UNIFIED COMPLIANCE LABORATORY

427 West 12800 South
Draper, UT 84020

Test Report

Certification

FCC ID	SWX-LTUL
Equipment Under Test	LTU-Lite
Test Report Serial Number	LTUL_15.407_UNII-2_V 1.1
Date of Test	08/13/19
Report Issue Date	08/15/2019

Test Specification	Applicant
47 CFR FCC Part 15, Subpart E	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10019 U.S.A.

NVLAP® TESTING ilac-MRA

NVLAP LAB CODE 600241-0

Certification of Engineering Report

This report has been prepared by Unified Compliance Laboratory (UCL) to document compliance of the device described below with the requirement of Federal Communication Commissions (FCC) Part 15, Subpart E. This report may be reproduced in full. Partial reproduction of this report may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

Applicant	Ubiquiti Networks, Inc.
Manufacturer	Ubiquiti Networks, Inc.
Brand Name	LTU
Model Number	LTU-Lite
FCC ID	SWX-LTUL

On this 14th day of August 2019, I individually and for Unified Compliance Laboratory certify that the statements made in this engineering report are true, complete and correct to the best of my knowledge and are made in good faith.

Although NVLAP has accredited the Unified Compliance Laboratory testing facilities, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government.

Unified Compliance Laboratory

Written By: Alex Macon

Reviewed By: Clay Allred

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	08/15/2019
1.1	Added Conducted power for UNII-2C on page 16	08/16/2019
1.2	Added PTMP capability into product description	08/19/2019

Table of Contents

1 Client Information

1.1 Applicant

Company	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10017 U.S.A.
Contact Name	Mark Feil
Title	Compliance Manager

1.2 Manufacturer

Company	Ubiquiti Networks, Inc. 685 Third Avenue, 27th Floor New York, NY 10017 U.S.A.
Contact Name	Mark Feil
Title	Compliance Manager

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	LTU
Model Number	LTU-Lite
Serial Number	N/A
Dimensions (cm)	15.4 x 8.4 x 3.95

2.2 Description of EUT

The LTU-L is a fixed point-to-point or point-to-multiple point transceiver, meant for outdoor use, operating in the UNII-1, UNII-2 and UNII-3 frequency bands. A Bluetooth LE transceiver is included for device management. An Ethernet port is used for data transfer and to provide power using a POE-24V-5X-HD POE supply.

The UNII transceiver use 5 modulation bandwidths with channels spaced 5 MHz apart. Modulation bandwidths of 10 MHz, 20 MHz, 30 MHz, 40 MHz, and 50 MHz are used. There are 2 antennas on the PCB, one vertically polarized and on horizontally polarized, with reflectors. The maximum gain is 12 dBi. The table below show the channels used in each band with the different modulation bandwidths and maximum power settings. This report covers the circuitry of the device subject to FCC Part 15, Subpart E. The circuitry of the device subject to FCC Part 15 Subpart B was found to be compliant.

Band	Modulation Bandwidth	Frequency (MHz)
UNII-2A	10 MHz	5255, 5260, 5265, 5270, 5275, 5280, 5285, 5290, 5295, 5300, 5305, 5310, 5315, 5320, 5325, 5330, 5335, 5340
	20 MHz	5260, 5265, 5270, 5275, 5280, 5285, 5290, 5295, 5300, 5305, 5310, 5315, 5320, 5325, 5330, 5335
	30 MHz	5265, 5270, 5275, 5280, 5285, 5290, 5295, 5300, 5305, 5310, 5315, 5320, 5325, 5330
	40 MHz	5270, 5275, 5280, 5285, 5290, 5295, 5300, 5305, 5310, 5315, 5320, 5325
	50 MHz	5275, 5280, 5285, 5290, 5295, 5300, 5305, 5310, 5315, 5320

