



# H.B. Compliance Solutions

## Intentional Radiator Test Report

For the

**Raveon Technologies Corporation**

**RV-M6S-UC Radio Modem**

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 90 for

Private Land Mobile Radio Services

February 19, 2021

**Prepared for:**

Raveon Technologies Corporation

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Vista, CA 92081

**Prepared By:**

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Tempe, Arizona 85282

**Reviewed By:**

A handwritten signature in black ink, appearing to read 'Hoosamuddin Bandukwala'.

Hoosamuddin Bandukwala



Cert # ATL-0062-E

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 90 of the FCC Rules under normal use and maintenance. All results contained herein relate only to the sample tested.

## Report Status Sheet

Revision #	Report Date	Reason for Revision
∅	February 19, 2021	Initial Issue

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## EXECUTIVE SUMMARY

### 1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 90. All tests were conducted using measurement procedure from ANSI TIA/EIA-603-D-2010 and ANSI C63.26-2015 Procedures for Compliance Testing of Transmitters Used in Licensed Radio Services as appropriate.

Test Name	Test Method/Standard	Result	Comments
RF Output Power	2.1046; 90.205	Pass	
Modulation Characteristics	2.1047(a)	Pass	The EUT does not transmit voice. The device transmits data signal only
Occupied Bandwidth	2.1049; 90.210	Pass	EUT Meets Mask C, D & E
Spurious Emissions at Antenna Terminals	2.1051; 90.210	Pass	
Radiated Spurious Emissions	2.1053; 90.210	Pass	
Frequency Stability over Temperature Variations	2.1055(a)(1); 90.213	Pass	
Frequency Stability over Voltage Variations	2.1055(d)	Pass	
Transient Frequency Behavior	90.214	Pass	

## EQUIPMENT CONFIGURATION

### 1. Overview

H.B Compliance Solutions was contracted by Raveon Technologies to perform testing on the Radio Modem RV-M6S-UC under the purchase order number 16370.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Raveon Technologies, Radio Modem RV-M6S-UC.

The tests were based on FCC Part 90 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Raveon Technologies should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

<b>Product Name:</b>	Radio Modem
<b>Model(s) Tested:</b>	RV-M6S-UC
<b>FCC ID:</b>	SRS-M6S-UC
<b>Supply Voltage Input:</b>	Primary Power: 6-34 V DC
<b>Frequency Range:</b>	450MHz to 480MHz
<b>No. of Channels:</b>	Single Channel
<b>Necessary Bandwidth</b>	6.25 kHz / 12.5 kHz / 25kHz
<b>Type(s) of Modulation:</b>	4-Level FSK / 2-Level FSK
<b>Range of Operation Power:</b>	2.0W
<b>Voltage into final Transistor</b>	8 volts
<b>Current into final Transistor</b>	1.5 amps
<b>Emission Designator:</b>	4K0F1D / 11k0F1D / 15K0F1D
<b>Channel Spacing(s)</b>	None
<b>Test Item:</b>	Pre-Production
<b>Type of Equipment:</b>	Fixed
<b>Antenna:</b>	50-ohm TNC Connector
<b>Environmental Test Conditions:</b>	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
<b>Modification to the EUT:</b>	None
<b>Evaluated By:</b>	Staff at H.B. Compliance Solutions
<b>Test Date(s):</b>	01/12/2021 till 02/02/2021

## 2. Test Facility

All testing was performed at H.B. Compliance Solutions. This facility is located at 5005 S. Ash Avenue, Suite # A-10, Tempe AZ-85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements from 30MHz to 1GHz were performed in a GTEM chamber (equivalent to an Open Area Test Site). Radiated Emission above 1GHz were performed on an Open Area Test Site (OATS). In accordance with §2.948(a)(3), a complete site description is contained at H.B. Compliance Solutions.

Test facility H.B. Compliance Solutions is an ANAB accredited test site. The ANAB certificate number is L2458. The scope of accreditation can be found on ANAB website [www.anab.org](http://www.anab.org)



### 3. Description of Test Sample

The Raveon Technologies, RV-M6S-UC is a RF radio modem capable of high-speed narrow-band data communications. Its microprocessor enables it to perform as both a data radio modem and a paging receiver. It contains a receiver, a transmitter, and modem, creating an easy-to-use transparent data radio link.

### 4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Radio Modem	RV-M6S-UC	N/A

Table 1. Equipment Configuration

### 5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
#2	Universal Module Evaluation Kit	Raveon	5A689B	94V-03616
#3	Laptop Computer	Dell	Inspiron 1545	88LSZJ1

Table 2. Support Equipment

### 6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
#4	#2 Serial	Serial to USB A	1	0.5	N	#3
#5	#2 DC	DC Power leads	1	1	N	12V Power Supply

Table 3. Ports and Cabling Information

## **7. Method of Monitoring EUT Operation**

A test receiver will be used to monitor the data transmission from the EUT.

## **8. Mode of Operation**

The EUT will be configured to transmit at maximum power level. Test mode was provided to select the lower, middle and upper band of the transmitter by customer provided software. This software programmed the transmitter from three frequencies modulated and the other three in CW mode. These settings were created for testing purpose only.

## **9. Modifications**

### **9.1 Modifications to EUT**

No modifications were made to the EUT

### **9.2 Modifications to Test Standard**

No Modifications were made to the test standard.

## **10. Disposition of EUT**

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Raveon Technologies upon completion of testing & certification.



## Criteria for Intentional Radiators

### 1. RF Power Output

<b>Test Requirement(s):</b>	§2.1046 and §90.215	<b>Test Engineer(s):</b>	Sean E.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/12/2021

**Test Procedures:** As required by 47 CFR 2.1046, RF Power output measurements were made at the RF output terminals of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer capable of making power measurements. Measurements were made at the low, mid, and high channels of the entire frequency band.

Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)
451	33.72	2.35
465	33.53	2.25
479	33.28	2.13

Table 4. RF Power Output, Test Results

**Test Setup:**

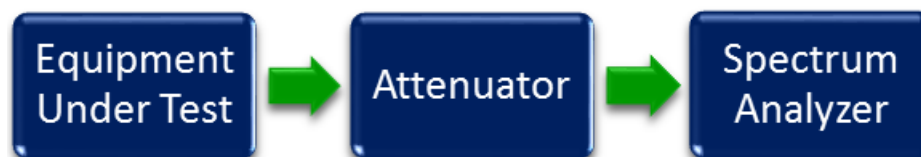
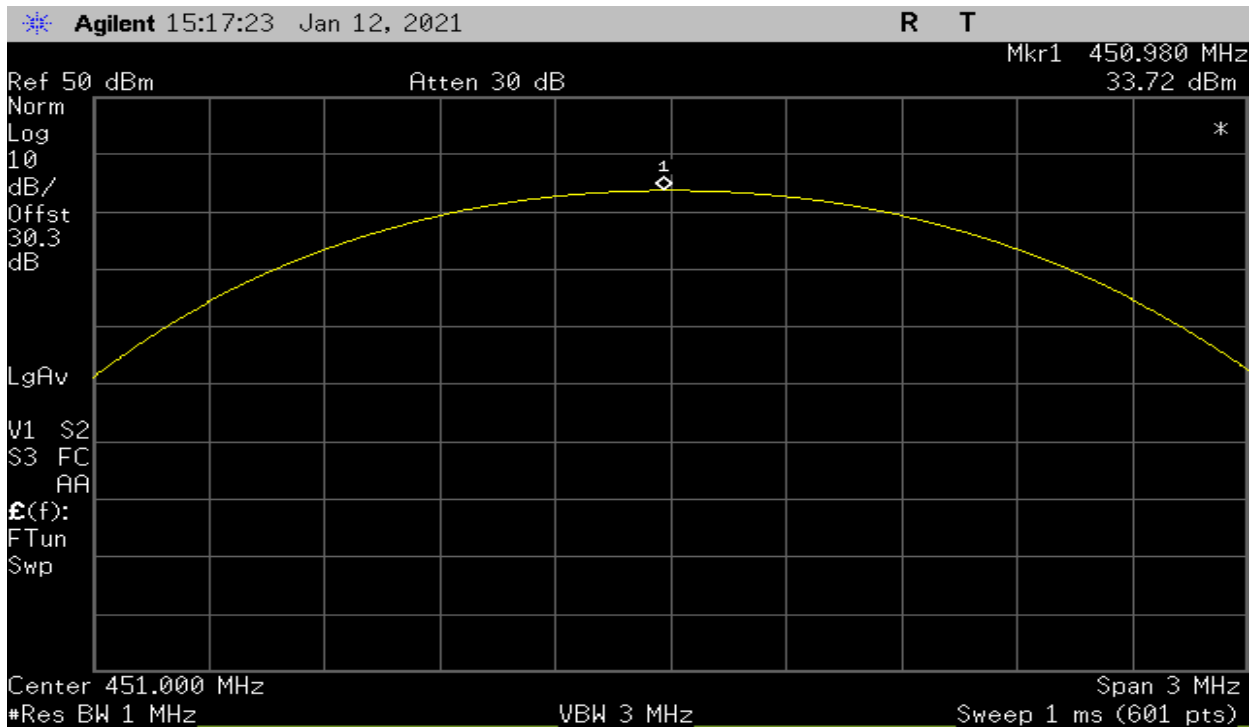
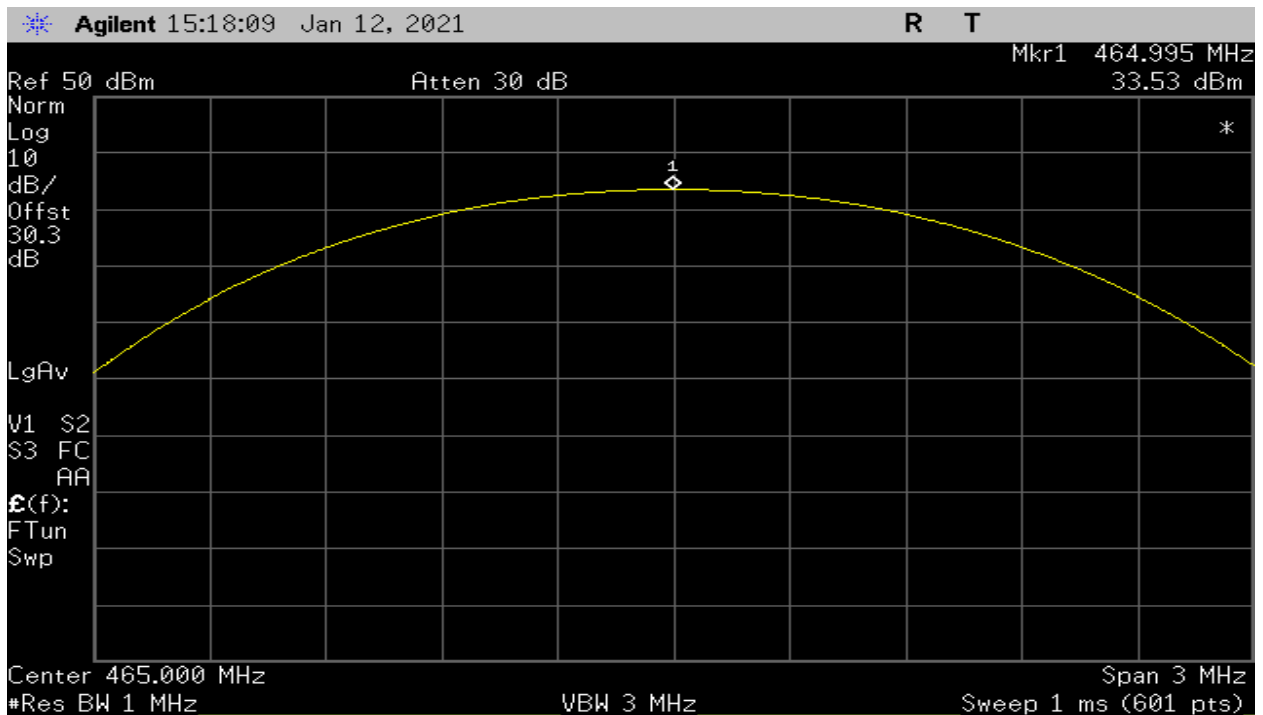


