HCT CO., LTD.

CERTIFICATE OF COMPLIANCE

FCC Certification

Applicant Name:
LG Electronics Inc.

Address:
222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do 451-713, Korea

Date of Issue:
July 11, 2014
Test Site/Location:
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil,Majang-myeo,Icheon-si, Gyeonggi-do, Korea
Report No.: HCT-R-1407-F012-1
HCT FRN: 0005866421
IC Recognition No.: 5944A-3

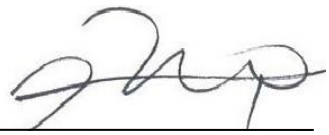
FCC ID	**: BEJ9QK-TWFMB008D**
IC	**: 2703H-TWFMB008D**
APPLICANT	**: LG Electronics Inc.**

FCC/ IC Model(s):	TWFM-B008D
EUT Type:	WLAN Module
Port 0 Max. RF Output Power:	Wi-Fi 802.11a (5180~5240) (10.06 dBm)/ Wi-Fi 802.11n_20 MHz BW (5180~5240) (10.58 dBm)/ Wi-Fi 802.11n_40 MHz BW(5190~5230) (12.47 dBm)
Port 1 Max. RF Output Power:	Wi-Fi 802.11a (5180~5240) (9.58 dBm)/ Wi-Fi 802.11n_20 MHz BW (5180~5240) (9.44 dBm)/ Wi-Fi 802.11n_40 MHz BW(5190~5230) (12.57 dBm)
Port0 & 1 Sum Max. RF Output Power:	Wi-Fi 802.11a (5180~5240) (12.51 dBm)/ Wi-Fi 802.11n_20 MHz BW (5180~5240) (13.01 dBm)/ Wi-Fi 802.11n_40 MHz BW(5190~5230) (15.53 dBm)
Frequency Range:	20 MHz BW: 5180 MHz - 5240 MHz (UNII 1) 40 MHz BW: 5190 MHz - 5230 MHz (UNII 1)
Modulation type	OFDM
FCC Classification:	Unlicensed National Information Infrastructure(UNII)
FCC Rule Part(s):	Part 15.407
IC Rule :	RSS-GEN Issue 3(December 2010), RSS-210 Issue 8(December 2010)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)



Report prepared by
: Kyung Soo Kang
Test engineer of RF Team

Approved by
: Chang Seok Choi
Manager of RF Team

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1407-F012	July 03, 2014	- First Approval Report
HCT-R-1407-F012-1	July 11, 2014	-Add the Port0 & 1 Sum Max. RF Output Power on page 1 -Revised the Antenna gain Section 6

Table of Contents

1. GENERAL INFORMATION

Applicant:	LG Electronics Inc.
Address:	222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do 451-713, Korea
FCC ID:	BEJ9QK-TWFMB008D
IC:	2703H-TWFMB008D
EUT Type:	WLAN Module
FCC/ IC Model name(s):	TWFM-B008D
Date(s) of Tests:	June 16, 2014 ~ June 30, 2014
Place of Tests:	HCT Co., Ltd. 74,Seoicheon-ro 578beon-gil,Majang-myeon, Icheon-si, Gyeonggi-do, Korea. (IC Recognition No. : 5944A-3)

2. EUT DESCRIPTION

EUT Type	WLAN Module	
FCC/ IC Model Name	TWFM-B008D	
Power Supply	DC 3.5 V	
Frequency Range	TX_20 MHz BW: 40 MHz BW: RX_20 MHz BW: 40 MHz BW:	5180 MHz - 5240 MHz (UNII 1) 5190 MHz - 5230 MHz (UNII 1) 5180 MHz - 5240 MHz (UNII 1) 5190 MHz - 5230 MHz (UNII 1)
Port 0 **Max. RF Output Power**	Wi-Fi 802.11a (5180~5240) (10.06 dBm)/ Wi-Fi 802.11n_20 MHz BW (5180~5240) (10.58 dBm)/ Wi-Fi 802.11n_40 MHz BW(5190~5230) (12.47 dBm)	
Port 1 **Max. RF Output Power**	Wi-Fi 802.11a (5180~5240) (9.58 dBm)/ Wi-Fi 802.11n_20 MHz BW (5180~5240) (9.44 dBm)/ Wi-Fi 802.11n_40 MHz BW(5190~5230) (12.57 dBm)	
Modulation Type	OFDM(802.11a, 802.11n)	
Antenna Specification	Manufacturer: Amotech Antenna type: PCB Antenna Peak Gain : cf. Section 6	

2.1 EUT OPERATING MODE

▣ Operating mode

Mode	Operating Mode	Operating Ant.
802.11a,n	SISO	Ant 0
		Ant 1
	MIMO	Ant 0 & 1

Note :

1. In case of radiation test, we have done all test case. Worst case is Ant 0 & 1. So, we attached the results of only worst case.

3. TEST METHODOLOGY

The measurement procedure described in FCC KDB 789033 D01 General UNII Test Procedures Old Rules v01r04 dated June 06, 2014 entitled " Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part15, Subpart E" and the American National Standard for Testing Unlicensed Wireless Devices(ANSI C63.4-2003) were used in the measurement.

3.1 EUT CONFIGURATION

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

3.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.407 under the FCC Rules Part 15 Subpart E.

3.3 GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.4. (Version :2003) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m 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 hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 13.1.4.1 of ANSI C63.4. (Version: 2003)

Conducted Antenna Terminal

See Section from 8.1 to 8.4.(KDB 789033)

3.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

4. INSTRUMENT CALIBRATION

The. measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipments, which is traceable to recognized national standards

5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2003) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated February 28, 2014 (Registration Number: 90661)

5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

6. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of this E.U.T are permanently attached.

*The E.U.T Complies with the requirement of §15.203

▣ Directional Gain Calculations

▪ If any transmit signals are correlated with each other(802.11a,n),

Directional gain = $10*\log[(10^{G1/20} + 10^{G2/20}+\ldots+10^{GN/20})^2/N]$ dBi

▪ If all transmit signals are completely uncorrelated with each other(802.11n)

Directional gain = $10*\log[(10^{G1/10} + 10^{G2/10}+\ldots+10^{GN/10})/N]$ dBi

▣ Antenna Gain

CDD mode(UNII 1)

Antenna Gain	Ant 0	4.09 dBi
	Ant 1	3.85 dBi
Directional Antenna Gain	Ant 0 & 1	6.98 dBi(802.11a,n)

7. SUMMARY OF TEST RESULTS

7.1 FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
26dB Bandwidth	§15.407 (for Power Measurement)	NA	CONDUCTED	PASS
Maximum Conducted Output Power,	§15.407(a)(1)	< 50 mW or 4+10 log $_{10}$ (BW) dBm (5150-5250 MHz)		PASS
Peak Power Spectral Density	§15.407(a)(1), (5)	<4 dBm/ MHz (5150-5250)		PASS
Peak Excursion	§15.407(a)(6)	<13 dB/ MHz maximum difference		PASS
Frequency Stability	§15.407(g)	NA		NA
AC Conducted Emissions 150 kHz-30 MHz	§15.207	<FCC 15.207 limits		NA
Undesirable Emissions	§15.407(b)(1), (2), (3)	<-27 dBm/ MHz EIRP (5150-5350 MHz, 5470-5725 MHz)	RADIATED	PASS
General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	§15.205, 15.407(b)(1), (5), (6)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		PASS

7.2 IC Part

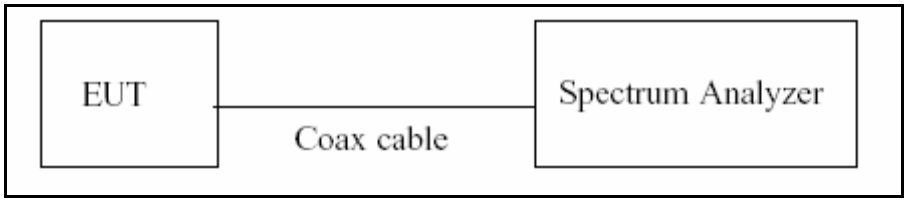
Test Description	IC Part Section(s)	Test Limit	Test Condition	Test Result
99% Bandwidth(IC)	RSS-GEN 4.6.1	NA	CONDUCTED	PASS
Maximum e.i.r.p (IC)	RSS-210 [A9.2]	< 200 mW or 10+10 log $_{10}$ (BW) dBm (5150-5250 MHz)		PASS
e.i.r.p Spectral Density	RSS-210 [A9.2]	<10 dBm/ MHz (5150-5250)		PASS
AC Conducted Emissions 150 kHz-30 MHz	RSS-GEN, Section 7.2.4	RSS-GEN section 7.2.4 table 4		NA
Undesirable Emissions	RSS-210 [A8.5]	<-27 dBm/ MHz EIRP (5150-5250 MHz)	RADIATED	PASS
General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	RSS-GEN, Section 7.2.3	Emissions in restricted bands must meet the radiated limits detailed in 15.209		PASS
Receiver Spurious Emissions	RSS-GEN, Section 7.2.3	cf. Section 8.8.3		PASS

8. TEST RESULT

8.1 DUTY CYCLE

The zero-span mode on a spectrum analyzer or EMI receiver ,if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ EBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/*T*, where *T* is defined in section B)1)a), and the number of sweep points across duration *T* exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if *T* ≤ 16.7 microseconds.)

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We tested accroding to the zero-span measurement method, B)2) in KDB 789033(issued 06/06/2014)
The largest availble value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)
The zero-span method was used becaure all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest availble value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

▣ Duty Cycle Factor

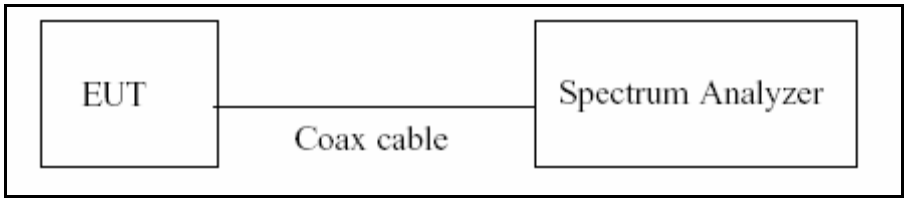
Mode	Data Rate	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor
802.11a_20 MHz BW	6	2.057	2.177	0.94487827	0.246
	9	1.380	1.455	0.94845361	0.230
	12	1.038	1.095	0.94794521	0.232
	18	0.700	0.740	0.94594595	0.241
	24	0.529	0.558	0.94802867	0.232
	36	0.362	0.388	0.93298969	0.301
	48	0.275	0.299	0.91973244	0.363
	54	0.247	0.272	0.90808824	0.419
802.11n_20 MHz BW	6.5	1.902	2.007	0.94768311	0.233
	13	0.966	1.017	0.94985251	0.223
	19.5	0.650	0.684	0.95029240	0.221
	26	0.492	0.518	0.94980695	0.224
	39	0.338	0.364	0.92857143	0.322
	52	0.259	0.283	0.91519435	0.385
	58.5	0.236	0.260	0.90769231	0.421
	65	0.215	0.239	0.89958159	0.460
802.11n_40 MHz BW	13.5	0.927	1.029	0.90087464	0.453
	27	0.478	0.528	0.90530303	0.432
	40.5	0.327	0.362	0.90331492	0.442
	54	0.251	0.275	0.91272727	0.397
	81	0.176	0.199	0.88442211	0.533
	108	0.140	0.163	0.85889571	0.661
	121.5	0.127	0.151	0.84105960	0.752
	135	0.115	0.139	0.82733813	0.823

8.2 26 dB BANDWIDTH MEASUREMENT

The bandwidth at 26 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum power control level, as defined in KDB 789033(issued 06/06/2014), at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 26 dB bandwidth.

The 26 dB bandwidth is used to determine the conducted power limits.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

1. The Spectrum Analyzer is set to(C in KDB 789033, issued 06/06/2014)
2. RBW = approximately 1 % of the emission bandwidth
3. VBW > RBW
4. Detector = Peak
5. Trace mode = max hold
6. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1 %.

Note : We tested 26 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 26 dB.

▣ TEST RESULTS Ant.0

20 MHz BW

Conducted 26 dB Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5180	36	19.09	N/A	Pass
5200	40	19.21	N/A	Pass
5240	48	19.37	N/A	Pass

Conducted 26 dB Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5180	36	19.40	N/A	Pass
5200	40	19.36	N/A	Pass
5240	48	19.34	N/A	Pass

40 MHz BW

Conducted 26 dB Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5190	38	39.24	N/A	Pass
5230	46	39.46	N/A	Pass

▣ TEST RESULTS Ant.1

20 MHz BW

Conducted 26 dB Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5180	36	19.07	N/A	Pass
5200	40	19.15	N/A	Pass
5240	48	19.23	N/A	Pass

Conducted 26 dB Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5180	36	19.56	N/A	Pass
5200	40	19.43	N/A	Pass
5240	48	19.43	N/A	Pass

40 MHz BW

Conducted 26 dB Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]	Minimum Bandwidth [MHz]	Pass / Fail
Frequency [MHz]	Channel No.			
5190	38	39.25	N/A	Pass
5230	46	39.70	N/A	Pass

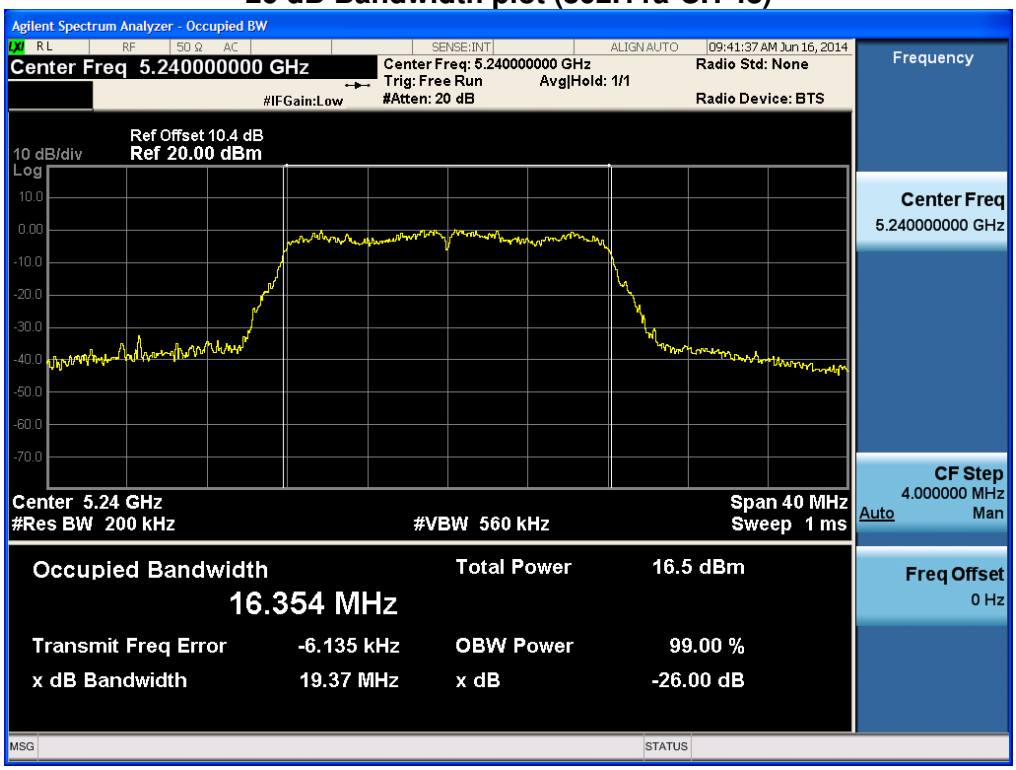
Note :

1. **In order to simplify the report, attached plots were only the most wide channel.**
2. **We did not perform 20 dB BW test. Because already 26 dB BW is narrower than 20 MHz. We performed the 26 dB BW test for highest channel in UNII1 band to prove that no part of the fundamental emissions of any UNII1 band signals lies within the UNII2 band.**

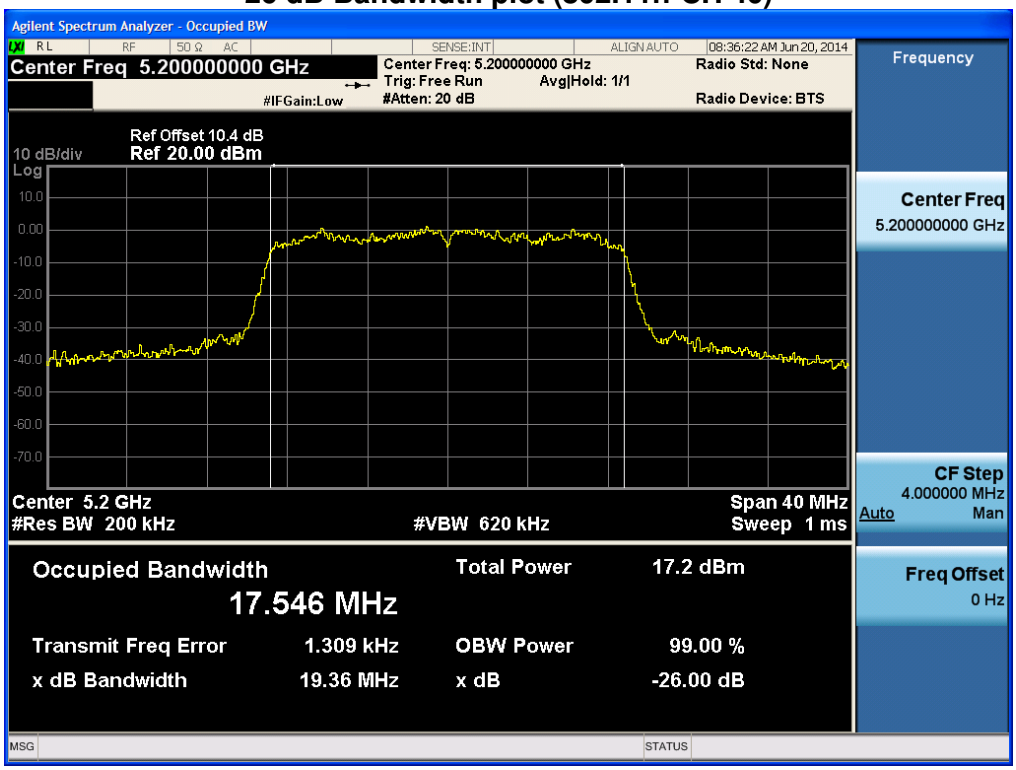
▣ RESULT PLOTS Ant.0

20 MHz BW

26 dB Bandwidth plot (802.11a-CH 48)

