

MRT Technology (Suzhou) Co., Ltd Phone: +86-512-66308358

Web: www.mrt-cert.com

Report No.: 1911RSU052-U8 Report Version: V01 Issue Date: 12-30-2019

## **DFS MEASUREMENT REPORT**

## FCC PART 15.407 / IC RSS-247 Issue 2

**FCC ID:** O57VR3030S

IC: 10407A-VR3030S

**APPLICANT:** Lenovo (Shanghai) Electronics Technology Co., Ltd

**Application Type:** Certification

**Product:** Standalone VR Headset

Model No.: Lenovo VR-3030S

FCC Rule Part(s): Part 15 Subpart E - 15.407 Section (h)(2)

IC Rule(s): RSS-247 Issue 2 Clause 6.3

Test Procedure(s): KDB 905462 D02v02, KDB 905462 D04v01

**Type of Device:** Client Device without radar detection

**Test Date:** December 02 ~ 20, 2019

Reviewed By:

(Sunny Sun)

Approved By:

( Dobin Wu)

(Robin VVU)





The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in KDB 905462 D02v02. Test results reported herein relate only to the item(s) tested.

The test report shall not be reproduced except in full without the written approval of MRT Technology (Suzhou) Co., Ltd.

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# **Revision History**

Report No.	Version	Description	Issue Date	Note
1911RSU052-U8	Rev. 01	Initial report	12-30-2019	Valid

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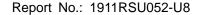
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#### **General Information**

Applicant:	Lenovo (Shanghai) Electronics Technology Co., Ltd.		
Applicant Address:	Section 304-305, Building No. 4, # 222, Meiyue Road, China		
	(Shanghai) Pilot Free Trade Zone		
Manufacturer:	Lenovo PC HK Limited		
Manufacturer Address:	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay,		
	Hong Kong, P.R.China		
Test Site:	MRT Technology (Suzhou) Co., Ltd		
Test Site Address:	D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development		
	Zone, Suzhou, China		
Test Device Serial No.:	N/A ☐ Production ☐ Pre-Production ☐ Engineering		

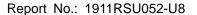
#### **Test Facility / Accreditations**

Measurements were performed at MRT Laboratory located in Tian'edang Rd., Suzhou, China.

- MRT facility is a FCC accredited (MRT Designation No. CN1166) test facility with the site description report on file and has met all the requirements specified in ANSI C63.4-2014.
- MRT facility is an IC registered (MRT Reg. No. 11384A-1) test laboratory with the site description on file at Industry Canada.
- MRT facility is a VCCI registered (R-20025, G-20034, C-20020, T-20020) test laboratory with the site description on file at VCCI Council.
- MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA) under the American Association for Laboratory Accreditation Program (A2LA Cert. No. 3628.01) in EMC, Telecommunications, Radio and SAR testing.



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#### 1. INTRODUCTION

#### 1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

#### 1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taihu Lake. These measurement tests were conducted at the MRT Technology (Suzhou) Co., Ltd. Facility located at D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China. The measurement facility compliant with the test site requirements specified in ANSI C63.4-2014.







#### **PRODUCT INFORMATION** 2.

## 2.1. Equipment Description

Product Name	Standalone VR Headset
Model No.	Lenovo VR-3030S
WLAN Specification	802.11a/b/g/n/ac
Bluetooth Version	v4.2 dual mode
Antenna Specification	Refer to section 2.4
Accessories	
Adapter	MODEL/MODELO: UC13US
	PRI/ENTRADA: 100-240V ~ 50/60Hz, 0.35A
	SEC/SALIDA: 5Vdc, 2A

## 2.2. Product Specification Subjective to this report

Frequency Range	802.11a/n-HT20/ac-VHT20:
	5260~5320MHz, 5500~5720MHz
	802.11n-HT40/ac-VHT40:
	5270~5310MHz, 5510~5710MHz
	For 802.11ac-VHT80:
	5290MHz, 5530MHz, 5610MHz, 5690MHz
Type of Modulation	802.11a/n/ac: OFDM
Data Rate:	802.11a: 6/9/12/18/24/36/48/54Mbps
	802.11n: up to 300Mbps
	802.11ac: up to 866.6Mbps
Uniform Spreading	For the 5250-5350MHz, 5470-5725 MHz bands, the Master device
	provides, on aggregate, uniform loading of the spectrum across all devices
	by selecting an operating channel among the available channels using a
	random algorithm.

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### 2.3. DFS Band Carrier Frequencies Operation

#### 802.11a/n-HT20/ac-VHT20

Channel	Frequency	Channel	Frequency	Channel	Frequency
52	5260 MHz	56	5280 MHz	60	5300 MHz
64	5320 MHz	100	5500 MHz	104	5520 MHz
108	5540 MHz	112	5560 MHz	116	5580 MHz
120	5600 MHz	124	5620 MHz	128	5640 MHz
132	5660 MHz	136	5680 MHz	140	5700 MHz
144	5720 MHz				

#### 802.11n-HT40/ac-VHT40

Channel	Frequency	Channel	Frequency	Channel	Frequency
54	5270 MHz	62	5310 MHz	102	5510 MHz
110	5550 MHz	118	5590 MHz	126	5630 MHz
134	5670 MHz	142	5710 MHz		

#### 802.11ac-VHT80

Channel	Frequency	Channel	Frequency	Channel	Frequency
58	5290 MHz	106	5530 MHz	122	5610 MHz
138	5690 MHz				

Note: Frequencies fall between 5600 ~ 5650 are not used in Canada

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2.4. Description of Available Antennas

Antenna	Frequency Band	T <sub>X</sub> Paths	Max Peak Gain (dBi)		Directional Gain(dBi)	
Туре	(GHz)		Ant 1	Ant 2	For Power	For PSD
WLAN Inte	WLAN Internal Antenna					
EDC.	2.4	2	2.40	2.25	2.40	5.41
FPC	5	2	4.10	4.28	4.28	7.29
Bluetooth Internal Antenna						
FPC	2.4	1	2.40			

Note 1: The EUT supports Cyclic Delay Diversity (CDD) mode, and CDD signals are correlated.

For CDD transmissions, directional gain is calculated as follows,  $N_{\text{ANT}} = 2$ ,  $N_{\text{SS}} = 1$ .

Directional gain =  $G_{ANT}$  + Array Gain, where Array Gain is as follows.

• For power spectral density (PSD) measurements on all devices,

Array Gain =  $10 \log(N_{ANT}/N_{SS}) dB = 3.01$ ;

• For power measurements on IEEE 802.11 devices,

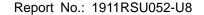
Array Gain = 0 dB for  $N_{ANT} \le 4$ ;

Note 2: WLAN and Bluetooth share Ant 1 port together.

#### 2.5. Test Mode

Test Mode 1: Communication with the Access Point
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#### 3. DFS DETECTION THRESHOLDS AND RADAR TEST WAVEFORMS

#### 3.1. Applicability

The following table from FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 lists the applicable requirements for the DFS testing.

Requirement	Operational Mode		
	Master Client Without Client with Rada		
		Radar Detection	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

Table 3-1: Applicability of DFS Requirements Prior to Use of a Channel

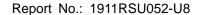
Requirement	Operational Mode		
	Master Device or Client		
	with Radar Detection	Detection	
DFS Detection Threshold	Yes	Not required	
Channel Closing Transmission Time	Yes	Yes	
Channel Move Time	Yes	Yes	
U-NII Detection Bandwidth	Yes	Not required	

Master Device or Client with	Client Without Radar
Radar Detection	Detection
All BW modes must be	Not required
tested	
Test using widest BW mode	Test using the widest BW
available	mode available for the link
Any single BW mode	Not required
	Radar Detection  All BW modes must be tested  Test using widest BW mode available

Note: Frequencies selected for statistical performance check 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.

Table 3-2: Applicability of DFS Requirements during normal operation

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#### 3.2. DFS Devices Requirements

# Per FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 the following are the requirements for Client Devices:

- 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.
- 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.

# Channel Move Time and Channel Closing Transmission Time requirements are listed in the following table.

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
Charmer wove Time	See Note 1.
	200 milliseconds + an aggregate of 60
Channel Closing Transmission Time	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

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#### 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.

**Table 3-3: DFS Response Requirements** 

#### 3.3. DFS Detection Threshold Values

The DFS detection thresholds are defined for Master devices and Client Devices with In-service monitoring. These detection thresholds are listed in the following table.

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

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.

Table 3-4: Detection Thresholds for Master Devices and Client Devices with Radar Detection



#### 3.4. Parameters of DFS Test Signals

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.

**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 3-6  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} \begin{cases} \left(\frac{1}{360}\right). \\ \left(\frac{19 \cdot 10^6}{\text{PRI}_{\text{usec}}}\right) \end{cases} $	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 Typ	pes 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 3-5: Parameters for Short Pulse Radar Waveforms

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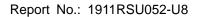


A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms.

Pulse Repetition Frequency	Pulse Repetition Frequency	Pulse Repetition Interval
Number	(Pulses Per Second)	(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

Table 3-6: Pulse Repetition Intervals Values for Test A

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#### Long Pulse Radar Test Waveform

Radar	Pulse	Chirp	PRI	Number	Number of	Minimum	Minimum
Туре	Width	Width	(µsec)	of Pulses	Bursts	Percentage of	Number of
	(µsec)	(MHz)		per Burst		Successful	Trials
						Detection	
5	50 - 100	5 - 20	1000 - 2000	1 - 3	8 - 20	80%	30

Table 3-7: Parameters for Long Pulse Radar Waveforms

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.

#### **Frequency Hopping Radar Test Waveform**

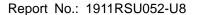
Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses Per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

**Table 3-8: Parameters for Frequency Hopping Radar Waveforms** 

For the Frequency Hopping Radar Type, the same Burst parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm:

The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

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#### 3.5. Conducted Test Setup

The FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v01 describes a radiated test setup and a conducted test setup. The conducted test setup was used for this testing. Figure 3-1 shows the typical test setup.

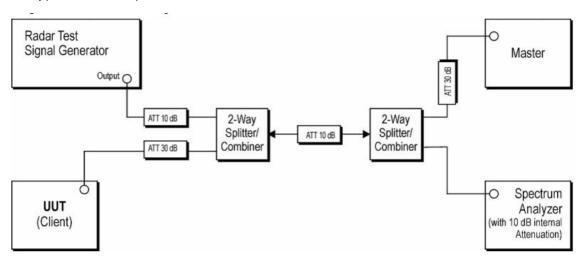
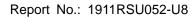


Figure 3-1: Conducted Test Setup where UUT is a Client and Radar Test Waveforms are injected into the Masters





## 4. TEST EQUIPMENT CALIBRATION DATE

Dynamic Frequency Selection - SR4

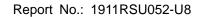
Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	KEYSIGHT	N9010B	MRTSUE06452	1 year	2020/07/11
ESG Vector Signal Generator	Agilent	E4438C	MRTSUE06026	1 year	2020/11/07
Vector Signal Generator	R&S	SMBV100A	MRTSUE06279	1 year	2020/04/15
Thermohygrometer	Testo	608-H1	MRTSUE06222	1 year	2020/11/10

#### Master Information

Instrument	Manufacturer	Type No.	FCC ID
Access Point	HAN Networks Co., Ltd	AP211	2ALJ3AP211

Software	Version	Manufacturer	Function
Pulse Building	N/A	Agilent	Radar Signal Generation Software
R&S Pulse Sequencer DFS	V 1.4	R&S	DFS Test Software
DFS Tool	V 6.9.2	Agilent	DFS Test Software

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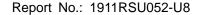


## **TEST RESULT**

## 5.1. Summary

Parameter	Limit	Test Result	Reference
Channel Move Time, Channel Closing			
Transmission Time and Non-Occupancy	Refer Table 3-3	Pass	Section 5.4
Period Measurement			

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#### 5.2. Radar Waveform Calibration

#### 5.2.1. Calibration Setup

The conducted test setup was used for this calibration testing. Figure 3-2 shows the typical test setup.

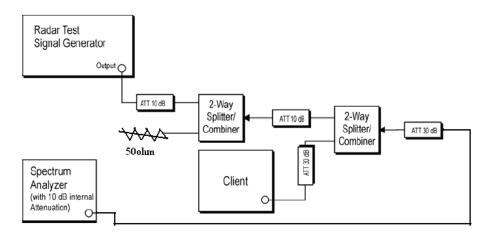
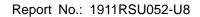


Figure 3-2: Conducted Test Setup

#### 5.2.2. Calibration Procedure

The Interference Radar Detection Threshold Level is (-64dBm) + (0) [dBi] + 1 dB= -63 dBm that had been taken into account the output power range and antenna gain. The above equipment setup was used to calibrate the conducted Radar Waveform. A vector signal generator was utilized to establish the test signal level for each radar type. During this process there were replace 50ohm terminal form Master and Client device and no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) at the frequency of the Radar Waveform generator. Peak detection was used. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to at least 3MHz. The vector signal generator amplitude was set so that the power level measured at the spectrum analyzer was (-64dBm) + (0) [dBi] + 1 dB= -63dBm. Capture the spectrum analyzer plots on short pulse radar types, long pulse radar type and hopping radar waveform.

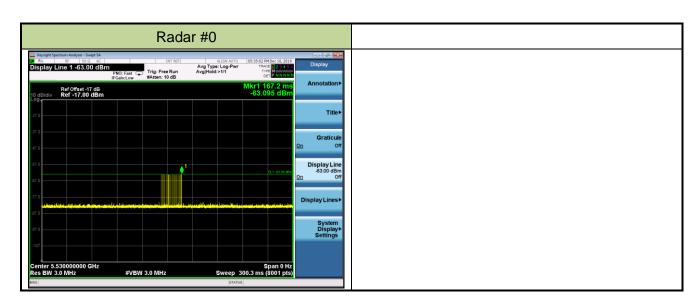
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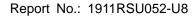




#### 5.2.3. Cablibration Result

Product	Standalone VR Headset	Temperature	25°C
Test Engineer	Gordon Qi	Relative Humidity	54%
Test Site	SR4	Test Date	2019/12/10
Test Item	Radar Waveform Calibration		

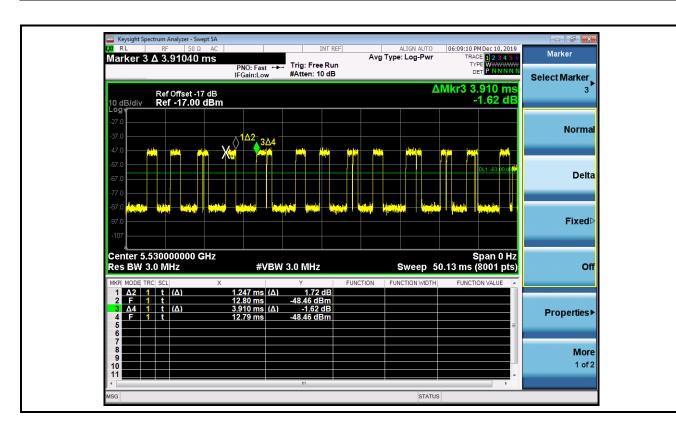






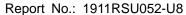
#### 5.3. Channel Loading Test Result

Product	Standalone VR Headset	Temperature	25°C
Test Engineer	Gordon Qi	Relative Humidity	54%
Test Site	SR4	Test Date	2019/12/10
Test Item	Channel Loading (802.11ac-VHT80 mode - 5530MHz)		



Test Mode	Test Frequency	Packet ratio	Requirement ratio	Test Result
802.11ac-VHT80	5530 MHz	31.89%	≥ 17%	Pass

Note: System testing was performed with the designated iperf test file. This file is used by IP and Frame based systems for loading the test channel during the In-service compliance testing of the U-NII device. Packet ratio = Time On / (Time On + Off Time).





## 5.4. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period Measurement

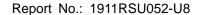
#### 5.4.1.Test Limit

The EUT has In-Service Monitoring function to continuously monitor the radar signals. If the radar is detected, must leave the channel (Shutdown). The Channel Move Time to cease all transmissions on the current channel upon detection of a Radar Waveform above the DFS Detection Threshold within 10 sec. The total duration of Channel Closing Transmission Time is 260ms, consisting of data signals and the aggregate of control signals, by a U-NII device during the Channel Move Time. The Non-Occupancy Period time is 30 minute during which a Channel will not be utilized after a Radar Waveform is detected on that Channel.

#### 5.4.2.Test Procedure Used

- 1. The test should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0.
- 2. When the radar burst with a level equal to the DFS Detection Threshold + 1dB is generated on the Operating Channel of the U-NII device. A U-NII device operating as a Master Device will associate with the Client Device at Channel. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test. At time T0 the Radar Waveform generator sends a Burst of pulses for each of the radar types at Detection Threshold + 1dB.
- 2. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel. Measure and record the transmissions from the EUT during the observation time (Channel Move Time).
- 3. Measurement of the aggregate duration of the Channel Closing Transmission Time method. With the spectrum analyzer set to zero span tuned to the center frequency of the EUT operating channel at the radar simulated frequency, peak detection, and max hold, the dwell time per bin is given by: Dwell (1.5ms) = S (12 sec) / B (8000); where Dwell is the dwell time per spectrum analyzer sampling bin, S is the sweep time and B is the number of spectrum analyzer sampling bins. An upper bound of the aggregate duration of the intermittent control signals of Channel Closing Transmission Time is calculated by: 80MHz: C = N X Dwell; where C is the Closing Time, N is the number of spectrum analyzer sampling bins showing a U-NII transmission and Dwell is the dwell time per bin.
- 4. Measure the UUT for more than 30 minutes following the channel close/move time to verify that the UUT does not resume any transmissions on this Channel.

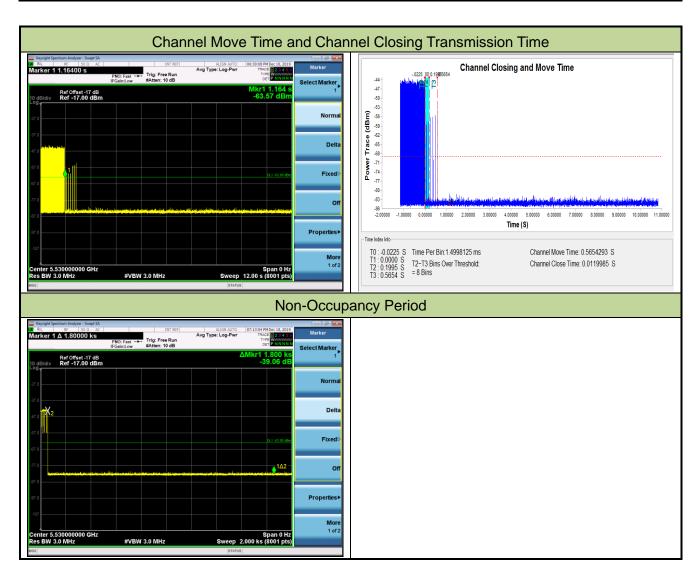
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#### 5.4.3.Test Result

Product	Standalone VR Headset	Temperature	25°C
Test Engineer	Gordon Qi	Relative Humidity	54%
Test Site	SR4	Test Date	2019/12/10
Test Item	Channel Move Time and Channel Closing Transmission Time		
	(802.11ac-VHT80 mode - 5530MHz)		





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Parameter	Test Result	Limit
	Type 0	
Channel Move Time (s)	0.565s	<10s
Channel Closing Transmission Time (ms) (Note)	12.0ms	< 60ms
Non-Occupancy Period (min)	≥ 30min	≥ 30 min

Note: 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 seconds period. The aggregate duration of control signals will not count quiet periods in between transmissions.

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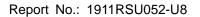
Report No.: 1911RSU052-U8

### 6. CONCLUSION

The data collected relate only the item(s) tested and show that the unit is compliance with Part 15E of the FCC Rules and ISED Rules.

————— The End

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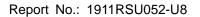




# **Appendix A - Test Setup Photograph**

Refer to "1911RSU052-UT" file.

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# Appendix B - EUT Photograph

Refer to "1911RSU052-UE" file.

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