FCC Test Report

Report No.:	FCC_RF_SL19040901-ROK-004_5G Rev 1.0
FCC ID:	TC2-R1028
Test Model (host):	RC-EL1
Series Model:	N/A
Received Date:	12/17/2019
Test Date:	12/30/2019/-01/29/2020
Issued Date:	03/04/2020
Applicant:	Roku, Inc.
Address:	150 Winchester Circle, Los Gatos CA 95032
Manufacturer:	Roku, Inc.
Address:	150 Winchester Circle, Los Gatos CA 95032
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035, USA
FCC Test Site Reg No.:	540430

TESTING CERT # 2742-01

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Release Control Record

Issue No.	Description	Date Issued
FCC_RF_SL19040901-ROK-004_5G	Original release	01/29/2020
FCC_RF_SL19040901-ROK-004_5G Rev 1.0	Minor typo corrections	03/04/2020

1 Certificate of Conformity

Product:	WiFi Remote Control
Brand:	Roku, Inc.
Test Model (host):	RC-EL1
Series Model:	N/A
Sample Status:	Engineer Sample
Applicant:	Roku, Inc.
Test Date:	12/30/2019/-01/28/2020
Standard:	47 CFR FCC Part 15, Subpart E (Section 15.407) 789033 D02 General UNII Test Procedures New Rules v02r01 ANSI C63.10:2013

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

Prepared by : _____ , **Date:** 01/29/2020

Deon Dai / Test Engineer

Approved by : _____ , **Date:** 01/29/2020

Chen Ge / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart E (Section 15.407			
Standard Section	Test Item	Result	Remarks
15.203	Antenna Requirement	Pass	The EUT uses a chip antenna to permanently attach to the device.
15.407 (b)(6)	AC Power Conducted Emissions	N/A	N/A
15.407 (b)(1/2/3/4(i/ii)/6)	Radiated Emissions & Band Edge Measurement*	Pass	Meet the requirement of limit.
15.407 (a)(1/2/3)	Max Average Transmit Power	Pass	Meet the requirement of limit.
-	Occupied Bandwidth	Pass	Meet the requirement of limit.
15.407 (e)	6 dB Emission Bandwidth	Pass	Meet the requirement of limit. (U-NII-3 only)
15.407 (a)(1/2/3)	Peak Power Spectral Density	Pass	Meet the requirement of limit.
15.407(g)	Frequency Stability	Pass	Meet the requirement of limit.

Note: N/A: EUT worked with battery.

2.1 Measurement Uncertainty

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

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

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	WiFi Remote Control
Brand	Roku, Inc.
Test Model (host)	RC-EL1
Identification No. of EUT	N/A
Series Model	N/A
Model Difference	N/A
Status of EUT	Engineer Sample
Power Supply Rating	2 x AAA batteries 1.5V
Modulation Type	64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS, OFDM
Transfer Rate	802.11a: up to 54Mbps 802.11n: up to 450Mbps
Operating Frequency	5150 ~ 5250MHz, 5745~5825MHz
Number of Channel	5150~5250MHz: 802.11a, 802.11n (HT20): 4 5745~5825MHz: 802.11a, 802.11n (HT20): 5
Antenna Type	Chip Antenna 5150~5250MHz:2.8 dBi 5745~5825MHz:4.4 dBi
Antenna Connector	N/A

Note:

1. The EUT provides one completed transmitter and one receiver.

Modulation Mode	Tx Function
802.11a	1TX
802.11n (HT20)	1TX

3.2 Description of Operation Modes

FOR 5180 ~ 5240MHz

4 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

FOR 5745 ~ 5825MHz:

5 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz		

Power setting is as below:

802.11a		802.11n	
Channel	Power Setting	Channel	Power Setting
36	90	36	90
40	90	40	90
48	90	48	90
149	90	149	90
157	90	157	90
165	90	165	90

1. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable To				Description
	RE≥1G	RE<1G	PLC	APCM	
A	√	√	√	√	Powered by adapter
B	-	√	√	-	Powered by POE

Where **RE≥1G:** Radiated Emission above 1GHz **RE<1G:** Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

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

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11a	5180-5240	36 to 48	36, 40, 48	OFDM	BPSK	6
-	802.11n (HT20)		36 to 48	36, 40, 48	OFDM	BPSK	6.5
-	802.11a	5745-5825	149 to 165	149, 157, 165	OFDM	BPSK	6
-	802.11n (HT20)		149 to 165	149, 157, 165	OFDM	BPSK	6.5

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11a	5180-5320	36 to 64	62	OFDM	BPSK	6
-	802.11a	5745-5825	149 to 165	149	OFDM	BPSK	6

Power Line Conducted Emission Test:

☐ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☐ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11a	5180-5320	36 to 64	62	OFDM	BPSK	6
-	802.11a	5745-5825	149 to 165	149	OFDM	BPSK	6

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	FREQ. Band (MHz)	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11a	5180-5240	36 to 48	36, 40, 48	OFDM	BPSK	6
-	802.11n (HT20)		36 to 48	36, 40, 48	OFDM	BPSK	6.5
-	802.11a	5745-5825	149 to 165	149, 157, 165	OFDM	BPSK	6
-	802.11n (HT20)		149 to 165	149, 157, 165	OFDM	BPSK	6.5

Test Condition:

Applicable To	Environmental Conditions	Input Power	Tested By
RE≥1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
PLC	25deg. C, 68%RH	120Vac, 60Hz	Deon Dai
APCM	21deg. C, 60%RH	120Vac, 60Hz	Deon Dai

3.3 Description of Support Units

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

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Dell	Latitude 3550	N/A	N/A	N/A
B.						
C.						
D.						
E.						
F.						
G.						

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB	1	0.8m	No	0	Connect from EUT to Laptop
2.						
3.						

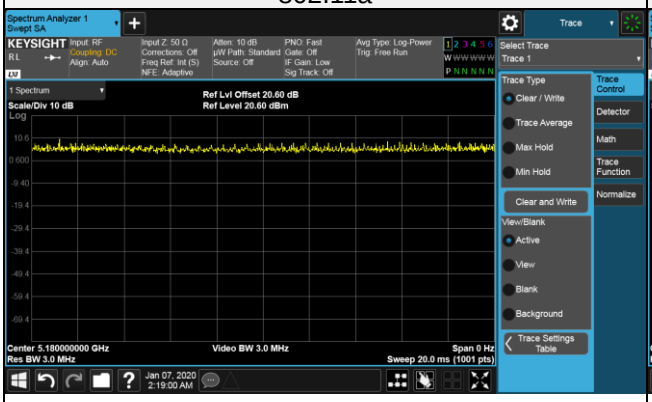
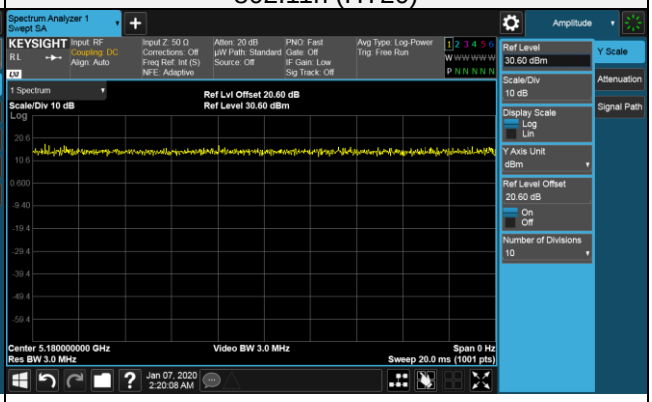
3.3.1 Duty Cycle of Test Signal

MODULATION TYPE: BPSK

If Duty cycle of test signal is < 98 %, duty factor is required.

802.11a: Duty cycle = 100%

802.11n (HT20): Duty cycle = 100%

802.11a	802.11n (HT20)
	

3.4 General Description of Applied Standard

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

47 CFR FCC Part 15, Subpart E (Section 15.407)
789033 D02 General UNII Test Procedures New Rules v02r01
ANSI C63.10:2013

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

4 Test Types and Results

4.1 Antenna Requirement

Spec	Requirement	Applicable
15.203	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. Antenna requirement must meet at least one of the following: a) Antenna must be permanently attached to the device. b) The antenna must use a unique type of connector to attach to the device. c) Device must be professionally installed. The installer shall be responsible for ensuring that the correct antenna is employed by the device.	☒
Remark	The EUT uses a chip antenna to permanently attach to the device.	
Result	☒ PASS ☐ FAIL	

4.2 Radiated Emission and Bandedge Measurement

4.2.1 Limits of Radiated Emission Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

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

NOTE:

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

Limits of unwanted emission out of the restricted bands

<table>
<tr><td colspan="3">Applicable To</td><td colspan="2">Limit</td></tr>
<tr><td colspan="3" rowspan="2">789033 D02 General UNII Test Procedure New Rules v02r01</td><td colspan="2">Field Strength at 3m</td></tr>
<tr><td>PK:74 (dBµV/m)</td><td>AV:54 (dBµV/m)</td></tr>
<tr><td>Frequency Band</td><td colspan="2">Applicable To</td><td>EIRP Limit</td><td>Equivalent Field Strength at 3m</td></tr>
<tr><td>5150~5250 MHz</td><td colspan="2">15.407(b)(1)</td><td rowspan="3">PK:-27 (dBm/MHz)</td><td rowspan="3">PK:68.2(dBµV/m)</td></tr>
<tr><td>5250~5350 MHz</td><td colspan="2">15.407(b)(2)</td></tr>
<tr><td>5470~5725 MHz</td><td colspan="2">15.407(b)(3)</td></tr>
<tr><td rowspan="2">5725~5850 MHz</td><td>☐</td><td>15.407(b)(4)(i)</td><td>PK:-27 (dBm/MHz) *1
PK:10 (dBm/MHz) *2
PK:15.6 (dBm/MHz) *3
PK:27 (dBm/MHz) *4</td><td>PK: 68.2(dBµV/m) *1
PK:105.2 (dBµV/m) *2
PK: 110.8(dBµV/m) *3
PK:122.2 (dBµV/m) *4</td></tr>
<tr><td>☒</td><td>15.407(b)(4)(ii)</td><td colspan="2">Emission limits in section 15.247(d)</td></tr>
<tr><td colspan="5">*1 beyond 75 MHz or more above of the band edge.
*2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above.
*3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above.
*4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.</td></tr>
</table>

Note:

The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

$E = \frac{1000000\sqrt{30P}}{3}$ µV/m, where P is the eirp (Watts).

4.2.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
50GHz Spectrum Analyzer	N9030B (PXA)	MY57140597	06/05/2019	06/05/2020
Biconilog Antenna Sunol	JB1	A030702	03/09/2018	03/09/2020
Pre-Amplifier RF Bay, Inc.	LPA-6-30	11170601	04/27/2019	04/27/2020
Horn Antenna ETS-Lindgren	3117	218554	11/22/2019	11/22/2020
Pre-Amplifier RF-Lambda	RAMP00M50GA	17032300048	06/18/2019	06/18/2020

4.2.3 Test Procedure

For Radiated emission below 30MHz

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

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

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

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

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

NOTE:

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

For Radiated emission above 30MHz

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

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

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

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

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

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

Note:

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

For Band edge Measurement

789033 D02 General U-NII Test Procedures New Rules v02r01, II.F. Method SA-1

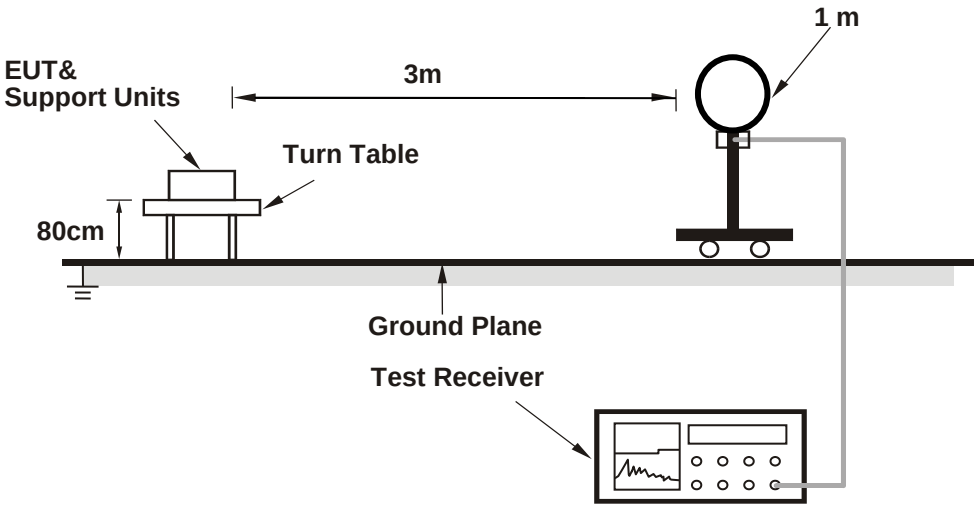
1. For average emissions measurements, follow the procedures described in section II.G.6., “Procedures for Average Unwanted Emissions Measurements above 1000 MHz”, except for the following changes:
2. Set RBW=100 kHz
3. Set VBW=300 kHz
4. Perform a band-power integration across the 1 MHz bandwidth in which the band-edge emission level is to be measured.

4.2.4 Deviation from Test Standard

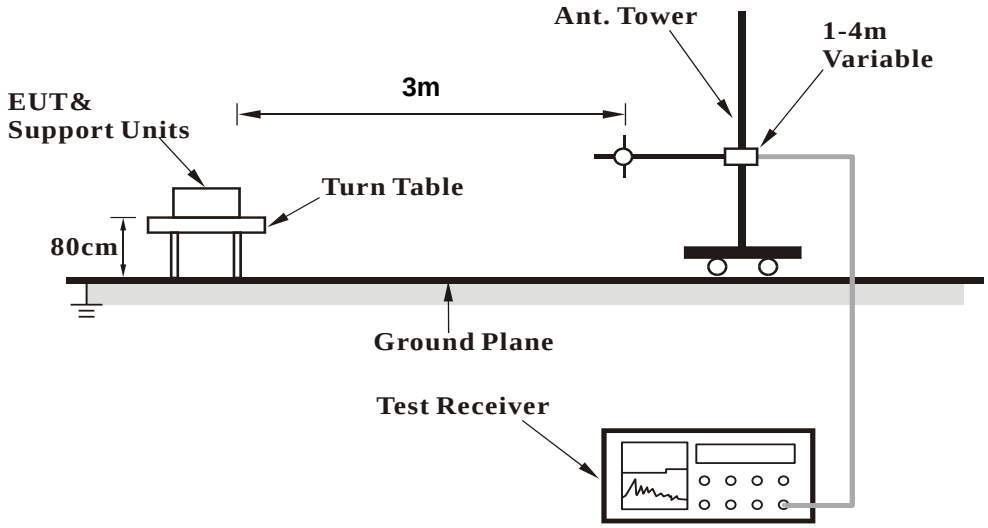
No deviation.