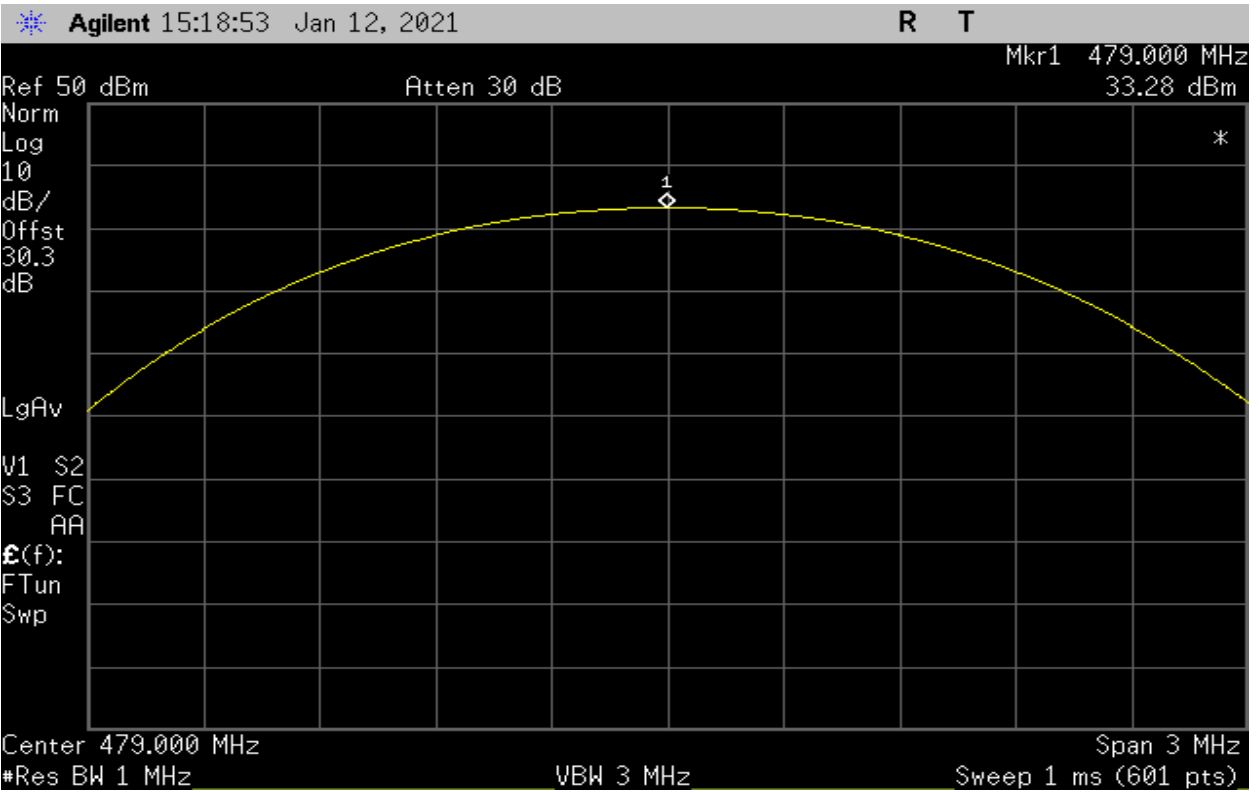
Figure 1 Output RF power Test Setup



**Plot 1 – Output Power – Low**



**Plot 2 – Output Power – Mid**



**Plot 3 – Output Power – High**

## 2. Modulation Characteristics

<b>Test Requirement(s):</b>	2.1047 and §90.207	<b>Test Engineer(s):</b>	Sean E.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/15/2021

**Test Procedure:** As required by 47 CFR 2.1047, Modulation characteristics measurements were made at the RF output terminals of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer.

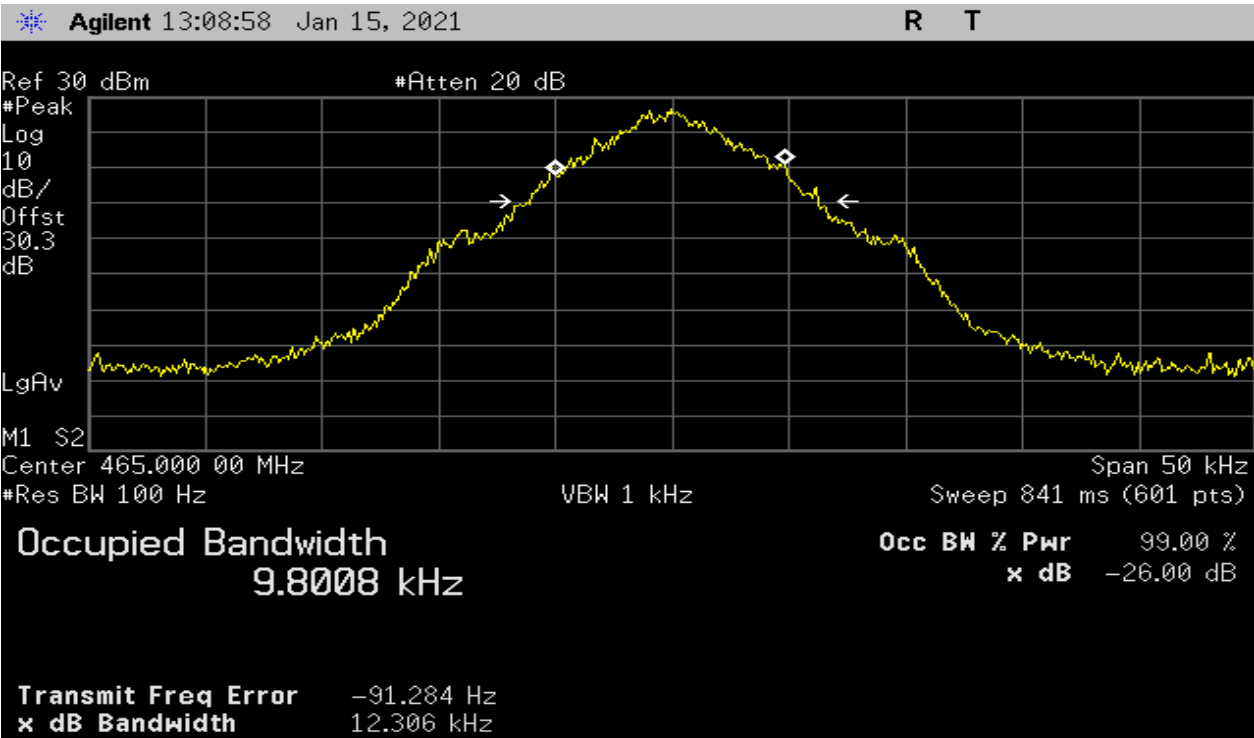
As per standard a curve or equivalent data of the EUT is shown

The plot(s) of the modulation characteristic is presented hereinafter as reference.

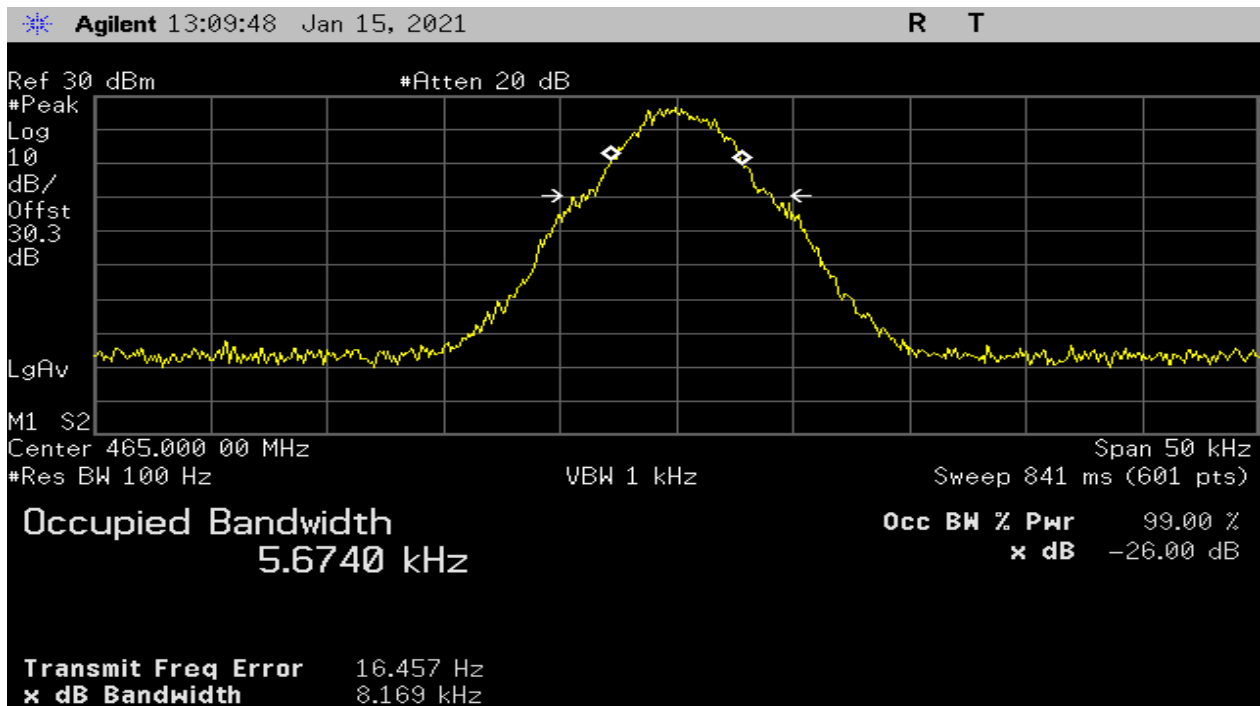
### Test Setup:



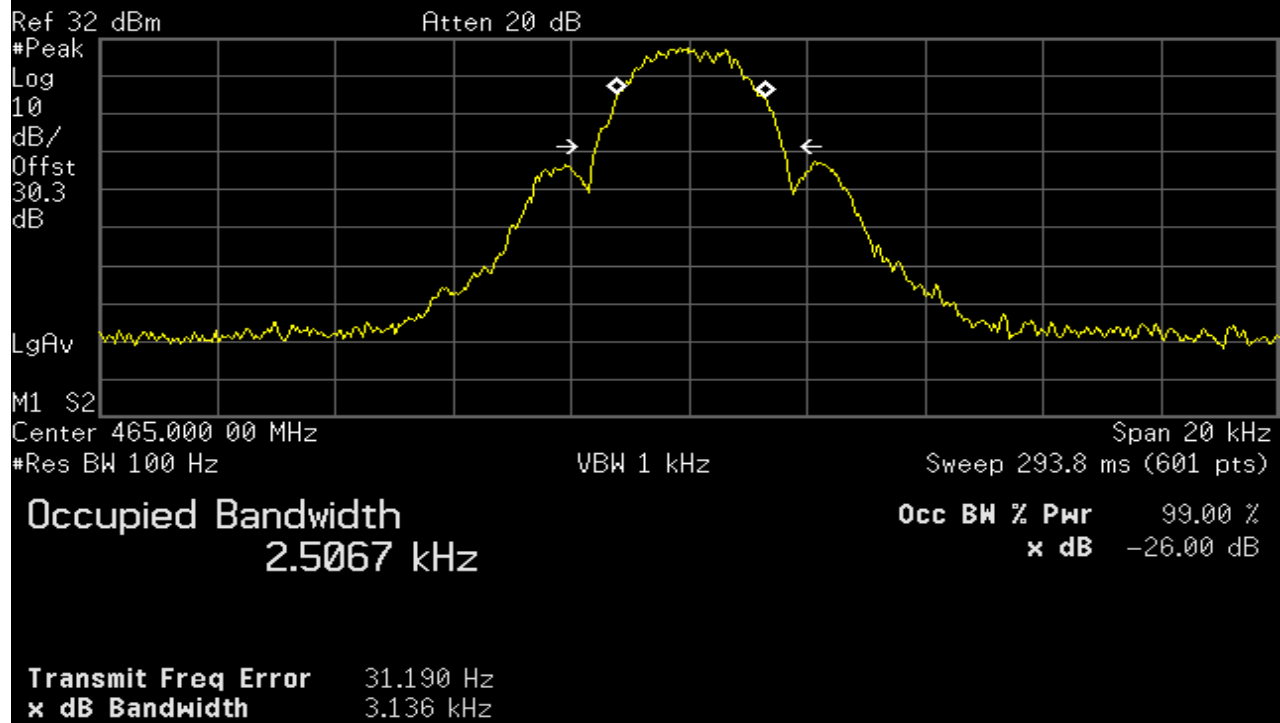
**Figure 2: Modulation Characteristics Bandwidth Test Setup**



Plot 4 – 25 kHz Wide Band



Plot 5 – 12.5 kHz Narrow Band



Plot 6 – 6.26 kHz Narrow Band (2.4kHz Bit Rate)

### 3. Occupied Bandwidth (Emission Mask)

<b>Test Requirement(s):</b>	2.1049 and §90.210 with FCC (Emission Masks C, D & E)	<b>Test Engineer(s):</b>	Keith T. Sean E.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/15/2021

**Test Procedure:** As required by 47 CFR 2.1049, occupied bandwidth measurements were made at the output terminals of the EUT.

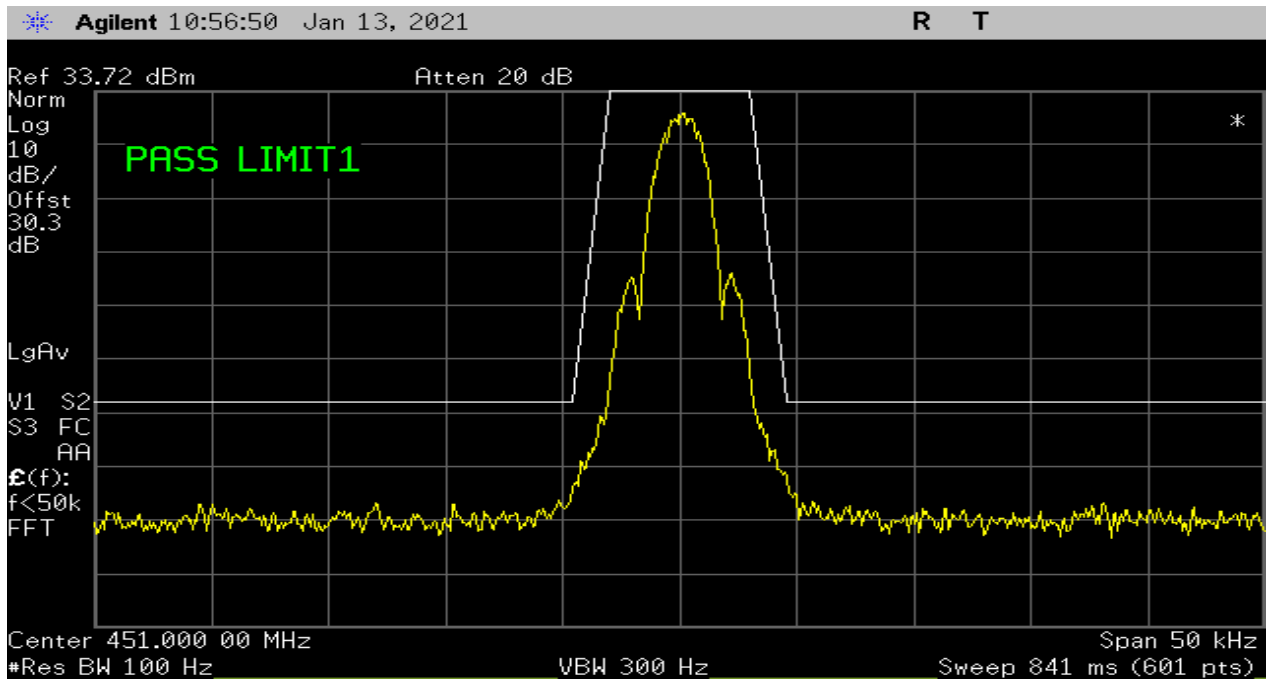
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to at least 1% of the channel bandwidth. Measurements were carried out at the low, mid and high channels of the TX band.

