



427 West 12800 South
Draper, UT 84020

Test Report Certification

FCC ID	SWX-WAVEAM
IC ID	6545A-WAVEAM
Equipment Under Test	WAVE-AP-MICRO
Test Report Serial Number	TR7597_01
Date of Test(s)	August 12, through September 12, 2022, and October 27, 2022
Report Issue Date	October 28, 2022

Test Specification	Applicant
47 CFR FCC Part 15, Subpart C RSS-GEN Issue 5	Ubiquiti Inc. 685 Third Avenue, 27 th Floor New York, NY 10019 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 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	Wave
Model Number	WAVE-AP-MICRO
FCC ID	SWX-WAVEAM
IC ID	6545A-WAVEAM

On this 28th day of October 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: Clay Allred



Reviewed By: Richard L. Winter

Revision History		
Revision	Description	Date
01	Original Report Release	October 28, 2022

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1 Client Information

1.1 Applicant

Company	Ubiquiti Inc. 685 Third Avenue, 27 th Floor New York, NY 10017 U.S.A.
Contact Name	Alex Macon
Title	Compliance

1.2 Manufacturer

Company	Ubiquiti Inc. 685 Third Avenue, 27 th Floor 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	Wave
Model Number	Wave-AP-Micro
Serial Number	0418D6A28CB3
Dimensions (cm)	28.4 x 15.6 x 7.6

2.2 Description of EUT

The Wave-AP-Micro is 60 GHz point-to-multipoint customer premise equipment that features wave technology with a 1.5+ Gbps throughput rate. The Wave-AP-Micro 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-AP-Micro 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: Wave MN: Wave-AP-Micro (Note 1) SN: 0418D6A28CB3	Wireless P-P/P-MP Radio	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
PoE	1	Shielded or Un-Shielded Cat 5e Cable/ 7 meters

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-AP-MICRO 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.

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

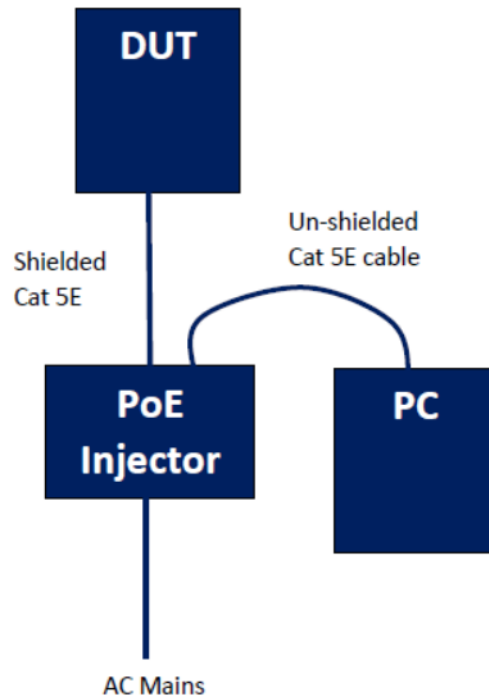


Diagram 1: Test Configuration Block Diagram

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 15.255 Limits and methods of measurement of radio interference characteristics of radio frequency devices. RSS-Gen, issue 5, General Requirements for Compliance of Radio Apparatus RSS-210, issue 10, Licence-Exempt Radio Apparatus: Category I Equipment
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 / RSS-GEN

See test standard for details.

3.2.2 47 CFR FCC Part 15 Section 15.207 / RSS-GEN

See test standard for details.

3.2.3 47 CFR FCC Part 15 Section 15.255 / RSS-210

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	N/A
15.255 (e)	RSS-210 § J.4	Bandwidth Requirement	57000 - 71000	Compliant
15.255 (c)	RSS-210 § J.4	Peak Output Power	57000 - 71000	Compliant
15.255 (d)	RSS-210 § J.3	Antenna Conducted Spurious Emissions	0.009 to 40000	N/A
15.255 (d)	RSS-210 § J.3	Radiated Spurious Emissions	0.009 to 200000	Compliant
15.255 (c)	RSS-210 § J.4	Peak Power Spectral Density	57000 - 71000	Compliant
15.255 (f)	RSS-210 § J.6	Frequency Stability	57000 - 71000	Compliant
The testing was performed according to the procedures in ANSI C63.10-2013, KDB 558074 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 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 and has registered MRA Test Site number US5037.

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	6/27/2023
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

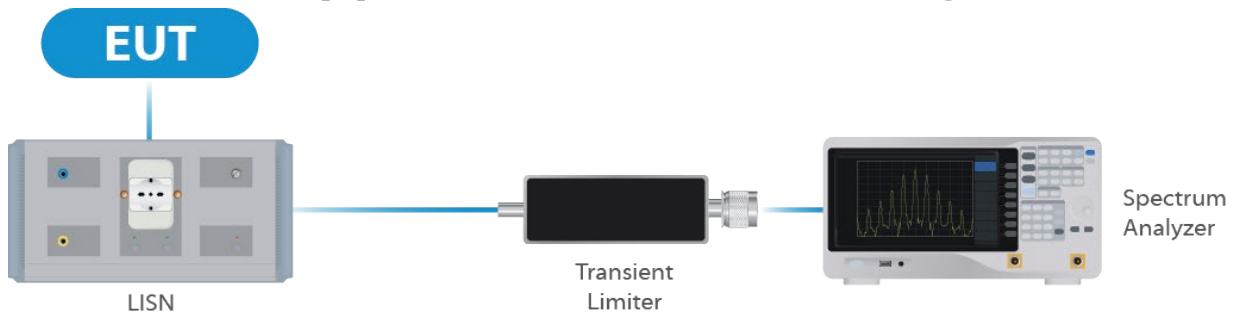


Figure 1: Conducted Emissions Test

4.2 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	11/7/2022
Double Ridge Horn Antenna	Com-Power	AH-118	UCL-5582	11/19/2020	11/19/2022
Log Periodic 15 - 40 GHz Horn Antenna	Scwarzbeck	STLP 9129	UCL-3068	11/16/2020	11/16/2022
Pre-Amplifier 9 kHz – 1 GHz	Sonoma Instruments	310N	UCL-4793	10/7/2021	10/7/2023
Pre-Amplifier 1 – 18 GHz	Com-Power	PAM 118A	UCL-3833	10/7/2021	11/7/2022

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
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
Test Software	UCL	Revision 1	UCL-3108	N/A	N/A
Conical Horn Antenna	VDI	WR15CH	UCL-5774	N/A	N/A
Conical Horn Antenna	VDI	WR12CH	UCL-4869	N/A	N/A
Conical Horn Antenna	VDI	WR19CH	UCL-4873	N/A	N/A
Conical Horn Antenna	VDI	WR5.1CH	UCL-4880	N/A	N/A
Conical Horn Antenna	VDI	WR8.0CH	UCL-4886	N/A	N/A
Spectrum Analyzer Extension Module	VDI	SAX 705	UCL-4887	N/A	N/A
Spectrum Analyzer Extension Module	VDI	SAX 706	UCL-4883	N/A	N/A
USB Switch	Keysight	U1816C	UCL-4957	N/A	N/A
Spectrum Analyzer	Keysight	N9041B	UCL-4964	1/28/2022	1/27/2023

Table 2: List of equipment used for Radiated Emissions

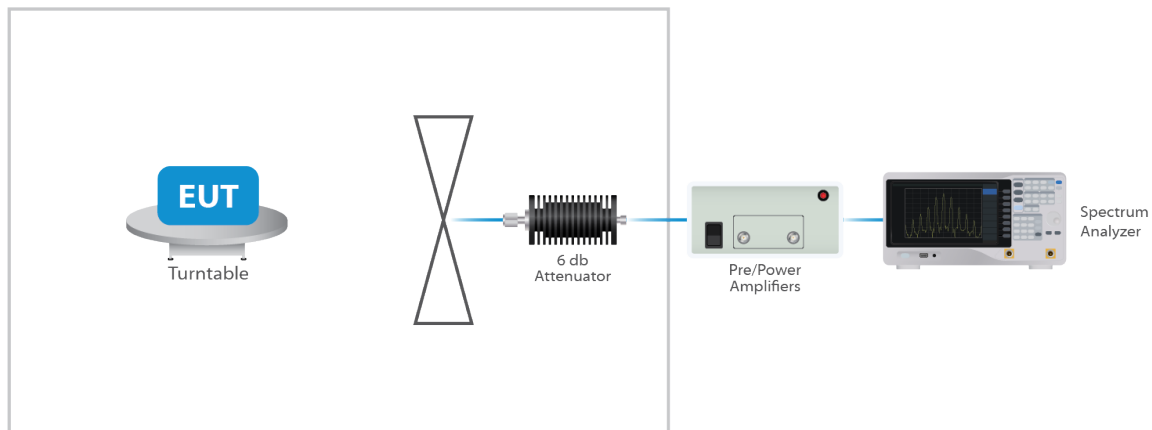


Figure 2: Radiated Emissions Test

4.3 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.

