FCC Test Report

Dynamic Frequency Selection

Report No: WD-RF-R-190342-E0

Product Name	:	Time Clock
Model Name	:	NT8000X-XX(X can be 0~9 or a~z or A~Z or blank)
Series Model Name	:	NT8000Y-YY(Y can be 0~9 or a~z or A~Z or blank)
FCC ID	:	2ASPANOVATIME-HID
Applicant	:	NOVAtime Technology, Inc.
Received Date	:	Feb. 18, 2019
Tested Date	:	May. 09, 2019 ~ August. 16, 2019
Applicable Standard	:	47 CFR FCC Part 15, Subpart E (Section 15.407) KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

Wendell Industrial Co., Ltd
Wendell Electrical Testing Lab.

Test Report

Issued Date: August 16, 2019

Project No.: 19Q021808

Product Name	Time Clock
Trade Name	NOVAtime Technology, Inc.
Model Name	NT8000X-XX(X can be 0~9 or a~z or A~Z or blank)
Series Model Name	NT8000Y-YY(Y can be 0~9 or a~z or A~Z or blank)
FCC ID	2ASPANOVATIME-HID
Applicant	NOVAtime Technology, Inc.
Manufacturer	unitech electronics co., ltd.
EUT Rated Voltage	AC 100 ~ 240V / 50 or 60Hz、PoE
EUT Test Voltage	AC 120V / 60Hz
EUT Supports Radios Application	WLAN 802.11a/b/g、WLAN 802.11n (HT20/HT40) Bluetooth BR/EDR/LE、RFID
Applicable Standard	47 CFR FCC Part 15, Subpart E (Section 15.407) KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02
Test Result	Complied

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(Project Manager / Gary Wu)

Table of Contents

Document Revision History

Report No.	Issue date	Description
WD-RF-R-190342-E0	August 16, 2019	Initial report

Summary of Test Result

Ref. Std. Clause	Test Items	Result
15.407	DFS Detection Threshold	N/A
15.407	Channel Availability Check Time	N/A
15.407	Channel Move Time	Pass
15.407	Channel Closing Transmission Time	Pass
15.407	Non-Occupancy Period	Pass
15.407	Uniform Spreading	N/A
15.407	U-NII Detection Bandwidth	N/A
15.407	Non-associated test	N/A
15.407	Non-Co-Channel test	N/A
Remark：N/A is not applicable		

1 Generation Information

1.1 Applicant

NOVAtime Technology, Inc.
9680 Haven Avenue, Suite #200, Rancho Cucamonga, CA 91730

1.2 Manufacturer

unitech electronics co., ltd.
5FI., No.136, Lane 235, Pao-Chiao Rd., Hsin-Tien Dist, New Taipei City, Taiwan 231, R.O.C.

1.3 Description of Equipment under Test

Product Name	Time Clock
Model No.	NT8000X-XX(X can be 0~9 or a~z or A~Z or blank)
Series Model No.	NT8000Y-YY(Y can be 0~9 or a~z or A~Z or blank)
FCC ID	2ASPANOVATIME-HID
Frequency Range	802.11a/n-20MHz: 5180-5320MHz, 5500-5700MHz, 5745-5825MHz 802.11n-40MHz: 5190-5310, 5510-5670MHz, 5755-5795MHz
Number of Channels	802.11a/n-20MHz: 24; 802.11n-40MHz: 11
Data Rate	802.11a: 6 - 54Mbps 802.11n: up to 300Mbps
Type of Modulation	802.11a/n: OFDM, BPSK, QPSK, 16QAM, 64QAM
Antenna Information	Refer to the table “Antenna List”
DFS Function	☐ Master ☒ Client (without radar detection) ☐ Client (with radar detection)
TPC Function	☒ < 500mW not required ☐ ≥ 500mW employ a TPC
Category of equipment	☐ Adaptive Equipment with LBT based Channel Access Mechanism (Frame Based Equipment) ☒ Adaptive Equipment with LBT based Channel Access Mechanism (Load Based Equipment)
EUT Supports Radios Application	WLAN 802.11a/b/g WLAN 802.11n (HT20/HT40) Bluetooth BR/EDR/LE RFID
EUT Rated Voltage	AC 100 ~ 240V / 50 or 60Hz、PoE
EUT Test Voltage	AC 120V / 60Hz

The EUT uses following adapter

Trade Name	ENG Electric co., Ltd.
Model No.	6A-601DB12
Input Power	AC 100 ~ 240V / 50 or 60Hz、PoE
Output Power	DC 12V/5.0A
Power Line	Non-shielded, 1 Core, 1.5m

Note: FCC ID: 2ASPANOVATIME-EM, 2ASPANOVATIME-HID and 2ASPANOVATIME-OEM use the same WIFI and Bluetooth modules, be used platform Time Clock, the platform is used identical internal printed circuit board layouts, have a common design and components, differ only in the 125kHz and 13.56MHz modular.

