ncee labs
Product Compliance Solutions

4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

Test Report

Prepared for:	**Intervet Inc.**
Address:	**2 Giralda Farms, Madison, NJ 7940**
Model:	**410-476-000**
FCCID: **IC:**	**2AUHWET400** **4246BET300**
Test Report No:	**R20230228-20-E1A**
Approved by:	

Fox Lane
EMC Test Engineer

DATE:	**8 March 2024**
Total Pages:	**42**

ilac-MRA A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
Original	16 November 2023	Issued by FLane Reviewed by KVepuri Prepared by Flane
A	8 March 2024	Added test setup drawing - FL

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 3

SUMMARY		
Standard Section	**Test Type and Limit**	**Result**
FCC 15.203	Unique Antenna Requirement	Pass
FCC 15.209 RSS-Gen, 7.1	Receiver Radiated Emissions	Pass
FCC 15.247(a)(1)(i) RSS-247, 5.1(c)	Bandwidth Frequency Separation	Pass
FCC Part 15.247(b)(2) RSS-247 Issue 3 Section 5.4(d)	Peak output power	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 3 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC 15.247(f) RSS-247, 5.3	Hybrid system dwell time	Pass
FCC 15.209, 15.205,15.247(d) RSS-Gen, 8.9 RSS-247, 5.5	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass
FCC Part 15.247(e) RSS-247 Issue 3 Section 5.2 (b)	Power Spectral Density	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless Hybrid transmitter

EUT	410-476-000
EUT Tested	12/13/2022- 10/17/2023
Serial No.	NCEETEST1 (Lab assigned SN)
Operating Band	902.0 – 928.0 MHz
Device Type	Hybrid
Power Supply	1.5V internal AAA battery

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low	902.3
Middle	908.6
High	914.9

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

EUT was modified to transmit at the highest practical duty cycle on the lowest, highest, middle and a hopping mode that was used for all RF tests.

2.3 DESCRIPTION OF SUPPORT UNITS

N/A

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
CAB MRA Recognition Identification No:	US0177

Environmental conditions varied slightly throughout the tests.

3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Fox Lane	EMC Test Engineer	Testing and Report
2	Karthik Vepuri	EMC Test Engineer	Report
3	Blake Winter	EMC Test Engineer	Testing

Notes:
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (44GHz)	N9038A	MY59050109	July 17, 2023	July 17, 2025
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 17, 2023	July 17, 2025
SunAR RF Motion	JB1	A091418	July 27, 2023	July 26, 2024
ETS-Lindgren Red Horn Antenna	3115	218576	July 31, 2023	July 30, 2024
Agilent Preamp*	87405A	3950M00669	June 5, 2023	June 5, 2025
Rohde & Schwarz Preamplifier*	6HC330	23042	April 22, 2022	April 22, 2024
MiniCircuits High Pass Filter*	VHF-1320+	15542	June 5, 2023	June 5, 2025
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2025
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	June 5, 2023	June 5, 2025
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	June 5, 2023	June 5, 2025
RF Cable (control room bulkhead to test receiver)	FSCM 64639	01F1206	June 5, 2023	June 5, 2025
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	June 5, 2023	June 5, 2025
N connector bulkhead (control room)	PE9128	NCEEBH2	June 5, 2023	June 5, 2025
TDK Emissions Lab Software	V11.25	700307	NA	NA
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2024
NCEE Labs-NSA on 10m Chamber	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2025

*Internal Characterization

Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities. All equipment were in Cal during testing. However, latest calibration dates were provided.

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

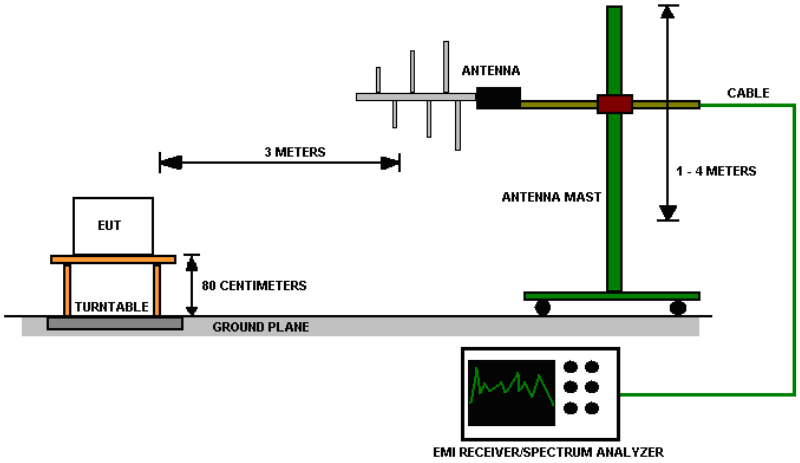


Figure 2 - Radiated Emissions Test Setup, 30MHz – 1GHz

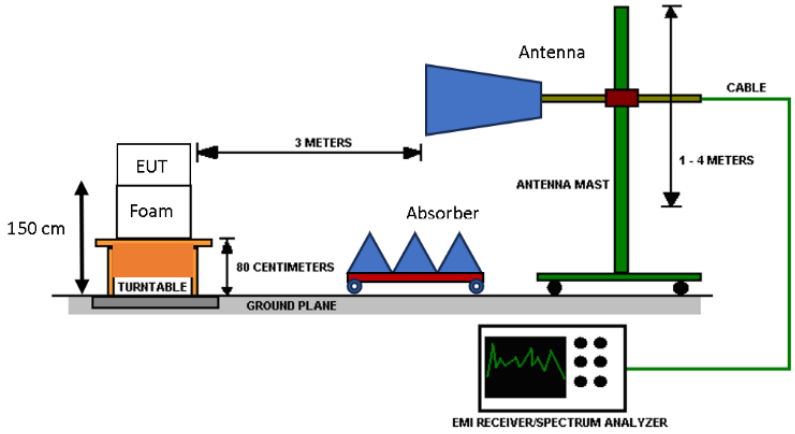


Figure 3 - Radiated Emissions Test Setup, 1GHz – 18GHz

4.0 DETAILED RESULTS

DSS Radiated Radio Measurements								
CHANNEL	**Mode**	**99% Occupied Bandwidth (kHz)**	**20 dB Bandwidth (kHz)**	**PEAK Conducted EIRP Power (dBm)**	**PEAK Conducted EIRP Power (mW)**	**RESULT**	**No. of Hopping Channels**	**ON Time(ms)**
							64	82.40
Low	Continuous*	126.39	143.1	8.476	7.04	PASS	**Min Frequency Separation (kHz)**	**Time of Occupancy (ms)**
Mid	Continuous*	125.72	144.5	8.436	6.98	PASS		
High	Continuous*	126.67	144.8	8.385	6.89	PASS	191.07	82.40
Occupied Bandwidth = N/A; 20 dB Bandwidth Limit < 250kHz				Time of Occupancy<400ms in 25.6s period Manufacture declares; device will not transmit more than once on the same channel within 25.6s				

Unrestricted Band-Edge							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Relative Highest out of band level (dBm)**	**Relative Fundamental (dBm)**	**Delta (dB)**	**Min Delta (dB)**	**Result**
Low	Continuous	902.4	33.495*	76.615*	43.12	20.0	PASS
Low	Hopping	902.4	-46.532	8.679	55.211	20.0	PASS
High	Continuous	927.6	34.734*	76.971*	42.237	20.0	PASS
High	Hopping	927.6	-68.912	8.550	77.462	20.0	PASS
*Test units are uncorrected dBuV/m values, no correction used. Limits are relative values							

Quasi-Peak Restricted Band-Edge							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)***	**Margin**	**Result**
Low	Continuous	609.596	32.224	Radiated	46.02	13.796	PASS
High	Continuous	960.04	39.857	Radiated	53.98	14.123	PASS
*Limit shown is the Quasi-peak limit taken from FCC Part 15.209							

Power Spectral Density		
CHANNEL	**Peak PSD (dBm)**	**Result**
Low	2.884	PASS
Mid	2.493	PASS
High	2.398	PASS

4.1 DUTY CYCLE

All transmitters/modulations operated at >98% duty cycle, no duty cycle correction factor was used

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

Test procedures:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10-meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1GHz and 1.5m for measurements from 1GHz to 10 GHz.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

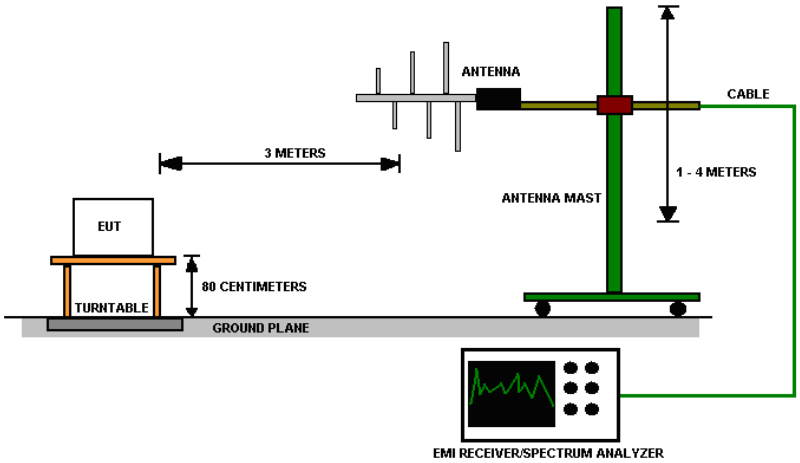


Figure 4 - Radiated Emissions Test Setup

EUT operating conditions
Details can be found in section 2.1 of this report.

Test results:

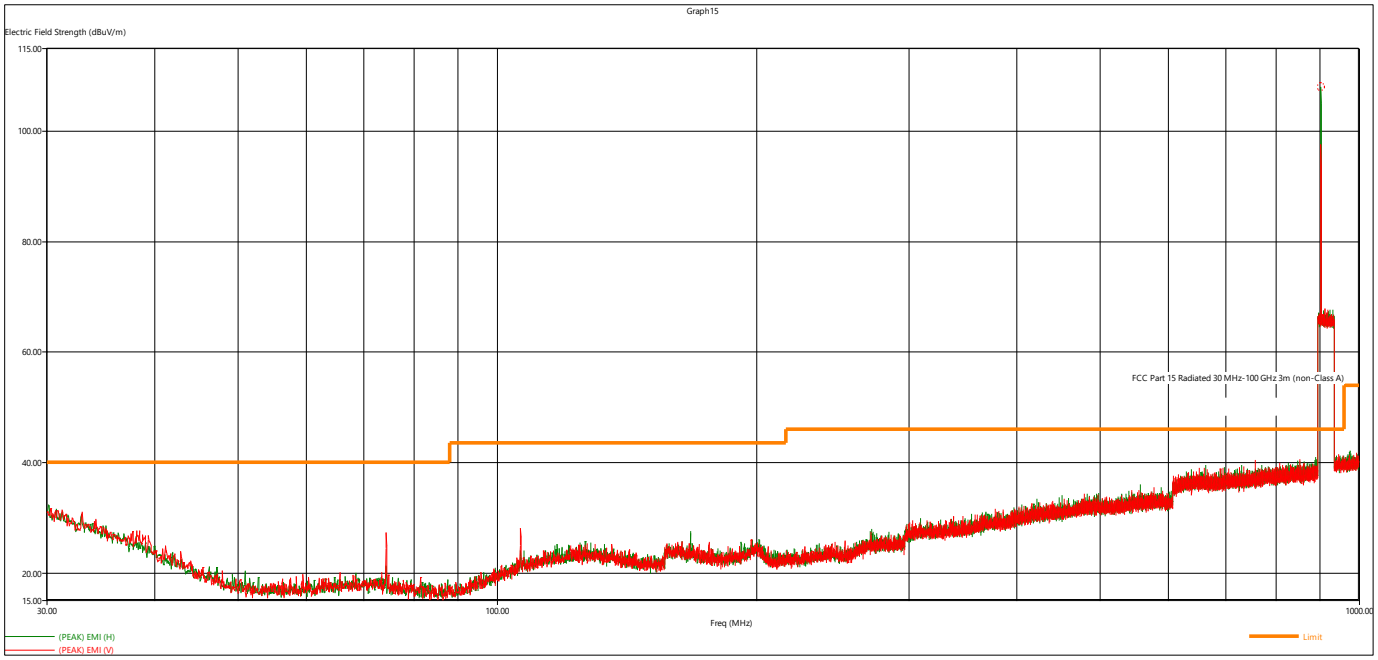


Figure 5 - Radiated Emissions Plot, Low Channel, 30 MHz-1GHz

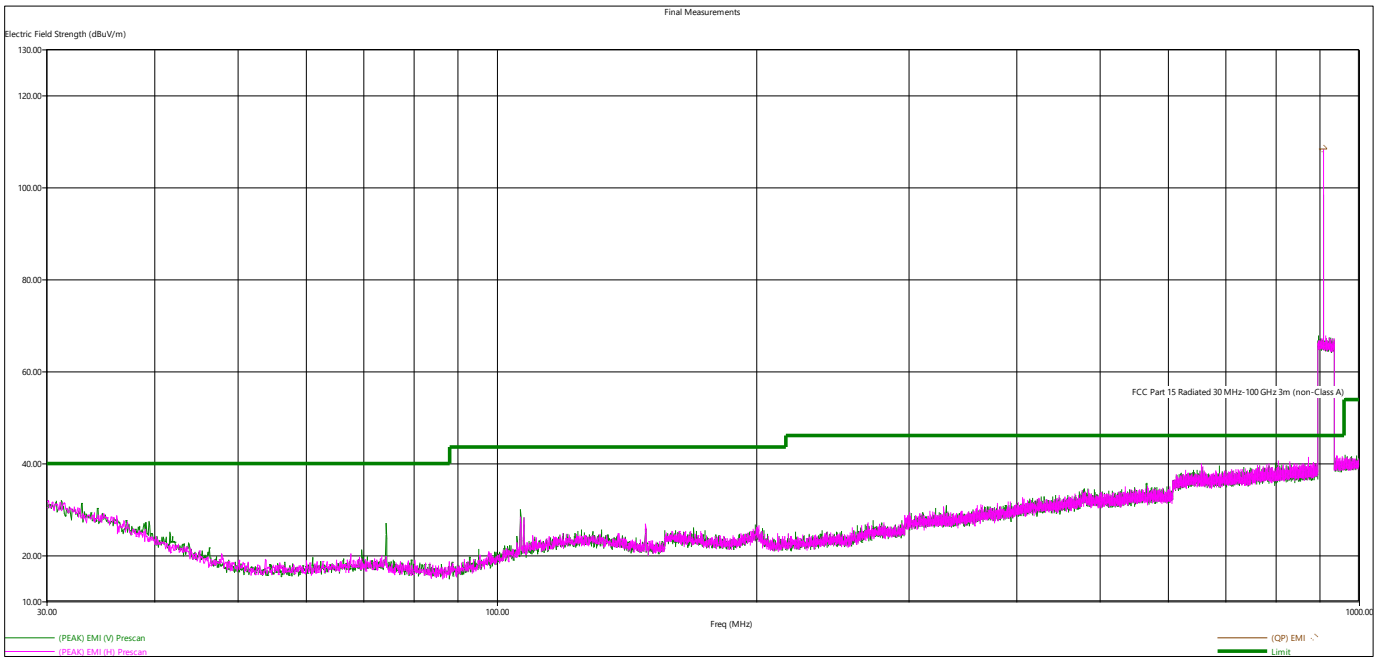


Figure 6 - Radiated Emissions Plot, Mid Channel, 30 MHz-1GHz

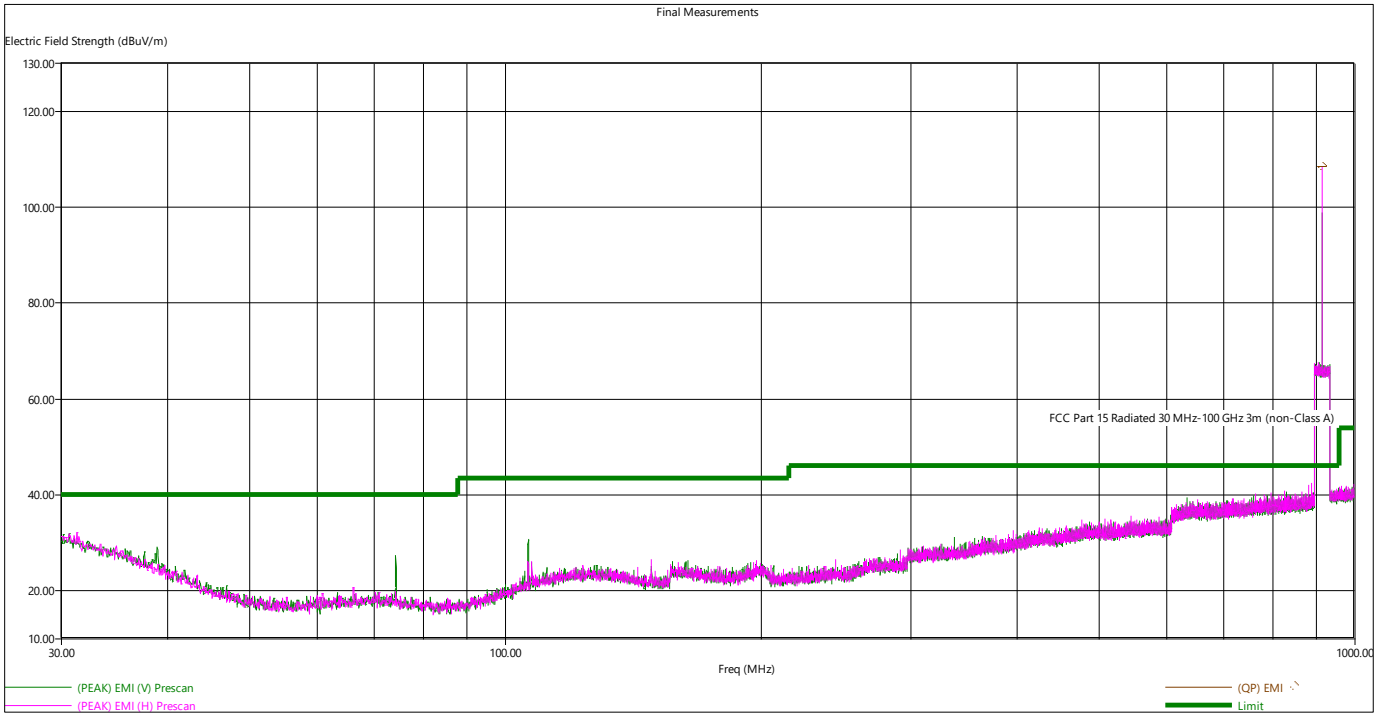


Figure 7 - Radiated Emissions Plot, High Channel, 30 MHz-1GHz

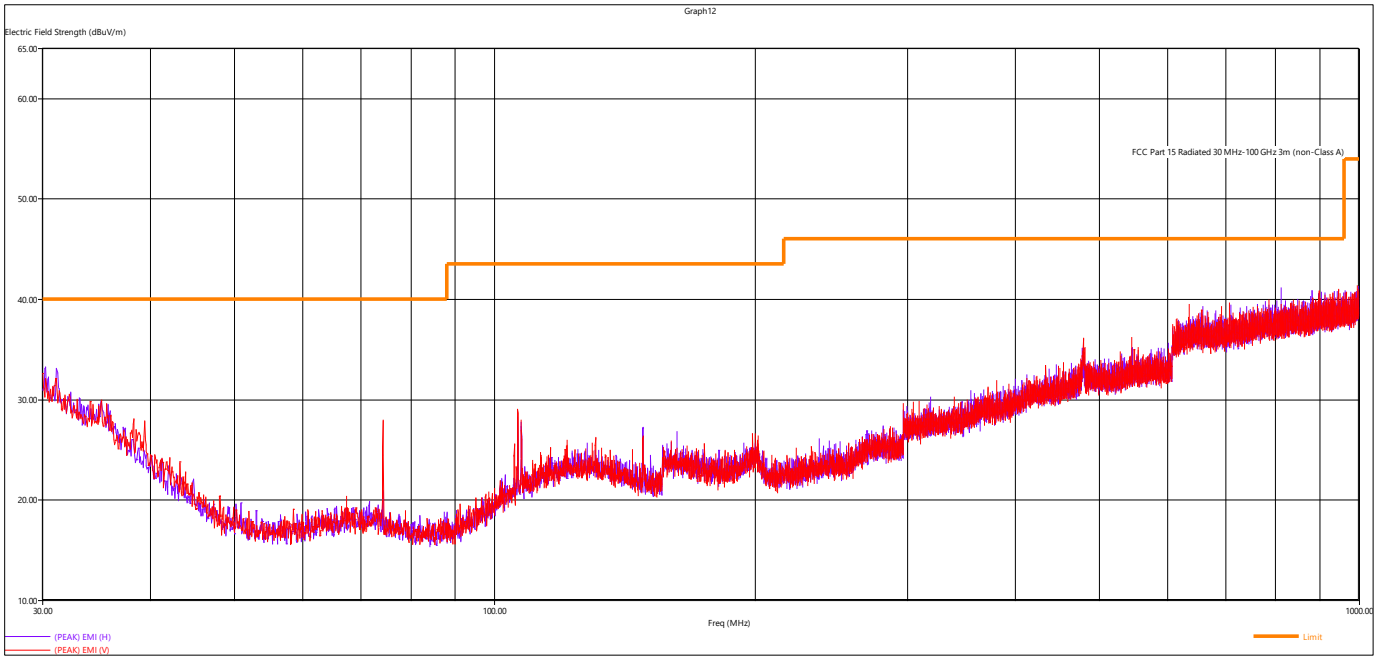


Figure 8 - Radiated Emissions Plot, Transmitter Off, 30 MHz-1GHz

Quasi-Peak Measurements, 900 MHz Radio								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Radio Band**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			**MHz**
902.280160	107.90	NA	NA	196.00	270.00	H	Low	900-928
908.647360	108.40	NA	NA	196.00	302.00	H	Mid	900-928
914.925280	108.20	NA	NA	192.00	302.00	H	High	900-928
All other measurements were found to be at least 6dB below the limit line.								

Peak Measurements, 900 MHz Radio								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Radio Band**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			**MHz**
9085.672000	56.94	73.98	17.04	151.00	137.00	V	Mid	900-928
9023.318000	56.73	73.98	17.25	124.00	114.00	V	Low	900-928
9148.722000	55.74	73.98	18.24	209.00	11.00	V	High	900-928
All other measurements found to be at least 6dB below limit								

Average Measurements, 900 MHz Radio								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Radio Band**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			**MHz**
9085.672000	48.72	53.98	5.26	151.00	137.00	V	Mid	900-928
9023.318000	47.79	53.98	6.19	124.00	114.00	V	Low	900-928
9148.722000	47.45	53.98	6.53	209.00	11.00	V	High	900-928
All other measurements found to be at least 6dB below limit								

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Limit Value – Emission Level.