Band	Modulation Bandwidth	Frequency (MHz)
UNII-2C	10 MHz	5480, 5845, 5490, 5495, 5500, 5505, 5510, 5515, 5520, 5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5615, 5620, 5625, 5630, 5635, 5640, 5645, 5650, 5655, 5660, 5665, 5670, 5675, 5680, 5685, 5690, 5695, 5700, 5705, 5710, 5715
	20 MHz	5845, 5490, 5495, 5500, 5505, 5510, 5515, 5520, 5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5615, 5620, 5625, 5630, 5635, 5640, 5645, 5650, 5655, 5660, 5665, 5670, 5675, 5680, 5685, 5690, 5695, 5700, 5705, 5710
	30 MHz	5490, 5495, 5500, 5505, 5510, 5515, 5520, 5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5615, 5620, 5625, 5630, 5635, 5640, 5645, 5650, 5655, 5660, 5665, 5670, 5675, 5680, 5685, 5690, 5695, 5700, 5705
	40 MHz	5495, 5500, 5505, 5510, 5515, 5520, 5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5615, 5620, 5625, 5630, 5635, 5640, 5645, 5650, 5655, 5660, 5665, 5670, 5675, 5680, 5685, 5690, 5695, 5700
	50 MHz	5500, 5505, 5510, 5515, 5520, 5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5615, 5620, 5625, 5630, 5635, 5640, 5645, 5650, 5655, 5660, 5665, 5670, 5675, 5680, 5685, 5690

2.3 EUT and Support Equipment

The EUT and support equipment used during the test are listed below.

Brand Name Model Number Serial Number	Description	Name of Interface Ports / Interface Cables
BN: LTU MN: LTU-Lite (Note 1) SN: None	Point to Point Transceiver	See section 2.4
BN: Ubiquiti MN: POE-24V-5X-HD (Note 1) SN: None	POE Supply	See Section 2.4
BN: Dell MN: XPS 13 SN: None	Computer	Ethernet/Shielded Cat 5e cable (Note 2)

Notes: (1) EUT

(2) Interface port connected to EUT (See Section 2.4)

The support equipment listed above was not modified in order to achieve compliance with this standard.

2.4 Interface Ports on EUT

Name of Ports	No. of Ports Fitted to EUT	Cable Description/Length
POE/Data	1	Shielded Cat 5e cable/8 meters
AC	1	3 conductor power cord/80 cm
Data	1	Shielded Cat 5e cable/1 meters
POE/Data	1	Shielded Cat 5e cable/8 meters

2.5 Operating Environment

Power Supply	120 VAC
AC Mains Frequency	60 Hz
Temperature	25.6 C – 28.3 C
Humidity	26.5 % - 32.3%
Barometric Pressure	1018 mbar

2.6 Operating Modes

The transmitter was tested while the UNII transceiver was in a constant transmit mode at the upper, middle, and lower channels for each modulation bandwidth and frequency band. The Bluetooth LE transceiver was active while testing the UNII transceiver to assess any transmitter interactions.

2.7 EUT Exercise Software

Ubiquiti test software and firmware were used to control the transceivers of the EUT. (ART)

2.8 Block Diagram of Test Configuration

N/A

2.9 Modification Incorporated/Special Accessories on EUT

There were no modifications made to the EUT during testing to comply with the specification.

2.10 Deviation, Opinions Additional Information or Interpretations from Test Standard

There were no deviations, opinions, additional information or interpretations from the test specification.

3 Test Specification, Method and Procedures

3.1 Test Specification

Title	47 CFR FCC Part 15, Subpart E, Section 15.407 Limits and methods of measurement of radio interference characteristics of Unlicensed National Information Infrastructure Devices
Purpose of Test	The tests were performed to demonstrate initial compliance

3.2 Methods & Procedures

3.2.1 47 CFR FCC Part 15 Section 15.407

See test standard for details.

3.3 FCC Part 15, Subpart E

3.3.1 Summary of Tests

FCC Section	Environmental Phenomena	Frequency Range (MHZ)	Result
15.407(a)	Antenna requirements	Structural Requirement	Compliant
15.407(b)	Conducted Disturbance at Mains Port	0.15 to 30	Compliant
15.407(c)	Bandwidth Requirement	5150 to 5875	Compliant
15.407(e)	Peak Output Power	5150 to 5875	Compliant
15.407(f)	Antenna Conducted Spurious Emissions	0.009 to 40000	Compliant
15.407(g)	Radiated Spurious Emissions	0.009 to 40000	Compliant
15.407(h)	Peak Power Spectral Density	5150 to 5875	Compliant
The testing was performed according to the procedures in ANSI C63.10-2013, KDB 789033 and 47 CFR Part 15.			

3.4 Results

In the configuration tested, the EUT complied with the requirements of the specification.

3.5 Test Location

Testing was performed at the Unified Compliance Laboratory 3-Meter chamber located at 427 West 12800 South, Draper, UT 84020. Unified Compliance Laboratory is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Code 600241-0 which is effective until 30 June 2020.

