

TEST REPORT

Product Name: WIFI+BT Module

Trade Mark: GSD

Model No.: WCT6PA2201

HVIN: WCT6PA2201

Report Number: 171227005RFC-3

Test Standards: FCC 47 CFR Part 15 Subpart C

RSS-247 Issue 2

RSS-Gen Issue 4

FCC ID: 2AC23-WCT6LA2701

IC: 12290A-WCT6LA2701

Test Result: PASS

Date of Issue: February 2, 2018

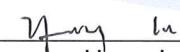
Prepared for:

**Hui Zhou Gaoshengda Technology Co., LTD
NO.75 Zhongkai Development Area, Huizhou, Guangdong, China**

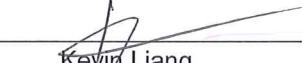
Prepared by:

**Shenzhen UnionTrust Quality and Technology Co., Ltd.
16/F, Block A, Building 6, Baoneng Science and Technology Park,
Qingxiang Road No.1, Longhua New District, Shenzhen, China**
**TEL: +86-755-2823 0888
FAX: +86-755-2823 0886**

Tested by:


Henry Lu
Engineer

Reviewed by:


Kevin Liang
Team Leader

Approved by:


Jim Long
Assistant Manager

Date:



Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China
Tel: +86-755-28230888 Fax: +86-755-28230886 E-mail: info@uttlab.com

[Http://www.uttlab.com](http://www.uttlab.com)

Version

Version No.	Date	Description
V1.0	February 2, 2018	Original

**Shenzhen UnionTrust Quality and Technology Co., Ltd.**

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China
Tel: +86-755-28230888

Fax: +86-755-28230886

E-mail: info@uttlab.com

[Http://www.uttlab.com](http://www.uttlab.com)

CONTENTS

1. GENERAL INFORMATION	4
1.1 CLIENT INFORMATION	4
1.2 EUT INFORMATION	4
1.2.1 GENERAL DESCRIPTION OF EUT	4
1.2.2 DESCRIPTION OF ACCESSORIES.....	4
1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD.....	5
1.4 OTHER INFORMATION.....	5
1.5 DESCRIPTION OF SUPPORT UNITS	6
1.6 TEST LOCATION.....	6
1.7 TEST FACILITY.....	6
1.8 DEVIATION FROM STANDARDS	6
1.9 ABNORMALITIES FROM STANDARD CONDITIONS.....	7
1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER	7
1.11 MEASUREMENT UNCERTAINTY	7
2. TEST SUMMARY	8
3. EQUIPMENT LIST	9
4. TEST CONFIGURATION	10
4.1 ENVIRONMENTAL CONDITIONS FOR TESTING	10
4.1.1 NORMAL OR EXTREME TEST CONDITIONS	10
4.2 TEST CHANNELS	10
4.3 EUT TEST STATUS	10
4.4 PRE-SCAN.....	11
4.4.1 PRE-SCAN UNDER ALL RATES	11
4.4.2 WORST-CASE DATA RATES	11
4.5 TEST SETUP	11
4.5.1 FOR RADIATED EMISSIONS TEST SETUP	11
4.5.2 FOR CONDUCTED RF TEST SETUP	13
4.6 SYSTEM TEST CONFIGURATION	13
4.7 DUTY CYCLE	14
5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION	17
5.1 REFERENCE DOCUMENTS FOR TESTING	17
5.2 ANTENNA REQUIREMENT	17
5.3 CONDUCTED PEAK OUTPUT POWER.....	18
5.4 6 dB BANDWIDTH & OCCUPIED BANDWIDTH.....	21
5.5 POWER SPECTRAL DENSITY	26
5.6 CONDUCTED OUT OF BAND EMISSION	34
5.7 RADIATED SPURIOUS EMISSIONS.....	43
5.8 BAND EDGE MEASUREMENTS (RADIATED).....	54
APPENDIX 1 PHOTOS OF TEST SETUP	79
APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS	79

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Hui Zhou Gaoshengda Technology Co.,LTD
Address of Applicant:	NO.75 Zhongkai Development Area, Huizhou, Guangdong, China
Manufacturer:	Hui Zhou Gaoshengda Technology Co.,LTD
Address of Manufacturer:	NO.75 Zhongkai Development Area, Huizhou, Guangdong, China

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	WIFI+BT Module		
Model No.:	WCT6PA2201		
HVIN:	WCT6PA2201		
Add. Model No.:	N/A		
Trade Mark:	GSD		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n Bluetooth: V3.0+EDR & V4.1 LE	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
		5 250 MHz to 5 350 MHz	IEEE 802.11a/n/ac
		5 470 MHz to 5 725 MHz	IEEE 802.11a/n/ac
		5 725 MHz to 5 850 MHz	IEEE 802.11a/n/ac
Sample Received Date:	December 27, 2017		
Sample Tested Date:	December 28, 2017 to January 17, 2018		

1.2.2 Description of Accessories

None.

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Range:	2400 MHz to 2483.5 MHz	
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40	
Type of Modulation:	IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM(64-QAM, 16-QAM, QPSK, BPSK)	
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS15 IEEE 802.11n-HT40: Up to MCS15	
Number of Channels:	IEEE 802.11b: 13 IEEE 802.11g: 13 IEEE 802.11n-HT20: 13 IEEE 802.11n-HT40: 9	
Channel Separation:	5 MHz	
Antenna Type:	Chain 0	PIFA Antenna
	Chain 1	PIFA Antenna
Antenna Gain:	Chain 0	2.02 dBi
	Chain 1	2.29 dBi
Directional gain:	5.17 dBi	
Maximum Peak Power:	SISO_ Chain 0	IEEE 802.11b: 19.92 dBm IEEE 802.11g: 22.97 dBm IEEE 802.11n-HT20: 18.52 dBm IEEE 802.11n-HT40: 18.59 dBm
	SISO_ Chain 1	IEEE 802.11b: 20.49 dBm IEEE 802.11g: 22.82 dBm IEEE 802.11n-HT20: 17.33 dBm IEEE 802.11n-HT40: 17.26 dBm
	MIMO_ Chain 0+1	IEEE 802.11n-HT20: 20.71 dBm IEEE 802.11n-HT40: 20.90 dBm
Maximum EIRP:	SISO_ Chain 0	IEEE 802.11b: 21.94 dBm IEEE 802.11g: 24.99 dBm IEEE 802.11n-HT20: 20.54 dBm IEEE 802.11n-HT40: 20.61 dBm
	SISO_ Chain 1	IEEE 802.11b: 22.78 dBm IEEE 802.11g: 25.11 dBm IEEE 802.11n-HT20: 19.62 dBm IEEE 802.11n-HT40: 19.55 dBm
	MIMO_ Chain 0+1	IEEE 802.11n-HT20: 22.84 dBm IEEE 802.11n-HT40: 23.03 dBm
Normal Test Voltage:	3.3 Vdc	

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20	$f = 2407 + 5k \text{ MHz}, k = 1, \dots, 13$
IEEE 802.11n-HT40	$f = 2407 + 5k \text{ MHz}, k = 3, \dots, 11$
Note: f	is the operating frequency (MHz);
k	is the operating channel.