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10, Section(s) 7.8.5

Limits of Power measurements:
Per FCC Part 15(b)(2)
30dBm / 1 Watt

Test procedures:
Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel. Output power was measured by direct coaxial connection to the EUT output port.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:
1. All the output power plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

4.4 BANDWIDTH

Test Method: ANSI C63.10, Section(s) 6.9.2

Limits of bandwidth measurements:
The allowed 20 dB bandwidth of the hopping channel is ≤ 250 kHz

Test procedures:
The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 30 kHz VBW.

The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB.
The 99% bandwidth is defined as the bandwidth that contains 99% of the power.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in Conducted section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.
Test results:

Pass

Comments:
1. All the bandwidth plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

4.5 BANDEDGES

Test Method: ANSI C63.10, Section(s) 6.10.6

Limits of band edge measurements:
For emissions outside of the allowed band of operation (902 – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:
The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band edge to the fundamental frequency with a Peak detector. The highest emissions level beyond the band edge was measured and recorded. For restricted band edge measurements, the unit was tested to the same method as section 4.2 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in Conducted section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

4.6 POWER SPECTRAL DENSITY

Test Method:
All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:
For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in Conducted section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:
Pass
Comments:
1. All the Power Spectral Density (PSD) plots can be found in Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.7 CARRIER FREQUENCY SEPARATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

Test Method: ANSI C63.10, Section 7.8.2, 7.8.3, 7.8.4

Limits for Time of Occupancy
Average time of occupancy on any frequency, not to exceed 0.4 seconds within a (#of channels * 0.4) = 64 * 0.4 = 25.6 second period.

Test procedures:
The method from KDB 558074 D01 v05;

Test setup:
Details can be found in section 3.4 of this report.

EUT operating conditions:
Details can be found in section 2.1 of this report.

.

Test results:

Pass

Comments:
1. All the plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.
Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m
AV is calculated by taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / 30
Power (watts) = 10^[Power (dBm)/10] / 1000
Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)
Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6
Gain = 1 (numeric gain for isotropic radiator)
Conversion from 3m field strength to EIRP (d=3):

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3
EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23
10log(10^9) is the conversion from micro to milli

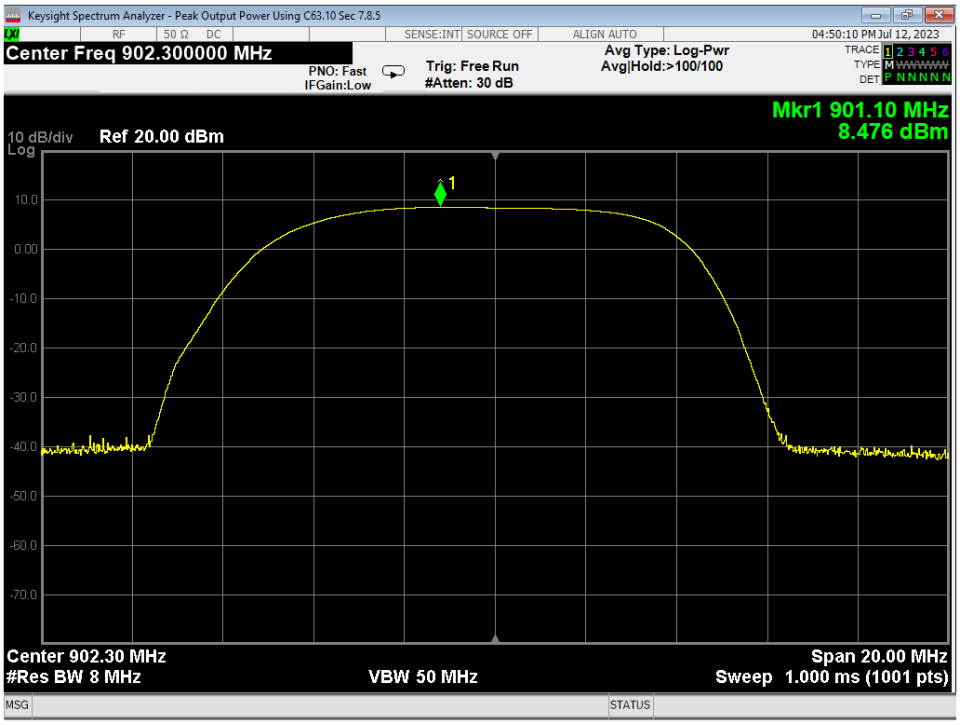
APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

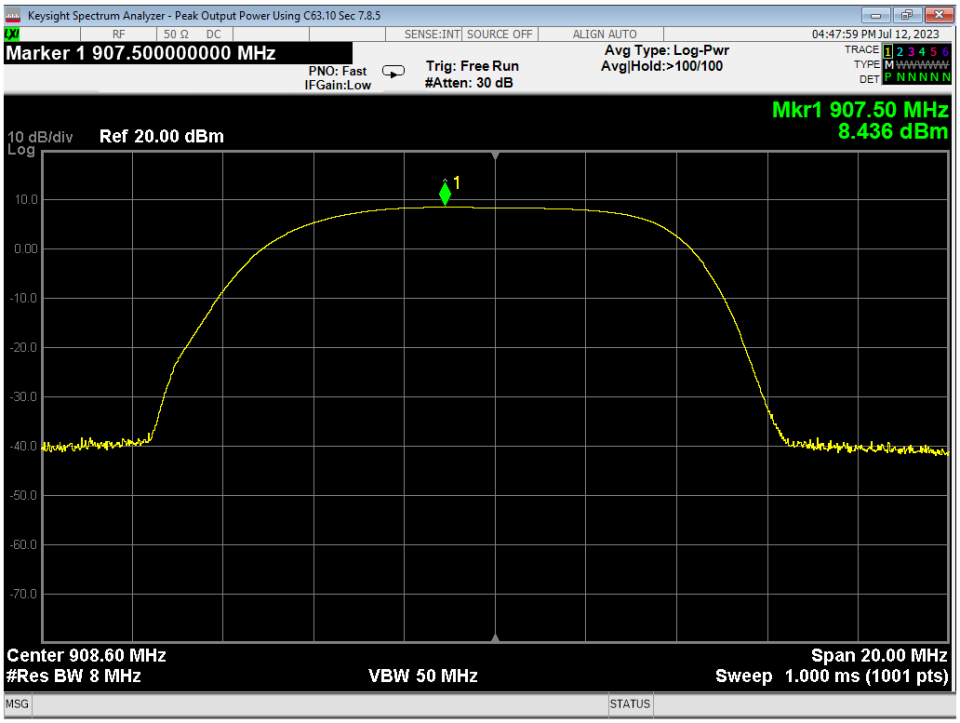
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

Expanded uncertainty values are calculated to a confidence level of 95%.

