UNIFIED COMPLIANCE LABORATORY

427 West 12800 South
Draper, UT 84020

Test Report

Certification

FCC ID	SWX-WAVEPRO
IC ID	6545A-WAVEPRO
Equipment Under Test	Wave-Pro
Test Report Serial Number	TR7357_01
Date of Test(s)	26, 28 July; 3, 8, 17 August 2022
Report Issue Date	19 August 2022

Test Specification	Applicant
47 CFR FCC Part 15, Subpart C	Ubiquiti Inc. 685 Third Avenue New York, NY 10017 U.S.A.

NVLAP TESTING ilac-MRA

NVLAP LAB CODE 600241-0

Certification of Engineering Report

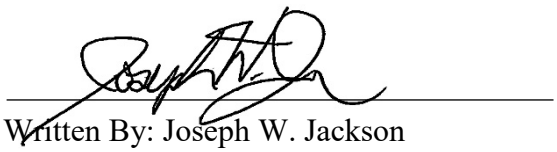
This report has been prepared by Unified Compliance Laboratory (UCL) to document compliance of the device described below with the requirement of Federal Communication Commissions (FCC) Part 15, Subpart C. This report may be reproduced in full. Partial reproduction of this report may only be made with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

Applicant	Ubiquiti Inc.
Manufacturer	Ubiquiti Inc.
Brand Name	airFiber
Model Number	Wave-Pro
FCC ID	SWX-WAVEPRO
IC ID	6545A-WAVEPRO

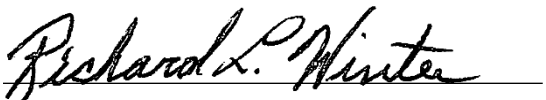
On this 19th day of August 2022, I individually and for Unified Compliance Laboratory certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge and are made in good faith.

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 U.S. federal government.

Unified Compliance Laboratory



Written By: Joseph W. Jackson



Reviewed By: Richard L. Winter

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	19 August 2022

Table of Contents

1 Client Information

1.1 Applicant

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

1.2 Manufacturer

Company	Ubiquiti Inc. 685 Third Avenue 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	airFiber
Model Number	Wave-AP
Serial Number	A26196
Dimensions (cm)	42.4 x 42.4 x 16.6

2.2 Description of EUT

The Wave-Pro is a client 60 GHz point-to-multipoint customer premise equipment that features wave technology with a 2.5 Gbps throughput rate. The Wave-Pro is also equipped with a 5 GHz WiFi 6 backup radio to sustain connectivity during a 60 GHz link disruption caused by inclement weather conditions. A Bluetooth LE transceiver is included for device management. The Wave-Pro is an outdoor device and has an Ethernet port which is used for data transfer and to provide power using an Ubiquiti U-POE-at 48-volt PoE power adapter.

This report covers the circuitry of the device subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Part 15 Subpart B was found to be compliant and is covered under a separate Unified Compliance Laboratory test report.

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: airFiber MN: Wave-Pro (Note 1) SN: A26196	Wireless Access Point	See Section 2.4
BN: Ubiquiti MN: U-POE-at SN: N/A	PoE Power Adapter	Shielded or Un-shielded cat 5e cable
BN: Dell MN: XPS 13 SN: N/A	Laptop Computer	Shielded or Un-shielded cat 5e cable

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
AC (PoE Injector)	1	3 conductor power cord/80cm
LAN (PoE Injector)	1	Shielded or Un-shielded cat 5e cable/1 meter
Data	1	Shielded or Un-shielded cat 5e cable/1 meter

2.5 Operating Environment

Power Supply	120 Volts AC to 48 Volts PoE
AC Mains Frequency	60 Hz
Temperature	23.7 – 24.1 °C
Humidity	28.1 – 35.9 %
Barometric Pressure	1013mBar

2.6 Operating Modes

The Wave-Pro was connected to a personal computer laptop and tested using test software in order to enable to constant duty cycle greater or equal to 98% of the Bluetooth transceiver.

2.7 EUT Exercise Software

EUT firmware version 1.0 was used to operate the transmitter using a constant transmit mode.

