Flom Test Labs
EMI, EMC, RF Testing Experts Since 1963
toll-free: (866) 311-3268
fax: (480) 926-3598
http://www.flomlabs.com
info@flomlabs.com

**Date:** May 2, 2008

Federal Communications Commission
Via: Electronic Filing

**Attention:** Authorization & Evaluation Division

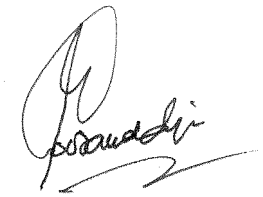
**Applicant:** Thermodynamic Process Control LLC
**Equipment:** LFC-01-001
**FCC ID:** V87LFC001TPCMVPMV
**FCC Rules:** 15.247

Gentlemen:

On behalf of the Applicant, enclosed please find Application Form 731, Engineering Test Report and all pertinent documentation, the whole for approval of the referenced equipment as shown.

We trust the same is in order. Should you need any further information, kindly contact the writer who is authorized to act as agent.

Sincerely yours,



Hoosamuddin S. Bandukwala, Lab Director

**List Of Exhibits**
(FCC **Certification** (Transmitters) - Revised 9/28/98)

**Applicant:** Thermodynamic Process Control LLC

**FCC ID:** V87LFC001TPCMVPMV

**By Applicant**:

1. Letter Of Authorization

2. Identification Drawings
   - __ Id Label
   - __ Location Info
   - __ Attestation Statement(S)
   - __ Location of Compliance Statement

3. Documentation: 2.1033(B)
   - (3) User Manual(S)
   - (4) Operational Description
   - (5) Block Diagram
   - (5) Schematic Diagram
   - (7) External Photographs
   - Internal Photographs
   - Parts List
   - Active Devices

**By F.T.L. Inc.**

A. Testimonial & Statement of Certification

B. Statement of Qualifications

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# Test Report

for

**FCC ID:** V87LFC001TPCMVPMV

**Model:** LFC-01-001

to

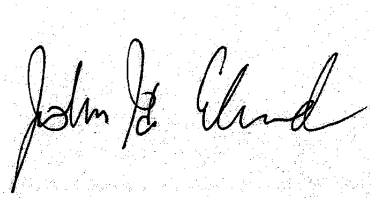
**Federal Communications Commission**

Rule Part(s) 15.247

**Date Of Report:** May 2, 2008
Date of Revised Report: July 9, 2008

**On the Behalf of the Applicant**: Thermodynamic Process Control LLC
5935 Kopetsky Dr, Ste C
Indianapolis, IN 46217

**Attention of:** ATTN: David Johnson, Jr
PH: (866) 660-3569
FAX: (317) 228-9771
email: davej@flowintel.com



Supervised By: John Erhard

# Revision History

| Revision | Date | Revised By | Reason for revision |
|---|---|---|---|
| 1.0 | May 2, 2008 | J Erhard | Original Document |
| 2.0 | June 26, 2008 | J Erhard | Correct FCC ID, Correct minor technical reporting issues |
| 3.0 | July 9, 2008 | J Erhard | Add PSD and remove dwell time test information |
| | | | |

**The applicant has been cautioned as to the following:**

15.21 Information to User.

The users manual or instruction manual for an intentional 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.

15.27(a) Special Accessories.

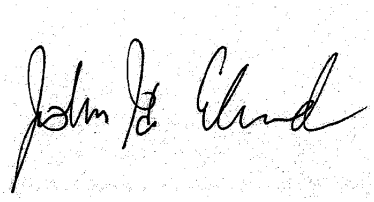
Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

# Testimonial And Statement Of Certification

**This is to certify that**:

1. **That** the application was prepared either by, or under the direct supervision of, the undersigned.
2. **That** the technical data supplied with the application was taken under my direction and supervision.
3. **That** the data was obtained on representative units, randomly selected.
4. **That**, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.



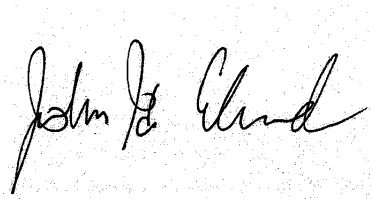
Certifying Engineer: John Erhard

Flom Test Labs
3356 N. San Marcos Place, Suite 107
Chandler, Arizona 85225-7176
(866) 311-3268 phone, (480) 926-3598 fax

# Table Of Contents

*Required information per ISO 17025-2005, paragraph 5.10.2:*

a) **Test Report**

| | |
|---|---|
| b) Laboratory:<br>(FCC: 31040/SIT)<br>(Canada: IC 2044A-1) | Flom Test Lab, Inc.<br>3356 N. San Marcos Place, Suite 107<br>Chandler, AZ 85225 |
| c) Report Number: | d0850003 |
| d) Client: | Thermodynamic Process Control LLC |
| e) Identification: | LFC-01-001 |
| Description: | 2.4 GHz TX with Zigbee |
| f) EUT Condition: | Not required unless specified in individual tests. |
| g) Report Date:<br>EUT Received: | May 2, 2008 |
| h, j, k): | As indicated in individual tests. |
| i) Sampling method: | No sampling procedure used. |
| l) Uncertainty: | In accordance with FTL internal quality manual. |
| m) Supervised by: |  <br>John Erhard |
| n) Results: | The results presented in this report relate only to the item tested. |
| o) Reproduction: | This report must not be reproduced, except in full, without written permission from this laboratory. |

**List Of General Information Required For Certification**

In Accordance with FCC Rules and Regulations,
Volume II, Part 2 and to

15.247

**Sub-Part 2.1033**
(c)(1):

**Name and Address of Applicant:** Thermodynamic Process Control LLC

(c)(2): **FCC ID**: V87LFC001TPCMVPMV

**Model Number**: LFC-01-001

(c)(3): **Instruction Manual(s)**:

Please See Attached Exhibits

(c)(4): **Type of Emission**: DSS

(c)(5): **FREQUENCY RANGE, MHz**: 2405 to 2475

(c)(6): **Power Rating, W**: 1.6 mW

____ Switchable ____ Variable __X__ N/A

(c)(7): **Maximum Power Rating, W**: 1

15.203: **Antenna Requirement**:

**The EUT utilizes a reverse SMA connection for antenna connection**

_____ The antenna is permanently attached to the EUT
__X__ The antenna uses a unique coupling
_____
_____ The EUT must be professionally installed
_____ The antenna requirement does not apply

**The unit was tested with a monopole antenna with a gain of 2 dBi.**

**Subpart 2.1033** (continued)

(c)(8): **Circuit Diagram/Circuit Description**:
Including description of circuitry & devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation and limiting power.

Please See Attached Exhibits

(c)(9): **Label Information**:

Please See Attached Exhibits

(c)(10): **Photographs**:

Please See Attached Exhibits

(c)(11): **Digital Modulation Description**:

___ Attached Exhibits
_x_ N/A

(c)(12): **Test And Measurement Data**:

Follows

Sub-part 2.1033(b): **Test And Measurement Data**

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II; Part 2 and the following individual Parts:

15.247 Operation within bands 902-928, 2400-2483.5, 5725-5850 MHz

**Standard Test Conditions and Engineering Practices**

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.4-2003, FCC DTS Guide March 23, 2005, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104 °F) unless the particular equipment requirements specify testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

**A2LA**

"A2LA has accredited Flom Test Labs, Inc. Chandler, AZ for technical competence in the field of Electrical testing. The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO 17025:2005 'General Requirements for the Competence of Testing and Calibration Laboratories' and any additional program requirements in the identified field of testing."

Please refer to www.a2la.org for current scope of accreditation.

Certificate number: 2152.01

ACCREDITED
CERT NO: 2152-01

**IC O.A.T.S. Number: 2044A-1**

**Test Results Summary**

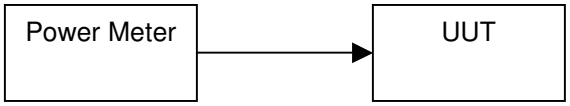
| Specification | Test Name | Pass, Fail, N/A | Comments |
|---|---|---|---|
| 15.247(b) | Peak Output Power | Pass | |
| 15.247(d) | Conducted Spurious Emissions | Pass | |
| 15.247(d), 15.209(a), 15.205 | Radiated Spurious Emissions | Pass | |
| 15.247(d), 15.209(a), 15.205 | Emissions At Band Edges | Pass | |
| 15.247(a) | Occupied Bandwidth | Pass | |
| 15.247(e) | Transmitter Power Spectral Density | Pass | |
| 15.207 | A/C Powerline Conducted Emissions | Pass | |

**Name of Test**: Peak Output Power
**Specification**: 15.247(b)
**Test Equipment Utilized** i00228, i00317 **Test Date: 4/10/2008**

**Test Procedure**

The UUT was connected directly to a power meter input. The peak readings were taken and the result was then compared to the limit.

**Test Setup**




**Transmitter Peak Output Power**

| Tuned Frequency MHz | Recorded Measurement | Specification Limit | Result |
|---|---|---|---|
| 2405 | 1.9 dBm | 1 W | Pass |
| 2440 | 2.0 dBm | 1 W | Pass |
| 2475 | 1.8 dBm | 1 W | Pass |

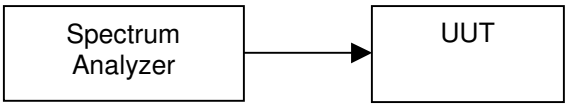
**Name of Test**: Conducted Spurious Emissions
**Specification**: 15.247(d)
**Spec. Limit**: -20 dBC
**Test Equipment Utilized** ii00331 **Test Date: 4/10/2008**

## Test Procedure

The UUT was connected directly to a spectrum analyzer to verify that the UUT met the requirements for spurious emissions. The reference level was offset for the peak power output with the resolution bandwidth set for 1 MHz. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed. Only detectable spurious emissions were recorded and plotted. The reference level is added to the recorded measurement to provide the corrected level dBc

Only the worst case is recorded in the Conducted Spurious Emissions Summary Test Table.

