

# FCC Radio Test Report

## FCC ID: XMR2019SC650TNA

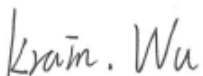
This report concerns: Original Grant

**Project No.** : 2001H013  
**Equipment** : Smart Module  
**Brand Name** : QUECTEL  
**Test Model** : SC650T-NA  
**Series Model** : N/A  
**Applicant** : Quectel Wireless Solutions Co., Ltd.  
**Address** : Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233.  
**Manufacturer** : Quectel Wireless Solutions Co., Ltd.  
**Address** : Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233.  
**Date of Receipt** : Jan. 15, 2020  
**Date of Test** : Jan. 15, 2020~Mar. 05, 2020  
**Issued Date** : Mar. 16, 2020  
**Report Version** : R00  
**Test Sample** : Engineering Sample No.: SH2020011452  
**Standard(s)** : FCC Part 15, Subpart E (Section 15.407) / FCC 06-96  
 FCC KDB 789033 D02 General U-NII Test Procedures New Rules v02r01  
 FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02  
 FCC KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.



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The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

**Limitation**

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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**REPORT ISSUED HISTORY**

| Report Version | Description     | Issued Date   |
|----------------|-----------------|---------------|
| R00            | Original Issue. | Mar. 16, 2020 |

## 1. EUT INFORMATION

### 1.1 EUT SPECIFICATION TABLE

Table 1: Specification of EUT

|                           |                                                                                                                    |
|---------------------------|--------------------------------------------------------------------------------------------------------------------|
| Product Name              | Smart Module                                                                                                       |
| Brand Name                | QUECTEL                                                                                                            |
| Test Model                | SC650T-NA                                                                                                          |
| Series Model              | N/A                                                                                                                |
| Model Difference(s)       | N/A                                                                                                                |
| Software Version          | SC650TNAPAR05A03                                                                                                   |
| Hardware Version          | R1.0                                                                                                               |
| Operational Mode          | Slave                                                                                                              |
| Operating Frequency Range | UNII-1: 5150 MHz~5250 MHz<br>UNII-2A: 5250 MHz~5350 MHz<br>UNII-2C: 5470 MHz~5725 MHz<br>UNII-3: 5725 MHz~5850 MHz |
| Modulation                | OFDM                                                                                                               |

**Note:** This device was functioned as a

☐ Master    ☒ Slave device without radar detection    ☐ Slave device with radar detection

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.

## 2. Channel List:

| IEEE 802.11a<br>IEEE 802.11n (HT20)<br>IEEE 802.11ac (VHT20) |                 | IEEE 802.11n (HT40)<br>IEEE 802.11ac (VHT40) |                 | IEEE 802.11ac (VHT80) |                 |
|--------------------------------------------------------------|-----------------|----------------------------------------------|-----------------|-----------------------|-----------------|
| UNII-2A                                                      |                 | UNII-2A                                      |                 | UNII-2A               |                 |
| Channel                                                      | Frequency (MHz) | Channel                                      | Frequency (MHz) | Channel               | Frequency (MHz) |
| 52                                                           | 5260            | 54                                           | 5270            | 58                    | 5290            |
| 56                                                           | 5280            | 62                                           | 5310            |                       |                 |
| 60                                                           | 5300            |                                              |                 |                       |                 |
| 64                                                           | 5320            |                                              |                 |                       |                 |

| IEEE 802.11a<br>IEEE 802.11n (HT20)<br>IEEE 802.11ac (VHT20) |                 | IEEE 802.11n (HT40)<br>IEEE 802.11ac (VHT40) |                 | IEEE 802.11ac (VHT80) |                 |
|--------------------------------------------------------------|-----------------|----------------------------------------------|-----------------|-----------------------|-----------------|
| UNII-2C                                                      |                 | UNII-2C                                      |                 | UNII-2C               |                 |
| Channel                                                      | Frequency (MHz) | Channel                                      | Frequency (MHz) | Channel               | Frequency (MHz) |
| 100                                                          | 5500            | 102                                          | 5510            | 106                   | 5530            |
| 104                                                          | 5520            | 110                                          | 5550            | 122                   | 5610            |
| 108                                                          | 5540            | 118                                          | 5590            |                       |                 |
| 112                                                          | 5560            | 126                                          | 5630            |                       |                 |
| 116                                                          | 5580            | 134                                          | 5670            |                       |                 |
| 120                                                          | 5600            |                                              |                 |                       |                 |
| 124                                                          | 5620            |                                              |                 |                       |                 |
| 128                                                          | 5640            |                                              |                 |                       |                 |
| 132                                                          | 5660            |                                              |                 |                       |                 |
| 136                                                          | 5680            |                                              |                 |                       |                 |
| 140                                                          | 5700            |                                              |                 |                       |                 |

