Dynamic Frequency Selection Test Report

EUT Name: Audio Player

Model No.: No.519

CFR 47 Part 15.407 2015 and RSS 247: 2015

Prepared for:

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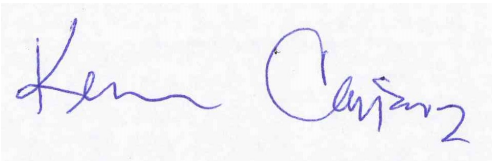
Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	06/09/2016	Original Document	N/A
1	07/21/2016	Corrected minor error to test report.	Kerwinn Corpuz

Note: Latest revision report will replace all previous reports.

This report is prepared by: Reviewed by:



Kerwinn Corpuz	July 21, 2016	David Spencer	July 21, 2016
Test Engineer	Date	A2LA Signatory	Date

1 Product Information

1.1 Product Description

The Model No.519, Mark Levinson Audio Player, a modern music player. It combines wireless and wired music streaming with a traditional CD player, plus connections for USB drives, additional digital sources, and Bluetooth audio and HARMAN Clari-Fi® technology for home capable of operating in the 2.4 GHz and 5 GHz frequency bands over 20 MHz and 40 MHz channels.

The Model No.519, Mark Levinson Audio Player operates in the following bands:

1. 2400-2483.5 MHz
2. 5150-5350 MHz
3. 5470-5725 MHz (5600-5650 MHz is blocked by permanent configuration settings)
4. 5725-5850 MHz

Note: DFS is handled by Wi-Fi access point.

When Wi-Fi access point changes channel due to detection of Radar Pulses, Model No.519 will follow in less than 5 seconds.

In case connection to Wi-Fi access point is lost, Model No.519 will try for less than 5 seconds to reach the access point, thereafter it will stop transmitting and wait for the Wi-Fi access point to re-establish the link.

1.2 Operating Mode

A web client application was used to communicate through AP (Master) and EUT (Client). Laptop F5 key was used to update the status of the EUT in every 1 second.

2 Dynamic Frequency Selection

Testing was performed in accordance with CFR47 Part 15.407 (h) and RSS 247 Sect. 6.3. 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 KDB Publication 905462 D02 were used.

2.1 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 No.519, the following requirements shall apply per KDB Publication 905462 D02 procedures.

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
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master or Client With Radar Detection	**Client Without Radar Detection**
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

Additional requirements for devices with multiple bandwidth modes	Master or Client With Radar Detection	Client Without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequencies.		

2.2 DFS Requirements

Base on the applicability of No.519*, 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 (See Notes 1, 2, and 3)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt and Power spectral density < 10 dBm/MHz	-62 dBm
< 200 milliwatt that does 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. For MIMO devices refer to KDB Publication 662911 D01.	

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 100% of the U-NII 99% transmission power bandwidth. See Note 3.

Note 1: *Channel Move Time* and the *Channel Closing Transmission Time* should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.
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 should be used. 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 Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 6	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60%	30
		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			
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

Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.

Table 6: Pulse Repetition Intervals Values for Test A

Pulse Repetition Frequency Number	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