Antenna List

No.	Manufacturer	Model No.	Antenna Type	Peak Gain
1	JOYMAX	TBF-UT01MPXX-752	Dipole	6 dBi for 5.15 ~ 5.25 GHz 6 dBi for 5.25 ~ 5.35 GHz 6 dBi for 5.47 ~ 5.725 GHz 6 dBi for 5.725 ~ 5.85 GHz

Remark: The antenna of EUT is conforming to FCC 15.203

Channel List

802.11a/n HT20		802.11n HT40	
Channel	**Frequency(MHz)**	**Channel**	**Frequency(MHz)**
36	5180	38	5190
40	5200	46	5230
44	5220	54	5270
48	5240	62	5310
52	5260	102	5510
56	5280	110	5550
60	5300	118	5590
64	5320	126	5630
100	5500	134	5670
104	5520	151	5755
108	5540	159	5795
112	5560	--	--
116	5580	--	--
120	5600	--	--
124	5620	--	--
128	5640	--	--
132	5660	--	--
136	5680	--	--
140	5700	--	--
149	5745	--	--
153	5765	--	--
157	5785	--	--
161	5805	--	--
165	5825	--	--

1.4 Test Facility

Items	Required (IEC 60068-1)	Actual
Temperature (°C)	15-35	25
Humidity (% RH)	25-75	65
Barometric pressure (mbar)	860-1060	1001

Description: Accredited by TAF
Accredited Number: 2965

Issued by: Wendell Industrial Co., Ltd

Lab Address: 6F/6F-1, No.188, Baoqiao Rd., Xindian Dist.,
New Taipei City 23145, Taiwan R.O.C

Test Lab: Wendell Electrical Testing Laboratory

Test Location: No.67-9, Shimen Rd., Tucheng Dist.,
New Taipei City 236, Taiwan R.O.C

FCC Accreditation Number: TW2965

FCC Designation Number: TW1118

1.5 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence (level based on a coverage factor K=2)

Measurement	Frequency (MHz)	Expended Uncertainty
Radiated Emission	0.009 ~ 30	3.8 dB
	30 ~ 1000	3.5 dB
	1000 ~ 18000	3.7 dB
	18000 ~ 40000	3.8 dB
RF Power, Conducted	1000 ~ 6000 MHz	1.3 dB
Occupied Bandwidth	1000 ~ 6000 MHz	3 %
Power Density	1000 ~ 6000 MHz	1.4 dB
Duty Cycle	1000 ~ 6000 MHz	1.1 %
DC Power Supply	0.5 ~ 30 V	1.7 %
Temperature	15 ~ 30 ℃	0.8 ℃
Humidity	40 ~ 80 %	3.8 %
Frequency Stability	1000 ~ 6000 MHz	5.1 ppm

1.6 List of Test Equipment

For Conducted measurements / RF Conducted Measurement Room

Equipment		Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
✓	Spectrum analyzer	Keysight	N9010A	MY54200737	2018/10/24	2019/10/23
✓	RF Vector Signal Generator	Keysight	N5182B	MY53052599	2018/10/25	2019/10/24
✓	DFS Fixture	MVE	N/A	CT-9-059	2019/6/15	2020/6/14

Remark:

1. All equipments are calibrated every one year.
2. The test instruments marked with "✓" are used to measure the final test results.
3. Test Software version: Keysight DFS Radar Profiles v3.0.0.0

Product	Manufacturer	Model No.	Serial No.	Power Cord
Notebook PC	acer	N16Q1	NXVD4TA023742254707600	Non-shielded, 1 Core, 0.8m
Access Point	LINKSYS	WHW03	N/A	Non-shielded, Non-Core, 1.5m

Remark: Access Point with FCC ID: Q87-WHW03

2 Requirements of DFS Test

2.1 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

2.2 Applicability of DFS Requirements During Normal Operation

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

Additional requirements for devices with multiple bandwidth modes	Operational Mode	
	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 frequency.