4.2.5 Test Setup

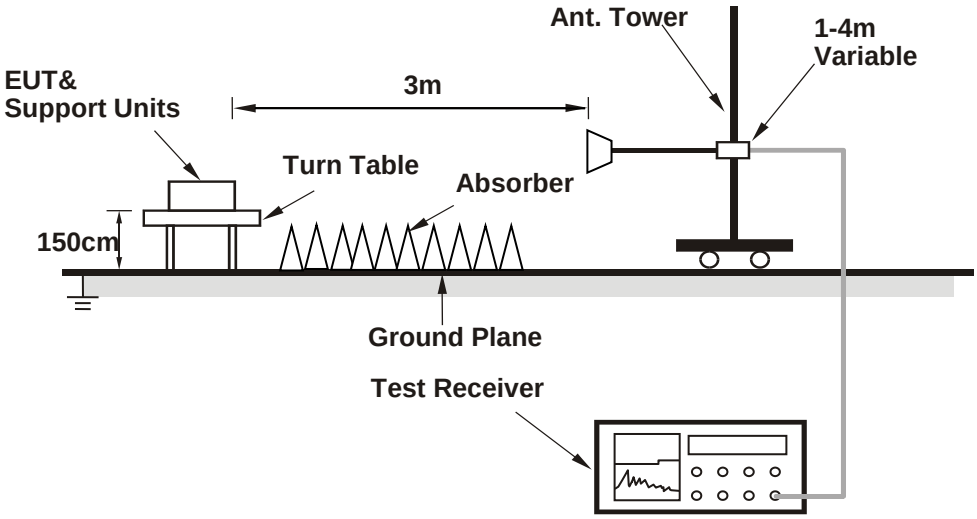
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



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

4.2.6 EUT Operating Condition

a. Placed the EUT on the testing table.
b. Prepared notebooks to act as communication partner and placed it outside of testing area.
c. The communication partner connected with EUT via a USB cable and ran a test program (provided by manufacturer) to enable EUT under transmission condition continuously at specific channel frequency.
d. The necessary accessories enable the system in full functions.

4.2.7 Test Results

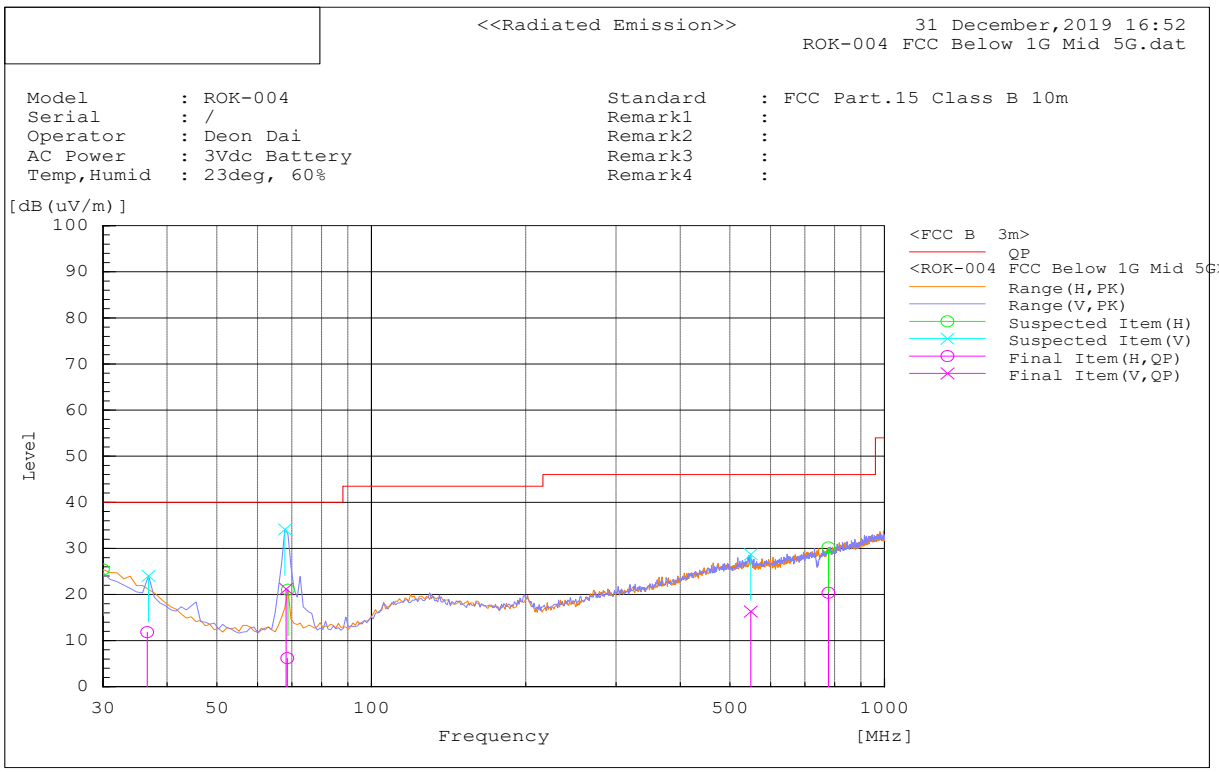
Below 1GHz Worst-Case Data:

CHANNEL	802.11n Channel 40	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	30.932	H	-1.4	12.7	11.3	40	28.7	341	247	Pass
2	36.587	H	-10	21.8	11.8	40	28.2	100	5.3	Pass
3	68.206	V	8.2	13	21.2	40	18.8	100	290	Pass
4	68.57	H	-7.3	13.5	6.2	43.5	33.8	171	296	Pass
5	548.75	V	-8.8	25.1	16.3	46	29.7	100	74.2	Pass
6	777.69	H	-8.6	29	20.4	46	25.6	205	9.5	Pass

REMARKS:

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



Above 1GHz Test Data:

1GHz-40GHz – 802.11a – 5180MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2629.458	V	46.4	-9.1	Average	37.3	54	16.7	132	52.7
4826.51	V	41.6	-5.9	Average	35.7	54	18.3	400	0
10360.59	H	36.9	3.1	Average	40	54	14	100	141
2629.458	V	57.6	-9.1	Peak	48.5	74	25.5	132	52.7
4826.51	V	53.7	-5.9	Peak	47.8	74	26.2	400	0
10360.59	H	48.6	3.1	Peak	51.7	74	22.3	100	141

1GHz-40GHz – 802.11a – 5200MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
10399.16	H	36.8	3.2	Average	40	54	14	400	345
17459.16	V	37.1	12.2	Average	49.3	54	4.7	400	22.9
8129.427	V	39.4	0.4	Average	39.8	54	14.2	328	345.5
10399.16	H	48.6	3.2	Peak	51.8	74	22.2	400	345
17459.16	V	48.1	12.2	Peak	60.3	74	13.7	400	22.9
8129.427	V	50	0.4	Peak	50.4	74	23.6	328	345.5

1GHz-40GHz – 802.11a – 5240MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4675.662	V	42.2	-6.7	Average	35.5	54	18.5	156	185.6
7821.953	H	37.9	-0.1	Average	37.8	54	16.2	291	265
10481.59	V	39	3.4	Average	42.4	54	11.6	100	267.2
4675.662	V	53.4	-6.7	Peak	46.7	74	27.3	156	185.6
7821.953	H	50.4	-0.1	Peak	50.3	74	23.7	291	265
10481.59	V	49.1	3.4	Peak	52.5	74	21.5	100	267.2

1GHz-40GHz – 802.11n – 5180MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
10360.48	V	38.1	3.1	Average	41.2	54	12.8	268	349.7
16530.63	V	38	10.2	Average	48.2	54	5.8	268	268.3
8130.579	V	38.2	0.4	Average	38.6	54	15.4	147	345
10360.48	V	49.2	3.1	Peak	52.3	74	21.7	268	349.7
16530.63	V	49.7	10.2	Peak	59.9	74	14.1	268	268.3
8130.579	V	50.1	0.4	Peak	50.5	74	23.5	147	345

1GHz-40GHz – 802.11n – 5200MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2630.567	V	45.9	-9.1	Average	36.8	54	17.2	208	0
4987.421	H	41.6	-5.9	Average	35.7	54	18.3	216	204.9
10400.25	V	37	3.2	Average	40.2	54	13.8	117	0
2630.567	V	57.3	-9.1	Peak	48.2	74	25.8	208	0
4987.421	H	54.6	-5.9	Peak	48.7	74	25.3	216	204.9
10400.25	V	48.9	3.2	Peak	52.1	74	21.9	117	0

1GHz-40GHz – 802.11n – 5240MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2080.118	H	45.9	-10.3	Average	35.6	54	18.4	328	17.3
2630.513	V	45.9	-9.1	Average	36.8	54	17.2	298	99.4
10480.55	H	37.6	3.4	Average	41	54	13	201	315.2
2080.118	H	55.6	-10.3	Peak	45.3	74	28.7	328	17.3
2630.513	V	57.7	-9.1	Peak	48.6	74	25.4	298	99.4
10480.55	H	48.8	3.4	Peak	52.2	74	21.8	201	315.2

1GHz-40GHz – 802.11a – 5745MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
6832.25	V	39.2	-1.4	Average	37.8	54	16.2	201	0.2
8099.464	V	38.5	0.5	Average	39	54	15	253	79
11490.5	V	35.6	4	Average	39.6	54	14.4	125	126.9
6832.25	V	50.9	-1.4	Peak	49.5	74	24.5	201	0.2
8099.464	V	49.3	0.5	Peak	49.8	74	24.2	253	79
11490.5	V	48.6	4	Peak	52.6	74	21.4	125	126.9

1GHz-40GHz – 802.11a – 5785MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4986.73	H	41.7	-5.9	Average	35.8	54	18.2	291	189.4
6735.443	H	38.3	-1.6	Average	36.7	54	17.3	367	287.5
11571.6	V	35.8	4.2	Average	40	54	14	117	69
4986.73	H	54.1	-5.9	Peak	48.2	74	25.8	291	189.4
6735.443	H	50.9	-1.6	Peak	49.3	74	24.7	367	287.5
11571.6	V	48.2	4.2	Peak	52.4	74	21.6	117	69

1GHz-40GHz – 802.11a – 5825MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4473.7	H	42.8	-6.8	Average	36	54	18	100	23.1
8130.733	V	39.2	0.4	Average	39.6	54	14.4	253	33.4
11651.71	H	36.5	4.4	Average	40.9	54	13.1	396	63.3
4473.7	H	53.5	-6.8	Peak	46.7	74	27.3	100	23.1
8130.733	V	51.2	0.4	Peak	51.6	74	22.4	253	33.4
11651.71	H	49.2	4.4	Peak	53.6	74	20.4	396	63.3

1GHz-40GHz – 802.11n – 5745MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
1921.813	H	43.5	-10.3	Average	33.2	54	20.8	253	0
2630.83	H	44.9	-9.1	Average	35.8	54	18.2	307	76.1
11491.02	H	37.3	4	Average	41.3	54	12.7	125	54.8
1921.813	H	56.1	-10.3	Peak	45.8	74	28.2	253	0
2630.83	H	57.6	-9.1	Peak	48.5	74	25.5	307	76.1
11491.02	H	47.9	4	Peak	51.9	74	22.1	125	54.8

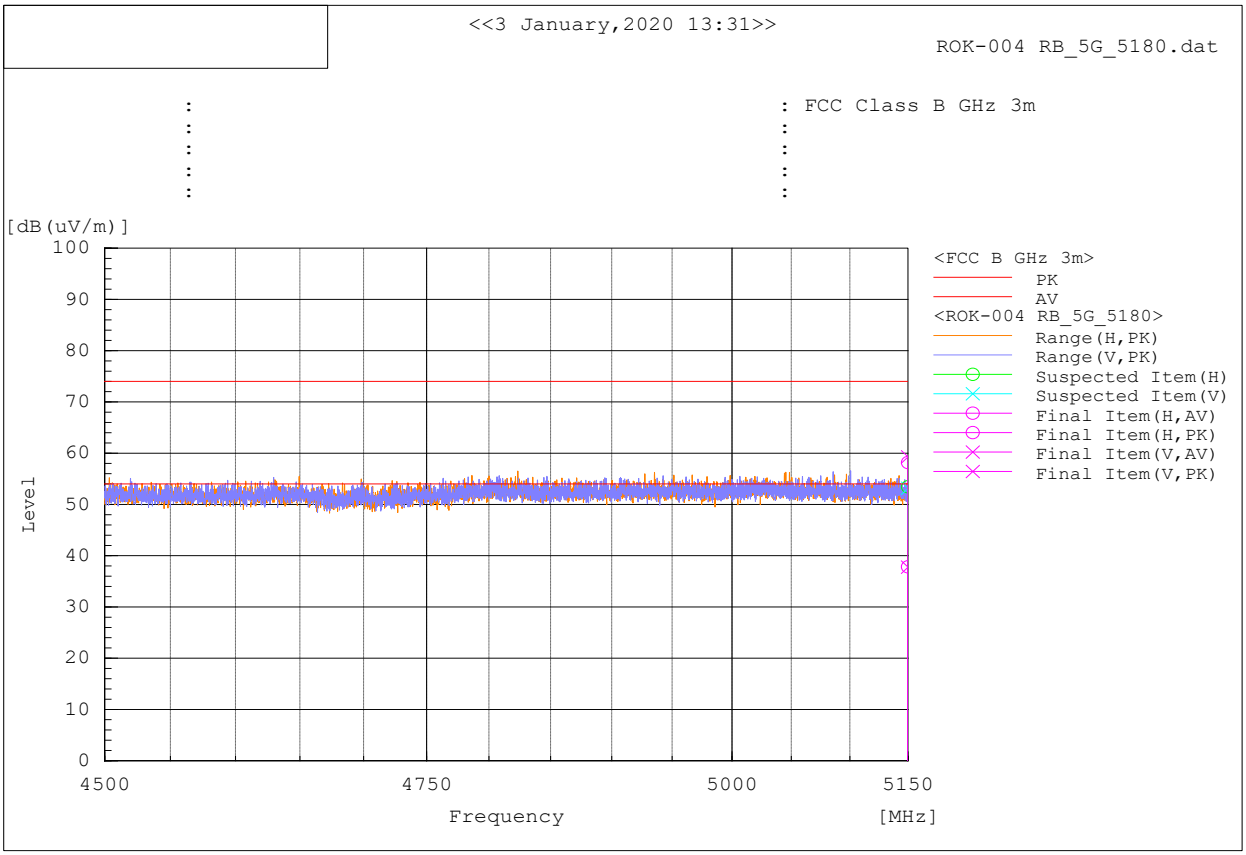
1GHz-40GHz – 802.11n – 5785MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2631.172	V	45.5	-9.1	Average	36.4	54	17.6	374	351
3734.497	V	43.1	-7.3	Average	35.8	54	18.2	125	234.4
11568.61	H	36.7	4.2	Average	40.9	54	13.1	307	91.7
2631.172	V	57.3	-9.1	Peak	48.2	74	25.8	374	351
3734.497	V	54.7	-7.3	Peak	47.4	74	26.6	125	234.4
11568.61	H	48.3	4.2	Peak	52.5	74	21.5	307	91.7

