H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Nautel Limited

FM Broadcast Transmitter Model VX300

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 73 Subpart G and Part 74 Subpart L for

Radio Broadcast Services

February 26, 2021

Prepared for:

Nautel Limited

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Prepared By:

H.B. Compliance Solutions

5005 S. Ash Avenue, Suite A-10

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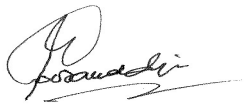
Reviewed By:



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 74 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
Ø	August 31, 2020	Initial Issue
1	February 26, 2021	Corrected low band channel

Table of Contents

EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47 FCC Part 73 and 74. All tests were conducted using measurement procedure from ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz 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; §73.811, §74.1235	Pass	
Modulation Characteristics	§2.1047(a); §73.1590	Pass	
Occupied Bandwidth	§2.1049; §73.317, §74.1236	Pass	
Spurious Emissions at Antenna Terminals	§2.1051; §73.317; §74.1236	Pass	
Radiated Spurious Emissions	§2.1053	Pass	
Frequency Stability over Temperature Variations	§2.1055(a)(1); §73.1545(b); §74.1261	Pass	
Frequency Stability over Voltage Variations	§2.1055(d); §73.1545(b); §74.1261	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Nautel Limited to perform testing on the FM Broadcast Transmitter VX300 under the purchase order number 10096213.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Nautel Limited, FM Broadcast Transmitter VX300.

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. Nautel Limited 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.

Product Name:	FM Broadcast Transmitter
Model(s) Tested:	VX300
FCC ID:	B3W-VX300
Supply Voltage Input:	Primary Power: 230 Vac
Frequency Range:	88MHz to 108MHz
No. of Channels:	N/A
Necessary Bandwidth	180kHz
Type(s) of Modulation:	FM
Range of Operation Power:	30W to 300W
Voltage into final Transistor	26.96 volts
Current into final Transistor	14.41 amps
Emission Designator:	180KF3E
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment:	Fixed
Antenna:	External N Connector – Device is not sold with antenna
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at H.B. Compliance Solutions
Test Date(s):	08/03/2020 till 08/24/2020
Firmware Number	0.0.0.3
PCBA Version	C

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

ISED Test Site Registration number is 9481A

3. Description of Test Sample

The Nautel, VX300 FM Broadcast transmitter is a FM transmitter with rated 150W in a compact 2RU rack mounted design. The key parameters for this series are improved cost, increased power density, and industry leading efficiency.

This transmitter is intended to be used by licensed FM broadcasting services and have been designed for use in a traditional transmission sites with controlled access and adequate services for transmitter operation.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	FM Transmitter	VX300	10011320

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	2kW 30dB RF Load	Bird	8329	120501251

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
# 3	RF Out	RG 393 with 7/16 DIN	1	1.5	Y	# 2
# 4	AC In	C19	1	2.5	N	AC Power
# 5	Analog Audio	XLR3	2	1.5	Y	Audio Source

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 front panel access to the 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 Nautel Limited upon completion of testing & certification.

1. RF Power Output

Test Requirement(s):	§2.1046; §73.811 and §74.1235	Test Engineer(s):	Sean Eggleston
Test Results:	Pass	Test Date(s):	02/26/2021

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

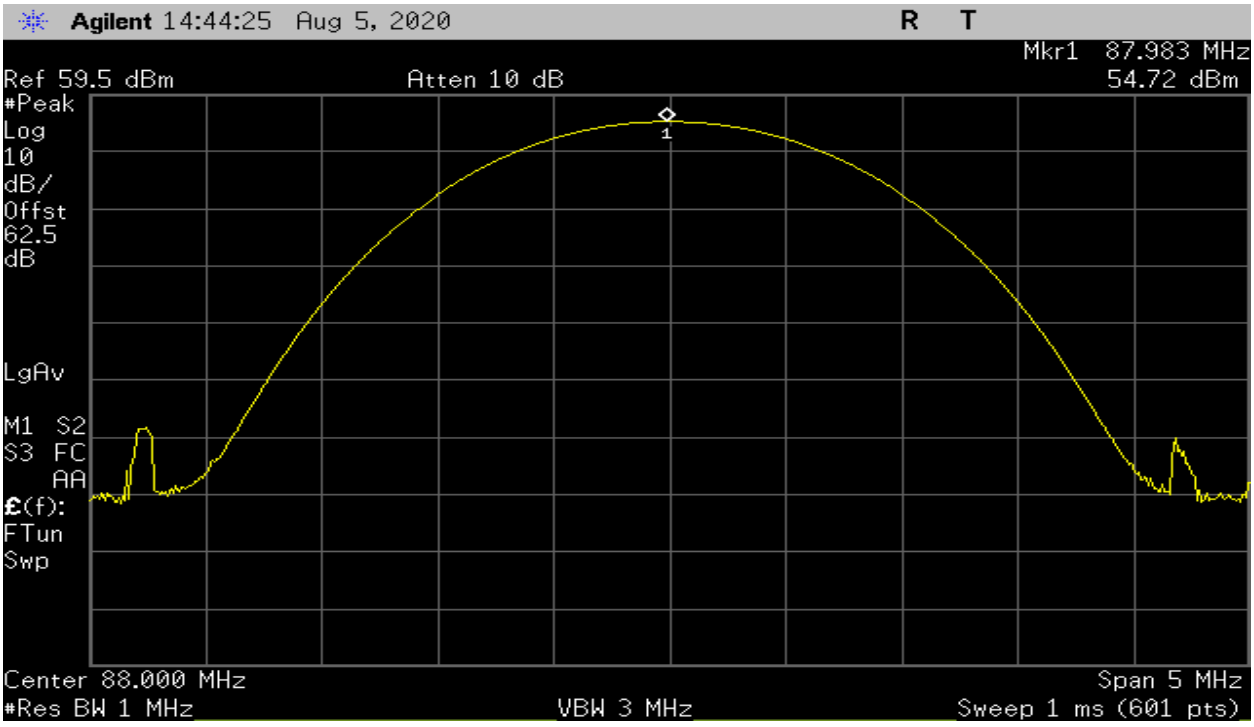
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer capable of making power measurements. Measurements were made at the low, mid, and high channels of the entire frequency band.

Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)	Rated Output Power (W)
88.0	54.72	296.48	300
98.0	54.68	293.76	300
107.9	54.55	285.10	300

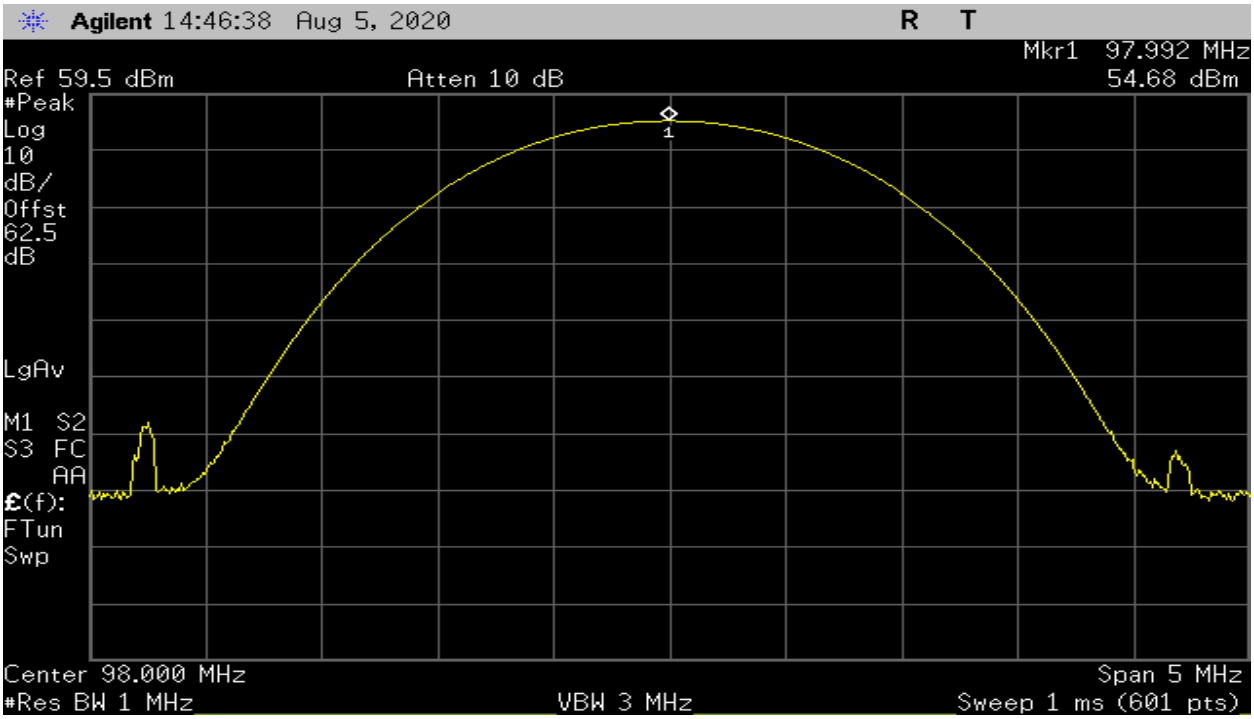
Table 4. RF Power Output, Test Results

Test Setup:

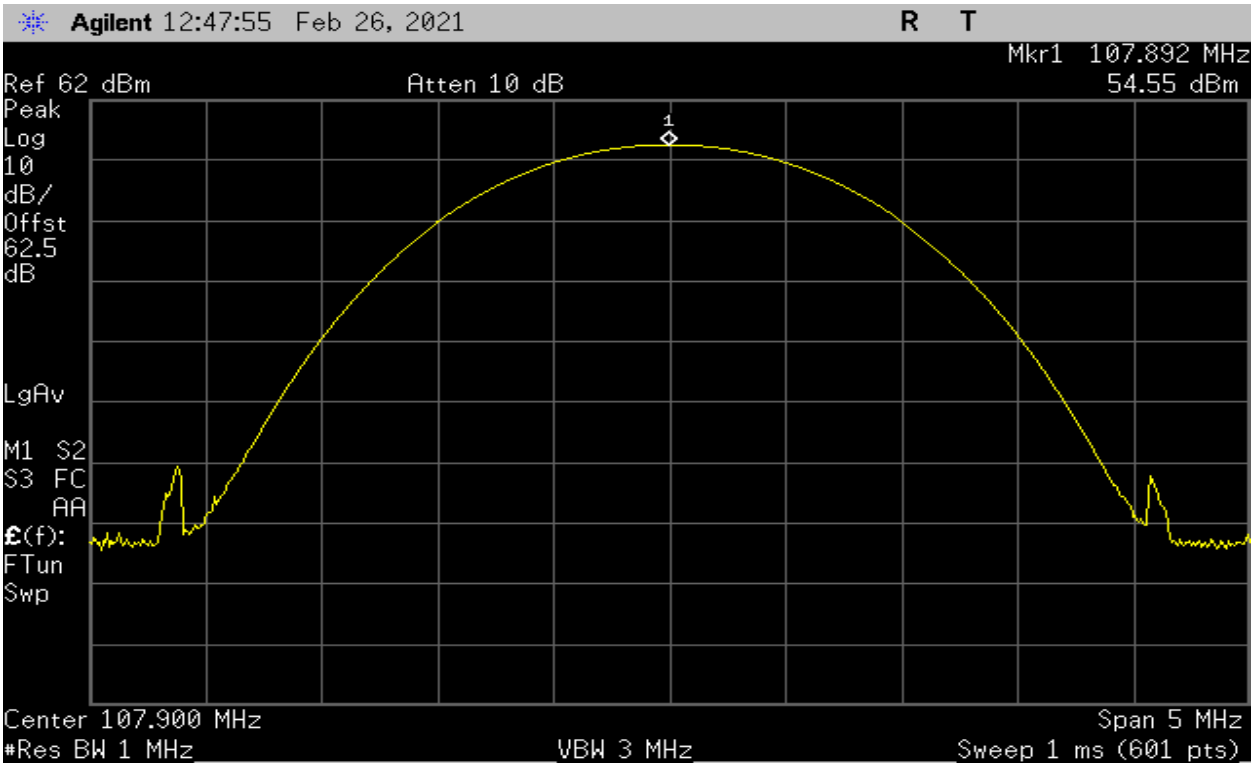
Figure 1 Output RF power Test Setup



Plot 1 – Output Power – Low



Plot 2 – Output Power – Mid



Plot 3 – Output Power – High

2. Modulation Characteristics

Test Requirement(s):	§2.1047 and §73.1590	**Test Engineer(s):**	Sean Eggleston
Test Results:	Pass	**Test Date(s):**	08/11/2020

Test Procedure:

As required by 47 CFR 2.1047, Modulation characteristics measurements were made at the RF output terminals of the EUT. Measurements were made in accordance with the procedures of the ANSI C63.26-2015

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 an Spectrum Analyzer.

For Modulating Limiting – Data was plotted as a percentage of deviation relative to the 0 dB reference point versus input voltage.

For Audio Response – As per standard a curve or equivalent data showing frequency response of the audio modulating circuit shall be submitted.

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

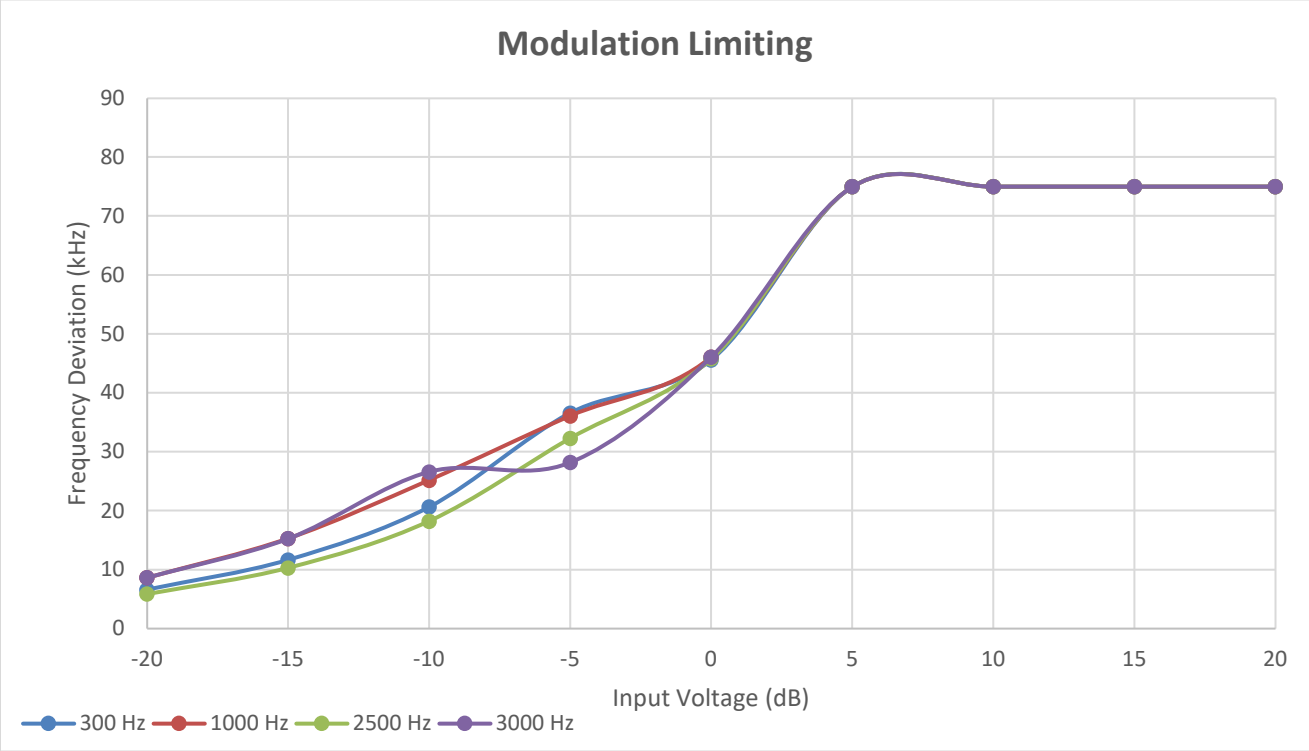
Test Setup:

Figure 2: Modulation Characteristics Bandwidth Test Setup

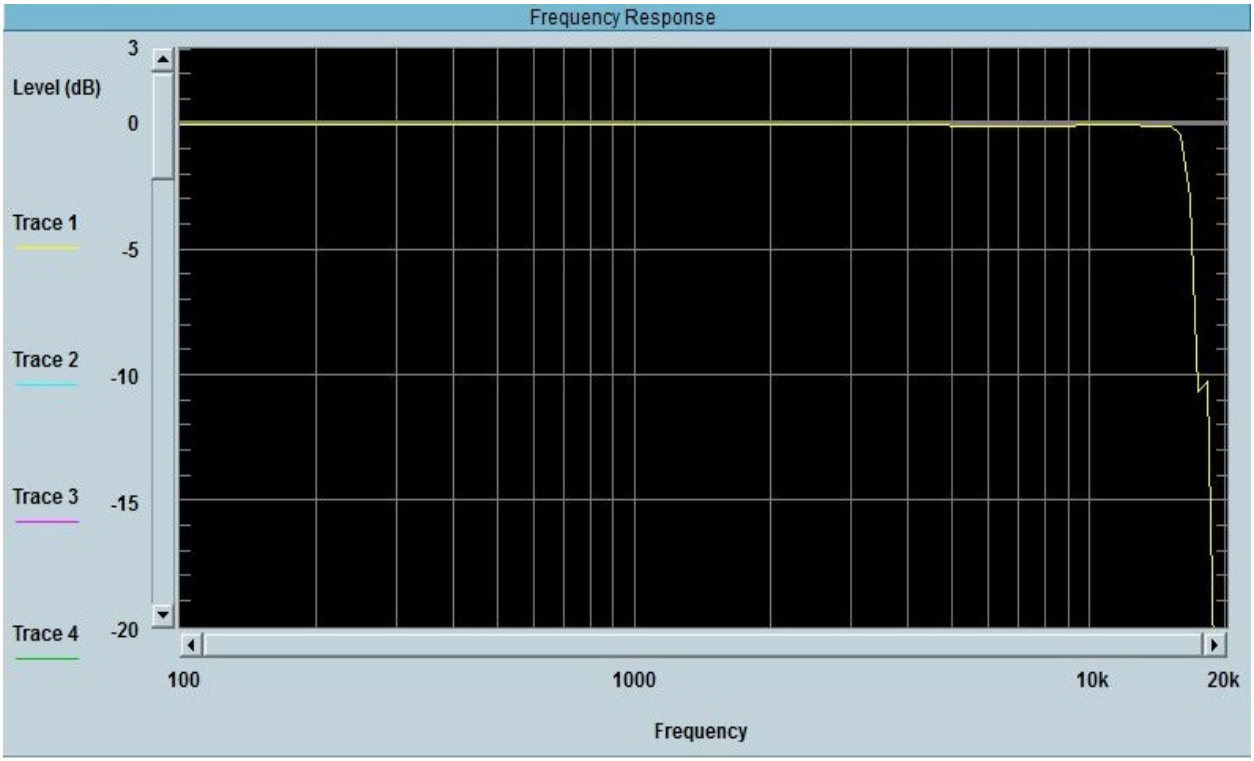
Test Results:

Modulation Level (dB)	Peak Frequency Deviation @300Hz	Peak Frequency Deviation @1000Hz	Peak Frequency Deviation @ 2500Hz	Peak Frequency Deviation @ 3000Hz
20	75	75	75	75
15	75	75	75	75
10	75	75	75	75
5	75	75	75	75
0	45.6	46.1	45.8	46.1
-5	36.6	36.1	32.3	28.2
-10	20.65	25.2	18.24	26.6
-15	11.68	15.3	10.32	15.28
-20	6.63	8.67	5.88	8.65

Table 5. Modulating Limiting, Test Results



Plot 4 – Modulating Limiting



Plot 5 – Audio Frequency Response

3. Occupied Bandwidth (Emission Mask)

Test Requirement(s):	§2.1049; §73.317 and §74.1236	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	02/26/2021