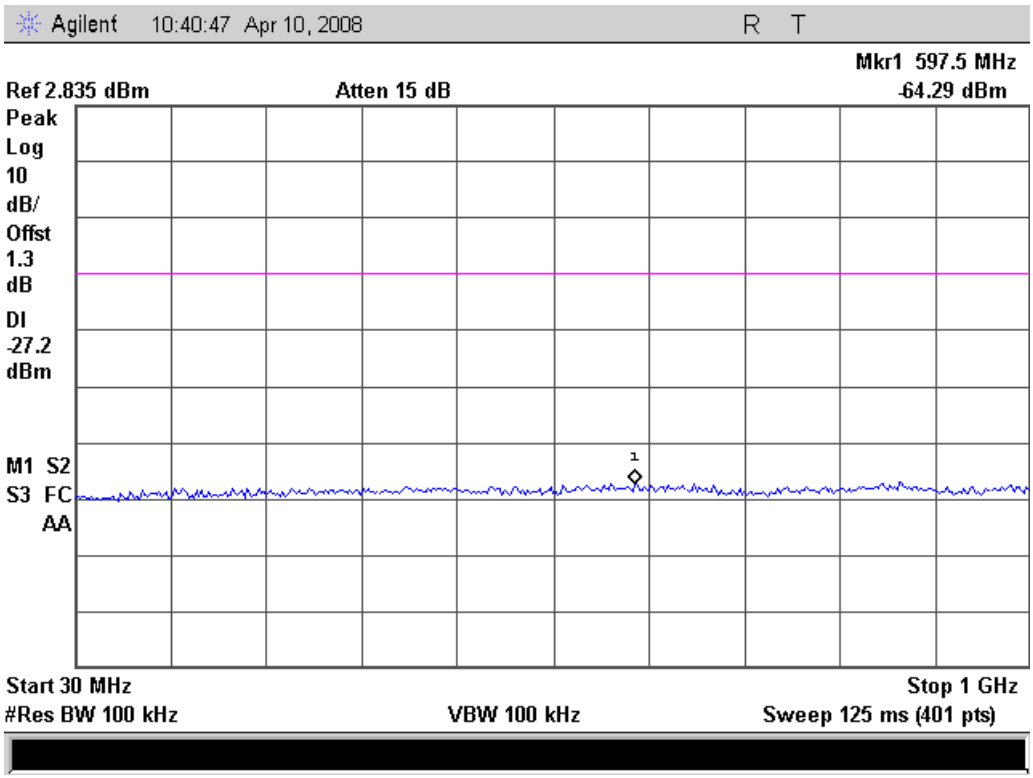
## Test Setup

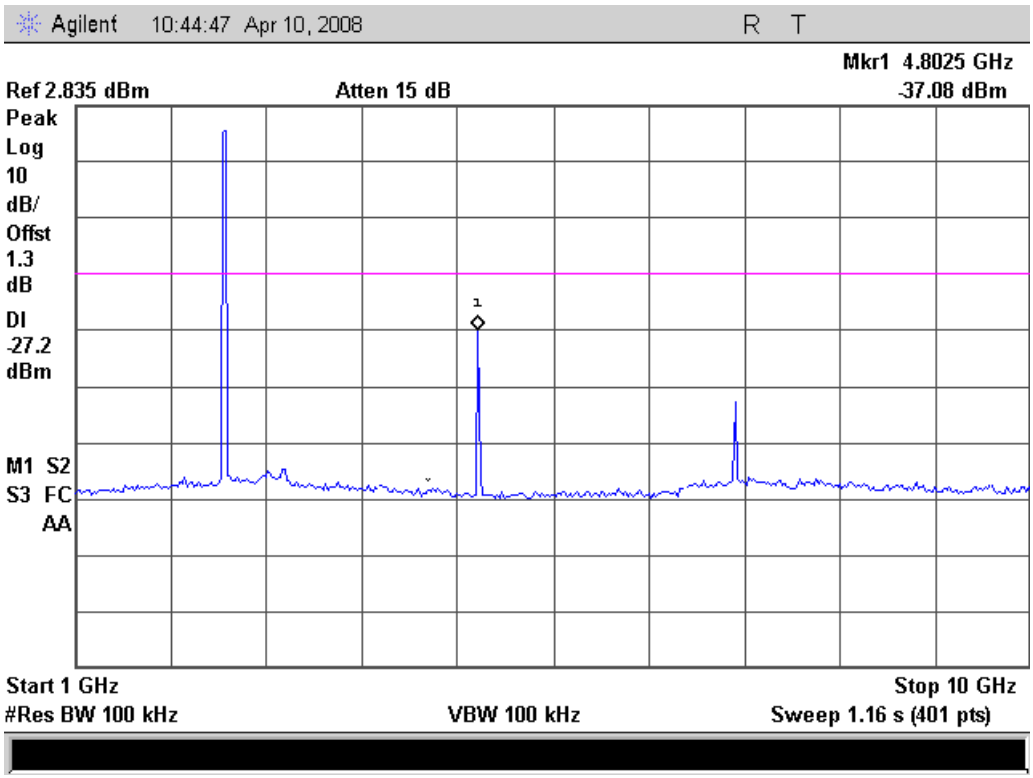


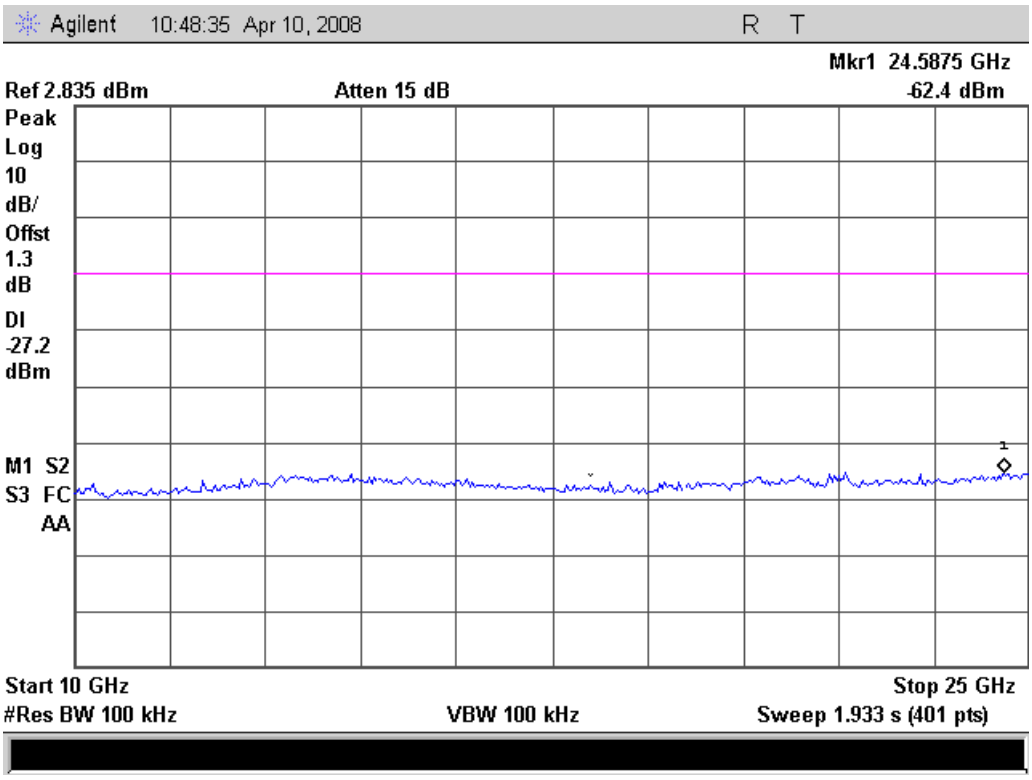

## Conducted Spurious Emissions Summary Test Table

| Tuned Frequency MHz | Emission Frequency MHz | Recorded Measurement dBm | Reference Level dBm | Corrected Measurement dBc | Specification Limit | Result |
|---|---|---|---|---|---|---|
| 2405 | 4802.5 | -37.08 | 2.835 | -39.915 | -20 dBc | Pass |
| 2440 | 4870.0 | -36.78 | 2.875 | -39.655 | -20 dBc | Pass |
| 2475 | 4960.0 | -36.44 | 2.671 | -39.111 | -20 dBc | Pass |

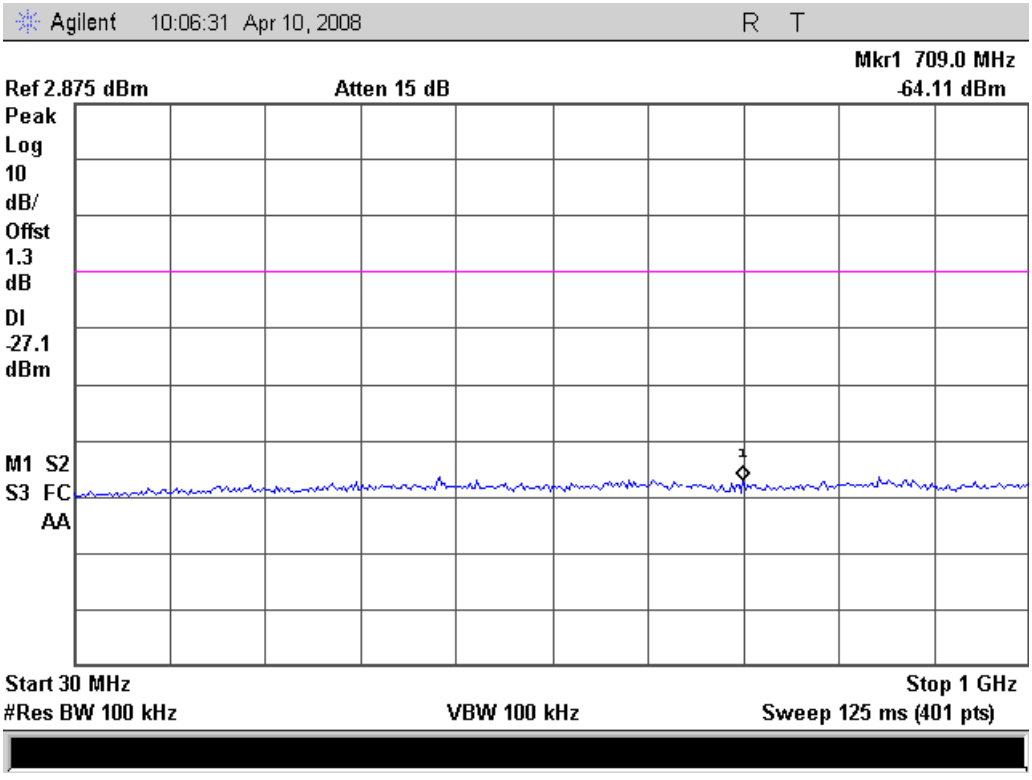
## Conducted Spurious Emissions 2405 MHz

