



427 West 12800 South
Draper, UT 84020

Test Report Certification

FCC ID	SWX-WAVEAPR
ISED ID	6545A-WAVEAPR
Equipment Under Test	Wave-AP
Test Report Serial Number	TR6987_01
Date of Test(s)	14, 28 February and 1, 15, 16 March 2022
Report Issue Date	18 May 2022

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



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 Inc.
Manufacturer	Ubiquiti Inc.
Brand Name	airFiber
Model Number	Wave-AP
FCC ID	SWX-WAVEAPR
ISED ID	6545A-WAVEAPR

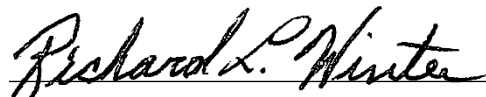
On this 18th day of May 2022, I individually and for Unified Compliance Laboratory certify that the statements made in this engineering report are true, complete and correct to the best of my knowledge and are made in good faith.

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	18 May 2022

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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	245A4C2F9610
Dimensions (cm)	21.2 x 20.5 x 17.0

2.2 Description of EUT

The Wave-AP is a fixed point-to-point or point-to-multiple point transceiver operating in the 57 GHz to 71 GHz range. The Wave-AP provides 2.5+ Gbps throughput and supports up to 15 client devices. The Wave-AP has a 5150 MHz to 5875 MHz (802.11ax) back-up radio. A Bluetooth LE transceiver is included for device management. The Wave-AP is an outdoor device and has an Ethernet port is used for transfer and to provide power using an Ubiquiti U-POE-at Power Supply.

The table below show the channels used within the different modulation bandwidths.

Band	WiFi Mode	Modulation Bandwidth	Modulation Type	Frequency (MHz)
UNII-3	ax	20 MHz	HE	5485, 5600, 5710
	ax	40 MHz	HE	5495, 5600, 5700
	ax	80 MHz	HE	5515, 5600, 5680
	ax	160 MHz	HE	5570

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 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: Ubiquiti MN: Wave-AP (Note 1) SN: 245A4C2F9610	Wireless Access Point	See Section 2.4
BN: Ubiquiti Inc. MN: U-POE-at SN: N/A	PoE Injector Power Supply	Shielded or Un-shielded Cat 5e cable (Note 2)

BN: Dell MN: XPS 13 SN: N/A	Laptop Personal Computer	Shielded or Un-shielded Cat 5e cable (Note 2)
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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
Ethernet/PoE	1	Shielded or Un-shielded Cat 5e cable

2.5 Operating Environment

Power Supply	120 Volts ac to 48 Volt PoE Power
AC Mains Frequency	60 Hz
Temperature	21.9 – 22.2 °C
Humidity	16.6 – 23.5 %
Barometric Pressure	1021 mBar

2.6 Operating Modes

The Wave-AP was tested using test software in order to enable a constant transmission. The measurements within this report are corrected to reference a 100% duty cycle. All emission modes of 802.11 ax were investigated. All measurements are reported with the worst-case mode (802.11ax) unless otherwise stated.

2.7 EUT Exercise Software

EUT firmware version 3.0.6 was used to operate the transmitter using a constant transmit mode.

