**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE ! BALTIMORE, MARYLAND 21230-3432 ! PHONE (410) 354-3300 ! FAX (410) 354-3313
33439 WESTERN AVENUE ! UNION CITY, CALIFORNIA 94587 ! PHONE (510) 489-6300 ! FAX (510) 489-6372
3162 BELICK STREET ! SANTA CLARA, CA 95054 ! PHONE (408) 748-3585 ! FAX (510) 489-6372
13301 MCCALLEN PASS ! AUSTIN, TX 78753 ! PHONE (512) 287-2500 ! FAX (512) 287-2513

May 21, 2018

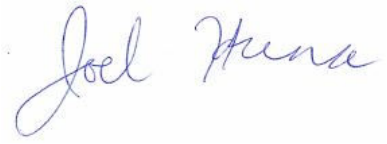
Intelligent Automation, Inc.
15400 Calhoun Place Suite 400
Rockville, MD 20855

Dear Eric van Doorn,

Enclosed is the EMC Wireless test report for compliance testing of the Intelligent Automation, Inc., ARGUS GUARDIAN 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: (\Intelligent Automation, Inc.\EMC97200-FCC247 FHSS)



ACCREDITED
TESTING CERT #0591.01

# Electromagnetic Compatibility Criteria
# Test Report

for the

**Intelligent Automation, Inc.**
**ARGUS GUARDIAN**

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart C

**MET Report: EMC97200-FCC247 FHSS**

May 21, 2018

**Prepared For:**

**Intelligent Automation, Inc.**
**15400 Calhoun Place Suite 400**
**Rockville, MD 20855**

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

# Electromagnetic Compatibility Criteria
# Test Report

for the

## Intelligent Automation, Inc.
## ARGUS GUARDIAN

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B
for Class A Digital Devices
&
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 Part 15.247 under normal use and maintenance.

John Mason,
Director, Electromagnetic Compatibility Lab

# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | May 21, 2018 | Initial Issue. |
| 1 | December 14, 2018 | Correction of Typographical Errors |

# Table of Contents

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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**ilovolt |
| **LISN** | **L**ine **I**mpedance **S**tabilization **N**etwork |
| **MHz** | **M**ega**h**ertz |
| **µH** | **micro**henry |
| µ | **micro**farad |
| **µs** | **micro**seconds |
| **NEBS** | **N**etwork **E**quipment-**B**uilding **S**ystem |
| **PRF** | **P**ulse **R**epetition **F**requency |
| **RF** | **R**adio **F**requency |
| **RMS** | **R**oot-**M**ean-**S**quare |
| **TWT** | **T**raveling **W**ave **T**ube |
| **V/m** | **V**olts **per m**eter |
| **VCP** | **V**ertical **C**oupling **P**lane |

# I. Executive Summary

## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Intelligent Automation, Inc. ARGUS GUARDIAN, 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 ARGUS GUARDIAN. Intelligent Automation, Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the ARGUS GUARDIAN, 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 Intelligent Automation, Inc., purchase order number 3004-173011-002. All tests were conducted using measurement procedure ANSI C63.4-2003.

| FCC Reference 47 CFR Part 15.247:2005 | Description | Compliance |
|---|---|---|
| Title 47 of the CFR, Part 15 §15.203 | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | Conducted Emission Limits | Not Applicable |
| Title 47 of the CFR, Part 15 §15.247(a)(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) | Spurious Conducted Emissions | Not Applicable |
| Title 47 of the CFR, Part 15 §15.247(g) & (h) | Declaration Statements for FHSS | 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**

# II. Equipment Configuration

# A. Overview

MET Laboratories, Inc. was contracted by Intelligent Automation, Inc. to perform testing on the ARGUS GUARDIAN, under Intelligent Automation, Inc.'s purchase order number 3004-173011-002.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Intelligent Automation, Inc., ARGUS GUARDIAN.

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

| | | |
|---|---|---|
| **Model(s) Tested:** | ARGUS GUARDIAN | |
| **Model(s) Covered:** | ARGUS GUARDIAN | |
| **EUT Specifications:** | Primary Power: 2.1-3.6VDC | |
| | FCC ID: 2AI6Y-GUARDIAN | |
| | Type of Modulations: | DSSS OQPSK |
| | Equipment Code: | FHSS |
| | Peak RF Output Power: | 6.16 dBm |
| | EUT Frequency Ranges: | 2.405-2.475GHz |
| **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):** | May 21, 2018 | |

**Table 2. EUT Summary Table**

## B. References

| | |
|---|---|
| **CFR 47, Part 15, Subpart C** | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| **ANSI C63.4:2014** | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **ISO/IEC 17025:2005** | General Requirements for the Competence of Testing and Calibration Laboratories |
| **ANSI C63.10-2013** | American National Standard for Testing Unlicensed Wireless Devices |

**Table 3. References**

## 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**

## E. Description of Test Sample

The Intelligent Automation, Inc. ARGUS GUARDIAN, Equipment Under Test (EUT), is a system of fence-mounted sensors used for the purpose of perimeter intrusion detection, typically surrounding a building or other high valued asset needed protection. Each individual ARGUS GUARDIAN sensor is comprised of two radio transceivers – one 2.4GHz transceiver for the purpose of networking and communications, and one 900MHz transceiver for the purpose of sending/receiving the transmissions that are actually used to detect the intruders.

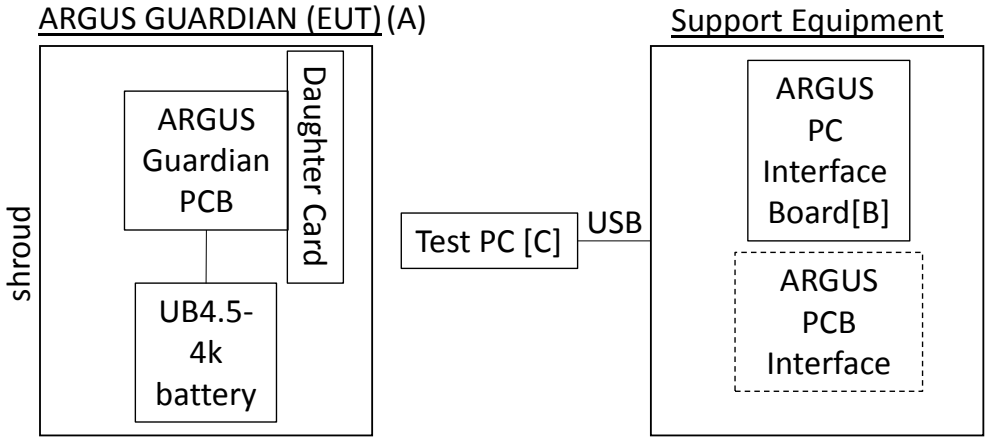



**Figure 1. Block Diagram of Test Configuration**

## 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. # |
|---|---|---|---|---|---|---|
| A | | ARGUS GUARDIAN | | | | |

**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 |
|---|---|---|---|---|
| B | ARGUS Programming/Interface Board | Intelligent Automation, Inc. | IAI15001_DEV_X2 | Not Applicable |
| C | Test/Configuration PC | Panasonic | Toughbook CF-31 | Not Applicable |
| 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**

## 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 | BAT | 2 conductor, 26 awg | 1 | 0.2 | | No | |

**Table 7. Ports and Cabling Information**

## I. Mode of Operation

For testing purposes, we expect to operate either/both transceivers in a continuous modulation (CM) mode on a particular channel to represent a "worst-case" configuration for the device.

## J. Method of Monitoring EUT Operation

1. The EUT will blink its onboard LED green three times indicating that it has started up. After startup, no LED indication is present.
2. If directly connected to a PC USB port (via the separate configuration interface board), the EUT will print out statements indicating the test mode being used upon startup. This would be done only to confirm a configuration, but would not be used during actual testing.
3. The 2.4GHz and/or 900MHz transmissions can be observed on a spectrum analyzer.

## 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 Intelligent Automation, Inc. upon completion of testing.

# 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. EUT has a built-in antenna.

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

**Test Date(s):** March 29, 2018

| Gain | Type |
|---|---|
| ~1dBi | **Embedded monopole** |

**Table 8. Antenna List**

## 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:

For frequency hopping systems, the EUT 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.

**Test Procedure:** The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately between to 1-5% 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):** March 29, 2018

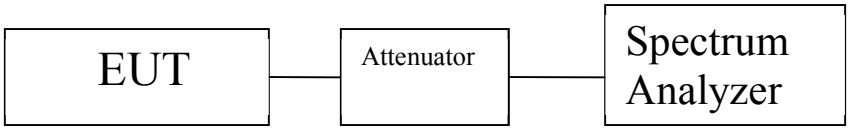


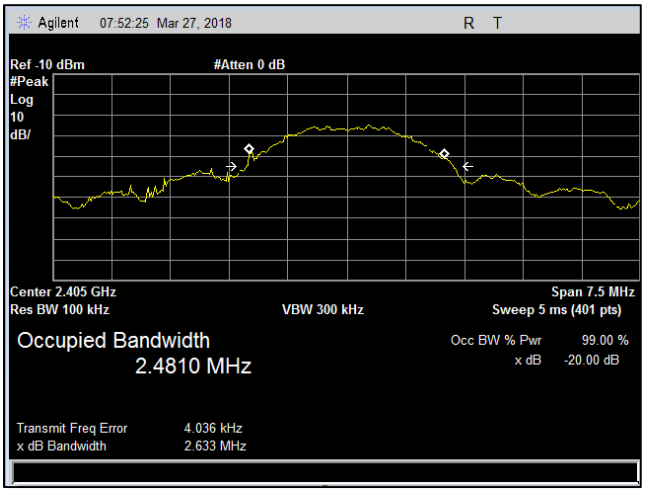

**Figure 2. Block Diagram, Occupied Bandwidth Test Setup**

| Center Frequency (MHz) | 20dB bandwidth (MHz) |
|---|---|
| 2405 | 2.633 |
| 2440 | 2.626 |
| 2475 | 2.658 |

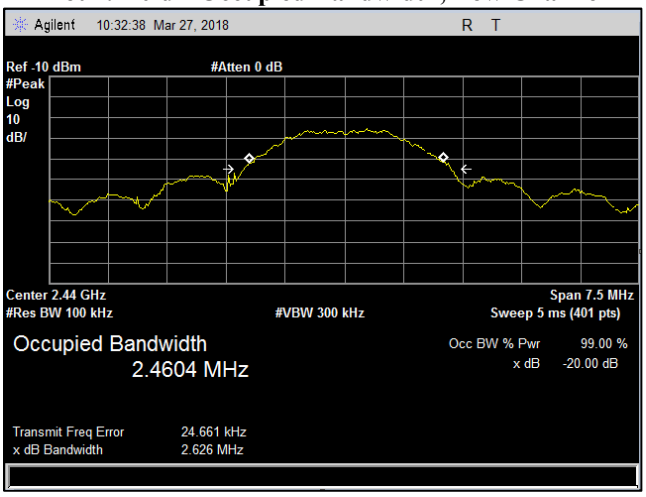
**Table 9. 20dB Bandwidth, Test Results**