## 3. Antenna Specification:

| Ant. | Manufacturer | Model Name | Antenna Type | Connector | Gain (dBi) |
|------|--------------|------------|--------------|-----------|------------|
| 1    | Saintenna    | SAA31092A  | Dipole       | IPEX      | 5.05       |

## 1.2 TEST FACILITY

The test facilities used to collect the test data in this report is at the location of No. 29, Jintang Road, Tangzhen Industry Park, Pudong New Area, Shanghai 201210, China

BTL's Test Firm Registration Number for FCC: 476765

BTL's Designation Number for FCC: CN1241

## 1.3 CONDUCTED OUTPUT POWER AND EIRP

Table 2: The Conducted Output Power and EIRP List

| Mode: TX (11a)       |                                  |              |                |               |
|----------------------|----------------------------------|--------------|----------------|---------------|
| Frequency Band (MHz) | Max Couducted Output Power (dBm) | Antenna Gain | Max EIRP (dBm) | Max EIRP (mW) |
| 5250~5350            | 18.16                            | 5.05         | 23.21          | 209.411       |
| 5470~5725            | 18.12                            | 5.05         | 23.17          | 207.491       |

| Mode: TX (11ac 80 MHz) |                                  |              |                |               |
|------------------------|----------------------------------|--------------|----------------|---------------|
| Frequency Band (MHz)   | Max Couducted Output Power (dBm) | Antenna Gain | Max EIRP (dBm) | Max EIRP (mW) |
| 5250~5350              | 15.23                            | 5.05         | 23.31          | 214.289       |
| 5470~5725              | 15.26                            | 5.05         | 20.31          | 107.399       |

## 2.U-NII DFS RULE REQUIREMENTS

### 2.1 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 3 and 4 for the applicability of DFS requirements for each of the operational modes.

Table 3: 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                |
| Uniform Spreading               | ✓                | Not required                   | Not required                |
| U-NII Detection Bandwidth       | ✓                | Not required                   | ✓                           |

Table 4: Applicability of DFS requirements during normal operation.

| Requirement                       | Operational Mode |                                |                             |
|-----------------------------------|------------------|--------------------------------|-----------------------------|
|                                   | Master           | Client without radar detection | Client with radar detection |
| DFS Detection Threshold           | ✓                | Not required                   | ✓                           |
| Channel Closing Transmission Time | ✓                | ✓                              | ✓                           |
| Channel Move Time                 | ✓                | ✓                              | ✓                           |
| U-NII Detection Bandwidth         | ✓                | Not required                   | ✓                           |

## 2.2 TEST LIMITS AND RADAR SIGNAL PARAMETERS

### DETECTION THRESHOLD VALUES

Table 5: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection.

| Maximum Transmit Power                                                          | Value<br>(See Notes 1 and 2) |
|---------------------------------------------------------------------------------|------------------------------|
| EIRP $\geq$ 200 milliwatt                                                       | -64 dBm                      |
| EIRP < 200 milliwatt and<br>power spectral density < 10 dBm/MHz                 | -62 dBm                      |
| EIRP < 200 milliwatt that do not meet the power<br>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.

**Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 6: 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<br>remaining 10 second period. See Notes 1 and 2. |
| U-NII Detection Bandwidth         | Minimum 100% of the UNII<br>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 7: 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 $\left\{ \left( \frac{1}{360} \right) \cdot \left( \frac{19 \cdot 10^6}{PRI_{\mu sec}} \right) \right\}$ | 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                      |
| <b>Note 1:</b> 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.

Table 8: 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                       |

The parameters for this waveform are randomly chosen (The center frequency for each of the 30 trials of the Bin 5 radar shall be randomly selected within 80% of the Occupied Bandwidth.) 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.

Table 9: Frequency Hopping 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 |
|------------|--------------------|-------------------|------------|----------------------------|------------------|--------------------------------------------|--------------------------|
| 6          | 1                  | 333               | 9          | 0.333                      | 300              | 70%                                        | 30                       |

### 3. TEST INSTRUMENTS

Table 10: Test instruments list.

| Kind of Equipment                       | Manufacturer       | Type No.      | Serial No.    | Calibrated until |
|-----------------------------------------|--------------------|---------------|---------------|------------------|
| EXA Spectrum Analyzer                   | Keysight           | N9010A        | MY56480561    | Mar. 29, 2020    |
| MXG X-Series RF Vector Signal Generator | Keysight           | N5182B        | MY56200484    | Mar. 29, 2020    |
| Power Divider                           | JUK                | PD-2SF-2060   | N/A           | N/A              |
| Power Divider                           | JUK                | PD-2SF-2060   | N/A           | N/A              |
| Attenuator                              | Solvang Technology | 5.8GHz 0-65dB | STI02-0203-01 | Sep. 01, 2020    |

Note: Calibration interval of instruments listed above is one year.

