



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372
3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372
13501 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

December 12, 2018

HID Global Corporation
611 Center Ridge Dr.
Austin, TX 78753

Dear Robert Cresswell,

Enclosed is the EMC test report for compliance testing of the HID Global Corporation, OMNIKEY 5127 Modular Mini, 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 MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Joel Huna
Documentation Department

Reference: (\HID Global Corporation\EMCA99642-FCC225 Rev. 1)

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc. While use of the A2LA logo in this report reflects MET accreditation under these programs, the report must not be used by the client to claim product certification, approval, or endorsement by A2LA or any agency of the Federal Government. This letter of transmittal is not a part of the attached report.



The Nation's First Licensed Nationally Recognized Testing Laboratory

Electromagnetic Compatibility Criteria Test Report

for the

**HID Global Corporation
OMNIKEY 5127 Modular Mini**

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

MET Report: EMCA99642-FCC225 Rev. 1

December 12, 2018

Prepared For:

**HID Global Corporation
611 Center Ridge Dr.
Austin, TX 78753**

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

Electromagnetic Compatibility Criteria Test Report

for the

**HID Global Corporation
OMNIKEY 5127 Modular Mini**

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



Giuliano Messina, Project Engineer
Electromagnetic Compatibility Lab



Joel Huna
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
Ø	October 1, 2018	Initial Issue.
1	December 12, 2018	Updated customer address.

Table of Contents

I.	Executive Summary	1
	A. Purpose of Test	2
	B. Executive Summary	2
II.	Equipment Configuration	3
	A. Overview.....	4
	B. References.....	4
	C. Test Site	5
	D. Measurement Uncertainty	5
	E. Description of Test Sample.....	5
	F. Equipment Configuration.....	6
	G. Support Equipment	6
	H. Ports and Cabling Information.....	6
	I. Mode of Operation.....	6
	J. Method of Monitoring EUT Operation	6
	K. Modifications	7
	a) Modifications to EUT.....	7
	b) Modifications to Test Standard.....	7
	L. Disposition of EUT.....	7
III.	Electromagnetic Compatibility Criteria for Intentional Radiators.....	8
	§ 15.203 Antenna Requirement	9
	§ 15.207(a) Conducted Emissions Limits.....	10
	20 dB Occupied Bandwidth.....	14
	§ 15.225(a) Spurious Emission Limits, within the band 13.553 – 13.567 MHz.....	16
	§ 15.225(b) Spurious Emission Limits, within the bands 13.410 – 13.553 MHz and 13.567 – 13.710 MHz	19
	§ 15.225(c) Spurious Emission Limits, within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz	20
	§ 15.225(d) Spurious Emission Limits, outside the bands 13.110 – 14.010 MHz.....	21
	§ 15.225(e) Frequency Stability	28
	§ 2.1093 Radiofrequency radiation exposure portable devices	32
IV.	Test Equipment	33
V.	Certification & User's Manual Information.....	35
	A. Certification Information	36
	B. Label and User's Manual Information	40

List of Tables

Table 1. Executive Summary of EMC Part 15.225 Compliance Testing	2
Table 2. EUT Summary Table.....	4
Table 3. References	4
Table 4. Uncertainty Calculations Summary.....	5
Table 5. Equipment Configuration	6
Table 6. Support Equipment.....	6
Table 7. Ports and Cabling Information	6
Table 8. Antenna List	9
Table 9. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)	10
Table 10. Conducted Emissions, Bonding Measurements	11
Table 11. Conducted Emissions, Test Results	11
Table 12. Frequency Stability, Test Results	28
Table 13. Test Equipment List	34

List of Plots

Plot 1. Conducted Emissions, Line.....	12
Plot 2. Conducted Emissions, Neutral	12
Plot 3. 20 dB Occupied Bandwidth	15
Plot 4. Field Strength Within the Band 13.553 – 13.567 MHz, 0 degrees	17
Plot 5. Field Strength Within the Band 13.553 – 13.567 MHz, 90 degrees	17
Plot 6. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 0 degrees.....	21
Plot 7. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 90 degrees.....	22
Plot 8. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 0 degrees	22
Plot 9. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 90 degrees	22
Plot 10. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 0 degrees	23
Plot 11. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 90 degrees	23
Plot 12. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 0 degrees	23
Plot 13. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 90 degrees	24
Plot 14. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 14.010 MHz – 30 MHz, 0 degrees	24
Plot 15. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 14.010 MHz – 30 MHz, 90 degrees	24
Plot 16. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Horizontal	25
Plot 17. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Vertical.....	25
Plot 18. Frequency Stability, Vnom, 20 deg.....	29
Plot 19. Frequency Stability, Vnom, -20 deg	29
Plot 20. Frequency Stability, Vnom, 50 deg.....	29
Plot 21. Frequency Stability, +15 pct, 20 deg	30
Plot 22. Frequency Stability, +15 pct, -20 deg	30
Plot 23. Frequency Stability, +15 pct, 50 deg	30
Plot 24. Frequency Stability, -15 pct, 20 deg	31
Plot 25. Frequency Stability, -15 pct, -20 deg	31
Plot 26. Frequency Stability, -15 pct, 50 deg	31

List of Figures

Figure 1. Block Diagram of Test Configuration.....	5
--	---

List of Photographs

Photograph 1. Conducted Emissions, Overall Test Setup	13
---	----

Photograph 2. Conducted Emissions, LISN Connection.....	13
Photograph 3. Conducted Testing Setup	15
Photograph 4. Field Strength Within the Band 13.553 MHz – 13.567 MHz, 9 kHz – 30 MHz, Antenna	18
Photograph 5. Field Strength Within the Band 13.553 – 13.567 MHz, 9 kHz – 30 MHz Rear.....	18
Photograph 6. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Front.....	26
Photograph 7. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Rear	26
Photograph 8. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Antenna	27
Photograph 9. Spurious Emissions Outside the Bands, 13.553 – 13.567 MHz, 9 kHz – 30 MHz, Antenna.....	27

List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dBμA	Decibels above one microamp
dBμV	Decibels above one microvolt
dBμA/m	Decibels above one microamp per meter
dBμV/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μH	microhenry
μ	microfarad
μs	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation OMNIKEY 5127 Modular Mini, 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 OMNIKEY 5127 Modular Mini. 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 OMNIKEY 5127 Modular Mini, 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 1110960792. All tests were conducted using measurement procedure ANSI C63.4-2014 and 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	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
Part 2 §2.1093	Radio Frequency radiation exposure, portable devices	Compliant

Table 1. Executive Summary of EMC Part 15.225 Compliance Testing

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by HID Global Corporation to perform testing on the OMNIKEY 5127 Modular Mini, under HID Global Corporation's purchase order number 1110960792.

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, OMNIKEY 5127 Modular Mini.

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

Model(s) Tested:	OMNIKEY 5127 Modular Mini	
Model(s) Covered:	OMNIKEY 5127 Modular Mini	
EUT Specifications:	Primary Power: 5 VDC	
	FCC ID: JQ6-5127MODMIN	
	Type of Modulations:	GFSK
	Equipment Code:	DXX
	Peak RF Output Power:	-59.477 dBm
	EUT Frequency Ranges:	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:	Giuliano Messina	
Report Date(s):	December 12, 2018	

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 17025:2005	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

C. Test Site

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

Radiated Emissions measurements were performed in a 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%
Conducted Emissions	±2.68 dB	2	95%
Radiated Emissions	±2.95 dB	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The HID Global Corporation OMNIKEY 5127 Modular Mini, Equipment Under Test (EUT), is an RF card reader with Bluetooth connection capability.