**Test Setup:**

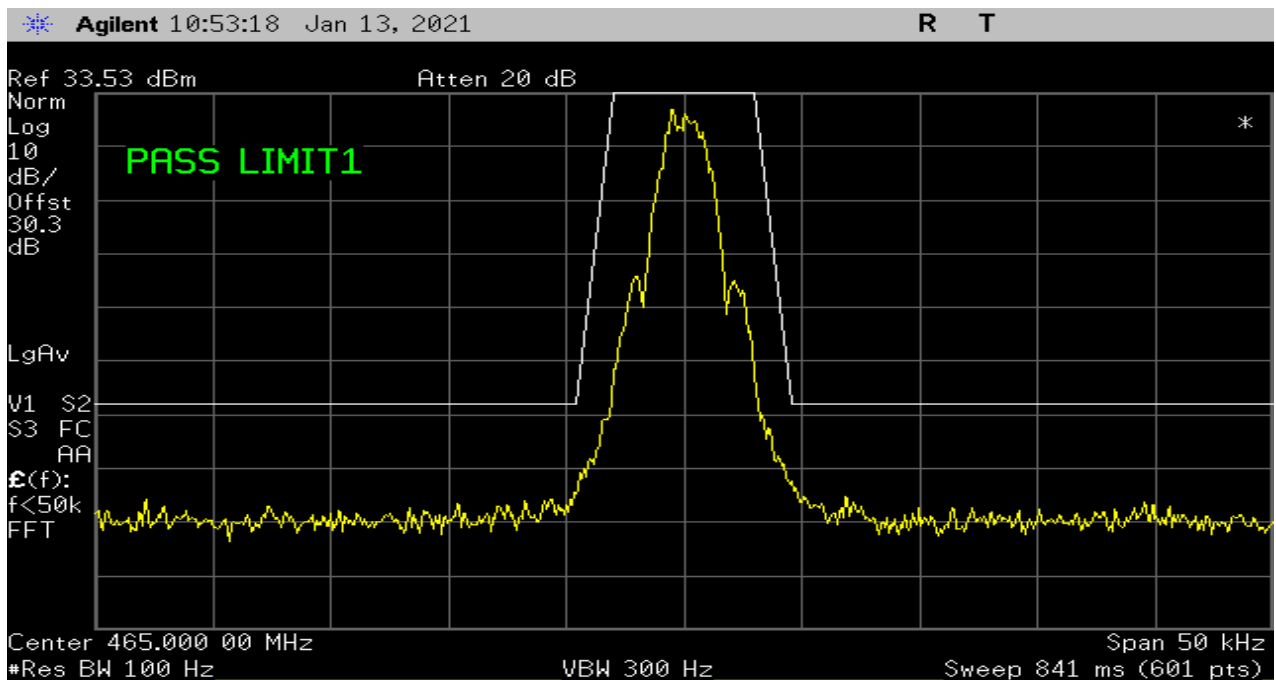


**Figure 3: Occupied Bandwidth Test Setup**

The following pages show measurements of Emission Mask plots:

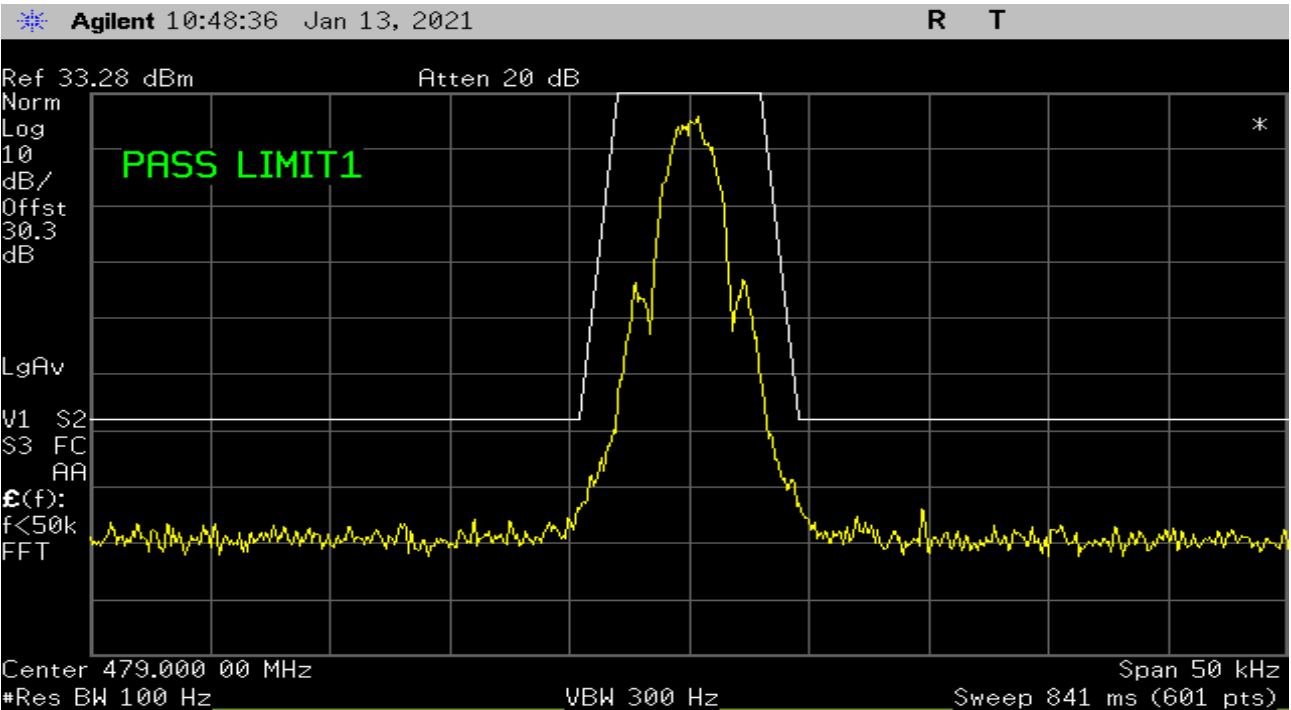


Plot 7 – Low Channel 6.25 kHz Spacing (2.4kbps bit rate) – Mask E

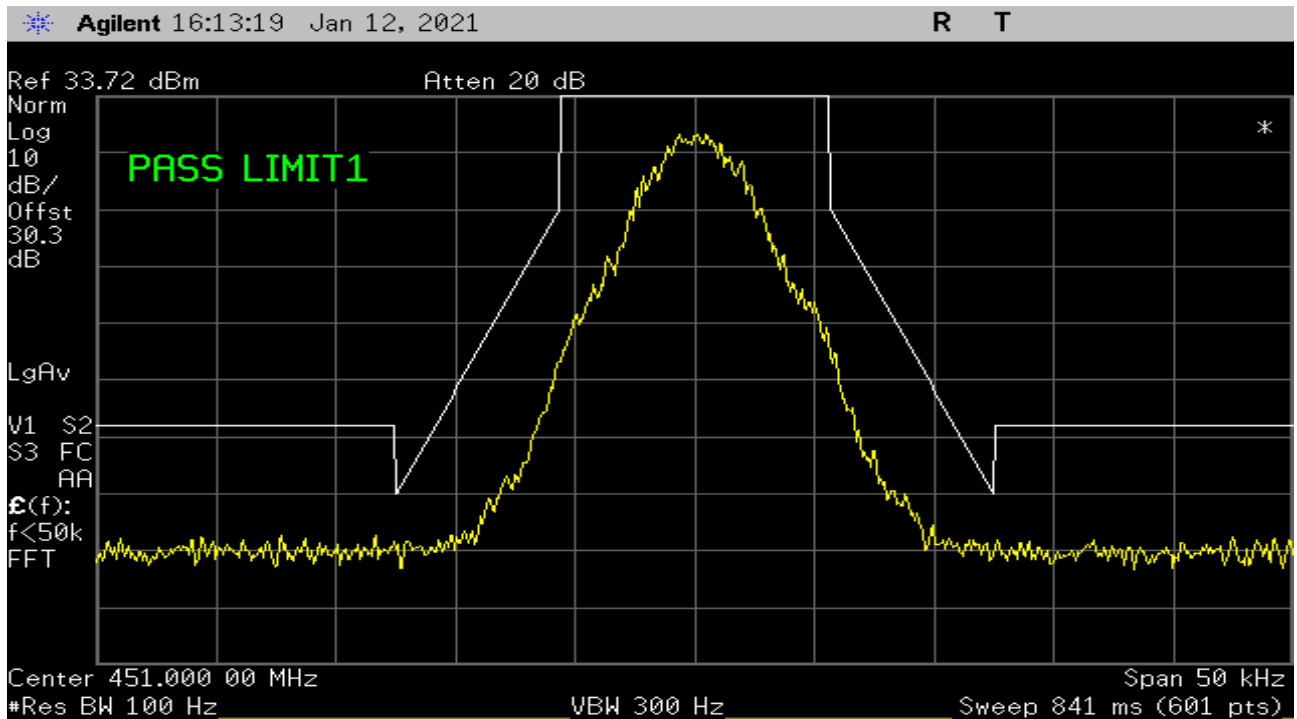


Plot 8 – Mid Channel 6.25 kHz Spacing (2.4kbps bit rate) – Mask E

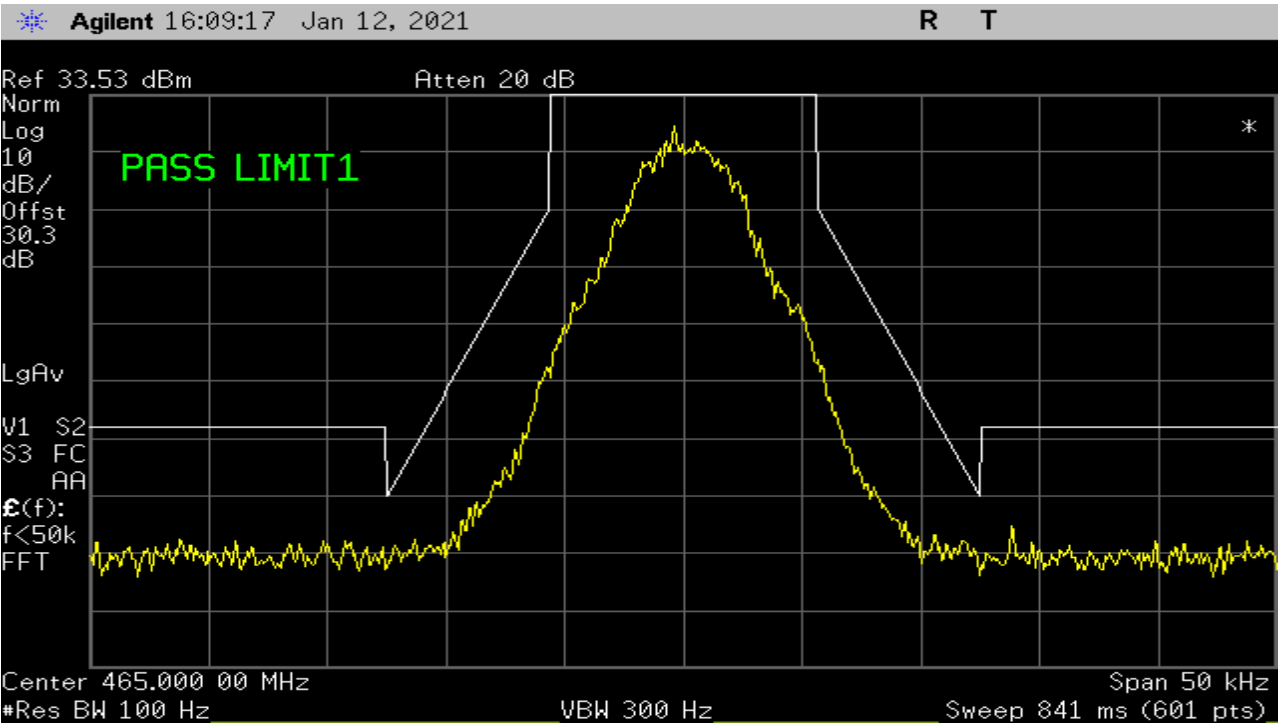




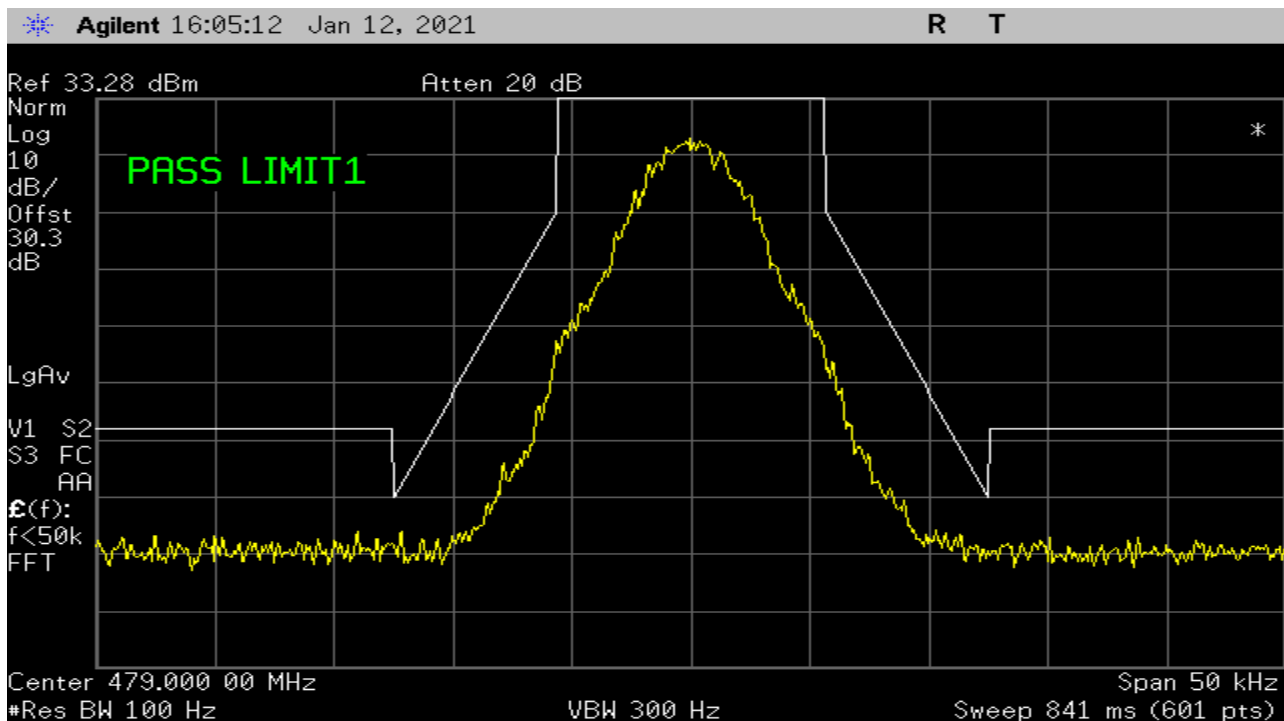
Plot 9 – High Channel 6.25 kHz Spacing (2.4kbps bit rate) – Mask E



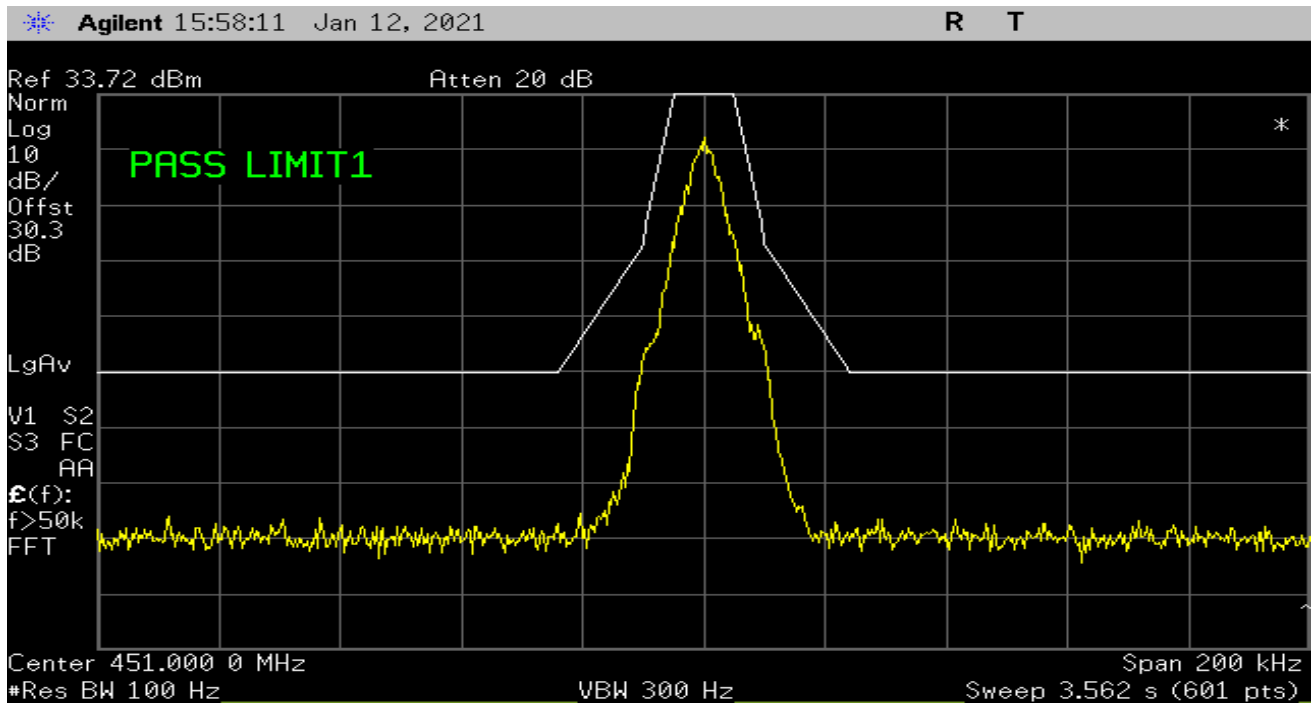
Plot 10 – Low Channel 12.5 kHz Spacing – Mask D



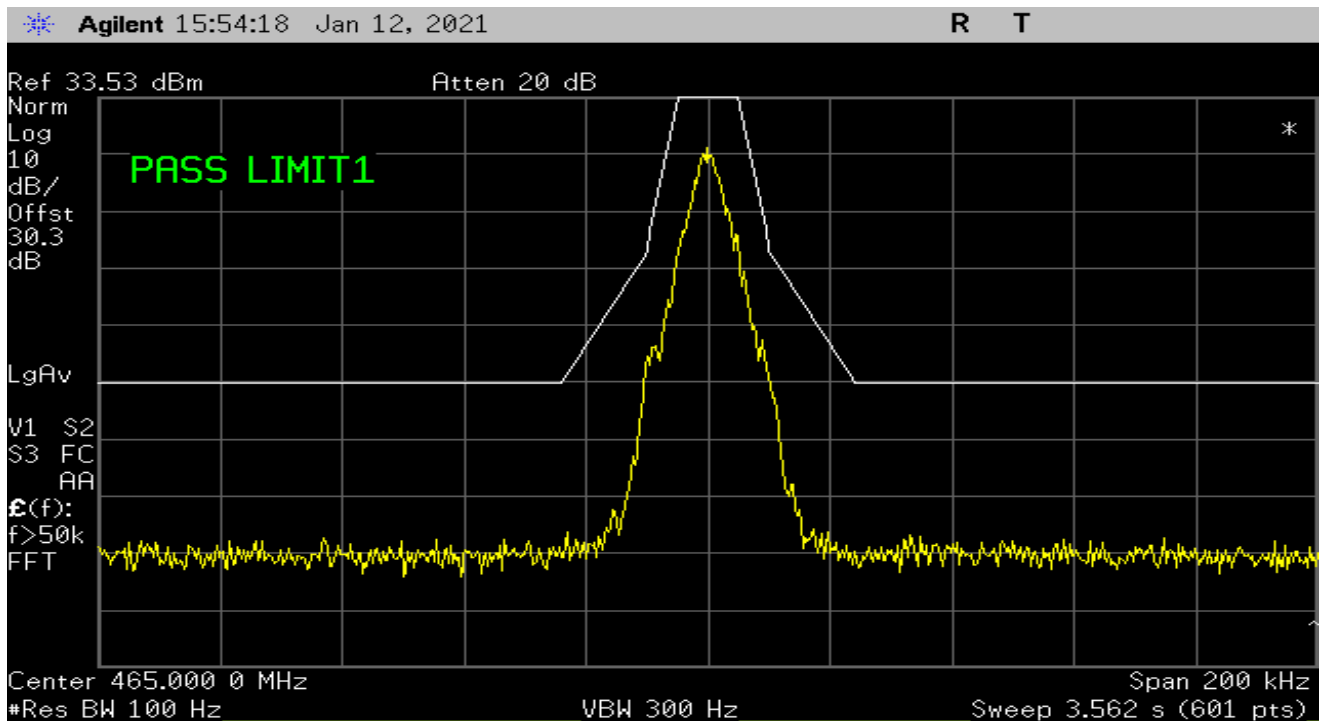
Plot 11 – Mid Channel 12.5 kHz Spacing – Mask D



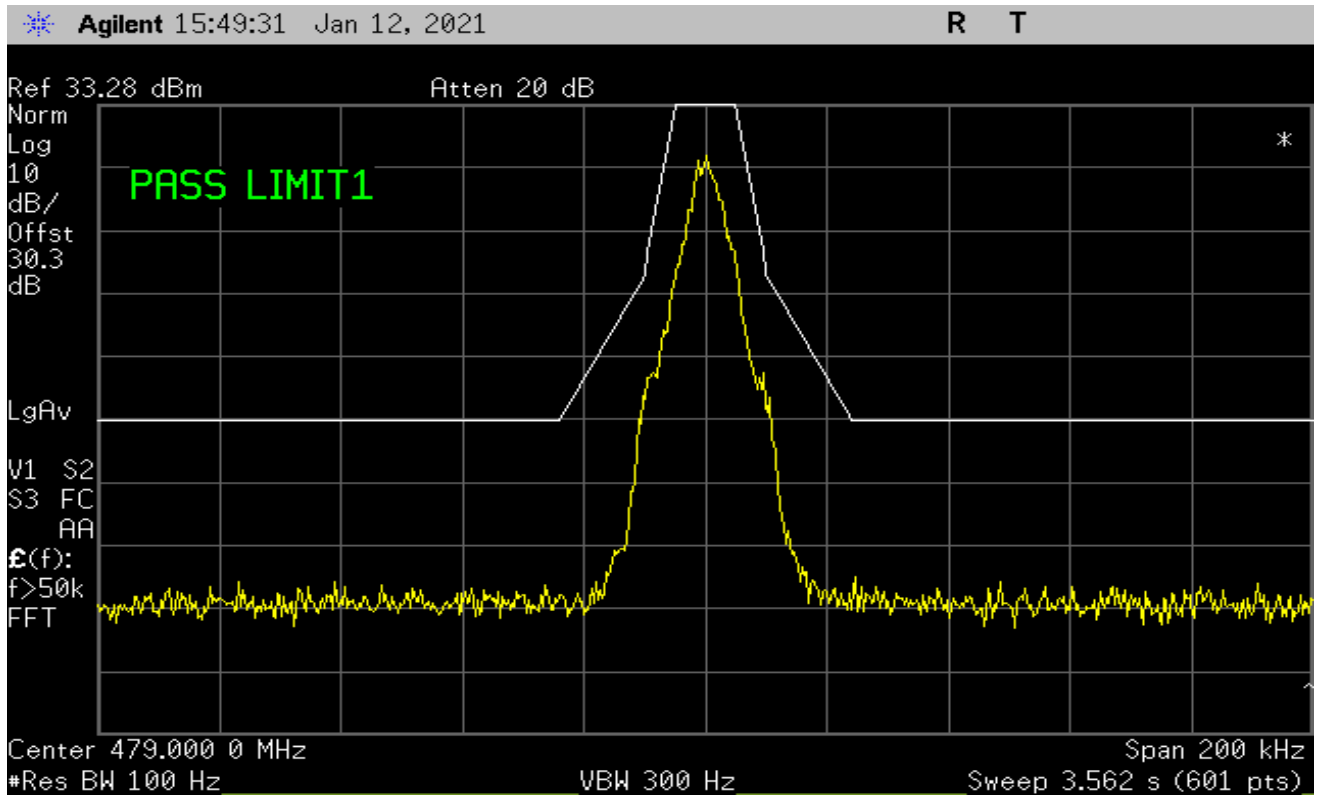
Plot 12 – High Channel 12.5 kHz Spacing – Mask D



Plot 13 – Low Channel 25 kHz Spacing – Mask C



Plot 14 – Mid Channel 25 kHz Spacing – Mask C



Plot 15 – High Channel 25 kHz Spacing – Mask C

#### 4. Spurious Emissions at Antenna Terminals

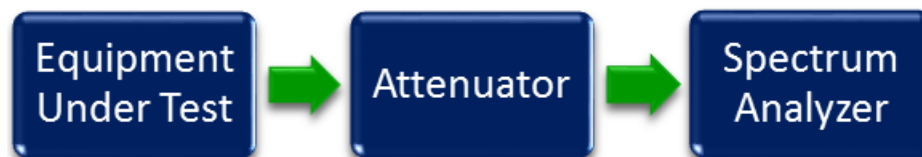
<b>Test Requirement(s):</b>	§2.1051 and 90.210(m)	<b>Test Engineer(s):</b>	Sean E.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/15/2021

