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May 30, 2019

Openpath Security Inc.
5839 Green Valley Cir.
Culver City, CA 90230

Dear Michael Biggs,

Enclosed is the EMC test report for compliance testing of the Openpath Security Inc., Smart Reader HF & Mullion Smart Reader HF, 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 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

Jennifer Warnell
Documentation Department

Reference: (\Openpath Security Inc.\EMCS101883-FCC225 Rev. 7)

Electromagnetic Compatibility Criteria
Test Report

for the

Openpath Security Inc.
Mullion Smart Reader HF

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

MET Report: EMCS101883-FCC225 Rev. 7

May 30, 2019

Prepared For:

Openpath Security Inc.
5839 Green Valley Cir.
Culver City, CA 90230

Prepared By:
Eurofins | MET Labs
3162 Belick St.,
Santa Clara, CA 95054

Electromagnetic Compatibility Criteria
Test Report

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Openpath Security Inc.
Smart Reader HF & Mullion Smart Reader HF

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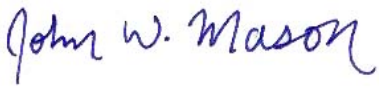
15.225 Subpart C
for Intentional Radiators

James Borrott, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
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.



John Mason,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 24, 2019	Initial Issue.
1	March 12, 2019	Corrected standard references and updated Frequency Stability test results.
2	April 23, 2019	Editorial corrections.
3	May 6, 2019	Editorial corrections
4	May 10, 2019	Editorial corrections
5	May 23, 2019	TCB Corrections.`
6	May 29, 2019	TCB Corrections.
7	May 30, 2019	TCB Corrections.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Openpath Security Inc. Smart Reader HF & Mullion Smart Reader HF, 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 Smart Reader HF & Mullion Smart Reader HF. Openpath Security Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Smart Reader HF & Mullion Smart Reader HF, 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 Openpath Security Inc., purchase order number PO-2004. All tests were conducted using measurement procedure ANSI 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	Completed
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 ComplianceTesting

II. Equipment Configuration

A. Overview

Eurofins | MET Labs was contracted by Openpath Security Inc. to perform testing on the Smart Reader HF & Mullion Smart Reader HF, under Openpath Security Inc.'s purchase order number PO-2004.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Openpath Security Inc., Smart Reader HF & Mullion Smart Reader HF.

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

Model(s) Tested:	Smart Reader HF	
EUT Specifications:	Primary Power: 12 VDC from a 120 VAC AC/DC converter	
	FCC ID: 2APJVOPRHF	
	Type of Modulations:	GFSK
	Equipment Code:	DXX
	EUT Frequency Ranges:	13.56 - 13.56 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	James Borrott	
Report Date(s):	May 30, 2019	

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
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
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

Table 3. References

C. Test Site

All testing was performed at Eurofins | MET Labs, 3162 Belick Street, Santa Clara, CA 95054. 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. Description of Test Sample

The Smart Reader HF & Mullion Smart Reader HF, Equipment Under Test (EUT), is a contactless smart card and mobile-enabled access control reader. It is an RFID card reader, BLE beacon and interface for BLE-enabled smartphones, and a touch sensor in order to allow entry to the secure location. It communicates over RS-485 to the Openpath Smart Hub in order to authenticate users, and receives 12V power from the Smart Hub. It is intended to be used by anyone that accesses the secured location's entrance/exit.

Photograph 1. Openpath Security Inc. Smart Reader (HF)

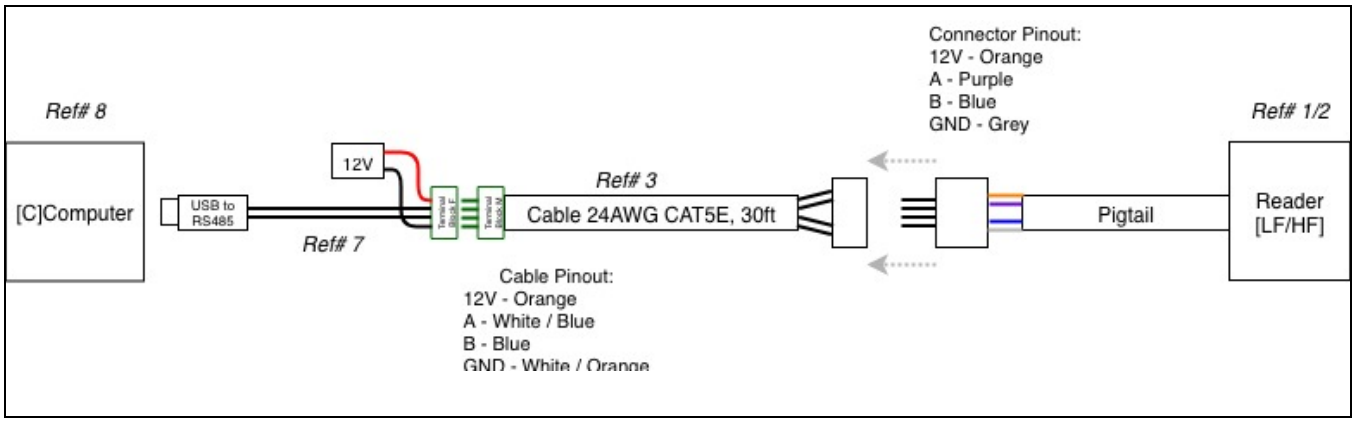


Figure 1. Block Diagram of Test Configuration, Standard Smart Reader (HF)

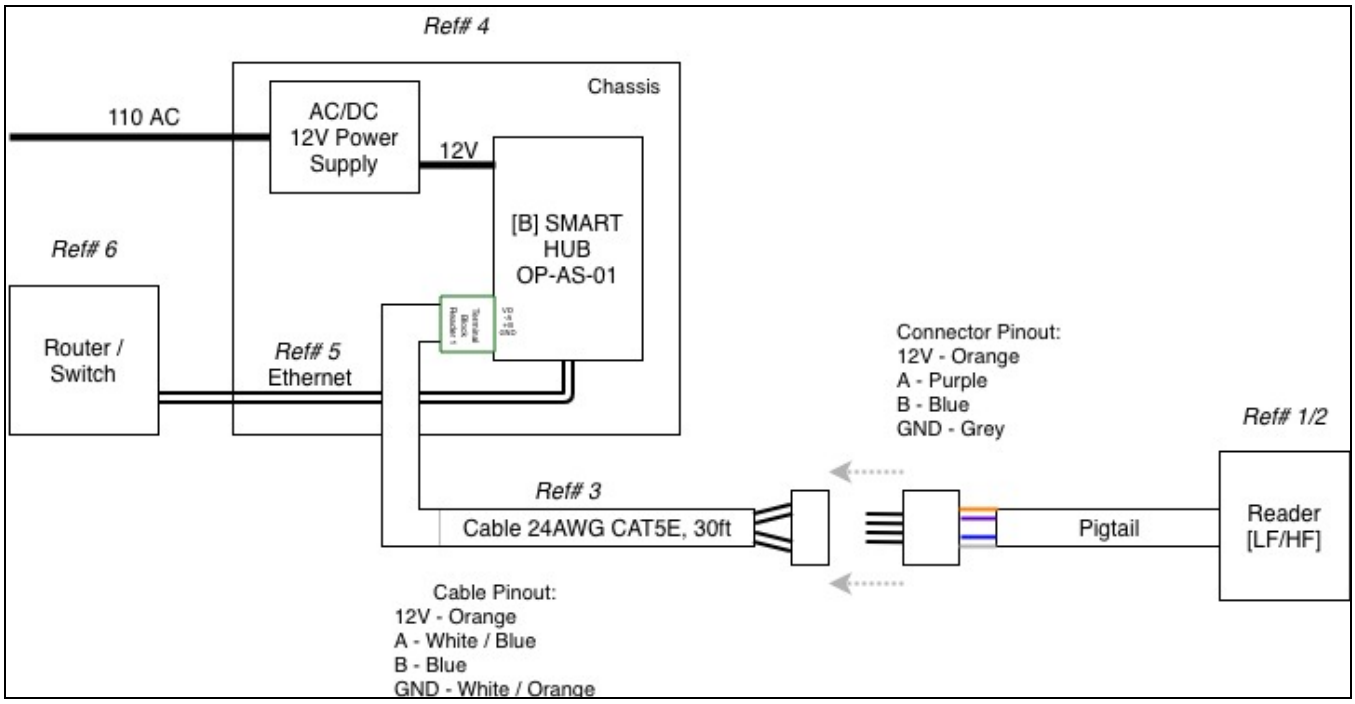


Figure 2. Block Diagram of Test Configuration, Mullion Smart Reader (HF)

E. Equipment Configuration

All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Part Number	Serial Number
2	Smart Reader HF	OP-ASSY-RDRH-001	ENG 2 -HF

Table 4. Equipment Configuration, Standard Smart Reader (HF)

Ref. ID	Name / Description	Part Number	Serial Number
2	Mullion Smart Reader HF	OP-ASSY-RDRH-002	ENG 3 -HF

Table 5. Equipment Configuration, Mullion Smart Reader (HF)

F. Support Equipment

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

Ref. ID	Name / Description	Model Number
8	Computer	--
--	Smart Card (HF)	OP-ACCS-CRD-001
--	Phone	--

Table 6. Support Equipment, Standard Smart Reader (HF)

Ref. ID	Name / Description	Manufacturer	Model Number
--	Smart Hub	Openpath	OP-AS-01
--	Smart Card (HF)	--	OP-ACCS-CRD-001
--	Phone	--	--

Table 7. Support Equipment, Mullion Smart Reader (HF)

G. Ports and Cabling Information

Ref. ID	Cable Description or reason for no cable	Qty	Length as tested (m)	Shielded? (Y/N)	Termination Box ID & Port Name
3	CAT5E Cable 24awg	1	9.14m	Yes	B. Reader 1
7	USB to Reader test cable	1	--	--	C. Computer
--	12V 1A Power supply	1	--	--	Terminal Block, CAT5E Cable

Table 8. Ports and Cabling Information, Standard Smart Reader (HF)

Ref. ID	Cable Description or reason for no cable	Qty	Length as tested (m)	Shielded? (Y/N)	Termination Box ID & Port Name
3	CAT5E Cable 24awg	1	9.14m	Yes	B. Reader 1
5	Ethernet cable	1	--	Yes	B. Ethernet
--	110V AC	1	--	--	4. AC/DC 12V PS

Table 9. Ports and Cabling Information, Mullion Smart Reader (HF)

H. Mode of Operation

The Openpath Smart Reader can be tested in either production mode or test mode depending on which unit is tested.