2.8 Block Diagram of Test Configuration

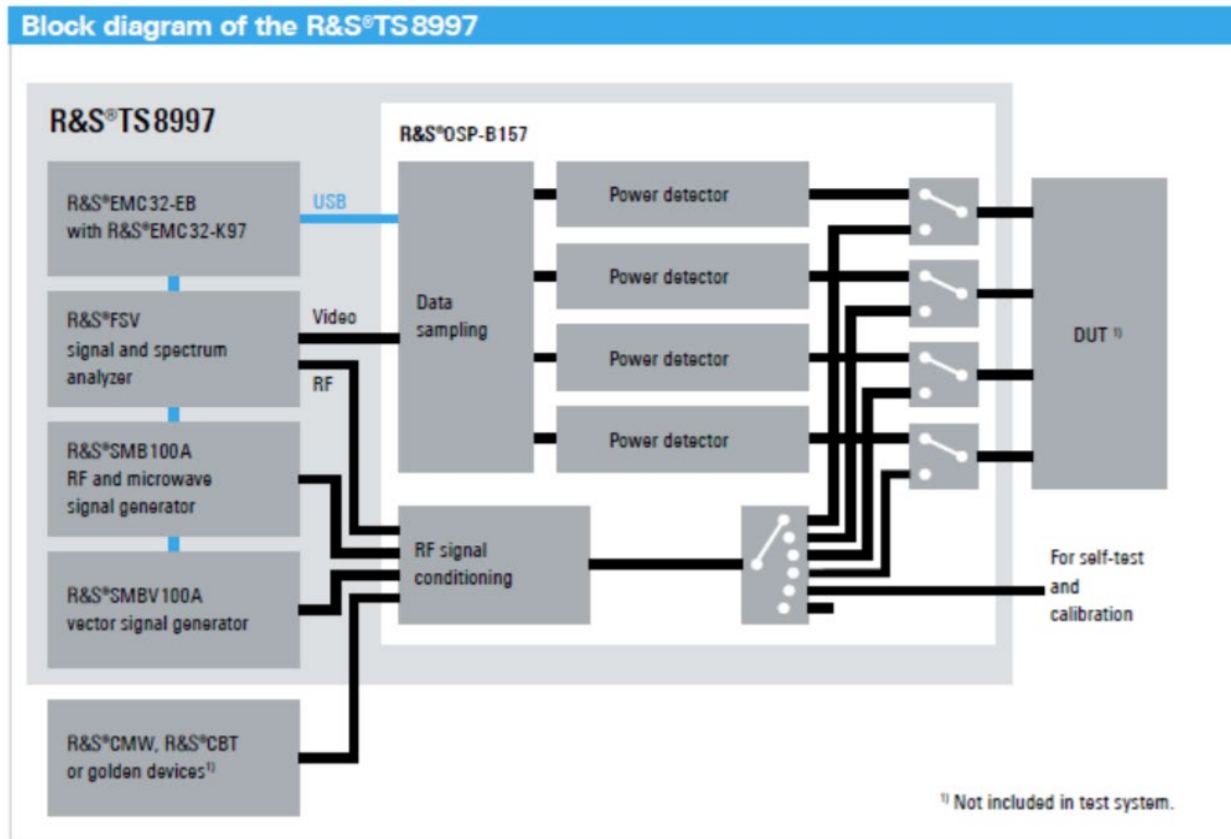


Diagram 1: Test Configuration Block Diagram

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 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	ISED Section	Environmental Phenomena	Frequency Range (MHZ)	Result
15.407(a)	N/A	Antenna requirements	Structural Requirement	Compliant
15.407(b)	RSS-Gen	Conducted Disturbance at Mains Port	0.15 to 30	Compliant
15.407(c)	RSS-247 §6.2.2, §6.2.3	Bandwidth Requirement	5725 to 5850	Compliant
15.407(e)	RSS-247 §6.2.2, §6.2.3	Peak Output Power	5725 to 5850	Compliant
15.407(f)	RSS-247 §6.2.2, §6.2.3	Antenna Conducted Spurious Emissions	0.009 to 40000	N/A
15.407(g)	RSS-247 §6.2.2, §6.2.3	Radiated Spurious Emissions	0.009 to 40000	Compliant
15.407(h)	RSS-247 §6.2.2, §6.2.3	Peak Power Spectral Density	5725 to 5850	Compliant

The testing was performed according to the procedures in ANSI C63.10-2013, KDB 789033 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 2022. This site has also been registered with Innovations, Science and Economic Development (ISED) department as was accepted under Appendix B, Phase 1 procedures of the APEC Tel MRA for Canadian recognition. ISED No.: 25346, effective until 30 June 2022. 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	6/4/2021	6/4/2022
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

