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Dynamic Frequency Selection Test Report

EUT Name: WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER

Model No.: AW500

CFR 47 Part 15.407 2014 and RSS 210: 2010

Prepared for:

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This report is prepared by:

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Test Engineer — Date March 12, 2015

1 Dynamic Frequency Selection

Testing was performed in accordance with CFR47 Part 15.407 (h). These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures and verifies the characteristics and probability of EUT to switch to different operating channel, once the radar signal is detected. Procedures described in FCC-06-96A1 were used.

1.1 DFS Applicability

All devices operated in the frequency range of 5250 MHz-5350 MHz and 5470 MHz-5725MHz must equip with the DFS mechanism. Base on the operational mode of AW500 the following requirements shall apply per FCC-06-96A1procedures.

Table 1: Applicability of DFS Requirements Prior to Use of a Channel

Requirement	**Operational Mode**		
	Master	**Client Without Radar Detection**	**Client With Radar Detection**
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	**Operational Mode**		
	Master	**Client w/o Radar Detection**	**Client With Radar Detection**
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

1.2 DFS Requirements

Base on the applicability of AW500*, the following parameters and probability must be tested for conformance.*

Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

Maximum Transmit Power	Value
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

Table 4: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds. See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 80% of the U-NII 99% transmission power Bandwidth. See Note 3.

Note 1: The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows:

- For the Short Pulse Radar Test Signals this instant is the end of the *Burst*.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar Burst generated.
- For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the Radar Waveform.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

Table 5: Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See	See
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A	Roundup {(1/360)x (19x10E6/PRI uS	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.

Details are available in 905462 D02 UNII DFS Compliance Procedures New Rules v01r01

Table 6: Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7: Frequency Hopping Radar Test Waveform

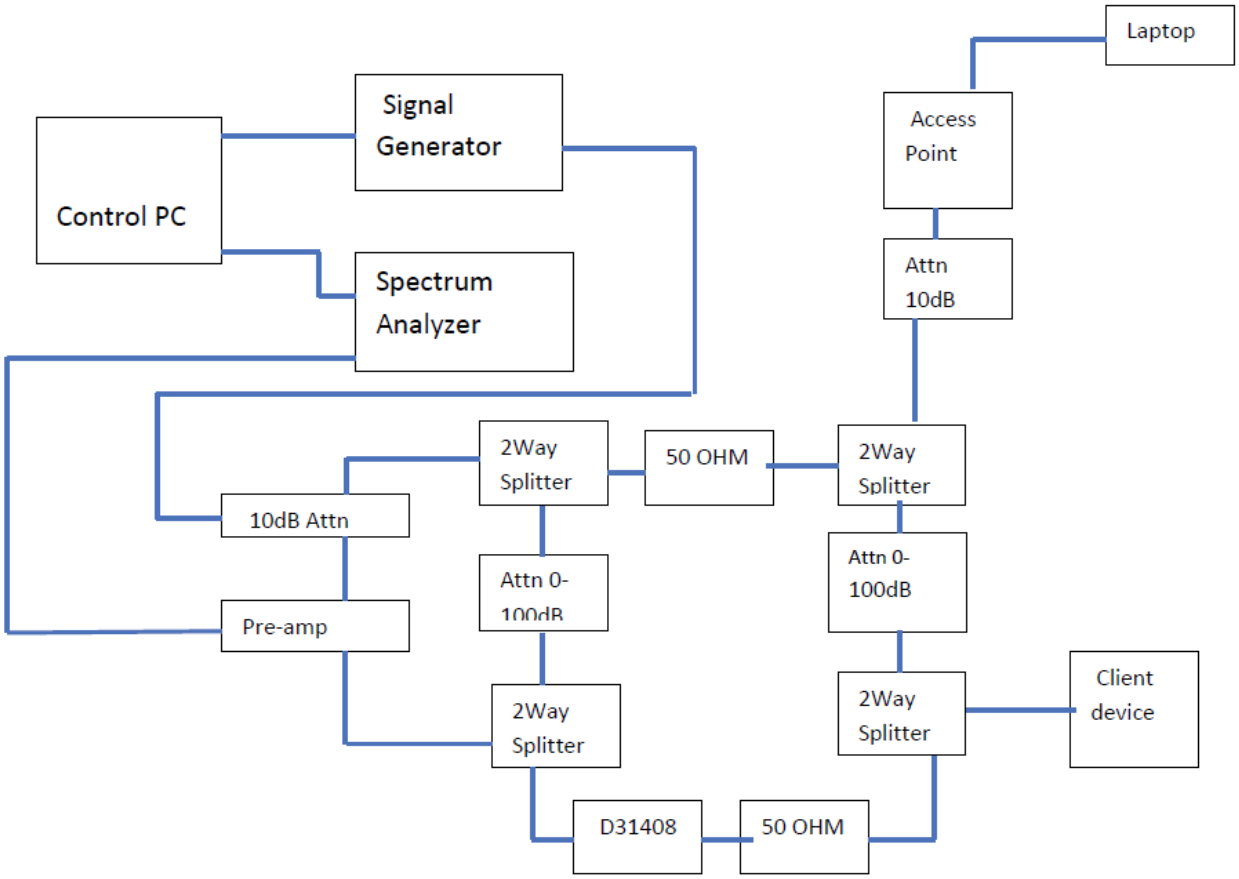
Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