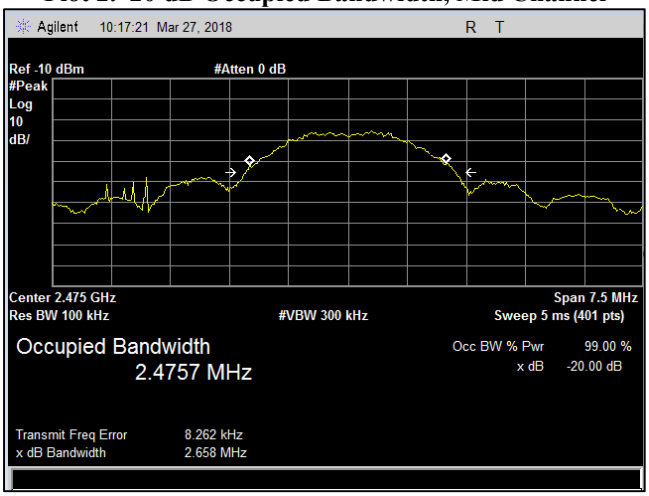
## 20 dB Occupied Bandwidth Test Results




**Plot 1. 20 dB Occupied Bandwidth, Low Channel**




**Plot 2. 20 dB Occupied Bandwidth, Mid Channel**




**Plot 3. 20 dB Occupied Bandwidth, High Channel**

# Electromagnetic Compatibility Criteria for Intentional Radiators

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

**Requirement:** Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

**Procedure:** EUT was set to have its hopping function enabled. Procedure 7.7.4 from ANSI C63.10 was used to capture the pulse width and entire dwell time per hopping channel.

**Dwell Time Calculation;**

Hopping period = Number of channel * 0.4

Number of Burst = Burst per hopping period

Burst Duration = pulse width

Dwell time = Number of Burst * Burst duration

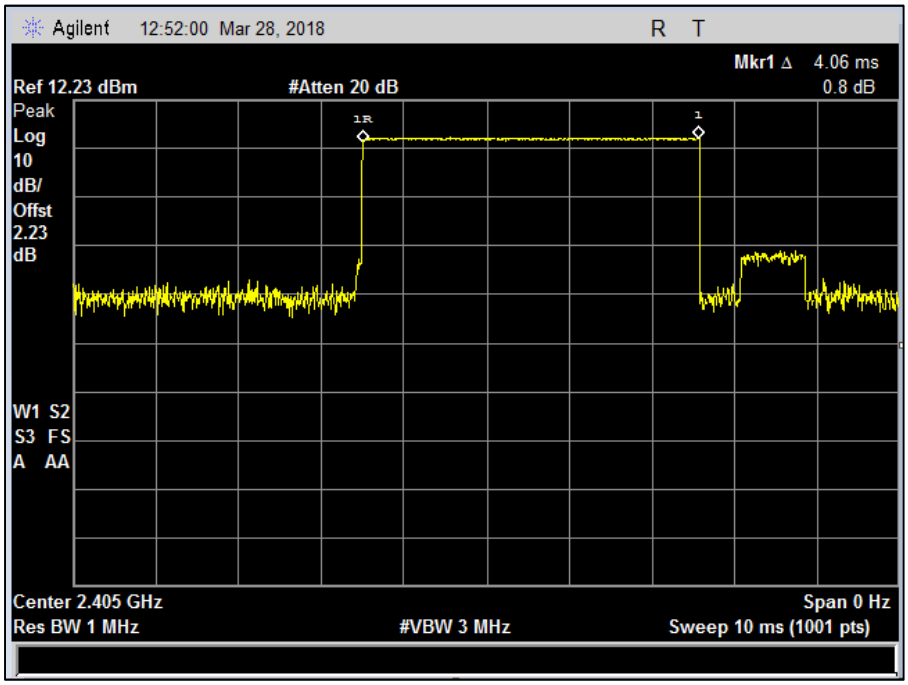
**Remarks:** The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 6 second period.

Total hopping channels is 15. The EUT meets the specifications of Section 15.247(a) (1) (iii) for Number of Hopping Channels.

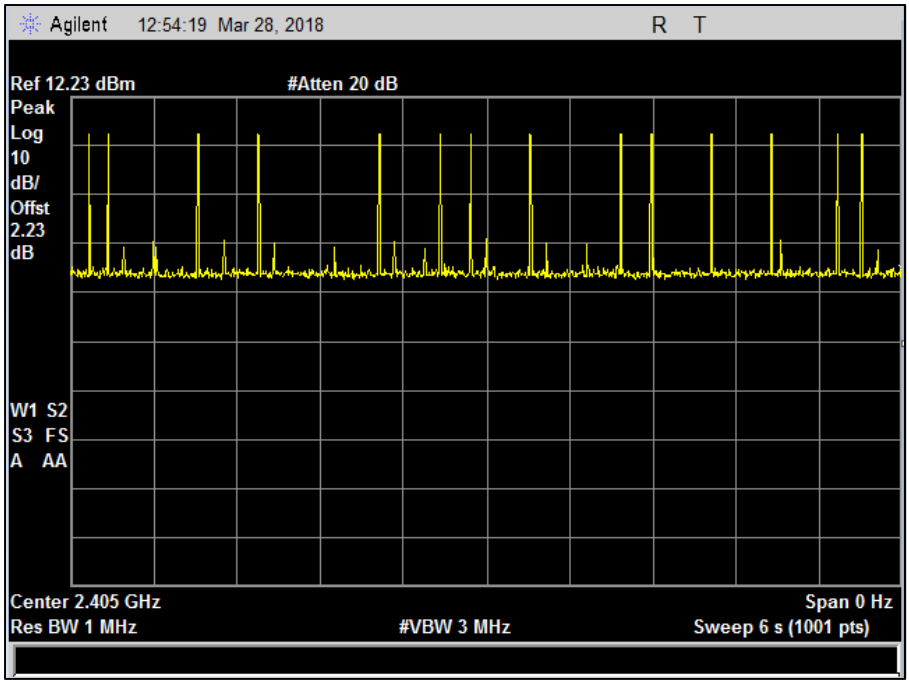
| Dwell Time | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency Range (MHz)** | **No of Channels** | **Hopping Period (s)** | **No of Bursts per Period** | **Burst duration (s)** | **Dwell Time (s)** | **Limit (s)** | **Margin** |
| 2405 - 2475 | 15 | 6 | 14 | 0.00406 | 0.05684 | 0.4 | -0.34316 |

