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

3/25/2024

HID Global Corporation (US)
6533 Flying Cloud Drive, Ste. 1000
Eden Prairie, MN 55344
USA

Dear Richard Georgerian,

Enclosed is the EMC test report for compliance testing of HID Global Corporation (US), OMNIKEY SE Reader Core, tested to the requirements of:

- Title 47 of the CFR, Part 15.225, Subpart C for Certification as an Intentional Radiator.
- RSS-210: Issue 10, License-Exempt Radio Apparatus: Category 1 Equipment

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,

Nancy LaBrecque
Documentation Department
Eurofins Electrical and Electronic Testing NA, Inc.

Reference: WIRA125908 – FCC-IC-RFID-HF_R1

# 13.56MHz RFID
# Test Report

for the

## HID Global Corporation (US)
## OMNIKEY SE Reader Core (Model: RCL5510)

**Tested under**
the FCC Certification Rules
contained in
15.225 Subpart C and
RSS-210: Issue 10
for Intentional Radiators

Bryan Taylor, Wireless Team Lead
Electromagnetic Compatibility Lab

Nancy LaBrecque
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.

Matthew Hinojosa
EMC Manager, Austin Electromagnetic Compatibility Lab

# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | 2/26/2024 | Initial Issue. |
| 1 | 3/25/2024 | Addressed comments from HID and from TCB reviewer |

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# Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the HID Global Corporation (US) OMNIKEY SE Reader Core, with the requirements of Part 15, §15.225 and RSS-210 Issue10, Annex B, B.6. All references are to the most current version of Title 47 of the Code of Federal Regulations and RSS-210 in effect. The following data is presented in support of the Certification of the OMNIKEY SE Reader Core. HID Global Corporation (US) should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the OMNIKEY SE 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 Part 15, §15.225 and RSS-210, in accordance with HID Global Corporation (US), under purchase order number 1110985118. All tests were conducted using measurement procedures ANSI C63.4-2014 and C63.10-2013.

| FCC Reference | ISED Reference | Description | Compliance |
|---|---|---|---|
| Part 15 §15.203 | --- | Antenna Requirement | **Compliant** |
| Part 15 §15.207(a) | RSS-Gen (8.8) | Conducted Emission Limits | **Compliant** |
| Part 15 §15.215 | --- | 20dB Occupied Bandwidth | **Compliant** |
| --- | RSS-Gen (6.7) | 99% Occupied Bandwidth | **Compliant** |
| Part 15 §15.225(a) | RSS-210 (B.6.a.i) | Field Strength emissions within the band 13.553 – 13.567 MHz | **Compliant** |
| Part 15 §15.225(b) | RSS-210 (B.6.a.ii) | Field Strength emissions within the band 13.410 – 13.553 MHz and 13.567 – 13.710 MHz | **Compliant** |
| Part 15 §15.225(c) | RSS-210 (B.6.a.iii) | Field Strength emissions within the band 13.110 – 13.410 MHz and 13.710 – 14.010 MHz | **Compliant** |
| Part 15 §15.225(d) | RSS-210 (B.6.a.iv) | Outside-Band Field Strength emissions per 15.209 - 13.110 – 14.010 MHz | **Compliant** |
| Part 15 §15.225(e) | RSS-210 (B.6.b) | Frequency Tolerance of the Carrier | **Compliant** |

**Table 1. Executive Summary**

# Equipment Configuration

## A. Overview

Eurofins E&E North America was contracted by HID Global Corporation (US) to perform testing on the OMNIKEY SE Reader Core.

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 (US) OMNIKEY SE Reader Core.

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

| | | |
|---|---|---|
| **Product Name:** | OMNIKEY SE Reader Core | |
| **Model(s) Tested:** | RCL5510 | |
| **Model(s) Included by Similarity** | RCS5510 | |
| **FCC Identifiers** | JQ6-RCL5510 (for model RCL5510), JQ6-RCS5510 (for model RCS5510) | |
| **ISED Identifiers** | 2236B-RCL5510 (for model RCL5510), JQ6-RCS5510 (for model RCS5510) | |
| **EUT Specifications:** | Primary Power: 3.6 – 6VDC | |
| | Type of Modulation(s): | ASK |
| | Equipment Code: | DXX |
| | Maximum field Strength: | 78.24dBuV/m |
| | Antenna Type: | loop |
| | EUT Frequency Ranges: | 13.56MHz |
| **Analysis:** | The results obtained relate only to the item(s) tested. | |
| **Environmental Test Conditions:** | Temperature: 15-35º C | |
| | Relative Humidity: 30-60% | |
| | Barometric Pressure: 860-1060 mbar | |
| **Evaluated by:** | Bryan Taylor and Sergio Gutierrez | |
| **Test Date(s):** | 1/8/2024 to 1/16/2024 | |

**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 |
| **RSS-210 Issue 10** | Licence-Exempt Radio Apparatus: Category I Equipment |
| **ANSI C63.4:2014** | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **ISO/IEC 17025:2017** | General Requirements for the Competence of Testing and Calibration Laboratories |
| **ANSI C63.10-2013** | American National Standard for Testing Unlicensed Wireless Devices |

**Table 3. References**

## C. Test Site

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

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

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

Correlation between semi-anechoic chamber and OATS:

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

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

## D. Measurement Uncertainty

| Test Method | Typical Expanded Uncertainty | K | Confidence Level |
|---|---|---|---|
| RF Frequencies | ±4.52 Hz | 2 | 95% |
| RF Power Conducted Emissions | ±2.97 dB | 2 | 95% |
| RF Power Radiated Emissions | ±2.95 dB | 2 | 95% |
| Radiated Emissions, (30 MHz – 1 GHz) | ±2.95 | 2 | 95% |
| Radiated Emissions, (1 GHz – 18 GHz) | ±3.54 | 2 | 95% |
| Conducted Emission Voltage | ±2.97 | 2 | 95% |

**Table 4. Uncertainty Calculations Summary**

## E. Description of Test Sample

OMNIKEY SE Reader Core/OMNIKEY SE Reader Core Standard (RCL55100000, SRD Model: RCL5510) OMNIKEY SE Reader Core/OMNIKEY SE Reader Core MINI (RCS55100000, SRD Model: RCS5510) The OMNIKEY SE Reader Core's triple frequency capability allows the use of the high, low, and BLE frequency credentials with the same reader, providing a solution for mixed credential and credential migration applications. It includes more memory, faster performance, expanded connectivity, and Bluetooth Smart (BLE), while still offering a secure and standards-based independent technology and flexible identity data structure.

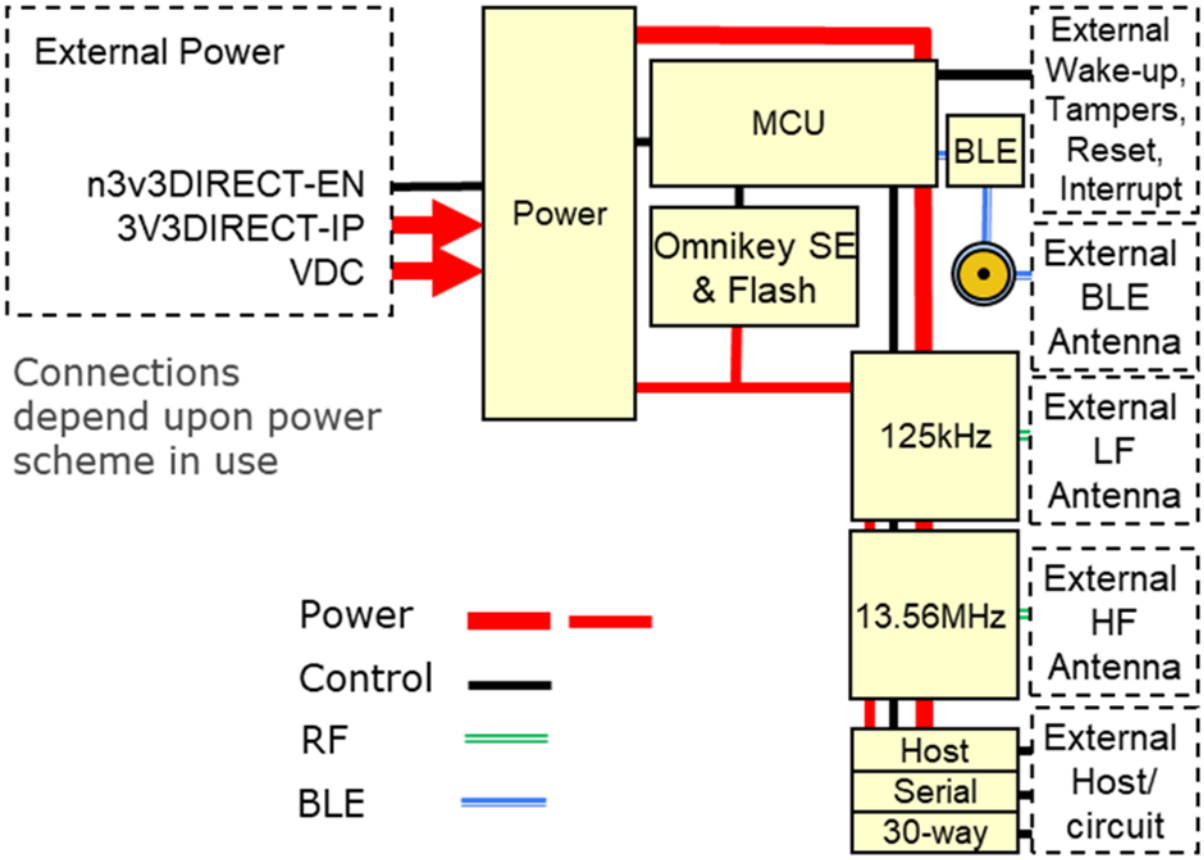



**Figure 1. Block Diagram of Test Configuration**

## F. Equipment Configuration

A 13.56MHz Credential was placed in front of the OMNIKEY SE Reader Core to force a continuous reading operation.

## 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 | Customer Supplied Calibration Data |
|---|---|---|---|---|
| | USB port, host | USB cable | Generic | Not applicable. |
| | USB to Fibre optic | Fibre optic cable | Generic | Not applicable. |
| | DELL Laptop | DELL | Latitude 7480 | Not applicable. |
| | USB-UART Convertor | Waveshare | FT232 USB UART Board (Micro) | Not applicable. |
| | UART-Fibre Optic convertor | AVAGO | AFBR-1629, AFBR-2529 | Not applicable. |
| | Motorola /Android phone | Motorola | YDMW1942401P | Not applicable. |
| | Battery pack, 4x1.2Vdc, NiMH | Generic | Not applicable. | Not applicable. |
| | LF credential/Prox | HID Global | Indala FlexISO | Not applicable. |
| | HF credential/14443A | HID Global | MIFARE Classic 4K SE | Not applicable. |
| | Small HF antenna | HID Global | 4090A10 | Not applicable. |
| | Large HF antenna | HID Global | 4090A11 | Not applicable. |
| | Combined LF/HF antenna | HID Global | 4090A16 | Not applicable. |

**Table 5. Support Equipment**

## H. Ports and Cabling Information

| Ref. Id | Port Name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length (m) | Shielded? (Y/N) | Termination Box ID & Port Name |
|---|---|---|---|---|---|---|---|
| | Rx-Tx | 3-wire twisted | | 0.2 | 0.2 | No | Not applicable. |

**Table 6. Ports and Cabling Information**

## I. Mode of Operation

The RF Credential was placed in front of the OMNIKEY SE Reader Core in order to force continuous reading operations.

| Transmit Band | Modulation | Channel Frequencies Tested | Exercising Method |
|---|---|---|---|
| 13.56MHz | ASK | 13.56MHz | 13.56MHz RFID Credential |

**Table 7. Test Channels Utilized**

## 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 (US) upon completion of testing.

## Antenna Requirements

### § 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 OMNIKEY SE Reader Core as evaluated, was compliant as the antenna was permanently attached.

**Test Engineer(s):** Bryan Taylor

**Test Date(s):** 1/10/2024

## Conducted Emissions

### § 15.207(a) Conducted Emissions Limits

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

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

**Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)**

Note: *Decreases with the logarithm of the frequency.

## RSS-GEN (8.8) AC Power-Line Conducted Emissions Limits

**Test Requirement(s):** **RSS-GEN (8.8):** Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in the below figure, as measured using a 50 µH / 50 Ω line impedance stabilization network (LISN). This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in the below figure shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

| Frequency (MHz) | Conducted Limit (dBµV) | |
|---|---|---|
| | Quasi-Peak | Average |
| * 0.15-0.5 | 66 to 56 | 56 to 46[1] |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

**Table 9. AC Power Line Conducted Emissions Limits**

Note: *Decreases with the logarithm of the frequency.

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

**Test Results:** The OMNIKEY SE Reader Core was compliant with this requirement. Both the LF and HF antennas were replaced with 50 ohm load resistors. The resistors were located at the antenna solder locations on the main printed circuit board.

**Test Engineer(s):** An Dang

**Test Date(s):** 1/9/2024

## Conducted Emissions Voltage Test Setup

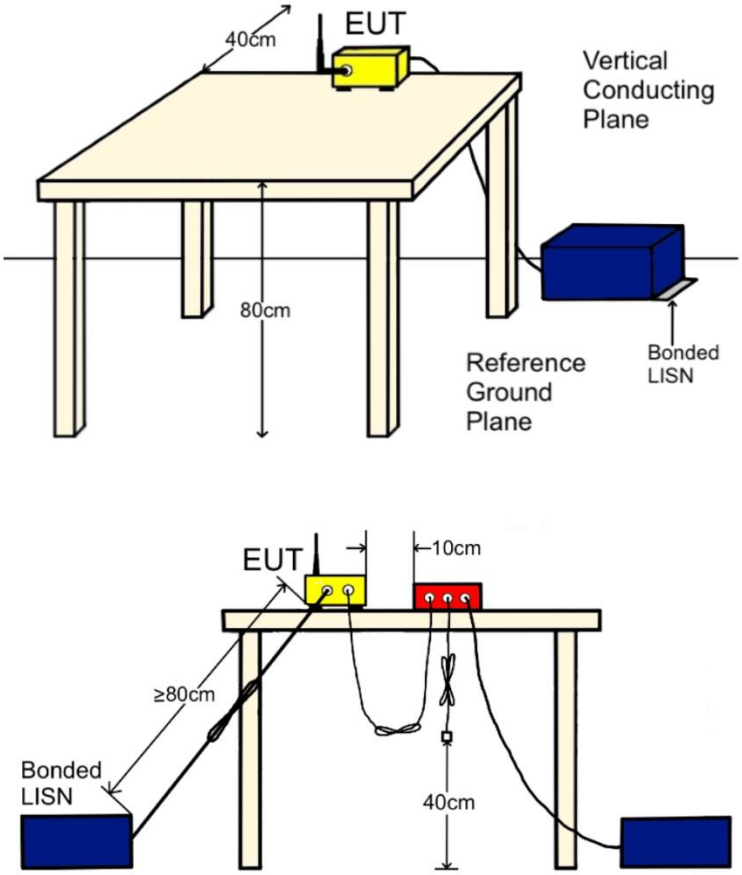
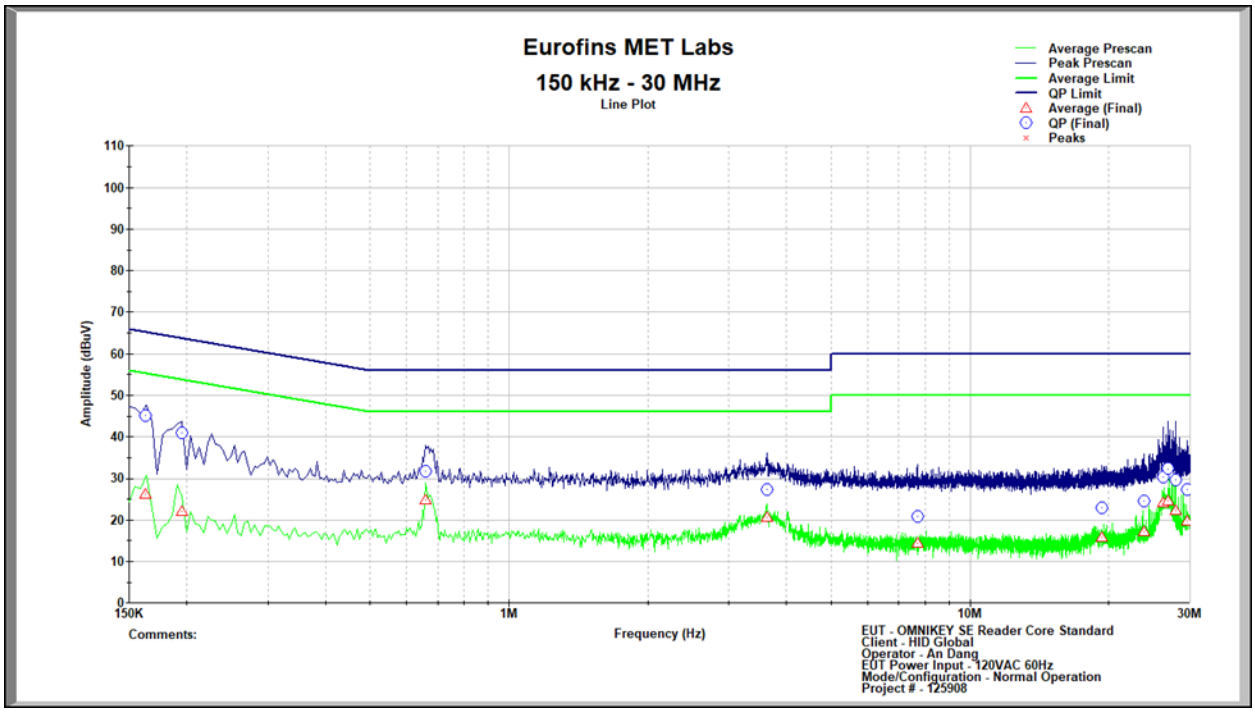



**Figure 2. CEV Test Setup**

## 15.207(a) Conducted Emissions Test Results

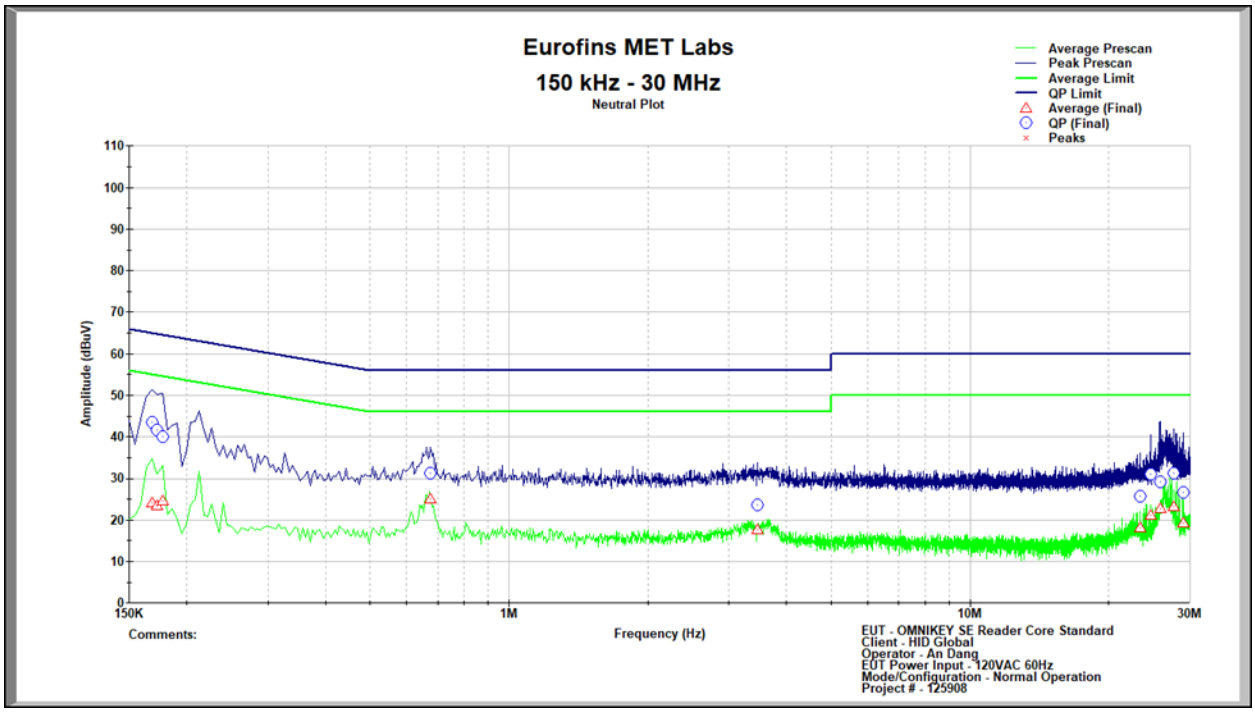



**Conducted Emissions, 15.207(a), Phase**

| Frequency (MHz) | Quasi-Peak (dBµV/m) | Quasi-Peak Limit (dBµV/m) | Quasi-Peak Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Average Margin (dB) |
|---|---|---|---|---|---|---|
| 0.163 | 45.158 | 65.629 | 20.471 | 26.151 | 55.629 | 29.478 |
| 0.195 | 40.944 | 64.714 | 23.770 | 21.949 | 54.714 | 32.765 |
| 0.658 | 31.720 | 56.000 | 24.280 | 24.796 | 46.000 | 21.204 |
| 3.621 | 27.253 | 56.000 | 28.747 | 20.667 | 46.000 | 25.333 |
| 7.686 | 20.888 | 60.000 | 39.112 | 14.462 | 50.000 | 35.538 |
| 19.297 | 22.913 | 60.000 | 37.087 | 15.845 | 50.000 | 34.155 |
| 23.826 | 24.610 | 60.000 | 35.390 | 17.184 | 50.000 | 32.816 |
| 26.271 | 30.304 | 60.000 | 29.696 | 24.116 | 50.000 | 25.884 |
| 26.838 | 32.296 | 60.000 | 27.704 | 24.637 | 50.000 | 25.363 |
| 27.897 | 29.623 | 60.000 | 30.377 | 22.290 | 50.000 | 27.710 |
| 29.611 | 27.365 | 60.000 | 32.635 | 19.645 | 50.000 | 30.355 |

**Table 10. Conducted Emissions, 15.207(a), Phase, Test Results**

## 15.207(a) Conducted Emissions Test Results




**Conducted Emissions, 15.207(a), Neutral**

| Frequency (MHz) | Quasi-Peak (dBµV/m) | Quasi-Peak Limit (dBµV/m) | Quasi-Peak Margin (dB) | Average (dBµV/m) | Average Limit (dBµV/m) | Average Margin (dB) |
|---|---|---|---|---|---|---|
| 0.168 | 43.415 | 65.486 | 22.070 | 24.109 | 55.486 | 31.376 |
| 0.172 | 41.643 | 65.357 | 23.714 | 23.334 | 55.357 | 32.024 |
| 0.177 | 40.104 | 65.229 | 25.124 | 24.524 | 55.229 | 30.705 |
| 0.676 | 31.213 | 56.000 | 24.787 | 24.986 | 46.000 | 21.014 |
| 3.463 | 23.685 | 56.000 | 32.315 | 17.534 | 46.000 | 28.466 |
| 23.363 | 25.678 | 60.000 | 34.322 | 17.970 | 50.000 | 32.030 |
| 24.674 | 31.047 | 60.000 | 28.953 | 21.155 | 50.000 | 28.845 |
| 25.852 | 29.224 | 60.000 | 30.776 | 22.716 | 50.000 | 27.284 |
| 27.645 | 31.164 | 60.000 | 28.836 | 23.195 | 50.000 | 26.805 |
| 29.076 | 26.585 | 60.000 | 33.415 | 19.213 | 50.000 | 30.787 |

**Table 11. Conducted Emissions, 15.207(a), Neutral, Test Results**

## Occupied Bandwidth Measurements

### § 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. Per ANSI C63.10: 2020 the RBW should be between 1% and 5% of the occupied bandwidth. Due to the nature of the fundamental transmission being very "CW like" it was not possible to meet the RBW requirement. During the measurement the RBW was therefore set as narrow as possible. The 20 dB Bandwidth was measured and recorded.

**Test Results:** The OMNIKEY SE Reader Core was compliant with this requirement. The 20dB Bandwidth is shown on the plots on the following pages.

**Test Engineer(s):** Bryan Taylor

**Test Date(s):** 1/8/2024

## RSS-GEN (6.7) 99% Occupied Bandwidth

**Test Requirements:** The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

**Test Procedure:** The EUT was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer. Per ANSI C63.10: 2020 the RBW should be between 1% and 5% of the occupied bandwidth. Due to the nature of the fundamental transmission being very "CW like" it was not possible to meet the RBW requirement. During the measurement the RBW was therefore set as narrow as possible. The 99% Bandwidth was measured and recorded.

**Test Results** The OMNIKEY SE Reader Core was compliant with this requirement. The 99% Bandwidth is shown on the plots on the following pages.

**Test Engineer(s):** Bryan Taylor

**Test Date(s):** 1/8/2024

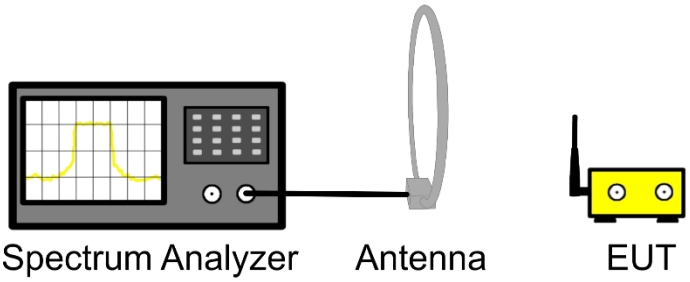
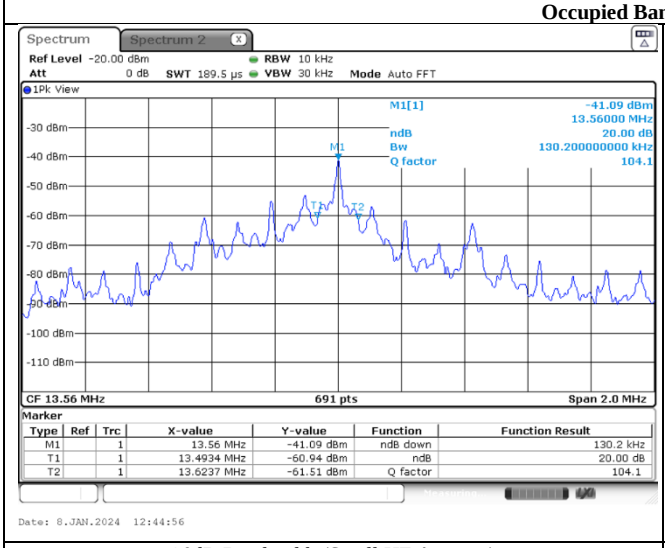



**Figure 3. 20 dB Bandwidth and 99% Bandwidth Test Setup**

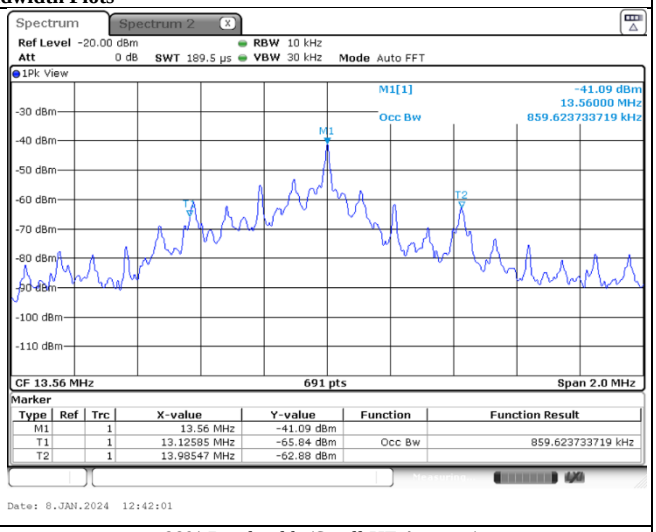
| Antenna Tested | Center Frequency (MHz) | 20 dB Bandwidth | 99% Bandwidth |
|---|---|---|---|
| Small HF Antenna | 13.56MHz | 130.2kHz | 859.6kHz |
| Large HF Antenna | 13.56MHz | 136.0kHz | 712.0kHz |
| Combined HF Antenna | 13.56MHz | 143.3kHz | 694.4kHz |

**Table 12. Occupied Bandwidth Test Results**

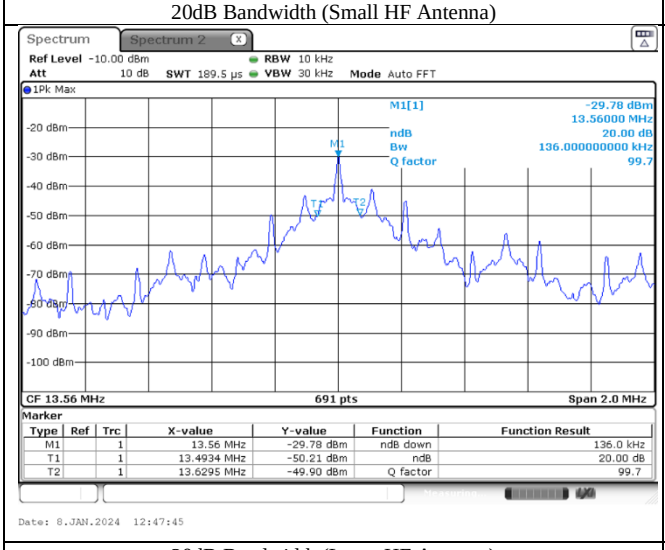
**Occupied Bandwidth Plots**



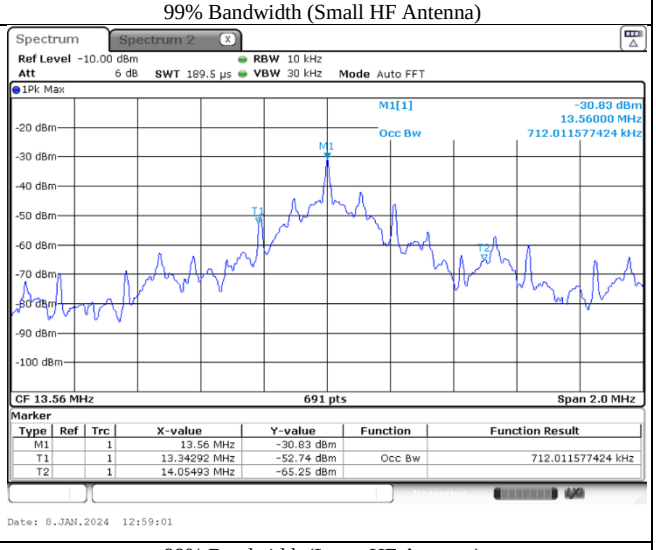

20dB Bandwidth (Small HF Antenna)



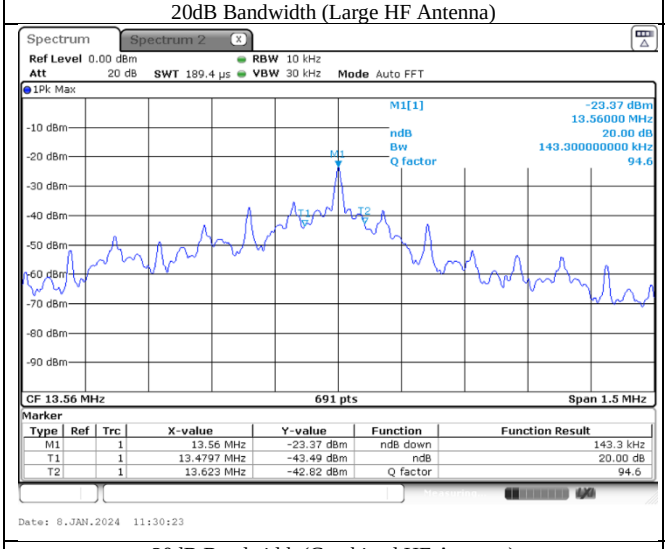

99% Bandwidth (Small HF Antenna)



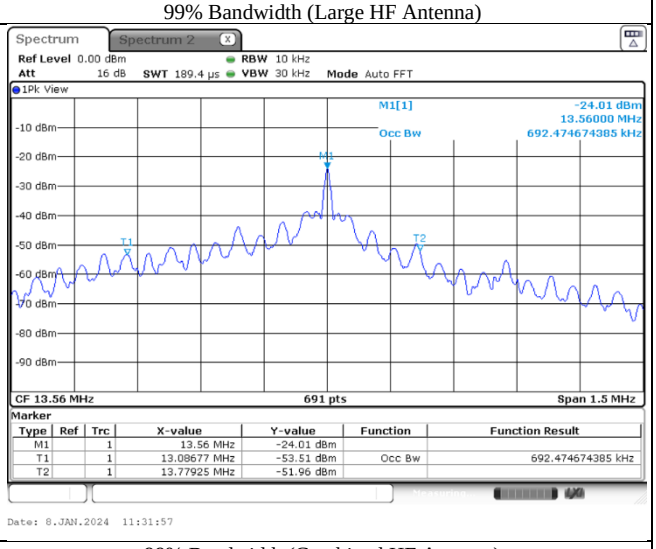

20dB Bandwidth (Large HF Antenna)




99% Bandwidth (Large HF Antenna)




20dB Bandwidth (Combined HF Antenna)




99% Bandwidth (Combined HF Antenna)

## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.225(a-d) Field Strength of Radiated Emissions

**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.

**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.

**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.

**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.

## RSS-210 (B.6.a(ii - iv)) Field Strength of Radiated Emissions

**Test Requirement(s):**

**RSS-210 (B.6.a(i))** The field strength of any emissions within the band 13.553 – 13.567 MHz shall not exceed 15.848 mV/m (84 dBµV/m) at 30 meters.

**RSS-210 (B.6.a(ii))** Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m (50.5 dBµV/m) at 30 meters.

**RSS-210 (B.6.a(iii))** Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 µV/m (40.5 dBµV/m) at 30 meters.

**RSS-210 (B.6.a(iv))** 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 RSS-GEN Section 8.9.

**Test Procedure:**

The EUT was set to transmit and placed on a 0.8 m-high wooden stand inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.10: 2013 were used. For measurements below 30 MHz a loop antenna placed 3m away from the unit was used. For measurements above 30 MHz a biconalog antenna placed 10 m away from the unit was used. Measurements below 30 MHz were conducted with the loop antenna at coaxial (parallel) and planar (perpendicular) orientations. Measurements above 30 MHz were conducted with the biconalog antenna in the vertical and horizontal polarizations. A peak detector was used to perform a pre-scan from 9 kHz to 10 times the fundamental frequency. Spurious emissions within 20 dB of the applicable limit were measured using a quasi-peak detector and recorded in the subsequent section. Peak emissions that were observed over the appliable limit were determined to be digital emissions subject to the requirements of FCC Part 15 Subpart B and ICES-003 subsection 6.2 for Class A devices.

The measurements made at 3 m with the loop antenna (below 30MHz) were then extrapolated to 30m or 300 m using the following correction factors which were applied to the limit.

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

The measurements made at 10 m with the biconilog antenna (above 30MHz) were then extrapolated to the 3m using the following correction factor.

20log (10/3) = +10.46 dB

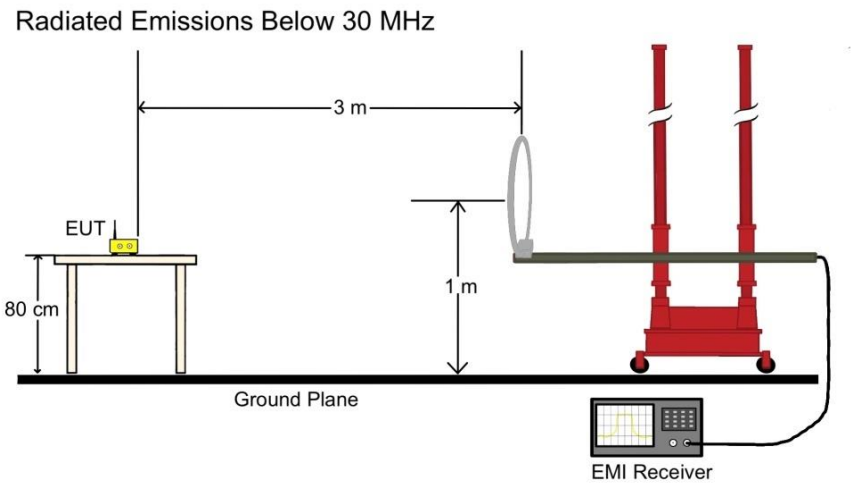



**Figure 4: Radiated Emissions (Below 30MHz), Test Setup**

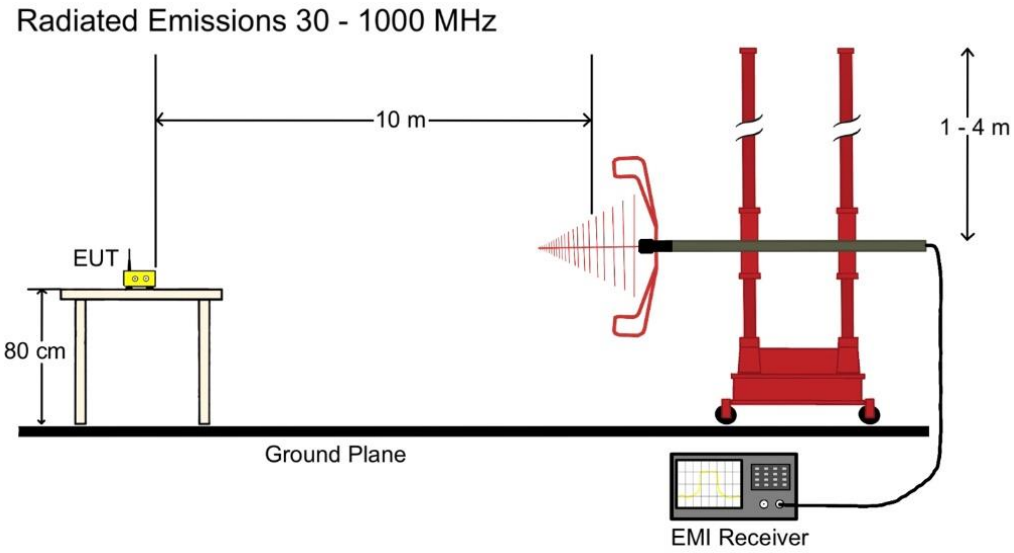



**Figure 5. Radiated Emissions (Above 30MHz), Test Setup**

**Test Results:** The OMNIKEY SE Reader Core was compliant with the requirements of **§15.225(a - d)** and **RSS-210 RSS-210 (B.6.a(i, ii, iii, and iv))**.

**Test Engineer(s):** Sergio Gutierrez and Michael Ermer

**Test Date(s):** 1/9/2024 – 1/11/2024

## Radiated Field Strength Test Results

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 13.137 | 44.22 | 80.50 | 36.28 | 10.79 | V | 168.7 | 1 | 9.000 | Pass |
| 13.137 | 44.38 | 80.50 | 36.12 | 10.79 | H | 166.2 | 1 | 9.000 | Pass |
| 13.533 | 53.44 | 90.50 | 37.06 | 10.77 | V | 169.4 | 1 | 9.000 | Pass |
| 13.533 | 53.24 | 90.50 | 37.26 | 10.77 | H | 164.4 | 1 | 9.000 | Pass |
| 13.560 | 69.18 | 124.00 | 54.82 | 10.77 | V | 169.3 | 1 | 9.000 | Pass |
| 13.560 | 69.32 | 124.00 | 54.68 | 10.77 | H | 179.2 | 1 | 9.000 | Pass |
| 13.587 | 52.03 | 90.50 | 38.47 | 10.77 | V | 6.4 | 1 | 9.000 | Pass |
| 13.587 | 52.31 | 90.50 | 38.19 | 10.77 | H | 187.9 | 1 | 9.000 | Pass |
| 13.983 | 41.12 | 80.50 | 39.38 | 10.75 | V | 174.3 | 1 | 9.000 | Pass |
| 13.983 | 41.24 | 80.50 | 39.26 | 10.75 | H | 176.7 | 1 | 9.000 | Pass |

**Figure 6. Worst Case In-Band Field Strength (Small HF Antenna)**

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 12.287 | 24.99 | 69.50 | 44.51 | 10.88 | H | 259.7 | 1 | 9.000 | Pass |
| 27.119 | 25.61 | 69.50 | 43.89 | 9.36 | H | 92 | 1 | 9.000 | Pass |
| 27.121 | 25.71 | 69.50 | 43.79 | 9.36 | V | 99.6 | 1 | 9.000 | Pass |

**Figure 7. Worst Case Field Strength Below 30MHz (Small HF Antenna)**

| Frequency [MHz] | QPK Level [dBµV/m] | QPK Limit [dBµV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 94.920 | 19.50 | 33.07 | 13.57 | -10.29 | H | 29.3 | 4 | 120.000 | Pass |
| 122.040 | 17.22 | 33.07 | 15.85 | -7.56 | V | 21.1 | 1.21 | 120.000 | Pass |
| 135.600 | 25.33 | 33.07 | 7.74 | -8.16 | V | 348.9 | 1 | 120.000 | Pass |
| 135.600 | 22.97 | 33.07 | 10.10 | -8.16 | H | 222.4 | 3.98 | 120.000 | Pass |
| 189.840 | 23.04 | 33.07 | 10.03 | -10.16 | H | 170.9 | 3.62 | 120.000 | Pass |
| 311.880 | 28.02 | 35.57 | 7.55 | -4.80 | H | 53.8 | 3.08 | 120.000 | Pass |

**Figure 8. Worst Case Field Strength Above 30MHz (Small HF Antenna)**

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 13.389 | 47.82 | 80.50 | 32.68 | 10.78 | V | 170.7 | 1 | 9.000 | Pass |
| 13.394 | 44.43 | 80.50 | 36.07 | 10.78 | H | 93.9 | 1 | 9.000 | Pass |
| 13.535 | 62.50 | 90.50 | 28.00 | 10.77 | V | 164.6 | 1 | 9.000 | Pass |
| 13.535 | 62.24 | 90.50 | 28.26 | 10.77 | H | 0.4 | 1 | 9.000 | Pass |
| 13.560 | 78.24 | 124.00 | 45.76 | 10.77 | V | 179.2 | 1 | 9.000 | Pass |
| 13.560 | 78.18 | 124.00 | 45.82 | 10.77 | H | 170.5 | 1 | 9.000 | Pass |
| 13.583 | 61.96 | 90.50 | 28.54 | 10.77 | V | 155.6 | 1 | 9.000 | Pass |
| 13.587 | 57.06 | 90.50 | 33.44 | 10.77 | H | 58.1 | 1 | 9.000 | Pass |
| 13.720 | 48.62 | 80.50 | 31.88 | 10.76 | V | 13.6 | 1 | 9.000 | Pass |
| 13.720 | 49.23 | 80.50 | 31.27 | 10.76 | H | 172 | 1 | 9.000 | Pass |

**Figure 9. Worst Case In-Band Field Strength (Large HF Antenna)**

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 27.121 | 34.69 | 69.50 | 34.81 | 9.36 | H | 87.2 | 1 | 9.000 | Pass |
| 27.121 | 33.25 | 69.50 | 36.25 | 9.36 | V | 173.5 | 1 | 9.000 | Pass |

**Figure 10. Worst Case Field Strength Below 30MHz (Large HF Antenna)**

| Frequency [MHz] | QPK Level [dBµV/m] | QPK Limit [dBµV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 94.920 | 19.80 | 33.07 | 13.27 | -10.29 | H | 37.3 | 3.56 | 120.000 | Pass |
| 122.040 | 23.05 | 33.07 | 10.02 | -7.56 | V | 18.9 | 1.34 | 120.000 | Pass |
| 189.840 | 22.40 | 33.07 | 10.67 | -10.16 | H | 0 | 3.84 | 120.000 | Pass |
| 292.770 | 22.77 | 35.57 | 12.80 | -5.96 | H | 39.4 | 2.56 | 120.000 | Pass |
| 682.440 | 22.16 | 35.57 | 13.41 | 2.00 | V | 44.1 | 3.94 | 120.000 | Pass |

**Figure 11. Worst Case Field Strength Above 30MHz (Large HF Antenna)**

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 13.137 | 44.30 | 80.50 | 36.20 | 10.79 | V | 164.9 | 1 | 9.000 | Pass |
| 13.137 | 44.59 | 80.50 | 35.91 | 10.79 | H | 190.9 | 1 | 9.000 | Pass |
| 13.535 | 49.41 | 90.50 | 41.09 | 10.77 | V | 181.6 | 1 | 9.000 | Pass |
| 13.535 | 49.11 | 90.50 | 41.39 | 10.77 | H | 169.2 | 1 | 9.000 | Pass |
| 13.560 | 65.15 | 124.00 | 58.85 | 10.77 | V | 175.5 | 1 | 9.000 | Pass |
| 13.560 | 65.16 | 124.00 | 58.84 | 10.77 | H | 178.9 | 1 | 9.000 | Pass |
| 13.583 | 45.05 | 90.50 | 45.45 | 10.77 | H | 99.1 | 1 | 9.000 | Pass |
| 13.585 | 48.35 | 90.50 | 42.15 | 10.77 | V | 183 | 1 | 9.000 | Pass |
| 13.983 | 41.37 | 80.50 | 39.13 | 10.75 | V | 160.1 | 1 | 9.000 | Pass |
| 13.983 | 41.35 | 80.50 | 39.15 | 10.75 | H | 206.1 | 1 | 9.000 | Pass |

**Figure 12. Worst Case In-Band Field Strength (Combined HF Antenna)**

| Frequency [MHz] | Peak Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 12.289 | 26.50 | 69.50 | 43.00 | 10.88 | H | 261.1 | 1 | 9.000 | Pass |
| 13.135 | 44.77 | 69.50 | 24.73 | 10.79 | V | 179.9 | 1 | 9.000 | Pass |
| 27.119 | 20.58 | 69.50 | 48.92 | 9.36 | V | 0 | 1 | 9.000 | Pass |
| 27.121 | 22.45 | 69.50 | 47.05 | 9.36 | H | 90.9 | 1 | 9.000 | Pass |

**Figure 13. Worst Case Field Strength Below 30MHz (Combined HF Antenna)**

| Frequency [MHz] | QPK Level [dBµV/m] | QPK Limit [dBµV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|---|---|---|---|---|---|---|---|---|---|
| 94.920 | 18.40 | 33.07 | 14.67 | -10.29 | V | 156.7 | 1.21 | 120.000 | Pass |
| 108.480 | 21.69 | 33.07 | 11.38 | -8.02 | H | 199.8 | 3.85 | 120.000 | Pass |
| 122.040 | 29.17 | 33.07 | 3.90 | -7.56 | H | 213.7 | 3.84 | 120.000 | Pass |
| 135.570 | 16.74 | 33.07 | 16.33 | -8.16 | H | 20.6 | 3.9 | 120.000 | Pass |
| 149.160 | 19.87 | 33.07 | 13.20 | -9.03 | H | 16.3 | 3.95 | 120.000 | Pass |
| 610.200 | 30.36 | 35.57 | 5.21 | 1.56 | V | 198.5 | 2.84 | 120.000 | Pass |

**Figure 14. Worst Case Field Strength Above 30MHz (Combined HF Antenna)**

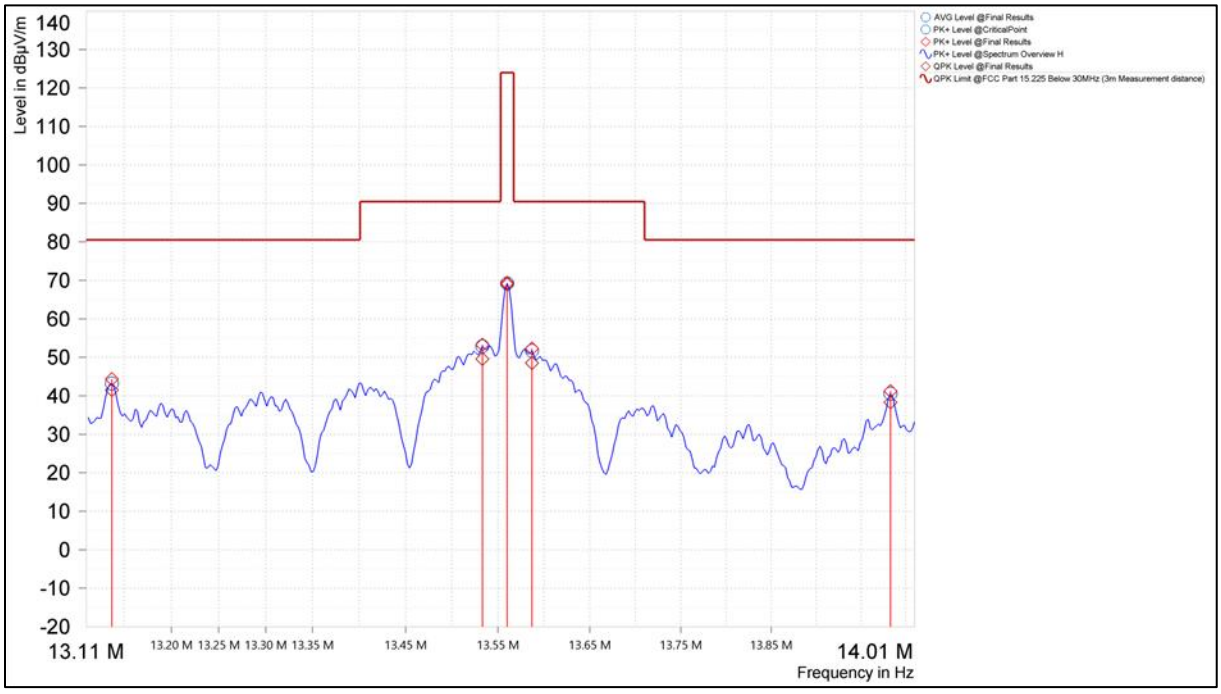



**Figure 15. In-Band Emission Mask (Coplanar Loop, Small HF Antenna)**

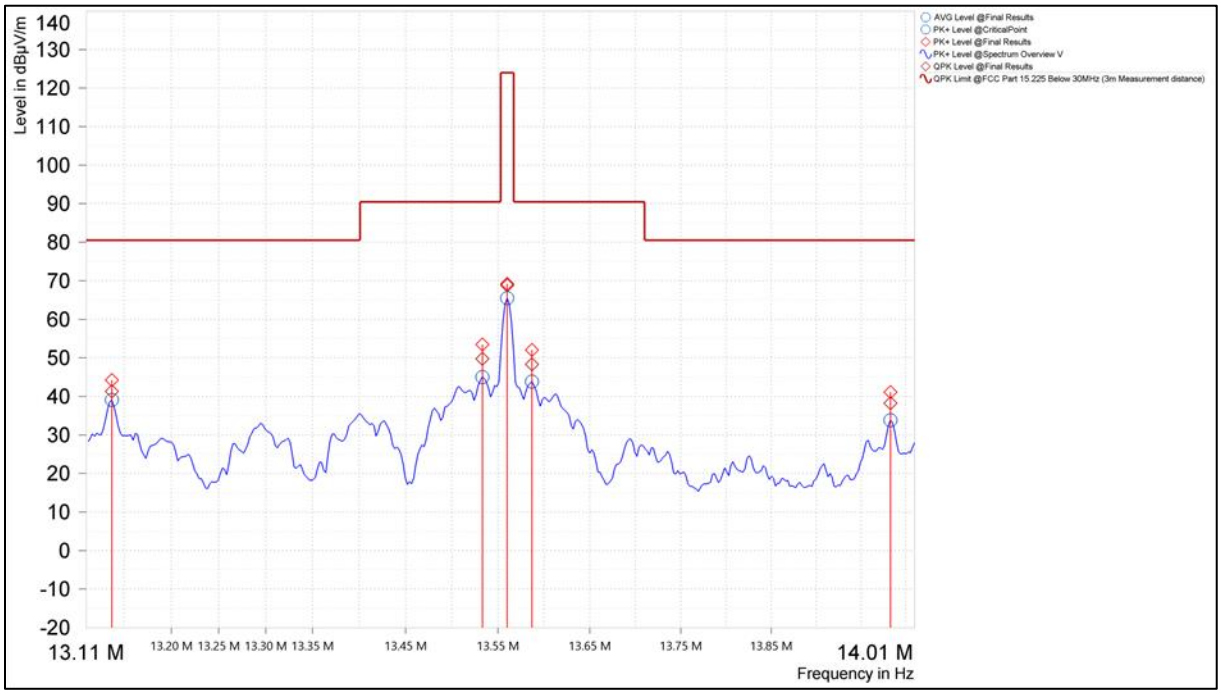



**Figure 16. In-Band Emission Mask (Coaxial Loop, Small HF Antenna)**

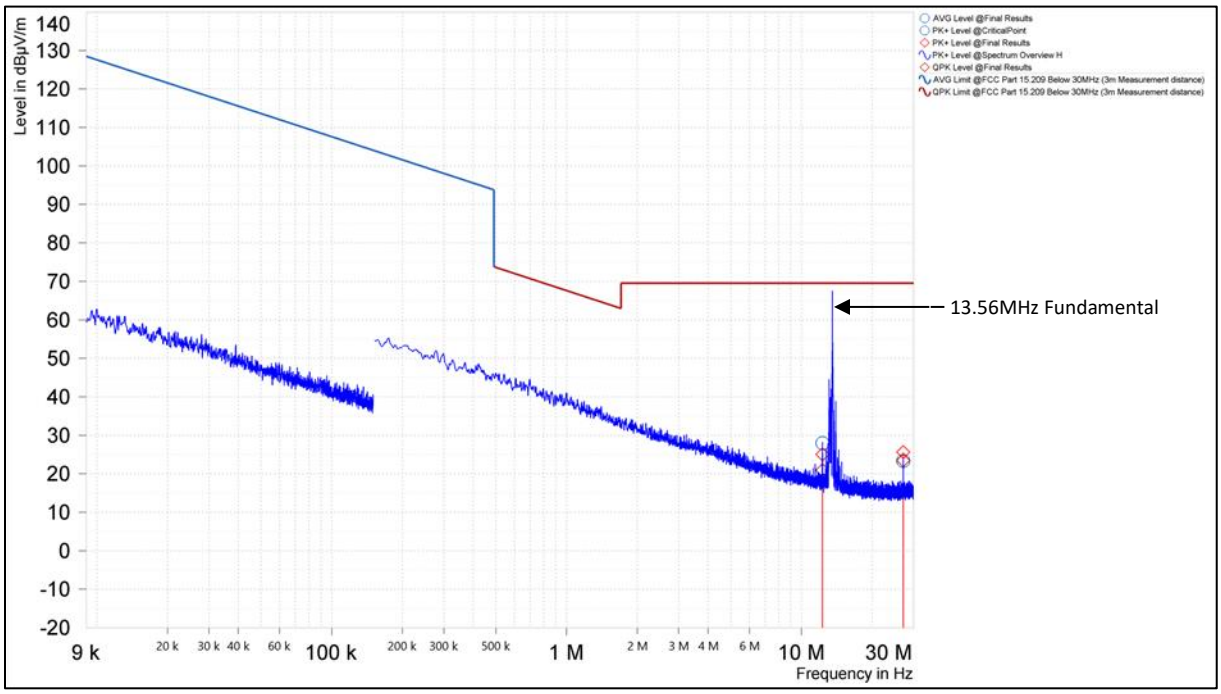



**Figure 17. Out of Band Emissions Below 30MHz (Coplanar Loop, Small HF Antenna)**

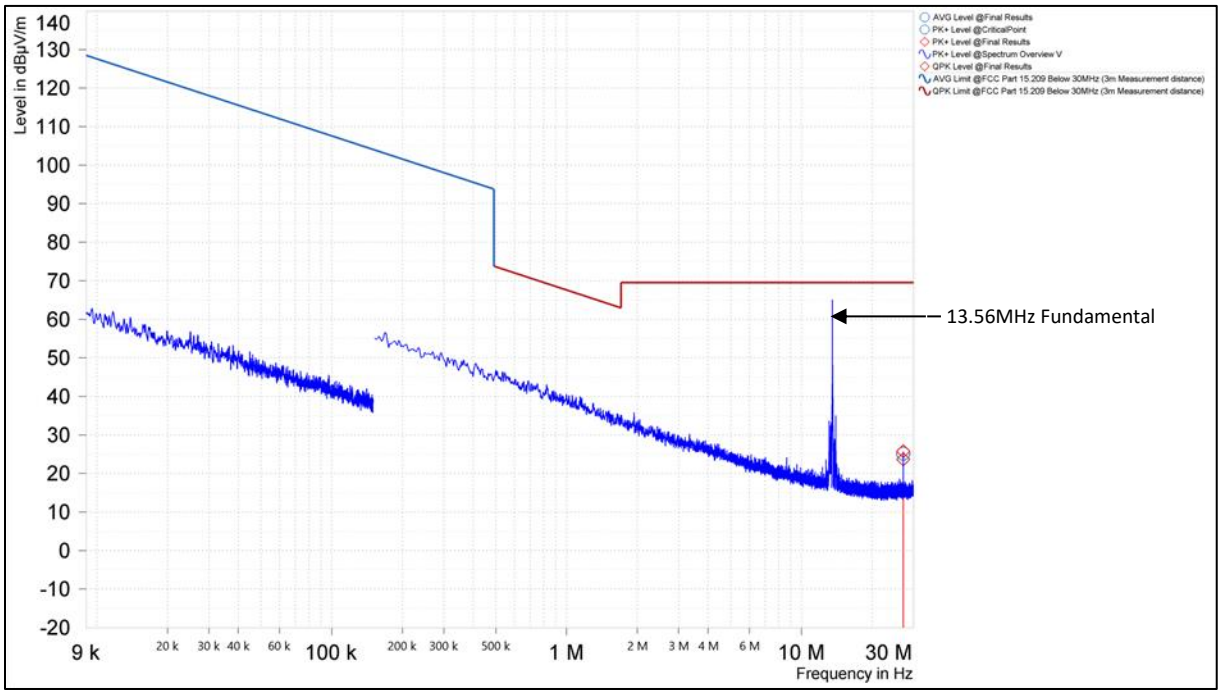



**Figure 18. Out of Band Emissions Below 30MHz (Coaxial Loop, Small HF Antenna)**

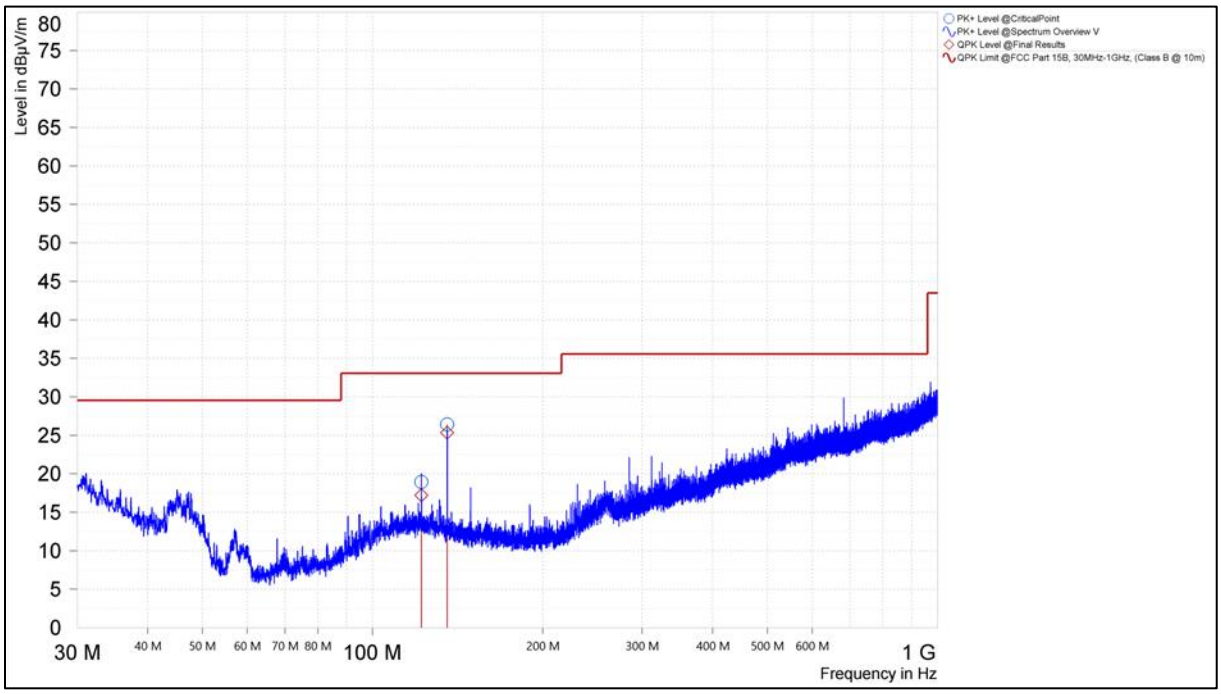



**Figure 19. Out of Band Emissions Above 30MHz (Vertical Polarity, Small HF Antenna)**

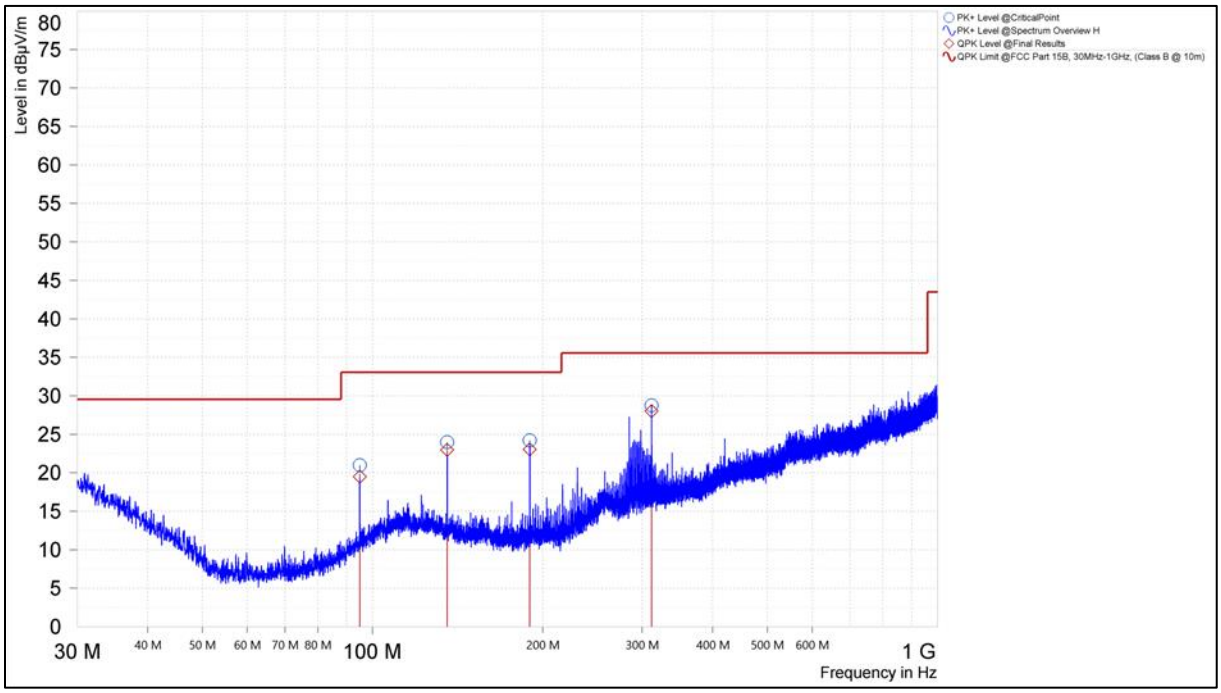



**Figure 20. Out of Band Emissions Above 30MHz (Horizontal Polarity, Small HF Antenna)**

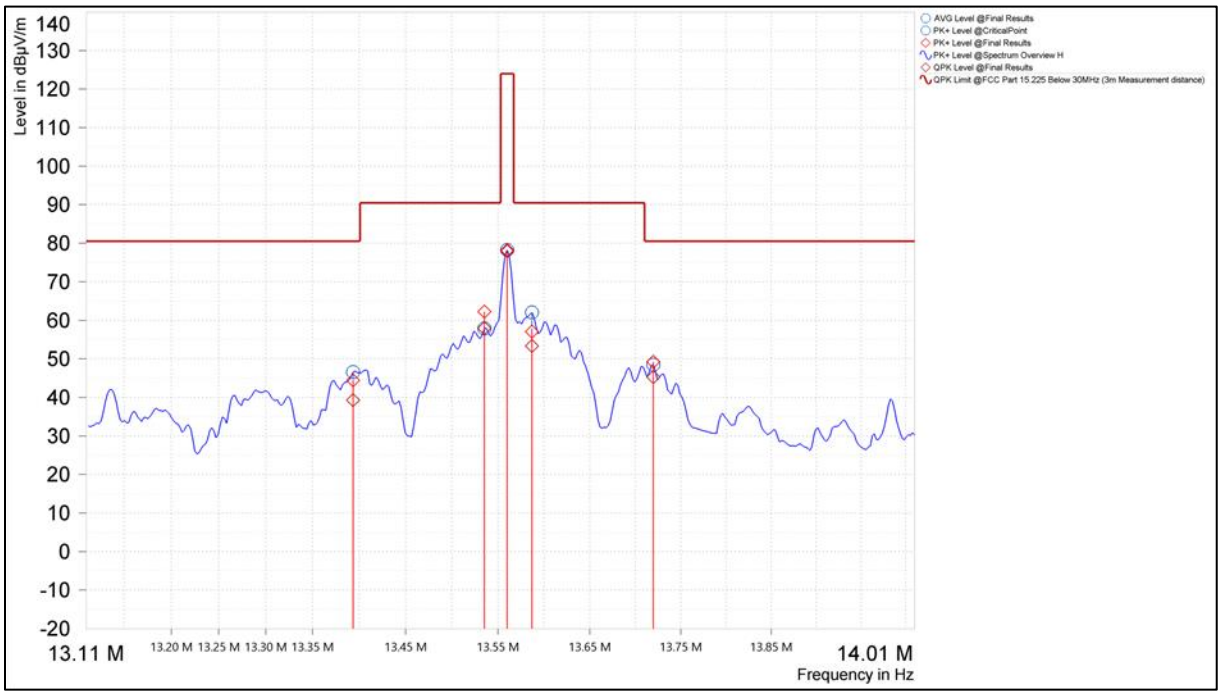



**Figure 21. In-Band Emission Mask (Coplanar Loop, Large HF Antenna)**

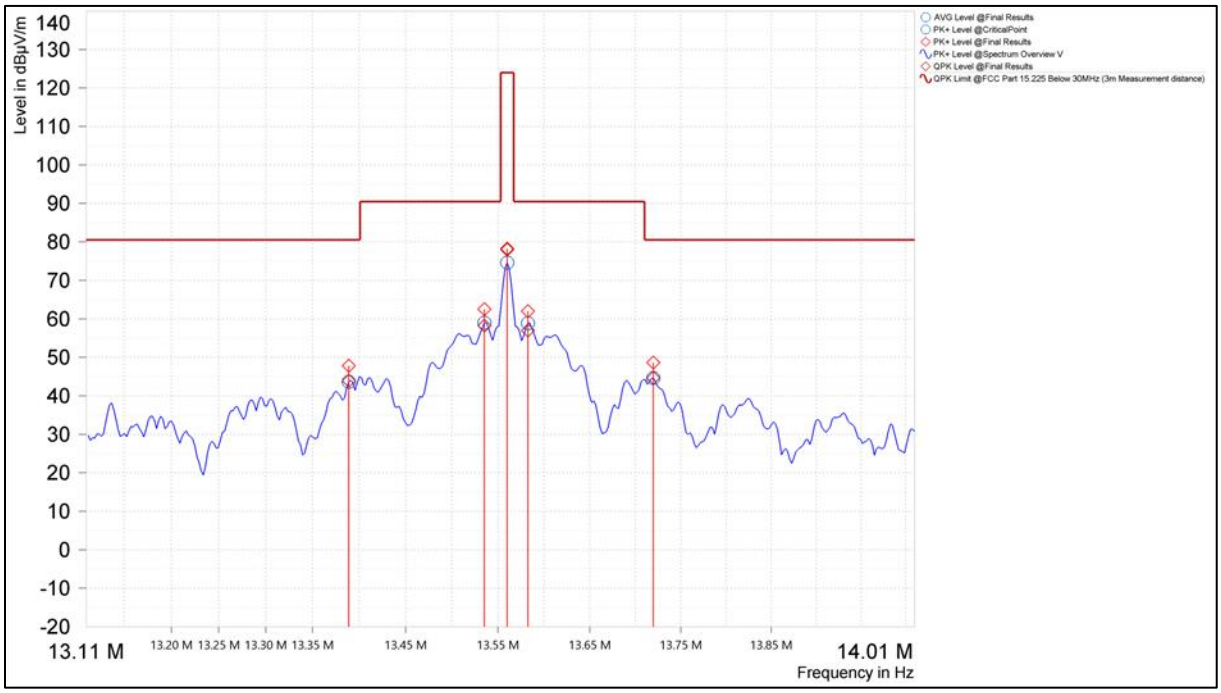



**Figure 22. In-Band Emission Mask (Coaxial Loop, Large HF Antenna)**

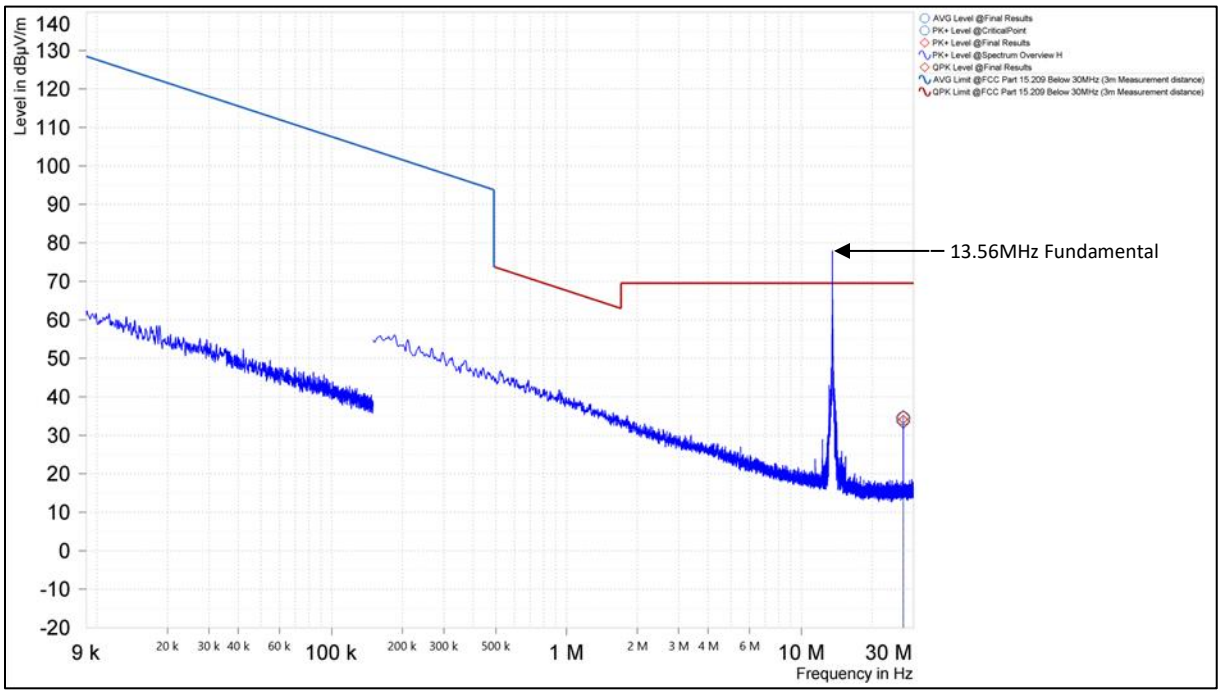



**Figure 23. Out of Band Emissions Below 30MHz (Coplanar Loop, Large HF Antenna)**

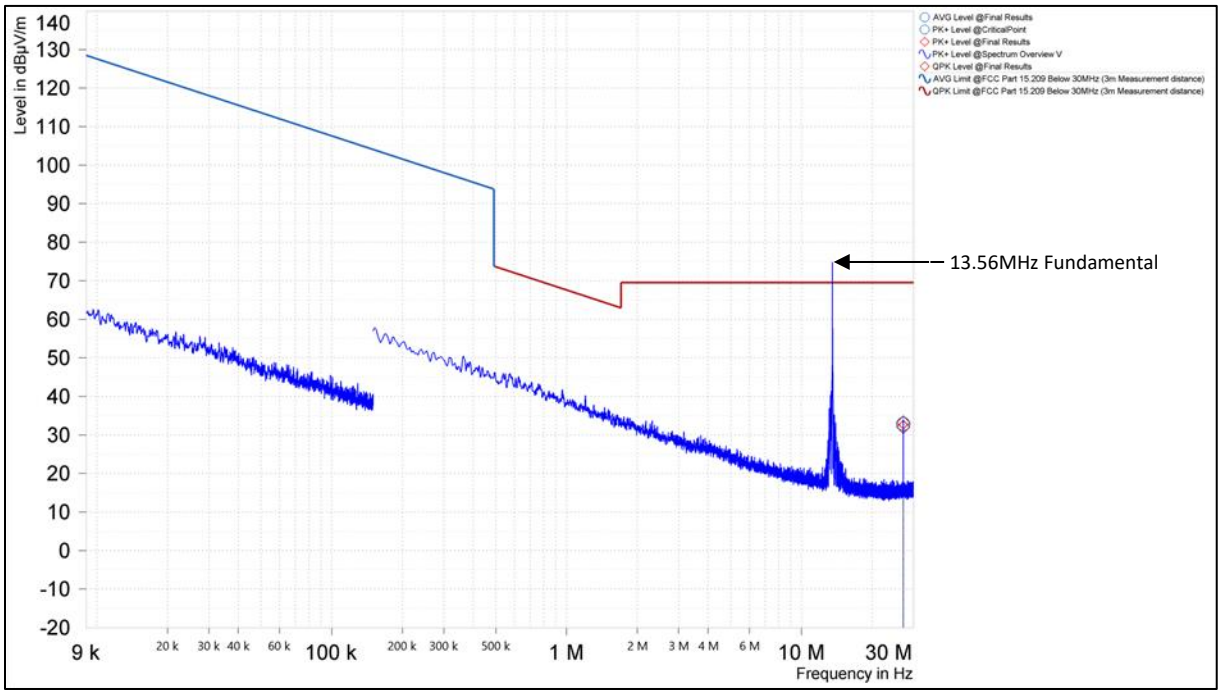



**Figure 24. Out of Band Emissions Below 30MHz (Coaxial Loop, Large HF Antenna)**

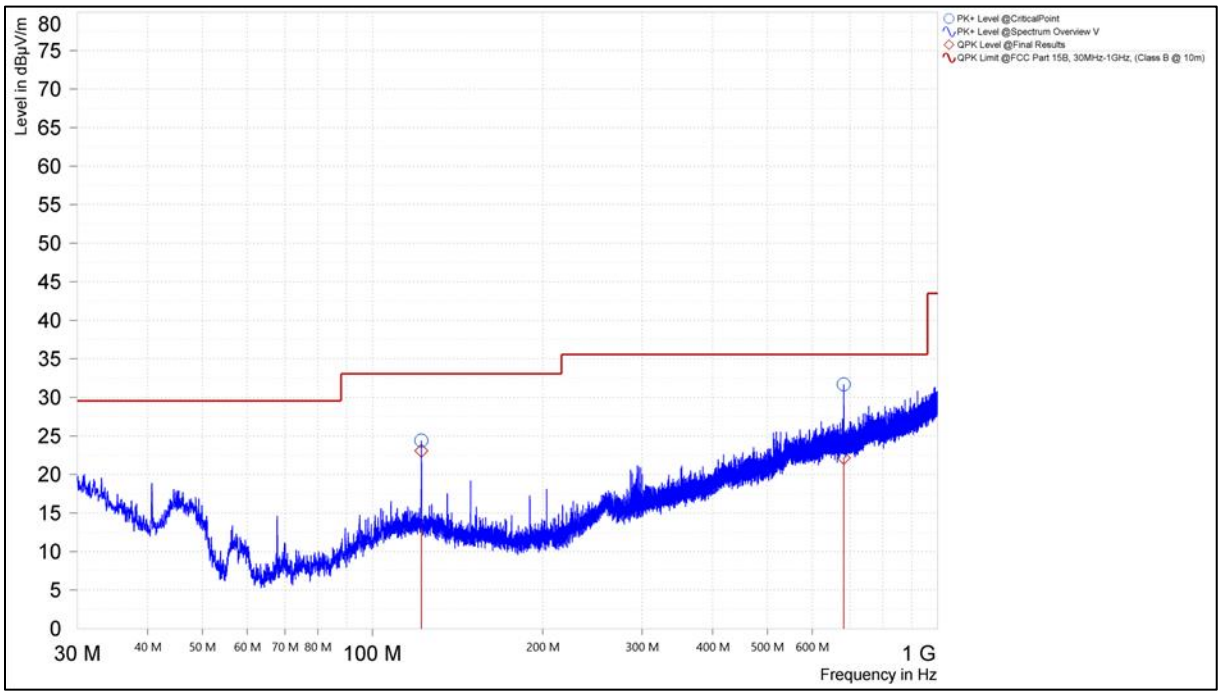



**Figure 25. Out of Band Emissions Above 30MHz (Vertical Polarity, Large HF Antenna)**

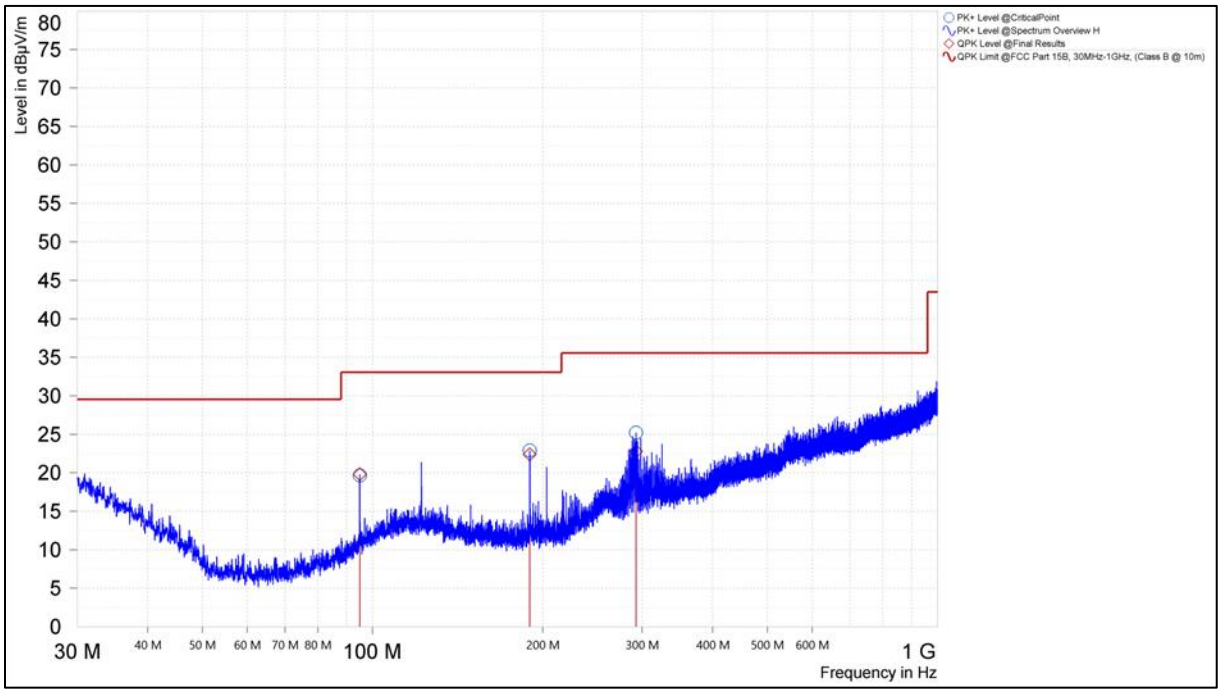



**Figure 26. Out of Band Emissions Above 30MHz (Horizontal Polarity, Large HF Antenna)**

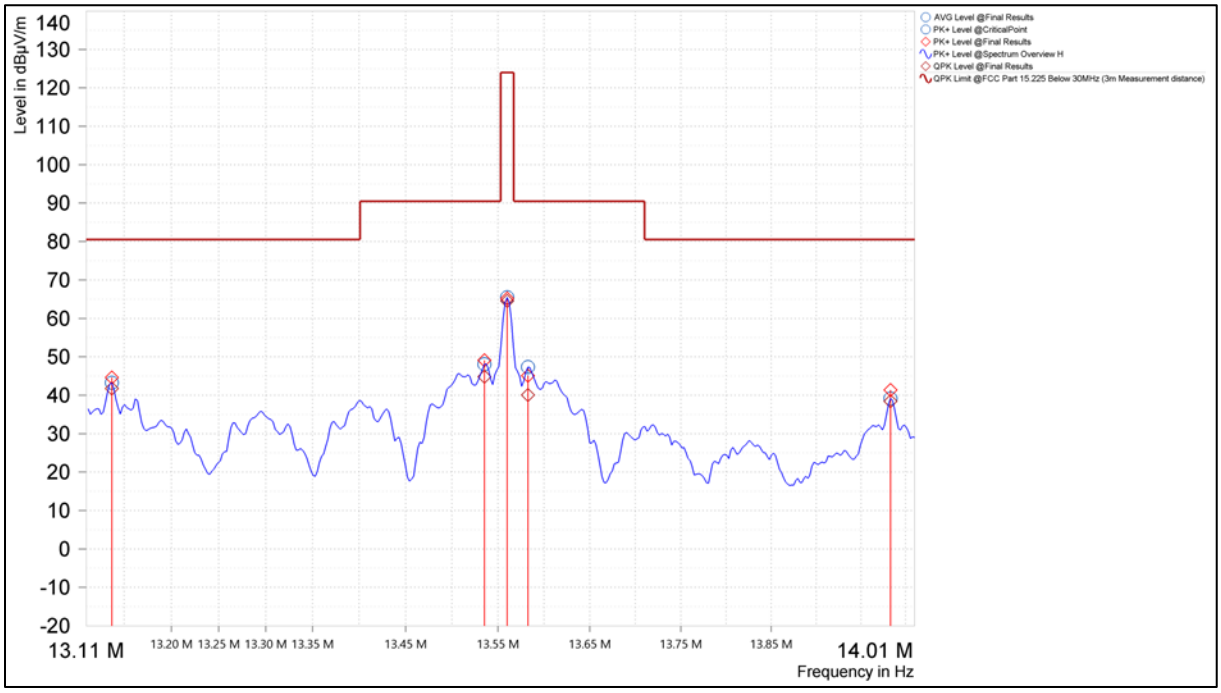



**Figure 27. In-Band Emission Mask (Coplanar Loop, Combined HF Antenna)**

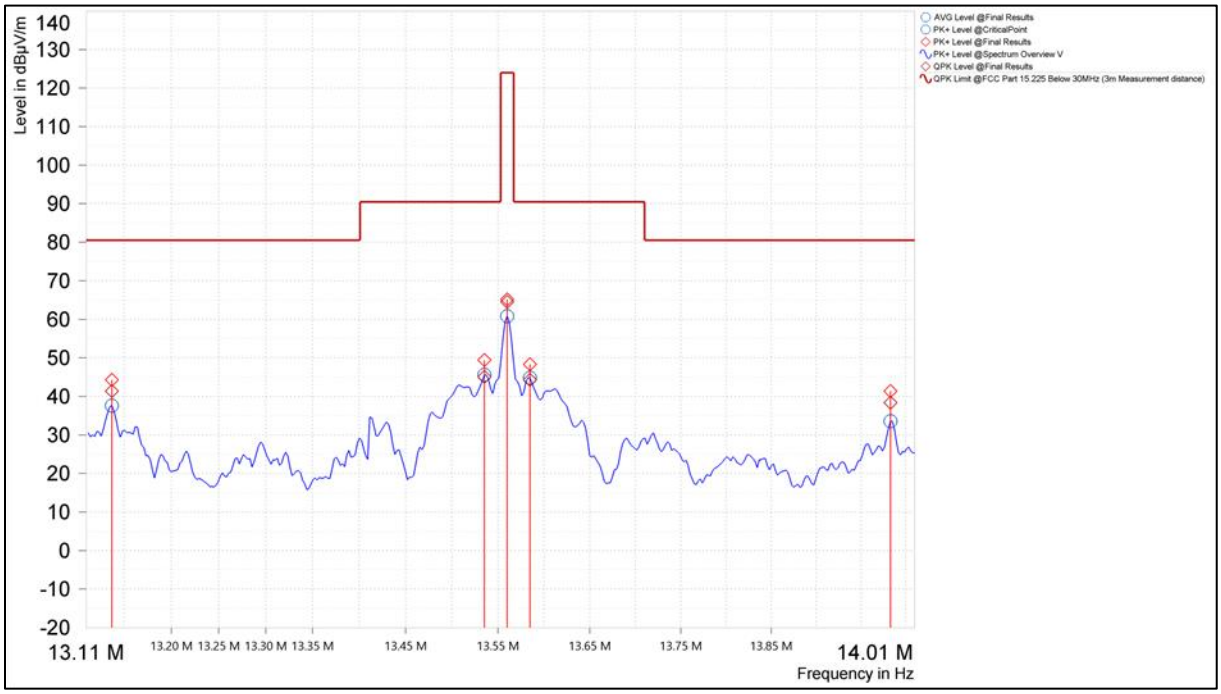



**Figure 28. In-Band Emission Mask (Coaxial Loop, Combined HF Antenna)**

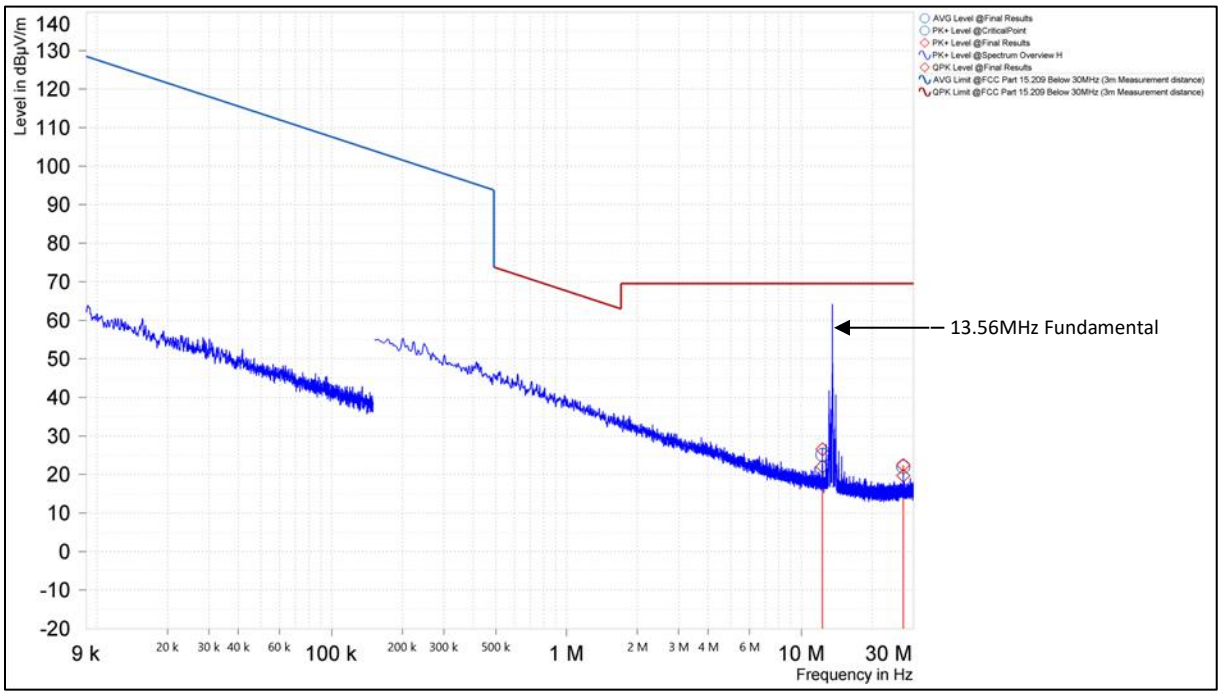



**Figure 29. Out of Band Emissions Below 30MHz (Coplanar Loop, Combined HF Antenna)**

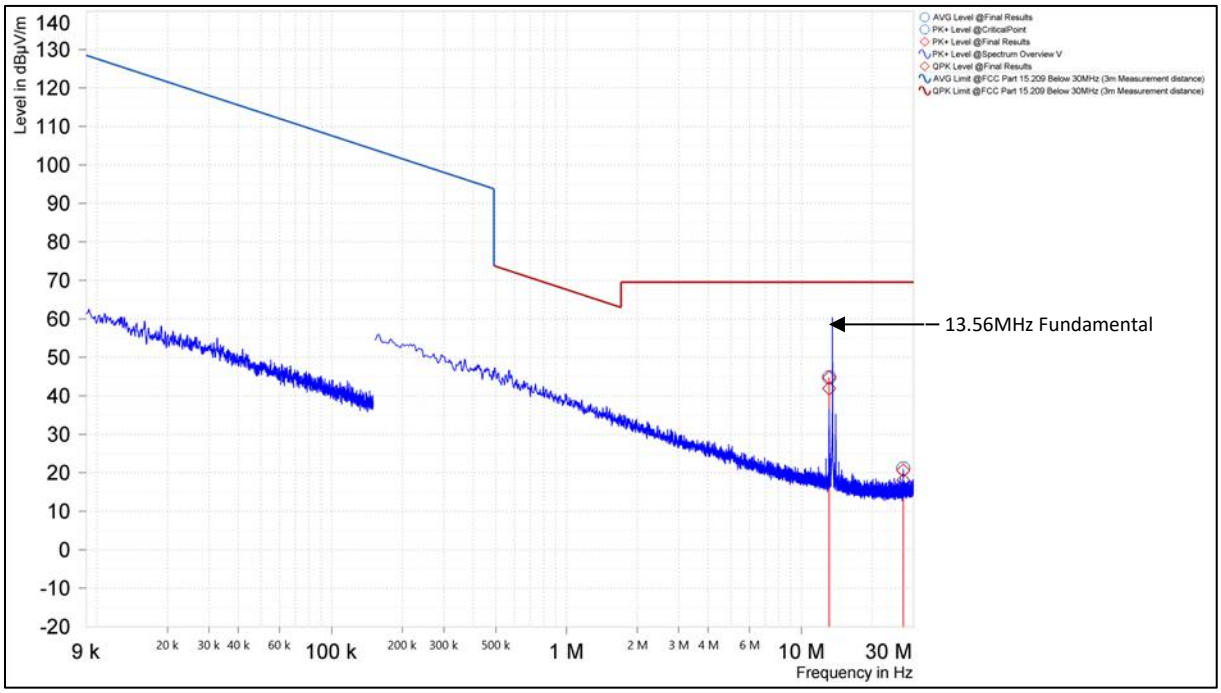



**Figure 30. Out of Band Emissions Below 30MHz (Coaxial Loop, Combined HF Antenna)**

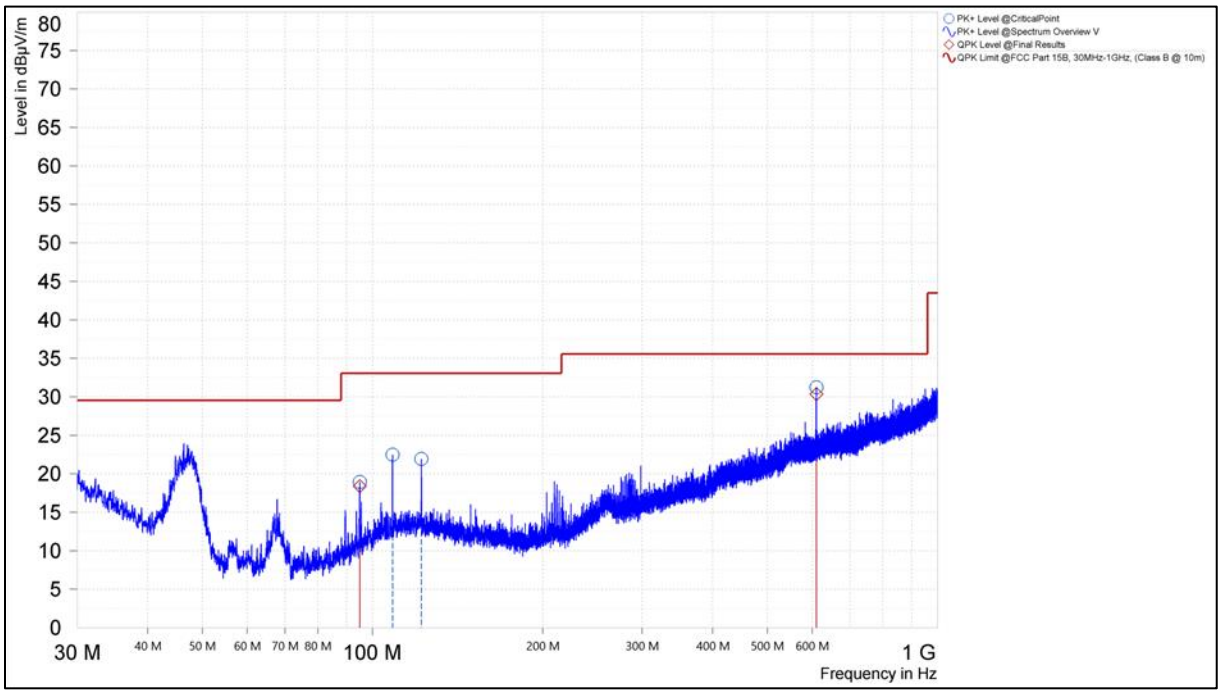



**Figure 31. Out of Band Emissions Above 30MHz (Vertical Polarity, Combined HF Antenna)**

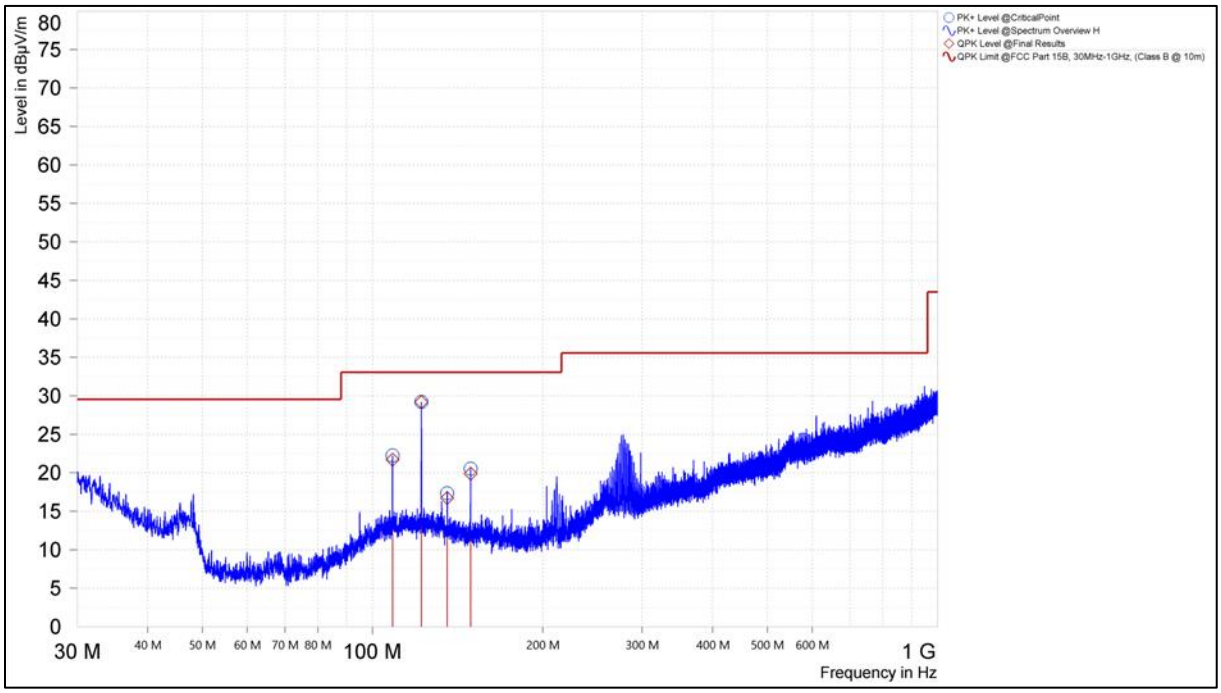



**Figure 32. Out of Band Emissions Above 30MHz (Horizontal Polarity, Combined HF Antenna)**

## Electromagnetic Compatibility Criteria for Intentional Radiators

## 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.

**RSS-210 (B.6.b)** The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% (± 100 ppm) of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

**Test Procedure:** Measurements are in accordance with section 6.8 of ANSI C63.10. The EUT was placed in the Environmental Chamber and allowed to reach desired temperature. A spectrum analyzer was used to measure the frequency drift. The EUT was set to transmit in the operating frequency range. Frequency drift was investigated for the extreme temperatures and nominal temperature, until the unit is stabilized then recorded the reading in tabular format with the temperature range of -20º to 50ºC.

**Test Results:** The OMNIKEY SE Reader Core was compliant with Part 15.225 (e) and RSS-210 (B.6.b) requirement(s) of this section.

**Test Engineer(s):** Bryan Taylor

**Test Date(s):** 1/8/2024 – 1/9/2024

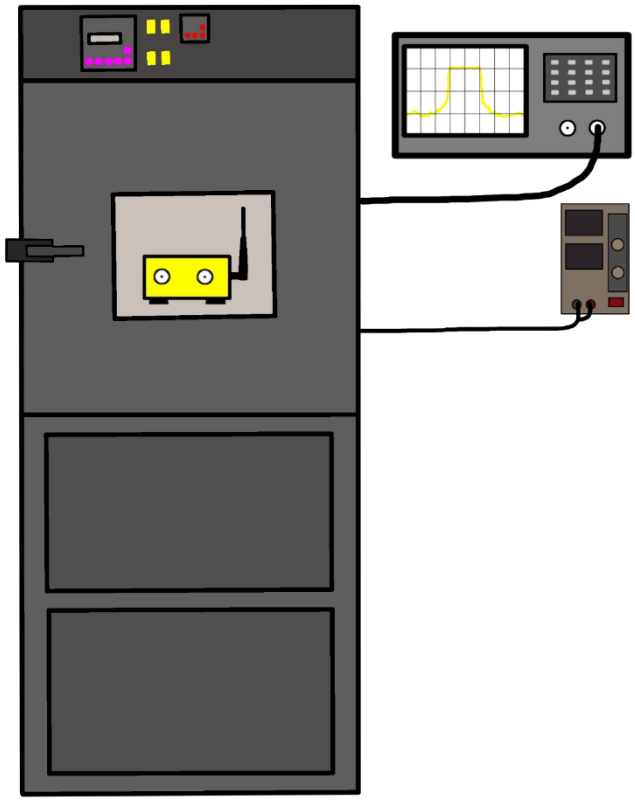


**Figure 33. Temperature Stability Test Setup**

| | | |
|---|---|---|
| **Operating Freqeuncy:** | 13,560,000 | Hz |
| **Reference Voltage:** | 5 | VDC |
| **Deviation Limit:** | 0.01 | % |

| Voltage % | Voltage (VDC) | Temp (°C) | Measured Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|
| 100% | 5 | -30 | 13,559,981 | -19 | -0.0001 | 0.01 |
| 100% | 5 | -25 | 13,559,962 | -38 | -0.0003 | 0.01 |
| 100% | 5 | -20 | 13,559,971 | -29 | -0.0002 | 0.01 |
| 100% | 5 | -10 | 13,560,040 | 40 | 0.0003 | 0.01 |
| 100% | 5 | 0 | 13,560,015 | 15 | 0.0001 | 0.01 |
| 100% | 5 | 10 | 13,560,041 | 41 | 0.0003 | 0.01 |
| 100% | 5 | 20 | 13,560,032 | 32 | 0.0002 | 0.01 |
| 100% | 5 | 30 | 13,559,964 | -36 | -0.0003 | 0.01 |
| 100% | 5 | 40 | 13,559,955 | -45 | -0.0003 | 0.01 |
| 100% | 5 | 50 | 13,559,943 | -57 | -0.0004 | 0.01 |
| 100% | 5 | 65 | 13,559,933 | -67 | -0.0005 | 0.01 |
| 115% | 5.75 | 20 | 13,559,999 | -1 | 0.0000 | 0.01 |
| 85% | 4.25 | 20 | 13,560,028 | 28 | 0.0002 | 0.01 |

**Figure 34. Frequency Stability Test Results (Small HF Antenna)**

| | | |
|---|---|---|
| **Operating Freqeuncy:** | 13,560,000 | Hz |
| **Reference Voltage:** | 5 | VDC |
| **Deviation Limit:** | 0.01 | % |

| Voltage % | Voltage (VDC) | Temp (°C) | Measured Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|
| 100% | 5 | -30 | 13,559,975 | -25 | -0.0002 | 0.01 |
| 100% | 5 | -25 | 13,559,964 | -36 | -0.0003 | 0.01 |
| 100% | 5 | -20 | 13,559,966 | -34 | -0.0003 | 0.01 |
| 100% | 5 | -10 | 13,560,026 | 26 | 0.0002 | 0.01 |
| 100% | 5 | 0 | 13,560,012 | 12 | 0.0001 | 0.01 |
| 100% | 5 | 10 | 13,560,027 | 27 | 0.0002 | 0.01 |
| 100% | 5 | 20 | 13,560,034 | 34 | 0.0003 | 0.01 |
| 100% | 5 | 30 | 13,559,965 | -35 | -0.0003 | 0.01 |
| 100% | 5 | 40 | 13,559,971 | -29 | -0.0002 | 0.01 |
| 100% | 5 | 50 | 13,559,974 | -26 | -0.0002 | 0.01 |
| 100% | 5 | 65 | 13,559,945 | -55 | -0.0004 | 0.01 |
| 115% | 5.75 | 20 | 13,559,997 | -3 | 0.0000 | 0.01 |
| 85% | 4.25 | 20 | 13,560,031 | 31 | 0.0002 | 0.01 |

**Figure 35. Frequency Stability Test Results (Large HF Antenna)**

| | | |
|---|---|---|
| **Operating Freqeuncy:** | 13,560,000 | Hz |
| **Reference Voltage:** | 5 | VDC |
| **Deviation Limit:** | 0.01 | % |

| Voltage % | Voltage (VDC) | Temp (°C) | Measured Frequency (Hz) | Frequency Error (Hz) | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|
| 100% | 5 | -30 | 13,559,981 | -19 | -0.0001 | 0.01 |
| 100% | 5 | -25 | 13,559,971 | -29 | -0.0002 | 0.01 |
| 100% | 5 | -20 | 13,559,956 | -44 | -0.0003 | 0.01 |
| 100% | 5 | -10 | 13,560,027 | 27 | 0.0002 | 0.01 |
| 100% | 5 | 0 | 13,560,021 | 21 | 0.0002 | 0.01 |
| 100% | 5 | 10 | 13,560,051 | 51 | 0.0004 | 0.01 |
| 100% | 5 | 20 | 13,559,993 | -7 | -0.0001 | 0.01 |
| 100% | 5 | 30 | 13,559,981 | -19 | -0.0001 | 0.01 |
| 100% | 5 | 40 | 13,559,948 | -52 | -0.0004 | 0.01 |
| 100% | 5 | 50 | 13,559,957 | -43 | -0.0003 | 0.01 |
| 100% | 5 | 65 | 13,559,935 | -65 | -0.0005 | 0.01 |
| 115% | 5.75 | 20 | 13,560,000 | 0 | 0.0000 | 0.01 |
| 85% | 4.25 | 20 | 13,560,033 | 33 | 0.0002 | 0.01 |

**Figure 36. Frequency Stability Test Results (Combined HF Antenna)**

## Test Equipment

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

| MET Asset # | Description | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| MY46180897 | Spectrum Analyzer | Keysight | E4448A | 7/27/2023 | 7/27/2024 |
| 1A1234 | FSV Signal Analyzer | Rohde & Schwarz | FSV 40 | 1/23/2023 | 1/23/2024 |
| 1A1083 | Receiver | Rohde & Schwarz | ESU40 | 11/20/2023 | 11/20/2024 |
| 1A1176 | Active Loop Antenna (9KHz-30MHz) | ETS-Lindgren | 6502 | 7/13/2023 | 7/13/2024 |
| 1A1050 | Bilog Antenna (30MHz – 1GHz) | Schaffner | CBL 6112D | 1/24/2023 | 1/24/2024 |
| 1A1183 | Horn Antenna (1GHz – 18GHz) | ETS Lindgren | 3117 | 1/4/2023 | 1/4/2024 |
| 1A1161 | Horn Antenna (18GHz – 40GHz) | ETS Lindgren | 3116C | 7/11/2023 | 7/11/2024 |
| 1A1065 | EMI Receiver | Rohde & Schwarz | ESCI | 8/4/2023 | 8/4/2024 |
| 1A1177 | Pulse Limiter | Rohde & Schwarz | ESH3Z2 | 12/14/2023 | 12/14/2024 |
| 1A1122 | LISN | TESEQ | NNB 51 | 09/21/2023 | 09/21/2024 |
| 1A1123 | LISN | Teseq | NNB 51 | 12/20/2023 | 12/20/2024 |
| 1A1149 | DC Milliohm Meter | GW Instek | GOM-802 | 9/20/2023 | 9/20/2024 |
| 1A1117 | Digital Multimeter | Fluke | 87 III | 11/6/2023 | 11/6/2024 |
| 1A1225 | Environmental Chamber | Espec | EXP-2H/New | 5/16/2023 | 5/16/2024 |
| 1A1099 | Generator | Com-Power | CGO-51000 | See Note | |
| 1A1088 | Preamplifier | Rohde & Schwarz | TS-PR1 | See Note | |
| 1A1044 | Generator | Com-Power | CG-520 | See Note | |
| 1A1073 | Multi Device Controller | ETS | 2090 | See Note | |
| 1A1074 | System Controller | Panasonic | WV-CU101 | See Note | |
| 1A1080 | Multi-Device | ETS | 2090 | See Note | |
| 1A1180 | Preamplifier | Miteq | AMF-7D-01001800-22-10P | See Note | |

**Table 13. Test Equipment List**

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

# End of Report