



## DFS TEST REPORT

**Report No.:** RF141225E06-5

**FCC ID:** MCLT77H566

**Test Model:** T77H566

**Received Date:** Dec. 24, 2014

**Test Date:** Jan. 26, 2015

**Issued Date:** Feb. 10, 2015

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### RELEASE CONTROL RECORD

| ISSUE NO.     | REASON FOR CHANGE | DATE ISSUED   |
|---------------|-------------------|---------------|
| RF141225E06-5 | Original release  | Feb. 10, 2015 |



## 2. EUT INFORMATION

### 2.1 OPERATING FREQUENCY BANDS AND MODE OF EUT

**TABLE 1: OPERATING FREQUENCY BANDS AND MODE OF EUT**

| OPERATIONAL MODE                                   | OPERATING FREQUENCY RANGE |              |
|----------------------------------------------------|---------------------------|--------------|
|                                                    | 5250~5350MHz              | 5470~5725MHz |
| Client without radar detection and ad hoc function | ✓                         | ✓            |

### 2.2 EUT SOFTWARE AND FIRMWARE VERSION

**TABLE 2: THE EUT SOFTWARE/FIRMWARE VERSION**

| PLATFORM  | NO. | PRODUCT      | MODEL NO. | SOFTWARE/FIRMWARE VERSION |
|-----------|-----|--------------|-----------|---------------------------|
| Windows 8 | 1   | Wi-Fi module | T77H566   | 2014/12/18<br>1.315.28.0  |

### 2.3 DESCRIPTION OF AVAILABLE ANTENNAS TO THE EUT

**TABLE 3: ANTENNA LIST**

| Antenna No | PCB Chain No.     | Brand | Model | Gain (dBi) | Antenna Type | Connector Type | Frequency range (GHz to GHz) |
|------------|-------------------|-------|-------|------------|--------------|----------------|------------------------------|
| 1          | Chain (0)<br>Main | NA    | NA    | 1.88       | PCB          | i-pex(MHF)     | 2.4~2483.5                   |
|            |                   |       |       | 2.51       |              |                | 5.15~5.25                    |
|            |                   |       |       | 2.27       |              |                | 5.25~5.35                    |
|            |                   |       |       | 1.77       |              |                | 5.47~5.725                   |
|            |                   |       |       | 1.54       |              |                | 5.725~5.825                  |
| 2          | Chain (1)<br>Aux  | NA    | NA    | 1.73       | PCB          | i-pex(MHF)     | 2.4~2483.5                   |
|            |                   |       |       | 3.02       |              |                | 5.15~5.25                    |
|            |                   |       |       | 3.4        |              |                | 5.25~5.35                    |
|            |                   |       |       | 2.48       |              |                | 5.47~5.725                   |
|            |                   |       |       | -0.16      |              |                | 5.725~5.825                  |



## 2.4 EUT MAXIMUM CONDUCTED POWER

TABLE 4: THE MEASURED CONDUCTED OUTPUT POWER

### IEEE 802.11a

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 21.97             | 157.233          |
| 5470~5725MHz        | 22.05             | 160.175          |

### IEEE 802.11ac (VHT20)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 21.94             | 156.163          |
| 5470~5725MHz        | 22.05             | 160.34           |

### IEEE 802.11ac (VHT40)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 21.82             | 152.067          |
| 5470~5725MHz        | 21.90             | 154.719          |

### IEEE 802.11ac (VHT80)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 17.29             | 53.586           |
| 5470~5725MHz        | 21                | 125.758          |



## 2.5 EUT MAXIMUM EIRP POWER

TABLE 5: THE EIRP OUTPUT POWER

### IEEE 802.11a

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 25.37             | 343.988          |
| 5470~5725MHz        | 24.53             | 283.527          |

### IEEE 802.11ac (VHT20)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 27.80             | 601.975          |
| 5470~5725MHz        | 27.19             | 523.651          |

### IEEE 802.11ac (VHT40)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 27.68             | 586.185          |
| 5470~5725MHz        | 27.04             | 505.293          |

### IEEE 802.11ac (VHT80)

| Frequency Band(MHz) | MAX. Power        |                  |
|---------------------|-------------------|------------------|
|                     | Output Power(dBm) | Output Power(mW) |
| 5250~5350MHz        | 23.15             | 206.562          |
| 5470~5725MHz        | 26.14             | 410.710          |

## 2.6 TRANSMIT POWER CONTROL (TPC)

U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an EIRP of less than 500 mW.

Maximum EIRP of this device is 601.975mW which more than 500mW, therefore it's require TPC function.

TPC is auto controlled by software to adjust power level when the TX power needs to increase or decrease. So it is automatic TPC.

