TEST REPORT

Report Number. : 14160419-E7V3

Applicant	:	DISH TECHNOLOGIES LLC 90 INVERNESS CIRCLE EAST ENGLEWOOD, CO 80112, UNITED STATES
Model	:	D45
Brand	:	DISH
FCC ID	:	DKNHR44
EUT Description	:	TV SET TOP BOX
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C FCC 47 CFR PART 15 SUBPART E

Date Of Issue:
April 08, 2022

Prepared by:
UL VERIFICATION SERVICES
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

ACCREDITED
CERT #0751.05

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	3/17/2022	Initial Issue	---
V2	3/22/2022	Updated Section 6.6 radiated setup description table	Tina Chu
V3	4/8/2022	Added additional spot test data, updated Section 1, Section 6.2, 6.3, 6.6 and Section 8.	Tina Chu

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

TABLE OF CONTENTS

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: DISH TECHNOLOGIES LLC
90 INVERNESS CIRCLE EAST
ENGLEWOOD, CO 80112, UNITED STATES

EUT DESCRIPTION: TV SET TOP BOX

MODEL: D45

BRAND: DISH

SERIAL NUMBER: RADIATED: W54P6LB11

SAMPLE RECEIPT DATE: MARCH 03, 2022

DATE TESTED: MARCH 10, 2022, MARCH 23, 2022, APRIL 07, 2022

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
CFR 47 Part 15 Subpart E	Complies

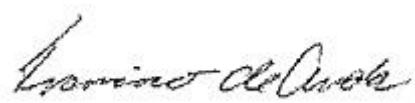
UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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 A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

Approved & Released For
UL Verification Services Inc. By:



Francisco deAnda
Staff Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:

Adrian Fong
Laboratory Engineer
Consumer Technology Division
UL Verification Services Inc.

Reviewed By:

Tina Chu
Senior Project Engineer
Consumer Technology Division
UL Verification Services Inc.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

2. TEST RESULT SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for the validity of results after the integration of the data provided by the customer.

Zigbee

FCC Clause	Requirement	Result	Comment
See Comment	Duty Cycle	Not performed	ANSI C63.10 Section 11.6.
-	99% OBW	Not performed	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	6dB BW	Not performed	None.
15.247 (b) (3)	Output Power	Not performed	None.
See Comment	Average power	Not performed	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	PSD	Not performed	None.
15.247 (d)	Conducted Spurious Emissions	Not performed	None.
15.209, 15.205	Radiated Emissions	Partial testing performed and complies	None.
15.207	AC Mains Conducted Emissions	Not performed	None.

UNII

FCC Clause	Requirement	Result	Comment
See Comment	Duty Cycle	Not performed	Per ANSI C63.10, Section 12.2.
See Comment	26dB BW/99% OBW	Not performed	Per ANSI C63.10 Sections 6.9.2 and 6.9.3
15.407 (e)	6 dB BW	Not performed	None.
15.407 (a) (1-3), (h) (1)	Output Power	Not performed	None.
15.407 (a) (1-3)	PSD	Not performed	None.
15.209, 15.205, 15.407 (b)	Radiated Emissions	Partial testing performed and complies	None.
15.207	AC Mains Conducted Emissions	Not performed	None.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with;

- FCC CFR 47 Part 2
- FCC CFR 47 Part 15
- KDB 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 662911 D01 v02r01,D03 v01
- FCC KDB 905462 D02 v02/D03 v01r02/D06 v02
- FCC KDB 789033 D02 v02r01,
- KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013
- KDB 484596 D01

4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building 1: 47173 Benicia Street, Fremont, CA 94538	US0104	2324A	550739
☐	Building 2: 47266 Benicia Street, Fremont, CA 94538	US0104	22541	550739
☒	Building 4: 47658 Kato Rd, Fremont, CA 94538	US0104	2324B	550739

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	U_{Lab}
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB

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

5.4. 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

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a TV Set Top Box with RF4CE Zigbee, BLE (1Mbps), BT and 5GHz 802.11a/n/ac/ax radios.

6.2. INTRODUCTION OF TEST DATA REUSE

This application for certification is leveraging the data reuse procedures from KDB 484596 D01 based on reference FCC ID: DKNRW33, to covers FCC ID: DKNHR44.

The major difference between two FCC IDs is FCC ID: DKNHR44 is using a new BT/BLE radio, all other circuitry and features are identical.

This report is to cover the Zigbee and UNII portion, where reference FCC ID Zigbee/UNII data is reused, colocation radiated emissions, Zigbee and UNII's previous FCC ID: DKNRW33 worst-case modes were performed on this FCC ID: DKNHR44 to ensure the testing remains compliant with new BT/BLE radio. See reference information as below.

Reference application that contains the reused reference data which is attached to this report in Appendix A.

Equipment Class	Reference FCC ID	Frequency Range	Reference Report	Report Title/Section
DTS	DKNRW33	2425 to 2475 MHz	13619076-E3V2	Zigbee Report / All sections
NII	DKNRW33	5180 to 5720 MHz	13619076-E4V3	UNII_802.11n_ac modes/All sections
NII	DKNRW33	5180 to 5720 MHz	13619076-E5V3	UNII_802.11ax/ All sections
NII	DKNRW33	5250-5350 MHz, 5470-5725 MHz	13619076-E8V2	UNII WLAN DFS/ All sections

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

6.3. SPOT CHECK VERIFICATION RESULTS SUMMARY

FCC ID: DKNHR44 SPOT CHECK RESULTS									
Technology	Mode	Test Item	Channel	Original model (Worst margin dB)		Spot check model (Worst margin dB)		Delta (dB)	
				D45		D45			
				DKNRW33		DKNHR44			
				H	V	H	V	H	V
Zigbee	250kbps, O-QPSK	RBE	High	-7.6	-8.37	-13.24	-12.89	-5.64	-4.52
UNII	802.11n HT40 CDD 3TX	RBE	High (Channel 62, 5310MHz)	-1.08	-0.51	-0.5	-1.22	0.58	-0.71
UNII	802.11ax HE80 OFDMA 3TX	RBE	Low (Channel 106, 5530MHz, 26T, index 0)	-1.53	-0.48	-2.29	-0.92	-0.76	-0.44
				Worst margin (dB)		Worst margin (dB)		Delta (dB)	
Zigbee	250kbps, O-QPSK	RSE	Mid	-6.28		-11.05		-4.77	
UNII	802.11n HT40 CDD 3TX	RSE	Low (Channel 151, 5755MHz)	-0.96		-2.81		-1.85	
UNII	802.11ax HE20 OFDMA 3TX	RSE	High (Channel 165, 5825MHz, 26T, index 8)	-0.1		-12.6		-12.5	
BT/Zigbee/UNII simultaneous RSE above 1G				-3.84		-3.11		0.73	

Comparison of the models, deviation is within 3dB range and all tests are under FCC Technical Limits.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

6.4. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

ZigBee uses a PCB Inverted F antenna, with a maximum gain of 4.1 dBi.

According to FCC KDB 662911 D03 v01, a measurement of directional gain of multi-antenna systems is allowed for compliance verification. Antenna gains are approved through manufacturers KDB. KDB reference can be found as part of the original certification.

EUT uses three antennas for 5GHz 3TX MIMO operation.The radio utilizes PCB Inverted F antennas. Below is total gain per operational band;

Frequency Band	Uncorrelated Total Gain	Correlated Total Gain
5.15 to 5.25 GHz	2.5	6.9
5.25 to 5.35 GHz	3.2	7.7
5.47 to 5.725 GHz	3.2	7.8
5.725 to 5.85 GHz	2.9	7.6

6.5. SOFTWARE AND FIRMWARE

ZigBee:
The EUT firmware installed during testing was Dish Agency Build 3.4.

UNII:
The EUT firmware installed during testing was Linux with MFG Driver
The test utility software used during testing was Mtool version 3.2.1.0

6.6. WORST-CASE CONFIGURATION AND MODE

The EUT is a desktop device, therefore, all final radiated testing was performed with the EUT in X orientation.