**Table 10. Average Time of Occupancy**

## Dwell Time




**Plot 4. Dwell Time, Burst Duration**

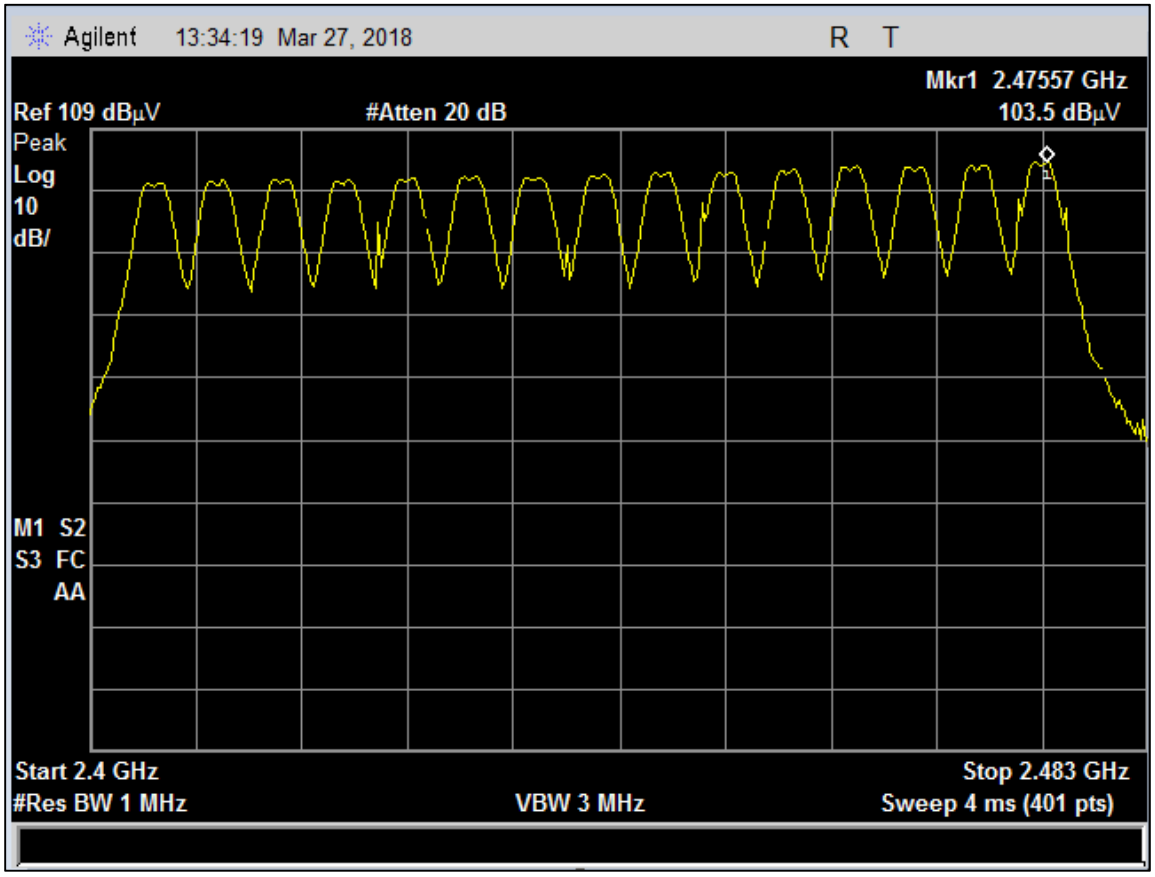



**Plot 5. Dwell Time, Burst per Period**

# Electromagnetic Compatibility Criteria for Intentional Radiators

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

**Requirement:** Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.



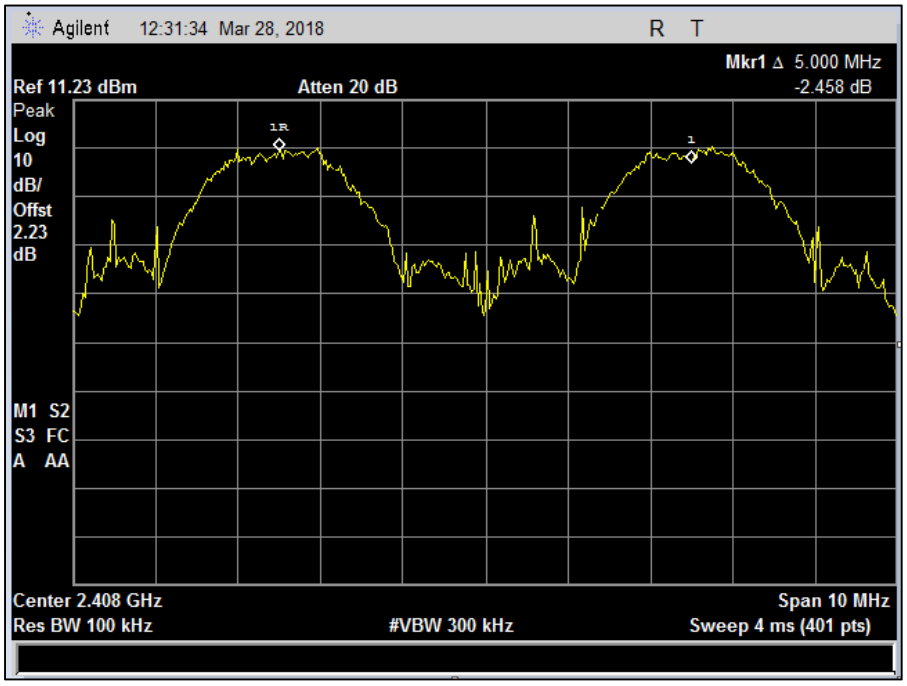

**Plot 6. Number of Channels**

# Electromagnetic Compatibility Criteria for Intentional Radiators

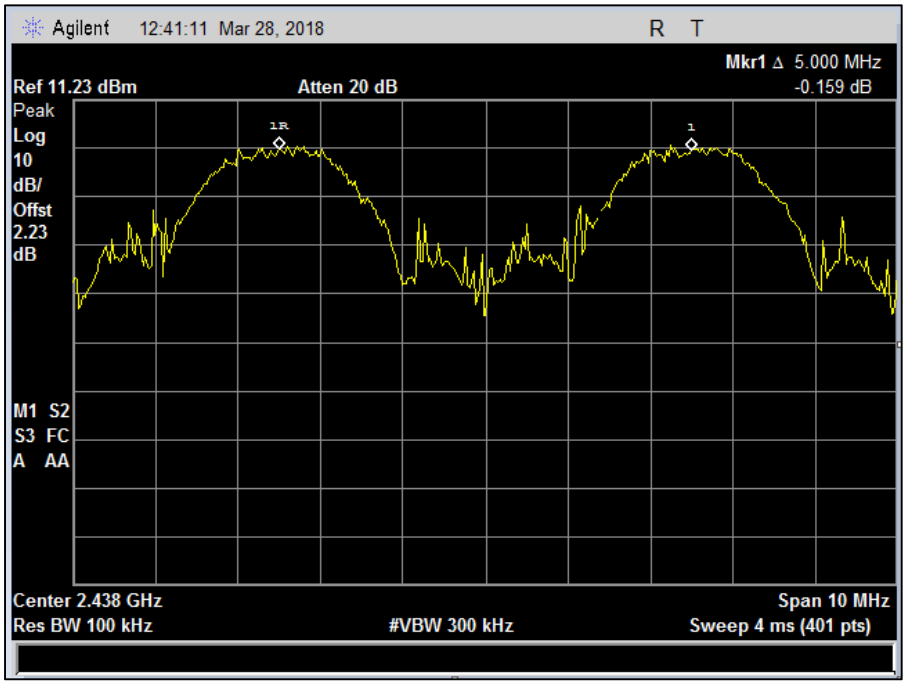
## § 15.247(a)(1) RF Channel Separation

**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.

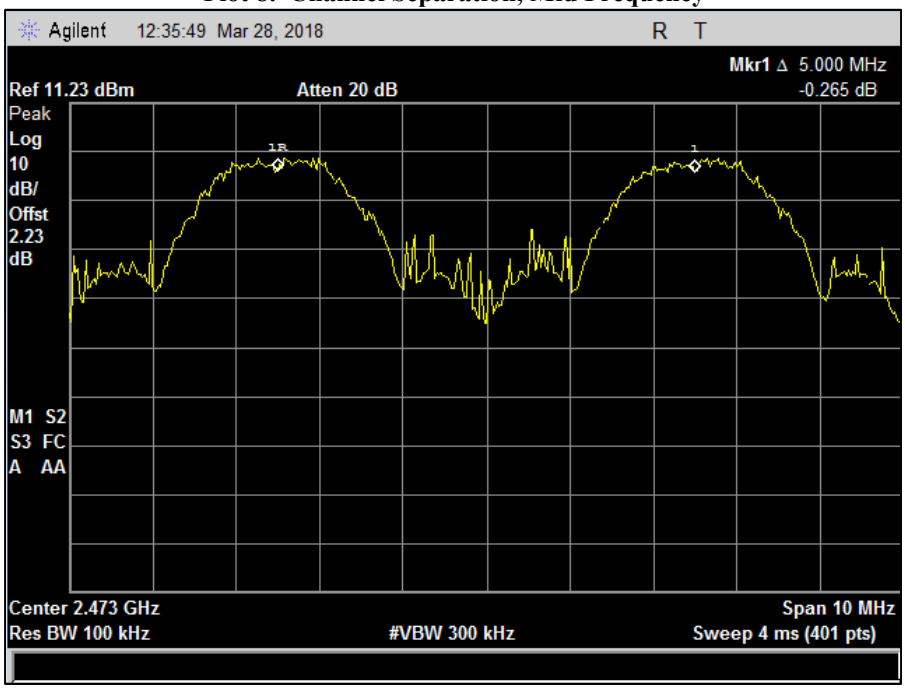
**Procedure:** Procedure 7.7.2 from ANSI C63.10 was used to perform the measurement. With the EUT configured to operate with its hopping function enabled, the spectrum analyzer was configured as follows: Span set to be wide enough to capture 2 adjacent channels. RBW ≥ 1% span, and VBW ≥ RBW. After allowing the trace to stabilize with max hold enabled, the marker-delta function was used to determine the separation between peaks on adjacent channels.




**Plot 7. Channel Separation, Low Frequency**




**Plot 8. Channel Separation, Mid Frequency**




**Plot 9. Channel Separation, High Frequency**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(b) Peak Power Output

**Test Requirements:** **§15.247(b)(1):** For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

**§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 spectrum analyzer was set up as follows: Span set to approximately 5 times the 20dB bandwidth, RBW > 20dB bandwidth, VBW ≥ RBW, max hold enabled. Once the trace stabilized, the peak search function was used to locate peak of the emission. The EUT was measured at the low, mid and high channels of each band. The EUT utilizes a 1dBi Antenna. Since the EUT did not have antenna ports temporal or permanent, the test was performed on a radiated setup. The measured field strength was converted to conducted power with the following formula:

EIRP (dBm) = E (dBuV/m) + 20log(d) – 104.77 = P (dBm) + G (dBi)
P (dBm) = E (dBuV/m) + 20log(d) – 104.77 – G (dBi)

Where, P is conducted power
E is field strength
G is antenna gain.

**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):** March 29, 2018

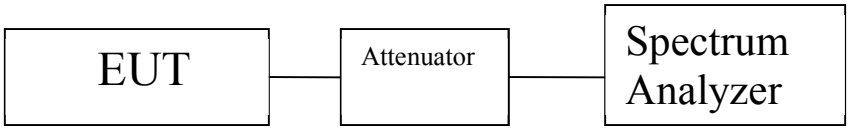


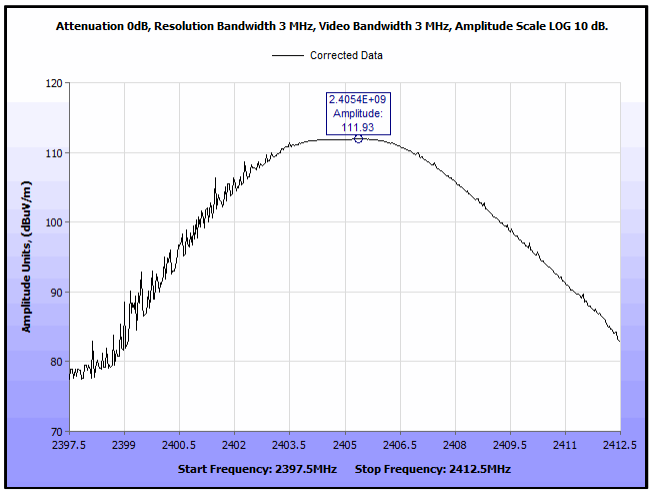

**Figure 3. Peak Power Output Test Setup**

| Freq (MHz) | Field Strength (dBuV/m) | EIRP (dBm) | Antenna Gain (dBi) | Conducted Power (dBm) | Limit (dBm) | Margin | Result |
|---|---|---|---|---|---|---|---|
| 2405 | 111.93 | 7.16 | 1 | 6.16 | 21 | -14.84 | Pass |
| 2440 | 111.5 | 6.73 | 1 | 5.73 | 21 | -15.27 | Pass |
| 2475 | 111.85 | 7.08 | 1 | 6.08 | 21 | -14.92 | Pass |

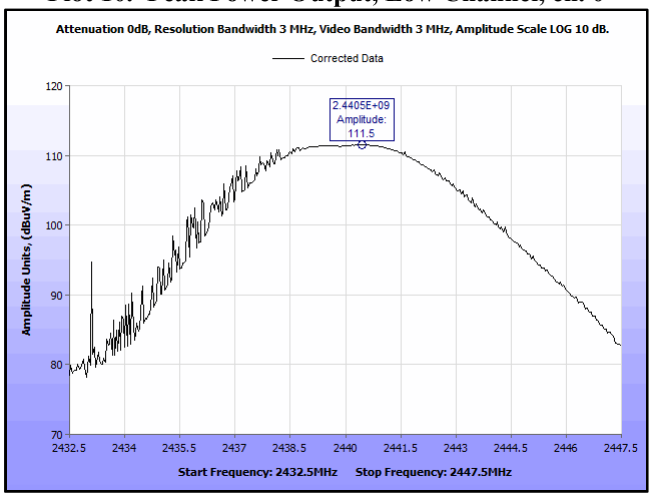
**Table 11. Peak Output Power, Test Results**

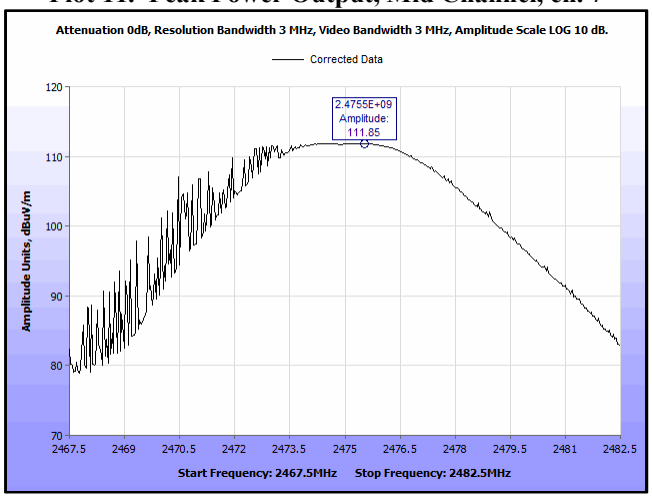
## Peak Power Output Test Results




**Plot 10. Peak Power Output, Low Channel, ch. 0**




**Plot 11. Peak Power Output, Mid Channel, ch. 7**




**Plot 12. Peak Power Output, High Channel, ch. 14**

# 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, 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. 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) (see §15.205(c)).