1GHz-40GHz – 802.11n – 5825MHz

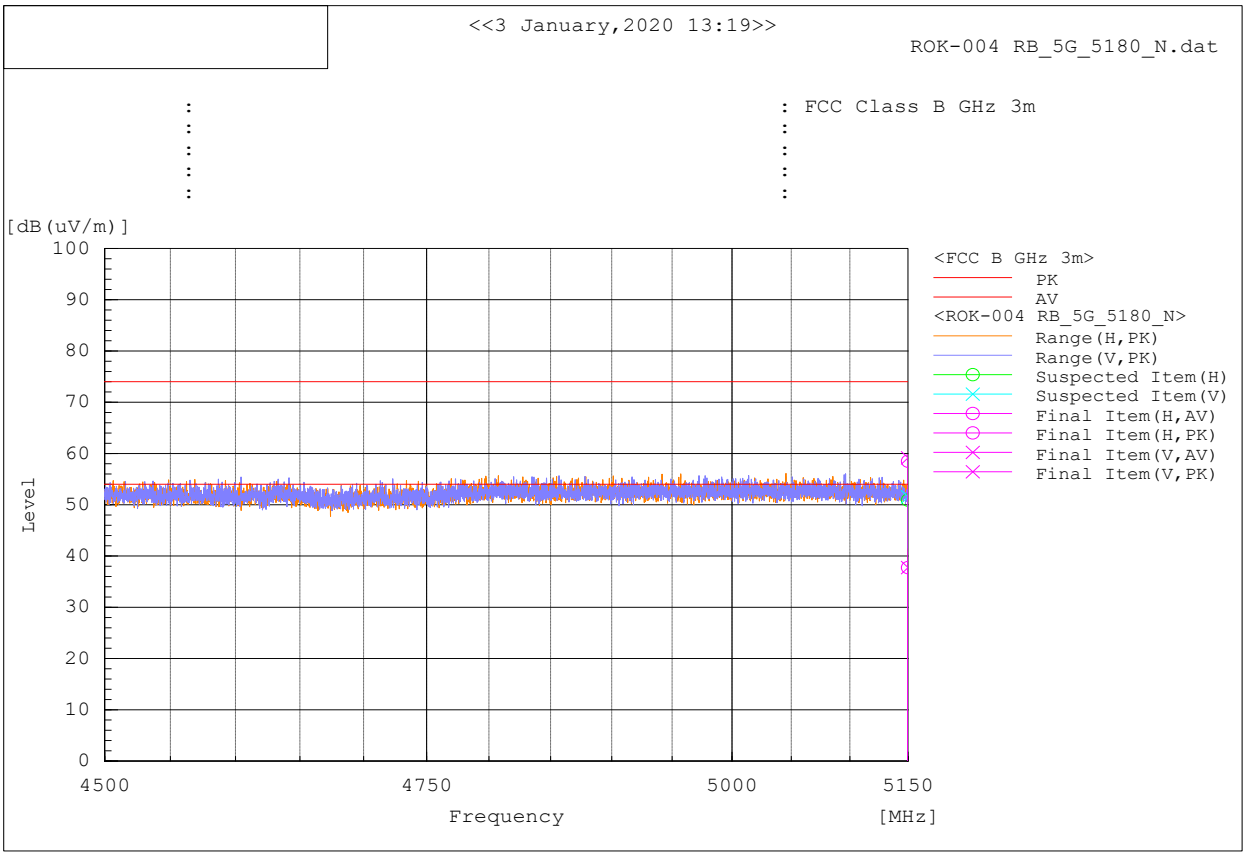
ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
1123.699	V	45.2	-15.1	Average	30.1	54	23.9	162	126.7
2668.697	H	47	-9	Average	38	54	16	186	189.2
11651.25	V	36.6	4.4	Average	41	54	13	367	173
1123.699	V	58	-15.1	Peak	42.9	74	31.1	162	126.7
2668.697	H	57.1	-9	Peak	48.1	74	25.9	186	189.2
11651.25	V	49	4.4	Peak	53.4	74	20.6	367	173

RESTRICTED BAND Test Plots
802.11a – 5180MHz



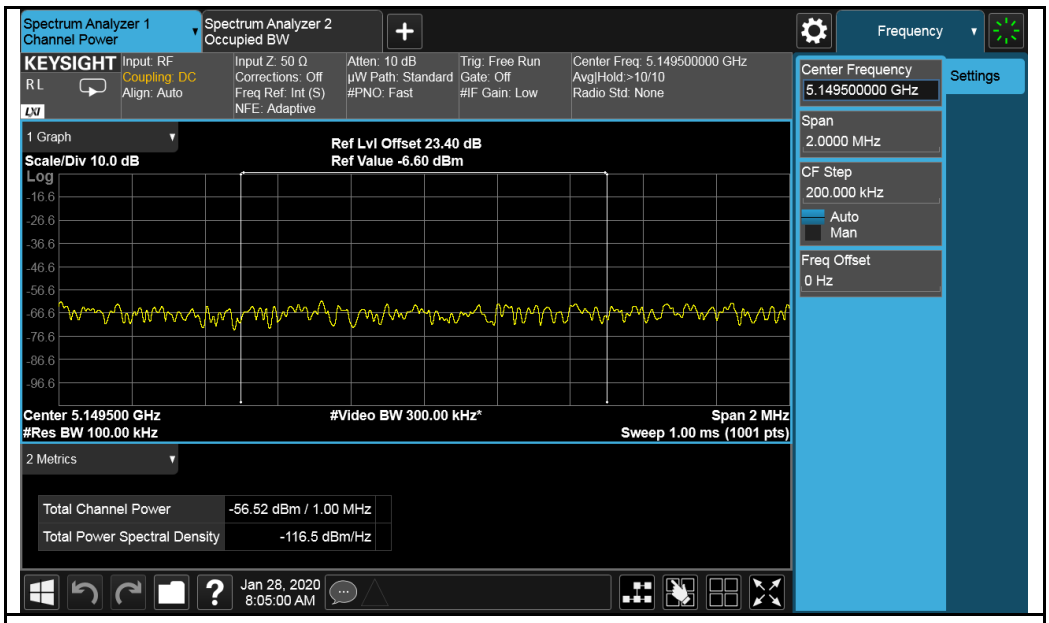
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
5150	V	-4.9	Average	42.7	37.8	54	16.2	163	292
5150	V	16.6	Peak	42.7	59.3	74	14.7	163	292

RESTRICTED BAND
802.11n – 5180MHz

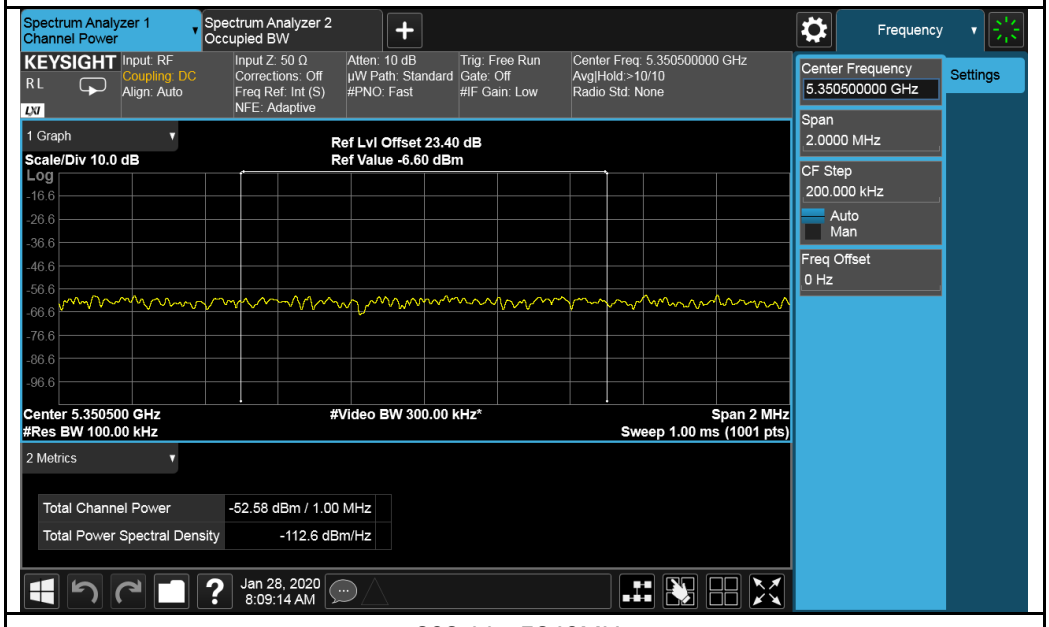


Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
5150	V	-5	Average	42.7	37.7	54	16.3	108	151
5150	V	15.8	Peak	42.7	58.5	74	15.5	108	151

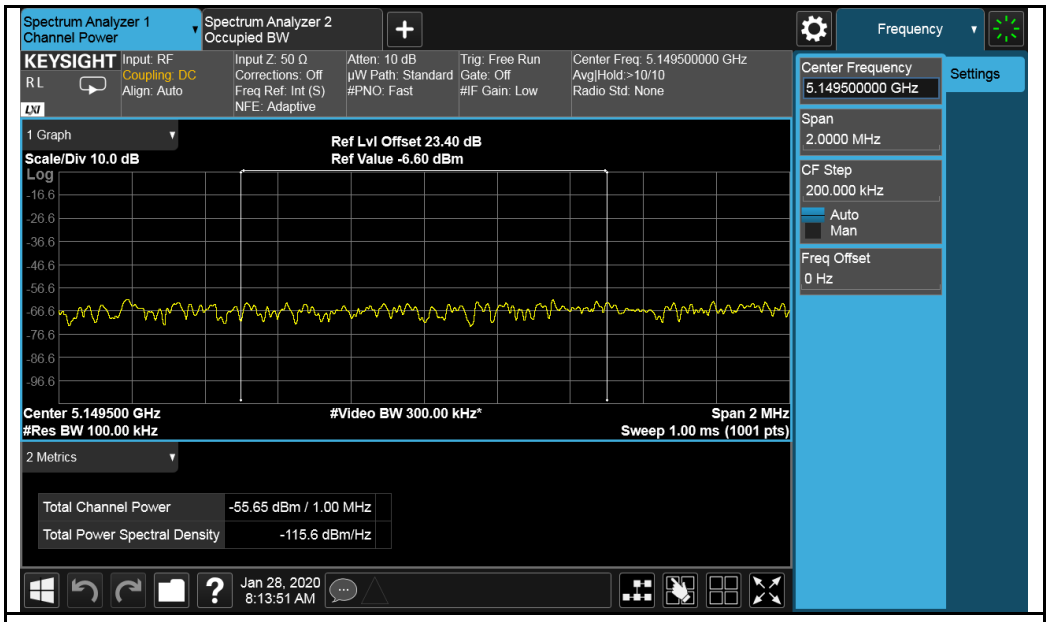
Band Edge Test Plots for U-NII-1 Band:



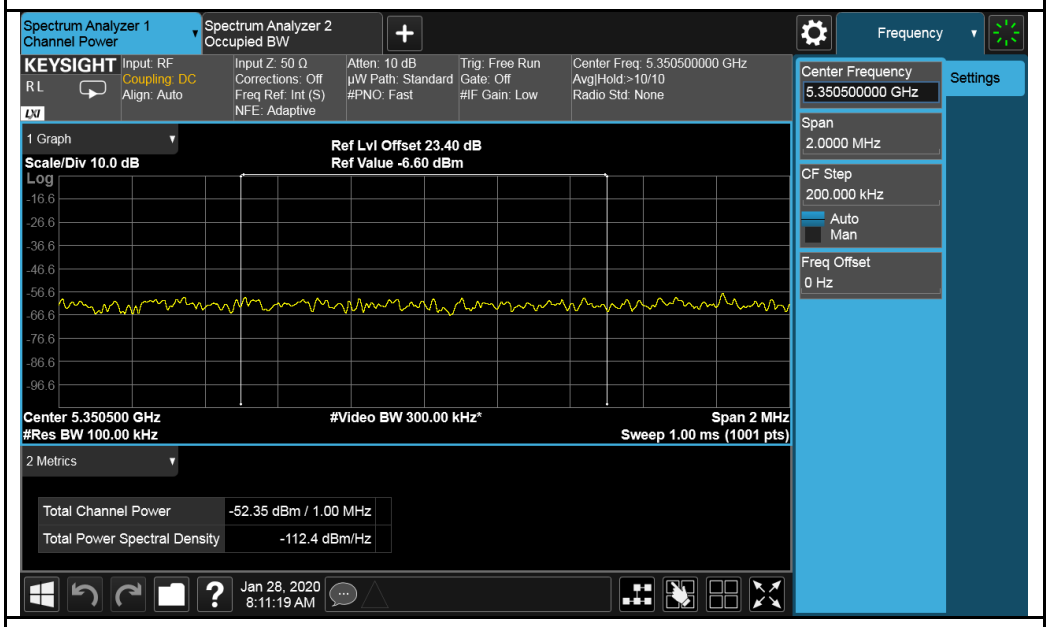
802.11a-5180MHz



802.11a-5240MHz

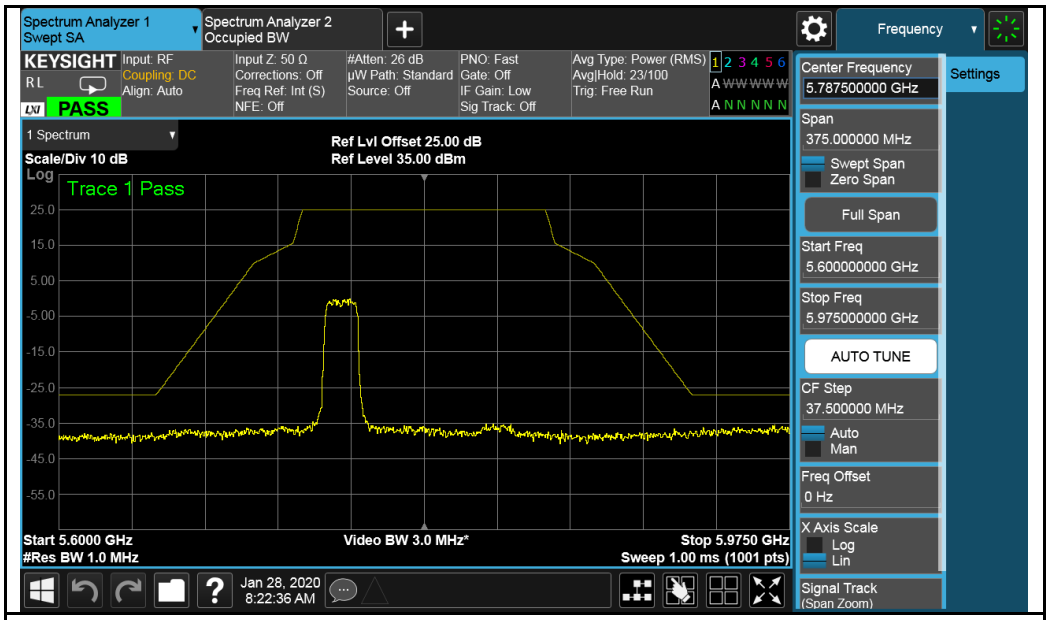


802.11n-5180MHz

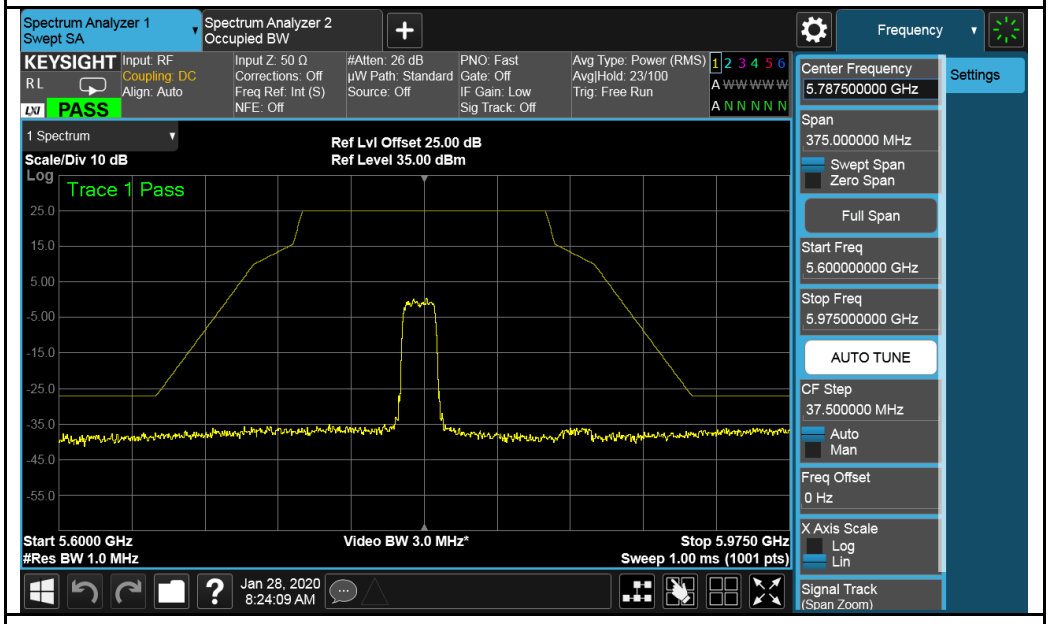


802.11n-5240MHz

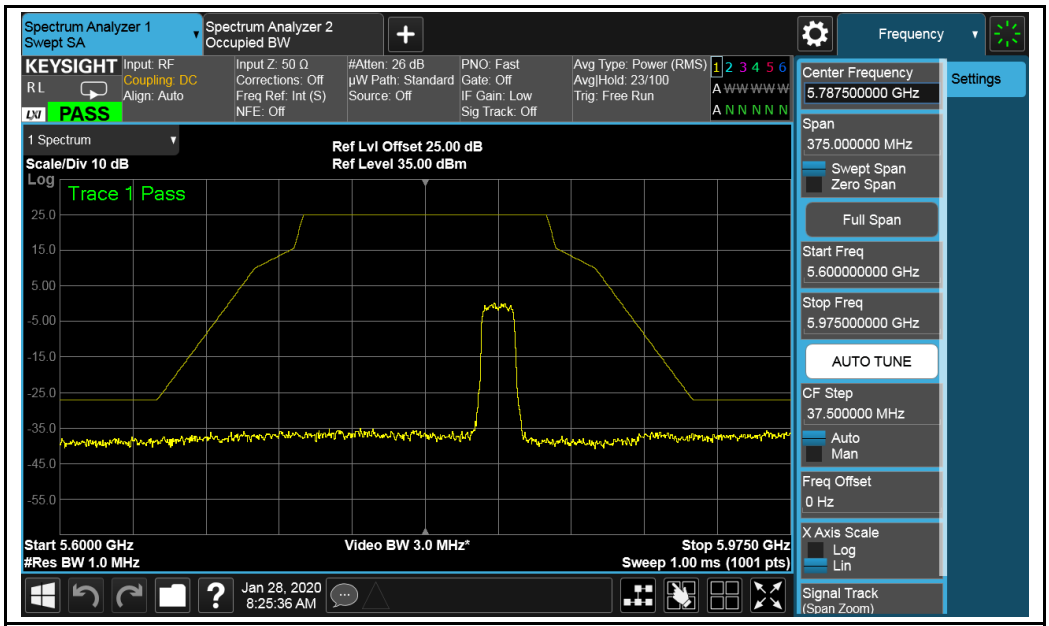
Test Plots for U-NII-3 Band:



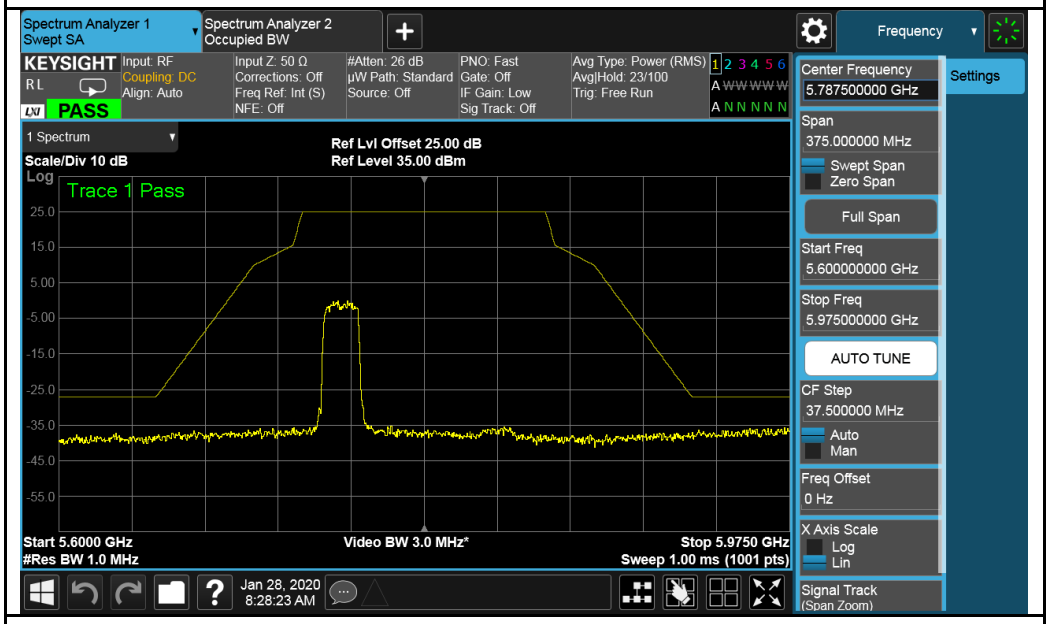
802.11a-5745MHz



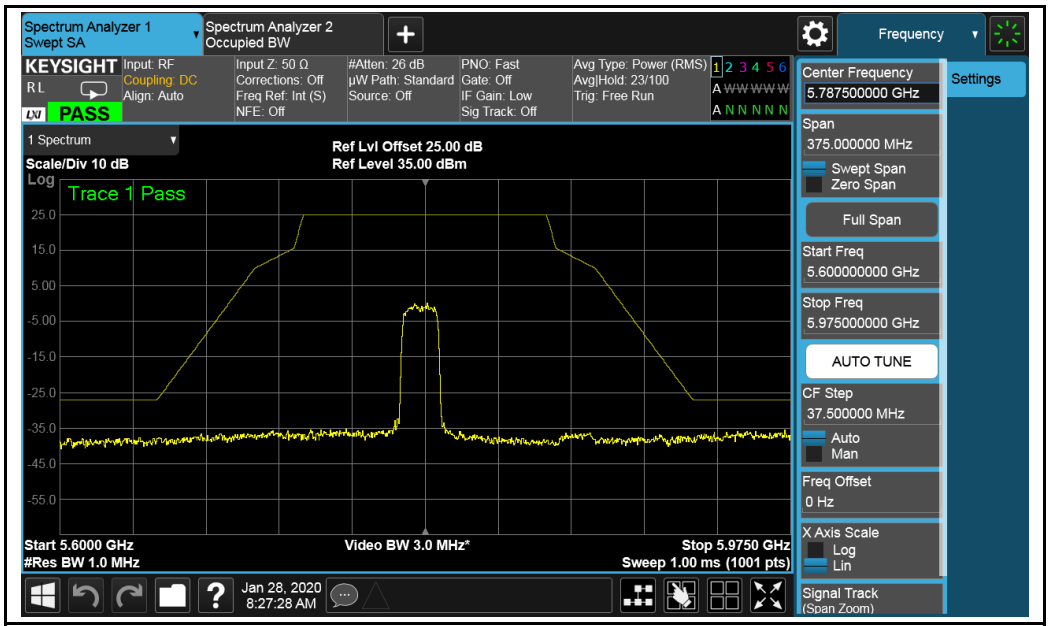
802.11a-5785MHz



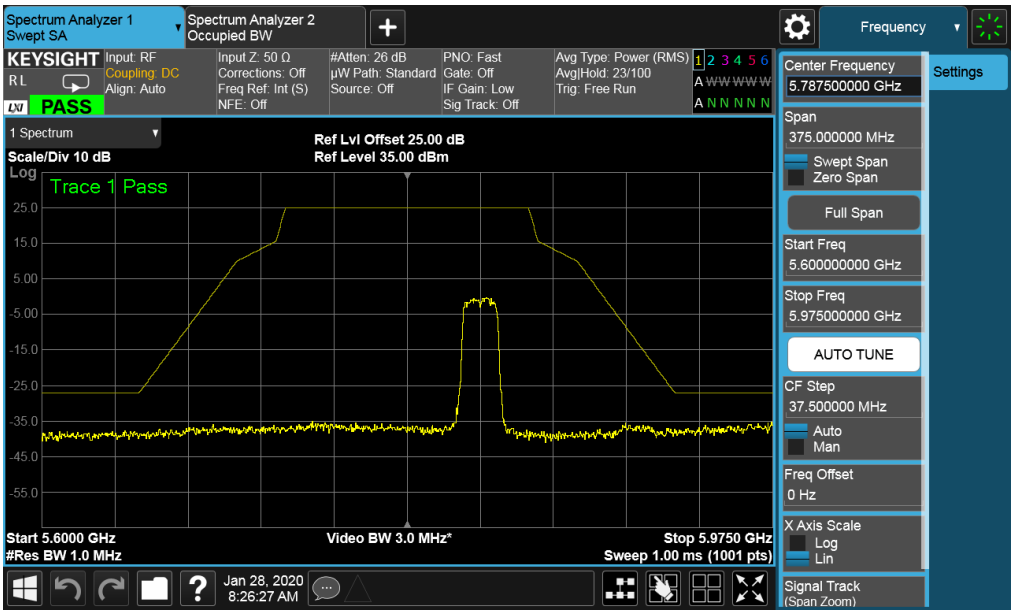
802.11a-5825MHz



802.11n-5745MHz



802.11n-5785MHz



802.11n-5825MHz

4.3 Conducted Emission Measurement

4.3.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.3.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	08/28/2020
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2019	12/31/2020
LISN EMCO	3816/2NM	214372	03/10/2019	03/10/2020

4.3.3 Test Procedure

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

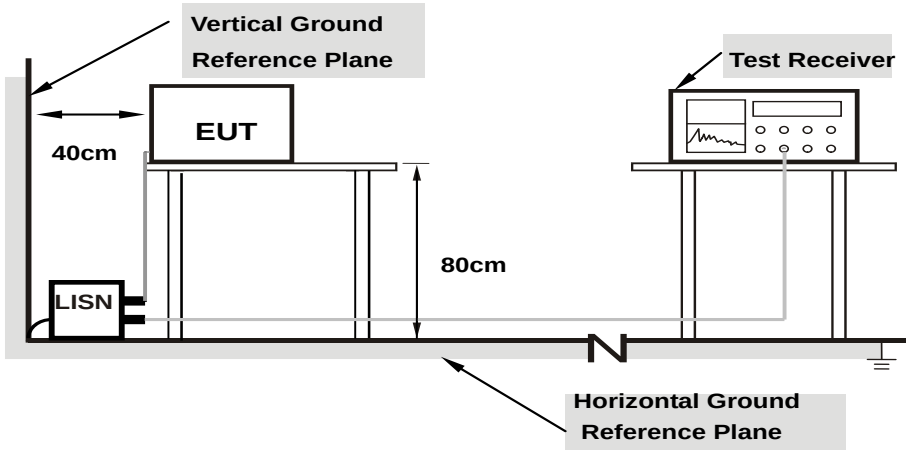
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: All modes of operation were investigated and the worst-case emissions are reported.

4.3.4 Deviation from Test Standard

No deviation.

4.3.5 Test Setup



Note: 1.Support units were connected to second LISN.

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

4.3.6 EUT Operating Condition

Same as 4.1.6.

4.3.7 Test Results

N/A

4.4 Transmit Power Measurement

4.4.1 Limits of Transmit Power Measurement

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) (Max. e.i.r.p ≦ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon)
		Fixed point-to-point Access Point	1 Watt (30 dBm)
		Indoor Access Point	1 Watt (30 dBm)
	√	Client device	250mW (24 dBm)
U-NII-2A	---		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-2C	---		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-3	---		1 Watt (30 dBm)

*B is the 26 dB emission bandwidth in megahertz

Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

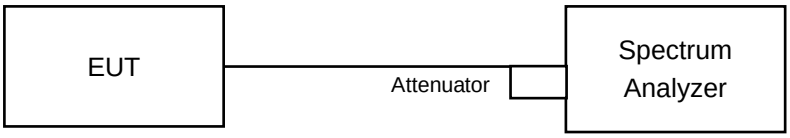
For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

4.4.2 Test Setup

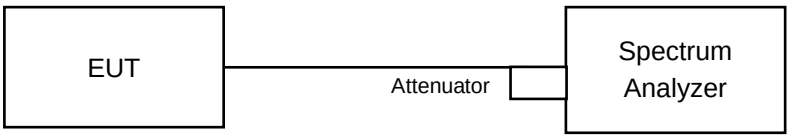
FOR POWER OUTPUT MEASUREMENT

◆ **Power Meter Measurement**

◆ **Spectrum Measurement**



FOR 26dB OCCUPIED BANDWIDTH



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

For Average Power Measurement

For 802.11a, 802.11n (HT20), 802.11n (HT40)

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

For 802.11ac (VHT80)

1) Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
2) Set sweep trigger to “free run”.
3) Set RBW = 1 MHz.
4) Set VBW ≥ 3 MHz
5) Number of points in sweep ≥ 2 Span / RBW.
6) Sweep time ≤ (number of points in sweep) * T
7) Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
8) Detector = RMS.
9) Trace mode = max hold.
10) Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.

◆ **Power Meter Measurement**

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

◆ **Spectrum Measurement**

Follow FCC KDB 789033 UNII test procedure:
Method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Set trigger to free run (duty cycle ≥ 98 percent)
7. Detector = RMS.
8. Trace average at least 100 traces in power averaging mode
9. Compute power by integrating the spectrum across the 26 dB EBW of the signal.

Follow FCC KDB 789033 UNII test procedure:
Method SA-2

1. Set span to encompass the emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Detector = RMS.
7. Trace average at least 100 traces in power averaging mode
8. Compute power by integrating the spectrum across the 26 dB EBW of the signal.
9. Duty factor need added to measured value (duty cycle < 98 percent).