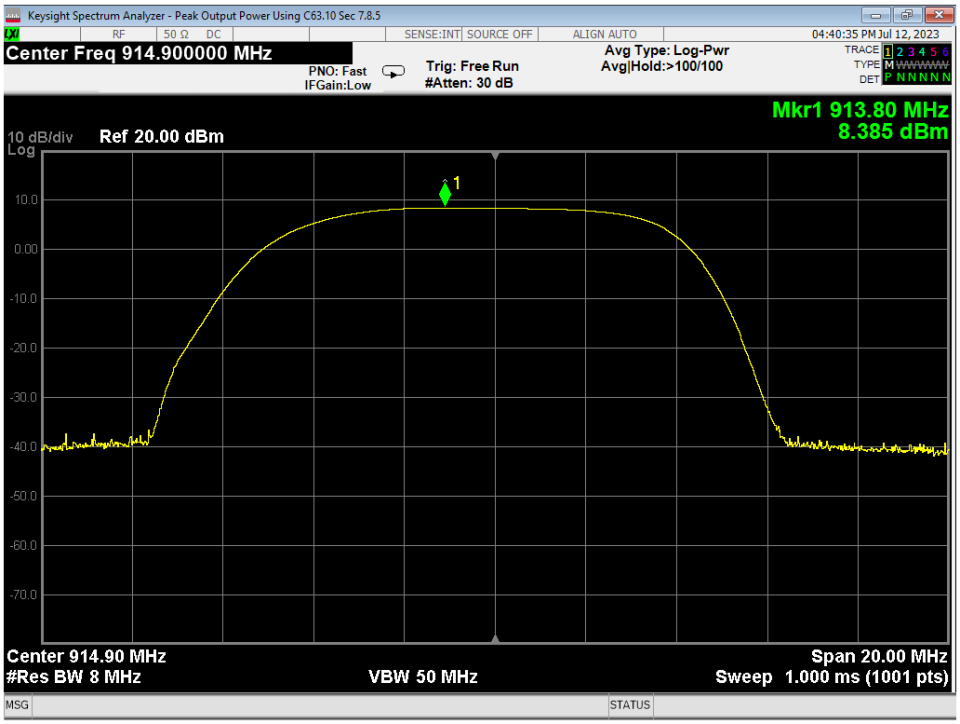
APPENDIX C – GRAPHS AND TABLES



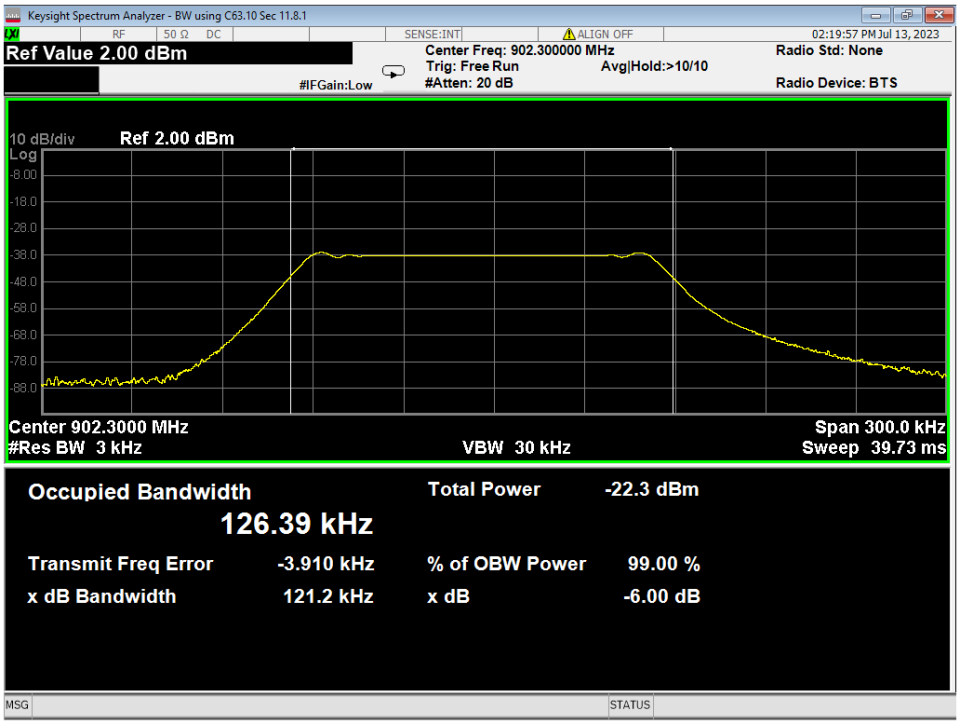
Peak Output Power, Low



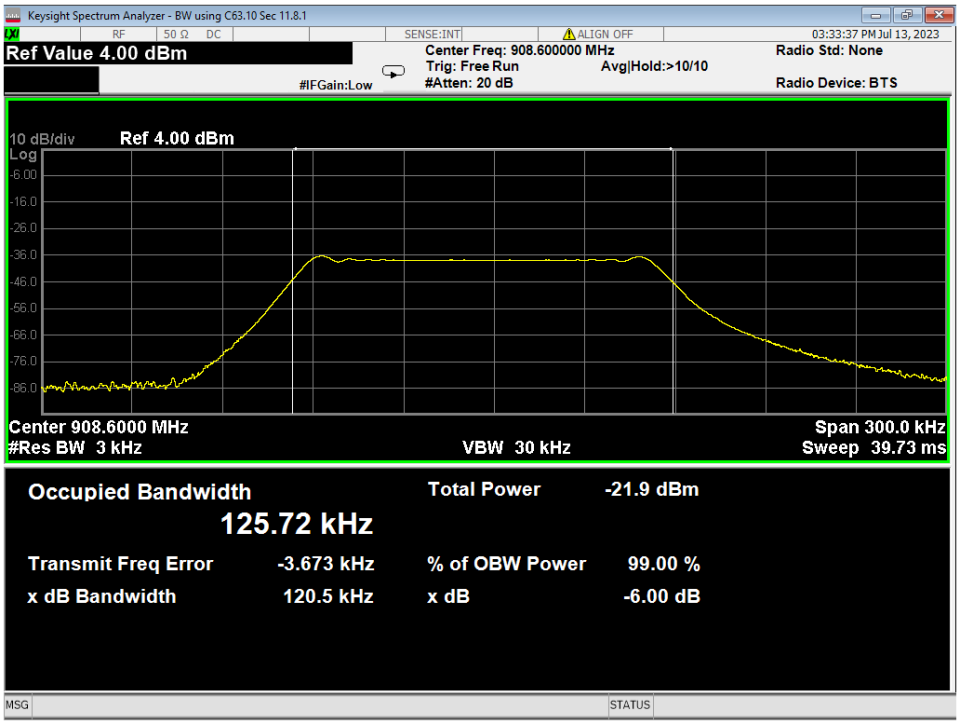
Peak Output Power, Mid



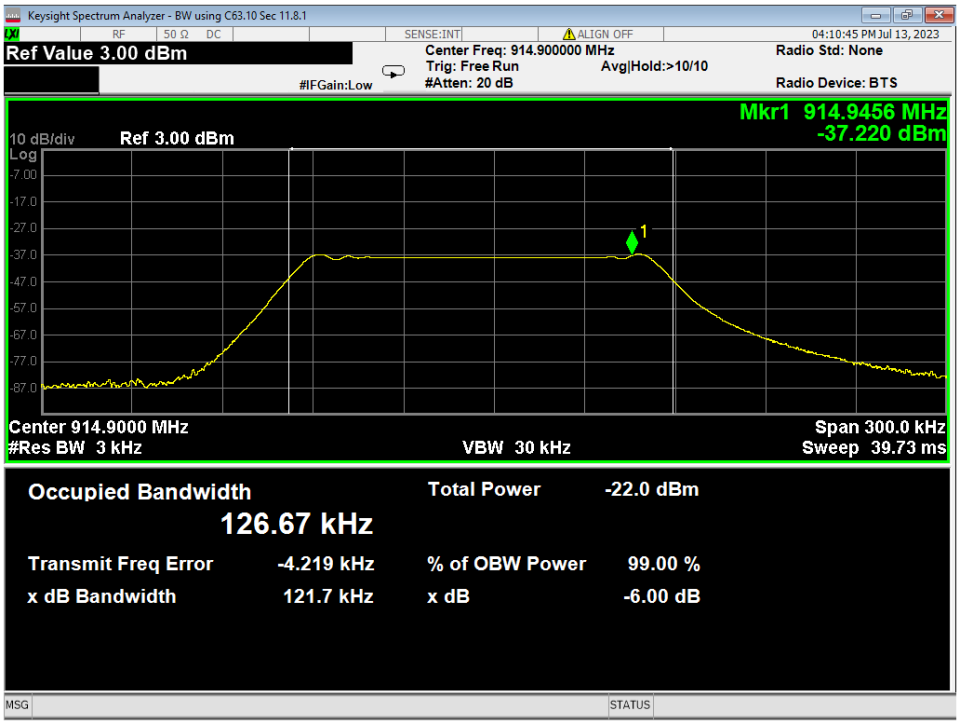
Peak Output Power, High



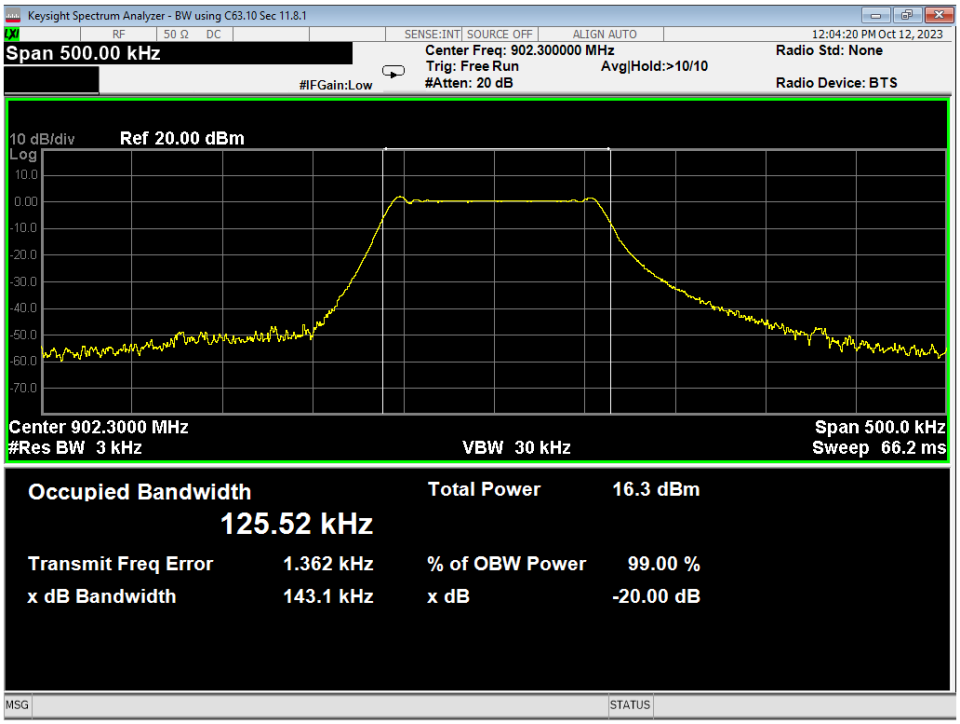
OBW, Low



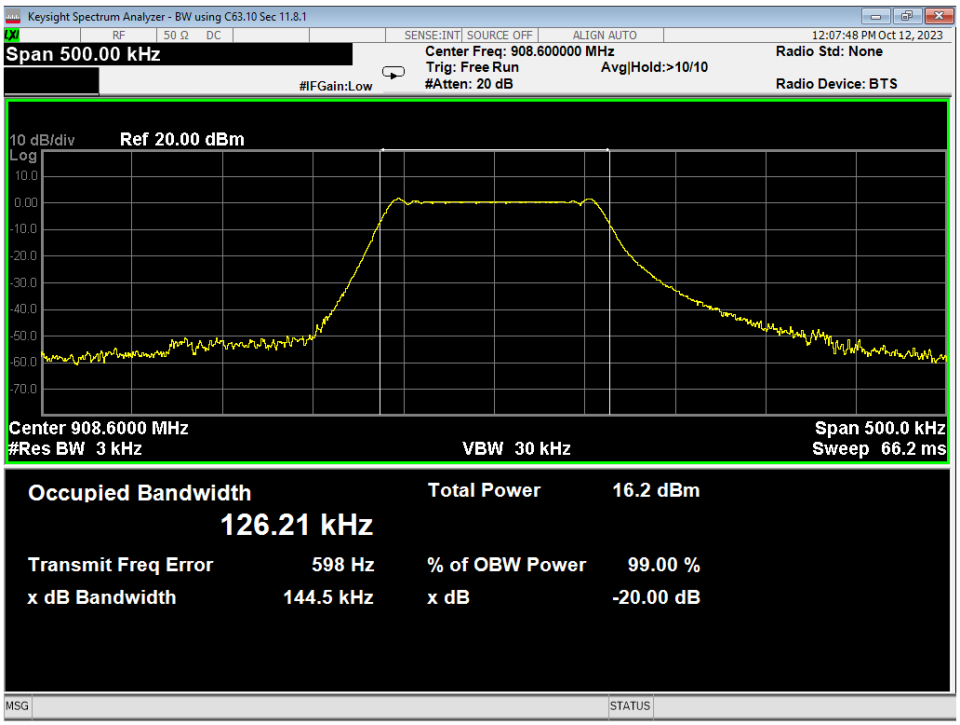
