ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C AND INDUSTRY CANADA RSS 247 REQUIREMENT

OF

Applicant:	Murata Manufacturing Co., Ltd. 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan
Product Name:	Communication Module
Brand Name:	muRata
FCC Model No.:	LBEE5XV1VA
IC Model No.:	LBEE5XV1VA_3ANT, LBEE5XV1VA_2ANT
Model Difference:	LBEE5XV1VA_3ANT: Connect BT_IN to BT_OUT LBEE5XV1VA_2ANT: Connect BT_IN to 50 ohm termination resistor
Report Number:	T190506W05-RP3
FCC ID:	VPYLB1VA
IC:	772C-LB1VA
FCC Rule Part:	§15.247, Cat: DTS
IC Rule Part:	RSS-247 issue 2 Feb 2017
Issue Date:	Jun. 05, 2019
Date of Test:	May 07, 2019 ~ May 24, 2018
Date of EUT Received:	May 07, 2019

Note: The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.
The test results of this report relate only to the tested sample identified in this report.

Tested By: Peter Weng

Peter Weng / Engineer

Approved By: Kevin Tsai

Kevin Tsai / Deputy Manager

Testing Laboratory
1309

Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
T190506W05-RP3	Rev.00	Initial creation of document	All	Jun. 05, 2019	Elle Chang

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1 GENERAL INFORMATION

1.1 Product description

Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEE5XV1VA
Model Difference:	N/A
Product SW/HW Version:	1.0 / 1.0
Radio SW/HW Version:	1.0 / 1.0
Power Supply:	3.6Vdc

Wi-Fi	Frequency Range	Channels	Rated Power in dBm (Peak)	Rated Power in dBm (EIRP)	Modulation Technology
802.11b	2412-2462	11	22.16	24.62	DSSS
802.11g			26.24	24.47	OFDM
802.11n HT20			27.17	25.46	
Antenna Designation:	Dipole Antenna, Antenna Gain: 5.79dBi				
Modulation type:	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM				
Transition Rate:	802.11 b: 1/2/5.5/11 Mbps 802.11 g: 6/9/12/18/24/36/48/54 Mbps 802.11 n_20MHz: 6.5 – 144.4Mbps				

1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas. Guidance v05r02

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

RSS-247 issue 2 Feb. 2017

RSS-Gen. issue 5 Apr. 2018

ANSI C63.10:2013

Note: All test items have been performed and record as per the above standards.

1.3 Test Facility

Compliance Certification Services Inc. Wugu Lab. No.11, Wugong 6th Rd.,

Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) (TAF code 1309)

FCC Designation number: TW1309
Canada Registration number: 2324G

1.4 Special Accessories

There are no special accessories used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

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

2.2 EUT Exercise

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

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

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

2.3.3 Radiated Emissions

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

2.4 Measurement Results Explanation Example

For all conducted test items:

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

Note:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor. Following shows an offset computation example with cable loss and attenuator.

2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission Configuration

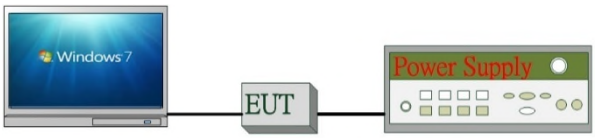


Fig.2-3 Conducted Emission (Antenna Port) Configuration

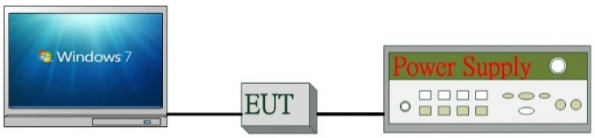


Fig. 2-2 Conducted Emission (AC Power Line) Configuration

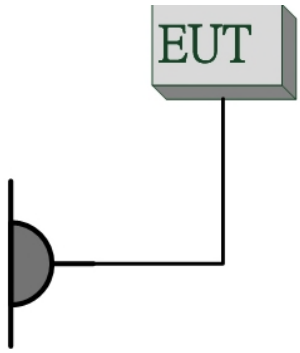


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	WLAN Test Software	N/A	N/A	N/A	N/A	N/A
2.	DC Power Supply	Agilent	E3640A	KR93300208	N/A	Unshielded
3.	Notebook	N/A	N/A	N/A	N/A	N/A

3 SUMMARY OF TEST RESULTS

FCC Rules	IC Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	RSS-247 §5.4(4)	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.1 (1) RSS-Gen §6.7	6dB & 99% Emission Bandwidth	Compliant
§15.247(d)	RSS-247 §5.5 RSS-Gen §8.10	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5 RSS-Gen §8.9 RSS-Gen §8.10 RSS-Gen §6.13	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	RSS-247 §5.2(2)	Power Spectral Density	Compliant
§15.203 §15.247(b)	RSS- Gen §6.8	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

11 channels are provided for 802.11b,g and n_HT20

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

4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case.The gevin UE is pre-scanned among below modes.
4. Therefore, below summary is the modes of test configuration that yield the highest reading and generate the highest emission chosen to carry out the relevantly mandatory test items.

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11g	1 to 11	1,6,11	OFDM	6	Ch0

RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11b	1 to 11	1, 6, 11	DSSS	1	Ch0
802.11g	1 to 11	1, 6, 11	OFDM	6	Ch0
802.11n (HT20)	1 to 11	1, 6, 11	OFDM	MCS 8	MIMO

Note:
The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for 802.11b/g/n WLAN Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11b	1 to 11	1, 6, 11	DSSS	1	Ch0
802.11g	1 to 11	1, 6, 11	OFDM	6	Ch0
802.11n (HT20)	1 to 11	1, 6, 11	OFDM	MCS 8	MIMO

5 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
AC Powerline Conducted Emission	+/- 1.2575 dB
Peak Output Power	+/- 1.92 dB
6dB Bandwidth	+/- 61.248 Hz
100 kHz Bandwidth of Frequency Band Edges	+/- 1.92 dB
Peak Power Density	+/- 1.996 dB
3M Semi Anechoic Chamber / 30M~200M	+/- 4.12 dB
3M Semi Anechoic Chamber / 200M~1000M	+/- 4.68 dB
3M Semi Anechoic Chamber / 1G~8G	+/- 5.18 dB
3M Semi Anechoic Chamber / 8G~18G	+/- 5.47 dB
3M Semi Anechoic Chamber / 18G~26G	+/- 3.81 dB
3M Semi Anechoic Chamber / 26G~40G	+/- 3.87 dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. Determination of compliance is based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

6 CONDUCTED EMISSION TEST

6.1 Standard Applicable

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

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

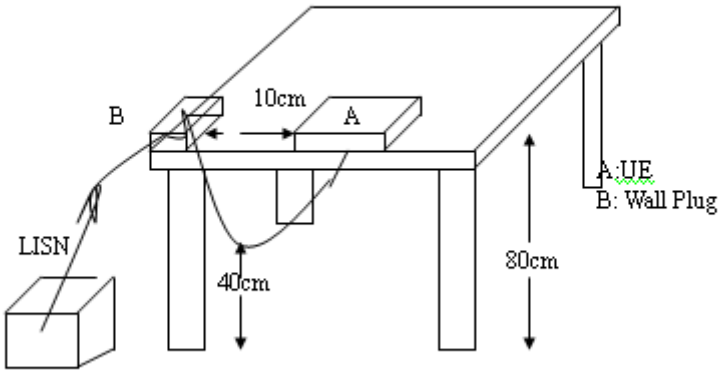
6.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUM-BER	LAST CAL.	CAL DUE.
CABLE	EMCI	CFD300-NL	CERF	06/29/2018	06/28/2019
EMI Test Receiver	R&S	ESCI	100064	07/24/2018	07/23/2019
LISN	SCHWARZ-BECK	NSLK 8127	8127-541	01/31/2019	01/30/2020
LISN	SCHAFFNER	NNB 41	03/10013	02/13/2019	02/12/2020
Software	EZ-EMC(CCS-3A1-CE)				

6.3 EUT Setup

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

6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

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

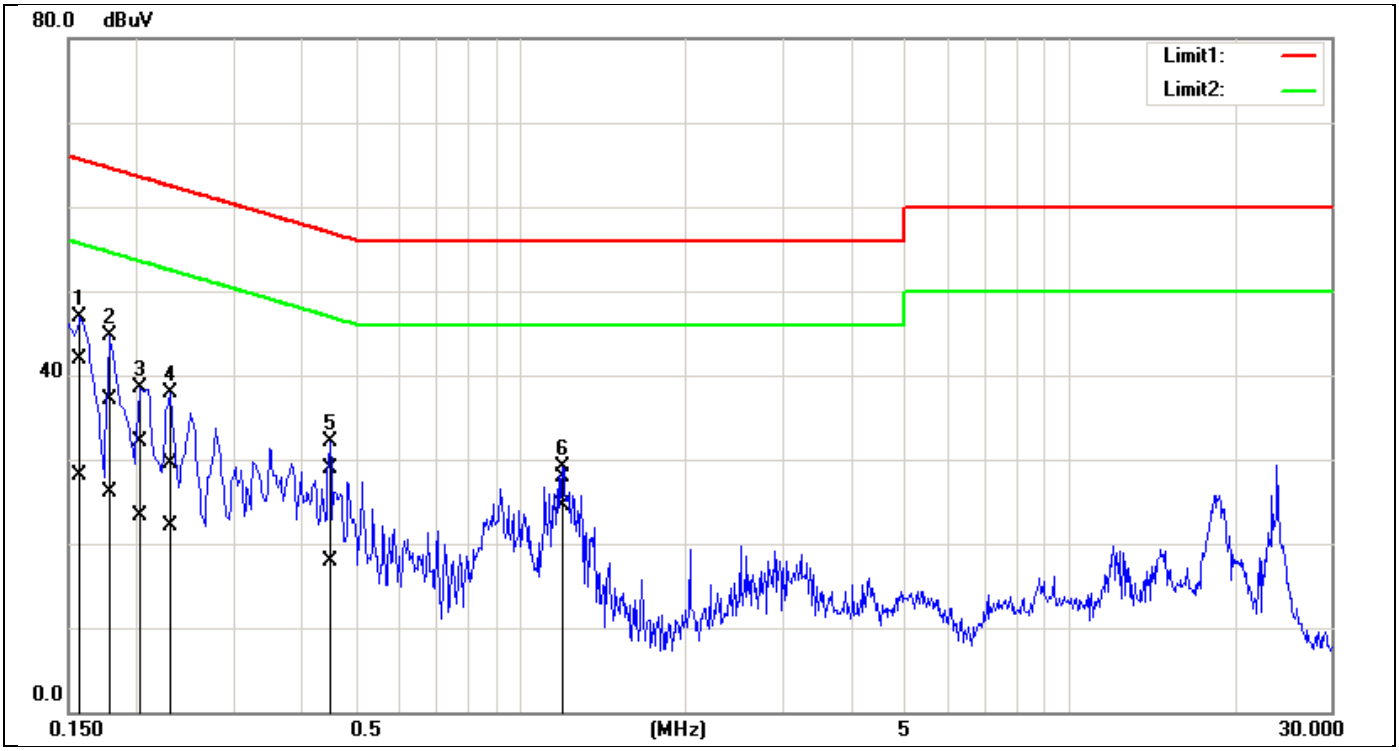
6.6 Measurement Result

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

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

AC POWER LINE CONDUCTED EMISSION TEST DATA

Description:	**Operation**	**Date:**	**2019/5/21**
Line:	**L1**	**Temp.(℃)/Hum.(%):**	**22.5(℃)/61%**
Test Voltage:	**AC 120V/60Hz**	**Test By:**	**Peter**



No.	Frequency	Quasi-Peak reading	Average reading	Correction factor	Quasi-Peak result	Average result	Quasi-Peak limit	Average limit	Quasi-Peak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	0.1580	41.75	28.03	0.16	41.91	28.19	65.56	55.57	-23.65	-27.38	Pass
2	0.1780	36.99	26.02	0.15	37.14	26.17	64.57	54.58	-27.43	-28.41	Pass
3	0.2020	31.99	23.18	0.15	32.14	23.33	63.52	53.53	-31.38	-30.20	Pass
4	0.2300	29.40	21.95	0.15	29.55	22.10	62.45	52.45	-32.90	-30.35	Pass
5	0.4500	28.78	17.84	0.16	28.94	18.00	56.87	46.88	-27.93	-28.88	Pass
6*	1.1940	27.73	24.30	0.19	27.92	24.49	56.00	46.00	-28.08	-21.51	Pass

Description:	**Operation**	**Date:**	**2019/5/21**
Line:	**N**	**Temp.(℃)/Hum.(%):**	**22.5(℃)/61%**
Test Voltage:	**AC 120V/60Hz**	**Test By:**	**Peter**

No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1*	0.1539	44.30	32.05	0.10	44.40	32.15	65.78	55.79	-21.38	-23.64	Pass
2	0.1620	37.55	27.72	0.10	37.65	27.82	65.36	55.36	-27.71	-27.54	Pass
3	0.1819	40.04	28.95	0.10	40.14	29.05	64.39	54.40	-24.25	-25.35	Pass
4	0.2460	32.21	22.84	0.10	32.31	22.94	61.89	51.89	-29.58	-28.95	Pass
5	0.3300	27.90	22.56	0.11	28.01	22.67	59.45	49.45	-31.44	-26.78	Pass
6	0.4500	26.06	14.13	0.11	26.17	14.24	56.87	46.88	-30.70	-32.64	Pass

7 DUTY CYCLE OF TEST SIGNAL

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

Formula:

Duty Cycle = Ton / (Ton+Toff)

Measurement Procedure:

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

Duty Cycle:

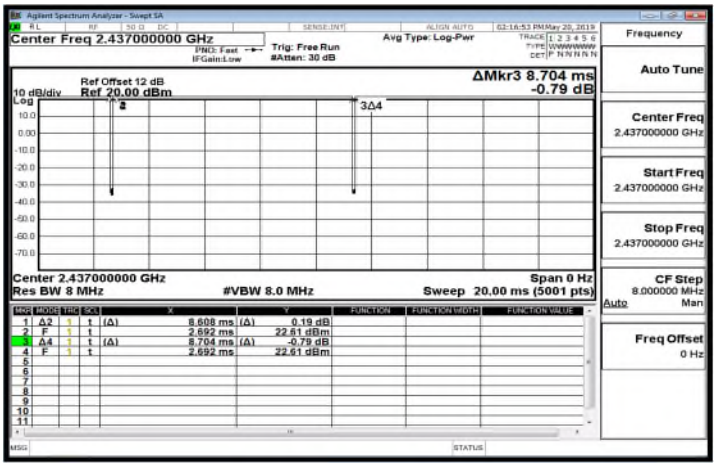
	Duty Cycle (%)	Duty Factor (dB)	1/T (kHz)	VBW setting (kHz)
802.11b	98.90	0.05	0.12	0.01
802.11g	93.33	0.30	0.70	1.00
802.11n_20	92.91	0.32	0.75	1.00

b = 98.9%, g = 93.33%,n_ht_20 = 92.91%

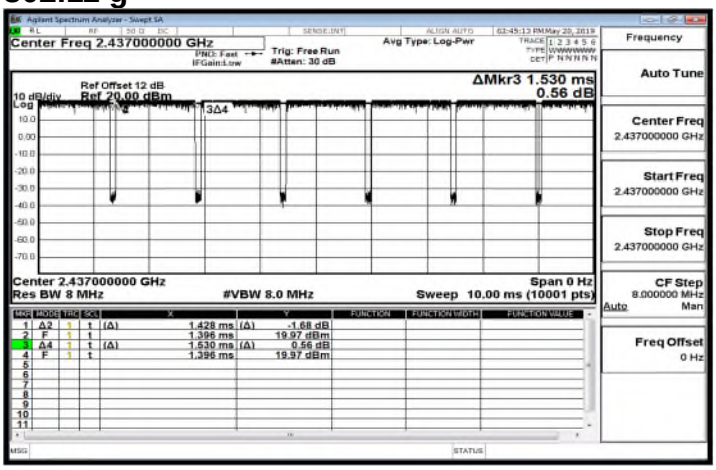
Duty Cycle Factor: 10 * log(1/0.989) = 0.05
Duty Cycle Factor: 10 * log(1/0.9333) = 0.3
Duty Cycle Factor: 10 * log(1/0.9291) = 0.32

7.1 DUTY CYCLE TEST SIGNAL Measurement Result

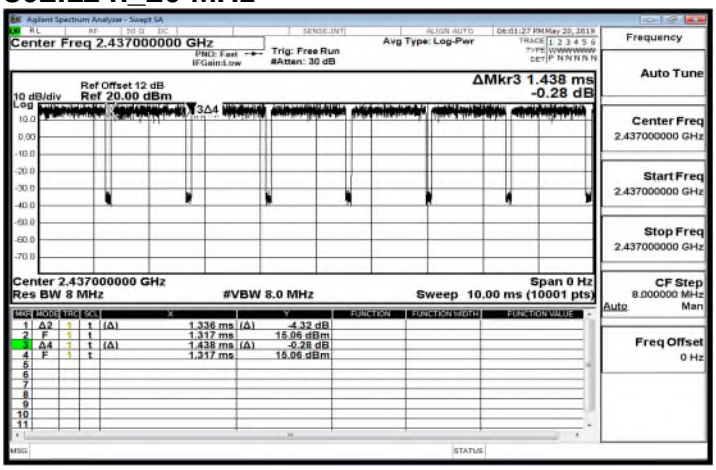
802.11 b



802.11 g



802.11 n_20 MHz



8 PEAK OUTPUT POWER MEASUREMENT

8.1 Standard Applicable

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

Per RSS-247 §5.4(d)

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

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

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

As per FCC KDB 662911 D01

Unequal antenna gains, with equal transmit powers. For antenna gains given by G1, G2, …, GN dBi.

(i) If transmit signals are correlated, then Directional gain

$= 10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}]$ dBi

[Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

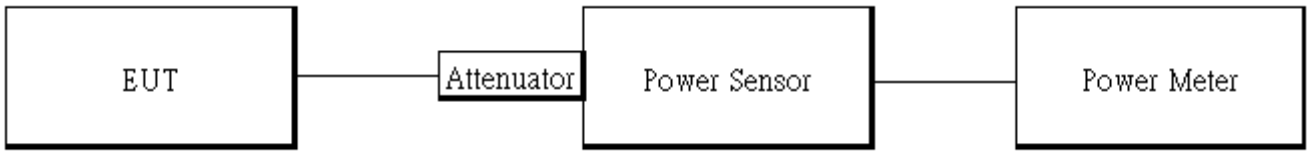
The antenna gain is not grater than 6 dBi. Therefore, reduction of power is not required.

8.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUM-BER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1242004	10/23/2018	10/22/2019
Power Sensor	Anritsu	MA2411B	1207365	10/23/2018	10/22/2019
Power Sensor	Anritsu	MA2411B	1207368	10/24/2018	10/23/2019
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
DC Power Supply	GWINSTEK	SPS-3610	GPE880163	01/14/2019	01/13/2020
Attenuator	Mini-Circuit	BW-S10W2+	1	02/26/2019	02/25/2020
Attenuator	Mini-Circuit	BW-S10W2+	3	02/26/2019	02/25/2020

8.3 Test Set-up

Power Meter:



8.4 Measurement Procedure

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

   Power Meter:

   It is used as the auxiliary test equipment to conduct the output power measurement.
4. Record the max. Reading as observed from Spectrum or Power Meter.

8.5 Measurement Result

Antenna Chain 0

802.11b Ch0					
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	1	22.11	30.00	PASS
6	2437	1	21.79	30.00	PASS
11	2462	1	22.16	30.00	PASS
802.11b Ch0					
CH	Freq. (MHz)	Data Rate	Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
1	2412	1	18.93	30.00	PASS
6	2437	1	18.86	30.00	PASS
11	2462	1	**18.94**	30.00	PASS

802.11g Ch0					
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	6	24.20	30.00	PASS
6	2437	6	26.24	30.00	PASS
11	2462	6	25.37	30.00	PASS
802.11g Ch0					
CH	Freq. (MHz)	Data Rate	Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
1	2412	6	13.92	30.00	PASS
6	2437	6	**18.79**	30.00	PASS
11	2462	6	16.05	30.00	PASS

802.11n_HT20M Ch0					
CH	Freq. (MHz)	Data Rate	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	26.10	30.00	PASS
6	2437	MCS0	26.17	30.00	PASS
11	2462	MCS0	26.15	30.00	PASS
802.11n_HT20M Ch0					
CH	Freq. (MHz)	Data Rate	Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	17.92	30.00	PASS
6	2437	MCS0	17.89	30.00	PASS
11	2462	MCS0	17.97	30.00	PASS

MIMO

802.11n_HT20M MIMO							
CH	Freq. (MHz)	Data Rate	Peak Output Power		Total Peak Output Power (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1			
1	2412	MCS8	22.17	21.81	25.00	27.20	PASS
6	2437	MCS8	24.28	24.03	27.17	27.20	PASS
11	2462	MCS8	22.96	22.63	25.81	27.20	PASS
802.11n_HT20M MIMO							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)		Max. Avg. Output include tune up tolerance Power (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1			
1	2412	MCS8	11.32	10.78	14.39	27.20	PASS
6	2437	MCS8	13.40	13.47	16.76	27.20	PASS
11	2462	MCS8	12.41	12.08	15.58	27.20	PASS

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

EIRP
Antenna Chain 0

802.11b Ch0							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	1	18.93	5.68	24.61	36	PASS
6	2437	1	18.86	5.68	24.54	36	PASS
11	2462	1	18.94	5.68	**24.62**	36	PASS
802.11g Ch0							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	6	13.92	5.68	19.60	36	PASS
2	2417	6	16.78	5.68	22.46	36	PASS
6	2437	6	18.79	5.68	**24.47**	36	PASS
10	2457	6	18.72	5.68	24.40	36	PASS
11	2462	6	16.05	5.68	21.73	36	PASS
802.11n_HT20M Ch0							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	17.92	5.68	23.60	36	PASS
6	2437	MCS0	17.89	5.68	23.57	36	PASS
11	2462	MCS0	17.97	5.68	23.65	36	PASS

MIMO

802.11n_HT20M MIMO									
CH	Freq. (MHz)	Data Rate	Avg. Output Power		Total Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
			CH 0	CH 1					
1	2412	MCS8	22.17	21.81	14.39	8.69	23.08	36	PASS
6	2437	MCS8	24.28	24.03	16.76	8.69	25.46	36	PASS
11	2462	MCS8	22.96	22.63	15.58	8.69	24.27	36	PASS

*** *Note:*** EIRP = Average Power + Gain

9 6DB & 99% BANDWIDTH MEASUREMENT

9.1 Standard Applicable

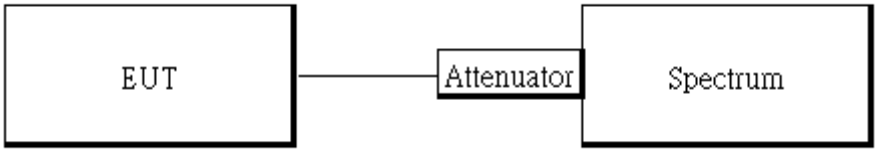
The minimum 6 dB bandwidth shall be at least 500 kHz.

