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September 10, 2020

HID Global Corporation
611 Center Ridge Drive
Austin, Texas 78753

Dear Robert Cresswell,

Enclosed is the EMC test report for compliance testing of the HID Global Corporation, X001800-2 / DTCii Plus, 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 E&E North America. If you have any questions regarding these results or if we can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

Jennifer Warnell
Documentation Department

Reference: (\HID Global Corporation\EMCA108954-FCC225 Rev. 1)

Electromagnetic Compatibility Criteria
Test Report

for the

HID Global Corporation
X001800-2 / DTCii Plus

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

Report: EMCA108954-FCC225 Rev. 1

September 10, 2020

Prepared For:

HID Global Corporation
611 Center Ridge Drive
Austin, Texas 78753

Prepared By:
Eurofins E&E North America
13501 McCallen Pass,
Austin, TX 78753

Electromagnetic Compatibility Criteria
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for Intentional Radiators

Jonathan Tavira,
Manager, Electromagnetic Compatibility Lab

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.

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	August 27, 2020	Initial Issue.
1	September 10, 2020	TCB Comments.

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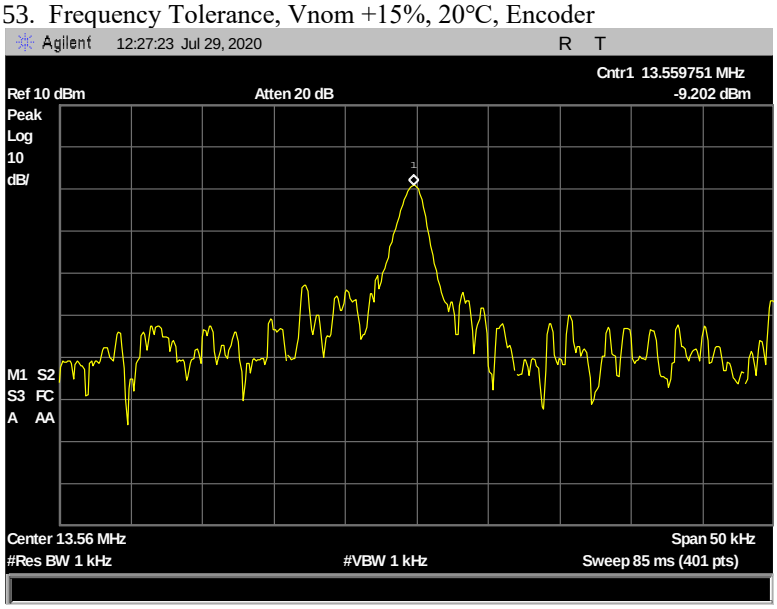


List of Photographs

No table of figures entries found.

Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation X001800-2 / DTCii Plus, 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 X001800-2 / DTCii Plus. 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 X001800-2 / DTCii Plus, 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 005507. All tests were conducted using measurement procedures ANSI C6434-2014 and C63.10-2013.

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

Table 1. Executive Summary of EMC Part 15.225 Compliance Testing

Equipment Configuration

A. Overview

Eurofins E&E North America was contracted by HID Global Corporation to perform testing on the X001800-2 / DTCii Plus, under HID Global Corporation's purchase order number 005507.

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, X001800-2 / DTCii Plus.

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

Model(s) Tested:	X001800-2 / DTCii Plus	
Model(s) Covered:	X001800-2 / DTCii Plus	
EUT Specifications:	Primary Power: 24 VDC	
	FCC ID: JQ6-X001800002	
	Type of Modulation(s):	ASK
	Equipment Code:	DXX
	Maximum field Strength (RFID Contactless Card Encoder):	26.62 dBµV/m (@ 30m)
	Maximum field Strength (Print Ribbon RFID Reader):	29.87 dBµV/m (@ 30m)
	Antenna Type:	Inductive Loop
	Peak Antenna Gain:	1 dBi
	Firmware Version:	N/A
	EUT Frequency Ranges:	13.56 MHz
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:	Jonathan Tavira	
Report Date(s):	September 3, 2020	

Table 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

Table 3. . References

SSSS

C. Test Site

Eurofins MET Laboratories Inc. (Eurofins E&E North America) is part of the Eurofins Electrical & Electronics (E&E) global compliance network.

All testing was performed at Eurofins E&E North America, 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 10 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	±2.97 dB	2	95%
RF Power Radiated Emissions	±2.95 dB	2	95%
Radiated Emissions, (30 MHz – 1 GHz)	±2.95	2	95%
Radiated Emissions, (1 GHz – 18 GHz)	±3.54	2	95%
Conducted Emission Voltage	±2.97	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

Name of EUT/Model:	X001800-2 / DTCii Plus
Description of EUT and its intended use:	The DTCii Plus is a card printer with a ribbon print only. Intend to print an image on a card. The EUT consists of two HF RFID radios operating at 13.56 MHz. The encoder radio assigns an ID string to an RFID credential. The ribbon radio detects the ribbon identification tag during the printing process.
Selected Operation Mode(s):	The normal operation of the printer is simply by printing an image on a credential. To exercise both the Encoder and Ribbon radios, respectively, proprietary software was used to generate a constant modulated carrier at 13.56 MHz. The factory default power shall be used for both Radios.
Rationale for the selection of the Operation Mode(s):	The constant modulated carrier shall produce the worst-case emission profile for in band and out of band emissions.
Monitoring Method(s):	Verify proper connection to RFID radio controllers via Reader Utility and TestLab Spooler
Emissions Class Declaration:	**Class A ITE** where the device is intended primarily for use in an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 m. A warning will be included in the user manual.
Configuration(s):	The EUT is a stand-alone unit and controlled by a laptop connected via ethernet cable.
EUT Power Requirement:	Voltage: 24 V AC or DC: DC Frequency: N/A Number of phases: N/A Amperage: 5 A Uses an external AC/DC adapter: Yes Additional comments: none
Physical Description	EUT Arrangement (tabletop, floor standing or both): Tabletop System w/Multiple Chassis? (Yes/No): No Size: (HxWxD): 19.4x10.4x10.3 inches Weight: 13 lbs
Other Info:	Highest frequency used in device: 2.4GHz (LPDDR4 Memory) EUT Software (internal to EUT): N/A Support Software (used by support PC to exercise EUT): Encoder Software Control: OMNIKEY Reader Utility Version 5.0.0.4 Ribbon Software Control: TestLab Spooler

Table 5. Equipment Overview and Test Configuration Information

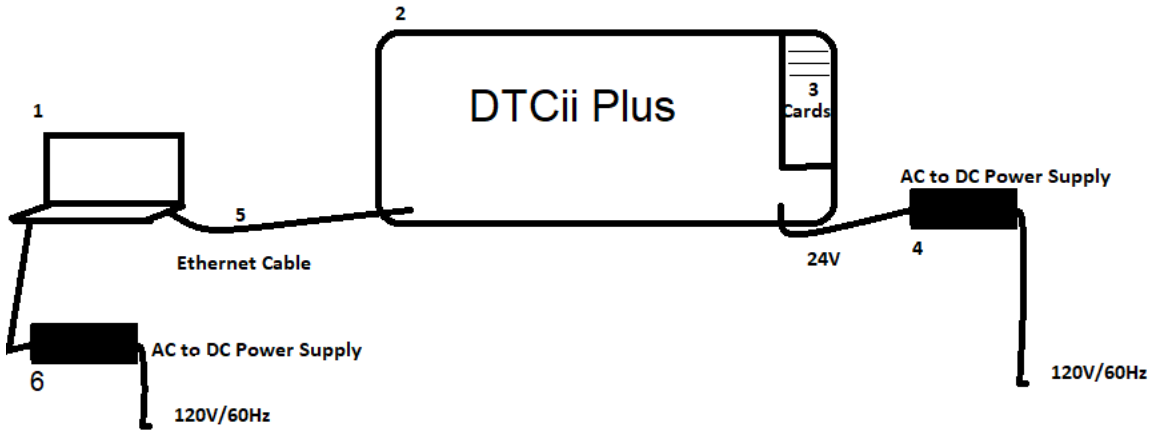


Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
2	--	Printer	X001800-2	--	--	--
4	--	AC to DC Power supply	STD-24050	--	--	--

Table 6. Equipment Configuration

G. Support Equipment

Ref. ID	Name / Description	Manufacturer	Model Number
1	Laptop	Dell	Inspiron 15
5	Ethernet cable	RJ45	--
6	AC to DC Power Supply	Dell	DA45NM140

Table 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
4	DC Voltage	2 conductors	1	3	3	N	--
1	Ethernet	Cat 5e cable	1	2	2	N	--

Table 8. Ports and Cabling Information

I. 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.

J. 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.

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 were 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.

Results: Both the Encoder and Ribbon reader, as evaluated, were compliant as they meet criteria A of §15.203.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/28/2020

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

Table 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, both transmitters were turned on at full power during the scans.

Test Results: The Encoder and Ribbon reader were compliant with this requirement.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/28/2020

Conducted Emissions Voltage Test Setup

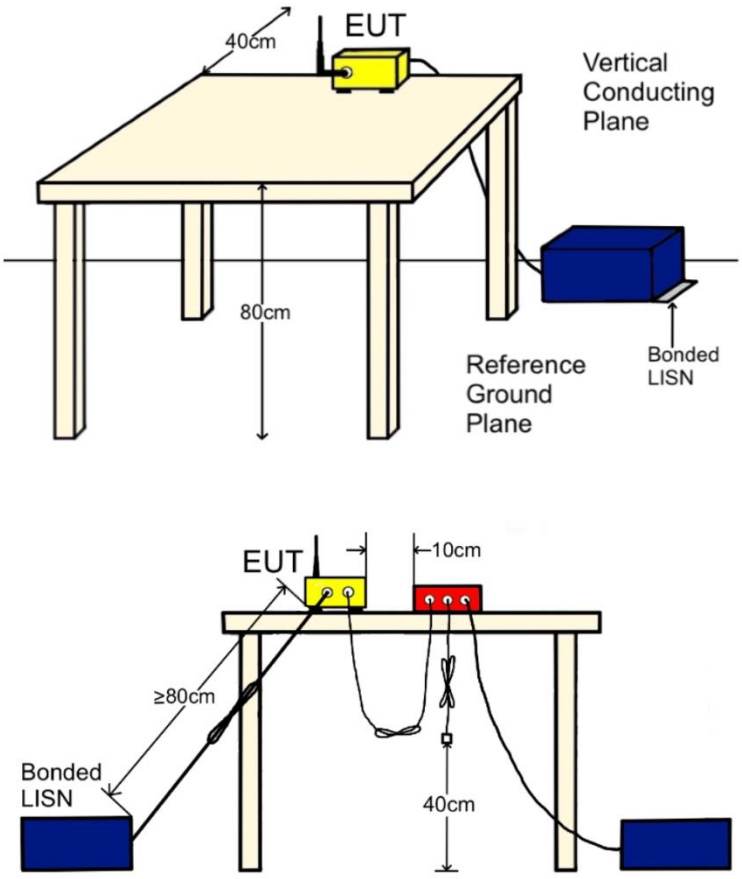
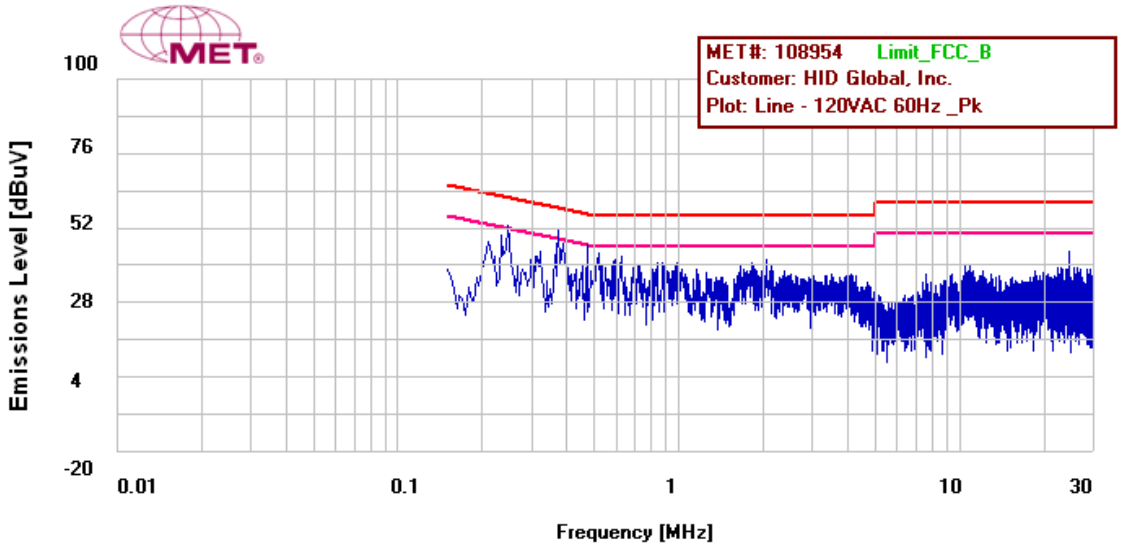


Figure 2. CEV Test Setup

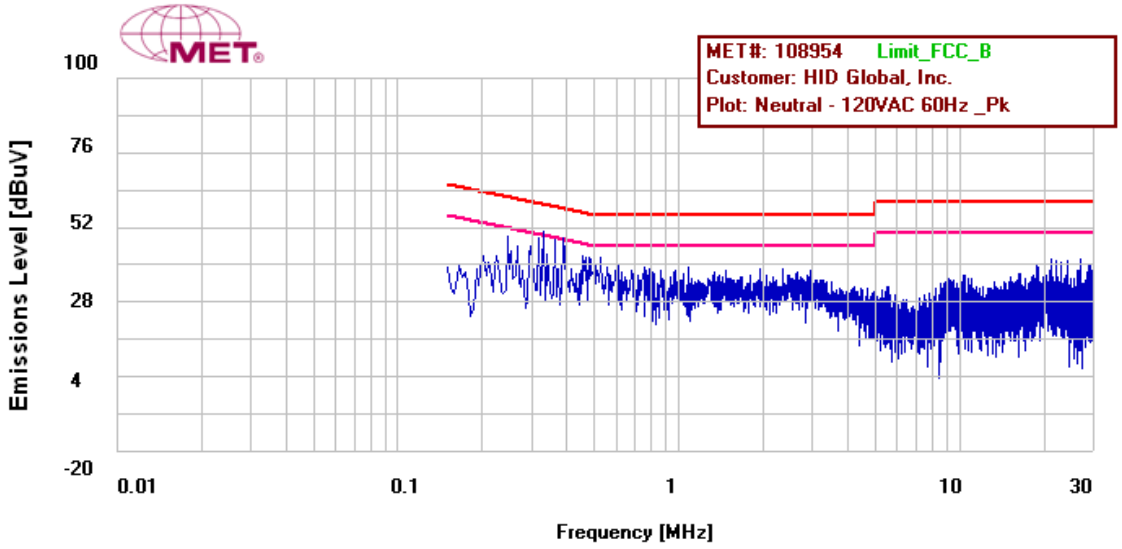
Measurement Location	Measurement	Limit	Pass/Fail
Bonding measurement from LISN ground to ground plane	1.932 mΩ	< 2.5 mΩ	Pass

Line	Freq (MHz)	QP Amplitude (dBµV)	QP Limit (dBµV)	Margin (dB)	Pass/Fail	Average Amplitude (dBµV)	Average Limit (dBµV)	Margin (dB)	Pass/Fail
Line - 120VAC 60Hz	0.210	46.78	63.213	-16.433	Pass	43.19	53.213	-10.023	Pass
Line - 120VAC 60Hz	0.234	43.30	62.317	-19.017	Pass	44.63	52.317	-7.687	Pass
Line - 120VAC 60Hz	0.246	46.48	61.902	-15.422	Pass	35.38	51.902	-16.522	Pass
Line - 120VAC 60Hz	0.302	44.56	60.204	-15.644	Pass	35.65	50.204	-14.554	Pass
Line - 120VAC 60Hz	0.374	49.31	58.432	-9.122	Pass	39.70	48.432	-8.732	Pass
Line - 120VAC 60Hz	0.390	45.54	58.085	-12.545	Pass	44.72	48.085	-3.365	Pass
Neutral - 120VAC 60Hz	0.246	50.39	61.902	-11.512	Pass	43.50	51.902	-8.402	Pass
Neutral - 120VAC 60Hz	0.298	44.31	60.314	-16.004	Pass	44.84	50.314	-5.474	Pass
Neutral - 120VAC 60Hz	0.318	33.74	59.776	-26.036	Pass	25.06	49.776	-24.716	Pass
Neutral - 120VAC 60Hz	0.330	47.29	59.469	-12.179	Pass	35.08	49.469	-14.389	Pass
Neutral - 120VAC 60Hz	0.362	49.04	58.702	-9.662	Pass	37.77	48.702	-10.932	Pass
Neutral - 120VAC 60Hz	0.390	46.40	58.085	-11.685	Pass	36.08	48.085	-12.005	Pass

Table 10. Conducted Emissions, Test Results, Encoder & Ribbon



Plot 1. Conducted Emissions, Phase Line, Encoder & Ribbon



Plot 2. Conducted Emissions, Neutral Line, Encoder & Ribbon

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.

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.

