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January 10, 2021

Nexxiot Inc
7290 Virginia Parkway Suite 3000
McKinney, TX 75071
USA

Dear Kenneth Mannka,

Enclosed is the EMC Wireless test report for compliance testing of the Nexxiot Inc, Globehopper Crossmodal 3.0 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

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

Arsalan Hasan
Wireless Laboratory

Reference: (\Nexxiot Inc\WIRS109627-FCC247 BLE Rev 0)

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

# Electromagnetic Compatibility Criteria
# Test Report

for the

**Nexxiot Inc**
**Globehopper Crossmodal 3.0**

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

**Report: WIRS109627-FCC247 BLE Rev 0**

January 10, 2021

**Prepared For:**

**Nexxiot Inc**
**7290 Virginia Parkway Suite 3000**
**McKinney, TX 75071**
**USA**

**Prepared By:**
**Eurofins E&E North America**
3162 Belick Street
Santa Clara, CA 95054


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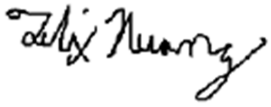
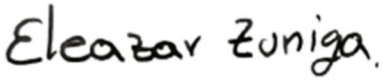


Felix Huang
Engineer, Wireless Laboratory

Arsalan Hasan
Manager, Wireless Laboratory

**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 15.247 under normal use and maintenance.



Eleazar Zuniga, PhD.
Director, Wireless Technologies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# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | January 10, 2021 | Initial Issue. |


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# List of Terms and Abbreviations

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


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# I. Executive Summary


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## 1.1 Purpose of Test

An EMC Wireless evaluation was performed to determine compliance of the Nexxiot Inc Globehopper Crossmodal 3.0, with the requirements of Part 15, §15.247. 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 Globehopper Crossmodal 3.0. Nexxiot Inc should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Globehopper Crossmodal 3.0, has been **permanently** discontinued.

## 1.2 Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Nexxiot Inc, purchase order number PO00435. All tests were conducted using measurement procedure ANSI C63.4-2014.

| FCC Reference 47 CFR Part 15.247:2005 | Description | Compliance |
|---|---|---|
| Title 47 of the CFR, Part 15 §15.203 | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | Conducted Emission Limits | Not Applicable |
| Title 47 of the CFR, Part 15 §15.247(a)(2) | 6dB Occupied Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.247(b) | Peak Power Output | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205 | Radiated Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RF Conducted Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RF Conducted Band Edge | Compliant |
| Title 47 of the CFR, Part 15; §15.247(e) | Peak Power Spectral Density | Compliant |

**Table 1: Executive Summary of EMC Part 15.247 ComplianceTesting**


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# II. Equipment Configuration


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## 2.1 Overview

Eurofins MET Laboratories, Inc. was contracted by Nexxiot Inc to perform testing on the Globehopper Crossmodal 3.0, under Nexxiot Inc's purchase order number PO00435.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Nexxiot Inc, Globehopper Crossmodal 3.0.

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

| | | |
|---|---|---|
| **Model(s) Tested:** | Globehopper Crossmodal 3.0 | |
| **Model(s) Covered:** | Globehopper Crossmodal 3.0 | |
| **EUT Specifications:** | Primary Power: 2.4VDC (Battery Operated) | |
| | FCC ID: 2AXRX-AX3A | |
| | Type of Modulations: | GFSK |
| | Equipment Code: | DTS |
| | Peak RF Output Power: | 4.038 dBm |
| | EUT Frequency Ranges: | 2402 – 2480 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:** | Arsalan Hasan | |
| **Report Date(s):** | January 10, 2021 | |

**Table 2: EUT Summary Table**


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## 2.2 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**

## 2.3 Test Site

All testing was performed at Eurofins MET Labs, 3162 Belick St., Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Eurofins MET Labs is a ISO/IEC 17025 accredited site by A2LA, California #0591.02.

## 2.4 Measurement Uncertainty

| Test Method | Typical Expanded Uncertainty | K | Confidence Level |
|---|---|---|---|
| **RF Frequencies** | ±4.52 Hz | 2 | 95% |
| **RF Power Conducted Emissions** | ±2.32 dB | 2 | 95% |
| **RF Power Conducted Spurious Emissions** | ±2.25 dB | 2 | 95% |
| **RF Power Radiated Emissions** | ±3.01 dB | 2 | 95% |

**Table 4. Measurement Uncertainty**


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## 2.5 Description of Test Sample

The Nexxiot Inc Globehopper Crossmodal 3.0 is a zero-maintenance hardware unit for enabling real-time monitoring of non-powered rail cars. Device installation can be done in under 2 minutes ensuring quick and effortless onboarding. Once set up, the Crossmodal device provides real-time updates of location, utilization and sensor readings as often as every 5 minutes. Intelligent energy harvesting, and energy management techniques ensures a hassle-free operation for a guaranteed time of 6 years.

## 2.6 Equipment Configuration

| Ref. ID | Slot # | Name / Description | Model Number | Part Number | Serial Number | Rev. # |
|---|---|---|---|---|---|---|
| | NA | Telemetrics Device | Globehopper Crossmodal 3.0 | NA | NA | NA |

**Table 5: Equipment Configuration**

## 2.7 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 |
|---|---|---|---|---|
| | Laptop with Windows 10 | HP | NA | N/A |

**Table 6: Support Equipment**

## 2.8 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 |
|---|---|---|---|---|---|---|---|
| | NA | NA | NA | NA | NA | NA | NA |

**Table 7: Ports and Cabling Information**

## 2.9 Mode of Operation During Testing

Standard test mode was used. Allows independent activation of all radios in their various test modes, as well as methods to generate traffic similar to normal operation on all digital busses.


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## 2.10 Method of Monitoring EUT Operation

The signal will be displayed on a spectrum analyzer.

## 2.11 Modifications

### 2.11.1 Modifications to EUT

No modifications were made to the EUT.

### 2.11.2 Modifications to Test Standard

No modifications were made to the test standard.

## 2.12 Disposition of EUT

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


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# III. Electromagnetic Compatibility Criteria for Intentional Radiators


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# 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 **completed testing** to the criteria of §15.203.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/20/2020

| EUT Model/Mode | Gain | Type | Manufacturer |
|---|---|---|---|
| Serica/SR4W035 | 3.5 dBi | SMD | antenova |

**Table 8: Antenna Requirement, Antenna List**


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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.207(a) Conducted Emissions Limits

**Test Requirement(s):** **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Σ 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- 0.45 | 66 - 56 | 56 - 46 |
| 0.45 - 0.5 | 56 | 46 |
| 0.5 - 30 | 60 | 50 |

**Table 9: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)**

**Test Procedure:** The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 µH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 µH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

**Test Results:** This requirement is not applicable since the EUT is battery powered.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/20/2020

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## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(2) 6 dB Bandwidth

**Test Requirements:** **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

**Test Procedure:** The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using an RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

**Test Results** The EUT **completed testing** to the requirements of § 15.247 (a)(2). No anomalies noted.

The 6 dB Bandwidth was determined from the plots on the following pages.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/20/2020

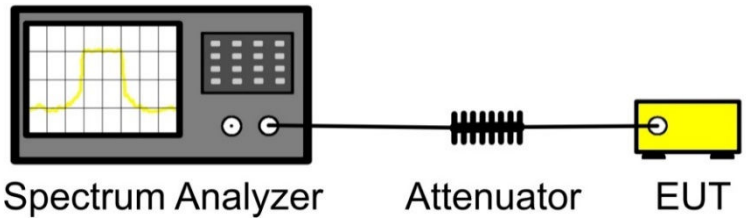


**Figure 1: Block Diagram, Occupied Bandwidth Test Setup**

| Occupied Bandwidth | | | |
|---|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured 6 dB Bandwidth (KHz)** | **Limit (KHz)** |
| Low | 2402 | 751.975 | ≥500 |
| Mid | 2442 | 731.701 | ≥500 |
| High | 2480 | 745.629 | ≥500 |

**Table 10: 6 dB Bandwidth, Test Data**


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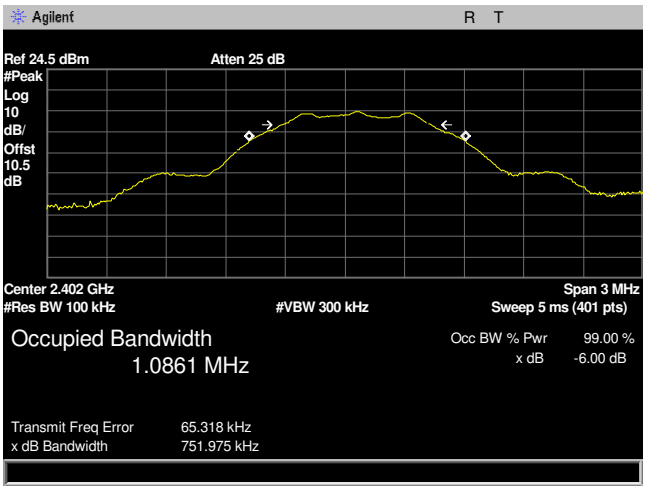
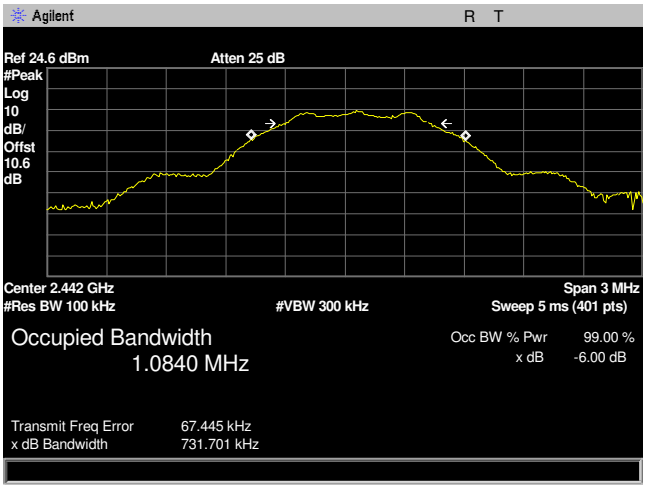
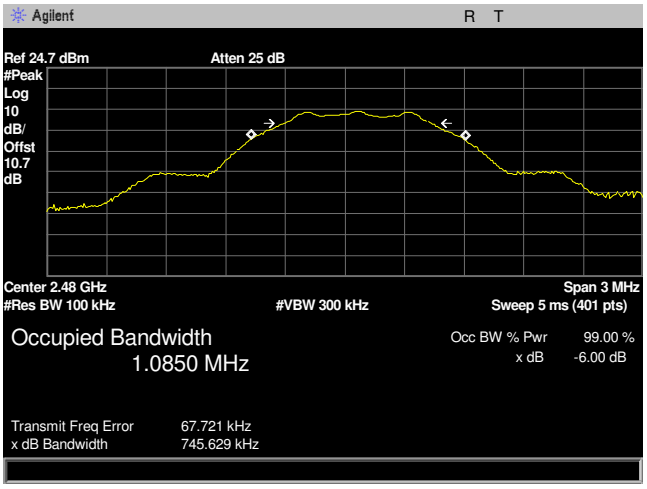



**Plot 1: 6 dB Bandwidth, 2402MHz Low Channel**




**Plot 2: 6 dB Bandwidth, 2442MHz Mid Channel**




**Plot 3: 6 dB Bandwidth, 2480MHz High Channel**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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(b) Peak Power Output

**Test Requirements:** **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

| Digital Transmission Systems (MHz) | Output Limit (Watts) |
|---|---|
| 902-928 | 1.000 |
| 2400–2483.5 | 1.000 |
| 5725– 5850 | 1.000 |

**Table 11 Output Power Requirements from §15.247(b)**

**§15.247(c):** if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Figure 21, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

**Test Procedure:** The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band at the maximum power level.

**Test Results:** The EUT **completed testing** to the requirements of **§15.247(b)**. No anomalies noted.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/15/2020


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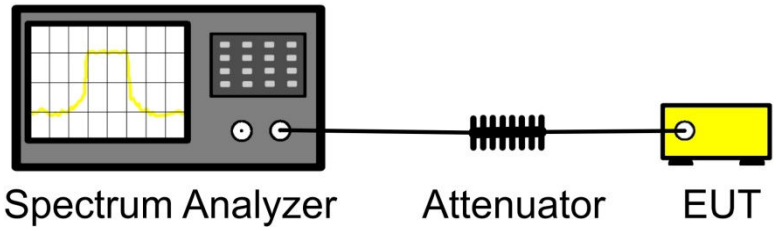


**Figure 2: Peak Power Output Test Setup**

| Output Power | | | |
|---|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured Conducted Power (dBm)** | **Limit (dBm)** |
| Low | 2402 | 4.038 | ≥30 |
| Mid | 2442 | 3.999 | ≥30 |
| High | 2480 | 4.012 | ≥30 |

**Table 12: Peak Power Output, Test Data**


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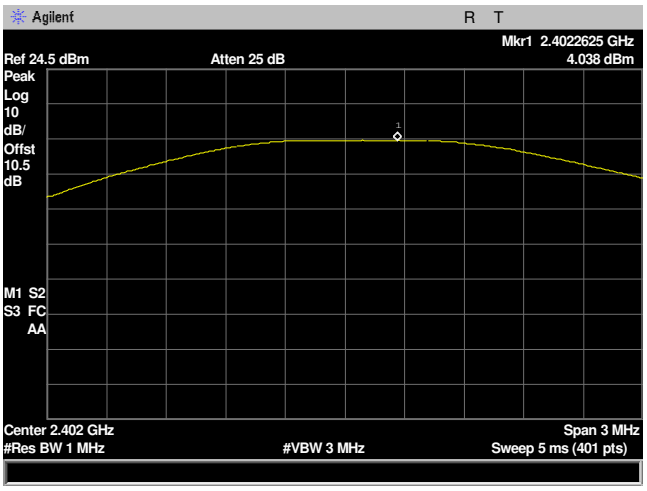
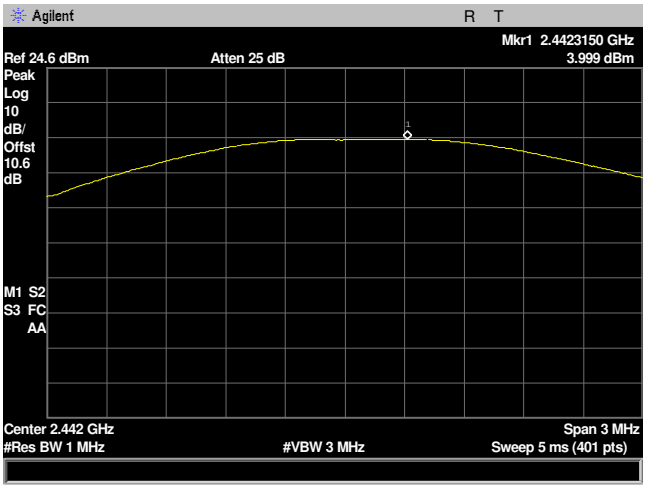
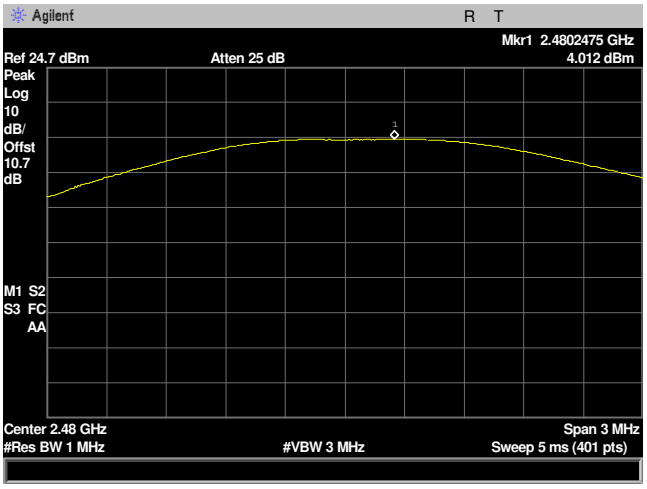



**Plot 4: Peak Power Output, 2402MHz Low Channel**




**Plot 5: Peak Power Output, 2442MHz Mid Channel**




**Plot 6: Peak Power Output, 2480MHz High Channel**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## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

**Test Requirements:** **§15.247(d); §15.205:** Emissions outside the frequency band.

**§15.247(d):** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

**§15.205(a):** Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110---------- | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| [1] 0.495–0.505---------- | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905---------- | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128---------- | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775---------- | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775---------- | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218---------- | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825---------- | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225---------- | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294---------- | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366---------- | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675---------- | 156.7–156.9 | 2655–2900 | 22.01–23.12 |
| 8.41425–8.41475---------- | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293---------- | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025---------- | 240–285 | 3345.8–3358 36. | 43–36.5 |
| 12.57675–12.57725---------- | 322–335.4 | 3600–4400 | ([2]) |

**Table 13: Restricted Bands of Operation**

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6


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**Test Requirement(s):** **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 14:

| Frequency (MHz) | § 15.209(a),Radiated Emission Limits (dBµV) @ 3m |
|---|---|
| 30 - 88 | 40.00 |
| 88 - 216 | 43.50 |
| 216 - 960 | 46.00 |
| Above 960 | 54.00 |

**Table 14: Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedures:** The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured below 30 MHz and above 18 GHz.

**Test Results:** The EUT **completed testing** to the requirements of **§ 15.247(d)**. No anomalies noted.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/15/2020


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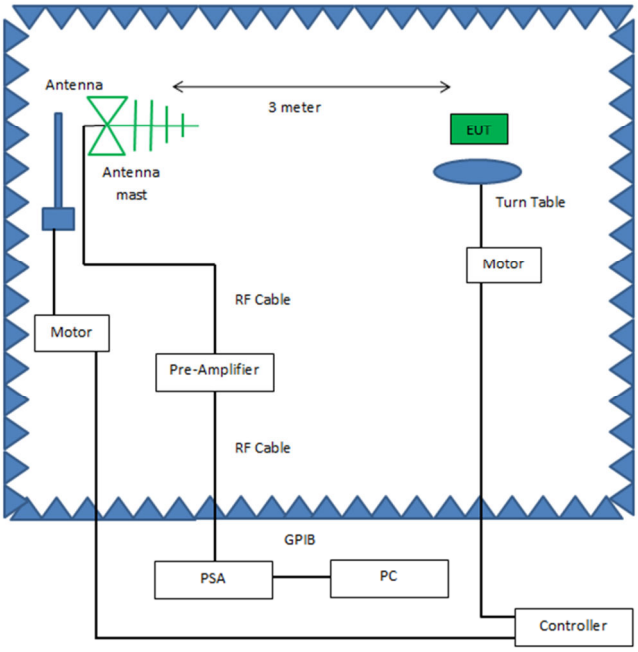


**Figure 3: Radiated Emissions, Below 1GHz, Test Setup**

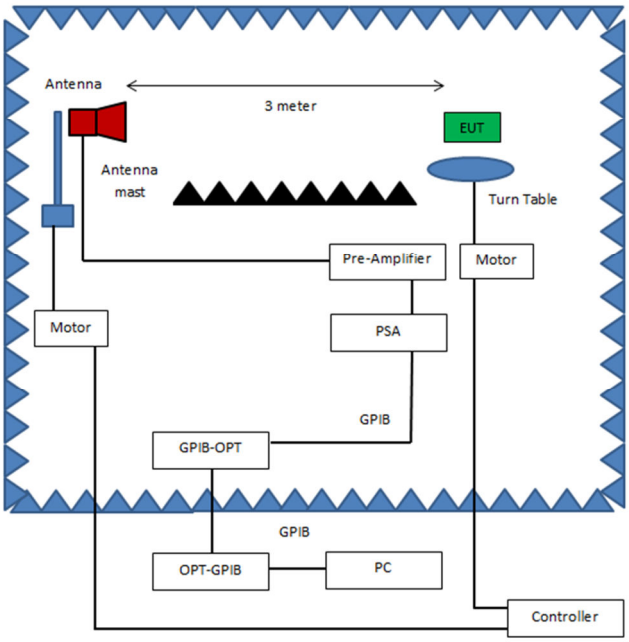


**Figure 4: Radiated Emissions, Above 1GHz, Test Setup**


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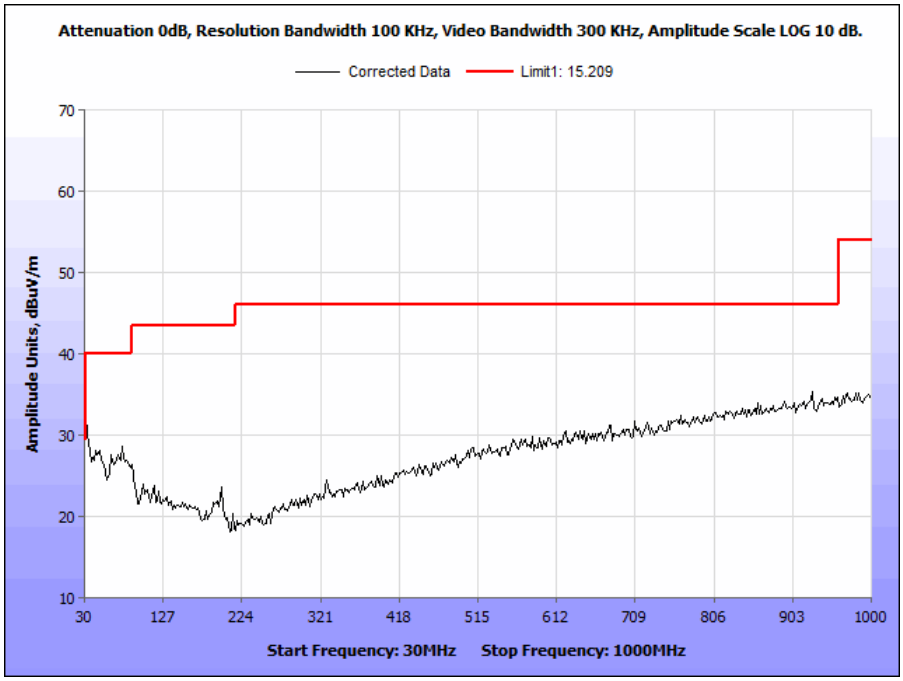
| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected EMI Meter Reading (dBuV) | Antenna Correction Factor (dB/m) (+) | Cable Loss (dB) (+) | Distance Correction Factor (dB) (-) | Corrected Amplitude (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 62.36 | 157 | V | 1.2 | 19.67 | 7.83 | 1.40 | 0.00 | 28.90 | 40.00 | -11.10 |
| 79.43 | 132 | H | 1.6 | 18.37 | 8.03 | 1.56 | 0.00 | 27.96 | 40.00 | -12.04 |
| 421.78 | 186 | V | 1.1 | 8.56 | 15.68 | 2.37 | 0.00 | 26.61 | 46.00 | -19.39 |
| 721 | 241 | V | 1.8 | 9.23 | 16.25 | 2.96 | 0.00 | 28.44 | 46.00 | -17.56 |
| 892 | 147 | H | 1 | 10.38 | 17.15 | 3.28 | 0.00 | 30.81 | 46.00 | -15.19 |
| 930 | 295 | V | 1 | 11.38 | 17.94 | 3.86 | 0.00 | 33.18 | 46.00 | -12.82 |

**Table 15: Radiated Emissions Data 30MHz – 1GHz**




**Plot 7: Radiated Emissions, BLE, 30 MHz - 1 GHz, (worst case)**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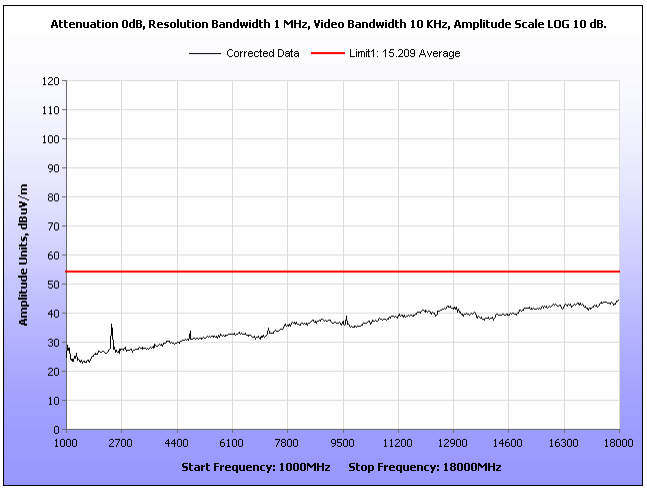
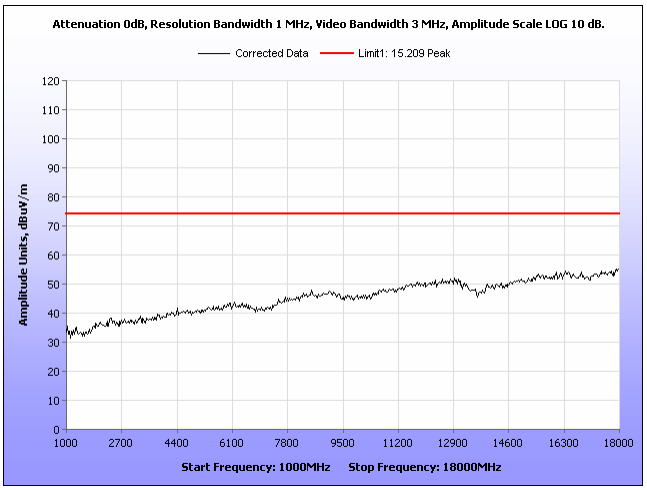
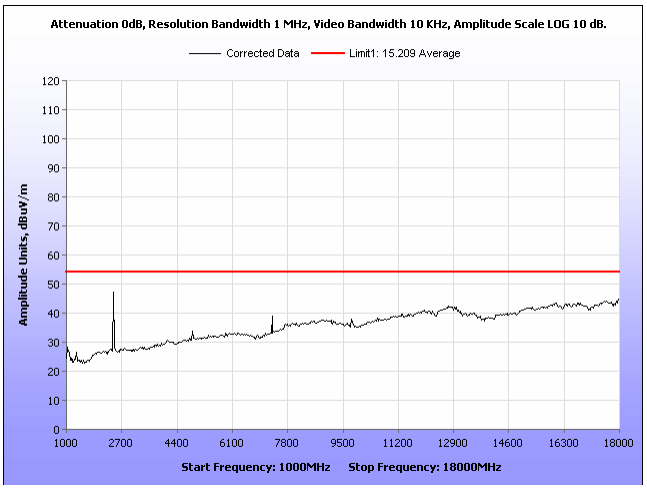



**Plot 8: Radiated Spurious Emissions Requirements, Low Channel 2402MHz, Average**




**Plot 9: Radiated Spurious Emissions Requirements, Low Channel 2402MHz, Peak**




**Plot 10: Radiated Spurious Emissions Requirements, Mid Channel 2442MHz, Average**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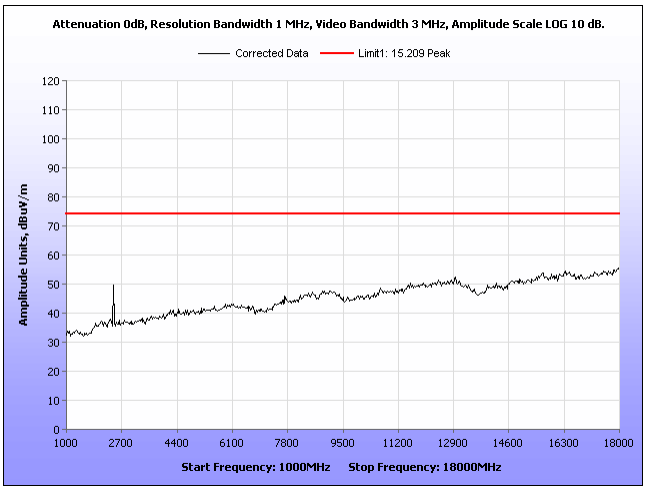
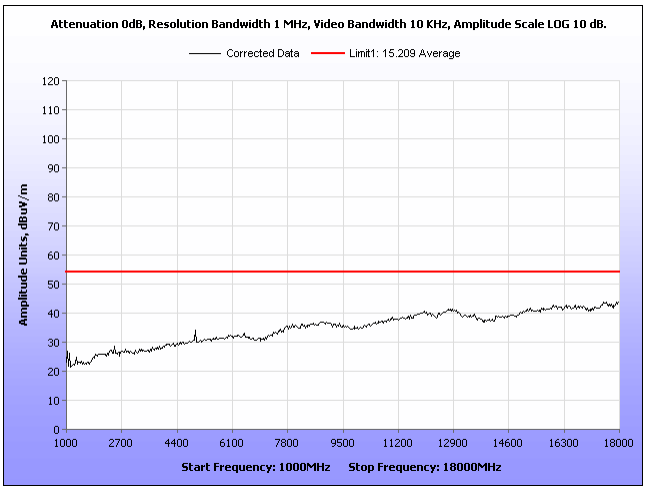
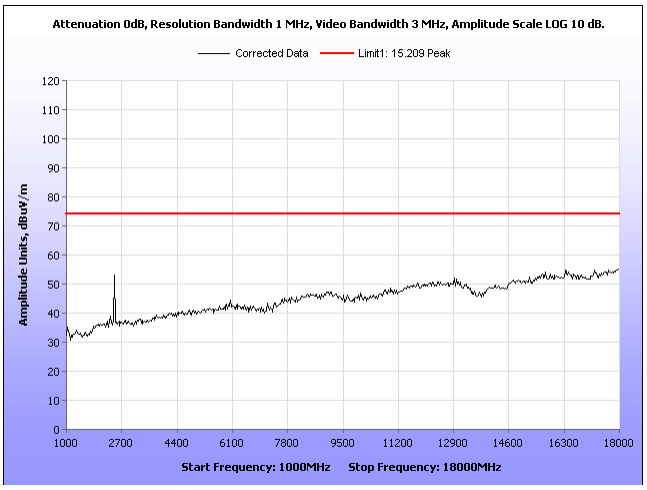



**Plot 11: Radiated Spurious Emissions Requirements, Mid Channel 2442MHz, Peak**




**Plot 12: Radiated Spurious Emissions Requirements, High Channel 2480MHz, Average**




**Plot 13 Radiated Spurious Emissions Requirements, High Channel 2480MHz, Peak**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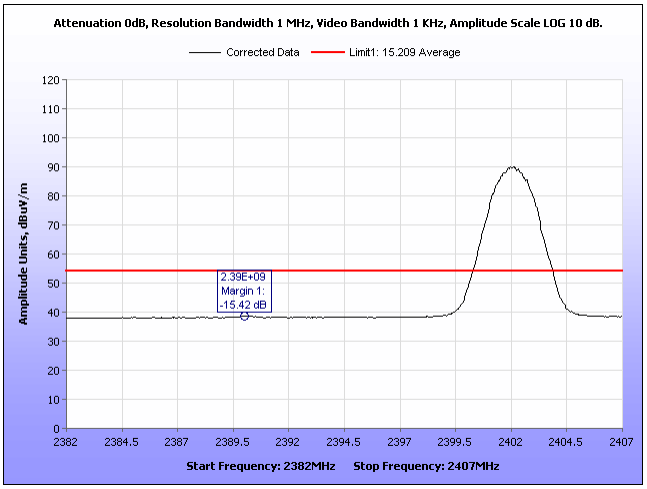
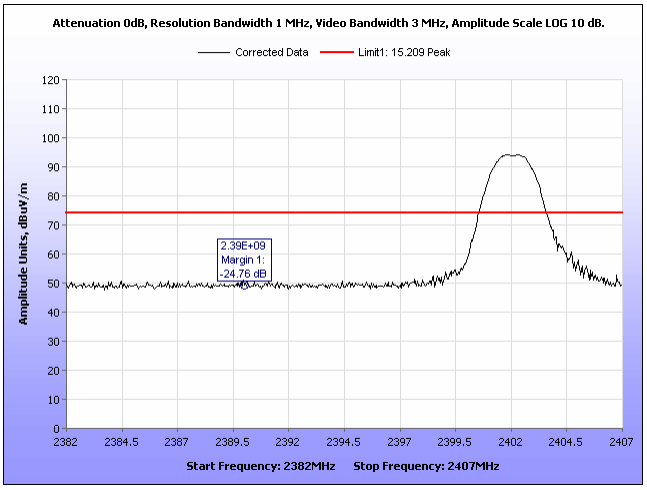
## Radiated Band Edge Measurements

**Test Procedures:** The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.




**Plot 14: Radiated Band Edge, Low Channel 2402MHz, Average**




**Plot 15: Radiated Band Edge, Low Channel 2402MHz, Peak**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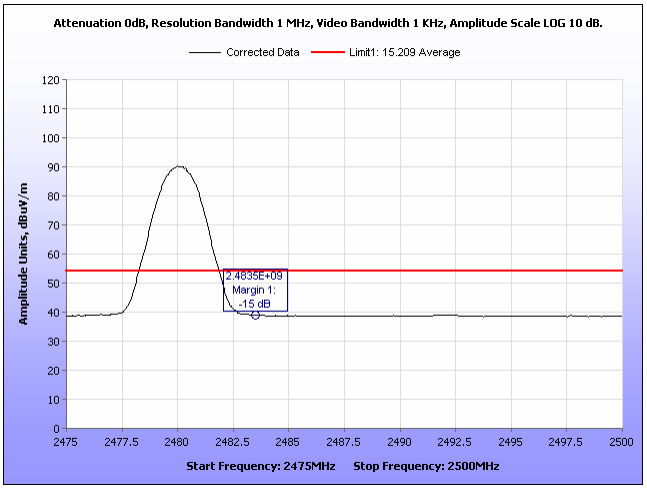
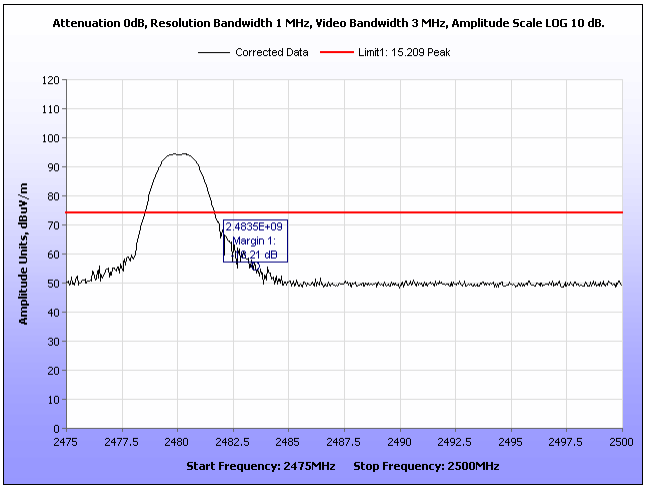



**Plot 16: Radiated Band Edge, High Channel 2480MHz, Average**




**Plot 17: Radiated Band Edge, High Channel 2480MHz, Peak**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## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

**Test Requirement:** **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

**Test Procedure:** For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10$^{th}$ harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Since the EUT had an integral antenna, conducted measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable lost.

See following pages for detailed test results with RF Conducted Spurious Emissions.

**Test Results:** The EUT **completed testing** to the requirements of **§15.247(d)**. No anomalies noted.

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/17/2020

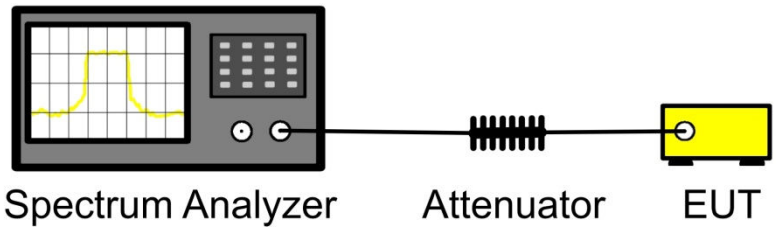


**Figure 5: Block Diagram, Conducted Spurious Emissions Test Setup**


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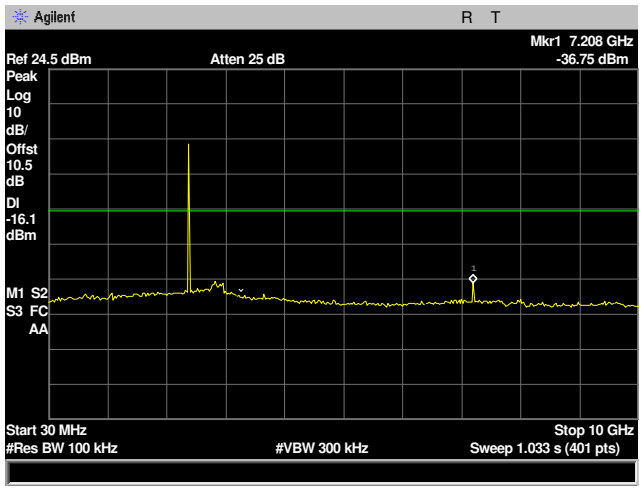
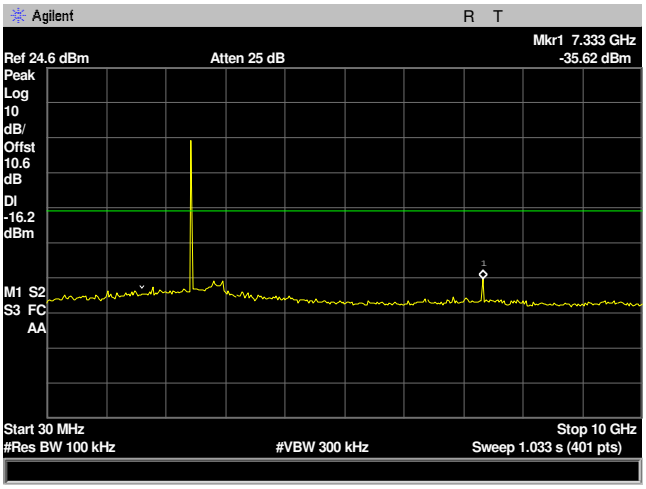
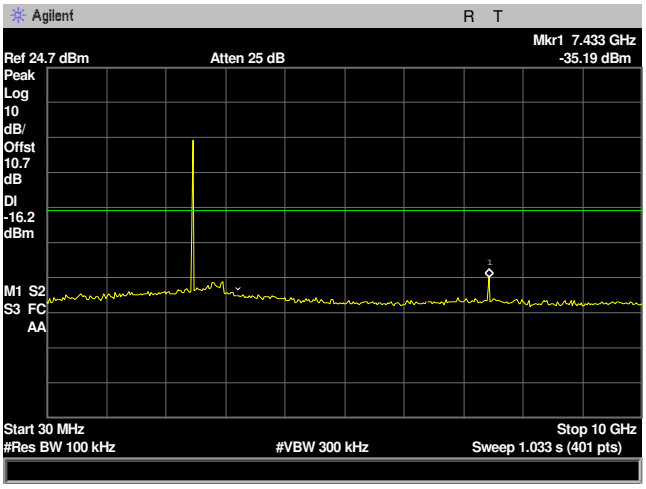



**Plot 18: RF Conducted Spurious Emissions Requirements, 30MHz-10GHz 2402MHz Low Channel**




**Plot 19: RF Conducted Spurious Emissions Requirements, 30MHz-10GHz 2442MHz Mid Channel**




**Plot 20: RF Conducted Spurious Emissions Requirements, 30MHz-10GHz 2480MHz High Channel**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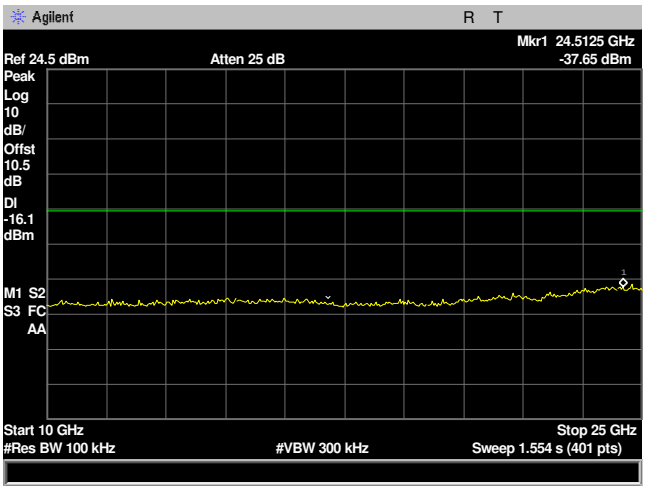
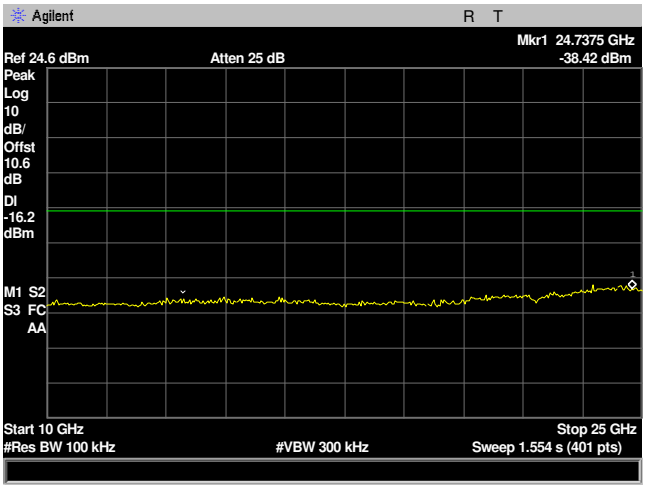
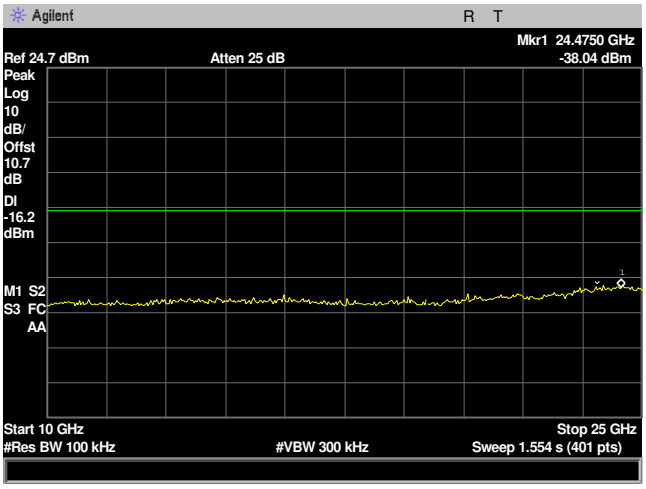



**Plot 21: RF Conducted Spurious Emissions Requirements, 10GHz-25GHz 2402MHz Low Channel**




**Plot 22: RF Conducted Spurious Emissions Requirements, 10GHz-25GHz 2442MHz Mid Channel**




**Plot 23: RF Conducted Spurious Emissions Requirements, 10GHz-25GHz 2480MHz High Channel**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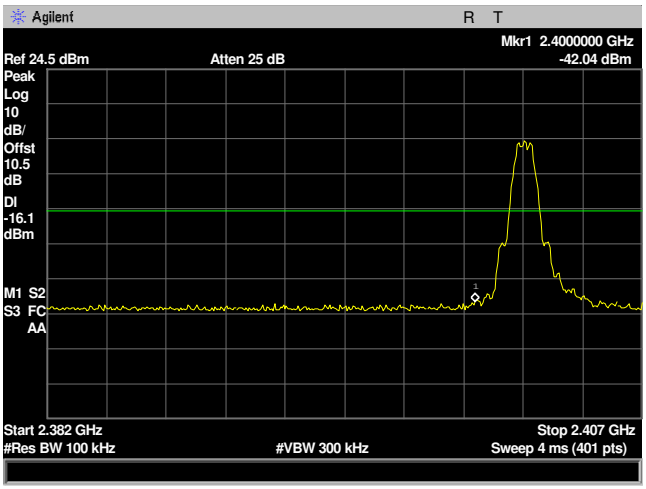
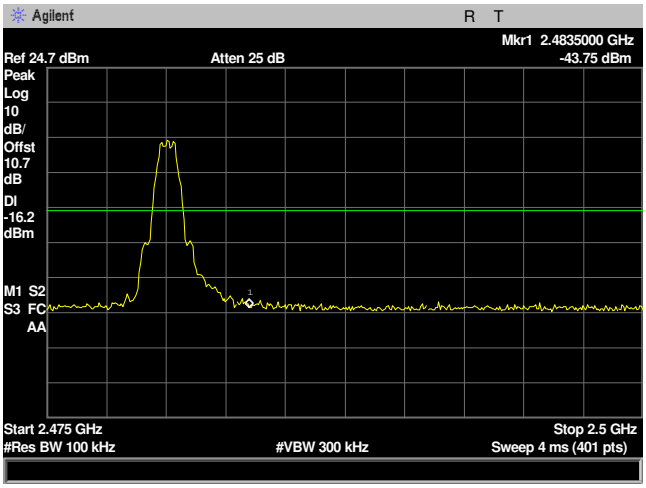



**Plot 24: RF Conducted Band Edge, 2402MHz Low Channel**




**Plot 25: RF Conducted Band Edge, 2480MHz High Channel**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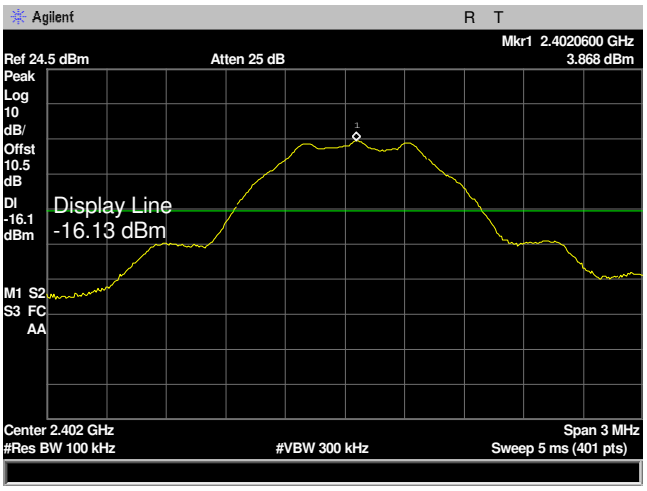
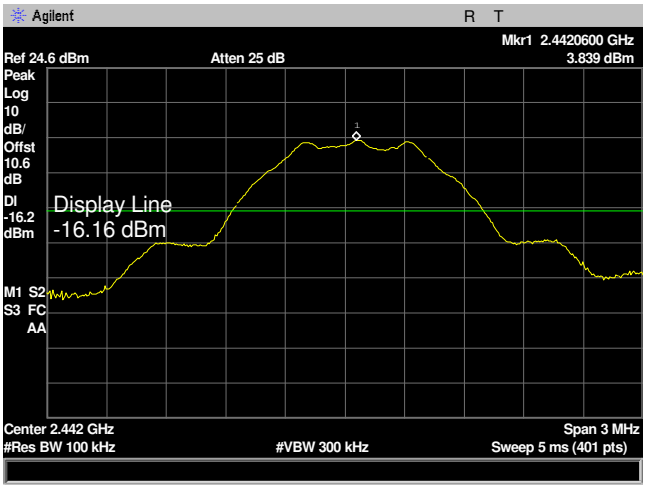
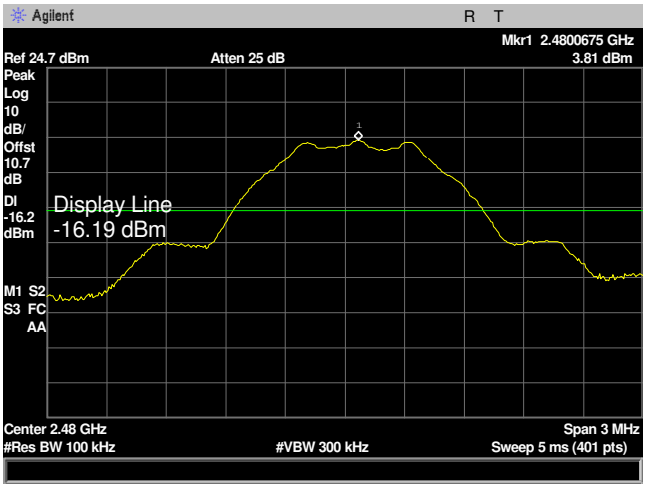



**Plot 26: RF Conducted Band Edge, Reference Level 2402MHz Low Channel**




**Plot 287 RF Conducted Band Edge, Reference Level 2442MHz Mid Channel**




**Plot 28: RF Conducted Band Edge, Reference Level 2480MHz High Channel**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## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.247(e) Peak Power Spectral Density

**Test Requirements:** **§15.247(e):** For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

**Test Procedure:** The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level throughout each of the 100 sweeps of power averaging. The RBW was set to 3 kHz and a VBW set to 9 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

**Test Results:** The EUT **completed testing** to the requirements of **§ 15.247 (e)**. No anomalies noted.

The peak power spectral density was determined from plots on the following page(s).

**Test Engineer(s):** Felix Huang

**Test Date(s):** 12/18/2020

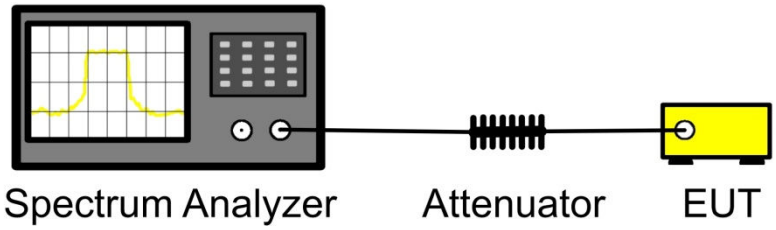


Figure 6: Block Diagram, Peak Power Spectral Density Test Setup

| Power Spectral Density | | | |
|---|---|---|---|
| **Carrier Channel** | **Frequency (MHz)** | **Measured Conducted Power (dBm)** | **Limit (dBm)** |
| Low | 2402 | -10.62 | 8 |
| Mid | 2442 | -10.65 | 8 |
| High | 2480 | -10.81 | 8 |

**Table 16: Peak Power Output, Test Data**


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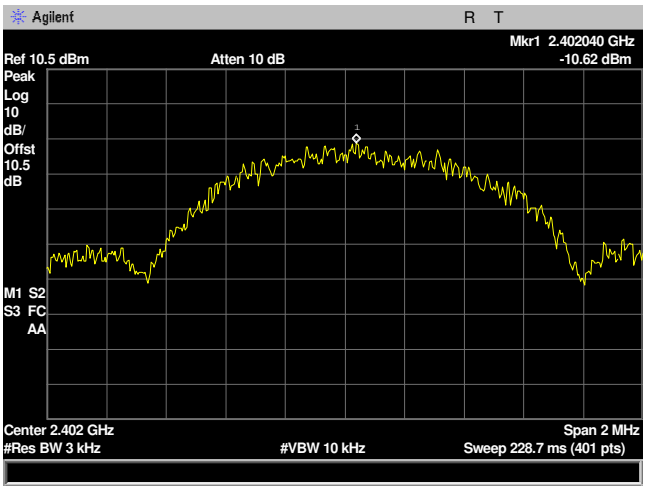
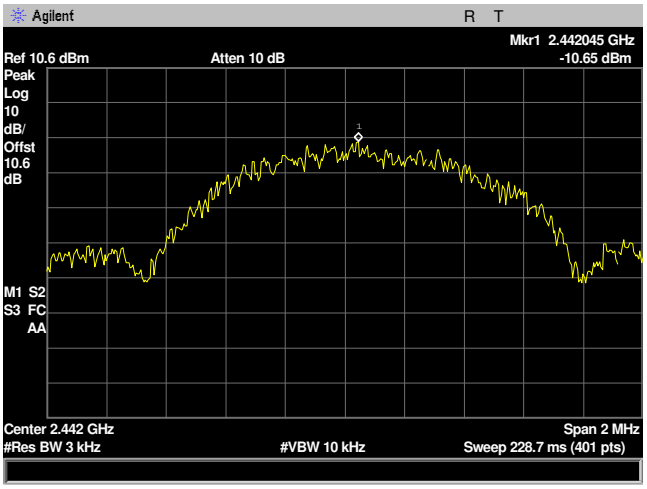
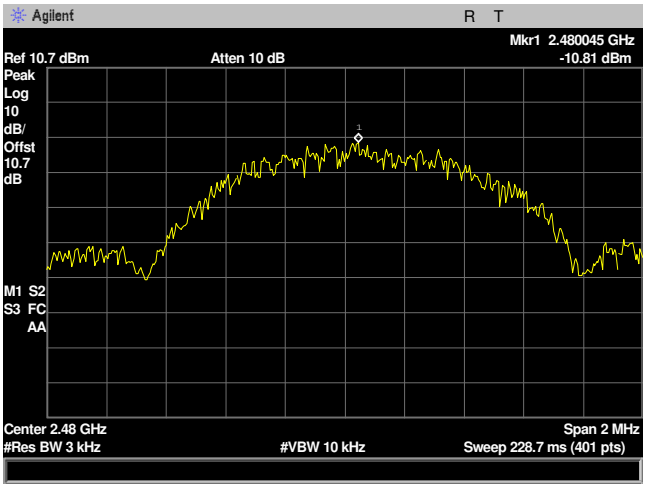



**Plot 29: Peak Power Spectral Density, 2402MHz Low Channel**




**Plot 30: Peak Power Spectral Density, 2442MHz Mid Channel**




**Plot 31: Peak Power Spectral Density, 2480MHz High Channel**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# IV. Test Equipment


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## Test Equipment

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

| ASSET # | NOMENCLATURE | MANUFACTURER | MODEL | LAST CAL | CAL DUE |
|---|---|---|---|---|---|
| 1S2399 | TURNTABLE CONTROLLER | SUNOL SCIENCE | SC99V | FUNCTIONAL VERIFY | |
| 1S3928 | EMI TESTER RECEIVER | ROHDE & SCHWARZ | ESR26 | 03/04/2020 | 03/04/2021 |
| 1S2600 | BILOG ANTENNA | TESEQ | CBL6112D | 03/19/2019 | 03/19/2021 |
| 1S2486 | 5 METER CHAMBER CONTROL ROOM | PANASHIELD | 5 METER CONTROL ROOM | FUNCTIONAL VERIFY | |
| 1S3926 | 1MHZ STEP, 1GHZ COMBO GENERATOR | COM-POWER CORP | CGO-501 | FUNCTIONAL VERIFY | |
| 1S2481 | 10 METER CHAMBER | ETS-LINGREN | DKE-8X8 DBL | FUNCTIONAL VERIFY | |
| 1S406 | DIGITAL BAROMETER | CONTROL CO | 6530 | 6/22/2020 | 06/22/2022 |
| 1S245 | COMB GENERATOR (RADIATED) | COM-POWER | GG510 | FUNCTIONAL VERIFY | |
| 1S2599 | LASER PROBE INTERFACE | AMPLIFIER RESEARCH | F1700 | FUNCTIONAL VERIFY | |
| 1S3826 | DRG HORN ANTENNA | ETS-LINDGREN | 3117 | 12/03/2020 | 12/03/2022 |
| 1S2003 | PXA Signal Analyzer | Keysight | N9030B | 09/15/2020 | 09/15/2021 |

**Table 17: Test Equipment List**

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


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# End of Report


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