FOR 26dB OCCUPIED BANDWIDTH

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Condition

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

4.4.7 Test Results

Output Power measurement result for UNII-1 Band

Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output Power	802.11a	5180	Low	6.73	24	Pass
		5200	Mid	6.97	24	Pass
		5240	High	7.15	24	Pass
	802.11n-HT20	5180	Low	6.84	24	Pass
		5200	Mid	6.87	24	Pass
		5240	High	7.12	24	Pass

Output Power measurement result for UNII-3 Band

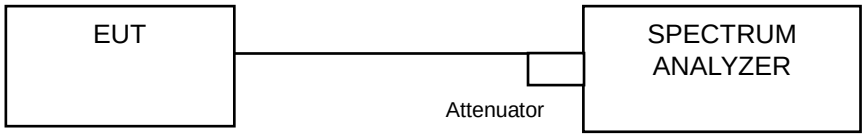
Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output Power	802.11a	5745	Low	6.45	30	Pass
		5785	Mid	6.47	30	Pass
		5825	High	6.41	30	Pass
	802.11n-HT20	5745	Low	6.26	30	Pass
		5785	Mid	6.35	30	Pass
		5825	High	6.36	30	Pass

4.5 26dB Bandwidth & 6dB Bandwidth Measurement

4.5.1 Limits of 6 dB Bandwidth Measurement

The minimum of 6 dB Bandwidth Measurement is 0.5 MHz.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

26dB Emission bandwidth measurement procedure (Other than 5.725-5.85 GHz)
- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 26dB BW.
  Set RBW = around 1% of emission bandwidth
  Set VBW > RBW
  Detector = Peak
  Trace mode = max hold
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

6 dB Minimum emission bandwidth measurement procedure
- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 6dB BW.
  Set RBW = 100 KHz
  Set VBW ≥ 3 x RBW
  Detector = Peak
  Trace mode = max hold
  Sweep = auto couple
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

4.5.5 Test Results

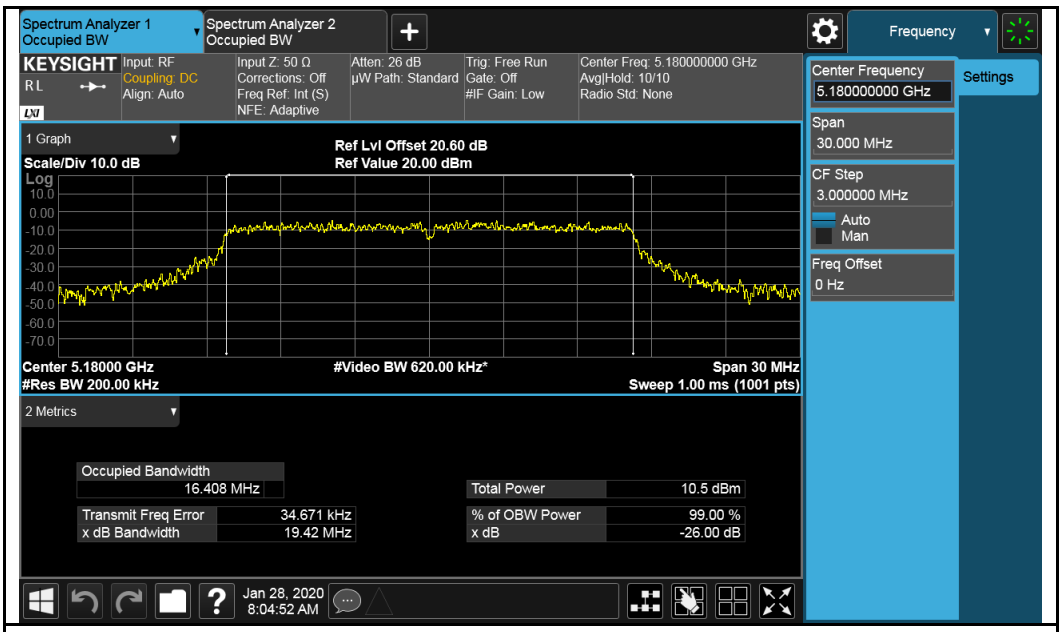
26dB Bandwidth measurement result for UNII-1 Band

Type	Test mode	Freq (MHz)	CH	Result (MHz)
26dB BW	802.11a	5180	Low	19.42
		5200	Mid	19.72
		5240	High	20.41
	802.11n-HT20	5180	Low	20.92
		5200	Mid	20.97
		5240	High	20.53

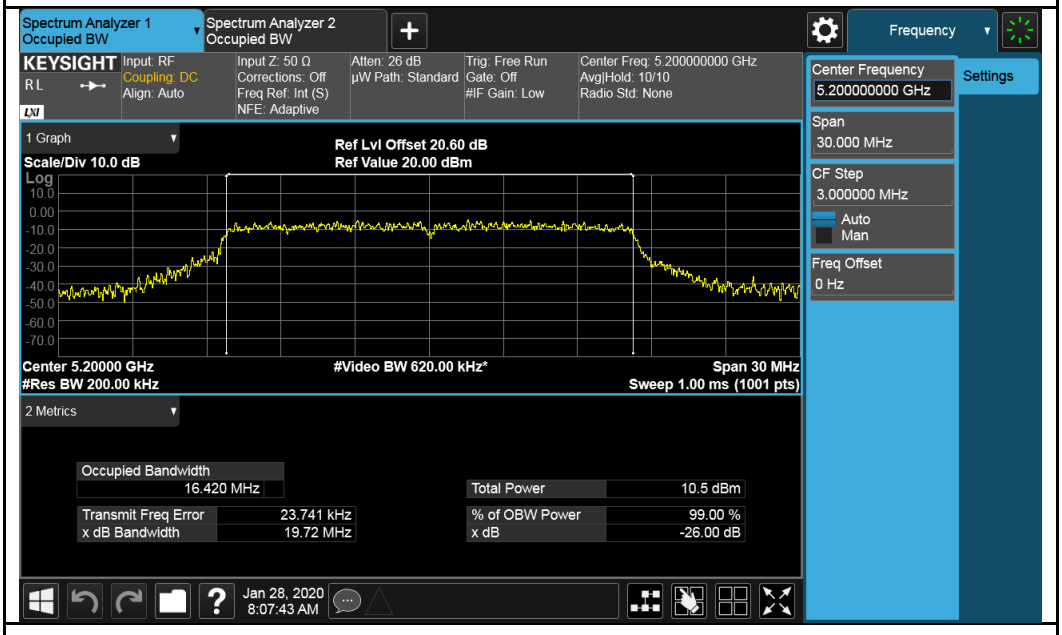
6dB Bandwidth measurement result for UNII-3 Band

Type	Test mode	Freq (MHz)	CH	Result (MHz)	Limit (MHz)	Result
6dB BW	802.11a	5745	Low	16.39	0.5	Pass
		5785	Mid	16.46	0.5	Pass
		5825	High	16.40	0.5	Pass
	802.11n-HT20	5745	Low	17.61	0.5	Pass
		5785	Mid	17.58	0.5	Pass
		5825	High	17.56	0.5	Pass

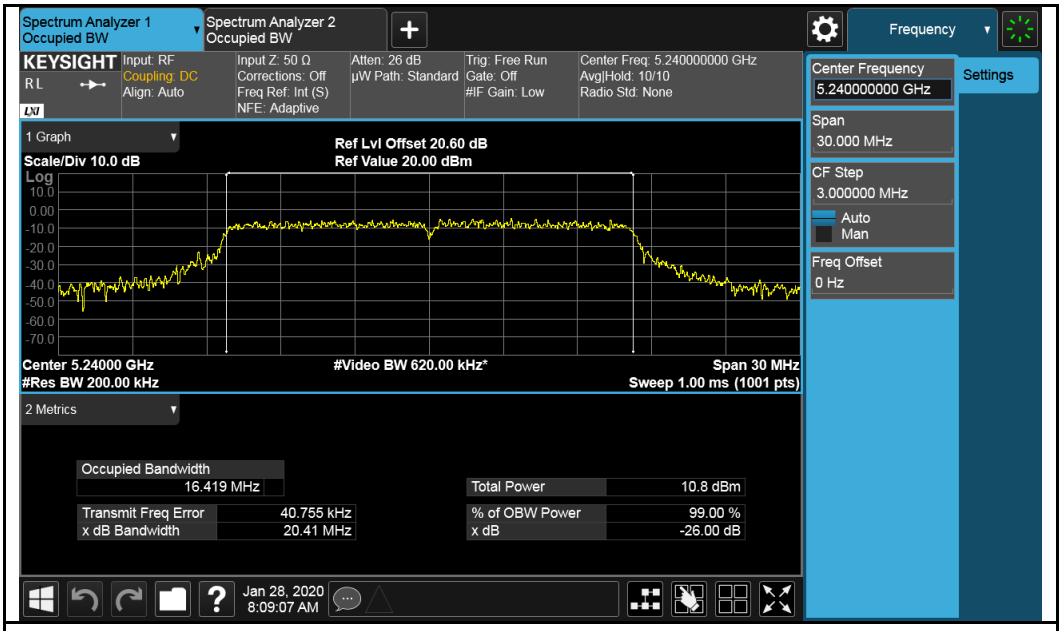
Occupied Bandwidth Test Plots
UNII-1 Band



