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HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

January 10, 2020

HID Global Corporation
6533 Flying Cloud Drive
Eden Prairie, MN 55344

Dear Robert Cresswell,

Enclosed is the EMC test report for compliance testing of the HID Global Corporation, Model: 20K, tested to the requirements of Title 47 of the CFR, Part 15.225, Subpart C for Certification as an Intentional Radiator.

Thank you for using the services of Eurofins MET Labs, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS MET LABS, INC.

Michelle Tawmging
Documentation Department

Reference: (\HID Global Corporation\EMCA104934-FCC225 SRD 20K Rev. 3)

Electromagnetic Compatibility Criteria
Test Report

for the

HID Global Corporation
HID Signo Reader
Model: 20K

Tested under
the FCC Certification Rules
contained in
15.225 Subpart C
for Intentional Radiators

MET Report: EMCA104934-FCC225 SRD 20K Rev. 3

January 10, 2020

Prepared For:

HID Global Corporation
6533 Flying Cloud Drive
Eden Prairie, MN 55344

Prepared By:
Eurofins MET Labs, Inc.
13501 McCallen Pass
Austin, TX 78753

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Adan Arab
Electromagnetic Compatibility Lab

Michelle Tawmging
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures 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 measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.225 under normal use and maintenance.

Jonathan Tavira,
Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	October 24, 2019	Initial Issue
1	October 29, 2019	Implemented Customer-Requested Revisions
2	November 4, 2019	Implemented Customer-Requested Revisions
3	January 10, 2020	Implemented TCB-Requested Revisions

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I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation Model: 20K, with the requirements of Part 15, §15.225. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Model: 20K. HID Global Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Model: 20K, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.225, in accordance with HID Global Corporation, purchase order number HID000518. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.225	Description	Compliance Model: 20K Pigtail	Compliance Model: 20K Terminal
Part 15 §15.203	Antenna Requirement	Compliant	Compliant
Part 15 §15.207(a)	Conducted Emission Limits	Compliant	Compliant
Part 15 §15.215	20dB Occupied Bandwidth	Compliant	Compliant
Part 15 §15.225(a)	Field Strength emissions within the band 13.553 – 13.567 MHz	Compliant	Compliant
Part 15 §15.225(b)	Field Strength emissions within the band 13.410 – 13.553 MHz and 13.567 – 13.710 MHz	Compliant	Compliant
Part 15 §15.225(c)	Field Strength emissions within the band 13.110 – 13.410 MHz and 13.710 – 14.010 MHz	Compliant	Compliant
Part 15 §15.225(d)	Outside-Band Field Strength emissions per 15.209 – 13.110 – 14.010 MHz	Compliant	Compliant
Part 15 §15.225(e)	Frequency Tolerance of the Carrier	Compliant	Compliant

Figure 1: Executive Summary of EMC Part 15.225 ComplianceTesting

II. Equipment Configuration

A. Overview

Eurofins MET Labs, Inc. was contracted by HID Global Corporation to perform testing on the Model: 20K, under HID Global Corporation's purchase order number HID000518.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the HID Global Corporation, Model: 20.

The results obtained relate only to the item(s) tested.

Models Tested:	20K Pigtail and Terminal	
Models Covered:	20K	
EUT Specifications:	Primary Power: 12VDC	
	FCC ID: JQ6-SIGNO20K	
	Type of Modulations:	FSK
	Equipment Code:	DXX
	Peak Field Strength:	35.98 dBµV/m
	Operating Frequency:	13.56 MHz
	Antenna Type:	Inductive Loop
	Antenna Gain:	1 dBi
	Firmware Version:	R9.1.0.19
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860 – 1060 mbar	
Evaluated by:	Adan Arab	
Report Date:	January 10, 2020	

Figure 2: EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Figure 3: References

C. Test Site

All testing was performed at Eurofins MET Labs, Inc., 13501 McCallen Pass, Austin, TX 78753. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

Correlation between semi-anechoic chamber and OATS:

Two calibrated Loop antennas were used on an OATS. One antenna was driven by a signal generator with a known power. The receive antenna was initially placed 1m away from the transmit antenna. The two antennas were placed parallel to each other. The receive antenna was in turn connected to a calibrated spectrum analyzer. The emissions were swept from 9 kHz to 30 MHz. The receive antenna was then rotated 90 Degrees and measurements re-taken. Additional measurements were taken when the receive antenna was placed at 3meters. This same setup was taken to inside the semi-anechoic chamber and the measurements repeated.

The data was used to correlate the semi-anechoic chamber and OATS.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Figure 4: Uncertainty Calculations Summary

E. Description of Test Sample

The Model: 20K, Equipment Under Test (EUT) is typically installed near doorway as part of physical access system, to control access to that door. A user will approach the door and present a BLE or RFID credentials to the leader with intention of entering the door. The reader will read the credential and send its data to a connected access control panel, which determine whether or not grant the user access to the door. Optionally, a personal identification number (PIN) may also be required, in which case the user will enter the PIN on the reader's keypad.

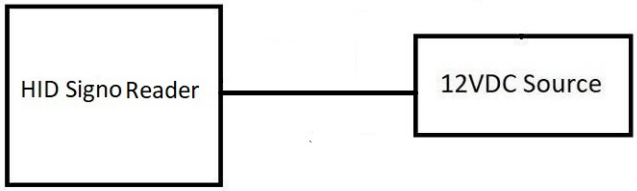


Figure 5: Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in **Figure 5.** All equipment incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
	N/A	HID Signo Reader	20K	N/A	N/A	N/A

Figure 6: Equipment Configuration

G. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part number	Serial Number	Rev. #
N/A	N/A	12VDC Source	DURACELL Battery	N/A	N/A	N/A
N/A	N/A	Tablet	Galaxy Tab 4	N/A	N/A	N/A

Figure 7: Support Equipment

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length(m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	+VDC	Power	1	0.3	0.3	Y	
2	GND	Power	1	0.3	0.3	Y	
3	Data1	Data	1	0.3	0.3	Y	
4	Data0	Data	1	0.3	0.3	Y	
5	GLED	Data	1	0.3	0.3	Y	
6	RLY1	Data	1	0.3	0.3	Y	
7	RLY2	Data	1	0.3	0.3	Y	
8	RLED	Data	1	0.3	0.3	Y	
9	HOLD	Data	1	0.3	0.3	Y	
10	Beep	Data	1	0.3	0.3	Y	

Figure 8: Ports and Cabling

I. Mode of Operation During Testing

A 12V DC provided to the EUT, once booting process done and LED's on readers turn solid RED the unit is ready to be tested. An HF/LF credential were presented to the reader for a continuously operation. The unit will beep every few seconds and LED's flashing constantly means that the unit is reading and data is going back and forth between the credential and the reader. In order to operate the BT radio, a tablet was paired to the unit via BT link and signal information presented via the HID app to insure connection is constant.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to HID Global Corporation upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT was analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Model: 20K Pigtail

Test Results: The EUT is **compliant** with the requirement of §15.203. The 20K-Pigtail Card Reader implements a loop antenna that is permanently installed. Therefore, the 20K-Pigtail Card Reader satisfies the all requirements under section 15.203.

Test Engineer: Jonathan Tavira

Test Date: September 17, 2019

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.203 Antenna Requirement. The 20K-Terminal Card Reader implements a loop antenna that is permanently installed.
Therefore, the 20K-Terminal Card Reader satisfies the all requirements under section 15.203.

Test Engineer: Jonathan Tavira

Test Date: September 12, 2019

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50

Figure 9: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Note: *Decreases with the logarithm of the frequency.

Test Procedure: The EUT was placed on a 0.8 m-high non-conducting table above a ground plane. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.10-2013 "Procedures for Compliance Testing of Unlicensed Wireless Devices"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMI receiver. For the purpose of this testing, the transmitter was turned on at full power during scans.

Sample Calculation:

Rr – S = M

where:

Rr = Receiver Reading in dBμV
S = Specification Limit in dBμV
M = Margin to Specification in +/- dB

Sample formula for calculating the Corrected Data for the Conducted Emissions Measurements:

Line	Freq (MHz)	Uncorrected QP** Amplitude (dBμV)	LISN IL (dB)	CBL (dB)	Corrected QP** Amplitude (dBμV)	QP** Limit (dBμV)	Delta (dB)	Results
XYZ	0.18	42.65	10	0.58	53.23	79	-25.77	Pass

*Corrected QP** Amplitude (dBμV) = Uncorrected Amplitude (dBμV) +LISN IL (dB) + CBL (dB)=42.65+10+0.58=53.23*
*** Same Calculation applies to Corrected Avg. amplitude as well.*

Conducted Emissions Voltage Test Setup

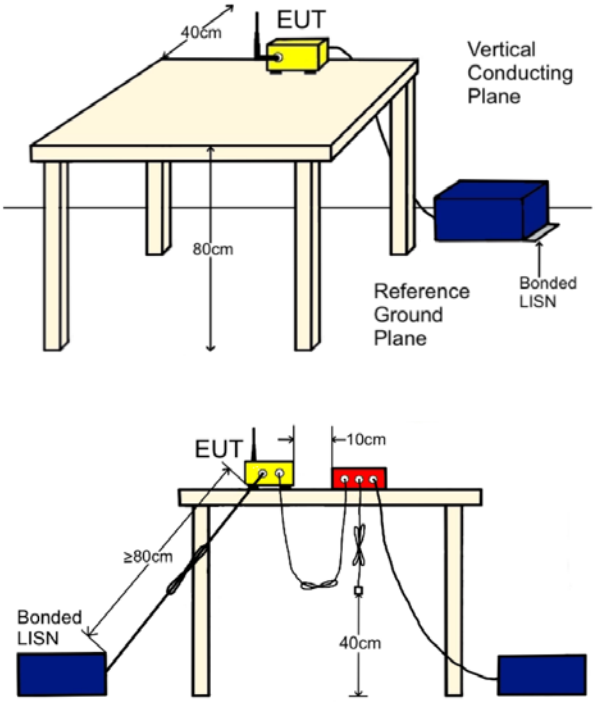


Figure 10: CEV Test Setup

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.207(a) Conducted Emissions Limits. Measured emissions were below applicable limits.

Test Engineer: Adan Arab

Test Date: August 6, 2019

Test Data, Model: 20K Pigtail

Meas. Location	Meas. mΩ	Limit	Pass/Fail
Bonding measurement from LISN ground to ground plane	0.874	< 2.5 mΩ	Pass

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line1_120VAC 60Hz	0.482	41.90	56.313	-14.41	Pass	24.40	46.313	-21.91	Pass
Line1_120VAC 60Hz	0.438	43.80	57.124	-13.32	Pass	30.80	47.124	-16.32	Pass
Line1_120VAC 60Hz	0.522	45.50	56.000	-10.50	Pass	36.40	46.000	-9.60	Pass
Line1_120VAC 60Hz	0.406	41.90	57.752	-15.85	Pass	32.50	47.752	-15.25	Pass
Line1_120VAC 60Hz	0.294	40.00	60.426	-20.43	Pass	31.40	50.426	-19.03	Pass
Line1_120VAC 60Hz	1.222	40.40	56.000	-15.60	Pass	30.90	46.000	-15.10	Pass

Figure 11: Conducted Emissions Limits, Pigtail, Phase Line, Test Results

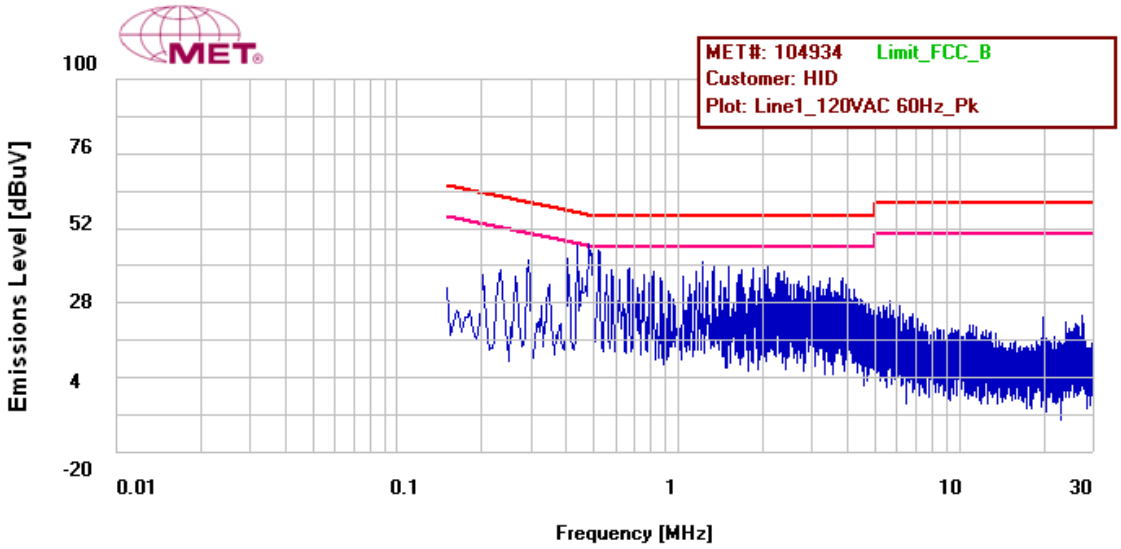


Figure 12: Conducted Emissions Limits, Pigtail, Phase Line, Prescan

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral_120VAC 60Hz	0.550	36.20	56.000	-19.80	Pass	24.10	46.000	-21.90	Pass
Neutral_120VAC 60Hz	0.726	34.50	56.000	-21.50	Pass	23.30	46.000	-22.70	Pass
Neutral_120VAC 60Hz	0.466	48.40	56.602	-8.20	Pass	37.40	46.602	-9.20	Pass
Neutral_120VAC 60Hz	0.294	36.90	60.426	-23.53	Pass	25.60	50.426	-24.823	Pass
Neutral_120VAC 60Hz	3.318	29.40	56.000	-26.60	Pass	17.40	46.000	-28.60	Pass
Neutral_120VAC 60Hz	1.426	30.80	56.000	-25.20	Pass	19.40	46.000	-26.60	Pass

Figure 13: Conducted Emissions Limits, Pigtail, Neutral Line, Test Results

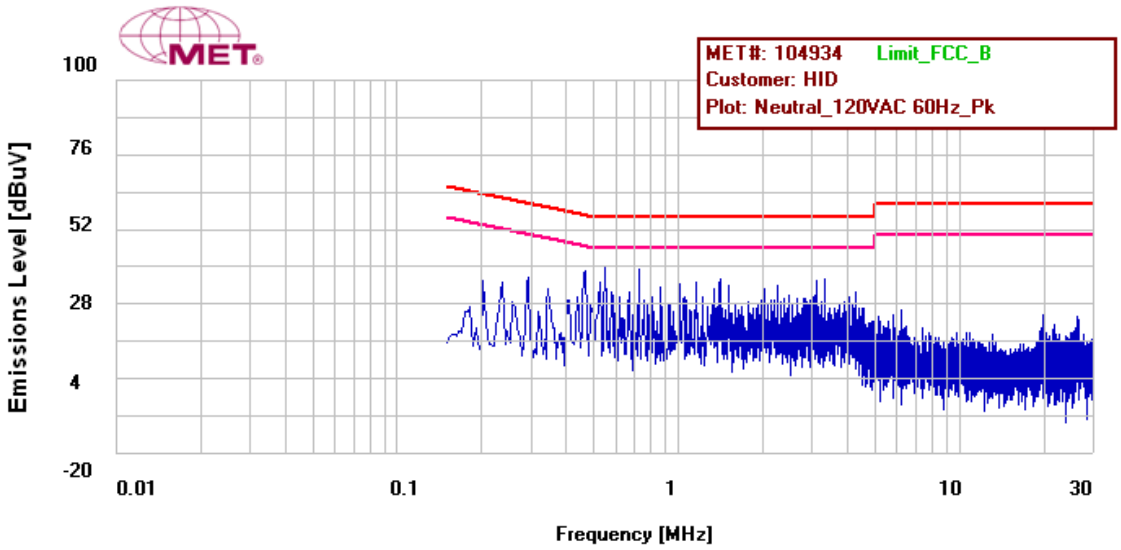


Figure 14: Conducted Emissions Limits, Pigtail, Neutral Line, Prescan

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.207(a) Conducted Emissions Limits. Measured emissions were below applicable limits.

