# Electromagnetic Compatibility Test Report

***Prepared in accordance with***

## FCC Part 15C, RSS-210 Issue 8 and ANSI C63.10

On

# VirtualZone® Family

# Model: DAMPER SSD

**SmartStuff, Inc.**
**7001 Sassafrass CT**
**Summerville, SC 29485 USA**

Prepared by:

## TUV Rheinland of North America, Inc.

# Manufacturer's statement - attestation

The manufacturer; SmartStuff, Inc., as the responsible party for the equipment tested, hereby affirms:

a) That he has reviewed and concurs that the test shown in this report are reflective of the operational characteristics of the device for which certification is sought;

b) That the device in this test report will be representative of production units;

c) That all changes (in hardware and software/firmware) to the subject device will be reviewed.

d) That any changes impacting the attributes, functionality or operational characteristics documented in this report will be communicated to the body responsible for approving (certifying) the subject equipment.

| | |
|---|---|
| **Richard Day Jr.** |  |
| Printed name of official | Signature of official |
| SmartStuff, Inc.<br>7001 Sassafrass CT<br>Summerville, SC 29485 USA | 05 February 2015 |
| Address | Date |
| 860-202-1845 | rday@SmartStff.com |
| Telephone number | Email address of official |

| | | | |
|---|---|---|---|
| ***Client:*** | SmartStuff, Inc. | SmartStuff, Inc.<br>7001 Sassafrass CT<br>Summerville, SC 29485 USA | Richard Day Jr.<br>Ph: 860-202-1845<br>Fax:<br>Email: rday@SmartStff.com |
| ***Identification:*** | VirtualZone® Family | ***Serial No.:*** | PRODUCTION PROTOTYPE |
| ***Test item:*** | Model DAMPER SSD | ***Date tested:*** | 31 January 2015 |
| ***Testing location:*** | TUV Rheinland of North America<br>762 Park Avenue<br>Youngsville, NC 27596-9470<br>U.S.A. | Tel: (919) 554-3668<br>Fax: (919) 554-3542 | |
| ***Test specification:*** | **Emissions:** FCC Part 15, Subpart C, RSS-210 Issue 8:<br>FCC Parts 15.207(a) and RSS-GEN 7.2.4,<br>FCC Parts 15.249(d), 15.209, 15.215(c) and RSS-210 A2.9, RSS-GEN 7.2.1<br>FCC Part 15.249 and RSS-210 Annex 2.9,<br>FCC Parts 15.249(a), 15.249(c), RSS-210 A2.9(a),<br>FCC Part 2.1093 and RSS-102, Issue 4, | | |
| ***Test Result*** | **The above product was found to be Compliant to the above test standard(s)** | | |

| | |
|---|---|
| ***tested by:*** Mark Ryan | ***reviewed by:*** Michael Moranha |
| 7 March 2015 _____<br>***Date*** ***Signature*** | 7 March 2015 _____<br>***Date*** ***Signature*** |
| ***Other Aspects:*** | **None** |

Abbreviations: OK, Pass, Compliant, Complies = passed
Fail, Not Compliant, Does Not Comply = failed
N/A = not applicable

| | | |
|---|---|---|
| | | **Industry Canada** |
| **90552 and 100881** | **Testing Cert #3331.05** | **2932H-1 and 2932H-2** |

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# 1 General Information

## 1.1 Scope

This report is intended to document the status of conformance with the requirements of the FCC Part 15C, RSS-210 Issue 8 and ANSI C63.10 based on the results of testing performed on 31 January 2015 on the VirtualZone® Family, Model No. SENSOR SSS, manufactured by SmartStuff, Inc. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

## 1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

## 1.3 Revision History

| Revision | Date | Description of Revision |
|---|---|---|
| - - | 05February2015 | Initial Release |
| B | 12February2015 | Updated testing procedures |
| C | 6 March 2015 | Correct typo in FCC ID |
| | | |
| | | |
| | | |
| | | |

## 1.1 *Summary of Test Results*

| | | | | | |
|---|---|---|---|---|---|
| **Applicant** | SmartStuff, Inc.<br>7001 Sassafrass CT<br>Summerville, SC 29485 USA | **Tel** | 860-202-1845 | **Contact** | Richard Day Jr. |
| | | **Fax** | | **e-mail** | rday@SmartStff.com |

| | | | |
|---|---|---|---|
| **Description** | DAMPER | **Model** | DAMPER SSD |
| **Serial Number** | Production Prototype | **Test Voltage/Freq.** | 24 VAC |
| **Test Date Completed:** | 31 January 2015 | **Test Engineer** | Mark Ryan |

| Standards | Description | Severity Level or Limit | Worst-case Values | Test Result |
|---|---|---|---|---|
| FCC Part 15, Subpart C Standard | Radio Frequency Devices-Subpart C: Intentional Radiators | See called out parts below | See Below | **Complies** |
| RSS-210 Issue 8 Standard | Low-Power Licence-exempt Radiocommunication Devices Category I Equipment | See called out parts below | See Below | **Complies** |
| FCC Part 15.249 and RSS-210 Annex 2.9 | Operation within the band 2400 to 2483.5 MHz | See called out parts below | See Below | Complies |
| FCC Parts 15.249(a), 15.249(c), RSS-210 A2.9(a) | Radiated Output Power for Fundamental and Harmonic Frequencies | Fund: Shall not exceed 50 mV/m at 3m<br>Harmonics: Shall not exceed 500µV/m (0.5 mV/m) at 3m, (unresticted bands) | 19.4 mV/m<br>243.2 µV/m<br>- | Complies |
| FCC Parts 15.249(d), 15.209, 15.215(c) and RSS-210 A2.9, RSS-GEN 7.2.1 | Out-of-Band Spurious Emissions and Band Edges (EUT in Transmit Mode) | Below the applicable limits | 20.72 dBµV | Complies |
| FCC Parts 15.207(a) and RSS-GEN 7.2.4 | Conducted Emissions on AC Mains | 15.207(a) and RSS-210, 150kHz - 30MHz | 64.58 dBµV | Complies |
| RSS-GEN 4.6.1 | Occupied Bandwidth | 99% Power Band Width | 1.09 MHz | Complies |
| FCC Part 2.1093 and RSS-102, Issue 4 | RF Exposure and Antenna Gain Calulation | SAR or MPE Requirements | 0.226 mW | Complies |

# 2 Laboratory Information

## 2.1 Accreditations

### 2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at 762 Park Avenue, Youngsville, NC 27596-9470 is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 90552 and 100881). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

### 2.1.2 ILAC / A2LA

The laboratory has been assessed and accredited by A2LA in accordance with ISO Standard 17025:2005 (Certificate Number: 3331.05, Master Code: 134288). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

### 2.1.3 Industry Canada

Registration No.: 2932H-1 The OATS has been accepted by Industry Canada to perform testing to 3 and to 10 meters, based on the test procedures described in ANSI C63.4-2009.

Registration No.: 2932H-2 The 5 meter chamber has been accepted by Industry Canada to perform testing to 3 meters, based on the test procedures described in ANSI C63.4-2009.

### 2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland at the 762 Park Ave. Youngsville, N.C 27596 address has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Laboratory Registration No: A-0034).

### 2.1.5 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

**Sample radiated emissions calculation @ 30 MHz**

**Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)**

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

## 2.2 Measurement Uncertainty Emissions

| | $U_{lab}$ | $U_{cispr}$ |
|---|---|---|
| **Radiated Disturbance @ 10m** | | |
| 30 MHz – 1,000 MHz | 3.3 dB | 5.2 dB |
| **Conducted Disturbance @ Mains Terminals** | | |
| 150 kHz – 30 MHz | 1.18 dB | 3.6 dB |
| **Disturbance Power** | | |
| 30 MHz – 300 MHz | 3.88 dB | 4.5 dB |

## 2.3 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

### 2.4 Measurement Equipment Used

| Equipment | Manufacturer | Model # | Serial/Inst # | Last Cal dd/mm/yy | Next Cal dd/mm/yy |
|---|---|---|---|---|---|
| Radiated Emissions (5 Meter Chamber) | | | | | |
| Receiver, EMI | Rohde & Schwarz | ESIB40 | 100043 | 19-Aug-14 | 19-Aug-15 |
| Spectrum Analyzer | Agilent Tec. | E7405A | US39440161 | 20-Aug-14 | 20-Aug-15 |
| Amplifier, preamp | Agilent Technologies | 8449B | 3008A01480 | 14-Aug-13 | 14-Aug-15 |
| Ant. BiconiLog | Chase | CBL6140A | 1108 | 16-Sep-13 | 16-Sep-15 |
| Antenna Horn 1-18 GHz | EMCO | 3115 | 3115 | 30-Dec14 | 30-Dec15 |
| Antenna Horn 18-26.5 GHz | ATM | 42-442-6/cal | G181104-01 | 31-Dec-14 | 31-Dec-15 |
| Cable, Coax | MicroCaox | MKR300C-0-0-1200-500500 | 002 | 22-Aug-14 | 22-Aug-15 |
| Cable, Coax | MicroCaox | MKR300C-0-1968-500310 | 005 | 22-Aug-14 | 22-Aug-15 |
| Cable, Coax | MicroCaox | UFB29C-1-5905-50U-50U | 009 | 22-Aug-14 | 22-Aug-15 |
| Cable, Coax | Andrew | FSJ1-50A | 045 | 22-Aug-14 | 22-Aug-15 |
| 3.0 GHz High Pass Filter | Bonn Electronik | BHF 3000 | 025155 | 14-Aug-13 | 14-Aug-15 |
| Notch Filter | Micro-tronics | BRM50702 | 049 | 14-Aug-13 | 14-Aug-15 |
| | | | | | |
| General Laboratory Equipment | | | | | |
| Meter, Multi & Thermocouple | Fluke | 179 | 90580752 | 19-Aug-14 | 19-Aug-15 |
| Meter, Temp/Humid/Barom | ExTech | SD700 | Q677933 | 06-May-13 | 06-May-15 |
| Meter, Temp/Humid/Barom | ExTech | SD700 | Q677942 | 06-May-13 | 06-May-15 |

# 3 Product Information

## 3.1 Product Description

The EUT is a family of wireless Zone Temperature Control System with a Bluetooth Low-Energy (BLE) transmitter. The models in the family are SENSOR SSS, DAMPER SSD and CONTROLLER SSC.

