



FCC CFR47 PART 15 SUBPART H

DATABASE TEST REPORT

FOR

FIXED TV BAND DEVICE

MODEL NUMBER: ACRS2-B1000

REPORT NUMBER: 12605133-E2V2

FCC ID: A2UACRS2F-B1

ISSUE DATE: January 17, 2019

Prepared for

ADAPTRUM

25 E. TRIMBLE ROAD

SAN JOSE, CA 95131

Prepared by

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NVLAP Lab code: 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	12/19/2018	Initial Issue	---
V2	1/17/2019	Update section 8.9	F. de Anda

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Adaptrum
25 E. Trimble Road
San Jose, CA 95131

EUT DESCRIPTION: FIXED TV BAND DEVICE

MODEL: ACRS2-B1000

SERIAL NUMBER: A2HX1044

DATE TESTED: JANUARY 13 to14, 2014

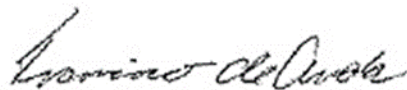
APPLICABLE STANDARDS	
SECTION	TEST RESULTS
DATABASE PORTIONS OF FCC PART 15 SUBPART H	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

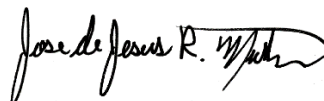
This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:



FRANCISCO DE ANDA
OPERATIONS LEAD
UL Verification Services Inc.

Prepared By:



Jose Martinez
TEST ENGINEER
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 15 Subpart H and KDB 416271 D01 White Space Test Procedures v03.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd.
☐ Chamber A (ISED:2324B-1)	☐ Chamber D (ISED:22541-1)	☐ Chamber I (ISED: 2324A-5)
☐ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)	☒ Chamber J (ISED: 2324A-6)
☒ Chamber C (ISED:2324B-3)	☐ Chamber F (ISED:22541-3)	☐ Chamber K (ISED: 2324A-1)
	☐ Chamber G (ISED:22541-4)	☐ Chamber L (ISED: 2324A-3)
	☐ Chamber H (ISED:22541-5)	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT are Adaptrum A2UACRS2F-B1 base and client radios operating as Fixed TV Band Devices in compliance with Part 15 Subpart H of Title 47 of the Code of Federal Regulations. Adaptrum A2UACRS2F-B1 radios are broadband wireless communication equipment operating in the UHF TV band with frequency range from 470 Mhz to 698 MHz (Channels 14 – 51 excluding Channels 36 to 38) and modulation modes QPSK, 16QAM and 64QAM.

The A2UACRS2F-B1 radios are Fixed TV Band Devices that require professional installation.

5.2. CLASS II PERMISSIVE CHANGE

This Class 2 Permissive change is to add a new database. The new database provider is Nominet. No RF changes are made and power levels remain as originally granted.

5.3. DATABASE information

Nominet is the new alternate TVWS Database provider, referred to as the TVWS Database throughout this report.

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was version A2.1.3.

5.5. DETAILS OF TESTED SYSTEM

SUPPORT EQUIPMENT & PERIPHERALS

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	Manufacturer	Model	S/N	FCC ID
Laptop	Acer	E3-111 series	NXMQVAA001439014FE7600	DoC
Switch	HP	J979A	CN20FQ8DNV	DoC
AC/DC Adapter	HP	5066-1122	N/A	DoC
PoE Adapter	LairdTech	PoE-48-i	167015470DRC04	DoC

I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	micro USB	Shielded	0.8	
2	LAN	3	RJ45	un -Shielded	1	

TEST SETUP

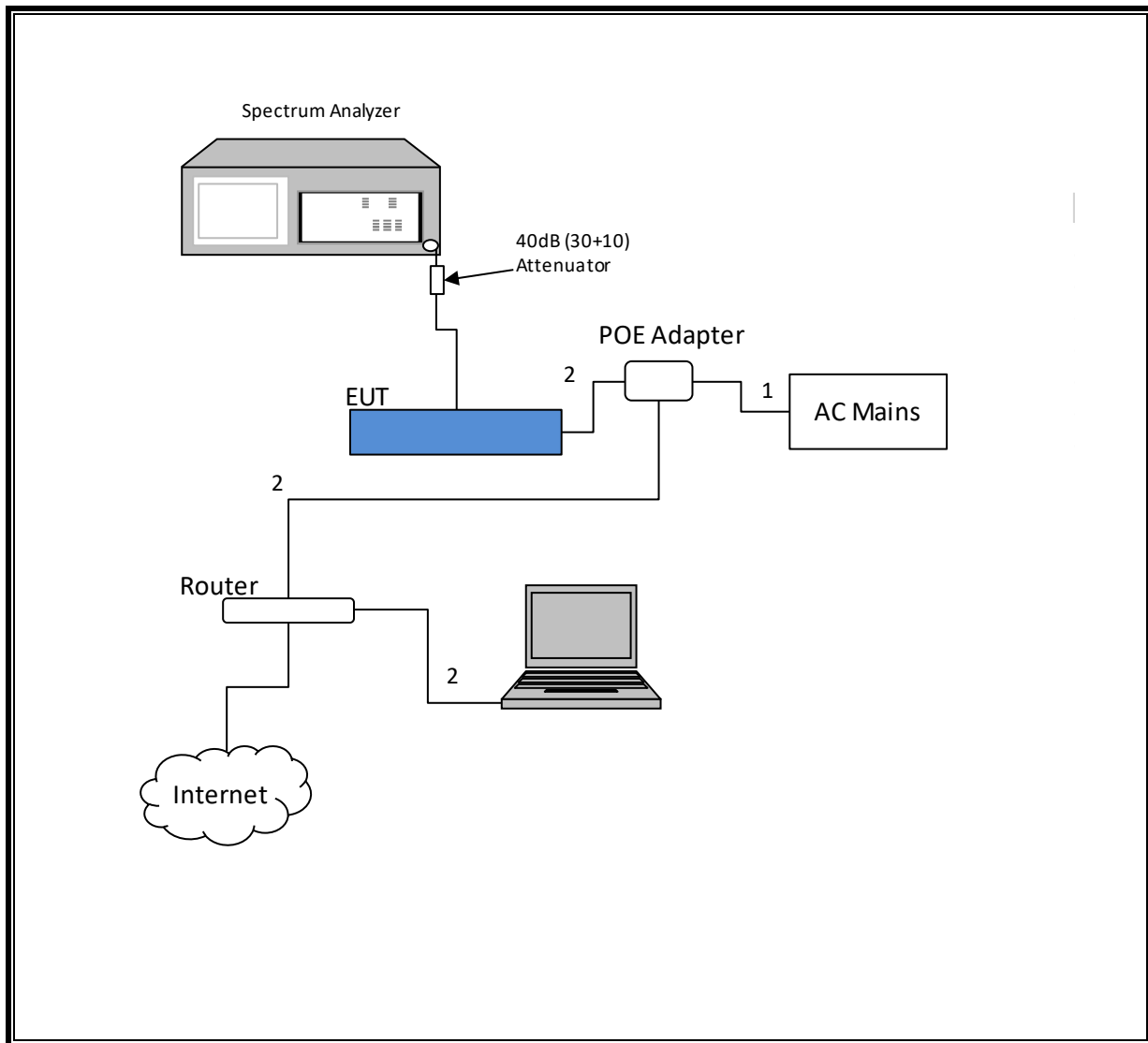
As illustrated in the following setup diagram, the EUT is the Adaptrum A2UACRS2F-B1 base and client radios connected through cable assembly with proper attenuation to form a broadband communications system allowing the client-side PC to connect to the Internet (on the base side) through the TV White Space connection between the client and base radios. The BASE PC and CLIENT PC are used to configure the radio devices and monitor the device-and-database interactions.

The A2UACRS2F-B1 radios are Fixed TV Band Devices that require professional installation. The A2UACRS2F-B1 radio software has a database module that communicates with the TVWS Database and controls the radio operation in accordance with FCC Part 15 Subpart H rules. The EUT radios have been provisioned in the TVWS Database prior to the testing. For the testing conducted in this report, the EUT software was configured in the installer mode to demonstrate the compliance to the Part 15 Subpart H database rules. Once the device registration and location information has been entered into the radio software by the professional installer, the devices will communicate with the TVWS Database to perform device registration and retrieve TVWS channel list. After the installation, the device registration information will be stored in the device firmware and used by the device to automatically perform device registration and channel list request upon power cycling.

As shown in the diagram, the base radio has a direct connection to the Internet and upon power cycling will automatically communicate with the TVWS Database to 1) perform device registration and 2) retrieve TVWS channel list using the device registration information including device type, serial number, location, contact information, etc. The base radio can only operate on a channel that is within the channel list returned from the TVWS Database. Upon power cycling, the client radio will first scan a specified set of channels to look for the base signal. Once the client detects the base signal on a channel, it will send a connection request to the base which contains the client serial number and location information. The base will contact the TVWS Database on behalf of the client to perform device registration and channel list request. Only when the device registration is successful and the returned channel list for the client device contains the channel that the base is currently operating on, the base will grant the connection request from the client.

During normal operation, the base radio will periodically contact the TVWS Database to retrieve the updated channel lists for itself and on behalf of the client radio. The client channel list will be sent over the air to the client. If either the base or the client discovers its current operating channel is no longer in its updated channel list, it will cease operation on the channel immediately.

TEST SETUP DIAGRAM



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	Manufacturer	Model	Asset	Cal Due
Spectrum Analyzer, 44 GHz	Agilent	E4446A	T146	8/13/2019

8. STATION DATABASE CERTIFICATION TESTS

Both base and client software and hardware are identical the only difference is the deployment location. The test requirements were done on the base except for a few scenarios where client was also tested.

