Relay2, Inc.

Wireless Router

Main Model: R2-CAP-ND-900N
Serial Model: N/A

November 13, 2013

Report No.: 13070456-FCC-R2
(This report supersedes none)

Modifications made to the product : None

This Test Report is Issued Under the Authority of:		
Herith shi	Alex Liu	
Herith Shi **Compliance Engineer**	**Alex Liu** **Technical Manager**	

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Test result presented in this test report is applicable to the representative sample only.

RF Test Report

SIEMIC, INC.
Accessing global markets

Laboratory Introduction

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SIEMIC (Shenzhen-China) Laboratories Accreditations for Conformity Assessment

Country/Region	Scope
USA	EMC , RF/Wireless , Telecom
Canada	EMC, RF/Wireless , Telecom
Taiwan	EMC, RF, Telecom , Safety
Hong Kong	RF/Wireless ,Telecom
Australia	EMC, RF, Telecom , Safety
Korea	EMI, EMS, RF , Telecom, Safety
Japan	EMI, RF/Wireless, Telecom
Singapore	EMC , RF , Telecom
Europe	EMC, RF, Telecom , Safety

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CONTENTS

1 EXECUTIVE SUMMARY & EUT INFORMATION

The purpose of this test programme was to demonstrate compliance of the Relay2, Inc., Wireless Router and model: R2-CAP-ND-900N against the current Stipulated Standards. The Wireless Router has demonstrated compliance with the FCC Part 15.407: 2013, ANSI C63.4: 2009.

EUT Information

EUT Description	:	**Wireless Router**
Main Model	:	**R2-CAP-ND-900N**
Serial Model	:	**N/A**
Antenna Gain	:	**WIFI 2.4GHz: 3 dBi** **WIFI 5GHz: 5 dBi**
Input Power	:	**Adapter:** **Model:FSP025-1AD207A** **Input: AC 100-240V 50/60Hz 0.7A** **Output: DC 48V 0.52A**
Classification Per Stipulated Test Standard	:	**FCC Part 15.407: 2013, ANSI C63.4: 2009**

2 TECHNICAL DETAILS

Purpose	**Compliance testing of Wireless Router with stipulated standard**
Applicant / Client	**Relay2, Inc. 1525 McCarthy Blvd., Suite 209, Milpitas, CA 95035, USA**
Manufacturer	**Relay2, Inc. 1525 McCarthy Blvd., Suite 209, Milpitas, CA 95035, USA**
Laboratory performing the tests	**SIEMIC (Shenzhen-China) Laboratories Zone A, Floor 1, Building 2, Wan Ye Long Technology Park, South Side of Zhoushi Road, Bao'an District, Shenzhen, Guangdong, China Tel: +86-0755-2601 4629 / 2601 4953 Fax: +86-0755-2601 4953-810 Email: China@siemic.com.cn**
Test report reference number	**13070456-FCC-R2**
Date EUT received	**October 10 2013**
Standard applied	**FCC Part 15.407: 2013, ANSI C63.4: 2009**
Dates of test (from – to)	**October 10 to November 12, 2013**
No of Units :	**#1**
Equipment Category :	**Spread Spectrum System/Device**
Trade Name :	**N/A**
RF Operating Frequency (ies)	**WIFI(802.11a/b/g/n20): 2412-2462 MHz; 5180-5240 MHz; 5745-5825MHz WIFI (802.11n40): 2422-2452 MHz; 5190-5230 MHz; 5755-5795 MHz**
Number of Channels	**WIFI 2.4G(802.11a/b/g/n-20): 11CH WIFI 5.18-5.24G(802.11a/ n-20): 8CH WIFI 5.745-5.825G(802.11a/ n-20): 5CH WIFI 2.4G(n-40): 7CH WIFI 5.19-5.23G(n-40):2CH WIFI 5.755-5.795G(n-40): 2CH**
Modulation	**WIFI(802.11a/b/g/n): DSSS/OFDM**
FCC ID	**2AAA9-R2CAPND900N**

3 MODIFICATION

NONE

4 TEST SUMMARY

The product was tested in accordance with the following specifications.
All testing has been performed according to below product classification:

Test Results Summary

FCC Rules	Description of Test	Result
§15.407 (i), §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.407 (a)(1)	DTS (99%&26 dB) CHANNEL BANDWIDTH	Compliance
§15.407(a/1/2)	Conducted Maximum Output Power	Compliance
§15.407(a/1/2)	Peak Power Spectral Density	Compliance
§15.407(a)(6)	Peak Power Excursion	Compliance
§15.207 (a),	AC Power Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(b/1/2/3/6)	Radiated Spurious Emissions & Unwanted Emissions into Restricted Frequency Bands	Compliance

Table for RF Out Put

The RF board has three RF out port: CH0; CH1; CH2

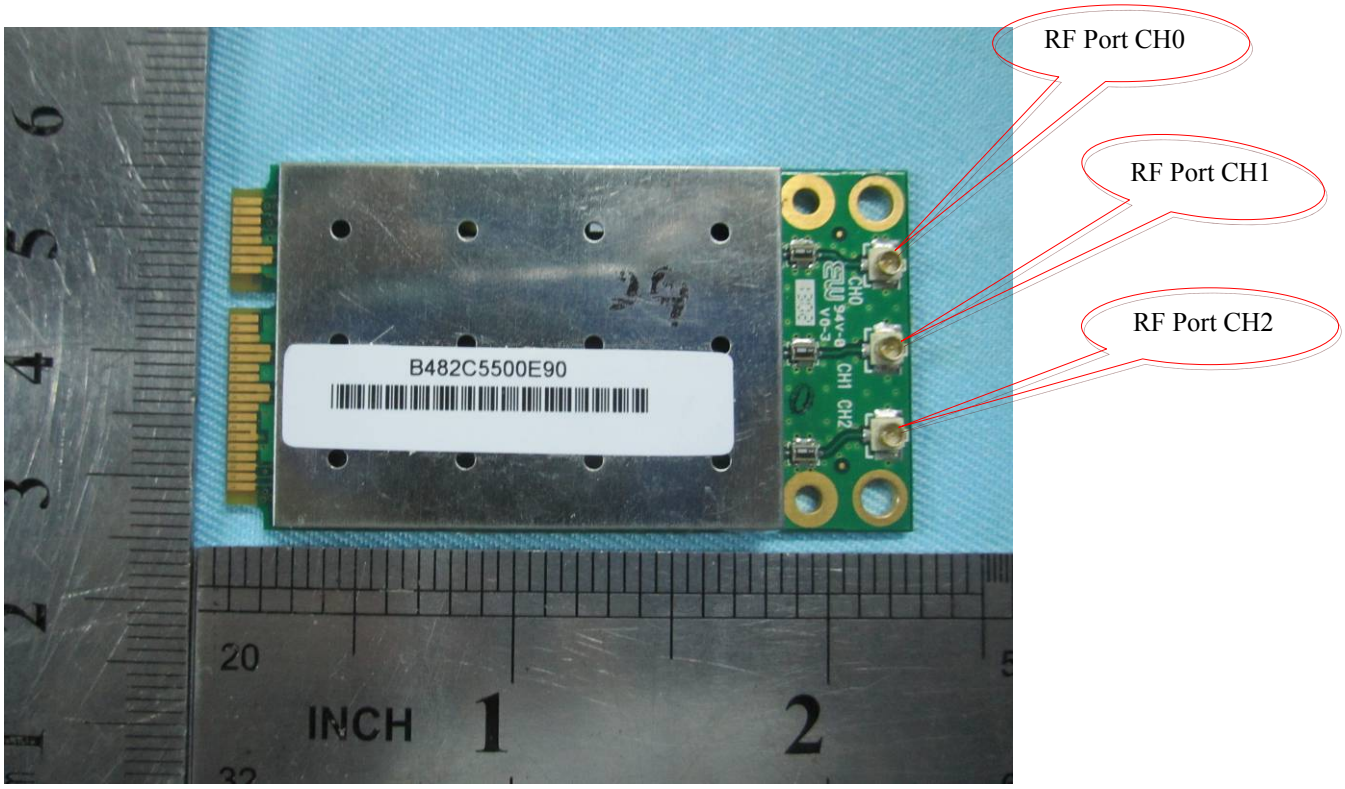


Table for frequency list

For 2.4G band

802.11b\g\n-20		802.11n-40	
Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	3	2422
2	2417	4	2427
3	2422	5	2432
4	2427	6	2437
5	2432	7	2442
6	2437	8	2447
7	2442	9	2452
8	2447		
9	2452		
10	2457		
11	2462		

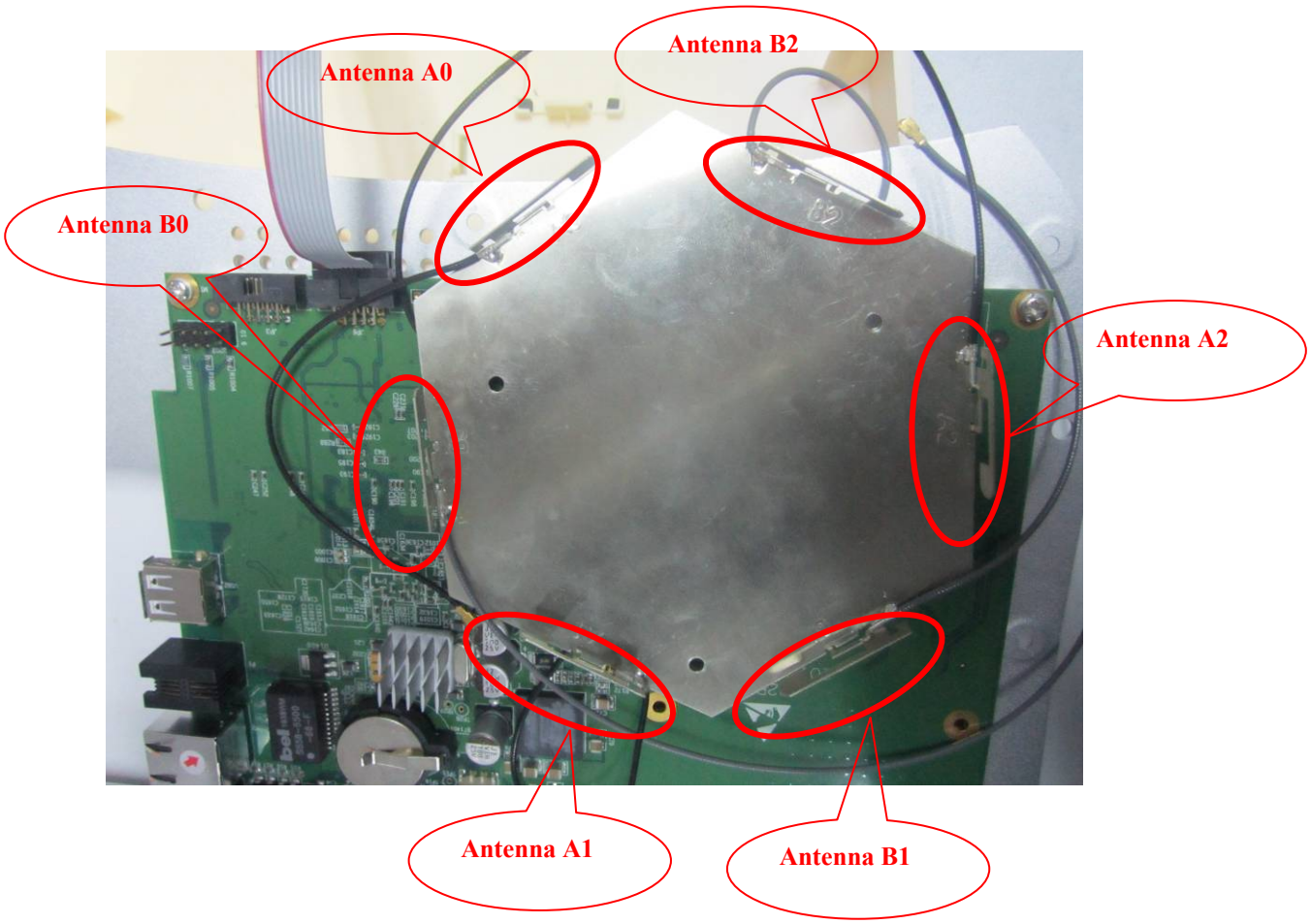
For 5.18-5.24G band

802.11a\n-20		802.11n-40	
Channel	Frequency (MHz)	Channel	Frequency (MHz)
36	5180	38	5190
40	5200	46	5230
44	5220		
48	5240		

For 5.755-5.795G band

802.11a\n-20		802.11n-40	
Channel	Frequency (MHz)	Channel	Frequency (MHz)
149	5745	151	5755
153	5765	159	5795
157	5785		
161	5805		
165	5825		

Table for antenna list



For 2.4GHz MIMO mode: the three IFA (Antenna A0; A1; A2, is for 2.4GHz) antennas is fixed on a metal plate. The antenna is a Sectorized antenna; the gain is 3 dBi is including all of the antennas.

For 5GHz MIMO mode: the three IFA (Antenna B0; B1; B2, is for 5GHz) antennas is fixed on a metal plate. The antenna is a Sectorized antenna; the gain is 5 dBi is including all of the antennas.

MIMO antenna requirement according with KDB 662911 section F

5 MEASUREMENTS, EXAMINATION AND DERIVED RESULTS

5.1 §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has antennas: .a Sectorized antenna for 2.4GHz the gain is 3 dBi;
a Sectorized antenna for 5GHz, the gain is 5 dBi

Result: PASS

§15.407(a)–DTS (99% &26 dB) CHANNEL BANDWIDTH

1. Conducted Measurement
   EUT was set for low, mid, high channel with modulated mode and highest RF output power.
   The spectrum analyzer was connected to the antenna terminal.
2. Environmental Conditions

Temperature	26°C
Relative Humidity	56%
Atmospheric Pressure	1001mbar

3. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.
4. Test date : October 28, 2013
   Tested By : Herith Shi

Standard Requirement:

According to §15.407(a)(1), For the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Procedures:

1. Set center frequency to the nominal EUT channel center frequency
2. Set span = 1.5 times to 5.0 times the OBW.
3. Set RBW = 1 % to 5 % of the OBW
4. he video bandwidth (VBW) ≥ 3 x RBW.
5. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used
6. Use the 99 % power bandwidth function of the instrument (if available)
7. If the instrument does not have a 99 % power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

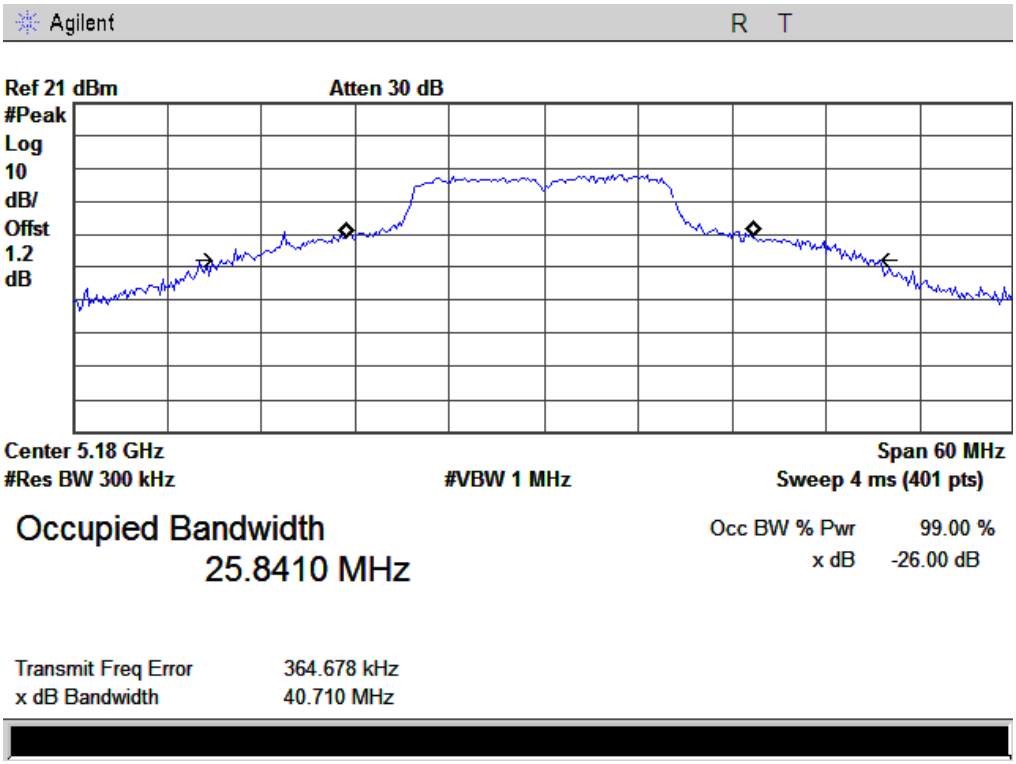
Test Result: Pass.

Please refer to the following tables and plots.

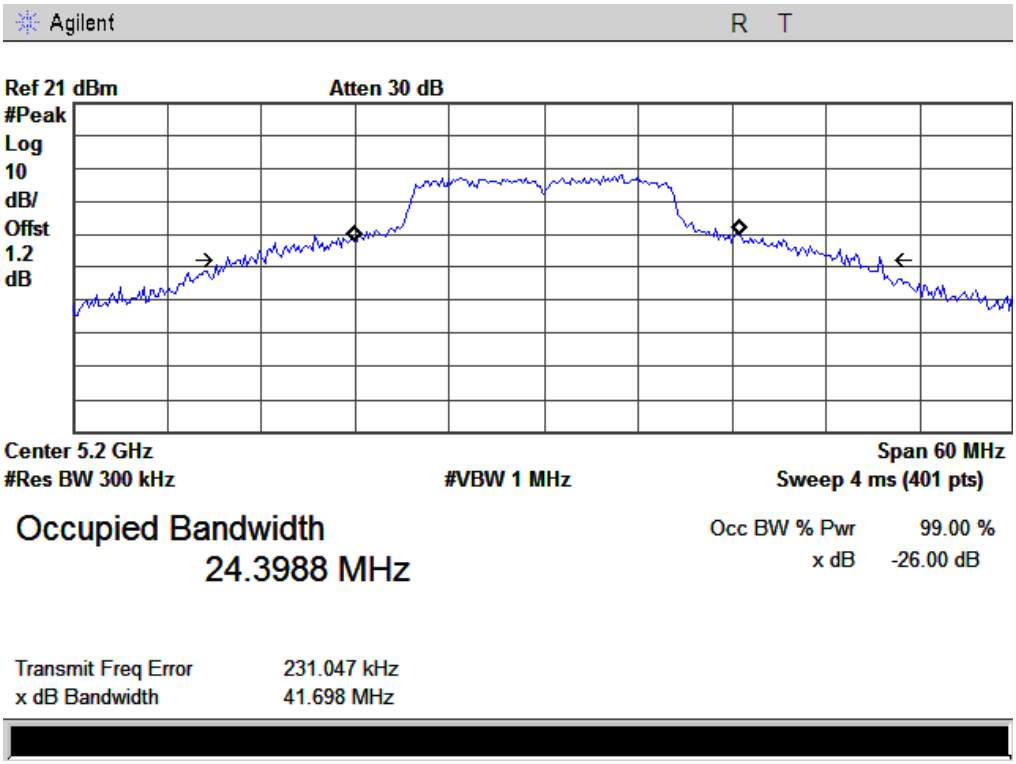
RF Port CH0 bandwidth:

Channel	Channel Frequency (MHz)	Data Rate (Mbps)	Measured 99% Bandwidth (MHz)	Measured 26dB Bandwidth (MHz)
802.11b mode				
Low	5180	6	25.8710	40.710
Middle	5200	6	24.3988	41.698
High	5240	6	24.0372	40.705
802.11n(20M) mode				
Low	5180	13	27.1623	44.384
Middle	5200	13	26.8378	43.626
High	5240	13	25.7645	43.918
802.11n(40M) mode				
Low	5190	27	56.0087	92.566
High	5230	27	56.1923	91.596