Test Results: The Encoder and Ribbon reader were compliant with this requirement.

Test Engineer(s): Jonathan Tavira

Test Date(s): 08/03/2020

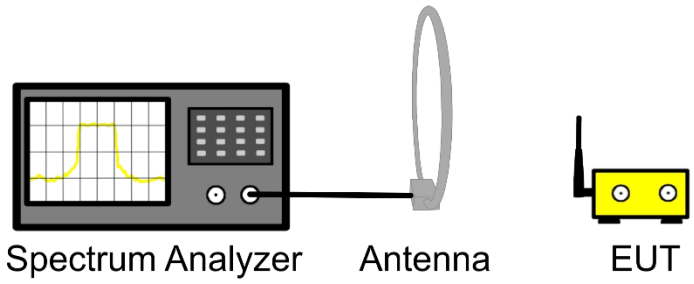
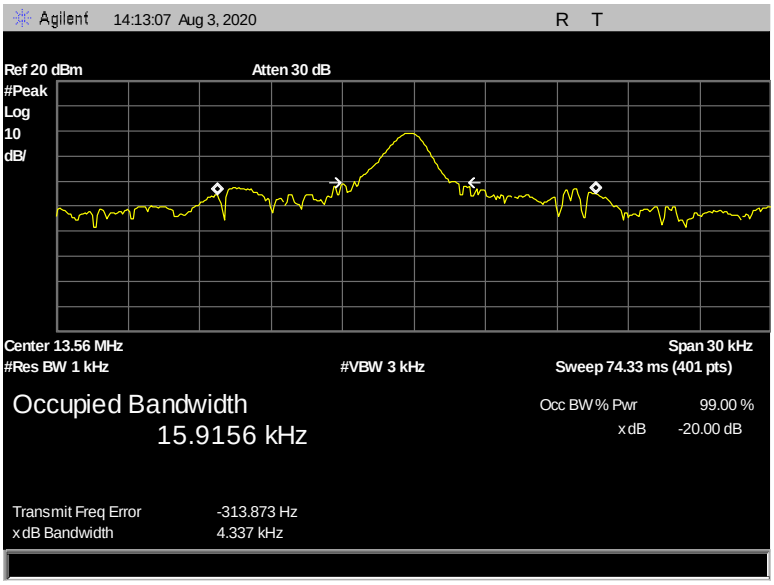


Figure 3. 20 dB Bandwidth Test Setup

Center Frequency (MHz)	20 dB Bandwidth of Emission (kHz)
13.56	4.337

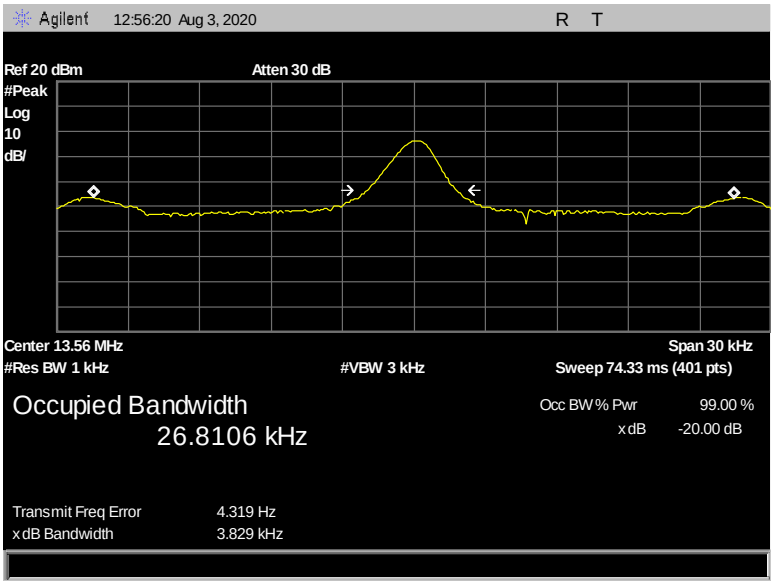
Table 11. 20 dB Emission Bandwidth Test Results, Encoder



Plot 3. 20 dB Occupied Bandwidth, Encoder, 4.337 kHz

Center Frequency (MHz)	20 dB Bandwidth of Emission (kHz)
13.56	3.829

Table 12. 20 dB Emission Bandwidth Test Results, Ribbon



Plot 4. 20 dB Occupied Bandwidth, Ribbon, 3.829 kHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(a) Field Strength, 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 wooden stand inside a semi-anechoic chamber. The method of testing and test conditions of 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. A peak detector was used to perform a pre-scan. The worst-case emissions were recorded in the subsequent section.

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

40log(3/30) = -40 dB

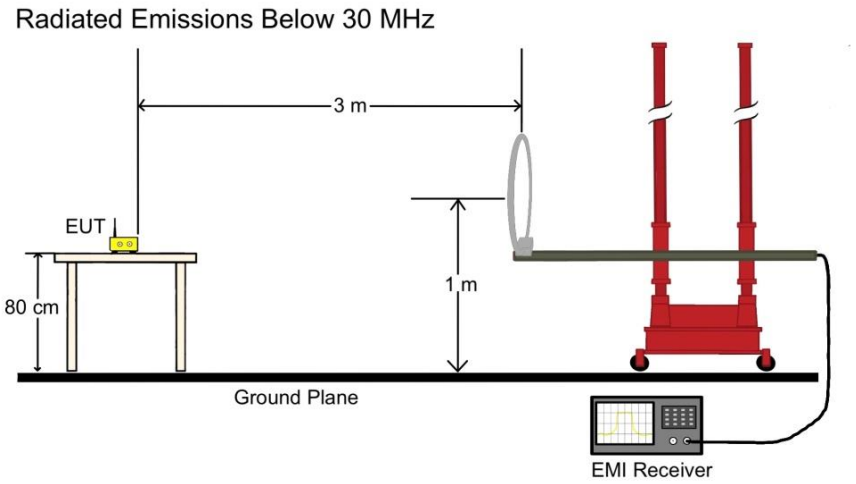


Figure 4: Radiated Emissions, Test Setup

Test Results: The Encoder and Ribbon Reader were compliant with the requirements of **§15.225(a)**.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/27/2020

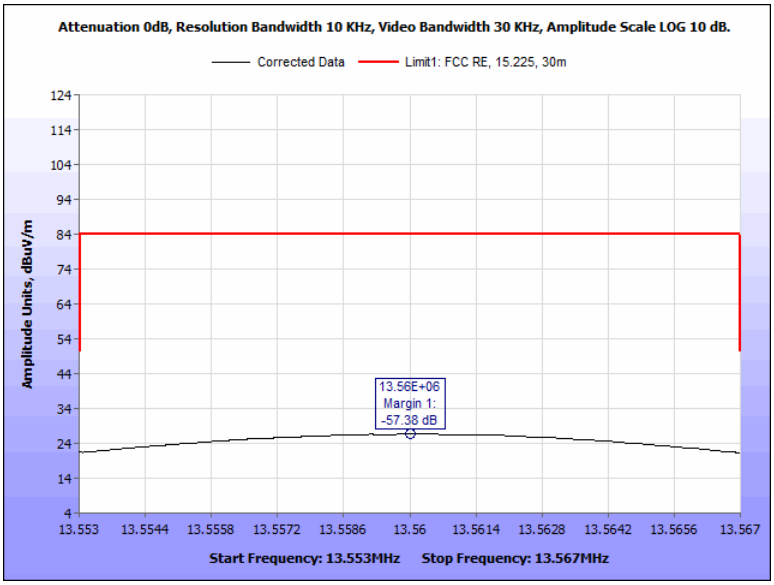
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.5600	55.77	0	-40	10.64	0.2	26.62	84	-57.38
13.5600	49.19	90	-40	10.64	0.2	23.20	84	-63.96

Table 13. Field Strength Within the Band 13.553 – 13.567 MHz, Test Results, Encoder

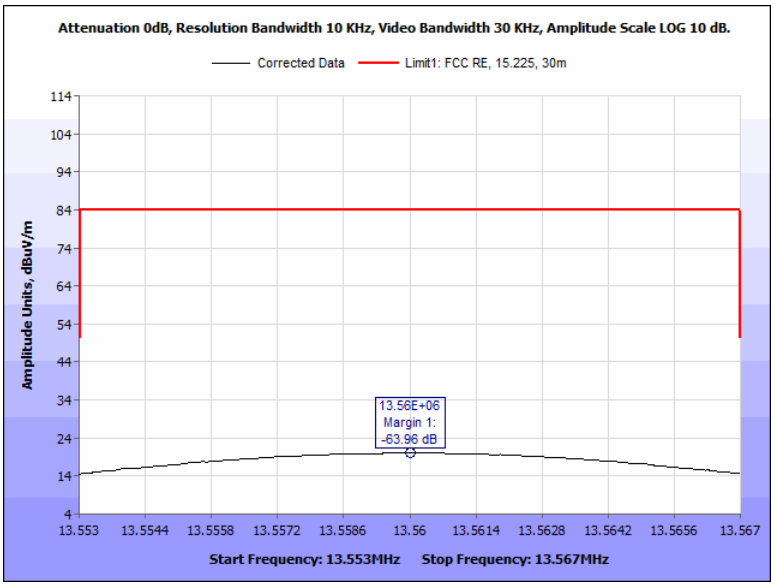
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.5600	59.03	0	-40	10.64	0.2	29.87	84	-54.13
13.5600	52.36	90	-40	10.64	0.2	23.20	84	-60.80

Table 14. Field Strength Within the Band 13.553 – 13.567 MHz, Test Results, Ribbon

Field Strength, within the band 13.553 – 13.567 MHz, Encoder

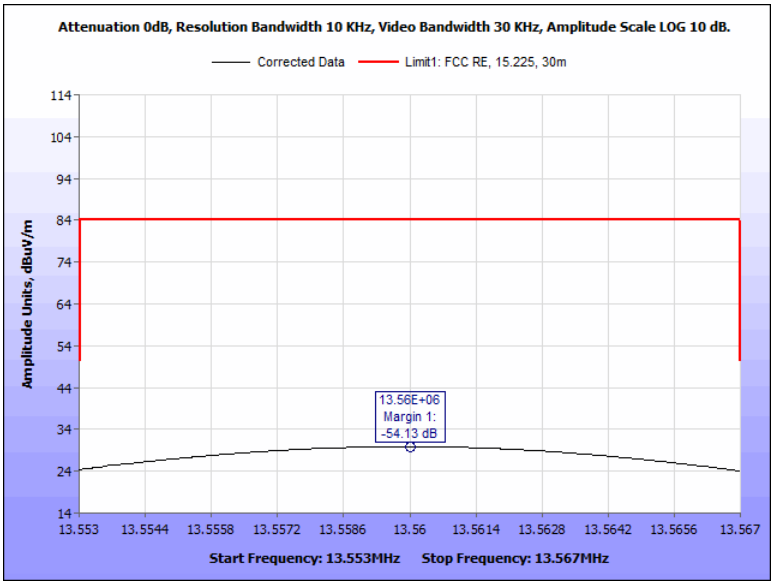


Plot 5. Field Strength Within the Band 13.553 -13.567 MHz, 0 Degrees, Encoder

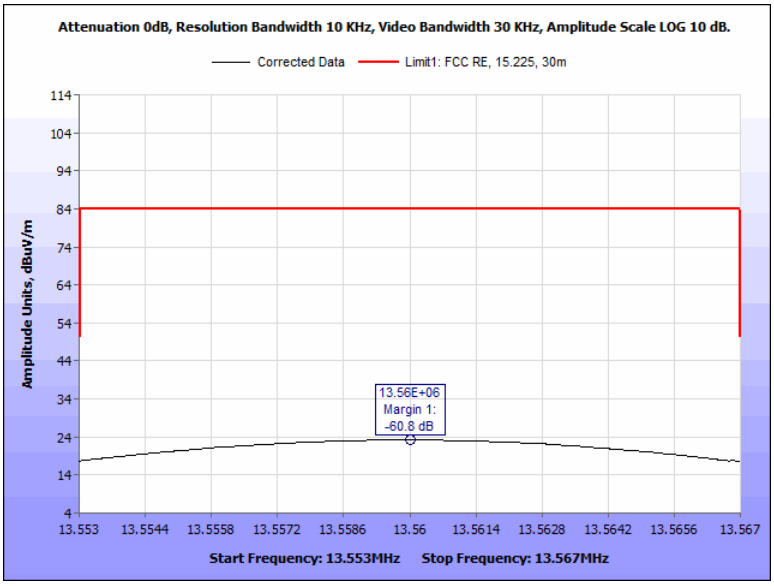


Plot 6. Field Strength Within the Band 13.553 -13.567 MHz, 90 Degrees, Encoder

Field Strength, within the band 13.553 – 13.567 MHz, Ribbon



Plot 7. Field Strength Within the Band 13.553 -13.567 MHz, 0 Degrees, Ribbon



Plot 8. Field Strength Within the Band 13.553 -13.567 MHz, 90 Degrees, Ribbon

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(b) Field Strength 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 Procedures: 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 C63.10: 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. A peak detector was used to perform a pre-scan. The worst-case emissions were recorded in the subsequent section.

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

40log(3/30) = -40 dB

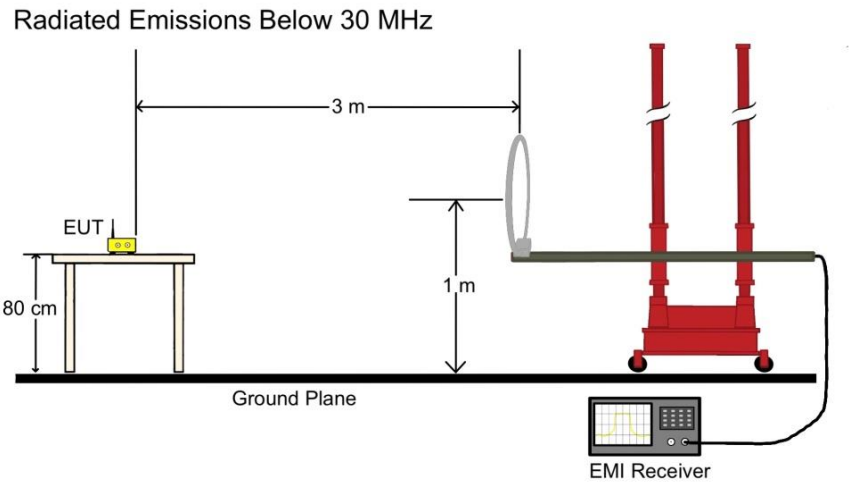


Figure 5: Radiated Emissions, Test Setup

Test Results: The Encoder and Ribbon Reader were compliant with the requirements of **§ 15.225(b)**.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/27/2020

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.553	50.66	0	-40	10.64	0.2	21.51	50.47	-28.96
13.553	47.02	90	-40	10.64	0.2	17.87	50.47	-32.60

Table 15. Field Strength Within the Band 13.410-13.553 MHz, Test Results, Encoder

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.567	50.20	0	-40	10.64	0.2	21.05	50.47	-29.42
13.567	46.31	90	-40	10.64	0.2	17.16	50.47	-33.31

Table 16. Field Strength Within the Band 13.567-13.710 MHz, Test Results, Encoder

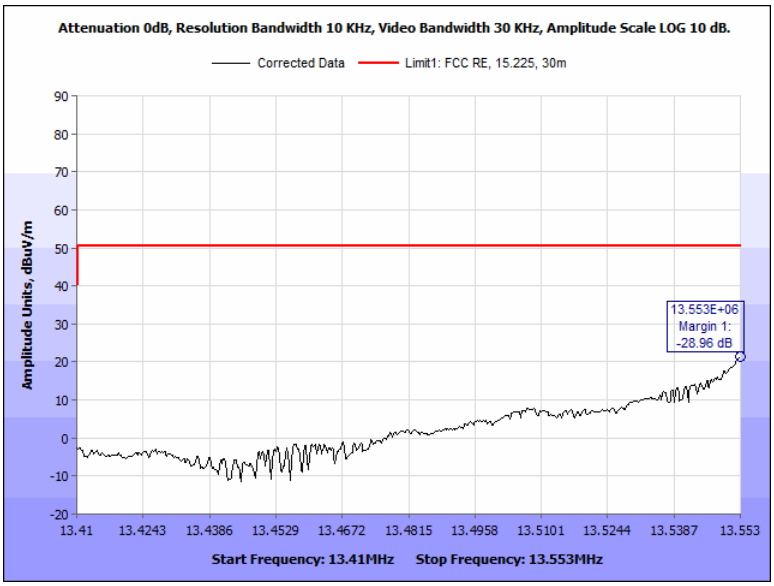
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.553	53.80	0	-40	10.64	0.2	24.64	50.47	-25.83
13.553	46.93	90	-40	10.64	0.2	17.77	50.47	-32.70