2.3 Requirement of DFS Detection Threshold

Maximum Transmit Power	Value (see notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.
Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.
Note 3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

2.4 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 99% power bandwidth (See Note 3)

Note 1: The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows:

- For the Short pulse radar Test Signals this instant is the end of the Burst.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar Burst generated.
- For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate Channel changes (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 is used and for each frequency step the minimum percentage of detection is 90%. Measurements are performed with no data traffic.

2.5 Requirements of Radar Test Waveforms

Short Pulse Radar Test Waveforms

Once the performance requirements check is complete, statistical data will be gathered, to determine the ability of the device to detect the radar test waveforms (Short Pulse Radar Types 1-4) found in Table 5. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trials. The percentage of successful detection is calculated by:

$$\frac{TotalWaveformDetections}{TotalWaveformTrials} \times 100 = \text{Percentage of Successful Detection } \textit{Radar Waveform } N = P_d N$$

In addition an aggregate minimum percentage of successful detection across all Short Pulse Radar Types 1-4 is required and is calculated as follows:

$$\frac{P_d 1 + P_d 2 + P_d 3 + P_d 4}{4}$$

The minimum number of trails, minimum percentage of successful detection and the aggregate minimum percentage of successful detection are found in **Table 5**.

Table 5

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum 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 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	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	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
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.

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

Long Pulse Radar Test Waveforms

Statistical data will be gathered to determine the ability of the device to detect the Long Pulse Radar Type 5 found in **Table 6**. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trials.

Table 6

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

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.
Note: The center frequency for each of the 30 trials of the Bin 5 radar shall be randomly selected within 80% of the Occupied Bandwidth.

(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 transmission period will have the same chirp width. 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 time between the first and second pulses is chosen independently of the time between the second and third pulses.

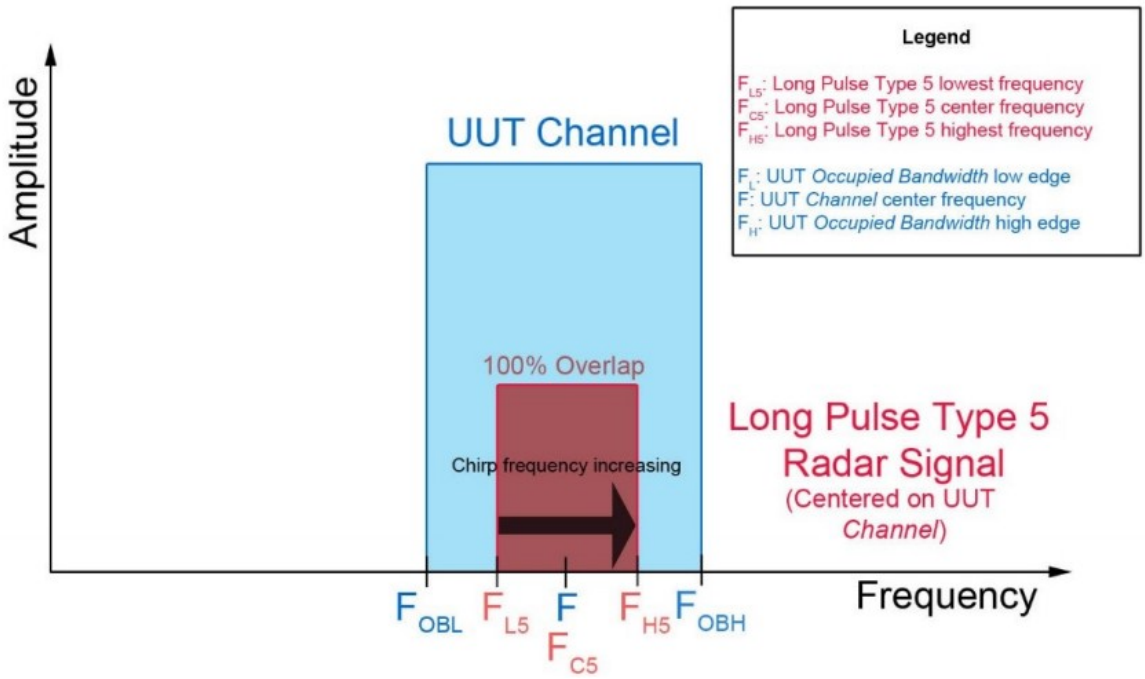
(7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst_Count. Each interval is of length (12,000,000 / Burst_Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 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.