8.1. Fixed WSD Registration

CLAUSES

- §15.713(g)(3)

REQUIREMENT

- The Fixed WSD must provide the required information to the database and obtain a successful registration.
- The management software must be able to collect the data listed below. Confirm that the EUT will not operate unless a successful registration notification is received from the database.
 - i. FCC ID
 - ii. Serial Number
 - iii. Location Coordinates
 - iv. Location uncertainty with 95% accuracy (covered by section 3.8 in this report)
 - v. Antenna Height AGL (must not be > 30 m)
 - vi. Contact information (Device owner and device contact)
- For a fixed WSD without a direct connection to the internet, confirm that registration through a registered fixed device takes place only on a channel available to that registered device.
- PRE-REGISTRATION PROCESS
- Both the Base and Client Station are registered using an authorized database via the Internet at the depot facility. Following registration a common available channel between each is site is selected as the initial transmitting channel for each site. This channel will be the initial “listening” channel for the Remote Station

8.1.1. SUCCESSFUL REGISTRATION

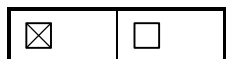
TEST PROCEDURE

- Configure the base EUT with correct registration information:
 - o The FCC ID and serial number are permanently programmed to the device and cannot be modified.
 - o Known acceptable geographic coordinates, antenna height AGL and contact information were entered into the EUT.
- The base EUT automatically contacts the TVWS Database to perform device registration.
- Upon successful registration, the base EUT automatically contacts the TVWS Database to retrieve device channel list.
- Selects a channel from the channel list returned from the TVWS Database and start normal radio operation on the selected channel.
- Verify base output signal on the selected channel on the spectrum analyzer.

RESULTS

The EUT successfully registered when correct registration information was submitted to the TVWS Database. The EUT transmission was observed on the spectrum analyzer on the selected TV channel from the returned channel list from the TVWS Database.

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19



BASE SOFTWARE SHOWING SUCCESSFUL DEVICE REGISTRATION WITH THE TVWS DATABASE

Adaptrum - Device Logs - LuCI

10.19.0.20/luci/admin/system/deviceLogs

Adaptrum

Device

Database

Channels

Link

Clients

System

Device Logs

Device Password

Support

Logout

Status

Device: A2HX1044

Version: A2.1.3

Firmware: R0.c3.5

Link: Not Transmitting

Channel: -1

Power: 0% / 0%

Logs

Radio

Database

Register Device

Dec-17-2018 17:08:45

Sending Request to https://paws.wsdh.uk/?token=d-9820457-8160-4b61-ad4d-116bd63a0f7d :

("id":2,"method":"spectrum.paws.register","jsonrpc":"2.0","params":{"type":"REGISTRATION_REQ","version":"1.0","location":{"point":{"semiInOrder":0,"orient

Got Response:

Code: 200

Response: {"id":2,"jsonrpc":"2.0","result":{"type":"REGISTRATION_RESP","version":"1.0","serverMessage":null,"databaseChange":null,"rulesetInfos":{"maxLocal

Registration Passed!

Request Channels

Dec-17-2018 17:08:47

Sending Request to https://paws.wsdh.uk/?token=d-9820457-8160-4b61-ad4d-116bd63a0f7d :

("id":3,"method":"spectrum.paws.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":{"stop

Got Response:

Code: 200

Response: {"id":3,"jsonrpc":"2.0","result":{"type":"AVAIL_SPECTRUM_RESP","version":"1.0","spectrumSpecs":{"timeRange":{"stopTime":"2018-12-19T17:08:48.267

Channel 16 (489000000 - 489000000): 40

Channel 17 (488000000 - 494000000): 40

SAVE FILE

Adaptrum - Channel Selection -

10.19.0.20/luci/admin/channels/channelSelection

Adaptrum

Device

Database

Channels

Channel Selection

Link

Clients

System

Logout

Status

Device: A2HX1044

Version: A2.1.3

Firmware: R0.c3.5

Link: Transmitting

Channel: 21

Power: 0.59% / 0%

Channels

Channel Expansion

Run Channel Scan

Request Available Channels

Stop Transmit

Set Channels

All Available

Select	CH	Max Power (MOP / GOP)	Noise Level
☐	14		
☐	15		
☐	16	40 / undefined	
☐	17	40 / undefined	
☐	18		
☐	19	40 / undefined	
☐	20	40 / undefined	
☒	21	40 / undefined	

SPECTRUM ANALYZER SHOWING ACTIVE BASE SIGNAL ON THE SELECTED CHANNEL (CHANNEL 21)

Agilent 09:26:27 Dec 17, 2018

L

APV9.3(120718),19497 AF, Conducted B

Mkr1 515.00 MHz

Ref -14 dBm

Atten 10 dB

-54.97 dBm

#Avg

Log

10

dB/

#PAvg

W1 S2

S3 FC

AA

£(f):

FTun

Swp

Center 515.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Amplitude

Ref Level

-14.00 dBm

Attenuation

10.00 dB

Auto

Man

Scale/Div

10.00 dB

Scale Type

Log

Lin

Presel Center

Presel Adjust

[3-26 GHz]P

0.000 Hz

More

1 of 3

Copyright 2000-2011 Agilent Technologies

TVWS DATABASE BASE FIXED TVBD REGISTRATION RECORD

8.1.2. FAILED REGISTRATION – Location Coordinates

TEST PROCEDURE

- Configure the EUT with restricted coordinates which is a location that is prohibited to transmit
- Observe the base EUT registration failure indicated by the database message

RESULT

The base EUT failed to register when restricted coordinates information were submitted to the TVWS Database.

Test Results		
Pass	Fail	Comment
☒	☐	Please refer to report 13U14997-1A Section 9.1.2

BASE SOFTWARE SHOWING FAILED DEVICE REGISTRATION DUE TO RESTRICTED COORDINATES

Adaptrum

Device

Database

Channels

Link

Clients

System

Device Logs

Device Password

Support

Logout

Status

A2HX1044

A2.1.3

R0.c3.5

Not Transmitting

-1

0% / 0%

Logs

Radio Database

Request Channels

Dec-17-2018 17:24:09

Sending Request to https://paws.wsdh.uk/?token=d-9820d457-8160-4b61-ad4d-116bd63a0f7d :

Response: [{"id":2,"jsonrpc":"2.0","error":{"message":"location is outside coverage area","data":"","code":-104}}

Code: 400

Request Channels MOP Failed!

Request Channels

Dec-17-2018 17:24:44

Sending Request to https://paws.wsdh.uk/?token=d-9820d457-8160-4b61-ad4d-116bd63a0f7d :

Response: [{"id":3,"jsonrpc":"2.0","error":{"message":"location is outside coverage area","data":"","code":-104}}

Code: 400

Request Channels MOP Failed!

SAVE FILE

8.1.3. FAILED REGISTRATION – ANTENNA HEIGHT AGL

TEST PROCEDURE

- Configure the EUT with antenna height Above Ground Level (AGL) > 30 meters.
- Observe the base registration failure indicated by the database message.

RESULTS

The base EUT failed to register when it is set to a location with antenna AGL above the limit.

Test Results		
Pass	Fail	Comment
☒	☐	

BASE SOFTWARE SHOWING FAILED DEVICE REGISTRATION DUE TO RESTRICTED COORDINATES

8.1.4. FAILED REGISTRATION – INCOMPLETE CONTACT INFORMATION

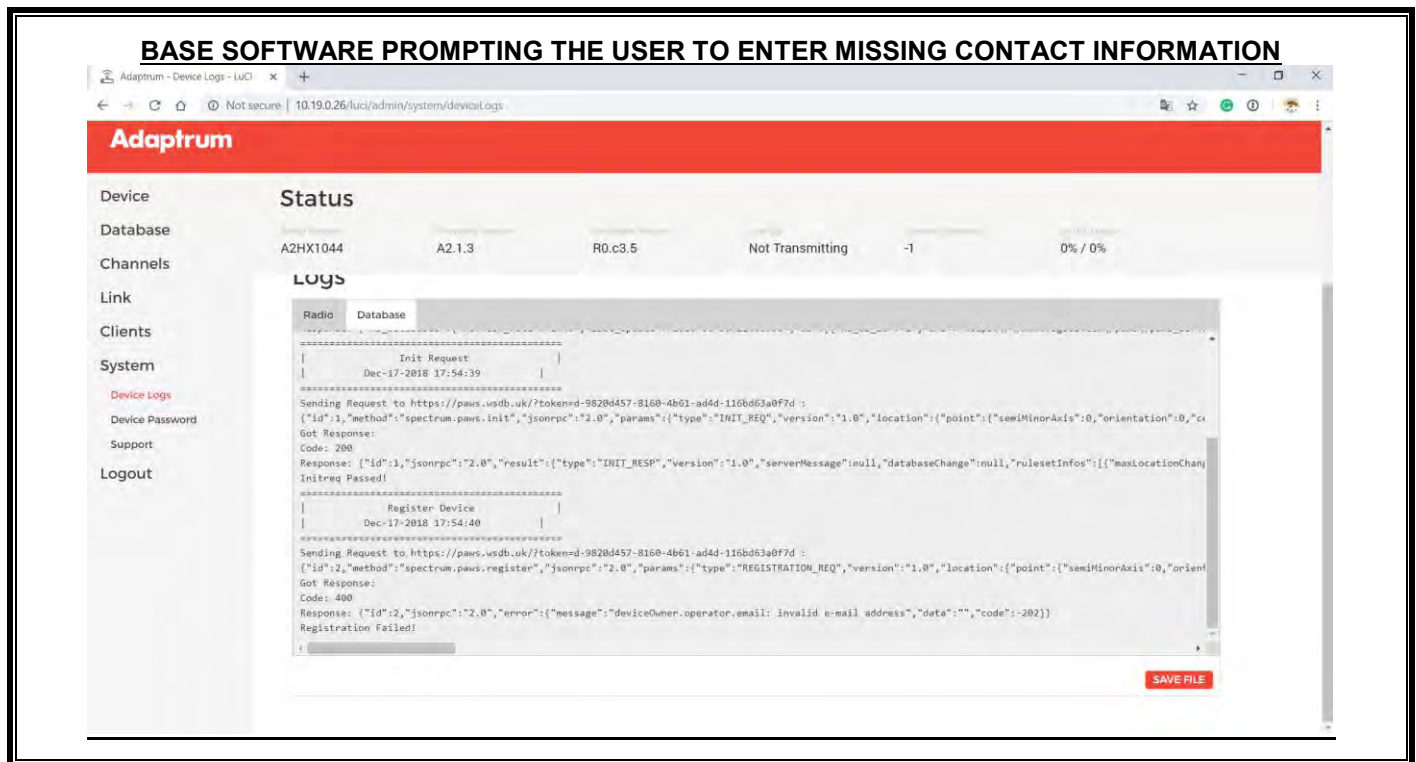
TEST PROCEDURE

- Configure the base EUT with missing contact information, e.g. email.
- The device software cannot proceed with registration and prompts user to enter the missing information.

RESULTS

Software didn't proceed with registration when contact information fields are missing.

