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FCC/ISED TEST REPORT

Prepared for:	**Aerostar International**
Address:	**205 E 6th Street. Sioux Falls, SD 57104, USA**
Product:	**HiPointer 100**
Test Report No:	**R20210412-23-E1C**
Approved By:	**Nic Johnson, Technical Manager**
DATE:	**November 3, 2023**
Total Pages:	**37**

ilac-MRA
A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	24 January 2023	Issued by NJohnson Reviewed by FLane Prepared by KVepuri
A	15 March 2023	Removed references to Part 90
B	31 August 2023	Added Frequency ppm error to table - FL
C	10 October 2023	Added calculation for Freq Stability – FL Approved by NJohnson

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The EUT has been tested according to the following specifications:

FCC Part 80 requirements **Test Method:** IEEE ANSI C63.26-2015, TIA-603-D		**Result**
Test	**FCC Rule Part**	
RF Output Power	Part 80.215(a)(3)	Pass
Modulation characteristics	Part 80.213 (g)	Pass
Occupied bandwidth	Part 80.205(a)	Pass
Spurious emissions at antenna terminals	Part 80.211(f)	Pass
Field strength of spurious emission	Part 80.211(f)	Pass
Frequency Stability Tested in temperature chamber set to high and low of mfg specs	Part 80.209(b)	Pass

See Section 4 for details on the test methods used for each test.

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Model	HiPointer 100
EUT Received	25 July 2022
EUT Tested	25 July 2022- 4 November 2022
Serial No.	NCEETEST1 (Assigned by the test lab)
Operating Band	9410 MHz – 9463 MHz
Device Type	Licensed Radio
Power Supply	24VDC battery (2 X 12 V Marine batteries)

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:

Mode	CHANNEL FREQUENCY (MHz)
A	9410.000000
B	9413.000000
C	9460.000000
D	9463.000000

See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worst-case scenario. The manufacturer modified the unit to transmit continuously on four different modes.

2.3 DESCRIPTION OF SUPPORT UNITS

NA

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
NCC CAB Identification No: US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

All testing was performed by Karthik Vepuri and Fox Lane of NCEE Labs. The results were reviewed by Karthik Vepuri and Nic Johnson.

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 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)***	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A091418-1	July 26, 2022	July 26, 2023
EMCO Horn Antenna**	3115	6416	July 28, 2021	July 28, 2023
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	March 21, 2022	March 21, 2024
8447F POT H64 Preamplifier	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

Serial No.	Manufacturer	Model	Description	Last Cal.	Calibration due
2576	ETS	3116	Horn Antenna	9 Mar 2020	9 Mar 2023**
MY51391050	Keysight	M1970V-002	Mixer, 50 – 80 GHz	13 Apr 2019	13 Apr 2023*
700307	V11.25	700307	TDK Emissions Lab S/W	NA	NA
32/2016	Pasternack	PE9881-24	WR-15 Horn Antenna	CNR***	CNR***
16434-01	Sage Millimeter	SAZ-2410-10-S1	WR-10 Horn Antenna	CNR***	CNR***
3903A03916	Agilent	11970Q	Mixer, 33 – 50 GHz	CNR****	CNR****
Ncee1	Pasternack	SH122-23	WR-22 Horn Antenna	CNR***	CNR***
181004-2	OML	DPL313B	Diplexer	CNR****	CNR****

All mixers and pre-amplifiers were calibrated with associated cables.
*4 Year Cal ** 3 Year Cal ****Calibration Not Required, internal verification ***Calibration not required, standard gain horn antenna.

4.0 DETAILED RESULTS

4.1 UNWANTED EMISSIONS & FIELD STRENGTH OF EMISSIONS

Test Method: ANSI C63.26:2015:
Section 5.5, “Radiated Emissions Testing”

Limits for field strength of emissions measurements:
47 CFR 80.211(f):

The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:

(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10log10 (mean power in watts) dB.

Test procedures:
The EUT was connected directly to a spectrum analyzer using attenuators to protect the test equipment. Analyzer measurement settings can be found in the plots below along with the corresponding power levels.

All Radiated Emissions were performed at 3m test distance.

Deviations from test standard:
No deviation.

Test setup:

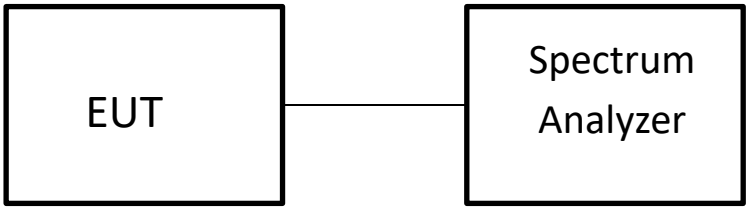

Figure 1 - Conducted Spurious Test Setup

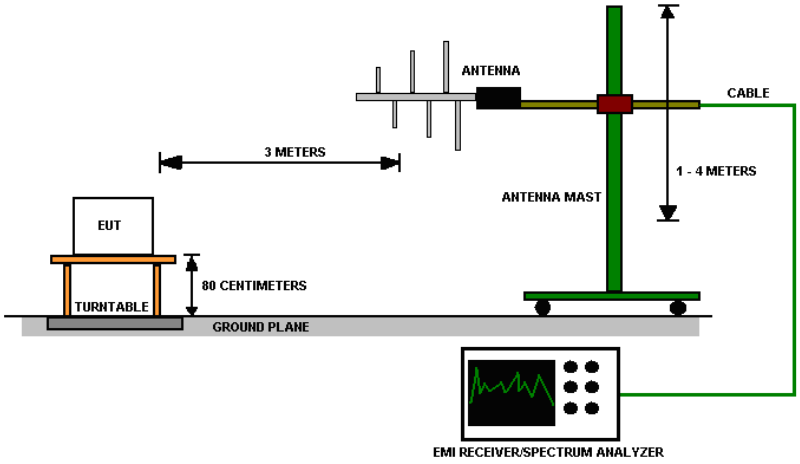

Figure 2 - Radiated Emissions Test Setup

EUT operating conditions

See Section 2.1 & 2.2

Test results:
Only worst-case measurements were reported. The EUT was evaluated by following the recommendation in C63.26 Section 5.1.1 (a) (1).

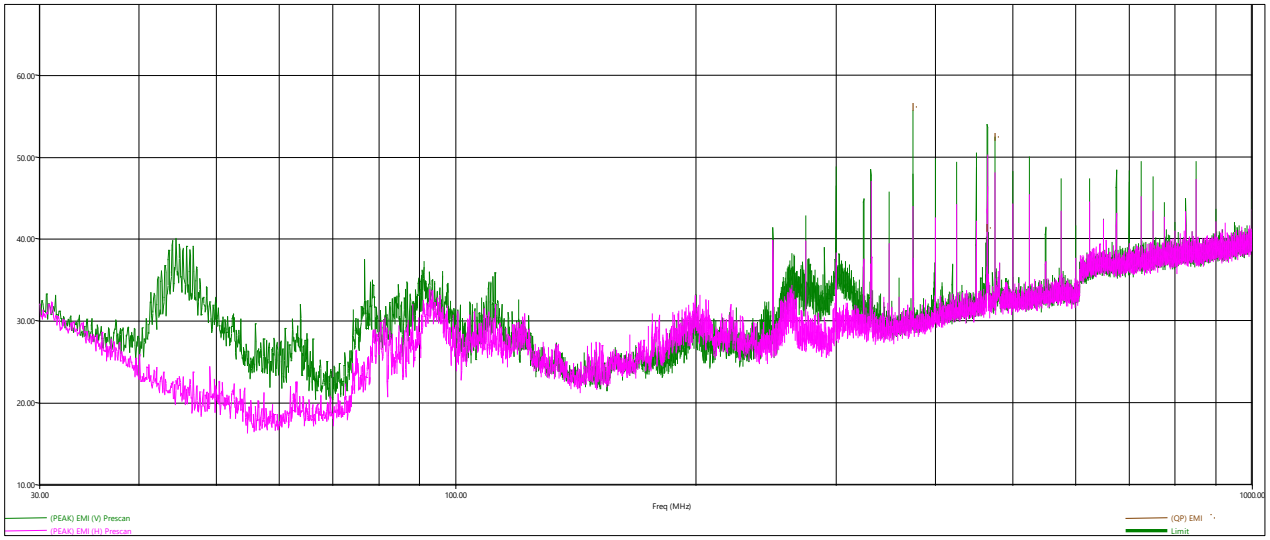

Figure 3 - Conducted Unwanted Emissions Plot, 30 MHz -1 GHz

*Limit is 82.23dBuV/m – all the radiated measurements were found to be at least 6dB below the limit-Pass.

Limit Calculation:
43+10log(100)=63; 50dBm-63= -13 dBm; 3m limit in dBuV/m= 95.23-13 dBm = 82.23 dBuV/m