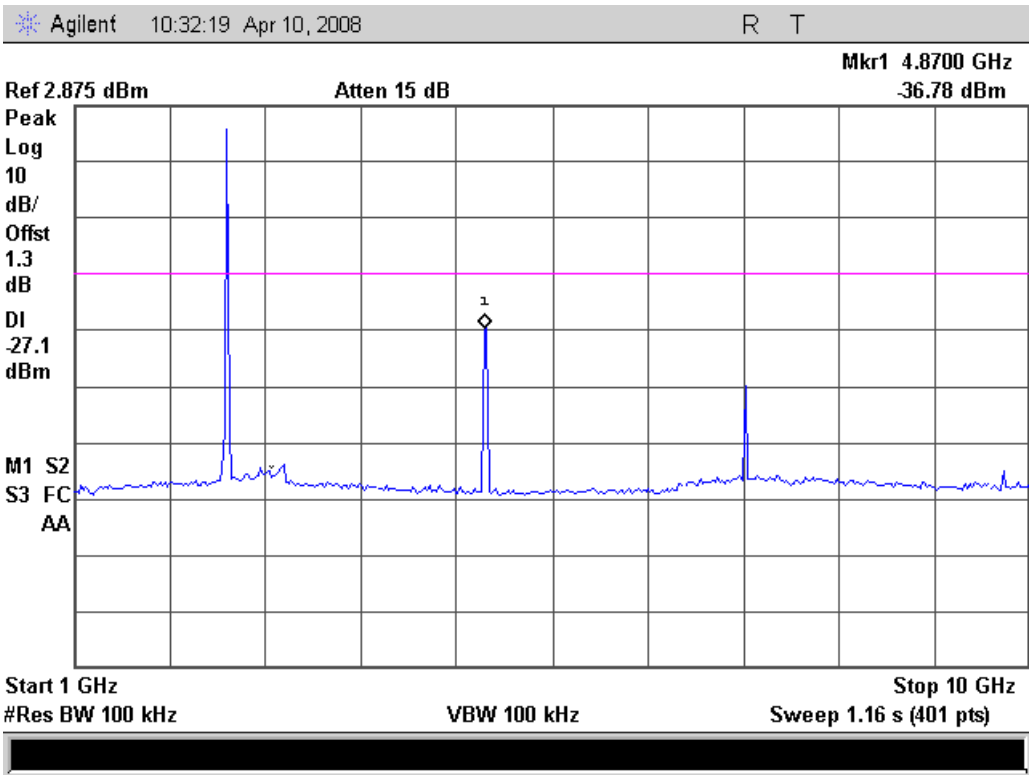


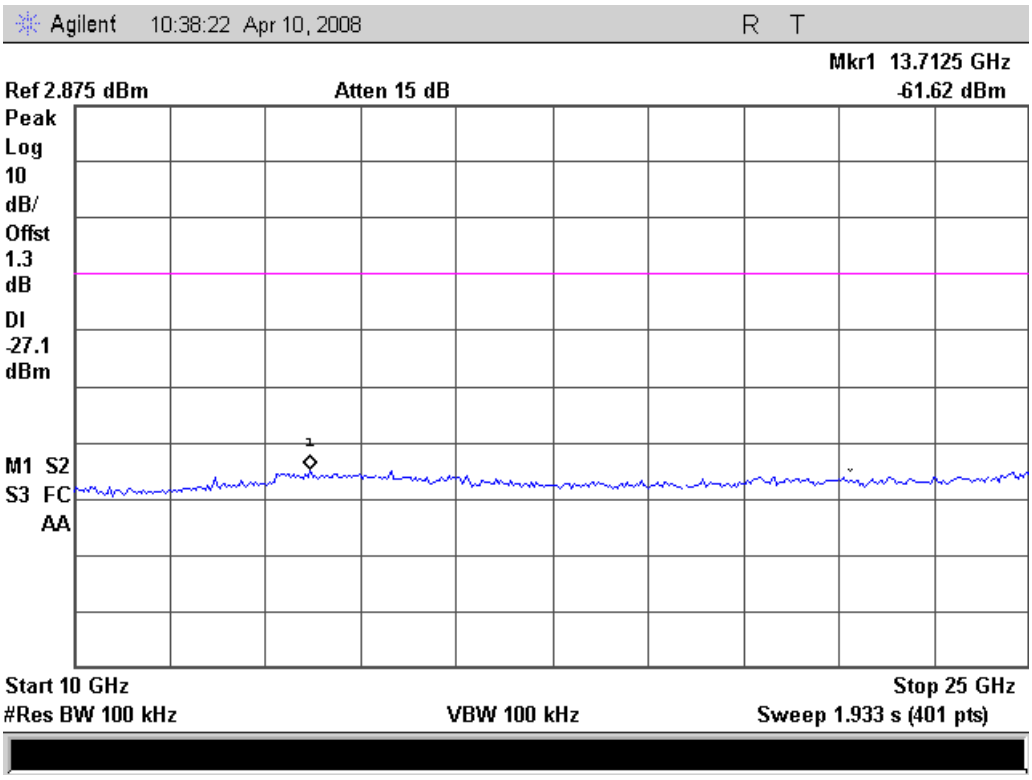





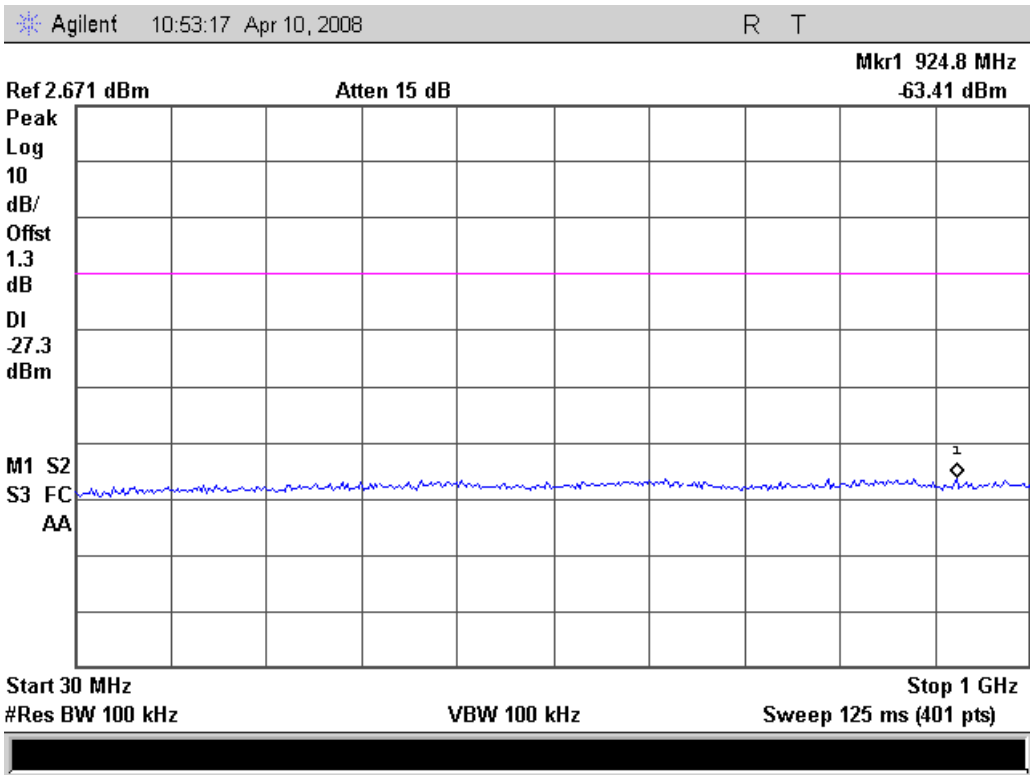

**Conducted Spurious Emissions 2440 MHz**

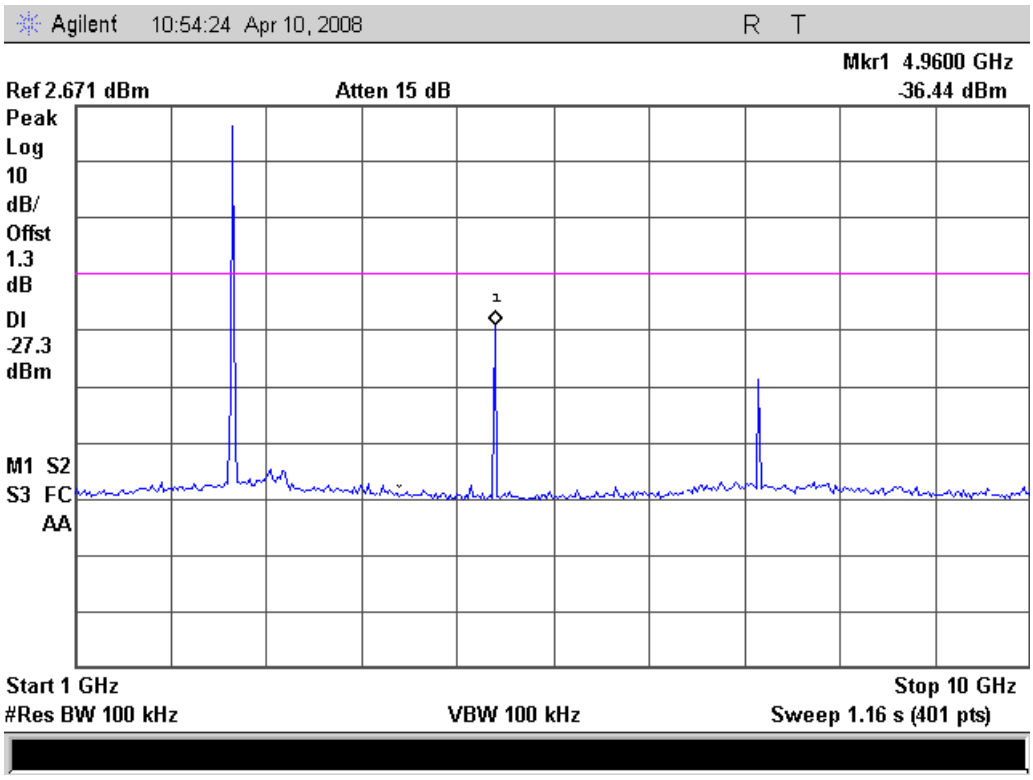


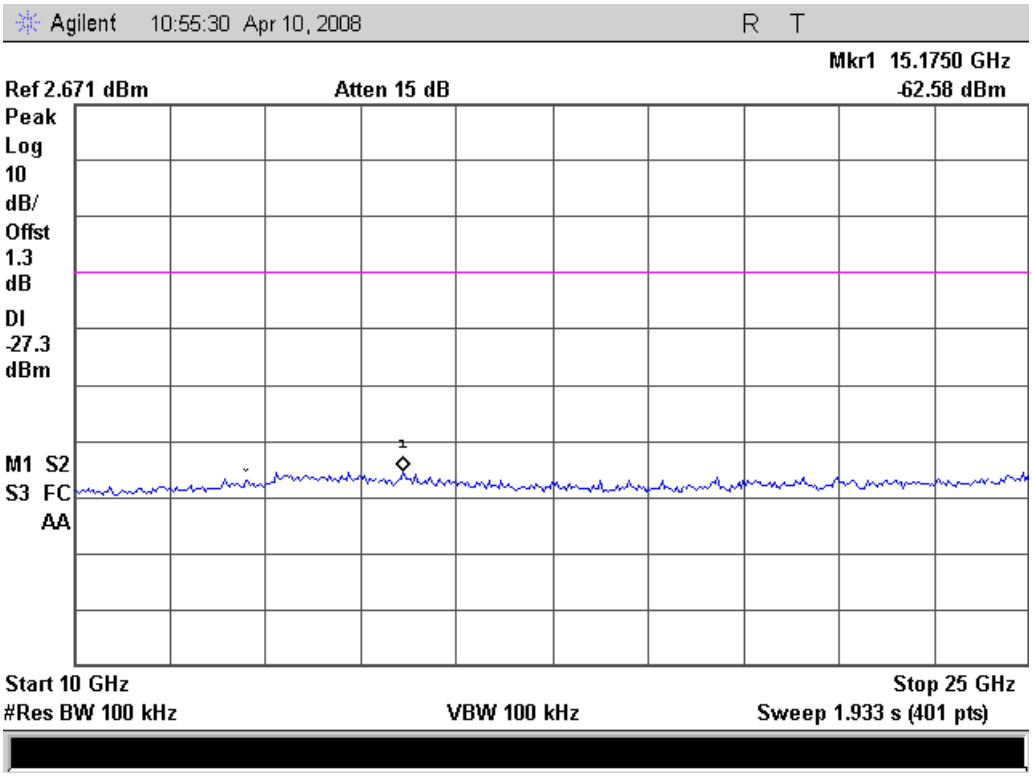

Agilent 10:32:19 Apr 10, 2008
R T
Mkr1 4.8700 GHz
Ref 2.875 dBm
Atten 15 dB
-36.78 dBm
Peak
Log
10
dB/
Offst
1.3
dB
Dl
-27.1
dBm
M1 S2
S3 FC
AA
Start 1 GHz
Stop 10 GHz
#Res BW 100 kHz
VBW 100 kHz
Sweep 1.16 s (401 pts)


Agilent 10:38:22 Apr 10, 2008
R T
Mkr1 13.7125 GHz
Ref 2.875 dBm
Atten 15 dB
-61.62 dBm
Peak
Log
10
dB/
Offst
1.3
dB
Dl
-27.1
dBm
M1 S2
S3 FC
AA
Start 10 GHz
Stop 25 GHz
#Res BW 100 kHz
VBW 100 kHz
Sweep 1.933 s (401 pts)

## Conducted Spurious Emissions 2475 MHz



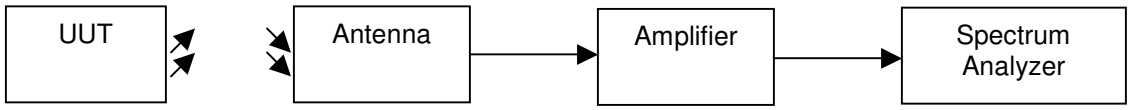

Agilent 10:55:30 Apr 10, 2008
R T
Mkr1 15.1750 GHz
Ref 2.671 dBm
Atten 15 dB
-62.58 dBm
Peak
Log
10
dB/
Offst
1.3
dB
Dl
-27.3
dBm
M1 S2
S3 FC
AA
Start 10 GHz
Stop 25 GHz
#Res BW 100 kHz
VBW 100 kHz
Sweep 1.933 s (401 pts)

**Name of Test**: Radiated Spurious Emissions
**Specification**: 15.247(d), 15.209(a), 15.205
**Spec. Limit**: See Table
**Test Equipment Utilized** i00103, i00331 **Test Date: 5/02/2008**

## Test Procedure

The UUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the UUT met the requirements for Radiated Spurious Emissions. The antenna and cable correction factors were summed with the amplifier gain and input into the spectrum analyzer as an offset to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