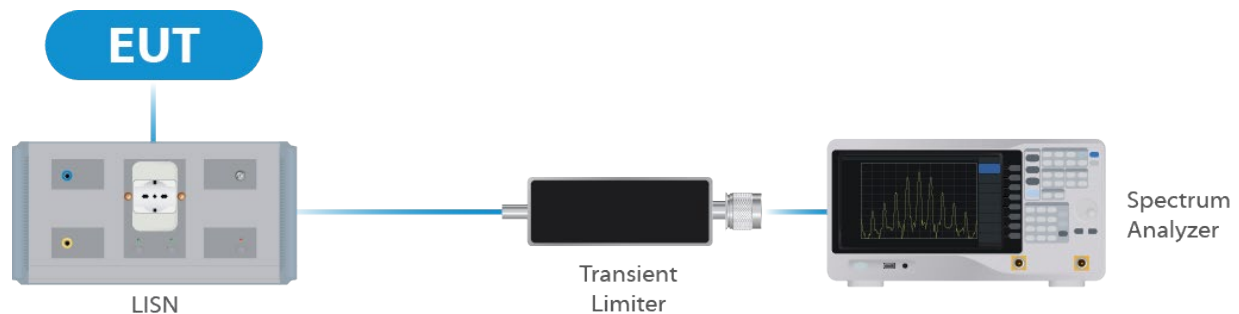


Figure 1: Conducted Emissions Test

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

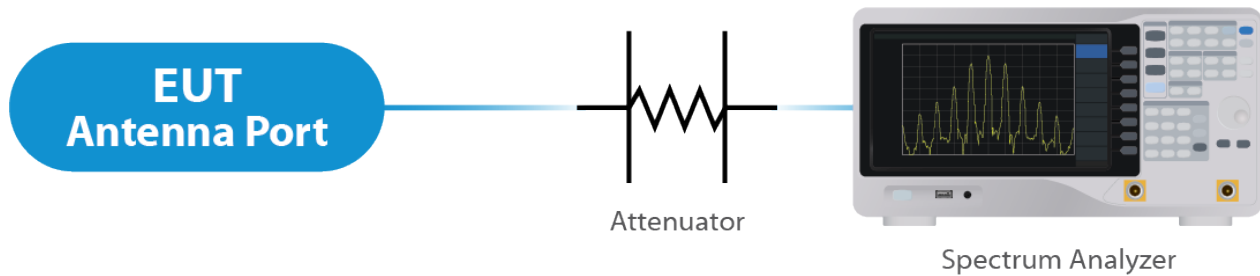


Figure 2: Direct Connect at the Antenna Port Test



Figure 3: Output Power Measurement

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	6/21/2021	6/21/2022
Pre-Amplifier 9 kHz – 1 GHz	Sonoma Instruments	310N	UCL-2889	10/7/2021	10/7/2022
Broadband Antenna	Scwarzbeck	VULB 9163	UCL-3062	8/28/2020	8/27/2022
Broadband Antenna	Scwarzbeck	VULB 9163	UCL-3071	5/19/2020	5/19/2022
Double Ridge Horn Antenna	Scwarzbeck	BBHA 9120D	UCL-3065	7/8/2021	7/8/2022
Log Periodic	Scwarzbeck	STLP 9129	UCL-3068	11/16/2020	11/16/2022
15 - 40 GHz Horn Antenna	Scwarzbeck	BBHA 9170	UCL-2487	5/21/2020	5/21/2022
1 – 18 GHz Amplifier	Com-Power	PAM 118A	UCL-3833	10/7/2021	10/7/2022
Test Software	UCL	Revision 1	UCL-3108	N/A	N/A

Table 3: List of equipment used for Radiated Emissions

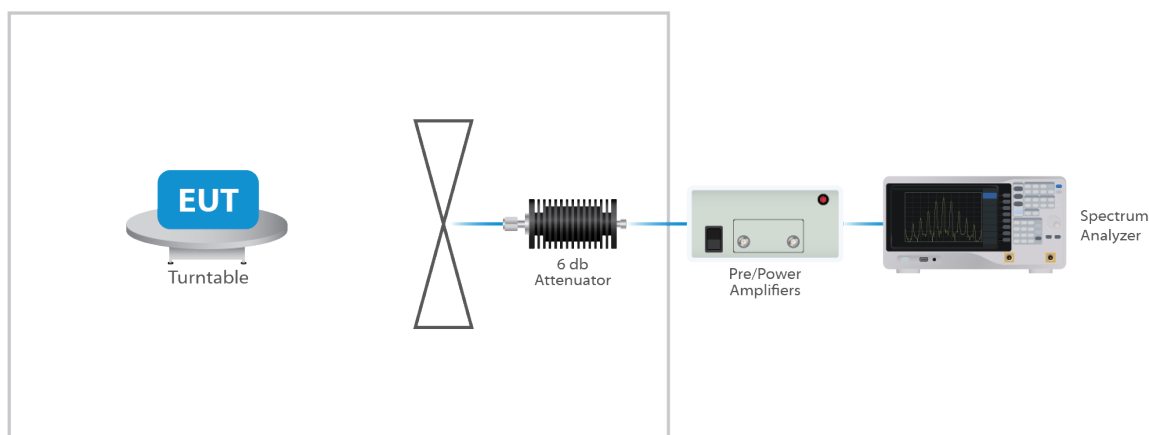


Figure 4: Radiated Emissions Test

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 ($\pm$ 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