**Test Procedures:**

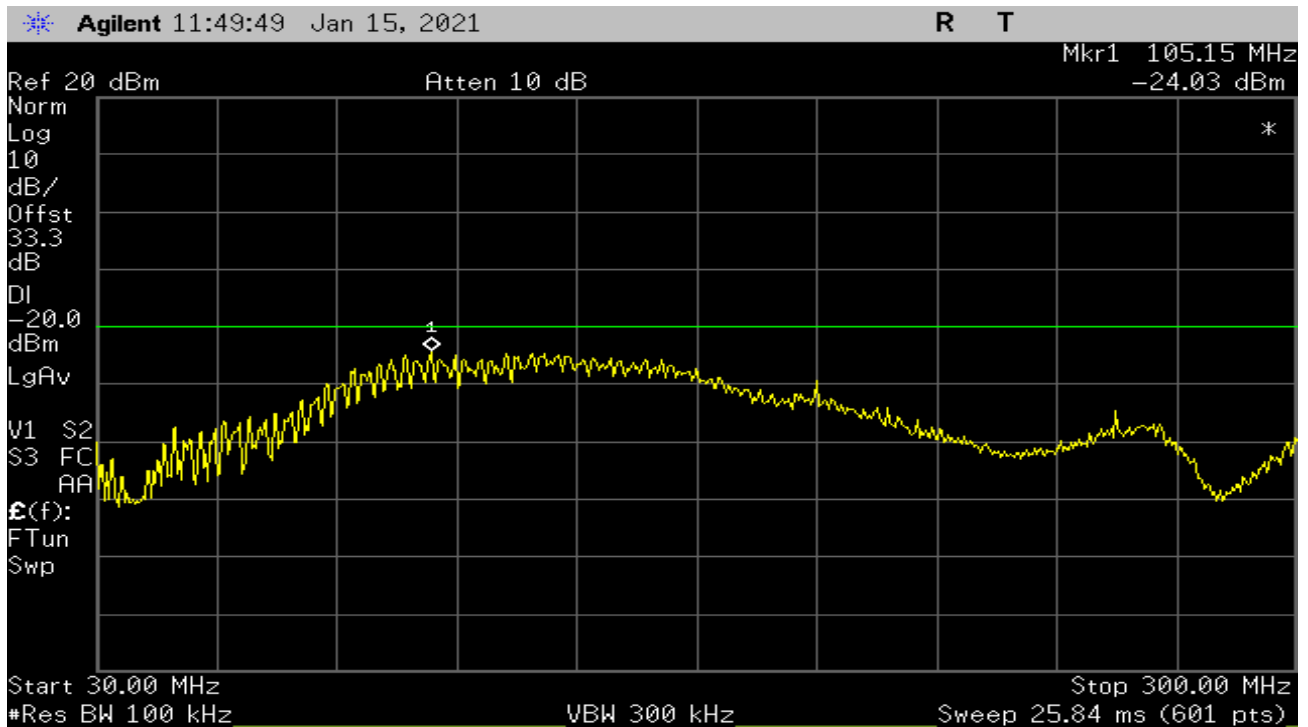
As required by 47 CFR 2.1051, spurious emissions at antenna terminal measurements were made at the RF output antenna terminal of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The Spectrum Analyzer was set to sweep from 30MHz up to 10<sup>th</sup> harmonic of the fundamental or 40GHz whichever is the lesser. Measurements were made at the low, mid and high frequency of the transmit band.

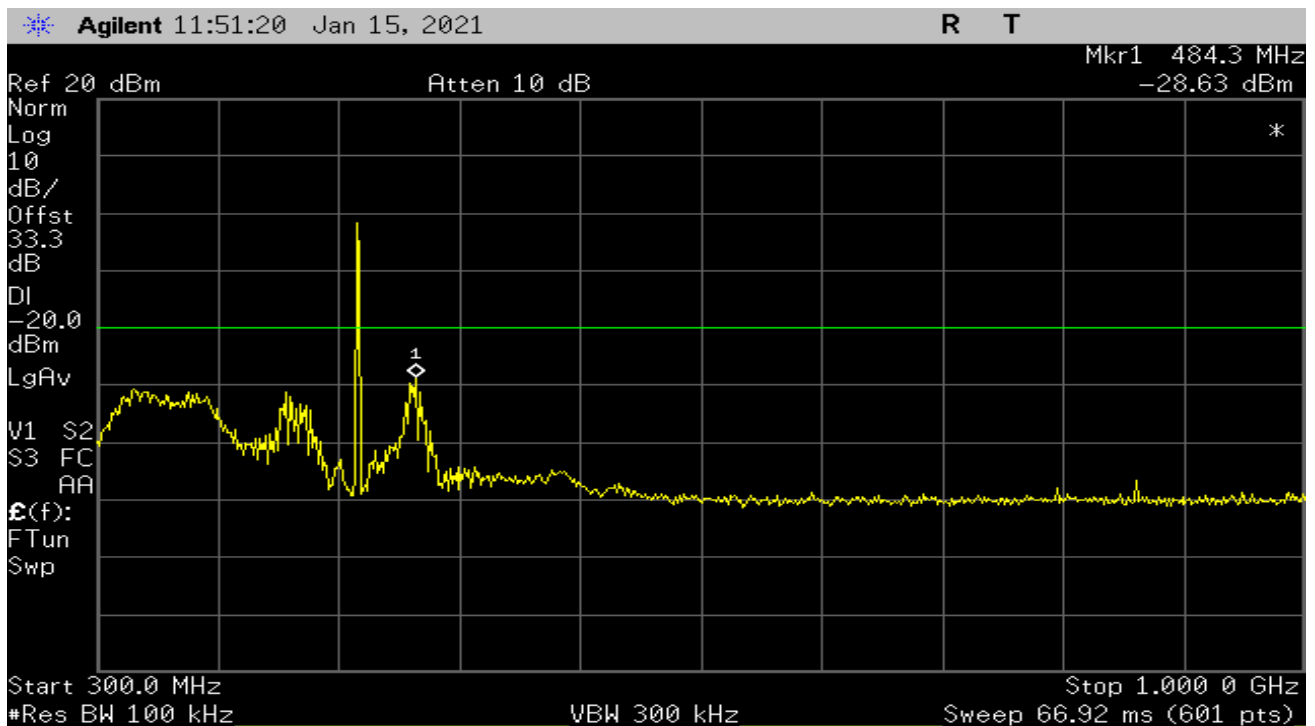
**Test Setup:**



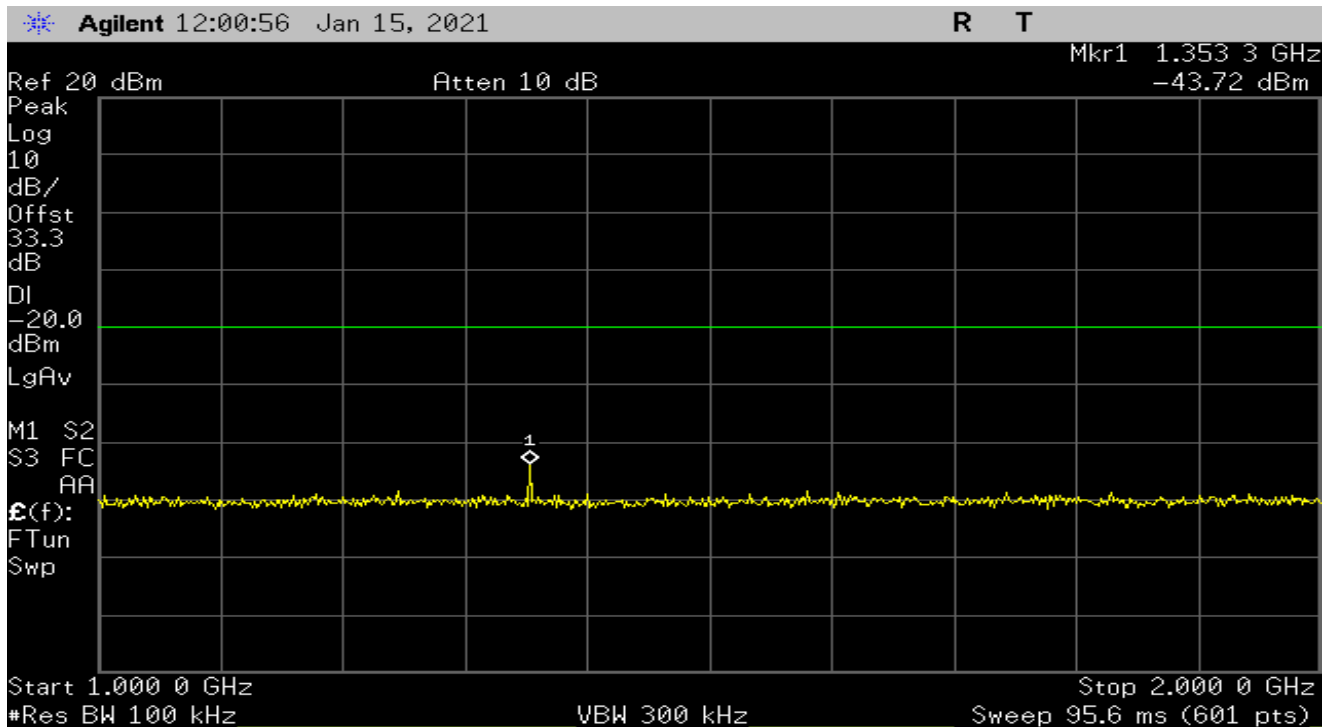
**Figure 4: Spurious Emission at Antenna Terminal Test setup**