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	Lenovo	E450	SL10G10780	UnionTrust
--	--	--	--	--

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable * 2	SMA	0.30 Meter	UnionTrust
2	USB Cable	USB	0.80 Meter	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109

Telephone: +86 (0) 755 2823 0888

Fax: +86 (0) 755 2823 0886

1.7 TEST FACILITY

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

CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

IC-Registration No.: 21600-1

The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 21600-1.

A2LA-Lab Certificate No.: 4312.01

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

FCC Accredited Lab.

Designation Number: CN1194

Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China
Tel: +86-755-28230888 Fax: +86-755-28230886 E-mail: info@uttlab.com

[Http://www.uttlab.com](http://www.uttlab.com)

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9KHz-150KHz	±3.8 dB
2	Conducted emission 150KHz-30MHz	±3.4 dB
3	Radiated emission 9KHz-30MHz	±4.9 dB
4	Radiated emission 30MHz-1GHz	±4.7 dB
5	Radiated emission 1GHz-18GHz	±5.1 dB
6	Radiated emission 18GHz-26GHz	±5.2 dB
7	Radiated emission 26GHz-40GHz	±5.2 dB

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	Test Requirement	Test Method	Result
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c) RSS-Gen Issue 4, Section 8.3	ANSI C63.10-2013	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207 RSS-Gen Issue 4, Section 8.8	ANSI C63.10-2013	N/A <small>NOTE 1, 2</small>
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3) RSS-247 Issue 2, Section 5.4(d)	KDB 558074 D01 v04 Section 9.1.3	PASS <small>NOTE 3</small>
6dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2) RSS-247 Issue 2, Section 5.2(a)	KDB 558074 D01 v04 Section 8.1	PASS <small>NOTE 3</small>
Occupied Bandwidth	RSS-Gen section 6.6	RSS-Gen section 6.6	PASS <small>NOTE 3</small>
Power Spectral Density	FCC 47 CFR Part 15 Subpart C Section 15.247 (e) RSS-247 Issue 2, Section 5.2(b)	KDB 558074 D01 v04 Section 10.2	PASS <small>NOTE 3</small>
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d) RSS-247 Issue 2, Section 5.5	KDB 558074 D01 v04 Section 11	PASS <small>NOTE 3</small>
Radiated Spurious Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209 RSS-Gen Issue 4, Section 6.13/8.9/8.10	KDB 558074 D01 v04 Section 12.1	PASS <small>NOTE 3</small>
Band Edge Measurements (Radiated)	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209 RSS-247 Issue 2, Section 5.5	KDB 558074 D01 v04 Section 12.1	PASS <small>NOTE 3</small>

Note:

- 1) N/A: In this whole report not application.
- 2) This EUT is powered by DC.
- 3) The EUT (WCT6PA2201) this time and original model (WCT6LA2701) both WIFI+BT Module are identical in chipset, about the difference between the both WIFI+BT Module, please refer to the difference statement. After assessment, all technical data is referred to previous report no. 170615002RFC-3 dated July 10, 2017 except Radiated Emissions, Band edge (Radiated), e.i.r.p. and all other items that increase the channels.

3. EQUIPMENT LIST

Radiated Emission Test Equipment List (3M Chamber)						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
<input checked="" type="checkbox"/>	3M Chamber & Accessory Equipment	ETS-LINDGREN	3M	N/A	Dec. 20, 2015	Dec. 19, 2018
<input checked="" type="checkbox"/>	Receiver	R&S	ESIB26	100114	Dec. 10, 2017	Dec. 10, 2018
<input checked="" type="checkbox"/>	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Dec.10, 2017	Dec. 10, 2018
<input checked="" type="checkbox"/>	Loop Antenna	ETS-LINDGREN	6502	00202525	Dec. 17, 2017	Dec. 17, 2018
<input checked="" type="checkbox"/>	Broadband Antenna	ETS-LINDGREN	3142E	00201566	Dec. 17, 2017	Dec. 17, 2018
<input checked="" type="checkbox"/>	Preamplifier	HP	8447F	2805A02960	Dec. 10, 2017	Dec. 10, 2018
<input checked="" type="checkbox"/>	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201874	Dec. 17, 2017	Dec. 17, 2018
<input checked="" type="checkbox"/>	Horn Antenna	ETS-LINDGREN	3116C	00200180	Jul. 28, 2015	Jul. 27, 2018
<input checked="" type="checkbox"/>	Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	Dec. 17, 2017	Dec. 17, 2018
<input checked="" type="checkbox"/>	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
<input checked="" type="checkbox"/>	Test Software	Audix	e3	Software Version: 9.160323		

Conducted RF test Equipment List						
Used	Equipment	Manufacturer	Model No.	Serial Number	Cal. date (mm dd, yyyy)	Cal. Due date (mm dd, yyyy)
<input checked="" type="checkbox"/>	EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY51440197	Dec. 10, 2017	Dec. 10, 2018
<input checked="" type="checkbox"/>	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	Dec. 10, 2017	Dec. 10, 2018
<input checked="" type="checkbox"/>	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430023	Dec. 10, 2017	Dec. 10, 2018

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter		Selected Values During Tests		
Test Condition		Ambient		
		Temperature (°C)	Voltage (V)	Relative Humidity (%)
NT/NV		+15 to +35	3.3	20 to 75
Remark:				
1) NV: Normal Voltage; NT: Normal Temperature				

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists				
		Lowest(L)	Middle(M)	Highest(H11)	Highest(H12)	Highest(H13)
IEEE 802.11b	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
IEEE 802.11g	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
IEEE 802.11n-HT20	2412 MHz to 2472 MHz	Channel 1	Channel 7	Channel 11	Channel 12	Channel 13
		2412 MHz	2437 MHz	2462 MHz	2467 MHz	2472 MHz
Mode	Tx/Rx Frequency	Test RF Channel Lists				
		Lowest(L)	Middle(M)	Highest(H9)	Highest(H10)	Highest(H11)
IEEE 802.11n-HT40	2422 MHz to 2462 MHz	Channel 3	Channel 7	Channel 9	Channel 10	Channel 11
		2422 MHz	2437 MHz	2452 MHz	2457 MHz	2462 MHz