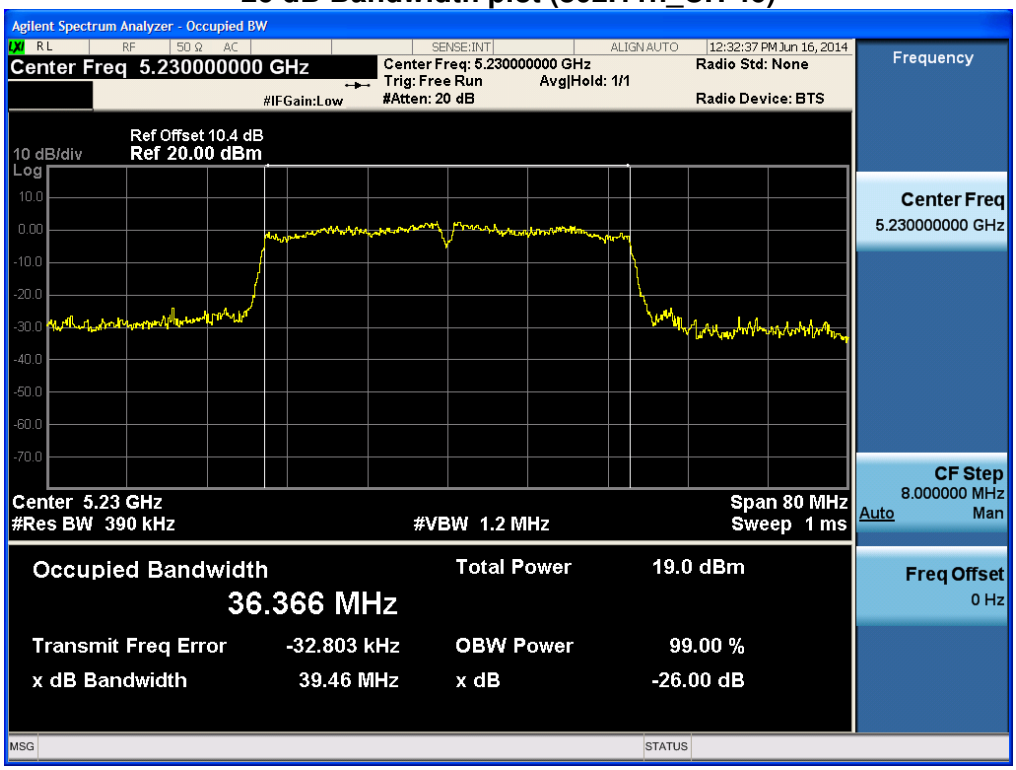


26 dB Bandwidth plot (802.11n-CH 40)



40 MHz BW

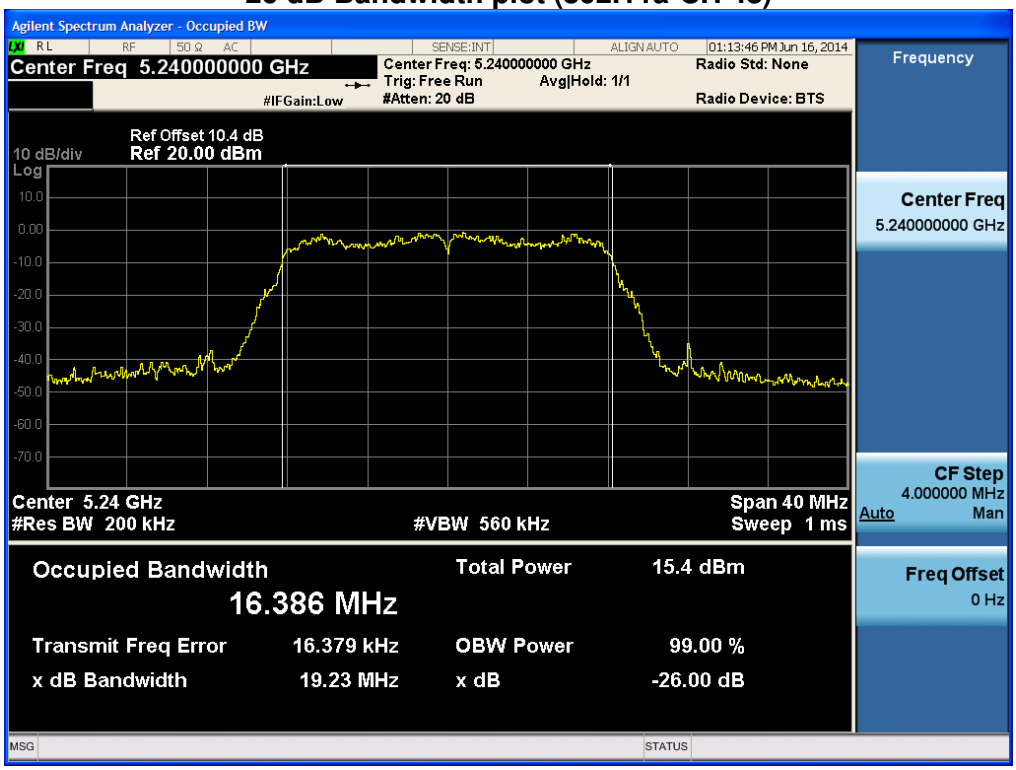
26 dB Bandwidth plot (802.11n_CH 46)



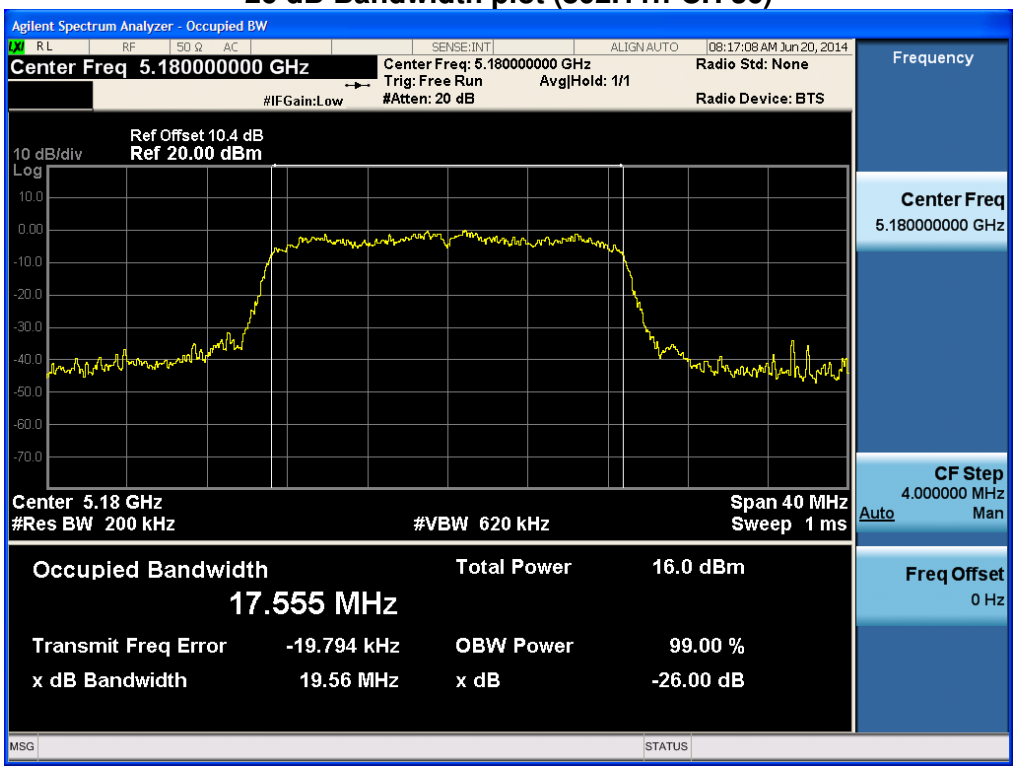
▣ RESULT PLOTS Ant.1

20 MHz BW

26 dB Bandwidth plot (802.11a-CH 48)

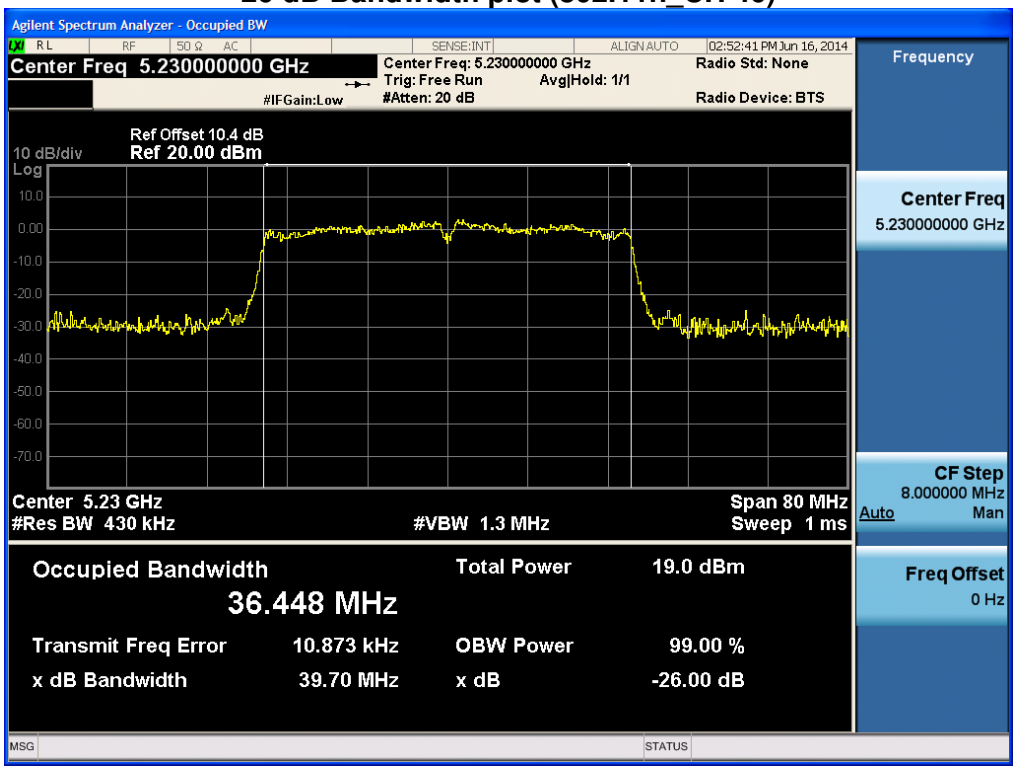


26 dB Bandwidth plot (802.11n-CH 36)



40 MHz BW

26 dB Bandwidth plot (802.11n_CH 46)



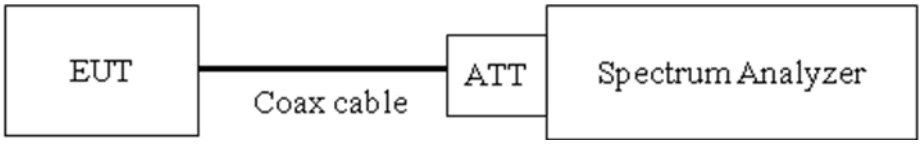
8.3 99% BANDWIDTH MEASUREMENT

limit

None; for IC reporting purposes only

The 99 % bandwidth is used to determine the conducted power limits(for IC).

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to as close to 1% of the selected span. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RBW = 1% of the total span
VBW ≥ 3 x RBW
Detector = Peak
Trace mode = max hold
Sweep = auto couple
Allow the trace to stabilize

▣ TEST RESULTS Ant.0

20 MHz BW

Conducted 99% Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5180	36	16.485
5200	40	16.518
5240	48	16.527

Conducted 99% Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5180	36	17.625
5200	40	17.614
5240	48	17.605

40 MHz BW

Conducted 99% Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5190	38	36.508
5230	46	36.471

▣ TEST RESULTS Ant.1

20 MHz BW

Conducted 99% Bandwidth Measurements for 802.11a

802.11a Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5180	36	16.520
5200	40	16.503
5240	48	16.461

Conducted 99% Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5180	36	17.614
5200	40	17.608
5240	48	17.592

40 MHz BW

Conducted 99% Bandwidth Measurements for 802.11n

802.11n Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
5190	38	36.451
5230	46	36.496

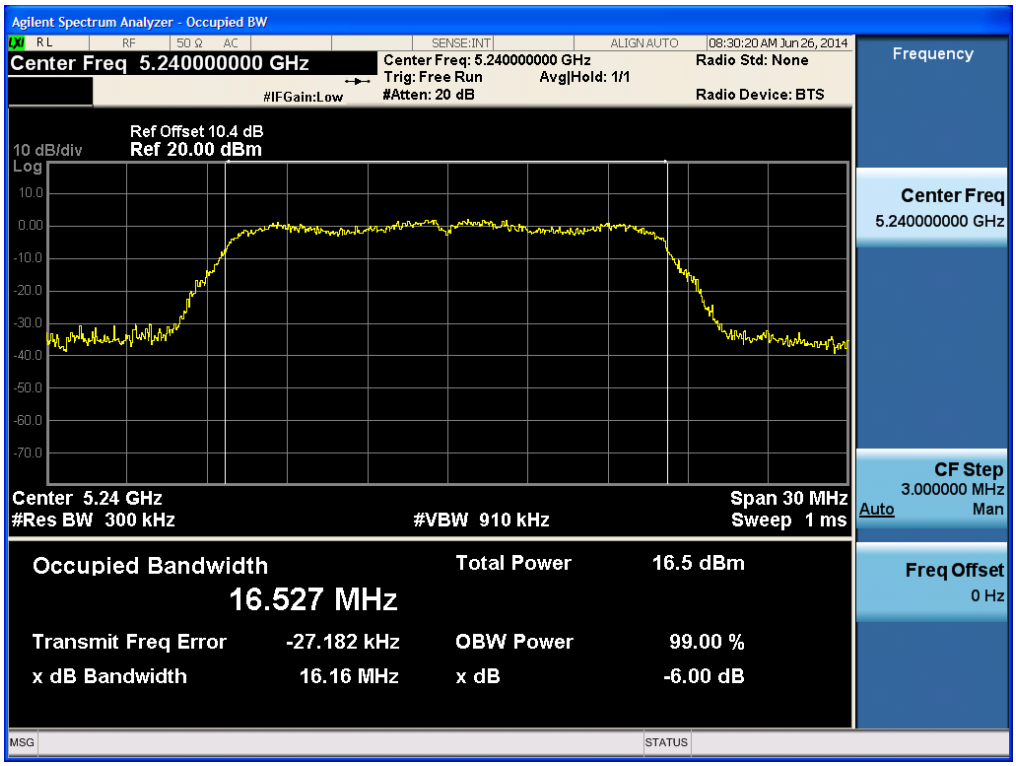
Note :

1. **In order to simplify the report, attached plots were only the most wide channel.**

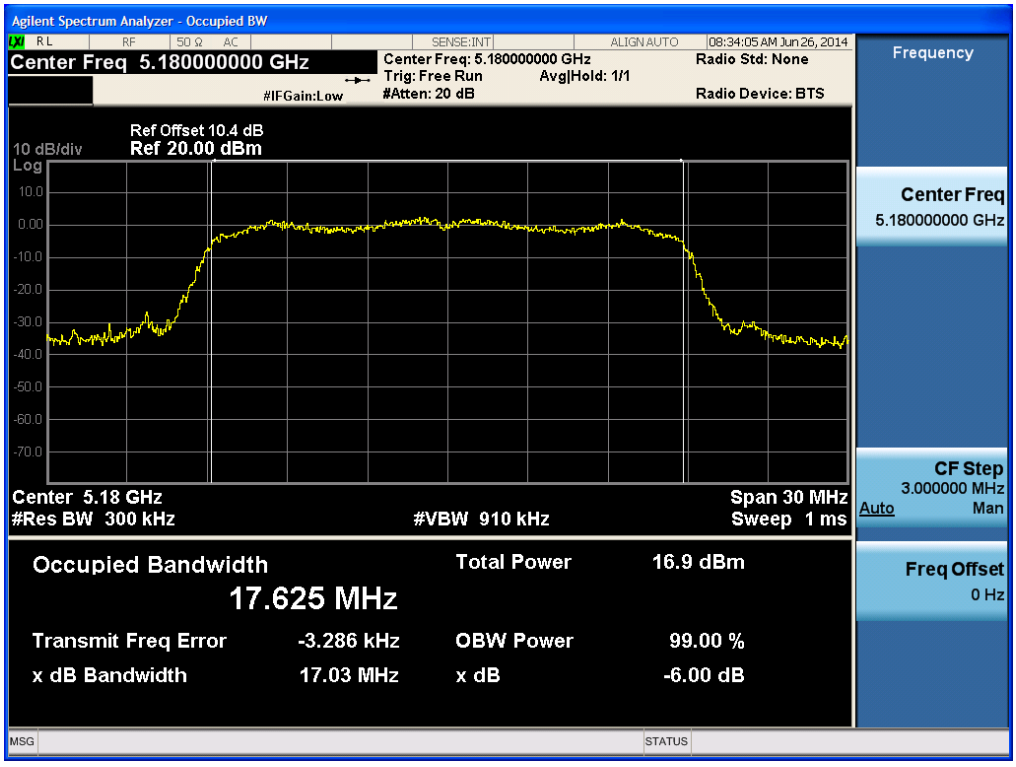
▣ RESULT PLOTS Ant.0

20 MHz BW

99% Bandwidth plot (802.11a-CH48)

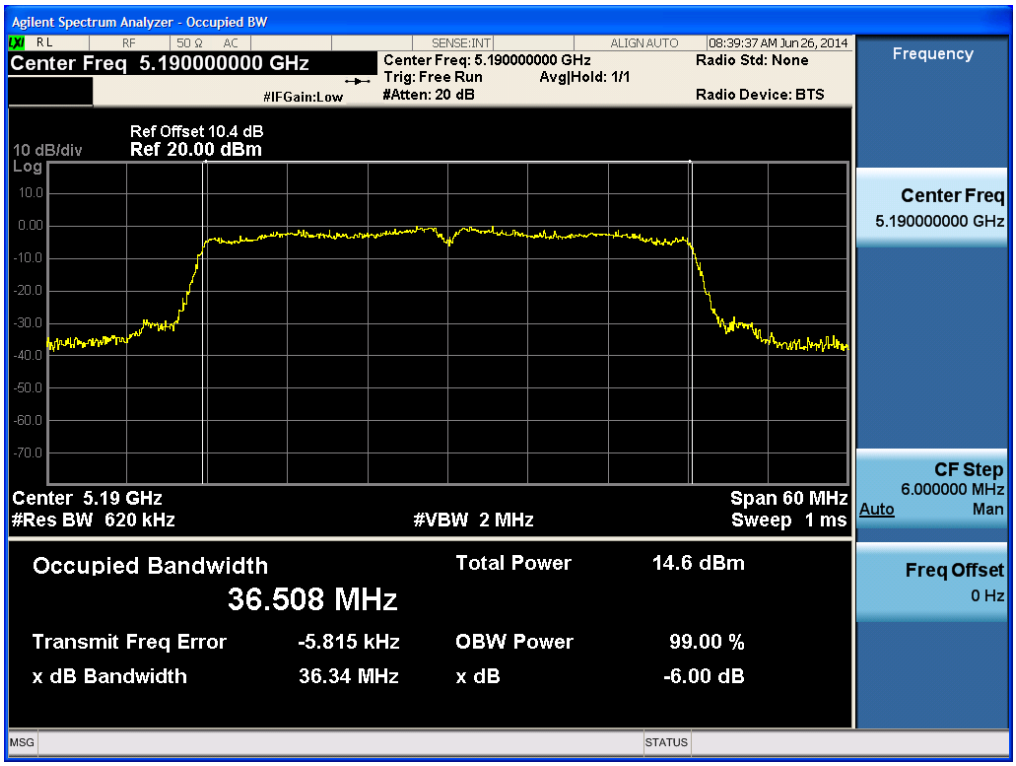


99% Bandwidth plot (802.11n-CH36)



