Nalloy, LLC.

TEST REPORT FOR

A2D0US

Tested to The Following Standards:

FCC Part 15 Subpart E Section(s)

15.407 (h)(2)
Radar Detection Function of Dynamic Frequency Selection (DFS)

Report No.: 106407-33

Date of issue: Feburary 8, 2022

Test Certificate # 803.01

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

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Representative: Naga Suryadevara
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REPORT PREPARED BY:

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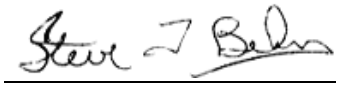
Project Number: 106407

DATE OF EQUIPMENT RECEIPT: January 24, 2022
DATE(S) OF TESTING: January 24 & 28, 2022

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.



Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
Canyon Park
22116 23rd Drive S.E., Suite A
Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.19

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

SUMMARY OF RESULTS

Standard: FCC Part 15 Subpart E - 15.407(h)(2) (UNII) 5.25-5.35 GHz and 5.47-5.725 GHz bands

Requirement	Test Procedure Clause	Description	Modification	Results
15.407(h)(2)	7.5	DFS Detection Threshold (master & client with DFS)	NA	NA1
15.407(h)(2)	7.8.1	UNII Detection Bandwidth (master & client with DFS)	NA	NA1
15.407(h)(2)(i)(A) 15.407(h)(2)(ii)	7.8.2.1 7.8.2.2 7.8.2.3	Channel Availability Check Time. (master & client with DFS)	NA	NA1
15.407(h)(2)(i)(B) 15.407(h)(2)(iii)	7.8.3	Channel Move Time, Channel Closing Time (master, client with DFS, client)	NA	Pass
15.407(h)(2)(iv)	7.8.3	Non-Occupancy Period (master & client with DFS)	NA	Pass
5.1 Table 2*	7.8.4	Statistical Performance Check (master & client with DFS)	NA	NA1
7.7*	7.7	Channel Loading (master and client with radar detection)	NA	Pass

NA = Not Applicable
* KDB requirement.
NA1: EUT is Client without radar detection.

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
The Test Setup Photos are incorporated by reference 106407-33_Test Setup_Photos

Test Procedure
The DFS testing presented in this report is perform in accordance with the following test procedure to meet the requirement. 905462 D02 UNII DFS Compliance Procedures New Rules v02. April 8, 2016. Each clause of the test procedure is identified in specific section of this report.

EQUIPMENT UNDER TEST (EUT)

During testing numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
None	Nalloy, LLC	A2D0US	G3A1VF021386000B

Support Equipment:

Device	Manufacturer	Model #	S/N
Headphones	Poly	C5220T	NA
Laptop	HP	14-fq0032od	5CD12654D3
None	Nalloy, LLC	Gala	XXX
None	Nalloy, LLC	Gala	XXX
USB to Ethernet Adapter	Amazon	Gigabit Ethernet Adapter	0050B6E212BA
AC Adapter	Delta Electronics, Inc.	MDS-030AAC15	NA

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Operational Mode(s):	☐ Master ☐ Client with Radar Detection ☒ Client without Radar Detection
FCCID of Master Used for Testing:	Client mode was tested with FCC ID: PY315100319
Network Type:	☐ Bridge ☐…Mesh ☒ Access Point
System Architecture:	IP Based/Load Based
Operating Frequency Range(s):	☒ 5150-5250 MHz ☒ 5250-5350 MHz * ☒ 5470-5725 MHz ☒ 5725-5850 MHz *Test performed using 5230-5350 MHz Band with 802.11VHT80
Modulation Type(s):	802.11a, 802.11ac VHT 20, 802.11ac VHT 40, 802.11ac VHT80
Channel bandwidth(s):	☒ 20 MHz ☒ 40 MHz ☒ 80 MHz ☐ 160MHz contiguous ☐ 80 MHz+80MHz noncontiguous
Measured 99% BW:	5250-5350 MHz 802.11VHT80: 76.5 MHz
Maximum Duty Cycle:	100%
Highest Power (EIRP, dBm/Watt):	23.4 dBm
Lowest Power (EIRP, dBm/Watt):	15.6 dBm
Number of TX/RX Chains:	1
Antenna Type(s) and Gain:	Omnidirectional / 3.8dBi
Antenna cable loss	NA
Beamforming Capable:	NA
Antenna Connection Type:	u.fl
Antenna Impedance (ohm):	50
Nominal Input Voltage:	120VAC 60Hz
Boot up time from power cycle:	NA
Manufacturer Statement:	The manufacturer has confirmed that information regarding the parameters of the detected Radar Waveforms is not available to the end user.
Firmware / Software used for Test:	mainline-1.0.2137.0 Bin file- Golden 082621 Qualcomm radio control toolkit v4.0