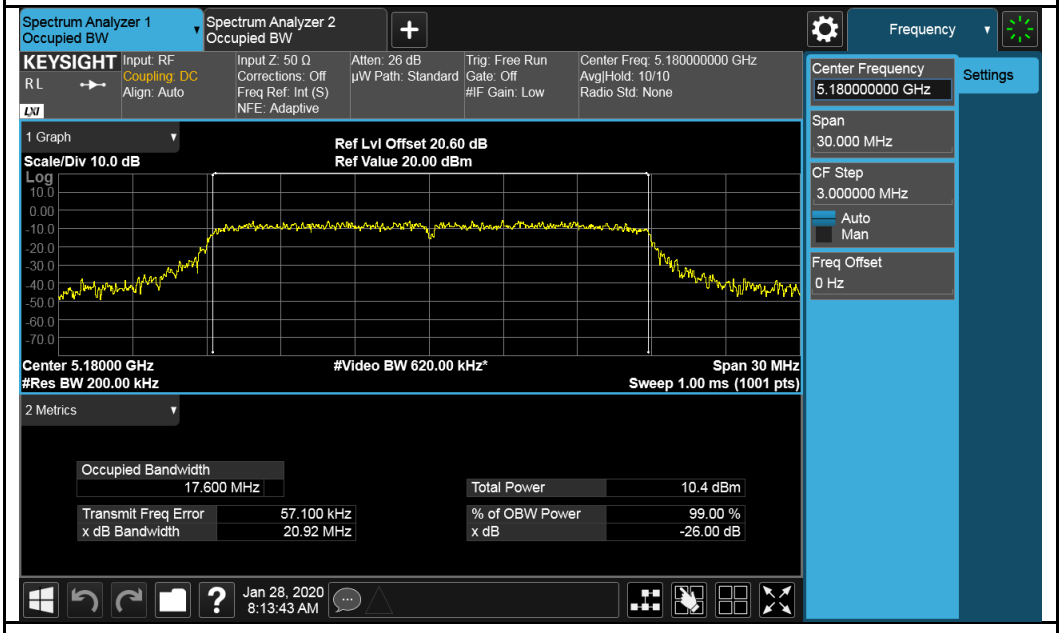
802.11a-5180MHz



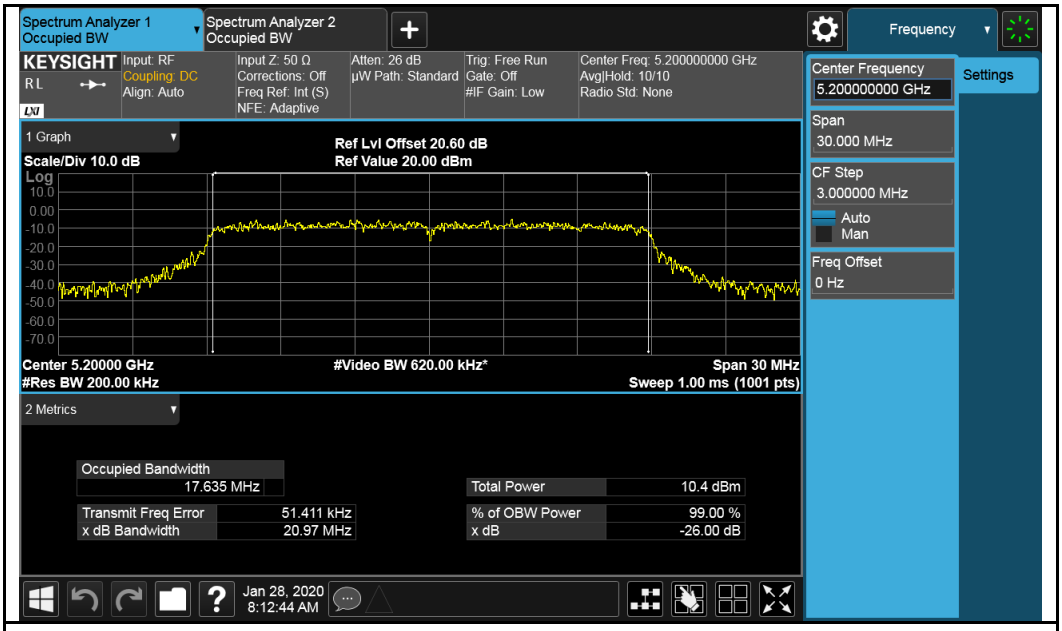
802.11a-5200MHz



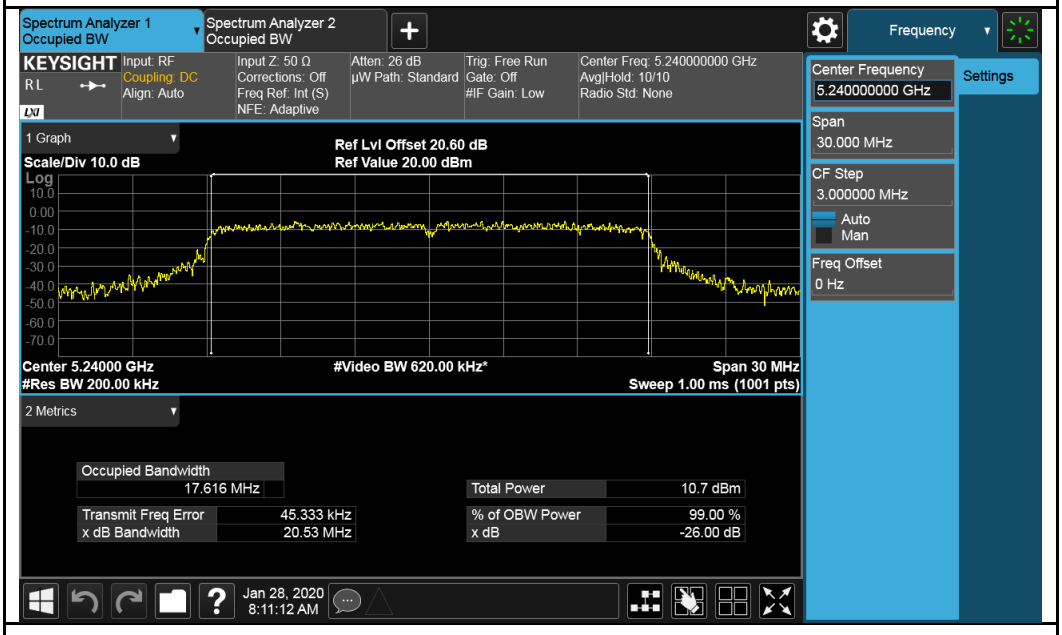
802.11a-5240MHz



802.11n-HT20-5180MHz

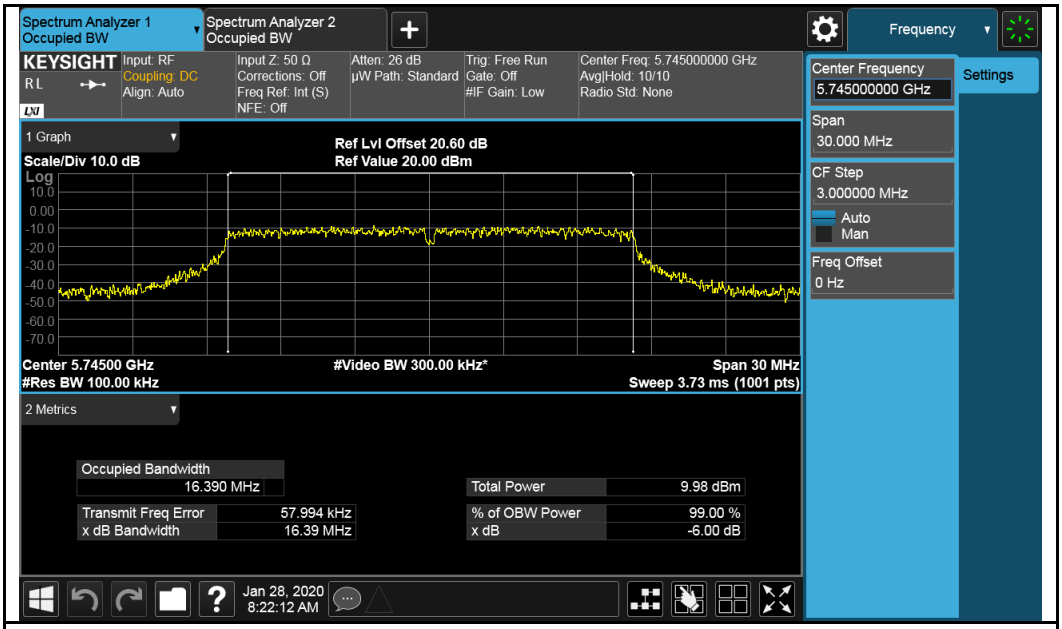


802.11n-HT20-5200MHz

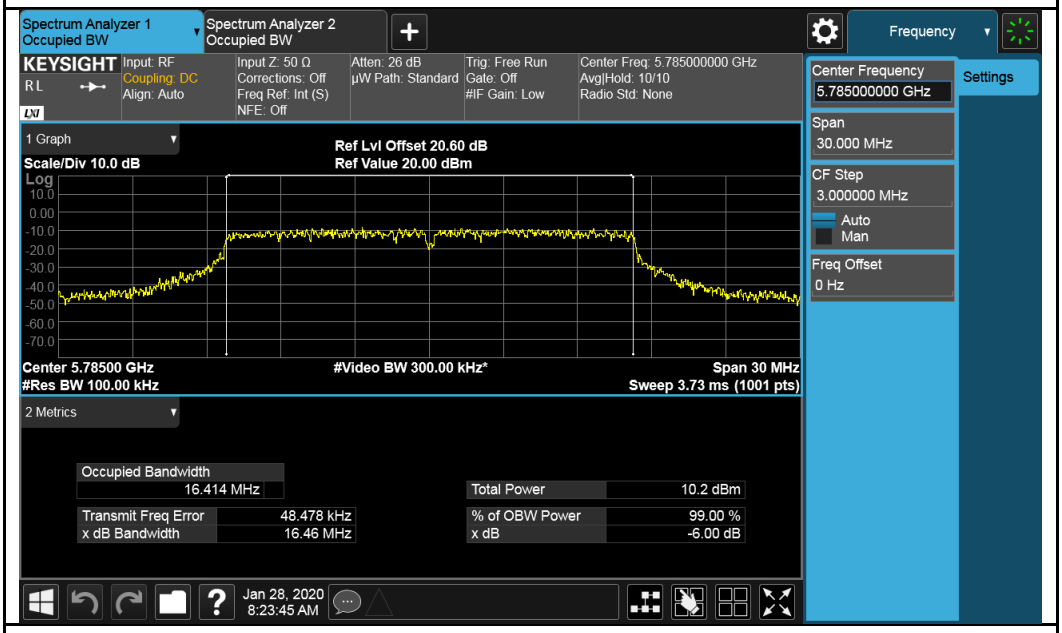


802.11n-HT20-5240MHz

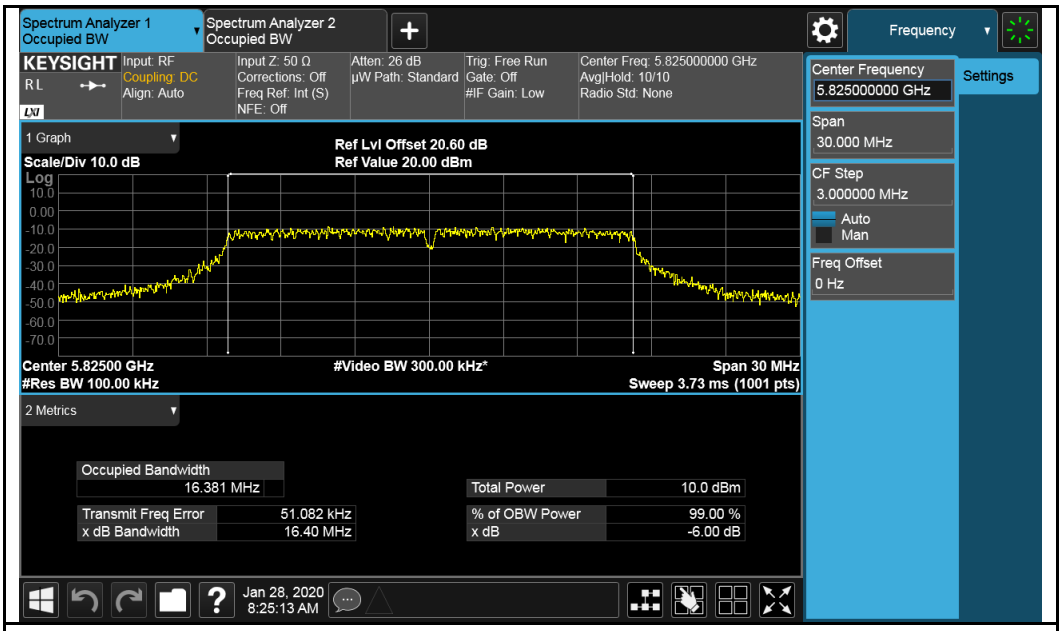
6dB Bandwidth Test Plots
U-NII-3 Band:



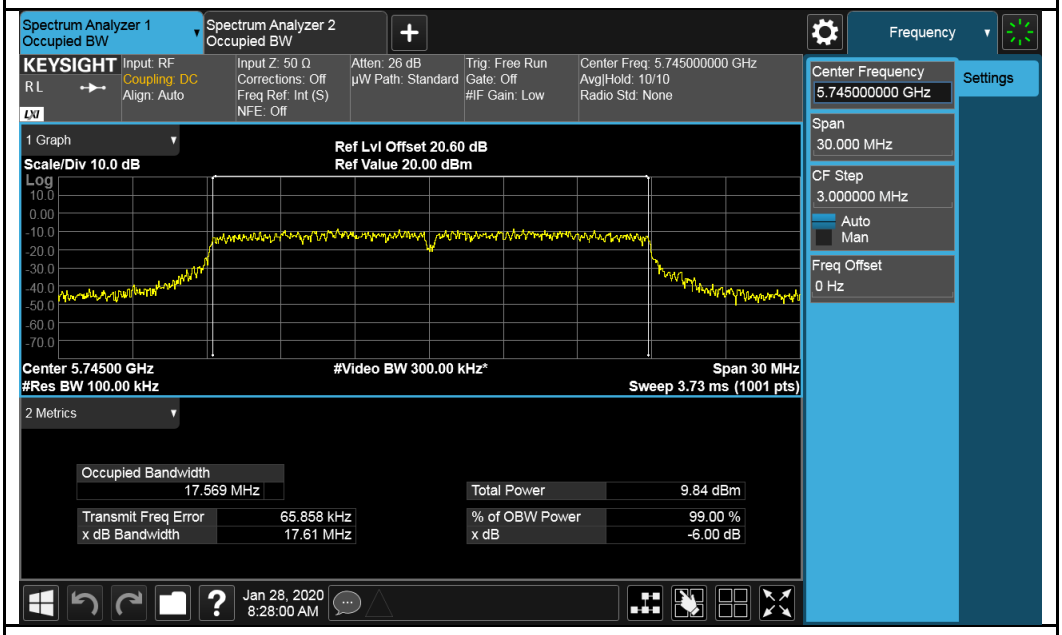
802.11a-5745MHz



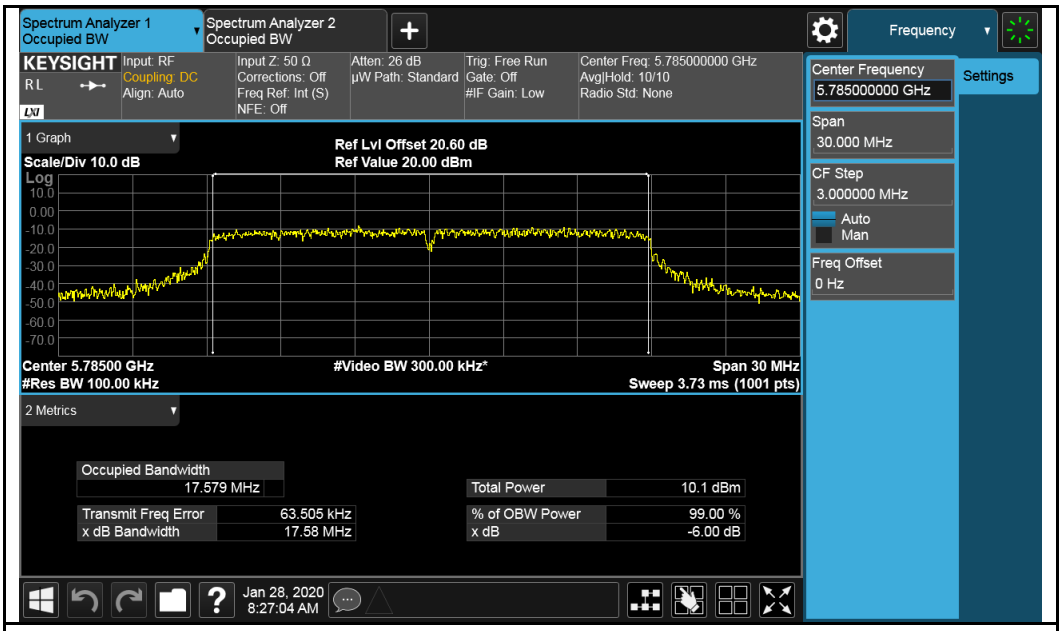
802.11a-5785MHz



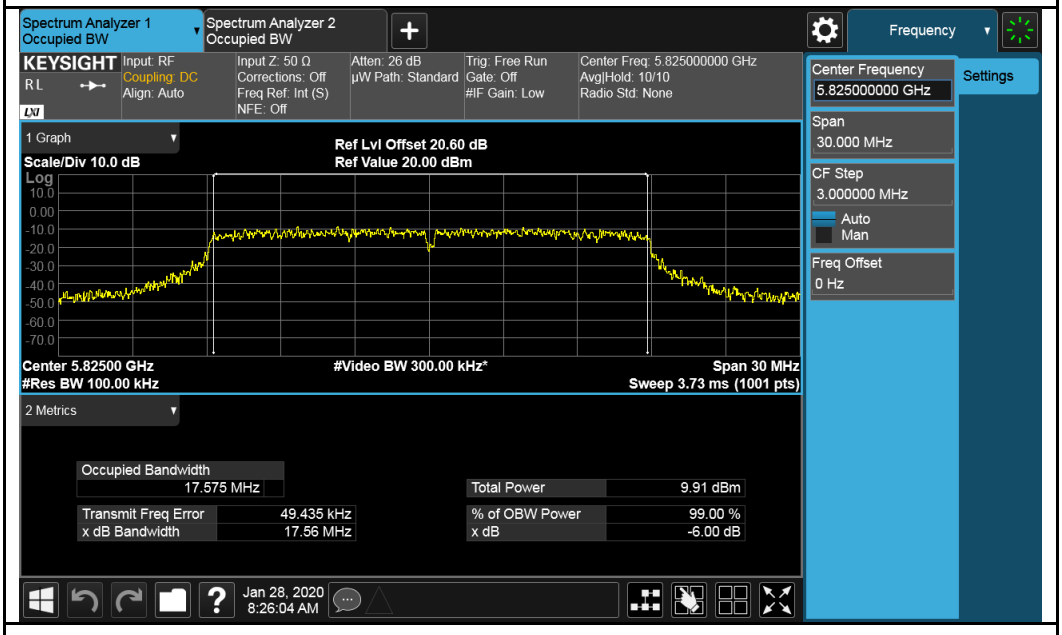
802.11a-5825MHz



802.11n-HT20-5745MHz



802.11n-HT20-5785MHz



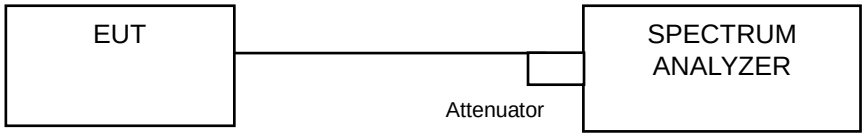
802.11n-HT20-5825MHz

4.6 Peak Power Spectral Density Measurement

4.6.1 Limits of Peak Power Spectral Density Measurement

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz
		Fixed point-to-point Access Point	
		Indoor Access Point	
	√	Client device	11dBm/ MHz
U-NII-2A	---		11dBm/ MHz
U-NII-2C	---		11dBm/ MHz
U-NII-3	---		30dBm/ 500kHz

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

For U-NII-1, U-NII-2A, U-NII-2C band:

Using method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 1 MHz, Set VBW ≥ 3 MHz, Detector = RMS
3. Sweep time = auto, trigger set to “free run”.
4. Trace average at least 100 traces in power averaging mode.
5. Record the max value

For U-NII-3:

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
3. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
4. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
5. Sweep time = auto, trigger set to “free run”.
6. Trace average at least 100 traces in power averaging mode.
7. Record the max value

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

Same as Item 4.3.6.