2.8 Block Diagram of Test Configuration

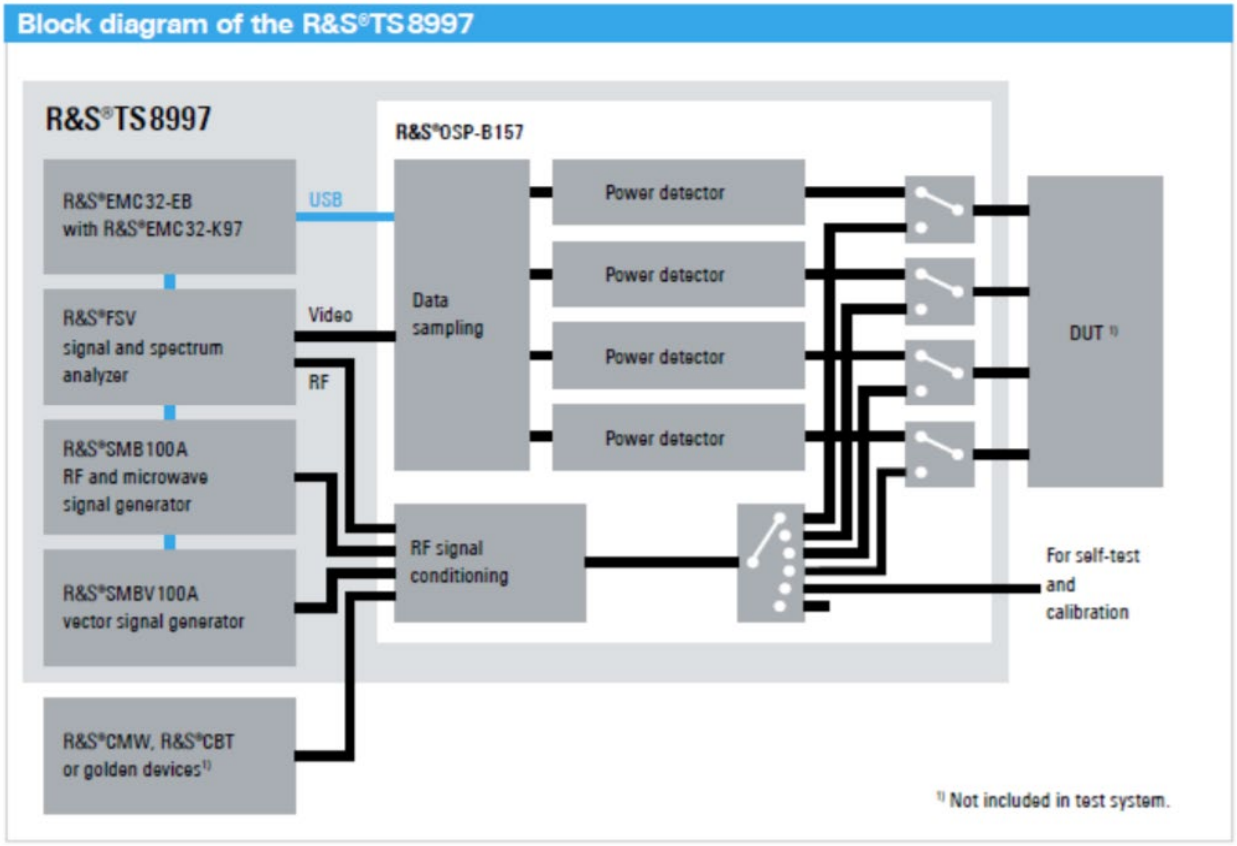


Diagram 1: Test Configuration Block Diagram

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 C 15.203, 15.207 and 15.247 Limits and methods of measurement of radio interference characteristics of radio frequency 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 15.203

See test standard for details.

3.2.2 47 CFR FCC Part 15 Section 15.207

See test standard for details.

3.2.3 47 CFR FCC Part 15 Section 15.247

See test standard for details.

3.3 FCC Part 15, Subpart C

3.3.1 Summary of Tests

FCC Section	ISED Section	Environmental Phenomena	Frequency Range (MHZ)	Result
15.203	N/A	Antenna requirements	Structural Requirement	Compliant
15.207	RSS-Gen	Conducted Disturbance at Mains Port	0.15 to 30	Compliant
15.247(a)	RSS-247 § 5.2	Bandwidth Requirement	2400 to 2483.5	Compliant
15.247(b)	RSS-247 § 5.4	Peak Output Power	2400 to 2483.5	Compliant
15.247(d)	RSS-247 § 5.4	Antenna Conducted Spurious Emissions	0.009 to 40000	N/A
15.247(d)	RSS-247 § 5.4	Radiated Spurious Emissions	0.009 to 40000	Compliant
15.247(e)	RSS-247 § 5.2	Peak Power Spectral Density	2400 to 2483.5	Compliant
The testing was performed according to the procedures in ANSI C63.10-2013, KDB 558074 and 47 CFR Part 15. Where applicable, KDB 662911 was followed to sum required measurements.				

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 and 10-Meter chambers 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 2023. This site has also been registered with Innovations, Science and Economic Development (ISED) department and was accepted under Appendix B, Phase 1 procedures of the APEC Tel MRA for Canadian recognition. ISED No.: 25346, effective until 30 June 2023. Unified Compliance Laboratory has been assigned Conformity Assessment Number US0223 by ISED.

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-6754	12/8/2021	12/8/2022
LISN	AFJ	LS16C/10	UCL-6749	12/6/2021	12/6/2023
Cat6 ISN	Teseq	ISN T8-Cat6	UCL-2971	1/30/2022	1/30/2023
ISN	Teseq	ISN T800	UCL-2974	6/27/2022	6/272023
LISN	Com-Power	LIN-120C	UCL-2612	1/6/2022	1/6/2023
AC Power Source	Laplace Instruments	AC1000A	UCL-2857	N/A	N/A
Test Software	UCL	Revision 1	UCL-3107	N/A	N/A

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

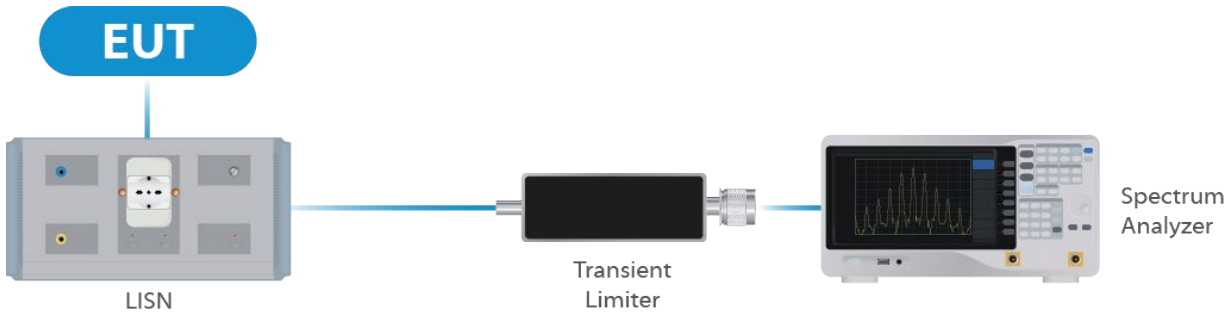


Figure 1: Conducted Emissions Test

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	1/03/2022	1/03/2023
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	1/03/2022	1/03/2023
Switch Extension	R&S	OSP-150W	UCL-2870	1/03/2022	1/03/2023