4.3 EUT TEST STATUS

Mode	Tx/Rx Function	Description
IEEE 802.11b		1. Keep the EUT in continuously transmitting or receiving with modulation test single.
IEEE 802.11g		
IEEE 802.11n-HT20	1Tx/1Rx	
IEEE 802.11n-HT40		
IEEE 802.11n-HT20	2Tx/2Rx	2. Keep the EUT in continuously transmitting or receiving with modulation test single.
IEEE 802.11n-HT40		

4.4 PRE-SCAN

4.4.1 Pre-scan under all rates

Mode and Frequency	Maximum Conducted Average Power (dBm)_Chain 0							
	1	2	5.5			11		
IEEE 802.11b 2437 MHz	16.77		16.69			16.62		16.50
IEEE 802.11g 2437 MHz	6	9	12	18	24	36	48	54
	16.55	16.54	16.40	16.38	16.31	16.09	15.01	15.04
IEEE 802.11n-HT20 2437 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	11.51	11.39	11.7	12.09	10.09	10.03	10.13	10.03
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	11.57	11.50	11.46	11.45	10.86	10.81	10.77	10.77
IEEE 802.11n-HT40 2437 MHz	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
	11.22	11.07	10.83	10.52	9.26	9.16	9.22	9.10
	MCS8	MCS9	MCS10	MCS11	MCS12	MCS13	MCS14	MCS15
	11.27	11.30	11.26	11.25	9.56	9.51	9.46	9.43