Test Results		
Pass	Fail	Comment
☒	☐	



8.2. FIXED WSD CHANNELS OF OPERATION

CLAUSES

- §15.711(c)(2)(ii)

REQUIREMENT

Confirm that the device only operates on channels provided by the database

TEST PROCEDURE

- The base EUT geographic coordinates are entered at registration time and stored in the device. The device channel list request uses the same coordinates established at registration time. No separate coordinates can be entered for channel list request.
- The device requires professional installation and device registration information including device location will be entered by the professional installer.
- Once the registration is complete, upon power cycling the device will use the stored registration location for channel list request.

RESULTS

The device only uses its registered location for channel list request. The device registered location will be established at installation time by a professional installer and cannot be altered after installation

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19

Adaptrum - Location - Luci

← → ↺ ⚙ Not secure | 10.19.0.26/luci/admin/device/location

Adaptrum

Device

Status

IP Address

Location

Update

Diagnostics

Reboot

Database

Channels

Link

Clients

System

Logout

Status

Device Name

IP Address

MAC Address

Signal

Bandwidth

Band Usage

A2HX1044

A2.1.3

R0.c3.5

Not Transmitting

-1

0% / 0%

Location

The location of your device

GPS

Latitude

Longitude

Altitude

41.40809

-75.64332

10

SAVE & APPLY

RESET

Adaptrum - Device Logs - LuCI

< > ↺ ⌂

Not secure | 10.19.0.26/luci/admin/system/device_logs

Adaptrum

Device

Database

Channels

Link

Clients

System

Logout

Status

Device: A2HX1044

Firmware Version: A2.1.3

Hardware Version: R0.c3.5

State: Not Transmitting

Channel: -1

Signal Strength: 0% / 0%

Logs

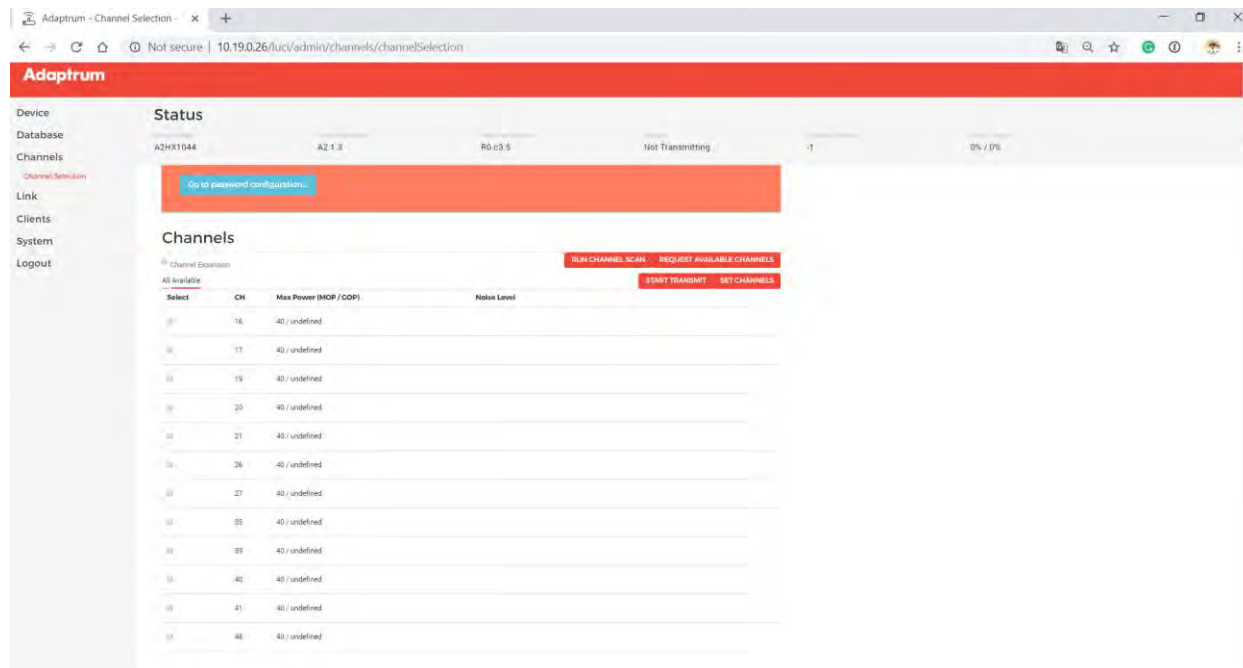
Radio

Database

```
*****
|               Register Device                |
| Dec-17-2018 17:58:26                         |
|-----|
Sending Request to https://paws.wsdb.uk/?token=d-9826d457-8160-4b61-addd-116bd63ae0f7d :
{"id":2,"method":"spectrum.paws.register","jsonrpc":"2.0","params":{"type":"REGISTRATION_REQ","version":"1.0","location":{"point":{"semiMinorAxis":0,"orient":
Got Response:
Code: 200
Response: {"id":2,"jsonrpc":"2.0","result":{"type":"REGISTRATION_RESP","version":"1.0","serverMessage":null,"databaseChange":null,"rulesetInfos":[{"maxLocalI
Registration Passed!
*****
|               Request Channels                 |
| Dec-17-2018 17:58:28                         |
|-----|
Sending Request to https://paws.wsdb.uk/?token=d-9826d457-8160-4b61-addd-116bd63ae0f7d :
{"id":3,"method":"spectrum.paws.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":[{"stopT
Got Response:
Code: 200
Response: {"id":3,"jsonrpc":"2.0","result":{"type":"AVAIL_SPECTRUM_RESP","version":"1.0","spectrumSpecs":[{"timeRange":{"stopTime":"2018-12-19T17:58:29.600
Channel 16 (482000000 - 488000000): 40
Channel 17 (488000000 - 494000000): 40
*****
```

SAVE FILE

BASE SOFTWARE SHOWING SUCCESSFUL DEVICE REGISTRATION WITH PERMITTED CHANNELS - CONTINUE



8.3. FIXED TVDB DATABASE UPDATE

CLAUSES

- §15.711(h)

REQUIREMENT

If a fixed or Mode II personal/portable TVBD fails to successfully contact the white space database during any given day, it may continue to operate until 11:59 p.m. of the following day at which time it must cease operations until it re-establishes contact with the white space database and re-verifies its list of available channels.

To simulate that the device fails to successfully contact the database, block access to the database from the WSD by removing connection to the database. All other radio functions, including internet connectivity should be maintained. Confirm that the WSD ceases operation by 11:59PM on the following day

TEST PROCEDURE

- Set the base EUT to normal operation mode:
 - o Enter proper registration information on the base.
 - o Base contacts the TVWS to perform registration.
 - o Base contacts the TVWS to retrieve channel list.
 - o Select an operating channel from returned channel list.
 - o Enable base transmission.
- Observe the base EUT output signal on the spectrum analyzer.
- Use a programmable router to block the database URL.
- Observe that there is no output signal from the base after 11:59 PM on the following day.

RESULTS

During normal operation, the base and client channel lists are updated periodically by sending channel list requests to the TVWS Database. For test purposes this time period was shortened. After the database access was blocked, the next channel list requests failed and the EUTs stopped transmission immediately.

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19

BASE SOFTWARE BEFORE DATABASE BLOCKING (BASE ON CHANNEL 21)

Adaptrum

Device: A2HX1044 | Database: A2.1.3 | Channels: R0.c3.5 | Status: Transmitting | Channel: 21 | Signal: 0.59% / 0%

Channels

Channel Expansion

All Available

[RUN CHANNEL SCAN](#) [REQUEST AVAILABLE CHANNELS](#)

[STOP TRANSMIT](#) [SET CHANNELS](#)

Select	CH	Max Power (MOP / GOP)	Noise Level
☐	14		
☐	15		
☐	16	40 / undefined	
☐	17	40 / undefined	
☐	18		
☐	19	40 / undefined	
☐	20	40 / undefined	
☒	21	40 / undefined	

BASE SIGNAL SPECTRUM BEFORE DATABASE BLOCKING

Agilent 10:10:14 Dec 17, 2018

L

APv9.3(120718),19497 AF, Conducted B

Mkr1 515.00 MHz

Ref -14 dBm

Atten 10 dB

-51.44 dBm

#Avg

Log

10

dB/

#PAvg

W1 S2

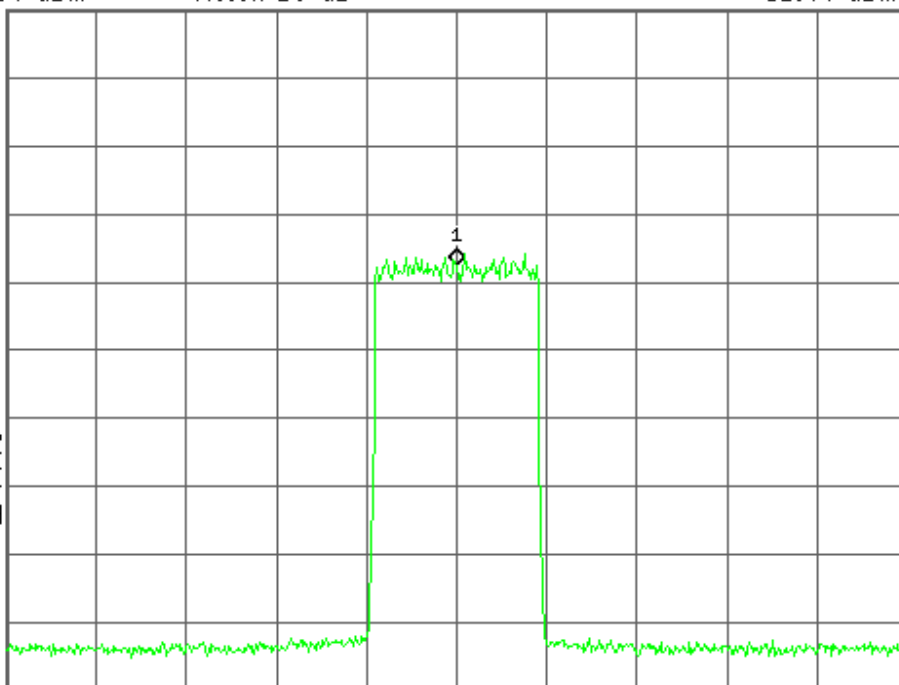
S3 FC

AA

£(f):

FTun

Swp



Center 515.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Freq/Channel

Center Freq

515.000000 MHz

Start Freq

500.000000 MHz

Stop Freq

530.000000 MHz

CF Step

3.00000000 MHz

Auto

Man

Freq Offset

0.00000000 Hz

Signal Track

On

Off

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BASE SOFTWARE 5 MINUTES AFTER DATABASE BLOCKING (BASE STOPPED)

The screenshot displays the Adaptrum web interface in a browser window. The address bar shows the URL `10.19.0.26/luci/admin/system/deviceLogs`. The interface has a red header with the 'Adaptrum' logo. On the left is a sidebar menu with options: Device, Database, Channels, Link, Clients, System, Device Logs (highlighted in red), Device Password, Support, and Logout. The main content area is titled 'Status' and shows device information: Serial Number 'A2HX1044', Software Version 'A2.1.3', Hardware Version 'R0.c3.5', Link State 'Transmitting', Current Channels '21', and U/L/RX Utilization '0.59% / 0%'. Below this is a 'Logs' section with a table showing 'Radio' and 'Database' logs. The logs contain a list of channels (16 to 48) and their frequency ranges, followed by a 'Request Channels' entry dated 'Dec-17-2018 18:04:34'. Below the logs, there is a message: 'Sending Request to https://pavs.wdb.uk/?token=d-9820d457-8160-4b61-ad4d-116bd63a0f7d : [{"id":4,"method":"spectrum.pavs.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":[{"stopTime":"2018-12-19T17:58:29.680"}]}]}] Request Channels MDP Failed!'. A 'SAVE FILE' button is located at the bottom right of the logs section.