Two sets of each EUT were provided for testing. One is normal a configuration for unintentional cabinet radiation. The second was modified with test firmware to allow the low, medium and high hopping channels to continuously transmit with modulation. External batteries were included on the modified devices to allow long-term transmissions.

There is enough difference is size and layout of the circuit boards to require separate testing and certification. The Model DAMPER SSD was the device provided for testing in this report.

For the other members of the family, refer to TUV test report Number 31453815.001 for the Sensor and report number 31550198.001 for the Controller.

## 3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

# 4 Radiated Emissions in Transmit mode

## 4.1 Radiated emissions - FCC Parts 15.249, RSS-210 A2.9(a)

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following limits:
Fundamental Frequency: 2400 to 2483.5 MHz – 50 mV/m (94 dB µV/m) at 3m.
Harmonic Frequencies: 500 µV/m (54 dB µV/m) at 3m.
Spurious Emissions: To the limits of FCC Part 15.209 and RSS-GEN 7.2.1.

### 4.1.1 Over View of Test

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Results** | **Complies** (as tested per this report) | | | | **Date** | 27-30 January 2015 | |
| **Standard** | FCC Parts 15.205, 15.209, 15.215(c), 15.249(a), 15.249(c), 15.249(d) RSS-210 A2.9, and RSS-GEN | | | | | | |
| **Product Model** | DAMPER SSD | | | **Serial#** | Production Prototype | | |
| **Test Set-up** | Tested in a 5m Semi Anechoic chamber. For Emissions below 1 GHz, the EUT was placed on a 1.0m x 1.5m foam table 80cm above the ground plane on a turn-table. For Emissions above 1 GHz, the EUT was placed on a 1.0m x 1.5m foam table 1.5m above the ground plane | | | | | | |
| **EUT Powered By** | 24 VAC | **Temp** | 74º F | **Humidity** | 19% | **Pressure** | 1008 mbar |
| **Perf. Criteria** | (Below Limit) | | **Perf. Verification** | | Readings Under Limit | | |
| **Mod. to EUT** | None | | **Test Performed By** | | Mark Ryan | | |

### 4.1.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2009, RSS-GEN Issue 4. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

### 4.1.3 Deviations

Since all emissions outside the band are within the limits of FCC Part 15.209 and RSS-GEN 7.2.1, the emissions shown below are also compliant with FCC Parts 15.205, 15.209, 15.215(c), 15.249(d), RSS-210 A8.5, and RSS-GEN 7.2.1.

### 4.1.4 Final Test

All final radiated spurious emissions measurements were below (in compliance) the limits.

The worst –case emissions are shown below. All other emissions are on file at TUV Rheinland.

### 4.1.4.1 Final Graphs and Tabulated Data

Orientations:

| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| Orientation A | | | | | | | | | | |
| 2402.00 | V | 1.8 | 29 | 55.66 | 0.00 | 5.89 | 28.54 | 90.09 | | |
| 2402.00 | V | 1.2 | 246 | 56.93 | 0.00 | 5.89 | 28.54 | 91.36 | | |
| 2402.00 | H | 1.8 | 29 | 54.01 | 0.00 | 5.89 | 28.54 | 88.44 | | |
| 2402.00 | V | 1.2 | 246 | 55.27 | 0.00 | 5.89 | 28.54 | 89.70 | | |
| Orientation B | | | | | | | | | | |
| 2440.00 | H | 1.3 | 333 | 53.75 | 0.00 | 5.95 | 28.56 | 88.26 | | |
| 2440.00 | V | 1.2 | 137 | 55.27 | 0.00 | 5.95 | 28.56 | 89.78 | | |
| 2440.00 | H | 1.3 | 333 | 52.06 | 0.00 | 5.95 | 28.56 | 86.57 | | |
| 2440.00 | V | 1.2 | 137 | 50.28 | 0.00 | 5.95 | 28.56 | 84.79 | | |
| Orientation C | | | | | | | | | | |
| 2402.00 | H | 1.9 | 146 | 58.90 | 0.00 | 5.89 | 28.54 | 93.33 | 114.00 | -20.06 |
| 2402.00 | V | 2.2 | 70 | 51.81 | 0.00 | 5.89 | 28.54 | 86.24 | | |
| 2402.00 | H | 1.9 | 146 | 57.50 | 0.00 | 5.89 | 28.54 | 91.93 | 94.00 | -2.07 |
| 2402.00 | V | 2.2 | 70 | 49.82 | 0.00 | 5.89 | 28.54 | 84.25 | | |
| | | | | | | | | | | |

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor

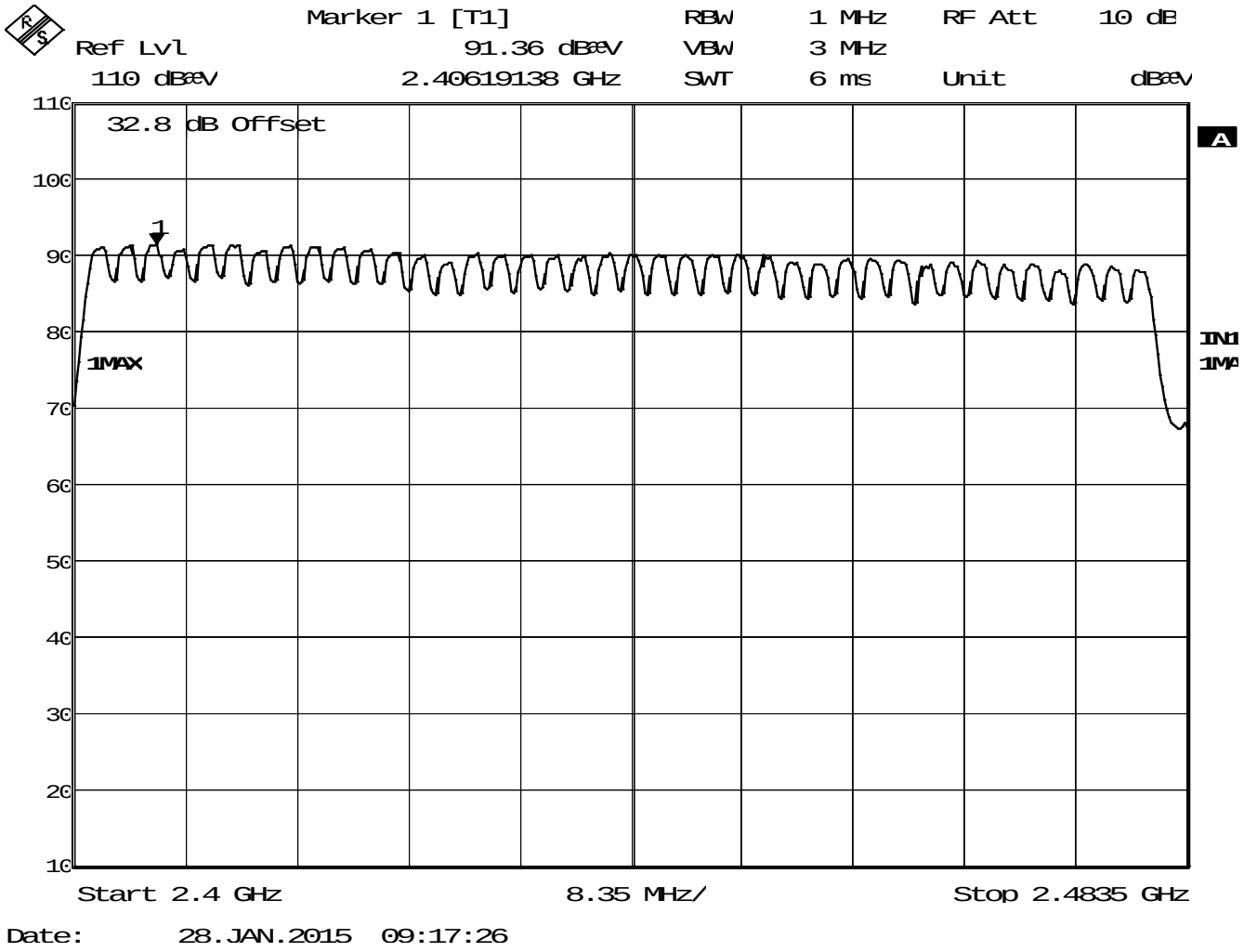
Notes: **Red = Peak Detector, Blue = Average Detector**
The Limit using the Peak Detector is 20dB higher than the Average Detector limit.
EUT in Orientation C is worst case as shown. All other data is on file at TUV Rheinland.