The production mode unit will need to be wired to the Openpath Smart Hub in order to operate normally. It will allow the operator to scan RFID cards: one Reader will be configured to read 13.56MHz cards and another will be configured to read 125kHz cards. The Readers will also broadcast a BLE beacon and attempt to pair with nearby smartphones running Openpath software.

The test mode Smart Reader will have a test suite giving the operator full control of the BLE radios through a serial interface. The test mode will allow the operator to configure the two BLE radios independently to: fixed channels at maximum duty cycle, power control, and turn them on or off.

I. Method of Monitoring EUT Operation

Production mode:
If the center dot quickly switches between multiple colors and outer ring quickly spins once, the reader has just received power
If all lights are off, the reader is not connected to power (check to see if the power wires are swapped)
If the center dot is flashing red, the reader is connected to power but cannot communicate with the Smart Hub (check to see if the +B and -A lines are swapped)
If the center dot is solid blue, the reader is connected to power and can communicate with the Smart Hub, but has not been configured as an entry in the online portal
If the center dot is solid white, then the door is locked
If the outer ring is solid white, then the door is unlocked

Test mode:
The center dot will remain white and the status can be monitored in the serial console that is used to control the Smart Reader.

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 Openpath Security Inc. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

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: The EUT as tested is compliant the criteria A of §15.203. The EUT antenna is integrated into the unit and cannot be modified by the user.

Test Engineer(s): James Borrott

Test Date(s): 01/02/2019

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/50Ω 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

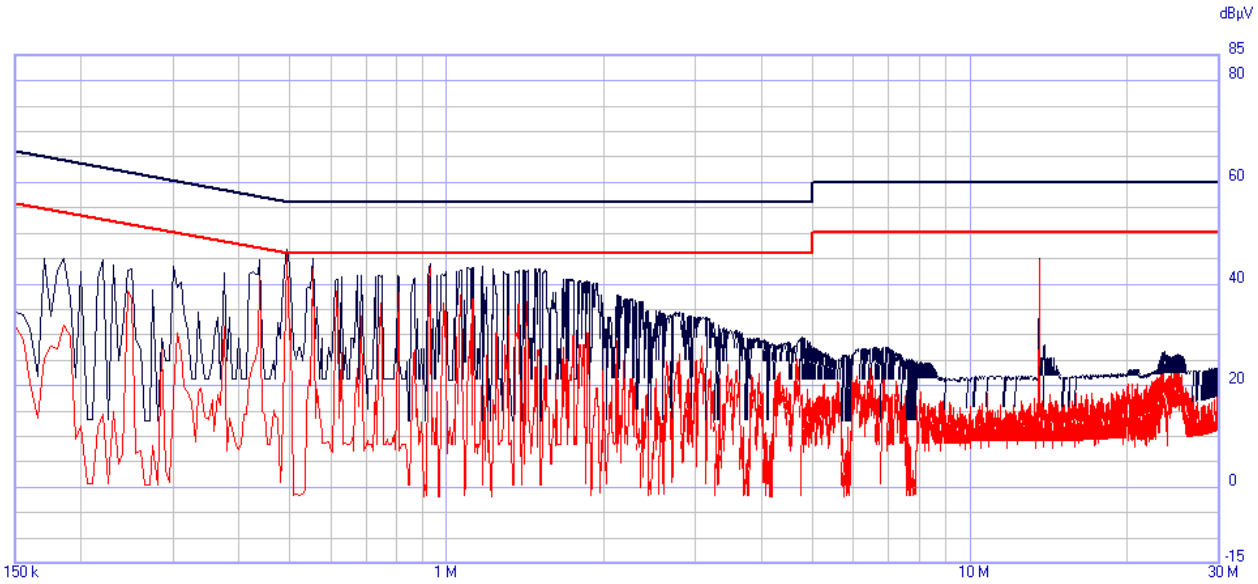
Table 10. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high non-conductive table inside a screen room. 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 C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. 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 EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT as tested is compliant with the requirements of this section. Measured emissions were within applicable limits.

Test Engineer: James Borrott

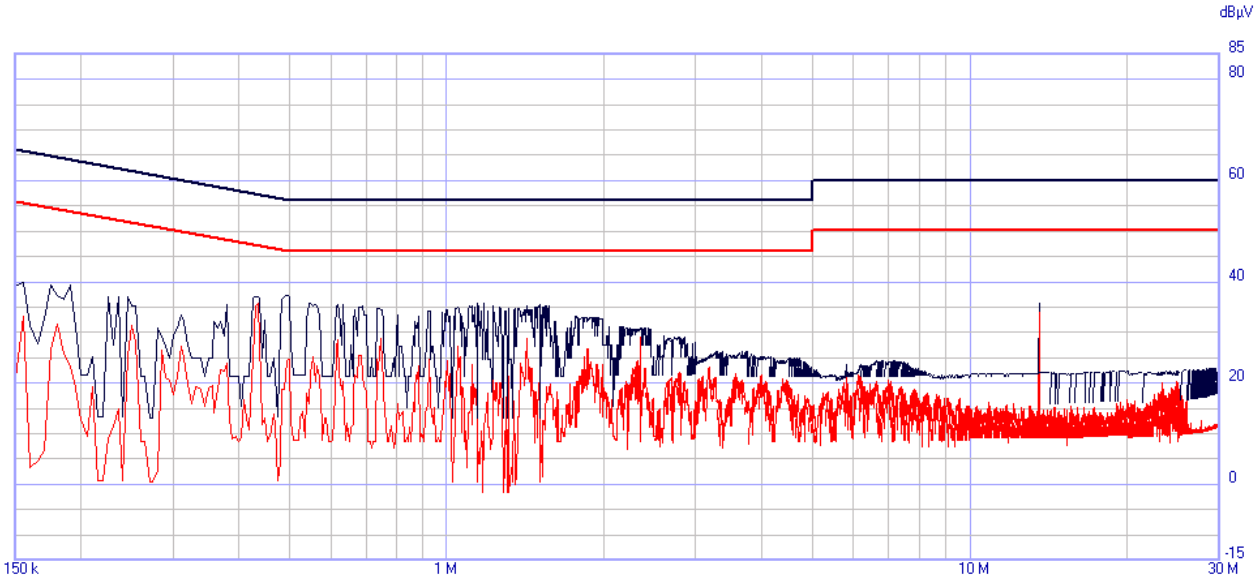
Test Date: May 9, 2019



Plot 1. Conducted Emissions, Line

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass	Notes
Line	.495	51.12	56.086	-4.966	Pass	37.5	46.086	-8.586	Pass	
Line	.555	41.14	56	-14.86	Pass	26.66	46	-19.34	Pass	
Line	.44	50.56	57.086	-6.436	Pass	40.83	47.086	-6.256	Pass	
Line	13.56	41.65	60	-18.35	Pass	34.56	50	-15.44	Pass	
Line	.185	51.32	64.263	-12.943	Pass	33.37	54.263	-20.893	Pass	
Line	.17	40.97	64.963	-23.993	Pass	23.69	54.963	-31.273	Pass	

Table 11. Conducted Emissions, Line, Test Results



Plot 2. Conducted Emissions, Neutral

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass	Notes
Neutral	13.56	50.28	60	-9.72	Pass	36.98	50	-13.02	Pass	
Neutral	.495	49.72	56.086	-6.366	Pass	32.66	46.086	-13.426	Pass	
Neutral	.225	39.78	62.641	-22.861	Pass	20.79	52.641	-31.851	Pass	
Neutral	.19	49.35	64.042	-14.692	Pass	31.99	54.042	-22.052	Pass	
Neutral	.43	39.05	57.277	-18.227	Pass	23.84	47.277	-23.437	Pass	
Neutral	.155	49.55	65.728	-16.178	Pass	33.74	55.728	-21.988	Pass	

Table 12. Conducted Emissions, Neutral, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(a) Fundamental 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 non-reflective (acrylic) table 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 RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The EUT was rotated 360° on a turntable in the X, Y, and Z axis. The cumulative measurements were made at 3m, and then the data was extrapolated to 30m using the following correction factor in accordance with §15.31.