40 MHz BW

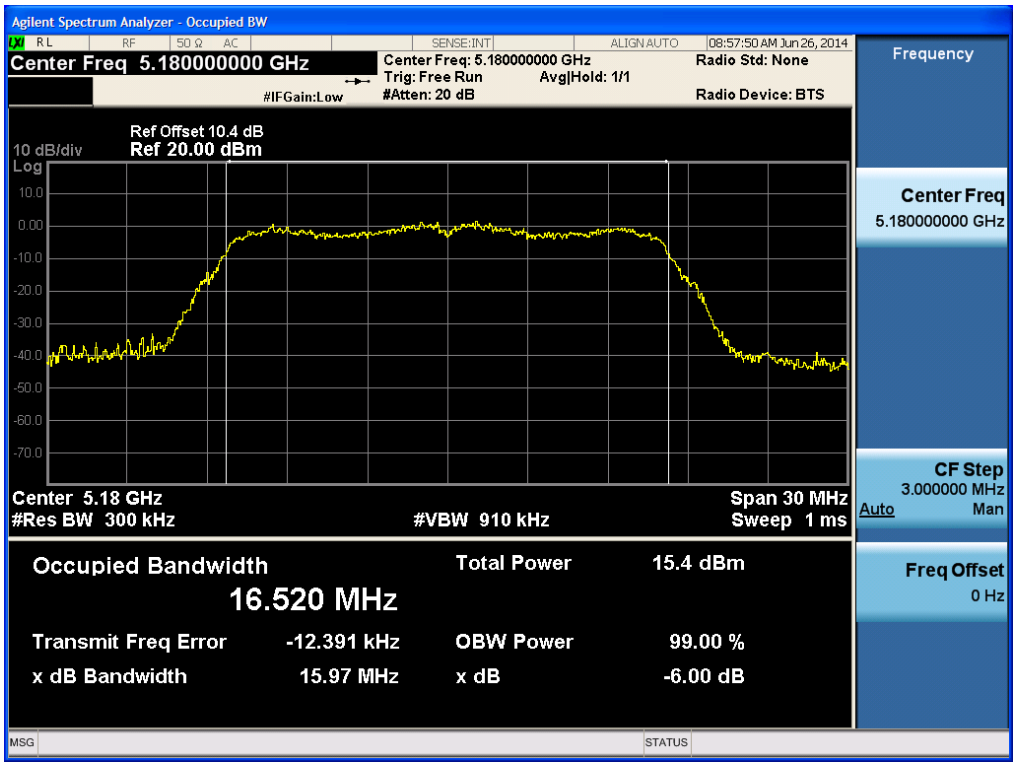
99% Bandwidth plot (802.11n-CH38)



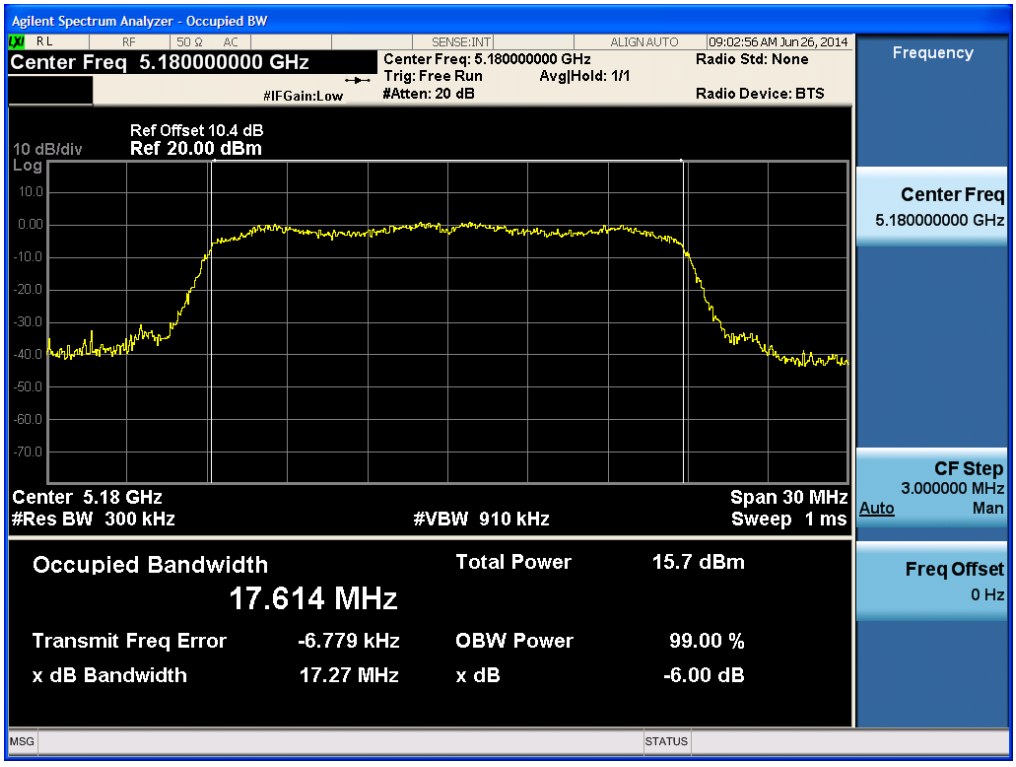
▣ RESULT PLOTS Ant.1

20 MHz BW

99% Bandwidth plot (802.11a-CH36)

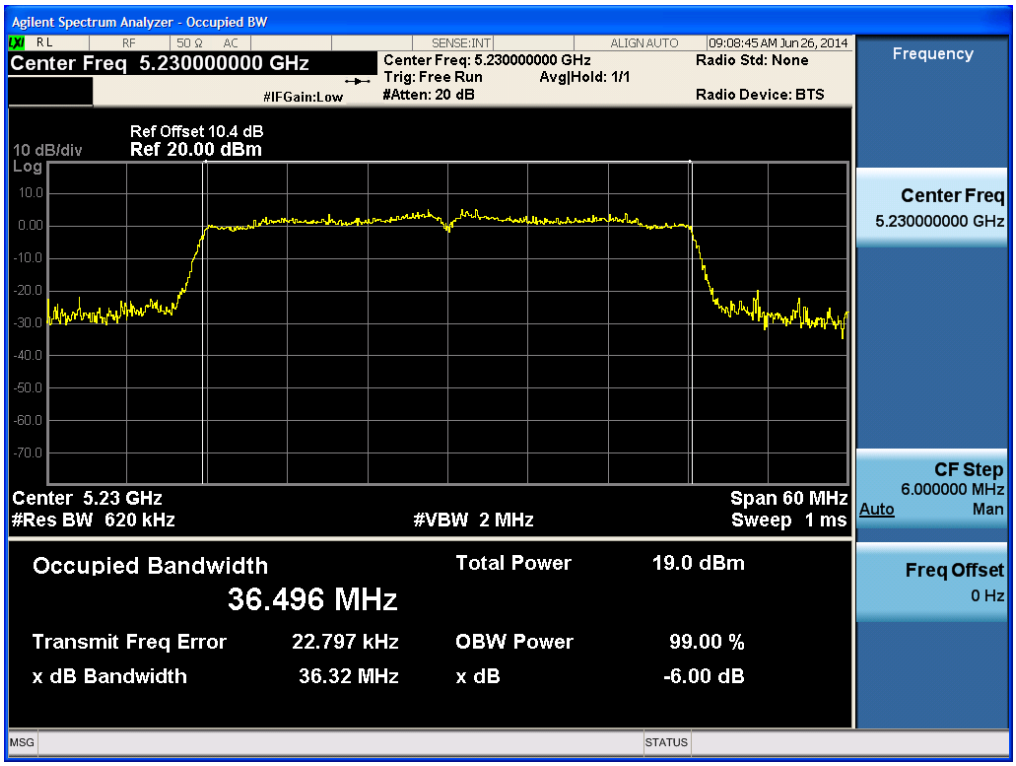


99% Bandwidth plot (802.11n-CH36)



40 MHz BW

99% Bandwidth plot (802.11n-CH46)



8.4 OUTPUT POWER MEASUREMENT AND E.I.R.P.

Test Requirements and limit, §15.407(a)(1) & RSS-210

The transmitter output is connected to the input of a RF power sensor or spectrum analyzer. Measurement is made using a broadband power meter capable of making peak and average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

▣ Limit(CDD)

1. Maximum Conducted Output Power(for FCC)
2. 50 mW(16.99 dBm) or 4+10 log $_{10}$ (BW) dBm whichever power is less.

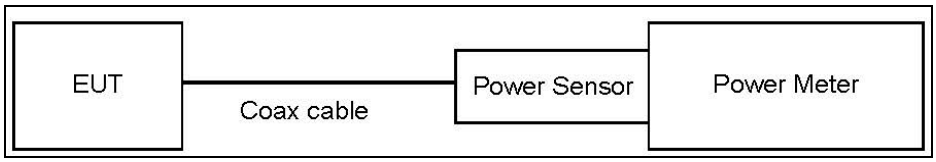
Operating Mode	Band	Mode	Ant. Port	Ant. Gain (dBi)	Limit (dBm)
SISO	UNII 1	802.11a,n_20 MHz	0	4.09	16.81
			1	3.85	16.80
		802.11n_40 MHz	0	4.09	16.99
			1	3.85	16.99
MIMO(2 TX)	UNII 1	802.11a,n_20 MHz	0 & 1	6.98	15.82
		802.11n_40 MHz	0 & 1	6.98	16.01

Note : Above the limits is calculated according to antenna gain. Because antenna gain is higher than 6 dBi.

3. Maximum EIRP(for & IC) : 200 mW or 10+10 log $_{10}$ (BW) dBm whichever power is less.

Note : The limits of conducted power were applied the antenna gain. Therefore, if conducted power is pass, EIRP is also pass. So, we attached only conducted power table.

▣ TEST CONFIGURATION(20 MHz BW)



▣ TEST PROCEDURE(20 MHz BW)

We tested according to Method E)3)a) in KDB 789033(issued 06/06/2014).

▪ Average Power

1. Measure the duty cycle.
2. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
3. Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

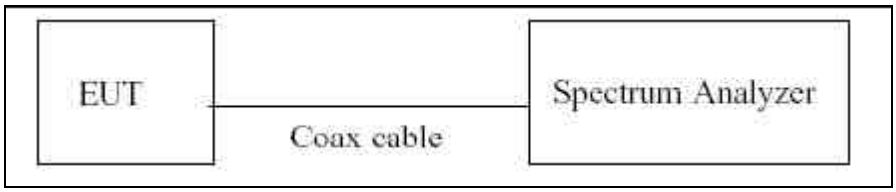
Note :

1. We apply to the offset in the UNII 1 band that was rounded off to the closest tenth dB. Actual value of loss for the attenuator and cable combination is below table. We used the particular cable type that is supported by manufacture.

Band	Loss(dB)
UNII 1	10.4

(Actual value of loss for the attenuator and cable combination)

▣ TEST CONFIGURATION(40 MHz BW)



▣ TEST PROCEDURE(40 MHz BW)

The transmitter output is connected to the Spectrum Analyzer. We use the spectrum analyzer's integrated band power measurement function. We tested according to Method SA-2 in KDB 789033(issued 06/06/2014).

The Spectrum Analyzer is set to

▪ Average Power

1. Measure the duty cycle.
2. Set span to encompass the 26 dB EBW of the signal.
3. RBW = 1 MHz.
4. VBW ≥ 3 MHz.
5. Number of points in sweep ≥ 2*span/RBW.

6. Sweep time = auto.
7. Detector = RMS.
8. Do not use sweep triggering. Allow the sweep to “free run”.
9. Trace average at least 100 traces in power averaging(RMS) mode
10. Integrated bandwidth = OBW
11. Add 10log(1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Note :

1. We apply to the offset in the UNII 1 band that was rounded off to the closest tenth dB. Actual value of loss for the attenuator and cable combination is below table.

Band	Loss(dB)
UNII 1	10.4

(Actual value of loss for the attenuator and cable combination)

▣ Sample Calculation (Conducted)

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

▣ Sample Calculation (EIRP)

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor + Ant. Gain

▣ TEST RESULTS_Ant.0

Conducted Output Power Measurements (802.11a Mode: 5180~5240)

802.11a Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5180	36	6	8.88	0.246	9.12	16.81
		9	9.25	0.230	9.48	16.81
		12	9.18	0.232	9.41	16.81
		18	8.99	0.241	9.23	16.81
		24	9.12	0.232	9.35	16.81
		36	9.05	0.301	9.36	16.81
		48	8.97	0.363	9.33	16.81
		54	8.91	0.419	9.32	16.81
5200	40	6	9.77	0.246	10.01	16.81
		9	9.80	0.230	10.03	16.81
		12	9.81	0.232	10.04	16.81
		18	9.78	0.241	10.02	16.81
		24	9.81	0.232	10.04	16.81
		36	9.76	0.301	10.06	16.81
		48	9.59	0.363	9.95	16.81
		54	9.54	0.419	9.96	16.81
5240	48	6	9.56	0.246	9.81	16.81
		9	9.60	0.230	9.83	16.81
		12	9.53	0.232	9.76	16.81
		18	9.57	0.241	9.81	16.81
		24	9.55	0.232	9.78	16.81
		36	9.51	0.301	9.81	16.81
		48	9.55	0.363	9.92	16.81
		54	9.39	0.419	9.81	16.81

▣ TEST RESULTS_Ant.1

Conducted Output Power Measurements (802.11a Mode: 5180~5240)

802.11a Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5180	36	6	9.23	0.246	9.48	16.80
		9	9.17	0.230	9.40	16.80
		12	9.35	0.232	9.58	16.80
		18	9.32	0.241	9.56	16.80
		24	8.89	0.232	9.13	16.80
		36	8.80	0.301	9.10	16.80
		48	8.71	0.363	9.07	16.80
		54	8.68	0.419	9.10	16.80
5200	40	6	8.49	0.246	8.73	16.80
		9	8.06	0.230	8.29	16.80
		12	8.21	0.232	8.44	16.80
		18	8.23	0.241	8.47	16.80
		24	8.21	0.232	8.44	16.80
		36	8.18	0.301	8.48	16.80
		48	8.12	0.363	8.48	16.80
		54	8.12	0.419	8.54	16.80
5240	48	6	8.54	0.246	8.79	16.80
		9	8.54	0.230	8.77	16.80
		12	8.25	0.232	8.48	16.80
		18	8.56	0.241	8.80	16.80
		24	8.63	0.232	8.86	16.80
		36	8.55	0.301	8.86	16.80
		48	8.04	0.363	8.40	16.80
		54	8.40	0.419	8.81	16.80

▣ TEST RESULTS_Sum Data of Ant.0 and Ant.1

Conducted Output Power Measurements (802.11a Mode: 5180~5240)

802.11a Mode		Rate	Measured	Limit
Frequency[MHz]	Channel No.	(Mbps)	Power(dBm)	(dBm)
5180	36	6	12.31	15.82
		9	12.45	15.82
		12	12.51	15.82
		18	12.41	15.82
		24	12.25	15.82
		36	12.24	15.82
		48	12.21	15.82
		54	12.22	15.82
5200	40	6	12.43	15.82
		9	12.26	15.82
		12	12.32	15.82
		18	12.32	15.82
		24	12.32	15.82
		36	12.35	15.82
		48	12.29	15.82
		54	12.32	15.82
5240	48	6	12.34	15.82
		9	12.34	15.82
		12	12.18	15.82
		18	12.34	15.82
		24	12.35	15.82
		36	12.37	15.82
		48	12.24	15.82
		54	12.35	15.82

▣ TEST RESULTS_Ant.0

Conducted Output Power Measurements (802.11n Mode: 5180~5240) _20 MHz BW

802.11n Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5180	36	6.5	10.26	0.233	10.49	16.81
		13	10.35	0.223	10.58	16.81
		19.5	10.34	0.221	10.57	16.81
		26	10.24	0.224	10.46	16.81
		39	10.20	0.322	10.53	16.81
		52	10.14	0.385	10.53	16.81
		58.5	10.08	0.421	10.50	16.81
		65	10.07	0.460	10.53	16.81
5200	40	6.5	10.22	0.233	10.45	16.81
		13	10.29	0.223	10.52	16.81
		19.5	10.16	0.221	10.38	16.81
		26	10.18	0.224	10.40	16.81
		39	10.06	0.322	10.38	16.81
		52	9.97	0.385	10.36	16.81
		58.5	9.85	0.421	10.27	16.81
		65	9.76	0.460	10.22	16.81
5240	48	6.5	10.00	0.233	10.24	16.81
		13	10.05	0.223	10.27	16.81
		19.5	10.07	0.221	10.29	16.81
		26	10.18	0.224	10.41	16.81
		39	10.05	0.322	10.38	16.81
		52	9.68	0.385	10.07	16.81
		58.5	9.98	0.421	10.40	16.81
		65	9.90	0.460	10.36	16.81

▣ TEST RESULTS_Ant.1

Conducted Output Power Measurements (802.11n Mode: 5180~5240) _20 MHz BW

802.11n Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5180	36	6.5	9.20	0.233	9.44	16.80
		13	8.66	0.223	8.88	16.80
		19.5	8.69	0.221	8.92	16.80
		26	9.11	0.224	9.33	16.80
		39	9.00	0.322	9.32	16.80
		52	8.60	0.385	8.98	16.80
		58.5	8.60	0.421	9.02	16.80
		65	8.61	0.460	9.07	16.80
5200	40	6.5	8.62	0.233	8.86	16.80
		13	8.58	0.223	8.81	16.80
		19.5	9.00	0.221	9.23	16.80
		26	8.51	0.224	8.73	16.80
		39	8.46	0.322	8.78	16.80
		52	8.35	0.385	8.74	16.80
		58.5	8.81	0.421	9.23	16.80
		65	8.35	0.460	8.81	16.80
5240	48	6.5	8.75	0.233	8.99	16.80
		13	8.85	0.223	9.07	16.80
		19.5	8.90	0.221	9.12	16.80
		26	8.91	0.224	9.13	16.80
		39	8.86	0.322	9.18	16.80
		52	8.74	0.385	9.13	16.80
		58.5	8.69	0.421	9.11	16.80
		65	8.69	0.460	9.15	16.80