This EUT supports BLE/BT + Zigbee + WLAN 5GHz simultaneous transmission. Radiated emission test 30MHz to 18GHz , Zigbee and UNII's previous FCC ID: DKNRW33 worst-case modes were performed on this FCC ID: DKNHR44 to ensure the testing remains compliant with new BT/BLE radio.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

6.7. DESCRIPTION OF TEST SETUP

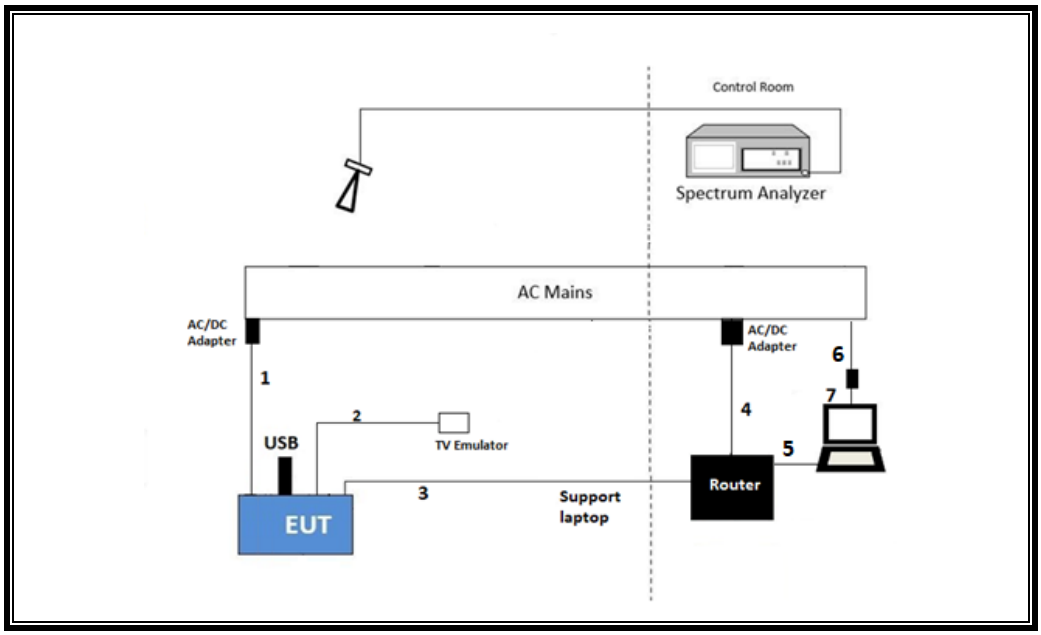
SUPPORT TEST EQUIPMENT				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID/ DoC**
AC/DC Adapter(EUT)	NetBit	NBC25A120210VU	222109	DoC
Router	D-Link	EBR-2310	F311388010596	DoC
Router Adapter	D-Link	AF0605	LF4R07082717180	DoC
TV Emulator	DISH	TV Emulator	D52-12	
Laptop: Radiated test	HP	Elitebook 740	N/A	DoC
AC/DC Adapter(Laptop): Radiated test	HP	N/A	N/A	DoC
USB Flash Drive	Sandisk	Cruzer Glide 16GB	SDCZ60-016G	DoC

I/O CABLES (RF RADIATED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC	1	Barrel	Un-shielded	1.5	EUT to AC/DC adapter Mains
2	HDMI	1	HDMI	shielded	1	EUT to Emulator
3	RJ45	1	RJ45	Un-shielded	More than 3	EUT to Ethernet Router
4	DC	1	Barrel	Un-shielded	1	Ethernet router to AC/DC Adapter
5	RJ45	1	RJ45	Un-shielded	1	Laptop to Ethernet Router
6	AC	1	Two Prong	Un-shielded	2	AC adapter to AC Mains
7	DC	1	DC	Un-shielded	1	AC Adapter Laptop

I/O CABLES (COLOCATION RADIATED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC	1	Barrel	Un-shielded	1.5	EUT to AC/DC adapter Mains
2	HDMI	1	HDMI	shielded	1	EUT to Emulator
3	RJ45	1	RJ45	Un-shielded	More than 3	EUT to Ethernet Router
4	DC	1	Barrel	Un-shielded	1	Ethernet router to AC/DC Adapter
5	UART	1	UART	Un-shielded	0.1	EUT to USB adapter
6	UART	1	USB	Un-shielded	2	USB adapter to laptop
7	DC	1	DC	Un-shielded	1	AC Adapter Laptop
8	AC	1	Two Prong	Un-shielded	2	AC adapter to AC Mains

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

RF RADIATED TEST SETUP DIAGRAM

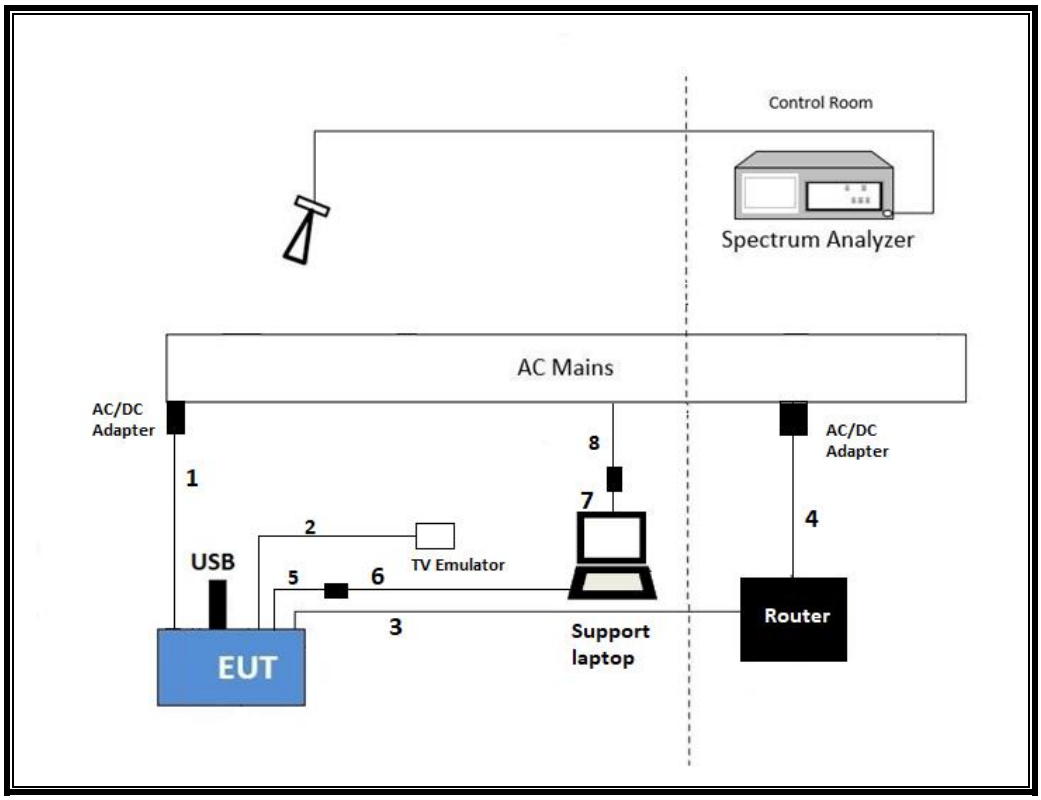


TEST SETUP

The EUT is connected to a test laptop by RJ45 cable, support equipment and powered by AC/DC adapter during the tests. Test software exercised the radio card.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

CO-LOCATION RADIATED TEST SETUP DIAGRAM



TEST SETUP

The EUT is connected to a test laptop by USB to UART cable adapter, support equipment and powered by AC/DC adapter during the tests. Test software exercised the radio card.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

7. MEASUREMENT METHOD

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, and G.5.

8. 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**	**ID Num**	**Cal Due**	**Last Cal**
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T119	05/07/2022	05/07/2021
Amplifier 1-8GHz 30dB gain	L3 Narda	AMF-4D-01000800-30-29P	167495	03/09/2023	03/09/2022
Amplifier, 1 - 18GHz	MITEQ	AFS42-00101800-25-S-42	T1568	03/09/2023	03/09/2022
Amplifier, 10KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310N	T300	04/09/2022	04/09/2021
Amplifier, 1-7GHz, 24dB	AMPLICAL	AMP1G7-24-27	T1607	03/09/2023	03/09/2022
Antenna, BroadBand Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	171862	09/28/2022	09/28/2021
EMI TEST RECEIVER, with B8 option	Rohde & Schwarz	ESW44	PRE0179377	02/20/2023	02/20/2022
NSA, Test Site Validation	TDK RF SOLUTIONS INC.	ANSI C63.4 & CISPR 16-1-4	210613	09/18/2022	09/18/2021
Thermometer - Digital	Control Company	14-650-118	175731	02/03/2023	02/03/2022
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	80404	08/04/2022	08/04/2021
Amplifier, 100MHz-18GHz	AMPLICAL	AMP0.1G18-47-20	185686	04/08/2022	04/08/2021
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	169927	02/16/2023	02/16/2022
NSA, Test Site Validation	TDK RF SOLUTIONS INC.	ANSI C63.4 & CISPR 16-1-4	210429	09/04/2024	09/04/2021
Thermometer - Digital	Control Company	14-650-118	175737	03/30/2022	03/30/2021

Test Software List			
Description	**Manufacturer**	**Model**	**Version**
Radiated Software	UL	UL EMC	Rev 9.5, April 30, 2020, Oct 21, 2019

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9. RADIATED TEST RESULTS

LIMITS

FCC §15.205 and §15.209 -Restriced bands

FCC §15.407(b)(1-3) -Un-Restriced bands

After January 01, 2019 for Outside of the Restricted Bands Emissions

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements in the 30-1000MHz range, 9kHz for peak and/or quasi-peak detection measurements in the 0.15-30MHz range and 200Hz for peak and/or quasi-peak detection measurements in the 9 to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9-90kHz and 110-490kHz).

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

The spectrum from 30 MHz to 1GHz and 18GHz to 40 GHz is investigated with the transmitter set to transmit at the channel with highest output power as worst-case scenario. 1GHz to 18GHz was set to the lowest, middle, and highest channels in the 5 GHz bands.

