



427 West 12800 South
Draper, UT 84020

Test Report Certification

FCC ID	SWX-WAVENANO
ISED ID	6545A-WAVENANO
Equipment Under Test	Wave-Nano
Test Report Serial Number	TR7131_01
Date of Tests	16 February; 1, 15 March; 20-22 April 2022
Report Issue Date	11 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

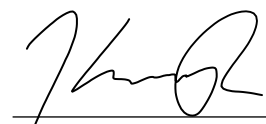
This report has been prepared by Unified Compliance Laboratory (UCL) to document compliance of the device described below with the requirement of Federal Communication Commissions (FCC) Part 15, Subpart E. This report may be reproduced in full. Partial reproduction of this report may only be made with 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-Nano
FCC ID	SWX-WAVENANO
ISED ID	6545A-WAVENANO

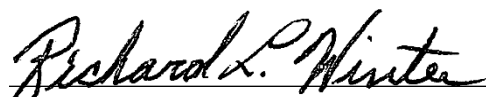
On this 11th day of May 2022, I individually and for Unified Compliance Laboratory certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge and are made in good faith.

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: Kimberly Rodriguez



Reviewed By: Richard L. Winter

Revision History		
Revision	Description	Date
01	Original Report Release	11 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-Nano
Serial Number	245A4CF99E6C
Dimensions (cm)	25.7 x 25.7 x 11.4

2.2 Description of EUT

The 60 GHz Wave Nano (Wave Nano) is a CPE device that connects to a Wave AP functioning as a base station. The Wave Nano has a 1.2+ Gbps throughput rate and can sustain its connection over 5 kilometers. The Wave Nano is also equipped with a 5 GHz WiFi 6 backup radio to sustain connectivity during 60 GHz link disruptions. This easy-to-deploy CPE device can be set up in minutes with the UISP™ application using Bluetooth-powered setup and tracked from anywhere with its built-in GPS antenna.

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: airFiber MN: Wave-Nano SN: 245A4CF99E6C	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 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 Volts PoE
AC Mains Frequency	60 Hz
Temperature	22.1-22.8 °C
Humidity	19.3-23.9 %
Barometric Pressure	1009 mBar

2.6 Operating Modes

The Wave-Nano 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.

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

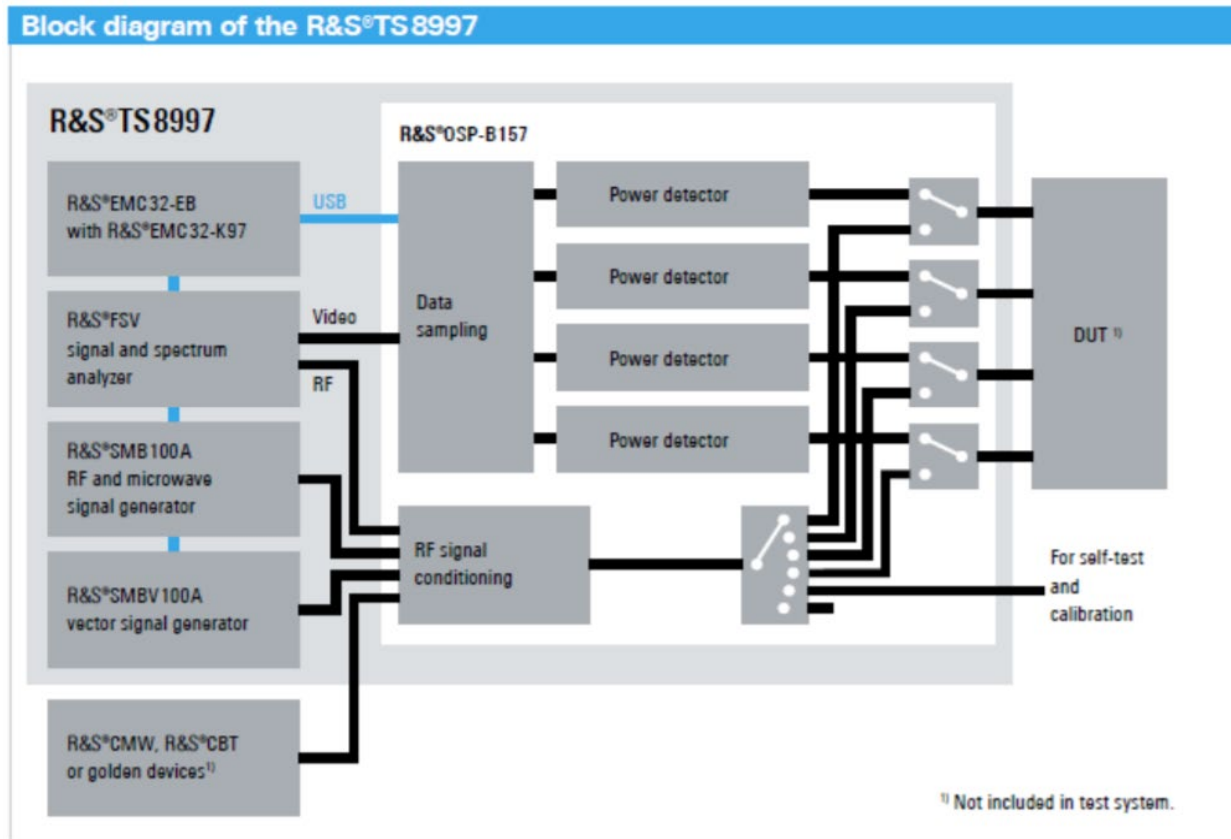


Diagram 1: Test Configuration Block Diagram

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	30 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 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