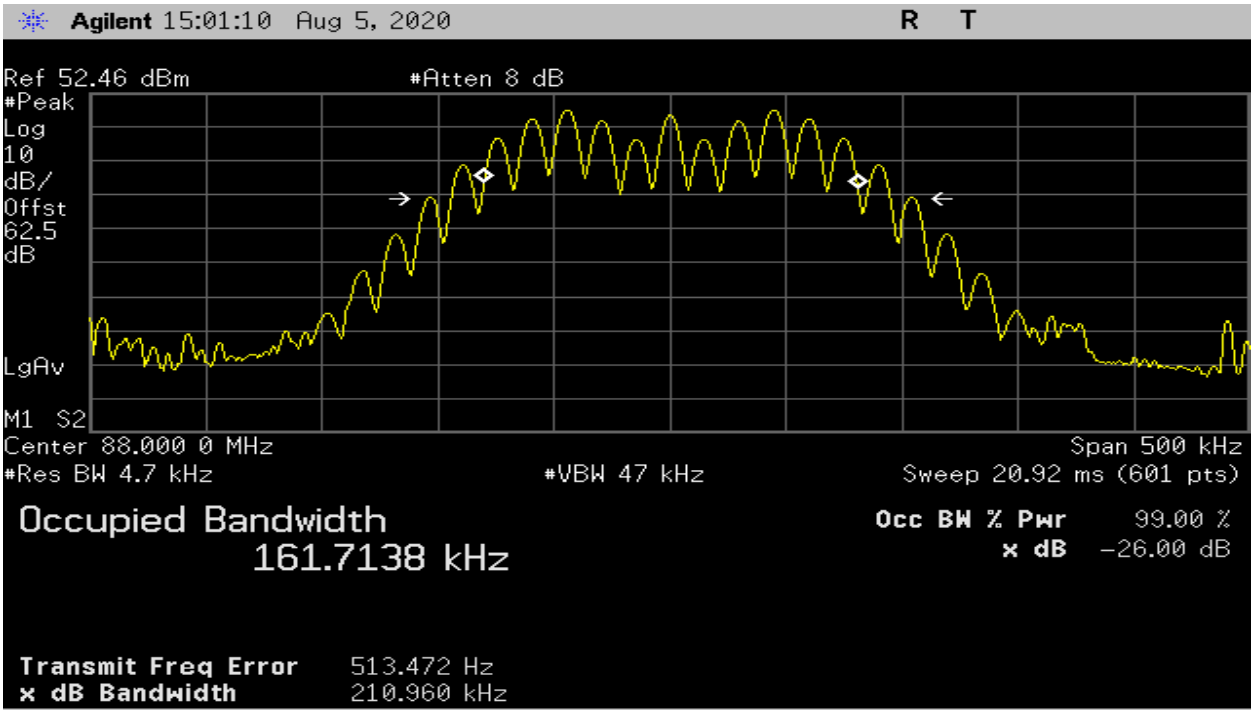
Test Procedure: As required by 47 CFR 2.1049, occupied bandwidth measurements were made at the output terminals of the EUT.

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.

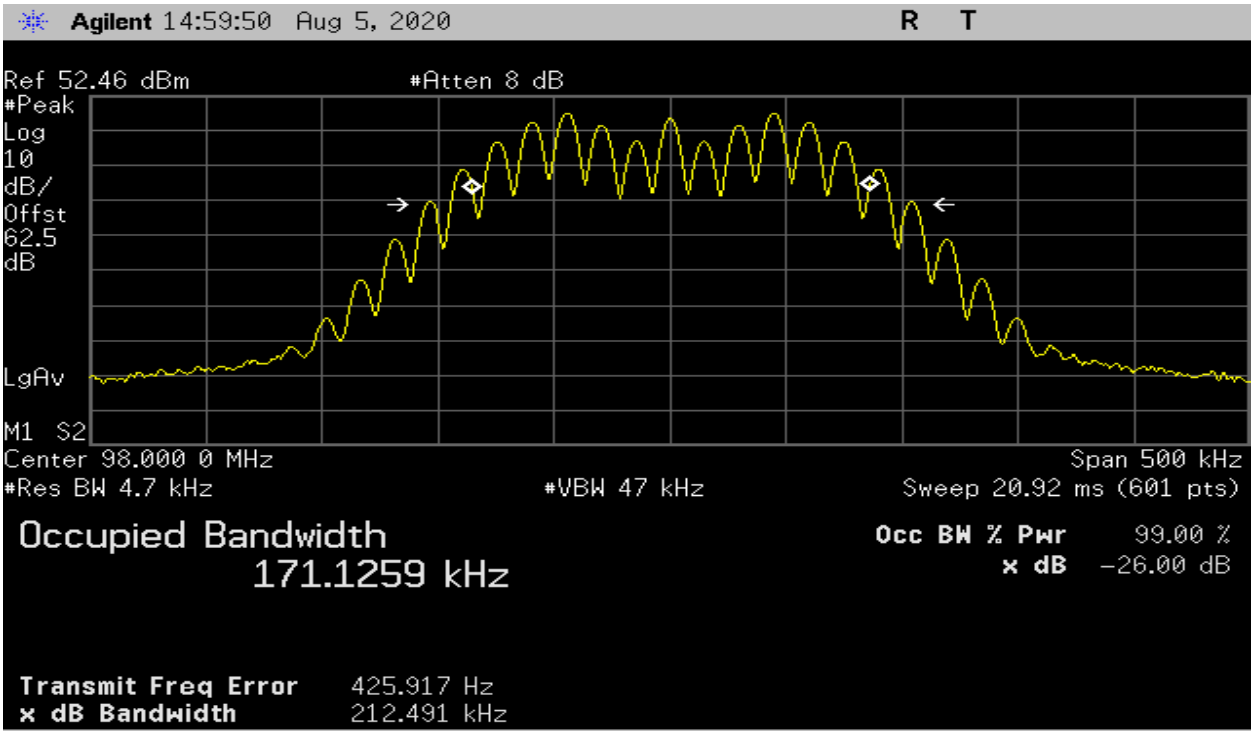
Test Setup:

Figure 3: Occupied Bandwidth Test Setup

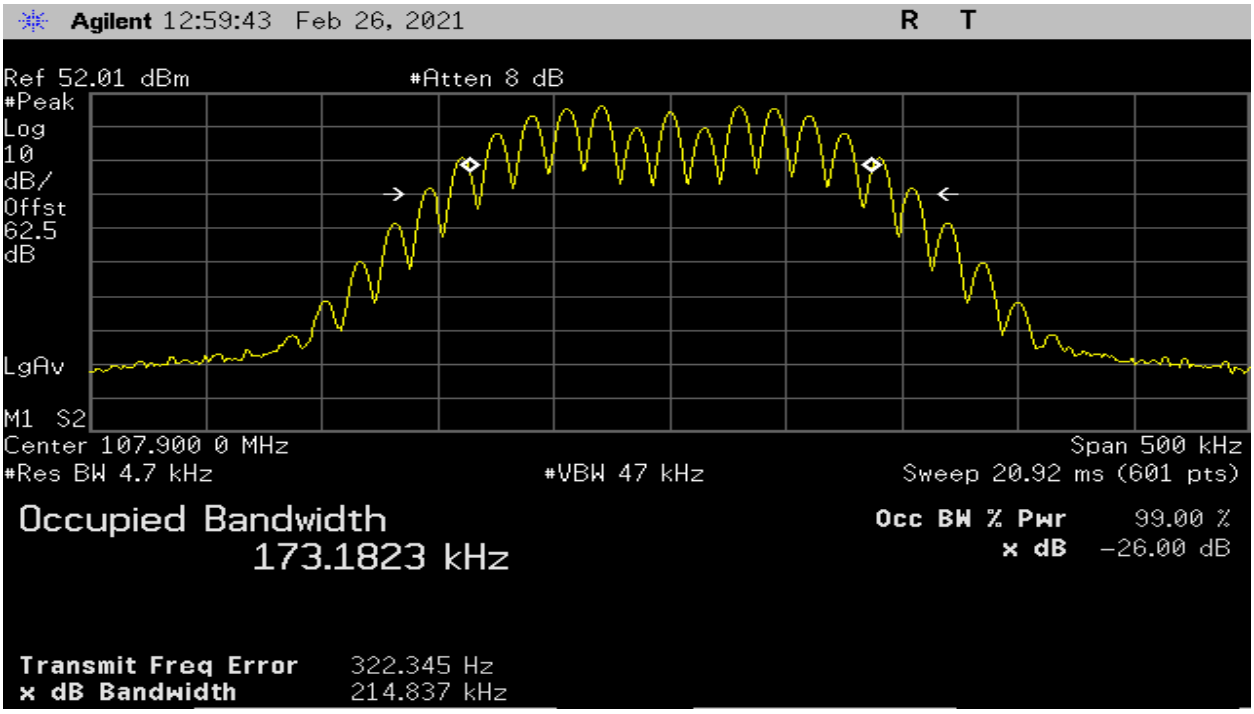
The following pages show measurements of Emission Mask plots:



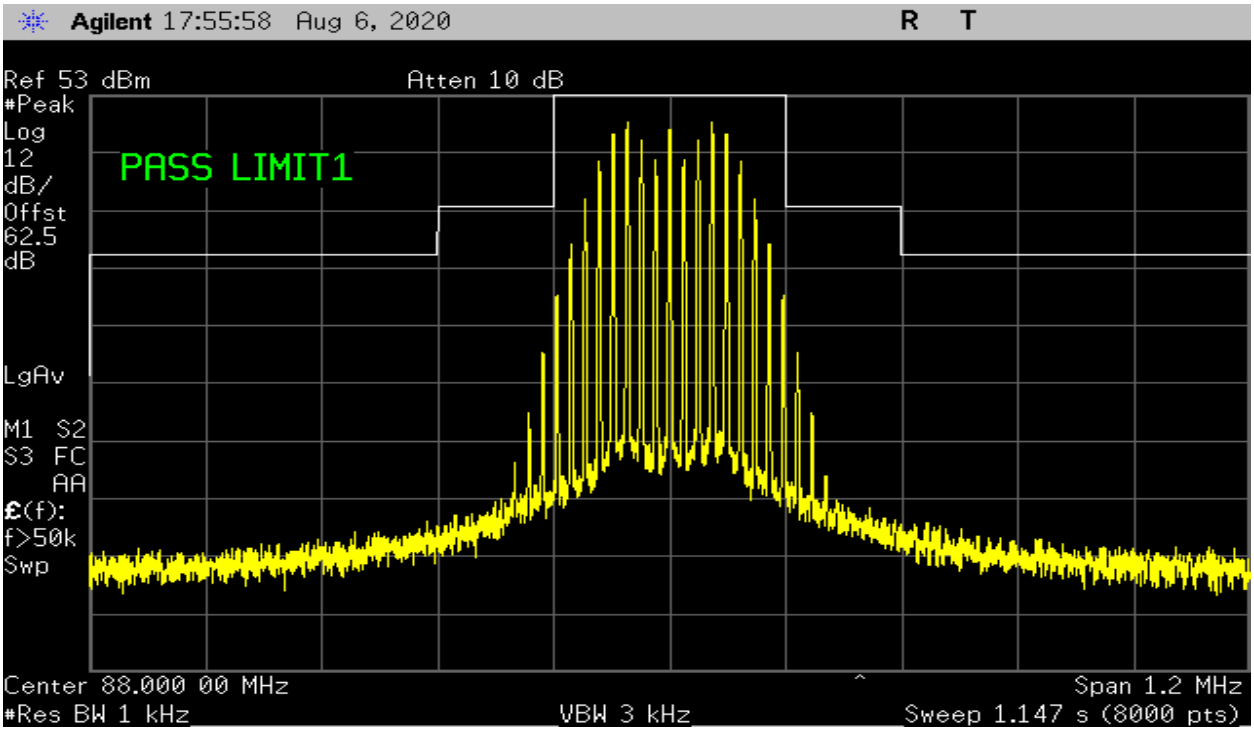
Plot 6 – Low Channel 15 kHz @ 85%



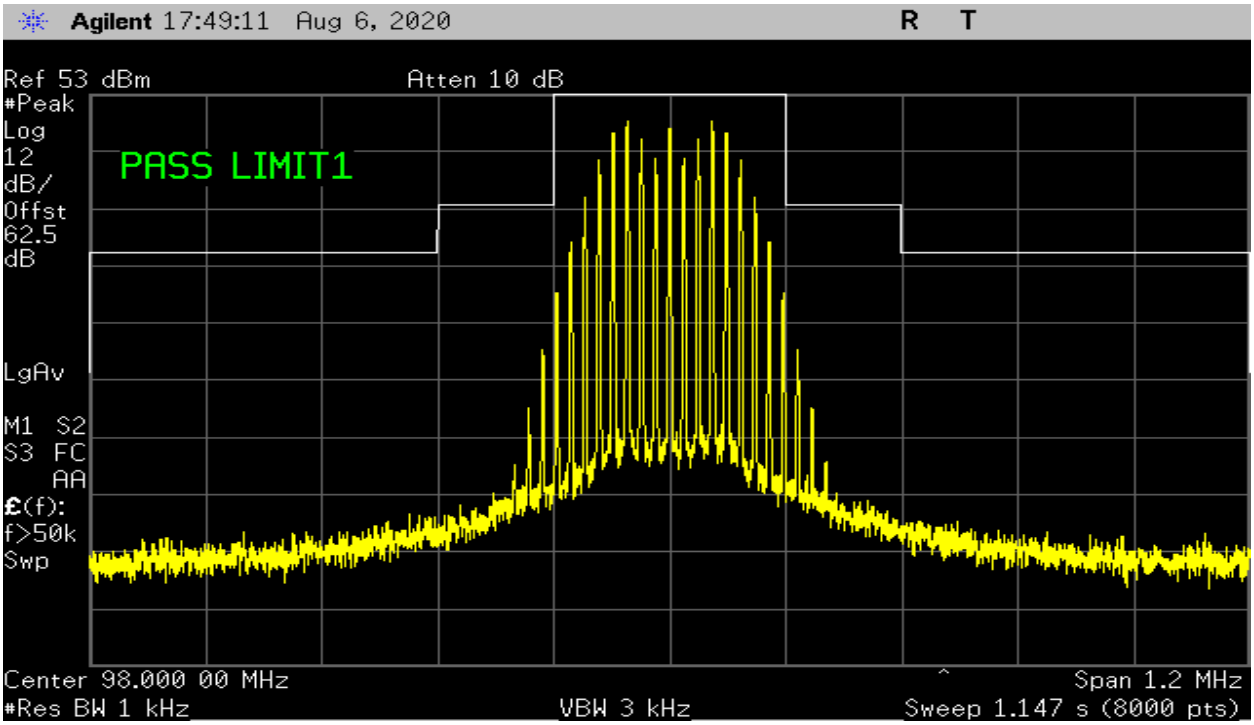
Plot 7 – Mid Channel 15 kHz @ 85%



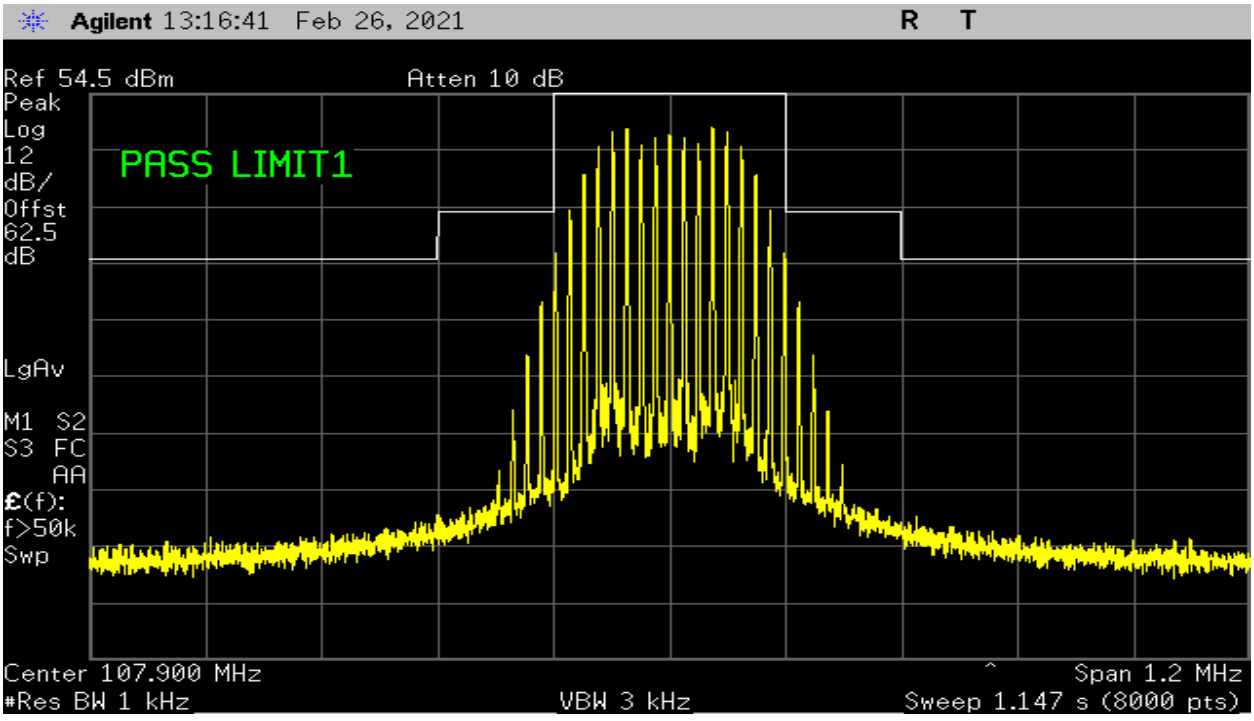
Plot 8 – High Channel 15 kHz @85%



Plot 9 – Low Channel



Plot 10 – Mid Channel



Plot 11 – High Channel

4. Spurious Emissions at Antenna Terminals

Test Requirement(s):	§2.1051; §73.317 and §74.1236	**Test Engineer(s):**	Sean E.
Test Results:	Pass	**Test Date(s):**	08/14/2020

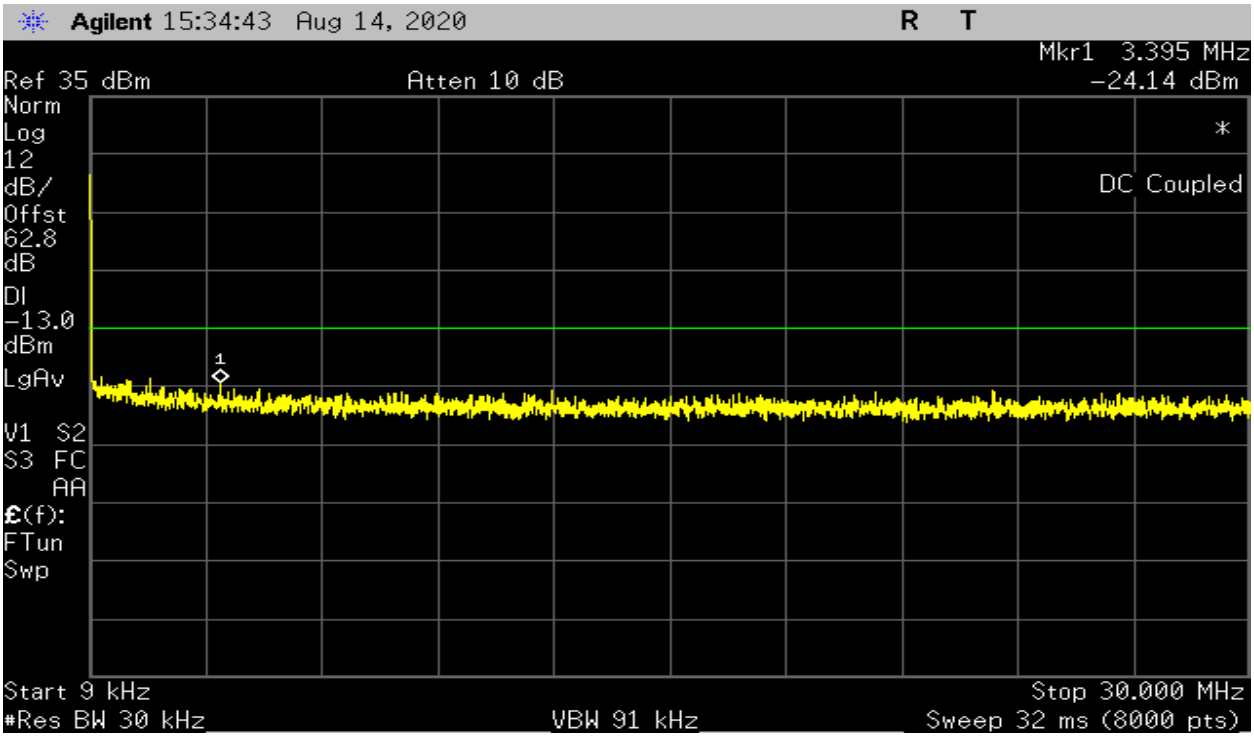
Test Procedures:

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

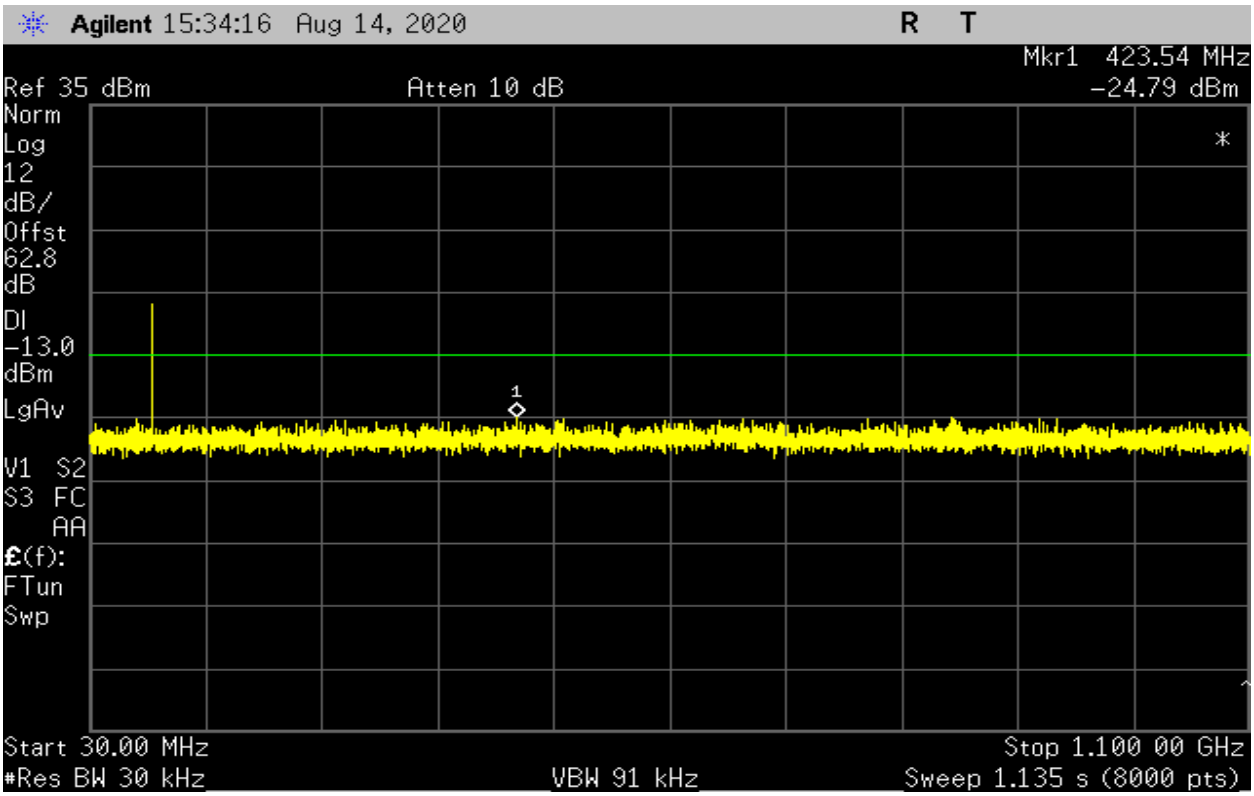
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The Spectrum Analyzer was set to sweep from 9kHz up to 10th harmonic of the fundamental or 40GHz whichever is the lesser. Measurements were made at the low, mid and high frequency of the transmit band.

Test Setup:

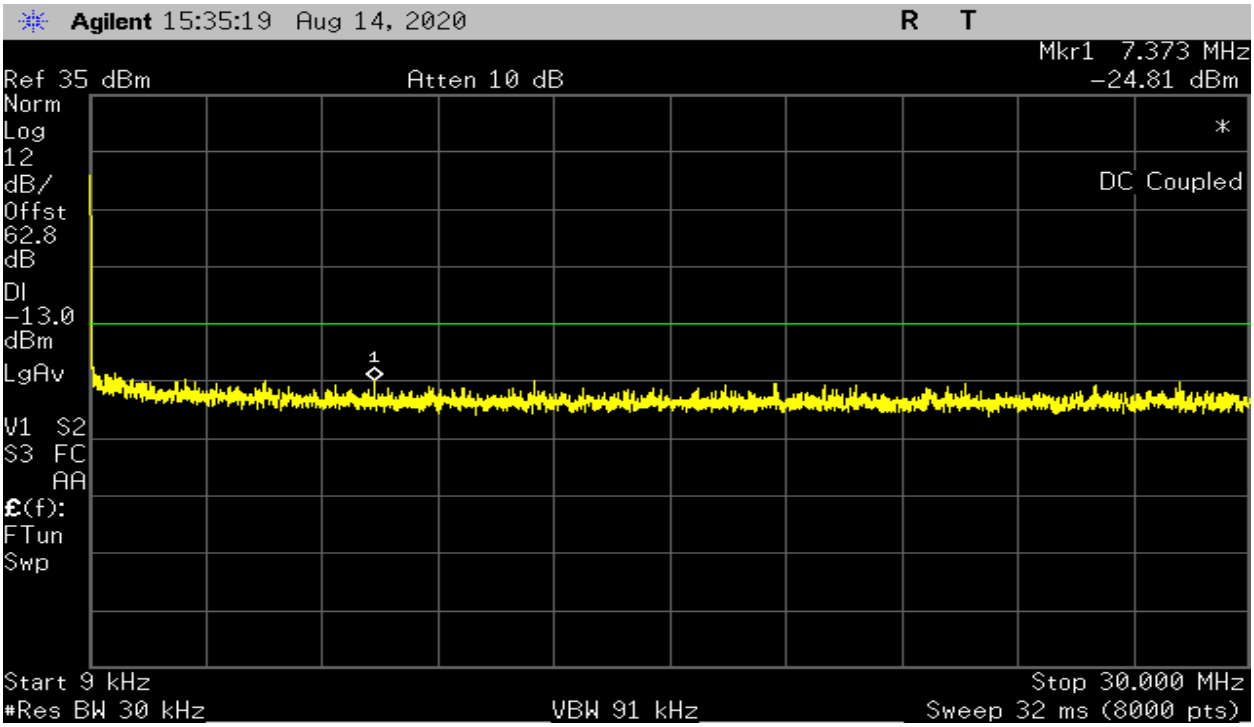
Figure 4: Spurious Emission at Antenna Terminal Test setup