Test Engineer: Adan Arab

Test Date: August 5, 2019

Test Data, Model: 20K Terminal

Meas. Location	Meas. mΩ	Limit	Pass/Fail
Bonding measurement from LISN ground to ground plane	00.9987	< 2.5 mΩ	Pass

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Line1_120VAC 60Hz	0.494	47.70	56.103	-8.40	Pass	35.80	46.103	-10.30	Pass
Line1_120VAC 60Hz	0.478	43.90	56.384	-12.48	Pass	32.80	46.384	-13.58	Pass
Line1_120VAC 60Hz	0.438	43.00	57.124	-14.12	Pass	31.90	47.124	-15.22	Pass
Line1_120VAC 60Hz	0.234	41.90	62.317	-20.42	Pass	34.40	52.317	-17.92	Pass
Line1_120VAC 60Hz	0.818	40.20	56.000	-15.80	Pass	30.40	46.000	-15.60	Pass
Line1_120VAC 60Hz	0.526	41.60	56.000	-14.40	Pass	31.70	46.000	-14.30	Pass

Figure 15: Conducted Emissions Limits, Terminal, Phase Line, Test Results

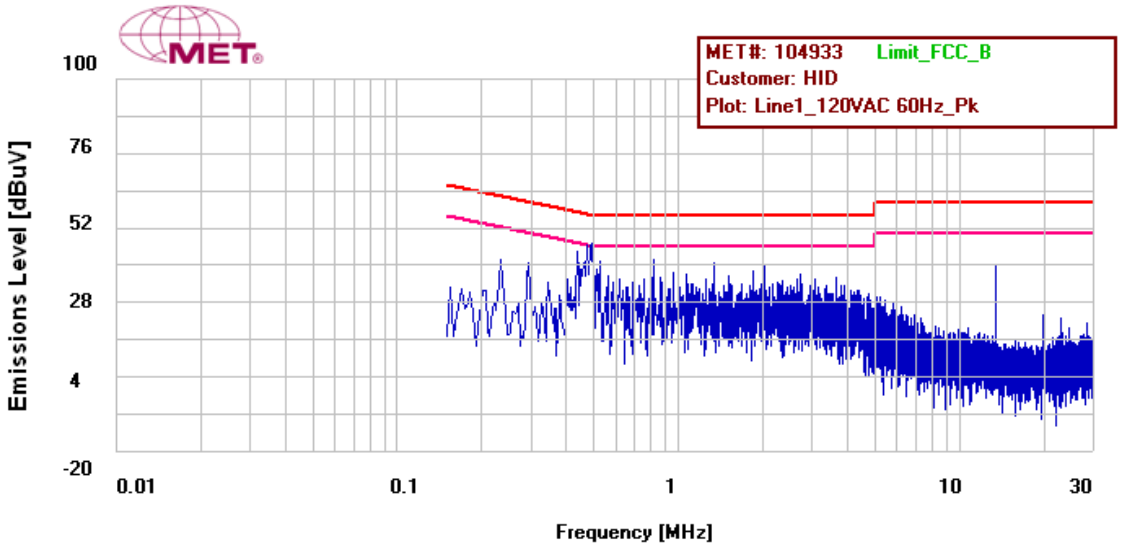


Figure 16: Conducted Emissions Limits, Terminal, Phase Line, Prescan

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass
Neutral_120VAC 60Hz	0.234	39.50	62.317	-22.82	Pass	29.50	52.320	-22.82	Pass
Neutral_120VAC 60Hz	2.038	35.10	56.000	-20.90	Pass	24.90	46.000	-21.10	Pass
Neutral_120VAC 60Hz	0.758	36.90	56.000	-19.10	Pass	27.00	46.000	-19.00	Pass
Neutral_120VAC 60Hz	0.486	37.40	56.243	-18.84	Pass	24.70	46.243	-21.54	Pass
Neutral_120VAC 60Hz	0.670	34.00	56.000	-22.00	Pass	21.40	46.000	-24.60	Pass
Neutral_120VAC 60Hz	3.086	30.30	56.000	-25.70	Pass	19.90	46.000	-26.10	Pass

Figure 17: Conducted Emissions Limits, Terminal, Neutral Line, Test Results

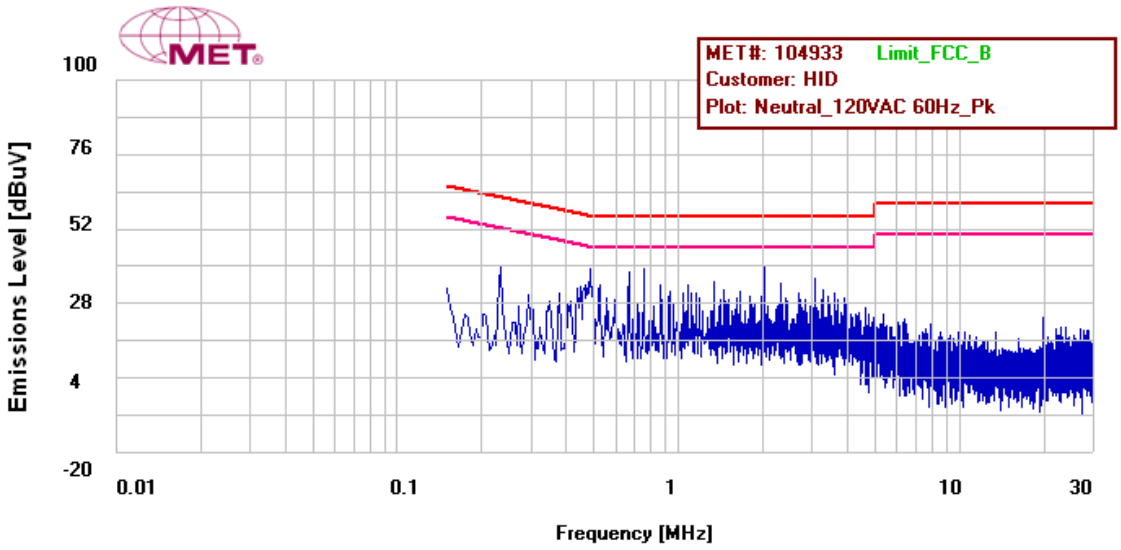


Figure 18: Conducted Emissions Limits, Terminal, Neutral Line, Prescan

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.215(c) 20 dB Occupied Bandwidth

Test Requirement(s): **§ 15.215 (c)** Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measure with the spectrum analyzer using an RBW approximately 1% of the total emission bandwidth. The 20 dB Bandwidth was measured and recorded.

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.215(c) 20 dB Occupied Bandwidth. No anomalies noted.

Test Engineer: Adan Arab

Test Date: August 26, 2019

Test Data, Model: 20K Pigtail

Center Frequency (MHz)	20 dB Bandwidth of Emission (kHz)
13.56	6.249

Figure 19: 20 dB Occupied Bandwidth, Pigtail, Test Results

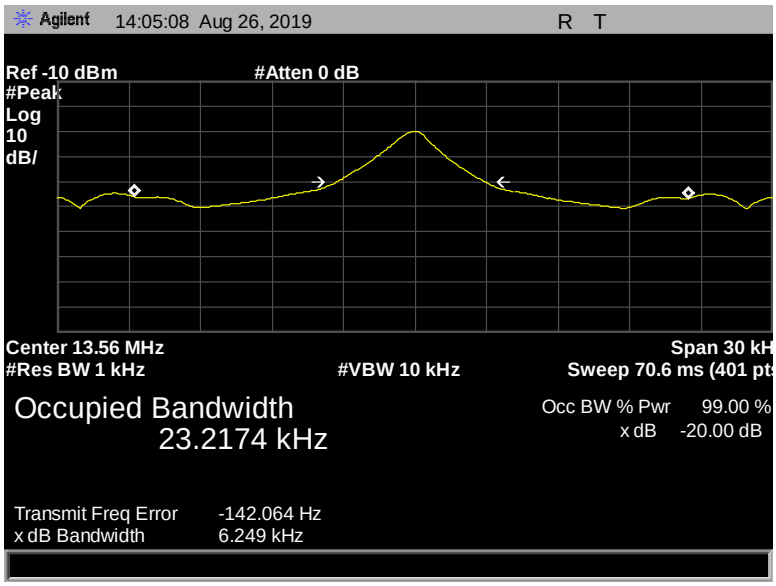


Figure 20: 20 dB Occupied Bandwidth, Pigtail, 6.249 KHz

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.215(c) 20 dB Occupied Bandwidth. No anomalies noted.

Test Engineer: Adan Arab

Test Date: August 26, 2019

Test Data, Model: 20K Terminal

Center Frequency (MHz)	20 dB Bandwidth of Emission (kHz)
13.56	6.214

Figure 21: 20 dB Occupied Bandwidth, Terminal, Test Results

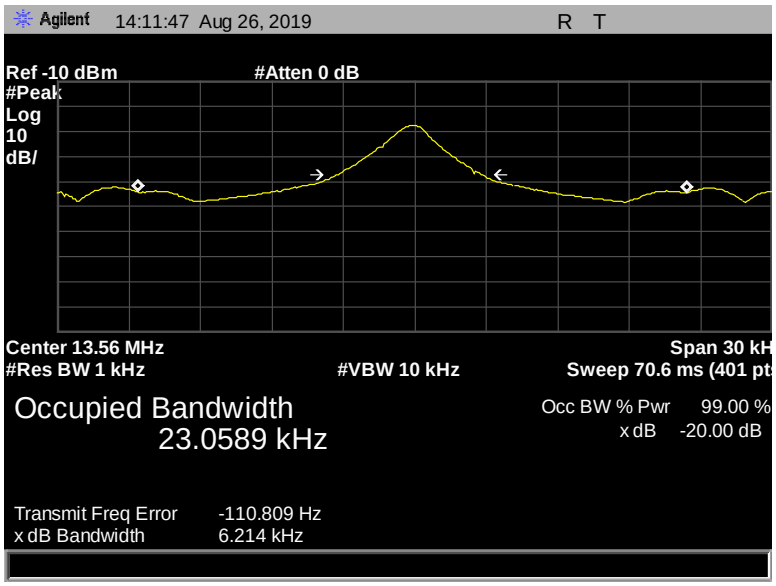


Figure 22: 20 dB Occupied Bandwidth, Terminal, 6.214 KHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(a) Spurious Emission Limits, within the band 13.553 – 13.567 MHz

Test Requirement(s): 15.225 (a) The field strength of any emissions within the band 13.553 – 13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

Test Procedure: The EUT was set to transmit and placed on a 0.8m-high acrylic table inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4: 2014 and ANSI C63.10: 2013 were used. The loop antenna was located 3 m from the EUT. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The measurements were made at 3m and then extrapolated to 30m using the following correction factor.

40log(3/30) = -40 dB

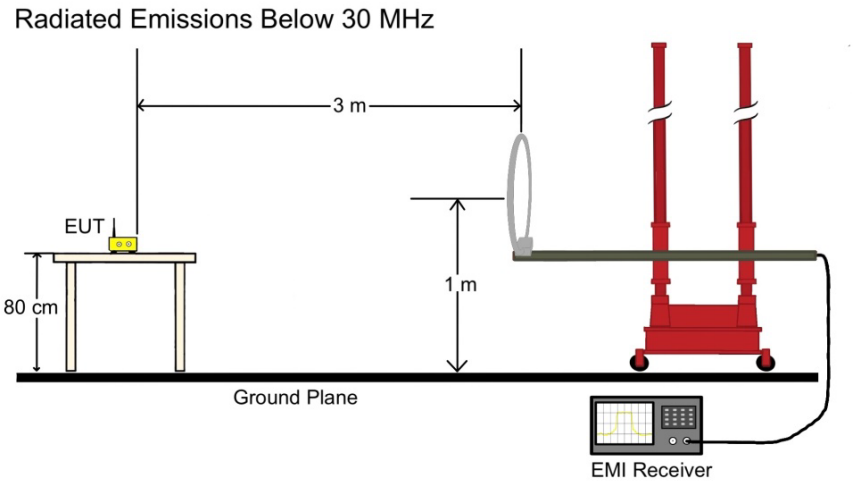


Figure 23: Radiated Emissions, Test Setup

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(a) Spurious Emission Limits, within the band 13.553 – 13.567 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 14, 2019

Test Data, Model: 20K Pigtail

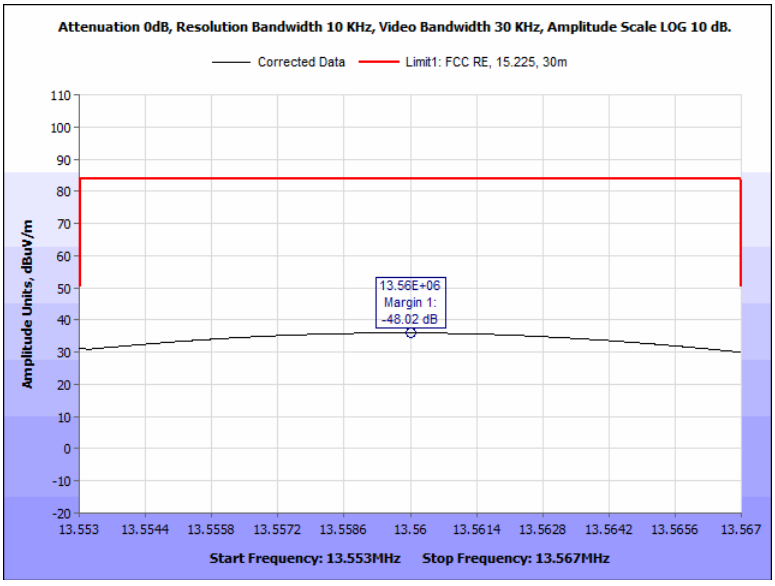


Figure 24: Spurious Emission Limits, within the band 13.553 – 13.567 MHz, Pigtail, 13.553 – 13.567 MHz, 0 Deg

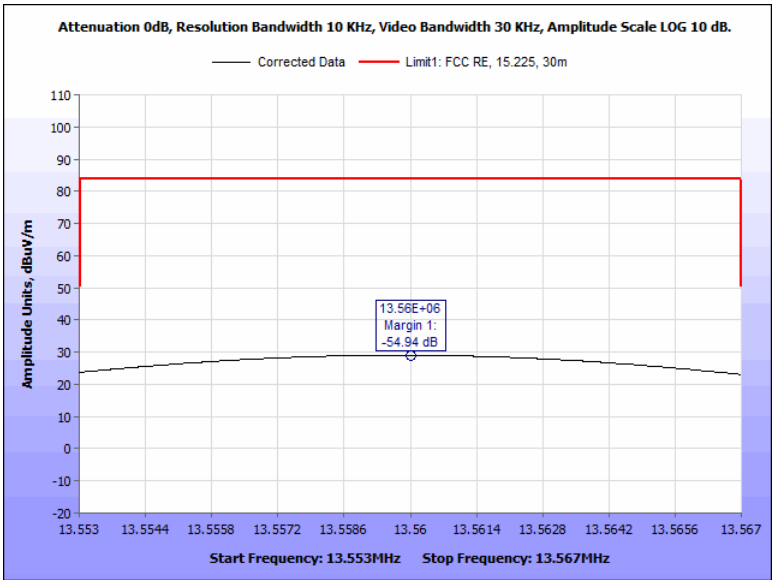


Figure 25: Spurious Emission Limits, within the band 13.553 – 13.567 MHz, Pigtail, 13.553 – 13.567 MHz, 90 Deg

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(a) Spurious Emission Limits, within the band 13.553 – 13.567 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 8, 2019

Test Data, Model: 20K Terminal

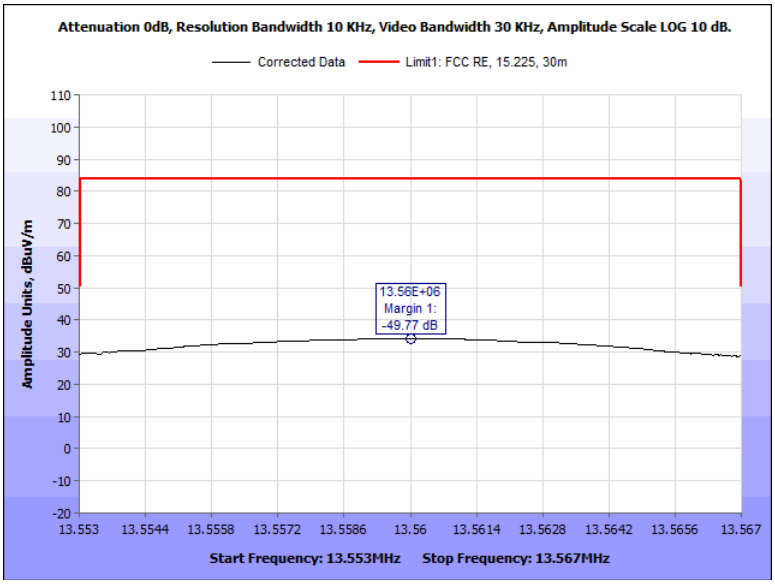


Figure 26: Spurious Emission Limits, within the band 13.553 – 13.567 MHz, Terminal, 13.553 MHz – 13.567 MHz, 0 Deg

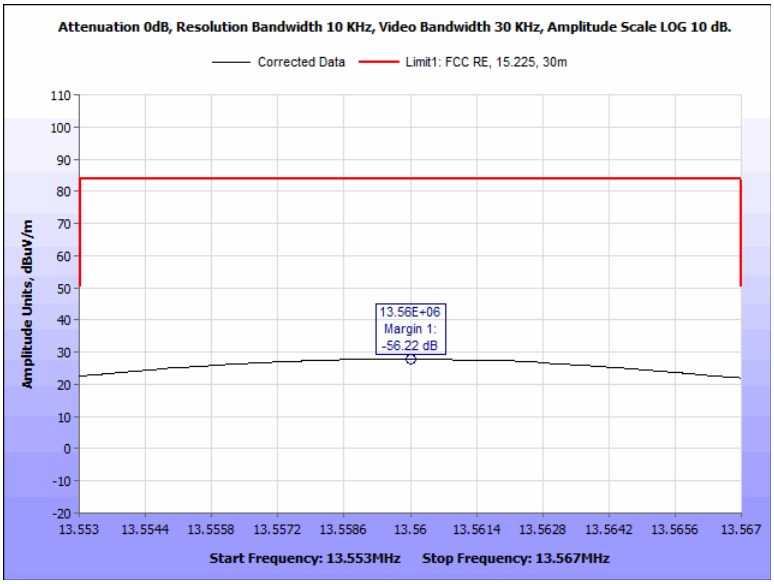


Figure 27: Spurious Emission Limits, within the band 13.553 – 13.567 MHz, Terminal, 13.553 MHz – 13.567 MHz, 90 Deg

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(b) Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz

Test Requirement(s): **15.225 (b)** Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

Test Procedure: The EUT was set to transmit and placed on a 0.8m-high wooden stand inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4: 2014 and ANSI C63.10: 2013 were used. The loop antenna was located 3 m from the EUT. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The measurements were made at 3m and then extrapolated to 30m using the following correction factor.

