	VERITAS
	DFS Test Report
Report No.:	RFBHAT-WTW-P20110381-4
FCC ID:	R68OQ865S
Test Model:	Open-Q 865XR SOM
Received Date:	Nov. 12, 2020
Test Date:	Dec. 14 , 2020
Issued Date:	Jan. 04, 2021
A	
Applicant:	
Address:	7535 Irvine Center Drive, Suite 100, Irvine, CA 92618 USA
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
	Lin Kou Laboratories
Lab Address:	No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan
Test Location:	No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, TAIWAN
FCC Registration / Designation Number:	788550 / TW0003
	Iac-MRA
	Testing Laboratory 2021

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## **Release Control Record**

Issue No.	Description	Date Issued
RFBHAT-WTW-P20110381-4	Original release	Jan. 04, 2021

1 Certificate of C	Conformity
Product:	Open-Q 865 SOM
Brand:	Lantronix
Test Model:	Open-Q 865XR SOM
Sample Status:	Engineering sample
Applicant:	Lantronix
Test Date:	Dec. 14 , 2020
Standards:	FCC Part 15, Subpart E (Section 15.407)
	KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02
Guidance:	KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

The above equipment has been tested by Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

 Prepared by :
 Rolly Chief / Specialist
 Date:
 Jan. 04, 2021

 Polly Chief / Specialist
 Buce Chen
 , Date:
 Jan. 04, 2021

Approved by :

Bruce Chen / Senior Project Engineer



### 2 EUT Information

### 2.1 Operating Frequency Bands and Mode of EUT

### Table 1: Operating Frequency Bands and Mode of EUT

Operational Made	Operating Frequency Range		
Operational Mode	5250~5350MHz	5470~5725MHz	
Client without radar detection and ad hoc function	$\checkmark$	✓	

Note: The EUT doesn't operate in 5600 ~ 5650MHz via software controls.

#### 2.2 EUT Software and Firmware Version

### Table 2: The EUT Software/Firmware Version

No.	Product	Model No.	Software/Firmware Version
1	Open-Q 865 SOM	Open-Q 865XR SOM	Linux version 4.19.81+ (jenkins@jenkins) (clang version 8.0.12 for Android NDK)#1 SMP PREEMPT Tue Aug 25 01:01:34 PDT 2020

#### 2.3 Description of Available Antennas to the EUT

### Table 3: Antenna List

Ant. No.	Туре	Operation Frequency Range	MAX Gain(dBi)
1	Flexible Dipole	5250-5350 MHz	6.11
1	Flexible Dipole	5470-5725 MHz	6.11
2	Flexible Dipole	5250-5350 MHz	6.11
2	Flexible Dipole	5470-5725 MHz	6.11

\* The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.



# 2.4 EUT Maximum Conducted Power

Table 4: The Measured Conducted Output Power

### CDD Mode

### 802.11a

Frequency Band (MHz)	Max. Power	
	Output Power (mW)	Output Power (dBm)
5250~5350	40.167	16.04
5470~5725	88.066	19.45

# 802.11ac (VHT20)

Frequency Rand (MHz)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	40.354	16.06
5470~5725	93.615	19.71

### 802.11ac (VHT40)

Frequency Band (MHz)		Power
	Output Power (mW)	Output Power (dBm)
5250~5350	39.960	16.02
5470~5725	237.482	23.76

# 802.11ac (VHT80)

Frequency Rend (MHz)	Max.	Power
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	37.317	15.72
5470~5725	213.847	23.30



# 802.11ax (HE20)

Fraguanay Rand (MHz)	Max.	Power
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	40.075	16.03
5470~5725	94.336	19.75

# 802.11ax (HE40)

Frequency Rend (MHz)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	40.307	16.05
5470~5725	241.341	23.83

# 802.11ax (HE80)

Frequency Dand (MUT)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	37.317	15.72
5470~5725	216.323	23.35