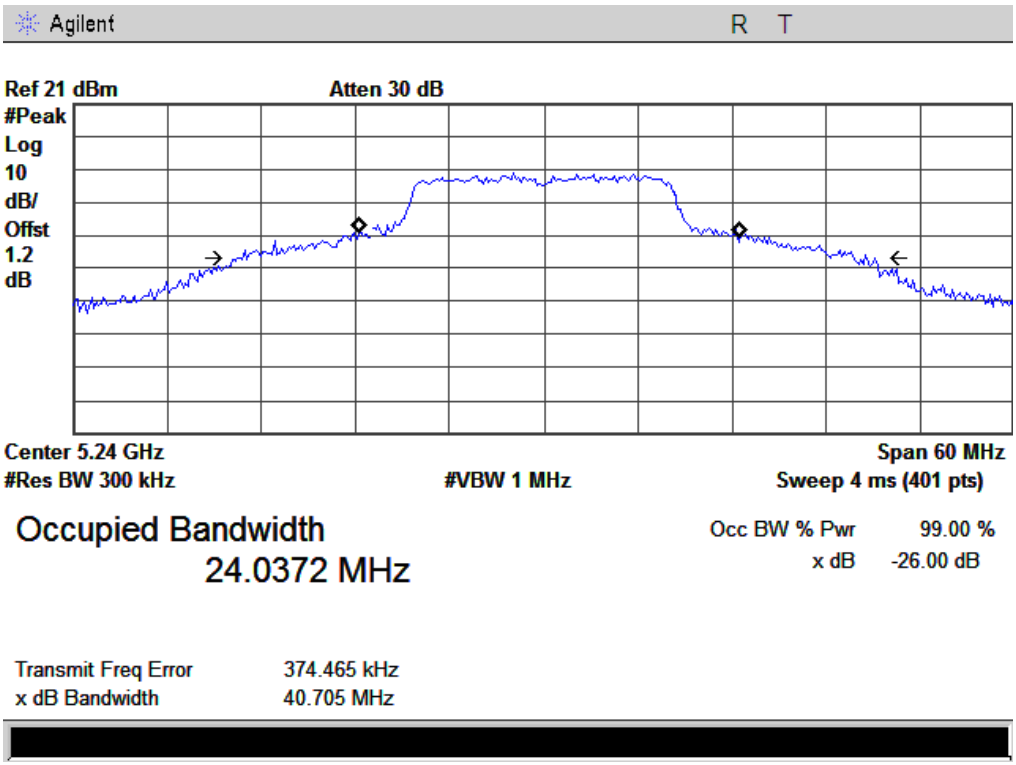
802.11a Low Channel



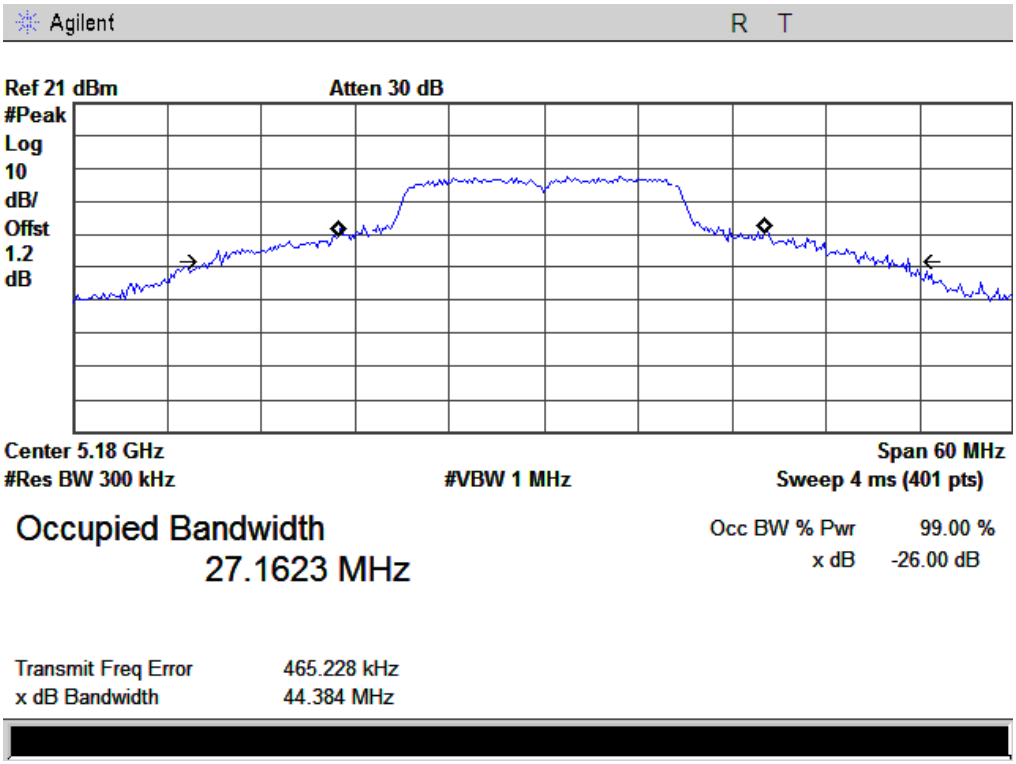
802.11a Middle Channel



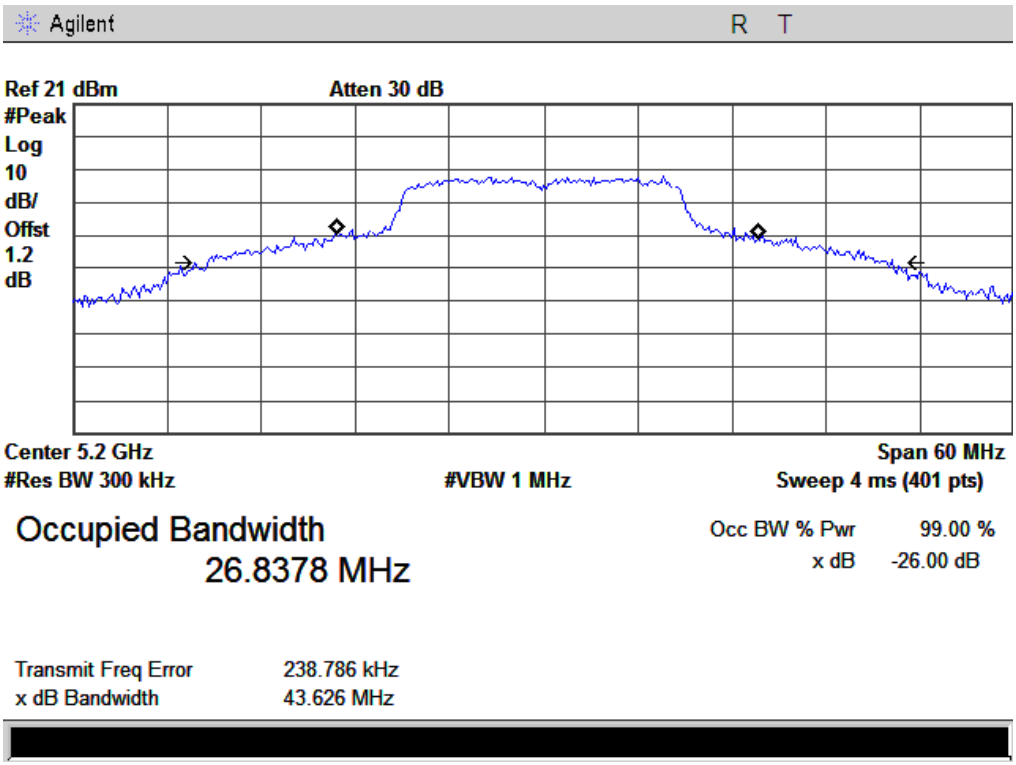
802.11a High Channel



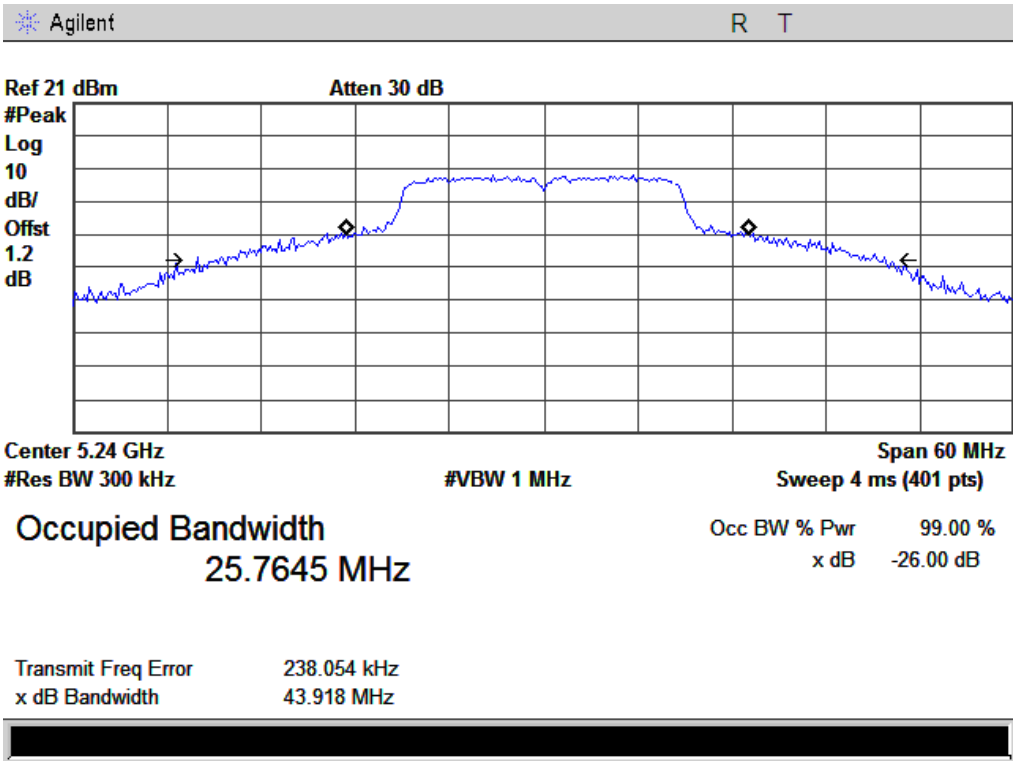
802.11n20 Low Channel



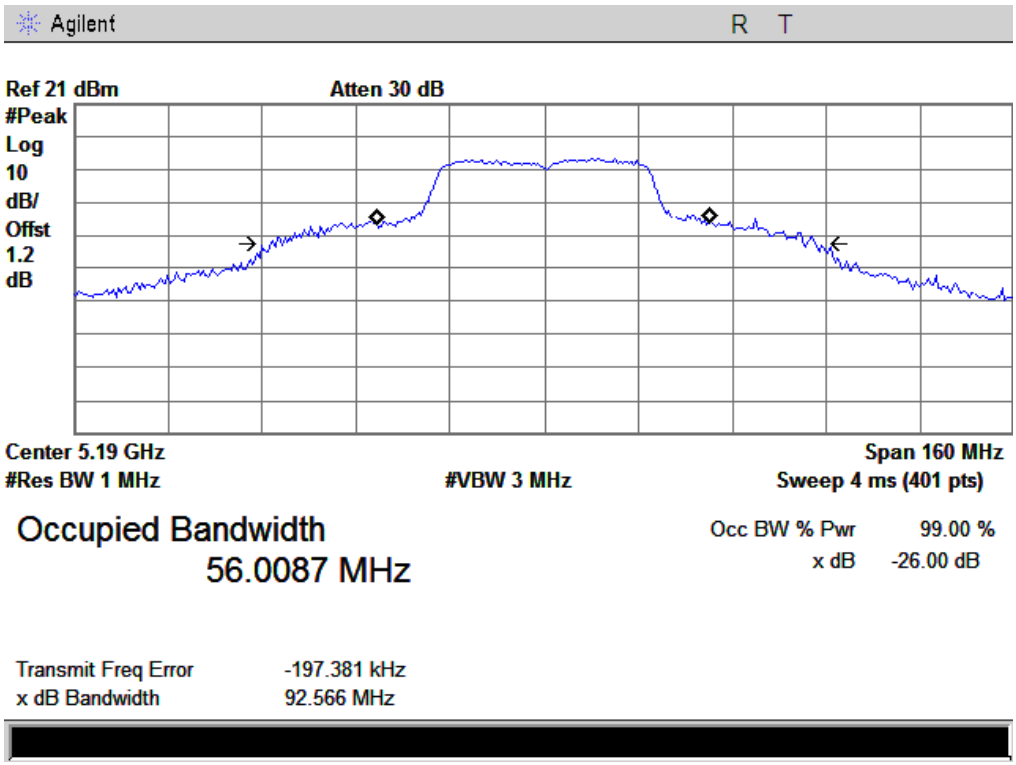
802.11n20 Middle Channel



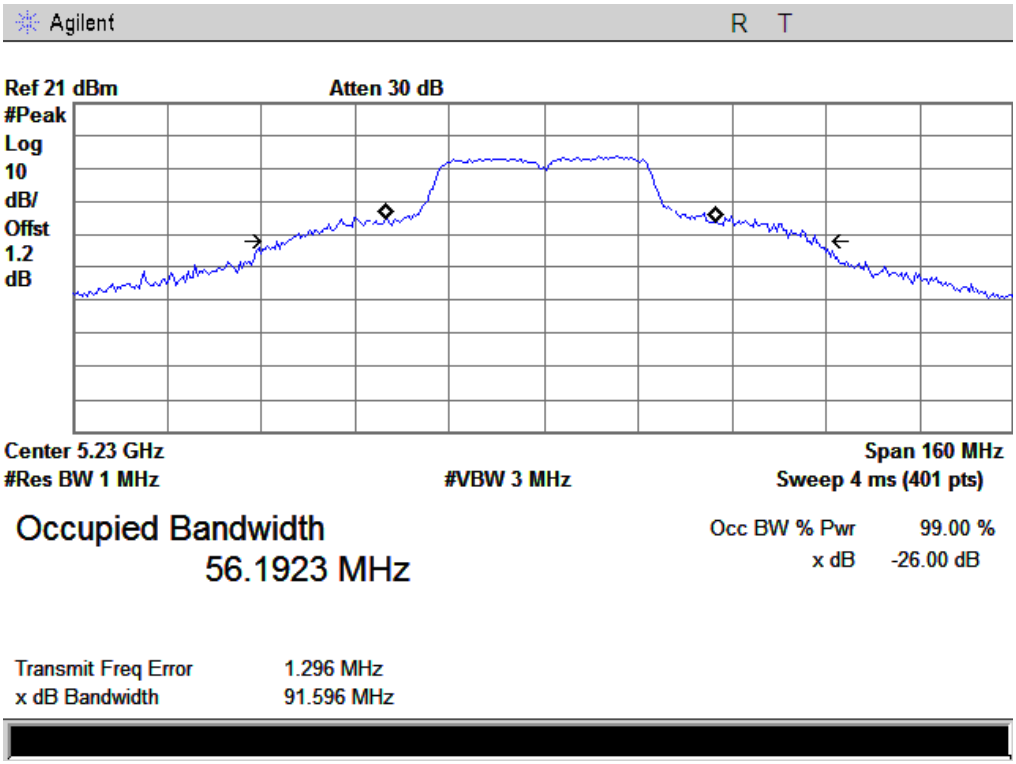
802.11n20 High Channel



802.11n40 Low Channel



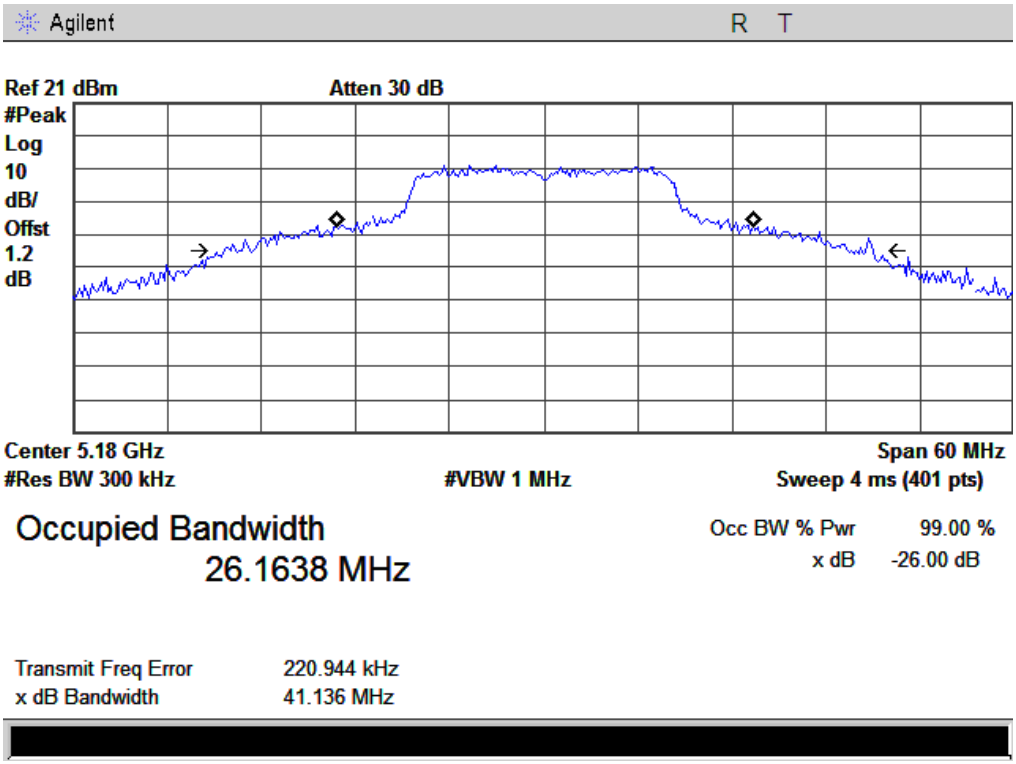
802.11n40 High Channel



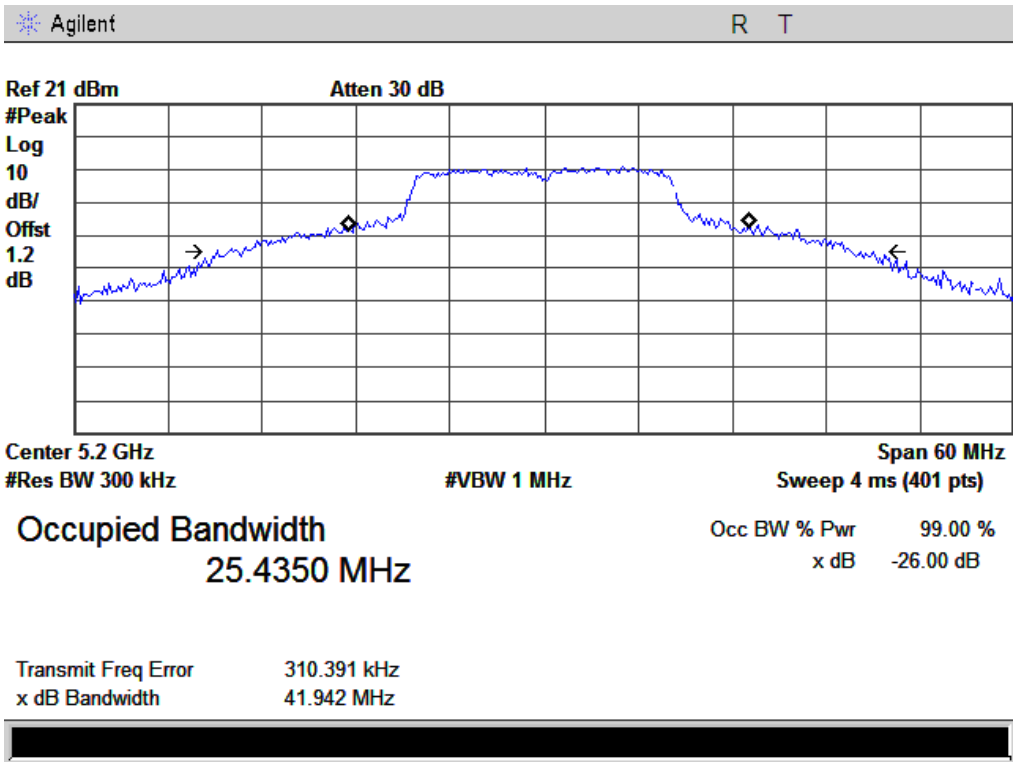
RF Port CH1 bandwidth:

Channel	Channel Frequency (MHz)	Data Rate (Mbps)	Measured 99% Bandwidth (MHz)	Measured 26dB Bandwidth (MHz)
802.11b mode				
Low	5180	6	26.1638	41.136
Middle	5200	6	25.4350	41.942
High	5240	6	22.9180	39.766
802.11n(20M) mode				
Low	5180	13	28.6109	44.834
Middle	5200	13	26.8289	43.791
High	5240	13	25.0743	43.010
802.11n(40M) mode				
Low	5190	27	61.3692	92.798
High	5230	27	59.6895	93.915

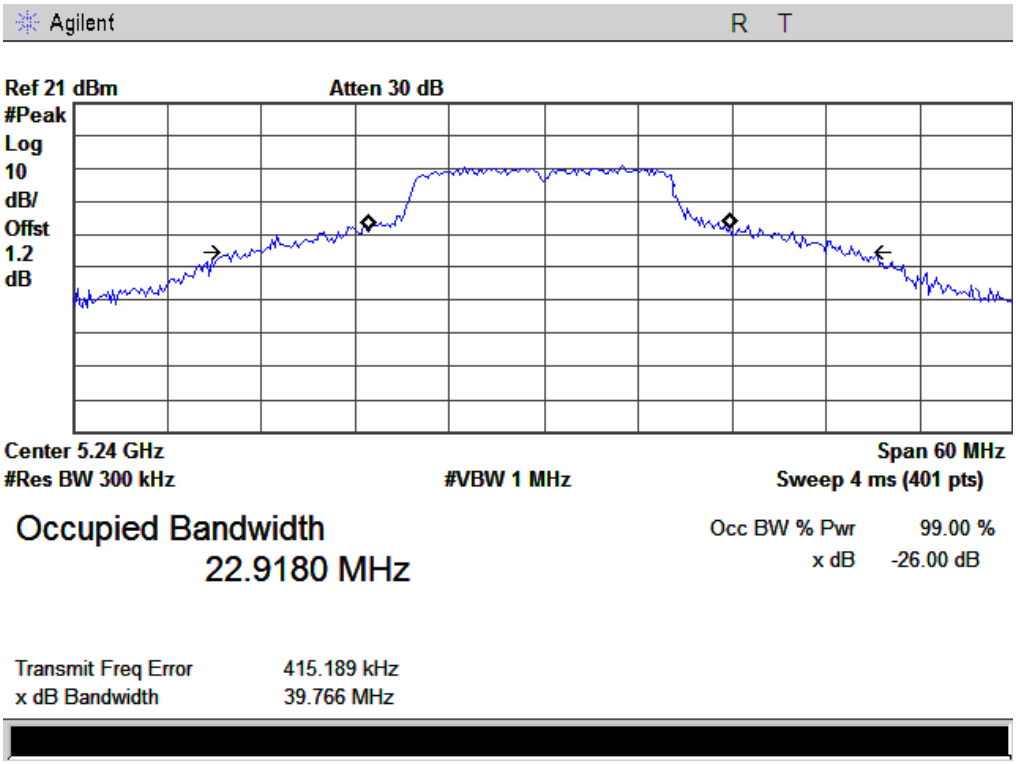
802.11a Low Channel



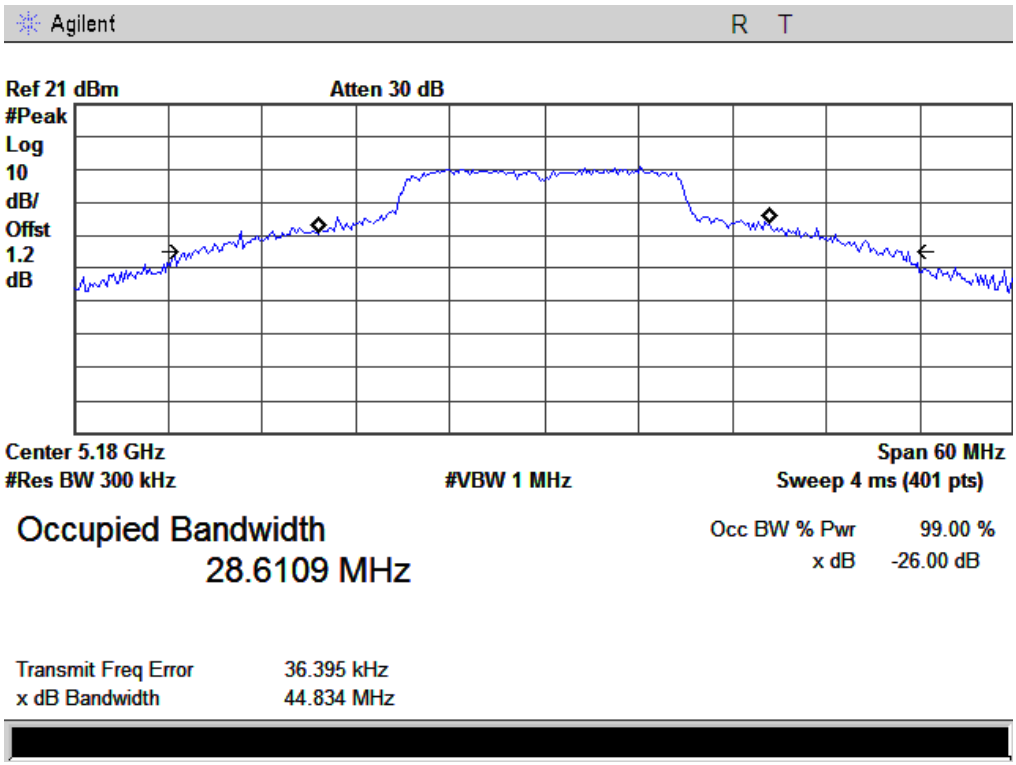
802.11a Middle Channel



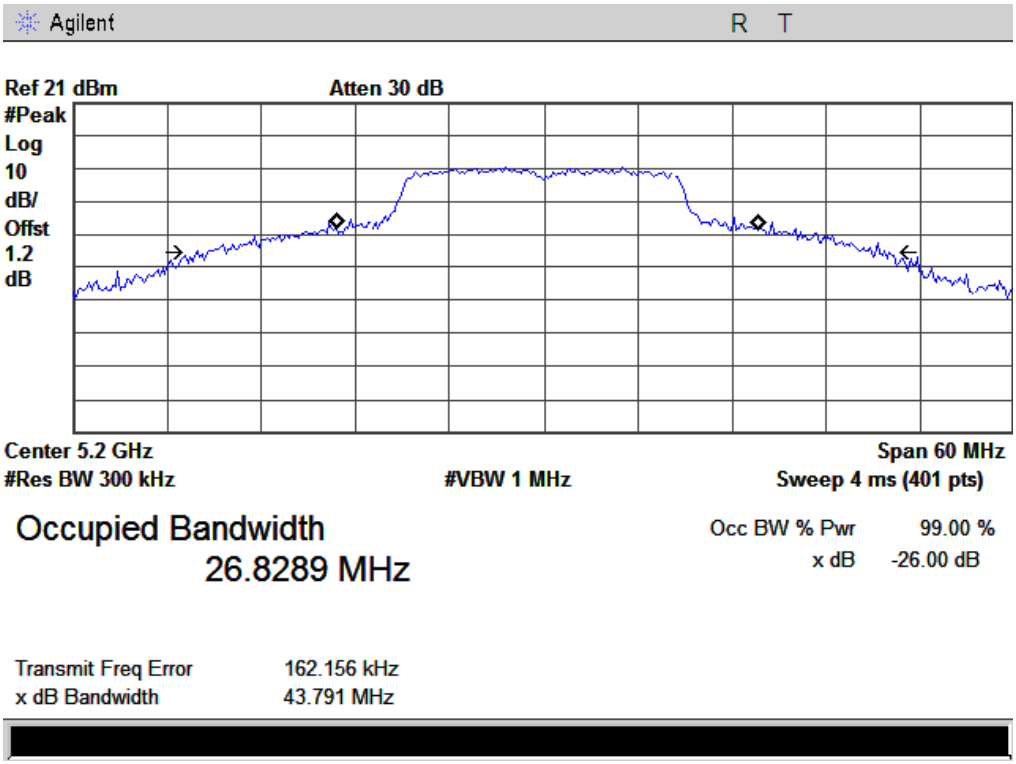
802.11a High Channel



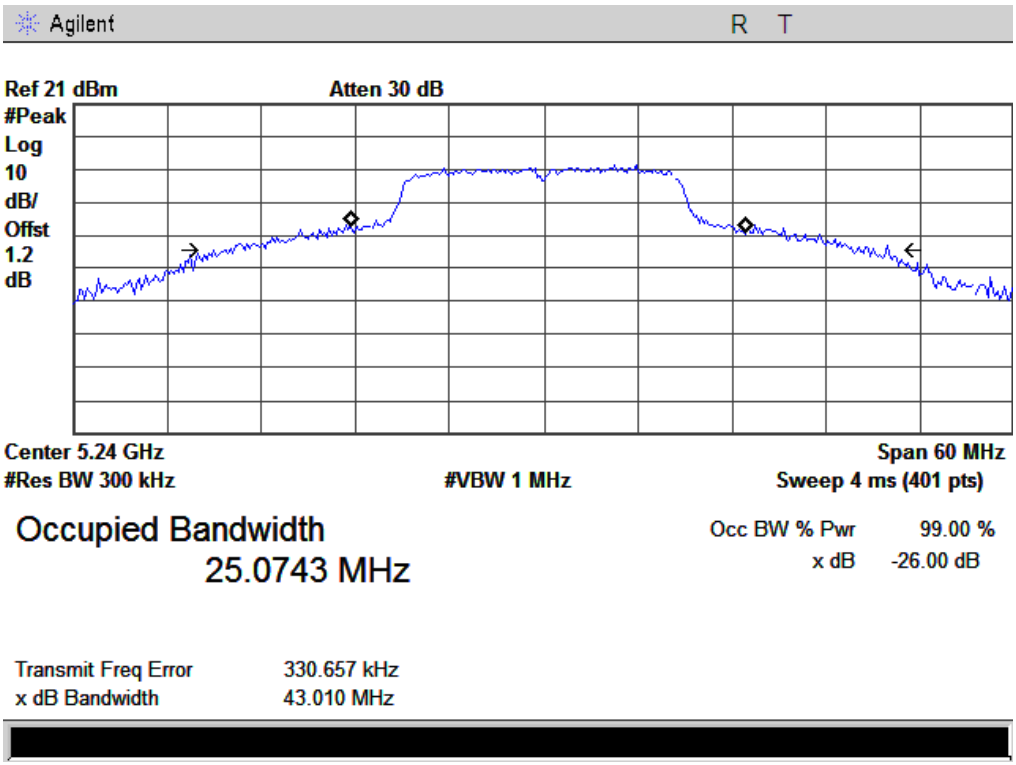
802.11 n20 Low Channel



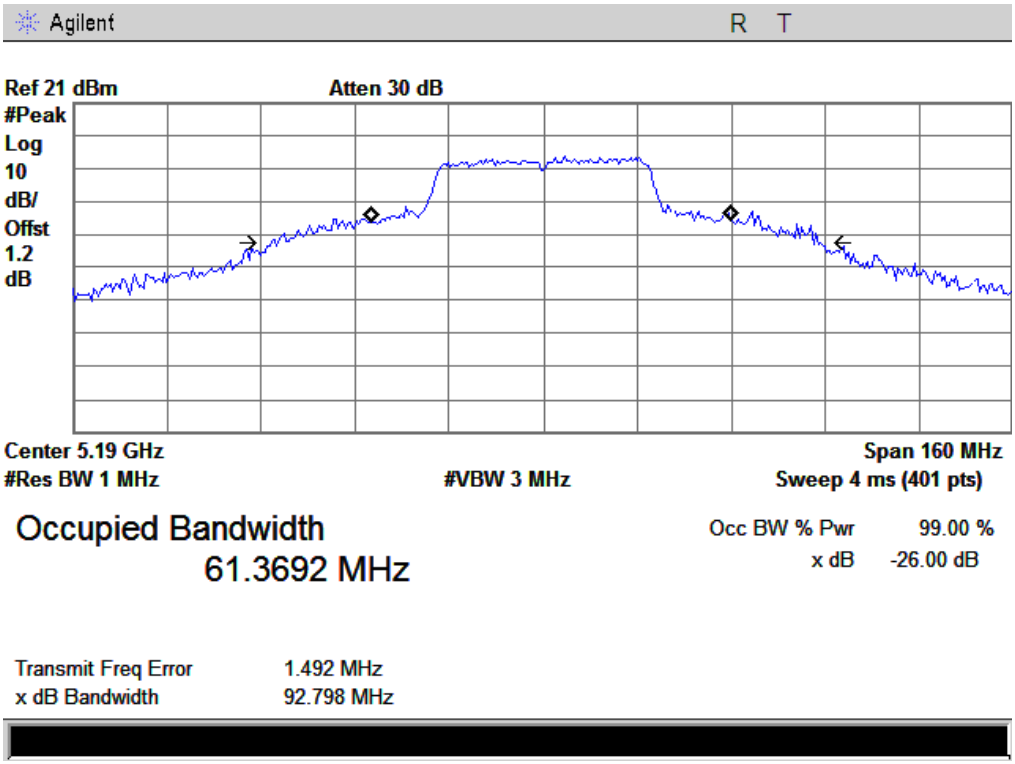
802.11 n20 Middle Channel



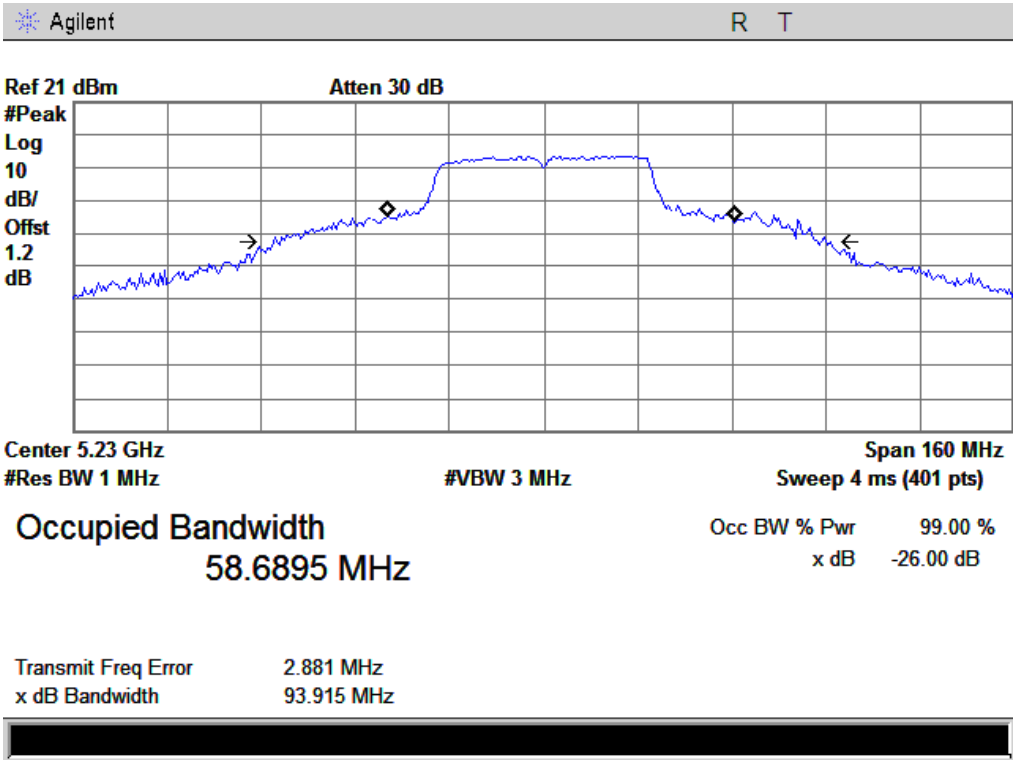
802.11n20 High Channel



802.11n40 Low Channel



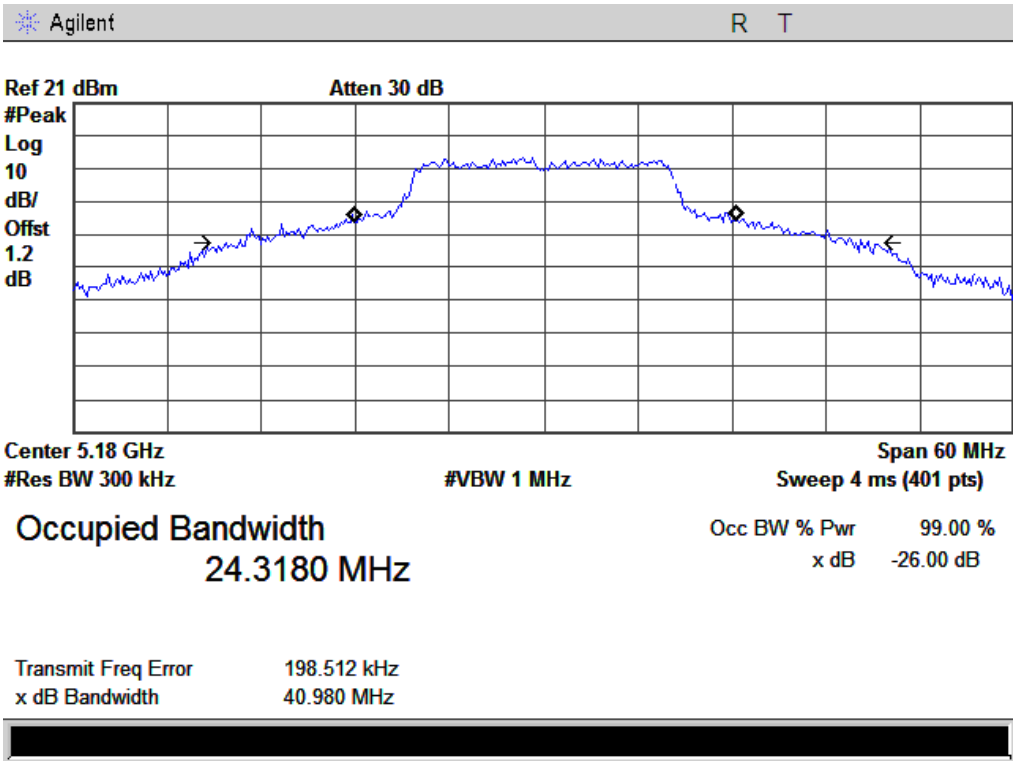
802.11n40 High Channel



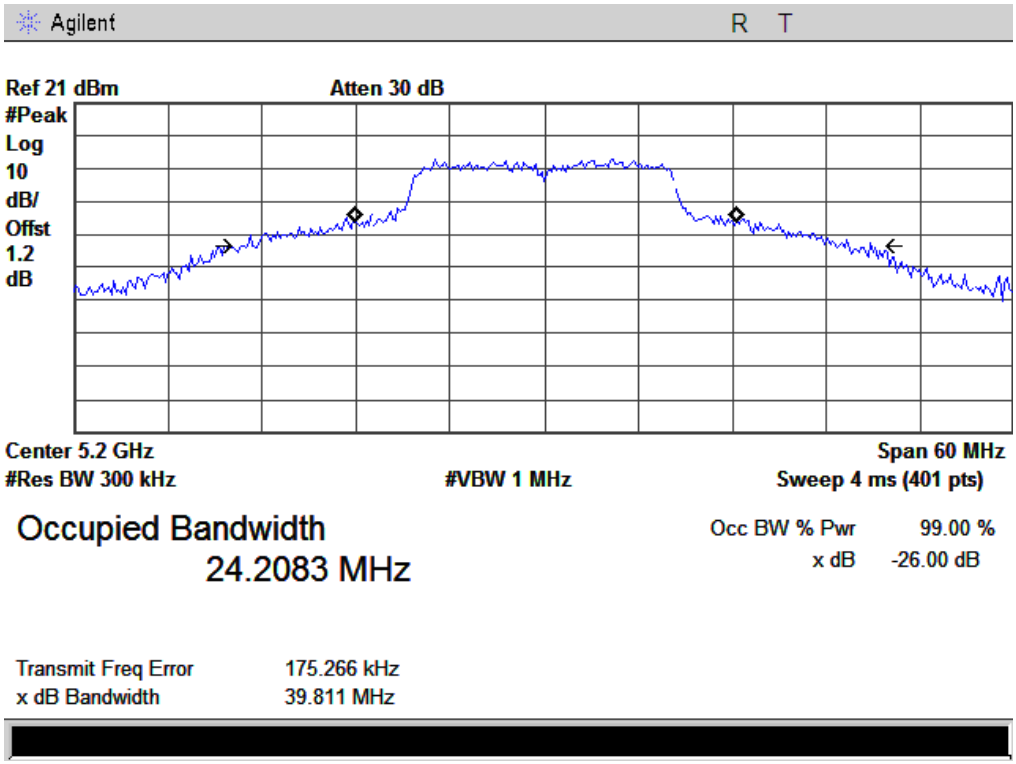
RF Port CH2 bandwidth:

Channel	Channel Frequency (MHz)	Data Rate (Mbps)	Measured 99% Bandwidth (MHz)	Measured 26dB Bandwidth (MHz)
802.11b mode				
Low	5180	6	24.3180	40.980
Middle	5200	6	24.2083	39.811
High	5240	6	23.3309	39.232
802.11n(20M) mode				
Low	5180	13	25.9872	43.295
Middle	5200	13	26.1121	43.939
High	5240	13	25.9178	43.711
802.11n(40M) mode				
Low	5190	27	56.8081	91.287
High	5230	27	55.1254	93.810