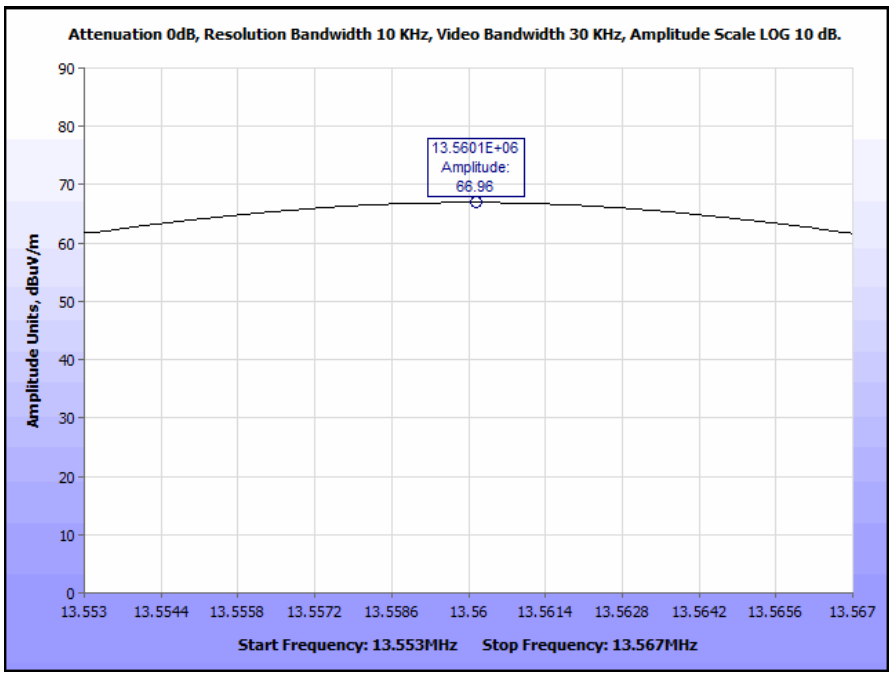
40log(3/30) = -40 dB

Test Results: The EUT was compliant with the requirements of **§15.225(a)**.

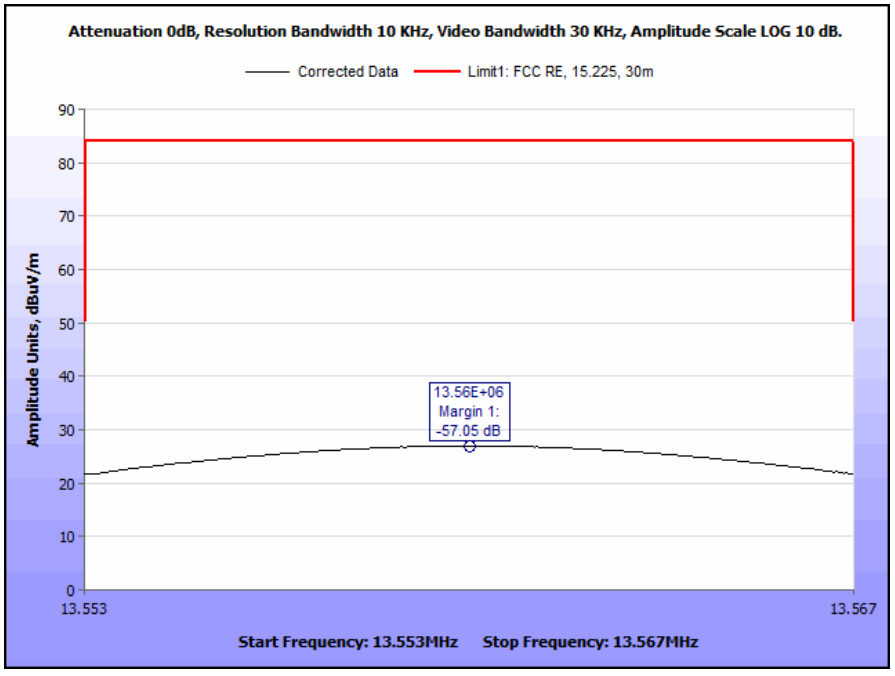
Test Engineer(s): James Borrott

Test Date(s): 01/04/2019

Fundamental Field Strength, within the band 13.553 – 13.567 MHz, Test Results



Plot 3. Radiated Field Strength measured at 3m



Plot 4. Fundamental within In Band Emissions Mask

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(b) Fundamental Field Strength, 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 non-reflective (acrylic) table 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 RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The EUT was rotated 360° on a turntable in the X, Y, and Z axis. The cumulative measurements were made at 3m, and then the data was extrapolated to 30m using the following correction factor in accordance with §15.31.

40log(3/30) = -40 dB

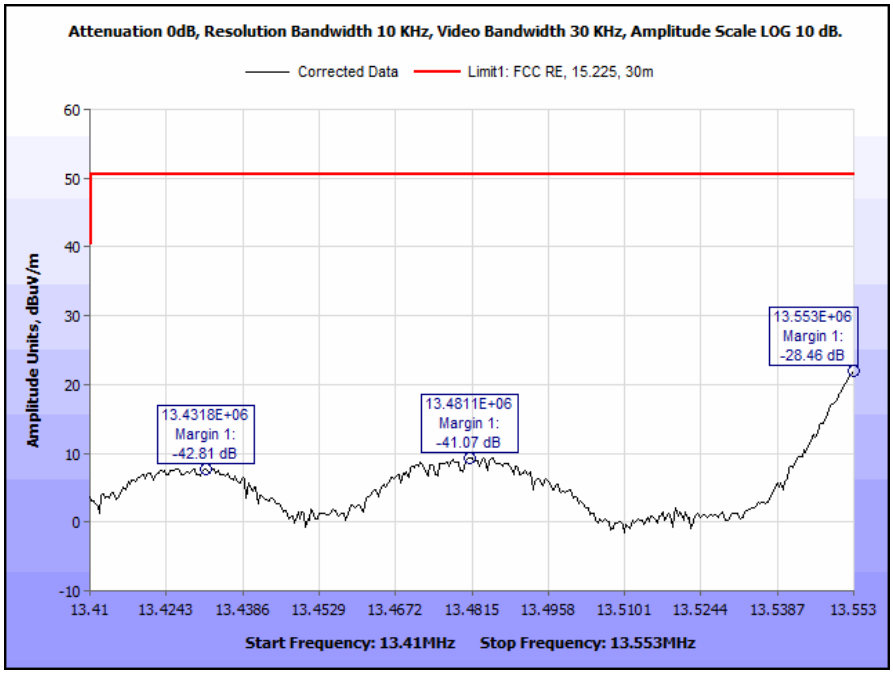
Since all peak measurements made were greater than 20 dB below the limit, no further measurements were made.

Test Results: The EUT was compliant with the requirements of **§ 15.225(b)**.