4.6.7 Test Results

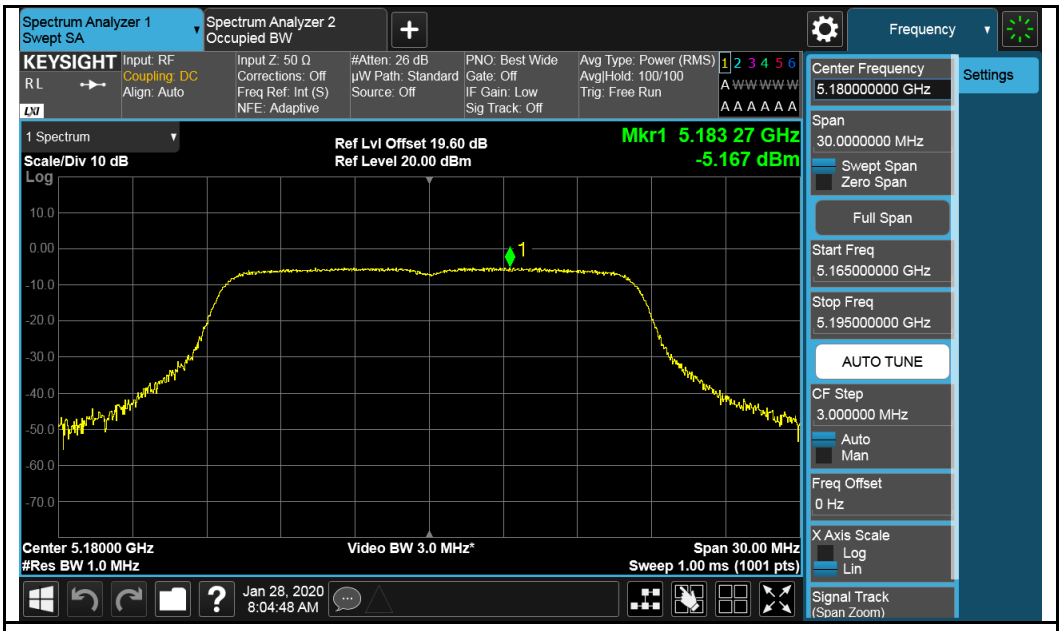
PSD measurement result for UNII-1 Band

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/MHz)	Limit (dBm/MHz)	Result
Output Power	802.11a	5180	Low	-5.17	11	Pass
		5200	Mid	-4.84	11	Pass
		5240	High	-4.53	11	Pass
	802.11n-HT20	5180	Low	-5.14	11	Pass
		5200	Mid	-5.18	11	Pass
		5240	High	-4.83	11	Pass

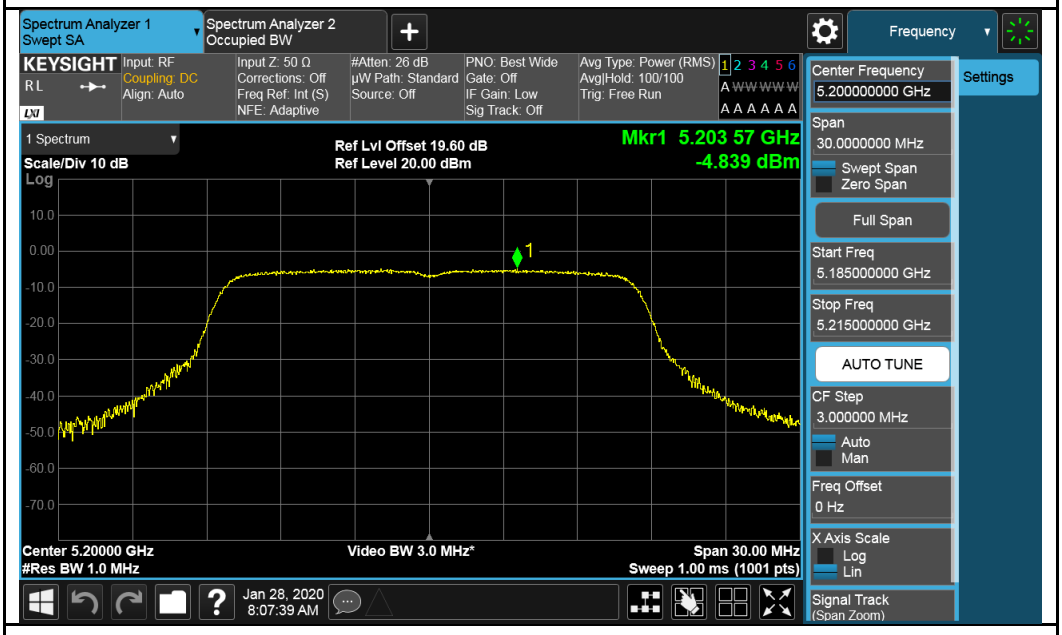
PSD measurement result for UNII-3 Band

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/MHz)	Correction factor (dB)	Correction PSD (dBm/MHz)	Limit (dBm/MHz)	Result
Output Power	802.11a	5180	Low	-12.59	6.99	-5.60	30	Pass
		5200	Mid	-13.08	6.99	-6.09	30	Pass
		5240	High	-13.22	6.99	-6.23	30	Pass
	802.11n-HT20	5180	Low	-13.05	6.99	-6.06	30	Pass
		5200	Mid	-13.31	6.99	-6.32	30	Pass
		5240	High	-12.99	6.99	-6.00	30	Pass
Note	BW correction factor = 10log (500kHz/RBW), RBW was set to 100kHz during test.							

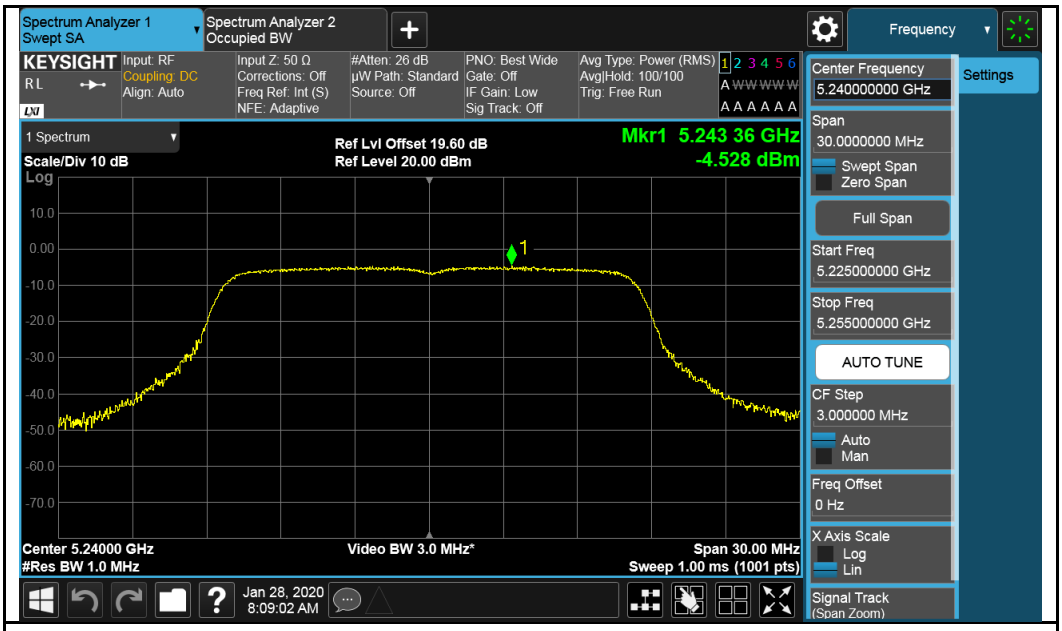
Test Plot for UNII-1 Band:



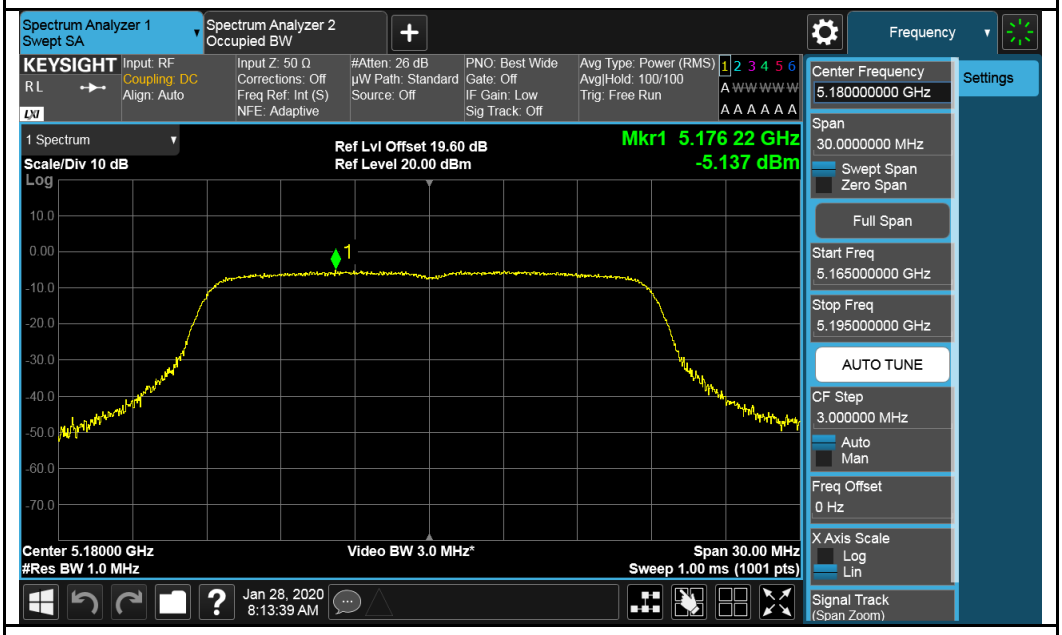
802.11a-5180MHz



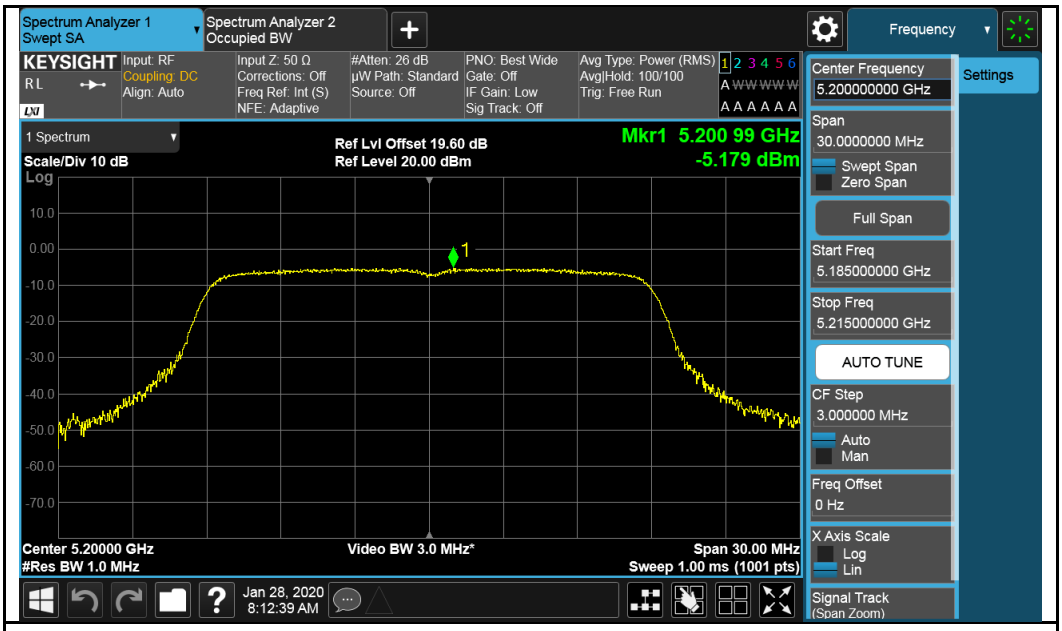
802.11a-5200MHz



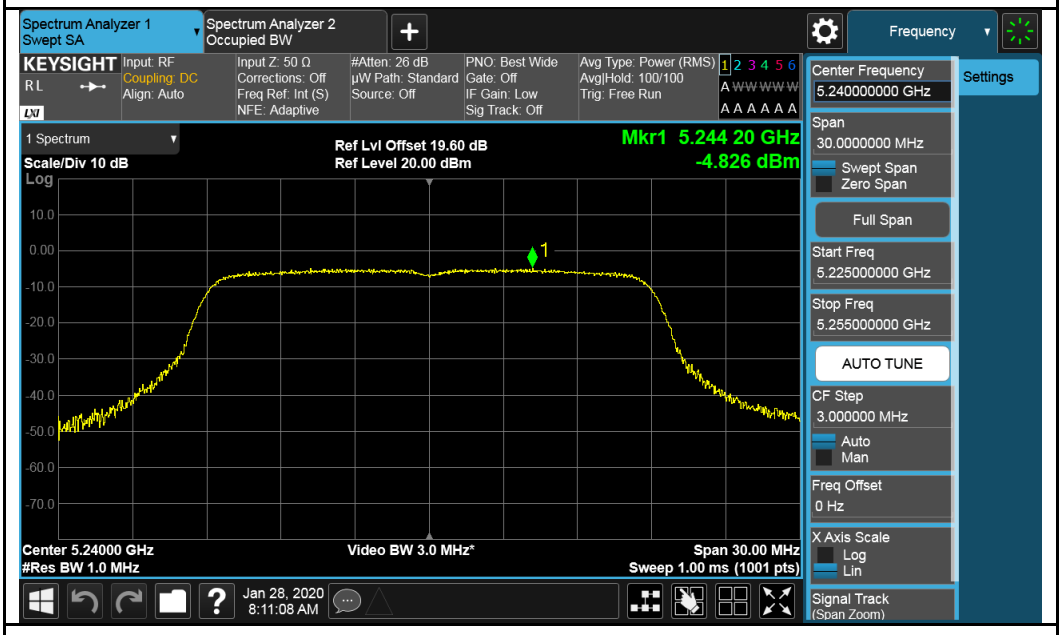
802.11a-5240MHz



802.11n-HT20-5180MHz

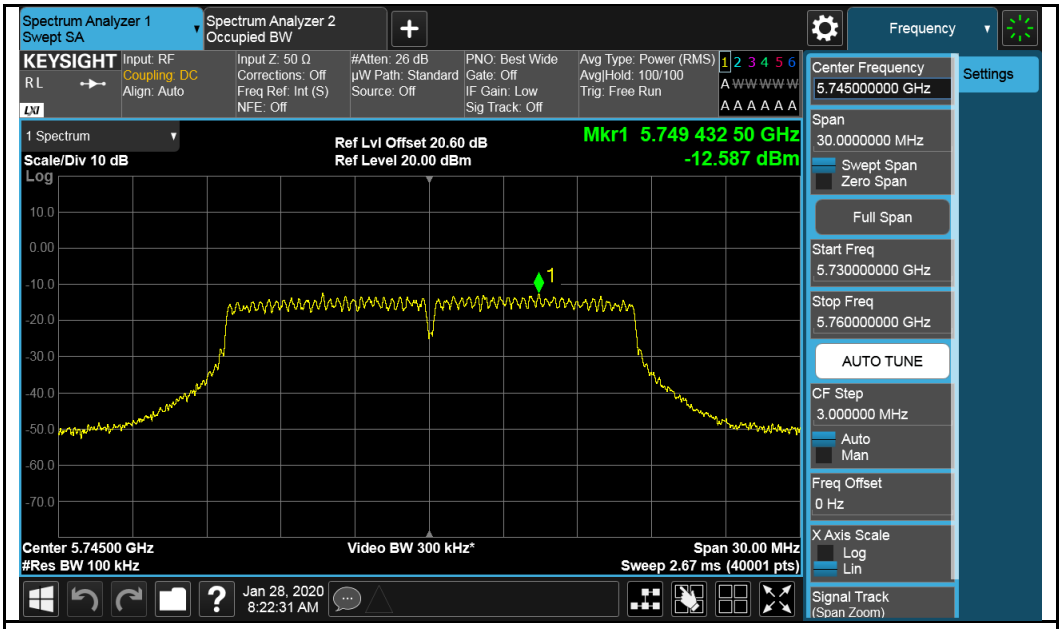


802.11n-HT20-5200MHz

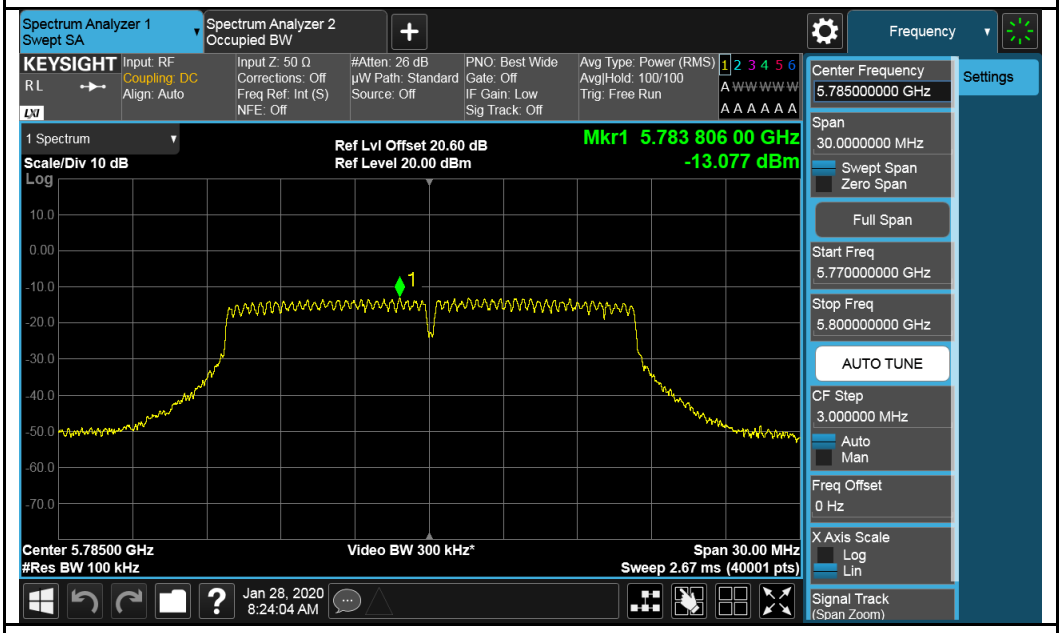


802.11n-HT20-5240MHz

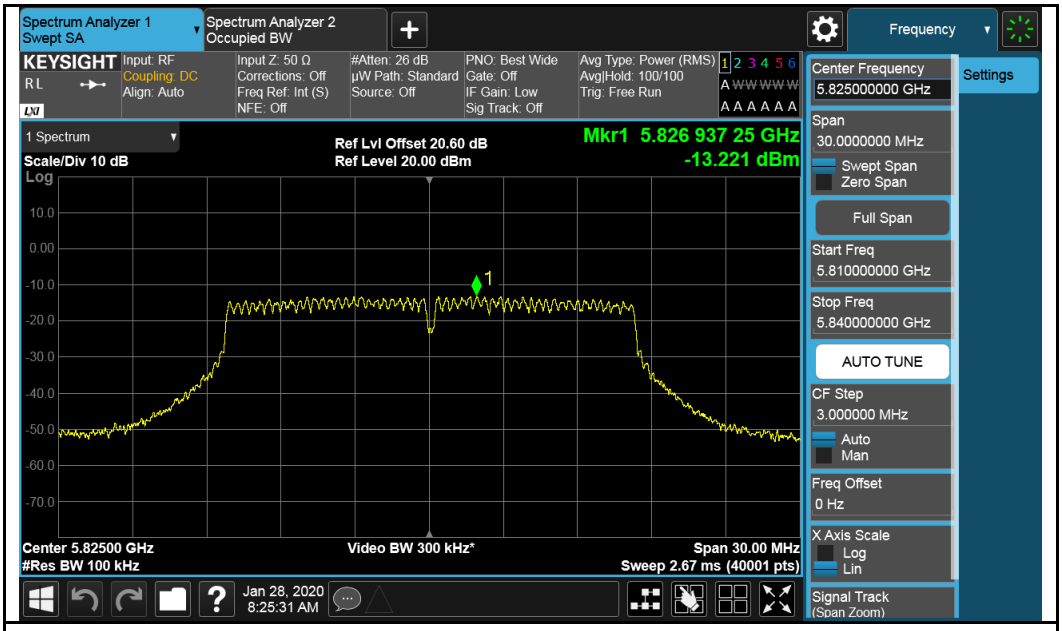
Test Plot for UNII-3 Band:



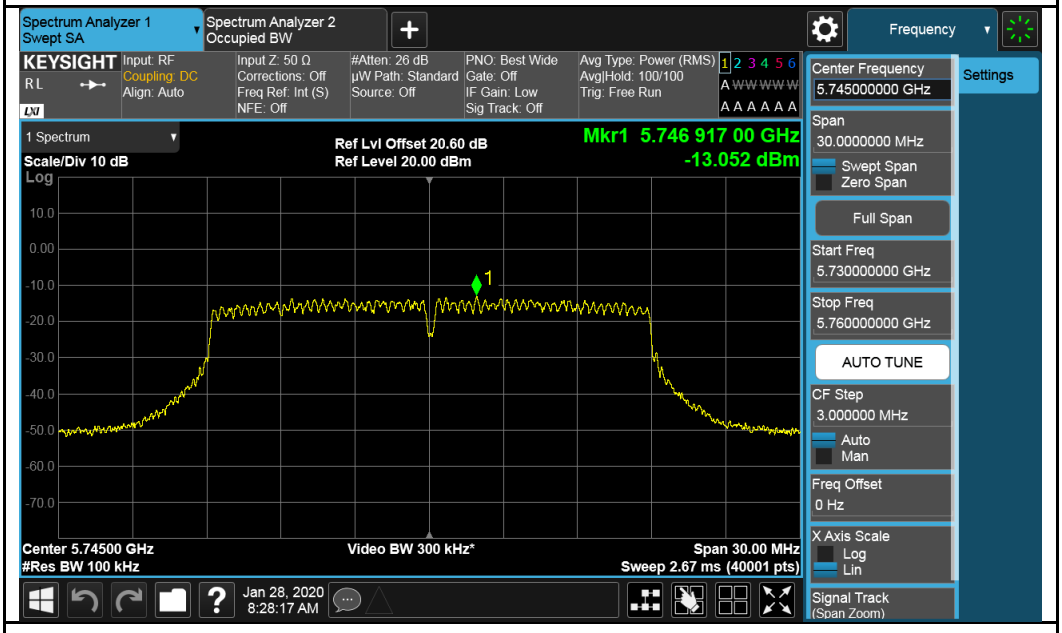
802.11a-5745MHz



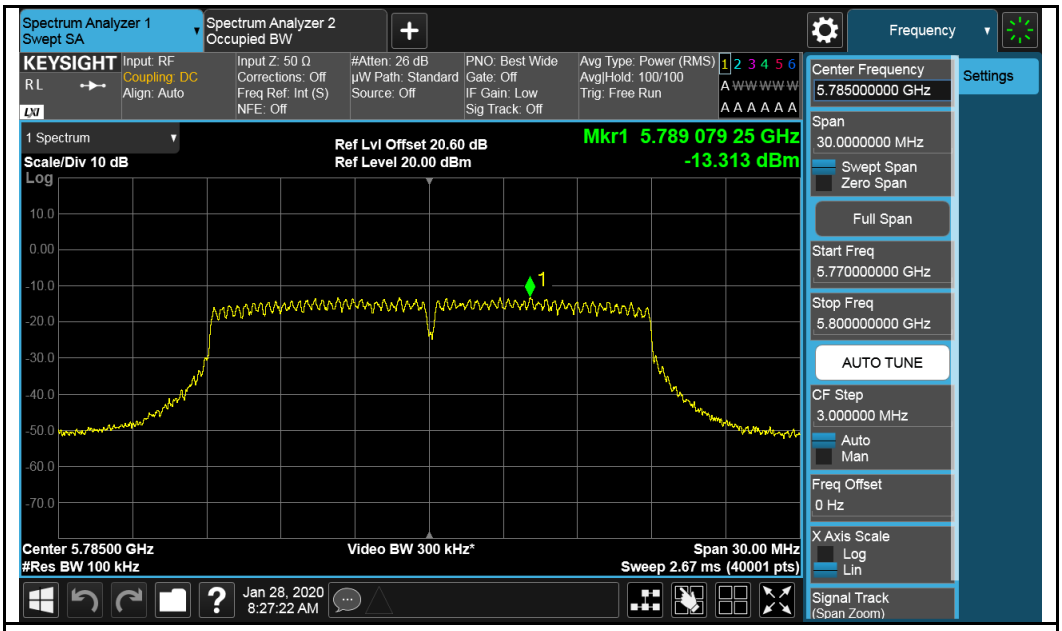
802.11a-5785MHz



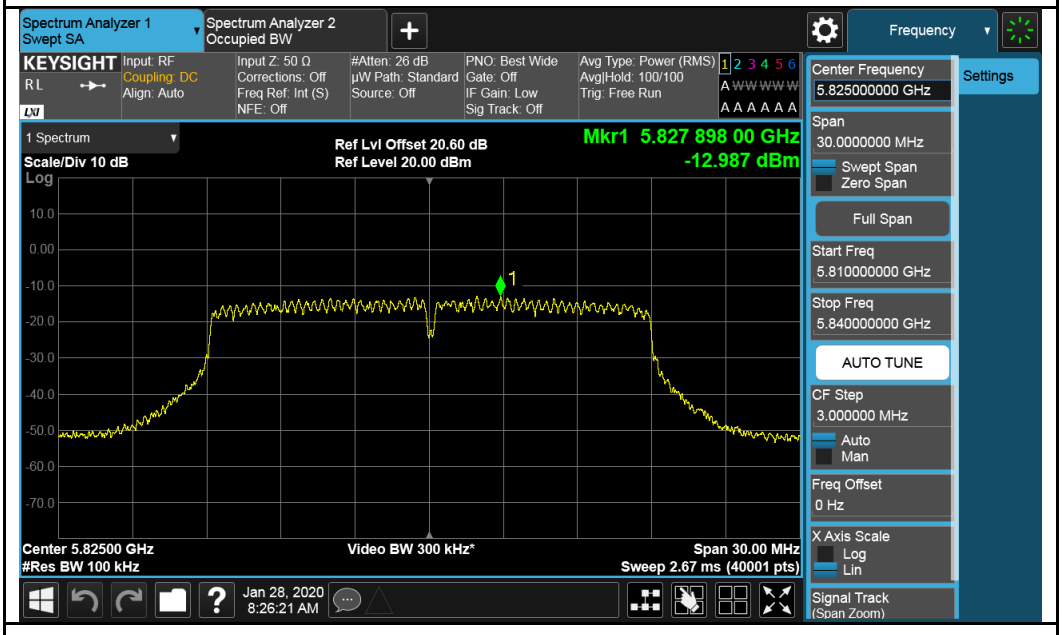
802.11a-5825MHz



802.11n-HT20-5745MHz



802.11n-HT20-5785MHz



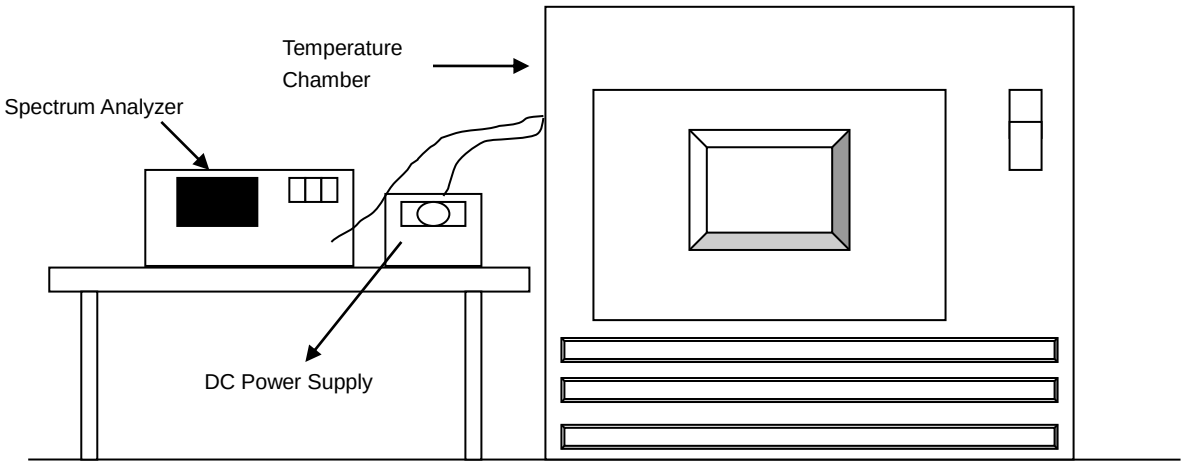
802.11n-HT20-5825MHz

4.7 Frequency Stability Measurement

4.7.1 Limits of Frequency Stability Measurement

The frequency of the carrier signal shall be maintained within band of operation.

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedure

a. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
b. Turn the EUT on and couple its output to a spectrum analyzer.
c. Turn the EUT off and set the chamber to the highest temperature specified.
d. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
e. Repeat step (d) with the temperature chamber set to the next desired temperature until measurements down to the lowest specified temperature have been completed..
f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
.

4.7.5 Deviation from Test Standard

No deviation.

4.7.6 EUT Operating Condition

Set the EUT transmit at un-modulation mode to test frequency stability.

4.7.7 Test Results

Frequency Stability Versus Temp.									
Operating Frequency: 5180 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)
50	3.0	5179.998	-0.000046	5180.002	0.000046	5179.992	-0.000154	5179.991	-0.000174
40	3.0	5180.003	0.000058	5179.994	-0.000116	5180.003	0.000058	5180.003	0.000064
30	3.0	5180.004	0.000077	5180.002	0.000042	5180.006	0.000116	5180.002	0.000039
20	3.0	5179.996	-0.000077	5179.993	-0.000135	5179.992	-0.000154	5180.001	0.000019
10	3.0	5179.983	-0.000328	5179.983	-0.000328	5179.992	-0.000154	5179.992	-0.000154
0	3.0	5179.998	-0.000039	5179.992	-0.000154	5179.991	-0.000174	5180.991	0.019131
-10	3.0	5179.994	-0.000116	5179.997	-0.000054	5180.003	0.000052	5179.992	-0.000154
-20	3.0	5179.997	-0.000058	5179.994	-0.000116	5180.006	0.000106	5179.982	-0.000347
-30	3.0	5179.99	-0.000201	5179.992	-0.000151	5180.003	0.000062	5179.998	-0.000037

Frequency Stability Versus Voltage									
Operating Frequency: 5180 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)	Measured Frequency (MHz)	Frequency Drift (ppm)
20	3.45	5180.004	0.000077	5179.992	-0.000154	5180.004	0.000077	5179.994	-0.000116
	3.0	5179.995	-0.000097	5179.996	-0.000077	5179.992	-0.000154	5180.997	0.019247
	2.55	5179.982	-0.000347	5180.006	0.000116	5179.991	-0.000174	5179.995	-0.000097

5 Pictures of Test Arrangements

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

Appendix – Information on the Testing Laboratories

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

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

Milpitas EMC/RF/Safety/Telecom Lab
775 Montague Expressway, Milpitas, CA 95035
Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab
1293 Anvilwood Avenue, Sunnyvale, CA 94089
Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab
1 Distribution Center Cir #1, Littleton, MA 01460
Tel: +1 978 486 8880

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

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

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