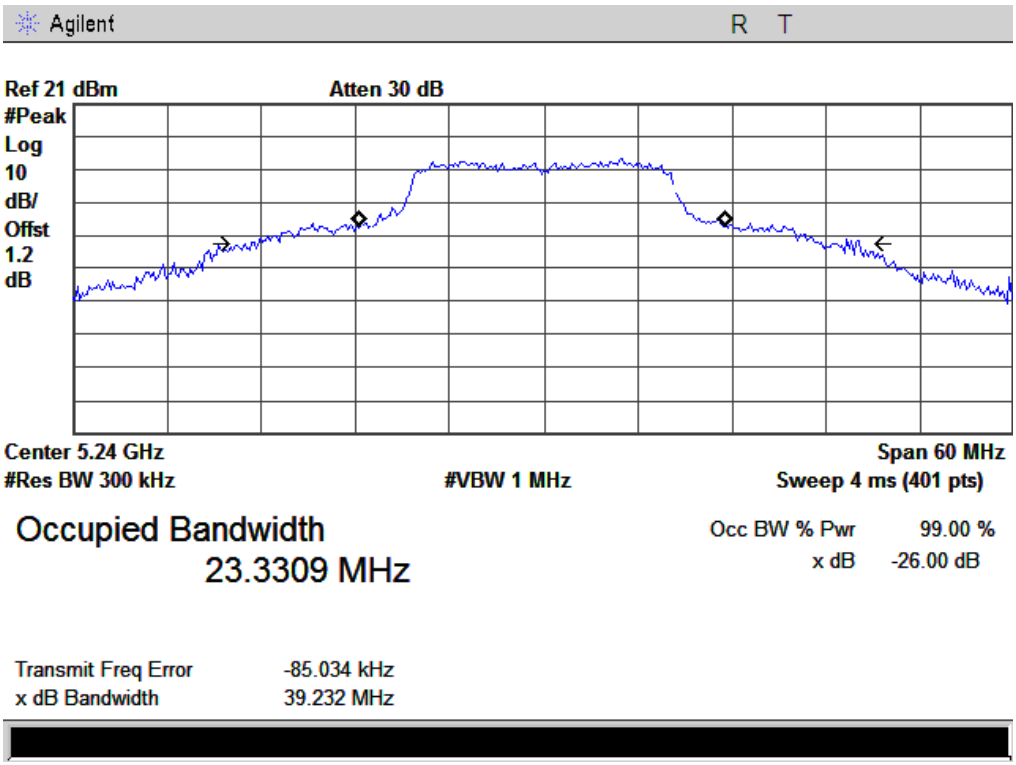
802.11a Low Channel



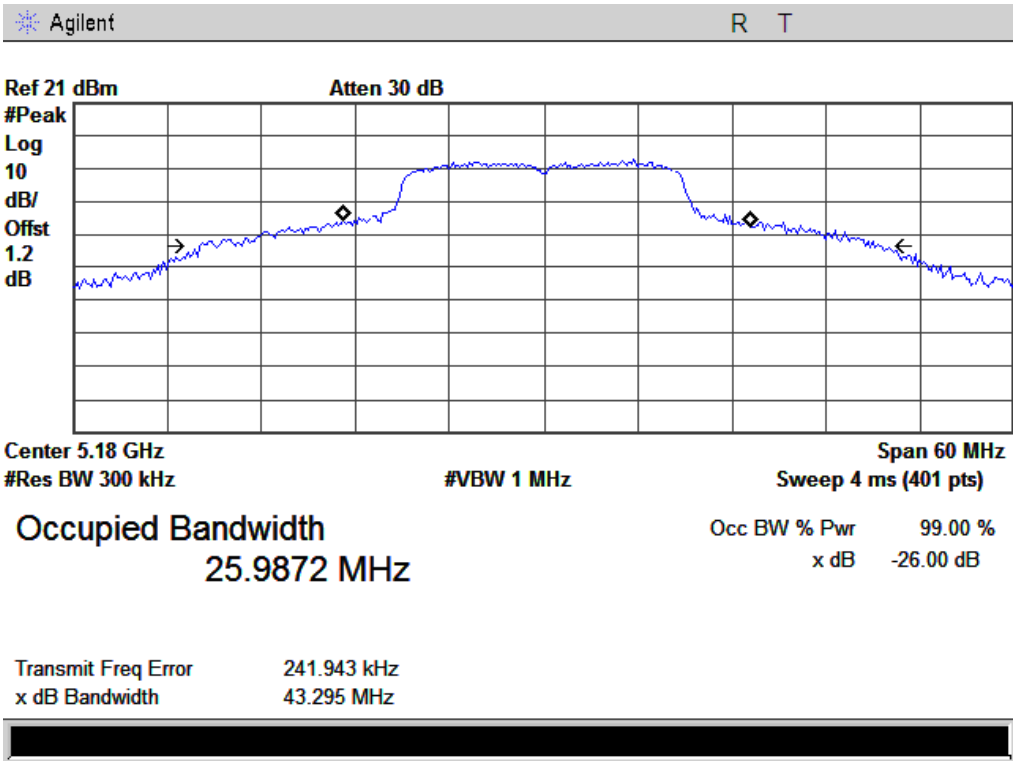
802.11a Middle Channel



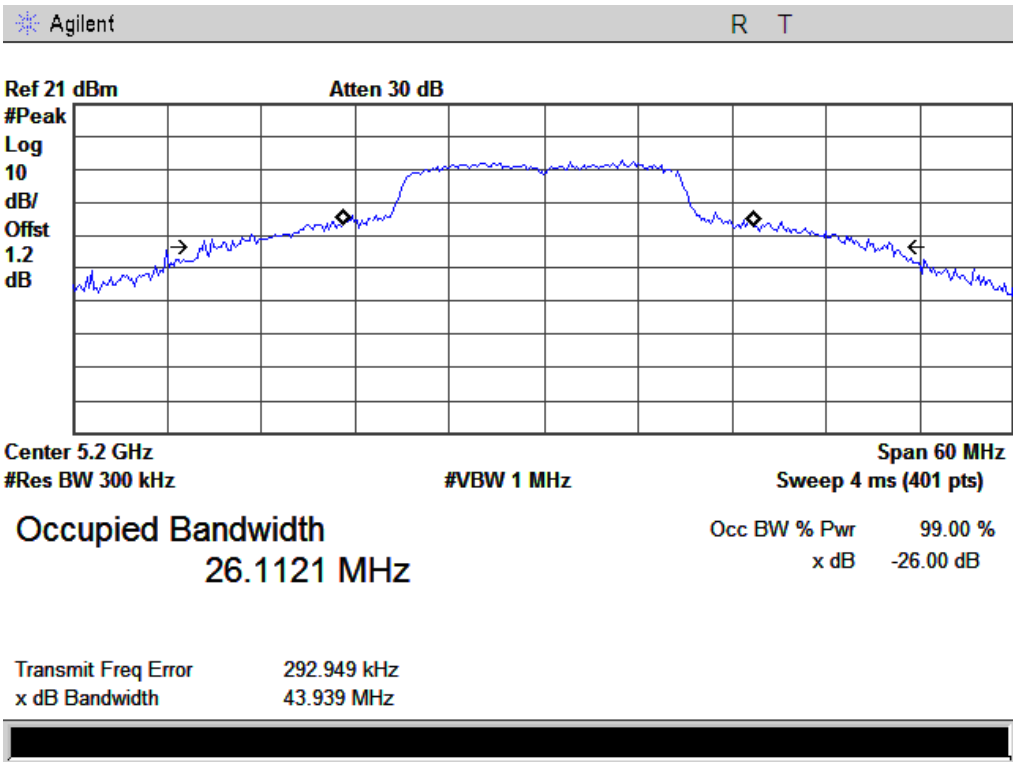
802.11a High Channel



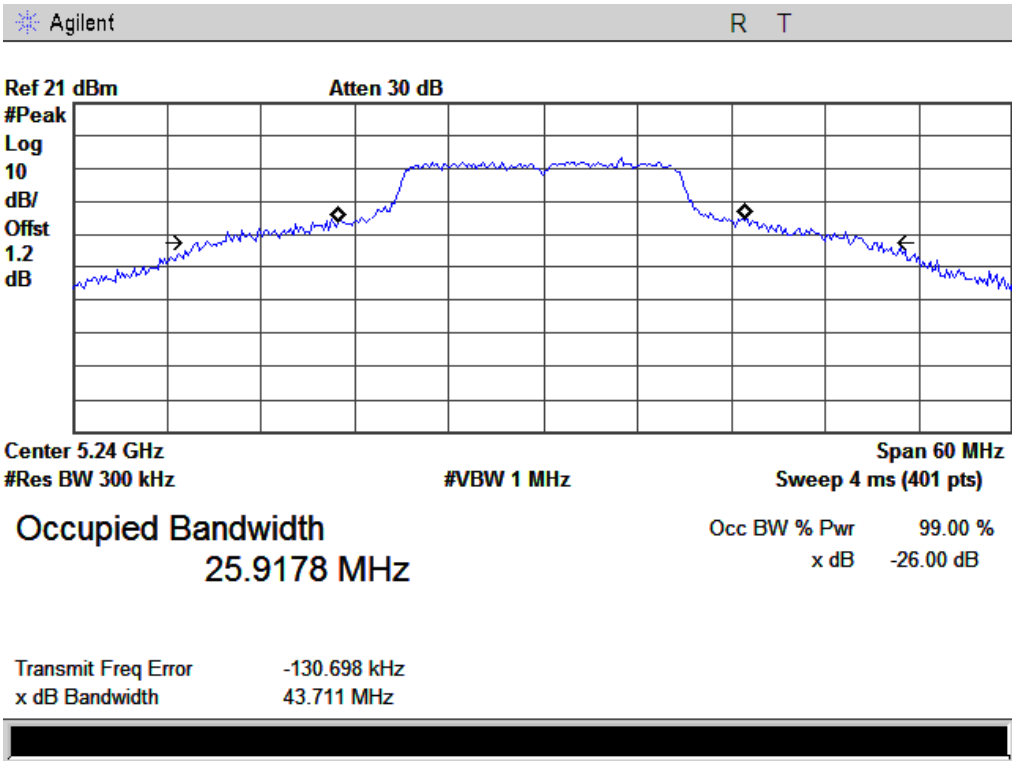
802.11n20 Low Channel



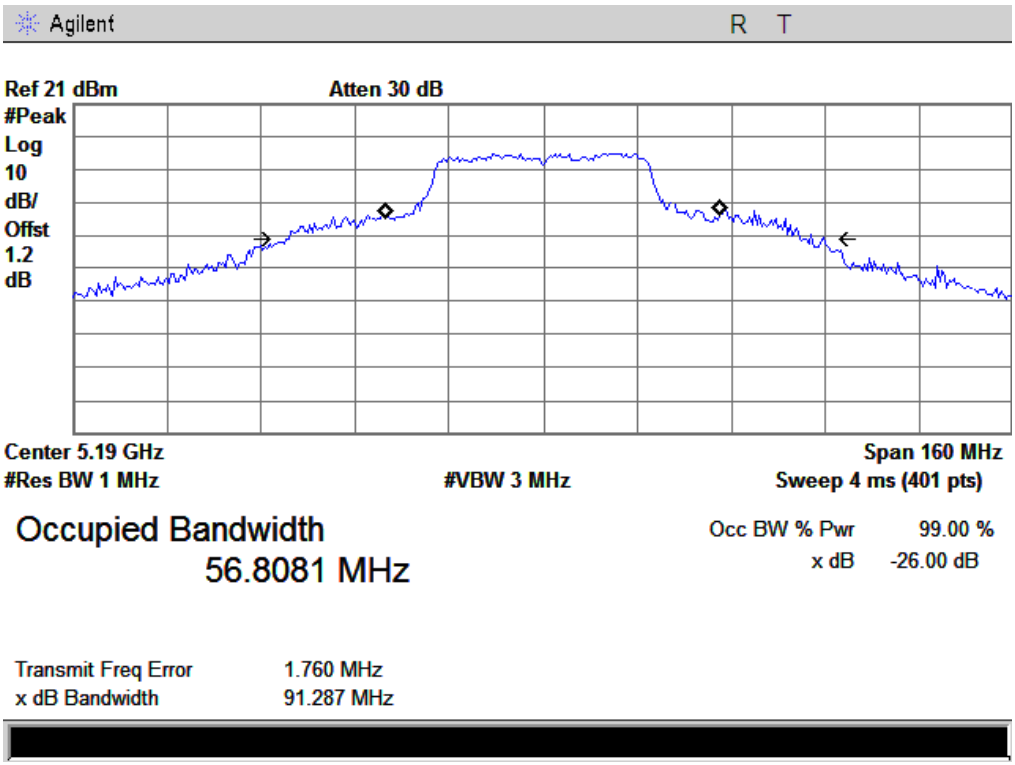
802.11n20 Middle Channel



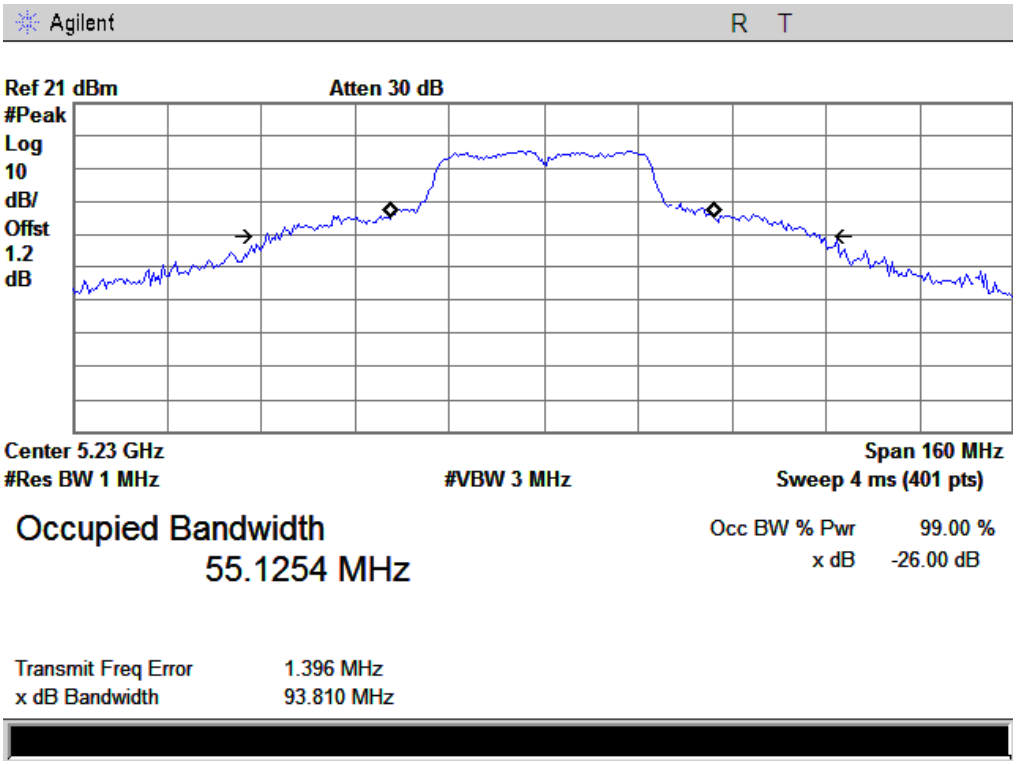
802.11n20 High Channel



802.11n40 Low Channel



802.11n40 High Channel



5.2 §15.407(a) - Conducted Maximum Output Power

1. Conducted Measurement
   EUT was set for low, mid, high channel with modulated mode and highest RF output power.
   The spectrum analyzer was connected to the antenna terminal.
2. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.
3. Environmental Conditions

Temperature	26°C
Relative Humidity	57%
Atmospheric Pressure	1002mbar

4. Test date : October 29, 2013
   Tested By : Herith Shi

Standard Requirement:

According to §15.407(a)(1), For the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Procedures:
Measurement Procedure Maximum conducted output power:

1. Set span to encompass the entire 26-dB emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.
2. Set the RBW = 1 MHz.
3. Set the VBW ≥ 3 MHz.
4. Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
5. Sweep time = auto couple.
6. Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
7. If transmit duty cycle < 98 percent, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 percent, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run".
8. Trace average at least 100 traces in power averaging (i.e., RMS) mode.
9. Compute power by integrating the spectrum across the 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the spectrum.

Test Result: Pass.
Please refer to the following tables and plots.

Power limit =4+10logB(Note1)			
802.11a mode			
Data Rate	**Channel**	**Min 26db band**	**Determined Limit(dBm)**
6Mbps	5180	40.710	20.0(Note2)
6Mbps	5200	39.811	20.0(Note2)
6Mbps	5240	39.232	19.9(Note2)
Power limit =4+10logB*(Note1)			
802.11n20 mode			
Data Rate	**Channel**	**Min 26db band**	**Determined Limit(dBm)**
6Mbps	5180	43.295	20.4(Note2)
6Mbps	5200	43.626	20.4(Note2)
6Mbps	5240	43.010	20.4(Note2)
802.11n40 mode			
Data Rate	**Channel**	**Min 26db band**	**Determined Limit(dBm)**
6Mbps	5190	91.287	23.6(Note2)
6Mbps	5230	91.596	23.6(Note2)

Note1: B is the 26-dB emission bandwidth in MHz
Note2: According to §15.407(a)(1), the output power limit should be 50mw(17dBm) because the calculated limit is over 50mw.

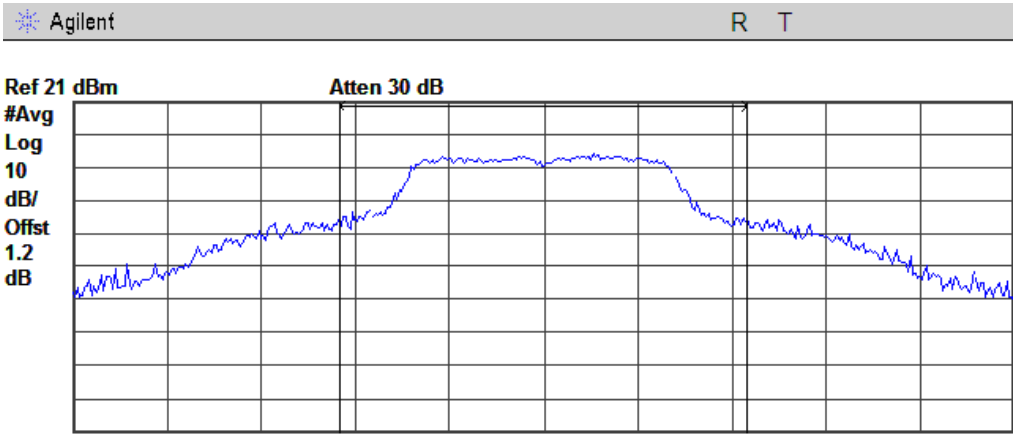
The Peak Power

802.11a mode					
Data Rate:6Mbps					
Channel	AV Output Power(dBm)			Total AV Power(dBm)	Limit(dBm)(Note)
	CH0	CH1	CH2		
5180	8.49	9.00	10.50	14.19	17
5220	9.28	9.02	10.31	14.34	17
5240	9.13	9.29	10.59	14.49	17
802.11n20 mode					
Data Rate:13Mbps					
Channel	AV Output Power(dBm)			Total AV Power(dBm)	Limit(dBm)
	CH0	CH1	CH2		
5180	8.51	8.90	10.22	14.04	17
5220	8.87	8.81	10.79	14.36	17
5240	8.52	8.52	10.88	14.22	17
802.11n40 mode					
Data Rate:27Mbps					
Channel	AV Output Power(dBm)			Total AV Power(dBm)	Limit(dBm)
	CH0	CH1	CH2		
5190	8.87	9.02	10.13	14.14	17
5230	8.44	9.15	9.99	14.01	17

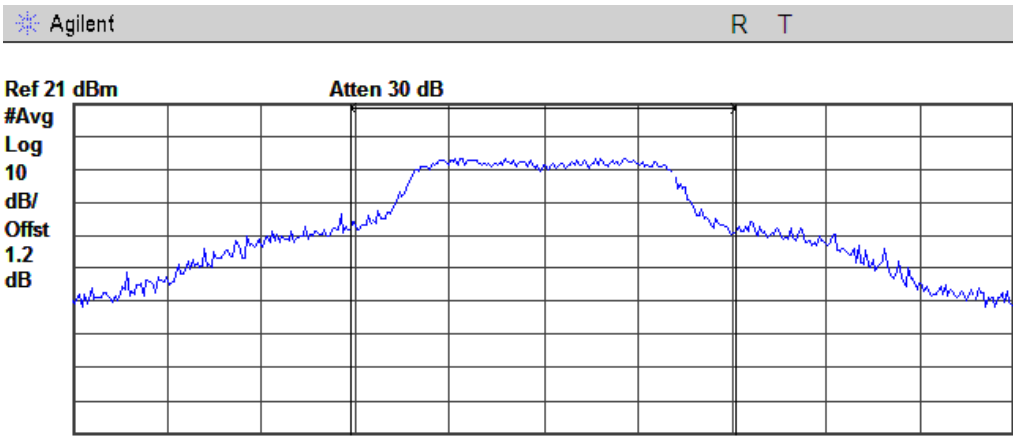
Note: According to §15.407(a)(1), the output power limit should be 50mw(17dBm) because the calculated limit is over 50mw(17dBm).