This highlighted frequency and orientation was worst case (2402 MHz, Orientation A).

Notes:

The maximum average Field Value of 91.93 dBµV/m is below the limit of FCC Part 15.249 and RSS-210 (A2.9).

Therefore, this report is tested to the requirements of FCC Part 15.249 and RSS-210 (A2.9)




Plot of all hopping frequencies, Showing Orientation C – Horizontal is worst case near the low channel. Plots of the other orientations and polarities are on file at TUV Rheinland.

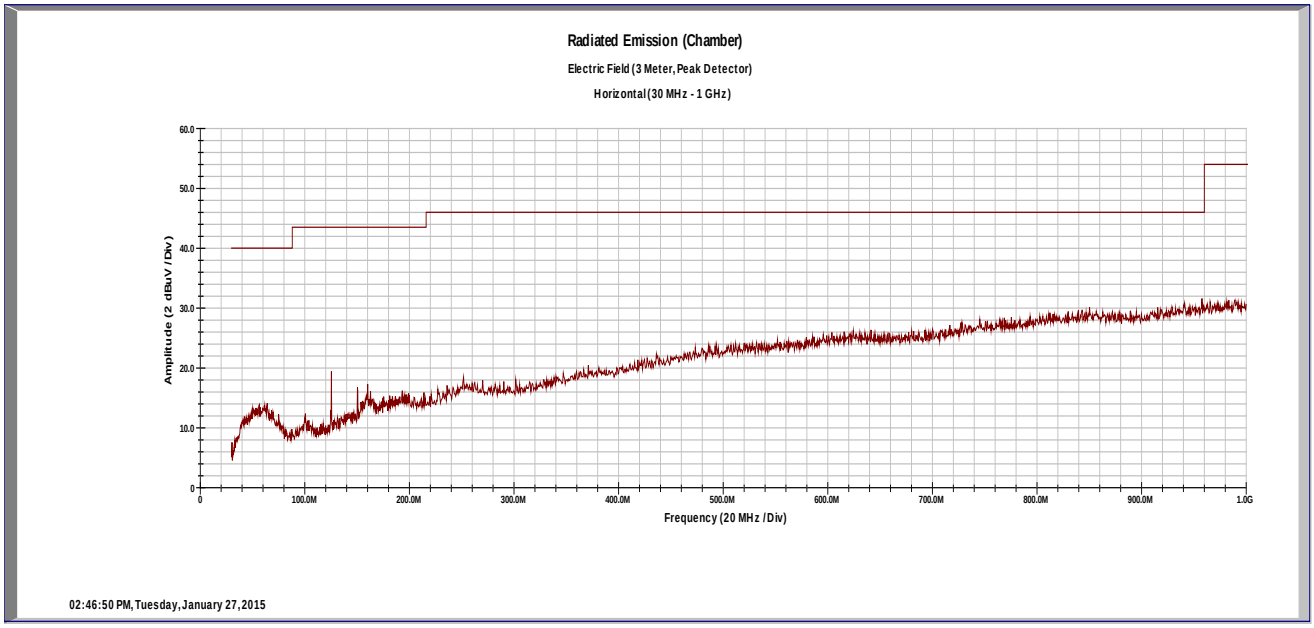
### 4.1.4.2 Maximum Time-weighted Emission:

The EUT was modified to transmit continuously at 100% Duty cycle.

Even at 100% Duty Cycle the EUT is compliant to the rules.

### 4.1.4.3 Emissions Outside the Frequency Band:

**Radiated Emissions – 30 MHz to 1 GHz**
**Horizontal**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.56 | | | | | | | | | | |
| | | | | | | | | | | |
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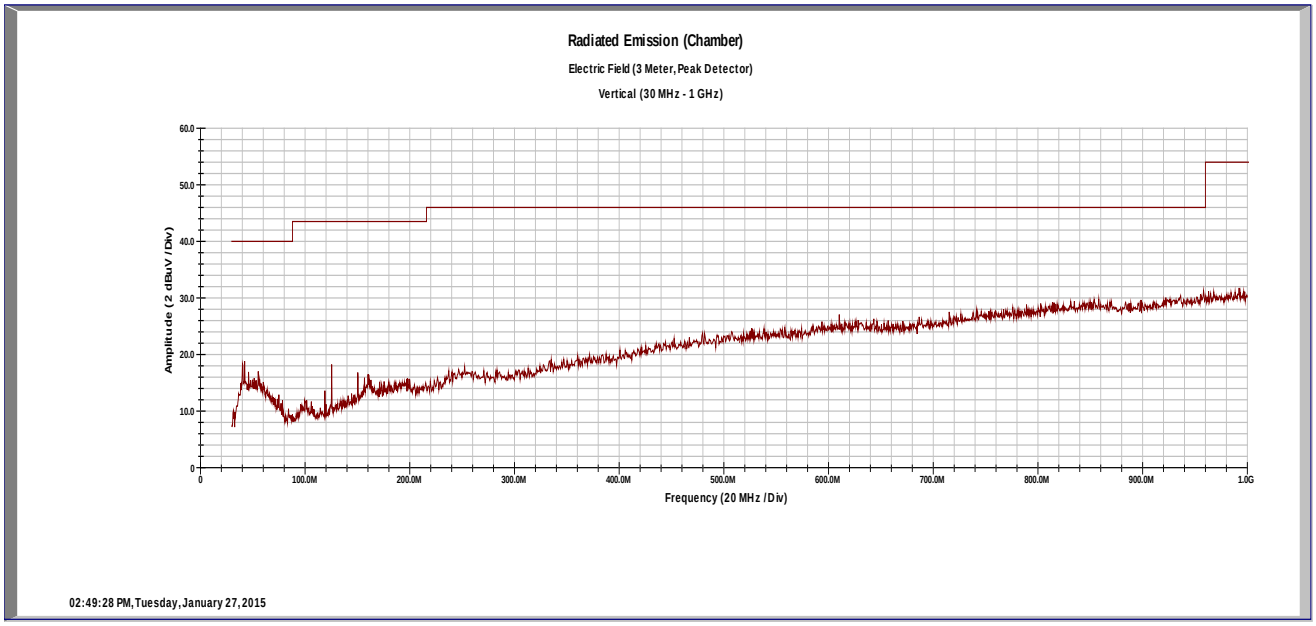
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: All emissions were below the noise floor of the instrumentation.
The EUT was set to hopping all channels.

The signals shown below 200 MHz are anomalies in the preamp of the measuring instrument.
A notch filter at the transmitter fundamental frequency was used.

## Radiated Emissions – 30 MHz to 1 GHz

**Vertical**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.56 | V | 1.4 | 10 | 6.43 | 0.00 | 0.75 | 9.19 | 16.36 | 40.00 | -23.64 |
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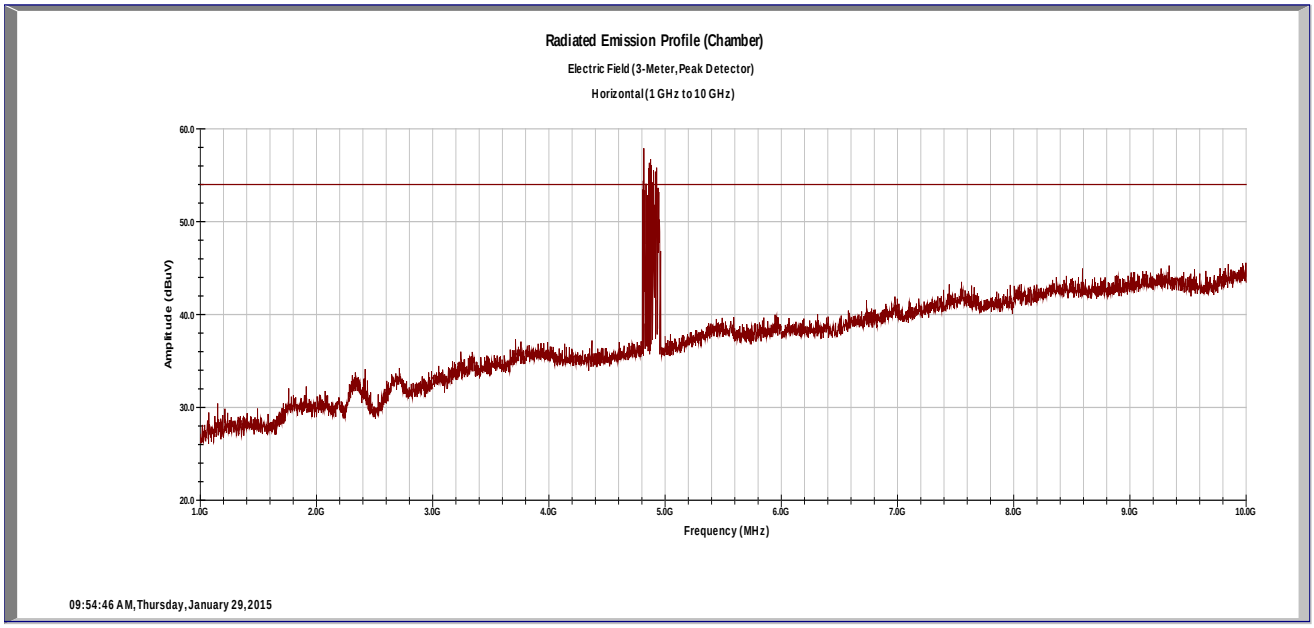
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: All emissions were below the noise floor of the instrumentation.
The EUT was set to hopping all channels.