Radio	Database
Channel 16	(482000000 - 488000000): 40
Channel 17	(488000000 - 494000000): 40
Channel 19	(500000000 - 506000000): 40
Channel 20	(506000000 - 512000000): 40
Channel 21	(512000000 - 518000000): 40
Channel 26	(542000000 - 548000000): 40
Channel 27	(548000000 - 554000000): 40
Channel 35	(596000000 - 602000000): 40
Channel 39	(620000000 - 626000000): 40
Channel 40	(626000000 - 632000000): 40
Channel 41	(632000000 - 638000000): 40
Channel 48	(674000000 - 680000000): 40

Request Channels
Dec-17-2018 18:04:34

Sending Request to https://pavs.wdb.uk/?token=d-9820d457-8160-4b61-ad4d-116bd63a0f7d : [{"id":4,"method":"spectrum.pavs.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":[{"stopTime":"2018-12-19T17:58:29.680"}]}]}] Request Channels MDP Failed!

SAVE FILE

BASE SIGNAL SPECTRUM 5 MINUTES AFTER DATABASE BLOCKING

Agilent 10:15:51 Dec 17, 2018

L

APv9.3(120718),19497 AF, Conducted B Mkr1 515.00 MHz

Ref -14 dBm Atten 10 dB -108.30 dBm

#Avg

Log

10

dB/

#PAvg

W1 S2

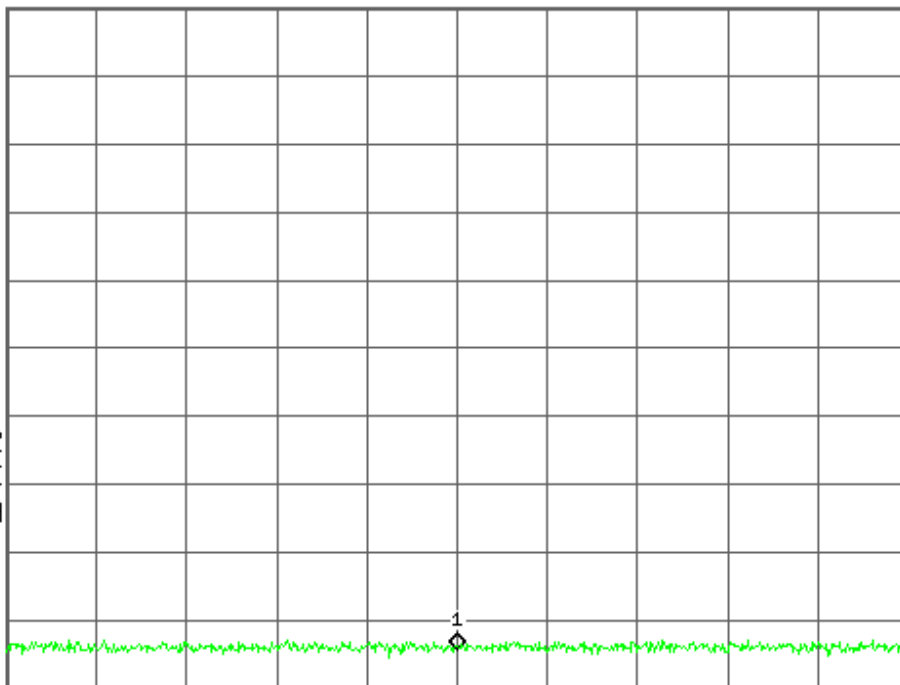
S3 FC

AA

£(f):

FTun

Swp



Center 515.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Freq/Channel

Center Freq

515.000000 MHz

Start Freq

500.000000 MHz

Stop Freq

530.000000 MHz

CF Step

3.00000000 MHz

Auto

Man

Freq Offset

0.00000000 Hz

Signal Track

On

Off

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8.4. 48 HOUR CHANNEL SCHEDULING

CLAUSES

- FCC §15.711(c)(2)(iii)
- FCC §15.713(a)(1)

REQUIREMENT

Each fixed whitespace device shall access the database at least once a day to verify that the operating channels continue to remain available. Each fixed white space device must adjust its use of channels in accordance with channel availability schedule information provided by its database for the 48-hour period beginning at the time the device last accessed the database for a list of available channels.

After receiving an available channel list, register a low-power auxiliary device on the WSD operating channel to operate on an available channel and in the upcoming time period when the device will be tested. Repeat the available channel request after the update interval and in the time period when the low-power auxiliary device is scheduled to operate, and confirm that the low-power device is accounted for in the schedule. Using the system management software, confirm that the device changes channels at the scheduled time.

TEST PROCEDURE

1. A lower power auxiliary devices are registered and scheduled for protection at both base and client locations
2. Allow the base and client EUT to enter normal operations prior to testing
3. Upon channel list request to the TVWS Database, the base EUT obtains the channel list expiration time reflecting the low power auxiliary device's registered protection period
4. The base EUT requests new channel list upon the channel list expiration time and the base EUT's current operation channel is no longer in the returned channel list
5. The base EUT ceases transmission on the protected channel immediately
6. Steps 3-5 were repeated for client EUT

RESULTS

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19

48 HOUR CHANNEL SCHEDULING TESTING TIMELINE ILLUSTRATION



48 HOUR CHANNEL SCHEDULING BASE SOFTWARE BEFORE PROTECTION PERIOD

The screenshot shows the Adaptrum base software interface. The top navigation bar is red with the 'Adaptrum' logo. The left sidebar contains a list of menu items: Device, Database, Channels, Link, Clients, System, Device Logs, Device Password, Support, and Logout. The main content area is titled 'Status' and displays the following information: Device: A2HX1044, Database: A2.1.3, R0.c3.5, Status: Transmitting, Channels: 19, and Power: 0.59% / 0%. Below the status information is a 'Logs' section with a 'Radio' tab selected. The log content shows a 'Request Channels' message from 'Dec-17-2018 18:54:07'. The log text is as follows:

```
Request Channels
Dec-17-2018 18:54:07
Sending Request to https://paws.usdb.uk/?tokenid=98204457-8160-4b61-ad4d-116b63a0f7d :
{"id":7,"method":"spectrum.paws.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":{"stopTime":2018-12-17T18:54:08.216Z}}}
Got Response:
Code: 200
Response: {"id":7,"jsonrpc":"2.0","result":{"type":"AVAIL_SPECTRUM_RESP","version":"1.0","spectrumSpecs":[{"timeRange":{"stopTime":2018-12-17T18:54:08.216Z}}]}
```

 A 'SAVE FILE' button is visible at the bottom right of the log area.

48 HOUR CHANNEL SCHEDULING BASE SIGNAL SPECTRUM BEFORE PROTECTION PERIOD

Agilent 11:01:06 Dec 17, 2018

L

Freq/Channel

APv9.3(120718),19497 AF, Conducted B

Mkr1 503.00 MHz

Ref -14 dBm

Atten 10 dB

-53.82 dBm

Center Freq

503.000000 MHz

Start Freq

488.000000 MHz

Stop Freq

518.000000 MHz

CF Step

3.00000000 MHz

Auto

Man

Freq Offset

0.00000000 Hz

Signal Track

On

Off

#Avg

Log

10

dB/

#PAvg

W1 S2

S3 FC

AA

£(f):

FTun

Swp

Center 503.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Copyright 2000-2011 Agilent Technologies

48 HOUR CHANNEL SCHEDULING BASE SOFTWARE DURING PROTECTION PERIOD (CHANNEL 19 UNAVAILABLE)

The screenshot displays the Adaptrum web interface. The top navigation bar is red with the 'Adaptrum' logo. A left sidebar contains a menu with items: Device, Database, Channels, Link, Clients, System, Device Logs (highlighted in red), Device Password, Support, and Logout. The main content area is titled 'Status' and shows device information: A2HX1044, A2.1.3, R0.c3.5, Not Transmitting, 19, and 0% / 0%. Below this is a 'Logs' section with tabs for 'Radio' and 'Database'. The 'Database' tab is active, showing a log entry for 'Channel 48 (674000000 - 680000000): 40'. The log text includes a timestamp 'Dec-17-2018 19:14:10', a request to 'https://paws.wdb.uk/?tokenid=98204457-8160-4b61-a84d-116bd63a0f7d', and a JSON response listing available channels and their frequencies. A 'SAVE FILE' button is located at the bottom right of the log area.

