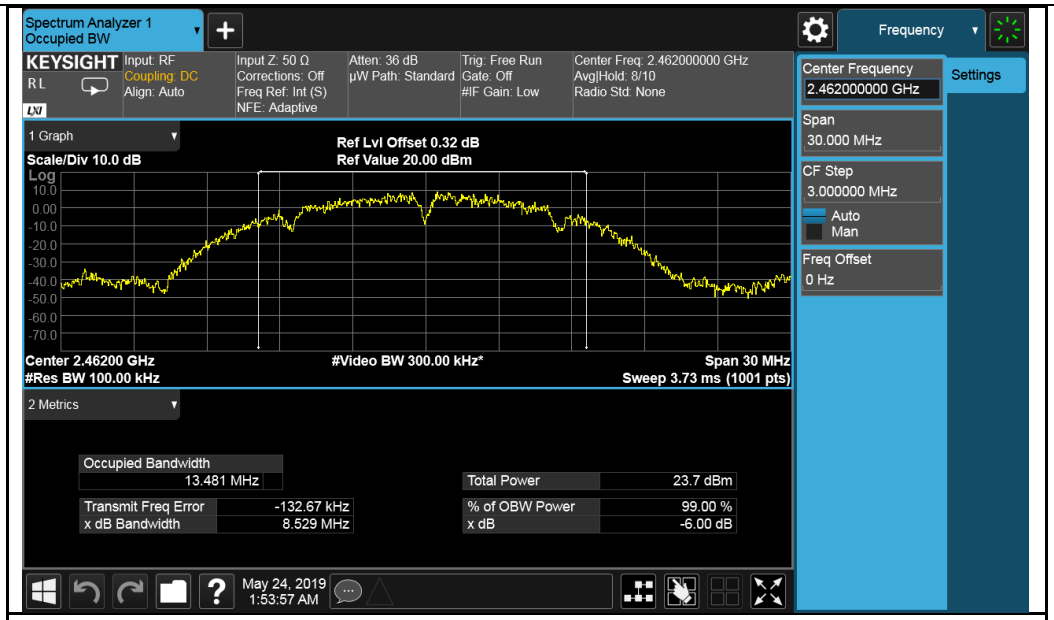
6dB & 99% Bandwidth Test Plots



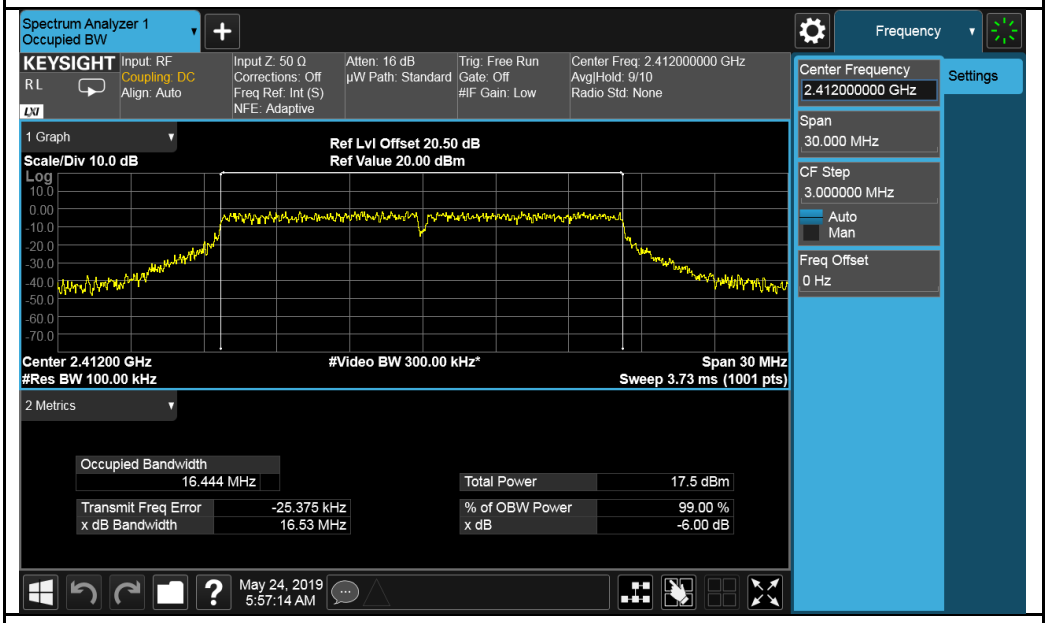
802.11b-2412MHz



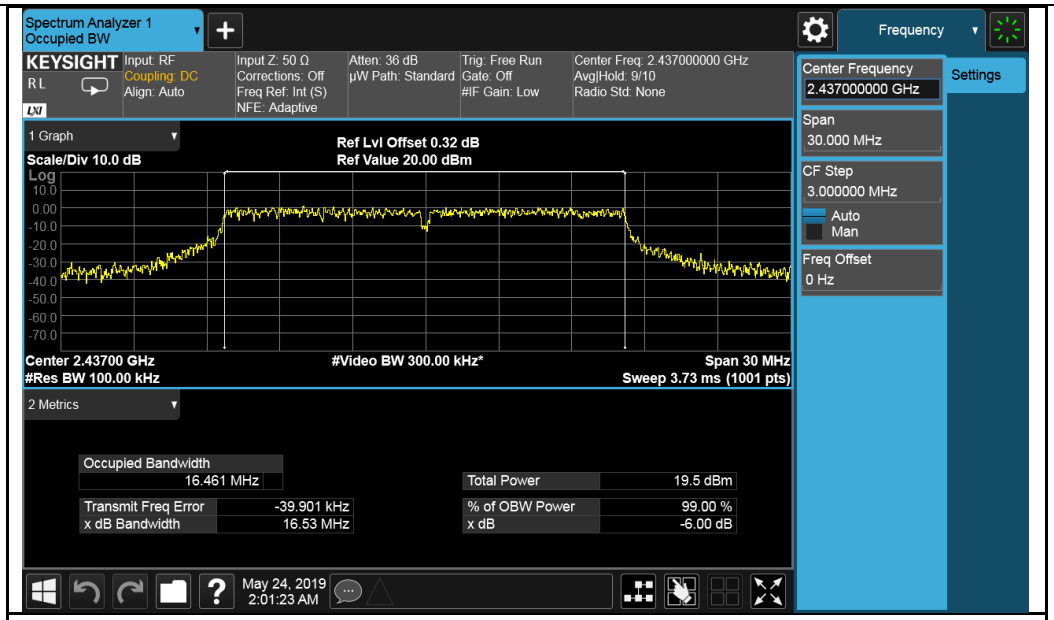
802.11b-2437MHz



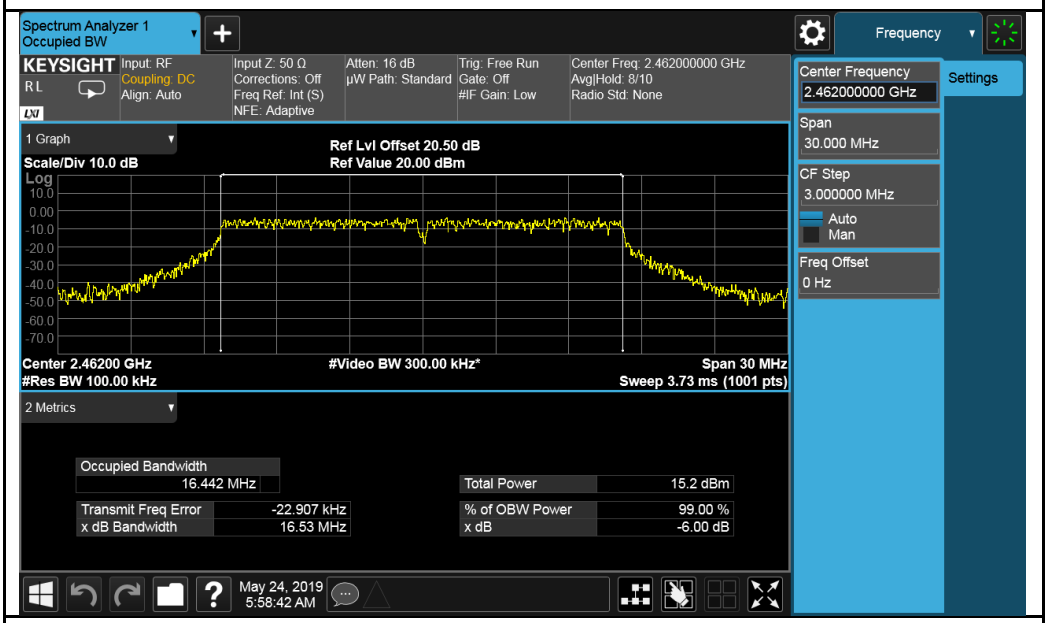
802.11b-2462MHz



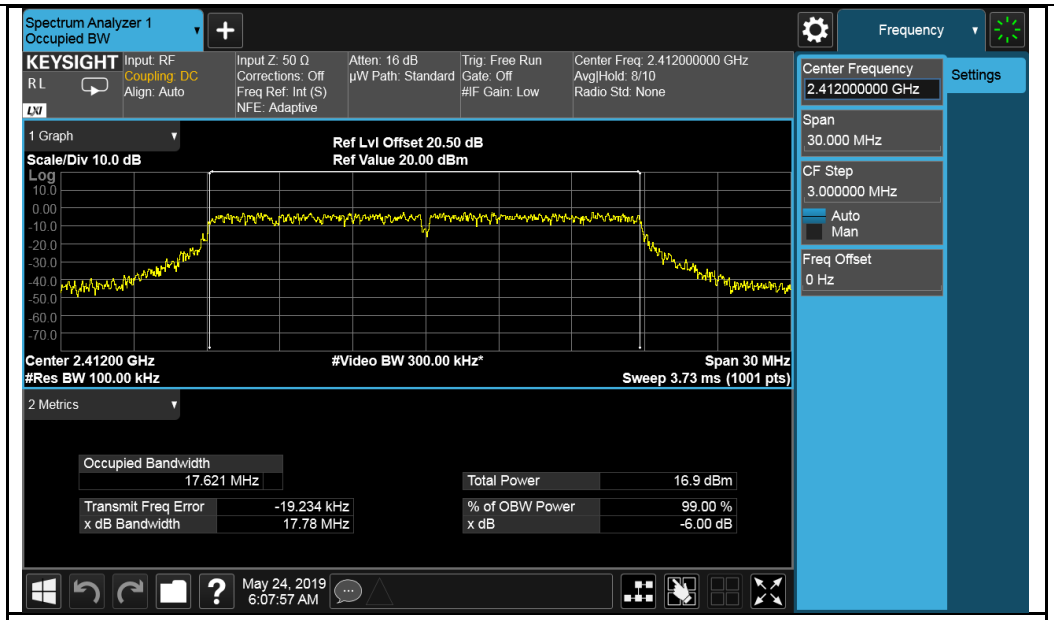
802.11g-2412MHz



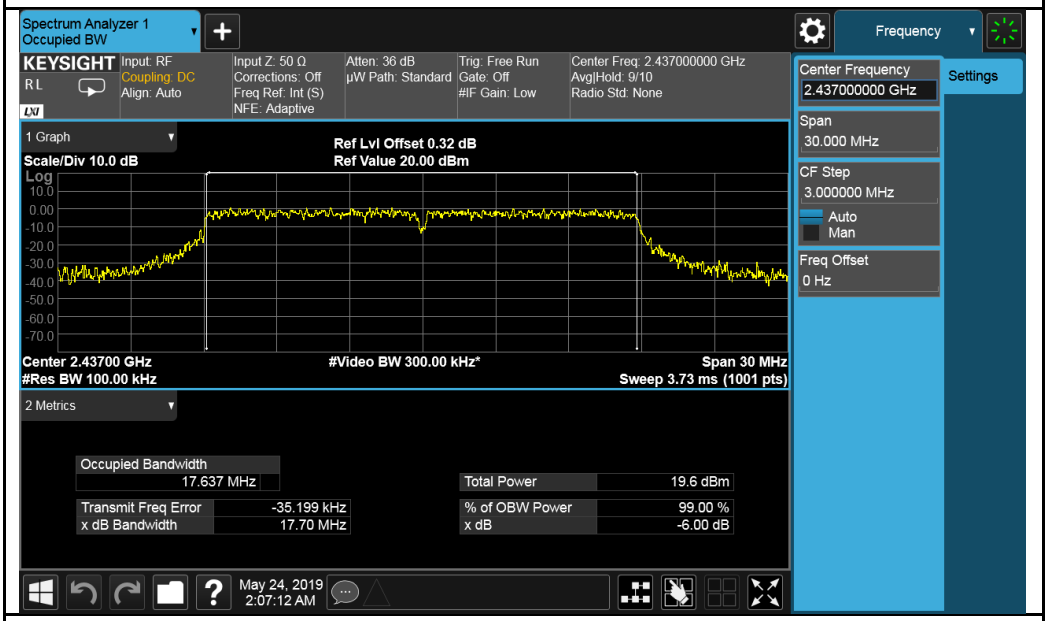
802.11g-2437MHz



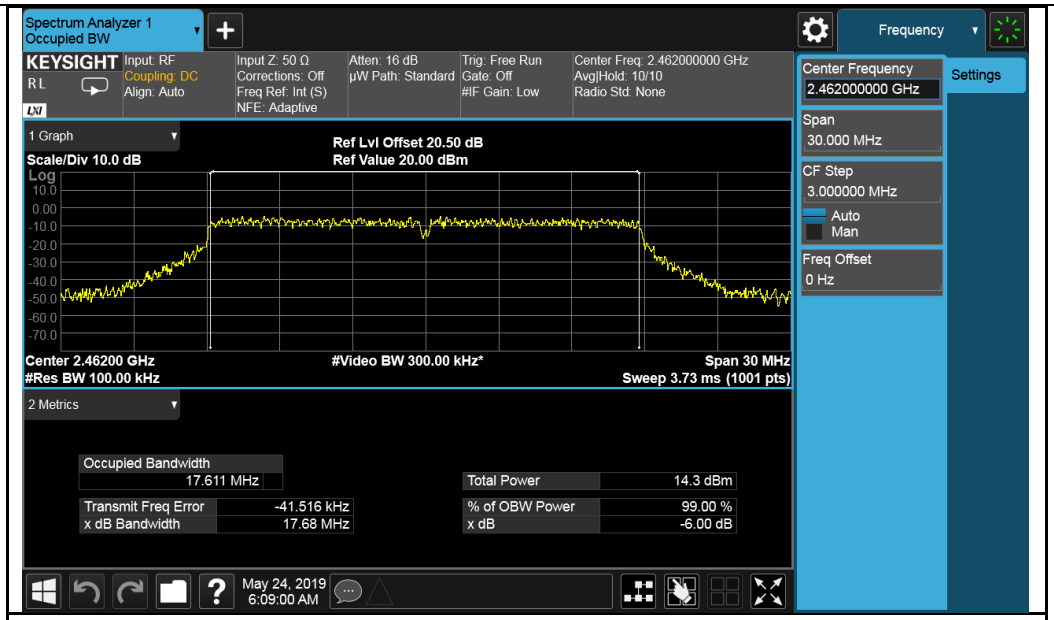
802.11g-2462MHz



802.11n-HT20-2412MHz



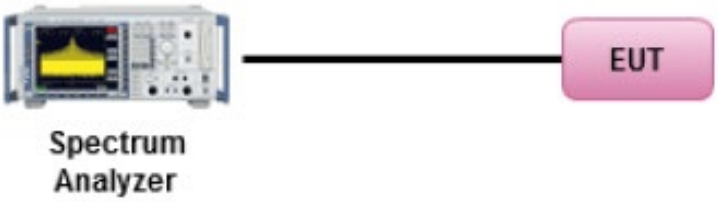
802.11n-HT20-2437MHz



802.11n-HT20-2462MHz

10.3 Output Power

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247 RSS247 (5.4.d)	f)	DSSS in 902-928MHz, 2400-2483.5MHz, 5725-5850MHz: ≤1 Watt	☒
Test Setup			
Test Procedure	558074 D01 DTS Meas Guidance v05r01, 8.3.2.2 ANSI C63.10, 11.9.2.2 Measurement using a Spectrum Analyzer (SA) (a) Set span to at least 1.5 times the OBW (b) Set RBW = 1-5% of the OBW, not to exceed 1 MHz. (c) Set VBW ≥ 3 x RBW. (d) Number of points in sweep ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.) (e) Sweep time = auto. (f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode. (g) If transmit duty cycle < 98 %, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run". (h) Trace average at least 100 traces in power averaging (i.e., RMS) mode (i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.		
Test Date	05/23/2019	Environmental condition	Temperature 23ºC Relative Humidity 44% Atmospheric Pressure 1021mbar
Remark	N/A		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

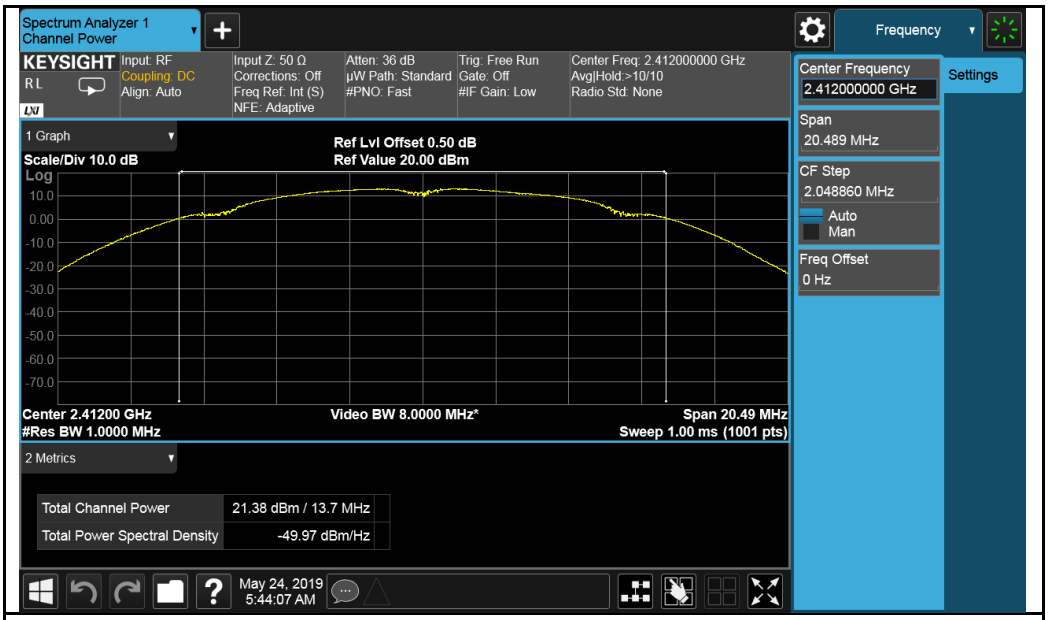
Test Plot ☐ Yes (See below) ☒ N/A

Test was done by Deon Dai at RF test site.

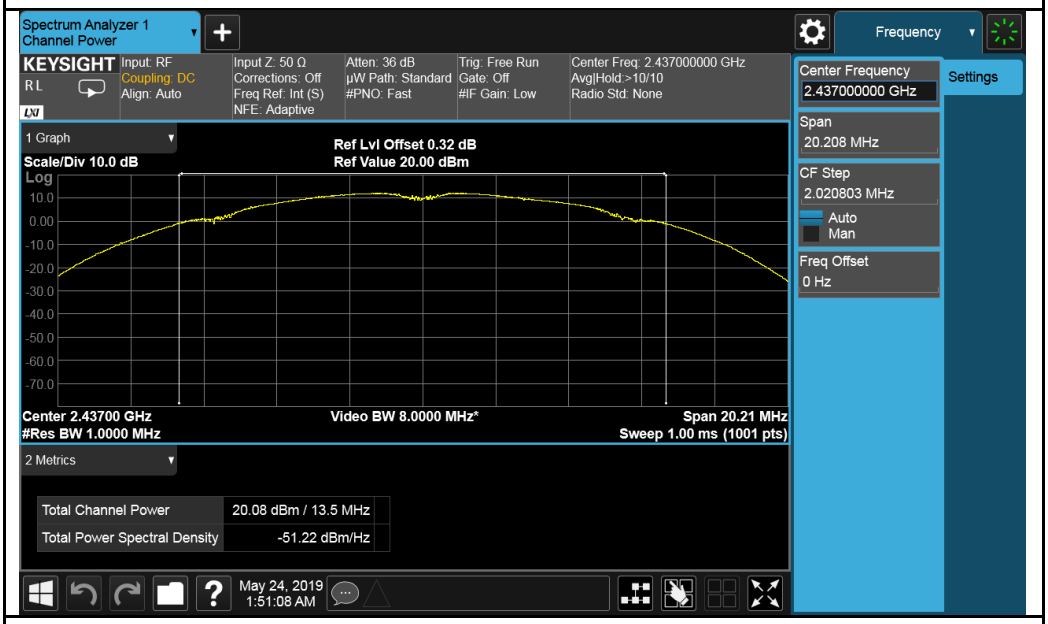
Output Power measurement result

Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output Power	802.11b	2412	Low	21.37	30	Pass
		2437	Mid	20.08	30	Pass
		2462	High	19.60	30	Pass
	802.11g	2412	Low	14.18	30	Pass
		2437	Mid	16.26	30	Pass
		2462	High	12.12	30	Pass
	802.11n-20M	2412	Low	13.66	30	Pass
		2437	Mid	16.25	30	Pass
		2462	High	10.86	30	Pass
Note	Directional gain of the EUT is 3.8 dBi. No limit adjustment is needed.					

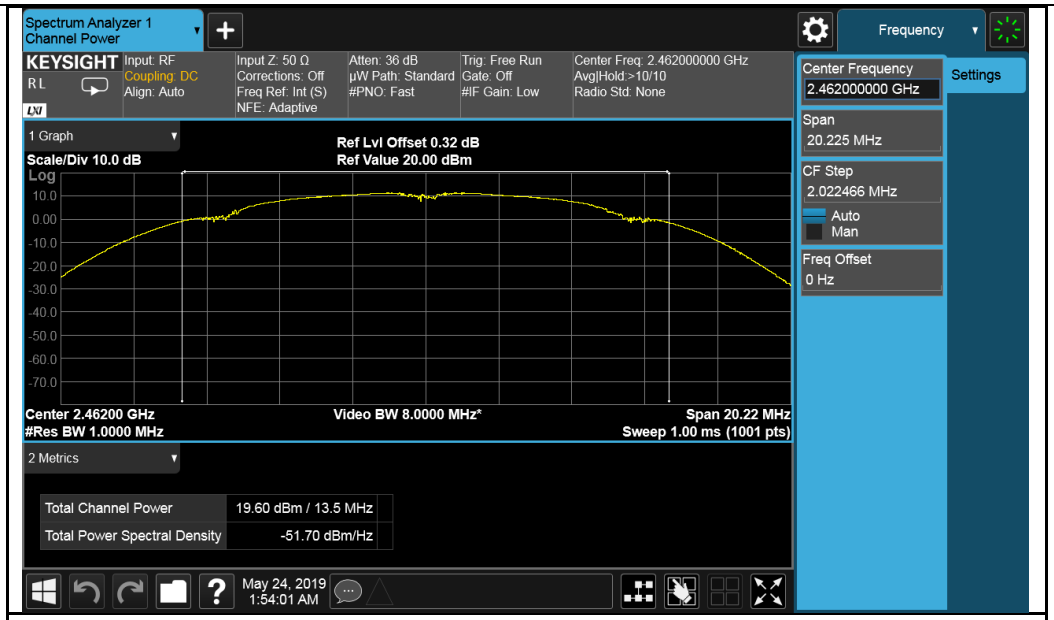
Test Plots:



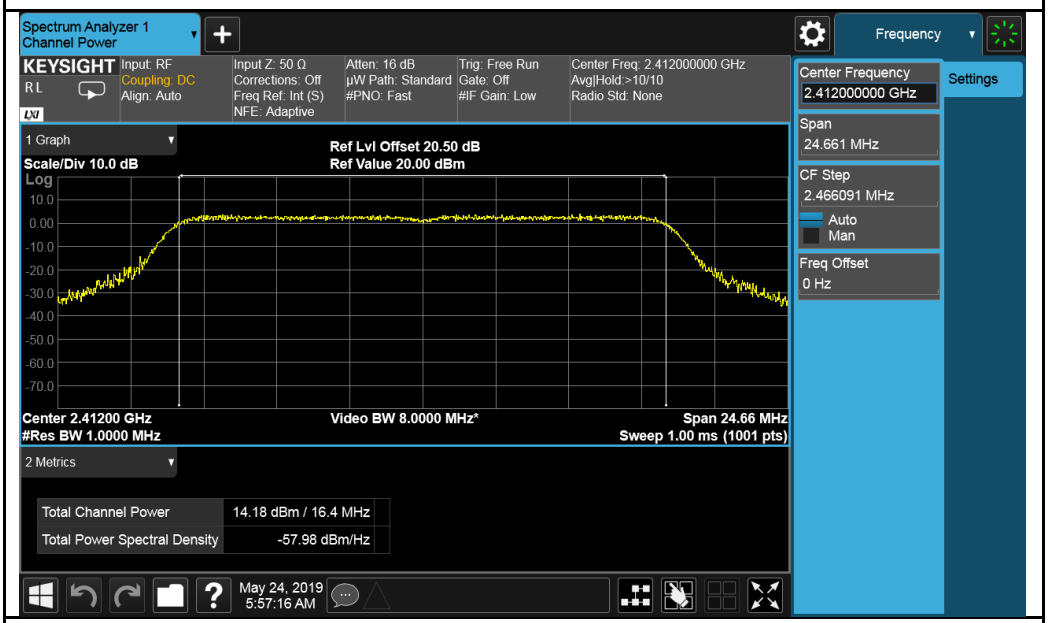
802.11b-2412MHz



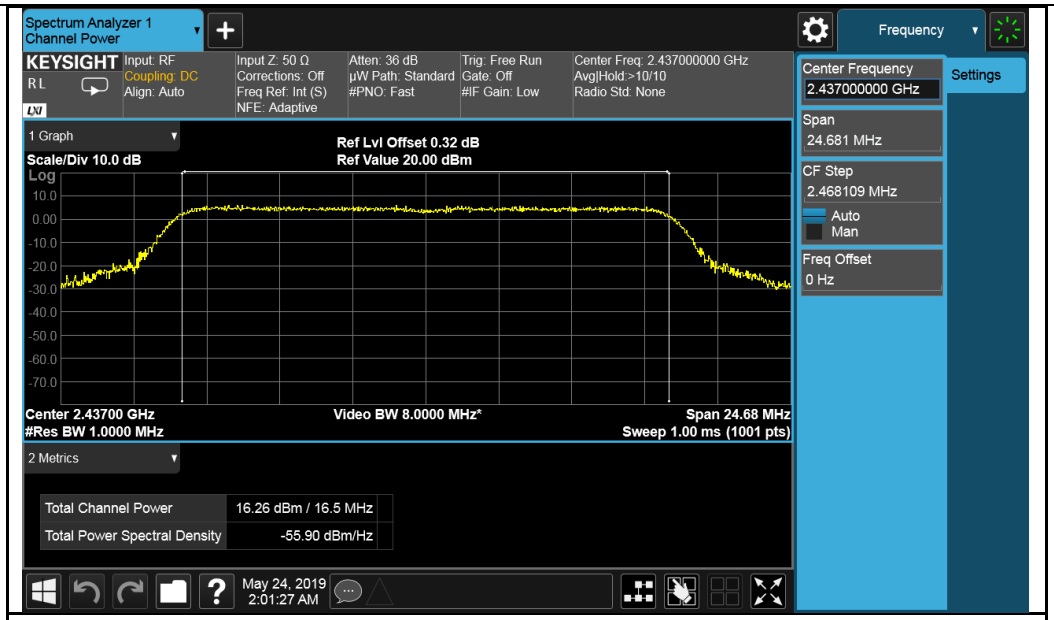
802.11b-2437MHz



802.11b-2462MHz

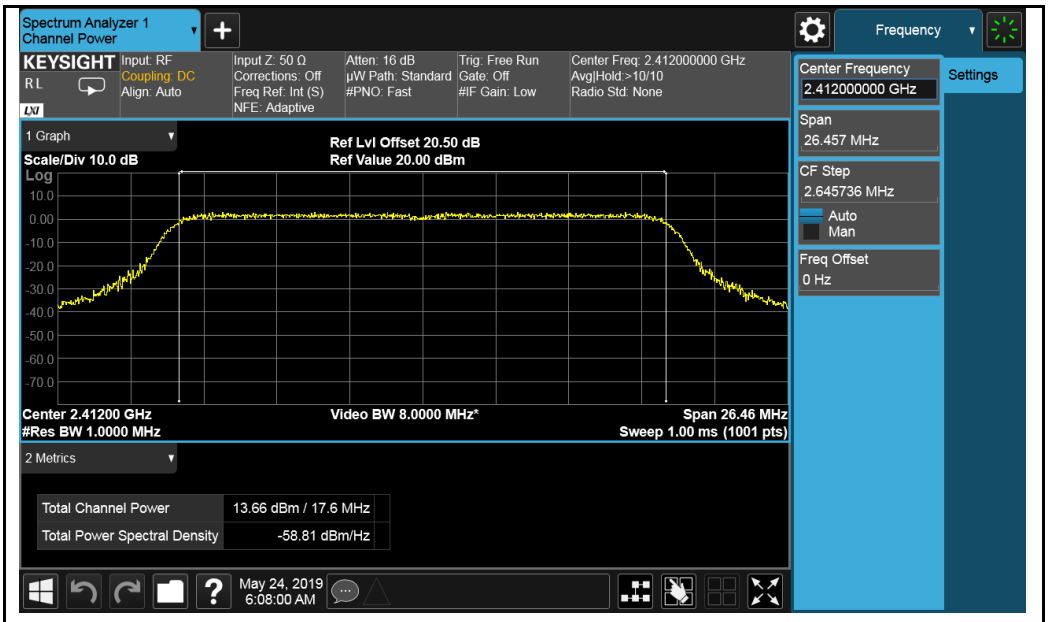


802.11g-2412MHz

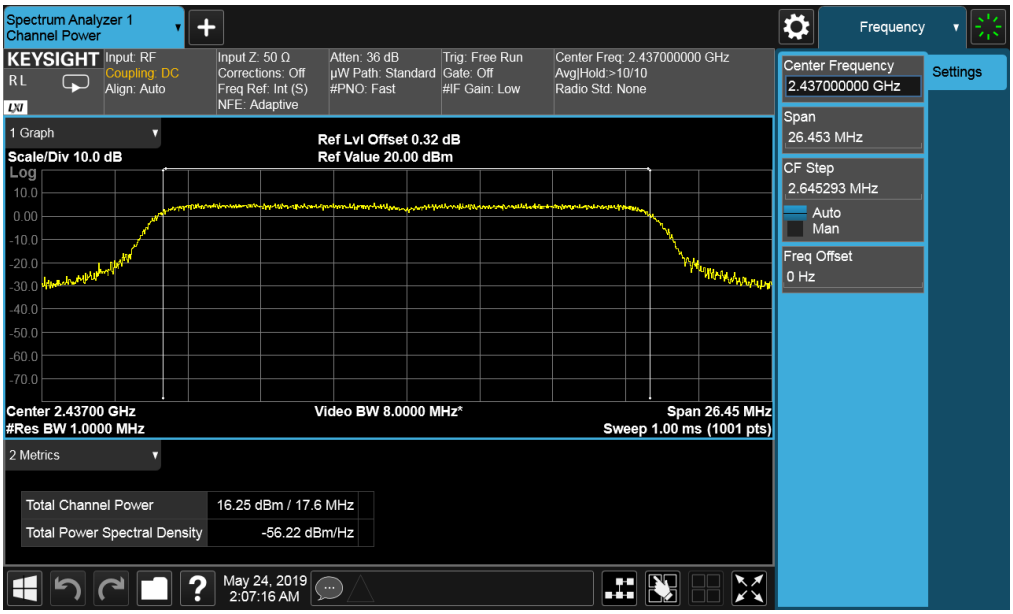


802.11g-2437MHz

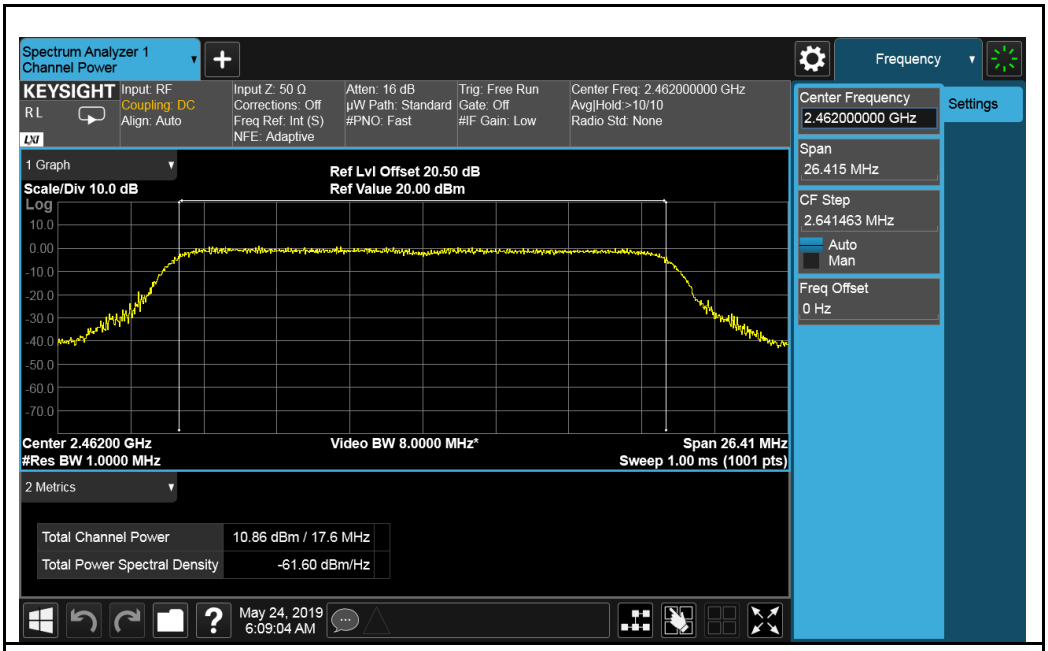
802.11g-2462MHz



802.11n-HT20 2412MHz



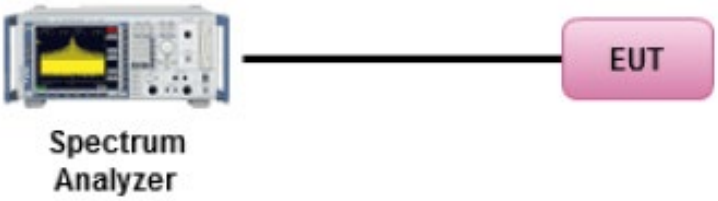
802.11n-HT20 2437MHz



802.11n-HT20 2462MHz

10.4 Band Edge

Requirement(s):

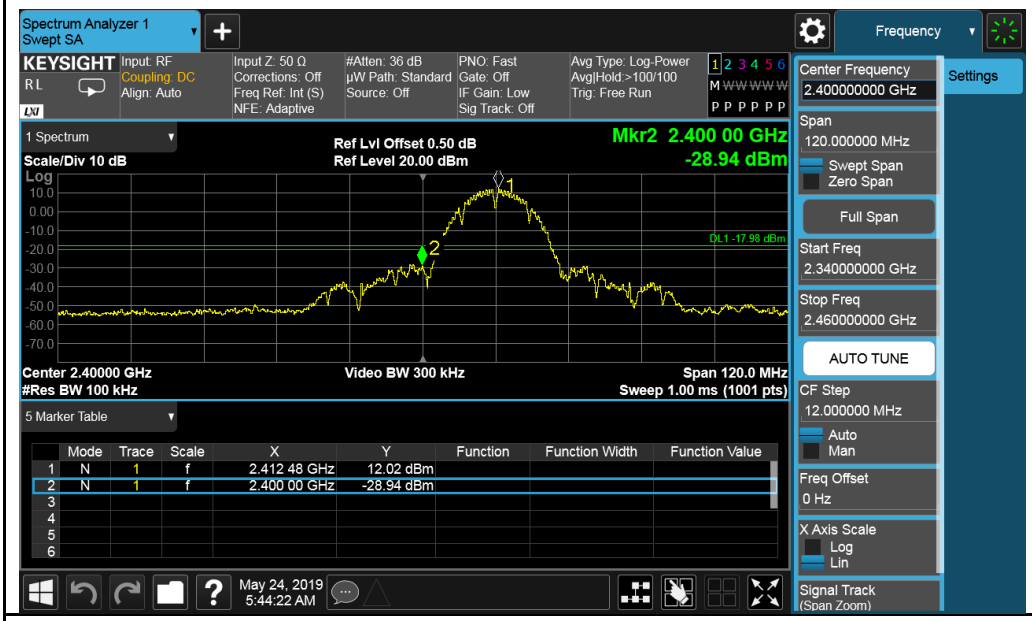
Spec	Item	Requirement	Applicable
§ 15.247 RSS247(5.5)	d)	For non-restricted band, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB or 30dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, determined by the measurement method on output power to be used. Attenuation below the general limits specified in § 15.209 (a) is not required ☐ 20 dB down ☒ 30 dB down	☒
Test Setup			
Test Procedure	558074 D01 DTS Meas Guidance v05r01 ANSI C63.10 Band Edge measurement procedure 1. Set the EUT to maximum power setting and enable the EUT transmit continuously. 2. Band edge emissions must be at least 30 dB down from the highest emission level within the authorized band as a measured. The attunation shall be be 30 dB instead of 20 dB when Peak conducted output power procedure is used. 3. Change modulation and channel bandwidth then repeat step 1 to 2. 4. Measured and record the results in the test report.		
Test Date	05/23/2019	Environmental condition	Temperature 22ºC Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☐ Yes ☒ N/A

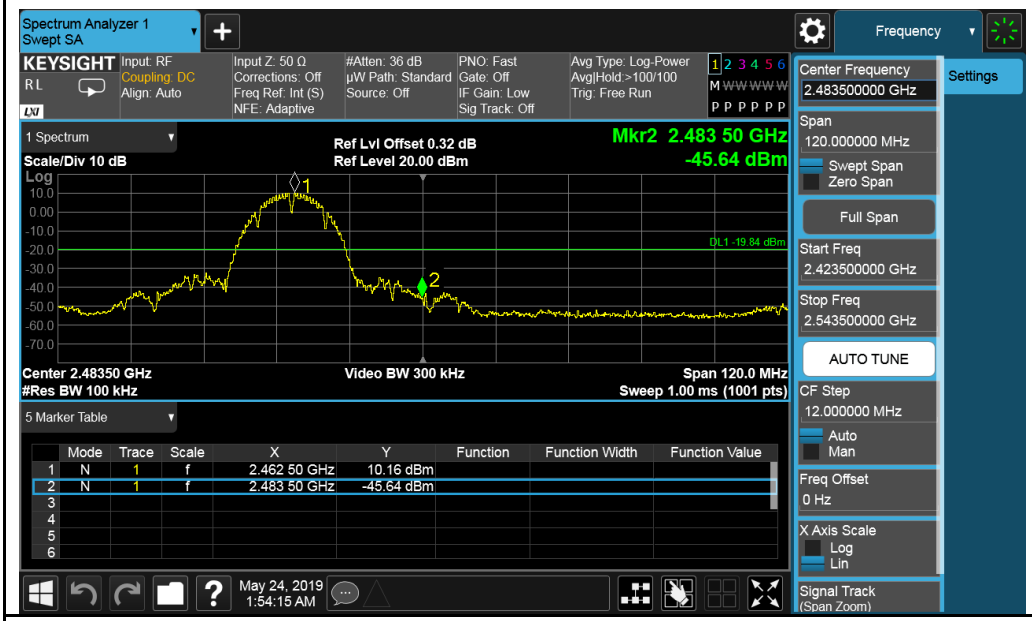
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Deon Dai at RF test site.

