Dynamic Frequency Selection (DFS) Test Report

For

CP-8821 IP Phone with

2.4/5.0 GHz Wi-Fi Radio 802.11a/ac/b/g/n + Bluetooth v3.0

FCC ID: LDK88211296

IC ID: 2461B-88211296

5250-5350, 5470-5725 MHz

Against the following Specifications:
CFR47 Part 15.407
RSS247 issue1

Cisco Systems
170 West Tasman Drive
San Jose, CA 95134

Author: Danh Le
Approved By:
Title: See EDCS
Revision: See EDCS

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Section 1: Dynamic Frequency Selection (DFS) Test Results Summary

Basic Standard	Technical Requirements / Details	Result
FCC 15.407 (h) (2) (i) (b) (iii) / RSS 247 Section 6.3 (2) (iv)	Channel Closing Transmission Time	**Pass**
FCC 15.407 (h) (2) (i) (b) (iii) / RSS 247 Section 6.3 (2) (iii)	Channel Move Time	**Pass**
FCC 15.407 (h) (2) (i) (b) (iv) / RSS 247 Section 6.3 (2) (v)	Non-occupancy period	**Pass**

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Radio Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc.:

With regard to this assessment, the following points should be noted:

a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.

b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.

c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).

d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

e) All AC testing was performed at one or more of the following supply voltages:
110V 60 Hz (+/-20%)

2.2 Test Conditions

Temperature	28 °C
Humidity	39%
Pressure	56 PA

2.3 Date of Testing

24-Oct-2015 to 09-Sep-2016

2.4 Report Issue Date

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

2.5 Testing facilities

This assessment was performed by:

Testing Laboratory

Cisco Systems, Inc.
125 West Tasman Drive (Building P)
San Jose, CA 95134
USA

Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134
USA

Test Engineer

Danh Le

2.6 Equipment Assessed (EUT)

CP-8821

2.7 EUT Description

The CP-8821 is the next generation IP Phone with Wi-Fi (802.11a/ac/b/g/n) and Bluetooth module support. The specification is applied to IEEE802.11a/ac/b/g/n + Bluetooth Basic rate/ EDR

Here is a brief summary of the Heracles hardware:

- IEEE 802.11 a/b/g/n/ac compliant wireless LAN
- USB 2.0/OTG interface (Shared with docking connector)
- 2.4-inch TFT LCD display, with 240 x 320 pixels, 16M colors
- Capacitive standard 12-key backlit keypad, 2 soft keys, volume and ringer control hard keys, mute hard key, speakerphone hard key, push-to-talk hard key, dedicated end call button (shared with power-on and off function) and send/dial button, 5-way joystick/navigation keys
- 512MB LPDDR2 RAM, 4GB eMMC flash storage, version4.41
- 2020 mAh removable standard battery
- Ring, Wireless low signal, battery condition and MWI LED
- Shared antenna for 802.11a/b/g/n/ac and Bluetooth Basic rate /EDR.
- Separate ringer and voice speaker
- 3.5 mm headset interface
- Vibrate alert support
- Two Digital Microphone & Two loud speaker Interface
- Audio codec support, MP3, WAV, AAC etc.
- IP67 certified water and dust proof.

2.8 Antenna Information

Frequency	Part Number	Antenna Type	Frequency Range (MHz)	Antenna Gain (dBi)
5 GHz	Internal	Monopole	5250 - 5350	3
	Internal	Monopole	5470 - 5725	3

Section 3: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for worst Case test Configuration" section of this report for further details on the selection of EUT samples.

3.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial No.
S01	Conducted Sample	Cisco Systems, Inc.	01	Sip8821.10-3-2HER-157 dev	Rootfs8821.10-3-2HER-157-dev	FCH192180BK

3.2 Mode of Operation Details

Mode#	Description	Comments
1	Apps mode	This mode allows the EUT to be able to registered to Call Manager, establish Wi-Fi connection with AP router and making phone calls with the remote IP phone. Image version : Rootfs8821.10-3-2HER-157-dev

Measurements were made in accordance with

- 905462 D02 UNII DFS Compliance Procedures New Rules v01r02

3.3 Supporting EUT

SEUT#	Manufacturer	Model	Description	Serial no.
1	Cisco	MCS7800	Call Manager Server	SnUSE724N5AT
2	Lenovo	W530	Laptop	SnPK05YAC
3	Cisco	CP-9971	IP-Phone	SnFCH16359V8W
4	Cisco	Air-CAP3702I-A-K9	Access Point Router	SnFGL1851X6L2

Appendix A Dynamic Frequency Selection (DFS)

in the 5250 MHz – 5350 MHz and 5470 MHz – 5725 MHz bands.

A.1 DFS Overview

A UNII network will employ a DFS function to detect signal from radar systems and to avoid co-channel operation with these systems. This applies to the 5250 MHz – 5350 MHz and/or 5470 MHz – 5725 MHz bands.

Within the context of the operation of the DFS function, a U-NII device will operate in either Master Mode or Client Mode. U-NII devices operating in the Client Mode can only operate in a network controlled by a U-NII device operating in Master Mode.

A.2 DFS Technical Requirements

FCC 15.407: U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

U-NII devices operating in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems.

A.2.1 DFS Detection Thresholds

Table1: **Interference Threshold for Master Devices and Client devices With Radar Detection**

Maximum Transmit Power	**Value (see note)**
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 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. **Note 3**: EIRP is based on the highest antenna gain.	

A.2.2 DFS Response Requirements

Table2: **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 99% 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 transmission.

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 *Channel* changes (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 1 is used and for each frequency step the minimum percentage of detection is 90%. Measurements are performed with no data traffic.

A.3 Radar Test Waveforms

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

Table3: **Short Pulse Radar Test Waveforms**

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
0	1	1428	18	See Note1	See Note1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in table 5a		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
Note1: short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time and channel close time tests.					