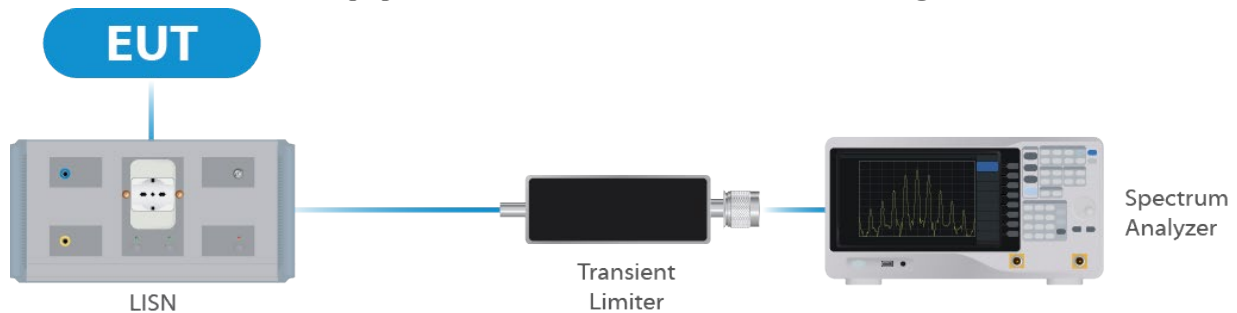


Figure 1: Conducted Emissions Test

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

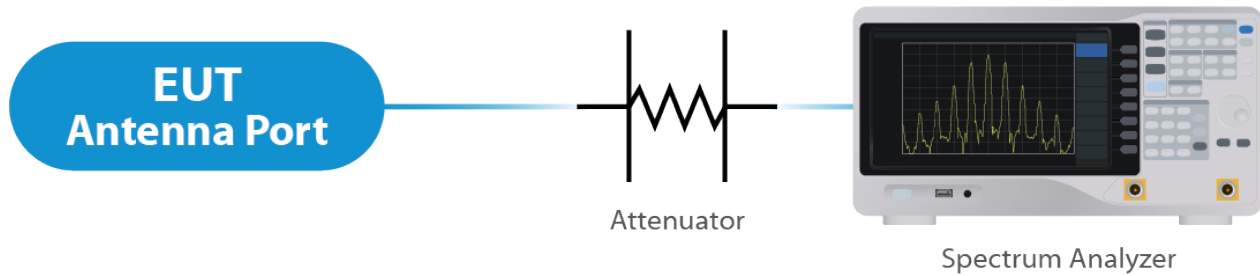


Figure 2: Direct Connect at the Antenna Port Test



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

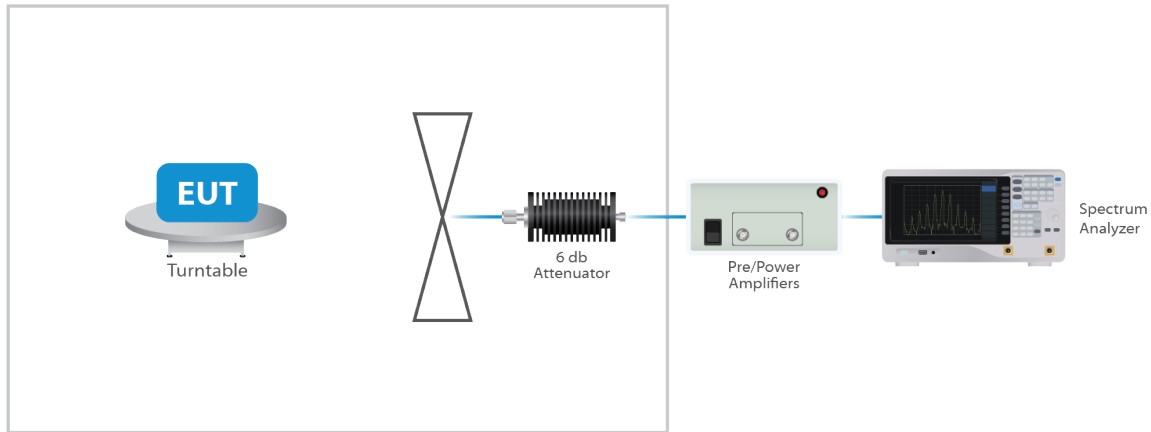


Figure 4: Radiated Emissions Test

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 folding antenna structure. The maximum gain of the antenna per chain is 18.2 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 $N_{ANT} \leq 4$;

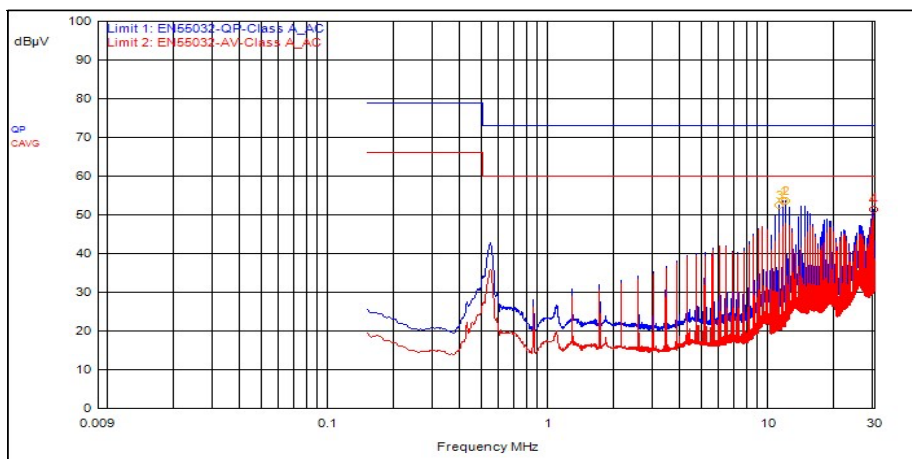
For PSD measurements when $N_{ss}=1$: Array Gain = $10 \log(N_{ant}/N_{ss})$ dB = 6.02dB