4.4 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 a single integral antenna structure. The maximum gain of the antenna per chain is 20 dBi. This is an 802.11 device and utilizes MIMO modes as described in KDB 662911 D01. The antenna is not user replaceable.

Results

The EUT complied with the specification

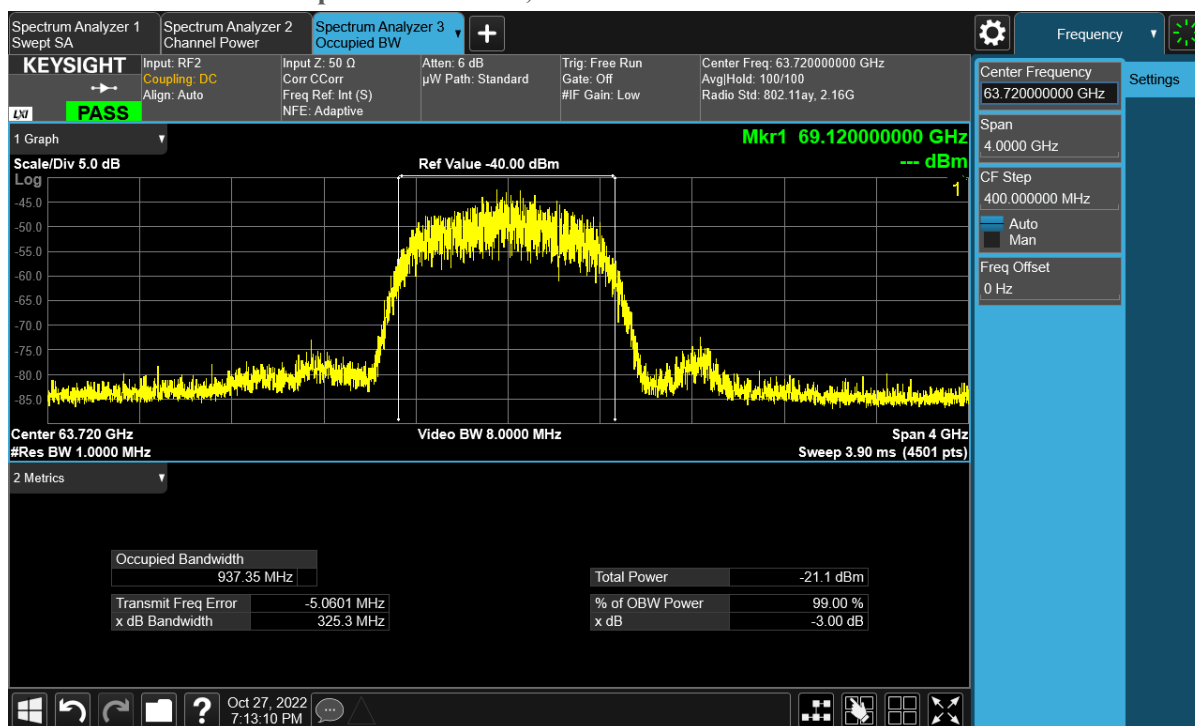
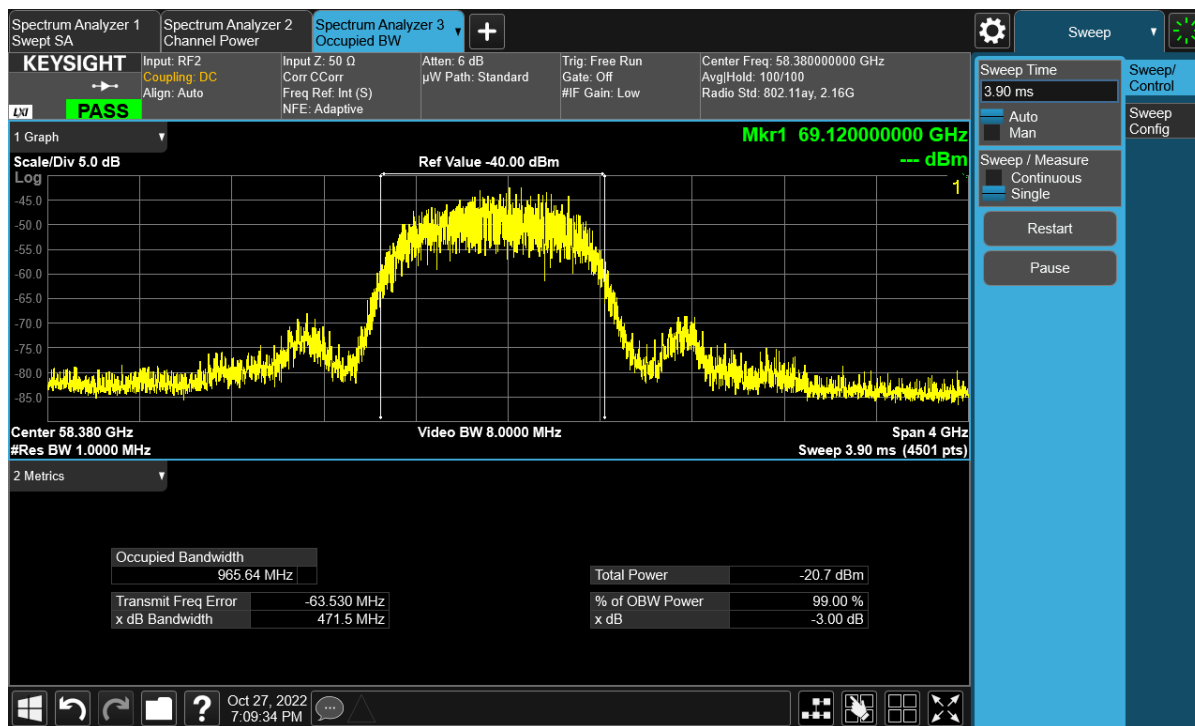
5.2 Emissions Bandwidth

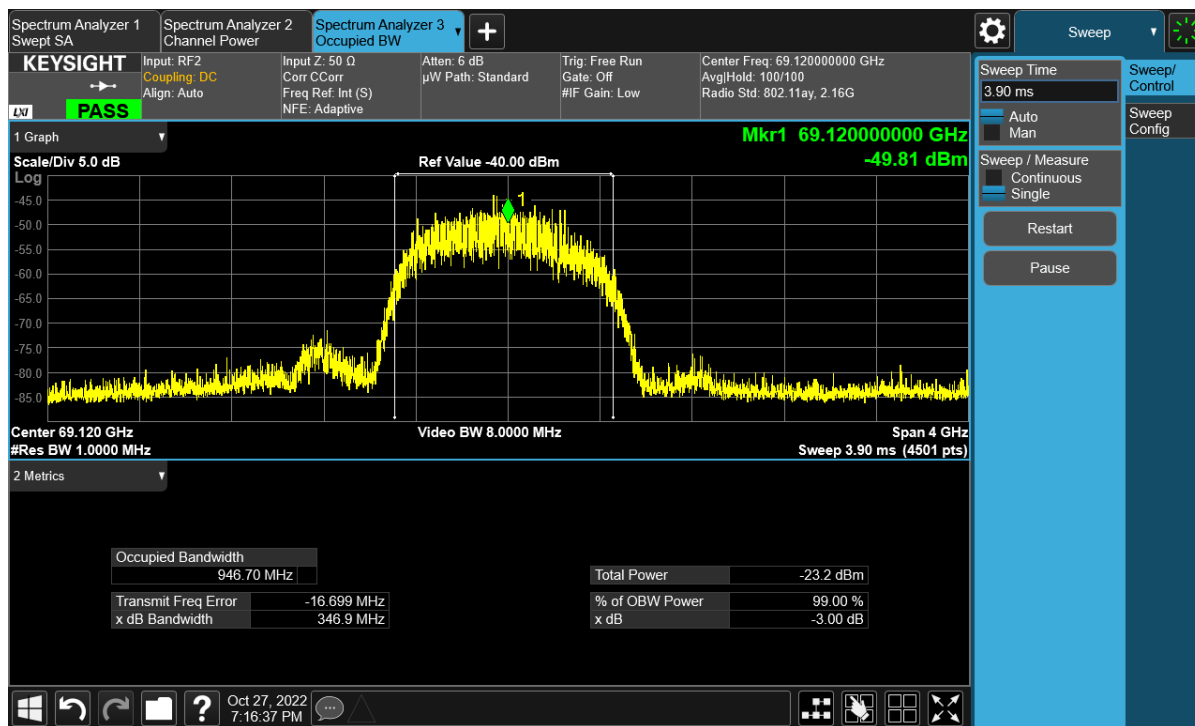
Channel Width (GHz)	Frequency (MHz)	Emissions 99% Bandwidth (MHz)
1.06	58320	966
	63720	937
	70200	1243
2.12	58320	1963
	63720	1870
	69120	1856