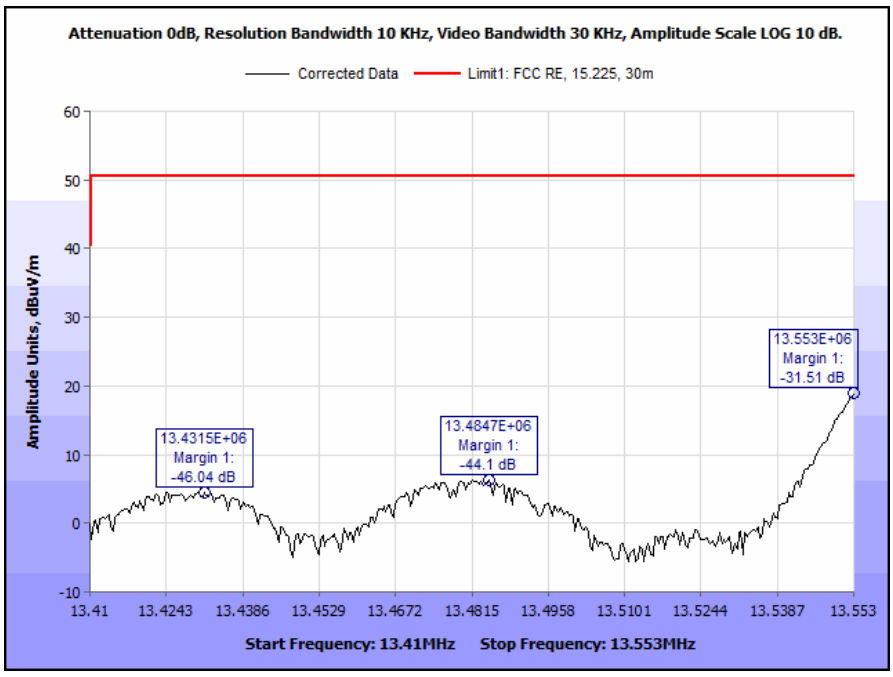
Test Engineer(s): James Borrott

Test Date(s): 01/04/2019

Fundamental Field Strength, within the bands 13.410 – 13.553 MHz, Test Results

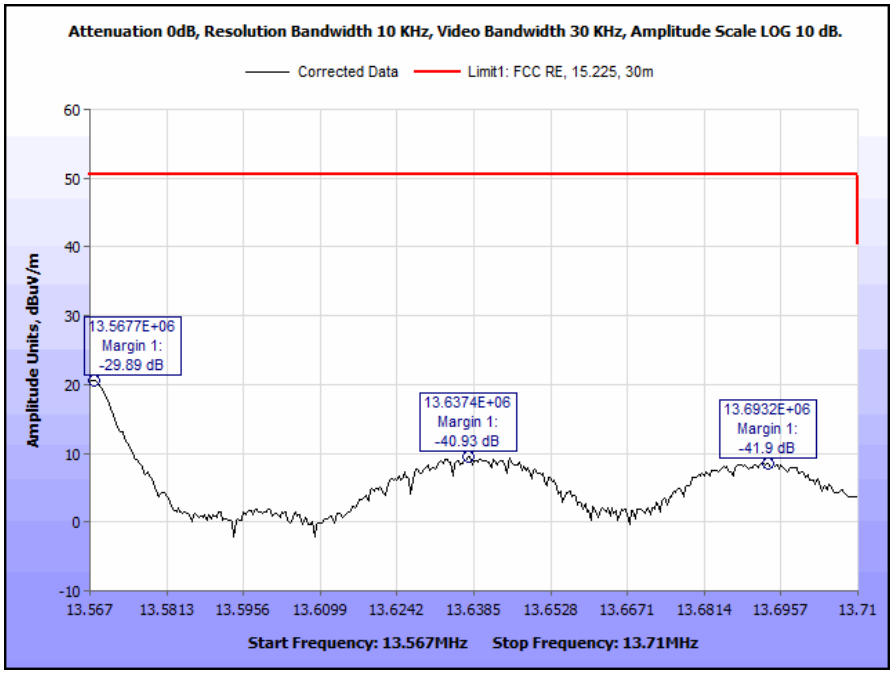


Plot 5. Fundamental Field Strength Within the Band 13.410 – 13.553 MHz, 0°

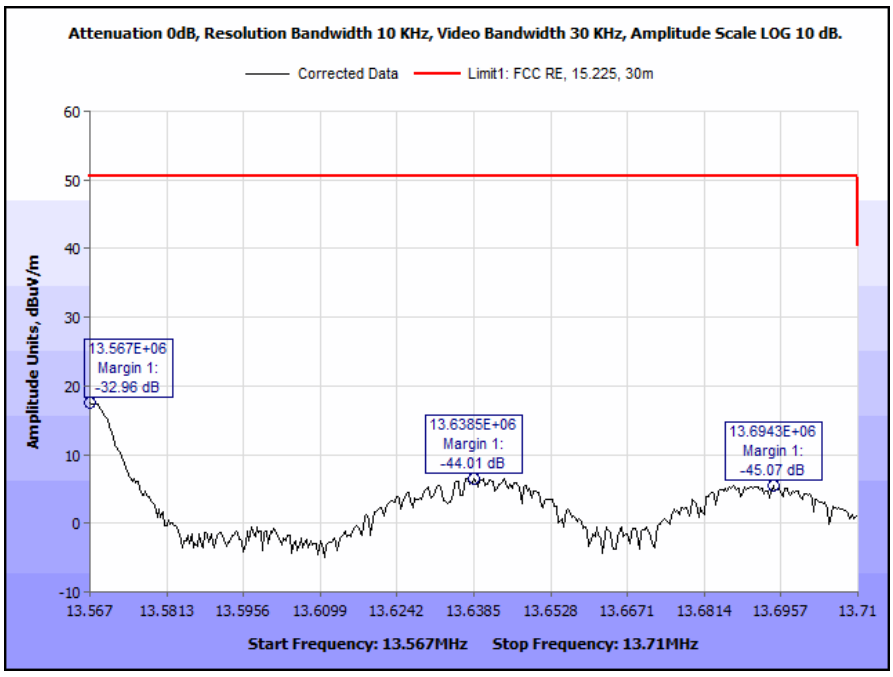


Plot 6. Fundamental Field Strength Within the Band 13.410 – 13.553 MHz, 90°

Fundamental Field Strength, within the bands 13.567 – 13.710 MHz, Test Results



Plot 7. Fundamental Field Strength Within the Band 13.567 – 13.710 MHz, 0°



Plot 8. Fundamental Field Strength Within the Band 13.567 – 13.710 MHz, 90°

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.225(c) Fundamental Field Strength, 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 non-reflective (acrylic) table 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 RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The EUT was rotated 360° on a turntable in the X, Y, and Z axis. The cumulative measurements were made at 3m, and then the data was extrapolated to 30m using the following correction factor in accordance with §15.31.

40log(3/30) = -40 dB

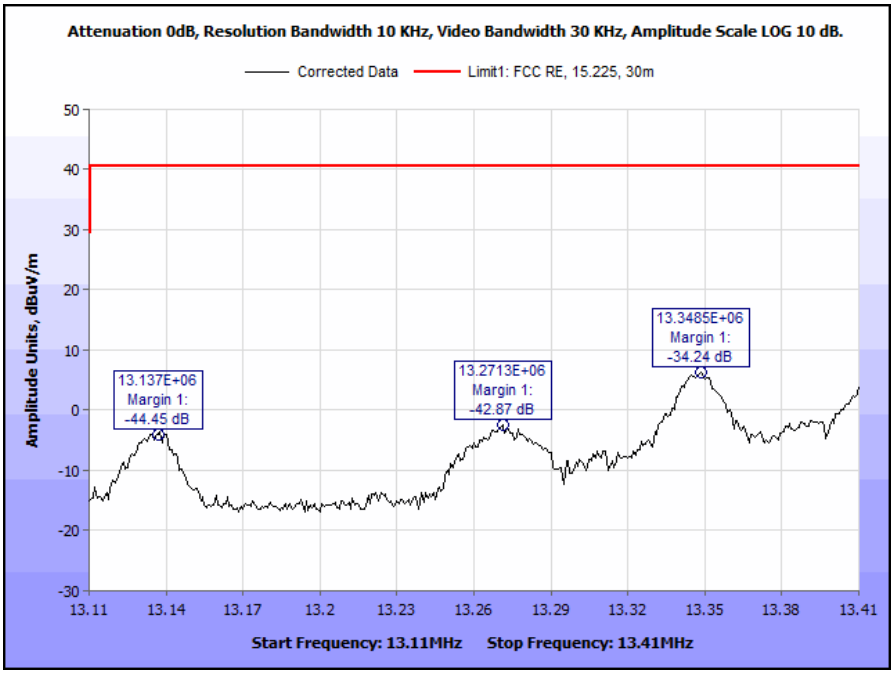
Since all peak measurements made were greater than 20 dB below the limit, no further measurements were made.

Test Results: The EUT was compliant with the requirements of **§15.225(c)**.