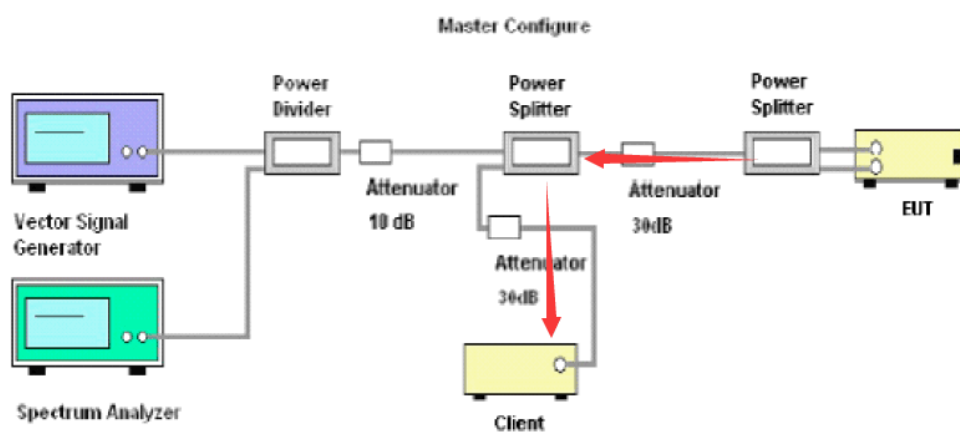
## 4. DYNAMIC FREQUENCY SELECTION (DFS) TEST

### 4.1 DFS MEASUREMENT SYSTEM

#### Test Procedure

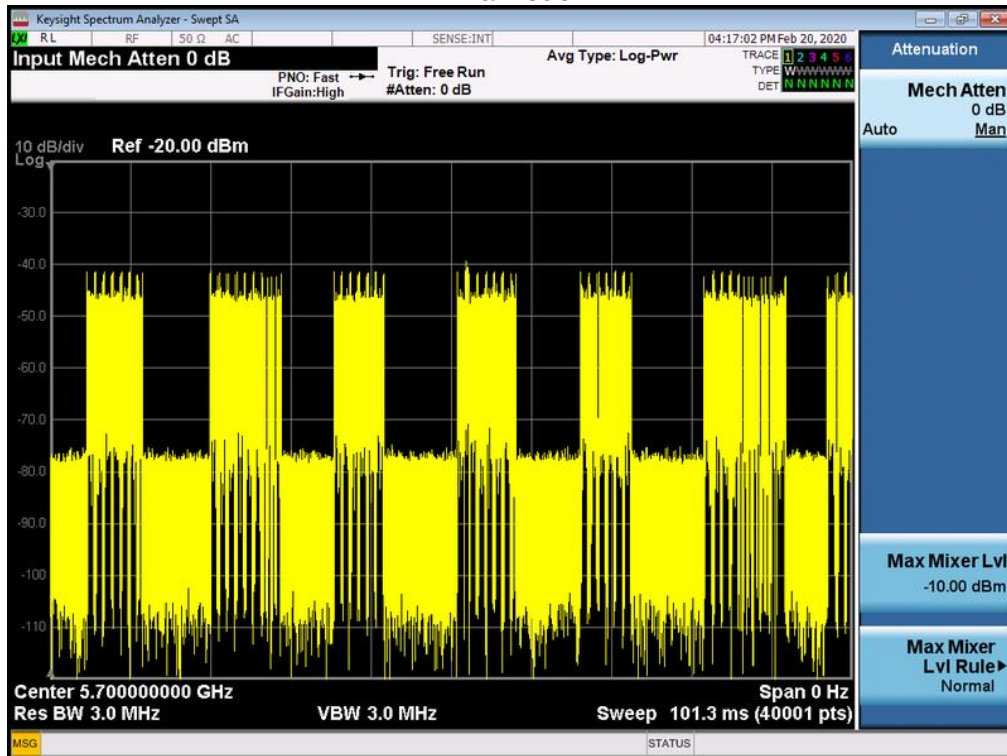
1. Master device and client device are set up by conduction method as the following configuration.
2. The client device is connected to notebook and to access a IP address on wireless connection with the master device.
3. Then the master device is connected to another notebook to access a IP address.
4. Finally, let the two IP addresses run traffic with each other through the Run flow software "Lan test" to reach 17% channel loading as below.