Result

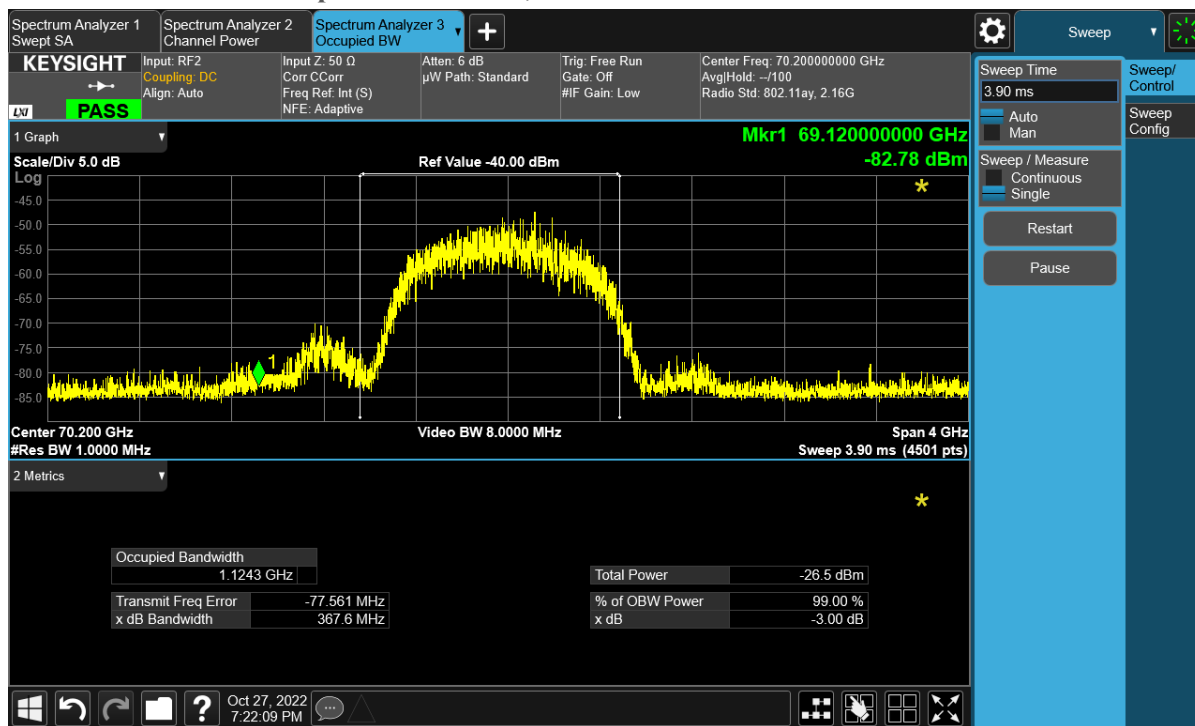
All chains were tested and the highest bandwidth per chain is reported above.

In the configuration tested, the 99% bandwidth was greater than 500 kHz; therefore, the EUT complied with the requirements of the specification (see spectrum analyzer plot below).

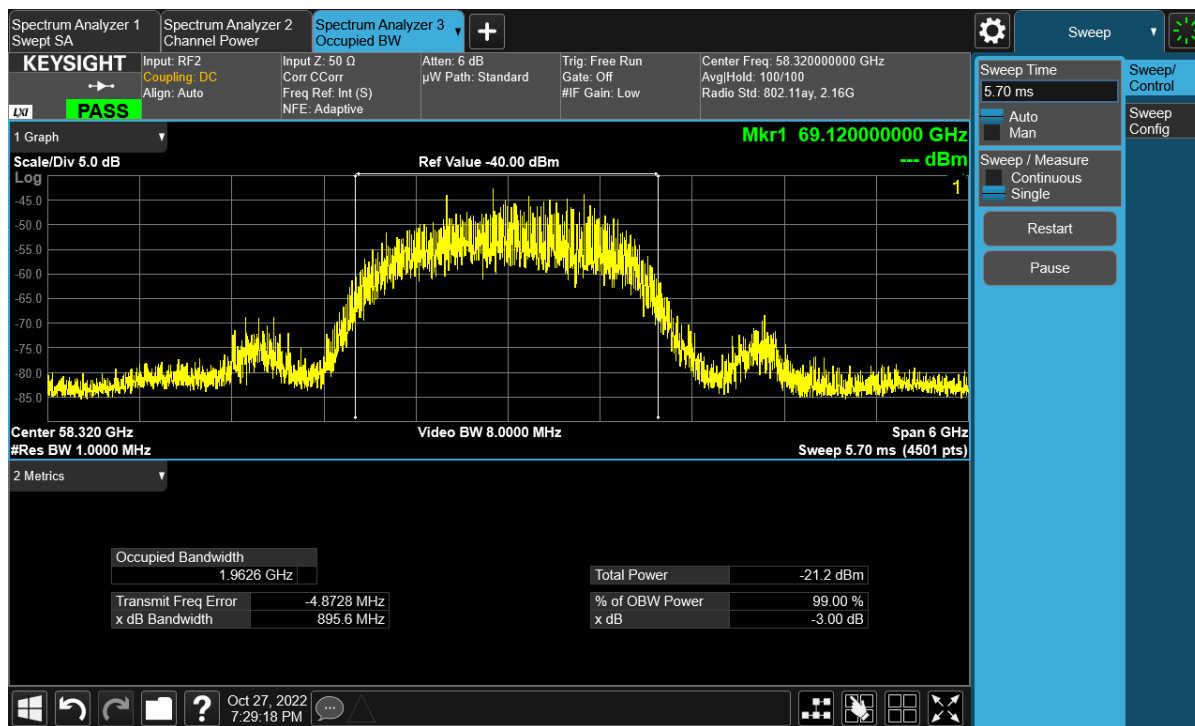




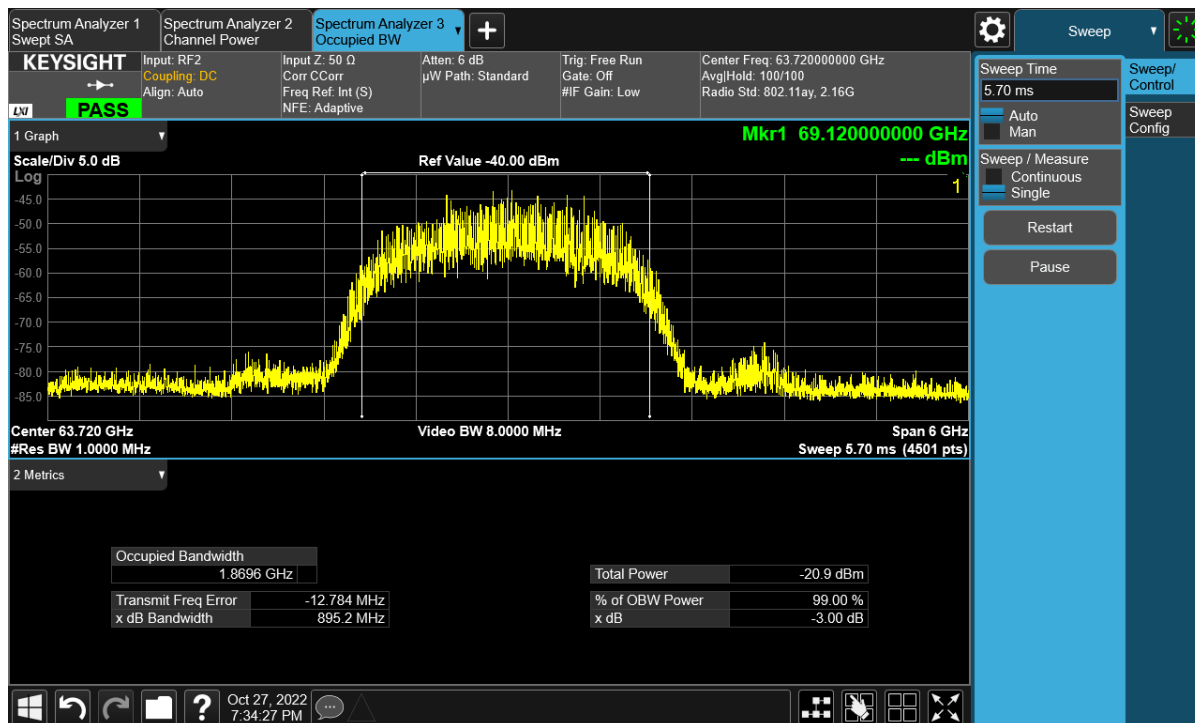
Graph 3: 69.12GHz, 1.06GHz Emissions Bandwidth



