# Dynamic Frequency Selection (DFS) Test Report
## FCC Part15 Subpart E & RSS-247 Issue 2

Product Name : Virtual Reality System

Model No. : MH-A32, MH-A64

FCC ID : 2AGOZMH-A

IC : 20849-MHA

Applicant : Oculus VR LLC

Address : 1 Hacker Way, Bldg 18Menlo Park CA 94025-1456

Date of Receipt : Sep. 12, 2017

Test Date : Sep. 12, 2017~ Oct. 26, 2017

Issued Date : Dec. 04, 2017

Report No. : 1792053R-RF-FCC-DFS

Report Version : V1.0

# DFS Test Report

Issued Date: Dec. 04, 2017

Report No. : 1792053R-RF-FCC-DFS

| | | |
|---|---|---|
| Product Name | : | Virtual Reality System |
| Applicant | : | Oculus VR LLC |
| Address | : | 1 Hacker Way, Bldg 18Menlo Park CA 94025-1456 |
| Manufacturer | : | Oculus VR LLC |
| Address | : | 1 Hacker Way, Bldg 18Menlo Park CA 94025-1456 |
| Model No. | : | MH-A32, MH-A64 |
| FCC ID | : | 2AGOZMH-A |
| IC | | 20849-MHA |
| EUT Voltage | : | 5 V dc, 2 A |
| Test Voltage | : | AC 120V/60Hz |
| Brand Name | : | Oculus Go |
| Applicable Standard | : | FCC CFR Title 47 Part 15 Subpart E |
| | | KDB 905462 D02 v02 |
| | | KDB 905462 D03 v01r02 |
| | | RSS-Gen Issue 4 / RSS-247 Issue 2 |
| Test Result | : | Pass |
| Performed Location | : | DEKRA Testing and Certification (Suzhou) Co., Ltd. |
| | | No.99 Hongye Rd., Suzhou Industrial Park, Suzhou, 215006, Jiangsu, China |
| | | TEL: +86-512-6251-5088 / FAX: +86-512-6251-5098 |
| | | FCC Designation Number: CN1199; ISED Lab Code: 4075B |
| Operation Mode (5470~5725MHz) | : | ☐ Master device |
| | | ☐ Slaver device with radar detection function |
| | | ☒ Slaver device without radar detection function |

Documented By :

( Adm. Specialist: Kitty Li )

Reviewed By :

(Senior Engineer: Frank He)

Approved By :

(Engineering Manager: Harry Zhao )

TABLE OF CONTENTS

Description Page

# 1. GENERAL INFORMATION

## 1.1. EUT Description

| Product Name | Virtual Reality System | | | | |
|---|---|---|---|---|---|
| Brand Name | Oculus Go | | | | |
| Model No. | MH-A32, MH-A64 | | | | |
| EUT Voltage | 5 V dc, 2 A | | | | |
| Type of Modulation | OFDM-BPSK, QPSK, 16QAM, 64QAM, 128QAM, 256QAM | | | | |
| Data Rate | 802.11a: 6/9/12/18/24/36/48/54Mbps | | | | |
| | 802.11n: up to 300Mbps | | | | |
| | 802.11ac: up to 866.6Mbps | | | | |
| Channel Control | Auto | | | | |
| Transmit modes | ☒ | 802.11a | ☒ | 802.11n(20MHz) | ☒ 802.11n(40MHz) |
| | ☒ | 802.11ac(20MHz) | ☒ | 802.11ac(40MHz) | ☒ 802.11ac(80MHz) |
| Support Bands | ☒ | 5150MHz~5250MHz | ☐ Outdoor AP | | |
| | | | ☐ Indoor AP | | |
| | | | ☐ Fixed point-to-point AP | | |
| | | | ☒ Mobile and Portable Client | | |
| | ☒ | 5250MHz~5350MHz | | | |
| | ☒ | 5470MHz~5725MHz | ☒ With TDWR Channels | | |
| | | | ☐ Without TDWR Channels | | |
| | ☒ | 5725MHz~5850MHz | | | |

Note:

1. The RF specifications of two models are identical. The difference is below:

Their memory is different.

| | MH-A32 | MH-A64 |
|---|---|---|
| memory | 32G | 64G |

There is not any change in design, circuitry or construction for this device, including RF parameters (antenna, software, firmware and hardware versions, power, frequency ranges, etc.).

We used MH-A32 for all the test items.