40log(3/30) = -40 dB

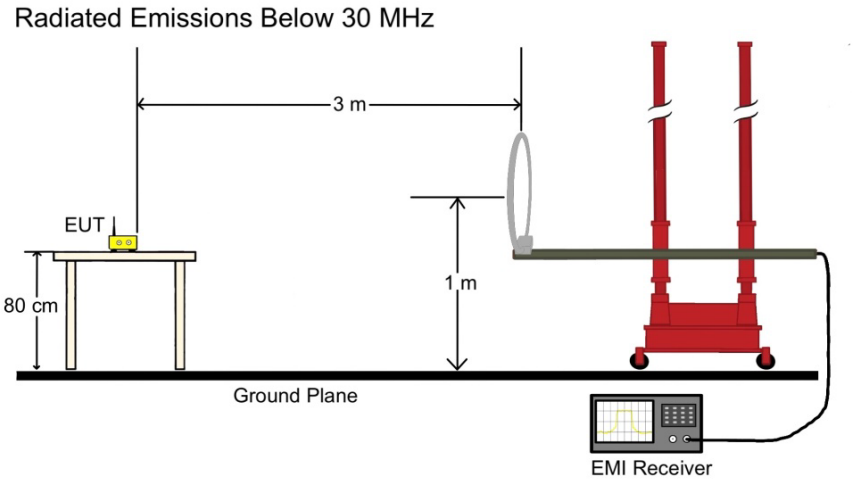


Figure 28: Radiated Emissions, Test Setup

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(b) Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 14, 2019

Test Data, Model: 20K Pigtail

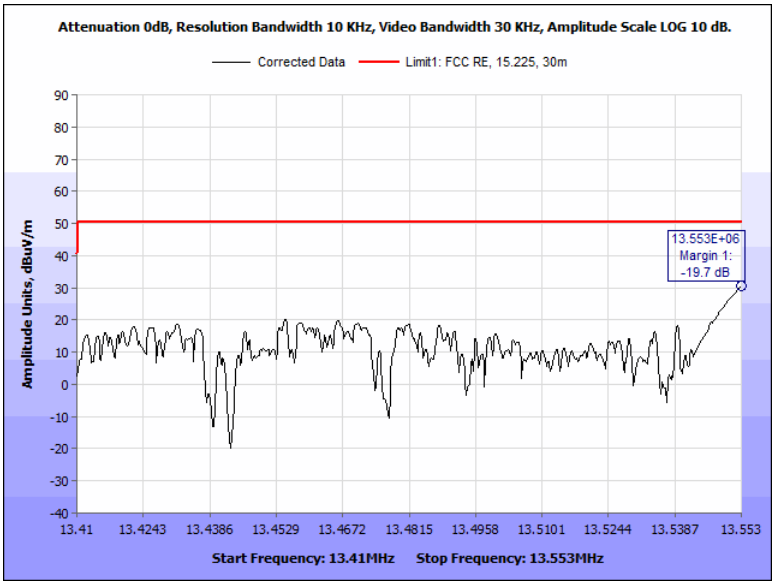


Figure 29: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Pigtail, 13.410 – 13.553 MHz, 0 Deg

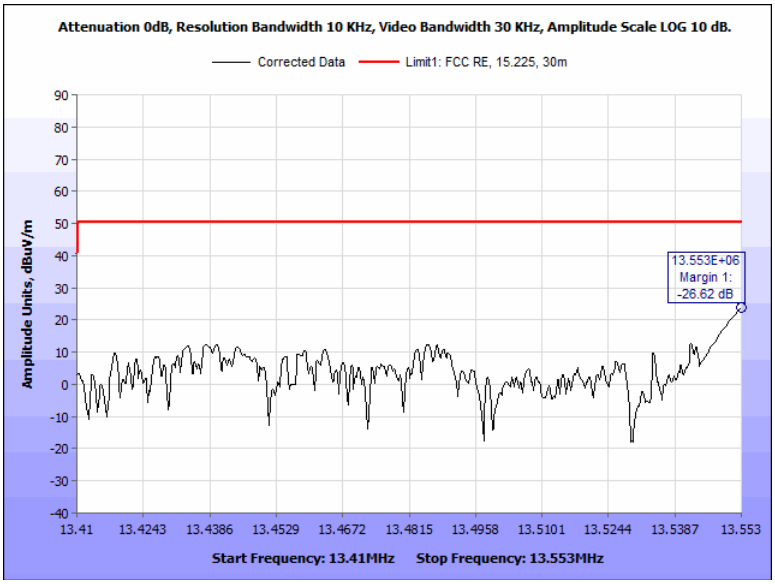


Figure 30: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Pigtail, 13.410 – 13.553 MHz, 90 Deg

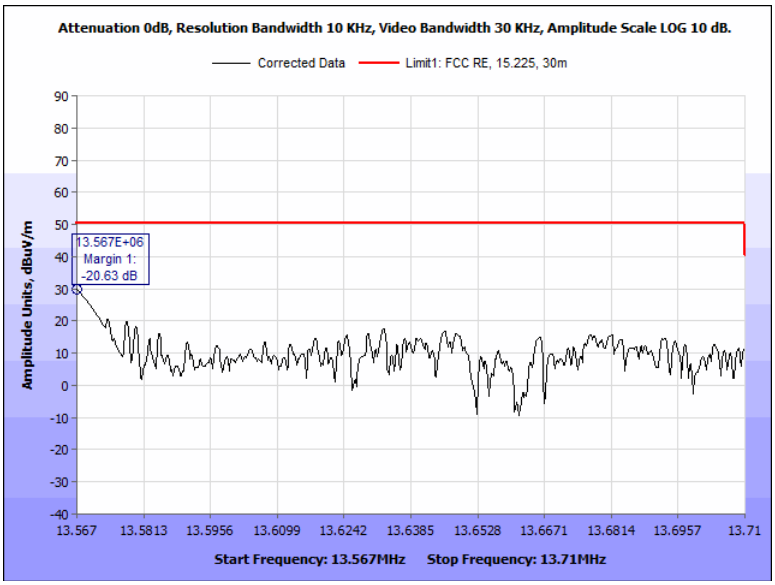


Figure 31: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Pigtail, 13.567 – 13.710 MHz, 0 Deg

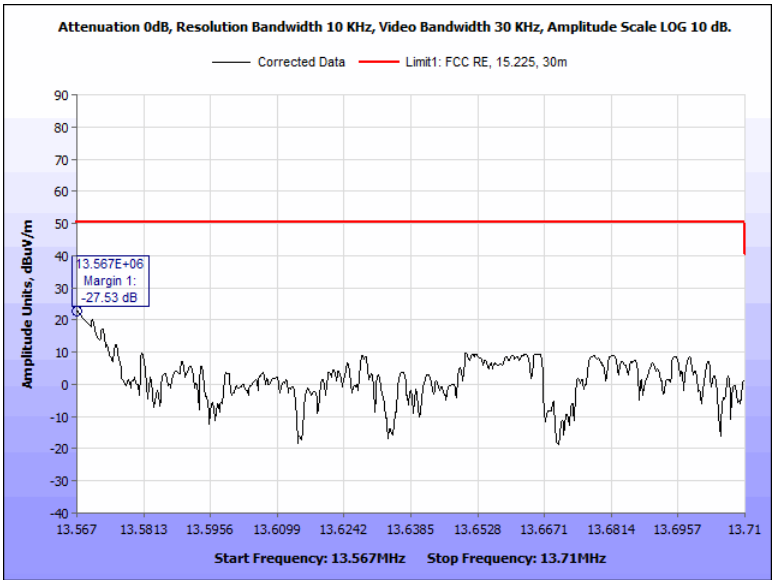


Figure 32: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Pigtail, 13.567 – 13.710 MHz, 90 Deg

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(b) Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 8, 2019

Test Data, Model: 20K Terminal

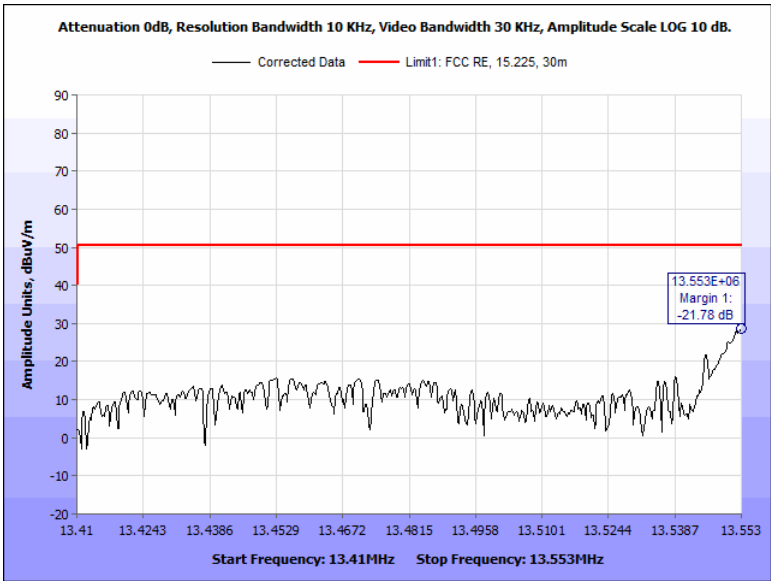


Figure 33: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Terminal, 13.410 MHz – 13.553 MHz, 0 Deg

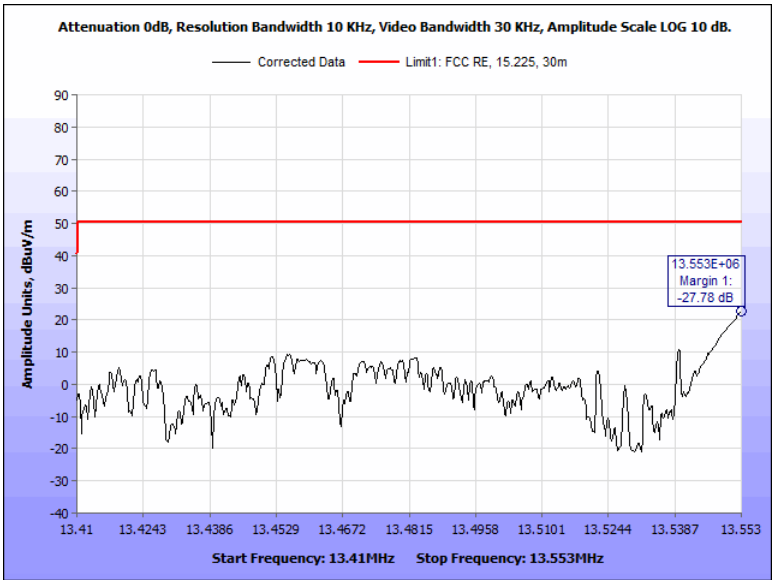


Figure 34: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Terminal, 13.410 MHz – 13.553 MHz, 90 Deg

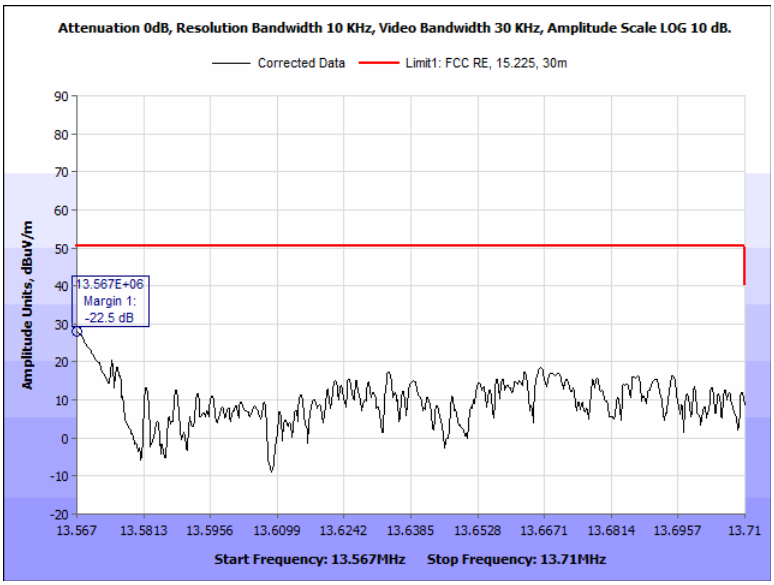


Figure 35: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Terminal, 13.567 MHz – 13.710 MHz, 0 Deg

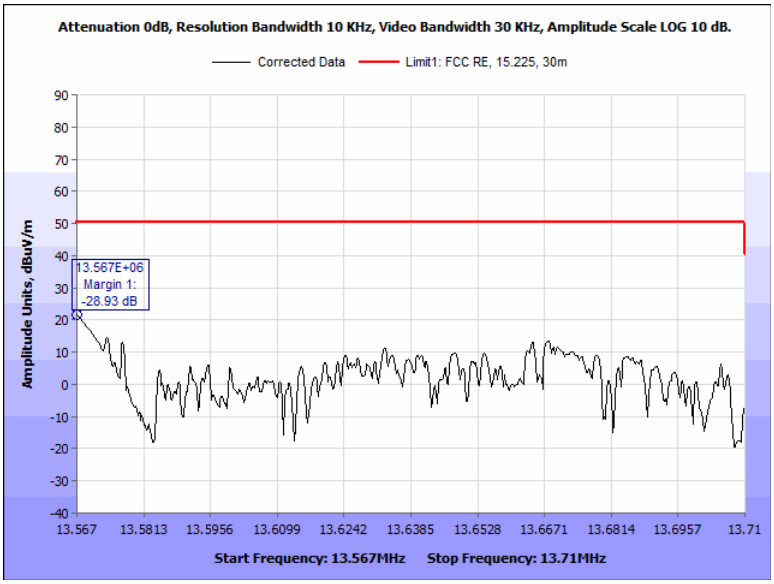


Figure 36: Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Terminal, 13.567 MHz – 13.710 MHz, 90 Deg

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(c) Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz

Test Requirement(s): **15.225 (c)** Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

Test Procedure: The EUT was set to transmit and placed on a 0.8m-high wooden stand inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4: 2014 and ANSI C63.10: 2013 were used. The loop antenna was located 3 m from the EUT. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The measurements were made at 3m and then extrapolated to 30m using the following correction factor.