The signals shown below 200 MHz are anomalies in the preamp of the measuring instrument.
A notch filter at the transmitter fundamental frequency was used.

## Radiated Emissions – 1 GHz to 10 GHz

**Horizontal**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | V | 1.6 | 309 | 43.23 | 33.84 | 11.60 | 32.88 | 53.87 | 54.00 | -0.13 |
| 4804.00 | H | 1.6 | 309 | 50.74 | 33.84 | 11.60 | 32.88 | 61.38 | 74.00 | -12.62 |
| Mid: | | | | | | | | | | |
| 4880.00 | H | 1.5 | 302 | 42.87 | 33.77 | 11.71 | 33.03 | 53.83 | 54.00 | -0.17 |
| 4880.00 | H | 1.5 | 302 | 49.88 | 33.77 | 11.71 | 33.03 | 60.84 | 74.00 | -13.16 |
| Hi: | | | | | | | | | | |
| 4960.00 | H | 1.3 | 307 | 42.52 | 33.66 | 11.81 | 33.19 | 53.87 | 54.00 | -0.13 |
| 4960.00 | H | 1.3 | 307 | 49.75 | 33.66 | 11.81 | 33.19 | 61.10 | 74.00 | -12.90 |
| | | | | | | | | | | |

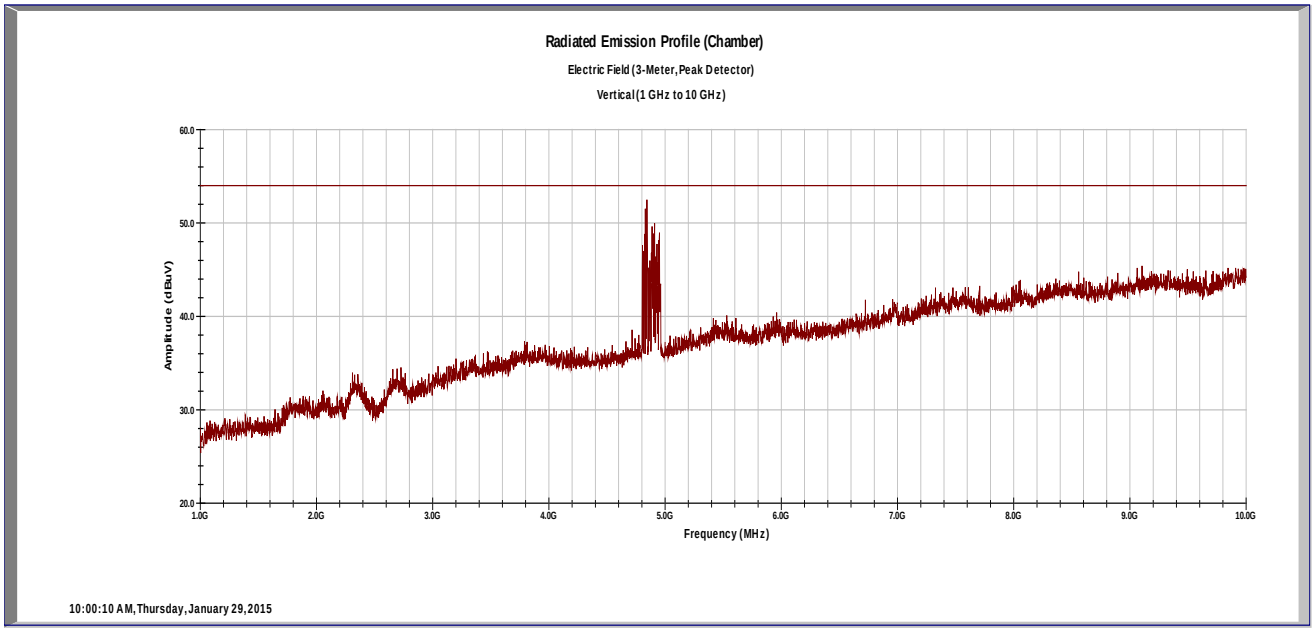
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: A Band-Notch filter was used to attenuate the fundamental frequency.
The EUT was set to hopping all channels.
The worst case emission was a harmonic at **53.87 dBµV/m** at 3m, (avg) which is equivalent to **493 µV/m**.

The **Blue** emissions are using the Average detector
The **RED** emissions are using the Peak detector

## Radiated Emissions – 1 GHz to 10 GHz

**Vertical**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | V | 1.6 | 330 | 41.60 | 33.84 | 11.60 | 32.88 | 52.24 | 54.00 | -1.76 |
| 4804.00 | V | 1.6 | 330 | 49.18 | 33.84 | 11.60 | 32.88 | 59.82 | 74.00 | -14.18 |
| Mid: | | | | | | | | | | |
| 4880.00 | V | 1.8 | 335 | 39.66 | 33.77 | 11.71 | 33.03 | 50.62 | 54.00 | -3.38 |
| 4880.00 | V | 1.8 | 335 | 47.74 | 33.77 | 11.71 | 33.03 | 58.70 | 74.00 | -15.30 |
| Hi: | | | | | | | | | | |
| 4960.00 | V | 1.9 | 330 | 37.94 | 33.66 | 11.81 | 33.19 | 49.29 | 54.00 | -4.71 |
| 4960.00 | V | 1.9 | 330 | 49.39 | 33.66 | 11.81 | 33.19 | 60.74 | 74.00 | -13.26 |
| | | | | | | | | | | |
| | | | | | | | | | | |

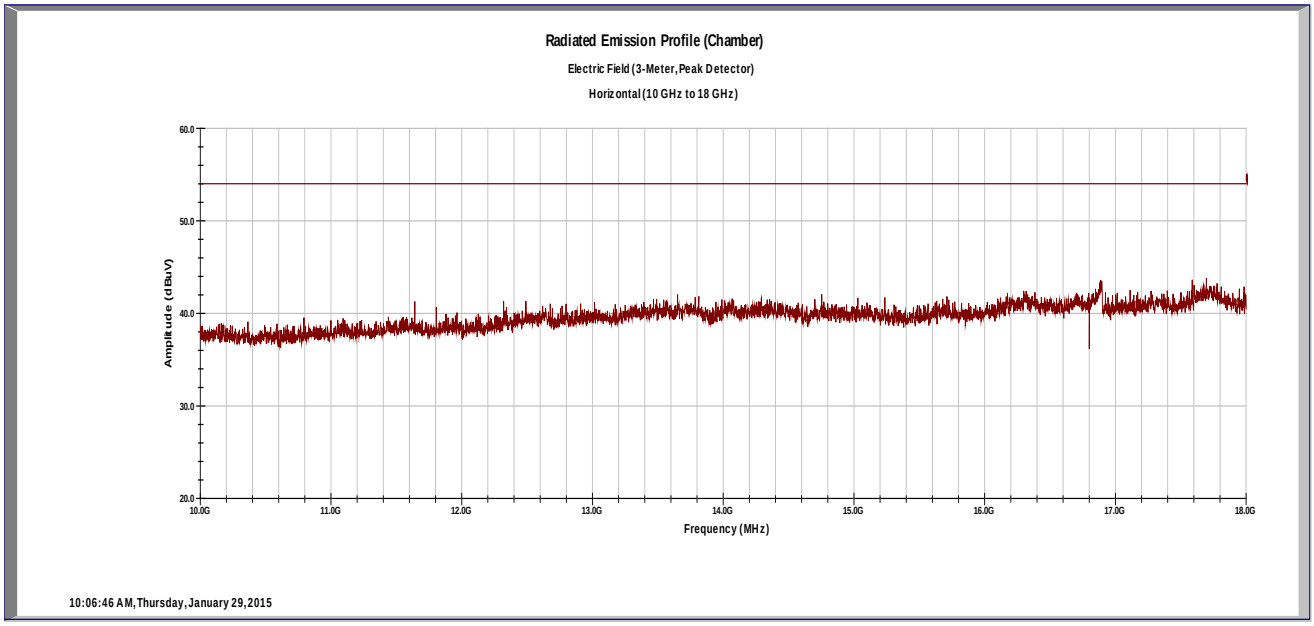
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: The EUT was set to hopping all channels.
Worst case emission is in the Horizontal Polarity (see previous page)

The **Blue** emissions are using the Average detector
The **RED** emissions are using the Peak detector
All spurious and harmonic emissions are below the level of Part 15.209, including those not in restricted bands.
A Band- Notch filter was used to attenuate the fundamental frequency.