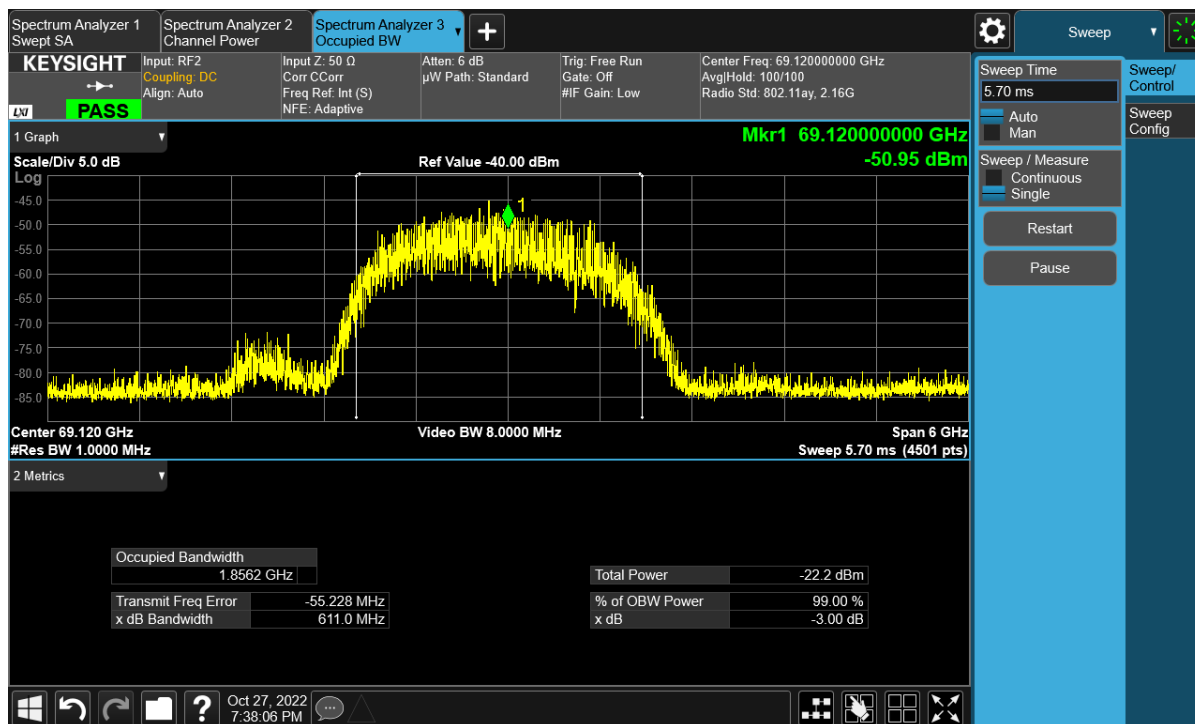
Graph 4: 70.2GHz, 1.06GHz Emissions Bandwidth



Graph 5: 58.32GHz, 2.12GHz Emissions Bandwidth



Graph 6: 63.72GHz, 2.12GHz Emissions Bandwidth



Graph 7: 69.12GHz, 2.12GHz Emissions Bandwidth

5.3 §15.255(c)(1)(i) Maximum Average Output Power

All chains were measured and summed under the guidance of KDB 558074 Section 8.3.2.3. and KDB 66291 D01. Please see associated annex for details on instrument settings.

The maximum average RF EIRP measured for this device was 36.7 dBm or 4.677 Watts.

For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.). The antenna gain is 20dBi therefore the limit of 40 and 43 take precedence.

Nominal BW	Freq. (MHz)	Air Path Loss (dB)	Total Correction	Peak SA Reading	Cond. Peak	Peak Conducted Limit	EIRP Peak	Peak EIRP Limit
1.08	58320	84.7	63.5	-20.7	22.8	27	42.8	43
	63720	85.4	63.8	-21.1	22.7	27	42.7	43
	70200	86.3	64.4	-26.5	17.9	27	37.9	43
2.12	58320	84.7	63.5	-21.2	22.3	27	42.3	43
	63720	85.4	63.8	-20.9	22.9	27	42.9	43
	69120	86.1	64.3	-22.2	22.1	27	42.1	43

Nominal BW	Frequency (MHz)	Air Path Loss (dB)	Total Correction	AvG SA Reading	EIRP Avg	Avg EIRP Limit	Avg Delta
1.08	58320	84.7	63.5	-26.8	36.7	40	-3.3
	63720	85.4	63.8	-27.3	36.5	40	-3.5
	70200	86.3	64.4	-31.4	33.0	40	-7.0
2.12	58320	84.7	63.5	-28.0	35.5	40	-4.5
	63720	85.4	63.8	-27.6	36.2	40	-3.8
	69120	86.1	64.3	-28.7	35.6	40	-4.4

Result

In the configuration tested, the maximum average RF EIRP was less than 40 dBm; therefore, the EUT complied with the requirements of the specification. (see spectrum analyzer plot below/within the Annex).

5.4 §15.255(d) Spurious Emissions

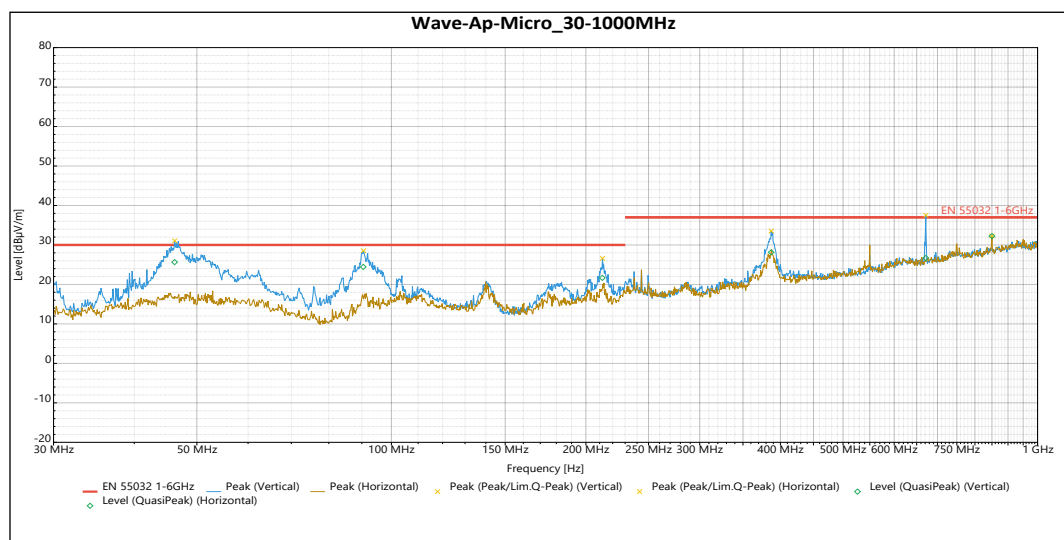
5.4.1 Radiated Spurious Emissions in the Restricted Bands of §15.205

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 between 18.0 and 40 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 bands must meet the limits specified in §15.209. Tabular data for each of the spurious emissions is shown below for each of the units. The BLE radio and 60 GHz radio are active during all plots. The limit above 40 GHz is 90pW/cm². The measurement distance above 40 GHz was 3 meters.

Result

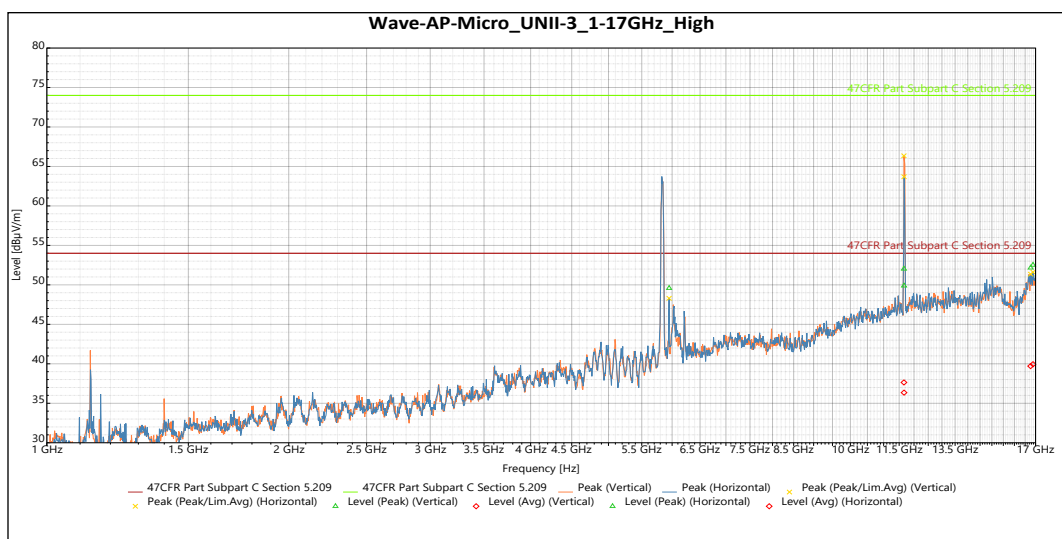
All emissions in the restricted bands of §15.205 met the limits specified in §15.209. All emissions met the limits set out in 15.255(d) therefore, the EUT complies with the specification.