Table 17. Field Strength Within the Band 13.410-13.553 MHz, Test Results, Ribbon

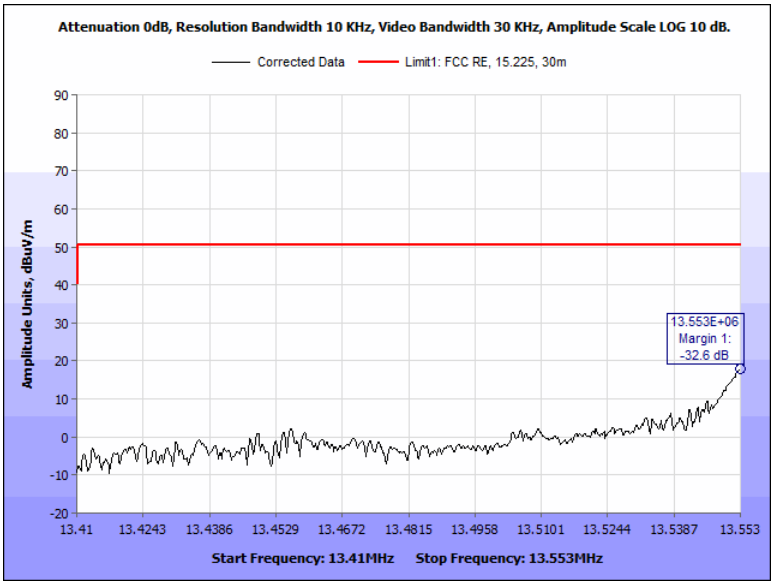
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.567	53.09	0	-40	10.64	0.2	23.94	50.47	-26.53
13.567	46.48	90	-40	10.64	0.2	17.33	50.47	-33.14

Table 18. Field Strength Within the Band 13.567-13.710 MHz, Test Results, Ribbon

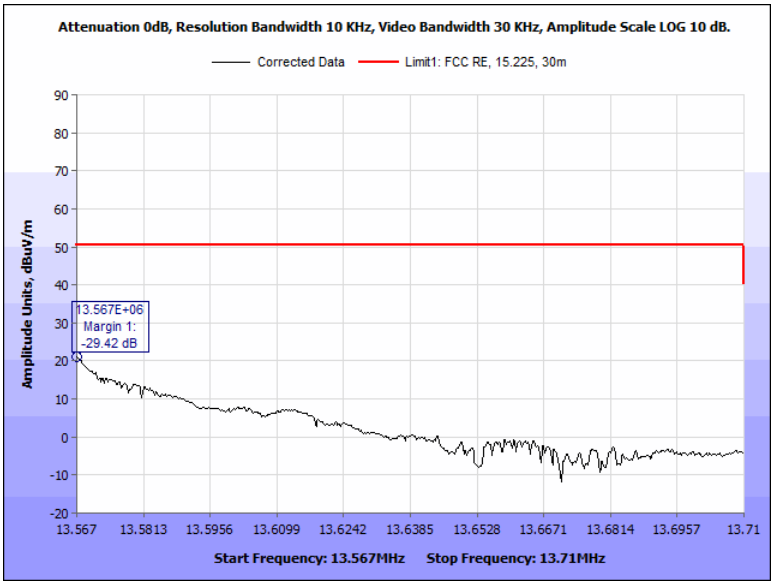
Field Strength Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Encoder



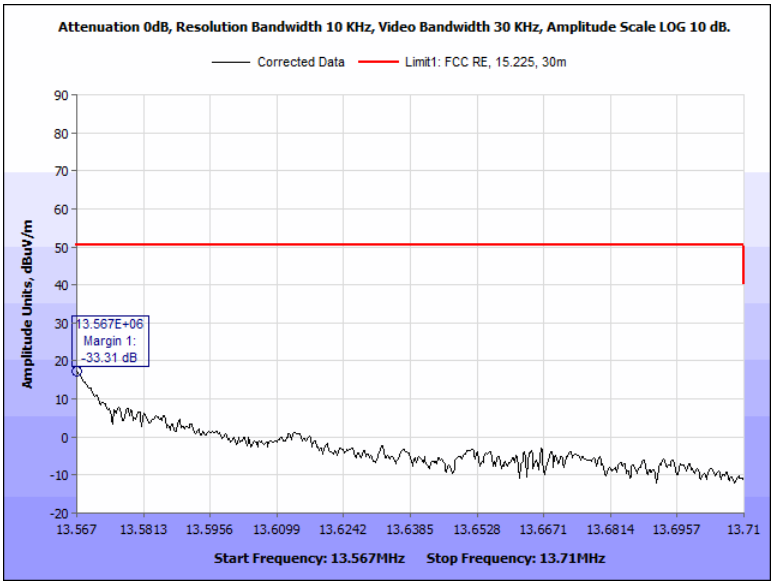
Plot 9. Field Strength Within the Band 13.410-13.553 MHz, 0 Degrees, Encoder, Peak Scan



Plot 10. Field Strength Within the Band 13.410-13.553 MHz, 90 Degrees, Encoder, Peak Scan

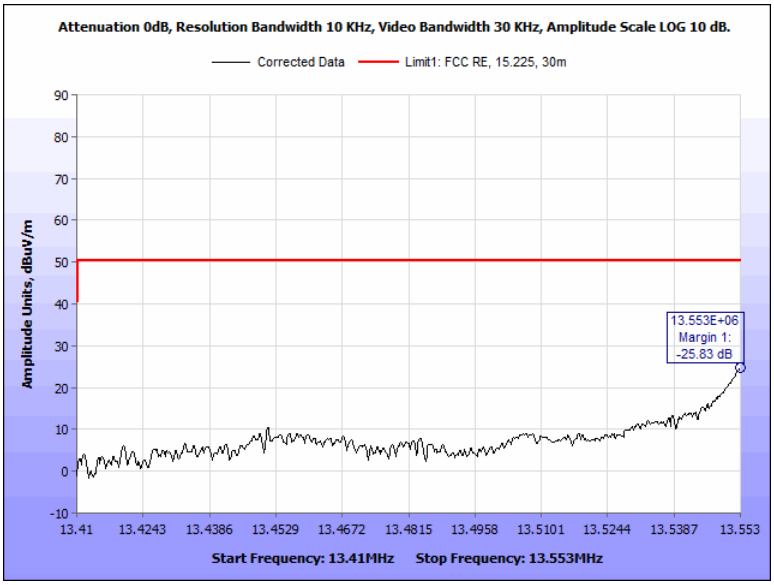


Plot 11. Field Strength Within the Band 13.567-13.710 MHz, 0 Degrees, Encoder, Peak Scan

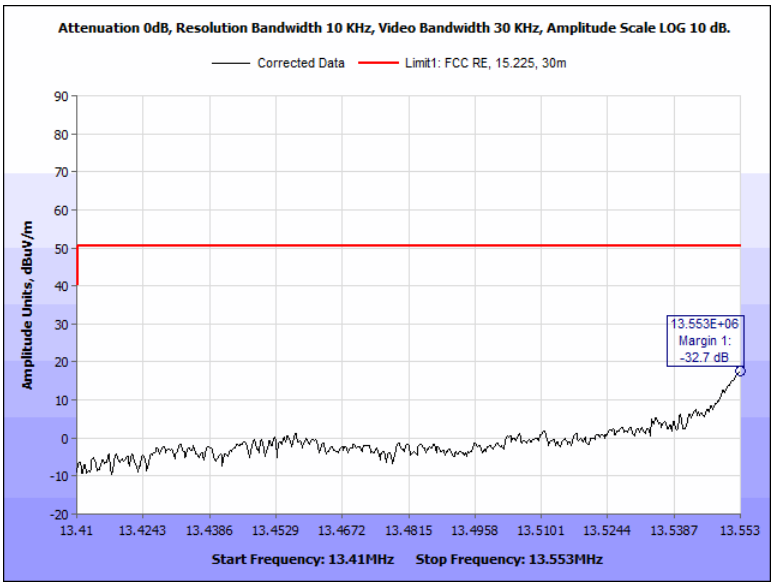


Plot 12. Field Strength Within the Band 13.567-13.710 MHz, 90 Degrees, Encoder, Peak Scan

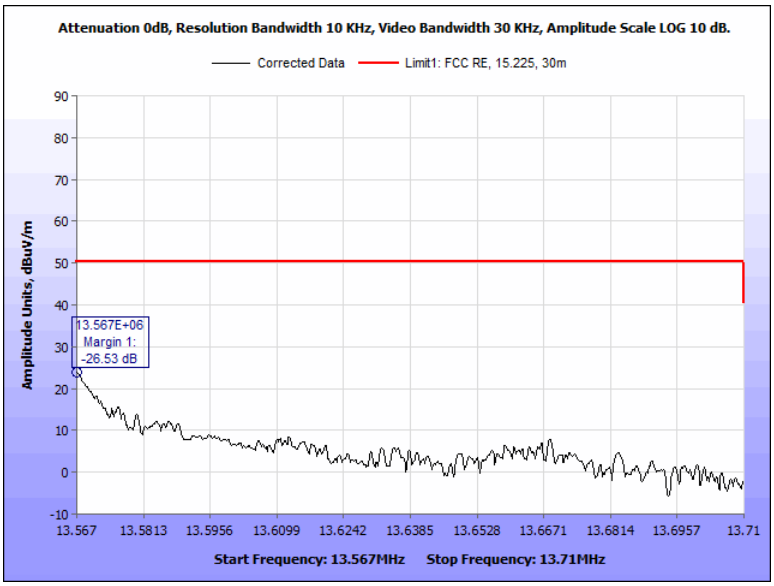
Field Strength Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz, Ribbon



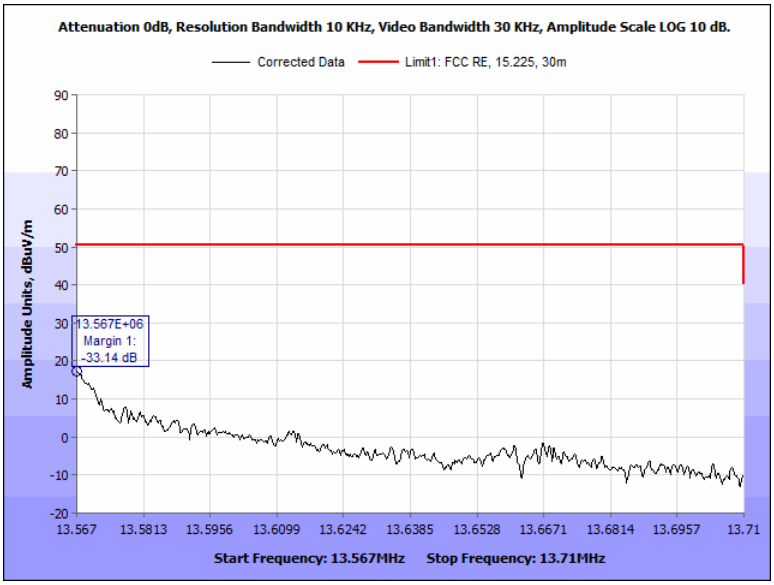
Plot 13. Field Strength Within the Band 13.410-13.553 MHz, 0 Degrees, Ribbon, Peak Scan



Plot 14. Field Strength Within the Band 13.410-13.553 MHz, 90 Degrees, Ribbon, Peak Scan



Plot 15. Field Strength Within the Band 13.567-13.710 MHz, 0 Degrees, Ribbon, Peak Scan



Plot 16. Field Strength Within the Band 13.567-13.710 MHz, 90 Degrees, Ribbon, Peak Scan

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(c) Field Strength 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 Procedures: 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 C63.10: 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. A peak detector was used to perform a pre-scan. The worst-case emissions were recorded in the subsequent section.

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

40log(3/30) = -40 dB

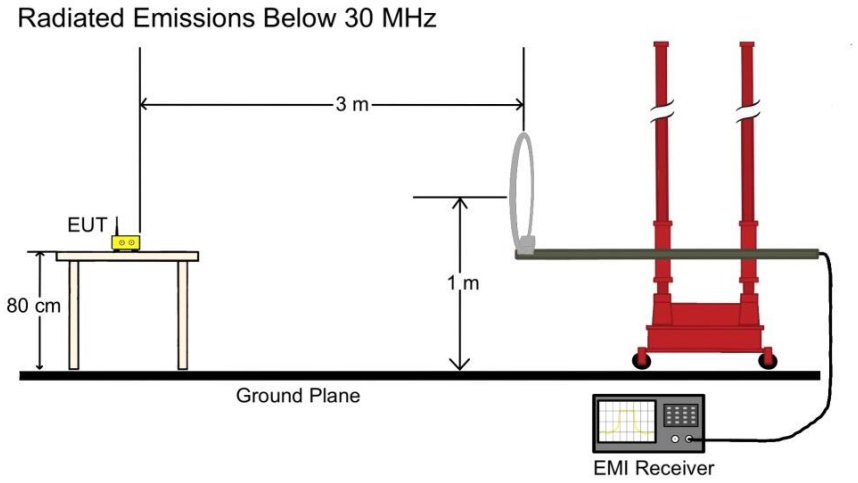


Figure 6: Radiated Emissions, Test Setup

Test Results: The Encoder and Ribbon Reader were compliant with the requirements of **§15.225(c)**.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/27/2020

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.1355	32.63	0	-40	10.69	0.2	3.52	40.50	-36.98
13.3470	26.83	90	-40	10.69	0.2	-2.28	40.50	-42.78

Table 19. Field Strength Within the Band 13.110 -13.410 MHz, Test Results, Encoder

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.7177	25.72	0	-40	10.63	0.20	-3.45	40.50	-43.95
13.7701	21.92	90	-40	10.62	0.21	-7.25	40.50	-47.75

Table 20. Field Strength Within the Band 13.710-14.010 MHz, Test Results, Encoder

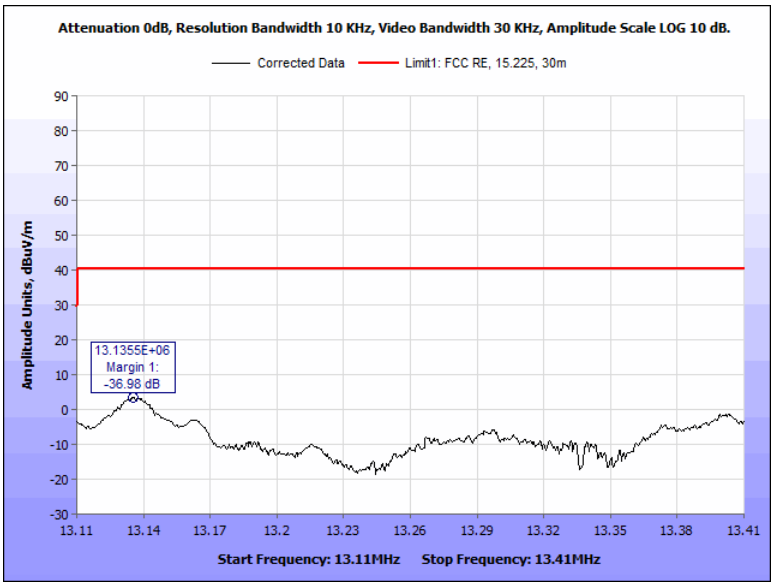
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.3470	35.47	0	-40	10.67	0.2	6.34	40.50	-34.16
13.3465	27.29	90	-40	10.67	0.2	-1.84	40.50	-42.34

Table 21. Field Strength Within the Band 13.110 -13.410 MHz, Test Results, Ribbon

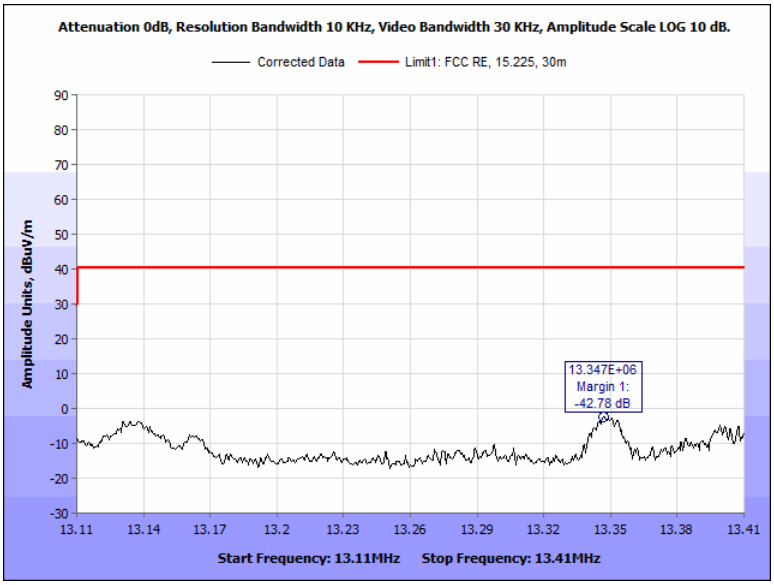
Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
13.773	30.85	0	-40	10.62	0.21	1.68	40.50	-38.82
13.772	21.57	90	-40	10.62	0.21	-7.60	40.50	-48.10