Device: A2HX1044, A2.1.3, R0.c3.5, Not Transmitting, 19, 0% / 0%

Logs

Radio Database

Channel 48 (674000000 - 680000000): 40

Request Channels

Dec-17-2018 19:14:10

Sending Request to https://paws.wdb.uk/?tokenid=98204457-8160-4b61-a84d-116bd63a0f7d :

({"id":8,"method":"spectrum.paws.getSpectrum","jsonrpc":"2.0","params":{"type":"AVAIL_SPECTRUM_REQ","version":"1.0","capabilities":{"frequencyRanges":{"stop

Got Response:

Code: 200

Response: {"id":8,"jsonrpc":"2.0","result":{"type":"AVAIL_SPECTRUM_RESP","version":"1.0","spectrumSpecs":[{"timeRange":{"stopTime":"2018-12-19T19:14:11.275

Channel 16 (482000000 - 488000000): 40

Channel 17 (488000000 - 494000000): 40

Channel 20 (506000000 - 512000000): 40

Channel 26 (542000000 - 548000000): 40

Channel 27 (548000000 - 554000000): 40

Channel 35 (596000000 - 602000000): 40

Channel 39 (626000000 - 632000000): 40

Channel 40 (632000000 - 638000000): 40

Channel 41 (638000000 - 644000000): 40

Channel 48 (674000000 - 680000000): 40

SAVE FILE

**48 HOUR CHANNEL SCHEDULING BASE SIGNAL SPECTRUM DURING PROTECTION PERIOD
(TRANSMISSION STOPPED)**

Agilent 11:20:46 Dec 17, 2018

L

APv9.3(120718),19497 AF, Conducted B

Mkr1 503.00 MHz

Ref -14 dBm

Atten 10 dB

-108.04 dBm

#Avg

Log

10

dB/

#PAvg

W1 S2

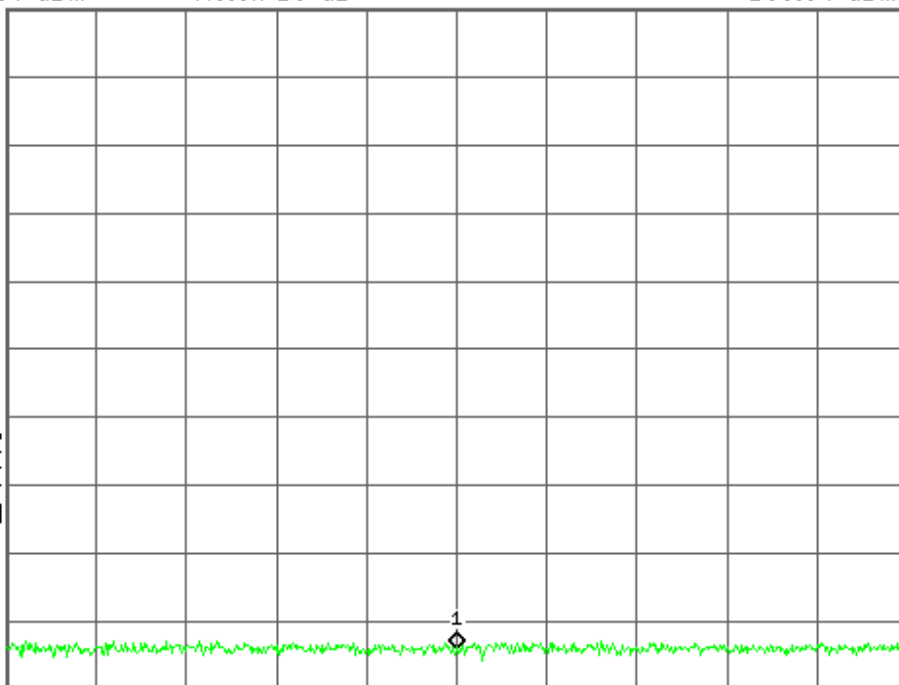
S3 FC

AA

E(f):

FTun

Swp



Center 503.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Freq/Channel

Center Freq

503.000000 MHz

Start Freq

488.000000 MHz

Stop Freq

518.000000 MHz

CF Step

3.00000000 MHz

Auto

Man

Freq Offset

0.00000000 Hz

Signal Track

On

Off

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8.5. WSD CHANNEL AVAILABILITY

CLAUSES

- FCC §15.707
- FCC §15.711(c)
- FCC §15.712

REQUIREMENT

Confirm that WSD properly identifies itself as fixed or personal/portable to the database by comparing the channel list provided by the database with those allowable to the class of WSD under test. Confirm that the WSD is operating on a channel or channels from the list at the authorized power and cannot be made to operate on an unauthorized channel.

TEST PROCEDURE

- Configure the base EUT with correct registration information.
- The base EUT automatically contacts the TVWS Database to perform device registration.
- Upon successful registration, base automatically contacts the TVWS Database to retrieve device channels.
- Confirm the base EUT software only allows the user to select a channel from the channel list returned from the database which are within the device operating frequency range
- Upon successful registration the database returns the allowable power according to the device type.
- Verify on the spectrum analyzer that the base EUT is operating on the selected channel

RESULTS

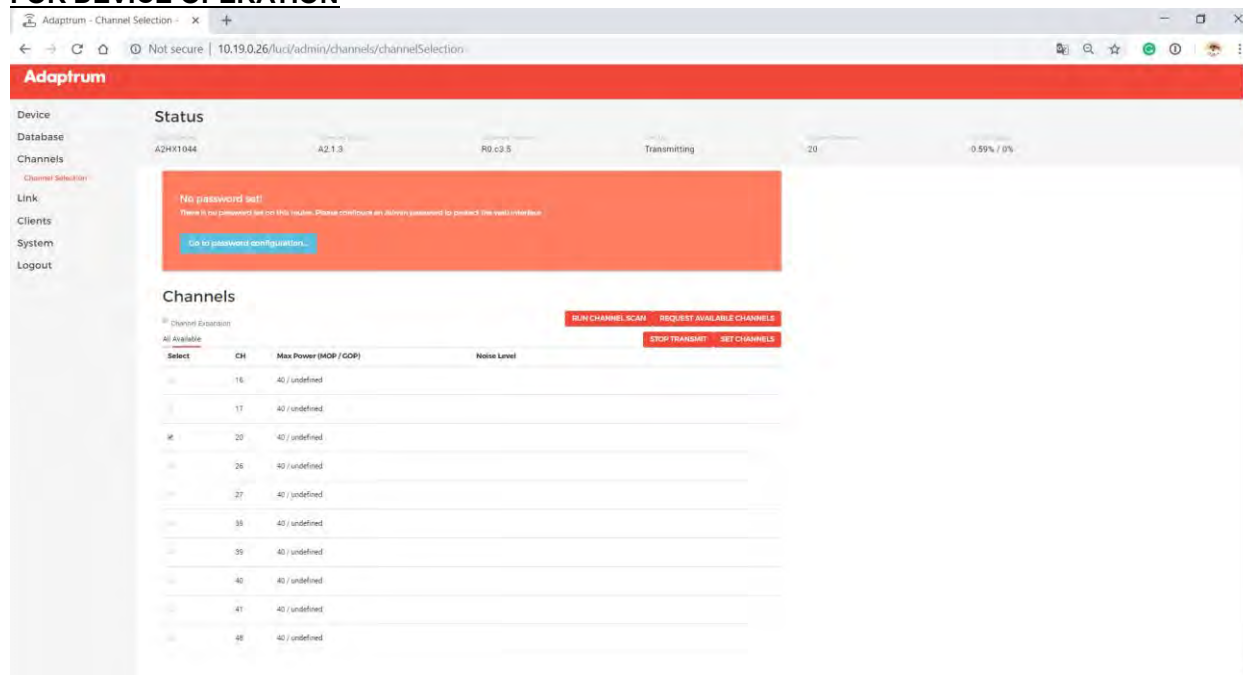
The EUT operates on a channel from the authorized channel list and at the authorized power level.

The EUT cannot select and operate on any channel other than those within the authorized channel list returned from the TVWS Database, which are within the device operating frequency range.

RESULTS

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19

BASE SOFTWARE ONLY ALLOWS A CHANNEL FROM AUTHORIZED CHANNEL LISTS TO BE SELECTED FOR DEVICE OPERATION



BASE SIGNAL SPECTRUM ON THE AUTHORIZED CHANNEL

Agilent 11:52:21 Dec 17, 2018

L

APv9.3(120718),19497 AF, Conducted B

Mkr1 509.00 MHz

Ref -14 dBm

Atten 10 dB

-51.25 dBm

#PAvg

Log

10

dB/

#PAvg

W1 S2

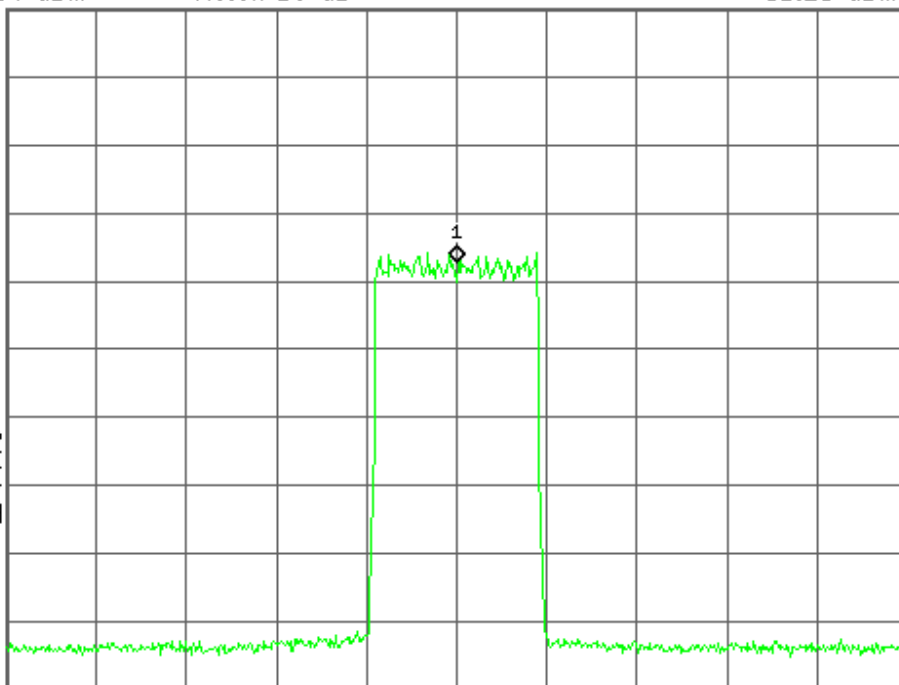
S3 FC

AA

E(f):

FTun

Swp



Center 509.00 MHz

Span 30 MHz

#Res BW 3 kHz

VBW 3 kHz

Sweep 12.71 s (601 pts)

Freq/Channel

Center Freq

509.000000 MHz

Start Freq

494.000000 MHz

Stop Freq

524.000000 MHz

CF Step

3.00000000 MHz

Auto

Man

Freq Offset

0.00000000 Hz

Signal Track

On

Off

Copyright 2000-2011 Agilent Technologies

8.6. SECURITY

CLAUSES

- §15.715(f)
- §15.713(i)
- §15.711(j)

REQUIREMENT

The device operations procedures must include documentation with a detailed explanation of the following for each database the device is expected to work with:

- i. What communication protocol is used between the database and the WSD?
- ii. How are communications initiated?
- iii. How does the WSD validate messages from the database?
- iv. How does the device handle failure to communicate or authenticate the database?
- v. How does the database validate messages from a WSD?
- vi. What encryption method is used?
- vii. How does the database ensure secure registration of protected devices?