**§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 12. 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 13.

| 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 13. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedure:** The transmitter was set to the mid channel at the highest output power and placed on a 0.8 m high wooden 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.

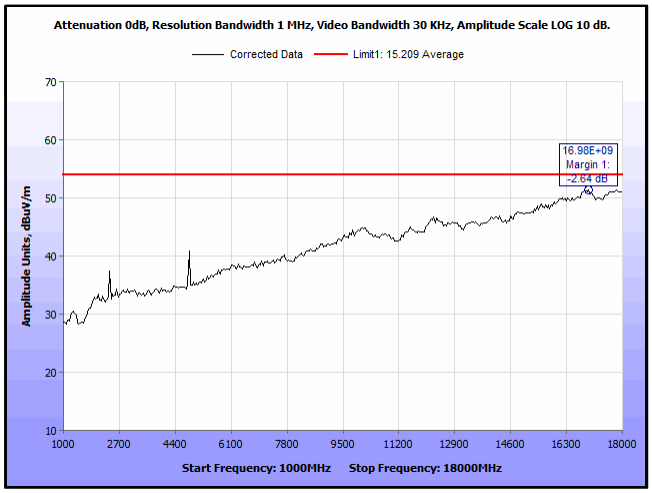
EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor

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

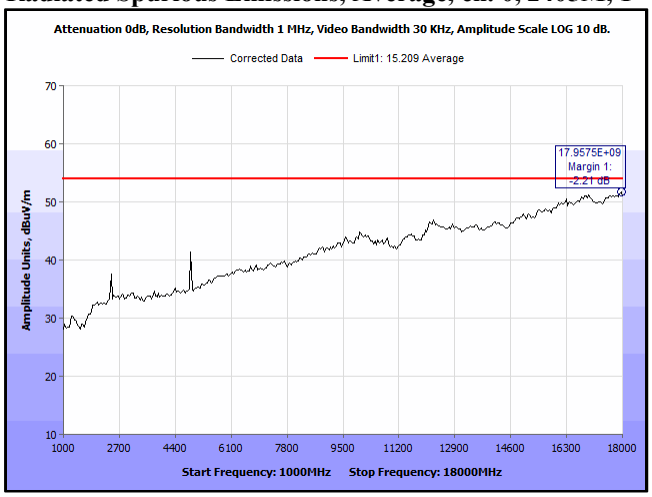
**Test Engineer(s):** Donald Salguero

**Test Date(s):** April 2, 2018

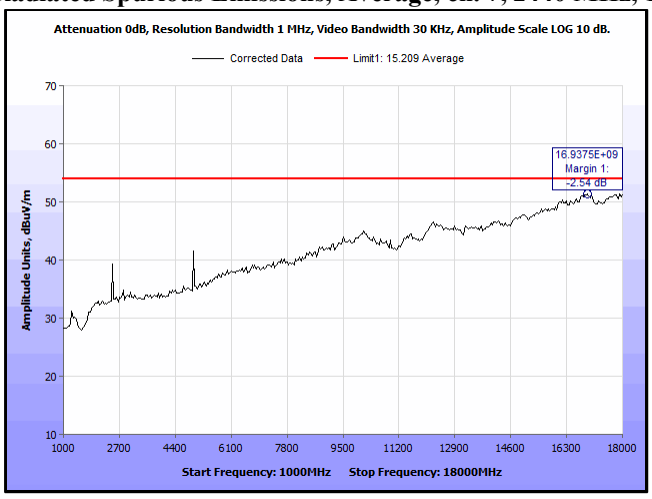
## Radiated Spurious Emissions Test Results