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs

9.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Power Supply	GWINSTEK	SPS-3610	GPE880163	01/14/2019	01/13/2020
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020
Attenuator	Mini-Circuit	BW-S10W2+	1	02/26/2019	02/25/2020

9.3 Test Set-up



9.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. For 6dB Bandwidth:

   Set the spectrum analyzer as RBW = 100 kHz, VBW = 3*RBW, Span = 30M/50MHz, Detector=peak, Sweep=auto.
5. Mark the peak frequency and –6dB (upper and lower) frequency.
6. For 99% Bandwidth:

   Set the spectrum analyzer as RBW=1%, VBW = 3*RBW, Span = 30M/50MHz, Detector=Sample, Sweep=auto.
7. Turn on the 99% bandwidth function, max reading.
8. Repeat above procedures until all frequency of interest measured was complete.

9.5 Measurement Result

6dB Bandwidth

Antenna Chain 0

802.11b Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	**7073.00**	> 500	PASS
2437	7063.00	> 500	PASS
2462	7034.00	> 500	PASS

802.11g Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	**16370.00**	> 500	PASS
2437	16360.00	> 500	PASS
2462	**16370.00**	> 500	PASS

802.11_n_HT20 Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	17610.00	> 500	PASS
2437	17610.00	> 500	PASS
2462	**17620.00**	> 500	PASS

Antenna Chain 1

802.11_n_HT20 Ch1

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	**17630.00**	> 500	PASS
2437	**17630.00**	> 500	PASS
2462	17610.00	> 500	PASS

99% Bandwidth

Antenna Chain 0

802.11b Ch0	
Freq. (MHz)	99% BW (MHz)
2412	**10.198**
2437	10.194
2462	10.17

802.11g Ch0	
Freq. (MHz)	99% BW (MHz)
2412	17.02
2437	**17.103**
2462	17.057

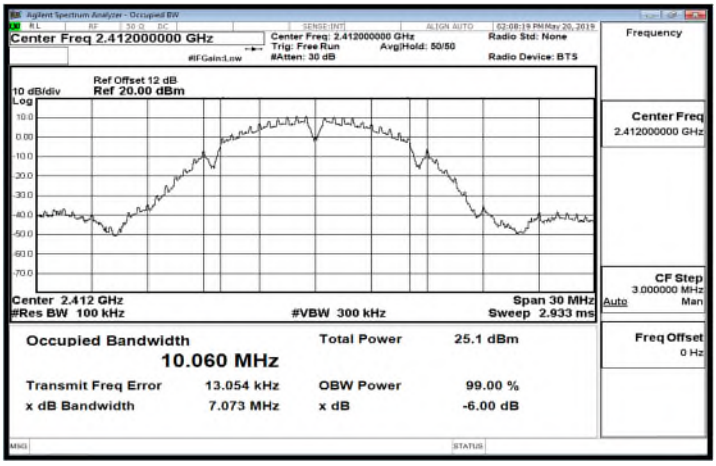
802.11n_HT20M Ch0	
Freq. (MHz)	99% BW (MHz)
2412	18.101
2437	**18.128**
2462	18.115

Antenna Chain 1

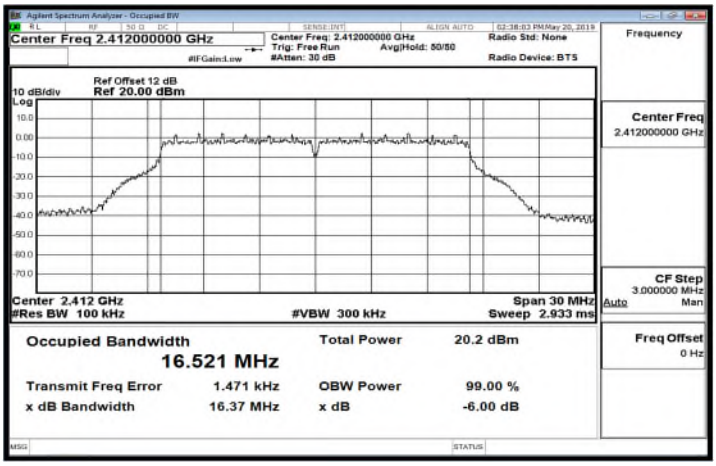
802.11n_HT20M Ch1	
Freq. (MHz)	99% BW (MHz)
2412	**17.942**
2437	17.929
2462	17.937