Results

The EUT complied with the specification

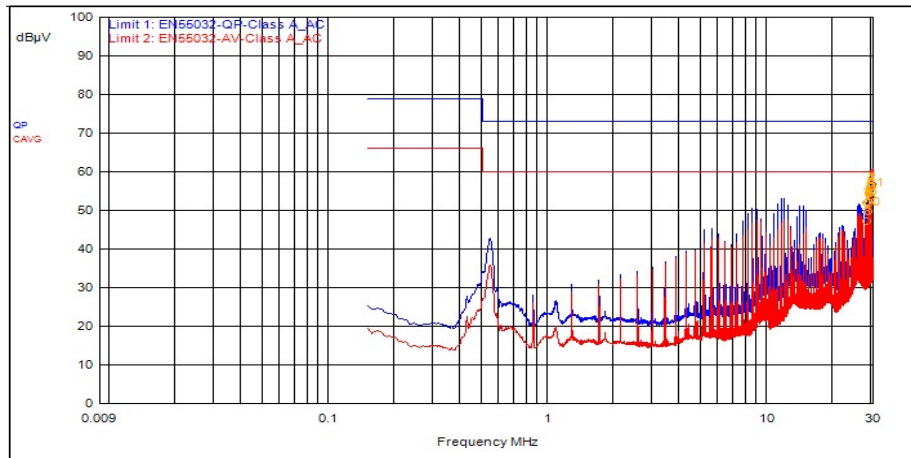
5.2 Conducted Emissions at Mains Ports Data

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	11.427MHz	9.6	0.3		QPeak	43.8	53.7	73.0	-19.3		
2	11.850MHz	9.6	0.3		QPeak	43.8	53.7	73.0	-19.3		
3	11.004MHz	9.6	0.3		QPeak	42.6	52.5	73.0	-20.5		
4	29.613MHz	10.1	0.3		QPeak	41.1	51.5	73.0	-21.5		

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	29.613MHz	9.9	0.3		QPeak	46.6	56.7	73.0	-16.3		
2	29.610MHz	9.9	0.3		QPeak	45.9	56.1	73.0	-16.9		
4	29.190MHz	9.9	0.3		QPeak	45.9	56.0	73.0	-17.0		
5	28.767MHz	9.9	0.3		QPeak	44.3	54.5	73.0	-18.5		
9	28.359MHz	9.8	0.3		QPeak	42.2	52.3	73.0	-20.7		
7	27.933MHz	9.8	0.3		QPeak	41.8	52.0	73.0	-21.0		
3	29.190MHz	9.9	0.3		C_AVG	43.5	53.7			60.0	-6.3
6	28.767MHz	9.9	0.3		C_AVG	41.8	52.0			60.0	-8.0
8	27.921MHz	9.8	0.3		C_AVG	37.2	47.3			60.0	-12.7
10	28.344MHz	9.8	0.3		C_AVG	39.5	49.7			60.0	-10.3
11	29.613MHz	9.9	0.3		C_AVG	44.4	54.6			60.0	-5.4

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	18.90	20.90
HE20	5200	18.90	21.20
HE20	5240	18.90	21.30
HE40	5175	37.25	39.75
HE40	5200	37.50	40.05
HE40	5230	37.75	39.90
HE80	5195	77.00	81.00
HE80	5200	77.00	82.00
HE80	5210	76.50	82.50

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 associated annex for details on instrument settings.

The maximum average RF conducted output power measured for this device was 22.70 dBm or 186.21 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 18.2 dBi.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Conducted Output Power	Measured EIRP	Measured PSD
HE 20	5165	Mcs0	28	16.70	34.90	3.09
HE 20	5200	Mcs0	38	22.20	40.40	8.79
HE 20	5240	Mcs0	39	22.60	40.80	9.12
HE 40	5175	Mcs0	30	18.00	36.20	1.94
HE 40	5200	Mcs0	32	19.20	37.40	3.20
HE 40	5230	Mcs0	37	21.90	40.10	5.79
HE 80	5195	Mcs0	21	12.90	31.10	-5.43
HE 80	5200	Mcs0	31	18.50	36.70	0.11
HE 80	5210	Mcs0	31	18.50	36.70	0.32

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).

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 18.2 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.

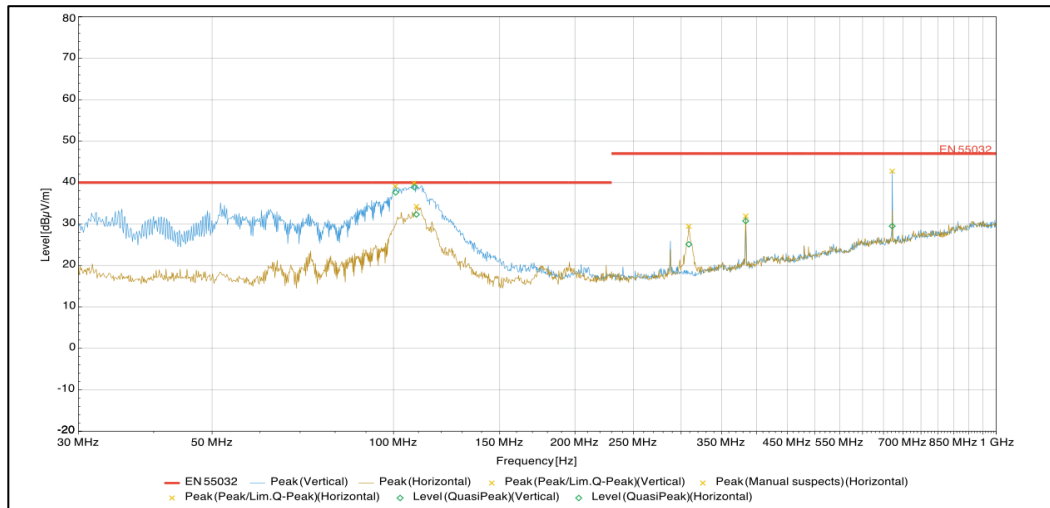
5.5.2 Radiated Spurious Emissions in the Restricted Bands of § 15.205

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 TP39, 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.