## Radiated Emissions – 10 GHz to 18 GHz

**Horizontal**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
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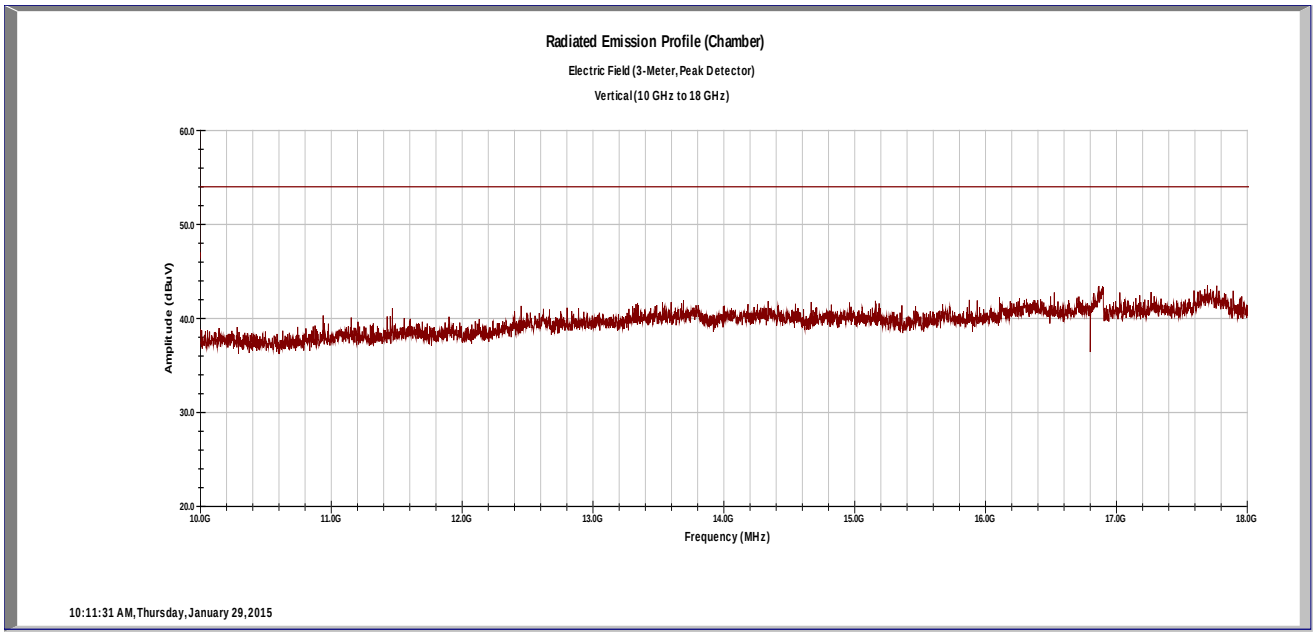
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: The EUT was set to hopping all channels.
No measureable emissions were noted.
A High-Pass filter was used to attenuate the fundamental frequency.
No emissions were seen above the noise floor of the instrumentation.

## Radiated Emissions – 10 GHz to 18 GHz

**Vertical**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
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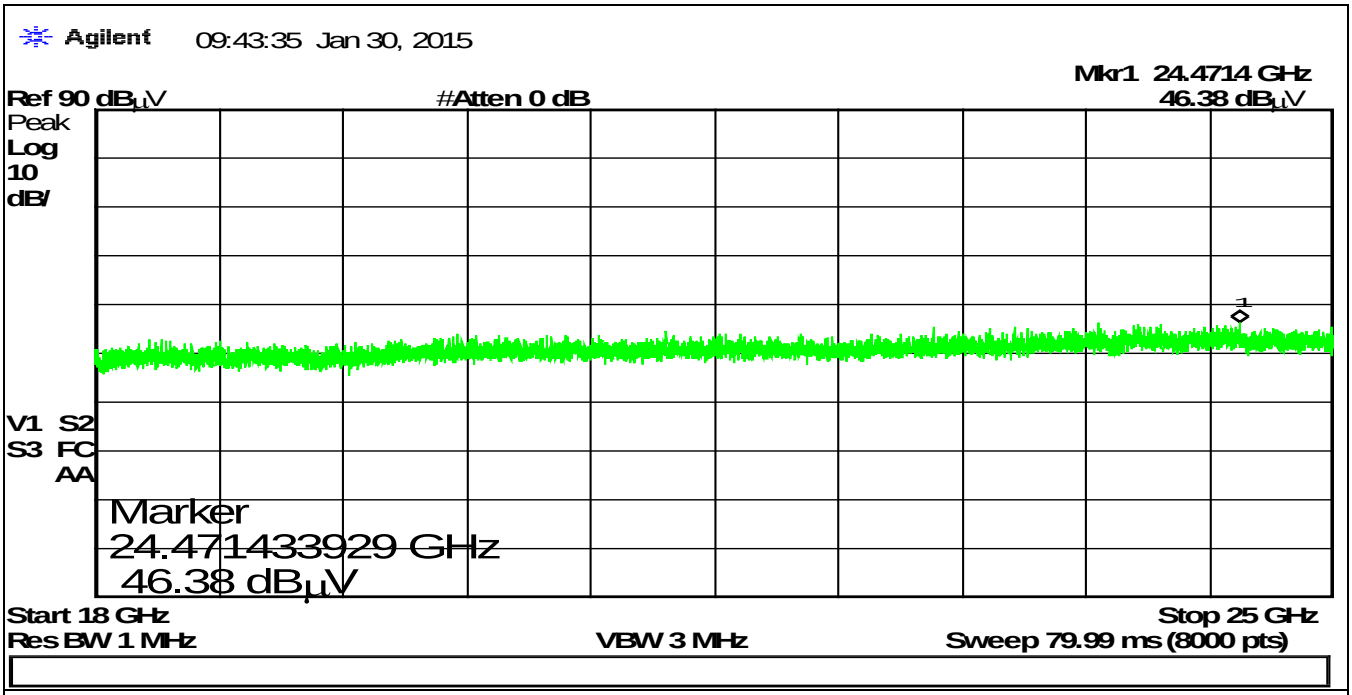
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: The EUT was set to hopping all channels.
No measureable emissions were noted.
A High-Pass filter was used to attenuate the fundamental frequency.
No emissions were seen above the noise floor of the instrumentation.

## Radiated Emissions – 18 GHz to 25 GHz

**Horizontal**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
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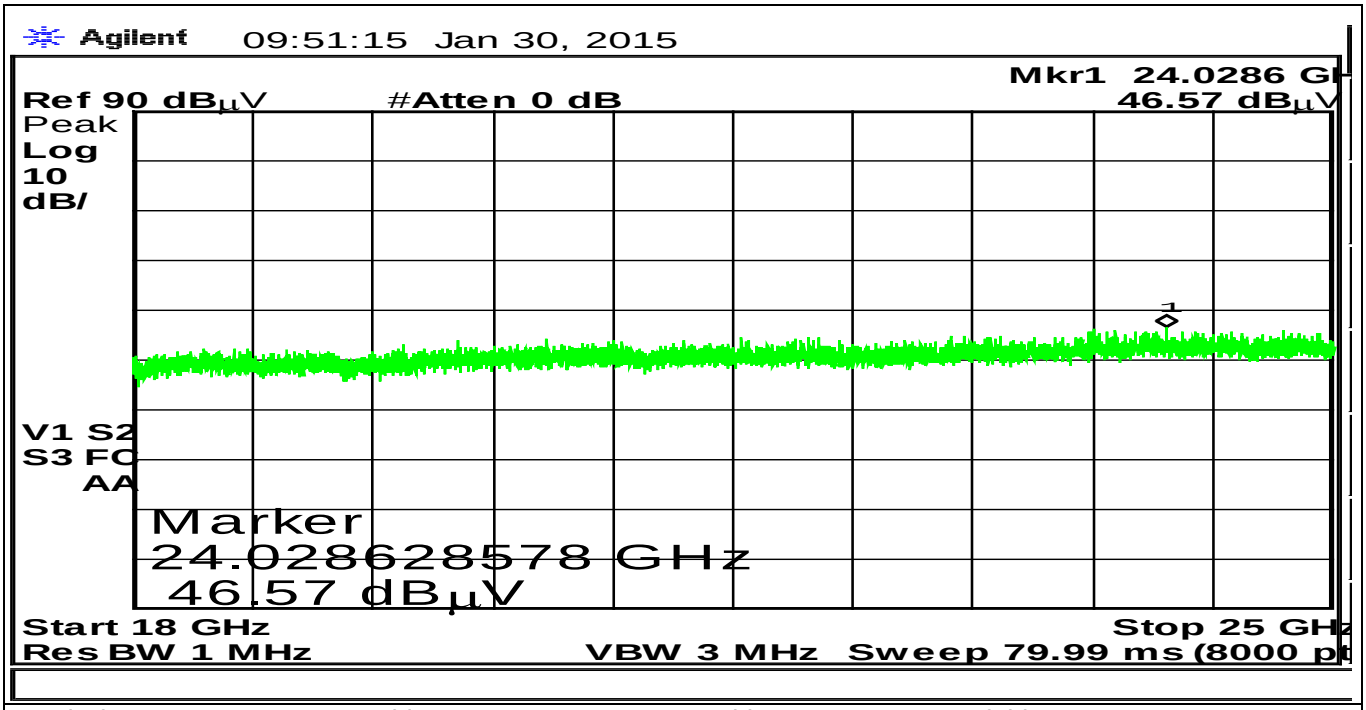
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: The EUT was set to hopping all channels.
No measureable emissions were noted.
No correction factors were used for the above graph. The number of Sweep Points was increased to 8000.
The Measuring distance was decreased to 1 meter.
No notch filter was used for this frequency range.