RF Port CH0
Output Power

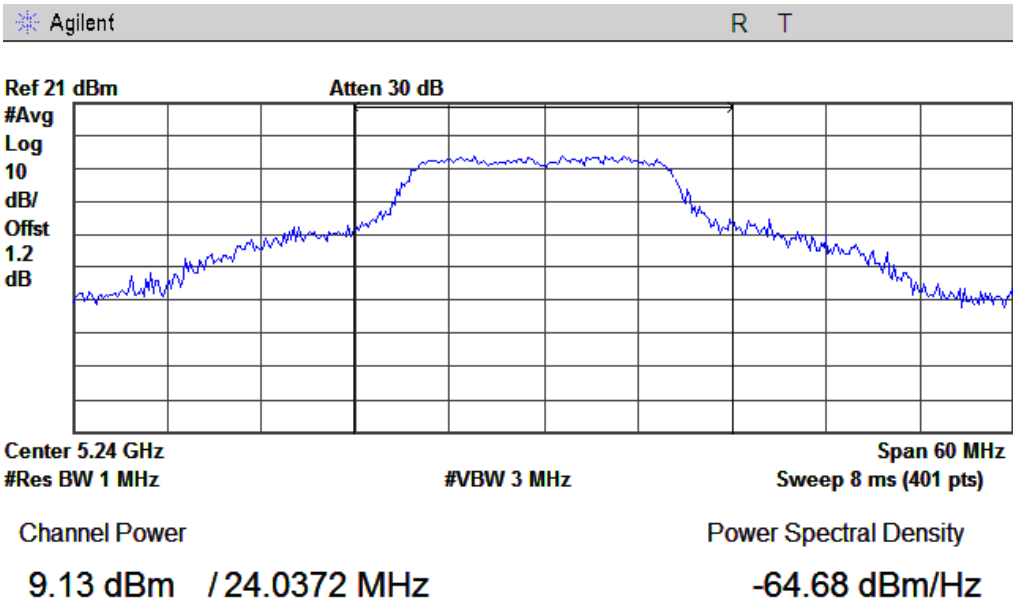
802.11a Low Channel



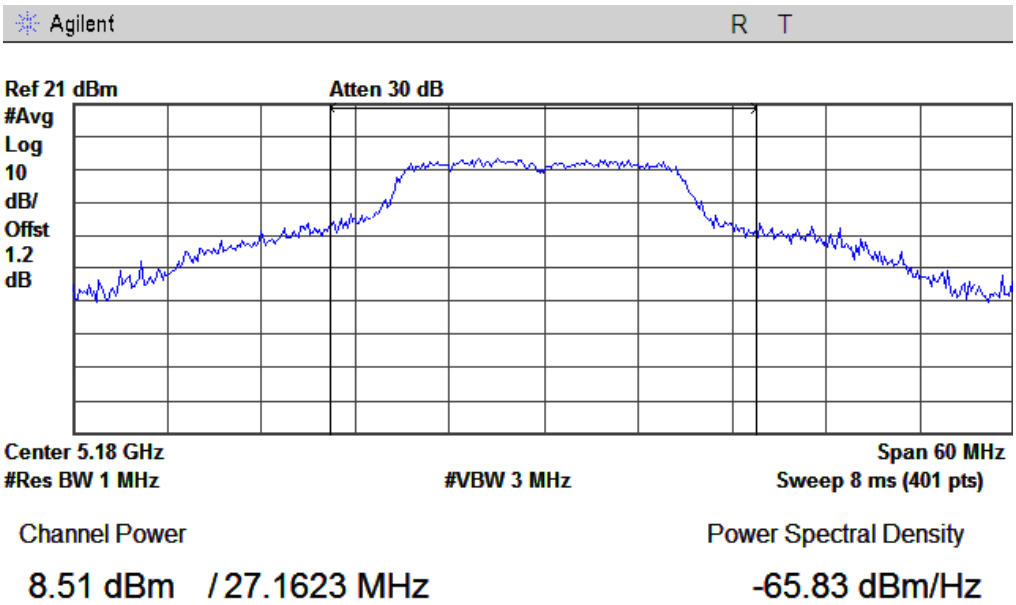
802.11a Middle Channel



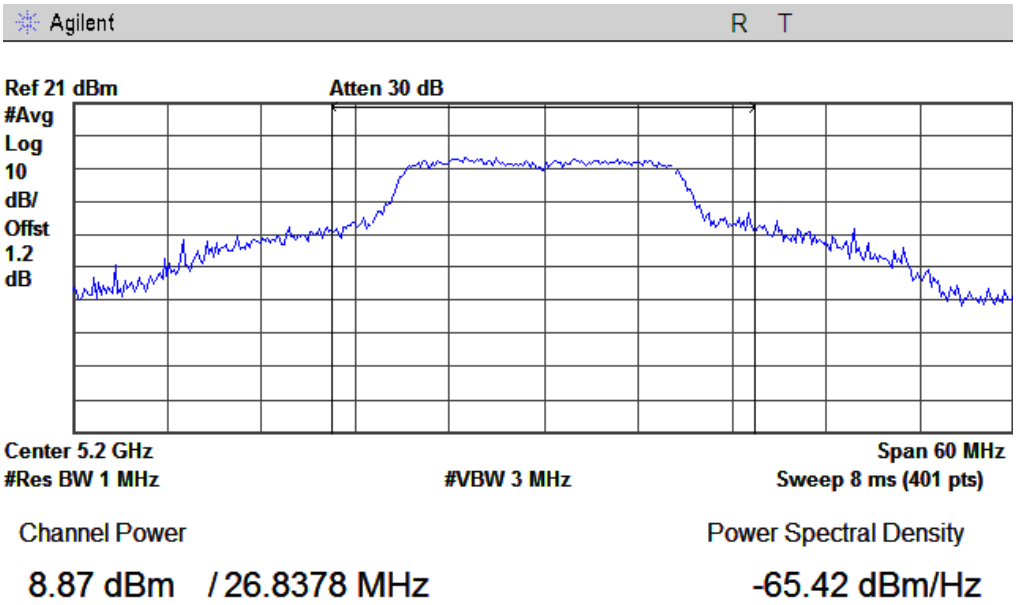
802.11a High Channel



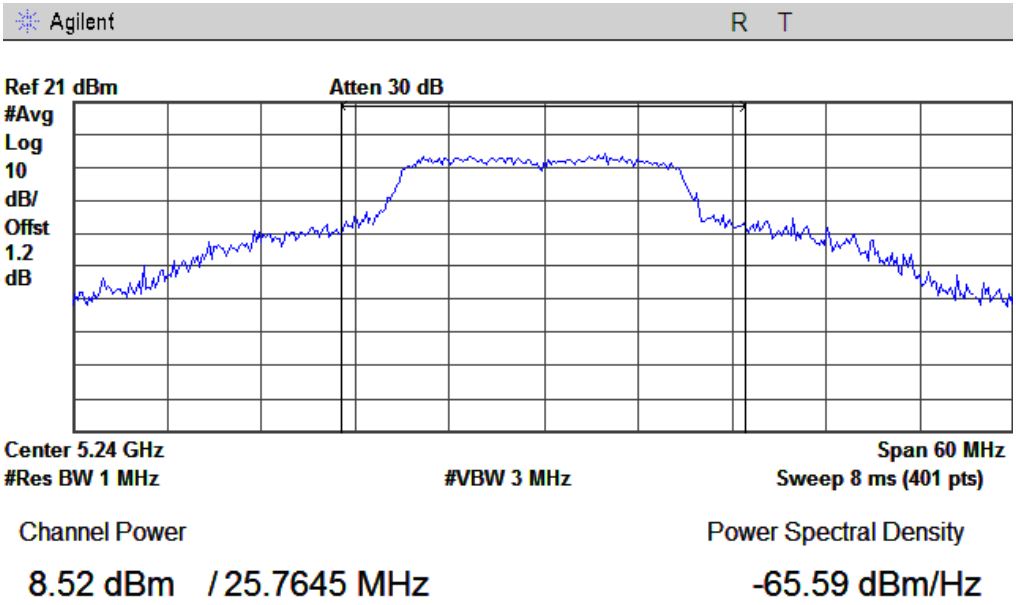
802.11n20 Low Channel



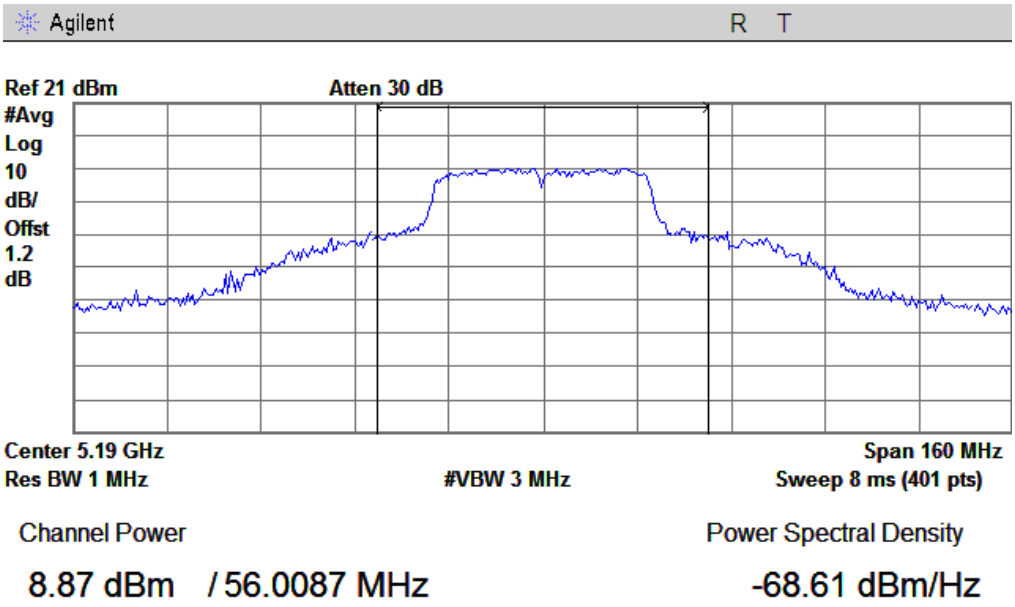
802.11n20 Middle Channel



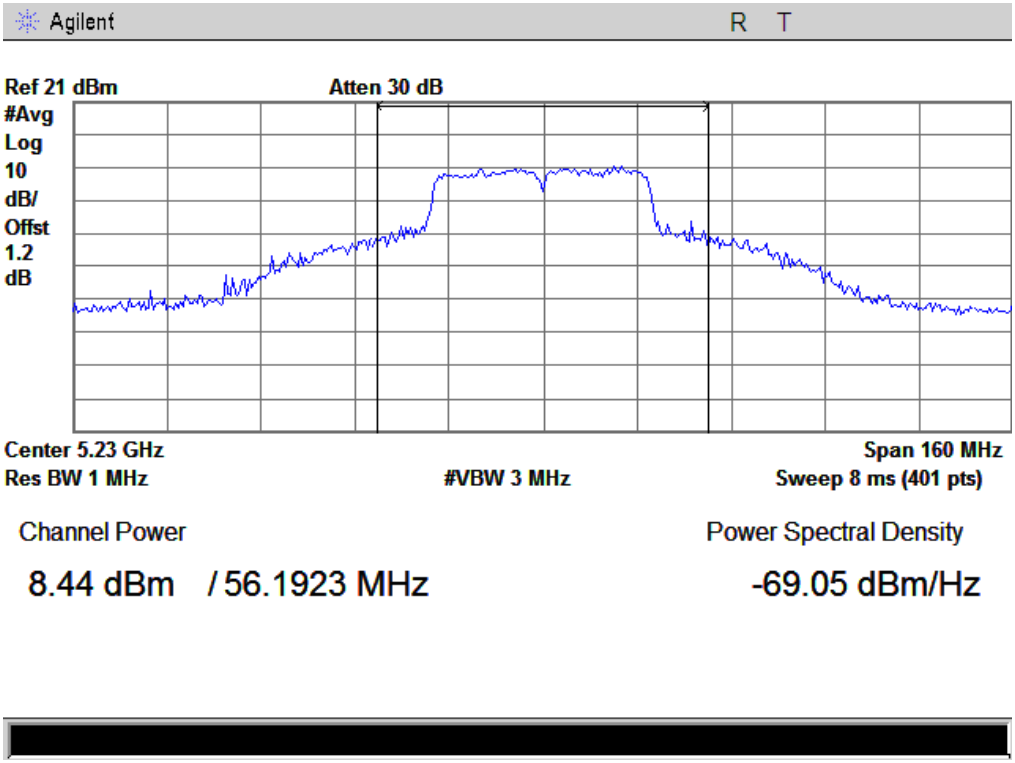
802.11n20 High Channel



802.11n40 Low Channel

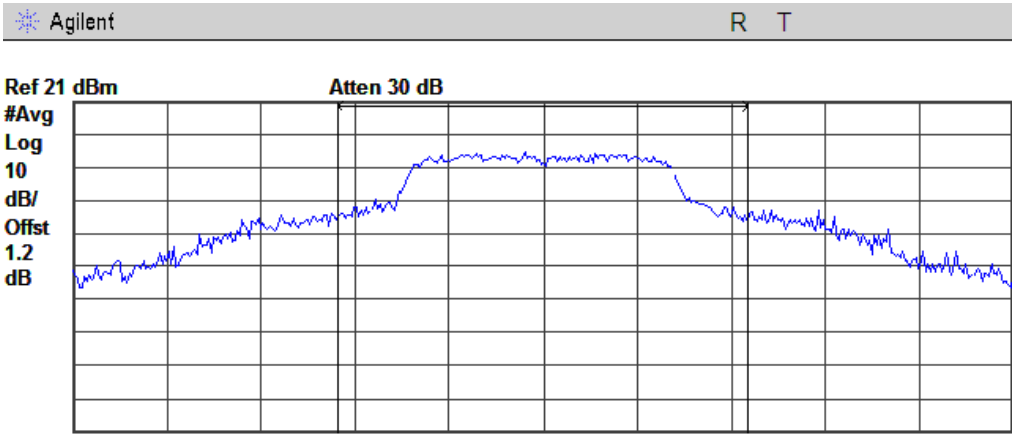


802.11n40 High Channel

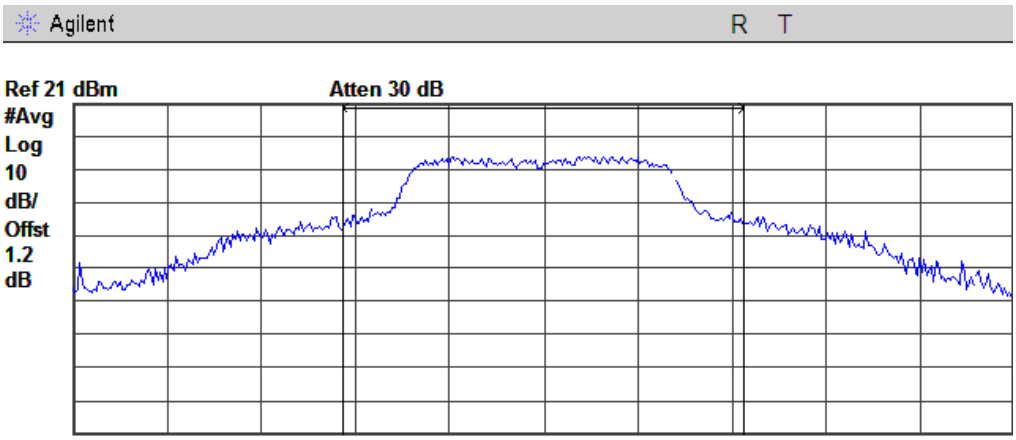


RF Port CH1
Output Power

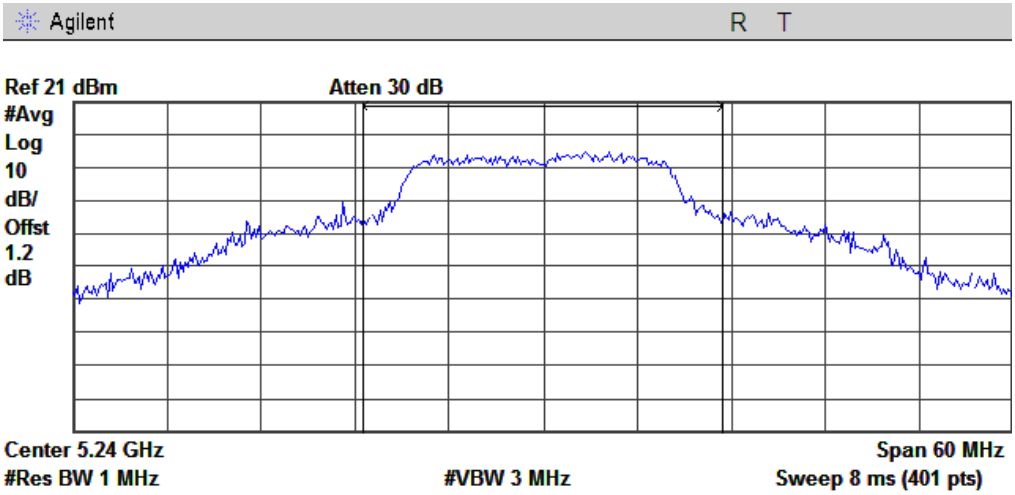
802.11a Low Channel



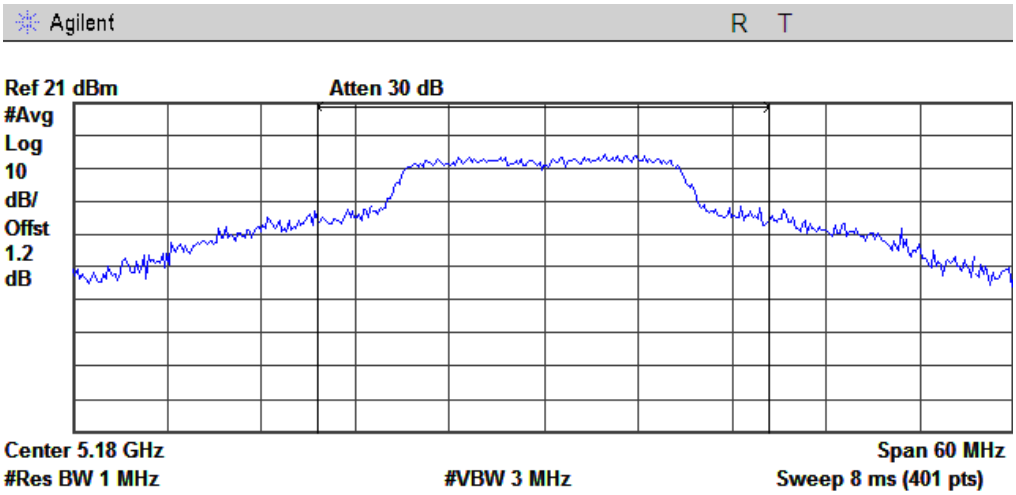
802.11a Middle Channel



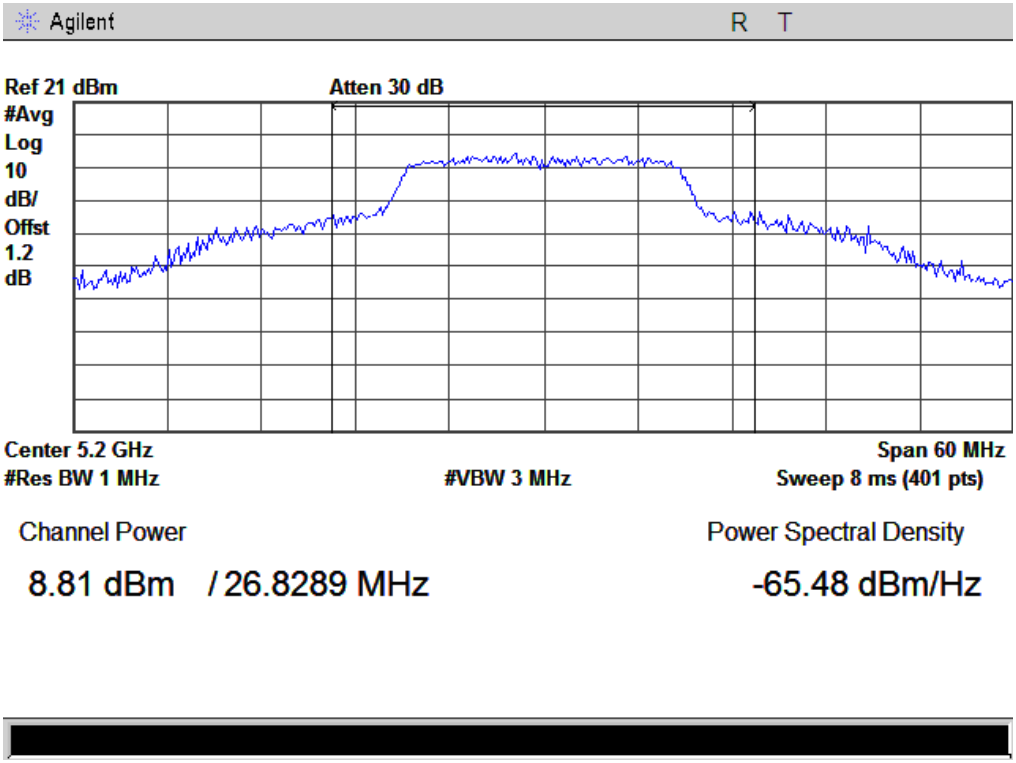
802.11a High Channel



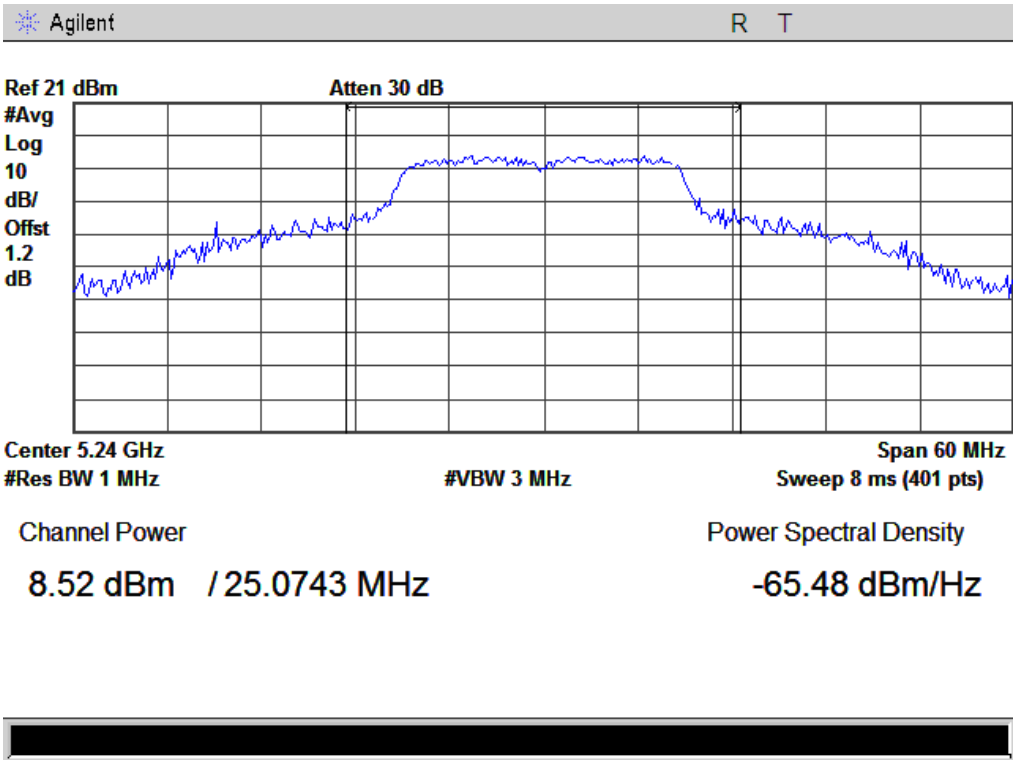
802.11n20 Low Channel



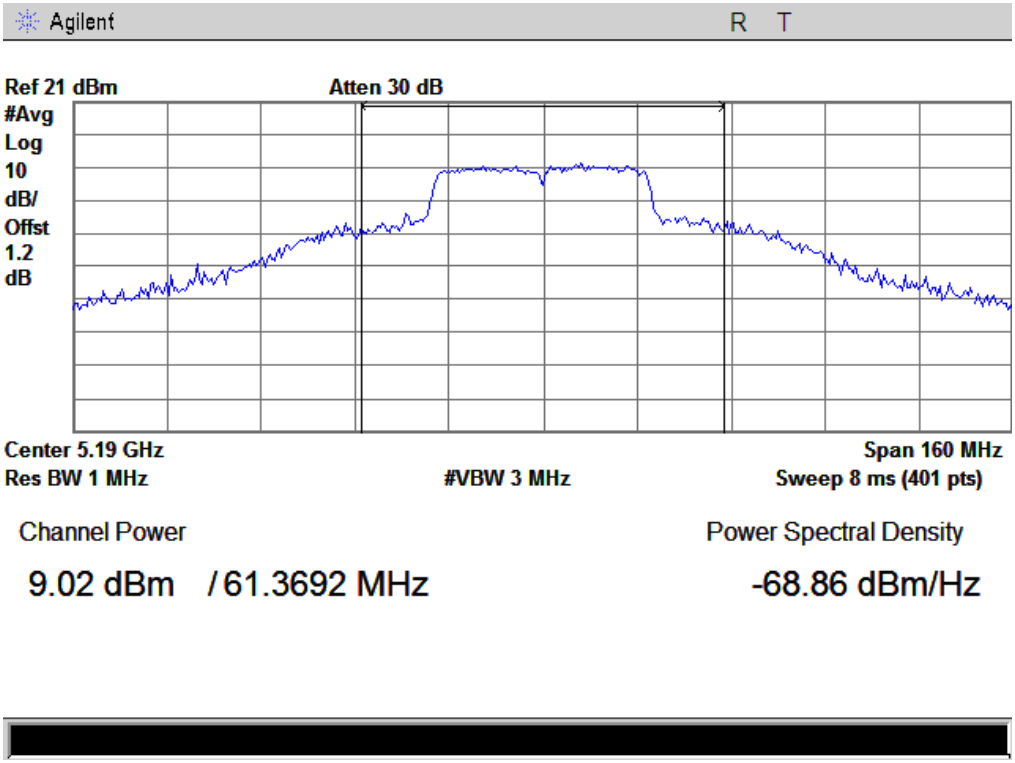
802.11n20 Middle Channel



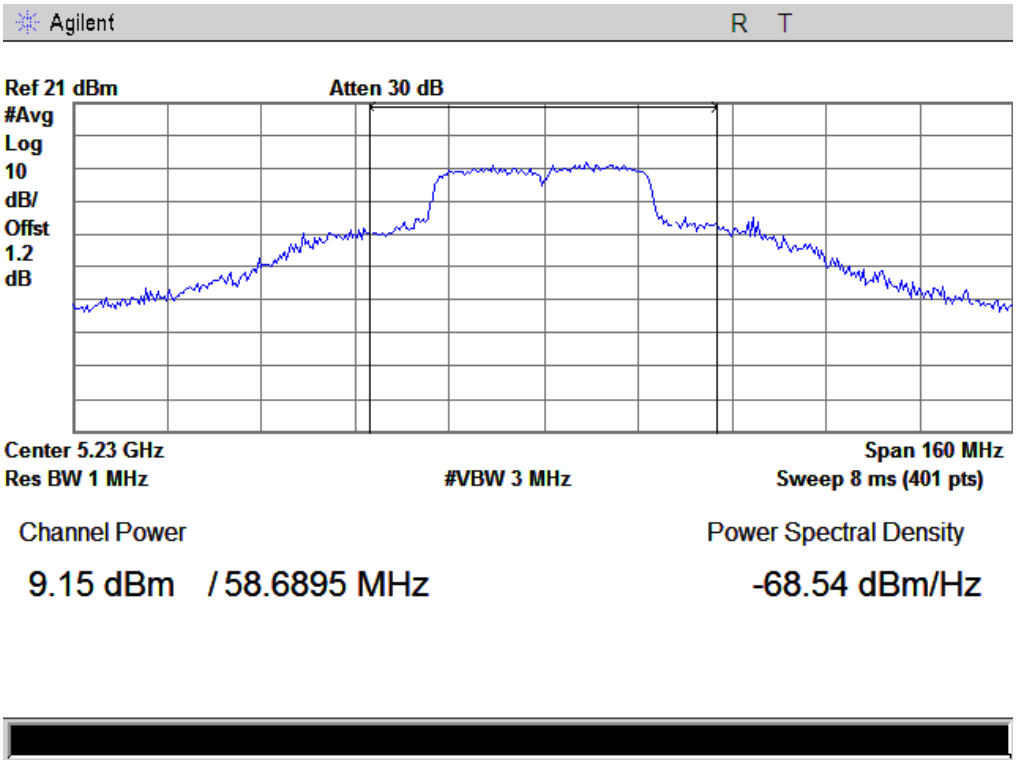
802.11n20 High Channel



802.11n40 Low Channel

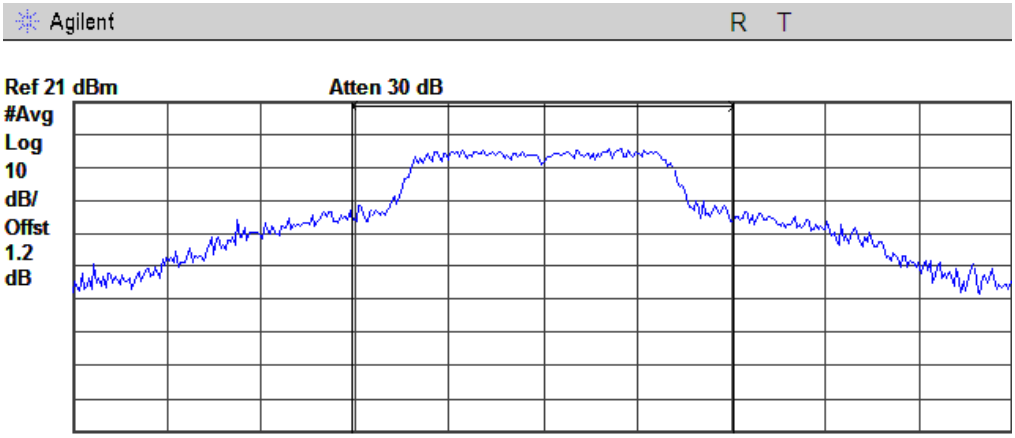


802.11n40 High Channel

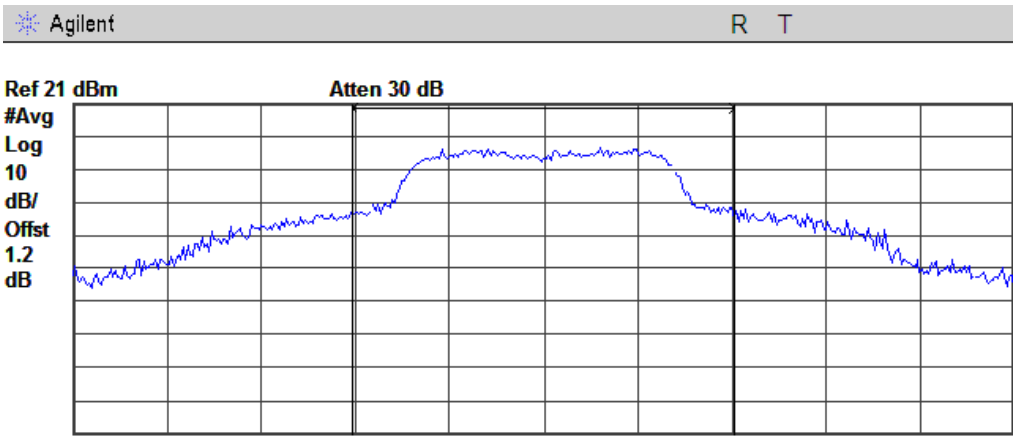


RF Port CH2
Output Power

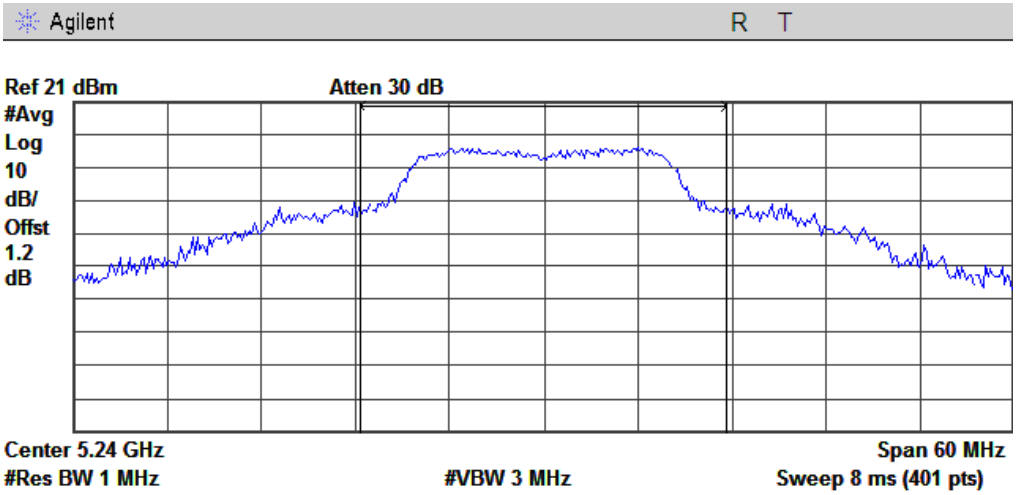
802.11a Low Channel



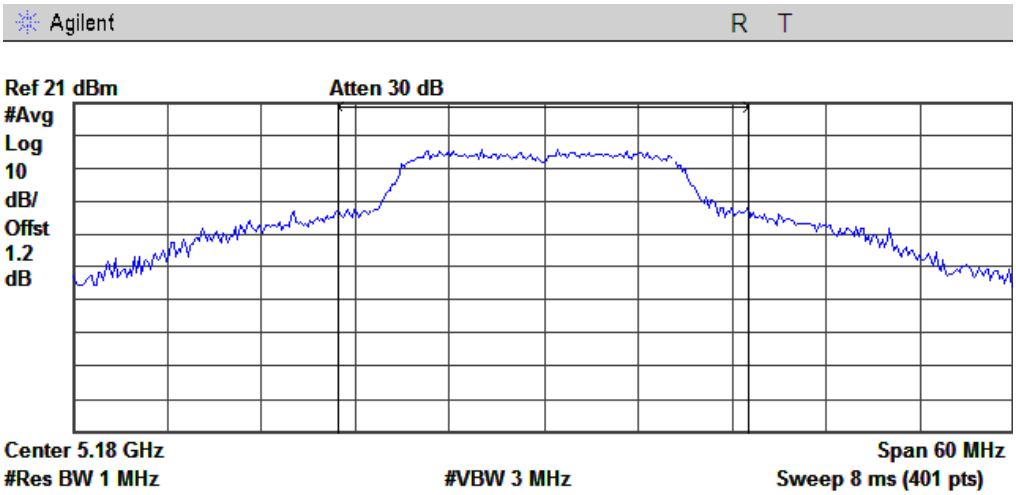
802.11a Middle Channel



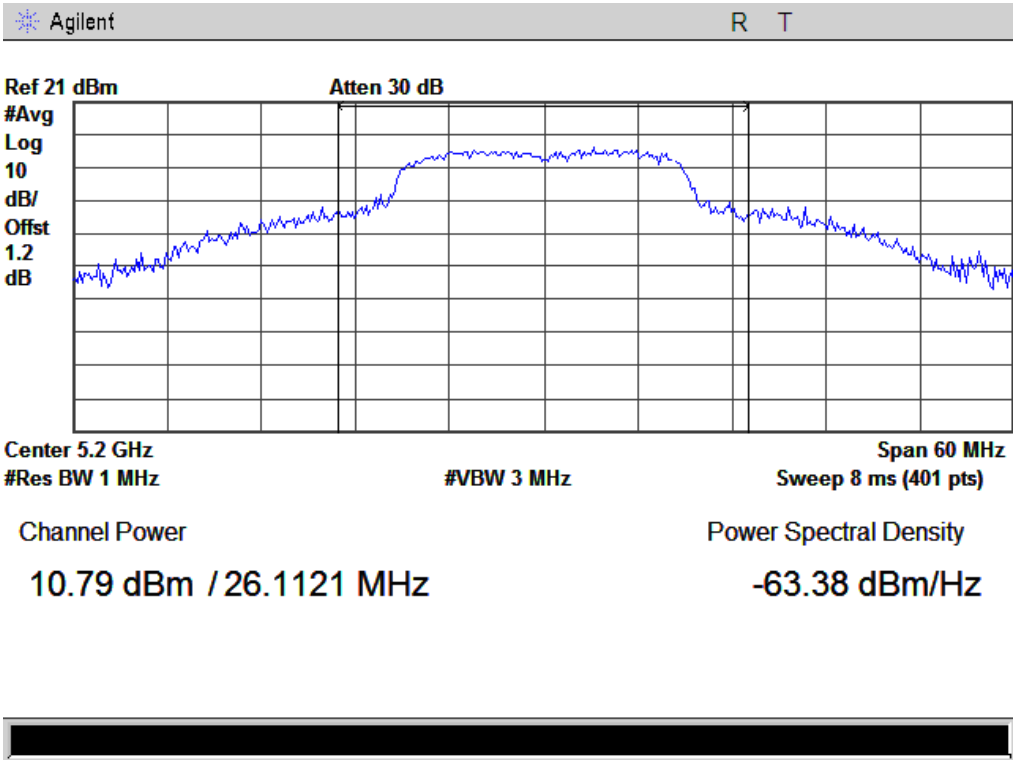
802.11a High Channel



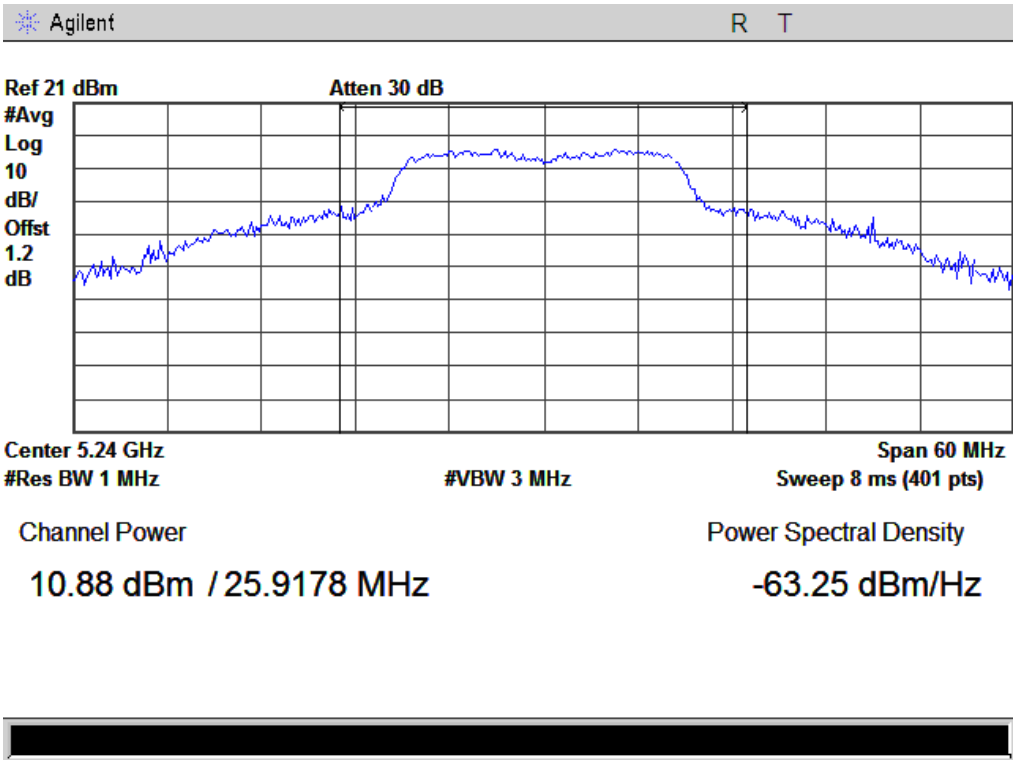
802.11n20 Low Channel



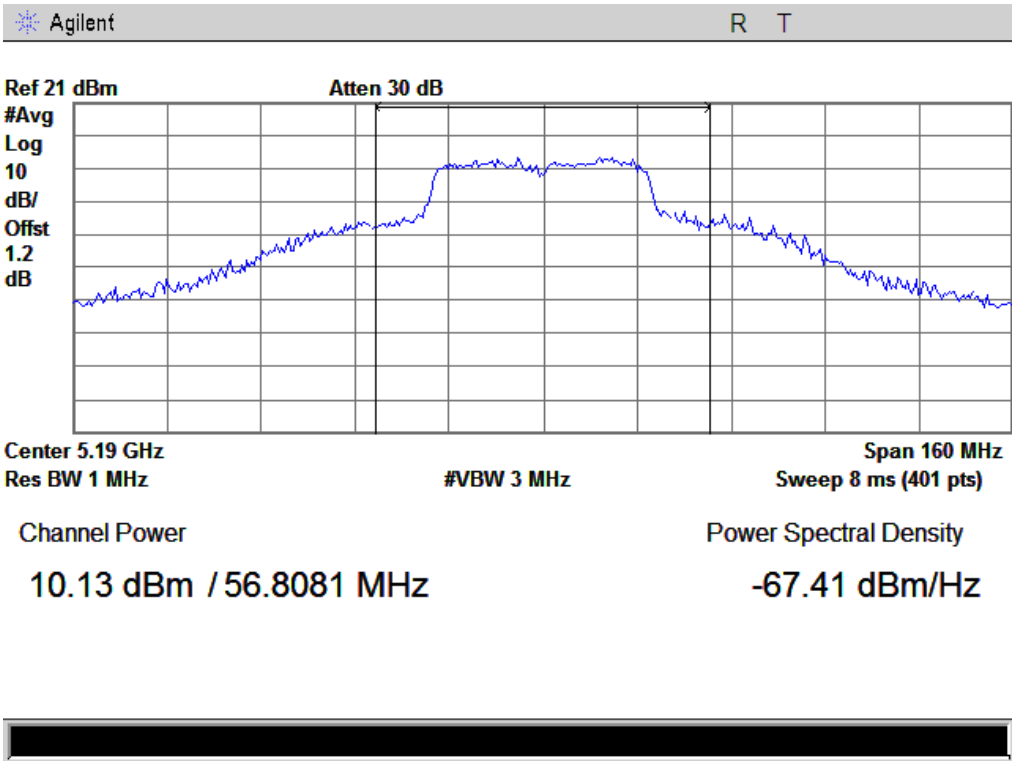
802.11n20 Middle Channel



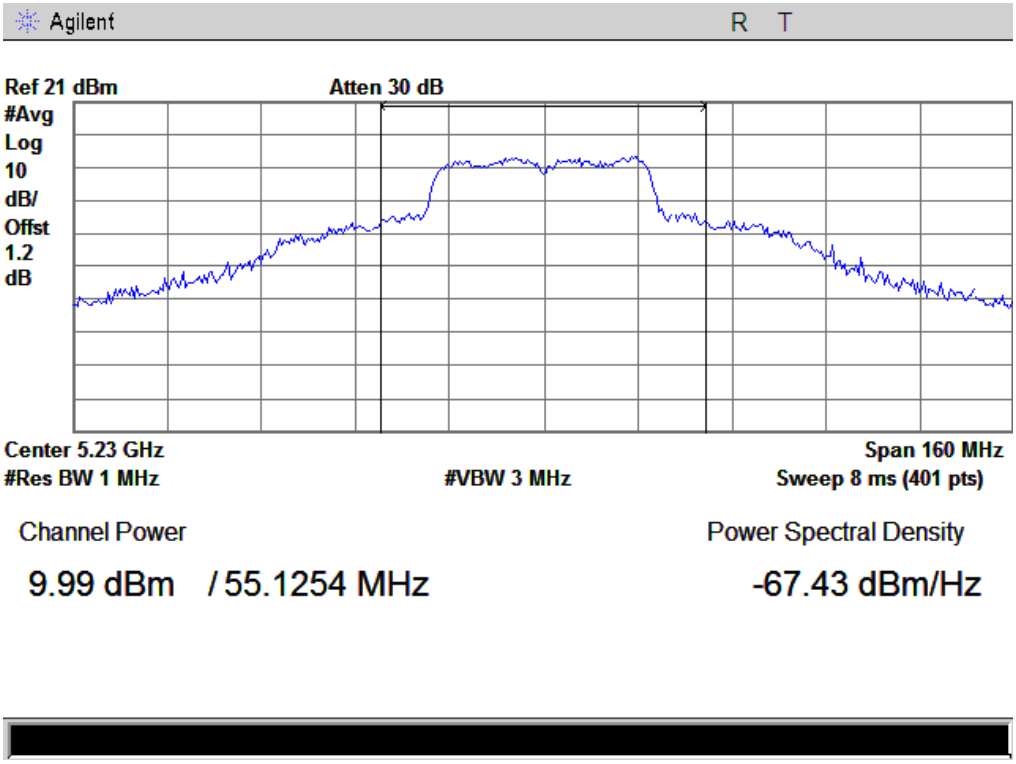
802.11n20 High Channel



802.11n40 Low Channel



802.11n40 High Channel



5.3 §15.407(a) - Power Spectral Density

1. Conducted Measurement
   EUT was set for low, mid, high channel with modulated mode and highest RF output power.
   The spectrum analyzer was connected to the antenna terminal.
2. Environmental Conditions

Temperature	26°C
Relative Humidity	58%
Atmospheric Pressure	1001mbar

3. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 40GHz is ±1.5dB.
4. Test date : October 28, 2013
   Tested By : Herith Shi

Standard Requirement:

According to §15.407(a)(1), For the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Procedures:
Measurement Procedure Peak power spectral density (PPSD) :

Note: Though the rule refers to "peak power spectral density", the intent is to measure the maximum value of the time average of the power spectral density measured during a period of continuous transmission.

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section E)2) for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, "Compute power…". (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
2. Use the peak search function on the instrument to find the peak of the spectrum.
3. Make the following adjustments to the peak value of the spectrum, if applicable:
   a) If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.
   b) If Method SA-3 Alternative was used and the linear mode was used in step E)2)g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the PPSD.
5. The above procedures make use of 1 MHz resolution bandwidth to satisfy the 1 MHz measurement bandwidth specified in the 15.407(a)(5). That rule section also permits use of resolution bandwidths less than 1 MHz "provided that the measured power is integrated to show the total power over the measurement bandwidth" (i.e., 1 MHz). If measurements are performed using a reduced resolution bandwidth and integrated over 1 MHz bandwidth, the following adjustments to the procedures apply:
   A) Set RBW ≥ 1/T, where T is defined in section B)1)a).
   B) Set VBW ≥ 3 RBW.
   C) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

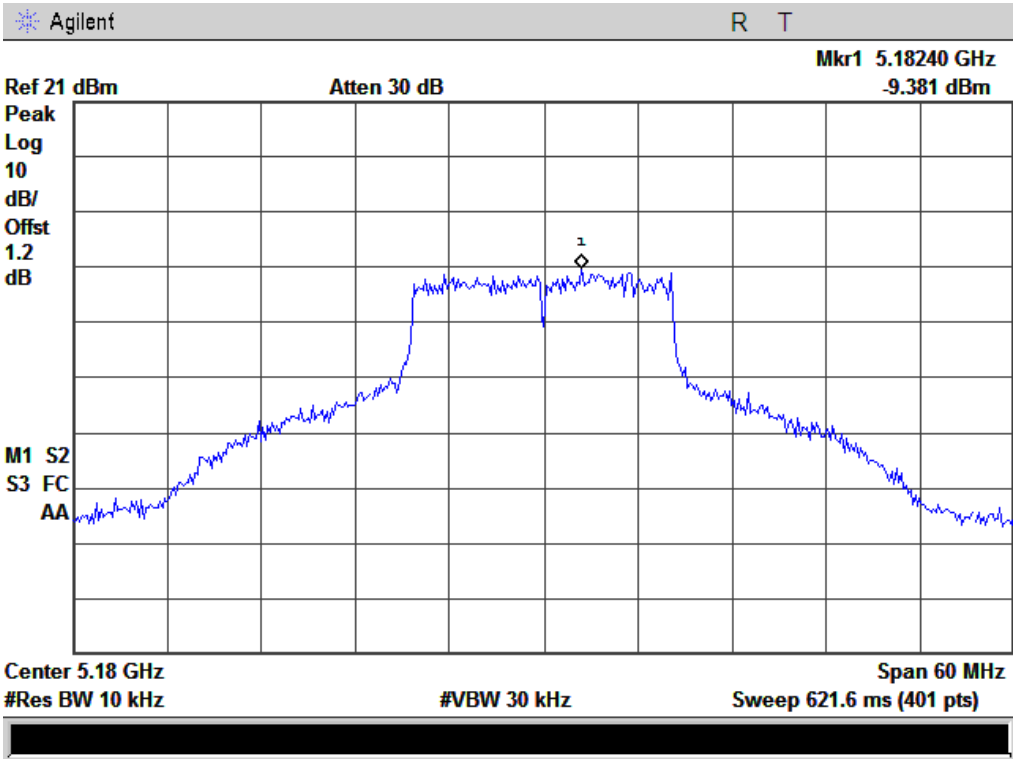
Test Result: Pass.
Please refer to the following tables and plots.