▣ TEST RESULTS_Sum Data of Ant.0 and Ant.1

Conducted Output Power Measurements (802.11n Mode: 5180~5240) _20 MHz BW

802.11n Mode		Rate	Measured	Limit
Frequency[MHz]	Channel No.	(Mbps)	Power(dBm)	(dBm)
5180	36	6.5	13.01	15.82
		13	12.82	15.82
		19.5	12.83	15.82
		26	12.94	15.82
		39	12.98	15.82
		52	12.83	15.82
		58.5	12.83	15.82
		65	12.87	15.82
5200	40	6.5	12.74	15.82
		13	12.76	15.82
		19.5	12.85	15.82
		26	12.66	15.82
		39	12.66	15.82
		52	12.64	15.82
		58.5	12.79	15.82
		65	12.58	15.82
5240	48	6.5	12.67	15.82
		13	12.72	15.82
		19.5	12.75	15.82
		26	12.83	15.82
		39	12.83	15.82
		52	12.64	15.82
		58.5	12.81	15.82
		65	12.81	15.82

▣ TEST RESULTS_Ant.0

Conducted Output Power Measurements (802.11n Mode: 5190~5230) _40 MHz BW

802.11n Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5190	38	13.5	7.25	0.453	7.70	16.99
		27	7.33	0.432	7.76	16.99
		40.5	7.33	0.442	7.77	16.99
		54	7.36	0.397	7.76	16.99
		81	7.28	0.533	7.81	16.99
		108	7.02	0.661	7.68	16.99
		121.5	7.04	0.752	7.79	16.99
		135	6.96	0.823	7.78	16.99
5230	46	13.5	11.95	0.453	12.40	16.99
		27	11.06	0.432	11.49	16.99
		40.5	12.01	0.442	12.45	16.99
		54	12.07	0.397	12.47	16.99
		81	11.86	0.533	12.40	16.99
		108	11.80	0.661	12.46	16.99
		121.5	11.51	0.752	12.26	16.99
		135	11.60	0.823	12.43	16.99

▣ TEST RESULTS_Ant.1

Conducted Output Power Measurements (802.11n Mode: 5190~5230) _40 MHz BW

802.11n Mode		Rate (Mbps)	Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency [MHz]	Channel No.					
5190	38	13.5	4.46	0.453	4.92	16.99
		27	4.98	0.432	5.41	16.99
		40.5	4.97	0.442	5.41	16.99
		54	4.51	0.397	4.91	16.99
		81	4.83	0.533	5.37	16.99
		108	4.24	0.661	4.90	16.99
		121.5	4.66	0.752	5.41	16.99
		135	4.14	0.823	4.96	16.99
5230	46	13.5	12.11	0.453	12.56	16.99
		27	11.56	0.432	11.99	16.99
		40.5	11.59	0.442	12.03	16.99
		54	11.65	0.397	12.05	16.99
		81	11.91	0.533	12.45	16.99
		108	11.91	0.661	12.57	16.99
		121.5	11.23	0.752	11.98	16.99
		135	11.63	0.823	12.46	16.99

▣ TEST RESULTS_Sum Data of Ant.0 and Ant.1

Conducted Output Power Measurements (802.11n Mode: 5190~5230) _40 MHz BW

802.11n Mode		Rate	Measured	Limit
Frequency[MHz]	Channel No.	(Mbps)	Power(dBm)	(dBm)
5190	38	13.5	9.54	16.01
		27	9.75	16.01
		40.5	9.76	16.01
		54	9.58	16.01
		81	9.77	16.01
		108	9.52	16.01
		121.5	9.77	16.01
		135	9.61	16.01
5230	46	13.5	15.49	16.01
		27	14.76	16.01
		40.5	15.26	16.01
		54	15.28	16.01
		81	15.44	16.01
		108	15.53	16.01
		121.5	15.13	16.01
		135	15.46	16.01

Note :

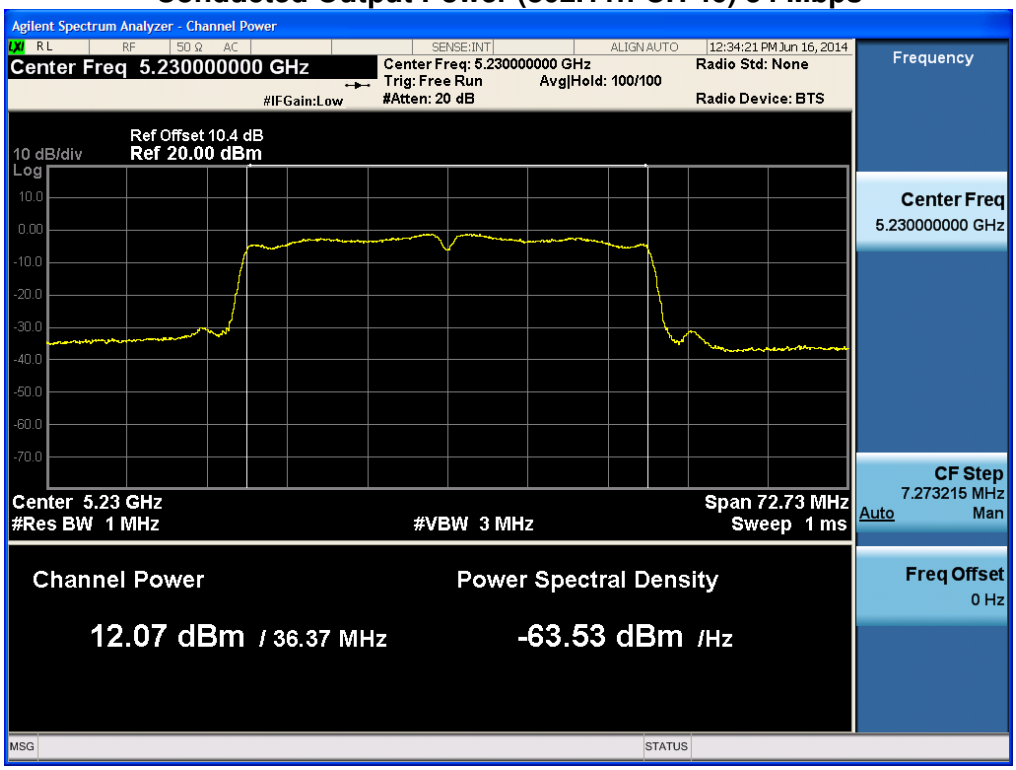
1. **In order to simplify the report, attached plots were only the highest conducted power channel.**

▣ RESULT PLOTS Ant.0

40 MHz BW

▣ RESULT PLOTS (5190 ~ 5230 MHz)

Conducted Output Power (802.11n-CH 46) 54 Mbps

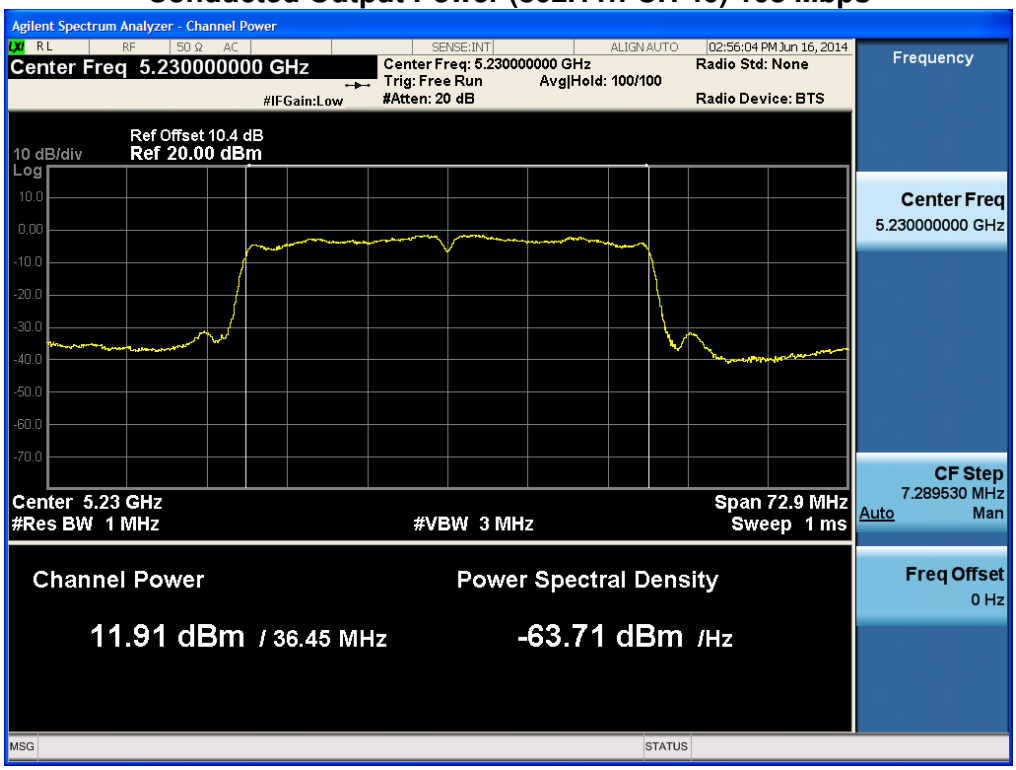


▣ RESULT PLOTS Ant.1

40 MHz BW

▣ RESULT PLOTS (5190 ~ 5230 MHz)

Conducted Output Power (802.11n-CH 46) 108 Mbps



8.5 POWER SPECTRAL DENSITY

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies. The maximum permissible peak power spectral density is 4 dBm/ MHz in the 5.15 GHz – 5.25 GHz band.

▣ Limit(CDD)

1. Maximum Conducted Power Spectral Density(for FCC)

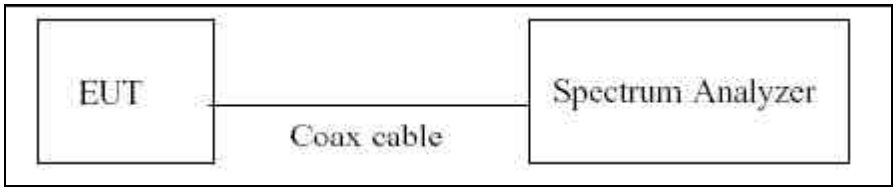
Operating Mode	Band	Mode	Ant. Port	Ant. Gain (dBi)	Limit (dBm)
SISO	UNII 1	802.11a,n	0	4.09	4
			1	3.85	4
MIMO(2 TX)	UNII 1	802.11a,n	0 & 1	6.98	3.02

Note : Above the limits is calculated according to antenna gain. Because antenna gain is higher than 6 dBi.

2. EIRP Sepctral Density : 10 dBm

   Note : The limits of conducted power spectral density were applied the antenna gain. Therefore, if PSD is pass, e.i.r.p. spectral density is also pass. So, we attached only PSD table.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

We tested according to Method in KDB 789033(issued 06/06/2014).

The spectrum analyzer is set to :

1. Set span to encompass the entire emission bandwidth(EBW) of the signal.
2. RBW = 1 MHz.
3. VBW ≥ 3 MHz.
4. Number of points in sweep ≥ 2*span/RBW.
5. Sweep time = auto.
6. Detector = RMS(i.e., power averaging), if available. Otherwise, use sample detector mode.
7. Do not use sweep triggering. Allow the sweep to “free run”.
8. Trace average at least 100 traces in power averaging(RMS) mode

9. Use the peak search function on the spectrum analyzer to find the peak of the spectrum.
10. If Method SA-2 was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.

▣ Sample Calculation

PSD = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

Output Power = -5 dBm + 10 dB + 0.8 dB + 0.21 dB = 16.01 dBm

Note :

1. Spectrum reading values are not plot data. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the UNII 1 band that was rounded off to the closest tenth dB. Actual value of loss for the attenuator and cable combination is below table.

Band	Loss(dB)
UNII 1	10.4

(Actual value of loss for the attenuator and cable combination)

▣ TEST RESULTS_Ant.0

Conducted Power Density Measurements

Frequency (MHz)	Channel No.	Mode	Test Result				
			Measured Power Density (dBm)	Duty Cycle Factor (dB)	Measured Power Density(dBm) + Duty Cycle Factor	Limit (dBm)	Pass/Fail
5180	36	802.11a	-0.935	0.229839	-0.705	4	Pass
5200	40		-0.134	0.301232	0.167		Pass
5240	48		0.024	0.363385	0.387		Pass
5180	36	802.11n 20MHz BW	0.047	0.223438	0.270		Pass
5200	40		0.127	0.223438	0.350		Pass
5240	48		0.110	0.223647	0.334		Pass
5190	38	802.11n 40MHz BW	-5.810	0.533404	-5.277		Pass
5230	46		-0.969	0.39659	-0.572		Pass

▣ TEST RESULTS_Ant.1

Conducted Power Density Measurements

Frequency (MHz)	Channel No.	Mode	Test Result				
			Measured Power Density (dBm)	Duty Cycle Factor (dB)	Measured Power Density(dBm) + Duty Cycle Factor	Limit (dBm)	Pass/Fail
5180	36	802.11a	-1.249	0.232168	-1.017	4	Pass
5200	40		-1.648	0.246241	-1.402		Pass
5240	48		-1.738	0.231785	-1.506		Pass
5180	36	802.11n 20MHz BW	-1.338	0.233369	-1.105		Pass
5200	40		-1.841	0.420613	-1.420		Pass
5240	48		-1.016	0.321847	-0.694		Pass
5190	38	802.11n 40MHz BW	-8.658	0.441608	-8.216		Pass
5230	46		-1.677	0.660596	-1.016		Pass

▣ TEST RESULTS_Sum Data of Ant.0 and Ant.1

Conducted Power Density Measurements

Frequency (MHz)	Channel No.	Mode	Test Result		
			Power Density (dBm)	Limit (dBm)	Pass/Fail
5180	36	802.11a	2.15	3.02	Pass
5200	40		2.46		Pass
5240	48		2.55		Pass
5180	36	802.11n 20MHz BW	2.65		Pass
5200	40		2.56		Pass
5240	48		2.86		Pass
5190	38	802.11n 40MHz BW	-3.49		Pass
5230	46		2.22		Pass

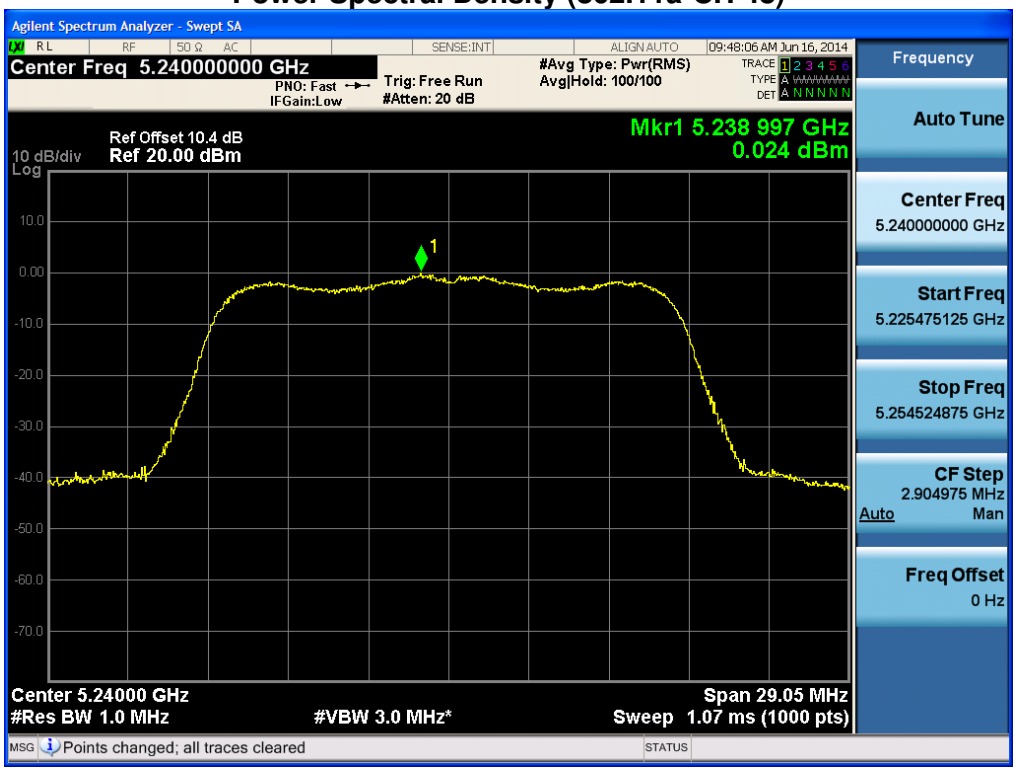
Note :

1. **In order to simplify the report, attached plots were only the highest PSD channel.**

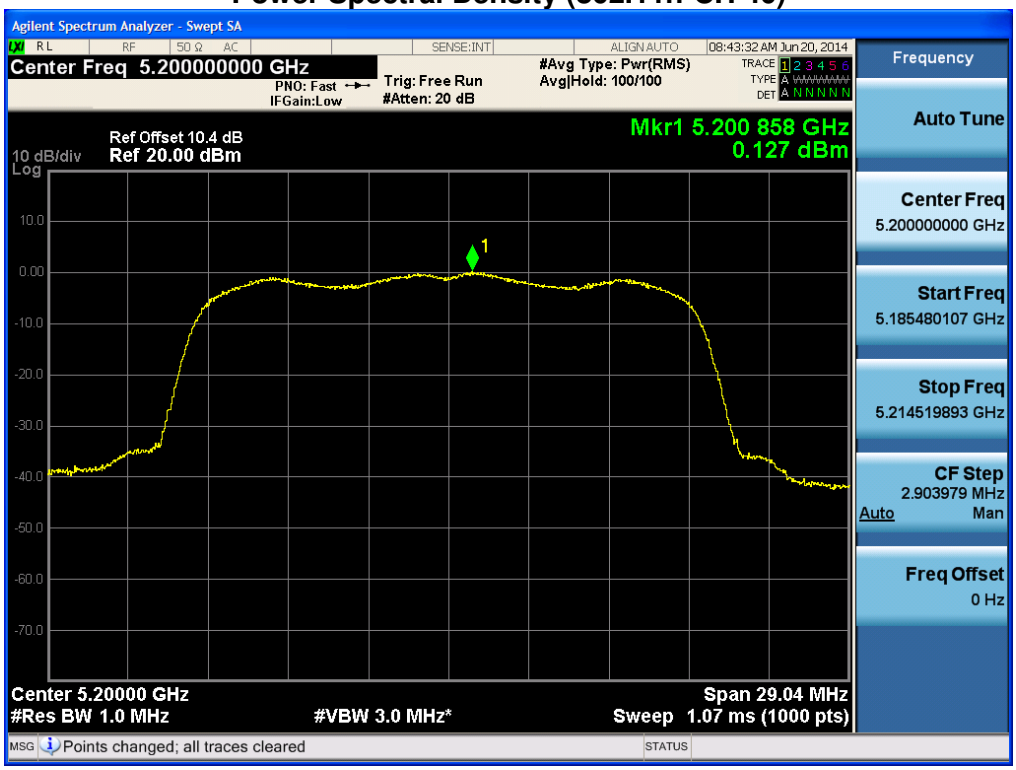
▣ RESULT PLOTS Ant.0

20 MHz BW

Power Spectral Density (802.11a-CH 48)