## Antenna information

| Antenna Model No. | N/A | | | | | |
|---|---|---|---|---|---|---|
| Antenna Manufacturer | SPEED | | | | | |
| Antenna Delivery | ☒ | 1*TX+1*RX | ☒ | 2*TX+2*RX | ☐ | 3*TX+4*RX |
| Antenna Technology | ☒ | SISO | | | | |
| | ☒ | MIMO | ☐ | Basic methodology | | |
| | | | ☐ | Sectorized antenna systems | | |
| | | | ☐ | Cross-polarized antennas | | |
| | | | ☒ | Unequal antenna gains, with equal transmit powers | | |
| | | | ☒ | Spatial Multiplexing | | |
| | | | ☒ | Cyclic Delay Diversity (CDD) | | |
| Antenna Type | PIFA Antenna | | | | | |

### Antenna Gain

| Antenna Technology | | | Ant Gain (dBi) |
|---|---|---|---|
| ☒ SISO | ☒ | Ant1 | 4.0 |
| | ☒ | Ant2 | 2.9 |
| ☒ CDD | | | 3.48dBi for Power; 6.48dBi for PSD |

802.11a/n/ac-20MHz Center Working Frequency of Each Channel:

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 52: | 5260 MHz | Channel 56: | 5280 MHz | Channel 60: | 5300 MHz | Channel 64 | 5320 MHz |

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 100: | 5500 MHz | Channel 104: | 5520 MHz | Channel 108: | 5540 MHz | Channel 112: | 5560 MHz |
| Channel 116: | 5580 MHz | Channel 120: | 5600 MHz | Channel 124: | 5620 MHz | Channel 128: | 5640 MHz |
| Channel 132: | 5660 MHz | Channel 136: | 5680 MHz | Channel 140: | 5700 MHz | N/A | N/A |

802.11n/ac-40MHz Center Working Frequency of Each Channel:

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 54: | 5270 MHz | Channel 62: | 5310 MHz | N/A | N/A | N/A | N/A |

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 102: | 5510 MHz | Channel 110: | 5550 MHz | Channel 118: | 5590 MHz | Channel 126: | 5630 MHz |
| Channel 134: | 5670 MHz | N/A | N/A | N/A | N/A | N/A | N/A |

802.11ac-80MHz Center Working Frequency of Each Channel:

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 42: | 5210 MHz | Channel 58: | 5290 MHz | N/A | N/A | N/A | N/A |

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---|---|---|---|---|---|---|---|
| Channel 106: | 5530 MHz | Channel 122: | 5610 MHz | Channel 138: | 5690 MHz | Channel 155: | 5775 MHz |

## 1.2.     Standard Requirement

**FCC Part 15.407:**

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 30dBm. A TPC mechanism is not required for systems with an E.I.R.P. of less than 500mW.

## 1.3.     UNII Device Description

The UUT operates in the following band: 5250-5350 MHz, 5470-5725 MHz

The UUT is a Client Device that does not have radar detection capability and ad-hoc function. The highest gain antenna assembly utilized with the EUT has a maximum gain of 4.0dBi in 5GHz frequency band. The 50-ohm Tx/Rx antenna port is connected to the test system to perform conducted tests. TPC is not required since the maximum EIRP is less than 500mW (27dBm).

The UUT utilizes 802.11a/n IP based architecture. Three nominal channel bandwidths, 20 MHz, 40MHz and 80MHz are implemented.

WLAN traffic is generated by streaming the video file "TestFile.mp2" from the Master device to the Slave device in full motion video mode using the "Nero Show Time 3" with the V3.0.1.3 Codec package.

The master device is a Cisco 802.11a/b/g/n Access Point. The Cisco Access Point FCC ID: LDK102061.

The UUT is a client device without radar detection therefore the interference threshold level is not required.

**Statement:** Information regarding the parameters of the detected Radar Waveforms is not available to the end user.

## 1.4. Test Equipment

Dynamic Frequency Selection (DFS) / TR-8

| Instrument | Manufacturer | Type No. | Serial No | Cal. Due Date |
|---|---|---|---|---|
| Spectrum Analyzer | Agilent | N9010A | MY48030494 | 2018.05.12 |
| Vector Signal Generator | Agilent | E4438C | MY49070163 | 2018.03.28 |

| Instrument | Manufacturer | Type No. | Serial No |
|---|---|---|---|
| Splitter/Combiner (Qty: 2) | Mini-Circuits | ZAPD-50W 4.2-6.0 GHz | NN256400424 |
| Splitter/Combiner (Qty: 2) | MCLI | PS3-7 | 4463/4464 |
| ATT (Qty: 1) | Mini-Circuits | VAT-30+ | 30912 |
| Laptop PC | Asus | N80V | 8BN0AS226971468 |
| RF Cable (Qty: 6) | Mini-Circuits | N/A | DFS-1~6 |

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

## 1.5. Test Setup
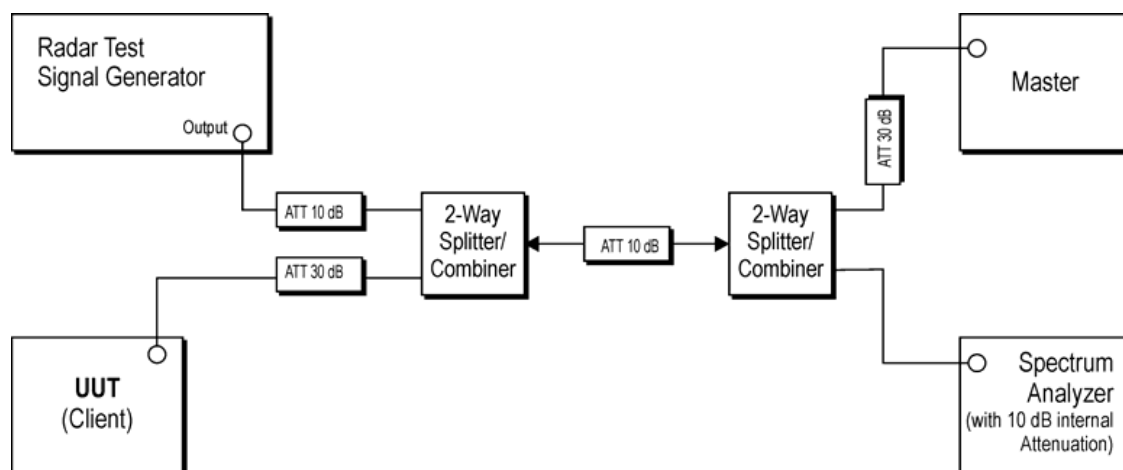
## 1.6. Limits

According to §15.407(h), 905462 D02 UNII DFS Compliance Procedures New Rules v01 and FCC 14-30 APPENDIX "COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION".

**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 |

**Applicability of DFS requirements during normal operation**

| Requirement | Operational Mode | |
| --- | --- | --- |
| | Master or Client (with radar detection) | Client (without radar detection) |
| DFS Detection Threshold | Yes | **Not Required** |
| Channel Closing Transmission Time | Yes | **Yes** |
| Channel Move Time | Yes | **Yes** |
| U-NII Detection Bandwidth | Yes | **Not required** |

| Additional requirements for devices with multiple bandwidth modes | Master Device 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. | | |

**DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection**

| Maximum Transmit Power | Value (see note) |
|---|---|
| EIRP ≥ 200 milliwatt | -64 dBm |
| EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz | -62 dBm |
| EIRP < 200 milliwatt that do not meet the power spectral density requirement | -62 dBm |
| Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01. | |

**DFS Response requirement values**

| Parameter | Value |
|---|---|
| Non-Occupancy Period | Minimum 30 minutes |
| Channel Availability Check Time | 60 Seconds |
| Channel Move Time | 10 Seconds (See Note1) |
| 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 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. | |

**Short Pulse Radar Test Waveforms**

Table 5 – Short Pulse Radar Test Waveforms

| Radar Type | Pulse Width (μsec) | PRI (μsec) | Number of Pulses | Minimum Percentage of Successful Detection | Minimum Number of Trials |
|---|---|---|---|---|---|
| 0 | 1 | 1428 | 18 | See Note 1 | See Note 1 |
| 1 | 1 | Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a<br><br>Test B: 15 unique PRI values randomly selected within the range of 518-3066 $\mu$ sec, with a minimum increment of 1 $\mu$ sec, excluding PRI values selected in Test A | $\text{Roundup}\left\{ \dfrac{\left(\dfrac{1}{360}\right)\cdot}{\left(\dfrac{19\cdot10^6}{PRI_{\mu sec}}\right)} \right\}$ | 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.

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

pulses would be = Roundup $\left\{ \left(\dfrac{1}{360}\right)\cdot\left(\dfrac{19\cdot10^6}{3066}\right) \right\} = \text{Roundup}\{17.2\} = 18.$

**Table 5a - Pulse Repetition Intervals Values for Test A**

| Pulse Repetition Frequency Number | Pulse Repetition Frequency (Pulses Per Second) | Pulse Repetition Interval (Microseconds) |
|---|---|---|
| 1 | 1930. 5 | 518 |
| 2 | 1858. 7 | 538 |
| 3 | 1792. 1 | 558 |
| 4 | 1730. 1 | 578 |
| 5 | 1672. 2 | 598 |
| 6 | 1618. 1 | 618 |
| 7 | 1567. 4 | 638 |
| 8 | 1519. 8 | 658 |
| 9 | 1474. 9 | 678 |
| 10 | 1432. 7 | 698 |
| 11 | 1392. 8 | 718 |
| 12 | 1355 | 738 |
| 13 | 1319. 3 | 758 |
| 14 | 1285. 3 | 778 |
| 15 | 1253. 1 | 798 |
| 16 | 1222. 5 | 818 |
| 17 | 1193. 3 | 838 |
| 18 | 1165. 6 | 858 |
| 19 | 1139 | 878 |
| 20 | 1113. 6 | 898 |
| 21 | 1089. 3 | 918 |
| 22 | 1066. 1 | 938 |
| 23 | 326. 2 | 3066 |

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4.

**Long Pulse Radar Test Signal**

| Radar Waveform | Bursts | Pulses Per Burst | Pulse Width ($\mu$ sec) | Chirp Width (MHz) | PRI ($\mu$ sec) | Minimum Percentage of Successful Detection | Minimum Trials |
|---|---|---|---|---|---|---|---|
| 5 | 8-20 | 1-3 | 50-100 | 5-20 | 1000-2000 | 80% | 30 |

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the long pulse radar test signal. If more than 30 waveforms are used for the long pulse radar test signal, then each additional waveform must also be unique and not repeated from the previous waveforms.

**Frequency Hopping Radar Test Signal**

| Radar Waveform | Pulse Width ($\mu$sec) | PRI ($\mu$sec) | Hopping Sequence Length (msec) | Pulses Per Hop | Hopping Rate (kHz) | Minimum Percentage of Successful Detection | Minimum Trials |
|---|---|---|---|---|---|---|---|
| 6 | 1 | 333 | 300 | 9 | .333 | 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.
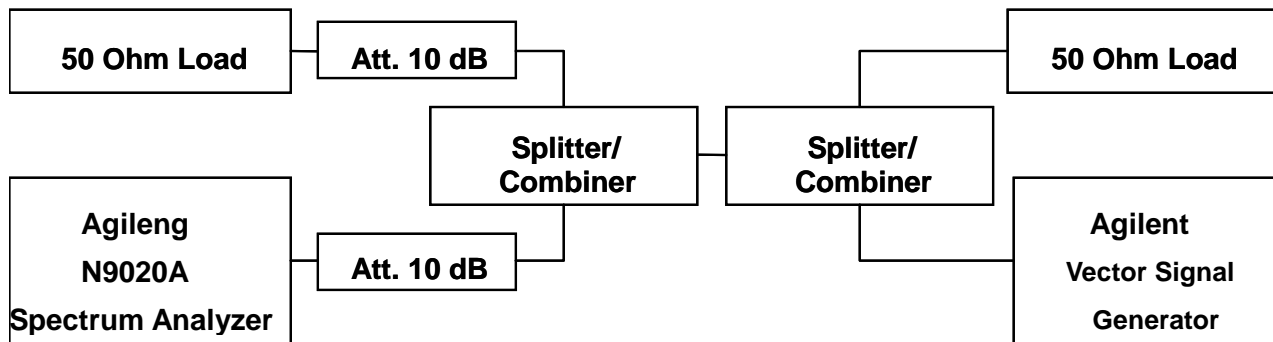
## 1.7. Client Device requreiment

a)   A Client Device will not transmit before having received appropriate control signals from a Master Device.

b)   A Client Device will stop all its transmissions whenever instructed by a Master Device to which it is associated and will meet the Channel Move Time and Channel Closing Transmission Time requirements.   The Client Device will not resume any transmissions until it has again received control signals from a Master Device.

c)   If a Client Device is performing In-Service Monitoring and detects a Radar Waveform above the DFS Detection Threshold, it will   inform the Master Device.   This is equivalent to the Master Device detecting the Radar Waveform and d) through f) of section 5.1.1 apply.

d)   Irrespective of Client Device or Master Device detection the Channel Move Time and Channel Closing Transmission Time requirements remain the same.

e)   The client test frequency must be 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.

## 1.8. Radar Waveform Calibration

The following equipment setup was used to calibrate the conducted radar waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were replace 50ohm terminal from master and client device and no transmissions by either the master or client device. The spectrum analyzer was switched to the zero span (time domain) at the frequency of the radar waveform generator. Peak detection was utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to 3MHz and 3 MHz.

The signal generator amplitude was set so that the power level measured at the spectrum analyzer was -61dBm due to the interference threshold level is not required.

Conducted Calibration Setup

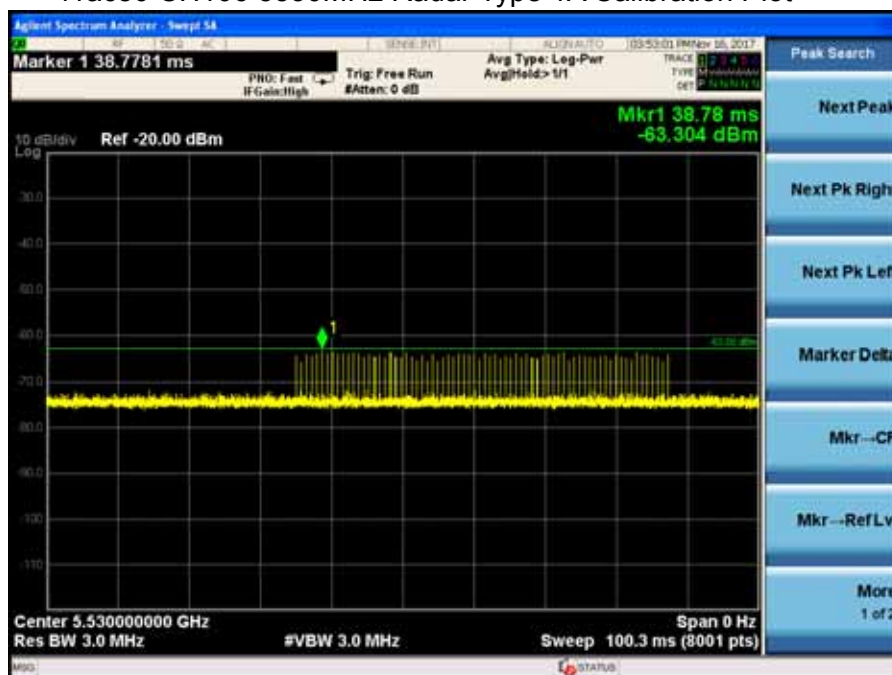| 50 Ohm Load | Att. 10 dB | | | | 50 Ohm Load |
|---|---|---|---|---|---|
| | | Splitter/ Combiner | Splitter/ Combiner | | |
| Agileng N9020A Spectrum Analyzer | Att. 10 dB | | | | Agilent Vector Signal Generator |

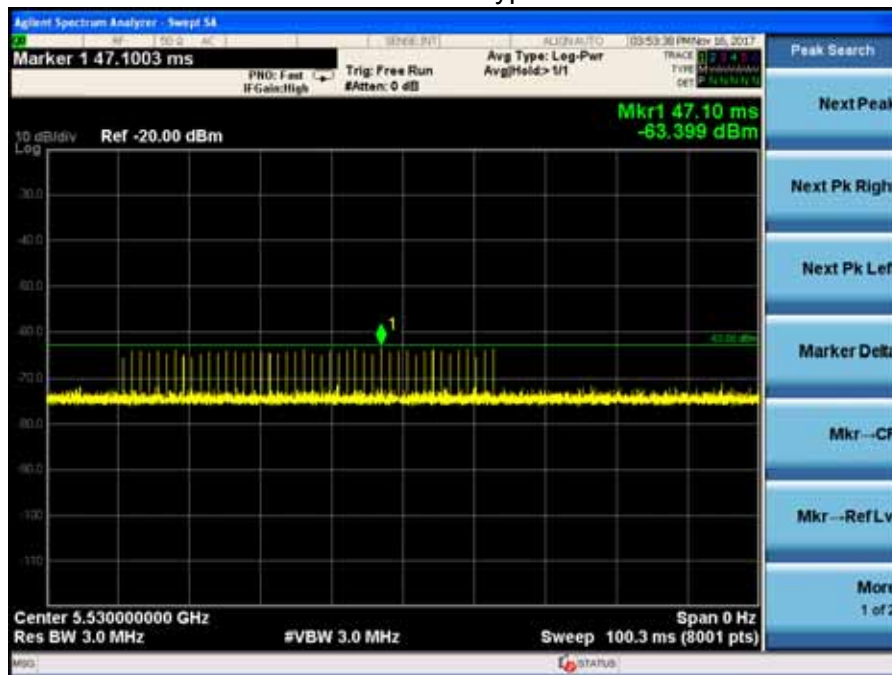## 1.9. Radar Waveform Calibration Result

11ac80 CH106 5530MHz Radar Type 0 Calibration Plot
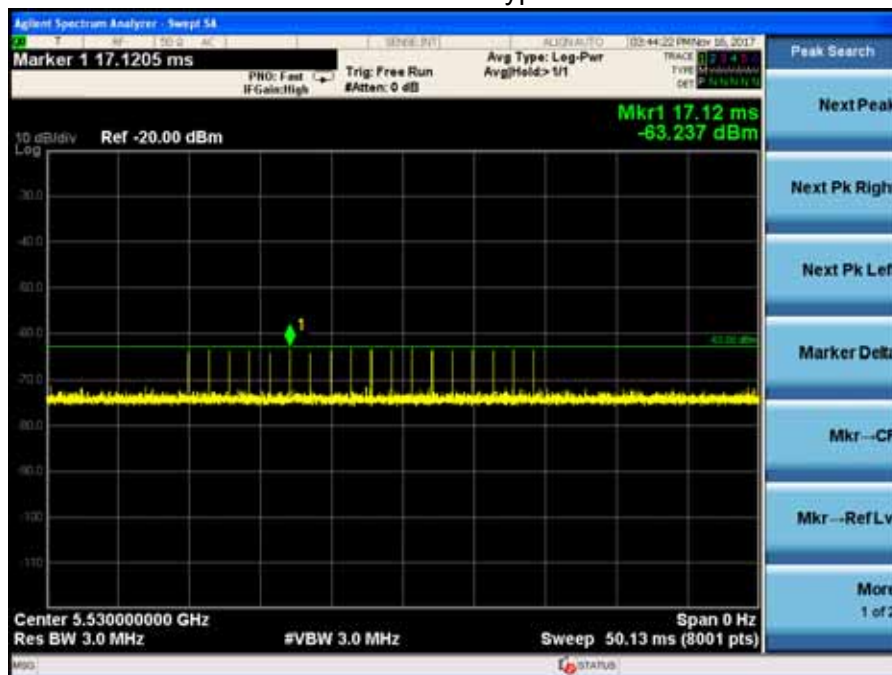


11ac80 CH106 5530MHz Radar Type 1A Calibration Plot

## 11ac80 CH106 5530MHz Radar Type 1B Calibration Plot



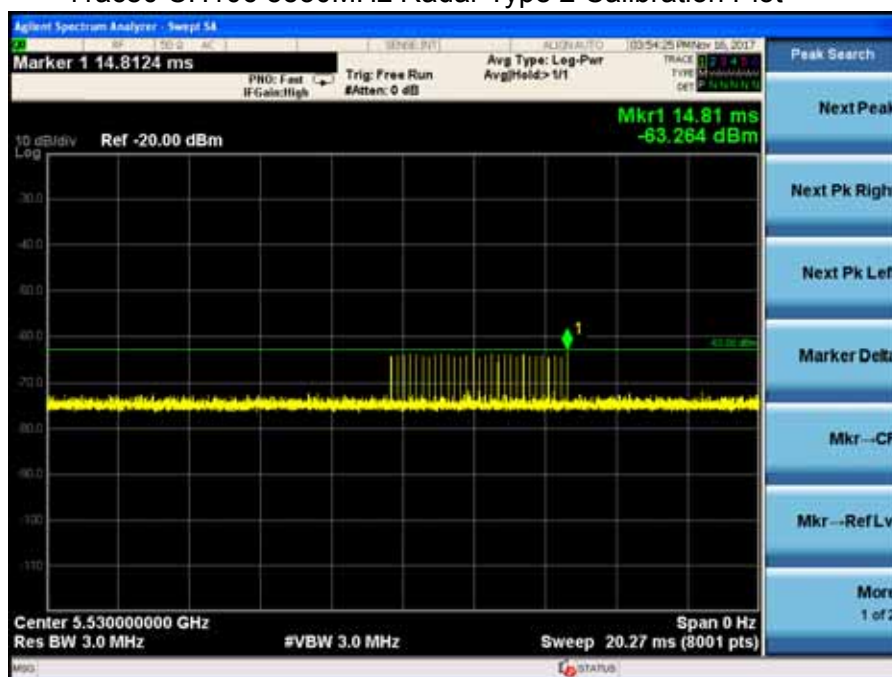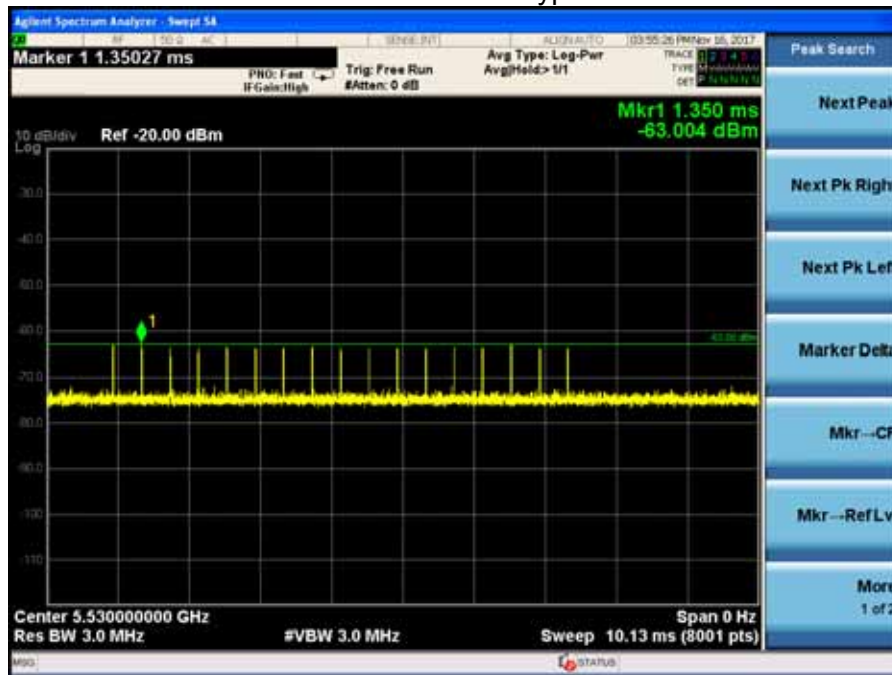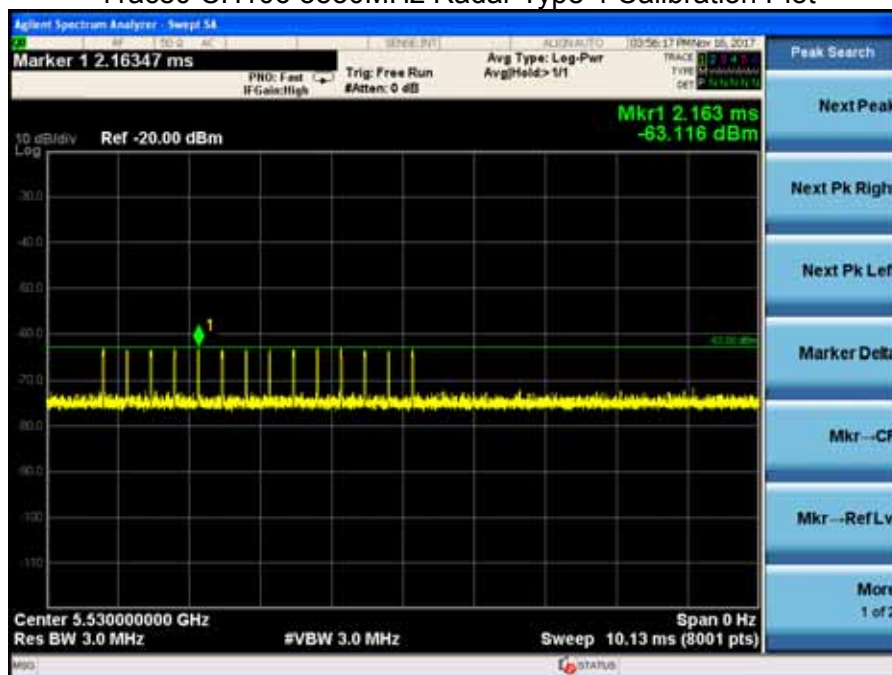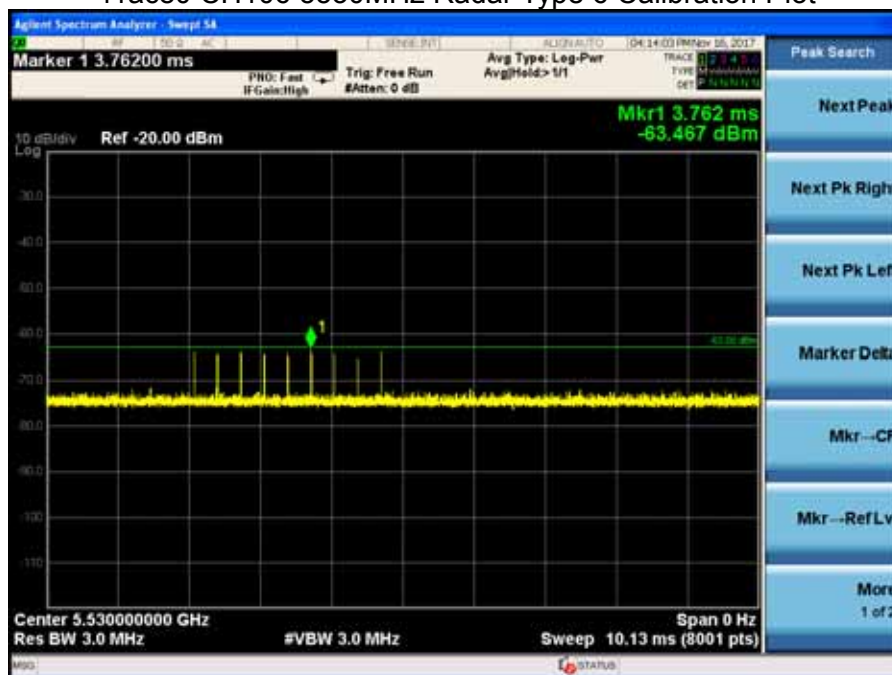## 11ac80 CH106 5530MHz Radar Type 2 Calibration Plot

11ac80 CH106 5530MHz Radar Type 3 Calibration Plot



11ac80 CH106 5530MHz Radar Type 4 Calibration Plot

## 11ac80 CH106 5530MHz Radar Type 5 Calibration Plot



## 11ac80 CH106 5530MHz Radar Type 6 Calibration Plot

## 2. Channel Move Time and Channel Closing Transmission Time

### 2.1. Test Procedure

These tests define how the following DFS parameters are verified during In-Service Monitoring; Channel Closing Transmission Time and Channel Move Time.