Please refer to the following tables and plots.

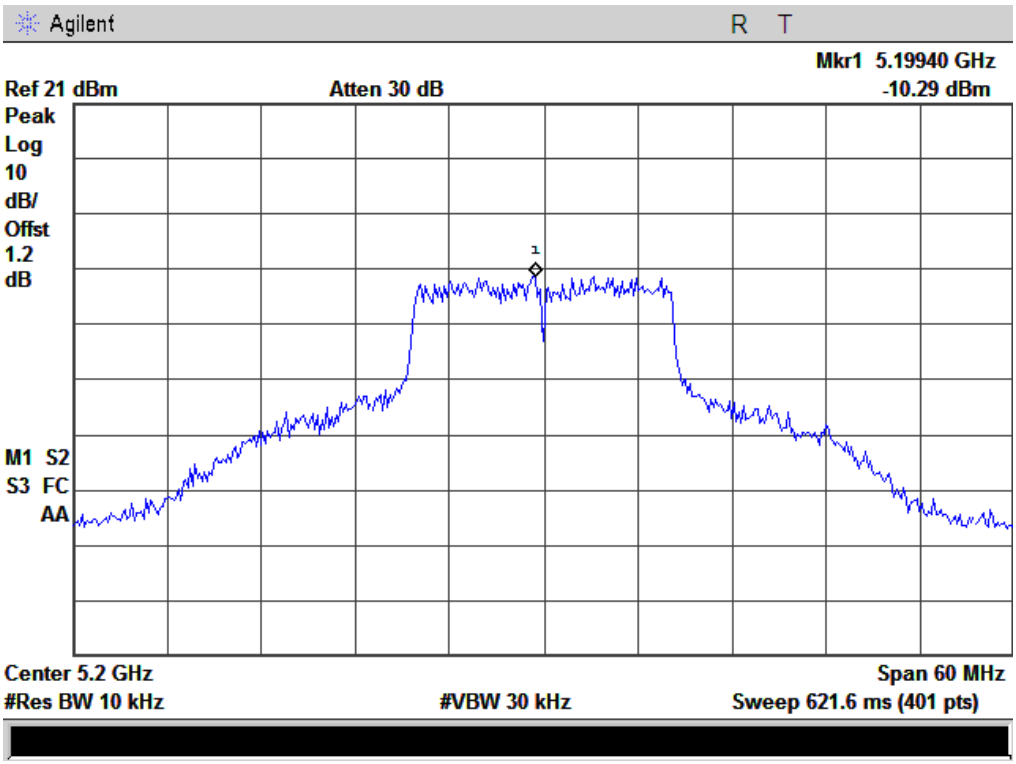
802.11b mode					
Data Rate:1Mbps					
Channel	PSD (dBm)			Total PSD (dBm)	Limit (dBm
	CH0	CH1	CH2		
5180	-9.381	-9.398	-7.535	-3.908	4
5200	-10.29	-9.765	-6.495	-3.734	4
5240	-9.667	-9.718	-7.247	-3.945	4
802.11n20 mode					
Data Rate: 7.2Mbps					
Channel	PSD (dBm)			Total PSD (dBm)	Limit (dBm
	CH0	CH1	CH2		
5180	-10.72	-9.337	-7.904	-4.398	4
5200	-9.856	-10.330	-7.558	-4.300	4
5240	-10.29	-9.286	-8.293	-4.442	4
802.11n40 mode					
Data Rate: 15Mbps					
Channel	PSD (dBm)			Total PSD (dBm)	Limit (dBm
	CH0	CH1	CH2		
5190	-11.850	-10.820	-10.170	-6.121	4
5230	-11.960	-11.320	-9.618	-6.079	4

RF Port CH0

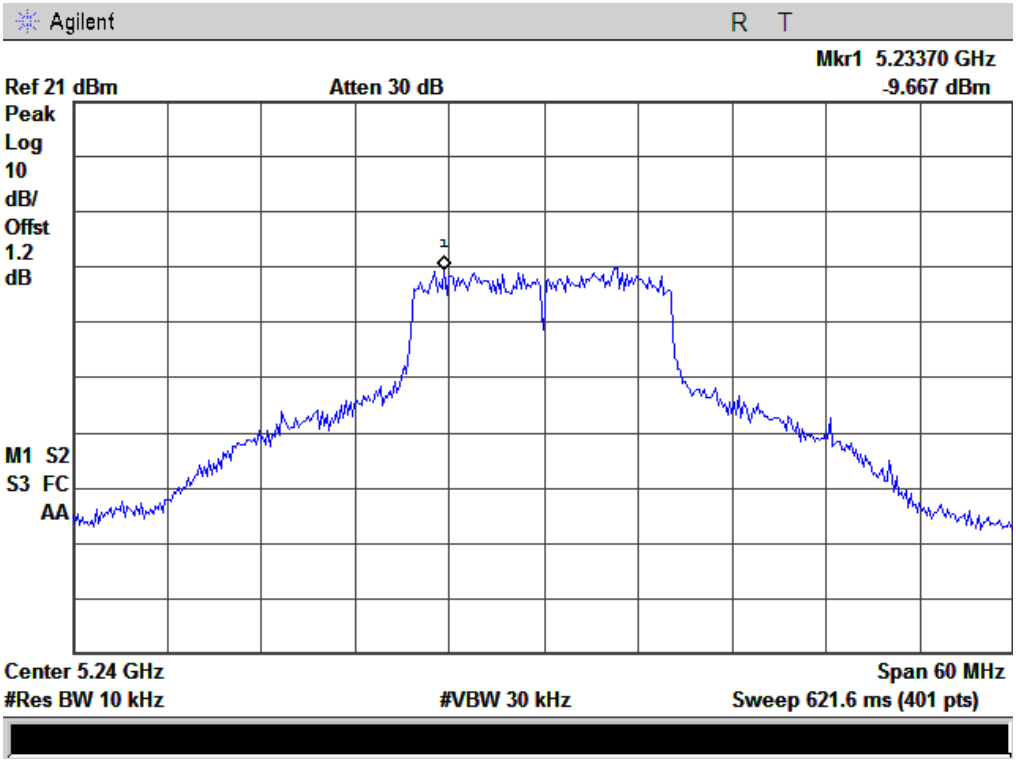
Power Spectral Density, 802.11a Low Channel



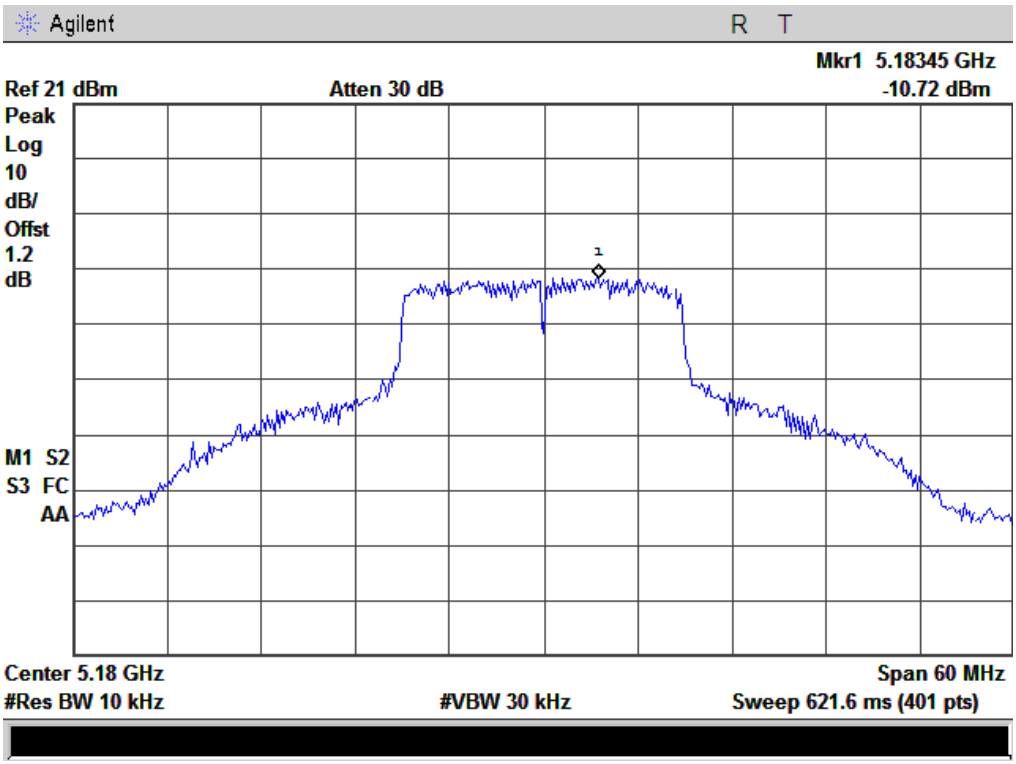
Power Spectral Density, 802.11a Middle Channel



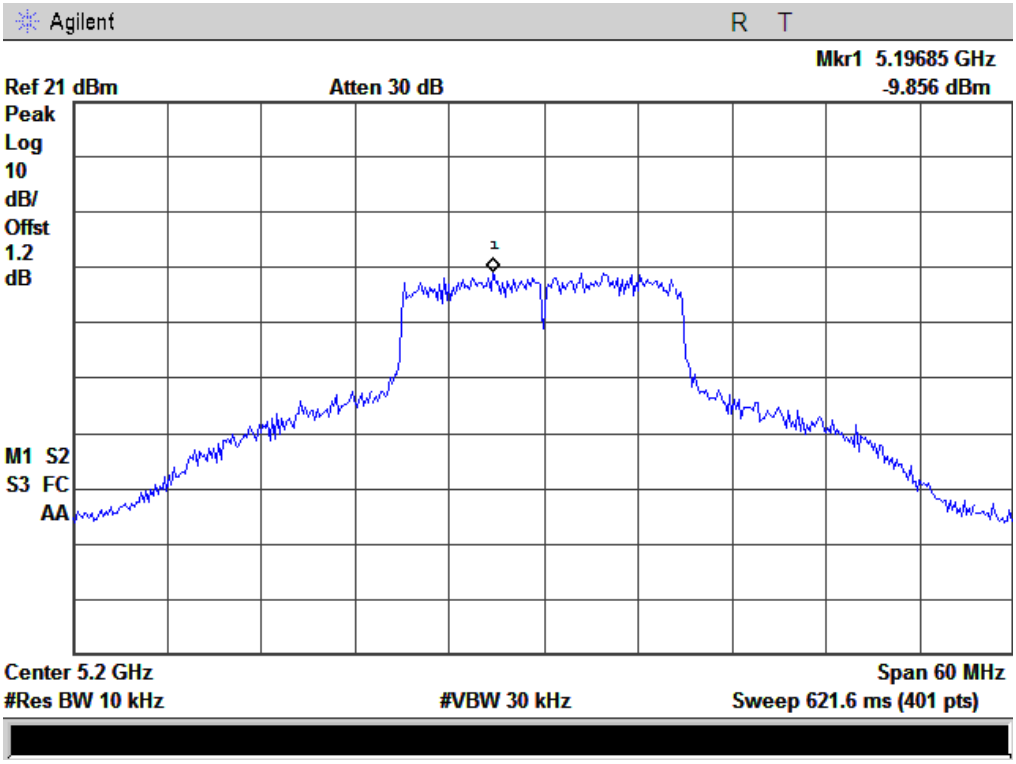
Power Spectral Density, 802.11a High Channel



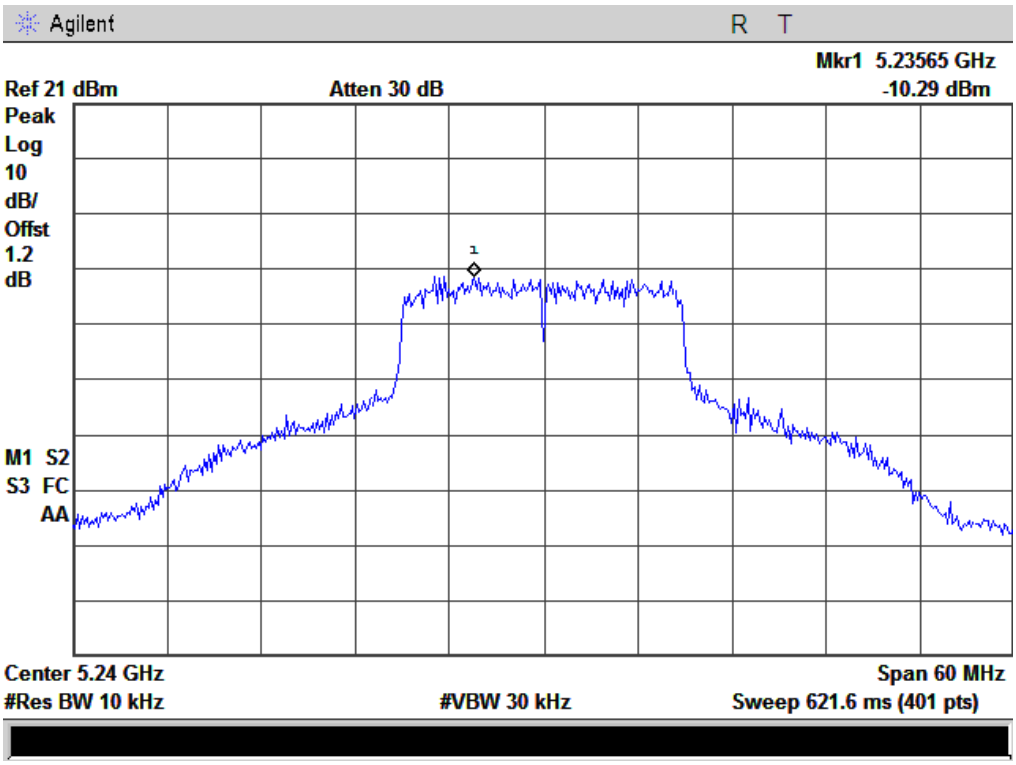
Power Spectral Density, 802.11n20 Low Channel



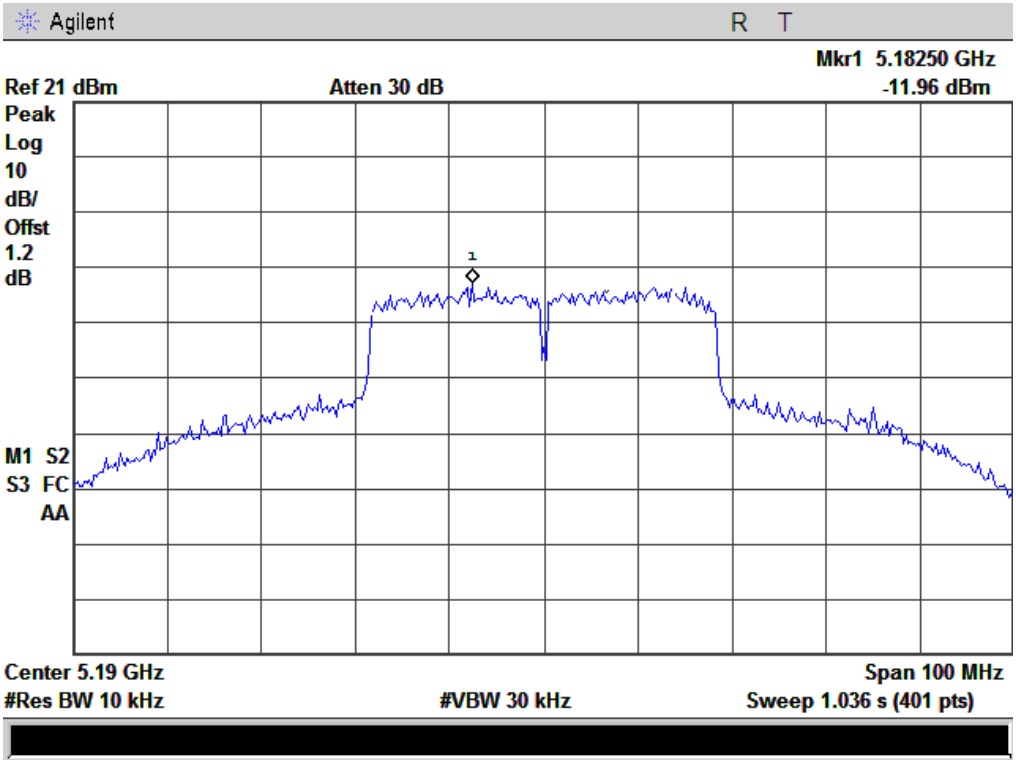
Power Spectral Density, 802.11n20 Middle Channel



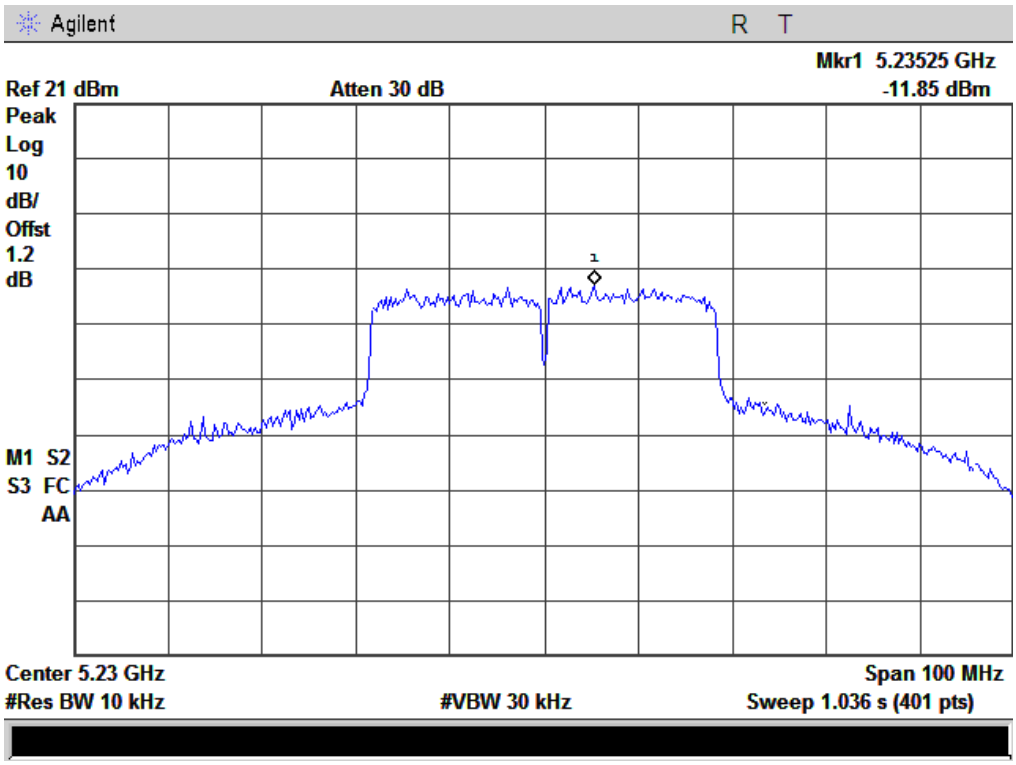
Power Spectral Density, 802.11n20 High Channel



Power Spectral Density, 802.11n40 Low Channel

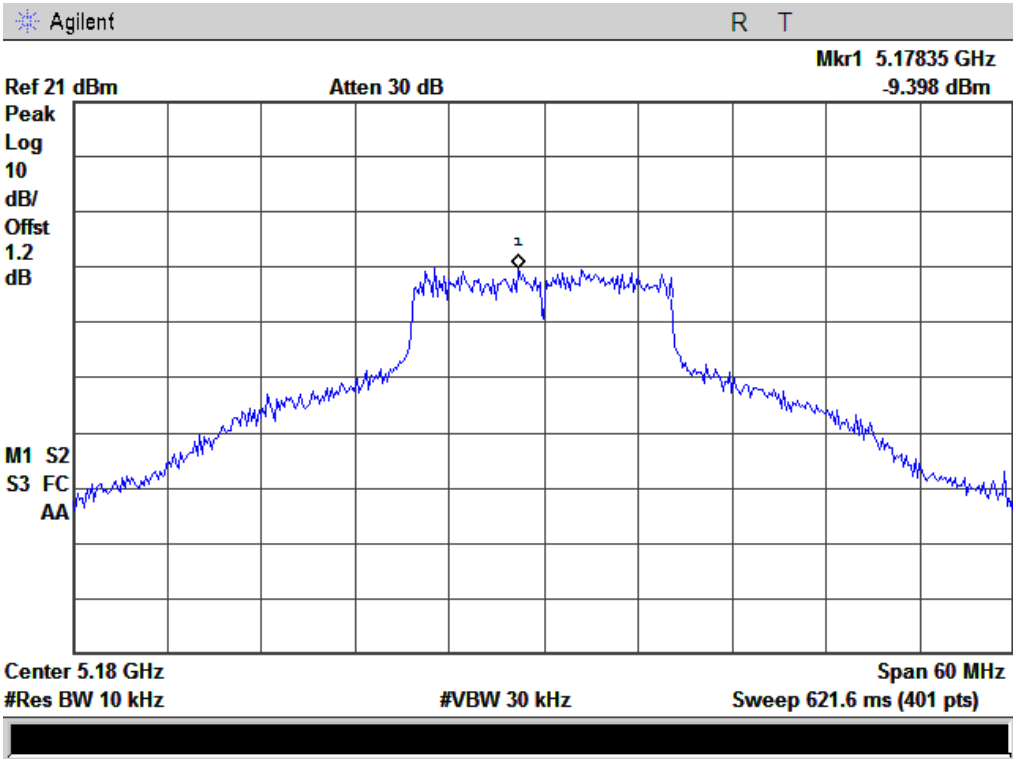


Power Spectral Density, 802.11n40 High Channel

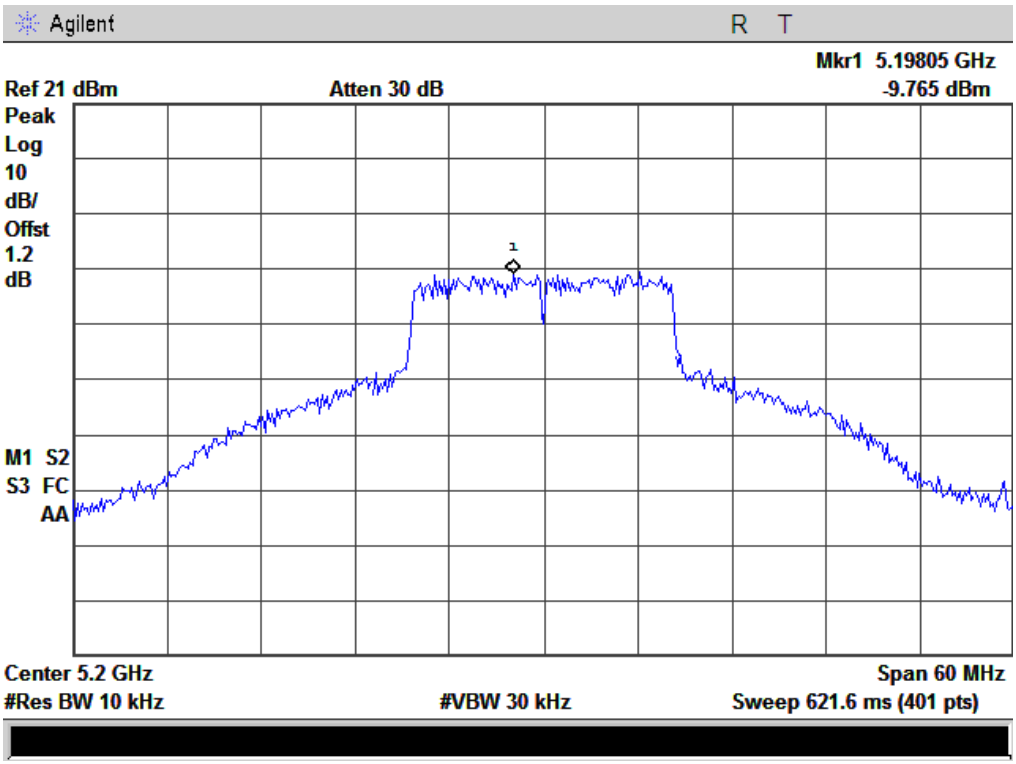


RF Port CH1

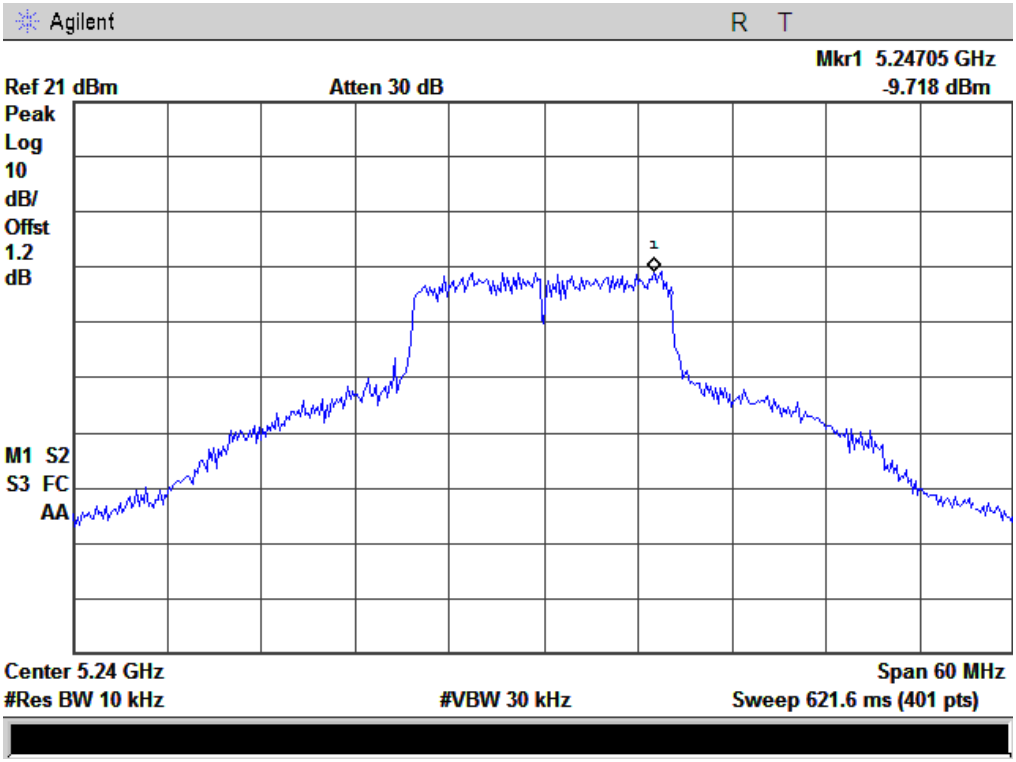
Power Spectral Density, 802.11a Low Channel



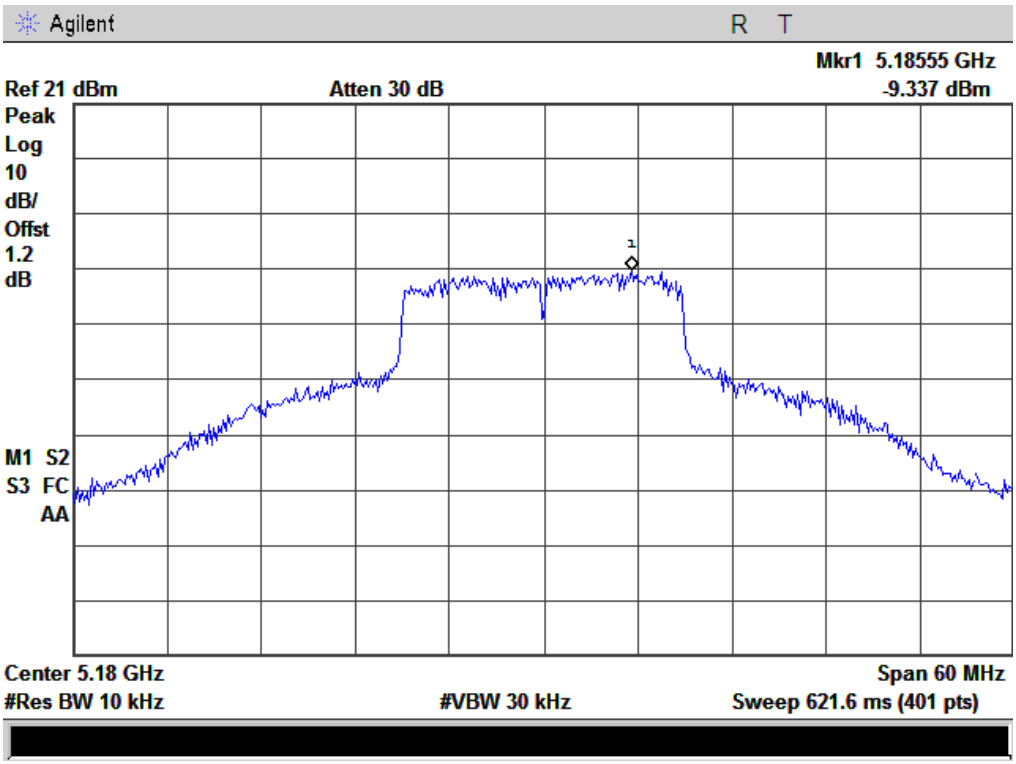
Power Spectral Density, 802.11a Middle Channel



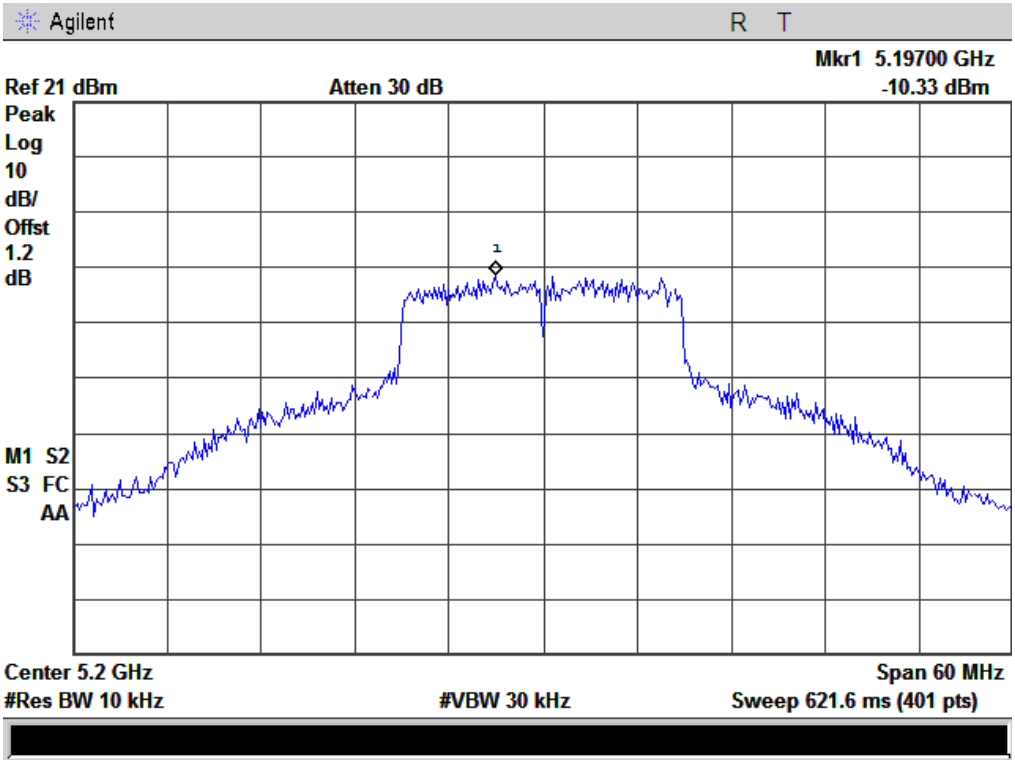
Power Spectral Density, 802.11a High Channel