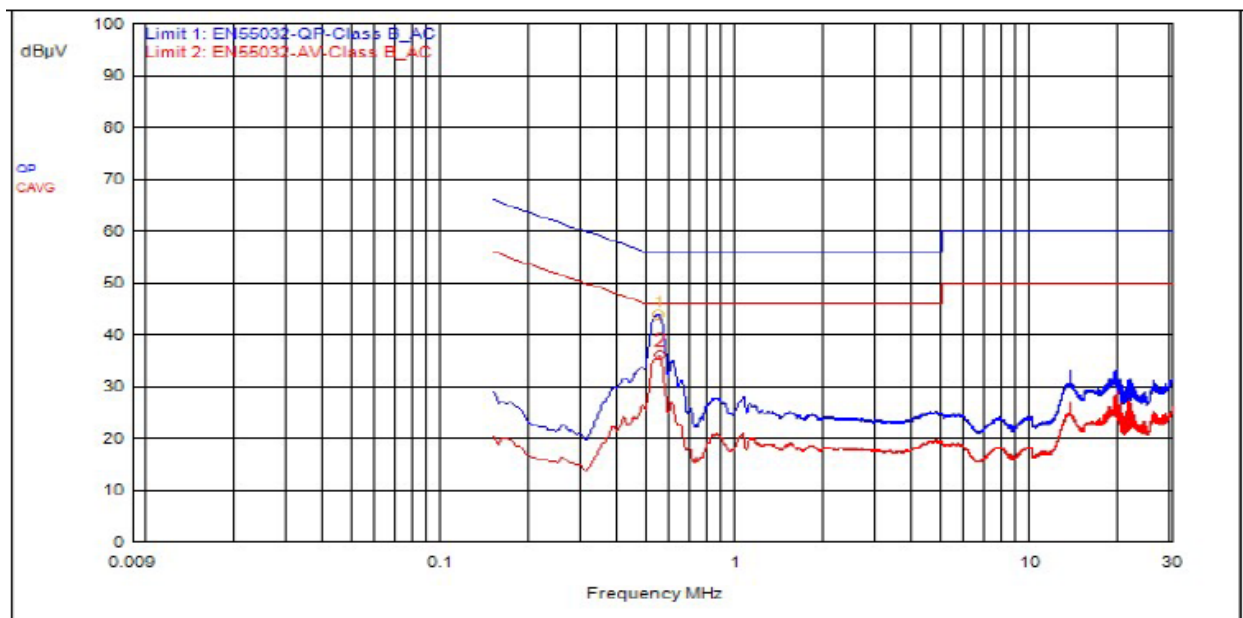
The EUT uses an integral disk antenna structure. The maximum gain of the antenna is 12 dBi. This is an 802.11 device and utilizes CDD as described in KDB 662911 D01. The antenna is not user replaceable.

Results

The EUT complied with the specification

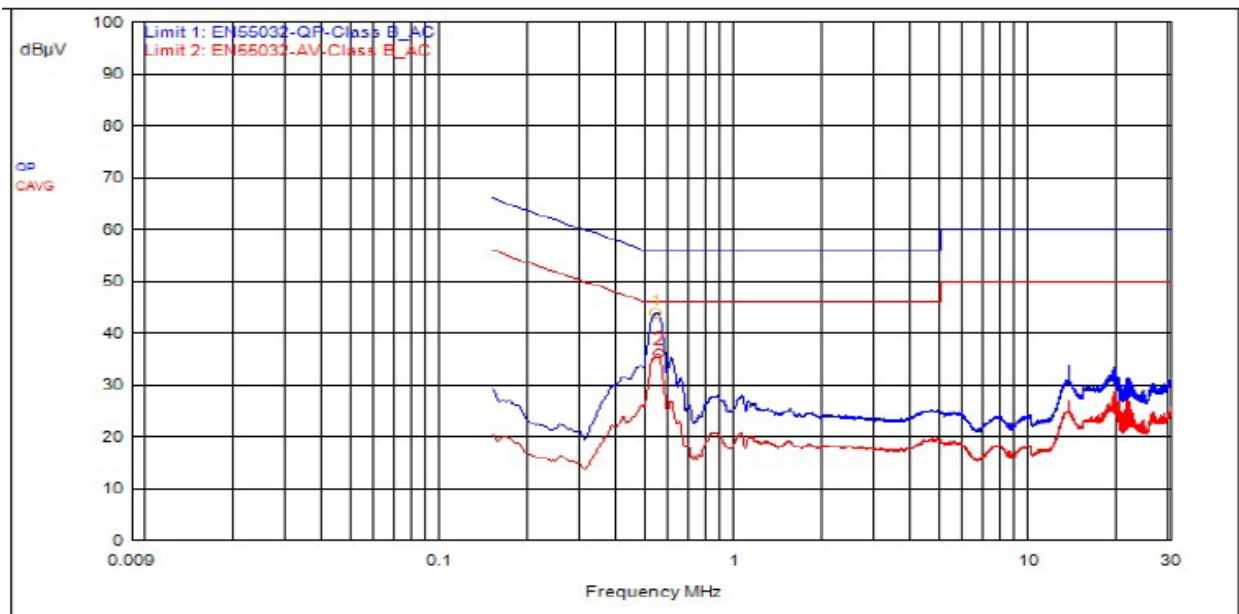
5.2 Conducted Emissions at Mains Ports Data

5.2.1 Line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.
1	543,000kHz	9.5	0.1		QPeak	34.2	43.9	56.0	-12.1		
2	546,000kHz	9.5	0.1		C_AVG	26.3	36.0			46.0	-10.0

5.2.2 Neutral



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.
1	537,000kHz	9.5	0.1		QPeak	34.2	43.9	56.0	-12.1		
2	546,000kHz	9.5	0.1		C_AVG	26.5	36.2			46.0	-9.8

Result

The EUT complied with the specification limit.