4 Test Equipment

4.1 Conducted Emissions at Mains Ports

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
EMI Receiver	AFJ	FFT3010	UCL-2500	12/14/2018	4/17/2020
Transient Limiter	Com-Power	LIT-930A	UCL-2496	2/11/2019	2/11/2020
LISN	AFJ	LS16C/10	UCL-2512	12/14/2018	4/17/2020
Cat6 ISN	Teseq	ISN T8-Cat6	UCL-2971	2/11/2019	5/21/2020
ISN	Teseq	ISN T800	UCL-2974	2/19/2019	5/21/2020
LISN	Com-Power	LIN-120C	UCL-2612	2/11/2019	2/11/2020
AC Power Source	B&K Instruments	9805	UCL-2587	N/A	N/A
Monitoring Probe	Teseq	MD 4070A	UCL-2980	3/16/2019	5/21/2020
Test Software	UCL	Revision 1	UCL-3107	N/A	N/A

Table 1:List of equipment used for Conducted Emissions Testing at Mains Port

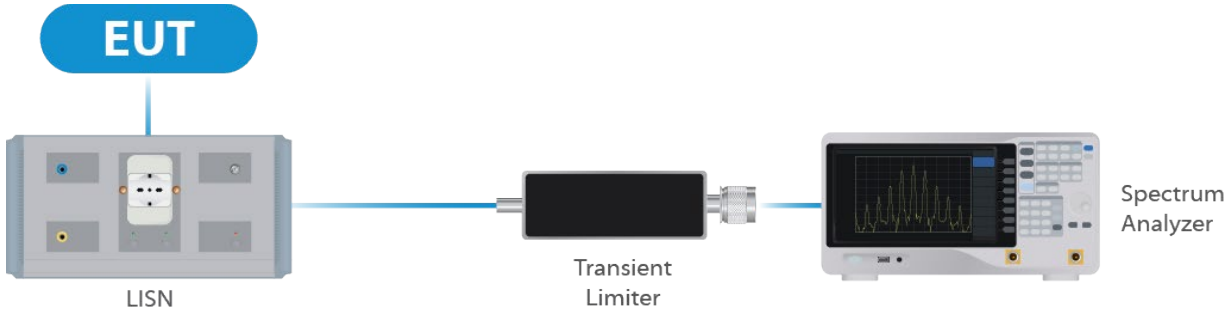


Figure 1: Conducted Emissions Test

4.2 Direct Connect at the Antenna Port Tests

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer	R&S	FSV40	UCL-2861	06/12/2019	06/12/2020
Signal Generator	R&S	SMB100A	UCL-2864	N/A	N/A
Vector Signal Generator	R&S	SMBV100A	UCL-2873	N/A	N/A
Switch Extension	R&S	OSP-B157WX	UCL-2867	06/13/2019	06/13/2020
Switch Extension	R&S	OSP-150W	UCL-2870	06/14/2019	06/14/2020

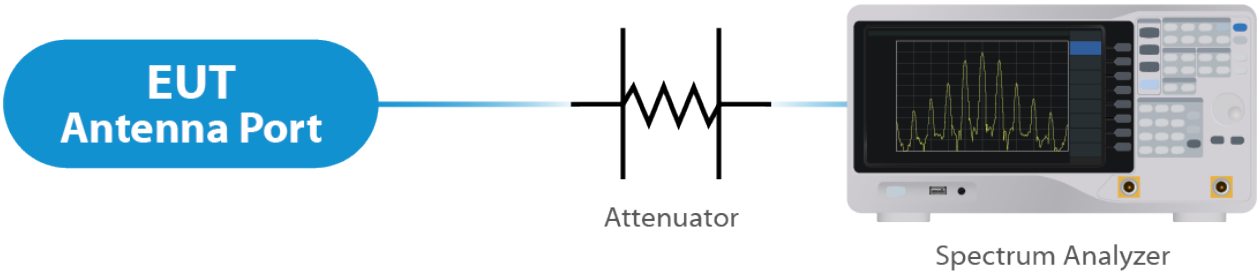


Figure 2: Direct Connect at the Antenna Port Test

4.3 Radiated Emissions

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
EMI Receiver	Keysight	N9038A	UCL-2778	11/26/2018	5/3/2020
Pre-Amplifier	Sonoma Instruments	310N	UCL-2889	9/13/2018	5/16/2020
Double Ridge Horn Antenna	Scwarzbeck	BBHA 9120D	UCL-3065	4/11/2019	6/3/2020
Biconilog	Scwarzbeck	VULB 9163	UCL-3062	4/11/2019	6/3/2020
15 - 40 GHz Horn Antenna	Scwarzbeck	BBHA 9170	UCL-2487	2/15/2017	4/16/2020
18 – 40 GHz Amplifier	Scwarzbeck	BBV 9721	UCL-2490	4/1/2019	4/1/2020
0.5 – 18 GHz Amplifier	Scwarzbeck	BBV 9718C	UCL-2493	4/1/2019	4/1/2020
Loop Antenna	Com-Power	AL-130R	UCL-2596	10/26/2018	4/23/2020
Test Software	UCL	Revision 1	UCL-3108	N/A	N/A