Table 2: List of equipment used for Direct Connect at the Antenna Port

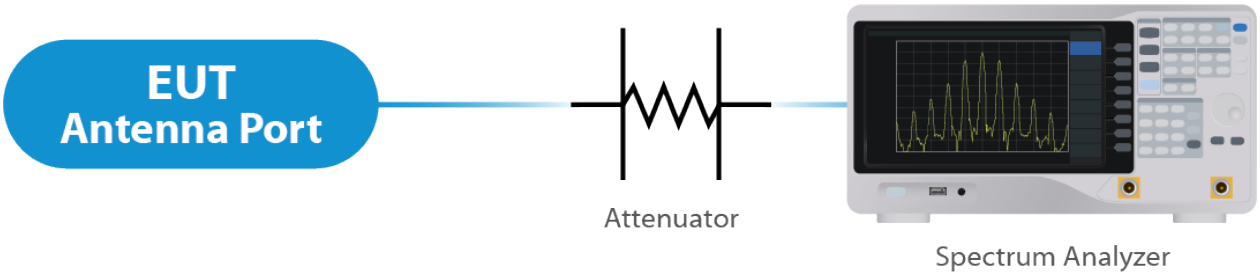


Figure 2: Direct Connect at the Antenna Port Test

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	1/4/2022	1/4/2023
Pre-Amplifier 9 kHz – 1 GHz	Sonoma Instruments	310N	UCL-2889	10/7/2021	10/7/2022
Pre-Amplifier 9 kHz – 1 GHz	Sonoma Instruments	310N	UCL-4793	10/7/2021	10/7/2022
Pre-Amplifier 1 – 18 GHz	Com-Power	PAM 118A	UCL-3833	10/7/2021	10/7/2022
Pre-Amplifier 1 – 18 GHz	The EMC Shop	PA18G	UCL-5896	3/11/3022	3/11/2023
Pre-Amplifier 15 – 40 GHz	L3 Harris	LNA-40-18004000-40-15P	UCL-4465	11/3/2021	11/3/2022
Broadband Antenna	Scwarzbeck	VULB 9163	UCL-3062	8/28/2020	8/28/2022
Double Ridge Horn Antenna	Com-Power	AH-118	UCL-5582	11/19/2020	11/19/2022
Log Periodic	Scwarzbeck	STLP 9129	UCL-3068	11/16/2020	11/16/2022
15 - 40 GHz Horn Antenna	ETS-Lindgren	3116C	UCL-7209	6/1/2022	6/6/2024
Test Software	UCL	Revision 1	UCL-3108	N/A	N/A

Table 3: List of equipment used for Radiated Emissions

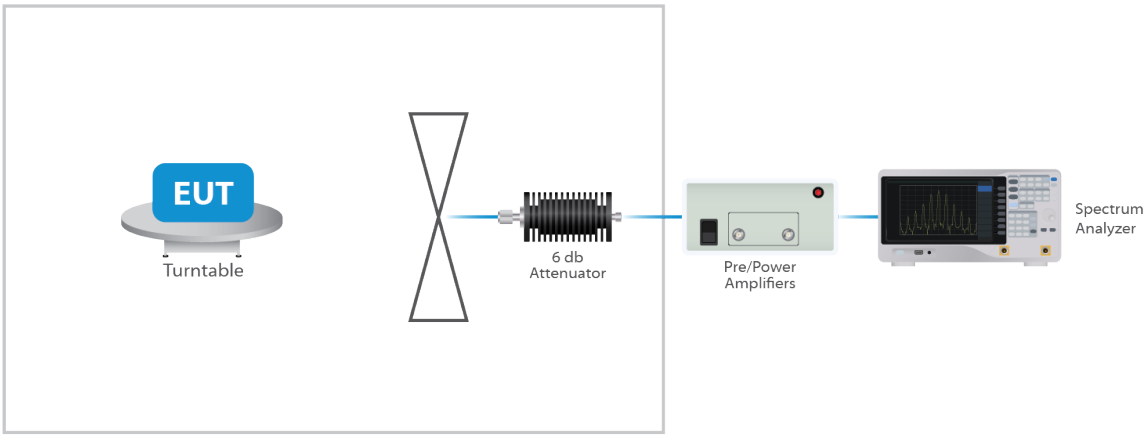


Figure 3: Radiated Emissions Test

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)	4.38	95
Radiated Emissions (1 GHz to 18 GHz)	4.37	95
Radiated Emissions (18 GHz to 40 GHz)	3.93	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