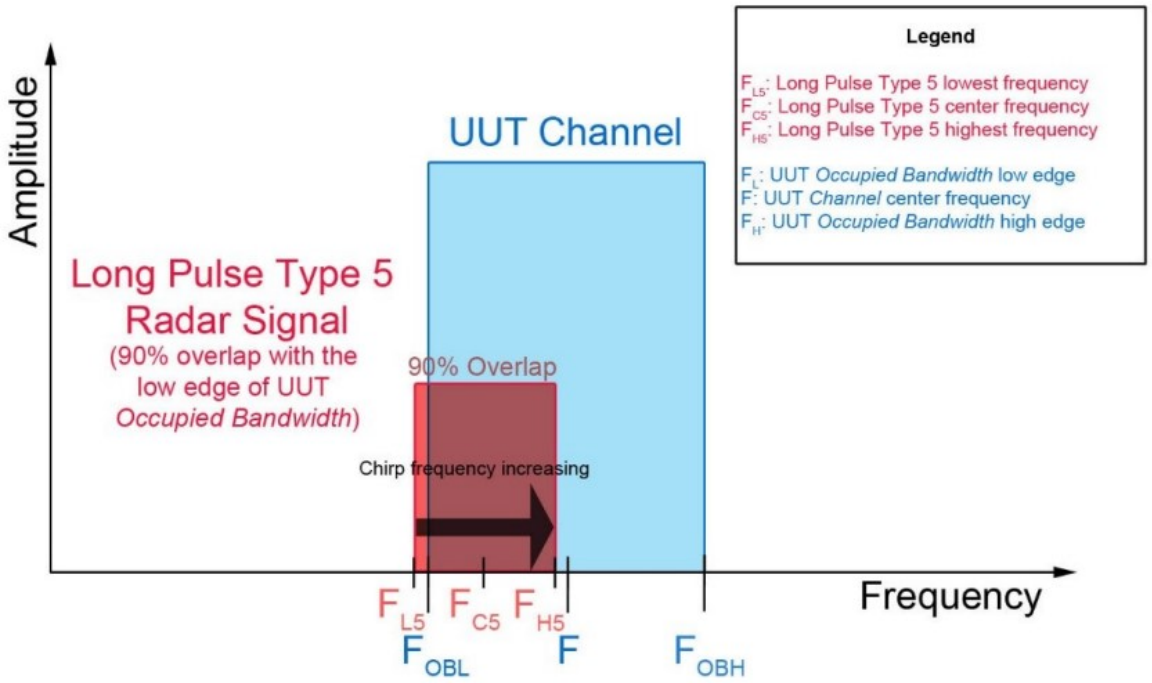
Three subsets of trials will be performed with a minimum of ten trials per subset.
The subset of trials differs in where the Long Pulse Type 5 Signal is tuned in frequency:
a) The Channel center frequency (subset case 1).
b) Tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the low edge of the UUT Occupied Bandwidth (subset case 2).
c) Tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the high edge of the UUT Occupied Bandwidth (subset case 3).

For subset case 1: the center frequency of the signal generator will remain fixed at the center of the UUT Channel.
For subset case 2: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 2. The center frequency of the signal generator for each trial is calculated by: $FL + (0.4 * Chirp\ Width\ [in\ MHz])$
For subset case 3: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 3. The center frequency of the signal generator for each trial is calculated by: $FH - (0.4 * Chirp\ Width\ [in\ MHz])$