4.4.2 Worst-case data rates

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

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

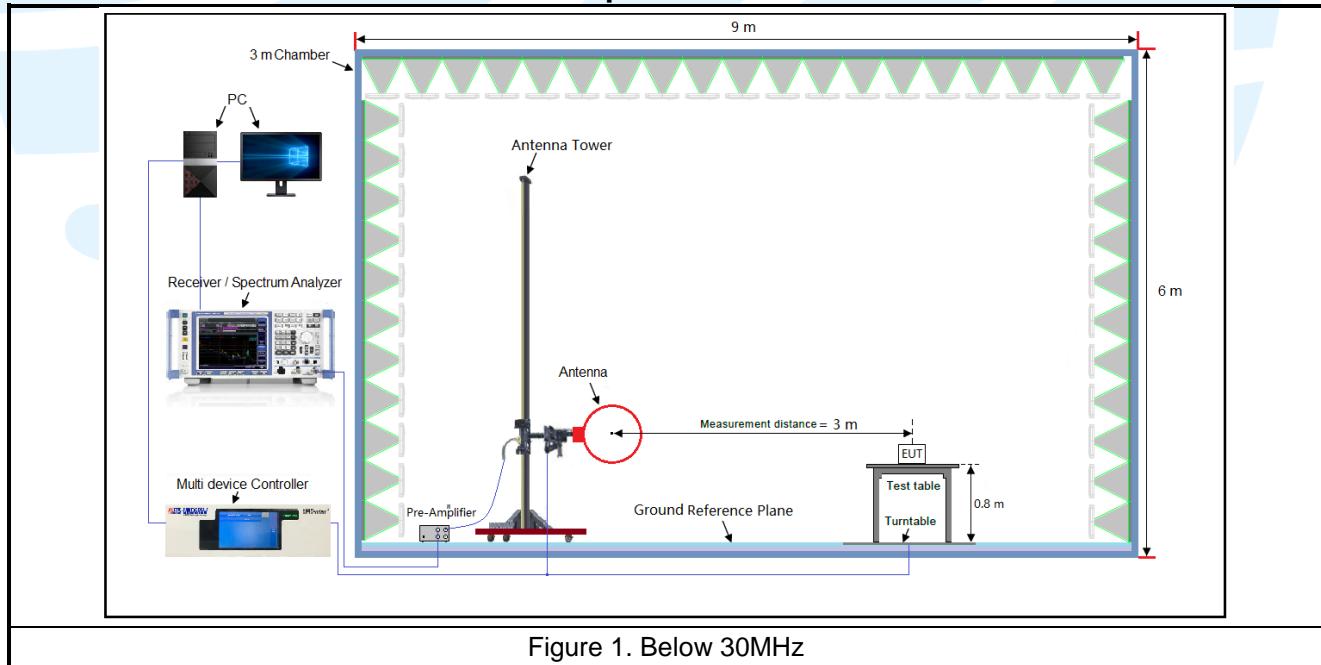


Figure 1. Below 30MHz

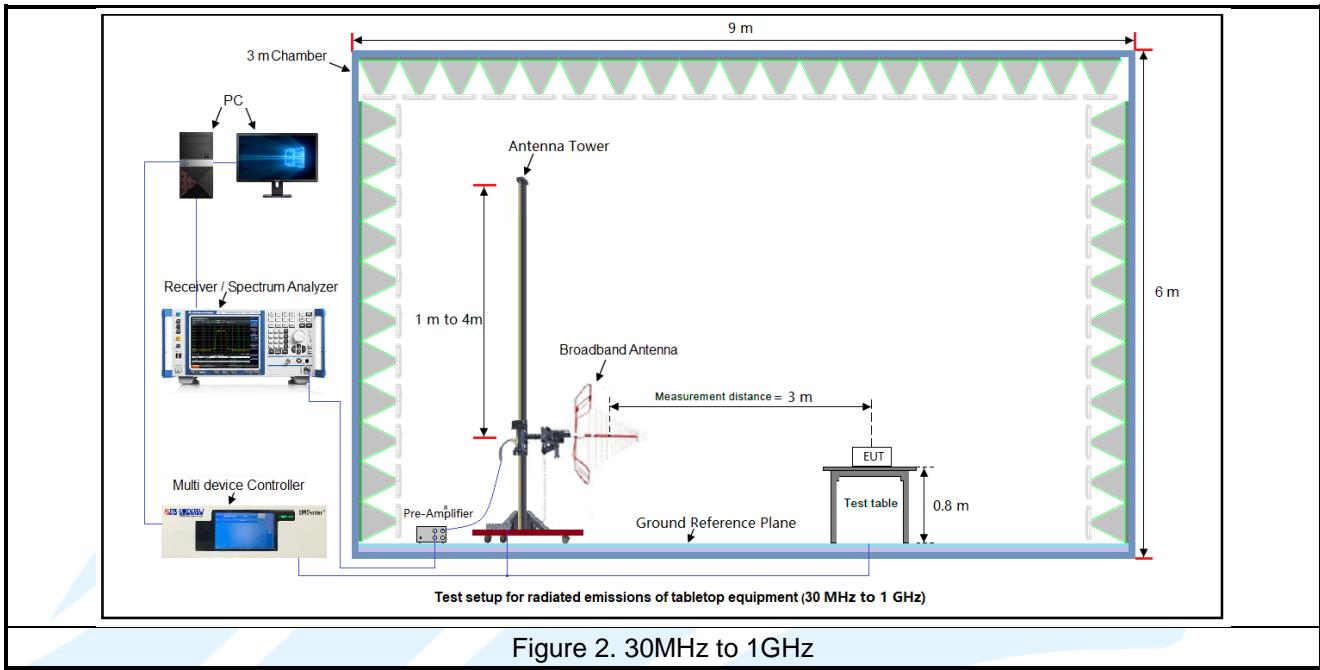


Figure 2. 30MHz to 1GHz

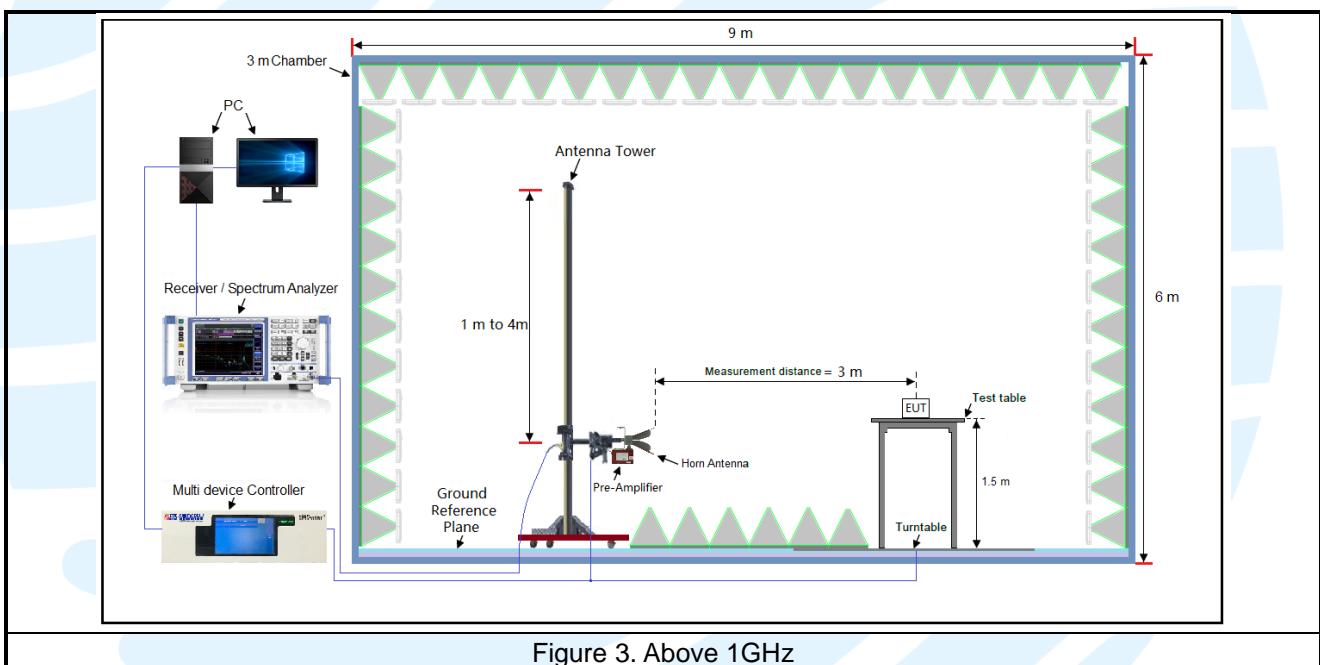
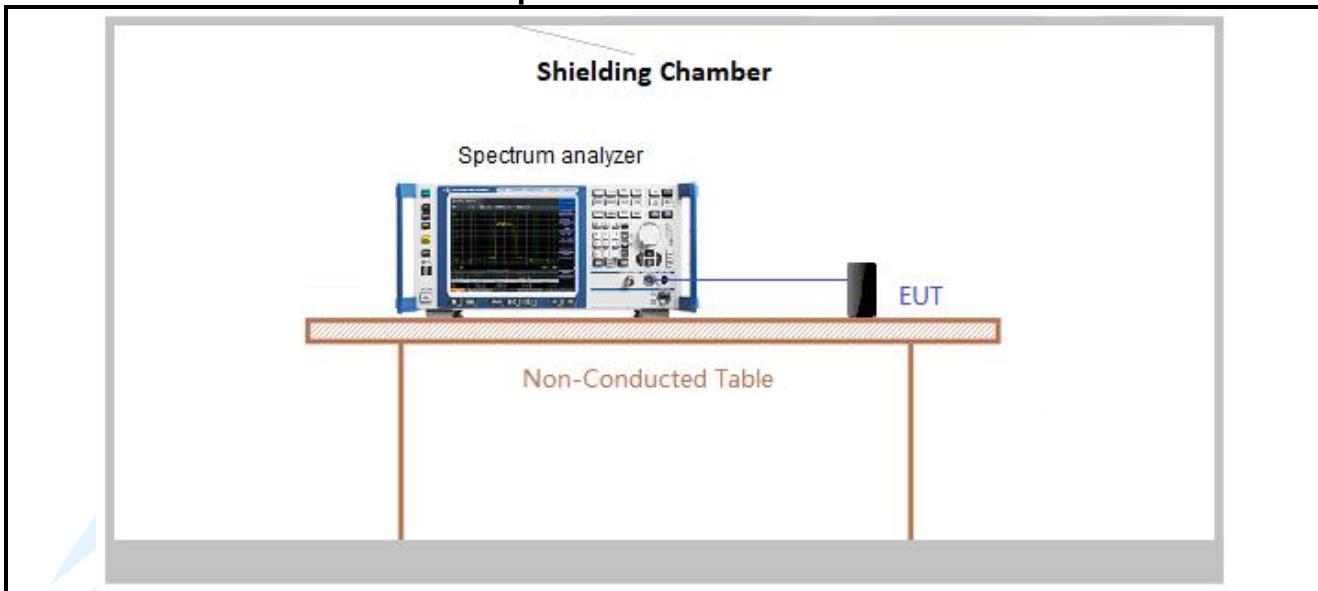


Figure 3. Above 1GHz

4.5.2 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by a 3.3Vdc. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency	Mode	Antenna Port	Worst-case axis positioning
Above 1GHz	1TX	Chain 0	Y axis
	1TX	Chain 1	Y axis
	2TX	Chain 0+1	Y axis