Table 22. Field Strength Within the Band 13.710-14.010 MHz, Test Results, Ribbon

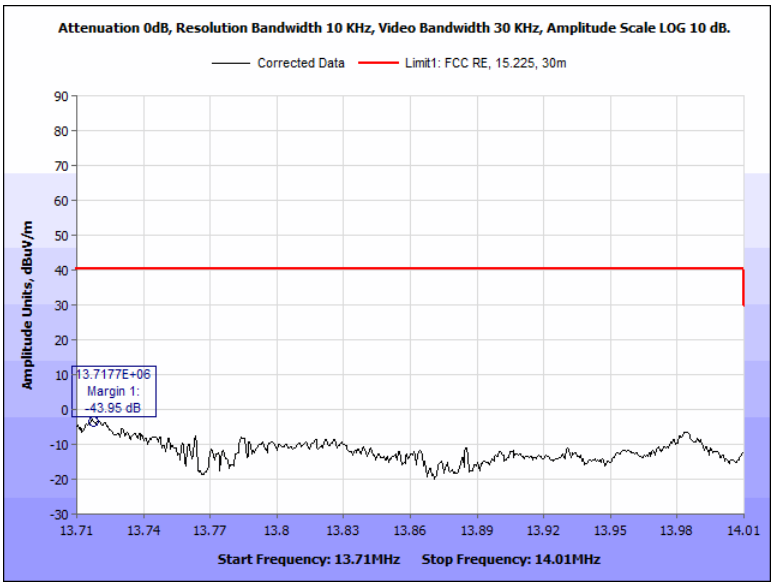
Field Strength Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Encoder



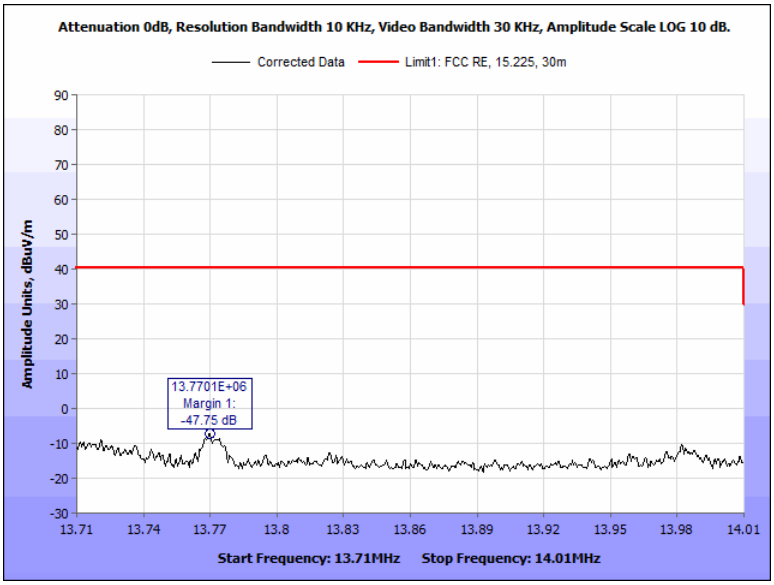
Plot 17. Field Strength Within the Band 13.110-13.410 MHz, 0 Degrees, Encoder, Peak Scan



Plot 18. Field Strength Within the Band 13.110-13.410 MHz, 90 Degrees, Encoder, Peak Scan

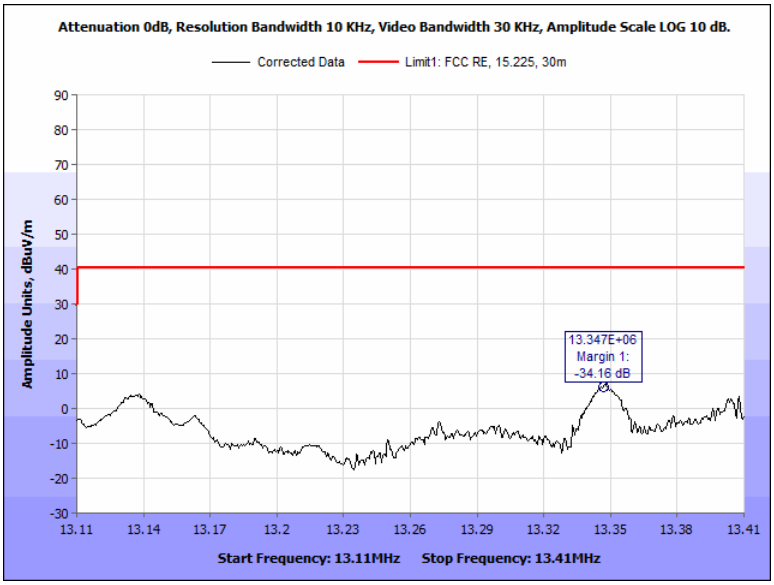


Plot 19. Field Strength Within the Band 13.710-14.010 MHz, 0 Degrees, Encoder, Peak Scan

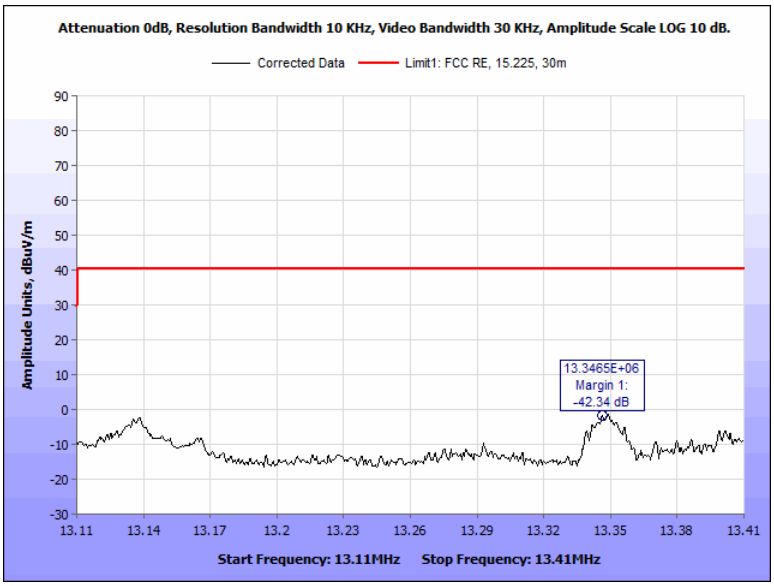


Plot 20. Field Strength Within the Band 13.710-14.010 MHz, 90 Degrees, Encoder, Peak Scan

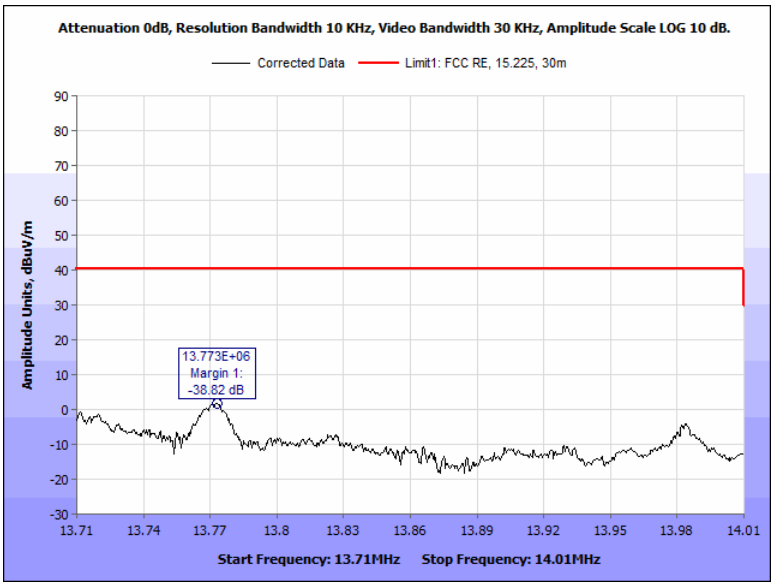
Field Strength Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz, Ribbon



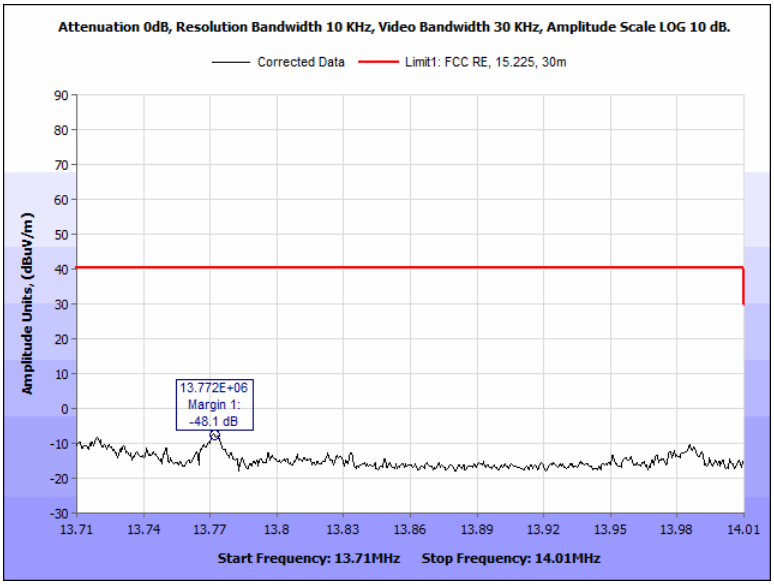
Plot 21. Field Strength Within the Band 13.110-13.410 MHz, 0 Degrees, Ribbon, Peak Scan



Plot 22. Field Strength Within the Band 13.110-13.410 MHz, 90 Degrees, Ribbon, Peak Scan



Plot 23. Field Strength Within the Band 13.710-14.010 MHz, 0 Degrees, Ribbon, Peak Scan



Plot 24. Field Strength Within the Band 13.710-14.010 MHz, 90 Degrees, Ribbon, Peak Scan

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(d) Field Strength 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 Procedures: 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 C63.10: 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 below 30 MHz were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. Measurements above 30 MHz were conducted with the biconalog antenna in the vertical and horizontal polarizations. A peak detector was used to perform a pre-scan from 9 kHz to 140 MHz. Spurious emissions within 20 dB of the applicable limit were measured using a quasi-peak detector and recorded in the subsequent section. Peak emissions that were observed over the appliable limit were determined to be digital emissions subject to the requirements of FCC Part 15B subsection 109 for Class A devices.

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

Test Results: The Encoder and Ribbon Reader were compliant with requirements of **§ 15.225 (d)**.

Test Engineer: Jonathan Tavira

Test Date: 07/27/2020

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Azimuth (Degrees)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
0.7139183	42.27	0	105.20	-40	11.10	0	13.37	30.53	-17.16
0.7158654	38.54	90	150.80	-40	11.10	0	9.64	30.55	-20.91

Table 23. Field Strength outside 13.110 – 14.010 MHz band, 0.009-30 MHz, Quasi-Peak Test Results, Encoder

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 10m)	Antenna Polarization (H/V)	Antenna Height (cm)	Azimuth (Degrees)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Corrected Amplitude (dBµV/m @3m)	Limit, FCC 15.209 (dBµV/m)	Margin (dB)
30.3526	22.23	V	188.10	134.30	10.45	24.86	-24.80	32.74	40.00	-7.26
32.9968	28.56	V	347.00	100.00	10.45	23.00	-24.70	37.31	40.00	-2.78
50.9776	32.16	H	171.60	367.90	10.45	11.50	-24.34	29.77	40.00	-10.23
65.9615	40.27	V	262.50	108.90	10.45	11.29	-24.16	37.85	40.00	-2.15
75.1282	26.68	H	344.60	261.00	10.45	11.79	-23.98	24.94	40.00	-15.06
84.1186	35.52	V	139.90	171.30	10.45	11.59	-23.90	33.66	40.00	-6.34
84.1186	29.75	H	5.30	367.90	10.45	11.10	-23.90	27.40	40.00	-12.60
93.109	23.24	H	209.80	278.00	10.45	12.23	-23.80	22.12	43.50	-21.38
102.9808	36.92	H	280.30	392.30	10.45	14.99	-23.70	38.66	43.50	-4.84
104.2147	40.17	V	347.60	100.00	10.45	14.54	-23.68	41.48	43.50	-2.02
114.6154	30.32	V	323.90	100.00	10.45	16.66	-23.57	33.86	43.50	-9.64
125.5449	28.29	H	0.00	336.80	10.45	17.70	-23.50	32.94	43.50	-10.56

Table 24. Field Strength outside 13.110 – 14.010 MHz band, 30-140 MHz, Quasi-Peak Test Results, Encoder

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 3m)	Loop Antenna Orientation (Degree)	Azimuth (Degrees)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Amplitude (dBµV/m @ 30m)	Limit, FCC 15.225, 30m (dBµV/m)	Margin (dB)
0.7139183	44.98	0	112.50	-40	11.10	0	16.08	30.53	-14.45
0.7126426	38.39	90	161.80	-40	11.10	0	9.49	30.55	-21.06

Table 25. Field Strength outside 13.110 – 14.010 MHz band, 0.009-30 MHz, Quasi-Peak Test Results, Ribbon

Frequency (MHz)	Uncorrected Amplitude (dBµV @ 10m)	Antenna Polarization (H/V)	Antenna Height (cm)	Azimuth (Degrees)	Distance Correction Factor (dB)	Antenna Factor (dB/m)	Preamp Factor (dB)	Corrected Amplitude (dBµV/m @3m)	Limit, FCC 15.209 (dBµV/m)	Margin (dB)
40.5769	33.09	V	257.00	227.90	10.45	16.44	-24.57	35.41	40.00	-4.59
75.1282	29.37	H	15.60	285.60	10.45	11.79	-23.98	27.63	40.00	-12.37
84.1186	40.06	H	0.00	268.90	10.45	11.1	-23.90	37.71	40.00	-2.29
84.1186	34.86	V	40.00	103.50	10.45	11.59	-23.90	33.00	40.00	-7.00
89.5833	29.69	V	190.50	185.60	10.45	12.02	-23.79	28.37	43.50	-15.13
92.9327	35.90	H	347.70	339.90	10.45	12.19	-23.80	34.74	43.50	-8.76
94.8718	26.96	V	335.00	253.60	10.45	12.9	-23.80	26.51	43.50	-16.99
95.9295	34.30	H	356.30	370.90	10.45	12.98	-23.76	33.97	43.50	-9.53
99.1026	30.68	H	357.50	400.00	10.45	13.93	-23.76	31.30	43.50	-12.2
102.0994	33.20	H	343.60	400.00	10.45	14.73	-23.71	34.67	43.50	-8.83
104.0385	38.27	V	317.20	171.50	10.45	14.51	-23.69	39.54	43.50	-3.96
107.0353	34.84	V	345.90	159.60	10.45	15.11	-23.65	36.75	43.50	-6.75

Table 26. Field Strength outside 13.110 – 14.010 MHz band, 30-140 MHz, Quasi-Peak Test Results, Ribbon

Radiated Emissions Limits Test Setup

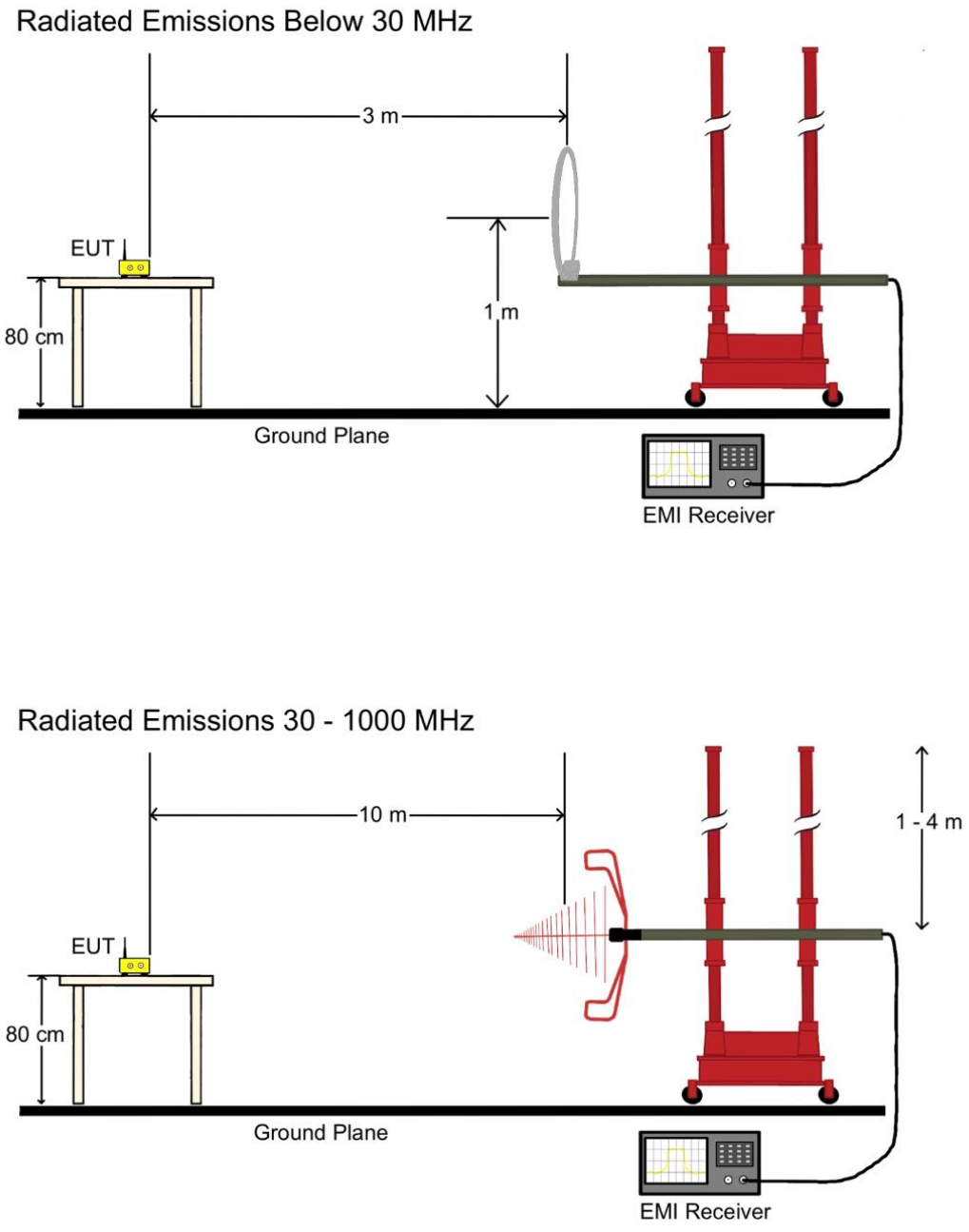
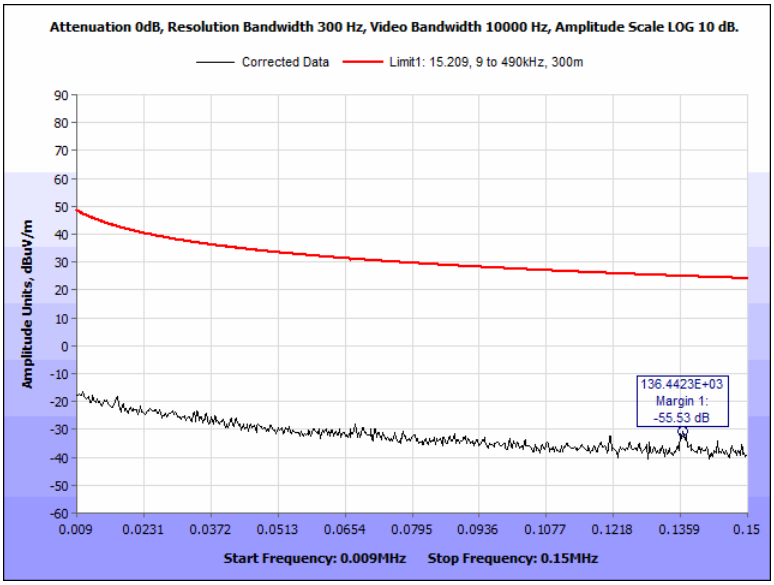