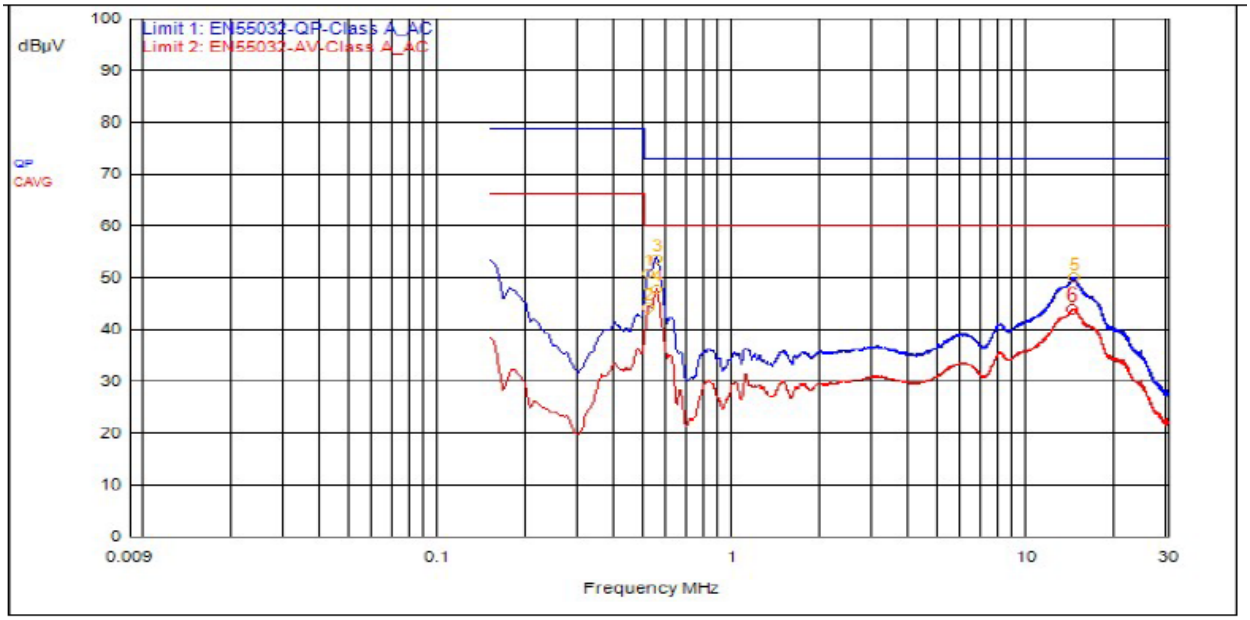
5.1 §15.203 Antenna Requirements

The EUT uses an integral antenna. The Maximum gain of the antenna is 2.0 dBi. The antenna is not user replaceable.

Results

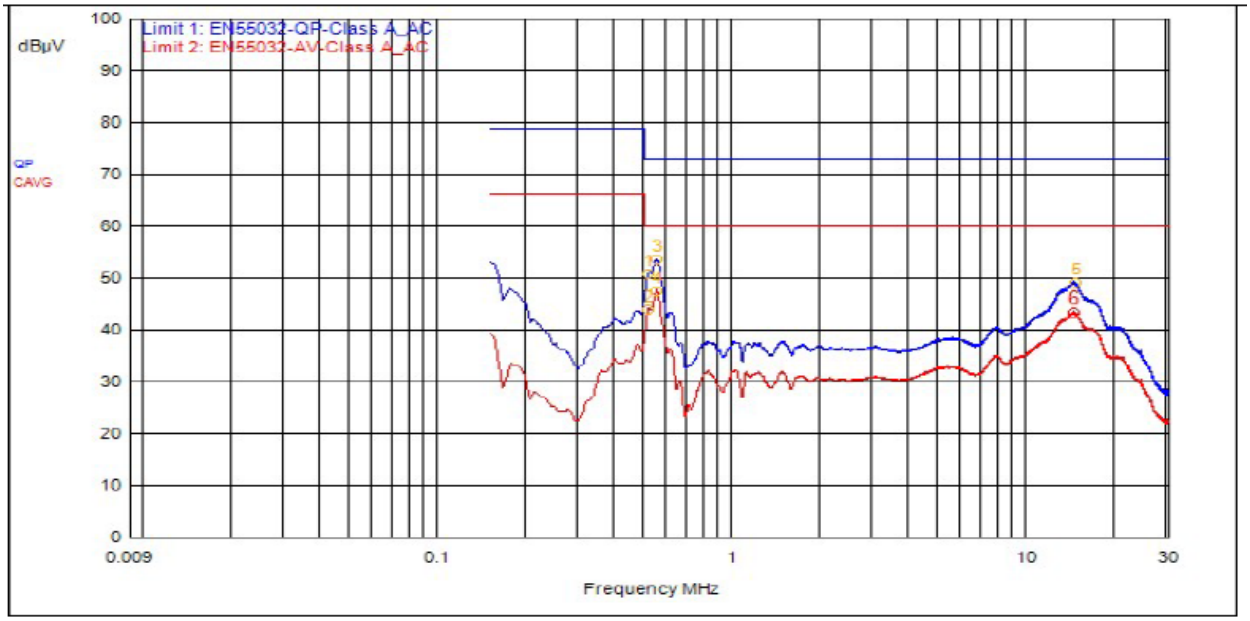
The EUT complied with the specification

5.2 Conducted Emissions at Mains Ports Data



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.
3	549,000kHz	9.5	0.1		QPeak	44.1	53.7	73.0	-19.3		
1	513,000kHz	9.5	0.1		QPeak	41.1	50.8	73.0	-22.2		
5	14.319MHz	9.6	0.2		QPeak	40.0	49.9	73.0	-23.1		
2	513,000kHz	9.5	0.1		C_AVG	34.4	44.1			60.0	-15.9
4	549,000kHz	9.5	0.1		C_AVG	38.0	47.7			60.0	-12.3
6	14.154MHz	9.6	0.2		C_AVG	34.2	44.0			60.0	-16.0

Graph 1: Conducted Emissions Plot - Neutral



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.
3	546,000kHz	9.5	0.1		QPeak	43.8	53.5	73.0	-19.5		
1	516,000kHz	9.5	0.1		QPeak	41.2	50.8	73.0	-22.2		
5	14.385MHz	9.7	0.2		QPeak	39.4	49.3	73.0	-23.7		
2	513,000kHz	9.5	0.1		C_AVG	34.4	44.0			60.0	-16.0
4	549,000kHz	9.5	0.1		C_AVG	38.0	47.6			60.0	-12.4
6	14.334MHz	9.7	0.2		C_AVG	33.5	43.4			60.0	-16.6

Graph 2: Conducted Emissions Plot – Line 1

Result

The EUT complied with the specification limit.

