TEST REPORT

Report Number :   12778862-E1V3

Applicant	:	Saankhya Labs Pvt Ltd Embassy Icon, Floor 3, No. 3 Infantry Road Bengaluru, Karnataka, 560 001 IN
Model	:	Meghdoot
FCC ID	:	2AUUC-MEGHDOOT
EUT Description	:	UHF TVWS FIXED BASE STATION
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART H

Date of Issue:
December 4, 2019

Prepared by:
UL Verification Services Inc.
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NVLAP LAB CODE 200065-0

<u>Revision History</u>

Rev.	Issue Date	Revisions	Revised By
V1	11/15/2019	Initial release	---
V2	11/20/2019	Updated Applicant address	S. Kuwatani
V3	12/04/2019	Updated per TCB comments	F. de Anda

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Saankhya Labs Pvt Ltd
Embassy Icon, Floor 3, No. 3 Infantry Road
Bengaluru, Karnataka, 560 001
IN

EUT DESCRIPTION: UHF TVWS FIXED BASE STATION

MODEL: Meghdoot

SERIAL NUMBER: SLB-631F-1904-3090, SLB-631F-1904-3096

DATE TESTED: 10/22/2019 – 11/01/2019

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 15 SUBPART H	Complies
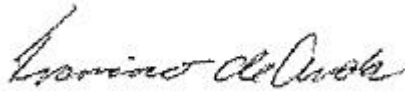
UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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.

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2. SCOPE

This report documents the results of RF, emissions and database tests for a TVWS Fixed Base Station. This report will demonstrate compliance to the applicable rules in Part 15 Subpart H – White Space Devices.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 15 Subpart H, KDB 416721 D01 v03, and ANSI C63.10-2013.

4. 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. Line conducted emissions are measured only at the 47173 address. 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	☐ Chamber D	☒ Chamber I
☐ Chamber B	☐ Chamber E	☐ Chamber J
☐ Chamber C	☐ Chamber F	☐ Chamber K
	☐ Chamber G	☐ Chamber L
	☐ Chamber H	☐ Chamber M

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 2324A.

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

5. CALIBRATION AND UNCERTAINTY

5.1.   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.

5.2.   SAMPLE CALCULATION

RADIATED EMISSIONS
Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS
Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

5.3.   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	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

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

6. EQUIPMENT UNDER TEST

6.1.   DESCRIPTION OF EUT

The EUT is a UHF TVWS fixed Base Station.

Base Station is identical in hardware to client device. The difference is in the antenna type and gain, software configuration and deployment location.

6.2.   DATABASE INFORMATION

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

6.3.   MAXIMUM OUTPUT POWER

The transmitter has a maximum output power as follows;

		Conducted		EIRP	
BAND	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)	Output Power (dBm)	Output Power (mW)
UHF	470 -608	25.12	325.09	31.12	1294.20

6.4.   DESCRIPTION OF AVAILABLE ANTENNAS

The base radio uses the following antenna type, and has the following antenna gain;

Type	Band	Gain
Omni Directional Monopole	UHF	6 dBi

6.5.   SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was as follows

	Firmware revision
Meghdoot (Base station unit)	V5.1.9-fcc
TVWS Application	V1.0.10-fcc

Note, base and client stations firmware's are same, but differ in software configuration management system for given function, base or client.

6.6.   WORST-CASE CONFIGURATION AND MODE

For power line conducted emissions were performed with the EUT set to transmit at the channel with the highest power and worst-case data rate as worst-case scenario.

Radiated emissions Below 30MHz were not performed on the EUT. Lowest clock or frequency used by the radio is 32MHz.

Radiated emissions from 30MHz to 1GHz and above 1GHz were performed with the EUT set to transmit at low middle and high channels

Preliminary baseline tests were performed to determine worst case data rate:

-QPSK
-16-QAM
-64-QAM

The worst case data rate was determined to be QPSK.

All final radiated testing was performed with the EUT in the normal orientation as indicated by manufacturer.

6.7.   DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	Mean Well	GSM60A48-P1J	No Serial #	DoC
Laptop 1	HP	EliteBook 840 G3	5CG7061F32	DoC
AC Adapter	HP	USNT-HP-19.5V	WDHML0AGC8N1B5	DoC
Laptop 2	HP	EliteBook 840 G2	5CG6075ORT	DoC
AC Adapter	HP	USNT-HP-19.5V	WCZTT0B1R5NA5W	DoC
Laptop 3	Lenovo	Think Pad L480	PF1H0N14	DoC
AC Adapter	Lenovo	ADLX45DLC2A	SA10E75792	DoC
Router	TP-Link	TL-WR841N	2159230001005	TE7WR841NXV10
GPS Sensor	Anand Technologies	AT-ANT-GPSGNSS-SMA-4	AT-GNSS-1610-000001	N/A
Direction Coupler	Mini Circuit	ZUDC10-83-S+	1913	N/A
20dB Attenuator	Mini Circuit	BW-N20W20+	1834	N/A
40dB Attenuator	Mini Circuit	BW-N40W5+	1638	N/A

I/O CABLES (CONDUCTED TEST)

I/O Cable List					
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	0.2	to AC/DC Adapter
2	DC	1	DC	Un-shielded	1	to Laptop
3	AC	1	AC	Un-shielded	0.6	AC to Router
4a	Ethernet	1	RJ45	Un-shielded	1.2	Laptop to Router
4b	Ethernet	1	RJ45	Un-shielded	1.2	POE to Router
4c	Ethernet	1	RJ45	Un-shielded	1.2	POE adapter cable to EUT
5	AC	1	AC	Un-shielded	0.2	to AC/DC Adapter
6	DC	1	DC	Un-shielded	1	DC to POE adapter cable
7	DC	1	Ethernet	Un-shielded	0.2	DC to POE
8	N-Type	1	N-type	Un-shielded	1	EUT to Analyzer

I/O CABLES (RADIATED)

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	0.2	to AC/DC Adapter
2	DC	1	DC	Un-shielded	1	to POE
3	DC	1	Ethernet	Un-shielded	0.2	DC to POE adapter cable
4	Ethernet	1	RJ45	Un-shielded	1.8	POE adapter cable to EUT
5	N-Type	1	N-type	Un-shielded	0.8	EUT to Antenna
6	N-Type	1	N-type	Un-shielded	0.5	EUT to GPS

I/O CABLES (AC LINE CONDUCTED)

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	0.2	to AC/DC Adapter
2	DC	1	DC	Un-shielded	1	to Laptop
3	AC	1	AC	Un-shielded	0.6	AC to Router
4a	Ethernet	1	RJ45	Un-shielded	1	Laptop to Router
4b	Ethernet	1	RJ45	Un-shielded	1	POE to Router
4c	Ethernet	1	RJ45	Un-shielded	1.2	POE to EUT
4d	Ethernet	1	RJ45	Un-shielded	1.2	POE adapter cable to EUT
5	AC	1	AC	Un-shielded	0.2	to AC/DC Adapter
6	DC	1	DC	Un-shielded	1	to POE
7	DC	1	Ethernet	Un-shielded	0.2	DC to POE adapter cable
8	N-Type	1	N-type	Un-shielded	1	EUT to GPS
9	N-Type	1	N-type	Un-shielded	1	EUT to Attenuator
10	N-Type	1	N-type	Un-shielded	1	Attenuator to Client

I/O CABLES (DATABASE)

I/O Cable List					
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1a	Ethernet	1	RJ45	Un-shielded	0.8	EUT to Router
1b	Ethernet	1	RJ45	Un-shielded	0.8	Base Laptop to Router
1c	Ethernet	1	RJ45	Un-shielded	0.8	Router to Internet
1d	Ethernet	1	RJ45	Un-shielded	0.8	Client Device to Laptop
2a	N-type	1	N-Type	Un-shielded	0.7	EUT to Coupler
2b	N-type	1	N-Type	Un-shielded	0.7	Client Device to Coupler
3	SMA	1	SMA	Un-shielded	1m	Coupler to Analyzer

TEST SETUP

The customer provided test software to exercise the EUT during tests.

The EUT was setup for four types of tests: RF conducted, Radiated emissions, AC Line conducted emissions and Database testing. See below diagrams for configurations.

SETUP DIAGRAM FOR ANTENNA PORT CONDUCTED TESTS
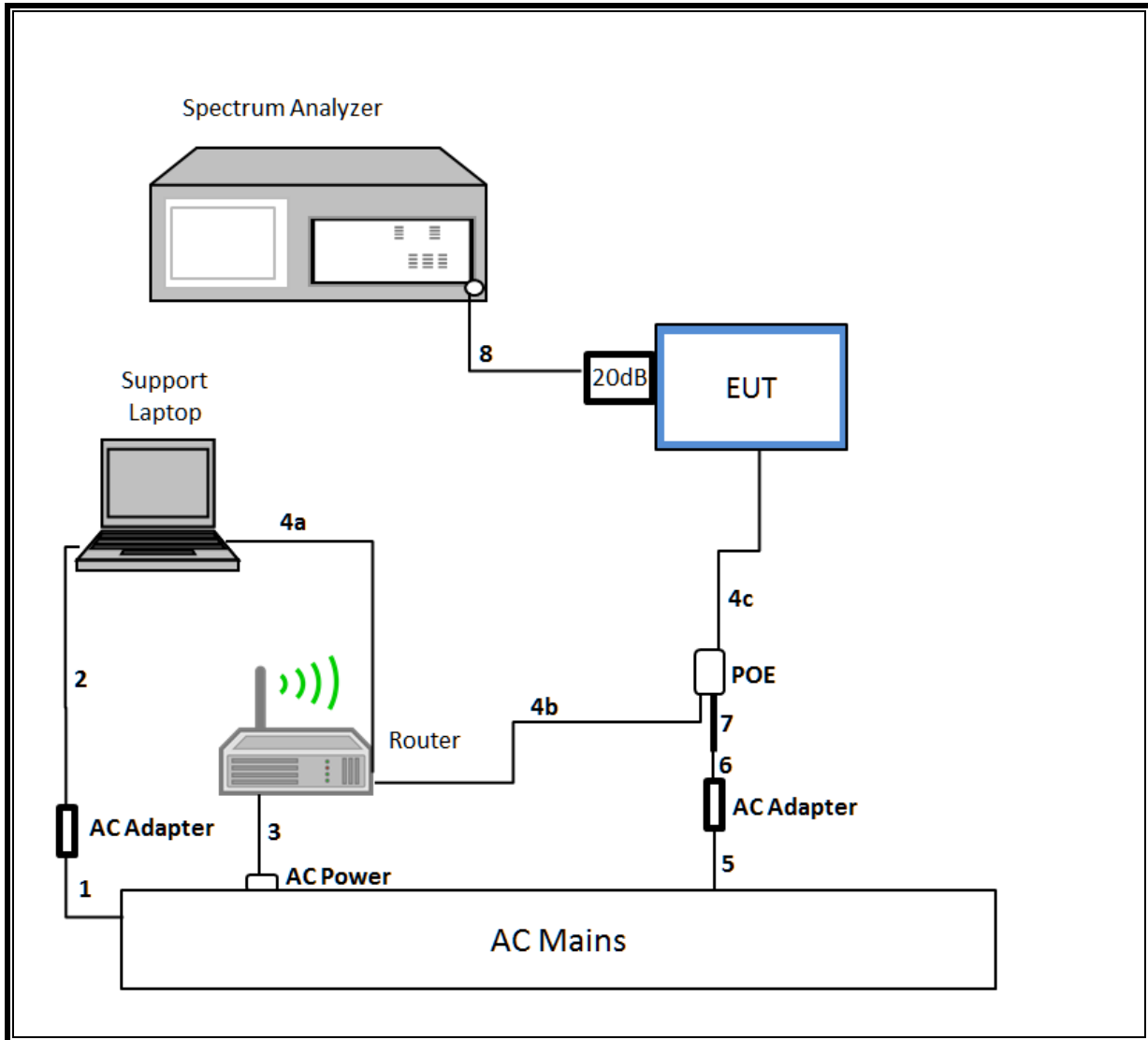
SETUP DIAGRAM FOR RADIATED EMISSIONS TESTS
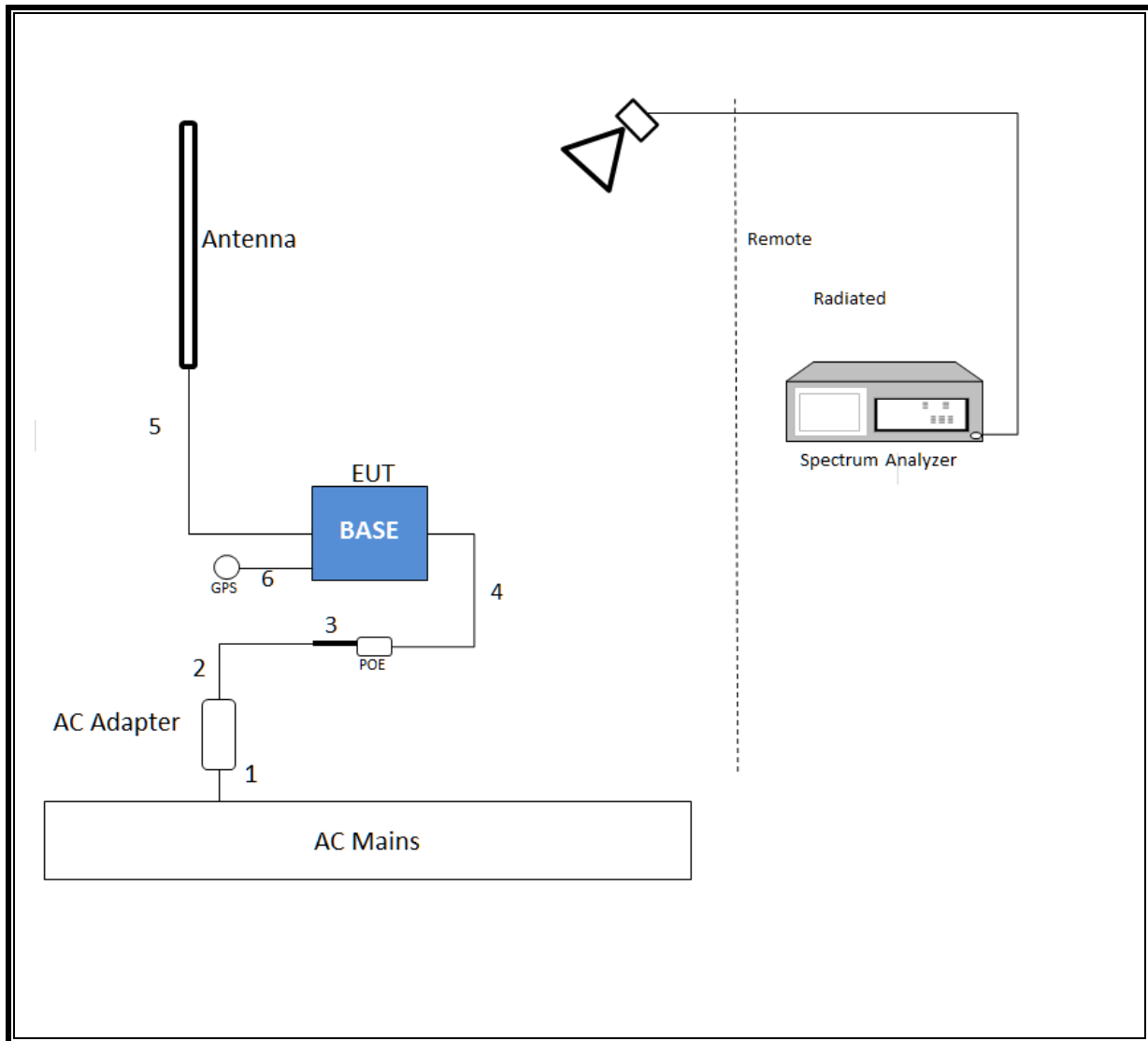
SETUP DIAGRAM FOR AC LINE CONDUCTED TESTS

Note: Base and Client station were linked via direct connection with 40 dB attenuation to provide internet connection to client.

SETUP DIAGRAM FOR DATABASE TESTS

Diagram showing communications links
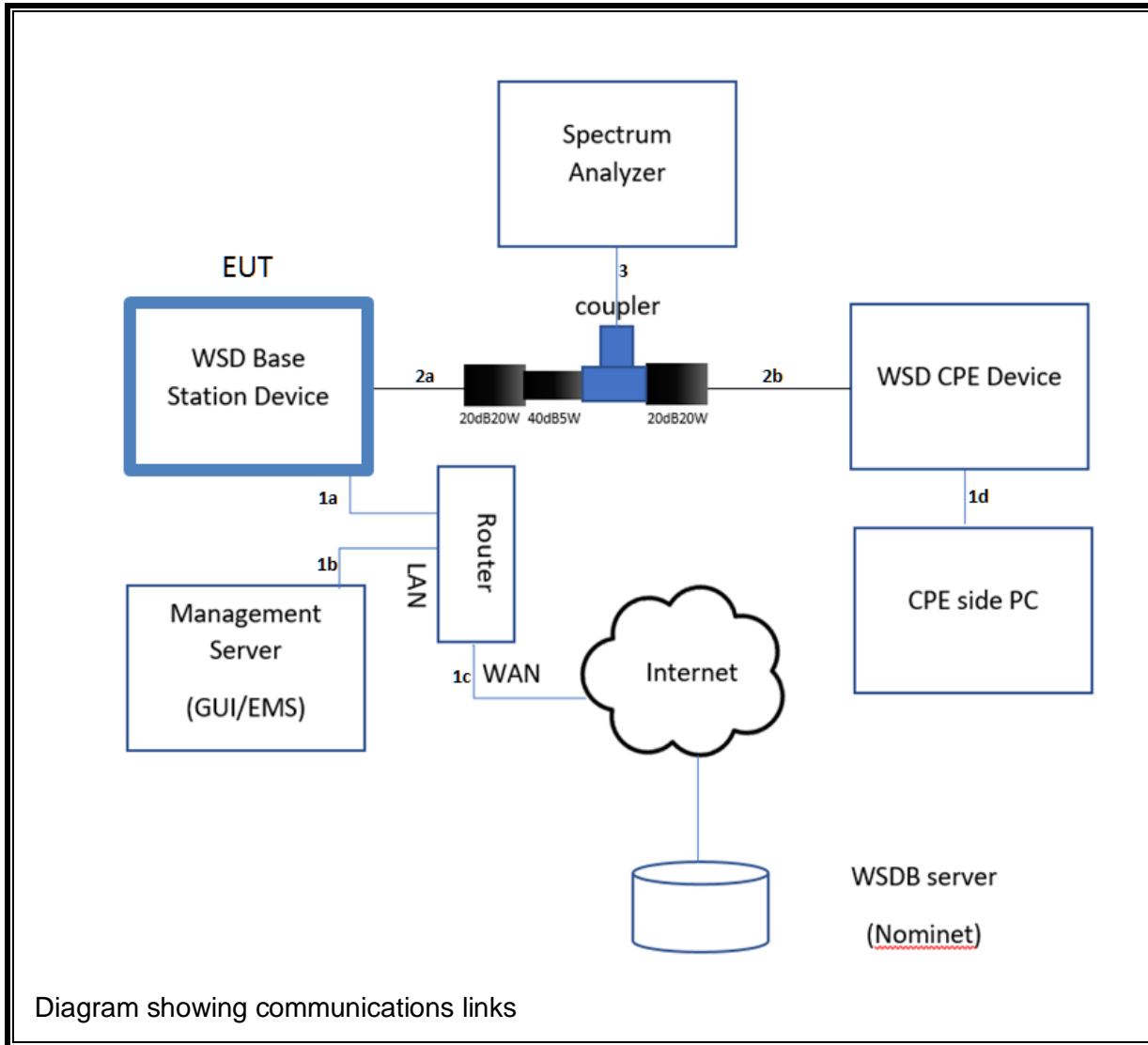
7. TEST AND MEASUREMENT EQUIPMENT