40log(3/30) = -40 dB

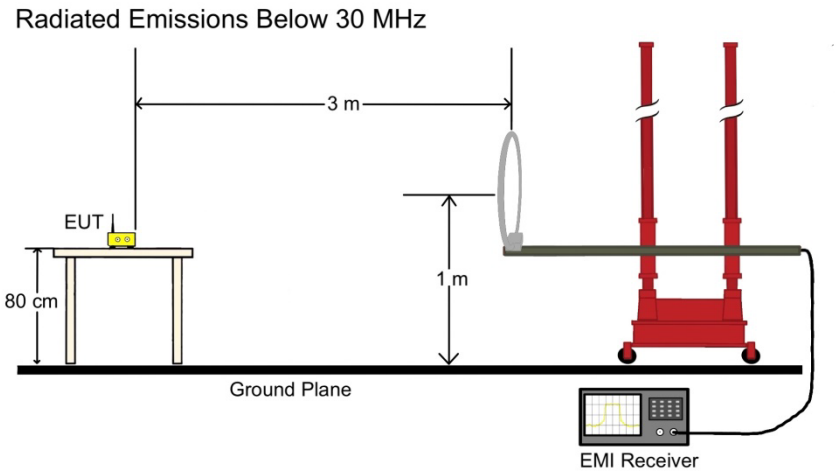


Figure 37: Radiated Emissions, Test Setup

Model: 20 K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(c) Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 14, 2019

Test Data, Model: 20K Pigtail

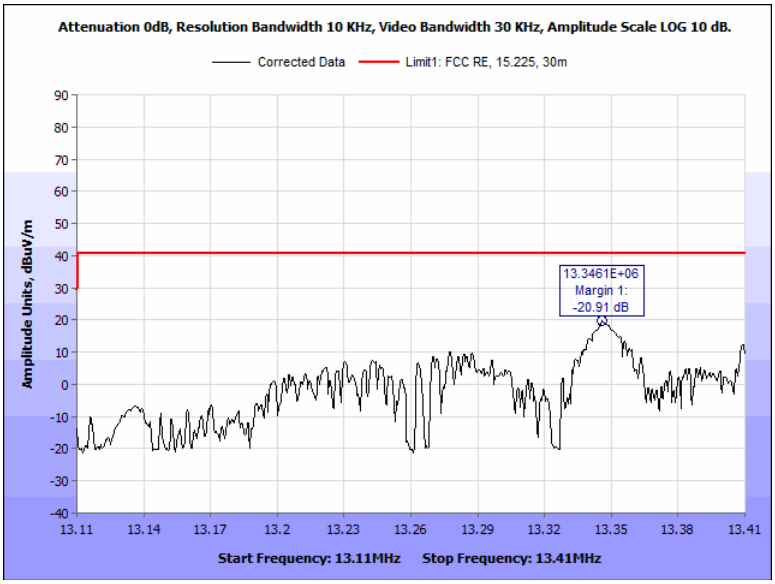


Figure 38: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Pigtail, 13.110 – 13.410 MHz, 0 Deg

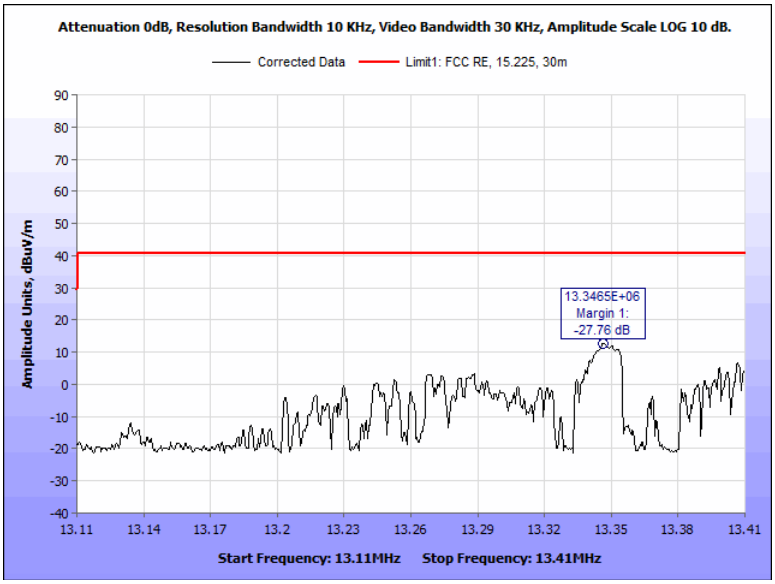


Figure 39: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Pigtail, 13.110 – 13.410 MHz, 90 Deg

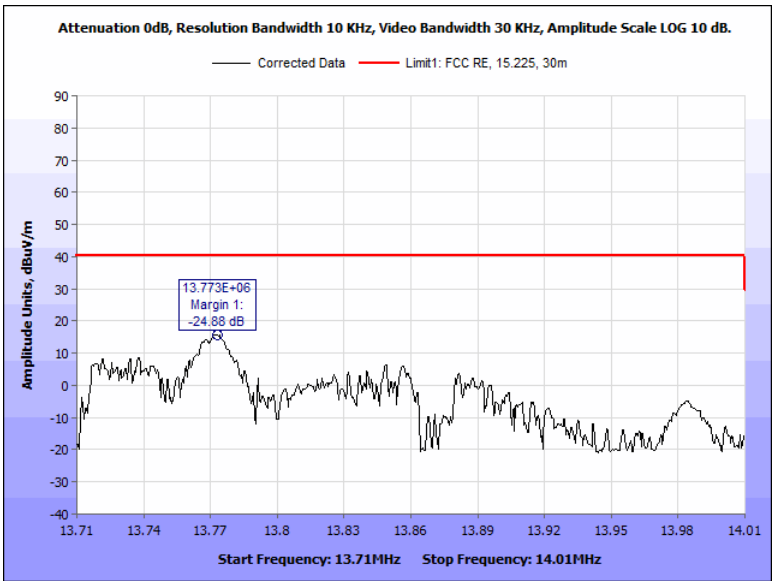


Figure 40: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Pigtail, 13.710 – 14.010 MHz, 0 Deg

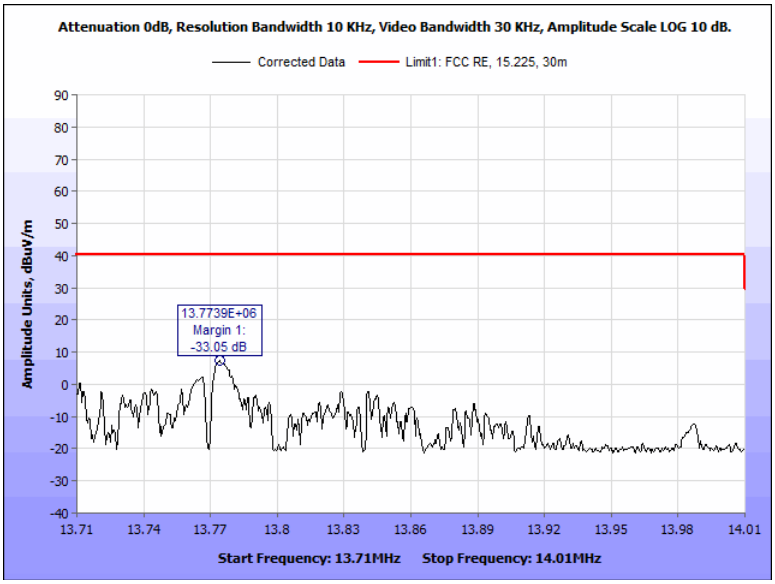


Figure 41: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Pigtail, 13.710 – 14.010 MHz, 90 Deg

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(c) Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 8, 2019

Test Data, Model: 20K Terminal

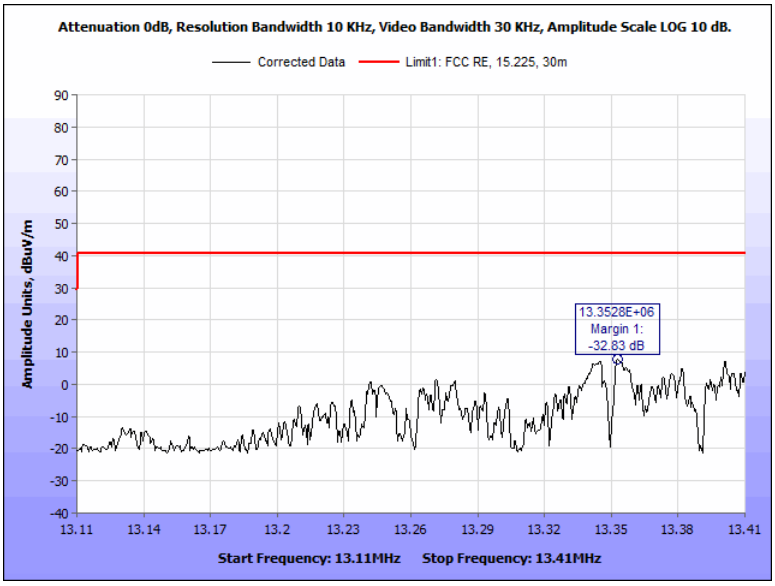


Figure 42: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Terminal, 13.110 MHz – 13.410 MHz, 0 Deg

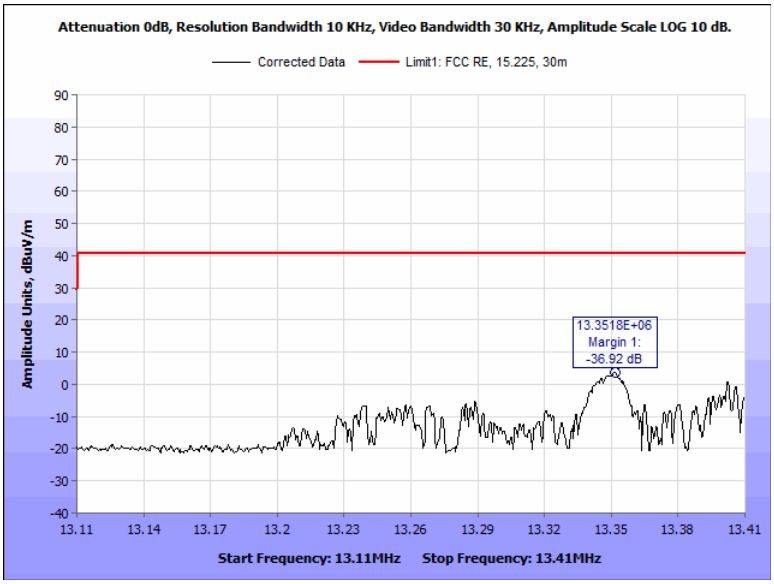


Figure 43: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Terminal, 13.110 MHz – 13.410 MHz, 90 Deg

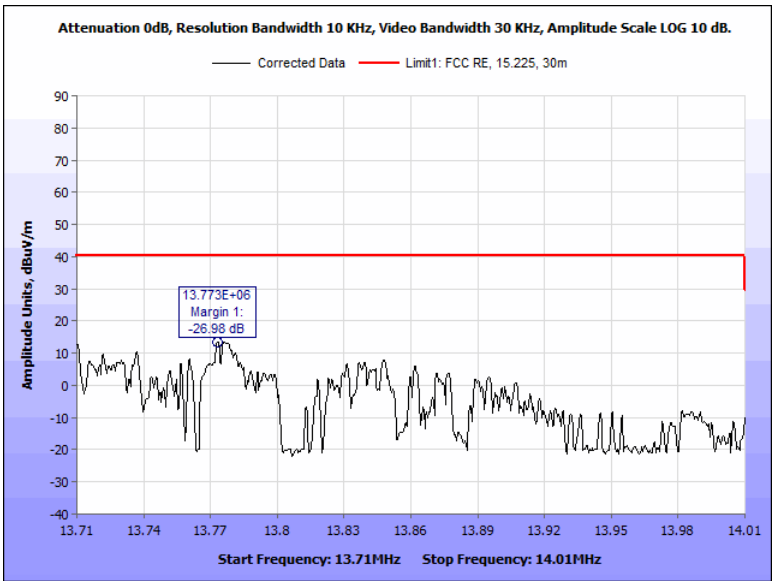


Figure 44: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Terminal, 13.710 MHz – 14.010 MHz, 0 Deg

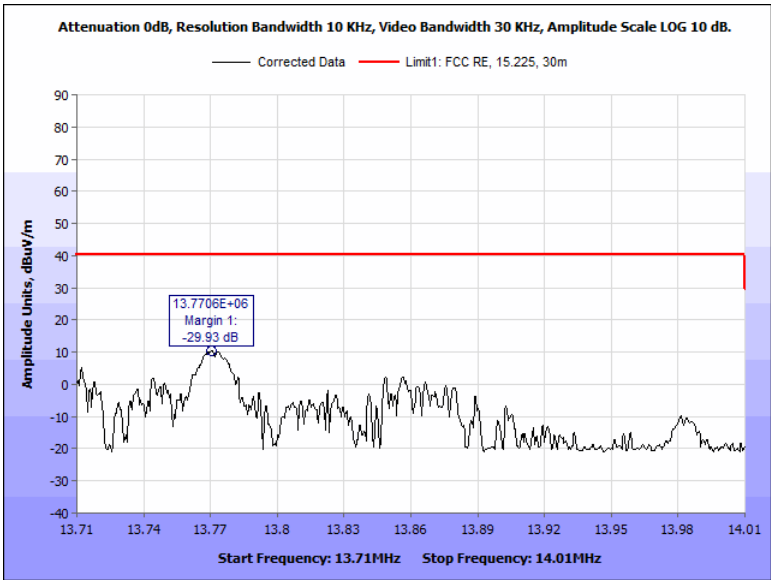


Figure 45: Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Terminal, 13.710 MHz – 14.010 MHz, 90 Deg

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(d) Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz

Test Requirement(s): 15.225 (d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

Test Procedure: The EUT was set to transmit and placed on a 0.8m-high wooden stand inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4: 2014 and ANSI C63.10: 2013 were used. For measurements below 30 MHz a loop antenna placed 3m away from the unit was used. For measurements above 30 MHz a biconalog antenna placed 10m away from the unit was used. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. Below 150 kHz, the RBW was set to 300 Hz and the VBW set to 1 kHz. Above 30 MHz, the RBW was set to 100 kHz and the VBW set to 300 kHz. A peak detector was used below 30 MHz and a Quasi-peak detector was used for measurements for above 30 MHz.

The measurements made at 3m with the loop antenna were then extrapolated to 30m or 300 m using the following correction factors.

40log(3/30) = -40 dB
40log(3/300) = -80 dB

The measurements made at 10m with the biconilog antenna were then extrapolated to the 3m using the following correction factor.