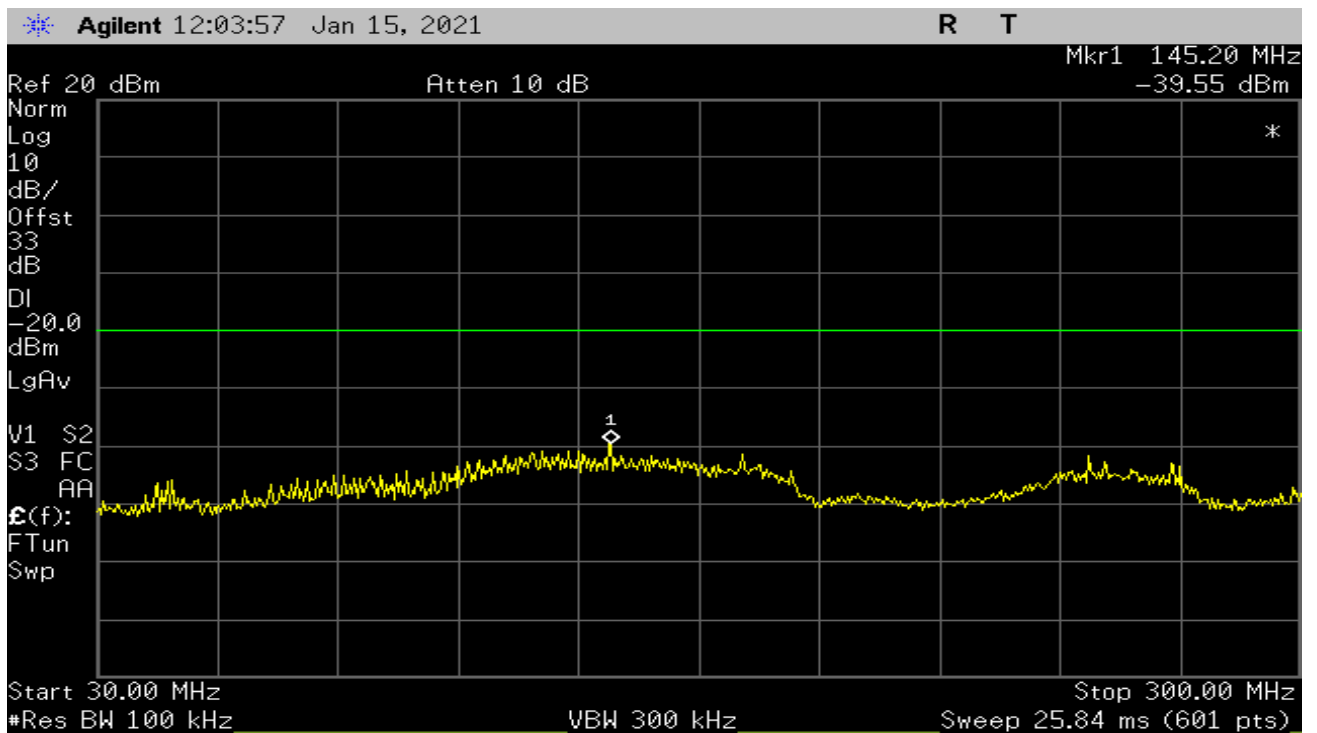
**Plot 16 – Low Band**



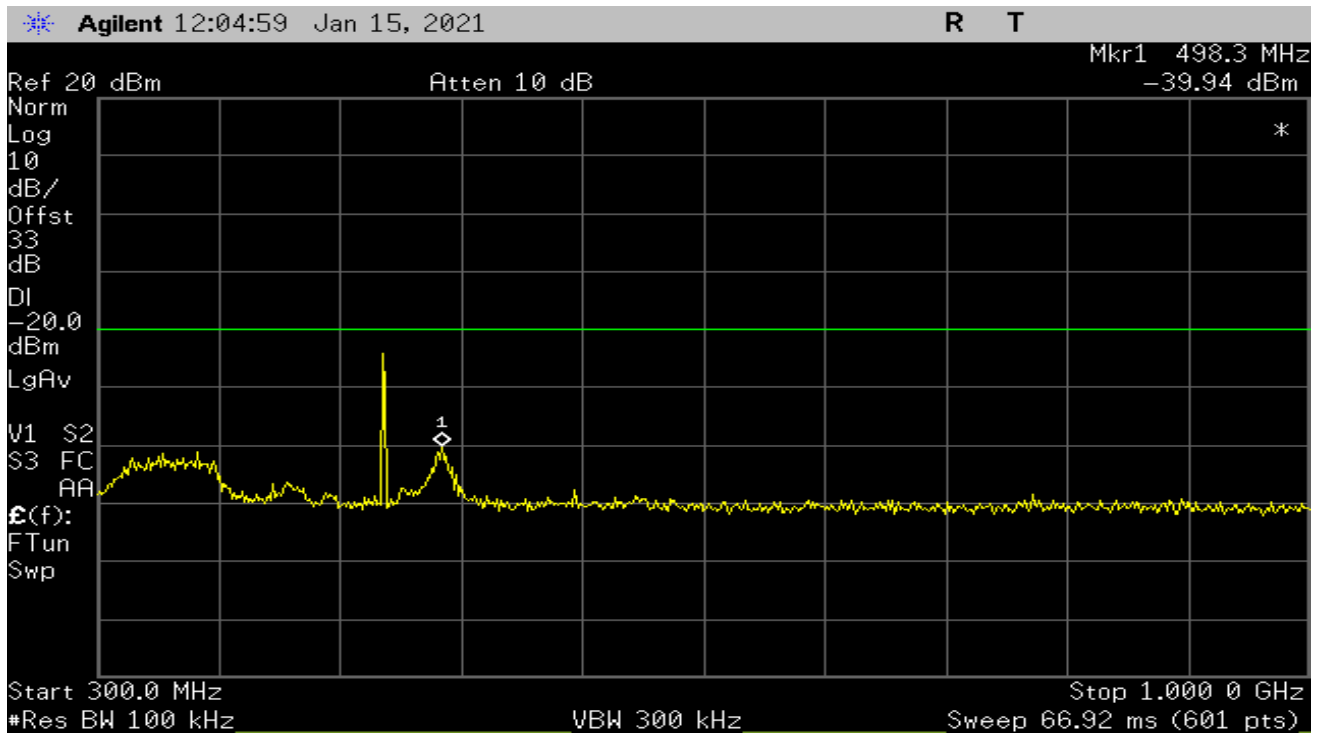
**Plot 17 – Low Band**



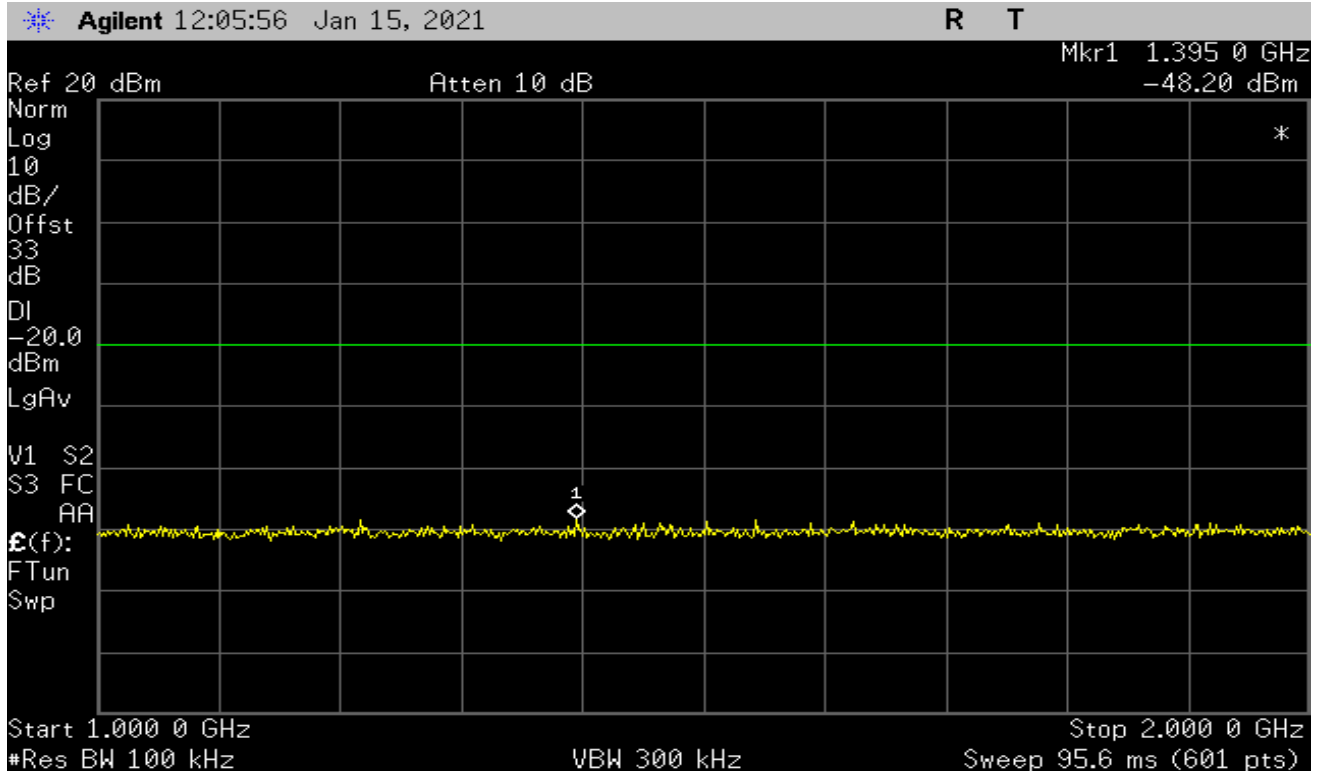
**Plot 18 – Low Band**



**Plot 19 – Mid Band**

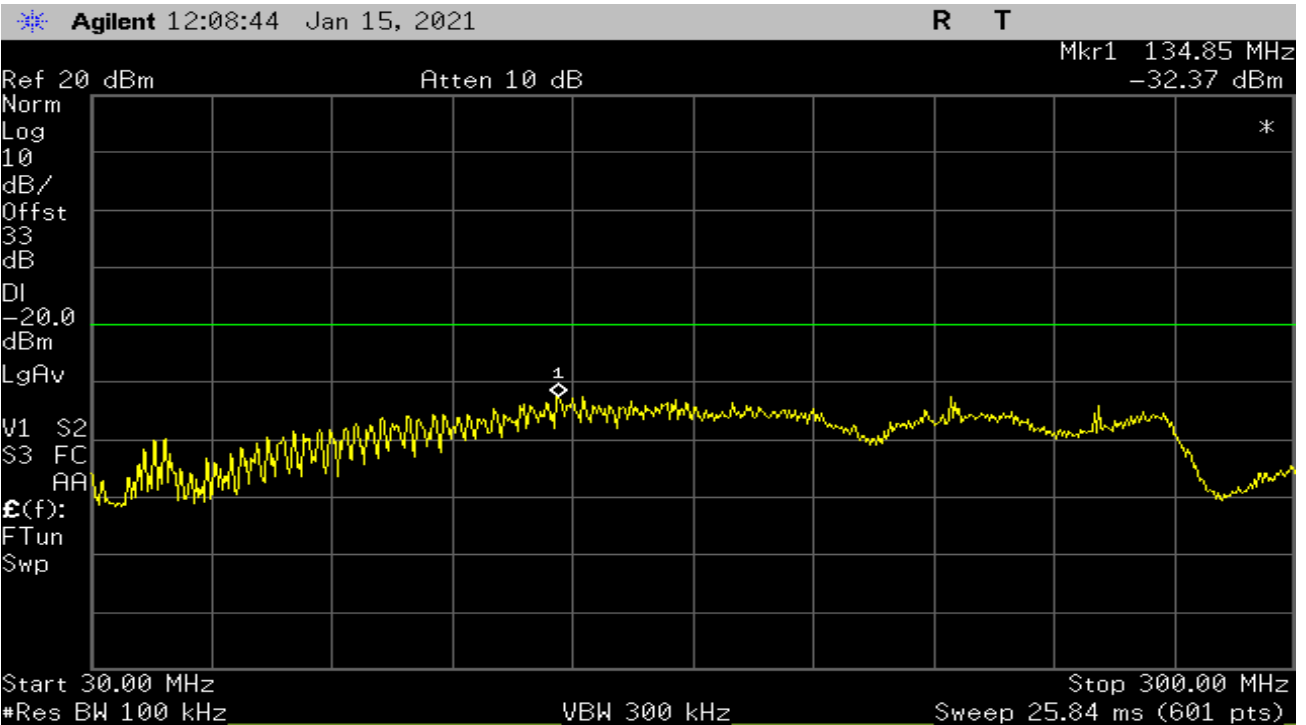


**Plot 20 – Mid Band**

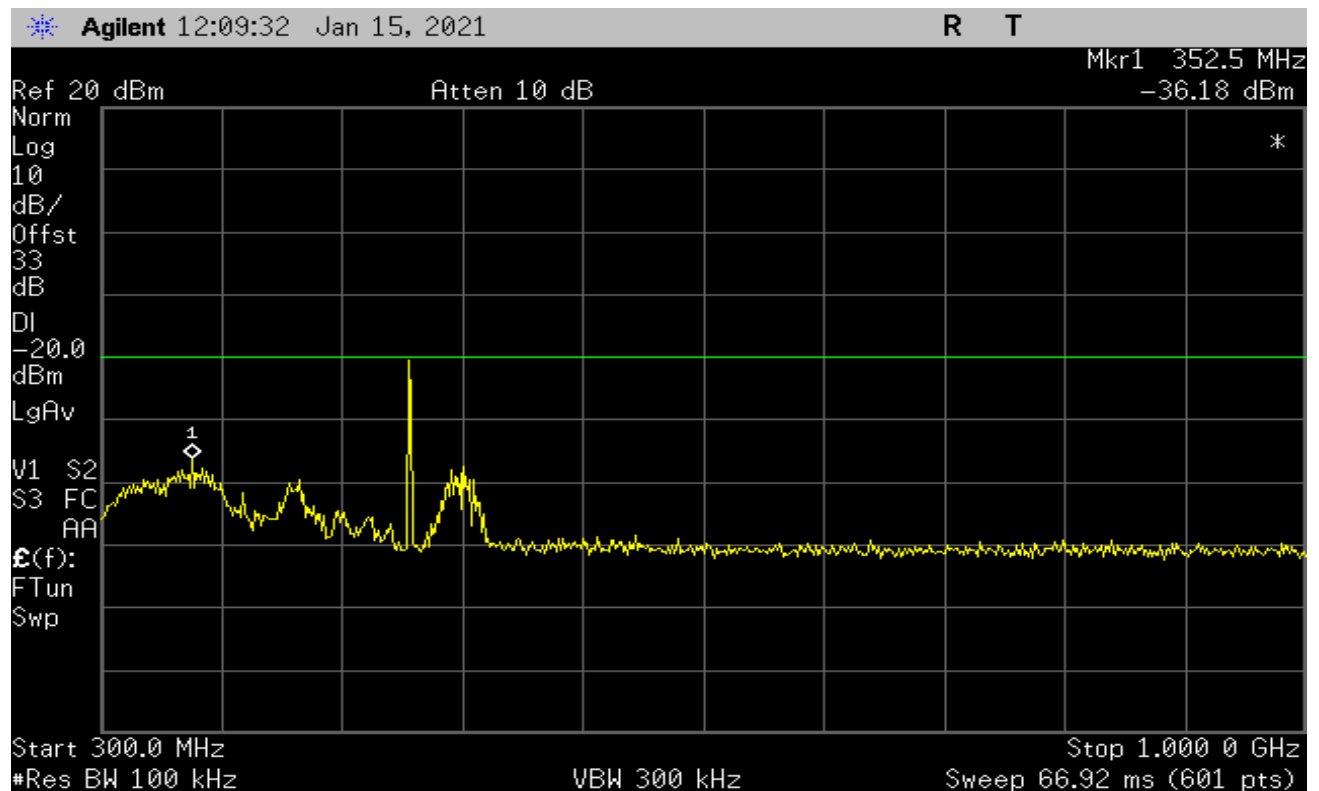


**Plot 21 – Mid Band**

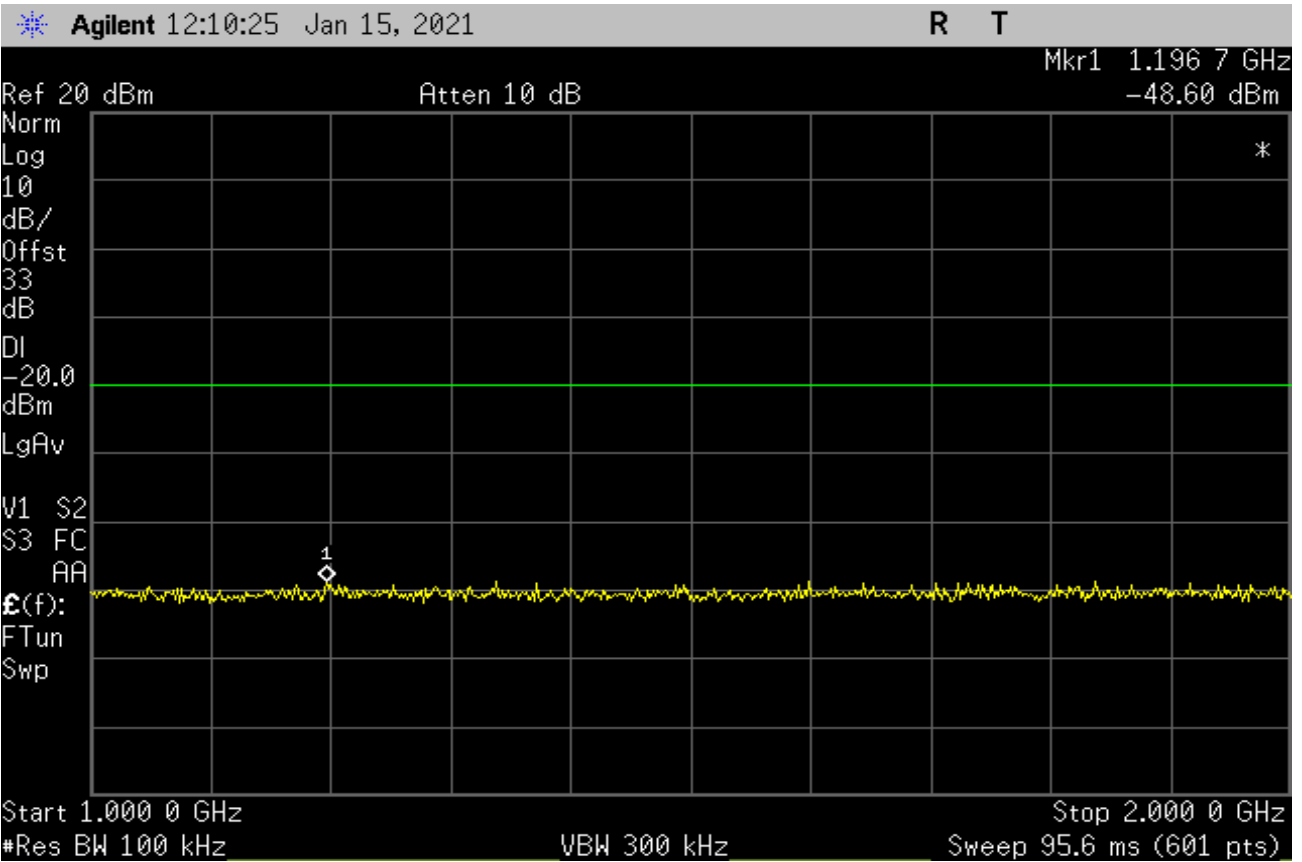




**Plot 22 – High Band**



**Plot 23 – High Band**



**Plot 24 – High Band**

## 5. Radiated Spurious Emissions

<b>Test Requirement(s):</b>	§2.1053 and 90.210	<b>Test Engineer(s):</b>	Sean E.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/19/2021

**Test Procedures:** As required by 47 CFR 2.1053, field strength of radiated spurious measurements were made in accordance with the procedures of the ANSI C63.26-2015.