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

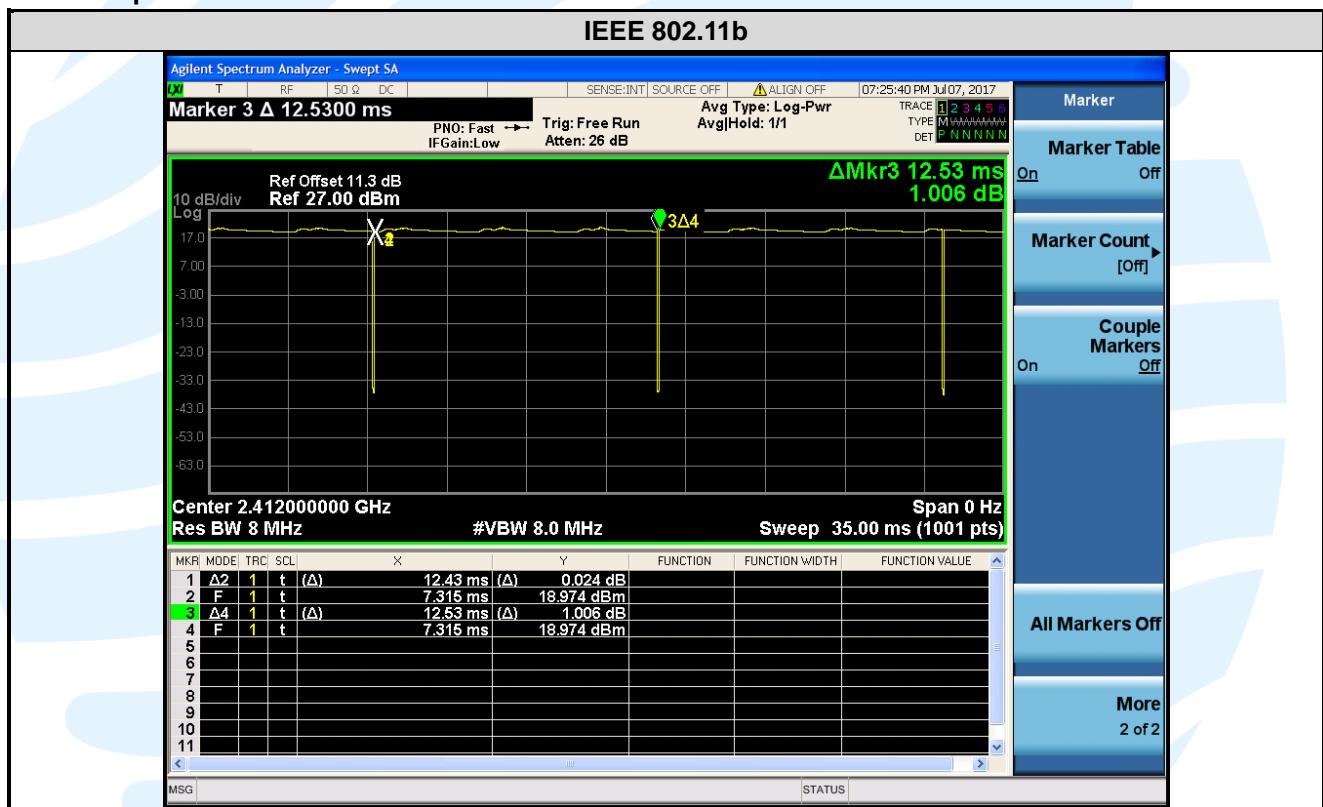
4.7 DUTY CYCLE

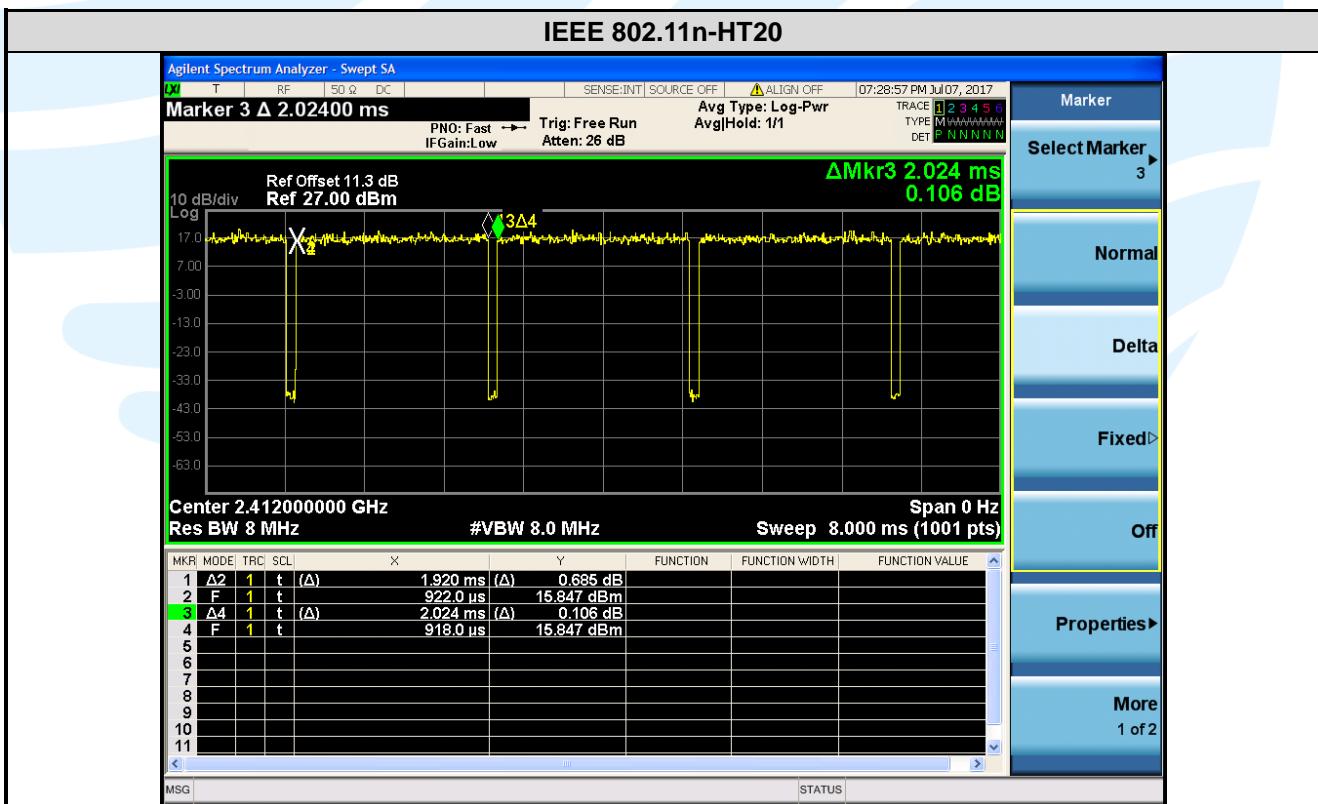
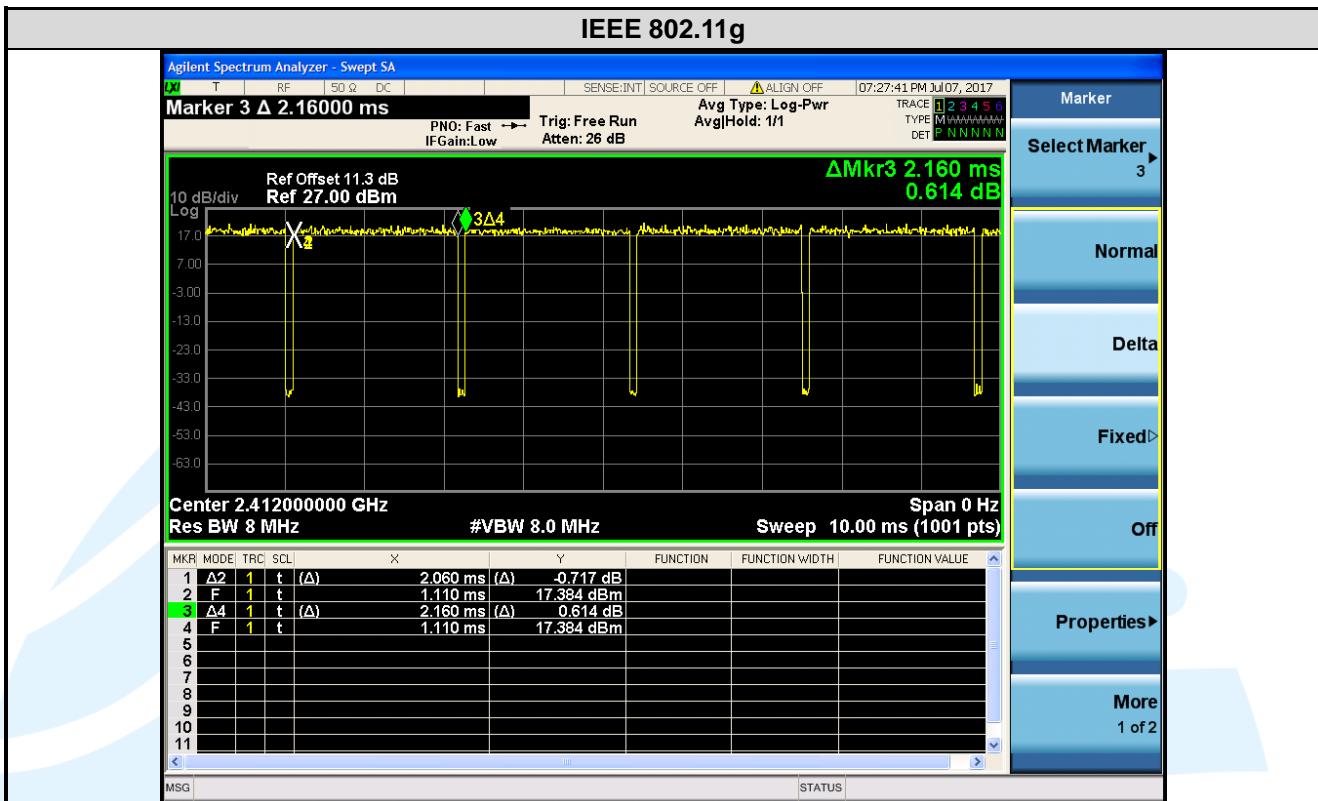
Mode	Data rates (Mbps)	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/T Minimum VBW (kHz)	Average Factor (dB)