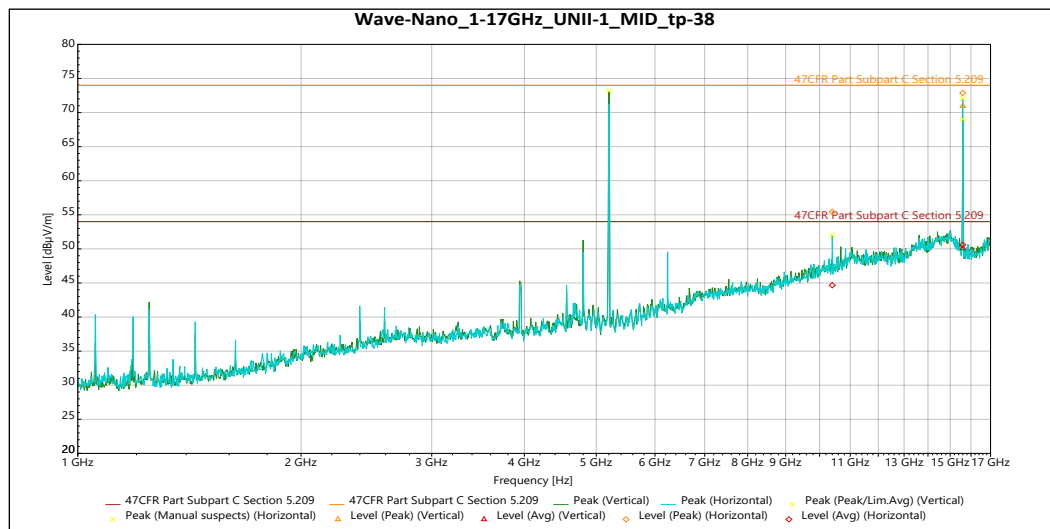
Result

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.



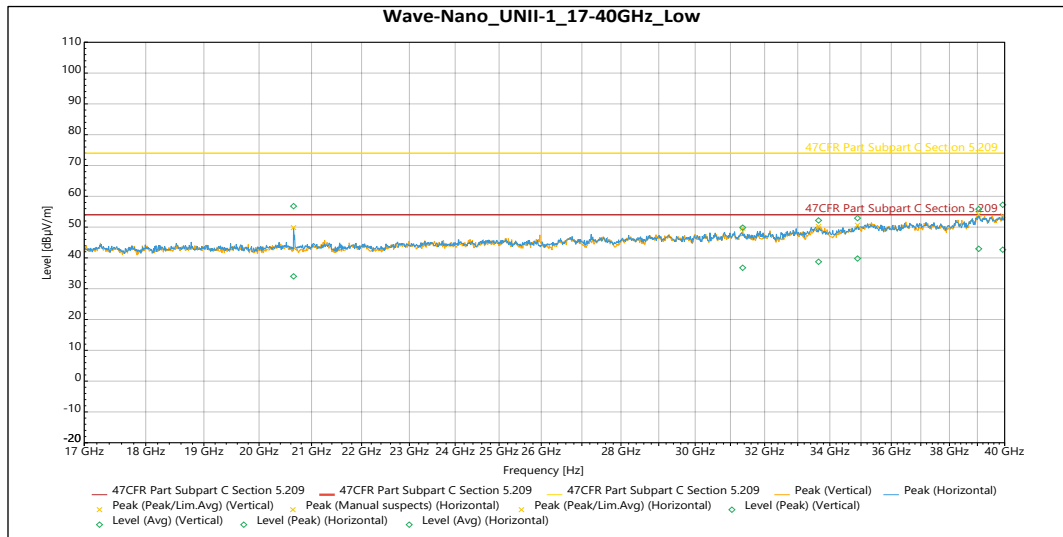
Frequency	SR #	Level (dBμV/m)	Limit (dBμV/m)	Margin	Azimuth (°)	Height	Pol.	RBW (Hz)	Correction (dB)
100.83 MHz	QPeak	37.627	40	-2.373	340	1.378	Vertical	120000	-12.8
108.29 MHz	QPeak	38.899	40	-1.101	102	1.053	Vertical	120000	-13.591
671.94 MHz	QPeak	29.487	47	-17.513	301	2.656	Vertical	120000	-4.084
109.13 MHz	QPeak	32.305	40	-7.695	56	3.826	Horizontal	120000	-13.784
308.98 MHz	QPeak	25.1	47	-21.9	183	2.535	Horizontal	120000	-11.098
383.97 MHz	QPeak	30.743	47	-16.257	163	1.791	Horizontal	120000	-9.171

Table 4: Radiated Emissions within 30MHz-1GHz



Frequency	SR #	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Correction (dB)
15.6 GHz	1	70.968	74	-3.032	97	2.751	Vertical	13.668
15.6 GHz	1	50.089	54	-3.911	97	2.751	Vertical	13.668
10.4 GHz	2	55.44	74	-18.56	56	1.841	Horizontal	12.01
15.595 GHz	2	72.876	74	-1.124	116	3.114	Horizontal	13.69
10.4 GHz	2	44.674	54	-9.326	56	1.841	Horizontal	12.01
15.595 GHz	2	50.58	54	-3.42	116	3.114	Horizontal	13.69

Table 5: Transmitting on the Middle Frequency 5200 MHz



Frequency	SR #	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Pol.	Correction (dB)
31.354 GHz	Peak	49.818	74	-24.182	225	Vertical	-0.719
33.645 GHz	Peak	52.168	74	-21.832	39	Vertical	1.149
39.047 GHz	Peak	55.826	74	-18.174	191	Vertical	3.145
31.354 GHz	AVG	36.793	54	-17.207	225	Vertical	-0.719
33.645 GHz	AVG	38.739	54	-15.261	39	Vertical	1.149
39.047 GHz	AVG	42.946	54	-11.054	191	Vertical	3.145
20.652 GHz	Peak	56.802	74	-17.198	224	Horizontal	-5.585
34.887 GHz	Peak	52.906	74	-21.094	212	Horizontal	1.078
39.93 GHz	Peak	57.243	74	-16.757	56	Horizontal	3.797
20.652 GHz	AVG	34.011	54	-19.989	224	Horizontal	-5.585
34.887 GHz	AVG	39.801	54	-14.199	212	Horizontal	1.078
39.93 GHz	AVG	42.66	54	-11.34	56	Horizontal	3.797

Table 6: Radiated Emissions within 17-40GHz Transmitting on Middle Frequency

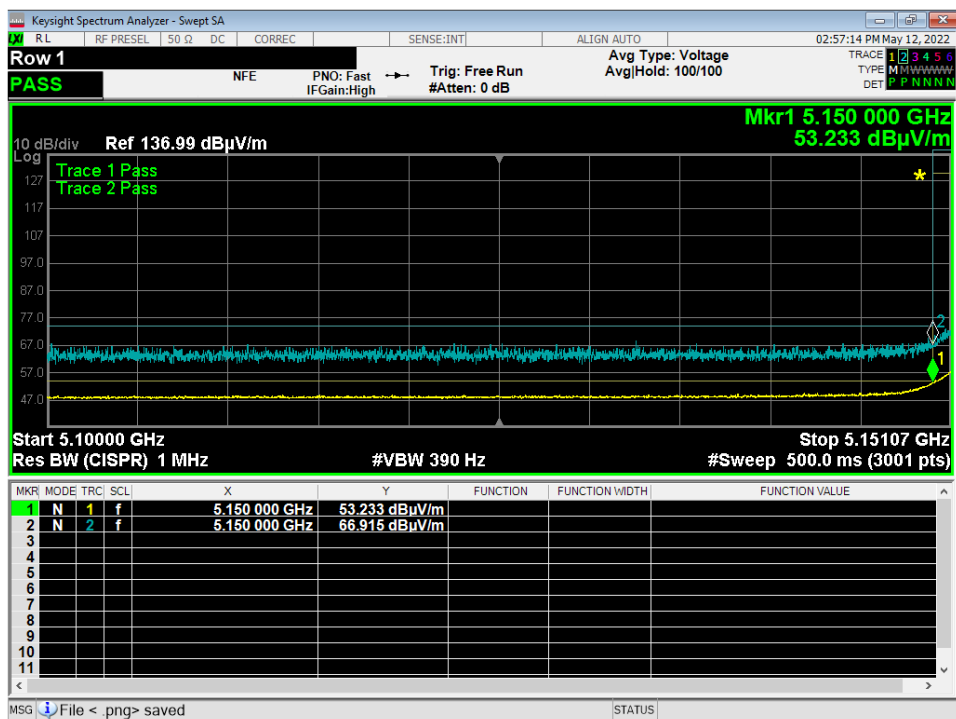


Figure 5: Band Edge HE20 5165MHz

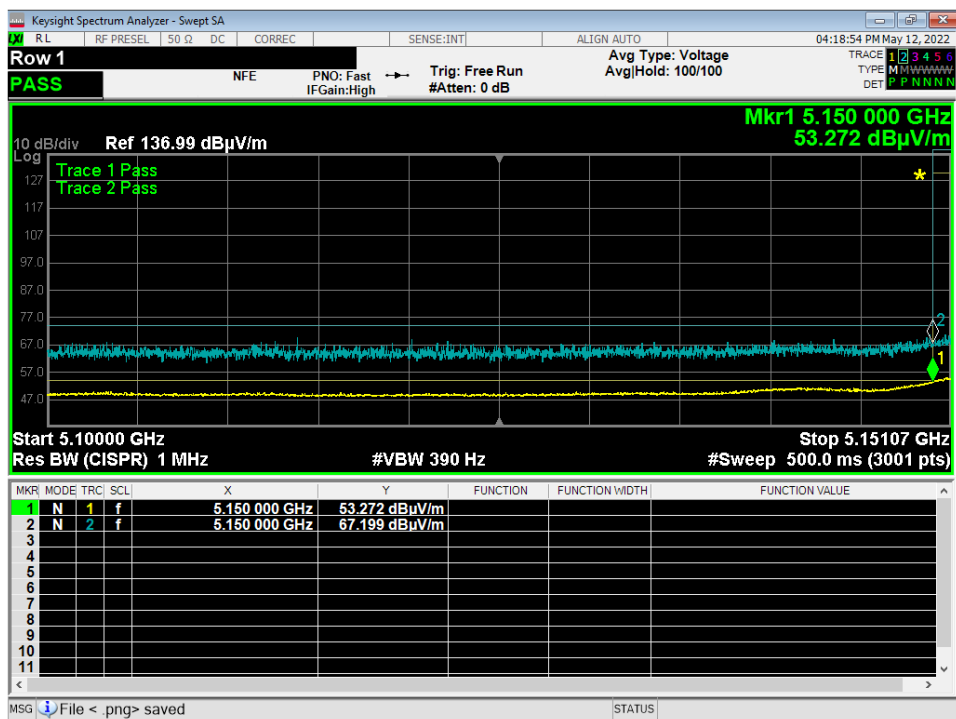


Figure 6: Band Edge HE20 5200MHz

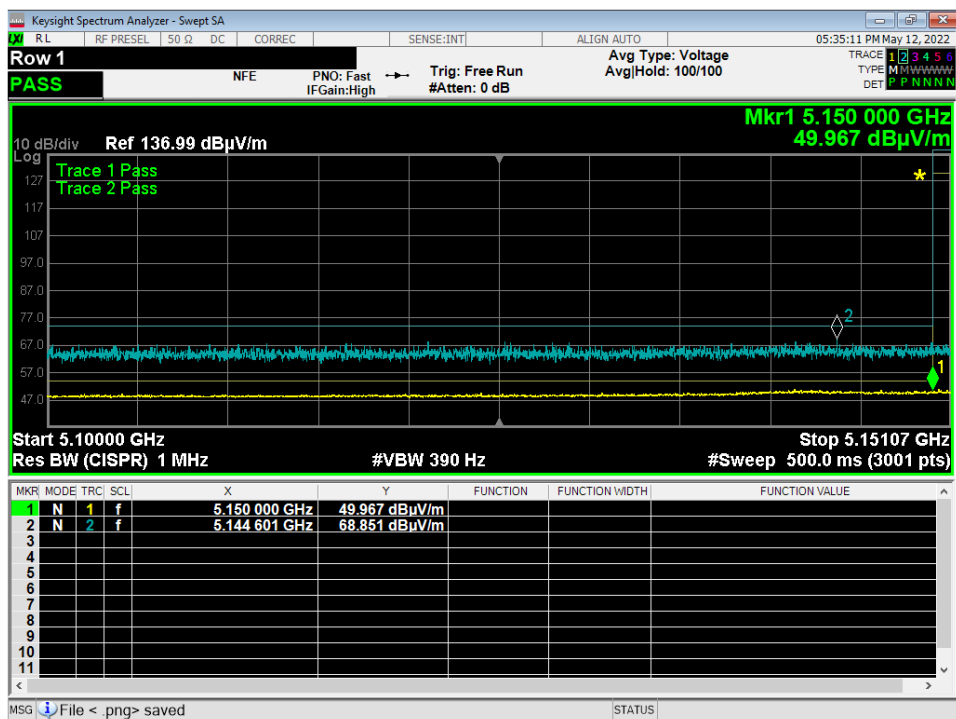