ANSWERS

- i. What communication protocol is used between the database and the WSD?

The Fixed WSD (WSD) connects to the Nominet database using HTTP over SSL/TLS. The protocol, as certified by Nominet at the FCC, used over this transport layer is similar to the IETF Protocol to Access White Space (PAWS) Draft-12 specification.

- ii. How are communications initiated?

The WSD initiates communication with the Nominet database by initially sending an INIT_REQ message containing a Device Descriptor. The Device Descriptor element contains the device serial number, manufacturer ID, and model ID, which in the US is FCC ID.

- iii. How does the WSD validate messages from the database?

The identity of the Nominet database is validated through verification of the Nominet SSL certificate through standard third-party certificate authority mechanisms, ensuring communications are secure and authenticated between the WSD and the database. At the application layer both the WSD and database only handle messages that conform to the PAWS protocol specification. One additional message validation feature included in PAWS is the ability for the WSD to correlate a response with a specific request by comparing the message's ID field with the ID field of the request that was sent.

- iv. How does the device handle failure to communicate or authenticate the database?

If the WSD has never communicated with or authenticated the database, it will not allow operations to begin. If the WSD experiences a communication or authentication failure, then it will cease operation by 11:59 PM on the following day.

- v. How does the database validate messages from a WSD?

The database validates messages from the WSD by checking a token that must correspond with the provided serial number, manufacturer name, and FCC ID received in the Device Descriptor data element present in every message versus a table of validated client devices that is populated ahead of deployment. The list of valid serial numbers is communicated from device manufacturer to Nominet via a separate web dashboard where authorized (by Nominet) parties can generate tokens for specific devices (one at a time or via bulk method).

- vi. What encryption method is used?

SSL/TLS standard encryption is used to encrypt packets sent between WSD and database.

- vii. How does the database ensure secure registration of protected devices?

In this document, we interpret "protected devices" to mean entities authorized by the rules for protection from WSD transmissions, e.g., Temporary BAS, MVPD, Licensed and Unlicensed Microphones.

Nominet provides a public interface that is available to entities, authorized for protection under CFR Title 47 Part 15 Subpart H, to create protected contours.

8.7. Push notification to Fixed

CLAUSES

- §15.711(i)

REQUIREMENT

Confirm that the WSD device changes channels (or cease operation) when it receives 'push' notification from the database.

Using system management software, register the device at (specific coordinates) and wait for the database to send a push notification. Confirm that, once the notification is received, the device responds to the new channel availability list provided by the database, which would include ceasing operation on a channel no longer available, or ceases operation.

TEST PROCEDURE

- Obtain a successful registration to the database.
- Transmit on desired channel
- Wait for database to send a push notification to cease operation on desired channel
- Confirm that once the push notification is received, a new channel availability list is provided and the desired channel ceases operation.

RESULTS

Per FCC Order DA-18-983, filing by Office of Engineering in Technology on 9/26/2018, the push notification requirements specified in §15.711(i) are waived through 3/31/2019

8.8. Location accuracy

CLAUSES

- §15.711(b)

REQUIREMENT

For Fixed and Mode II devices, provide details regarding the technologies used by the device to determine its location and how, in case of other than GPS technology, the location uncertainty is calculated with a 95% confidence level

RESULTS

See theory of operations for details on Location accuracy

8.9. Interference protection requirement

CLAUSES

- §15.712

REQUIREMENT

Using system management software or database, provide different location (coordinates) so that compliance with operating channel and power level is shown under each of the scenarios outlines in §15.712. Include a sample scan showing the total channel power and adjacent channel emission settings for test coordinates.

TEST PROCEDURE

For the scenarios listed below confirm there is no allowance of transmission on specific channels according to that particular location

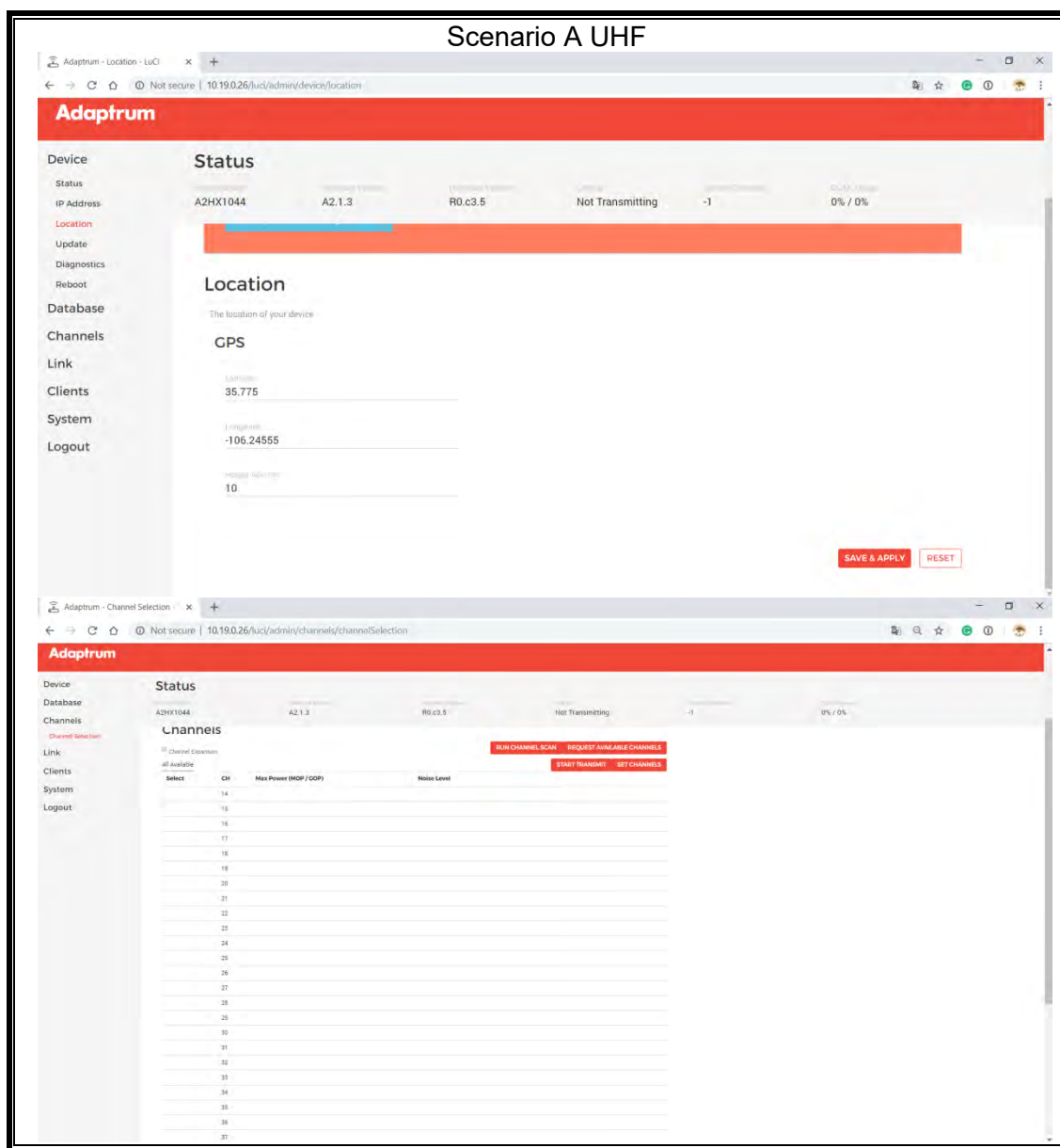
Scenarios

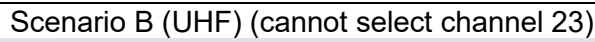
- a) Digital television stations, and digital and analog Class A TV, low power TV, TV translator and TV booster stations
- b) TV translator, Low power TV(including Class A) and Multi-channel Video Programming Distributor (MVPD)
- c) Fixed Broadcast Auxiliary Service (BAS) links
- d) PLMR/CMRS operations
- e) Offshore Radiotelephone Service
- f) Low power auxiliary services including wireless microphones
- g) Border areas near Canada and Mexico
- h) Radio astronomy services
- i) 600 Mhz service band
- j) Wireless Medical Telemetry Service
- k) 488-494 MHz band in Hawaii