1.3 Test Setup Protocol

The following test setup was used to evaluate the WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER *for DFS conformance.*

Dynamic Frequency Selection in Block Diagram:

Dynamic Frequency Selection in Conducted Setup:



Simplified Block diagram of Dynamic Frequency Selection Testing

1.4 Radar Waveform Verifications

The radar signal level must be -60 dBm (-64 dBm+ 3dB +1dB).

Note:

3dB is added for minimum antenna gain for Host Device to insure that the Radar-Injection-Level is above the AP-Detection-Threshold-Level

These waveforms were compensated for the path loss as offset on spectrum analyzer.

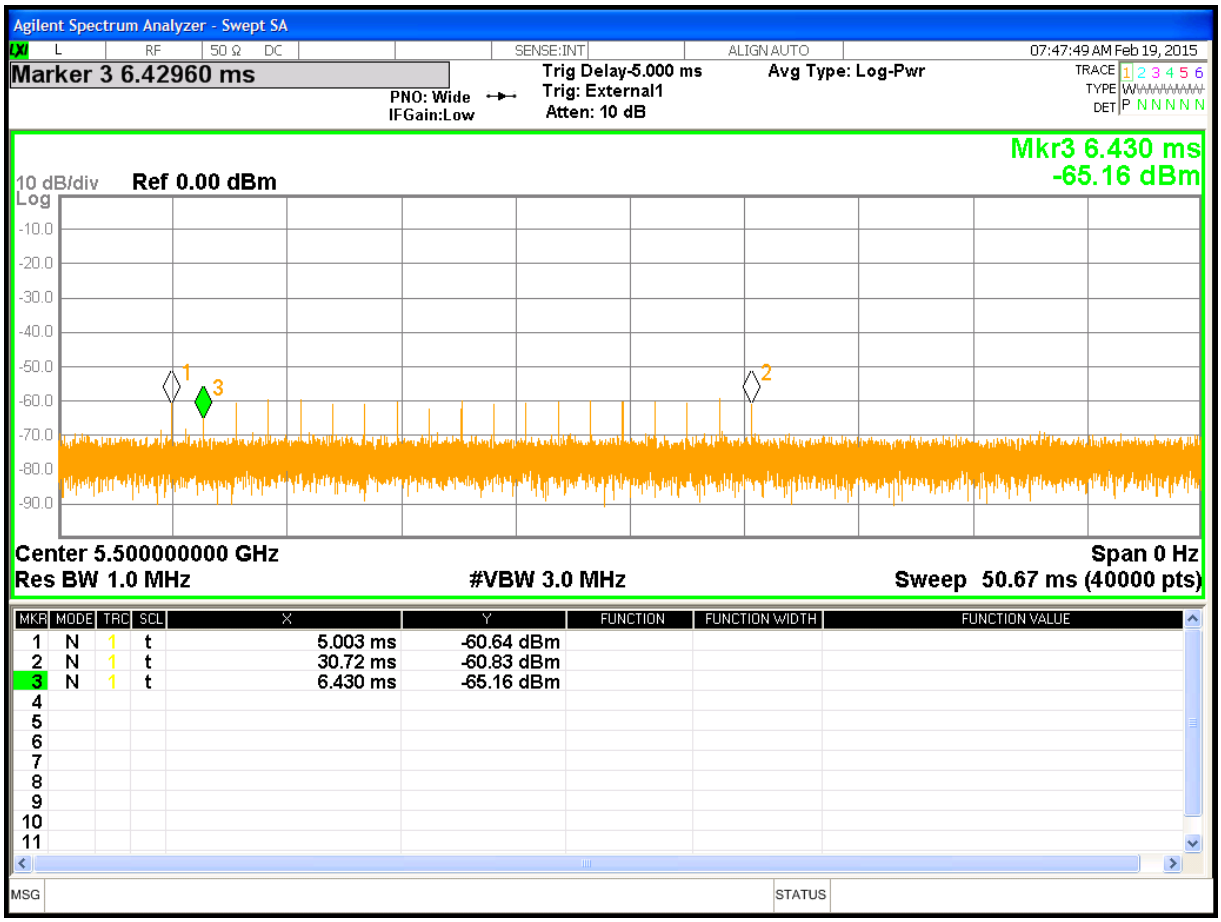


Figure 1: 5500 MHz Radar Pulse Type 0 at Master

1.5 In-Service Monitoring

In-service monitoring performance checks consist of the channel move time, channel Closing transmission time, and non-occupancy period. These parameters of the WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER *is verified to give the radar system the priority of the frequency rand and minimize the interference with nearby radar systems when the WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER is being used.*

The WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER is a client device without any radar detection.

The verified Pulse #0 was conductively injected to the above test circuit. Since Pace 5268 AP was qualified for DFS, the WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER was evaluated with the Pace 5268 as a whole network system for conformance to the channel move time and channel closing transmission time.

As originally tested, the WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER was found to be compliant to the requirements of the test standard(s).

Table 8: DFS Response – Test Results

Test Method: Conducted					
Center Frequency: see below.			**EUT State:** Streaming MPEG Video		
Min. Antenna Gain: 3.8dB			**Max. Transmitted Power:** nominal		
Required Threshold: -64dBm			**Detection Threshold:** -60 dBm		
Ambient Temperature: 21° C			**Relative Humidity:** 38 RH%		
Bandwidth (MHz)	**Channel (MHz)**	**CMT (msec)**	**CCTT (msec)**	**Figure**	**Results**
20	5500	211.00	13.5	Plot 2	Complies
40	5500	135.20	10.8	Plot 3	Complies
80	5500	74.72	6	Plot 4	Complies
Note: One channel was evaluated as Pace AW500 employs as same chip set for all bands of operation . *CCTT= Channel Closing Transmission Time.* *CMT= Channel Move Time*					

Figure 2: Channel move time, signal plotted 10 secs after radar signal is applied at 5500 MHz for 20MHz BW

