

04/14/2020

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 5127CK Reader Core, tested to the requirements of LP0002 Low-power Radio-frequency Devices Technical Regulations for Certification as an Intentional Radiator.

Thank you for using the services of Eurofins E&E North America. If you have any questions regarding these results or if we can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

A handwritten signature in blue ink that reads "Joel Huna".

Joel Huna
Documentation Department

Reference: (\HID Global Corporation\EMCA106319-LP0002 RFID Rev. 4)

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Electromagnetic Compatibility Criteria Test Report

for the

**HID Global Corporation
OMNIKEY 5127CK Reader Core**

Tested under

LP0002 Low-power Radio-frequency Devices Technical Regulations
for Intentional Radiators

Report: EMCA106319-LP0002 RFID Rev. 4

04/14/2020

Prepared For:

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

Prepared By:

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

**Electromagnetic Compatibility Criteria
Test Report**

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OMNIKEY 5127CK Reader Core**

Tested under

LP0002 Low-power Radio-frequency Devices Technical Regulations
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 LP0002 under normal use and maintenance.



Jonathan Tavira,
Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	02/24/2020	Initial Issue.
1	03/09/2020	Customer Comments.
2	03/26/2020	Customer Comments.
3	04/01/2020	Customer Comments.
4	04/14/2020	Customer Comments.

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB μ A	Decibels above one microamp
dB μ V	Decibels above one microvolt
dB μ A/m	Decibels above one microamp per meter
dB μ V/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
μ H	microhenry
μ	microfarad
μ s	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 5127CK Reader Core, with the requirements of LP0002 Low-power Radio-frequency Devices Technical Regulations. In accordance with LP0002, the following data is presented in support of the Certification of the OMNIKEY 5127CK Reader Core. 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 5127CK Reader Core, 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 LP0002, in accordance with HID Global Corporation, purchase order number 1110972109. All tests were conducted using the measurement procedures of ANSI C63.10-2013 and LP0002 Appendix.

LP0002 Reference	Description	Compliance
2.2	Antenna Requirement	Compliant
2.3	Conducted Emission Limits	Compliant
3.2.1.1	Field Strength emissions within the band 13.553 – 13.567 MHz	Compliant
3.2.1.2	Field Strength emissions within the band 13.410 – 13.553 MHz and 13.567 – 13.710 MHz	Compliant
	Field Strength emissions within the band 13.110 – 13.410 MHz and 13.710 – 14.010 MHz	Compliant
	Outside-Band Field Strength emissions per 15.209 - 13.110 – 14.010 MHz	Compliant
3.2.1.3	Frequency Tolerance of the Carrier	Compliant
5.20	RF Exposure	Compliant

Figure 1. Executive Summary of EMC LP0002 Compliance Testing

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

II. Equipment Configuration

A. Overview

Eurofins E&E North America was contracted by HID Global Corporation to perform testing on the OMNIKEY 5127CK Reader Core, under HID Global Corporation's purchase order number 1110972109.

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 5127CK Reader Core.

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

Model(s) Tested:	OMNIKEY 5127CK Reader Core	
Model(s) Covered:	OMNIKEY 5127CK Reader Core	
EUT Specifications:	Primary Power: 5 VDC	
	Type of Modulations:	ASK
	Equipment Code:	DXX
	Maximum Field Strength:	47.52 dB μ V/m
	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):	03/09/2020	

Figure 2. EUT Summary Table

B. References

LP0002: 2018	Low-power Radio-frequency Devices Technical Regulations.
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

Figure 3. References

C. Test Site

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

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

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with LP0002, a complete site description is contained at Eurofins MET Labs.

D. Description of Test Sample

The OMNIKEY 5127CK Reader Core, Equipment Under Test (EUT), is an RF card reader. A user will approach the card reader and present a BLE or RFID credentials to the reader with intention of granting access. The reader will read the credential and send its data to a connected access control panel, which determine whether or not grant the user access of the user.

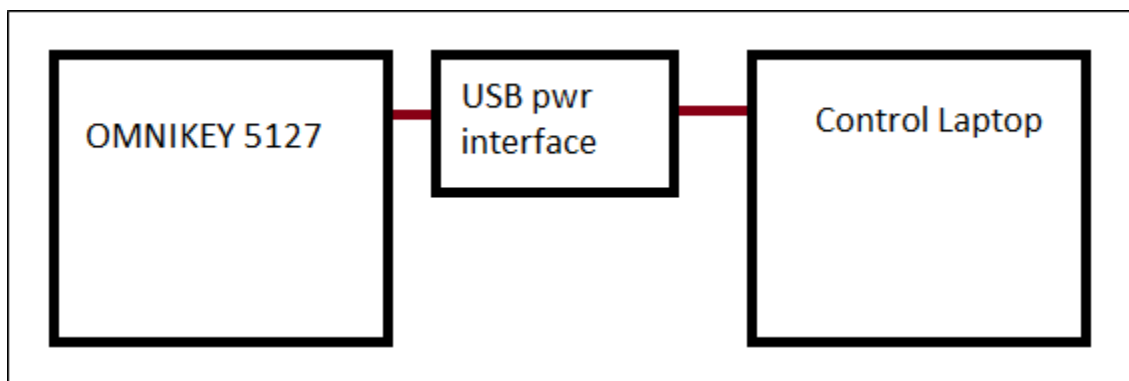


Figure 4. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 4. 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	Smart Card Reader	OMNIKEY 5127CK Reader Core	N/A	N/A	N/A

Figure 5. Equipment Configuration

F. 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	5127CK-Reader Core USB Interface Adapter	HID Global	MDP-03923
N/A	Cable, FFC 10 POS 0.5mm	Wurth Elektronik	CBL-00169

Figure 6. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
N/A	Power	Cable, FFC 10 POS 0.5mm	1	0.1	N	5127CK-Reader Core USB Interface Adapter
N/A	NA	USB to TTL Serial Cable	1	1	N	Laptop

Figure 7. Ports and Cabling Information

H. 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.

I. 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.

J. Modifications**a) Modifications to EUT**

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

K. Disposition of EUT

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

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.2 Antenna Requirement

Test Requirement: § 2.2: Antenna requirement: Low-power radio frequency transmitter or transceiver (receiver) shall utilize a permanently, semi-permanently attached antenna or uses a unique coupling of the antenna and at any cable connector between the transmitter and the antenna. The antenna shall be an omni-directional type. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector or other than authorized is prohibited. Such standard connectors are for example: BNC, F type, N type, M type, UG type, RCA, SMA, SMB, and other standard type antenna connectors.

Results: The EUT as tested is compliant with §2.2. 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

Figure 8. Antenna List

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 2.3 Conducted Emissions Limits

Test Requirement(s): § 2.3: 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)	§ 2.3, 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

Figure 9. Conducted Limits for Intentional Radiators from § 2.3

Note: *Decreases with the logarithm of the frequency.

Test Procedure: The EUT was placed on a 0.8 m-high non-conductive 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 C63.10-2013 and LP0002 Appendix*. 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 EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Sample Calculation:

$$R_r - S = M$$

where:

- R_r = Receiver Reading in dB μ V
- S = Specification Limit in dB μ V
- M = Margin to Specification in +/- dB

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

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

Corrected QP** Amplitude (dB μ V) = Uncorrected Amplitude (dB μ V) + LISN IL (dB) + CBL (dB) = 42.65 + 10 + 0.58 = 53.23

** Same Calculation applies to Corrected Avg. amplitude as well.

Conducted Emissions Voltage Test Setup

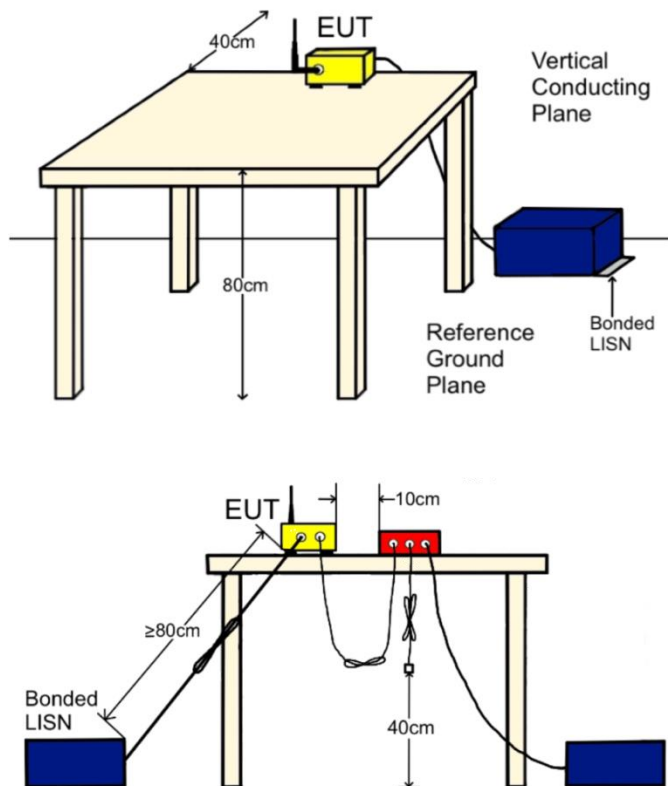


Figure 10: CEV Test Setup

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

Figure 11. Conducted Emissions, Bonding Measurements

Line	Freq (MHz)	QP Amplitude (dBμV)	QP Limit (dBμV)	Delta (dB)	Pass	Average Amplitude (dBμV)	Average Limit (dBμV)	Delta (dB)	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

Figure 12. Conducted Emissions, Phase Line, Test Results

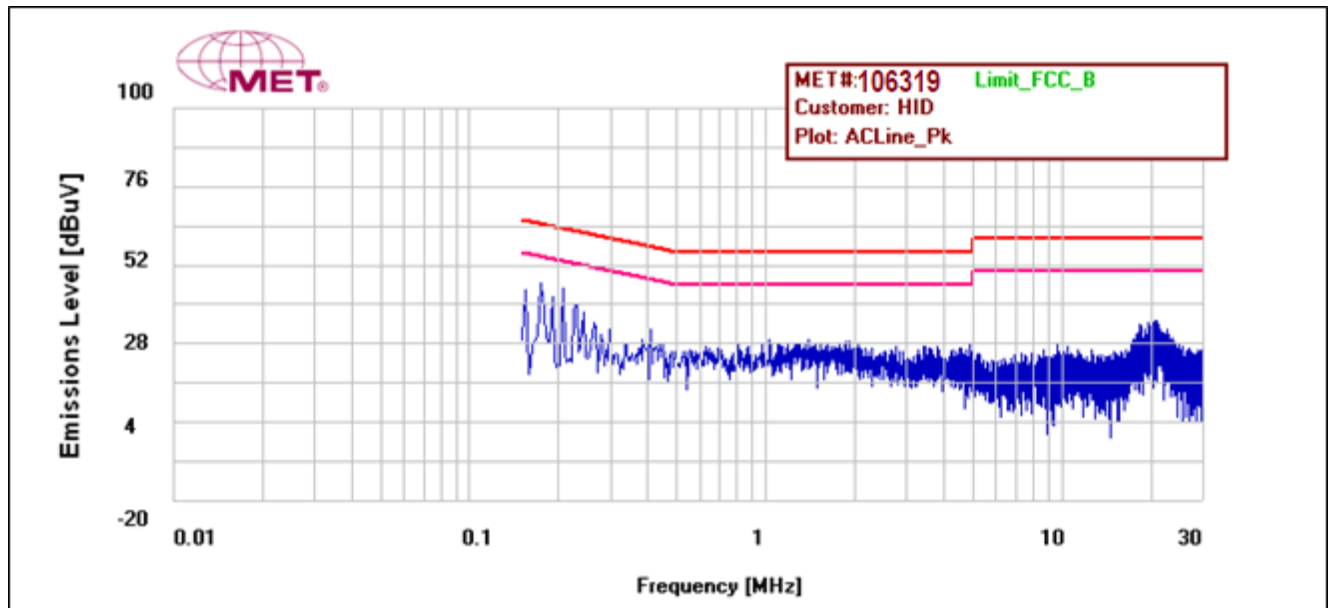


Figure 13. Conducted Emissions, Phase Line

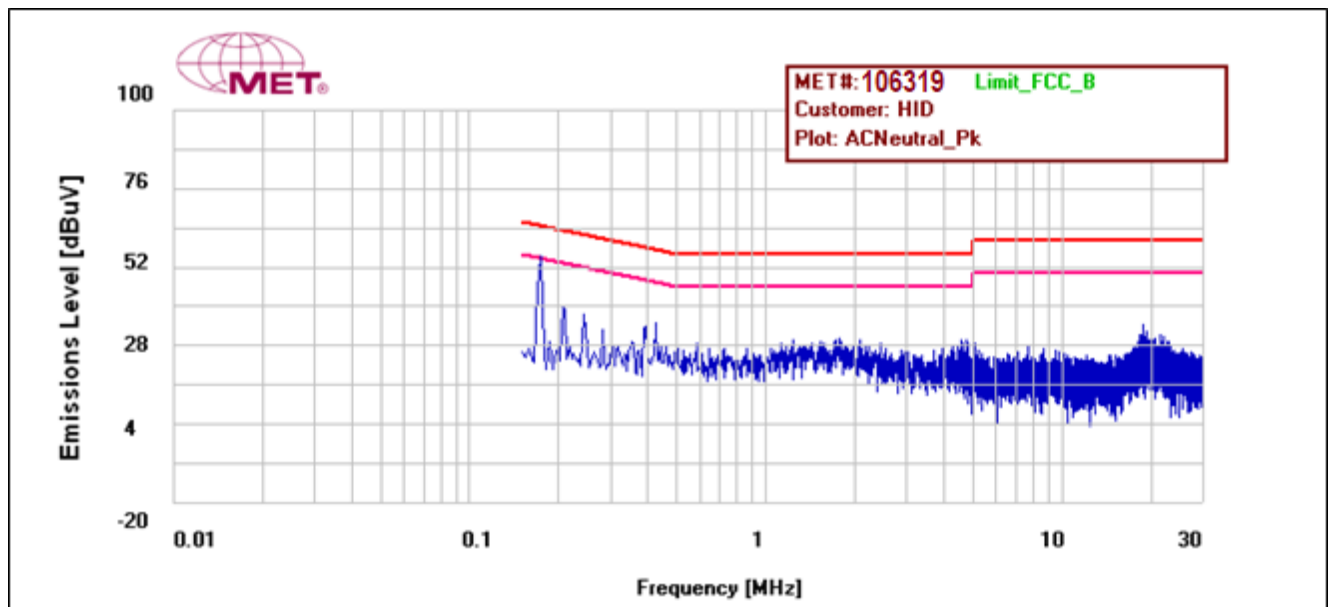


Figure 14. Conducted Emissions, Neutral Line

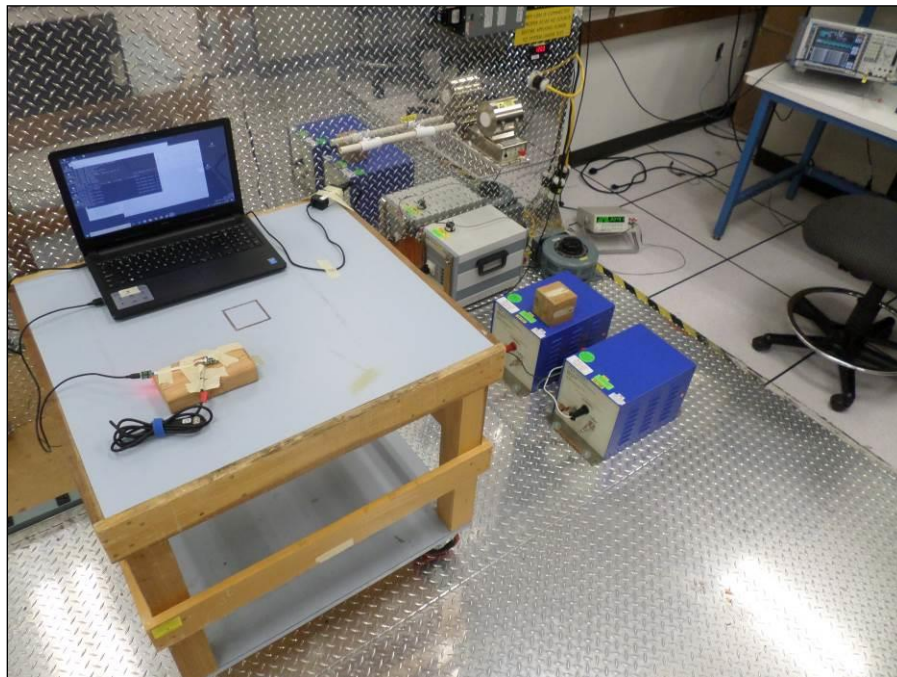


Figure 15. Conducted Emissions, Station Setup

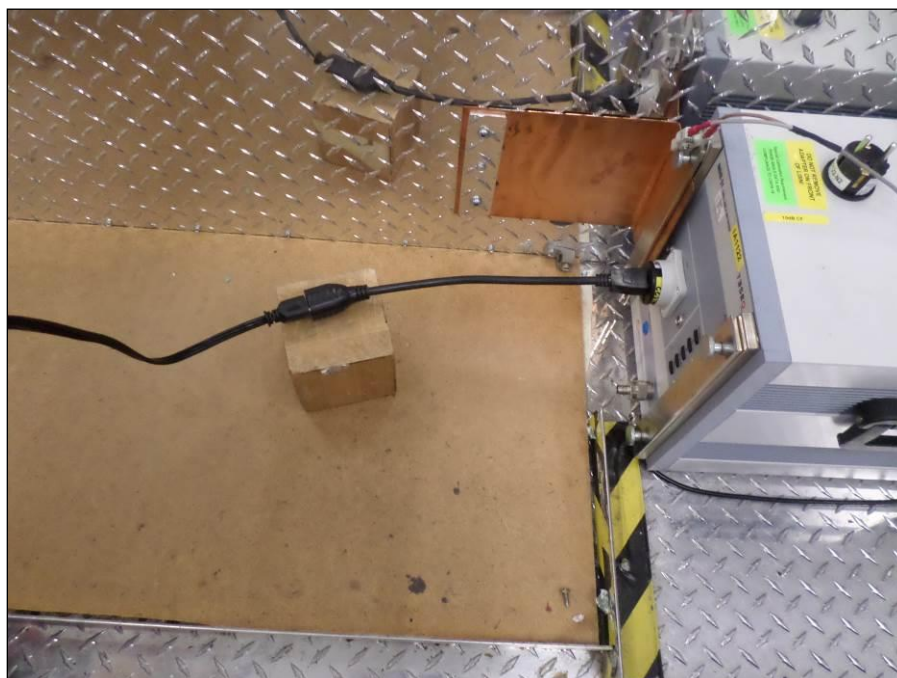


Figure 16. Conducted Emissions, Rear LISN Connection, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 3.2.1.1 Operation within the band 13.553 – 13.567 MHz

Test Requirement(s): § 3.2.1.1: 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.: 2013 and LP0002 appendix 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 §3.2.1.1.

Test Engineer(s): Giuliano Messina

Test Date(s): June 25, 2018

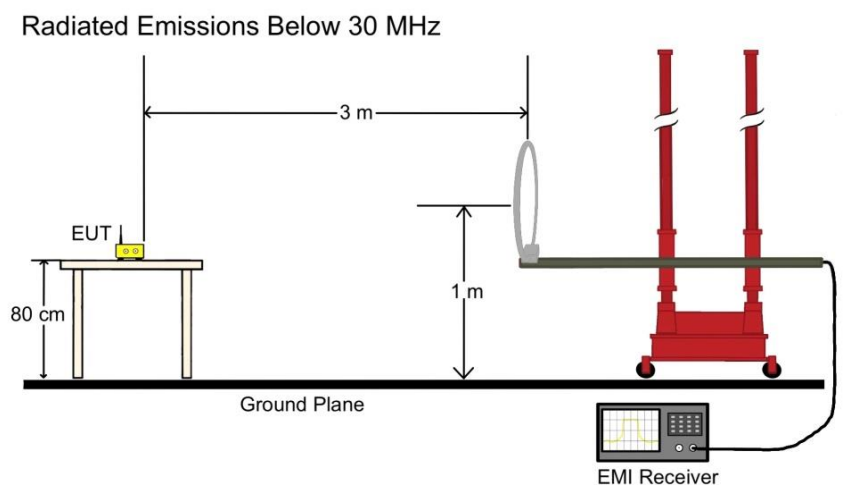


Figure 16: Radiated Emissions, Test Setup

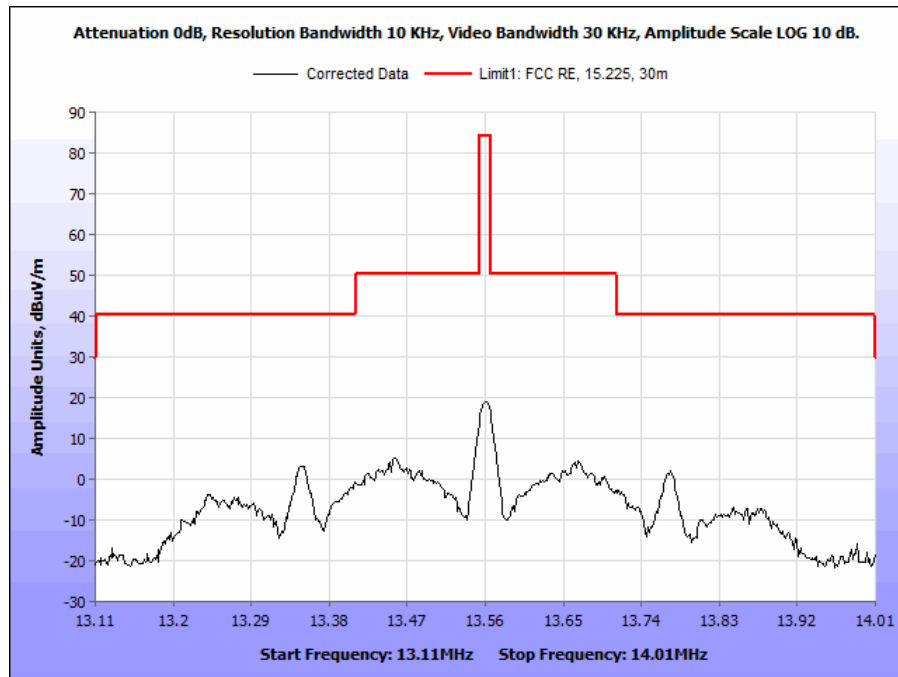


Figure 17. Operation Within the Band 13.553 – 13.567 MHz, 0 degrees

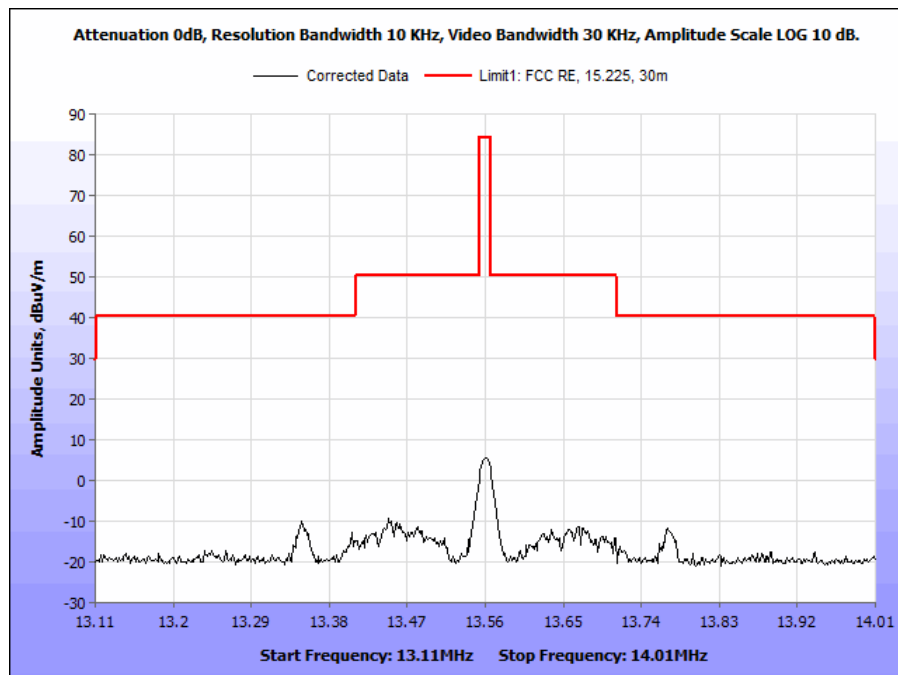


Figure 18. Operation Within the Band 13.553 – 13.567 MHz, 90 degrees



Figure 19. Field Strength Within the Band 13.553 MHz – 13.567 MHz, 9 kHz – 30 MHz, Antenna

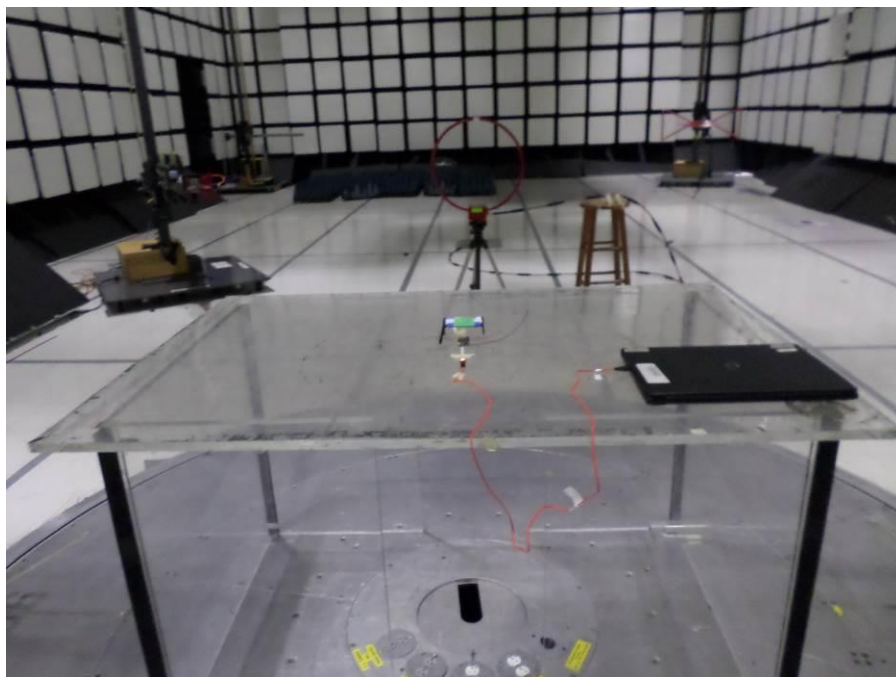


Figure 20. Field Strength Within the Band 13.553 – 13.567 MHz, 9 kHz – 30 MHz Rear

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 3.2.1.2 Unwanted Emissions Outside 13.553 – 13.567 MHz

Test Requirement(s): § 3.2.1.2: The field strength of unwanted emissions shall not exceed the general radiated emissions limits in LP0002 § 2.8

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
0.009 – 0.490 (included)	2,400/Freq. (kHz)	300
0.490 (excluded) – 1.705 (included)	24,000/Freq. (kHz)	30
1.705 (excluded) – 30 (excluded)	30	30
30 (included) – 88 (included)	100	3
88 (excluded) – 216 (included)	150	3
216 (excluded) – 960 (included)	200	3
Above 960 (excluded)	500	3

Figure 21. General Radiated Emissions Limits of §2.8

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 and LP0002 Appendix were used. For measurements below 30 MHz a loop antenna placed 3m away from the unit was used. For measurements above 30 MHz a biconilog 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 300 Hz for measurements below 150 kHz, 10 kHz for measurements between 150 kHz and 30 MHz, and 100 kHz for measurements above 30 MHz. A peak detector was used below 30 MHz and a quasi-peak detector was used for measurements for above 30 MHz.

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

$$40\log(3/30) = -40 \text{ dB and } 40\log(3/300) = -80 \text{ dB}$$

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

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

Test Results: The EUT was compliant with the requirements of § 3.2.1.2

Test Engineer(s): Giuliano Messina

Test Date(s): June 25, 2018

Spurious Emissions Test Setup

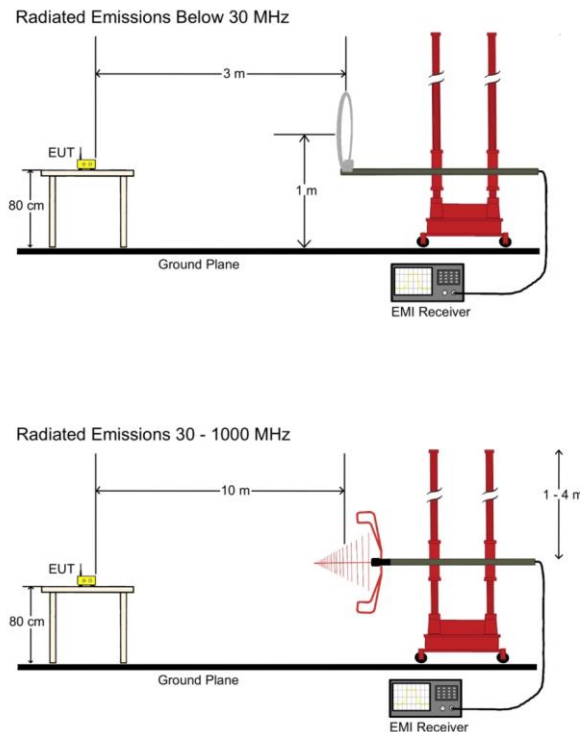


Figure 22: Radiated Spurious Emissions Test Setup

Sample Calculation for Distance Correction factor (DCF) measurement:

$$F_d = 20 \cdot \log_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

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

Frequency (MHz)	Antenna Polarity	EUT Azimuth (Degrees)	Antenna Height (cm)	Uncorrected Amplitude (dBμV/m)	ACF (dB/m) (+)	Pre Amp Gain + CBL (dB)(-)	DCF (dB) (+)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
249.99	V	359.9	240.7	55.46	11.4	28.335	10.46	48.985	47	-8.475

$$\text{Corrected Amplitude (dB}\mu\text{V/m)} = \text{Uncorrected Amplitude (dB}\mu\text{V/m)} + \text{ACF (dB/m)} - (\text{Preamp Gain (dB)} + \text{CBL (dB)} + \text{DCF (dB)})^{**}$$

$$= 55.46 + 11.4 - 28.335 + 10.46 = \mathbf{48.985}$$

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

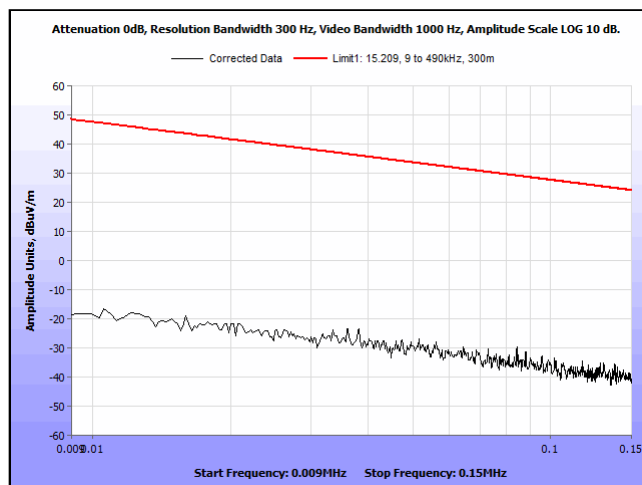


Figure 23. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 0 degrees

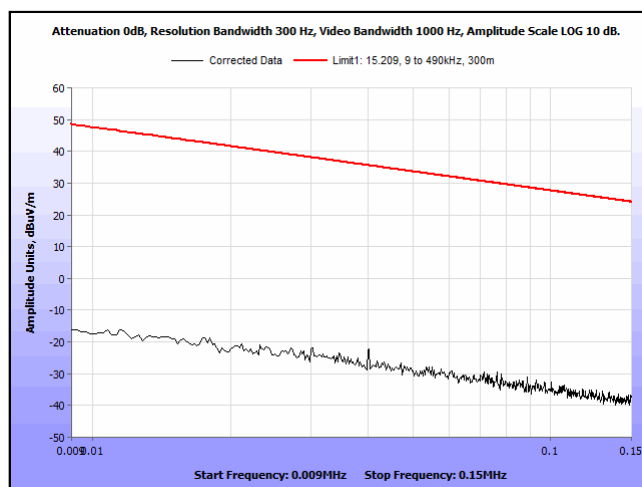


Figure 24. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.009 – 0.150 MHz, 90 degrees

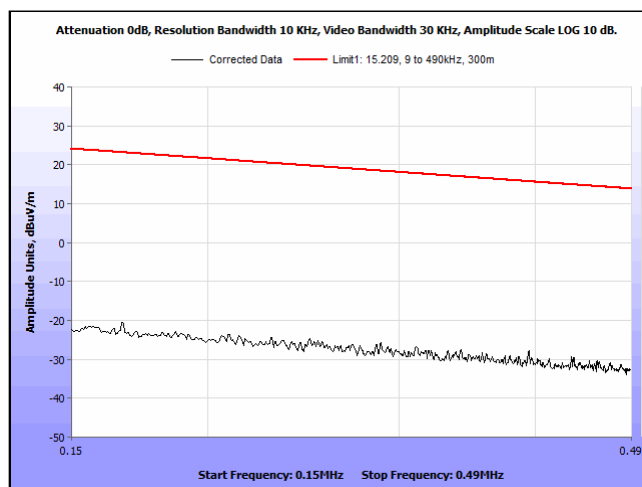


Figure 25. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 0 degrees

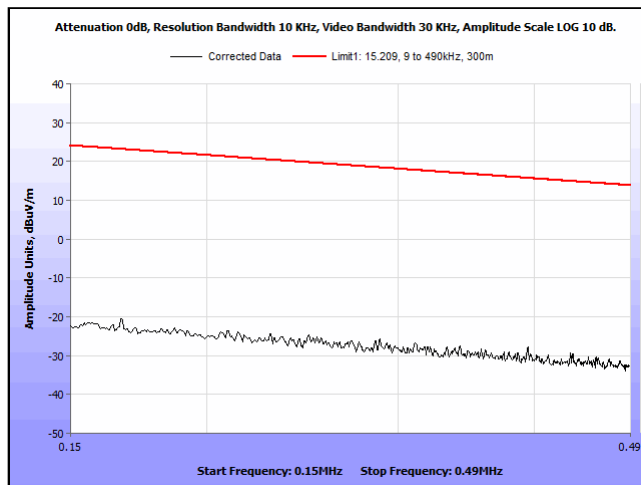


Figure 26. Spurious Emissions, Outside the Bands 13.110 - 14.010 MHz, 0.150 MHz – 0.490 MHz, 90 degrees

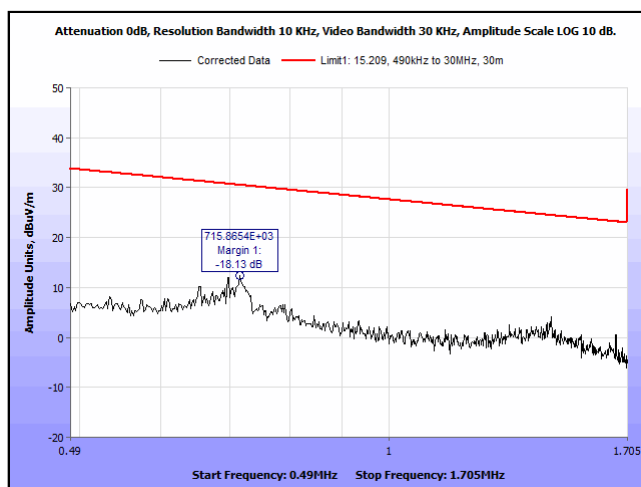


Figure 27. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 0 degrees

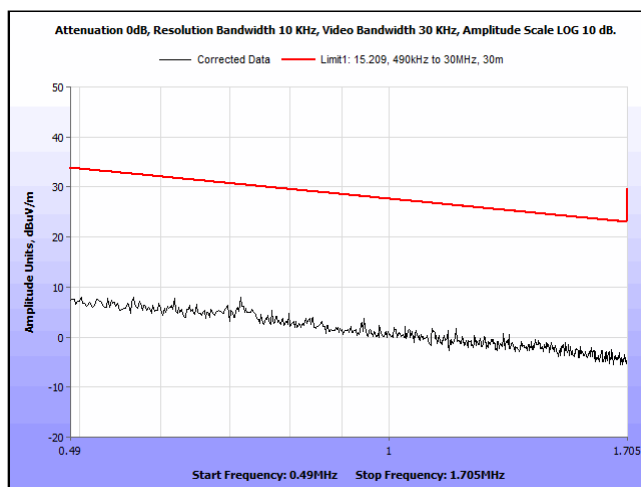


Figure 28. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 0.490 MHz – 1.705 MHz, 90 degrees

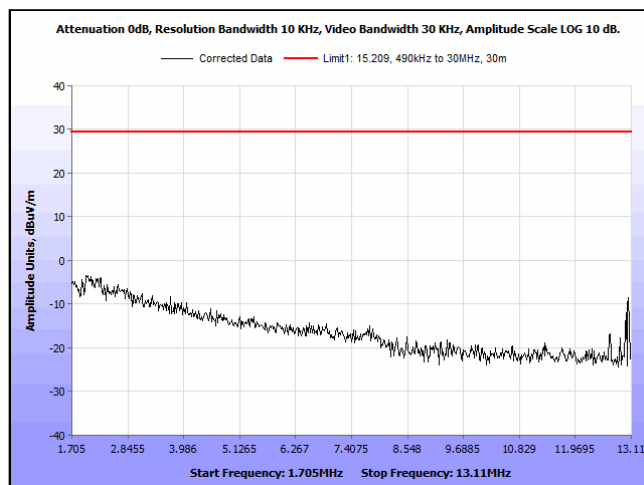


Figure 29. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 0 degrees

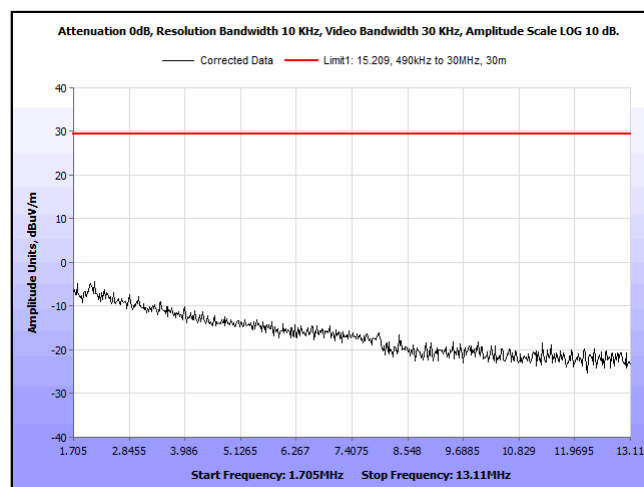


Figure 30. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 1.705 MHz – 13.11 MHz, 90 degrees

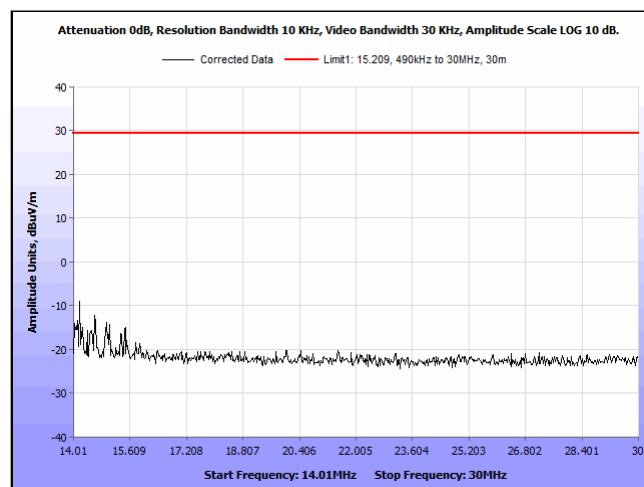


Figure 31. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 14.010 MHz – 30 MHz, 0 degrees

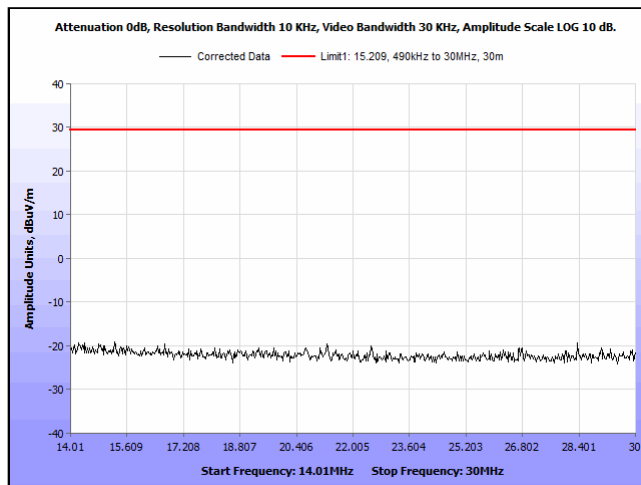


Figure 32. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 14.010 MHz - 30 MHz, 90 degrees

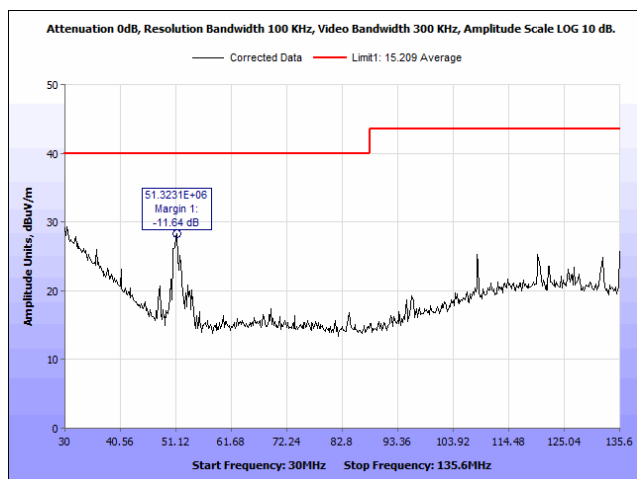


Figure 33. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz - 135.6 MHz, Horizontal

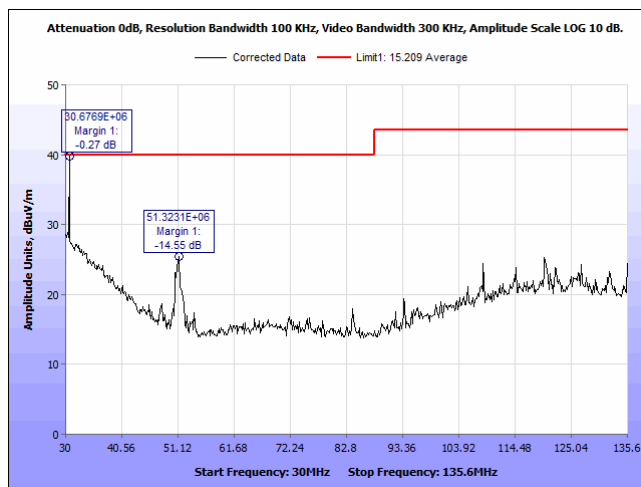


Figure 34. Spurious Emissions, Outside the Bands, 13.110 - 14.010 MHz, 30 MHz - 135.6 MHz, Vertical

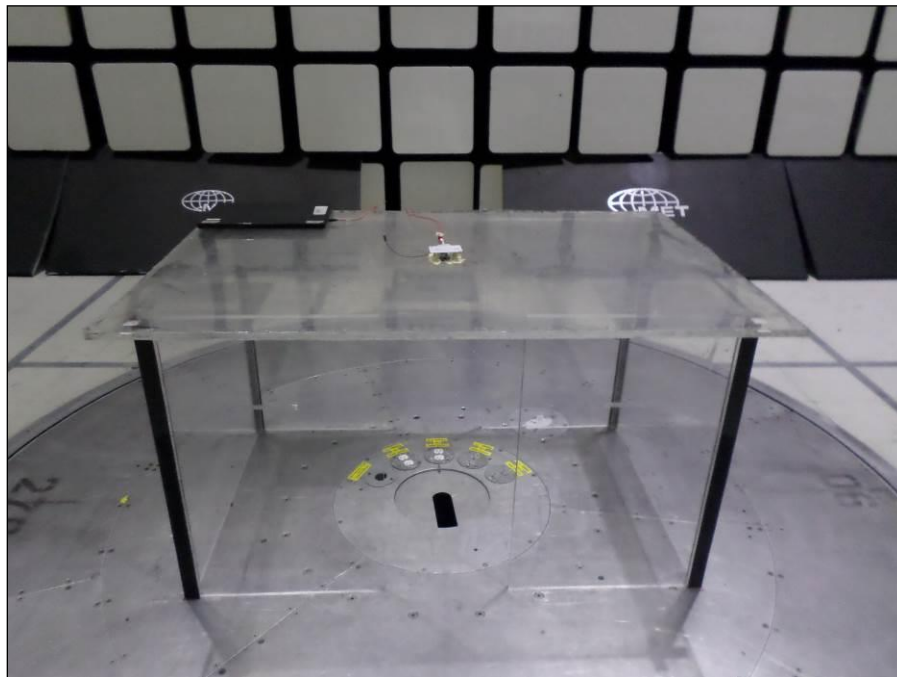


Figure 35. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Front

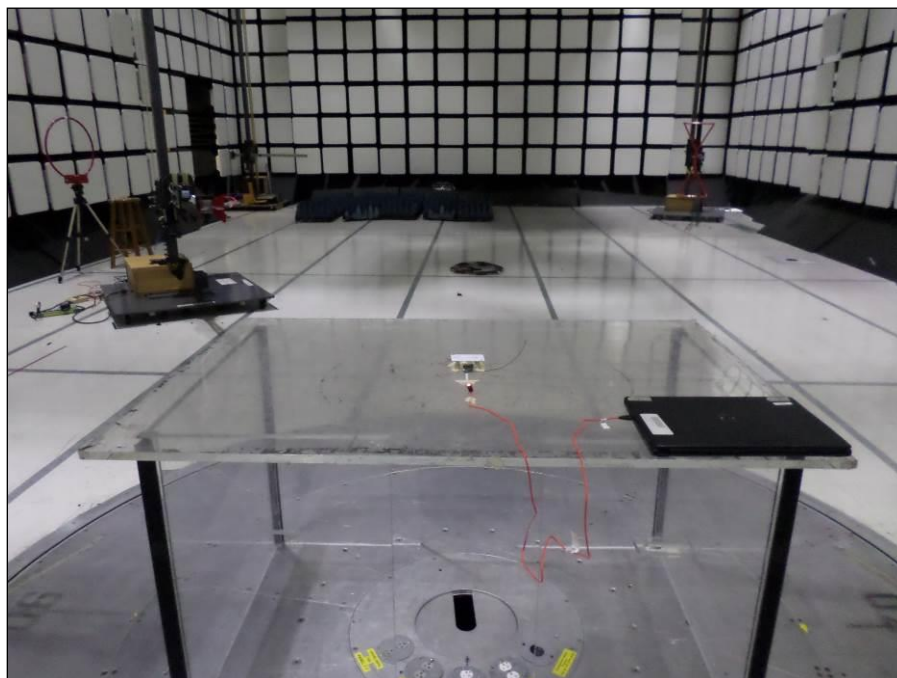


Figure 36. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Rear



Figure 37. Spurious Emissions Outside the Bands, 13.110 - 14.010 MHz, 30 MHz – 135.6 MHz, Antenna



Figure 38. Spurious Emissions Outside the Bands, 13.553 – 13.567 MHz, 9 kHz – 30 MHz, Antenna

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 3.2.1.3 Frequency Tolerance

Test Requirement(s): § 3.2.1.3: 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 3.2.1.3. 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.

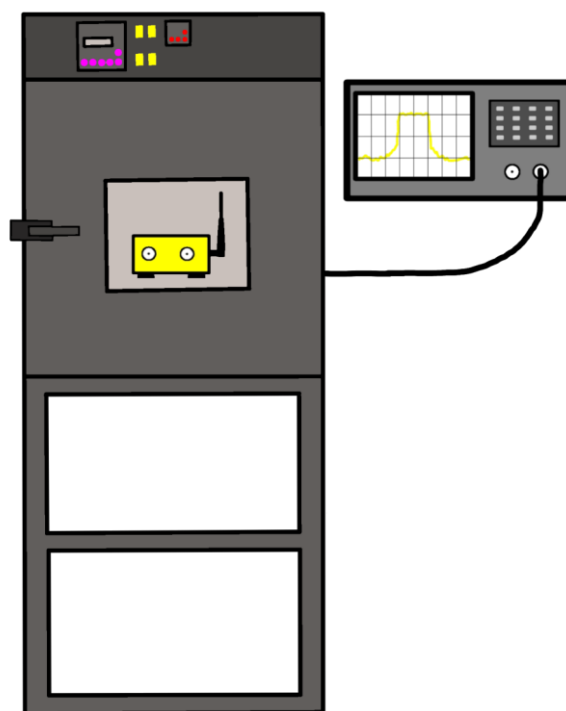


Figure 39: Temperature Stability Test Setup

Test Results: The EUT was found **Compliant** with §3.2.1.3 requirement(s) of this section.

Test Engineer(s): Giuliano Messina

Test Date(s): June 26, 2018

Voltage Variation (%)	Temperature (°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

Figure 40. Frequency Stability, Test Results

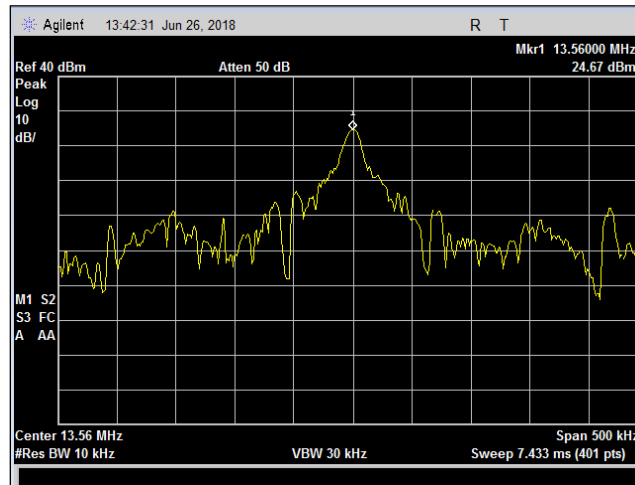


Figure 41. Frequency Stability, Vnom, 20 deg

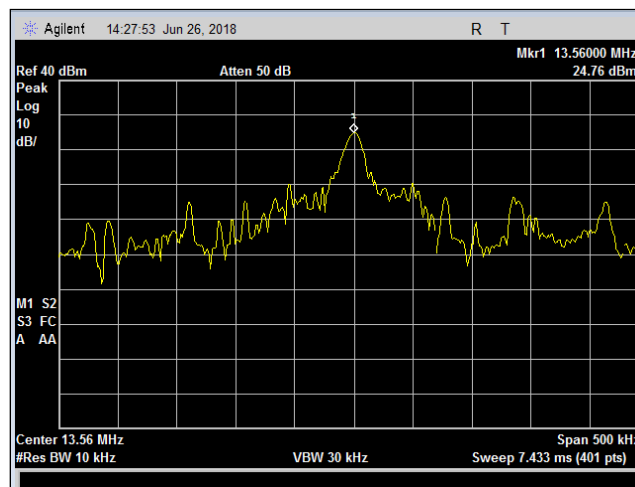


Figure 42. Frequency Stability, Vnom, -20 deg

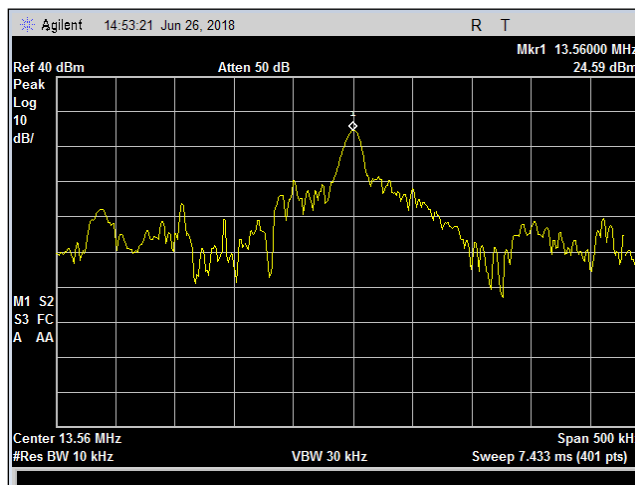


Figure 43. Frequency Stability, Vnom, 50 deg

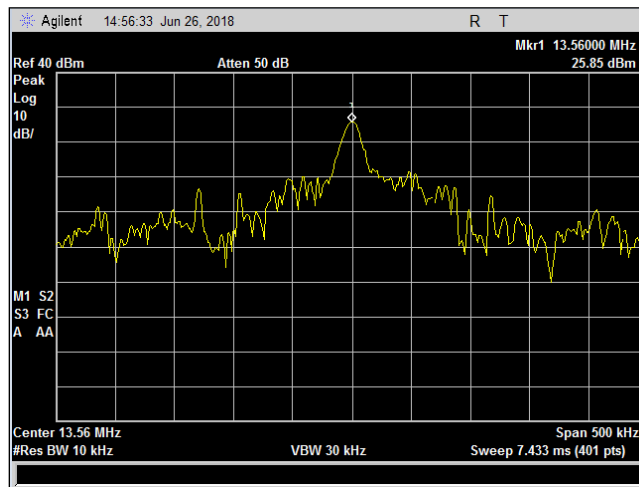


Figure 44. Frequency Stability, +15 pct, 20 deg

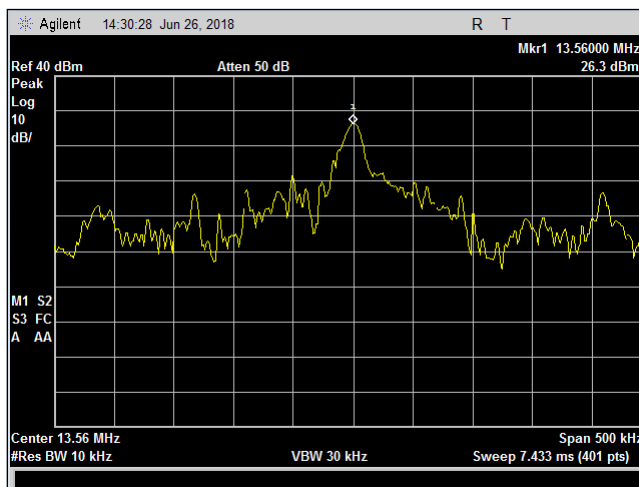


Figure 45. Frequency Stability, +15 pct, -20 deg

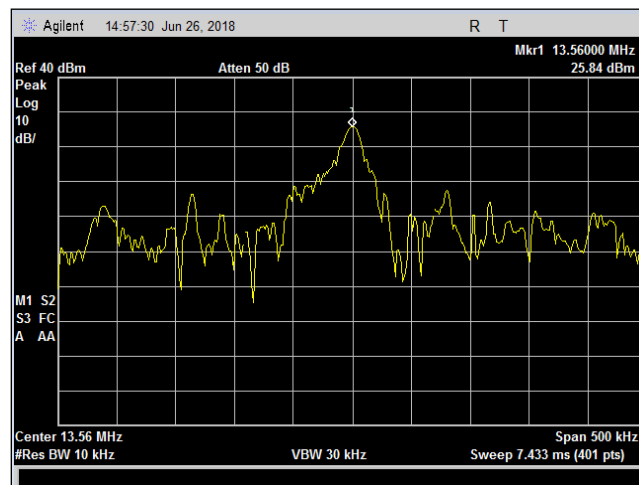


Figure 46. Frequency Stability, +15 pct, 50 deg

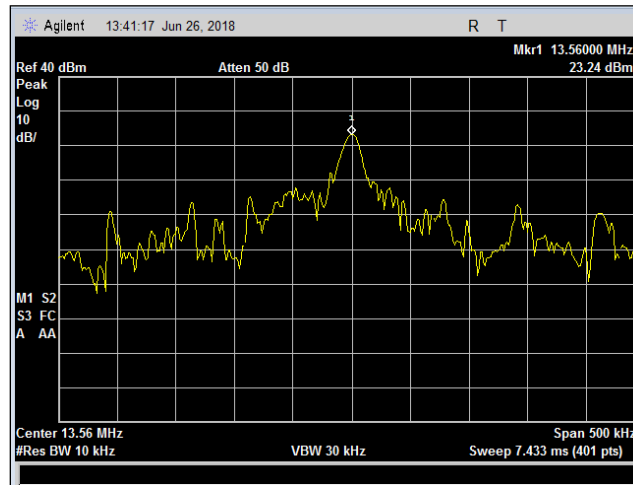


Figure 47. Frequency Stability, -15 pct, 20 deg

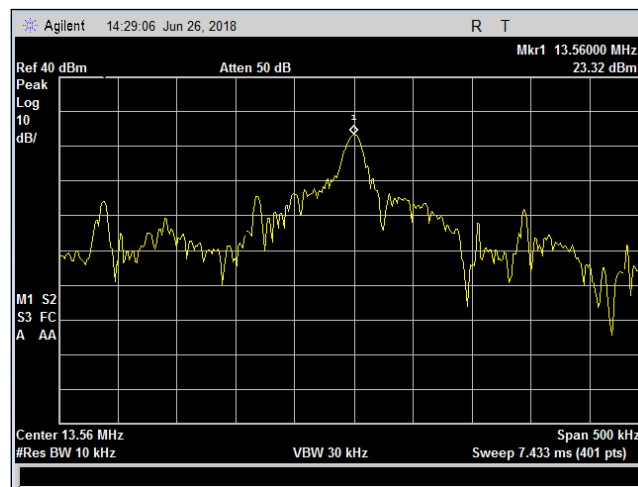


Figure 48. Frequency Stability, -15 pct, -20 deg

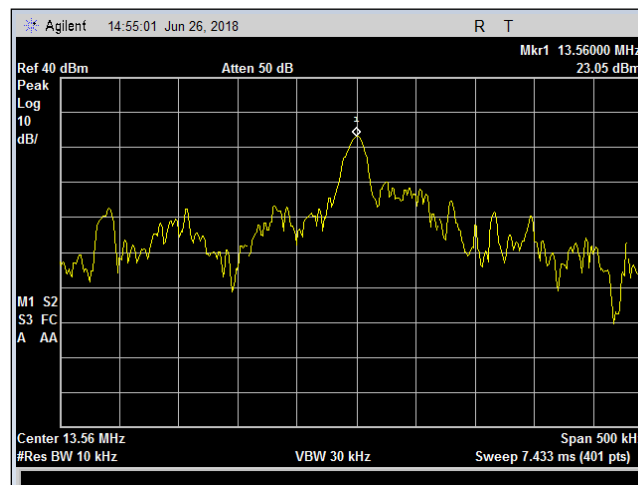


Figure 49. Frequency Stability, -15 pct, 50 deg

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 5.20 Radiofrequency radiation exposure

RF Exposure Requirements: **FCC §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: **FCC §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.

FCC §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:
(Power allowed at numeric threshold for 50 mm in step 4.3.1 (a)) +

$$(\text{test separation distance} - 50 \text{ mm}) * \left(\frac{f [\text{MHz}]}{150}\right)$$

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

- 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 =

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

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	

Figure 50. Test Equipment List

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

End of Report