#### Setup

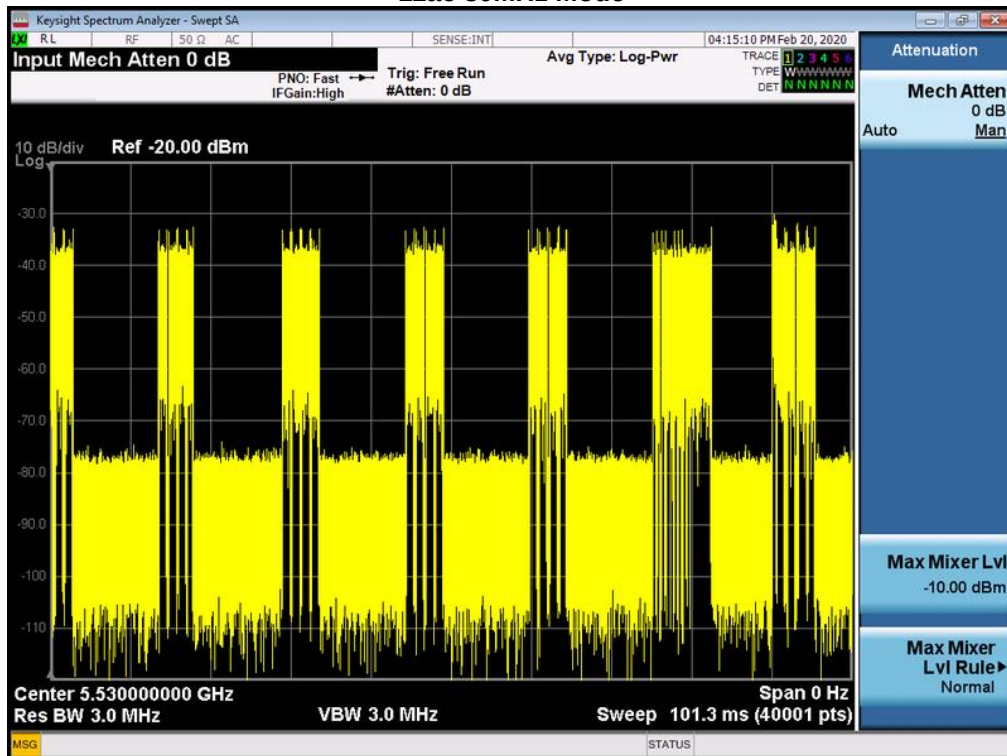


## Channel Loading

### 11a Mode



### 11ac 80MHz Mode



The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of FCC 06-96. The frequency of the signal generator is incremented in 1 MHz steps from FL to FH for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer set to display 8001 bins on the horizontal axis. The time-domain resolution is 2 msec / bin with a 16 second sweep time, meeting the 10 second short pulse reporting criteria. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

Should multiple RF ports be utilized for the Master and/or Slave devices (for example, for diversity or MIMO implementations), additional combiner/dividers are inserted between the Master Combiner/Divider and the pad connected to the Master Device (and/or between the Slave Combiner/Divider and the pad connected to the Slave Device). Additional pads are utilized such that there is one pad at each RF port on each EUT.