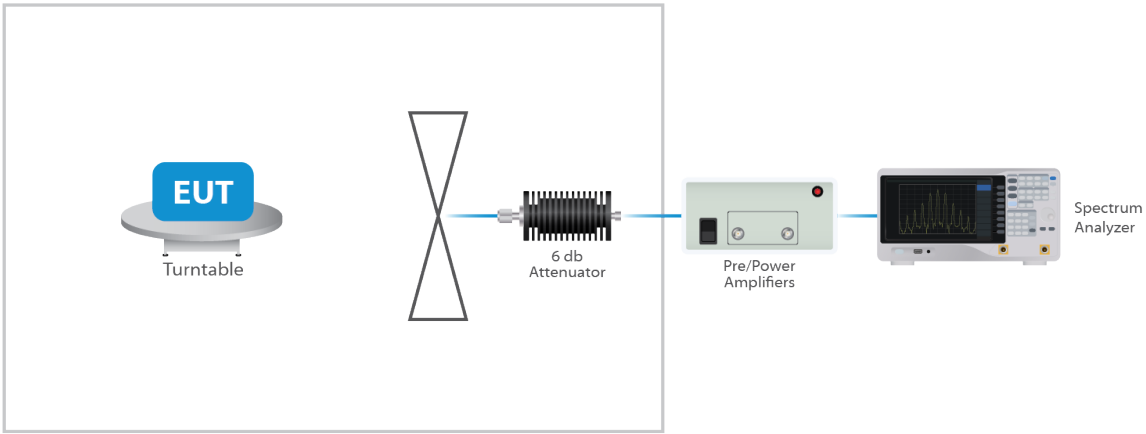


Figure 3: Radiated Emissions Test

4.4 Equipment Calibration

All applicable equipment is calibrated using either an independent calibration laboratory or Unified Compliance Laboratory personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to traceability is on file and is available for examination upon request.

4.5 Measurement Uncertainty

Test	Uncertainty (± dB)	Confidence (%)
Conducted Emissions	1.44	95
Radiated Emissions (9 kHz to 30 MHz)	2.50	95
Radiated Emissions (30 MHz to 1 GHz)	3.95	95
Radiated Emissions (1 GHz to 18 GHz)	5.56	95
Radiated Emissions (18 GHz to 40 GHz)	5.16	95
Direct Connect Tests	**K Factor**	**Value**
Emissions Bandwidth	2	2.0%
Output Power	2	1.0 dB
Peak Power Spectral Density	2	1.3 dB
Band Edge	2	0.8 dB
Transmitter Spurious Emissions	2	1.8 dB