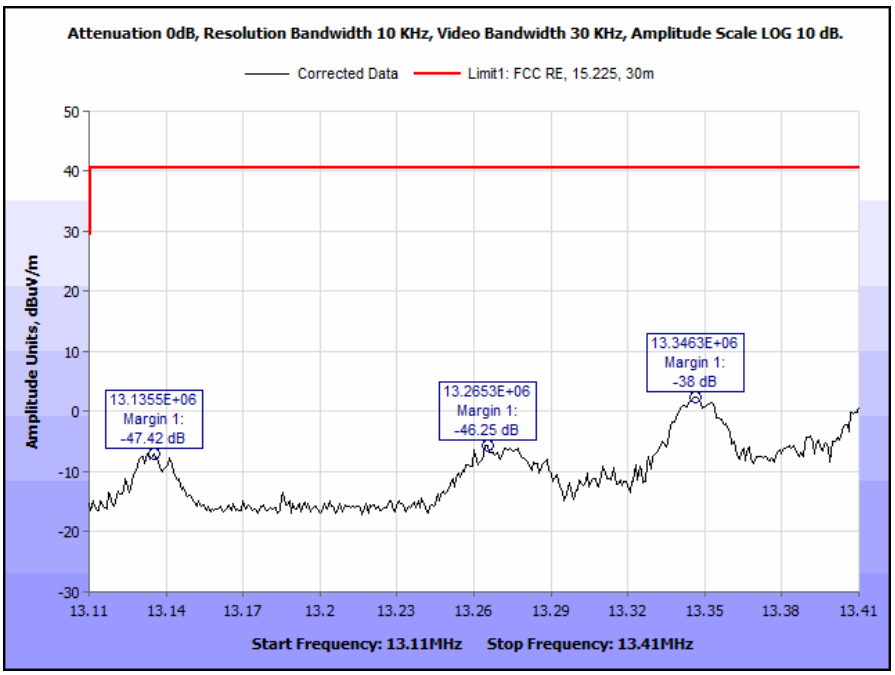
Test Engineer(s): James Borrott

Test Date(s): 01/04/2019

Fundamental Field Strength, within the bands 13.110 – 13.410 MHz, Test Results

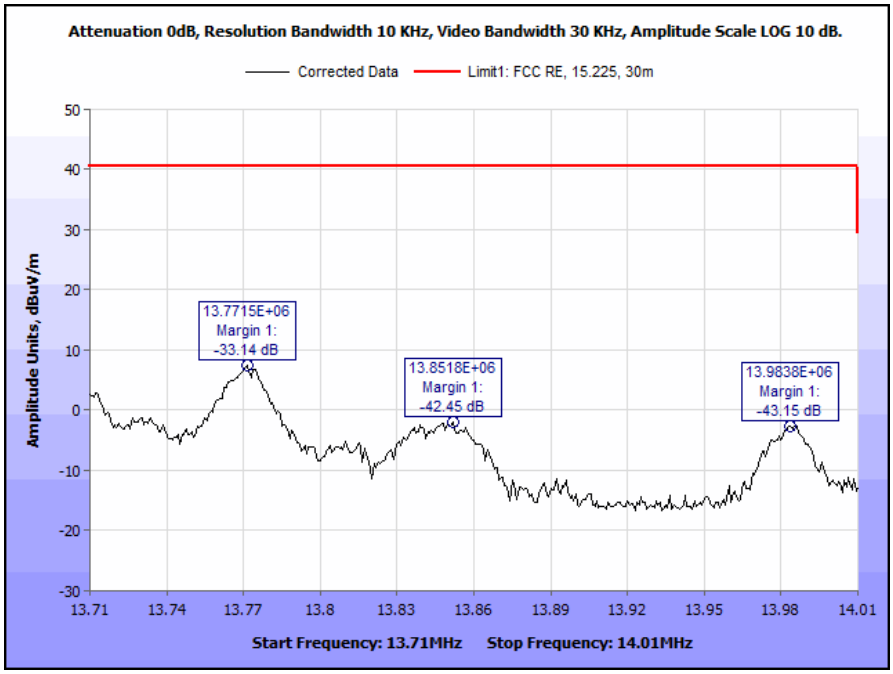


Plot 9. Fundamental Field Strength Within the Band 13.110 – 13.410 MHz, 0°

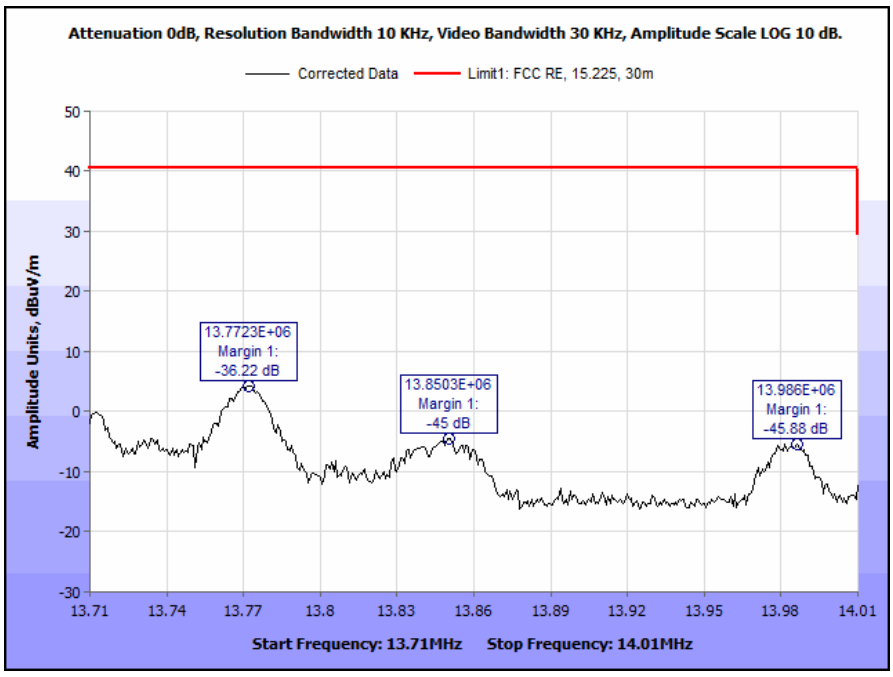


Plot 10. Fundamental Field Strength Within the Band 13.110 – 13.410 MHz, 90°

Spurious Emission Limits, within the bands 13.710 – 14.010 MHz, Test Results



Plot 11. Fundamental Field Strength Within the Band 13.710 – 14.010 MHz, 0°



Plot 12. Fundamental Field Strength Within the Band 13.710 – 14.010 MHz, 90°

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 Procedures: The EUT was set to transmit and placed on a 0.8m-high non-reflective (acrylic) table 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 RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

The EUT was rotated 360° on a turntable in the X, Y, and Z axis. The cumulative measurements were made at 3m, and then the data was extrapolated to 30 m or 300 m using the following correction factor in accordance with §15.31.

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

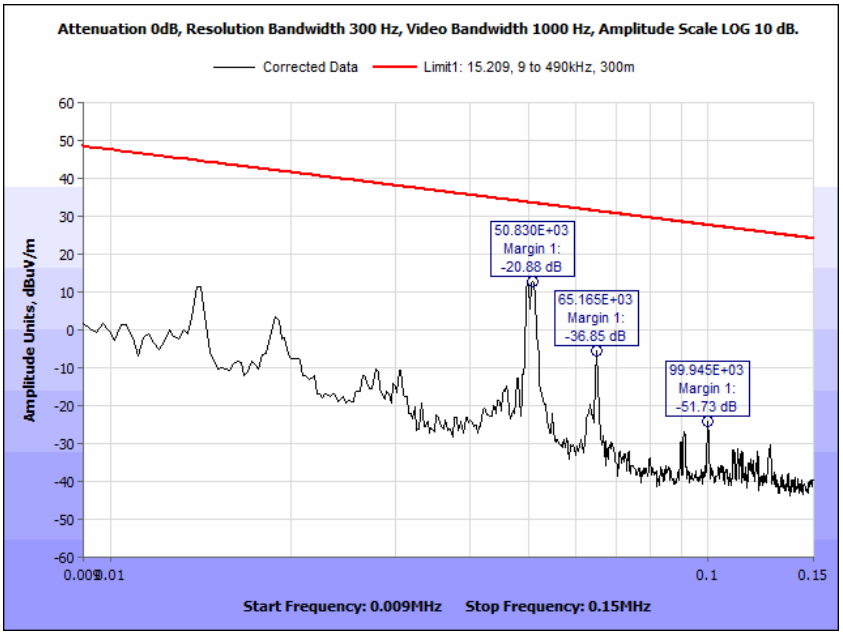
Since all peak measurements made were greater than 20 dB below the limit, no further measurements were made.

Test Results: The EUT was compliant with requirements of **§ 15.225 (d)**.

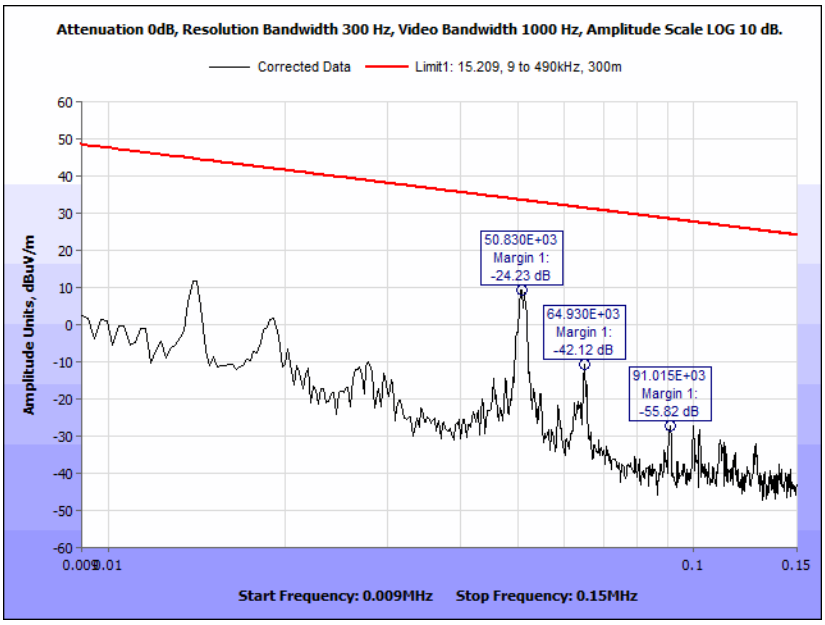
Test Engineer: James Borrott

Test Date: 01/04/2019

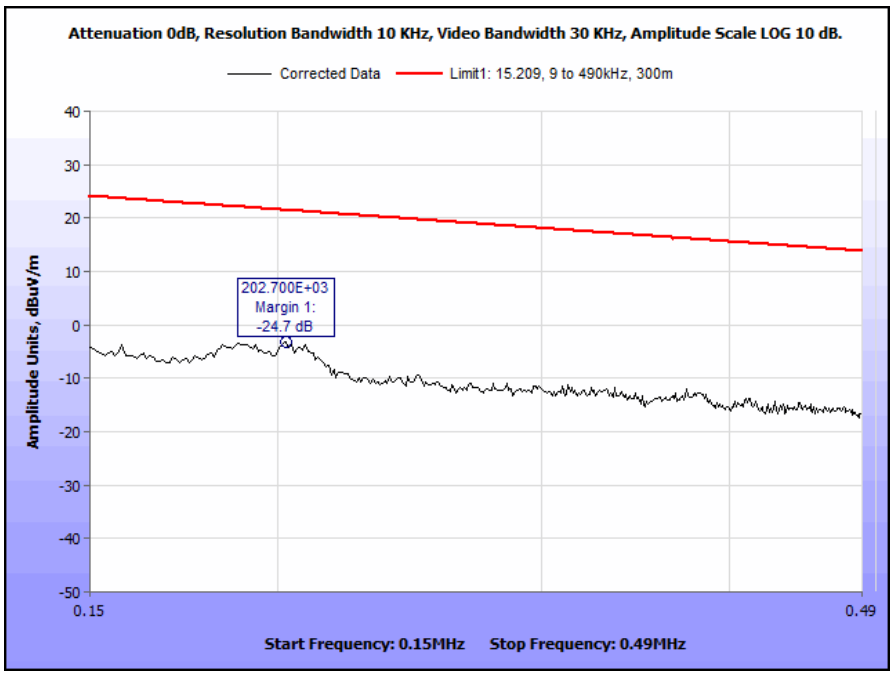
Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz, Test Results



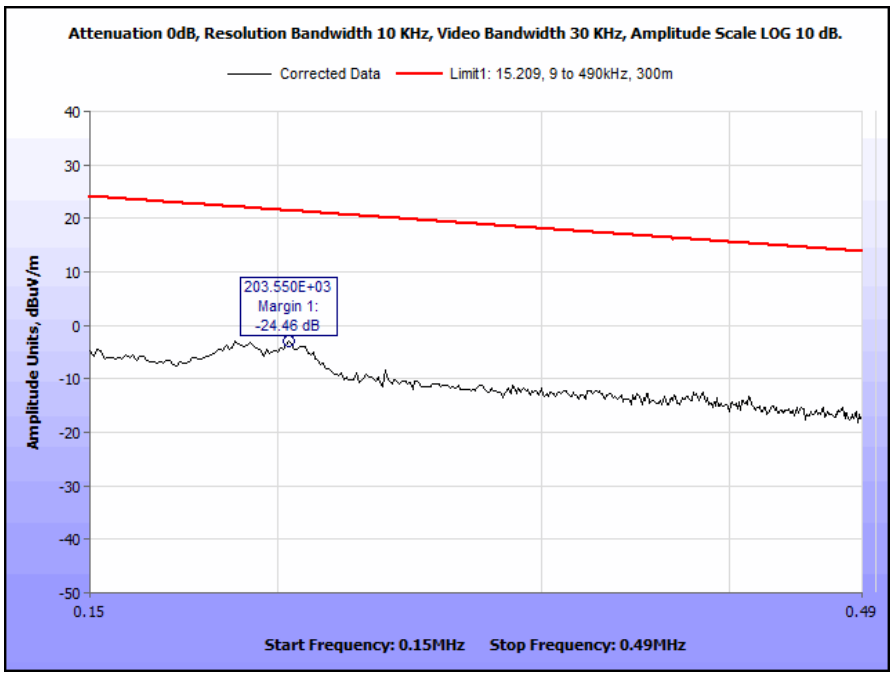
Plot 13. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 9 kHz – 150 kHz, 0°