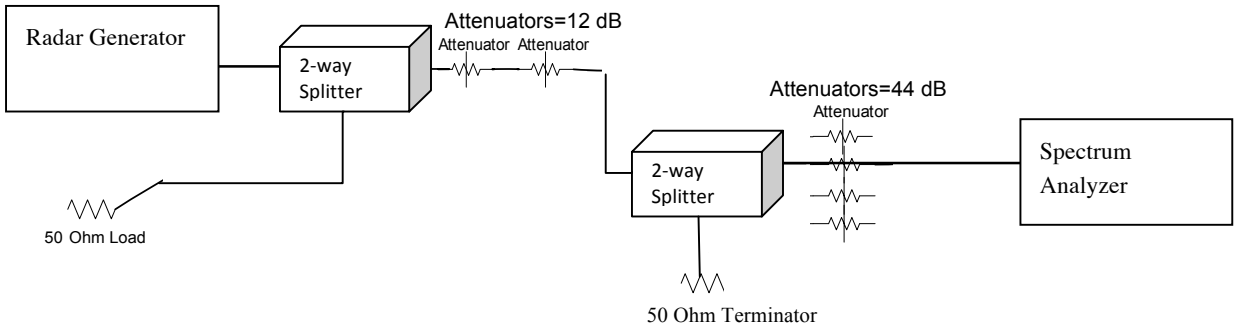
A.4 Radar Waveform Calibration

A.4.1 Block Diagram

The following equipment setup was used to calibrate the conducted Radar Waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to largest bandwidth available.

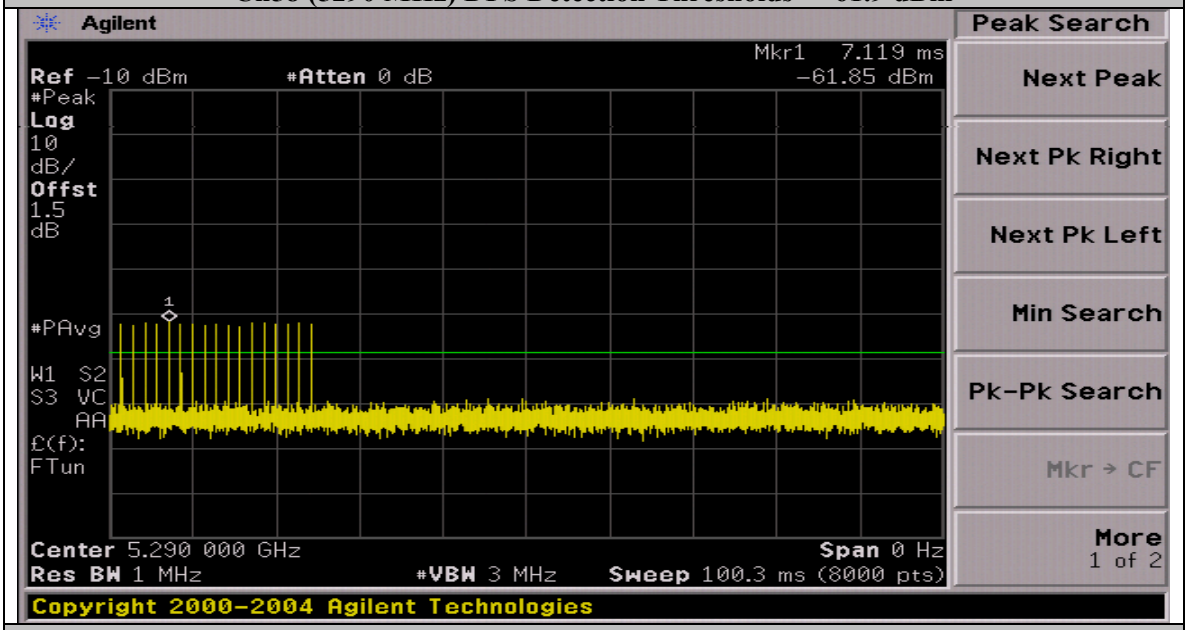
The signal generator amplitude was calibrated so that the power level measured approximately at -61.0dBm.

Conducted Calibration Test Setup Block Diagram

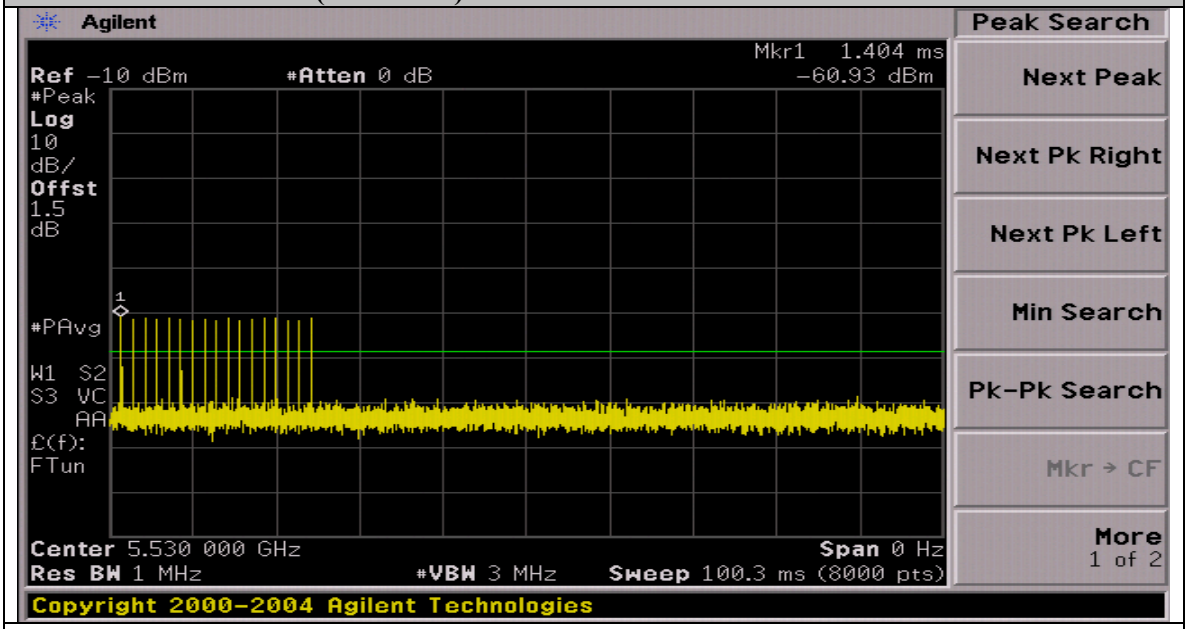


A.4.2 Calibration plots

Calibration for Type 0 radar
Mode: 802.11ac VHT80 / Band: UNII-2A
Ch58 (5290 MHz) DFS Detection Thresholds = -61.9 dBm



Mode: 802.11ac VHT80 / Band: UNII-2C
Ch106 (5530 MHz) DFS Detection Thresholds = -60.9 dBm



The DFS detection thresholds level of -62 dBm at the input of the receiver is assuming a 0 dBi of antenna gain during calibration of the test setup. Throughout the test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in the measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS

response.