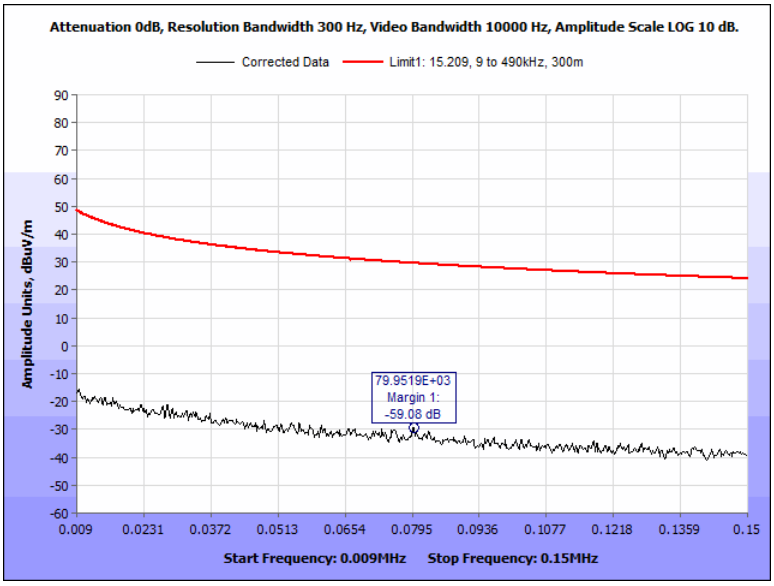
Figure 7. Radiated Emissions Test Setup

Field Strength Limits, outside the bands 13.110 – 14.010 MHz, Encoder



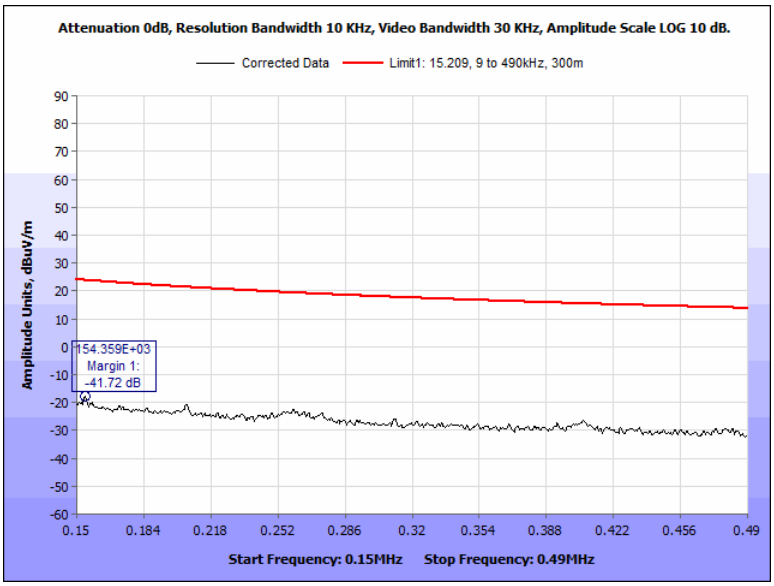
*all out of band emissions were greater than 20 dB below the limit

Plot 25. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.009 – 0.150 MHz, 0 degrees, Encoder, Peak Scan



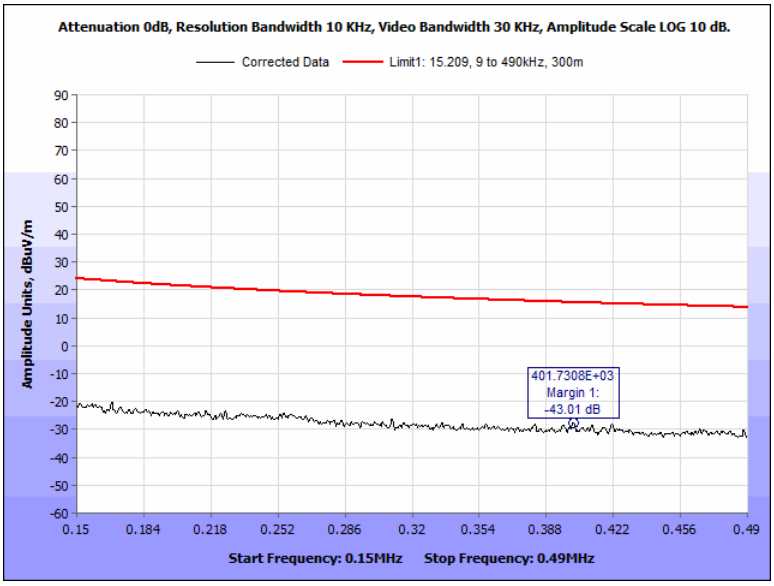
*all out of band emissions were greater than 20 dB below the limit

Plot 26. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.009 – 0.150 MHz, 90 degrees, Encoder, Peak Scan



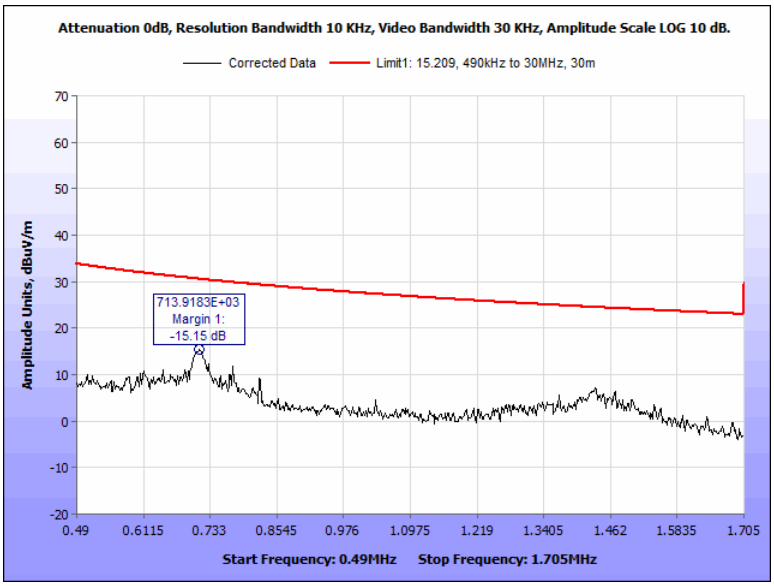
*all out of band emissions were greater than 20 dB below the limit

Plot 27 Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.150 – 0.490 MHz, 0 degrees, Encoder, Peak Scan

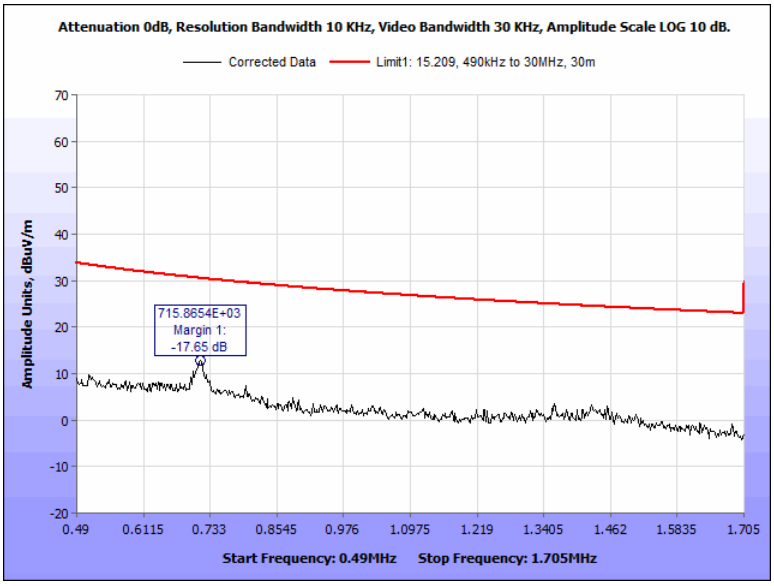


*all out of band emissions were greater than 20 dB below the limit

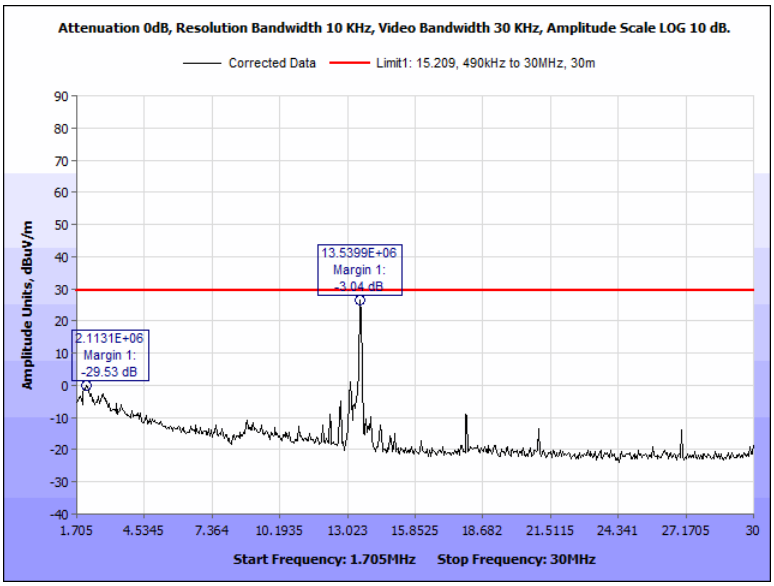
Plot 28. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.150 – 0.490 MHz, 90 degrees, Encoder, Peak Scan



Plot 29. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.490 – 1.705 MHz, 0 degrees, Encoder, Peak Scan

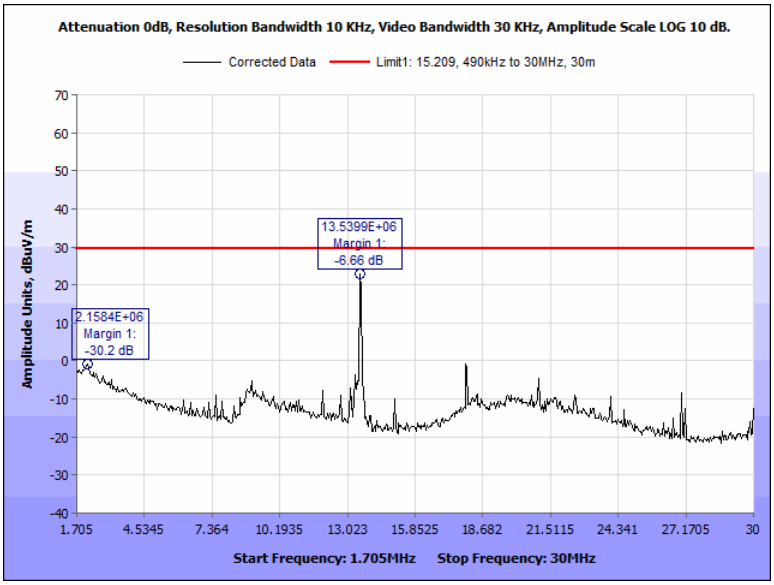


Plot 30 Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.490 – 1.705 MHz, 90 degrees, Encoder, Peak Scan



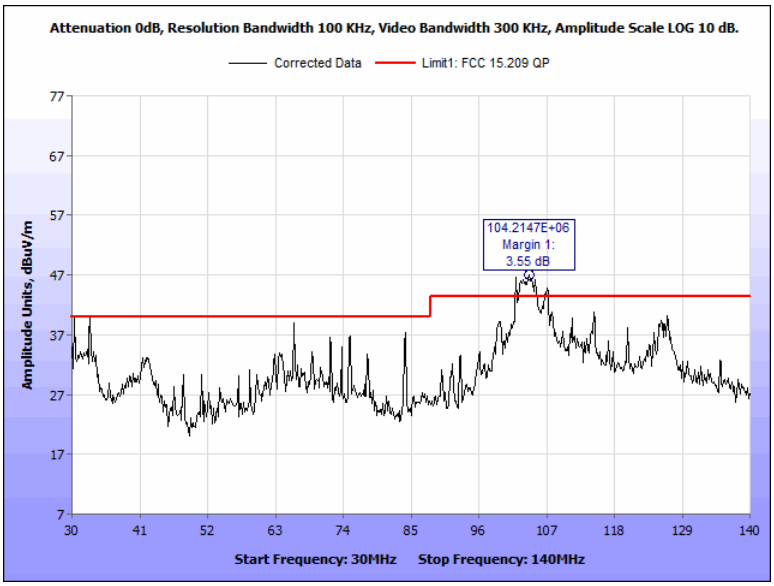
*all out of band emissions were greater than 20 dB below the limit

Plot 31 Field Strength Outside the Band 13.110 – 14.010 MHz band, 1.705-30 MHz, 0 degrees, Encoder, Peak Scan

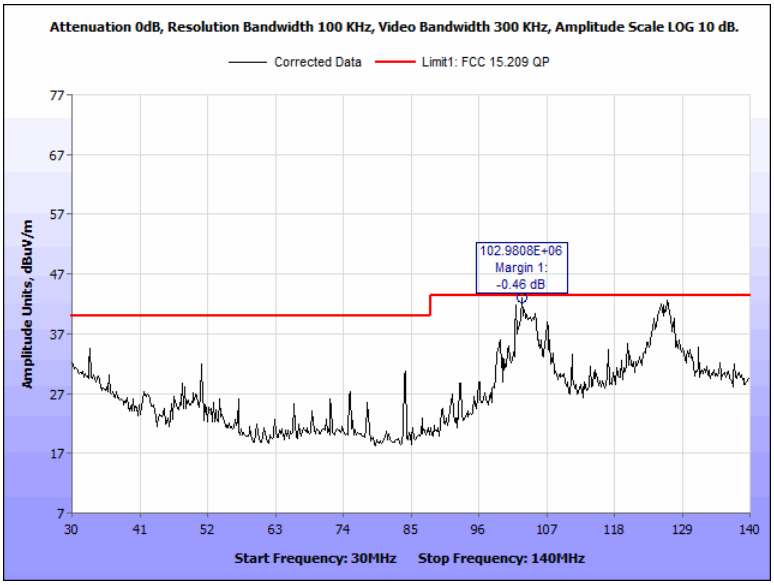


*all out of band emissions were greater than 20 dB below the limit

Plot 32. Field Strength Outside the Band 13.110 – 14.010 MHz band, 1.705-30 MHz, 90 degrees, Encoder, Peak Scan