The EUT was placed on a non-reflective table inside a 3-meter Alternate Test Site. The EUT was transmitting into a non-radiating load which was directly connected to the EUT antenna port.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3 orthogonal axis. The frequency range up to the 10<sup>th</sup> harmonic was investigated.

To get a maximum emissions level from the EUT, the EUT was rotated throughout the X-axis, Y-axis and Z-Axis. Worst case is X-

<b>Detector Setting</b>	<b>Resolution Bandwidth</b>	<b>Video Bandwidth</b>	<b>Span</b>
Peak	1MHz	1MHz	As necessary
Average	1MHz	10Hz	0 Hz

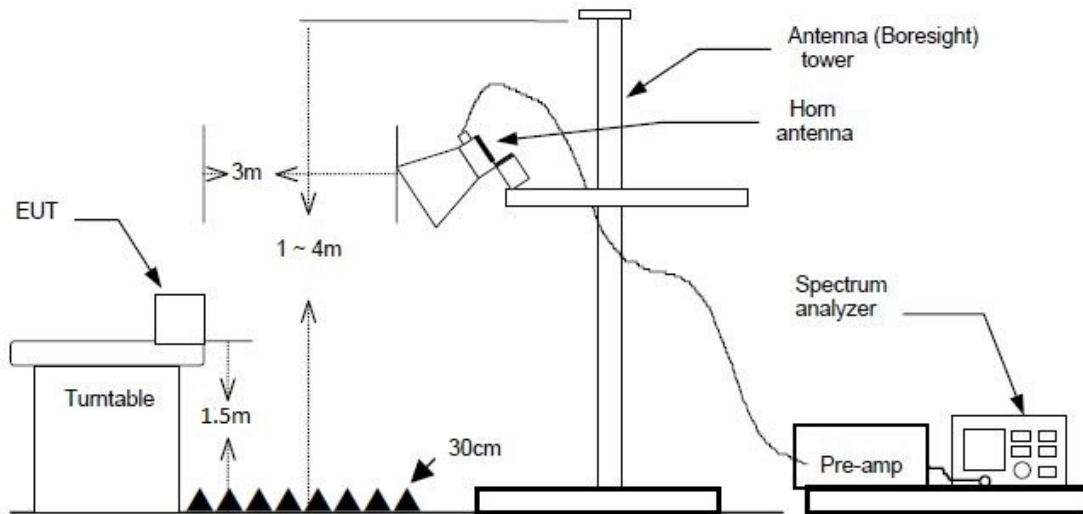
Table 5. Analyzer Settings

**Limit:** **For Emissions Mark C** – On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 +10 Log (P) dB

**For Emission Mask D** – On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 12.5kHz: At least 50 +10 Log (P) or 70dB, whichever is the lesser attenuation.

**For Emission Mask E** – On any frequency removed from the center of the authorized bandwidth by more than 4.6kHz: At least 55 +10 Log (P) or 65dB, whichever is the lesser attenuation.

**Test Setup:**



**Figure 5 – Radiated Spurious Emissions**

**Note:** E.I.R.P Limit = -20dBm which converts to 75.23dBuV/m @ 3meter

\*\* 82.23 dBuV/m is = -13 EIRP, we used -20 EIRP for 75.23 dBuV/m @ 3m

**Test Results:**

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	FCC Peak Limit (dBuV/m)	Peak Margin (dB)
902	51.223	75.23	-24.007
1353	55.546	75.23	-19.684
1804	49.206	75.23	-26.024
2255	44.742	75.23	-30.488
2706	45.406	75.23	-29.824
3157	43.72	75.23	-31.51

**Table 5 - Spurious Radiated Emission Data – Low Band**

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	FCC Peak Limit (dBuV/m)	Peak Margin (dB)
930	51.96	75.23	-23.27
1395	53.534	75.23	-21.696
1860	46.536	75.23	-28.694
2325	42.424	75.23	-32.806
2790	42.442	75.23	-32.788

**Table 6 – Spurious Radiated Emission Data – Mid Band**

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	FCC Peak Limit (dBuV/m)	Peak Margin (dB)
958	53.635	75.23	-21.595
1437	52.647	75.23	-22.583
1916	48.228	75.23	-27.002
2395	48.746	75.23	-26.484
2874	47.35	75.23	-27.88

**Table 7 – Spurious Radiated Emission Data – High Band**

## 6. Frequency Stability vs Temperature

<b>Test Requirement(s):</b>	§2.1055 and 90.213	<b>Test Engineer(s):</b>	Jerry M.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	02/02/2021

**Test Procedures:** As required by 47 CFR 2.0155, Frequency Stability measurements were made at the RF antenna output terminals of the EUT.

The EUT was placed in an Environmental Chamber with all the support equipment outside the chamber. The EUT was set to transmit a modulated carrier. The reference frequency at 20°C was observed and noted down. The frequency drift was investigated for every 10°C increment until the unit was stabilized then recorded the reading in tabular format with the temperature range of -30°C to 50°C.

### Test Setup:

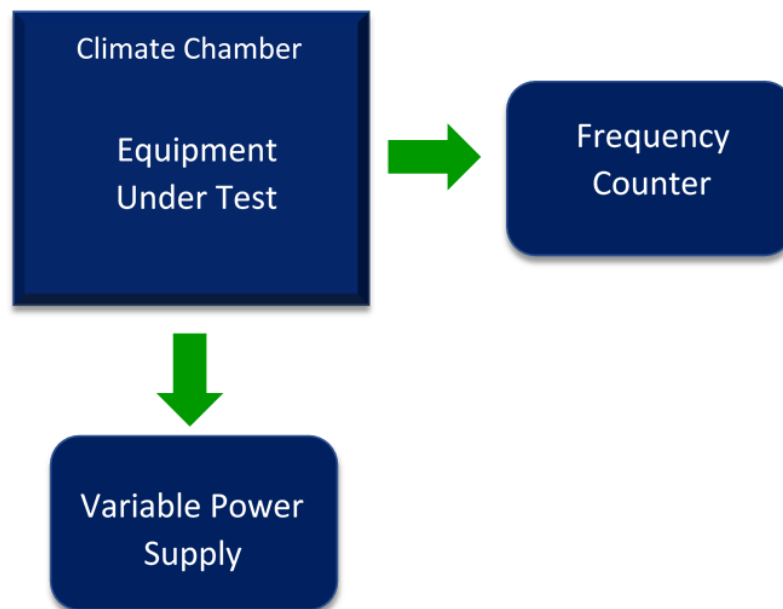
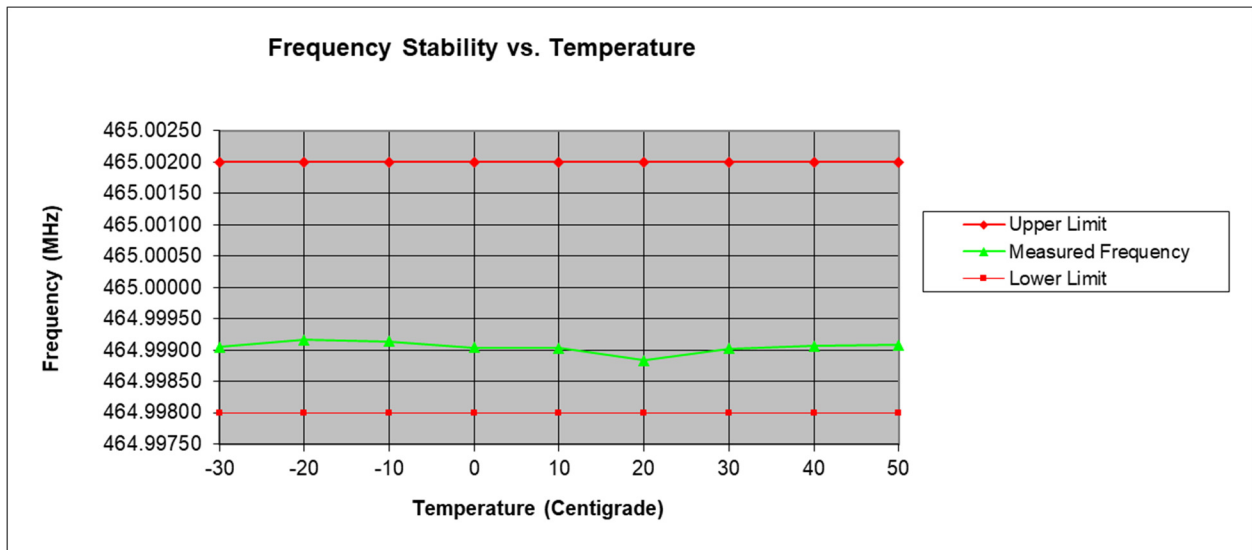


Figure 6 – Frequency Stability Test Setup

### Test Results:

Temperature centigrade	Measured Frequency (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
-30	464.9990542	-0.00295	0.00105
-20	464.9991676	-0.00283	0.00117
-10	464.9991436	-0.00286	0.00114
0	464.9990445	-0.00296	0.00104
10	464.9990378	-0.00296	0.00104
20	464.9988347	-0.00317	0.00083
30	464.9990305	-0.00297	0.00103
40	464.9990681	-0.00293	0.00107
50	464.9990847	-0.00292	0.00108

**Table 8 – Temperature vs Frequency Test Result**



**Plot 25 – Temperature vs Frequency**

## 7. Frequency Stability vs Voltage

<b>Test Requirement(s):</b>	§2.1055	<b>Test Engineer(s):</b>	Jerry Mejak
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	02/02/2021

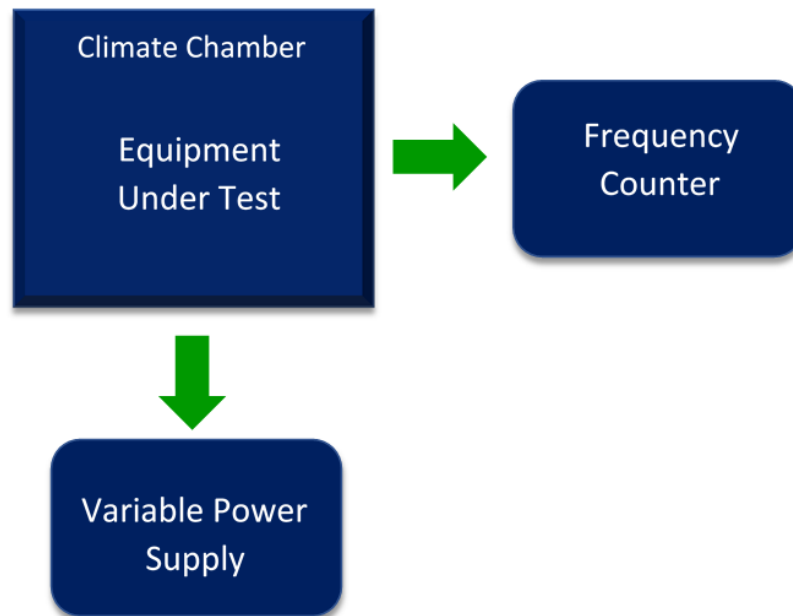
**Test Procedures:** As required by 47 CFR 2.0155, Frequency Stability measurements were made at the RF antenna output terminals of the EUT.

The EUT was connected to a variable DC source. The frequency was measured at both the nominal 12Vdc of the EUT and at the extreme lower and upper voltages.

With the voltage set to a measurement point, the transmitted signal was captured by the spectrum analyzer and the frequency value determined. The frequencies are compared to the tuned frequency. All data for these measurements are found in the table 9.