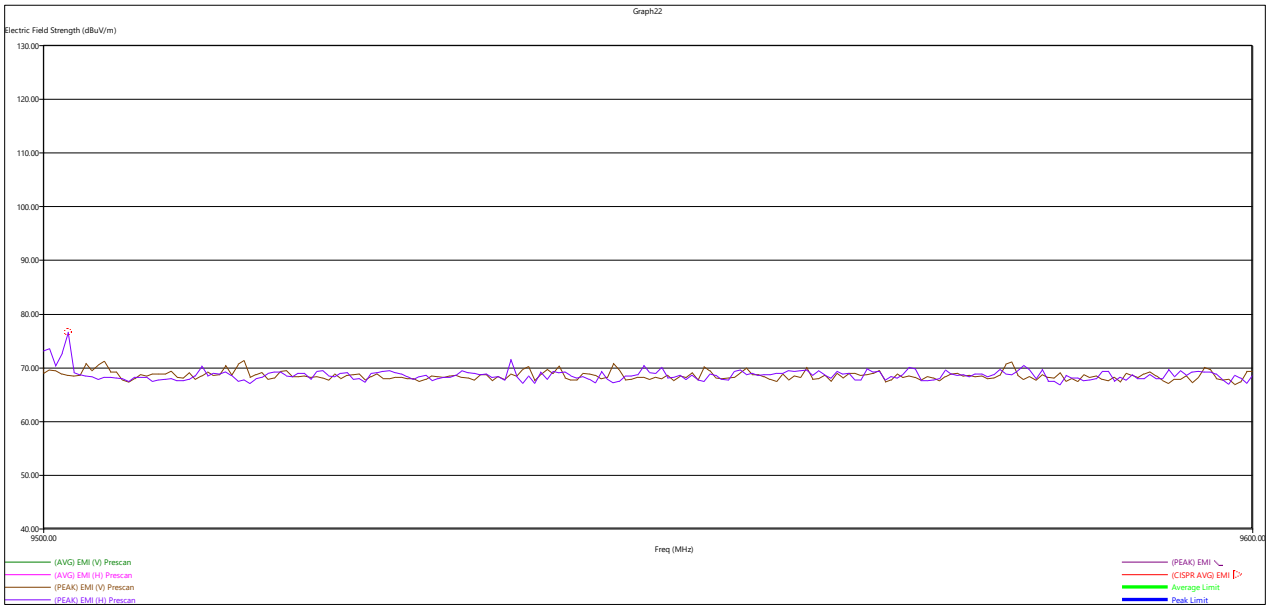

Figure 4 – Lower Band Edge, Mode C, 9200MHz – 9300MHz

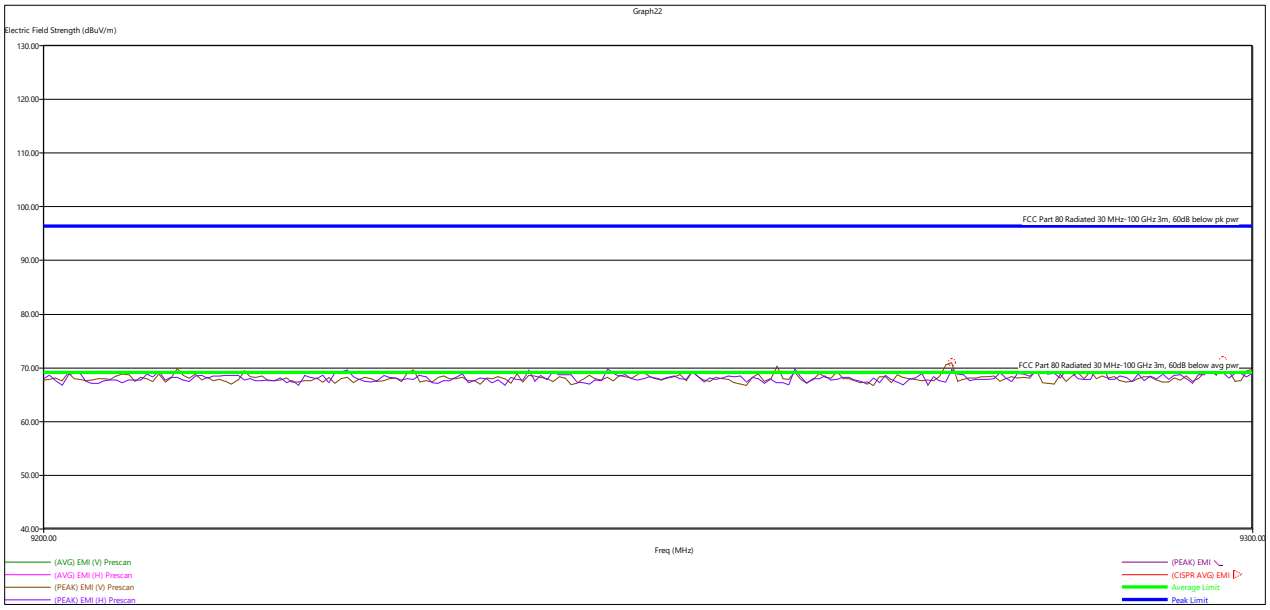

Figure 5 – Higher Band Edge, Mode C, 9500MHz – 9600MHz

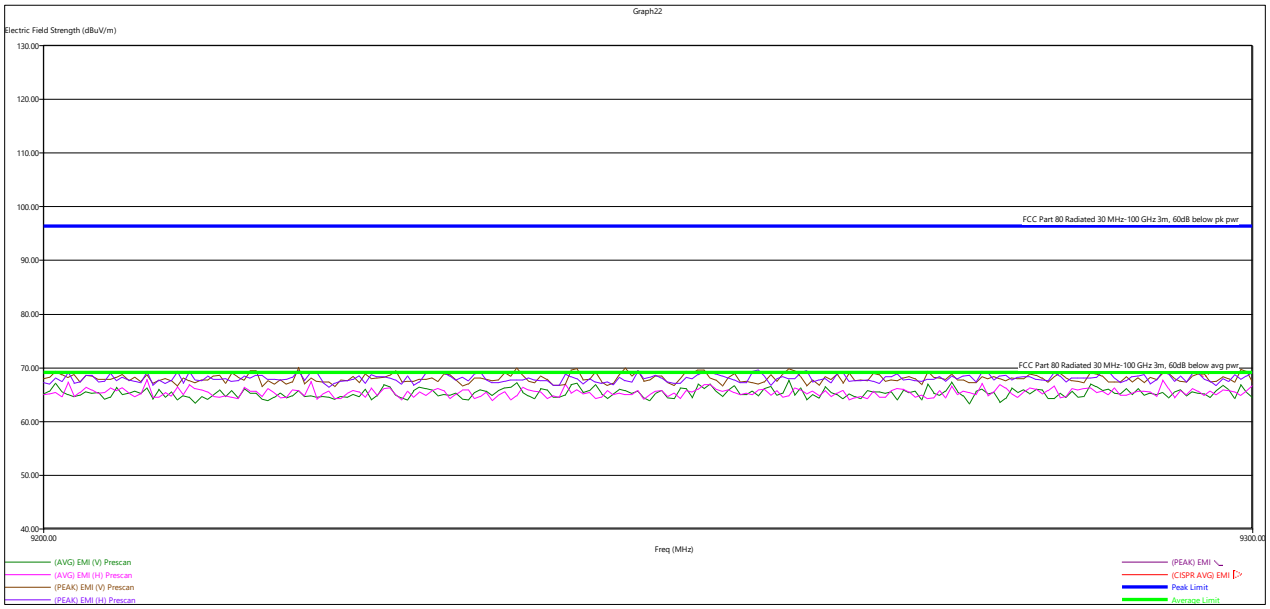

Figure 6 – Lower Band Edge, Mode A, 9200MHz – 9300MHz

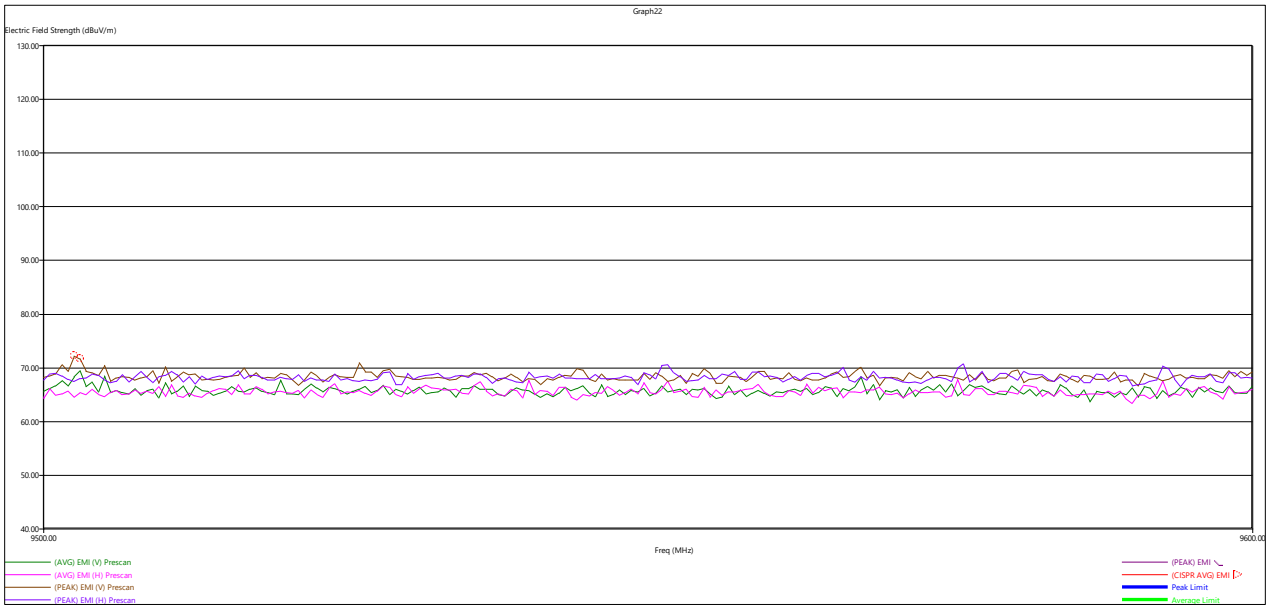

Figure 7 – Lower Band Edge, Mode A, 9500MHz – 9600MHz

Lower Band edge, Peak							
Band	**Mode**	**Freq**	**Peak H**	**Peak V**	**Limit(dBuV/m)***	**Peak H Margin**	**Peak V Margin**
Lower	C	9275	69.65	70.93	96.36	26.71	25.43
Lower	C	9297.5	69.08	71.35	96.36	27.28	25.01
Lower	A	9292.5	69.51	68.94	96.36	26.85	27.42
Lower	A	9296	67.84	68.9	96.36	28.52	27.46

*Limit calculated from 2.1053

Higher Band edge, Peak							
Band	**Mode**	**Freq**	**Peak H**	**Peak V**	**Limit(dBuV/m)***	**Peak H Margin**	**Peak V Margin**
Higher	C	9502	76.65	68.58	96.36	19.71	27.78
Higher	A	9502.5	67.44	72.23	96.36	28.92	24.13
Higher	A	9503	68.03	71.7	96.36	28.33	24.66

*Limit calculated from 2.1053

Lower Band edge, Average										
Band	**Mode**	**Freq**	**Peak H**	**Peak V**	**DCCF**	**Avg (H)**	**Avg (V)**	**Limit (dBuV/m)***	**Peak H Margin**	**Peak V Margin**
Lower	C	9275.00	69.65	70.93	27.96	41.69	42.97	69.08	27.39	26.11
Lower	C	9297.50	69.08	71.35	27.96	41.12	43.39	69.08	27.96	25.69
Lower	A	9292.50	69.51	68.94	27.96	41.55	40.98	69.08	27.53	28.10
Lower	A	9296.00	67.84	68.90	27.96	39.88	40.94	69.08	29.20	28.14

*Limit calculated from 2.1053

Lower Band edge, Average										
Band	**Mode**	**Freq**	**Peak H**	**Peak V**	**DCCF**	**Avg (H)**	**Avg (V)**	**Limit (dBuV/m)***	**Peak H Margin**	**Peak V Margin**
Higher	C	9502.00	76.65	68.58	27.96	48.69	40.62	69.08	20.39	28.46
Higher	A	9502.50	67.44	72.23	27.96	39.48	44.27	69.08	29.60	24.81
Higher	A	9503.00	68.03	71.70	27.96	40.07	43.74	69.08	29.01	25.34
Higher	C	9502.00	76.65	68.58	27.96	48.69	40.62	69.08	20.39	28.46