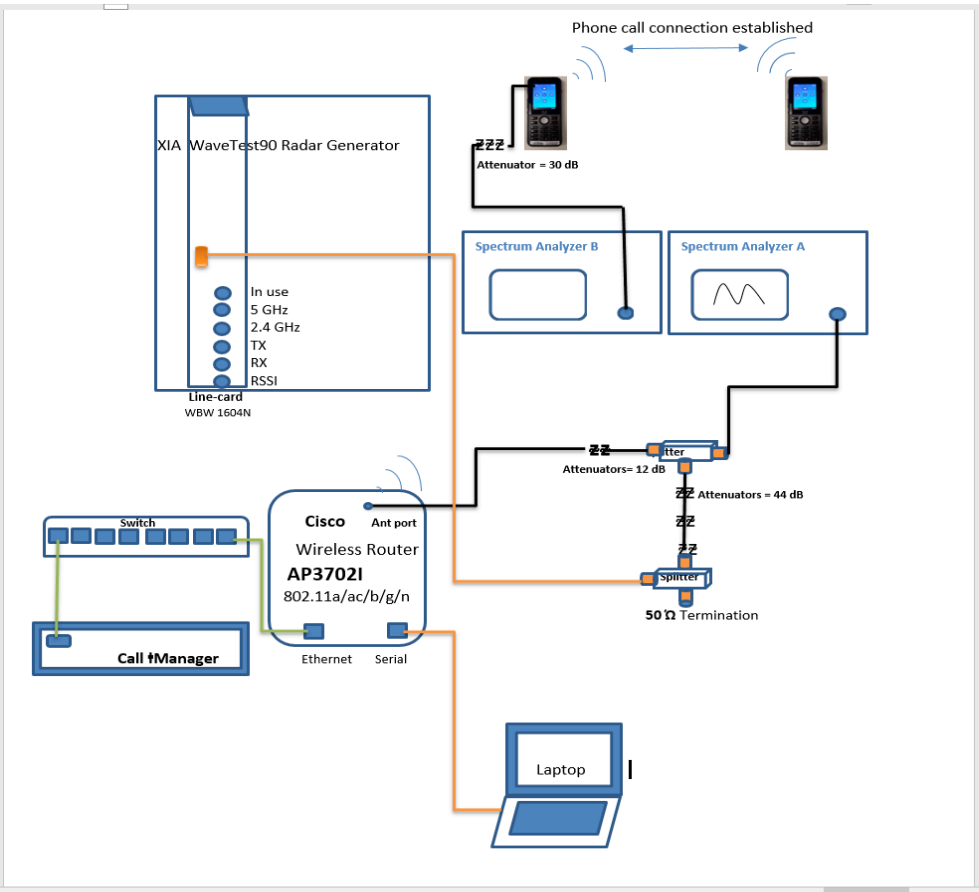
A.5 Test Procedures

Ref. KDB 905462 D02 UNII DFS Compliance Procedures New Rules v01r02, section 7.8.3

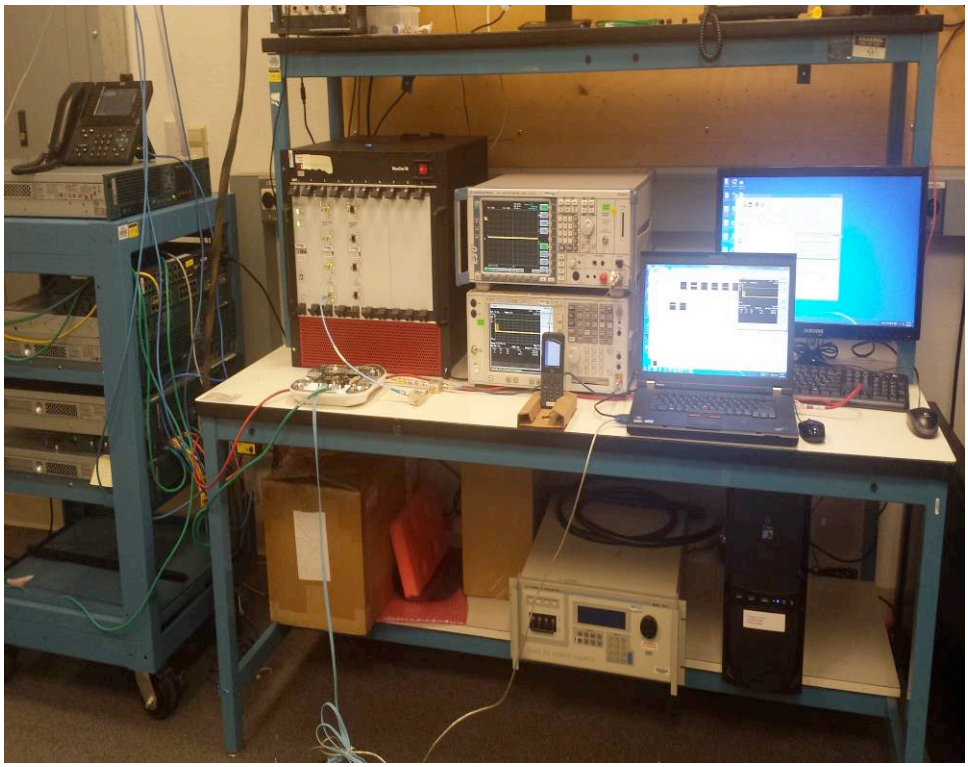
1. A spectrum analyzer is used as a monitor to verify that the UUT has vacated the Channel within the (Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the detection and Channel move.
2. Following is the test setup used to generate the Radar Waveforms, and for all DFS tests described herein.