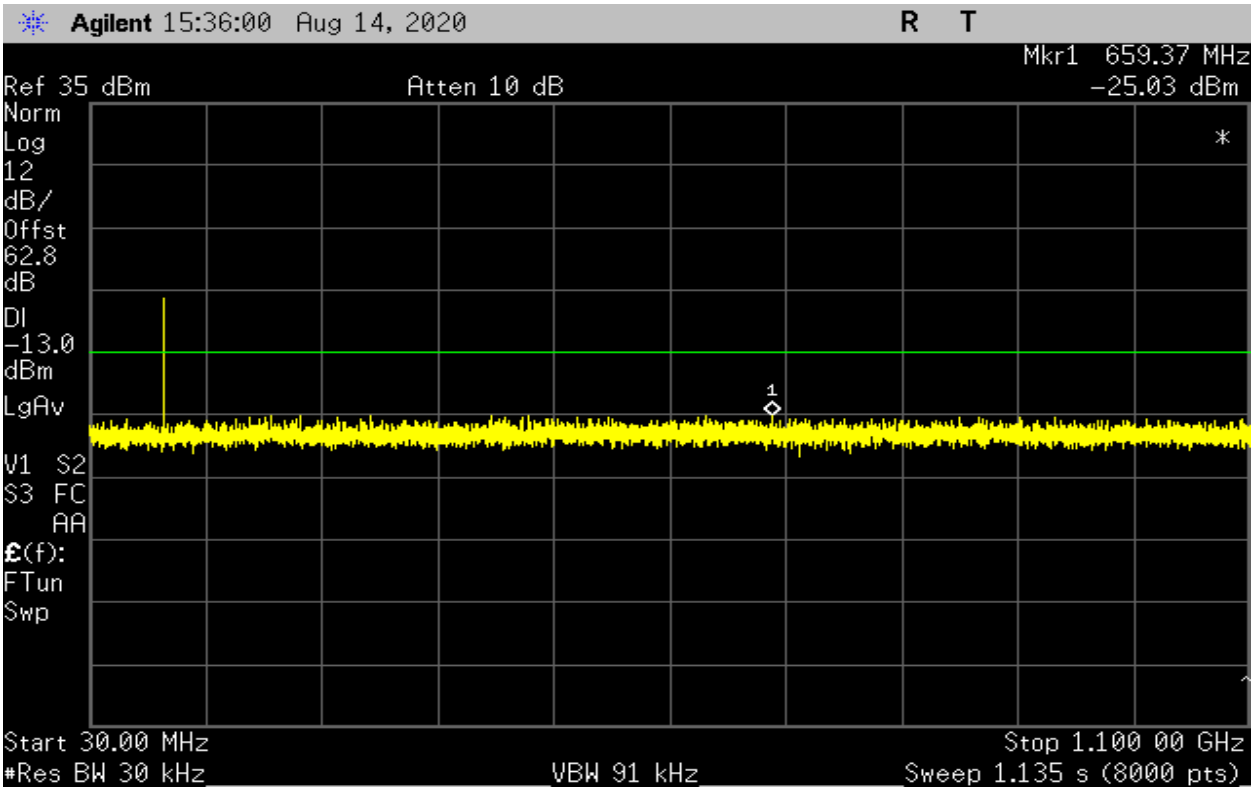
Plot 12 – Low Band



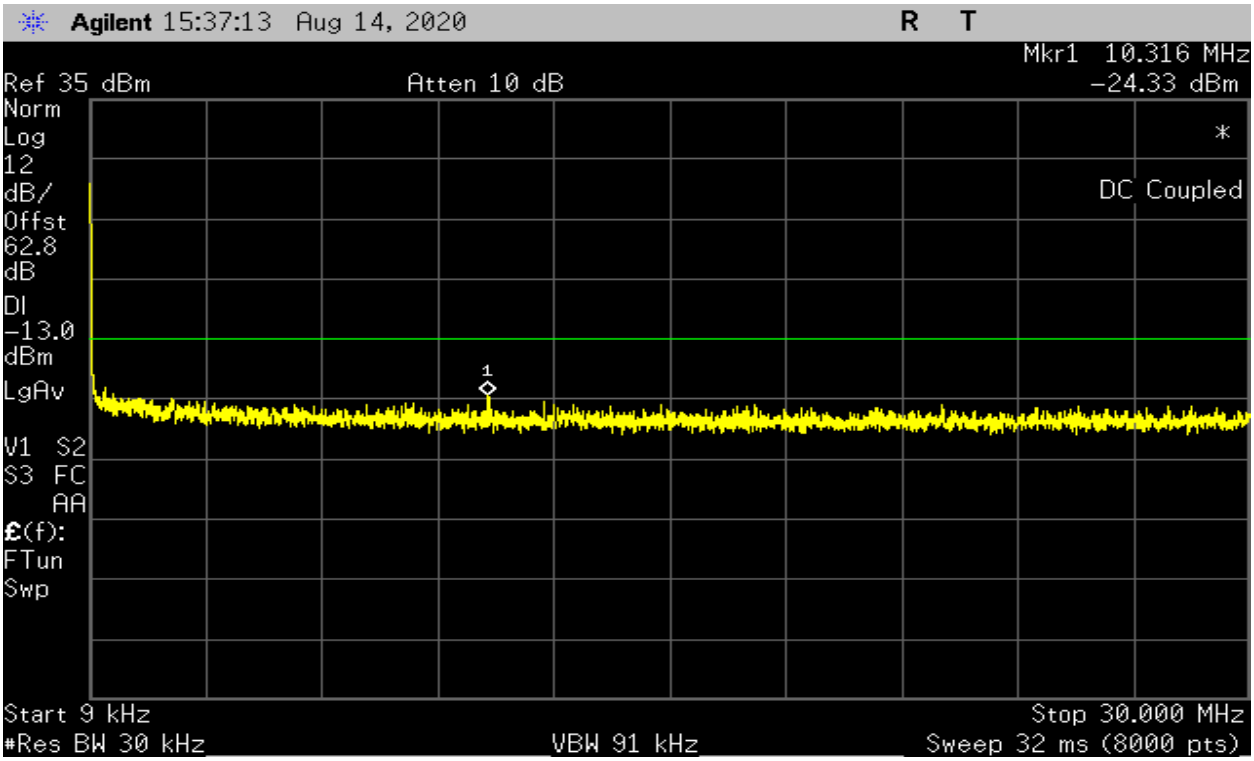
Plot 13 – Low Band



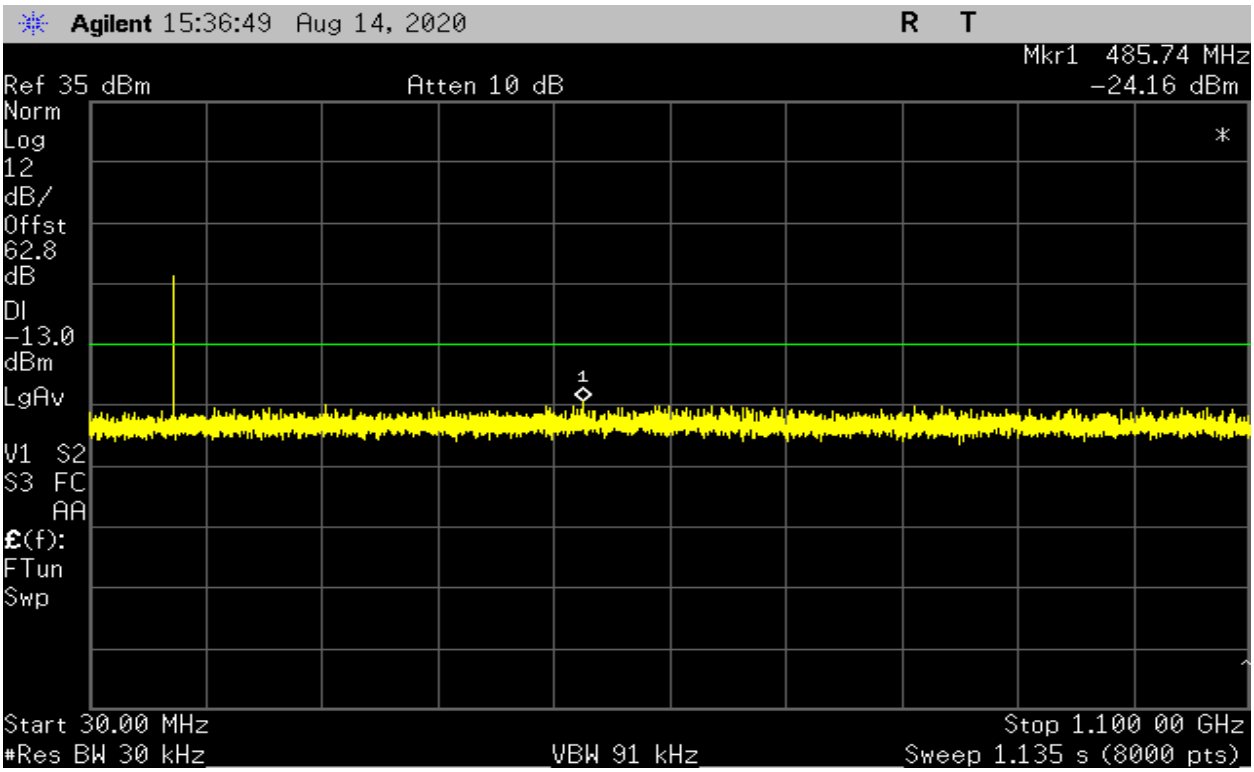
Plot 14 – Mid Band



Plot 15 – Mid Band



Plot 16 – High Band



Plot 17 – High Band

5. Radiated Spurious Emissions

Test Requirement(s):	§2.1053 and §74.1236	**Test Engineer(s):**	Sean E.
Test Results:	Pass	**Test Date(s):**	08/03/2020

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

The EUT was placed on a wooden table inside a GTEM chamber. The EUT was transmitting into a 50Ω non-radiating load which was directly connected to the EUT antenna port.

The measurement antenna was set at 3 meters from the EUT. During the tests, 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^{th} 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-

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	10Hz	0 Hz

Table 5. Analyzer Settings

Limit: Any emissions appearing on a frequency removed from the carrier by more than 600kHz must be attenuated at least 43 + 10Log_{10} (Power, in watts) dB below the level of the unmodulated carrier, or 80dB, whichever is the lesser attenuation.

Test Setup:

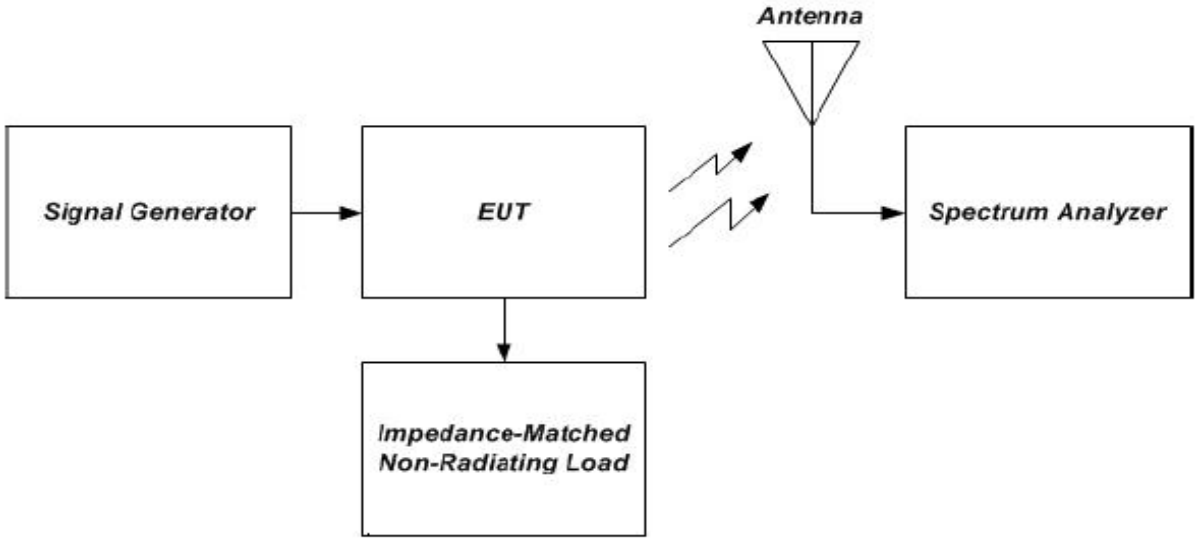
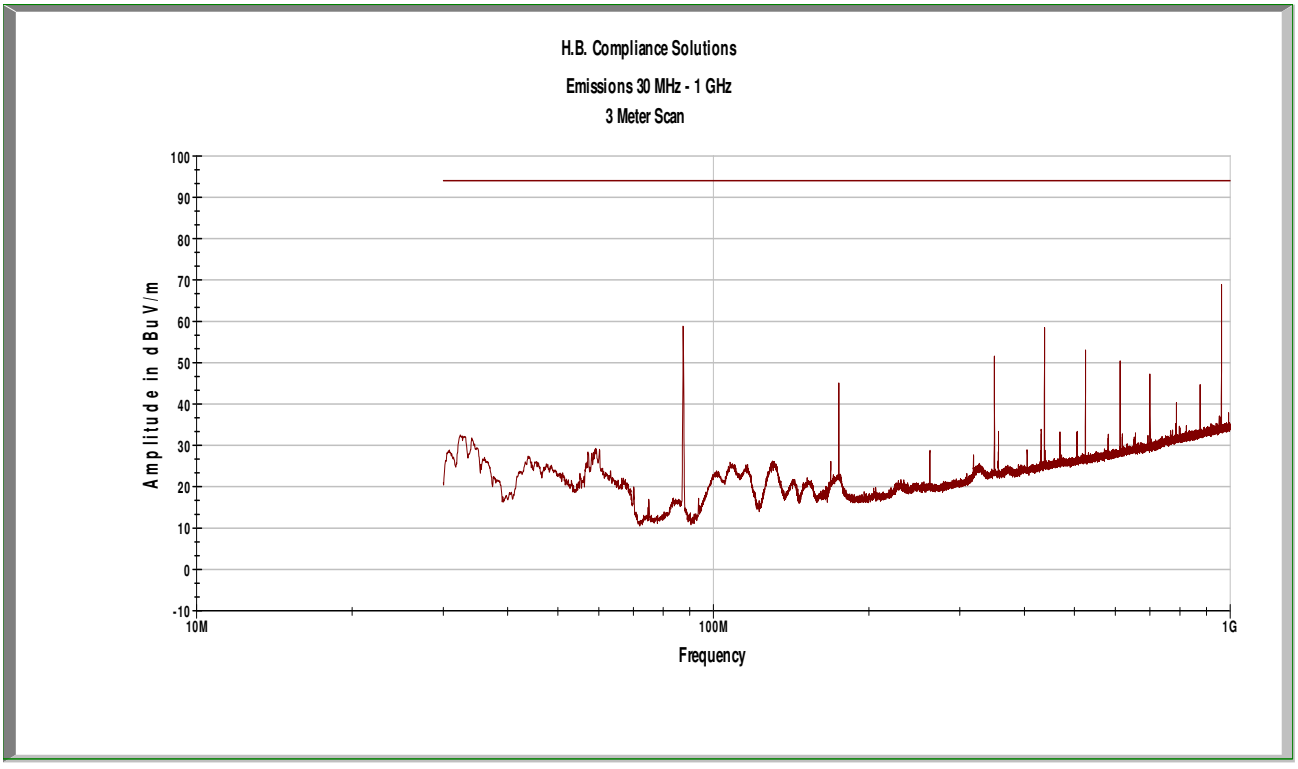
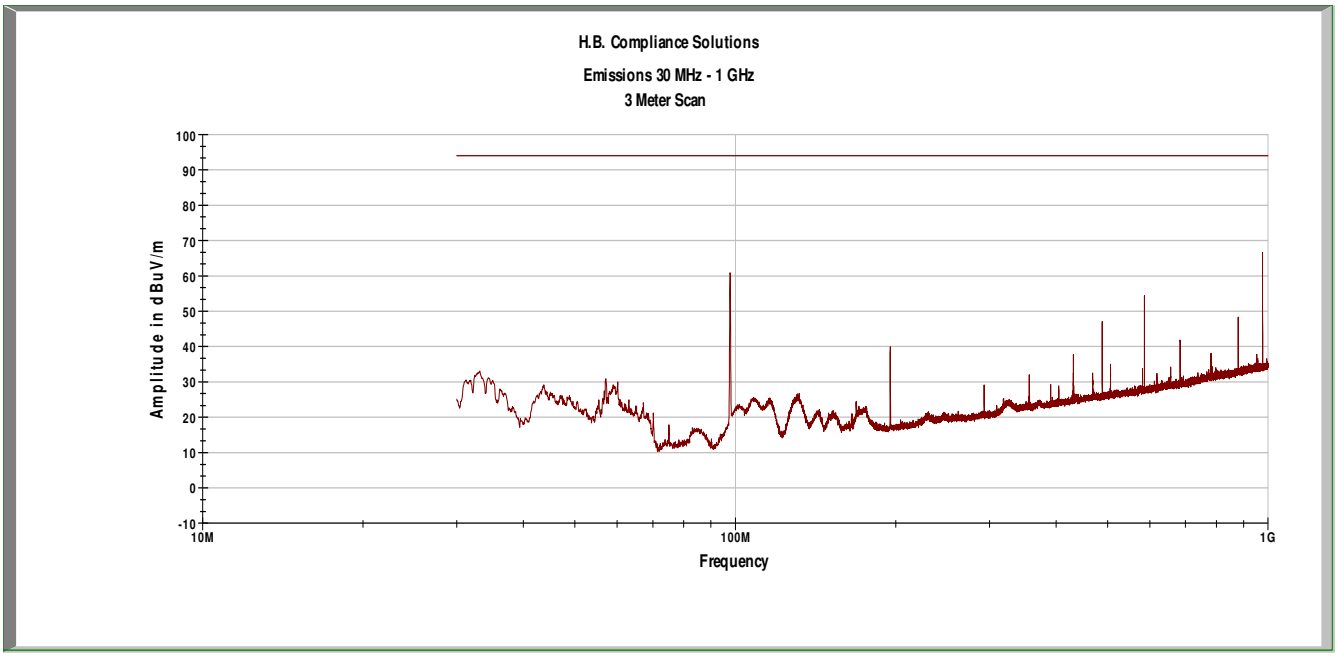


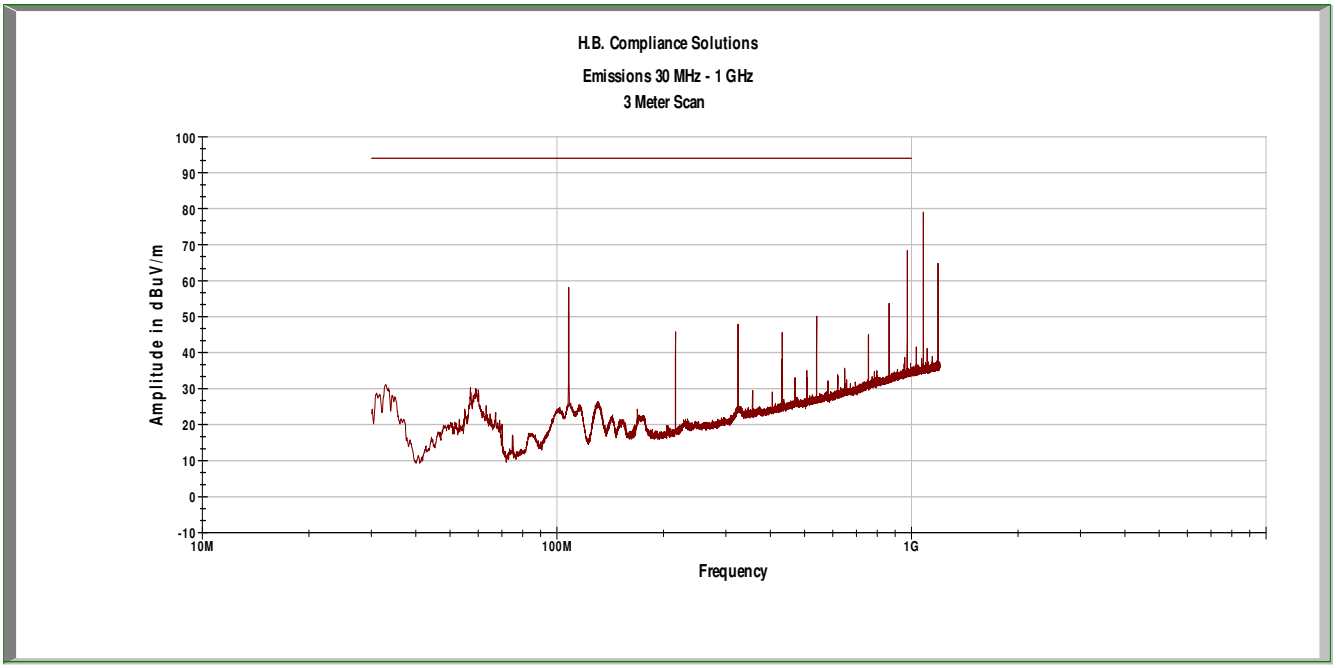
Figure 5 – Radiated Spurious Emissions



Plot 18 – Low Band



Plot 19 – Mid Band



Plot 20 – High Band

Test Results:

Frequency (MHZ)	Peak Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
175	45.0	84.38	-39.38
350	51.5	84.38	-32.88
437.5	58.4	84.38	-25.98
525	52.9	84.38	-31.48
875	44.6	84.38	-39.78
962.5	68.3	84.38	-16.08

Table 5 - Spurious Radiated Emission Data – Low Band

Frequency (MHZ)	Peak Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
195.4	39.9	84.38	-44.48
488.5	44.8	84.38	-39.58
586.2	54.2	84.38	-30.18
683.9	41.8	84.38	-42.58
781.6	37.4	84.38	-46.98
977.0	65.6	84.38	-18.78

Table 6 – Spurious Radiated Emission Data – Mid Band

Frequency (MHZ)	Peak Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
216	44.9	84.38	-39.48
324	47.8	84.38	-36.58
432	45.5	84.38	-38.88
540	50.1	84.38	-34.28
864	53.6	84.38	-30.78
972	68.3	84.38	-16.08

Table 7 – Spurious Radiated Emission Data – High Band

Note: ERP Limit = -13dBm which converts to 84.38dBuV/m @ 3meter

6. Frequency Stability vs Temperature

Test Requirement(s):	§2.1055; §73.1545(b) and §74.1261	**Test Engineer(s):**	Jerry M.
Test Results:	Pass	**Test Date(s):**	08/24/2020

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:

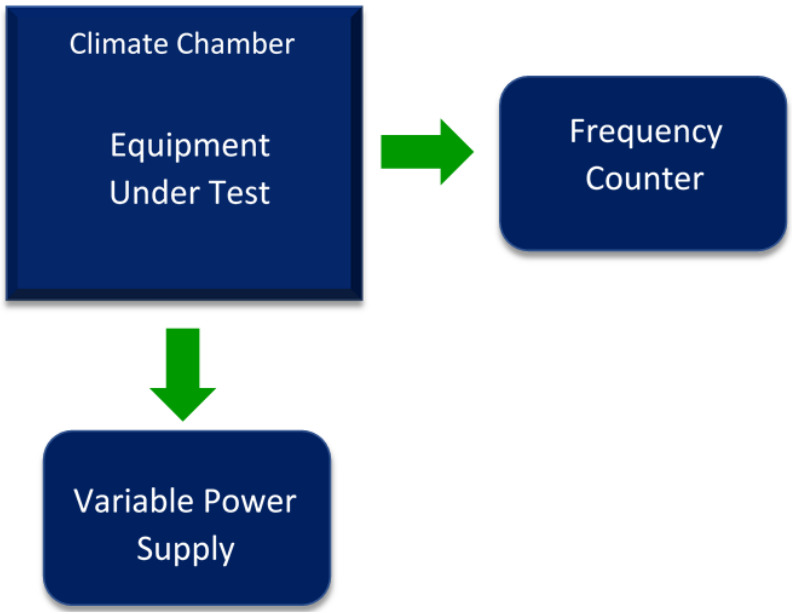
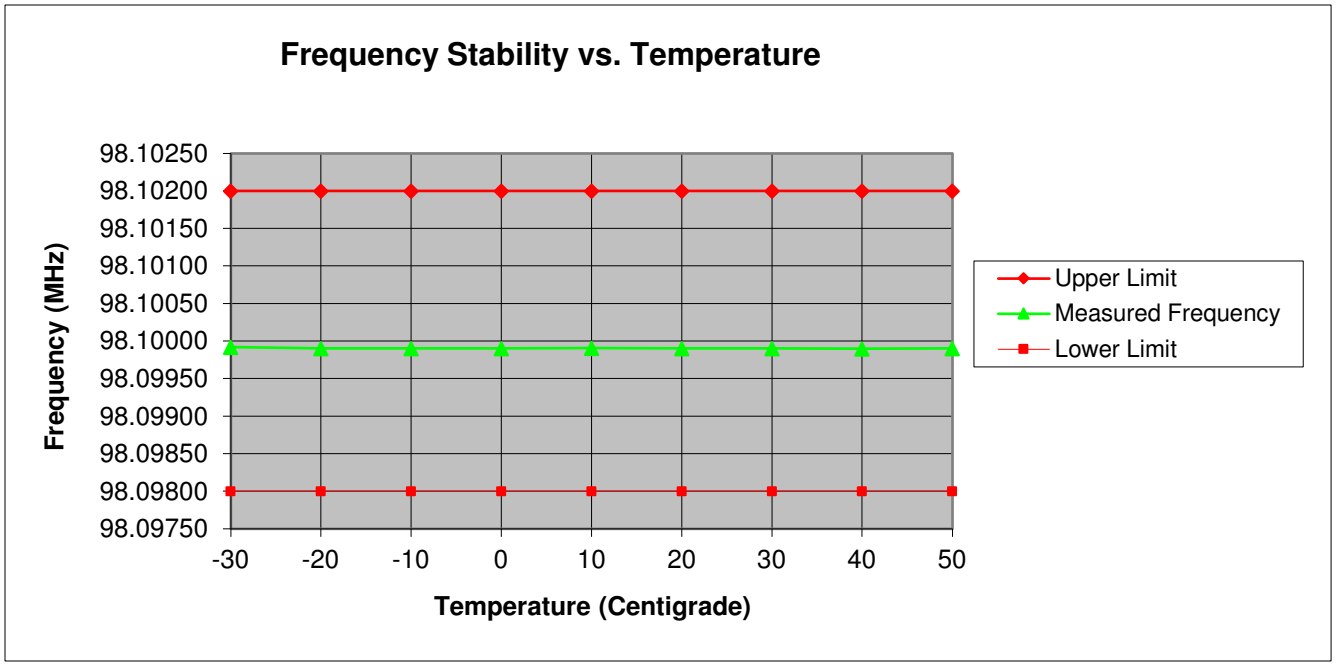


Figure 6 – Frequency Stability Test Setup

Test Results:

Temperature centigrade	Measured Frequency (MHz)	Upper Margin (MHz)	Lower Margin (MHz)	Limit
-30	98.099921	-0.0020790	0.001921	±2kHz
-20	98.099903	-0.0020970	0.001903	±2kHz
-10	98.099904	-0.0020960	0.001904	±2kHz
0	98.099903	-0.0020970	0.001903	±2kHz
10	98.099905	-0.0020950	0.001905	±2kHz
20	98.099902	-0.0020980	0.001902	±2kHz
30	98.099901	-0.0020990	0.001901	±2kHz
40	98.099900	-0.0021000	0.001900	±2kHz
50	98.099902	-0.0020980	0.001902	±2kHz

Table 8 – Temperature vs Frequency Test Result



Plot 21 – Temperature vs Frequency

7. Frequency Stability vs Voltage

Test Requirement(s):	§2.1055; §73.1545(b) and §74.1261	**Test Engineer(s):**	Jerry Mejak
Test Results:	Pass	**Test Date(s):**	08/24/2020

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 AC source. The frequency was measured at both the nominal 230Vac 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: 98.1MHz at 230Vac at 20°C

Test Setup:

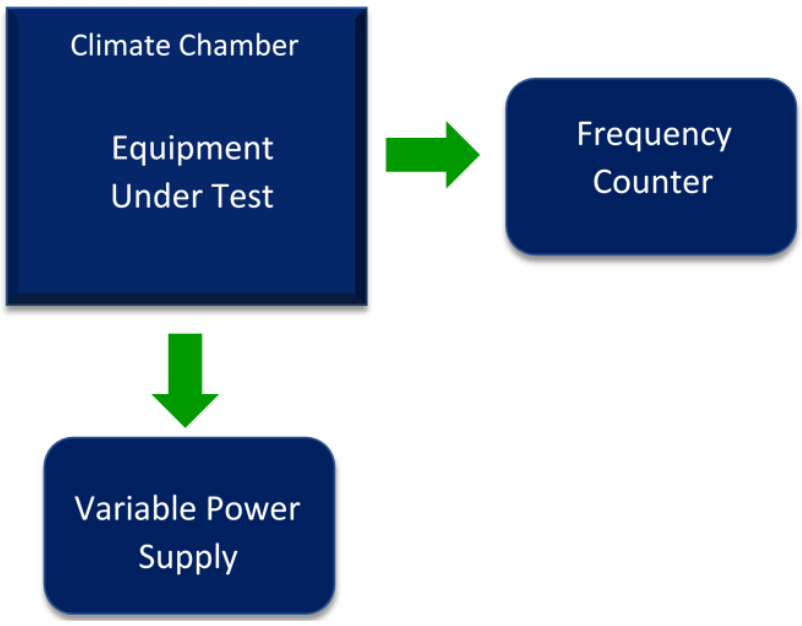
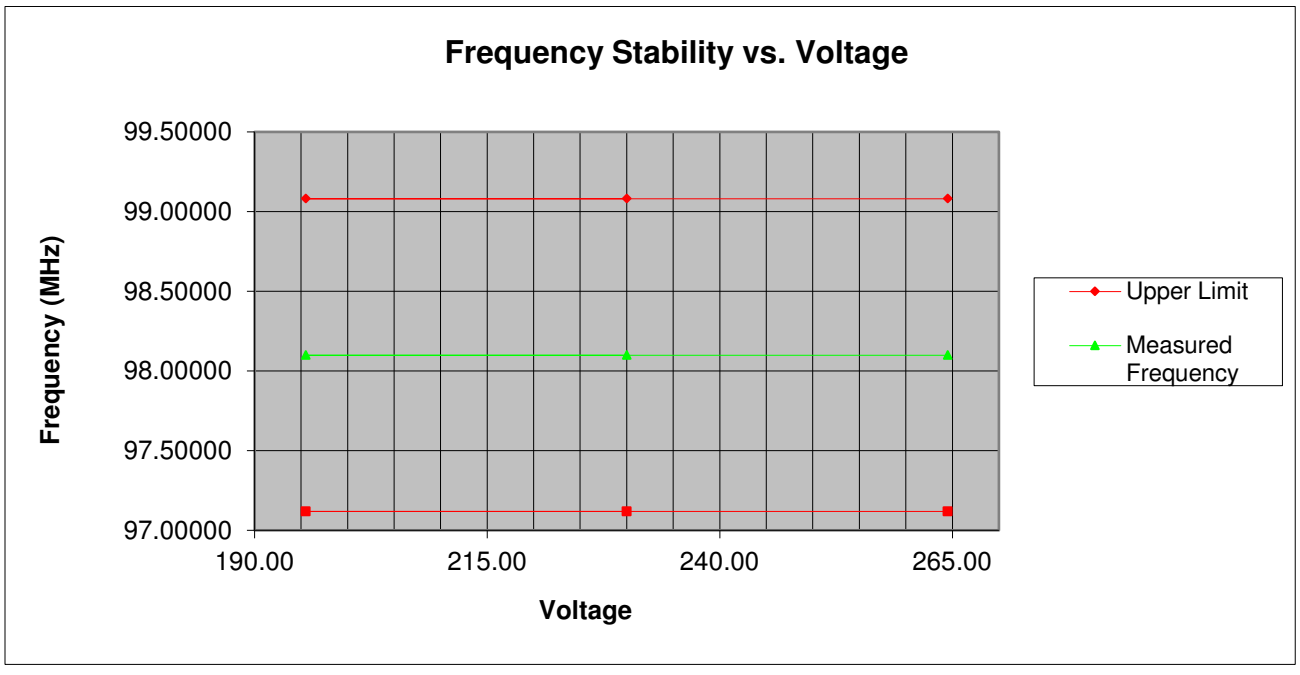


Figure 7 – Frequency Stability Test Setup

Test Results:

Input Voltage (Vdc)	Measured Frequency (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
230.00	98.09990	-0.98110	0.98090
195.50	98.09990	-0.98110	0.98090
264.50	98.09990	-0.98110	0.98090

Table 9. Temperature vs. Voltage Test Result



Plot 22 – Temperature vs Voltage

8. Necessary Bandwidth

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

B = 2M + 2DK

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

Calculation

M = 15K

Peak Deviation of Carrier (D) = 75kHz

K = 1

Bn = 2(15kHz) + 2(75kHz) (1) = 180kHz

Emission Designator: 180KF3E

9. Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Digital Multimeter	Fluke	77 III	72550270	Apr-10-20	Apr-10-21
Spectrum Analyzer	Agilent	E4443A	US41420164	Jan/03/20	Jan/03/21
Temperature Chamber	Test Equity	1207C	60161	Aug/31/20	Aug/31/21
Antenna	EMCO	GTEM 5417	1063	Verified	
Spectrum Analyzer	Hewlett Packard	8563E	3821A09316	May/01/20	May/01/21
Modulation Analyzer	Hewlett Packard	8901B	2806A01528	Aug/24/20	Aug/24/21
Function Generator	Wavetek	145	L6610707	Verified	
Band Stop Filter	Mini-Circuits	ZX7BS-88108S+	None	Verified	
EMI Receiver	Hewlett Packard	8568B	2314A02642	11-Oct-19	11-Oct-20
Signal Generator	Agilent	E4432B	US40053021	Sep/23/19	Sep/23/21
Attenuator 30dB	Weinschel	33-30-34	8F1679	Verified	
Horn Antenna	Com-Power	AHA-118	711150	Nov/12/18	Nov/12/20
Diode/Crystal Detector	H.P.	8470B	None	Verified	
Combiner/Splitter	Mini-Circuits	ZFSC-2-2	None	Verified	
Oscilloscope	Tektronix	TDS 3052	B013389	Oct/10/19	Oct/10/20

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)

10. 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
RF Power, Conducted	dBm	150kHz – 18GHz	± 0.2dB
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