*Limit calculated from 2.1053

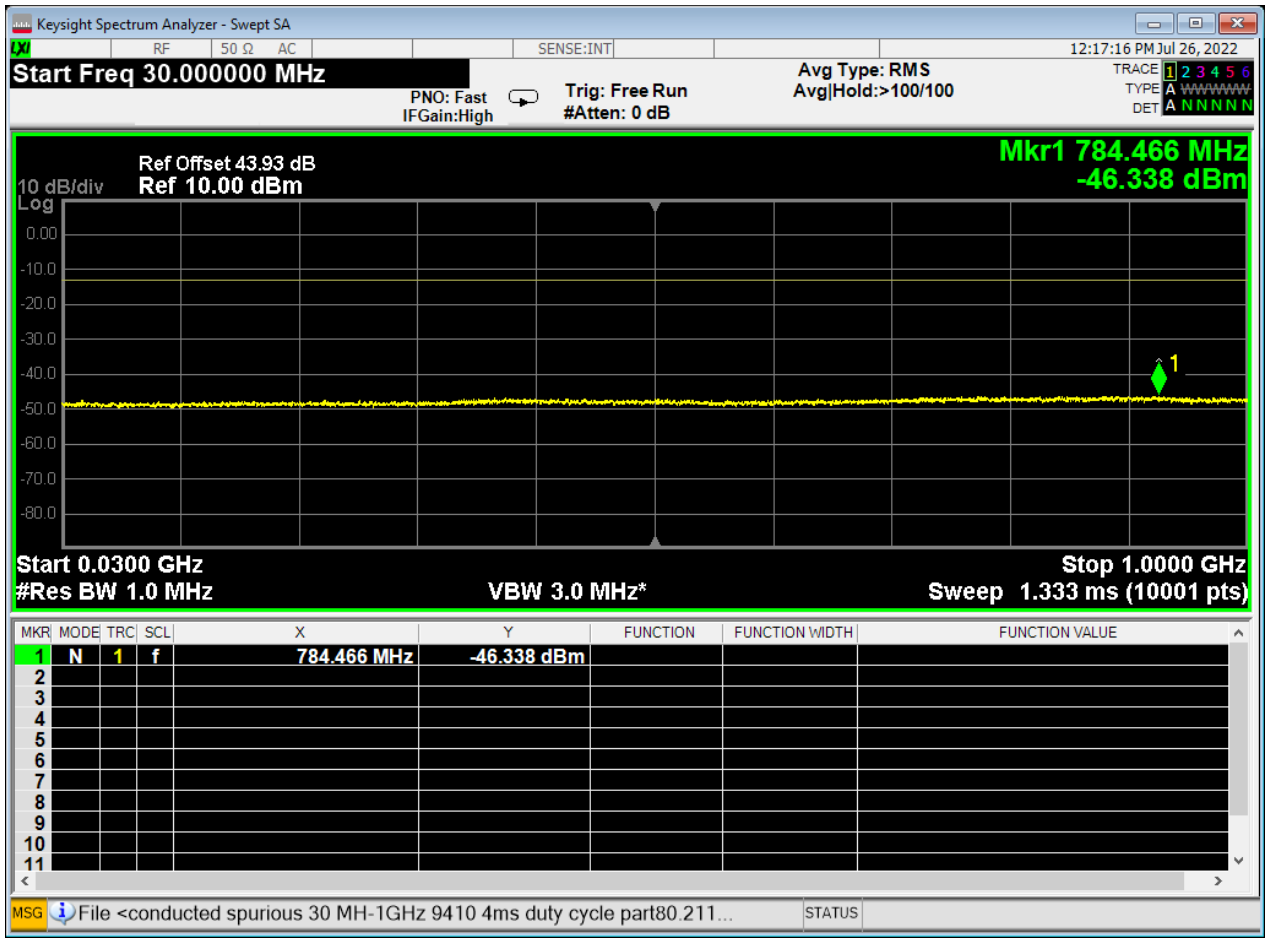

Figure 8 - Conducted Unwanted Emissions Plot, 30 MHz-1 GHz

*Limit is -13dBm – Pass

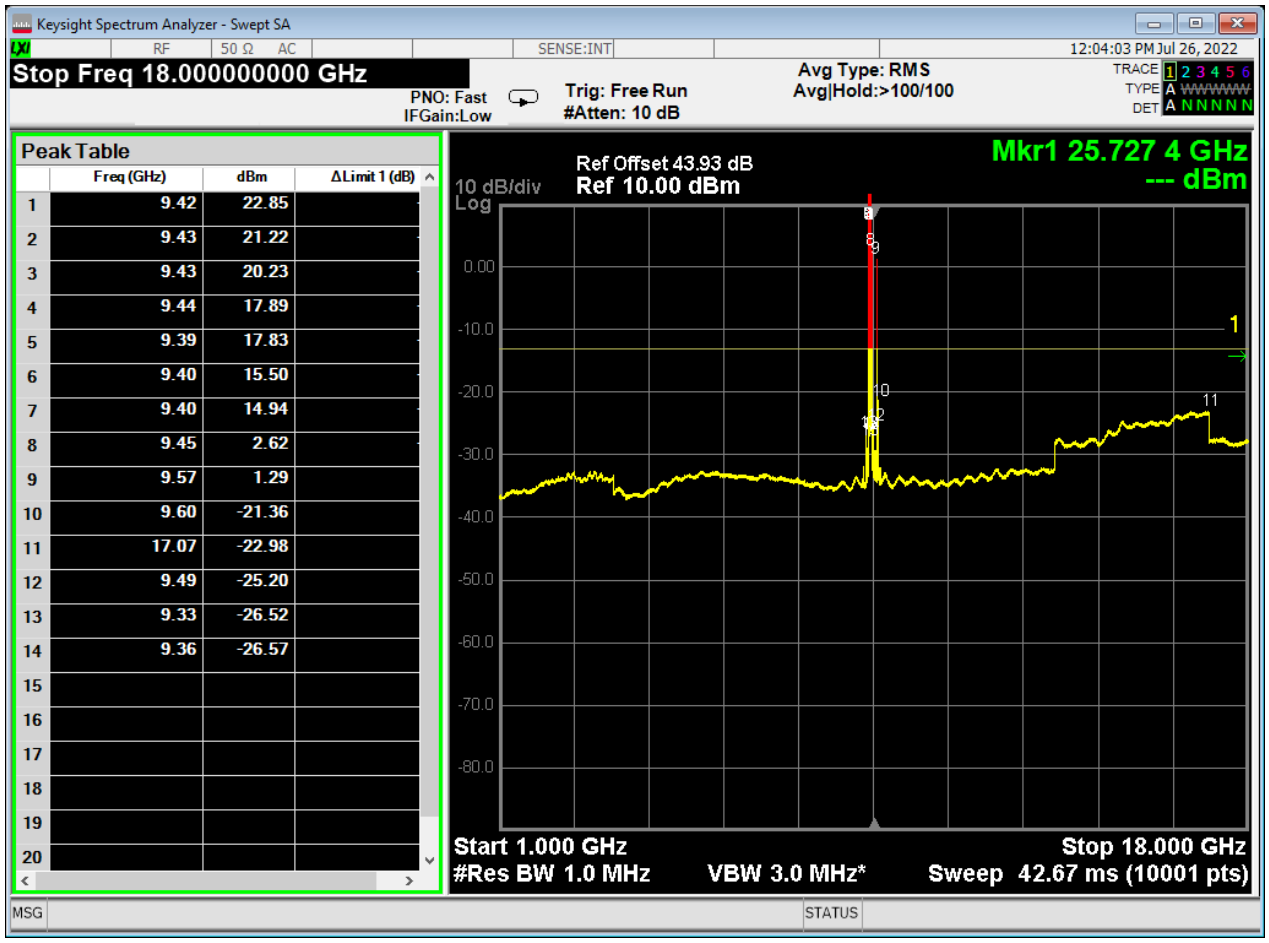

Figure 9 - Conducted Unwanted Emissions Plot, 1 GHz-18 GHz

*Limit is -13dBm – Pass

Marker 1 is on the fundamental frequency and thus can be disregarded. Also, the green line is for reference only not a limit.

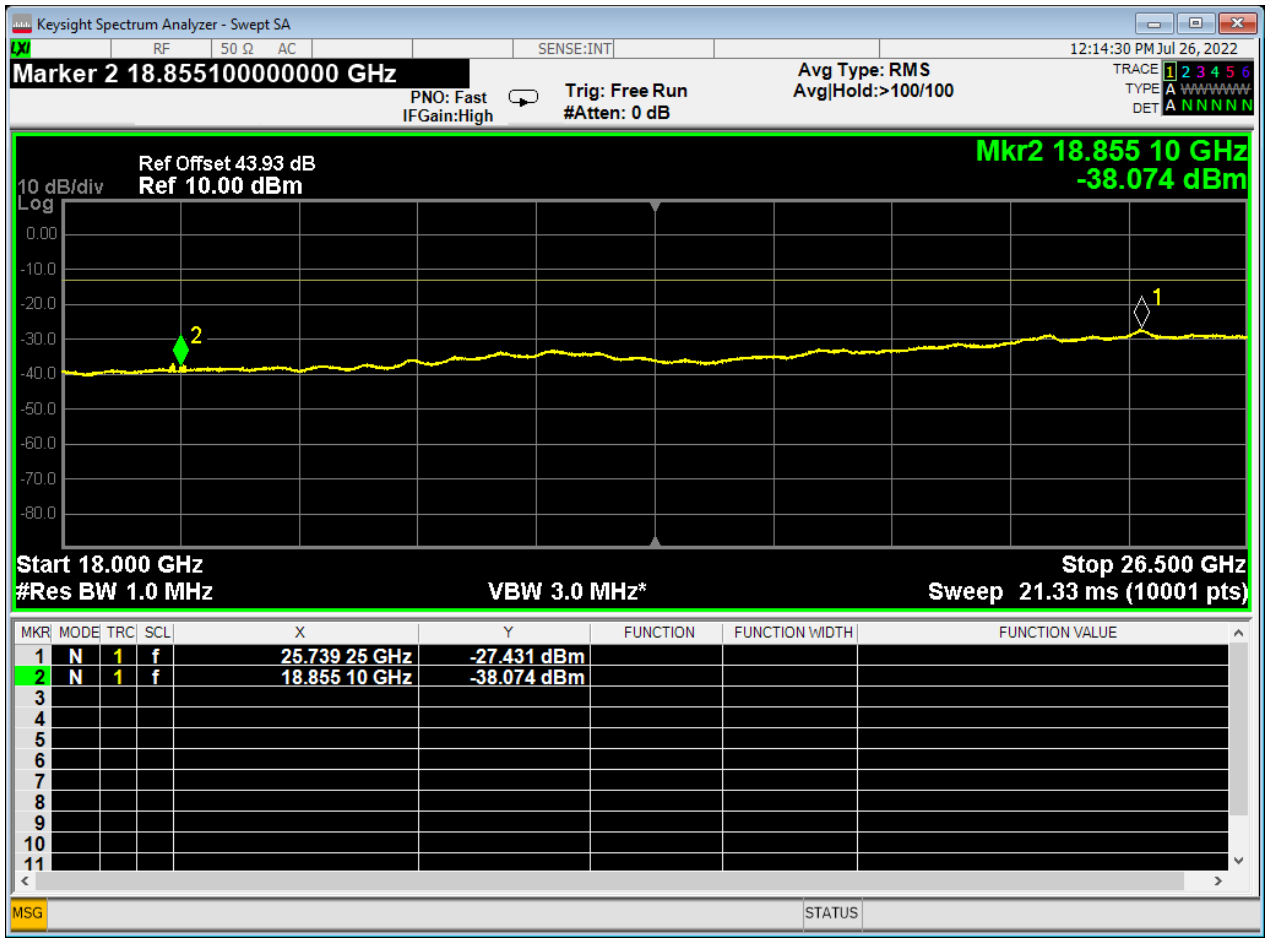

Figure 10 - Conducted Unwanted Emissions Plot, 18 GHz-26 GHz

*Limit is -13dB – Pass

All other measurements including above 26 GHz were found to be at least 6 dB below the limits.