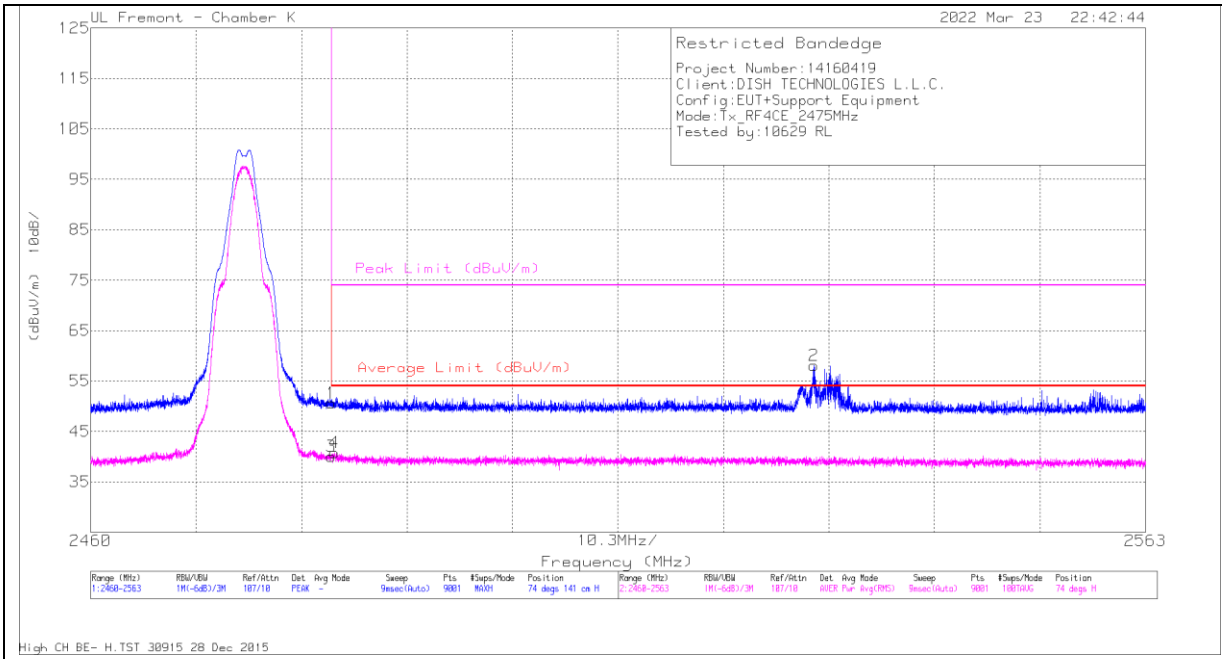
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.1. TRANSMITTER ABOVE 1 GHz (Zigbee)

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT

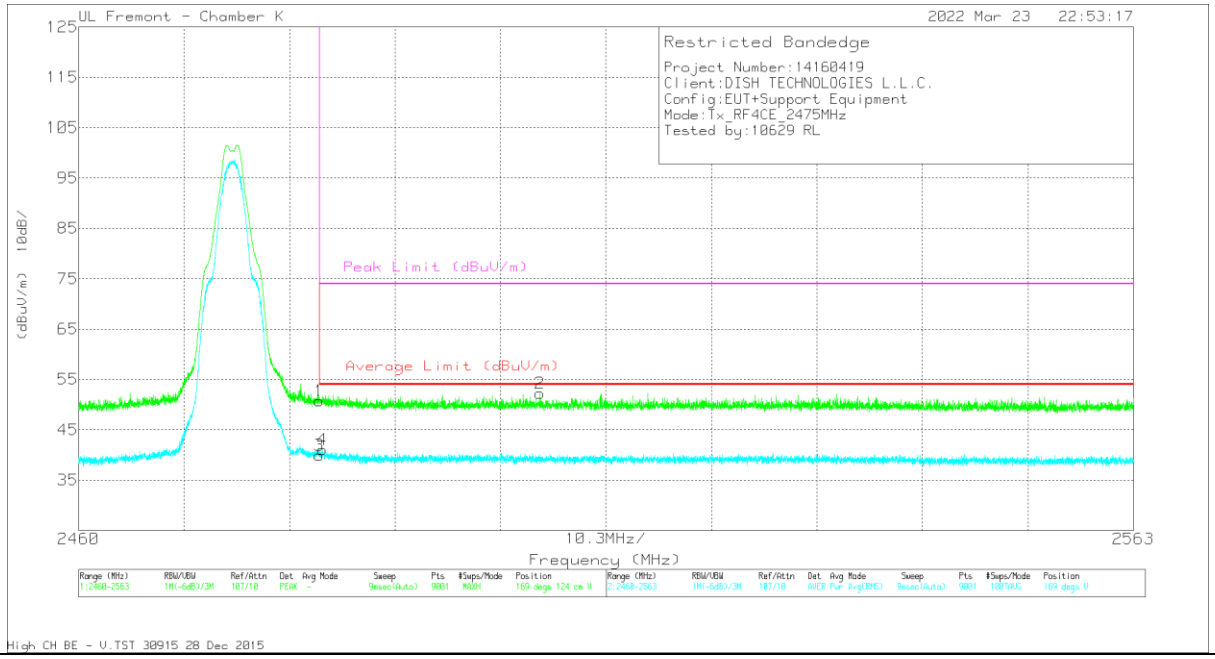


Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	51.98	Pk	32.7	-34	50.68	-	-	74	-23.32	74	141	H
2	2530.632	59.15	Pk	32.8	-33.8	58.15	-	-	74	-15.85	74	141	H
3	* 2483.5	41.34	RMS	32.7	-34	40.04	54	-13.96	-	-	74	141	H
4	* 2483.804	42.06	RMS	32.7	-34	40.76	54	-13.24	-	-	74	141	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

VERTICAL RESULT



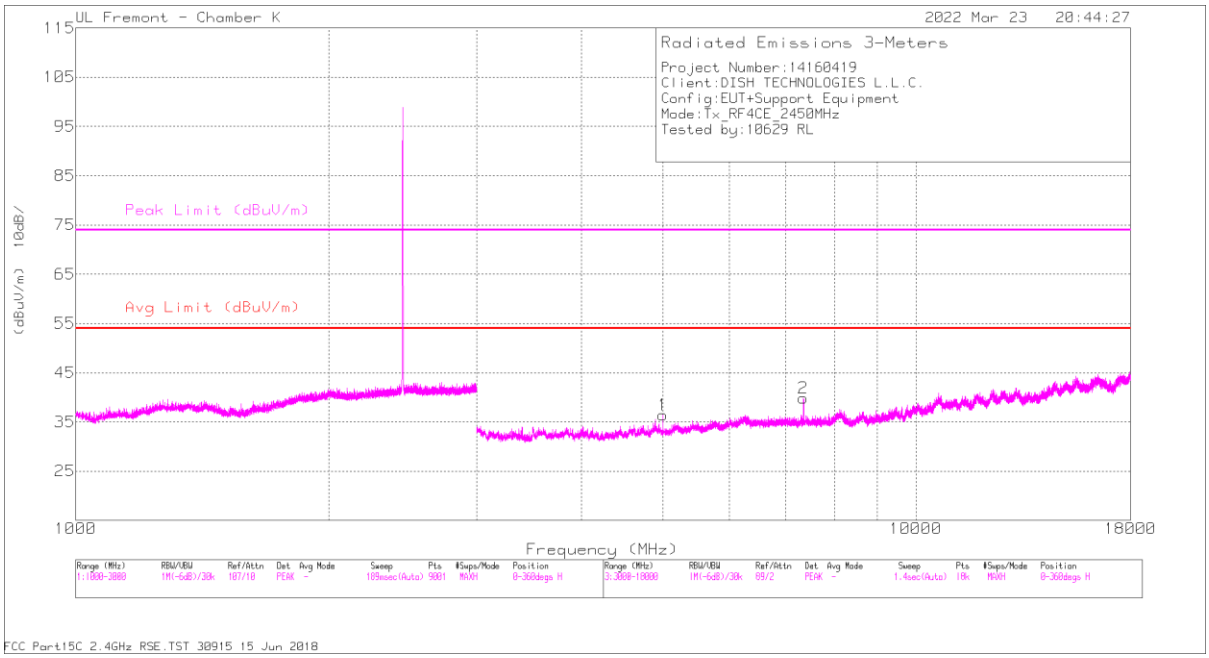
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2483.5	52	Pk	32.7	-34	50.7	-	-	74	-23.3	169	124	V
2	2505.066	53.4	Pk	32.8	-34	52.2	-	-	74	-21.8	169	124	V
3	* 2483.5	41.28	RMS	32.7	-34	39.98	54	-14.02	-	-	169	124	V
4	* 2483.815	42.41	RMS	32.7	-34	41.11	54	-12.89	-	-	169	124	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