20log(10/3) = +10.46 dB

Spurious Emissions Test Setup

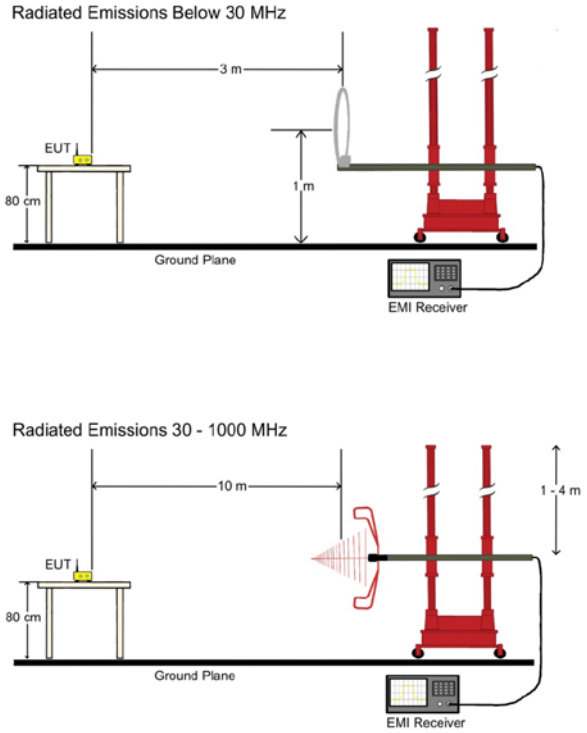


Figure 46: Radiated Spurious Emissions Test Setup

Sample Calculation for Distance Correction factor (DCF) measurement:

$F_d = 20*LOG_{10} (D_m/D_s)$

where:

F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

Sample formula for calculating the Corrected Data for the Radiated Emissions Measurements:

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBµV/m)	ACF (dB/m) (+)	Pre Amp Gain + CBL (dB)(-)	DCF (dB) (+)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
249.99	V	359.9	240.7	55.46	11.4	28.335	10.46	***38.525***	47	-8.475

*Corrected Amplitude (dBµV/m) = Uncorrected Amplitude (dBµV/m) +ACF (dB/m) – (Preamp Gain (dB) + CBL (dB) +DCF (dB) ** = 55.46 + 11.4 – 28.355 + 10.46 =* ***38.525***

*** DCF Column represents the appropriate correction factor used when the measurement distance differs from the specification distance.*

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(d) Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 14, 2019

Test Data, Model: 20K Pigtail

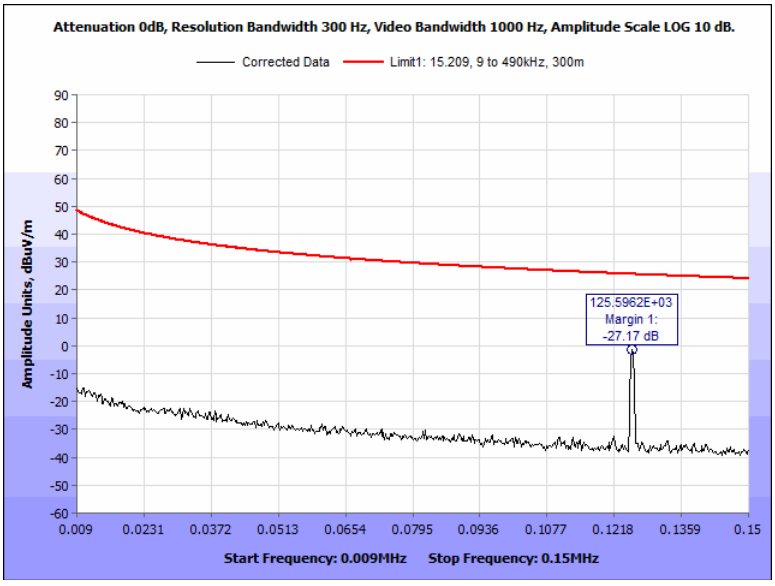


Figure 47: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.009 MHz – 0.150 MHz, 0 Deg

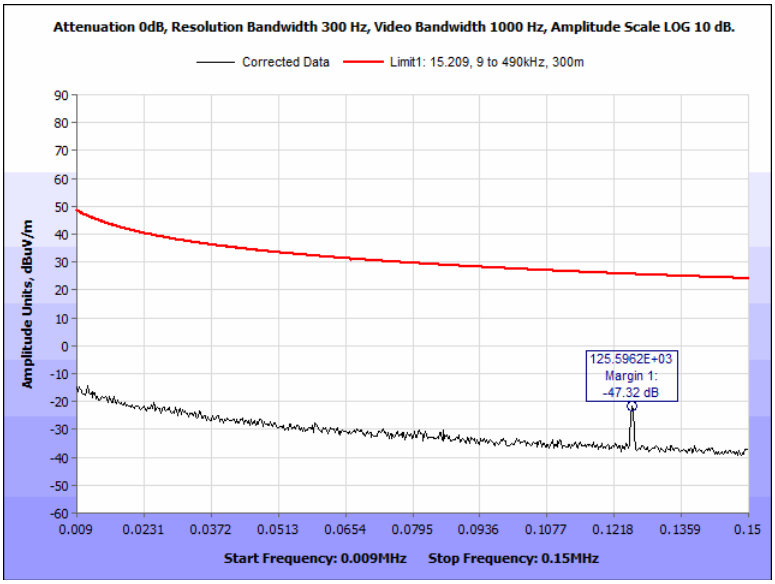


Figure 48: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.009 MHz – 0.150 MHz, 90 Deg

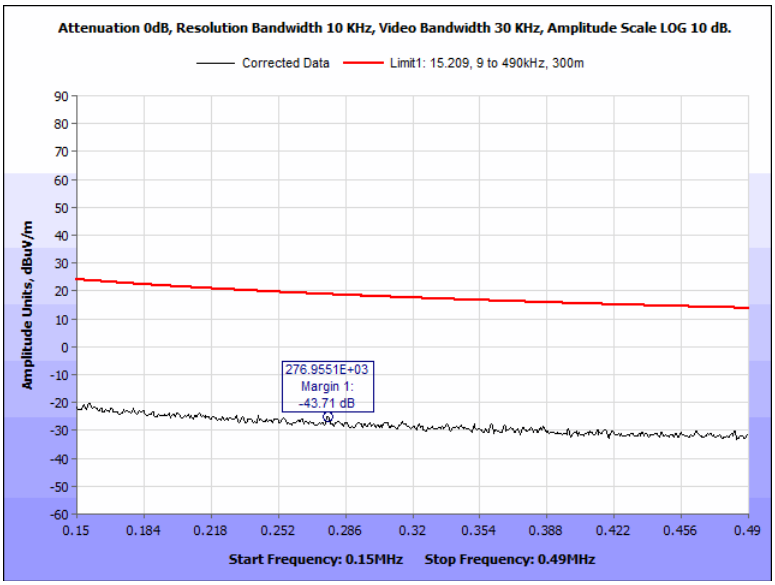


Figure 49: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.150 MHz – 0.490 MHz, 0 Deg

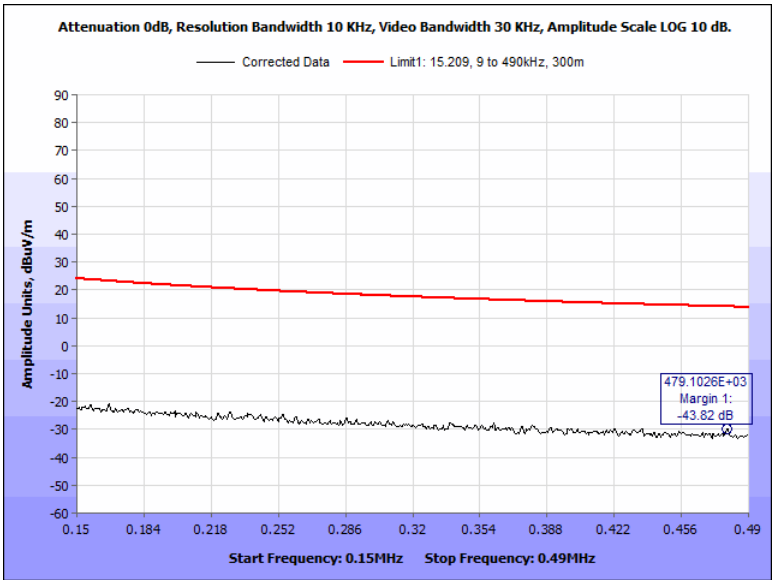


Figure 50: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.150 MHz – 0.490 MHz, 90 Deg

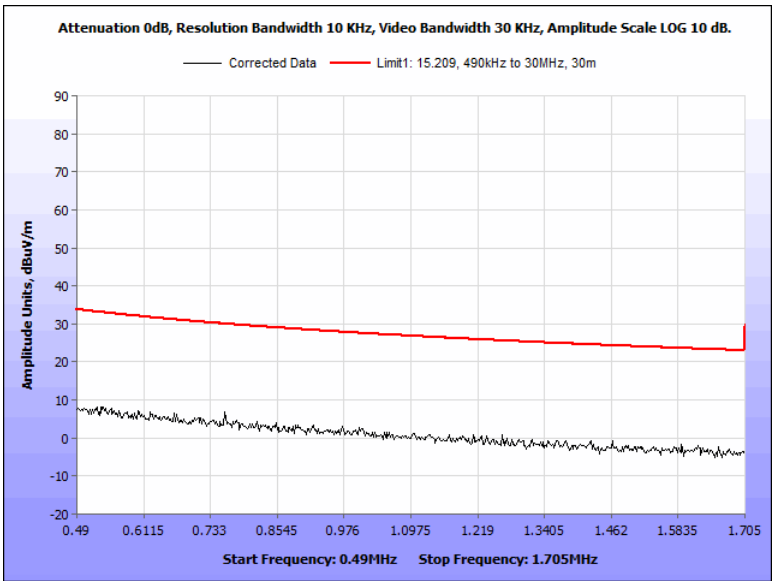


Figure 51: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.490 MHz – 1.705 MHz, 0 Deg

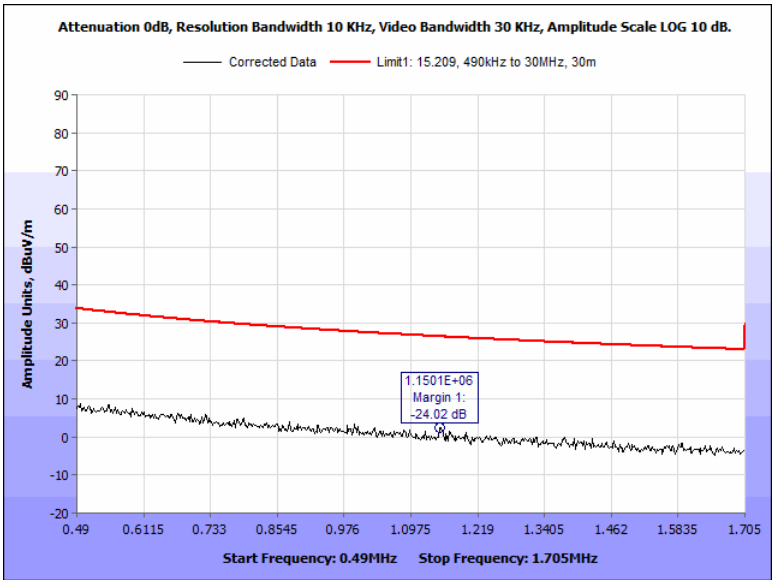
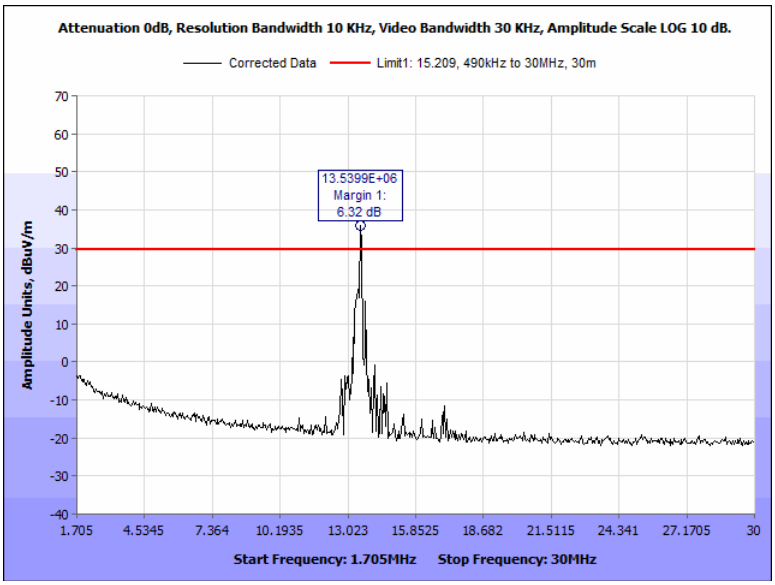


Figure 52: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 0.490 MHz – 1.705 MHz, 90 Deg



*Note: Emission that appears over the spurious limit is the fundamental frequency

Figure 53: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 1.705 MHz – 30 MHz, 0 Deg

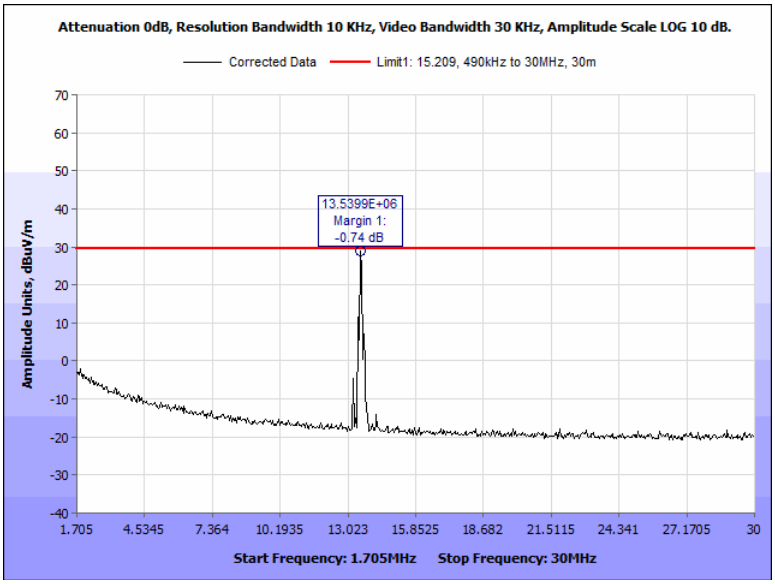


Figure 54: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 1.705 MHz – 30 MHz, 90 Deg

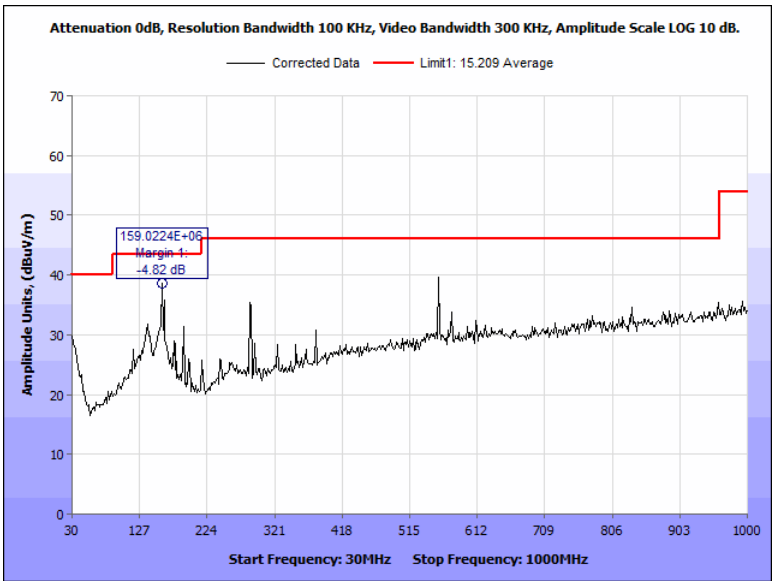


Figure 55: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 30 MHz – 1000 MHz, Horizontal

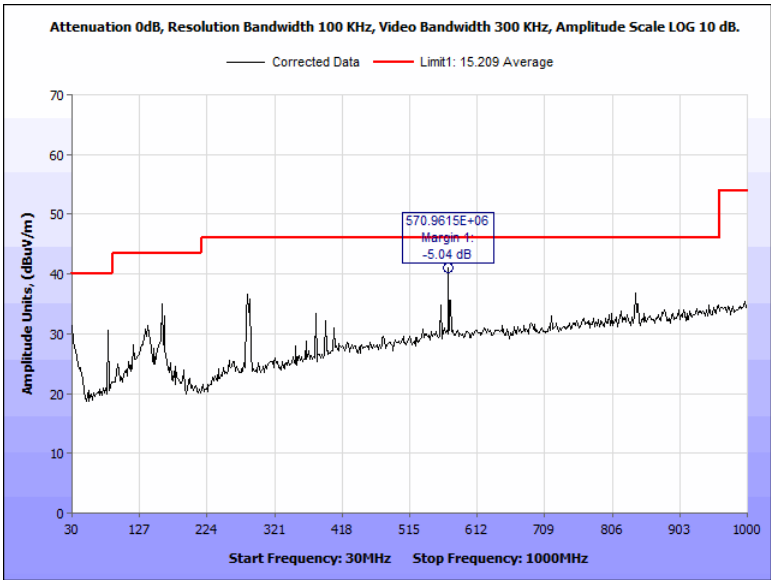


Figure 56: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Pigtail, 30 MHz – 1000 MHz, Vertical

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (cm)	Uncorrected EMI Meter Reading (dBµV)	Antenna Correction Factor (dB/m) (+)	Distance Correction Factor (dB) (+)	Cable Loss/Pre-amp (dB) (-)	Corrected Amplitude (dBµV /m)	Limit (dBµV /m)	Margin (dB)
139.130	297.7	H	400.5	29.6	15.487	10.46	23.408	32.139	43.5	-11.361
162.710	143	H	301.4	29.6	14.229	10.46	23.12	31.169	43.5	-12.331
286.355	5.2	V	297.4	20.27	17.4	10.46	22.608	25.522	46	-20.478
352.560	342.6	H	282	24.9	18.656	10.46	22.27	31.746	46	-14.254
379.660	346.6	H	305.2	29.8	19.2	10.46	22.149	37.311	46	-8.689
406.811	343.4	H	151.2	29.6	20.281	10.46	21.934	38.407	46	-7.593

Figure 57: Radiated Spurious Emissions, Pigtail, 30 MHz – 1000 MHz

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(d) Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz. No anomalies noted.