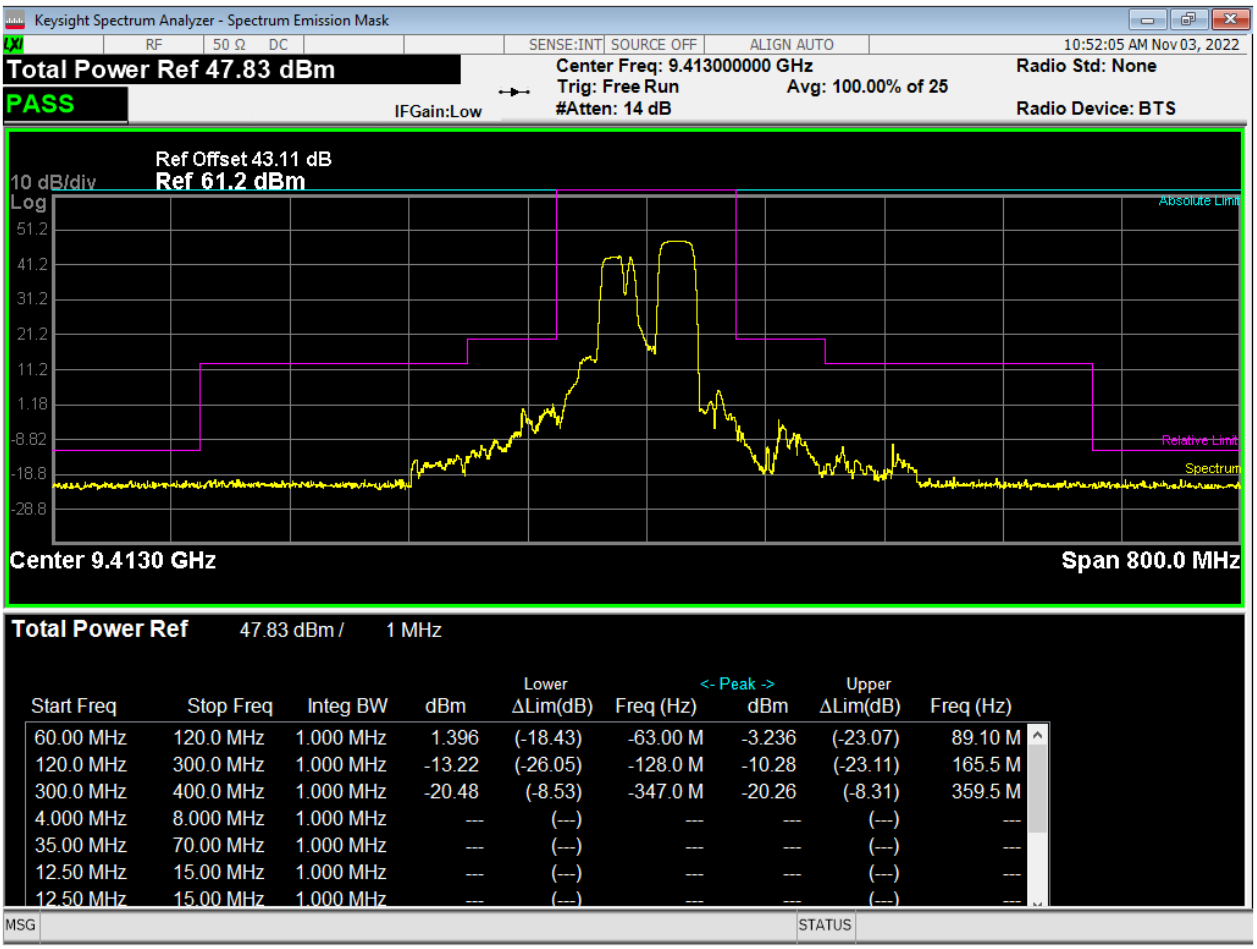

Figure 11 – Emissions Mask, Mode A, 120 MHz Authorized BW

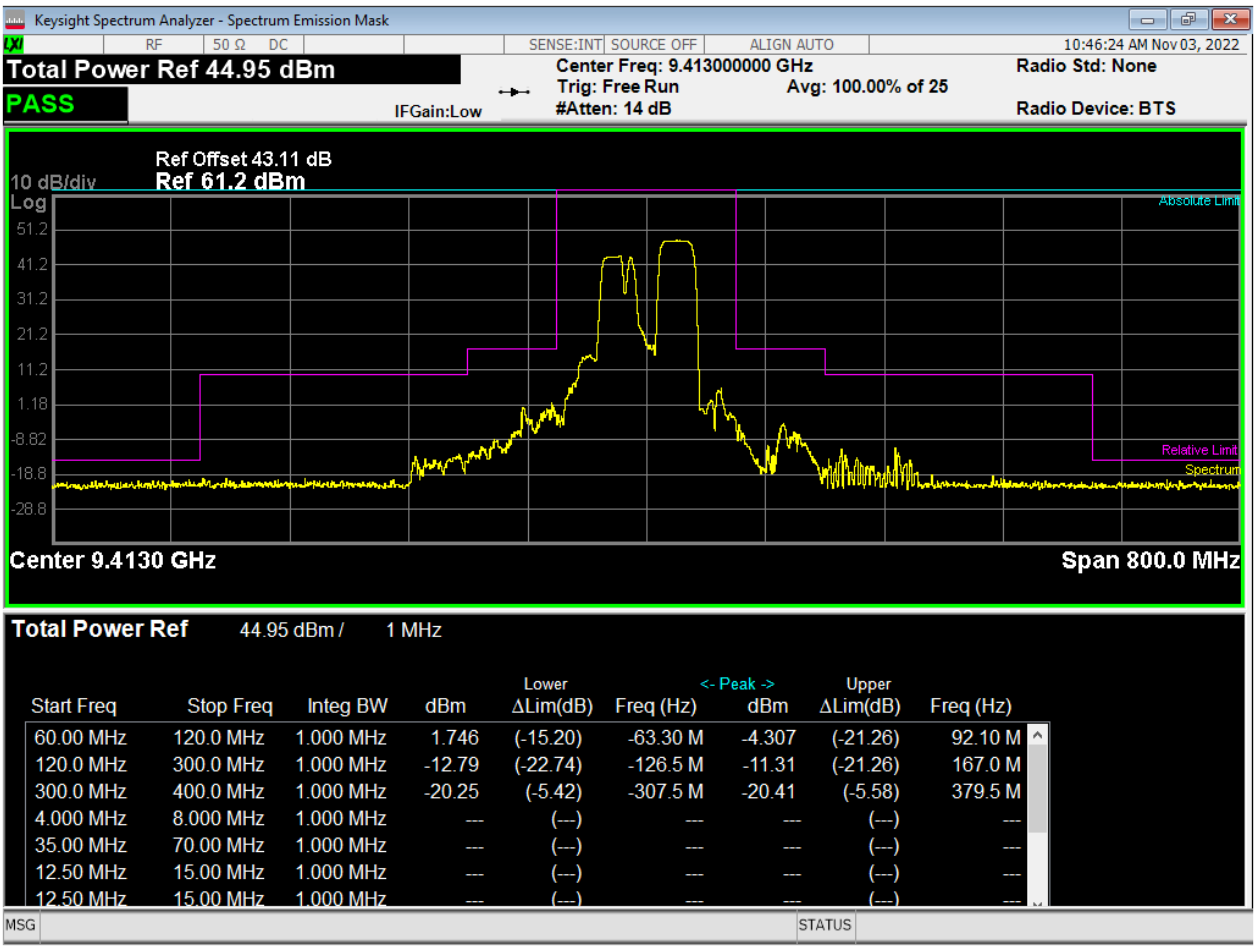

Figure 12 – Emissions Mask, Mode B, 120 MHz Authorized BW

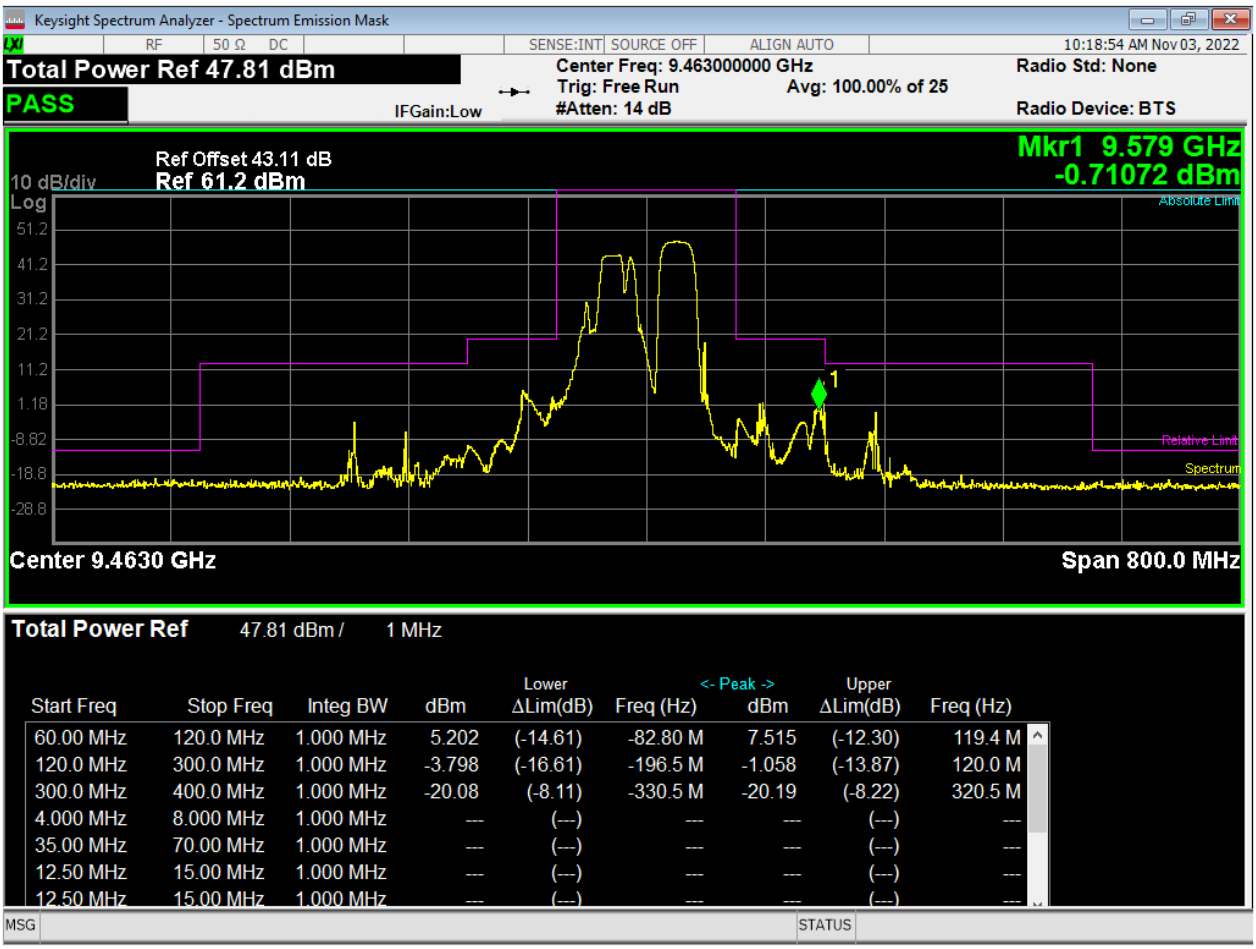

Figure 13 – Emissions Mask, Mode C, 120 MHz Authorized BW

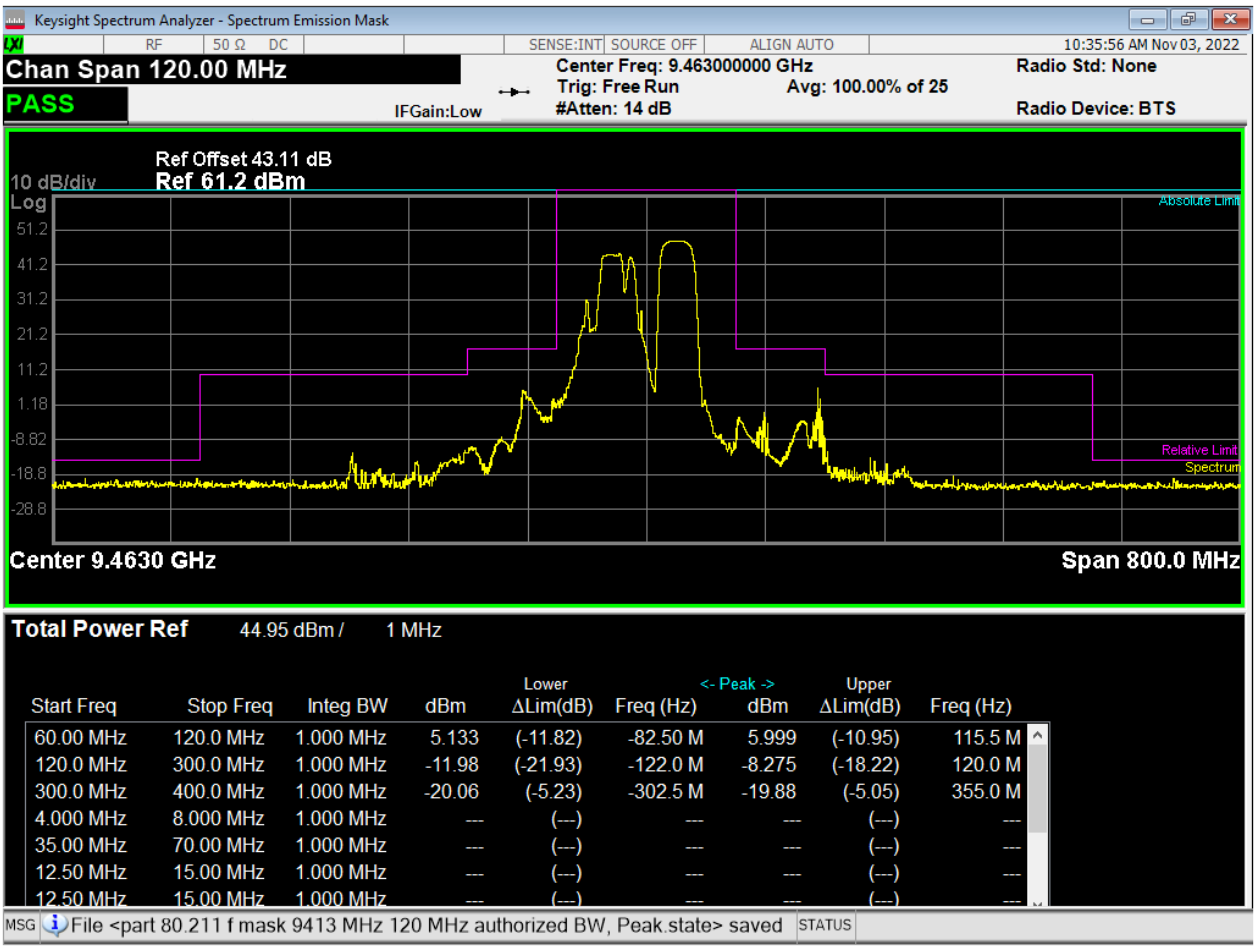

Figure 14 – Emissions Mask, Mode D, 120 MHz Authorized BW

4.2 OUTPUT POWER

Test Method: ANSI C63.26:
Section(s) 5.2.4.4.2

Limits of power measurements:

Transmitter power shown on the radio station authorization is the maximum power the licensee is authorized to use. Power is expressed in the following terms: For PON and F3N emission: Mean power

Test procedures:
All the measurements were done with RBW greater than OBW of the signal.

Deviations from test standard:
No deviation.

Test setup:

Figure 15 – Output Power Measurements Test Setup

EUT operating conditions:
See Section 2.1 & 2.2

Test results:

Output Power

Mode	CHANNEL FREQUENCY (MHz)	Duty Cycle Correction Factor (DCCF)	Raw uncorrected level (dBm)	Corrected Output Power (dBm)	Corrected Output Power (mW)	Method	RESULT
A-4% Duty Cycle	9410.000000	13.9794	33.55	47.53	56616.11	Conducted	PASS
B-2% Duty Cycle	9413.000000	16.9897	30.52	47.51	56359.87	Conducted	PASS
C-4% Duty Cycle	9460.000000	13.9794	33.41	47.39	54820.12	Conducted	PASS
D-2% Duty Cycle	9463.000000	16.9897	30.59	47.58	57275.65	Conducted	PASS
Duty cycle is declared by the manufacturer. Corrected Output Power=DCCF + Raw uncorrected level. Limit-50 dBm/100 W							