5.3 §15.247(a)(2) Emissions Bandwidth

Frequency (MHz)	Emissions 6 dB Bandwidth (MHz)	Emissions 99% Bandwidth (MHz)
2402	0.67	0.99
2442	0.50	0.99
2480	0.67	0.99

Result

In the configuration tested, the 6 dB bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plot within the Annex).

5.4 §15.247(b)(3) Maximum Average Output Power

The maximum average RF conducted output power measured for this device was 6.61 dBm or 4.58 mW. The limit is 30 dBm or 1 Watt when using antennas with 6 dBi or less gain. The antenna has a gain of 2.0 dBi.

Frequency (MHz)	Measured Output Power (dBm)	Output Power (mW)
2402	6.61	4.58
2442	6.27	4.24
2480	5.24	3.34

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 plot within the Annex).

5.5 §15.247(d) Spurious Emissions

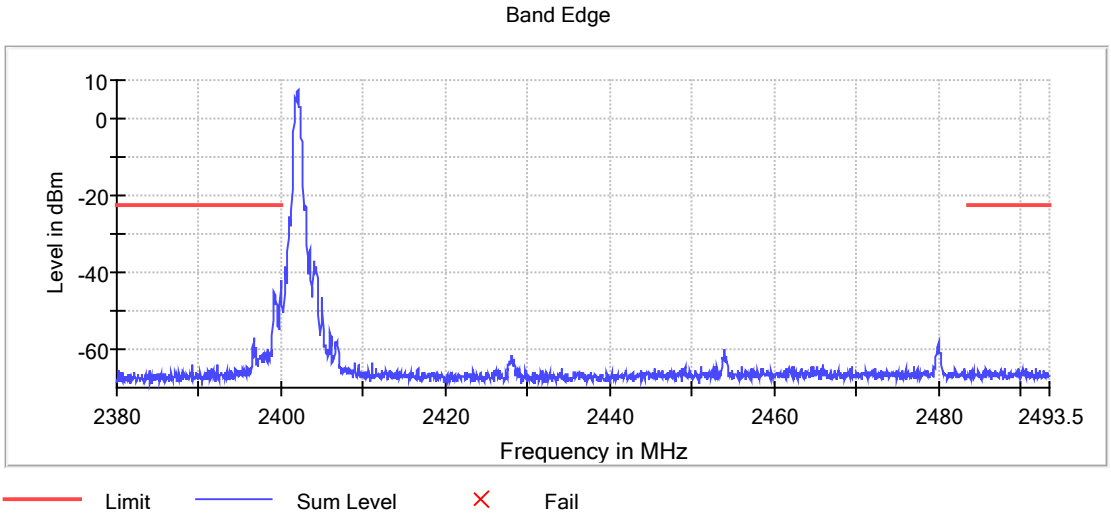
5.5.1 Conducted Spurious Emissions

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 table 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 and within the Annex are plot(s) with the EUT tuned to the upper and lower channels. These demonstrate compliance with the provisions of this section at the band edges.

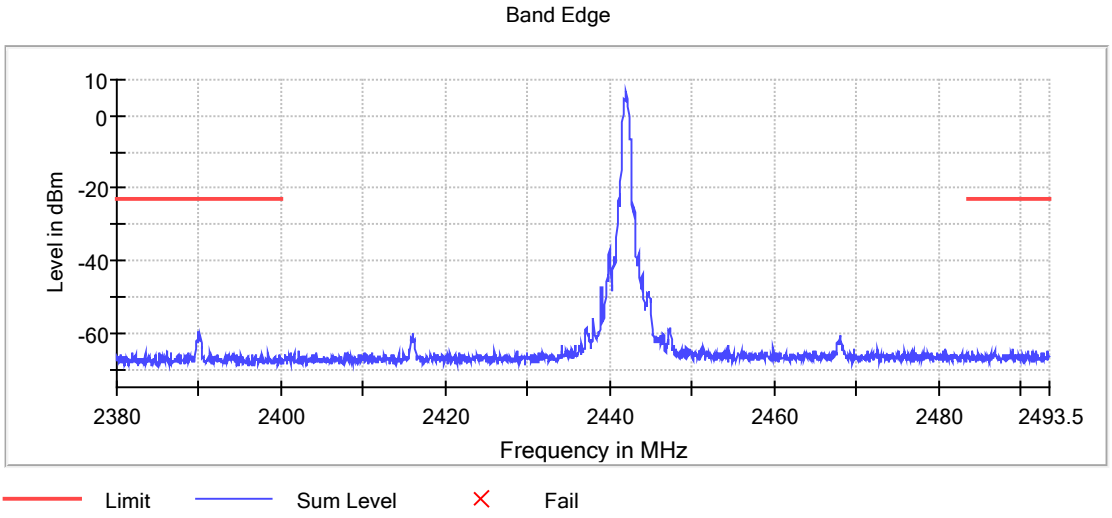
The emissions must be attenuated 30 dB below the highest power spectral density level measured within the authorized band as measured with a 100 kHz RBW.