Refer to next page for plots

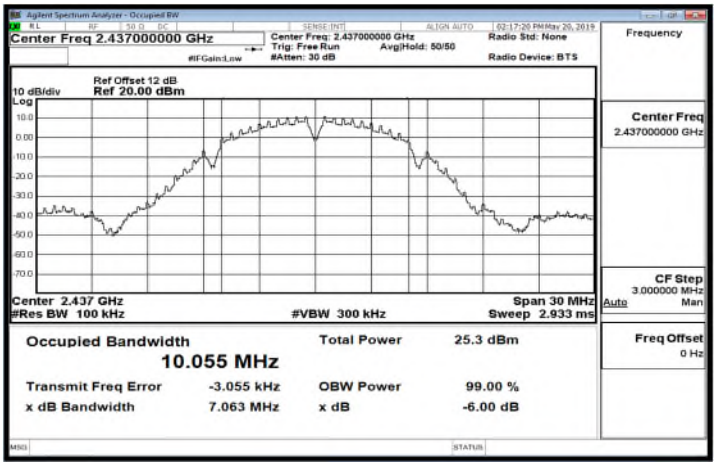
OBW 6dB_802.11b_20MHz_Chain0_2412MHz



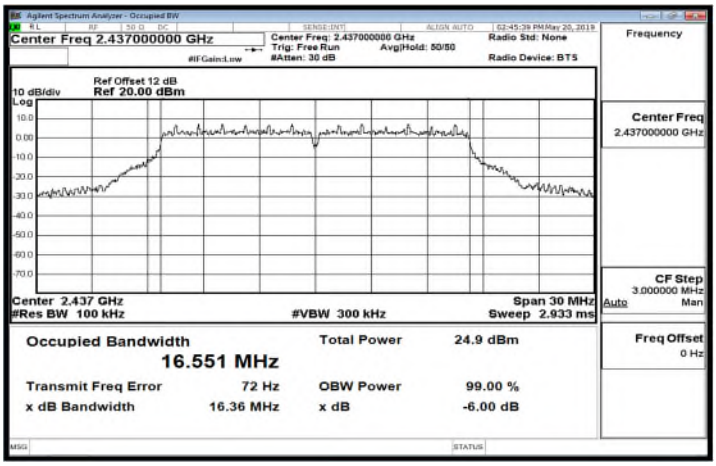
OBW 6dB_802.11g_20MHz_Chain0_2412MHz



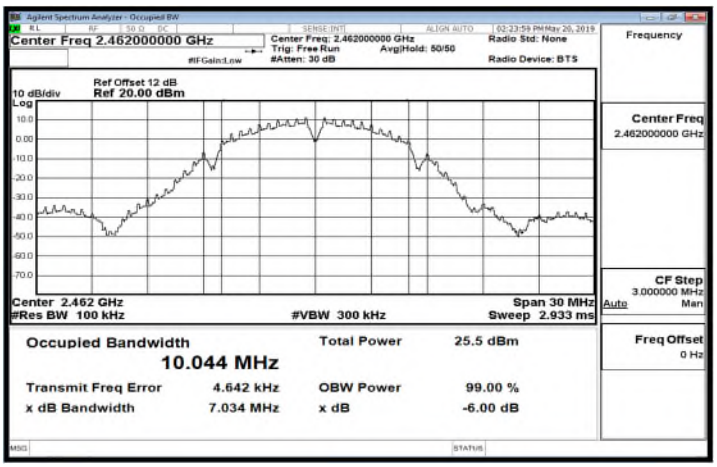
OBW 6dB_802.11b_20MHz_Chain0_2437MHz



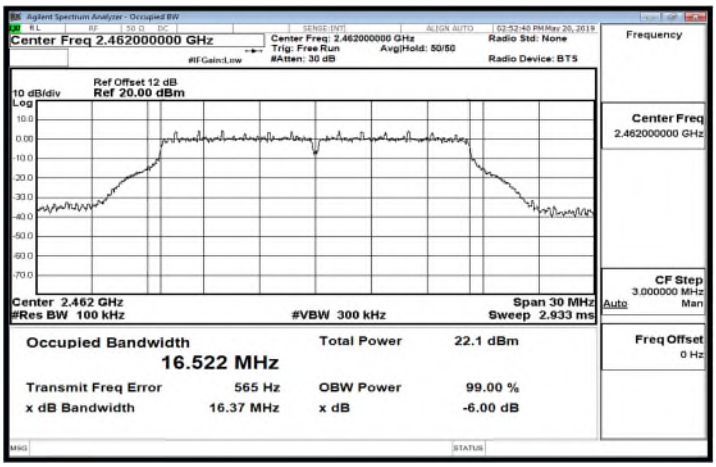
OBW 6dB_802.11g_20MHz_Chain0_2437MHz



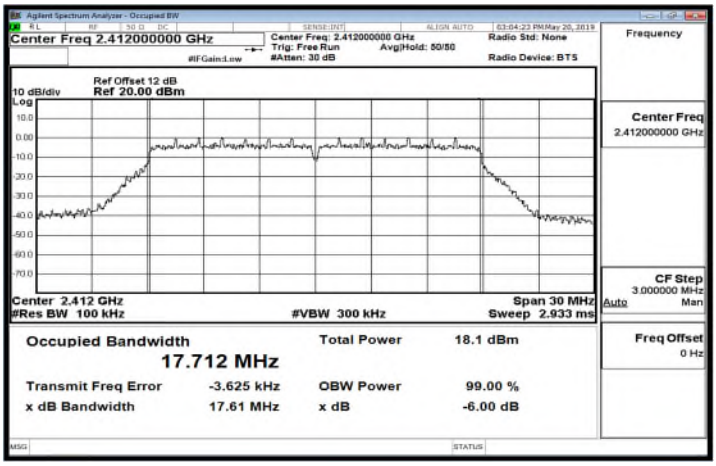
OBW 6dB_802.11b_20MHz_Chain0_2462MHz



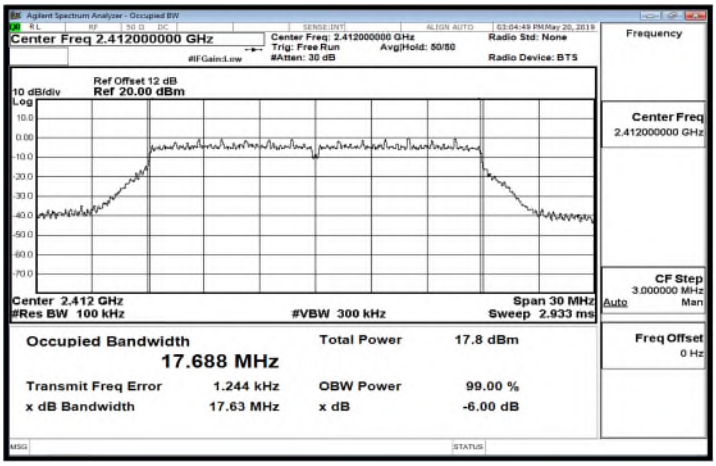
OBW 6dB_802.11g_20MHz_Chain0_2462MHz



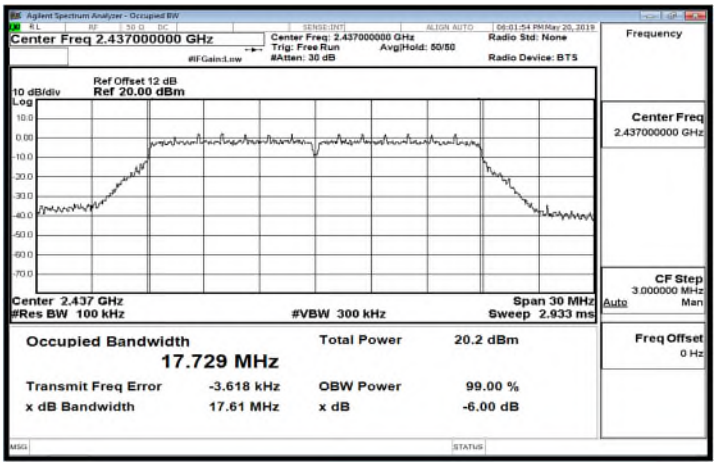
OBW 6dB_802.11n_20MHz_Chain0_2412MHz



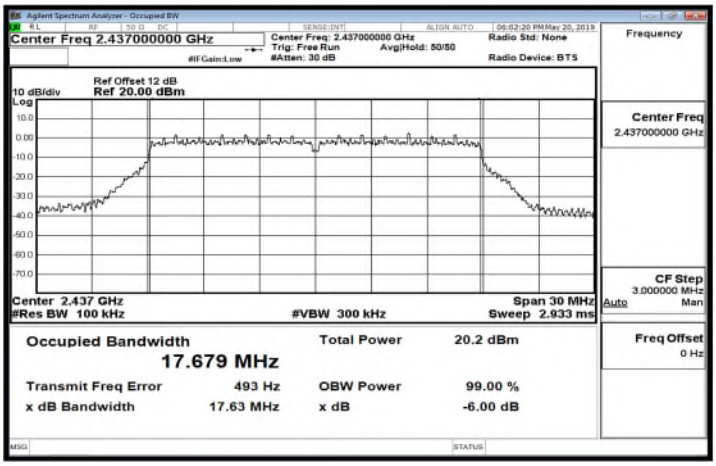
OBW 6dB_802.11n_20MHz_Chain1_2412MHz



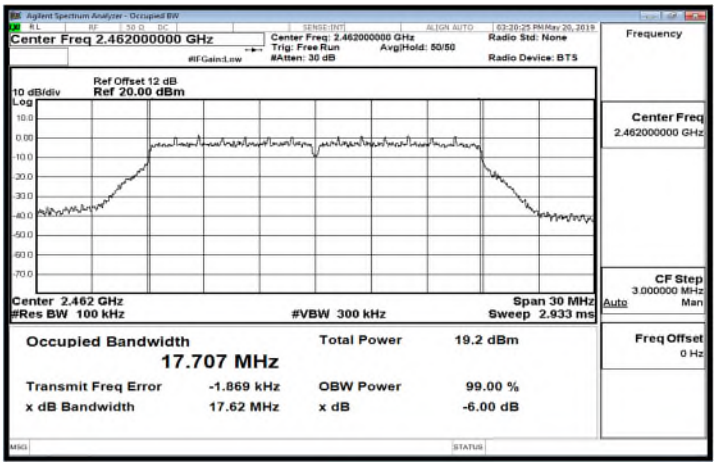
OBW 6dB_802.11n_20MHz_Chain0_2437MHz



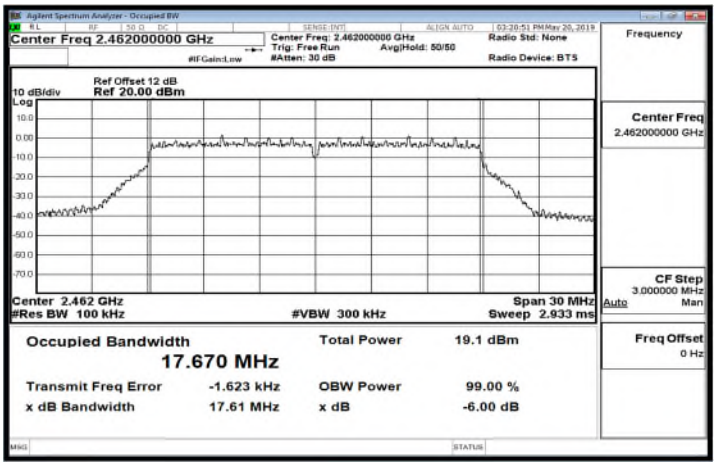
OBW 6dB_802.11n_20MHz_Chain1_2437MHz



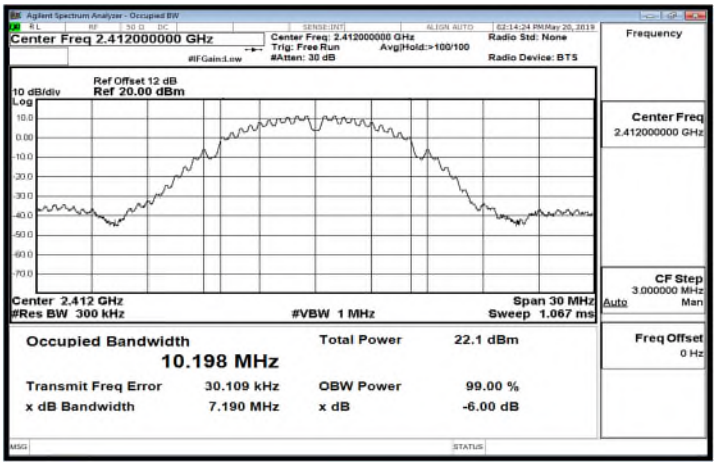
OBW 6dB_802.11n_20MHz_Chain0_2462MHz



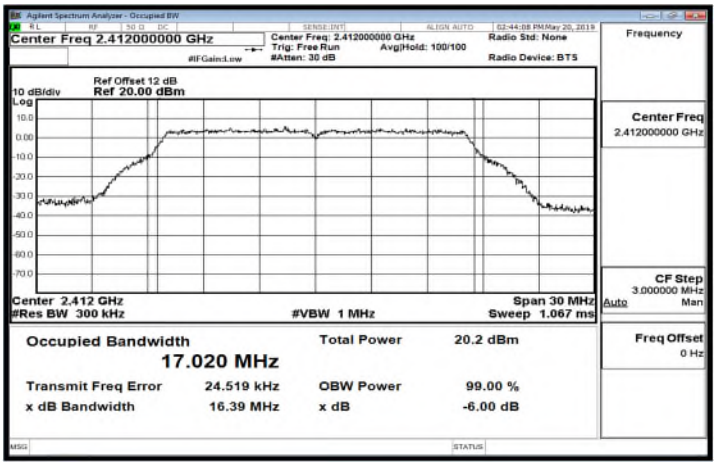
OBW 6dB_802.11n_20MHz_Chain1_2462MHz



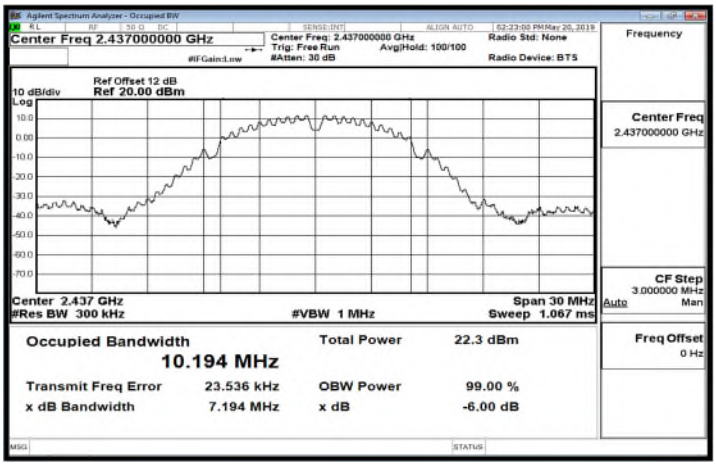
OBW 99%_802.11b_20MHz_Chain0_2412MHz



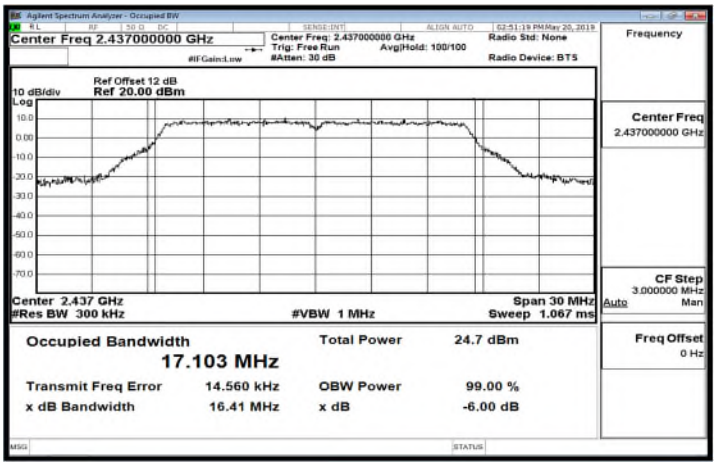
OBW 99%_802.11g_20MHz_Chain0_2412MHz



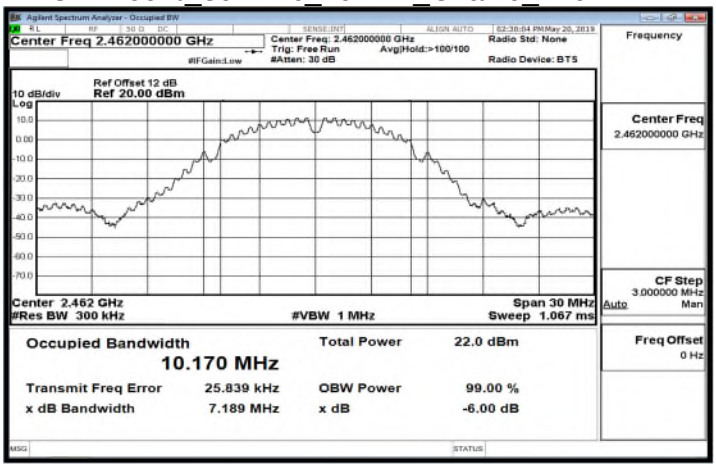
OBW 99%_802.11b_20MHz_Chain0_2437MHz



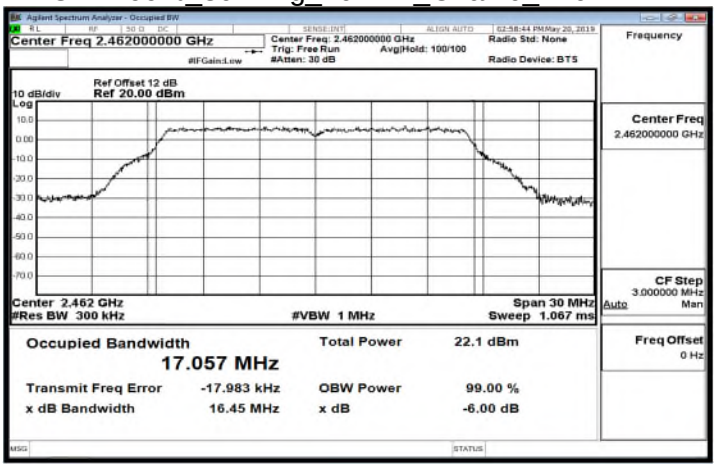
OBW 99%_802.11g_20MHz_Chain0_2437MHz



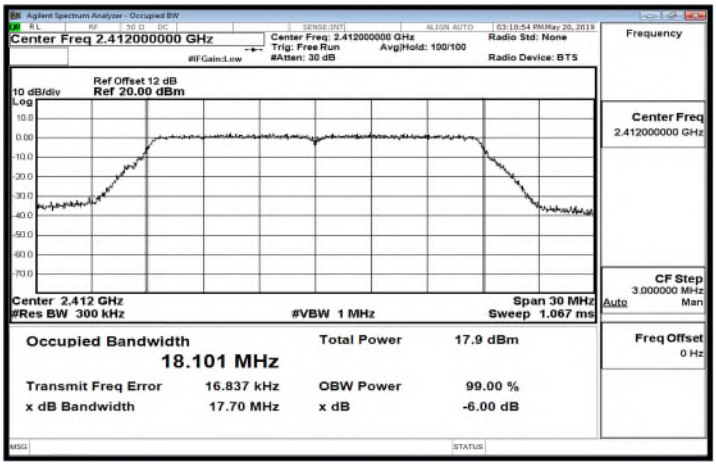
OBW 99%_802.11b_20MHz_Chain0_2462MHz



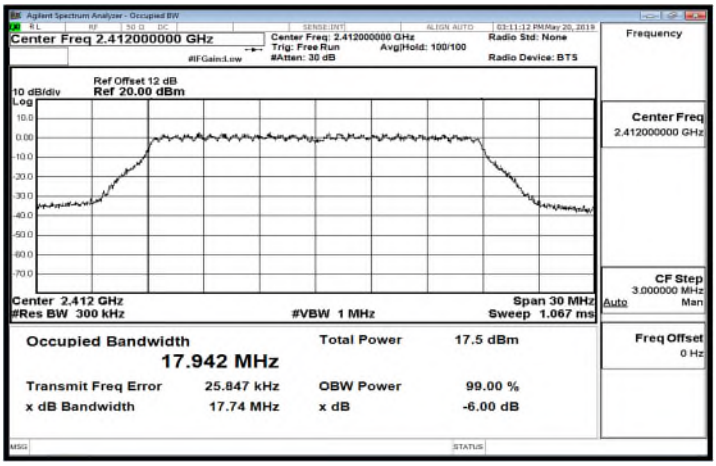
OBW 99%_802.11g_20MHz_Chain0_2462MHz



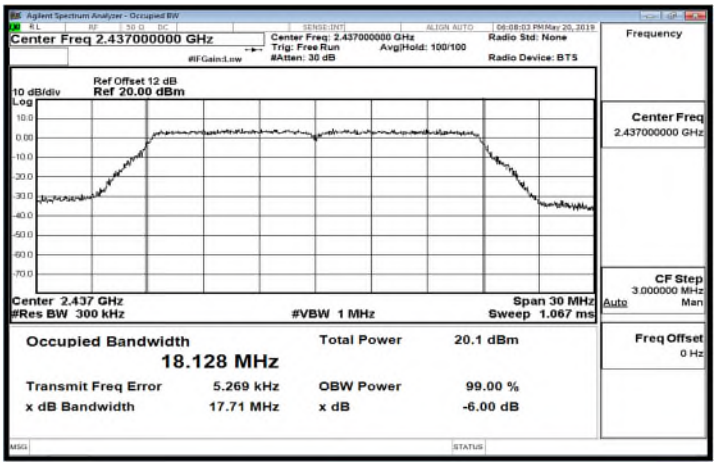
OBW 99%_802.11n_20MHz_Chain0_2412MHz



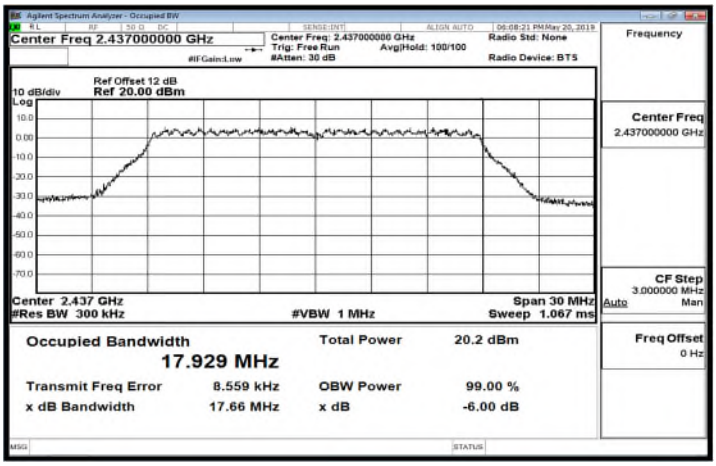
OBW 99%_802.11n_20MHz_Chain1_2412MHz



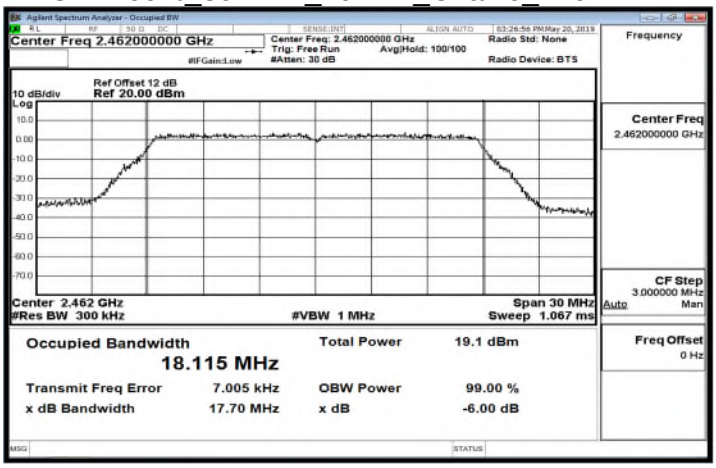
OBW 99%_802.11n_20MHz_Chain0_2437MHz



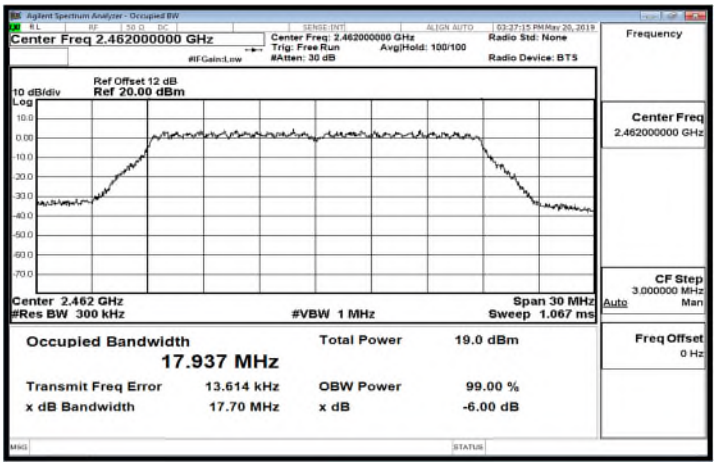
OBW 99%_802.11n_20MHz_Chain1_2437MHz



OBW 99%_802.11n_20MHz_Chain0_2462MHz



OBW 99%_802.11n_20MHz_Chain1_2462MHz



10 CONDUCTED BAND EDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

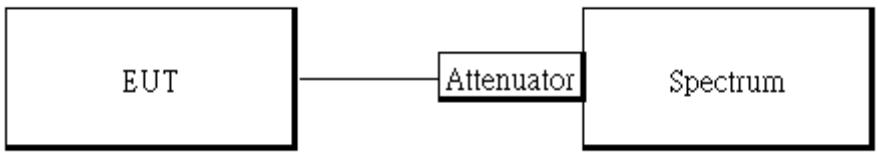
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Power Supply	GWINSTEK	SPS-3610	GPE880163	01/14/2019	01/13/2020
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020
Attenuator	Mini-Circuit	BW-S10W2+	1	02/26/2019	02/25/2020

10.3 Test SET-UP



10.4 Measurement Procedure

Conducted Band Edge Limt

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance & ANSI C63.10.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance & ANSI C63.10.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker 1 – 20dBm
8. Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 kHz immediately outside the authorized (2400~2483.5) be attenuated by 20dB at least relative to the maximum emission of power.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance & ANSI C63.10.
3. Set RBW = 100 kHz & VBW= 300 kHz, Detector =Peak, Sweep = Auto.
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

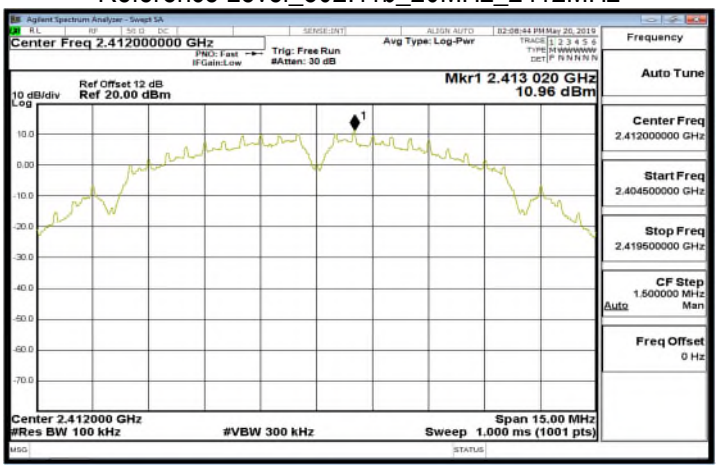
6. Repeat above procedures until all default test channel measured were complete.

10.5 Measurement Result

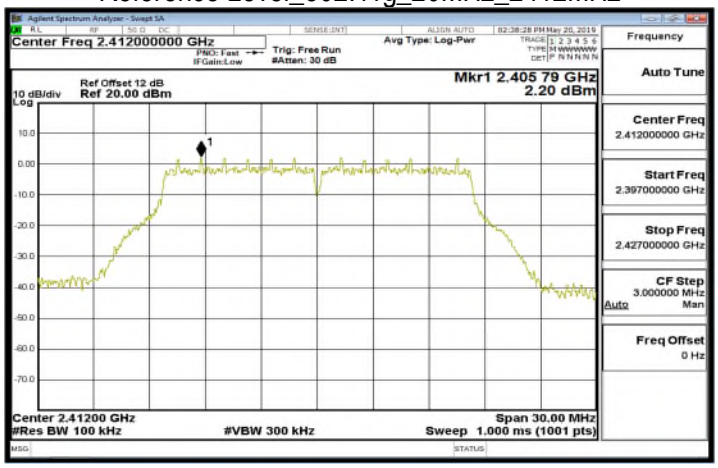
Reference Level of Limit 802.11b mode			Reference Level of Limit 802.11g mode		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)	Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	10.96	-9.04	2412	2.20	-17.80
2437	11.07	-8.93	2437	6.90	-13.10
2462	10.83	-9.17	2462	4.08	-15.92

Reference Level of Limit 802.11n20 mode		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	2.98	-17.02
2437	5.11	-14.89
2462	4.10	-15.90