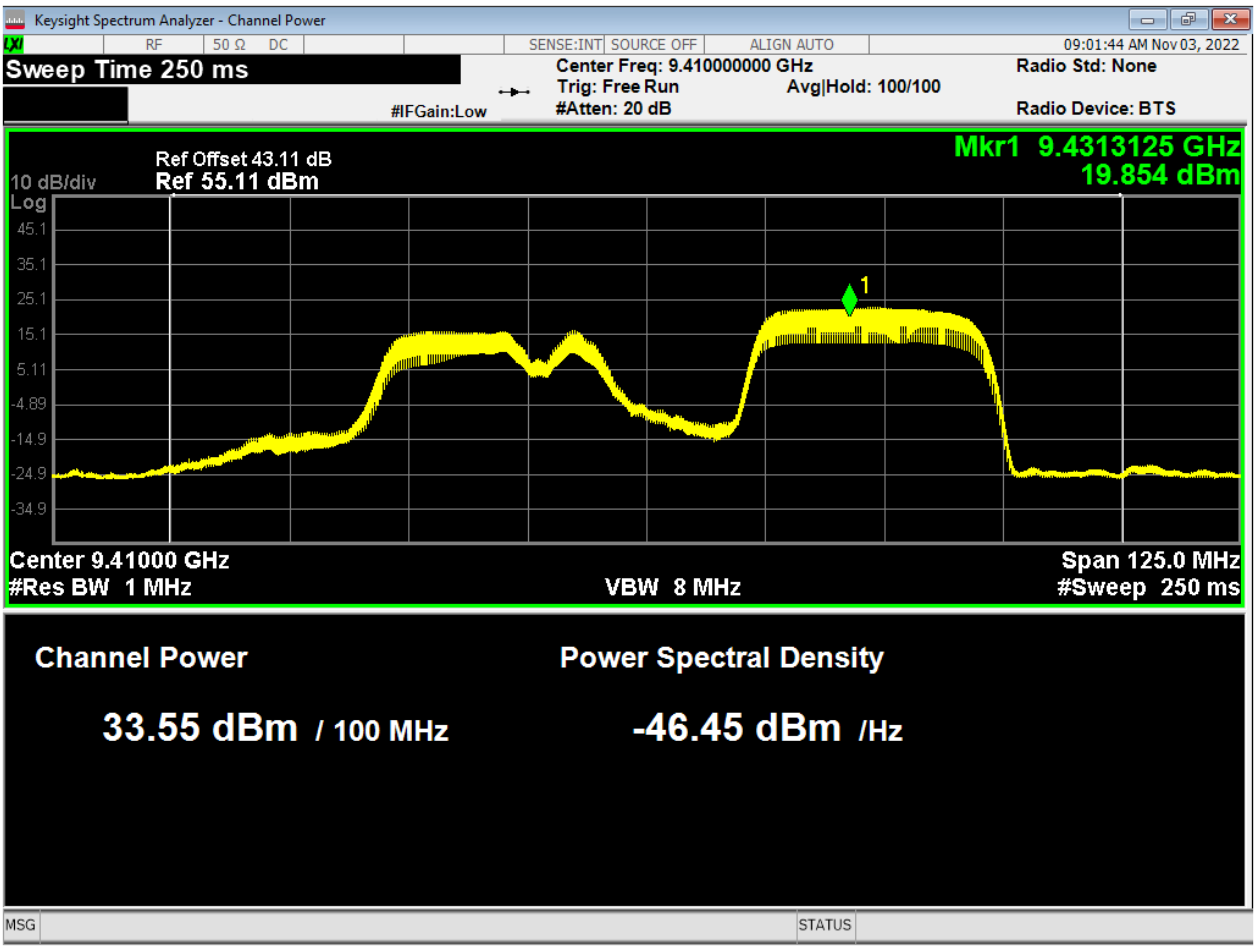

Figure 16 – Average Power, Mode A

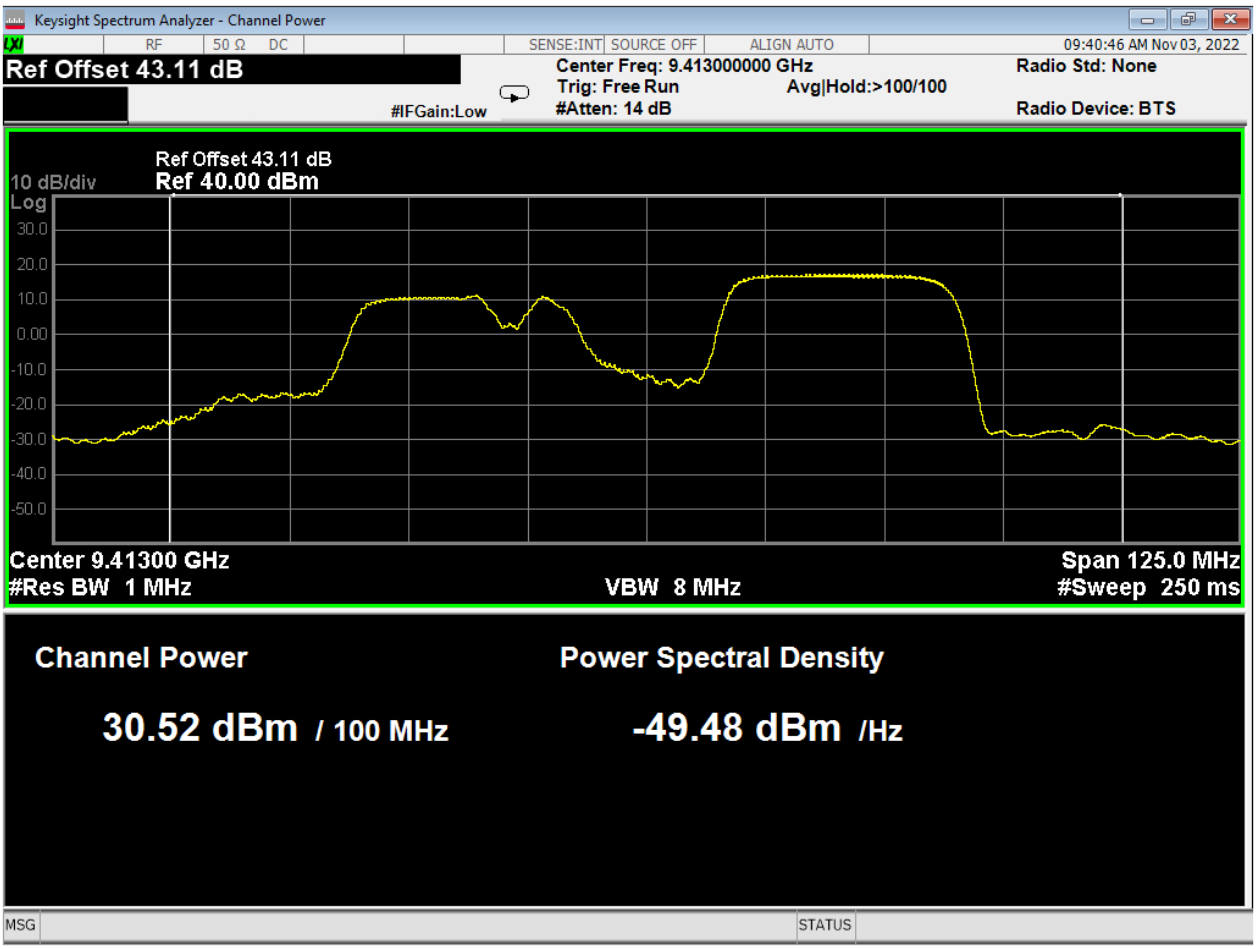

Figure 17 – Average Power, Mode B

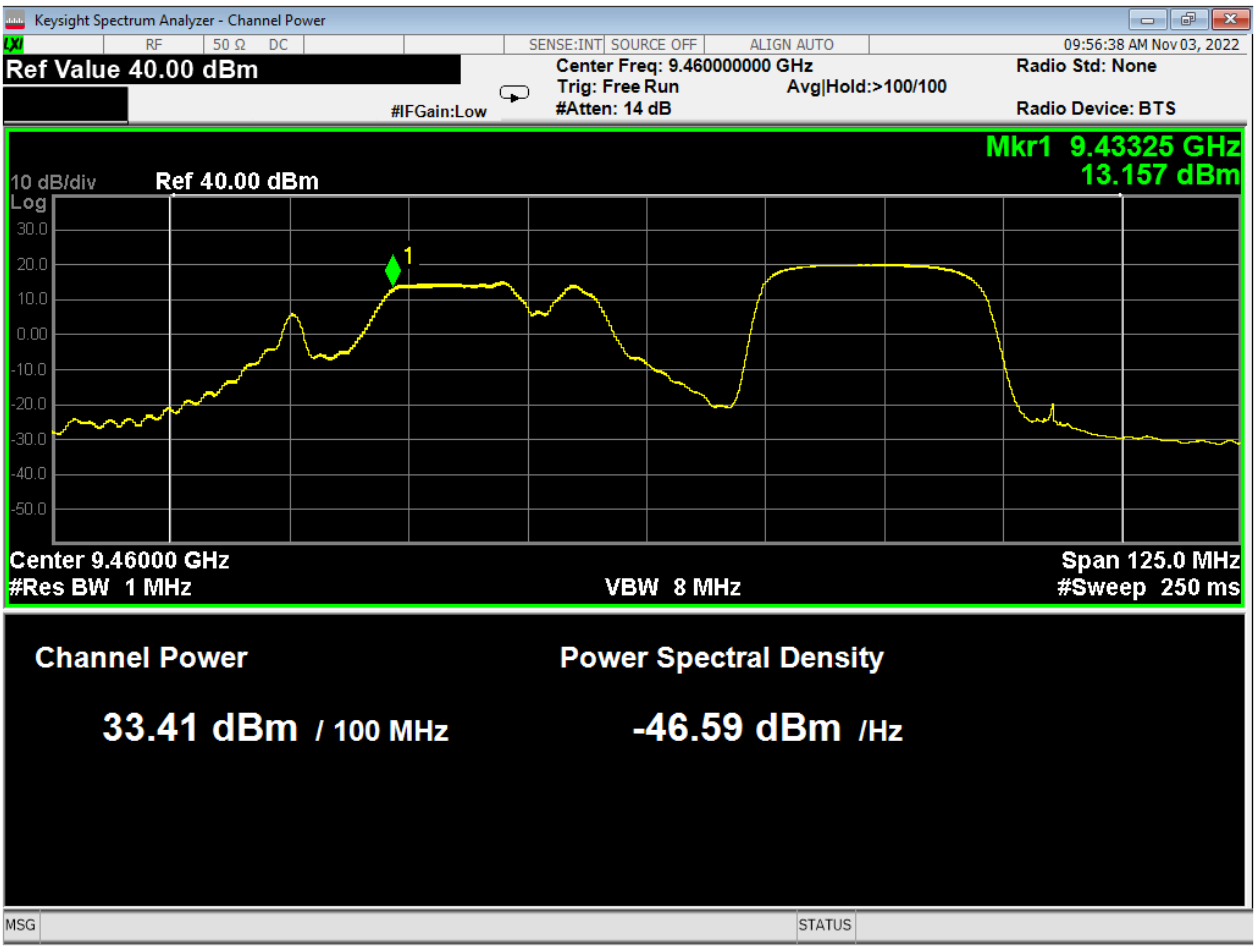

Figure 18 – Average Power, Mode C

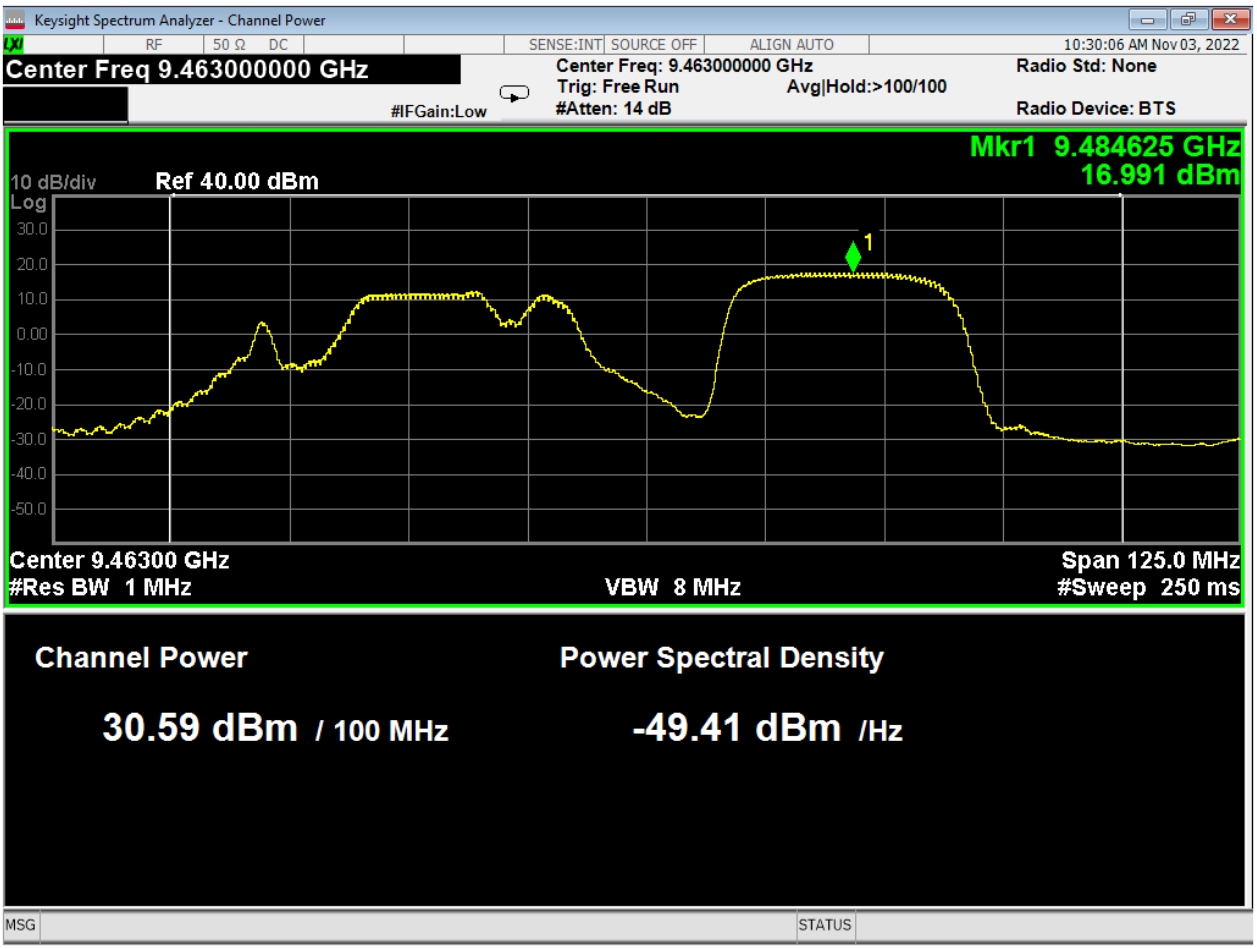

Figure 19 – Average Power, Mode D

4.3 BANDWIDTH AND MODULATION CHARACTERISTICS

Test Method: ANSI C63.26,

1. Section(s) 5.4.3, 5.4.4

Limits of bandwidth measurements:
Authorized Bandwidth is 120 MHz. Operating Range is 9410 MHz – 9463 MHz.

Limits for Modulation Characteristics:
Radar stations operating in the bands above 2.4 GHz may use any type of modulation consistent with the bandwidth requirements in § 80.209(b).