Result

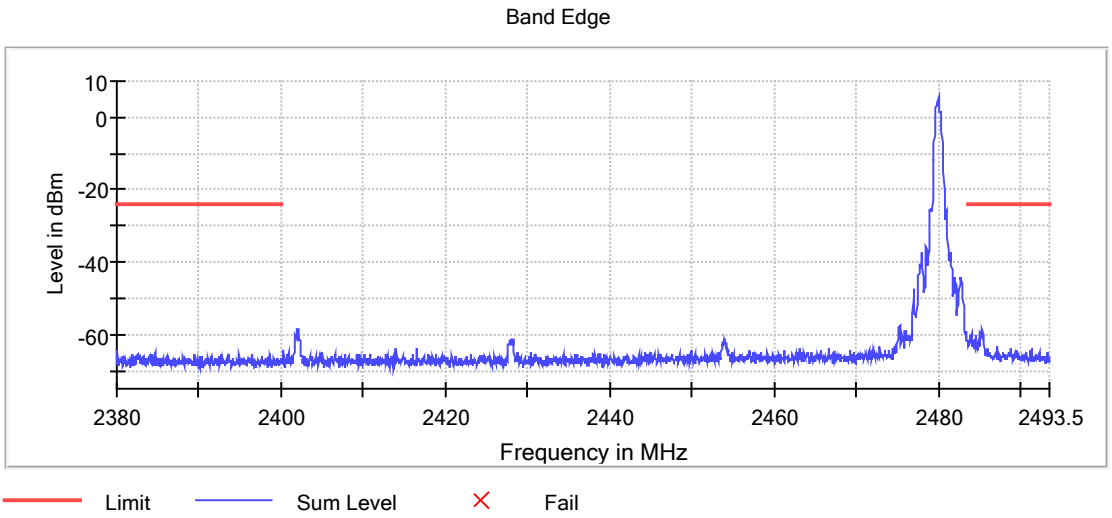
Conducted spurious emissions were attenuated 30 dB or more below the fundamental; therefore, the EUT complies with the specification.



Graph 3: Band Edge Plot 2402 MHz



Graph 4: Band Edge Plot 2442 MHz



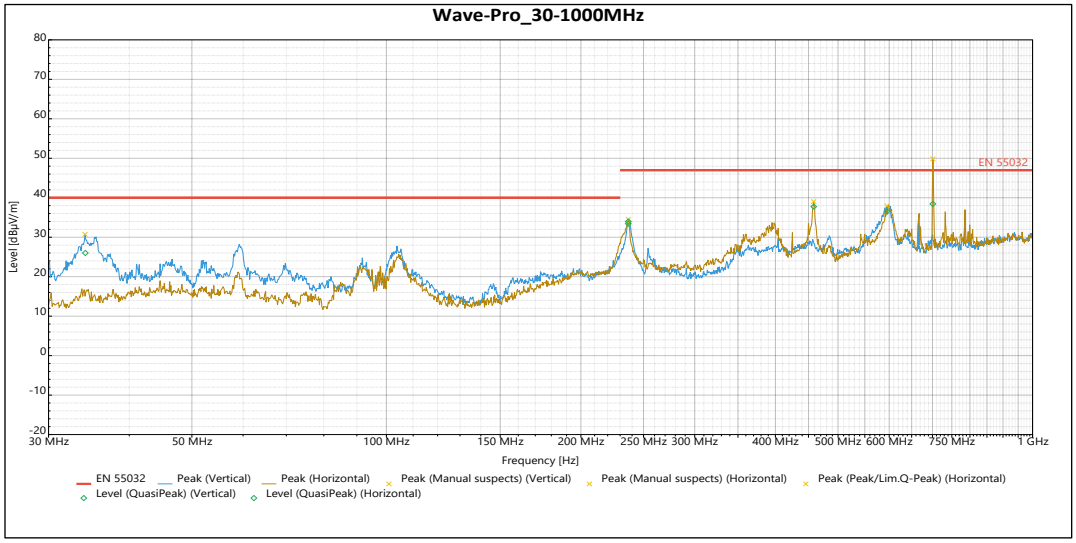
Graph 5: Band Edge Plot 2480 MHz

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. The following tables show measurements of any emissions that fell into the restricted bands of §15.205. The tables show the worst-case emissions measured from the EUT. For frequencies above 18.0 GHz, a measurement distance of 1 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. Tabular data for each of the spurious emissions is shown below for each of the units. Plots of the band edges are also shown.

Result

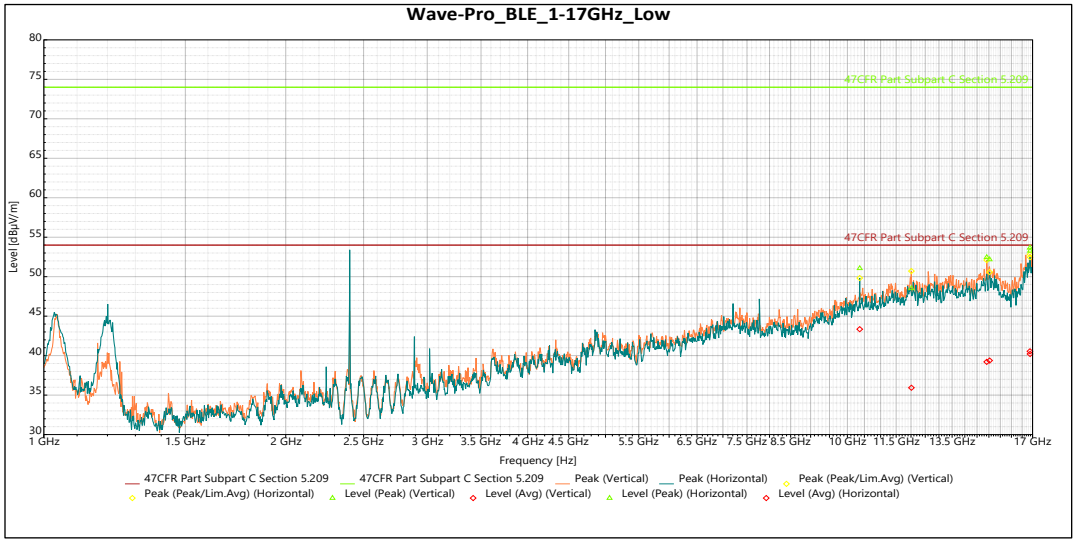
All emissions in the restricted bands of §15.205 met the limits specified in §15.209; therefore, the EUT complies with the specification.