OBW, Mid



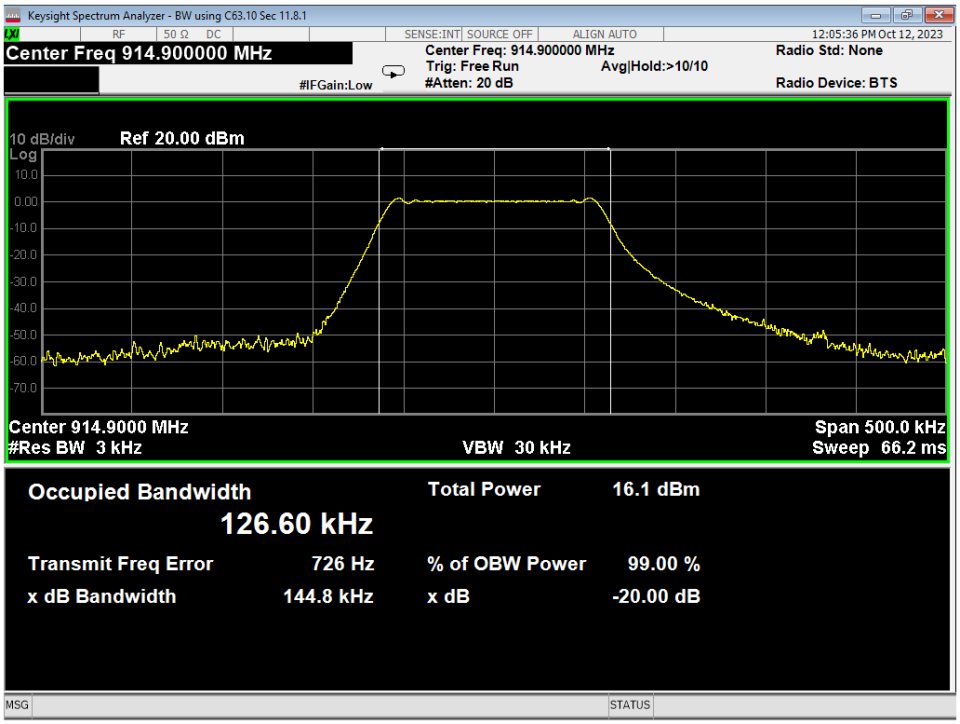
OBW, High



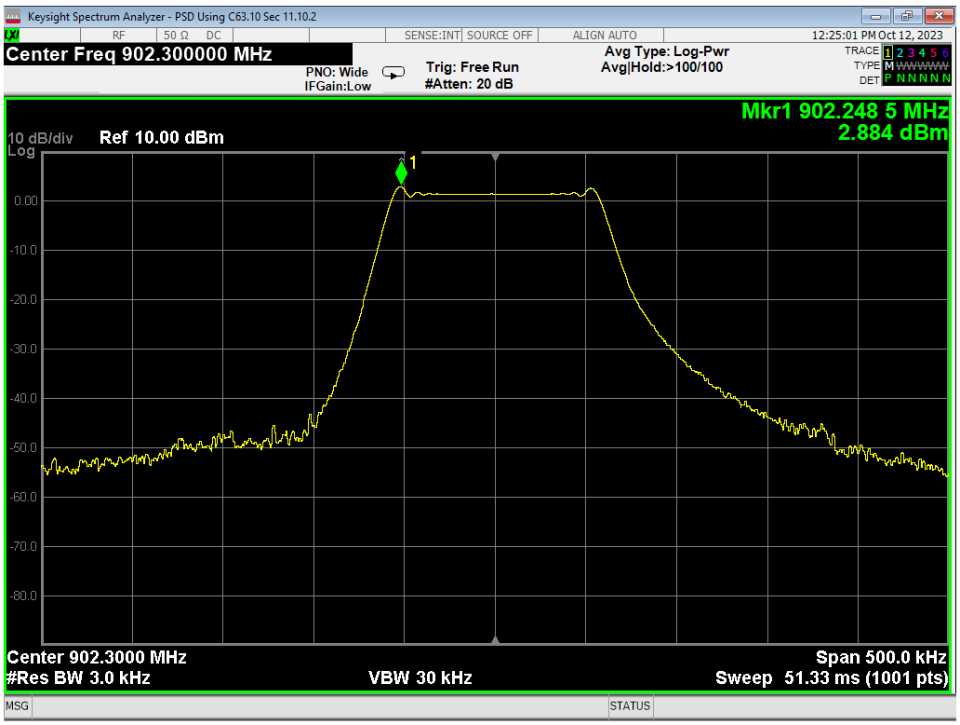
20dB BW, Low



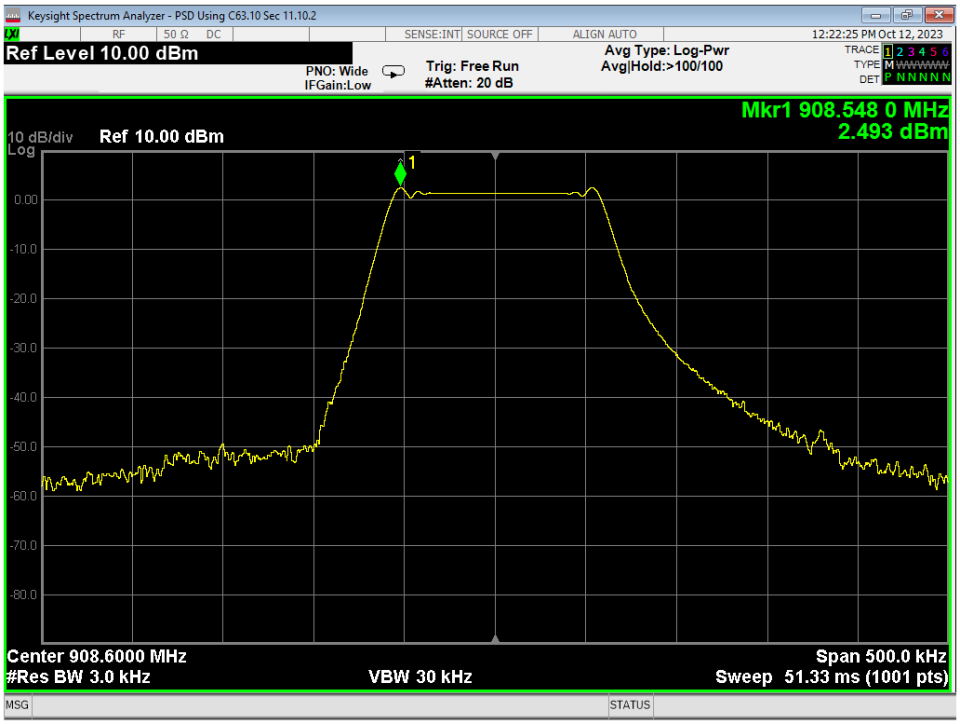
20dB BW, Mid



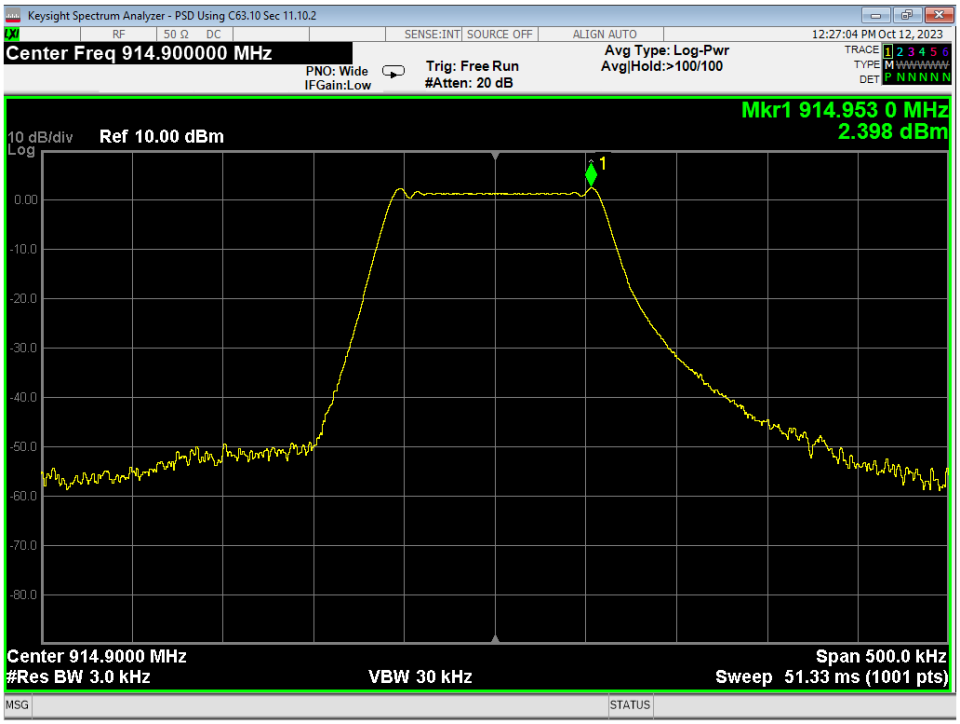
20dB BW, High



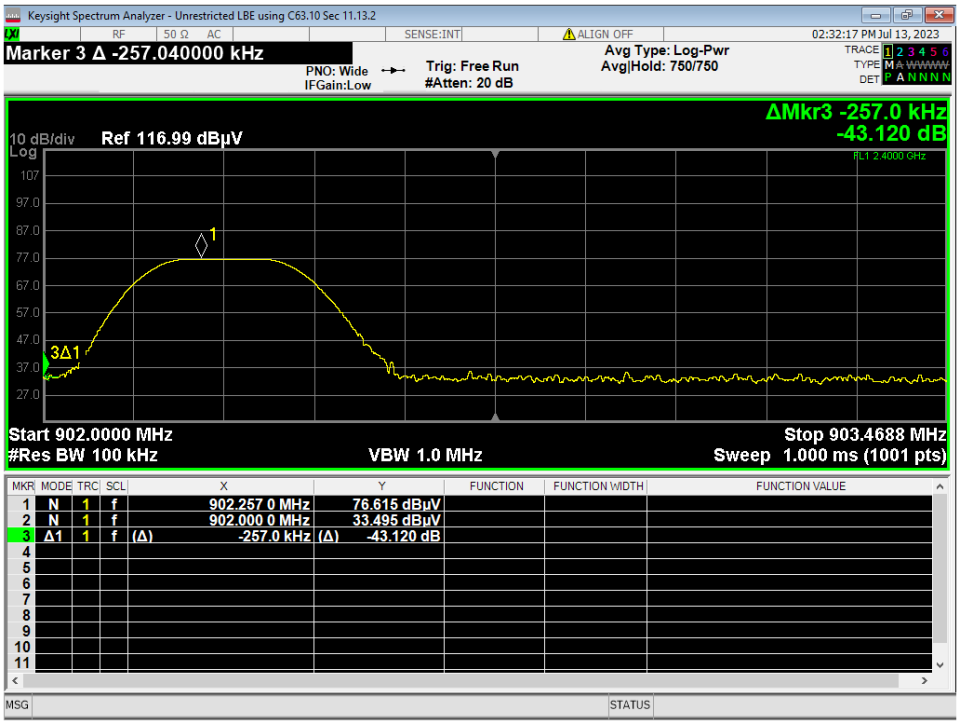
Peak PSD, Low



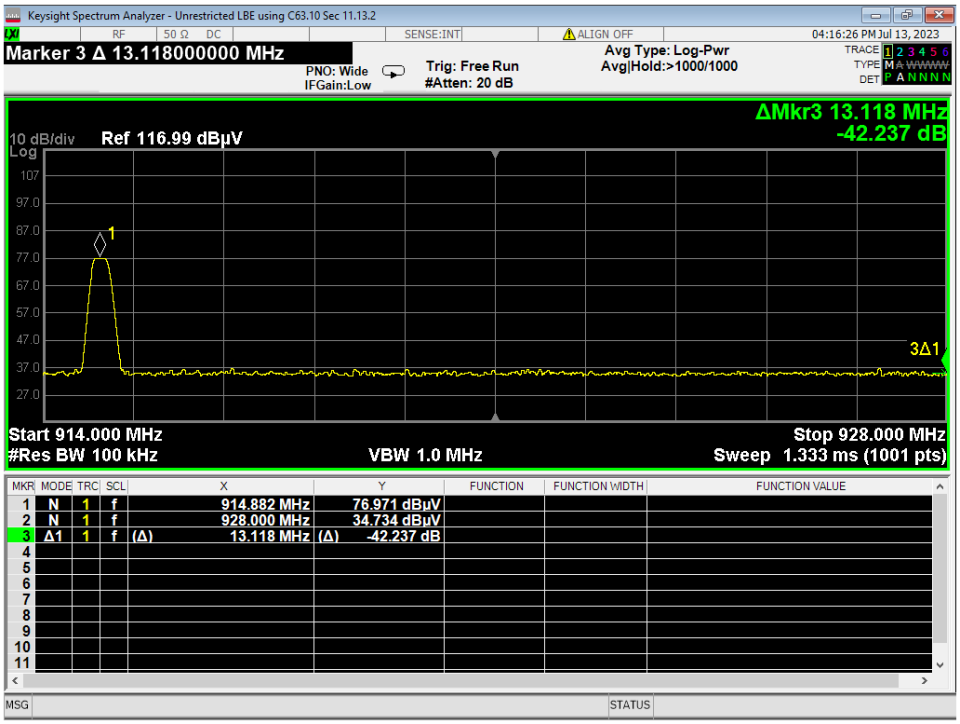
Peak PSD, Mid