5.3 §15.403(i) 26 dB Emissions Bandwidth

All chains were measured under the guidance of KDB 789033 Section II.C. and KDB 66291 D01. Please see associated annex for details on instrument settings.

Nominal BW (MHz)	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
20	5740	20.3	44.4
20	5790	24.9	48.3
20	5835	25.0	47.6
40	5750	40.3	81.5
40	5790	53.7	89.0
40	5825	38.3	65.4
80	5770	77.5	84.0
80	5790	77.5	90.0
80	5805	77.5	83.5

Result

All chains were tested and the highest bandwidth per chain is reported above.

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

5.4 §15.407(a)(3) Maximum Average Output Power

All chains were measured and summed under the guidance of KDB 789033 Section II. E.2. and KDB 66291 D01. Please see associated annex for details on instrument settings.

The maximum average RF conducted output power measured for this device was 29.32 dBm or 855.07 mW. The limit is 30 dBm, or 1 Watt. The antenna has a gain of 12 dBi.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Conducted Output Power *	Measured EIRP	Measured PSD
HE 20	5740	Mcs0	55	28.58	40.58	10.34
HE 20	5790	Mcs0	55	28.77	40.77	10.38
HE 20	5835	Mcs0	55	28.61	40.61	9.87
HE 40	5750	Mcs0	53	28.60	40.60	7.10
HE 40	5790	Mcs0	55	29.32	61.32	7.96
HE 40	5825	Mcs0	52	27.57	39.57	5.85
HE 80	5770	Mcs0	47	25.71	37.71	1.43
HE 80	5790	Mcs0	48	26.07	38.07	1.73
HE 80	5805	Mcs0	46	25.06	37.06	0.82

Result

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

* Gated EIRP shown in the Annex is the conducted measurement

5.5 §15.407(b)(7) Spurious Emissions

5.5.1 Conducted Spurious Emissions

The frequency ranges 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 within the annex below are plots with the EUT turned 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.

All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

Result

Conducted spurious emissions were attenuated below the limit; therefore, the EUT complies with the specification.

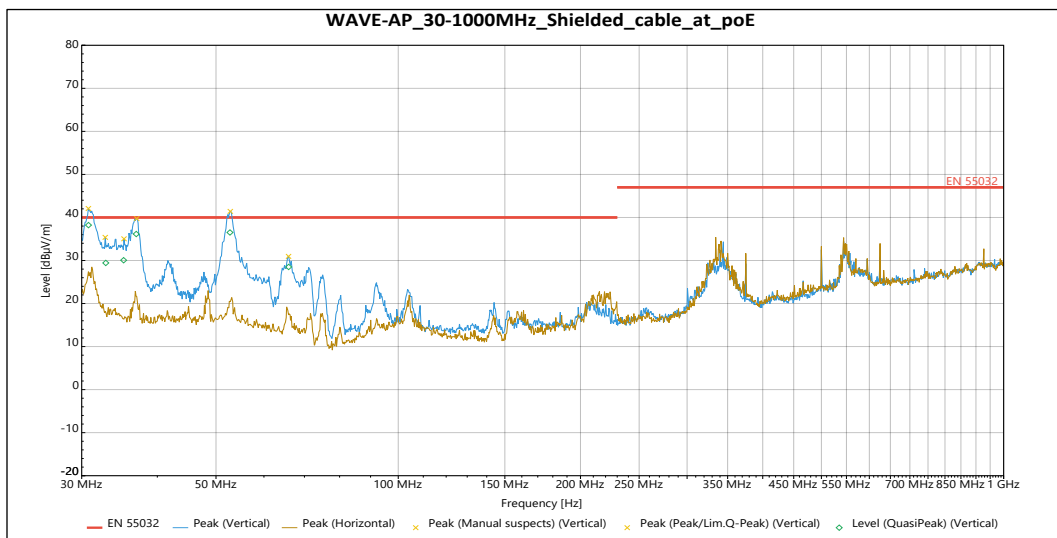
5.5.2 Radiated Spurious Emissions in the Restricted Bands of § 15.205

The EUT uses various power settings based on the channel in use. In order to reduce test time, the radiated spurious emissions at the lowest, middle, and highest channel were measured at the maximum power of TP55.

Correction Factor = Antenna Factor + Cable Loss - Pre-Amplifier Gain, and is added to the Receiver reading.