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

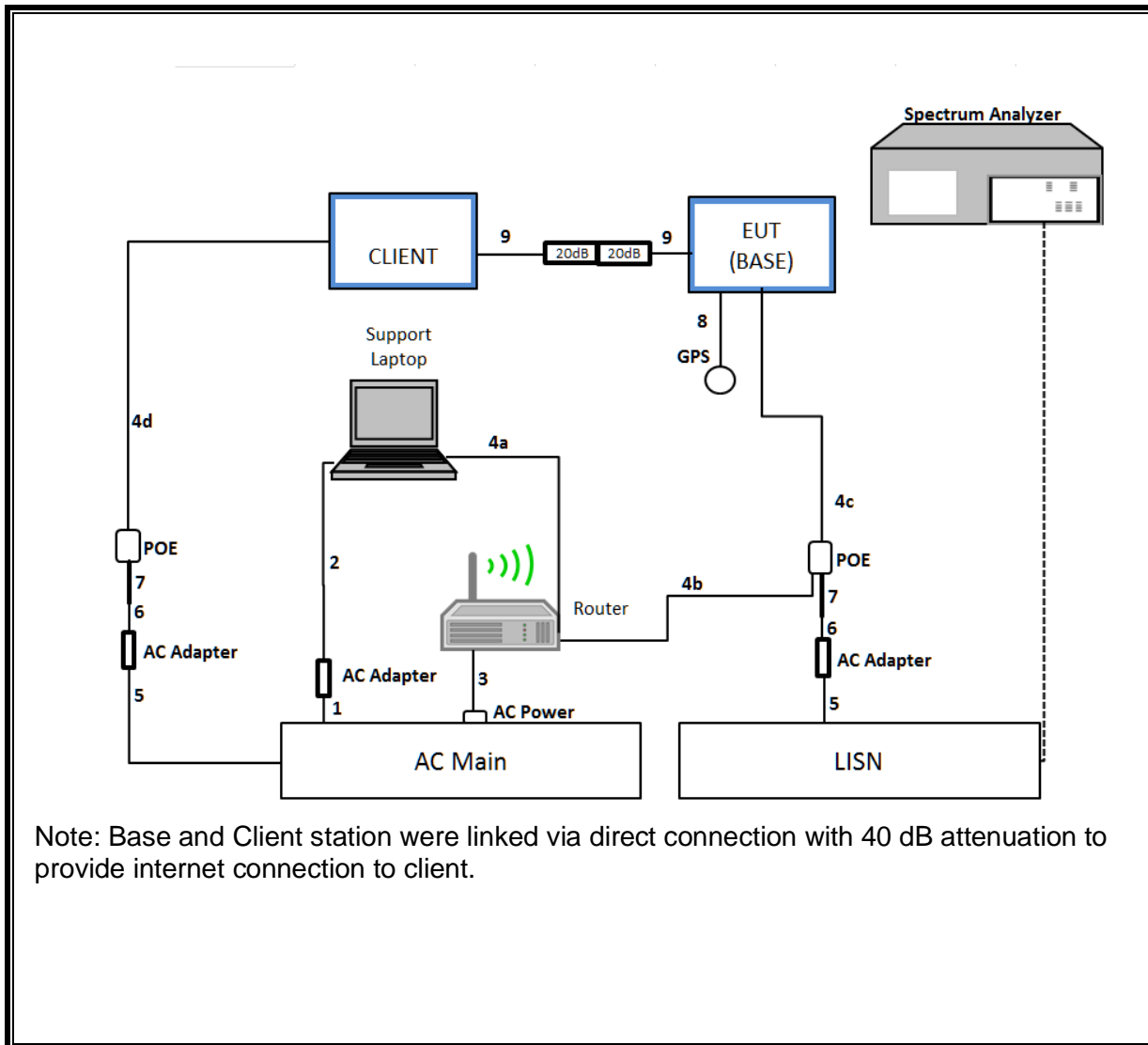| Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
TEST EQUIPMENT LIST					
Horn Antenna	ETS-Lindgren	3117	T862	06/05/2020	06/05/2019
Amplifier, 1 to18GHz	MITEQ	AFS42-00101800-25-S-42	PRE0181078	08/24/2020	08/24/2019
Antenna, Broadband Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	PRE0184971	11/13/2019	11/13/2018
Amplifier, 9kHz to 1GHz, 32 dB	Sonoma Instrument	310	PRE0180175	06/29/2020	06/29/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179376	2/14/2020	2/14/2019
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Agilent (Keysight) Technologies	E4440A	T200	1/28/2020	1/29/2019
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Agilent (Keysight) Technologies	E4440A	T908	1/29/2020	1/29/2019
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Agilent (Keysight) Technologies	E4440A	T198	1/29/2020	1/29/2019
587 MHz Notch Filter	EWT	EWT-14-0338	T239	08/07/2020	08/07/2019
515MHz Notch Filter	EWT	EWT-14-0348	T241	08/07/2020	08/07/2019
473MHz Notch Filter	EWT	EWT-14-0337	T232	08/07/2020	08/07/2019
1GHz High Pass Filter	Micro-Tronics	HPM50115	PRE0182589	09/04/2020	09/04/2019
AC Line Conducted					
EMI Receiver	Rohde & Schwarz	ESR	T1436	02/14/2020	02/14/2019
LISN for Conducted Emissions CISPR-16	FCC INC.	FCC LISN 50/250	T1310	01/24/2020	01/24/2019
Test Software List					
Radiated Software	UL	UL EMC	Ver 9.5, June 15, 2019		
Antenna Port Software	UL	UL RF	Ver 2019.10.18		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		

8. MEASUREMENT METHODS

Output Power & Power Spectral Density (Fixed WSD): KDB 416721 D01 v03 Section II, (2)(c)(i).

Band-Edge Measurement: KDB 416721 D01 v03 Section II (2)(d)(i)

Adjacent Channel Emissions: KDB 416721 D01 v03 Section II (2)(d)(ii)

Beyond Adjacent Channel Emissions: ANSI C63.10-2013, Section 6.5 and 6.6.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

9. ANTENNA PORT TEST RESULTS

9.1. OUTPUT POWER AND POWER SPECTRAL DENSITY

LIMITS

§15.709 (b)(1) Fixed White Space Device

For operation at EIRP levels of 36 dBm (4000 mW) or less, fixed white space devices may operate at EIRP levels between the values shown in the table provided that the conducted power and the conducted power spectral density (PSD) limits are linearly interpolated between the values shown and the adjacent channel emission limit of the higher value shown in the table is met. Operation at EIRP levels above 36 dBm (4000 mW) shall follow the requirements for 40 dBm (10,000 mW).

EIRP (6 MHz)	Conducted power limit[1] (6 MHz)	Conducted PSD limit (100 kHz)	Conducted adjacent channel emission limit (100 kHz)
16 dBm (40 mW)	10 dBm (10 mW)	−7.4 dBm	−62.8 dBm
20 dBm (100 mW)	14 dBm (25 mW)	−3.4 dBm	−58.8 dBm
24 dBm (250 mW)	18 dBm (63 mW)	0.6 dBm	−54.8 dBm
28 dBm (625 mW)	22 dBm (158 mW)	4.6 dBm	−50.8 dBm
32 dBm (1600 mW)	26 dBm (400 mW)	8.6 dBm	−46.8 dBm
36 dBm (4000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm
40 dBm (10000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm

[1]The conducted power spectral density from a fixed white space device shall not be greater than the values shown in the table when measured in any 100 kHz band during any time interval of continuous transmission, except that a 40 mW fixed white space device operating in a four megahertz channel within a seven megahertz guard band must comply with a conducted power spectral density limit of −5.4 dBm.

The conducted power, PSD and adjacent channel limits for fixed white space devices operating at up to 36 dBm (4000 milliwatts) EIRP shown in the table in paragraph (b)(1) of this section are based on a maximum transmitting antenna gain of 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The conducted power, PSD and adjacent channel limits for fixed white space devices operating at greater than 36 dBm (4000 milliwatts) EIRP shown in the table in paragraph (b)(1) of this section are based on a maximum transmitting antenna gain of 10 dBi. If transmitting antennas of directional gain greater than 10 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 10 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

RESULTS

9.1.1. UHF BAND

Tested By:	16080ZS
Test Date:	11/1/2019

Antenna Gain (dBi)	6.00

Output Power Results

Channel	Frequency (MHz)	Measured Total Output Power (dBM)	Measured Total EIRP (dBm)	Conducted Power Limit (dBm)	Margin (dB)
Low	473	25.12	31.12	25.12	0.00
Mid	539	25.07	31.07	25.07	0.00
High	605	24.39	30.39	24.39	0.00

PSD Results

Channel	Frequency (MHz)	Measured Total PSD Power (dBm)	Conducted PSD Limit (dBm)	Margin (dB)
Low	473	7.34	7.72	-0.38
Mid	539	7.26	7.67	-0.41
High	605	6.60	6.99	-0.40

POWER and PSD (LOW CHANNEL)

POWER and PSD (MID CHANNEL)

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POWER and PSD (HIGH CHANNEL)
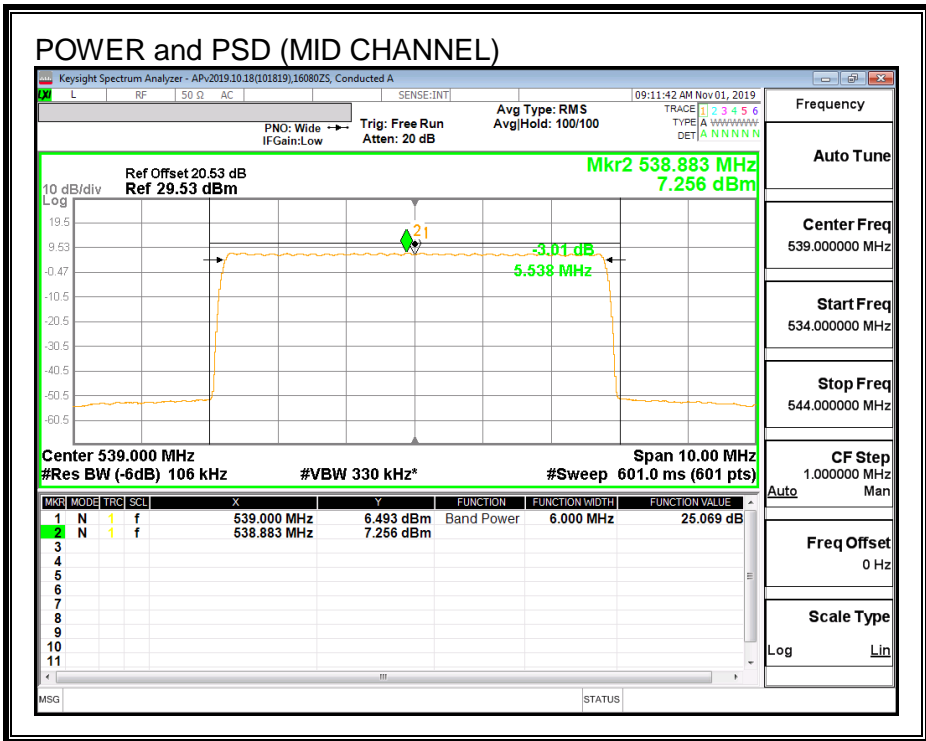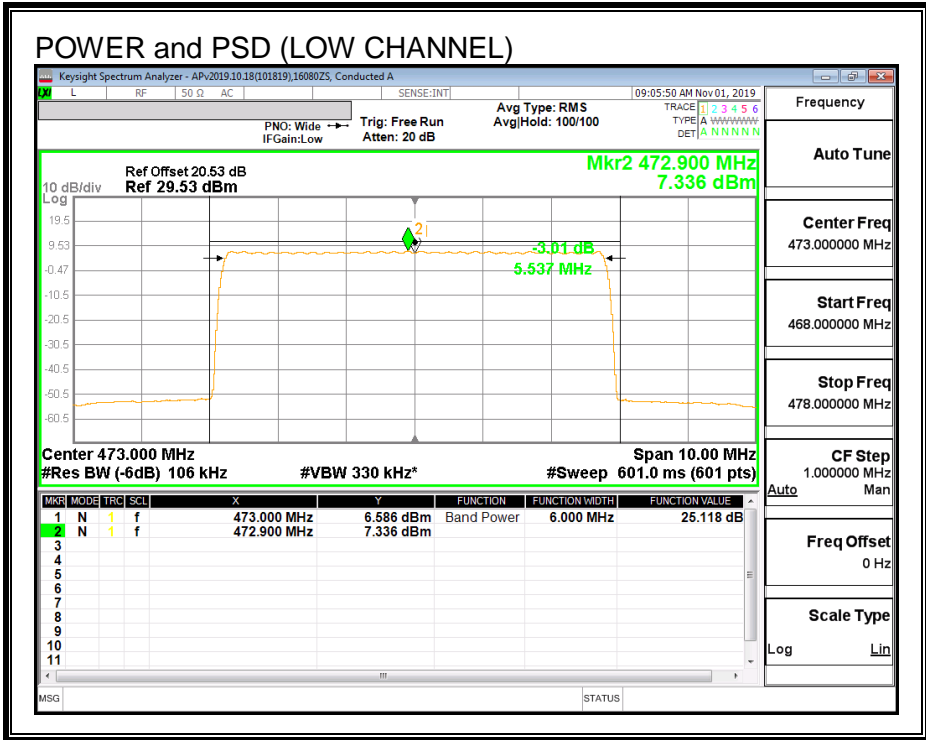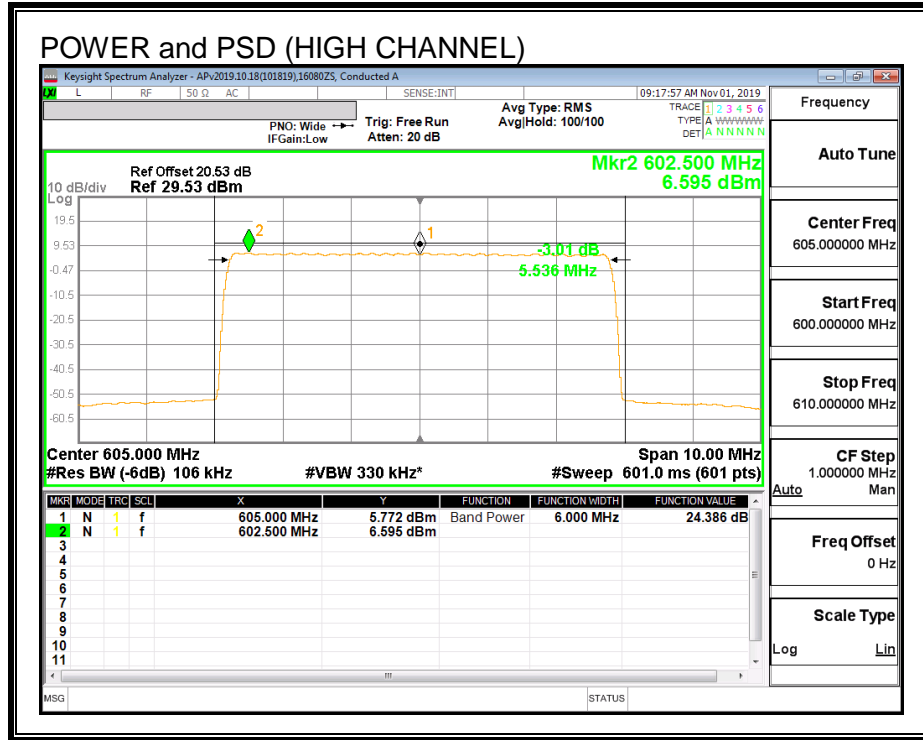
9.2. BAND-EDGE

LIMITS

§15.709 (b)(1)(iii) Fixed White Space Device

EIRP (6 MHz)	Conducted power limit[1] (6 MHz)	Conducted PSD limit (100 kHz)	Conducted adjacent channel emission limit (100 kHz)
16 dBm (40 mW)	10 dBm (10 mW)	−7.4 dBm	−62.8 dBm
20 dBm (100 mW)	14 dBm (25 mW)	−3.4 dBm	−58.8 dBm
24 dBm (250 mW)	18 dBm (63 mW)	0.6 dBm	−54.8 dBm
28 dBm (625 mW)	22 dBm (158 mW)	4.6 dBm	−50.8 dBm
32 dBm (1600 mW)	26 dBm (400 mW)	8.6 dBm	−46.8 dBm
36 dBm (4000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm
40 dBm (10000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm

(d) Emission limits.(1) The adjacent channel emission limits shown in the tables in paragraphs (b)(1) and (2) of this section apply in the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating.

(2) At frequencies beyond the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating the white space device shall meet the requirements of §15.209.

(3) Emission measurements in the adjacent bands shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.