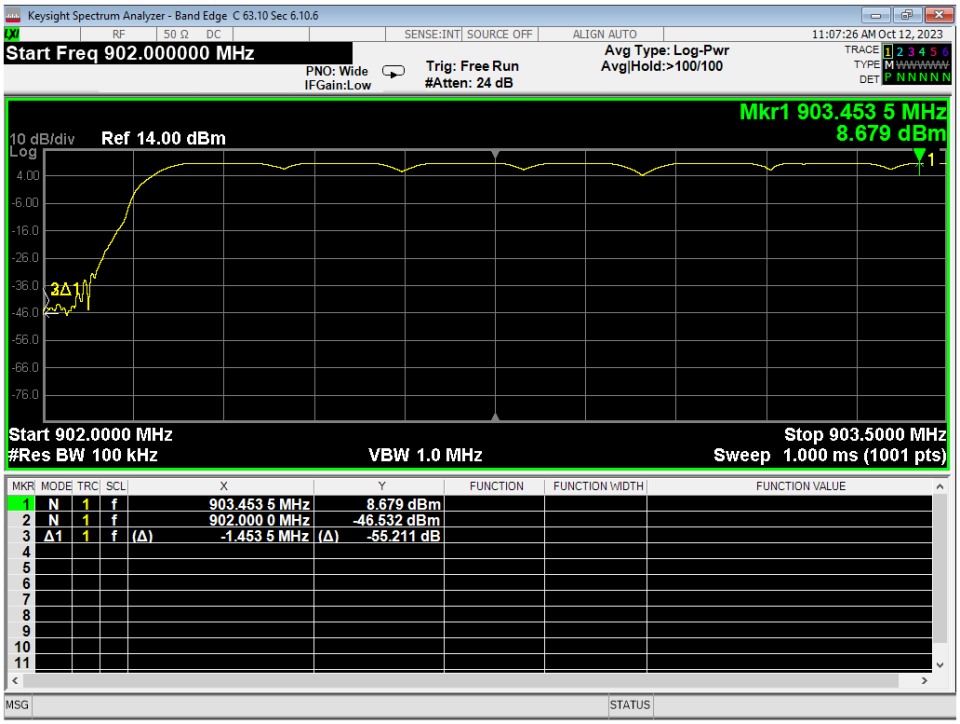
Peak PSD, High



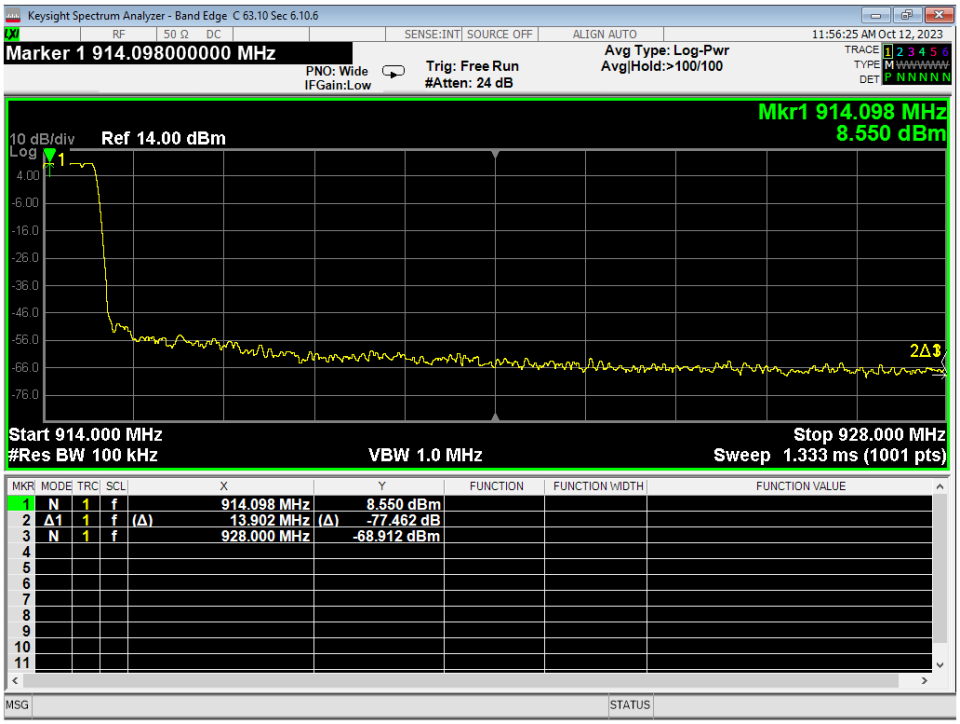
LBE Unrestricted



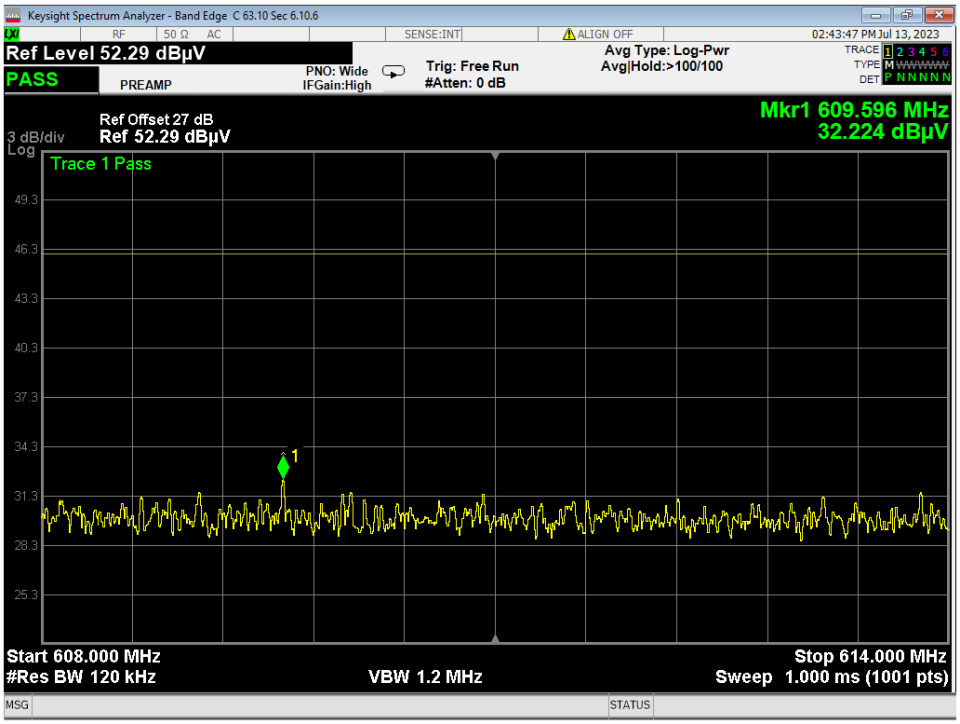
HBE Unrestricted



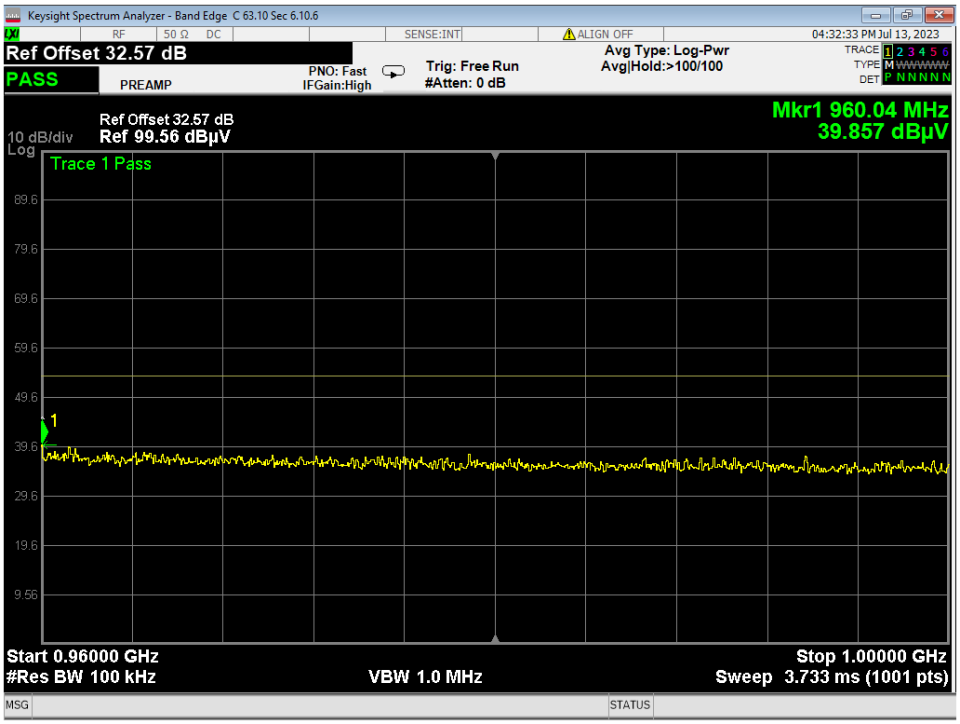
LBE Unrestricted, Hopping



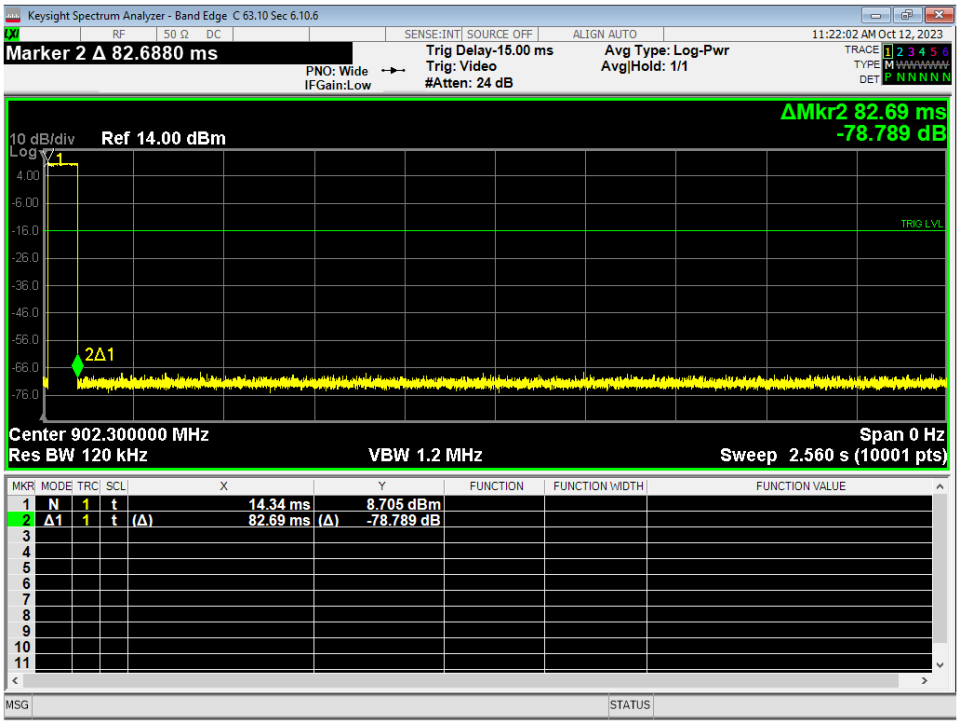
HBE Unrestricted, Hopping



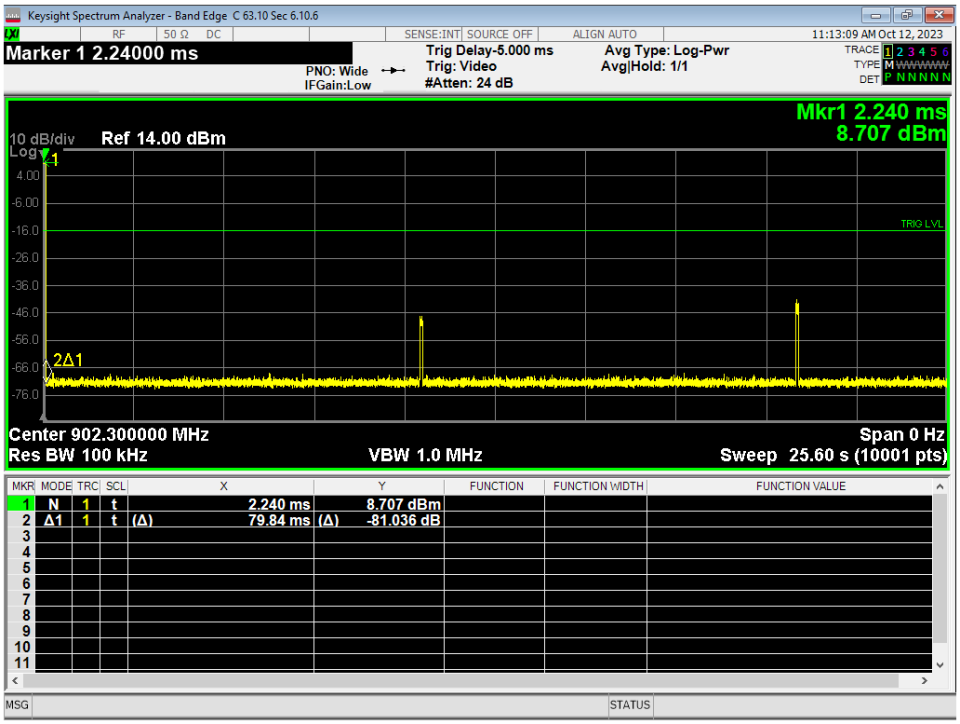