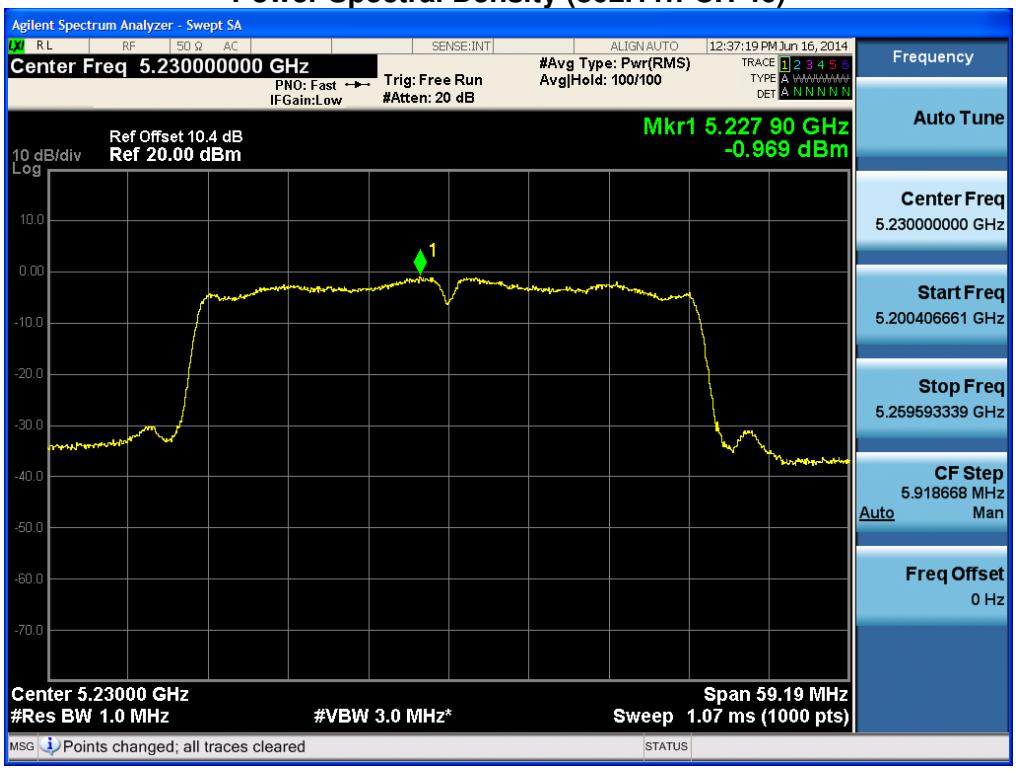


Power Spectral Density (802.11n-CH 40)



40 MHz BW

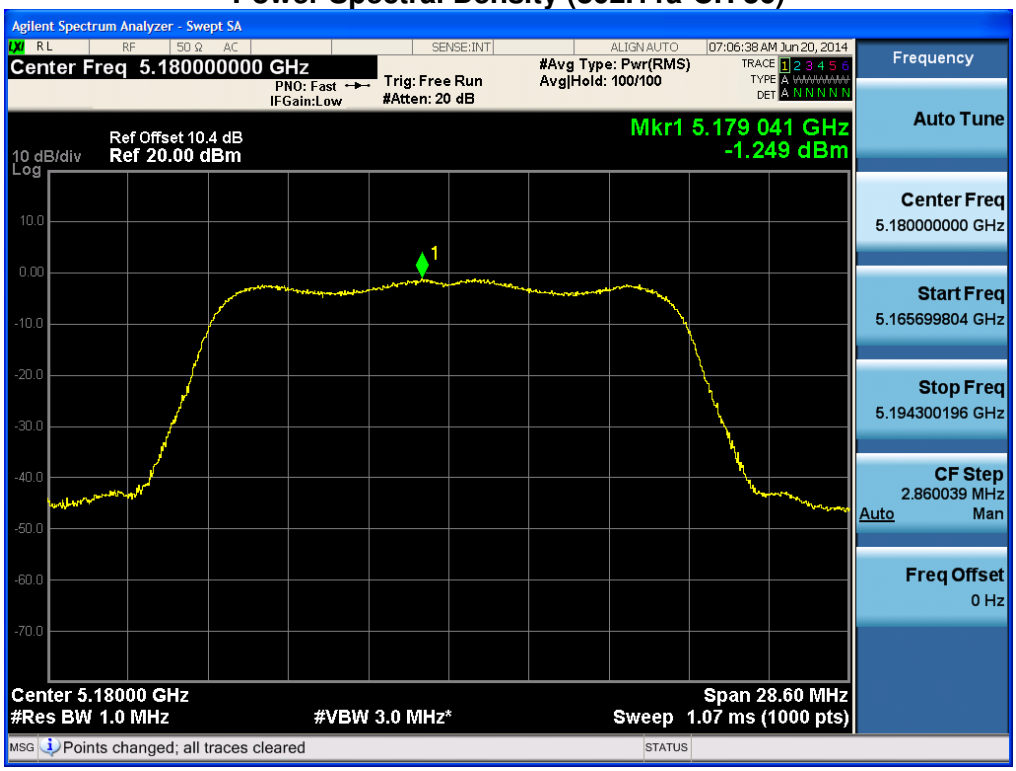
Power Spectral Density (802.11n-CH 46)



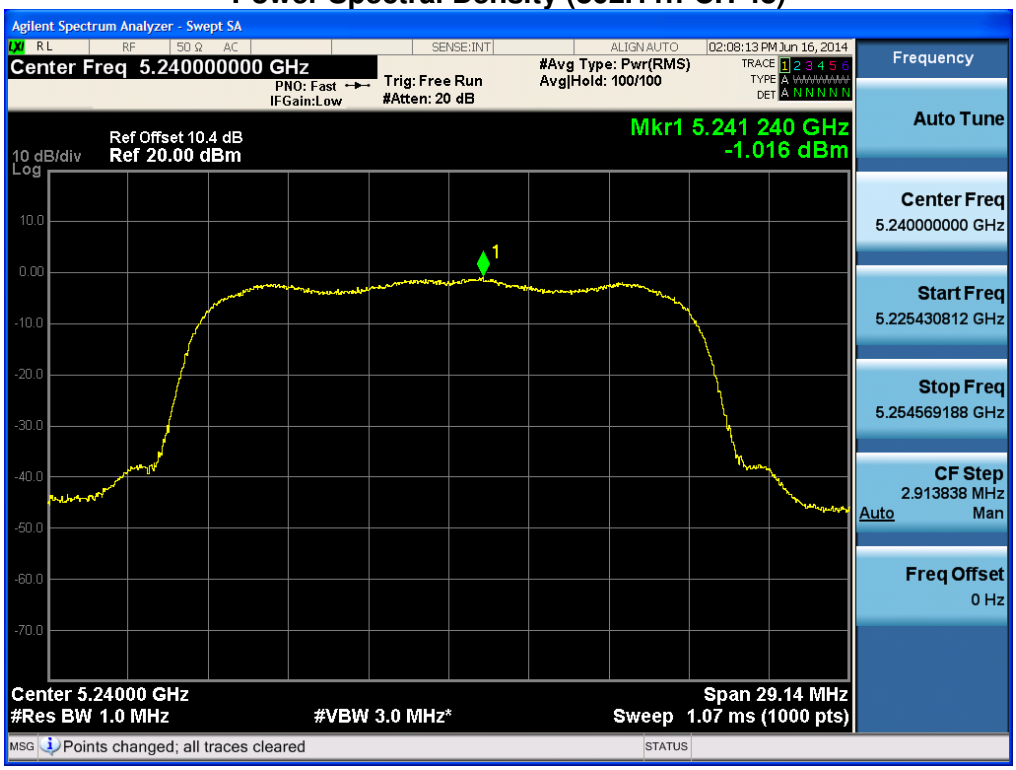
▣ RESULT PLOTS Ant.1

20 MHz BW

Power Spectral Density (802.11a-CH 36)

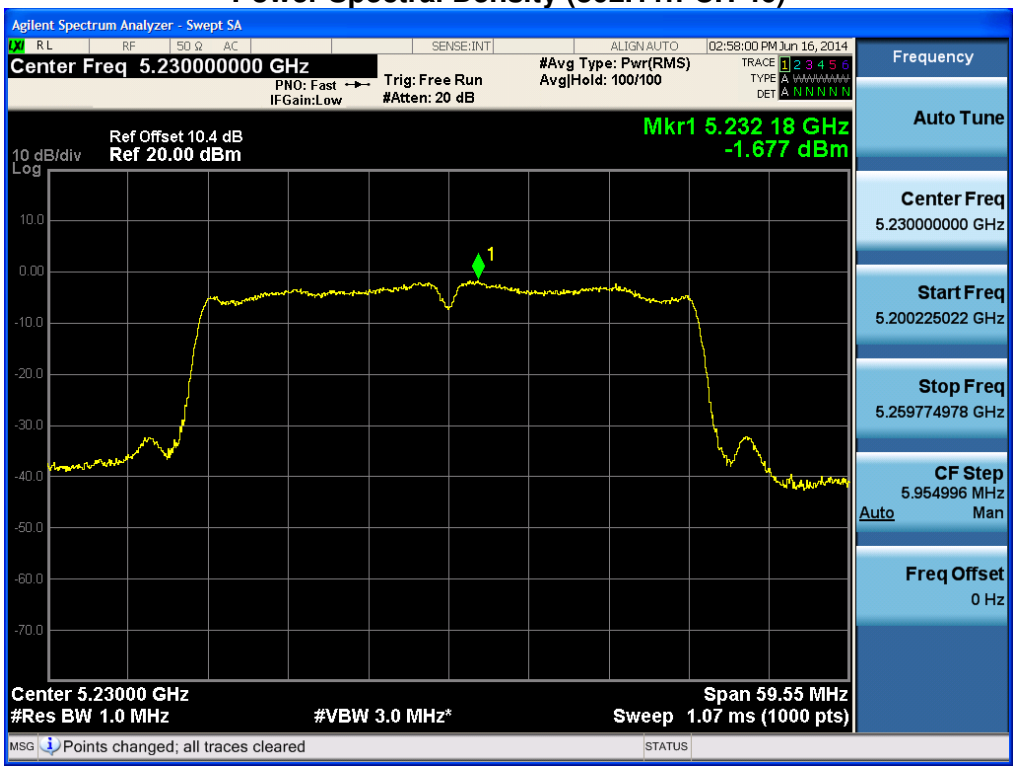


Power Spectral Density (802.11n-CH 48)



40 MHz BW

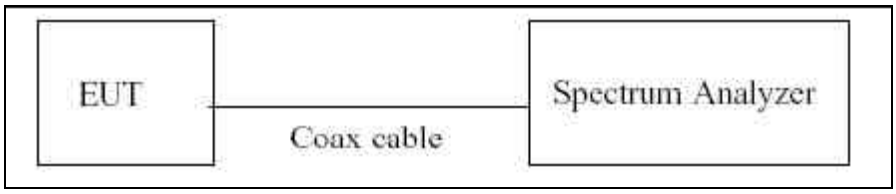
Power Spectral Density (802.11n-CH 46)



8.6 PEAK EXCURSION RATIO

The spectrum analyzer was connected to the antenna terminal while the EUT was operating in the continuous transmission mode at the appropriate center frequencies. The largest permissible difference between the modulation envelope(measured using a peak hold function) and the maximum conducted output power 13 dB/MHz.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

We tested according to KDB 789033(issued 06/06/2014).

The spectrum analyzer is set to :

1. Span = Set the span to view the entire emission bandwidth.
2. RBW = 1 MHz
3. VBW ≥ 3 MHz
4. Detector Mode = Peak
5. Trace Mode = Max hold
6. Allow the sweeps to continue until the trace stabilizes.
7. Use the peak search function to find the peak of the spectrum.
8. Use the procedure to measure the PPSD
9. Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.

Note :

1. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the UNII 1 band that was rounded off to the closest tenth dB. Actual value of loss for the attenuator and cable combination is below table.

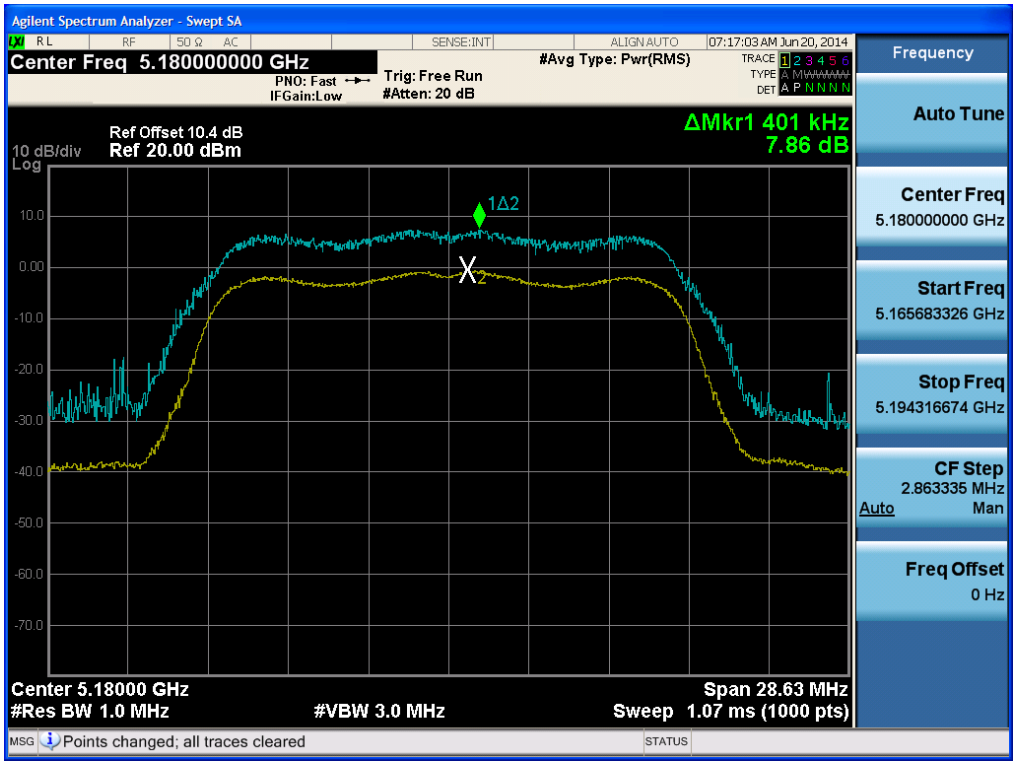
Band	Loss(dB)
UNII 1	10.4

(Actual value of loss for the attenuator and cable combination)

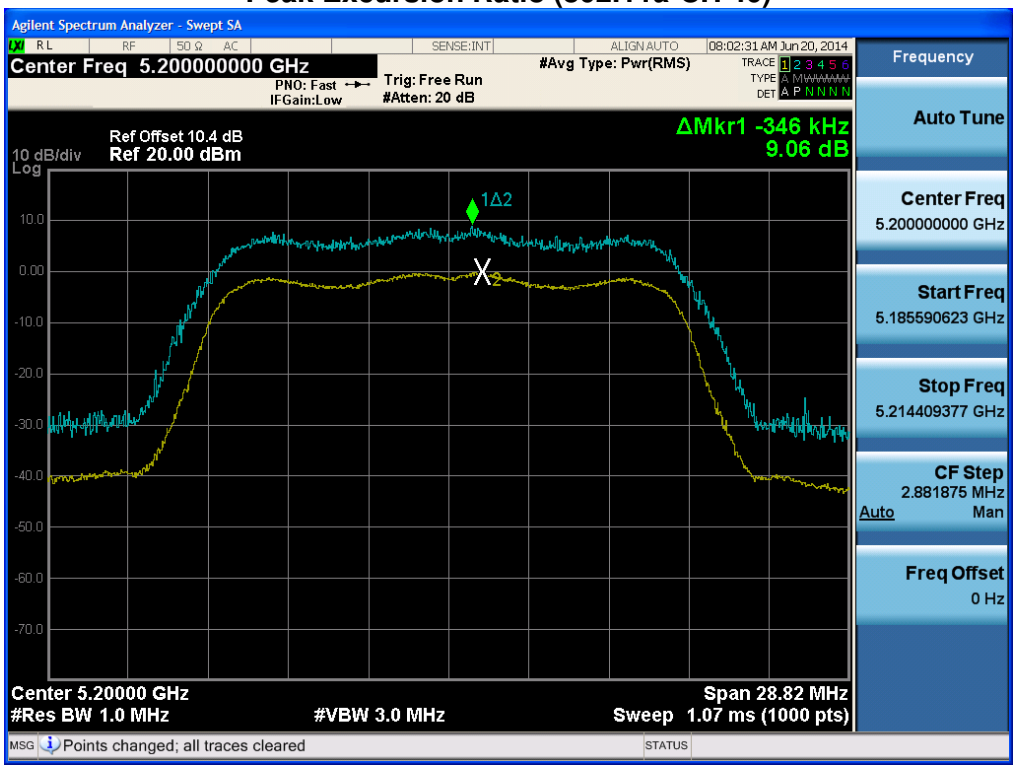
▣ RESULT PLOTS Ant.0

20 MHz BW

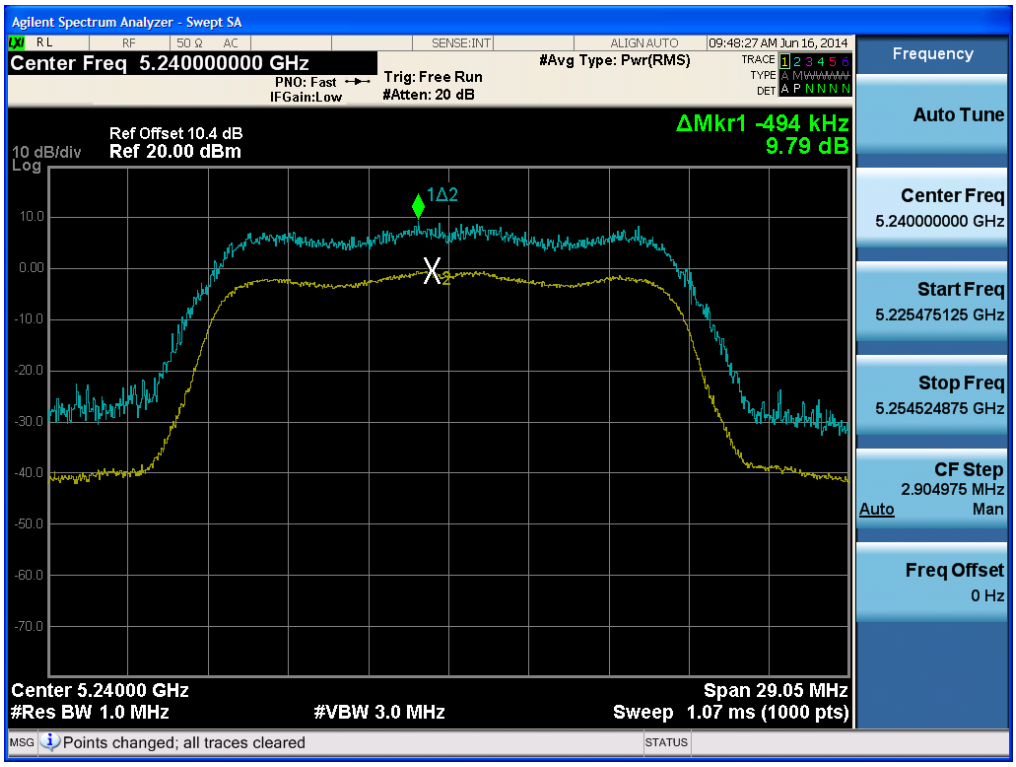
Peak Excursion Ratio (802.11a-CH 36)