Conducted Band edge limits for this Fixed WS device are:−46.8 dBm/100 kHz

Note: Adjacent channel emission limit of the higher value shown in the table above used

RESULTS

9.2.1. UHF BAND

Tested By:	16080ZS
Test Date:	10/30/19

Lower Band-Edge Emissions

Channel	Frequency (MHz)	Measured Total Emission (dBm)	Emissions Limit (dBm)	Worst Case Margin (dBm)
Low	473	-51.52	-46.8	-4.72
Mid	539	-49.55	-46.8	-2.75
High	605	-49.09	-46.8	-2.29

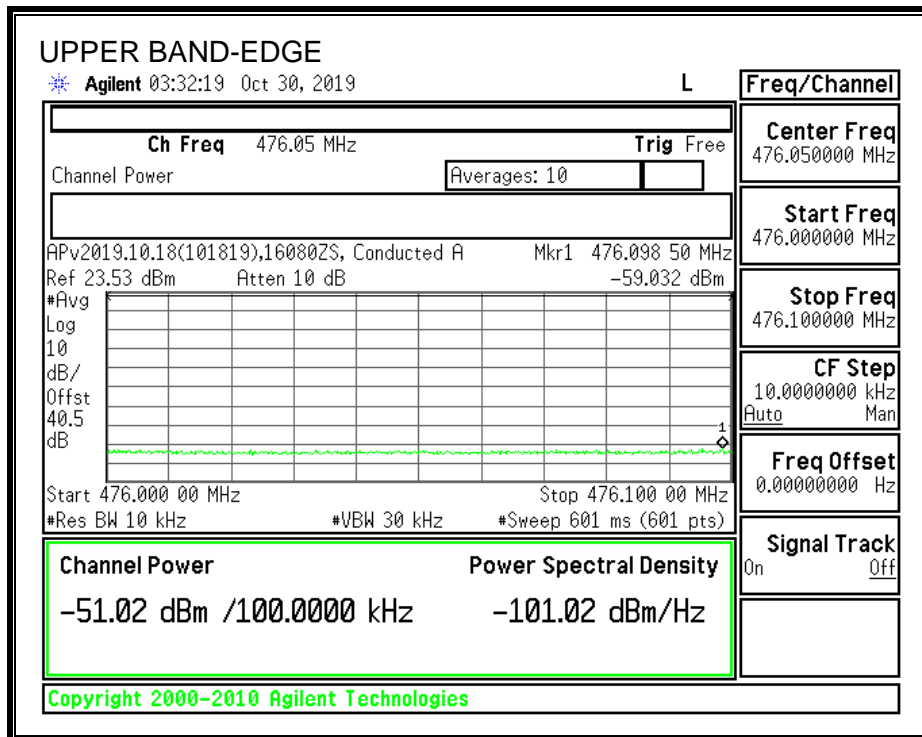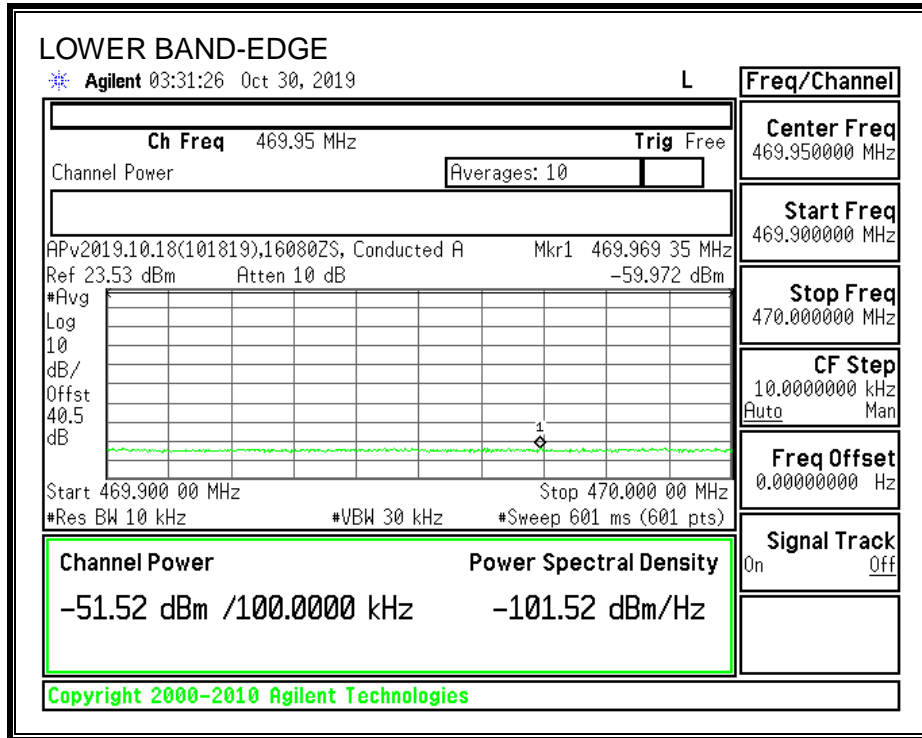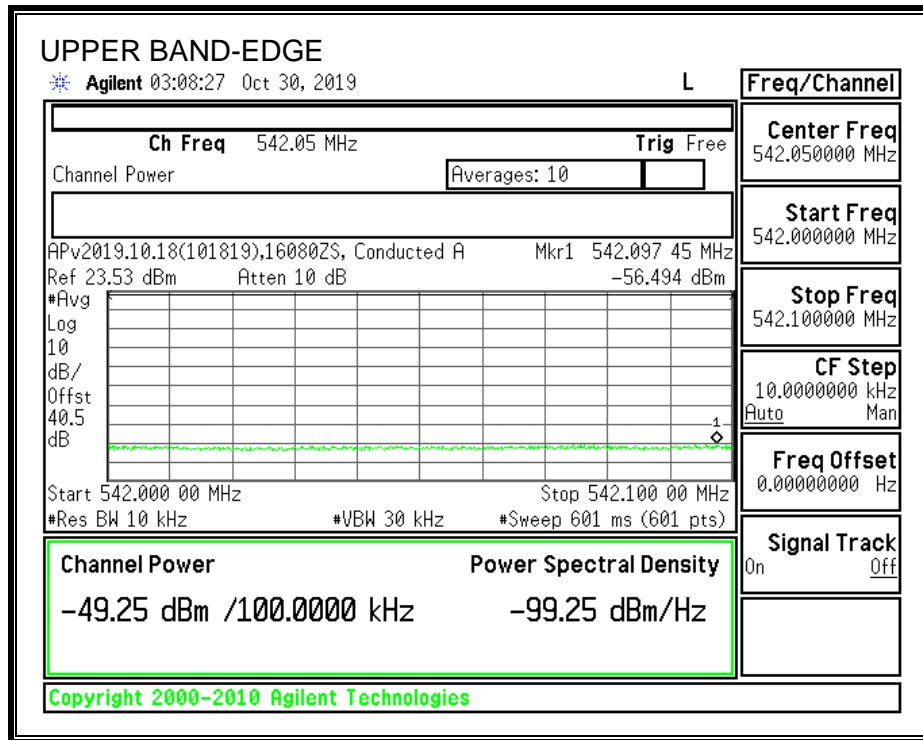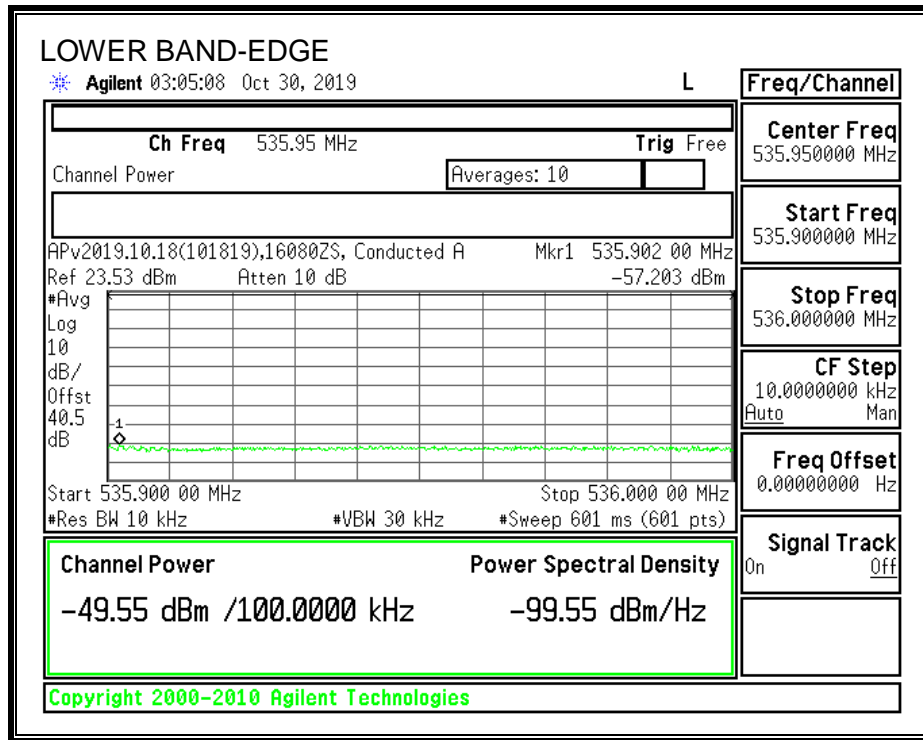**Upper Band-Edge Emissions**

Channel	Frequency (MHz)	Measured Total Emission (dBm)	Emissions Limit (dBm)	Worst Case Margin (dBm)
Low	473	-51.02	-46.8	-4.22
Mid	539	-49.25	-46.8	-2.45
High	605	-50.59	-46.8	-3.79