LBE Restricted



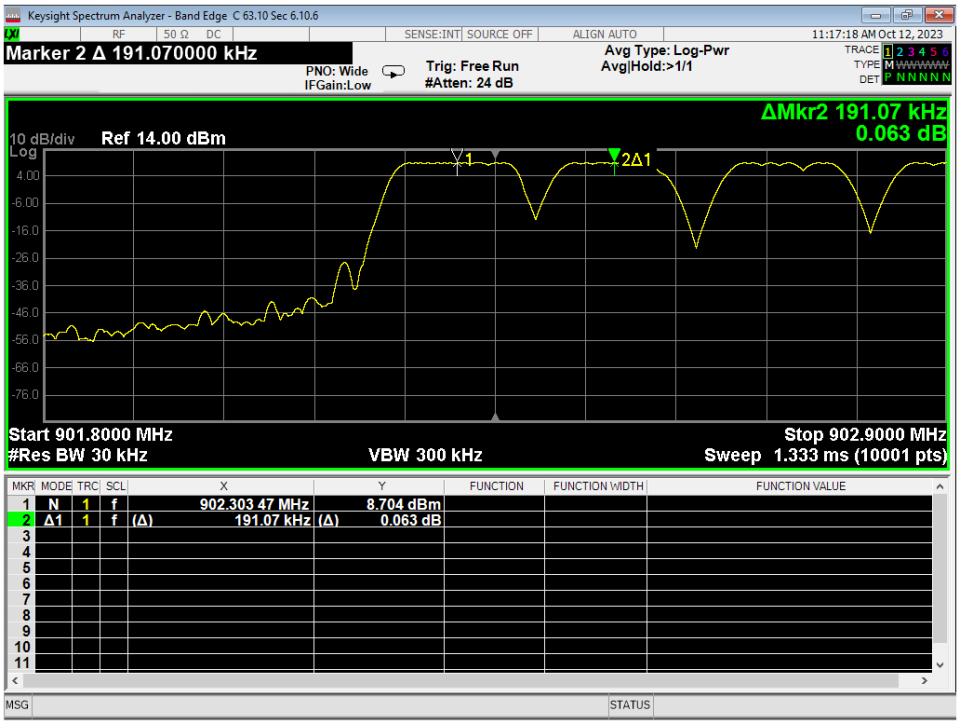
HBE Restricted



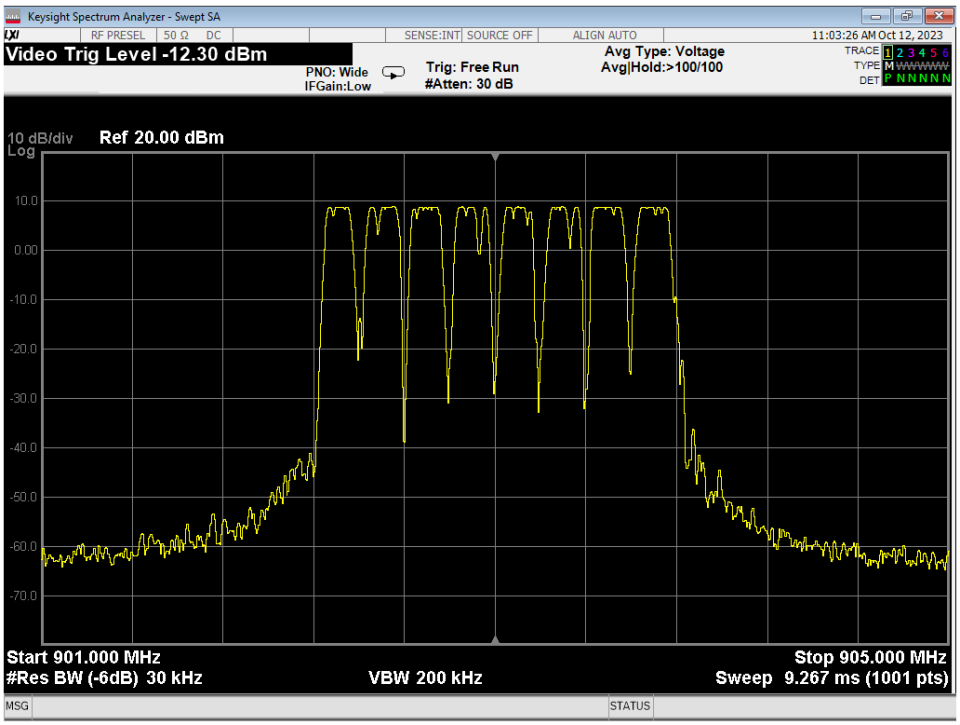
Dwell time, 2.56 seconds



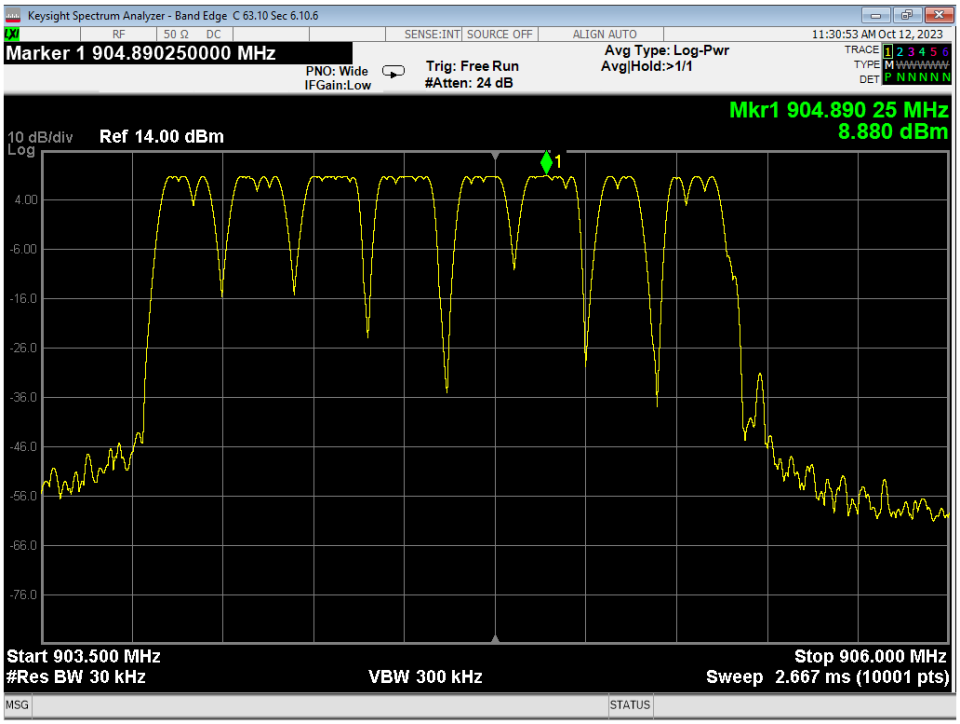
Dwell time, 25.6 seconds



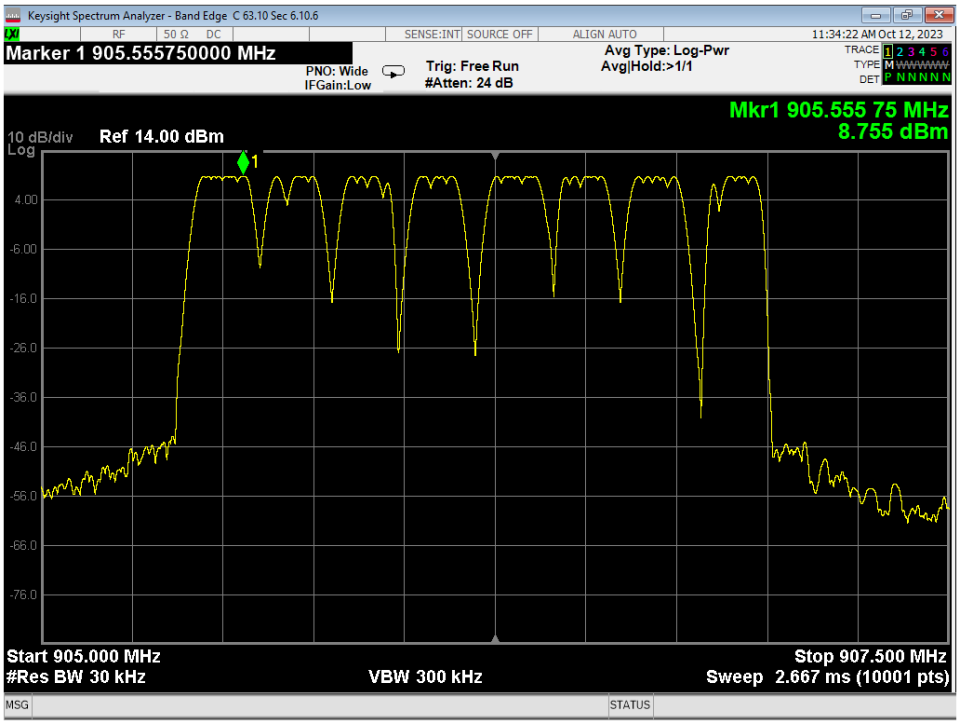
Frequency Separation



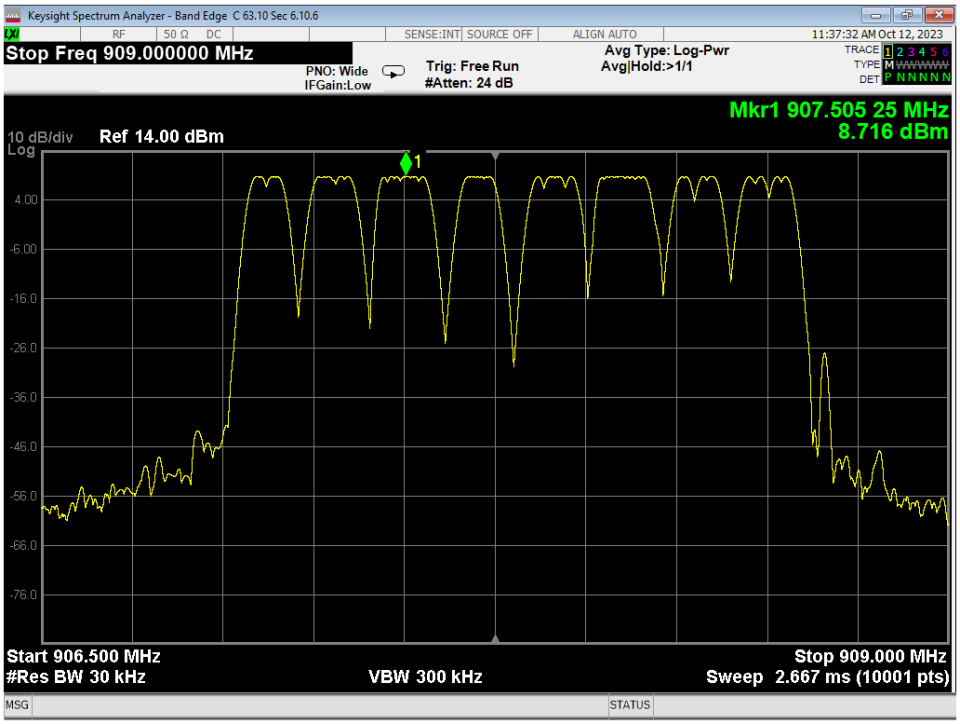
Hop Count, Block A