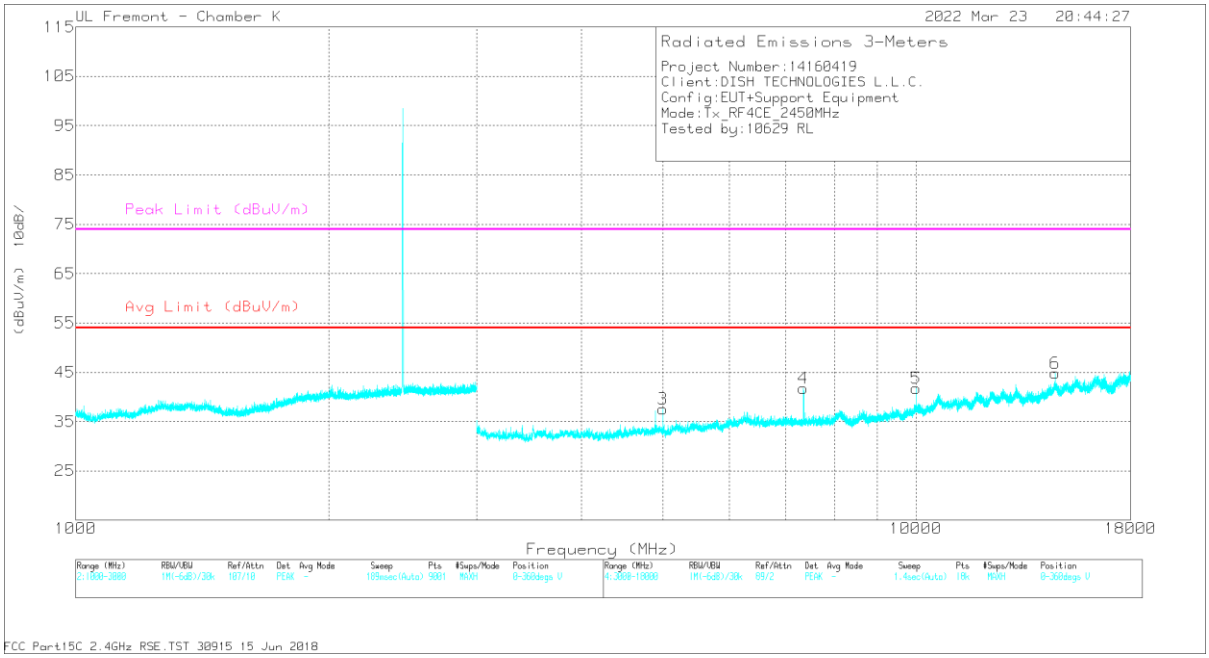
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

HARMONICS AND SPURIOUS EMISSIONS

MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

RADIATED EMISSIONS

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF 80404 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5000.012	50.85	PK2	34.2	-39.8	45.25	-	-	74	-28.75	285	98	H
	* 5000.102	40.33	MAv1	34.2	-39.8	34.73	54	-19.27	-	-	285	98	H
2	* 7351.515	50.95	PK2	35.8	-37.1	49.65	-	-	74	-24.35	323	103	H
	* 7348.548	41.87	MAv1	35.8	-37.1	40.57	54	-13.43	-	-	323	103	H
3	* 5000.082	51.47	PK2	34.2	-39.8	45.87	-	-	74	-28.13	146	111	V
	* 4999.972	43.62	MAv1	34.2	-39.8	38.02	54	-15.98	-	-	146	111	V
4	* 7348.708	51.76	PK2	35.8	-37.1	50.46	-	-	74	-23.54	257	98	V
	* 7348.608	44.25	MAv1	35.8	-37.1	42.95	54	-11.05	-	-	257	98	V
5	10000.042	47.61	PK2	37.2	-35.7	49.11	-	-	-	-	39	101	V
	10000.042	39.02	MAv1	37.2	-35.7	40.52	-	-	-	-	39	101	V
6	14640.115	44.73	PK2	39.9	-32.3	52.33	-	-	-	-	253	381	V
	14638.656	33.65	MAv1	39.9	-32.3	41.25	-	-	-	-	253	381	V

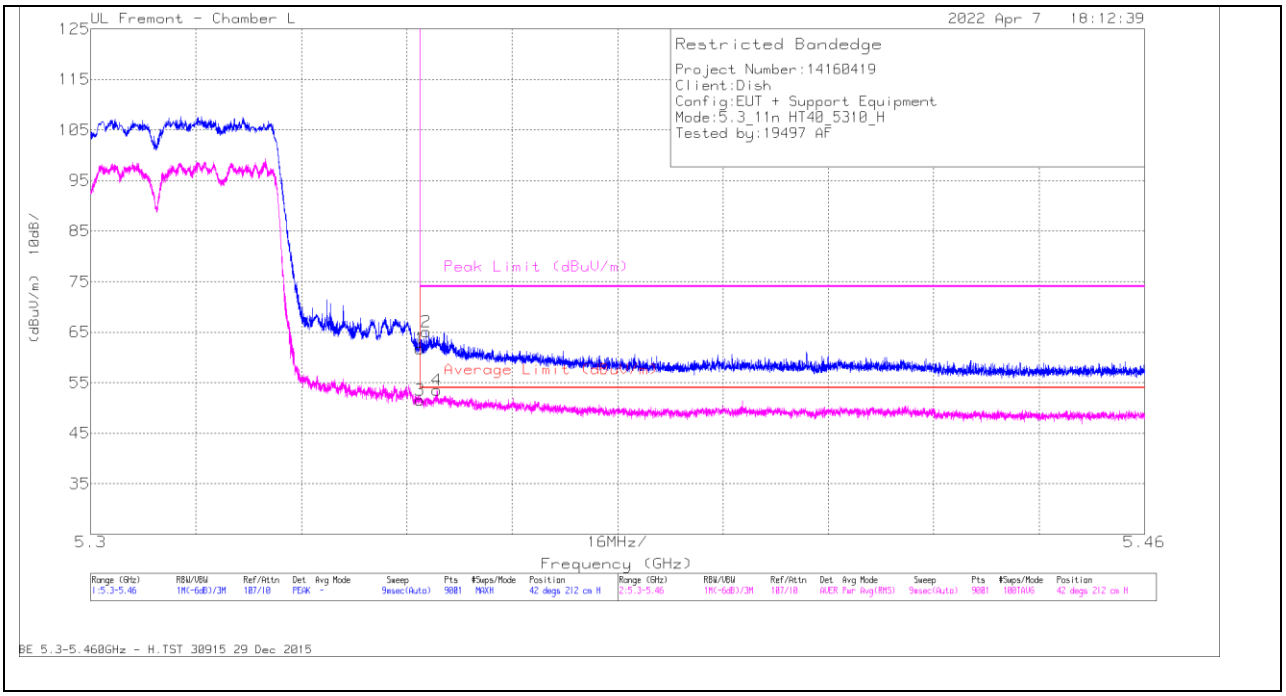
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK2 - KDB558074 Method: Maximum Peak
MAv1 - KDB558074 Option 1 Maximum RMS Average

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.2. TRANSMITTER ABOVE 1 GHz (UNII 802.11ac)

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT

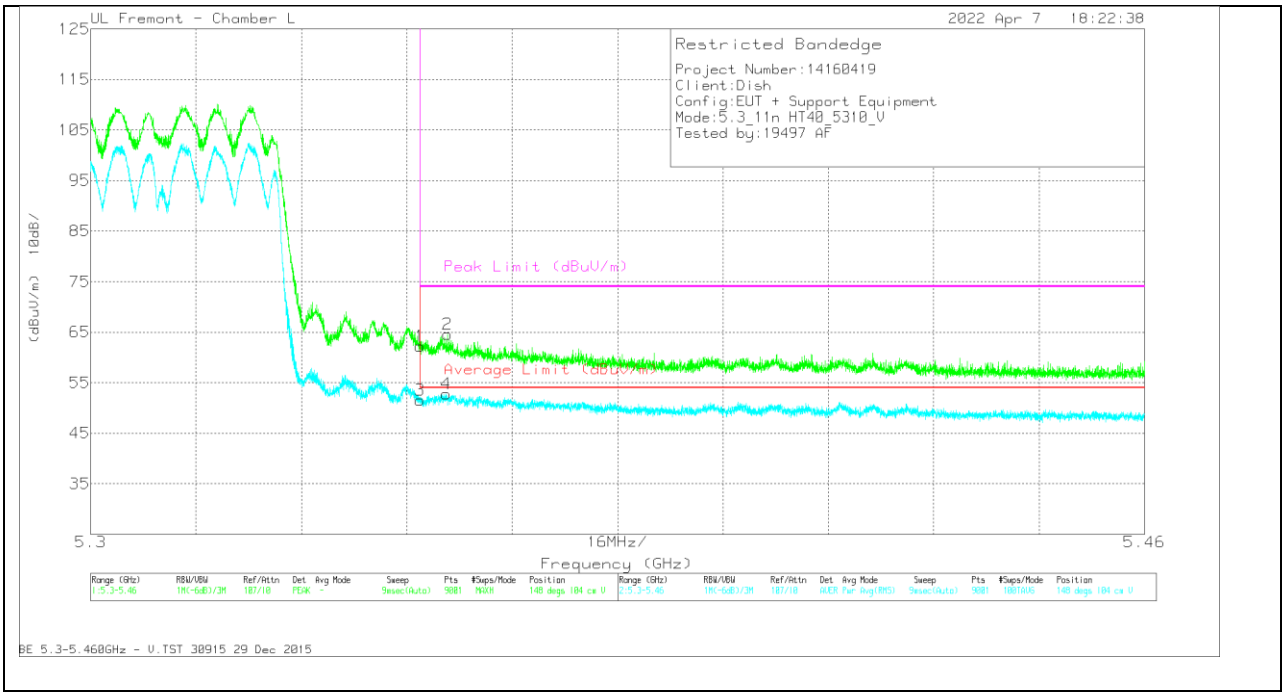


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5.35	41.27	Pk	34.9	-14.4	0	61.77	-	-	74	-12.23	42	212	H
2	* 5.350987	44.55	Pk	34.9	-14.4	0	65.05	-	-	74	-8.95	42	212	H
3	* 5.35	28.38	RMS	34.9	-14.4	2.63	51.51	54	-2.49	-	-	42	212	H
4	* 5.352552	30.37	RMS	34.9	-14.4	2.63	53.5	54	-.5	-	-	42	212	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