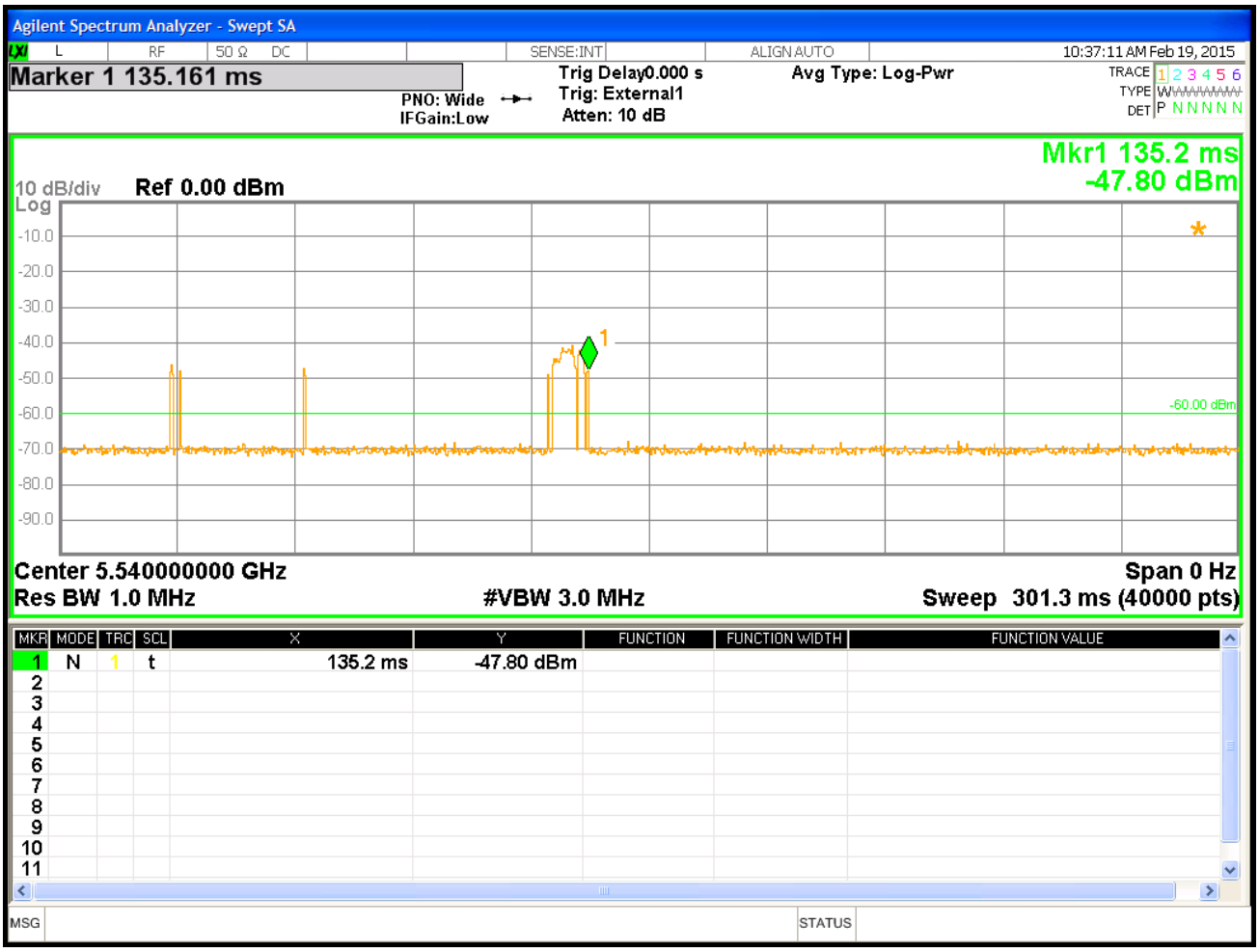


Figure 3: Channel Move Time (Zoom-In) at 5500MHz with 40MHz BW

Figure 4: Channel moving time at 5500MHz with 40MHz BW

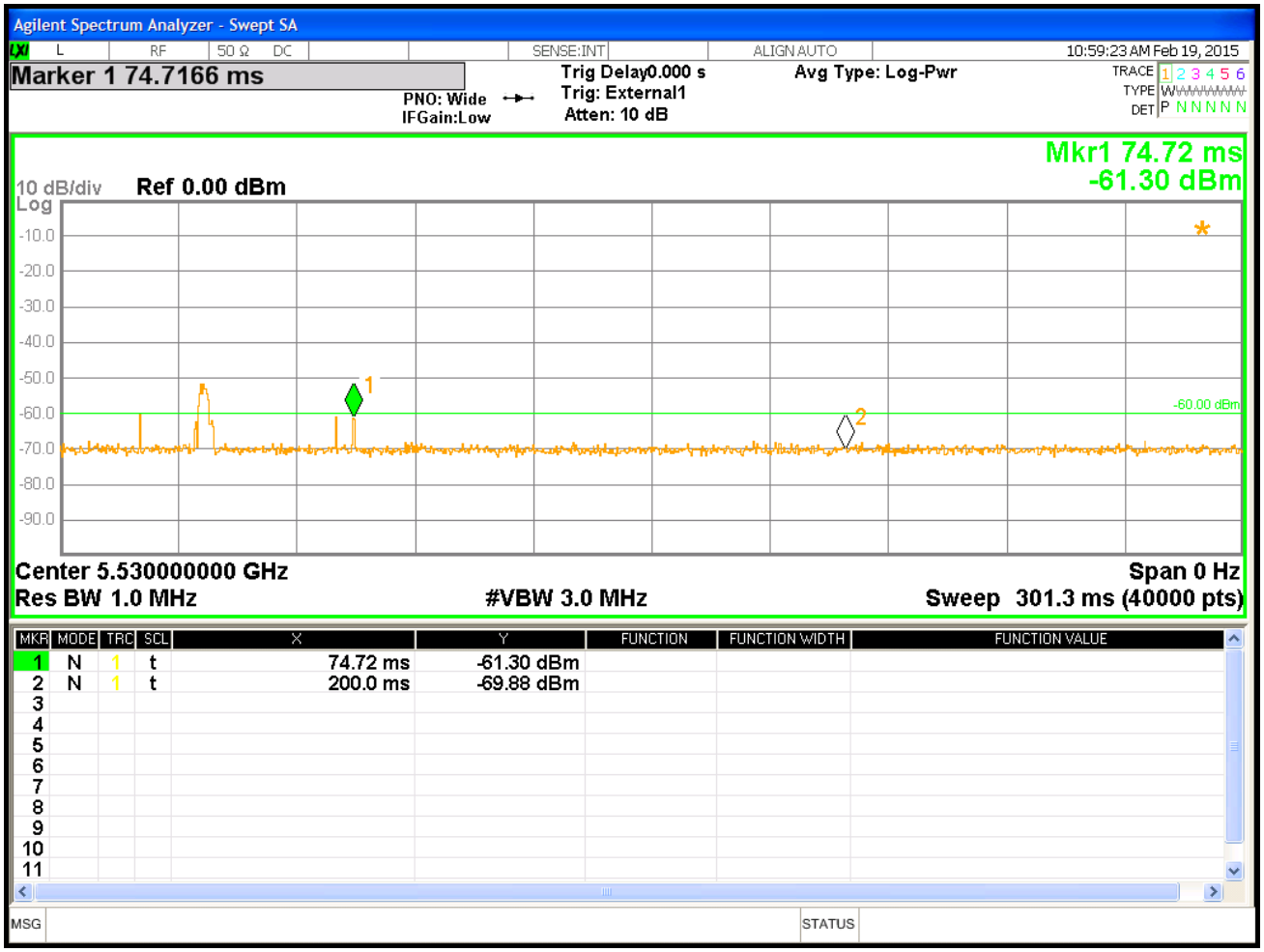


Figure 5: Channel moving time at 5500MHz with 80MHz BW

1.5.1 Bandwidth of 20 MHz

Channel Move Time and Channel Closing Transmission Time at 5500 MHz

1.5.1.1 Analysis of data from plot #: 2 for 20MHz Bw

Sweep Bins	40000	bins
Start time	0	ms
SweepTime	12.00237	ms
Threshold Level	-65	dBm
End of Radar Burst Bin	322	bins
Last of Radar Burst		ms
Total Bin Above Threshold	45	bins
Bin on After Burst	45	bins
Channel Closing Trans. Time	**13.5**	**ms**
Last Transmission	211.00	ms
Chanel Move Time	130.80	ms

1.5.2 Bandwidth of 40 MHz

Channel Move Time and Channel Closing Transmission Time at 5500 MHz

Analysis of data from plot #: 3 for 40MHz Bw

Sweep Bins	40000	bins
Start time	0	ms
SweepTime	12.00237	ms
Threshold Level	-65	dBm
End of Radar Burst Bin	322	bins
Last of Radar Burst		ms
Total Bin Above Threshold	36	bins
Bin on After Burst	36	bins
Channel Closing Trans. Time	**10.8**	**ms**
Last Transmission	211.00	ms
Chanel Move Time	130.80	ms

1.5.3 Bandwidth of 80 MHz

Channel Move Time and Channel Closing Transmission Time at 5500 MHz

Analysis of data from plot#: 4 for 80MHz Bw

Sweep Bins	40000	bins
Start time	0	ms
SweepTime	12.00237	ms
Threshold Level	-65	dBm
End of Radar Burst Bin	322	bins
Last of Radar Burst		ms
Total Bin Above Threshold	20	bins
Bin on After Burst	20	bins
Channel Closing Trans. Time	**6**	**ms**
Last Transmission	211.00	ms
Chanel Move Time	74.72	ms

2 Test Equipment Use List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Spectrum Analyzer	Agilent	N9038A	MY51210195	1/12/2015	1/12/2016
4 way Power divider	Krystar	701080	71009	NCR	NCR
2 way splitter	Mini -Circuits	ZN2PD-9G-S+	SF342500820	NCR	NCR
2 way splitter	Mini -Circuits	ZN2PD-9G-S+	SF342500820	NCR	NCR
Power Meter	Agilent	E4418	MY45103902	1/12/2015	1/12/2016
Power Sensor	Hewlett Packard	8482	55-5131	1/12/2015	01/12/2016
Vector Signal Generator	Rhode&Schwarz	SMU 200A	1141.2005.02	06/13/2013	06/13/2016

* Calibration of equipment past due for re-calibration will be performed expeditiously. If any equipment is found to be out of tolerance at that time, affected customers will be notified accordingly. NCR=No Calibration Required

3 EMC Test Plan

3.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

3.2 Customer

Table 9: Customer Information

Company Name	Pace America
Address	310 Providence Mine Road, Ste. 200
City, State, Zip	Nevada City, CA 95959
Country	USA
Phone	(530) 274 5440
Fax	(530) 273 6340