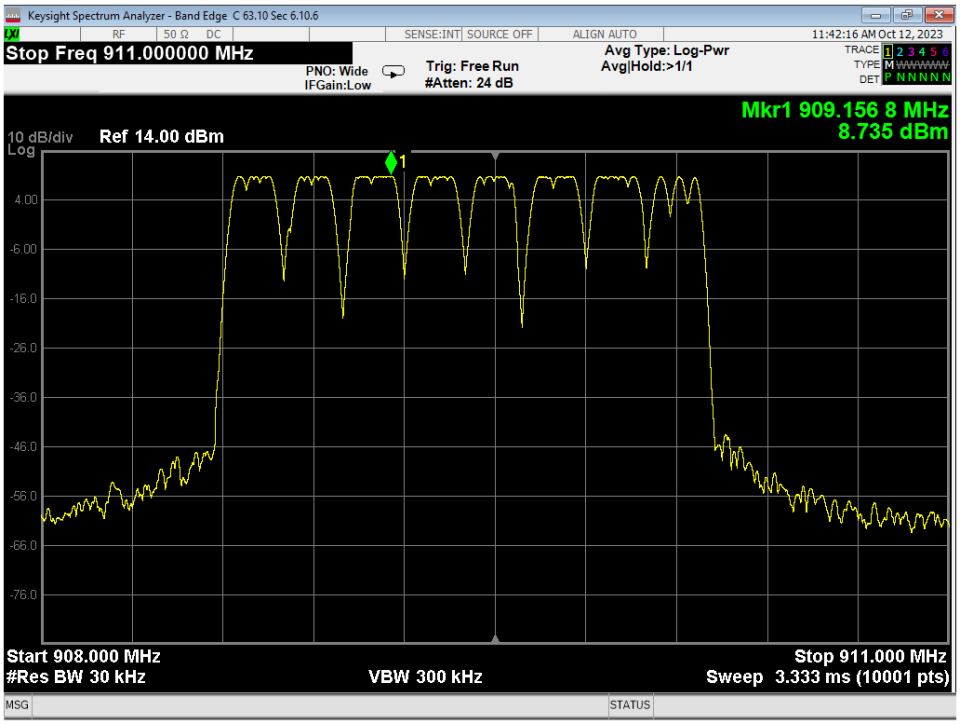
Hop Count, Block B



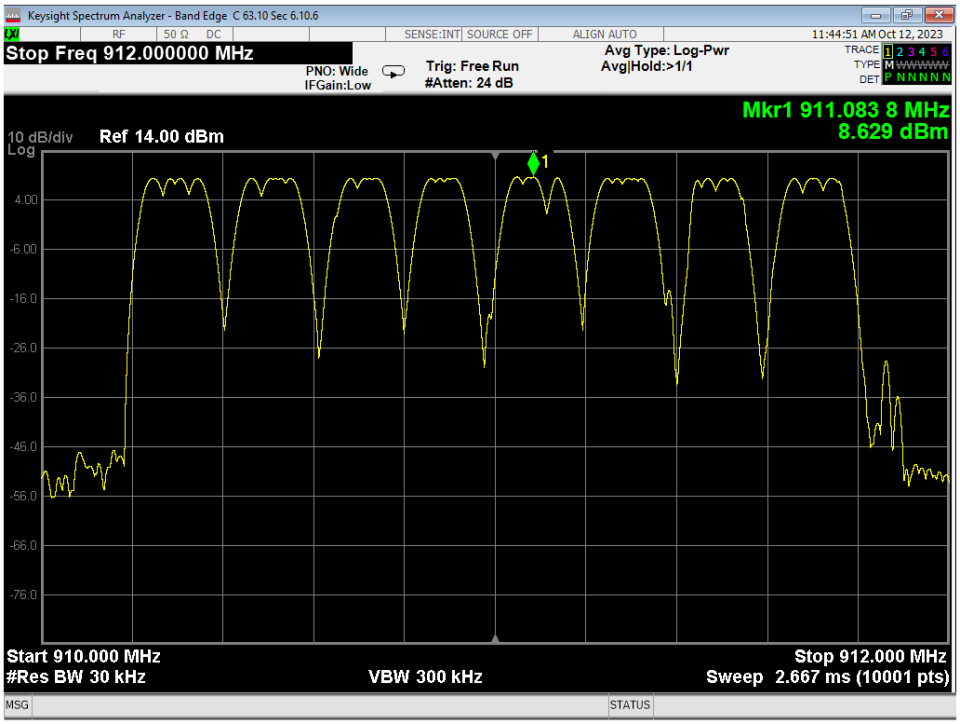
Hop Count, Block C



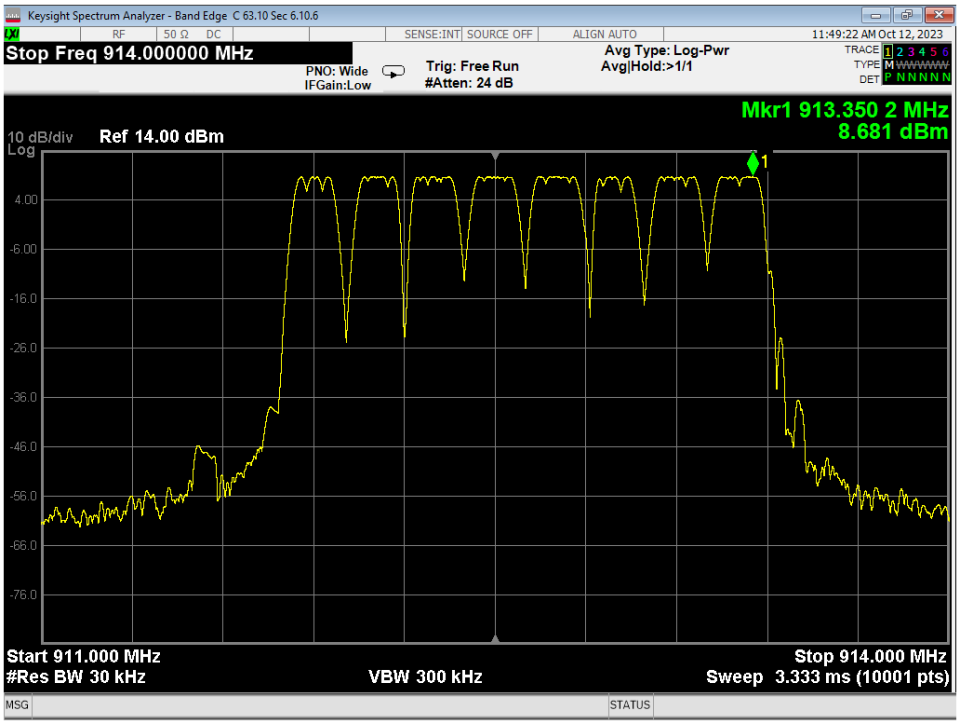
Hop Count, Block D



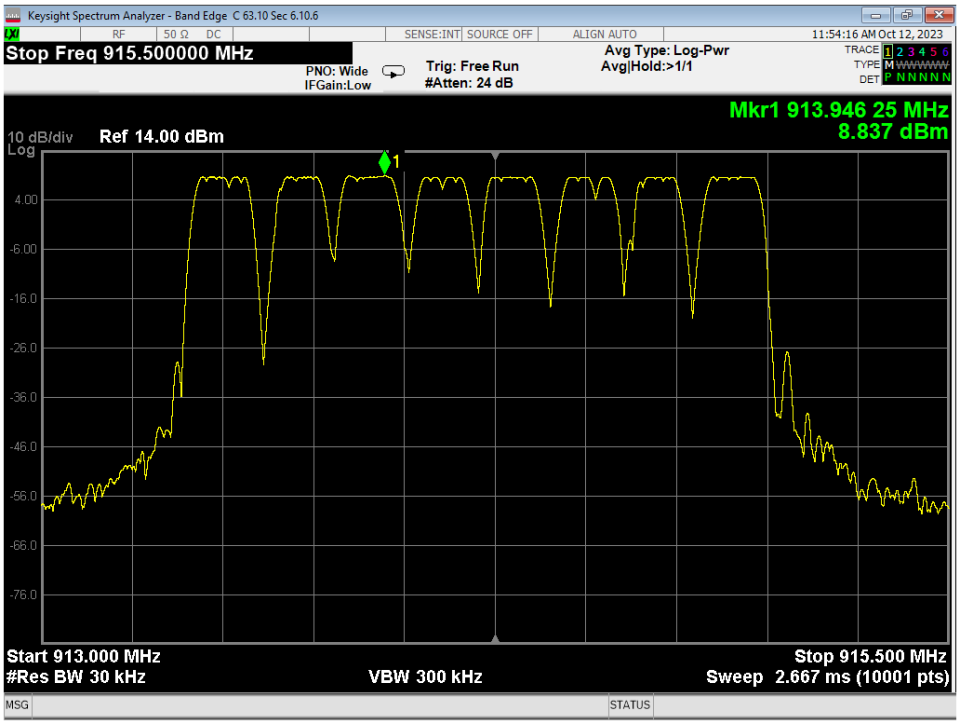
Hop Count, Block E



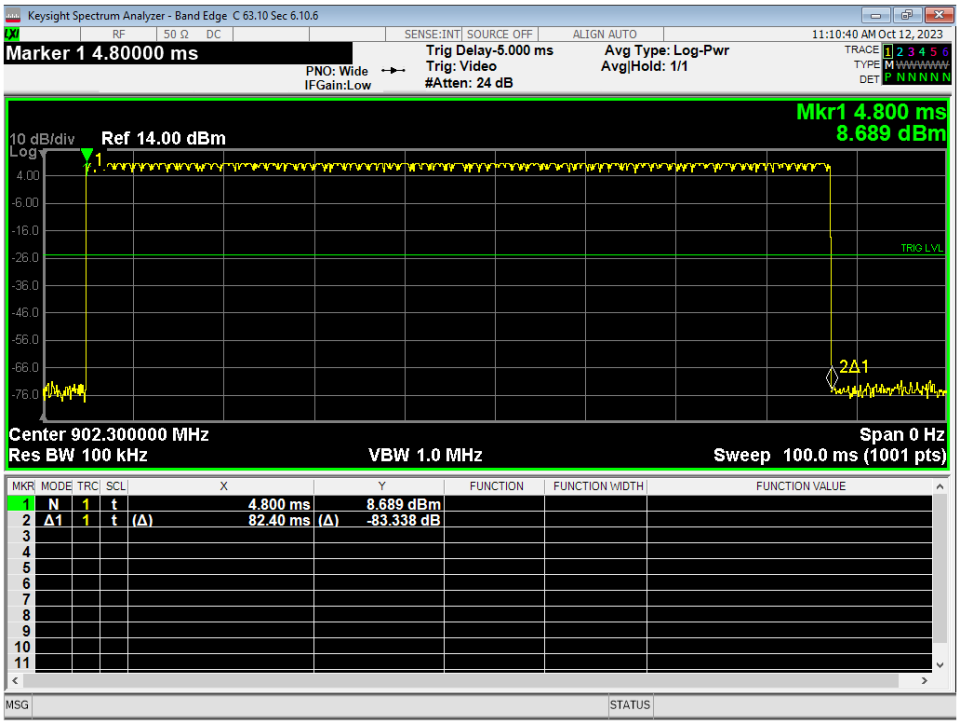
Hop Count, Block F



Hop Count, Block G



Hop Count, Block H



ON Time

REPORT END