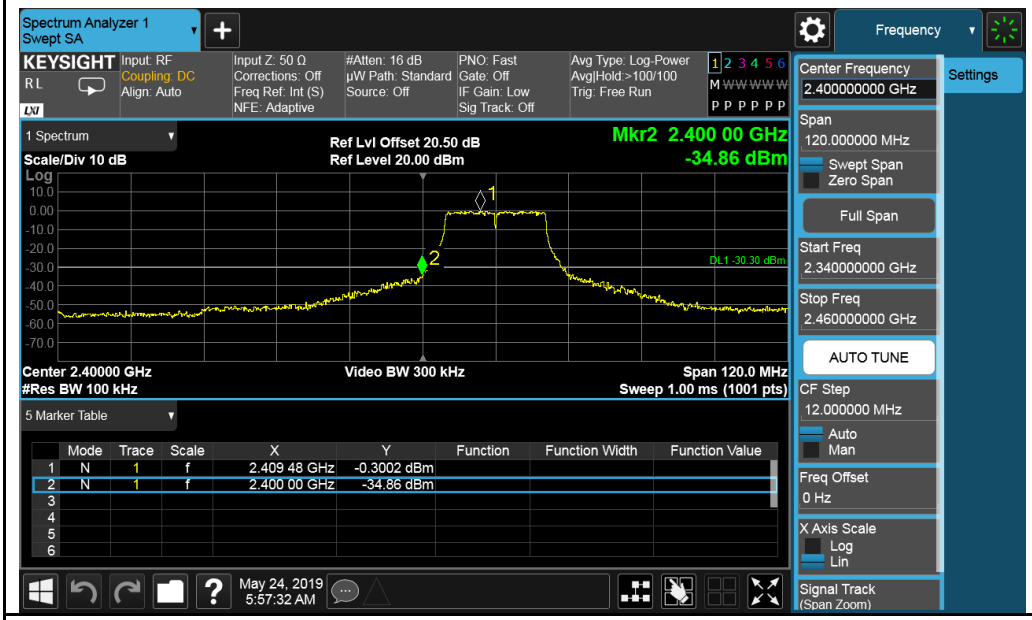
Test Plots



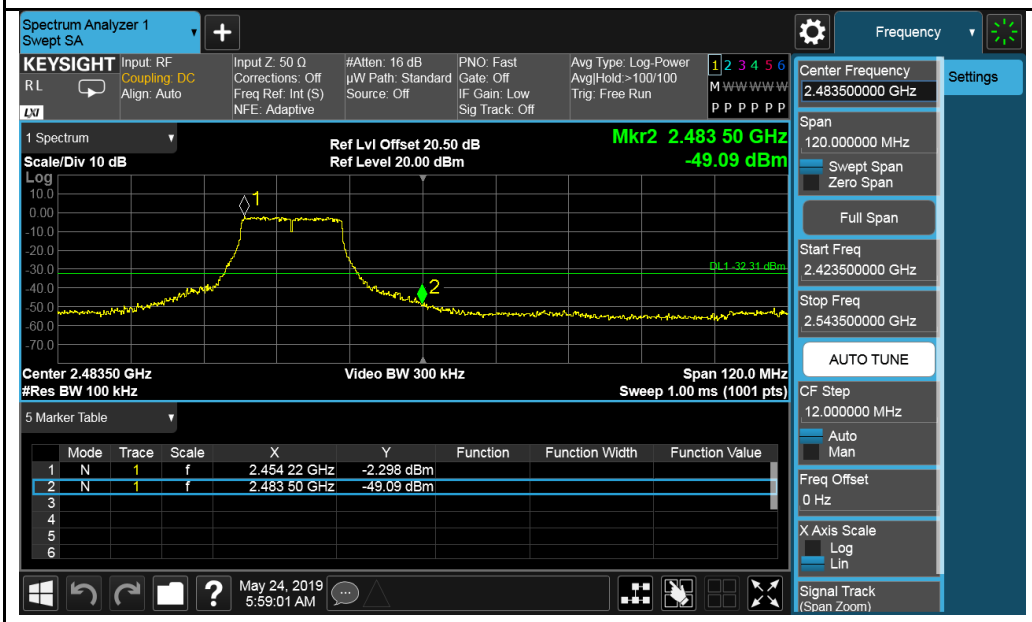
802.11b-2412MHz



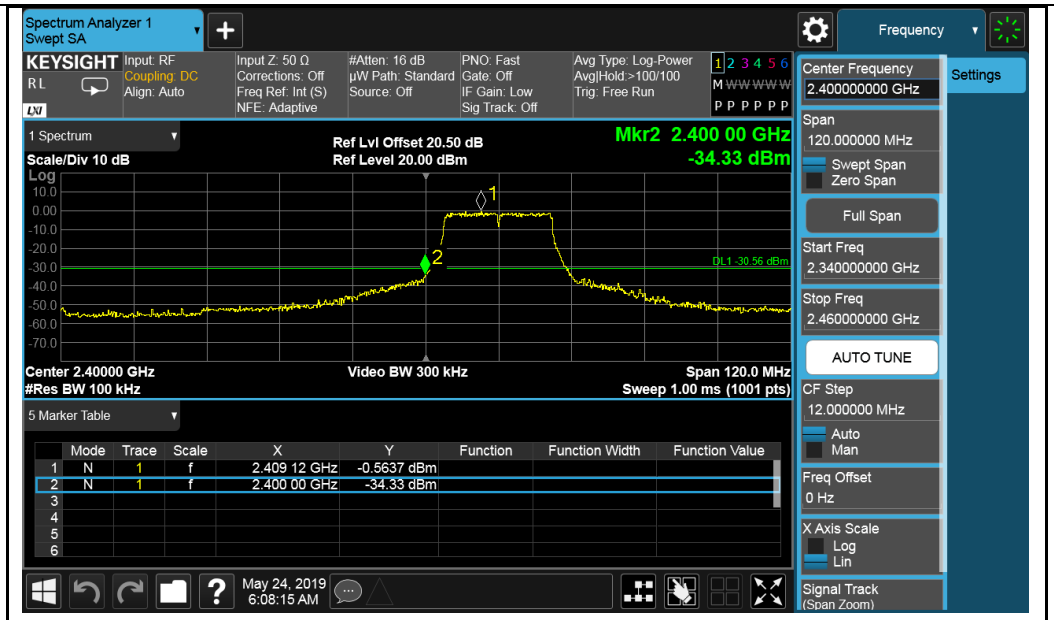
802.11b-2462MHz



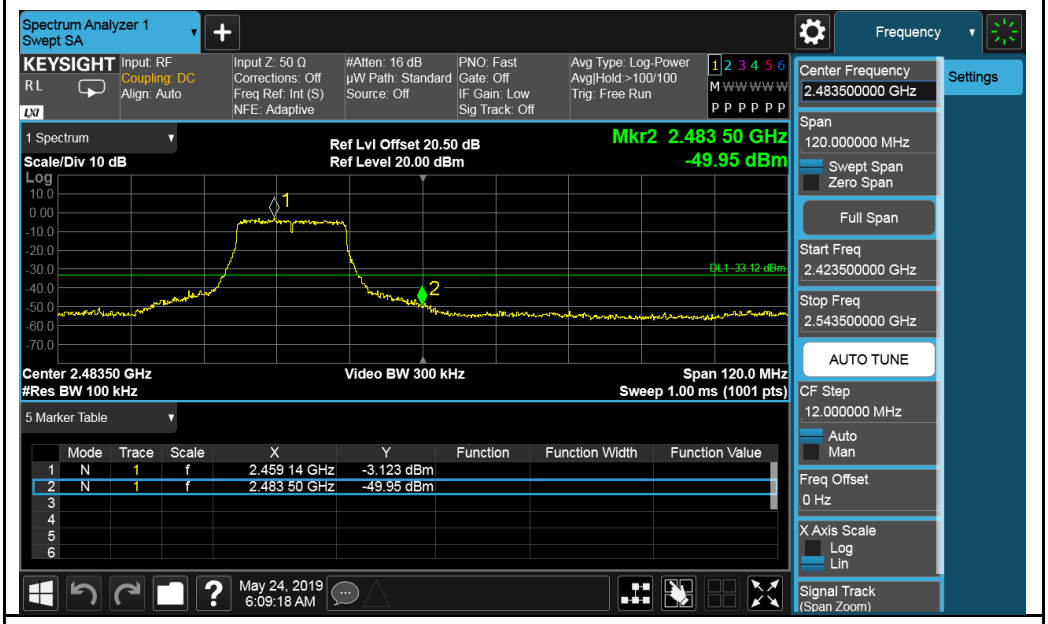
802.11g-2412MHz



802.11g-2462MHz



802.11n-HT20-2412MHz

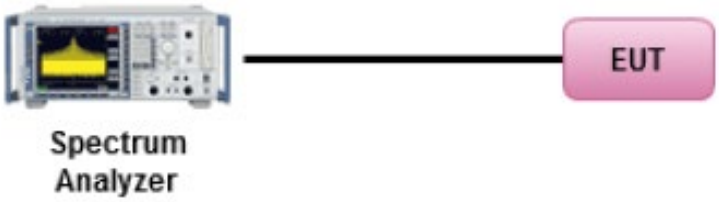


802.11n-HT20-2462MHz

10.5 Peak Spectral Density

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247(e) RSS247 (5.2.b)	e)	DSSS: ≤8dBm/3KHz	☒
	f)	DSSS in hybrid sys with FH turned off: ≤8dBm/3KHz	☐

Test Setup				
Test Procedure	558074 D01 DTS Meas Guidance v05r01, 8.4 ANSI C63.10:2013, 11.10.2 Peak spectral density measurement procedure - Set analyzer center frequency to DTS channel center frequency. - Set the span to 1.5 times the DTS bandwidth. - Set the RBW to: 3 kHz ⩽ RBW ⩽ 100 kHz. - Set the VBW ⩾ 3 x 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.			
Test Date	05/23/2019	Environmental condition	Temperature Relative Humidity Atmospheric Pressure	22ºC 46% 1020mbar
Remark	N/A			
Result	☒ Pass ☐ Fail			

Test Data ☒ Yes ☐ N/A

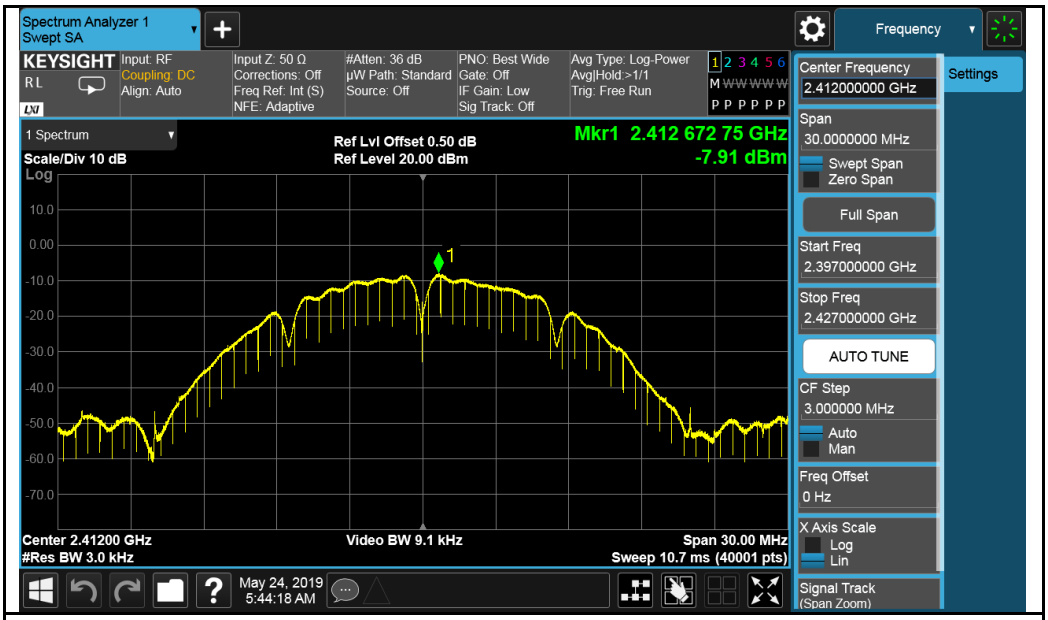
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Deon Dai at RF test site.