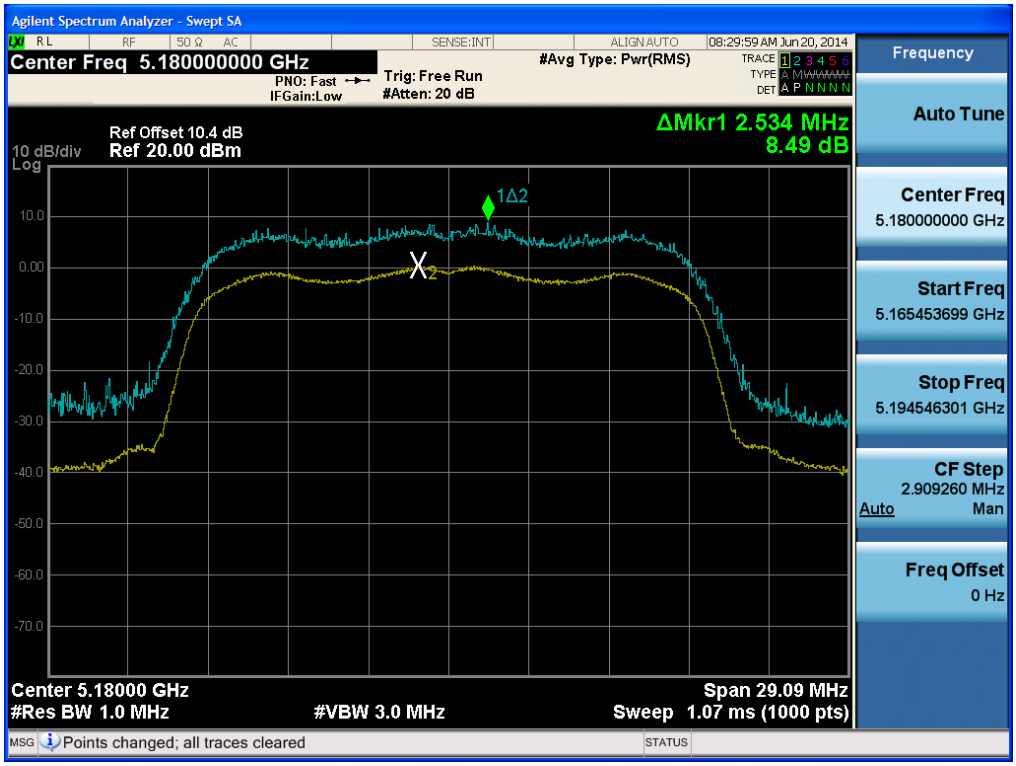
Peak Excursion Ratio (802.11a-CH 40)



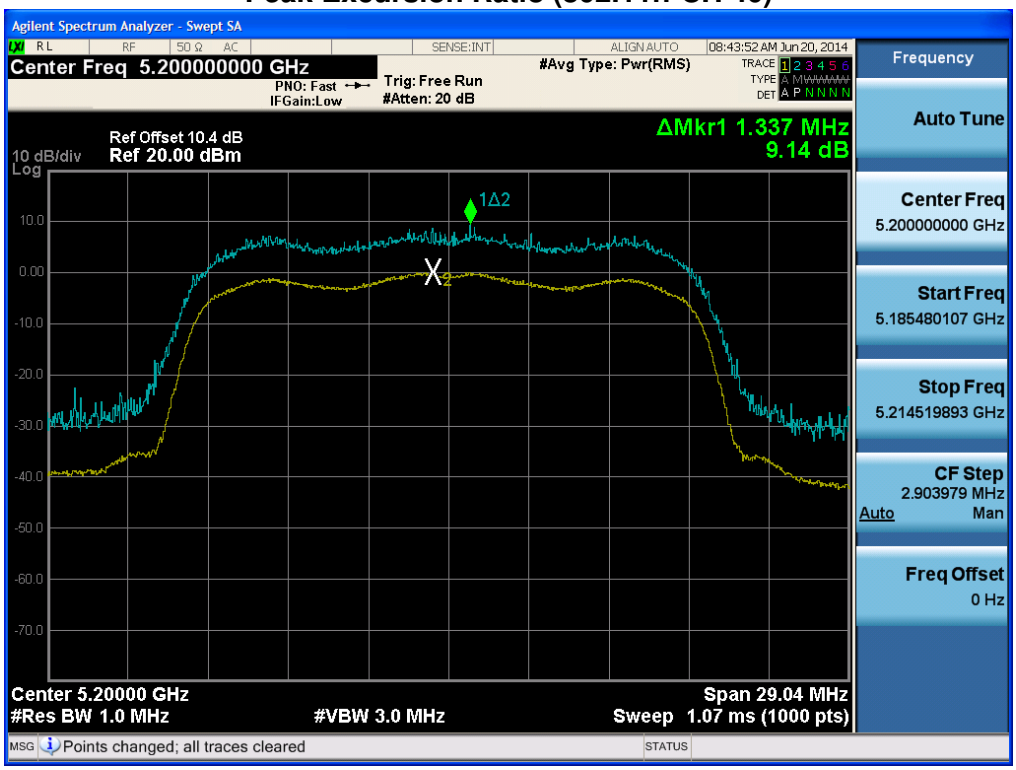
Peak Excursion Ratio (802.11a-CH 48)



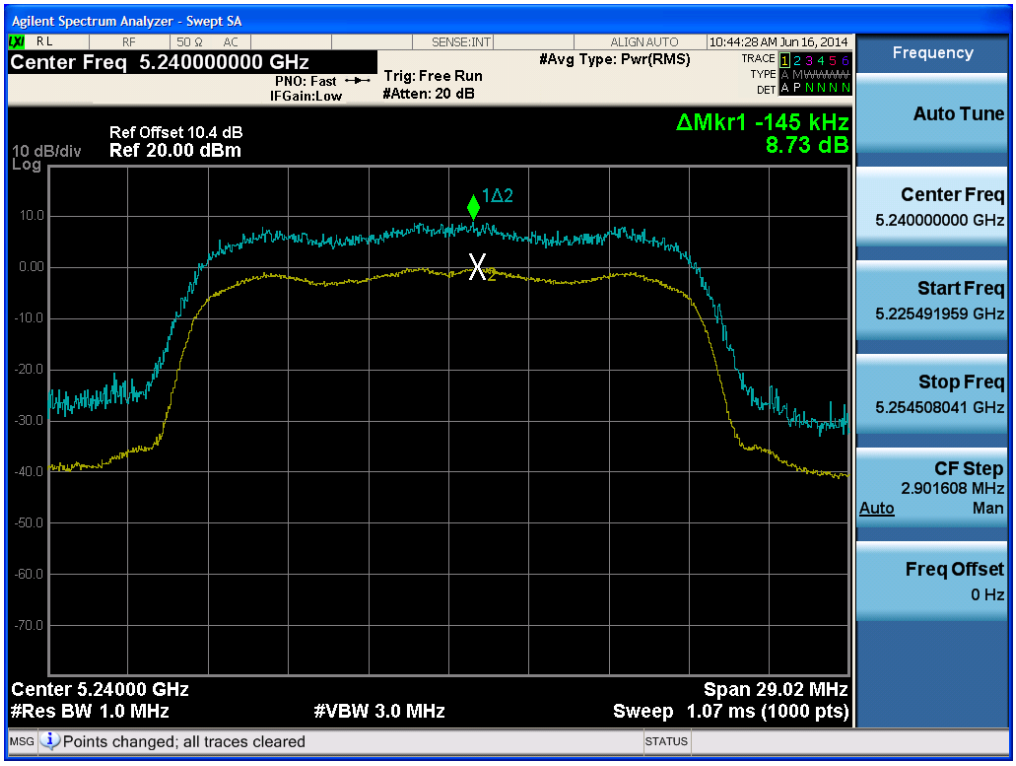
Peak Excursion Ratio (802.11n-CH 36)



Peak Excursion Ratio (802.11n-CH 40)

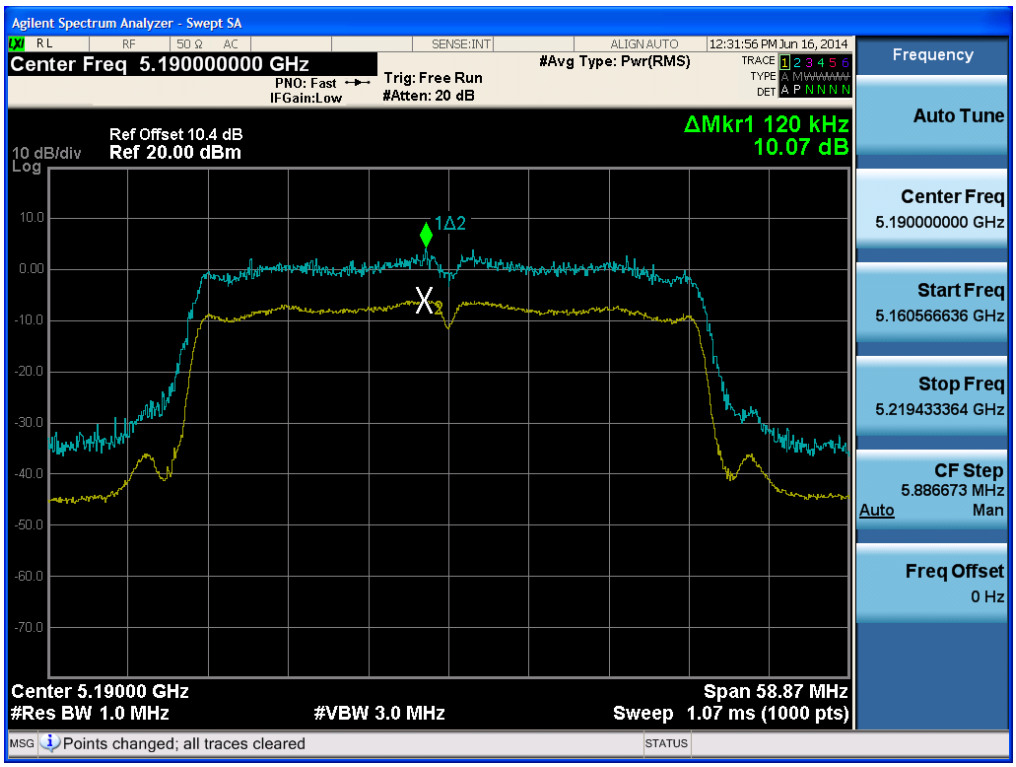


Peak Excursion Ratio (802.11n-CH 48)

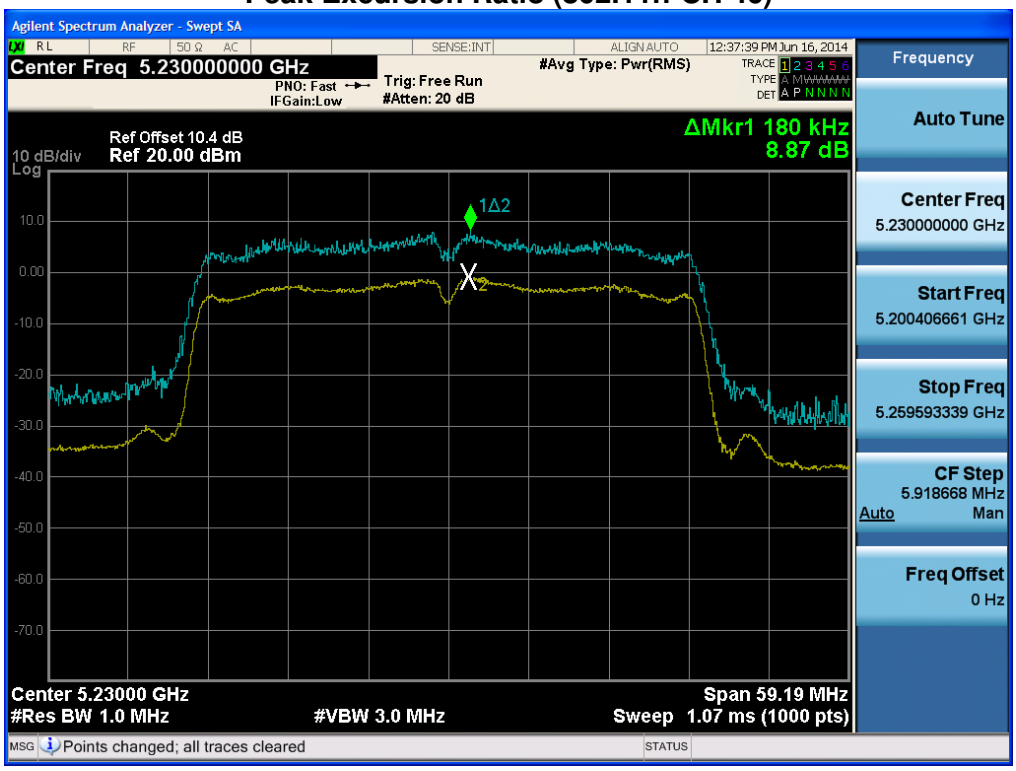


40 MHz BW

Peak Excursion Ratio (802.11n-CH 38)



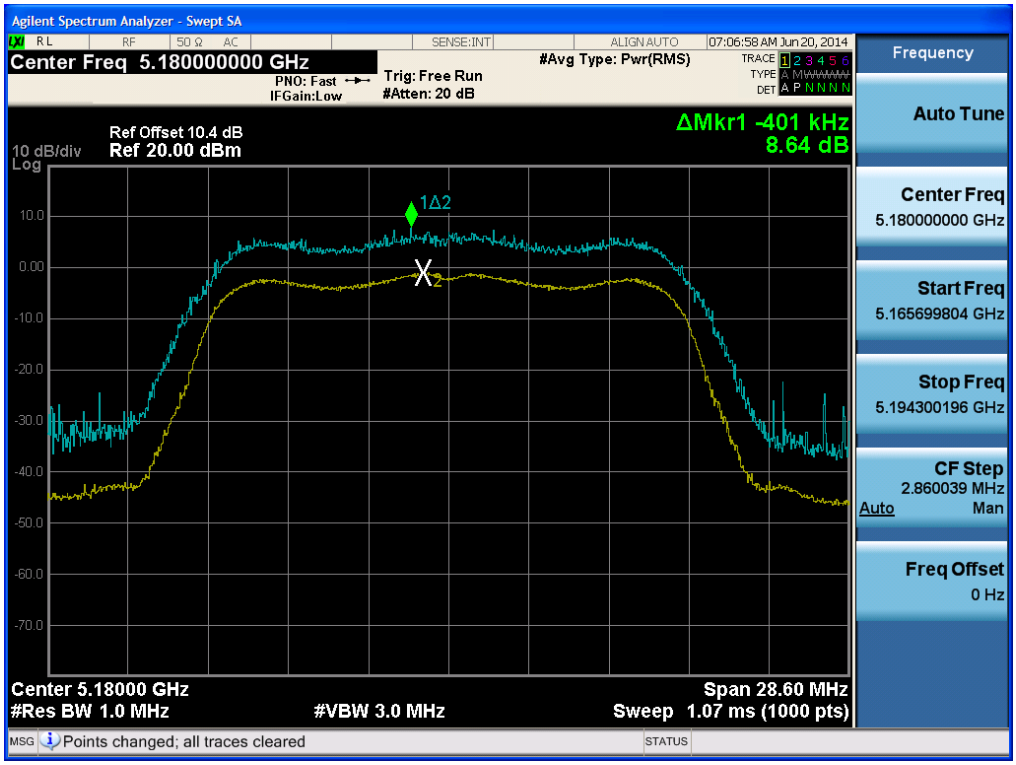
Peak Excursion Ratio (802.11n-CH 46)