Result

All emissions in the restricted bands of § 15.205 met the limits specified in § 15.209; therefore, the EUT complies with the specification. See Annex for Conducted Band edge plots.

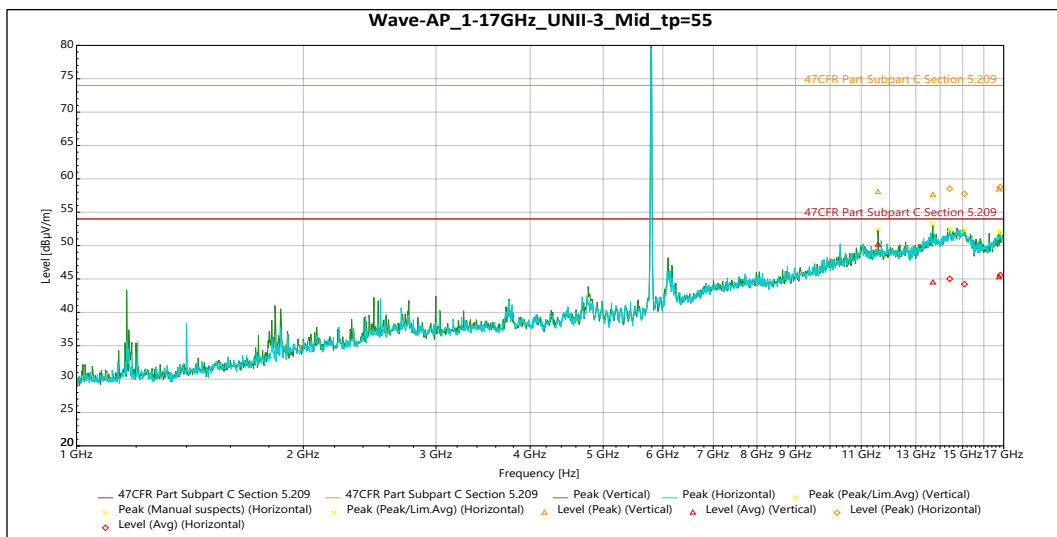


QuasiPeak

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin	Azimuth (°)	Height	Pol.	Correction (dB)
30.785 MHz	38.216	40	-1.784	204	1.089	Vertical	-11.711
32.877 MHz	29.429	40	-10.571	130	0.998	Vertical	-11.597
35.187 MHz	30.057	40	-9.943	154	1.664	Vertical	-11.444
36.916 MHz	36.154	40	-3.846	159	2.607	Vertical	-11.571
52.727 MHz	36.513	40	-3.487	3	3.441	Vertical	-11.811
65.913 MHz	28.496	40	-11.504	220	3.797	Vertical	-15.457

No significant emissions were observed in the Horizontal orientation of the antenna

Table 4: Radiated Emissions 30 – 1000 MHz



Peak

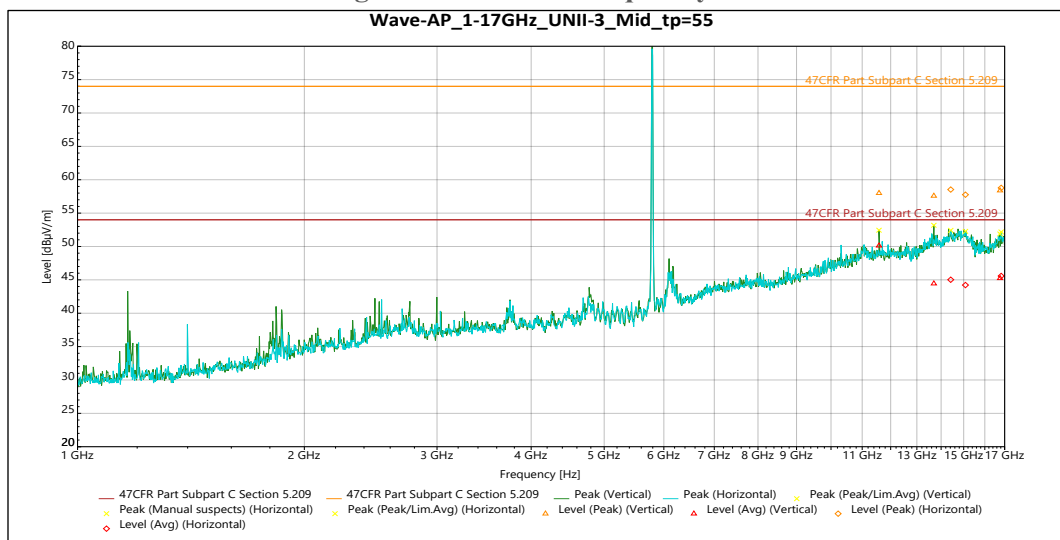
Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.58 GHz	57.987	74	-16.013	9	2.177	Vertical	13.778
13.693 GHz	57.584	74	-16.416	321	1.991	Vertical	15.541
16.763 GHz	58.383	74	-15.617	267	2.539	Vertical	17.394
14.418 GHz	58.533	74	-15.467	81	3.629	Horizontal	16.041
15.081 GHz	57.764	74	-16.236	106	2.049	Horizontal	15.745