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	Agilent	E4440A	11/29/2021	11/29/2023
03592	Vector Signal Generator	Keysight	N5182B	1/20/2022	1/20/2024
P07134	Attenuator	Weinschel	3M10	NCR	NCR
P07135	Attenuator	Weinschel	3M10	NCR	NCR
P07181	Attenuator	Weinschel	3M30	NCR	NCR
P07182	Attenuator	Weinschel	3M30	NCR	NCR
P06794	Splitter/Combiner	Anaren	41130	4/6/2021	4/6/2023
P07137	Power Divider	Anaren	41130	8/5/2021	8/5/2023
P07209	Power Divider	Anaren	40297	4/6/2021	4/6/2023

NCR = No Calibration Required

Environmental Conditions			
Temperature (ºC)	21	Relative Humidity (%):	40

Unless otherwise noted, all test performed under the listed environmental condition.

Waveform information.
The waveforms used are commercially available pre-defined DFS waveform per Agilent N7607B Signal Studio for DFS radar profile. The waveforms meeting the following requirement.
USA : FCC15.407, FCC-13-22

Requirements

Table 1: 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

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device 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 each of the bonded 20 MHz channels and the channel center frequency.		

Table 3: 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 4: 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.	

15.407(h)(2) DFS Detection Threshold

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	7.5	Test Date(s):	1/28/2022
Configuration:	1		
Test Setup:	Conducted DFS detection threshold is adjusted with test method as illustrated in test setup diagram. A spectrum analyzer with Peak detector activated, set at zero span and RBW and VBW >3 MHz was used for measurement of DFS detection threshold. Measurement made at Antenna port. Each Radar waveform is loaded into the Vector Signal Generator and triggered. The RF output level of the Signal generator with each waveform is adjust until the measured signal level at measuring point to be injected to the antenna port of the master device reaches the required equivalent DFS detection threshold. All other ports of test system are terminated to 50-ohm load. The signal output level of the vector signal generator is recorded and used for regeneration of test level. Waveform 13-22		

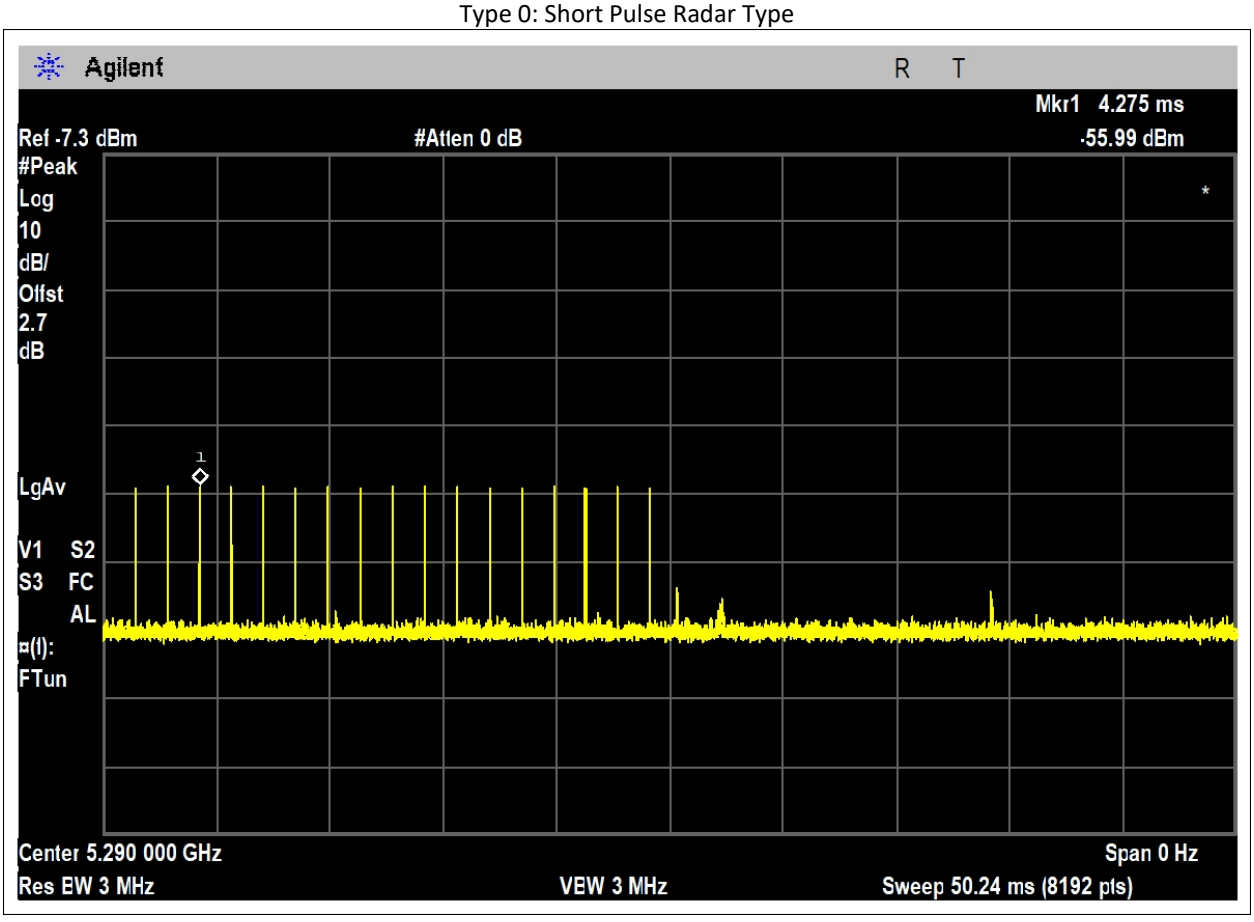
Calibration Data Summary								
Antenna Port: 1								
Frequency (MHz)	**Waveform Type**	**Detection Threshold** See note1 **(dBm)**	**Min antenna Gain (dBi)**	**Max cable Loss (dB)**	**Additional level** See note2 **(dB)**	**Required Equivalent Threshold (dBm)**	**Measured Level (dBm)**	**Sig Gen Level (dBm)**
5500	0	-64	7.13	0	1	-55.87	-55.99	16.4