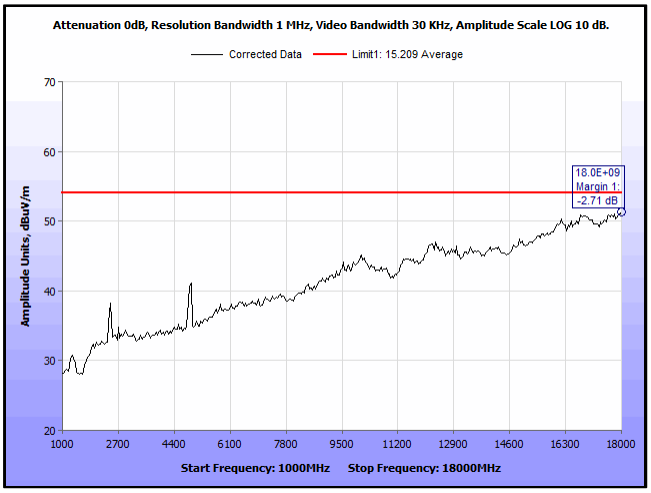

**Plot 13. Radiated Spurious Emissions, Average, ch. 0, 2405M, 1 – 18 GHz**



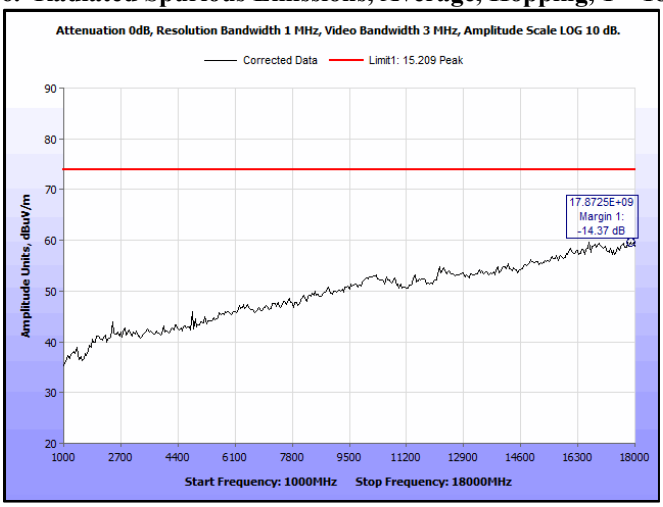

**Plot 14. Radiated Spurious Emissions, Average, ch. 7, 2440 MHz, 1 -18 GHz**



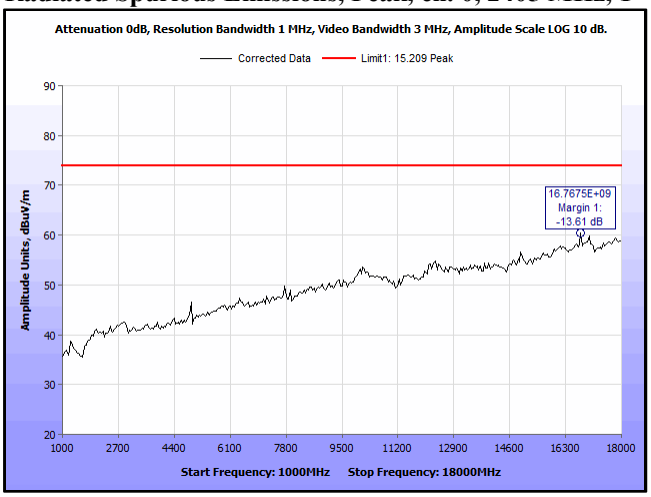

**Plot 15. Radiated Spurious Emissions, Average, ch. 14, 2475 MHz, 1 – 18 GHz**




**Plot 16. Radiated Spurious Emissions, Average, Hopping, 1 – 18 GHz**

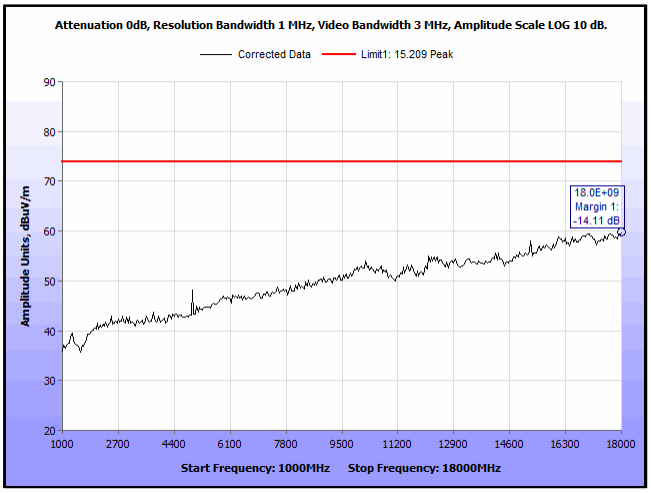



**Plot 17. Radiated Spurious Emissions, Peak, ch. 0, 2405 MHz, 1 – 18 GHz**

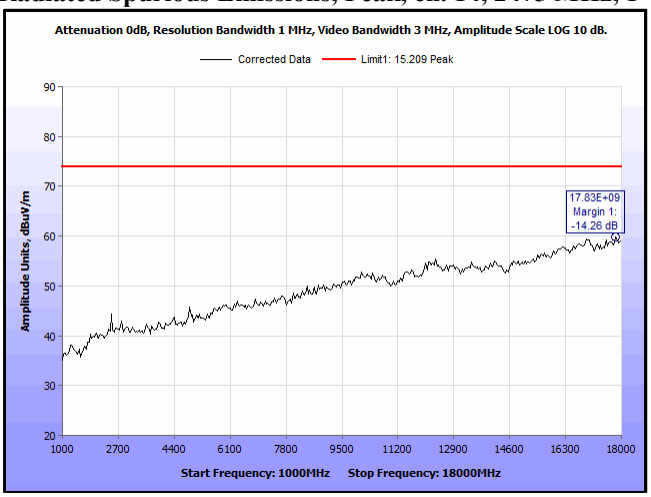



**Plot 18. Radiated Spurious Emissions, Peak, ch. 7, 2440 MHz, 1 – 18 GHz**

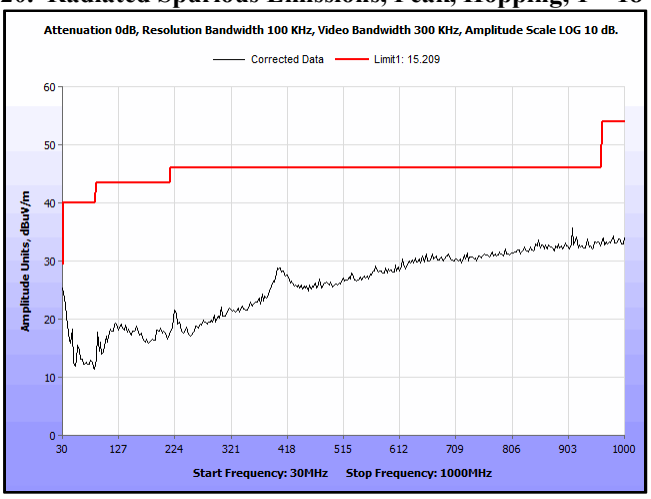
  




**Plot 19. Radiated Spurious Emissions, Peak, ch. 14, 2475 MHz, 1 – 18 GHz**

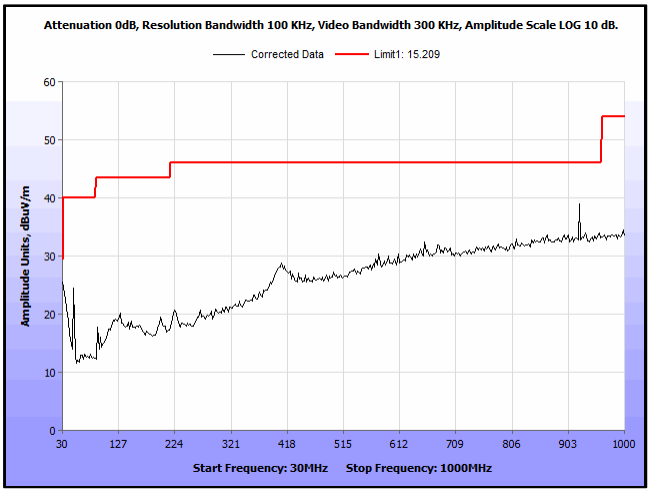



**Plot 20. Radiated Spurious Emissions, Peak, Hopping, 1 – 18 GHz**

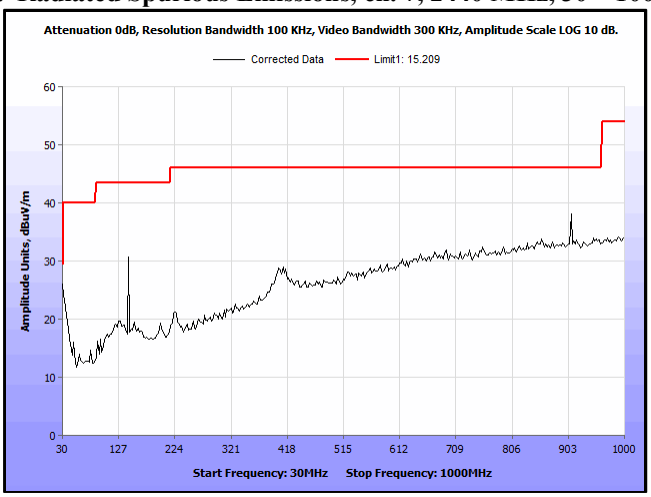



**Plot 21. Radiated Spurious Emissions, ch. 0, 2405 MHz, 30 – 1000 MHz**

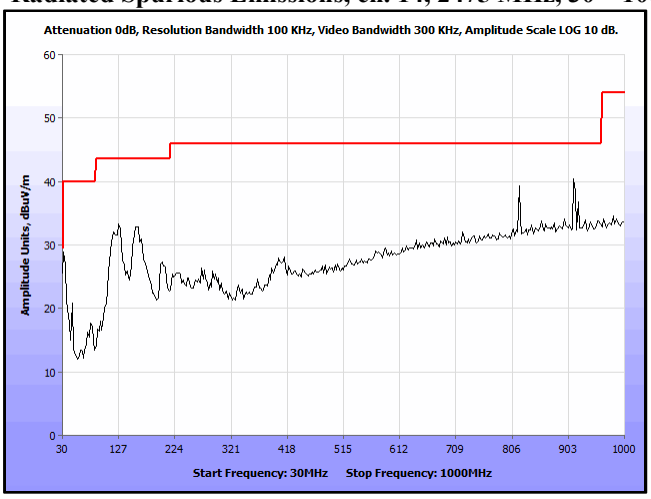
  




**Plot 22. Radiated Spurious Emissions, ch. 7, 2440 MHz, 30 – 1000 MHz**



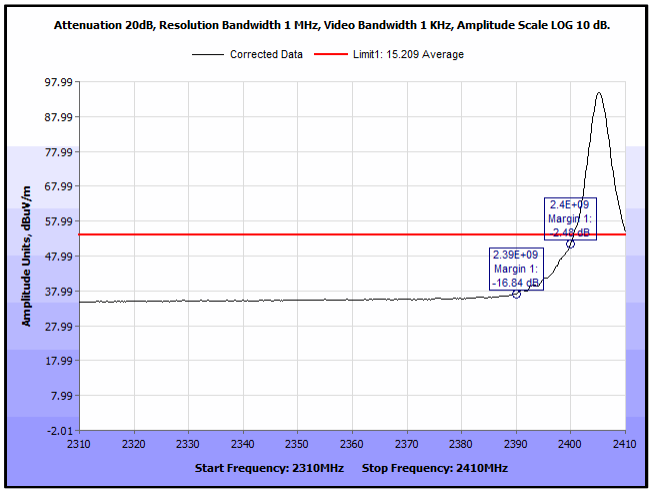

**Plot 23. Radiated Spurious Emissions, ch. 14, 2475 MHz, 30 – 1000 MHz**



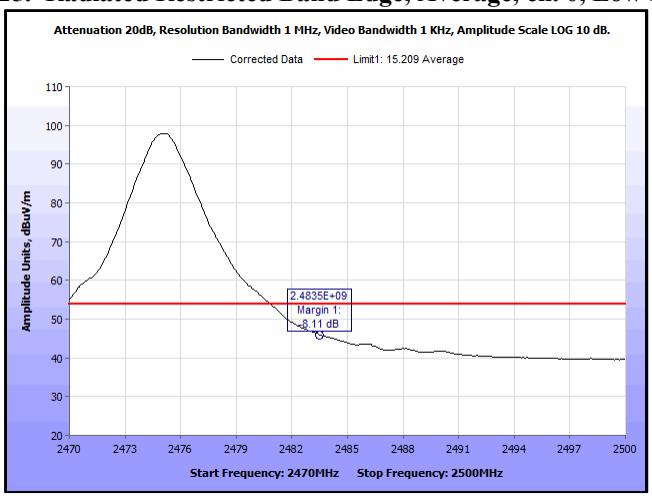

**Plot 24. Radiated Spurious Emissions, Hopping, 30 – 1000 MHz**

## Radiated Band Edge Measurements

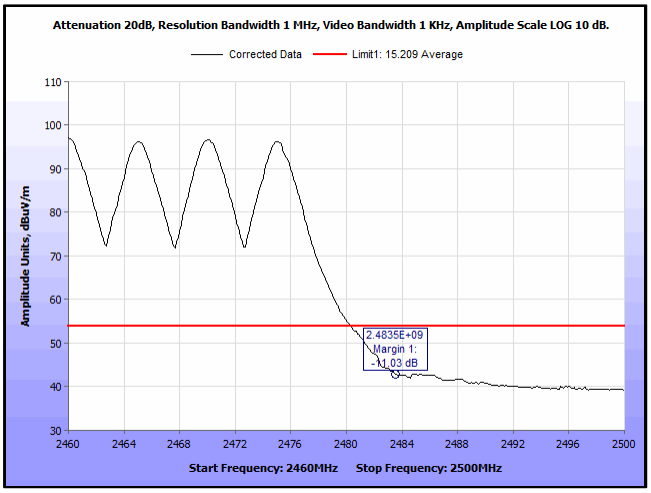
**Test Procedures:** The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.