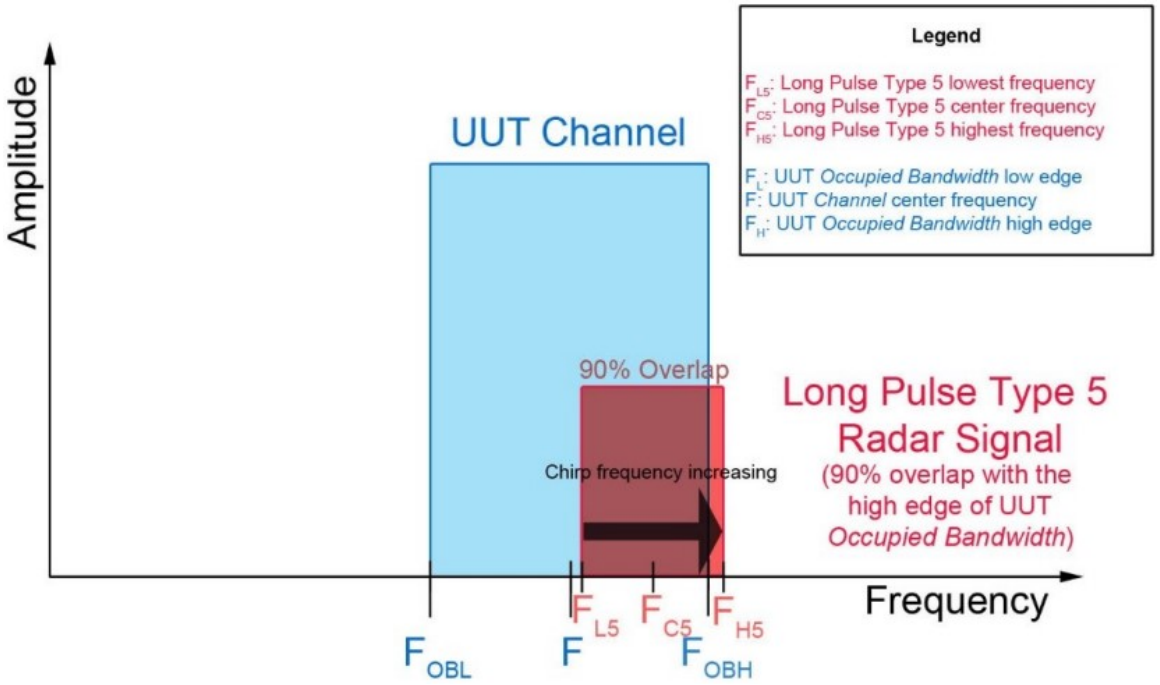
a) Channel center frequency (subset case 1)



b) Tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the low edge of the UUT Occupied Bandwidth. (subset case 2)



c) Tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the high edge of the UUT Occupied Bandwidth. (subset case 3)



The percentage of successful detection is calculated by:

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

Frequency Hopping Radar Test Waveform

Statistical data will be gathered to determine the ability of the device to detect the Frequency Hopping radar test signal (radar type 6) found in Table 7. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The probability of successful detection is calculated by:

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

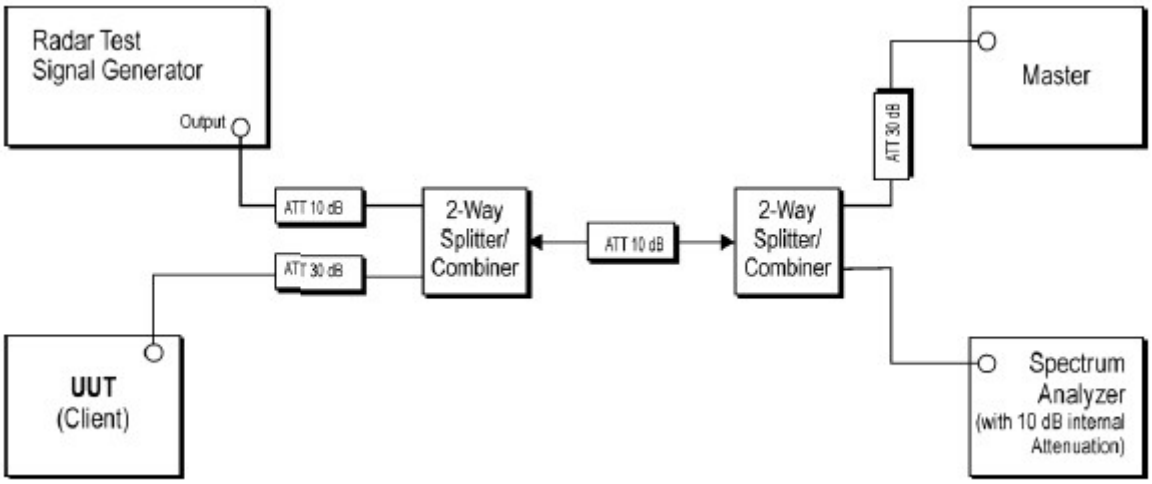
Table 7

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

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 – 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.