VERTICAL RESULT



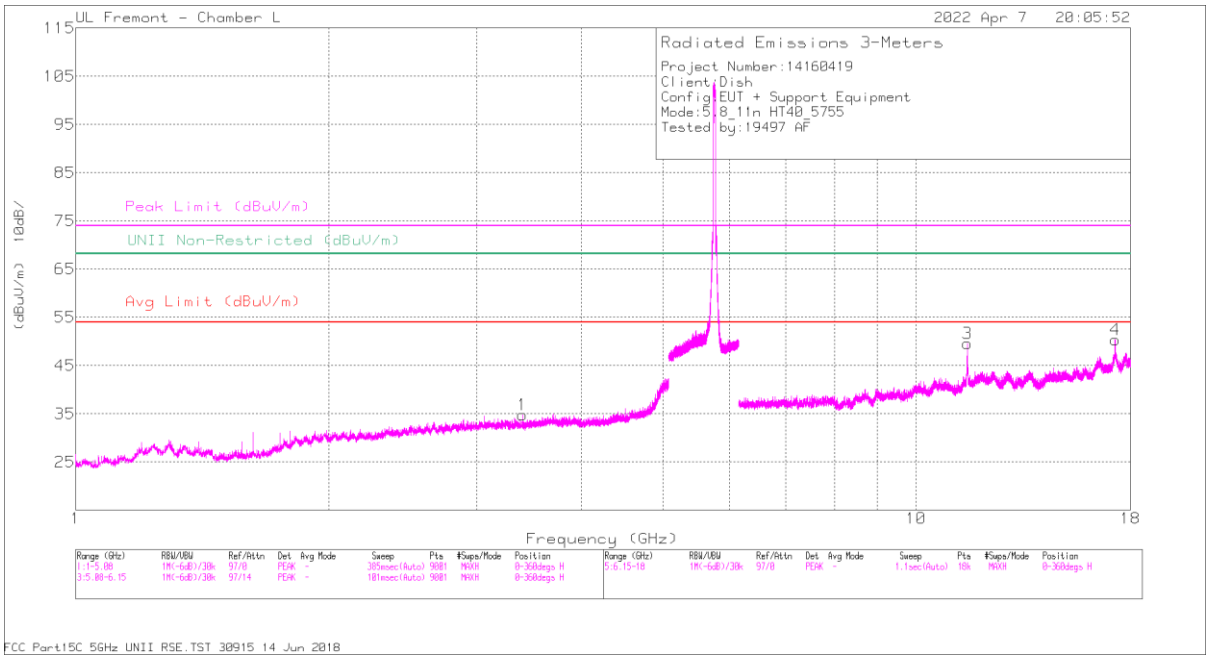
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5.35	41.77	Pk	34.9	-14.4	0	62.27	-	-	74	-11.73	148	104	V
2	* 5.35417	44.02	Pk	34.9	-14.4	0	64.52	-	-	74	-9.48	148	104	V
3	* 5.35	28.45	RMS	34.9	-14.4	2.63	51.58	54	-2.42	-	-	148	104	V
4	* 5.353956	29.65	RMS	34.9	-14.4	2.63	52.78	54	-1.22	-	-	148	104	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

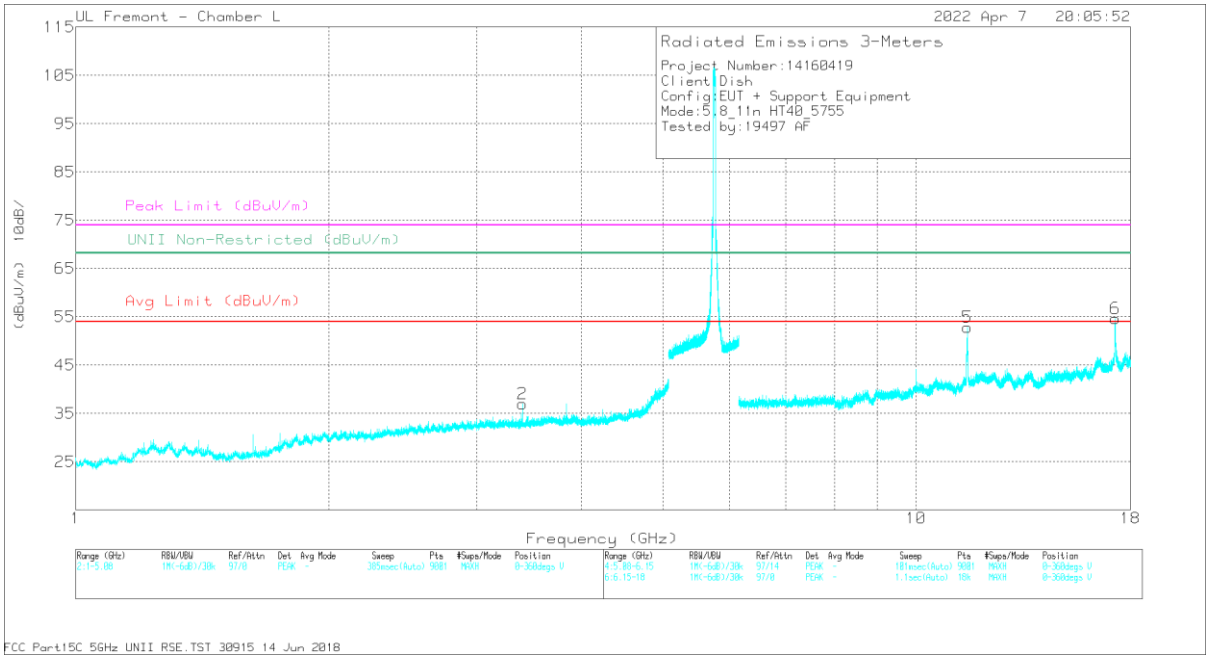
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AFT119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	UNII Non-Restricted (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	3.398554	37.54	PK-U	32.7	-26.9	0	43.34	-	-	-	-	68.2	-24.86	54	398	H
	3.399865	26.27	ADR	32.7	-26.9	2.63	34.7	-	-	-	-	-	-	54	398	H
3	* 11.50966	37.34	PK-U	38.6	-16.7	0	59.24	-	-	74	-14.76	-	-	247	103	H
	* 11.508989	22.79	ADR	38.6	-16.7	2.63	47.32	54	-6.68	-	-	-	-	247	103	H
4	17.265718	32.48	PK-U	41	-15.4	0	58.08	-	-	-	-	68.2	-10.12	8	152	H
	17.265385	19.95	ADR	41	-15.4	2.63	48.18	-	-	-	-	-	-	8	152	H
2	3.399853	38.36	PK-U	32.7	-26.9	0	44.16	-	-	-	-	68.2	-24.04	253	213	V
	3.400085	27.84	ADR	32.7	-26.9	2.63	36.27	-	-	-	-	-	-	253	213	V
5	* 11.509867	40.61	PK-U	38.6	-16.7	0	62.51	-	-	74	-11.49	-	-	32	155	V
	* 11.508972	26.66	ADR	38.6	-16.7	2.63	51.19	54	-2.81	-	-	-	-	32	155	V
6	17.276297	38.44	PK-U	41	-15.1	0	64.34	-	-	-	-	68.2	-3.86	342	104	V
	17.275382	24.92	ADR	41	-15.1	2.63	53.45	-	-	-	-	-	-	342	104	V