### Beamforming Mode

802.11ac (VHT20)

	Max. Power	
	requency Band (MHz) Output Power (mW) Output Power	
5250~5350	19.888	12.99
5470~5725	93.615	19.71

# 802.11ac (VHT40)

Frequency Rend (MHz)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	20.028	13.02
5470~5725	119.023	20.76

### 802.11ac (VHT80)

Frequency Rend (MHz)	Max. Power	
Frequency Band (MHz)         Output Power (mW)         Output Power (dBm)		Output Power (dBm)
5250~5350	18.498	12.67
5470~5725	106.440	20.27

# 802.11ax (HE20)

	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	20.085	13.03
5470~5725	94.336	19.75

### 802.11ax (HE40)

	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	20.201	13.05
5470~5725	120.957	20.83

### 802.11ax (HE80)

Frequency Dand (MUT)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	18.703	12.72
5470~5725	107.425	20.31



### 2.5 EUT Maximum E.I.R.P. Power

# Table 5: The EIRP Output Power List

#### CDD Mode

### 802.11a

Frequency Rend (MHz)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	164.059	22.15
5470~5725	359.749	25.56

#### 802.11ac (VHT20)

	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	164.816	22.17
5470~5725	381.944	25.82

### 802.11ac (VHT40)

	Max. Power	
Frequency Band (MHz)	Output Power (mW) Output Power (dBm)	
5250~5350	163.305	22.13
5470~5725	970.510	29.87

### 802.11ac (VHT80)

Frequency Rend (MUT)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	152.405	21.83
5470~5725	872.971	29.41

### 802.11ax (HE20)

	Frequency Band (MHz)	Max. Power		
		Output Power (mW)	Output Power (dBm)	
	5250~5350 163.682		22.14	
	5470~5725	385.478	25.86	



# 802.11ax (HE40)

Frequency Band (MHz)	Max. Power	
	Output Power (mW)	Output Power (dBm)
5250~5350 164.437		22.16
5470~5725	986.279	29.94

# 802.11ax (HE80)

Frequency Rend (MHz)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350 152.405		21.83
5470~5725	883.080	29.46



### Beamforming Mode

802.11ac (VHT20)

Frequency Rend (MHz)	Max. Power		
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)	
5250~5350	162.555	22.11	
5470~5725	763.836	28.83	

# 802.11ac (VHT40)

Frequency Band (MHz)	Max. Power		
	Output Power (mW)	Output Power (dBm)	
5250~5350 163.682		22.14	
5470~5725	972.747	29.88	

### 802.11ac (VHT80)

Frequency Band (MHz)	Max. Power	
	Output Power (mW)	Output Power (dBm)
5250~5350 151.008		21.79
5470~5725	868.960	29.39

# 802.11ax (HE20)

Frequency Band (MHz)	Max. Power		
	Output Power (mW)	Output Power (dBm)	
5250~5350	164.059	22.15	
5470~5725	770.903	28.87	

### 802.11ax (HE40)

Frequency Band (MHz)	Max. Power		
	Output Power (mW)	Output Power (dBm)	
5250~5350 164.816		22.17	
5470~5725	988.553	29.95	

### 802.11ax (HE80)

Frequency Rend (MUT)	Max. Power	
Frequency Band (MHz)	Output Power (mW)	Output Power (dBm)
5250~5350	152.757	21.84
5470~5725	877.001	29.43



### 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 e.i.r.p. of less than 500 mW.

Maximum EIRP of this device is 988.553mW which more than 500mW, therefore it's require TPC function.

Applicable	E.I.R.P	FCC 15.407 (h)(1)
$\checkmark$	>500mW	The TPC mechanism is required for system with an E.I.R.P of above 500mW
	<500mW	The TPC mechanism is not required for system with an E.I.R.P of less 500mW

### 2.7 Statement of Maunfacturer

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.