QuasiPeak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin	Azimuth (°)	Height	Pol.	Correction (dB)
34.199 MHz	26.004	40	-13.996	79	1.063	Vertical	-14.947
236.8 MHz	33.945	47	-13.055	115	1.004	Vertical	-12.533
595.17 MHz	36.5	47	-10.5	137	2.317	Vertical	-4.79
236.75 MHz	33.447	47	-13.553	166	3.863	Horizontal	-12.536
458.53 MHz	37.758	47	-9.242	118	1.849	Horizontal	-7.95
700.94 MHz	38.441	47	-8.559	153	1.218	Horizontal	-3.922

Table 4: Radiated Emission 30 – 1000 MHz



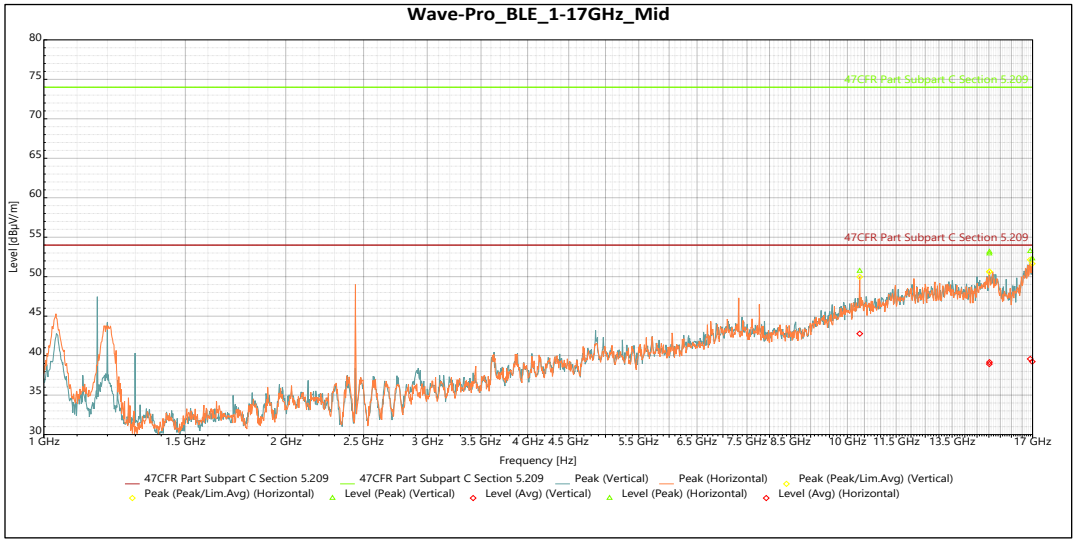
Peak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
12.014 GHz	48.525	74	-25.475	53	2.329	Vertical	4.118
14.908 GHz	52.464	74	-21.536	79	4	Vertical	7.338
16.874 GHz	53.658	74	-20.342	243	3.802	Vertical	9.736
10.36 GHz	51.063	74	-22.937	117	2.812	Horizontal	1.024
15.031 GHz	52.184	74	-21.816	14	3.802	Horizontal	7.795
16.879 GHz	53.269	74	-20.731	323	3.311	Horizontal	9.835

Avg

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
12.014 GHz	35.933	54	-18.067	53	2.329	Vertical	4.118
14.908 GHz	39.21	54	-14.79	79	4	Vertical	7.338
16.874 GHz	40.555	54	-13.445	243	3.802	Vertical	9.736
10.36 GHz	43.351	54	-10.649	117	2.812	Horizontal	1.024
15.031 GHz	39.38	54	-14.62	14	3.802	Horizontal	7.795
16.879 GHz	40.209	54	-13.791	323	3.311	Horizontal	9.835

Table 5: Radiated Emissions Transmitting at the Lowest Frequency 1 – 17 GHz



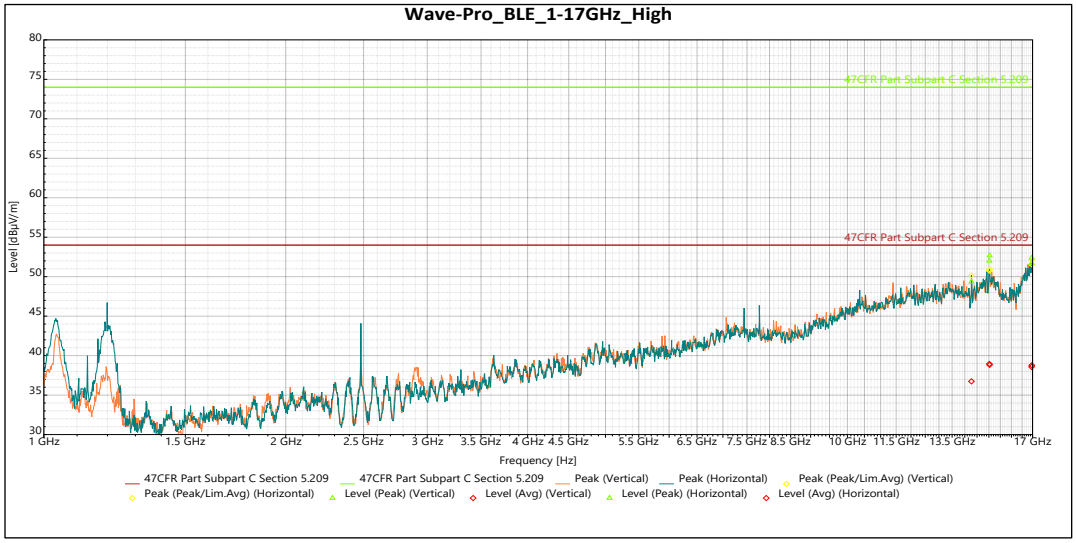
Peak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
15.02 GHz	52.918	74	-21.082	139	3.307	Vertical	7.926
16.888 GHz	53.226	74	-20.774	245	1.834	Vertical	9.736
10.36 GHz	50.72	74	-23.28	123	1.5	Horizontal	1.024
15.025 GHz	53.145	74	-20.855	273	4	Horizontal	8.131
16.988 GHz	52.292	74	-21.708	70	1.5	Horizontal	9.367