Req threshold at input of the receiver = Detection threshold + min antenna gain – max cable loss + additional level.

DFS Detection Thresholds	
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.	

Plot

Type 0: Short Pulse Radar Type



15.407(h)(2)(i)(A) Channel Availability Check Time

Nominal Noise Floor - Master/ Client with Radar Detection

Applies to Channel availability check, Initial radar bursts, in-service monitoring and 30-minute non-occupancy period tests.

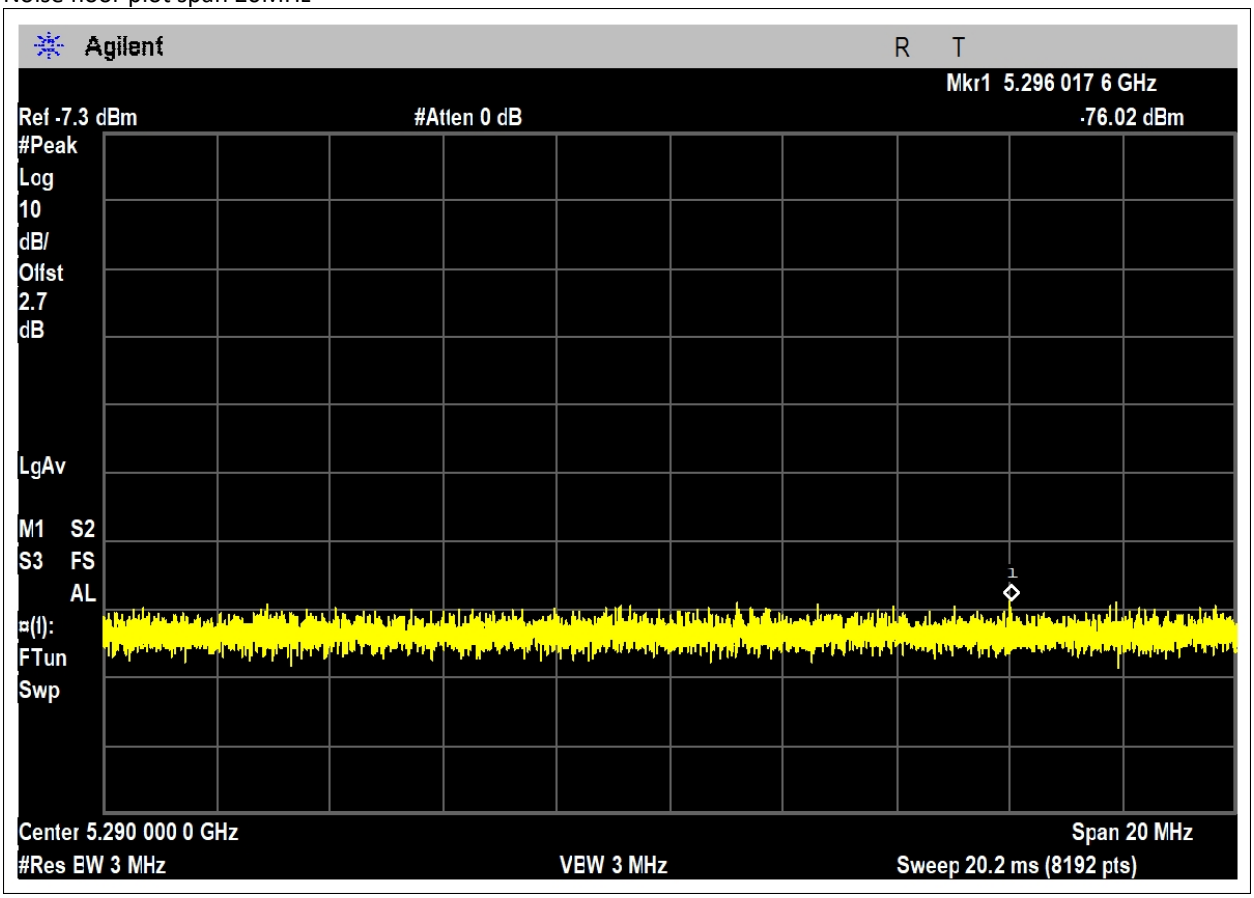
Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	7.8.2.1, 7.8.2.2, 7.8.2.3	Test Date(s):	1/28/2022
Configuration:	1		
Test Setup:	Conducted Nominal Noise floor measurement of the system was measured with test method as illustrated in test setup diagram. A spectrum analyzer with Peak detector activated and RBW and VBW >3 MHz was used for measurement of DFS detection threshold. The span is set to the bandwidth of the signal protocol to be used for Channel availability measurement IAW plot requirement of clause 8.3, d) 3) the Master and Client are not transmitting, the Radar signal is turned off.		

Test Data Summary		
Frequency (MHz)	**Channel bandwidth (MHz)**	**Nominal Noise Floor (dBm)**
5290	80	-75.3

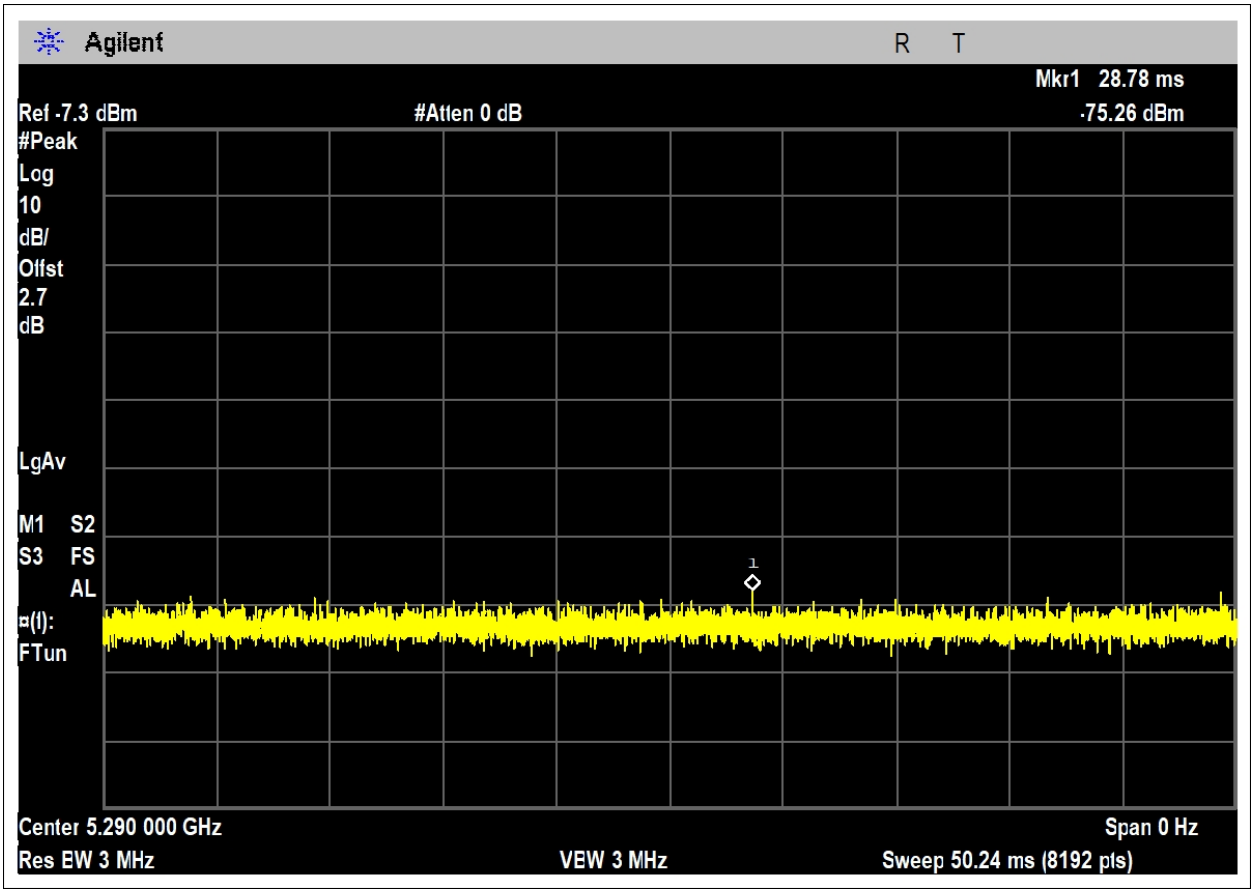
* No limit, however, must be below the Radar signal

Plot(s)

Noise floor plot span 20MHz



Noise floor plot span 0 MHz



15.407(h)(2)(i)(B) Channel Move Time, Channel Closing Time

Channel Move / Closing Time

Client without Radar Detection

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	7.8.3	Test Date(s):	1/24/2022
Configuration:	1		
Test Setup:	Conducted In-Service Monitoring was evaluated as illustrated in test setup diagram. The Test frequency contains control signals. A spectrum analyzer with Peak detector activated, set at zero span and RBW and VBW >3 MHz. In-Service monitoring was evaluated with the Widest bandwidth mode. Radar burst at required test level was triggered and the time to vacate the channel and remained unoccupied was evaluated. Plot and Spectrum analyzer trace data was captured with maximum available BIN, the trace data is imported to Analysis application to detect channel move time and channel closing time. Time above Threshold (T1 to T1+200ms) and (T1+200ms to Ts+10s) meet required maximum timing requirements. Test performed with widest BW mode available. (see table a2) 802.11VHT80, radar inject and monitored at 5290MHz, the service channel of 802,11HT80 is at 5290MHz. For Channel move and Channel closing time Sweep at 11sec, there was no transmission detected after 1 second, second acquisition performed at 2 second sweep time. Time analyses perform with 2 sec sweep.		

Test Data Summary						
Frequency (MHz)	**Protocol**	**Waveform Type**	**Channel Test**	**Measured Time**	**Limit**	**Results**
5290	802.11VHT80	0	Move[1]	0.42s	<10 s	Pass
5290	802.11VHT80	0	T1 - Closing[1,2]	20ms	<200ms	Pass
5290	802.11VHT80	0	CS - Closing[1,2]	51.3ms	<60 ms/10s	Pass

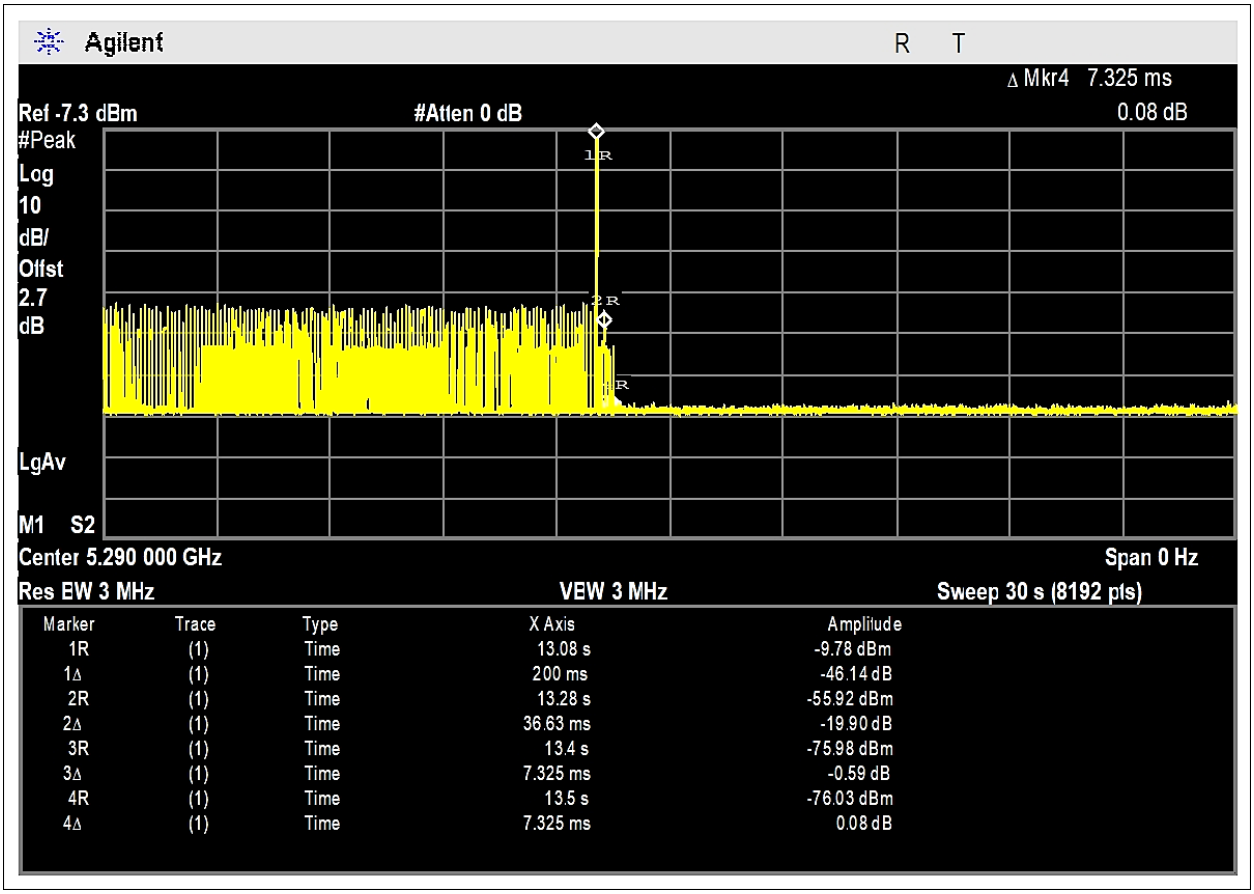
Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

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. This test is required for Master and Client with Radar Detection.

Plot(s)

Channel Closing Time

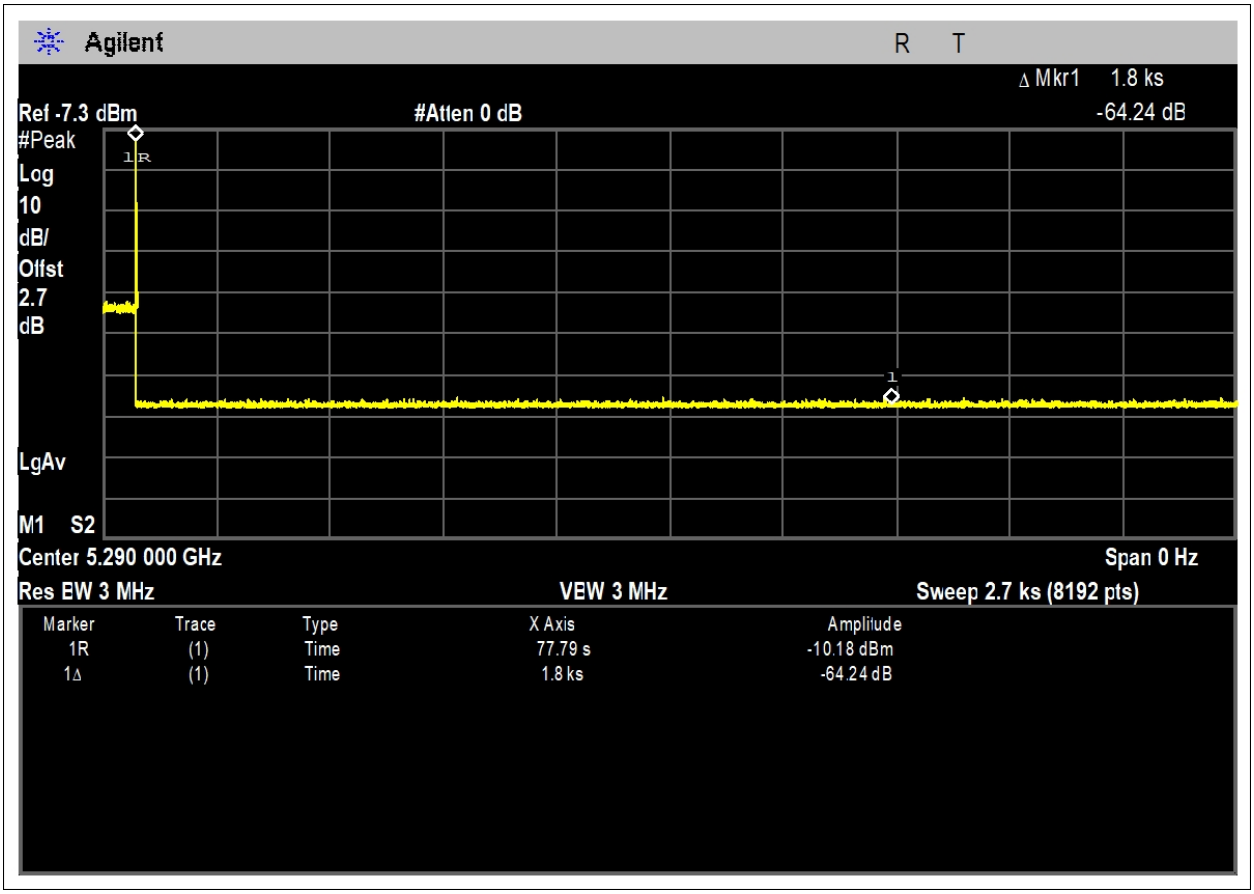


The channel move time =the delta between the Radar pulse @ 13.08s and the end of the signal @ 13.5s = 0.42s.

The T1- closing = 20ms end of the signal @ 13.08 to the next data point where the channel was closed.

The CS- Closing = the 3 pulses that after the 200ms (36.63 + 7.325 + 7.325ms = 51.3ms)

Non-Occupancy Period



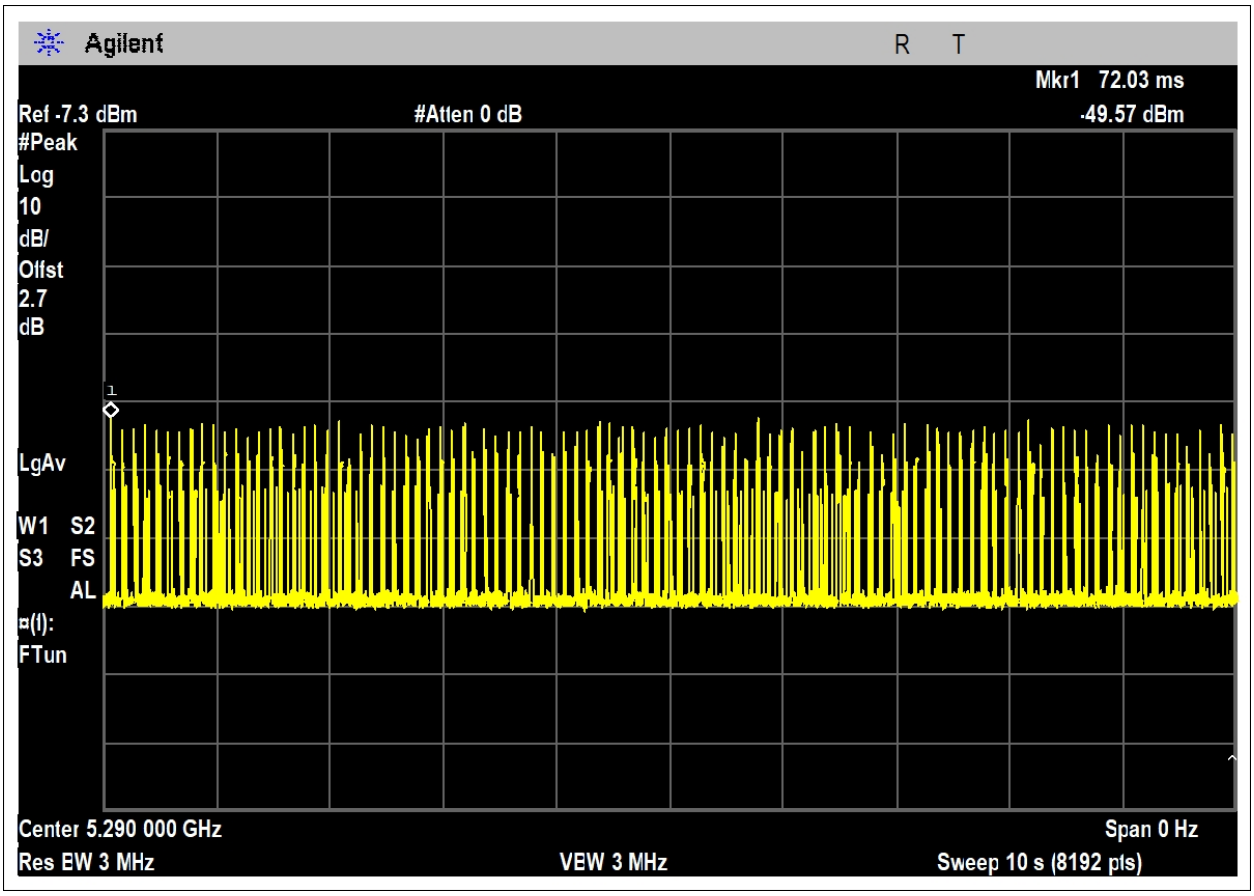
Channel Loading

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison
Test Method:	7.7	Test Date(s):	1/24/2022
Configuration:	1		
Test Setup:	Conducted Channel loading was measured as illustrated in test setup diagram. A spectrum analyzer with Peak detector activated, set at zero span and RBW and VBW >3 MHz. Channel loading of each protocol is evaluated. Data transfer: iPerf (Typical data transfer for EUT) Communication established between the master and client, ran iPerf. Channel loading is measured by Time On/ (Time On + Time Off), equivalently (BIN above Threshold/ total BIN)		

Test Data Summary				
Frequency (MHz)	**Protocol**	**Loading (%)**	**Limit (%)**	**Results**
5290	802.11VHT80, MCS9	19.3	> 17	Pass

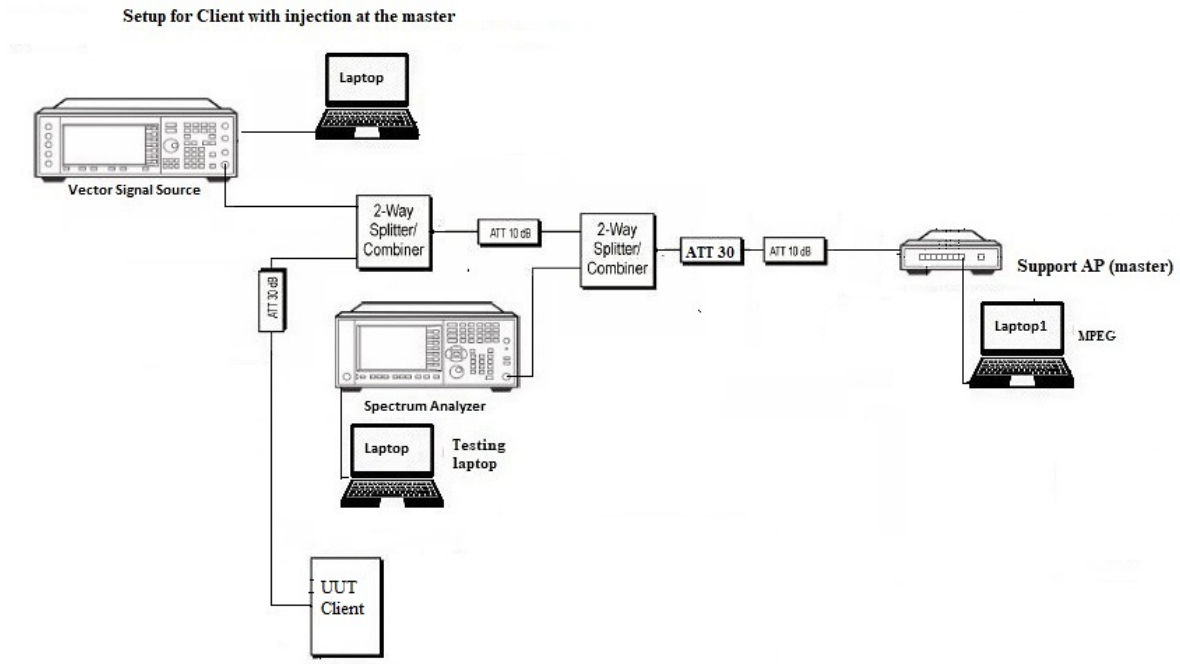
Plot(s)

7.7 Channel Loading_801.11VHT80_8192pt_MCS9



Total BIN	8192	
BIN Below Threshold	6613	
BIN Above Threshold	1579	
Percent On	19.27	%

Appendix A: Test Equipment Setup Block Diagram



Appendix B: Waveforms

Short Pulse Radar: Waveform Type 1				
Trial	Pulse width (µs)	PRI (µs)	Number of Pulses	Waveform Length (µs)
0	1	1428	18	25704.0

Appendix C: Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2.