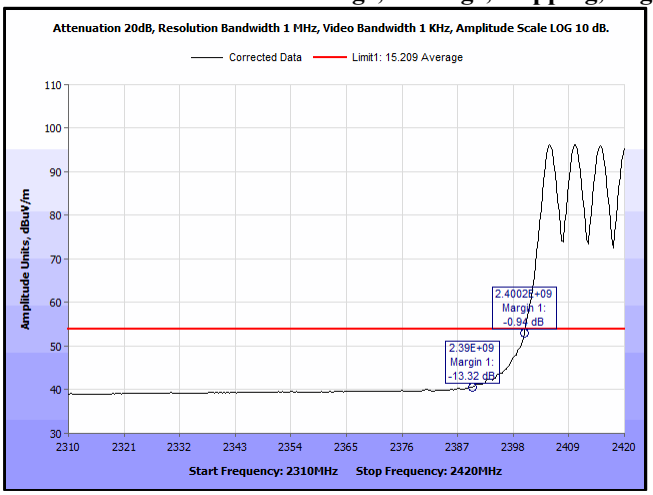

**Plot 25. Radiated Restricted Band Edge, Average, ch. 0, Low Edge**



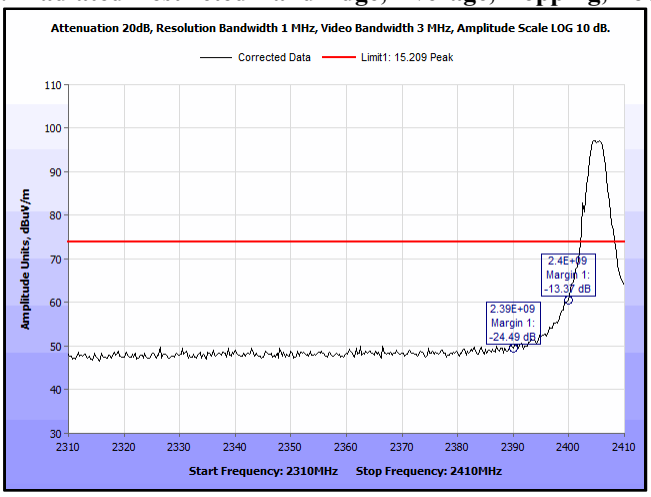

**Plot 26. Radiated Restricted Band Edge, Average, ch. 14, High Edge**



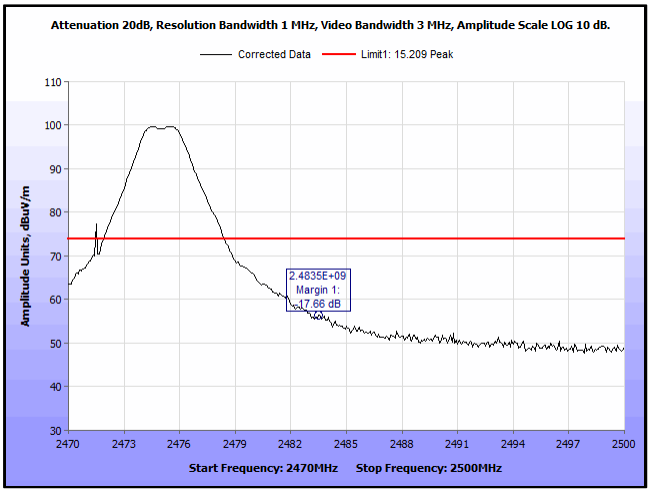

**Plot 27. Radiated Restricted Band Edge, Average, Hopping, High Edge**



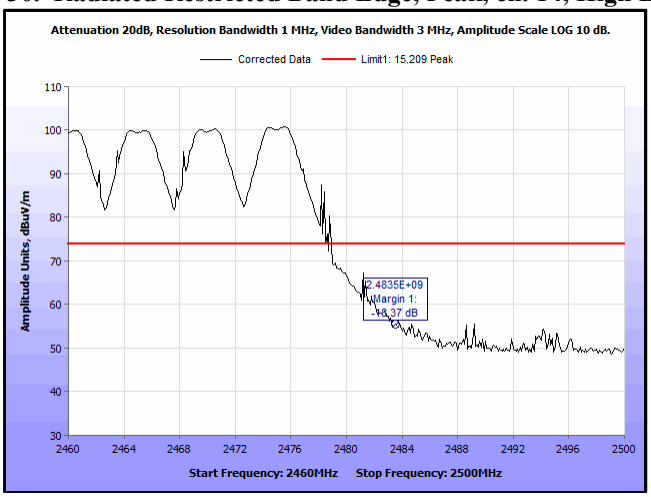

**Plot 28. Radiated Restricted Band Edge, Average, Hopping, Low Edge**



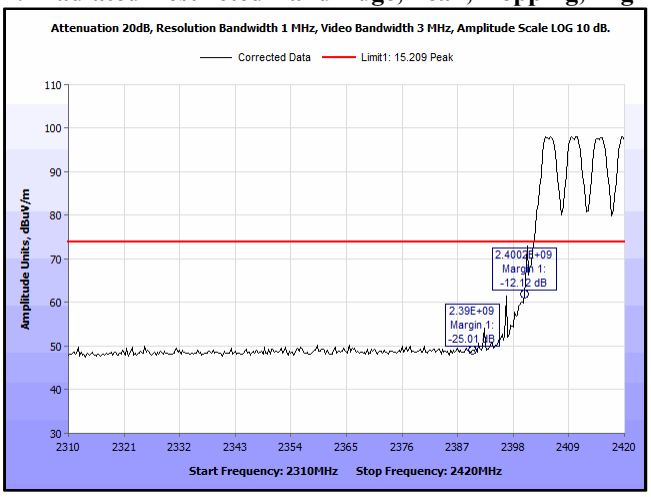

**Plot 29. Radiated Restricted Band Edge, Peak, ch. 0, Low Edge**




**Plot 30. Radiated Restricted Band Edge, Peak, ch. 14, High Edge**

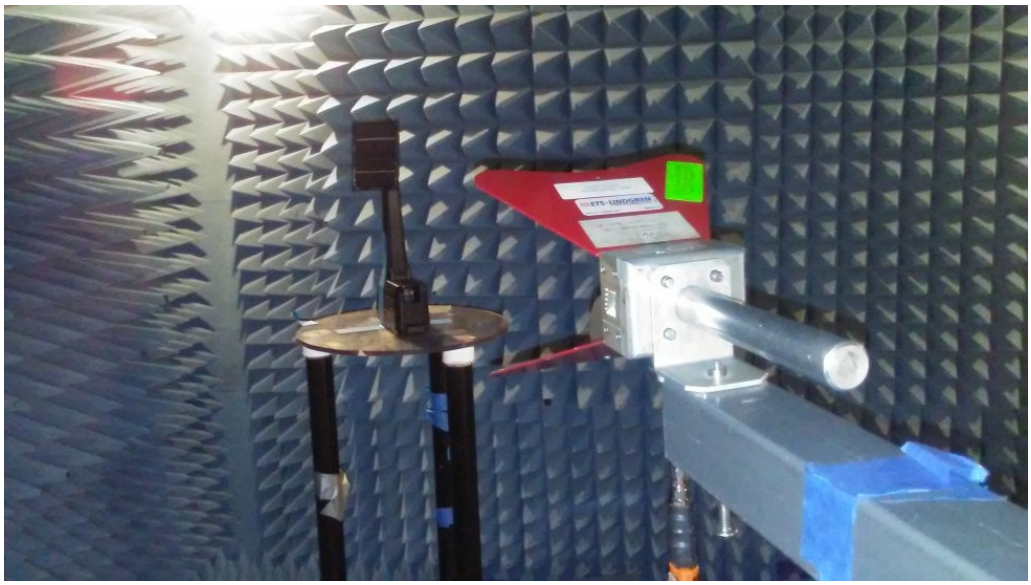



**Plot 31. Radiated Restricted Band Edge, Peak, Hopping, High Edge**

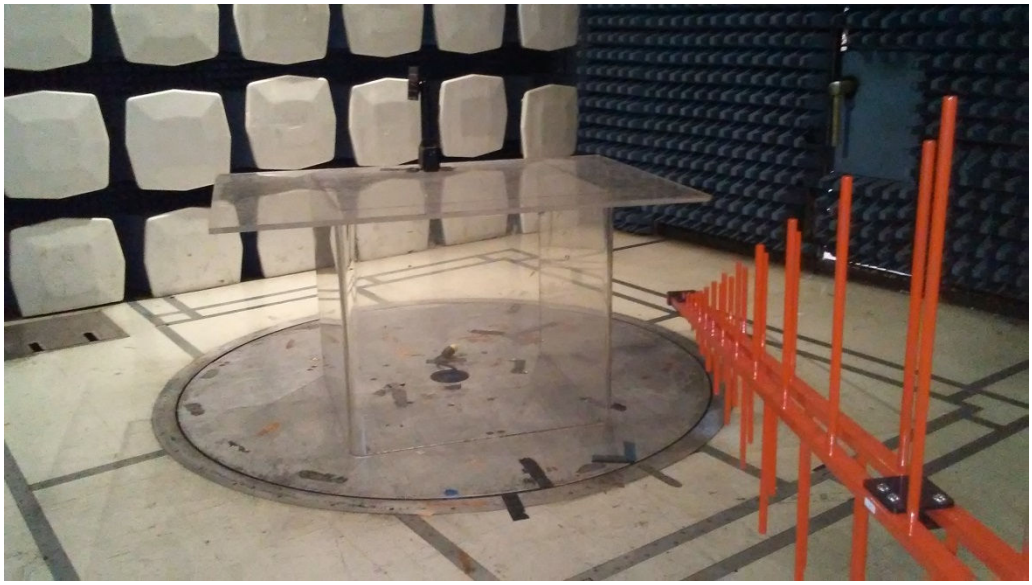



**Plot 32. Radiated Restricted Band Edge, Peak, Hopping, Low Edge**

## Radiated Spurious Emissions Test Setup

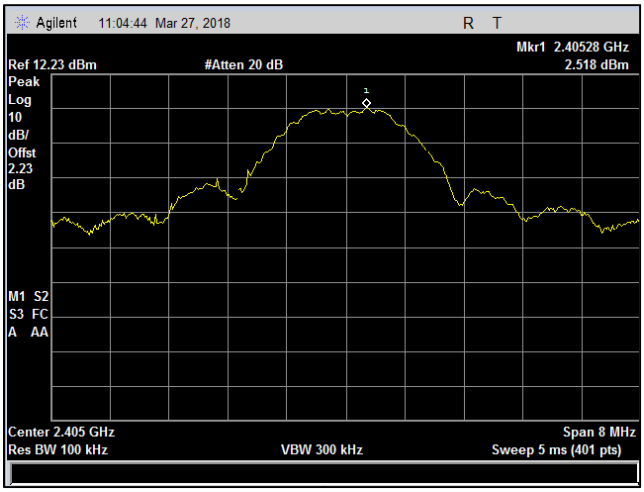


**Photograph 1. Radiated Spurious Emissions, Test Setup Above 1GHz**

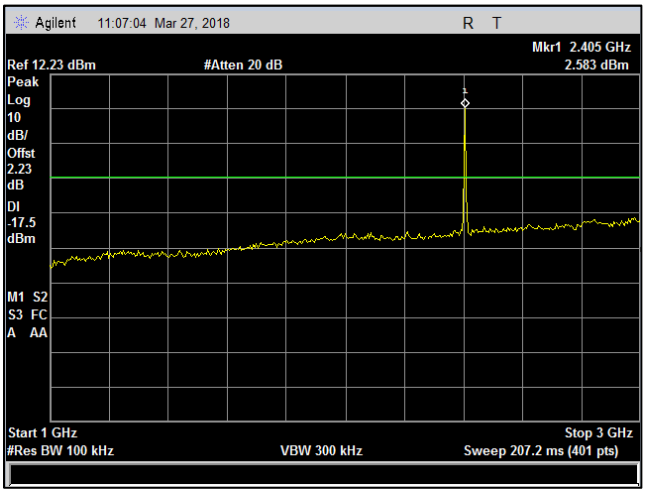


**Photograph. Radiated Spurious Emissions, Test Setup, 30 MHz - 1 GHz**

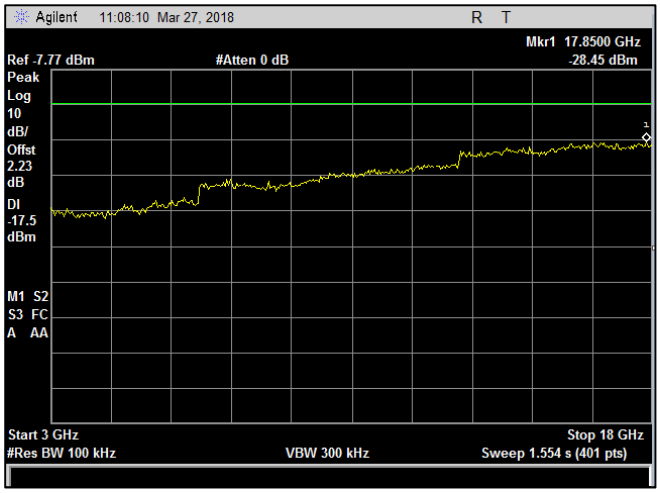
## 100 KHz Radiated Spurious Emissions




**Plot 33. Radiated Spurious Emissions, Ch. 0, 100 kHz, RBW reference level**

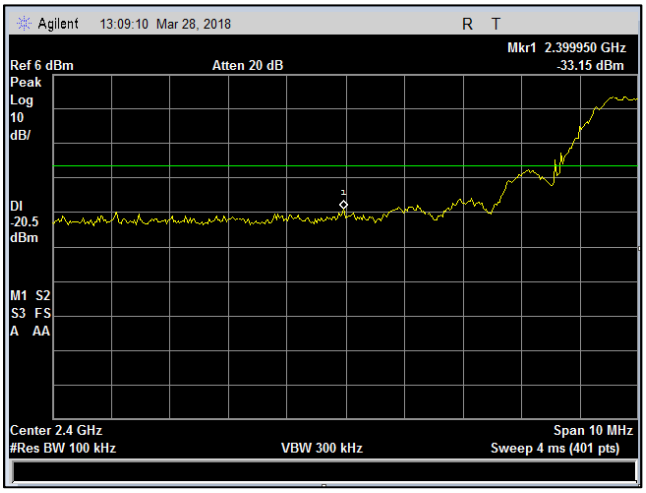



**Plot 34. Radiated Spurious Emissions, Ch. 0, 100 kHz, RBW 1 – 3 GHz**

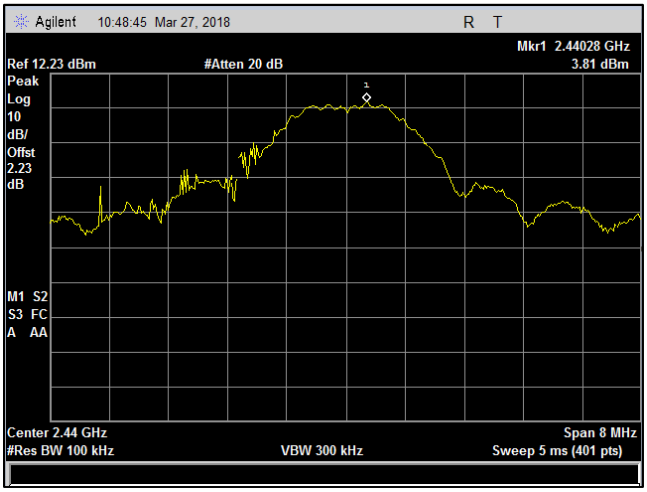



**Plot 35. Radiated Spurious Emissions, Ch. 0, 100 kHz, RBW 3 – 18 GHz**

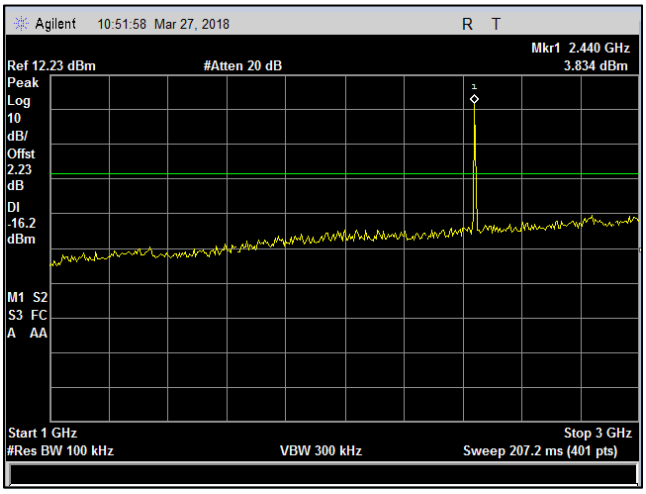
  



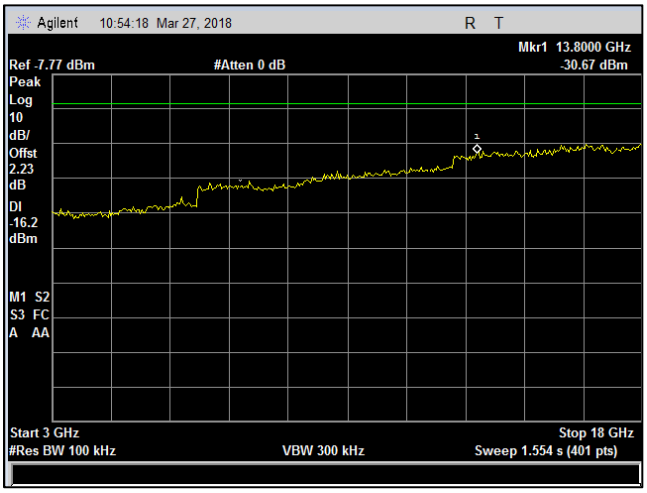

**Plot 36. Radiated Spurious Emissions, Ch. 0, 100 kHz, RBW, Low Bandedge**



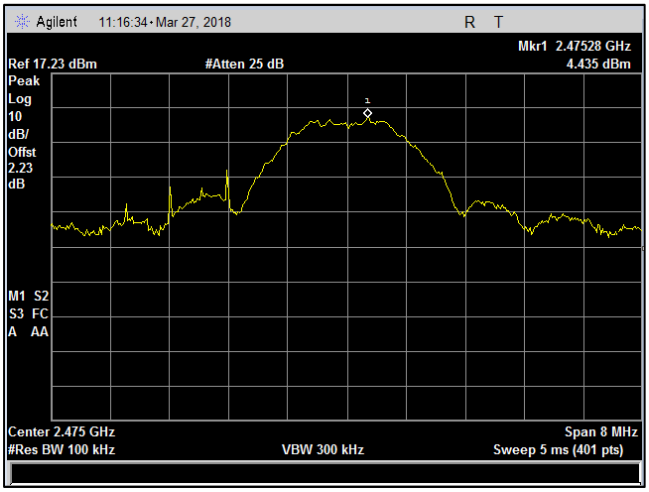

**Plot 37. Radiated Spurious Emissions, Ch. 7, 100 kHz, RBW reference level**



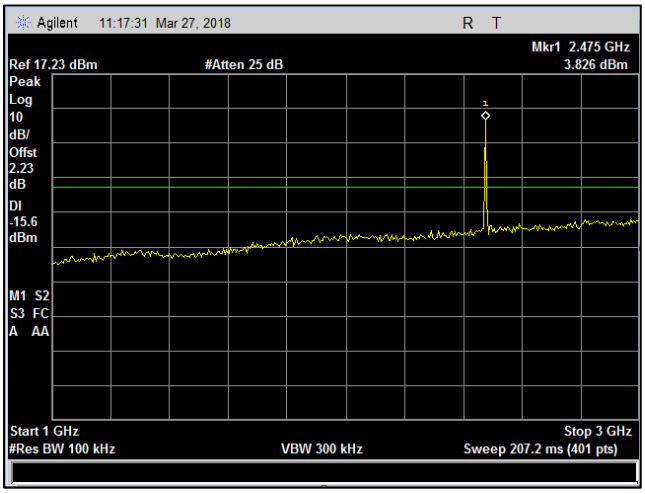

**Plot 38. Radiated Spurious Emissions, Ch. 7, 100 kHz, RBW 1 – 3 GHz**



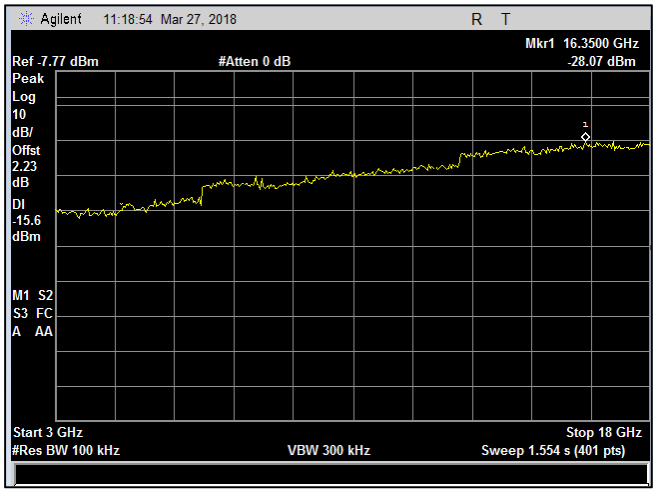

**Plot 39. Radiated Spurious Emissions, Ch. 7, 100 kHz, RBW 3 – 18 GHz**



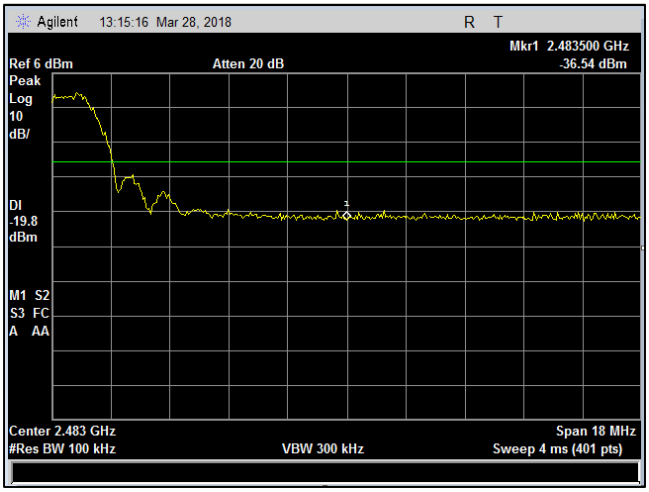

**Plot 40. Radiated Spurious Emissions, Ch. 14, 100 kHz, RBW reference level**



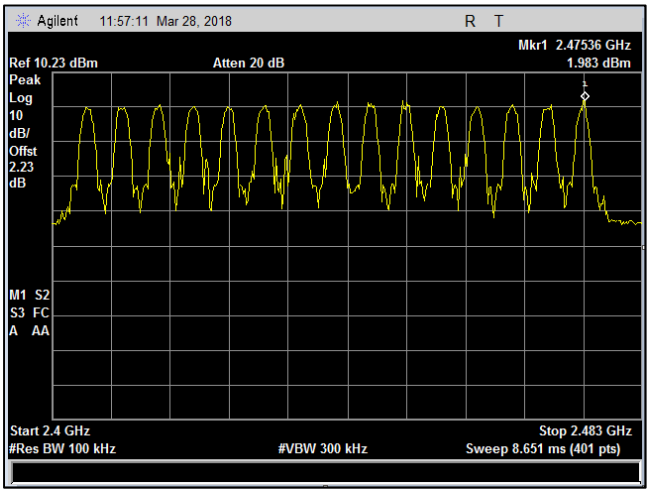