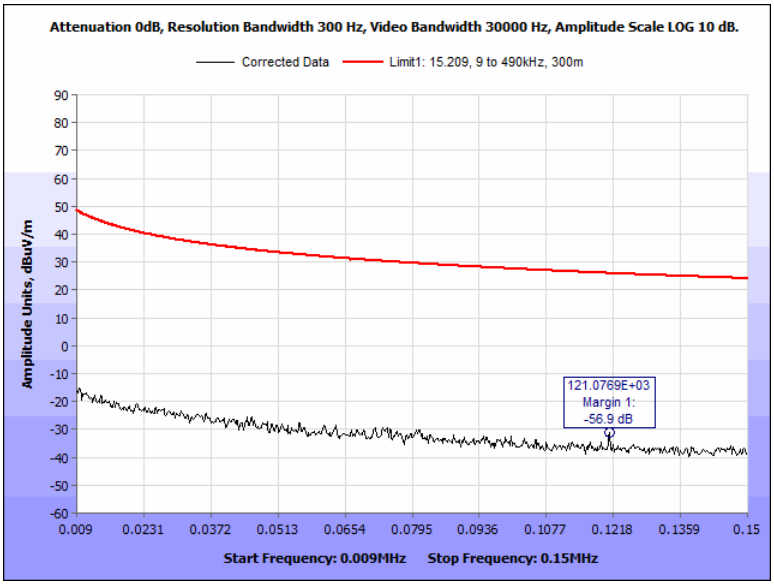


Plot 33 Field Strength Outside the Band 13.110 – 14.010 MHz band, 30-140 MHz, Vertical, Encoder, Peak Scan



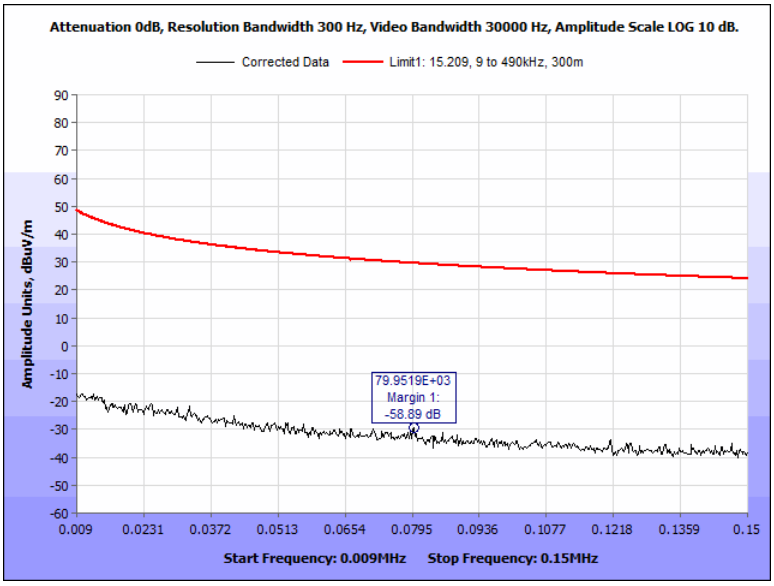
Plot 34. Field Strength Outside the Band 13.110 – 14.010 MHz band, 30-140 MHz, Horizontal, Encoder, Peak Scan

Field Strength Emission Limits, outside the bands 13.110 – 14.010 MHz, Ribbon



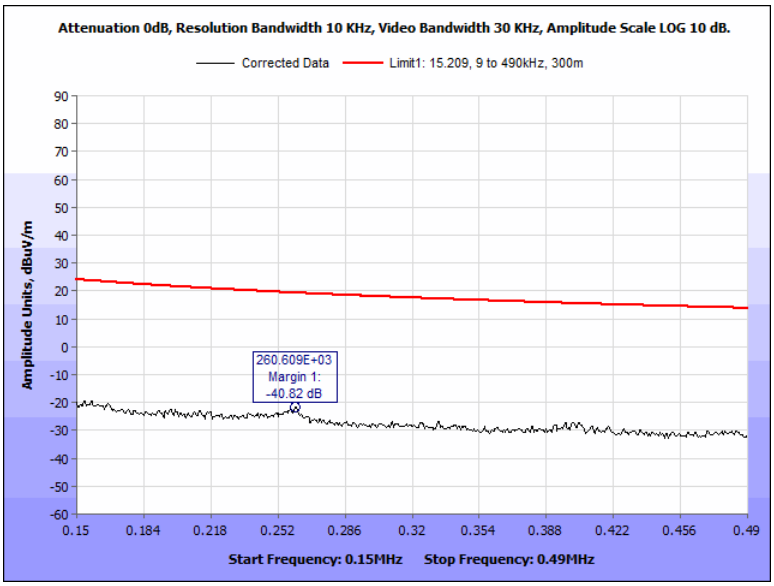
*all out of band emissions were greater than 20 dB below the limit

Plot 35 Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.009 – 0.150 MHz, 0 degrees, Ribbon, Peak Scan



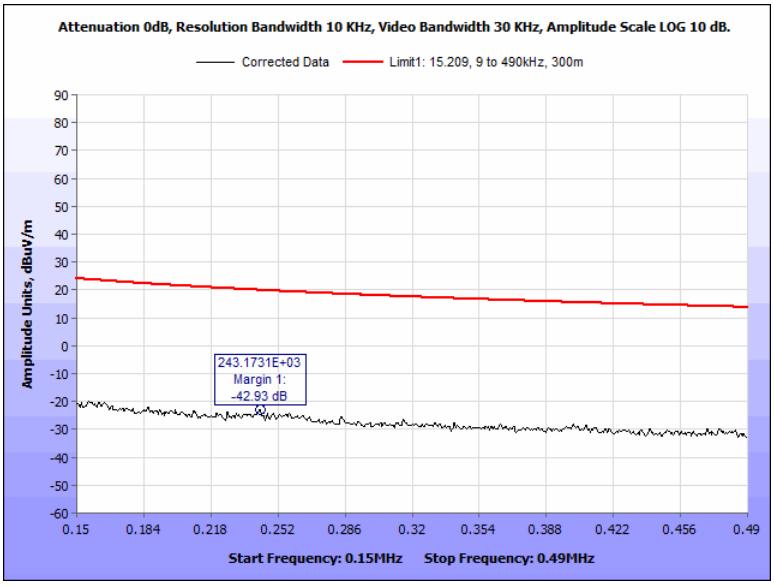
*all out of band emissions were greater than 20 dB below the limit

Plot 36. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.009 – 0.150 MHz, 90 degrees, Ribbon, Peak Scan



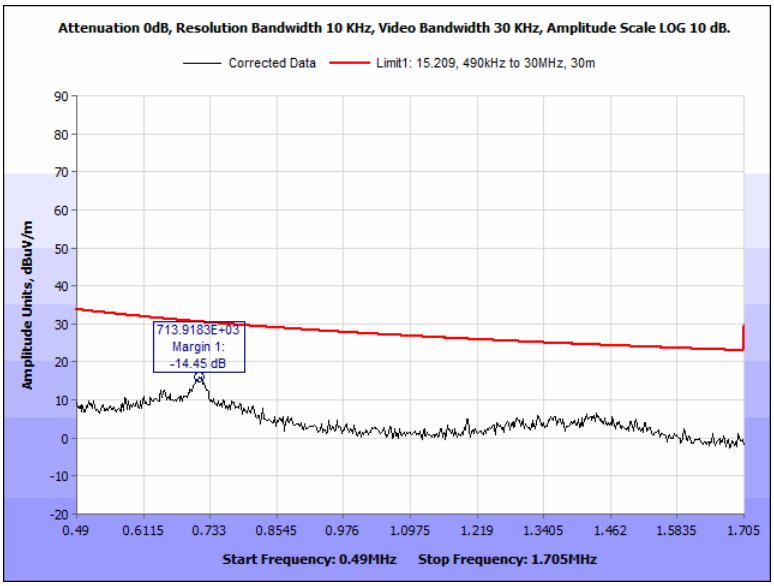
*all out of band emissions were greater than 20 dB below the limit

Plot 37. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.150 – 490 MHz, 0 degrees, Ribbon, Peak Scan

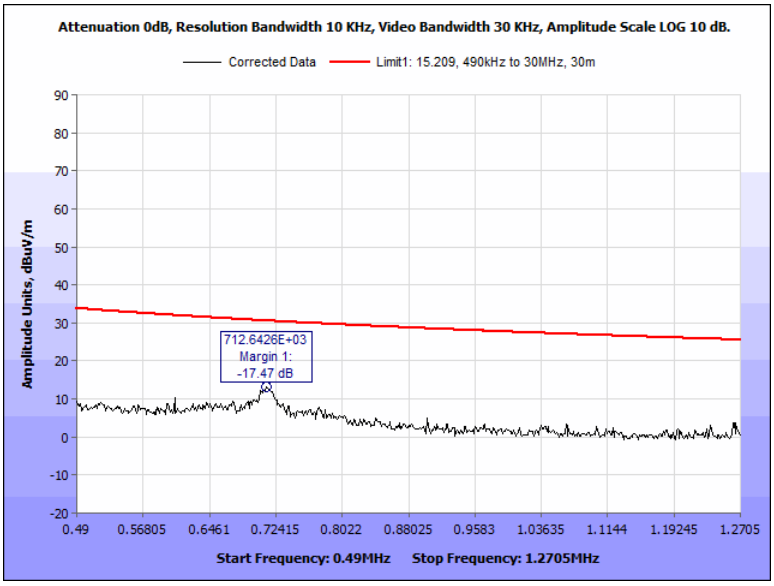


*all out of band emissions were greater than 20 dB below the limit

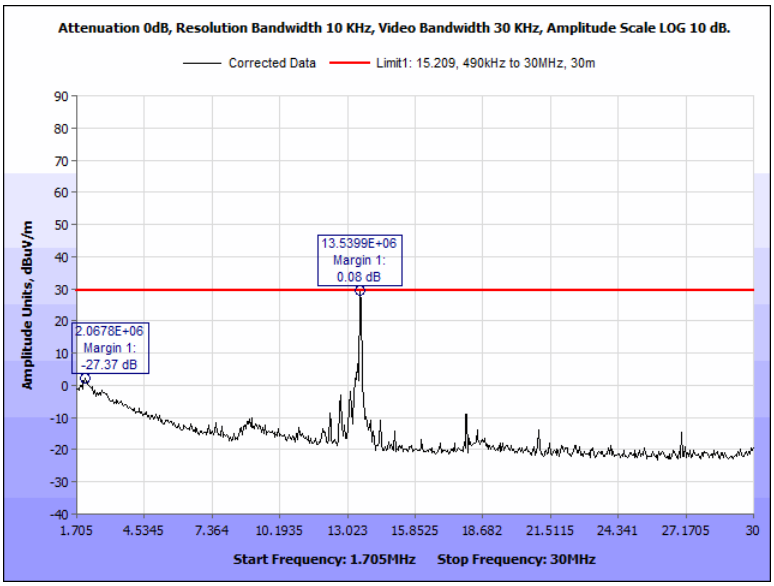
Plot 38. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.150 – 490 MHz, 90 degrees, Ribbon, Peak Scan



Plot 39. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.490 – 1.705 MHz, 0 degrees, Ribbon, Peak Scan

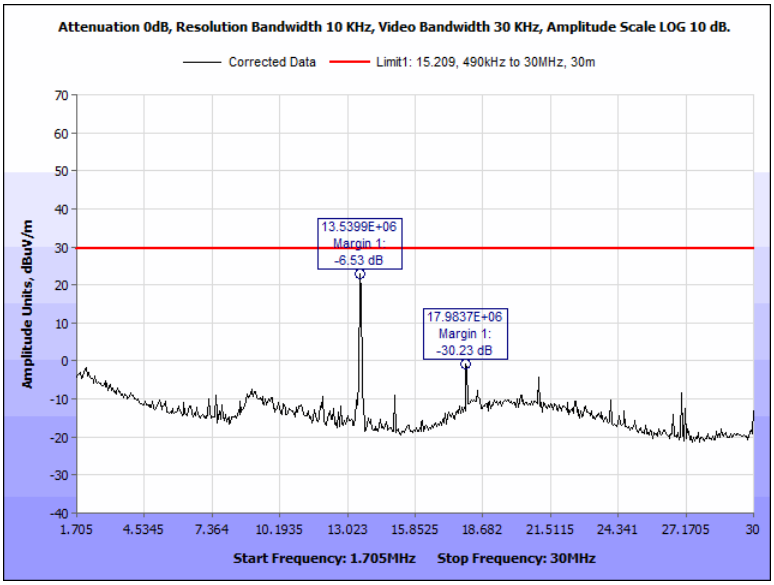


Plot 40. Field Strength Outside the Band 13.110 – 14.010 MHz band, 0.490 – 1.705 MHz, 90 degrees, Ribbon, Peak Scan



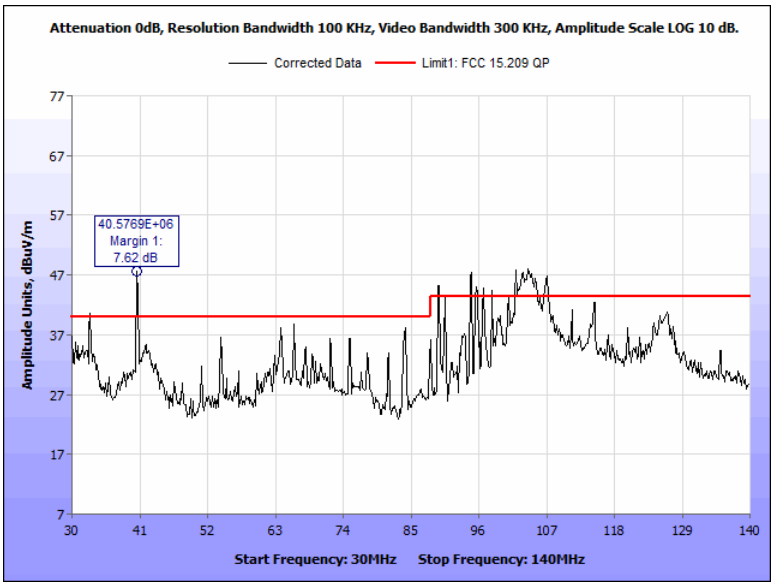
*all out of band emissions were greater than 20 dB below the limit

Plot 41. Field Strength Outside the Band 13.110 – 14.010 MHz band, 1.705-30 MHz, 0 degrees, Ribbon, Peak Scan

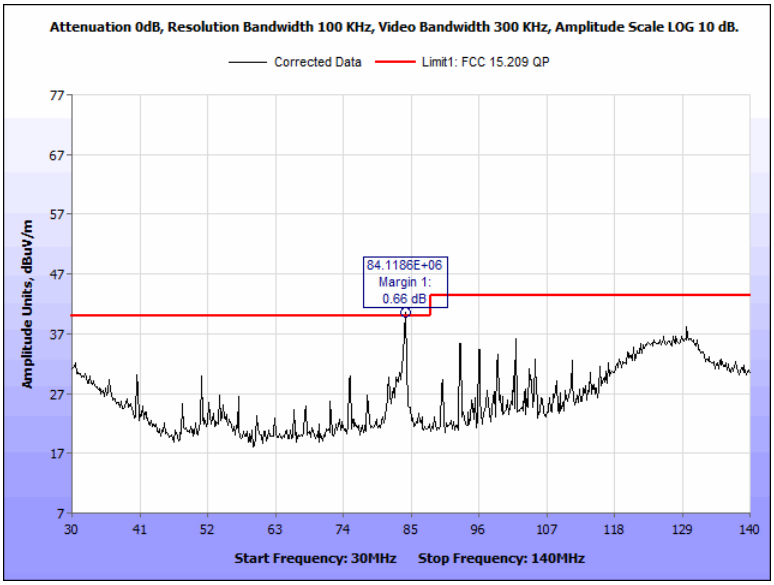


*all out of band emissions were greater than 20 dB below the limit

Plot 42. Field Strength Outside the Band 13.110 – 14.010 MHz band, 1.705-30 MHz, 90 degrees, Ribbon, Peak Scan



Plot 43. Field Strength Outside the Band 13.110 – 14.010 MHz band, 30-140 MHz, Vertical, Ribbon, Peak Scan



Plot 44. Field Strength Outside the Band 13.110 – 14.010 MHz band, 30-140 MHz, Horizontal, Ribbon, Peak Scan

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 section 6.8 of ANSI C63.10. 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.

The EUT is intended to be powered from an external power adapter. In accordance with section 5.13 a) of ANSI C63.10, voltage variations were applied to the input of the adapter provided with the EUT at the time of testing.

Test Results: The Encoder and Ribbon Reader were compliant with Part 15.225 (e) requirement(s) of this section.

Test Engineer(s): Jonathan Tavira

Test Date(s): 07/29/2020

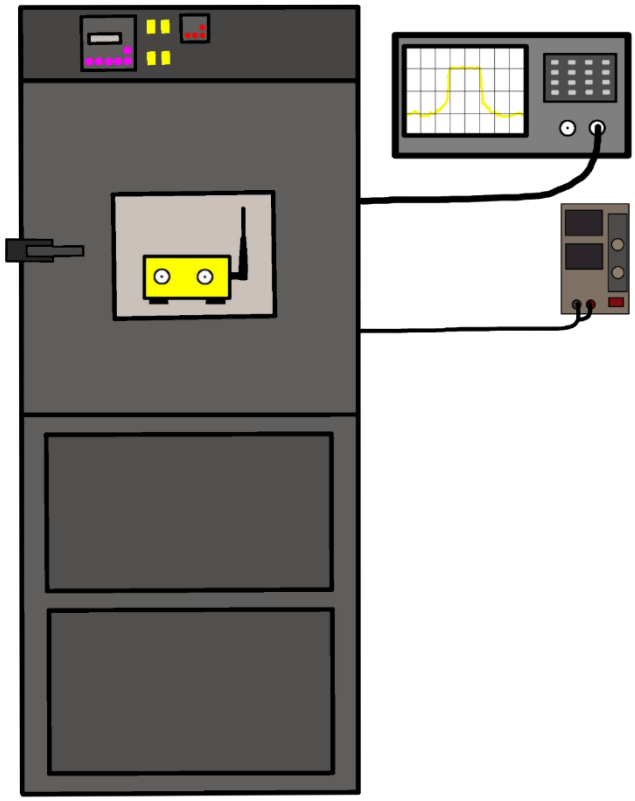


Figure 8. Temperature Stability Test Setup

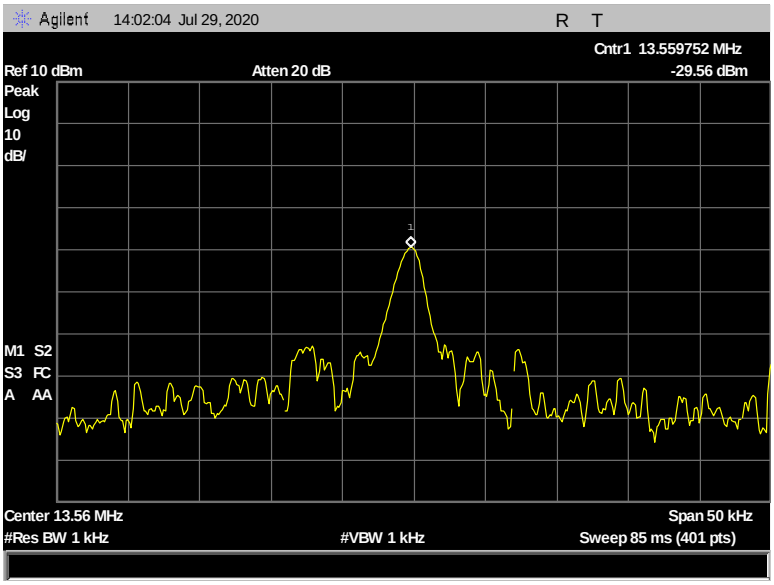
FCC 15.225 (e)	120VAC 60Hz (External Supply Input)				
Voltage Variation (%)	**Temperature (°C)**	**Nominal Freq (MHz)**	**Result (MHz)**	**% Difference**	**Limit**
V_{NOM}	50	13.56	13.559752	-0.0018289	**±0.01%**
	40	13.56	13.559762	-0.0017552	
	30	13.56	13.559776	-0.0016519	
	20	13.56	13.559752	-0.0018289	
	10	13.56	13.559789	-0.0015560	
	0	13.56	13.55978	-0.0016224	
	-10	13.56	13.559774	-0.0016667	
	-20	13.56	13.559778	-0.0016372	
15	20	13.56	13.559752	-0.0018289	
-15	20	13.56	13.559751	-0.0018363	

Table 27. Frequency Stability, Test Results, Encoder

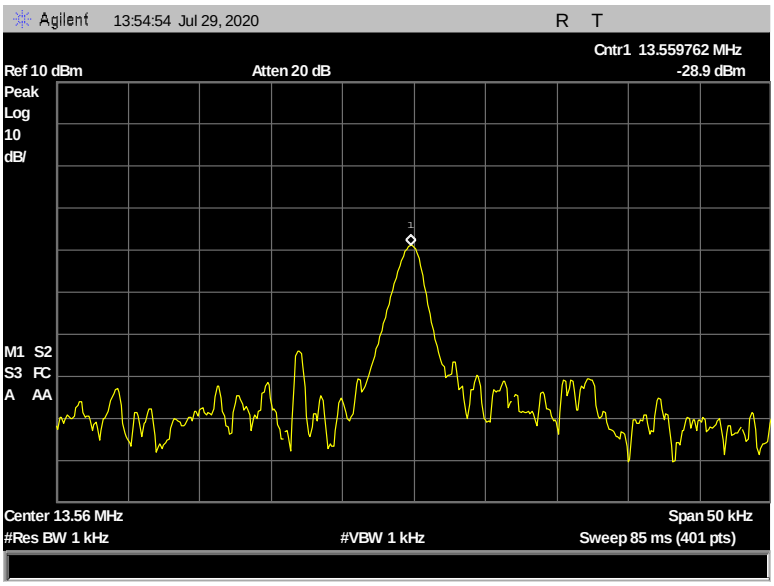
FCC 15.225 (e)	120VAC 60Hz (External Supply Input)				
Voltage Variation (%)	**Temperature (°C)**	**Nominal Freq (MHz)**	**Result (MHz)**	**% Difference**	**Limit**
V_{NOM}	50	13.56	13.560047	0.0003466	**±0.01%**
	40	13.56	13.560079	0.0005826	
	30	13.56	13.560107	0.0007891	
	20	13.56	13.560081	0.0005973	
	10	13.56	13.560119	0.0008776	
	0	13.56	13.560118	0.0008702	
	-10	13.56	13.560117	0.0008628	
	-20	13.56	13.560118	0.0008702	
15	20	13.56	13.560059	0.0004351	
-15	20	13.56	13.560068	0.0005015	

Table 28. Frequency Stability, Test Results, Ribbon

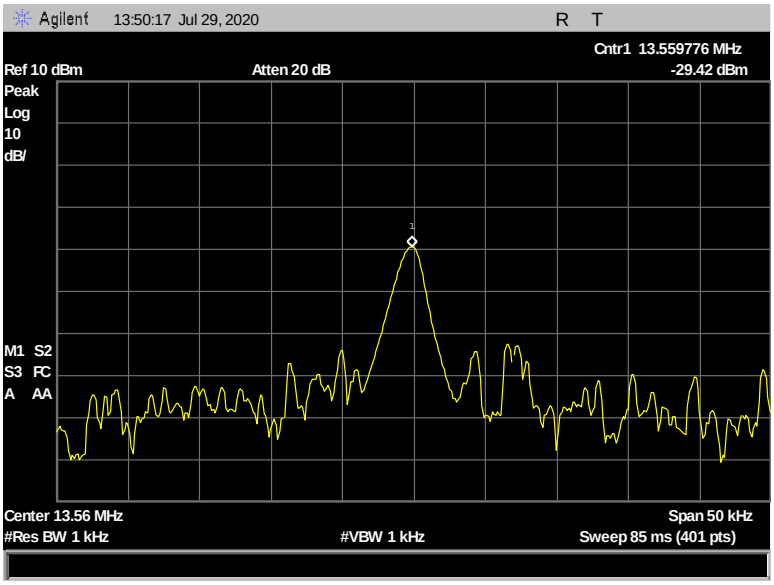
Frequency Stability, Encoder



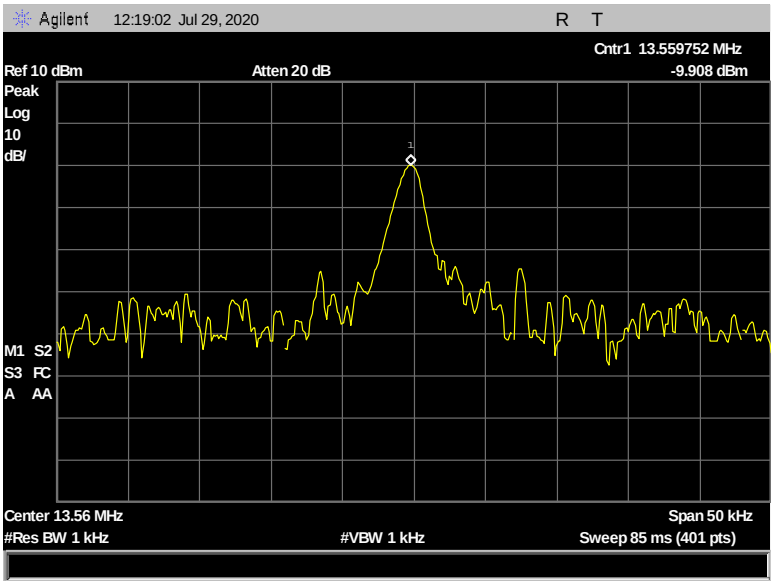
Plot 45. Frequency Tolerance, Vnom, 50 °C, Encoder



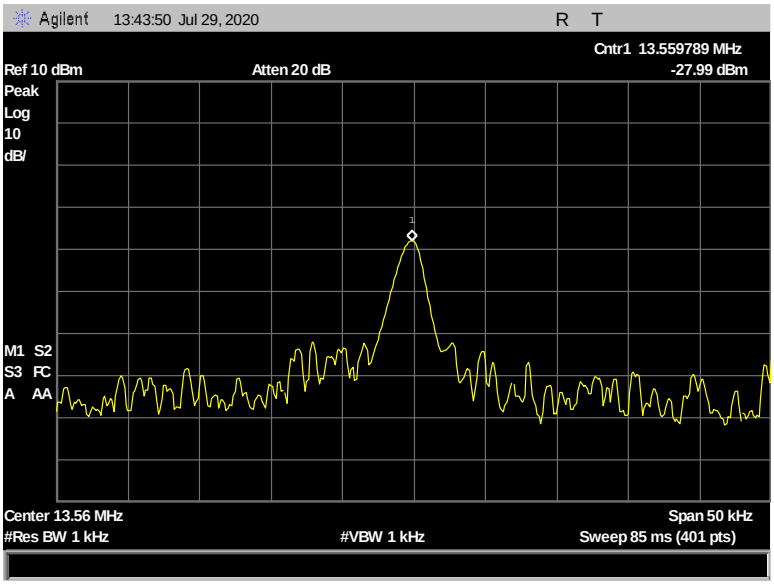
Plot 46. Frequency Tolerance, Vnom, 40°C, Encoder



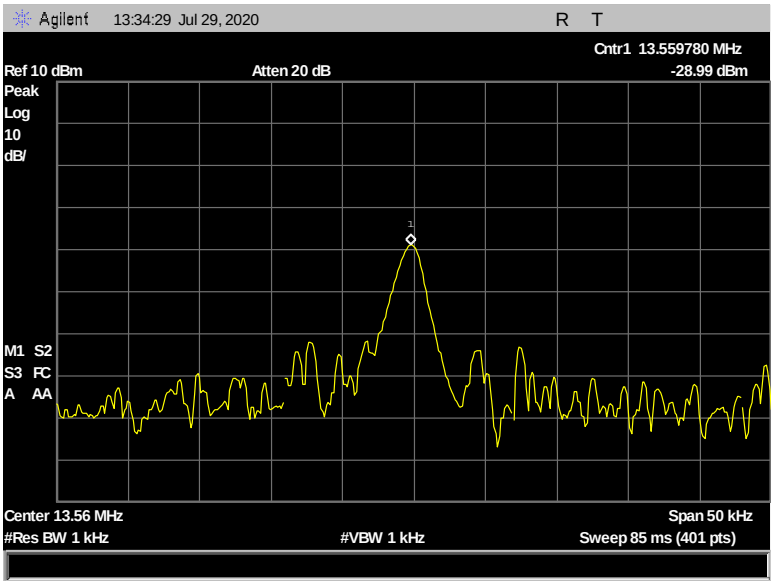
Plot 47. Frequency Tolerance, Vnom, 30°C, Encoder



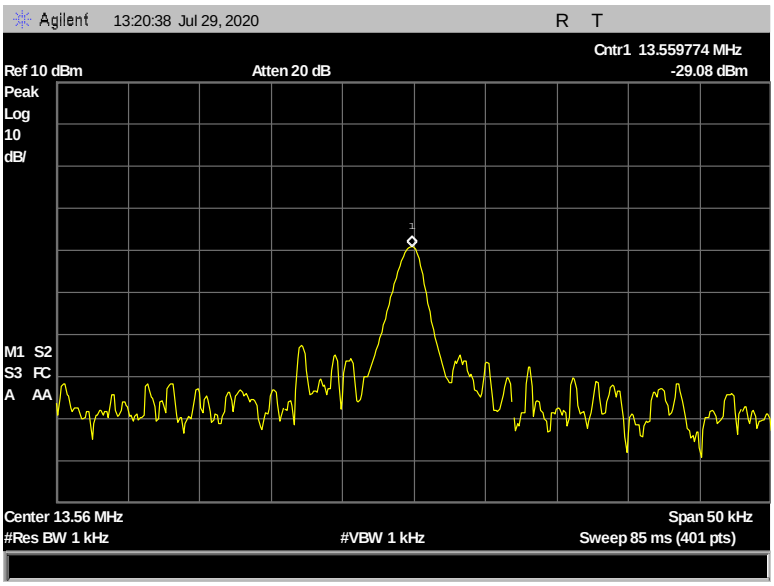
Plot 48. Frequency Tolerance, Vnom, 20°C, Encoder



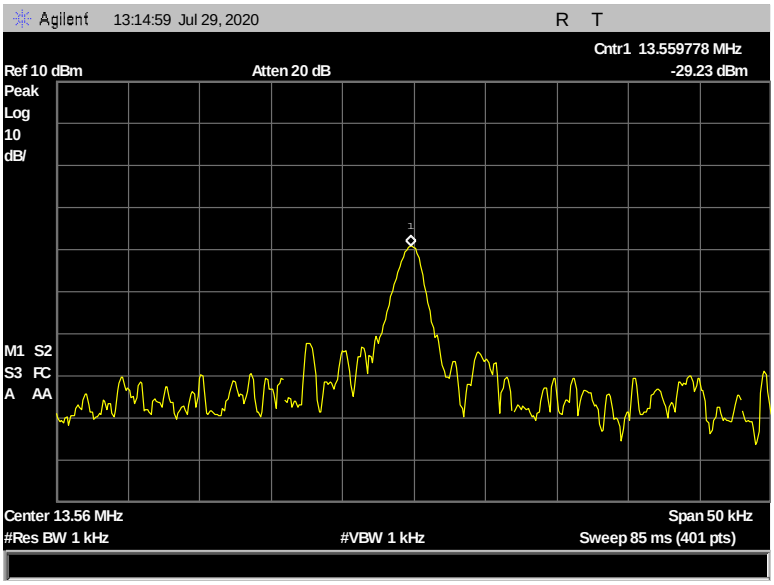
Plot 49. Frequency Tolerance, Vnom, 10°C, Encoder



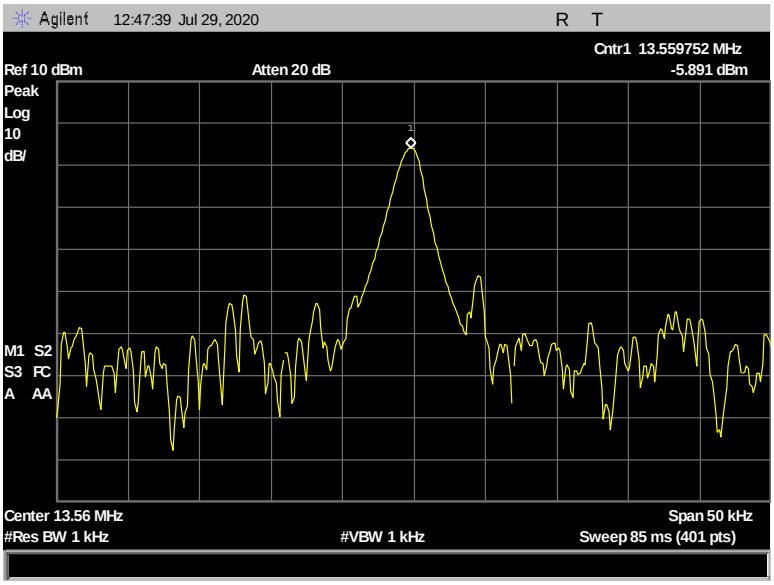
Plot 50. Frequency Tolerance, Vnom, 0°C, Encoder



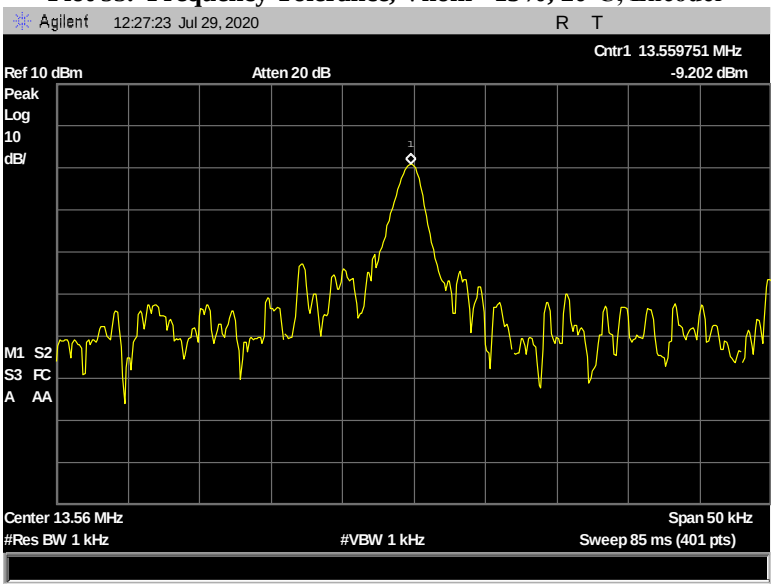
Plot 51. Frequency Tolerance, Vnom, -10°C, Encoder



Plot 52. Frequency Tolerance, Vnom, -20°C, Encoder

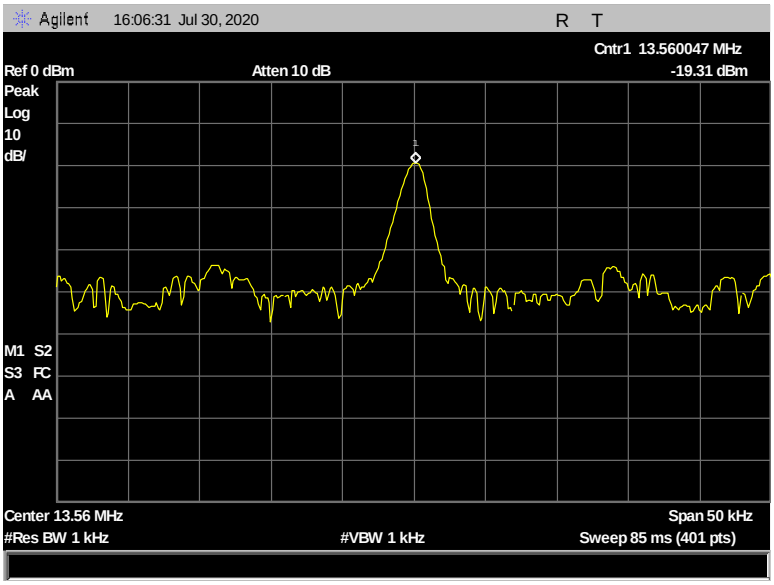


Plot 53. **Frequency Tolerance, Vnom +15%, 20°C, Encoder**

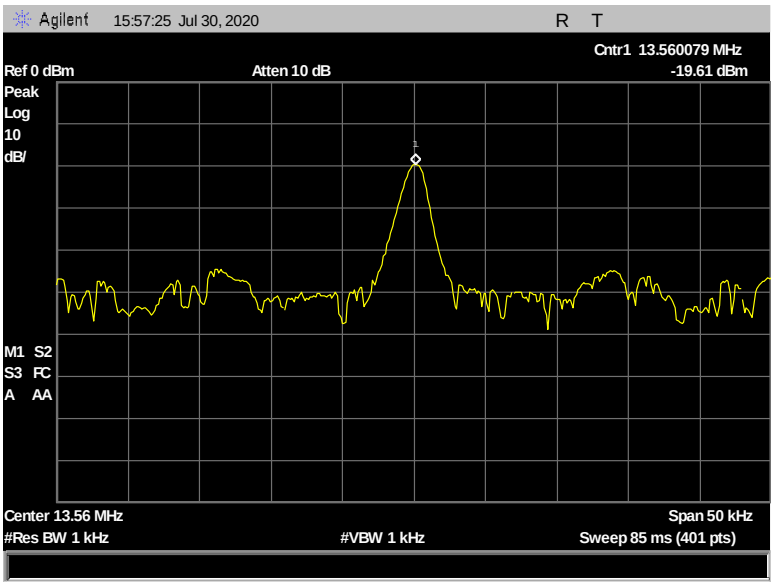


Plot 54. **Frequency Tolerance, Vnom -15%, 20°C, Encoder**

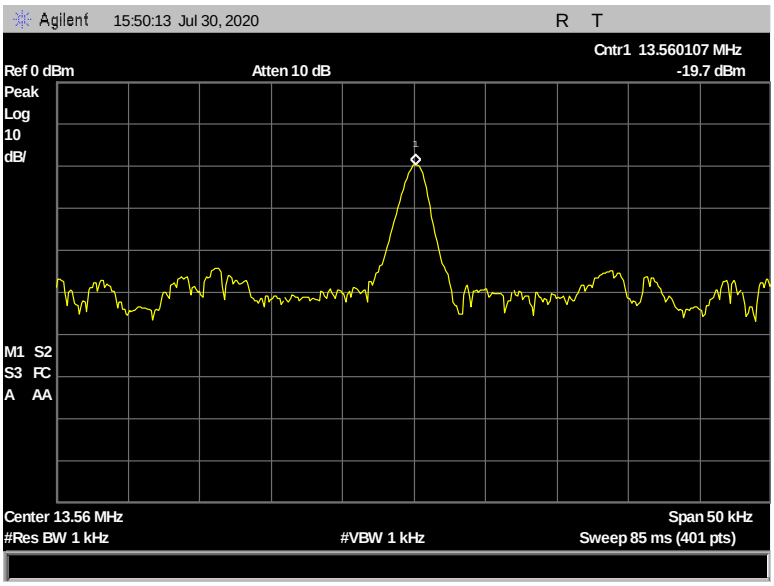
Frequency Stability, Ribbon



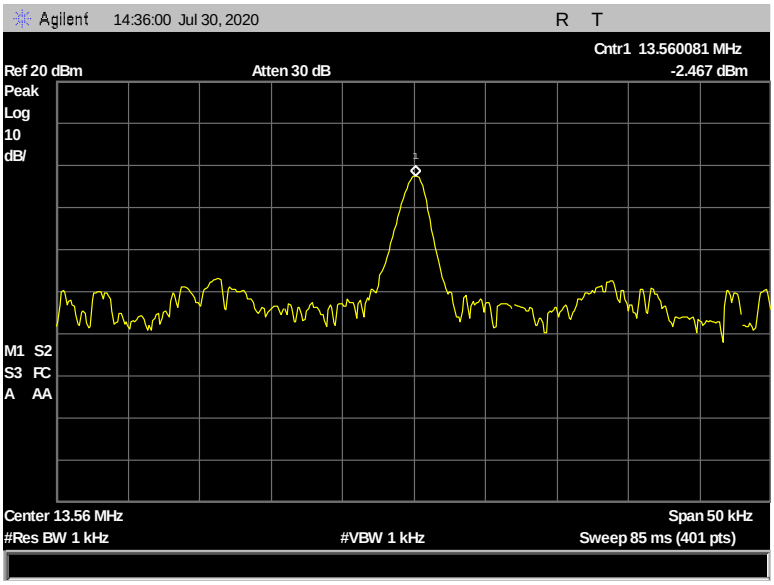
Plot 55. Frequency Tolerance, Vnom, 50°C, Ribbon



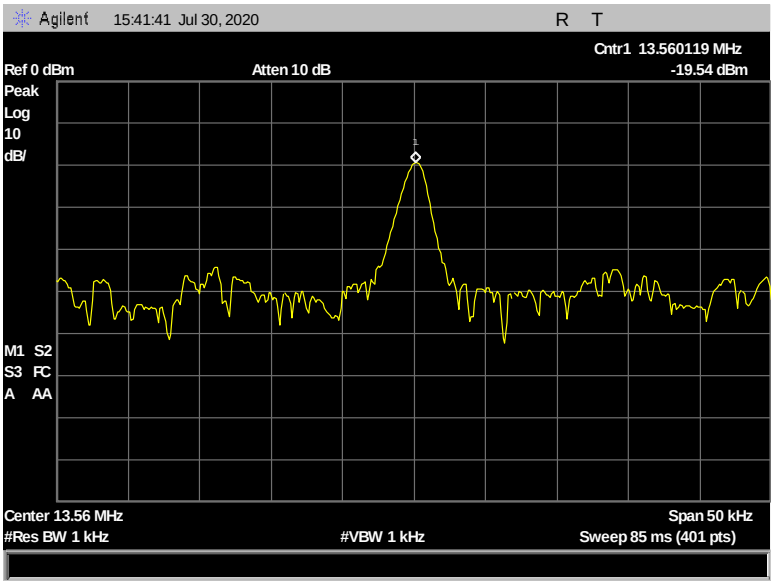
Plot 56. Frequency Tolerance, Vnom, 40°C, Ribbon



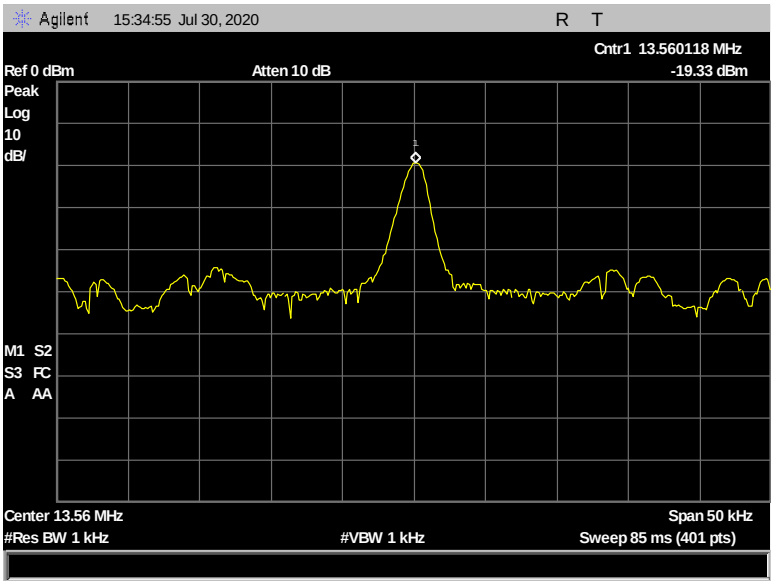
Plot 57. Frequency Tolerance, Vnom, 30°C, Ribbon



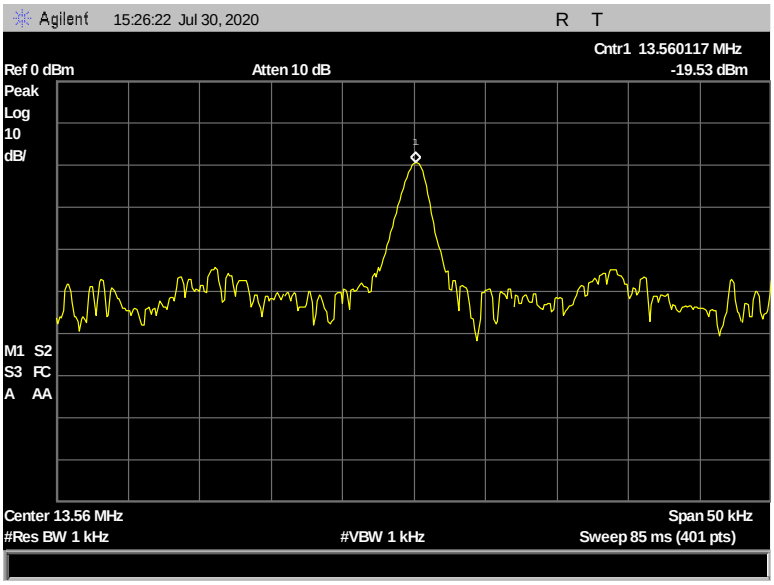
Plot 58. Frequency Tolerance, Vnom, 20°C, Ribbon



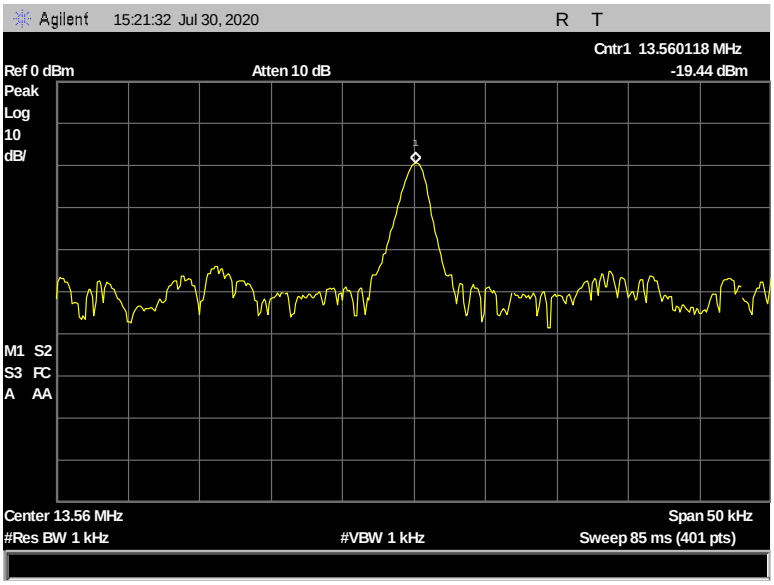
Plot 59. Frequency Tolerance, Vnom, 10°C, Ribbon



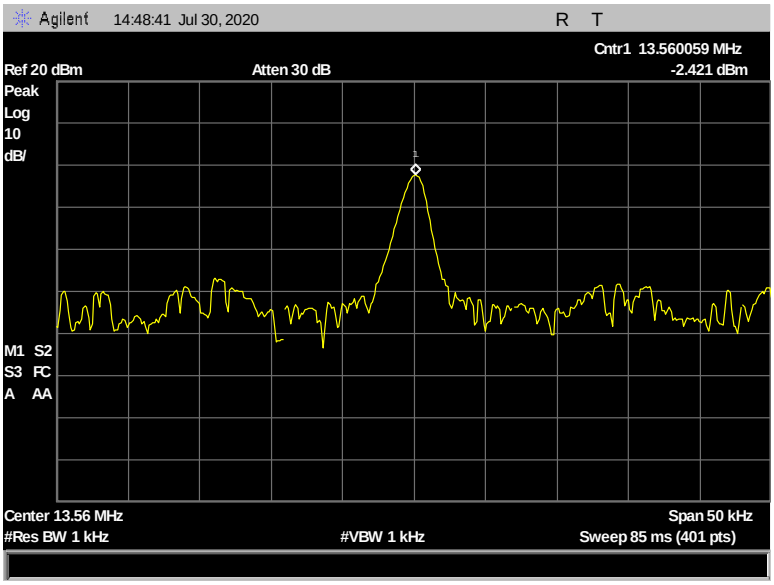
Plot 60. Frequency Tolerance, Vnom, 0°C, Ribbon



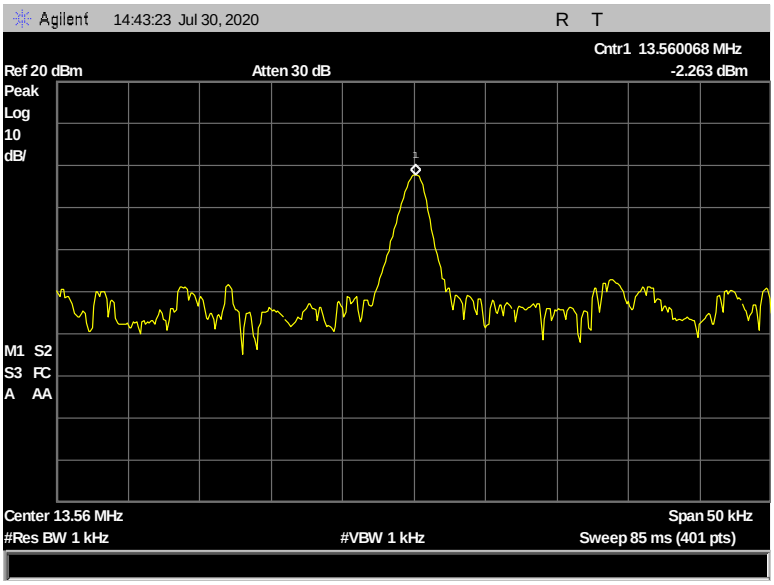
Plot 61. Frequency Tolerance, Vnom, -10°C, Ribbon



Plot 62. Frequency Tolerance, Vnom, -20°C, Ribbon



Plot 63. Frequency Tolerance, Vnom +15%, 20°C, Ribbon



Plot 64. Frequency Tolerance, Vnom -15%, 20°C, Ribbon

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	See Note
1A1099	Generator	COM-Power Corp	CG-51000	See Note	See Note
1A1079	Conducted Comb Generator	COM-Power Corp	CGC-255	See Note	See Note
1A1147	Bilog Antenna (30 MHz to 1 GHz)	Sunol Sciences Corp.	JB3	06/05/2019	12/05/2020
1A1088	Pre-Amp	Rhode & Schwarz	TS-PR1	See Note	
1A1073	Multi Device Controller	ETS Lindgren	2090		
1A1195	Preamplifier	A.H. Systems	PAM-0018P		
1A1074	System Camera Controller	Panasonic	WV-CU101		
1A1075	System Camera Controller	Panasonic	WV-CU101		
1A1080	Multi Device Controller	ETS Lindgren	2090		
1A1176	Active Loop Antenna	ETS-Lindgren	6502	06/02/2020	06/02/2021
1A1122	LISN	Teseq	NNB 51	08/09/2019	08/09/2020
1A1065	EMI Receiver	Rohde & Schwarz	ESCI	06/22/2020	06/22/2021
1A1149	Milliohm Meter	GW Instek	GOM-802	06/10/2020	06/10/2021
1A1141	Spectrum Analyzer	Agilent Technologies	E4407B	08/06/2019	08/06/2020
1A1225	Environmental Chamber	Espec	EXP-2H/New	02/27/2020	02/27/2021
1A1119	Test Area	Custom Made	N/A	See Note	
1A1177	Pulse Limiter / Attenuator	Rohde & Schwarz	ESH3Z2	06/10/2020	06/10/2021
1A1083	Test Receiver	Rohde & Schwarz	ESU40	10/10/2019	10/10/2020
1A1106	10 m Chamber (NSA)	ETS Lindgren	Semi-Anechoic	See Note	
Note	Functionally tested equipment is verified using calibrated instrumentation at the time of testing.				

Figure 9. Test Equipment List

End of Report