## Test Setup




| Detector Settings | RBW | VBW | Span |
|---|---|---|---|
| Peak | 1 MHz | 1 MHz | As necessary |
| Average | 1 MHz | 1 MHz | As necessary |

## Radiated Spurious Emissions

| Tuned Freq (MHz) | Emission Freq (MHz) | Peak Monitored Level (dBuV/m) | Peak Limit (dBuV/m) | Result |
|---|---|---|---|---|
| 2405 | 4811.1 | 48.66 | 74.0 | Pass |
| 2405 | 7215.0 | 47.29 | 74.0 | Pass |
| 2440 | 4879.1 | 47.46 | 74.0 | Pass |
| 2440 | 7320.0 | 46.91 | 74.0 | Pass |
| 2475 | 4951.1 | 49.81 | 74.0 | Pass |
| 2475 | 7425.9 | 47.98 | 74.0 | Pass |

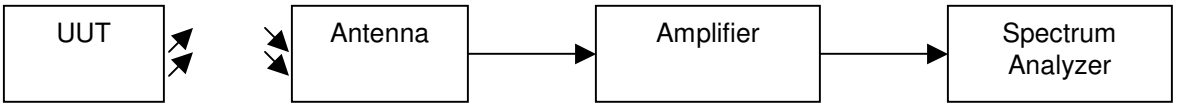
All peak emissions were below the average limit. All emissions were greater than –20 dBc.

**Name of Test**: Emissions At Band Edges
**Specification**: 15.247(d), 15.209(a), 15.205
**Limit**: -20 dBC and for restricted band 54 dBuV average and 74 dBuV peak
**Test Equipment Utilized** i00103, i00331 **Test Date: 5/02/2008**

## Test Procedure

The UUT was tested in a semi-anechoic chamber set 3m from the receiving transducer. A spectrum analyzer was used to verify that the UUT met the requirements for band edge with both peak and average measurements. The cable and transducer correction factors were input into the analyzer as a reference level offset to ensure accurate readings were obtained.