3. System test setup was configured with two IP-Phones registered to the Call Manager and using the Access Point router for Wi-Fi connection to establish call connection.

Conducted Setup Block Diagram: Radar Test Waveforms are injected into the Master



Conducted Setup Photo: Radar Test Waveforms are injected into the Master



DFS Setup

The test setup is constructed of the following equipment:

See Appendix C for complete detail of Test Equipment used and section 3.3 of this test report for support Equipment used for DFS Test setup.

4. **UNII Detection Bandwidth**: DFS testing was done at 5290 MHz and 5530 MHz in 802.11ac VHT80. The 99% channel bandwidth for 80MHz signals is 76.0 MHz (See the 99% BW section of the RF report for further measurement details).

   The generating equipment is configured as shown in the Conducted Test Setup above. A single *Burst* of the desired radar profile is produced at 5290 MHz for UNII-2A band and 5530MHz for UNII-2C band at a -61dBm level. The UUT is set up as a client device associated with the master with traffic during phone call established.

5. One frequency will be chosen from the *Operating Channels* of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands. For 802.11 devices, the test frequency must contain control signals. This can be verified by disabling channel loading and monitoring the spectrum analyzer. If no control signals are detected, another frequency must be selected within the emission bandwidth where control signals are detected.

6. In case the UUT is a U-NII device operating as a *Client Device* (with or without DFS), a U-NII device operating as a *Master Device* will be used to allow the UUT (Client device) to *Associate* with the *Master Device*. In case the UUT is a *Master Device*, a U-NII device operating as a *Client Device* will be used and it is assumed that the Client will *associate* with the UUT (Master). In both cases for conducted tests, the *Radar Waveform* generator will be connected to the *Master Device*. For radiated tests, the emissions of the *Radar Waveform* generator will be directed towards the *Master Device*. If the *Master Device* has antenna gain, the main beam of the antenna will be directed toward the radar emitter. Vertical polarization is used for testing.

7. Stream the channel loading test file from the *Master Device* to the *Client Device* on the test *Channel* for the entire period of the test.

8. At time T0 the *Radar Waveform* generator sends a *Burst* of pulses for one of the Short Pulse Radar Types 1-4 in **Table 3** at levels defined in **Table 1**, on the *Operating Channel*. An additional 1 dB is added to the radar test signal to ensure it is at or above the *DFS Detection Threshold*, accounting for equipment variations/errors.

9. Observe the transmissions of the UUT at the end of the radar *Burst* on the *Operating Channel* for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (*Channel Move Time)*. Measure and record the *Channel Move Time* and *Channel Closing Transmission Time* if radar detection occurs. **Figure 1** illustrates *Channel Closing Transmission Time.*

10. When operating as a *Master Device*, monitor the UUT for more than 30 minutes following instant T2 to verify that the UUT does not resume any transmissions on this *Channel*. Perform this test once and record the measurement result.

11. In case the UUT is a U-NII device operating as a *Client Device* with *In-Service Monitoring*, perform steps a) to f).

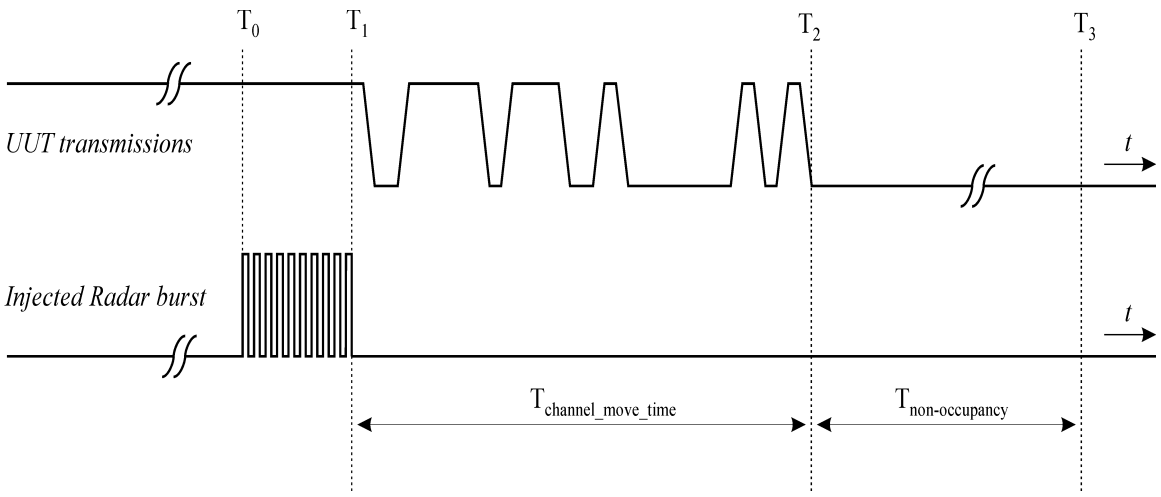


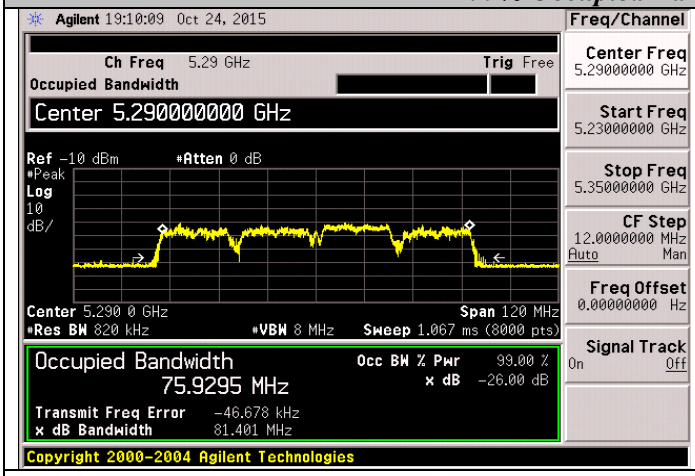
Figure 1: Example of Channel Closing Transmission Time & Channel Closing Time

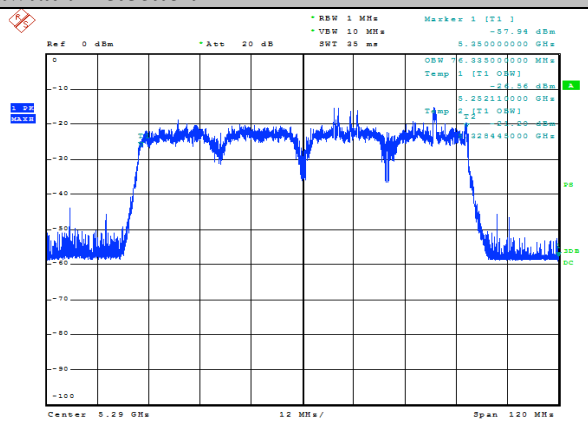
A.5 Graphical Test Results

Mode: 802.11ac VHT80 / Band: UNII-2A

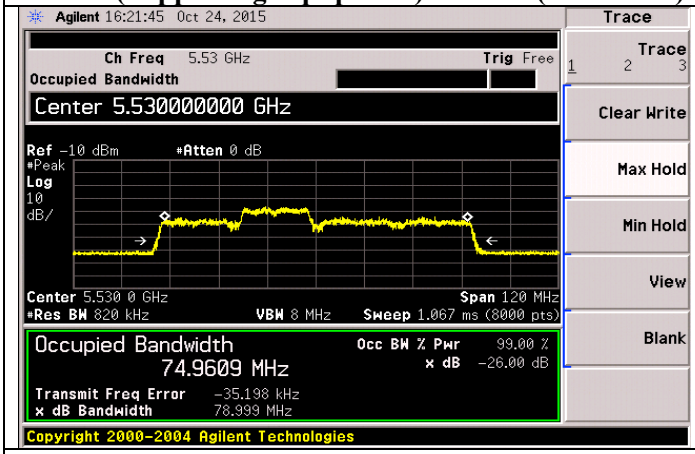
Master (Supporting Equipment) / Ch58 (5290 MHz)	Client (UUT) / Ch58 (5290 MHz)

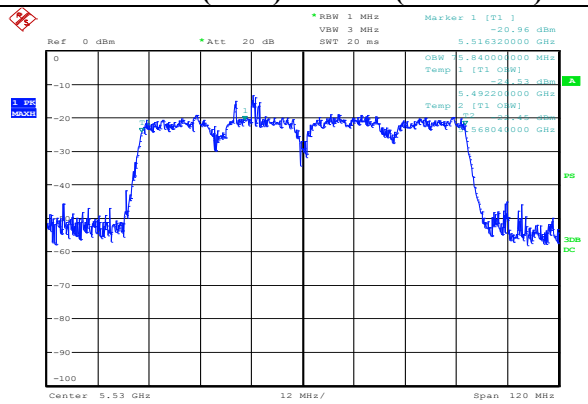
99% Occupied Bandwidth Detection



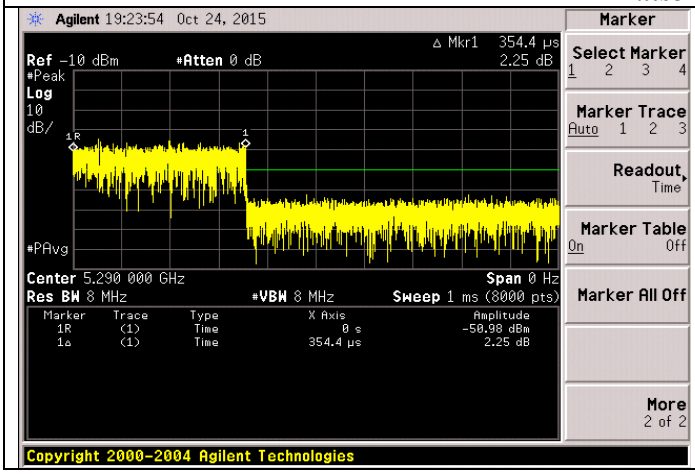


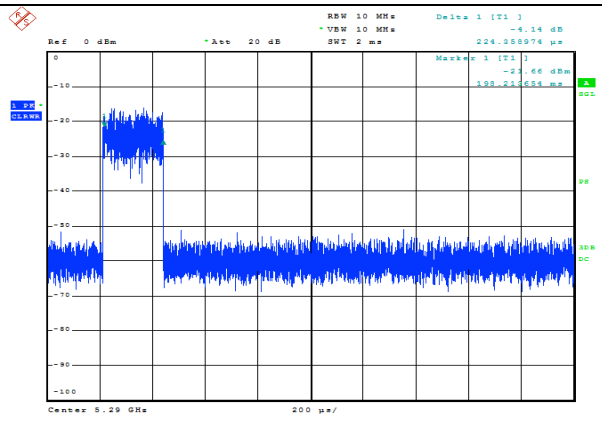
Master (Supporting Equipment) / Ch106 (5530 MHz)	Client (UUT) / Ch106 (5530 MHz)



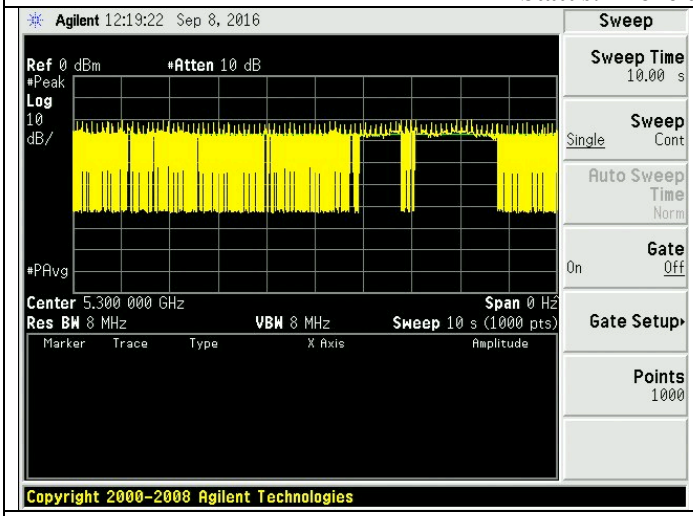
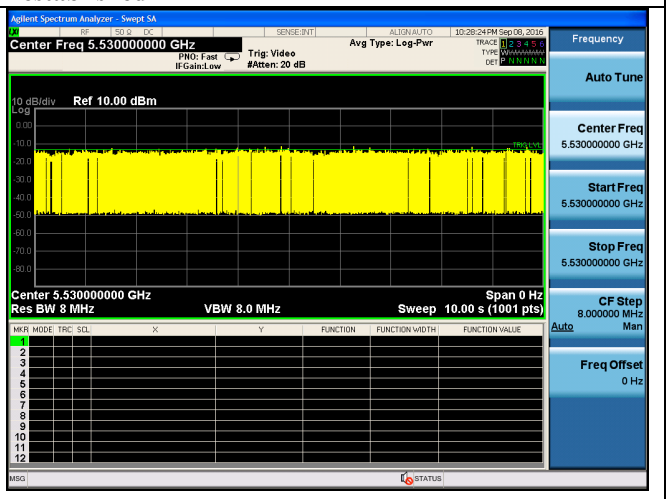
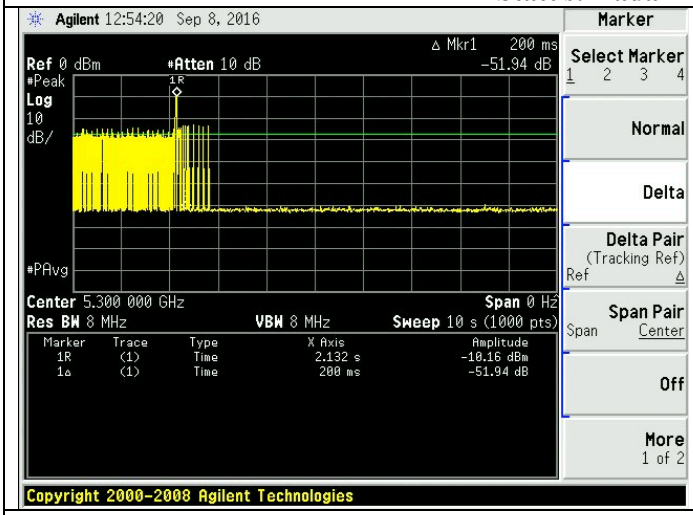
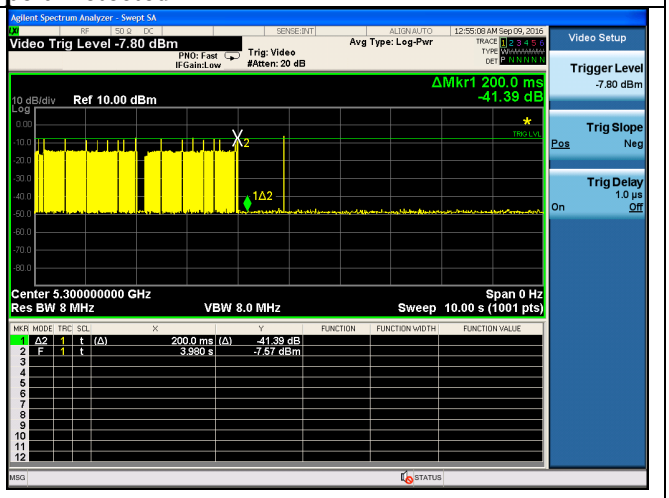


Pulse width

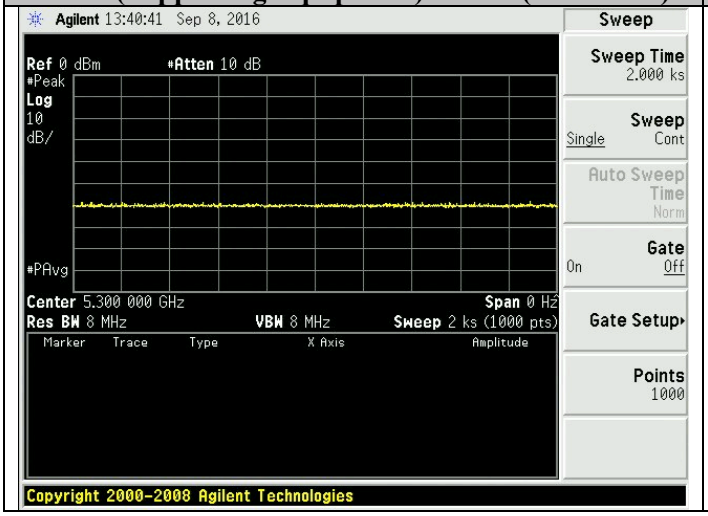
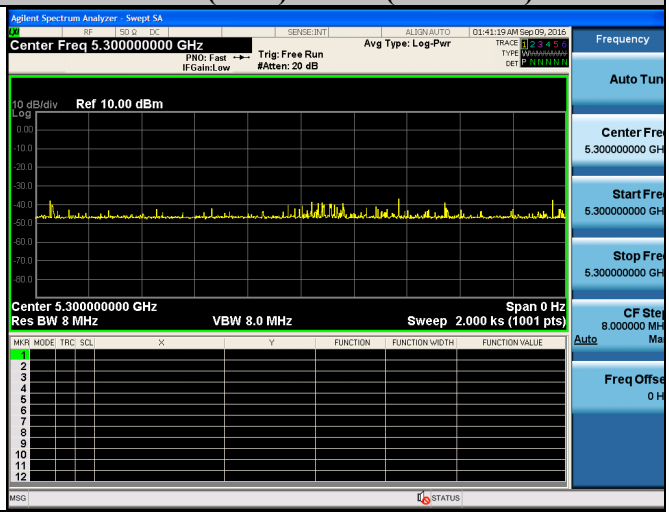




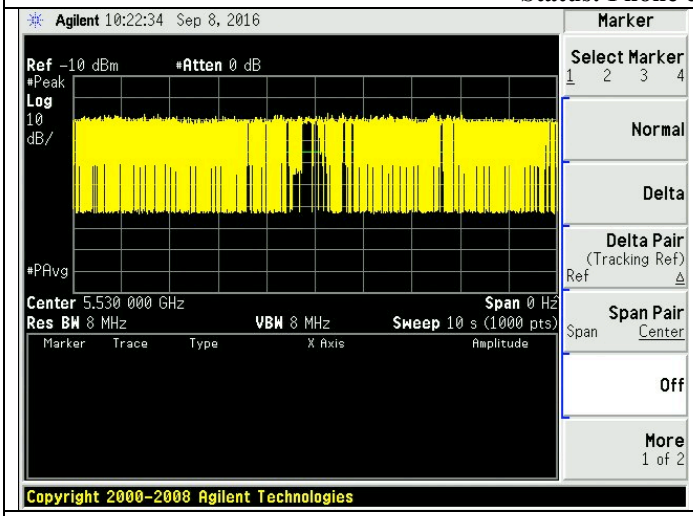
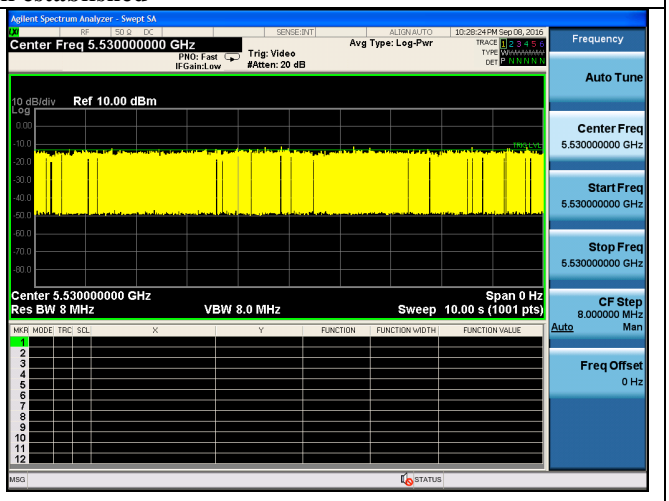
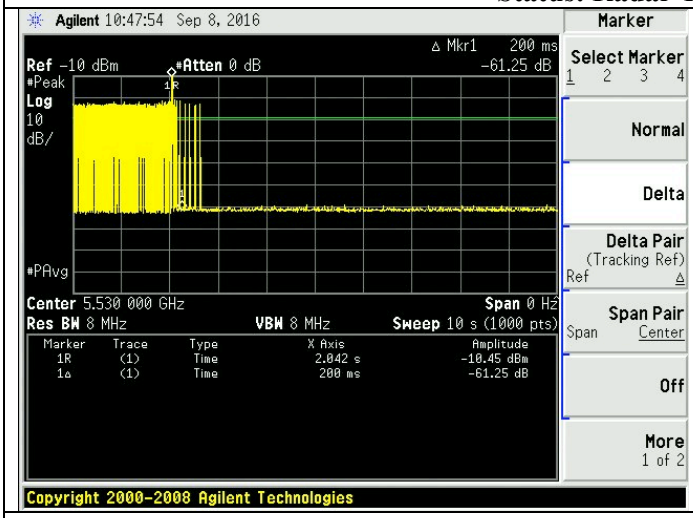
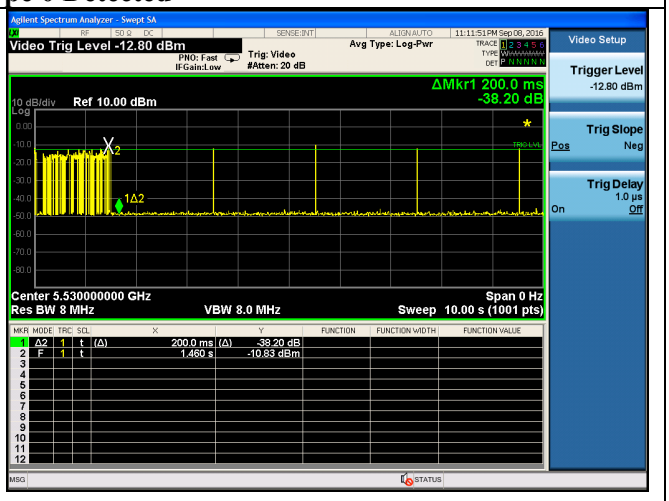
Channel Move Time, Channel Closing Transmission Time for Type 0 radar

Channel Move Time, Channel Closing Transmission Time for Type 0 radar.	
Mode: 802.11ac VHT80 / Band: UNII-2A	
Master (Supporting Equipment) / Ch58 (5290 MHz)	**Client (UUT) / Ch58 (5290 MHz)**
Status: Phone call established	
	
Status: Radar Type 0 Detected	
	
Result: Pass **Channel Closing TX time=** (# of bin) x (bin width) = 7 x 0.354 ms = **2.48ms**	**Result: Pass** **Channel Closing TX time=** (# of bin) x (bin width) = 1 x 0.224 ms = **0.22ms**