Test Engineer: Jonathan Tavira

Test Date: August 12, 2019

Test Data, Model: 20K Terminal

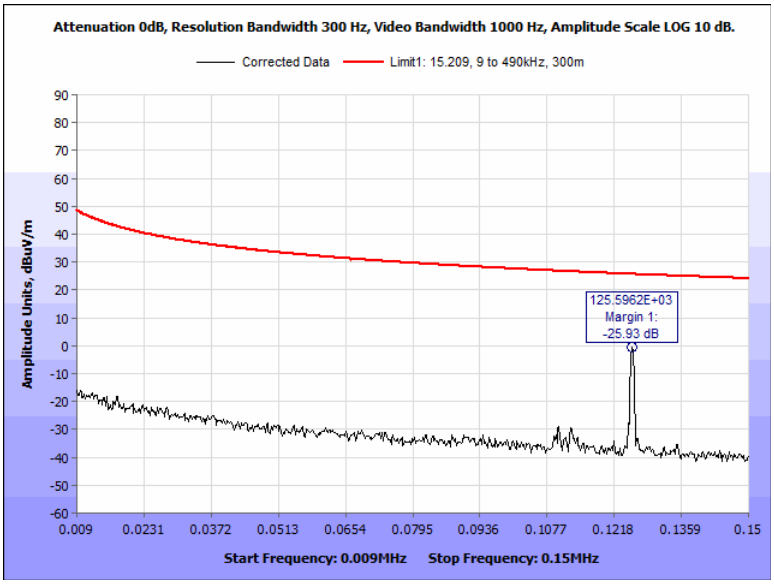


Figure 58: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.009 MHz – 0.150 MHz, 0 Deg

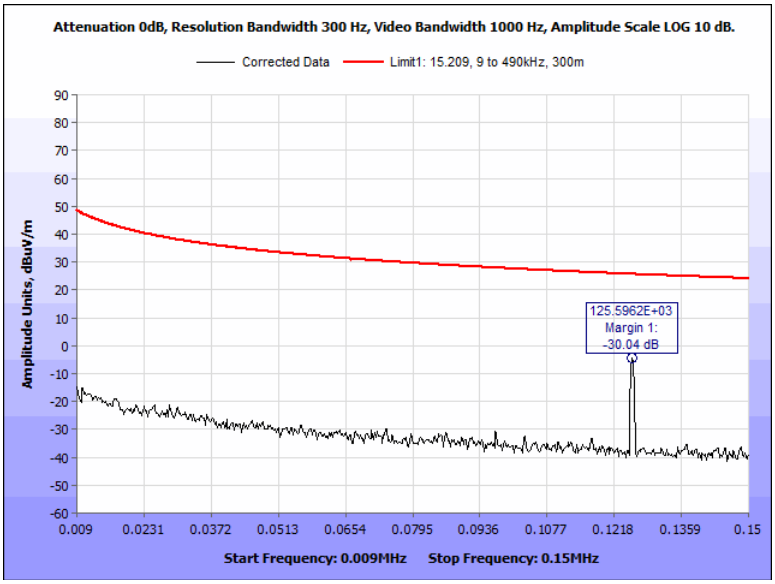


Figure 59: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.009 MHz – 0.150 MHz, 90 Deg

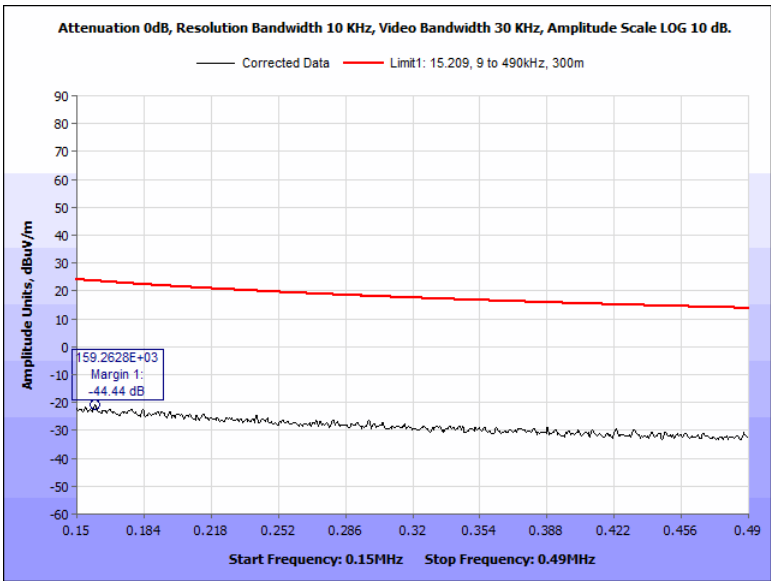


Figure 60: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.150 MHz – 0.490 MHz, 0 Deg

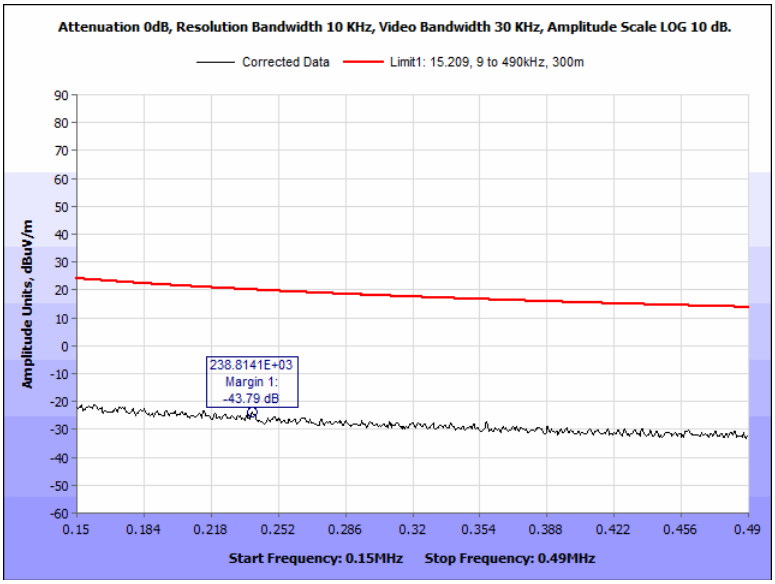


Figure 61: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.150 MHz – 0.490 MHz, 90 Deg

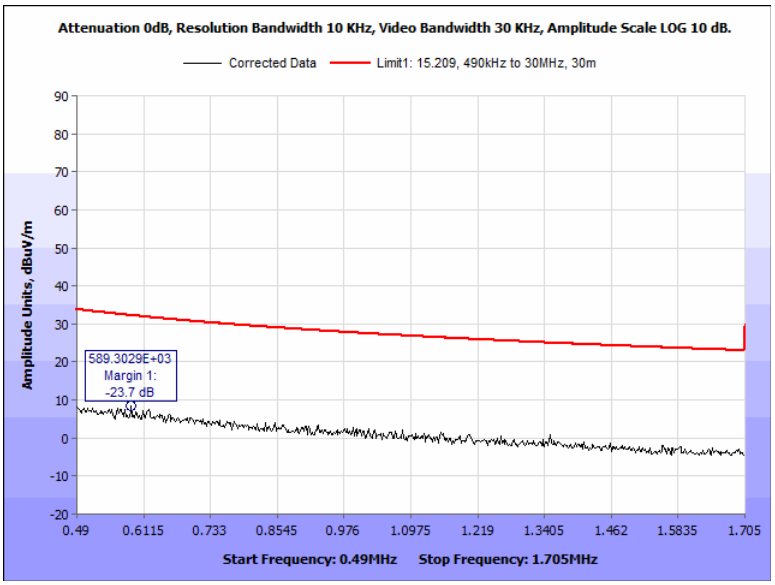


Figure 62: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.490 MHz – 1.705 MHz, 0 Deg

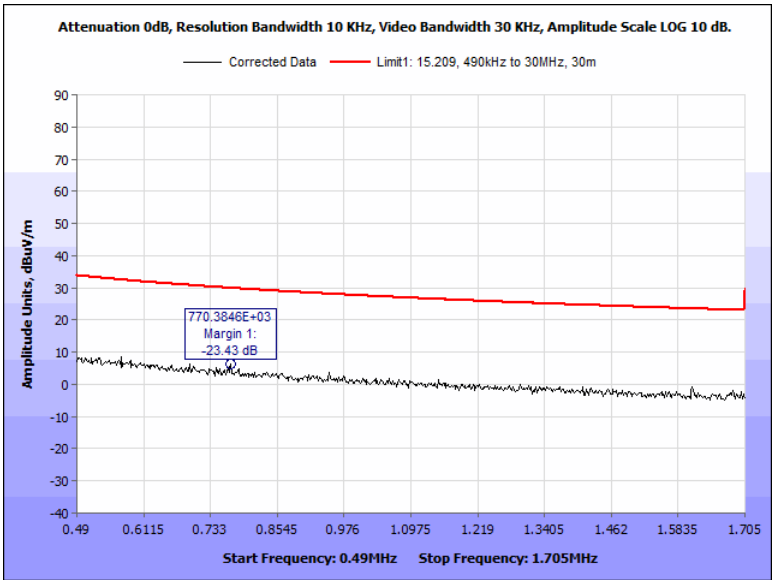
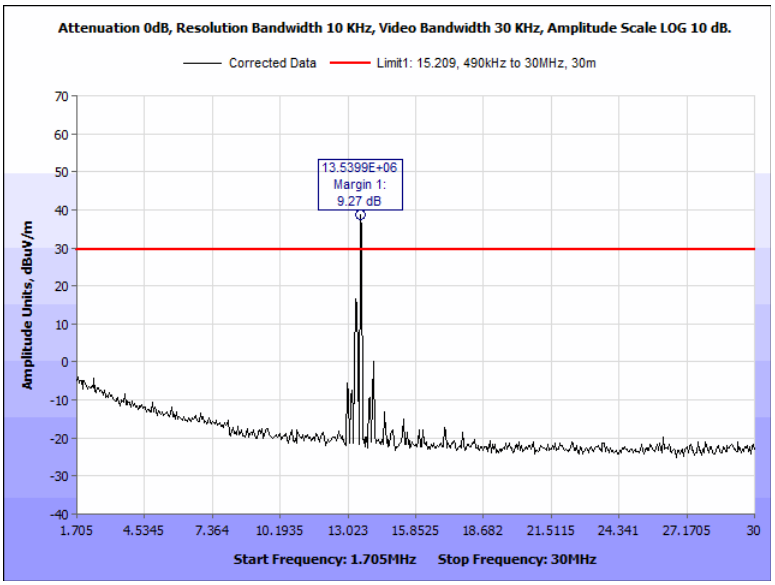


Figure 63: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 0.490 MHz – 1.705 MHz, 90 Deg



*Note: Emission that appears over the spurious limit is the fundamental frequency

Figure 64: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 1.705 MHz – 30 MHz, 0 Deg

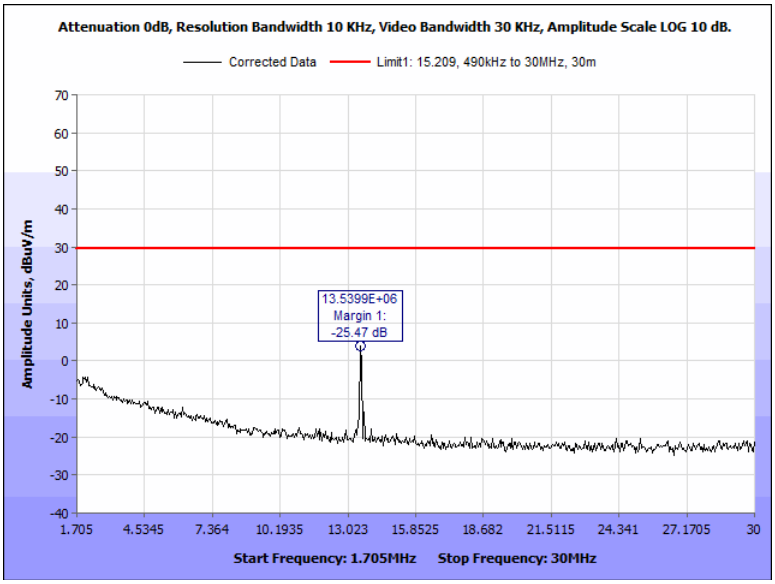


Figure 65: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 1.705 MHz – 30 MHz, 90 Deg

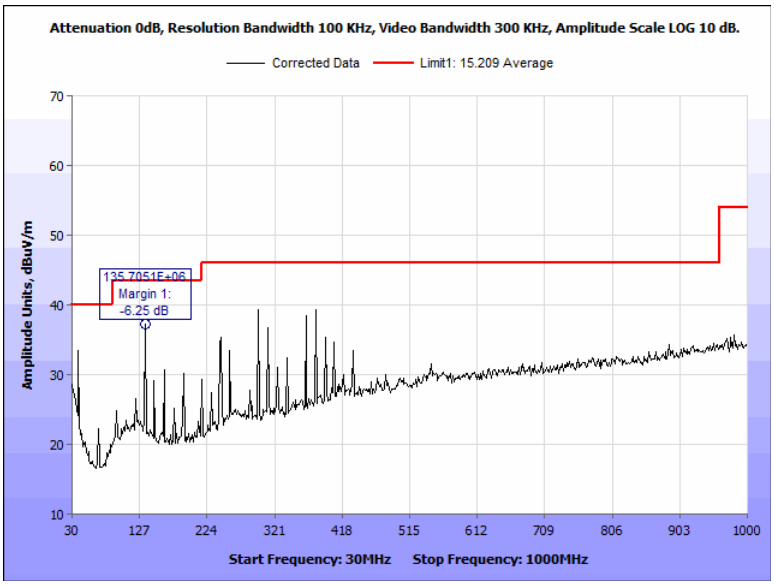


Figure 66: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 30 MHz – 1000 MHz, Horizontal

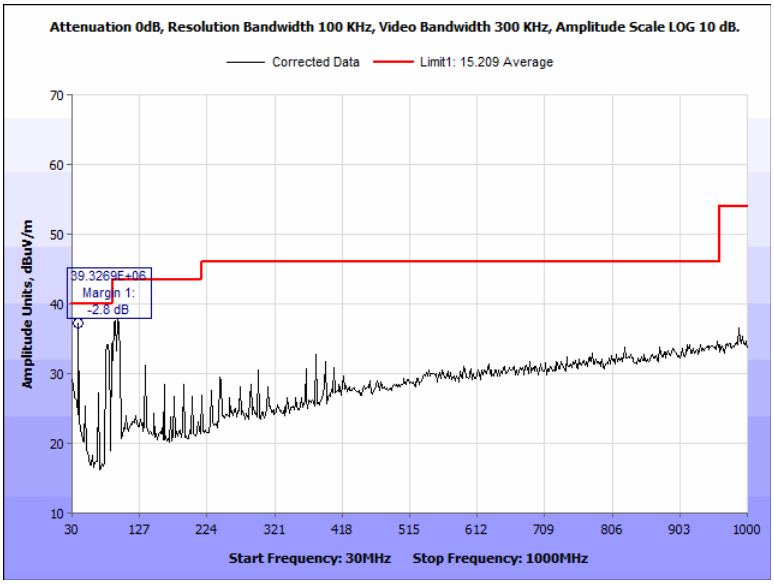


Figure 67: Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Terminal, 30 MHz – 1000 MHz, Vertical

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (cm)	Uncorrected EMI Meter Reading (dBµV)	Antenna Correction Factor (dB/m) (+)	Distance Correction Factor (dB) (+)	Cable Loss/Pre-amp (dB) (-)	Corrected Amplitude (dBµV /m)	Limit (dBµV /m)	Margin (dB)
120.512	176.30	H	277.80	32.54	16.4	10.46	23.637	35.891	43.5	-7.609
257.367	212.40	H	320.70	30.7	17.473	10.46	22.952	36.052	46	-9.948
284.775	205.50	H	236.20	30.3	17.1	10.46	22.952	35.261	46	-10.739
311.883	205.80	H	331.80	32.7	17.788	10.46	22.747	38.733	46	-7.267
366.102	191.10	H	236.50	27.9	19	10.46	22.417	35.187	46	-10.813
559.758	229.50	V	214.70	30.303	22.7	10.46	22.149	42.035	46	-3.965

Figure 68: Radiated Spurious Emissions, Terminal, 30 MHz – 1000 MHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(e) Frequency Stability

Test Requirement(s): 15.225(e) The frequency tolerance of the carrier signal shall be maintained within +/-0.01% of the operating frequency over a temperature variation of -20 Degrees to +50 Degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 Degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test Procedure: Measurements are in accordance with Part 2.1055. The EUT was placed in the Environmental Chamber and allowed to reach desired temperature. A spectrum analyzer was used to measure the frequency drift. The EUT was set to transmit in the operating frequency range. Frequency drift was investigated for the extreme temperatures and nominal temperature, until the unit is stabilized then recorded the reading in tabular format with the temperature range of -20º to 50ºC.