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
16.821 GHz	58.784	74	-15.216	267	2.174	Horizontal	17.628

Avg

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.58 GHz	50.124	54	-3.876	9	2.177	Vertical	13.778
13.693 GHz	44.441	54	-9.559	321	1.991	Vertical	15.541
16.763 GHz	45.245	54	-8.755	267	2.539	Vertical	17.394
14.418 GHz	45.021	54	-8.979	81	3.629	Horizontal	16.041
15.081 GHz	44.225	54	-9.775	106	2.049	Horizontal	15.745
16.821 GHz	45.58	54	-8.42	267	2.174	Horizontal	17.628

Table 5: Transmitting on the Lowest Frequency 5485 MHz 1 – 17 GHz



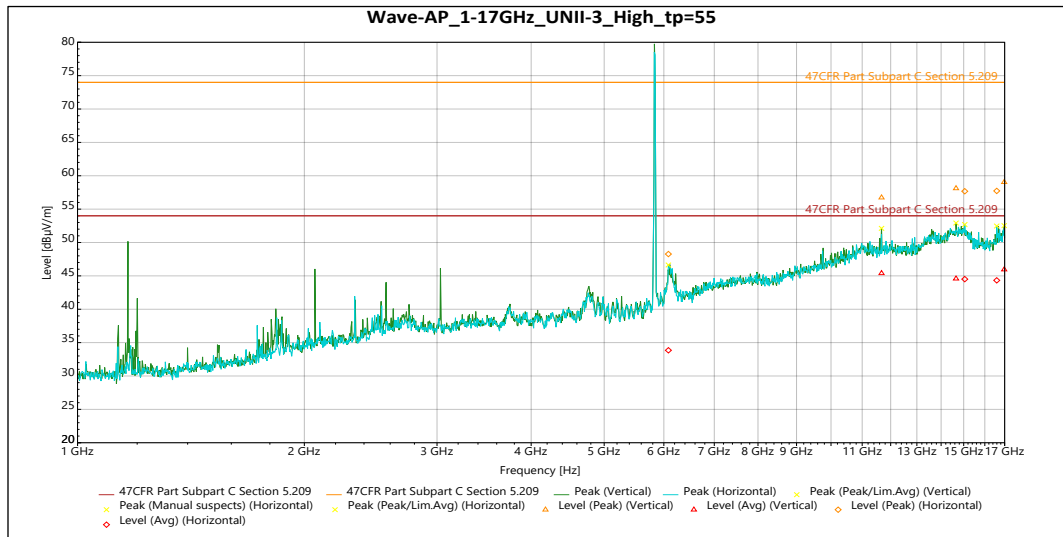
Peak

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.58 GHz	57.987	74	-16.013	9	2.177	Vertical	13.778
13.693 GHz	57.584	74	-16.416	321	1.991	Vertical	15.541
16.763 GHz	58.383	74	-15.617	267	2.539	Vertical	17.394
14.418 GHz	58.533	74	-15.467	81	3.629	Horizontal	16.041
15.081 GHz	57.764	74	-16.236	106	2.049	Horizontal	15.745
16.821 GHz	58.784	74	-15.216	267	2.174	Horizontal	17.628

Avg

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.58 GHz	50.124	54	-3.876	9	2.177	Vertical	13.778
13.693 GHz	44.441	54	-9.559	321	1.991	Vertical	15.541
16.763 GHz	45.245	54	-8.755	267	2.539	Vertical	17.394
14.418 GHz	45.021	54	-8.979	81	3.629	Horizontal	16.041
15.081 GHz	44.225	54	-9.775	106	2.049	Horizontal	15.745
16.821 GHz	45.58	54	-8.42	267	2.174	Horizontal	17.628