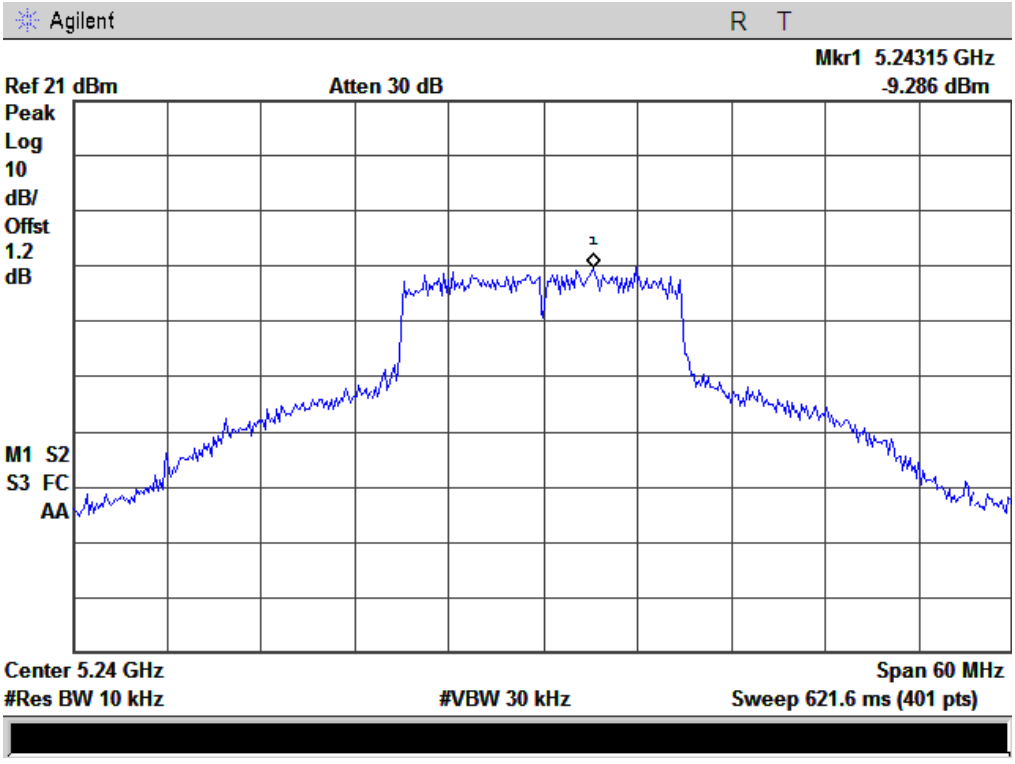
Power Spectral Density, 802.11n20 Low Channel



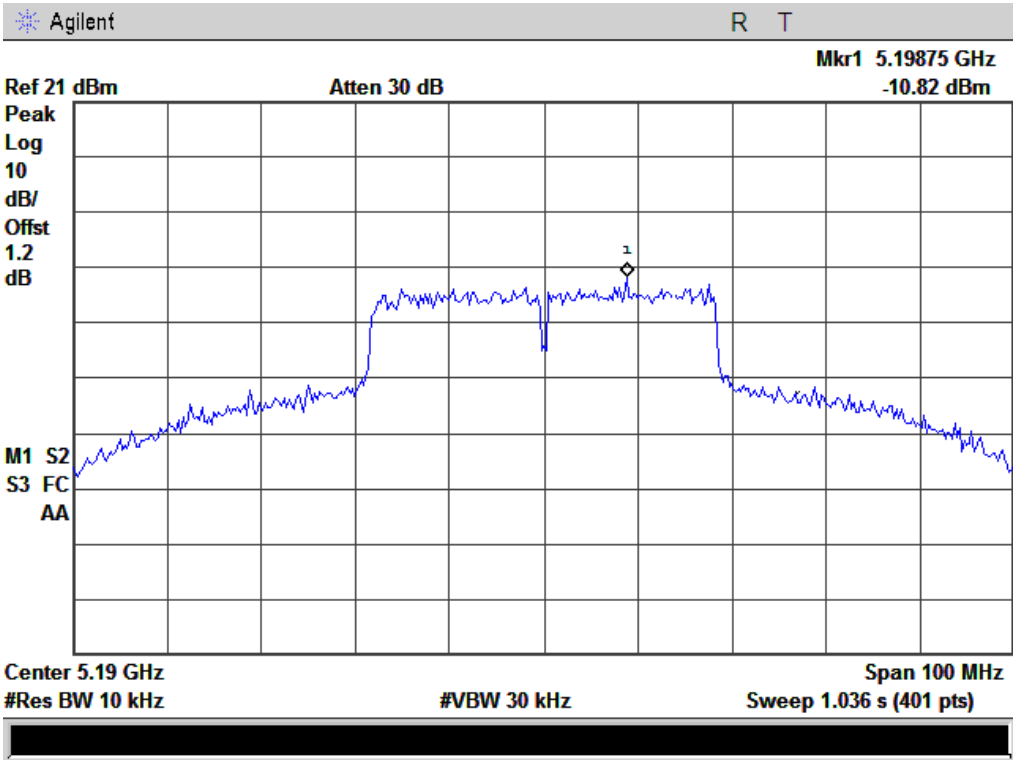
Power Spectral Density, 802.11n20 Middle Channel



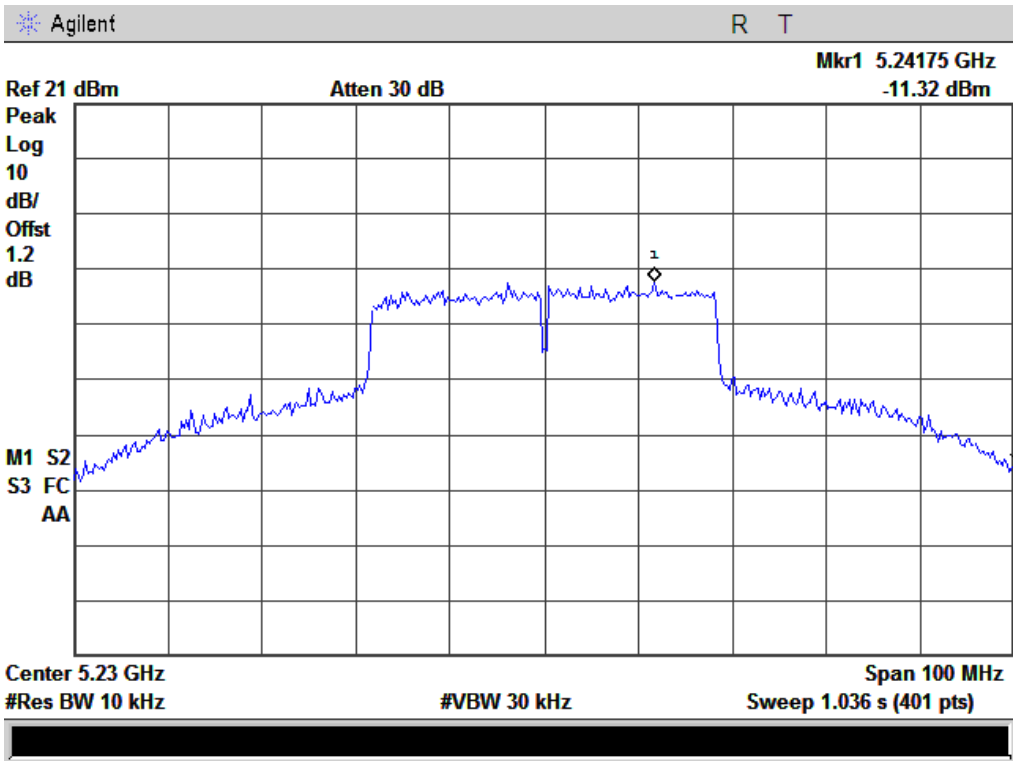
Power Spectral Density, 802.11n20 High Channel



Power Spectral Density, 802.11n40 Low Channel

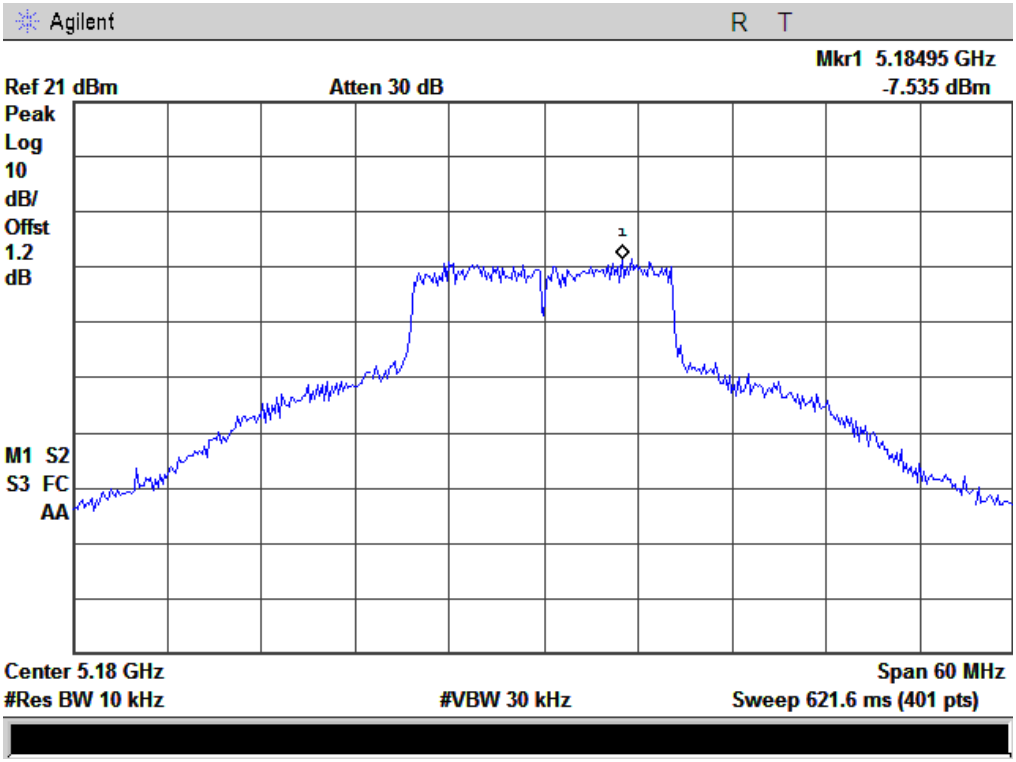


Power Spectral Density, 802.11n40 High Channel

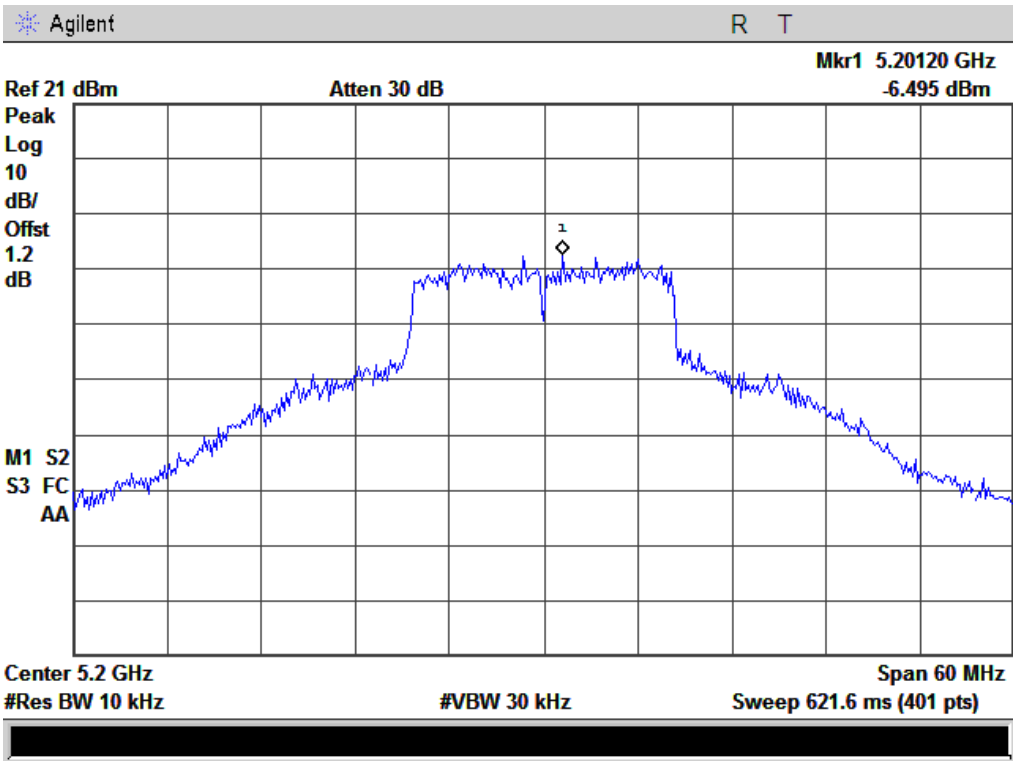


RF Port CH2

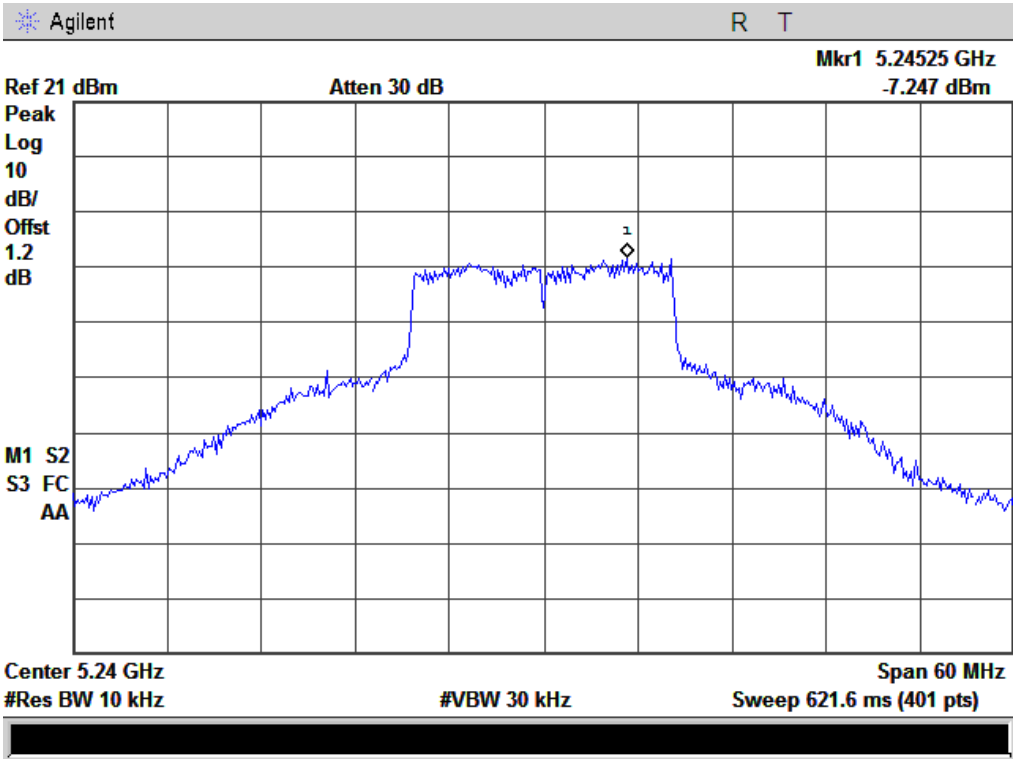
Power Spectral Density, 802.11a Low Channel



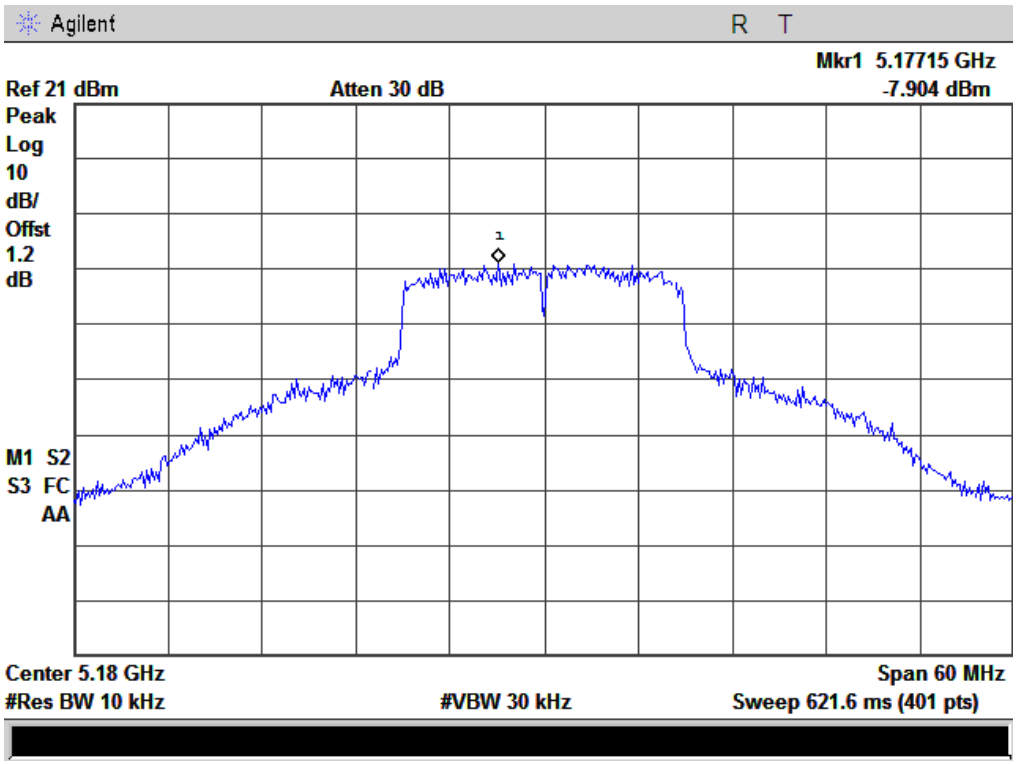
Power Spectral Density, 802.11a Middle Channel



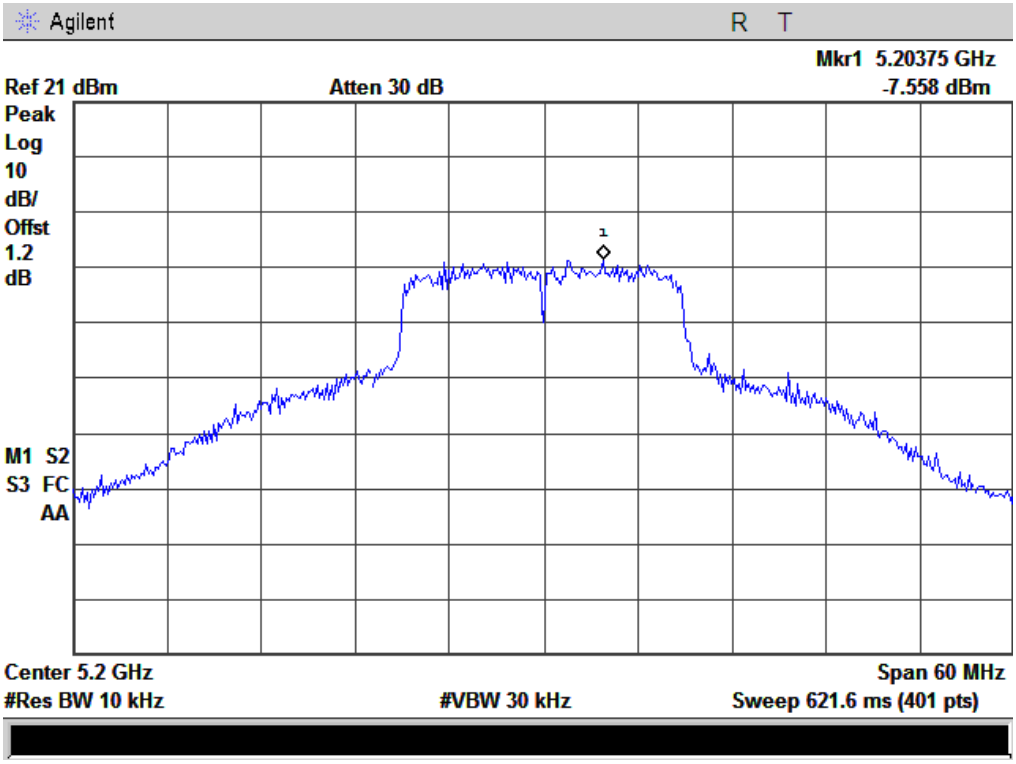
Power Spectral Density, 802.11a High Channel



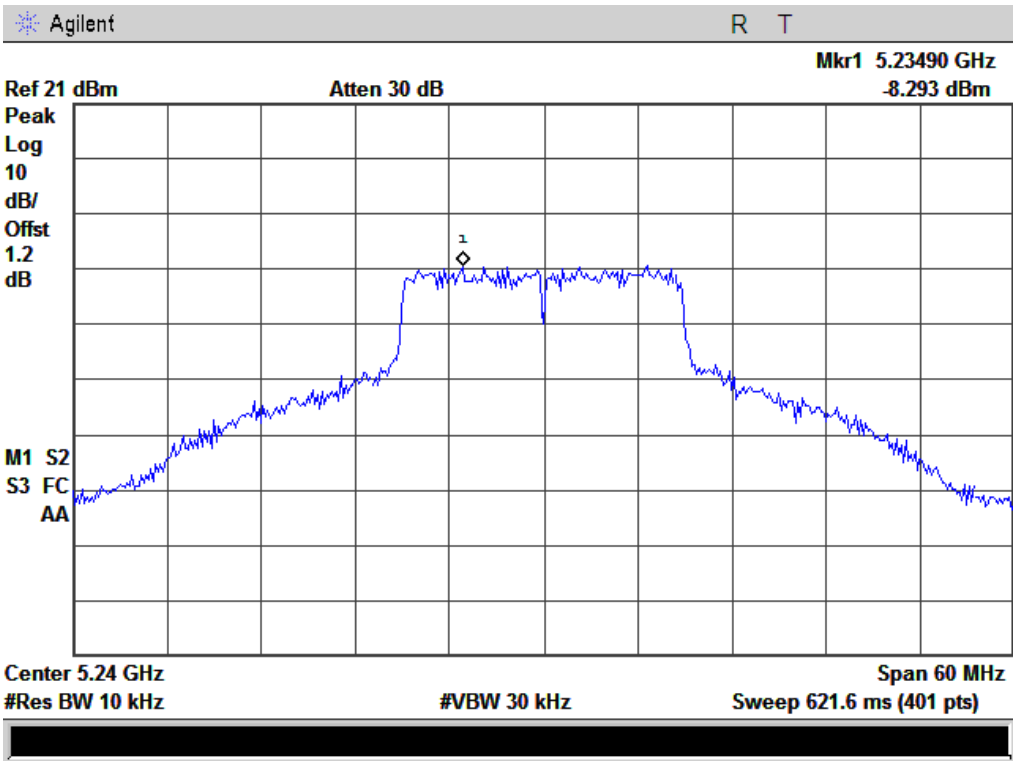
Power Spectral Density, 802.11n20 Low Channel



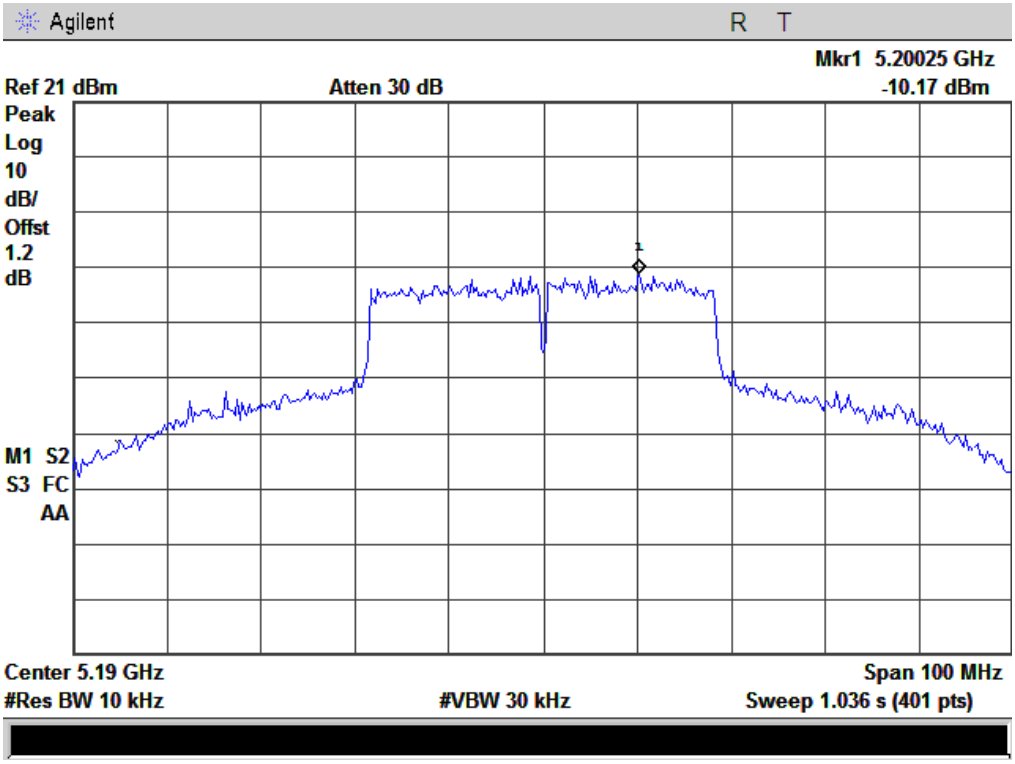
Power Spectral Density, 802.11n20 Middle Channel



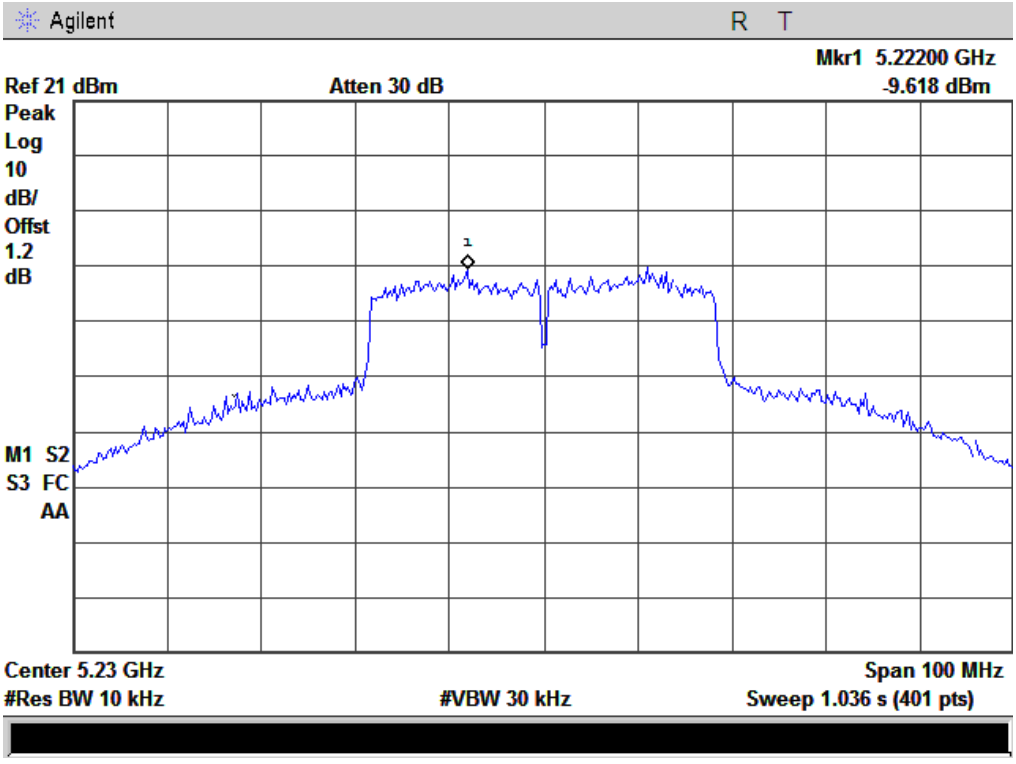
Power Spectral Density, 802.11n20 High Channel



Power Spectral Density, 802.11n40 Low Channel



Power Spectral Density, 802.11n40 High Channel



5.4 §15.407(a) –Peak Power Excursion Measurement

1. In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

2.	Environmental Conditions	Temperature	25 °C
		Relative Humidity	56%
		Atmospheric Pressure	1005mbar

3. Test date : November 6, 2013
   Tested By : Herith Shi

Standard Requirement:

According to §15.407(a) (6), the ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Procedures:

This procedure must be used if maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit, and is optional if the maximum (average) conducted output power was used to demonstrate compliance.

1. Set the spectrum analyzer or EMI receiver span to view the entire emission bandwidth
2. Find the maximum of the peak-max-hold spectrum.
   A) Set RBW = 1 MHz.
   B) VBW ≥ 3 MHz.
   C) Detector = peak.
   D) Trace mode = max-hold.
   E) Allow the sweeps to continue until the trace stabilizes.
   F) Use the peak search function to find the peak of the spectrum.
3. Use the procedure found under F) to measure the PPSD.
4. Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD

Test Result: Pass.

Please refer to the following tables and plots.

Mode	Antenna Port	Channel	PK Value	AV Value	PK Excursion	Limit	Result
802.11a	CH0	5180	7.386	4.219	3.167	13	Pass
802.11a	CH0	5200	6.854	4.343	2.511	13	Pass
802.11a	CH0	5240	7.567	4.616	2.951	13	Pass

Mode	Antenna Port	Channel	PK Value	AV Value	PK Excursion	Limit	Result
802.11n20	CH0	5180	6.542	4.674	1.868	13	Pass
802.11n20	CH0	5200	6.967	4.439	2.528	13	Pass
802.11n20	CH0	5240	6.929	4.487	2.442	13	Pass

Mode	Antenna Port	Channel	PK Value	AV Value	PK Excursion	Limit	Result
802.11n20	CH0	5180	4.519	1.209	3.310	13	Pass
802.11n20	CH0	5240	4.154	1.744	2.410	13	Pass

NOTE: The worst data is A Antenna CH0 ,only shown Antenna CH0 Plot.