**Plot 41. Radiated Spurious Emissions, Ch. 14, 100 kHz, RBW 1 – 3 GHz**



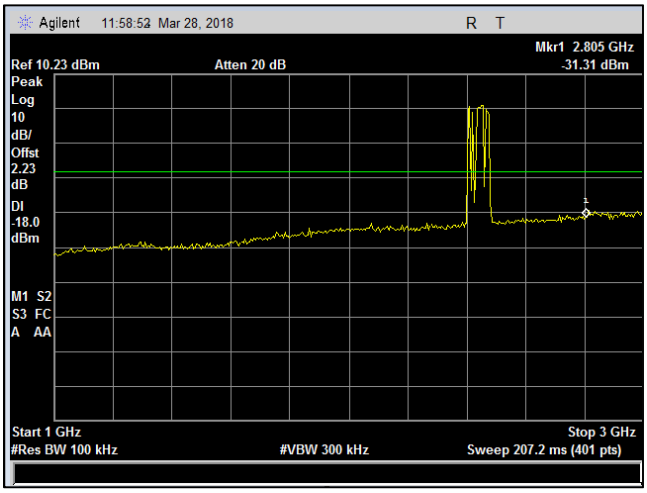

**Plot 42. Radiated Spurious Emissions, Ch. 14, 100 kHz, RBW 3 – 18 GHz**



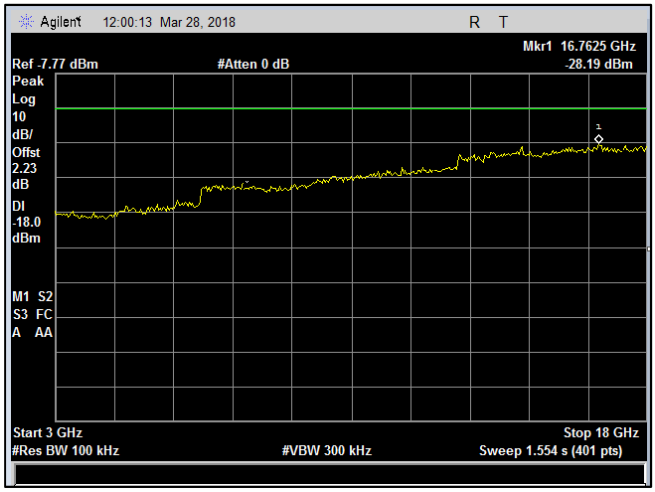

**Plot 43. Radiated Spurious Emissions, Ch. 14, 100 kHz, RBW High Bandedge**



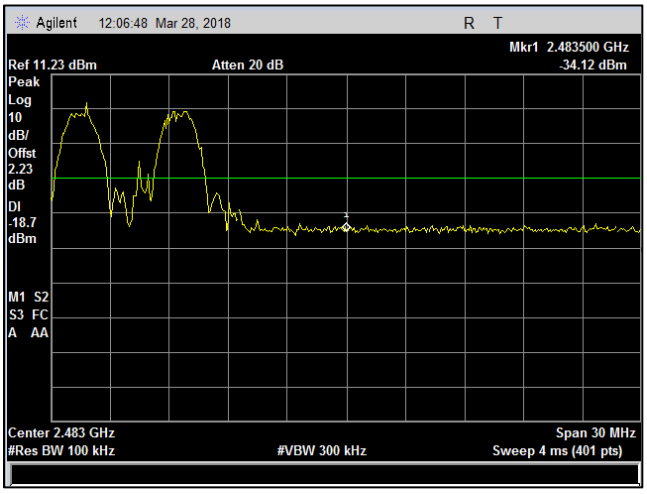

**Plot 44. Radiated Spurious Emissions, 100 kHz, Hopping, RBW reference level**



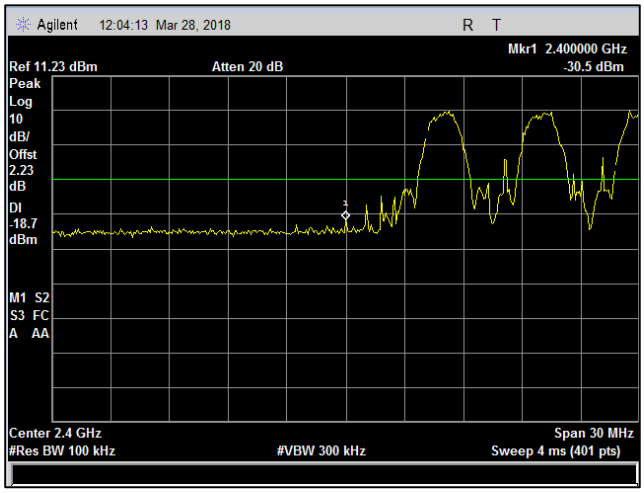

**Plot 45. Radiated Spurious Emissions, 100 kHz, Hopping, RBW 1 – 3 GHz**



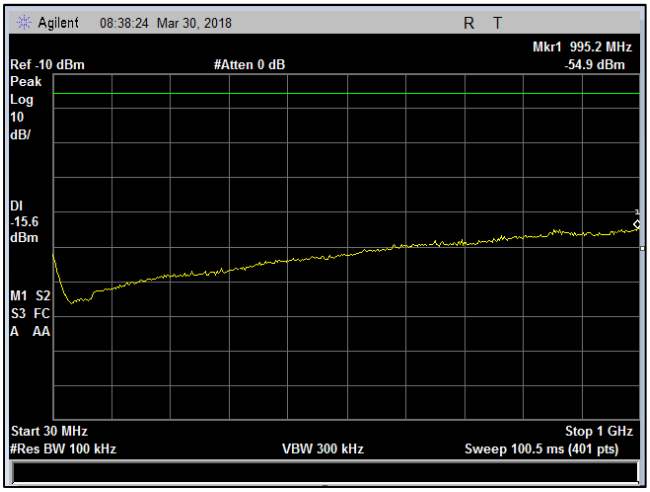

**Plot 46. Radiated Spurious Emissions, 100 kHz, Hopping, RBW 3 – 18 GHz**



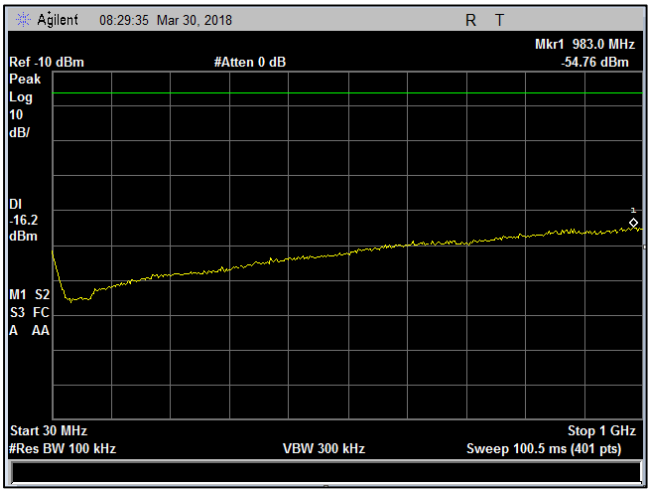

**Plot 47. Radiated Spurious Emissions, 100 kHz, Hopping, RBW High Bandedge**



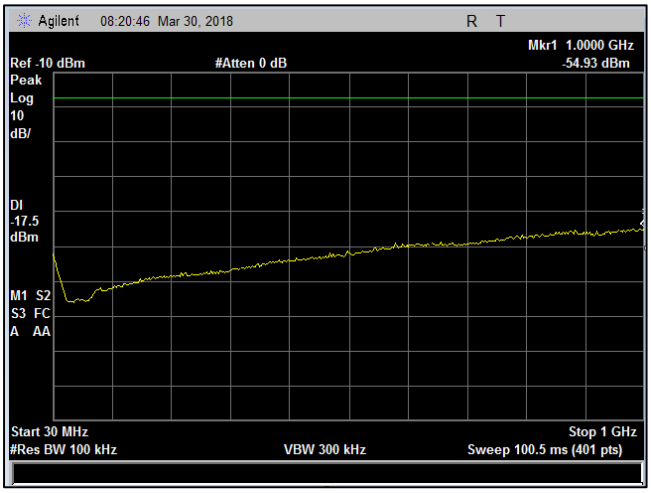

**Plot 48. Radiated Spurious Emissions, 100 kHz, Hopping, RBW Low Bandedge**



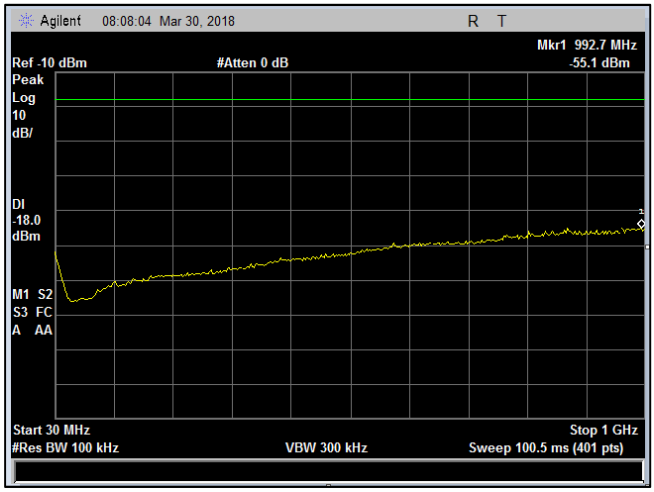

**Plot 49. Radiated Spurious Emissions, Ch. 14, 100 kHz, RBW 30 – 1000 MHz**




**Plot 50. Radiated Spurious Emissions, Ch. 7, 100 kHz, RBW 30 – 1000 MHz**




**Plot 51. Radiated Spurious Emissions, Ch. 0, 100 kHz, RBW 30 – 1000 MHz**




**Plot 52. Radiated Spurious Emissions, 100 kHz, Hopping RBW 30 – 1000 MHz**

# Electromagnetic Compatibility Criteria for Intentional Radiators
## § 15.247(g)(h) Declaration Statements for FHSS

Intelligent Automation, Inc.
15400 Calhoun Drive ▲ Suite 190 ▲ Rockville, MD 20855
Tel 301-294-5200 ▲ Fax 301-294-5201 ▲ www.i-a-i.com

April 23, 2018

MET Laboratories, Inc.
914 West Patapsco Avenue
Baltimore, MD 21230

RE: FHSS Declaration Statement Letter for "Guardian – Border Protection", with respect to FCC Part 15C Sections 15.247(g) and 15.247(h)

To Whom It May Concern:

**Compliance for section 15.247(g):**

The 2.4GHz system-on-chip (SoC) within the Guardian Border Protection device complies with the IEEE 802.15.4e standard and uses a Time Synchronized Channel Hopping (TSCH) MAC. According to this specification, the SoC transmits packets with a pseudorandom hopping pattern across 15 channels when presented with continuous data. Short burst transmissions from the system are also transmitted with pseudorandom frequency hopping.