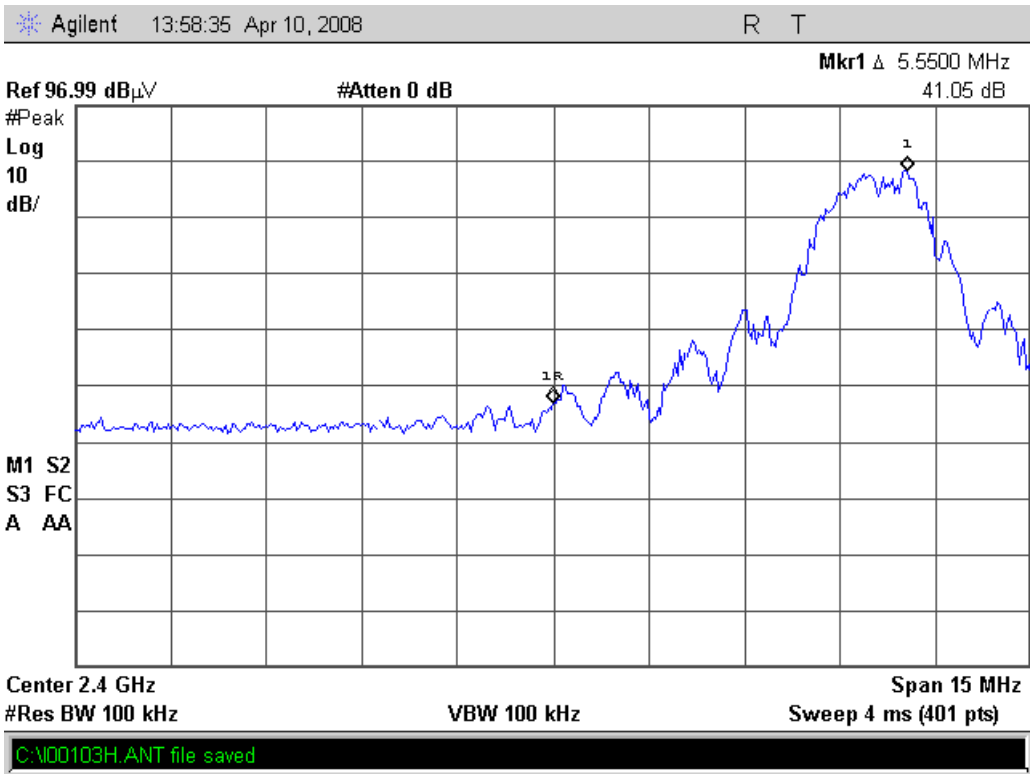
## Test Setup



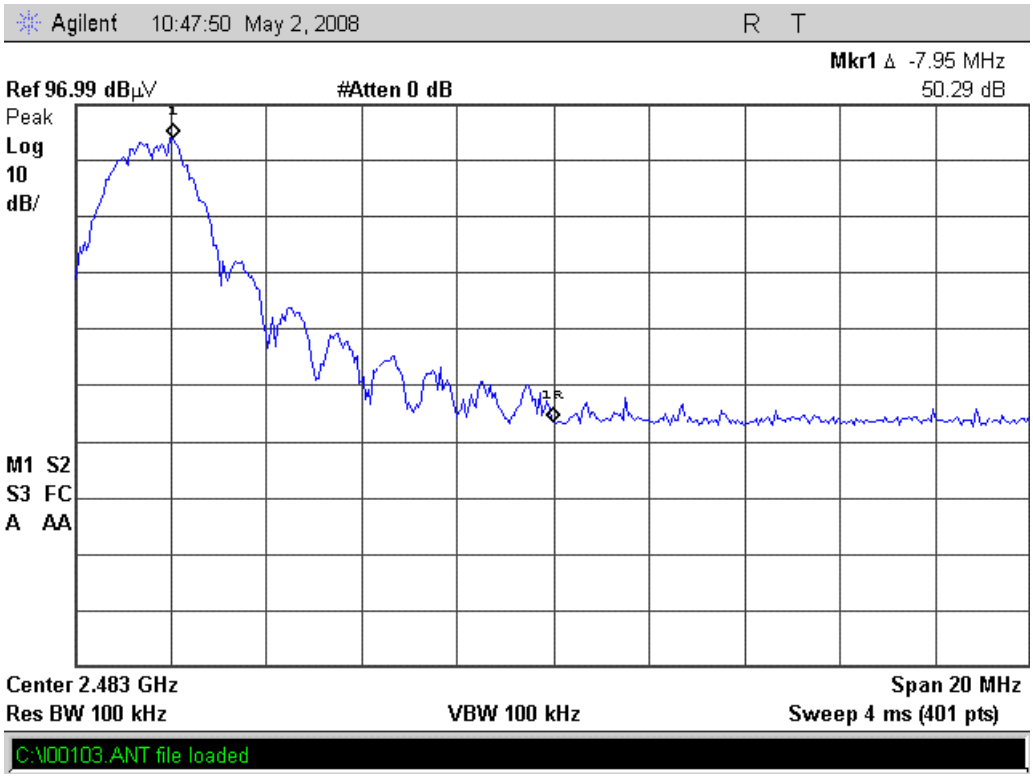

## Band Edge Emissions Summary

| Tuned Freq (MHz) | Emission Freq (MHz) | Monitored Level (-dBc) | Detector | Limit | Result |
|---|---|---|---|---|---|
| 2405 | 2400.0 | -41.05 | Peak | -20 dBc | Pass |
| 2475 | 2483.5 | -50.29 | Peak | -20 dBc | Pass |

**Band Edge 2400 MHz**



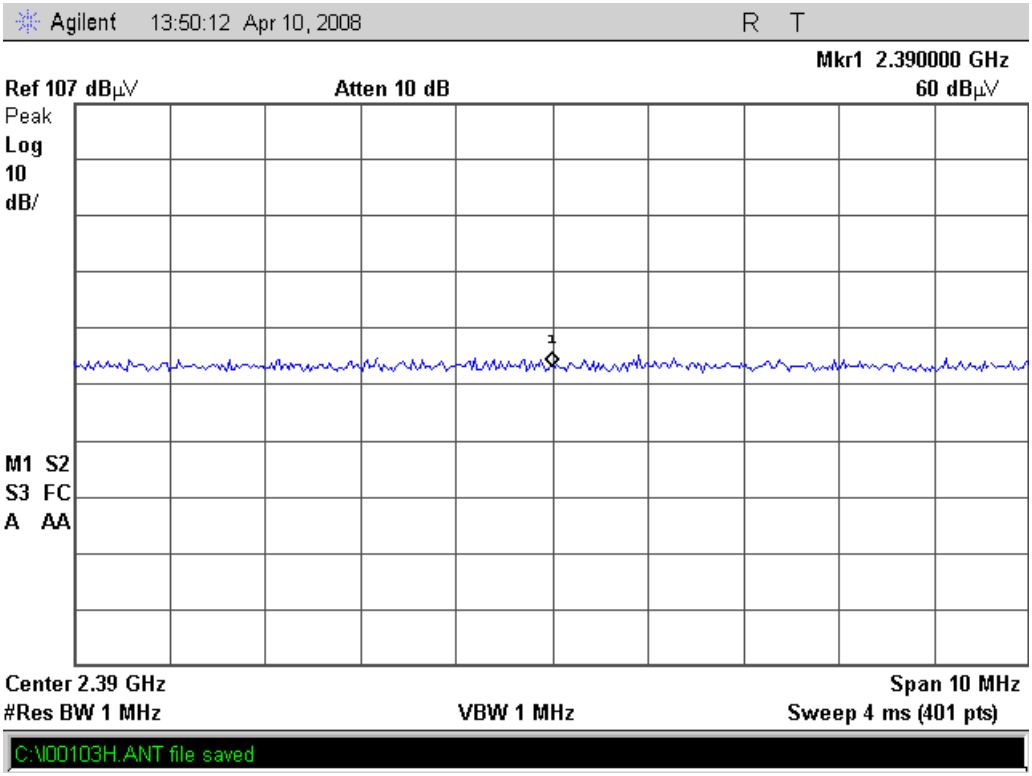

**Band Edge 2483.5 MHz**



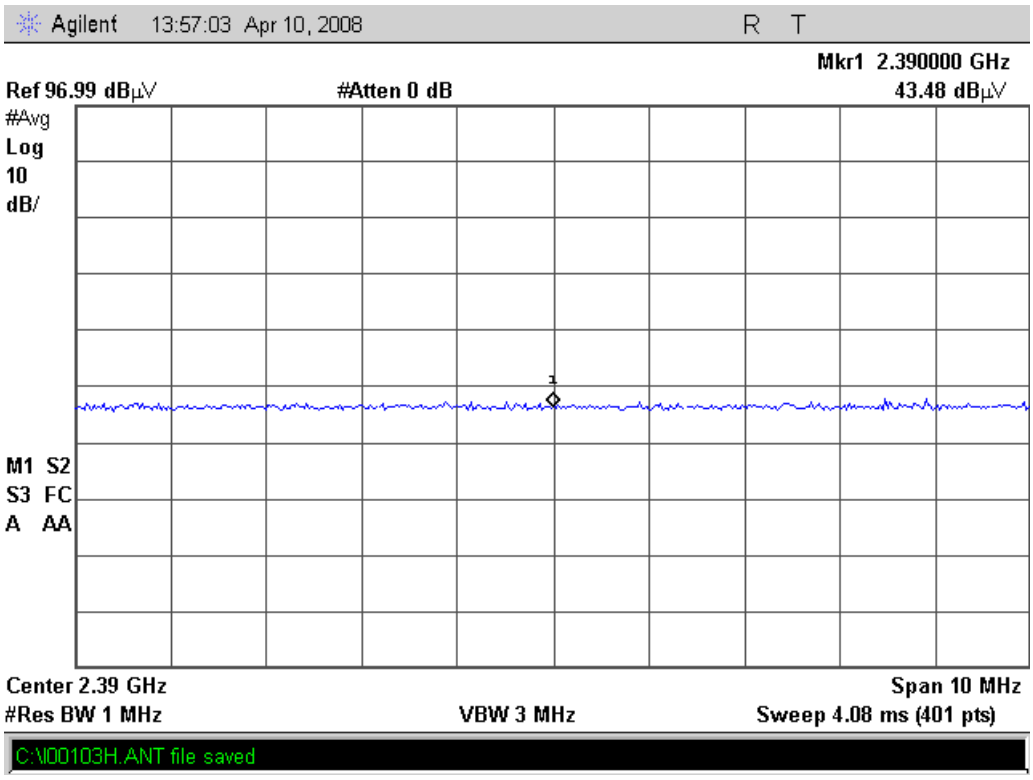
## Restricted Band Emissions Summary

| Tuned Freq (MHz) | Emission Freq (MHz) | Monitored Level (dBuV/m) | Detector | Limit (dBuV/m) | Result |
|---|---|---|---|---|---|
| 2405 | 2390.0 | 60.00 | Peak | 74 | Pass |
| 2405 | 2390.0 | 43.48 | Average | 54 | Pass |
| 2475 | 2483.5 | 52.70 | Peak | 74 | Pass |
| 2475 | 2483.5 | 48.16 | Average | 54 | Pass |