5.5 §15.207 (a) - AC Power Line Conducted Emissions

Requirement:

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

Procedures:

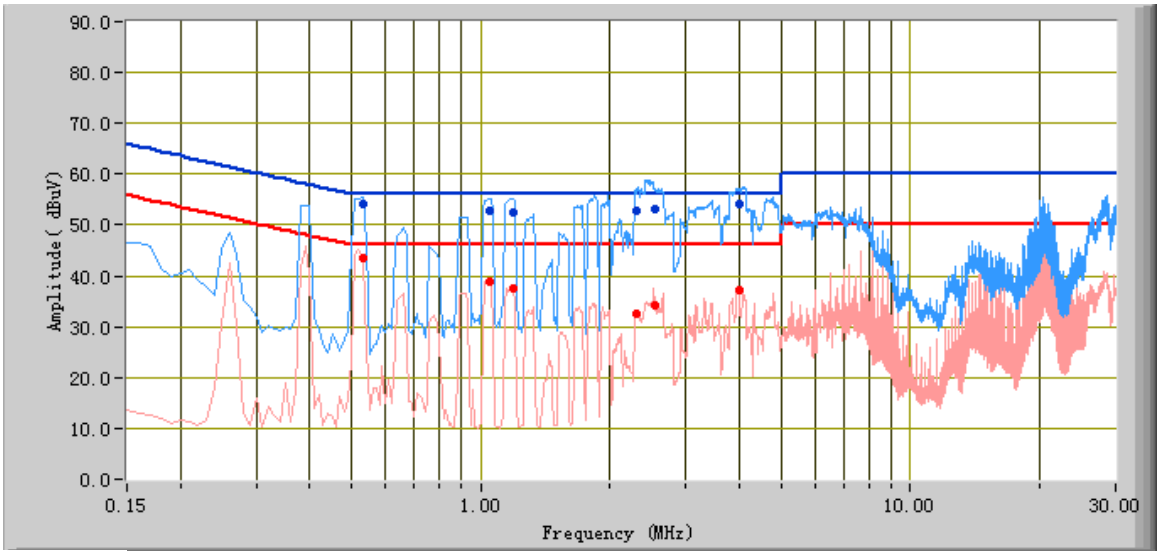
1. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR and Average detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±3.5dB.
4. Environmental Conditions

Temperature	25°C
Relative Humidity	58%
Atmospheric Pressure	1001mbar

5. Test date: November 7, 2013
   Tested By : Herith Shi

Test Mode:	5GHz 802.11a Transmitting Mode(Worse Case)

Peak Detector Quasi Peak Limit
Average Detector Average Limit

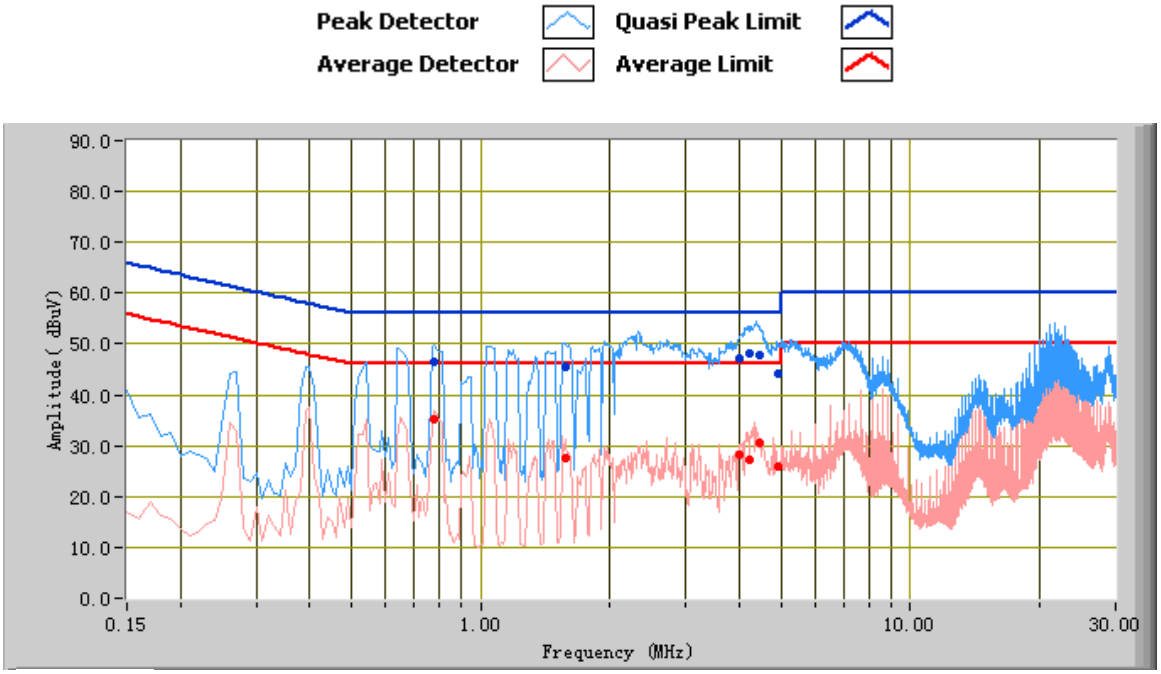


Test Data

Phase Line Plot at 120V AC, 60Hz

Frequency (MHz)	Quasi Peak (dBuV)	Limit (dBuV)	Margin (dB)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Factors (dB)
2.30	52.72	56.00	-3.28	32.42	46.00	-13.58	10.12
2.54	53.18	56.00	-2.82	34.29	46.00	-11.71	10.13
3.98	54.24	56.00	-1.76	37.26	46.00	-8.74	10.17
0.53	54.00	56.00	-2.00	43.56	46.00	-2.44	10.10
1.19	52.45	56.00	-3.55	37.45	46.00	-8.55	10.10
1.05	52.93	56.00	-3.07	38.93	46.00	-7.07	10.10

Test Mode:	5GHz 802.11a Transmitting Mode(Worse Case)



Test Data

Phase Natural Plot at 120V AC, 60Hz

Frequency (MHz)	Quasi Peak (dBuV)	Limit (dBuV)	Margin (dB)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Factors (dB)
4.46	47.68	56.00	-8.32	30.46	46.00	-15.54	10.18
4.22	48.08	56.00	-7.92	27.39	46.00	-18.61	10.17
3.98	47.08	56.00	-8.92	28.24	46.00	-17.76	10.17
4.94	44.06	56.00	-11.94	25.95	46.00	-20.05	10.18
1.58	45.38	56.00	-10.62	27.73	46.00	-18.27	10.10
0.78	46.56	56.00	-9.44	35.25	46.00	-10.75	10.10

5.6 §15.209, §15.205 & §15.407(b) - Radiated Spurious Emissions & Unwanted Emissions into Restricted Frequency Bands

1. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2, in the range 30MHz – 1GHz & 1GHz above (3m & 10m) is +/-6dB.
4. Environmental Conditions

Temperature	25°C
Relative Humidity	56%
Atmospheric Pressure	1001mbar

5. Test date : November 5 2013
   Tested By : Herith Shi

Requirement: §15.407(b) specifies that emissions which fall in the restricted bands, as defined in **§15.205(a)**, must comply with the radiated emission limits specified in **§15.209(a)**.

Procedures:

Radiated Spurious Emissions Measurement

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Established procedures for performing radiated measurements shall be used (see C63.10). All detected emissions must comply with the applicable limits.

Measurement Detectors

§15.35(a) specifies that on frequencies less than and below 1000 MHz, the radiated emissions limits assume the use of a CISPR quasi-peak detector function and related measurement bandwidths. **§15.35(b)** specifies that on frequencies above 1000 MHz, the radiated emissions limits assume the use of an average detector and a minimum resolution bandwidth of 1 MHz. In addition, **§15.35(b)** that when average radiated emissions measurements are specified there is also a limit on the peak emissions level which is 20 dB above the applicable maximum permitted average emission limit. These specifications also apply to conducted emissions measurements.

1. CISPR Quasi-Peak Measurement

The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

2. Peak Power Measurement Procedure

Utilize the peak power measurement procedure specified in Section 8.1.1 with the following modifications:

Set analyzer center frequency to the frequency associated with the restricted band emission under examination.

Set RBW = 1 MHz.

Note that if the peak measured value complies with the average limit, it is not necessary to perform a separate average measurement. If this option is exercised, it should be so noted in the test report.

3. Average Power Measurement Procedures

The average restricted band emission levels must be measured with the EUT transmitting continuously (≥ 98% duty cycle) at its maximum power control level. Optionally, video triggering/signal gating can be used to ensure that measurements are performed only when the EUT is transmitting at its maximum power control level.

The average power measurement procedures described in Section 8.2 shall be used with the following modifications:

Set analyzer center frequency to the frequency associated with the restricted band emission.

Set span to at least 1 MHz.

Use peak marker function to determine the highest amplitude within the RBW (1 MHz).

Above 1 GHz:

Test Mode: Transmitting

Note: Other modes were verified, only the result of worst case basic rate mode was presented.

Mode: 802.11a

Low Channel (5180 MHz)

Frequency (MHz)	Substituted level (dBμV/m)	Detector (PK/AV)	Direction (degree)	Height (cm)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
10360	31.10	AV	0	100	V	39.73	6.04	24	52.87	54	-1.13
10360	30.12	AV	12	120	H	39.73	6.04	24	51.89	54	-2.11
10360	42.02	PK	0	100	V	39.73	6.04	24	63.79	74	-10.21
10360	41.68	PK	12	120	H	39.73	6.04	24	63.45	74	-10.55

Middle Channel (5200MHz)

Frequency (MHz)	Substituted level (dBμV/m)	Detector (PK/AV)	Direction (degree)	Height (cm)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
10400	30.42	AV	28	100	V	39.73	6.04	24	52.19	54	-1.81
10400	30.36	AV	90	120	H	39.73	6.04	24	52.13	54	-1.87
10400	43.72	PK	28	100	V	39.73	6.04	24	65.49	74	-8.51
10400	42.49	PK	90	120	H	39.73	6.04	24	64.26	74	-9.74

High Channel (5240 MHz)

Frequency (MHz)	Substituted level (dBμV/m)	Detector (PK/AV)	Direction (degree)	Height (cm)	Polarity (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	Pre-Amp. Gain (dB)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
10480	31.19	AV	10	100	V	39.73	6.04	24	52.96	54	-1.04
10480	31.42	AV	92	120	H	39.73	6.04	24	53.19	54	-0.81
10480	41.25	PK	10	100	V	39.73	6.04	24	63.02	74	-10.98
10480	41.30	PK	92	120	H	39.73	6.04	24	63.07	74	-10.93

Annex A. TEST INSTRUMENT & METHOD

Annex A.i. TEST INSTRUMENTATION & GENERAL PROCEDURES

Instrument	Model	Serial #	Calibration Date	Calibration Due Date
AC Line Conducted Emissions				
EMI test receiver	ESL6	100262	11/19/2012	11/19/2013
Line Impedance Stabilization Network	LI-125A	191106	11/14/2012	11/13/2013
Line Impedance Stabilization Network	LI-125A	191107	11/14/2012	11/13/2013
Double Ridge Horn Antenna (1 ~18GHz)	AH-118	071259	11/20/2012	11/19/2013
Transient Limiter	LIT-153	531118	03/03/2013	3/02/2014
RF conducted test				
Agilent ESA-E SERIES SPECTRUM ANALYZER	E4407B	CFG038	10/25/2013	10/24/2014
Power Splitter	1#	1#	02/02/2013	02/01/2014
Temperature/Humidity Chamber	1007H	N/A	01/07/2013	01/06/2014
DC Power Supply	E3640A	MY40004013	03/22/2013	03/21/2014
Radiated Emissions				
EMI test receiver	ESL6	100262	11/19/2012	11/19/2013
Positioning Controller	UC3000	MF780208282	11/19/2012	11/19/2013
OPT 010 AMPLIFIER(0.1-1300MHz)	8447E	2727A02430	11/19/2012	11/19/2013
Microwave Preamplifier(0.5～18GHz)	PAM-118	443008	11/08/2013	11/07/2014
Bilog Antenna (30MHz~6GHz)	JB6	A110712	01/27/2013	01/26/2014
Double Ridge Horn Antenna (1 ~18GHz)	AH-118	071283	11/20/2012	11/19/2013
Horn Antenna (18 ~40GHz)	AH-840	10SL0073	04/23/2013	04/23/2014
Microwave Preamplifier(18～40GHz)	PA-840	181250	05/30/2013	05/30/2014

Annex A.ii. CONDUCTED EMISSIONS TEST DESCRIPTION

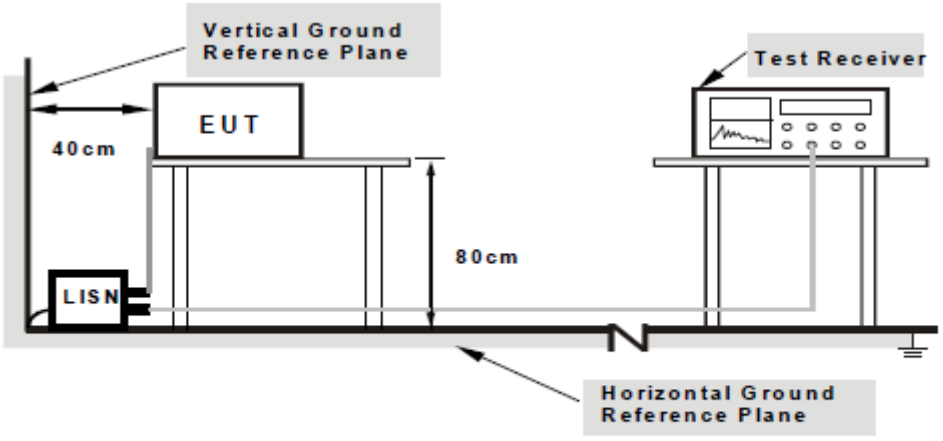
Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

4. All other supporting equipments were powered separately from another main supply.



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration1.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.

2. A scan was made on the NEUTRAL line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.

3. High peaks, relative to the limit line, were then selected.

4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, both Quasi-peak and Average measurements were made.

5. Steps 2 to 4 were then repeated for the LIVE line (for AC mains) or DC line (for DC power).

Description of Conducted Emission Program

This EMC Measurement software run LabView automation software and offers a common user interface for electromagnetic interference (EMI) measurements. This software is a modern and powerful tool for controlling and monitoring EMI test receivers and EMC test systems. It guarantees reliable collection, evaluation, and documentation of measurement results. Basically, this program will run a pre-scan measurement before it proceeds with the final measurement. The pre-scan routine will run the common scan range from 150 kHz to 30 MHz; the program will first start a peak and average scan on selectable measurement time and step size. After the program complete the pre-scan, this program will perform the Quasi Peak and Average measurement, based on the pre-scan peak data reduction result.

Sample Calculation Example

At 20 MHz limit = 250 μV = 47.96 dBμV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.20 dB

Q-P reading obtained directly from EMI Receiver = 40.00 dBμV
(Calibrated for system losses)

Therefore, Q-P margin = 47.96 – 40.00 = 7.96 i.e. **7.96 dB below limit**

Annex A. iii RADIATED EMISSIONS TEST DESCRIPTION

EUT Characterisation

EUT characterisation, over the frequency range from 30MHz to 10th Harmonic , was done in order to minimise radiated emissions testing time while still maintaining high confidence in the test results.

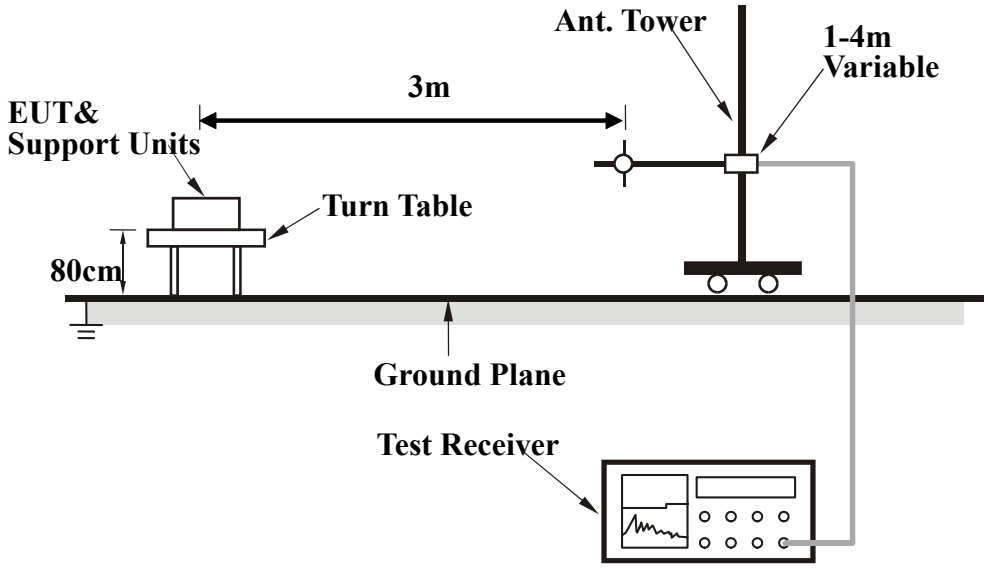
The EUT was placed in the chamber, at a height of about 0.8m on a turntable. Its radiated emissions frequency profile was observed, using a spectrum analyzer /receiver with the appropriate broadband antenna placed 3m away from the EUT. Radiated emissions from the EUT were maximised by rotating the turntable manually, changing the antenna polarisation and manipulating the EUT cables while observing the frequency profile on the spectrum analyzer / receiver. Frequency points at which maximum emissions occurred, clock frequencies and operating frequencies were then noted for the formal radiated emissions test at the Open Area Test Site (OATS).

Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.

2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.



Test Method

The following procedure was performed to determine the maximum emission axis of EUT:
1. With the receiving antenna is H polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
2. With the receiving antenna is V polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
3. Compare the results derived from above two steps. So, the axis of maximum emission from EUT was determined and the configuration was used to perform the final measurement.

Final Radiated Emission Measurement
1. Setup the configuration according to figure 1. Turn on EUT and make sure that it is in normal function.

2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.

3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.

4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0 ◦ to 360 ◦ with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading.

5. Repeat step 4 until all frequencies need to be measured was complete.

6. Repeat step 5 with search antenna in vertical polarized orientations.

During the radiated emission test, the Spectrum Analyzer was set with the following configurations:

Frequency Band (MHz)	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	Peak	100 kHz	100 kHz
Above 1000	Peak	1 MHz	1 MHz
	Average	1 MHz	10 Hz

Sample Calculation Example

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. For the limit is employed average value, therefore the peak value can be transferred to average value by subtracting the duty factor. The basic equation with a sample calculation is as follows:

Peak = Reading + Corrected Factor

where
Corr. Factor = Antenna Factor + Cable Factor - Amplifier Gain (if any)
And the average value is

Average = Peak Value + Duty Factor or
Set RBW = 1MHz, VBW = 10Hz.

Note :
If the measured frequencies are fall in the restricted frequency band, the limit employed must be quasi peak value when frequencies are below or equal to 1 GHz. And the measuring instrument is set to quasi peak detector function.

Annex B. EUT AND TEST SETUP PHOTOGRAPHS

Annex B.i. Photograph 1: EUT External Photo

Whole Package - Top View

EUT - Front View

EUT - Rear View

EUT - Top View

EUT - Bottom View

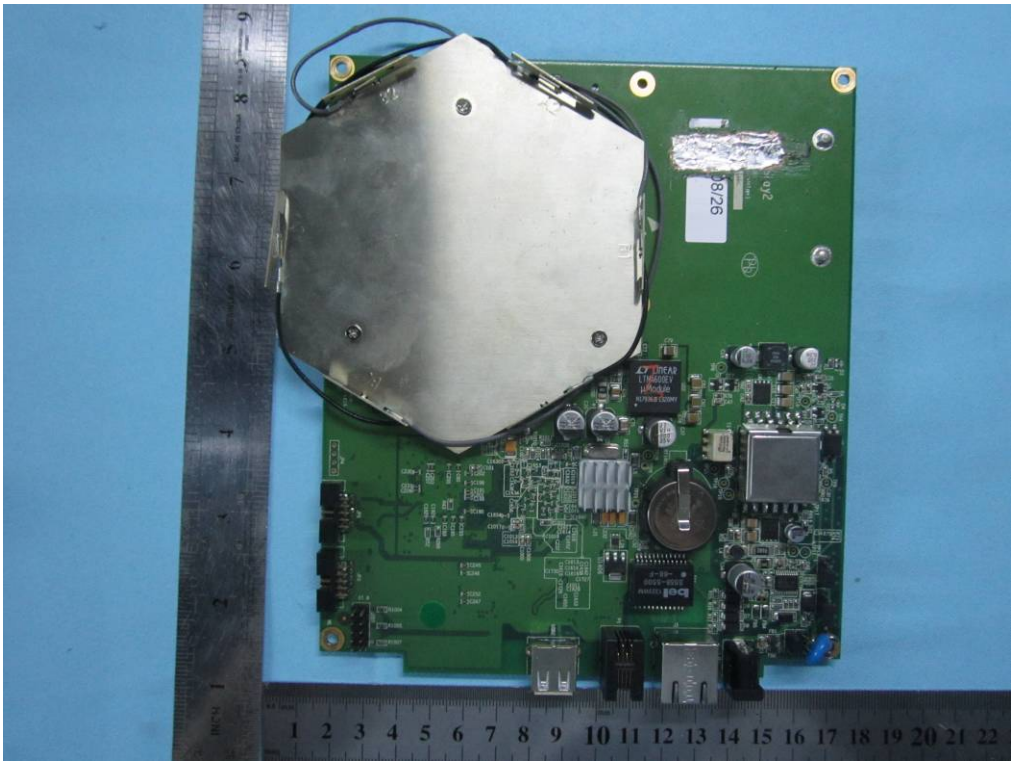
EUT - Left View

EUT - Right View

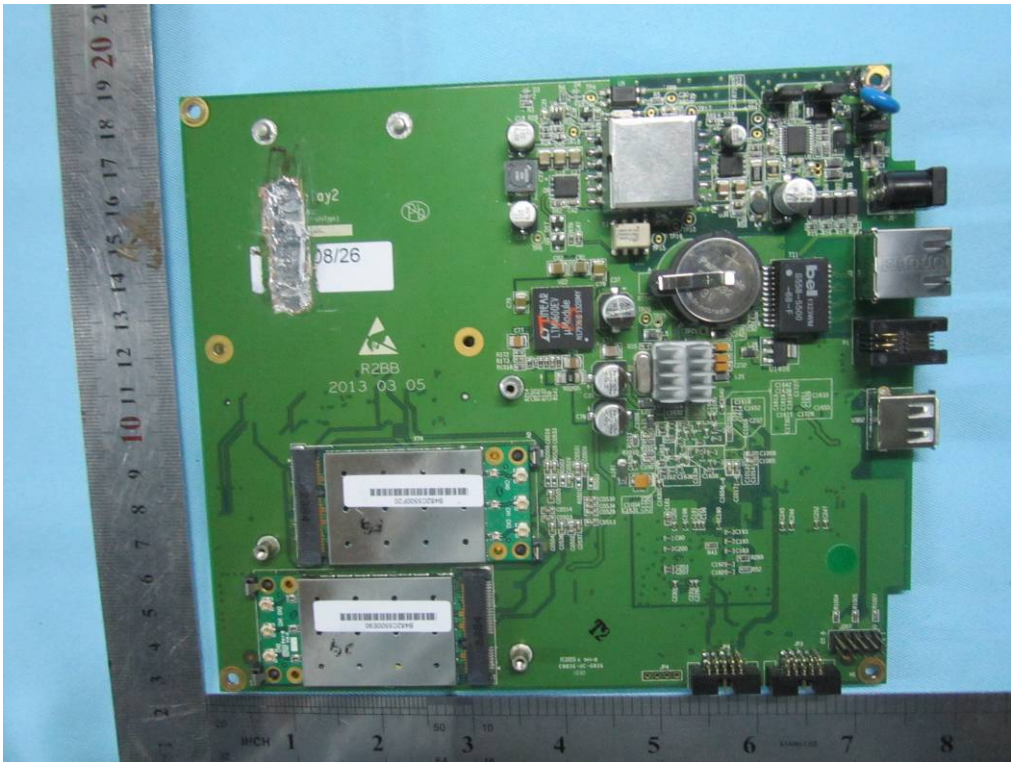
Annex B.ii. Photograph 2: EUT Internal Photo