The steps below define the procedure to determine the above mentioned parameters when a radar burst with a level -61dBm is generated on the operating channel of the U-NII device.

A U-NII device operating as a Client device will associate with the Master device at 5530MHz.

During the in-service monitoring detection probability and channel moving tests the system was configured with a streaming video file from the master device (sourced by the PC connected to the master device via an Ethernet interface) to the client device. The streamed file was the "FCC" test file and the client device was using Media Player Classic as required by FCC Part 15 Subpart E.

Observe the transmissions of the EUT at the end of the radar burst on the operating channel for duration greater than 10 seconds. Measure and record the transmissions from the spectrum analyzer during the observation time (Channel Move Time). Compare the channel move time and channel closing transmission time results to the limits defined in the DFS Response requirement values table.
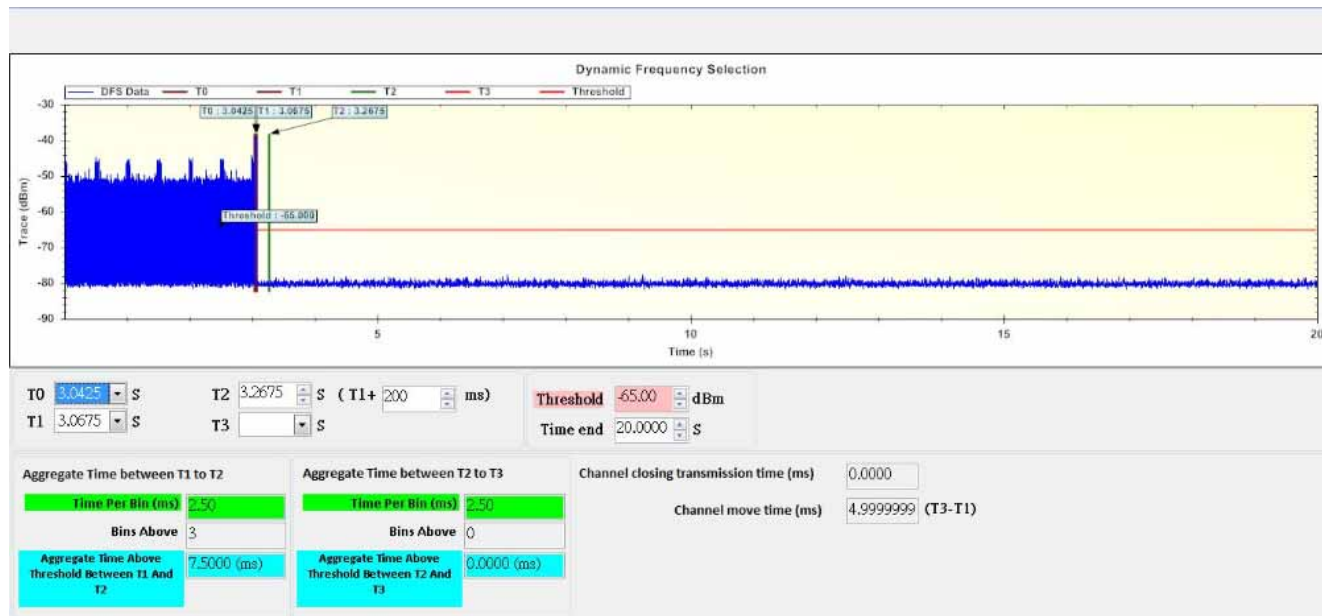
### 2.2. Test Requirement

| Parameter | Value |
|---|---|
| Channel Move Time | 10 Seconds |
| Channel Closing Transmission Time | 200 milliseconds + approx. 60 milliseconds over remaining 10 seconds period |

### 2.3. Uncertainty

± 1ms.

## 2.4. Test Result of Channel Move Time and Channel Closing Transmission Time

Product : Virtual Reality System
**5530MHz. (802.11ac80MHz)**



| Test Item | Limit | Results |
|---|---|---|
| Channel Move Time | 10 s | Pass |
| Channel Closing Transmission Time | 200ms + an aggregate of 60ms over remaining 10 second period. | Pass |

The End