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

Table 6: Applicability of DFS Requirements Prior To Use a Channel

Note: Per KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02 section (b)(5/6), If the client moves with the master, the device is considered compliant if nothing appears in the client nonoccupancy period test. For devices that shut down (rather than moving channels), no beacons should appear. An analyzer plot that contains a single 30-minute sweep on the original channel.

Table 7: Applicability of DFS Requirements during Normal Operation.

	Operational Mode		
Requirement	Master or Client with radar detection	Client without radar detection	
DFS Detection Threshold	$\checkmark$	Not required	
Channel Closing Transmission Time	$\checkmark$	$\checkmark$	
Channel Move Time	$\checkmark$	$\checkmark$	
U-NII Detection Bandwidth	$\checkmark$	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	Test using widest BW mode	Test using the widest BW mode	
Transmission Time	available	available for the link	
All other tests	Any single BW mode	Not required	

Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.

# 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 (See Notes 1, 2, and 3)			
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	-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 9: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 100% of the 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.

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 $ \begin{pmatrix} 1 \\ 360 \\ \hline \\ 19 \cdot 10^6 \\ \hline \\ PRI_{\#sec} \end{pmatrix} $	60%	30			
		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						
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 10: Short Pulse Radar Test Waveforms



				5			
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

Table 11: Long Pulse Radar Test Waveforn
--

Three subsets of trials will be performed with a minimum of ten trials per subset. The subset of trials differ in where the Long Pulse Type 5 Signal is tuned in frequency.

a) the Channel center frequency

b) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the low edge of the UUT Occupied Bandwidth

c) tuned frequencies such that 90% of the Long Pulse Type 5 frequency modulation is within the high edge of the UUT Occupied Bandwidth

It include 10 trails for every subset, the formula as below,

For subset case 1: the center frequency of the signal generator will remain fixed at the center of the UUT Channel.

For subset case 2: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 2. The center frequency of the signal generator for each trial is calculated by:

#### FL+(0.4\*Chirp Width [in MHz])

For subset case 3: to retain 90% frequency overlap between the radar signal and the UUT Occupied Bandwidth, the center frequency of the signal generator will vary for each of the ten trials in subset case 3. The center frequency of the signal generator for each trial is calculated by:

#### *FH*-(0.4\**Chirp Width* [*in MHz*])

#### Table 12: 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



## 4 Test & Support Equipment List

### 4.1 Test Instruments

#### Table 13: Test Instruments List

Description & Manufacturer	Model No.	Brand	Date Of Calibration	Due Date Of Calibration
Spectrum analyzer	ESR	R&S	Mar. 04, 2020	Mar. 03, 2021
Signal generator	MXG	KEYSIGHT	Jan. 18 ,2020	Jan. 17 ,2021
Horn antenna	BBHA 9120 D	Schwarzbeck	Nov. 22, 2020	Nov. 21, 2021
RF coaxial cable	SUCOFLEX 104	HUBER SUHNER	NA	NA

Note: Calibrate the RF coaxial cable before each test and use the radiation or conducted method to calibrate the reference FCC KDB 412172 standard.

#### 4.2 Description of Support Units

#### Table 14: Support Unit Information.

No.	Product	Brand	Model No.	FCC ID	Gain
1	802.11ax wireless Router	ASUS	RT-AX88U	MSQ- RTAXHP00	5G Ant gain : 2.24dBi Maximum EIRP : 26.30dBm

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.	802.11ax wireless Router	RT-AX88U	3.0.0.4.384_5329-gd8d34a4