IEEE 802.11b	1	12.43	12.53	0.99	99.20	0.00	0.01	-0.07
IEEE 802.11g	6	2.06	2.16	0.95	95.37	0.21	0.49	-0.41
IEEE 802.11n-HT20	MCS0	1.92	2.024	0.95	94.86	0.23	0.52	-0.46
IEEE 802.11n-HT40	MCS0	0.95	1.05	0.90	90.48	0.43	1.05	-0.87

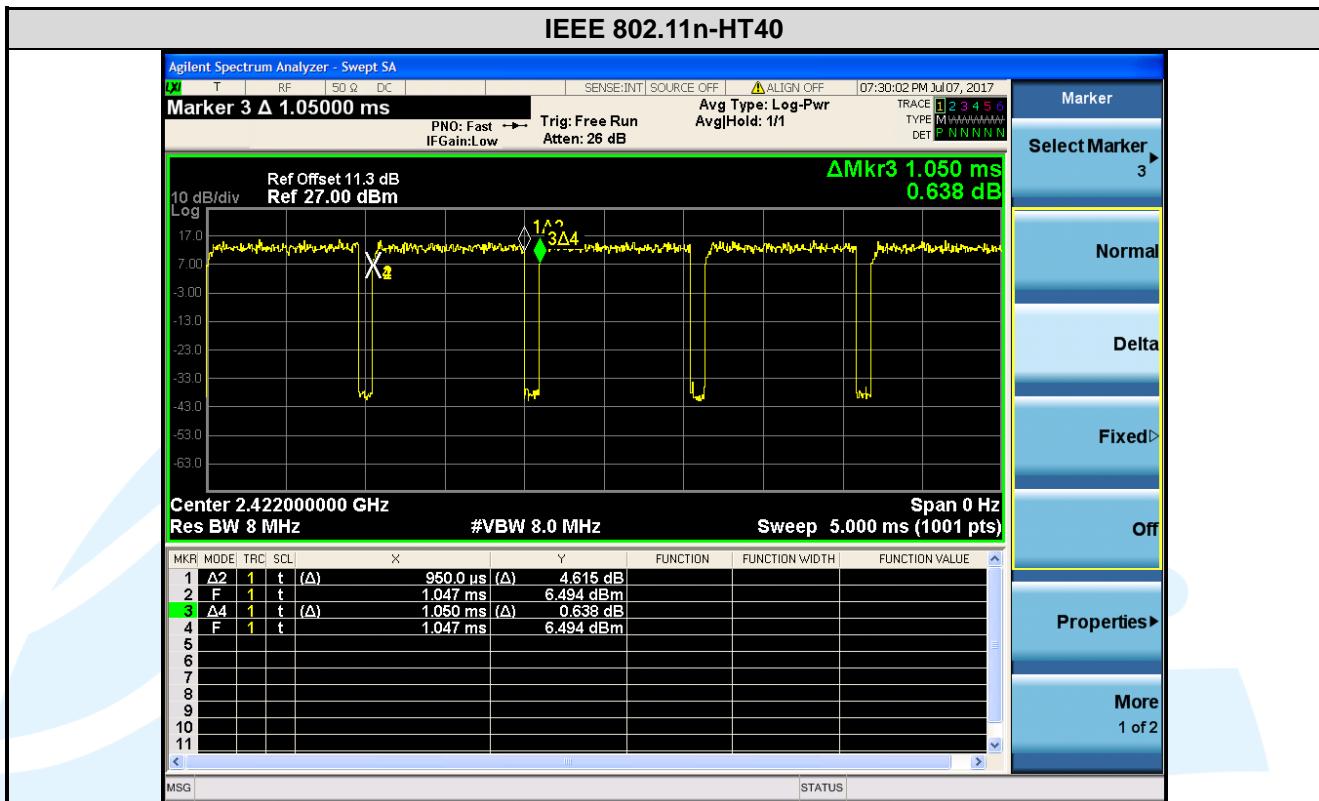
Remark:

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

The test plot as follows







5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
4	RSS-Gen Issue 4	General Requirements for Compliance of Radio Apparatus
5	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
6	KDB 558074 D01 DTS Meas Guidance v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
7	KDB 662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.
15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
RSS-Gen Issue 4, Section 8.3 requirement: According to RSS-Gen Issue 4, section 8.3, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.
EUT Antenna: Both antenna in the interior of the equipment and no consideration of replacement. The Tx chains are correlated and the antenna gain is unequal among the chains and the best case directional gain of the antenna is 5.17dBi (See section 5.3).

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement:	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3) RSS-247 Issue 2, Section 5.4(d)
Test Method:	KDB 558074 D01 v04, Section 9.1.3
Limit:	For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.
Test Procedure:	<ol style="list-style-type: none"> 1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter. 2. Measure out each test modes' peak or average output power, record the power level. <p>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.</p>
Test Setup:	Refer to section 4.4.3 for details.
Instruments Used:	Refer to section 3 for details
Test Mode:	Transmitter mode
Test Results:	Pass
Test Data:	

The worst case test data:
For maximum peak conducted output power

Mode	Channel/ Frequency (MHz)	Maximum Conducted Peak Output Power (dBm)				Pass / Fail
		SISO_ Chain 0	SISO_ Chain 1	Total Power MIMO_ Chain 0+1	Limit (dBm)	
IEEE 802.11b	1(2412)	19.12	19.97	---	30	Pass
	6(2437)	19.21	20.06	---	30	Pass
	11(2462)	19.92	20.49	---	30	Pass
	12(2467)	14.84	16.29	---	30	Pass
	13(2472)	14.86	16.30	---	30	Pass
IEEE 802.11g	1(2412)	22.65	22.57	---	30	Pass
	6(2437)	22.72	22.72	---	30	Pass
	11(2462)	22.97	22.82	---	30	Pass
	12(2467)	16.77	18.36	---	30	Pass
	13(2472)	16.93	18.27	---	30	Pass
IEEE 802.11n-HT20	1(2412)	18.37	16.42	20.51	30	Pass
	6(2437)	18.36	16.62	20.59	30	Pass
	11(2462)	18.52	16.69	20.71	30	Pass
	12(2467)	15.91	17.21	19.62	30	Pass
	13(2472)	15.82	17.33	19.65	30	Pass
IEEE 802.11n-HT40	3(2422)	18.59	16.84	20.81	30	Pass
	6(2437)	18.59	17.05	20.90	30	Pass
	9(2452)	18.57	16.79	20.78	30	Pass
	10(2457)	16.13	17.22	19.72	30	Pass
	11(2462)	15.94	17.26	19.66	30	Pass

Remark:

1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10^{\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]}$
3. Directional gain and the maximum conducted output power limit see table below:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	2.02	2.29	5.17	30.00
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:				
If transmit signals are correlated, then				
Directional gain = $10 \log[(10^G1 / 20 + 10^G2 / 20 + \dots + 10^GN / 20)^2 / NANT]$ 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.]				

For maximum e.i.r.p.

Mode	Channel/ Frequency (MHz)	Maximum Conducted Peak Output Power (dBm)				Pass / Fail
		SISO_Chain 0	SISO_Chain 1	Total Power MIMO_Chain 0+1	Limit (dBm)	
IEEE 802.11b	1(2412)	21.14	22.26	---	30	Pass
	6(2437)	21.23	22.35	---	30	Pass
	11(2462)	21.94	22.78	---	30	Pass
	12(2467)	16.86	18.58	---	30	Pass
	13(2472)	16.88	18.59	---	30	Pass
IEEE 802.11g	1(2412)	24.67	24.86	---	30	Pass
	6(2437)	24.74	25.01	---	30	Pass
	11(2462)	24.99	25.11	---	30	Pass
	12(2467)	18.79	20.65	---	30	Pass
	13(2472)	18.95	20.56	---	30	Pass
IEEE 802.11n-HT20	1(2412)	20.39	18.71	22.64	30	Pass
	6(2437)	20.38	18.91	22.72	30	Pass
	11(2462)	20.54	18.98	22.84	30	Pass
	12(2467)	17.93	19.50	21.80	30	Pass
	13(2472)	17.84	19.62	21.83	30	Pass
IEEE 802.11n-HT40	3(2422)	20.61	19.13	22.94	30	Pass
	6(2437)	20.61	19.34	23.03	30	Pass
	9(2452)	20.59	19.08	22.91	30	Pass
	10(2457)	18.15	19.51	21.89	30	Pass
	11(2462)	17.96	19.55	21.84	30	Pass