Table 6: Transmitting on the Middle Frequency 5600 MHz 1 – 17 GHz



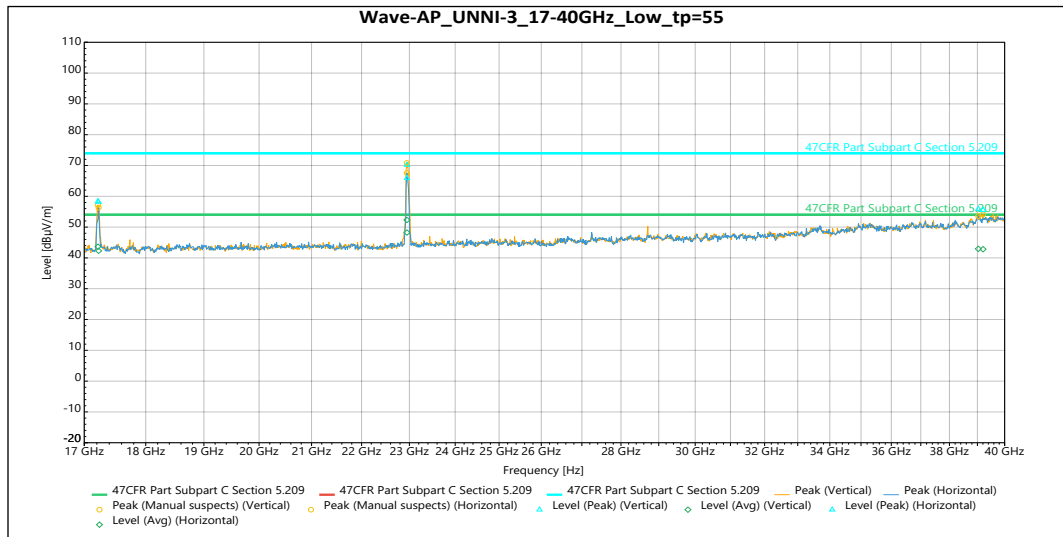
Peak

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.67 GHz	56.726	74	-17.274	35	3.456	Vertical	13.977
14.653 GHz	58.106	74	-15.894	238	3.808	Vertical	15.824
16.977 GHz	59.039	74	-14.961	113	3.106	Vertical	18.259
6.0842 GHz	48.269	74	-25.731	1	3.107	Horizontal	5.009
15.049 GHz	57.683	74	-16.317	212	2.049	Horizontal	15.839
16.594 GHz	57.733	74	-16.267	253	3.074	Horizontal	16.238

Avg

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
11.67 GHz	45.393	54	-8.607	35	3.456	Vertical	13.977
14.653 GHz	44.576	54	-9.424	238	3.808	Vertical	15.824
16.977 GHz	45.95	54	-8.05	113	3.106	Vertical	18.259
6.0842 GHz	33.848	54	-20.152	1	3.107	Horizontal	5.009
15.049 GHz	44.508	54	-9.492	212	2.049	Horizontal	15.839
16.594 GHz	44.332	54	-9.668	253	3.074	Horizontal	16.238

Table 7: Transmitting on the Highest Frequency 5710 MHz 1 – 17 GHz



Peak

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Pol.	Correction (dB)
17.218 GHz	58.364	74	-15.636	316	Vertical	-5.705
22.947 GHz	65.86	74	-8.14	235	Vertical	-4.947
39.206 GHz	55.551	74	-18.449	347	Vertical	3.468
17.228 GHz	58.175	74	-15.825	315	Horizontal	-5.7
22.947 GHz	70.191	74	-3.809	240	Horizontal	-4.947
39.033 GHz	55.888	74	-18.112	52	Horizontal	3.248

Avg

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Pol.	Correction (dB)
17.218 GHz	43.636	54	-10.364	316	Vertical	-5.705
22.947 GHz	48.244	54	-5.756	235	Vertical	-4.947
39.206 GHz	42.818	54	-11.182	347	Vertical	3.468
17.228 GHz	42.3	54	-11.7	315	Horizontal	-5.7
22.947 GHz	52.334	54	-1.666	240	Horizontal	-4.947
39.033 GHz	42.941	54	-11.059	52	Horizontal	3.248

Table 8: Transmitting on the Lowest Frequency 5740 MHz 17 – 40 GHz (worst case)

5.6 §15.407(a) Maximum Power Spectral Density

All chains were measured and summed under the guidance of KDB 789033 Section II. F. and KDB 66291 D01. Please see associated annex for details on instrument settings.

The maximum average power spectral density conducted from the intentional radiator of the antenna shall not be greater than 30 dBm in any 500 kHz band during any time interval of continuous transmission. Results of this testing are summarized.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Measured PSD
HE 20	5740	Mcs0	55	10.34
HE 20	5790	Mcs0	55	10.38
HE 20	5835	Mcs0	55	9.87
HE 40	5750	Mcs0	53	7.10
HE 40	5790	Mcs0	55	7.96
HE 40	5825	Mcs0	52	5.85
HE 80	5770	Mcs0	47	1.43
HE 80	5790	Mcs0	48	1.73
HE 80	5805	Mcs0	46	0.82

Result

The maximum summed average power spectral density was less than the limit of 30 dBm; therefore, the EUT complies with the specification.

-- End of Test Report --