DFS TEST REPORT (Wi-Fi DFS band)

No. 171100706SHA-005

Applicant	:	GES Singapore Pte Ltd. 28 Marsiling Lane, Singapore 739152
Manufacturing site	:	Same as applicant
Product Name	:	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Type/Model	:	QCNFA364A
TEST RESULT	**:**	**PASS**

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2017): Radio Frequency Devices

RSS-247 Issue 2 (Feb 2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

KDB905462 D03 UNII Clients Without Radar Detection New Rules v01r02

KDB905462 D02 UNII DFS Compliance Procedures New Rules v02

Date of issue: Dec 15, 2017

Prepared by: Reviewed by:

Wakeyou Wang (*Project Engineer*) Daniel Zhao (*Reviewer*)

Content

1 GENERAL INFORMATION

1.1 Description of Equipment Under Test (EUT)

Product Name	:	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Type/model	:	QCNFA364A
FCC ID	:	2AOE6-7357622
IC	:	9871A -7357622
Description of EUT	:	This device is a module supporting 802.11a/b/g/n/ac as well as Bluetooth dual modes. Among this report, only DFS function was assessed.
Port identification	:	/
Antenna	:	PIFA, 5dBi, 2*2 MIMO
Rating	:	3.3Vdc from host equipment
Declared Temperature range	:	-10℃ ~ 70℃
Category of EUT	:	Class B
EUT type	:	☒ Table top ☐ Floor standing
Sample received date	:	Nov 5, 2017
Sample Identification No	:	/
Date of test	:	Nov 12, 2017 – Nov 17, 2017

1.2 RF Technical Information

Specification Items	Description
Protocol	802.11a/n20/n40/ac80
Modulation	BPSK / QPSK / 16QAM / 64QAM / 256QAM
Working band	FCC: 5180-5240MHz, 5260-5320MHz, 5500-5720MHz, 5745-5825MHz IC: 5180-5240MHz, 5260-5320MHz, 5500-5580MHz, 5660-5725MHz, 5745-5825MHz
Channel Bandwidth	20/40/80MHz
Weather Band (5600~5650MHz)	☐Yes ☒No
Max. EIRP Power	☐ < 200mW ☒ ≥ 200mW
Operating Mode	☐ Master ☒ Salve without radar detection
Antenna	2*2 MIMO
Manufacturer Statement	Manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms are not available to the end user.

1.3 Description of Test Facility

Name: Intertek Testing Services Limited Shanghai
Address: Building 86, No. 1198 Qinzhou Rd., North, Shanghai 200233, P.R. China

FCC Accredited Lab Designation Number: CN1175
IC Assigned Code: 2042B-1

Name of contact: Jonny Jing
Tel: +86 21 61278271
Fax: +86 21 54262353

2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2017)
RSS-247 Issue 2 (Feb 2017)
KDB905462 D03 UNII Clients Without Radar Detection New Rules v01r02
KDB905462 D02 UNII DFS Compliance Procedures New Rules v02

2.2 Mode of operation during the test

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 if necessary.

2.3 Test peripherals used

Item No	Device	Band and Model	Description
1	Laptop computer	HP, EliteBook 2530P	-
2	Digital Home ONU (Master)	Alcatel - Lucent	FCC ID: 2ADZRA240ZA
3			

2.4 Instrument list

RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2018-09-10
☐	Power sensor	Agilent	U2021XA	EC 5338-1	2018-03-03
☑	Vector Signal Generator	Agilent	N5182B	EC 5175	2018-03-06
☐	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2018-03-03
☐	Mobile Test System	Litepoint	Iqxel	EC 5176	2018-01-11
☐	Test Receiver	R&S	ESCI 7	EC 4501	2018-02-23

Test Software	Manufacturer	Function
Pulse Building	Agilent	Radar Signal Generation Software
DFS Tool	Agilent	DFS Test Software

Ancillary Instrument	Manufacturer	Type No.
Splitter/Combiner (Qty: 2)	Mini-Circuits	ZX10R-14-S+
Splitter/Combiner (Qty: 2)	Shanghai Huaxiang	SHX-GF2-2-6
ATT (Qty: 2)	Shanghai Huaxiang	SMAG-10dB-6G
ATT (Qty: 2)	Shanghai Huaxiang	SMAG-20dB-6G
ATT (Qty: 2)	Shanghai Huaxiang	SMAG2-30dB-18G
Laptop PC(Qty: 2)	HP	ProBook 6470b

2.5 Test Summary

This report applies to tested sample only. The test results have been compared directly with the limits, and the measurement uncertainty is recorded. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

Test item	FCC CLAUSE	IC CLAUSE	TEST RESULT
Initial Channel Availability Check Time	Part 15.407(h)	RSS247 clause 6.2.3	NA
Radar Burst at the Beginning of the Channel Availability Check & End of the Channel Availability Check Time	Part 15.407(h)	RSS247 clause 6.2.3	NA
Channel Move Time, Channel Closing Time	Part 15.407(h)	RSS247 clause 6.2.3	Pass
Non-occupancy period	Part 15.407(h)	RSS247 clause 6.2.3	Pass
UNII Detection Bandwidth Measurement	Part 15.407(h)	RSS247 clause 6.2.3	NA
Statistical Performance Check	Part 15.407(h)	RSS247 clause 6.2.3	NA

Notes: 1: NA =Not Applicable

3 DFS DETECTION THRESHOLDS AND RADAR TEST WAVEFORMS

3.1 Interference Threshold values

Maximum Transmit Power	Value (see note)
≥ 200 mW	-64 dBm
< 200 mW	-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.	

3.2 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: *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.	

3.3 Radar Test Waveforms Minimum Step

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.

3.4 Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μs)	PRI (μs)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1a	1	15 unique PRI values randomly selected from the list of 23 PRI values in Note 2	Roundup {(1/360)*(19*10^6 /PRI)}	60%	30
1b		15 unique PRI values randomly selected within the range of 518-3066μsec, with a minimum increment of 1 μsec, excluding PRI values selected in radar type 1a			
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.

Note 2: Pulse Repetition Intervals Values for Radar Type 1a

Pulse Repetition Frequency No	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (us)
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

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.

3.5 Long Pulse Radar Test Waveform

Radar Type	Pulse Width (μs)	PRI (μs)	Chirp Width (MHz)	PRI (μsec)	Number of Pulses per Burst	Minimum Percentage of Successful Detection	Minimum Number of 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 Type waveforms. If more than 30 waveforms are used for the Long Pulse Radar Type waveforms, 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 frequency modulated 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 a 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 random time interval between the first and second pulses is chosen independently of the random time interval 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 randomly.

A representative example of a Long Pulse Radar Type waveform:

1) The total test waveform length is 12 seconds.
2) Eight (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).

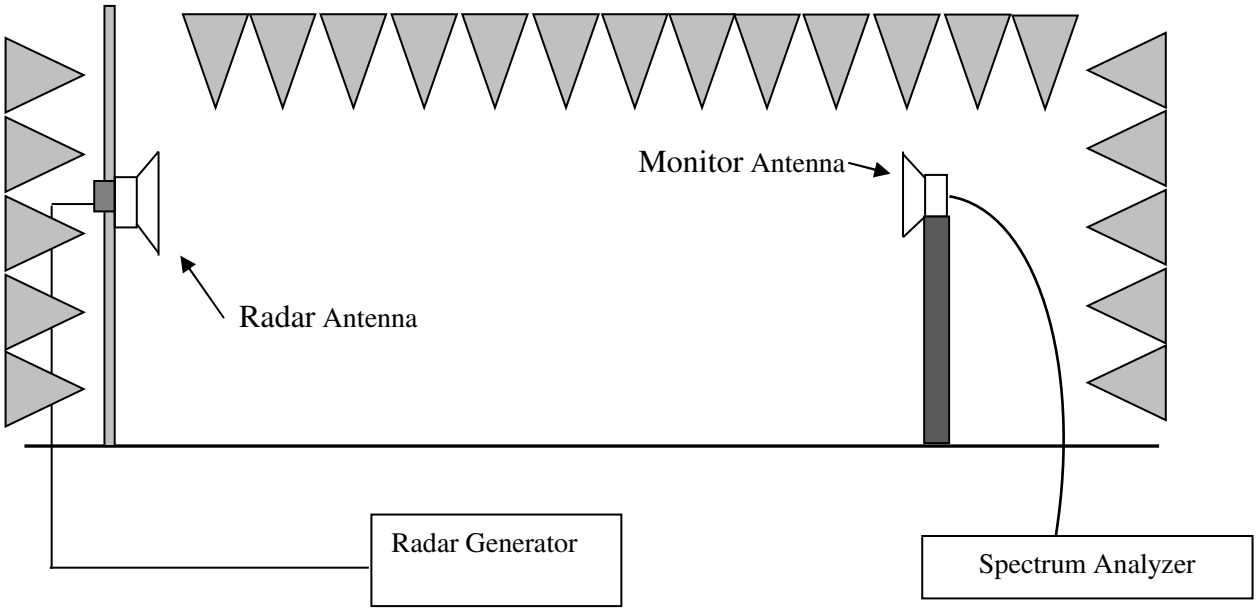
3.6 Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (µs)	PRI (µs)	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

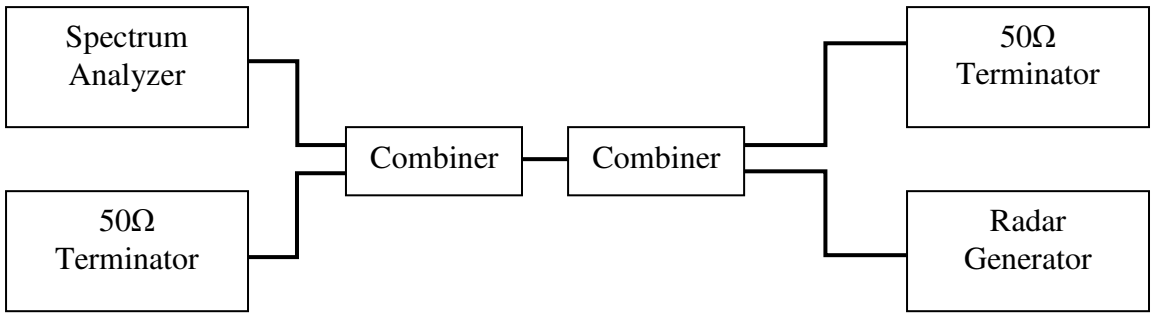
For the Frequency Hopping Radar Type, the same Burst parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm: The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724MHz. 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.

3.7 Calibration Setup

☐Radiated Method



☒Conducted Method



3.8 Radar Waveform Calibration Procedure

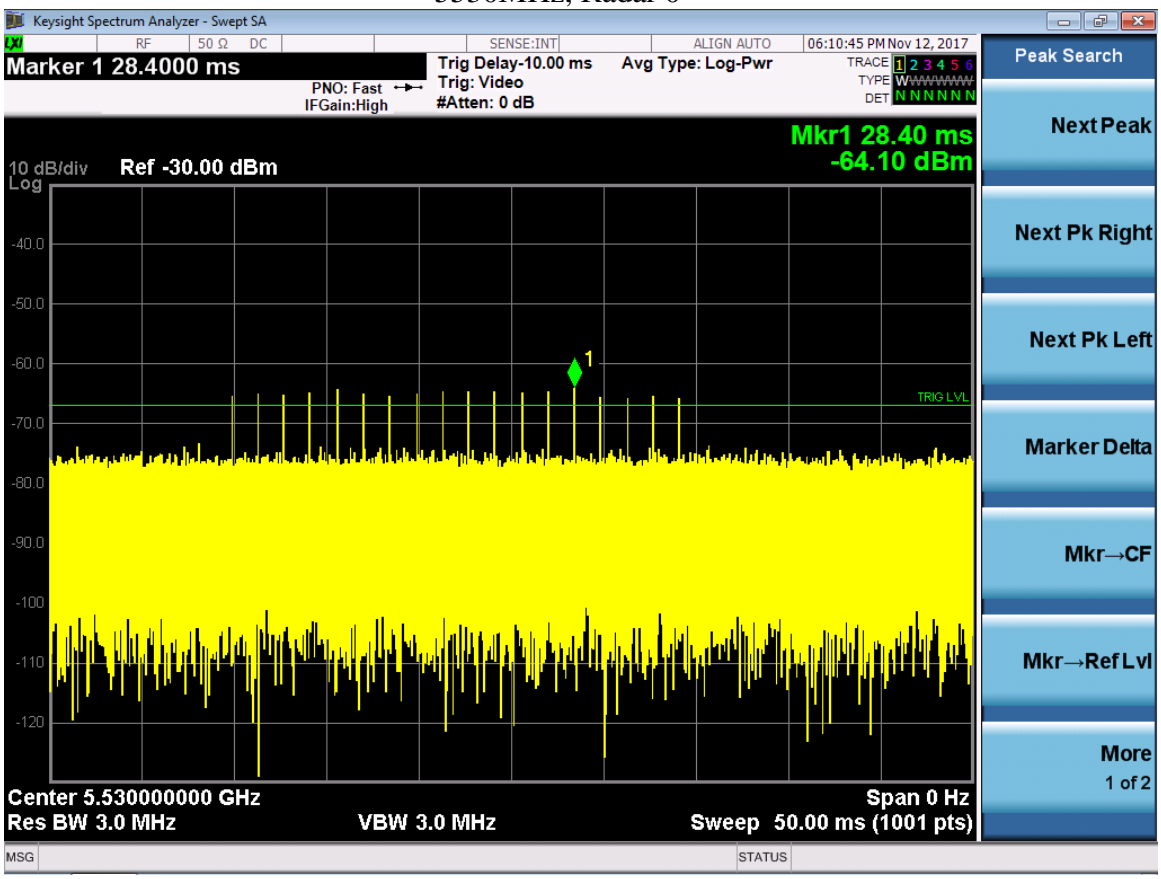
The Interference Radar Detection Threshold Level is -64dBm or -62dBm + 0 [dBi] + 1 dB that had been taken into account the output power range and antenna gain. The above equipment setup was used to calibrate the conducted Radar Waveform. A vector signal generator was utilized to establish the test signal level for each radar type. During this process there were replace 50ohm terminal form Master and Client device and no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) at the frequency of the Radar Waveform generator. Peak detection was used. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to at least 3MHz. The vector signal generator amplitude was set so that the power level measured at the spectrum analyzer was -64dBm or -62dBm + 0 [dBi] + 1 dB. Capture the spectrum analyzer plots on short pulse radar types, long pulse radar type and hopping radar waveform.

Central Frequency of Calibration:

☐ Bandwidth 20MHz: 5500MHz
☐ Bandwidth 40MHz: 5510MHz
☒ Bandwidth 80MHz: 5530MHz

3.9 Radar Waveform Calibration Result

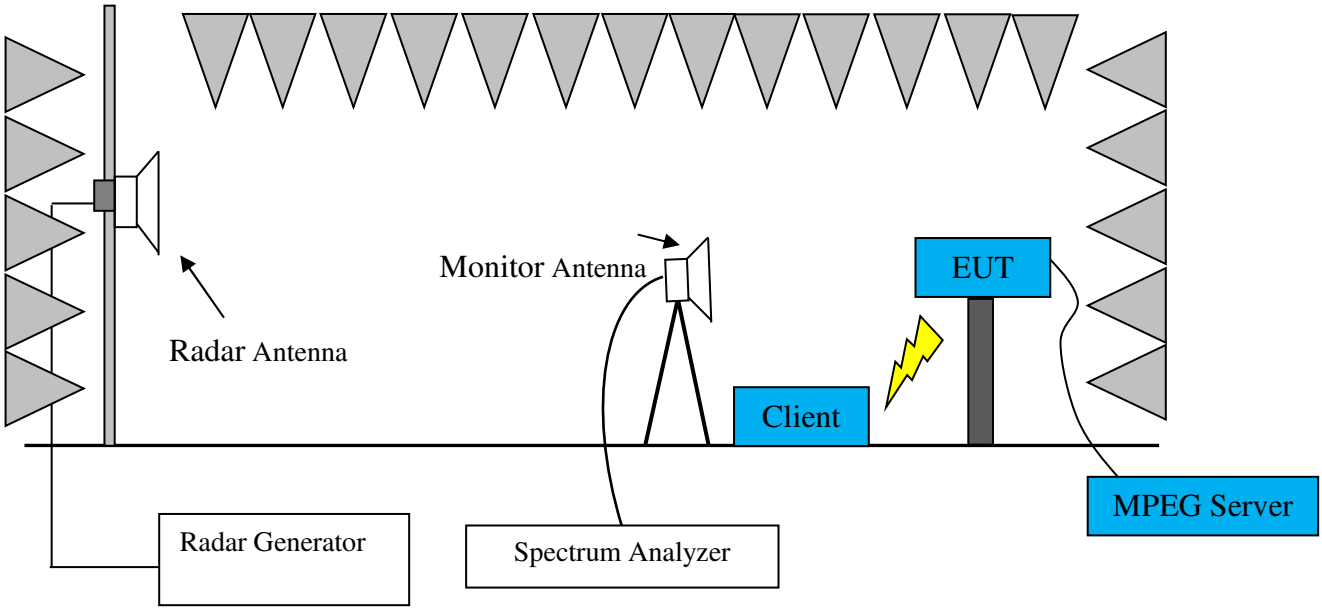
5530MHz, Radar 0



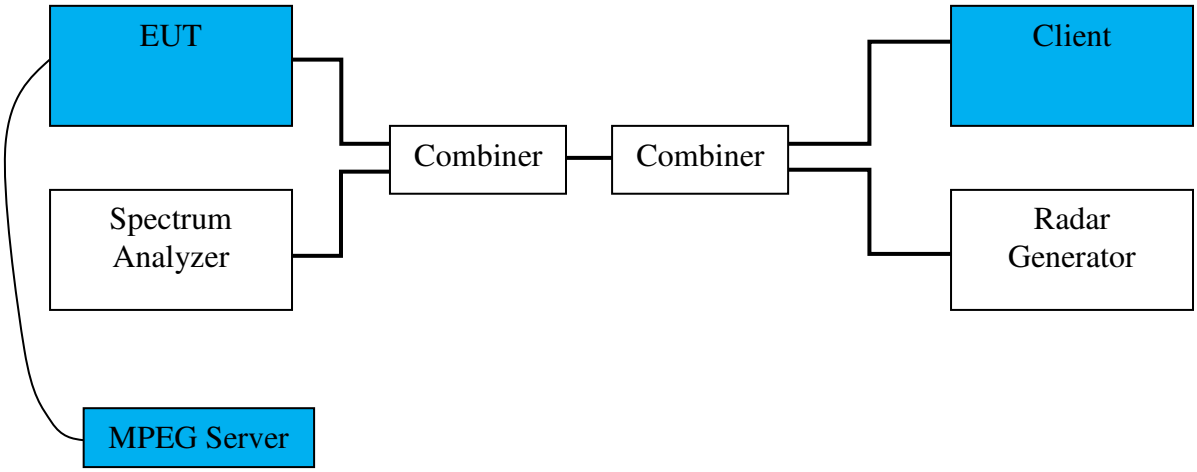
4 DFS DETECTION THRESHOLDS AND RADAR TEST WAVEFORMS

4.1 Test setup

☐Radiated Method



☒Conducted Method



4.2 Test Setup Operation

System testing was performed with the designated MPEG test file that streams full motion video from the Access Point to the Client in full motion video mode using the media player. This file is used by IP and Frame based systems for loading the test channel during the In-service compliance testing.
A spectrum analyzer is used as a monitor to verify that the EUT 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. It is also used to monitor EUT transmissions during the Channel Availability Check Time.

4.3 Move Time, Closing Time, Non-Occupancy Period Measurement

4.3.1 Limit

The Channel Move Time to cease all transmissions on the current Channel upon detection of a Radar Waveform above the DFS Detection Threshold within 10 sec.

The total duration of Channel Closing Transmission Time is 200ms + an aggregate of 60ms over remaining 10s period.

The Non-Occupancy Period time is 30 minute during which a Channel will not be utilized after a Radar Waveform is detected on that Channel.

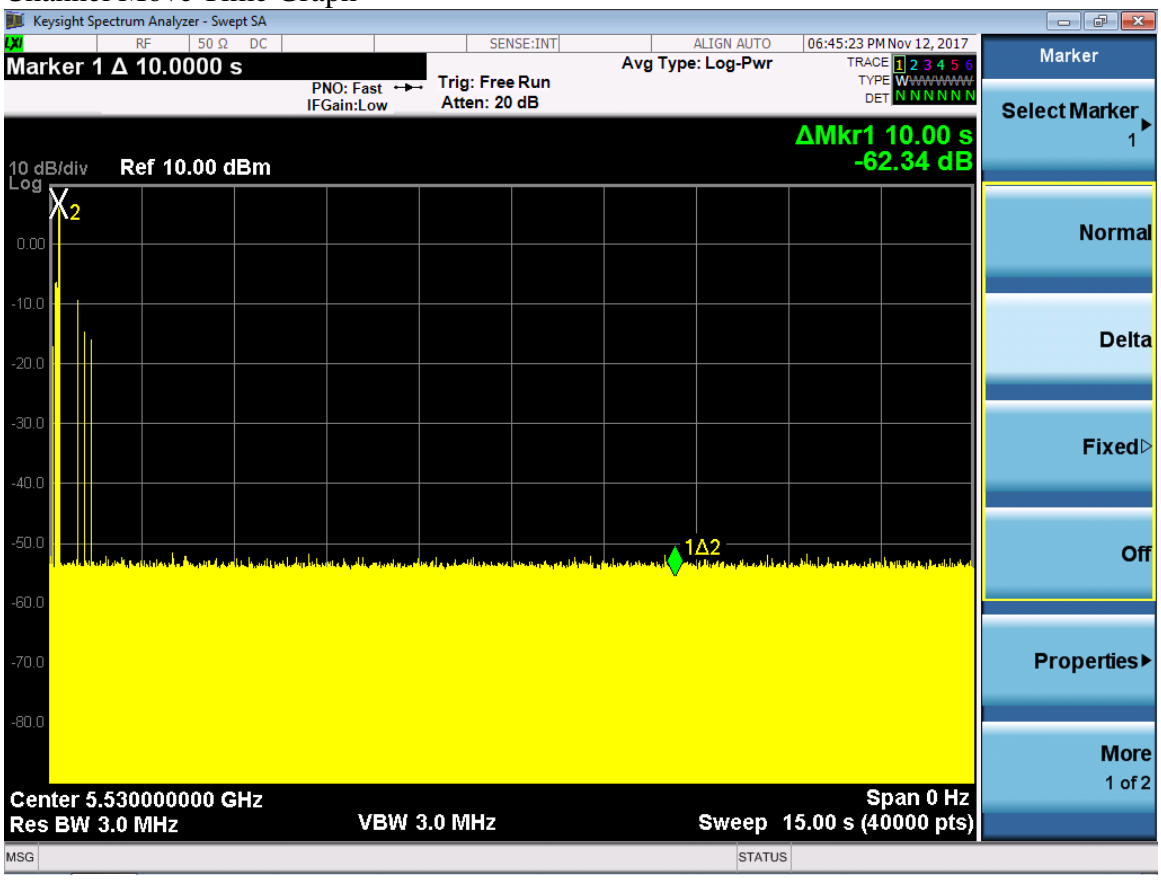
4.3.2 Test Procedures

1. When a radar Burst with a level equal to the DFS Detection Threshold + 1dB is generated on the Operating Channel of the U-NII device. A U-NII device operating as a Client Device will associate with the Master at Channel. 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 radar type 0 at Detection Threshold + 1dB.
2. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). At least a 10 second plot is reported. The *Channel Move Time* will be calculated based on the plot.
3. Measurement of the aggregate duration of the Channel Closing Transmission Time method. With the spectrum analyzer set to zero span tuned to the center frequency of the EUT operating channel at the radar simulated frequency, peak detection, and max hold, the dwell time per bin is given by: Dwell = S / B; where dwell is the dwell time per spectrum analyzer sampling bin, S is the sweep time and B is the number of spectrum analyzer sampling bins. An upper bound of the aggregate duration of the intermittent control signals of *Channel Closing Transmission Time* is calculated by: C = N * Dwell; where C is the Closing Time, N is the number of spectrum analyzer sampling bins (intermittent control signals) showing a U-NII transmission and Dwell is the dwell time per bin.
4. 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.

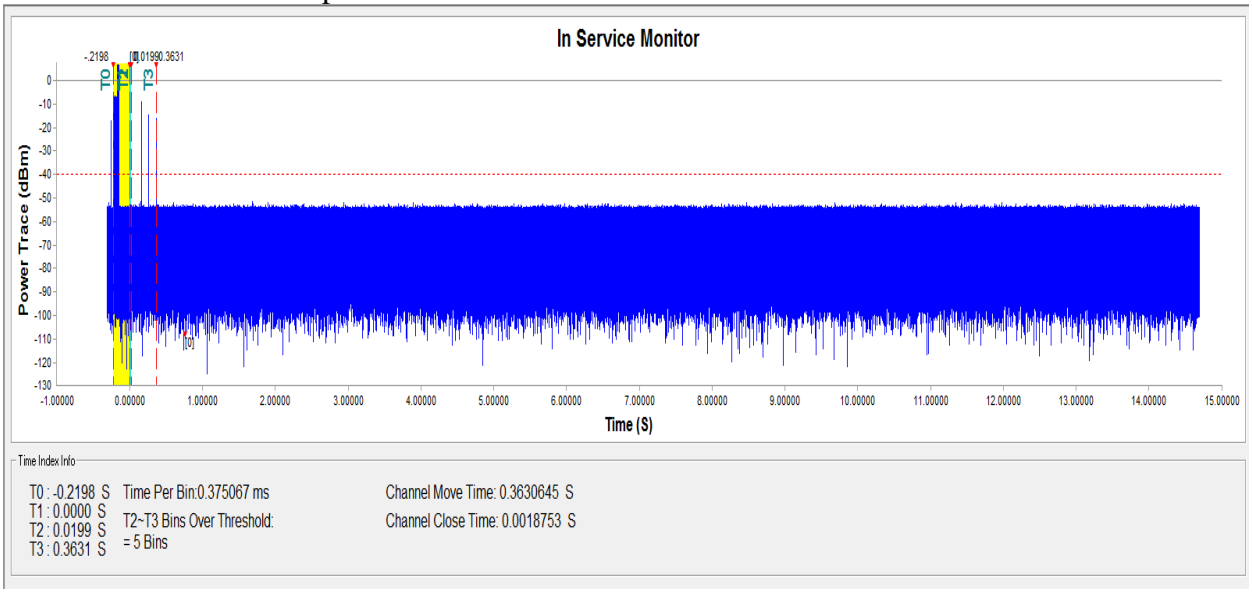
4.3.3 Test Result

Operating freq (MHz)	Channel Move Time (s)	Channel Closing Transmission Time (ms)	Non-Occupancy Period (min)
☐ 5500	/	/	/
☐ 5510	/	/	/
☒ 5530	>10 ***(limit ≥10)***	1.88 ***(limit ≤ 200+60)***	/

Channel Move Time Graph



Channel Close Time Graph



Non-Occupancy Period Graph