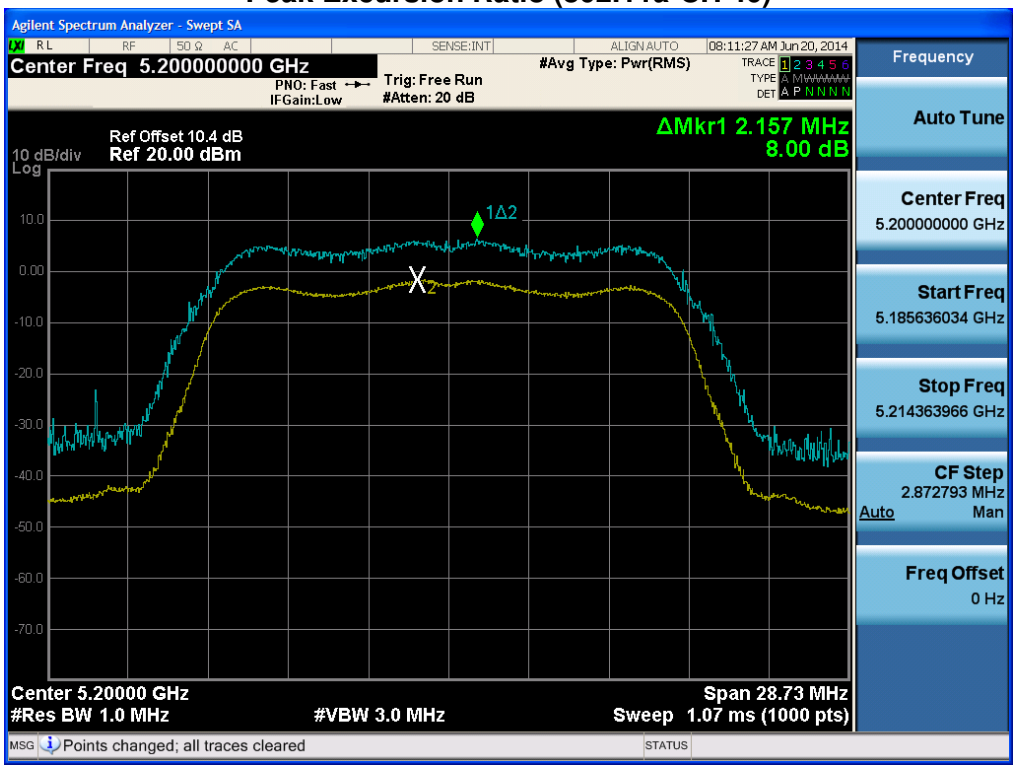
▣ RESULT PLOTS Ant.1

20 MHz BW

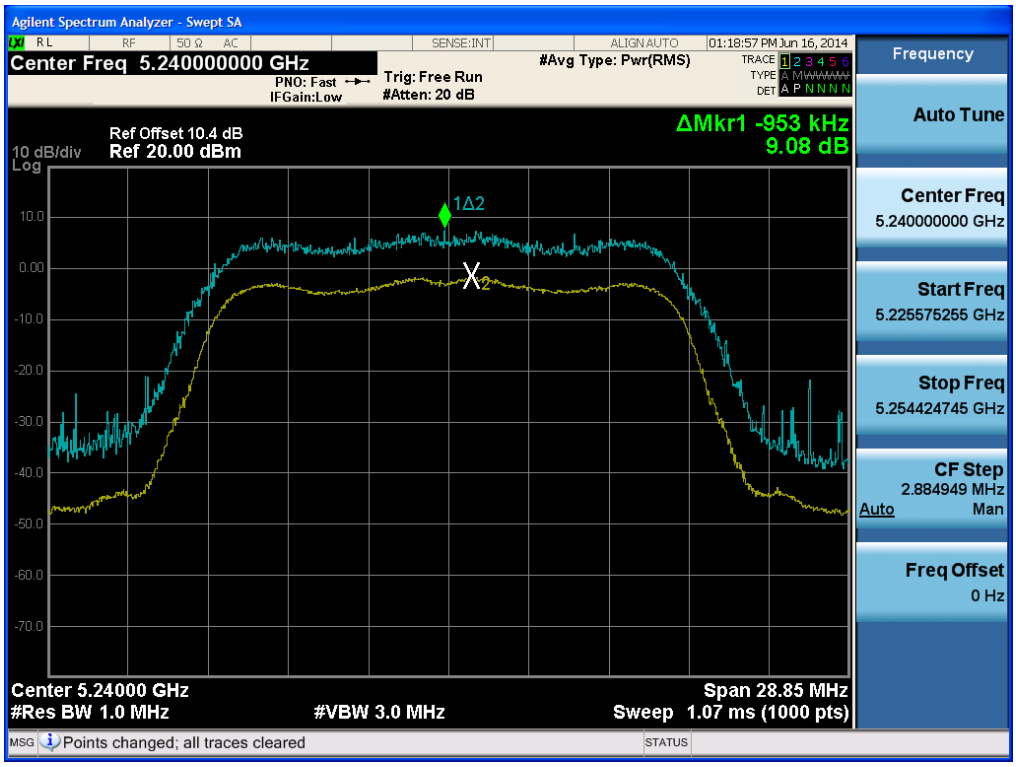
Peak Excursion Ratio (802.11a-CH 36)



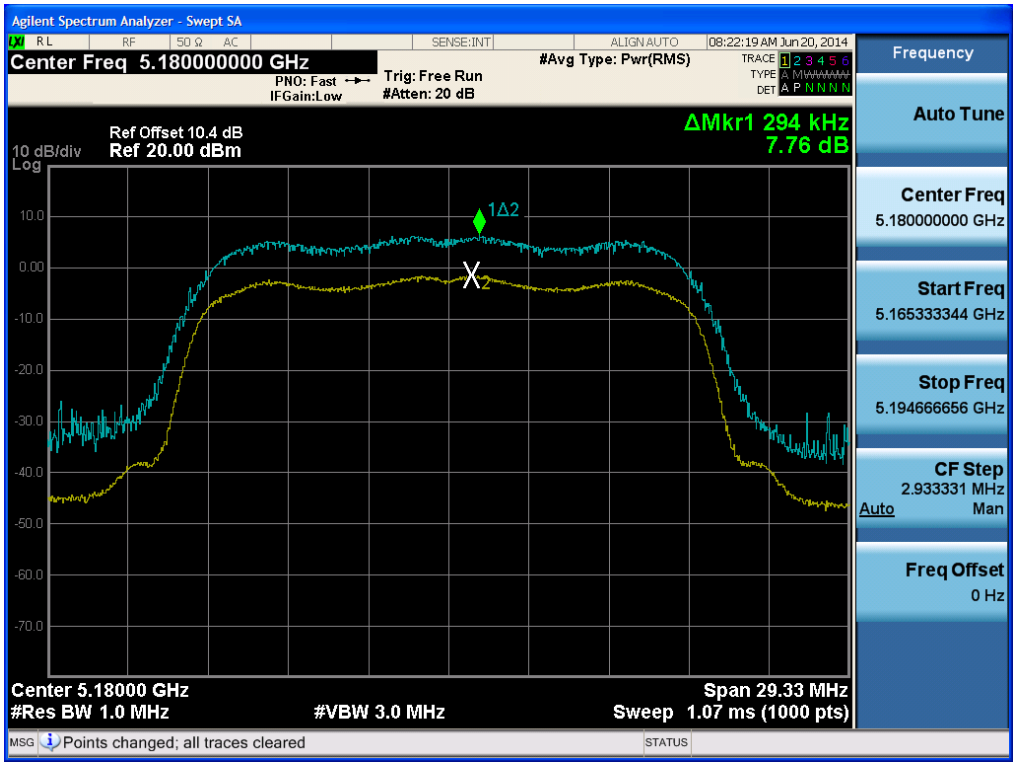
Peak Excursion Ratio (802.11a-CH 40)



Peak Excursion Ratio (802.11a-CH 48)

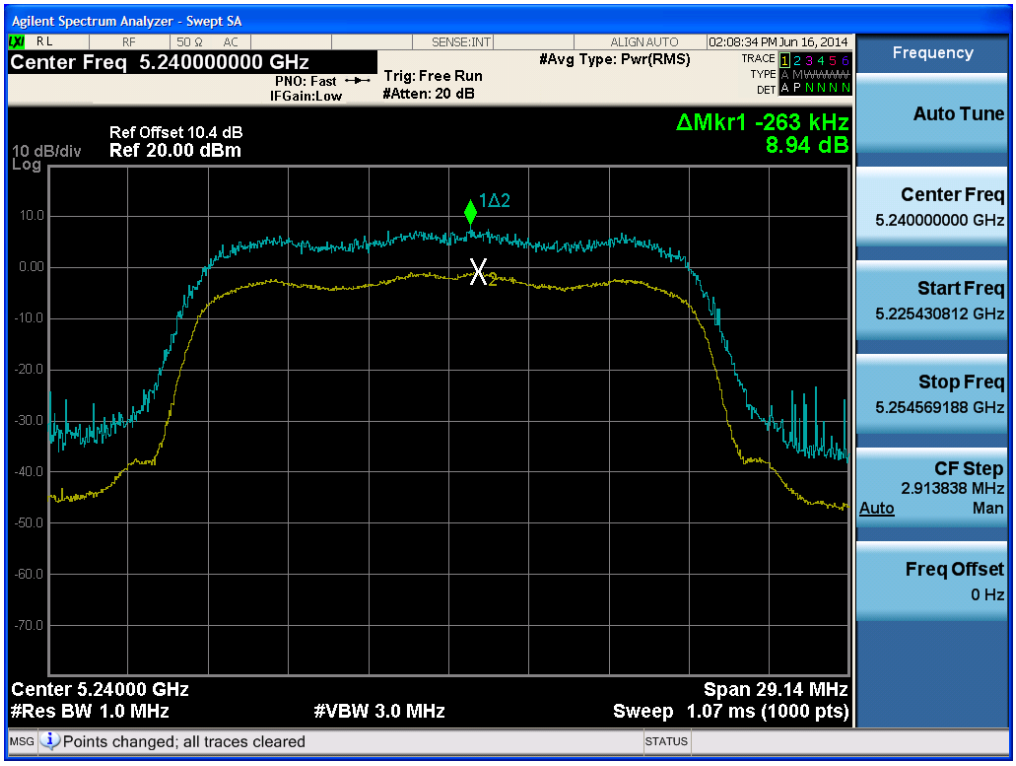


Peak Excursion Ratio (802.11n-CH 36)



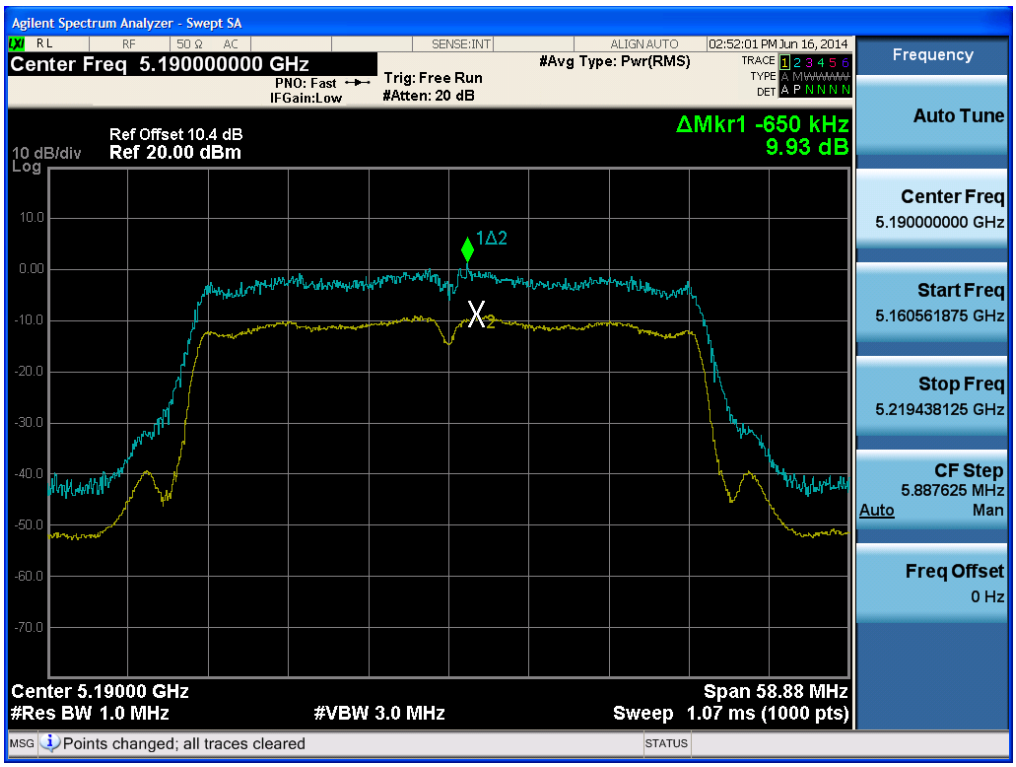
Peak Excursion Ratio (802.11n-CH 40)

Peak Excursion Ratio (802.11n-CH 48)

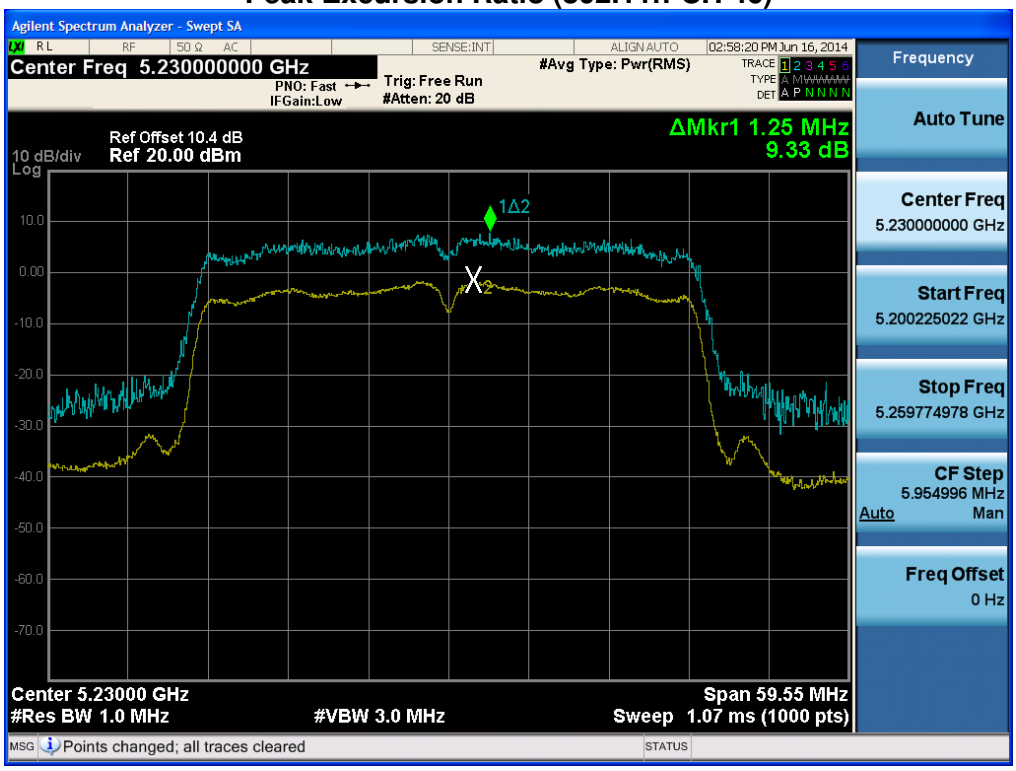


40 MHz BW

Peak Excursion Ratio (802.11n-CH 38)



Peak Excursion Ratio (802.11n-CH 46)



8.7 FREQUENCY STABILITY.

The EUT was placed inside an environmental chamber as the temperature in the chamber was varied between -30 ℃ and 50 ℃. The temperature was incremented by 10 ℃ intervals and the unit was allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

20 MHz BW

OPERATING BAND: UNII Band 1
OPERATING FREQUENCY: 5,180,000,000 Hz
CHANNEL: 36
REFERENCE VOLTAGE: 3.5 VDC

Voltage (%)	Power (VDC)	Temp. (℃)	Frequency (kHz)	Frequency Error (kHz)
100	3.5	+20(Ref)	5180013.50	13.50
100		-30	5180048.39	48.39
100		-20	5180052.33	52.33
100		-10	5180039.17	39.17
100		0	5180022.55	22.55
100		+10	5179969.87	-30.13
100		+30	5179960.42	-39.58
100		+40	5179989.75	-10.25
100		+50	5179971.63	-28.37
115	4.025	+20	5180017.40	17.40
85	2.975	+20	5180021.60	21.60

Note:

Based on the results of the frequency stability test shown above the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency error noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature and voltage range as tested.

40 MHz BW

OPERATING BAND: UNII Band 1

OPERATING FREQUENCY: 5,190,000,000 Hz

CHANNEL: 38

REFERENCE VOLTAGE: 220 VAC

Voltage (%)	Power (VDC)	Temp. (℃)	Frequency (kHz)	Frequency Error (kHz)
100	3.5	+20(Ref)	5189979.27	-20.73
100		-30	5190045.20	45.20
100		-20	5190031.84	31.84
100		-10	5190039.55	39.55
100		0	5190010.71	10.71
100		+10	5190005.94	5.94
100		+30	5189972.32	-27.68
100		+40	5189955.53	-44.47
100		+50	5189962.83	-37.17
115	4.025	+20	5189973.89	-26.11
85	2.975	+20	5189975.69	-24.31

Note:

Based on the results of the frequency stability test shown above the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency error noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature and voltage range as tested.

8.8 RADIATED MEASUREMENT.

8.8.1 RADIATED SPURIOUS EMISSIONS.

Test Requirements and limit, §15.205, §15.209, §15.407

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
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

▣ §15.407, KDB 789033

All harmonics that do not lie in a restricted band are subject to a peak limit of -27 dBm/MHz. At a distance of 3 meters the field strength limit in dBμV/m can be determined by adding a “conversion” factor of 95.2 dB to the EIRP limit of -27 dBm/MHz to obtain the limit for out of band spurious emissions of 68.2 dBμV/m.