Test procedures:
The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable and an attenuator to protect measurement equipment. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 1 MHz RBW and 8 MHz VBW. The bandwidth measurements were done using the automatic bandwidth measurement.

Deviations from test standard:
No deviation

Test setup:

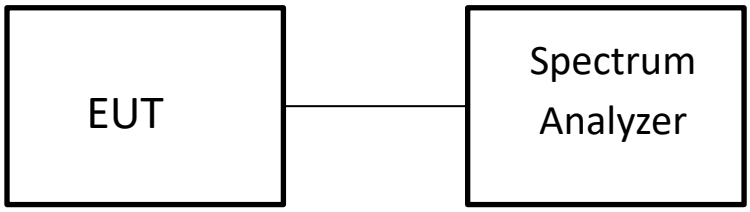

Figure 20 –Measurements Test Setup

EUT operating conditions:
See Section 2.1 & 2.2

Test results:

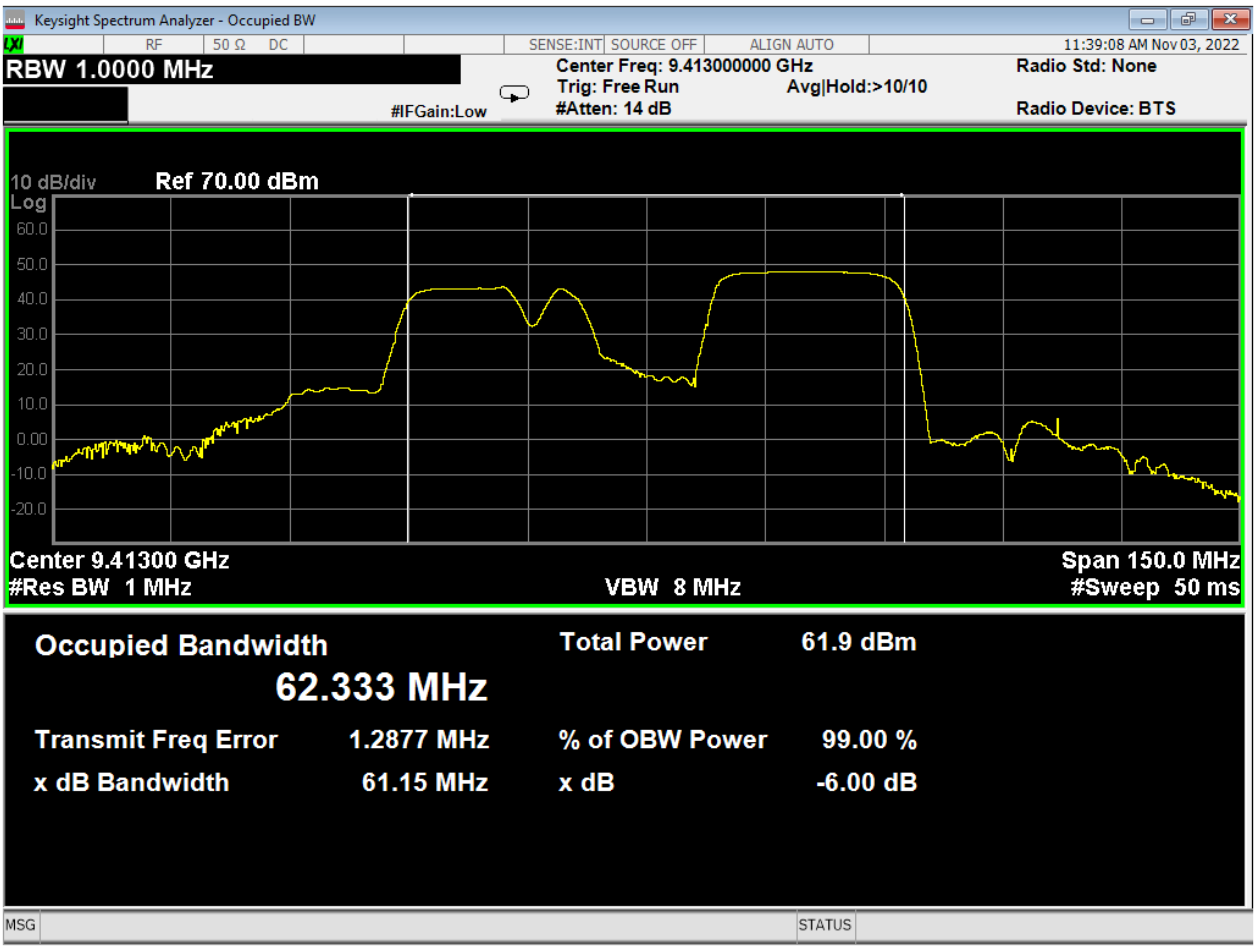

Figure 21 - 99% Occupied Bandwidth, Mode A

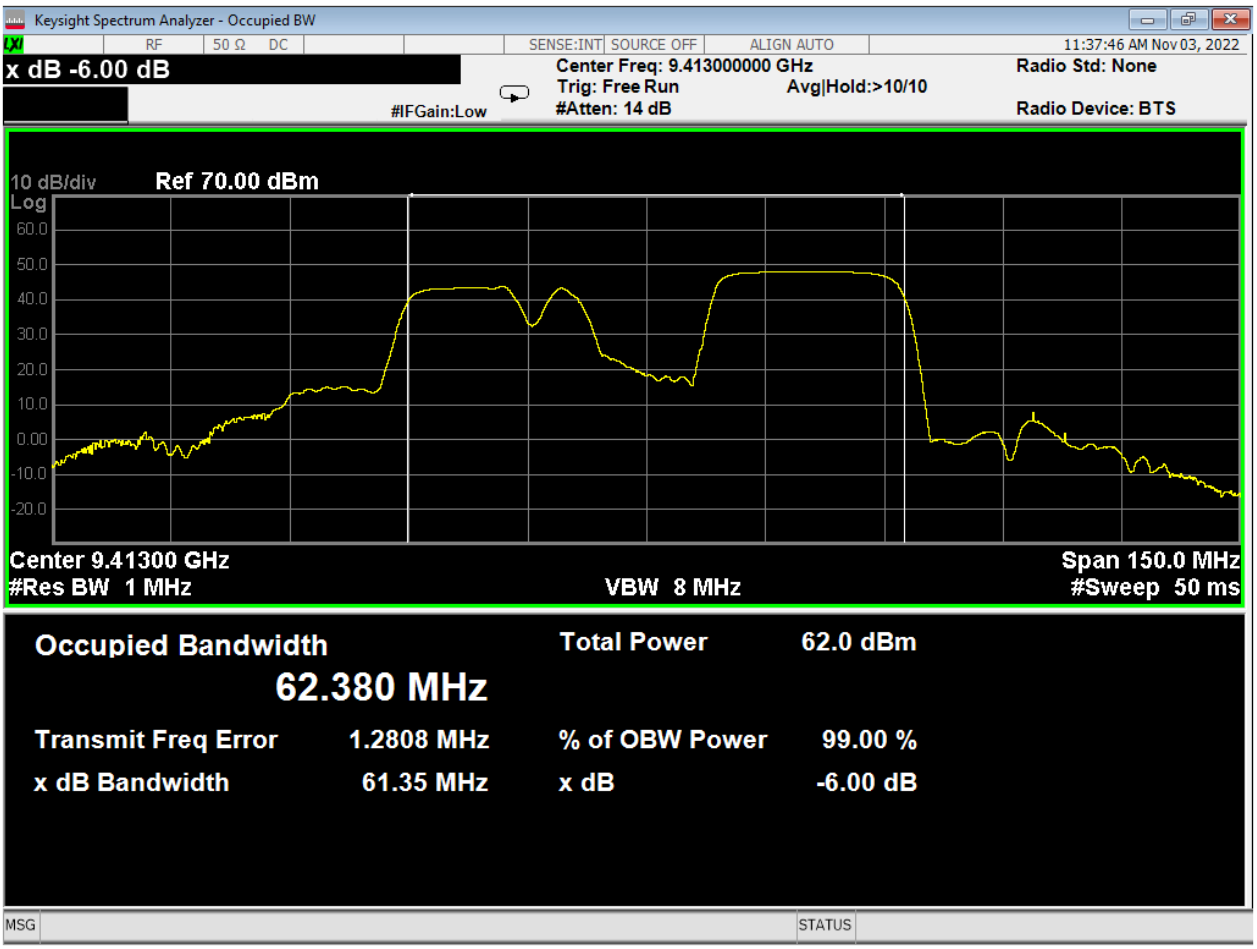

Figure 22 - 99% Occupied Bandwidth, Mode B

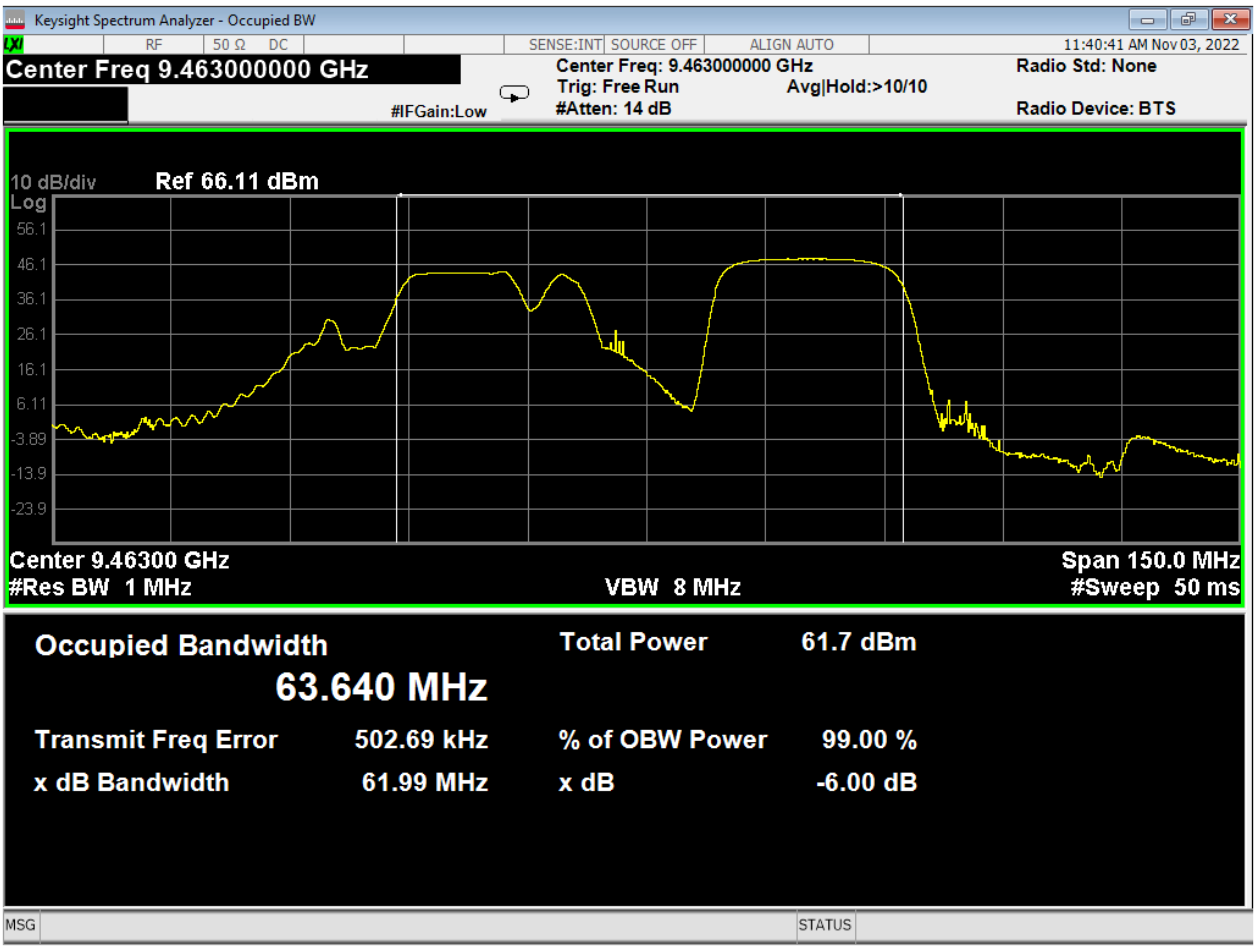

Figure 23 - 99% Occupied Bandwidth, Mode C

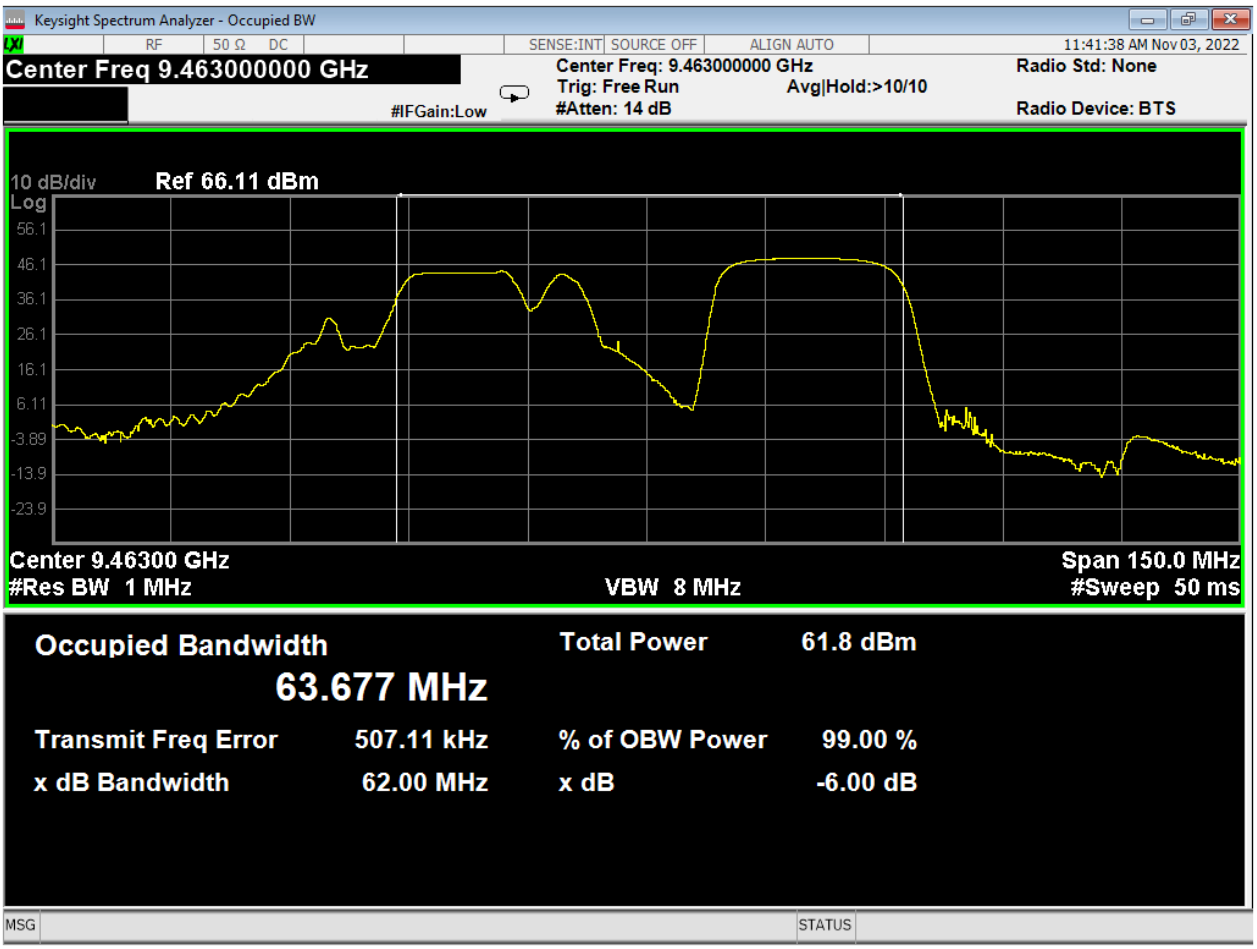

Figure 24 - 99% Occupied Bandwidth, Mode D

4.4 FREQUENCY STABILITY MEASUREMENTS

Test Method: ANSI C63.26,

1. Section(s) 5.6.3 “Procedures for frequency stability testing”

Limits:

47 CFR 80.209(b)

When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where “T” is the pulse duration in microseconds. In the band 14.00-14.05 GHz the center frequency must not vary more than 10 MHz from 14.025 GHz.

Test procedures:

Radiated power was measured on a spectrum analyzer with resolution bandwidth and video bandwidth set to 1 MHz and 8 MHz respectively. The frequency error functionality on the receiver was used. The temperature was varied from -30°C to +50°C.

Deviations from test standard:

No deviation

Test setup:

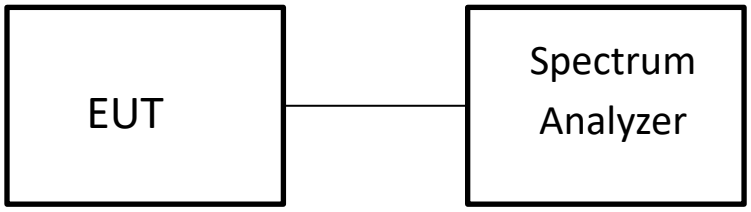

Figure 25 –Measurements Test Setup

EUT operating conditions:

See Section 2.1 & 2.2

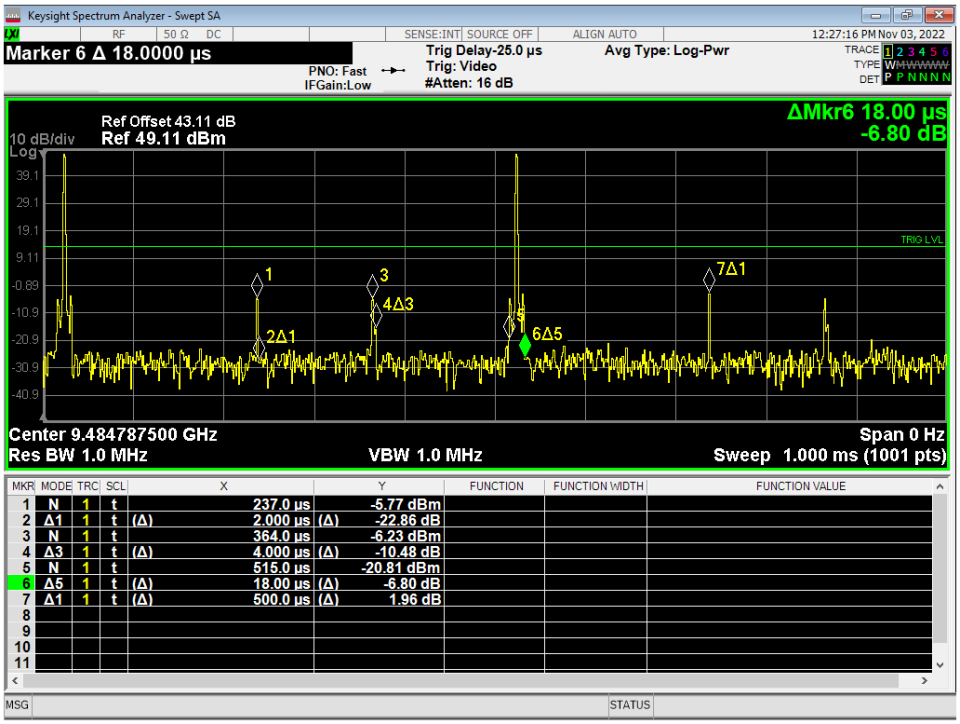

Figure 26 – Pulse length plot, shows shortest pulse length observed

T = pulse length (µs)
1.5/T = 1.5/2 = **0.75MHz**