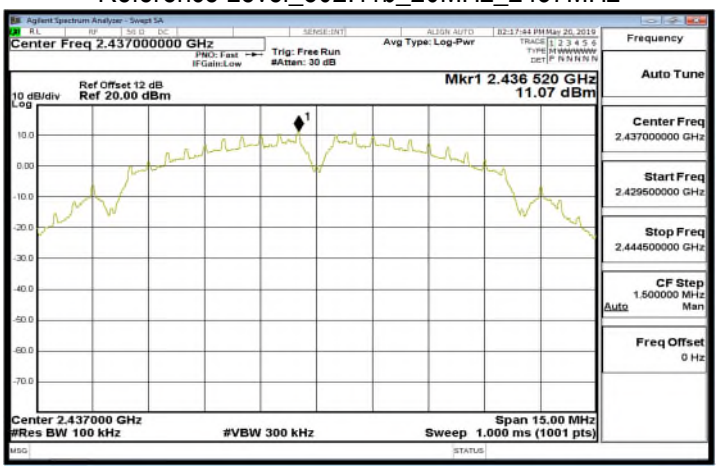
Reference Level_802.11b_20MHz_2412MHz



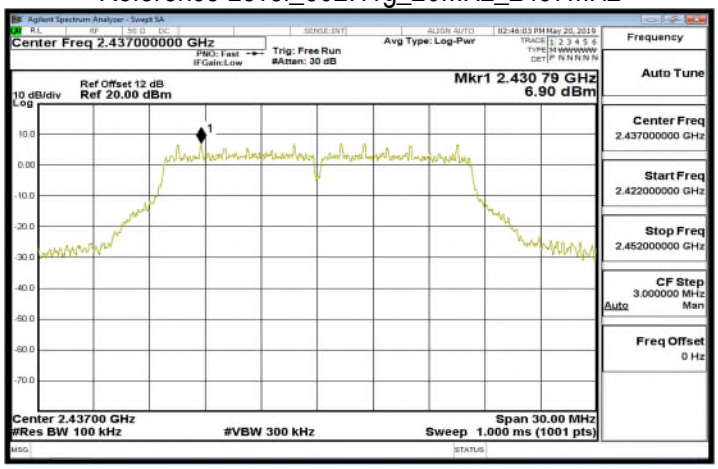
Reference Level_802.11g_20MHz_2412MHz



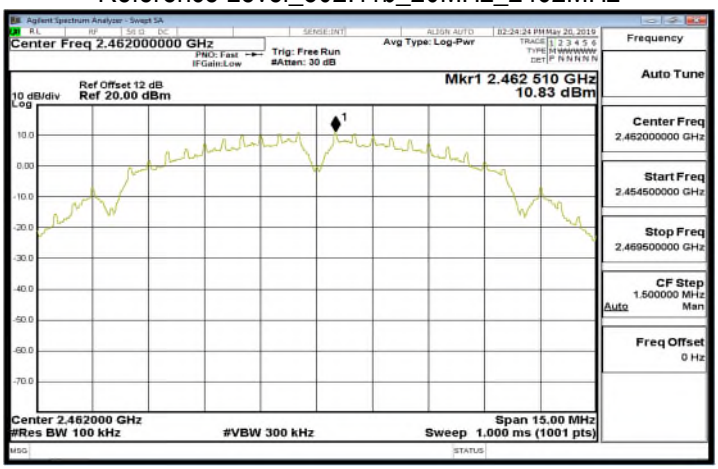
Reference Level_802.11b_20MHz_2437MHz



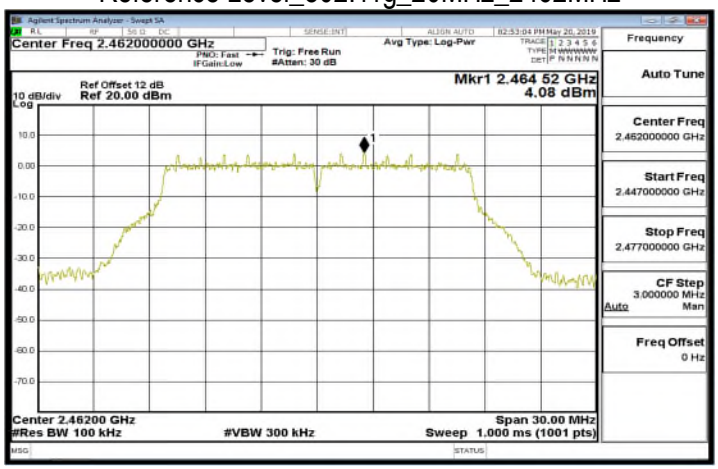
Reference Level_802.11g_20MHz_2437MHz



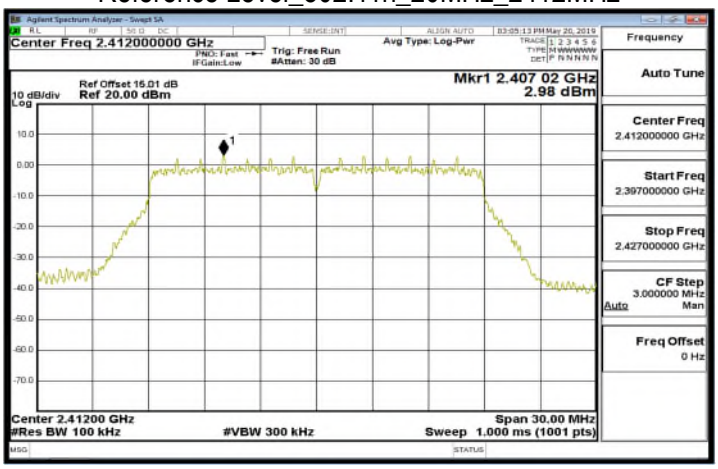
Reference Level_802.11b_20MHz_2462MHz



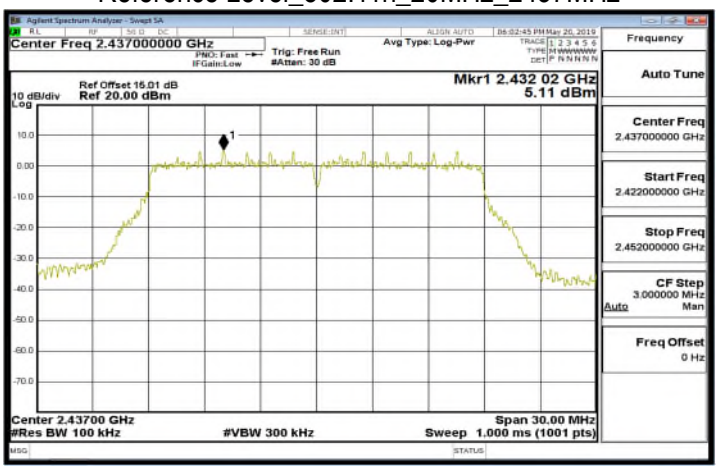
Reference Level_802.11g_20MHz_2462MHz



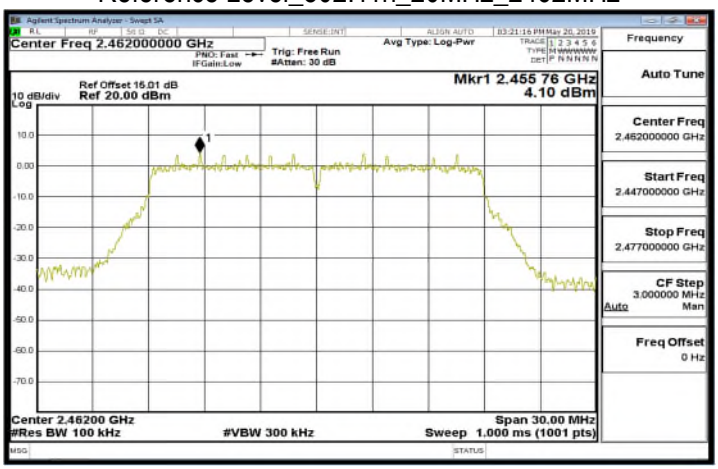
Reference Level_802.11n_20MHz_2412MHz



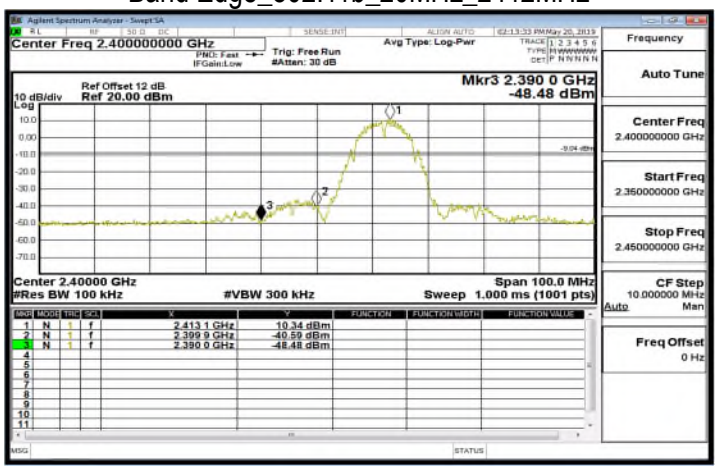
Reference Level_802.11n_20MHz_2437MHz



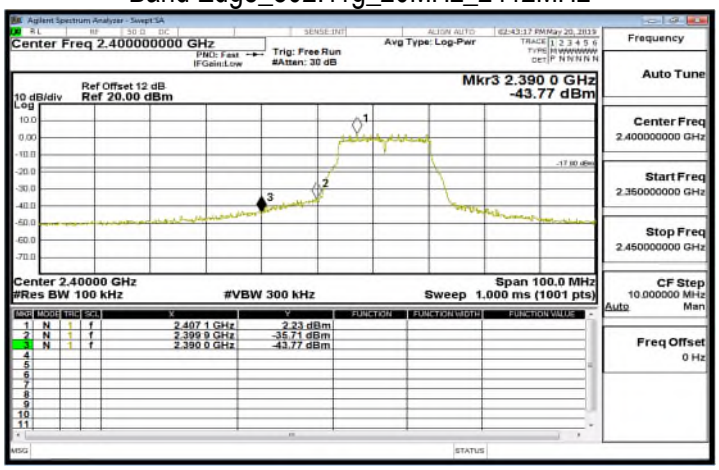
Reference Level_802.11n_20MHz_2462MHz



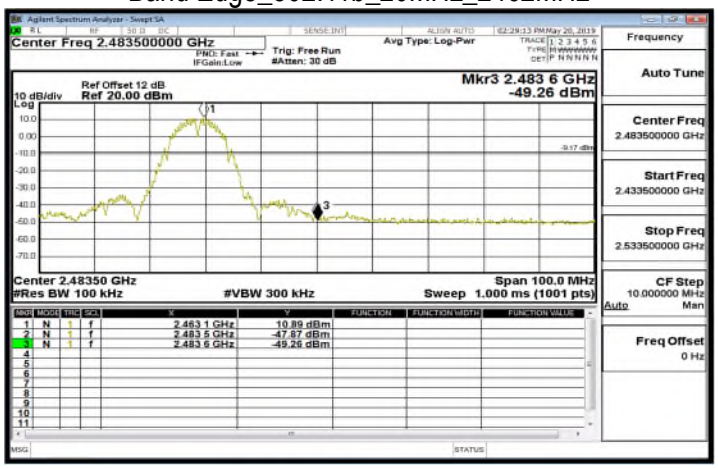
Band Edge_802.11b_20MHz_2412MHz



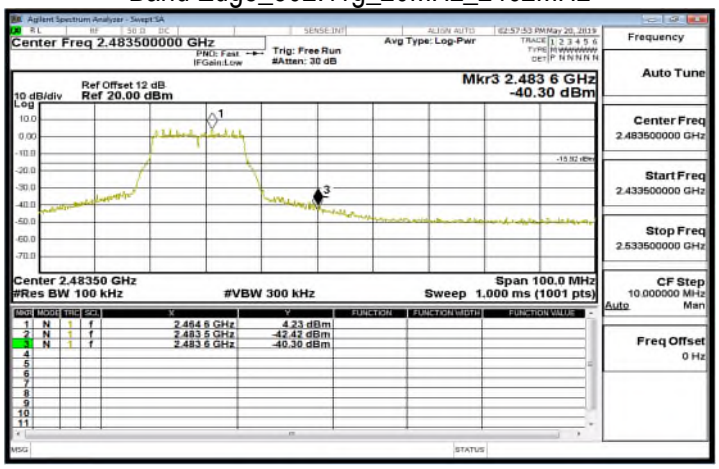
Band Edge_802.11g_20MHz_2412MHz



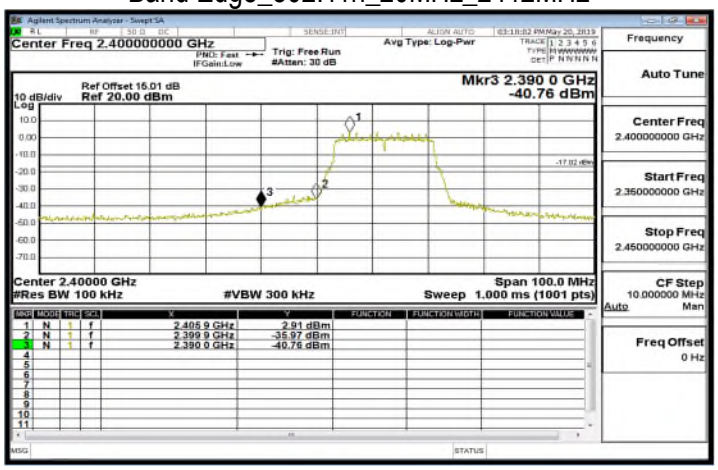
Band Edge_802.11b_20MHz_2462MHz



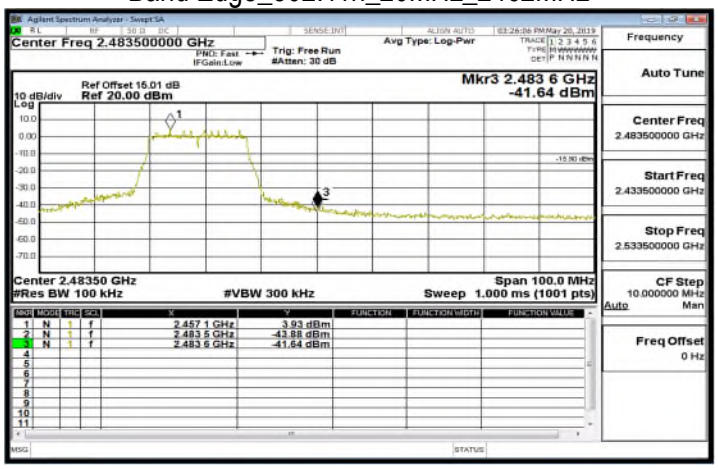
Band Edge_802.11g_20MHz_2462MHz



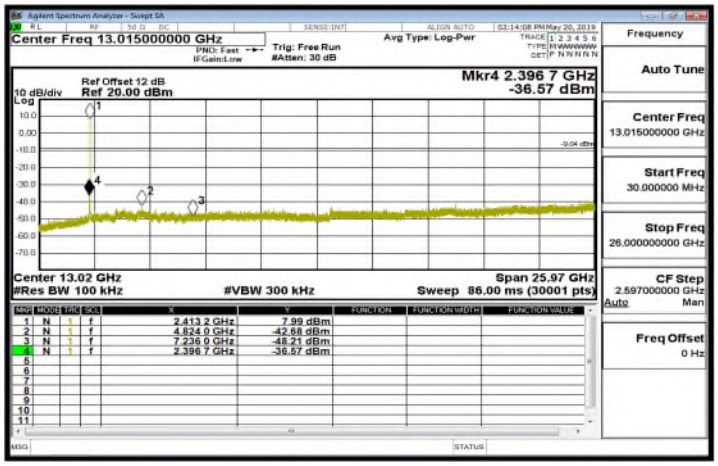
Band Edge_802.11n_20MHz_2412MHz



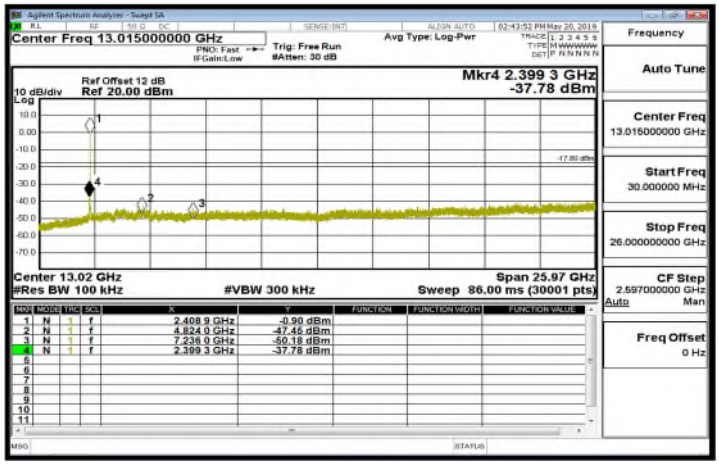
Band Edge_802.11n_20MHz_2462MHz



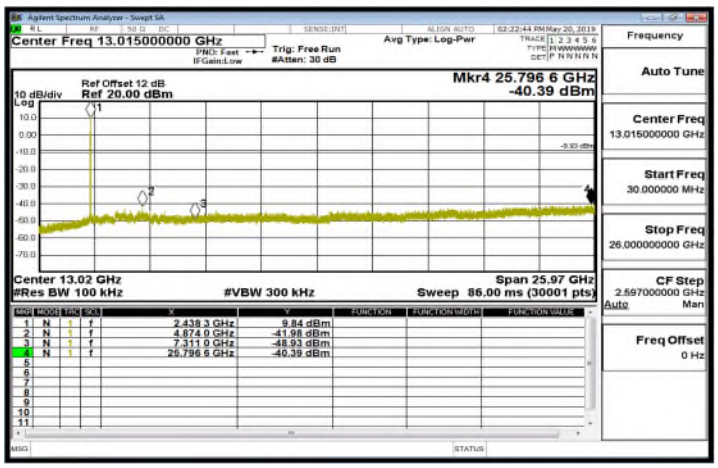
Spurious Emission_802.11b_20MHz_2412MHz



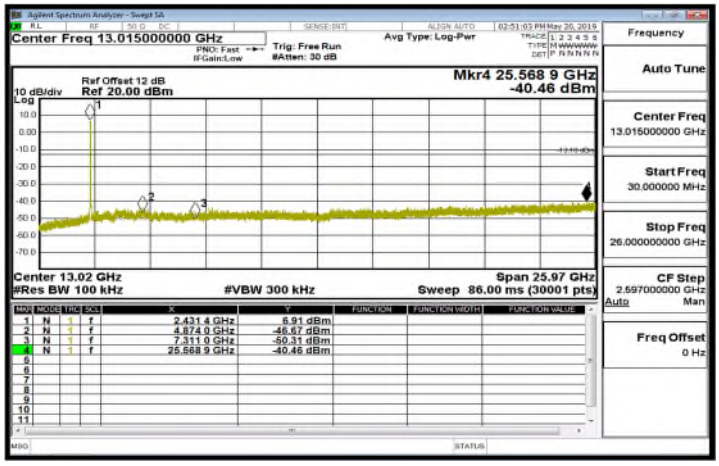
Spurious Emission_802.11g_20MHz_2412MHz



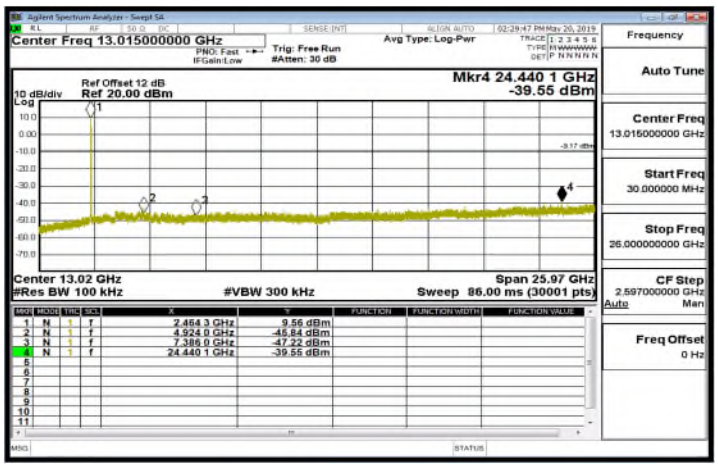
Spurious Emission_802.11b_20MHz_2437MHz



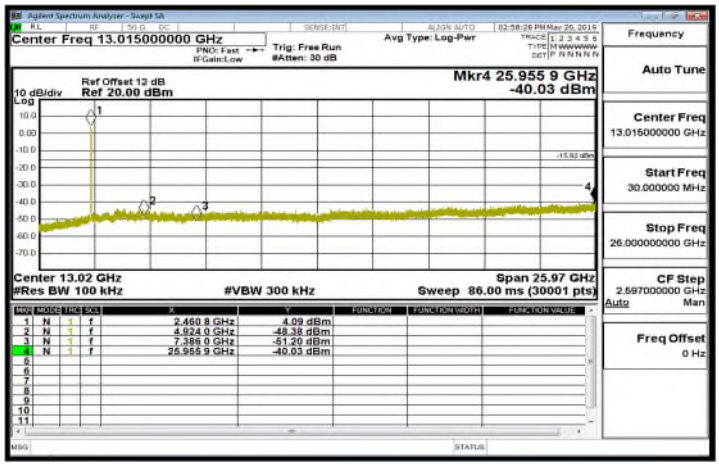
Spurious Emission_802.11g_20MHz_2437MHz



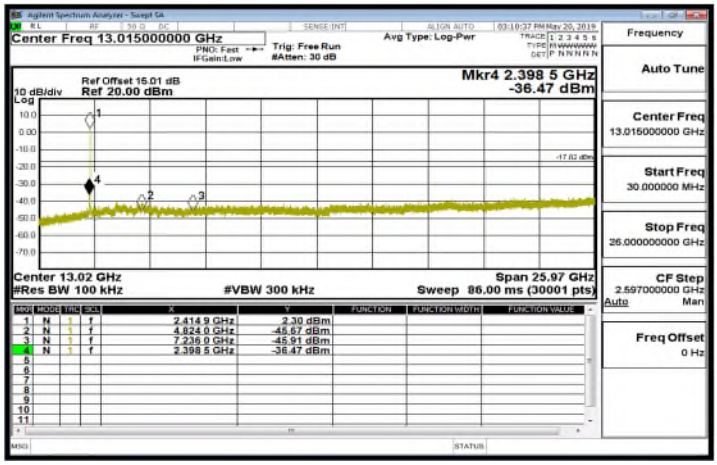
Spurious Emission_802.11b_20MHz_2462MHz



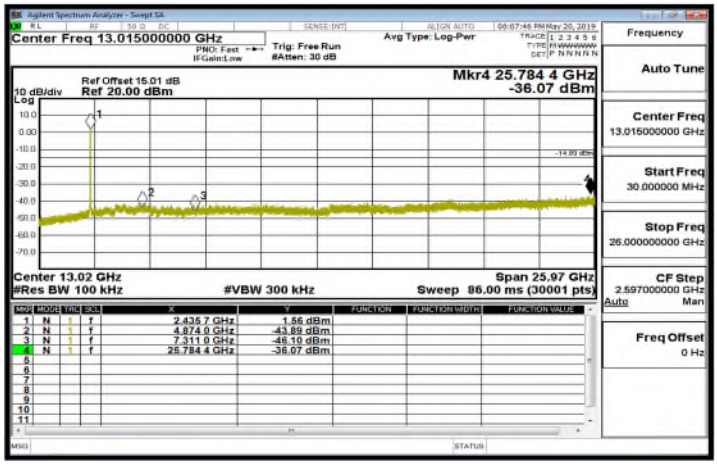
Spurious Emission_802.11g_20MHz_2462MHz



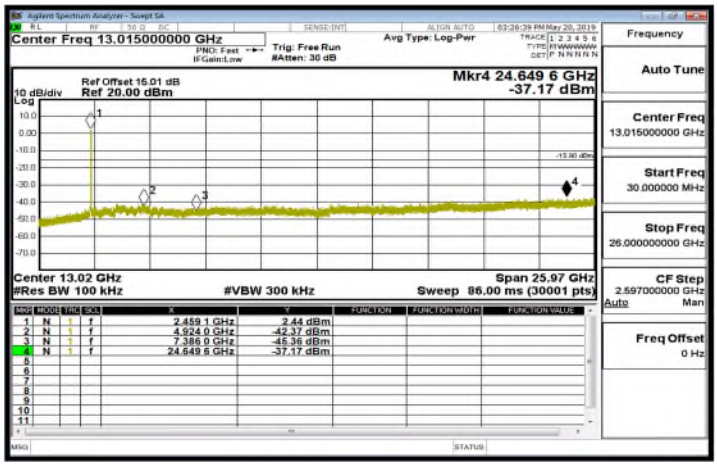
Spurious Emission_802.11n_20MHz_2412MHz



Spurious Emission_802.11n_20MHz_2437MHz



Spurious Emission_802.11n_20MHz_2462MHz



11 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

11.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the RSS-Gen §8.10 Table 7.

And according to 15.33(a)(1) & RSS-Gen §6.13(a) for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

According to RSS-Gen §8.9 Table 5 & 6 Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	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 (dBμV/m) = 20 log Emission level (dBμV/m)

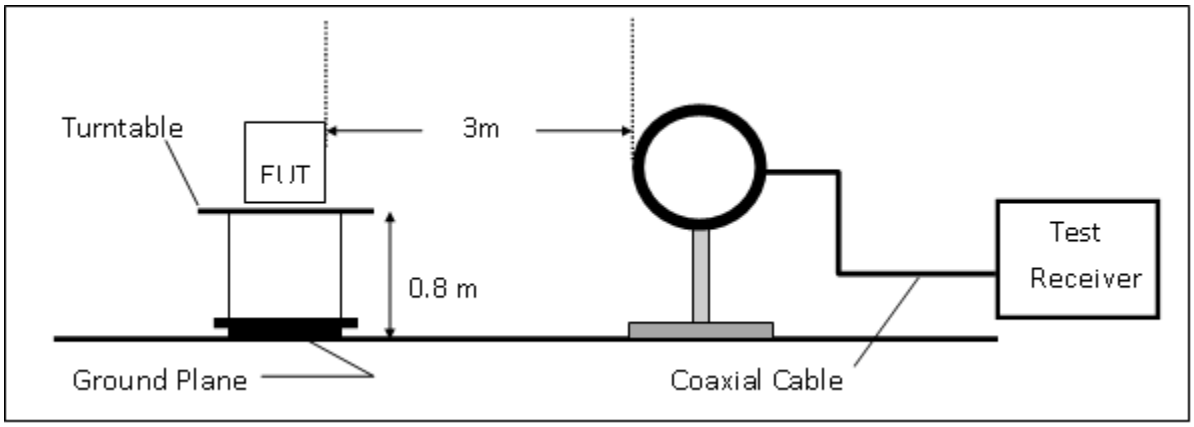
11.2 Measurement Equipment Used:

966A Chamber					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Date**	**Calibration Due**
Band Reject Filters	MICRO TRONICS	BRM 50702	120	02/26/2019	02/25/2020
Bilog Antenna	Sunol Sciences	JB3	A030105	07/13/2018	07/12/2019
Cable	HUBER SUHNER	SUCOFLEX 104PEA	25157	02/26/2019	02/25/2020
Cable	HUBER SUHNER	SUCOFLEX 104PEA	20995	02/26/2019	02/25/2020
Digital Thermo-Hygro Meter	WISEWIND	1206	D07	01/30/2019	01/29/2020
double Ridged Guide Horn Antenna	ETC	MCTD 1209	DRH13M02003	08/20/2018	08/19/2019
Loop Antenna	COM-POWER	AL-130	121051	03/22/2019	03/21/2020
Pre-Amplifier	EMEC	EM330	060609	02/26/2019	02/25/2020
Pre-Amplifier	HP	8449B	3008A00965	02/26/2019	02/25/2020
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
DC Power Supply	Agilent	E3640A	MY40000811	12/11/2018	12/10/2019
PSA Series Spectrum Analyzer	Agilent	E4446A	MY46180323	05/31/2018	05/30/2019
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R	N.C.R
Turn Table	CCS	CC-T-1F	N/A	N.C.R	N.C.R
Software	e3 V6.11-20180413				

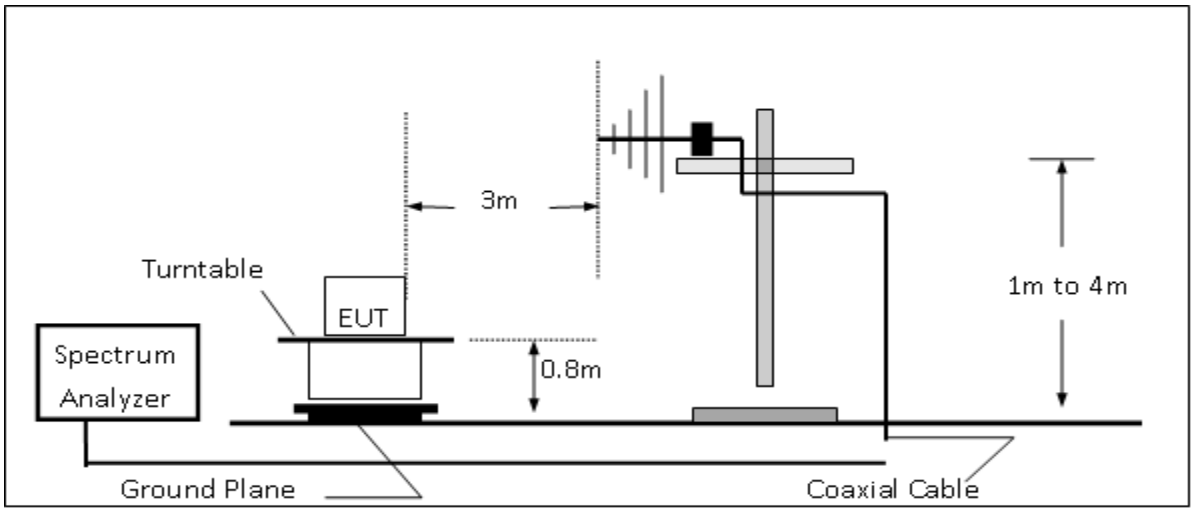
NOTE: N.C.R refers to Not Calibrated Required.

11.3 Test SET-UP

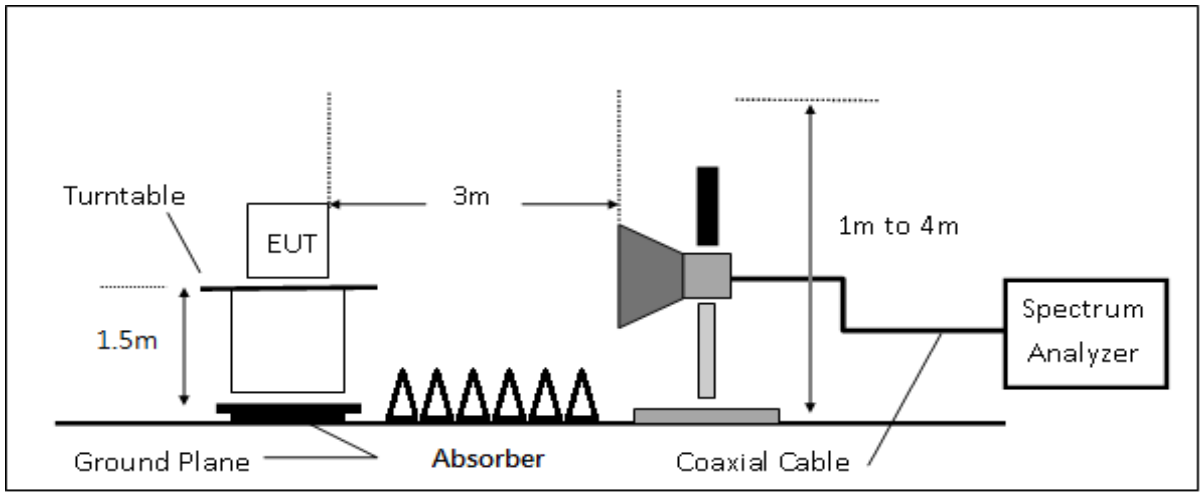
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



11.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance & ANSI C63.10.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
6. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
8. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
9. 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.
10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
12. Repeat above procedures until all default test channel measured were complete.