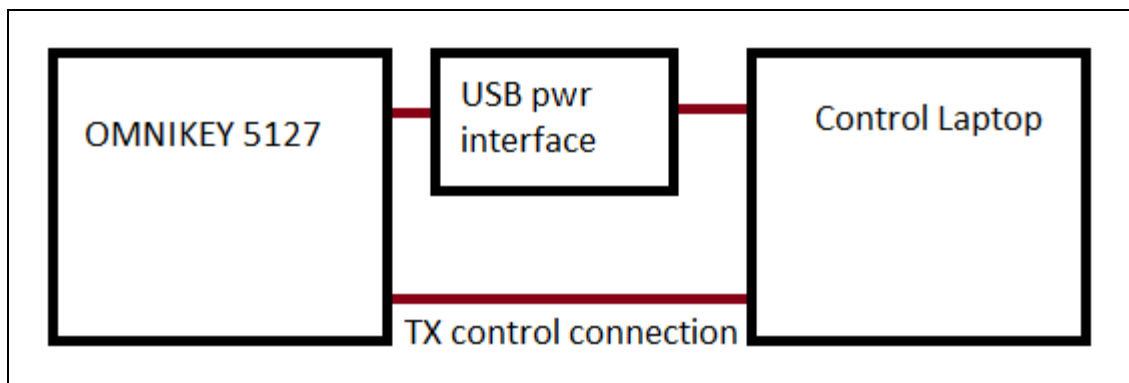


Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 1. All equipment incorporated as part of the EUT is included in the following list.

Ref. ID	Name / Description	Model Number	Part Number	Serial Number	Revision
N/A	Modular Mini	OmniKey 5127CK	N/A	N/A	N/A

Table 5. Equipment Configuration

G. Support Equipment

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

Ref. ID	Name / Description	Manufacturer	Model Number
N/A	Laptop	Dell	E6410
N/A	USB power interface board	HID	N/A

Table 6. Support Equipment

H. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
N/A	Power	Ribbon connector	1	0.1	N	Power interface board
N/A	NA	USB to Serial	1	1	N	Laptop

Table 7. Ports and Cabling Information

I. Mode of Operation

The EUT was powered via USB connection to the laptop. A GUI displayed an output when a card was held in close proximity to exercise the device's 13.56MHz functionality.

J. Method of Monitoring EUT Operation

In both radiated and conducted measurements, a spectrum analyzer was used to confirm that the EUT accepted control commands and provided the correct output based on those commands.

K. 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.

L. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Intentional Radiators

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 to criteria A of §15.203. The antenna has a non-standard connector and permanently attached to the unit.

Test Engineer(s): Giuliano Messina

Test Date(s): June 25, 2018

Antenna Type	Antenna Gain
Coil	1.0 dBi

Table 8. Antenna List

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 μ H/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 (dB μ V)	
	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 wooden 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 μ H 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 μ H LISN as the input transducer to an EMI receiver. For the purpose of this testing, the transmitter was turned on during scans.

Test Results: The EUT was compliant with this requirement. Measured emissions were within applicable limits.

Test Engineer(s): Giuliano Messina and Jonathan Tavira

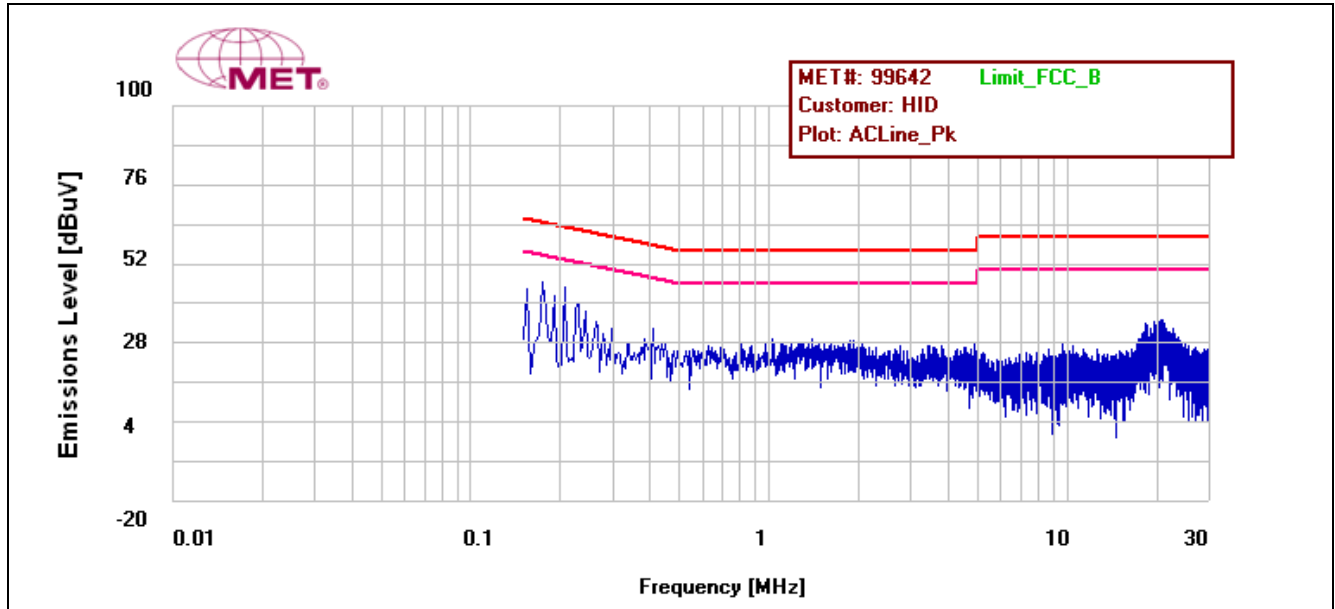
Test Date(s): July 16, 2018

Meas. Location	Meas.	Limit	Pass/Fail
Bonding measurement from LISN ground to ground plane	1.19 mΩ	< 2.5 mΩ	Pass

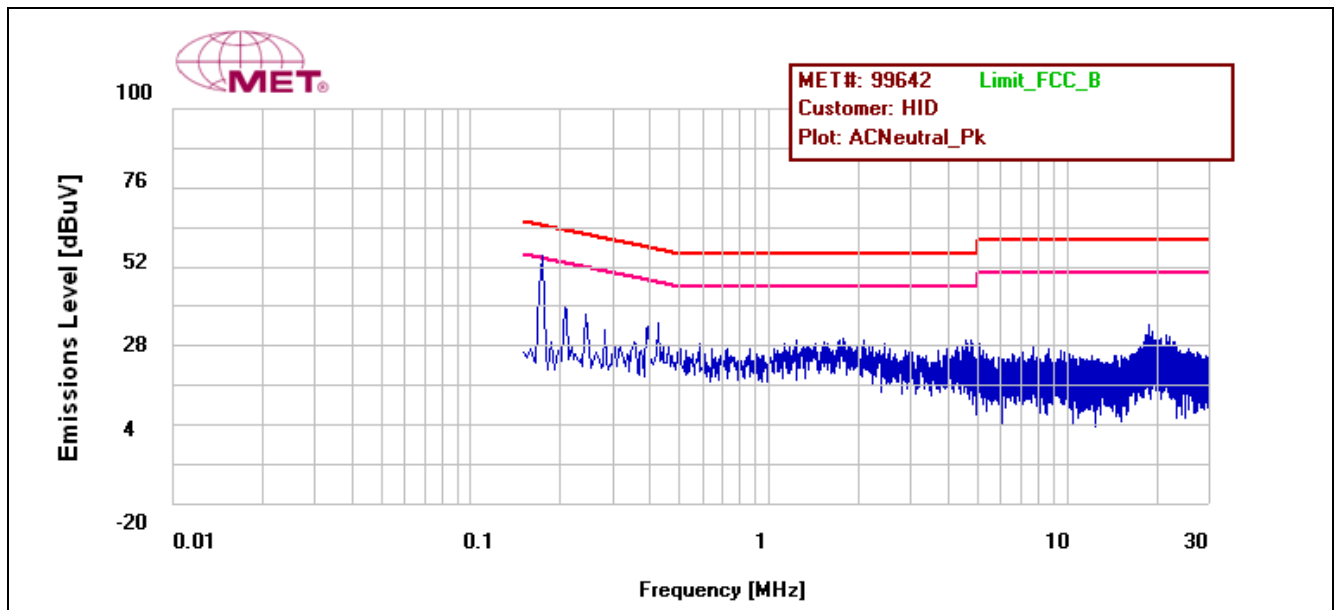
Table 10. Conducted Emissions, Bonding Measurements