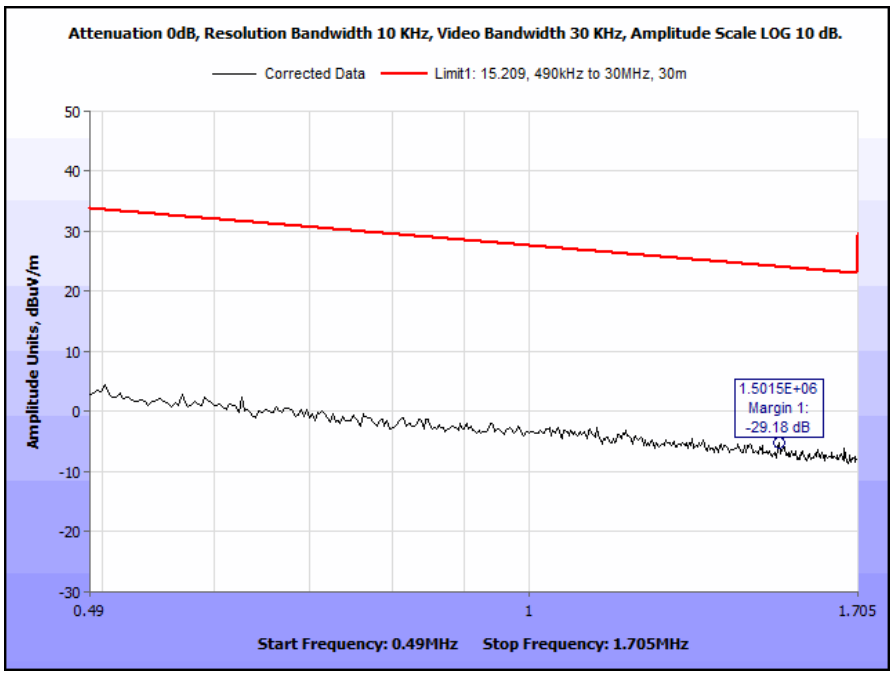
Plot 14. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 9 kHz – 150 kHz, 90°



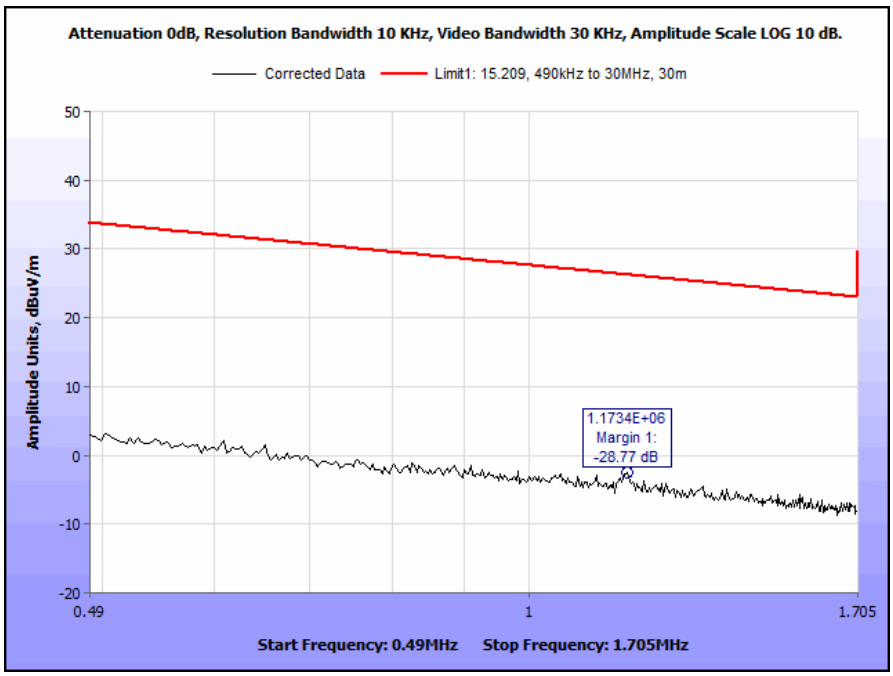
Plot 15. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 150 kHz – 490 kHz, 0°



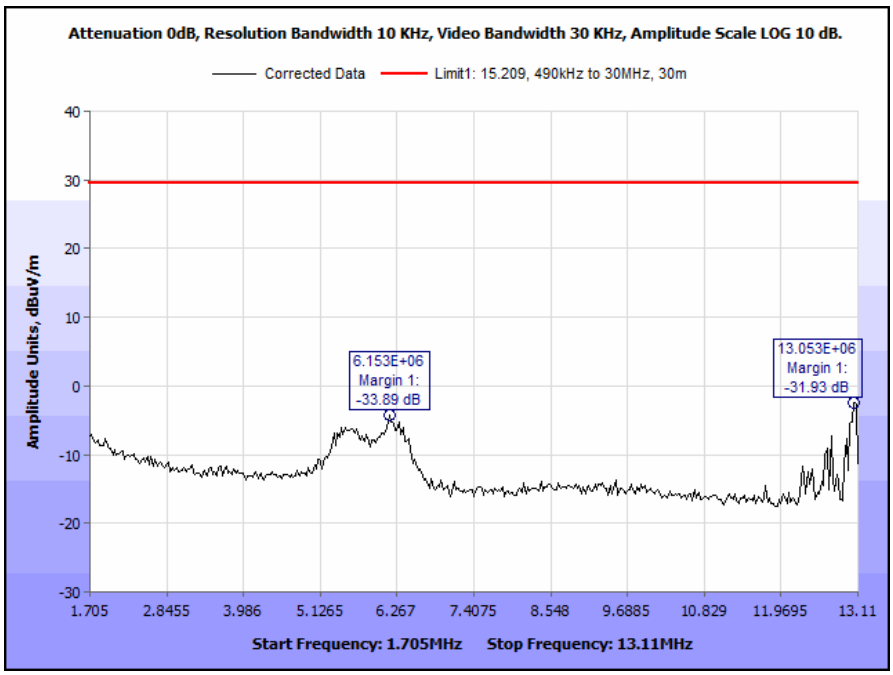
Plot 16. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 150 kHz – 490 kHz, 90°



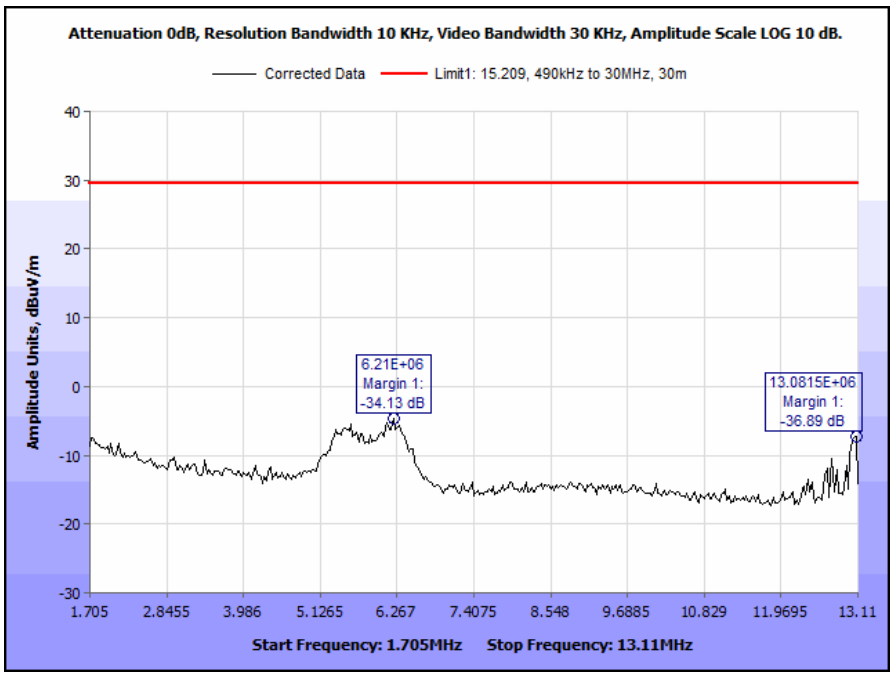
Plot 17. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 490 kHz – 1.705 MHz, 0°



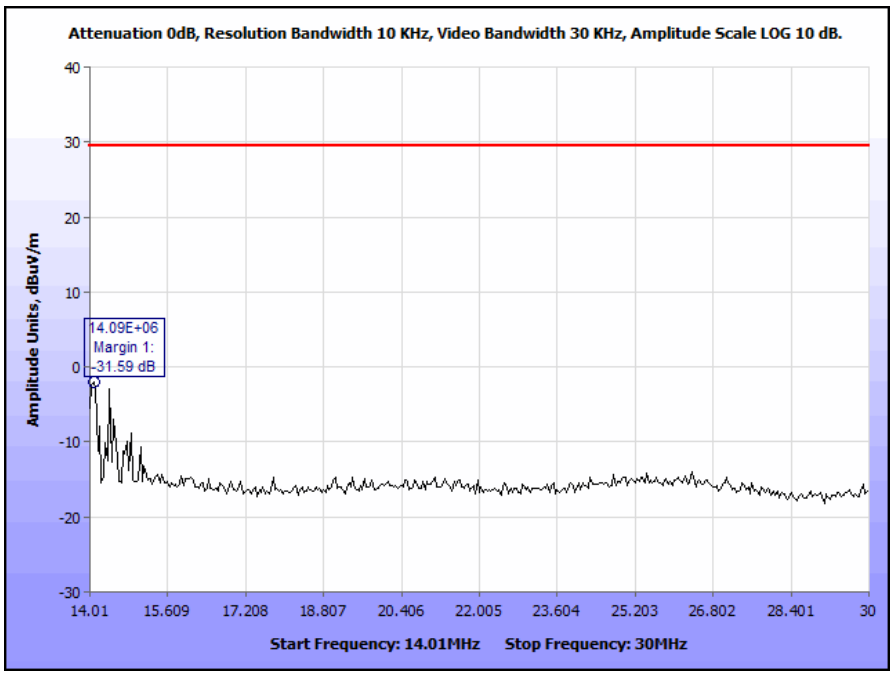
Plot 18. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 490 kHz – 1.705 MHz, 90°