2.6 Test Setup



2.7 Radar Test Waveform

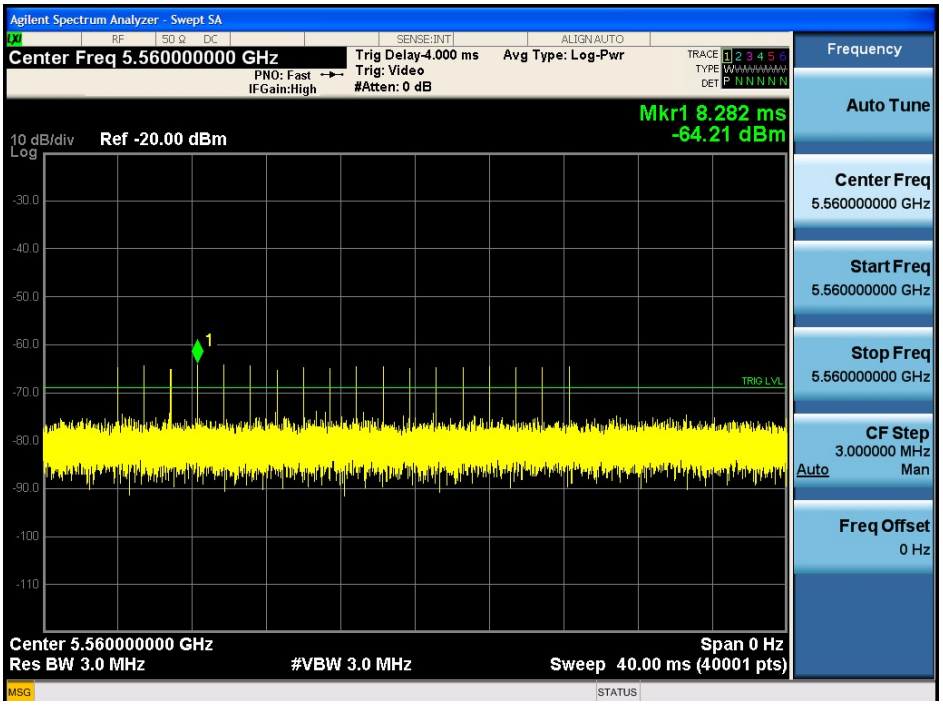
This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for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

2.7.1 Test Procedure

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 RBW and VBW were set to 3 MHz to measure the radar waveform.

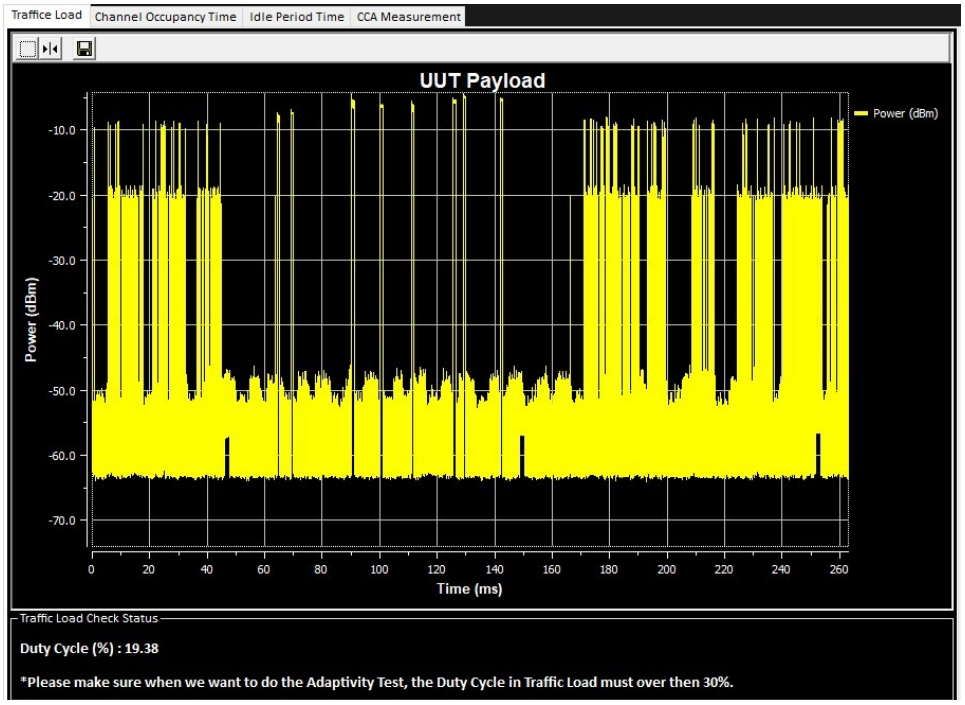
2.7.2 Radar Test Signal Plots

Radar Type 0 Calibration Plot (5560MHz)



2.7.3 Slave Data Traffic Plot Result

Plot of Slave Traffic at 5560MHz



2.8 In-Service Monitoring for Channel Move Time and Channel Closing Transmission Time and Non-Occupancy Period

2.8.1 Test Procedure

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 is generated on the Operating Channel of the U-NII device (In- Service Monitoring).