Avg

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
15.02 GHz	38.933	54	-15.067	139	3.307	Vertical	7.926
16.888 GHz	39.575	54	-14.425	245	1.834	Vertical	9.736
10.36 GHz	42.784	54	-11.216	123	1.5	Horizontal	1.024
15.025 GHz	39.172	54	-14.828	273	4	Horizontal	8.131
16.988 GHz	39.237	54	-14.763	70	1.5	Horizontal	9.367

Table 6: Radiated Emissions Transmitting at the Middle Frequency 1 – 17 GHz



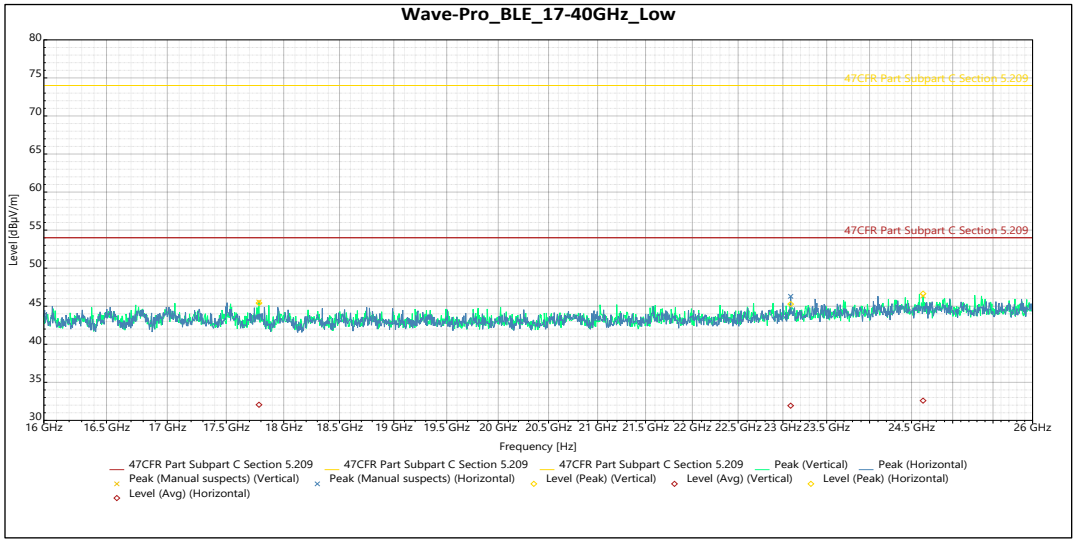
Peak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
15.022 GHz	51.995	74	-22.005	20	3.802	Vertical	8.007
16.962 GHz	52.382	74	-21.618	219	2.325	Vertical	8.874
14.269 GHz	49.343	74	-24.657	1	3.798	Horizontal	5.355
15.031 GHz	52.681	74	-21.319	57	3.798	Horizontal	7.795
16.952 GHz	51.703	74	-22.297	300	3.311	Horizontal	8.564

Avg

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
15.022 GHz	38.953	54	-15.047	20	3.802	Vertical	8.007
16.962 GHz	38.784	54	-15.216	219	2.325	Vertical	8.874
14.269 GHz	36.742	54	-17.258	1	3.798	Horizontal	5.355
15.031 GHz	38.825	54	-15.175	57	3.798	Horizontal	7.795
16.952 GHz	38.571	54	-15.429	300	3.311	Horizontal	8.564

Table 7: Radiated Emissions Transmitting at the Highest Frequency 1 – 17 GHz



Peak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Pol.	Correction (dB)
17.783 GHz	45.425	74	-28.575	316	Vertical	-5.674
24.639 GHz	46.652	74	-27.348	249	Vertical	-4.982
23.088 GHz	45.278	74	-28.722	140	Horizontal	-4.587

Avg

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Pol.	Correction (dB)
17.783 GHz	32.048	54	-21.952	316	Vertical	-5.674
24.639 GHz	32.593	54	-21.407	249	Vertical	-4.982
23.088 GHz	31.926	54	-22.074	140	Horizontal	-4.587

Table 8: Radiated Emissions Transmitting at the Lowest Frequency 17 – 40 GHz (worse case)

5.6 §15.247(e) Maximum Average Power Spectral Density

The maximum average power spectral density conducted from the intentional radiator of the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. Results of this testing are summarized.

Frequency (MHz)	Measurement (dBm)	Criteria (dBm)
2402	-0.96	8.0
2442	-1.40	8.0
2480	-2.44	8.0

Result

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

-- End of Test Report --