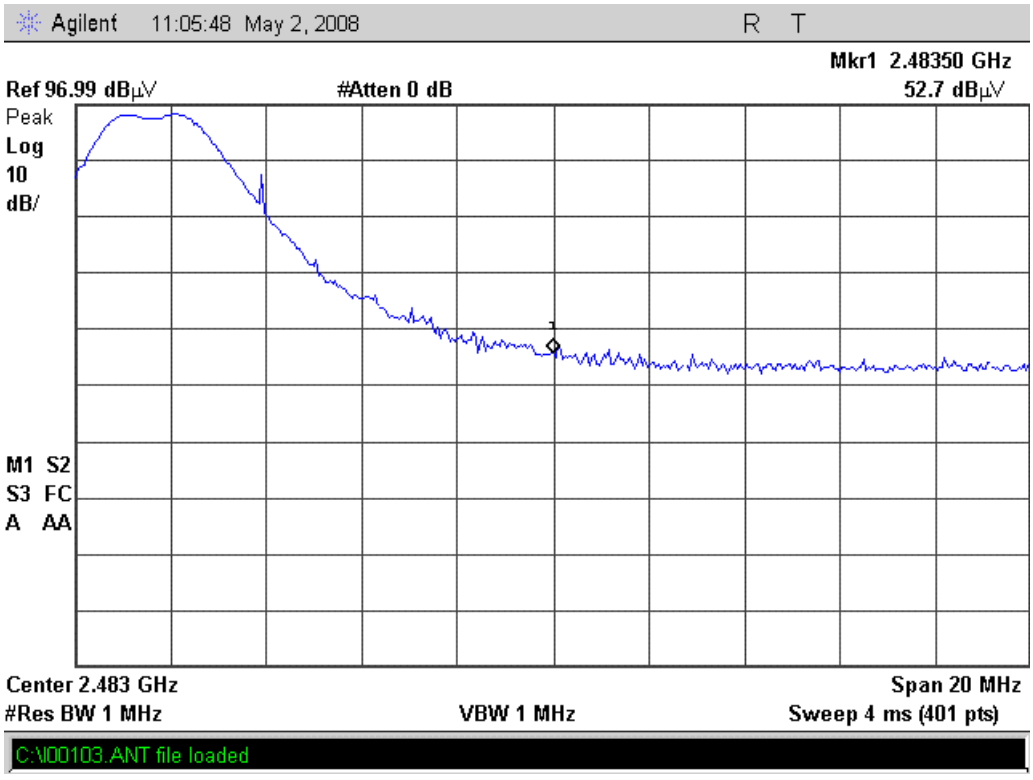
## Restricted Band Peak 2390 MHz



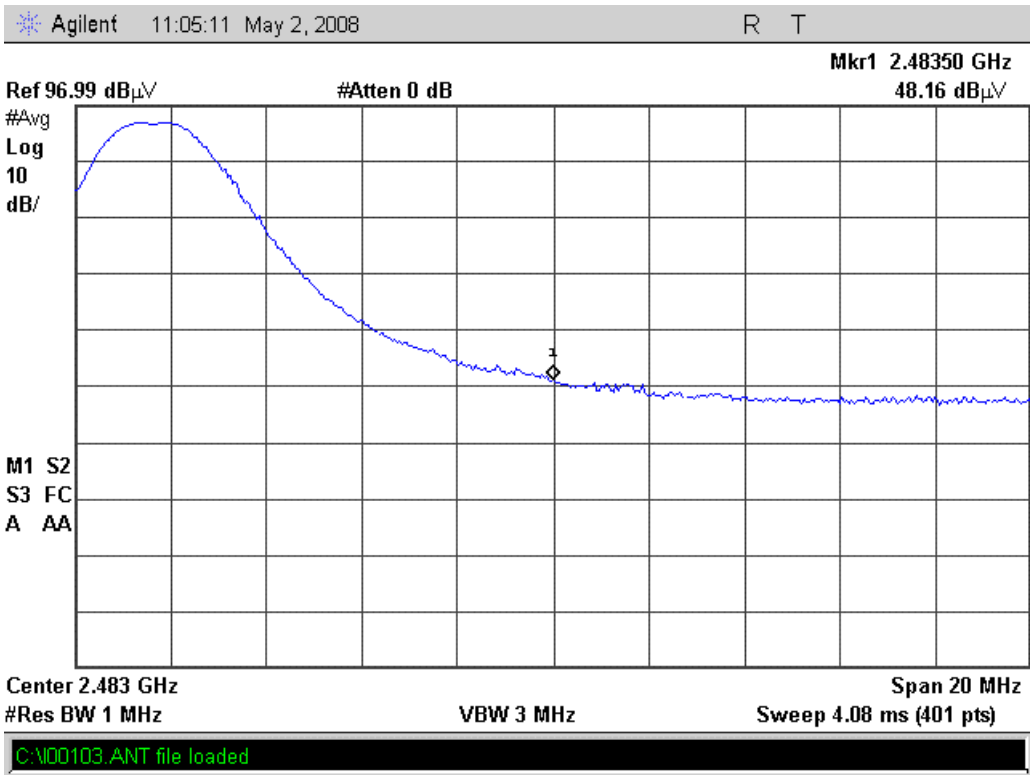
**Restricted Band Average 2390 MHz**




**Restricted Band Peak 2483.5 MHz**



**Restricted Band Average 2483.5 MHz**

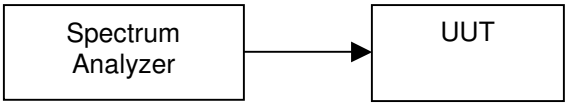


**Name of Test**: Occupied Bandwidth
**Specification**: 15.247(a)
**Test Equipment Utilized** i00331 **Test Date: 5/02/2008**

## Test Procedure

The UUT was connected directly to a spectrum analyzer. The Span was set wide enough to capture the entire transmit spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured the 20dB and 99% bandwidths were measured to verify the bandwidth met the specification.

## Test Setup



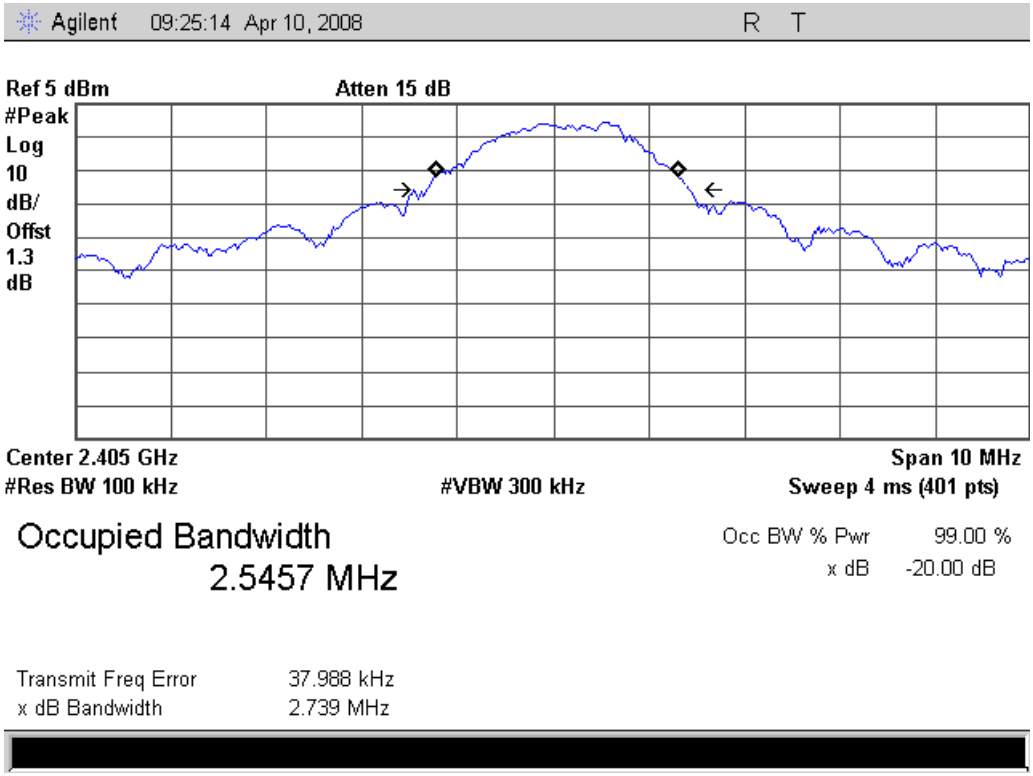

**-20 dB Bandwidth Summary**

| Frequency MHz | Recorded Measurement | Specification Limit | Result |
|---|---|---|---|
| 2405 | 2.739 MHz | ≥ 500 kHz | Pass |
| 2440 | 2.923 MHz | ≥ 500 kHz | Pass |
| 2475 | 2.945 MHz | ≥ 500 kHz | Pass |