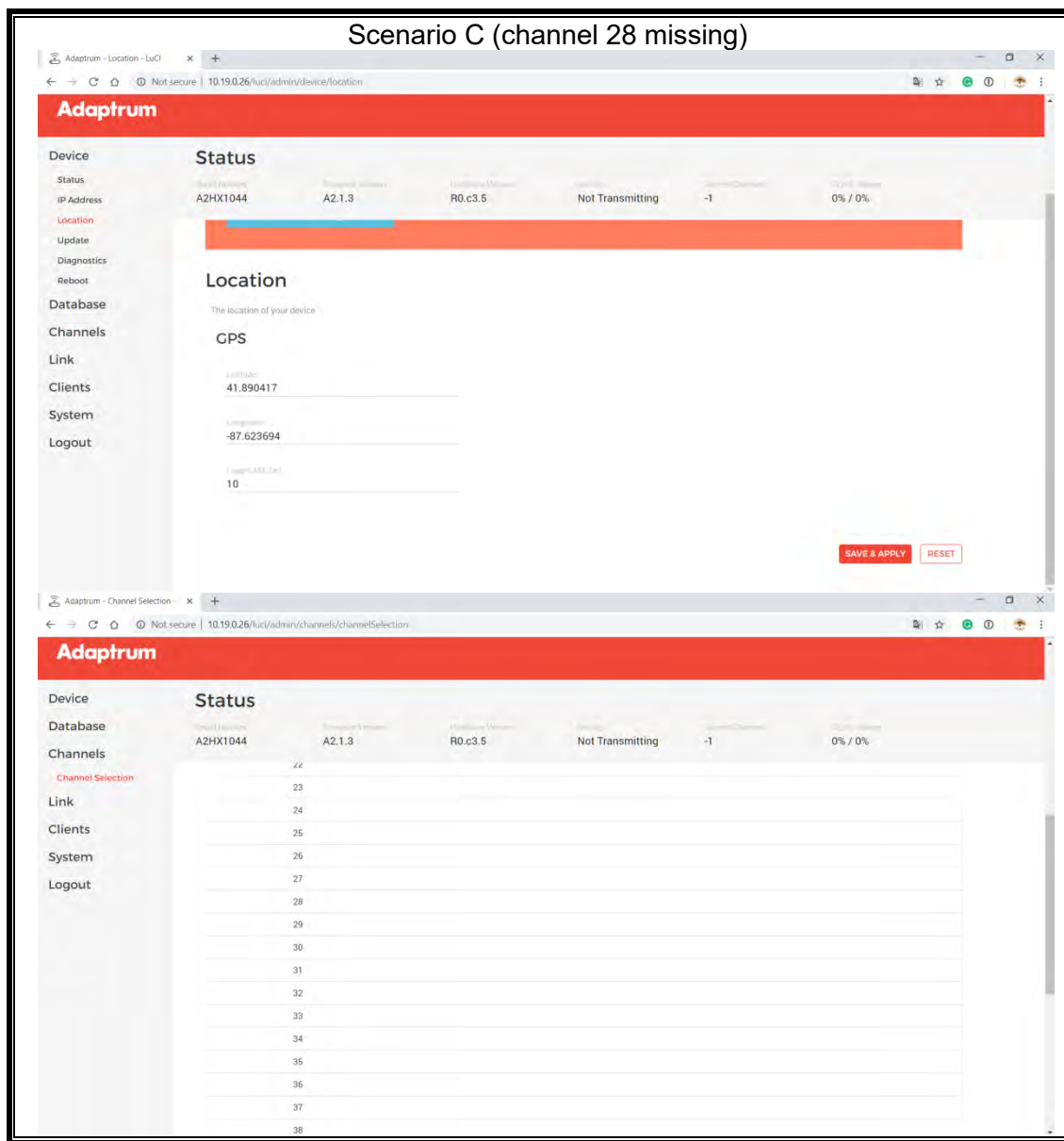
Scenario		Coordinate	Note
a	Digital television stations, and digital and analog Class A TV, low power TV, TV translator and TV booster stations	35.775, -106.24555 (UHF)	UHF No transmission allowed
b	TV translator, Low power TV(including Class A) and Multi-channel Video Programming Distributor (MVPD)	43.80102, -111.778 (UHF)	UHF coordinate cannot transmit Ch. 23
c	Fixed Broadcast Auxiliary Service (BAS) links	41.890417, -87.623694	Cannot transmit on Ch. 28
d	PLMR/CMRS operations	18.954722, -77.004722	Cannot transmit on Ch. 17 and 18
e	Offshore Radio telephone Service	18.954722, -77.004722	Cannot transmit on Ch. 17 and 18
f	Low power auxiliary services including wireless microphones	N/A	48 hour channel scheduling requirement was based off this scenario
g	Border areas near Canada and Mexico	32.608179, -116.969585	Cannot transmit on Ch. 6 and 32
h	Radio astronomy services	35.775, -106.24555	No channels available
i	600 MHz service band	40.78698, -119.206486	Cannot transmit on Ch. 37 and 38
j	Wireless Medical Telemetry Service	N/A	EUT does not support transmission in this frequency band
k	488-494 MHz band in Hawaii	20.88, -156.678611	Cannot transmit on Ch. 17

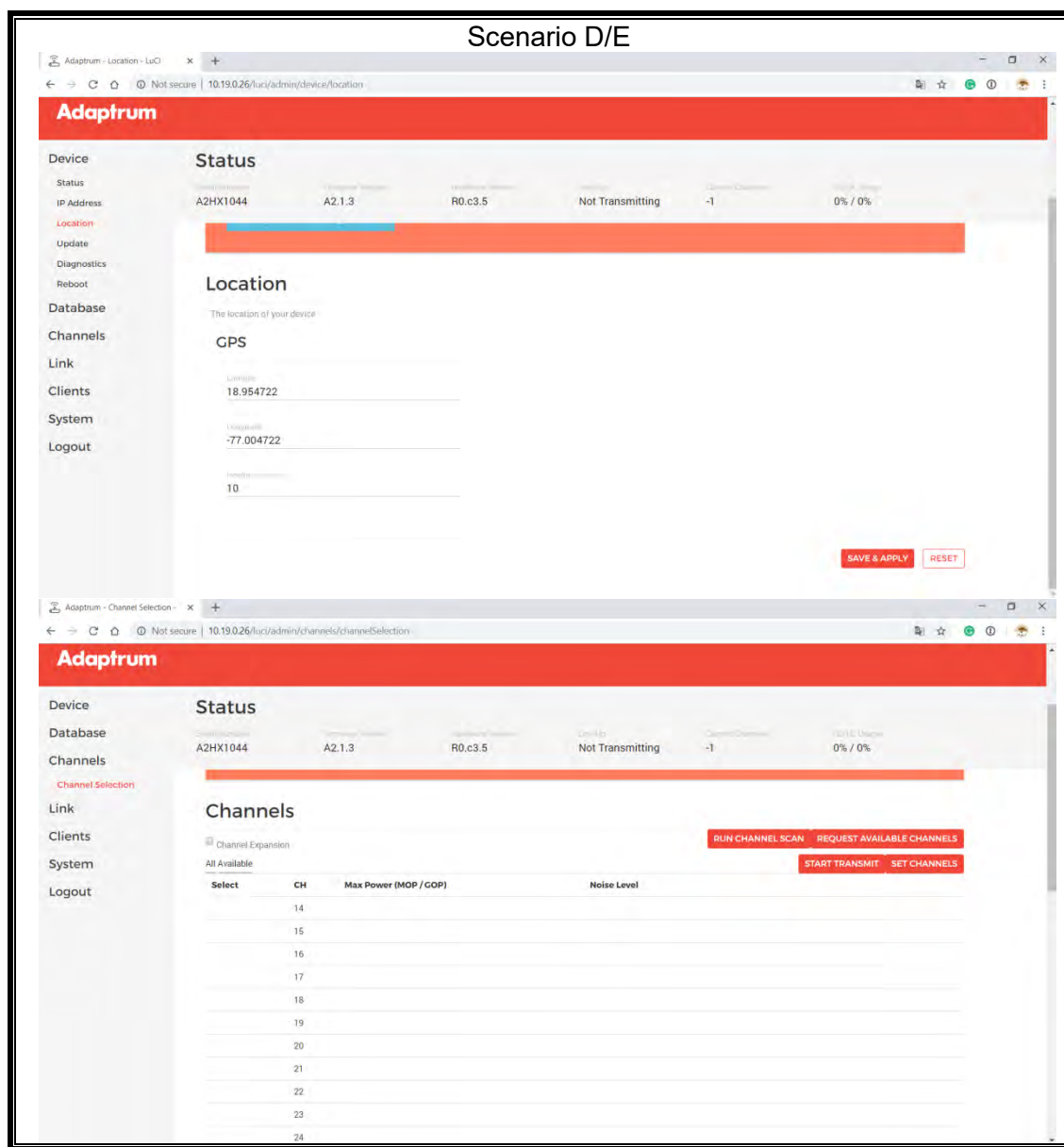
RESULTS

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19









Scenario G

Adaptrum

Device

Status

IP Address

A2HX1044

A2.1.3

R0.c3.5

Not Transmitting

-1

0% / 0%

Location

Update

Diagnostics

Reboot

Database

Channels

Link

Clients

System

Logout

Location

The location of your device

CPS

Latitude

32.608179

Longitude

-116.969585

Pressure (hPa, feet)

10

SAVE & APPLY

RESET

Adaptrum

Device

Database

Channels

Channel Selection

Link

Clients

System

Logout

Status

A2HX1044

A2.1.3

R0.c3.5

Not Transmitting

-1

0% / 0%

Channel Selection

Channel Expansion

At Available

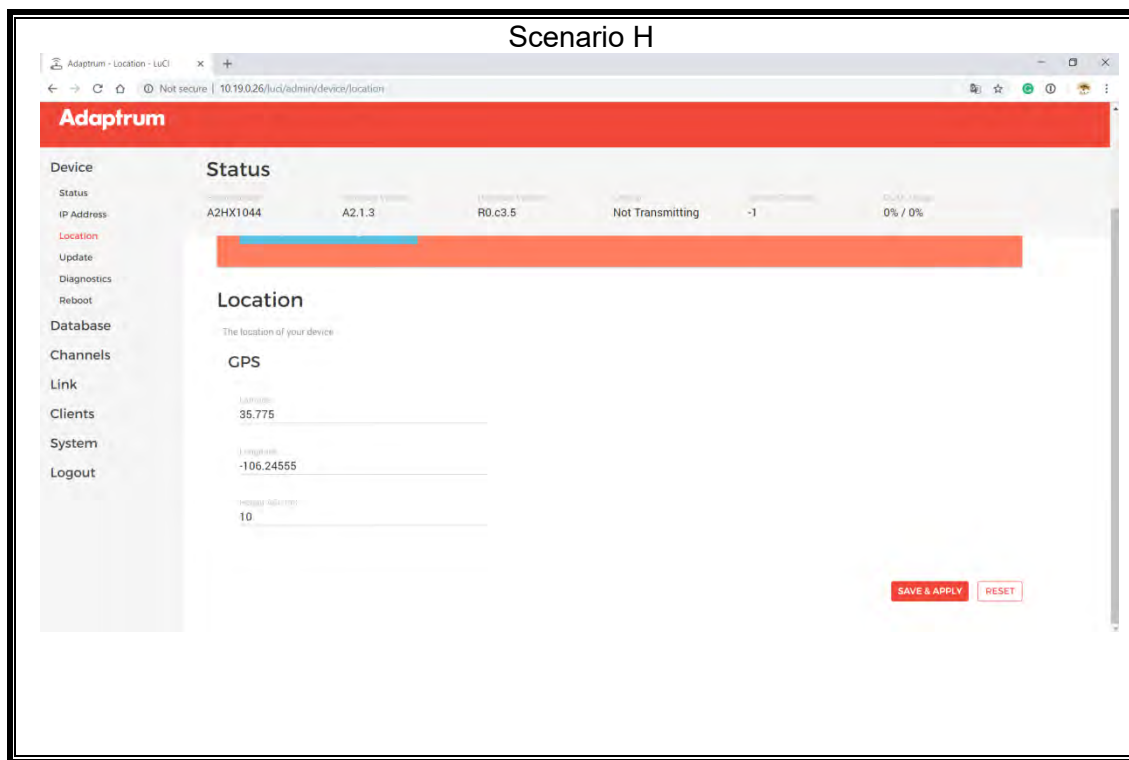
BUN CHANNEL SCAN

REQUEST AVAILABLE CHANNELS

START TRANSMIT

SET CHANNELS

Select	Ch	Max Power (MOP / COP)	Noise Level
☐	14	40 / undefined	
☐	15		
☐	16		
☐	17		
☐	18		
☐	19		
☐	20		
☐	21		
☐	22		
☐	23		
☐	24		
☐	25		
☐	26		
☐	27		
☐	28		
☐	29		
☐	30		
☐	31		
☐	32		
☐	33		