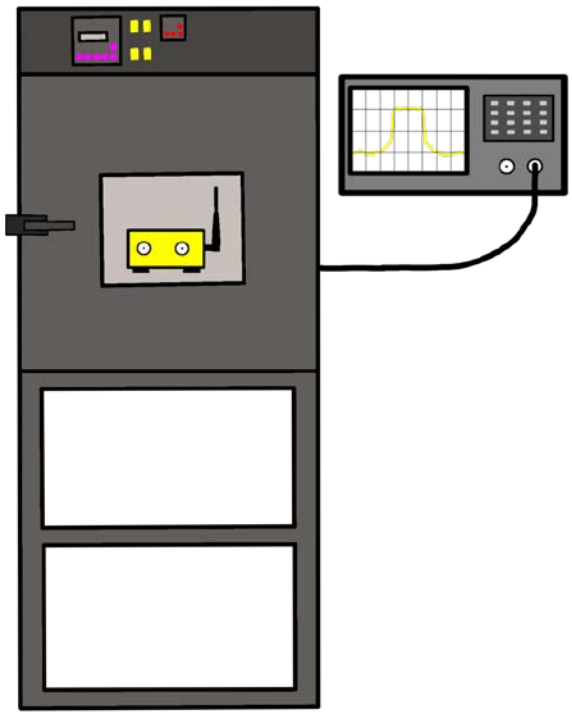


Figure 69: Temperature Stability Test Setup

Model: 20K Pigtail

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(e) Frequency Stability. No anomalies noted.

Test Engineer: Adan Arab

Test Date: August 12, 2019

Test Data, Model: 20K Pigtail

Operating Frequency	13,560,000 Hz
Reference Voltage	12VDC
Deviation Limit	±0.01% = 100 PPM = 1356 Hz

	FCC 15.225 Only				
	Voltage Variation (%)	**Temperature (°C)**	**Nominal Freq (MHz)**	**Result (MHz)**	**PPM**
13.8 VDC	15	-20	13.56	13.559988	0.8850
		20	13.56	13.560001	0.0737
		50	13.56	13.559957	3.1711
12VDC	0	-20	13.56	13.559979	1.5487
		20	13.56	13.560018	1.3274
		50	13.56	13.559966	2.5074
10.2VDC	-15	-20	13.56	13.559987	0.9587
		20	13.56	13.560013	0.9587
		50	13.56	13.559981	1.4012

Figure 70: Frequency Stability, Pigtail, Test Results

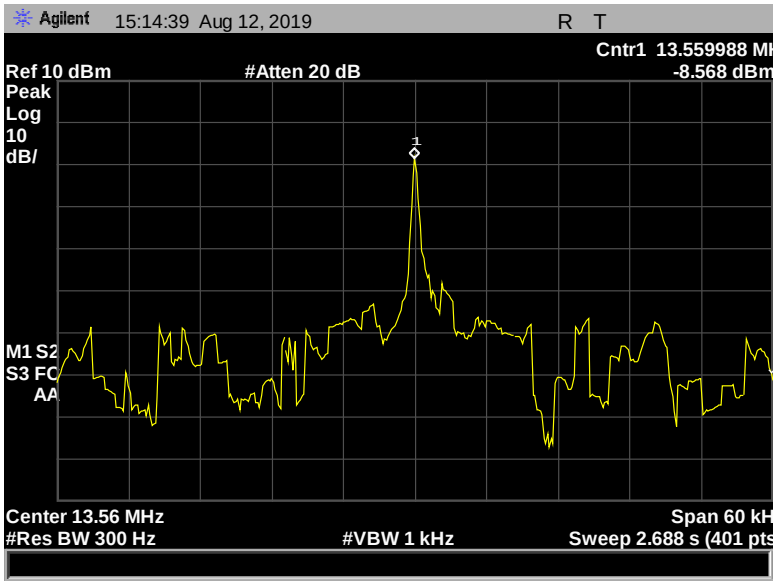


Figure 71: Frequency Stability, Pigtail, (-20), 10.2VDC

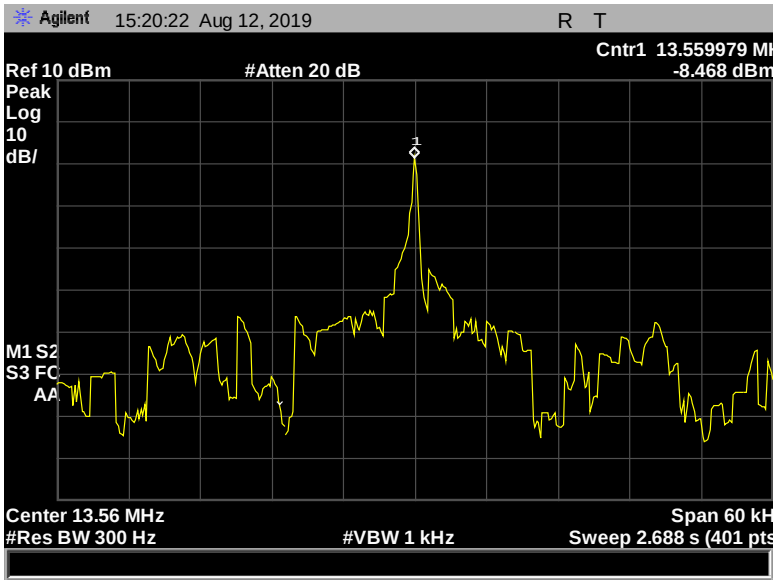


Figure 72: Frequency Stability, Pigtail, (-20), 12VDC

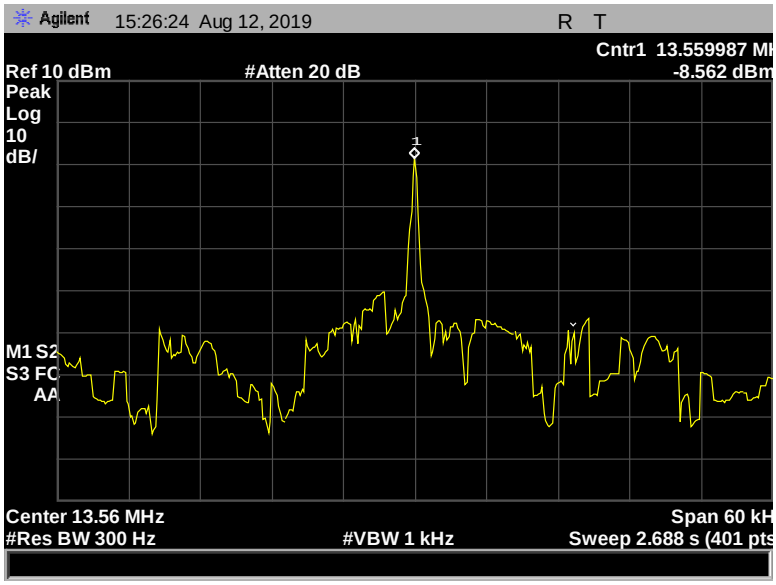


Figure 73: Frequency Stability, Pigtail, (-20), 13.8VDC

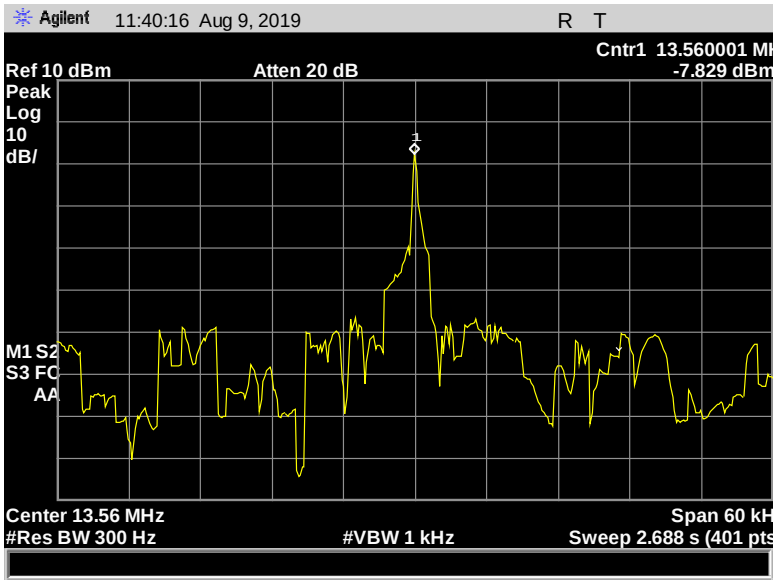


Figure 74: Frequency Stability, Pigtail, (20), 10.2VDC

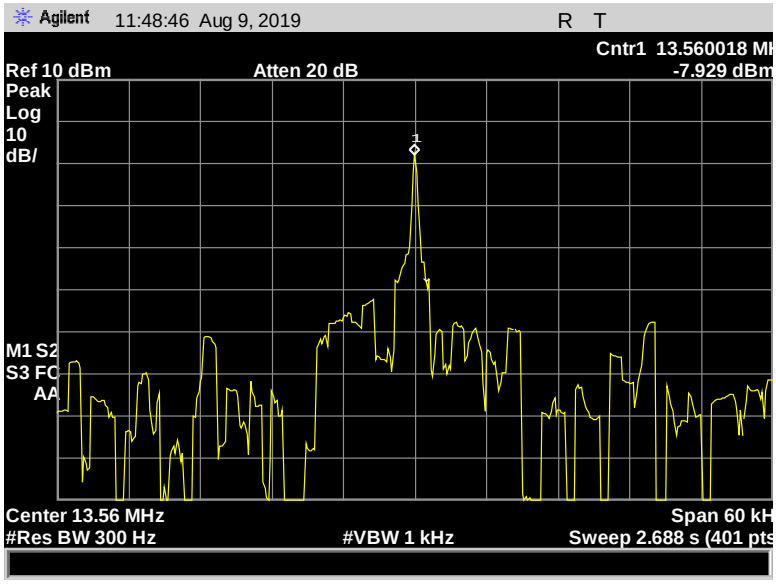


Figure 75: Frequency Stability, Pigtail, (20), 12VDC

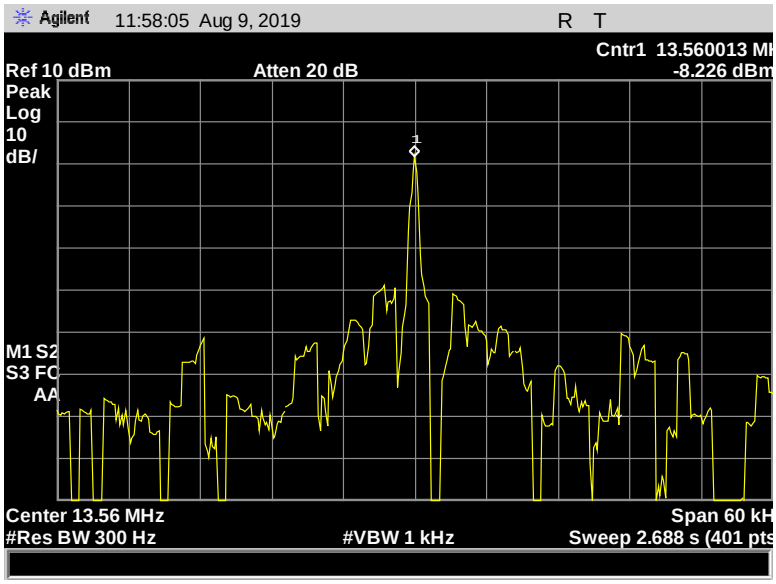


Figure 76: Frequency Stability, Pigtail, (20), 13.8VDC

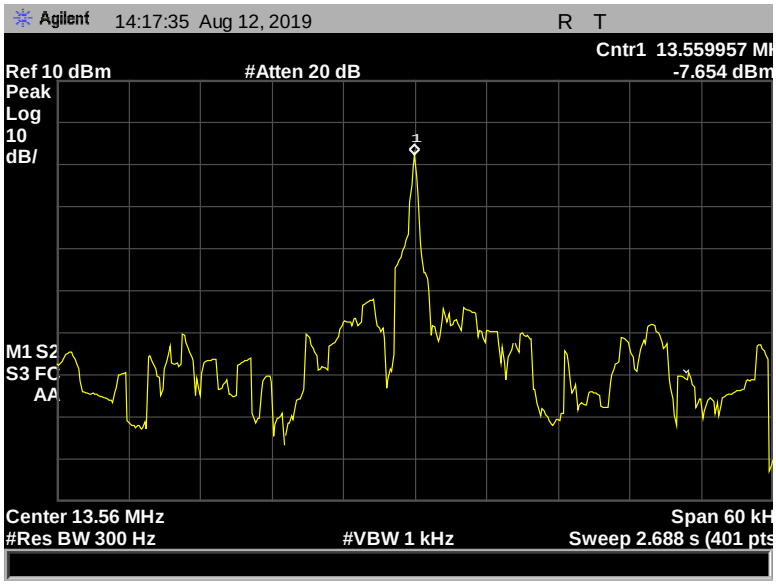


Figure 77: Frequency Stability, Pigtail, (50), 10.2VDC

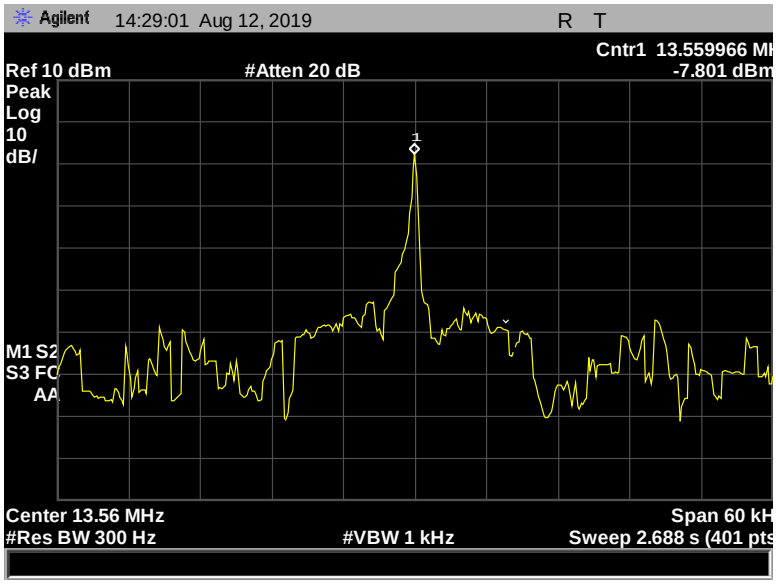


Figure 78: Frequency Stability, Pigtail, (50), 12VDC

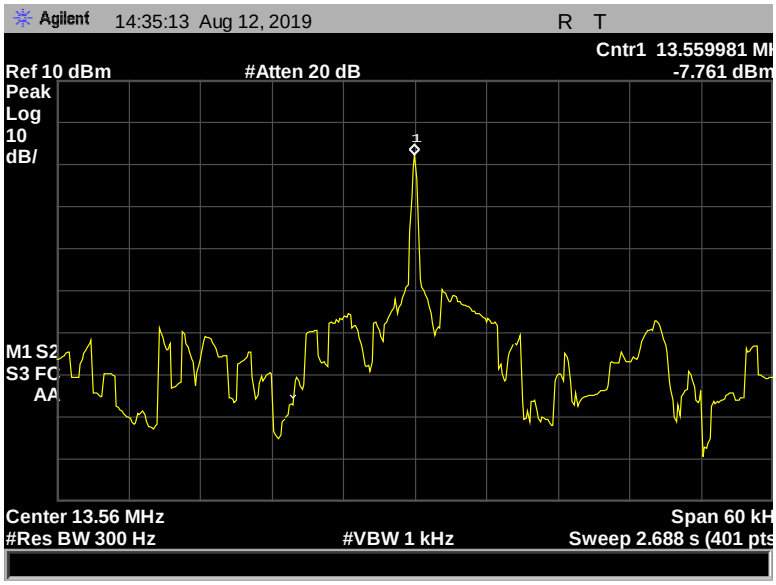


Figure 79: Frequency Stability, Pigtail, (50), 13.8VDC

Model: 20K Terminal

Test Results: The EUT as tested is **compliant** with the requirements of § 15.225(e) Frequency Stability. No anomalies noted.