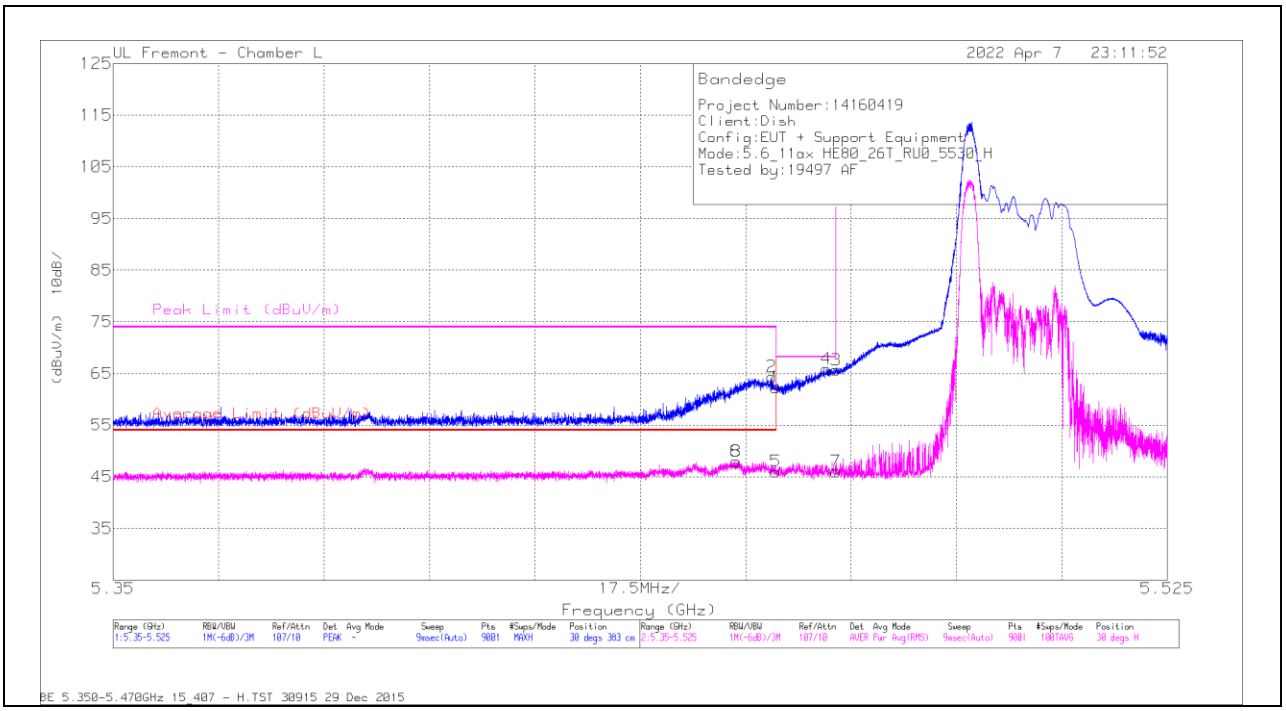
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

9.3. TRANSMITTER ABOVE 1 GHz (UNII 802.11ax)

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT

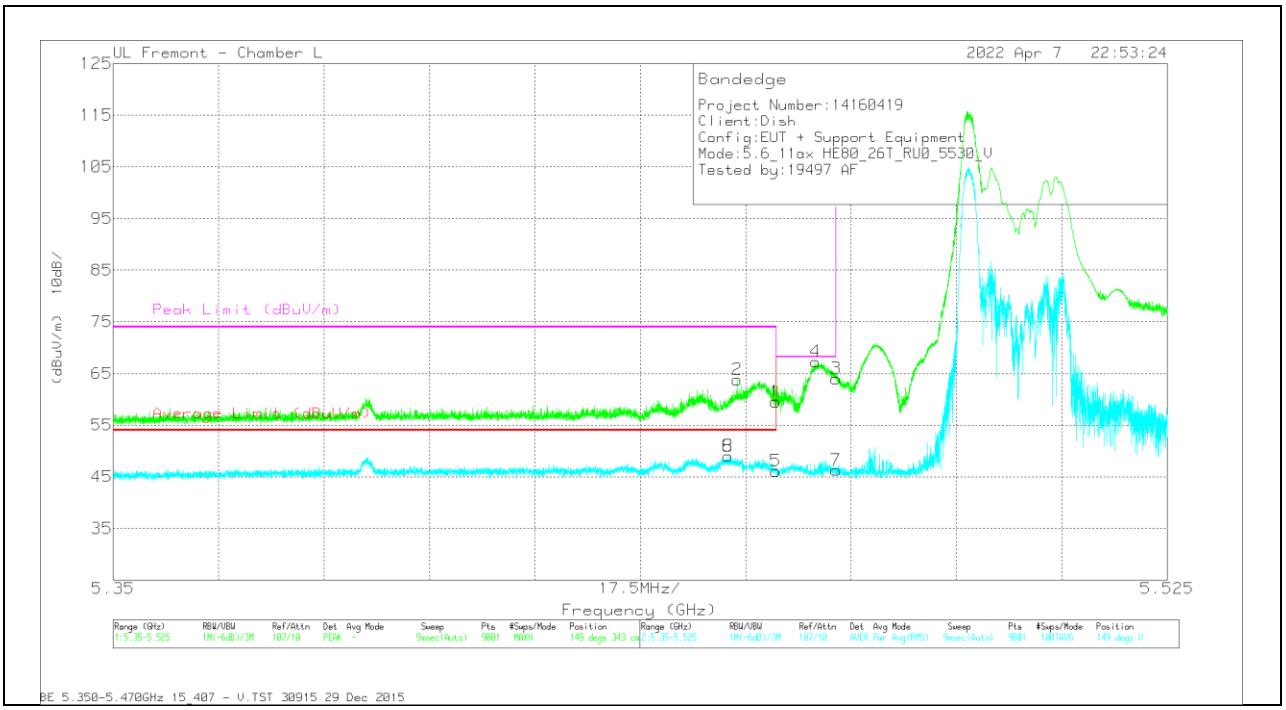


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5.46	41.63	Pk	34.9	-14.2	0	62.33	-	-	68.2	-5.87	30	383	H
2	* 5.459353	43.64	Pk	34.9	-14.2	0	64.34	-	-	74	-9.66	30	383	H
3	5.47	44.96	Pk	34.9	-14.2	0	65.66	-	-	68.2	-2.54	30	383	H
4	5.468414	45.21	Pk	34.9	-14.2	0	65.91	-	-	68.2	-2.29	30	383	H
5	* 5.46	25.01	RMS	34.9	-14.2	.28	45.99	54	-8.01	-	-	30	383	H
6	* 5.453423	26.98	RMS	34.9	-14.2	.28	47.96	54	-6.04	-	-	30	383	H
7	5.47	25.04	RMS	34.9	-14.2	.28	46.02	-	-	-	-	30	383	H
8	* 5.453423	26.98	RMS	34.9	-14.2	.28	47.96	54	-6.04	-	-	30	383	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

VERTICAL RESULT



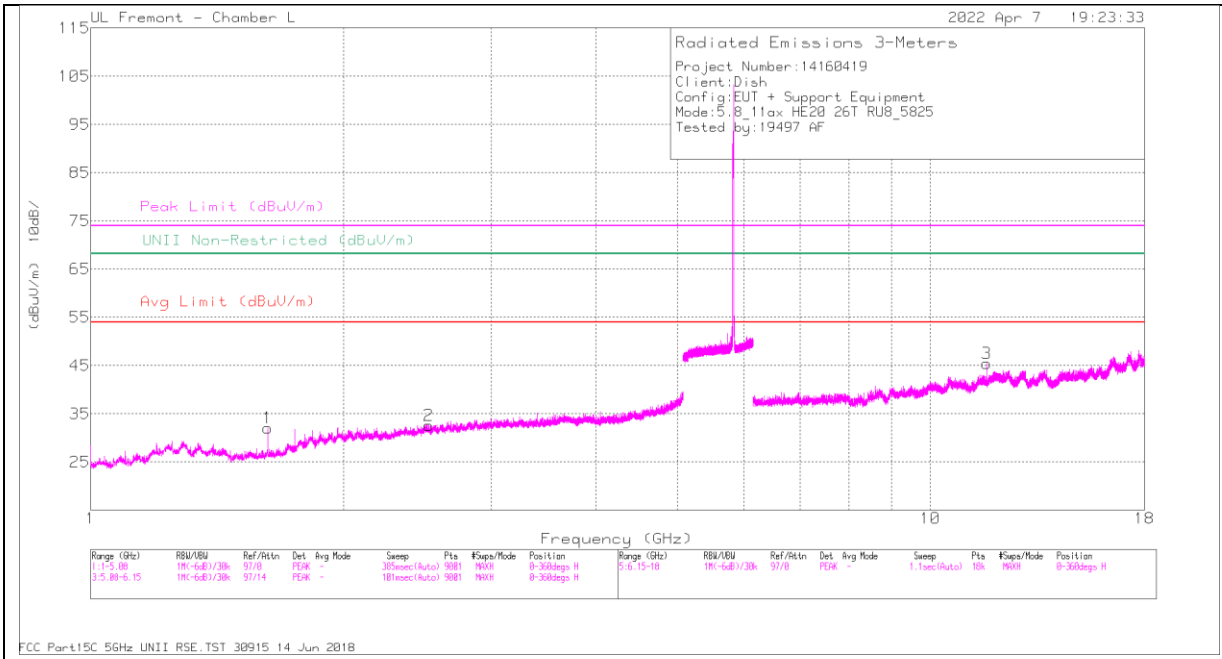
Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 5.46	38.83	Pk	34.9	-14.2	0	59.53	-	-	68.2	-8.67	149	343	V
2	* 5.453578	43.09	Pk	34.9	-14.2	0	63.79	-	-	74	-10.21	149	343	V
3	5.47	43.3	Pk	34.9	-14.2	0	64	-	-	68.2	-4.2	149	343	V
4	5.466625	46.58	Pk	34.9	-14.2	0	67.28	-	-	68.2	-.92	149	343	V
5	* 5.46	25.13	RMS	34.9	-14.2	.31	46.14	54	-7.86	-	-	149	343	V
6	* 5.452081	27.98	RMS	34.9	-14.2	.31	48.99	54	-5.01	-	-	149	343	V
7	5.47	25.29	RMS	34.9	-14.2	.31	46.3	-	-	-	-	149	343	V
8	* 5.452081	27.98	RMS	34.9	-14.2	.31	48.99	54	-5.01	-	-	149	343	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector
RMS - RMS detection

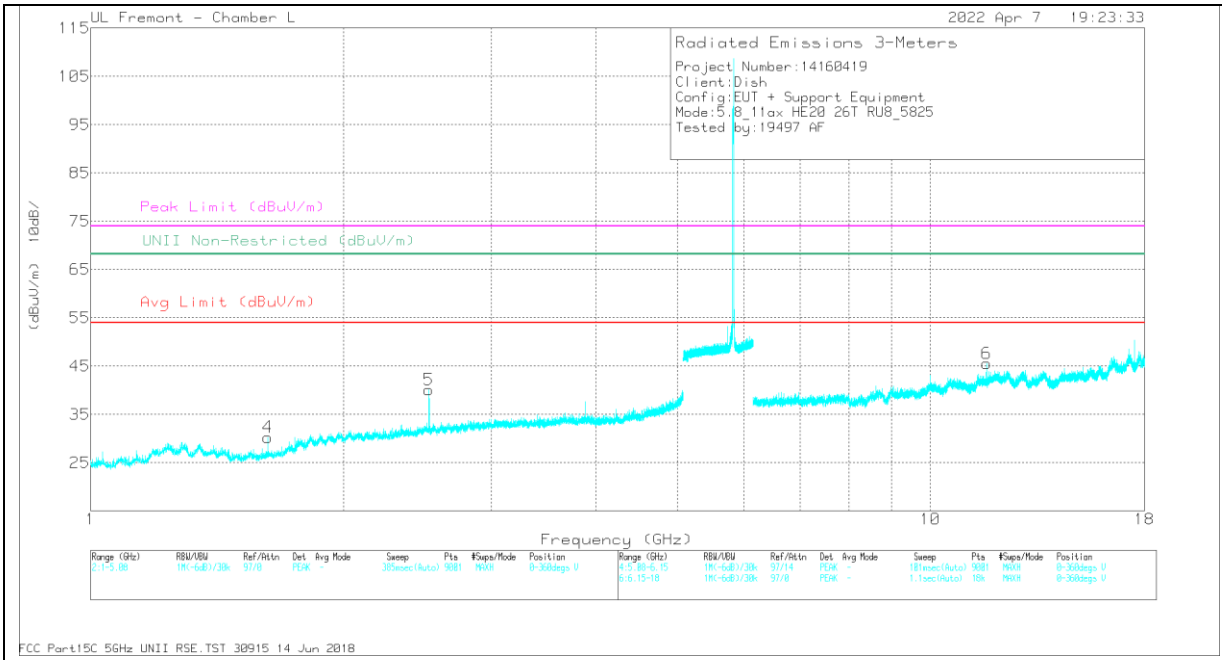
UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

HARMONICS AND SPURIOUS EMISSIONS

HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AFT119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	UNII Non-Restricted (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.62516	41.82	PK-U	28.4	-31.8	0	38.42	-	-	74	-35.58	-	-	202	136	H
	* 1.62478	32.73	ADR	28.4	-31.8	,13	29.46	54	-24.54	-	-	-	-	202	136	H
2	2.525857	38.16	PK-U	32.4	-28.8	0	41.76	-	-	-	-	68.2	-26.44	49	203	H
	2.524738	26.64	ADR	32.4	-28.8	,13	30.37	-	-	-	-	-	-	49	203	H
4	* 1.62478	41.2	PK-U	28.4	-31.8	0	37.8	-	-	74	-36.2	-	-	234	267	V
	* 1.62478	32.39	ADR	28.4	-31.8	,13	29.12	54	-24.88	-	-	-	-	234	267	V
5	2.52903	38.04	PK-U	32.5	-28.8	0	41.74	-	-	-	-	68.2	-26.46	70	250	V
	2.529114	26.31	ADR	32.5	-28.8	,13	30.14	-	-	-	-	-	-	70	250	V
3	* 11.668703	29.25	PK-U	38.9	-16.4	0	51.75	-	-	74	-22.25	-	-	59	241	H
	* 11.668315	17.72	ADR	38.9	-16.4	,13	40.35	54	-13.65	-	-	-	-	59	241	H
6	* 11.666578	31.55	PK-U	38.9	-16.5	0	53.95	-	-	74	-20.05	-	-	75	211	V
	* 11.666479	18.87	ADR	38.9	-16.5	,13	41.4	54	-12.6	-	-	-	-	75	211	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

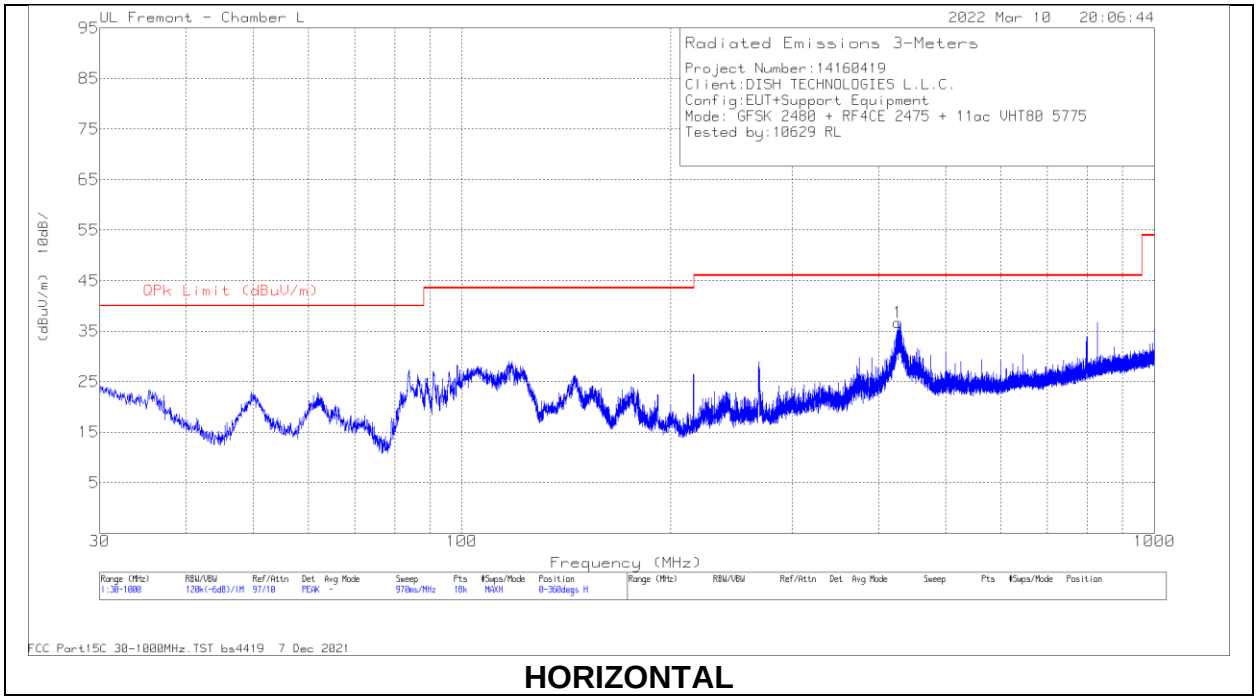
9.4. SPURIOUS EMISSIONS FOR CO-LOCATION

TEST-CASE CONDITIONS

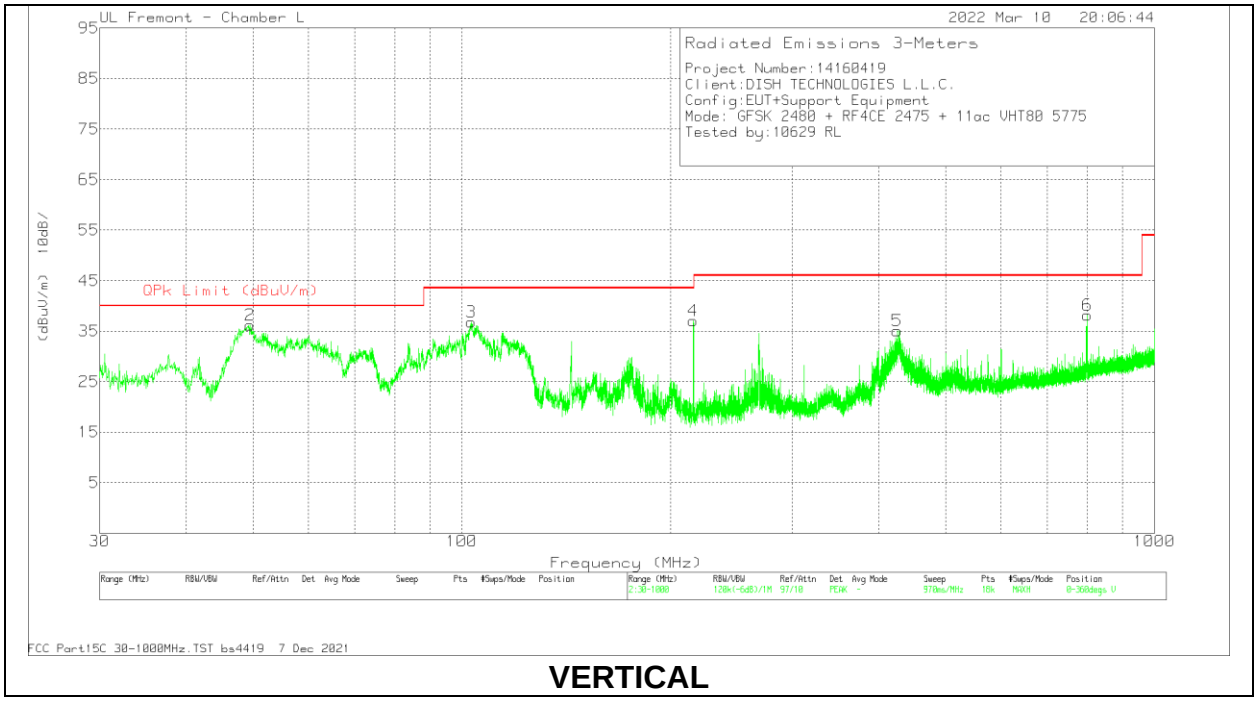
Mode	Frequency (MHz)
BT GFSK	2480
Zigbee	2475
UNII	VHT80 5775MHz

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

HARMONICS AND SPURIOUS EMISSIONS 30MHz TO 1GHz



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

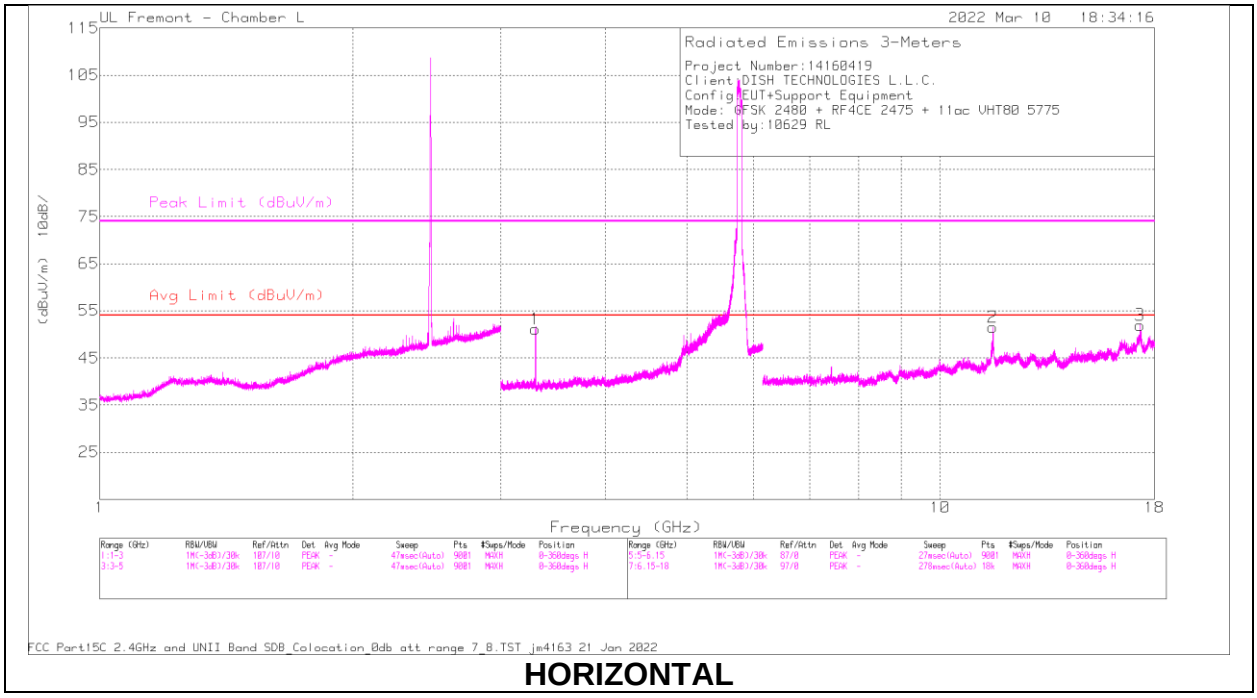
Radiated Emissions

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	171862 ACF (dB)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	426.731	43.17	Pk	22.3	-28.8	36.67	46.02	-9.35	0-360	99	H
2	49.4539	53.51	Pk	13.9	-31.2	36.21	40	-3.79	0-360	101	V
	49.8439	51.06	Qp	13.8	-31.2	33.66	40	-6.34	185	103	V
3	103.181	50.37	Pk	17.1	-30.7	36.77	43.52	-6.75	0-360	101	V
4	215.971	50.64	Pk	16.4	-30	37.04	43.52	-6.48	0-360	101	V
5	425.114	41.68	Pk	22.2	-28.8	35.08	46.02	-10.94	0-360	101	V
6	799.858	39.22	Pk	27	-28.1	38.12	46.02	-7.9	0-360	101	V

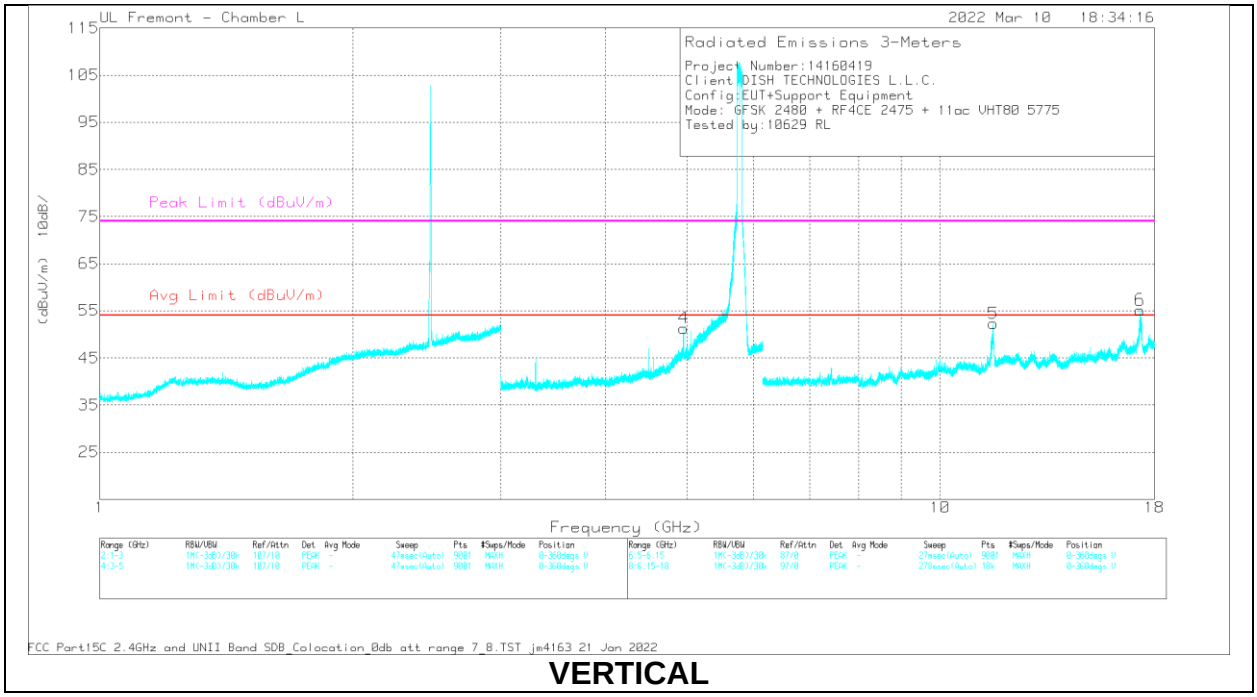
Pk - Peak detector
Qp - Quasi-Peak detector

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

HARMONICS AND SPURIOUS EMISSIONS ABOVE 1GHz



HORIZONTAL



VERTICAL

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

Radiated Emissions

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T119 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Filter (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	3.300352	47.69	PK-U	32.6	-26.5	2	0	55.79	-	-	-	-	172	106	H
	3.300262	41.7	ADR	32.6	-26.5	2	.96	50.76	-	-	-	-	172	106	H
4	* 4.950589	45.81	PK-U	34.2	-23.1	2	0	58.91	-	-	74	-15.09	198	110	V
	* 4.95	35.31	ADR	34.2	-23.1	2	.96	49.37	54	-4.63	-	-	198	110	V
2	* 11.553241	37.65	PK-U	38.6	-16.5	.5	0	60.25	-	-	74	-13.75	302	101	H
	* 11.559875	25.87	ADR	38.7	-16.5	.5	.96	49.53	54	-4.47	-	-	302	101	H
3	17.306639	35.69	PK-U	41	-14.8	.5	0	62.39	-	-	-	-	352	101	H
	17.306359	23.89	ADR	41	-14.8	.5	.96	51.55	-	-	-	-	352	101	H
5	* 11.567202	39.67	PK-U	38.7	-16.4	.5	0	62.47	-	-	74	-11.53	37	104	V
	* 11.55909	27.23	ADR	38.7	-16.5	.5	.96	50.89	54	-3.11	-	-	37	104	V
6	17.316229	39.82	PK-U	40.9	-14.9	.5	0	66.32	-	-	-	-	345	105	V
	17.307078	27.22	ADR	41	-14.8	.5	.96	54.88	-	-	-	-	345	105	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average
Note: no emissions above 18GHz were seen.

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

Appendix A - Reference Test Report

Attached are the test report numbers containing the reference data of the reference reports as indicated on Section 6.2 reports.

END OF REPORT

UL VERIFICATION SERVICES
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888