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

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

c) 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.

d) At time T0 the Radar Waveform generator sends a Burst of pulses for one of the Radar Type 0, on the Operating Channel. An additional 1 dB is added to the radar test signal to ensure it is at or above the DFS Detection Threshold, accounting for equipment variations/errors.

e) Observe the transmissions of the UUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the UUT during the observation time (Channel Move Time). Measure and record the Channel Move Time and Channel Closing Transmission Time if radar detection occurs. Figure 17 illustrates Channel Closing Transmission Time.

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

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

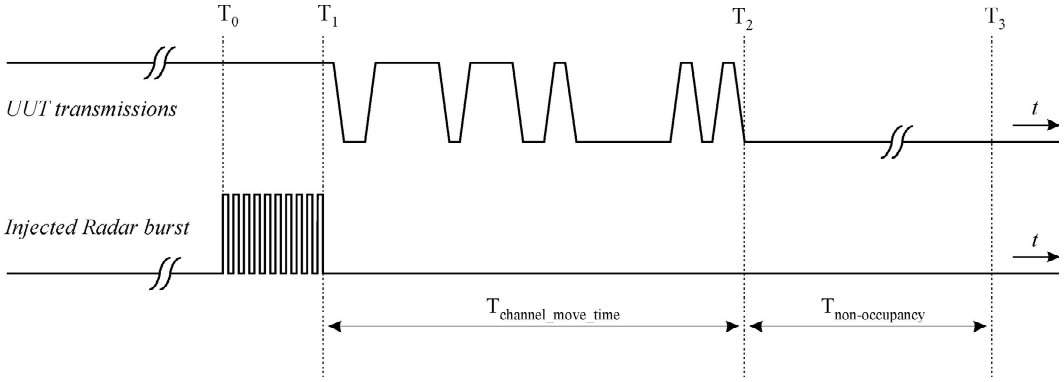
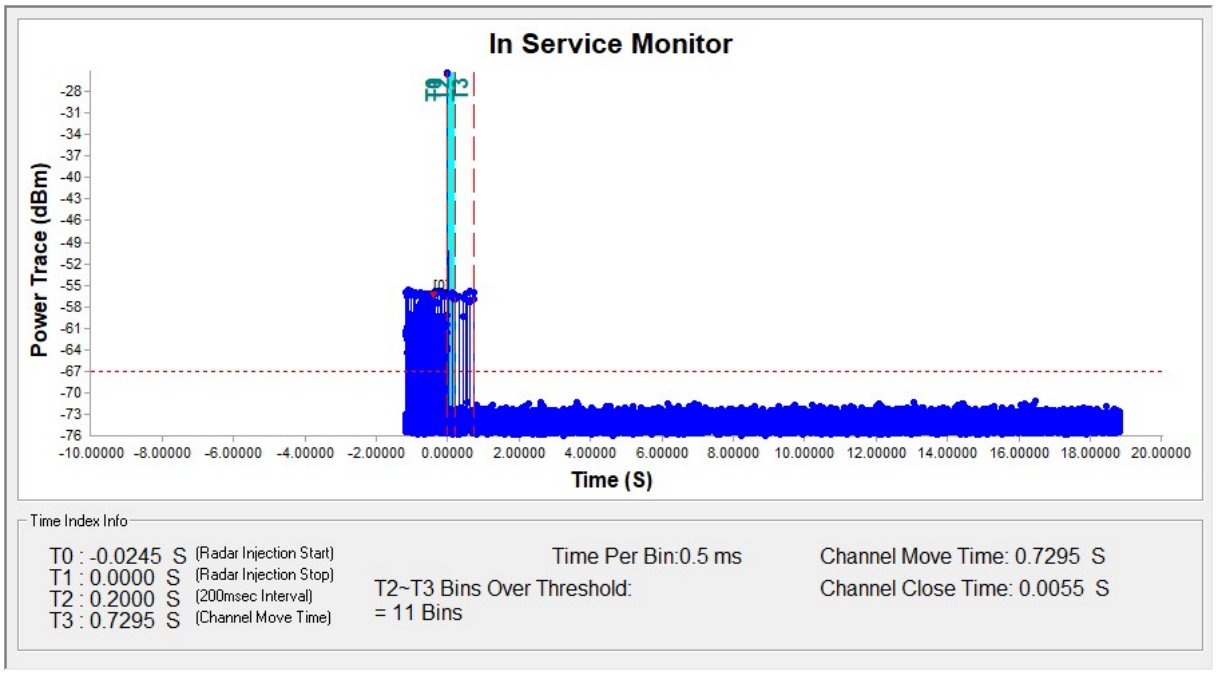


