



FCC Part 15.407

RSS-247 Issue 2, Feb 2017; RSS-Gen Issue 5, Mar 2019

DYNAMIC FREQUENCY SELECTION

TEST REPORT

For

Redpine Signals Inc

2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA

FCC ID: XF6-M7DB7
IC: 8407A-M7DB7

Report Type	Original Report
Product Name:	Dual Band 802.11 a/b/g/n, Bluetooth 5.0 SIP Module
Model Name:	M7DB
Report Number :	RLK200203002-00F
Report Date :	2020/05/18
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (Linkou Laboratory)

Revision History

Revision	Report Number	Issue Date	Description
1.0	RLK200203002-00F	2020/05/18	Original Report

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	Redpine Signals Inc 2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA
Manufacturer	Redpine Signals Inc 2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA
Brand Name	 REDPINE SIGNALS DRIVING WIRELESS CONVERGENCE
Product (Equipment)	Dual Band 802.11 a/b/g/n, Bluetooth 5.0 SIP Module
Model Name	M7DB
Modulation Type	IEEE 802.11b: DSSS IEEE 802.11 g/n HT20/n HT40: OFDM
Related Submittal(s)/Grant(s)	FCC Part 15.247 DTS with FCC ID: XF6-M7DB7 FCC Part 15.247 DSS with FCC ID: XF6-M7DB7 IC RSS-247 DTS with IC: 8407A-M7DB7 IC RSS-247 FHSS with IC: 8407A-M7DB7
FW Version	4.18.16-300
Received Date	2020-02-03
Date of Test	2020-05-05

*All measurement and test data in this report was gathered from production sample serial number: 190914002(Assigned by BACL, Linkou Laboratory)

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	<input type="checkbox"/> AC 120 V/60 Hz <input type="checkbox"/> Adapter <input type="checkbox"/> By Power Cord.
	<input checked="" type="checkbox"/> DC Type <input checked="" type="checkbox"/> DC Power Supply: 3.3V <input type="checkbox"/> Battery: <input type="checkbox"/> External from USB Cable <input type="checkbox"/> External DC Adapter
	<input type="checkbox"/> Host System

1.3 Environmental Conditions and Test Date

Test Site	Test Date	Temperature (°C)	Relative Humidity (% RH)	Test Engineer
DFS (DFS-01)	2020-05-05	22.1	56	Ethan Shao

1.4 Objective and Test Methodology

The Objective of this Test Report was to document the compliance of the Redpine Signals Inc. Appliance (Model: M7DB7) to the requirements of the following Standards:

- Part 2, Subpart J, Part 15, Subparts A and C, section 15.407 of the Federal Communication Commission’s rules.
- ANSI C63.10-2013 of t American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- RSS-Gen Issue 5, Mar 2019— General Requirements for Compliance of Radio Apparatus
- RSS-247 Issue 2, Feb 2017— Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02
- FCC KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

1.5 Measurement Uncertainty

Parameter	Expanded Measurement uncertainty
DFS Conducted test	± 0.34 dB

The test results with statement of conformity, the decision rules are based on the specifications and standards. The test results will not take the measurement uncertainty into account.

1.6 Support Equipment List and External Cable List

No.	Description	Manufacturer	Model Number
A	Notebook	DELL	Inspiron 15
B	Adapter	Chicony Power	HA65NS5-00 (DELL)
C	Notebook	Lenovo	Y520-15IKBN
D	Adapter	Chicony Power	ADL135NCC3A (Lenovo)
E	AP Router	NETGEAR	R7800
F	Adapter	Channel Well	2AAF042F (NETGEAR)

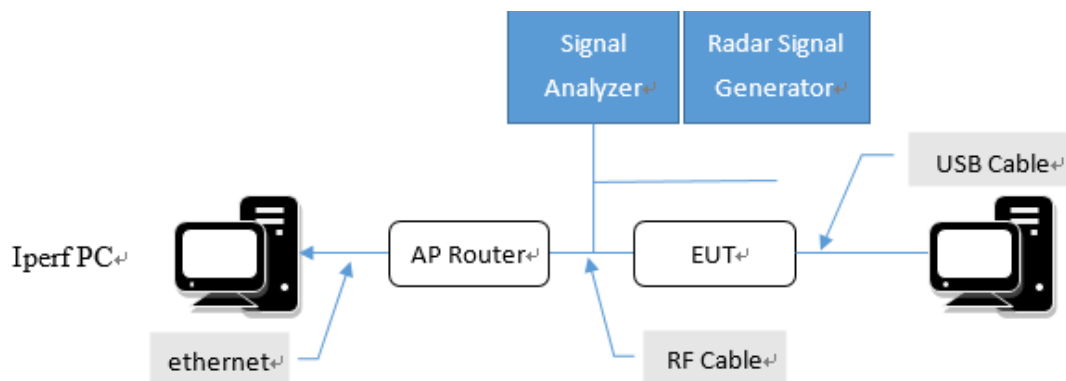
No.	Cable Description	Shielding Type	Length (m)	From	To
1	USB Cable	Non-Shielded	1	EUT	NB

1.7 Antenna List and Details

Brand	Model	Antenna Type	Antenna Gain (dBi)
TAOGLAS	GW.71.5153	Dipole	3.80
SMARTEQ	4211613980	PIFA	0.00
Inside WLAN	PRO-IS-299	Dipole	2.50
Redpine Signals	RSIA7	PCB Antenna	0.71

*DFS use SMARTEQ Antenna Gain to test.

1.8 System Test Configuration and Block Diagram



The EUT was configured for testing in a normal mode which was provided by the manufacturer.

1.9 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Linkou Laboratory) to collect test data is located on

No.6, Wende 2Rd., Guishan Dist., Taoyuan City 33382, Taiwan (R.O.C.).

Bay Area Compliance Laboratories Corp. (Linkou Laboratory) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3546) by Mutual Recognition Agreement (MRA). The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database. The FCC Registration No.: 0027578244. Designation No.: TW3546. The Test Firm Registration No.: 181430.

2 Summary of Test Results

A compliant test report to FCC 15.407 and RSS-247 section 6.3 shall be sufficient to show compliance of a transmitter or receiver with the requirement of this standard.

The following result table represents the list of measurements required under the CFR §47 Part 15.407(h), RSS-247 section 6.3 and KDB: 905462 D02 UNII DFS Compliance Procedures New Rules v02.

Dynamic frequency selection for devices operating in the bands 5250-5350 MHz, 5470-5600 MHz and 5650-5725 MHz, ISSED requires the use of either the FCC KDB Procedure 905462 3 for demonstrating compliance with the DFS radar detection requirements set out in this section.

If any part of an operating device’s emission bandwidth falls in the bands 5250-5350 MHz, 5470-5600 MHz or 5650-5725 MHz, the device shall comply with requirements in the following sections.

FCC/ISED DFS Item	Description of Test	Result
Detection Bandwidth	UNII Detection Bandwidth	Not applicable ^{Note1}
Performance Requirements Check	Initial Channel Availability Check Time (CAC)	Not applicable ^{Note1}
	Radar Burst at the Beginning of the CAC	Not applicable ^{Note1}
	Radar Burst at the End of the CAC	Not applicable ^{Note1}
In-Service Monitoring	Channel Move Time	Compliance
	Channel Closing Transmission Time	Compliance
Non-Occupancy Period	Non-Occupancy Period	Not applicable ^{Note1}
Radar Detection	Statistical Performance Check	Not applicable ^{Note1}

Note1: The EUT is the client device without radar detection

3 Applicable Standards

3.1 DFS Requirement

According to RSS-247 Issue 2 Section 6.3.

Dynamic frequency selection for devices operating in the bands 5250-5350 MHz, 5470-5600 MHz and 5650-5725 MHz, ISSED requires the use of either the FCC KDB Procedure 905462 for demonstrating compliance with the DFS radar detection requirements set out in this section.

If any part of an operating device’s emission bandwidth falls in the bands 5250-5350 MHz, 5470-5600 MHz or 5650-5725 MHz, the device shall comply with requirements in the following sections.

- DFS radar signal detection threshold

Devices shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. The device must detect radar signals within its entire emission bandwidth. The minimum DFS radar signal detection threshold is described below in Table 1.

Table 1: DFS Detection threshold for master devices and slave devices with radar detection

Devices	DFS Threshold
Devices with an e.i.r.p. < 200 mW AND a Power Spectral Density < 10 dBm/MHz	-62 dBm
Devices with 200 mW ≤ e.i.r.p. ≤ 1 W	-64 dBm
Note: The detection threshold power is the received power, averaged over a 1-microsecond reference to a 0 dBi antenna.	

- Operational requirements

Devices shall comply with the following requirements, however, the requirement for in-service monitoring does not apply to slave devices without radar detection.

- a) In-service monitoring: an LE-LAN device shall be able to monitor the operating channel to check that a co-channel radar has not moved or started operation within range of the LE-LAN device. During in-service monitoring, the LE-LAN radar detection function continuously searches for radar signals between normal LE-LAN transmissions.
- b) Channel availability check time: the device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in section 6.3.1 above is detected within 60 seconds. This requirement only applies in the master operational mode.
- c) Channel move time: after a radar signal is detected, the device shall cease all transmissions on the operating channel within 10 seconds.
- d) Channel closing transmission time: is comprised of 200 ms 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 ms) over the remaining 10-second period of the channel move time.

e) Non-occupancy period: a channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30-minute non-occupancy period where the channel cannot be used by the LE-LAN device. The non-occupancy period starts from the time that the radar signal is detected.

- Additional requirements

The following requirements shall apply:

a) The device shall automatically discontinue transmission in cases of absence of information to transmit, or operational failure. A description on how this is done shall accompany the application for equipment certification. Note that this is not intended to prohibit transmission of control or signalling information or the use of repetitive codes where required by the technology.

b) All LE-LAN devices must contain security features to protect against modification of software by unauthorized parties. Manufacturers must implement security features in any digitally modulated devices capable of operating in any of the frequency ranges within the 5 GHz band, so that third parties are not able to reprogram the device to operate outside the parameters for which the device was certified. The software must prevent the user from operating the transmitter with operating frequencies, output power, modulation types or other radio frequency parameters outside those that were approved for the device. Manufacturers may use various means, including the use of a private network that allows only authenticated users to download software, electronic signatures in software or coding in hardware that is decoded by software to verify that new software can be legally loaded into a device to meet these requirements and must describe the methods in their application for equipment certification. Manufacturers must take steps to ensure that DFS functionality cannot be disabled by the operator of the LE-LAN device.

c) The user manual for LE-LAN devices shall contain instructions related to the restrictions mentioned in the above sections, namely that:

i. the device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;⁴

ii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;

iii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p.

limits as appropriate; and

iv. where applicable, antenna type(s), antenna models(s), and worst-case tilt angle(s) necessary to remain compliant with the e.i.r.p. elevation mask requirement set forth in section 6.2.2.3 shall be clearly indicated.

According to FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 and RSS

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

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
<i>Non-Occupancy Period</i>	Yes	Not required	Yes
<i>DFS Detection Threshold</i>	Yes	Not required	Yes
<i>Channel Availability Check Time</i>	Yes	Not required	Not required
<i>U-NII Detection Bandwidth</i>	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
<i>DFS Detection Threshold</i>	Yes	Not required
<i>Channel Closing Transmission Time</i>	Yes	Yes
<i>Channel Move Time</i>	Yes	Yes
<i>U-NII Detection Bandwidth</i>	Yes	Not required

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection
<i>U-NII Detection Bandwidth and Statistical Performance Check</i>	All BW modes must be tested	Not required
<i>Channel Move Time and Channel Closing Transmission Time</i>	Test using widest BW mode available	Test using the widest BW mode available for the link
<i>All other tests</i>	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 frequency.		

The operational behavior and individual DFS requirements that are associated with these modes are as follows:

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

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
<p>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. Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.</p>	

Table 4: DFS Response Requirement Values

Parameter	Value
<i>Non-occupancy period</i>	Minimum 30 minutes
<i>Channel Availability Check Time</i>	60 seconds
<i>Channel Move Time</i>	10 seconds See Note 1.
<i>Channel Closing Transmission Time</i>	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
<i>U-NII Detection Bandwidth</i>	Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3.
<p>Note 1: <i>Channel Move Time</i> and the <i>Channel Closing Transmission Time</i> should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. Note 2: The <i>Channel Closing Transmission Time</i> is comprised of 200 milliseconds starting at the beginning of the <i>Channel Move Time</i> plus any additional intermittent control signals required to facilitate a <i>Channel move</i> (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 <i>U-NII Detection Bandwidth</i> 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.</p>	

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 5a	Roundup $\left\{ \left(\frac{1}{360} \right) \cdot \left(\frac{19 \cdot 10^6}{PRI_{\mu\text{sec}}} \right) \right\}$	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.					

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.

For example if in Short Pulse Radar Type 1 Test B a PRI of 3066 μsec is selected, the number of pulses

would be $\text{Roundup} \left\{ \left(\frac{1}{360} \right) \cdot \left(\frac{19 \cdot 10^6}{3066} \right) \right\} = \text{Round up} \{17.2\} = 18.$

Table 5a - 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

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

Radar Type	Number of Trials	Number of Successful Detections	Minimum Percentage of Successful Detection
1	35	29	82.9%
2	30	18	60%
3	30	27	90%
4	50	44	88%
Aggregate $(82.9\% + 60\% + 90\% + 88\%)/4 = 80.2\%$			

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

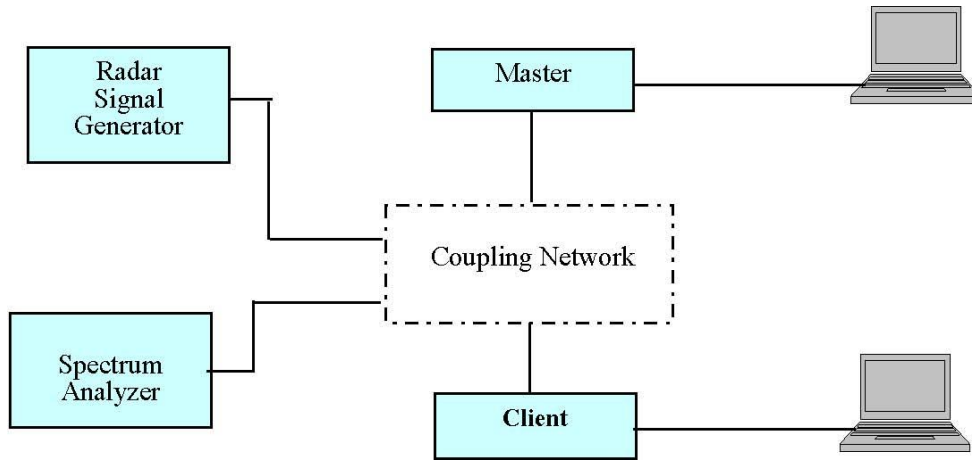
Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

3.2 DFS Measurement System

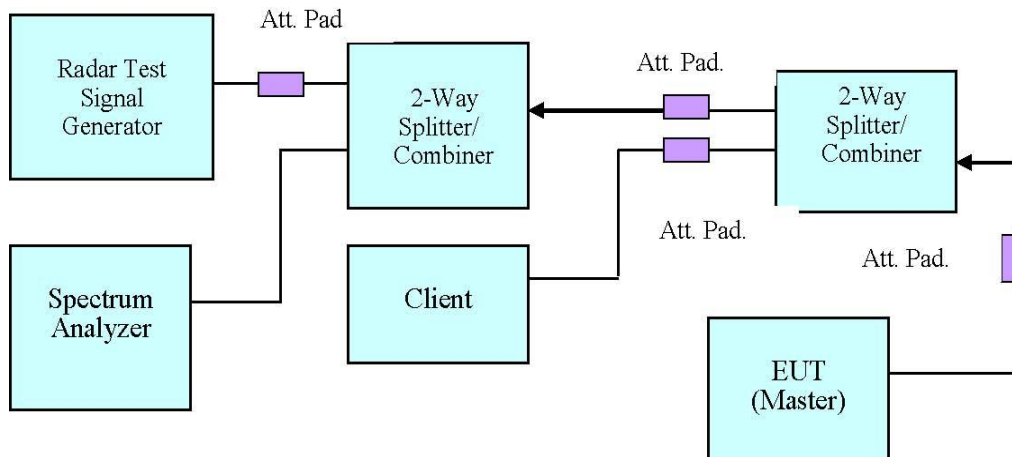
BACL DFS measurement system consists of two subsystems: (1) The radar signal generating subsystem and (2) the traffic monitoring subsystem.

3.3 System Block Diagram

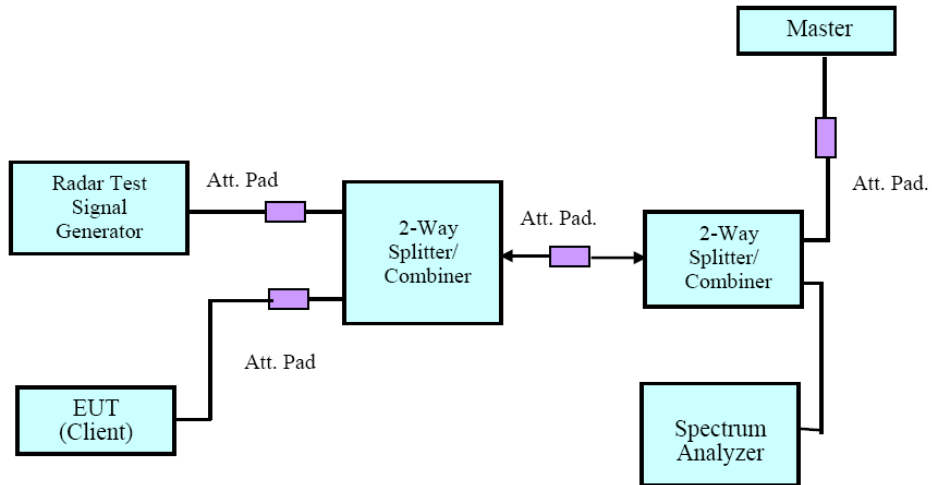
Conducted Method:



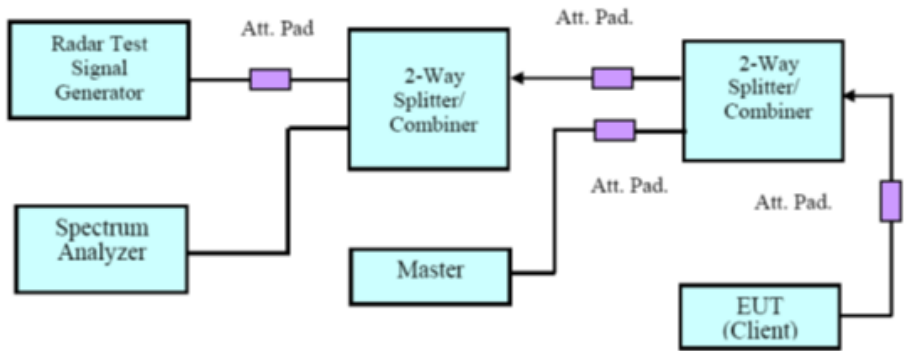
Setup for Master with injection at the Master:



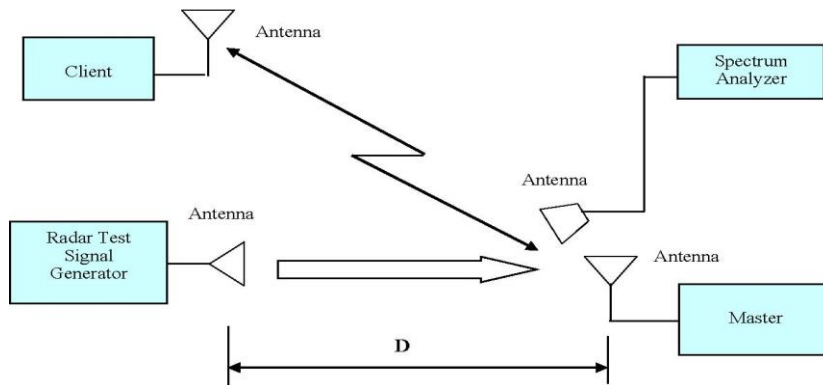
Setup for Client with injection at the Master:



Setup for Client with injection at the Client:



Radiated Method



3.4 Test Procedure

A spectrum analyzer is used as a monitor verifies that the EUT status including Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the diction and Channel move. It is also used to monitor EUT transmissions during the Channel Availability Check Time.

4 Test Result

4.1 Description of EUT

The EUT operates in 5250-5350 MHz and 5470-5725 MHz range.

The rated output power of master device is >23 dBm (EIRP), therefore the required interference threshold level is -64 dBm, the required radiated threshold at antenna port is -64dBm.

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.

The calibrated radiated DFS detection threshold level is set to $-62 + (\text{Master Antenna Gain}) = -62 + 0.11 = -61.89$ dBm.

4.2 Channel Loading

System testing will be performed with channel-loading using means appropriate to the data types that are used by the unlicensed device. The following requirements apply:

- a) The data file must be of a type that is typical for the device (i.e., MPEG-2, MPEG-4, WAV, MP3, MP4, AVI, etc.) and must generally be transmitting in a streaming mode.
- b) Software to ping the client is permitted to simulate data transfer but must have random ping intervals.
- c) Timing plots are required with calculations demonstrating a minimum channel loading of approximately 17% or greater. For example, channel loading can be estimated by setting the spectrum analyzer for zero span and approximate the Time On/ (Time On + Off Time). This can be done with any appropriate channel BW and modulation type.
- d) Unicast or Multicast protocols are preferable but other protocols may be used. The appropriate protocol used must be described in the test procedures.

The sample is use merhod (C)

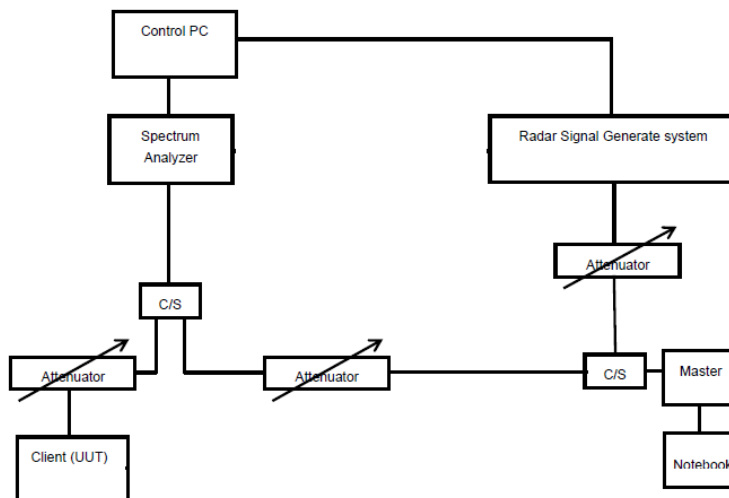
WLAN traffic is generated by streaming the video file TestFile.mpg, this file is used by IP and Frame based systems for loading the test channel during the In-service compliance testing of the U-NII device. The file is streamed from the Access Point to the Client in full motion video mode using the media player with the V2.61 Codec package.

4.3 Test Equipment List and Details

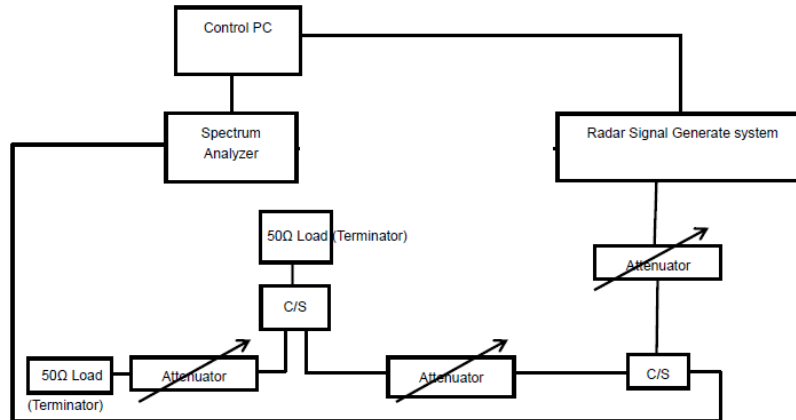
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
DFS Room (DFS-01)					
N5182B	MXG Vector Signal Generator	Keysight	MY53051691	2020/01/06	2021/01/05
N5183B	MXG X-Series Microwave Analog Signal Generator	Keysight	MY53270771	2020/01/06	2021/01/05
N9010A	EXA Signal Analyzer	Agilent	102448	2019/03/27	2020/03/26
RF Cable	MTJ	MT40S	MT40S-001	Each Use	/
Software	BACL	DFS Aggregate	DFSA-01	N.C.R	N.C.R

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

4.4 Conducted Test Setup Configuration

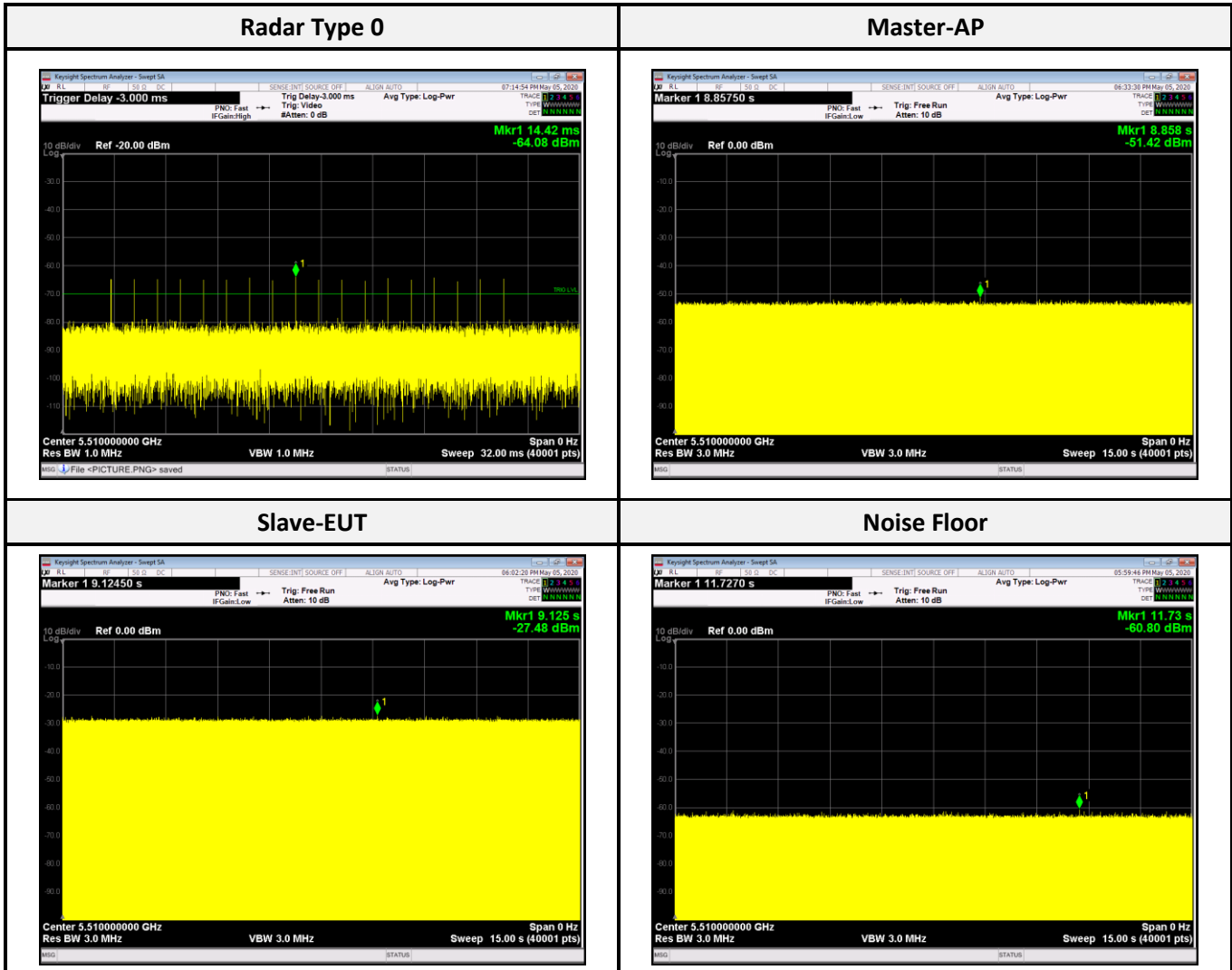


4.5 Calibration of DFS Detection Threshold Level



4.6 Radar Waveforms

Test Frequency: 5510 MHz:



5 Channel Move Time and Channel Closing Transmission Time

5.1 Test Procedure

Perform type 0 short pulse radar waveform. The aggregate channel closing transmission time is calculated as follows:

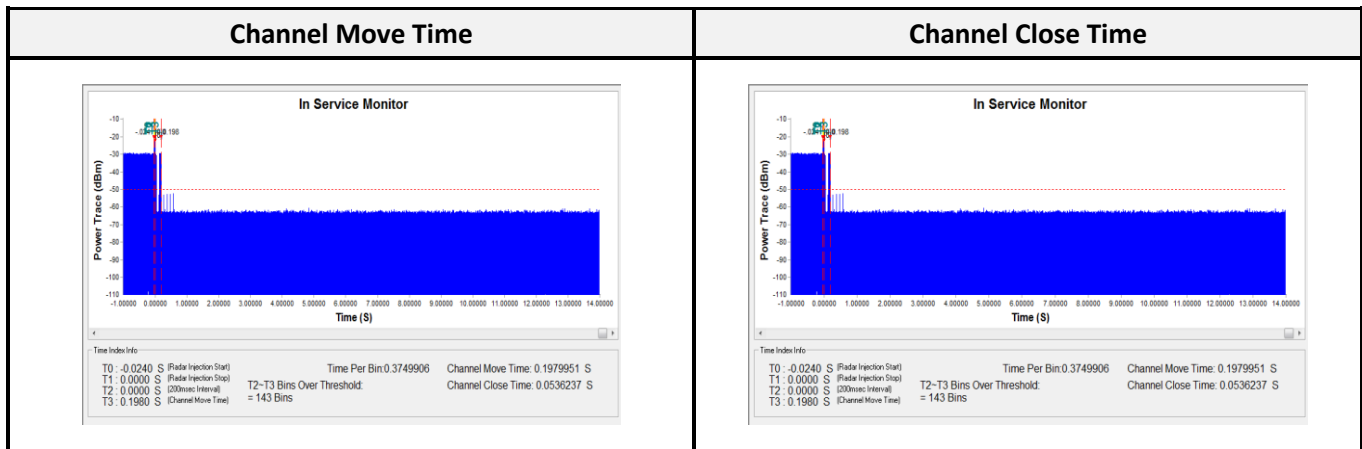
$$\text{Aggregate Transmission Time} = N * \text{Dwell Time}$$

N is the number of spectrum analyzer bins showing a device transmission Dwell Time is the dwell time per bin (i.e. Dwell Time = S/B, S is the sweep time and B is the number of bin, i.e. 10000)

5.2 Test Result

Test Frequency (MHz)	Bandwidth (MHz)	Radar Type	Results
5510	40	Type 0	Compliant

Item	Time (s)	Limit (s)
Channel move time	0.1980	<10
Item	Time (s)	Limit (ms)
Closing Transmission Time	0	<60



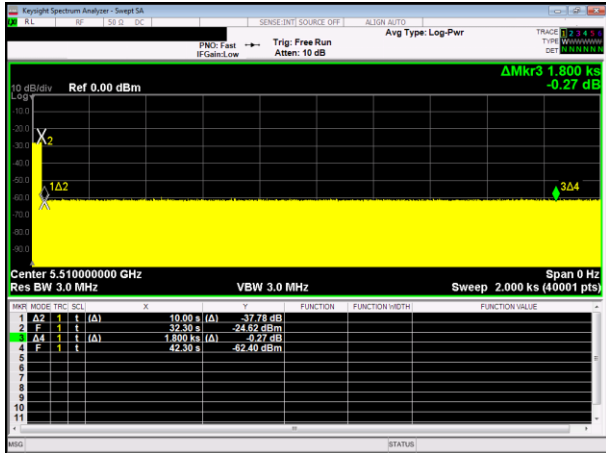
6 Non-Occupancy Period

6.1 Test Procedure

Measure the EUT for more than 30 minutes following the channel close/move time to verify that the EUT does not resume any transmissions on this channel. Provide one plot to demonstrate no transmission on the channel for the non-occupancy period (30 minutes observation time)

6.2 Test Result

Test Frequency (MHz)	Bandwidth (MHz)	Radar Type	Results
5510	40	Type 0	Compliant

5510MHz - Non-Occupancy Period	-																																													
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***** END OF REPORT *****