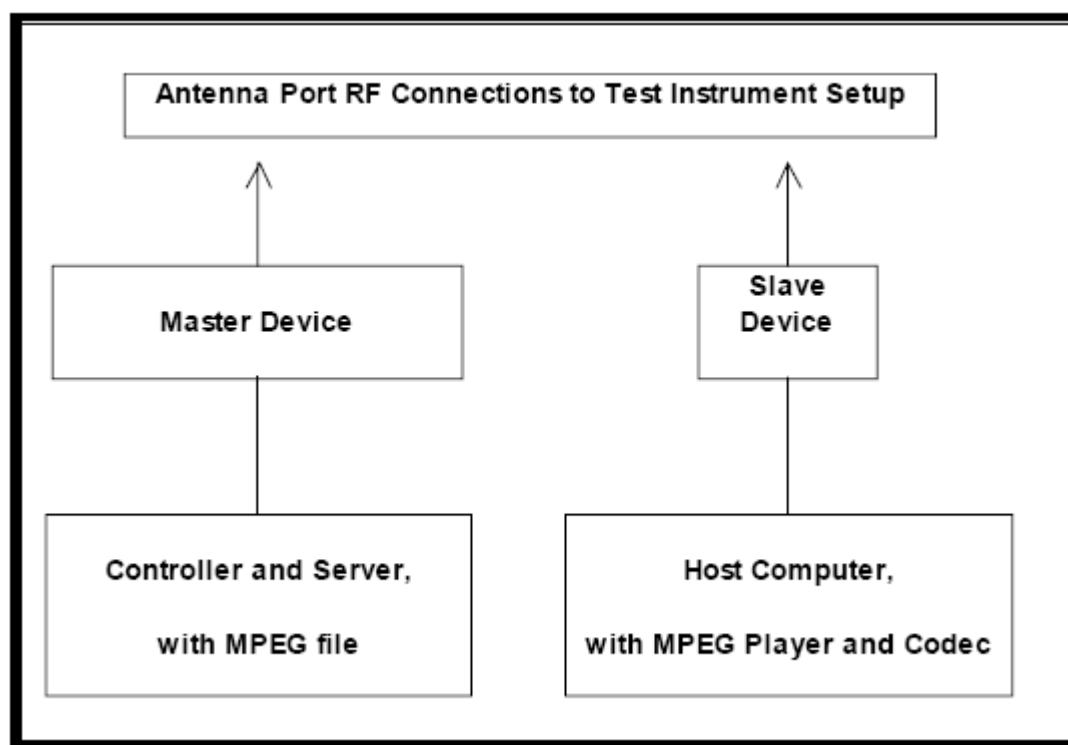
## 4.2 CALIBRATION OF DFS DETECTION THRESHOLD LEVEL

A 50 ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected in place of the master device and the signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of  $-64\text{dBm}$  as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. Measure the amplitude and calculate the difference from  $-64\text{ dBm}$ . Adjust the Reference Level Offset of the spectrum analyzer to this difference.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of  $-64\text{ dBm}$  and the spectrum analyzer will still indicate the level as received by the Master Device.

Set the signal generator to produce a radar waveform, trigger a burst manually and measure the level on the spectrum analyzer. Readjust the amplitude of the signal generator as required so that the peak level of the waveform is at a displayed level equal to the required or desired interference detection threshold. Separate signal generator amplitude settings are determined as required for each radar type.



## 4.3 DEVIATION FROM TEST STANDARD

No deviation.

## 5. TEST RESULTS

### 5.1 SUMMARY OF TEST RESULT

| Clause | Test Parameter                    | Test Mode and Channel               | Remarks        | Pass/Fail |
|--------|-----------------------------------|-------------------------------------|----------------|-----------|
| 15.407 | DFS Detection Threshold           | -                                   | No Applicable  | N/A       |
| 15.407 | Channel Availability Check Time   | -                                   | Not Applicable | N/A       |
| 15.407 | Channel Move Time                 | 11a 5700 MHz<br>11ac 80MHz 5530 MHz | Applicable     | Pass      |
| 15.407 | Channel Closing Transmission Time | 11a 5700 MHz<br>11ac 80MHz 5530 MHz | Applicable     | Pass      |
| 15.407 | Non- Occupancy Period             | -                                   | Not Applicable | N/A       |
| 15.407 | Uniform Spreading                 | -                                   | Not Applicable | N/A       |
| 15.407 | U-NII Detection Bandwidth         | -                                   | Not Applicable | N/A       |

### 5.2 TEST MODE: DEVICE OPERATING IN MASTER MODE.

Master with injection at the Master. (Radar Test Waveforms are injected into the Master)

### 5.3 DFS DETECTION THRESHOLD

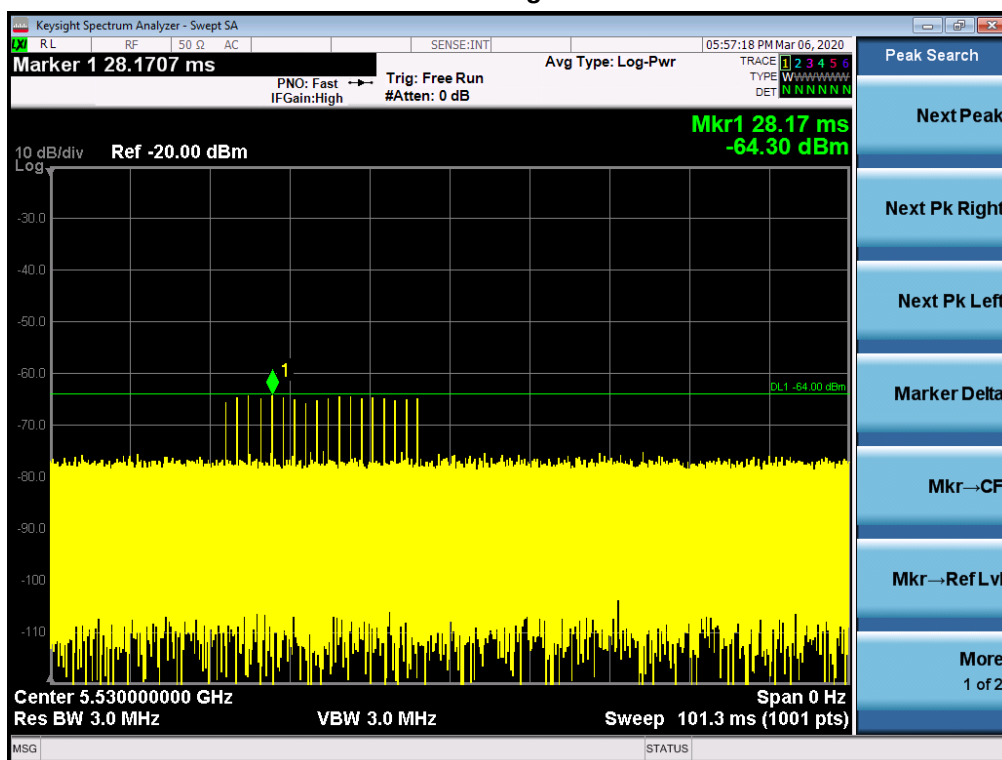
Calibration:

The EUT is slave equipment and it with a max gain is 5.05 dBi.

For a detection threshold level of -62dBm and the antenna gain is 5.05 dBi, required detection threshold is -58.95 dBm ( $= -64 + 5.05$ ).

Note: Maximum Transmit Power is EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz in this report, so detection threshold level is -62dBm.

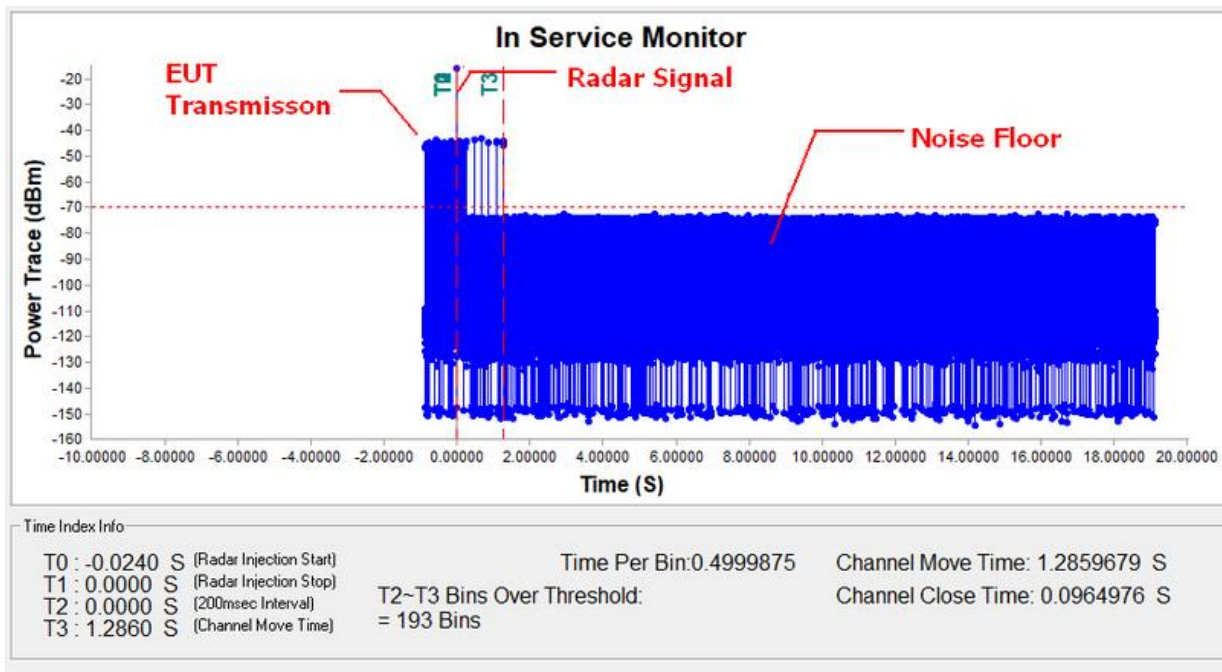
## Radar Signal 0



## 5.4 CHANNEL CLOSING TRANSMISSION AND CHANNEL MOVE TIME WLAN TRAFFIC

TX (11a Mode )

Radar signal 0

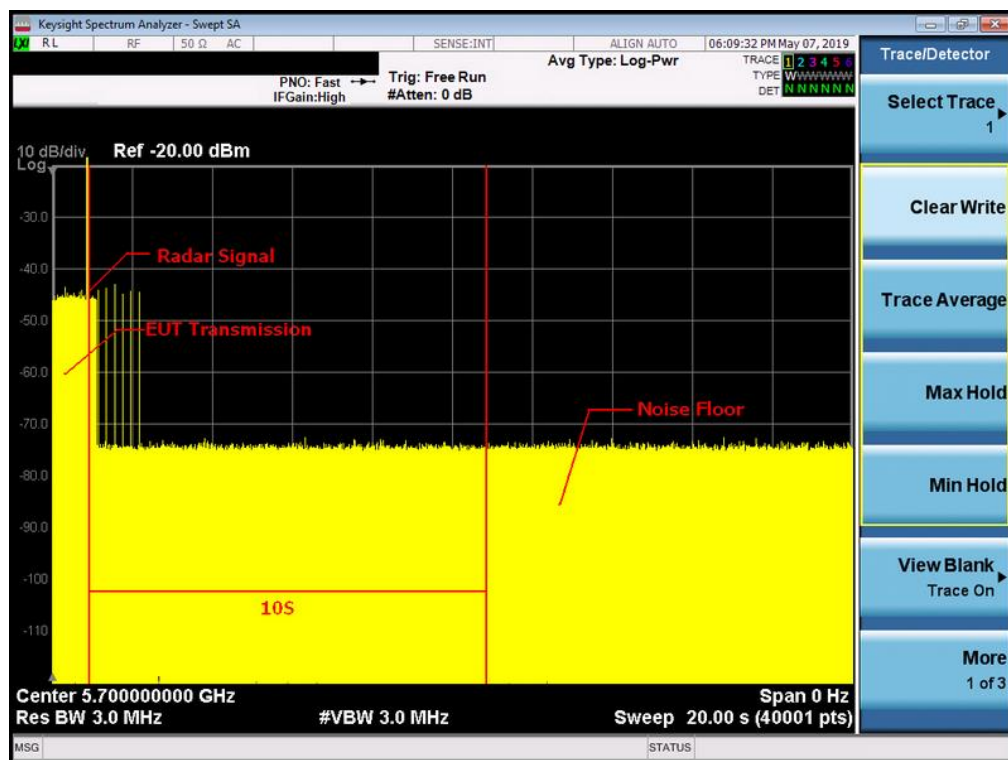


**Note:** T0 denotes the Radar Injection Start.

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.

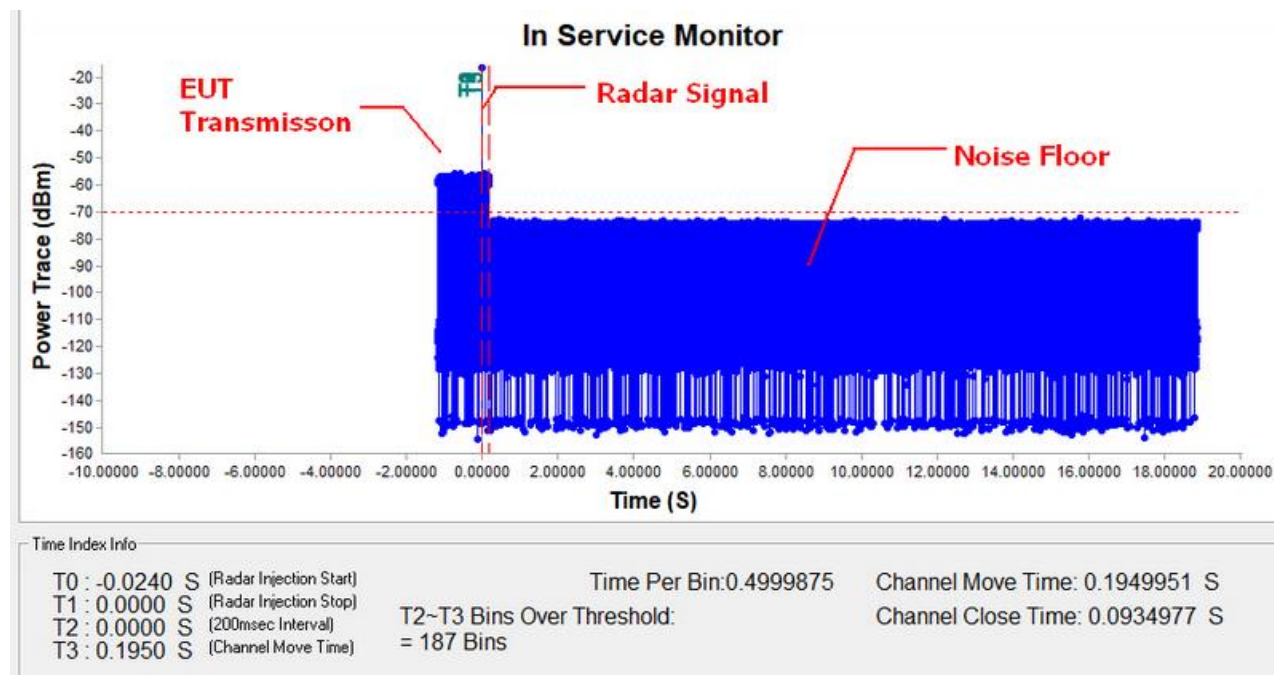
T3 denotes the end of Channel Move Time.



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

TX (11ac 80MHz Mode )

Radar signal 0

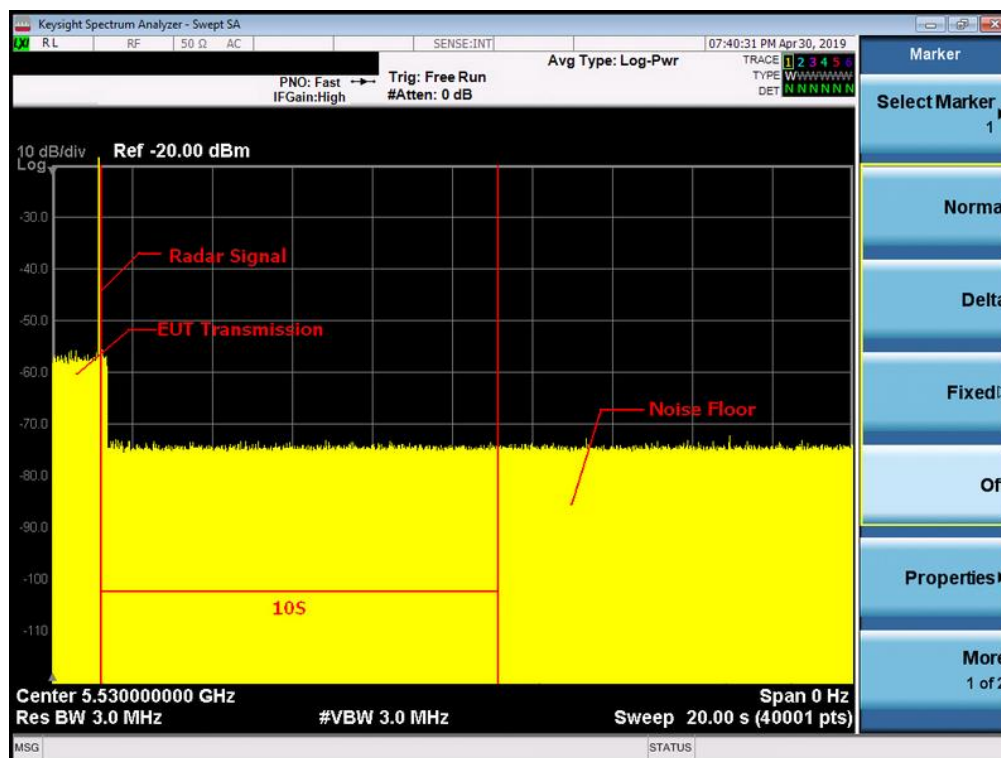


**Note:** T0 denotes the Radar Injection Start.

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.

T3 denotes the end of Channel Move Time.



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

| 11a Mode           |                   |                                                                                     |
|--------------------|-------------------|-------------------------------------------------------------------------------------|
| Item               | Measured Value(s) | Limit(s)                                                                            |
| Channel Move Time  | 1.2859679         | 10                                                                                  |
| Channel Close Time | 0.0964976         | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. |

| 11ac 80MHz Mode    |                   |                                                                                     |
|--------------------|-------------------|-------------------------------------------------------------------------------------|
| Item               | Measured Value(s) | Limit(s)                                                                            |
| Channel Move Time  | 0.1949951         | 10                                                                                  |
| Channel Close Time | 0.0934977         | 200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. |

**End of Test Report**