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13501 MCCALLEN PASS ● AUSTIN, TX 78753 ● PHONE (512) 287-2500 ● FAX (512) 287-2513

May 6, 2015

Amimon
2 Maskit St. Building D, 2nd Floor
Herzelia, Israel 46733

Dear Arik Israel,

Enclosed is the EMC Wireless test report for compliance testing of the Amimon, Connex Air-Unit as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Title 47 of the CFR, Part 15.407, Subpart E (UNII 1) for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Amimon\ EMC85243-FCC407 UNII 1 Rev. 3)

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# Electromagnetic Compatibility Criteria
# Test Report

for the

**Amimon**
**Model Connex Air-Unit**

**Tested under**
The FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.407 for Intentional Radiators

**MET Report: EMC85243-FCC407 UNII 1 Rev. 3**

May 6, 2015

**Prepared For:**

**Amimon**
**2 Maskit St. Building D, 2nd Floor**
**Herzelia, Israel 46733**

**Prepared By:**
**MET Laboratories, Inc.**
914 W. Patapsco Ave.
Baltimore, MD 21230

# Electromagnetic Compatibility Criteria
# Test Report

for the

## Amimon
## Model Connex Air-Unit

**Tested under**
The FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.407 for Intentional Radiators

Djed Mouada, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Parts 15B, 15.407, of the FCC Rules under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

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# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | April 13, 2015 | Initial Issue. |
| 1 | April 17, 2015 | Revised to reflect customer corrections. |
| 2 | April 30, 2015 | Revised to reflect customer corrections. |

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# List of Terms and Abbreviations

| | |
|---|---|
| **AC** | **A**lternating **C**urrent |
| **ACF** | **A**ntenna **C**orrection **F**actor |
| **Cal** | **Cal**ibration |
| ***d*** | **M**easurement **D**istance |
| **dB** | **D**eci**b**els |
| **dBµA** | **D**eci**b**els above one **micro**amp |
| **dBµV** | **D**eci**b**els above one **micro**volt |
| **dBµA/m** | **D**eci**b**els above one **micro**amp **per m**eter |
| **dBµV/m** | **D**eci**b**els above one **micro**volt **per m**eter |
| **DC** | **D**irect **C**urrent |
| **E** | **E**lectric Field |
| **DSL** | **D**igital **S**ubscriber **L**ine |
| **ESD** | **E**lectro**s**tatic **D**ischarge |
| **EUT** | **E**quipment **U**nder **T**est |
| ***f*** | **F**requency |
| **FCC** | **F**ederal **C**ommunications **C**ommission |
| **GRP** | **G**round **R**eference **P**lane |
| **H** | Magnetic Field |
| **HCP** | **H**orizontal **C**oupling **P**lane |
| **Hz** | **H**ert**z** |
| **IEC** | **I**nternational **E**lectrotechnical **C**ommission |
| **kHz** | **K**ilo**h**ert**z** |
| **kPa** | **K**ilo**pa**scal |
| **kV** | **K**ilo**v**olt |
| **LISN** | **L**ine **I**mpedance **S**tabilization **N**etwork |
| **MHz** | **M**ega**h**ertz |
| **µH** | **Microh**enry |
| µ | **Microf**arad |
| **µs** | **Micros**econds |
| **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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## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Amimon Connex Air-Unit, with the requirements of Part 15, §15.407. 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 Connex Air-Unit. Amimon should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Connex Air-Unit, 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, §15.407, in accordance with Amimon, purchase order number 15000104. All tests were conducted using measurement procedure ANSI C63.4-2003.

| FCC Reference | Description | Results |
|---|---|---|
| §15.203 | Antenna Requirements | Compliant |
| §15.207 | AC Conducted Emissions 150KHz – 30MHz | Not Applicable |
| §15.403 (i) | 26dB Occupied Bandwidth | Compliant |
| §15.407 (a)(1)(ii) | Conducted Transmitter Output Power | Compliant |
| §15.407 (a)(1)(ii) | Power Spectral Density | Compliant |
| §15.407 (b)(1), (6), (7) | Undesirable Emissions (15.205/15.209 - General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | Compliant |
| §15.407(f) | RF Exposure | Compliant |

**Table 1. Executive Summary of EMC Part 15.407 ComplianceTesting**

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# II. Equipment Configuration

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# A. Overview

MET Laboratories, Inc. was contracted by Amimon to perform testing on the Connex Air-Unit, under Amimon's purchase order number 15000104.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Amimon Connex Air-Unit.

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

| | | |
|---|---|---|
| **Model(s) Tested:** | Connex Air-Unit | |
| **Model(s) Covered:** | Connex Air-Unit | |
| **EUT Specifications:** | Primary Power: DC | |
| | FCC ID: VQSAMNBZT1 | |
| | Type of Modulations: | OFDM |
| | Equipment Code: | NII |
| | Peak RF Output Power: | 23.708 dBm |
| | EUT Frequency Ranges: | 5.180 to 5.240 GHz |
| **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:** | Djed Mouada | |
| **Report Date(s):** | May 6, 2015 | |

**Table 2. EUT Summary**

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## B. References

| | |
|---|---|
| **CFR 47, Part 15, Subpart E** | Unlicensed National Information Infrastructure Devices (UNII) |
| **ANSI C63.4:2003** | 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 C63.10-2009** | American National Standard for Testing Unlicensed Wireless Devices |

**Table 3. References**

## C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

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

## D. Description of Test Sample

The Amimon Connex Air-Unit, Equipment Under Test (EUT), is designed to modulate and transmit downstream video and audio content over the wireless medium and receive a control channel over the wireless upstream. The modulation uses a 40 or 20 MHz bandwidth and is carried over the 5GHz unlicensed band.

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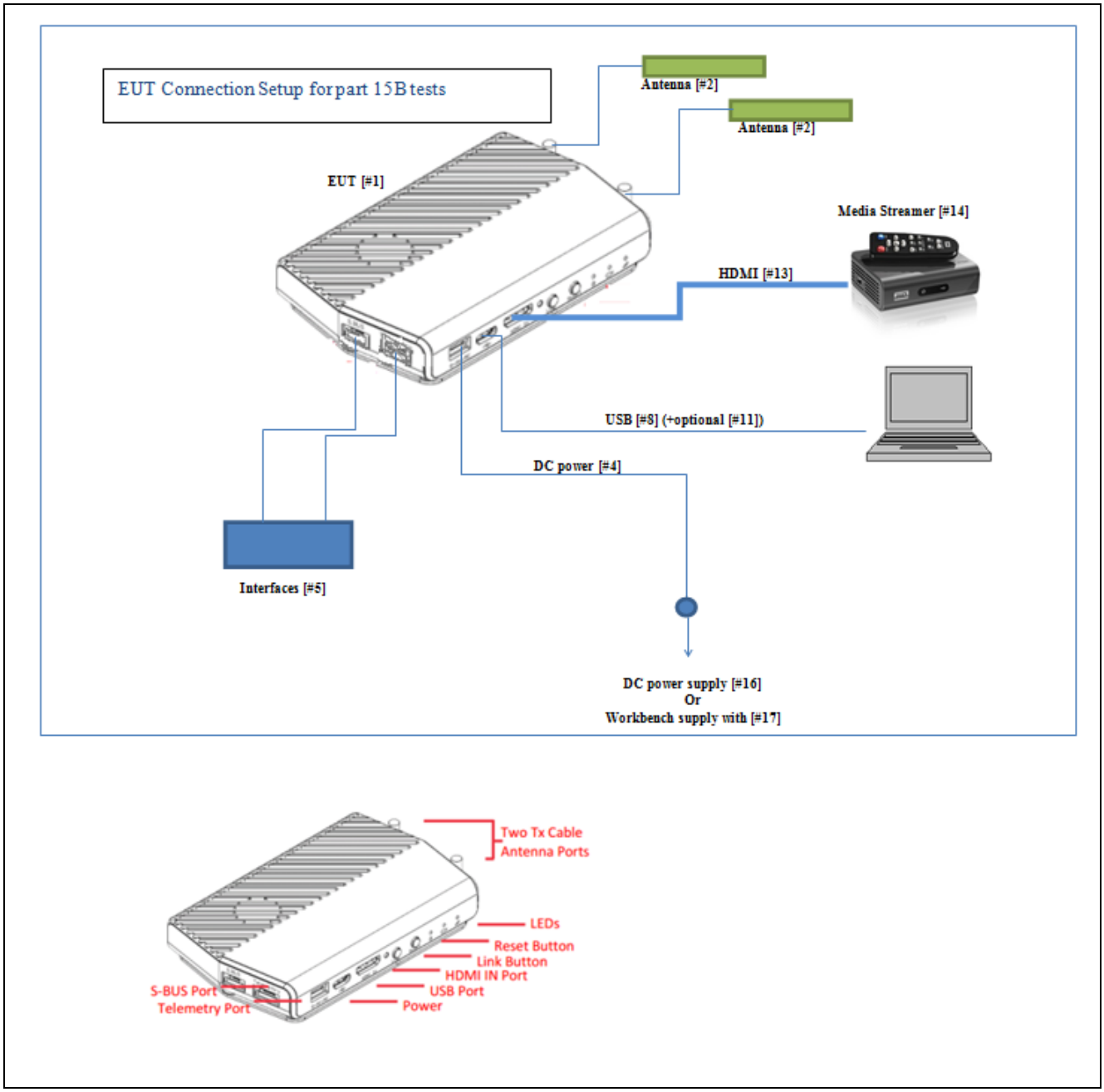


**Figure 1. Block Diagram of Test Configuration**

## E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

| Ref. ID | Name / Description | Model Number | Part Number | Serial Number | Revision |
|---|---|---|---|---|---|
| 1 | EUT – Connex Air-Unit | -- | -- | -- | -- |
| 2 | Antenna | -- | -- | -- | -- |

**Table 4. 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 |
|---|---|---|---|
| 5 | S-Bus + Telemetry terminated cable | Amimon | -- |
| 4 | DC Power cable | Amimon | -- |
| 8 | USB Cable | Wanshih | -- |
| 13 | HDMI Type A-B cable | Wanshih | -- |
| 14 | HDMI Media streamer | WD | -- |
| -- | PC | Dell | -- |

**Table 5. Support Equipment**

## G. Ports and Cabling Information

| Ref. ID | Port Name on EUT | Cable Description | Qty. | Length (m) | Shielded (Y/N) | Termination Point |
|---|---|---|---|---|---|---|
| -- | S-Bus Port | -- | 1 | -- | No | -- |
| -- | Telemetry Port | -- | 1 | -- | No | -- |
| -- | Power | -- | 1 | -- | No | -- |
| -- | USB Port | -- | 1 | -- | Yes | -- |
| -- | HDMI in Port | -- | 1 | -- | | -- |

**Table 6. Ports and Cabling Information**

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## H. Mode of Operation

The Connex Air-Unit is programmed to transmit a 100% duty cycle of streaming auto generated video test pattern. The frequency and power of operation may be programmed by the LAB using a PC tool and a serial communication connector.

## I. Method of Monitoring EUT Operation

Slow blinking (on-off once during 1sec) blue LED indicates that board is functioning.

Fast blinking (on-off 3-4 times during 1sec) same LED, means that the board is out of calibration.

When this LED is not blinking this means that board has a certain problem.

Using the SW tool to configure the board, when configuration ended successfully a clear green indication appears, while a red bad indication appears when the desired configuration fails.

## 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 Amimon upon completion of testing.

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# III. Electromagnetic Compatibility Criteria for Intentional Radiators

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.203 Antenna Requirement

**Test Requirement:** **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

**Results:** The EUT as tested is compliant the criteria of §15.203. The EUT has a unique antenna connector. EUT uses two types of antennas.

| Antenna Type | Gain (dBi) |
|---|---|
| Dipole Rubber Ducky | 2 |
| PCB | 2 |

**Table 7. Antenna List**

**Test Engineer(s):** Djed Mouada

**Test Date(s):** 03/18/15

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

**Test Results:** The EUT was not applicable with this requirement. EUT is battery operated.

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## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15. 403(i) 26dB Bandwidth

**Test Requirements:** **§ 15.403 (i):** For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

**Test Procedure:** The transmitter was set to low, mid, and high operating frequencies at the highest output power and connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth, VBW > RBW. The 26 dB Bandwidth was measured and recorded.

**Test Results** The 26 dB Bandwidth was compliant with the requirements of this section and was determined from the plots on the following pages.

**Test Engineer(s):** Djed Mouada

**Test Date(s):** 03/23/15

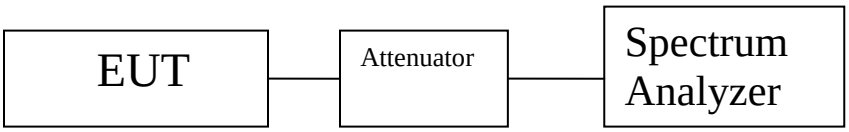


**Figure 2. Occupied Bandwidth, Test Setup**

## Occupied Bandwidth Test Results

| | Frequency (MHz) | Occupied Bandwidth (MHz) |
|---|---|---|
| Antenna 1 | 5180 (20 MHz) | 19.286 |
| | 5200 (20 MHz) | 19.873 |
| | 5220(20 MHz) | 19.492 |
| | 5190 (40 MHz) | 49.904 |
| | 5230 (40 MHz) | 50.000 |
| Antenna 2 | 5180 (20 MHz) | 19.698 |
| | 5200 (20 MHz) | 19.709 |
| | 5220(20 MHz) | 19.406 |
| | 5190 (40 MHz) | 48.272 |
| | 5230 (40 MHz) | 49.850 |

**Table 9. 26 dB Occupied Bandwidth, Test Results**

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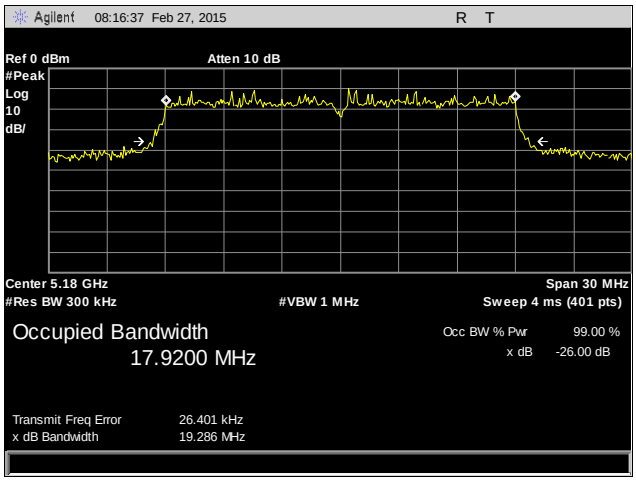
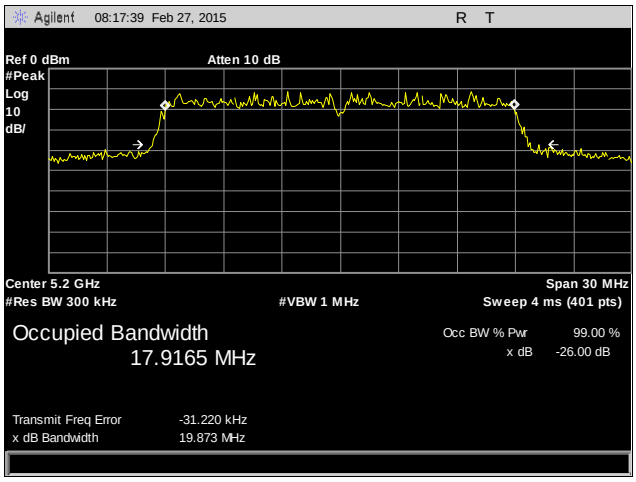
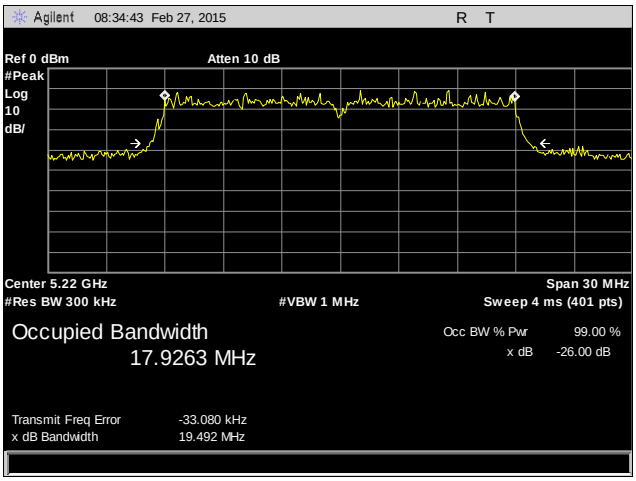
## 26 dB Occupied Bandwidth Test Results, Antenna 1



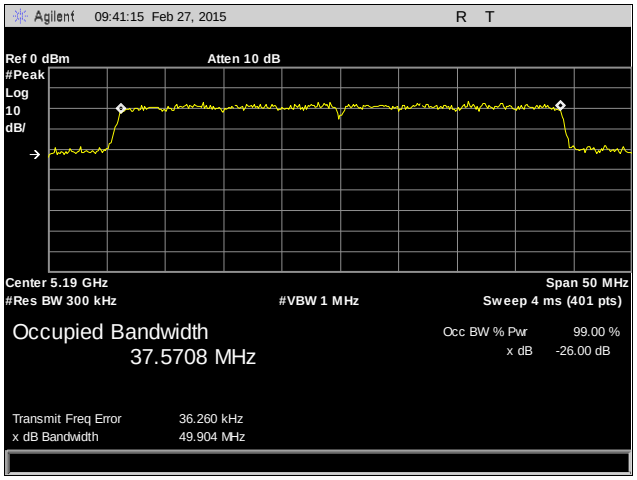

**Plot 1. 26 dB Occupied Bandwidth, 5180 MHz, Antenna 1**



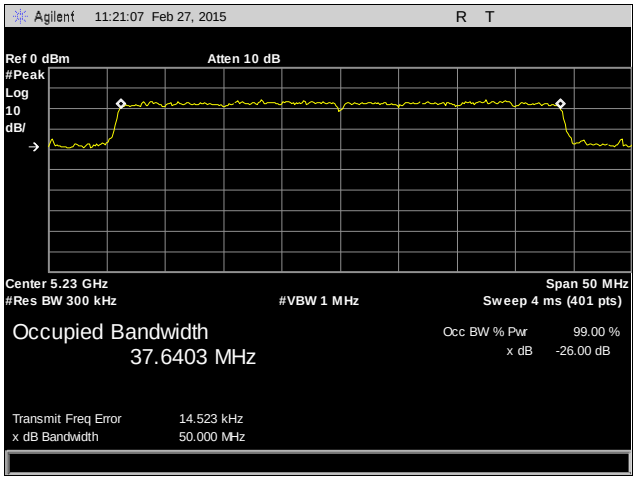

**Plot 2. 26 dB Occupied Bandwidth, 5200 MHz, Antenna 1**




**Plot 3. 26 dB Occupied Bandwidth, 5220 MHz, Antenna 1**

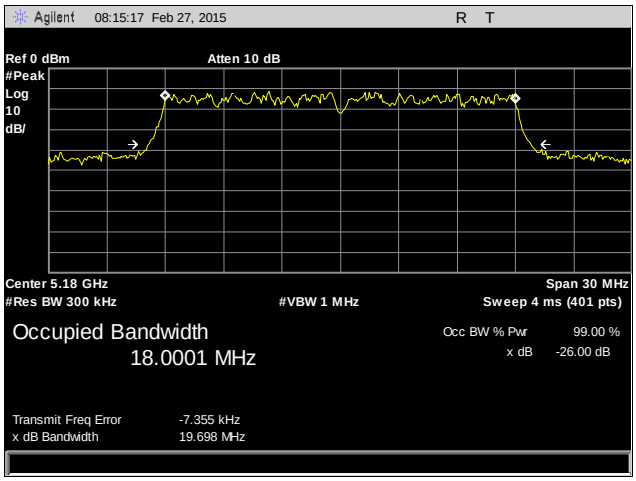



**Plot 4. 26 dB Occupied Bandwidth, 5190 MHz, Antenna 1**

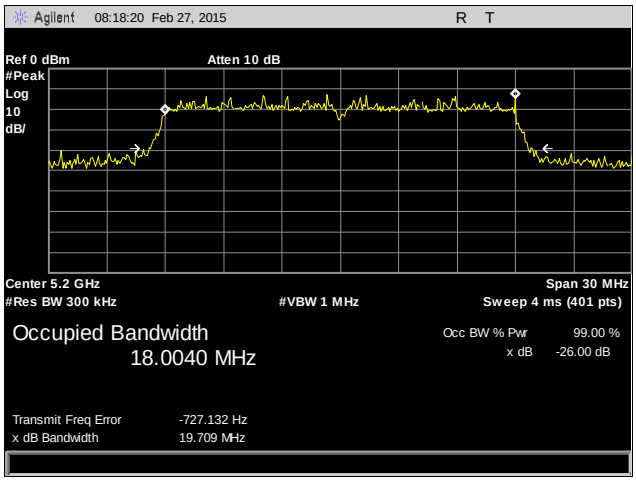



**Plot 5. 26 dB Occupied Bandwidth, 5230 MHz, Antenna 1**

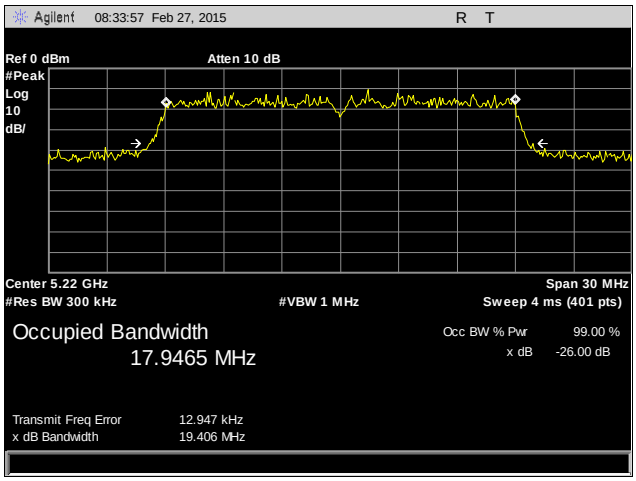
## 26 dB Occupied Bandwidth Test Results, Antenna 2




**Plot 6. 26 dB Occupied Bandwidth, 5180 MHz, Antenna 2**




**Plot 7. 26 dB Occupied Bandwidth, 5200 MHz, Antenna 2**




**Plot 8. 26 dB Occupied Bandwidth, 5220 MHz, Antenna 2**

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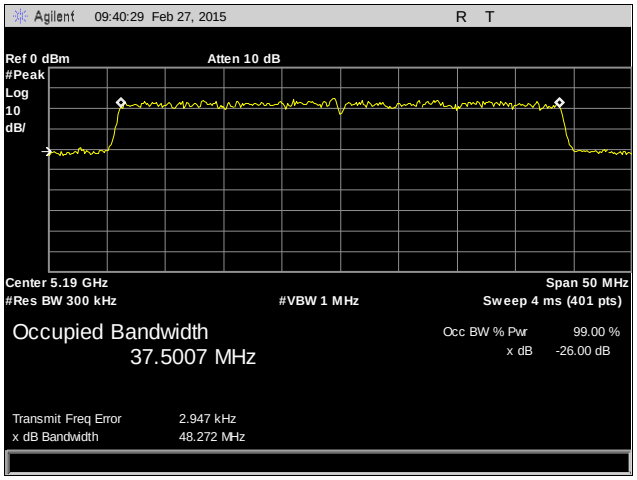
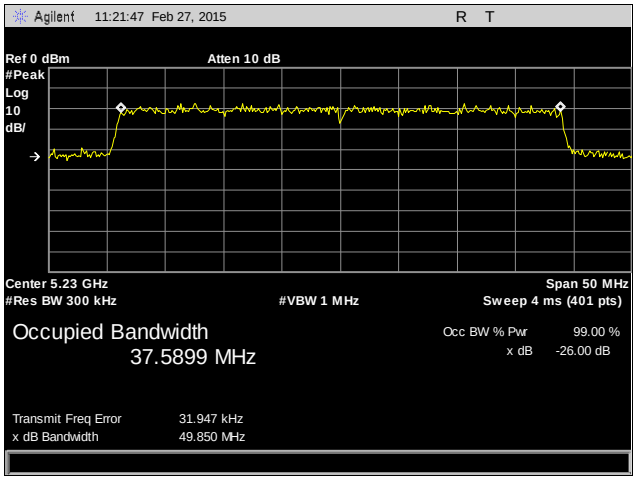



**Plot 9. 26 dB Occupied Bandwidth, 5190 MHz, Antenna 2**




**Plot 10. 26 dB Occupied Bandwidth, 5230 MHz, Antenna 2**

## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15. 407(a)(1)(i) RF Power Output

**Test Requirements:** **§15.407(a)(1)(i):** For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi.

**Test Procedure:** The EUT was connected to a spectrum analyzer through an attenuator and set to transmit continuously on the low, mid, and high channels. Its power was measured according to measurement method SA-1, as described in 789033 D02 General UNII Test Procedures New Rule v01. Plots were corrected for attenuator and cable loss. Power levels shown in tables below are the maximum that will be used for each type of antenna in 15.203.

**Test Results:** Equipment was compliant with the Peak Power Output limits of §15.401(a)(1)(i)
**Test Engineer(s):** Djed Mouada

**Test Date(s):** 03/23/15

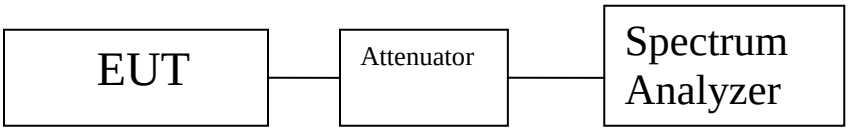



**Figure 3. Power Output Test Setup**

| Frequency (MHz) | Antenna 1 Power (dBm) | Antenna 2 Power (dBm) | Sum (dBm) | Limit (dBm) | Margin (dB) | GUI Setting |
|---|---|---|---|---|---|---|
| 5180 (20MHz) | 19.62 | 17.89 | 21.851 | 30 | -8.149 | 20 |
| 5220 (20MHz) | 19.83 | 18.02 | 22.029 | 30 | -7.971 | 22 |
| 5240 (20MHz) | 21.1 | 18.71 | 23.078 | 30 | -6.922 | 22 |
| 5190 (40 MHz) | 15.4 | 14.25 | 17.873 | 30 | -12.127 | 18 |
| 5230(40 MHz) | 18.23 | 17.86 | 21.059 | 30 | -8.941 | 22 |

**Table 10. RF Output Power**

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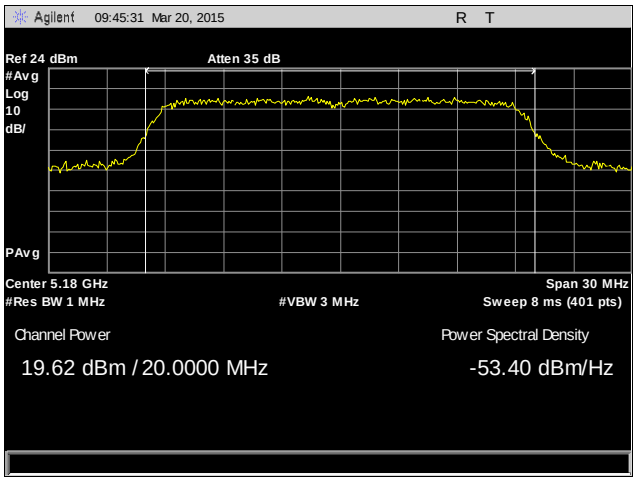
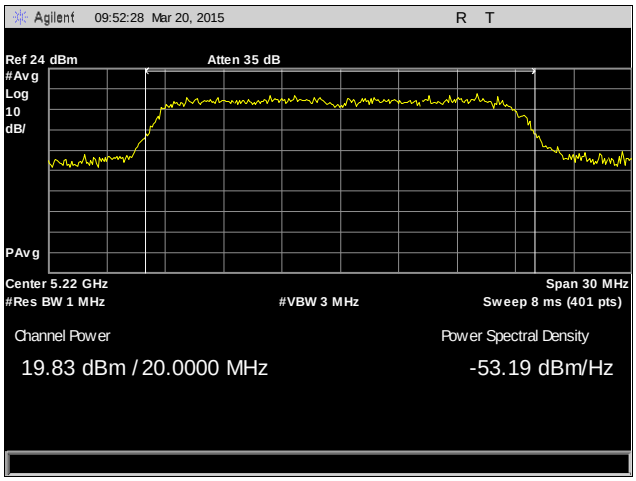
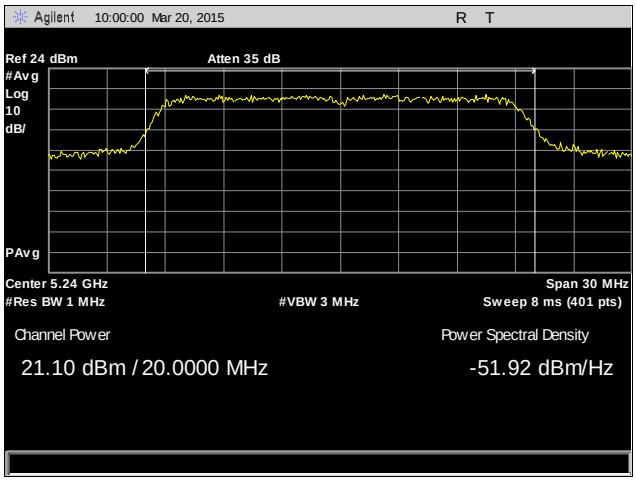
## Peak Power Output Test Results, Antenna 1




**Plot 11. Peak Power Output, 5180 MHz, Antenna 1**




**Plot 12. Peak Power Output, 5220 MHz, Antenna 1**




**Plot 13. Peak Power Output, 5240 MHz, Antenna 1**

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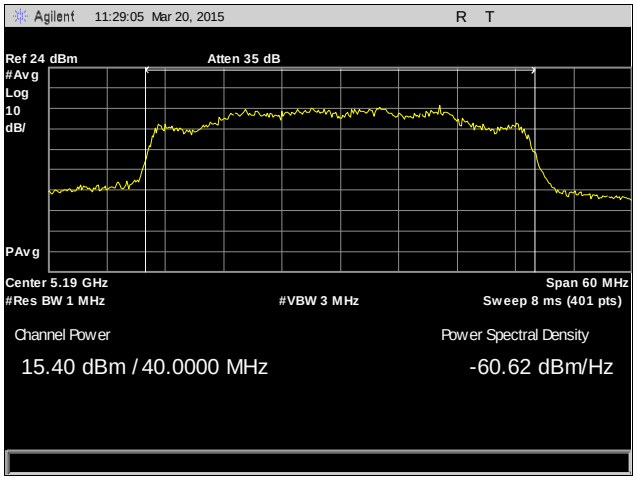
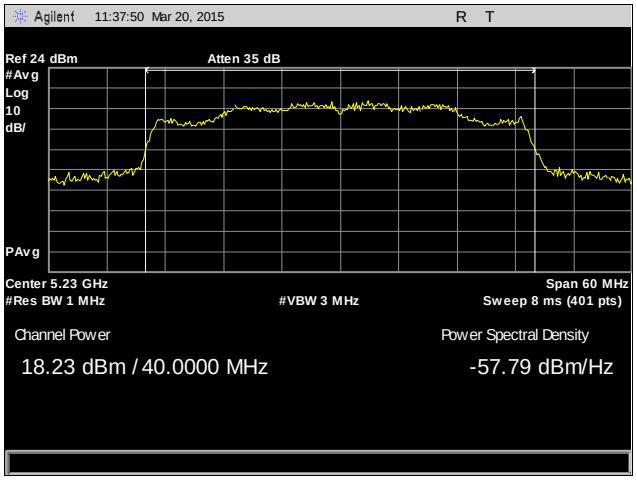



**Plot 14. Peak Power Output, 5190 MHz, Antenna 1**




**Plot 15. Peak Power Output, 5230 MHz, Antenna 1**

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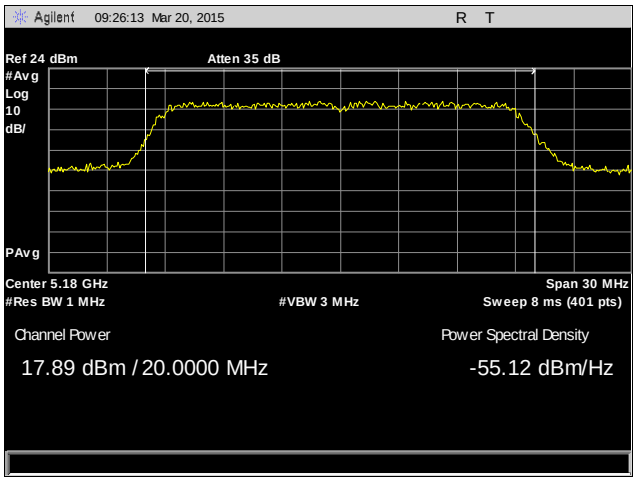
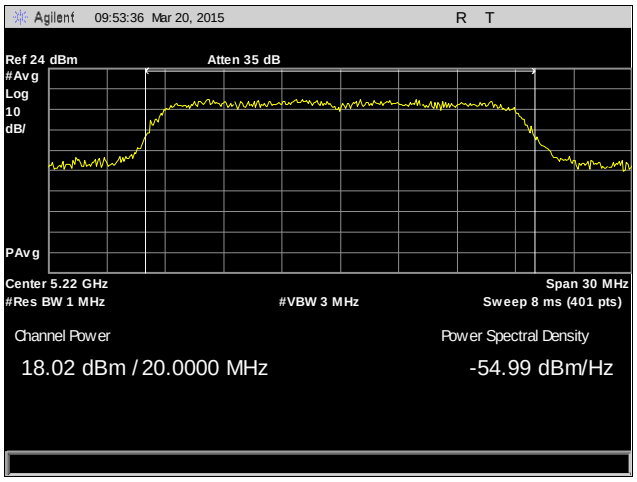
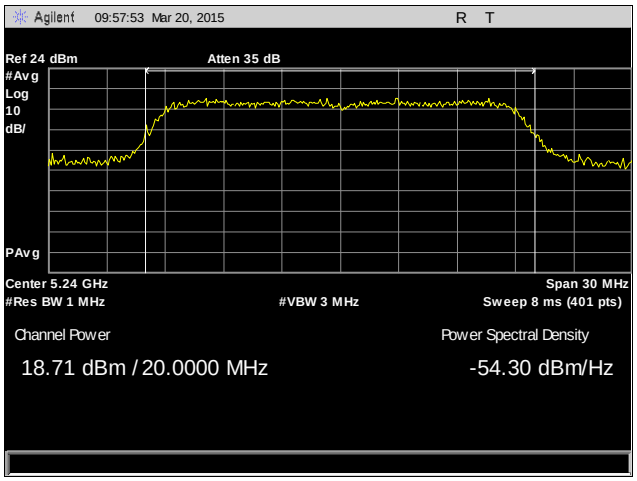
## Peak Power Output Test Results, Antenna 2




**Plot 16. Peak Power Output, 5180 MHz, Antenna 2**




**Plot 17. Peak Power Output, 5220 MHz, Antenna 2**




**Plot 18. Peak Power Output, 5240 MHz, Antenna 2**

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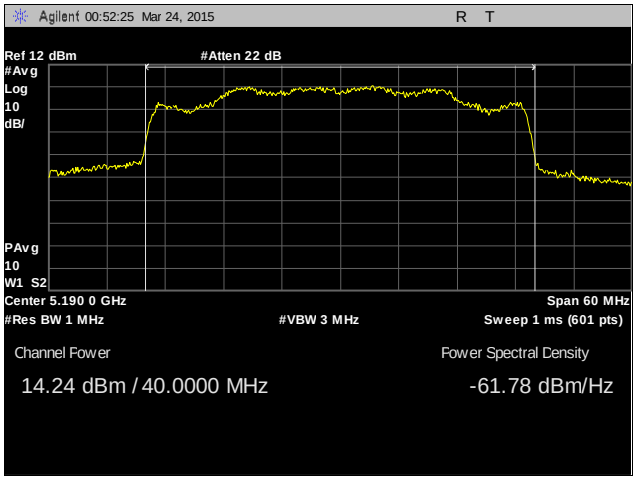
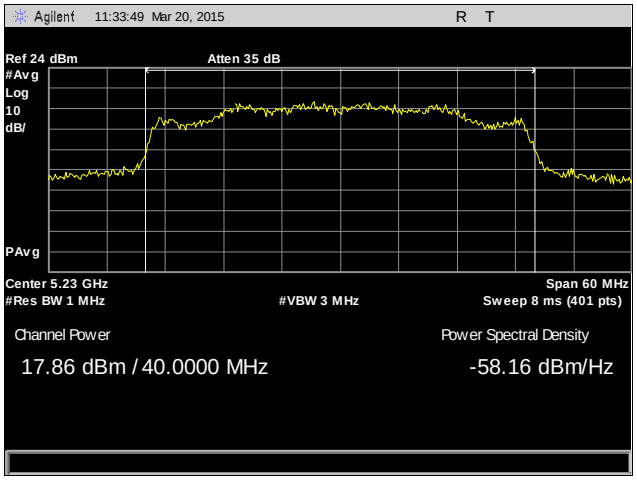



**Plot 19. Peak Power Output, 5190 MHz, Antenna 2**




**Plot 20. Peak Power Output, 5230 MHz, Antenna 2**

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## Electromagnetic Compatibility Criteria for Intentional Radiators

### §15.407(a)(1)(i) Peak Power Spectral Density

**Test Requirements:** **§ 15.407(a)(1)(i):** In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

**Test Procedure:** The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level on the EUT. The RBW was set to 1MHz and the VBW was set to 3MHz. The method of measurement used was method SA-1 from 789033 D02 General UNII Test Procedures New Rule v01. Plots are correct for attenuators and cable loss.

**Test Results:** Equipment was compliant with the peak power spectral density limits of §15.407 (a)(1)(i) The peak power spectral density was determined from plots on the following page(s).

**Test Engineer(s):** Djed Mouada

**Test Date(s):** 03/23/15

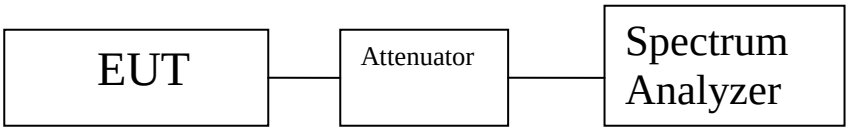


**Figure 4. Power Spectral Density Test Setup**

| Frequency (MHz) | Antenna 1 PSD (dBm) | Antenna 2 PSD (dBm) | Sum (dBm) | Limit (dBm) | Margin (dB) | GUI Setting |
|---|---|---|---|---|---|---|
| 5180 (20MHz) | 8.53 | 7.93 | 11.251 | 17 | -5.749 | 20 |
| 5220 (20MHz) | 8.285 | 5.929 | 10.275 | 17 | -6.725 | 22 |
| 5240 (20MHz) | 8.24 | 7.534 | 10.912 | 17 | -6.088 | 22 |
| 5190 (40 MHz) | 2.917 | 4.46 | 6.767 | 17 | -10.233 | 18 |
| 5230 (40 MHz) | 7.261 | 5.226 | 9.372 | 17 | -7.628 | 22 |

**Table 11. Peak Power Spectral Density, Test Results**

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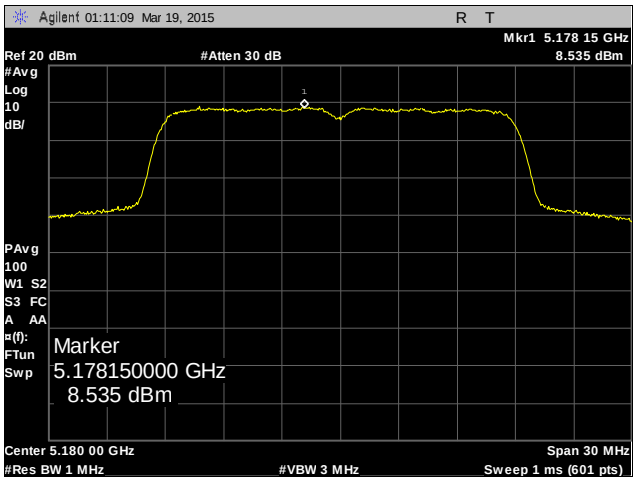
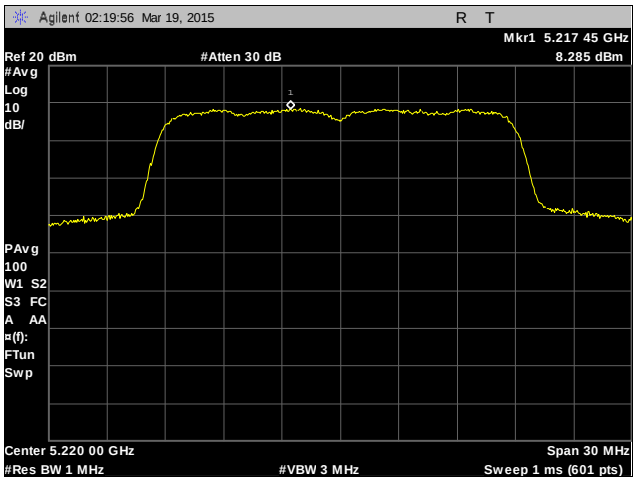
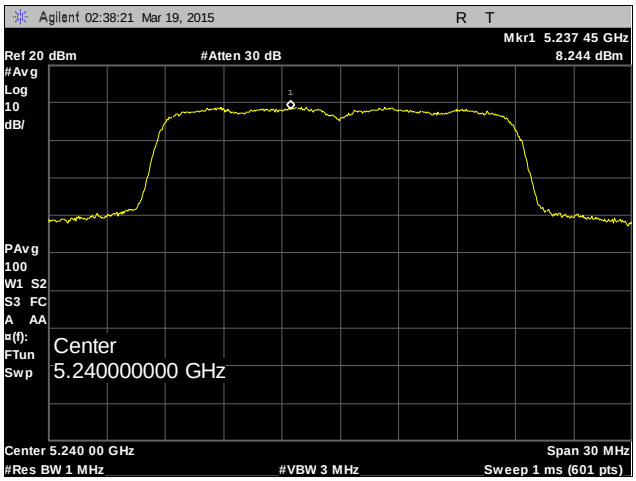
## Peak Power Spectral Density Test Results, Antenna 1




**Plot 21. Peak Power Spectral Density, 5180 MHz, Antenna 1**




**Plot 22. Peak Power Spectral Density, 5220 MHz, Antenna 1**




**Plot 23. Peak Power Spectral Density, 5240 MHz, Antenna 1**

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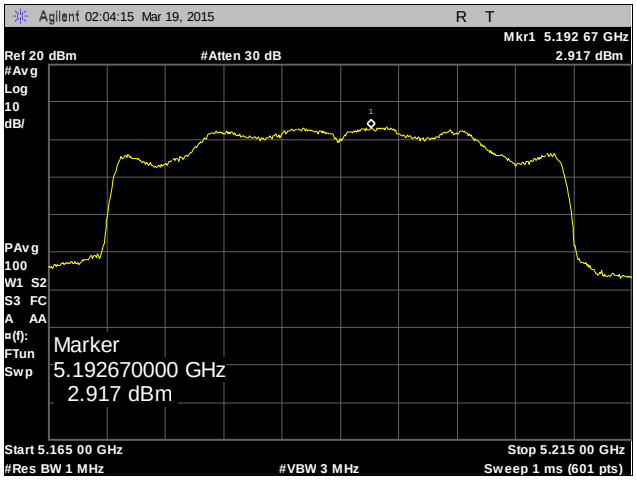
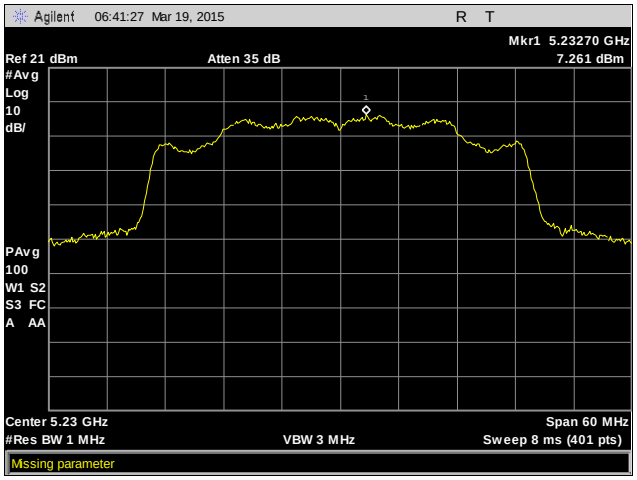



**Plot 24. Peak Power Spectral Density, 5190 MHz, Antenna 1**




**Plot 25. Peak Power Spectral Density, 5230 MHz, Antenna 1**

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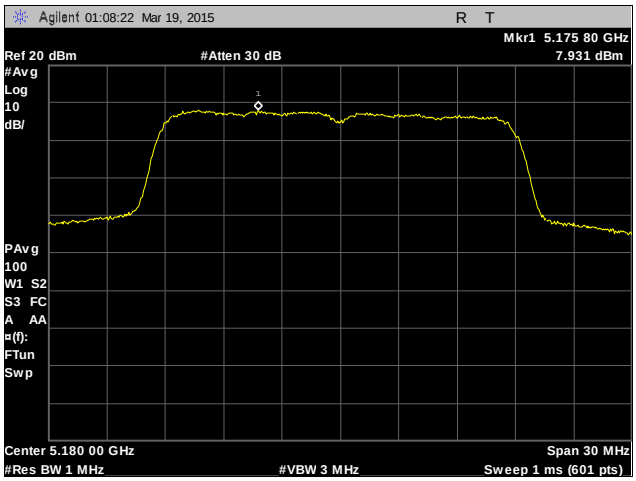
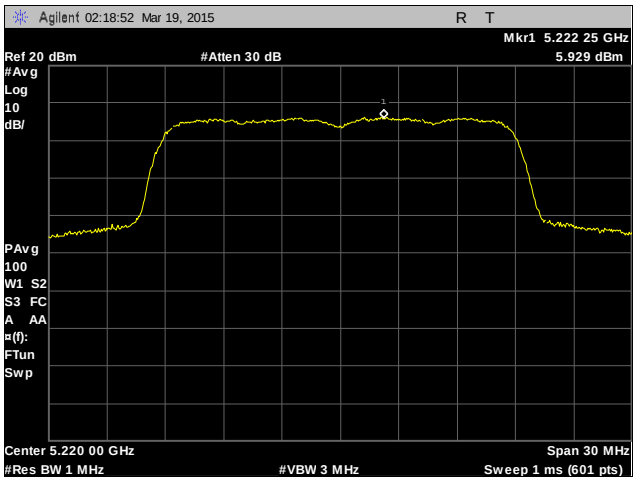
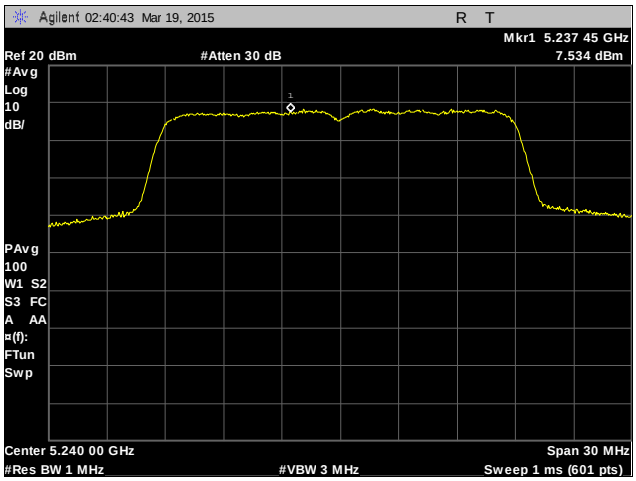
## Peak Power Spectral Density Test Results, Antenna 2




**Plot 26. Peak Power Spectral Density, 5180 MHz, Antenna 2**




**Plot 27. Peak Power Spectral Density, 5220 MHz, Antenna 2**




**Plot 28. Peak Power Spectral Density, 5240 MHz, Antenna 2**

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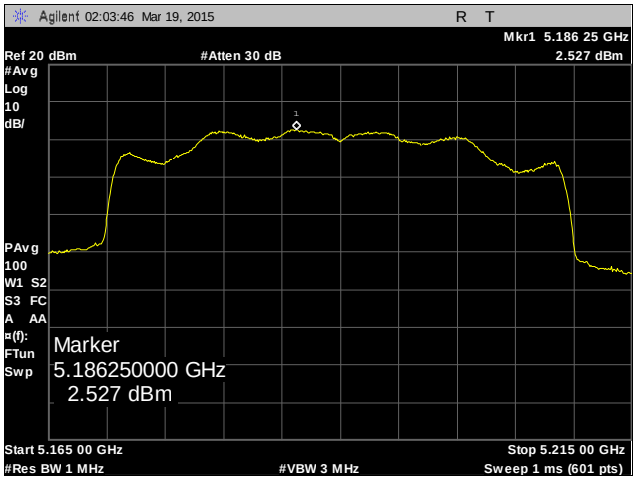
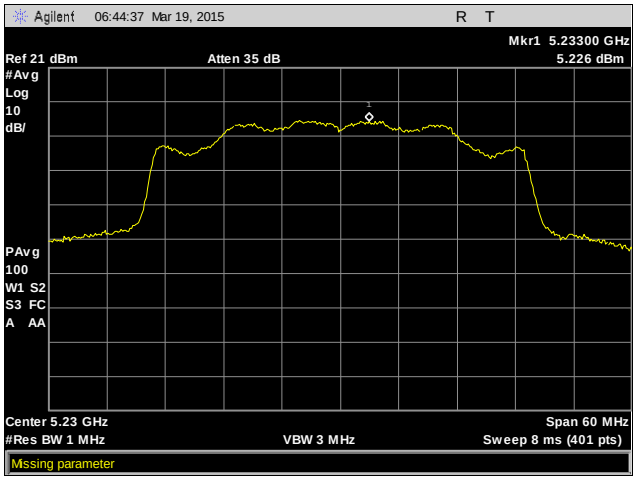



**Plot 29. Peak Power Spectral Density, 5190 MHz, Antenna 2**




**Plot 30. Peak Power Spectral Density, 5230 MHz, Antenna 2**

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## Electromagnetic Compatibility Criteria for Intentional Radiators

### §15.407(b)(1), §15.407(b)(6), & §15.407(b)(7) Undesirable Emissions

**Test Requirements:** **§15.407(b)(1), § 15.407(b)(6), § 15.407(b)(7)**; **§15.205:** Emissions outside the frequency band.

**§15.407(b)(1):** For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz.

**§15.407(b)(1):** For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

**§15.407(b)(6):** Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

**§15.407(b)(7):** The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

**Test Procedure:** The transmitter was placed on an 80cm wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast height to determine worst case orientation for maximum emissions. A preamp was used in the range from 7-18GHz to improve noise floor. Plots were corrected for cable loss, antenna, and preamp gain.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth. The procedure was used for average.

For measurements above 1 GHz, measurements were made with a Peak detector with 1 MHz resolution bandwidth. A notch filter was use to filter out the transmitting channel. Where the spurious emissions fell into a restricted band, measurements were also made with an average detector to make sure they complied with 15.209 limits. Only noise floor was seen above 18 GHz. Worst case emissions shown by antenna.

**Test Results:** The EUT was compliant with the Radiated Emission limits for Intentional Radiators. See following pages for detailed test results. All emissions above 18 GHz were at the noise floor of the receiver.

**Test Engineer(s):** Djed Mouada

**Test Date(s):** 03/23/15

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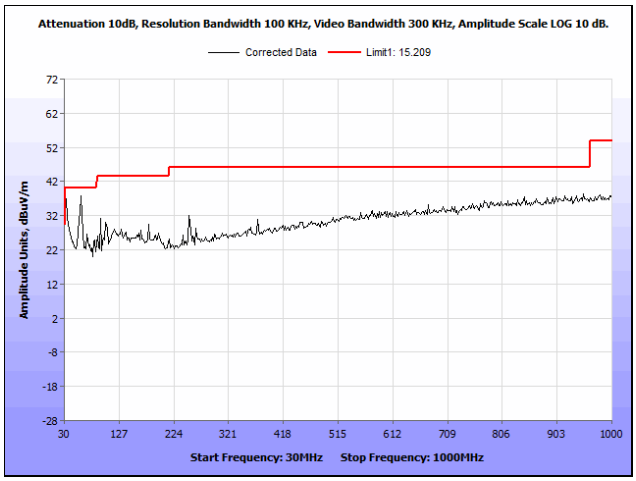
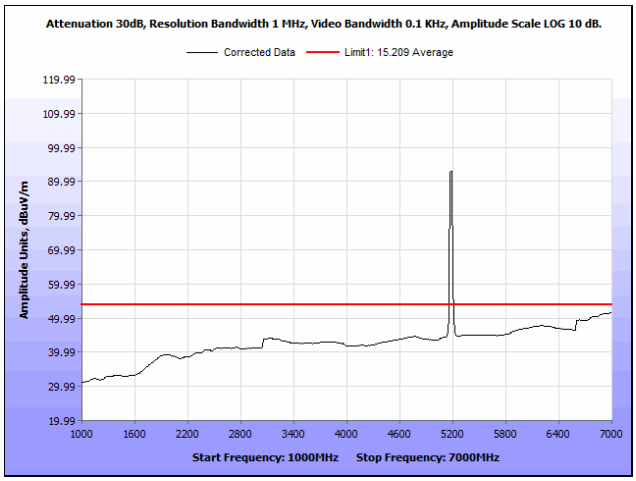
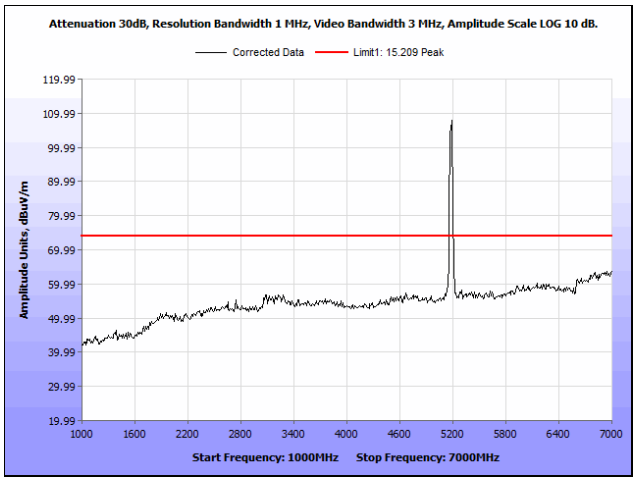
## Radiated Spurious Emissions, Rubber Ducky Antenna




**Plot 31. Radiated Spurious Emissions, 5180 MHz, Rubber Ducky Antenna, 30 MHz – 1 GHz**




**Plot 32. Radiated Spurious Emissions, 5180 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Average**




**Plot 33. Radiated Spurious Emissions, 5180 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Peak**

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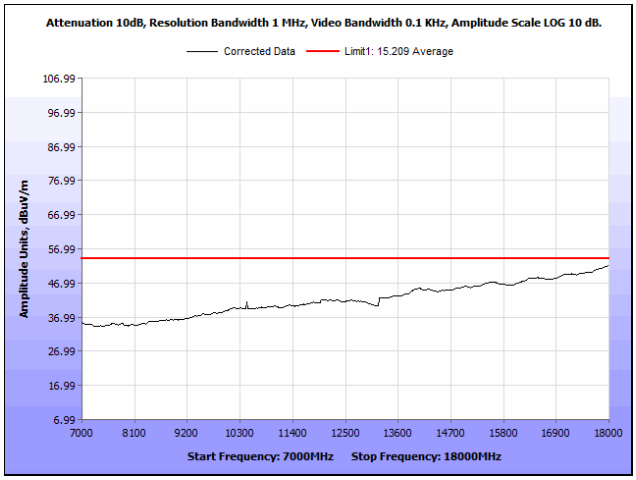
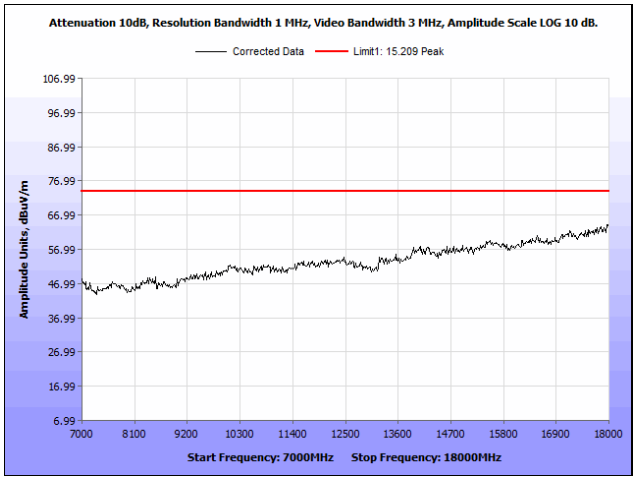
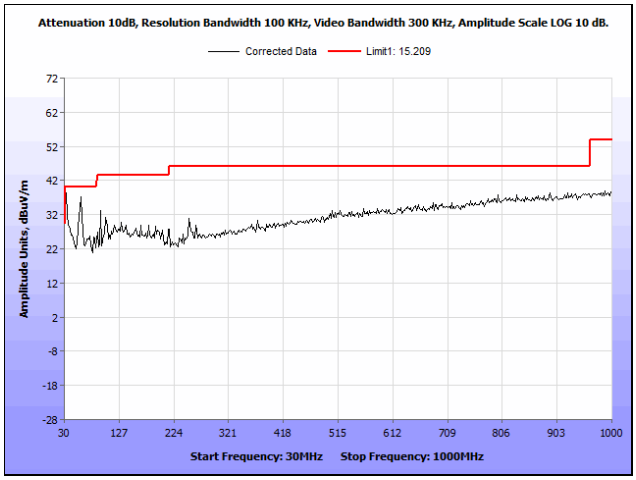



**Plot 34. Radiated Spurious Emissions, 5180 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Average**




**Plot 35. Radiated Spurious Emissions, 5180 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Peak**




**Plot 36. Radiated Spurious Emissions, 5200 MHz, Rubber Ducky Antenna, 30 MHz – 1 GHz**

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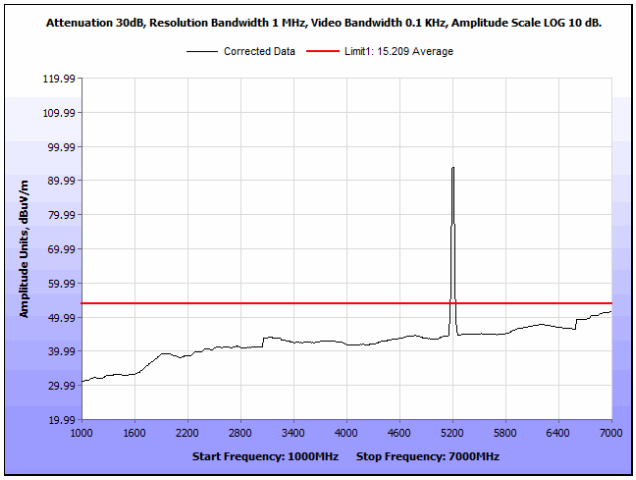
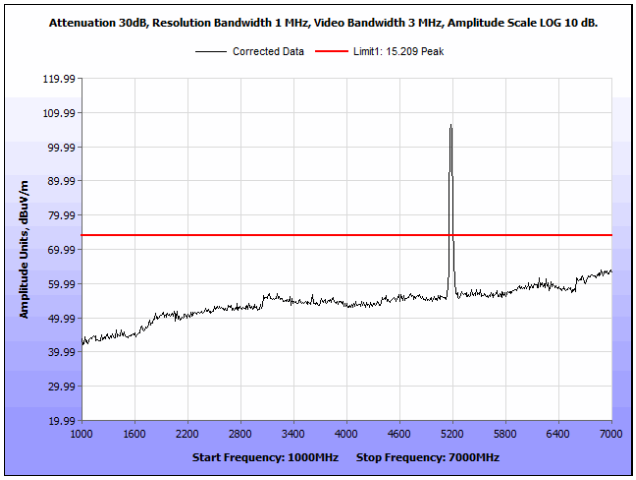
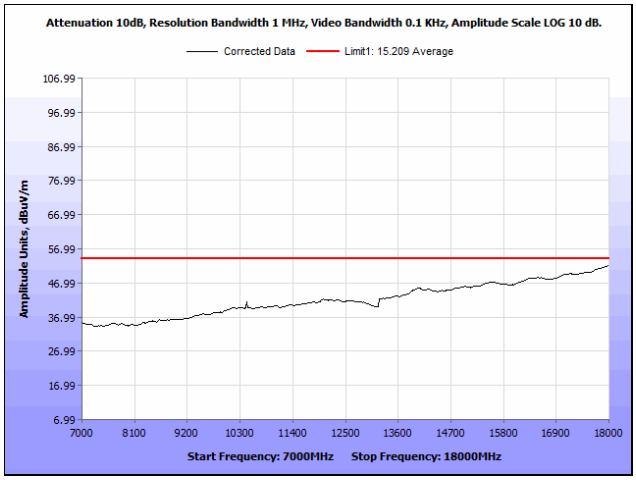



**Plot 37. Radiated Spurious Emissions, 5200 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Average**




**Plot 38. Radiated Spurious Emissions, 5200 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Peak**




**Plot 39. Radiated Spurious Emissions, 5200 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Average**

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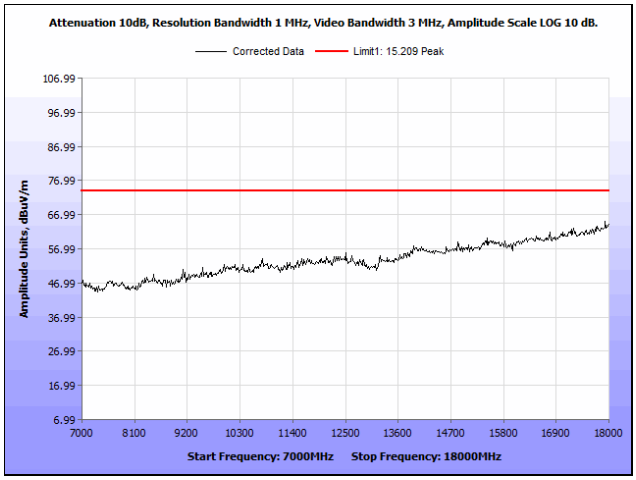
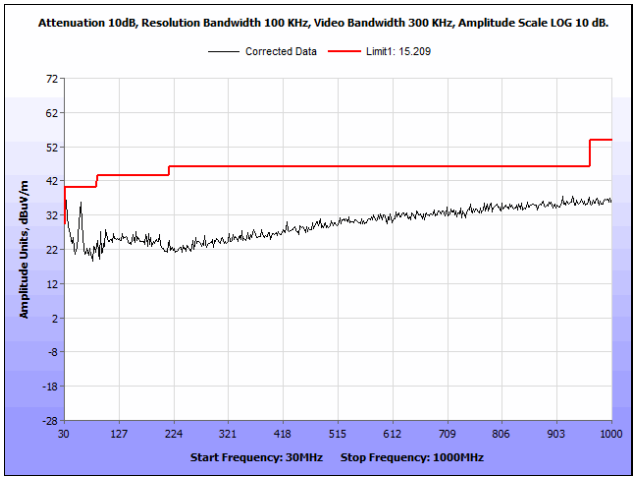
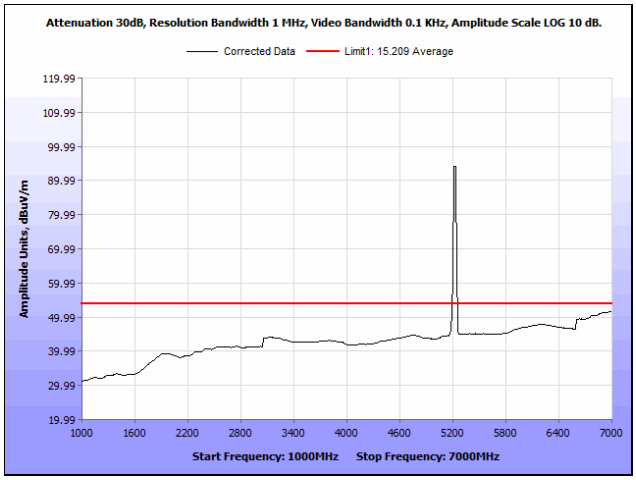



**Plot 40. Radiated Spurious Emissions, 5200 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Peak**




**Plot 41. Radiated Spurious Emissions, 5220 MHz, Rubber Ducky Antenna, 30 MHz – 1 GHz**




**Plot 42. Radiated Spurious Emissions, 5220 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Average**

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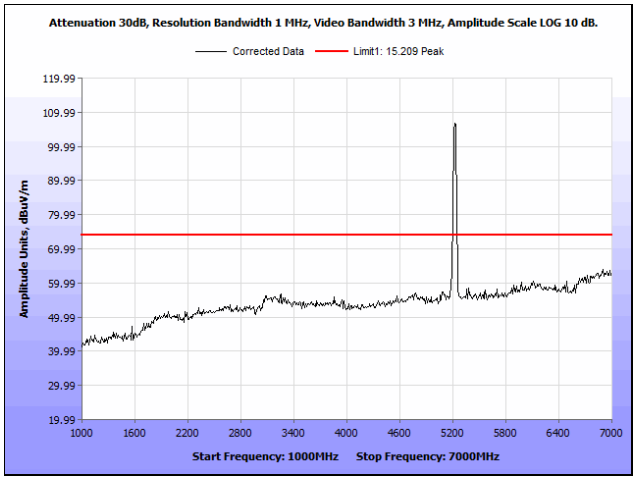
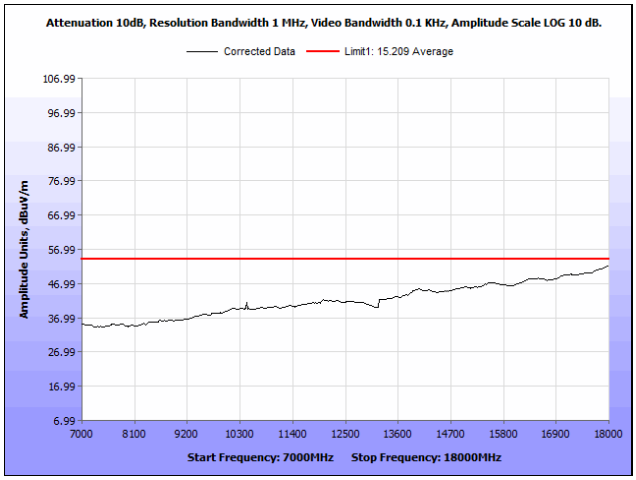
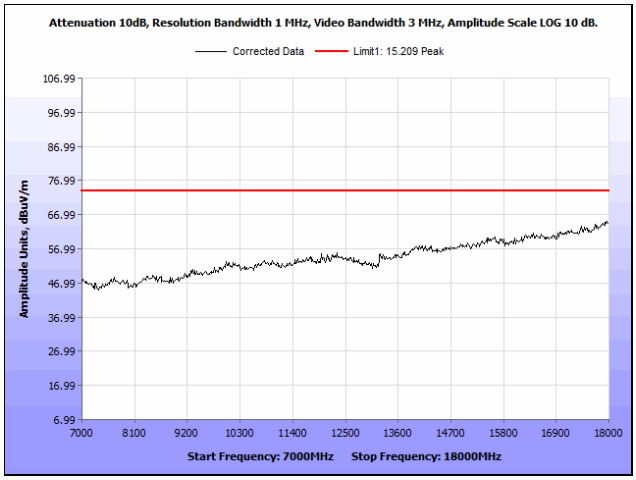



**Plot 43. Radiated Spurious Emissions, 5220 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Peak**




**Plot 44. Radiated Spurious Emissions, 5220 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Average**




**Plot 45. Radiated Spurious Emissions, 5220 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Peak**

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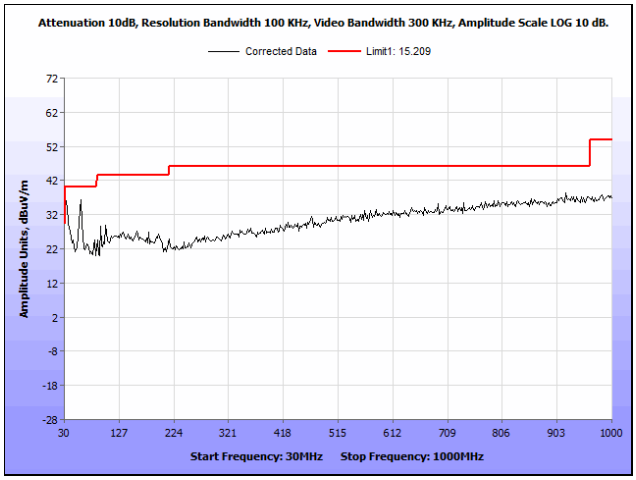
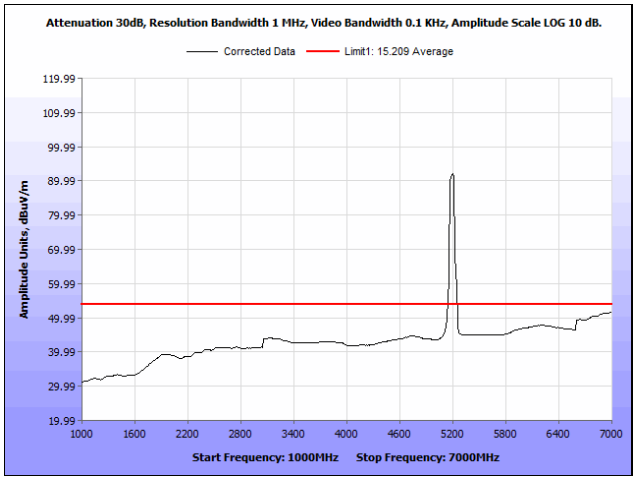
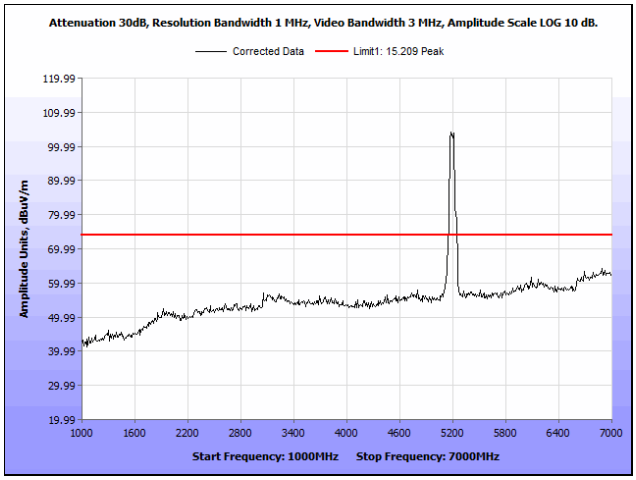



**Plot 46. Radiated Spurious Emissions, 5190 MHz, Rubber Ducky Antenna, 30 MHz – 1 GHz**




**Plot 47. Radiated Spurious Emissions, 5190 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Average**




**Plot 48. Radiated Spurious Emissions, 5190 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Peak**

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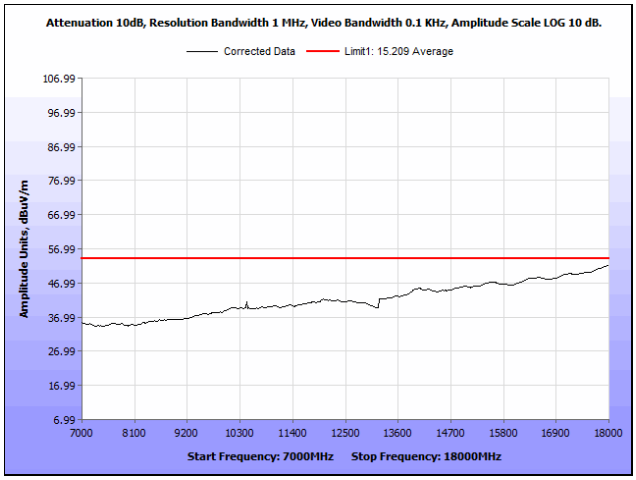
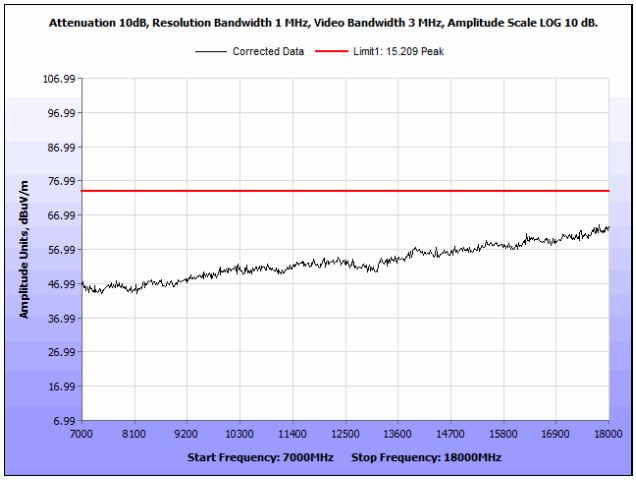
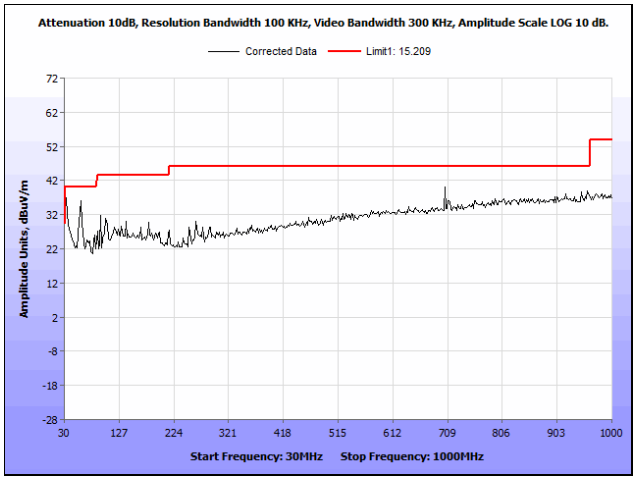



**Plot 49. Radiated Spurious Emissions, 5190 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Average**




**Plot 50. Radiated Spurious Emissions, 5190 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Peak**




**Plot 51. Radiated Spurious Emissions, 5230 MHz, Rubber Ducky Antenna, 30 MHz – 1 GHz**

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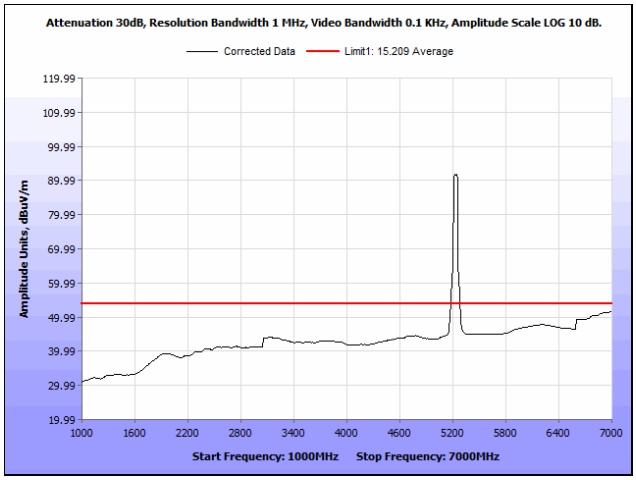
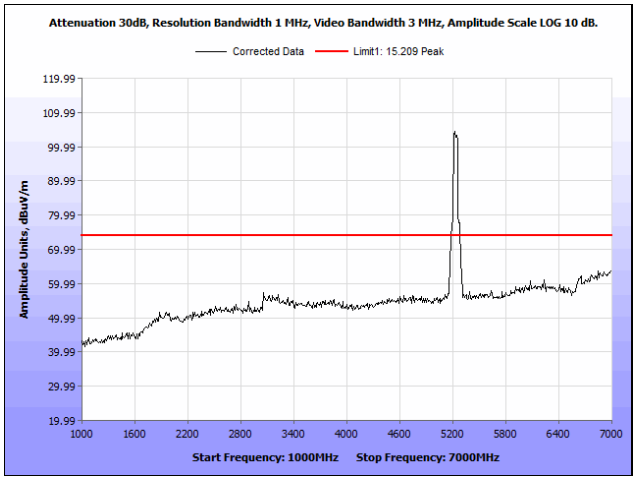
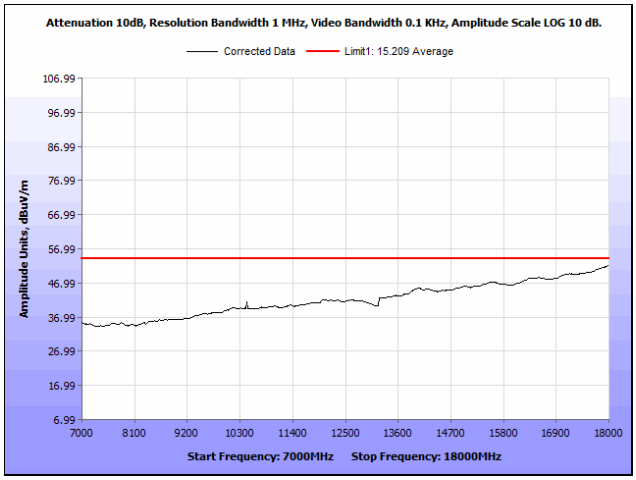



**Plot 52. Radiated Spurious Emissions, 5230 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Average**




**Plot 53. Radiated Spurious Emissions, 5230 MHz, Rubber Ducky Antenna, 1 GHz – 7 GHz, Peak**




**Plot 54. Radiated Spurious Emissions, 5230 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Average**

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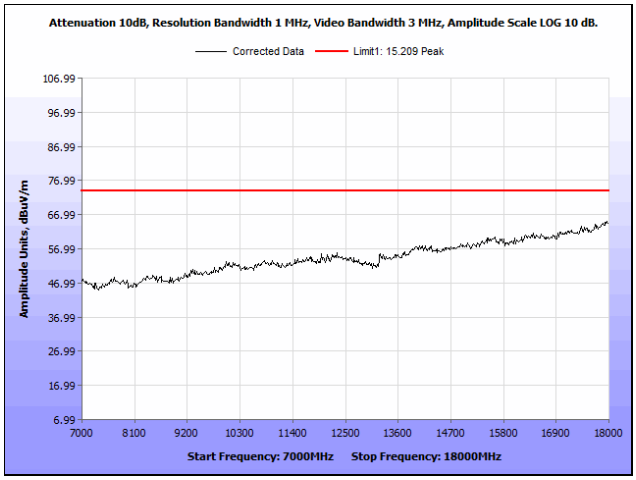
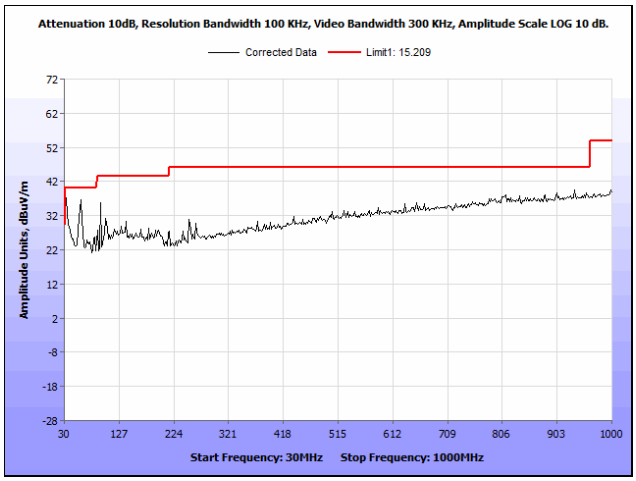
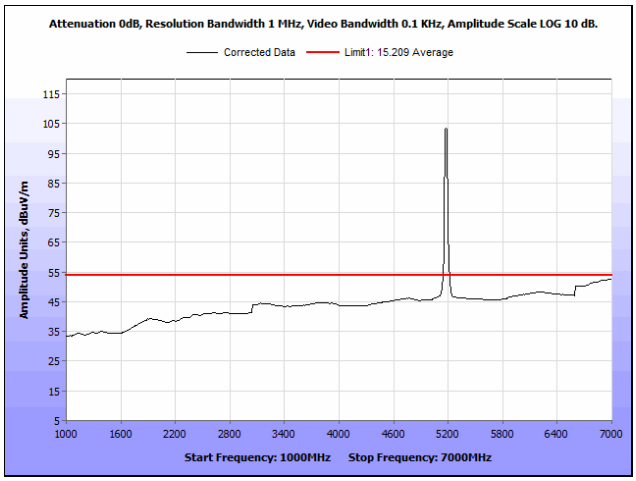



**Plot 55. Radiated Spurious Emissions, 5230 MHz, Rubber Ducky Antenna, 7 GHz – 18 GHz, Peak**

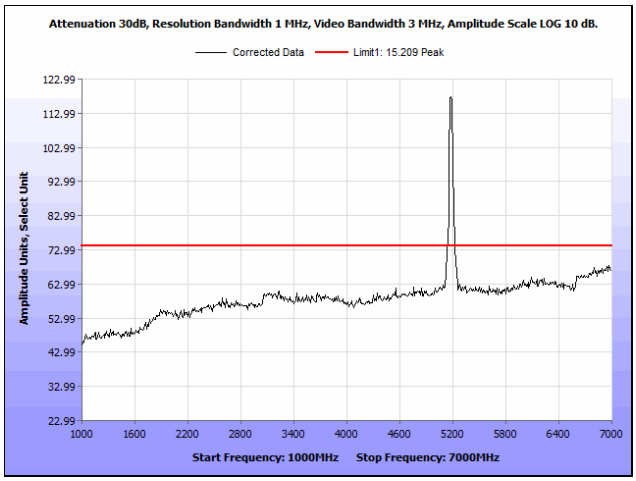
## Radiated Spurious Emissions, PCB Antenna




**Plot 56. Radiated Spurious Emissions, 5180 MHz, PCB Antenna, 30 MHz – 1 GHz**




**Plot 57. Radiated Spurious Emissions, 5180 MHz, PCB Antenna, 1 GHz – 7 GHz, Average**




**Plot 58. Radiated Spurious Emissions, 5180 MHz, PCB Antenna, 1 GHz – 7 GHz, Peak**

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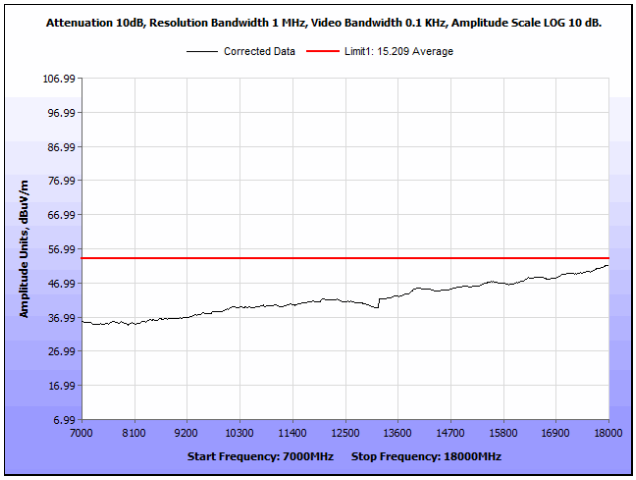
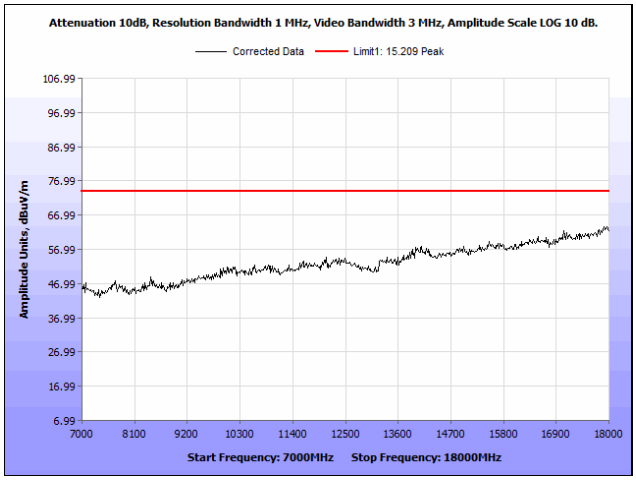
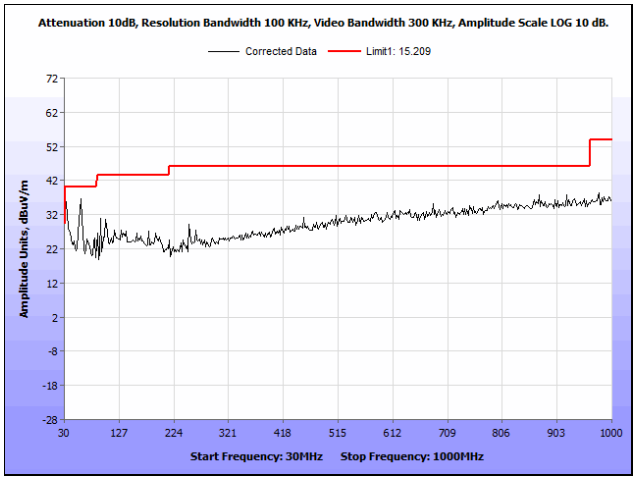



**Plot 59. Radiated Spurious Emissions, 5180 MHz, PCB Antenna, 7 GHz – 18 GHz, Average**




**Plot 60. Radiated Spurious Emissions, 5180 MHz, PCB Antenna, 7 GHz – 18 GHz, Peak**




**Plot 61. Radiated Spurious Emissions, 5200 MHz, PCB Antenna, 30 MHz – 1 GHz**

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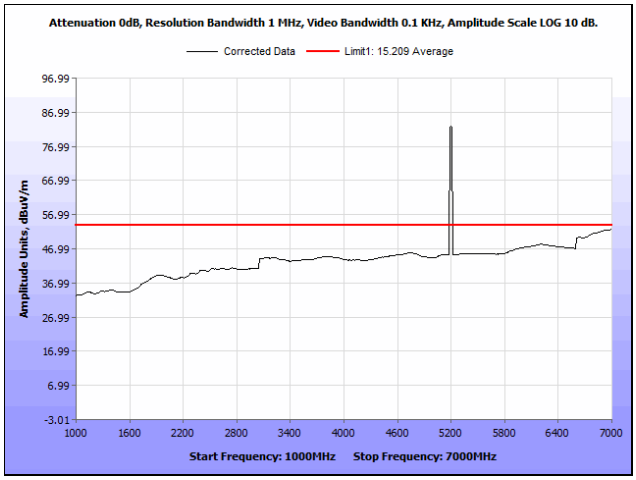
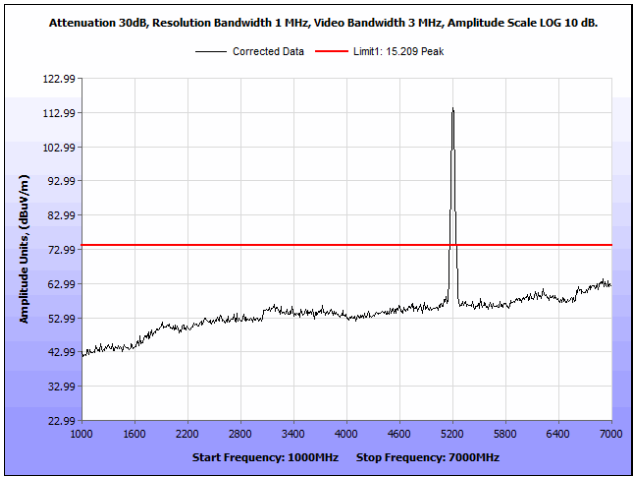
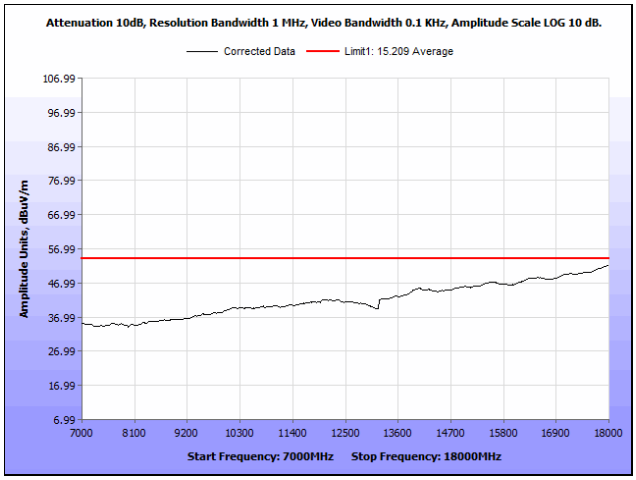



**Plot 62. Radiated Spurious Emissions, 5200 MHz, PCB Antenna, 1 GHz – 7 GHz, Average**




**Plot 63. Radiated Spurious Emissions, 5200 MHz, PCB Antenna, 1 GHz – 7 GHz, Peak**




**Plot 64. Radiated Spurious Emissions, 5200 MHz, PCB Antenna, 7 GHz – 18 GHz, Average**

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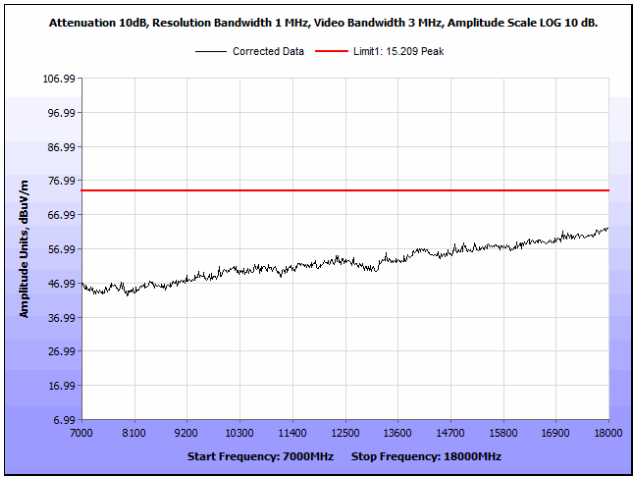
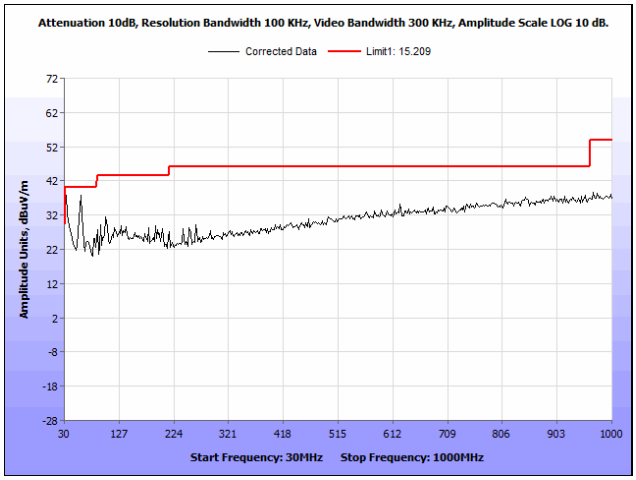
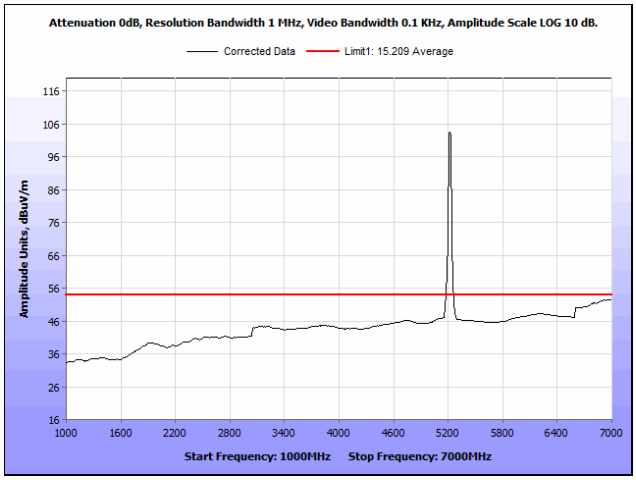



**Plot 65. Radiated Spurious Emissions, 5200 MHz, PCB Antenna, 7 GHz – 18 GHz, Peak**




**Plot 66. Radiated Spurious Emissions, 5220 MHz, PCB Antenna, 30 MHz – 1 GHz**




**Plot 67. Radiated Spurious Emissions, 5220 MHz, PCB Antenna, 1 GHz – 7 GHz, Average**

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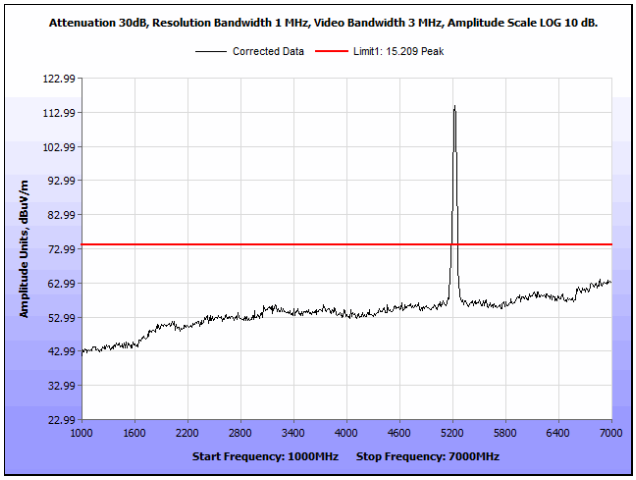
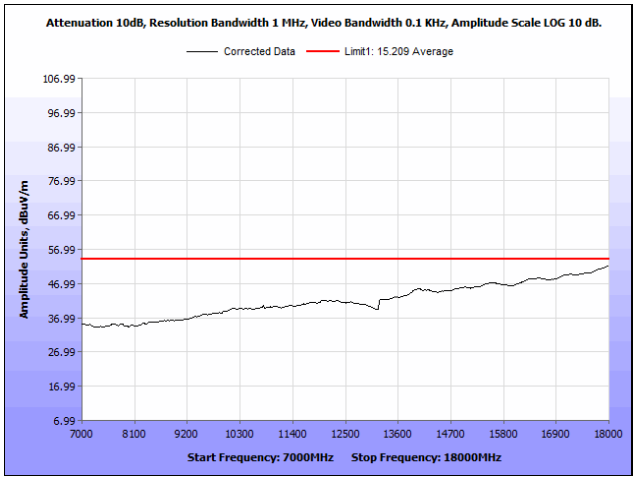
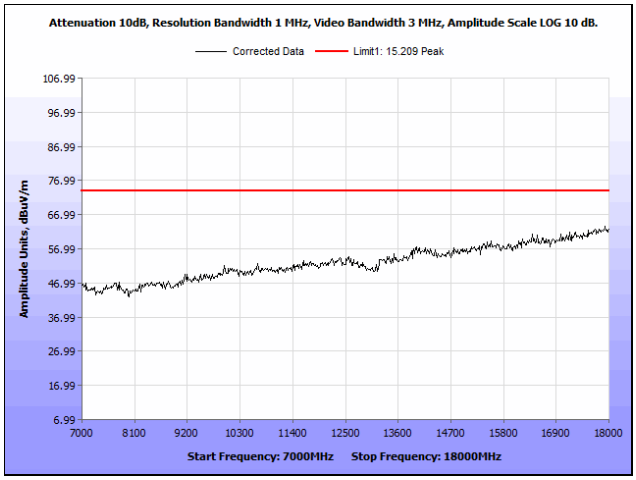



**Plot 68. Radiated Spurious Emissions, 5220 MHz, PCB Antenna, 1 GHz – 7 GHz, Peak**




**Plot 69. Radiated Spurious Emissions, 5220 MHz, PCB Antenna, 7 GHz – 18 GHz, Average**




**Plot 70. Radiated Spurious Emissions, 5220 MHz, PCB Antenna, 7 GHz – 18 GHz, Peak**

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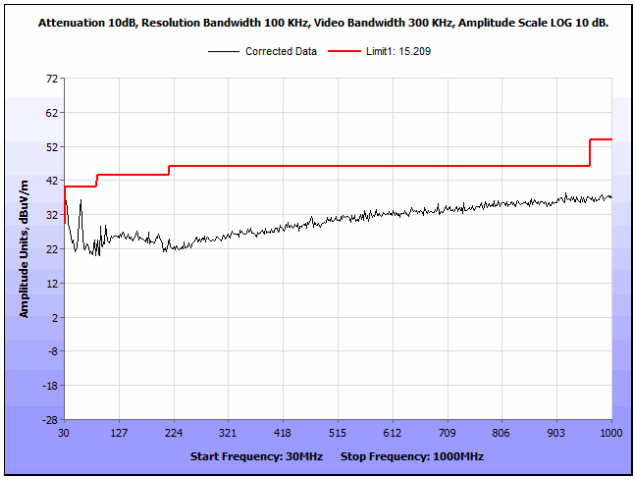
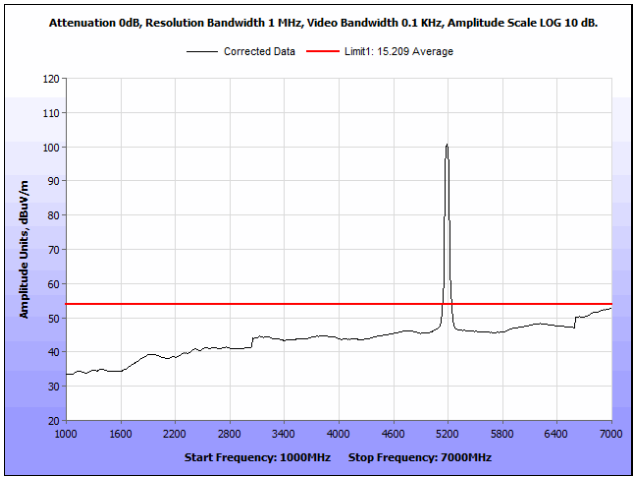
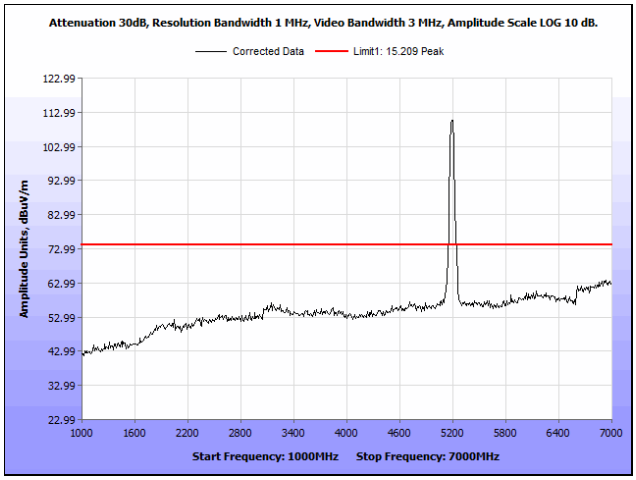



**Plot 71. Radiated Spurious Emissions, 5190 MHz, PCB Antenna, 30 MHz – 1 GHz**




**Plot 72. Radiated Spurious Emissions, 5190 MHz, PCB Antenna, 1 GHz – 7 GHz, Average**




**Plot 73. Radiated Spurious Emissions, 5190 MHz, PCB Antenna, 1 GHz – 7 GHz, Peak**

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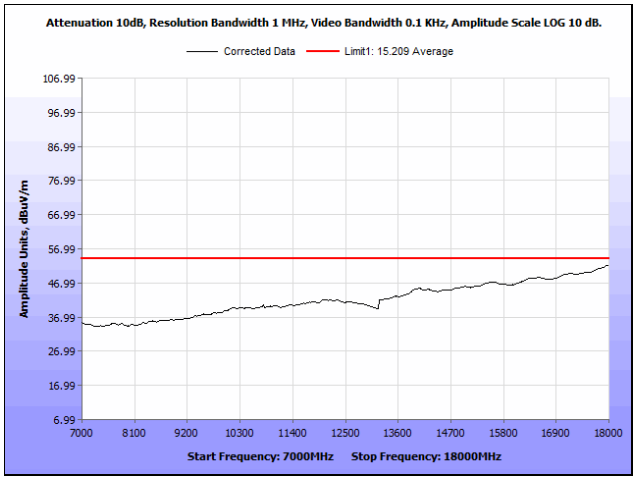
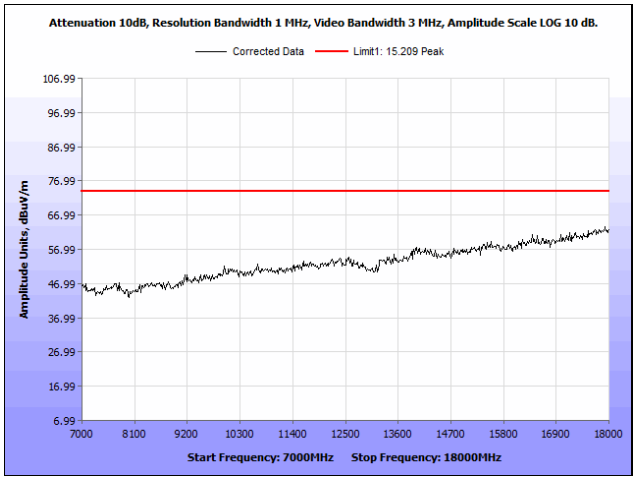
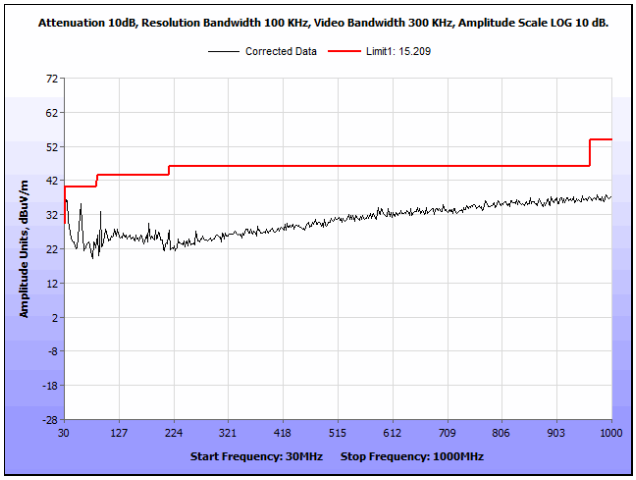



**Plot 74. Radiated Spurious Emissions, 5190 MHz, PCB Antenna, 7 GHz – 18 GHz, Average**




**Plot 75. Radiated Spurious Emissions, 5190 MHz, PCB Antenna, 7 GHz – 18 GHz, Peak**




**Plot 76. Radiated Spurious Emissions, 5230 MHz, PCB Antenna, 30 MHz – 1 GHz**

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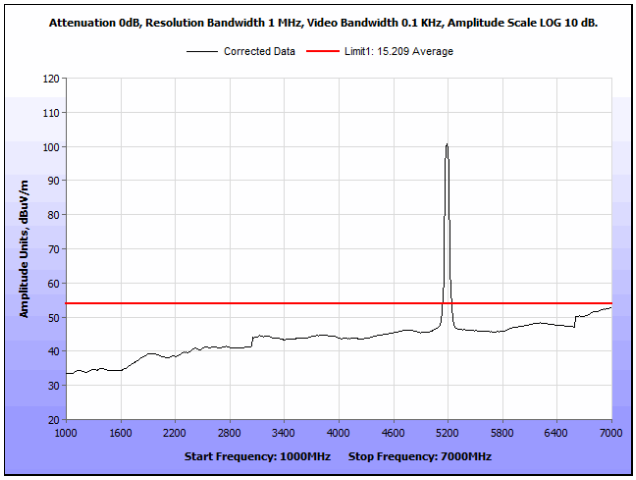
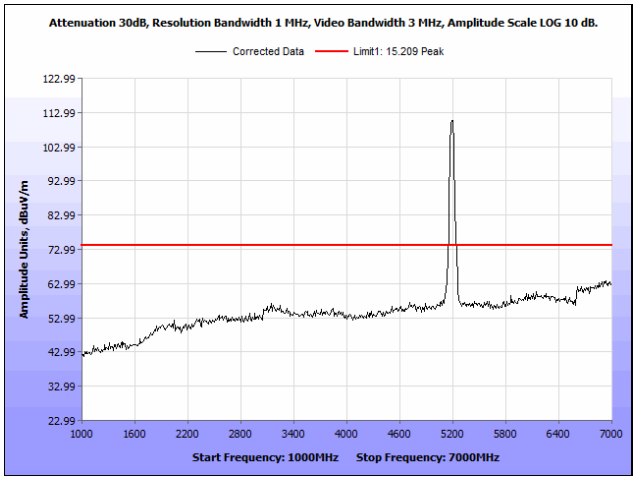
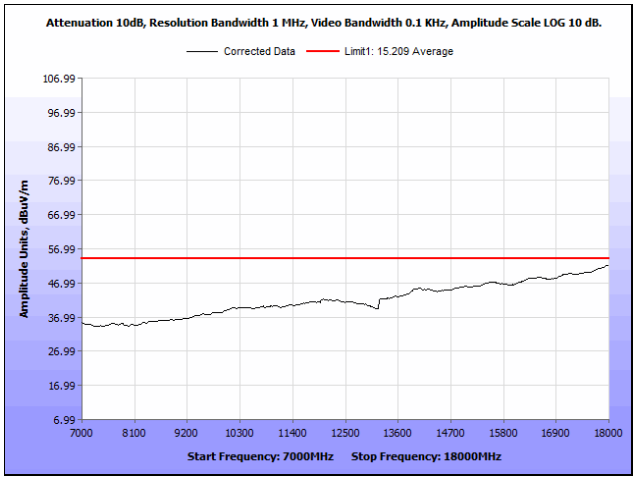



**Plot 77. Radiated Spurious Emissions, 5230 MHz, PCB Antenna, 1 GHz – 7 GHz, Average**




**Plot 78. Radiated Spurious Emissions, 5230 MHz, PCB Antenna, 1 GHz – 7 GHz, Peak**




**Plot 79. Radiated Spurious Emissions, 5230 MHz, PCB Antenna, 7 GHz – 18 GHz, Average**

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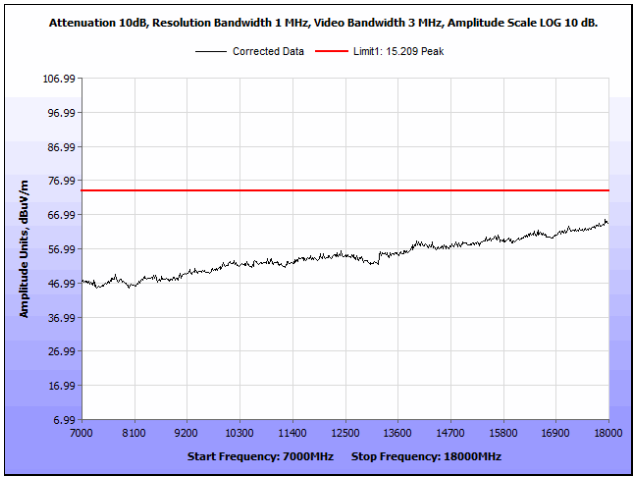
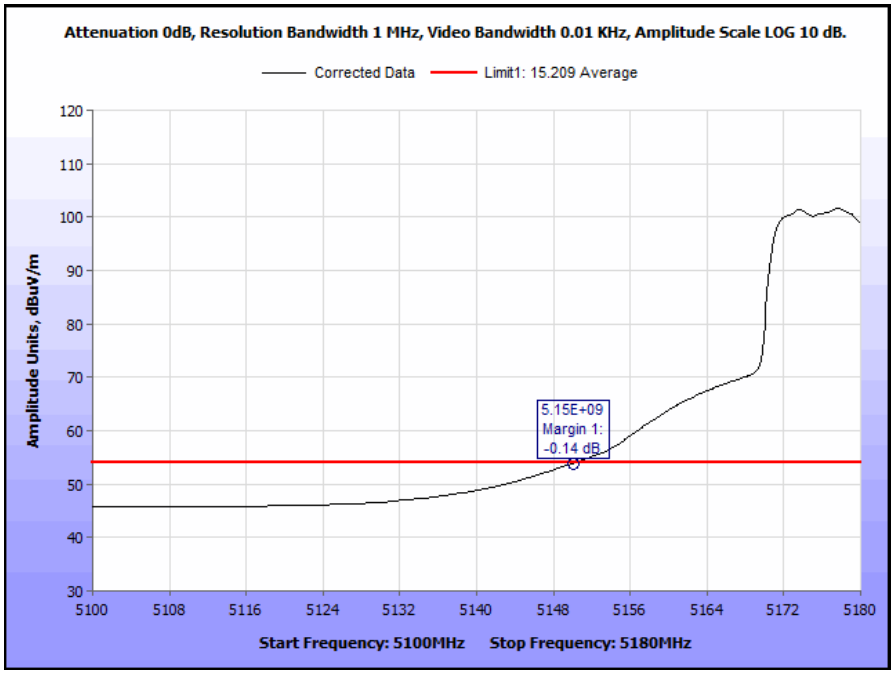
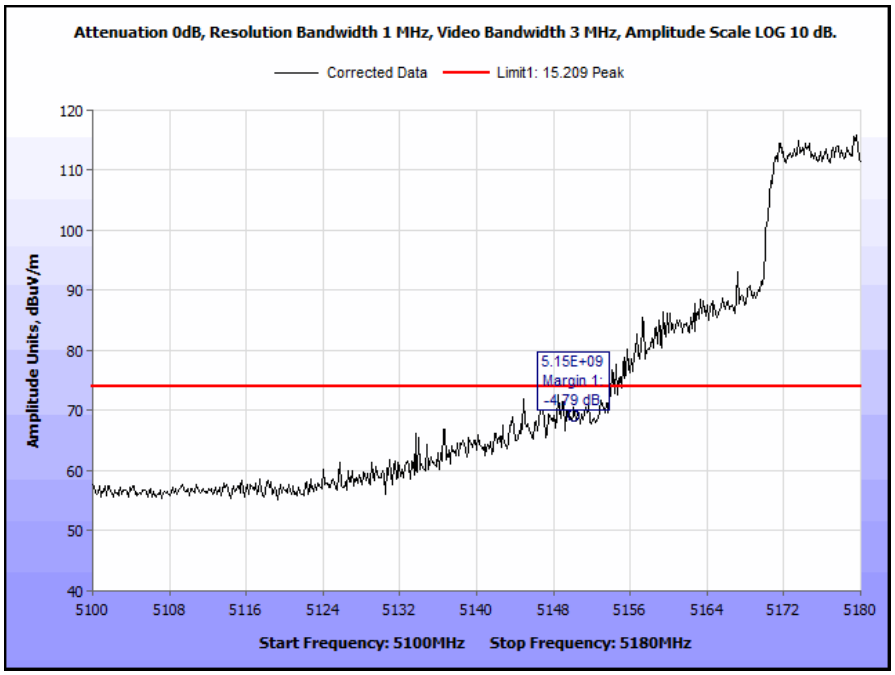



**Plot 80. Radiated Spurious Emissions, 5230 MHz, PCB Antenna, 7 GHz – 18 GHz, Peak**

## Band Edge, Rubber Ducky Antenna




**Plot 81. Radiated Band Edge, 5180 MHz @ 5150 MHz, Average, Rubber Ducky Antenna**




**Plot 82. Radiated Band Edge, 5180 MHz @ 5150 MHz, Peak, Rubber Ducky Antenna**

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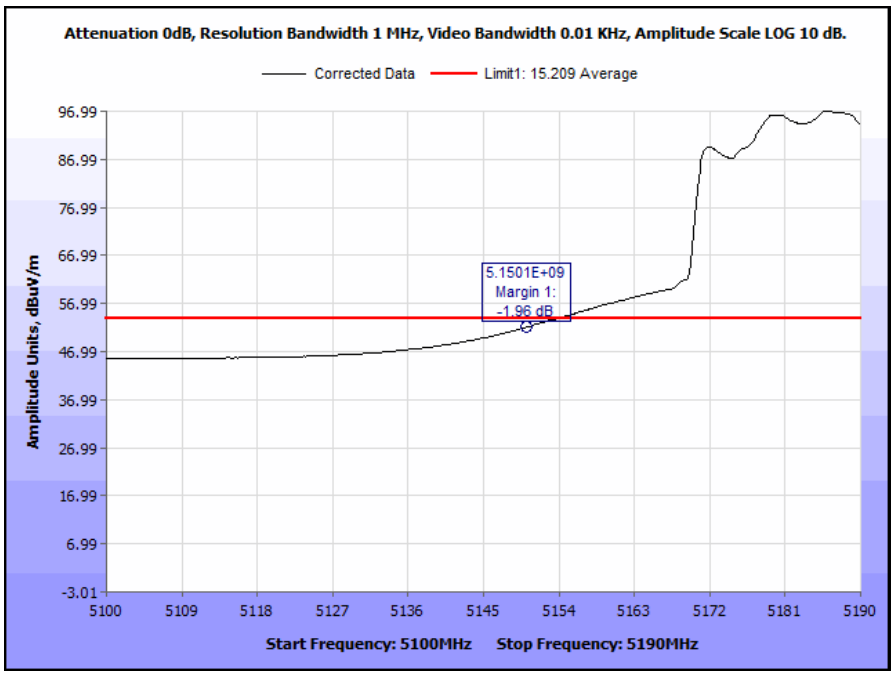
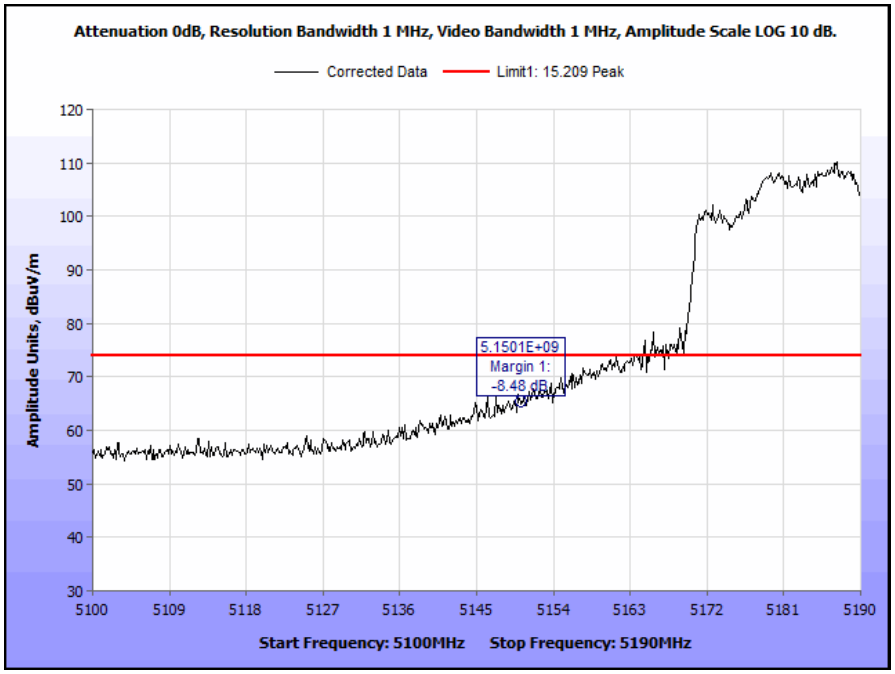



**Plot 83. Radiated Band Edge, 5190 MHz @ 5150 MHz, Average, Rubber Ducky Antenna**




**Plot 84. Radiated Band Edge, 5190 MHz @ 5150 MHz, Peak, Rubber Ducky Antenna**

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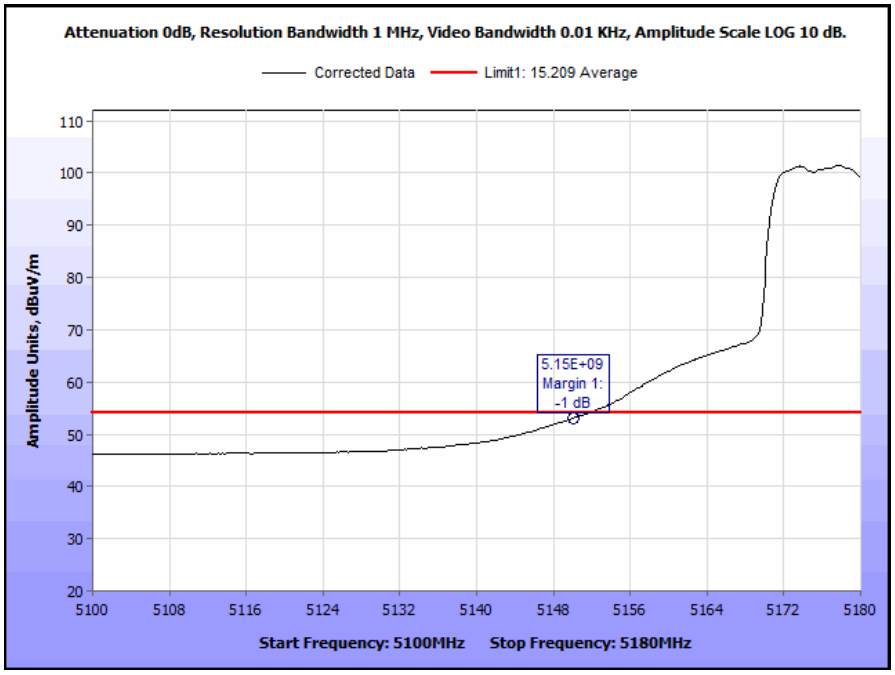
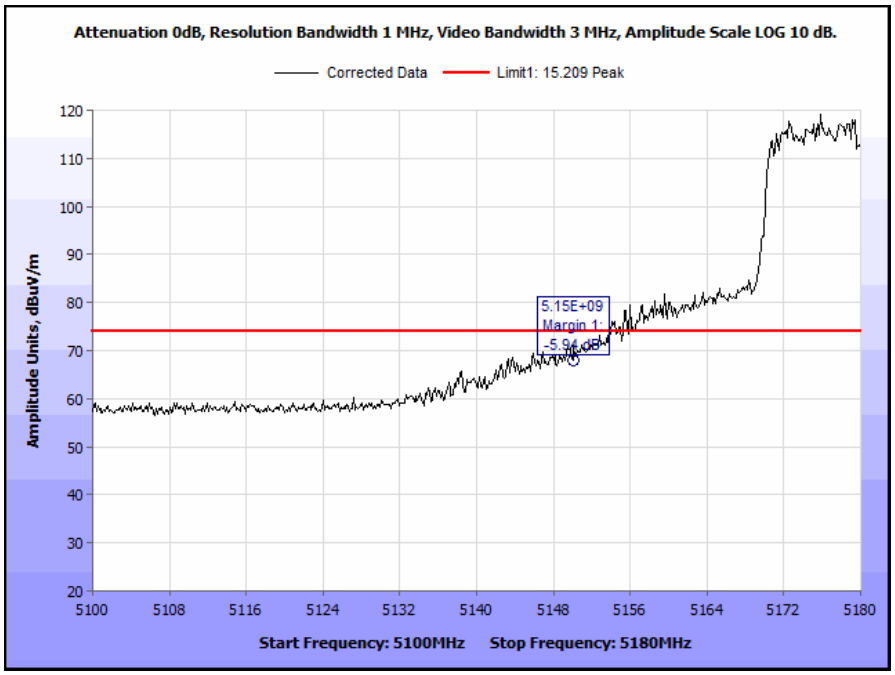
## Band Edge, PCB Antenna




**Plot 85. Radiated Band Edge, 5180 MHz @ 5150 MHz, Average, PCB Antenna**




**Plot 86. Radiated Band Edge, 5180 MHz @ 5150 MHz, Peak, PCB Antenna**

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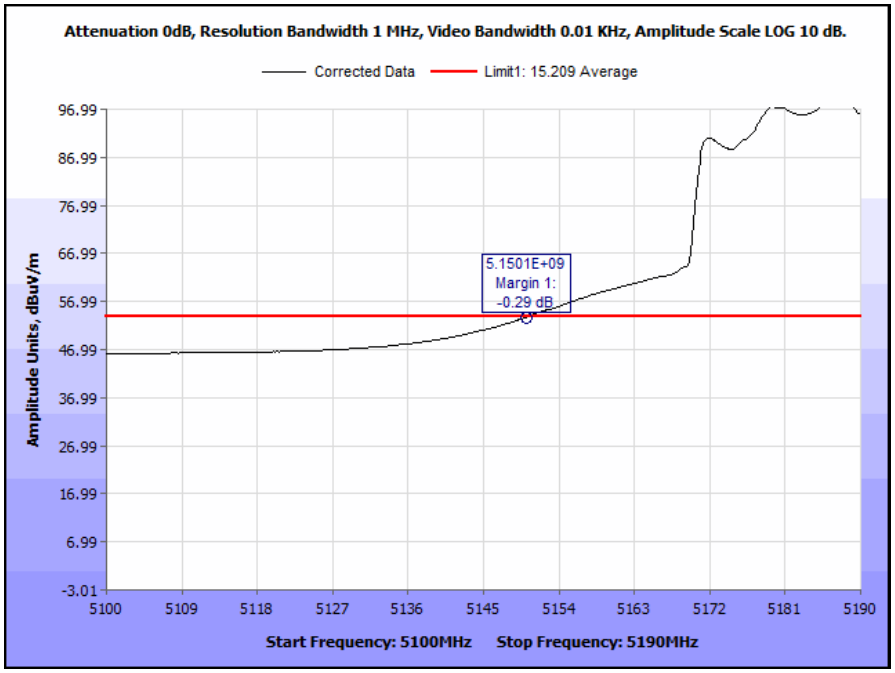
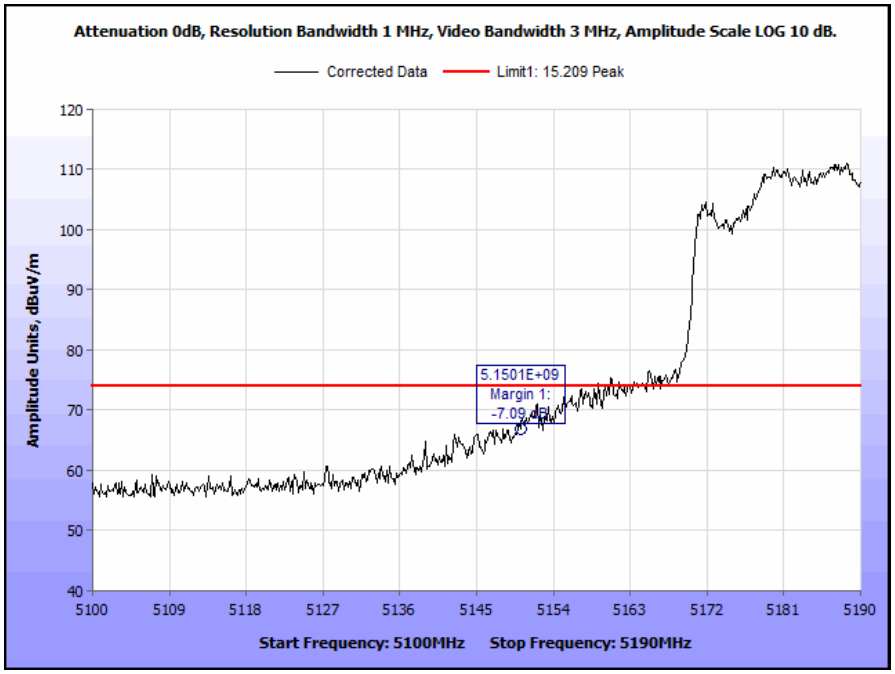



**Plot 87. Radiated Band Edge, 5190 MHz @ 5150 MHz, Average, PCB Antenna**




**Plot 88. Radiated Band Edge, 5190 MHz @ 5150 MHz, Peak, PCB Antenna**

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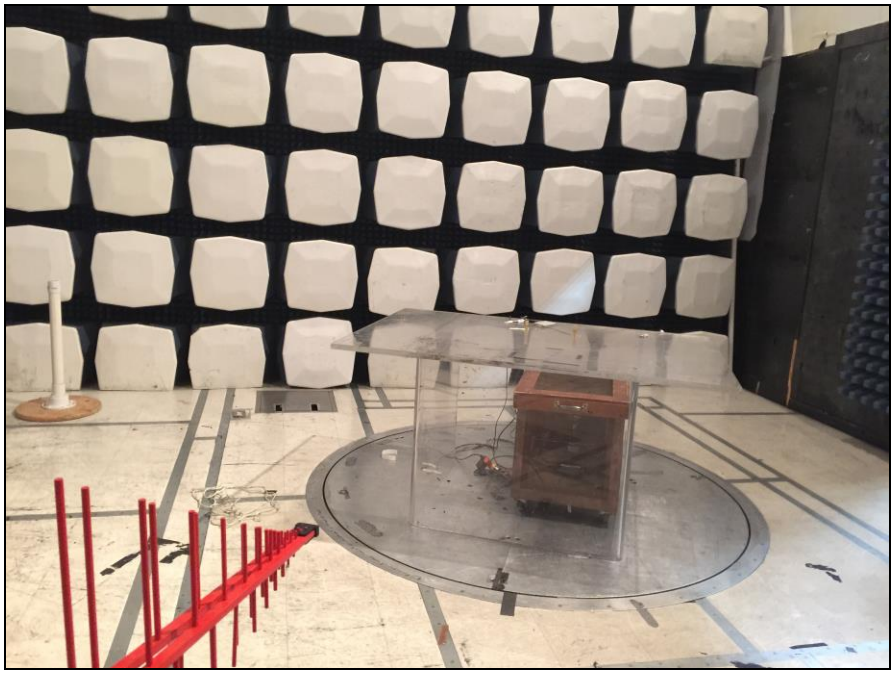

**Photograph 1. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz**

**Photograph 2. Radiated Spurious Emissions, Test Setup, Above 1 GHz**

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.407(f) RF Exposure

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

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

MPE Limit Calculation: EUT's operating frequencies @ 5150-5250 MHz; **Limit for Uncontrolled exposure: 1 mW/cm$^2$ or 10 W/m$^2$**

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density
P = Power Input to antenna=23.078 dBm (203.142 mW)
G = Antenna Gain 2 dBi, 1.58 linear)
R = Minimum Distance between User and Antenna (20cm)

$$S = (1.58*203.142)/(4*3.14*400) = 0.063 \text{ mW/cm2}$$

Since S < 1 mW/cm2, the minimum distance (R) is 20cm

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# 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 # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1T4409 | EMI RECEIVER | ROHDE & SCHWARZ | ESIB7 | 10/29/2014 | 10/29/2016 |
| 1T4751 | ANTENNA - BILOG | SUNOL SCIENCES | JB6 | 7/29/2014 | 1/29/2016 |
| 1T4771 | PSA SPECTRUM ANALYZER | AGILENT TECHNOLOGIES | E4446A | 11/25/2014 | 11/25/2015 |
| 1T4745 | ANTENNA, HORN | ETS-LINDGREN | 3116 | 11/14/2013 | 5/14/2015 |
| 1T4612 | SPECTRUM ANALYZER | AGILENT TECHNOLOGIES | E4407B | 7/25/2014 | 7/25/2015 |
| 1T4483 | ANTENNA; HORN | ETS-LINDGREN | 3117 | 2/28/2014 | 8/28/2015 |
| 1T2665 | ANTENNA; HORN | EMCO | 3115 | 4/3/2014 | 10/3/2015 |
| 1T4565 | LISN (24 AMP) | SOLAR ELECTRONICS | 9252-50-R-24-BNC | 6/26/2014 | 12/26/2015 |

**Table 12. Test Equipment List**

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# V. Certification & User's Manual Information

# Certification & User's Manual Information

## L. Certification Information

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

**§ 2.801 Radio-frequency device defined.**

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

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

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

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

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

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

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

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

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

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

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

*(i) Compliance testing;*

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

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

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

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

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

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

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## Certification & User's Manual Information

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

**§ 2.901 Basis and Purpose**

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

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

**§ 2.907 Certification.**

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

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

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

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## Certification & User's Manual Information

**§ 2.948 Description of measurement facilities.**

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

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

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

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

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

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# Certification & User's Manual Information

## Label and User's Manual Information

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

**§ 15.19 Labeling requirements.**

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

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

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

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

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

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

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

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

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

**§ 15.21 Information to user.**

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

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## Verification & User's Manual Information

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

**§ 15.105 Information to the user.**

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

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

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

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

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

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

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

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