



427 West 12800 South
Draper, UT 84020

Test Report Certification

FCC ID	SWX-WAVEPC
Equipment Under Test	Wave-Pico
Test Report Serial Number	TR8617_04
Date of Tests	11, 16, 18-19 October; 2 November 2023
Report Issue Date	25 January 2024

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	UBIQUITI
Model Number	Wave-Pico
FCC ID	SWX-WAVEPC

On this 25th day of January 2023, 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: Clay Allred



Reviewed By: Richard L. Winter

Revision History		
Revision	Description	Date
01	Original Report Release	9 November 2023
02	Amend Power Supply Model in Sections 2.2 and 2.3	19 December 2023
03	Updated Power and PSD data for 30 Degree Elevation reduction and OBW data in Section 5.3	17 January 2024
04	Updated Power table in section 5.4 and antenna gain in section 5.1 and throughout report.	25 January 2024

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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	Alex Macon
Title	Compliance

1.2 Manufacturer

Company	Ubiquiti Inc. 685 Third Avenue New York, NY 10017 U.S.A.
Contact Name	Alex Macon
Title	Compliance

2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	UBIQUITI
Model Number	Wave-Pico
Serial Number	A1A
Dimensions (cm)	15.2 x 15.2 x 5.6

2.2 Description of EUT

The Wave-Pico is a 60 GHz point – Point, point-to-multipoint customer premise equipment that features wave technology with a high throughput rate. The Wave-Pico 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-Pico is an outdoor device and has an Ethernet port which is used for data transfer and to provide power using a Model GP-H480-050G 48-volt PoE power adapter.

Band	WiFi Mode	Modulation Bandwidth	Modulation Type	Frequency (MHz)
UNII-1	ax	20 MHz	HE	5165, 5175, 5185, 5200, 5210, 5220, 5230, 5240
	ax	40 MHz	HE	5175, 5185, 5200, 5215, 5230
	ax	80 MHz	HE	5195, 5200, 5205, 5210

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-Pico (Note 1) SN: A1A	Wireless Access Point	See Section 2.4
BN: UBIQUITI MN: GP-H480-050G 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 Mains	1	3 conductor power cord/80cm
PoE	1	Shielded or Un-Shielded Cat 5e Cable/> 3 meters
Data	1	Shielded or Un-Shielded Cat 5e Cable/> 3 Meters

2.5 Operating Environment

Power Supply	120 Volts ac to 48 Volts PoE
AC Mains Frequency	60 Hz
Temperature	23.4 – 23.8 °C
Humidity	25.6 – 31.1 %
Barometric Pressure	1019 mBar

2.6 Operating Modes

The Wave-Pico 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 1.0 was used to operate the transmitter using a constant transmit mode.

2.8 Block Diagram of Test Configuration

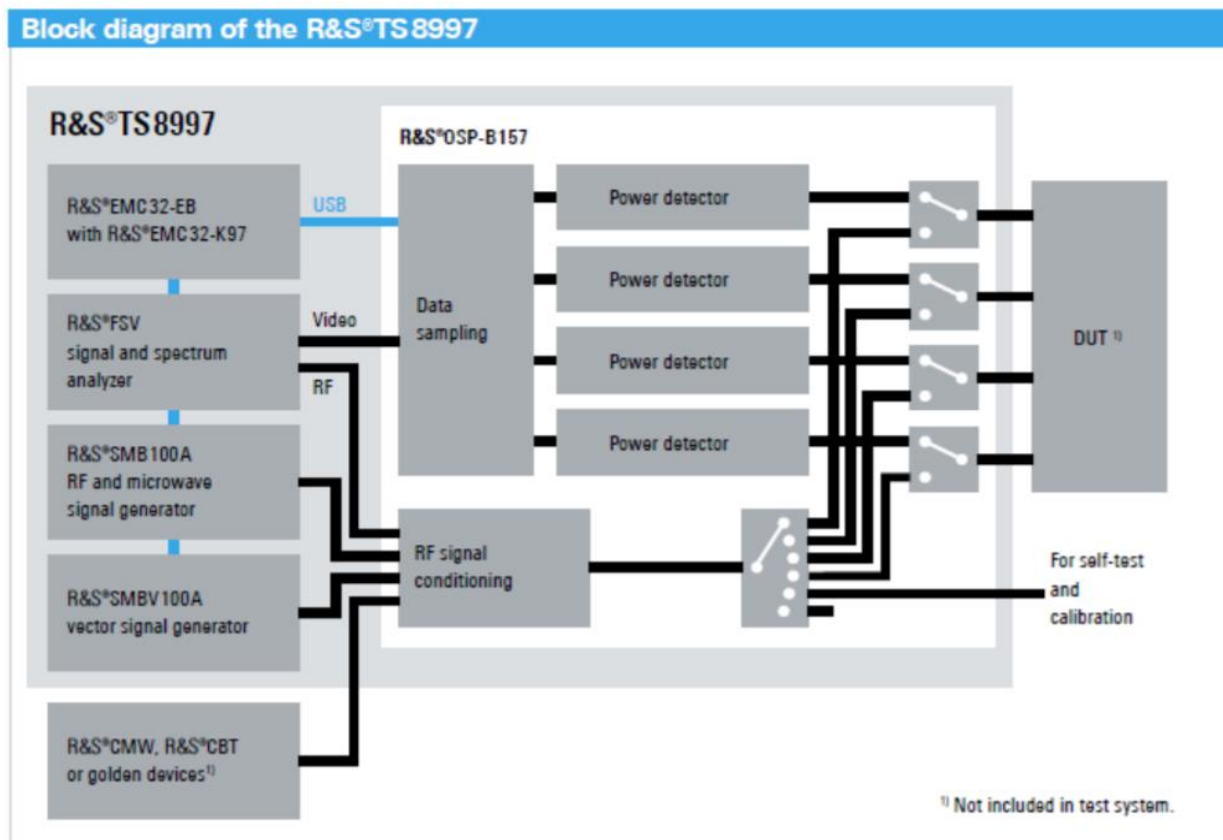


Diagram 1: Test Configuration Block Diagram

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 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	5165 to 5240	Compliant
15.407(e)	RSS-247 §6.2.2, §6.2.3	Peak Output Power	5165 to 5240	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	5165 to 5240	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 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 2024. 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 2024.