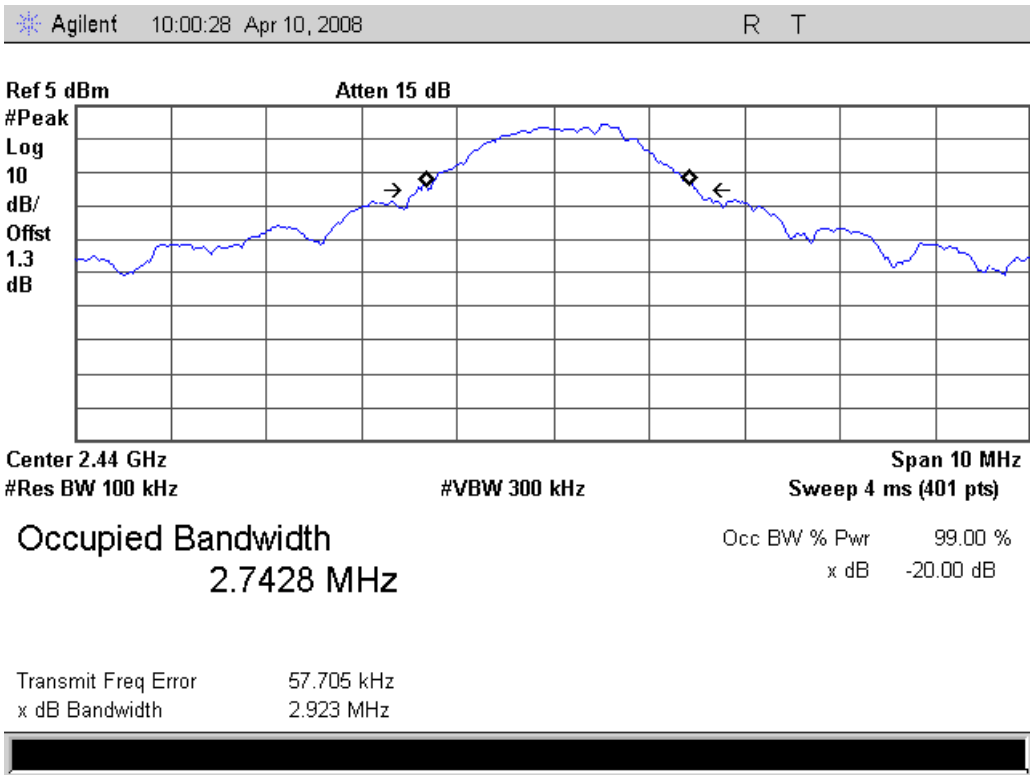
**99% Bandwidth Summary**

| Frequency MHz | Recorded Measurement | Result |
|---|---|---|
| 2405 | 2.5457 MHz | Pass |
| 2440 | 2.7428 MHz | Pass |
| 2475 | 2.8597 MHz | Pass |

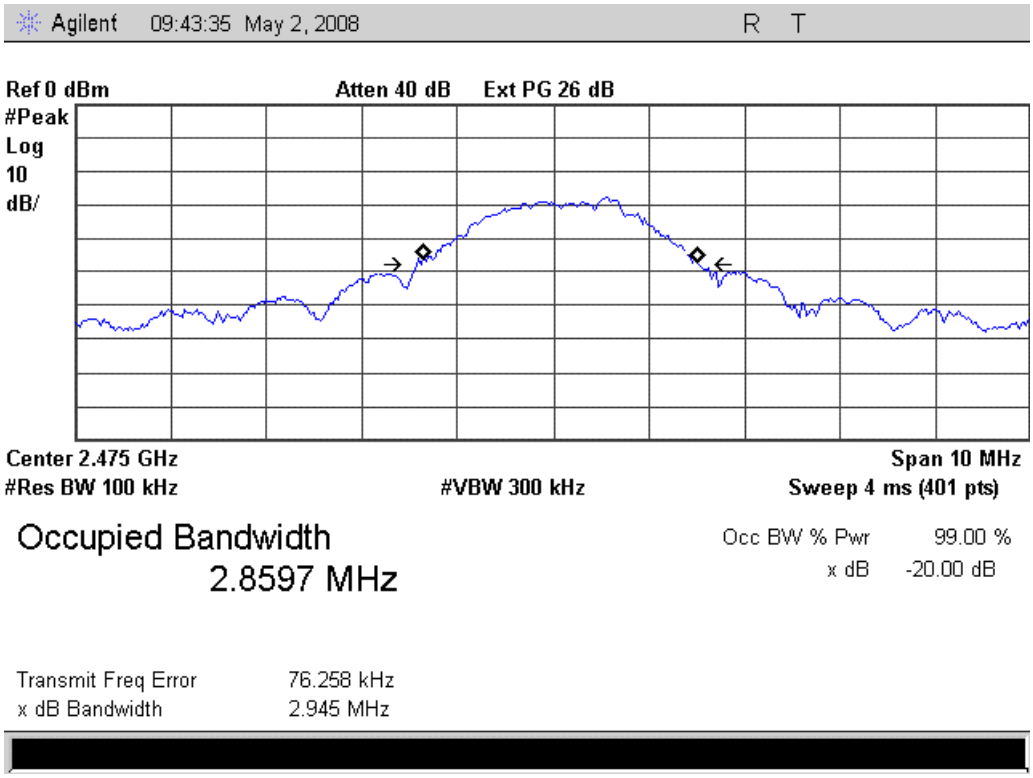
**Bandwidth 2405 MHz**



**Bandwidth 2440 MHz**




**Bandwidth 2475 MHz**

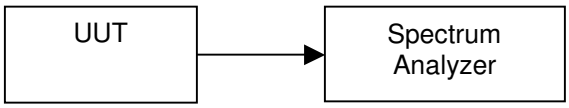


**Name of Test**: Transmitter Power Spectral Density (PSD)
**Specification**: 15.247(e)
**Limit**: 8 dBm in any 3 kHz Bandwidth
**Test Equipment Utilized** i00331 **Test Date: 7/8/2008**

## Test Procedure

The UUT was connected directly to a spectrum analyzer. The Span was set to 1.5 MHz and the resolution bandwidth was set to 3 KHz. The analyzer was set for a sweep time of 500 seconds. When the entire spectrum was captured the marker peak function of the analyzer was utilized to verify the PSD met the specification.

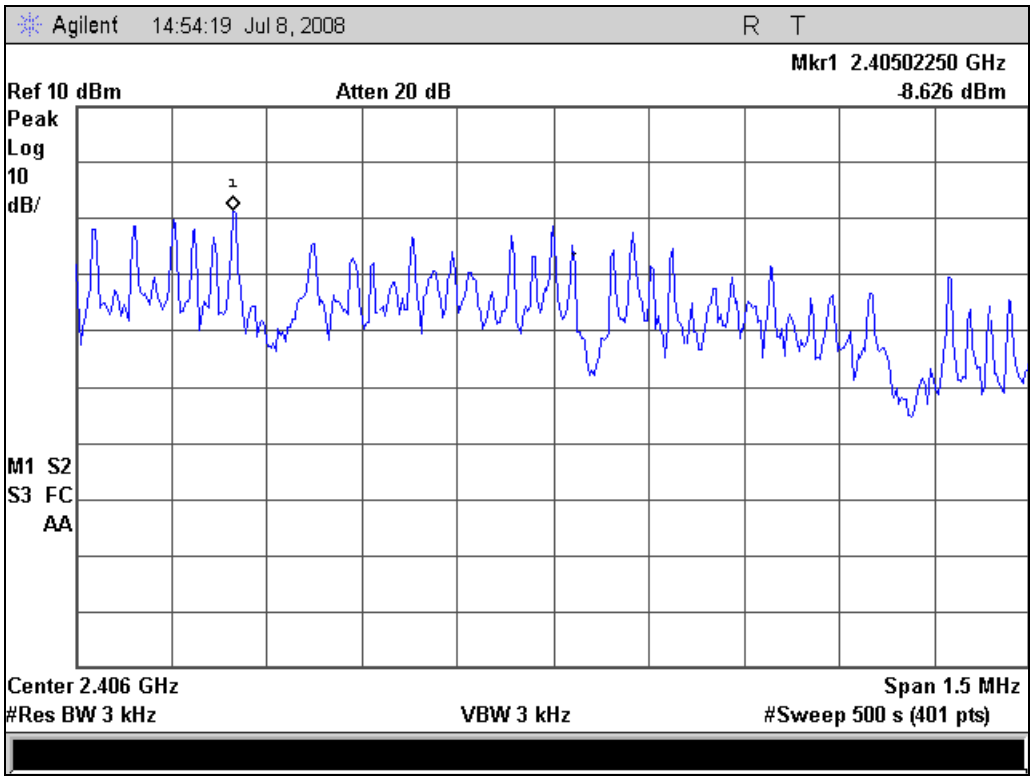
## Test Setup



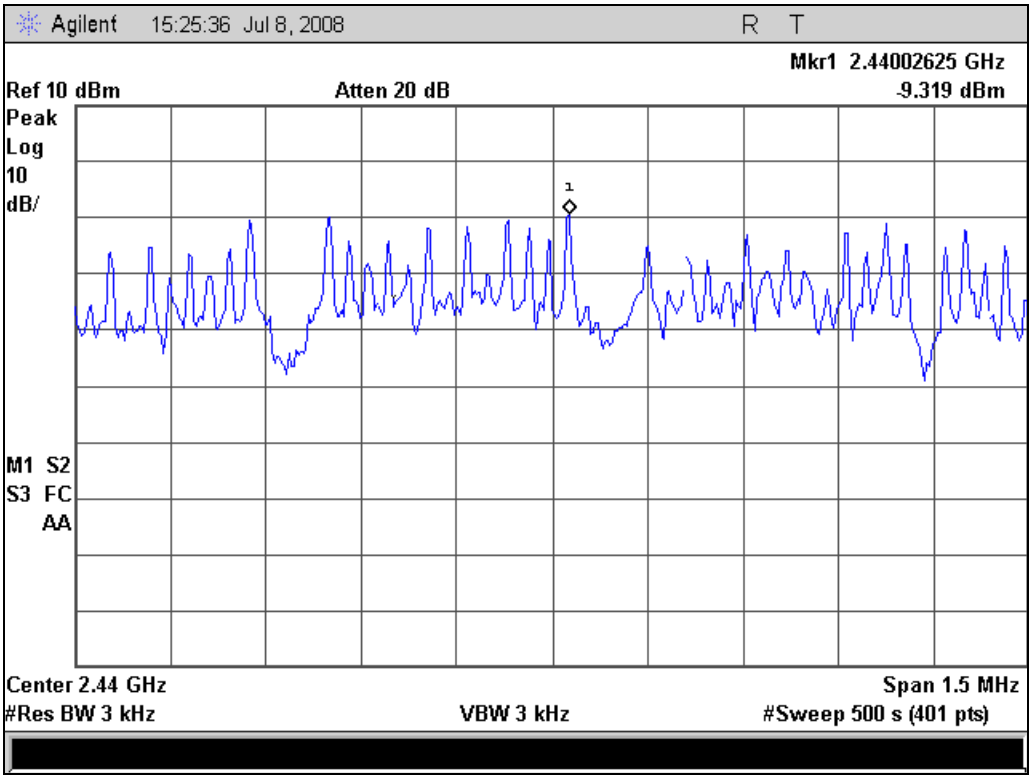

## PSD Summary

| Frequency MHz | Recorded Measurement | Specification Limit | Result |
|---|---|---|---|
| 2405 | -8.626 dBm | 8 dBm | Pass |
| 2440 | -9.319 dBm | 8 dBm | Pass |
| 2475 | -10.04 dBm | 8 dBm | Pass |