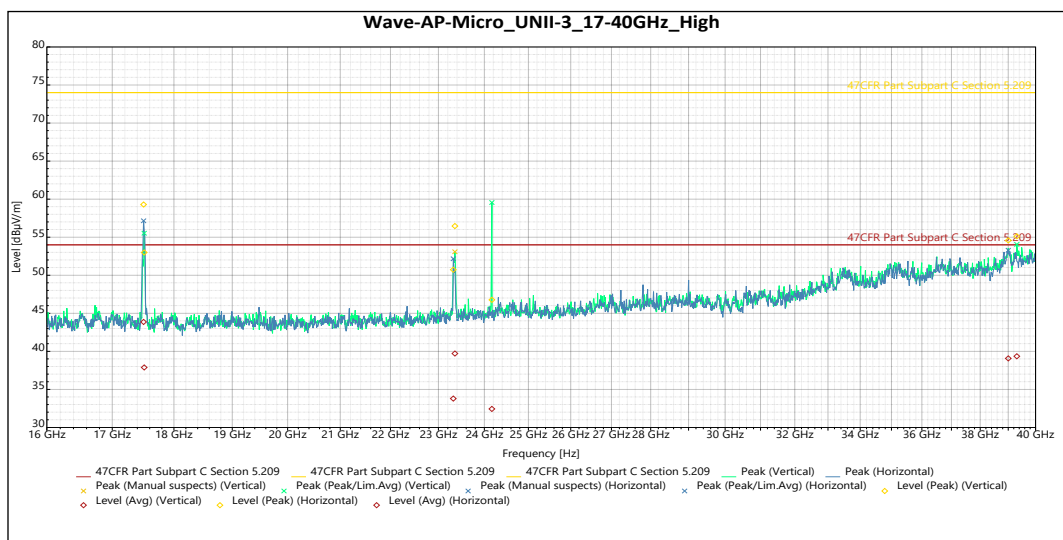
Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin	Azimuth (°)	Height	Pol.	Meas. Time	RBW (Hz)	Meas.Time (s)	Correction (dB)
46.183 MHz	25.648	30	-4.352	305	1.963	Vertical	15	120000	0.001	-12.249
90.45 MHz	24.444	30	-5.556	281	1.395	Vertical	15	120000	0.001	-15.565
212.05 MHz	21.675	30	-8.325	352	2.026	Vertical	15	120000	0.001	-14.138
387 MHz	28.141	37	-8.859	299	0.994	Vertical	15	120000	0.001	-8.875
671.45 MHz	26.692	37	-10.308	351	1.354	Vertical	15	120000	0.001	-4.327
849.98 MHz	32.228	37	-4.772	87	3.396	Horizontal	15	120000	0.001	-1.018



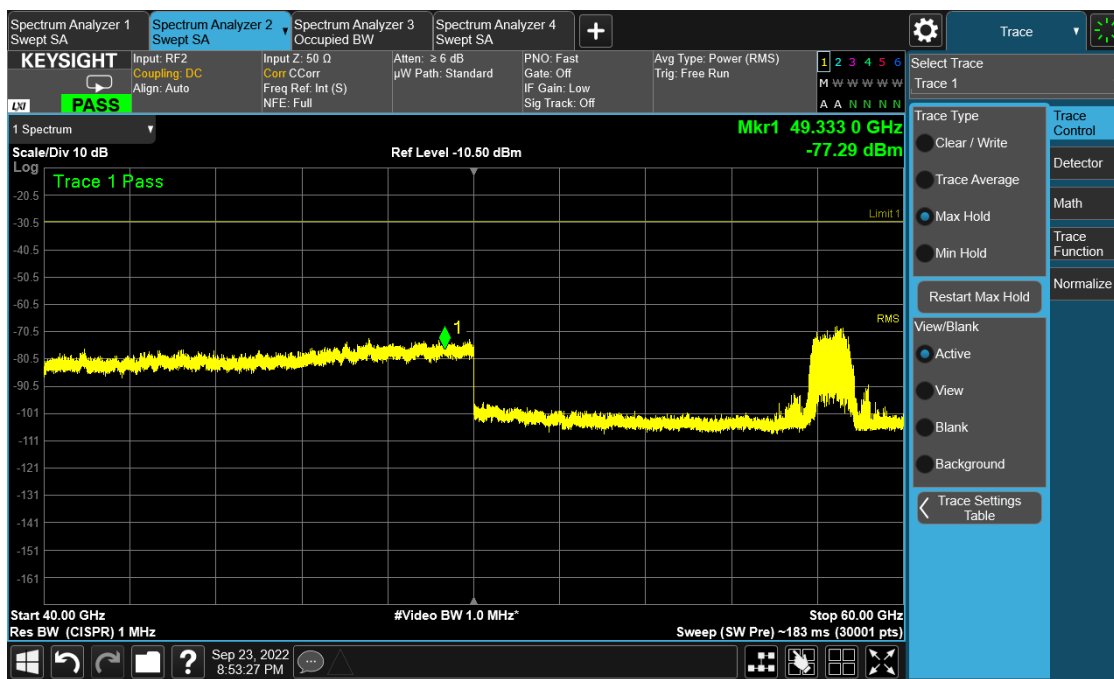
30-100MHz Spurious Emissions (all transmitters Active)

Frequency	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	Meas. Time (s)	RBW (Hz)	Detector	Correction (dB)
11.659 GHz	52.034	74	-21.966	2	3.307	Vertical	5	1000000	Peak	3.41
16.761 GHz	52.166	74	-21.834	195	1.5	Vertical	5	1000000	Peak	9.061
11.659 GHz	37.638	54	-16.362	2	3.307	Vertical	5	1000000	Average	3.41
16.761 GHz	39.714	54	-14.286	195	1.5	Vertical	5	1000000	Average	9.061
11.662 GHz	49.888	74	-24.112	9	3.307	Horizontal	5	1000000	Peak	3.414
16.876 GHz	52.515	74	-21.485	20	1.5	Horizontal	5	1000000	Peak	9.79
11.662 GHz	36.348	54	-17.652	9	3.307	Horizontal	5	1000000	Average	3.414
16.876 GHz	39.955	54	-14.045	20	1.5	Horizontal	5	1000000	Average	9.79
11.494 GHz	52.358	74	-21.642	359	2.142	Vertical	5	1000000	Peak	3.115
14.997 GHz	50.942	74	-23.058	256	1.643	Vertical	5	1000000	Peak	6.916
16.772 GHz	50.131	74	-23.869	219	2.645	Vertical	5	1000000	Peak	9.074
11.494 GHz	37.548	54	-16.452	359	2.142	Vertical	5	1000000	Average	3.115
14.997 GHz	37.383	54	-16.617	256	1.643	Vertical	5	1000000	Average	6.916
16.772 GHz	37.289	54	-16.711	219	2.645	Vertical	5	1000000	Average	9.074
11.584 GHz	54.35	74	-19.65	355	2.142	Vertical	5	1000000	Peak	3.376
14.902 GHz	52.459	74	-21.541	354	1.638	Vertical	5	1000000	Peak	7.118
16.902 GHz	52.459	74	-21.541	259	4	Vertical	5	1000000	Peak	9.366
11.584 GHz	40.701	54	-13.299	355	2.142	Vertical	5	1000000	Average	3.376
14.902 GHz	38.275	54	-15.725	354	1.638	Vertical	5	1000000	Average	7.118
16.902 GHz	38.948	54	-15.052	259	4	Vertical	5	1000000	Average	9.366
17.511 GHz	52.997	74	-21.003	11	1.500	Vertical	5	1000000	Peak	-5.447
23.354 GHz	56.469	74	-17.531	289	1.500	Vertical	5	1000000	Peak	-4.709
24.168 GHz	46.771	74	-27.229	146	1.500	Vertical	5	1000000	Peak	-5.042
39.312 GHz	55.118	74	-18.882	295	1.500	Vertical	5	1000000	Peak	3.863
17.511 GHz	37.888	54	-16.112	11	1.500	Vertical	5	1000000	Average	-5.447
23.354 GHz	39.725	54	-14.275	289	1.500	Vertical	5	1000000	Average	-4.709
24.168 GHz	32.443	54	-21.557	146	1.500	Vertical	5	1000000	Average	-5.042
39.312 GHz	39.364	54	-14.636	295	1.500	Vertical	5	1000000	Average	3.863
17.205 GHz	57.819	74	-16.181	241	1.500	Vertical	5	1000000	Peak	-5.063
22.964 GHz	51.148	74	-22.852	341	1.500	Vertical	5	1000000	Peak	-4.726
39.214 GHz	55.382	74	-18.618	14	1.500	Vertical	5	1000000	Peak	4.042
17.205 GHz	41.052	54	-12.948	241	1.500	Vertical	5	1000000	Average	-5.063
22.964 GHz	36.167	54	-17.833	341	1.500	Vertical	5	1000000	Average	-4.726
39.214 GHz	38.678	54	-15.322	14	1.500	Vertical	5	1000000	Average	4.042
17.375 GHz	60.166	74	-13.834	24	1.500	Vertical	5	1000000	Peak	-5.219
23.166 GHz	52.793	74	-21.207	13	1.500	Vertical	5	1000000	Peak	-4.875
39.86 GHz	54.423	74	-19.577	178	1.500	Vertical	5	1000000	Peak	4.038
17.375 GHz	45.02	54	-8.98	24	1.500	Vertical	5	1000000	Average	-5.219
23.166 GHz	37.783	54	-16.217	13	1.500	Vertical	5	1000000	Average	-4.875
39.86 GHz	38.049	54	-15.951	178	1.500	Vertical	5	1000000	Average	4.038
17.366 GHz	60.957	74	-13.043	359	1.500	Horizontal	5	1000000	Peak	-5.219
23.154 GHz	54.508	74	-19.492	327	1.500	Horizontal	5	1000000	Peak	-4.942
39.295 GHz	54.453	74	-19.547	243	1.500	Horizontal	5	1000000	Peak	3.879
17.366 GHz	45.388	54	-8.612	359	1.500	Horizontal	5	1000000	Average	-5.219
23.154 GHz	39.875	54	-14.125	327	1.500	Horizontal	5	1000000	Average	-4.942