Table 7: 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

Graphical Representation of a Long Pulse Radar Type Waveform

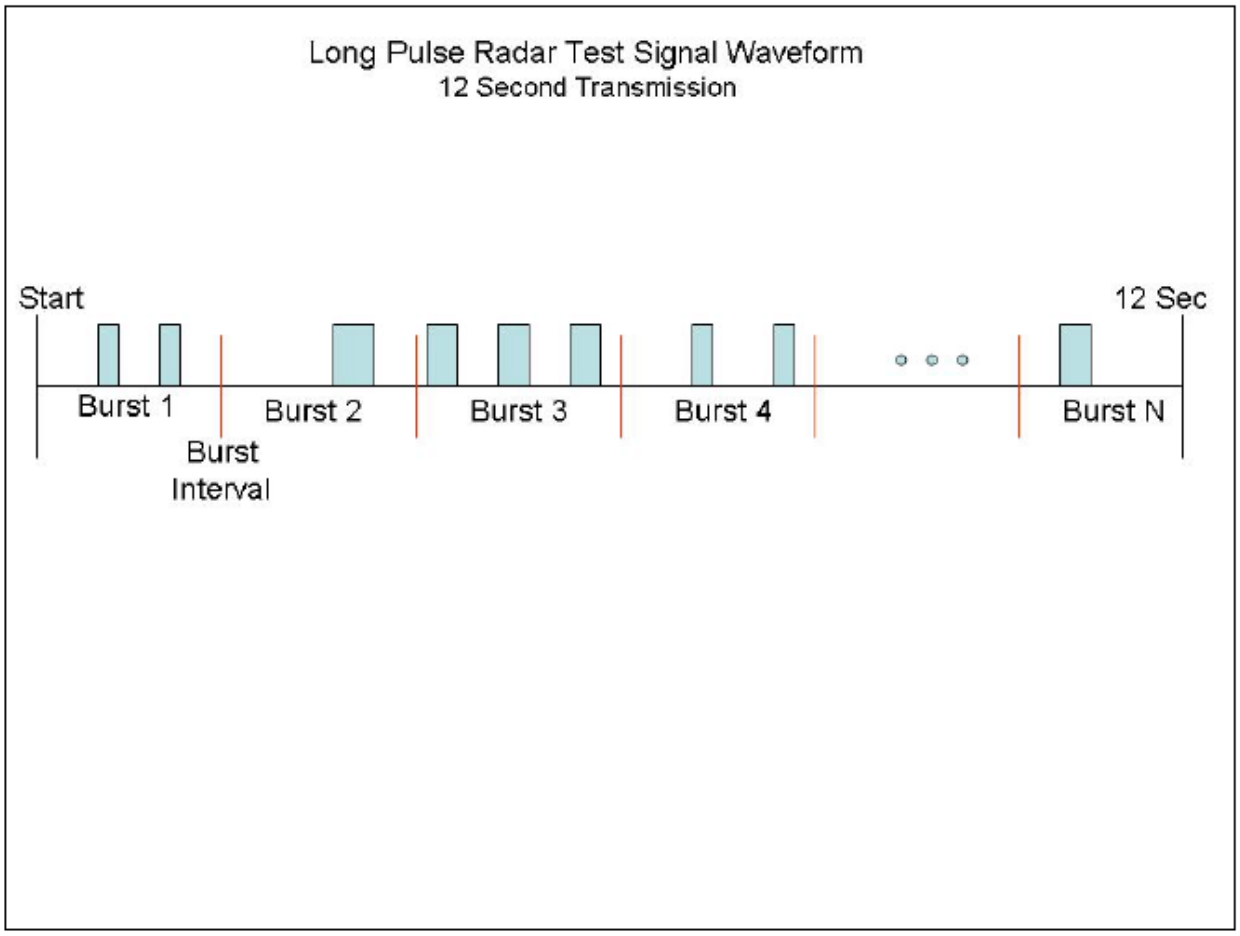


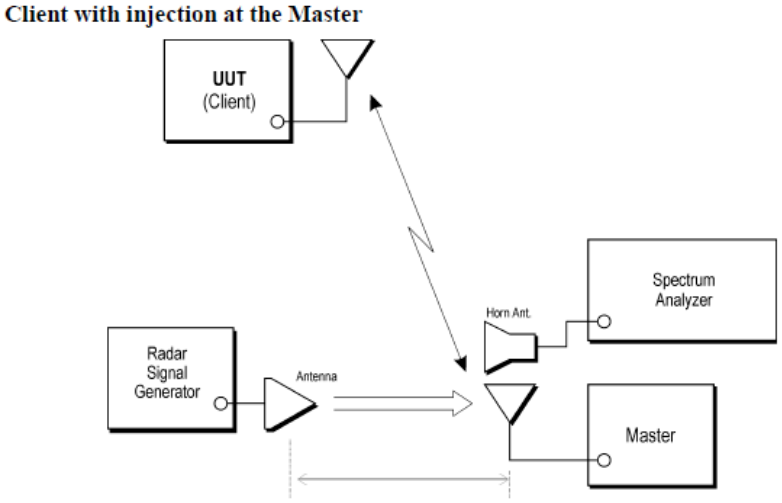
Table 8: Frequency Hopping Radar Test Waveform

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

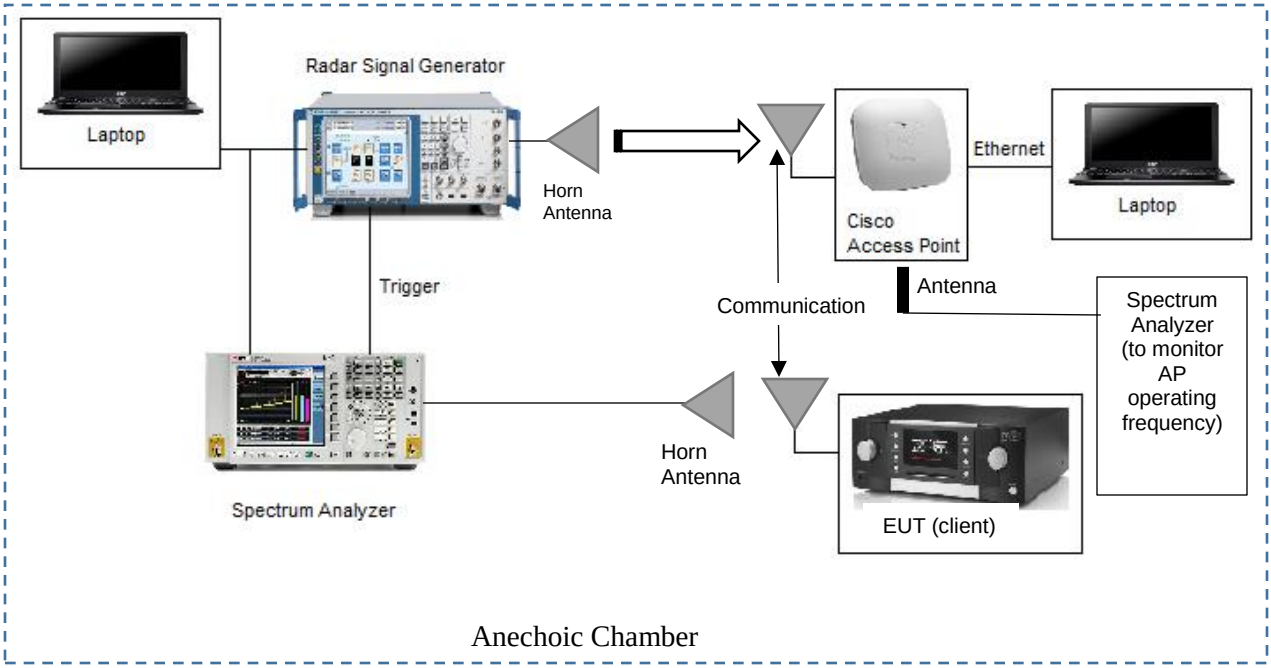
2.3 Test Setup Protocol

The following test setup was used to evaluate the Audio Player for DFS conformance.

Dynamic Frequency Selection Block Diagram for Client without Radar Detection: in Radiated Setup



Simplified Block Diagram of Dynamic frequency Selection Testing: in Radiated Setup



2.4 Radar Waveform Verifications

The radar signal level must be -63 dBm (-64 dBm +1dB).

Note: Cisco Access Point, assuming meets the EIRP ≥ 200mW

1dB is added to insure that the Radar-Injection-Level is above the AP-Detection-Threshold-Level

These waveforms were not compensated for the antenna factor and cable loss to spectrum analyzer. The level applied was Type 0 pulse.

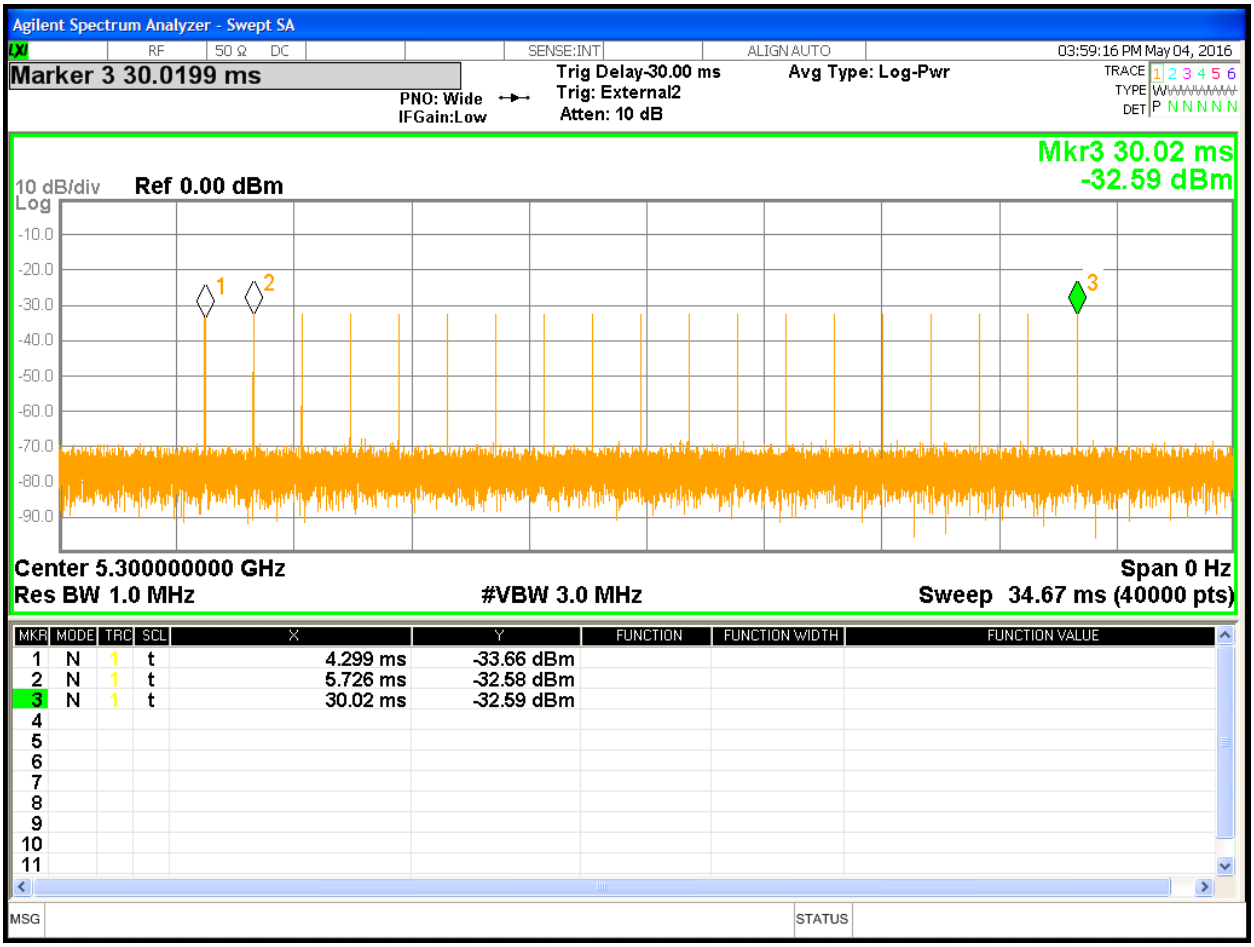


Figure 1: 5300 MHz Radar Pulse Type 0 at Master (Cisco AP)

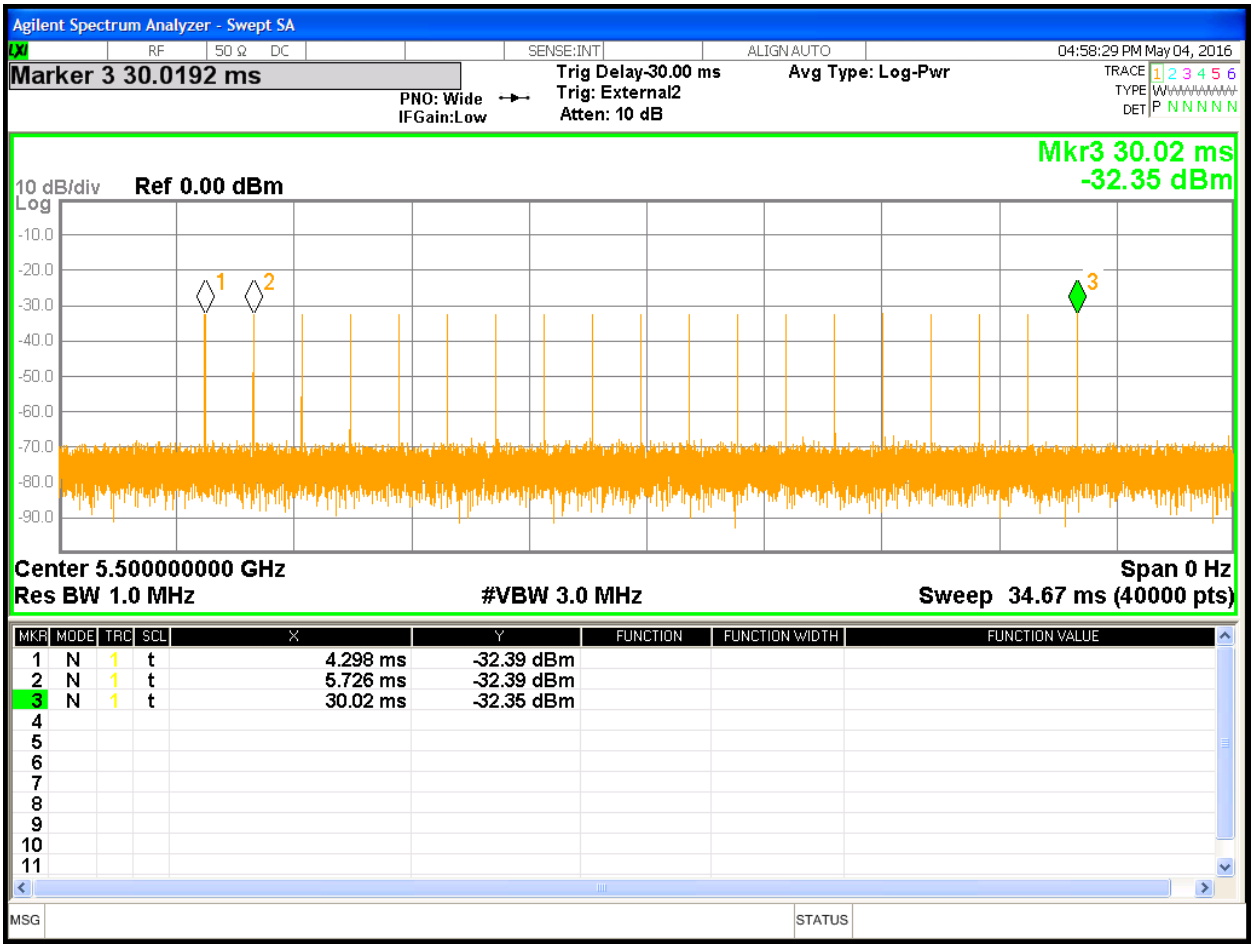


Figure 2: 5500 MHz Radar Pulse Type 0 at Master (Cisco AP)

2.5 In-Service Monitoring

In-service monitoring performance checks consist of the channel move time and channel closing transmission time. These parameters of the Audio Player are verified to give the radar system the priority of the frequency rand and minimize the interference with nearby radar systems when the Audio Player is being used.

The Audio Player is a client device without any radar detection.

The verified Pulse #1 was radiatively injected to the above test circuit. Since Cisco AP was qualified for DFS, the *Audio Player* was evaluated with the Cisco AP as a whole network system for conformance to the channel move time and channel closing transmission time.

As originally tested, the *Audio Player* was found to be compliant to the requirements of the test standard(s).

Table 9: DFS Response – Test Results

Test Method: Radiated					
Center Frequency: see below.			**EUT State:** Status update every 1 sec		
Min. Antenna Gain: 5.0dBi			**Max. Transmitted Power:** nominal		
Required Threshold: -64dBm			**Detection Threshold:** -60 dBm		
Ambient Temperature: 21° C			**Relative Humidity:** 37 RH%		
Bandwidth (MHz)	**Channel (MHz)**	**CMT (sec)**	**CCTT (msec)**	**Figure**	**Results**
20	5300	0.187	16.67	3	Complies
40	5310	0.261	26.67	4	Complies
20	5500	0.561	10.00	5	Complies
40	5510	8.459	16.67	6	Complies
Note: *CCTT= Channel Closing Transmission Time.* *CMT= Channel Move Time*					

2.5.1 **Bandwidth of 20 MHz**

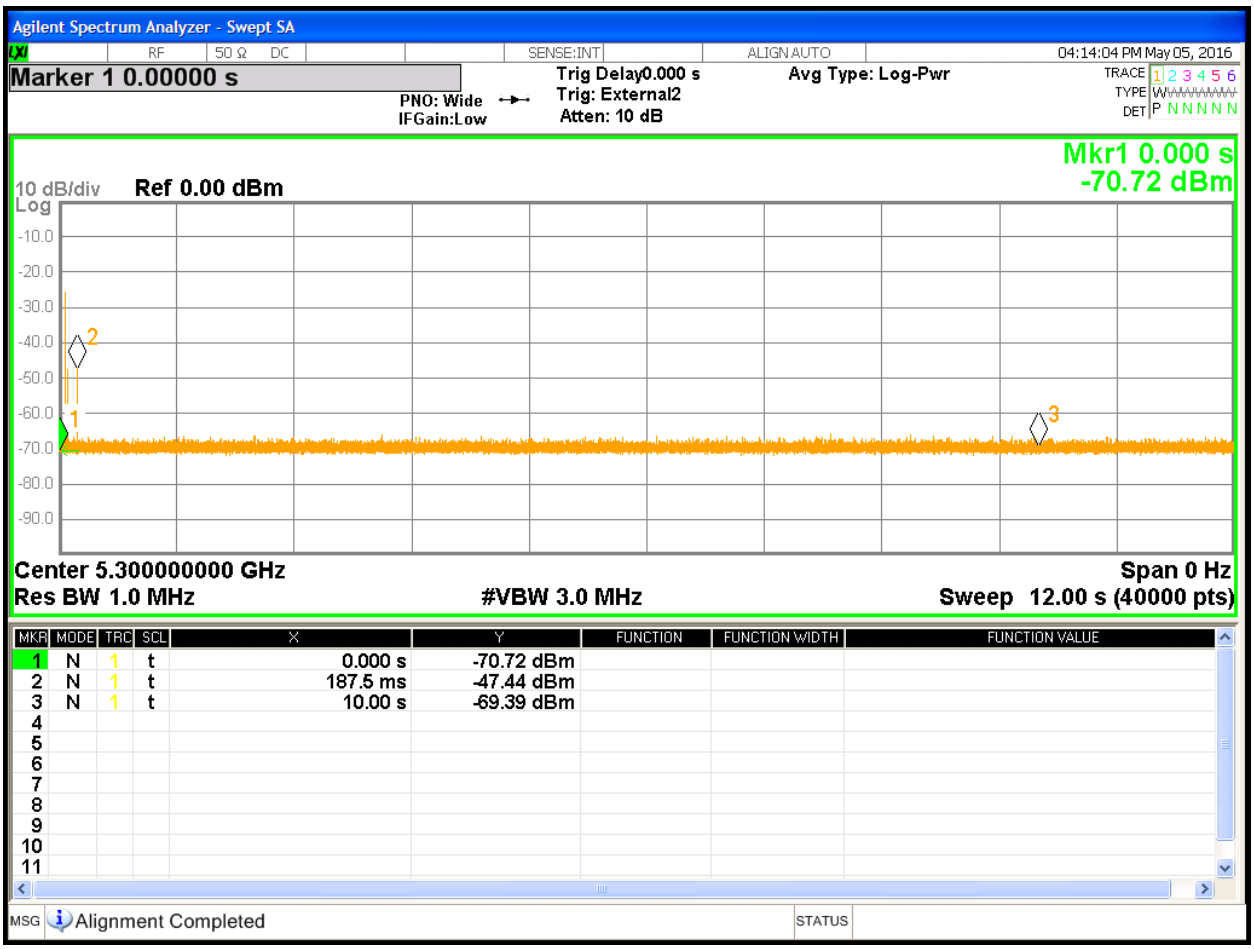


Figure 3: Channel Move Time and Channel Closing Transmission Time at 5300 MHz

Note: Marker 1 denotes the start of Channel Move Time upon the end of the last Radar burst.Marker 2 denotes the end of the Channel Move Time.

2.5.1.1 Analysis of data from figure # 3 for 20MHz BW

Sweep Bins	40000	bins
Start time	0.000	ms
Sweep Time	12000	ms
Threshold Level	-60	dBm
End of Radar Burst Bin	627	bins
Last of Radar Burst	0.00	ms
Total Bin Above Threshold	5	bins
Bin on after Burst	5	bins
Channel Closing Transmission Time	**16.67**	**ms**
Last Transmission	187.5	ms
Channel Move Time	187.5	ms

Channel Closing Transmission Time = (Sweep Bin/Sweep Time)*Total Bin above Threshold
No transmission was found at 5300MHz for 30 min.

2.5.2 **Bandwidth of 40 MHz**

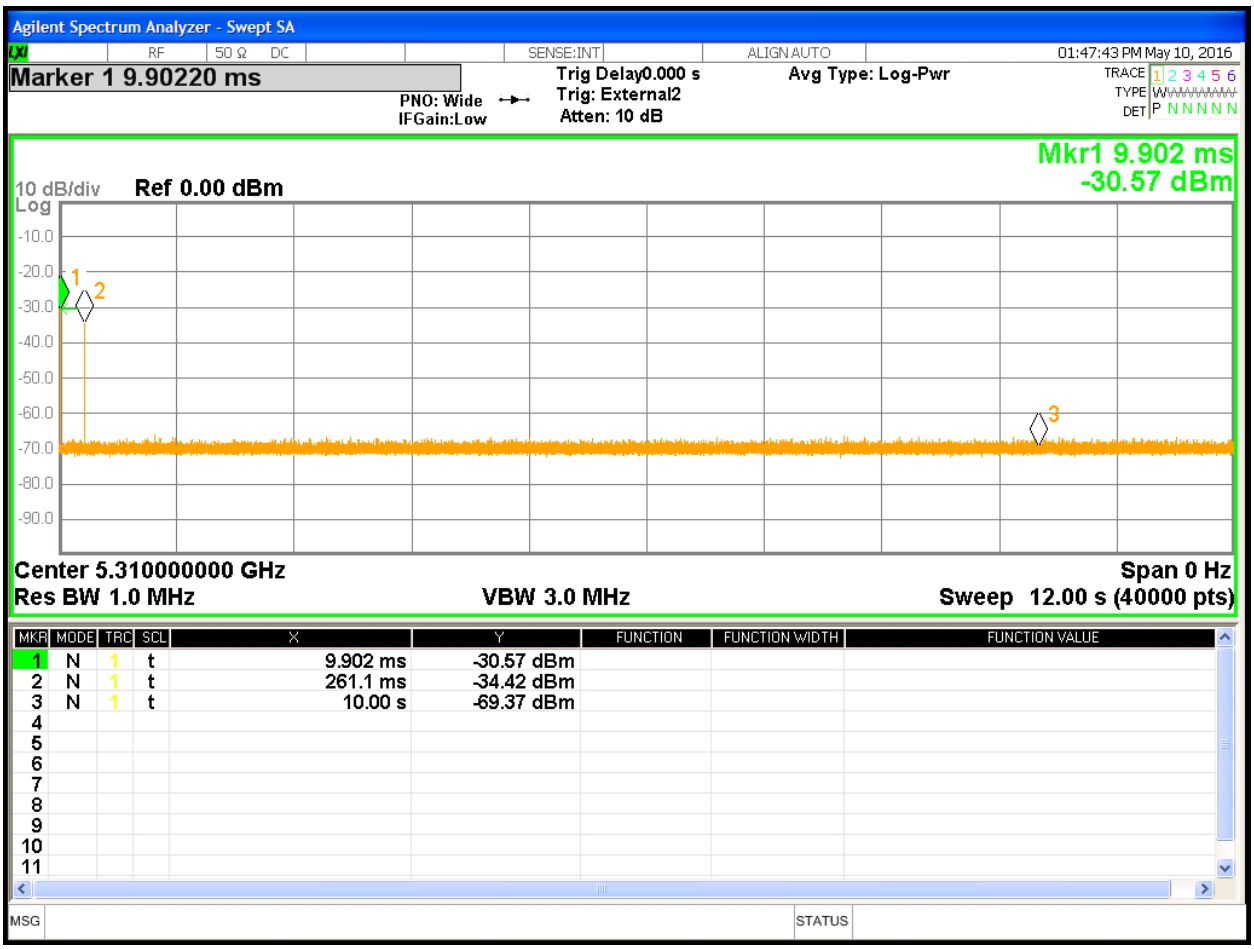


Figure 4: Channel Move Time and Channel Closing Transmission Time at 5310 MHz

Note: Marker 1 denotes the start of Channel Move Time upon the end of the last Radar burst.Marker 2 denotes the end of the Channel Move Time.

2.5.2.1 Analysis of data from figure # 4 for 40MHz BW

Sweep Bins	40000	bins
Start time	0.000	ms
Sweep Time	12000	ms
Threshold Level	-60	dBm
End of Radar Burst Bin	871	bins
Last of Radar Burst	0.00	ms
Total Bin Above Threshold	8	bins
Bin on after Burst	8	bins
Channel Closing Transmission Time	**26.67**	**ms**
Last Transmission	261.1	ms
Channel Move Time	261.1	ms

Channel Closing Transmission Time = (Sweep Bin/Sweep Time)*Total Bin above Threshold
No transmission was found at 5310MHz for 30 min.

2.5.3 **Bandwidth of 20 MHz**

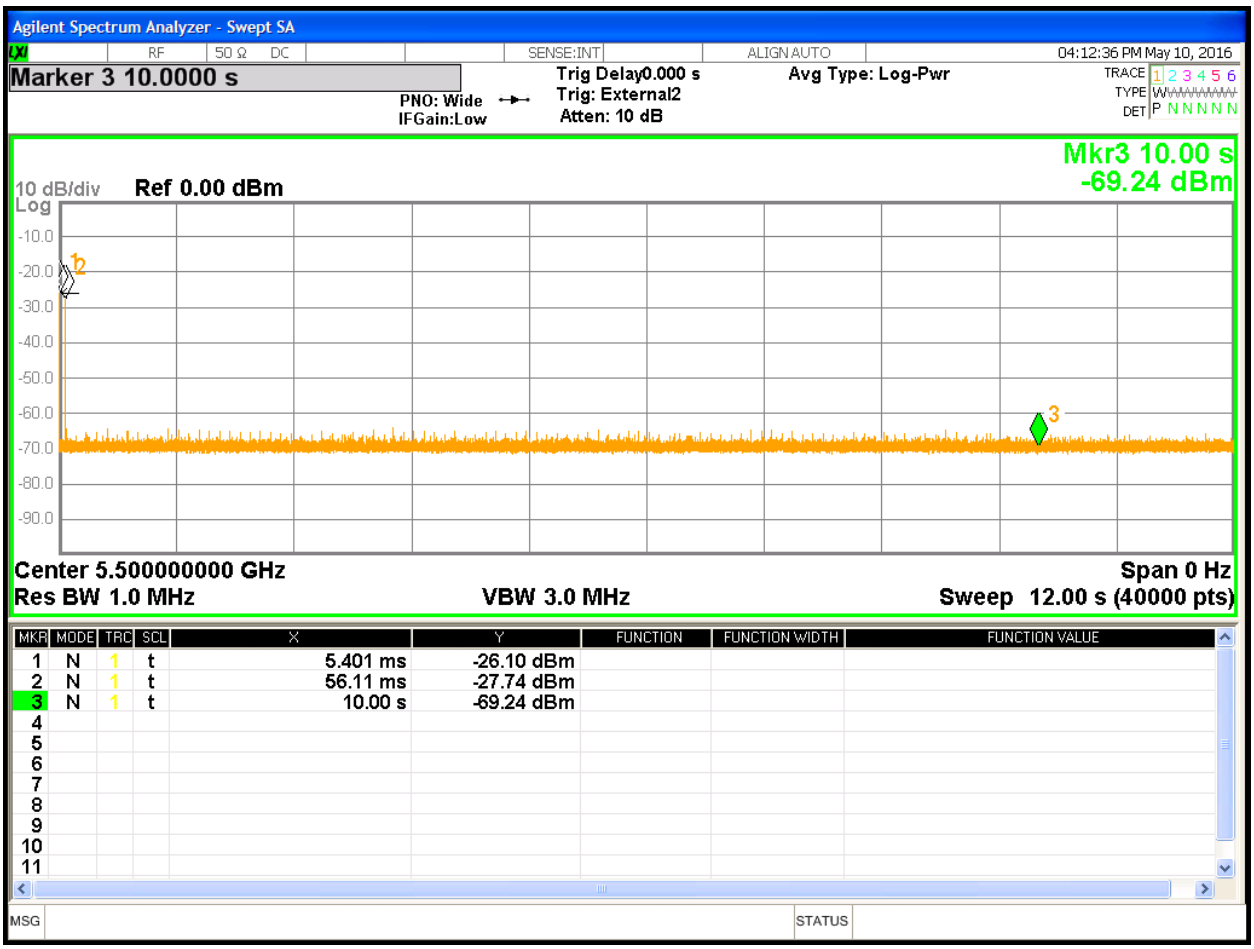


Figure 5: Channel Move Time and Channel Closing Transmission Time at 5500 MHz

Note: Marker 1 denotes the start of Channel Move Time upon the end of the last Radar burst.Marker 2 denotes the end of the Channel Move Time.

2.5.3.1 Analysis of data from figure # 5 for 20MHz BW

Sweep Bins	40000	bins
Start time	0.000	ms
Sweep Time	12000	ms
Threshold Level	-60	dBm
End of Radar Burst Bin	188	bins
Last of Radar Burst	0.00	ms
Total Bin Above Threshold	3	bins
Bin on after Burst	3	bins
Channel Closing Transmission Time	**10**	**ms**
Last Transmission	56.11	ms
Channel Move Time	56.11	ms

Channel Closing Transmission Time = (Sweep Bin/Sweep Time)*Total Bin above Threshold
No transmission was found at 5500MHz for 30 min.

2.5.4 **Bandwidth of 40 MHz**

Figure 6: Channel Move Time and Channel Closing Transmission Time at 5510 MHz

Note: Marker 1 denotes the start of Channel Move Time upon the end of the last Radar burst.Marker 2 denotes the end of the Channel Move Time.

2.5.4.1 Analysis of data from figure # 6 for 40MHz BW

Sweep Bins	40000	bins
Start time	0.000	ms
Sweep Time	12000	ms
Threshold Level	-60	dBm
End of Radar Burst Bin	28191	bins
Last of Radar Burst	0.00	ms
Total Bin Above Threshold	5	bins
Bin on after Burst	5	bins
Channel Closing Transmission Time	**16.67**	**ms**
Last Transmission	8459	ms
Channel Move Time	8459	ms

Channel Closing Transmission Time = (Sweep Bin/Sweep Time)*Total Bin above Threshold
No transmission was found at 5510MHz for 30 min.

3 Test Equipment Use List

3.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Horn Antenna	Sunol Sciences	DRH-118	A040806	NCR	NCR
Horn Antenna	Sunol Sciences	DRH-118	A040806	02/10/2015	02/10/2017
EMI Receiver	Agilent	N9038A	MY51210195	01/26/2016	01/26/2017
EMI Receiver	Rohde & Schwarz	FSL6	100169	01/20/2016	01/20/2017
Vector Signal Generator	Rhode&Schwarz	SMU 200A	1141.2005.02	10/01/2015	10/01/2016
Power Sensor	Agilent	8481A	US37295801	01/20/2016	01/20/2017
RF Power Meter	Agilent	E4418A	MY45103859	01/20/2016	01/20/2017

* 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.

4 EMC Test Plan

4.1 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.

4.2 Customer

Table 10: Customer Information

Company Name	Harman International Industries, Inc
Address	50 Waterview Drive, Suite 240
City, State, Zip	Shelton, CT 06484
Country	USA
Phone	(203) 924-5349
Fax	(203) 924-2382

Table 11: Technical Contact Information

Name	John Garay
E-mail	John.garay@harman.com
Phone	(203) 924-5349
Fax	(203) 924-2382

4.3 Equipment Under Test (EUT)

Table 12: EUT Specifications

EUT Specifications	
Dimensions	W: 17.25in (438.15mm) x D: 15.25-16in (387.35-406.4mm) x H: 6in (152.4mm)
AC Input	100-240V AC, 50 – 60 Hz
Environment	Indoor
Operating Temperature Range:	+10 to +40 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Hardware Version	Lab1 (L1)
Part Number	Stream820/4WE10-4-D3
RF Software Version	Marvell-sdio-fw_14.66.35-p25.bb
802.11-radio modules	
Operating Mode	802.11a, 802.11n (HT20, HT40)
Transmitter Frequency Band	5.25 GHz – 5.35 GHz and 5.47 GHz – 5.725 GHz, U-NII-2A and U-NII-2C band
Max. Rated Power Output	See Channel Planning Table.
Power Setting @ Operating Channel	See Channel Planning Table.
Antenna Type	Omnidirectional
Antenna Gain	+5.0 dBi
Modulation Type	☐ AM ☐ FM ☒ DSSS ☒ OFDM ☐ Other describe: 16QAM and 64 QAM
Data Rate	802.11a: 1 Spatial Streams: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11n HT20: 1 Spatial Streams: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps 802.11n HT40: 1 Spatial Streams: 13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps
TX/RX Chain (s)	Single chain; no beam forming
Directional Gain Type	☒ Uncorrelated ☐ Beam-Forming ☐ Other describe:
Type of Equipment	☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☐ Other:
Note: None.	

Table 13: EUT Channel Power Specifications, single stream.

TP Setting	No.	Frequency (MHz)	Target Power Value dBm		
			802.11a	802.11n (HT20)	802.11n (HT40)
16	52	5260	13.26		
16	60	5300	12.84		
16	64	5320	12.39		
16	100	5500	13.29		
16	116	5580	13.98		
16	140	5700	14.35		
15	52	5260		12.2	
15	60	5300		11.91	
15	64	5320		11.54	
15	100	5500		12.43	
15	116	5580		13.19	
15	140	5700		13.83	
15	54	5270			11.97
15	62	5310			11.62
15	102	5510			12.10
15	110	5550			12.24
15	134	5670			12.88

Note: The adjusted power target values are updated at the evaluated frequencies.

Table 14: 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?
Ethernet	RJ45	☒ No	☒ Metric: 2 m	☐ N/A

Table 15: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Lenovo	T420	R8-G4YVG 11/06	Setup EUT test operational
Laptop	Lenovo	E440	PF 063HA8 14/12	DFS Testing
Access Point	Cisco	AIR-CAP2602I-A-K9	FGL170928G5	DFS Testing
Note: None.				

Table 16: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.407 & RSS-247
Audio Player	919	External Antenna	Dynamic Frequency Selection

4.4 Test Specifications

Testing requirements

Table 17: Test Specifications

Dynamic Frequency Selection	
Standard	Requirement
CFR 47 Part 15.407: 2015	All
RSS 247 Issue 1, 2015	All

5 Photos

Figure 7: Photo of EUT (Front)

Figure 8: Photo of EUT (Left)

Figure 9: Photo of EUT (Right)

Figure 10: Photo of EUT (Back)

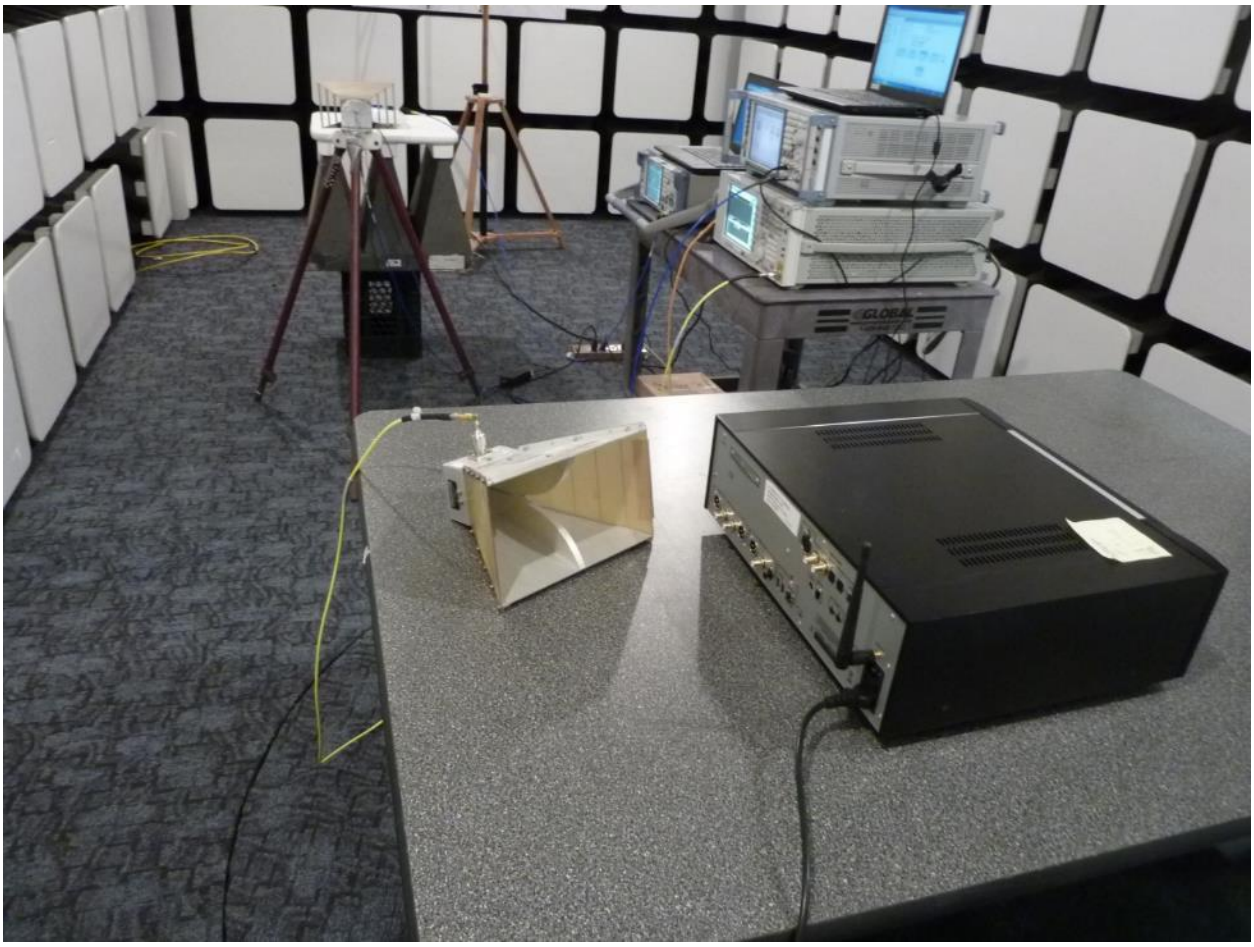


Figure 11: DFS Test Setup (View 1)

Figure 12: DFS Test Setup (View 2)

END OF REPORT