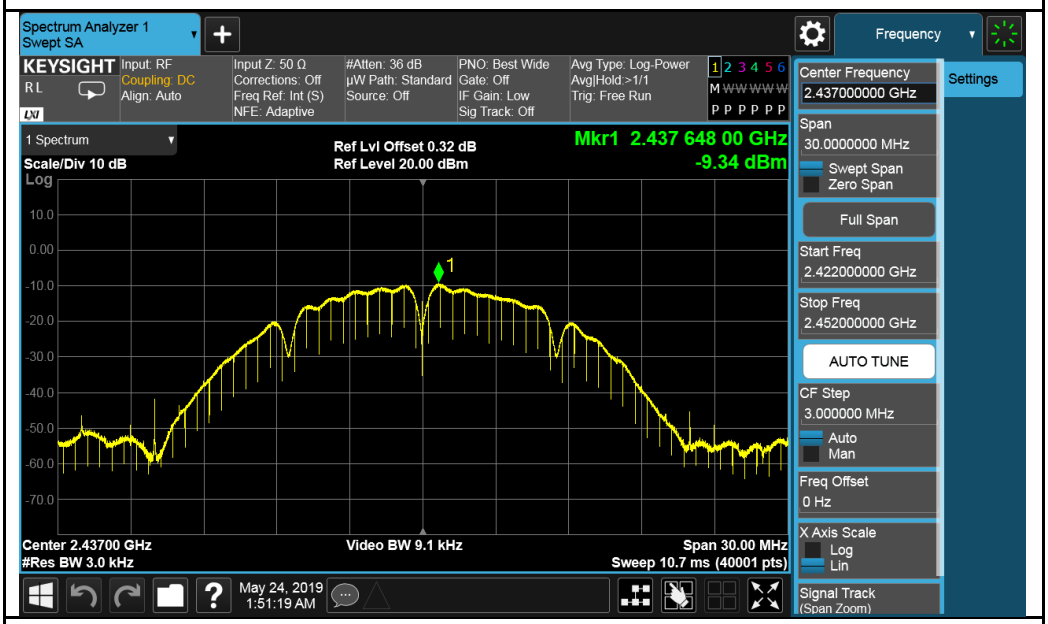
PSD measurement results

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/3KHz)	Limit (dBm/3KHz)	Result
PSD	802.11b	2412	Low	-7.91	≤8	Pass
		2437	Mid	-9.34	≤8	Pass
		2462	High	-9.72	≤8	Pass
	802.11g	2412	Low	-14.32	≤8	Pass
		2437	Mid	-12.07	≤8	Pass
		2462	High	-16.13	≤8	Pass
	802.11n-20M	2412	Low	-14.05	≤8	Pass
		2437	Mid	-11.31	≤8	Pass
		2462	High	-16.55	≤8	Pass

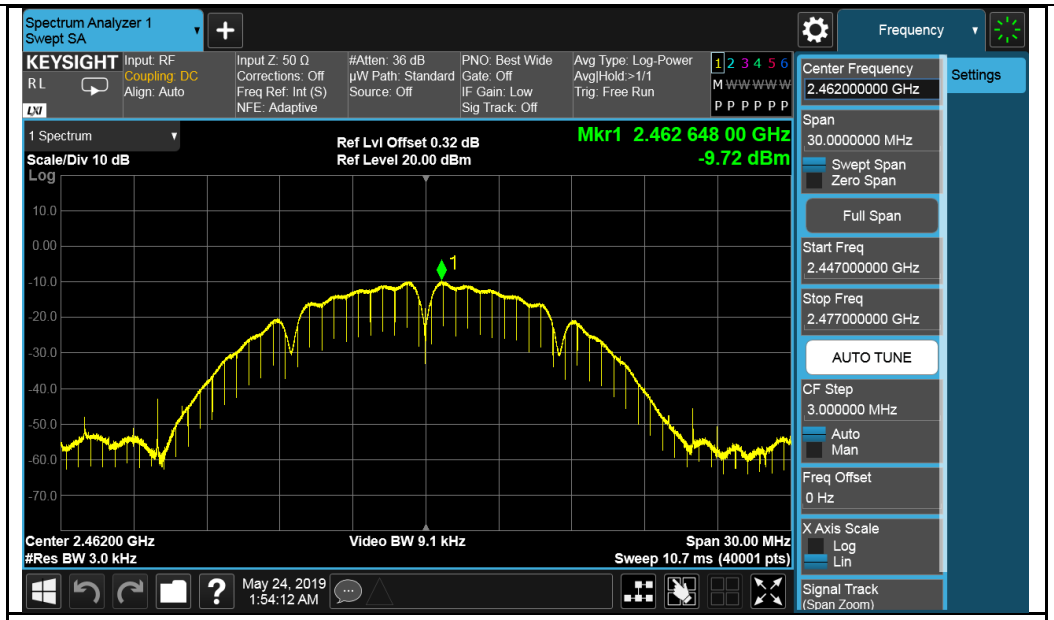
Test Plots:



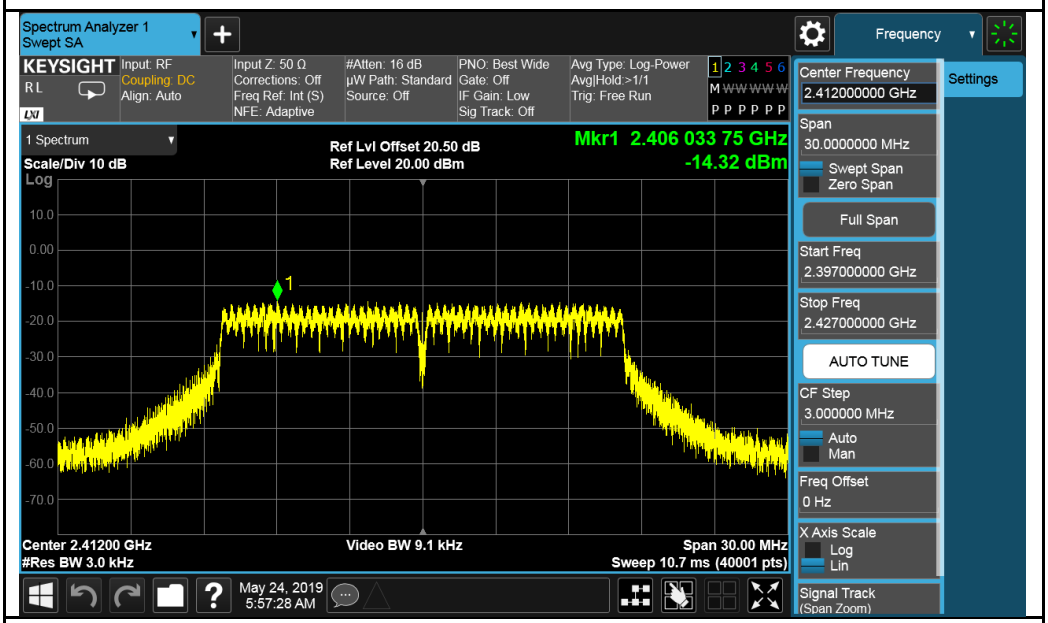
802.11b-2412MHz



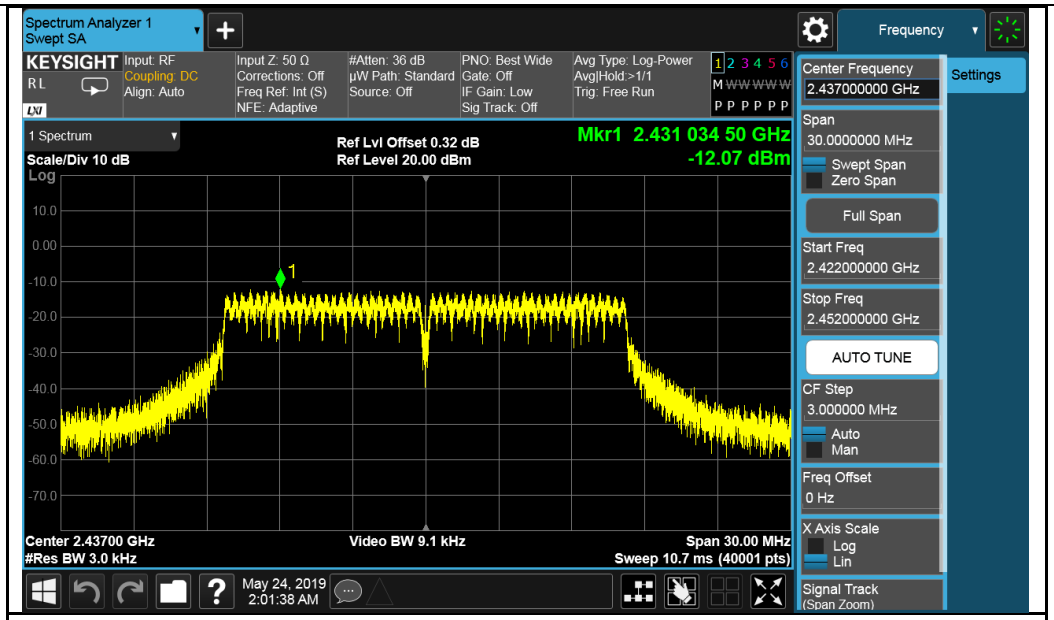
802.11b-2437MHz



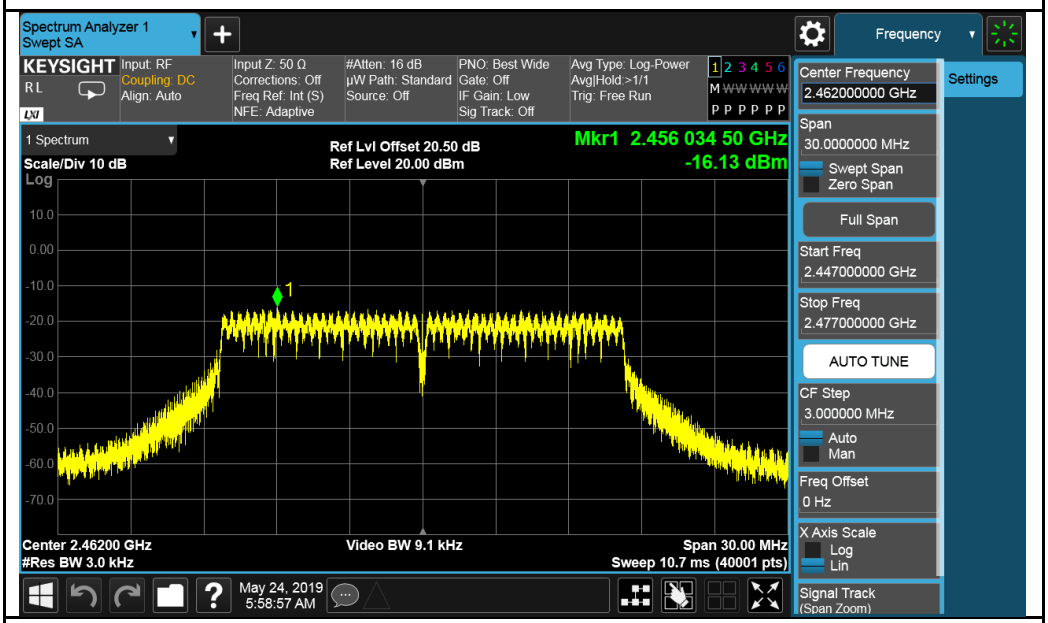
802.11b-2462MHz



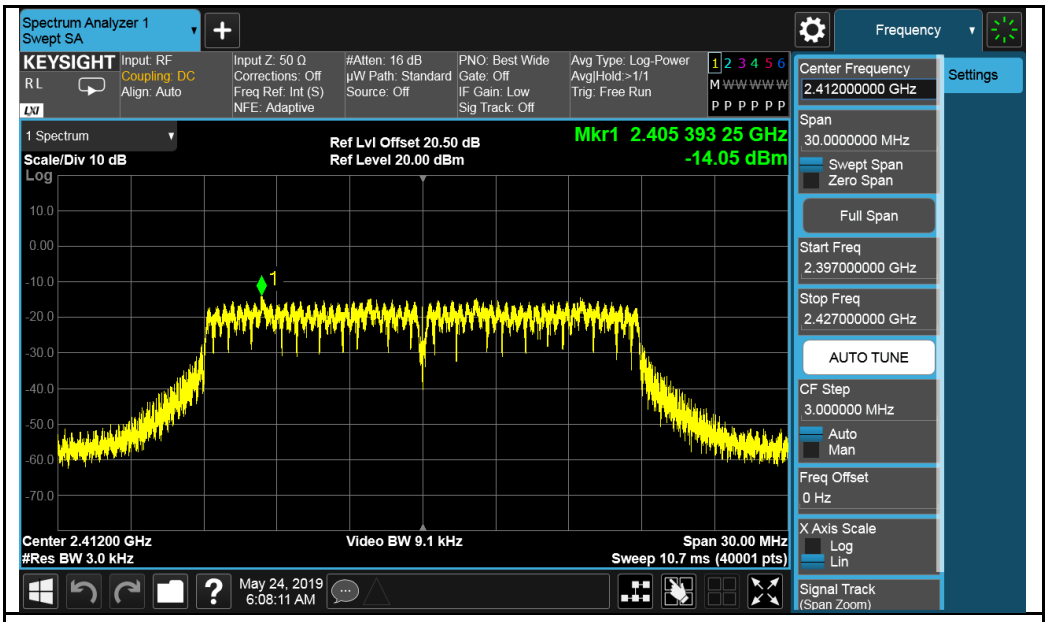
802.11g-2412MHz



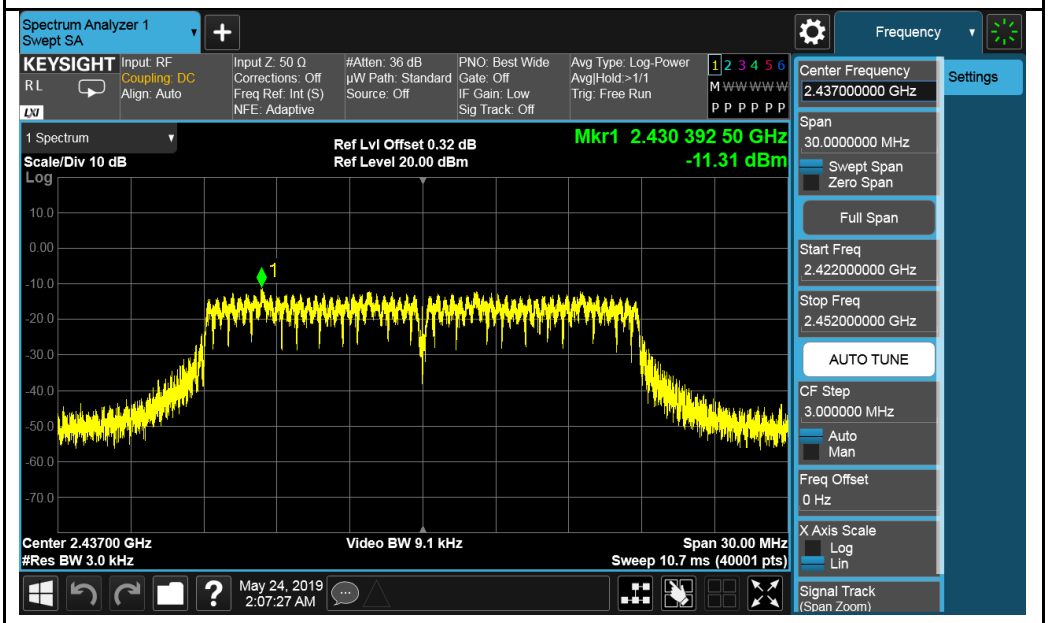
802.11g-2437MHz



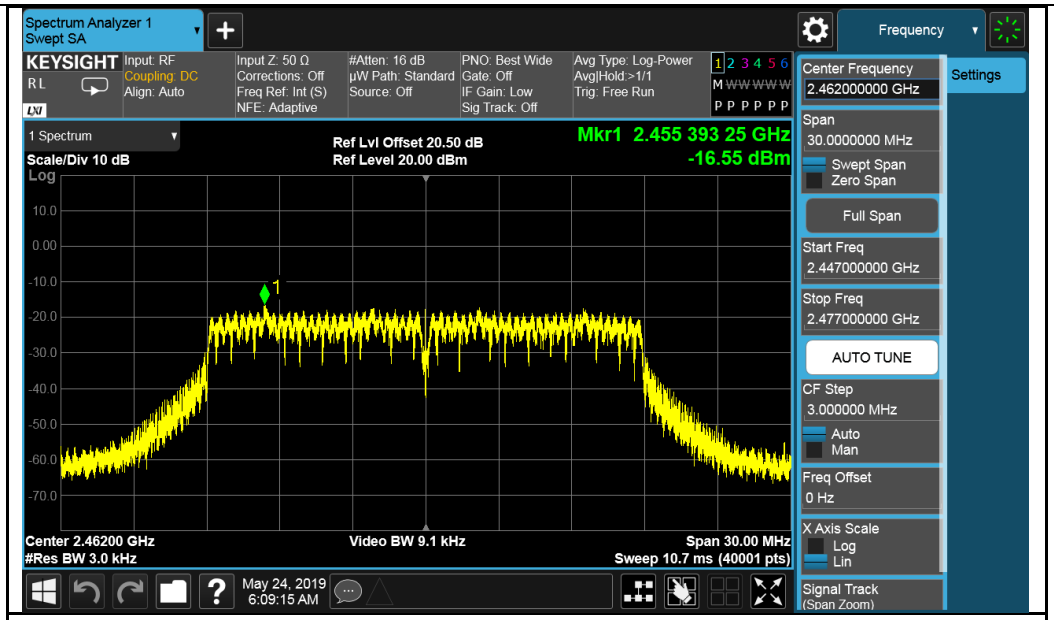
802.11g-2462MHz



802.11n-HT20 2412MHz



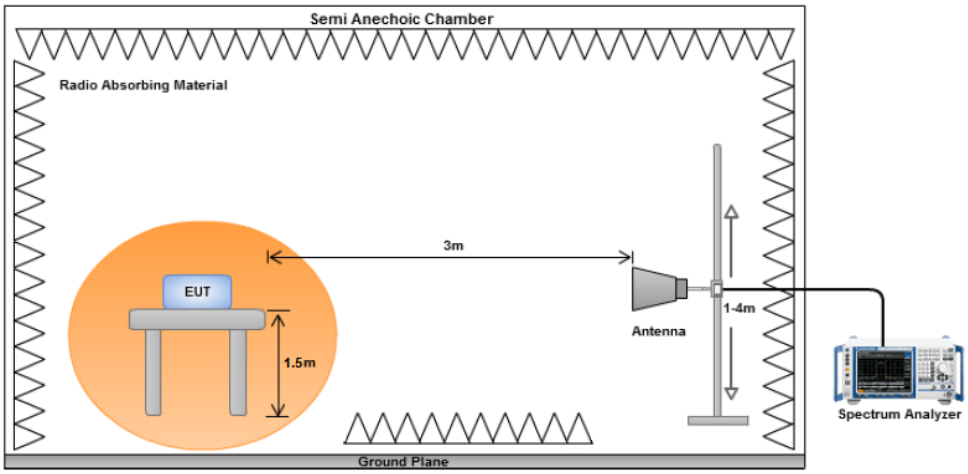
802.11n-HT20 2437MHz



802.11n-HT20 2462MHz

10.6 Radiated Spurious Emissions in restricted band

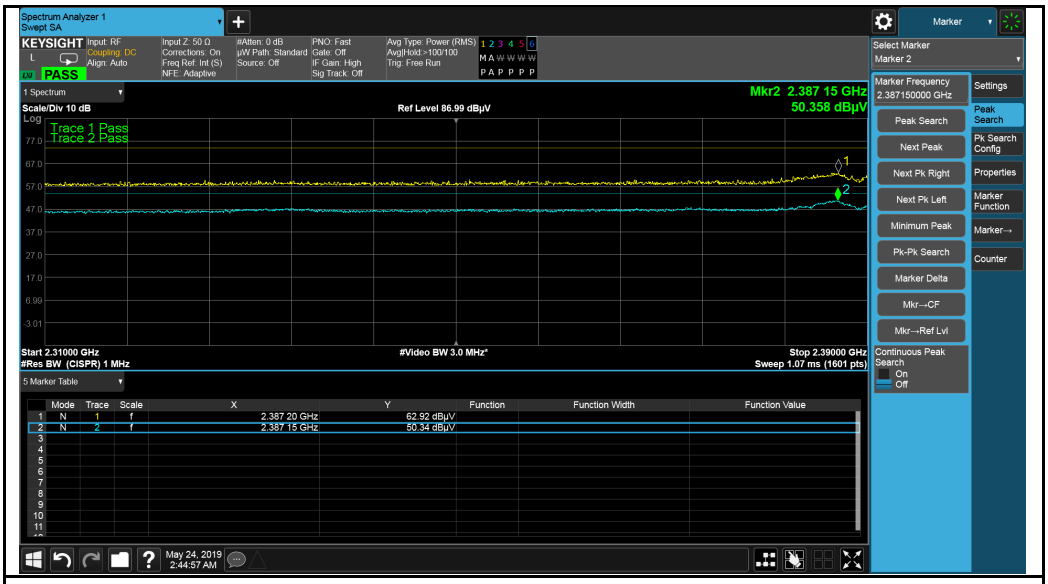
Requirement(s):

Spec	Item	Requirement	Applicable
47CFR§15.247(d), RSS247(A8.5)	a)	For non-restricted band, 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 or 30dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, determined by the measurement method on output power to be used. Attenuation below the general limits specified in § 15.209(a) is not required ☐ 20 dB down ☒ 30 dB down	☒
	b)	or restricted band, emission must also comply with the radiated emission limits specified in 15.209	☒
Test Setup			
Procedure	1. The EUT was switched on and allowed to warm up to its normal operating condition. 2. The test was carried out at the selected frequency points obtained from the EUT characterisation. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner: a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. b. The EUT was then rotated to the direction that gave the maximum emission. c. Finally, the antenna height was adjusted to the height that gave the maximum emission. 3. An average measurement was then made for that frequency point. 4. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.		
Remark	The EUT was scanned up to 40GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case. Radiated measurement was measured with antenna port terminated, there isn't outstanding emission found at the edge of restricted frequency, within x dB margin		
Result	☒ Pass ☐ Fail		

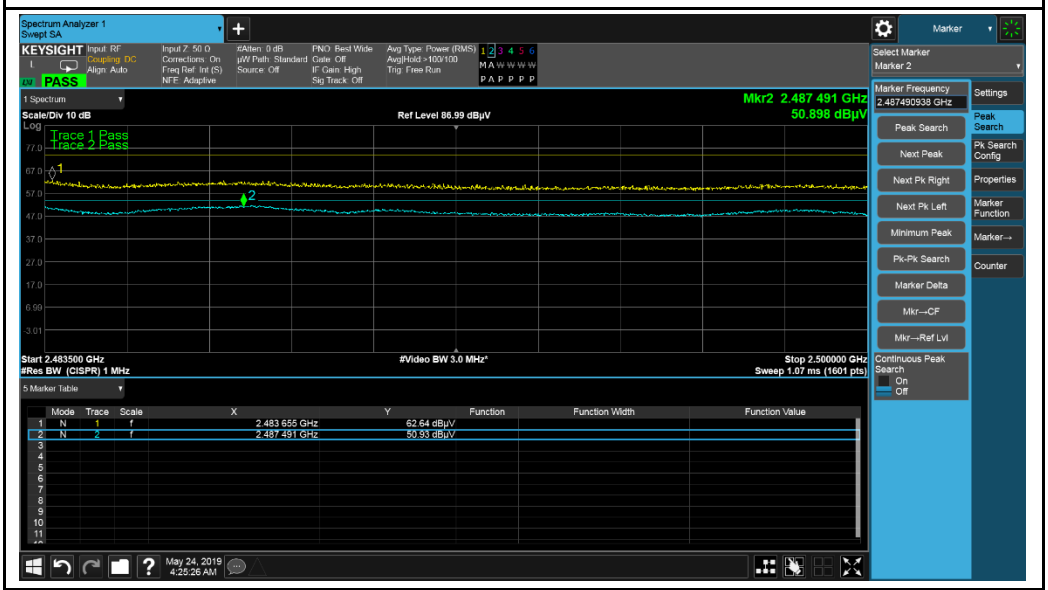
Test Data ☐ Yes (See below) ☒ N/A
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Deon Dai at 10m chamber.

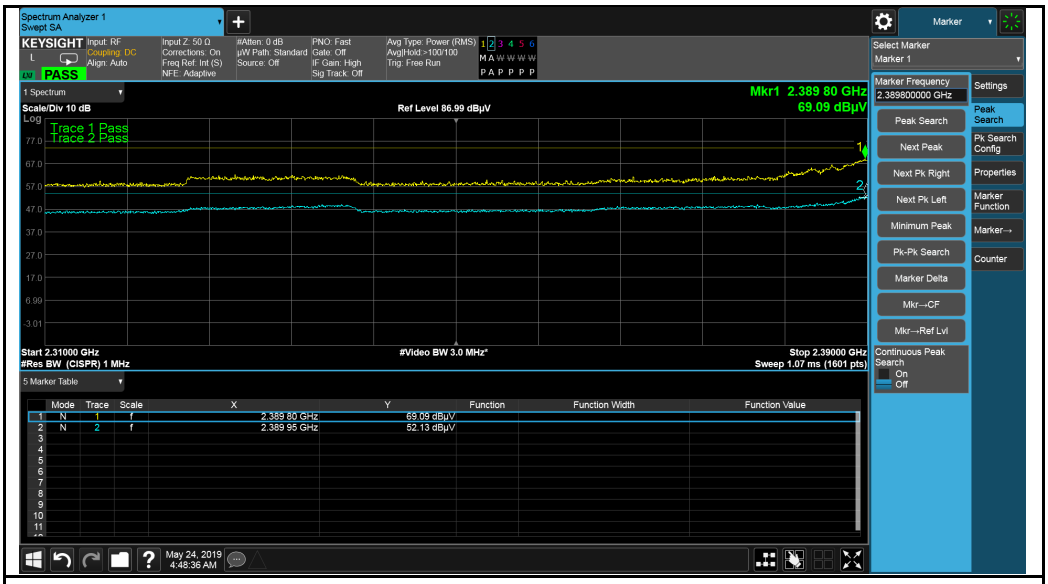
Restricted Band Measurement Plots:



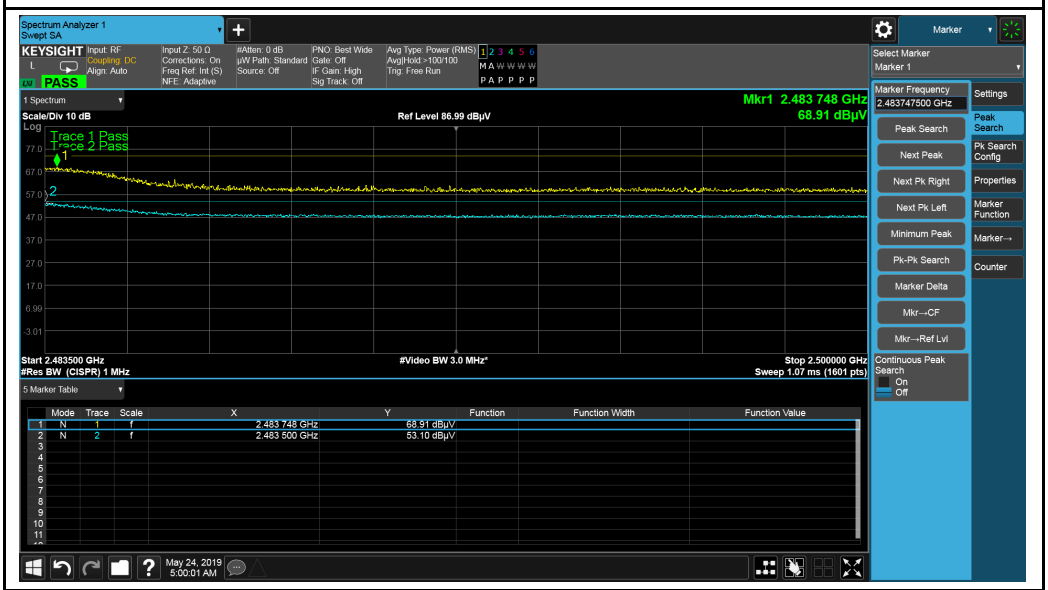
802.11b-2412MHz



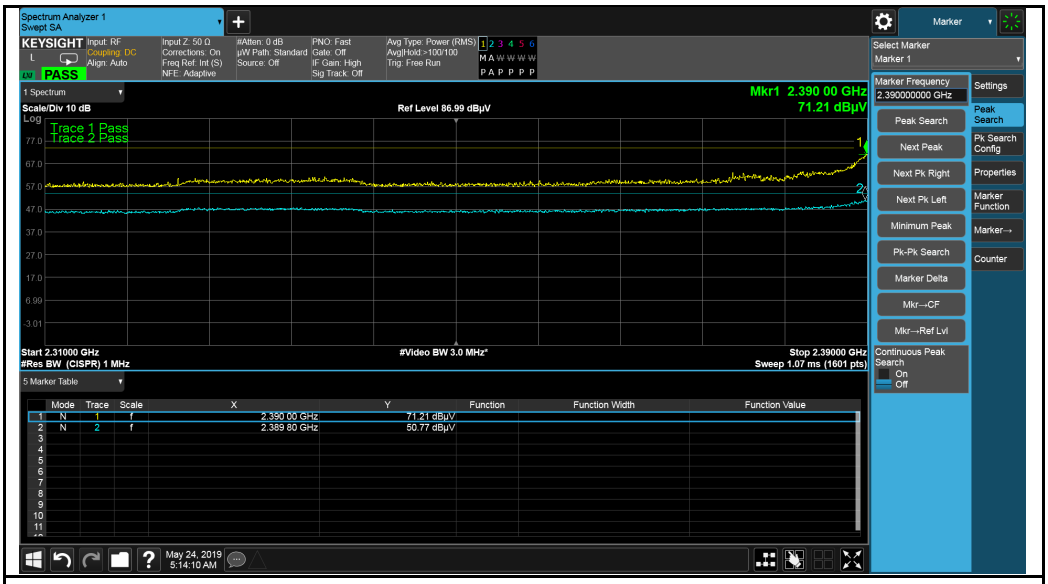
802.11b-2462MHz



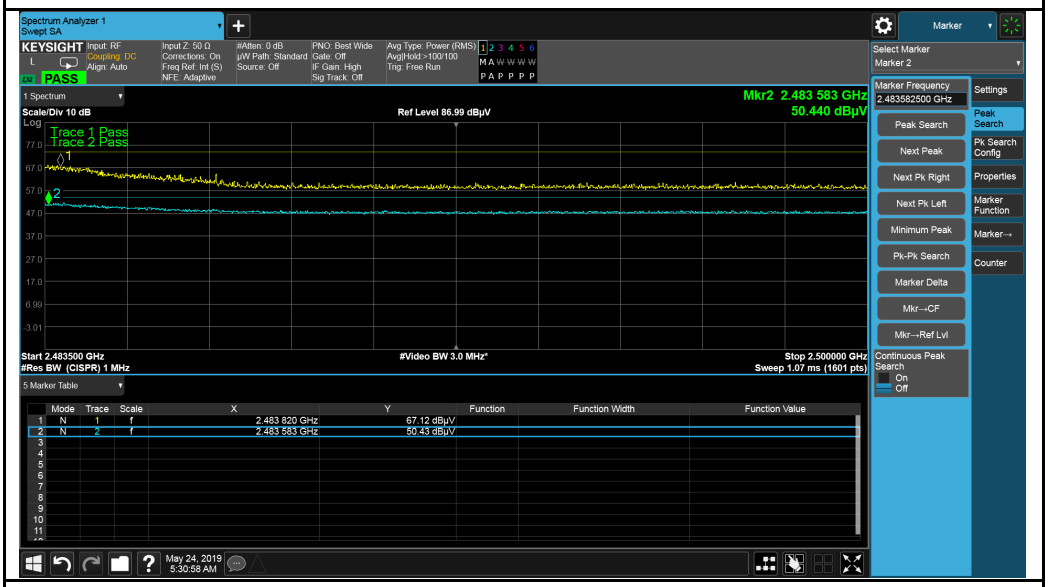
802.11g-2412MHz



802.11g-2462MHz



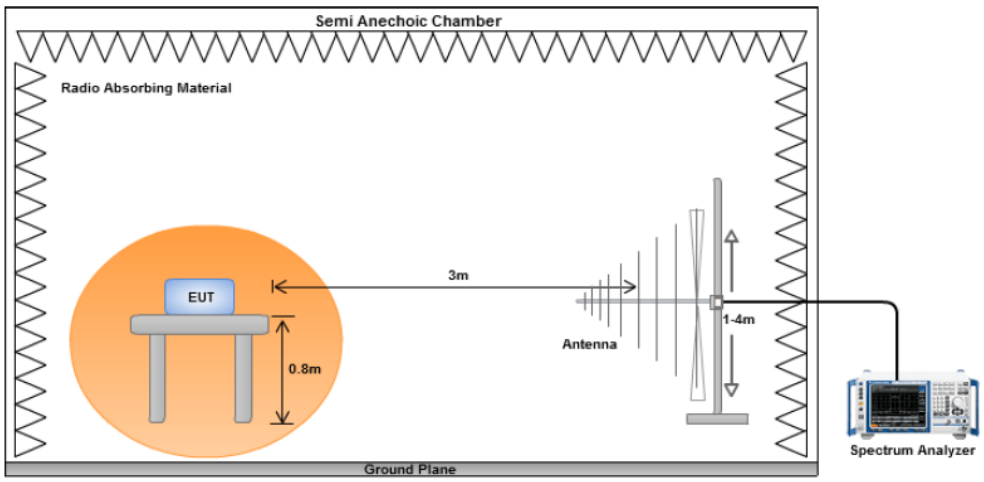
802.11n-HT20-2412MHz



802.11n-HT20-2462MHz

10.7 Radiated Spurious Emissions below 1GHz

Requirement(s):

Spec	Item	Requirement	Applicable
47CFR§15.247(d) RSS247 (5.5)	a)	Except higher limit as specified elsewhere in other section, the emissions from the low-power radio-frequency devices shall not exceed the field strength levels specified in the following table and the level of any unwanted emissions shall not exceed the level of the fundamental emission. The tighter limit applies at the band edges **Frequency range (MHz)** / **Field Strength (uV/m)** 30 – 88 / 100 88 – 216 / 150 216 960 / 200 Above 960 / 500	☒
Test Setup			
Procedure	1. The EUT was switched on and allowed to warm up to its normal operating condition. 2. The test was carried out at the selected frequency points obtained from the EUT characterisation. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner: a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. b. The EUT was then rotated to the direction that gave the maximum emission. c. Finally, the antenna height was adjusted to the height that gave the maximum emission. 3. A Quasi-peak measurement was then made for that frequency point. 4. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.		
Remark	The EUT was scanned up to 1GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.		
Result	☒ Pass ☐ Fail		

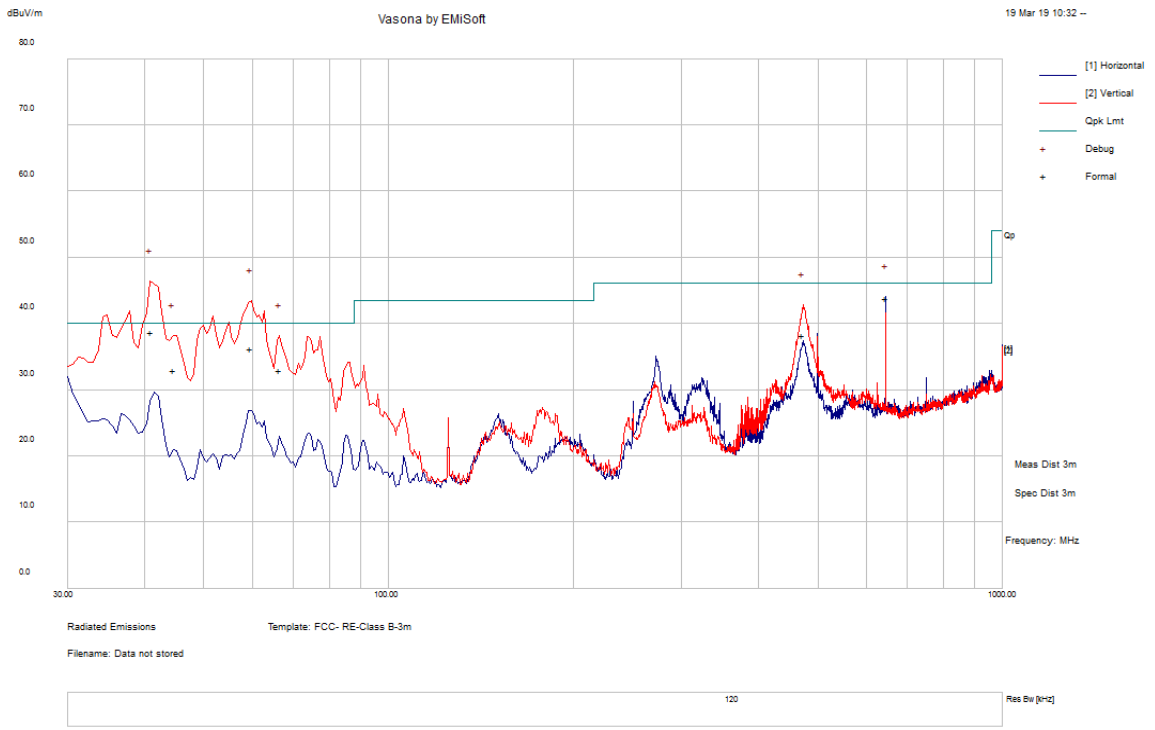
Test Data ☒ Yes (See below) ☐ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Deon Dai at 10m chamber.

Radiated Emission Test Results (Below 1GHz)

Test specification	below 1GHz			
Environmental Conditions:	Temp (°C):	23	Result	Pass
	Humidity (%)	46		
	Atmospheric (mbar):	1018		
Mains Power:	120VAC, 60Hz			
Tested by:	Deon Dai			
Test Date:	03/19/2019			
Remarks:	802.11n HT40, middle channel			



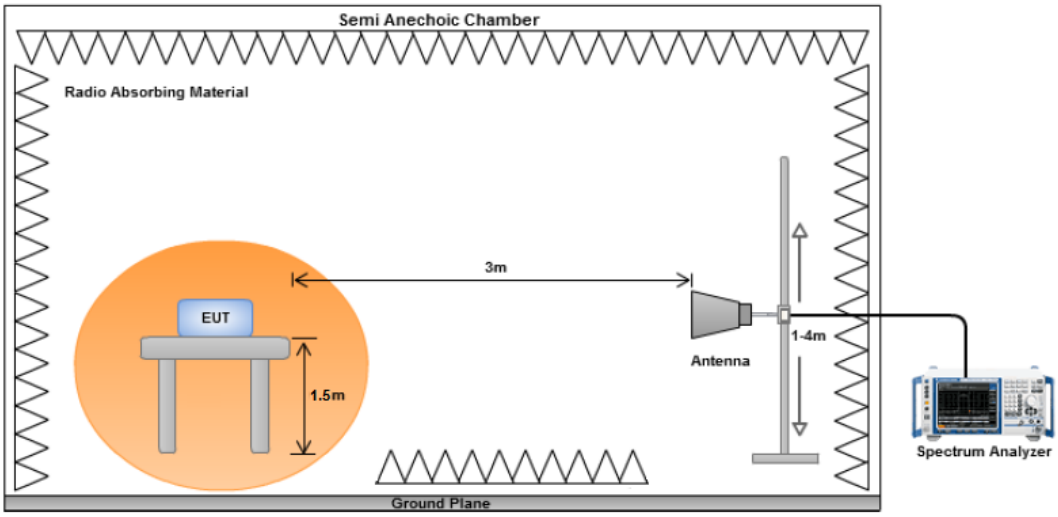
Test Data

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
41.08	48.44	11.33	-21.07	38.69	Quasi Max	V	117	148	40	-1.31	Pass
59.54	52.06	11.5	-27.31	36.25	Quasi Max	V	157	199	40	-3.75	Pass
44.70	45.1	11.39	-23.44	33.06	Quasi Max	V	105	198	40	-6.94	Pass
66.36	48.71	11.55	-27.26	33	Quasi Max	V	103	231	40	-7	Pass
644.55	44.72	14.99	-15.86	43.86	Quasi Max	H	114	197	46	-2.14	Pass
473.19	42.77	14.19	-18.64	38.33	Quasi Max	V	101	223	46	-7.67	Pass

Note: Both horizontal and vertical polarities were investigated. The results above show only the worst case.