## 2.7 STATEMENT OF MAUNFACTURER

This device (Client) is without radar detection, then the manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user. **And the device doesn't have Ad Hoc mode on DFS frequency band.**



### 3. U-NII DFS RULE REQUIREMENTS

#### 3.1 WORKING MODES AND REQUIRED TEST ITEMS

The manufacturer shall state whether the UUT is capable of operating as a Master and/or a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately. See tables 6 and 7 for the applicability of DFS requirements for each of the operational modes.

**TABLE 6: APPLICABILITY OF DFS REQUIREMENTS PRIOR TO USE A CHANNEL**

| Requirement                     | Operational Mode |                                |                             |
|---------------------------------|------------------|--------------------------------|-----------------------------|
|                                 | Master           | Client without radar detection | Client with radar detection |
| Non-Occupancy Period            | ✓                | Not required                   | ✓                           |
| DFS Detection Threshold         | ✓                | Not required                   | ✓                           |
| Channel Availability Check Time | ✓                | Not required                   | Not required                |
| U-NII Detection Bandwidth       | ✓                | Not required                   | ✓                           |

**TABLE 7: APPLICABILITY OF DFS REQUIREMENTS DURING NORMAL OPERATION**

| Requirement                       | Operational Mode                      |                                |
|-----------------------------------|---------------------------------------|--------------------------------|
|                                   | Master or Client with radar detection | Client without radar detection |
| DFS Detection Threshold           | ✓                                     | Not required                   |
| Channel Closing Transmission Time | ✓                                     | ✓                              |
| Channel Move Time                 | ✓                                     | ✓                              |
| U-NII Detection Bandwidth         | ✓                                     | 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 all 20 MHz channel blocks and a null frequencies between the bonded 20 MHz channel blocks. |                                       |                                                      |

### 3.2 TEST LIMITS AND RADAR SIGNAL PARAMETERS

#### DETECTION THRESHOLD VALUES

**TABLE 8: DFS DETECTION THRESHOLDS FOR MASTER DEVICES AND CLIENT DEVICES WITH RADAR DETECTION**

| Maximum Transmit Power                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Value<br>(See Notes 1, 2, and 3) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| EIRP $\geq$ 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.</p> <p>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.</p> <p>Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.</p> |                                  |



**TABLE 9: DFS RESPONSE REQUIREMENT VALUES**

| Parameter                         | Value                                                                                                     |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------|
| Non-occupancy period              | Minimum 30 minutes                                                                                        |
| Channel Availability Check Time   | 60 seconds                                                                                                |
| Channel Move Time                 | 10 seconds<br>See Note 1.                                                                                 |
| Channel Closing Transmission Time | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period.<br>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.

**PARAMETERS OF DFS TEST SIGNALS**

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.



**TABLE 10: 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                  | <p>Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a</p> <p>-----</p> <p>Test B: 15 unique PRI values randomly selected within the range of 518-3066 μ sec, with a minimum increment of 1 μ sec, excluding PRI values selected in Test A</p> | $\text{Roundup} \left\{ \begin{array}{l} \frac{1}{360} \\ \frac{19 \cdot 10^6}{\text{PRI}_{\mu\text{sec}}} \end{array} \right\}$ | 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. |                    |                                                                                                                                                                                                                                                                                      |                                                                                                                                  |                                            |                          |

**TABLE 11: 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                       |



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**TABLE 12: FREQUENCY HOPPING RADAR TEST WAVEFORM**

| <b>RADAR TYPE</b> | <b>PULSE WIDTH (μsec)</b> | <b>PRI (μsec)</b> | <b>PULSES PER HOP</b> | <b>HOPPING RATE (kHz)</b> | <b>HOPPING SEQUENCE LENGTH (msec)</b> | <b>MINIMUM PERCENTAGE OF SUCCESSFUL DETECTION</b> | <b>MINIMUM NUMBER OF TRIALS</b> |
|-------------------|---------------------------|-------------------|-----------------------|---------------------------|---------------------------------------|---------------------------------------------------|---------------------------------|
| 6                 | 1                         | 333               | 9                     | 0.333                     | 300                                   | 70%                                               | 30                              |

#### 4. TEST & SUPPORT EQUIPMENT LIST

##### 4.1 TEST INSTRUMENTS

**TABLE 13: TEST INSTRUMENTS LIST.**

| DESCRIPTION & MANUFACTURER  | MODEL NO. | SERIAL NO. | CALIBRATED DATE | CALIBRATED UNTIL |
|-----------------------------|-----------|------------|-----------------|------------------|
| Spectrum Analyzer R&S       | FSW8      | 101497     | Aug. 06, 2014   | Aug. 05, 2015    |
| Vector Signal Generator R&S | SMJ100A   | 101878     | Aug. 12, 2014   | Aug. 11, 2015    |

##### 4.2 DESCRIPTION OF SUPPORT UNITS

**TABLE 14: SUPPORT UNIT INFORMATION.**

| NO. | PRODUCT            | BRAND  | MODEL NO. | ID                  | SPEC.                                                   |
|-----|--------------------|--------|-----------|---------------------|---------------------------------------------------------|
| 1   | WIRELESS AC MODULE | D-Link | WMC-AC01  | RRK20120600<br>56-1 | The maximum EIRP is 27.64 dBm, Antenna Gain is 3.428dBi |

**NOTE:** This device was functioned as a  Master  Slave device during the DFS test.

**TABLE 15: SOFTWARE/FIRMWARE INFORMATION.**

| NO. | PRODUCT            | MODEL NO. | SOFTWARE/FIRMWARE VERSION |
|-----|--------------------|-----------|---------------------------|
| 1.  | WIRELESS AC MODULE | WMC-AC01  | 1.00 Wed 06 Mar 2013      |

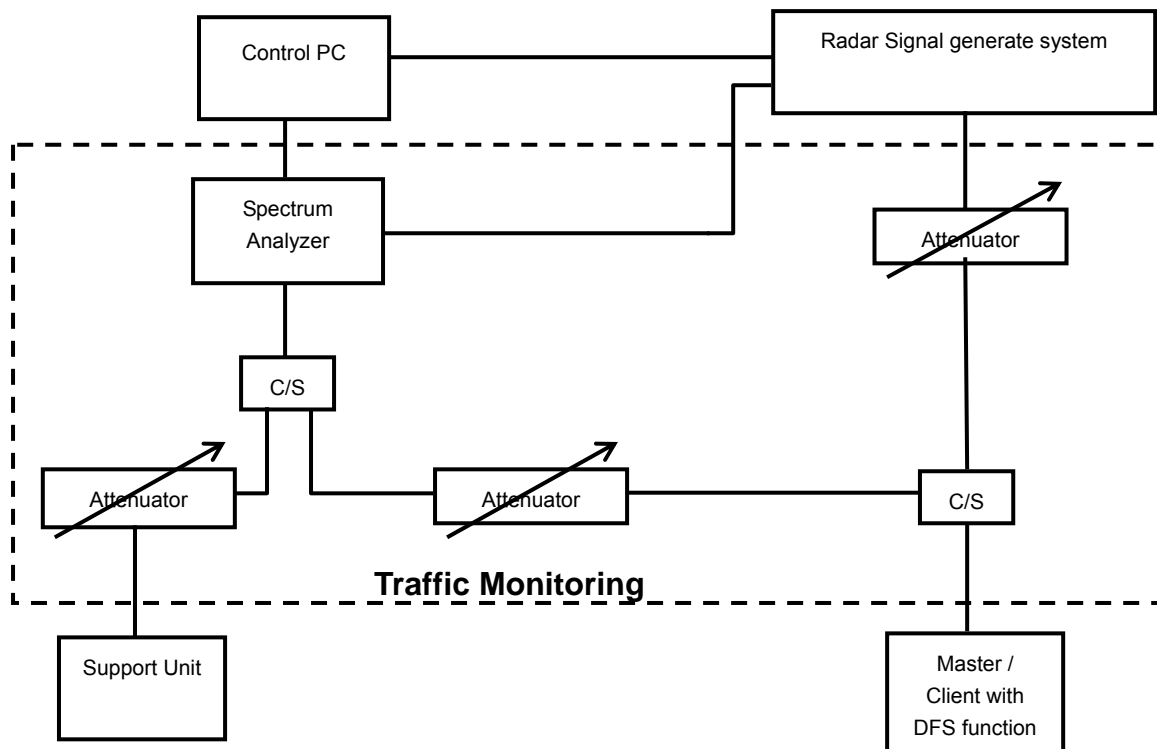
Note: This module WMC-AC01 was installed in the DIR-868L AP.

## 5. TEST PROCEDURE

### 5.1 DFS MEASUREMENT SYSTEM:

A complete DFS Measurement System consists of Radar signal generate system to generating the radar waveforms in Table 10, 11 and 12. The traffic monitoring system is specified to the type of unit under test (UUT).