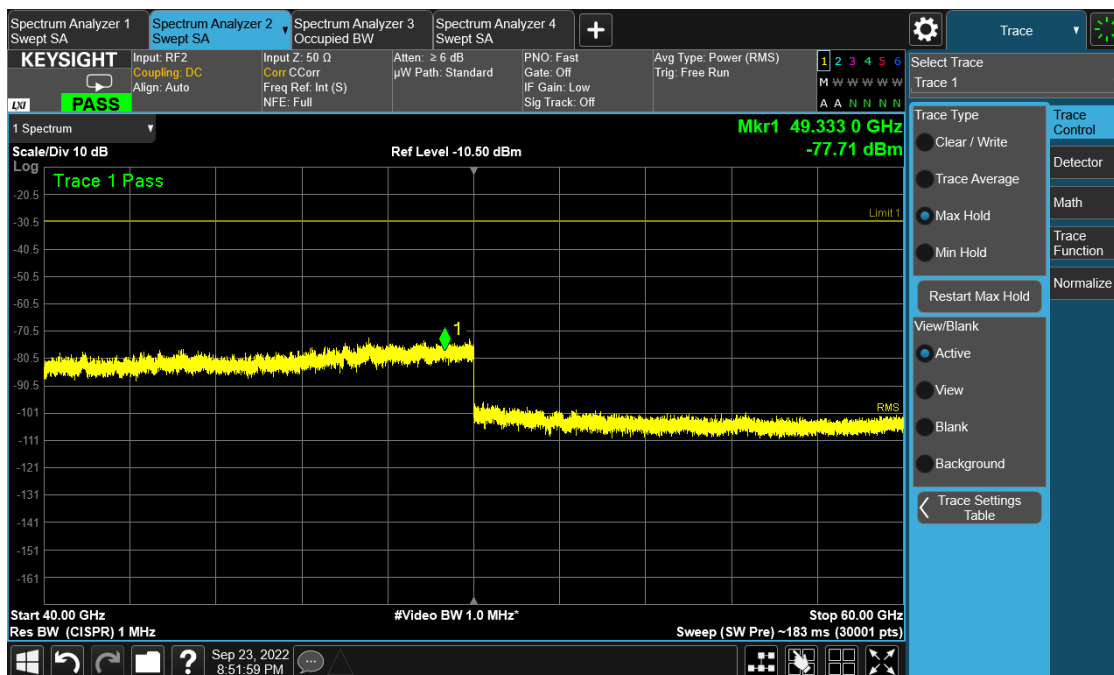




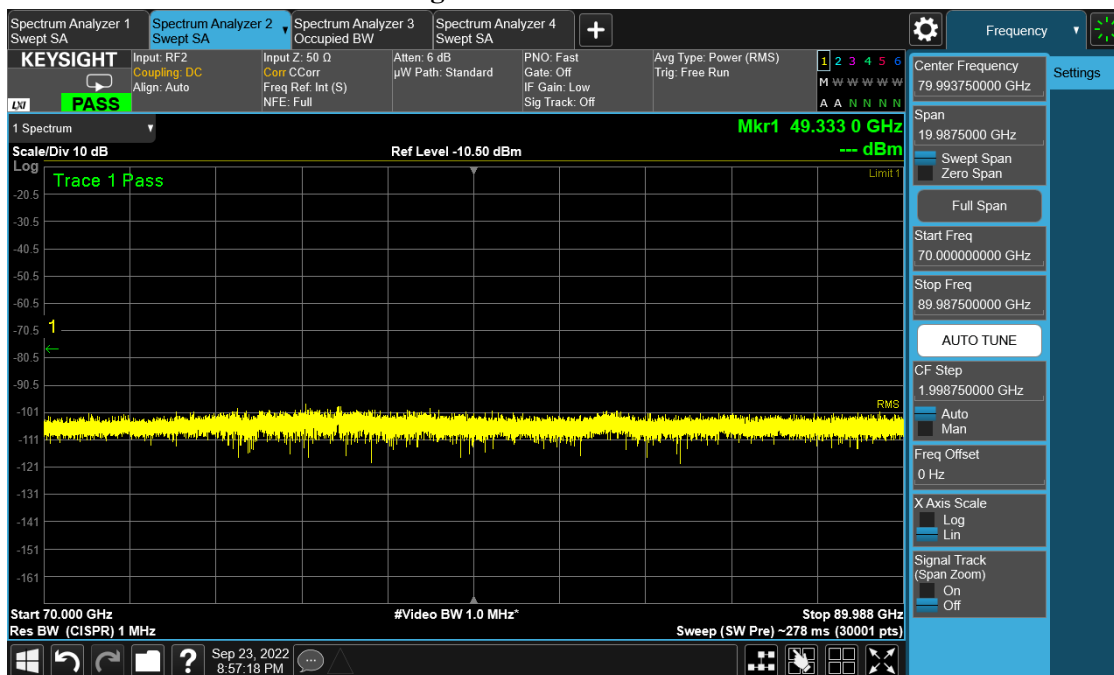
1-40GHz Spurious Emission (all Transmitters Active)