10.8 Radiated Spurious Emissions between 1GHz – 25GHz

Requirement(s):

Spec	Item	Requirement	Applicable
47CFR§15.247(d), RSS247(5.5)	a)	For non-restricted band, 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 or 30dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, determined by the measurement method on output power to be used. Attenuation below the general limits specified in § 15.209(a) is not required ☐ 20 dB down ☒ 30 dB down	☒
	b)	or restricted band, emission must also comply with the radiated emission limits specified in 15.209	☒
Test Setup			
Procedure	1. The EUT was switched on and allowed to warm up to its normal operating condition. 2. The test was carried out at the selected frequency points obtained from the EUT characterisation. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner: a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. b. The EUT was then rotated to the direction that gave the maximum emission. c. Finally, the antenna height was adjusted to the height that gave the maximum emission. 3. An average measurement was then made for that frequency point. 4. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.		
Remark	The EUT was scanned up to 40GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case. There isn't outstanding emission found at the edge of restricted frequency.		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes (See below) ☐ N/A

Test Plot ☐ Yes (See below) ☒ N/A

Test was done by Deon Dai at 10m chamber.

Radiated Emission Test Results (Above 1GHz)

Above 1GHz-25GHz – 802.11b – 2412MHz

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3922.39	48.11	3.76	-12.74	39.13	Peak Max	H	210	294	74	-34.87	Pass
4824.77	60.28	4.12	-10.92	53.48	Peak Max	V	220	32	74	-20.52	Pass
8634.47	49.69	5.58	-6.66	48.61	Peak Max	V	166	153	74	-25.39	Pass
3922.39	33.32	3.76	-12.74	24.34	Average Max	H	210	294	54	-29.66	Pass
4824.77	56.51	4.12	-10.92	49.71	Average Max	V	220	32	54	-4.29	Pass
8634.47	35.05	5.58	-6.66	33.97	Average Max	V	166	153	54	-20.03	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3206.40	47.71	3.44	-13.78	37.37	Peak Max	H	205	296	74	-36.63	Pass
4873.86	58.95	4.17	-11.01	52.11	Peak Max	V	219	31	74	-21.89	Pass
8309.64	50.13	5.39	-7.06	48.46	Peak Max	V	170	148	74	-25.54	Pass
3206.40	32.78	3.44	-13.78	22.44	Average Max	H	205	296	54	-31.56	Pass
4873.86	53.47	4.17	-11.01	46.63	Average Max	V	219	31	54	-7.37	Pass
8309.64	35.57	5.39	-7.06	33.9	Average Max	V	170	148	54	-20.1	Pass

Above 1GHz-25GHz – 802.11b – 2462MHz

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3454.15	47.37	3.56	-13.73	37.2	Peak Max	V	208	294	74	-36.8	Pass
4924.30	59	4.22	-11.11	52.11	Peak Max	V	223	33	74	-21.89	Pass
8055.14	50.09	5.41	-7.05	48.45	Peak Max	V	166	154	74	-25.55	Pass
3454.15	32.68	3.56	-13.73	22.51	Average Max	V	208	294	54	-31.49	Pass
4924.30	54.98	4.22	-11.11	48.09	Average Max	V	223	33	54	-5.91	Pass
8055.14	35.65	5.41	-7.05	34.01	Average Max	V	166	154	54	-19.99	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3298.33	47.49	3.49	-13.74	37.24	Peak Max	V	209	297	74	-36.76	Pass
4824.14	58.68	4.12	-10.92	51.88	Peak Max	H	224	26	74	-22.12	Pass
8024.30	50.65	5.42	-7.04	49.03	Peak Max	H	167	147	74	-24.97	Pass
3298.33	33.26	3.49	-13.74	23.01	Average Max	V	209	297	54	-30.99	Pass
4824.14	44.02	4.12	-10.92	37.22	Average Max	H	224	26	54	-16.78	Pass
8024.30	35.85	5.42	-7.04	34.23	Average Max	H	167	147	54	-19.77	Pass

Above 1GHz-25GHz – 802.11g – 2437MHz

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3979.45	48.11	3.83	-12.67	39.27	Peak Max	V	204	299	74	-34.73	Pass
4873.05	58.37	4.17	-11.01	51.53	Peak Max	H	221	29	74	-22.47	Pass
8352.12	49.98	5.42	-7.02	48.38	Peak Max	H	167	146	74	-25.62	Pass
3979.45	33.67	3.83	-12.67	24.83	Average Max	V	204	299	54	-29.17	Pass
4873.05	43.38	4.17	-11.01	36.54	Average Max	H	221	29	54	-17.46	Pass
8352.12	34.98	5.42	-7.02	33.38	Average Max	H	167	146	54	-20.62	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3113.17	48.32	3.36	-13.83	37.85	Peak Max	H	211	298	74	-36.15	Pass
4924.41	58.24	4.22	-11.11	51.35	Peak Max	V	221	28	74	-22.65	Pass
8800.55	50.07	5.63	-6.31	49.39	Peak Max	V	167	151	74	-24.61	Pass
3113.17	34.03	3.36	-13.83	23.56	Average Max	H	211	298	54	-30.44	Pass
4924.41	43.48	4.22	-11.11	36.59	Average Max	V	221	28	54	-17.41	Pass
8800.55	35.93	5.63	-6.31	35.25	Average Max	V	167	151	54	-18.75	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3848.68	48.23	3.68	-12.86	39.05	Peak Max	V	204	297	74	-34.95	Pass
4824.42	52.75	4.12	-10.92	45.95	Peak Max	H	217	29	74	-28.05	Pass
8979.60	49.84	5.62	-5.94	49.52	Peak Max	H	165	148	74	-24.48	Pass
3848.68	33.97	3.68	-12.86	24.79	Average Max	V	204	297	54	-29.21	Pass
4824.42	38.94	4.12	-10.92	32.14	Average Max	H	217	29	54	-21.86	Pass
8979.60	34.86	5.62	-5.94	34.54	Average Max	H	165	148	54	-19.46	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3621.24	47.35	3.58	-13.47	37.46	Peak Max	V	210	293	74	-36.54	Pass
4873.04	53.68	4.17	-11.01	46.84	Peak Max	H	221	31	74	-27.16	Pass
8072.68	50.08	5.41	-7.06	48.43	Peak Max	V	161	148	74	-25.57	Pass
3621.24	32.71	3.58	-13.47	22.82	Average Max	V	210	293	54	-31.18	Pass
4873.04	39.01	4.17	-11.01	32.17	Average Max	H	221	31	54	-21.83	Pass
8072.68	35.84	5.41	-7.06	34.19	Average Max	V	161	148	54	-19.81	Pass

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

Frequency MHz	Raw dBuV/m	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
3508.65	47.14	3.58	-13.71	37.01	Peak Max	V	207	300	74	-36.99	Pass
4924.18	55.73	4.22	-11.11	48.84	Peak Max	V	222	33	74	-25.16	Pass
8109.72	49.91	5.39	-7.07	48.23	Peak Max	H	168	154	74	-25.77	Pass
3508.65	32.42	3.58	-13.71	22.29	Average Max	V	207	300	54	-31.71	Pass
4924.18	39.33	4.22	-11.11	32.44	Average Max	V	222	33	54	-21.56	Pass
8109.72	35.9	5.39	-7.07	34.22	Average Max	H	168	154	54	-19.78	Pass

Annex A. TEST INSTRUMENT

Instrument	Model	Serial #	Cal Date	Cal Cycle	Cal Due	In use
Conducted Emissions						
R & S Receiver	ESIB 40	100179	08/28/2018	1 Year	08/29/2019	☑
LISN	3816/2NM	214372	01/10/2019	1 Year	01/10/2020	☑
Radiated Emissions						
50GHz Spectrum Analyzer	N9030B(PXA)	MY57140374	08/20/2018	1 Year	08/20/2019	☑
Bi-Log antenna (30MHz~6GHz)	JB6	A111717	08/12/2018	1 Year	08/12/2019	☑
Horn Antenna (1GHz~26GHz)	3115	100059	01/26/2019	1 Year	01/26/2020	☑
Horn Antenna (26GHz~40GHz)	AH-840	101013	08/28/2018	1 Year	08/28/2019	☑
Pre-Amplifier(0.3MHz-6.5GHz)	LPA-6-30	11170602	02/06/2019	1 Year	02/06/2020	☑
Pre-Amplifier (1-26.5GHz)	8449B	3008A00715	08/16/2018	1 Year	08/16/2019	☑
Pre-Amp (10MHz~50GHz)	RAMP00M50GA	17032300047	02/10/2019	1 Year	02/10/2020	☑
RF Conducted Measurement						
50GHz Spectrum Analyzer	N9030B (PXA)	MY57140584	10/02/2018	1 Year	10/02/2019	☑
ETS-Lingren USB RF Power Sensor	7002-006	10SL0190	09/03/2018	1 Year	09/03/2019	☑

Annex B. SIEMIC Accreditation

Accreditations	Document	Scope / Remark
ISO 17025 (A2LA)		Please see the documents for the detailed scope
ISO Guide 65 (A2LA)		Please see the documents for the detailed scope
TCB Designation		A1, A2, A3, A4, B1, B2, B3, B4, C
FCC DoC Accreditation		FCC Declaration of Conformity Accreditation
FCC Site Registration		3 meter site
FCC Site Registration		10 meter site
IC Site Registration		3 meter site
IC Site Registration		10 meter site
EU NB		**Radio & Telecommunications Terminal Equipment:** EN45001 – EN ISO/IEC 17025
		Electromagnetic Compatibility: EN45001 – EN ISO/IEC 17025
Singapore iDA CB(Certification Body)		Phase I, Phase II
Vietnam MIC CAB Accreditation		Please see the document for the detailed scope
Hong Kong OFCA		**(Phase II)** OFCA Foreign Certification Body for Radio and Telecom
		(Phase I) Conformity Assessment Body for Radio and Telecom
Industry Canada CAB		**Radio:** Scope A – All Radio Standard Specification in Category I
		Telecom: CS-03 Part I, II, V, VI, VII, VIII

Japan Recognized Certification Body Designation		**Radio**: A1. Terminal equipment for purpose of calling **Telecom**: B1. Specified radio equipment specified in Article 38-2, Paragraph 1, Item 1 of the Radio Law
Korea CAB Accreditation		**EMI:** KCC Notice 2008-39, RRL Notice 2008-3: CA Procedures for EMI KN22: Test Method for EMI **EMS:** KCC Notice 2008-38, RRL Notice 2008-4: CA Procedures for EMS KN24, KN61000-4-2, -4-3, -4-4, -4-5, -4-6, -4-8, -4-11: Test Method for EMS
		Radio: RRL Notice 2008-26, RRL Notice 2008-2, RRL Notice 2008-10, RRL Notice 2007-49, RRL Notice 2007-20, RRL Notice 2007-21, RRL Notice 2007-80, RRL Notice 2004-68
		Telecom: President Notice 20664, RRL Notice 2007-30, RRL Notice 2008-7 with attachments 1, 3, 5, 6; President Notice 20664, RRL Notice 2008-7 with attachment 4
Taiwan NCC CAB Recognition		LP0002, PSTN01, ADSL01, ID0002, IS6100, CNS14336, PLMN07, PLMN01, PLMN08
Taiwan BSMI CAB Recognition		CNS 13438
Japan VCCI		R-3083: Radiation 3 meter site C-3421: Main Ports Conducted Interference Measurement T-1597: Telecommunication Ports Conducted Interference Measurement
Australia CAB Recognition		**EMC:** AS/NZS CISPR 11, AS/NZS CISPR 14.1, AS/NZS CISPR22, AS/NZS 61000.6.3, AS/NZS 61000.6.4
		Radio communications: AS/NZS 4281, AS/NZS 4268, AS/NZS 4280.1, AS/NZS 4280.2, AS/NZS 4295, AS/NZS 4582, AS/NZS 4583, AS/NZS 4769.1, AS/NZS 4769.2, AS/NZS 4770, AS/NZS 4771
		Telecommunications: AS/ACIF S002:05, AS/ACIF S003:06, AS/ACIF S004:06 AS/ACIF S006:01, AS/ACIF S016:01, AS/ACIF S031:01, AS/ACIF S038:01, AS/ACIF S040:01, AS/ACIF S041:05, AS/ACIF S043.2:06, AS/ACIF S60950.1
Australia NATA Recognition		AS/ACIF S002, AS/ACIF S003, AS/ACIF S004, AS/ACIF S006, AS/ACIF S016,AS/ACIF S031, AS/ACIF S038, AS/ACIF S040, AS/ACIF S041, AS/ACIF S043.2