Mode	Channel/ Frequency (MHz)	Maximum Conducted Average Power (dBm)						
		SISO		Duty Cycle Factor (dB)	SISO		MIMO	
		Measured Power			Power with Duty Factor		Total Power	
		Chain 0	Chain 1		Chain 0	Chain 1	Chain 0+1	
IEEE 802.11b	1(2412)	16.77	16.55	0.00	16.77	16.55	--	
	6(2437)	16.70	16.62		16.70	16.62	--	
	11(2462)	17.19	17.12		17.19	17.12	--	
	12(2467)	12.78	13.44		12.78	13.44	--	
	13(2472)	12.69	13.42		12.69	13.42	--	
IEEE 802.11g	1(2412)	16.57	15.73	0.21	16.78	15.94	--	
	6(2437)	16.55	15.92		16.76	16.13	--	
	11(2462)	16.72	16.02		16.72	16.02	--	
	12(2467)	10.76	12.82		10.76	12.82	--	
	13(2472)	10.73	12.24		10.94	12.45	--	
IEEE 802.11n-HT20	1(2412)	11.54	9.36	0.23	11.77	9.59	13.83	
	6(2437)	12.09	9.48		12.32	9.71	14.22	
	11(2462)	11.64	9.70		11.64	9.70	13.79	
	12(2467)	9.75	10.77		9.75	10.77	13.30	
	13(2472)	9.62	10.92		9.85	11.15	13.56	
IEEE 802.11n-HT40	3(2422)	11.22	9.28	0.43	11.65	9.71	13.80	
	6(2437)	11.30	9.32		11.73	9.75	13.86	
	9(2452)	11.32	9.37		11.32	9.37	13.46	
	10(2457)	9.17	10.54		9.17	10.54	12.92	
	11(2462)	9.13	10.94		9.56	11.37	13.57	

Remark:

1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10^{\text{Chain 0/10}} + (10^{\text{Chain 1/10}})$

5.4.6 DB BANDWIDTH & OCCUPIED BANDWIDTH

FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)

Test Requirement: RSS-247 Issue 2, Section 5.2(a)
RSS-Gen Issue 4, Section 6.6

Test Method: KDB 558074 D01 v04, Section 8.1

Limit: For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

a) Set RBW = 100 kHz.

b) Set the video bandwidth (VBW) $\geq 3 \times$ RBW.

c) Detector = Peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.4.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Transmitter mode

Test Results: Pass

Test Data:

Mode	Channel/ Frequency (MHz)	6 dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit	Pass / Fail
The worst case test data:					
IEEE 802.11b SISO_Chain 1	1(2412)	8.089	12.953	> 500 kHz	Pass
	6(2437)	8.089	12.977	> 500 kHz	Pass
	11(2462)	8.090	12.992	> 500 kHz	Pass
	12(2467)	8.091	13.014	> 500 kHz	Pass
	13(2472)	8.091	13.023	> 500 kHz	Pass
IEEE 802.11g SISO_Chain 0	1(2412)	16.11	16.339	> 500 kHz	Pass
	6(2437)	16.08	16.346	> 500 kHz	Pass
	11(2462)	16.11	16.340	> 500 kHz	Pass
	12(2467)	16.30	16.342	> 500 kHz	Pass
	13(2472)	16.31	16.342	> 500 kHz	Pass
IEEE 802.11n-HT20 MIMO_Chain 0	1(2412)	16.84	17.537	> 500 kHz	Pass
	6(2437)	16.87	17.540	> 500 kHz	Pass
	11(2462)	16.85	17.543	> 500 kHz	Pass
	12(2467)	16.89	17.540	> 500 kHz	Pass
	13(2472)	16.89	17.533	> 500 kHz	Pass
IEEE 802.11n-HT40 MIMO_Chain 0	3(2422)	35.40	35.994	> 500 kHz	Pass
	6(2437)	35.20	35.990	> 500 kHz	Pass
	9(2452)	35.40	36.000	> 500 kHz	Pass
	10(2457)	35.24	36.016	> 500 kHz	Pass
	11(2462)	35.37	36.003	> 500 kHz	Pass

The test plot as follows:









5.5 POWER SPECTRAL DENSITY

Test Requirement:	FCC 47 CFR Part 15 Subpart C Section 15.247 (e) RSS-247 Issue 2, Section 5.2(b)
Test Method:	KDB 558074 D01 v04, Section 10.2
Limit:	For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.
Test Procedure:	<p>Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.</p> <p>Use the following spectrum analyzer settings:</p> <ul style="list-style-type: none">a) Set analyzer center frequency to DTS channel center frequency.b) Set the span to 1.5 times the DTS bandwidth.c) Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.d) Set the VBW $\geq 3 \times \text{RBW}$.e) Detector = peak.f) Sweep time = auto couple.g) Trace mode = max hold.h) Allow trace to fully stabilize.i) Use the peak marker function to determine the maximum amplitude level within the RBW.j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
Note:	The cable loss and attenuator loss were offset into measure device as an amplitude offset.
Test Setup:	Refer to section 4.4.3 for details.
Instruments Used:	Refer to section 3 for details
Test Mode:	Transmitter mode
Test Results:	Pass
Test Data:	

The worst case test data:

Mode	Channel/ Frequency (MHz)	Power spectral density (dBm)				
		SISO_ Chain 0	SISO_ Chain 1	Total PSD MIMO_ Chain 0+1	Limit @3kHz (dBm)	Pass / Fail
IEEE 802.11b	1(2412)	---	-6.212	---	8	Pass
	6(2437)	---	-7.608	---	8	Pass
	11(2462)	---	-6.752	---	8	Pass
	12(2467)	---	-9.353	---	8	Pass
	13(2472)	---	-9.636	---	8	Pass
IEEE 802.11g	1(2412)	-11.027	---	---	8	Pass
	6(2437)	-11.365	---	---	8	Pass
	11(2462)	-10.072	---	---	8	Pass
	12(2467)	---	-14.804	---	8	Pass
	13(2472)	---	-14.537	---	8	Pass
IEEE 802.11n-HT20	1(2412)	-13.463	-14.405	-10.90	8	Pass
	6(2437)	-12.240	-13.936	-10.00	8	Pass
	11(2462)	-12.089	-14.567	-10.14	8	Pass
	12(2467)	-17.701	-12.951	-11.70	8	Pass
	13(2472)	-16.570	-13.481	-11.75	8	Pass
IEEE 802.11n-HT40	3(2422)	-14.388	-16.616	-12.35	8	Pass
	6(2437)	-14.270	-16.284	-12.15	8	Pass
	9(2452)	-14.255	-16.049	-12.05	8	Pass
	10(2457)	-19.481	-13.960	-12.89	8	Pass
	11(2462)	-19.268	-14.380	-13.16	8	Pass

Remark:

1. Power with Duty Factor = Measured Power + Duty Cycle Factor
2. Total (Chain 0+1) = $10^{\log[(10^{\text{Chain 0/10}})+(10^{\text{Chain 1/10}})]}$
3. Directional gain and the maximum conducted power spectral density limit see table below:

Frequency Band	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Correlated chains directional gain (dBi)	Peak Power Limit (dBm)
2400 MHz to 2483.5 MHz	2.35	2.35	5.36	8.00

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

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

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

The test plot as follows:

