MET Laboratories, Inc. *Safety Certification - EMI – Telecom Environmental Simulation*
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March 28, 2012

Fortress Technologies
2 Technology Park Drive
Westford, MA 01886

Dear Owais Hassan,

Enclosed is the Dynamic Frequency Selection (DFS) test report for compliance testing of Radio 1 (Antenna Port 1) of the Fortress Technologies Model ES520 Dual Radio Access Point/Bridge as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-03 ed.), Title 47 of the CFR, Part 15.407 sub part E for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Fortress Technologies\25996A-FCCDFS_Rev2)

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Dynamic Frequency Selection Test Report

for

Radio 1 (Antenna Port 1) of the Fortress Technologies Model ES520 Dual Radio Access Point/Bridge

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.407
for Intentional Radiators

MET Report: EMCS25996A-FCCDFS_Rev2

March 28, 2012

Prepared For:

Fortress Technologies
2 Technology Park Drive
Westford, MA 01886

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

Dynamic Frequency Selection
Test Report

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Radio 1 (Antenna Port 1) of the Fortress Technologies
Model ES520 Dual Radio Access Point/Bridge

Tested Under
the FCC Certification Rules
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for Intentional Radiators

Randy Hoopai, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15.407, of the FCC Rules under normal use and maintenance.

Shawn McMillen, Manager
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 5, 2009	Initial Issue.
1	April 14, 2009	Revision 1; update antenna and power info.
2	March 28, 2012	Revised to reflect engineer corrections.

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List of Terms and Abbreviations

ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**Deci**b**els
dBµA	**Deci**b**els above one **micro**amp
dBµV	**Deci**b**els above one **micro**volt
dBµA/m	**Deci**b**els above one **micro**amp **per m**eter
dBµV/m	**Deci**b**els above one **micro**volt **per m**eter
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
Hz	**H**ert**z**
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
MHz	**M**ega**h**ertz
µ	**microf**arad
µ**s**	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of Radio 1 of the Fortress Technologies Model ES520 Dual Radio Access Point/Bridge, with the Dynamic Frequency Selection (DFS) requirements of part §15.407 sub part E. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of Radio 1 of the Model ES520 Dual Radio Access Point/Bridge. Fortress Technologies should retain a copy of this document which should be kept on file for at least two years after **permanently** discontinuing manufacturing of Radio 1 of the Model ES520 Dual Access Point/Bridge.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.407, in accordance with Fortress Technologies, purchase order number 1732.

Reference	Description	Results
15.407 (h)(1)	Transmit Power Control (TCP)	Compliant
15.407 (h)(2)	Radar Detection Function of Dynamic Frequency Selection (DFS)	Compliant
15.407 (h)(2)(ii)	Channel Availability Check Time	Compliant
15.407 (h)(2)(iii)	Channel Move Time and Channel Closing Transmission Time	Compliant
15.407 (h)(2)(iv)	Non-Occupancy Period	Compliant

Table 1. Executive Summary of EMC Part 15.407 DFS ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Fortress Technologies to perform testing on Radio 1 (Antenna Port 1) of the Model ES520 Dual Radio Access Point/Bridge, under Fortress Technologies purchase order number 1732.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of Radio 1 (Antenna Port 1) of the Model ES520 Dual Radio Access Point/Bridge.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	Radio 1 (Antenna Port 1) of the ES520 Dual Radio Access Point/Bridge	
Serial # Tested:	S/N 24760418	
Model(s) Covered:	Radio 1 (Antenna Port 1) of the ES520 Dual Radio Access Point/Bridge	
EUT Specifications:	Primary Power: 120V 50/60Hz	
	FCC ID: WYK-ES520	
	Equipment Code:	NII
	Peak RF Output Power:	0.0508W
	EUT Frequency Ranges:	5.260 - 5.320GHz, 5.500-5.700GHz,
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Randy Hoopai	
Test Date(s):	December 2, 2008 through December 4, 2008	

Table 2. EUT Summary Table

B. References

ET Docket FCC 60-96	Compliance Measurement Procedures for Unlicensed National Information Infrastructure Devices (UNII) Operating in the 5250-5350 MHz and 5470-5725 MHz Band Incorporating Dynamic Frequency Selection
CFR 47, Part 15, Subpart E	Unlicensed National Information Infrastructure Devices (UNII)
ANSI/NCSL Z540-1-1994	Calibration Laboratories and Measuring and Test Equipment - General Requirements
ANSI/ISO/IEC 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories

Table 3. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick Street, Santa Clara, California 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Dynamic Frequency Selection (DFS) testing was performed in the wireless test room. In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories. In accordance with §2.948(d), MET Laboratories has been accredited by A2LA (Certificate Number 591.02).

D. Description of Master Device

1. Operating Frequency Range (GHz): 5.260 - 5.320MHz, 5.500-5.700MHz
2. Modes of operation: Adaptive modulation as per 802.11 specifications.
3. Highest and lowest EIRP:
   Highest EIRP = Max antenna gain setting of 9 dBi + Max TPO setting of 17.66 dBm = 26.66 dBm
   Lowest EIRP = Min antenna gain setting of 9 dBi + Min TPO setting of 14.18 dBm = 23.18 dBm
4. List all antennas and associated gains:

Device	Manufacturer	Model	S/N
9 dBi Whip Antenna	Mobile Mark	ECO9-5500	N/A

5. List output power ranges: Senao NMP-8602 has 0.0508W output power
6. List antenna impedance: 50Ohms
7. Antenna type: Omni
8. Antenna gain (dBi): 9
9. State test file that is transmitted: Test file used: TestFile.mpg Downloaded from NTIA web site:http://ntiacsd.ntia.doc.gov/dfs/
10. TCP description: There are different algorithms for calculating maximum transmit power settings based on regulatory domain, band and channel assignment, network type, and antenna gain. Under all circumstances, the maximum transmit power does not exceed Max TPO.
11. Time for master to complete its power-on-cycle: Approx 45 seconds to the point that the radios are functioning.
12. Describe EUT's uniform channel spreading: Designed to meet 802.11 PHY and OFDM regulatory specifications.

The Fortress Technologies Model ES520 is a PoE powered Dual Radio Access Point/Bridge. It embeds two COTS High Power Radio modules: a 400mW 802.11a/b/g tri-band, and a 600mW 802.11a, which are housed in a single ruggedized enclosure. The 400mW radio is a Senao Model 8602+, which is connected to antenna port 1 and designated "Radio 1." The 600mW radio is a Ubiquity Model XR5, which is connected to antenna port 2 and designated "Radio 2." External Antennas are attachable by N-Type connectors.

The unit can be configured for point-to-point, multi-point, and wireless bridging and MESH applications. Indoors the ES520 with its front plate removed can be powered by 48V PoE or DC power supply. In this environment, it operates as both a dual radio access point and an 8 port 10/100 Ethernet switch. The radio transmitter technology is comprised of a COTS Atheros chipset (802.11MAC, adaptive modulation and based-band processor - OFDM), a low noise amplifier (AGC), and a duplexer that connects receiver stage to antenna port. The radio cards are COTS and based on the mPCI form factor. The Model ES520 is shown in Photograph 1 below.

Photograph 1. Fortress Technologies Model ES520 Dual Radio Access Point/Bridge

E. Mode of Operation

OFDM and DSSS are the modes of operation.

F. Method of Monitoring EUT Operation

A Spectrum Analyzer was use to monitor the EUT's transmitter channel and power output.

G. Modifications

1. Modifications to EUT

No modifications were made to the EUT.

2. Modifications to Test Standard

No modifications were made to the test standard.

H. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Fortress Technologies upon completion of testing.

III. DFS Requirements and Radar Waveform Description & Calibration

A. DFS Requirements

DFS Detection Thresholds for Master or Client Devices Incorporating DFS

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.	

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 facilitating *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.	

B. 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.

Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	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. For short pulse radar type 1, the same waveform is used a minimum of 30 times. 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. The aggregate is the average of the percentage of successful detections of short pulse radar types 1-4.

Long Pulse Radar Test Waveform

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

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse radar test signal. If more than 30 waveforms are used for the Long Pulse radar test signal, then each additional waveform must also be unique and not repeated from the previous waveforms.

Each waveform is defined as follows:

1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 Bursts in the 12 second period, with the number of Bursts being randomly chosen. This number is Burst_Count.
3) Each Burst consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each Burst within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a Burst will have the same pulse width. Pulses in different Bursts may have different pulse widths.
5) Each pulse has a linear FM chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a Burst will have the same chirp width. Pulses in different Bursts may have different chirp widths. The chirp is centered on the pulse. For example, with radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
6) If more than one pulse is present in a Burst, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a Burst, the time between the first and second pulses is chosen independently of the time between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst_Count. Each interval is of length (12,000,000 / Burst_Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 1 and [(12,000,000 / Burst_Count) – (Total Burst Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each Burst is chosen independently.

A representative example of a Long Pulse radar test waveform:

1) The total test signal length is 12 seconds.
2) 8 Bursts are randomly generated for the Burst_Count.
3) Burst 1 has 2 randomly generated pulses.
4) The pulse width (for both pulses) is randomly selected to be 75 microseconds.
5) The PRI is randomly selected to be at 1213 microseconds.
6) Bursts 2 through 8 are generated using steps 3 – 5.
7) Each Burst is contained in even intervals of 1,500,000 microseconds. The starting location for Pulse 1, Burst 1 is randomly generated (1 to 1,500,000 minus the total Burst 1 length + 1 random PRI interval) at the 325,001 microsecond step. Bursts 2 through 8 randomly fall in successive 1,500,000 microsecond intervals (i.e. Burst 2 falls in the 1,500,001 – 3,000,000 microsecond range).

Graphical Representation of a Long Pulse radar Test Waveform

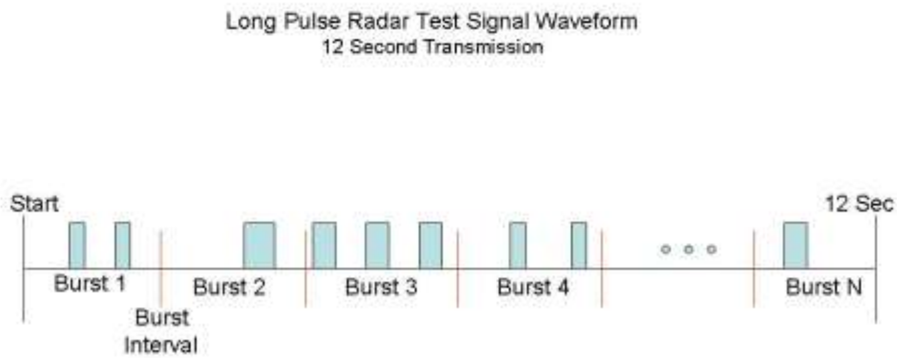


Figure 1. Long Pulse Radar Test Signal Waveform

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 Trials
6	1	333	9	.333	300	70%	30

For the Frequency Hopping Radar Type, the same *Burst* parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected1 from the hopping sequence defined by the following algorithm:

The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

C. Radar Waveform Calibration

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's resolution bandwidth (RBW) was set to 3 MHz and the video bandwidth (VBW) was set to 3 MHz. The calibration setup is diagrammed in Figure 2, and the radar test signal generator is shown in Photograph 2.

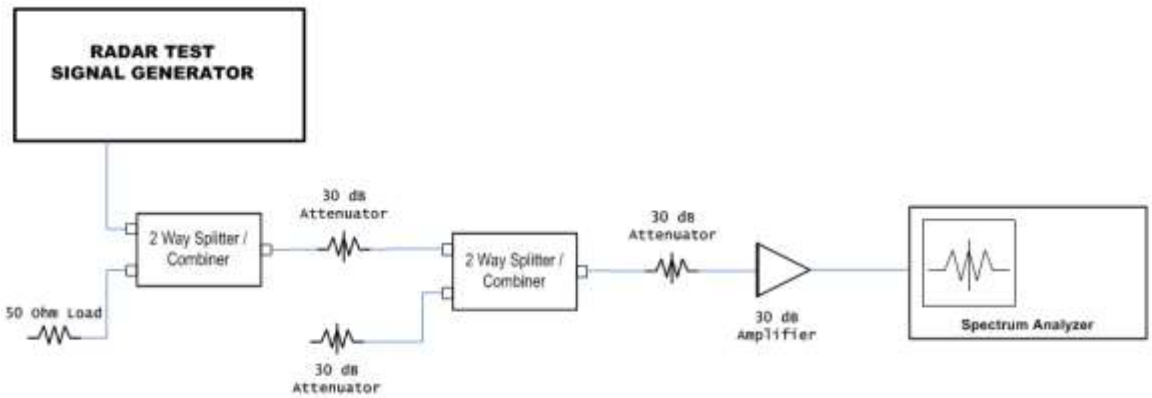
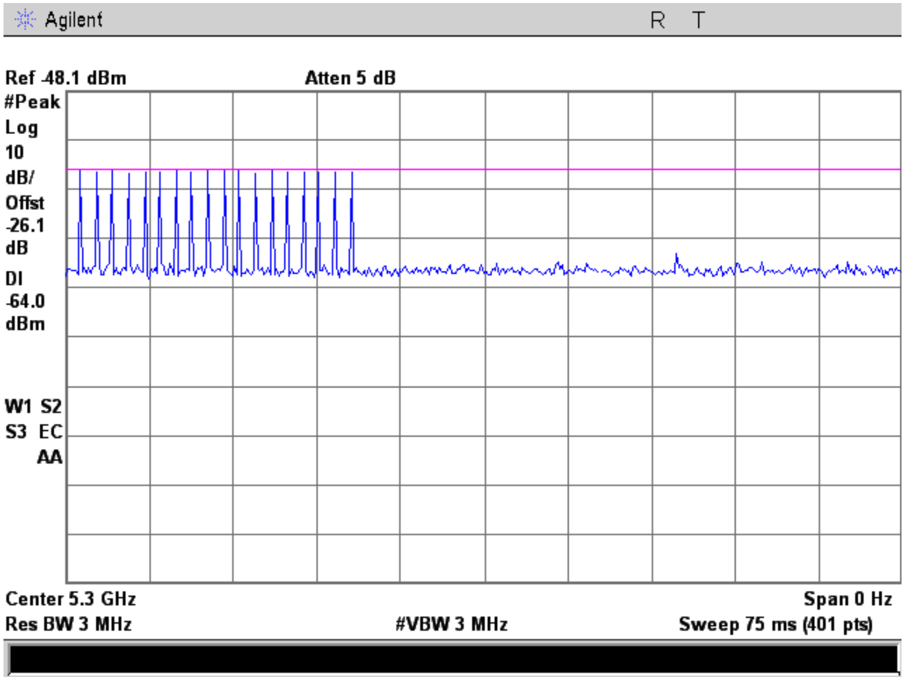


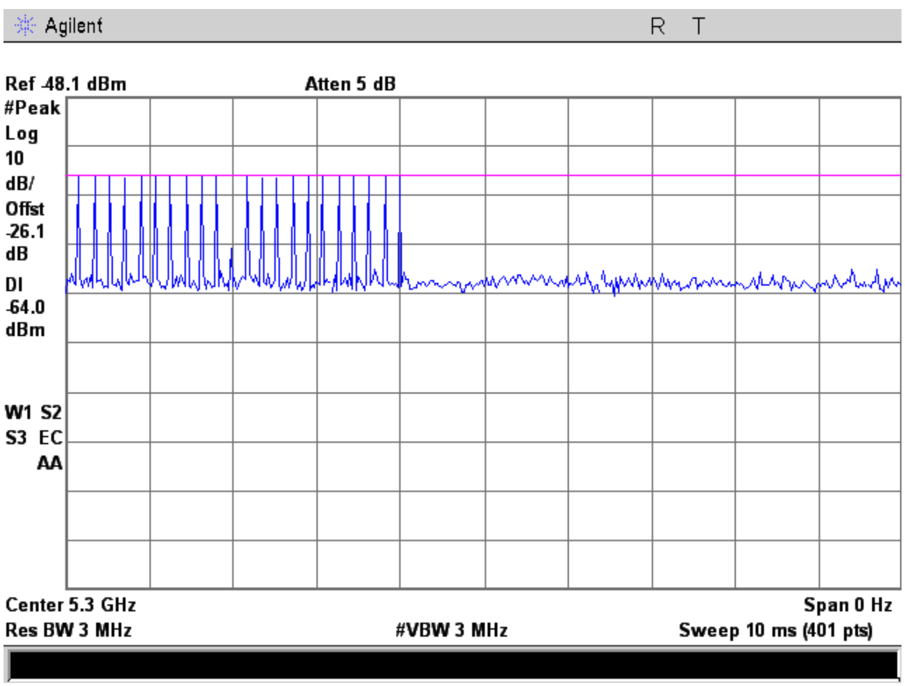
Figure 2. DFS Radar Waveform Calibration Setup

Photograph 2. DFS Radar Test Signal Generator

Radar Waveform Calibration

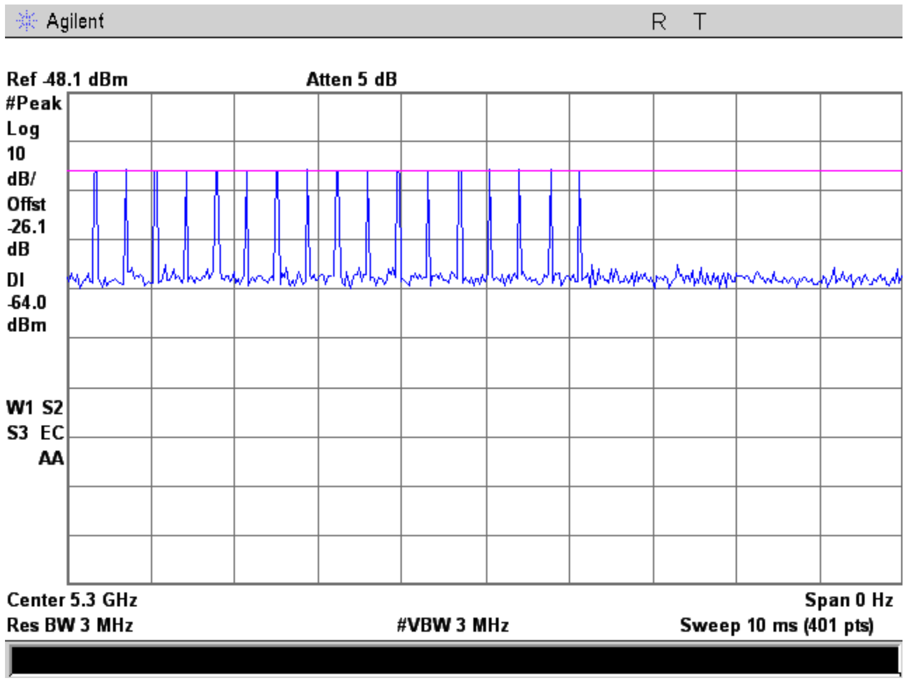


Plot 1. Radar Type 1 Calibration, 5300 MHz

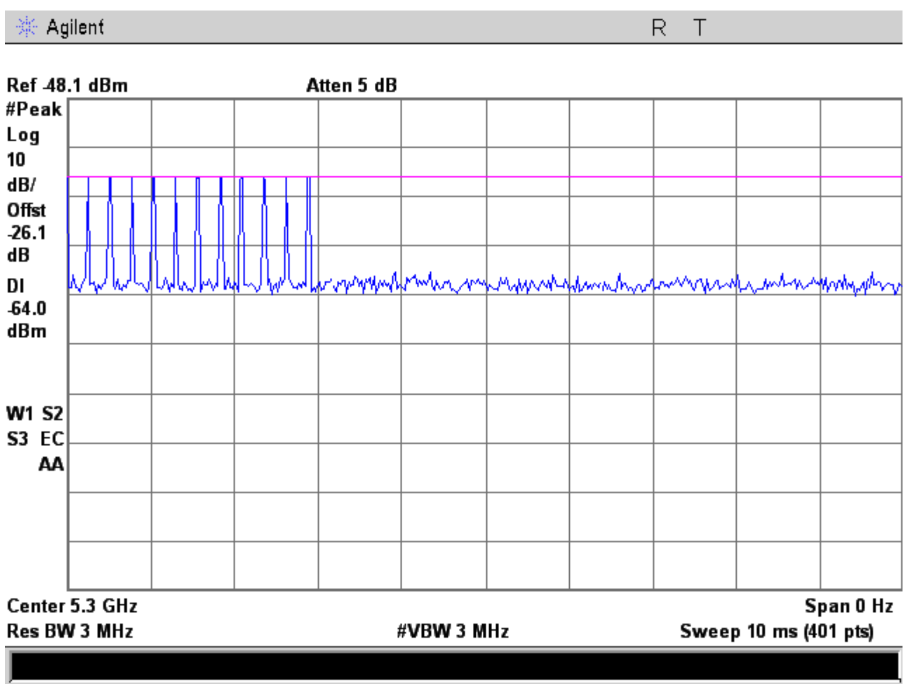


Plot 2. Radar Type 2 Calibration, 5300 MHz

Radar Waveform Calibration

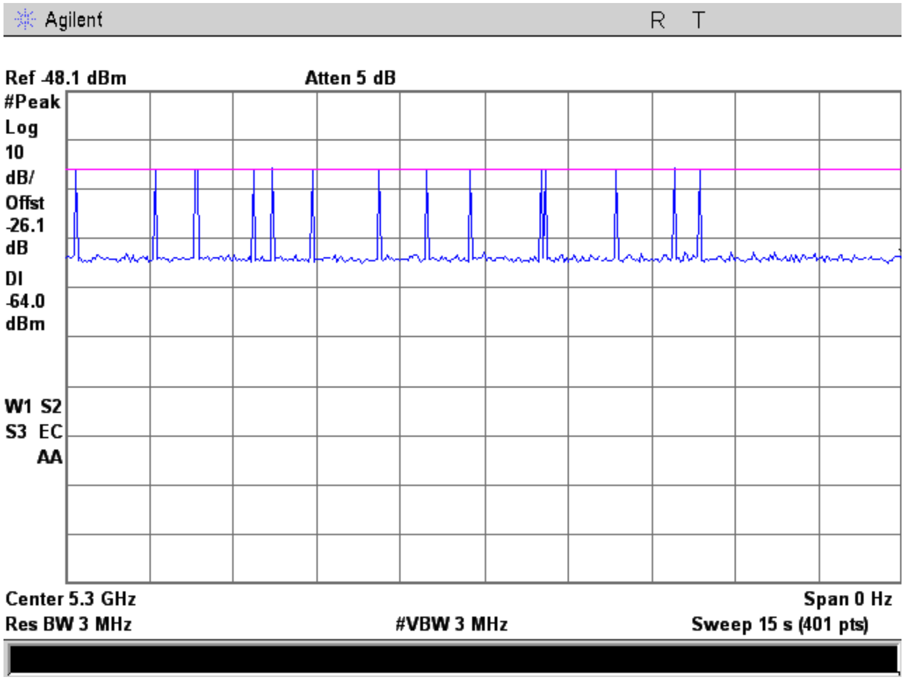


Plot 3. Radar Type 3 Calibration, 5300 MHz

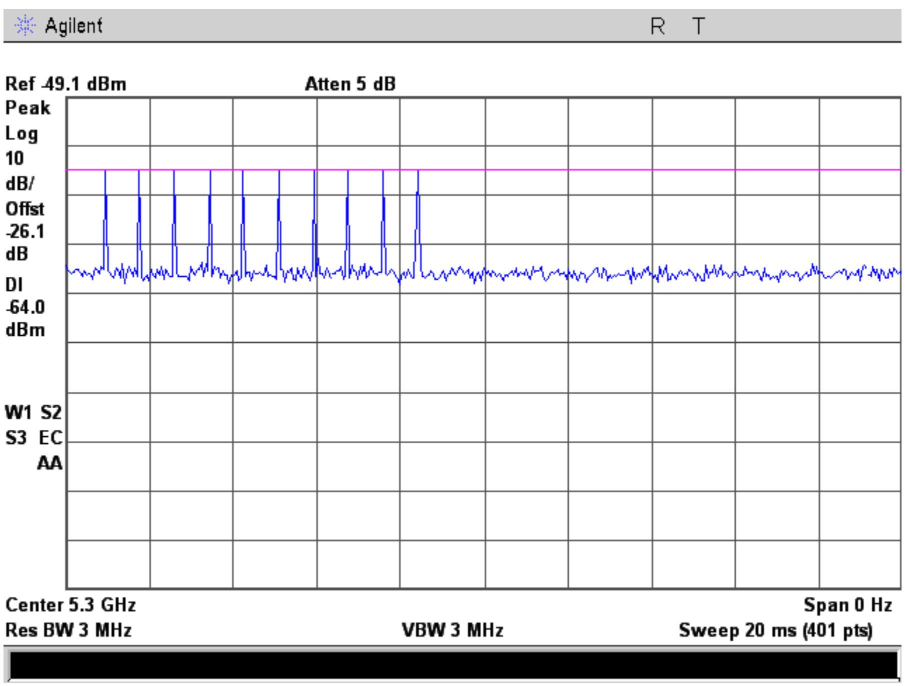


Plot 4. Radar Type 4 Calibration, 5300 MHz

Radar Waveform Calibration



Plot 5. Radar Type 5 Calibration, 5300 MHz



Plot 6. Radar Type 6 Calibration, 5300 MHz

IV. DFS Test Procedure and Test Results

A. DFS Test Setup

1. A spectrum analyzer is used as a monitor to verify that the Unit Under Test (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 subsequent Channel move. It is also used to monitor UUT transmissions during the Channel Availability Check Time.
2. The test setup, which consists of test equipment and equipment under test (EUT), is diagrammed in Figure 3 and pictured in Photograph 3

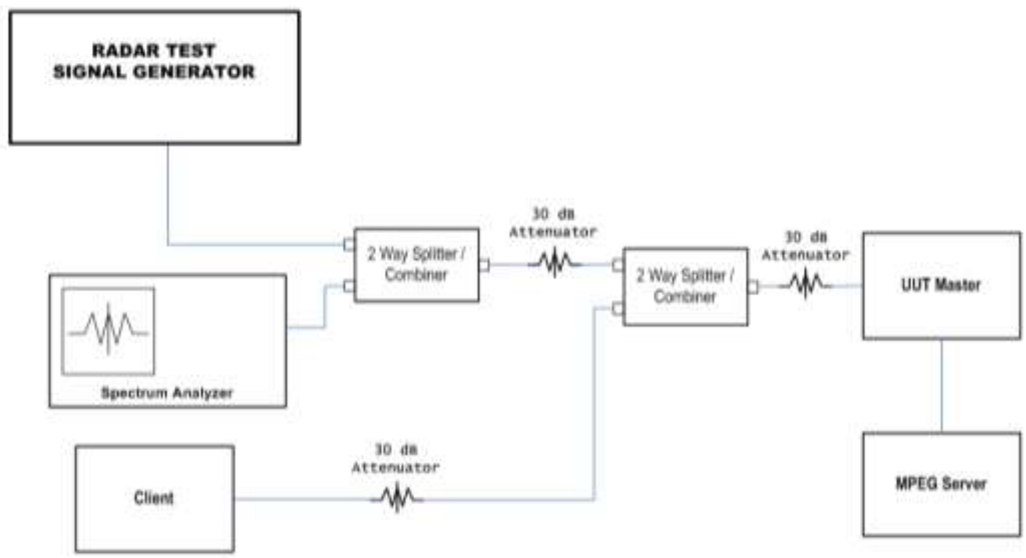


Figure 3. Test Setup Diagram

Photograph 3. Test Setup Photo

B. UNII Detection Bandwidth

Test Requirement(s): **§ 15.407** A minimum 80% detection rate is required across an EUT's 99% bandwidth.

Test Procedure: All UNII channels for this device have identical channel bandwidths. Therefore, all DFS testing was done at 5300 MHz.

A single burst of the short pulse radar type 1 is produced at 5300 MHz, at the -63dBm test level. The UUT is set up as a standalone device (no associated client, and no data traffic).

A single radar burst is generated for a minimum of 10 trials, and the response of the UUT is recorded. The UUT must detect the radar waveform 90% or more of the time.

The radar frequency is increased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The highest frequency at which detection is greater than or equal to 90% is denoted F_H.

The radar frequency is decreased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The lowest frequency at which detection is greater than or equal to 90% is denoted F_L.

The U-NII Detection Bandwidth is calculated as follows:

$$\text{U-NII Detection Bandwidth} = F_H - F_L$$

UNII Detection Bandwidth – Test Results

EUT Frequency- 5300MHz											
	DFS Detection Trials (1=Detection, 0= No Detection)										
Radar Frequency (MHz)	1	2	3	4	5	6	7	8	9	10	Detection Rate (%)
5290	0	0	0	0	0	0	0	0	0	0	0
5291(f_L)	1	1	1	1	1	1	1	1	1	1	100
5292	1	1	1	1	1	1	1	1	1	1	100
5293	1	1	1	1	1	1	1	1	1	1	100
5294	1	1	1	1	1	1	1	1	1	1	100
5295	1	1	1	1	1	1	1	1	1	1	100
5296	1	1	1	1	1	1	1	1	1	1	100
5297	1	1	1	1	1	1	1	1	1	1	100
5298	1	1	1	1	1	1	1	1	1	1	100
5299	1	1	1	1	1	1	1	1	1	1	100
5300	1	1	1	1	1	1	1	1	1	1	100
5301	1	1	1	1	1	1	1	1	1	1	100
5302	1	1	1	1	1	1	1	1	1	1	100
5303	1	1	1	1	1	1	1	1	1	1	100
5304	1	1	1	1	1	1	1	1	1	1	100
5305	1	1	1	1	1	1	1	1	1	1	100
5306	1	1	1	1	1	1	1	1	1	1	100
5307	1	1	1	1	1	1	1	1	1	1	100
5308	1	1	1	1	1	1	1	1	1	1	100
5309(f_H)	1	1	1	1	0	1	0	1	1	1	80
5310	0	0	0	0	0	0	0	0	0	0	0
Overall Detection Percentage											98%
Detection Bandwidth = 5309 – 5291 = 18 MHz											
EUT 99% Bandwidth = 16.4 MHz											

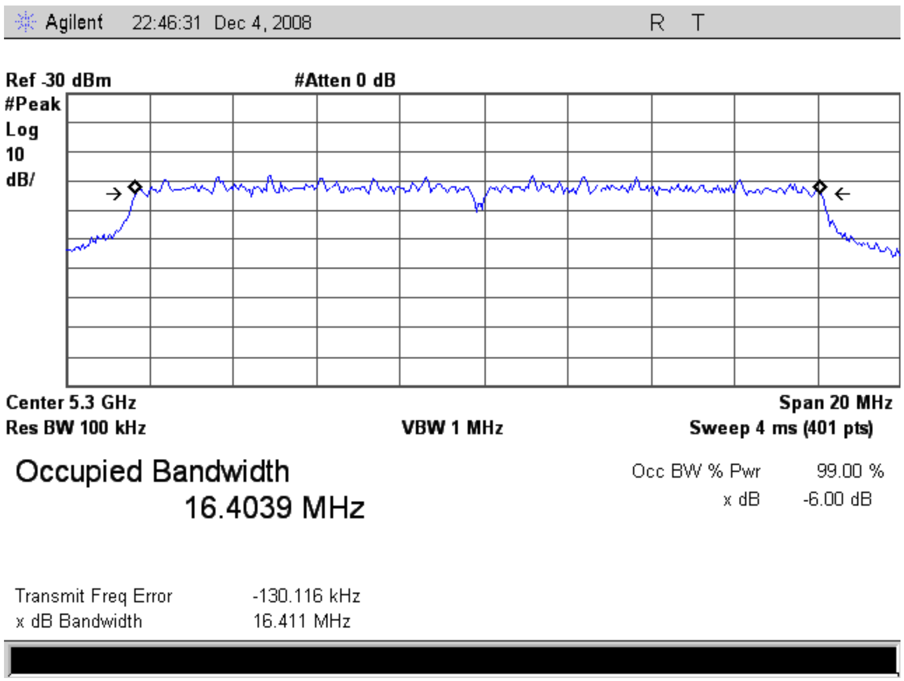
Table 4. UNII Detection Bandwidth Test Results

Test Results: Detection bandwidth test results are tabulated in Table 4. Occupied bandwidth measurements are captured in Plot 7. The UUT is compliant with the UNII Detection Bandwidth requirement.

Test Engineer: Randy Hoopai

Test Date: December 4, 2008

UNII Detection Bandwidth Plots



Plot 7. Occupied Bandwidth

C. Initial Channel Availability Check Time

Test Requirements: **§ 15.407** The Initial Channel Availability Check Time tests that the UUT does not emit beacon, control, or data signals on the test channel until the power-up sequence has been completed and the U-NII device has checked for radar waveforms, for one minute, on the test channel. This test does not use any of the radar waveforms and only needs to be performed once.

The UUT should not make any transmissions over the test channel, for at least 1 minute after completion of its power-on cycle.

Test Procedure: The U-NII device is powered on and instructed to operate at 5300 MHz. At the same time the UUT is powered on, the spectrum analyzer is set to 5300MHz with a zero span and a 2.5 minute sweep time. The analyzer is triggered at the same time power is applied to the U-NII device.

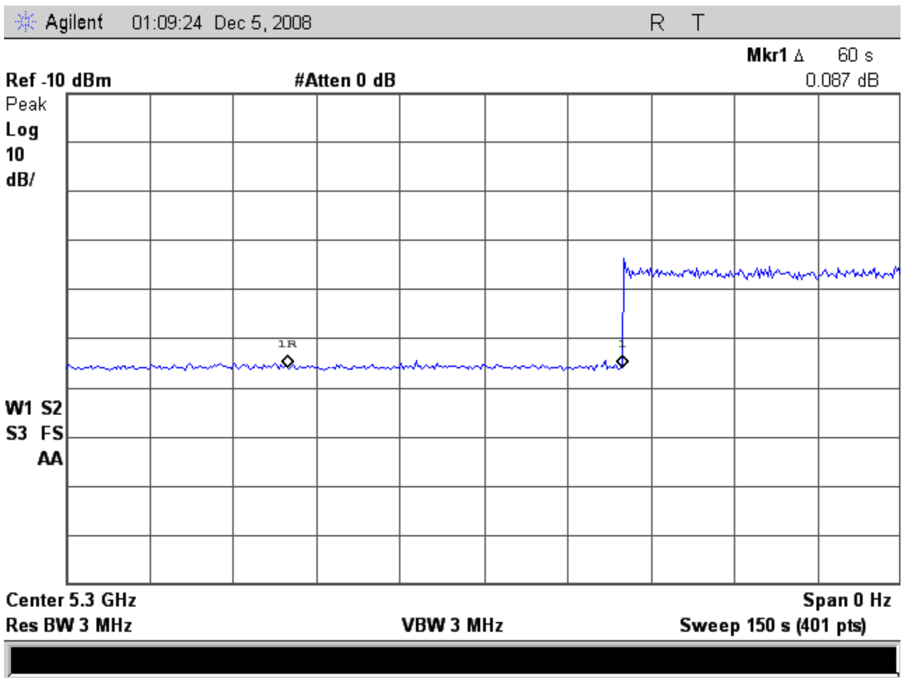
Test Results: The initial power up time of the UUT is indicated by marker 1R on Plot 8. Initial beacon/data transmission is indicated by marker 1.

The Equipment complies with § 15.407 Initial Channel Availability Check Time.

Test Engineer: Randy Hoopai

Test Date: December 5, 2008

Initial Channel Availability Check Time – Plot



Plot 8. Initial Channel Availability Check Time, 150 seconds

D. Radar Burst at the Beginning of Channel Availability Check Time

Test Requirements: **§ 15.407** A Radar Burst at the Beginning of the Channel Availability Check Time tests that the UUT does not emit beacon, control, or data signals on the test Channel if it has detected a radar burst during that time period until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-63dBm) occurs at the beginning of the Channel Availability Check Time.

Test Procedure: The UUT is powered on at T0. T1 denotes the instant when the UUT has completed its power-up sequence. The Channel Availability Check Time commences at instant T1 and will end no sooner than T1 + 60 seconds.

A single Burst of short pulse radar type 1, at -63 dBm, will commence within a 6 second window starting at T1.

Visual indication of the UUT of successful detection of the radar Burst will be recorded and reported. Observation of transmission at 5300MHz will continue for 2.5 minutes after the radar Burst has been generated.

Verify that during the 2.5 minute measurement window, no UUT transmissions occur at 5300MHz.

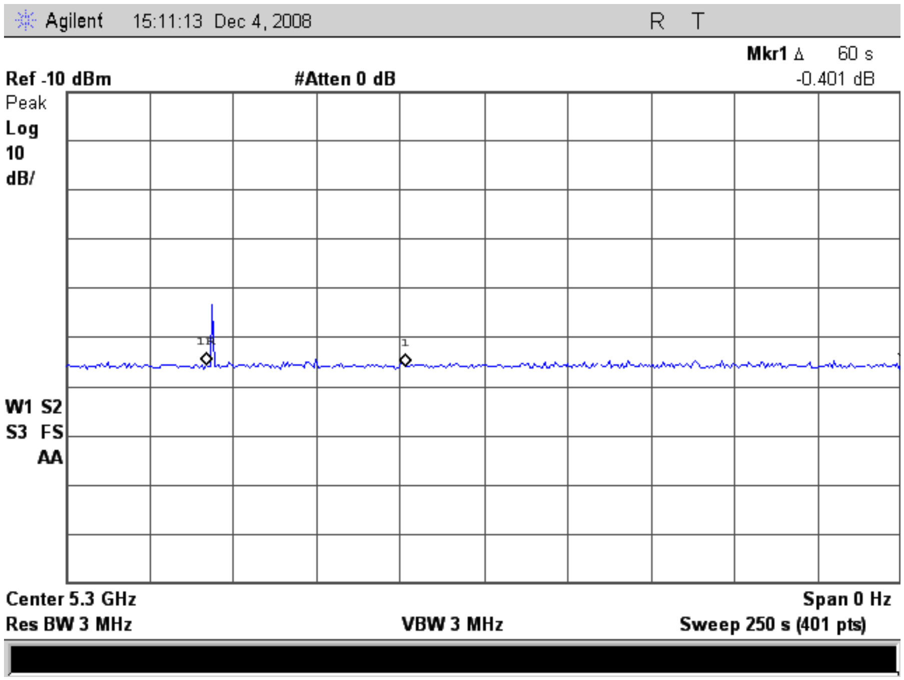
Test Results Plot 9 below indicates that there were no UUT transmissions during the 2.5 minute measurement window. Marker 1R indicates completion of the power-on cycle. Marker 1 indicates the end of the 60-second channel availability check time.

The equipment complies with § 15.407 Radar Burst at the Beginning of the Channel Availability Check Time.

Test Engineer: Randy Hoopai

Test Date: December 4, 2008

Radar Burst at the Beginning of Channel Availability Check Time – Plot



Plot 9. Radar Burst at the Beginning of CACT, 250 seconds

E. Radar Burst at the End of Channel Availability Check Time

Test Requirements: **§ 15.407** A Radar Burst at the End of the Channel Availability Check Time tests that the UUT does not emit beacon, control, or data signals on the test Channel if it has detected a radar burst during that time period until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-63dBm) occurs at the end of the Channel Availability Check Time.

Test Procedure: The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-63dBm) occurs at the end of the Channel Availability Check Time.

The UUT is powered on at T0. T1 denotes the instant when the UUT has completed its power-up sequence. The Channel Availability Check Time commences at instant T1 and will end no sooner than T1 + 60 seconds.

A single Burst of short pulse of radar type 1 at -63 dBm will commence within a 6 second window starting at T1+ 54 seconds.

Visual indication on the UUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5300MHz will continue for 2.5 minutes after the radar Burst has been generated.

Verify that during the 2.5 minute measurement window no UUT transmissions occurred at 5300MHz.

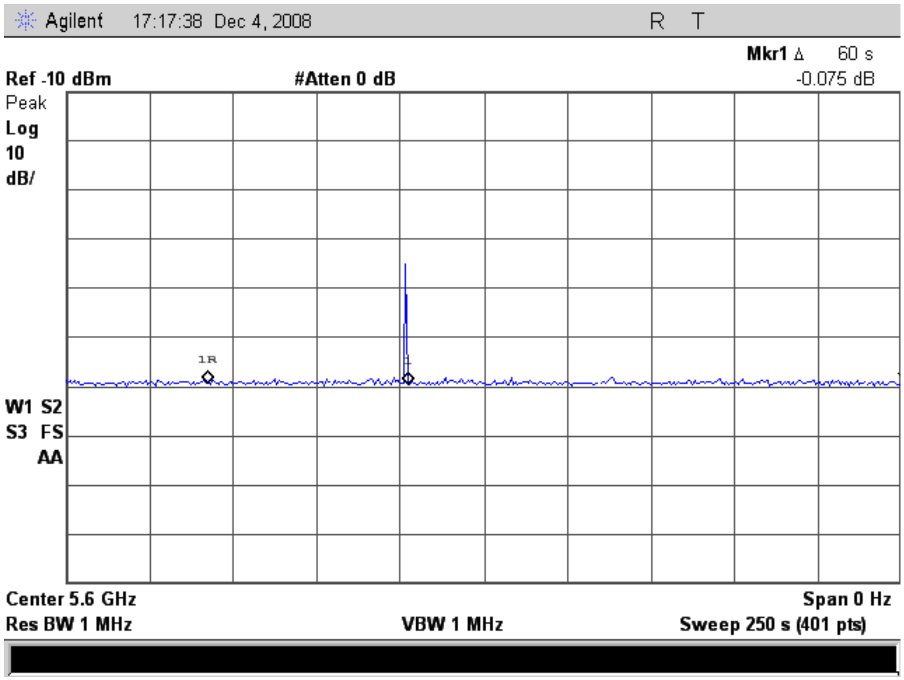
Test Results: Plot 10 indicates that no UUT transmissions occurred during the 2.5 minute measurement window. Marker 1R indicates completion of the power-on cycle. Marker 1 indicates the end of the 60-second channel availability check time.

The equipment complies with § 15.407 Radar Burst at the End of the Channel Availability Check Time.

Test Engineer: Randy Hoopai

Test Date: December 4, 2008

Radar Burst at the End of Channel Availability Check Time – Plot



Plot 10. Radar Burst at the End of CACT, 250 seconds

F. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time, and Non-Occupancy Period

Test Requirements: **§ 15.407** (Refer to DFS Response Requirement Values table in section III-A of this report.) The UUT shall continuously monitor for radar transmissions in the operating test channel. When a radar burst occurs in the test channel, it has 10 seconds to move to another channel. This 10 second window is termed Channel Move Time (CMT).

When a radar burst occurs, the UUT has 200 milliseconds, plus an aggregate of 60 milliseconds, to cease transmission in the operating test channel. This 200 ms + 60 ms requirement is termed Channel Closing Transmission Time (CCT).

After radar burst and subsequent move to another channel, the UUT shall not resume transmission, on the channel it moved from, for a period of 30 minutes. This requirement is termed Non-Occupancy Period (NOP).

Test Procedure: These tests define how the following DFS parameters are verified during In-Service Monitoring: Channel Closing Transmission Time, Channel Move Time, and Non-Occupancy Period.

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold + 1dB (-63dBm) is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5300 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

At time T0 the Radar Waveform generator sends a Burst of pulses for each of the radar types at -63dBm.

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). Compare the Channel Move Time and Channel Closing Transmission Time results to the limits defined in the *DFS Response Requirement Values table*.

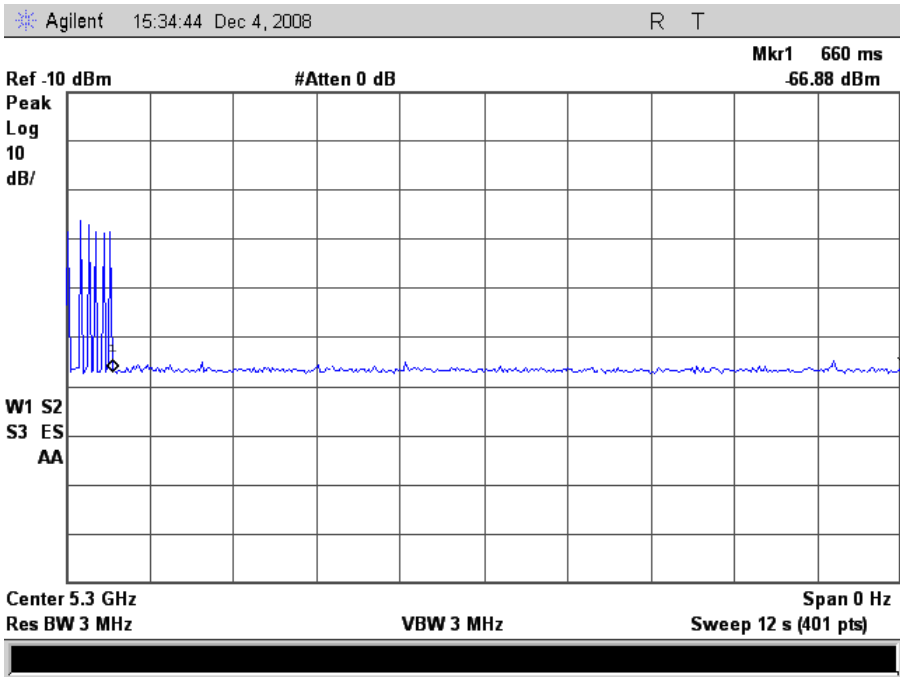
Test Results: Plot 11 and Plot 12 indicate cessation of transmission for more than 10 seconds after a radar burst (marker 1). Plot 13 depicts the 200 ms closing time window (marker 1), and Plot 14 depicts post 200 ms aggregate transmissions. Finally, Plot 15 shows that transmissions have not resumed within 30 minutes of channel move.

The UUT complies with § 15.407 In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time, and Non-Occupancy Period.

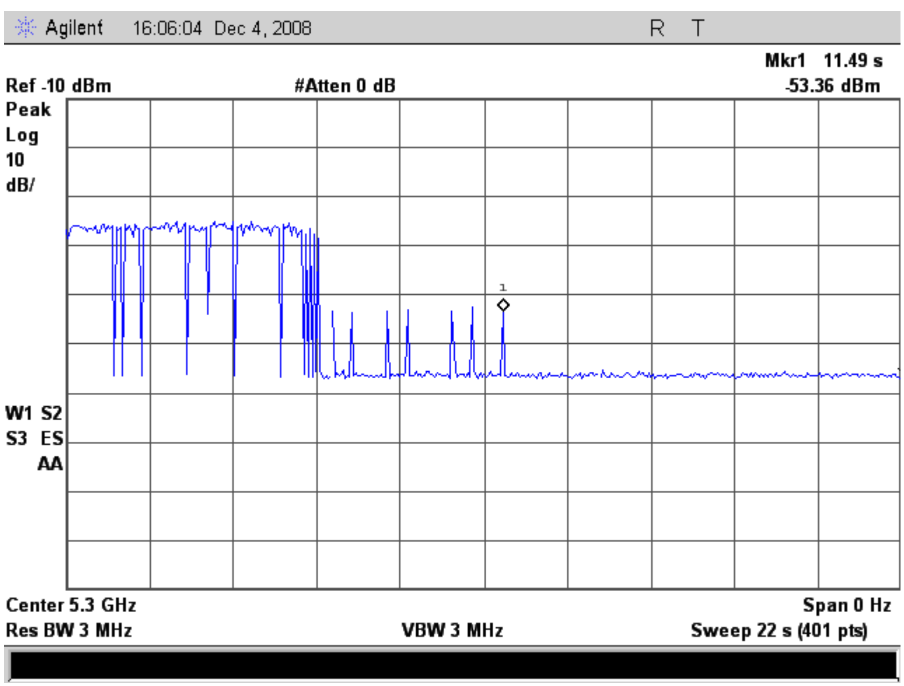
Test Engineer: Randy Hoopai

Test Date: December 4, 2008

In-Service Monitoring for Channel Move Time – Plots

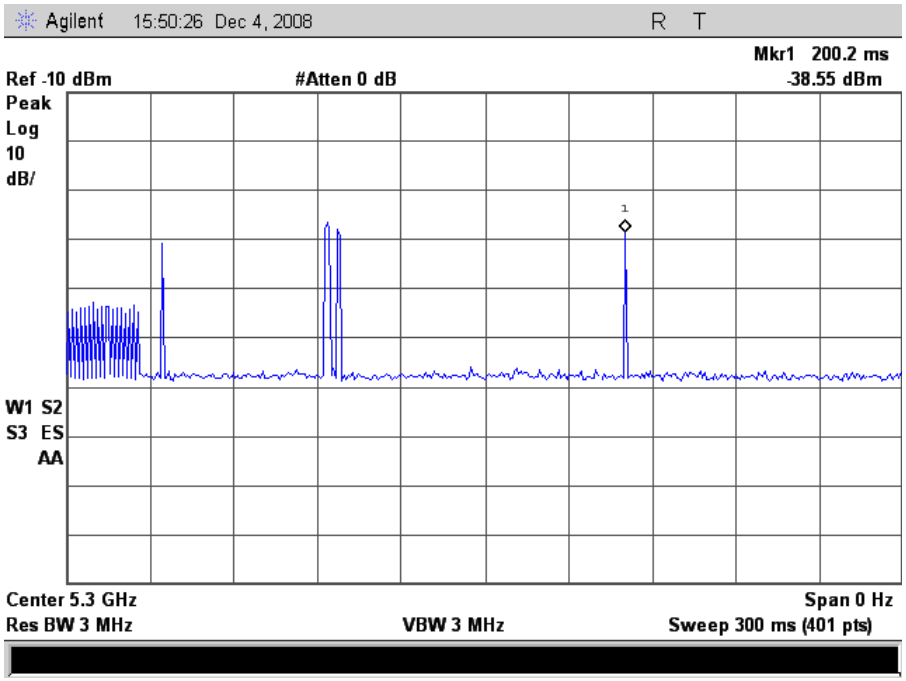


Plot 11. Channel Move Time for Radar Type 1, 12 seconds

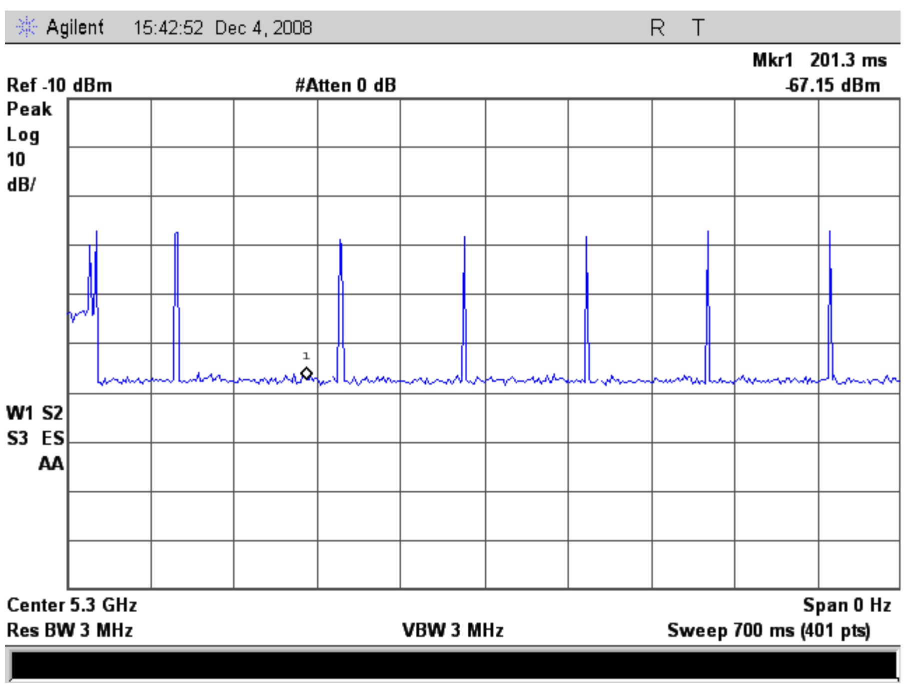


Plot 12. Channel Move Time for Radar Type 5, 22 seconds

In-Service Monitoring for Channel Closing Transmission Time – Plots

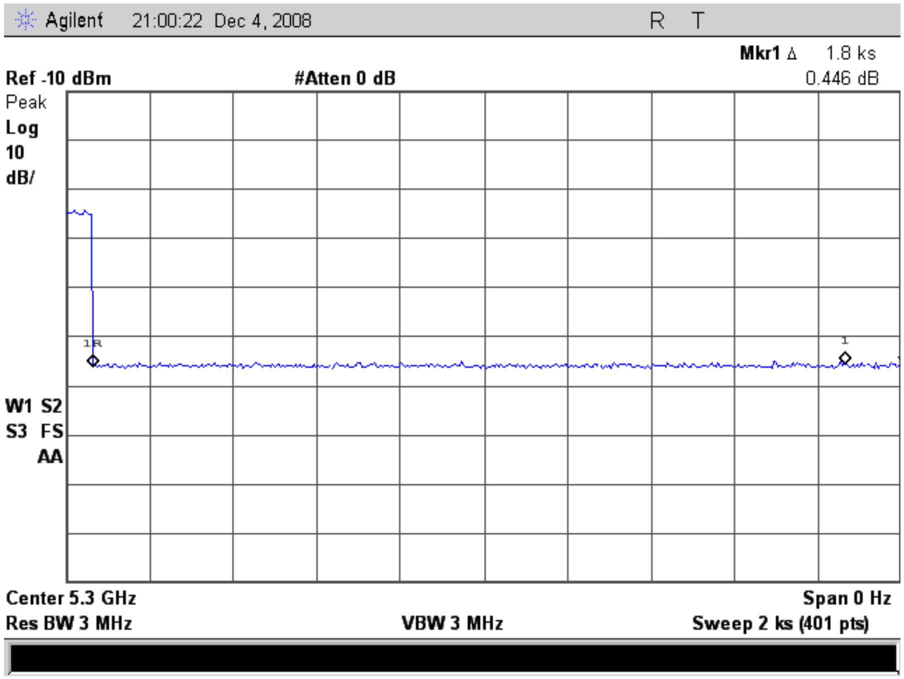


Plot 13. Channel Closing Transmission Time, 300 milliseconds



Plot 14. Channel Closing Transmission Time, 700 milliseconds

In-Service Monitoring for Non-Occupancy Period – Plot



Plot 15. Non-Occupancy Period, 30minutes

G. Statistical Performance Check

Test Requirements: **§ 15.407** During In-Service Monitoring, the EUT requires a minimum percentage of successful radar detections from all required radar waveforms at a level equal to the DFS Detection Threshold + 1dB.

Test Procedure: Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test. The Radar Waveform generator sends the individual waveform for each of the radar types 1-6 at -63dbm. Statistical data is gathered to determine the ability of the device to detect the radar test waveforms. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The percentage of successful detection is calculated by:

$$\frac{TotalWaveformDetections}{TotalWaveformTrials} \times 100$$

The Minimum number of trails, minimum percentage of successful detection and the average minimum percentage of successful detection are found in the Radar Test Waveforms section.

Test Results: Statistical performance for radar type 1 is tabulated in Table 5.

The equipment complies with § 15.407 Statistical Performance Check.

Test Engineer: Randy Hoopai

Test Date: December 4, 2008

Statistical Performance Check – Radar Type 1

Radar Type	Trial #	Pulses per Burst	Pulse Width (µsec)	PRI (µsec)	Detection 1 = Yes, 0 = No
1	1	18	1	1428	1
	2	18	1	1428	1
	3	18	1	1428	1
	4	18	1	1428	1
	5	18	1	1428	1
	6	18	1	1428	1
	7	18	1	1428	1
	8	18	1	1428	1
	9	18	1	1428	0
	10	18	1	1428	1
	11	18	1	1428	1
	12	18	1	1428	1
	13	18	1	1428	1
	14	18	1	1428	1
	15	18	1	1428	1
	16	18	1	1428	1
	17	18	1	1428	1
	18	18	1	1428	0
	19	18	1	1428	0
	20	18	1	1428	1
	21	18	1	1428	1
	22	18	1	1428	1
	23	18	1	1428	1
	24	18	1	1428	1
	25	18	1	1428	1
	26	18	1	1428	1
	27	18	1	1428	1
	28	18	1	1428	1
	29	18	1	1428	1
	30	18	1	1428	1
	Detection Percentage				**90.0% (> 60%)**

Table 5. Statistical Performance Check – Radar Type 1

Statistical Performance Check – Radar Type 2

Radar Type	Trial #	Pulses per Burst	Pulse Width	PRI	Detection
		23 to 29	1 to 5 us	150 to 230 us	1 = Yes, 0 = No
2	1	25	2.9	192	1
	2	27	1.2	160	1
	3	24	3.5	194	1
	4	23	5.0	167	1
	5	25	4.5	153	1
	6	27	1.8	181	1
	7	28	4.4	168	0
	8	28	1.7	224	1
	9	29	1.2	179	1
	10	28	4.3	191	0
	11	25	3.2	196	0
	12	27	2.2	216	0
	13	28	2.2	162	1
	14	25	4.8	207	1
	15	24	4.7	216	1
	16	27	4.0	218	1
	17	23	2.0	182	1
	18	25	3.6	189	1
	19	28	3.6	222	1
	20	26	3.8	207	1
	21	25	4.0	170	1
	22	29	2.8	163	1
	23	24	4.4	210	1
	24	23	1.6	189	0
	25	29	2.0	172	1
	26	29	1.1	211	0
	27	29	4.8	186	1
	28	25	2.8	192	1
	29	26	4.4	228	1
	30	23	1.5	192	0
	Detection Percentage				76.7% (> 60%)

Table 6. Statistical Performance Check – Radar Type 2

Statistical Performance Check – Radar Type 3

Radar Type	**Trial #**	**Pulses per Burst**	**Pulse Width**	**PRI**	**Detection**
		16 to 18	**6 to 10 us**	**200 to 500 us**	**1 = Yes, 0 = No**
3	1	16	7.6	259	1
	2	16	8.8	254	1
	3	16	7.3	304	1
	4	17	8.0	269	1
	5	17	7.1	266	1
	6	16	8.8	448	1
	7	18	7.9	366	1
	8	18	5.6	370	1
	9	18	7.4	426	1
	10	16	5.9	492	1
	11	17	7.5	350	1
	12	18	8.6	281	1
	13	16	8.3	348	1
	14	17	9.8	429	1
	15	17	9.8	421	1
	16	16	9.0	490	0
	17	17	6.8	433	1
	18	18	6.4	268	1
	19	17	6.9	251	1
	20	17	8.1	354	1
	21	18	7.5	404	1
	22	17	9.4	440	1
	23	18	7.6	355	1
	24	16	5.1	481	1
	25	17	8.1	428	1
	26	16	7.0	433	1
	27	16	6.7	335	1
	28	18	9.5	421	1
	29	16	8.2	419	1
	30	17	8.4	258	0
	Detection Percentage				**93.3% (> 60%)**

Table 7. Statistical Performance Check – Radar Type 3

Statistical Performance Check – Radar Type 4

Radar Type	Trial #	Pulses per Burst	Pulse Width	PRI	Detection
		12 to 16	11 to 20 us	200 to 500 us	1 = Yes, 0 = No
4	1	16	16.7	433	1
	2	15	18.9	293	1
	3	15	16.1	250	0
	4	12	14.6	279	1
	5	13	11.5	465	0
	6	16	14.4	381	1
	7	12	13.5	369	1
	8	13	16.1	482	1
	9	15	11.9	420	1
	10	13	19.1	292	1
	11	12	14.7	292	0
	12	14	16.6	469	1
	13	14	16.6	452	1
	14	15	12.7	301	1
	15	12	10.9	338	1
	16	13	14.9	280	1
	17	13	14.7	360	1
	18	13	12.9	328	1
	19	12	13.8	311	1
	20	12	19.2	447	1
	21	14	16.3	489	1
	22	15	13.6	324	0
	23	12	15.0	252	1
	24	15	15.3	499	1
	25	16	11.2	431	1
	26	15	12.2	299	1
	27	15	15.5	494	1
	28	15	13.1	337	1
	29	13	12.9	441	0
	30	16	15.4	359	1
	Detection Percentage				**83.3% (> 60%)**

Table 8. Statistical Performance Check – Radar Type 4

Statistical Performance Check – Radar Type 5

Radar Type	Trial #	Detection 1 = Yes, 0 = No
5	1	1
	2	1
	3	1
	4	0
	5	1
	6	1
	7	0
	8	1
	9	1
	10	1
	11	1
	12	1
	13	1
	14	0
	15	1
	16	1
	17	1
	18	1
	19	1
	20	0
	21	1
	22	1
	23	1
	24	1
	25	1
	26	1
	27	1
	28	0
	29	1
	30	0
	Detection Percentage	**80.0% (> 60%)**

Table 9. Statistical Performance Check – Radar Type 5

Note: Refer to Appendix A for results.

Statistical Performance Check – Radar Type 6

Radar Type	Trial #	Frequency (MHz)	Pulses/Hop	Pulse Width (usec)	PRI (usec)	Detection 1 = Yes, 0 = No
6	1	5296	9	1	333	1
	2	5307	9	1	333	1
	3	5300	9	1	333	1
	4	5309	9	1	333	1
	5	5293	9	1	333	1
	6	5309	9	1	333	1
	7	5294	9	1	333	1
	8	5299	9	1	333	1
	9	5306	9	1	333	1
	10	5299	9	1	333	1
	11	5292	9	1	333	1
	12	5291	9	1	333	1
	13	5294	9	1	333	1
	14	5291	9	1	333	1
	15	5302	9	1	333	1
	16	5299	9	1	333	1
	17	5306	9	1	333	1
	18	5306	9	1	333	1
	19	5305	9	1	333	1
	20	5298	9	1	333	1
	21	5294	9	1	333	1
	22	5309	9	1	333	1
	23	5302	9	1	333	1
	24	5301	9	1	333	1
	25	5309	9	1	333	1
	26	5303	9	1	333	1
	27	5308	9	1	333	1
	28	5304	9	1	333	1
	29	5296	9	1	333	1
	30	5306	9	1	333	1
	Detection Percentage					**100% (> 60%)**

Table 10. Statistical Performance Check – Radar Type 6

V. Appendix A

VI. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset	Equipment	Manufacturer	Last Cal Date	Cal Due Date
1S2243	NI PXI-1042 8-Slot 3U Chassis	National Instruments	See Note	
1S2460	NI PXI-5421 16-Bit 100MS/s Arbitrary Waveform Generator	National Instruments	See Note	
1S2278	NI PXI-5610 2.7GHz RF Upconverter	National Instruments	See Note	
1S2069	Upconverter, 7206 PXI 4.9 to 6GHz	Ascor	See Note	
N/A	Splitter/Combiner, ZFSC-2-9G (Qty 2)	Mini-Circuits	See Note	
N/A	30dB attenuator, BW-S30W2 (Qty 2)	Pasternak	See Note	
N/A	10dB attenuator, BW-S10W2 (Qty 2)	Pasternak	See Note	
1S2523	Pre-Amplifier, 8449B	Agilent	See Note	
1S2460	Spectrum Analyzer, E4407B	Agilent	3/24/2008	3/24/2009

Note: Functionally tested equipment is verified using calibrated instruments at the time of testing.

End of Report