11.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

11.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

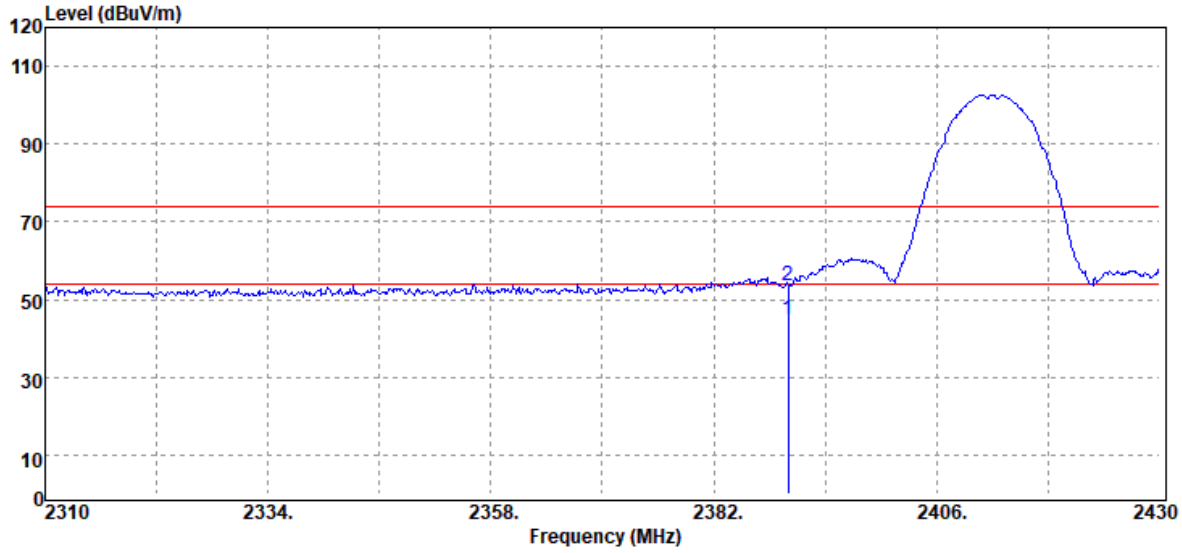
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

11.7 Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

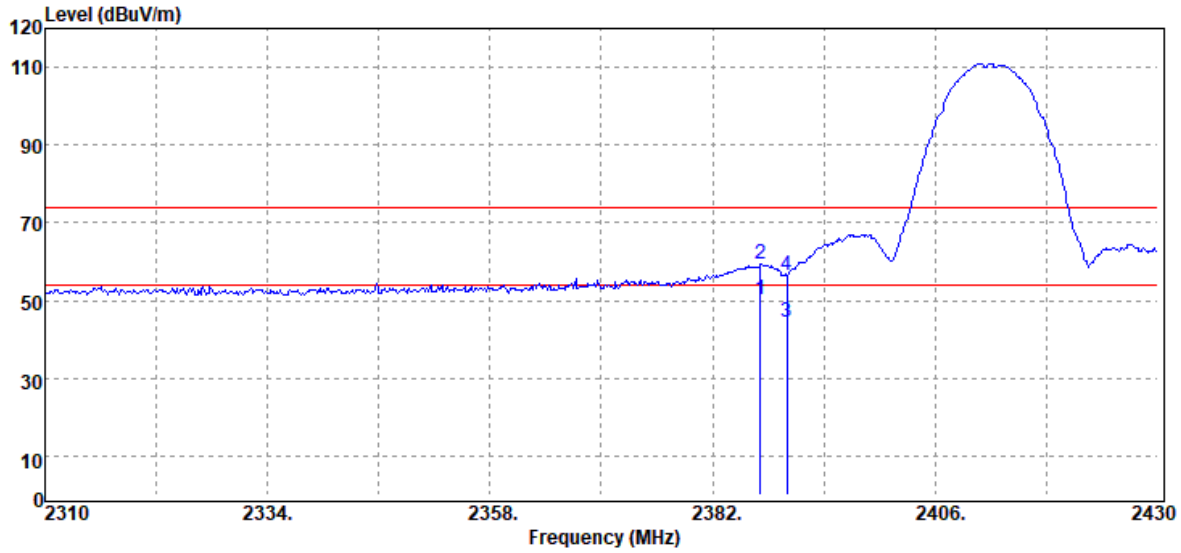
Radiated Band Edge Measurement Result

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



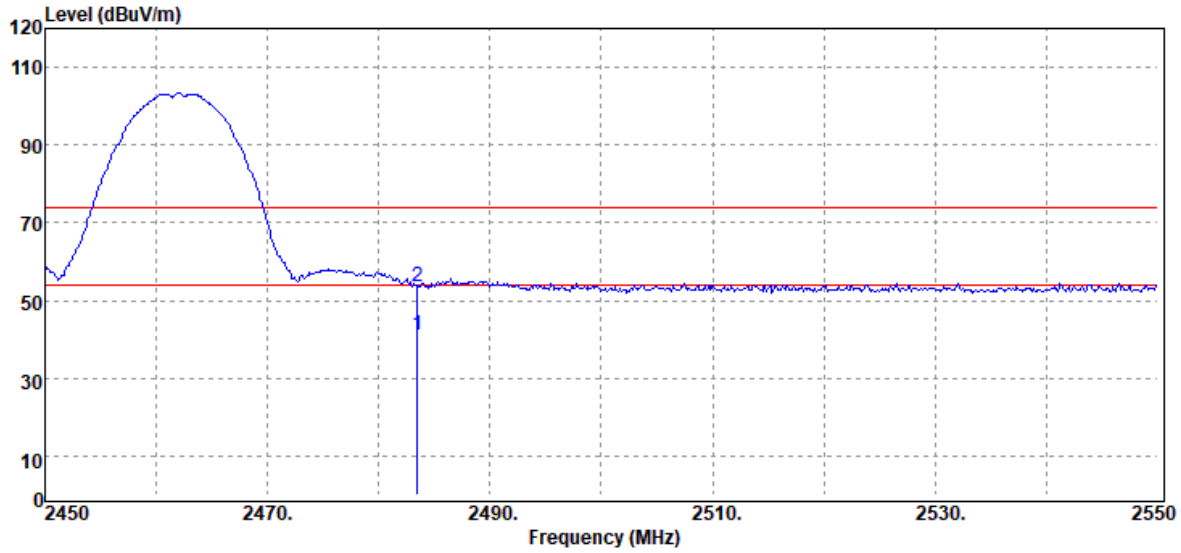
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	48.22	-3.38	44.84	54.00	-9.16
2390.00	Peak	57.05	-3.38	53.67	74.00	-20.33

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



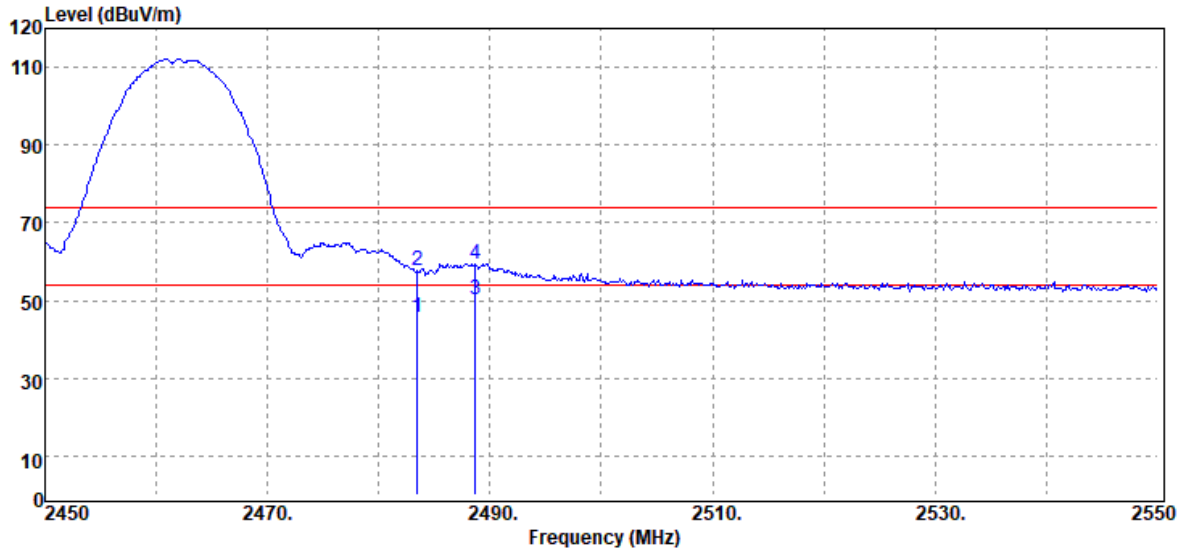
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2387.16	Average	53.64	-3.38	50.26	54.00	-3.74
2387.16	Peak	62.88	-3.38	59.50	74.00	-14.50
2390.00	Average	48.00	-3.38	44.62	54.00	-9.38
2390.00	Peak	59.67	-3.38	56.29	74.00	-17.71

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



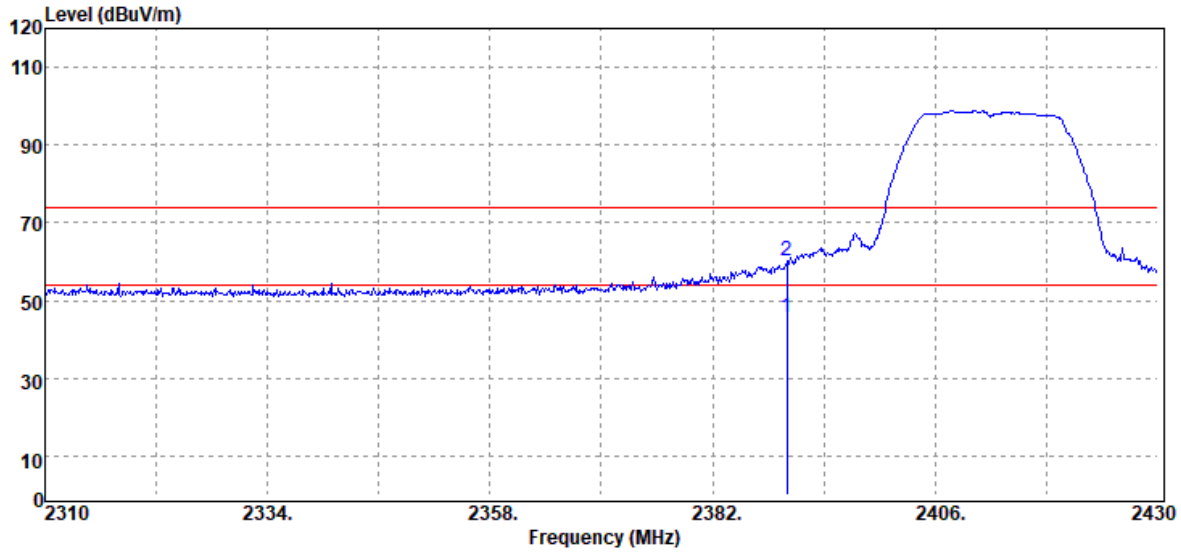
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	44.14	-2.83	41.31	54.00	-12.69
2483.50	Peak	56.44	-2.83	53.61	74.00	-20.39

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



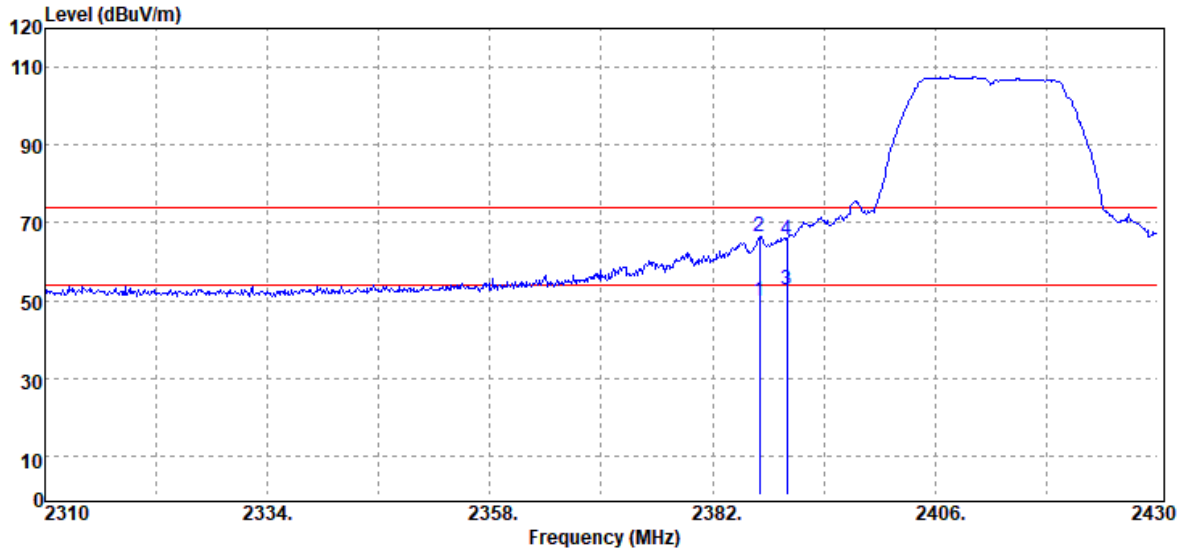
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	48.56	-2.83	45.73	54.00	-8.27
2483.50	Peak	60.48	-2.83	57.65	74.00	-16.35
2488.70	Average	52.86	-2.80	50.06	54.00	-3.94
2488.70	Peak	62.34	-2.80	59.54	74.00	-14.46

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



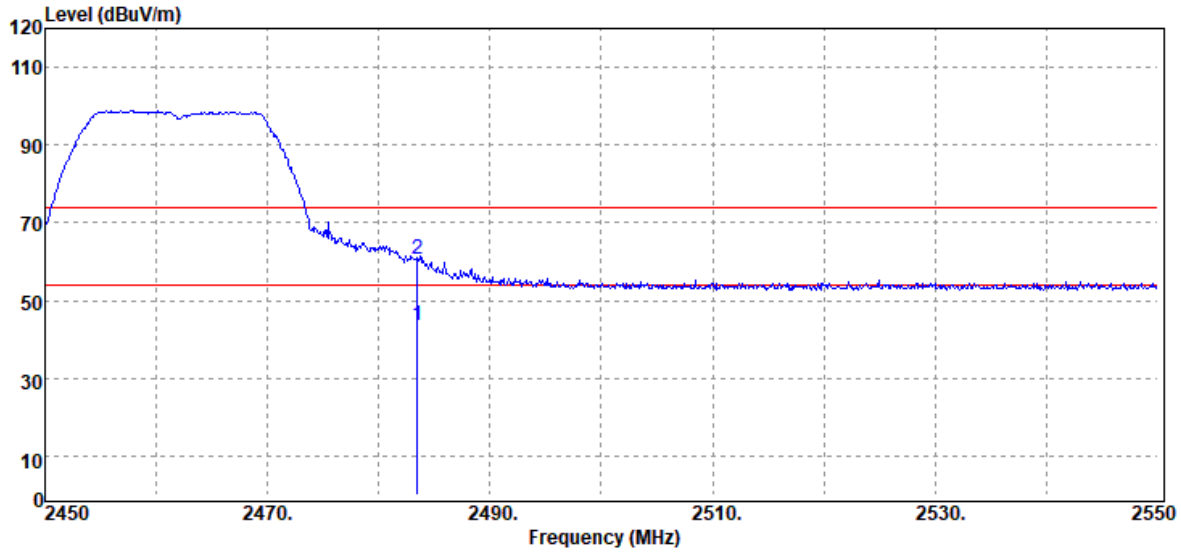
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	48.86	-3.38	45.48	54.00	-8.52
2390.00	Peak	63.55	-3.38	60.17	74.00	-13.83

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



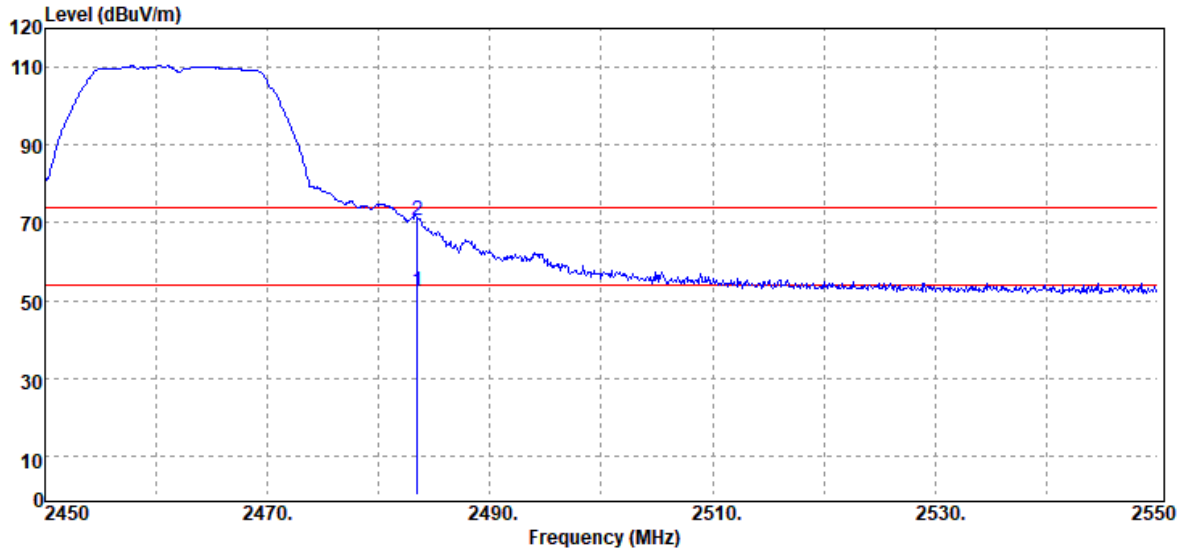
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2387.04	Average	53.18	-3.38	49.80	54.00	-4.20
2387.04	Peak	69.77	-3.38	66.39	74.00	-7.61
2390.00	Average	55.92	-3.38	52.54	54.00	-1.46
2390.00	Peak	69.19	-3.38	65.81	74.00	-8.19

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



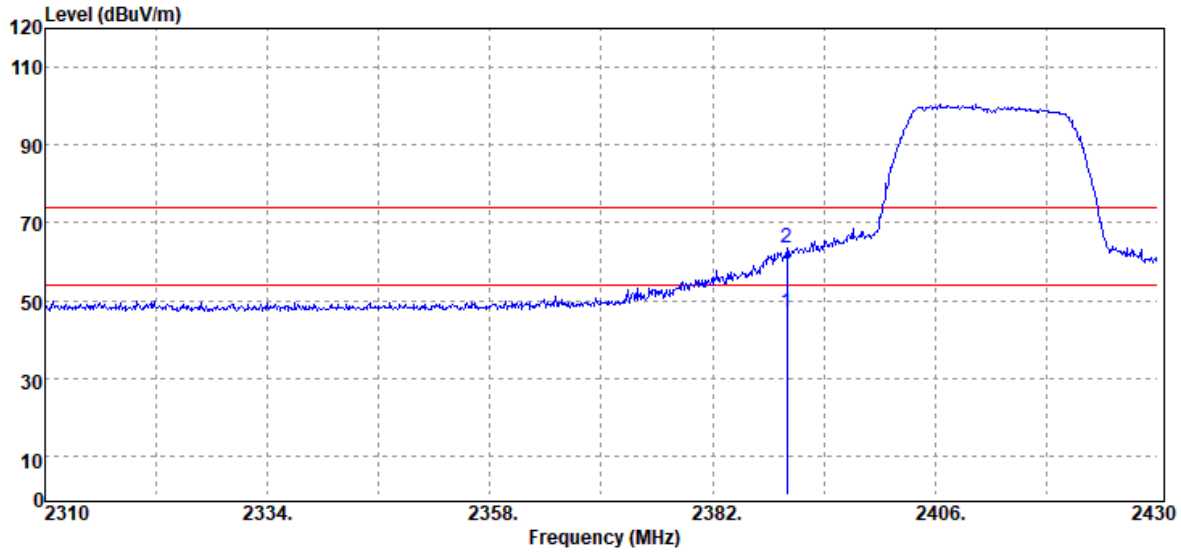
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	46.58	-2.83	43.75	54.00	-10.25
2483.50	Peak	63.56	-2.83	60.73	74.00	-13.27

Project Number	:T190506W05	Test Date	:2019-05-17
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



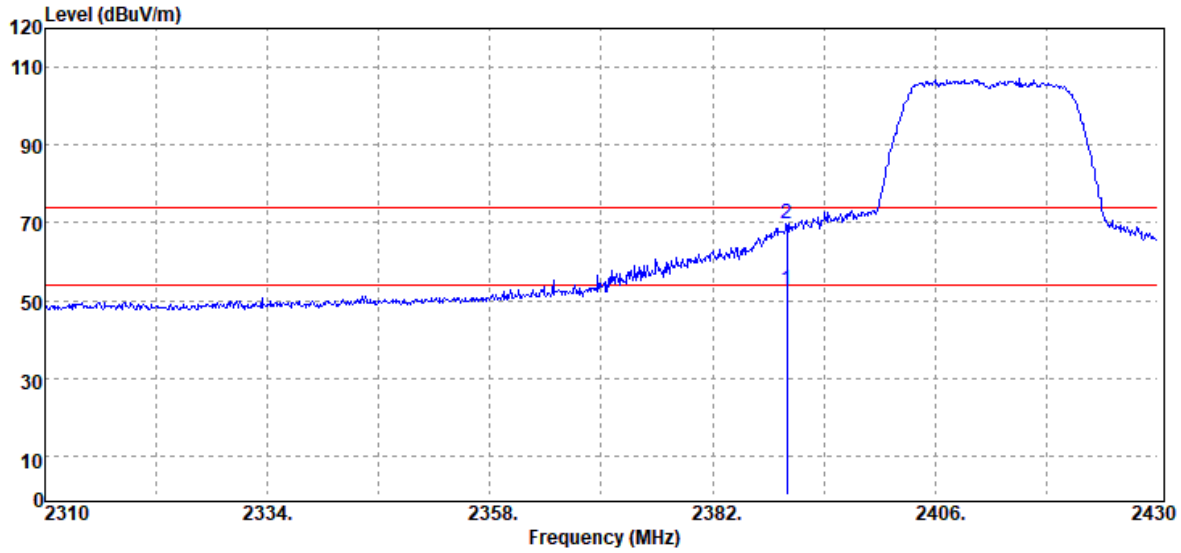
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	55.19	-2.83	52.36	54.00	-1.64
2483.50	Peak	73.41	-2.83	70.58	74.00	-3.42

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



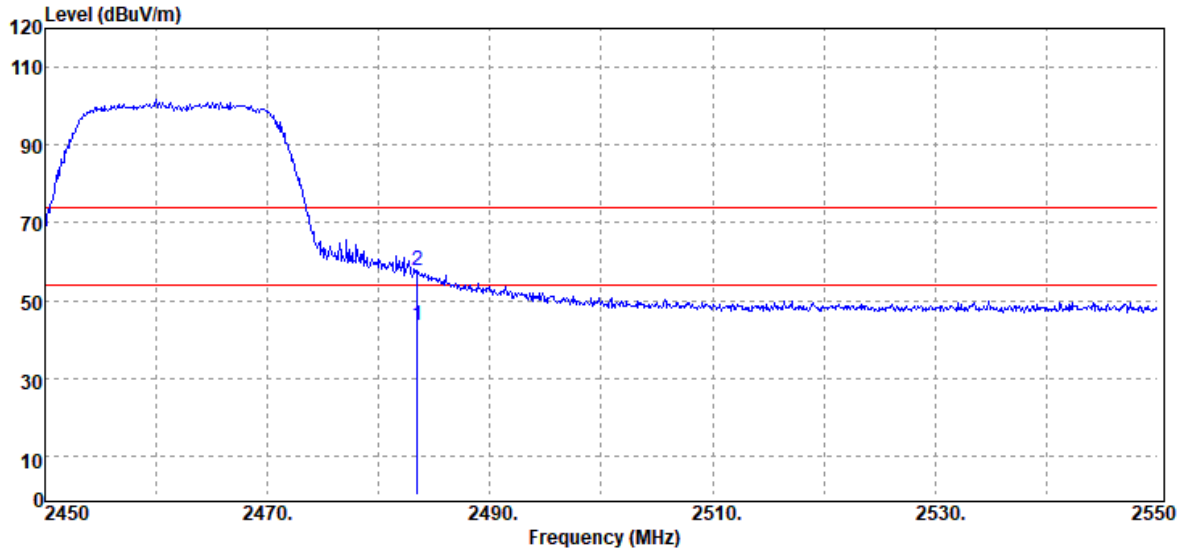
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	50.27	-3.38	46.89	54.00	-7.11
2390.00	Peak	66.84	-3.38	63.46	74.00	-10.54

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:BE CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



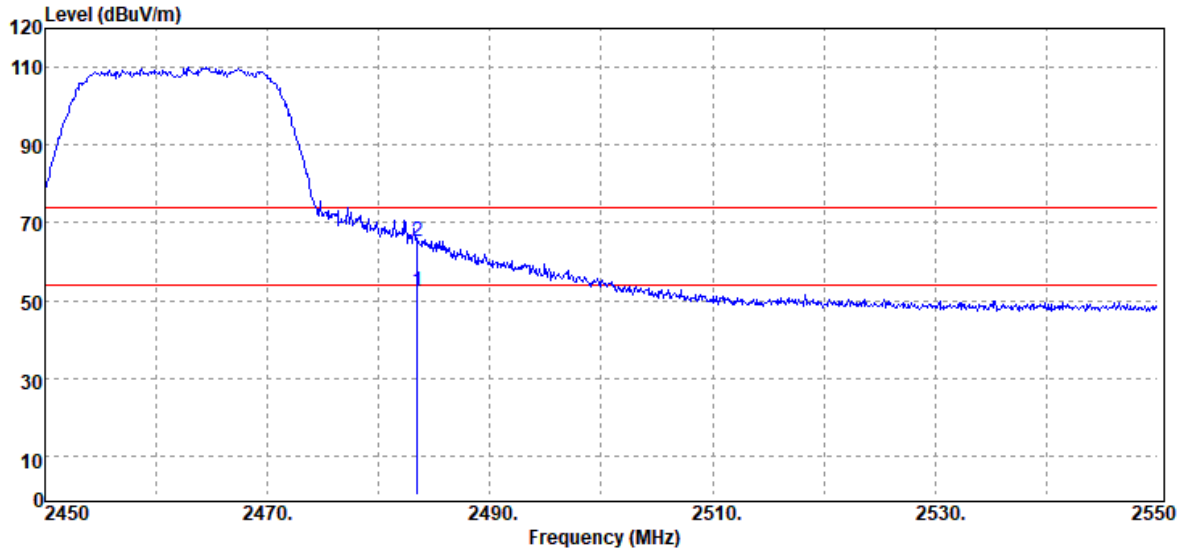
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2390.00	Average	56.27	-3.38	52.89	54.00	-1.11
2390.00	Peak	73.08	-3.38	69.70	74.00	-4.30

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	46.37	-2.83	43.54	54.00	-10.46
2483.50	Peak	60.41	-2.83	57.58	74.00	-16.42

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:BE CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		

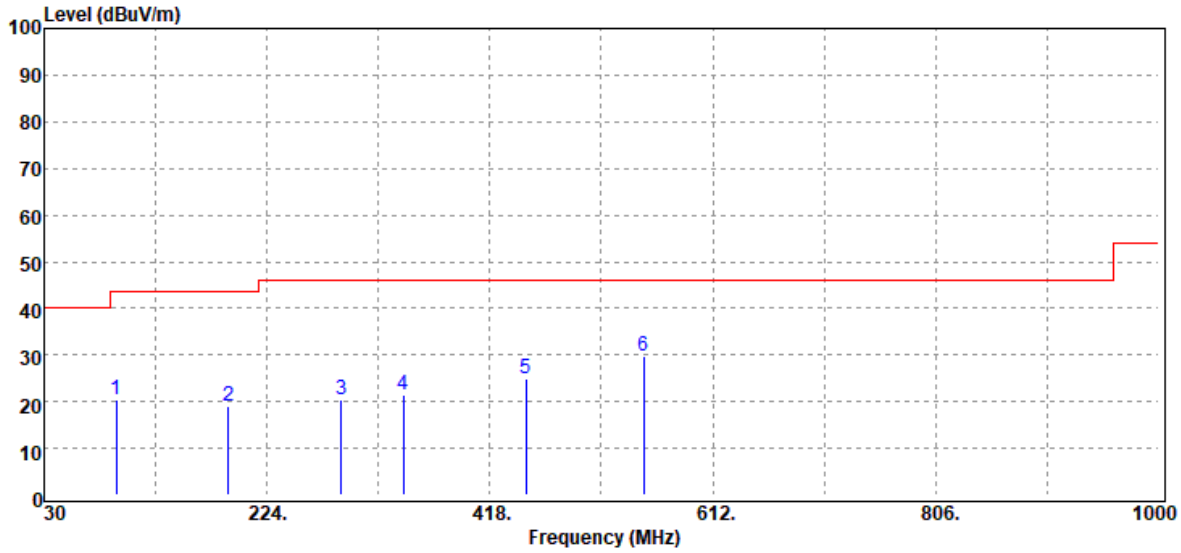


Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.50	Average	55.34	-2.83	52.51	54.00	-1.49
2483.50	Peak	68.21	-2.83	65.38	74.00	-8.62

Below 1GHz Worst-Case Data:

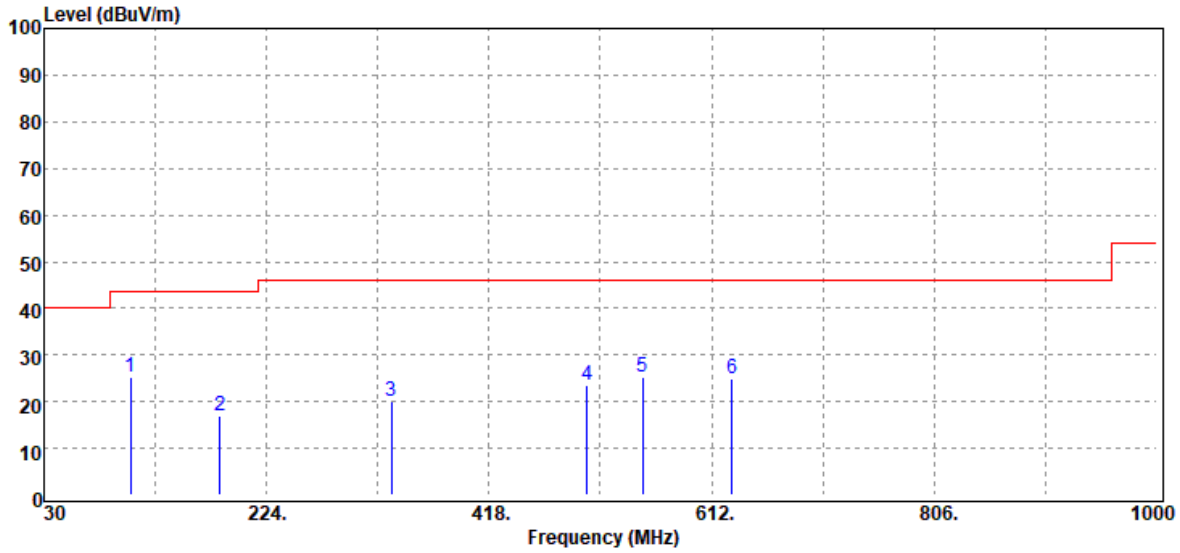
Radiated Spurious Emission Measurement Result

Project Number	:T190506W05	Test Date	:2019-05-22
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



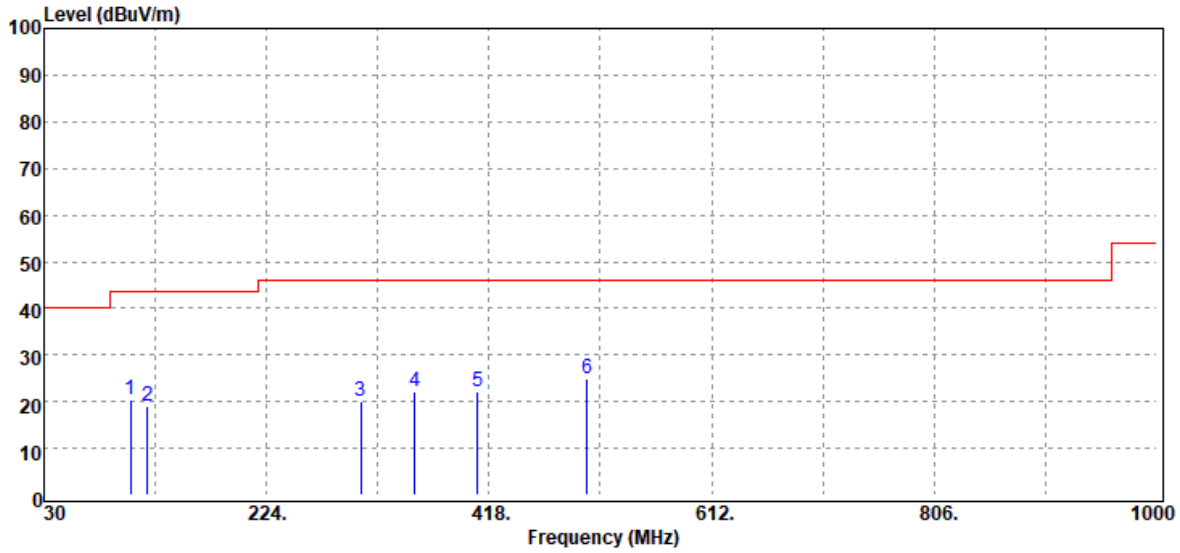
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
93.05	Peak	35.10	-14.62	20.48	43.50	-23.02
190.05	Peak	29.75	-10.77	18.98	43.50	-24.52
288.99	Peak	28.73	-8.36	20.37	46.00	-25.63
342.34	Peak	28.81	-7.19	21.62	46.00	-24.38
449.04	Peak	28.90	-3.88	25.02	46.00	-20.98
551.86	Peak	31.83	-2.22	29.61	46.00	-16.39

Project Number	:T190506W05	Test Date	:2019-05-22
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



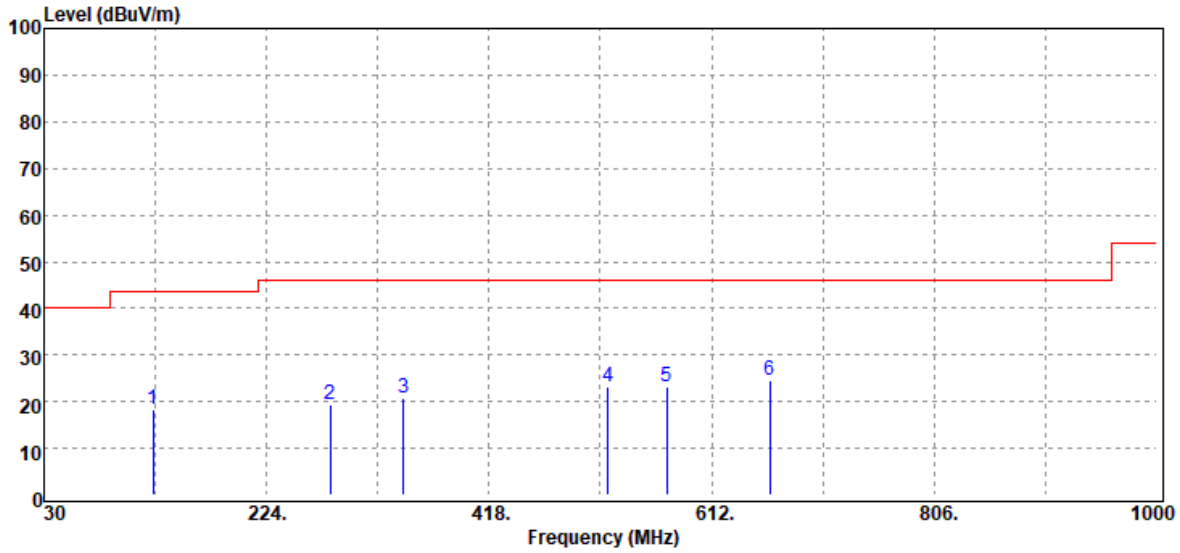
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
105.66	Peak	36.27	-11.02	25.25	43.50	-18.25
183.26	Peak	28.24	-11.23	17.01	43.50	-26.49
332.64	Peak	27.24	-7.17	20.07	46.00	-25.93
503.36	Peak	26.40	-3.03	23.37	46.00	-22.63
551.86	Peak	27.64	-2.22	25.42	46.00	-20.58
629.46	Peak	25.37	-0.54	24.83	46.00	-21.17

Project Number	:T190506W05	Test Date	:2019-05-22
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
105.66	Peak	31.47	-11.02	20.45	43.50	-23.05
120.21	Peak	27.92	-8.88	19.04	43.50	-24.46
306.45	Peak	28.18	-8.08	20.10	46.00	-25.90
353.01	Peak	29.01	-6.85	22.16	46.00	-23.84
408.30	Peak	27.57	-5.28	22.29	46.00	-23.71
503.36	Peak	27.99	-3.03	24.96	46.00	-21.04

Project Number	:T190506W05	Test Date	:2019-05-22
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		

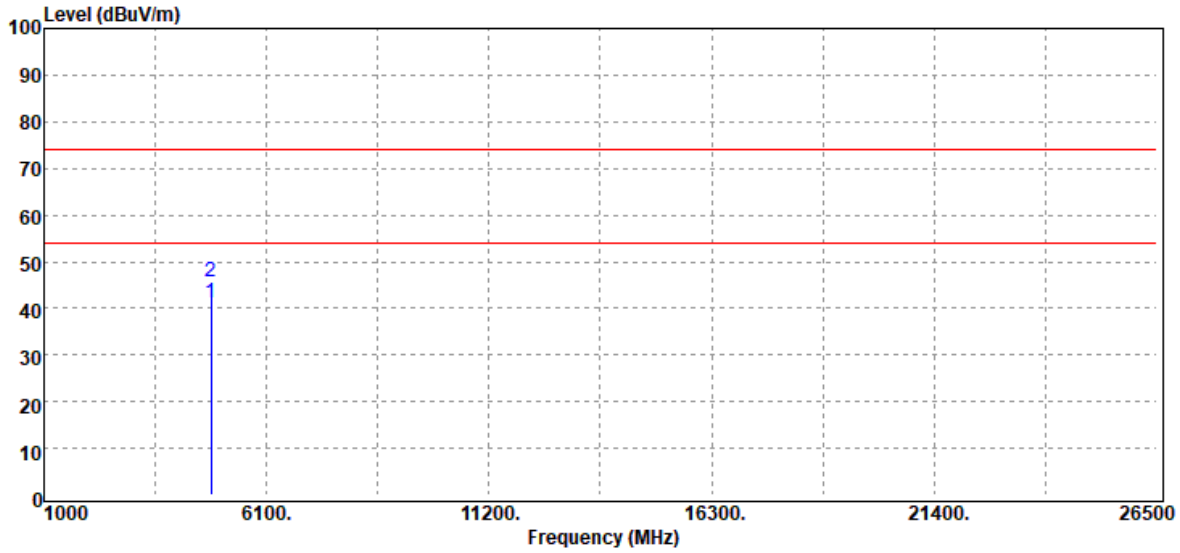


Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
125.06	Peak	27.09	-8.80	18.29	43.50	-25.21
279.29	Peak	27.89	-8.40	19.49	46.00	-26.51
343.31	Peak	28.01	-7.14	20.87	46.00	-25.13
521.79	Peak	25.45	-2.38	23.07	46.00	-22.93
573.20	Peak	24.98	-1.83	23.15	46.00	-22.85
662.44	Peak	24.46	0.01	24.47	46.00	-21.53

Above 1GHz Data:

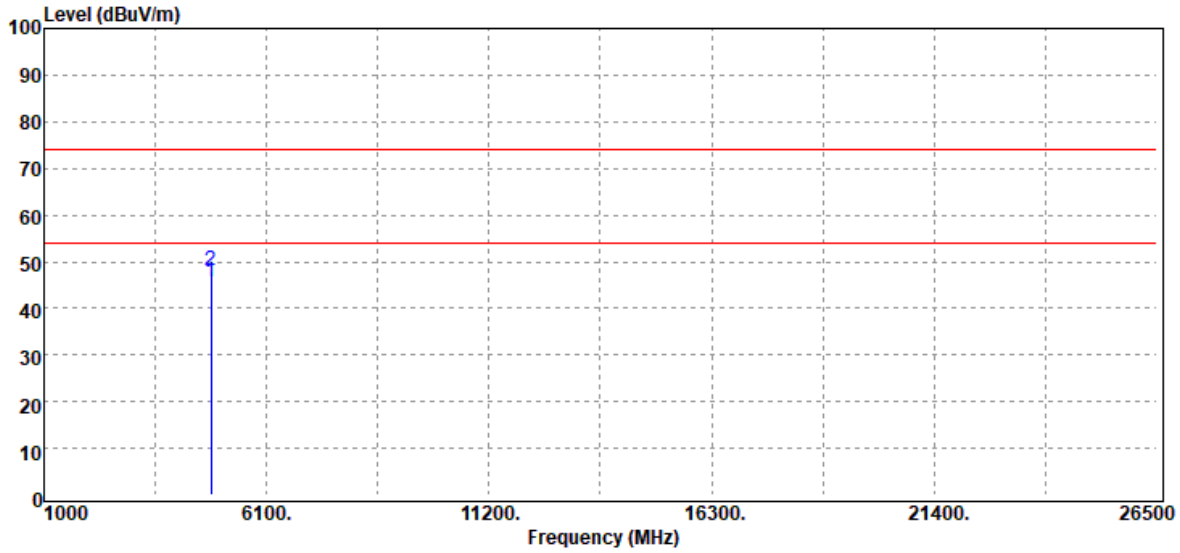
Radiated Spurious Emission Measurement Result

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



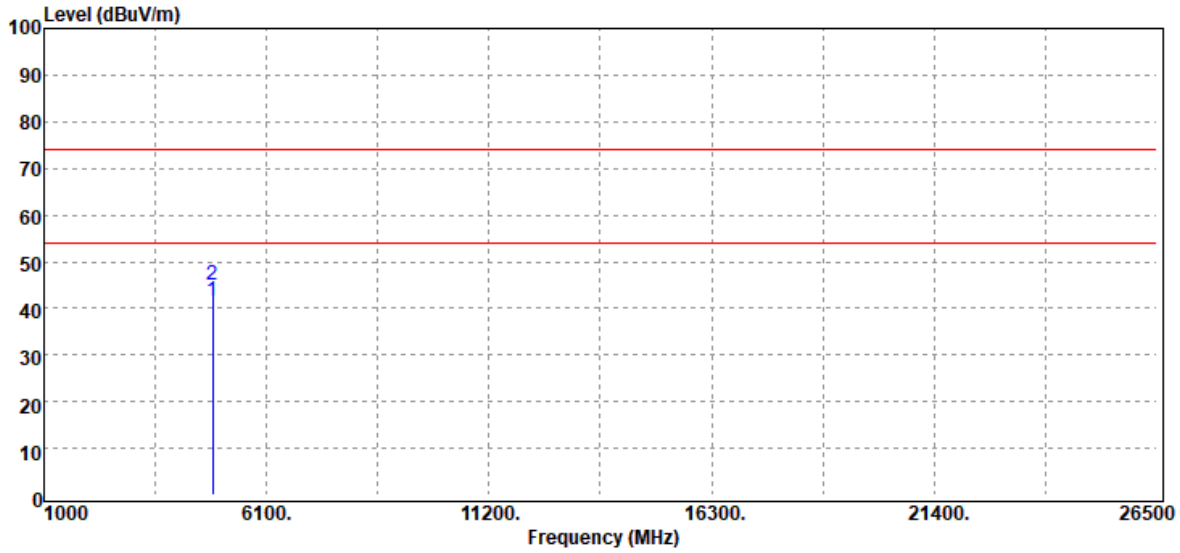
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	38.18	3.05	41.23	54.00	-12.77
4824.00	Peak	42.69	3.05	45.74	74.00	-28.26

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



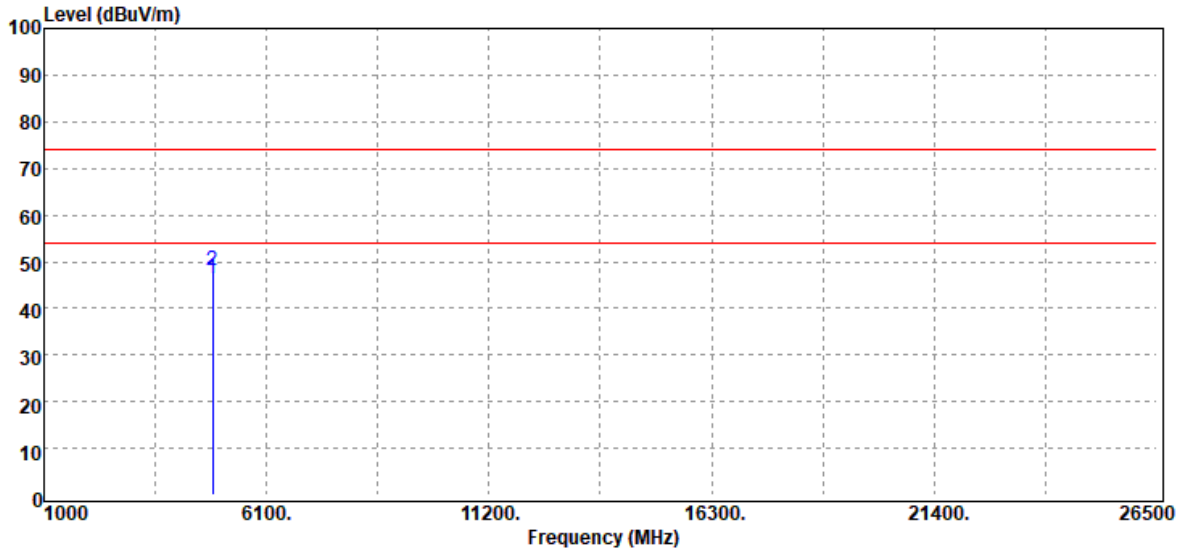
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	42.49	3.05	45.54	54.00	-8.46
4824.00	Peak	45.09	3.05	48.14	74.00	-25.86

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



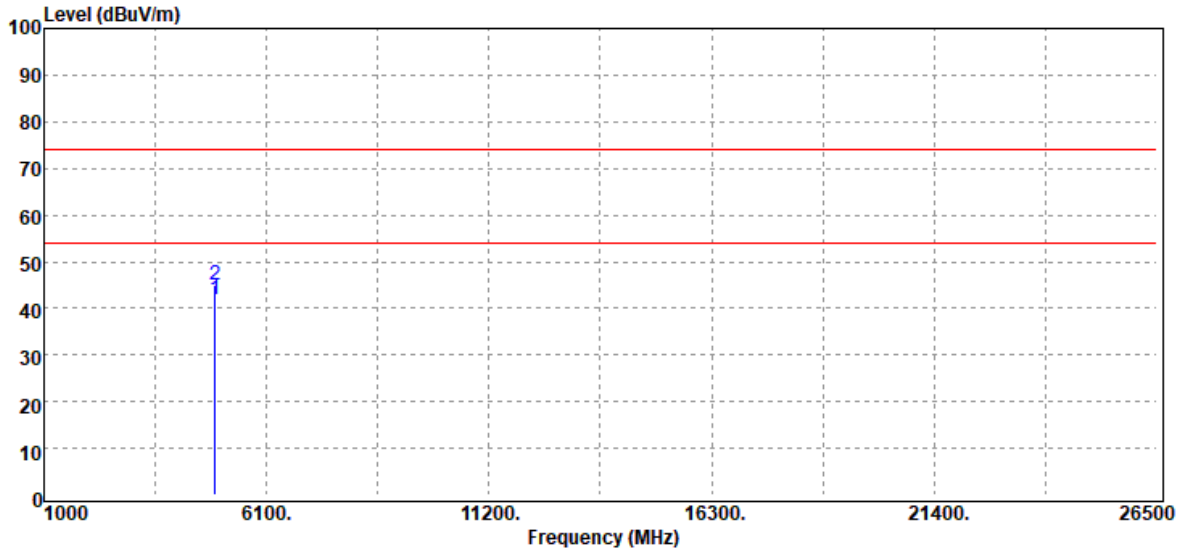
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	38.33	3.31	41.64	54.00	-12.36
4874.00	Peak	41.79	3.31	45.10	74.00	-28.90

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



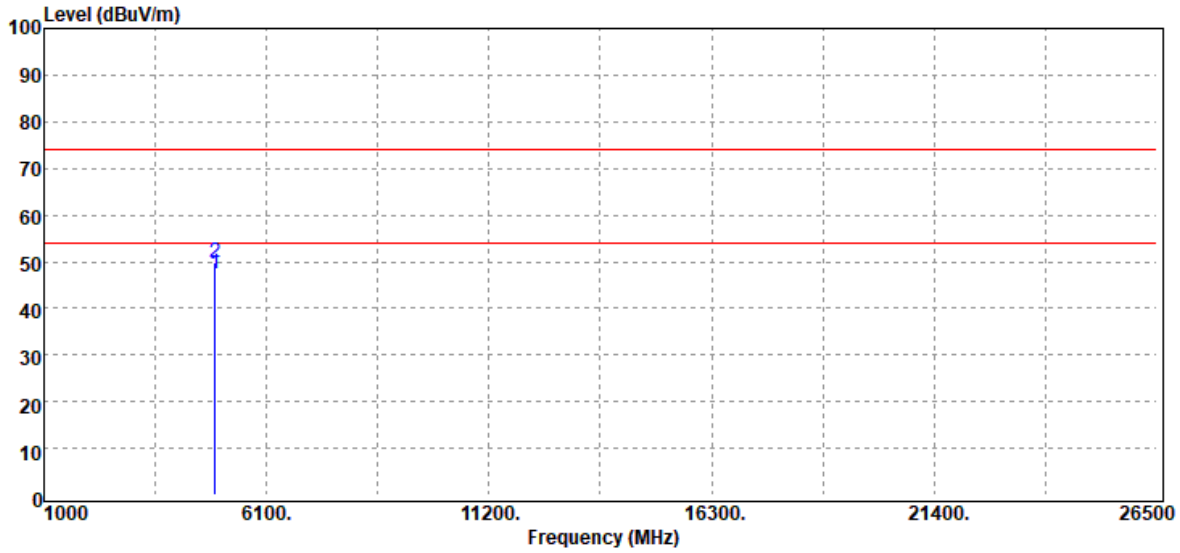
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	42.98	3.31	46.29	54.00	-7.71
4874.00	Peak	44.83	3.31	48.14	74.00	-25.86

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



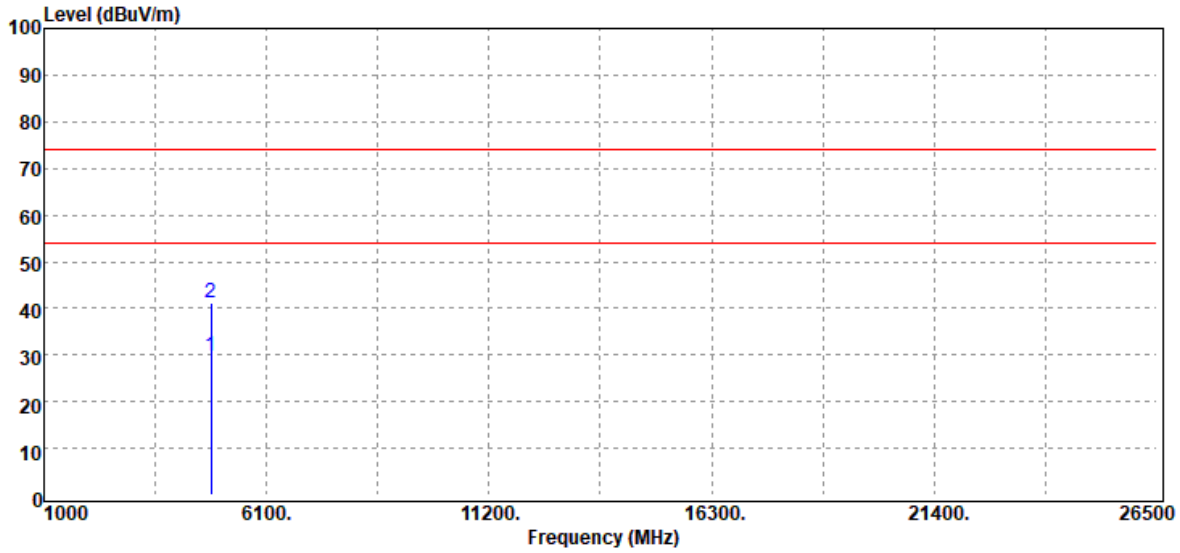
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	38.03	3.75	41.78	54.00	-12.22
4924.00	Peak	41.40	3.75	45.15	74.00	-28.85

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11b	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



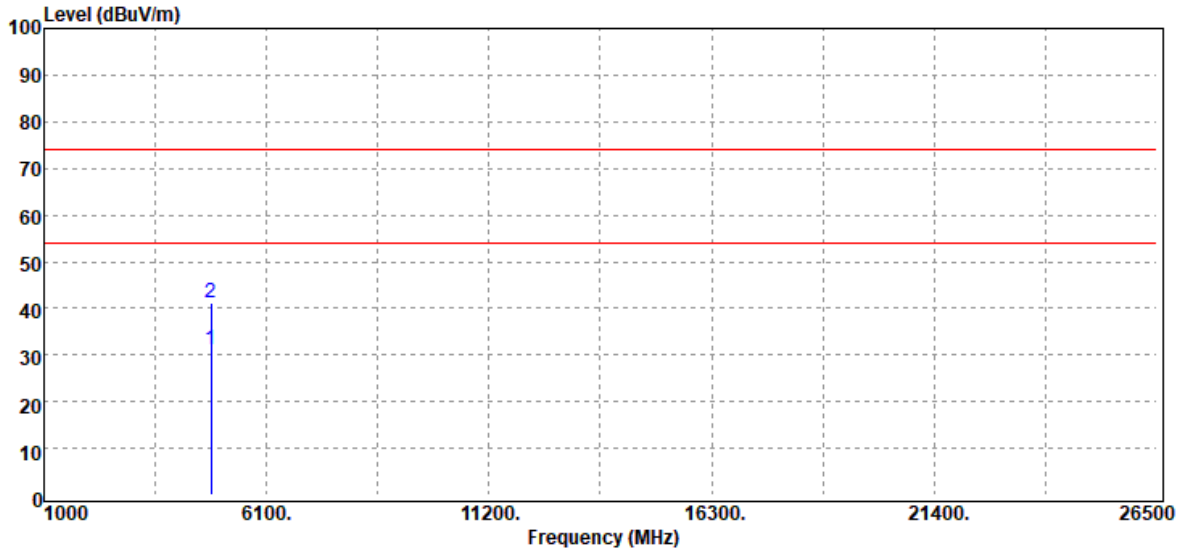
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	43.83	3.75	47.58	54.00	-6.42
4924.00	Peak	45.95	3.75	49.70	74.00	-24.30

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



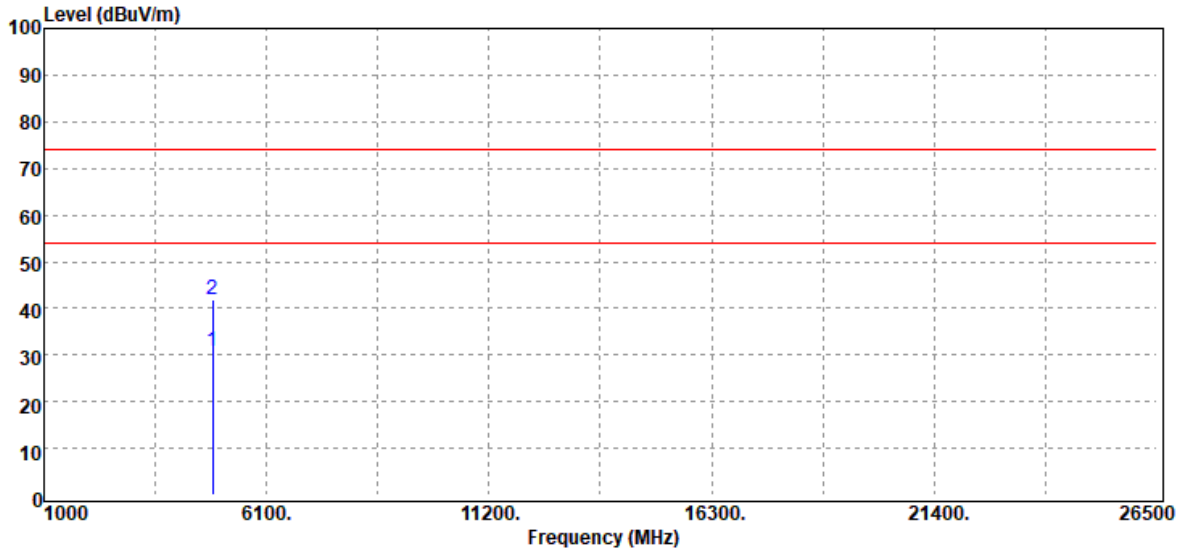
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	26.75	3.05	29.80	54.00	-24.20
4824.00	Peak	38.02	3.05	41.07	74.00	-32.93

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



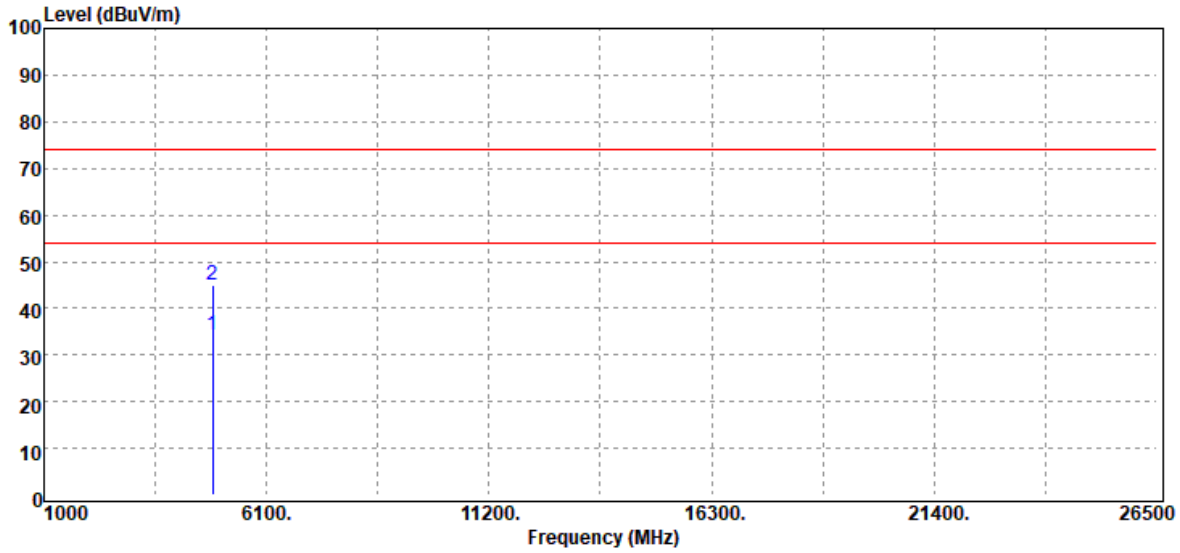
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	27.92	3.05	30.97	54.00	-23.03
4824.00	Peak	38.24	3.05	41.29	74.00	-32.71

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



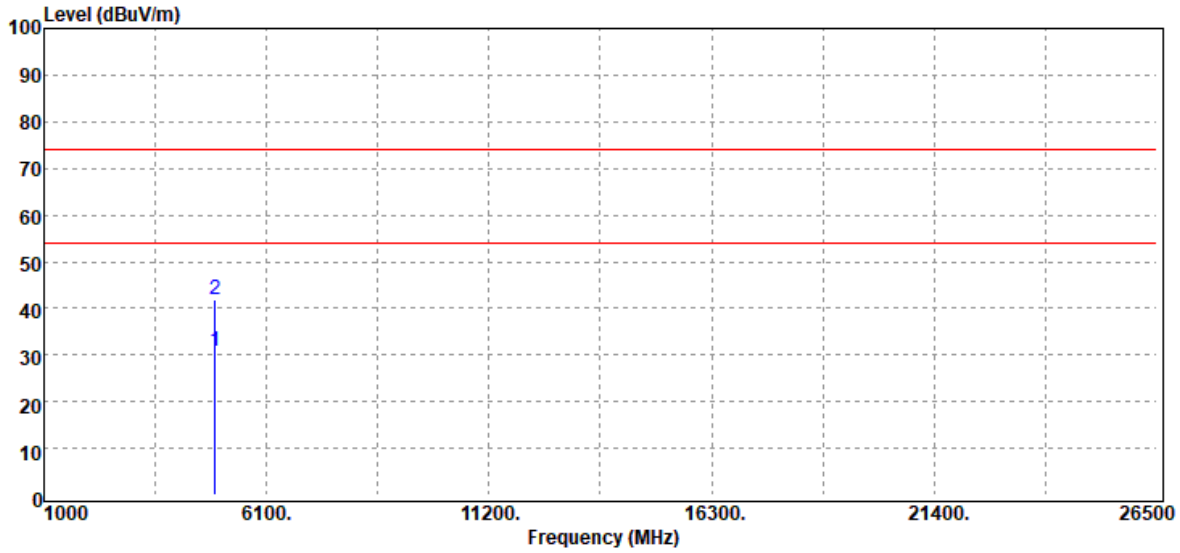
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	27.66	3.31	30.97	54.00	-23.03
4874.00	Peak	38.49	3.31	41.80	74.00	-32.20

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



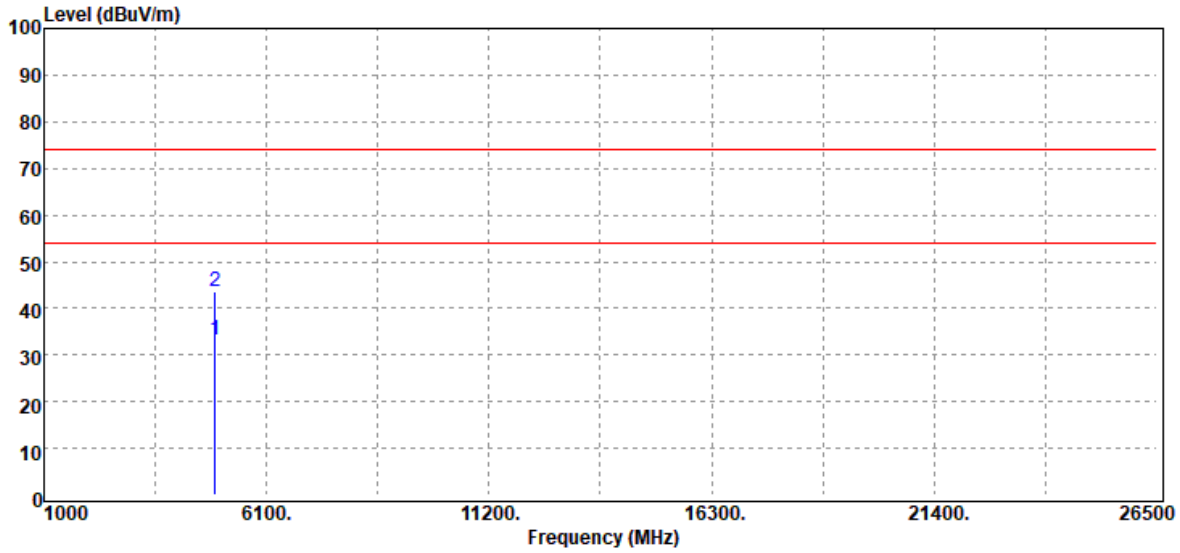
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	30.84	3.31	34.15	54.00	-19.85
4874.00	Peak	41.53	3.31	44.84	74.00	-29.16

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



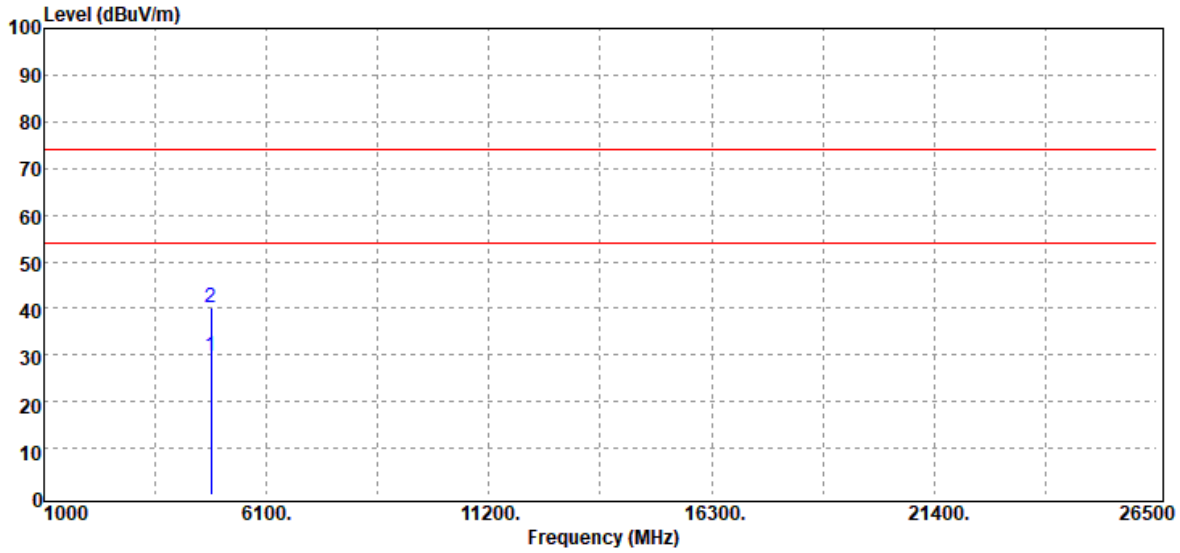
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	27.10	3.75	30.85	54.00	-23.15
4924.00	Peak	37.95	3.75	41.70	74.00	-32.30

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11g	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



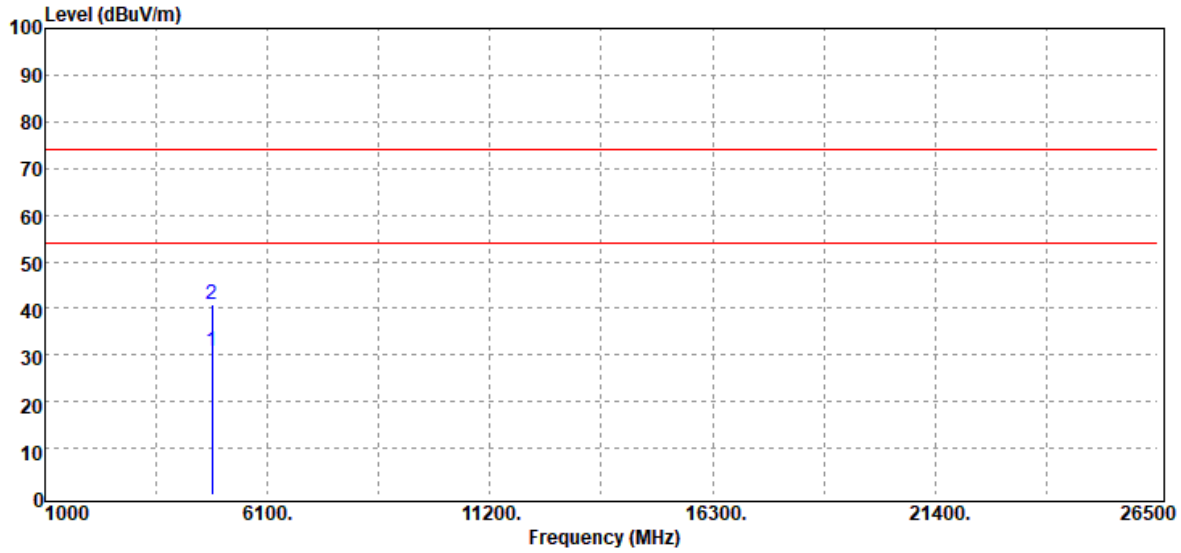
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	29.53	3.75	33.28	54.00	-20.72
4924.00	Peak	39.81	3.75	43.56	74.00	-30.44

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



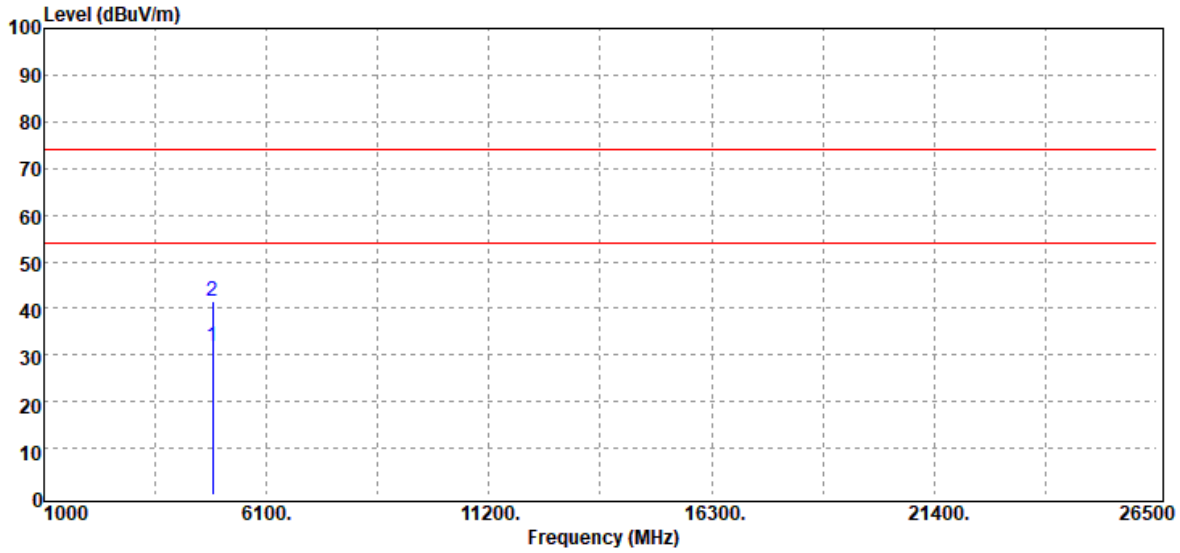
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	26.87	3.05	29.92	54.00	-24.08
4824.00	Peak	36.94	3.05	39.99	74.00	-34.01

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2412 MHz	Engineer	:Kane
Operation Mode	:Tx CH Low	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



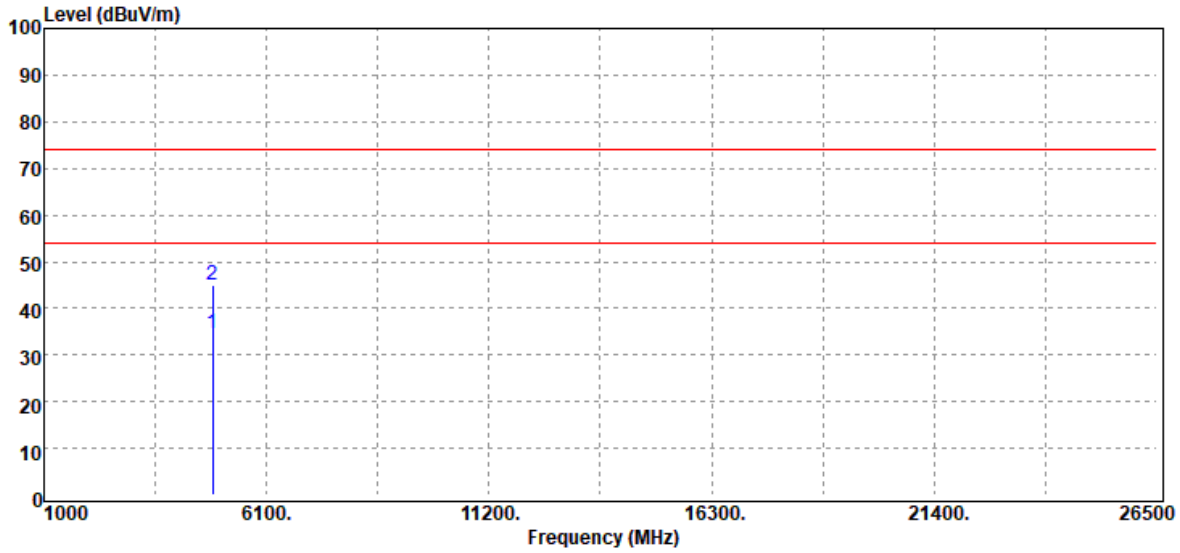
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4824.00	Average	27.60	3.05	30.65	54.00	-23.35
4824.00	Peak	37.81	3.05	40.86	74.00	-33.14

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



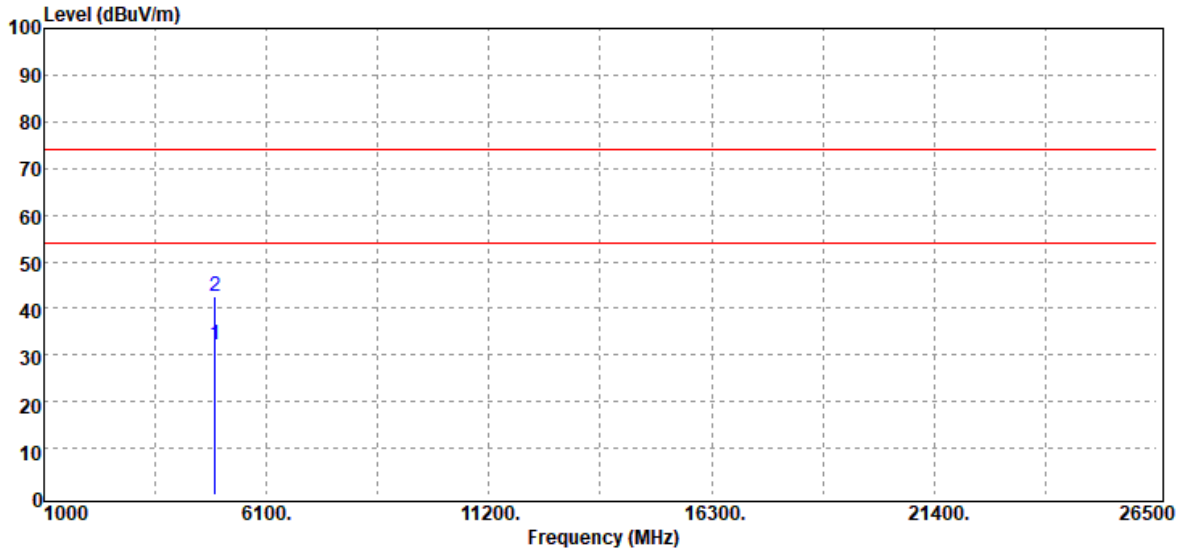
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	28.37	3.31	31.68	54.00	-22.32
4874.00	Peak	38.23	3.31	41.54	74.00	-32.46

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2437 MHz	Engineer	:Kane
Operation Mode	:Tx CH Mid	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



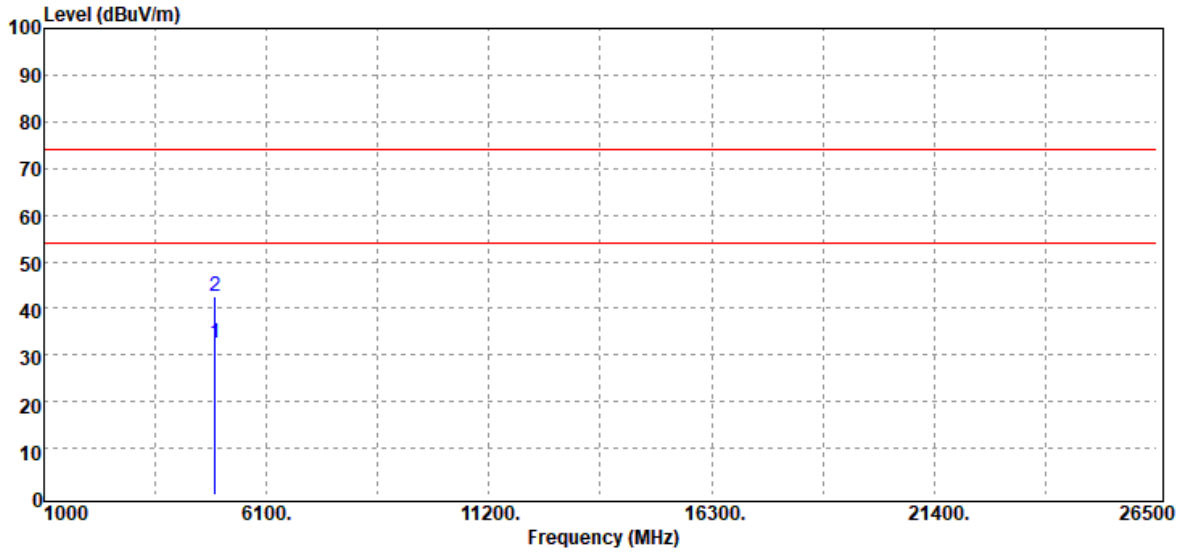
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4874.00	Average	31.13	3.31	34.44	54.00	-19.56
4874.00	Peak	41.76	3.31	45.07	74.00	-28.93

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:VERTICAL
EUT Pol.	:E2 Plan		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	28.27	3.75	32.02	54.00	-21.98
4924.00	Peak	38.70	3.75	42.45	74.00	-31.55

Project Number	:T190506W05	Test Date	:2019-05-14
Operation Band	:802.11n20	Temp./Humi.	:19/49
Fundamental Frequency	:2462 MHz	Engineer	:Kane
Operation Mode	:Tx CH High	Measurement Antenna Pol.	:HORIZONTAL
EUT Pol.	:E2 Plan		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
4924.00	Average	28.70	3.75	32.45	54.00	-21.55
4924.00	Peak	38.68	3.75	42.43	74.00	-31.57

12 POWER SPECTRAL DENSITY

12.1 Standard Applicable

Per Part 15.247 (e)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

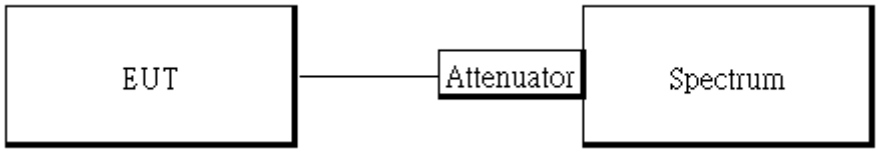
Per RSS-247 section 5.4 d

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

12.2 Measurement Equipment Used

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
DC Power Supply	Agilent	E3640A	KR93300208	08/15/2018	08/14/2019
Spectrum Analyzer	Agilent	N9010A	MY53400256	11/21/2018	11/20/2019
DC Power Supply	GWINSTEK	SPS-3610	GPE880163	01/14/2019	01/13/2020
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020
Attenuator	Mini-Circuit	BW-S10W2+	1	02/26/2019	02/25/2020

12.3 Test Set-up



12.4 Measurement Procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance & ANSI C63.10.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz. & the VBW = 10 kHz
5. For defining Restricted Band Edge Limit:
   Set the RBW = 100kHz & VBW = 300 kHz.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level.

As per FCC KDB 662911 D01

Unequal antenna gains, with equal transmit powers. For antenna gains given by G1, G2, …, GN dBi.

(i) If transmit signals are correlated, then Directional gain

$= 10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}]$ dBi

[Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.].

The antenna gain is not grater than 6 dBi. Therefore, reduction of power is not required.

12.5 Measurement Result

POWER DENSITY 802.11b_Ch0			
Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2412	-3.46	8.00	PASS
2437	-2.57	8.00	PASS
2462	-1.75	8.00	PASS

POWER DENSITY 802.11g_Ch0			
Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2412	-10.84	8.00	PASS
2437	-6.27	8.00	PASS
2462	-9.12	8.00	PASS

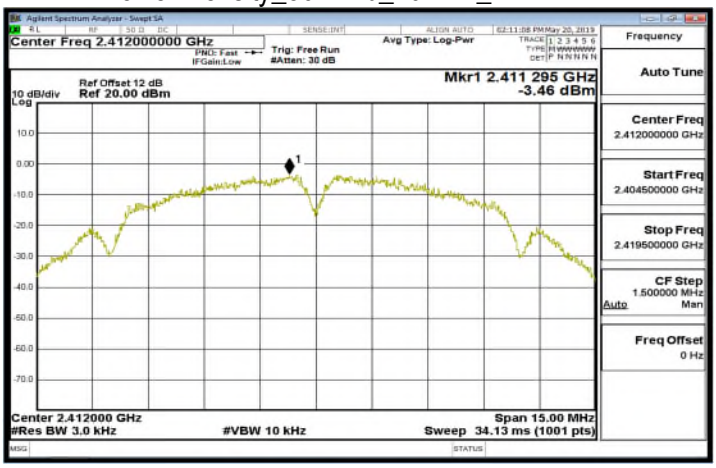
POWER DENSITY 802.11n HT20_Ch0			
Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2412	-9.80	5.20	PASS
2437	-6.73	5.20	PASS
2462	-7.81	5.20	PASS

Note

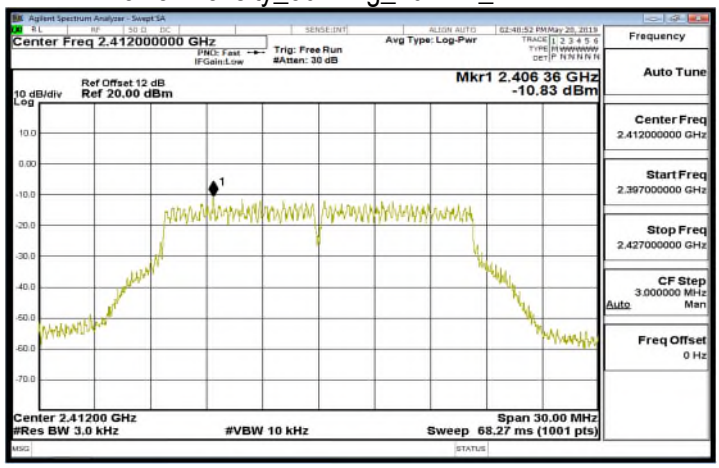
Cable Loss 12.00 dB

**Refer to next page for plots*

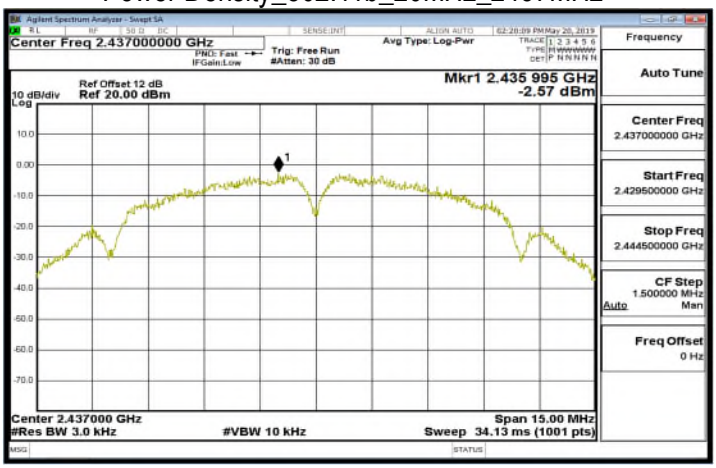
Power Density_802.11b_20MHz_2412MHz



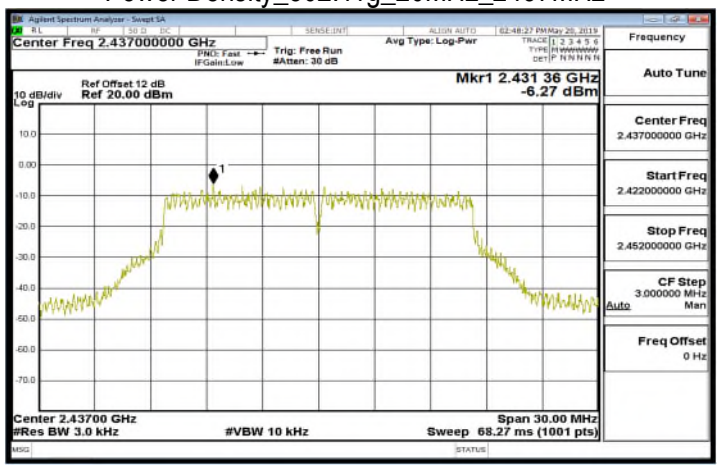
Power Density_802.11g_20MHz_2412MHz



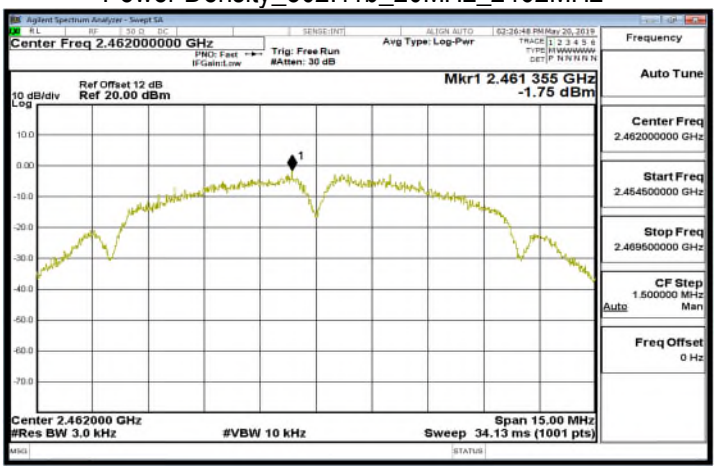
Power Density_802.11b_20MHz_2437MHz



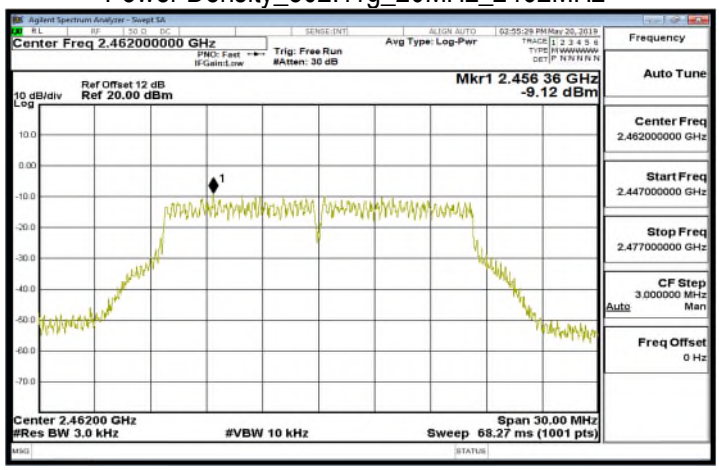
Power Density_802.11g_20MHz_2437MHz



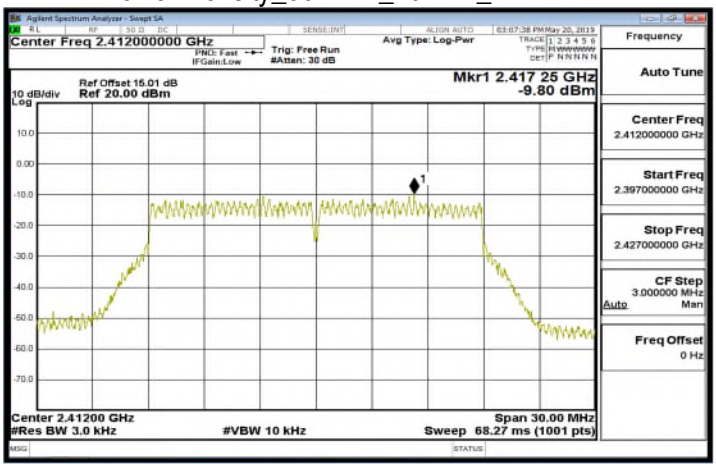
Power Density_802.11b_20MHz_2462MHz



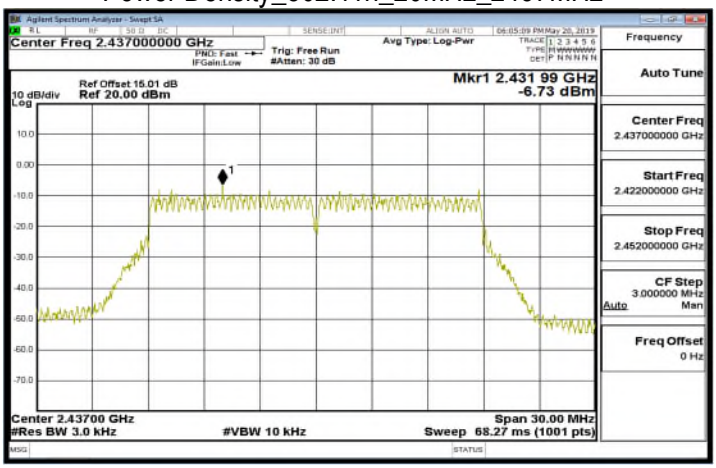
Power Density_802.11g_20MHz_2462MHz



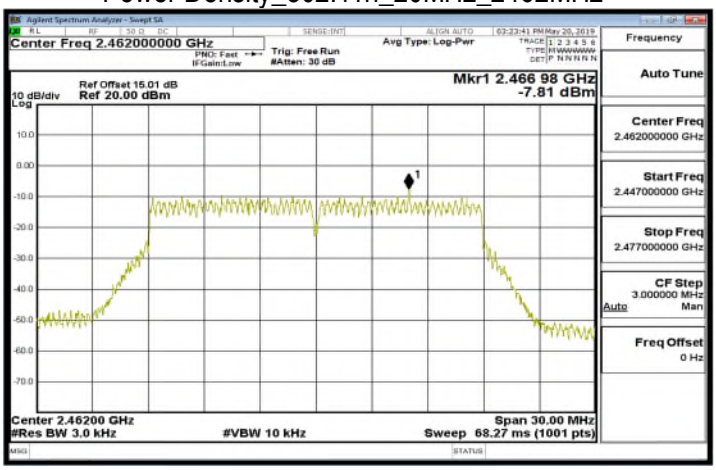
Power Density_802.11n_20MHz_2412MHz



Power Density_802.11n_20MHz_2437MHz



Power Density_802.11n_20MHz_2462MHz



13 ANTENNA REQUIREMENT

13.1 Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

13.2 Antenna Connected Construction

The antenna is designed with unique RF connector and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~