Scenario I

Adaptrum - Location - LUC

← → ↻ 🔒 Not secure | 10.19.0.26/fuct/admin/device/location

🔍 ☆ 📶 🔔

Adaptrum

Device

Status

IP Address

Location

Update

Diagnostics

Reboot

Database

Channels

Link

Clients

System

Logout

Status

A2HX1044

A2.1.3

R0.c3.5

Not Transmitting

-1

0% / 0%

Location

The location of your device

GPS

Latitude

40.78698

Longitude

-119.206486

Height (m) - sea

10

SAVE & APPLY

RESET

Adaptrum - Channel Selection

← → ↻ 🔒 Not secure | 10.19.0.26/fuct/admin/channels/channelSelection

🔍 ☆ 📶 🔔

Adaptrum

Device

Database

Channels

Link

Clients

System

Logout

Status

A2HX1044

A2.1.3

R0.c3.5

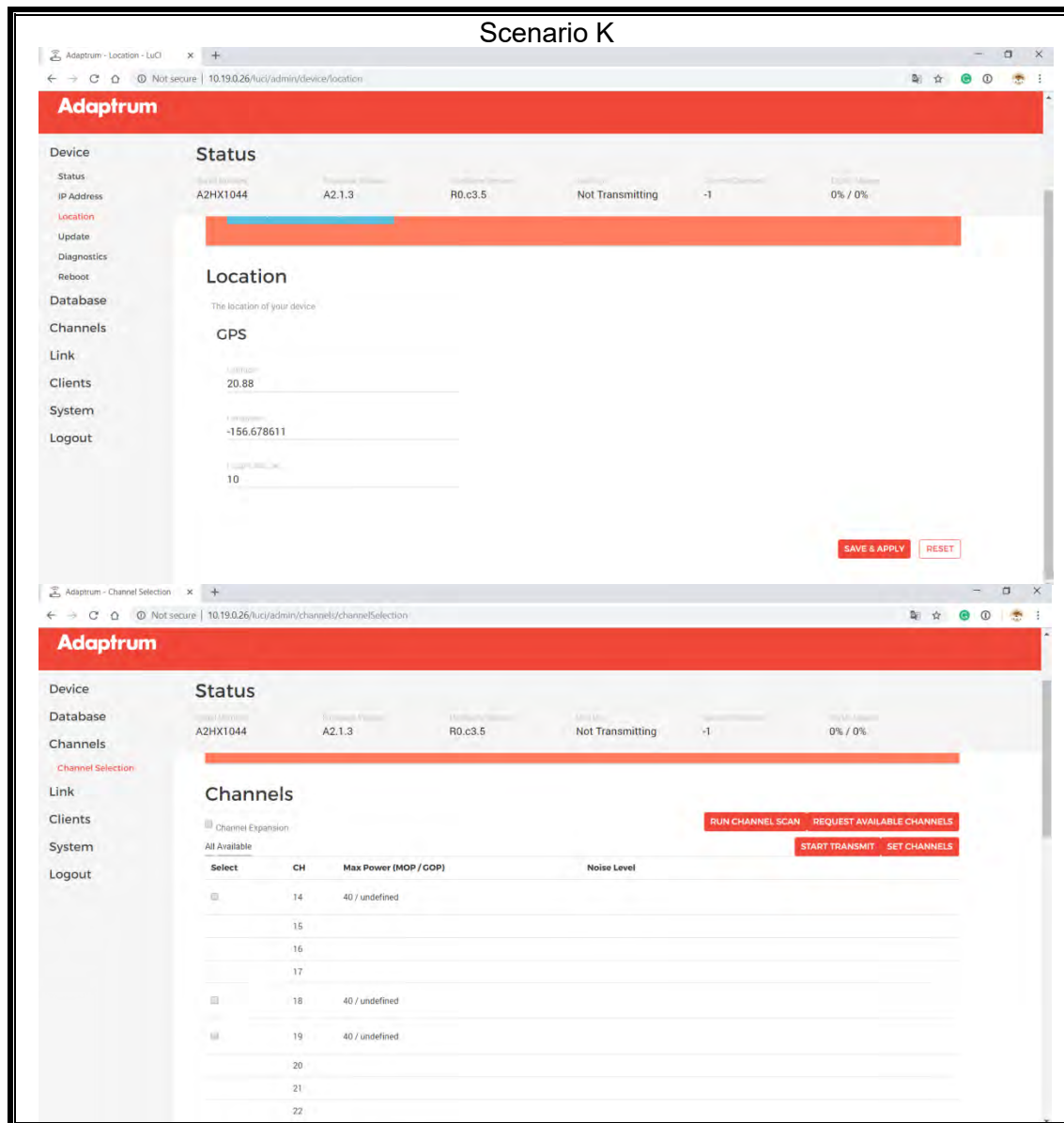
Not Transmitting

-1

0% / 0%

Channel Selection

☐	33	40 / undefined
☐	34	40 / undefined
☐	35	40 / undefined
☐	36	36 / undefined
☐	37	
☐	38	
☐	39	40 / undefined
☐	40	40 / undefined
☐	41	40 / undefined
☐	42	40 / undefined
☐	43	40 / undefined



8.10. Fixed Power level reduction

CLAUSES

- §15.711(c)(2)(ii)
- §15.715(e)

REQUIREMENT

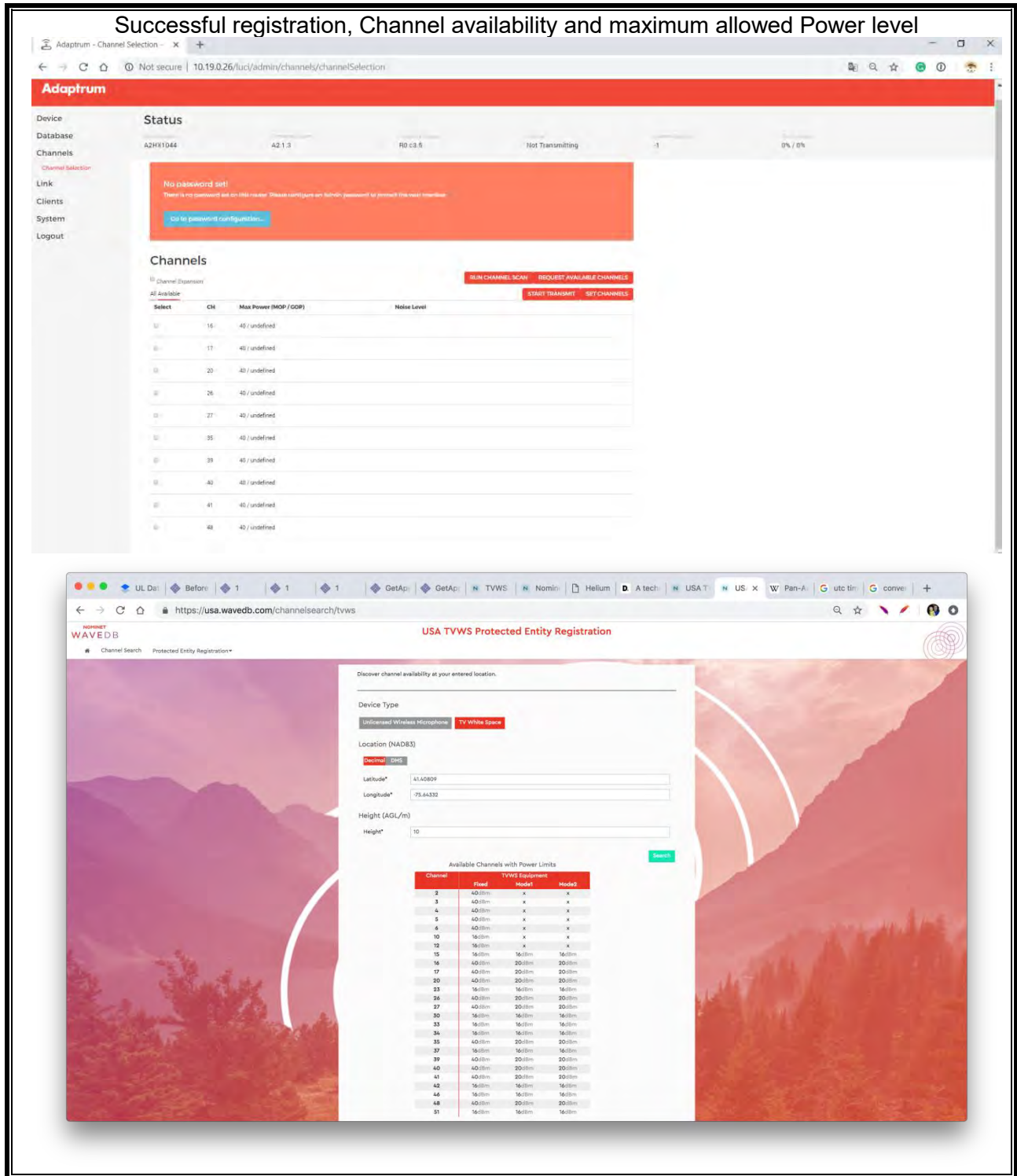
Using system management software, make a channel availability request to the database. Using the spectrum analyzer, confirm that the WSD operates at no more than the maximum power level indicated by the database and that the power level cannot be set to a higher level than indicated by the database at that specific location. If the device cannot reduce power, it must cease operation.

TEST PROCEDURE

- Create a successful registration with the database
- Transmit at desired channel
- Confirm with spectrum analyzer that the EUT does not operate more than the max power level indicated by the database.
- Confirm power level cannot be set higher than the level indicated by the database

RESULTS

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	12506	12/17/19



Adaptrum EUT will not transmit on any channel that power level reported by database is lower than 34dBm.