Figure 17: Channel Closing Transmission Time, Channel Move Time and Non-Occupancy Period

2.8.2 Test Result

Test Item	Measured Value (ms)	Limit	Result
Channel Move Time	729.5	＜ 10s	Pass
Channel Closing Transmission Time	5.5	200 milliseconds + approx. 60 milliseconds over remaining 10 seconds period	Pass

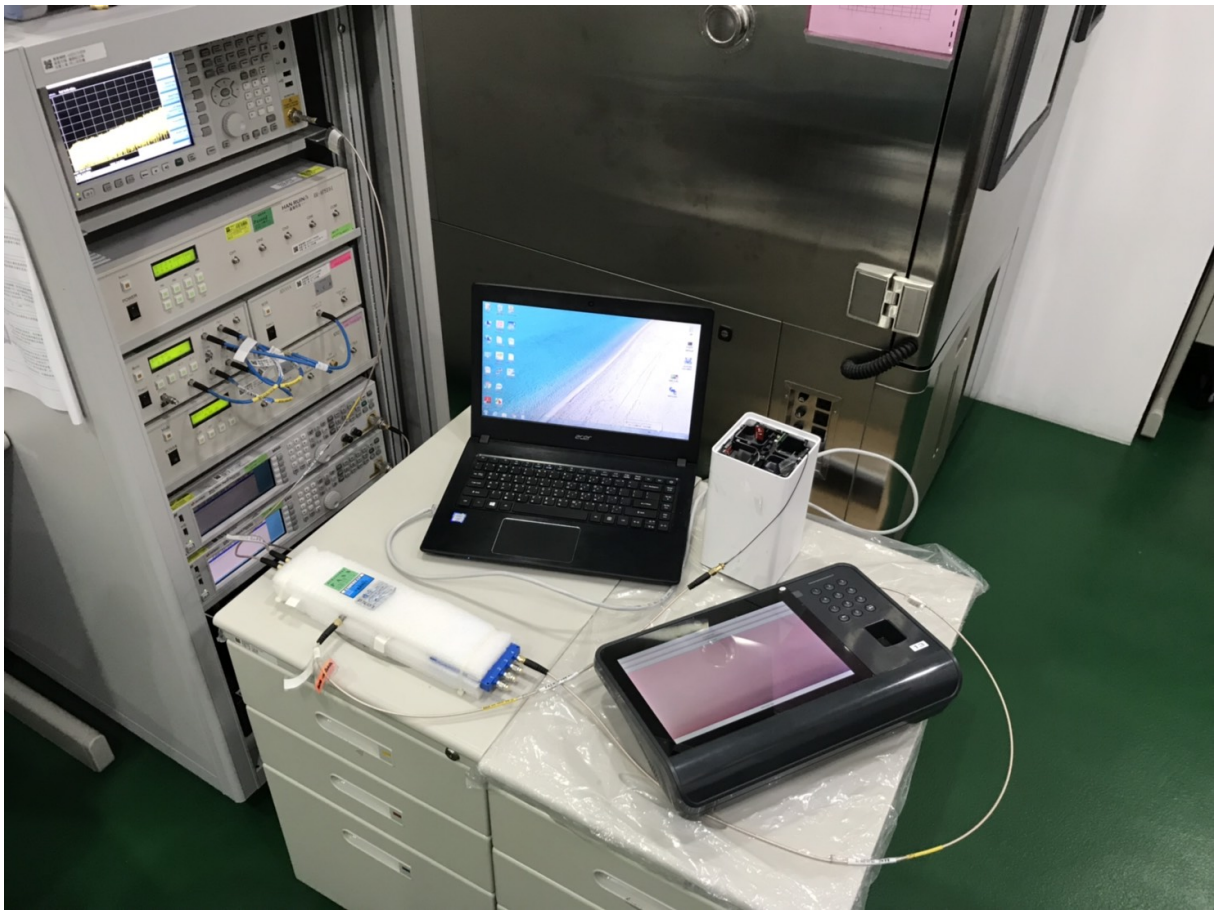
Channel Move Time and Channel Closing Transmission Time for Radar Test Type 0 at 5550MHz



Test Item	Test Result (minute)	Limit (minute)	Result
Non-Occupancy Period	> 30	30	Pass

Non-Occupancy Period for Radar Test Type 0 at 5550 MHz

3 Photographs of EUT DFS Test Configuration



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