**Radiated Emissions – 18 GHz to 25 GHz**
**Vertical**




| Emission Freq (MHz) | ANT Polar (H/V) | ANT Pos (m) | Table Pos (deg) | FIM Value (dBuV) | Amp Gain (dB) | Cable Loss (dB) | ANT Factor (dB/m) | E-Field Value (dBuV/m) | Spec Limit (dBuV/m) | Spec Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
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Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: The EUT was set to hopping all channels.
No measureable emissions were noted.
No correction factors were used for the above graph. The number of Sweep Points was increased to 8000.
The Measuring distance was decreased to 1 meter.
No notch filter was used for this frequency range.

## 4.2 Band Edge requirements - FCC Part 15.249(d), RSS-210 2.2

### 4.2.1 Test Over View

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Results** | **Complies** (as tested per this report) | | | | | **Date** | 29 January 2015 |
| **Standard** | FCC Part 15.249(d), RSS 210 2.2 | | | | | | |
| **Product Model** | DAMPER SSD | | | **Serial#** | Production Prototype | | |
| **Test Set-up** | Radiated Measurement | | | | | | |
| **EUT Powered By** | 24 VAC | **Temp** | 73º F | **Humidity** | 18% | **Pressure** | 1010 mbar |
| **Perf. Criteria** | (Below Limit) | | **Perf. Verification** | | Readings Under Limit | | |
| **Mod. to EUT** | None | | **Test Performed By** | | Mark Ryan | | |

### 4.2.2 Test Procedure

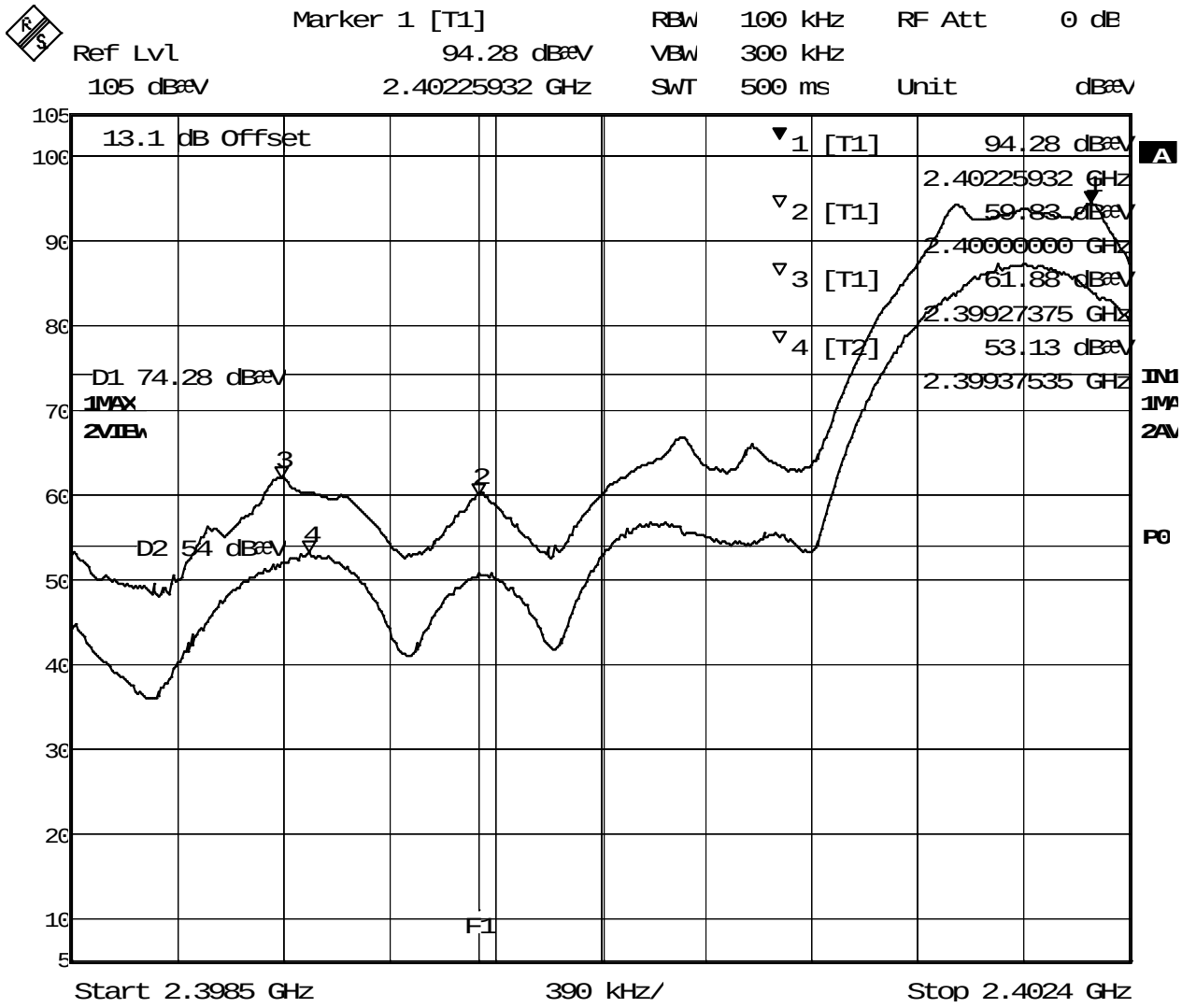
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Sec. 15.209, whichever is the lesser attenuation.

### 4.2.3 Deviations

There were no deviations from the test methodology listed in the test plan.

### 4.2.4 Final Test

The EUT met the performance criteria requirement as specified in the standards.



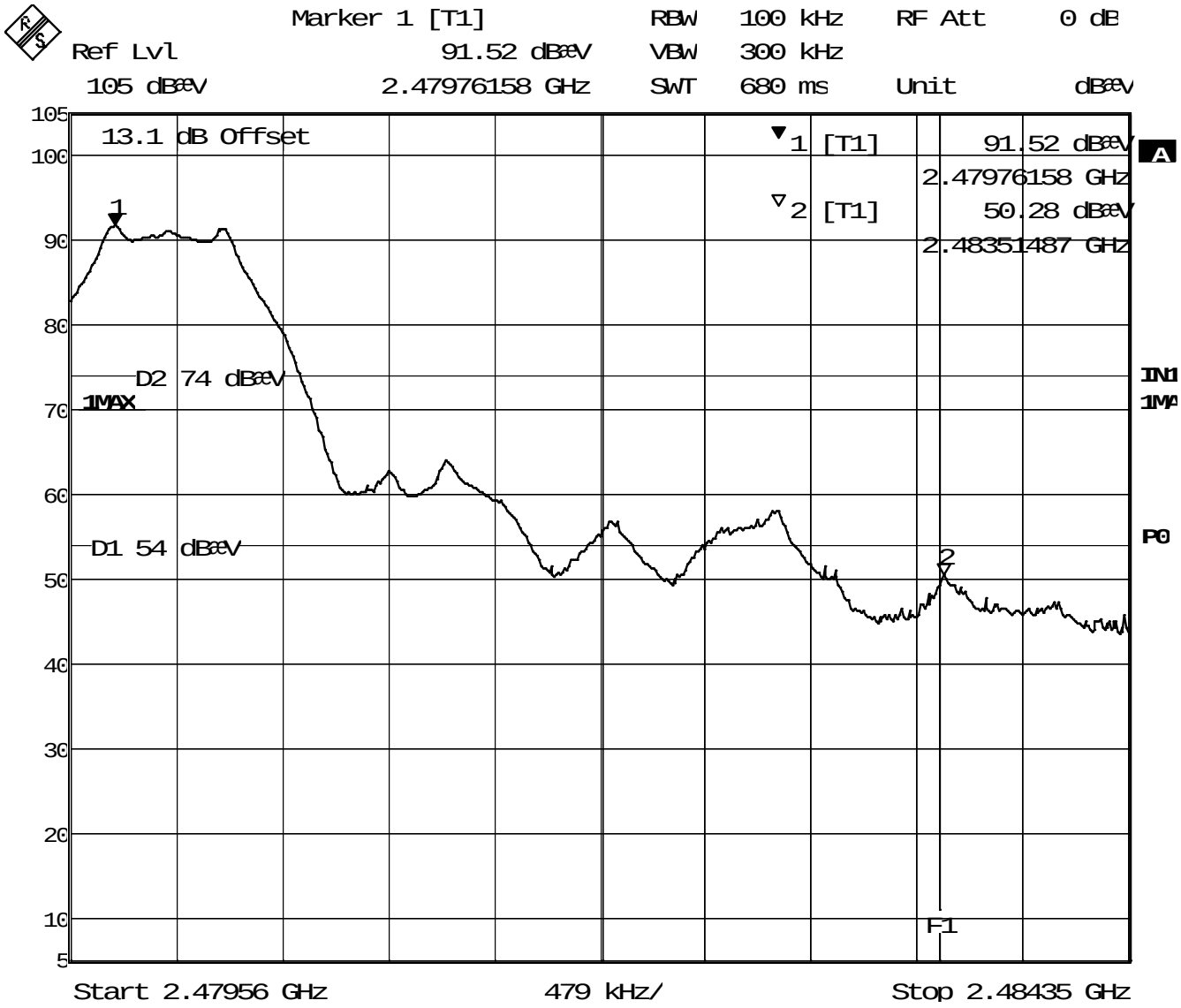

Notes: Measured using the Peak Detector, Line F1 is the Band Edge is at 2.4 GHz. Line D2 is the Restricted Band limit line and line D1 is the -20dBc Limit.

Plot includes Correction Factors.

The nearest restricted band (2390MHz) is 10 MHz below the band edge

The Highest frequency outside the band is at 61.88 dBµV (using the Peak Detector) which is more than 20dB below peak level of the lowest channel.

Figure 1: Lower Band Edge Measurement (Radiated Emission)




Date: 29.JAN.2015 09:01:11

Note: Measured using the Peak detector. Band Edge is at 2.483.5 MHz (Line F1), line D1 is the average restricted band limit and line D2 is the peak restricted band limit.

Band edge at 2483.5 MHz is also the start of a restricted band, so the restricted band rules apply.

The Highest frequency outside the band is at 50.28dBµV (using the Peak Detector) which is below the Average restricted-band limits)

Figure 2: Upper Band Edge Measurement (Radiated Emission)

The EUT is compliant with the rules.

## 4.1 Conducted Emissions on AC Mains – FCC 207(a) and RSS-GEN 7.2.4

This test measures the electromagnet levels of spurious signals generated by the EUT on the AC power line that may affect the performance of other nearby electronic equipment.

### 4.1.1 Over View of Test

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Results** | **Complies** (as tested per this report) | | | | | **Date** | 27 January 2015 |
| **Standard** | FCC Parts 15.207(a) and RSS-GEN 7.2.4 | | | | | | |
| **Product Model** | DAMPER SSD | | | **Serial#** | NA | | |
| **Test Set-up** | Tested in shielded room. EUT placed on table, see test plans for details | | | | | | |
| **EUT Powered By** | 24 VAC | **Temp** | 71º F | **Humidity** | 28% | **Pressure** | 994 mbar |
| **Frequency Range** | 150 kHz – 30 MHz | | | | | | |
| **Perf. Criteria** | (Below Limit ) | **Perf. Verification** | Readings Under Limit for L1 & Neutral | | | | |
| **Mod. to EUT** | None | **Test Performed By** | Engineer's Name | | | | |

### 4.1.1 Test Procedure

Conducted and FCC emissions tests were performed using the procedures of ANSI C63.10 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 150kHz – 30MHz was investigated for conducted emissions.

Conducted Emissions measurements were performed in either the shielded room or ground plane location (with attached vertical ground plane) using procedures specified in the test plan and standard.

The EUT was powered by a 24 VAC transformer. The emissions were made on the AC Mains side of the transformer.

### 4.1.2 Deviations

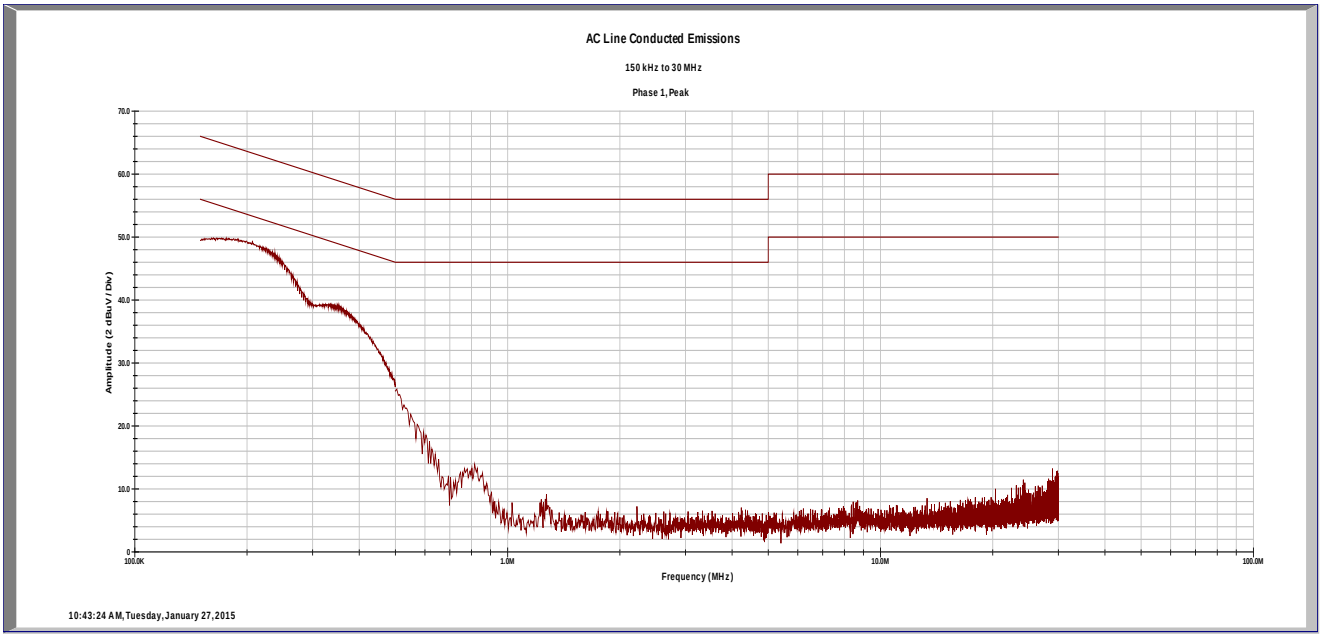
There were no deviations from the test methodology listed in the test plan for the conducted emission test.

### 4.1.3 Final Test

All final conducted emissions measurements were below (in compliance) the limits. It lists the final measurement data under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories.

### 4.1.1 Final Graphs and Tabulated Data

**Conducted Emissions @ 120V/60Hz**
**Line 1**




| Freq (MHz) | ID (1,2,3,N) | Quasi (dBuV) | Ave (dBuV) | Loss (dB) | T Limiter (dB) | Limit (dBuV) | Limit (dBuV) | Margin (dB) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.15 | 1 | 32.70 | 3.61 | 0.02 | 9.97 | 66.00 | 56.00 | -23.30 | -42.39 |
| 0.16 | 1 | 33.07 | 3.14 | 0.03 | 9.97 | 65.46 | 55.46 | -22.40 | -42.33 |
| 0.33 | 1 | 22.84 | 0.15 | 0.03 | 9.98 | 59.55 | 49.55 | -26.70 | -39.39 |
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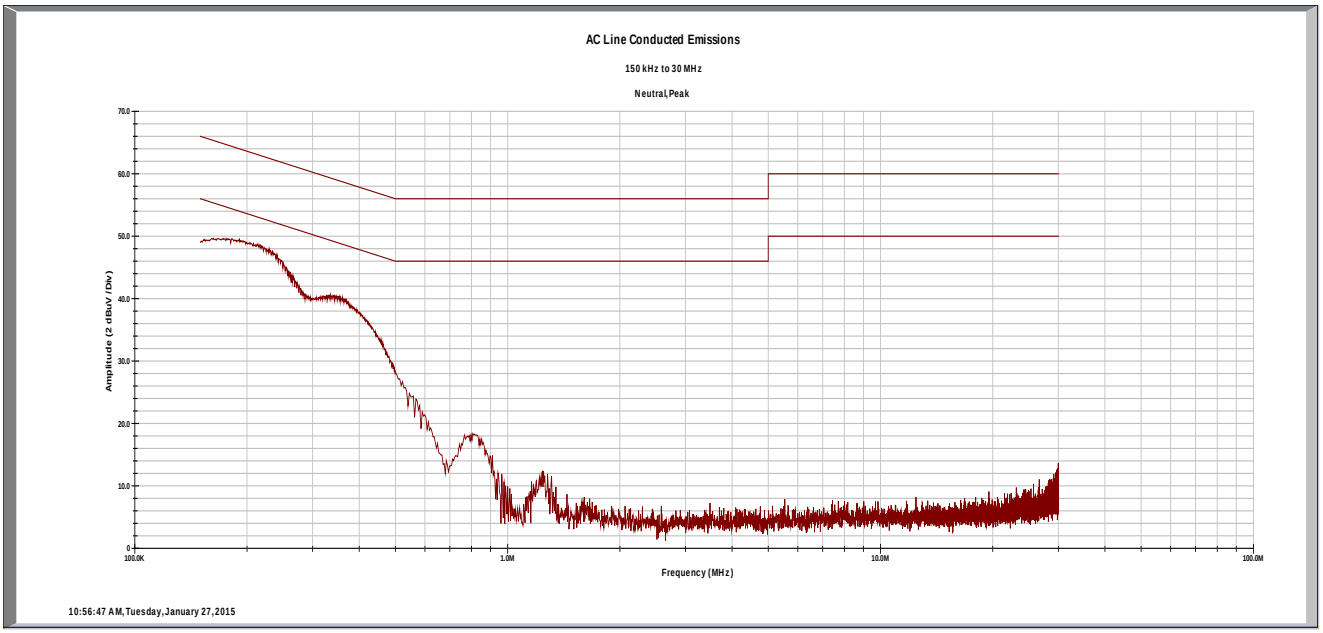
Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit ± Uncertainty
Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.66$dB  Expanded Uncertainty $U = ku_c(y)$  $k = 2$ for 95% confidence

Notes: EUT in continuous hopping mode.
All other Quasi-Peak and Average emissions are below 0 dBµV.

## Conducted Emissions @ 120V/60Hz

**Neutral**




| Freq (MHz) | ID (1,2,3,N) | Quasi (dBuV) | Ave (dBuV) | Loss (dB) | T Limiter (dB) | Limit (dBuV) | Limit (dBuV) | Margin (dB) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.15 | N | 33.01 | 3.77 | 0.02 | 9.97 | 66.00 | 56.00 | -22.99 | -42.23 |
| 0.18 | N | 33.30 | 3.04 | 0.03 | 9.96 | 64.58 | 54.58 | -21.29 | -41.55 |
| 0.33 | N | 24.24 | 0.43 | 0.03 | 9.96 | 59.35 | 49.35 | -25.12 | -38.93 |
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Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit ± Uncertainty
Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit ± Uncertainty

Notes: EUT in continuous hopping mode.
All other Quasi-Peak and Average emissions are below 0 dBµV.

## 4.1 99% Power Bandwidth

For the purpose of Section A1.1, the 99% bandwidth shall be no wider than .25% of the center frequency for devices operating between 70-900MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. This device operates above 900 MHz.

### 4.1.1 Test Over View

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Results** | **Complies** (as tested per this report) | | | | | **Date** | 29 January 2015 |
| **Standard** | RSS-GEN 4.6.1 | | | | | | |
| **Product Model** | DAMPER | | | **Serial#** | Production Prototype | | |
| **Test Set-up** | Radiated Measurement | | | | | | |
| **EUT Powered By** | 24 VAC | **Temp** | 73º F | **Humidity** | 18% | **Pressure** | 1010 mbar |
| **Perf. Criteria** | (Below Limit) | | **Perf. Verification** | | Readings Under Limit | | |
| **Mod. to EUT** | None | | **Test Performed By** | | Mark Ryan | | |

### 4.1.2 Test Procedure

Using the procedures of RSS-GEN section 4.6.1, the 30 kHz resolution bandwidth is 1% of the 3 MHz span. The 100 kHz video bandwidth is ≥ 3 times that of the resolution bandwidth.

### 4.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the Electrical Fast transients (EFT) Immunity test.

### 4.1.4 Final Results

The Maximum measured 99% bandwidth is 1.08 MHz, which is well below the 12 MHz limit.

| Frequency (MHz) | 99% BW (MHz) |
|---|---|
| 2402 | 1.070 |
| 2440 | 1.070 |
| 2480 | 1.082 |

99% Power Band Width.

### 4.1.5 Final Data

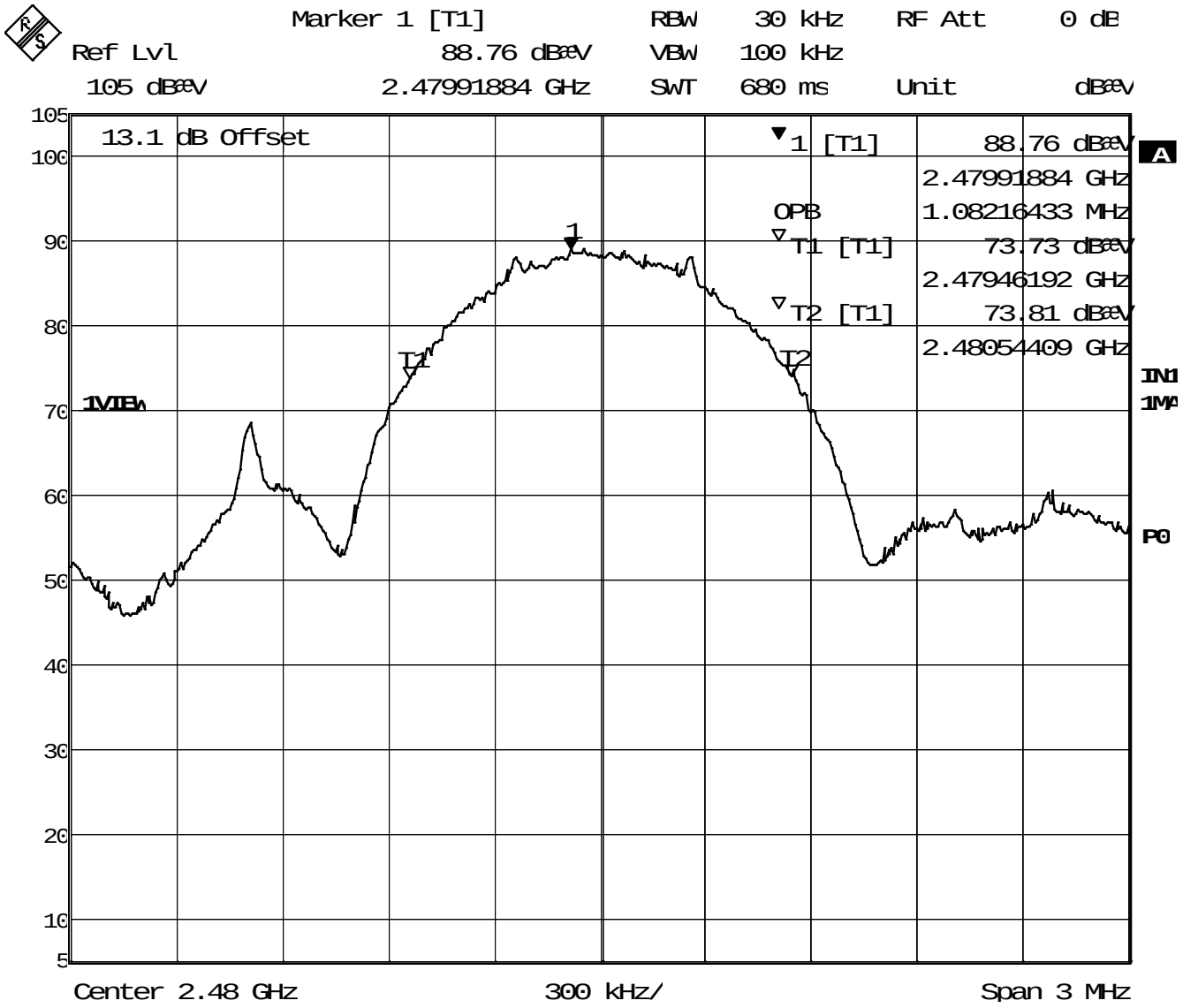


Figure 3 – 99% Power Bandwidth = 1.088 MHz. The Worst-Case shown.

Span = 3MHz, RBW = 30 kHz (1% of Span), VBW = 100 kHz (≥ 3x RBW)

The EUT is compliant to the requirements of RSS-210 A1.1.3

# 5 RF Exposure

## 5.1 Exposure Requirements – FCC KDB # 447498 DO1 and RSS-102 Issue 4

FCC KDB # 447498 DO1 V05r02 - Mobile and Portable Device RF Exposure and Procedures and Equipment, Appendix A shows that the SAR Text Exclusion Threshold for a device with a separation distance of 5 mm at 2450 MHz is 10 mW.

RSS-102 section 2.5.1 states that a device is exempt from SAR evaluation if the frequency is "above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (EiRP.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use…".

### 5.1.1 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

### 5.1.2 Evaluation

The EUT will be used as a portable device where the antenna may be located less than 20cm from the user, therefore SAR evaluation is required.

#### 5.1.2.1 Evaluation for FCC

FCC 447498 DO1 Mobile Portable RF Exposure V05r02, Appendix A shows that the SAR Text Exclusion Threshold for a device with a worst-case separation distance of 5mm at 2450 MHz is 10 mW.

The minimum power that requires SAR testing with a separation distance of 5mm at 2.445 GHz is 10 mW.

The maximum EiRP peak power output of the EUT is: 0.646 mW (See calculation next page).

The EUT is well below the 25mW power level.

#### 5.1.2.2 Evaluation for Industry Canada

The maximum EiRP peak power output of the EUT is: 0.646 mW (See calculation next page).

The EUT is well below the 20mW power level.

### 5.1.3 Conclusion

SAR data is not required for either FCC or Industry Canada.

Note: The 0.646 mW power level has not been time-averaged. (100% Duty Cycle).
This is considered to be the absolute worst case.

### 5.1.4 Calculated EiRP Level

Notes: The EUT does not have a means to make direct measurements.

This EiRP calculation was made using the maximum peak value in section 4.1.4.1 of this report (Page 10) which is 93.33 dBµV/m at 3m.

Per the equation in section 1.3.1 of FCC Document # 412172 D01 Determining ERP and EiRP v01;

**$EiRP = p_t \times g_t = (E \times d)^2 / 30$**,

where:

$\mathbf{p_t}$ = transmitter output power in watts,

$\mathbf{g_t}$ = Numeric gain of transmitting antenna (unitless),

**E** = electric field strength in V/m; $E = 10^{(93.33/20)} / 10^6 = 0.0464$ V/m,

**d** = measurement distance in meters; d = 3m,

**$EiRP = (0.0464 \times 3)^2 / 30 = 0.000646$ Watts or <u>0.646 mW</u>**

### 5.1.5 Antenna Gain Calculation:

The antenna used in the EUT is a Rufa antenova® Model A5887, SDM type antenna that is soldered to the circuit.

The stated Maximum output power by the Manufacturer is 1 mW or 0 dBm.

The Maximum EiRP output is 0.646 mW or -1.9 dBm.

The Gain of the antenna would be 0 dBm + (-1.09 dBm) = **<u>-1.9 dBi</u>** or a numeric gain of: **<u>0.65</u>**.