Line	Freq (MHz)	QP Amplitude	QP Limit	Delta	Pass	Average Amplitude	Average Limit	Delta	Pass	Notes
ACLine	0.154	48.8	65.782	-16.982	Pass	32.5	55.782	-23.282	Pass	None
ACLine	0.174	45.2	64.771	-19.571	Pass	30.2	54.771	-24.571	Pass	None
ACLine	0.190	44.5	64.042	-19.542	Pass	27.7	54.042	-26.342	Pass	None
ACLine	0.206	41.9	63.372	-21.472	Pass	27.3	53.372	-26.072	Pass	None
ACLine	0.410	28.8	57.671	-28.871	Pass	21.7	47.671	-25.971	Pass	None
ACLine	20.678	30.3	60	-29.7	Pass	25.2	50	-24.8	Pass	None
ACNeutral	0.174	45.5	64.771	-19.271	Pass	30.6	54.771	-24.171	Pass	None
ACNeutral	0.206	41	63.372	-22.372	Pass	27.1	53.372	-26.272	Pass	None
ACNeutral	0.242	36.1	62.038	-25.938	Pass	24	52.038	-28.038	Pass	None
ACNeutral	0.394	27.2	58.001	-30.801	Pass	19.9	48.001	-28.101	Pass	None
ACNeutral	0.426	30.5	57.354	-26.854	Pass	21.4	47.354	-25.954	Pass	None
ACNeutral	18.938	27.2	60	-32.8	Pass	22.1	50	-27.9	Pass	None

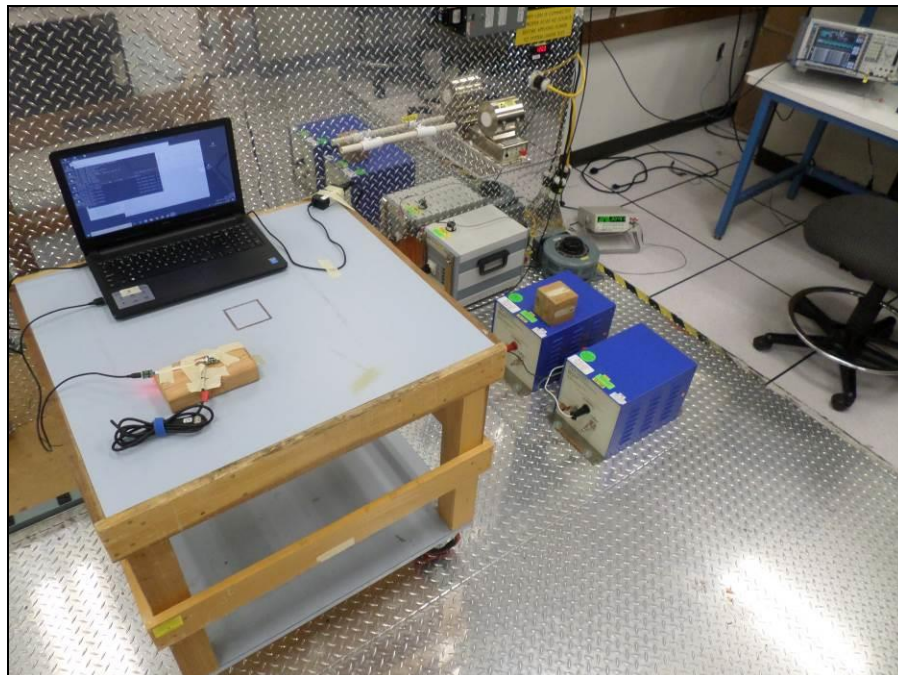
Table 11. Conducted Emissions, Test Results



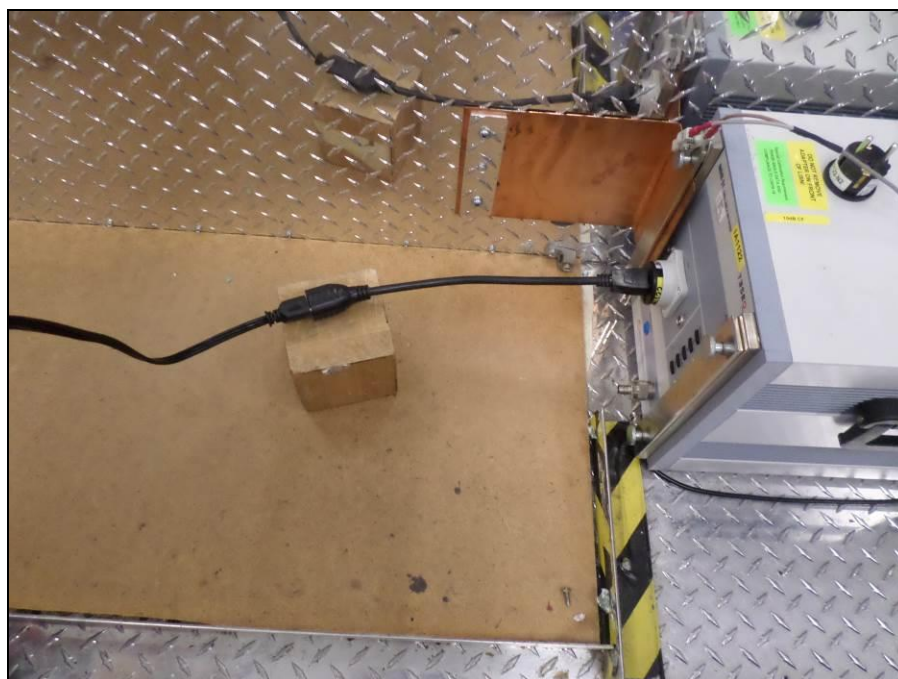
Plot 1. Conducted Emissions, Line



Plot 2. Conducted Emissions, Neutral



Photograph 1. Conducted Emissions, Overall Test Setup

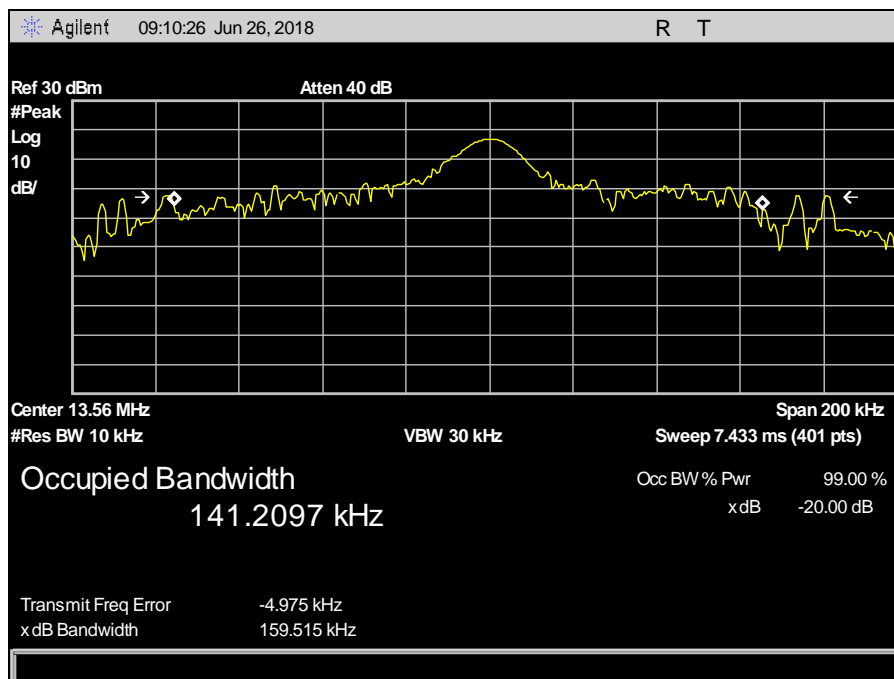


Photograph 2. Conducted Emissions, LISN Connection

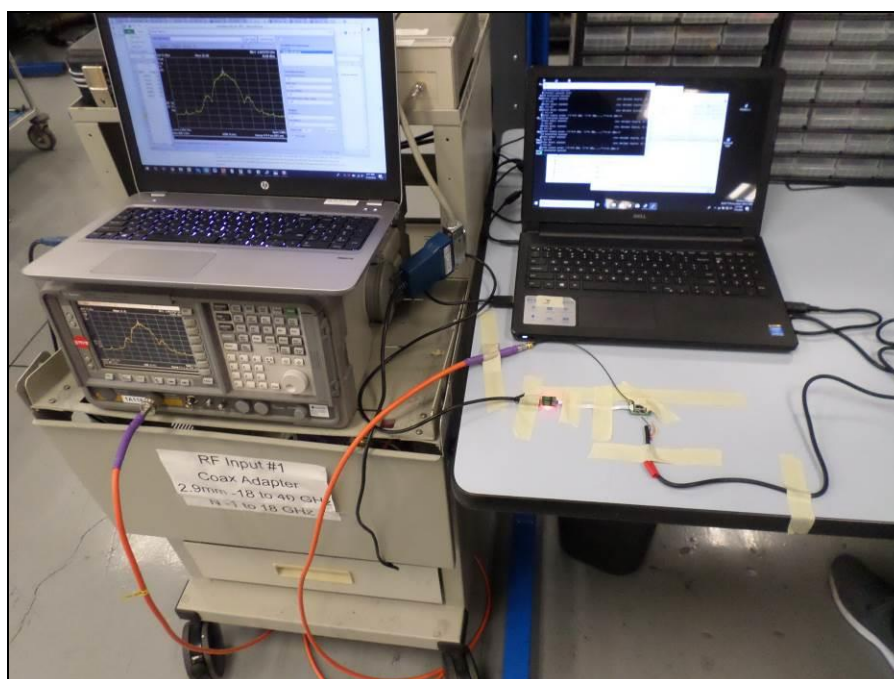
Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.215(c) 20 dB Occupied Bandwidth

Test Requirement(s):	§ 15.215 (c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.
Test Procedure:	The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer. The 20 dB Bandwidth was measured and recorded.
Test Results:	The EUT was compliant with this requirement.
Test Engineer(s):	Giuliano Messina
Test Date(s):	June 26, 2018



Plot 3. 20 dB Occupied Bandwidth



Photograph 3. Conducted Testing Setup

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

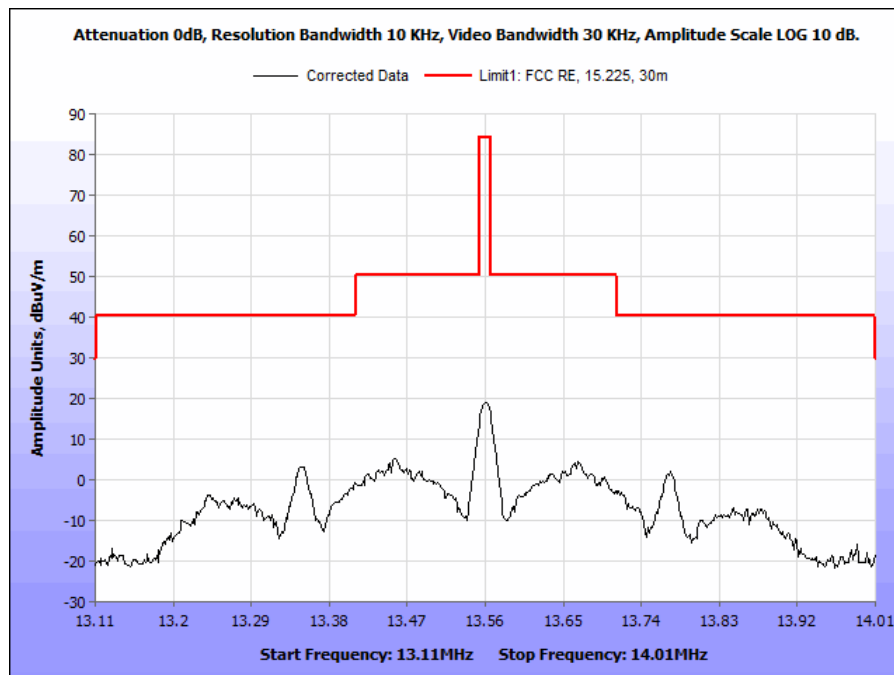
The measurements were made at 3m and then extrapolated to 30m using the following correction factor.

$$40\log(3/30) = -40 \text{ dB}$$

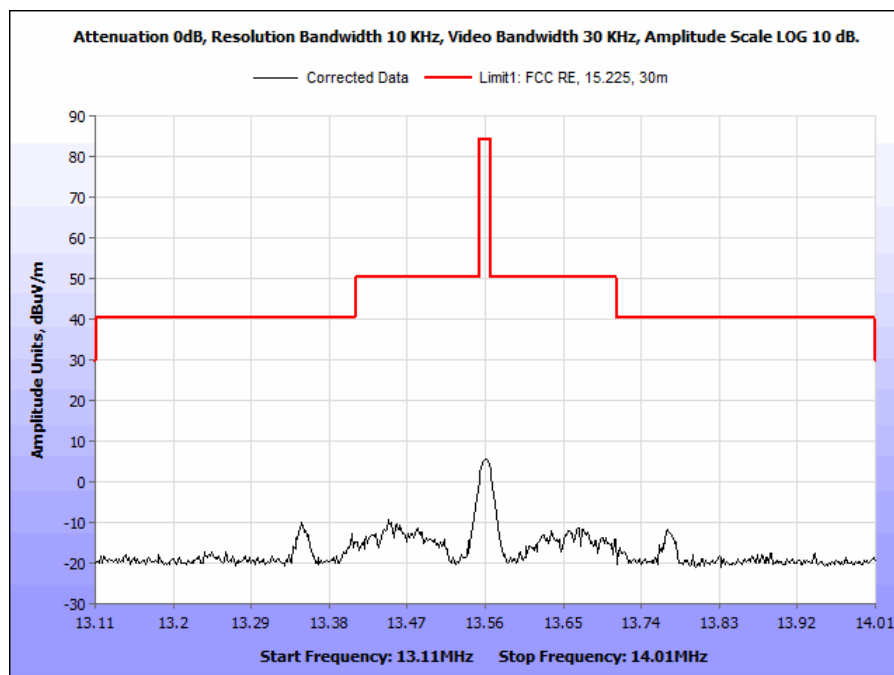
Test Results: The EUT was compliant with the requirements of §15.225(a).

Test Engineer(s): Giuliano Messina

Test Date(s): June 25, 2018



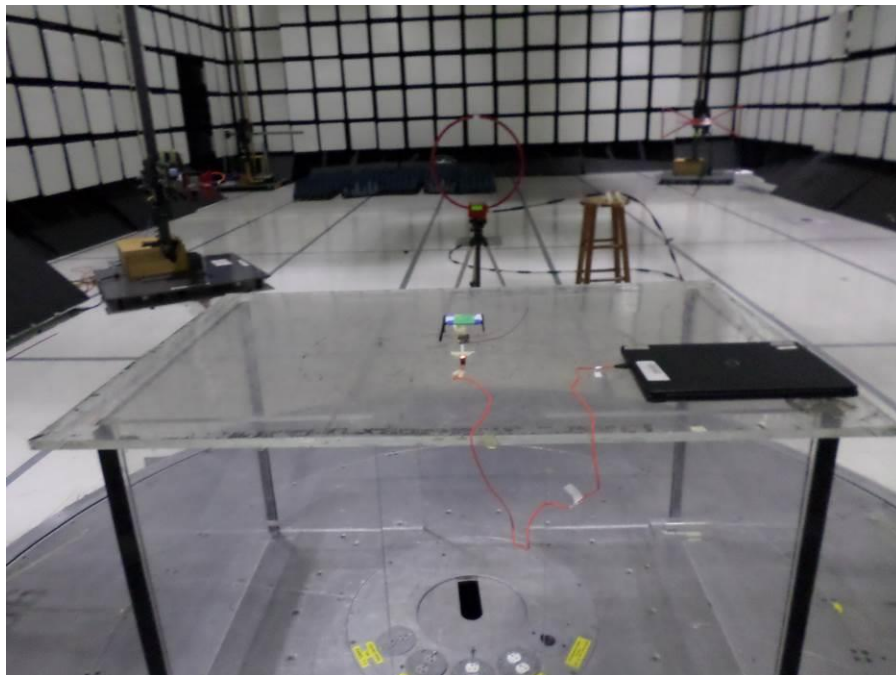
Plot 4. Field Strength Within the Band 13.553 – 13.567 MHz, 0 degrees



Plot 5. Field Strength Within the Band 13.553 – 13.567 MHz, 90 degrees



Photograph 4. Field Strength Within the Band 13.553 MHz – 13.567 MHz, 9 kHz – 30 MHz, Antenna



Photograph 5. Field Strength Within the Band 13.553 – 13.567 MHz, 9 kHz – 30 MHz Rear

Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

Test 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 C63.4: 2014 and ANSI C63.10: 2013 were used. The loop antenna was located 3 m from the EUT. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

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

$$40\log(3/30) = -40 \text{ dB}$$

Test Results: The EUT was compliant with the requirements of § 15.225(b). Please see 15.225 (a) for plots.

Test Engineer(s): Giuliano Messina

Test Date(s): June 25, 2018

Electromagnetic Compatibility Criteria for Intentional Radiators

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

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

Test 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 C63.4: 2014 and ANSI C63.10: 2013 were used. The loop antenna was located 3 m from the EUT. Measurements were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. The Spectrum analyzer RBW was set to 10 kHz and VBW was set to 30 kHz. A peak detector was used.

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

$$40\log(3/30) = -40 \text{ dB}$$

Test Results: The EUT was compliant with the requirements of §15.225(c). Please see **15.225(a)** for plots.

Test Engineer(s): Giuliano Messina

Test Date(s): July 17, 2018

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

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

$$40\log(3/30) = -40 \text{ dB}$$

$$40\log(3/300) = -80 \text{ dB}$$

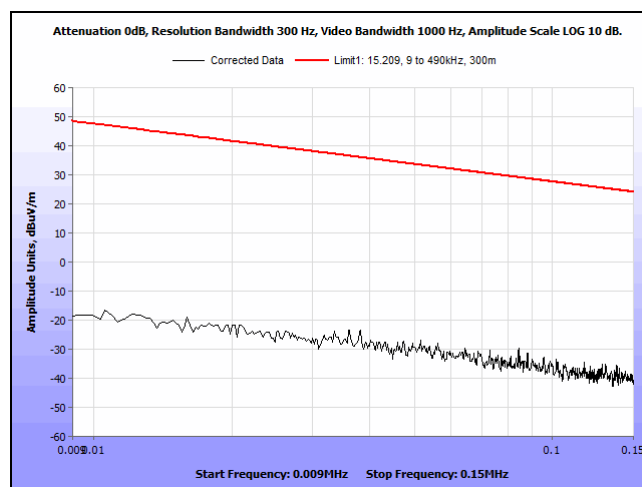
The measurements made at 10m with the biconal antenna were then extrapolated to 3m using the following correction factor.

$$20\log(10/3) = 10.46 \text{ dB}$$

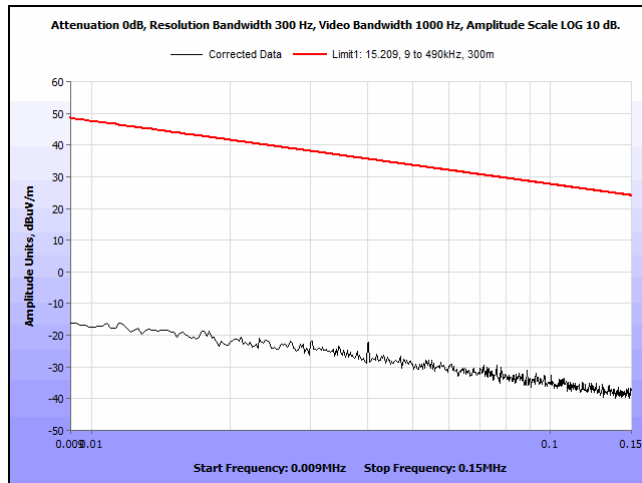
Test Results: The EUT was compliant with requirements of § 15.225 (d).

Test Engineer: Giuliano Messina

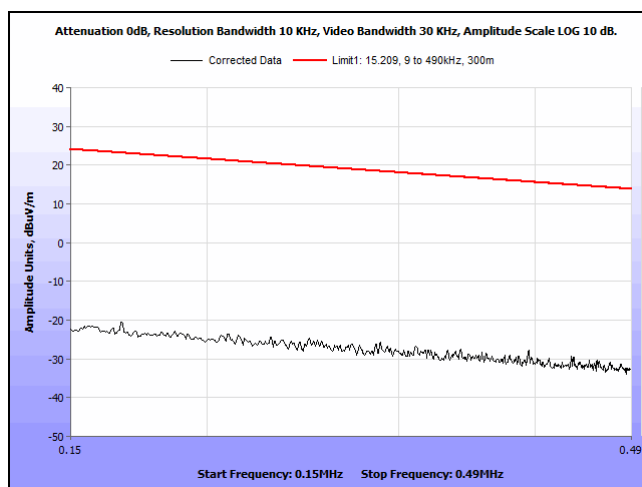
Test Date: June 25, 2018



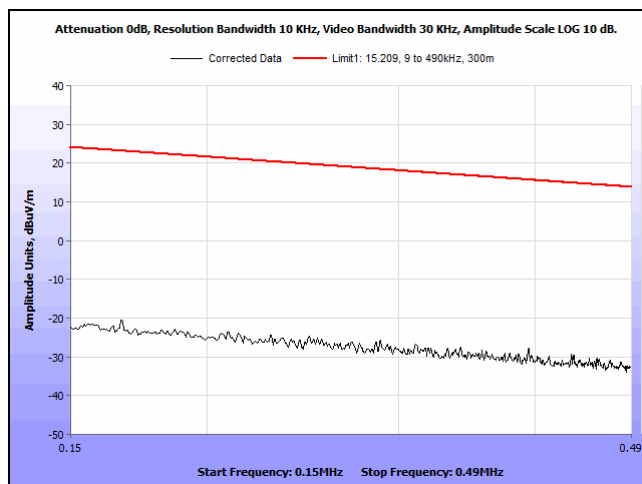
Plot 6. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 0 degrees



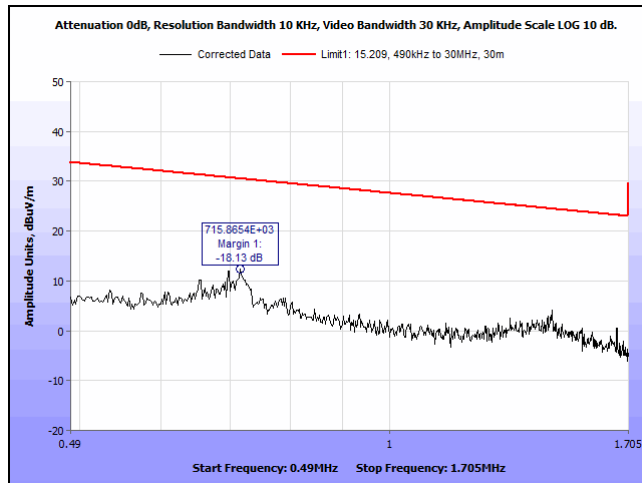
Plot 7. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 90 degrees



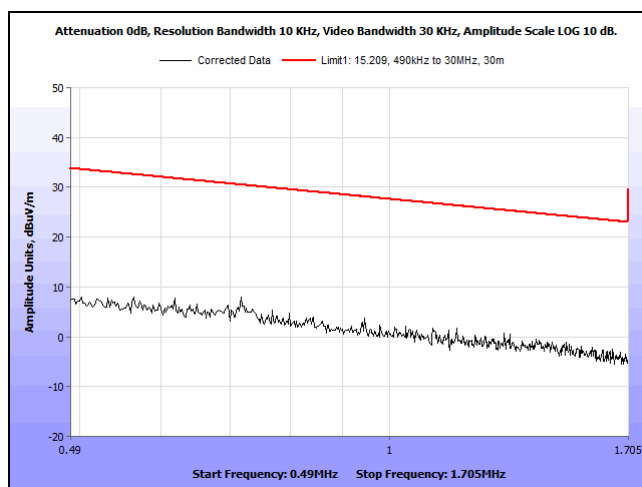
Plot 8. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 0 degrees



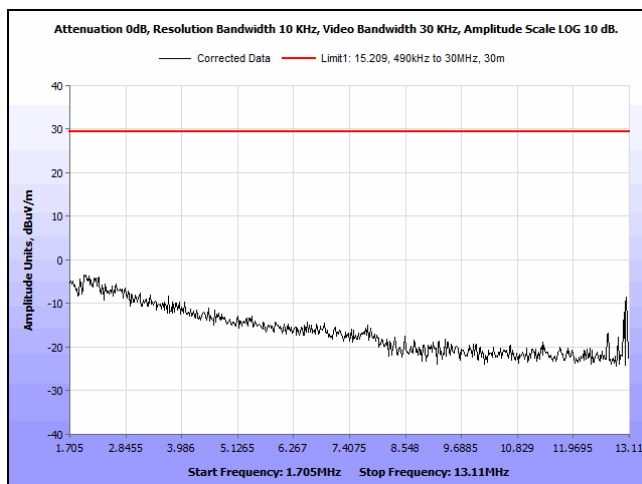
Plot 9. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 90 degrees



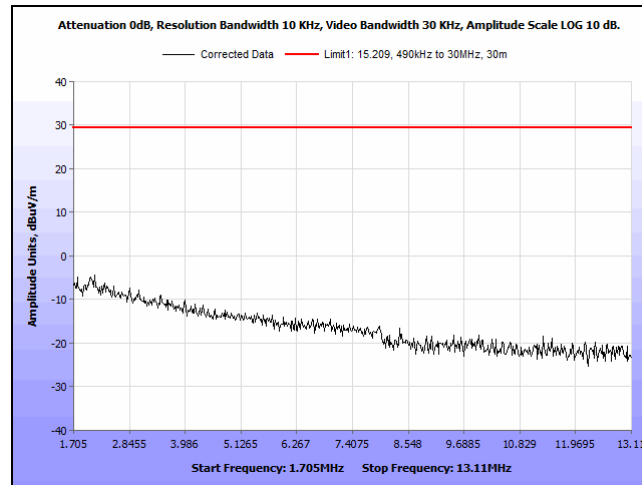
Plot 10. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 0 degrees



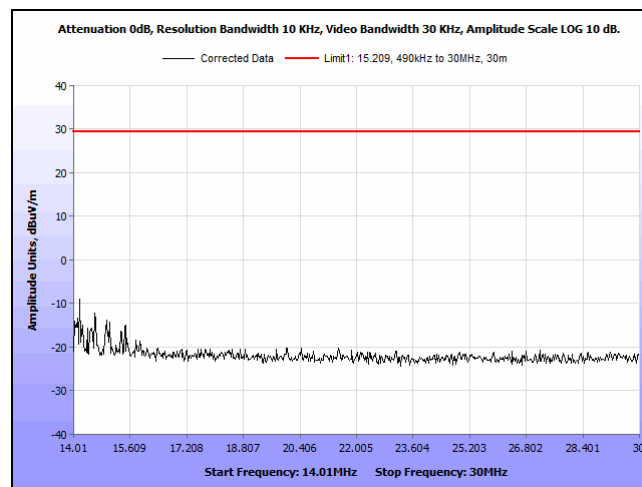
Plot 11. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 90 degrees



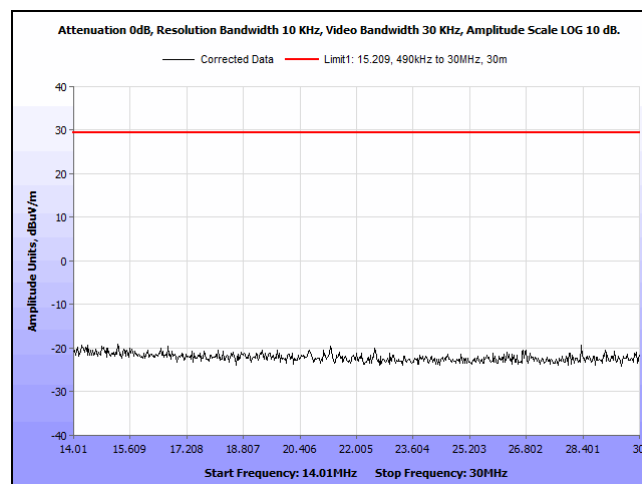
Plot 12. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 0 degrees



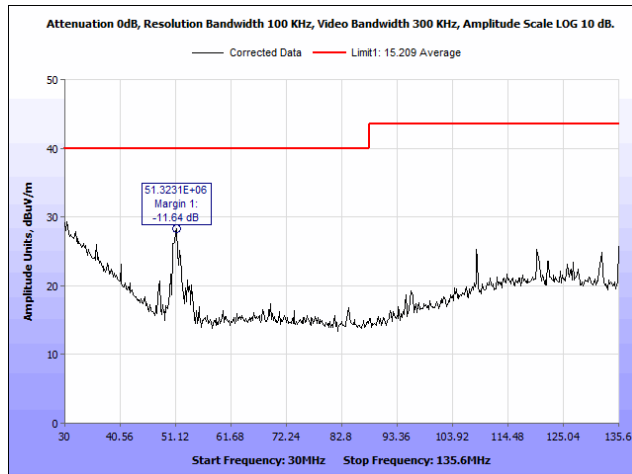
Plot 13. Spurious Emissions, Outside the Bands, 1.705 MHz – 13.11 MHz, 90 degrees



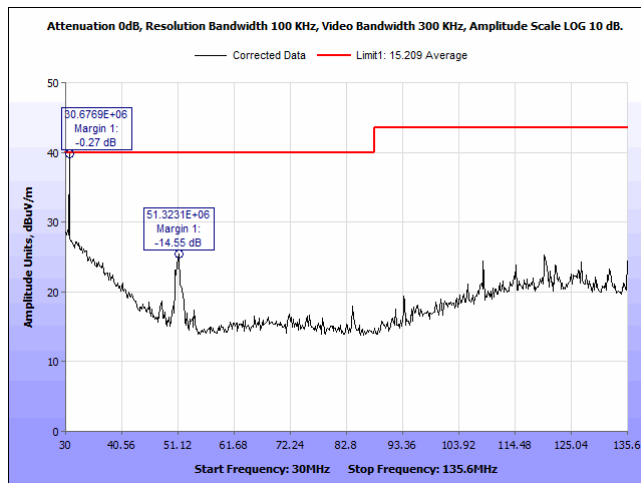
Plot 14. Spurious Emissions, Outside the Bands, 14.01 MHz – 30 MHz, 0 degrees



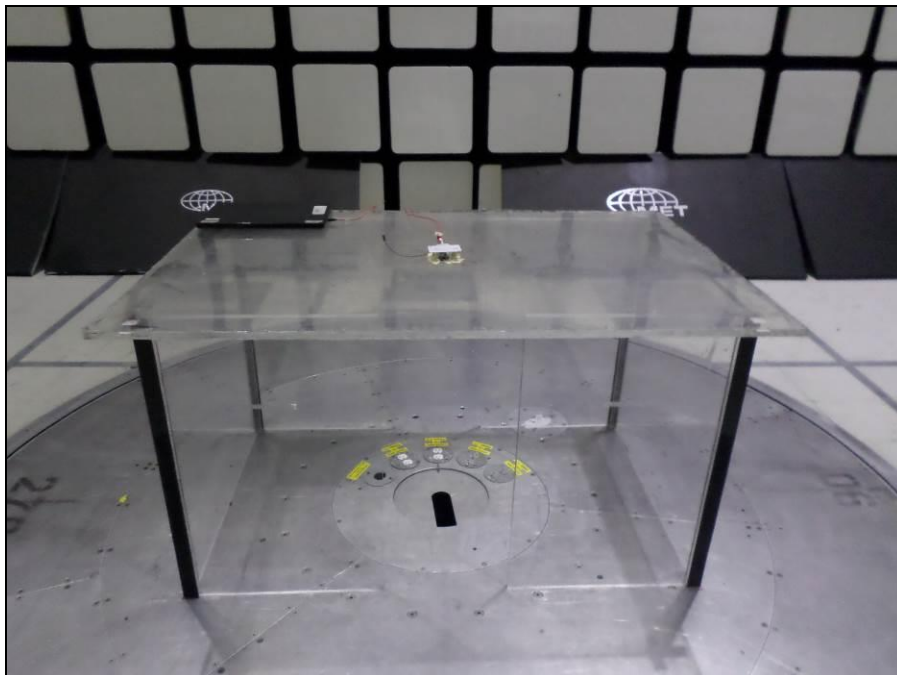
Plot 15. Spurious Emissions, Outside the Bands, 14.01 MHz – 30 MHz, 90 degrees



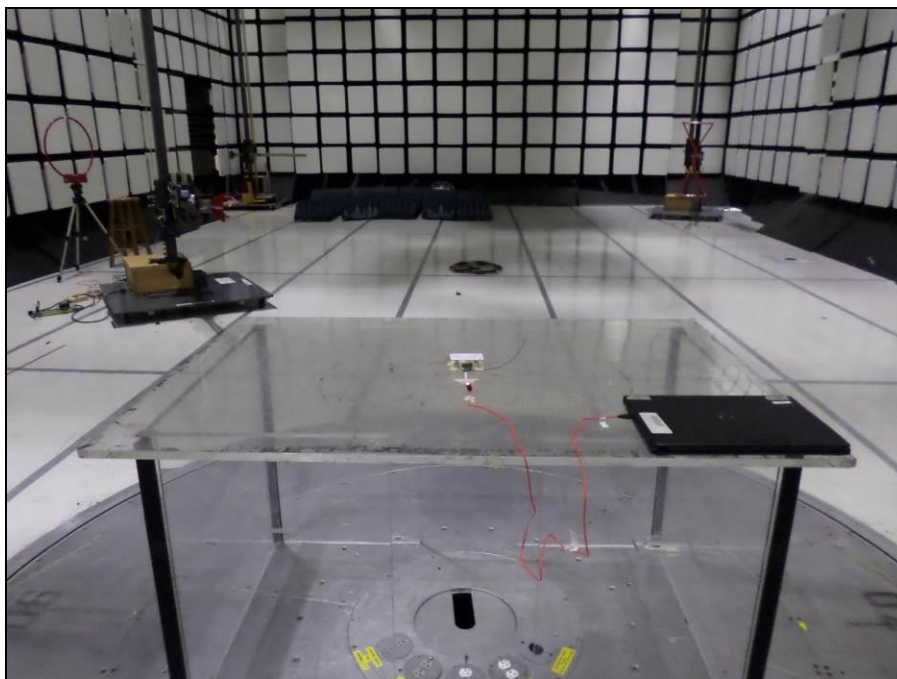
Plot 16. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Horizontal



Plot 17. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Vertical



Photograph 6. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Front



Photograph 7. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Rear



Photograph 8. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Antenna



Photograph 9. Spurious Emissions Outside the Bands, 13.553 – 13.567 MHz, 9 kHz – 30 MHz, Antenna

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 $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

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

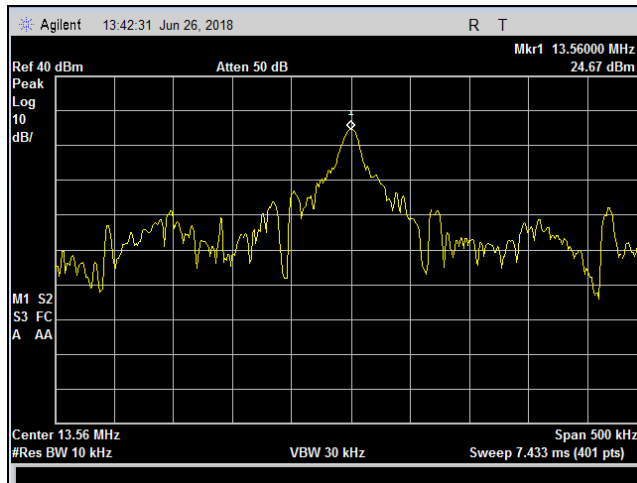
Test Results: The EUT was found compliant with Part 15.225 (e) requirement(s) of this section.

Test Engineer(s): Giuliano Messina

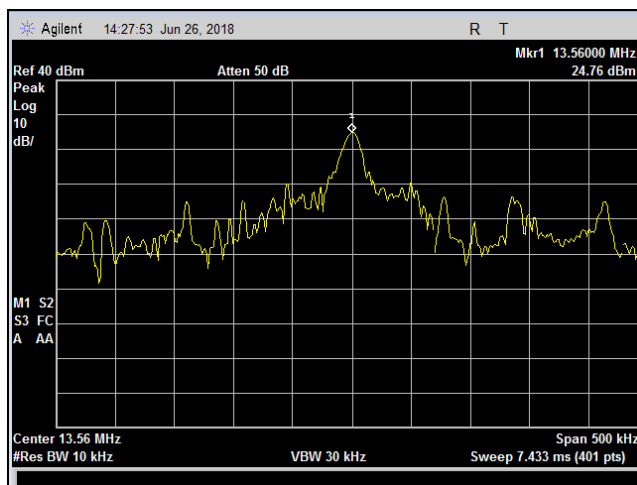
Test Date(s): June 26, 2018

Voltage Variation (%)	Temperature ($^{\circ}\text{C}$)	Nominal Freq (MHz)	Result (MHz)	% Difference
15	-20	13.56	13.56	0
	20	13.56	13.56	0
	50	13.56	13.56	0
0	-20	13.56	13.56	0
	20	13.56	13.56	0
	50	13.56	13.56	0
-15	-20	13.56	13.56	0
	20	13.56	13.56	0
	50	13.56	13.56	0

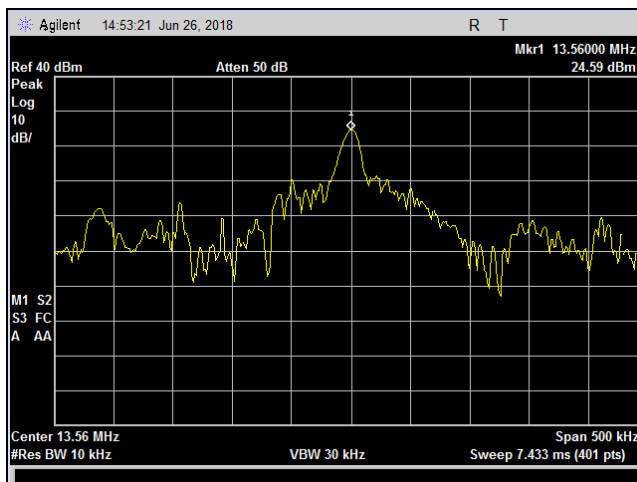
Table 12. Frequency Stability, Test Results



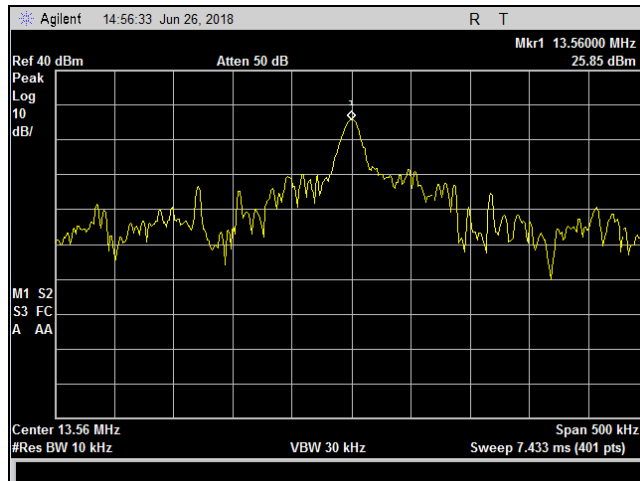
Plot 18. Frequency Stability, Vnom, 20 deg



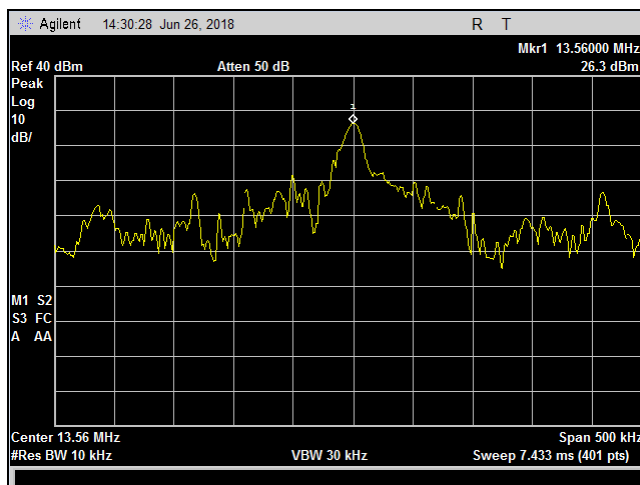
Plot 19. Frequency Stability, Vnom, -20 deg



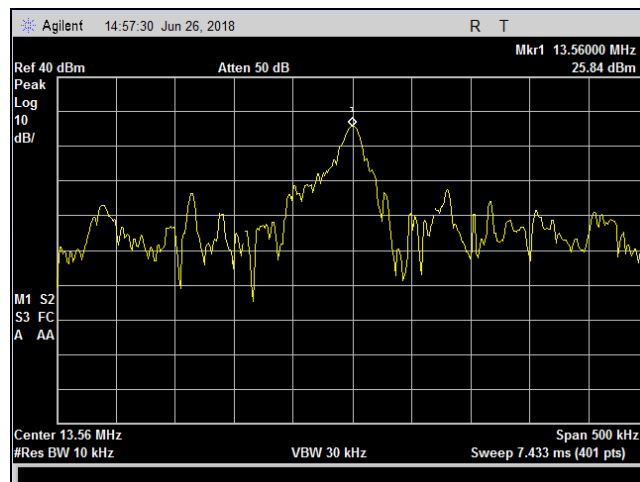
Plot 20. Frequency Stability, Vnom, 50 deg



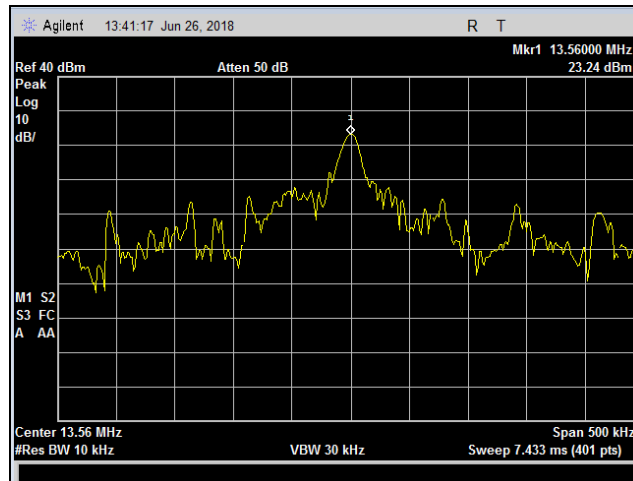
Plot 21. Frequency Stability, +15 pct, 20 deg



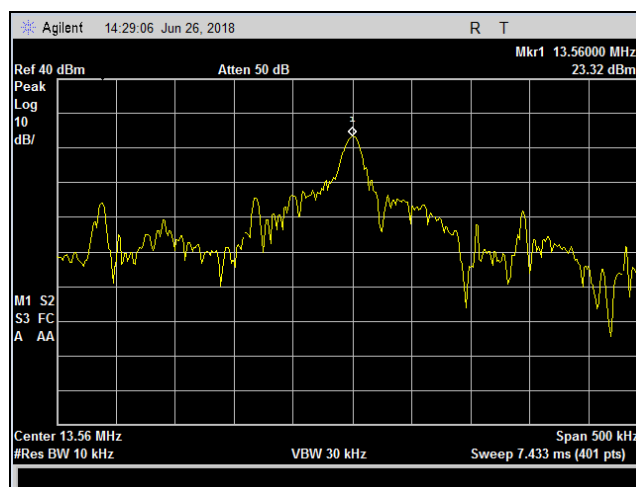
Plot 22. Frequency Stability, +15 pct, -20 deg



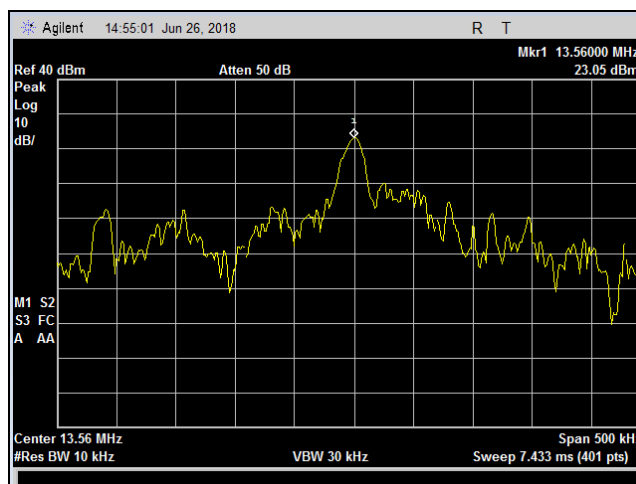
Plot 23. Frequency Stability, +15 pct, 50 deg



Plot 24. Frequency Stability, -15 pct, 20 deg



Plot 25. Frequency Stability, -15 pct, -20 deg



Plot 26. Frequency Stability, -15 pct, 50 deg

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.1093 Radiofrequency radiation exposure, portable devices

RF Exposure Requirements: §1.1307(b)(1) and §1.1307(b)(2): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

§2.1093: As specified in this section, a portable device is defined as a transmitting device designed to be used so that the radiated structure(s) of the device is within 20 centimeters of the body of the user.

Calculations below are in accordance with KDB 447498 D01 General RF Exposure Guidance v06, Section 4.3 General SAR test exclusion guidance.

The SAR test exclusion thresholds are 3.0 for 1-g SAR and 7.5 for 10-g extremity SAR.

13.56 MHz SAR Exclusion Calculation

Per KDB 447498, Section 4.3.1 (c)(2), applicable for frequencies below 100 MHz and test separation distances ≤ 50 mm:

- Using the information from 4.3.1 (b), the formula from 4.3.1 (a), and using the 1-g SAR limit of 3.0:

Power allowed at numeric threshold for 50 mm and 100 MHz in step 4.3.1 (a) =

$$\left(\frac{3}{\sqrt{0.1}}\right) * 50 \text{ mm} = 474.34 \text{ mW}$$

- Using information from 4.3.1 (c)(1) and the formula from 4.3.1 (b), defined at 50 mm and 100 MHz:

$$\left(\text{Power allowed at numeric threshold for 50 mm in step 4.3.1 (a)}\right) + \\ (\text{test separation distance} - 50 \text{ mm}) * \left(\frac{f [\text{MHz}]}{150}\right)$$

$$(474.34 \text{ mW}) + (50 \text{ mm} - 50 \text{ mm}) * \left(\frac{100 \text{ MHz}}{150}\right) = 474.34 \text{ mW}$$

- Using the information from 4.3.1 (c)(2) and the formula from 4.3.1 (c)(1), defined at 13.56 MHz, the final max power should be:

Max Power of 13.56MHz Transmitter under the 1g SAR Limit =

$$\frac{1}{2} * 474.34 \text{ mW} \left[1 + \log\left(\frac{100 \text{ MHz}}{13.56 \text{ MHz}}\right)\right] = 442.972 \text{ mW}$$

FCC						
Frequency (MHz)	Corrected Meter Reading (dBuV/m)	TX Power (dbm)	TX Power (mW)	1.0-g SAR Limit (mW)	Margin (mW)	Result
13.56	18.98	-59.477	1.128E-6	442.972	442.972	Pass

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 17025:2005.

MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1A1176	Loop Antenna	ETS-Lindgren	6502	1/31/2018	7/31/2019
1A1225	Temperature Chamber	Espec	EPX-2H	2/27/2018	2/27/2019
1A1184	Spectrum Analyzer	Agilent	E4407B	4/20/2018	4/20/2019
1A1083	EMI Test Receiver	Rohde & Schwarz	ESU40	9/12/2017	10/12/2018
1A1106	10m Chamber (FCC)	ETS	Semi-Anechoic	See Note	
1A1147	Bilog Antenna (30MHz to 1GHz)	Sunol Sciences Corp	JB3	3/9/2017	10/9/2018
1A1088	Pre-Amp	Rohde & Schwarz	TS-PR1	See Note	
1A1044	Generator	COM-Power Corp	CG-520	See Note	
1A1073	Multi Device Controller	ETS EMCO	2090	See Note	
1A1074	System Controller	Panasonic	WV-CU101	See Note	
1A1075	System Controller	Panasonic	WV-CU101	See Note	
1A1080	Multi Device Controller	ETS EMCO	2090	See Note	

Table 13. 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