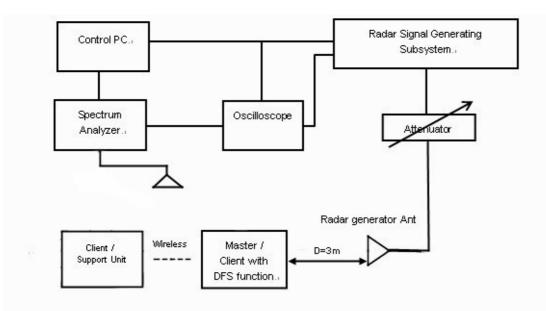


### 5 Test Procedure

### 5.1 DFS Measurement System

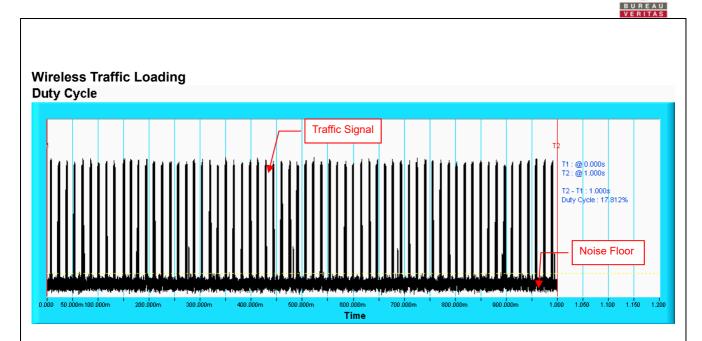
A complete DFS Measurement System consists of two subsystems: (1) the Radar Signal Generating Subsystem and (2) the Traffic Monitoring Subsystem. The control PC is necessary for generating the Radar waveforms in Table 10, 11 and 12. The traffic monitoring subsystem is specified to the type of unit under test (UUT).

### Radiated Setup Configuration of DFS Measurement System



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.				
V	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.				

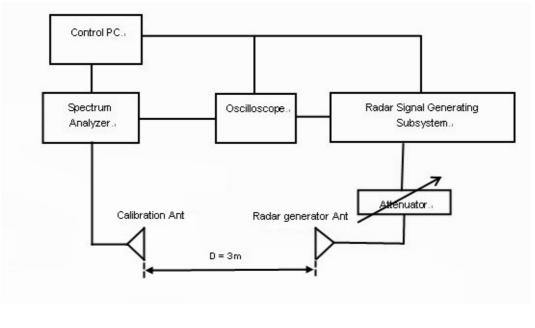


## 5.2 Calibration of DFS Detection Threshold Level

The measured channel is 5500MHz, 5510MHz and 5530MHz. The radar signal was the same as transmitted channels, and injected into the antenna of AP (master) or Client Device with Radar Detection, measured the channel closing transmission time and channel move time. The calibrated conducted detection threshold level is set to -64dBm. The tested level is lower than required level hence it provides margin to the limit.

### Radiated setup configuration of Calibration of DFS Detection Threshold Level

The calibrated conducted detection threshold level is set to -64dBm. The tested level is lower than required level hence it provides margin to the limit.

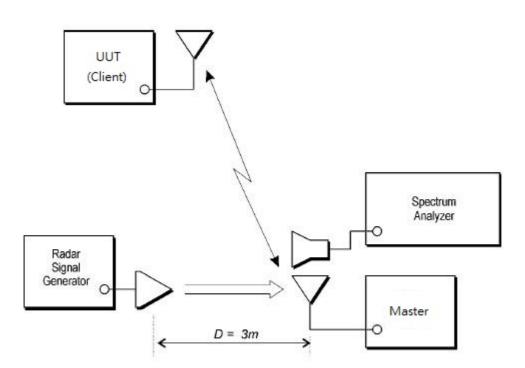


### 5.3 Deviation from Test Standard

No deviation.

# 5.4 Radiated Test Setup Configuration

### 5.4.1 Client without Radar Detection Mode





# 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	Uniform Spreading	Not Applicable	NA
15.407	U-NII Detection Bandwidth	Not Applicable	NA
15.407	Non-associated test	Applicable	Pass
15.407	Non-Co-Channel test	Applicable	Pass

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.