Test Engineer: Adan Arab

Test Date: August 13, 2019

Test Data, Model: 20K Terminal

Operating Frequency	13,560,000 Hz
Reference Voltage	12VDC
Deviation Limit	±0.01% = 100 PPM = 1356 Hz

	FCC 15.225 Only				
	Voltage Variation (%)	**Temperature (°C)**	**Nominal Freq (MHz)**	**Result (MHz)**	**PPM**
10.2VDC	-15	-20	13.56	13.559989	0.8112
		20	13.56	13.559989	0.8112
		50	13.56	13.559972	2.0649
12VDC	0	-20	13.56	13.559983	1.2537
		20	13.56	13.559991	0.6637
		50	13.56	13.559979	1.5487
13.8VDC	15	-20	13.56	13.55998	1.4749
		20	13.56	13.560012	0.8850
		50	13.56	13.559983	1.2537

Figure 80: Frequency Stability, Terminal, Test Results

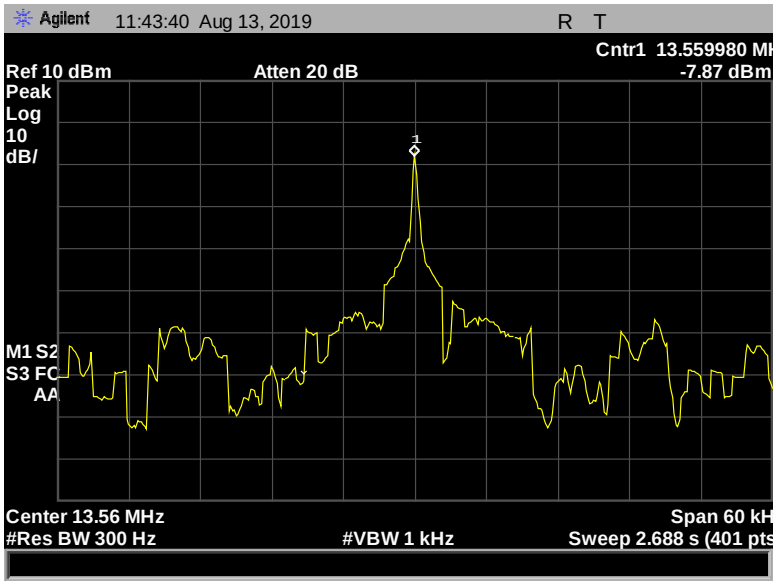


Figure 81: Frequency Stability, Terminal, (-20), 10.2VDC

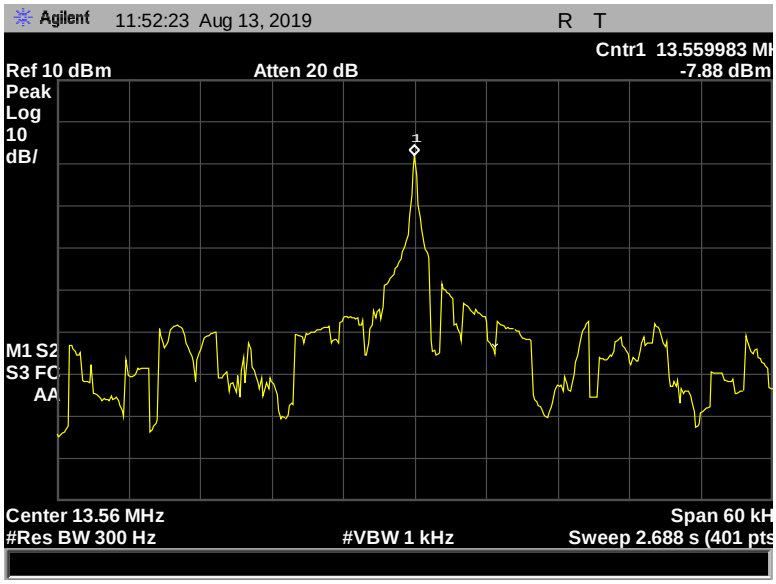


Figure 82: Frequency Stability, Terminal, (-20), 12VDC

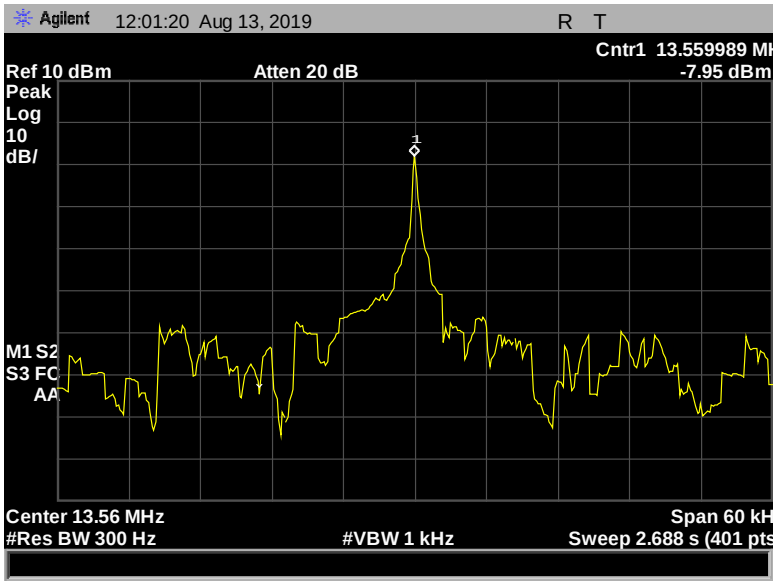


Figure 83: Frequency Stability, Terminal, (-20), 13.8VDC

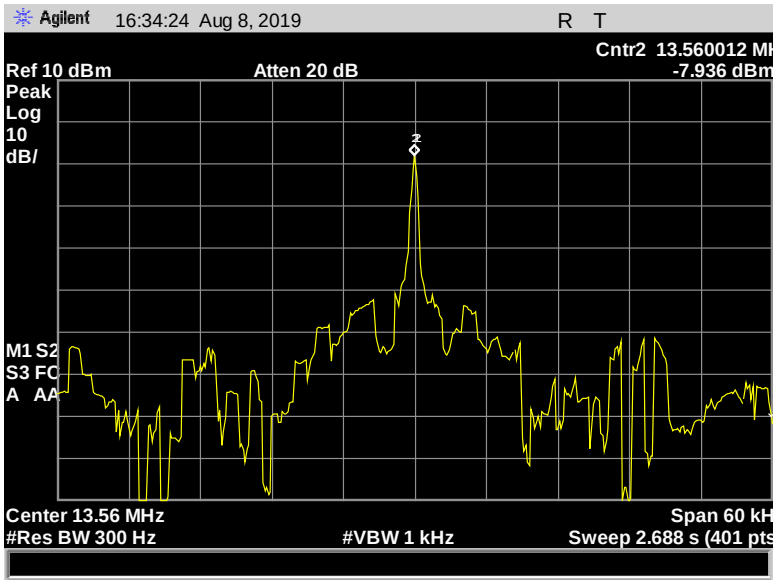


Figure 84: Frequency Stability, Terminal, (20), 10.2VDC

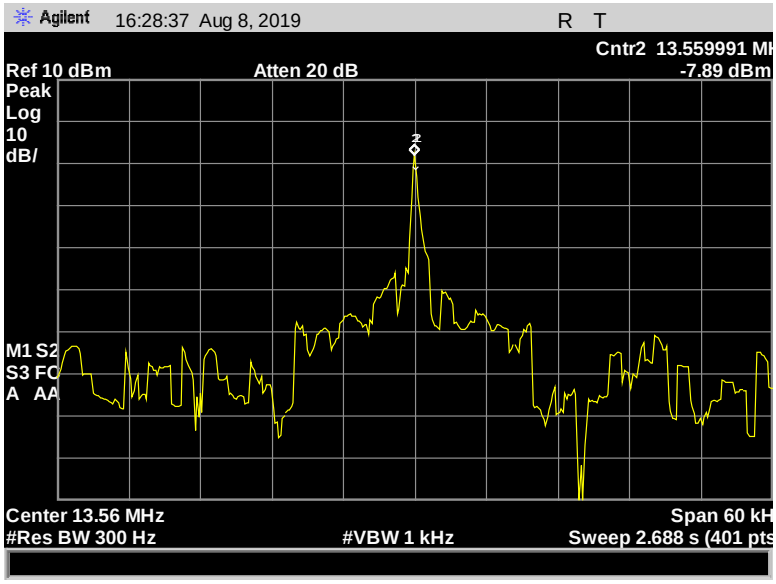


Figure 85: Frequency Stability, Terminal, (20), 12VDC

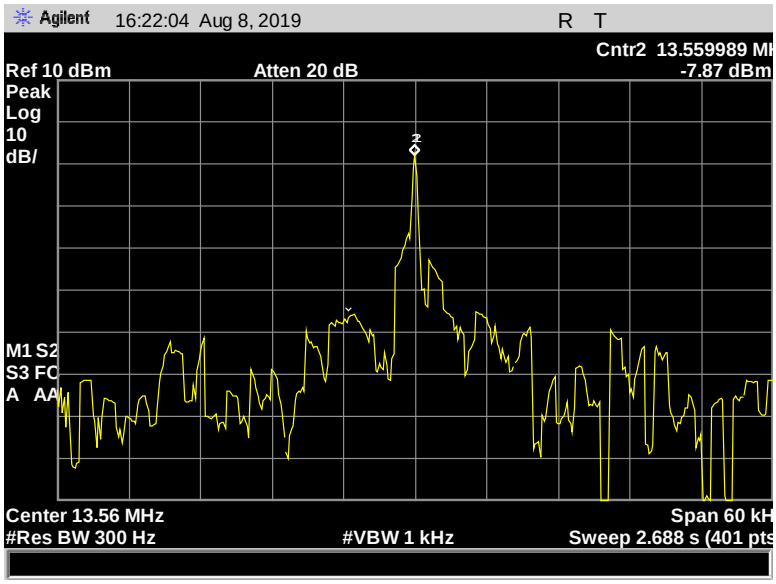


Figure 86: Frequency Stability, Terminal, (20), 13.8VDC

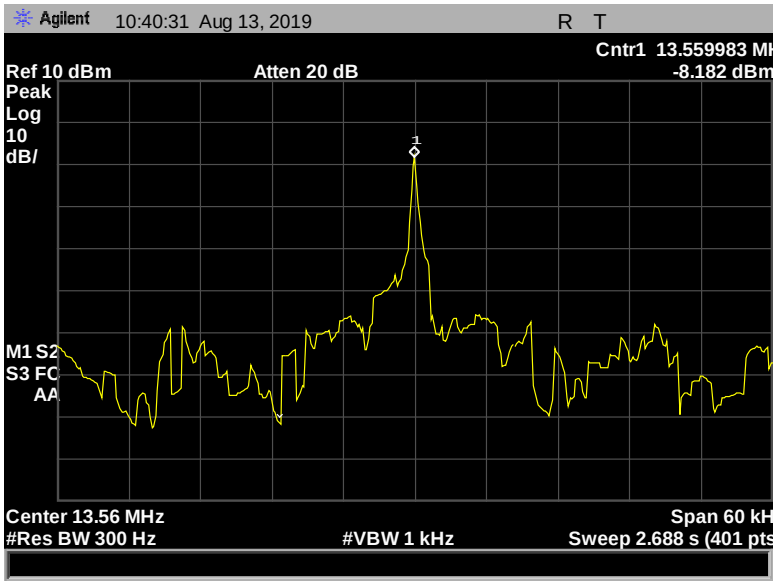


Figure 87: Frequency Stability, Terminal, (50), 10.2VDC

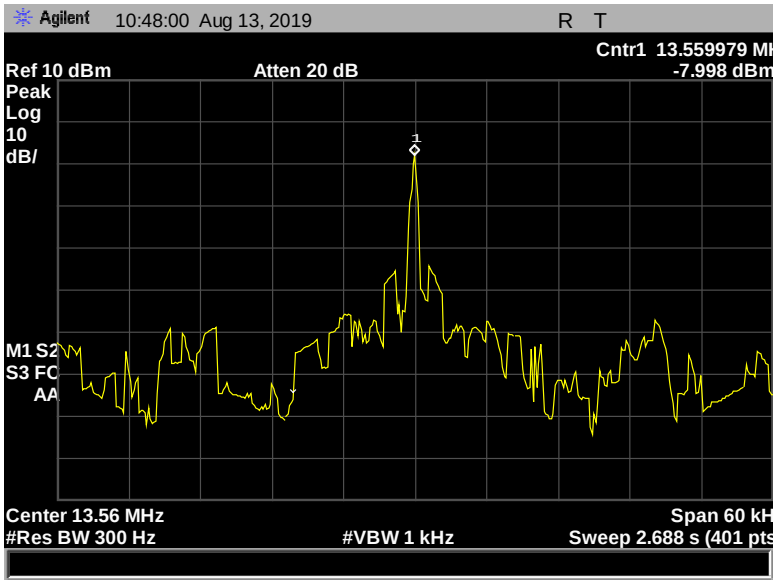


Figure 88: Frequency Stability, Terminal, (50), 12VDC

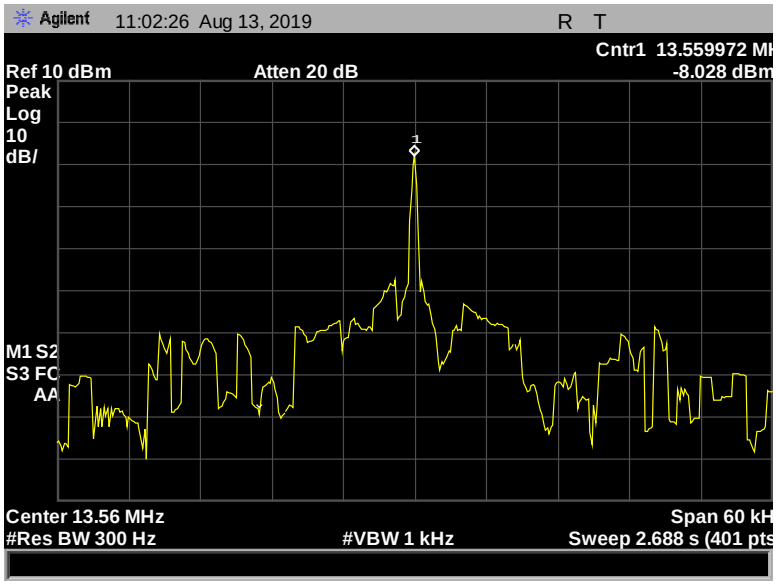


Figure 89: Frequency Stability, Terminal, (50), 13.8VDC

IV. Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

MET ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL DATE	CAL DUE DATE
1A1044	GENERATOR	COM-POWER CORP	CG-520	SEE NOTE	
1A1079	CONDUCTED COMB GENERATOR	COM-POWER CORP	CGC-255	SEE NOTE	
1A1050	BILOG ANTENNA (30 MHZ TO 1 GHZ)	SCHAFFNER	CBL 6112D	08/29/2018	02/29/2020
1A1050-A	4 DB FIXED ATTENUATOR	FAIRVIEW MICROWAVE	SA6N5WA-04	08/29/2018	02/29/2020
1A1088	PRE-AMP	RHODE & SCHWARZ	TS-PR1	SEE NOTE	
1A1073	MULTI DEVICE CONTROLLER	ETS LINDGREN	2090	SEE NOTE	
1A1195	PREAMPLIFIER	A.H. SYSTEMS	PAM-0018P	SEE NOTE	
1A1074	SYSTEM CAMERA CONTROLLER	PANASONIC	WV-CU101	SEE NOTE	
1A1075	SYSTEM CAMERA CONTROLLER	PANASONIC	WV-CU101	SEE NOTE	
1A1080	MULTI DEVICE CONTROLLER	ETS LINDGREN	2090	SEE NOTE	
1A1176	ACTIVE LOOP ANTENNA	ETS-LINDGREN	6502	04/03/2019	04/03/2020
1A1122	LISN	TESEQ	NNB 51	08/09/2019	08/09/2020
1A1065	EMI RECEIVER	ROHDE & SCHWARZ	ESCI	05/01/2019	05/01/2020
1A1149	MILLIOHM METER	GW INSTEK	GOM-802	04/19/2019	04/19/2020
1A1184	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	06/25/2019	06/25/2020
1A1225	ENVIRONMENTAL CHAMBER	ESPEC	EXP-2H/NEW	02/21/2019	02/21/2020
1A1119	TEST AREA	CUSTOM MADE	N/A	SEE NOTE	
1A1177	PULSE LIMITER / ATTENUATOR	ROHDE & SCHWARZ	ESH3Z2	11/30/2018	05/30/2020
1A1083	EMI RECEIVER	ROHDE & SCHWARZ	ESU 40	10/17/2018	10/17/2019
1A1106	10 M CHAMBER (NSA)	ETS LINDGREN	SEMI-ANECHOIC	SEE NOTE	

Figure 90: Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

End of Report