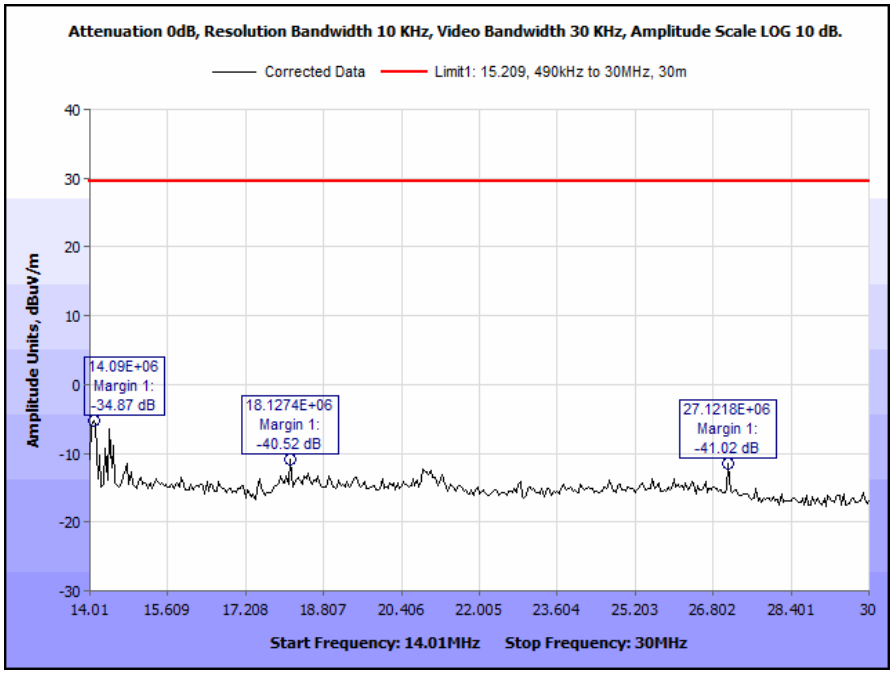
Plot 19. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 0°



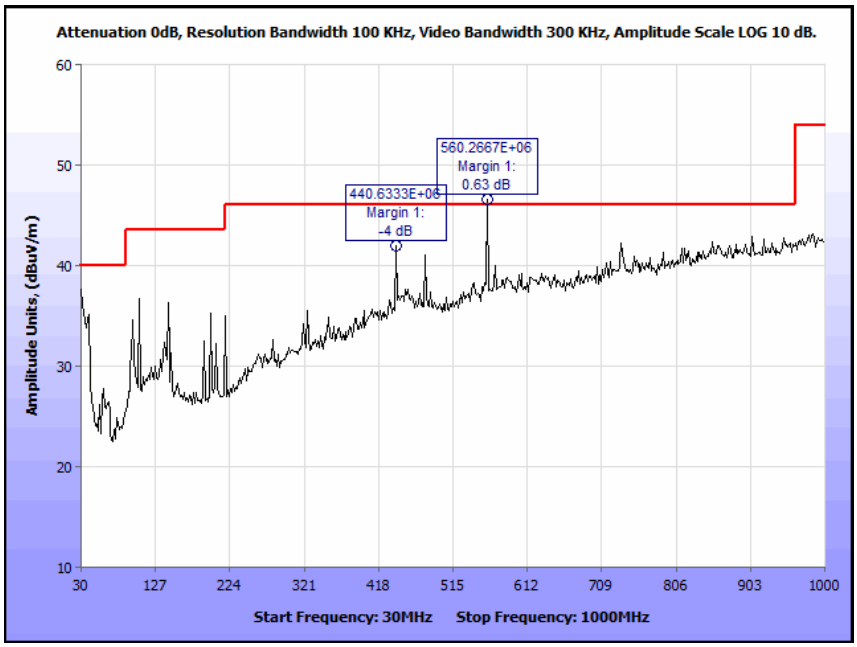
Plot 20. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 90°



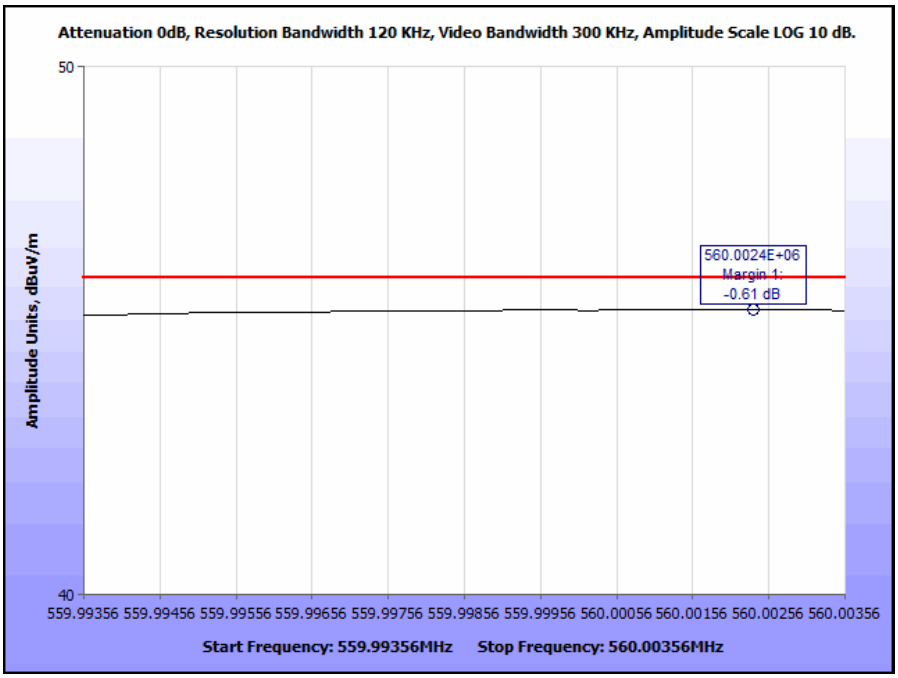
Plot 21. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 14.01 MHz – 30 MHz, 0°



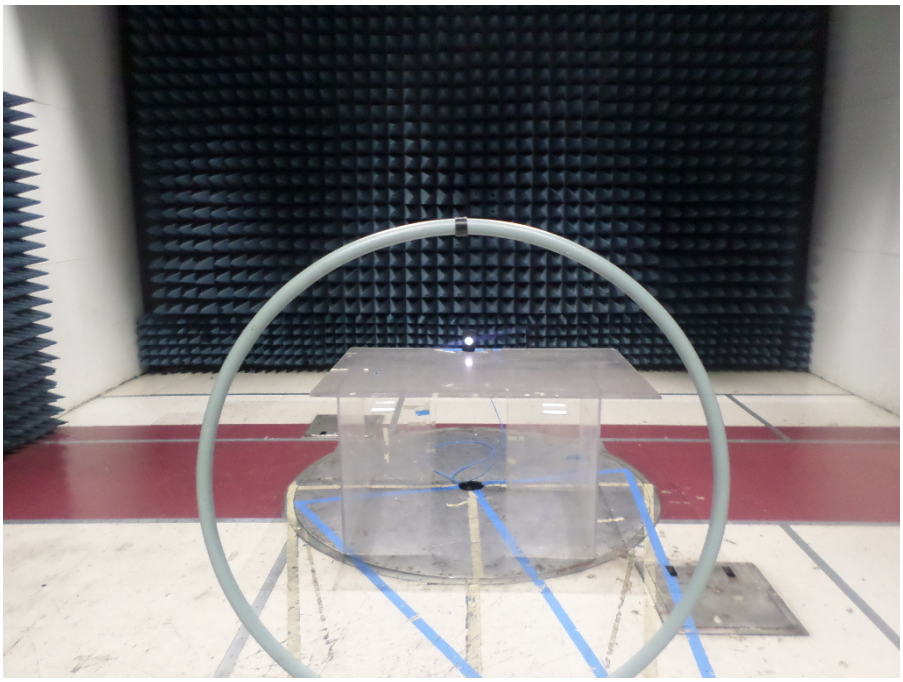
Plot 22. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 14.01 MHz – 30 MHz, 90°



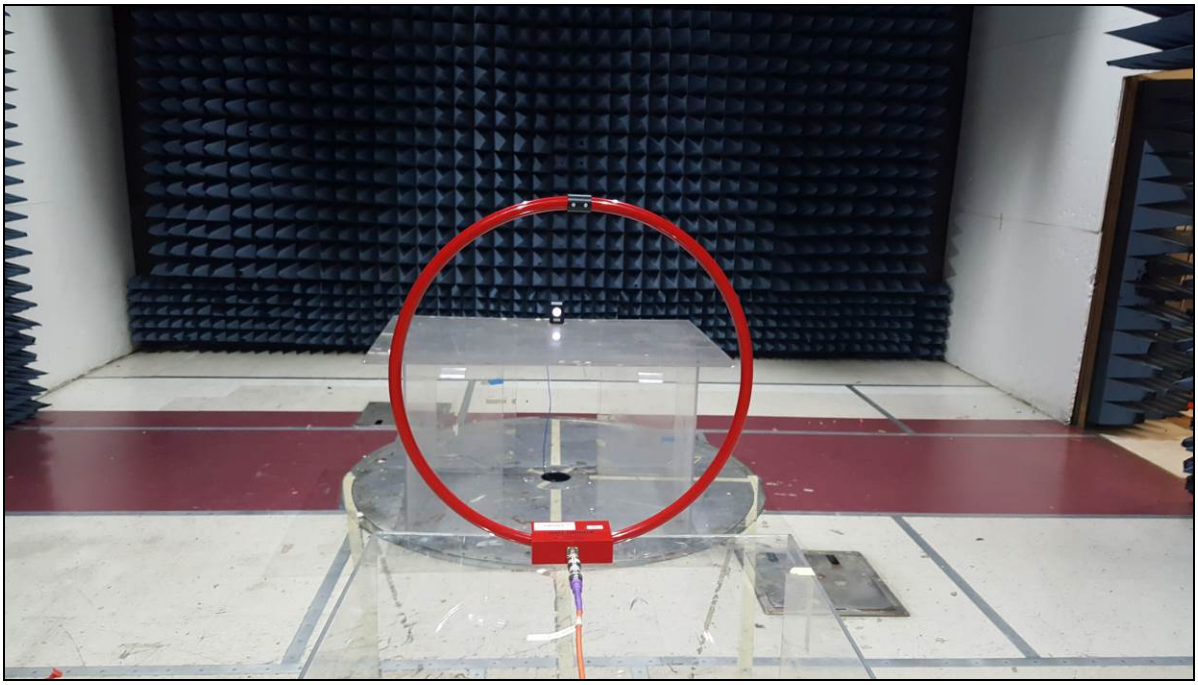
Plot 23. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 30 MHz – 1 GHz



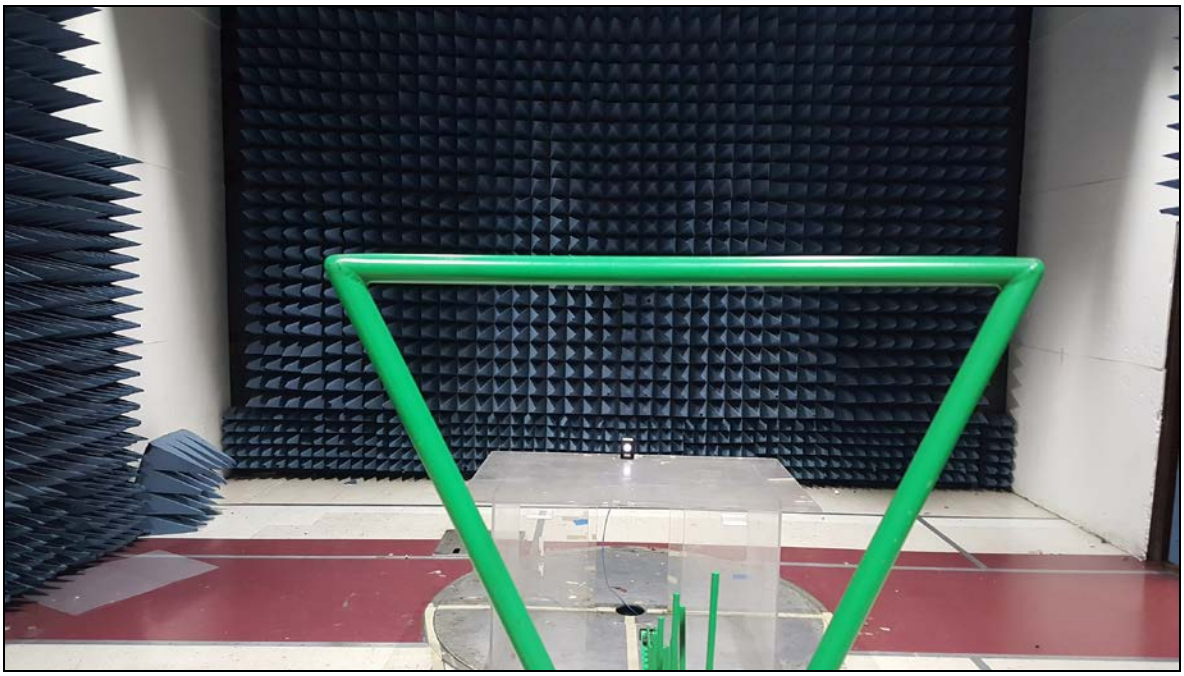
Plot 24. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 560 MHz Quasi-Peak



Photograph 2. Spurious Emissions, Test Setup, 9 kHz – 150 kHz



Photograph 3. Spurious Emissions, Test Setup, 150 kHz – 30 MHz



Photograph 4. Spurious Emissions, Test Setup, 30 MHz – 1 GHz

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 were made in accordance with ANSI C63.10: 2013. 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.

Test Results: The EUT was found compliant with Part 15.225 (e) requirement(s) of this section.

Test Engineer(s): James Borrott

Test Date(s): 01/10/2019

Temp (C°)	Fundamental (MHz)	Measured (MHz)	Percent (delta)	Limit (%)	P/F
-20	13.56	13.560275	2.02802E-05	0.01	Pass
-10	13.56	13.560212	1.56342E-05	0.01	Pass
0	13.56	13.5599	7.37463E-06	0.01	Pass
10	13.56	13.559962	2.80236E-06	0.01	Pass
20	13.56	13.559712	2.12389E-05	0.01	Pass
30	13.56	13.559737	1.93953E-05	0.01	Pass
40	13.56	13.560037	2.72861E-06	0.01	Pass
50	13.56	13.55985	1.10619E-05	0.01	Pass

Supply V (DC)	Fundamental	Measured	Percent (delta)	Limit (%)	P/F
10.2	13.56	13.560112	8.25959E-06	0.01	Pass
12	13.56	13.5600012	8.84956E-08	0.01	Pass
13.8	13.56	13.559875	9.21829E-06	0.01	Pass

Supply V (AC)	Fundamental	Measured	Percent (delta)	Limit (%)	P/F
102	13.56	13.5600625	0.00000461	0.01	Pass
120	13.56	13.5600125	0.00000092	0.01	Pass
138	13.56	13.560025	0.00000184	0.01	Pass

Table 13. Frequency Stability, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

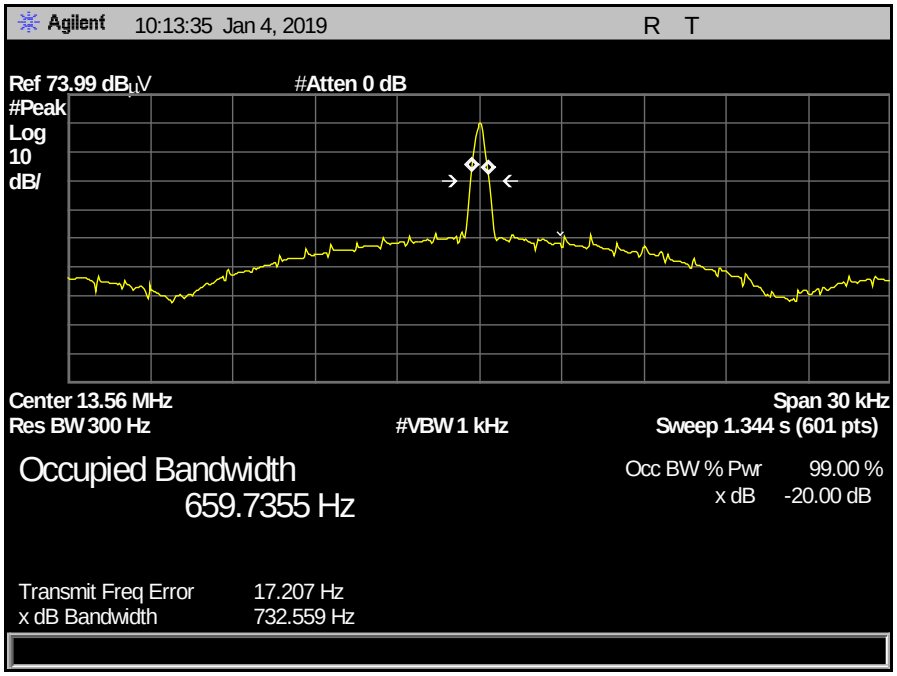
§ 15.215(c) 20 dB Occupied Bandwidth

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 measured with the spectrum analyzer using an RBW approximately 1% of the total emission bandwidth. The 20 dB Bandwidth was measured and recorded.

Test Engineer(s): James Borrott

Test Date(s): 01/04/19



Plot 38. Occupied Bandwidth, -20dB and 99%

IV. Test Equipment

Test Equipment

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

Asset	Equipment	Manufacturer	Model	Calibration Date	Calibration Due Date
1S3892	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	11/29/2018	11/29/2019
1S2482	5 METER CHAMBER	PANASHIELD	5 METER SEMI-ANECHOIC CHAMBER	SEE NOTE	
1S3983	LOOP ANTENNA	ETS-LINDGREN	6512	06/19/2018	06/19/2019
2U0002	TEMPERATURE & HUMIDITY CHAMBER	THERMOTRON	1000-705-705	09/24/2018	09/24/2019
--	LOOP ANTENNA	ELCTRO-METRICS	ALP-51L	1/6/2019	1/6/2021
1S2000	SPECTRUM ANALYZER	AGILENT	E4448A	10/17/2018	10/17/2019
1S2399	TURNTABLE CONTROLLER	SUNOL SCIENCE	SC99V	SEE NOTE	
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	11/28/2016	01/28/2019
1S4764	EMI Receiver	Narda	PMM 9010	03/14/2018	09/14/2019
1S2678	LISN, Dual-Line V-Network	Teseq	NNB 51	08/01/2018	08/01/2019
1S4070	Digital Barometer	Control Co	6530	06/22/2018	06/22/2020
1S2636	Micro-Ohmmeter	NDB Technologie	DRM-1A	02/05/2019	08/05/2020

Table 14. Test Equipment List

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

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report