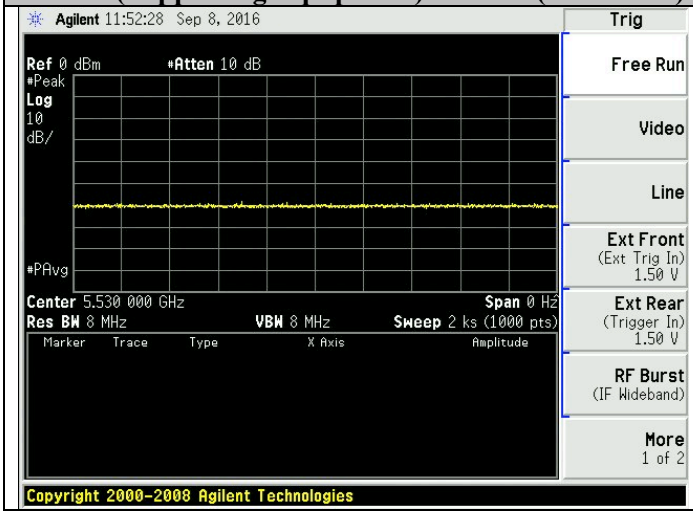
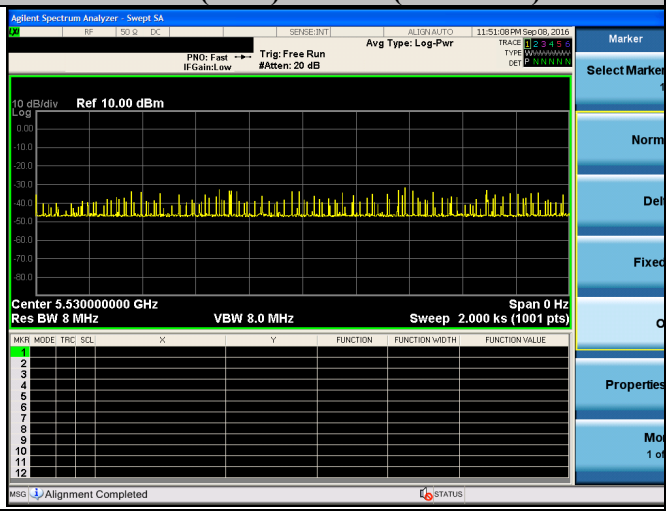
Non-Occupancy Period

Non-Occupancy Period (30 minutes minimum)	
Status: Phone call disconnected	
Master (Supporting Equipment) / Ch58 (5290 MHz)	**Client (UUT) / Ch58 (5290 MHz)**
	

Channel Move Time, Channel Closing Transmission Time for Type 0 radar

Channel Move Time, Channel Closing Transmission Time for Type 0 radar.	
Mode: 802.11ac VHT80 / Band: UNII-2A	
Master (Supporting Equipment) / Ch106 (5530 MHz)	**Client (UUT) / Ch106 (5530 MHz)**
Status: Phone call established	
	
Status: Radar Type 0 Detected	
	
Result: Pass **Channel Closing TX time=** (# of bin) x (bin width) = 5 x 0.354 ms = **1.77ms**	**Result: Pass** **Channel Closing TX time=** (# of bin) x (bin width) = 4 x 0.224 ms = **0.896ms**

Non-Occupancy Period

Non-Occupancy Period (30 minutes minimum)	
Status: Phone call disconnected	
Master (Supporting Equipment) / Ch106 (5530 MHz)	**Client (UUT) / Ch106 (5530 MHz)**
	

Appendix B: Test Equipment/Software Used to perform the test

Test Equipment List					
Equipment #	**Manufacturer**	**Model**	**Description**	**Last Cal**	**Next Cal Due Date**
CIS54445	IXIA	WT90 VW15-0009-00	Radar Generator	Not Required	Not Required
CIS54447	IXIA	WBW 1604N	802.11a/ac/b/g/n line-card generator	Not Required	Not Required
CIS040641	Rohde & Schwarz	ESU	EMI Test Receiver	04-Jun-15	08-Jun-17
CIS49516	Agilent	PXA N9030A	Signal Analyzer 3Hz-50GHz	22-Oct-15	22-Oct-16
CIS40603	Agilent	PSA E4440A	Spectrum Analyzer 3Hz-26GHz	20-Oct-15	20-Oct-16
CIS047280	Huber + Suhner	Sucoflex 106A	RF Coaxial Cable, to 18GHz	10-Jun-156	10-Jun-17
CIS054388	Huber + Suhner	Sucoflex 106A	RF Coaxial Cable, to 18GHz	25-Apr-16	25-Apr-17
CIS045066	Mini-Circuits	ZFSC-2-10+ 2-10 GHz	2-way Splitter	27-Jan-16	27-Jan-17
CIS055557	Mini-Circuits	ZFSC-2-10+ 2-10 GHz	2-way Splitter	06-Jul-16	06-Jul-17
CIS044583	Mini-Circuits	ZFSC-2-10+ 2-10 GHz	2-way Splitter	29-Jun-16	29-Jun-17
CIS049486	Mini-Circuits	50HF-006	6 dB attenuator	22-Apr-16	22-Apr-17
CIS054051	Mini-Circuits	50HF-006	6 dB attenuator	19-Apr-16	19-Apr-17
CIS049485	Mini-Circuits	50HF-006	6 dB attenuator	22-Apr-16	22-Apr-17
CIS041999	Mini-Circuits	S6w2	6 dB attenuator	16-Oct-15	16-Oct-16
CIS041995	Mini-Circuits	S6w2	6 dB attenuator	16-Oct-15	16-Oct-16
CIS049497	Mini-Circuits	50HF-020	20 dB attenuator	07-Jul-16	07-Jul-17
CIS049483	Mini-Circuits	50HF-006	6 dB attenuator	22-Apr-16	22-Apr-17
CIS021638	Mini-Circuits	ANNE-50	50Ohm Termination	19-Oct-15	19-Oct-16
CIS049503	Mini-Circuits	ANNE-50	50Ohm Termination	30-Jum-16	30-Jun-17
CIS054012	Aeroflex/Weinschel	3054	Variable attenuator	08-Apr-16	08-Apr-17

Appendix C: Test Procedures

Measurements were made in accordance with

- 905462 D02 U-NII DFS Compliance Procedures New Rules v02
- 905462 D03 U-NII Client Without Radar Detection Capability New Rules v01r01
- 905462 D04 Operational Modes Suggested for DFS Testing New Rules v01

Test procedures are summarized below:

FCC 5GHz Test Procedures	EDCS # - 1445052