5 Test Results

5.1 §15.203 Antenna Requirements

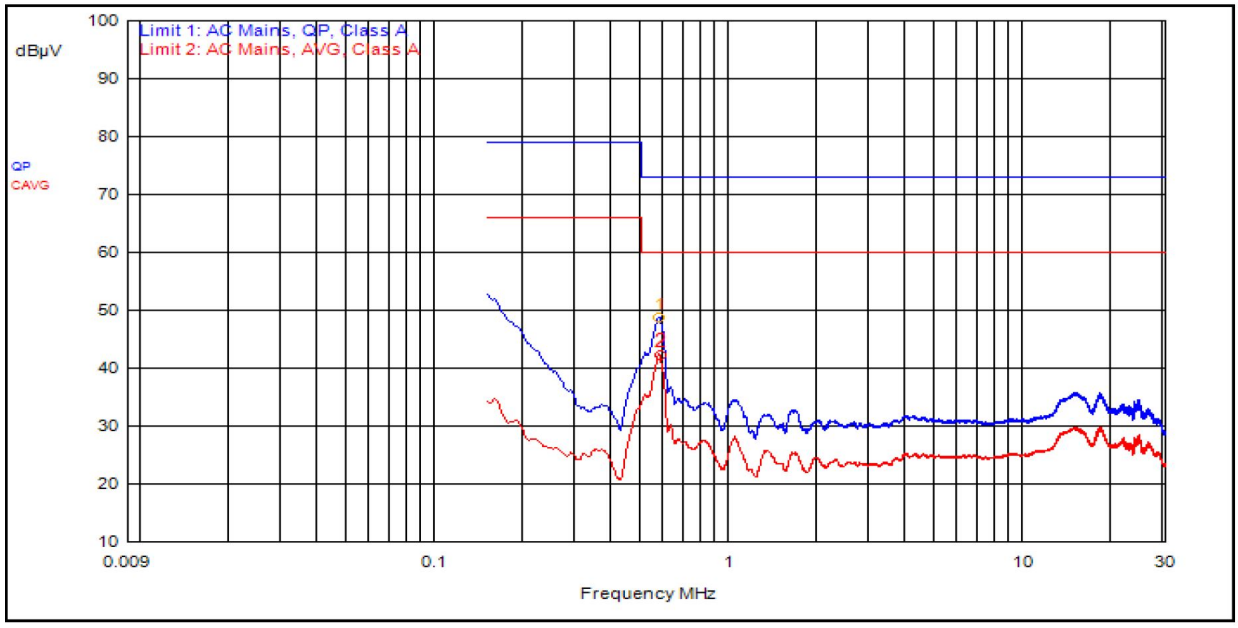
The EUT uses an integral antenna The Maximum gain of the antenna is 12 dBi. The antenna is not user replaceable.

Results

The EUT complied with the specification

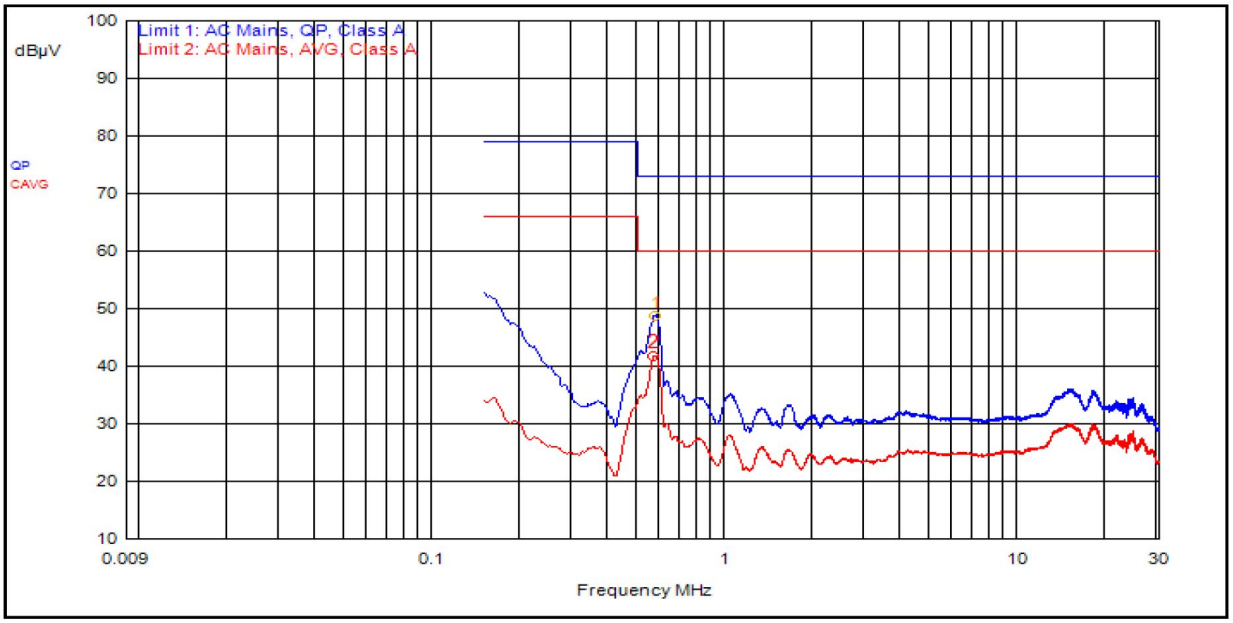
5.2 Conducted Emissions at Mains Ports Data

Line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	576.000kHz	12.3	0.0		C_AVG	30.0	42.2	60.0	-17.8
1	570.000kHz	12.3	0.0		QPeak	36.4	48.7	73.0	-24.3

Neutral



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit	Limit Dist.
2	567.000kHz	12.3	0.0		C_AVG	29.4	41.7	60.0	-18.3
1	570.000kHz	12.3	0.0		QPeak	36.6	48.8	73.0	-24.2

Result

The EUT complied with the specification limit.

5.3 §15.403(i) 26dB Emission Bandwidth

Frequency (MHz)	99% Bandwidth	Emissions 26 dB Bandwidth (MHz)
5255	9.4	10.4
5300	9.35	10.45
5340	9.4	10.4
5480	9.45	10.4
5600	9.45	10.4
5715	9.45	10.4

Result

The 26 dB bandwidths are reported for informational purposes. Please see Annex for all bandwidth measurements

5.4 §15.407(a)(1) Maximum Average Output Power

The maximum average RF conducted output power measured for this device within the UNII-2A band was 17.9 dBm or 61.7 mW. The maximum average RF conducted output power measured for this device within the UNII-2C band was 17.2 dBm or 52.5 mW. The limit is 24 dBm or 250 mWatt when using antennas with 6 dBi or less gain. The antenna has a maximum gain of 12 dBi. Therefor the conducted output power limit is 18 dBm.
EIRP - Ant Gain = Conducted Power.

UNII-2A

Bandwidth	Test Frequency	Data Rate	TP setting	Measured EIRP	Measured PSD
MHz	MHz			dBm	dBm
10	5255	vt0	15	27.1	4.52
10	5300	vt0	15	27.8	4.82
10	5340	vt0	12	24.3	1.95
20	5260	vt0	18	28.8	3.47
20	5300	vt0	15	26.8	1.84
20	5335	vt0	12	25	0.12
30	5265	vt0	18	29.9	4.33
30	5300	vt0	18	29.4	4.3
30	5330	vt0	11	24.1	-2.12
40	5270	vf0	18	29.8	2.72
40	5300	vf0	13	24.5	-1.99
40	5325	vf0	10	22.2	-4.57
50	5275	vf0	13	24	-3.08
50	5300	vf0	12	24.2	-3.42
50	5320	vf0	11	23.6	-4.66

UNII-2C

Bandwidth	Test Frequency	Data Rate	TP setting	Measured EIRP	Measured PSD
MHz	MHz			dBm	dBm
10	5480	vt0	12	26.2	2.49
10	5600	vt0	15	27.8	4.65
10	5715	vt0	11	24.7	1.53
20	5485	vt0	12	26.3	-0.25
20	5600	vt0	15	28.5	2.67
20	5710	vt0	11	24.8	-1.25
30	5490	vt0	11	25.2	-1.39
30	5600	vt0	15	29.2	2.2
30	5705	vt0	11	25.3	-1.49
40	5495	vf0	10	26.2	-1.77
40	5600	vf0	15	28.5	1.11
40	5700	vf0	11	24.6	-2.96
50	5500	vf0	10	24.4	-3.8
50	5600	vf0	15	28.3	-0.12
50	5690	vf0	11	24.5	-4.05

Result

In the configuration tested, the maximum average RF output power was less than 1 watt; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plots below).

5.5 §15.407(b)Spurious Emissions

5.5.1 Conducted Spurious Emissions

The frequency range from the lowest frequency generated or used in the device to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. The graphs show the measurement data from spurious emissions noted across the frequency range when transmitting at the lowest frequency, middle frequency and upper frequency. Shown below are plots with the EUT tuned to the upper and lower channels with the antenna gain of 12 dBi accounted for. These demonstrate compliance with the provisions of this section at the band edges.

The emissions must be remain below -27 dBm EIRP

Result

Conducted spurious emissions were below -27dBm; therefore, the EUT complies with the specification.

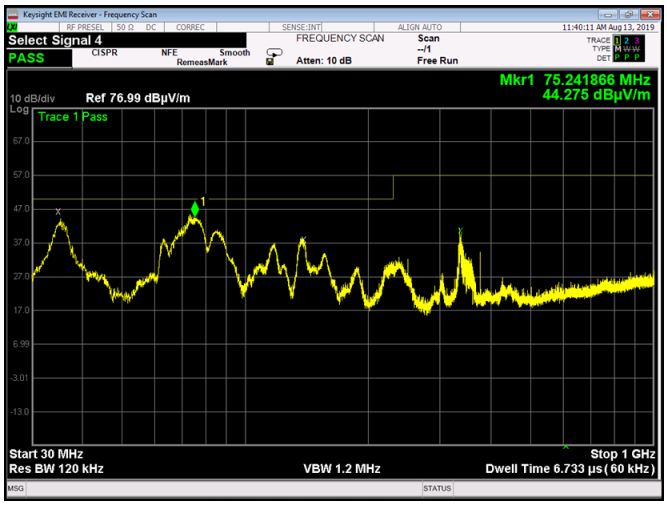
See Annex for results

5.5.2 Radiated Spurious Emissions in the Restricted Bands of §15.205

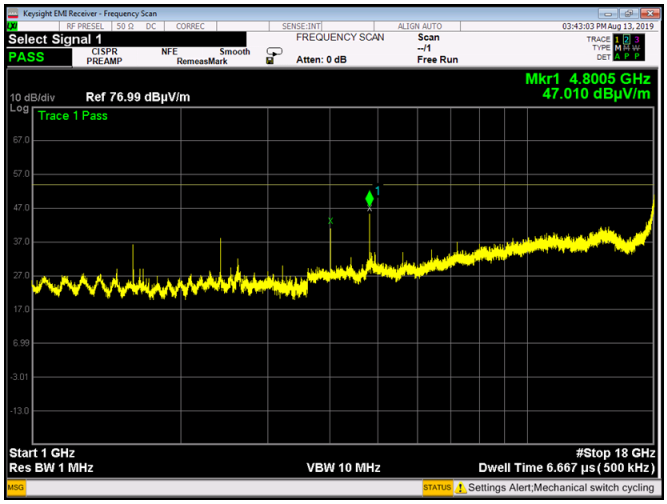
The frequency range from the lowest frequency generated or used in the device to the tenth harmonic of the highest fundamental emissions was investigated to measure any radiated emissions in the restricted bands. For frequencies above 18.0 GHz, a measurement distance of 3 meter was used. The noise floor was a minimum of 6 dB below the limits. The emissions in the restricted bans must meet the limits specified in §15.209. Conducted measurement results are included in the Annex. Radiated data with the EUT transmitting into a load is included below. All emissions between the required frequencies were investigate, the following plots represent the worst case.

Vertical

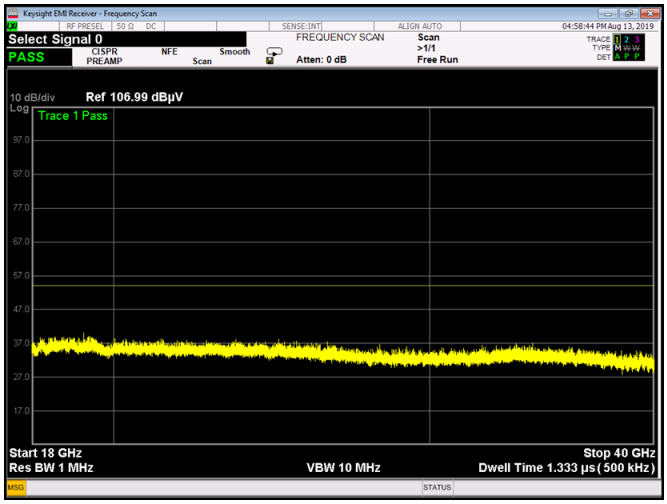
30 MHz - 1 GHz



1 – 18 GHz

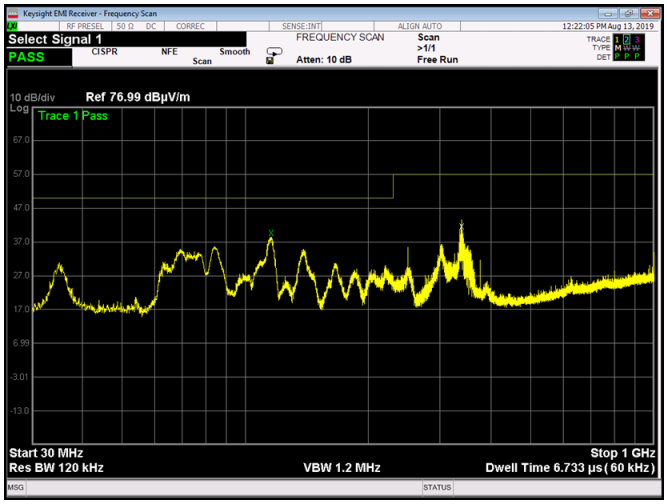


18 GHz – 40 GHz

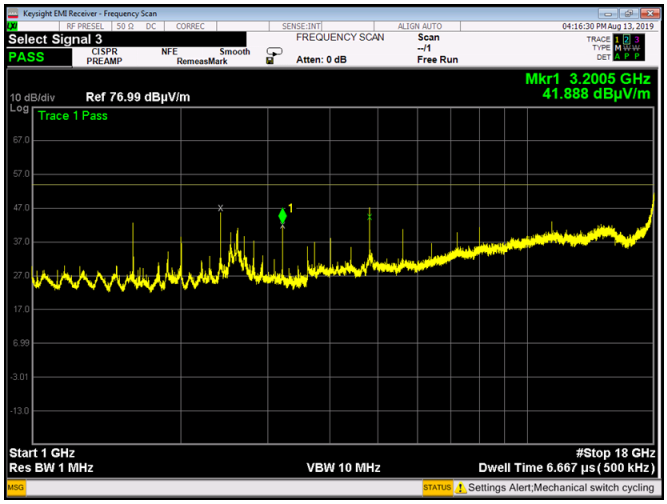


Horizontal

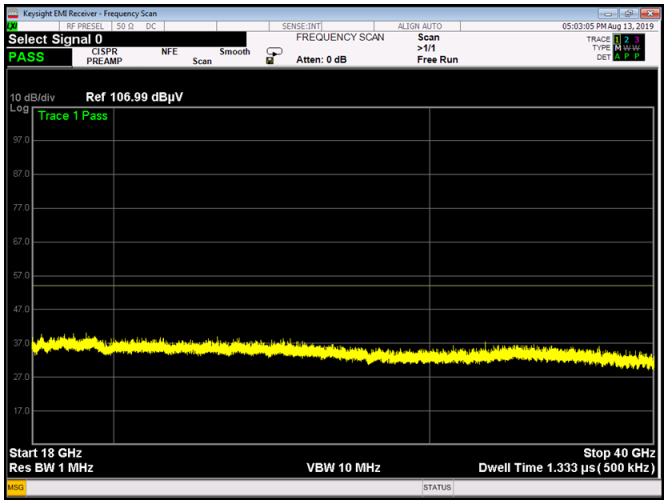
30 MHz – 1 GHz



1 GHz – 18 GHz



16 GHz – 40 GHz



Result

All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.

5.6 §15.407(a) Maximum Power Spectral Density

The maximum average power spectral density conducted from the intentional radiator of the antenna shall not be greater than 11 dBm in any 1 MHz band during any time interval of continuous transmission. Results of this testing are summarized. With a 12 dBi antenna, the conducted limit for power spectral density is 5 dBm

UNII-2A

Bandwidth	Test Frequency	Data Rate	TP setting	Measured EIRP	Measured PSD
MHz	MHz			dBm	dBm
10	5255	vt0	15	27.1	4.52
10	5300	vt0	15	27.8	4.82
10	5340	vt0	12	24.3	1.95
20	5260	vt0	18	28.8	3.47
20	5300	vt0	15	26.8	1.84
20	5335	vt0	13	25	0.12
30	5265	vt0	18	29.9	4.33
30	5300	vt0	18	29.4	4.3
30	5330	vt0	11	24.1	-2.12
40	5270	vf0	18	29.8	2.72
40	5300	vf0	13	24.5	-1.99
40	5325	vf0	10	22.2	-4.57
50	5275	vf0	13	24	-3.08
50	5300	vf0	12	24.2	-3.42
50	5320	vf0	11	23.6	-4.66

UNII-2C

Bandwidth	Test Frequency	Data Rate	TP setting	Measured EIRP	Measured PSD
MHz	MHz			dBm	dBm
10	5480	vt0	12	26.2	2.49
10	5600	vt0	15	27.8	4.65
10	5715	vt0	11	24.7	1.53
20	5485	vt0	12	26.3	-0.25
20	5600	vt0	15	28.5	2.67
20	5710	vt0	11	24.8	-1.25
30	5490	vt0	11	25.2	-1.39
30	5600	vt0	15	29.2	2.2
30	5705	vt0	11	25.3	-1.49
40	5495	vf0	10	26.2	-1.77
40	5600	vf0	15	28.5	1.11
40	5700	vf0	11	24.6	-2.96
50	5500	vf0	10	24.4	-3.8
50	5600	vf0	15	28.3	-0.12
50	5690	vf0	11	24.5	-4.05

Result

The maximum average power spectral density was less than the limit of 8 dBm; therefore, the EUT complies with the specification.

5.7 §15.407 DFS Requirement

This product is a client without radar detection. The outcome of the required DFS tests is located in the DFS Annex. The product passes all required DFS tests for a client without radar detection.

Table 1: Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	Master	**Client Without Radar Detection**	**Client With Radar Detection**
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	**Client Without Radar Detection**
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

-- End of Test Report --