Unified Compliance Laboratory has been assigned Designation Number US5037 by the FCC and 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	2/22/2023	2/22/2024
LISN	AFJ	LS16C/10	UCL-6749	12/6/2021	12/6/2023
ISN	Teseq	ISN T800	UCL-2974	6/27/2022	6/27/2024
LISN	Com-Power	LIN-120C	UCL-2612	1/24/2023	1/24/2024
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

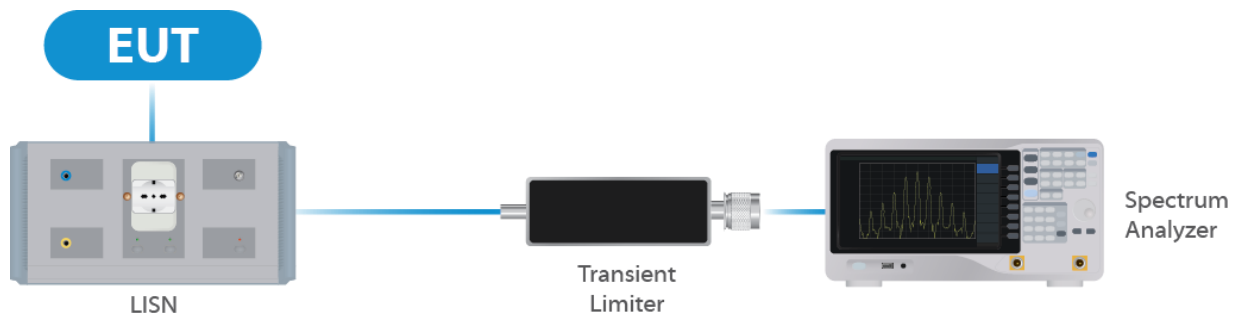


Figure 1: Conducted Emissions Test

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	11/7/2022	11/7/2023
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	2/22/2023	2/22/2024
Switch Extension	R&S	OSP-150W	UCL-2870	2/22/2023	2/22/2024

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

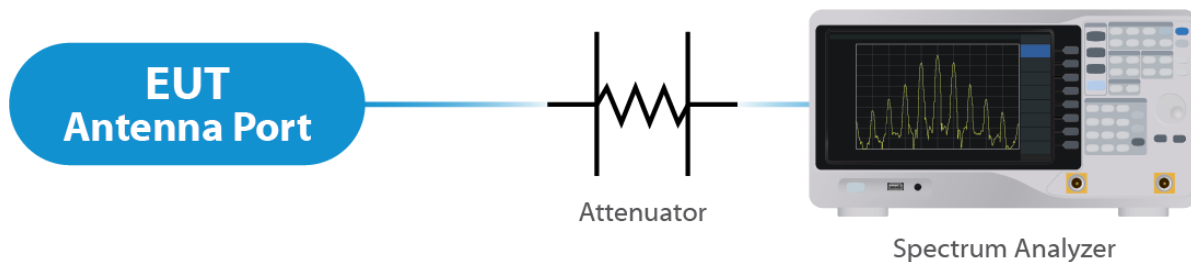


Figure 2: Direct Connect at the Antenna Port Test

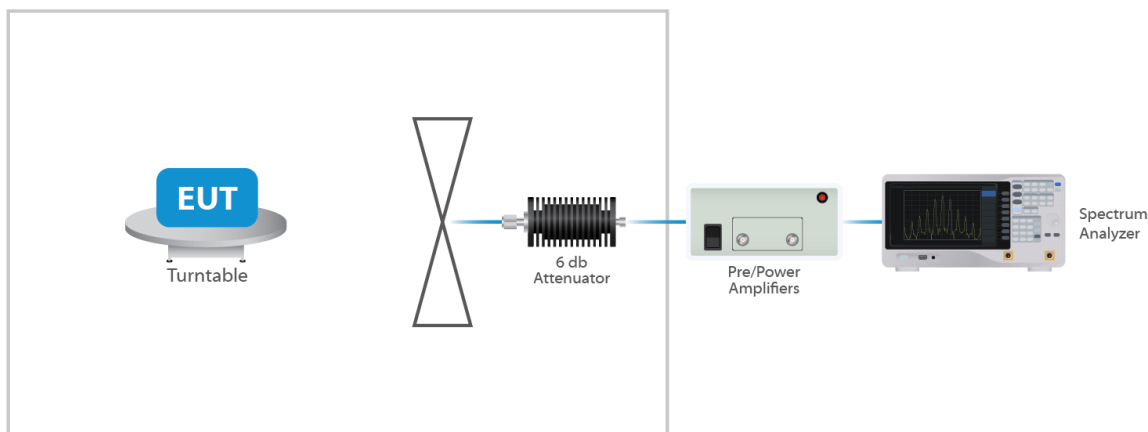


Figure 3: Output Power Measurement

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	1/27/2023	1/27/2024
Pre-Amplifier 9 kHz – 1 GHz	Sonoma Instruments	310N	UCL-2889	10/7/2021	10/7/2023
Broadband Antenna	Scwarzbeck	VULB 9163	UCL-3062	2/22/2023	2/22/2025
Broadband Antenna	Scwarzbeck	VULB 9163	UCL-3071	1/11/2023	1/11/2025
Double Ridge Horn Antenna	Scwarzbeck	BBHA 9120D	UCL-3065	9/22/2022	9/22/2024
Log Periodic	Scwarzbeck	STLP 9129	UCL-3068	1/27/2023	1/27/2025
15 - 40 GHz Horn Antenna	Scwarzbeck	BBHA 9170	UCL-2487	6/09/2022	6/09/2024
1 – 18 GHz Amplifier	Com-Power	PAM 118A	UCL-3833	12/9/2022	12/9/2023
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 folding antenna structure. Per the manufacturer, the maximum gain of the antenna per chain is 7 dBi. This is an 802.11 device and utilizes CDD as described in KDB 662911 D01. The antenna is not user replaceable.

For power measurements on IEEE 802.11 devices, Array Gain = 0 dB for NANT ≤ 4;

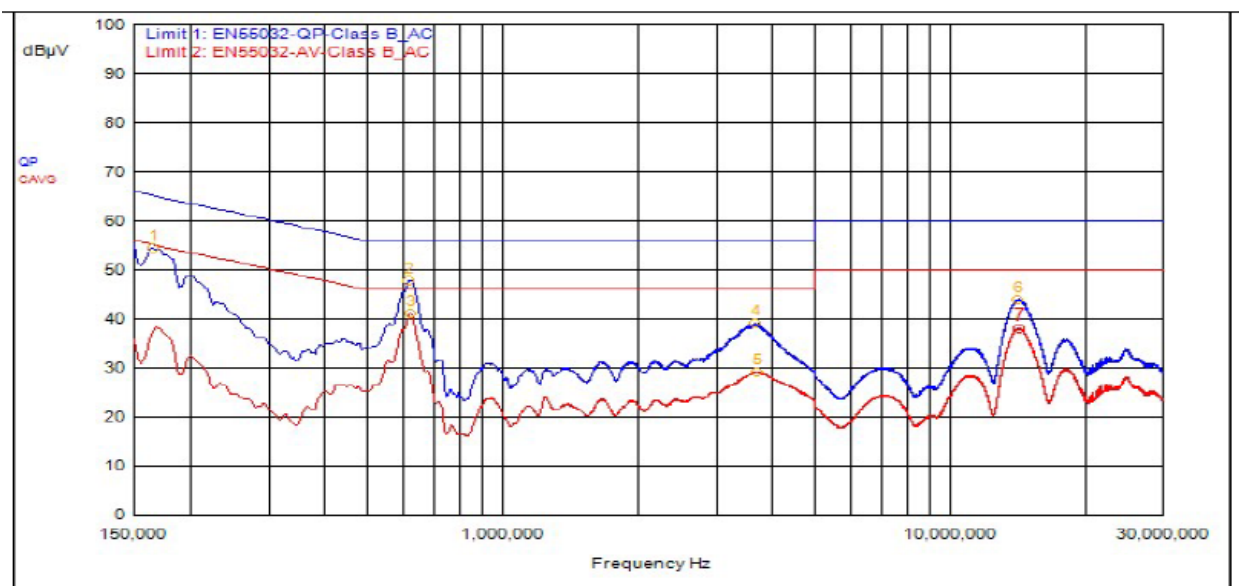
For PSD measurements when Nss=1: Array Gain = 10 log(Nant/Nss) dB = 3.01dB

Results

The EUT complied with the specification

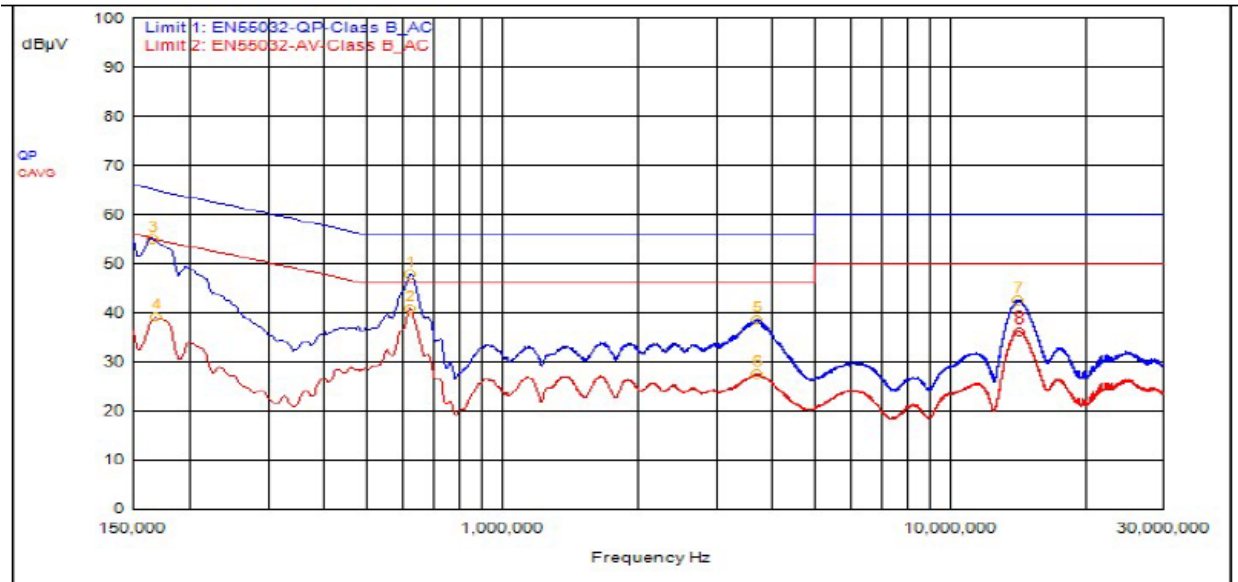
5.2 Conducted Emissions at Mains Ports Data

5.2.1 Line



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.	P/F
MU	MHz	dB	dB	dB	Type	dBµV	dBµV	dBµV	dB	dBµV	dB	P/F
2	618,000kHz	9.50	0.00		QPeak	38.34	47.84	56.00	-8.16			
1	165,000kHz	9.49	0.00		QPeak	44.96	54.45	65.21	-10.75			
6	14.184	9.68	0.00		QPeak	34.09	43.77	60.00	-16.23			
4	3.678	9.58	0.00		QPeak	29.57	39.15	56.00	-16.85			
3	621,000kHz	9.50	0.00		C_AVG	31.60	41.10			46.00	-4.90	
5	3.711	9.58	0.00		C_AVG	19.58	29.16			46.00	-16.84	
7	14.226	9.68	0.00		C_AVG	28.27	37.95			50.00	-12.05	

5.2.2 Neutral



ID	Frequency	Probe	Cable	Atten.	Detector	Meter Read	Meas Level	Limit 1	Limit 1 Dist.	Limit 2	Limit 2 Dist.	P/F
MU	MHz	dB	dB	dB	Type	dBµV	dBµV	dBµV	dB	dBµV	dB	P/F
1	624,000kHz	9.58	0.00		QPeak	38.13	47.71	56.00	-8.29			
3	165,000kHz	9.62	0.00		QPeak	45.42	55.04	65.21	-10.17			
7	14.208	9.73	0.00		QPeak	32.88	42.61	60.00	-17.39			
5	3.693	9.60	0.00		QPeak	28.90	38.50	56.00	-17.50			
2	624,000kHz	9.58	0.00		C_AVG	31.16	40.74			46.00	-5.26	
4	168,000kHz	9.62	0.00		C_AVG	29.41	39.03			55.06	-16.03	
6	3.699	9.60	0.00		C_AVG	17.93	27.53			46.00	-18.47	
8	14.226	9.73	0.00		C_AVG	26.46	36.19			50.00	-13.81	

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)	Emissions 26 dB Bandwidth (MHz)
HE20	5165	19.0	20.4
HE20	5200	19.0	20.3
HE20	5240	18.75	20.3
HE40	5175	38.5	39.75
HE40	5200	38.0	39.75
HE40	5230	38.0	39.75
HE80	5195	77.0	81.0
HE80	5200	77.0	81.5
HE80	5210	77.0	81.0

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)(2) Maximum Average Output Power

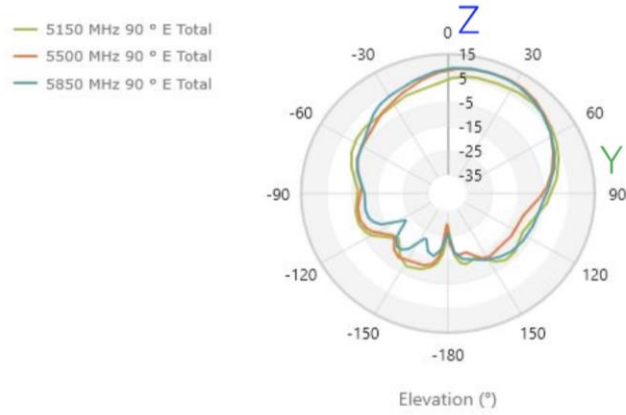
All chains were measured and summed under the guidance of KDB 789033 Section II. E.2. and KDB 66291 D01. Please see the associated annex for details on instrument settings.

The maximum average RF conducted output power measured for this device was 13.93 dBm or 24.7 mW. The limit is 30 dBm, or 1 Watt when using an antenna with 23 dBi or less gain. The antenna has a gain of 7 dBi, or 10.01dBi total directional gain. This device is intended for outdoor Point – Multipoint uses and therefore the output was limited to a 21 dBm EIRP for any elevation angle above 30 degrees.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Conducted Output Power	Measured EIRP
HE 20	5165	Mcs0	21	11.29	18.29
HE 20	5200	Mcs0	25	13.93	20.93
HE 20	5240	Mcs0	25	13.75	20.75
HE 40	5175	Mcs0	20	11.06	18.06
HE 40	5200	Mcs0	24	13.41	20.41
HE 40	5230	Mcs0	25	13.65	20.65
HE 80	5195	Mcs0	21	11.61	18.61
HE 80	5200	Mcs0	22	12.02	19.02
HE 80	5210	Mcs0	23	12.62	19.62

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).



Plot 1: Elevation Plot Greater Than 30-Degrees from Horizon

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 turned to the upper and lower channels with the antenna gain of 7 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 -27 dBm; therefore, the EUT complies with the specification.

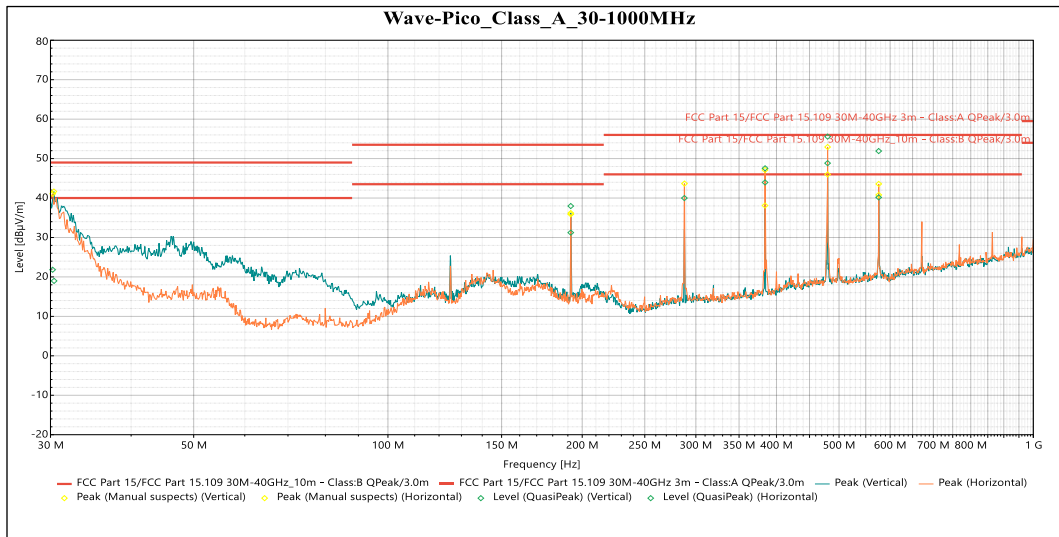
5.5.2 Radiated Spurious Emissions in the Restricted Bands of § 15.205

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 TP50, as this setting was found to be worst case for spurious emissions. Power was subsequently reduced during in-band and band edge testing. The band edge at the restricted band ending at 5150 MHz was measured using radiated measurement. All emissions modes were tested, and the worst-case measurement are shown below. For frequencies above 1 GHz, a measurement of 3 meters was used. For frequencies below 1 GHz, a measurement distance of 10 meters was used.

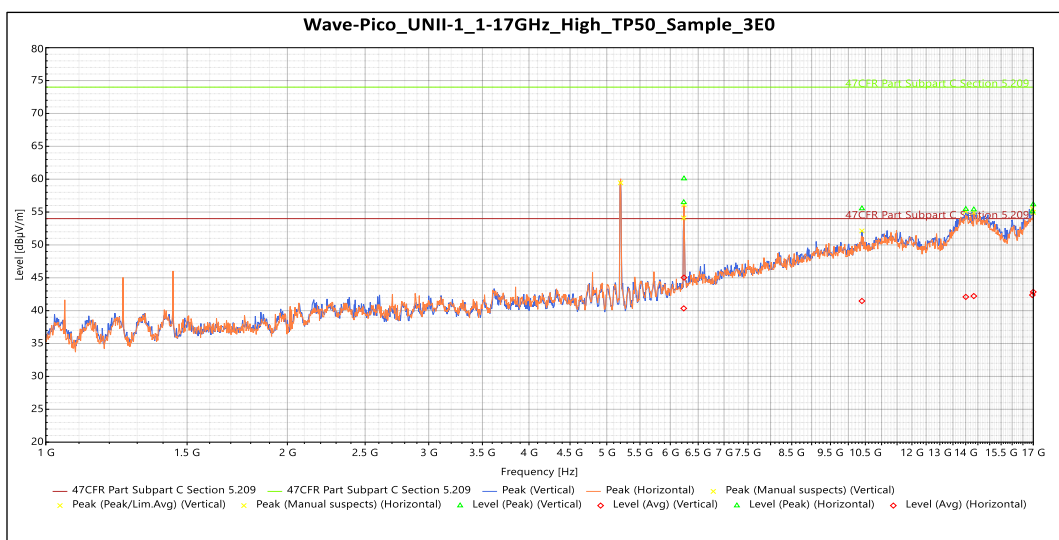
Correction Factor = Antenna Factor + Cable Loss - Pre-Amplifier Gain, and is added to the Receiver reading.

Result

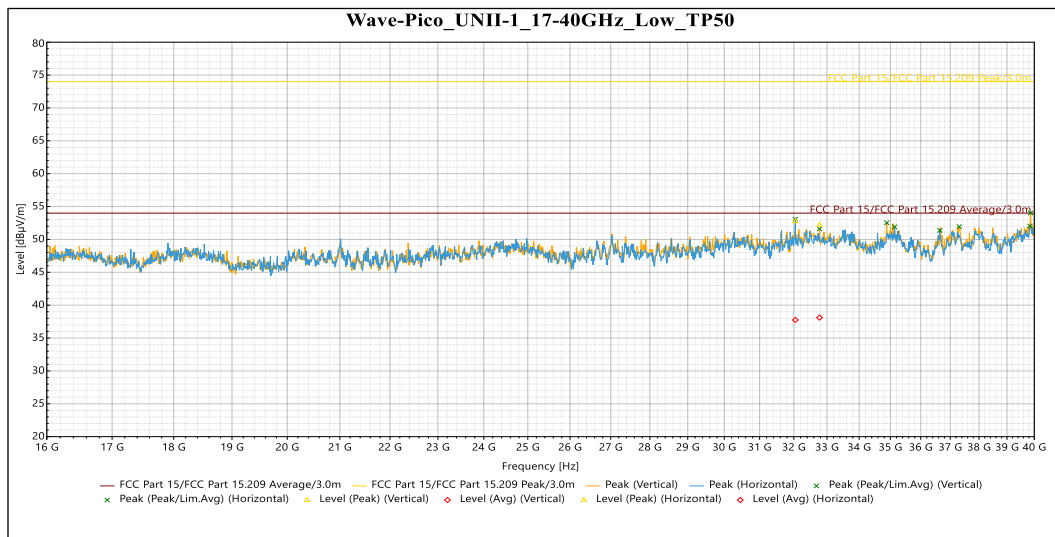
All emissions in the restricted bands of § 15.205 met the limits specified in § 15.209; therefore, the EUT complies with the specification. All emissions me the limits specified in § 15.407(b). Representative band edge plots are included in this report.


QuasiPeak

Frequency	Level (dBµV/m)	Limit (dBµV/m)	Margin	Azimuth (°)	Height	Pol.	Correction (dB)
30.386 MHz	18.991	49	-30.009	183	3.66	Vertical	-7.957
192 MHz	31.232	53.5	-22.268	185	2.059	Vertical	-16.393
384.03 MHz	43.962	56	-12.038	109	2.401	Vertical	-12.176
480 MHz	48.842	56	-7.158	265	1.863	Vertical	-9.391
575.95 MHz	40.156	56	-15.844	216	1.681	Vertical	-8.42
30.229 MHz	21.821	49	-27.179	19	4	Horizontal	-7.836
191.99 MHz	37.968	53.5	-15.532	303	1.701	Horizontal	-16.394
287.95 MHz	39.99	56	-16.01	125	1.138	Horizontal	-14.117
384.04 MHz	47.542	56	-8.458	328	2.22	Horizontal	-12.176
480.02 MHz	55.57	56	-0.43	1	1.858	Horizontal	-9.39
575.96 MHz	51.906	56	-4.094	143	1.496	Horizontal	-8.421

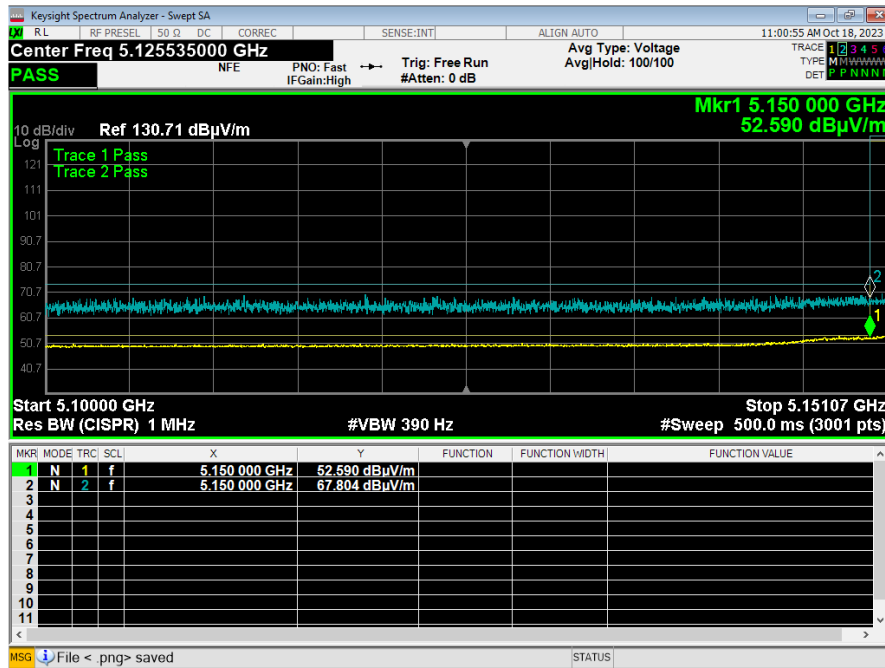
Table 4: Radiated Emissions 30 – 1000 MHz


Frequency	SR #	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Meas. Time (s)	RBW (Hz)	Correction (dB)
6.2359 GHz	Peak	56.484	74	-17.516	49	2.65	Vertical	5	1 M	-3.438
10.397 GHz	Peak	55.536	74	-18.464	251	3.153	Vertical	5	1 M	6.888
14.007 GHz	Peak	55.445	74	-18.555	221	3.802	Vertical	5	1 M	11.082
16.955 GHz	Peak	55.076	74	-18.924	267	3.798	Vertical	5	1 M	13.484
6.2359 GHz	AVG	40.349	54	-13.651	49	2.65	Vertical	5	1 M	-3.438
10.397 GHz	AVG	41.469	54	-12.531	251	3.153	Vertical	5	1 M	6.888
14.007 GHz	AVG	42.093	54	-11.907	221	3.802	Vertical	5	1 M	11.082
16.955 GHz	AVG	42.382	54	-11.618	267	3.798	Vertical	5	1 M	13.484
6.2402 GHz	Peak	60.093	74	-13.907	74	1.5	Horizontal	5	1 M	-3.428
14.332 GHz	Peak	55.377	74	-18.623	235	1.643	Horizontal	5	1 M	11.71
16.998 GHz	Peak	56.163	74	-17.837	343	1.638	Horizontal	5	1 M	13.497
6.2402 GHz	AVG	45.032	54	-8.968	74	1.5	Horizontal	5	1 M	-3.428
14.332 GHz	AVG	42.225	54	-11.775	235	1.643	Horizontal	5	1 M	11.71
16.998 GHz	AVG	42.846	54	-11.154	343	1.638	Horizontal	5	1 M	13.497

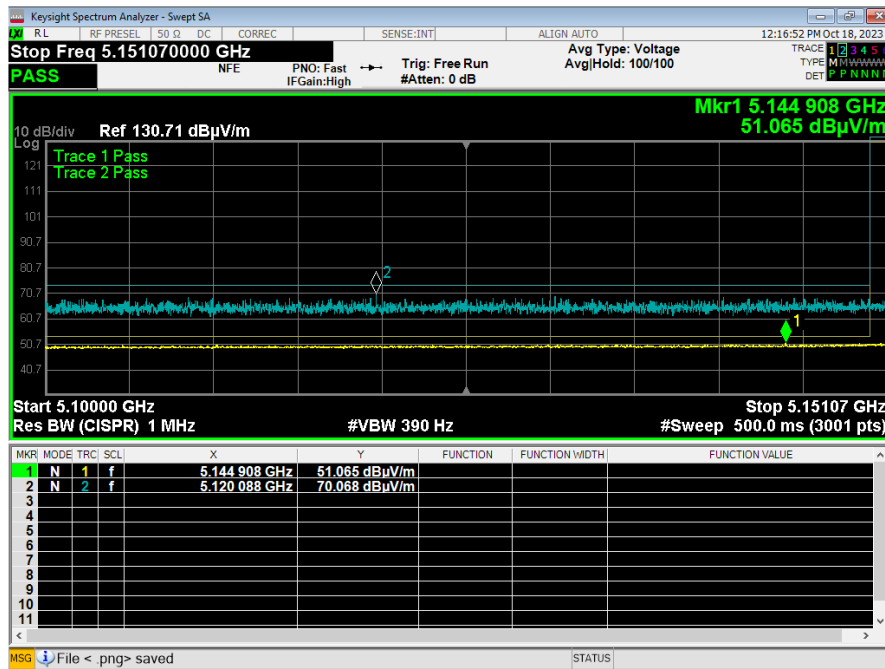
Table 5: Radiated Emissions in 1-17GHz Transmitting on the Highest Frequency 5240 MHz


Frequency	SR #	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Pol.	Meas. Time (s)	Correction (dB)
32.774 GHz	Peak	52.183	74	-21.817	8	Vertical	5	1.829
32.774 GHz	AVG	38.107	54	-15.893	8	Vertical	5	1.829
32.045 GHz	Peak	52.726	74	-21.274	204	Horizontal	5	1.88
32.045 GHz	AVG	37.746	54	-16.254	204	Horizontal	5	1.88

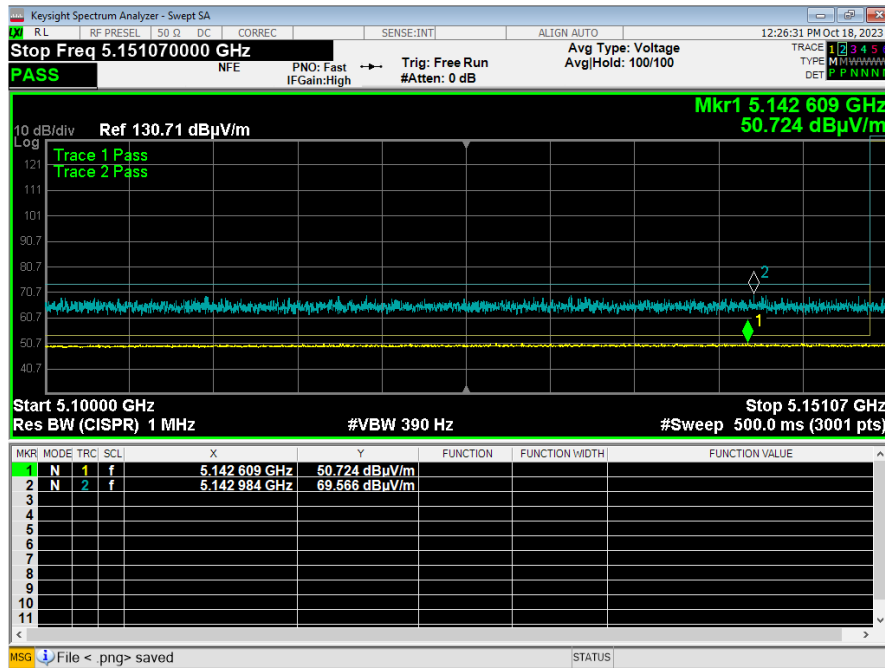
Table 6: Radiated Emissions in 17-40GHz Transmitting on the Highest Frequency 5240 MHz



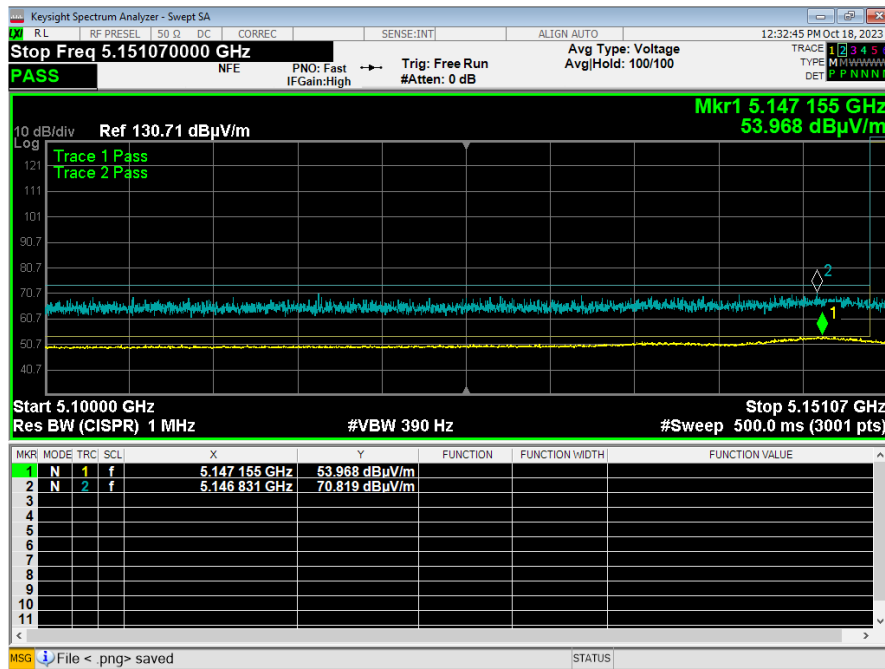
Graph 5: Band Edge ax Mode 20 MHz – 5165 MHz



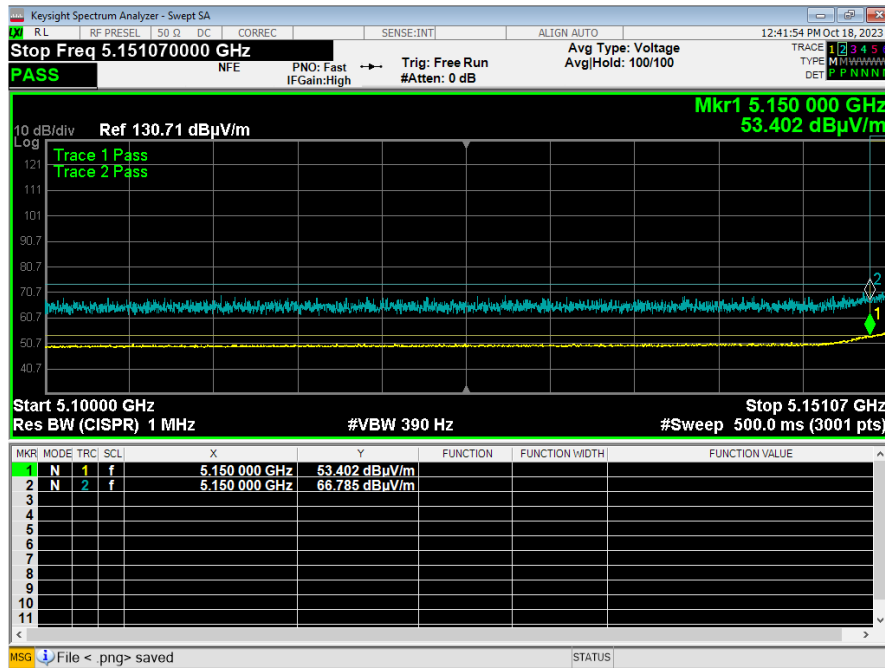
Graph 6: Band Edge ax Mode 20 MHz - 5200 MHz



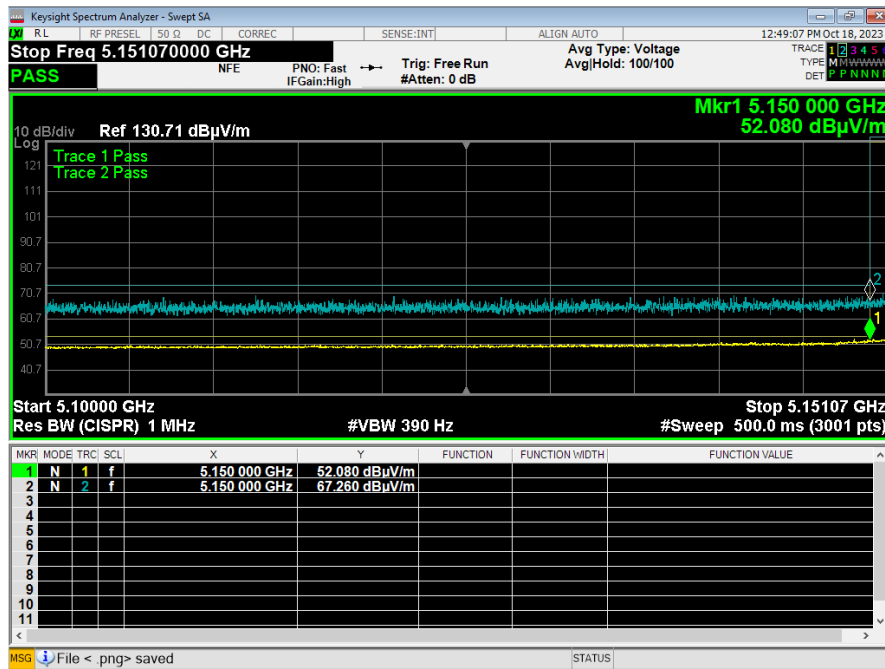
Graph 7: Band Edge a Mode 20 MHz – 5230 MHz



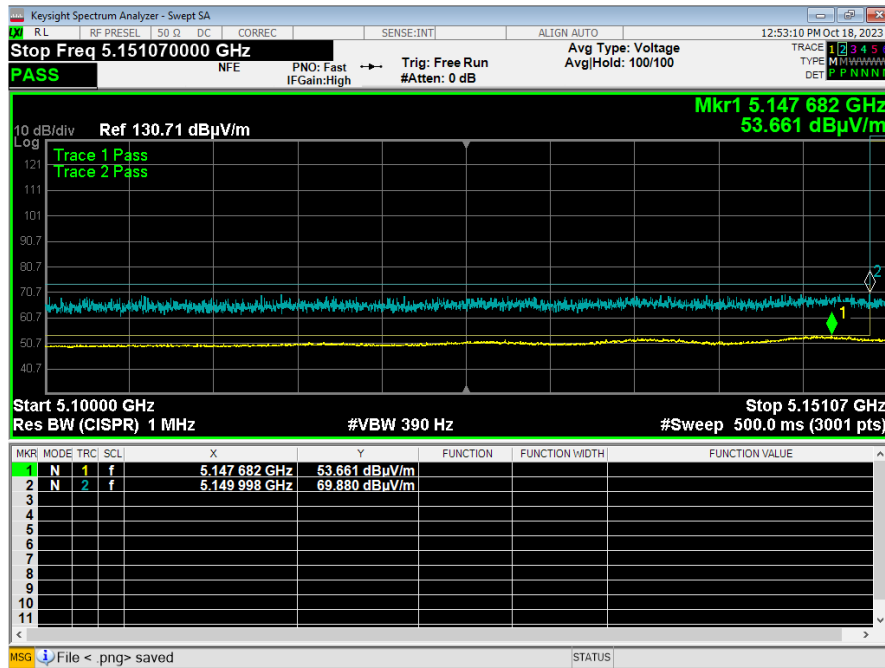
Graph 8: Band Edge a Mode 40 MHz - 5175 MHz



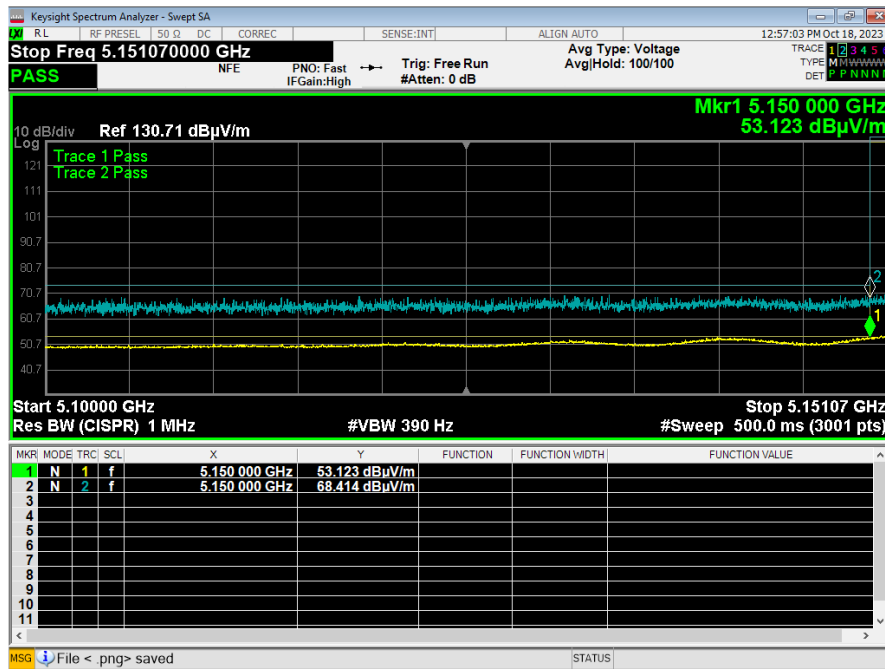
Graph 9: Band Edge ax Mode 40 MHz - 5200 MHz



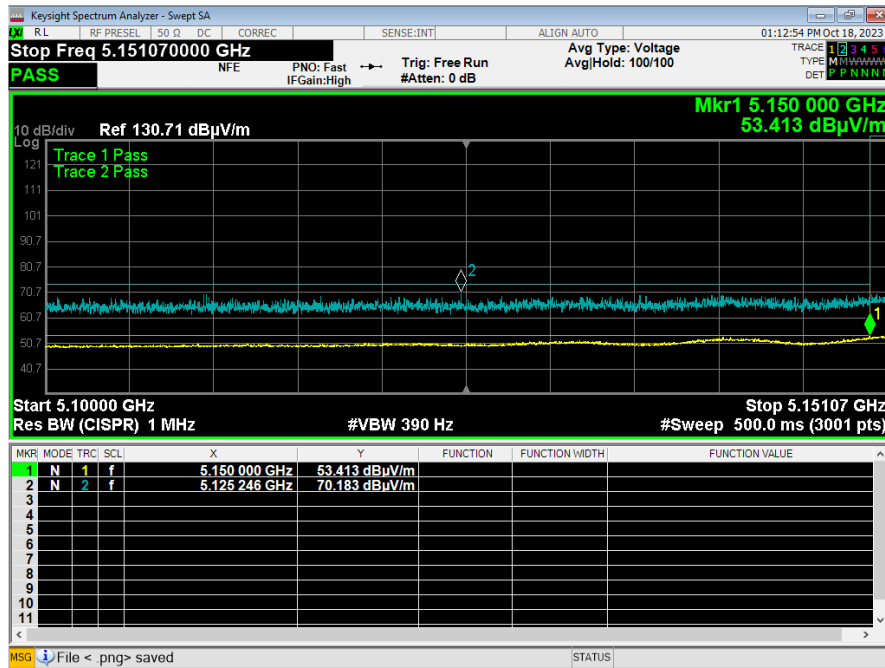
Graph 10: Band Edge ax Mode 40 MHz – 5230 MHz



Graph 11: Band Edge ax Mode 80 MHz - 5195 MHz



Graph 12: Band Edge ax Mode 80 MHz - 5200 MHz



Graph 13: Band Edge ax Mode 80 MHz - 5210 MHz

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 17 dBm in any 1 MHz band during any time interval of continuous transmission.

As per KDB 662911, when the EUT is using spatial-multiplexing in HT to HE modes, there is not additional array gain to accommodate. When the EUT uses Nss=1 data rates, the antenna gain is 7 dBi + Array gain of 3.01 dB which is a total of 10.01 dBi, therefore the limit was reduced to 12.99.

Results of this testing are summarized.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Measured PSD
HE 20	5165	Mcs0	21	-2.56
HE 20	5200	Mcs0	25	0.39
HE 20	5240	Mcs0	25	0.15
HE 40	5175	Mcs0	20	-5.00
HE 40	5200	Mcs0	24	-2.74
HE 40	5230	Mcs0	25	-2.71
HE 80	5195	Mcs0	21	-7.55
HE 80	5200	Mcs0	22	-7.08
HE 80	5210	Mcs0	23	-6.50

Result

The maximum summed average power spectral density was less than the limit of 12.99dBm; therefore, the EUT complies with the specification.

-- End of Test Report --