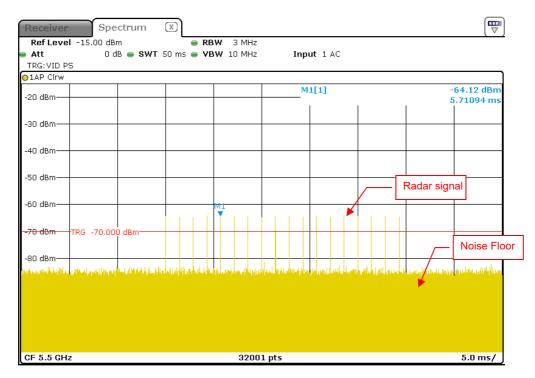
#### 6.2 Test Results

### 6.2.1 Test Mode: Device Operating In Client without Radar Detection Mode.

Client with injection at the Master. (The radar test signals are injected into the Master Device)

### **DFS Detection Threshold**

For detection threshold level of -64dBm, the required signal strength at AP antenna location is -64 dBm.

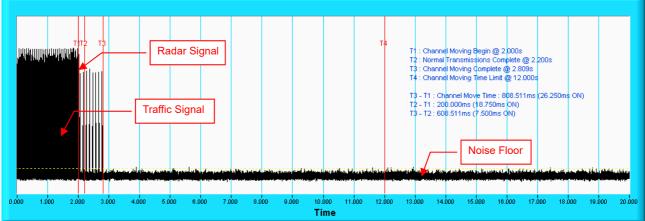


Radar Signal 0

# 6.2.2 Channel Closing Transmission and Channel Move Time

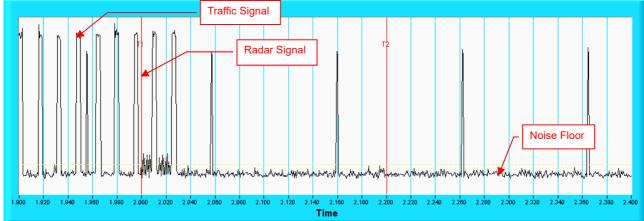
#### Radar Signal 0 802.11ax (HE20)

**Channel Closing Transmission Time & Channel Move Time** 



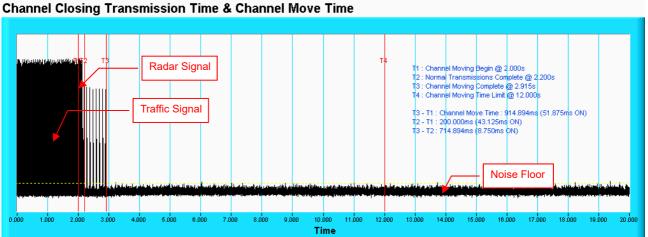
Note: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T3 denotes the end of Channel Move Time.T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

# Channel Closing Transmission Time & Channel Move Time

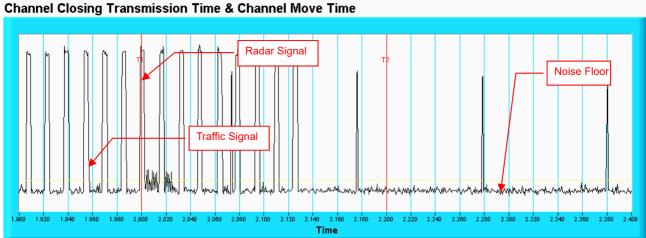


Note: An expanded plot for the device vacates the channel in the required 500ms.

### Radar Signal 0 802.11ax (HE40)

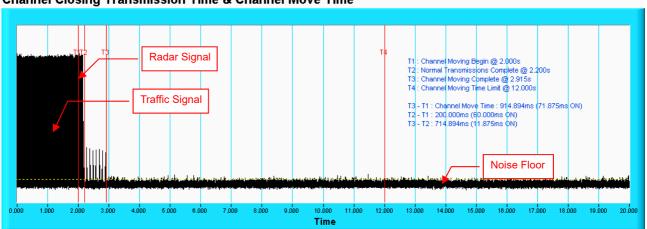


Note: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T3 denotes the end of Channel Move Time.T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.