**Compliance for section 15.247(h):**

The IEEE 802.15.4e compliant SoC does not use intelligence to adapt its hopset to avoid occupied channels, and it does not coordinate with any other FHSS systems to avoid simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Please contact me if there is any information you may need.

Sincerely yours,

David Mayhew
Principal Engineer
Intelligent Automation, Inc.

# 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.

MPE Limit Calculation: EUT's operating frequencies @ 2400-2483.5 MHz; **Limit for Uncontrolled exposure: 1 mW/cm$^2$ or 10 W/m$^2$**

EUT maximum antenna gain = *1 dBi.*

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

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density
P = Power Input to antenna G = Antenna Gain

| 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** |
| 2405 | 6.16 | 4.13 | 1 | 1.259 | 0.00103 | 1 | 0.99897 | 20 | Pass |

# IV. Test Equipment

## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| MET Asset # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1T4483 | Antenna; Horn | ETS-Lindgren | 3117 | 4/19/2017 | 10/19/2018 |
| 1T4751 | Antenna - Bilog | Sunol Sciences | JB6 | 2/28/2017 | 8/28/2018 |
| 1T4409 | EMI Receiver | Rohde & Schwarz | ESIB7 | 12/7/2016 | 12/7/2018 |
| 1T4300A | SEMI-ANECHOIC CHAMBER # 1 (FCC) | EMC TEST SYSTEMS | NONE | 1/31/2016 | 1/31/2019 |
| 1T4149 | High-Frequency Anechoic Chamber | Ray Proof | 81 | Not Required | |
| 1T4442 | Pre-amplifier, Microwave | Miteq | AFS42-01001800-30-10P | Func Verify | |
| 658297 | Spectrum Analyzer | Agilent Technologies | E4407B | 3/1/2018 | 3/1/2019 |

**Table 14. Test Equipment List**

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

# 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.

(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.

## 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.

## 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.

# 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.

## 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.

# End of Report