from the edge of the authorized band

Authorized bandwidth (AB) = 120MHz
Worst case deviation (WCD) = 0.69619MHz.
Largest OBW = 63.677MHz
Lowest Channel = 9410MHz
Highest Channel = 9463MHz

Device's worst-case deviation:
9463MHz + ½*OBW + (WCD) = 9495.53469MHz
9410MHz – ½*OBW + (WCD) = 9378.85769MHz
+Authorized edge = 9523MHz
-Authorized edge = 9350MHz
Margin to +Authorized edge = 9523 – 9495.43469 = 27.46531MHz
Complies
Margin to -Authorized edge = 9377.46531Mz – 9350 = 28.85769MHz
Complies
See bandwidth for plots. The device complies with frequency deviation limits.

Test results: Worst case is reported. Complies

Reference Freq (MHz)			9463
Frequency error versus temperature and supply voltage			
Temperature (°C)	Frequency Error (MHz)	Error in ppm	limit ppm
50	0.64871	68.55	100
40	0.59426	62.80	100
30	0.56803	60.03	100
20	0.5407	57.14	100
10	0.51142	54.04	100
0	0.31888	33.70	100
-10	0.1388	14.67	100
-20	0.055903	5.91	100
-30	0.18238	19.27	100
85% of nominal voltage	0.53957	57.02	100
115% of nominal voltage	0.5379	56.84	100
Nominal voltage (28VDC)	0.5407	57.14	100

Frequency Stability, Temp/Voltage Variation

Reference Freq (MHz)		9463	
Cold Start from first ability to activate transmission (-30C)			
power on to ability to transmit due to software			3:23
Minutes after ability to Transmit	Frequency Error (kHz)	Error in ppm	limit ppm
0 Min(s)	0.69619	73.57	100
1 Min(s)	0.6936	73.30	100
2 Min(s)	0.652	68.90	100
3 Min(s)	0.6252	66.07	100
4 Min(s)	0.6004	63.45	100
5 Min(s)	0.5752	60.78	100

Frequency Stability, Start-Up Variation

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

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 the 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

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

REPORT END