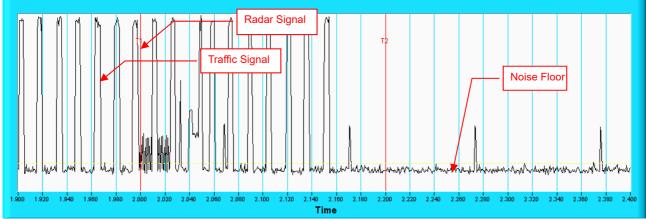
Note: An expanded plot for the device vacates the channel in the required 500ms.

#### Radar Signal 0 802.11ax (HE80) Channel Closing Transmission Time & Channel Move Time



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. T3 denotes the end of Channel Move Time.T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.





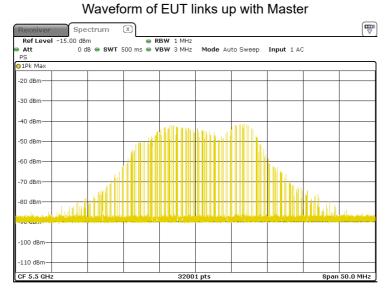
Note: An expanded plot for the device vacates the channel in the required 500ms.

## 6.2.3 Non-Occupancy Period

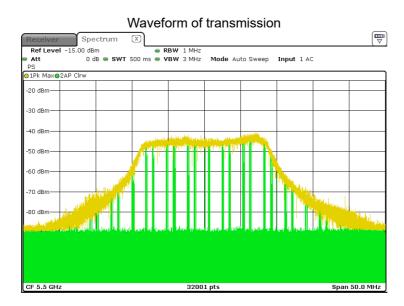
### Associate test:

During the 30 minutes observation time, UUT did not make any transmissions on a channel after a radar signal was detected on that channel by either the Channel Availability Check or the In-Service Monitoring.

1) EUT (Client) links with master on 5500MHz.



2) Client plays specified files via master.



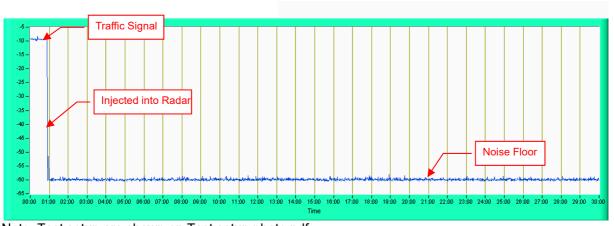


3) Radar signal 0 is applied to the Master device and WiFi traffic signal stop immediately.



4) 5500MHz has been monitored in 30 minutes period. In this period, no any transmission occurs.

Plot of 30minutes period



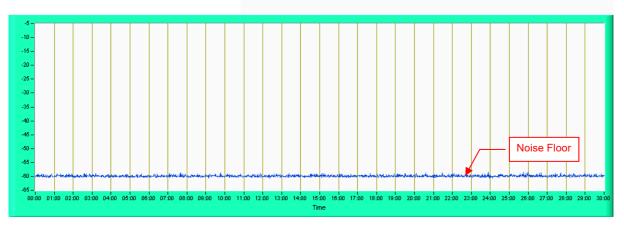
### 802.11ax HE20

Note: Test setup are shown on Test setup photo.pdf

## 6.2.4 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.



## 6.2.5 Non-Co-Channel Test

The UUT was investigated after radar was detected and confirmed that no co-channel operation with radars.



#### 7. Information of 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 FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

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

Lin Kou EMC/RF Lab Tel: 886-2-26052180 Fax: 886-2-26051924 Hsin Chu EMC/RF/Telecom Lab Tel: 886-3-6668565 Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab Tel: 886-3-3183232 Fax: 886-3-3270892

Email: <u>service.adt@tw.bureauveritas.com</u> Web Site: <u>www.bureauveritas-adt.com</u>

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

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