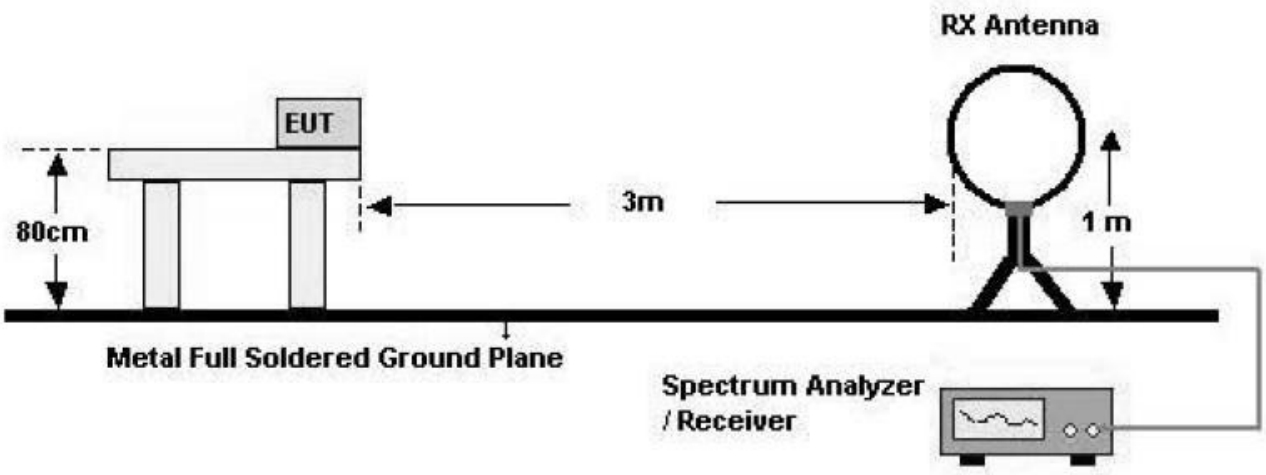
▣ Test case

Service	SISO	Ant 0
		Ant 1
	MIMO	Ant 0 & 1(Worst Case)

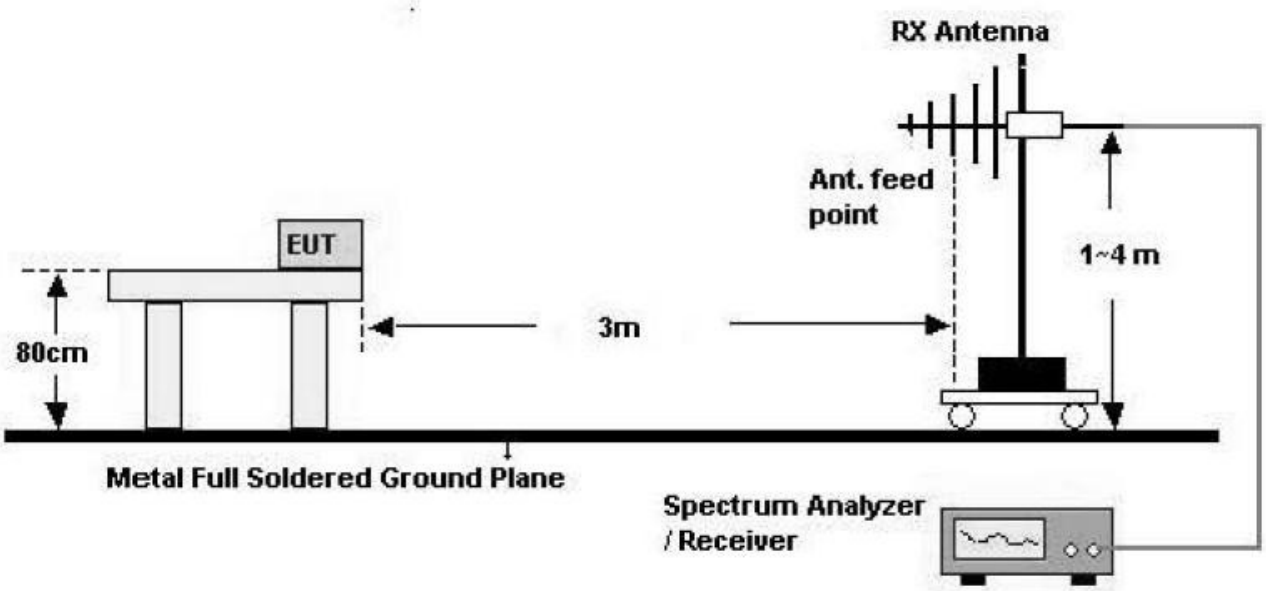
Note : We have done all test case. We attached the results of only worst case.

Test Configuration

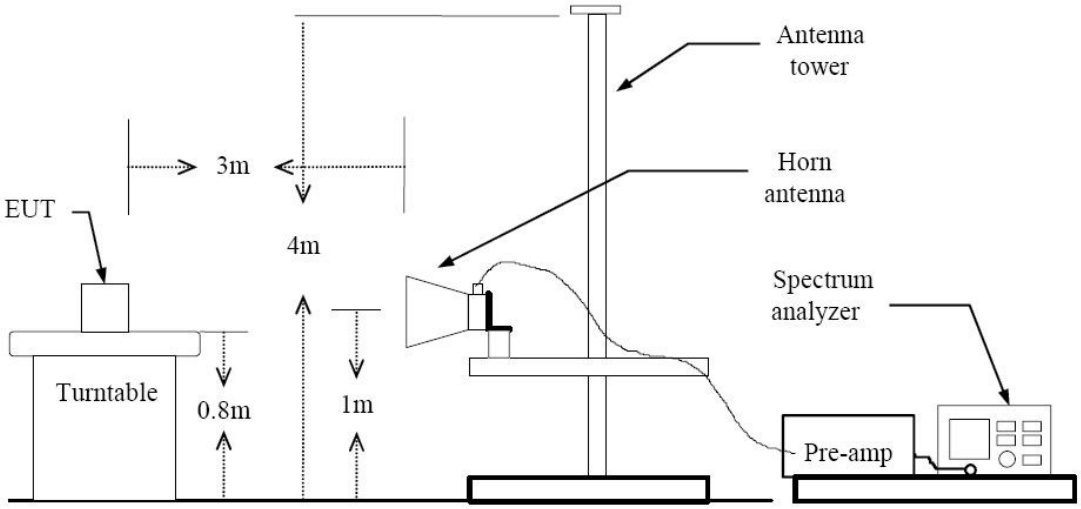
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



TEST PROCEDURE USED

ANSI C63.4(2003)

Method H)5) in KDB 789033, issued 06/06/2014 (Peak)

Method H)6)d) in KDB 789033, issued 06/06/2014 (Average)

. Spectrum setting:

- Peak.

1. RBW = 1 MHz
2. VBW ≥ 3 MHz
3. Detector = Peak
4. Sweep Time = auto
5. Trace mode = max hold
6. Allow sweeps to continue until the trace stabilizes.
7. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately 1/x, where x is the duty cycle.

- Average (Method VB :Averaging using reduced video bandwidth)

1. RBW = 1 MHz
2. VBW
   2.1. If the EUT is configured to transmit with duty cycle ≥ 98 percent, set VBW ≤ RBW/100(i.e., 10 kHz) but not less than 10 Hz.
   2.2. If the EUT duty cycle is < 98 percent, set VBW ≥ 1/T, where T is the minimum transmission duration.
3. The analyzer is set to linear detector mode.

4. Detector = Peak.
5. Sweep time = auto.
6. Trace mode = max hold.
7. Allow max hold to run for at least 50 traces if the transmitted signal is continuous or has at least 98 percent duty cycle. For lower duty cycles, increase the minimym number of traces by a factor of 1/x, where x is the duty cycle.

Note :

1. We used the case 2 for 802.11a/n_20/n_40 to perform the average filed strength measurements for RSE and radiated band edge test.
2. The actual setting value of VBW for 802.11a/n_20/n_40.

Mode	Worst Data rate (Mbps)	T_{on} (ms)	T_{total} (ms)	Duty Cycle (%)	VBW(1/T) (Hz)	The actual setting value of VBW (Hz)
a	6	2.057	2.177	94.49	486	1000
n_20 MHz BW	6.5	1.902	2.007	94.77	526	1000
n_40 MHz BW	13.5	0.927	1.029	90.09	1079	3000

TEST RESULTS

9 kHz – 30MHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
㎒	dB㎶	dB /m	dB	(H/V)	dB㎶/m	dB㎶/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

TEST RESULTS

Below 1 GHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
㎒	dB㎶	dB /m	dB	(H/V)	dB㎶/m	dB㎶/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Above 1 GHz

MIMO(Ant.0 & 1)

Band :	UNII 1
Operation Mode:	802.11 a
Transfer Rate:	6 Mbps
Operating Frequency	5180 MHz
Channel No.	36 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10360	64.24	-6.51	V	57.73	68.20	10.47	PK
15540	70.77	-6.42	V	64.35	73.98	9.63	PK
15540	52.35	-6.42	V	45.93	53.98	8.05	AV
10360	64.38	-6.51	H	57.87	68.20	10.33	PK
15540	71.34	-6.42	H	64.92	73.98	9.06	PK
15540	52.38	-6.42	H	45.96	53.98	8.02	AV

Band :	UNII 1
Operation Mode:	802.11 a
Transfer Rate:	6 Mbps
Operating Frequency	5200 MHz
Channel No.	40 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10400	67.79	-6.49	V	61.30	68.20	6.90	PK
15600	73.31	-7.15	V	66.16	73.98	7.82	PK
15600	57.68	-7.15	V	50.53	53.98	3.45	AV
10400	67.87	-6.49	H	61.38	68.20	6.82	PK
15600	73.89	-7.15	H	66.74	73.98	7.24	PK
15600	57.72	-7.15	H	50.57	53.98	3.41	AV

Band :	UNII 1
Operation Mode:	802.11 a
Transfer Rate:	6 Mbps
Operating Frequency	5240 MHz
Channel No.	48 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10480	67.42	-6.96	V	60.46	68.20	7.74	PK
15720	72.44	-6.62	V	65.82	73.98	8.16	PK
15720	56.79	-6.62	V	50.17	53.98	3.81	AV
10480	67.64	-6.96	H	60.68	68.20	7.52	PK
15720	72.46	-6.96	H	65.50	73.98	8.48	PK
15720	56.86	-6.62	H	50.24	53.98	3.74	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. We have done all data rate in 802.11a mode test. . Worst case of EUT is lowest data rate in 802.11a.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Band :	UNII 1
Operation Mode:	802.11 n_20 MHz BW
Transfer Rate:	6.5 Mbps
Operating Frequency	5180 MHz
Channel No.	36 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10360	64.68	-6.51	V	58.17	68.20	10.03	PK
15540	70.31	-6.42	V	63.89	73.98	10.09	PK
15540	52.57	-6.42	V	46.15	53.98	7.83	AV
10360	64.73	-6.51	H	58.22	68.20	9.98	PK
15540	71.01	-6.42	H	64.59	73.98	9.39	PK
15540	52.58	-6.42	H	46.16	53.98	7.82	AV

Band :	UNII 1
Operation Mode:	802.11 n_20 MHz BW
Transfer Rate:	6.5 Mbps
Operating Frequency	5200 MHz
Channel No.	40 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10400	66.61	-6.49	V	60.12	68.20	8.08	PK
15600	72.96	-7.15	V	65.81	73.98	8.17	PK
15600	57.58	-7.15	V	50.43	53.98	3.55	AV
10400	66.84	-6.49	H	60.35	68.20	7.85	PK
15600	72.39	-7.15	H	65.24	73.98	8.74	PK
15600	57.62	-7.15	H	50.47	53.98	3.51	AV

Band :	UNII 1
Operation Mode:	802.11 n_20 MHz BW
Transfer Rate:	6.5 Mbps
Operating Frequency	5240 MHz
Channel No.	48 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
10480	66.93	-6.96	V	59.97	68.20	8.23	PK
15720	71.56	-6.62	V	64.94	73.98	9.04	PK
15720	56.71	-6.62	V	50.09	53.98	3.89	AV
10480	67.48	-6.96	H	60.52	68.20	7.68	PK
15720	71.67	-6.96	H	64.71	73.98	9.27	PK
15720	56.74	-6.62	H	50.12	53.98	3.86	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. We have done all data rate in 802.11n_20 MHz BW mode test. . Worst case of EUT is lowest data rate in 802.11n_20 MHz BW.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Band :	UNII 1
Operation Mode:	802.11n_40 MHz BW
Transfer Rate:	13.5 Mbps
Operating Frequency	5190 MHz
Channel No.	38 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
10380	62.89	-5.38	V	57.51	68.20	10.69	PK
15570	63.01	-6.41	V	56.60	73.98	17.38	PK
15570	49.20	-6.41	V	42.79	53.98	11.19	AV
10380	63.09	-5.38	H	57.71	68.20	10.49	PK
15570	64.07	-6.41	H	57.66	73.98	16.32	PK
15570	49.21	-6.41	H	42.80	53.98	11.18	AV

Band :	UNII 1
Operation Mode:	802.11n_40 MHz BW
Transfer Rate:	13.5 Mbps
Operating Frequency	5230 MHz
Channel No.	46 Ch

Frequency [MHz]	Reading dBuV	AN.+CL-Amp G. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
10460	65.62	-6.88	V	58.74	68.20	9.46	PK
15690	69.21	-6.64	V	62.57	73.98	11.41	PK
15690	55.48	-6.64	V	48.84	53.98	5.14	AV
10460	66.15	-6.88	H	59.27	68.20	8.93	PK
15690	69.30	-6.64	H	62.66	73.98	11.32	PK
15690	55.52	-6.64	H	48.88	53.98	5.10	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
5. We have done all data rate in 802.11n_40 MHz BW. Worst case of EUT is lowest data rate in 802.11n_40 MHz BW.
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

8.8.2 RADIATED RESTRICTED BAND EDGE MEASUREMENTS

Test Requirements and limit, §15.407, §15.205, §15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

MIMO(Ant.0 & 1)

Band :	UNII 1
Operation Mode:	802.11 a
Transfer Rate:	6 Mbps
Operating Frequency	5180 MHz
Channel No.	36 Ch

Frequency [MHz]	Reading dBuV	AN.+CL+AMP+ATT. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
5150	60.99	8.79	H	69.78	73.98	4.20	PK
5150	42.18	8.79	H	50.97	53.98	3.01	AV
5150	57.97	8.79	V	66.76	73.98	7.22	PK
5150	40.81	8.79	V	49.60	53.98	4.38	AV

Band :	UNII 1
Operation Mode:	802.11 n_20 MHz BW
Transfer Rate:	6.5 Mbps
Operating Frequency	5180 MHz
Channel No.	36 Ch

Frequency [MHz]	Reading dBuV	AN.+CL+AMP+ATT. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
5150	60.84	8.79	H	69.63	73.98	4.35	PK
5150	42.14	8.79	H	50.93	53.98	3.05	AV
5150	57.78	8.79	V	66.57	73.98	7.41	PK
5150	40.72	8.79	V	49.51	53.98	4.47	AV

Band :	UNII 1
Operation Mode:	802.11n_40 MHz BW
Transfer Rate:	13.5 Mbps
Operating Frequency	5190 MHz
Channel No.	38 Ch

Frequency [MHz]	Reading dBuV	AN.+CL+AMP+ATT. [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Detect
5150	56.97	8.79	H	65.76	73.98	8.22	PK
5150	39.62	8.79	H	48.41	53.98	5.57	AV
5150	54.07	8.79	V	62.86	73.98	11.12	PK
5150	38.28	8.79	V	47.07	53.98	6.91	AV

Notes:

1. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + ATT
2. We have done all data rate in 802.11a/n/ac mode test. . Worst case of EUT is lowest data rate in 802.11a/n/ac
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

8.8.3 RECEIVER SPURIOUS EMISSIONS

IC Rule(s)	**RSS-GEN**
Test Requirements:	**Blow the table**
Operating conditions:	**Under normal test conditions**
Method of testing:	**Radiated**
S/A. Settings:	**F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)** **F > 1 GHz: RBW: 1 MHz, VBW: 1 MHz (Peak)**
Mode of operation:	**Receive**

Frequency (MHz)	Field Strength (microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

Operation Mode: Receive:

30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
㎒	dB㎶	dB /m	dB	(H/V)	dB㎶/m	dB㎶/m	dB
No Critical peaks found							

Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
㎒	dB㎶	dB /m	dB	(H/V)	dB㎶/m	dB㎶/m	dB
No Critical peaks found							

8.9 POWERLINE CONDUCTED EMISSIONS

Test Requirements and limit, §15.207

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	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

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

TEST PROCEDURE

1. The EUT is placed on a wooden table 80 cm above the reference groundplane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

Note: We don't perform powerline conducted emission test. Because this EUT is used DC voltage.

9. LIST OF TEST EQUIPMENT

9.1 LIST OF TEST EQUIPMENT(Conducted Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Calibration Due	Serial No.
Rohde & Schwarz	ENV216/ LISN	01/29/2014	Annual	01/29/2015	100073
Agilent	E4440A/ Spectrum Analyzer	04/09/2014	Annual	04/09/2015	US45303008
Agilent	N9020A/ SIGNAL ANALYZER	05/23/2014	Annual	05/23/2015	MY51110063
Agilent	N1911A/Power Meter	01/24/2014	Annual	01/24/2015	MY45100523
Agilent	N1921A /POWER SENSOR	07/11/2013	Annual	07/11/2014	MY45241059
Hewlett Packard	11636B/Power Divider	10/22/2013	Annual	10/22/2014	11377
Agilent	87300B/Directional Coupler	12/18/2013	Annual	12/18/2014	3116A03621
Hewlett Packard	11667B / Power Splitter	01/27/2014	Annual	01/27/2015	10545
DIGITAL	EP-3010 /DC POWER SUPPLY	10/29/2013	Annual	10/29/2014	3110117
ITECH	IT6720 / DC POWER SUPPLY	11/05/2013	Annual	11/05/2014	0100021562870011 99
TESCOM	TC-3000C / BLUETOOTH TESTER	04/11/2014	Annual	04/11/2015	3000C000276
Rohde & Schwarz	CBT / BLUETOOTH TESTER	05/07/2014	Annual	05/07/2015	100422
Agilent	8493C / Attenuator(10 dB)	07/24/2013	Annual	07/24/2014	76649
WEINSCHEL	2-3 / Attenuator(3 dB)	10/28/2013	Annual	10/28/2014	BR0617

9.2 LIST OF TEST EQUIPMENT(Radiated Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Calibration Due	Serial No.
Schwarzbeck	VULB 9160/ TRILOG Antenna	12/17/2012	Biennial	12/17/2014	3150
Rohde & Schwarz	ESCI / EMI TEST RECEIVER	01/24/2014	Annual	01/24/2015	100584
HD	MA240/ Antenna Position Tower	N/A	N/A	N/A	556
EMCO	1050/ Turn Table	N/A	N/A	N/A	114
HD GmbH	HD 100/ Controller	N/A	N/A	N/A	13
HD GmbH	KMS 560/ SlideBar	N/A	N/A	N/A	12
Rohde & Schwarz	SCU-18/ Signal Conditioning Unit	09/10/2013	Annual	09/10/2014	10094
CERNEX	CBL18265035 / POWER AMP	07/24/2013	Annual	07/24/2014	22966
CERNEX	CBL26405040 / POWER AMP	04/04/2014	Annual	04/04/2015	19660
Schwarzbeck	BBHA 9120D/ Horn Antenna	07/05/2013	Biennial	07/05/2015	1151
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	10/30/2012	Biennial	10/30/2014	BBHA9170124
Rohde & Schwarz	FSP / Spectrum Analyzer	01/24/2014	Annual	01/24/2015	839117/011
Wainwright Instrument	WHF3.0/18G-10EF / High Pass Filter	02/03/2014	Annual	02/03/2015	F6
Wainwright Instrument	WHNX6.0/26.5G-6SS / High Pass Filter	04/09/2014	Annual	04/09/2015	1
Wainwright Instrument	WHNX7.0/18G-8SS / High Pass Filter	04/04/2014	Annual	04/04/2015	29
TESCOM	TC-3000C / BLUETOOTH TESTER	04/11/2014	Annual	04/11/2015	3000C000276
Rohde & Schwarz	CBT / BLUETOOTH TESTER	05/07/2014	Annual	05/07/2015	100422
Rohde & Schwarz	LOOP ANTENNA	08/14/2012	Biennial	08/14/2014	100179
CERNEX	CBL06185030 / POWER AMP	07/24/2013	Annual	07/24/2014	22965
CERNEX	CBLU1183540 / POWER AMP	07/24/2013	Annual	07/24/2014	22964