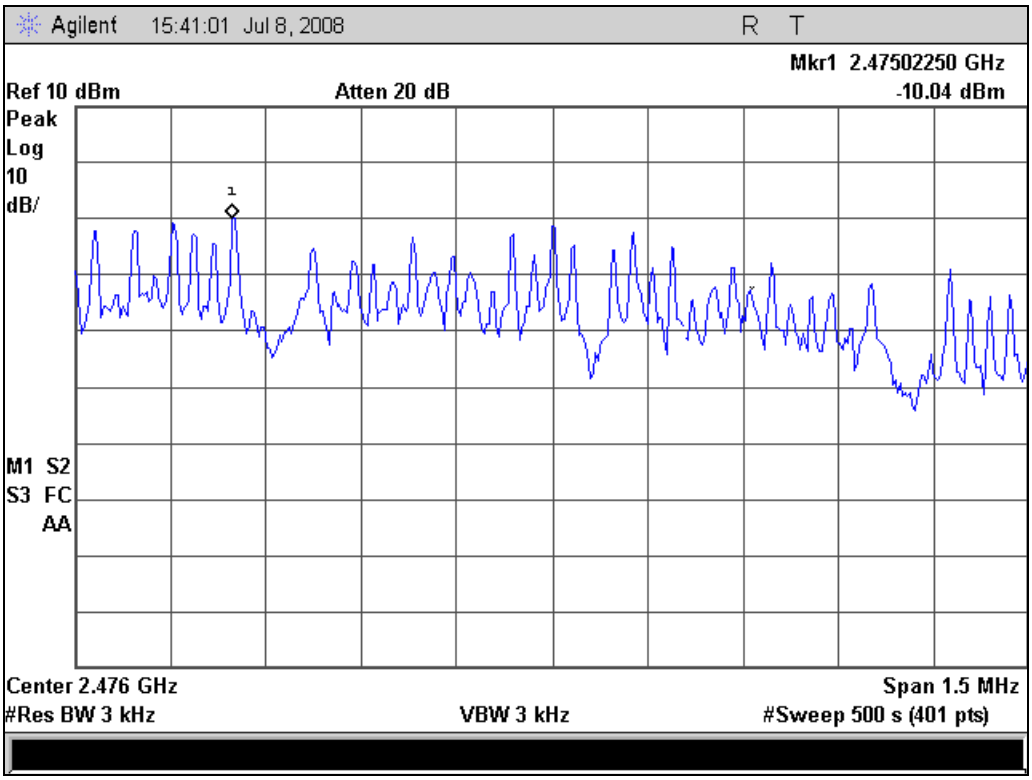
## PSD 2405 MHz



**PSD 2440 MHz**




**PSD 2475 MHz**

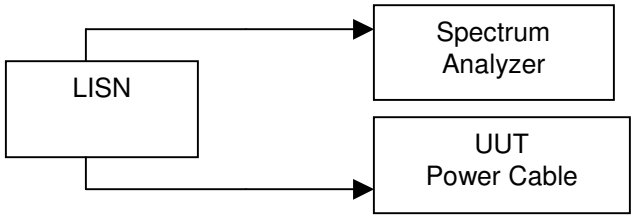


**Name of Test**: A/C Powerline Conducted Emissions
**Specification**: 15.207
**Test Equipment Utilized** i00033, i00270 **Test Date: 5/02/2008**

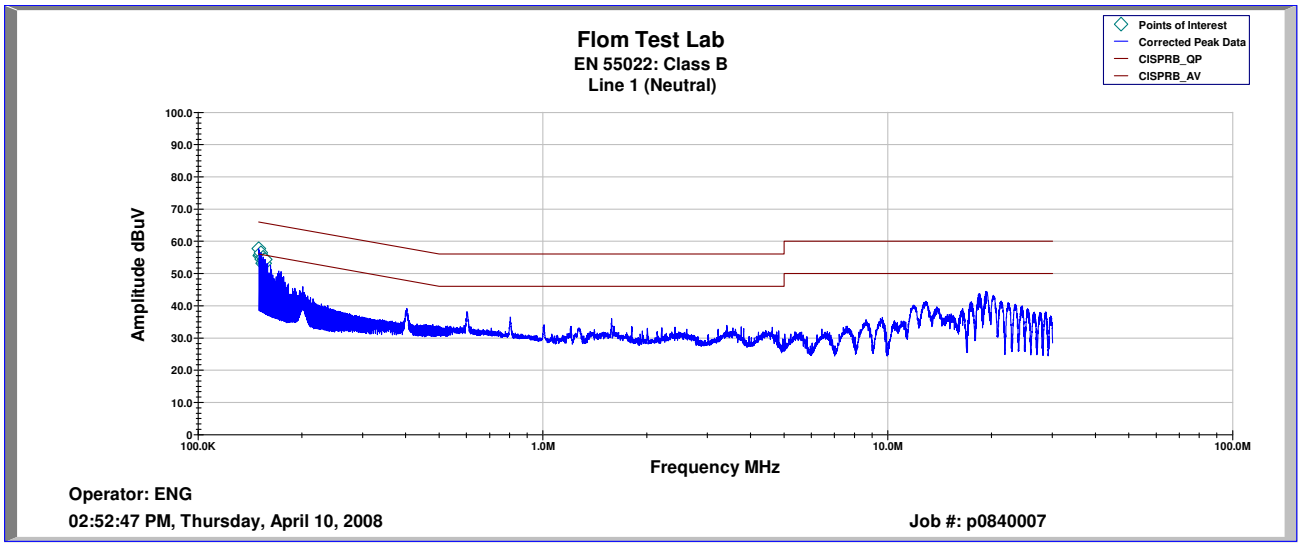
## Test Procedure

The UUT power cable connected to a LISN and the monitored output of the LISN was connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were monitored and compared to the specification limits. All peak emissions were below the quasi-peak limit.

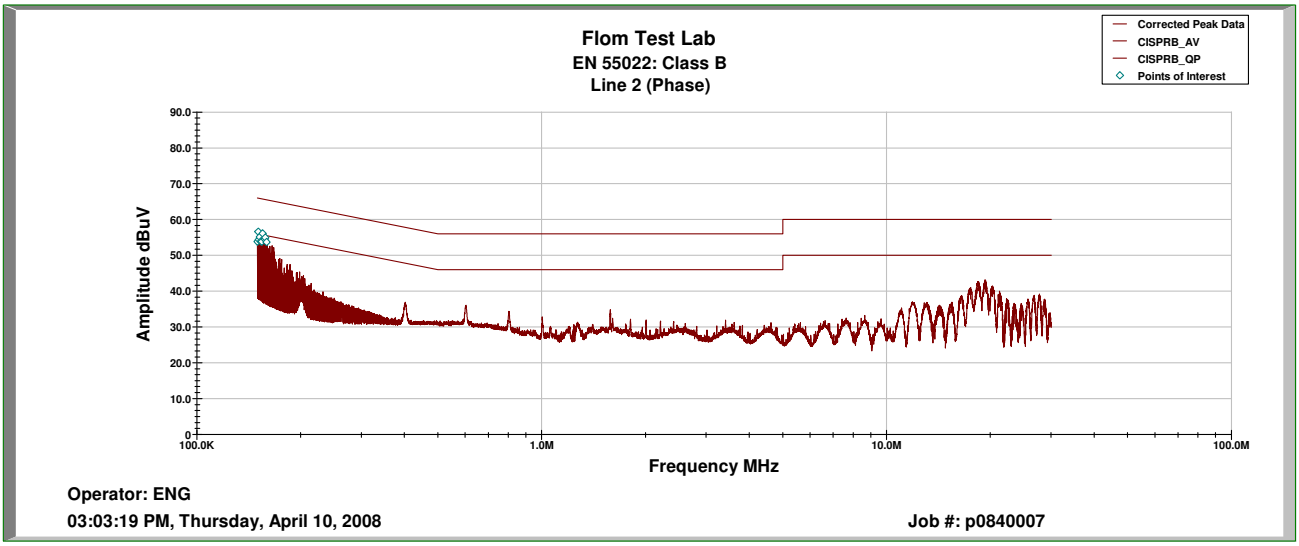
## Test Setup




## Line 1 Test Results




## Line 2 Test Results



**Test Equipment Utilized**

| Description | MFG | Model Number | FTL Asset Number | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| Spectrum Analyzer | HP | 85462A | i00033 | 10/1//2007 | 10/1//2008 |
| Horn Antenna | EMCO | 3115 | i00103 | 9/5/06 | 9/5/08 |
| Power Meter | HP | E4418B | i00228 | 9/6/07 | 9/6/08 |
| LISN | FCC | FCC-LISN-50-32-2-01 | i00270 | 10/22/2007 | 10/22/2009 |
| Power sensor | HP | 8481A | i00317 | 9/6/07 | 9/6/08 |
| Spectrum Analyzer | HP | E4407B | i00331 | 10/23/07 | 10/23/08 |

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT