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August 20, 2018

American Medical Depot
10315 USA Today Way
Miramar, FL 33025

Dear Adrian Gomez,

Enclosed is the EMC Wireless test report for compliance testing of the American Medical Depot, MedicSmart as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.) FCC Part 15 Subpart C 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.

Joel Huna
Documentation Department

Reference: (\American Medical Depot\EMC95326-FCC247 Rev. 1)

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# Electromagnetic Compatibility Criteria
# Test Report

for the

**American Medical Depot**
**MedicSmart**

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, FCC Part 15 Subpart C
for Intentional Radiators

**MET Report: EMC95326-FCC247 Rev. 1**

August 20, 2018

**Prepared For:**

**American Medical Depot**
**10315 USA Today Way**
**Miramar, FL 33025**

**Prepared By:**
**MET Laboratories, Inc.**
914 West Patapsco Avenue,
Baltimore, MD 21230

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# Electromagnetic Compatibility Criteria
# Test Report

for the

## American Medical Depot
## MedicSmart

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR,
15.247 Subpart C for Intentional Radiators

Donald Salguero, Project Engineer
Electromagnetic Compatibility Lab

Joel Huna
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules 15.247 under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

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# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | August 10, 2018 | Initial Issue. |
| 1 | August 20, 2018 | Addition of FCC ID. |

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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 |
| **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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## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the American Medical Depot MedicSmart, 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 MedicSmart. American Medical Depot should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the MedicSmart, 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, §15.247, in accordance with American Medical Depot, purchase order number 10068. All tests were conducted using measurement procedure ANSI C63.4-2003.

| FCC Reference<br>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 | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | 20 dB Occupied Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | Average Time of Occupancy (Dwell Time) | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | Number of RF Channels | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | RF Channel Separation | 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 | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | 100 kHz Spurious Emissions | Compliant |
| Title 47 of the CFR, Part 15 §15.247(i) | Maximum Permissible Exposure (MPE) | Compliant |

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

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# II. Equipment Configuration

# A. Overview

MET Laboratories, Inc. was contracted by American Medical Depot to perform testing on the MedicSmart, under American Medical Depot's purchase order number 10068.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the American Medical Depot, MedicSmart.

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

| | | |
|---|---|---|
| **Model(s) Tested:** | MedicSmart | |
| **Model(s) Covered:** | MedicSmart | |
| **EUT Specifications:** | Primary Power: 1.8VDC, 2.5VDC ,3.3VDC, 5VDC | |
| | FCC ID: 2AQW5MS-01000 | |
| | Type of Modulations: | PR-ASK |
| | Equipment Code: | DSS |
| | Peak RF Output Power: | 21.05 dBm |
| | EUT Frequency Ranges: | 902.5 – 927.5 MHz |
| **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:** | Donald Salguero | |
| **Report Date(s):** | August 20, 2018 | |

**Table 2. EUT Summary Table**

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## B. References

| | |
|---|---|
| **CFR 47, Part 15, Subpart C** | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| **CFR 47, Part 15, Subpart B** | Electromagnetic Compatibility: Criteria for Radio Frequency Devices |
| **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 West Patapsco Avenue, 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. 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. Uncertainty Calculations Summary**

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## E. Description of Test Sample

The American Medical Depot MedicSmart, Equipment Under Test (EUT), is a cabinet with RFID capabilities to track inventory items. Items will have RFID tag attached to it. The board has an RFID reader module. The module is connected to UHF Patch Antennas for transmission and reception of RFID signal. The software running in the board "computer on module" will detect changes in the inventory and send the item information over a wifi network to a central server for processing. The board has a second wifi module operating in "access point mode" that will allow users to setup the device directly from their phone or personal computers.

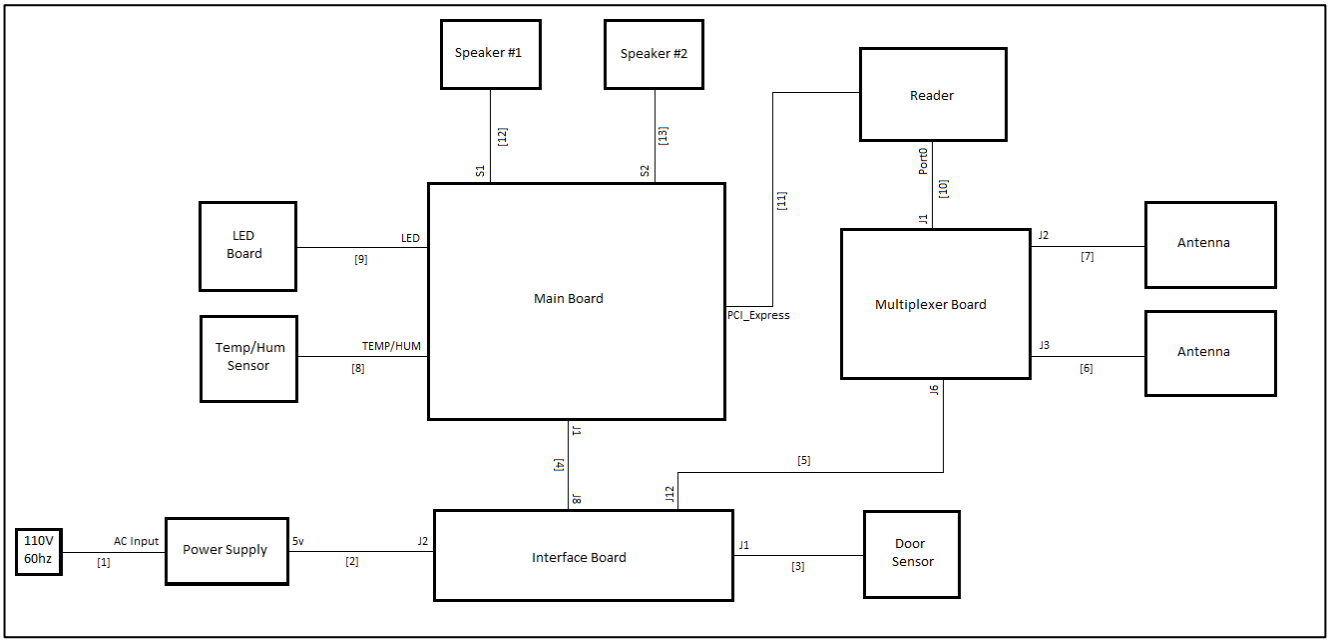


**Figure 1. Block Diagram of Test Configuration**

## F. 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 | Slot # | Name / Description | Model Number | Part Number | Serial Number | Rev. # |
|---|---|---|---|---|---|---|
| 001 | PCI/Express: | Skyetek-Nova RFID Reader | EV-NV-00 | | | |
| 002 | DDR | Computer On Module | Compute Module: 3 | | | |
| 003 | J2 | SD Card | | | | |
| 004 | USB | WIFI Dongle | TpLink TL-WN725N | | | |
| 005 | J6 | Camera Module | RaspiCam v 1.3 | | | |
| 006 | LED | Led Board | | | | |
| 007 | TEMP/HUM | Temp sensor | DHT22 | | | |
| 008 | J12/Docking board | UHF Multiplexer V1.0 | | | | |
| 009 | SMA on multiplexer | Patch Antenna UHF | | | | |
| 010 | Audio Connector | Speakers | | | | |
| 011 | DC input on Docking Interface | Meanwell | RID85A | | | |

**Table 5. Equipment Configuration**

## G. Support Equipment

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

| Ref. ID | Name / Description | Manufacturer | Model Number | *Customer Supplied Calibration Data |
|---|---|---|---|---|
| 001 | Generic HDMI Display | | | |
| 002 | Generic Mouse USB | | | |
| 003 | Generic Keyboard USB | | | |
| The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer. | | | | |

**Table 6. Support Equipment**

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## H. Ports and Cabling Information

| Ref. ID | Port name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length (m) | Shielded? (Y/N) | Termination Box ID & Port Name |
|---|---|---|---|---|---|---|---|
| 1 | AC Input | 3 conductor, AC Cable | 1 | - | - | No | 110c/60hz |
| 2 | J2 | 2 conductor, DC | 1 | - | - | No | 5v |
| 3 | J1 | 2 conductor cable | 1 | - | - | No | Door Sensor |
| 4 | J1 | Connector | 1 | - | - | Y | J8 |
| 5 | J12 | Data cable | 1 | - | - | N | J6 |
| 6 | J3 | Coax RG 316 | 1 | - | - | N | Antenna |
| 7 | J7 | Coax RG 316 | 1 | - | - | N | Antenna |
| 8 | TEMP/HUM | Cable | 1 | - | - | N | Temp/Hum Sensor |
| 9 | LED | Cable | 1 | - | - | N | Led Board |
| 10 | J1 | Coax RG 316 | 1 | - | - | N | Port0 |
| 11 | PCI_EXPRESS | Connector | 1 | - | - | Y | Reader |
| 12 | S1 | 2 conductor cable | 1 | - | - | N | Speaker #1 |
| 13 | S2 | 2 conductor cable | 1 | - | - | N | Speaker #2 |

**Table 7. Ports and Cabling Information**

## I. Mode of Operation

All modules can be controlled using the software provided for testing. Using the software RFID reader can be enable for continues transmission as well as WIFI modules.
To enable and disable each board components, please connect board to HDMI display to use the testing software.

## J. Method of Monitoring EUT Operation

RFID and WIFI modules has LED indicators. When RFID is operating a flashing green light will be observed in the module.

## K. Modifications

**a) Modifications to EUT**
No modifications were made to the EUT.

**b) Modifications to Test Standard**
No modifications were made to the test standard.

## L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to American Medical Depot 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 as tested is compliant the criteria of §15.203. Antenna uses a unique type of connector to attach to EUT

**Test Engineer(s):** Donald Salguero

**Test Date(s):** July 9, 2018

| Gain | Type |
|---|---|
| 4 dBi | UHF Patch |

**Table 8. 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 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

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

Note: *Decreases with the logarithm of the frequency.

**Test Procedure:** The EUT was placed on a 0.8 m-high wooden table 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 C63.4-2003 "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:** The EUT was compliant with this requirement. Measured emissions were within applicable limits.

**Test Engineer(s):** Bradley Jones

**Test Date(s):** July 17, 2018

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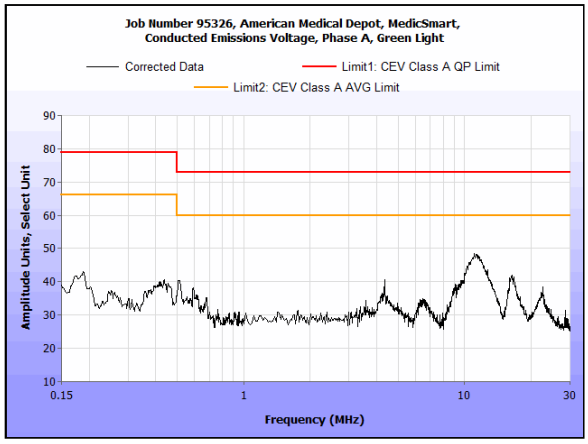
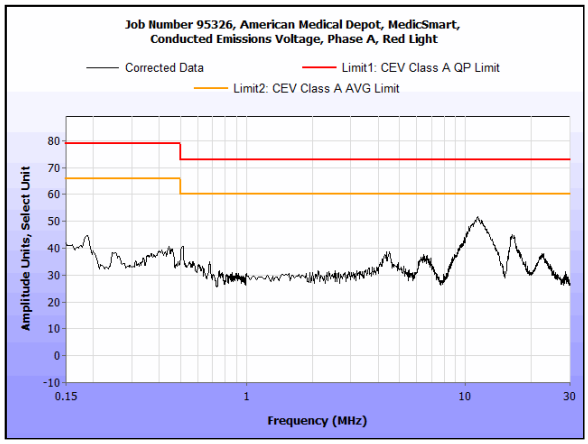
## 15.207(a) Conducted Emissions Test Results

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.187 | 31.73 | 10 | 41.73 | 79 | -37.27 | 23.77 | 10 | 33.77 | 66 | -32.23 |
| 0.444 | 25.95 | 10 | 35.95 | 79 | -43.05 | 19.82 | 10 | 29.82 | 66 | -36.18 |
| 4.478 | 21.98 | 10 | 31.98 | 73 | -41.02 | 14.61 | 10 | 24.61 | 60 | -35.39 |
| 11.2229 | 29.22 | 10 | 39.22 | 73 | -33.78 | 24.71 | 10 | 34.71 | 60 | -25.29 |
| 16.24 | 27.45 | 10 | 37.45 | 73 | -35.55 | 22.08 | 10 | 32.08 | 60 | -27.92 |
| 22.49 | 21.17 | 10 | 31.17 | 73 | -41.83 | 15.7 | 10 | 25.7 | 60 | -34.3 |

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




**Plot 1. Conducted Emissions, Green Light, Phase Line**

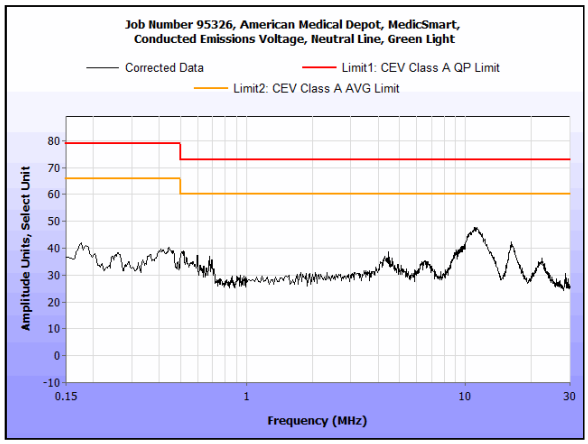



**Plot 2. Conducted Emissions , Red Light, Phase Line**

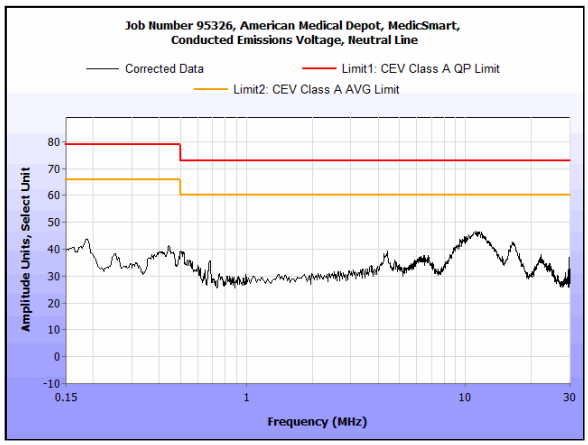
## 15.207(a) Conducted Emissions Test Results

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.186 | 28.34 | 0 | 28.34 | 79 | -50.66 | 20.82 | 0 | 20.82 | 66 | -45.18 |
| 0.444 | 23.33 | 0 | 23.33 | 79 | -55.67 | 18.52 | 0 | 18.52 | 66 | -47.48 |
| 4.424 | 22.9 | 0 | 22.9 | 73 | -50.1 | 14.98 | 0 | 14.98 | 60 | -45.02 |
| 11.05 | 34.9 | 0.09 | 34.99 | 73 | -38.01 | 32.57 | 0.09 | 32.66 | 60 | -27.34 |
| 16.29 | 29.88 | 0.12 | 30 | 73 | -43 | 26.27 | 0.12 | 26.39 | 60 | -33.61 |
| 22.12 | 22.88 | 0.2 | 23.08 | 73 | -49.92 | 17.8 | 0.2 | 18 | 60 | -42 |

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




**Plot 3. Conducted Emissions, Green Light, Neutral Line**




**Plot 4. Conducted Emissions, Red Light, Neutral Line**

## 15.207(a) Conducted Emissions Test Setup Photo

**Photograph 1. Conducted Emissions, 15.207(a), Test Setup**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) 20 dB Occupied Bandwidth

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

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

**Test Procedure:** The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

**Test Results** The EUT was compliant with § 15.247 (a)(2). No anomalies detected.

**Test Engineer(s):** Donald Salguero

**Test Date(s):** July 9, 2018

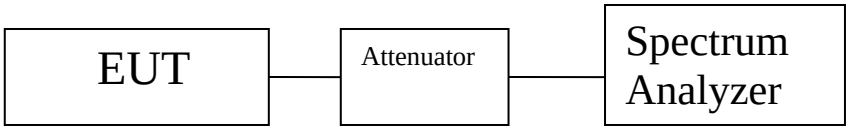



**Figure 2. Block Diagram, Occupied Bandwidth Test Setup**

| Channel | Center Frequency (MHz) | 20dB Bandwidth (kHz) |
|---|---|---|
| Low | 902.5 | 206.634 |
| Middle | 915 | 205.805 |
| High | 927.5 | 205.641 |

20dB Bandwidth, Test Results

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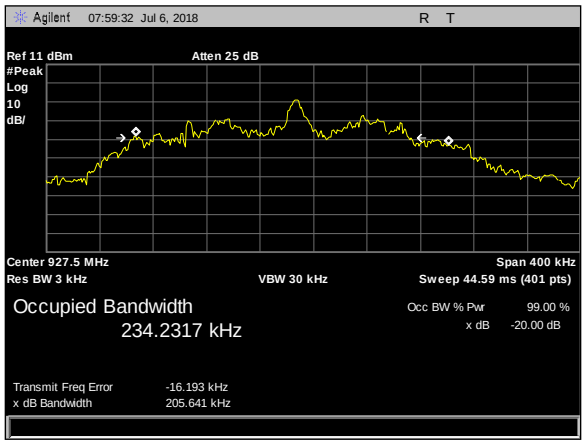
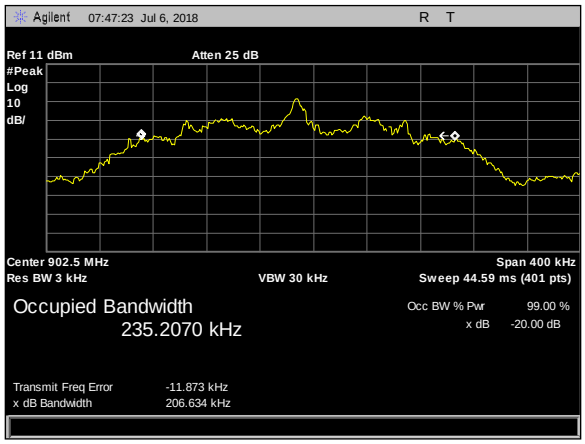
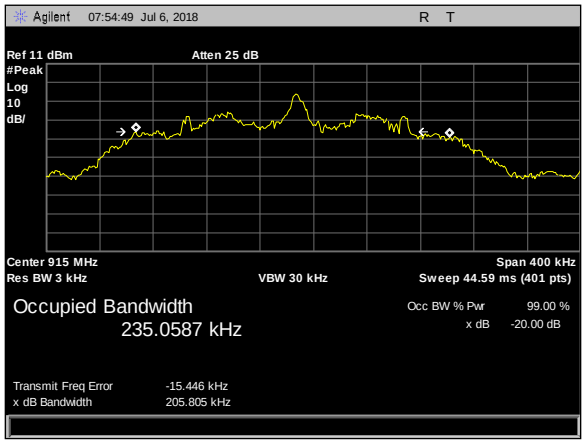
# 20 dB Occupied Bandwidth Test Results




**Plot 5. Occupied Bandwidth, 20 dB, high channel, 927.5MHz**




**Plot 6. Occupied Bandwidth, 20 dB, low channel, 902.5MHz**




**Plot 7. Occupied Bandwidth, 20 dB, mid channel, 915MHz**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) Average Time of Occupancy (Dwell Time)

**Test Requirements:** (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

**Test Procedure:** The EUT had its hopping function enabled. Procedure 7.8.4 from ANSI C63.10 – 2013 was used to compute the unit's dwell time.

**Remarks:** The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Total hopping channels is 50. The EUT meets the specifications of Section 15.247(a) (1) (i) for Number of Hopping Channels.

| Dwell Time | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency Range (MHZ)** | **No. of Channels** | **Hopping Period (s)** | **No. of Burst per Period** | **Burst duration (s)** | **Dwell Time (s)** | **Limit (s)** | **Margin** |
| 902-928 | 50 | 20 | 3 | 0.1057 | 0.3171 | 0.4 | -0.0829 |

**Table 12. Average Time of Occupancy**

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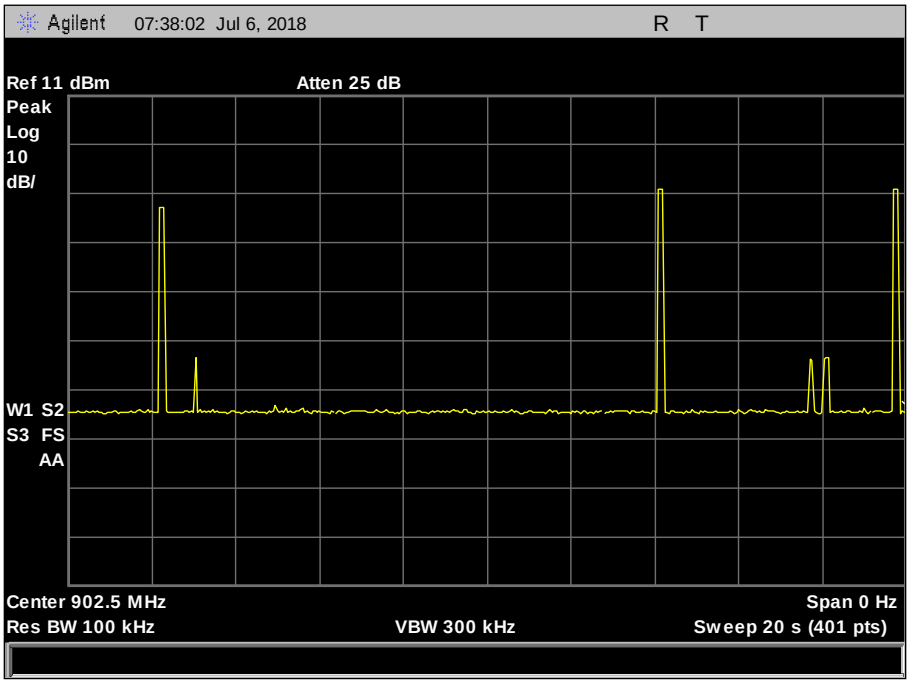
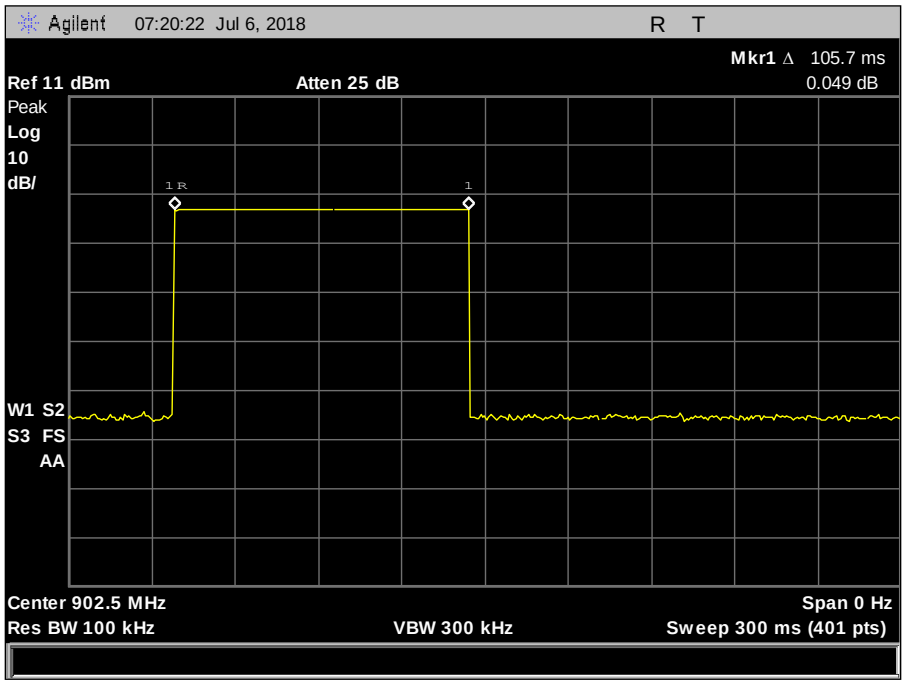
## Dwell Time




**Plot 8. Dwell Time, bursts per period**




**Plot 9. Dwell Time, pulse width**

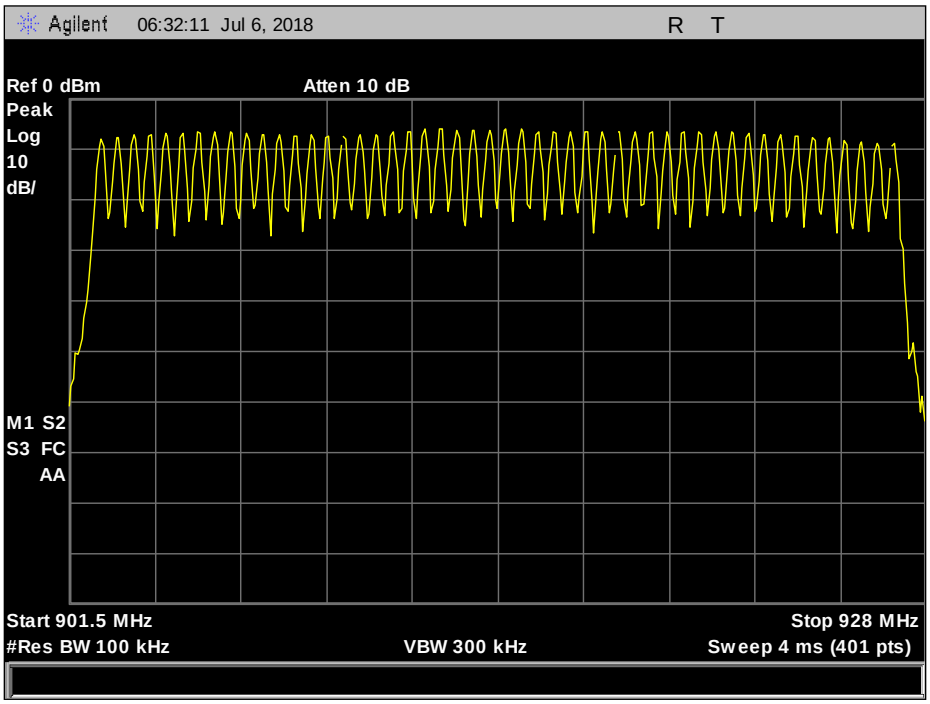
# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) Number of RF Channels

**Test Requirements:** (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

**Test Procedure:** The EUT had its hopping function enabled. Procedure 7.8.3 from ANSI C63.10 – 2013 was used to count the number of hopping channels.

**Test Results** The EUT was compliant with § 15.247 (a)(1)(i). No anomalies detected.




**Plot 10. Number of Hopping Channels**

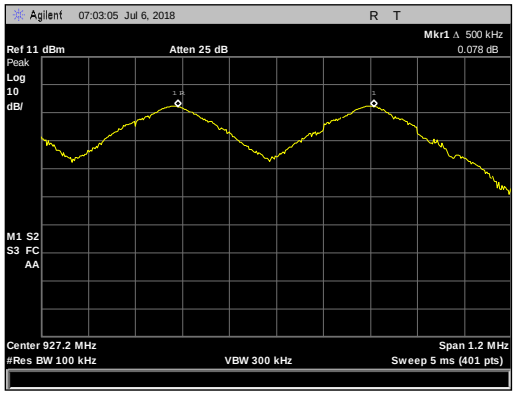
# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) RF Channel Separation

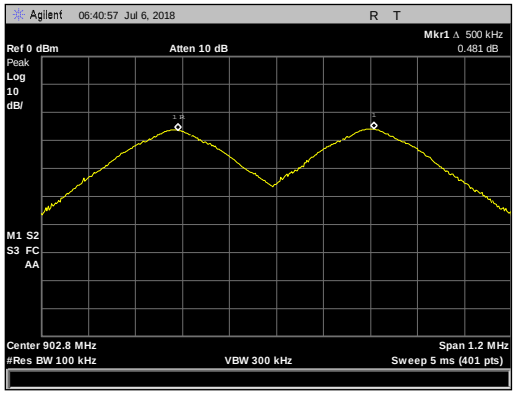
**Requirement:** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

**Procedure:** The EUT had its hopping function enabled. Procedure 7.8.2 from ANSI C63.10 – 2013 was used to measure the channel separation.

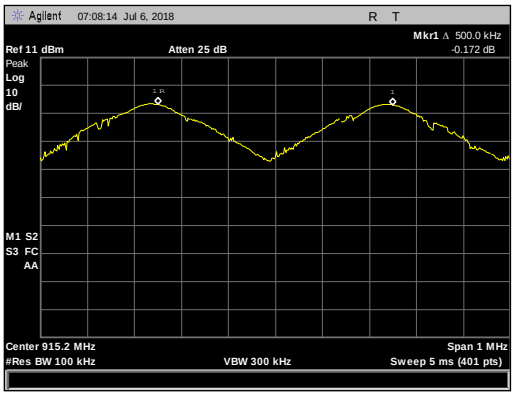
**Test Results** The EUT was compliant with § 15.247 (a)(1). No anomalies detected.




**Plot 11. Channel Separation, High Frequencies**




**Plot 12. Channel Separation, Low Frequencies**




**Plot 13. Channel Separation, Middle Frequencies**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(b) Peak Power Output

**Test Requirements:** **§15.247(b)(2):** For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.**§15.247(b) (4)** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Test Procedure:** The transmitter was on top of a RF invisible turn-table inside a semi-anechoic chamber. The receive antenna was located 1.5m away from the EUT. The receive antenna had its height varied and the turn table was rotated until the max emission was found. The field strength was measured at the low, mid and high channels. Procedure 9.1.1 from KDB 558074 v04 was used to measure the peak field strength.

**Test Results:** The EUT was compliant with the Peak Power Output limits of **§15.247(b)**. No anomalies detected.

**Test Engineer(s):** Donald Salguero

**Test Date(s):** July 24, 2018

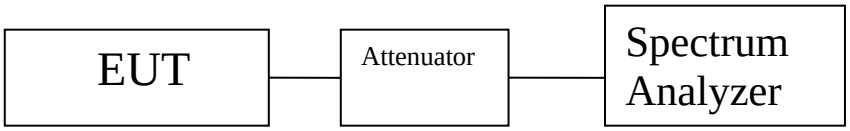



**Figure 3. Peak Power Output Test Setup**

| Center Frequency (MHz) | Peak Field Strength (dBuV/m) | EIRP (dBm) | Antenna Gain (dBi) | Peak Conducted Power (dBm) | Limit (dBm) |
|---|---|---|---|---|---|
| 902.5 | 124.12 | 22.87 | 4 | 18.87 | 30 |
| 915 | 126.13 | 24.88 | 4 | 20.88 | 30 |
| 927.5 | 126.3 | 25.05 | 4 | 21.05 | 30 |

Peak Power Output, Test Results

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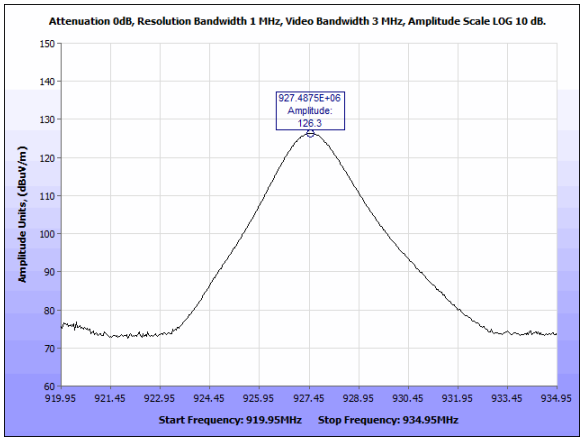
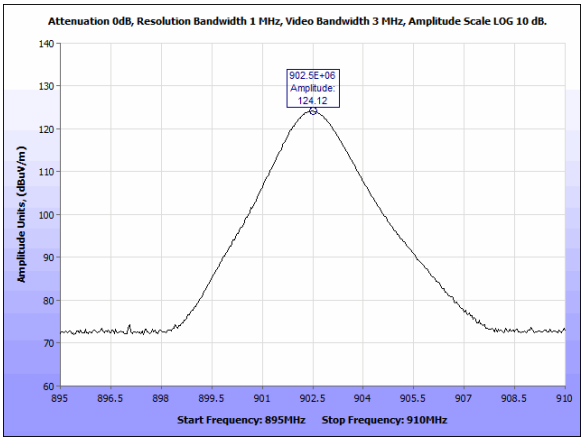
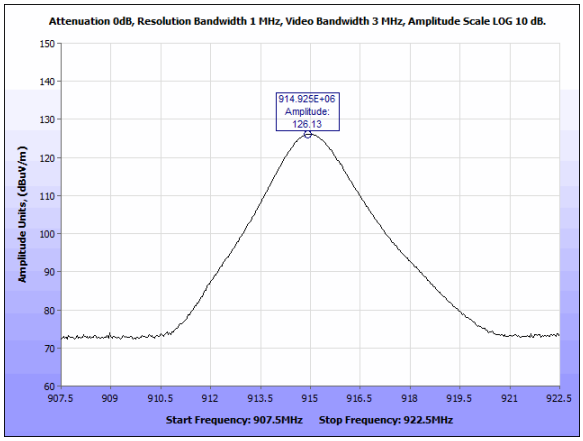
# Peak Power Output Test Results




**Plot 14. Peak Power Output, High channel**




**Plot 15. Peak Power Output, Low channel**




**Plot 16. Peak Power Output, Mid channel**

# 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

**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 Procedure:** The transmitter was set to the low, mid, and high channels at the highest output power and placed on a 0.8 m high RF invisible table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurement were repeated the measurement at the low and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

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 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor

**Test Results:** The EUT was compliant with the Radiated Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

**Test Engineer(s):** Donald Salguero

**Test Date(s):** July 24, 2018

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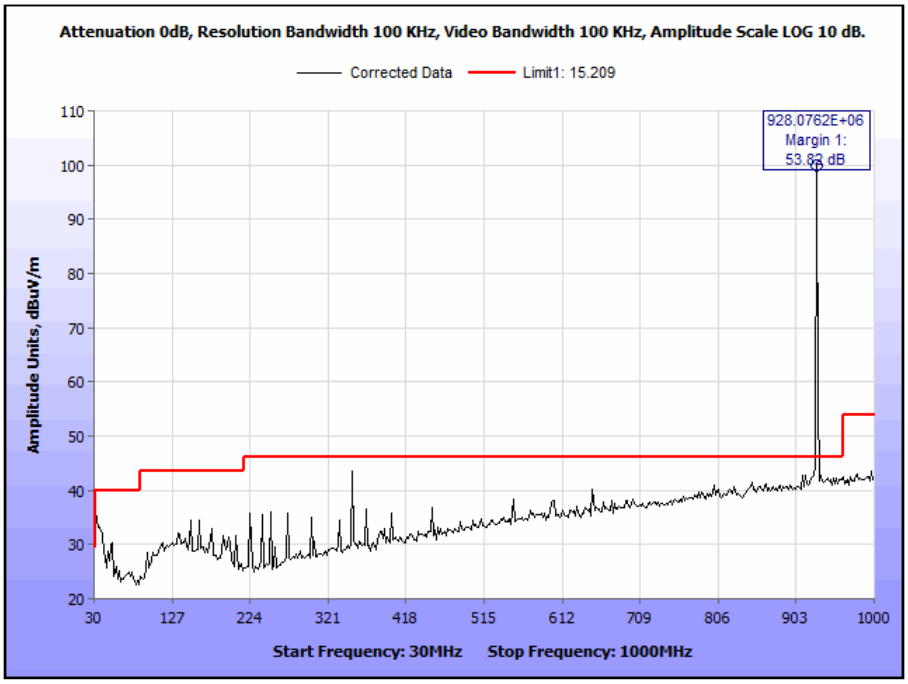
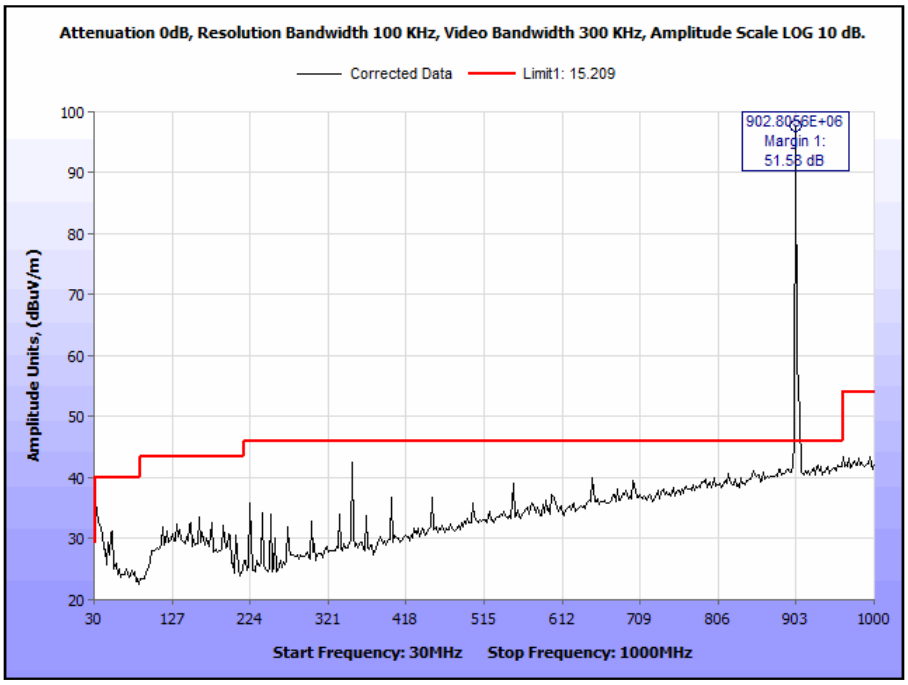
## Radiated Spurious Emissions Test Results




**Plot 17. Radiated Emissions, 30 MHz – 1 GHz, High Channel**




**Plot 18. Radiated Emissions, 30 MHz – 1 GHz, Low Channel**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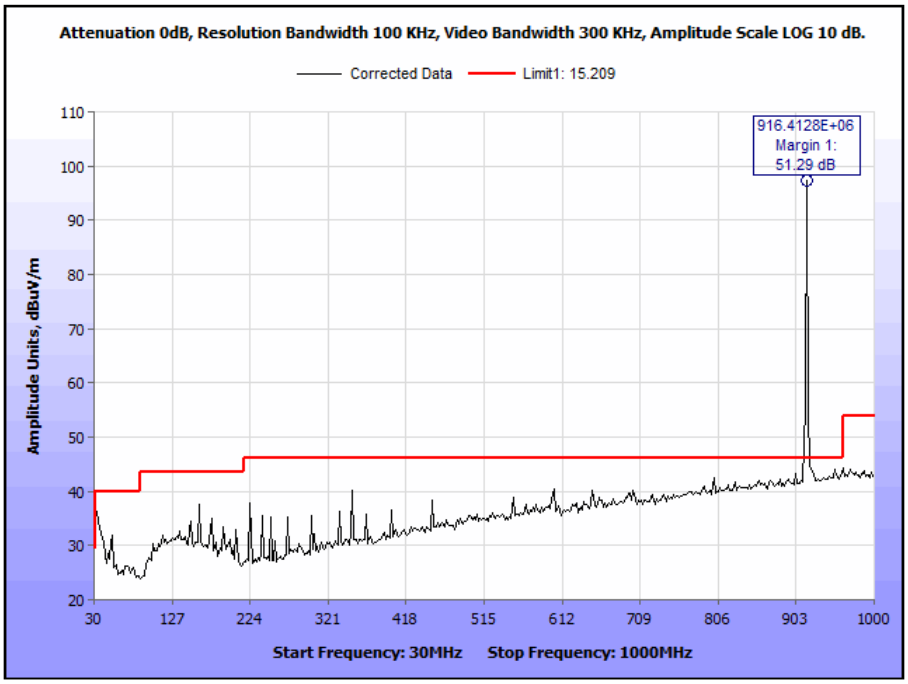
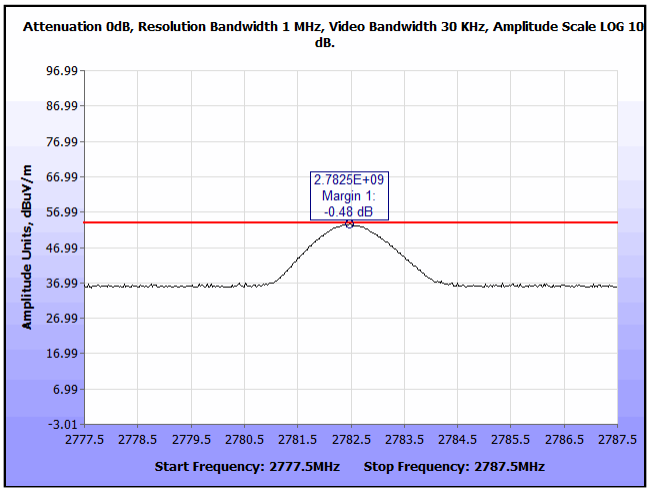
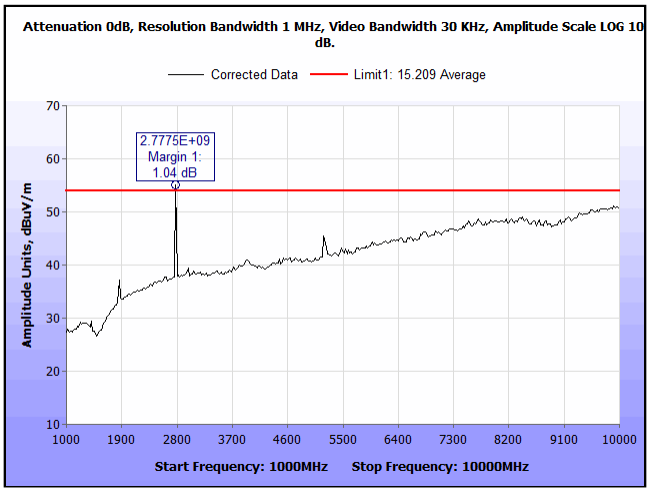


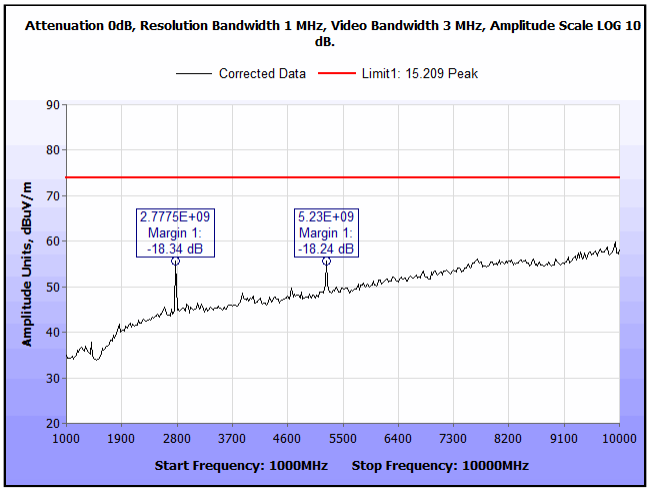

**Plot 19. Radiated Emissions, 30 MHz – 1GHz, Mid Channel**



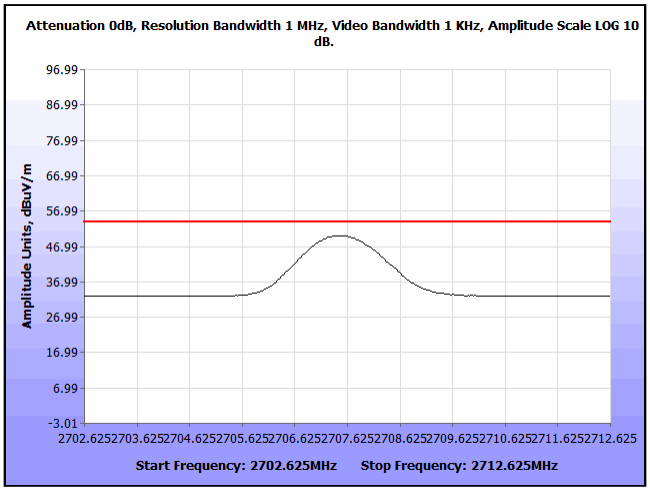

**Plot 20. Radiated Spurious Emissions, high channel, Avg, 2.7825 GHz spur**



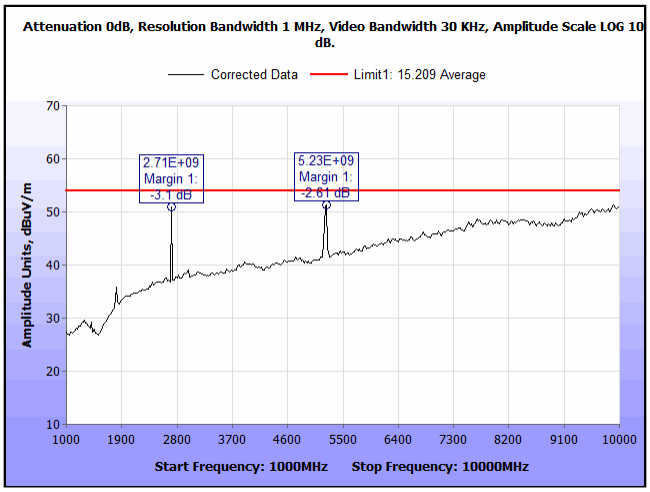

**Plot 21. Radiated Spurious Emissions, 1-10GHz, high channel, Avg**



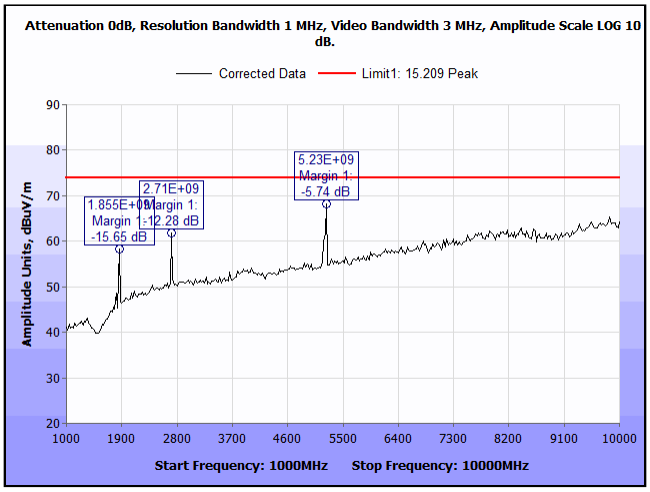

**Plot 22. Radiated Spurious Emissions, 1-10GHz, high channel, Peak**



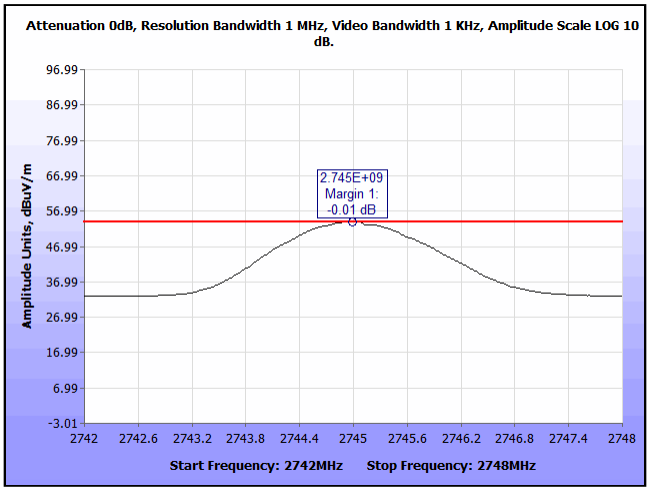

**Plot 23. Radiated Spurious Emissions, low channel, Avg, 2.708GHz spur**



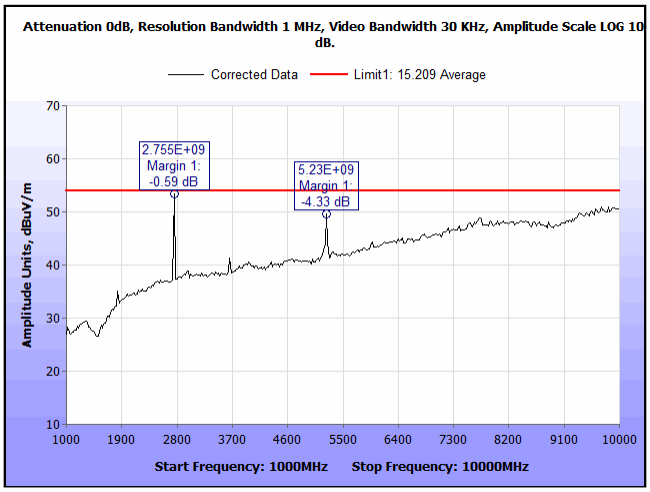

**Plot 24. Radiated Spurious Emissions, 1-10GHz, low channel, Avg**



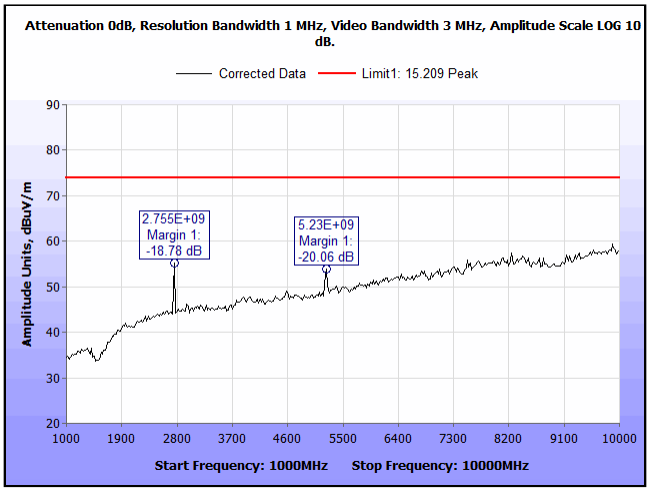

**Plot 25. Radiated Spurious Emissions, 1-10GHz, low channel, Peak**




**Plot 26. Radiated Spurious Emissions, mid channel, Avg, 2.745 GHz spur**




**Plot 27. Radiated Spurious Emissions, 1-10GHz, mid channel, Avg**

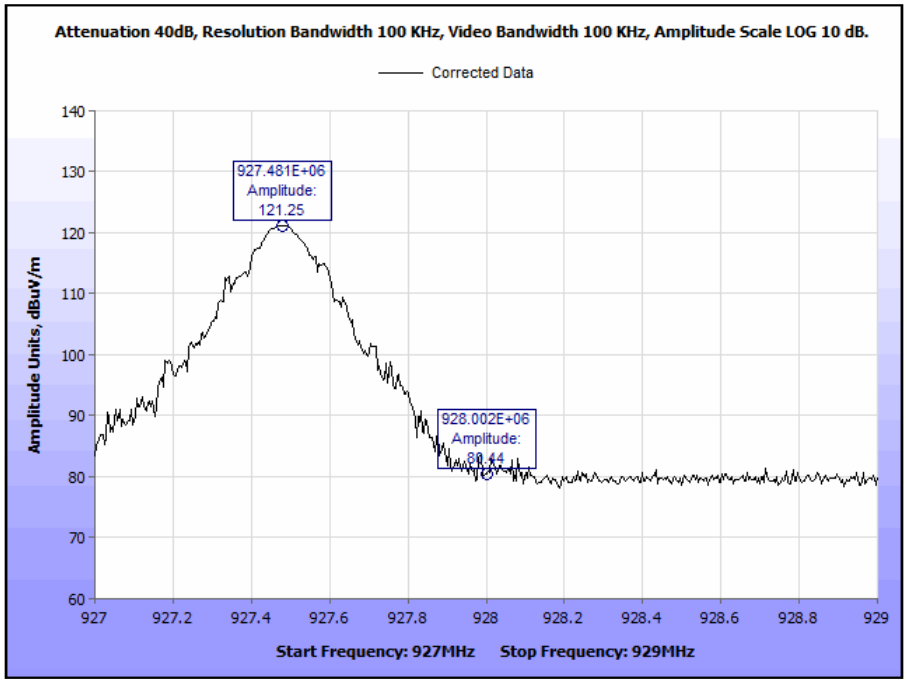



**Plot 28. Radiated Spurious Emissions, 1-10GHz, mid channel, Peak**

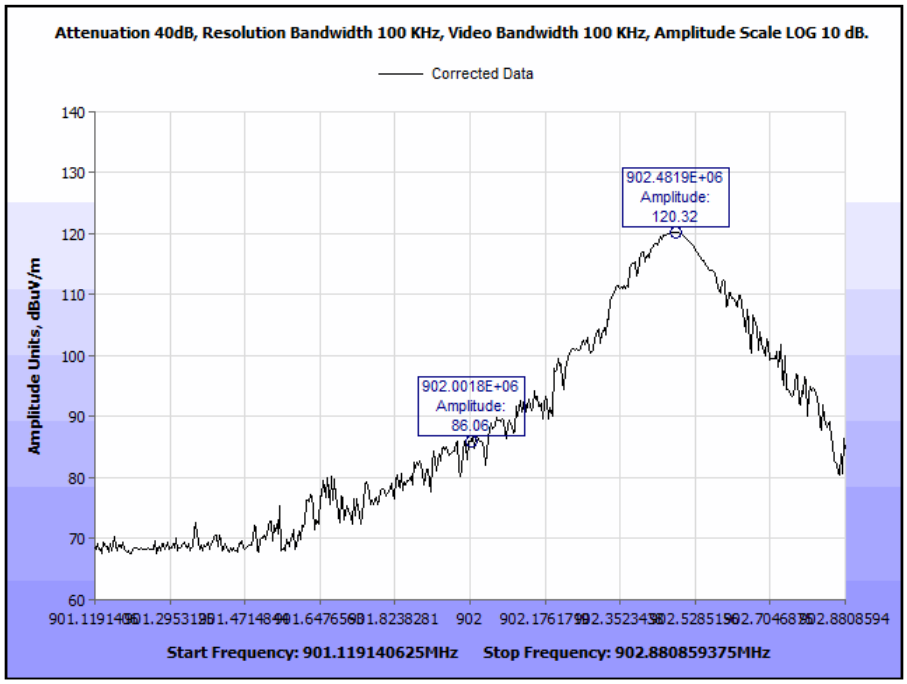
## Radiated Band Edge Measurements

**Test Procedures:** The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.

Test Results: Since the band edges at 902MHz and 928MHz do not start a restricted band, then the 100kHz outside band limit is applied. Emissions at the band edges are more than 20 dB below the highest level of desired power.

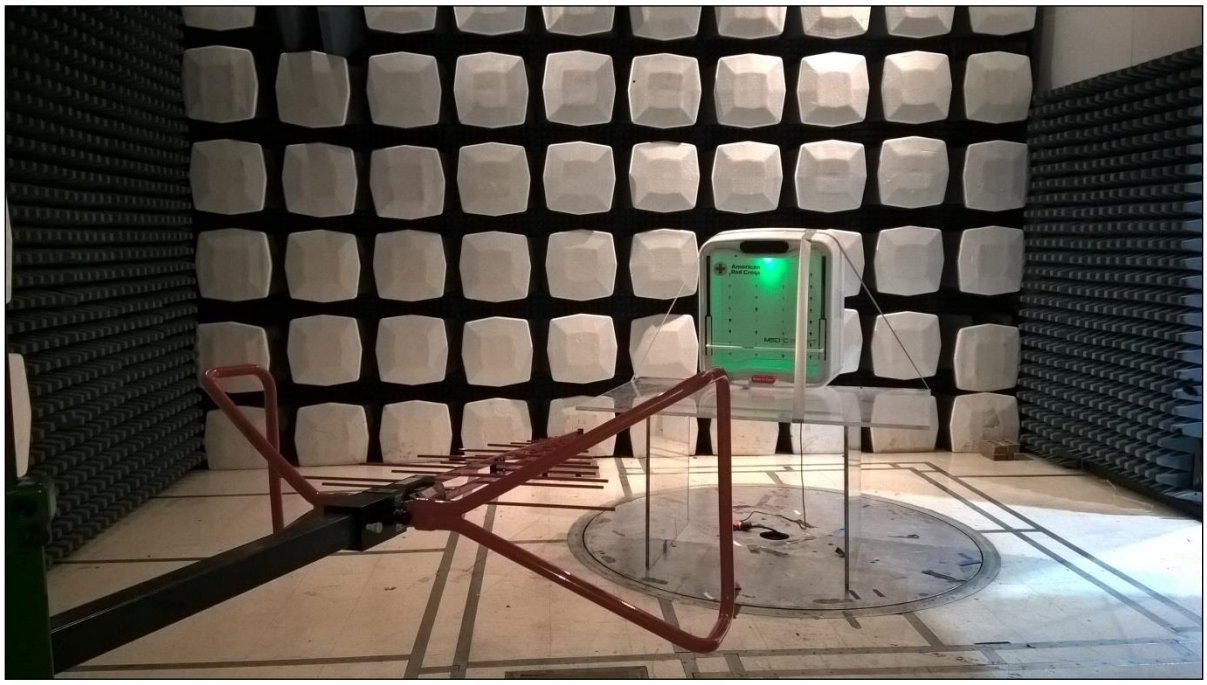



**Plot 29. Radiated Emissions, Band Edge, High**

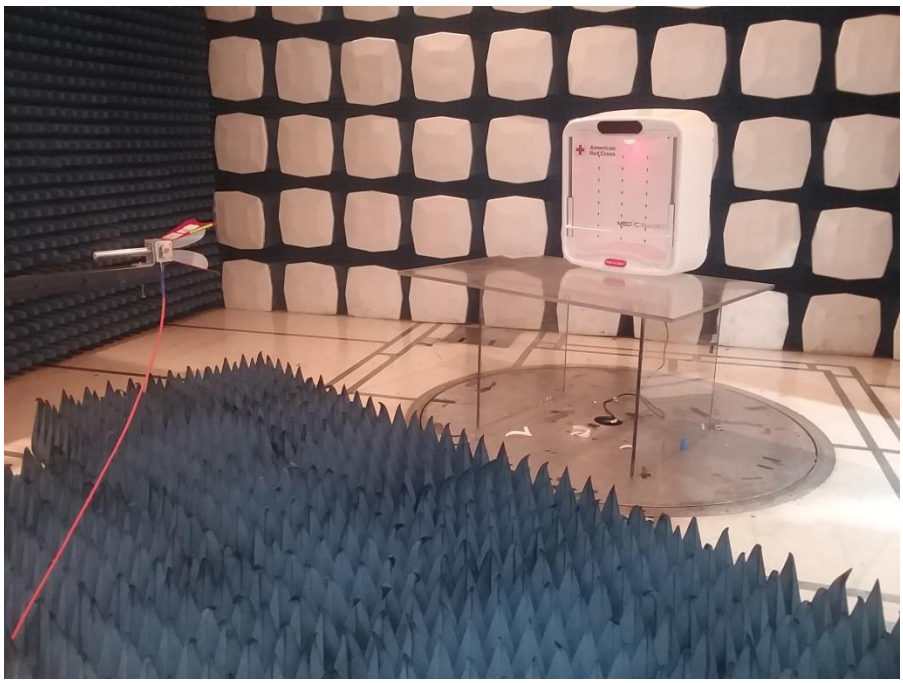



**Plot 30. Radiated Emissions, Band Edge, Low**

## Radiated Spurious Emissions Test Setup



**Photograph 2. Radiated Emissions, 30 – 1000 MHz, Test Setup**



**Photograph 3. Radiated Emissions, 1 – 10 GHz, Test Setup**

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(d) 100kHz 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 100kHz Spurious Emissions.

**Test Results:** The EUT was compliant with the 100kHz Spurious Emission limits of **§15.247(d)**. Measured emissions were within applicable limits.

**Test Engineer(s):** Donald Salguero

**Test Date(s):** July 24, 2018

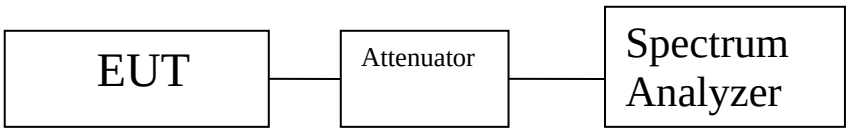


**Figure 4. Block Diagram, 100kHz Spurious Emissions Test Setup**

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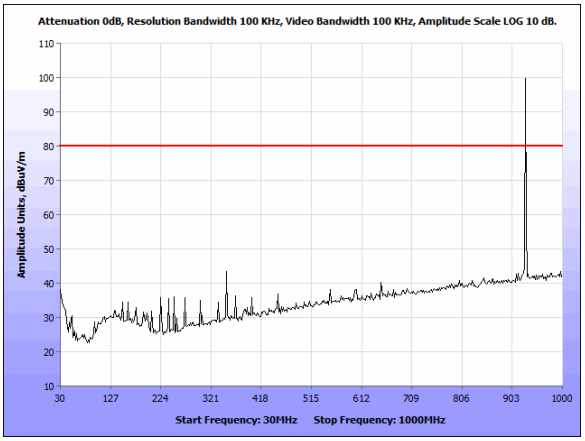
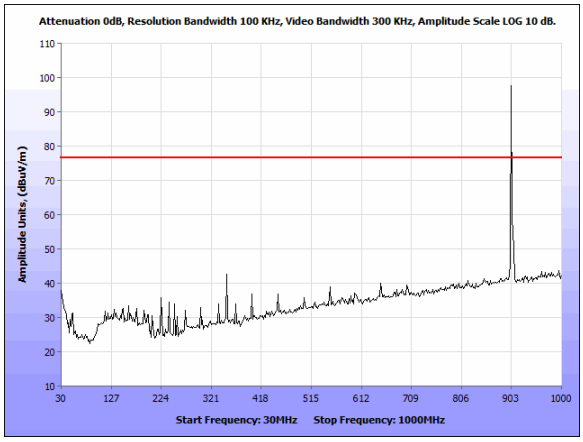
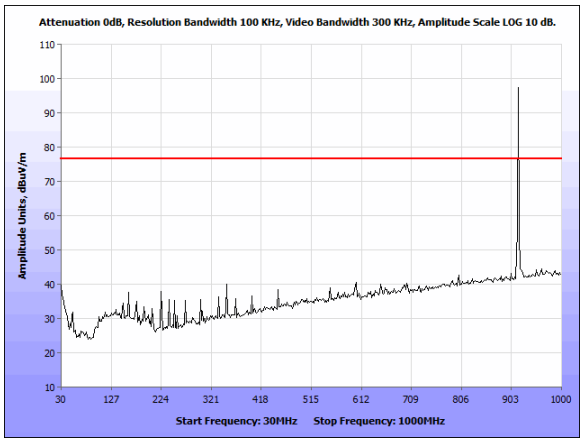
# 100kHz Spurious Emissions Test Results



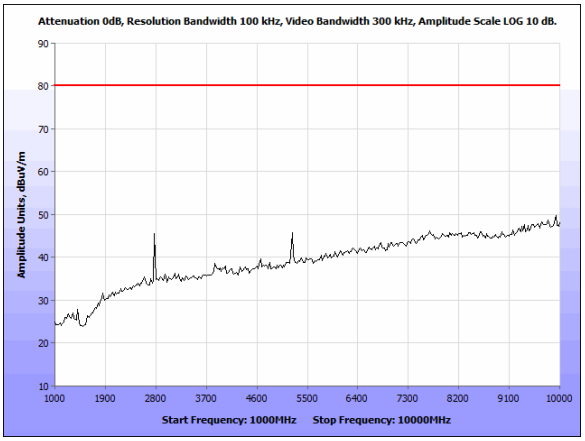

**Plot 31. 100kHz Spurious Emissions, 30MHz-1GHz, high channel**



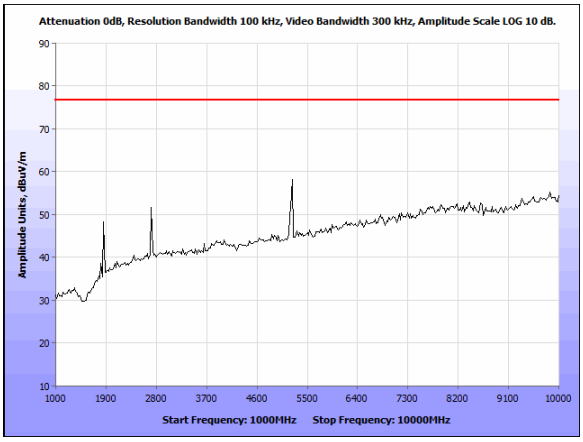

**Plot 32. 100kHz Spurious Emissions, 30MHz-1GHz, low channel**



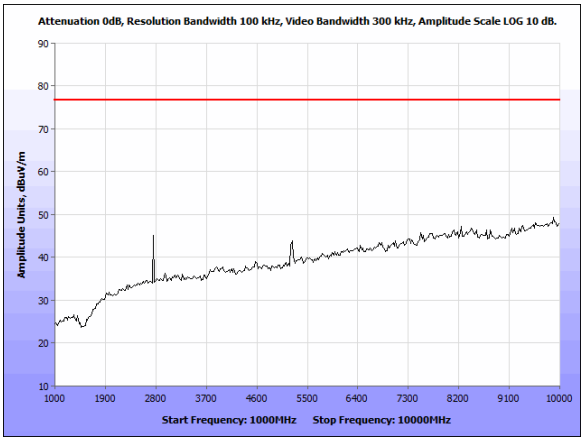

**Plot 33. 100Khz Spurious Emissions, 30MHz-1GHz, mid channel**




**Plot 34. 100 kHz Spurious Emissions, 1-10GHz, high channel**

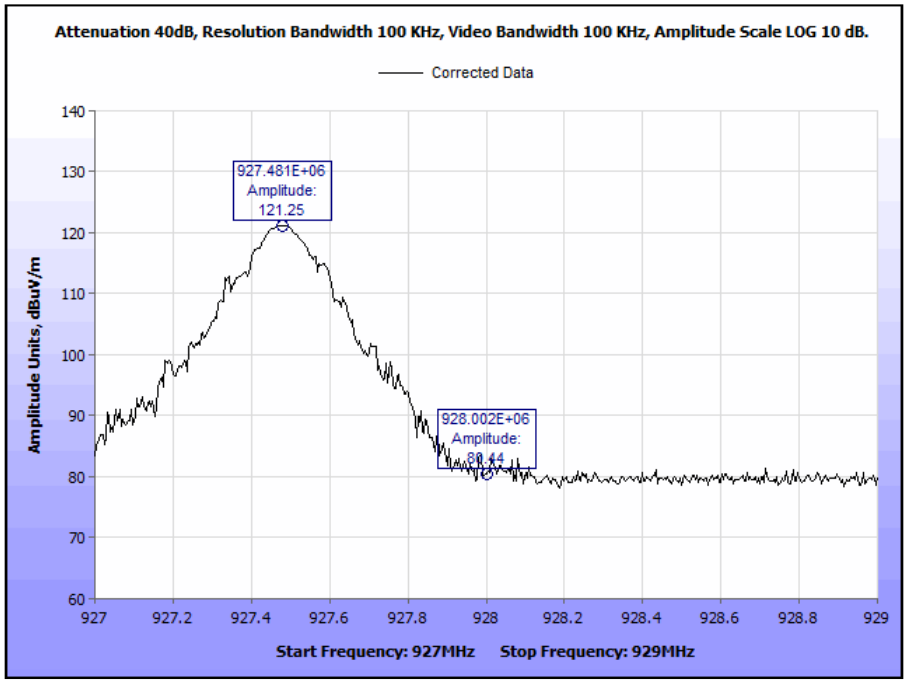



**Plot 35. 100 kHz Spurious Emissions, 1-10GHz, low channel**

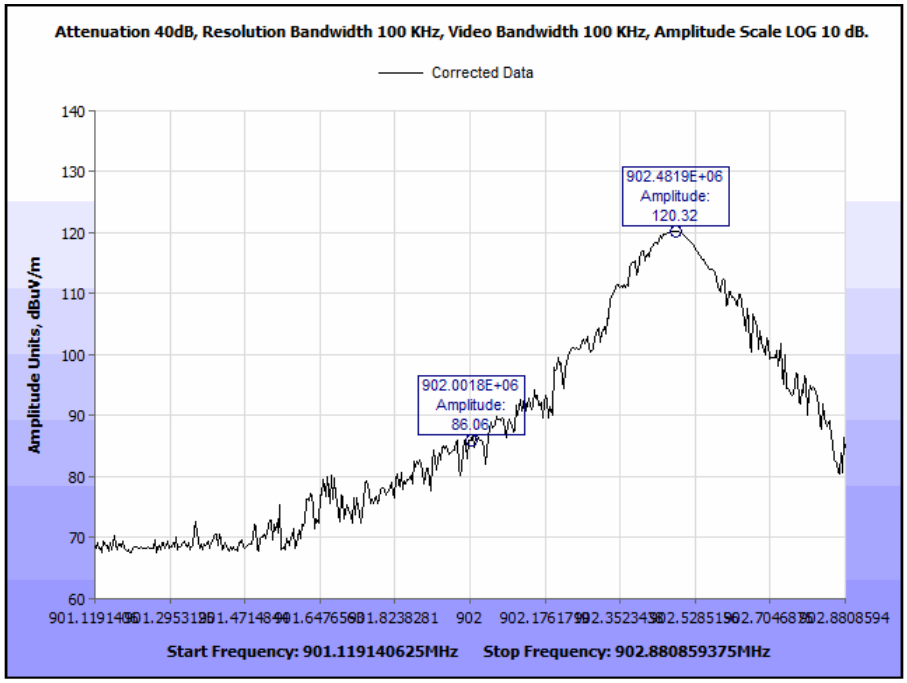



**Plot 36. 100 kHz Spurious Emissions, 1-10GHz, mid channel**

# 100kHz Spuriosu Emissions Band Edge Test Results




**Plot 37. Spurious RF Conducted Emissions, band edge, High**




**Plot 38. Spurious RF Conducted Emissions, band edge, Low**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(i) Maximum Permissible 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.

| FCC | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Con. Pwr. (dBm) | Con. Pwr. (mW) | Ant. Gain (dBi) | Ant. Gain numeric | Pwr. Density ($mW/cm^2$) | Limit ($mW/cm^2$) | Margin | Distance (cm) | Result |
| 927.5 | 21.05 | 127.35 | 4 | 2.512 | 0.06364 | 0.61833 | 0.55469 | 20 | Pass |

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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 17025:2005.

| MET Asset # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1T4300A | SEMI-ANECHOIC CHAMBER # 1 (FCC) | EMC TEST SYSTEMS | NONE | 1/31/2016 | 1/31/2019 |
| 1T4751 | Antenna - Bilog | Sunol Sciences | JB6 | 2/28/2017 | 8/28/2018 |
| 1T8743 | Preamplifier | A.H. Systems, Inc. | PAM-0118P | See note | |
| 1T4483 | Antenna; Horn | ETS-Lindgren | 3117 | 4/19/2017 | 10/19/2018 |
| 1T4409 | EMI Receiver | Rohde & Schwarz | ESIB7 | 12/7/2016 | 12/7/2018 |
| 1T4563 | LISN (10 AMP) | Solar Electronics Company | 9322-50-R-10-BNC | 3/13/2017 | 9/13/2018 |
| 1T4612 | Spectrum Analyzer | Agilent Technologies | E4407B | 5/15/2017 | 11/15/2018 |

**Table 15. Test Equipment List**

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

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# V. Certification & User's Manual Information

# Certification & User's Manual Information

## A. Certification Information

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

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

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

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

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

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

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

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

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

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

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

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

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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

## 1. Label and User's Manual Information

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

**§ 15.19 Labeling requirements.**

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

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

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

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

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

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

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

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

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

**§ 15.21 Information to user.**

The 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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# End of Report

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