Table 10: Technical Contact Information

Name	Mark Reiger
E-mail	Mark.Rieger@pace.com
Phone	(530) 274 5440
Fax	(530) 273 6340

3.3 Equipment Under Test (EUT)

Table 11: EUT Specifications

EUT Specification	
WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER	87x42x20cm
AC Adapter	NA EUT is powered by host device
Environment	Indoor and Outdoor
Operating Temperature Range:	0 to 50 degrees C
Multiple Feeds:	☐ Yes and ☒ two
Hardware Version	Rev. PD12-2230A1C
Part Number	E4282C20400
RF Software Version	NA
Radio Module 2 802.11-radio modules	
Operating Mode	802.11a, HT20, and HT40 and 802.11AC
Transmitter Frequency Band	5.15 GHz to 5.25 GHz 5.25 GHz to 5.35 GHz 5.47 GHz to 5.725 GHz 5.725 GHz to 5.85 GHz
Max. Rated Power Output	See Channel Planning Table.
Power Setting @ Operating Channel	See Channel Planning Table.
Antenna Type	PCB Mounted Antenna (2 per module)
Modulation Type	☐AM ☐FM ☒DSSS ☒OFDM other describe:

Date Rate	802.11a: 6, 9, 12, 18, 24, 36, 48, 54 Mbps at 1 Spatial Stream 802.11n HT20: 1 Spatial Stream: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps 2 Spatial Streams: 13, 26, 39, 58, 78, 104, 117, 130 Mbps 3 Spatial Streams: 19.5, 39, 58.5, 78, 117, 156, 175.5, 195 Mbps 802.11n HT40: 1 Spatial Stream: 13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps 2 Spatial Streams: 27, 54, 81, 108, 162, 216, 243, 270 Mbps 3 Spatial Streams: 40.5, 81, 121.5, 162, 243, 324, 364.5, 405 Mbps
TX/RX Chain (s)	MIMO (2x2)
Directional Gain Type	☒ Uncorrelated ☒ No Beam-Forming Other describe:
Type of Equipment	☐ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other *describe WIFI 802.11AC 2X2 5GHZ WIRELESS ADAPTER is limited modular approval device with*
Note: None	

Table 12: EUT Channel Power Specifications

-

No.	Frequency (MHz)	Target Power Value dBm				
		802.11a	802.11n HT20/VHT20	802.11n HT40/VHT40	802.11AC VHT80	
36	5180	14	14			
38	5190			12		
40	5200	14	14			
42	5210				12	
44	5220	14	14			
46	5230			14		
48	5240	14	14			
52	5260	14	14			
54	5270			14		
56	5280	14	14			
58	5290				12	
60	5300	14	14			
62	5310			12		
64	5320	14	14			
100	5500	14	14			
102	5510			12		
104	5520	14	14			
106	5530				12	
108	5540	14	14			
110	5550			14		
112	5560	14	14			
116	5580	14	14			
118	5590			14		
120	5600	14	14			
122	5610				14	

124	5620	14	14			
126	5630			14		
128	5640	14	14			
132	5660	14	14			
134	5670			14		
136	5680	14	14			
138	5690				14	
140	5700	14	14			
142	5710			14		
149	5745	14	14			
151	5755			14		
153	5765	14	14			
155	5775				14	
157	5785	14	14			
159	5795	14	14	14		
161	5805	14	14			
165	5825	14	14			

Note: 1. The center operating frequency is shifted upward by 10 MHz for HT40.
2. The adjusted power target values are updated at the evaluated frequencies.

Table 13: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB	Plugs into Host	NA	NA	NA

Table 14: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Access Point	P ace	5268AC	23141N012315	DFS Testing
Note: None.				

Table 15: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
AW 500	Prototype #1	Integrated Antenna	TX Emission, RX Emission, AC Conducted Emission
	Prototype #2	Direct via SMA	Peak Transmit Power, Peak Power Spectral Density, Peak Excursion Ratio Occupied Bandwidth Frequency Stability Dynamic Frequency Selection

Table 16: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
AW 500	Integrated	* Transmit * Receive	EUT laid flat.	EUT stood upright	EUT onside
Note: Pre-scans were performed in 3 orthogonal axis, and X-axis was worst.					

3.4 Test Specifications

Testing requirements

Table 18: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.407: 2014	All
RSS 210 Issue 8, 2010	All