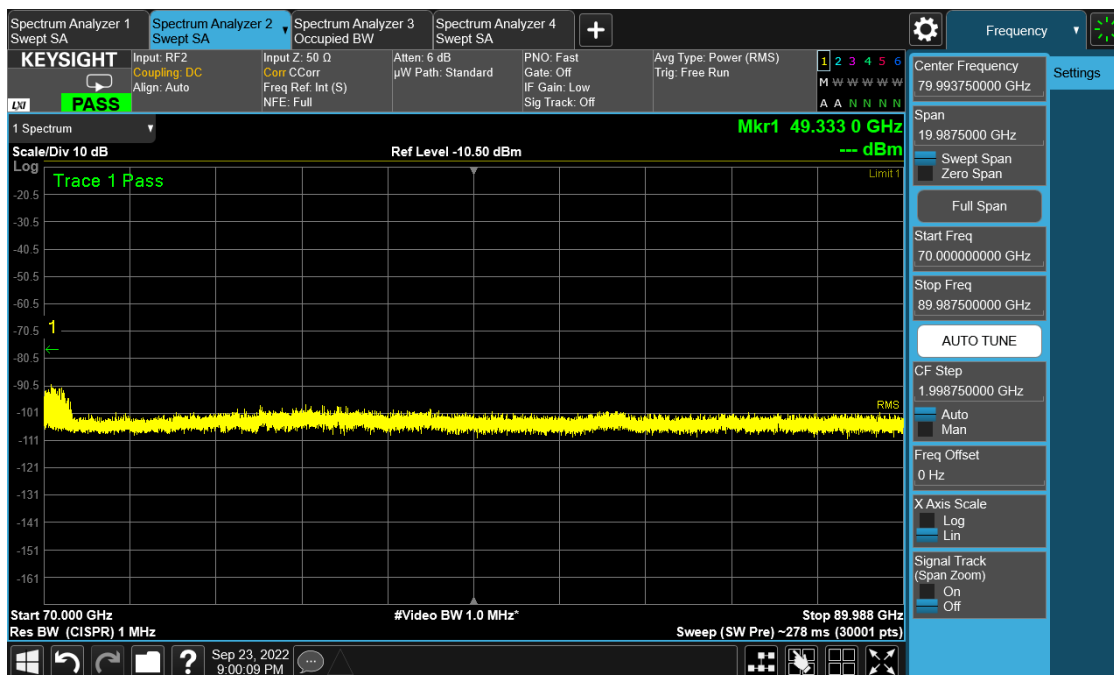
Low Channel 40 – 60 GHz



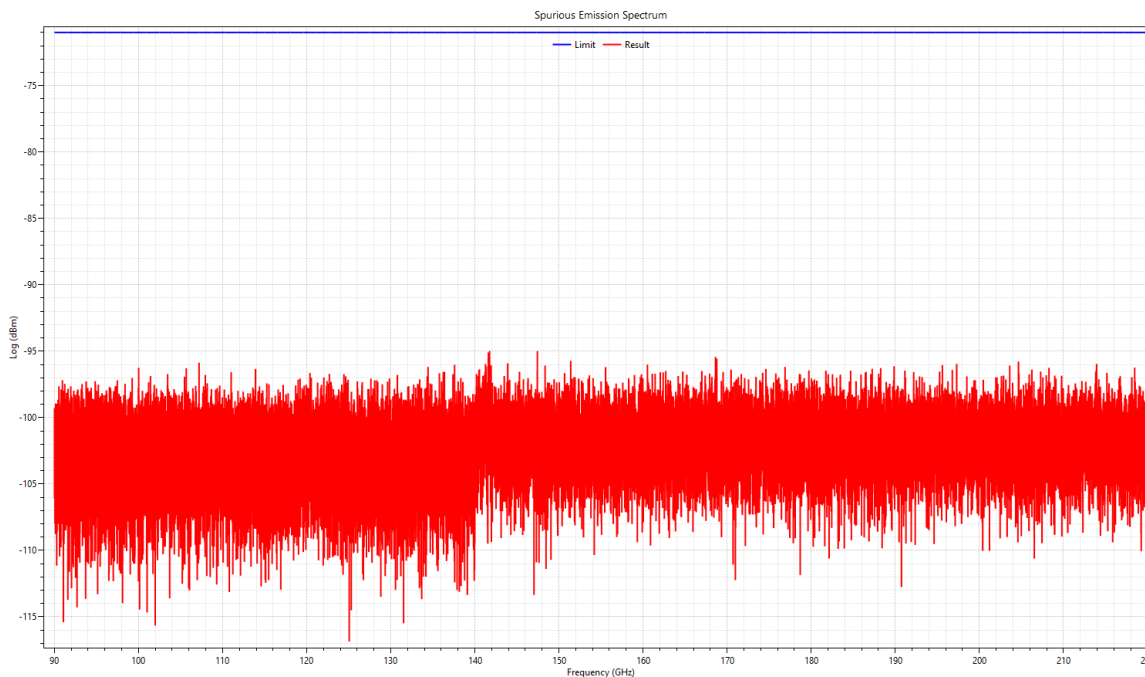
High Channel 40 – 60 GHz



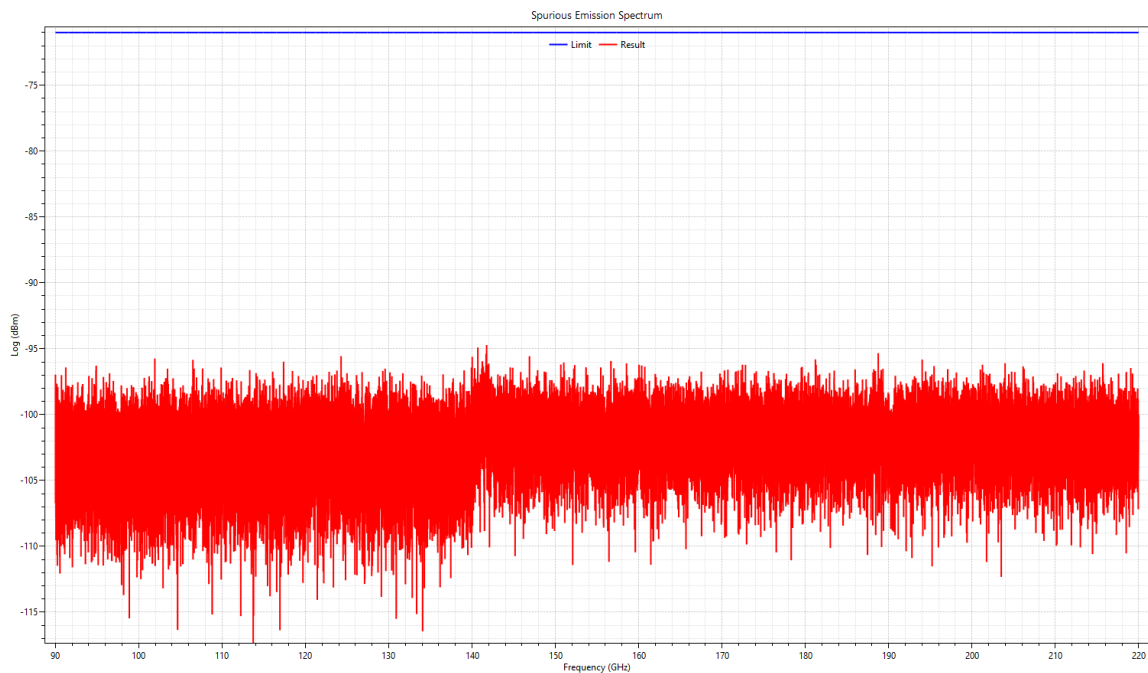
Low Channel 70 – 90 GHz



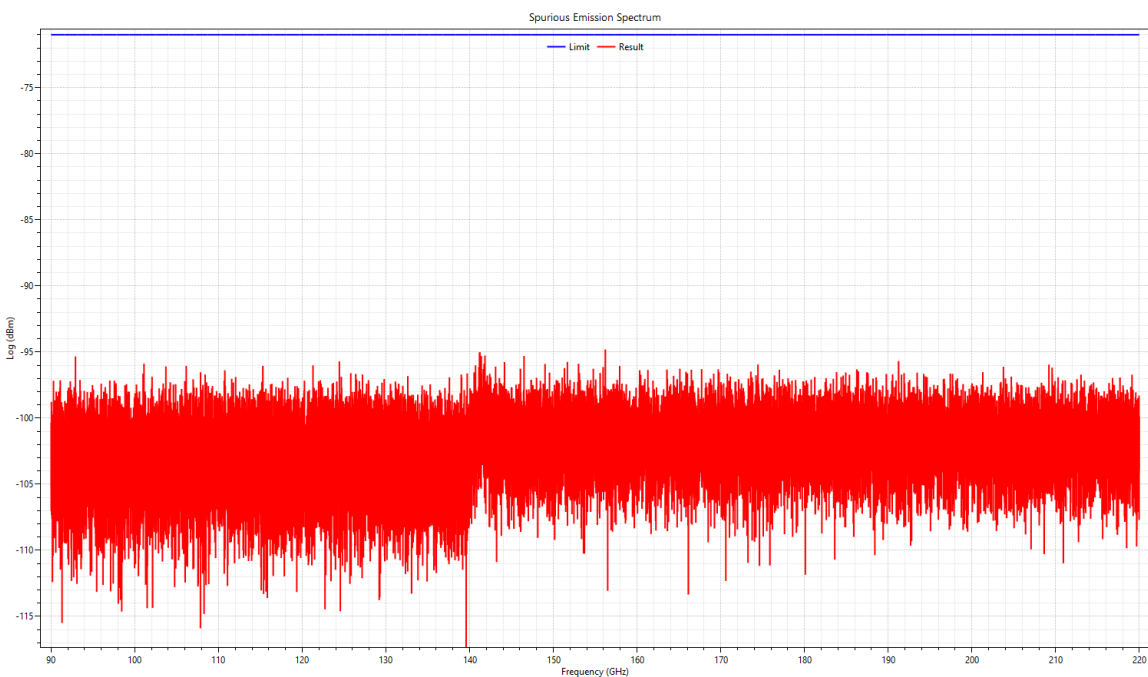
High Channel 70-90 GHz



Low Channel 90 – 220 GHz

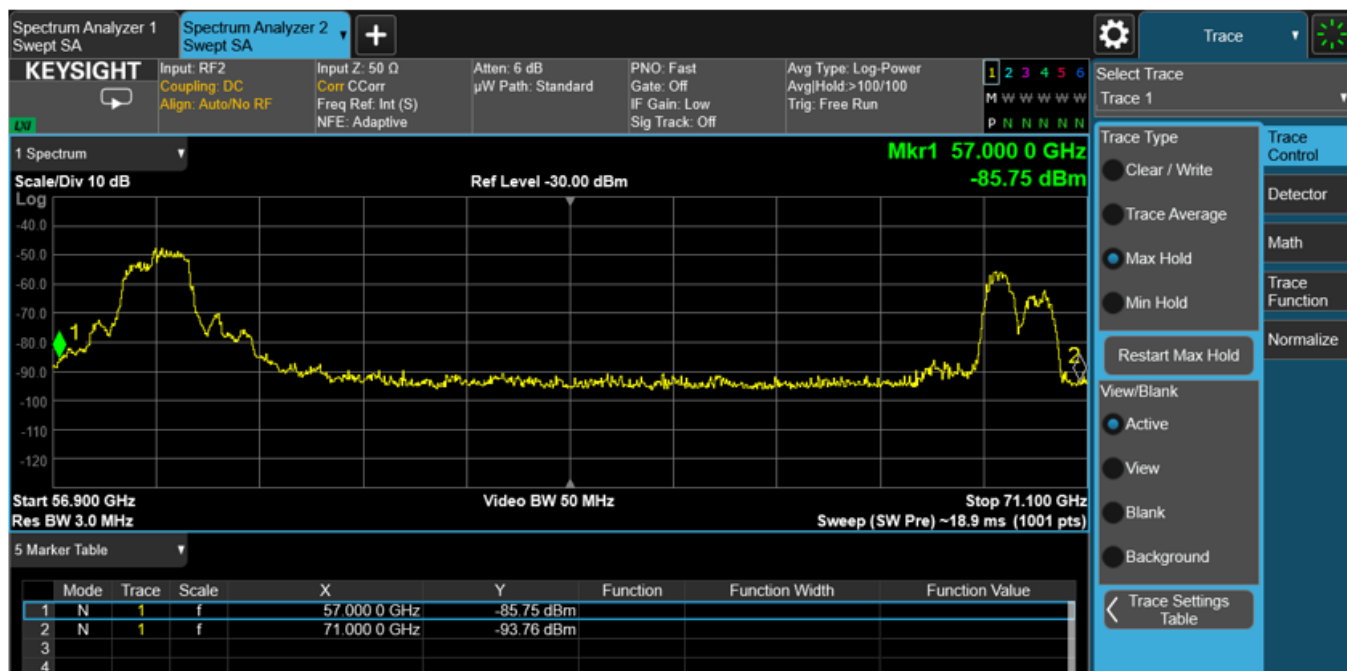


Mid Channel 90 – 220 GHz



High Channel 90 – 220 GHz

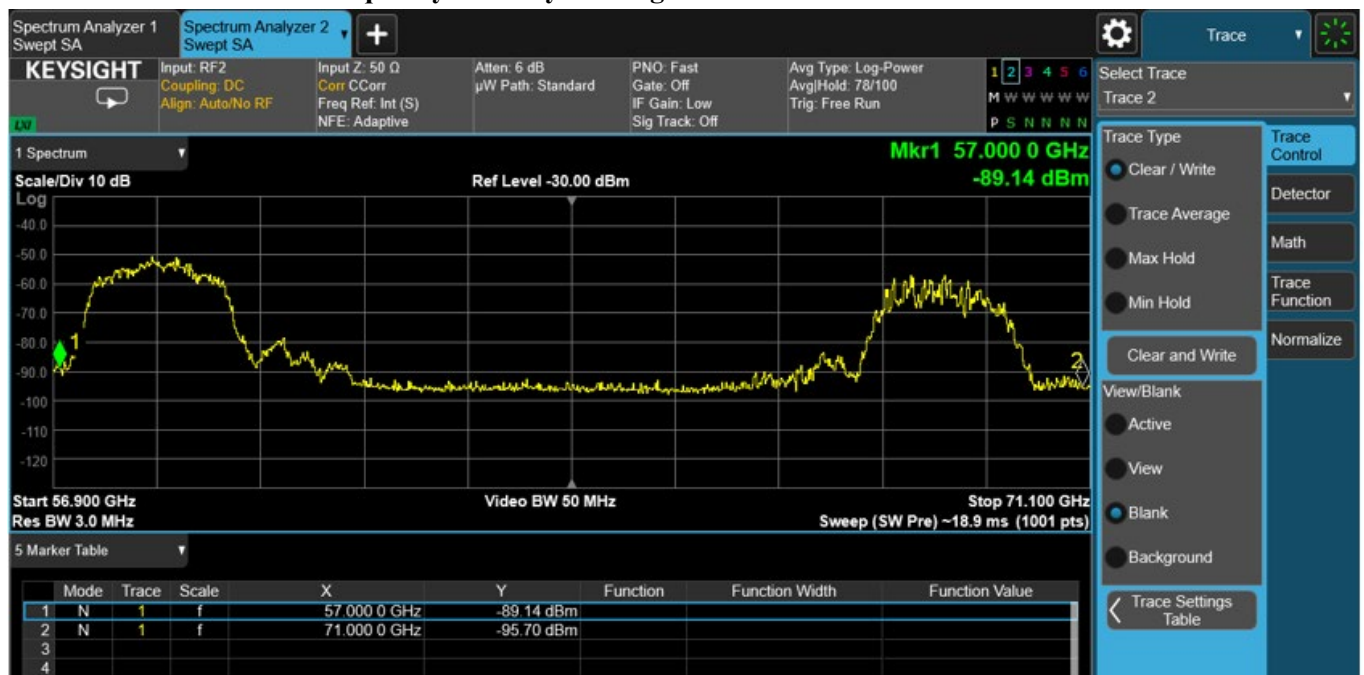
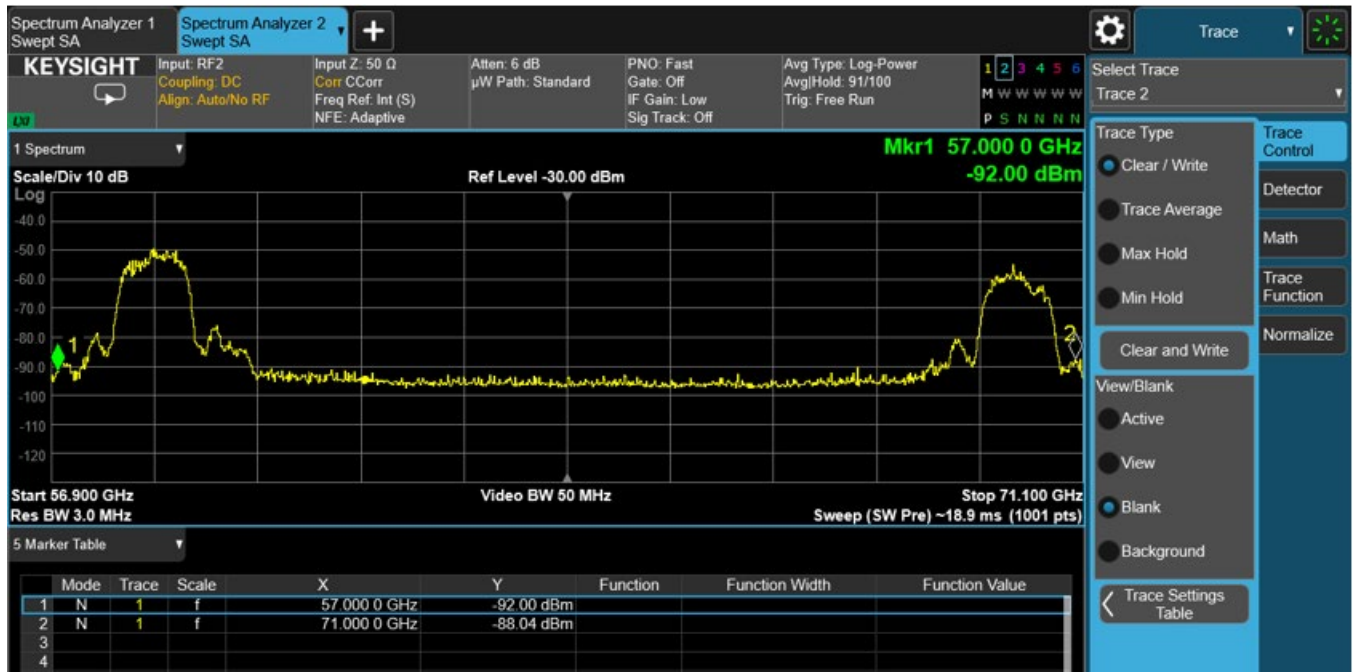
5.5 §15.255(f) Frequency Stability



Frequency Stability -40 degrees 1 GHz Bandwidth



Frequency Stability -40 degrees 2 GHz Bandwidth



-- End of Test Report --