#### Conducted setup configuration of DFS Measurement System



#### Channel Loading

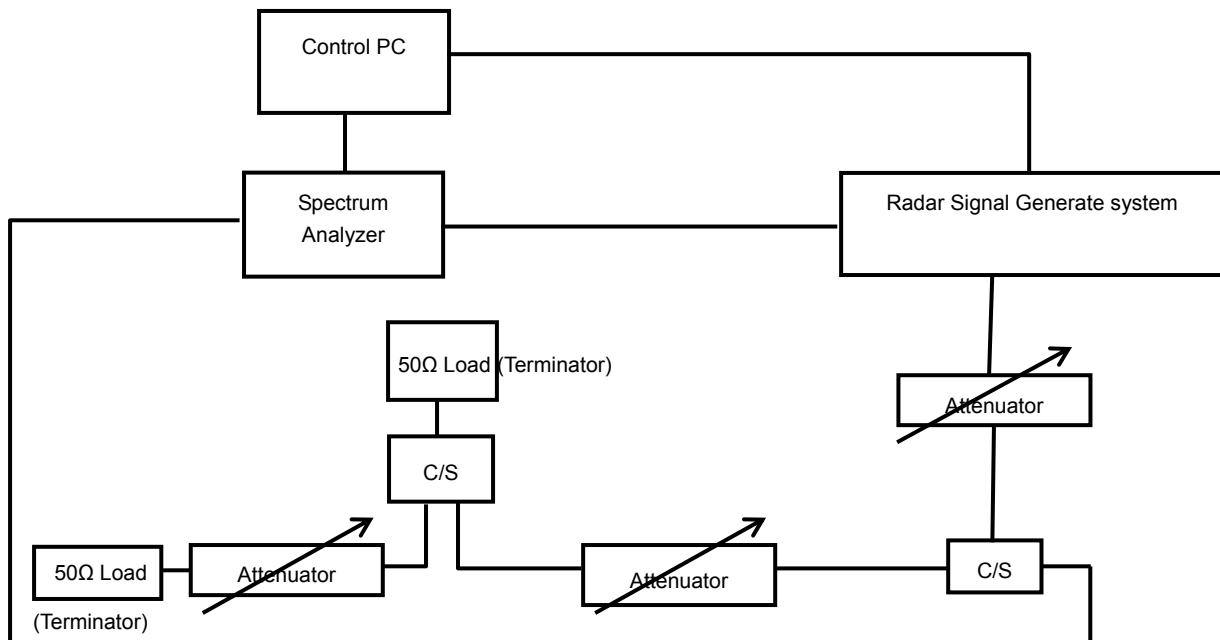
System testing will be performed with channel-loading using means appropriate to the data types that are used by the unlicensed device. The following requirements apply:

|    |                                                                                                                                                                         |   |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 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.                                                    | ✓ |
| d) | Unicast or Multicast protocols are preferable but other protocols may be used. The appropriate protocol used must be described in the test procedures.                  |   |

## 5.2 CALIBRATION OF DFS DETECTION THRESHOLD LEVEL:

The measured channel is 5500 MHz in 20MHz Bandwidth, 5510MHz in 40MHz Bandwidth and 5530MHz in 80MHz Bandwidth. The radar signal was the same as transmitted channels, and injected into the antenna port of AP (master) or Client Device with Radar Detection, measured the channel closing transmission time and channel move time. The Master antenna gain is 3.428dBi and required detection threshold is -59.572dBm (= -64 +1 +3.428). The calibrated conducted detection threshold level is set to -59.572 dBm.

### CONDUCTED SETUP CONFIGURATION OF CALIBRATION OF DFS DETECTION THRESHOLD LEVEL



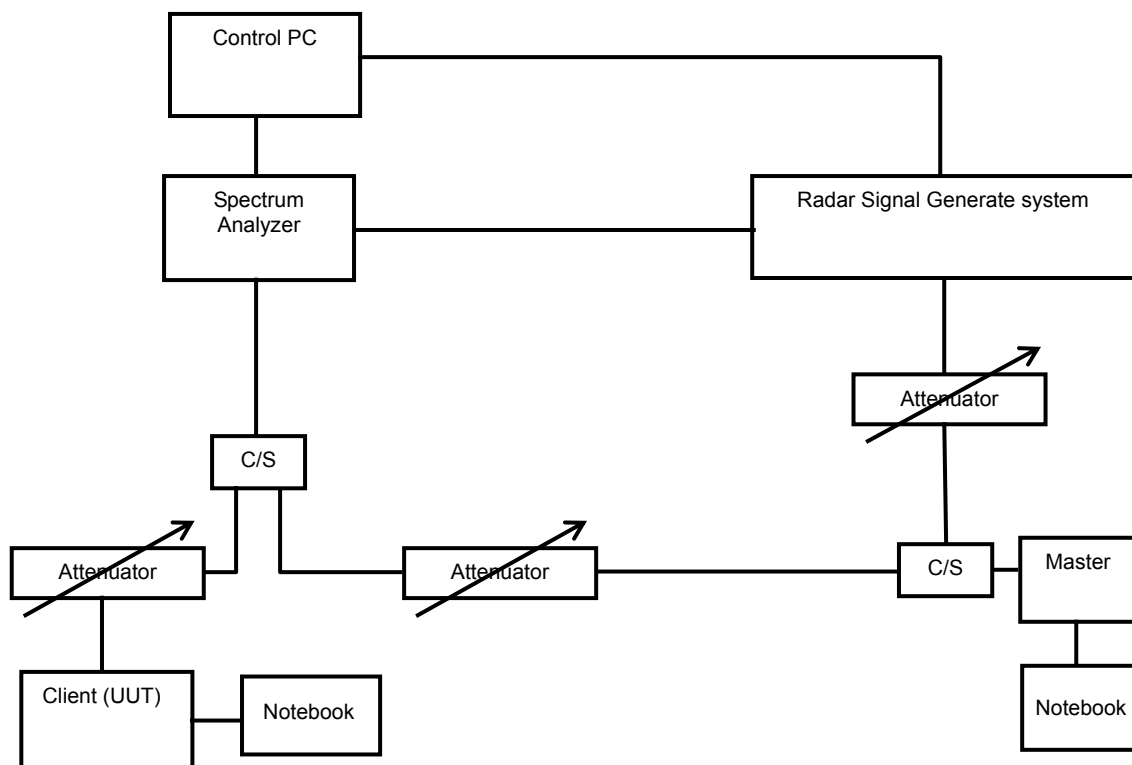


### 5.3 DEVIATION FROM TEST STANDARD

No deviation.

### 5.4 CONDUCTED TEST SETUP CONFIGURATION

#### 5.4.1 CLIENT WITHOUT RADAR DETECTION MODE



The UUT is a U-NII Device operating in Client mode without radar detection. The radar test signals are injected into the Master Device.



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## 6. TEST RESULTS

### 6.1 SUMMARY OF TEST RESULTS

| CLAUSE | TEST PARAMETER                    | REMARKS        | PASS/FAIL |
|--------|-----------------------------------|----------------|-----------|
| 15.407 | DFS Detection Threshold           | Not Applicable | NA        |
| 15.407 | Channel Availability Check Time   | Not Applicable | NA        |
| 15.407 | Channel Move Time                 | Applicable     | Pass      |
| 15.407 | Channel Closing Transmission Time | Applicable     | Pass      |
| 15.407 | Non- Occupancy Period             | Applicable     | Pass      |
| 15.407 | U-NII Detection Bandwidth         | Not Applicable | NA        |
| 15.407 | Non-associated test               | Applicable     | Pass      |
| 15.407 | Non-Co-Channel test               | Applicable     | Pass      |

## 6.2 DETAILED TEST RESULTS

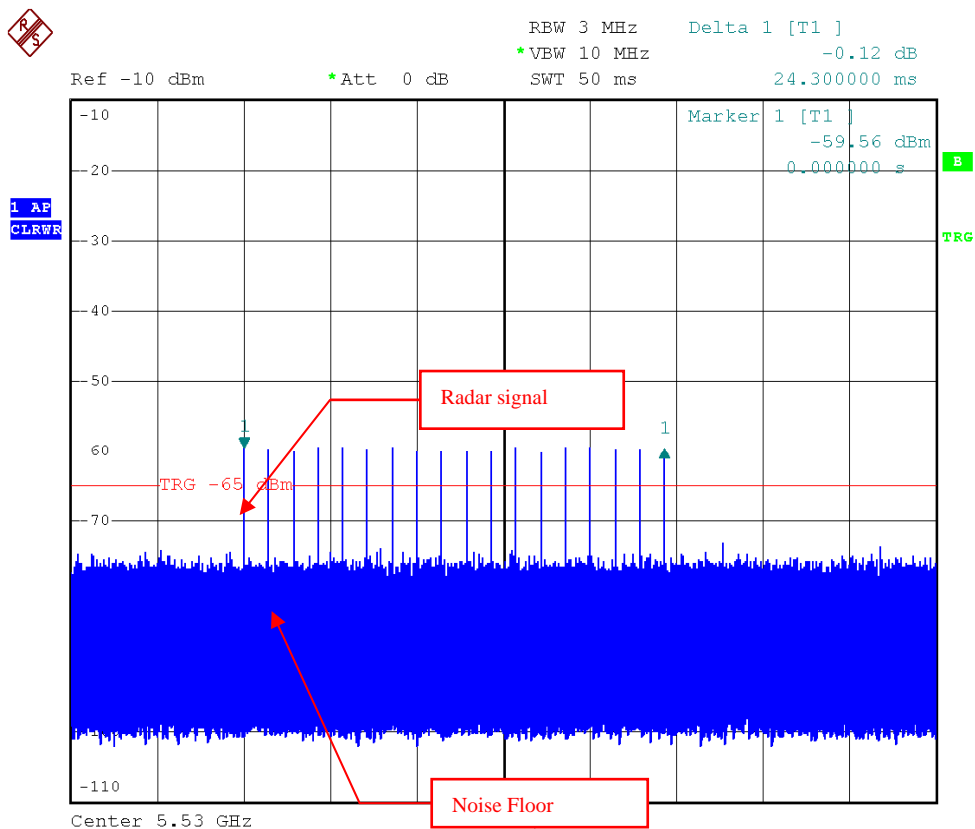
### 6.2.1 TEST MODE: DEVICE OPERATING IN CLIENT WITHOUT RADAR DETECTION MODE.

The radar test signals are injected into the Master Device.

This test was investigated for different bandwidth (20MHz , 40MHz and 80MHz). The following plots was done on 80MHz as a representative

#### 6.2.1.1 DFS DETECTION THRESHOLD

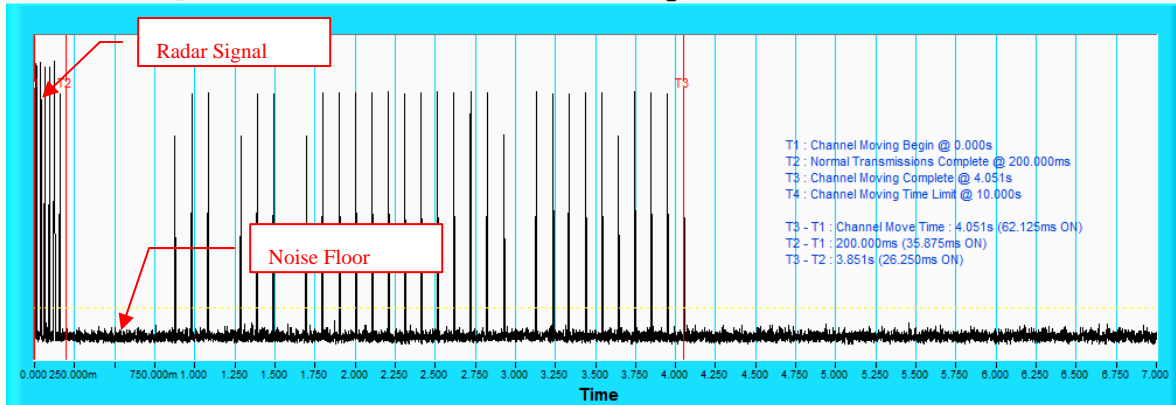
The required detection threshold is  $-59.572\text{dBm}$  ( $= -64 + 3.428 + 1$ ). The conducted radar burst level is set to  $-59.572\text{dBm}$ .



Radar Signal 0

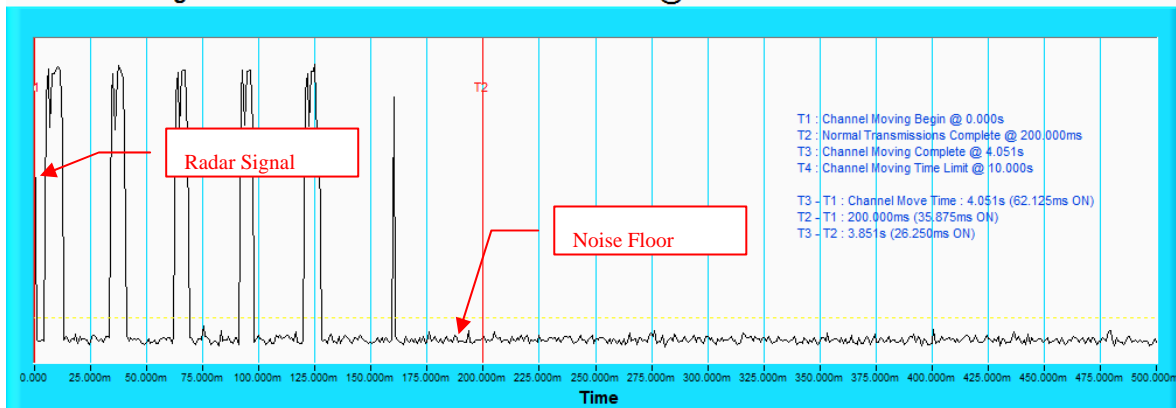
### 6.2.1.2 CHANNEL CLOSING TRANSMISSION AND CHANNEL MOVE TIME

Channel Closing Transmission Time & Channel Move Time @ CH106



**NOTE:** T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

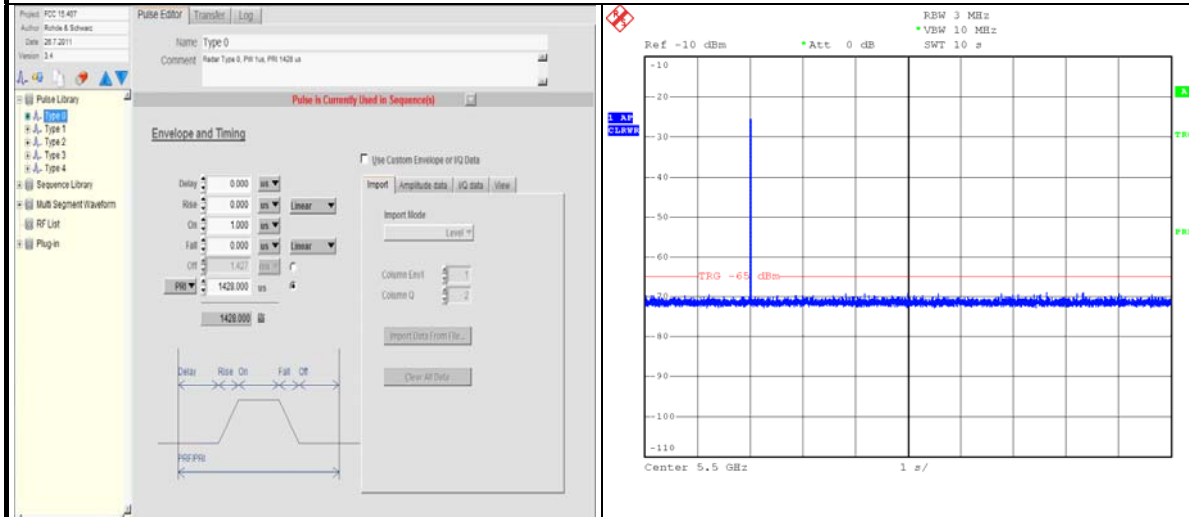
Channel Closing Transmission Time & Channel Move Time @ CH106



**NOTE:** An expanded plot for the device vacates the channel in the required 500ms.



3). The device transmits one type of radar as specified in the DFS Order.

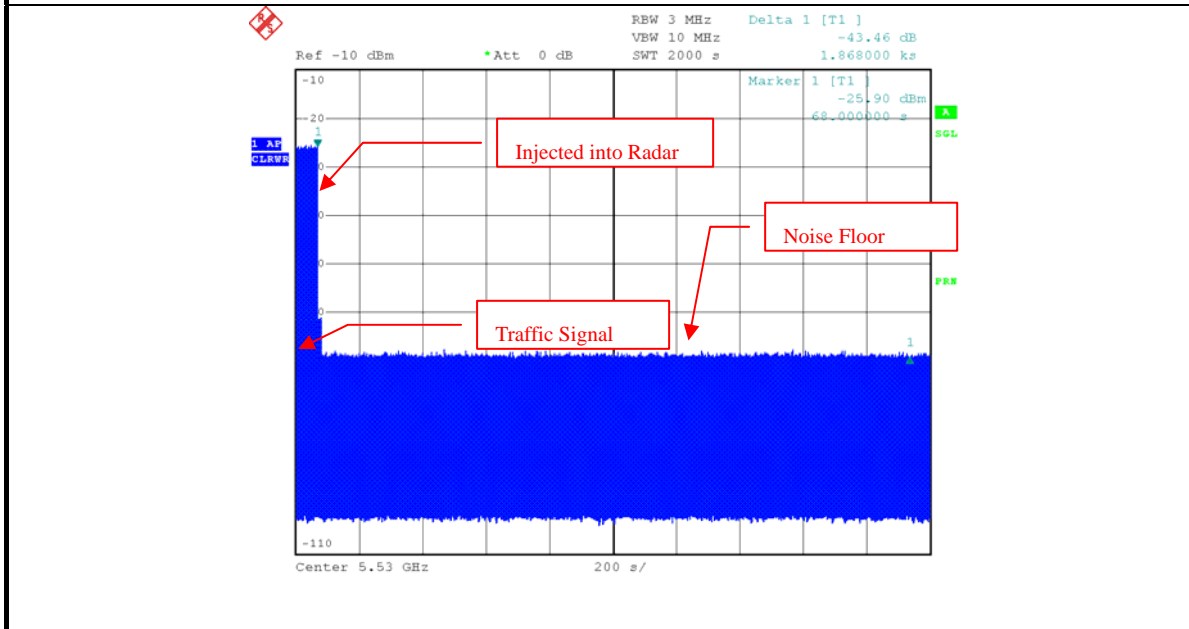


**Radar 0 is used to test during DFS testing.**

4) The test frequency has been monitored to ensure no transmission of any type has occurred for 30 minutes;

Note: If the client moves with the master, the device is considered compliant if nothing appears in the client non-occupancy period test. For devices that shut down (rather than moving channels), no beacons should appear;

5) An analyzer plot that contains a single 30-minute sweep on the original test frequency.

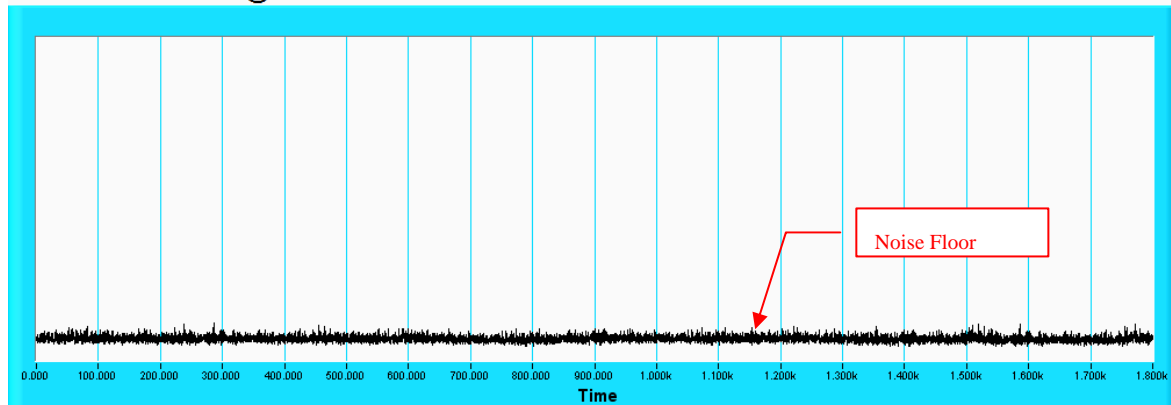


#### 6.2.1.4 NON-ASSOCIATED TEST

Master was off.

During the 30 minutes observation time, The UUT did not make any transmissions in the DFS band after UUT power up.

##### Non-Associated Test @ CH106 - 5530MHz



#### 6.2.1.5 NON- CO-CHANNEL TEST

The UUT was investigated after radar was detected the channel and made sure no co-channel operation with radars.



## 7. INFORMATION ON THE TESTING LABORATORIES

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

**Linko EMC/RF Lab:**

Tel: 886-2-26052180

Fax: 886-2-26052943

**Hsin Chu EMC/RF/Telecom Lab:**

Tel: 886-3-5935343

Fax: 886-3-5935342

**Hwa Ya EMC/RF/Safety Lab:**

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The address and road map of all our labs can be found in our web site also.



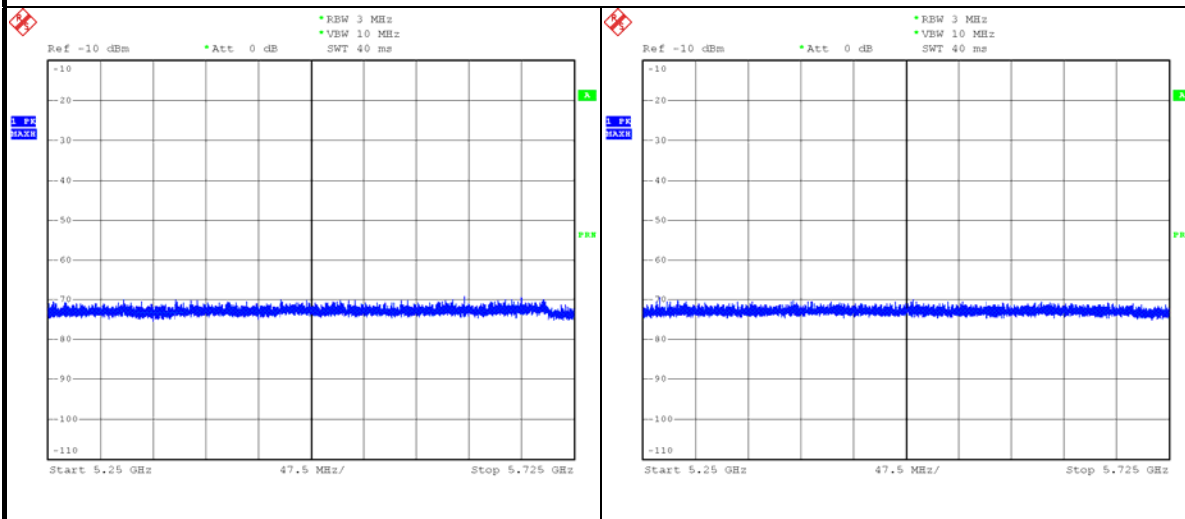


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## 8. APPENDIX-A

### NON BEACON ON DFS BAND

- 1) Test results demonstrating no any beacon on DFS band after power up.
- 2) Observation time is 10min after power up.



**EUT (Client ) links with master on 11ac(VHT20) mode**

**EUT (Client ) links with master on 11ac (VHT80) mode**



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## 9. APPENDIX B - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No modifications were made to the EUT by the lab during the test.

--- END ---