Figure 7: Band Edge HE20 5240MHz

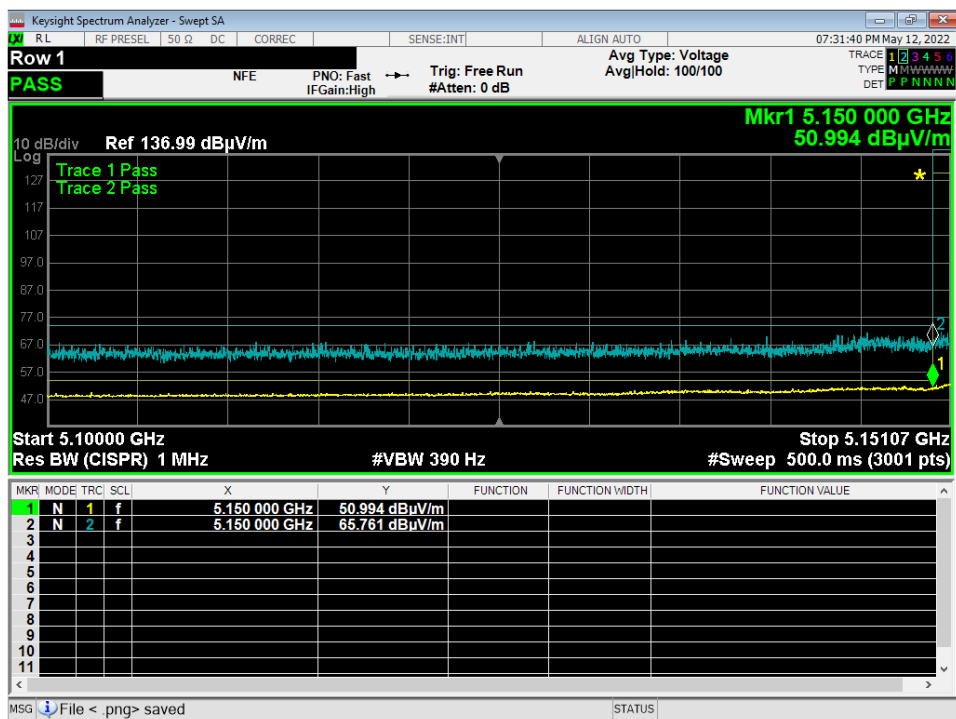


Figure 8: Band Edge HE40 5175MHz

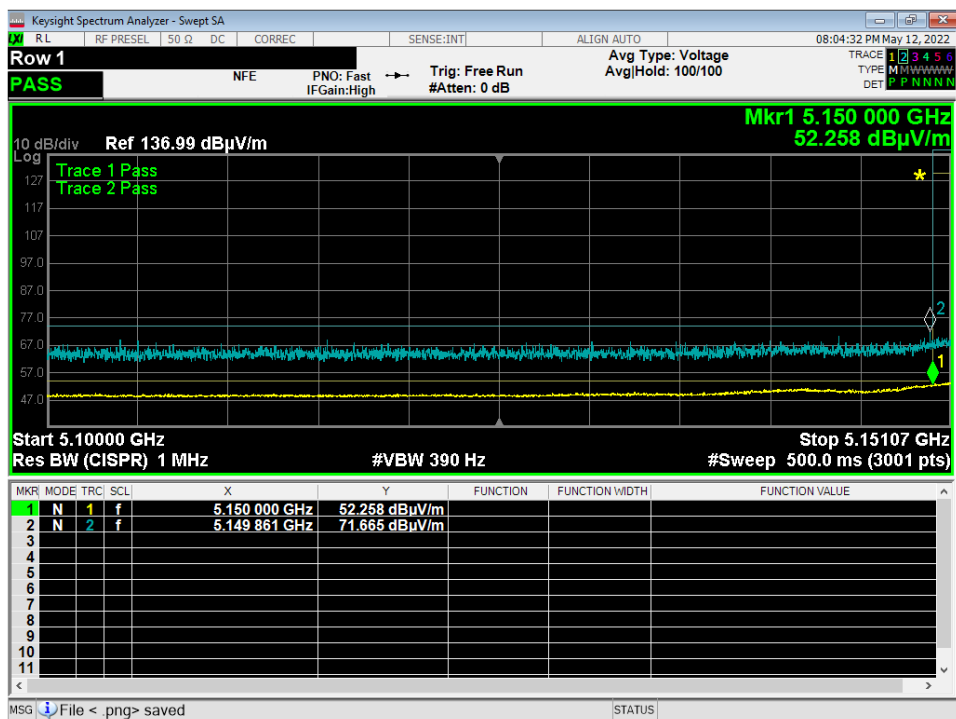


Figure 9: Band Edge HE40 5200MHz

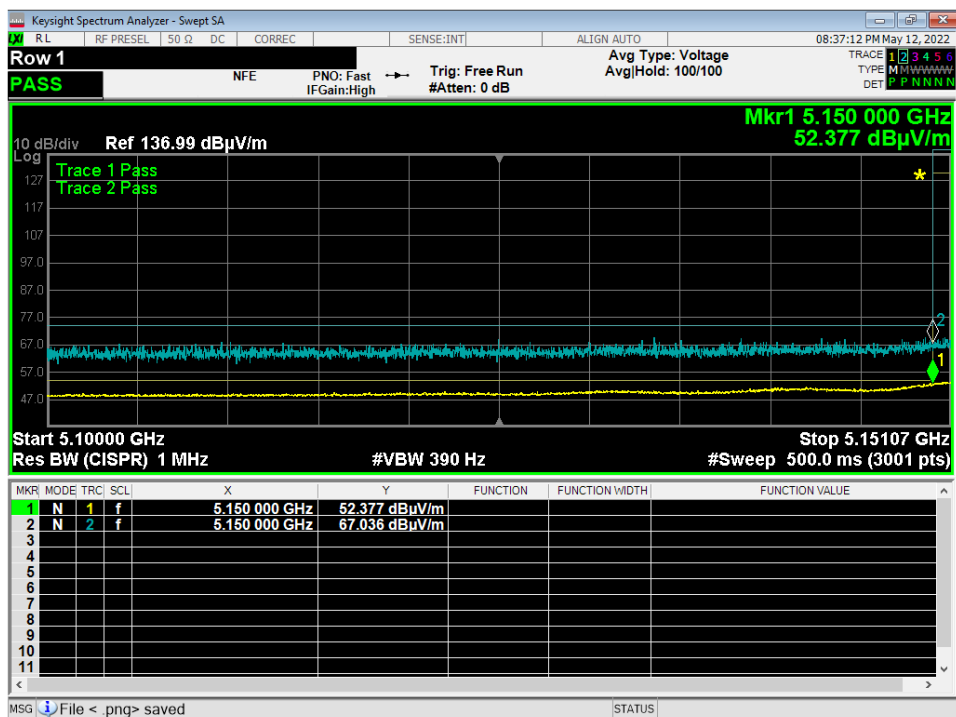


Figure 10: Band Edge HE40 5230MHz

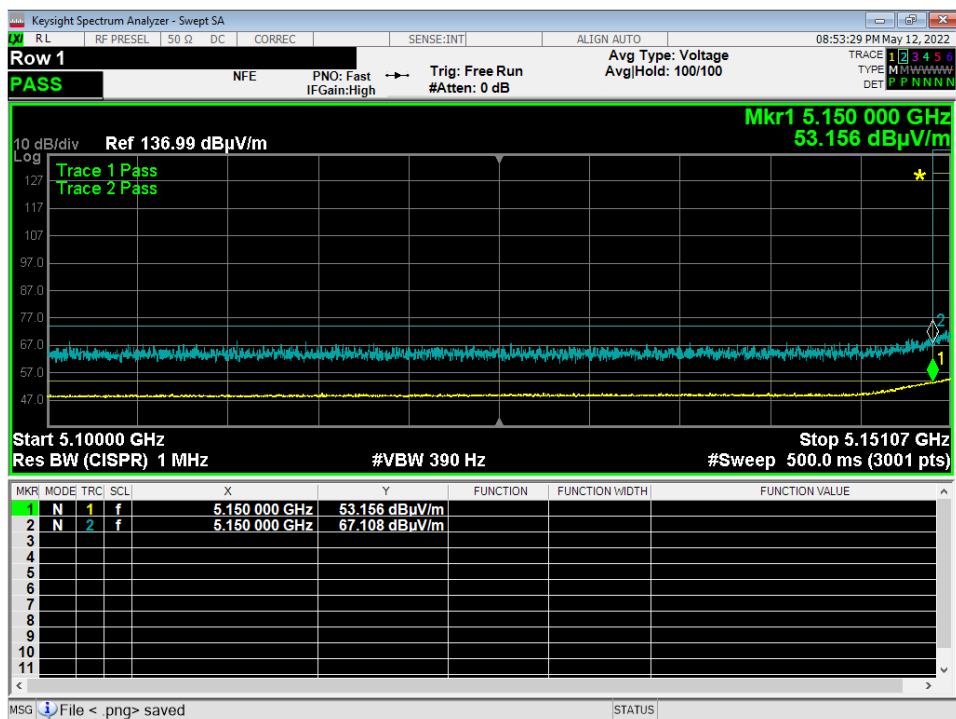


Figure 11: Band Edge HE80 5195MHz

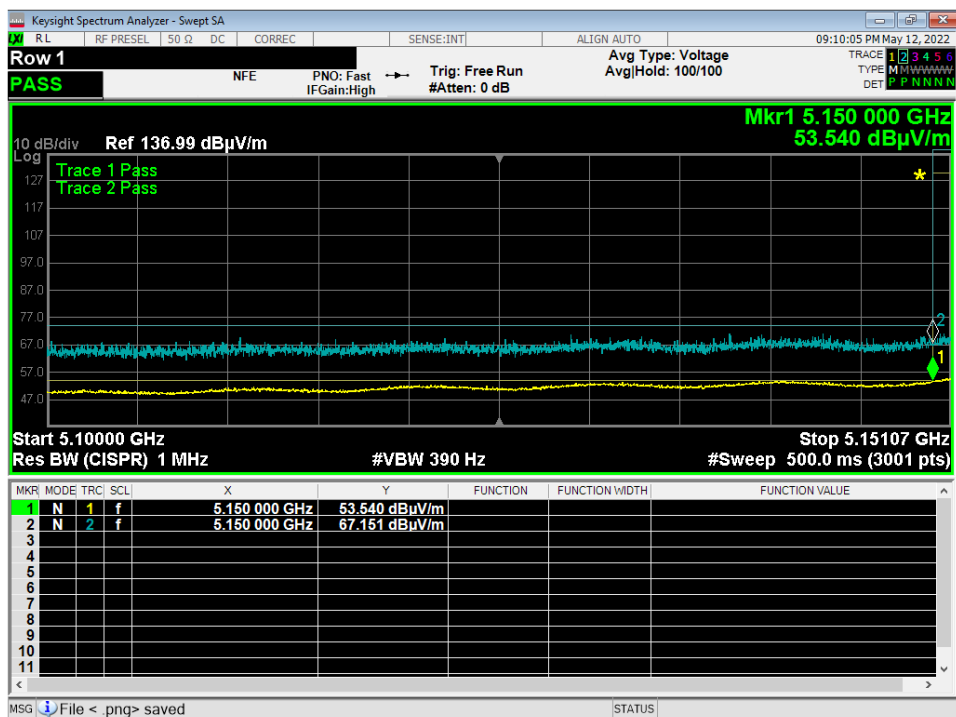


Figure 12: Band Edge HE80 5200MHz

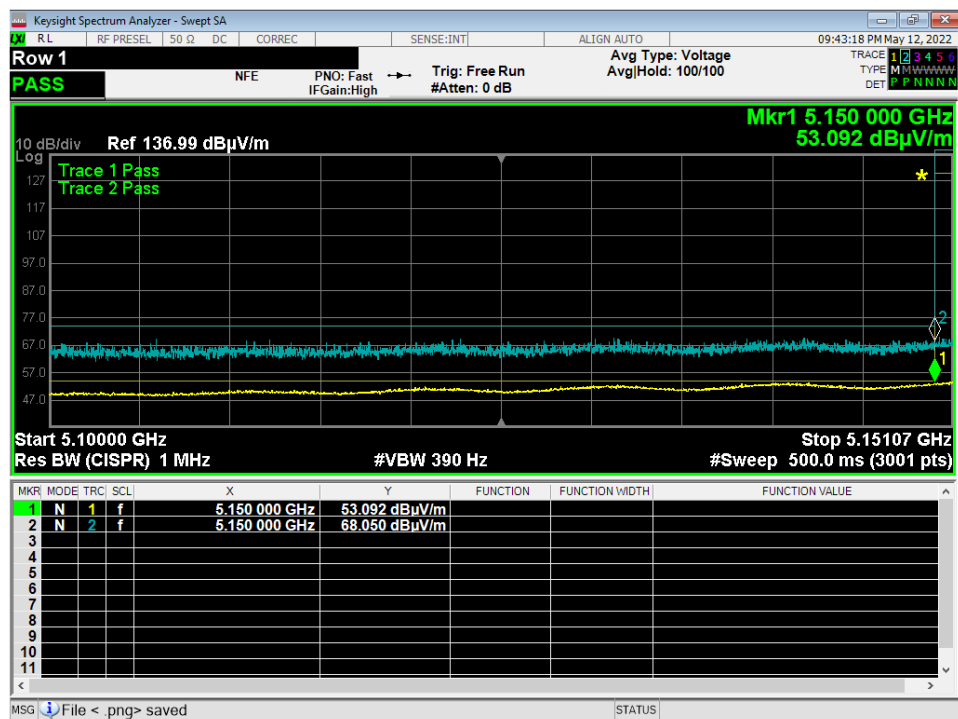


Figure 13: Band Edge HE80 5210MHz

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. Results of this testing are summarized.

Modulation (BW)	Frequency (MHz)	Data Rate	TP Setting	Measured PSD
HE 20	5165	Mcs0	28	3.09
HE 20	5200	Mcs0	38	8.79
HE 20	5240	Mcs0	39	9.12
HE 40	5175	Mcs0	30	1.94
HE 40	5200	Mcs0	32	3.20
HE 40	5230	Mcs0	37	5.79
HE 80	5195	Mcs0	21	-5.43
HE 80	5200	Mcs0	31	0.11
HE 80	5210	Mcs0	31	0.32

Result

The maximum summed average power spectral density was less than the limit of 17dBm; therefore, the EUT complies with the specification.

-- End of Test Report --