Cover Off - Top View

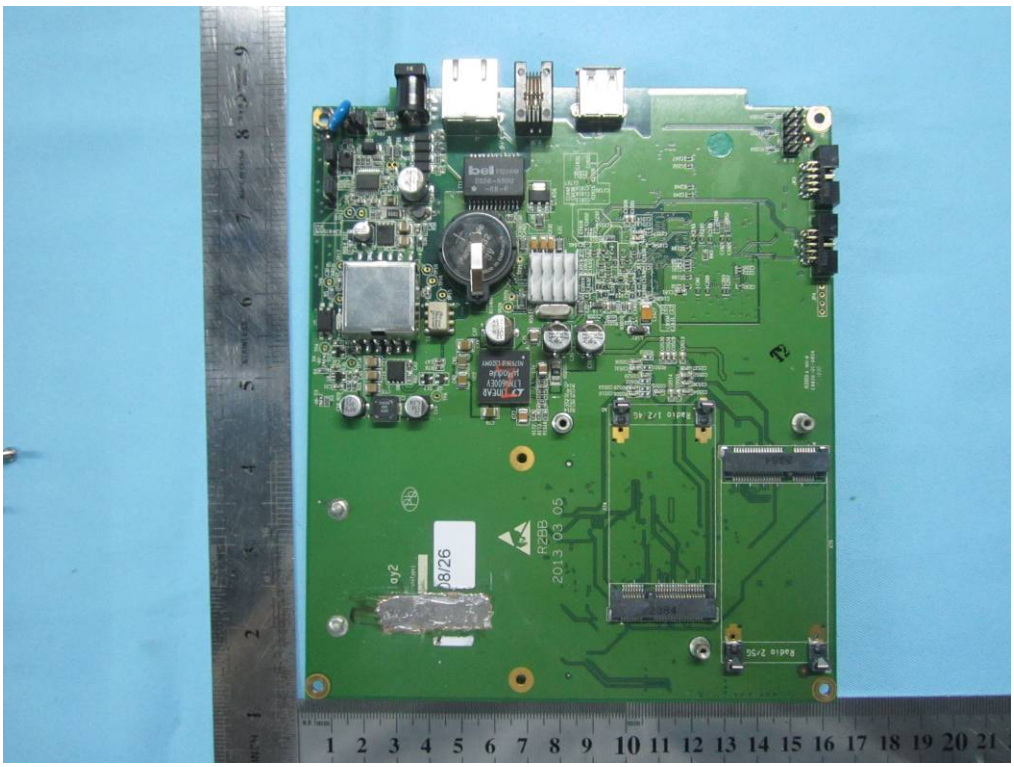
Adapter-front view



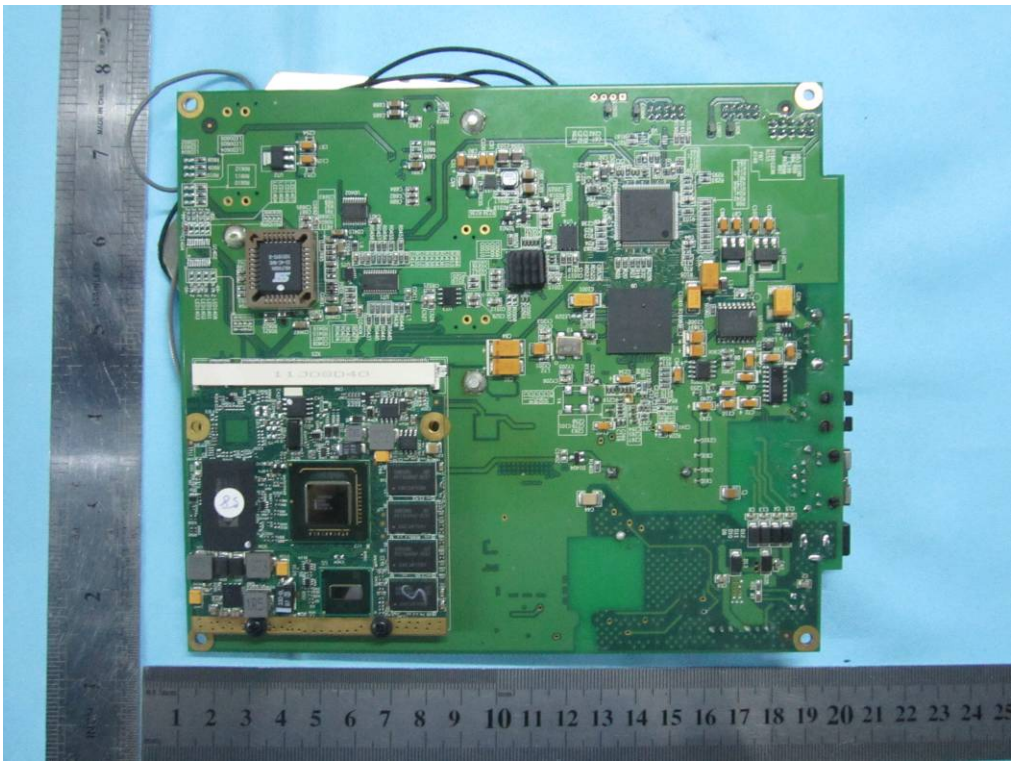
Mainborad - Top View



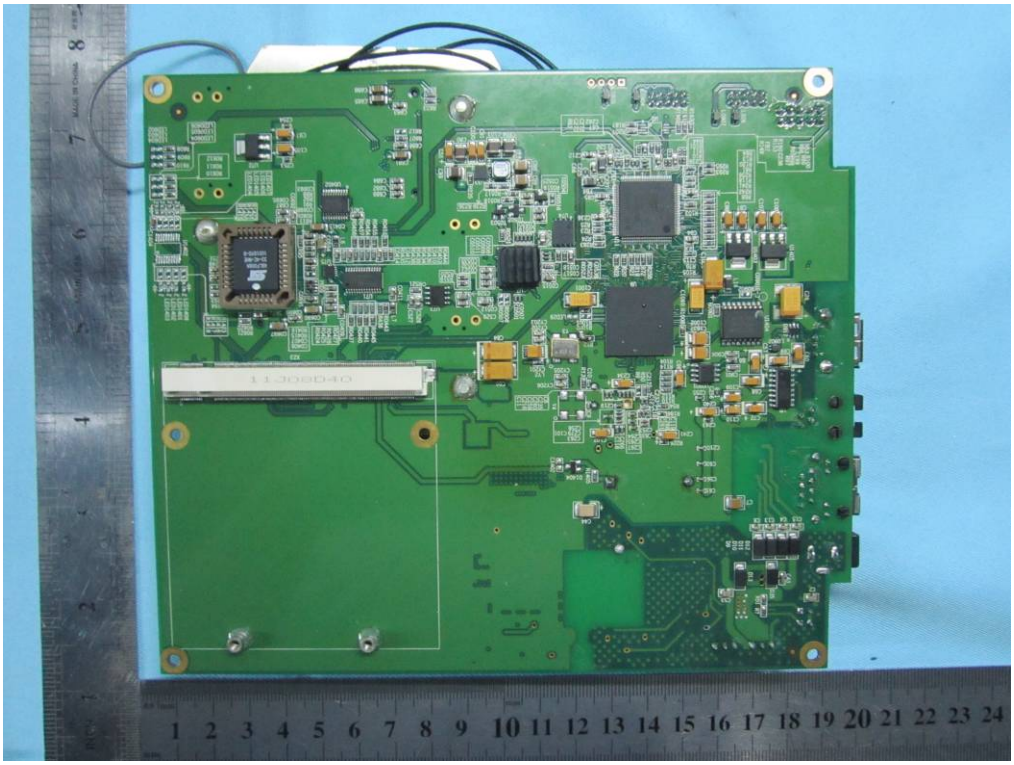
Mainborad Uncover - Top View-1



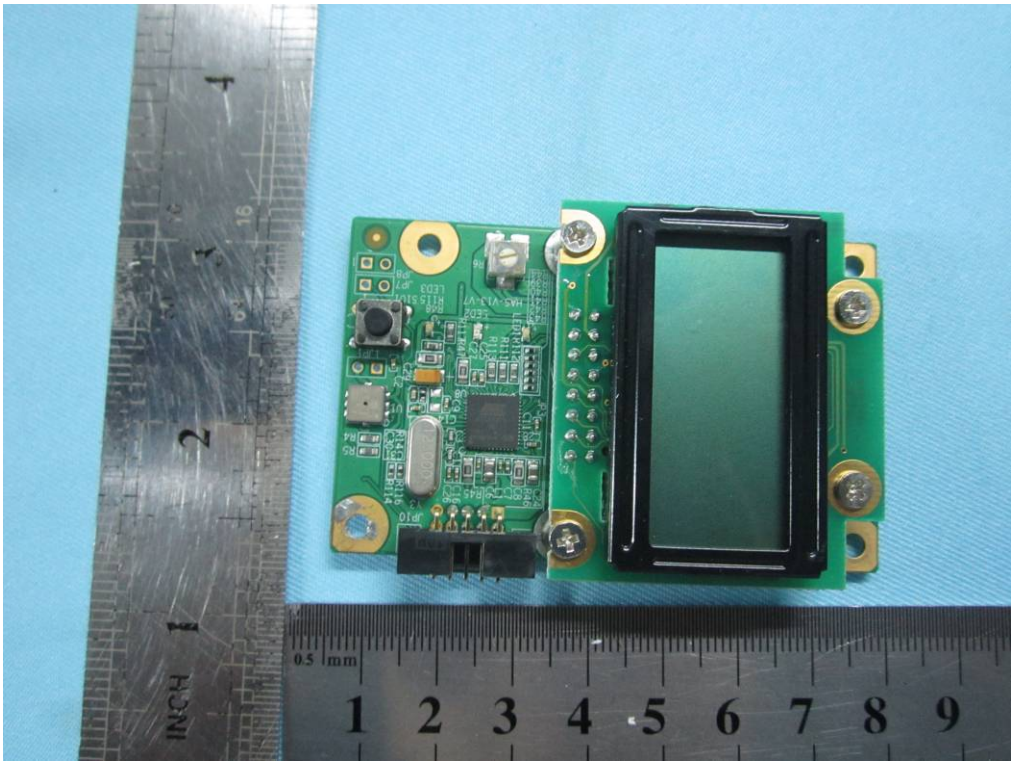
Mainborad Uncover - Top View-2



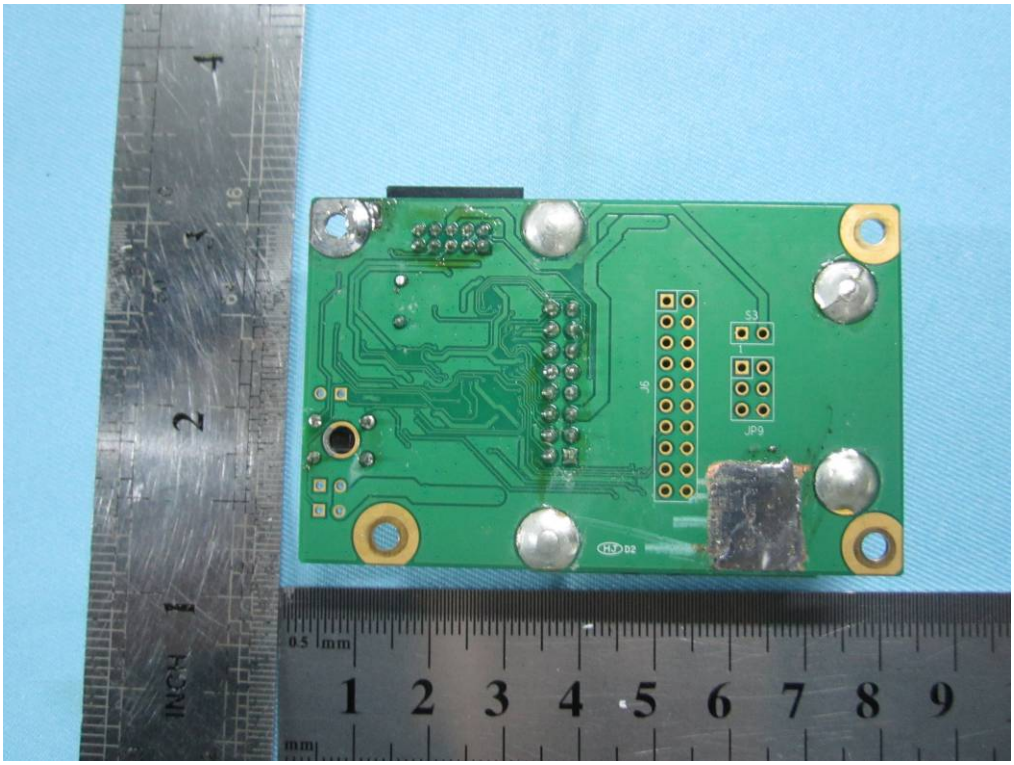
Mainborad - Bottom View



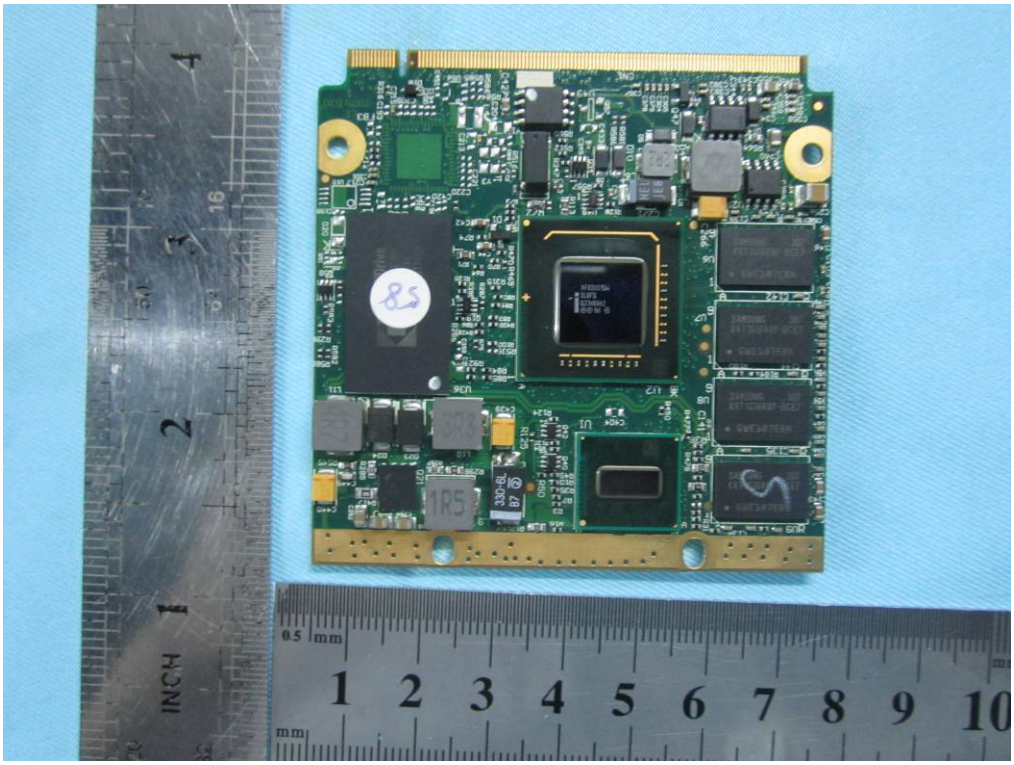
Mainborad Uncover - Bottom View



LED board - Top View



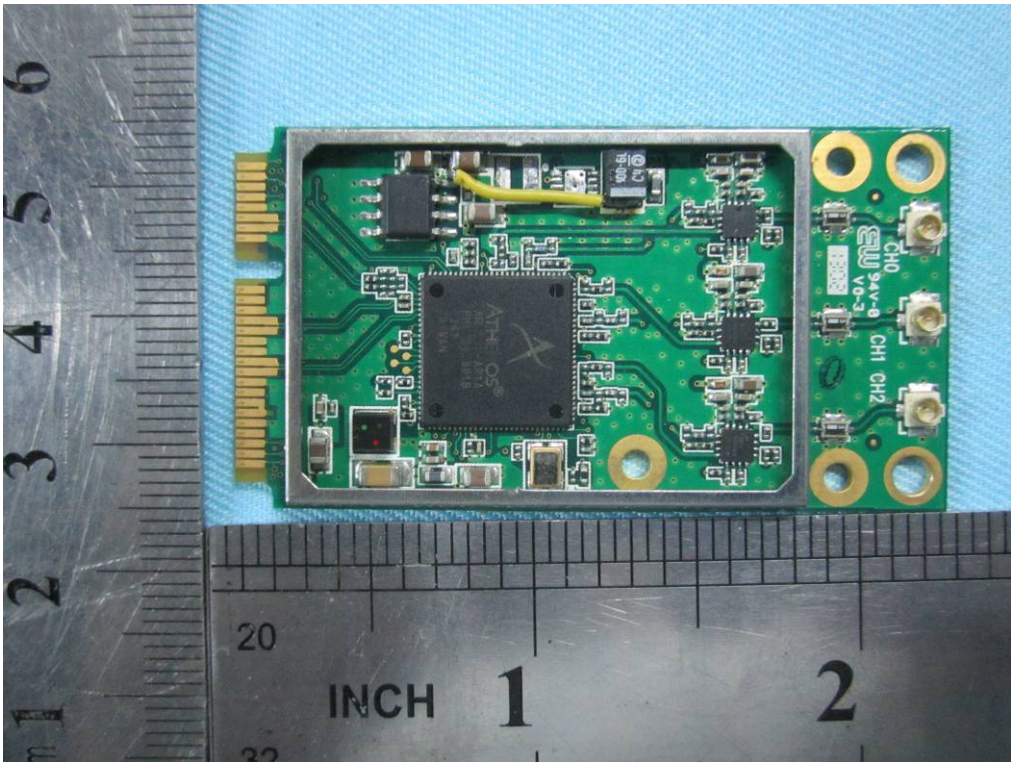
LED board - Bottom View



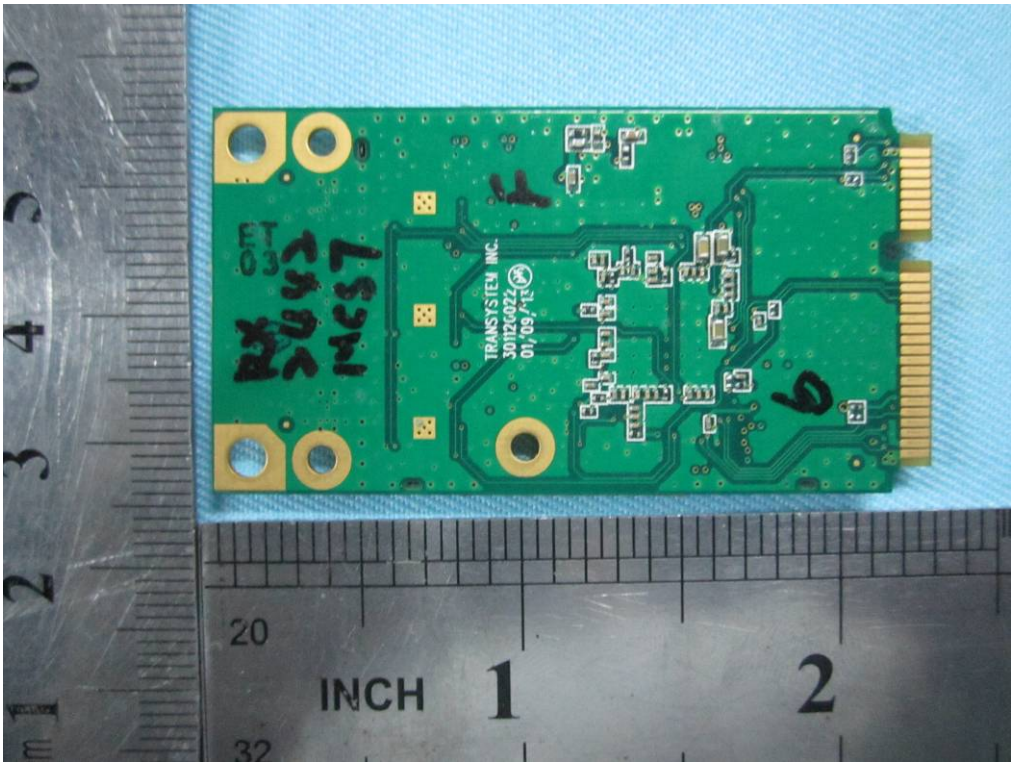
Control board - Top View

Control board – Botton View

2.4GHz RF board - Top View

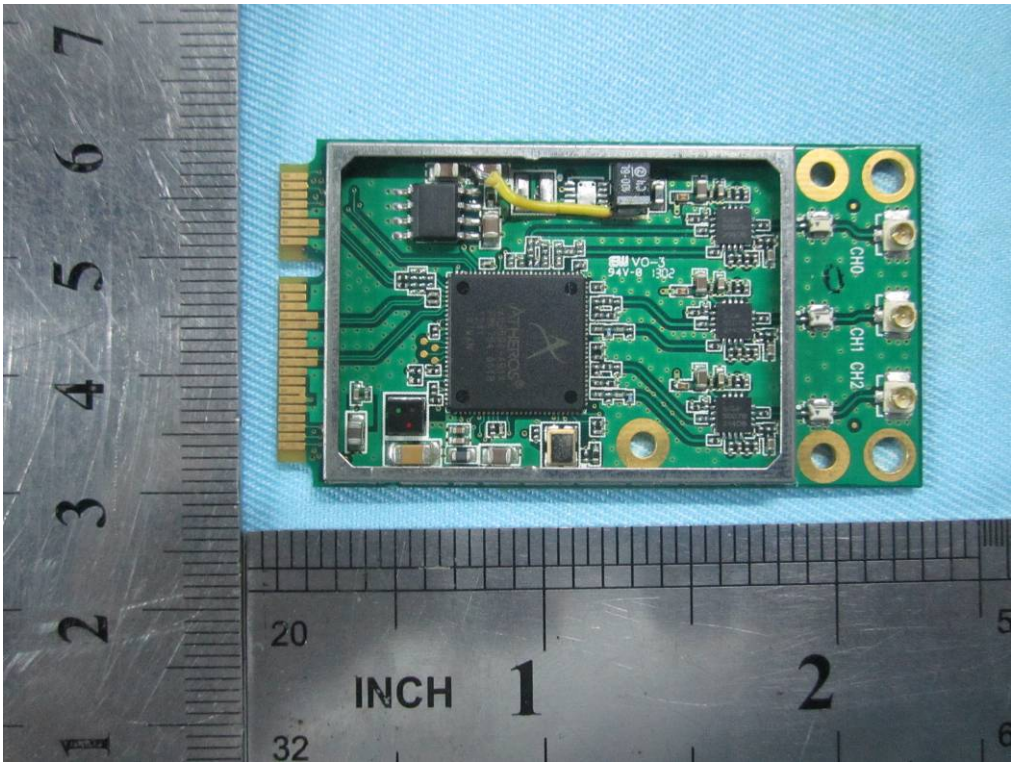


2.4GHz RF board Uncover - Top View

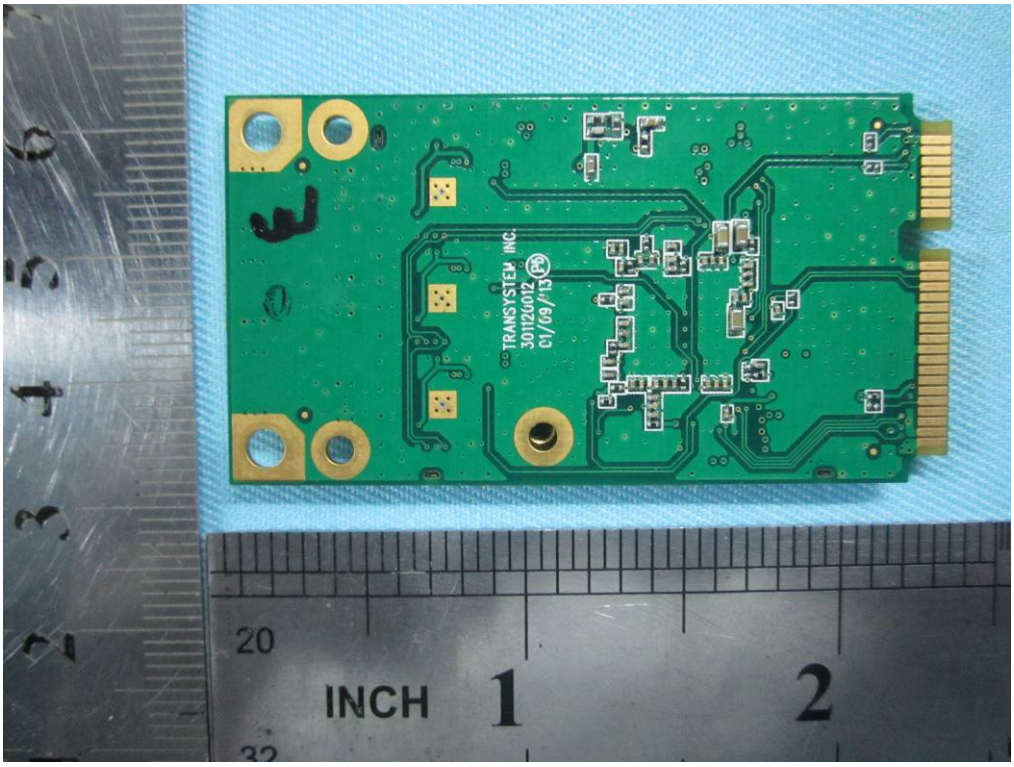


2.4GHz RF board – Botton View

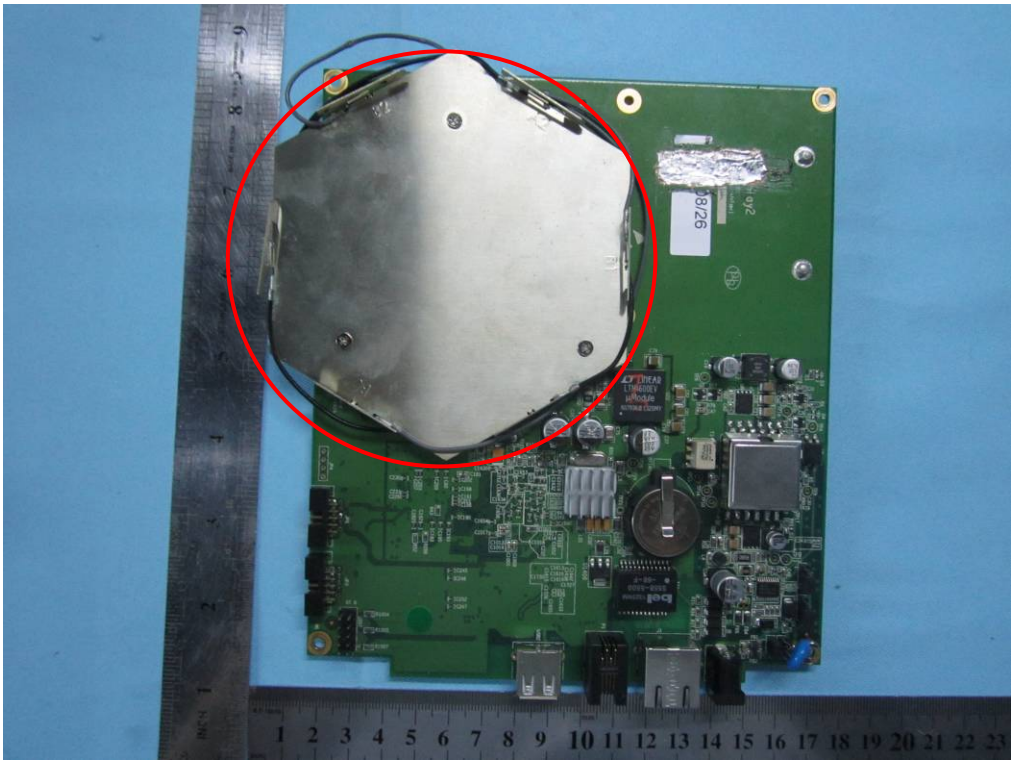
5GHz RF board - Top View



5GHz RF board Uncover - Top View

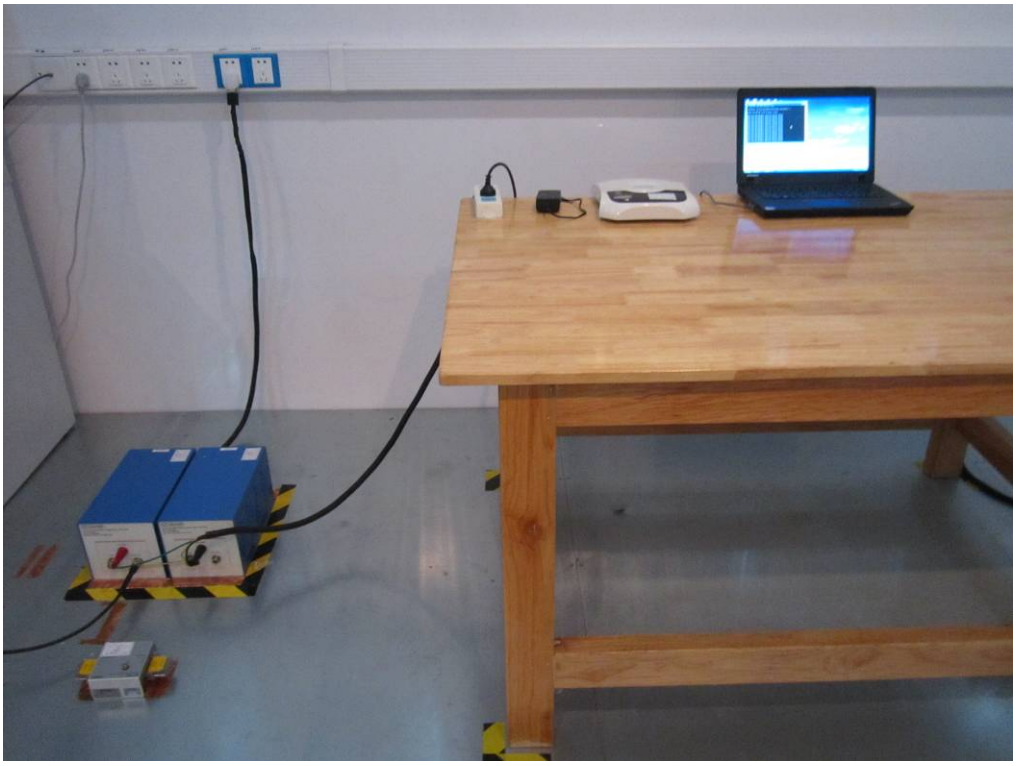


5GHz RF board – Botton View

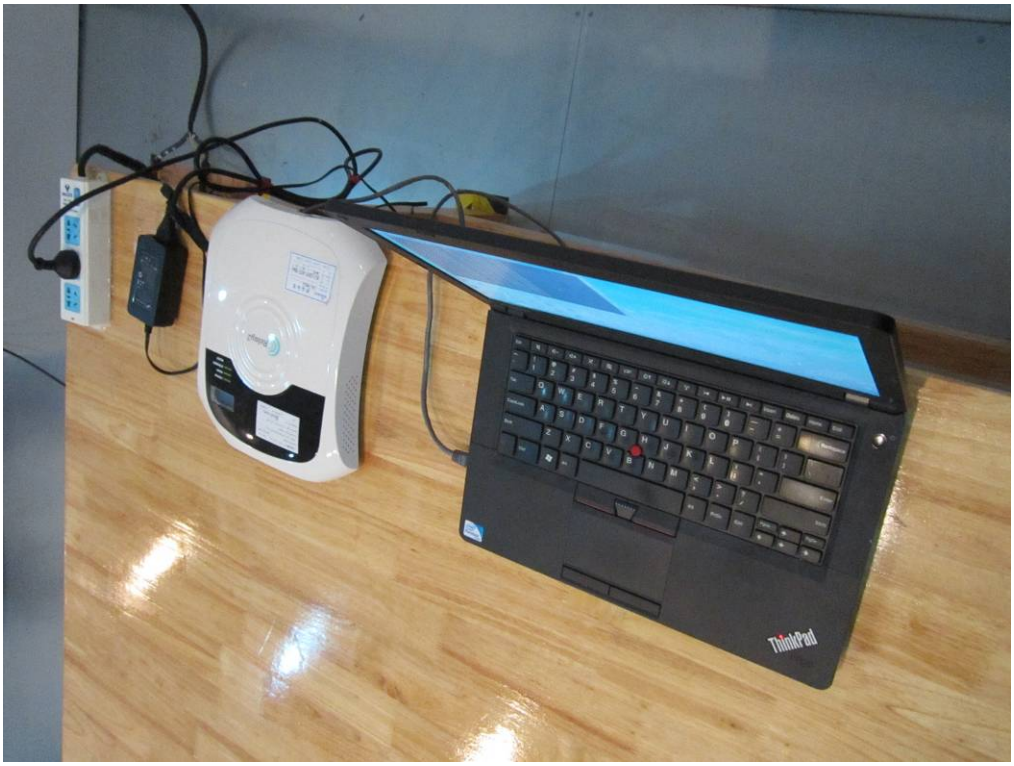


WIFI Antenna View

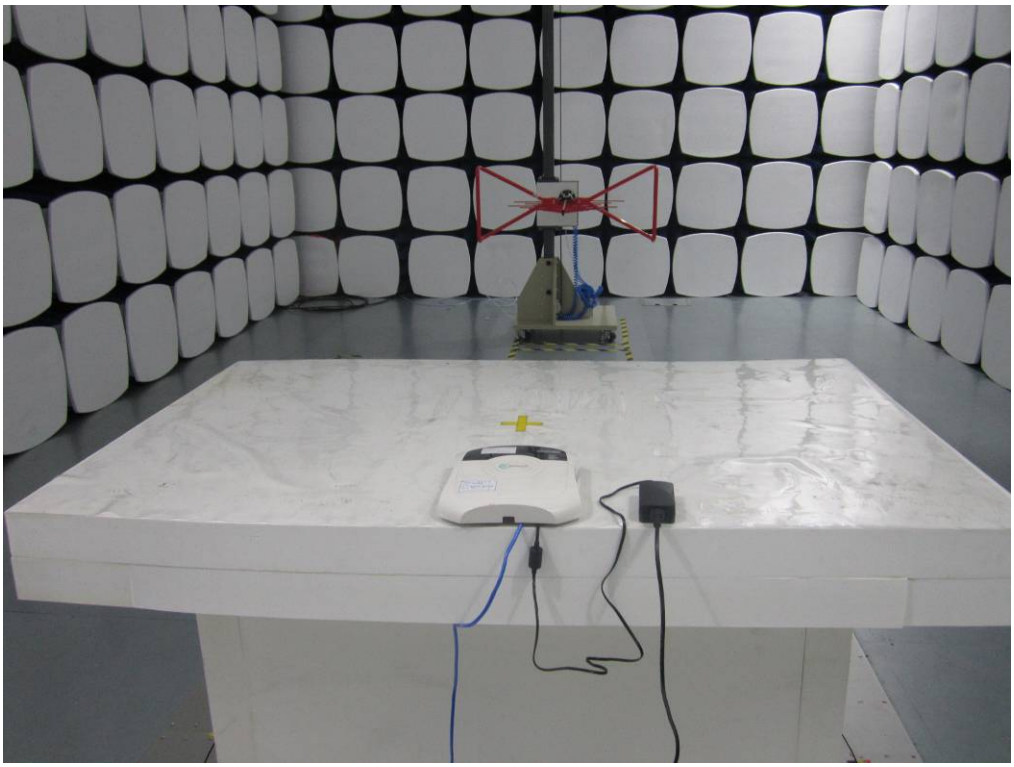
Annex B.iii. Photograph 3: Test Setup Photo



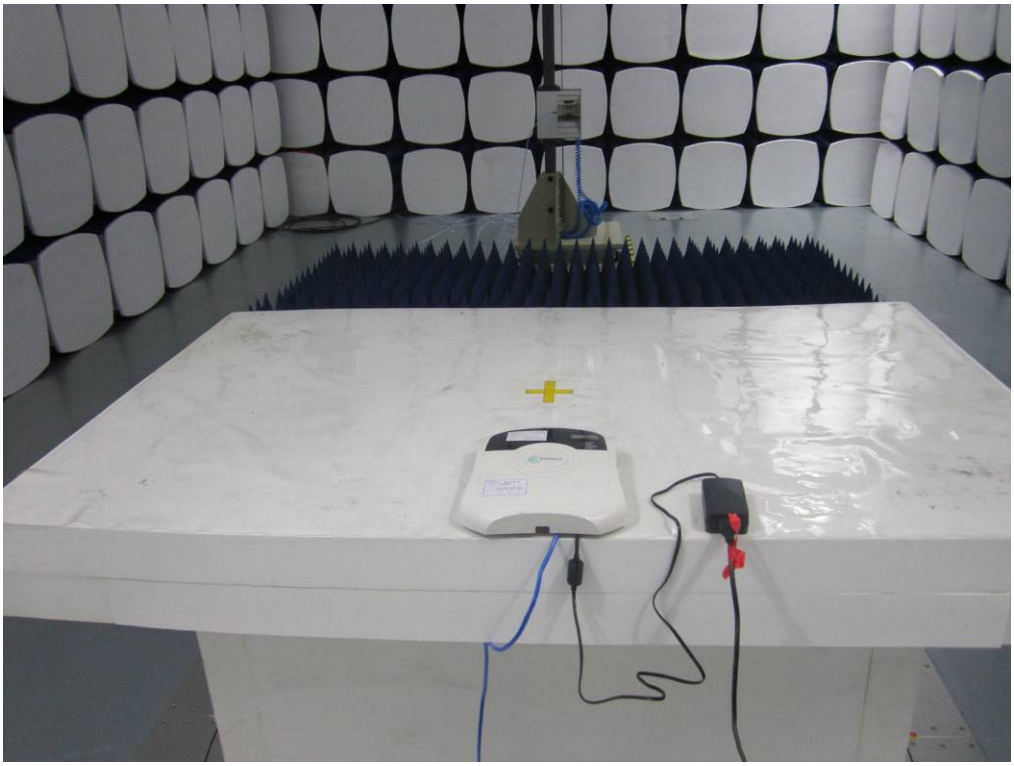
Conducted Emissions Test Setup Front View



Conducted Emissions Test Setup Side View



Radiated Spurious Emissions Test Setup Below 1GHz - Front View



Radiated Spurious Emissions Test Setup Above 1GHz –Front View

Annex C. TEST SETUP AND SUPPORTING EQUIPMENT

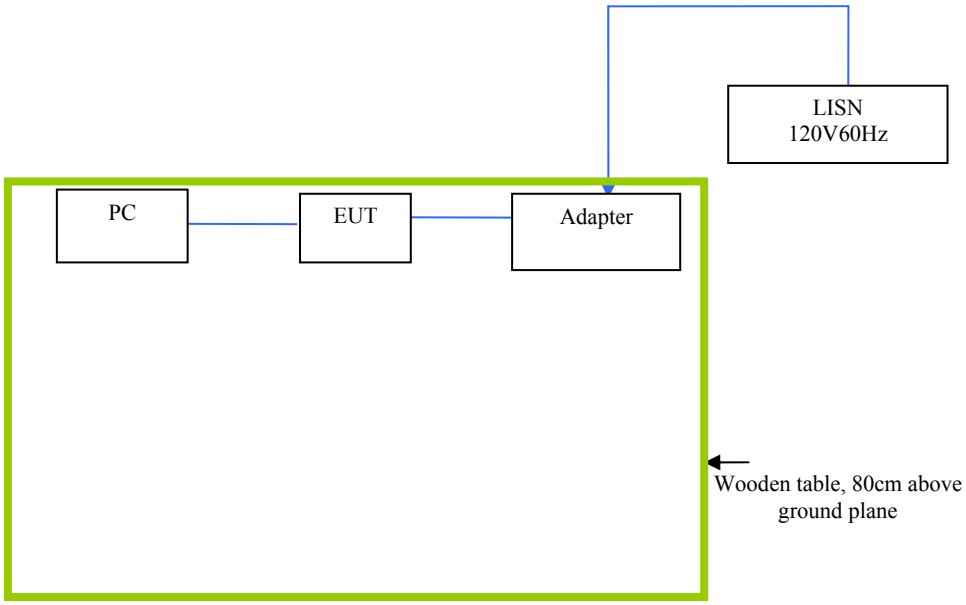
EUT TEST CONDITIONS

Annex C. i. SUPPORTING EQUIPMENT DESCRIPTION

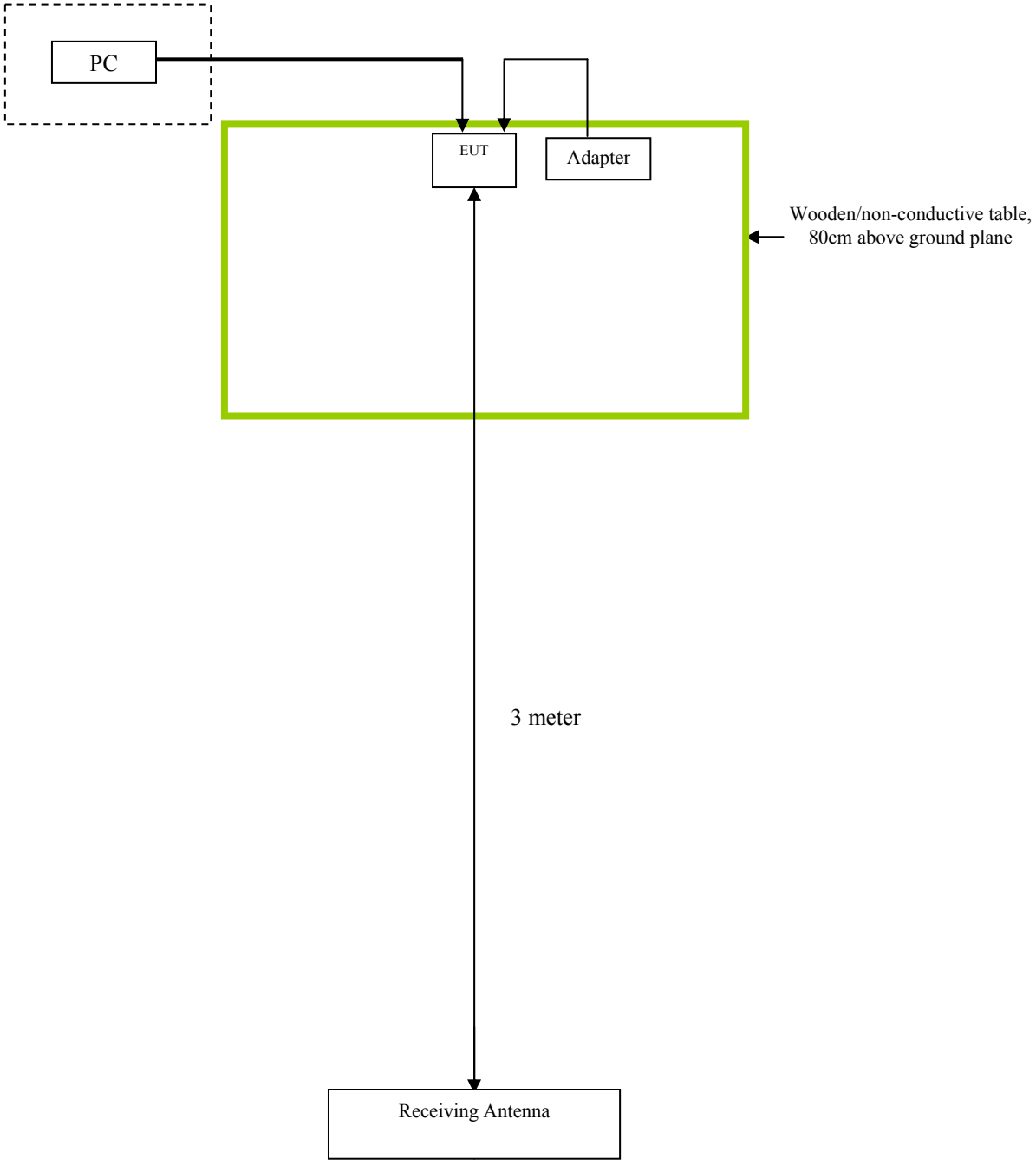
The following is a description of supporting equipment and details of cables used with the EUT.

Manufacturer	Equipment Description (Including Brand Name)	Model	Calibration Date	Calibration Due Date
Lenovo Laptop	E40& 0579A52	N/A	Lenovo Laptop	E40& 0579A52

Block Configuration Diagram for AC Line Conducted Emissions



Block Configuration Diagram for Radiated Emissions



Annex C.ii. EUT OPERATING CONDITIONS

The following is the description of how the EUT is exercised during testing.

Test	Description Of Operation
Emissions Testing	The EUT was continuously transmitting to stimulate the worst case.

Annex D. USER MANUAL / BLOCK DIAGRAM / SCHEMATICS / PART LIST

Please see attachment

Annex E. DECLARATION OF SIMILARITY

N/A