LOW CHANNEL

```
LOWER BAND-EDGE
  ☀ Agilent 03:31:26 Oct 30, 2019                          L       Freq/Channel

        Ch Freq    469.95 MHz                  Trig Free       Center Freq
                                                               469.950000 MHz
  Channel Power                    Averages: 10
                                                               Start Freq
                                                               469.900000 MHz
  APv2019.10.18(101819),16080ZS, Conducted A    Mkr1  469.969 35 MHz
  Ref 23.53 dBm      Atten 10 dB                    -59.972 dBm   Stop Freq
  #Avg                                                           470.000000 MHz
  Log
  10                                                              CF Step
  dB/                                                            10.0000000 kHz
  Offst                                                          Auto      Man
  40.5
  dB                              1                               Freq Offset
                                  ◇                              0.00000000 Hz
  Start 469.900 00 MHz                    Stop 470.000 00 MHz
  #Res BW 10 kHz          #VBW 30 kHz     #Sweep 601 ms (601 pts)  Signal Track
                                                                  On       Off
   Channel Power             Power Spectral Density

   -51.52 dBm /100.0000 kHz      -101.52 dBm/Hz

  Copyright 2000-2010 Agilent Technologies
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UPPER BAND-EDGE
  ☀ Agilent 03:32:19 Oct 30, 2019                          L       Freq/Channel

        Ch Freq    476.05 MHz                  Trig Free       Center Freq
                                                               476.050000 MHz
  Channel Power                    Averages: 10
                                                               Start Freq
                                                               476.000000 MHz
  APv2019.10.18(101819),16080ZS, Conducted A    Mkr1  476.098 50 MHz
  Ref 23.53 dBm      Atten 10 dB                    -59.032 dBm   Stop Freq
  #Avg                                                           476.100000 MHz
  Log
  10                                                              CF Step
  dB/                                                            10.0000000 kHz
  Offst                                                          Auto      Man
  40.5                                          1
  dB                                            ◇                 Freq Offset
                                                               0.00000000 Hz
  Start 476.000 00 MHz                    Stop 476.100 00 MHz
  #Res BW 10 kHz          #VBW 30 kHz     #Sweep 601 ms (601 pts)  Signal Track
                                                                  On       Off
   Channel Power             Power Spectral Density

   -51.02 dBm /100.0000 kHz      -101.02 dBm/Hz

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```

MID CHANNEL

LOWER BAND-EDGE

Agilent 03:05:08 Oct 30, 2019   L

Ch Freq   535.95 MHz   Trig Free
Channel Power   Averages: 10

APv2019.10.18(101819),16080ZS, Conducted A   Mkr1   535.902 00 MHz
Ref 23.53 dBm   Atten 10 dB   −57.203 dBm
#Avg
Log
10
dB/
Offst
40.5
dB   1

Start 535.900 00 MHz   Stop 536.000 00 MHz
#Res BW 10 kHz   #VBW 30 kHz   #Sweep 601 ms (601 pts)

Channel Power	Power Spectral Density
−49.55 dBm /100.0000 kHz	−99.55 dBm/Hz

Freq/Channel

Center Freq
535.950000 MHz

Start Freq
535.900000 MHz

Stop Freq
536.000000 MHz

CF Step
10.0000000 kHz
Auto   Man

Freq Offset
0.00000000 Hz

Signal Track
On   Off

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UPPER BAND-EDGE

Agilent 03:08:27 Oct 30, 2019   L

Ch Freq   542.05 MHz   Trig Free
Channel Power   Averages: 10

APv2019.10.18(101819),16080ZS, Conducted A   Mkr1   542.097 45 MHz
Ref 23.53 dBm   Atten 10 dB   −56.494 dBm
#Avg
Log
10
dB/
Offst
40.5
dB   1

Start 542.000 00 MHz   Stop 542.100 00 MHz
#Res BW 10 kHz   #VBW 30 kHz   #Sweep 601 ms (601 pts)

Channel Power	Power Spectral Density
−49.25 dBm /100.0000 kHz	−99.25 dBm/Hz

Freq/Channel

Center Freq
542.050000 MHz

Start Freq
542.000000 MHz

Stop Freq
542.100000 MHz

CF Step
10.0000000 kHz
Auto   Man

Freq Offset
0.00000000 Hz

Signal Track
On   Off

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HIGH CHANNEL

LOWER BAND-EDGE

UPPER BAND-EDGE

9.3.   ADJACENT CHANNEL EMISSIONS

LIMITS

§15.709 Fixed White Space Device

(d) Emission limits.(1) The adjacent channel emission limits shown in the tables in paragraphs (b)(1) and (2) of this section apply in the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating.

EIRP (6 MHz)	Conducted power limit[1] (6 MHz)	Conducted PSD limit (100 kHz)	Conducted adjacent channel emission limit (100 kHz)
16 dBm (40 mW)	10 dBm (10 mW)	−7.4 dBm	−62.8 dBm
20 dBm (100 mW)	14 dBm (25 mW)	−3.4 dBm	−58.8 dBm
24 dBm (250 mW)	18 dBm (63 mW)	0.6 dBm	−54.8 dBm
28 dBm (625 mW)	22 dBm (158 mW)	4.6 dBm	−50.8 dBm
32 dBm (1600 mW)	26 dBm (400 mW)	8.6 dBm	−46.8 dBm
36 dBm (4000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm
40 dBm (10000 mW)	30 dBm (1000 mW)	12.6 dBm	−42.8 dBm

(2) At frequencies beyond the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating the white space device shall meet the requirements of §15.209.

(3) Emission measurements in the adjacent bands shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.

Conducted Band edge limits for this Fixed WS device are:−46.8 dBm/100 kHz

Note: check limit -Adjacent channel emission limit of the higher value shown in the table above used

RESULTS

9.3.1. UHF BAND

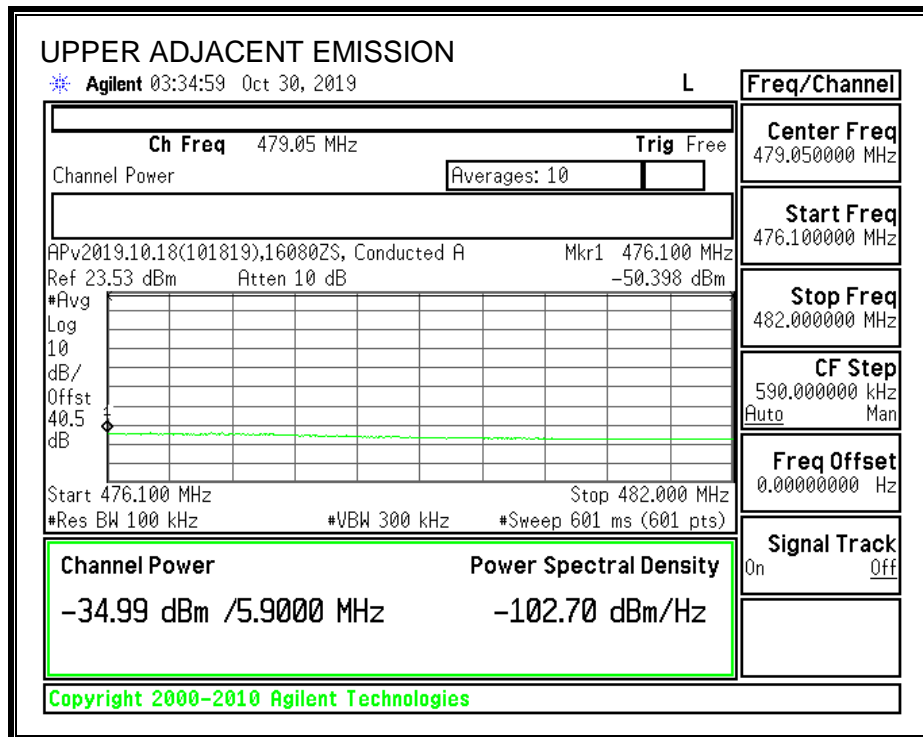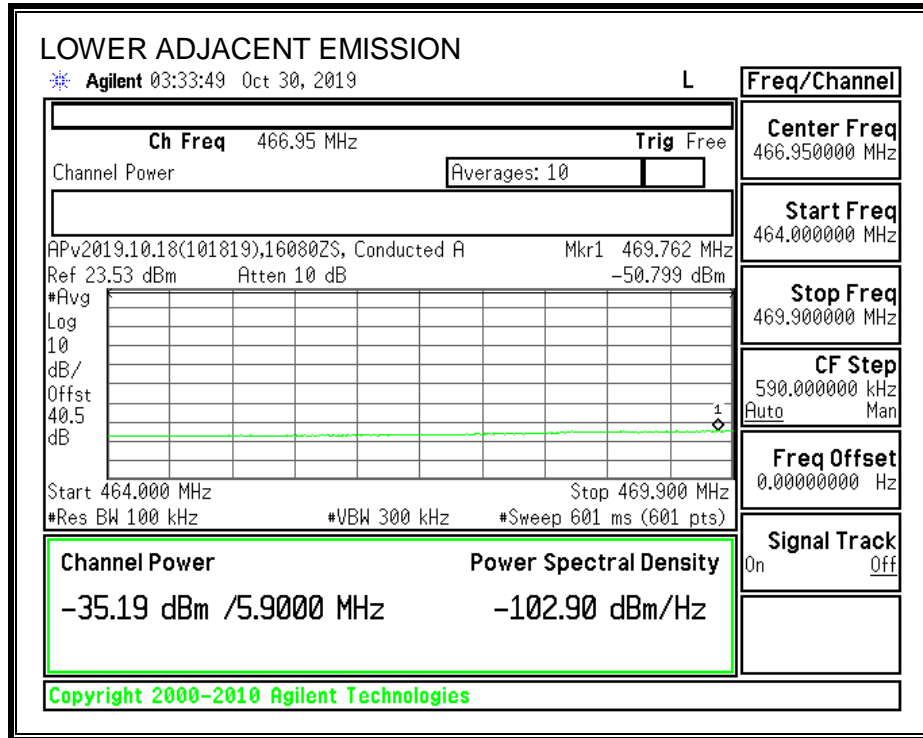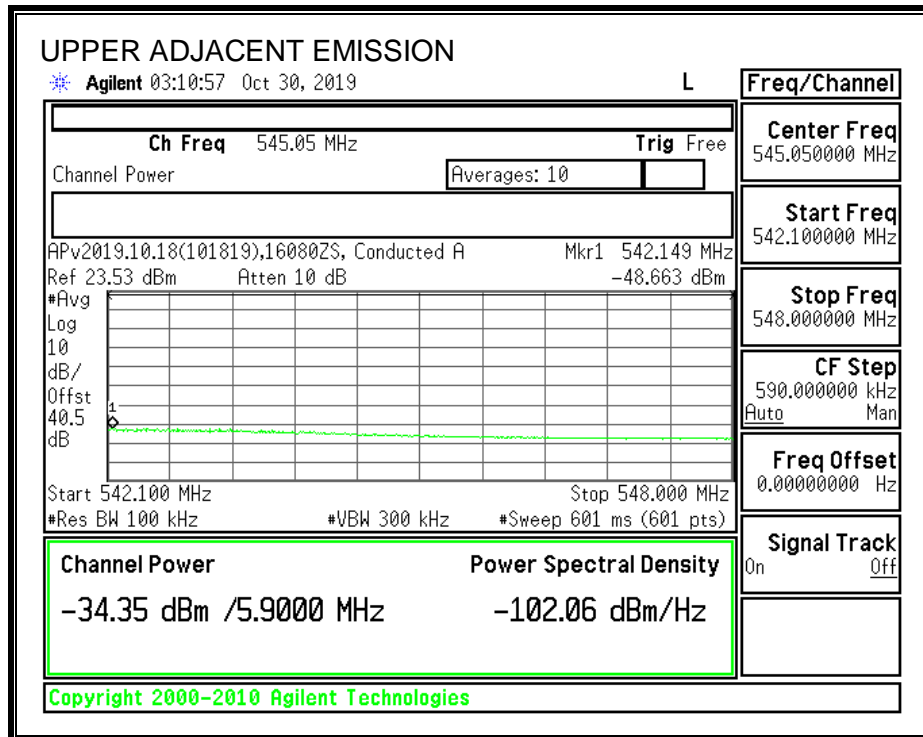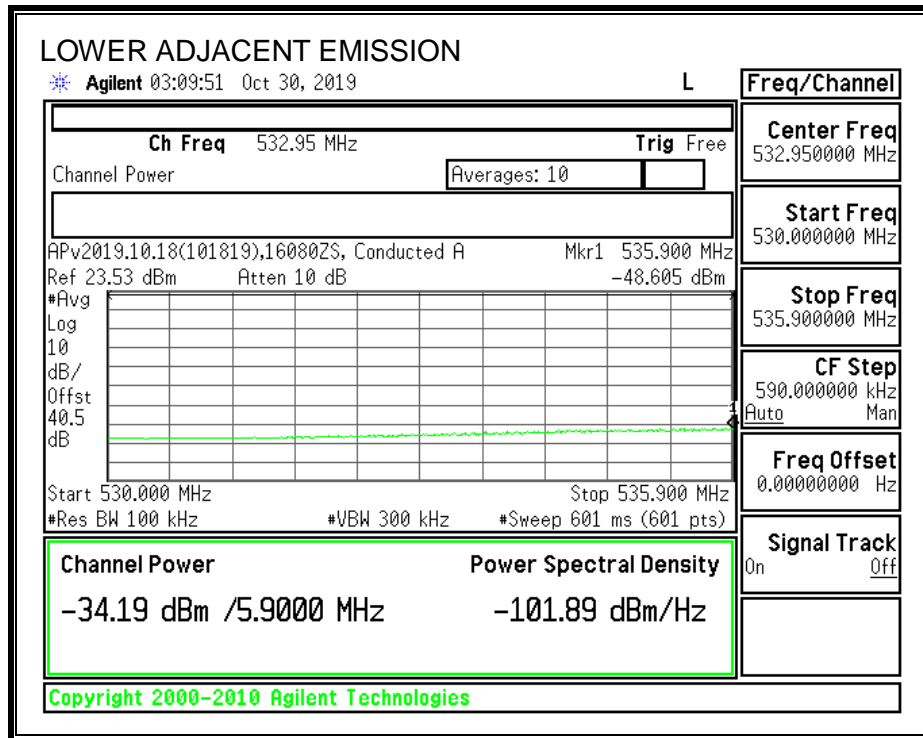| Tested By:	16080ZS
Test Date:	10/30/19

Lower Adjacent Channel Emissions

Channel	Frequency (MHz)	Measured Total Emission (dBm)	Emissions Limit (dBm)	Worst Case Margin (dBm)
Low	473	-50.80	-46.8	-4.00
Mid	539	-48.61	-46.8	-1.81
High	605	-48.36	-46.8	-1.56

Upper Adjacent Channel Emissions

Channel	Frequency (MHz)	Measured Total Emission (dBm)	Emissions Limit (dBm)	Worst Case Margin (dBm)
Low	473	-50.40	-46.8	-3.60
Mid	539	-48.66	-46.8	-1.86
High	605	-50.18	-46.8	-3.38

LOW CHANNEL

LOWER ADJACENT EMISSION

UPPER ADJACENT EMISSION

MID CHANNEL

LOWER ADJACENT EMISSION

UPPER ADJACENT EMISSION

HIGH CHANNEL

LOWER ADJACENT EMISSION

UPPER ADJACENT EMISSION
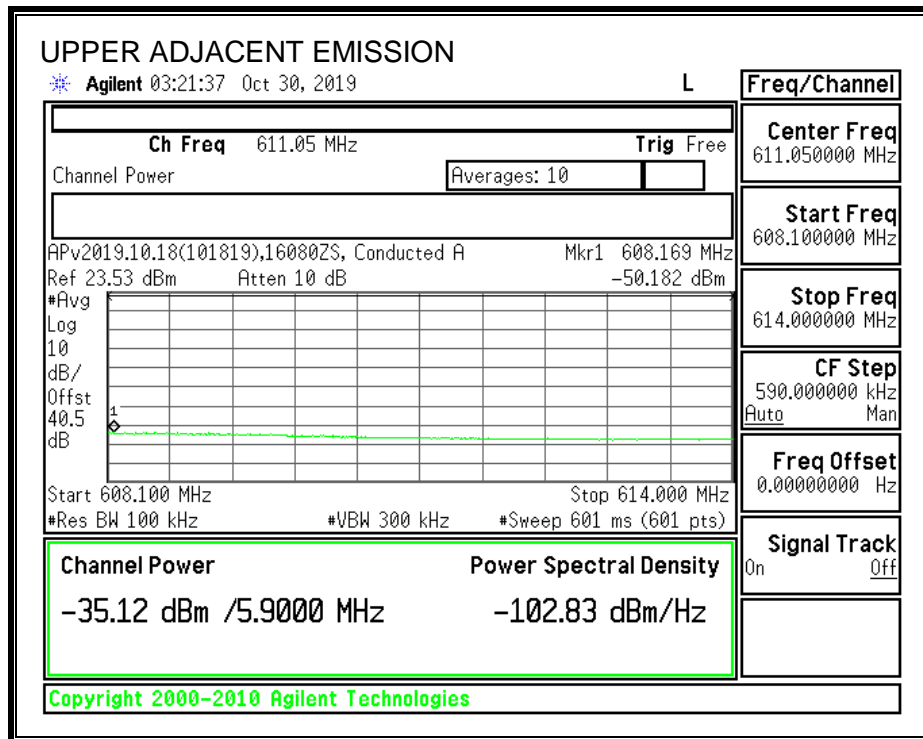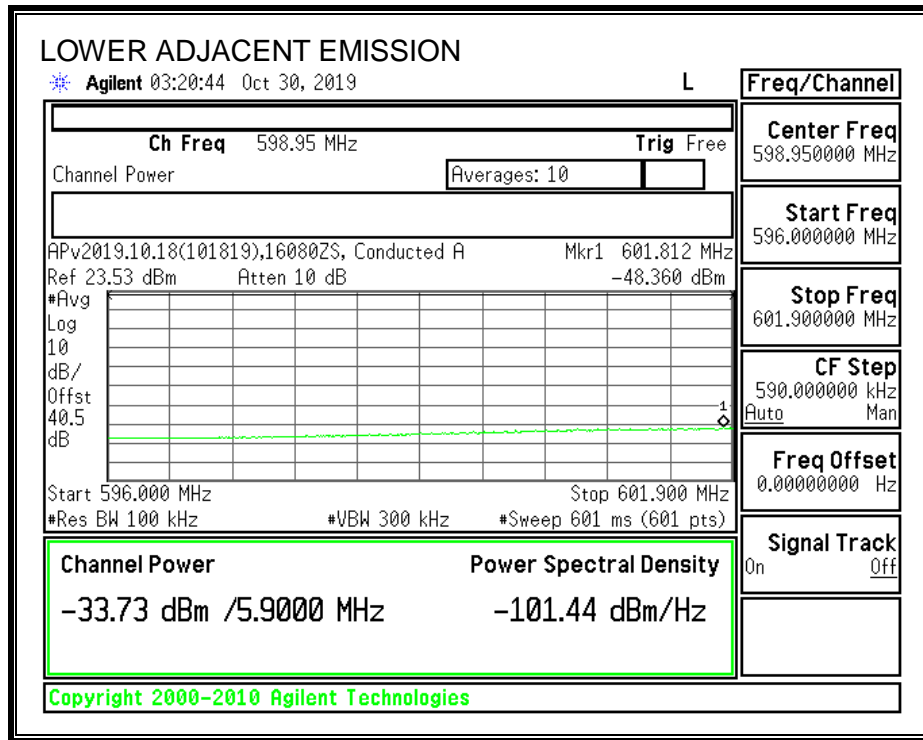
10. RADIATED EMISSIONS

BEYOND ADJACENT CHANNEL EMISSION LIMITS

FCC §15.709 (d) (2) At frequencies beyond the six megahertz channel immediately adjacent to each white space channel or group of contiguous white space channels in which the white space device is operating the white space device shall meet the requirements of §15.209.

The DUT must comply with radiated emission limits for a Class B digital device, except that authorization as a Class A device may be considered with appropriate justification for non-residential use.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3m	Measurement distance (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

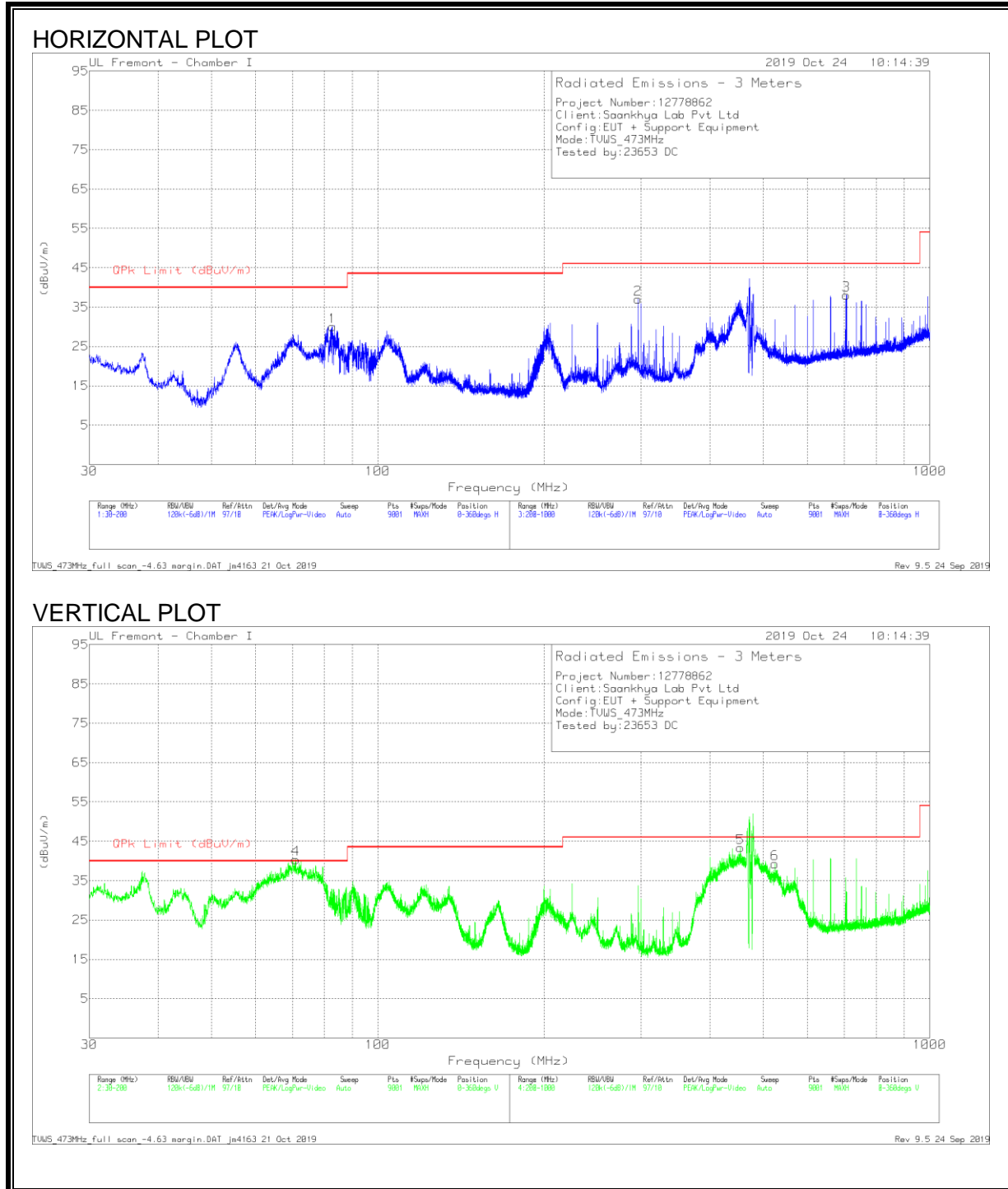**TEST PROCEDURE**

ANSI C63.10-2013.

The EUT is set to transmit in a continuous mode.

High-Q Cavity Notch filters are used to reduce the amplitude of the intentional transmitter and prevent overload of the system preamplifier.

10.1.   TRANSMITTER BELOW 1GHz

10.1.1.   UHF BAND

BEYOND ADJACENT CHANNEL (LOW CHANNEL)

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LOW CHANNEL DATA

Trace Markers

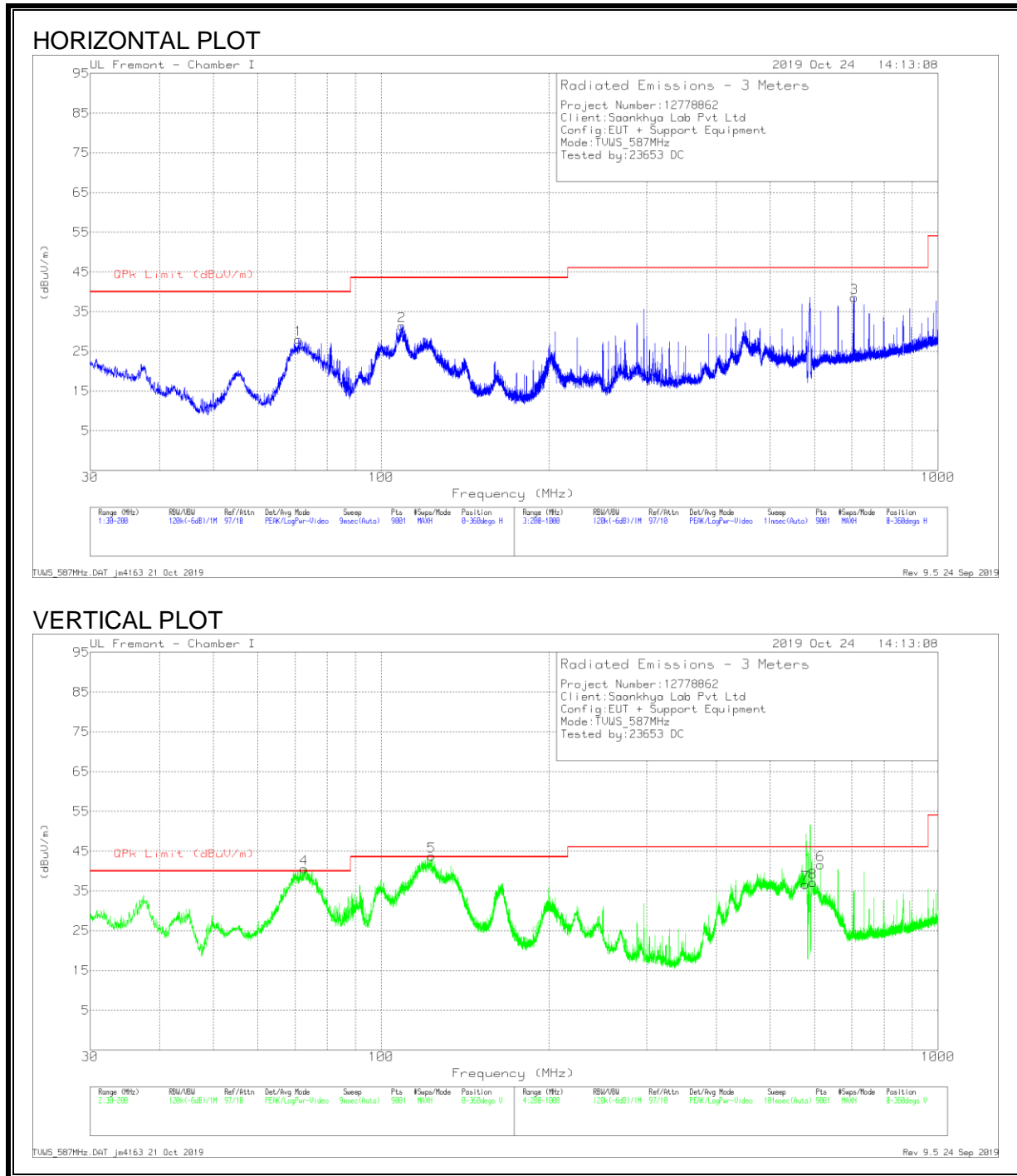| Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	82.6625	47.68	Pk	13.3	-31	.1	30.08	40	-9.92	0-360	199	H
4	70.9891	57.29	Pk	13.9	-30.9	.1	40.39	-	-	0-360	102	V
2	296.3557	47.78	Pk	19.2	-30	.1	37.08	46	-8.92	0-360	102	H
3	706.7562	40.8	Pk	26.1	-28.9	.1	38.1	46	-7.9	0-360	102	H
5	453.7781	49.99	Pk	22.8	-29.5	.1	43.39	46	-2.61	0-360	102	V
6	524.356	44.85	Pk	23.7	-29.4	.1	39.25	46	-6.75	0-360	102	V

Pk - Peak detector

Radiated Emissions

Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
70.8093	52.37	Qp	13.9	-31	.1	35.37	40	-4.63	177	100	V
453.904	45.49	Qp	22.8	-29.5	.1	38.89	46	-7.11	274	102	V

Qp - Quasi-Peak detector

BEYOND ADJACENT CHANNEL (MID CHANNEL)

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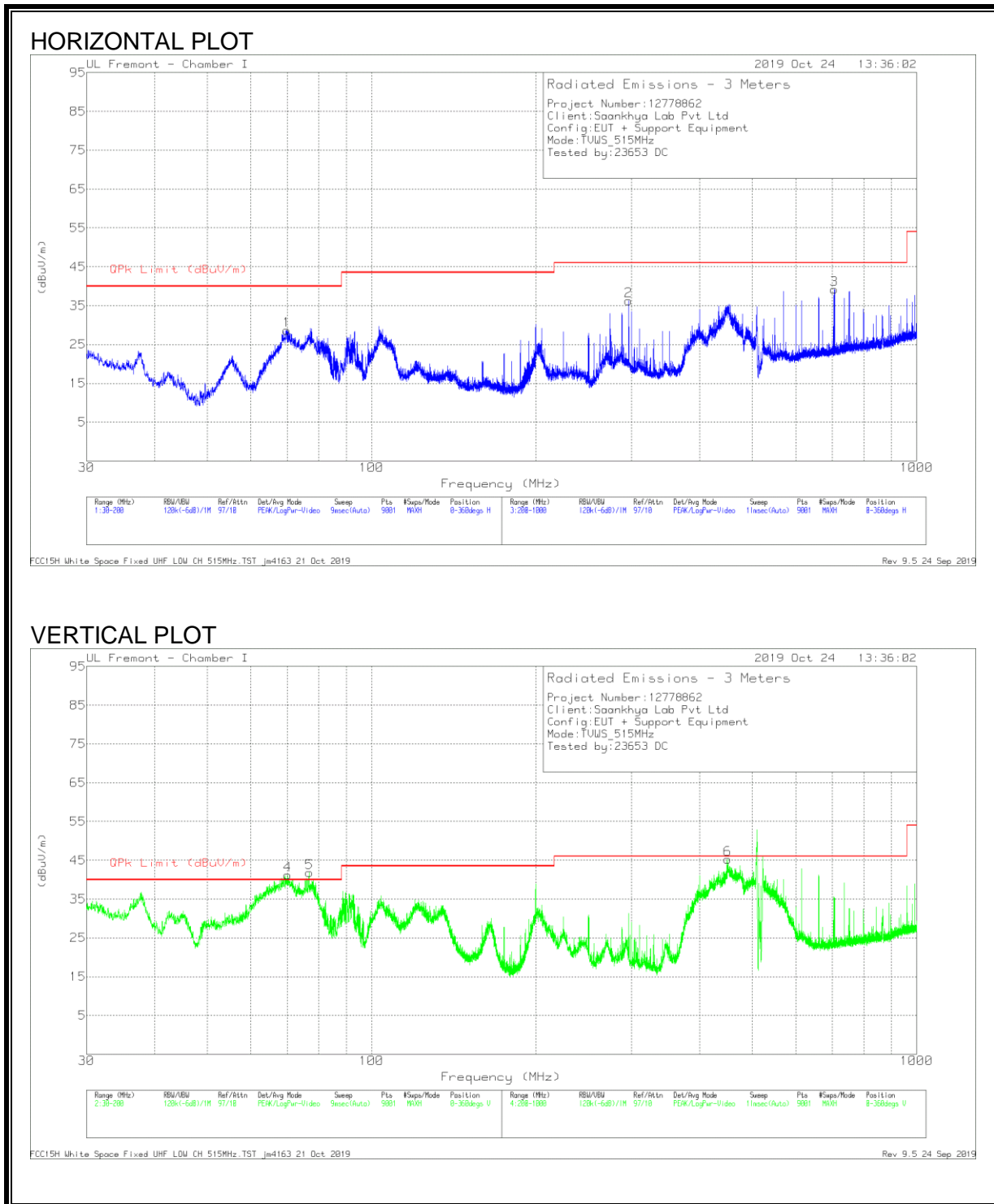
MID CHANNEL DATA

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	69.9502	45.61	Pk	13.9	-31	.1	28.61	40	-11.39	0-360	399	H
4	70.2336	58.26	Pk	13.9	-31	.1	41.26	-	-	0-360	102	V
5	76.9392	59.08	Pk	13.7	-31	.1	41.88	-	-	0-360	102	V
2	296.3557	46.94	Pk	19.2	-30	.1	36.24	46	-9.76	0-360	102	H
3	706.7562	41.87	Pk	26.1	-28.9	.1	39.17	46	-6.83	0-360	102	H
6	450.4892	51.83	Pk	22.7	-29.4	.1	45.23	46	-.77	0-360	300	V

Pk - Peak detector
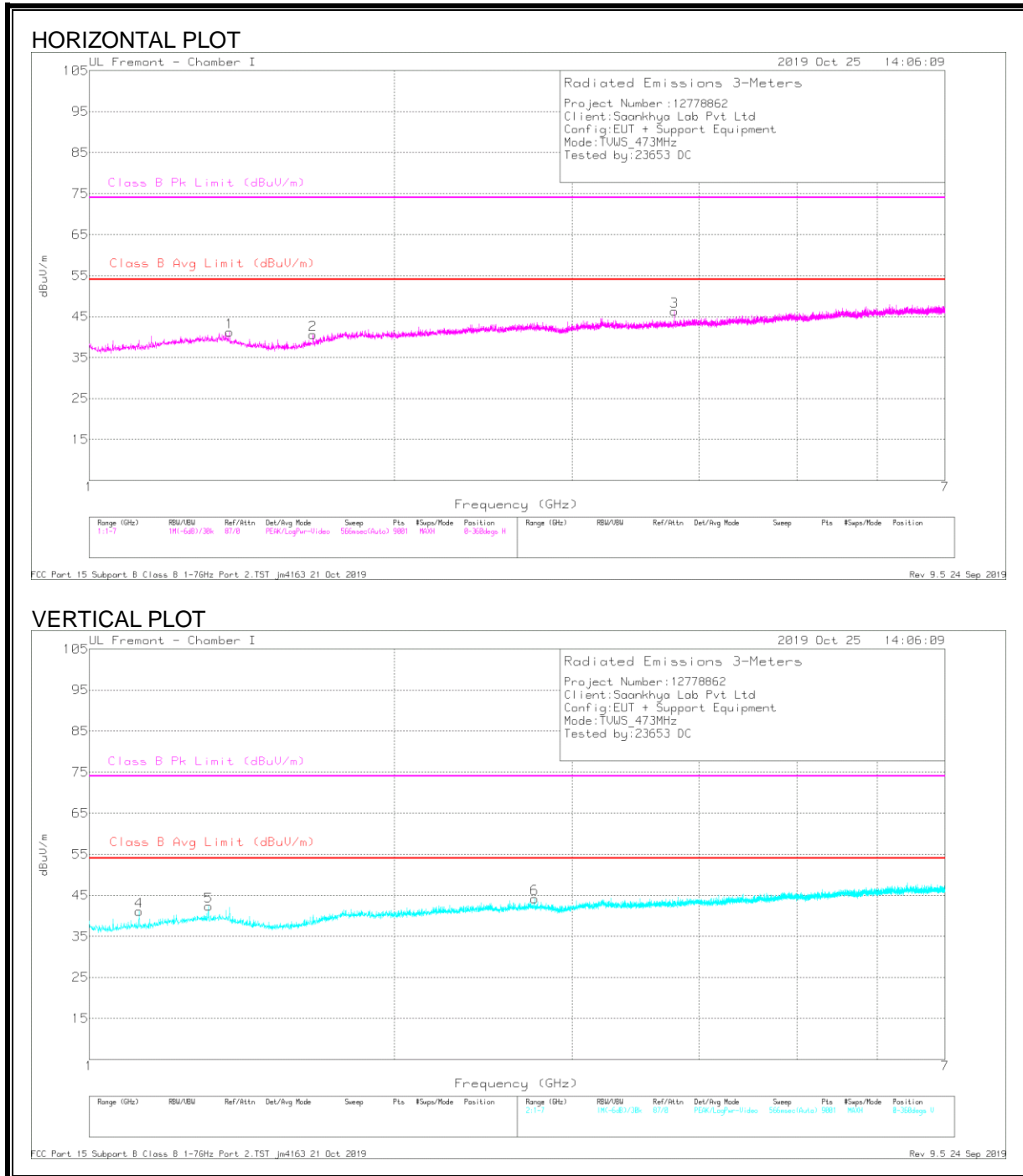
Radiated Emissions

Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
70.2816	52.85	Qp	13.9	-31	.1	35.85	40	-4.15	158	121	V
77.2019	52.39	Qp	13.7	-31	.1	35.19	40	-4.81	280	100	V
450.0766	46.09	Qp	22.7	-29.4	.1	39.49	46	-6.51	157	103	V

Qp - Quasi-Peak detector

BEYOND ADJACENT CHANNEL (HIGH CHANNEL)

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HIGH CHANNEL DATA

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	71.1214	44.83	Pk	13.9	-30.9	.2	28.03	40	-11.97	0-360	399	H
2	108.9938	43.87	Pk	18.3	-30.9	.2	31.47	43.5	-12.03	0-360	298	H
4	72.7836	57.49	Pk	13.9	-31	.2	40.59	-	-	0-360	102	V
5	123.2172	54.71	Pk	19.6	-30.7	.2	43.81	-	-	0-360	202	V
3	706.8451	41.15	Pk	26.1	-28.9	.2	38.55	46	-7.45	0-360	101	H
6	615.5561	45.75	Pk	24.9	-29.2	.2	41.65	46	-4.35	0-360	101	V
7	578.0449	41.02	Pk	24.5	-29.1	.2	36.62	46	-9.38	0-360	201	V
8	596.0005	41.9	Pk	24.2	-29.1	.2	37.2	46	-8.8	0-360	201	V

Pk - Peak detector

Radiated Emissions

Frequency (MHz)	Meter Reading (dBuV)	Det	AF PRE0184971 (dB/m)	Amp Cbl (dB)	Fltr (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
72.9165	52.52	Qp	13.9	-31	.2	35.62	40	-4.38	210	126	V
122.9665	50.42	Qp	19.6	-30.7	.2	39.52	43.5	-3.98	194	177	V
615.6031	44.62	Qp	24.9	-29.2	.2	40.52	46	-5.48	49	224	V
577.9366	39.36	Qp	24.5	-29.2	.2	34.86	46	-11.14	232	168	V
595.79	37.68	Qp	24.2	-29.1	.2	32.98	46	-13.02	214	168	V

Qp - Quasi-Peak detector

10.2. TRANSMITTER ABOVE 1GHz

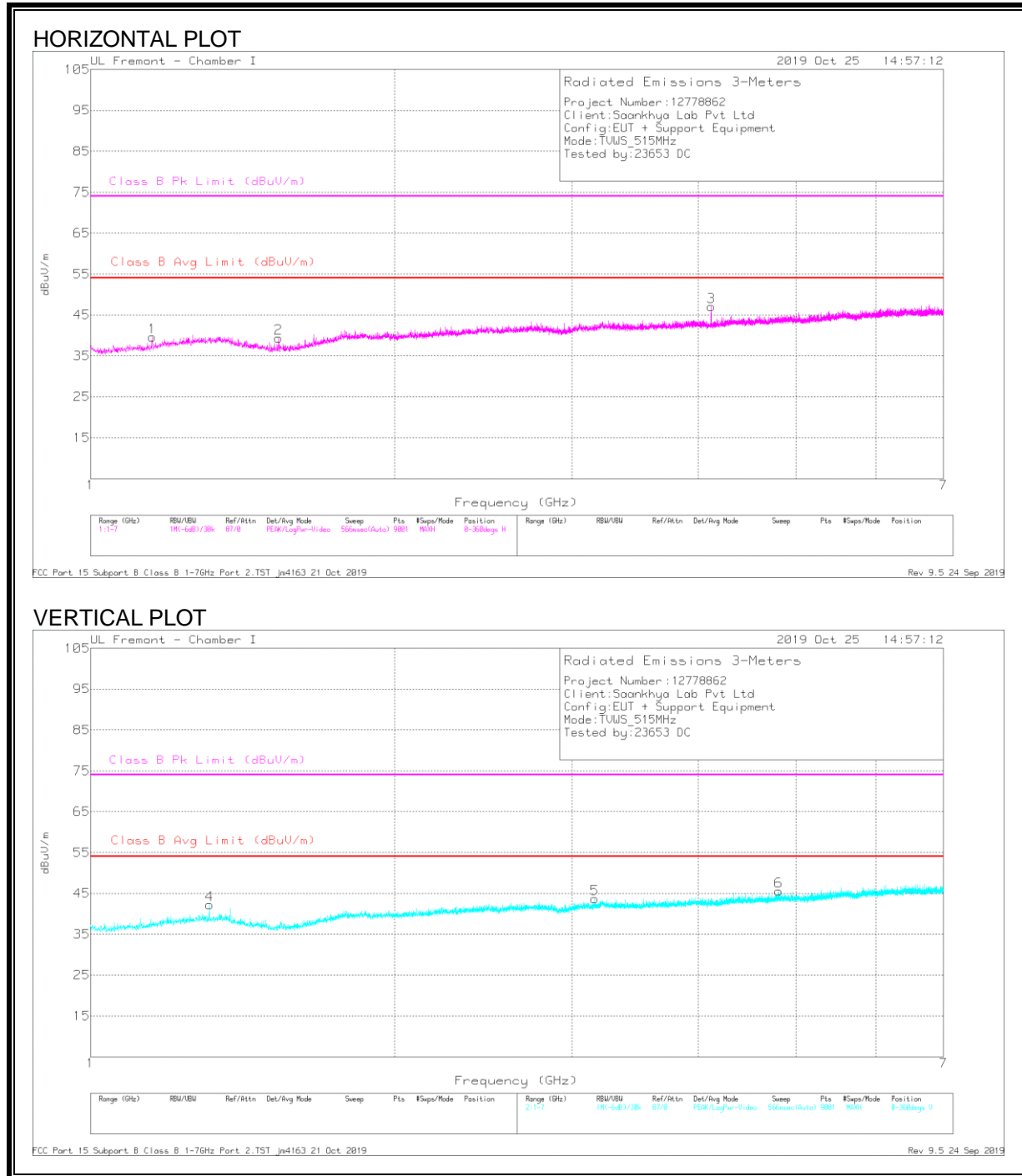### 10.2.1. HARMONICS AND SPURIOUS EMISSIONS IN THE UHF BAND

<u>LOW CHANNEL</u>

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LOW CHANNEL DATA

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T862 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading dBuV/m	Class B Avg Limit (dBuV/m)	Av Margin (dB)	Class B Pk Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1.37594	42.09	Pk	29.3	-21	50.39	-	-	74	-23.61	105	111	H
1.37581	29.81	Av	29.3	-21	38.11	54	-15.89	-	-	105	111	H
1.66407	41.28	Pk	28.7	-20.6	49.38	-	-	74	-24.62	76	202	H
1.66442	27.87	Av	28.7	-20.6	35.97	54	-18.03	-	-	76	202	H
3.78381	39.96	Pk	33	-17.8	55.16	-	-	74	-18.84	9	110	H
3.78405	29.88	Av	33	-17.8	45.08	54	-8.92	-	-	9	110	H
1.11982	41.83	Pk	27.7	-21.4	48.13	-	-	74	-25.87	234	152	V
1.12	30.02	Av	27.7	-21.4	36.32	54	-17.68	-	-	234	152	V
1.31121	41.31	Pk	29.4	-20.7	50.01	-	-	74	-23.99	59	362	V
1.31228	27.34	Av	29.3	-20.7	35.94	54	-18.06	-	-	59	362	V
2.75181	38.75	Pk	32.5	-19.1	52.15	-	-	74	-21.85	189	138	V
2.75446	25.15	Av	32.5	-19.1	38.55	54	-15.45	-	-	189	138	V

Pk - Peak detector

Av - Average detection

MID CHANNEL

HORIZONTAL PLOT

VERTICAL PLOT

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MID CHANNEL DATA

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T862 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading dBuV/m	Class B Avg Limit (dBuV/m)	Av Margin (dB)	Class B Pk Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1.1521	42.33	Pk	27.6	-21.1	48.83	-	-	74	-25.17	53	136	H
1.15189	31.45	Av	27.6	-21.1	37.95	54	-16.05	-	-	53	136	H
1.53575	41.6	Pk	28.1	-21.6	48.1	-	-	74	-25.9	67	168	H
1.53588	30.54	Av	28.1	-21.6	37.04	54	-16.96	-	-	67	168	H
4.12003	39.5	Pk	33.3	-18.2	54.6	-	-	74	-19.4	96	193	H
4.11992	29.81	Av	33.3	-18.2	44.91	54	-9.09	-	-	96	193	H
1.31202	40.97	Pk	29.3	-20.7	49.57	-	-	74	-24.43	233	118	V
1.31209	28.36	Av	29.3	-20.7	36.96	54	-17.04	-	-	233	118	V
3.15805	38.1	Pk	32.7	-19.1	51.7	-	-	74	-22.3	171	368	V
3.15955	24.84	Av	32.7	-19.1	38.44	54	-15.56	-	-	171	368	V
4.80762	36.54	Pk	34.2	-16.4	54.34	-	-	74	-19.66	25	107	V
4.80711	22.74	Av	34.2	-16.4	40.54	54	-13.46	-	-	25	107	V

Pk - Peak detector

Av - Average detection

HIGH CHANNEL

HORIZONTAL PLOT

VERTICAL PLOT

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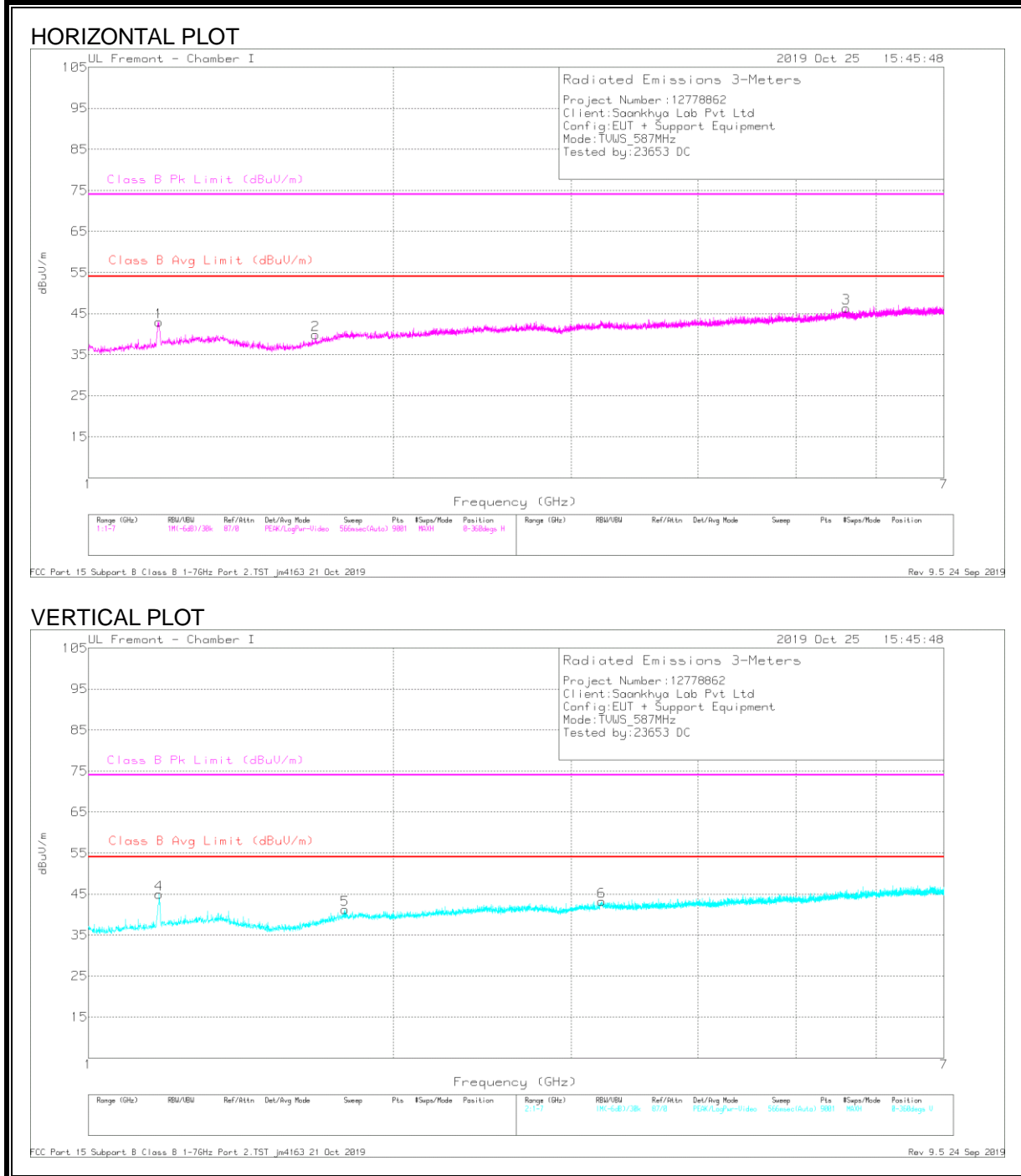
HIGH CHANNEL DATA

Radiated Emissions

Frequency (GHz)	Meter Reading (dBuV)	Det	AF T862 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading dBuV/m	Class B Avg Limit (dBuV/m)	Av Margin (dB)	Class B Pk Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1.17347	49.76	Pk	27.7	-20.9	56.56	-	-	74	-17.44	65	116	H
1.17326	32.98	Av	27.7	-20.9	39.78	54	-14.22	-	-	65	116	H
1.67496	39.68	Pk	28.9	-20.5	48.08	-	-	74	-25.92	18	318	H
1.67639	26.27	Av	28.9	-20.5	34.67	54	-19.33	-	-	18	318	H
5.60486	35.93	Pk	35.2	-16.6	54.53	-	-	74	-19.47	287	216	H
5.60564	22.74	Av	35.2	-16.6	41.34	54	-12.66	-	-	287	216	H
1.17343	49.93	Pk	27.7	-20.9	56.73	-	-	74	-17.27	301	117	V
1.17339	33.09	Av	27.7	-20.9	39.89	54	-14.11	-	-	301	117	V
1.79163	40.01	Pk	30.4	-20.1	50.31	-	-	74	-23.69	255	107	V
1.79185	27.29	Av	30.4	-20.1	37.59	54	-16.41	-	-	255	107	V
3.21471	37.94	Pk	33.5	-18.7	52.74	-	-	74	-21.26	95	391	V
3.21792	24.5	Av	33.4	-18.8	39.1	54	-14.9	-	-	95	391	V

Pk - Peak detector

Av - Average detection

11.   AC MAINS LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

Frequency range	Limits (dBµV)	
(MHz)	Quasi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50
*Decreases with the Logarithm of the frequency		

TEST PROCEDURE

ANSI C63.10-2013.

Line conducted data is recorded for both NEUTRAL and HOT lines.

11.1. UHF MODE

11.1.1. LINE 1 TX RESULTS
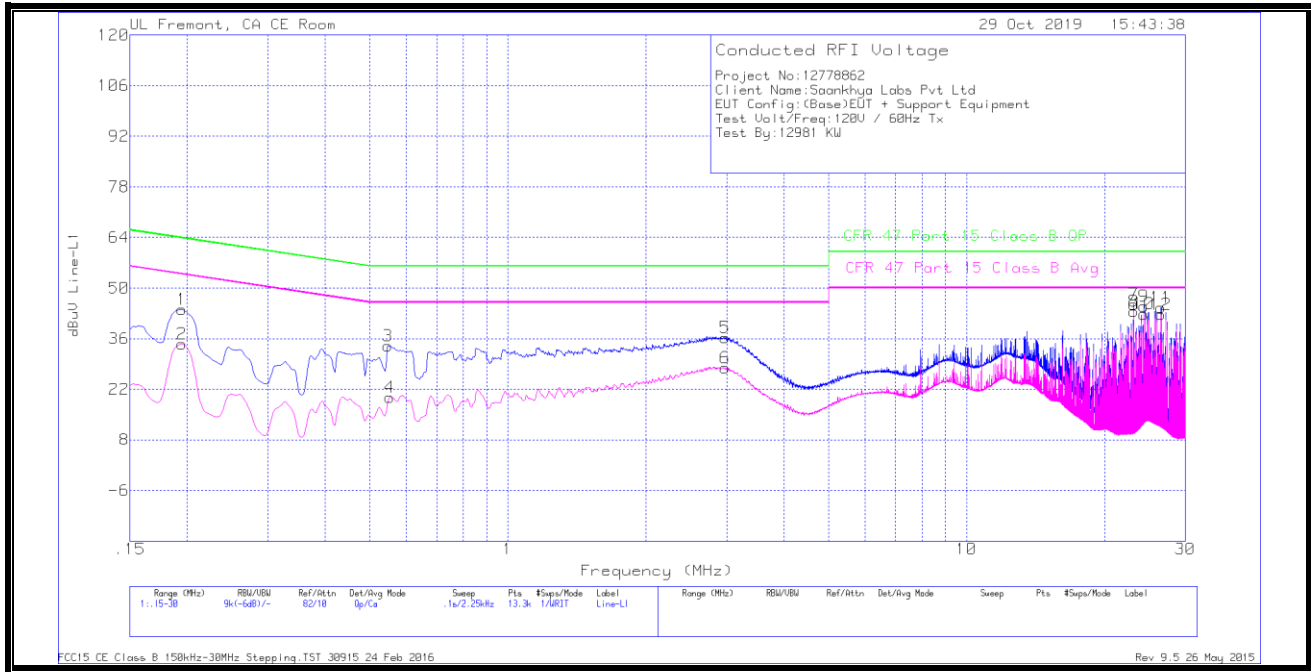
DATA

	Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables C1&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
1	.195	34.04	Qp	0	0	10.1	44.14	63.82	-19.68	-	-
2	.195	24.42	Ca	0	0	10.1	34.52	-	-	53.82	-19.3
3	.54825	23.93	Qp	0	0	10.1	34.03	56	-21.97	-	-
4	.55275	9.69	Ca	0	0	10.1	19.79	-	-	46	-26.21
5	2.9715	26.09	Qp	0	.1	10.1	36.29	56	-19.71	-	-
6	2.9715	17.66	Ca	0	.1	10.1	27.86	-	-	46	-18.14
7	23.12925	34.7	Qp	.1	.3	10.4	45.5	60	-14.5	-	-
8	23.12925	32.74	Ca	.1	.3	10.4	43.54	-	-	50	-6.46
9	24.34875	34.05	Qp	.1	.3	10.5	44.95	60	-15.05	-	-
10	24.34875	31.89	Ca	.1	.3	10.5	42.79	-	-	50	-7.21
11	26.48625	33.7	Qp	.1	.3	10.5	44.6	60	-15.4	-	-
12	26.48625	31.82	Ca	.1	.3	10.5	42.72	-	-	50	-7.28

Qp - Quasi-Peak detector
Ca - CISPR average detection

11.1.2. LINE 2 TX RESULTS
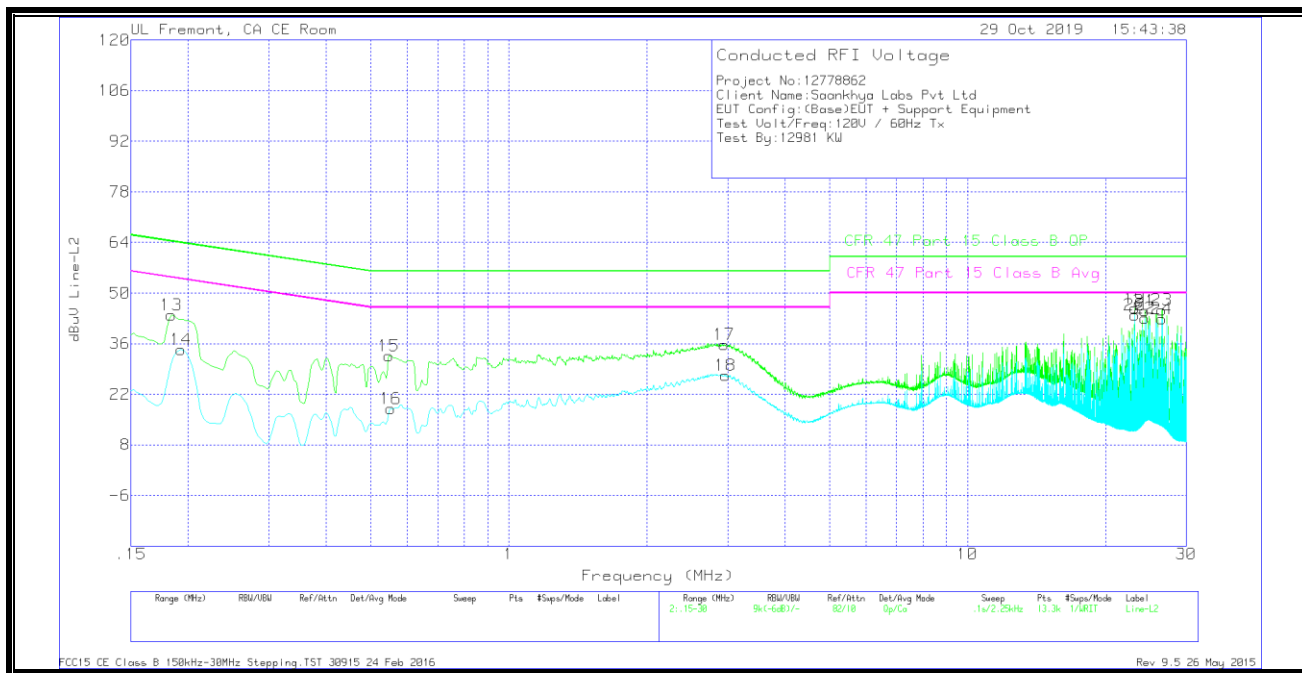
DATA

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L2	LC Cables C2&C3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR) Margin (dB)
13	.18375	33.89	Qp	0	0	10.1	43.99	64.31	-20.32	-	-
14	.19275	24.18	Ca	0	0	10.1	34.28	-	-	53.92	-19.64
15	.54825	22.59	Qp	0	0	10.1	32.69	56	-23.31	-	-
16	.55275	7.9	Ca	0	0	10.1	18	-	-	46	-28
17	2.949	25.5	Qp	0	.1	10.1	35.7	56	-20.3	-	-
18	2.96925	17.07	Ca	0	.1	10.1	27.27	-	-	46	-18.73
19	23.12925	35.04	Qp	.1	.3	10.4	45.84	60	-14.16	-	-
20	23.12925	33.07	Ca	.1	.3	10.4	43.87	-	-	50	-6.13
21	24.34875	34.3	Qp	.1	.3	10.5	45.2	60	-14.8	-	-
22	24.34875	32.16	Ca	.1	.3	10.5	43.06	-	-	50	-6.94
23	26.48625	34.37	Qp	.1	.3	10.5	45.27	60	-14.73	-	-
24	26.48625	31.98	Ca	.1	.3	10.5	42.88	-	-	50	-7.12

Qp - Quasi-Peak detector
Ca - CISPR average detection

12. FIXED BASE STATION DATABASE CERTIFICATION TESTS

The test requirements were done on the base connected to DB through TVWS application on Host PC and on client connected to DB through the base. The TVWS application acts as a proxy relaying messages from the base to the WSDB server.

12.1. 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**

- The Base Station is provisioned using an TVWS application via the Internet at the operator facility. During the course of provisioning a common available channel between the base and the client is selected as the initial transmitting channel by the base. This channel will be the initial "listening" channel for the Remote Station

Provisioned Base Unit
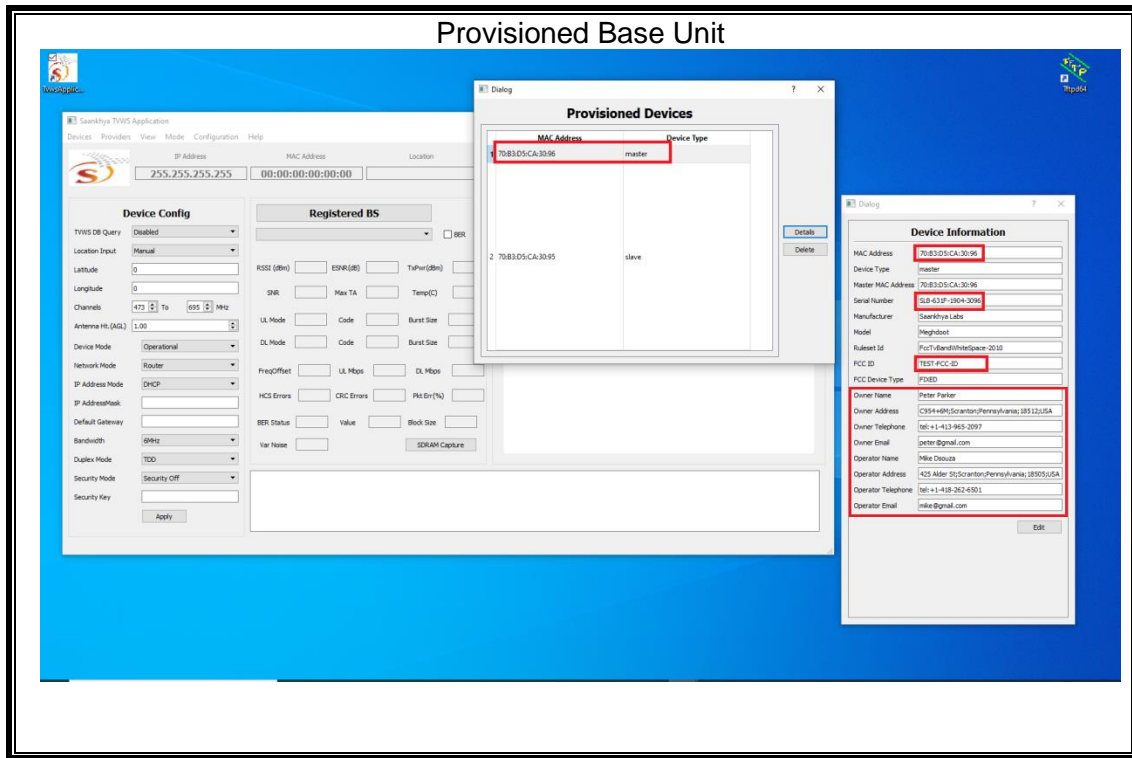
12.1.1. SUCCESSFUL REGISTRATION

TEST PROCEDURE

- Configure the base EUT with correct registration information:

    - The FCC ID and serial number are permanently programmed to the device and cannot be modified.
    - 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 base 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**
⊠	☐	16080ZS	10/25/19

Successful Device Registration with Database

Channel selection from Database with successful registration

Active Signal on Selected on Channel(27) 551MHz

12.1.2.   FAILED REGISTRATION – Location Coordinates

TEST PROCEDURE

- Configure the EUT with restricted coordinates: LAT=40° 34' 18.9264" (40.571924), LNG=-130° 0' 0" (-130) 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**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/25/19

Failed Registration EUT provides no channels and reboots

No channel transmission on EUT registration failure

Agilent 14:44:12 Oct 22, 2019   L

APv10.3(092019),12981 KW,

Ref 23 dBm   #Atten 30 dB

#Avg
Log
10
dB/
Offst
20.3
dB

PAvg

Center 551.000 MHz   Span 10 MHz

#Res BW 100 kHz   #VBW 300 kHz   #Sweep 600 ms (601 pts)

Channel Power

−36.40 dBm /6.0000 MHz

Power Spectral Density

−104.19 dBm/Hz

12.1.3. 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 could not be configured using TVWS Application with antenna AGL above the 30 meter limit hence registration with antenna height >30m AGL was not allowed

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/22/19

Antenna AGL > 30m

- EUT registration cannot happen without provisioning through the TVWS application (refer Theory of Operations)
- TVWS application does not allow number >30m AGL to be entered.

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12.1.4.   FAILED REGISTRATION –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

TVWS Software didn't proceed with provisioning when contact information fields are missing.
Base station does not proceed with registration without the provisioning information.

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/25/19

Contact information missing field

- EUT registration cannot happen without provisioning through the TVWS application (refer Theory of Operations)
- TVWS application does not allow provisioning with missing contact information field

Contact information missing field – registration failure
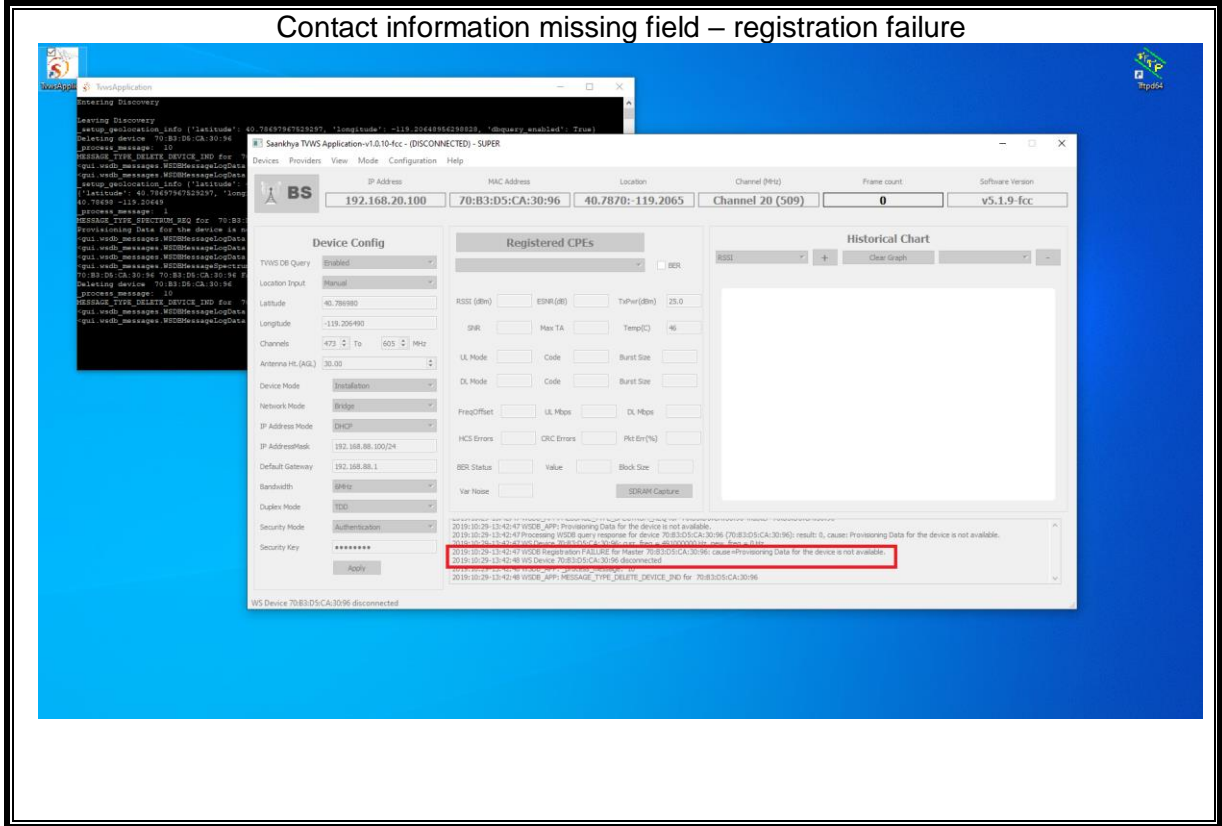
12.2. FIXED WSD CHANNELS OF OPERATION

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 base EUT 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 configured location for channel list request. The registered location will be established using GPS at installation time by a professional installer and re-acquires the new coordinates with included GPS receiver on sub-sequent reboots

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/25/19

Channel list after successful registration (before reboot)

Channel Selected after successful registration (after reboot)

- Device stores the last location co-ordinates and channel selected by the user
- After reboot the device doesn't prompt user to select the channel from the list given by the database but selects the last used channel
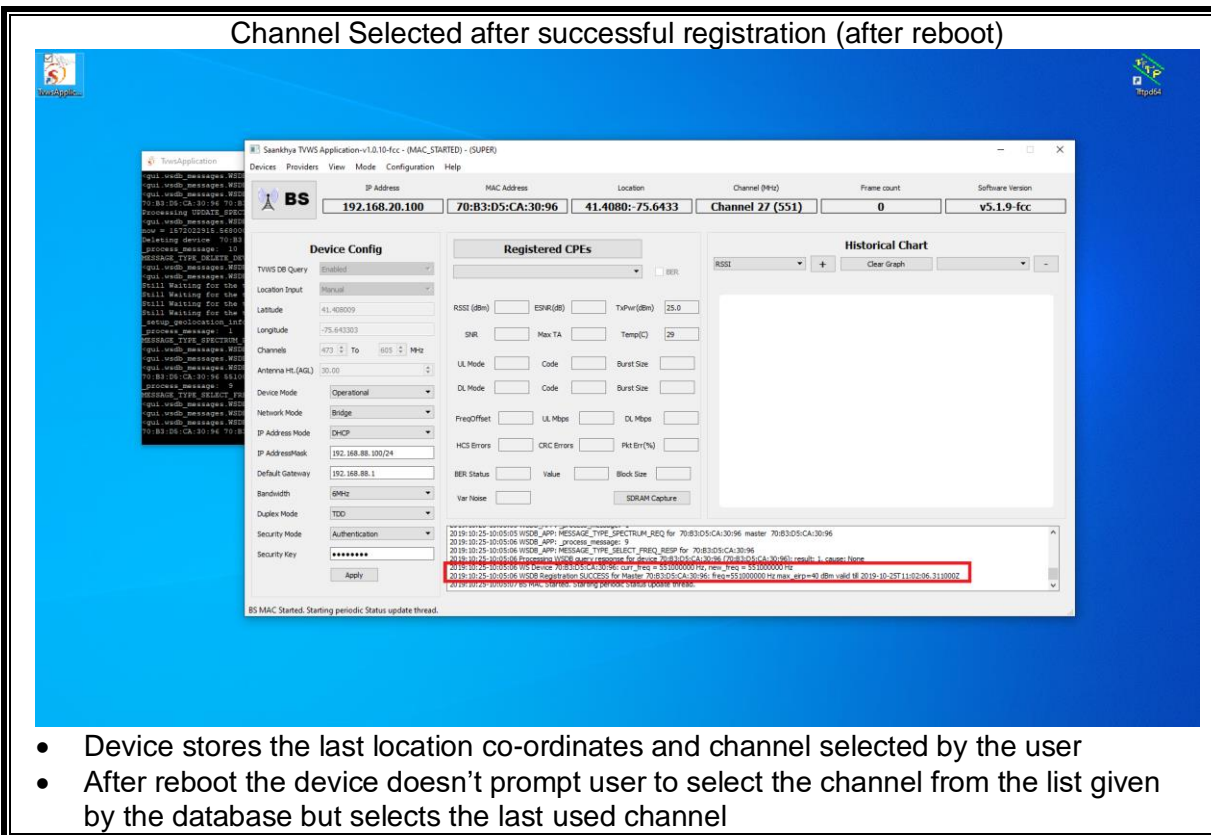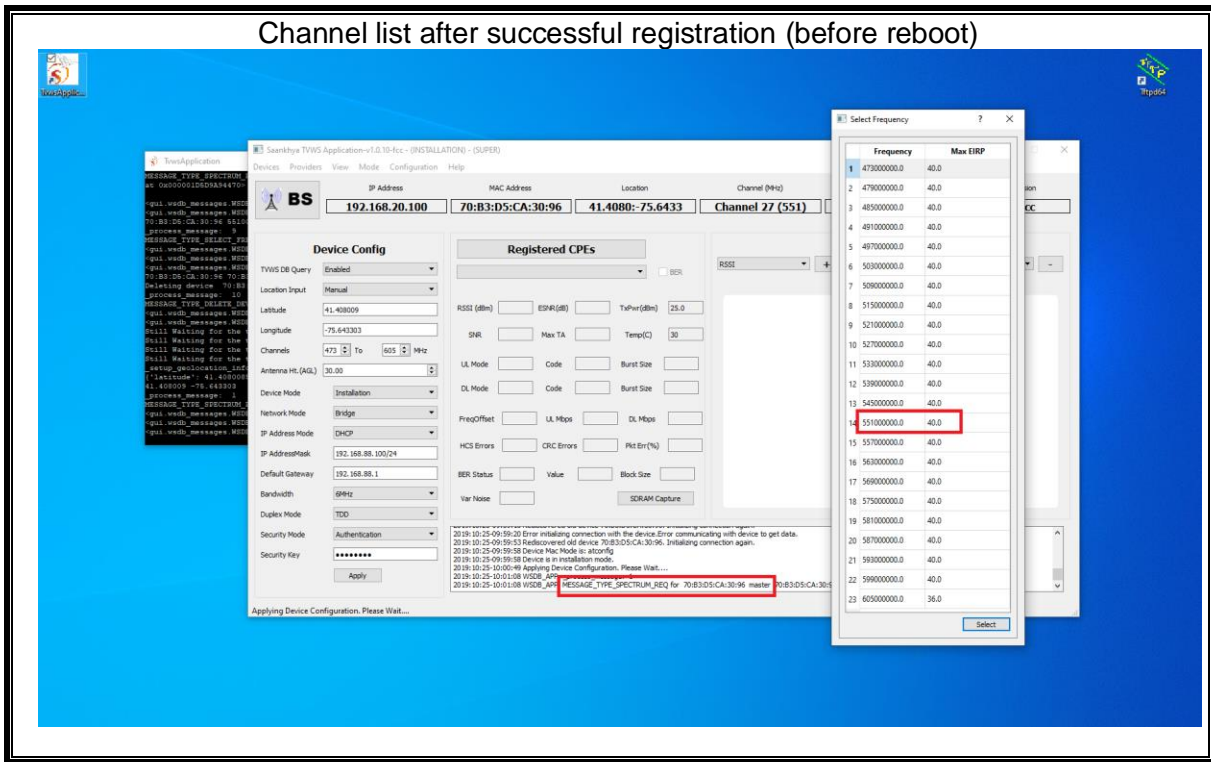
12.3.   FIXED TVDB DATABASE UPDATE

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:
    - Enter proper registration information on the base.
    - Base contacts Database thru TVWS Application to perform registration.
    - Base contacts Database thru TVWS Application to retrieve channel list.
    - Select an operating channel from returned channel list.
    - 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 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**
☒	☐	16080ZS	10/22/19

Successful registration

Tx Confirmation

UL VERIFICATION SERVICES INC.
47173 BENICIA STREET, FREMONT, CA 94538, USA   TEL: (510) 319-4000   FAX: (510) 661-0888
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Internet blocked

Internet connection lost, EUT reboots and fails to register.

Tx Off Confirmation

Channel Power

−36.47 dBm /6.0000 MHz

Power Spectral Density

−104.25 dBm/Hz

12.4. 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 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.

Test Results			
Pass	Fail	Tested By	Test Date
☒	☐	16080ZS	10/22/19

RESULTS FOR BASE

Power transmission before scheduled event

Low power auxiliary device is registered

Scheduled event occurs, EUT reboots

Channel shutdown due to scheduled event
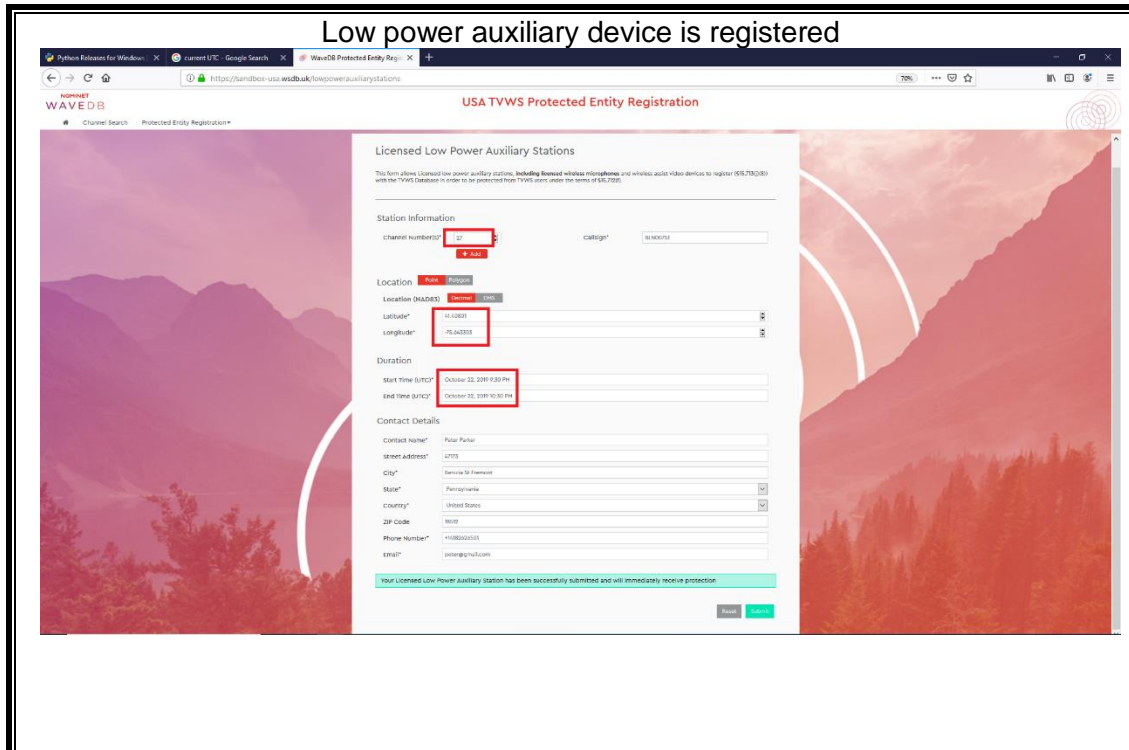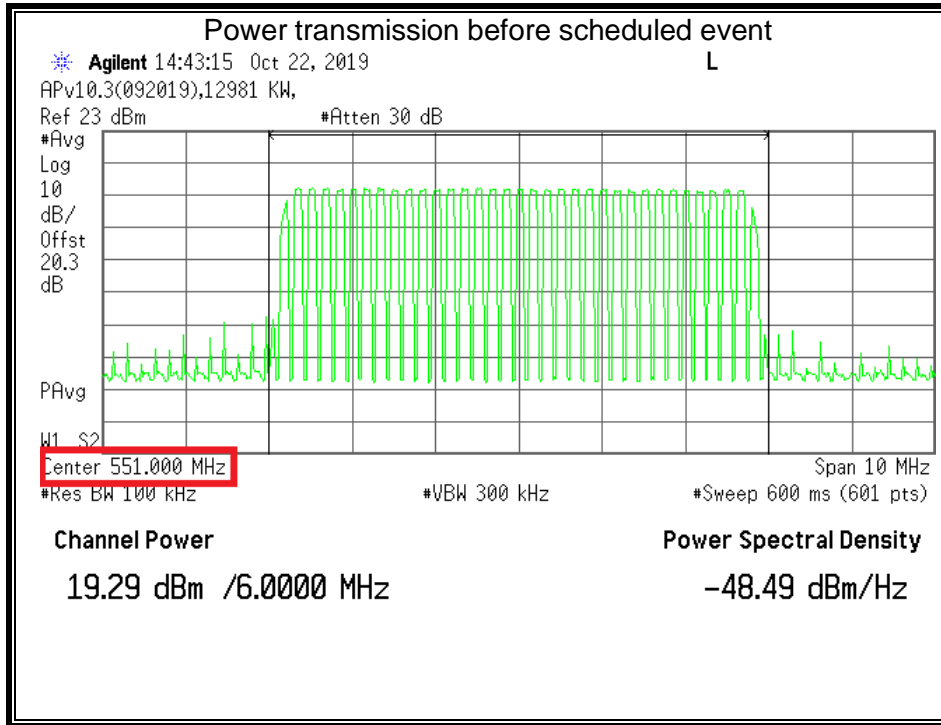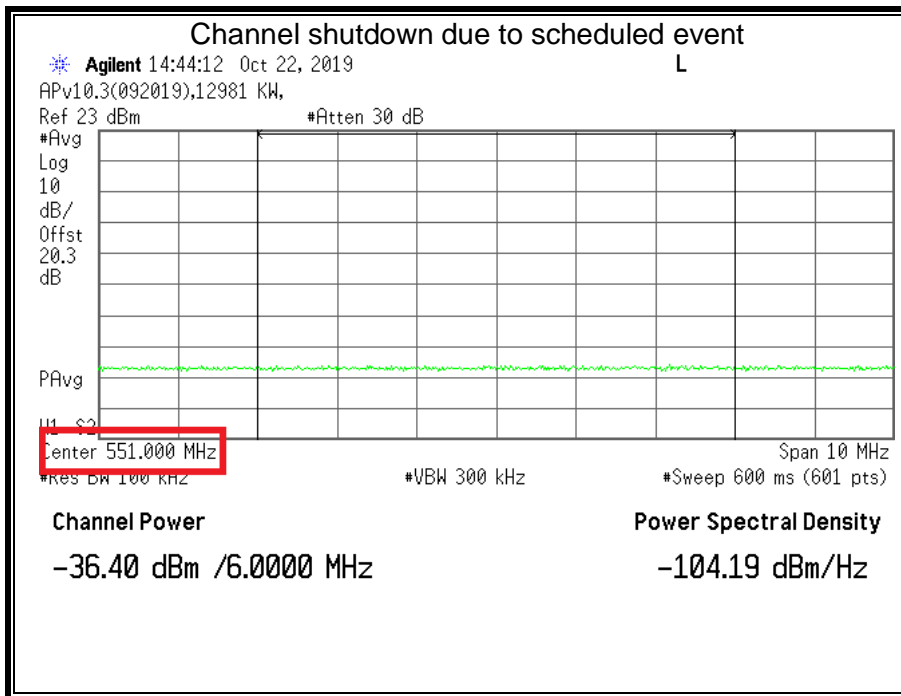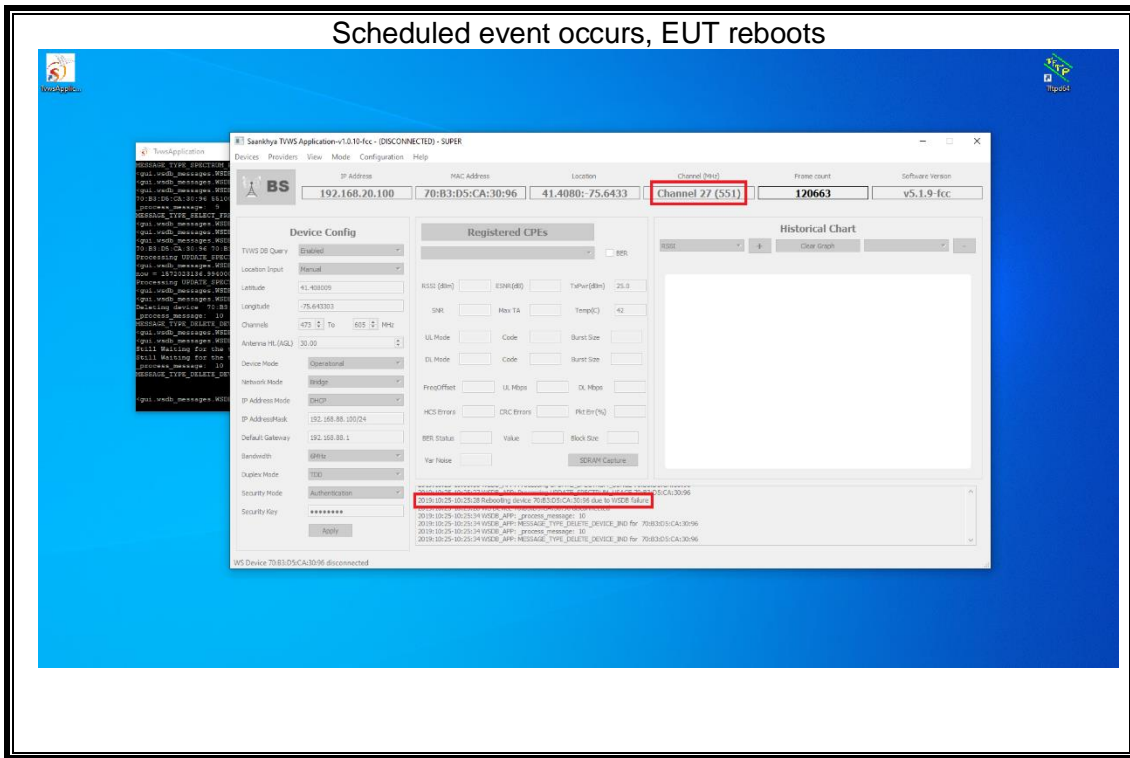
12.5.   WSD CHANNEL AVAILABILITY

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 Application
- TVWS Application contacts TVWS database to perform device registration
- Upon successful registration, base automatically contacts the TVWS Database to retrieve device channels through TVWS Application.
- 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 base EUT operates on a channel from the authorized channel list and at the authorized power level.
The base EUT cannot select or 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.

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/25/19

Channel Selection from Database

Successful Device Registration with Database
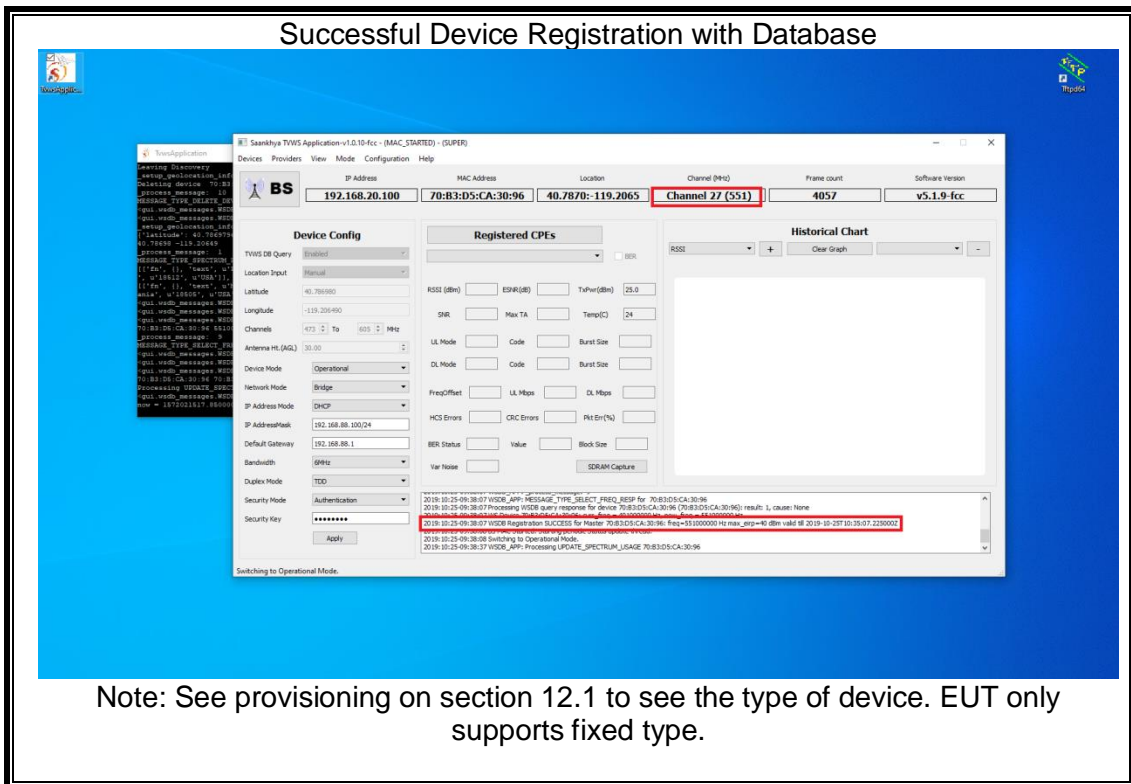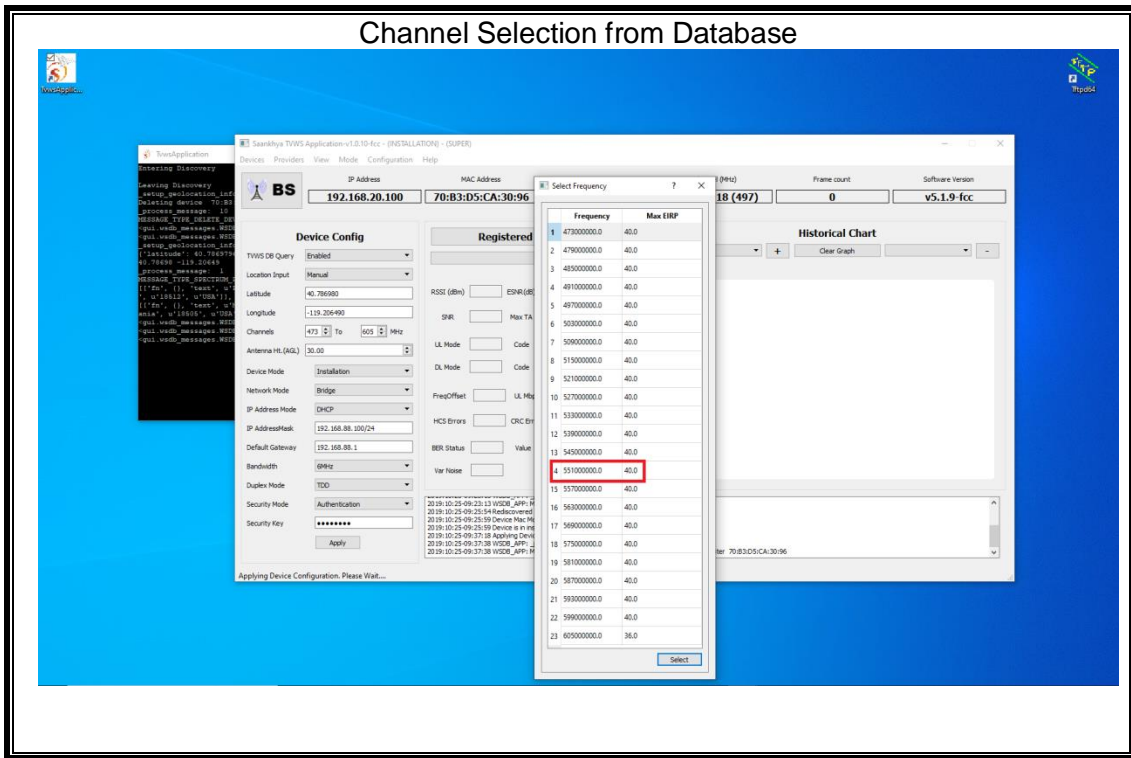
Note: See provisioning on section 12.1 to see the type of device. EUT only supports fixed type.

Power Transmission

Agilent 13:47:42 Oct 22, 2019   L
APv10.3(092019),12981 KW,
Ref 23 dBm   #Atten 30 dB
#Avg
Log
10
dB/
Offst
20.3
dB

PAvg

W1 S2
Center 551.000 MHz   Span 10 MHz
#Res BW 100 kHz   #VBW 300 kHz   #Sweep 600 ms (601 pts)

Channel Power   **Power Spectral Density**

   19.33 dBm /6.0000 MHz   −48.45 dBm/Hz
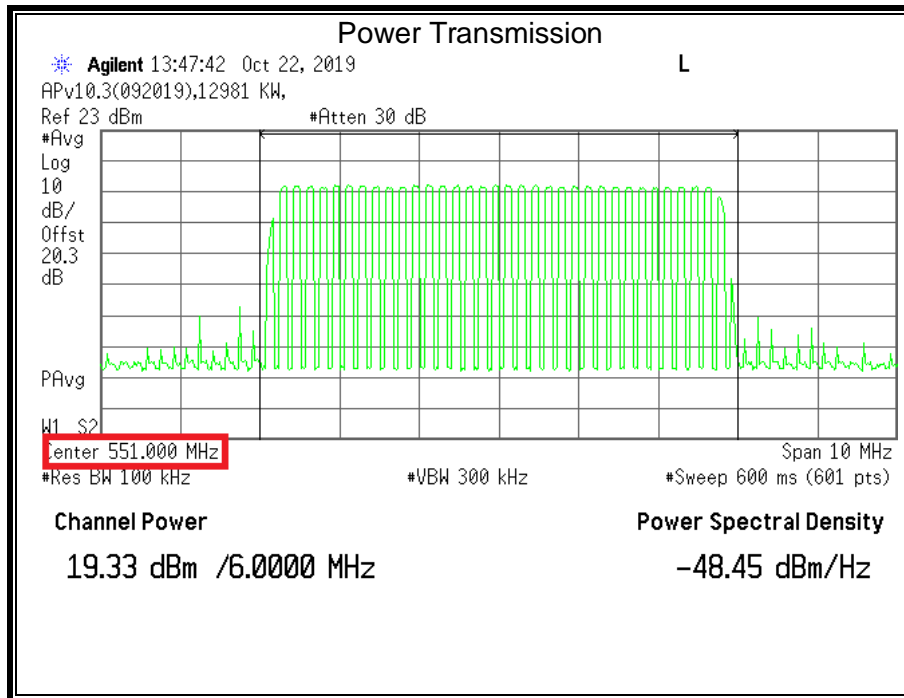
12.6.   SECURITY

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?
HTTPS is the communication protocol used between the database and the WSD

ii.   How are communications initiated?
The TV whitespace device will initiate the communication by sending available spectrum request. The details of the device included in the message helps WSDB server to uniquely identify the device and respond back with channels available for operation

iii.   How does the WSD validate messages from the database?
The TV white space device will first check for the HTTP response code. If the 200 code is not received, the device will continue to try again. If the 200 code is received, the device will proceed to check if the response from the database in correct XML format and if it is using the format that is specified by the database. As the communication is done using HTTPS protocol, the messages will be encrypted, hence it will ensure the confidentiality and integrity of data

iv.   How does the device handle failure to communicate or authenticate the database?
The device will stop its transmission immediately if it failed to communicate or authenticate with the database. This also results in rebooting of the device under certain circumstances

v.   How does the database validate messages from a WSD?
The database requires the WSD to be pre-enrolled before it will send any response to request. Hence, it will first check to see if device has been pre-enrolled. Next the database will validate the message received to see if it conforms to the specification of the request

definition on whether that field is mandatory or optional field. Lastly, it will validate the message content.

vi.   What encryption method is used?
TLS is used as a support layer to HTTPS, SSLV2

vii.   How does the database ensure secure registration of protected devices?
Protected devices are registered via a web form secured by HTTPS.

12.7. 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.

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/28/19

As per the waiver DA-19-960A1 issued by FCC on September 25, 2019, this test is waived till March 31, 2020 for base and client units

12.8.   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

EUT uses GPS technology for determining location.

12.9. 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
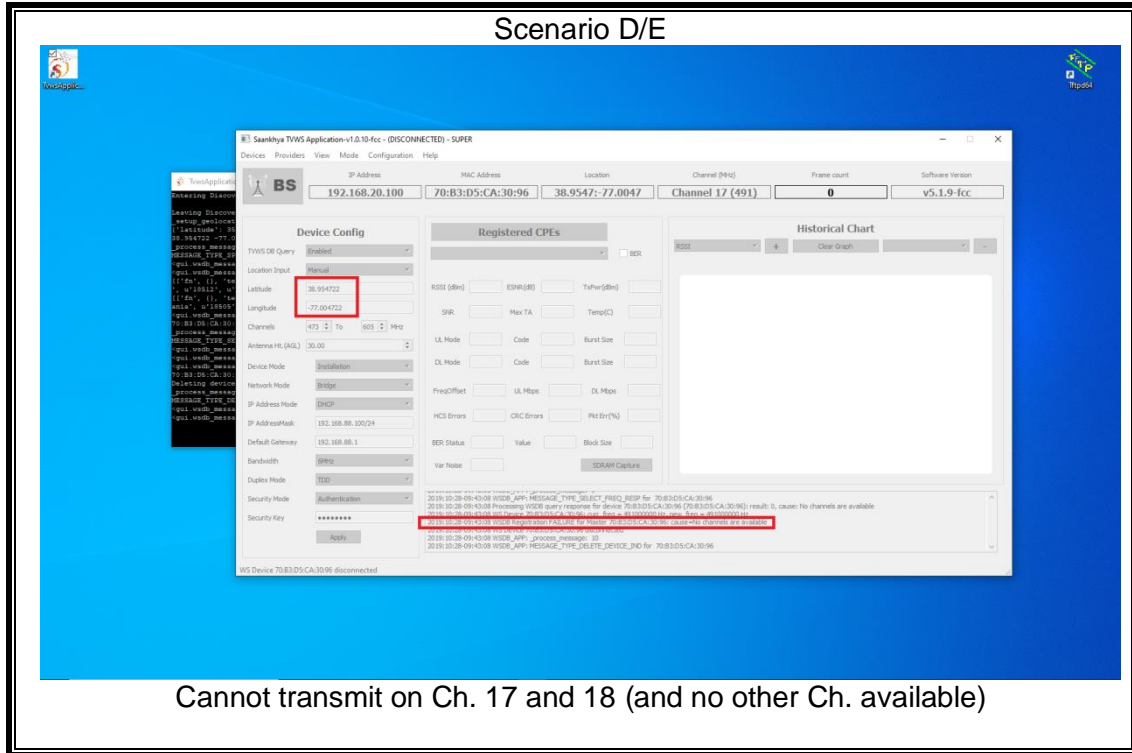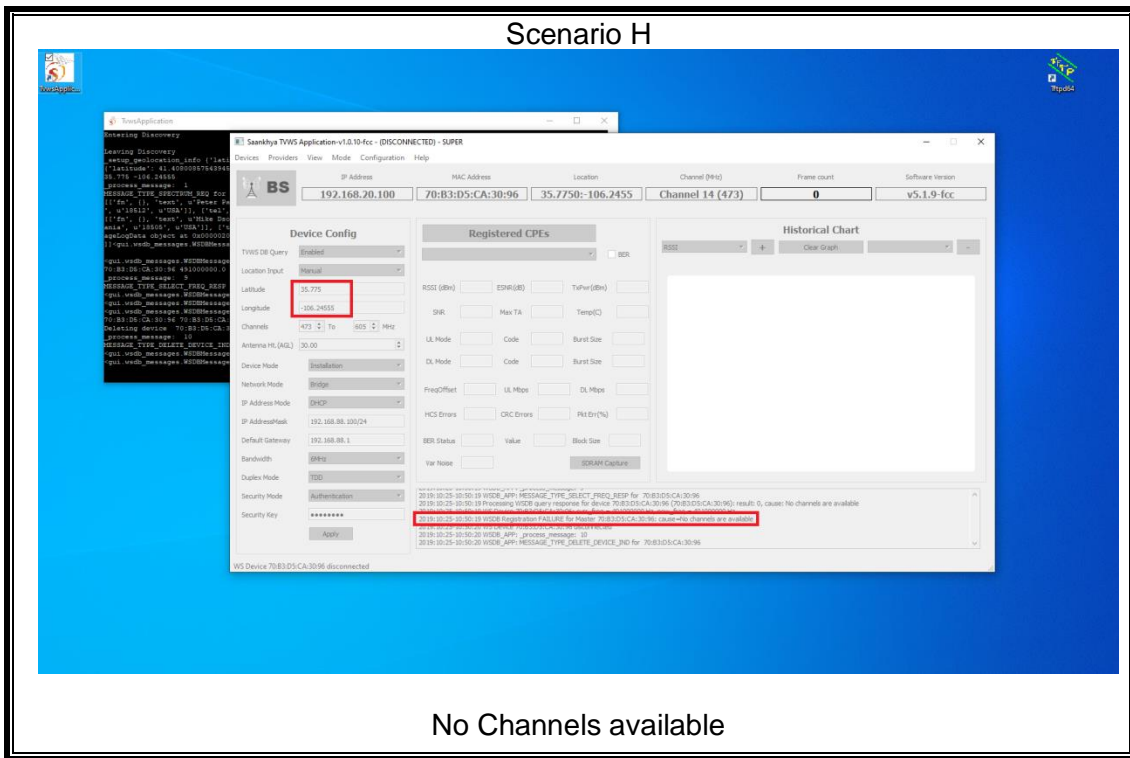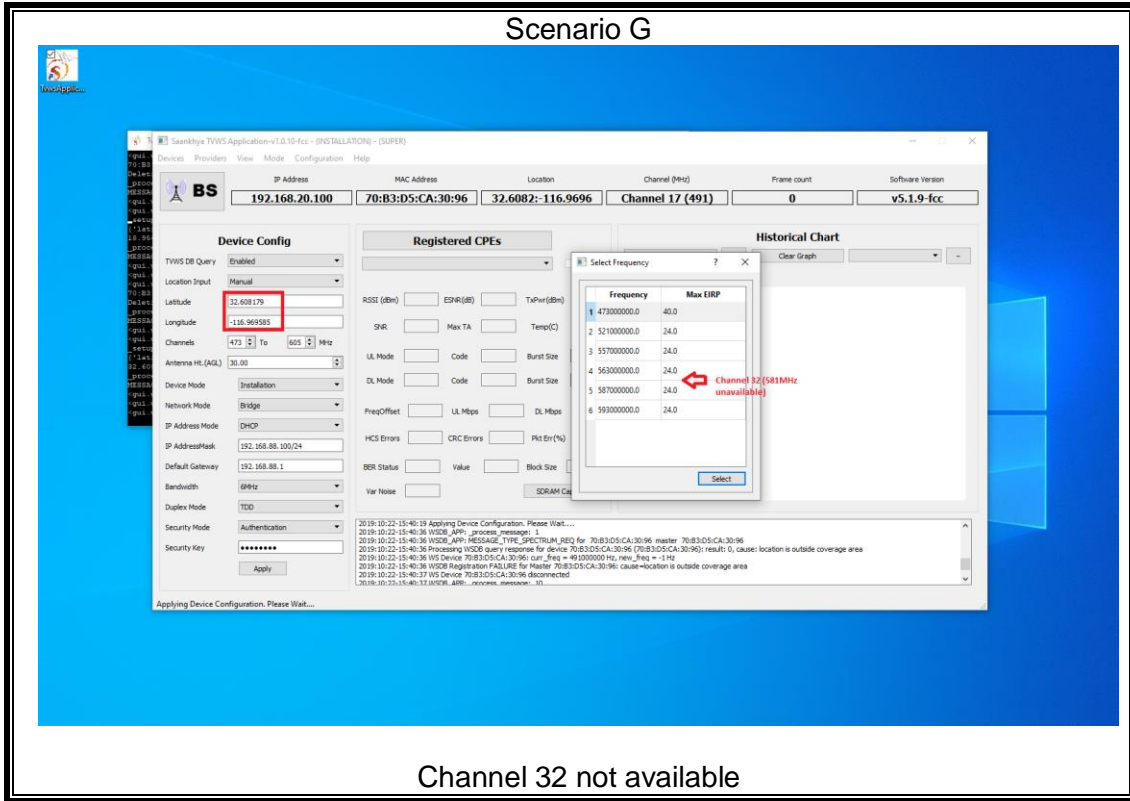- k) 488-494 MHz band in Hawaii

RESULTS

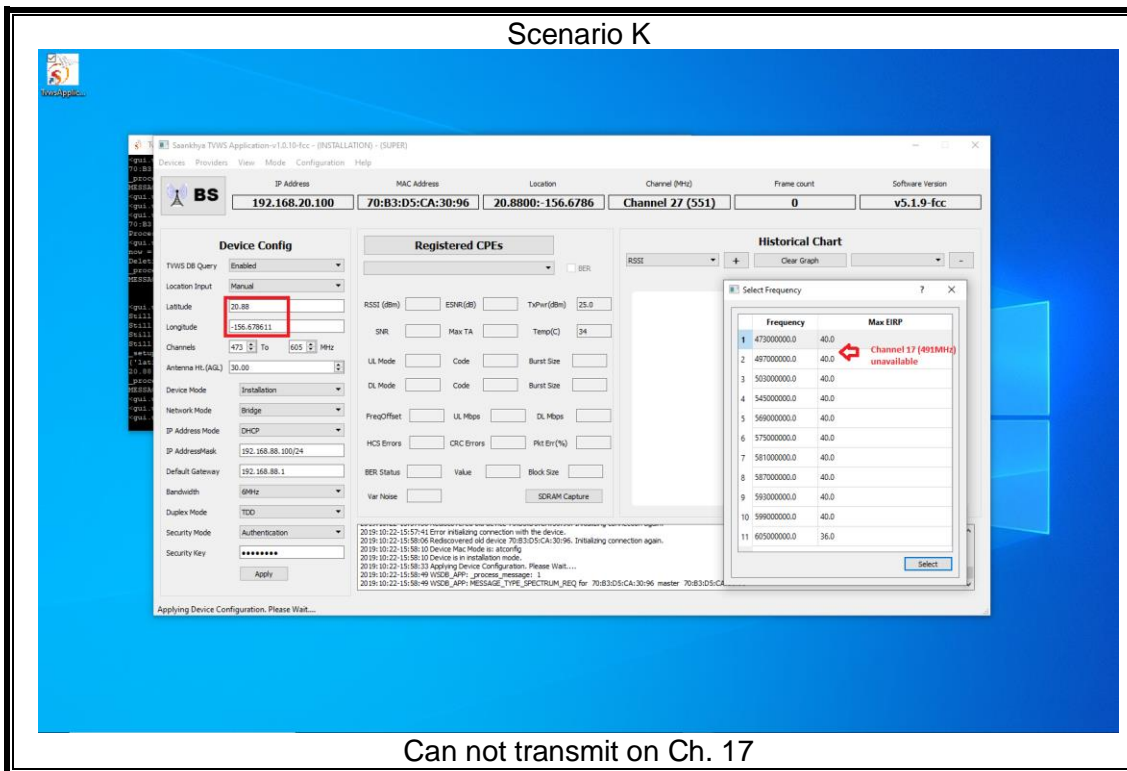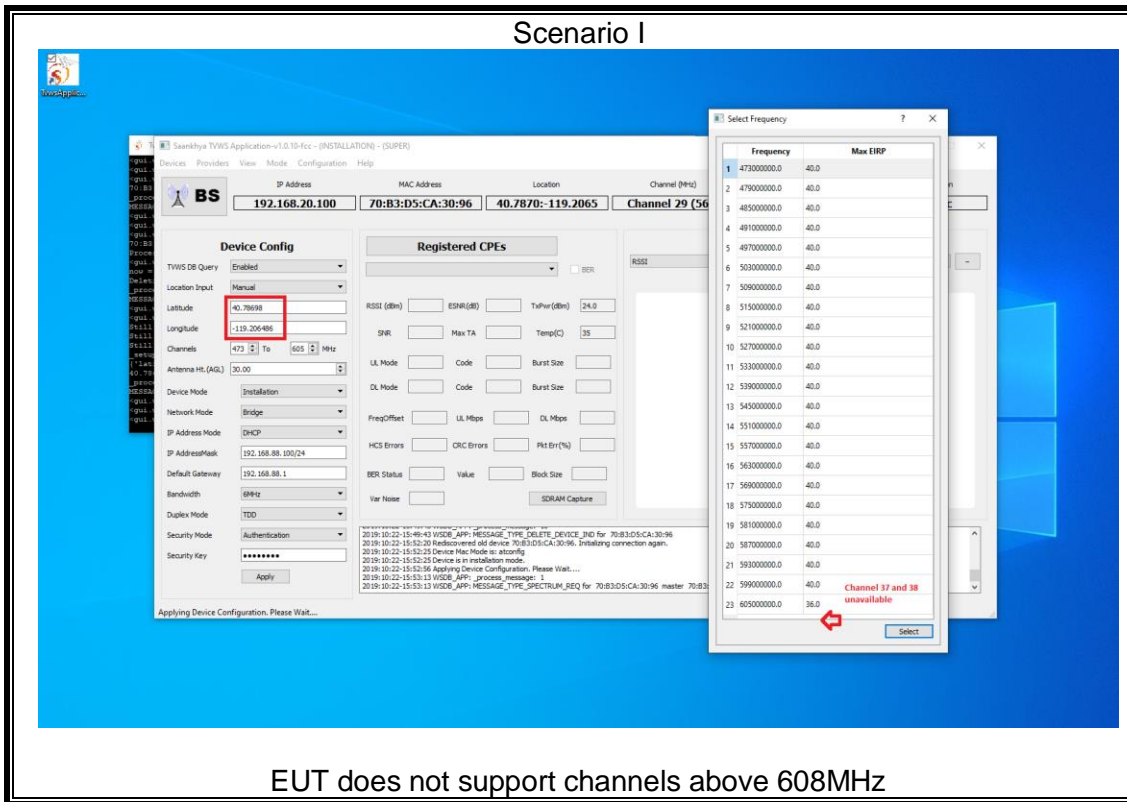|	Scenario	Coordinate	Note
a	Digital television stations, and digital and analog Class A TV, low power TV, TV translator and TV booster stations	35.775, -106.24555 (UHF)	UHF No transmission allowed
b	TV translator, Low power TV(including Class A) and Multi-channel Video Programming Distributor (MVPD)	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	38.954722, -77.004722	Cannot transmit on Ch. 17 and 18
e	Offshore Radio telephone Service	38.954722, -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

Test Results			
Pass	**Fail**	**Tested By**	**Test Date**
☒	☐	16080ZS	10/22/19

Scenario A UHF

No channels available for selection

Scenario B (UHF)

Cannot select channel 23

Scenario C

Channel 28 missing

Scenario C

No available channels from database (Cannot transmit on Ch. 28)

Scenario D/E

Cannot transmit on Ch. 17 and 18 (and no other Ch. available)

Scenario G
Channel 32 not available

Scenario H
No Channels available

Scenario I

EUT does not support channels above 608MHz

Scenario K

Can not transmit on Ch. 17

12.10. 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**
☒	☐	16080ZS	10/23/19

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Channel availability and maximum allowed Power level

Successful registration

TDD Mode - Power confirmation below max. allowed

Center 581.000 MHz

Channel Power

9.91 dBm

Power Spectral Density

−57.87 dBm/Hz

operation, the power
shown on Spectrum
Analyser is 6dB lower