

FCC&ISED RF TEST REPORT

No. 170902301SHA-001

Applicant : Muuselabs NV
Rue du Tocsin 12, 1000 Brussels, Belgium

Manufacturing site : Hansong (Nanjing) Technology Ltd.
8th Kangping Road, Jiangning Economy and Technology
Development Zone, Nanjing, 211106, China.

Product Name : Wireless module

Type/Model : ML-MW01A

TEST RESULT : PASS

SUMMARY

The equipment complies with the requirements according to the following standard(s) or specification:

47CFR Part 15 (2016): Radio Frequency Devices (Subpart C)

ANSI C63.10 (2013): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

RSS-247 Issue 2 (February 2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 4 (November 2014): General Requirements for Compliance of Radio Apparatus

Date of issue: December 5, 2017

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1 GENERAL INFORMATION

1.1 Description of Client

Applicant : Muuselabs NV
Rue du Tocsin 12, 1000 Brussels, Belgium
Name of contact : Mr Theodore Marescaux
Tel : +32 495 89 07 74
Fax : /
Manufacturing site : Hansong (Nanjing) Technology Ltd.
8th Kangping Road, Jiangning Economy and Technology
Development Zone, Nanjing, 211106, China.

1.2 Identification of the EUT

Product Name : Wireless module
Type/model : ML-MW01A
FCC ID : 2ANI9-MW01A
IC : 23121-MW01A

1.3 Technical Specification

Operation Frequency	: 2400~2483.5 MHz
Band	
Type of Modulation	: DBPSK, DQPSK, CCK, BPSK, QPSK, 16-QAM, 64-QAM
EUT Modes of Modulation	: 802.11b, 802.11g, 802.11n(HT20)
Channel Number	: 11Channels for 802.11b, 802.11g and 802.11n(HT20)
Description of EUT	: The EUT is a wireless module which support 2.4GHz WIFI and Bluetooth 4.1 technology, there have only one mode, we tested it and listed the WIFI result in this report.
Antenna	: 1: External PCB antenna, 2.0dBi Peak gain 2: Internal PCB antenna, 2.0dBi Peak gain
Rating	: DC 3.3V
Category of EUT	: Class B
EUT type	: ☒ Table top ☐ Floor standing
Sample received date	: October 11, 2017
Date of test	: October 11, 2017 to October 28, 2017

Antenna Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The EUT used a print internal PCB antenna or used a no-standard electrical connector for an external antenna, so fulfill these requirements.

2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2016)
ANSI C63.10 (2013)
RSS-247 Issue 2 (February 2017)
RSS-Gen Issue 4 (November 2014)
KDB 558074 (v04)

2.2 Mode of operation during the test

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

The lowest, middle and highest channel were tested as representatives.

Frequency Band (MHz)	Mode	Lowest (MHz)	Middle (MHz)	Highest (MHz)
2400-2483.5	802.11b	2412	2437	2462
	802.11g	2412	2437	2462
	802.11n(HT20)	2412	2437	2462

Data rate VS Power:

The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases. After this pre-scan, we choose the following table of the data rate as the worst case.

Frequency Band (MHz)	Mode	Worst case data rate
2400-2483.5	802.11b	1Mbps
	802.11g	6Mbps
	802.11n(HT20)	MCS0

The EUT will use two types antenna, and there have the following test mode:

Radiated test mode:

Mode 1: EUT transmitted signal with internal antenna;

Mode 2: EUT transmitted signal with external antenna;

Conducted test mode:

Mode 3: EUT transmitted signal from RF port connected to SPA directly;

We have verified all test modes, and choose the worst mode 1 for radiated test and mode 3 for conducted test as representatively to list the results in this report.

2.3 Test software list

Test Items	Software	Manufacturer	Version
Conducted emission	ESxS-K1	R&S	V2.1.0
Radiated emission	ES-K1	R&S	V1.71

2.4 Test peripherals list

Item No.	Name	Band and Model	Description
1	Laptop computer	HP ProBook 6470b	100-240V AC, 50/60Hz

2.5 Instrument list

Conducted Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Test Receiver	R&S	ESCS 30	EC 2107	2018-10-18
☒	A.M.N.	R&S	ESH2-Z5	EC 3119	2017-12-01
☒	Shielded room	Zhongyu	-	EC 2838	2018-01-08
Radiated Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Test Receiver	R&S	ESIB 26	EC 3045	2018-10-18
☒	Bilog Antenna	TESEQ	CBL 6112D	EC 4206	2018-05-30
☒	Horn antenna	R&S	HF 906	EC 3049	2018-09-22
☒	Horn antenna	ETS	3117	EC 4792-1	2018-08-23
☒	Horn antenna	TOYO	HAP18-26W	EC 4792-3	2020-07-09
☒	Pre-amplifier	R&S	Pre-amp 18	EC5881	2018-06-19
☒	Semi-anechoic chamber	Albatross project	-	EC 3048	2018-09-08
RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2018-09-10
☒	Power sensor	Agilent	U2021XA	EC 5338-1	2018-03-03
☒	Vector Signal Generator	Agilent	N5182B	EC 5175	2018-03-06
☒	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2018-03-03
☒	Mobile Test System	Litepoint	lqxl	EC 5176	2018-01-11
☒	Test Receiver	R&S	ESCI 7	EC 4501	2018-02-23
Additional instrument					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☒	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3323	2018-06-14
☒	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3324	2018-04-09
☒	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3325	2018-03-23
☒	Pressure meter	YM3	Shanghai Mengde	EC 3320	2018-06-28

2.6 Test Summary

This report applies to tested sample only. The test results have been compared directly with the limits, and the measurement uncertainty is recorded. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERENCE	IC REFERENCE	RESULT
Minimum 6dB Bandwidth & Occupied bandwidth	15.247(a)(2)	RSS-247 Issue 2 Clause 5.2	Pass
Maximum peak output power	15.247(b)	RSS-247 Issue 2 Clause 5.4	Pass
Power spectrum density	15.247(e)	RSS-247 Issue 2 Clause 5.2	Pass
Radiated emission	15.205 & 15.209	RSS-247 Issue 2 Clause 5.5	Pass
Emission outside the frequency band	15.247(d)	RSS-Gen Issue 4 Clause 8.9	Pass
Power line conducted emission	15.207	RSS-Gen Issue 4 Clause 8.8	Pass
Occupied bandwidth	-	RSS-Gen Issue 4 Clause 6.6	Tested

Notes: 1: NA =Not Applicable

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2.7 Measurement uncertainty

The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Test item	Measurement uncertainty
Maximum peak output power	$\pm 0.74\text{dB}$
Radiated Emissions in restricted frequency bands below 1GHz	$\pm 4.90\text{dB}$
Radiated Emissions in restricted frequency bands above 1GHz	$\pm 5.02\text{dB}$
Emission outside the frequency band	$\pm 2.89\text{dB}$
Power line conducted emission	$\pm 3.19\text{dB}$

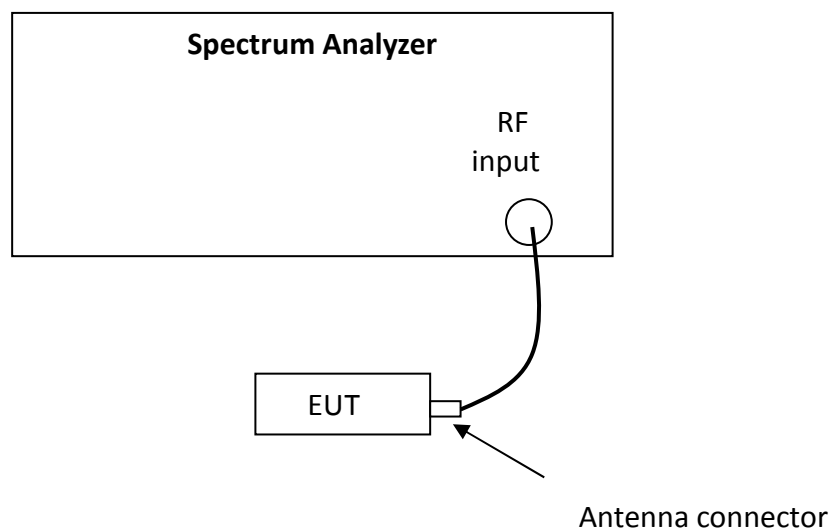
3 Minimum 6dB Bandwidth

Test result: Pass

3.1 Limit

For systems using digital modulation techniques that may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz bands, the minimum 6 dB bandwidth shall be at least 500 kHz.

3.2 Test Configuration



3.3 Test Procedure and test setup

The minimum 6dB bandwidth per FCC §15.247(a)(2) is measured using the Spectrum Analyzer according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance" for compliance to FCC 47CFR 15.247 requirements (clause 8.2).

- a) Set RBW = 100 kHz.
- b) Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- c) Detector = Peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

3.4 Test Protocol

Temperature: 25 °C
Relative Humidity: 55 %

Mode	Channel	Minimum 6dB Bandwidth (MHz)	Limits (MHz)
802.11b	L	8.087	> 0.5
	M	9.041	> 0.5
	H	9.012	> 0.5
802.11g	L	15.136	> 0.5
	M	15.158	> 0.5
	H	15.138	> 0.5
802.11n (HT20)	L	15.116	> 0.5
	M	15.153	> 0.5
	H	15.137	> 0.5

Test Plots:

802.11b-2412MHz



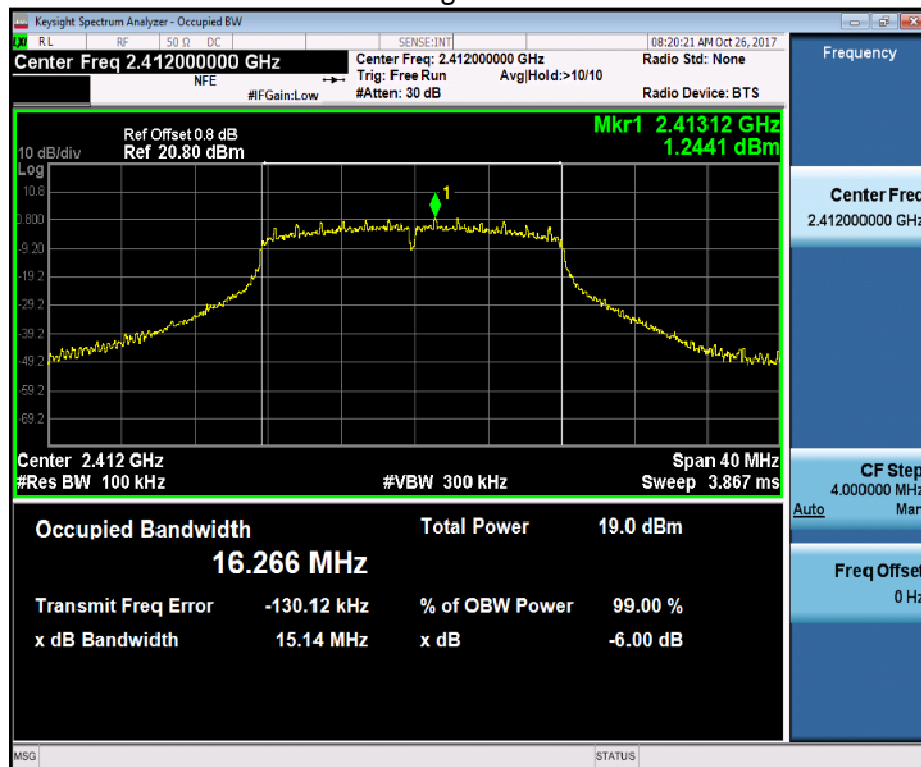
802.11b-2437MHz



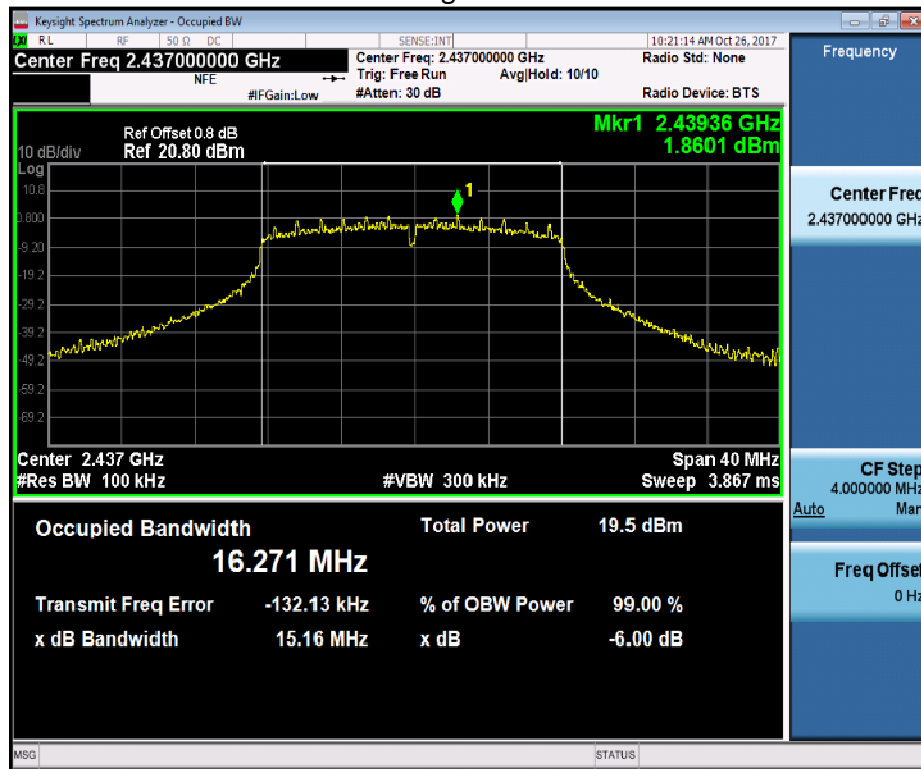
802.11b-2462MHz



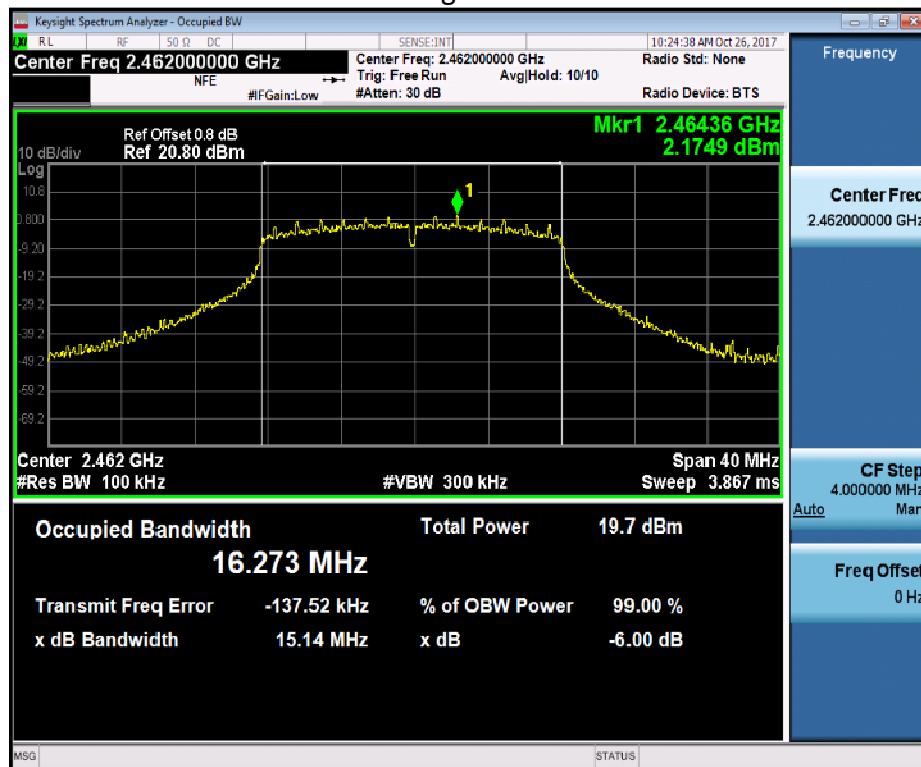
802.11g-2412MHz



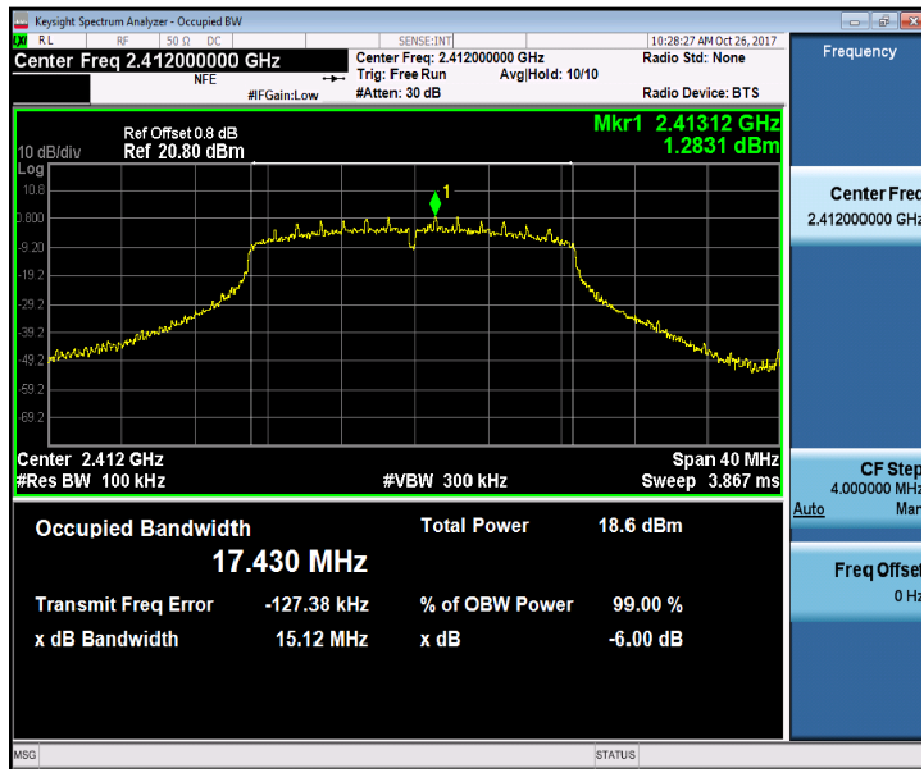
802.11g-2437MHz



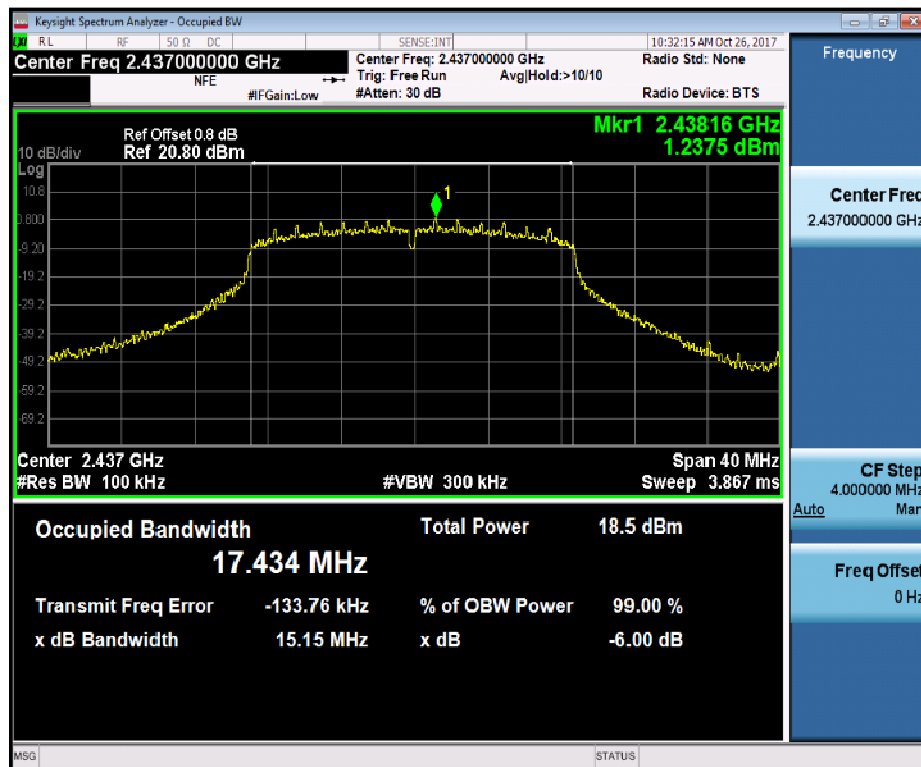
802.11g-2462MHz



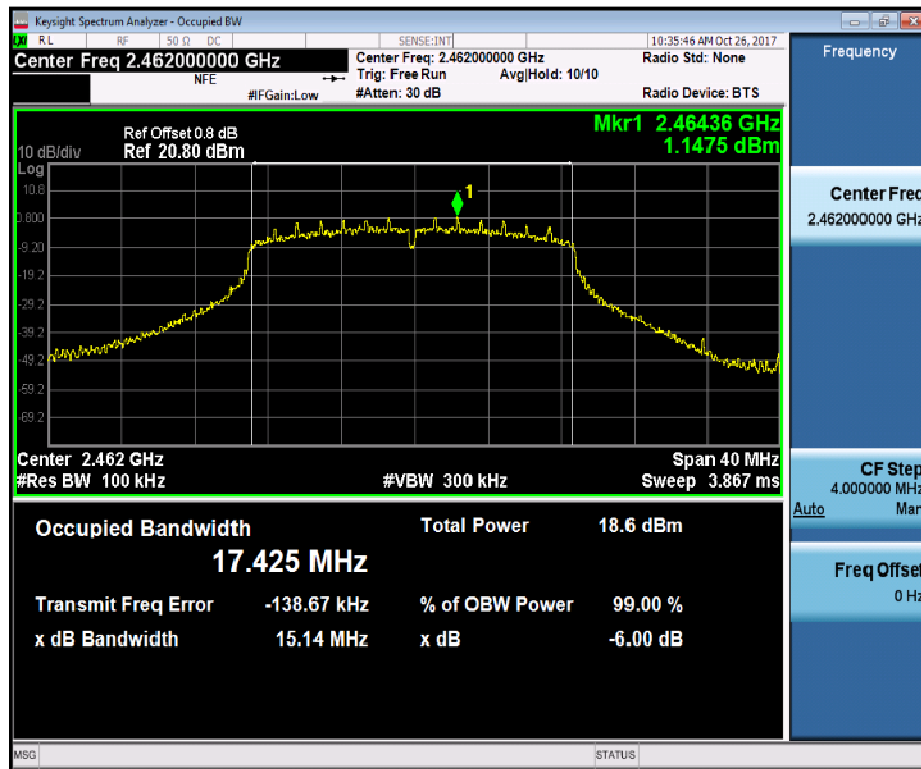
802.11n20-2412MHz



802.11n20-2437MHz



802.11n20-2462MHz



4 Maximum Conducted Output power

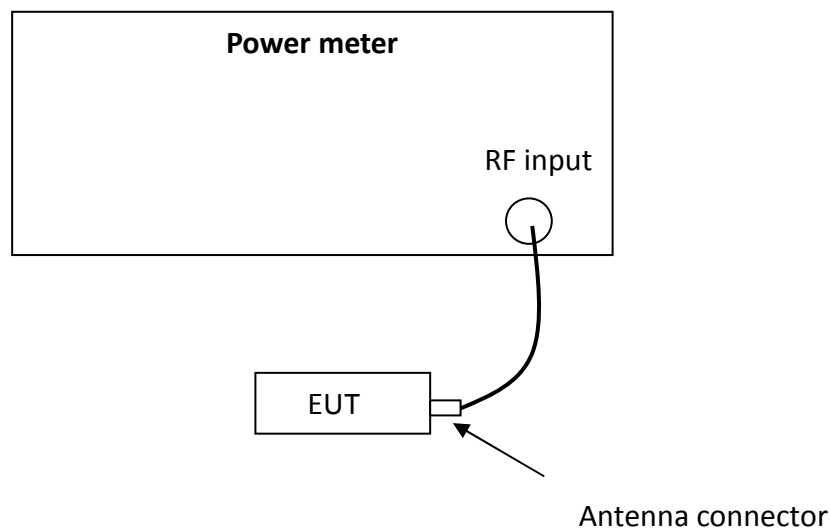
Test result: Pass

4.1 Test limit

- ☐ For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt
- ☐ For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts
- ☒ For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt and the e.i.r.p. shall not exceed 4 W.

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. If there have a beam forming type, the limit should be the minimum of 30dBm and 30+ (6 –antenna gain-beam forming gain).

4.2 Test Configuration



4.3 Test procedure and test setup

The EUT was tested according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance" for compliance to FCC 47CFR 15.247 requirements (9.2.2.4 Method AVGSA-2 (trace averaging across on- and off-times of the EUT transmissions, followed by duty cycle correction)).

4.4 Test protocol

Temperature: 25 °C

Relative Humidity: 55 %

Mode	Channel	Duty Cycle (%)	Factor (dB)	Corrected Reading (dBm)	Max Output Power (dBm)	Limit (dBm)	Result
802.11b	L	98.93	0.05	11.50	11.55	30.00	Pass
	M	98.93	0.05	11.55	11.60	30.00	Pass
	H	98.85	0.05	11.68	11.73	30.00	Pass
802.11g	L	93.45	0.29	11.77	12.06	30.00	Pass
	M	93.45	0.29	12.21	12.50	30.00	Pass
	H	93.48	0.29	12.53	12.82	30.00	Pass
802.11n (HT20)	L	92.59	0.33	11.20	11.53	30.00	Pass
	M	93.02	0.31	11.26	11.57	30.00	Pass
	H	93.06	0.31	11.21	11.52	30.00	Pass

NOTE:

$\text{Max Output Power (dBm)} = \text{Corrected Reading (dBm)} + \text{Factor (dB)}$;

$\text{Factor (dB)} = 10 * \log (1/\text{duty cycle (\%)} / 100)$.

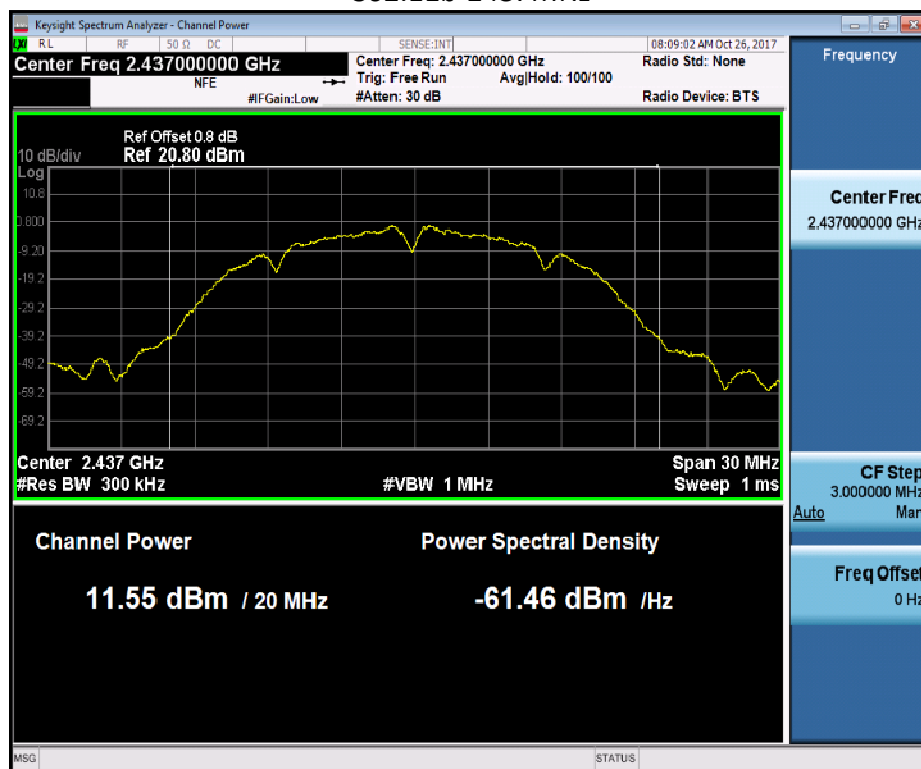
Conclusion: The maximum EIRP = 12.82dBm+2.0dBi = 14.82dBm = 0.030W which is lower than the limit of 4W listed in RSS-247.

Test Plots:

802.11b-2412MHz



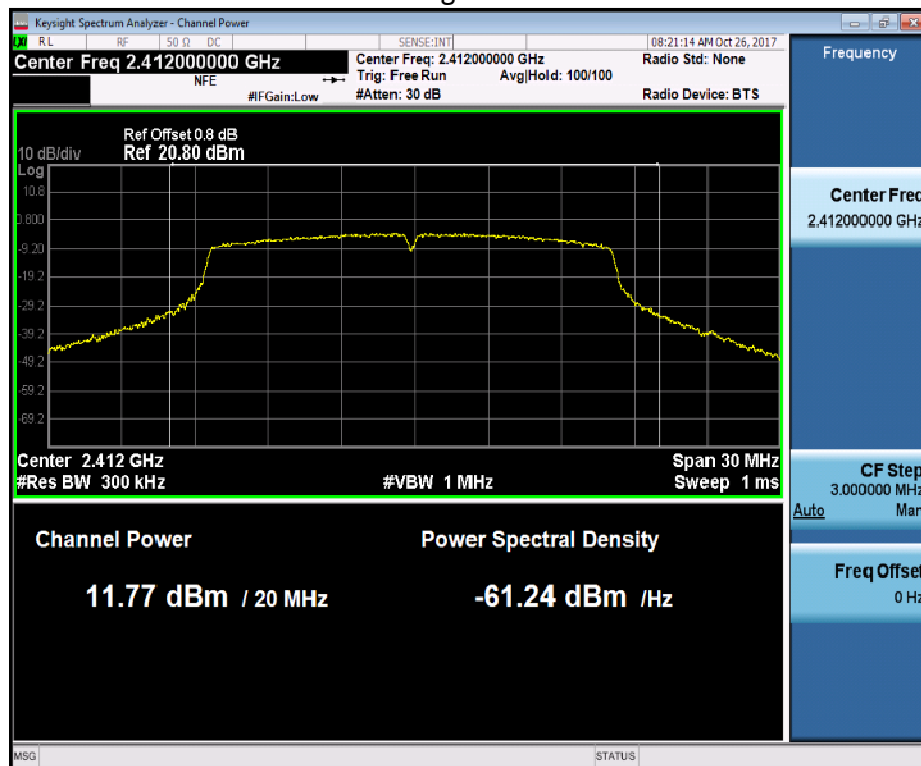
802.11b-2437MHz



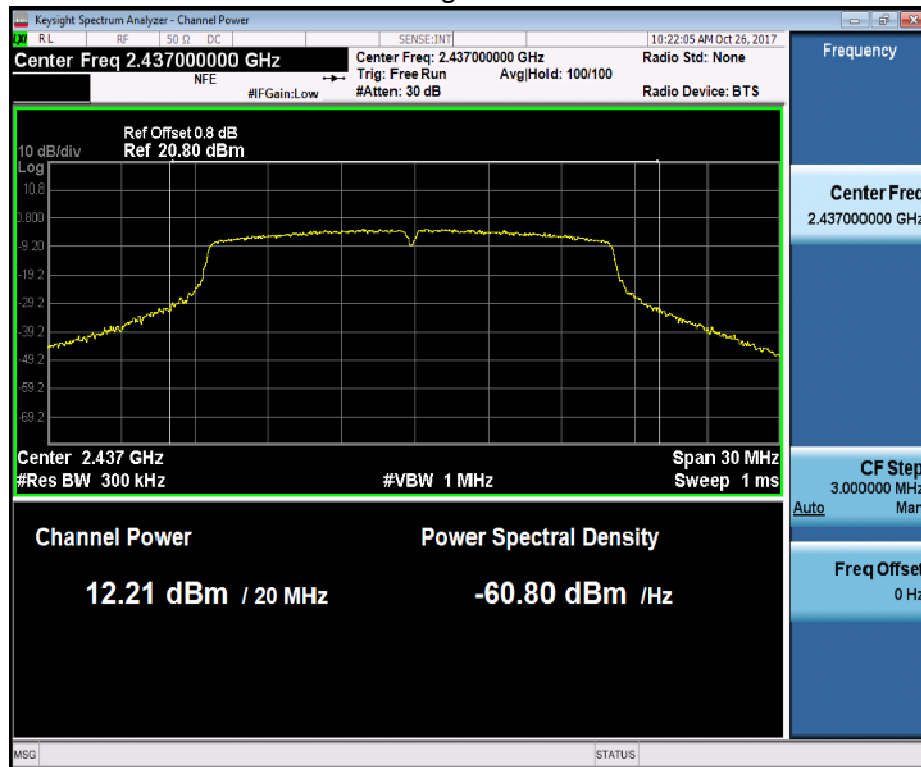
802.11b-2462MHz



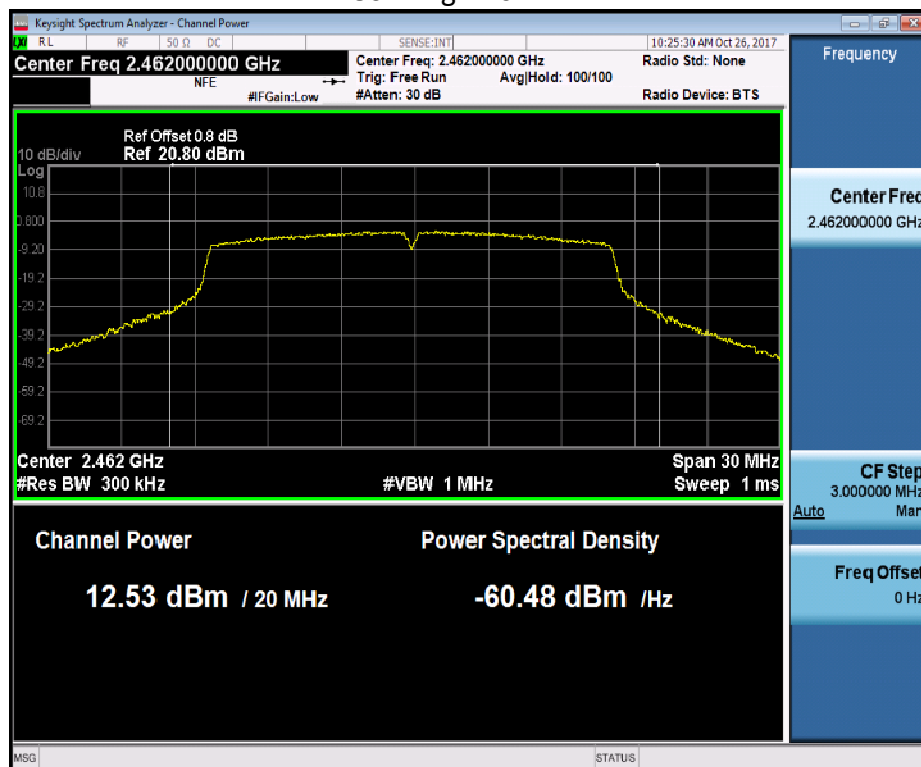
802.11g-2412MHz



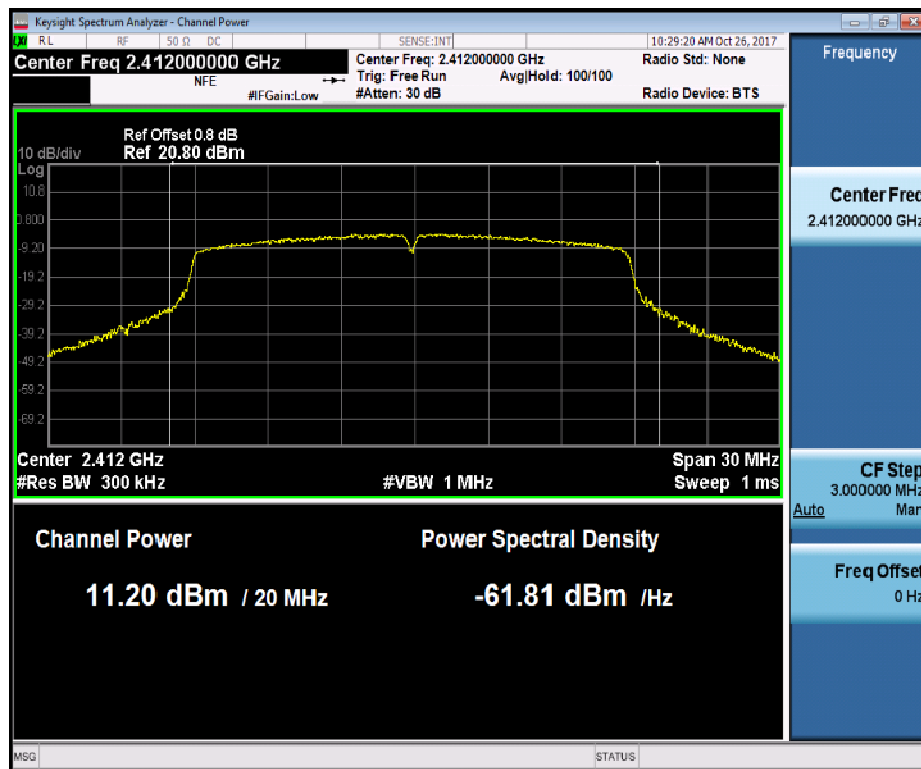
802.11g-2437MHz



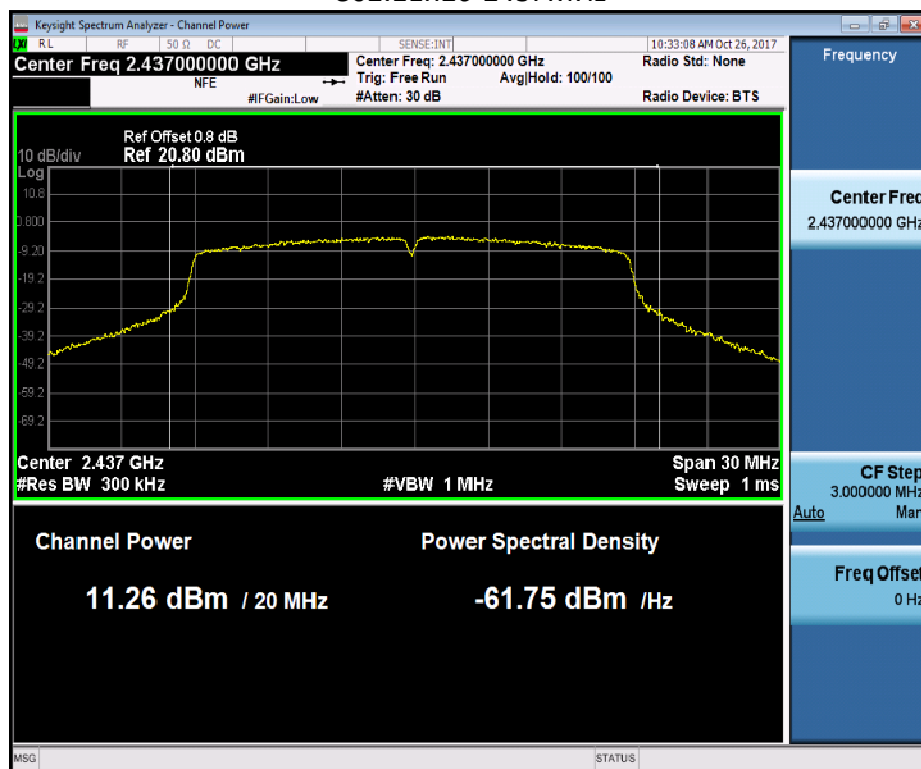
802.11g-2462MHz



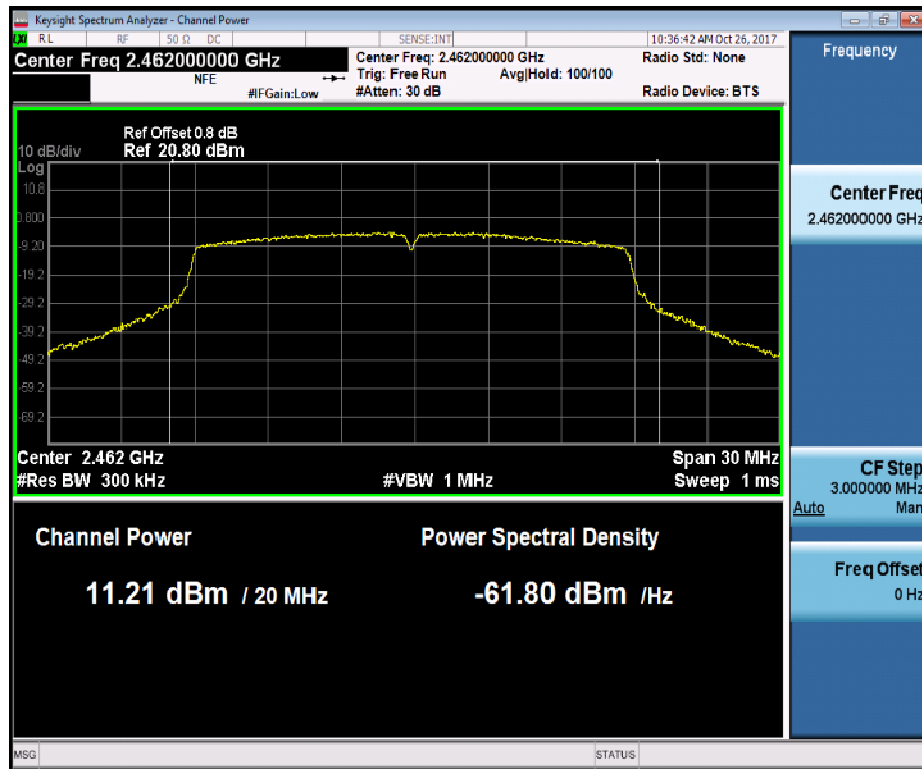
802.11n20-2412MHz



802.11n20-2437MHz



802.11n20-2462MHz



5 Power spectrum density

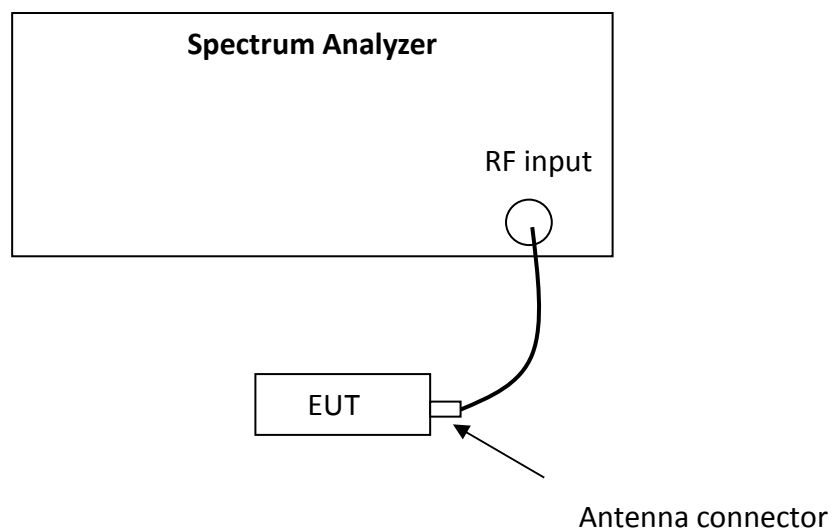
Test result:Pass

5.1 Test limit

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

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. If there have a beam forming type, the limit should be the minimum of 8dBm/3kHz and $8 + (6 - \text{antenna gain} - \text{beam forming gain})$.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC §15.247(e) was tested according to DTS test procedure of “KDB558074 D01 DTS Meas Guidance” (clause 10.5 Method AVGPDS-2 (trace averaging across on- and off-times of the EUT transmissions, followed by duty cycle correction)) for compliance to FCC 47CFR 15.247 requirements.

- a) Measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.
- b) Set instrument center frequency to DTS channel center frequency.
- c) Set span to at least $1.5 * \text{OBW}$.
- d) Set RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- e) Set VBW $\geq 3 * \text{RBW}$.
- f) Detector = power averaging (RMS) or sample detector (when RMS not available).
- g) Ensure that the number of measurement points in the sweep $\geq 2 * \text{span}/\text{RBW}$.
- h) Sweep time = auto couple.
- i) Do not use sweep triggering. Allow sweep to “free run”.
- j) Employ trace averaging (RMS) mode over a minimum of 100 traces.
- k) Use the peak marker function to determine the maximum amplitude level.
- l) Add $10 \log (1/x)$, where x is the duty cycle measured in step (a), to the measured PSD to compute the average PSD during the actual transmission time.
- m) If resultant value exceeds the limit, then reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

5.4 Test Protocol

Temperature: 25 °C

Relative Humidity: 55 %

Mode	Channel	Duty Cycle (%)	Factor (dB)	Corrected Reading (dBm/3KHz)	Max PSD (dBm/3KHz)	Limit (dBm/3kHz)	Result
802.11b	L	98.93	0.05	-19.926	-19.879	8	Pass
	M	98.93	0.05	-20.066	-20.019	8	Pass
	H	98.85	0.05	-19.937	-19.887	8	Pass
802.11g	L	93.45	0.29	-21.233	-20.943	8	Pass
	M	93.45	0.29	-21.369	-21.075	8	Pass
	H	93.48	0.29	-21.420	-21.127	8	Pass
802.11n (HT20)	L	92.59	0.33	-22.203	-21.869	8	Pass
	M	93.02	0.31	-22.664	-22.350	8	Pass
	H	93.06	0.31	-22.540	-22.228	8	Pass

NOTE:

$Max\ PSD(dBm/3KHz) = Corrected\ Reading(dBm/3KHz) + Factor(dB);$

$Factor(dB) = 10 * 10g(1/duty\ cycle\ (%)/100).$

Test Plots:

802.11b-2412MHz



802.11b-2437MHz



802.11b-2462MHz



802.11g-2412MHz