**Reference Frequency: 151MHz at 12Vdc at 20°C**

### Test Setup:



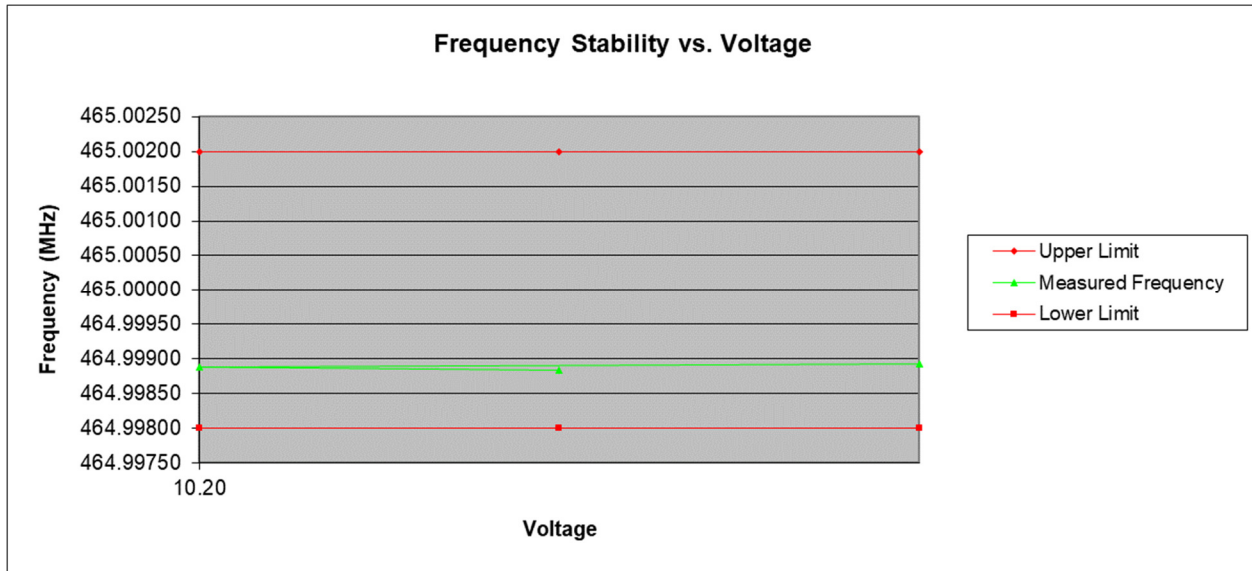
**Figure 7 – Frequency Stability Test Setup**



**Test Results:**

Input Voltage (Vdc)	Measured Frequency (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
13.80	464.998923	-0.00308	0.00092
12.00	464.998835	-0.00317	0.00083
10.20	464.998877	-0.00312	0.00088

**Table 9. Temperature vs. Voltage Test Result**



**Plot 26 – Temperature vs Voltage**

## 8. Transient Frequency Behavior

<b>Test Requirement(s):</b>	§90.214	<b>Test Engineer(s):</b>	Keith T.
<b>Test Results:</b>	Pass	<b>Test Date(s):</b>	01/15/2021

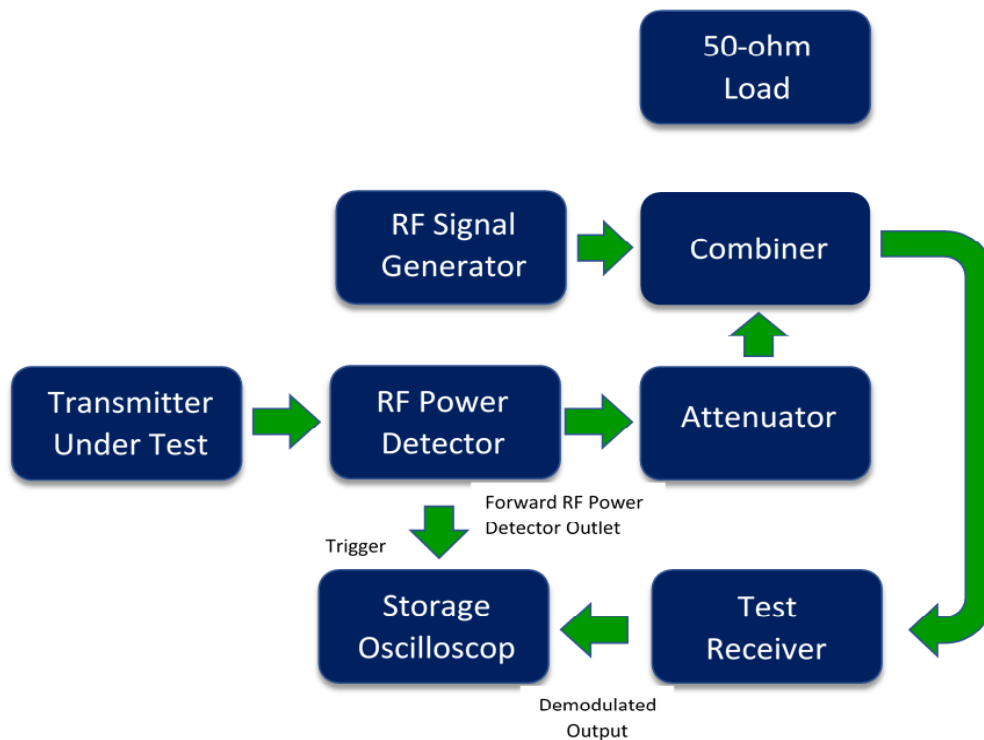
**Test Procedures:** The EUT was tested for transient frequency behavior using the test method of TIA/EIA 603.

RF Frequency	Channel Bandwidth	Transient Period	Transient Behavior	Result
451MHz	12.5KHz	t1= 10ms	<±12.5kHz	Pass
		t2= 25ms	<±6.25kHz	Pass
		t3= 10ms	<±12.5kHz	Pass

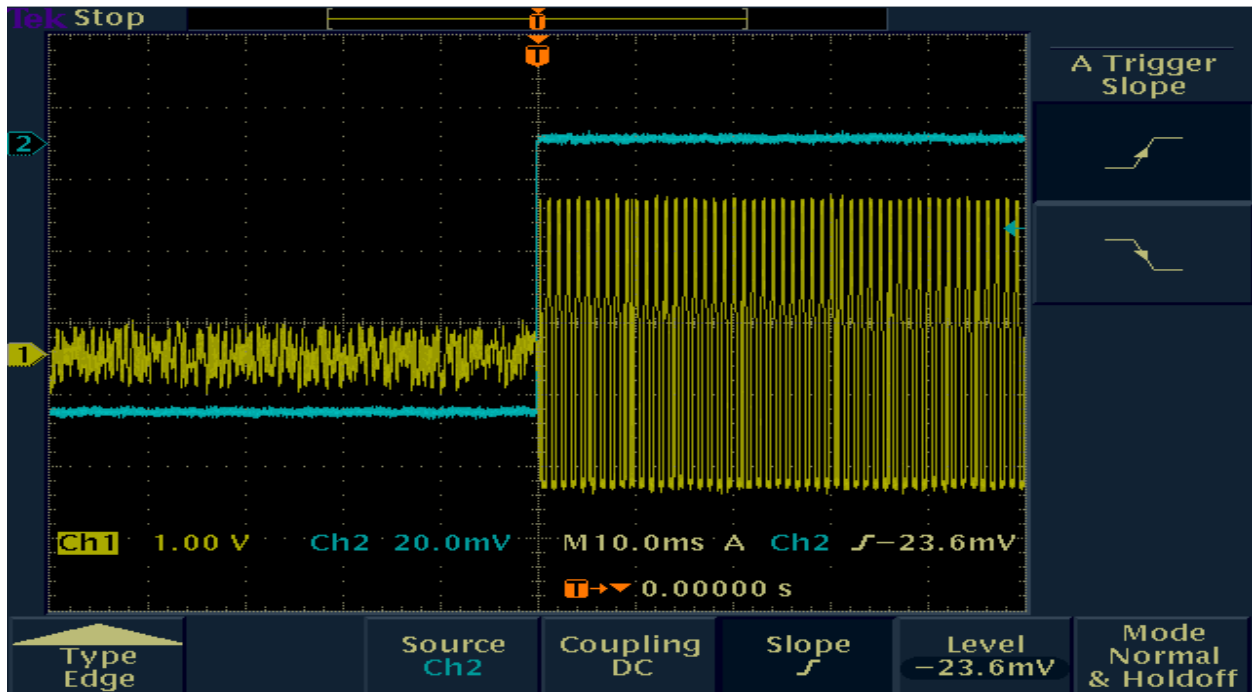
**Table 10. Transient Frequency – Test Requirement**

The following pages show measurements of Transient Frequency Behavior plots:

### Test Setup:

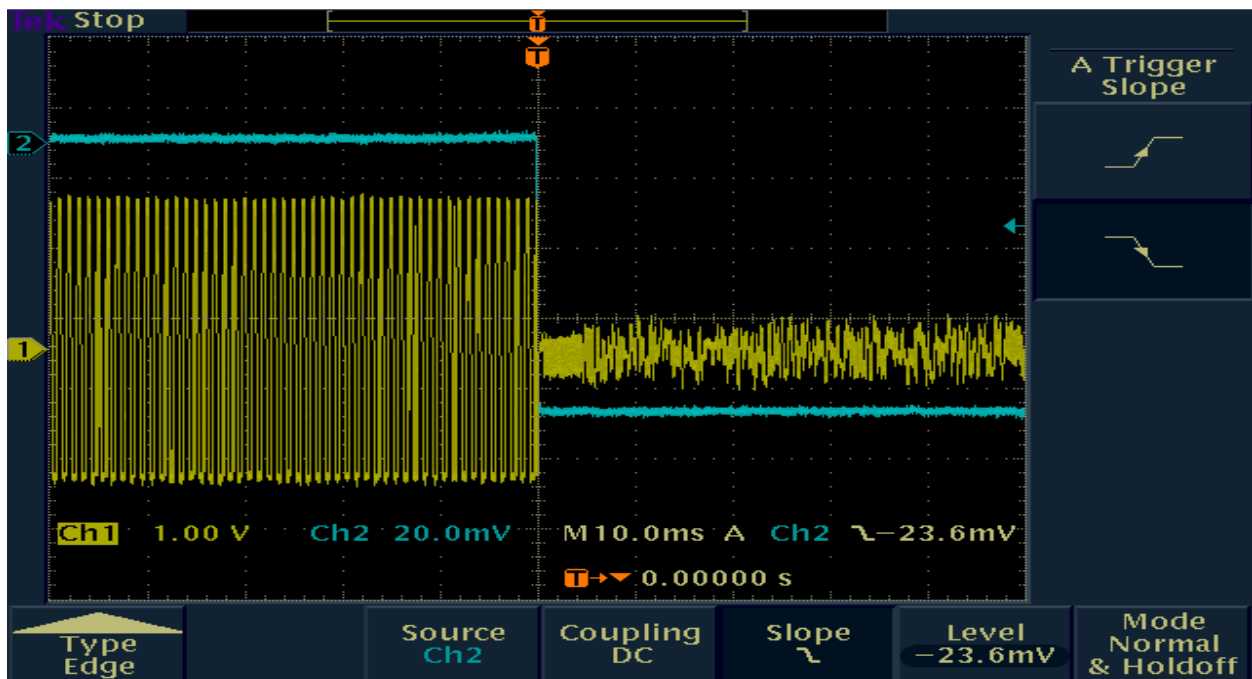


**Figure 8 – Transient Frequency Behavior Test Setup**



TDS 3052 - 5:01:02 PM 1/15/2021

Plot 27 – On Time



TDS 3052 - 5:00:27 PM 1/15/2021

Plot 28 – Off Time

## 9. Necessary Bandwidth

Referencing Part 2.202 of the FCC Rules and Regulation and using the following formula for calculating the Necessary Bandwidth

$$B = 2M + 2DK$$

Where M = Baud Rate, D = Deviation and K= Constant

### Calculation

Bandwidth Computed (kHz) (B)	Baud Rate (M)	Peak FM Deviation (kHz) (D)	States	K	2M	Emission Designator
3.93	4800	0.85	4	0.27	3.40	<b>4K0F1D</b>
10.17	9600	2.3	4	0.27	9.20	<b>11k0F1D</b>
15.02	19200	3.22	4	0.27	12.88	<b>15K0F1D</b>

## 10. Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Power Supply	Lambda	LA-200	LA2AA201433535	Verified	
Digital Multimeter	Fluke	77 III	72550270	Apr/10/20	Apr/10/21
Spectrum Analyzer	Agilent	E4443A	US41420164	Jan/28/20	Jan/28/21
Temperature Chamber	Test Equity	1027C	17953	Aug/31/20	Aug/31/21
Antenna	EMCO	GTEM 5417	1063	Verified	
Spectrum Analyzer	Hewlett Packard	8563E	3821A09316	May/01/20	May/01/21
Attenuator 10dB	Huber+Suhner	6810.17.A	757300	May/06/20	May/06/21
High Pass Filter	Mini-Circuits	VHF-3100+	1023	Verified	
Variable Attenuator	H.P.	None	None	NCR	None
EMI Receiver	Hewlett Packard	8566B	2318A04952	Nov/20/20	Nov/20/21
Signal Generator	Agilent	E4432B	US40053021	Sep/23/19	Sep/23/21
Attenuator 20dB	Weinschel	41-20-12	86332	Verified	
Horn Antenna	Com-Power	AHA-118	711150	Dec/17/20	Dec/17/22
Horn Antenna	Com-Power	AH-118	71350	Verified	
Diode/Crystal Detector	H.P.	8470B	None	Verified	
Combiner/Splitter	MiniCircuits	ZFSC-2-2	None	Verified	
Oscilloscope	Tektronix	TDS 3052	B013389	Jan/11/21	Jan/11/22

**Table 11 – Test Equipment List**

**\*Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

## 11. Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. These measurements figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2. Instrumentation measurement uncertainty has **not** been taken into account to determine compliance.

The following measurement uncertainty values have been calculated as show in the table below:

Measured Parameter	Measurement Unit	Frequency Range	Expanded Uncertainty
Conducted Emissions (AC Power)	dBuV or dBuA	150kHz – 30MHz	± 4.3dB
Radiated Emissions below 1GHz	dBuV/m	30 – 1000MHz	± 5.6dB
Radiated Emissions above 1GHz	dBuV/m	1 – 26.5GHz	± 4.1dB

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

**END OF TEST REPORT**