

Test of Sensus Metering Systems Navicomm Series

To: FCC 47 CFR Part 15, SubPart B and Radio  
Collocation

Test Report Serial No.: SNUS11-U2 Rev B



# TEST REPORT

From



**Test of:** Sensus Metering Systems Navicomm

**To:** FCC 47 CFR Part 15, SubPart B and Radio Collocation

**Test Report Serial No.:** SNUS11-U2 Rev B

This report supersedes: None

**Applicant:** Sensus Metering Systems  
8609 Six Forks Rd 3rd Floor  
Raleigh, NC 27615  
USA

**Product Function:** Remote telemetry device

**Copy No:** pdf      **Issue Date:** 4th January 2011

**This Test Report is Issued Under the Authority of;**

**MiCOM Labs, Inc.**

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TESTING CERTIFICATE #2381.01

**MiCOM Labs is an ISO 17025 Accredited Testing Laboratory**



**Title:** Sensus Metering Systems Navicomm  
**To:** FCC 47 CFR Part 15 & Radio Collocation  
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## 1 ACCREDITATION, LISTINGS & RECOGNITION

### 1.1 TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) [www.a2la.org](http://www.a2la.org) test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-01.pdf>



The American Association for Laboratory Accreditation

World Class Accreditation

## Accredited Laboratory

A2LA has accredited

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*Pleasanton, CA*

for technical competence in the field of

**Electrical Testing**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 14<sup>th</sup> day of April 2010.

President & CEO  
For the Accreditation Council  
Certificate Number 2381.01  
Valid to November 30, 2011

*For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.*

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## 1.2 RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA\*\* countries. Our test reports are widely accepted for global type approvals.

| Country   | Recognition Body                                                                                 | Status | Phase      | Identification No. |
|-----------|--------------------------------------------------------------------------------------------------|--------|------------|--------------------|
| USA       | Federal Communications Commission (FCC)                                                          | TCB    | -          | Listing #: 102167  |
| Canada    | Industry Canada (IC)                                                                             | FCB    | APEC MRA 2 | Listing #: 4143A   |
| Japan     | VCCI                                                                                             | -      | -          | No. 2959           |
| Australia | Australian Communications and Media Authority (ACMA)                                             | CAB    | APEC MRA 1 |                    |
| Hong Kong | Office of the Telecommunication Authority (OFTA)                                                 | CAB    | APEC MRA 1 |                    |
| Korea     | Ministry of Information and Communication Radio Research Laboratory (RRL)                        | CAB    | APEC MRA 1 |                    |
| Singapore | Infocomm Development Authority (IDA)                                                             | CAB    | APEC MRA 1 |                    |
| Taiwan    | National Communications Commission (NCC)<br>Bureau of Standards, Metrology and Inspection (BSMI) | CAB    | APEC MRA 1 |                    |
| Vietnam   | Ministry of Communication (MIC)                                                                  | CAB    | APEC MRA 1 |                    |

\*\*APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.  
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.

Phase I - recognition for product testing

Phase II – recognition for both product testing and certification

N/A – Not Applicable

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### 1.3 PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC Guide 65. The company is accredited by the American Association for Laboratory Accreditation (A2LA) [www.a2la.org](http://www.a2la.org) test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-02.pdf>



*The American Association for Laboratory Accreditation*

*World Class Accreditation*

## *Accredited Product Certification Body*

A2LA has accredited

**MICOM LABS**

*Pleasanton, CA*

for technical competence as a

**Product Certification Body**

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC Guide 65:1996 *General requirements for bodies operating product certification systems*. This accreditation demonstrates technical competence for a defined scope and the operation of a quality management system for a Telecommunications Certification Body (TCB) meeting FCC (U.S.), and IC (Canada) requirements.



Presented this 24<sup>th</sup> day of June 2010.

President & CEO  
For the Accreditation Council  
Certificate Number 2381.02  
Valid to November 30, 2011

*For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.*

### **United States of America – Telecommunication Certification Body**

TCB Identifier – US0159

### **Industry Canada – Certification Body**

CAB Identifier – US0159

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## 2 DOCUMENT HISTORY

| Document History |                              |                     |
|------------------|------------------------------|---------------------|
| Revision         | Date                         | Comments            |
| Draft            |                              |                     |
| Rev A            | 4 <sup>th</sup> January 2011 | Initial Release     |
| Rev B            | 4 <sup>th</sup> January 2011 | Correction of typo. |
|                  |                              |                     |

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### 3 TEST RESULT CERTIFICATE

|                 |                                                                                    |            |                                                                                            |
|-----------------|------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------------|
| Applicant:      | Sensus Metering Systems<br>8609 Six Forks Rd 3rd Floor<br>Raleigh<br>NC 27615, USA | Tested By: | MiCOM Labs, Inc.<br>440 Boulder Court<br>Suite 200<br>Pleasanton<br>California, 94566, USA |
| Product:        | Navicomm Series                                                                    | Telephone: | +1 925 462 0304                                                                            |
| Model No.:      | NaviComm-GSM/GPRS-G2<br>NaviComm-GSM/GPRS-F4<br>NaviComm-FLX-900                   | Fax:       | +1 925 462 0306                                                                            |
| S/No's:         | N/A - Engineering Samples                                                          |            |                                                                                            |
| Date(s) Tested: | 9/21/2010 - 9/23/2010                                                              | Website:   | www.micomlabs.com                                                                          |

| STANDARD(S)                                      | TEST RESULTS       |
|--------------------------------------------------|--------------------|
| FCC 47 CFR Part 15 Subpart B + radio collocation | EQUIPMENT COMPLIES |

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

#### Notes:

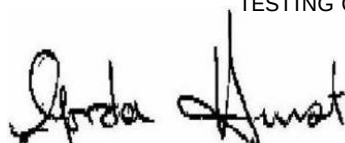
1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:



TESTING CERTIFICATE #2381.01

  
\_\_\_\_\_  
Graeme Grieve  
Quality Manager MiCOM Labs, Inc.

  
\_\_\_\_\_  
Gordon Hurst  
President & CEO MiCOM Labs, Inc.

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## 4 REFERENCES AND MEASUREMENT UNCERTAINTY

### 4.1 Normative References

| Ref.  | Publication         | Year                      | Title                                                                                                                                                                |
|-------|---------------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i.    | 47 CFR Part 15      | 2009                      | Code of Federal Regulations, Title 47, Part 15 (47 CFR 15)                                                                                                           |
| ii.   | 47 CFR Part 22H     | 2009                      | PART 22--PUBLIC MOBILE SERVICES                                                                                                                                      |
| iii.  | 47 CFR Part 24E     | 2009                      | PART 24--PERSONAL COMMUNICATIONS SERVICES                                                                                                                            |
| iv.   | FCC 47 CFR Part 90  | 2009                      | Code of Federal Regulations; Part 90                                                                                                                                 |
| v.    | FCC 47 CFR Part 101 | 2009                      | Code of Federal Regulations; Part 101                                                                                                                                |
| vi.   | ANSI C63.4          | 2009                      | American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| vii.  | CISPR 22/ EN 55022  | 2008<br>2006+A1:2007      | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment                                                          |
| viii. | M 3003              | Edition 1 Dec. 1997       | Expression of Uncertainty and Confidence in Measurements                                                                                                             |
| ix.   | LAB34               | Edition 1 Aug 2002        | The expression of uncertainty in EMC Testing                                                                                                                         |
| x.    | ETSI TR 100 028     | 2001                      | Parts 1 and 2<br>Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics          |
| xi.   | A2LA                | 9 <sup>TH</sup> June 2010 | Reference to A2LA Accreditation Status – A2LA Advertising Policy                                                                                                     |



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## **4.2 Test and Uncertainty Procedures**

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

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## 5 TEST SUMMARY

**List of Measurements:** The following table represents the list of measurements required under FCC 47 CFR Part 15, SubPart 15.247

| Standard Section(s) | Test Description                                                    | Condition | Result    | Test Report Section |
|---------------------|---------------------------------------------------------------------|-----------|-----------|---------------------|
| 15.205, 15.210      | Radiated (Digital) Emissions                                        | Radiated  | Compliant | 7.1                 |
| 15.207              | AC Wireline Emissions 0.15 – 30 MHz                                 | Conducted | Compliant | 7.2                 |
| (d), 15.205, 15.209 | Transmitter Radiated Spurious Emissions; Colocation F4 radio module | Radiated  | Compliant | 7.3.1               |
| (d), 15.205, 15.209 | Transmitter Radiated Spurious Emissions; Colocation G2 radio module | Radiated  | Compliant | 7.3.2               |
| (d), 15.205, 15.209 | Transmitter Radiated Spurious Emissions; Colocation G2 radio module | Radiated  | Compliant | 7.3.4               |

Note 1: Test results reported in this document relate only to the items tested

Note 2: The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria

Note 3: Section 6.8 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix



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## **6 PRODUCT DETAILS AND TEST CONFIGURATIONS**

### **6.1 Test Program Scope**

The purpose of this test report is to show compliance of the Sensus Metering Systems Navicomm series of devices with FCC Class B emissions and Radio collocation requirements.

The Navicomm series of devices uses the Horstmann 2.4 GHz Smart Controller FCC ID: YQVHHH002 in colocation with one of the following devices:

MultiTech 900/1800 MHz (G2) device; FCC ID: AU792U09D24824  
MultiTech 900/1800 MHz (F4) device; FCC ID: AU792U07A31817  
Sensus Model U905458B; Flexnet 900; FCC ID: SDBDAFLX;

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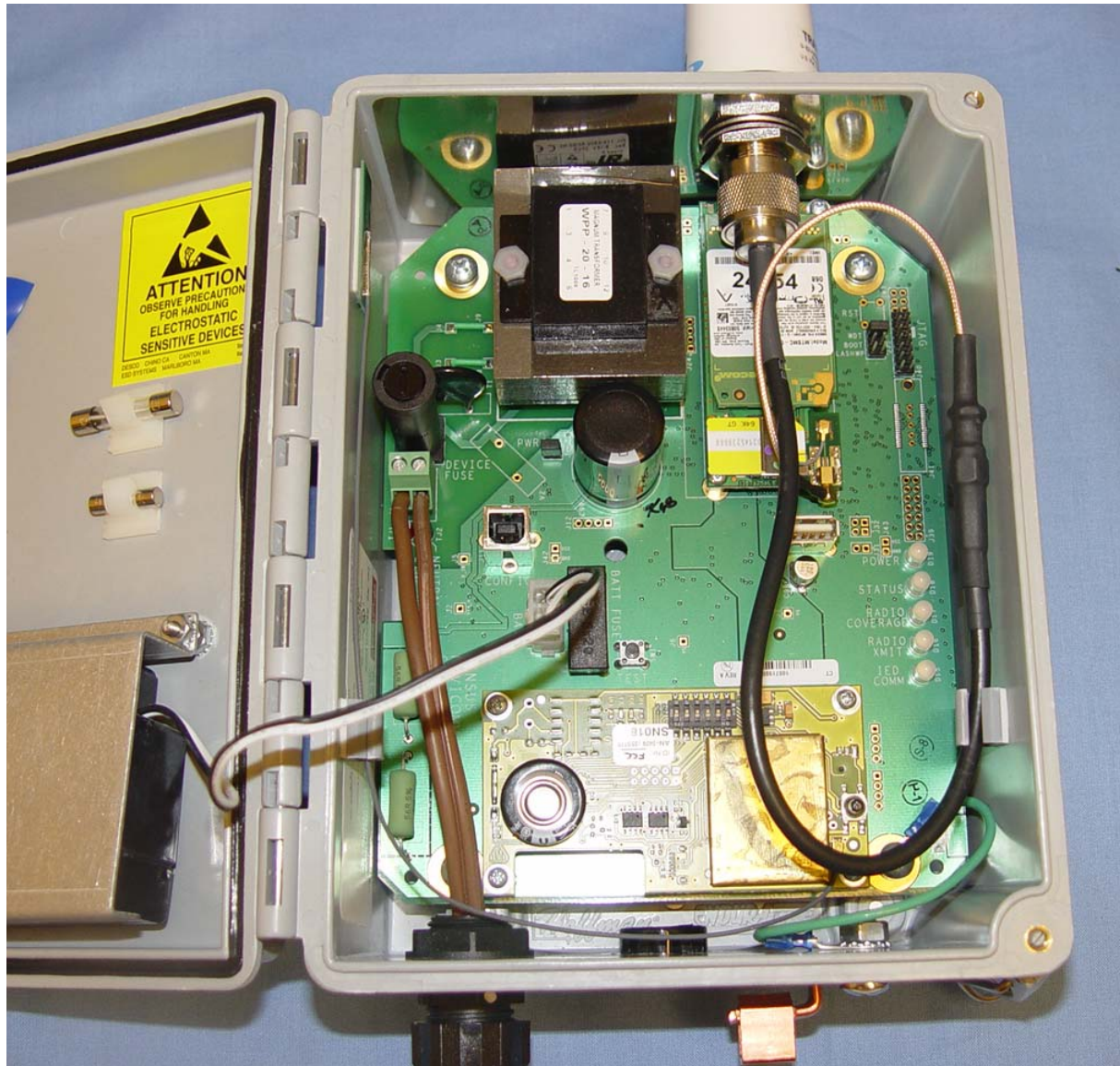
**APPLICANT:** Sensus Metering Systems **PRODUCT:** Navicomm



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**Internal Photograph of Navicomm showing location of Radio and Antennas.**



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## 6.2 EUT Details

| Detail                              | Description                                                                                                                                                                   |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Purpose:                            | The purpose of this test report is to show compliance of the Sensus Metering Systems Navicomm series of devices with FCC Class B emissions and Radio collocation requirements |
| Applicant:                          | Sensus Metering Systems<br>8609 Six Forks Rd 3rd Floor<br>Raleigh, NC 27615<br>USA                                                                                            |
| Manufacturer:                       | Same as applicant                                                                                                                                                             |
| Test Laboratory:                    | MiCOM Labs, Inc.<br>440 Boulder Court, Suite 200<br>Pleasanton, California 94566 USA                                                                                          |
| Test report reference number:       | SNUS11                                                                                                                                                                        |
| Date EUT received:                  | 20th September 2010                                                                                                                                                           |
| Dates of test (from - to):          | 21st to 23rd September 2010                                                                                                                                                   |
| No of Units Tested:                 | 2                                                                                                                                                                             |
| Product Name:                       | Navicomm                                                                                                                                                                      |
| Manufacturers Trade Name:           | Sensus                                                                                                                                                                        |
| Model No.:                          | NaviComm-GSM/GPRS-G2<br>NaviComm-GSM/GPRS-F4<br>NaviComm-FLX-900                                                                                                              |
| Equipment Primary Function:         | Remote Faulted Circuit Indicator                                                                                                                                              |
| Equipment Secondary Function(s):    | N/A                                                                                                                                                                           |
| Installation type:                  | Fixed                                                                                                                                                                         |
| Construction/Location for Use:      | Outdoor only                                                                                                                                                                  |
| Software/Firmware Release:          | 1.6.697                                                                                                                                                                       |
| Hardware Release:                   | REV A                                                                                                                                                                         |
| Test Software Release:              | Engineering release                                                                                                                                                           |
| Rated Input Voltage and Current AC: | 120VAC +/-10% (108VAC-132VAC), 0.1A                                                                                                                                           |
| Operating Frequency:                | 60Hz +/- 0.5%                                                                                                                                                                 |
| Rated Input Voltage and Current DC: | No DC option for normal operation                                                                                                                                             |
| Operating Temperature Range °C:     | -30C to +70C                                                                                                                                                                  |
| Long Term Frequency Stability:      | 20 p.p.m.                                                                                                                                                                     |
| Equipment Dimensions:               | 6" x 4" x 8"                                                                                                                                                                  |
| Weight:                             | 5lbs                                                                                                                                                                          |

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### 6.3 External A.C/D.C Power Adaptor

No AC/DC adaptor used with this device.

### 6.4 Antenna Details

The following is a description of the EUT antennas.

| Antenna Type:    | Manufacturer | Model                    | Gain (dBi) | Frequency Range (MHz) |
|------------------|--------------|--------------------------|------------|-----------------------|
| GSM/GPRS Antenna | Laird        | TRA821/18503P            | 3          | 821/1850              |
| 900 Antenna      | Laird        | TRAB8903NP               | 3          | 821/1850              |
| 2.4GHz Antenna   | Laird        | MAP24064 Mini Nano-blade | 2.5        | 2400-2483.5           |

### 6.5 Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

| Type of I/O Ports | Description                       | Screened (y/n) | Description | Qty | Tested |
|-------------------|-----------------------------------|----------------|-------------|-----|--------|
| AC Mains          | Connection to public AC power     | N              | 1m-3m       | 1   | Y      |
| RF                | N-Type connector for GPRS antenna | Y              | < 1m        | 1   | Y      |



## 6.6 Equipment Details

The following is a description of EUT and supporting equipment used during the test program.

| Type (EUT/Support) | Equipment Description                                          | Manufacturer | Model No.      | Serial No (s).            |
|--------------------|----------------------------------------------------------------|--------------|----------------|---------------------------|
| EUT                | Remote Faulted Circuit Indicator                               | Sensus       | Navicomm       | N/A - Engineering Samples |
| Radio Module       | Horstmann 2.4 GHz Smart Controller FCC ID: YQVHHH002           | Horstmann    | AN-0409/050710 | N/A                       |
| Radio Module       | MultiTech 900/1800 MHz (F4) device FCC ID: AU792U07A31817      | MultiTech    | MTSMC-G-F4     | N/A                       |
| Radio Module       | MultiTech 900/1800 MHz (G2) device FCC ID: AU792U09D24824      | MultiTech    | MTSMC-G2       | N/A                       |
| Radio Module       | Sensus FlexNet 900 MHz remote telemetry radio FCC ID: SDBDAFLX | Sensus       | U905458B       | N/A                       |

## 6.7 Test Configurations

| Configuration   | Radio Module 1                                       | Radio Module 2                                            |
|-----------------|------------------------------------------------------|-----------------------------------------------------------|
| Configuration 1 | Horstmann 2.4 GHz Smart Controller FCC ID: YQVHHH002 | MultiTech 900/1800 MHz (F4) device FCC ID: AU792U07A31817 |
| Configuration 2 | Horstmann 2.4 GHz Smart Controller FCC ID: YQVHHH002 | MultiTech 900/1800 MHz (G2) device FCC ID: AU792U09D24824 |
| Configuration 2 | Horstmann 2.4 GHz Smart Controller FCC ID: YQVHHH002 | Sensus 900 MHz remote telemetry radio FCC ID: SDBDAFLX    |

## 6.8 Equipment Modifications

No modifications were required.

## 6.9 Deviations from the Test Standard

Testing was performed as detailed in the response to inquiry to FCC (KDB Tracking Number 663683) concerning collocation testing of modules certified to two (2) different FCC parts.



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## **7 Test Results**

### **7.1 Radiated Spurious Emissions – Digital Apparatus**

#### **Standard Reference**

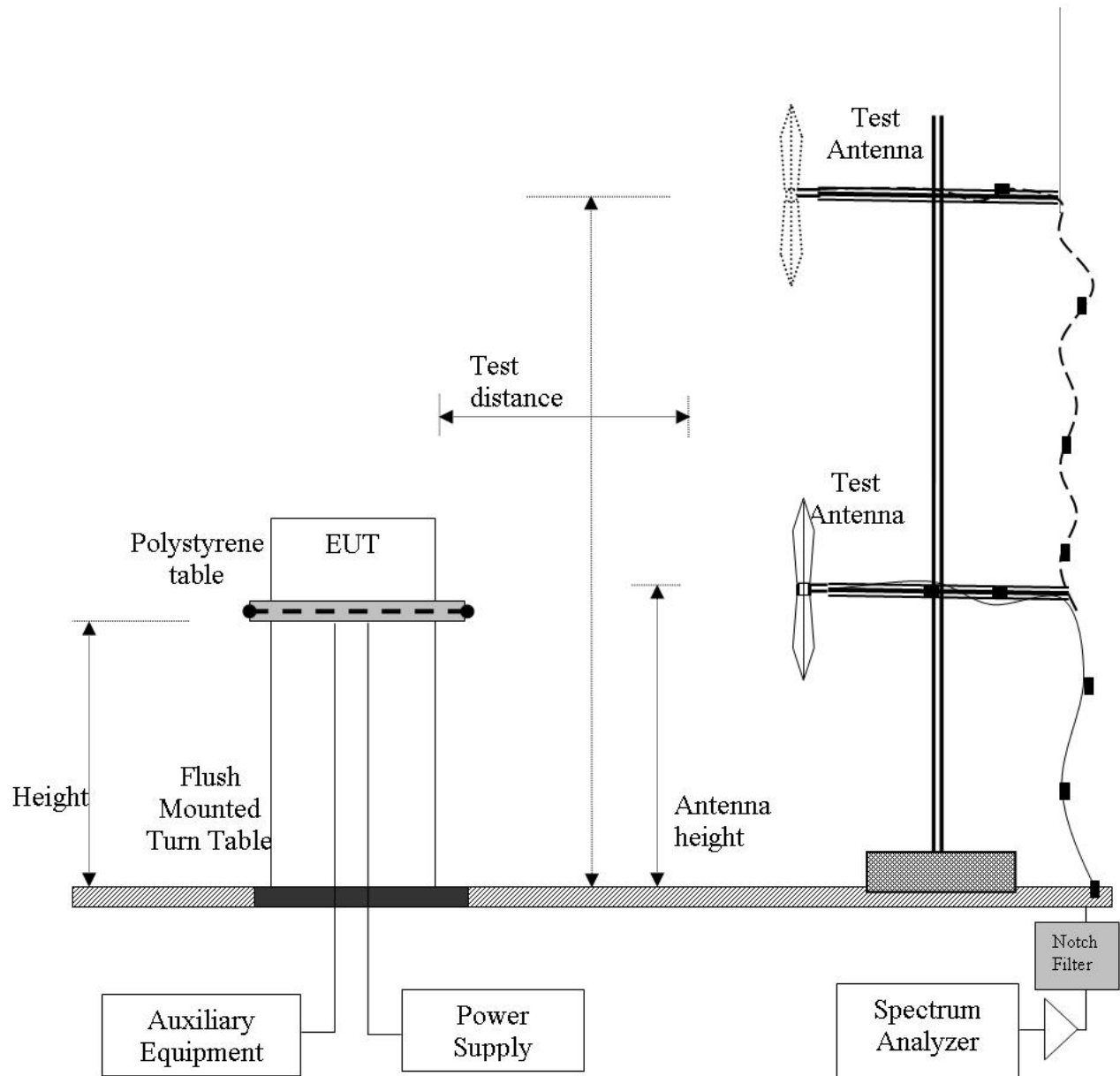
FCC, Part 15 Subpart B §15.109  
Industry Canada ICES-003 §5

#### **Test Procedure**

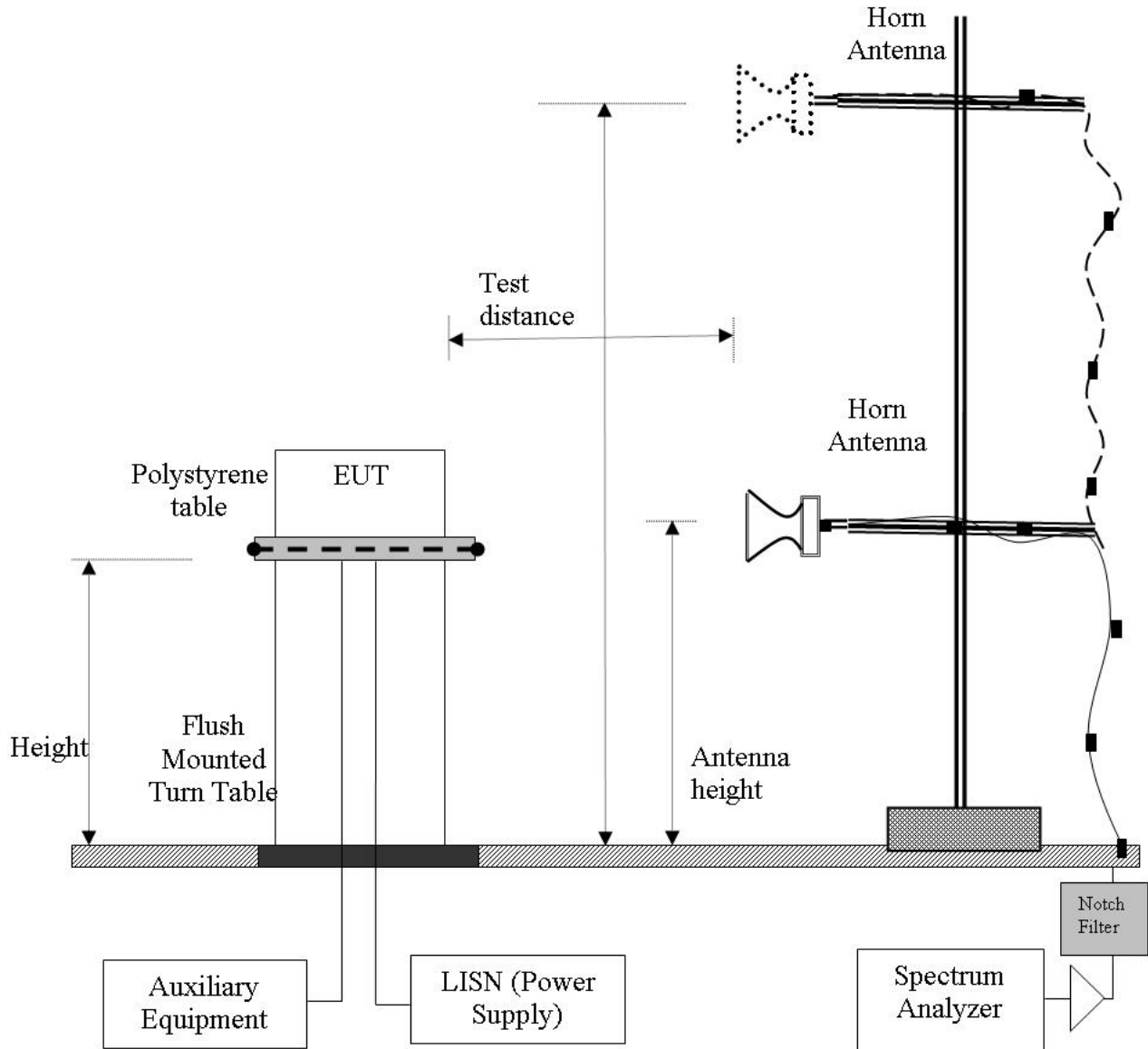
Testing was performed in a 3-meter semi-anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Only the highest emissions relative to the limit are listed.

## Test Measurement Set up



Measurement set up for Radiated Emission Test < 1 GHz



Measurement set up for Radiated Emission Test > 1 GHz



### Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

$$FS = R + AF + CORR - FO$$

FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

$$CORR = \text{Correction Factor} = CL - AG + NFL$$

CL = Cable Loss

AG = Amplifier Gain

FO = Distance Falloff Factor

NFL = Notch Filter Loss or Waveguide Loss

#### Field Strength Calculation Example:

Given receiver input reading of 51.5 dB $\mu$ V; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 \text{ dB}\mu\text{V/m}$$

Conversion between dB $\mu$ V/m (or dB $\mu$ V) and  $\mu$ V/m (or  $\mu$ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (}\mu\text{V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100 \mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250 \mu\text{V/m}$$



## Specification

### Radiated Spurious Emissions – Digital Apparatus

#### FCC, Part 15 Subpart B §15.109

A representative type or model of each digital apparatus shall be tested in accordance with the measurement methods described in FCC Part 15; Subpart A - General and FCC Subpart B – Unintentional Radiators.

#### Industry Canada ICES-003

A representative type or model of each digital apparatus shall be tested in accordance with the measurement method described in the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."].

### FCC, Part 15 Subpart B §15.109 Spurious Emissions Limits

Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values.

| Frequency (MHz) | Field Strength @ 3m<br>( $\mu\text{V/m}$ ) | Measurement<br>Distance (meters) | Field Strength<br>(dB $\mu\text{V/m}$ ) @ 3m |
|-----------------|--------------------------------------------|----------------------------------|----------------------------------------------|
| 30-88           | 100                                        | 3                                | 40.0                                         |
| 88-216          | 150                                        | 3                                | 43.5                                         |
| 216-960         | 200                                        | 3                                | 46.0                                         |
| Above 960       | 500                                        | 3                                | 54.0                                         |

Field Strength of radiated emissions for a Class A digital device are as follows.

| Frequency (MHz) | Field Strength @<br>10m ( $\mu\text{V/m}$ ) | Measurement<br>Distance (meters) | Field Strength<br>(dB $\mu\text{V/m}$ ) @ 3m |
|-----------------|---------------------------------------------|----------------------------------|----------------------------------------------|
| 30-88           | 90                                          | 3                                | 49.5                                         |
| 88-216          | 150                                         | 3                                | 54.0                                         |
| 216-960         | 210                                         | 3                                | 57.0                                         |
| Above 960       | 300                                         | 3                                | 60.0                                         |



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### ICES-003 §5 Spurious Emissions Limits

**Class A Digital Device:** The field intensity of radio noise emissions that are radiated from a Class A digital apparatus shall not exceed the limits specified in Table 5 of the publication referred to in Section 7.1, within the indicated frequency range.

| Frequency range<br>MHz | Quasi-peak limits dB(μV/m) @<br>10m                                       | Quasi-peak limits dB(μV/m) @<br>3m |
|------------------------|---------------------------------------------------------------------------|------------------------------------|
| 30 to 230              | 40                                                                        | 50.5                               |
| 230 to 1 000           | 47                                                                        | 57.5                               |
| Note 1                 | The lower limit shall apply at the transition frequency.                  |                                    |
| Note 2                 | Additional provisions may be required for cases where interference occurs |                                    |

**Class B Digital Device:** The field intensity of radio noise emissions that are radiated from a Class B digital apparatus shall not exceed the limits specified in Table 6 of the publication referred to in Section 7.1, within the indicated frequency range.

| Frequency range<br>MHz | Quasi-peak limits dB(μV/m) @<br>10m                                       | Quasi-peak limits dB(μV/m) @<br>3m |
|------------------------|---------------------------------------------------------------------------|------------------------------------|
| 30 to 230              | 30                                                                        | 40.5                               |
| 230 to 1 000           | 37                                                                        | 47.5                               |
| Note 1                 | The lower limit shall apply at the transition frequency.                  |                                    |
| Note 2                 | Additional provisions may be required for cases where interference occurs |                                    |

### Laboratory Measurement Uncertainty for Spectrum Measurement

|                                |               |
|--------------------------------|---------------|
| <b>Measurement Uncertainty</b> | +5.6/ -4.5 dB |
|--------------------------------|---------------|

### Traceability

| Method                 | Test Equipment Used                            |
|------------------------|------------------------------------------------|
| Work instruction WI-03 | 0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312 |

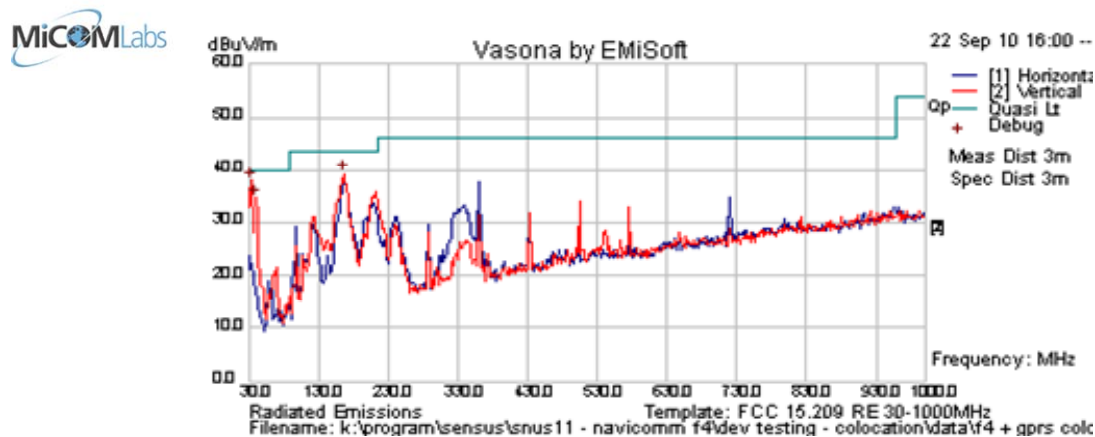
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### 7.1.1 Measurement Results for Radiated Spurious Emissions – Digital Apparatus

|               |                            |                |      |
|---------------|----------------------------|----------------|------|
| Test Freq.    | N/A                        | Engineer       | SB   |
| Variant       | Digital Emissions          | Temp (°C)      | 25.5 |
| Freq. Range   | 30 - 1000 MHz              | Rel. Hum.(%)   | 34   |
| Power Setting | 120V AC 60 Hz              | Press. (mBars) | 1003 |
| Antenna       | Laird and Integral 2.4 GHz |                |      |
| Test Notes 1  |                            |                |      |
| Test Notes 2  |                            |                |      |



#### Formally measured emission peaks

| Frequency MHz                                                                                  | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|------------------------------------------------------------------------------------------------|----------|------------|-------|--------------|------------------|-----|--------|---------|--------------|-----------|------------|----------|
| 34.629                                                                                         | 37.5     | 3.5        | -13.1 | 27.9         | Quasi Max        | V   | 104    | 0       | 40           | -12.1     | Pass       |          |
| 40.922                                                                                         | 44.4     | 3.6        | -17.6 | 30.4         | Quasi Max        | V   | 107    | 290     | 40           | -9.6      | Pass       |          |
| 166.729                                                                                        | 51.6     | 4.6        | -18.8 | 37.3         | Quasi Max        | V   | 98     | 97      | 43.5         | -6.2      | Pass       |          |
| 359.969                                                                                        | 47.3     | 5.5        | -15.1 | 37.6         | Quasi Max        | H   | 106    | 346     | 46           | -8.4      | Pass       |          |
| 431.960                                                                                        | 40.3     | 5.8        | -13.8 | 32.2         | Quasi Max        | V   | 114    | 7       | 46           | -13.8     | Pass       |          |
| 719.943                                                                                        | 36.5     | 6.8        | -9.5  | 33.8         | Quasi Max        | H   | 105    | 170     | 46           | -12.2     | Pass       |          |
| Legend: DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |          |            |       |              |                  |     |        |         |              |           |            |          |
| NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band              |          |            |       |              |                  |     |        |         |              |           |            |          |

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## **7.2 Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)**

### **Standard Reference**

FCC, Part 15 Subpart C §15.107  
Industry Canada ICES-003 §5.3

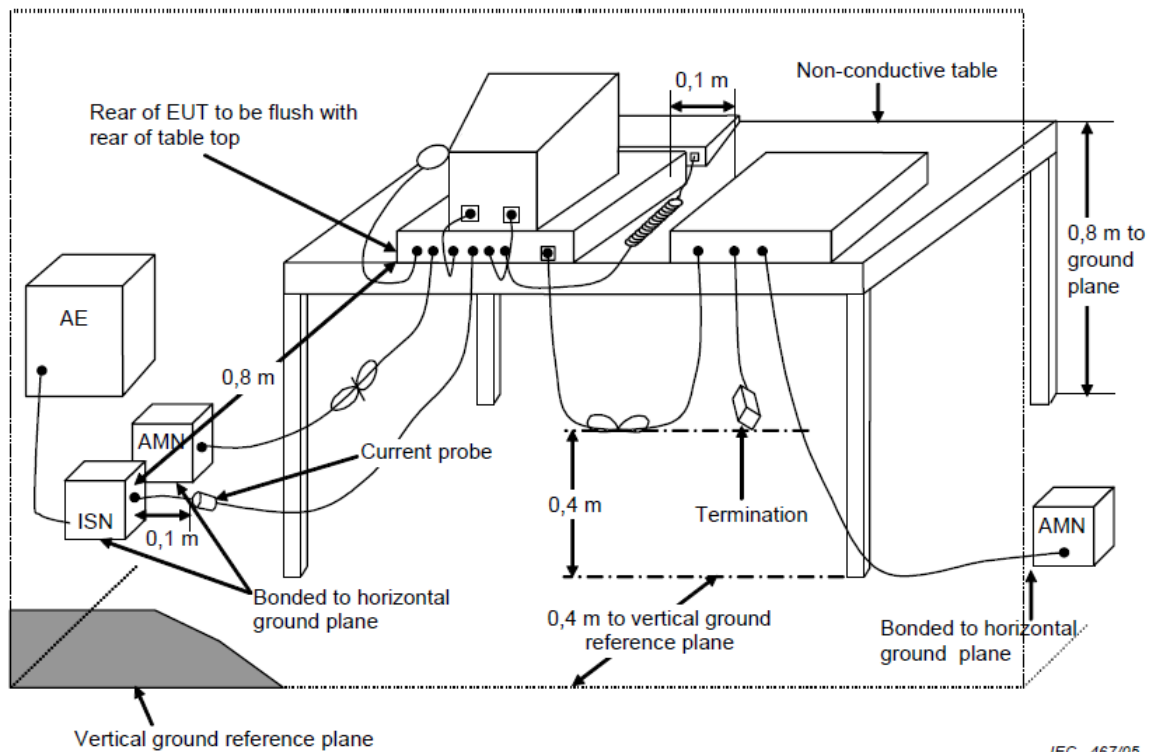
### **Test Procedure**

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

If the reading of the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the higher reading shall be recorded with the exception of any brief isolated high reading which shall be ignored.

## Test Measurement Set up



Measurement set up for Conducted Disturbance at Mains Terminals



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## Specification

### Conducted Disturbance at Mains Terminal – Digital Apparatus

#### FCC, Part 15 Subpart B §15.107

(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

(b) For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms LISN. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

#### Industry Canada ICES-003

The voltage of radio noise emissions that are conducted along the power supply lines of a Class A digital apparatus shall not exceed the limits specified in Table 1 of the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."], within the indicated frequency range.

The voltage of radio noise emissions that are conducted along the power supply lines of a Class B digital apparatus shall not exceed the limits specified in Table 2 of the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."], within the indicated frequency range.



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## FCC, Part 15 Subpart B §15.107 & Industry Canada ICES-003 Limits

Limits for conducted disturbance at the mains ports of class B ITE

| Frequency of emission (MHz) | Quasi-peak dBuV                                                    | Average dBuV |
|-----------------------------|--------------------------------------------------------------------|--------------|
| 0.15–0.5                    | 66 to 56*                                                          | 56 to 46*    |
| 0.5–5                       | 56                                                                 | 46           |
| 5–30                        | 60                                                                 | 50           |
| Note 1                      | * Decreases with the logarithm of the frequency                    |              |
| Note 2                      | * The lower limit applies at the boundary between frequency ranges |              |

Limits for conducted disturbance at the mains ports of class A ITE

| Frequency of emission (MHz) | Quasi-peak dBuV                                            | Average dBuV |
|-----------------------------|------------------------------------------------------------|--------------|
| 0.15–0.5                    | 79                                                         | 66           |
| 0.5–30                      | 73                                                         | 60           |
| Note 1                      | * The lower limit shall apply at the transition frequency. |              |

Laboratory Measurement Uncertainty for Conducted Emissions

|                                |          |
|--------------------------------|----------|
| <b>Measurement uncertainty</b> | ±2.64 dB |
|--------------------------------|----------|

Traceability

| Method                     | Test Equipment Used                |
|----------------------------|------------------------------------|
| Work instruction WI-EMC-01 | 0158, 0184, 0193, 0190, 0293, 0307 |

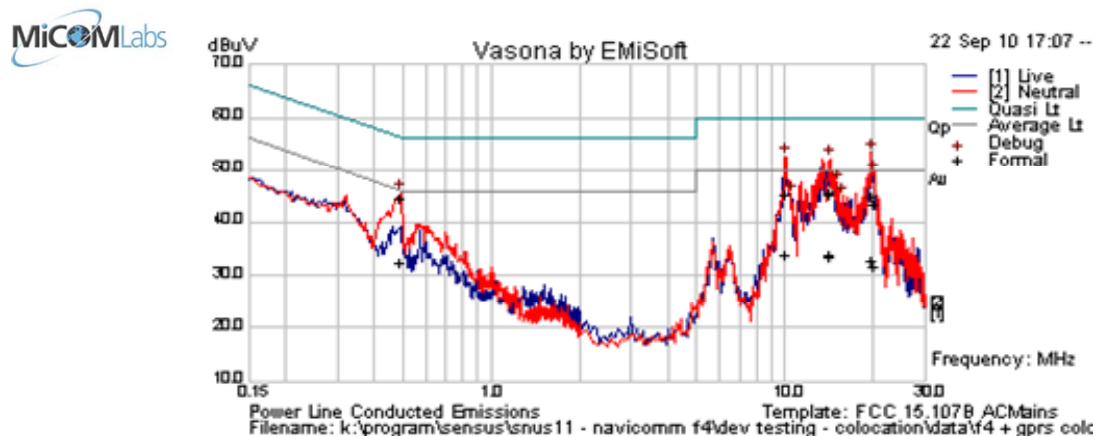
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### 7.2.1 Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)

|               |                    |                 |      |
|---------------|--------------------|-----------------|------|
| Test Freq.    | N/A                | Engineer        | SB   |
| Variant       | AC Line Emissions  | Temp (°C)       | 25.5 |
| Freq. Range   | 0.150 MHz - 30 MHz | Rel. Hum. (%)   | 34   |
| Power Setting | 120V AC 60 Hz      | Press. (m Bars) | 1003 |
| Antenna       | N/A                |                 |      |
| Test Notes 1  |                    |                 |      |
| Test Notes 2  |                    |                 |      |



#### Formally measured emission peaks

| Frequency MHz                                                                                  | Raw dBuV | Cable Loss | Factors dB | Level dBuV | Measurement Type | Line    | Limit dBuV | Margin dB | Pass /Fail | Comments |
|------------------------------------------------------------------------------------------------|----------|------------|------------|------------|------------------|---------|------------|-----------|------------|----------|
| 19.718                                                                                         | 33.7     | 10.5       | 0.7        | 45.0       | Quasi Peak       | Neutral | 60         | -15.1     | Pass       |          |
| 10.174                                                                                         | 34.7     | 10.3       | 0.4        | 45.4       | Quasi Peak       | Neutral | 60         | -14.6     | Pass       |          |
| 14.315                                                                                         | 34.6     | 10.4       | 0.6        | 45.6       | Quasi Peak       | Neutral | 60         | -14.4     | Pass       |          |
| 0.492                                                                                          | 34.7     | 9.9        | 0.1        | 44.7       | Quasi Peak       | Neutral | 56.13      | -11.4     | Pass       |          |
| 20.228                                                                                         | 32.4     | 10.5       | 0.7        | 43.7       | Quasi Peak       | Neutral | 60         | -16.4     | Pass       |          |
| 14.391                                                                                         | 34.5     | 10.4       | 0.6        | 45.5       | Quasi Peak       | Neutral | 60         | -14.5     | Pass       |          |
| 19.718                                                                                         | 21.7     | 10.5       | 0.7        | 32.9       | Average          | Neutral | 50         | -17.1     | Pass       |          |
| 10.174                                                                                         | 23.1     | 10.3       | 0.4        | 33.7       | Average          | Neutral | 50         | -16.3     | Pass       |          |
| 14.315                                                                                         | 23.1     | 10.4       | 0.6        | 34.1       | Average          | Neutral | 50         | -15.9     | Pass       |          |
| 0.492                                                                                          | 22.4     | 9.9        | 0.1        | 32.4       | Average          | Neutral | 46.13      | -13.7     | Pass       |          |
| 20.228                                                                                         | 20.5     | 10.5       | 0.7        | 31.7       | Average          | Neutral | 50         | -18.3     | Pass       |          |
| 14.391                                                                                         | 22.5     | 10.4       | 0.6        | 33.5       | Average          | Neutral | 50         | -16.5     | Pass       |          |
| Legend: DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |          |            |            |            |                  |         |            |           |            |          |
| NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band              |          |            |            |            |                  |         |            |           |            |          |

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### **7.3 Radiated Spurious Emissions - Radio Collocation**

#### **Test Procedure**

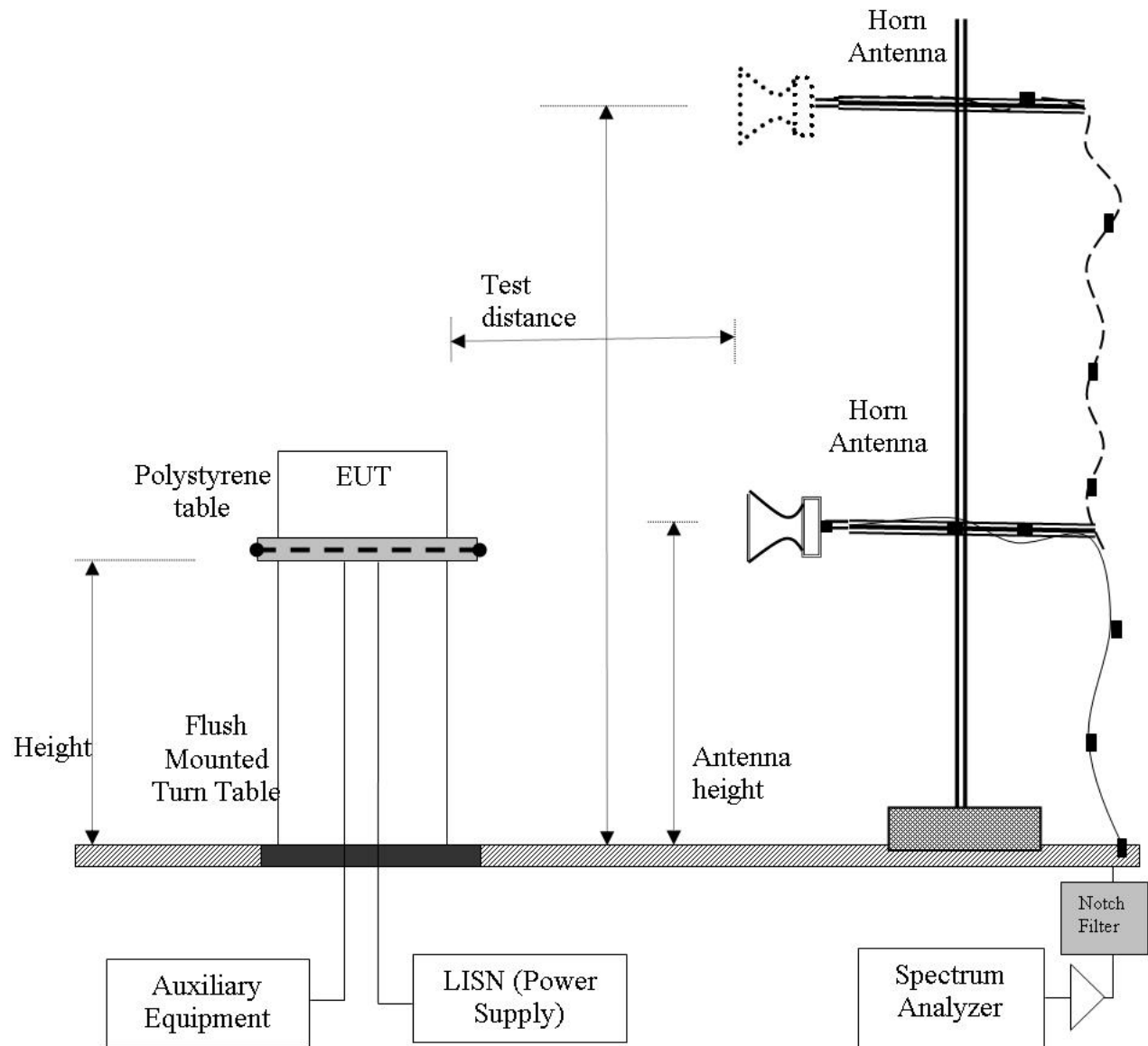
Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

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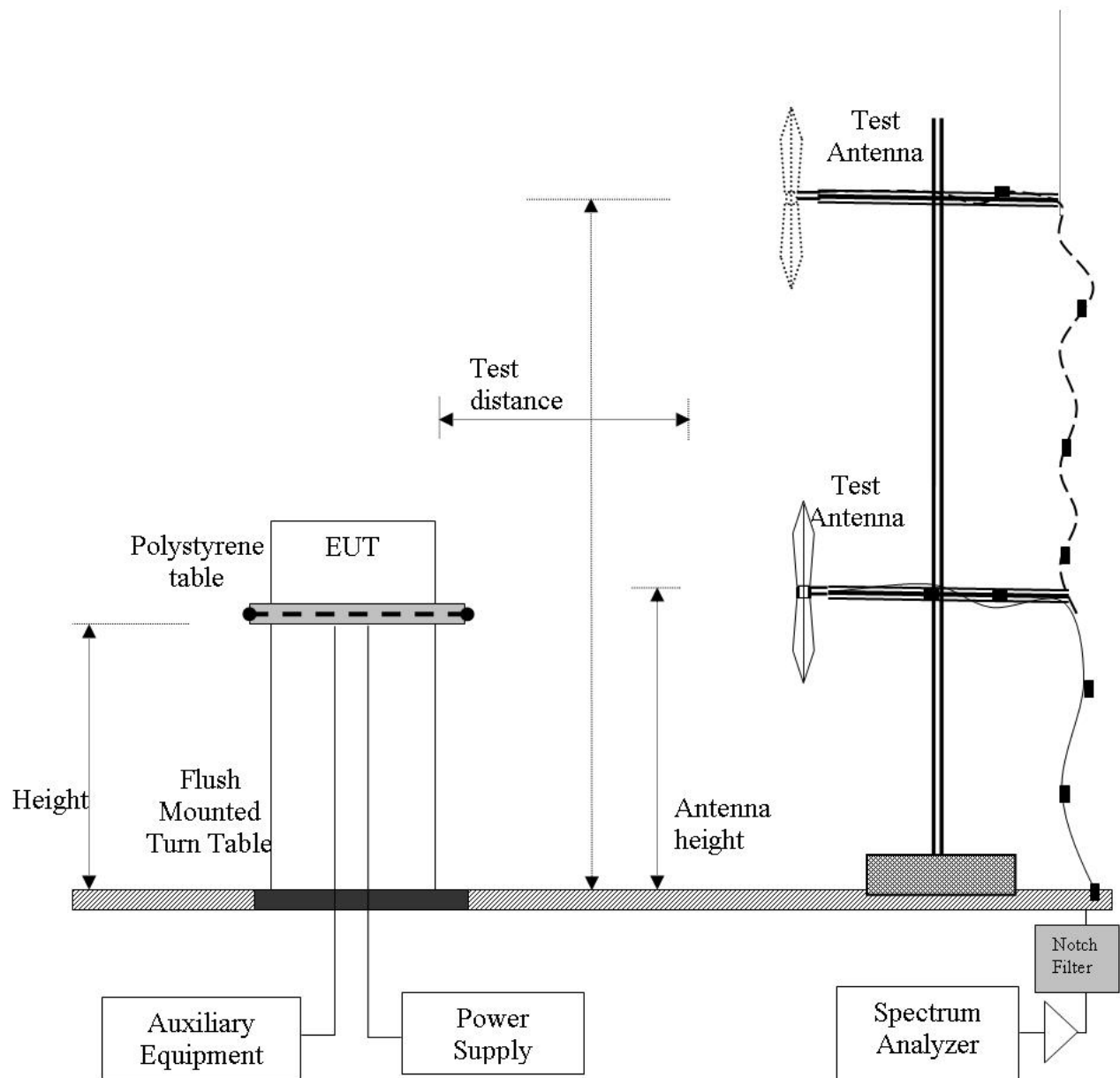
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### Radiated Emission Measurement Setup – Above 1 GHz



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## Radiated Emission Measurement Setup – Below 1 GHz



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### Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

$$FS = R + AF + CORR - FO$$

FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

$$CORR = \text{Correction Factor} = CL - AG + NFL$$

CL = Cable Loss

AG = Amplifier Gain

FO = Distance Falloff Factor

NFL = Notch Filter Loss or Waveguide Loss

#### Field Strength Calculation Example:

Given receiver input reading of 51.5 dB $\mu$ V; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 \text{ dB}\mu\text{V/m}$$

Conversion between dB $\mu$ V/m (or dB $\mu$ V) and  $\mu$ V/m (or  $\mu$ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (\mu V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100 \mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250 \mu\text{V/m}$$

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## Specification FCC

### Radiated Spurious Emissions

**FCC §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 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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

**FCC §15.205 (a)** Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

**FCC §15.205 (a)** Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

**FCC §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 the following table.

**Table 1: FCC 15.209 Spurious Emissions Limits**

| Frequency (MHz) | Field Strength (µV/m) | Field Strength (dBµV/m) | Measurement Distance (meters) |
|-----------------|-----------------------|-------------------------|-------------------------------|
| 30-88           | 100                   | 40.0                    | 3                             |
| 88-216          | 150                   | 43.5                    | 3                             |
| 216-960         | 200                   | 46.0                    | 3                             |
| Above 960       | 500                   | 54.0                    | 3                             |



## Specification IC

### Receiver Radiated Spurious Emissions

#### Industry Canada RSS-Gen §4.10

The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

#### RSS-Gen §6

If a radiated measurement is made, all spurious emissions shall comply with the limits of *Table 1: RSS-Gen §6 Spurious Emissions Limits*.

**Table 1: RSS-Gen §6 Spurious Emissions Limits**

| Frequency (MHz) | Field Strength (μV/m) | Field Strength (dBμV/m) | Measurement Distance (meters) |
|-----------------|-----------------------|-------------------------|-------------------------------|
| 30-88           | 100                   | 40.0                    | 3                             |
| 88-216          | 150                   | 43.5                    | 3                             |
| 216-960         | 200                   | 46.0                    | 3                             |
| Above 960       | 500                   | 54.0                    | 3                             |

### Laboratory Measurement Uncertainty for Spectrum Measurement

|                                |               |
|--------------------------------|---------------|
| <b>Measurement Uncertainty</b> | +5.6/ -4.5 dB |
|--------------------------------|---------------|

### Traceability:

| Method                 | Test Equipment Used                            |
|------------------------|------------------------------------------------|
| Work instruction WI-03 | 0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312 |



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### **7.3.1 Measurement Results: F4 Radio Collocation**

Testing was performed as detailed in the response to inquiry to FCC (Tracking Number 663683) concerning collocation testing of modules certified to two (2) different FCC parts.

#### **Test Plan:**

- 1) Test the device for spurious emissions with each radio operating independently to the applicable procedures / limits for each module.
- 2) Test the device for spurious emissions with both radios operating to access any intermodulation / mixing of spurious frequencies.
- 3) Investigate any new emissions that were not present on independent scans. These emissions should be less than the highest limits of the applicable rule parts for the radios used in the device.
- 4) Investigate amplitudes of emissions in step 2 to emissions in step 1. Emissions must still meet the limits of the rule part for the certified module.

#### **Response per FCC KDB #663683:**

"If you are co-locating 2 certified devices and a motherboard into one enclosure, you must get a completely new certification for these devices co-located within the one enclosure.

The testing is such that you must turn both transmitters on, ie. both certified devices, and test the enclosure the device consisting of 2 certified devices such that they comply with all rule parts associated to each certified device. That is to say rule part 15.209 with both previously certified devices turn on and rule parts Part 22, Part 24, Part 90, Part 101 rules for the other device with both devices turned on."

#### **Test Setup:**

2.4GHz and GSM: GSM antenna connection terminated with 50 Ohm cable into Willtek 2201 Prolock. 2.4GHz using internal antenna. Band stop filter in line before preamplifier.

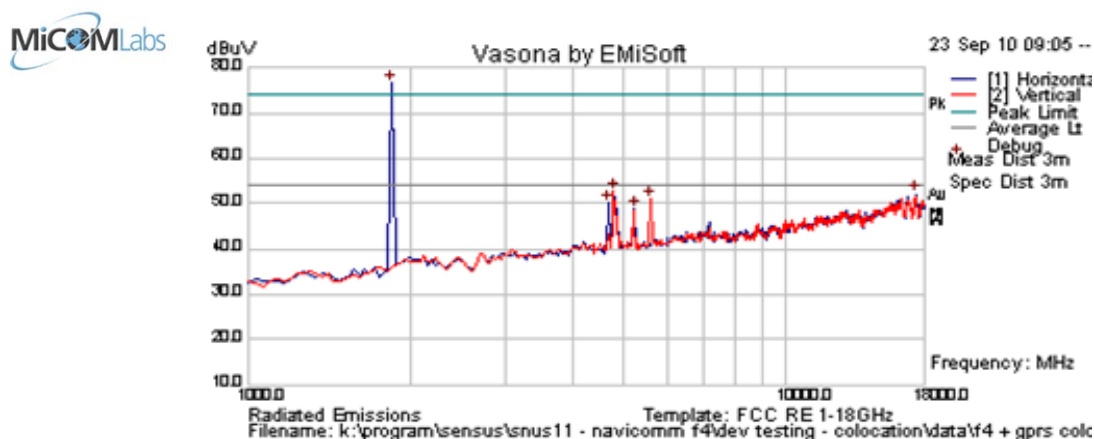
#### **Results Summary:**

No additional emissions were witnessed during Collocation testing. All emissions meet the requirements of their respective FCC parts.



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|                      |                                                                                         |                       |        |
|----------------------|-----------------------------------------------------------------------------------------|-----------------------|--------|
| <b>Date</b>          | Wednesday, September 22, 2010                                                           | <b>Tracker #</b>      | SNUS11 |
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                                   | <b>Engineer</b>       | SB     |
| <b>Variant</b>       | F4 GPRS radio w/ 2.4GHz radio                                                           | <b>Temp (°C)</b>      | 26     |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                        | <b>Rel. Hum. (%)</b>  | 34     |
| <b>Power Setting</b> | Maximum                                                                                 | <b>Press. (mBars)</b> | 995    |
| <b>Antenna</b>       | See below                                                                               | <b>Duty Cycle (%)</b> | 99%    |
| <b>Test Notes 1</b>  | Both transmitters operating simultaneously; Fundamental attenuated by band stop filter. |                       |        |
| <b>Test Notes 2</b>  | GPRS terminated with 50 Ohm cable; 802.11 connected to integral antenna                 |                       |        |



#### Formally measured emission peaks

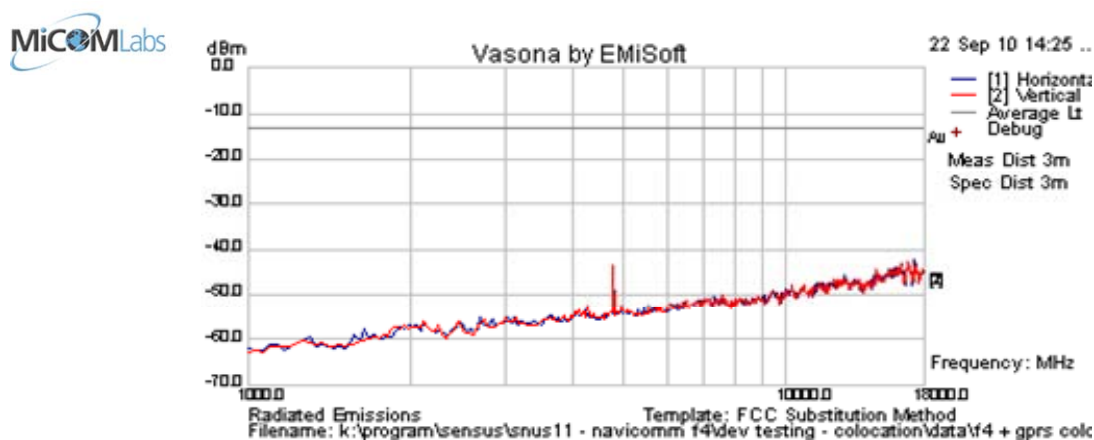
| Frequency MHz                                                                                                                                               | Raw dBuV | Cable Loss | AF dB | Level dBuV | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV | Margin dB | Pass /Fail | Comments |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|-------|------------|------------------|-----|--------|---------|------------|-----------|------------|----------|
| 4800.992                                                                                                                                                    | 56.0     | 4.5        | -9.4  | 51.1       | Peak Max         | V   | 126    | 266     | 74.0       | -22.9     | Pass       |          |
| 17352.274                                                                                                                                                   | 43.1     | 8.7        | 2.0   | 53.7       | Peak Max         | H   | 152    | 43      | 74.0       | -20.3     | Pass       |          |
| 5599.198                                                                                                                                                    | 47.3     | 4.7        | -8.6  | 43.3       | Peak Max         | V   | 111    | 192     | 74         | -30.7     | Pass       |          |
| 4788.707                                                                                                                                                    | 53.7     | 4.4        | -9.4  | 48.7       | Peak Max         | H   | 103    | 76      | 74         | -25.3     | Pass       |          |
| 5204.569                                                                                                                                                    | 48.2     | 4.6        | -9.5  | 43.3       | Peak Max         | H   | 152    | 129     | 74         | -30.7     | Pass       |          |
| 4800.992                                                                                                                                                    | 46.9     | 4.5        | -9.4  | 42.0       | Average Max      | V   | 126    | 266     | 54         | -12.0     | Pass       |          |
| 17352.274                                                                                                                                                   | 30.0     | 8.7        | 2.0   | 40.7       | Average Max      | H   | 152    | 43      | 54         | -13.3     | Pass       |          |
| 5599.198                                                                                                                                                    | 34.2     | 4.7        | -8.6  | 30.3       | Average Max      | V   | 111    | 192     | 54         | -23.7     | Pass       |          |
| 4788.707                                                                                                                                                    | 35.2     | 4.4        | -9.4  | 30.2       | Average Max      | H   | 103    | 76      | 54         | -23.8     | Pass       |          |
| 5204.569                                                                                                                                                    | 34.9     | 4.6        | -9.5  | 30.0       | Average Max      | H   | 152    | 129     | 54         | -24.0     | Pass       |          |
| 1851.703                                                                                                                                                    | 86.5     | 2.7        | -12.5 | 76.6       | Peak [Scan]      | H   | --     | --      | --         | --        | n/a        | FUND     |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission<br>NRB = Non-Restricted Band. RB = Restricted Band. |          |            |       |            |                  |     |        |         |            |           |            |          |

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|                      |                                                                                   |                       |     |
|----------------------|-----------------------------------------------------------------------------------|-----------------------|-----|
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                             | <b>Engineer</b>       | SB  |
| <b>Variant</b>       | F4 GPRS radio w / 2.4GHz radio                                                    | <b>Temp (°C)</b>      | 26  |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                  | <b>Rel. Hum .(%)</b>  | 34  |
| <b>Power Setting</b> | Maximum                                                                           | <b>Press. (mBars)</b> | 995 |
| <b>Antenna</b>       | See below                                                                         | <b>Duty Cycle (%)</b> | 99% |
| <b>Test Notes 1</b>  | Only GPRS Operation (-13 dBm limits); Fundamental attenuated by band stop filter. |                       |     |
| <b>Test Notes 2</b>  | GPRS terminated w ith 50 Ohm cable; 802.11 connected to integral antenna          |                       |     |



#### Formally measured emission peaks

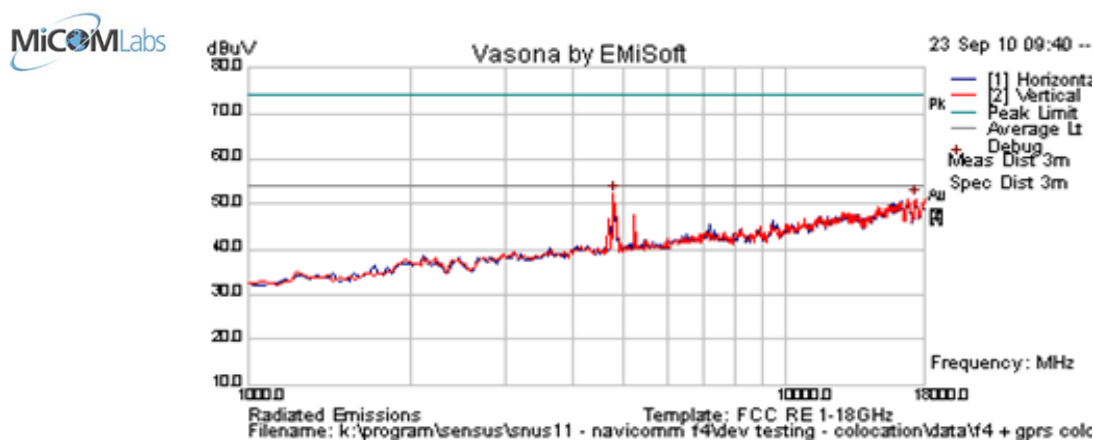
| Frequency MHz                                                                                                                                               | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|-------|--------------|------------------|-----|--------|---------|--------------|-----------|------------|----------|
| No emissions near limit.                                                                                                                                    |          |            |       |              |                  |     |        |         |              |           |            |          |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission<br>NRB = Non-Restricted Band. RB = Restricted Band. |          |            |       |              |                  |     |        |         |              |           |            |          |

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|                      |                                                                                     |                       |     |
|----------------------|-------------------------------------------------------------------------------------|-----------------------|-----|
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                               | <b>Engineer</b>       | SB  |
| <b>Variant</b>       | F4 GPRS radio w / 2.4GHz radio                                                      | <b>Temp (°C)</b>      | 26  |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                    | <b>Rel. Hum .(%)</b>  | 34  |
| <b>Power Setting</b> | Maximum                                                                             | <b>Press. (mBars)</b> | 995 |
| <b>Antenna</b>       | See below                                                                           | <b>Duty Cycle (%)</b> | 99% |
| <b>Test Notes 1</b>  | Only 2.4GHz Operation (-13 dBm limits); Fundamental attenuated by band stop filter. |                       |     |
| <b>Test Notes 2</b>  | GPRS terminated with 50 Ohm cable; 802.11 connected to integral antenna             |                       |     |



#### Formally measured emission peaks

| Frequency MHz                                                                                                                                               | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|-------|--------------|------------------|-----|--------|---------|--------------|-----------|------------|----------|
| All emissions measured in simultaneous transmission plot.                                                                                                   |          |            |       |              |                  |     |        |         |              |           |            |          |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission<br>NRB = Non-Restricted Band. RB = Restricted Band. |          |            |       |              |                  |     |        |         |              |           |            |          |

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### **7.3.2 Measurement Results: G2 Radio Collocation**

Testing was performed as detailed in the response to inquiry to FCC (Tracking Number 663683) concerning collocation testing of modules certified to two (2) different FCC parts.

#### **Test Plan:**

- 1) Test the device for spurious emissions with each radio operating independently to the applicable procedures / limits for each module.
- 2) Test the device for spurious emissions with both radios operating to access any intermodulation / mixing of spurious frequencies.
- 3) Investigate any new emissions that were not present on independent scans. These emissions should be less than the highest limits of the applicable rule parts for the radios used in the device.
- 4) Investigate amplitudes of emissions in step 2 to emissions in step 1. Emissions must still meet the limits of the rule part for the certified module.

#### **Response per FCC KDB #663683:**

"If you are co-locating 2 certified devices and a motherboard into one enclosure, you must get a completely new certification for these devices co-located within the one enclosure.

The testing is such that you must turn both transmitters on, ie. both certified devices, and test the enclosure the device consisting of 2 certified devices such that they comply with all rule parts associated to each certified device. That is to say rule part 15.209 with both previously certified devices turn on and rule parts Part 22, Part 24, Part 90, Part 101 rules for the other device with both devices turned on."

#### **Test Setup:**

2.4GHz and GSM: GSM antenna connection terminated with 50 Ohm cable into Willtek 2201 Prolock. 2.4GHz using internal antenna. Band stop filter in line before preamplifier.

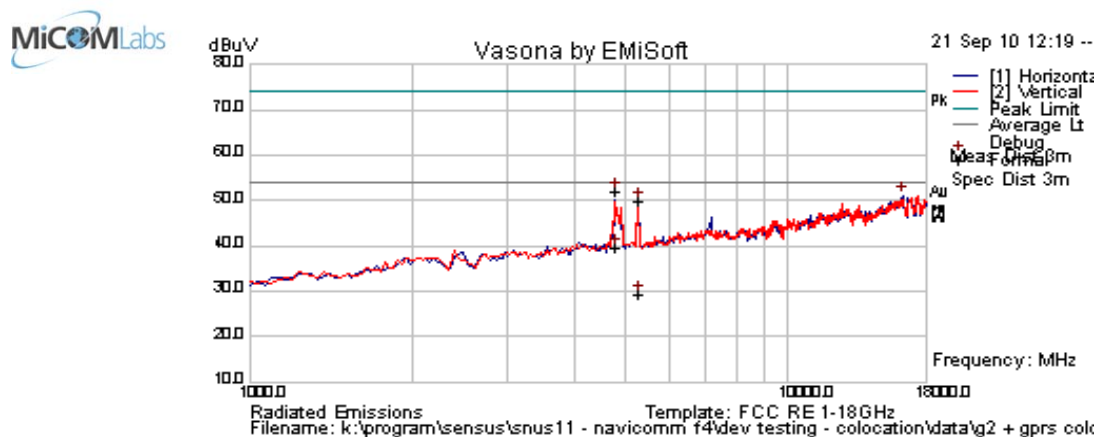
#### **Results Summary:**

No additional emissions were witnessed during Collocation testing. All emissions meet the requirements of their respective FCC parts.



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|                      |                                                                                          |                        |        |
|----------------------|------------------------------------------------------------------------------------------|------------------------|--------|
| <b>Date</b>          | Tuesday, September 21, 2010                                                              | <b>Tracker #</b>       | SNUS11 |
| <b>Lab. Notes</b>    | Tx at 2400.5 MHz (sw itches 1&2 Off); 2482.5 MHz (Sw itches 1&2 On);                     |                        |        |
| <b>Lab. Notes</b>    |                                                                                          |                        |        |
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                                    | <b>Engineer</b>        | SB     |
| <b>Variant</b>       | G2 GPRS radio w / 2.4GHz radio                                                           | <b>Temp (°C)</b>       | 26     |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                         | <b>Rel. Hum. (%)</b>   | 34     |
| <b>Power Setting</b> | Maximum                                                                                  | <b>Press. (m Bars)</b> | 995    |
| <b>Antenna</b>       | See below                                                                                | <b>Duty Cycle (%)</b>  | 99%    |
| <b>Test Notes 1</b>  | Both transmitters operating simultaneously. Fundamental attenuated via band stop filter. |                        |        |
| <b>Test Notes 2</b>  | GPRS terminated w ith 50 Ohm cable; 802.11 connected to integral antenna                 |                        |        |



#### Formally measured emission peaks

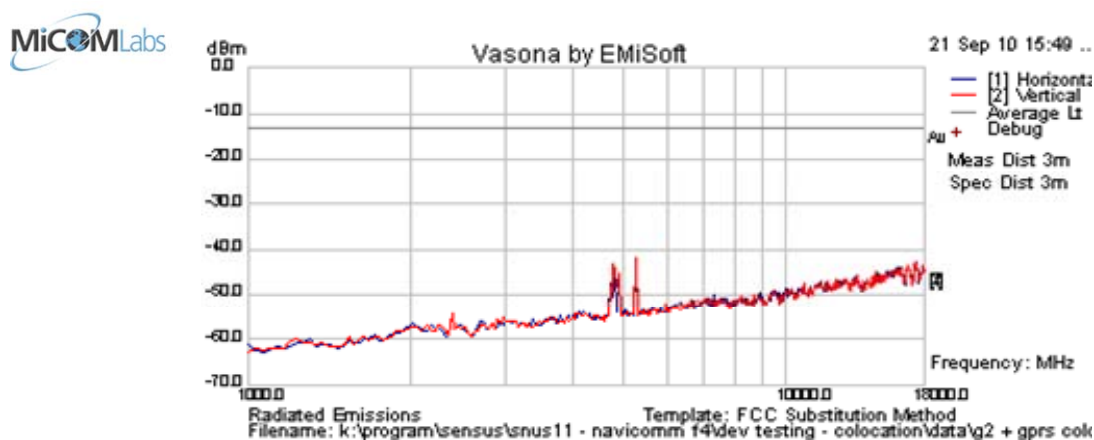
| Frequency MHz                                                                                                                                                      | Raw dBuV | Cable Loss | AF dB | Level dBuV | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV | Margin dB | Pass /Fail | Comments  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|-------|------------|------------------|-----|--------|---------|------------|-----------|------------|-----------|
| 4800.721                                                                                                                                                           | 44.6     | 4.5        | -9.4  | 39.7       | Average          | H   | 98     | 337     | 54.0       | -14.3     | Pass       |           |
| 4800.721                                                                                                                                                           | 57.0     | 4.5        | -9.4  | 52.1       | Peak             | H   | 98     | 337     | 74.0       | -21.9     | Pass       |           |
| 5269.098                                                                                                                                                           | 34.6     | 4.6        | -9.7  | 29.5       | Average          | H   | 98     | 337     | 54         | -24.6     | Pass       |           |
| 5269.098                                                                                                                                                           | 54.8     | 4.6        | -9.7  | 49.7       | Peak             | H   | 98     | 337     | 54         | -4.3      | Pass       | Transient |
| <b>Legend:</b> TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission<br>NRB = Non-Restricted Band. RB = Restricted Band. |          |            |       |            |                  |     |        |         |            |           |            |           |

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|                      |                                                                                    |                       |     |
|----------------------|------------------------------------------------------------------------------------|-----------------------|-----|
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                              | <b>Engineer</b>       | SB  |
| <b>Variant</b>       | G2 GPRS radio w / 2.4GHz radio                                                     | <b>Temp (°C)</b>      | 26  |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                   | <b>Rel. Hum .(%)</b>  | 34  |
| <b>Power Setting</b> | Maximum                                                                            | <b>Press. (mBars)</b> | 995 |
| <b>Antenna</b>       | See below                                                                          | <b>Duty Cycle (%)</b> | 99% |
| <b>Test Notes 1</b>  | Only GPRS Operation (-13 dBm limits); Fundamental attenuated via band stop filter. |                       |     |
| <b>Test Notes 2</b>  | GPRS terminated w ith 50 Ohm cable; 802.11 connected to integral antenna           |                       |     |



#### Formally measured emission peaks

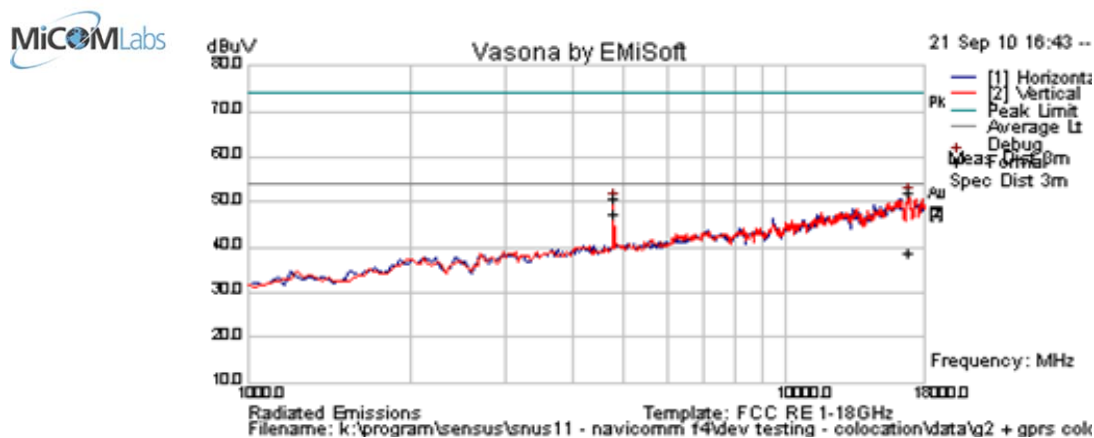
| Frequency MHz                                                                                           | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments |
|---------------------------------------------------------------------------------------------------------|---------|------------|-------|-----------|------------------|-----|--------|---------|-----------|-----------|------------|----------|
| 5262.084                                                                                                | -73.1   | 4.6        | 3.4   | -65.0     | Average Max      | H   | 201    | 229     | -13.0     | -52.0     | Pass       |          |
| 2402.001                                                                                                | -74.6   | 3.0        | 1.9   | -69.7     | Average Max      | H   | 163    | 342     | -13.0     | -56.7     | Pass       |          |
| 4801.017                                                                                                | -64.2   | 4.5        | 3.7   | -56.1     | Average Max      | H   | 137    | 360     | -13       | -43.1     | Pass       |          |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |         |            |       |           |                  |     |        |         |           |           |            |          |
| NRB = Non-Restricted Band. RB = Restricted Band.                                                        |         |            |       |           |                  |     |        |         |           |           |            |          |

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|                      |                                                                           |                       |     |
|----------------------|---------------------------------------------------------------------------|-----------------------|-----|
| <b>Test Freq.</b>    | 2400.5 2482.5 (1&2 On); ; GPRS 1900 C                                     | <b>Engineer</b>       | SB  |
| <b>Variant</b>       | G2 GPRS radio w / 2.4GHz radio                                            | <b>Temp (°C)</b>      | 26  |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                          | <b>Rel. Hum. (%)</b>  | 34  |
| <b>Power Setting</b> | Maximum                                                                   | <b>Press. (mBars)</b> | 995 |
| <b>Antenna</b>       | See below                                                                 | <b>Duty Cycle (%)</b> | 99% |
| <b>Test Notes 1</b>  | 2.4GHz only (15.209 Limits); Fundamental attenuated via band stop filter. |                       |     |
| <b>Test Notes 2</b>  | GPRS terminated w ith 50 Ohm cable; 802.11 connected to integral antenna  |                       |     |



#### Formally measured emission peaks

| Frequency MHz                                                                                                                                               | Raw dBuV | Cable Loss | AF dB | Level dBuV | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV | Margin dB | Pass /Fail | Comments |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|-------|------------|------------------|-----|--------|---------|------------|-----------|------------|----------|
| 16878.247                                                                                                                                                   | 42.4     | 8.6        | 1.1   | 52.0       | Peak Max         | V   | 121    | 149     | 74.0       | -22.0     | Pass       |          |
| 4800.677                                                                                                                                                    | 55.7     | 4.5        | -9.4  | 50.8       | Peak Max         | H   | 98     | 237     | 74.0       | -23.2     | Pass       |          |
| 16878.247                                                                                                                                                   | 29.3     | 8.6        | 1.1   | 39.0       | Average Max      | V   | 121    | 149     | 54         | -15.0     | Pass       |          |
| 4800.677                                                                                                                                                    | 52.2     | 4.5        | -9.4  | 47.3       | Average Max      | H   | 98     | 237     | 54         | -6.7      | Pass       |          |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission<br>NRB = Non-Restricted Band. RB = Restricted Band. |          |            |       |            |                  |     |        |         |            |           |            |          |

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### **7.3.3 Measurement Results: 900 Radio Collocation**

Testing was performed as detailed in the response to inquiry to FCC (Tracking Number 663683) concerning collocation testing of modules certified to two (2) different FCC parts.

#### **Test Plan:**

- 1) Test the device for spurious emissions with each radio operating independently to the applicable procedures / limits for each module.
- 2) Test the device for spurious emissions with both radios operating to access any intermodulation / mixing of spurious frequencies.
- 3) Investigate any new emissions that were not present on independent scans. These emissions should be less than the highest limits of the applicable rule parts for the radios used in the device.
- 4) Investigate amplitudes of emissions in step 2 to emissions in step 1. Emissions must still meet the limits of the rule part for the certified module.

#### **Response per FCC KDB #663683:**

"If you are co-locating 2 certified devices and a motherboard into one enclosure, you must get a completely new certification for these devices co-located within the one enclosure.

The testing is such that you must turn both transmitters on, ie. both certified devices, and test the enclosure the device consisting of 2 certified devices such that they comply with all rule parts associated to each certified device. That is to say rule part 15.209 with both previously certified devices turn on and rule parts Part 22, Part 24, Part 90, Part 101 rules for the other device with both devices turned on."

#### **Test Setup:**

2.4GHz and 900MHz: 900 MHz using external antenna. 2.4GHz using internal antenna.  
Band-stop filter in place before preamplifier to attenuate fundamental.

#### **Results Summary:**

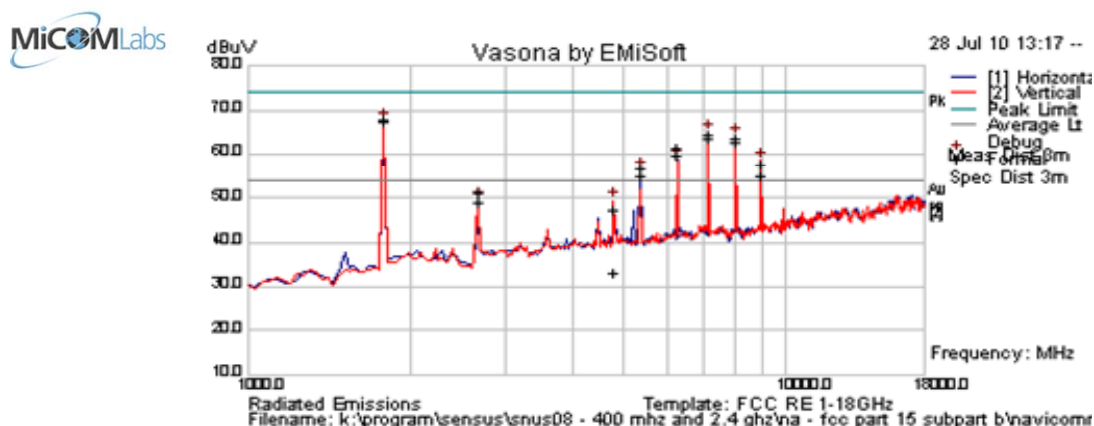
No additional emissions were witnessed during Collocation testing. All emissions meet the requirements of their respective FCC parts.

The first plot below indicates a combination of emissions from both the 900 MHz radio and 2.4 GHz radio. The limits referenced in this plot are only the Part 15.209 limits. The source of the emissions were determined by operating each radio individually. Emissions that appear to be above the 15.209 average limit provided in the initial plot were determined to be from the 900 MHz radio, which requires compliance to FCC Part 90/Part 101, with a limit of -20 dBm.



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|                      |                                                                                         |                       |      |
|----------------------|-----------------------------------------------------------------------------------------|-----------------------|------|
| <b>Test Freq.</b>    | 900MHz and 2.4GHz Radio                                                                 | <b>Engineer</b>       | CSB  |
| <b>Variant</b>       | Colocation Testing                                                                      | <b>Temp (°C)</b>      | 26   |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                        | <b>Rel. Hum.(%)</b>   | 33   |
| <b>Power Setting</b> | Maximum                                                                                 | <b>Press. (mBars)</b> | 1007 |
| <b>Antenna</b>       | Laird                                                                                   |                       |      |
| <b>Test Notes 1</b>  | Both radios transmitting at maximum power with modulation. Emissions limits in plot are |                       |      |
| <b>Test Notes 2</b>  | only Part 15 restricted band limits. These do not apply to all emissions in plot.       |                       |      |



#### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV | Margin dB | Pass /Fail | Comments |
|---------------|----------|------------|-------|------------|------------------|-----|--------|---------|------------|-----------|------------|----------|
| 1792.002      | 77.7     | 2.6        | -12.8 | 67.5       | Average Max      | V   | 102    | 98      | 54         | 13.5      | N/A        | NRB      |
| 1792.002      | 78.0     | 2.6        | -12.8 | 67.8       | Peak Max         | V   | 102    | 98      | 74         | -6.2      | N/A        | NRB      |
| 2688.039      | 59.3     | 3.2        | -11.2 | 51.2       | Peak Max         | V   | 104    | 282     | 74         | -22.8     | N/A        | NRB      |
| 2688.039      | 56.9     | 3.2        | -11.2 | 48.9       | Average Max      | V   | 104    | 282     | 54         | -5.1      | N/A        | NRB      |
| 4800.586      | 52.3     | 4.4        | -9.4  | 47.4       | Peak Max         | V   | 130    | 77      | 74         | -26.6     | N/A        | RB       |
| 4800.586      | 38.2     | 4.4        | -9.4  | 33.3       | Average Max      | V   | 130    | 77      | 54         | -20.7     | N/A        | RB       |
| 5376.065      | 61.5     | 4.6        | -9.3  | 56.8       | Peak Max         | H   | 99     | 245     | 74         | -17.2     | N/A        | RB       |
| 5376.065      | 59.7     | 4.6        | -9.3  | 55.0       | Average Max      | H   | 99     | 245     | 54         | 1.0       | N/A        | RB       |
| 6272.093      | 63.2     | 5.0        | -6.8  | 61.4       | Peak Max         | H   | 103    | 219     | 74         | -12.6     | N/A        | NRB      |
| 6272.093      | 61.5     | 5.0        | -6.8  | 59.7       | Average Max      | H   | 103    | 219     | 54         | 5.7       | N/A        | NRB      |
| 7168.081      | 63.3     | 5.4        | -5.3  | 63.5       | Average Max      | V   | 109    | 232     | 54         | 9.5       | N/A        | NRB      |
| 7168.081      | 64.4     | 5.4        | -5.3  | 64.5       | Peak Max         | V   | 109    | 232     | 74         | -9.5      | N/A        | NRB      |
| 8064.128      | 62.3     | 5.6        | -4.2  | 63.7       | Peak Max         | V   | 102    | 228     | 74         | -10.3     | N/A        | RB       |
| 8064.128      | 61.2     | 5.6        | -4.2  | 62.6       | Average Max      | V   | 102    | 228     | 54         | 8.6       | N/A        | RB       |
| 8960.128      | 53.0     | 6.2        | -4.1  | 55.1       | Average Max      | V   | 101    | 246     | 54         | 1.1       | N/A        | NRB      |
| 8960.128      | 55.6     | 6.2        | -4.1  | 57.7       | Peak Max         | V   | 101    | 246     | 74         | -16.3     | N/A        | NRB      |

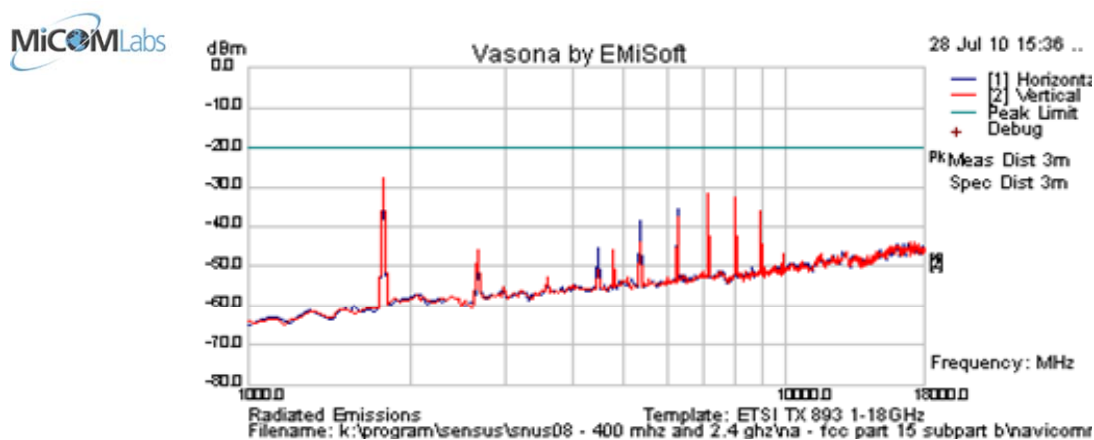
Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission  
 NRB = Non-Restricted Band. RB = Restricted Band.

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|                      |                                                                                   |                       |      |
|----------------------|-----------------------------------------------------------------------------------|-----------------------|------|
| <b>Test Freq.</b>    | 900MHz and 2.4GHz Radio                                                           | <b>Engineer</b>       | CSB  |
| <b>Variant</b>       | Colocation Testing                                                                | <b>Temp (°C)</b>      | 26   |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                                                                  | <b>Rel. Hum. (%)</b>  | 33   |
| <b>Power Setting</b> | Maximum                                                                           | <b>Press. (mBars)</b> | 1007 |
| <b>Antenna</b>       | Laird                                                                             | <b>Duty Cycle (%)</b> | 0    |
| <b>Test Notes 1</b>  | Flexnet 900 Radio transmitting. Emissions frequencies identicle to combination.   |                       |      |
| <b>Test Notes 2</b>  | only Part 15 restricted band limits. These do not apply to all emissions in plot. |                       |      |



#### Formally measured emission peaks

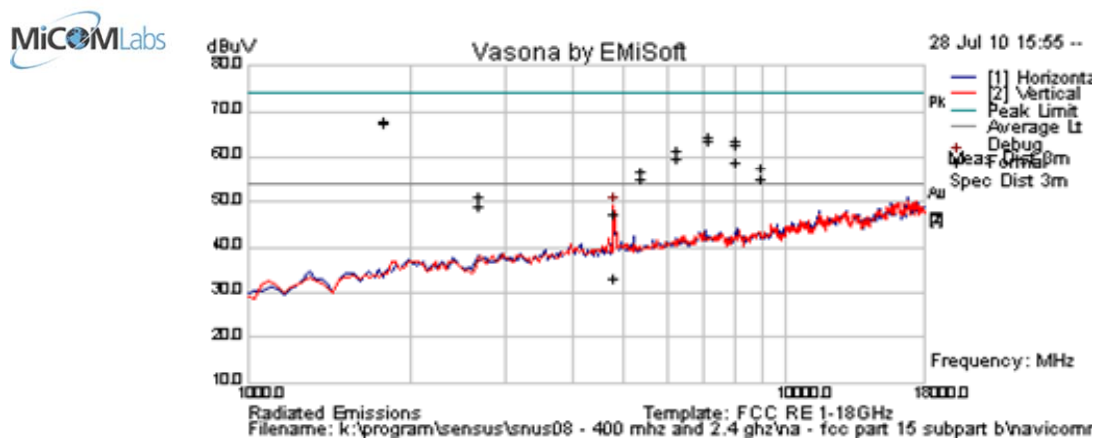
| Frequency MHz                                                                                           | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments    |
|---------------------------------------------------------------------------------------------------------|---------|------------|-------|-----------|------------------|-----|--------|---------|-----------|-----------|------------|-------------|
| 1792.002                                                                                                | -30.7   | 2.6        | 0.1   | -28.1     | Peak [Scan]      | V   | 98     | 360     | -20.0     | -8.1      | Pass       | Flexnet 900 |
| 2688.039                                                                                                | -51.5   | 3.1        | 1.9   | -46.5     | Peak [Scan]      | V   | 98     | 360     | -20.0     | -26.5     | Pass       | Flexnet 900 |
| 4800.586                                                                                                | -54.2   | 4.4        | 3.5   | -46.2     | Peak [Scan]      | V   | 98     | 360     | -20       | -26.2     | Pass       | Flexnet 900 |
| 7168.081                                                                                                | -44.9   | 5.4        | 7.7   | -31.8     | Peak [Scan]      | V   | 98     | 360     | -20       | -11.8     | Pass       | Flexnet 900 |
| 8064.128                                                                                                | -47.4   | 5.6        | 8.8   | -33.0     | Peak [Scan]      | V   | 98     | 360     | -20       | -13.0     | Pass       | Flexnet 900 |
| 8960.128                                                                                                | -51.4   | 6.2        | 9.3   | -35.9     | Peak [Scan]      | V   | 98     | 360     | -20       | -15.9     | Pass       | Flexnet 900 |
| 4475.448                                                                                                | -53.1   | 4.2        | 3.2   | -45.8     | Peak [Scan]      | H   | 98     | 360     | -20       | -25.8     | Pass       | Flexnet 900 |
| 5376.065                                                                                                | -47.2   | 4.6        | 3.5   | -39.1     | Peak [Scan]      | H   | 98     | 360     | -20       | -19.1     | Pass       | Flexnet 900 |
| 6272.093                                                                                                | -46.8   | 5.0        | 6.3   | -35.5     | Peak [Scan]      | H   | 98     | 360     | -20       | -15.5     | Pass       | Flexnet 900 |
| Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission |         |            |       |           |                  |     |        |         |           |           |            |             |
| NRB = Non-Restricted Band. RB = Restricted Band.                                                        |         |            |       |           |                  |     |        |         |           |           |            |             |

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**Title:** Sensus Metering Systems Navicomm  
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|                      |                                   |                       |      |
|----------------------|-----------------------------------|-----------------------|------|
| <b>Test Freq.</b>    | 900MHz and 2.4GHz Radio           | <b>Engineer</b>       | CSB  |
| <b>Variant</b>       | Colocation Testing                | <b>Temp (°C)</b>      | 26   |
| <b>Freq. Range</b>   | 1000 - 18000 MHz                  | <b>Rel. Hum. (%)</b>  | 33   |
| <b>Power Setting</b> | Maximum                           | <b>Press. (mBars)</b> | 1007 |
| <b>Antenna</b>       | Laird                             | <b>Duty Cycle (%)</b> | 0    |
| <b>Test Notes 1</b>  | 2.4GHz 802.11 radio transmitting. |                       |      |
| <b>Test Notes 2</b>  |                                   |                       |      |



#### Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV | Margin dB | Pass /Fail | Comments |
|---------------|----------|------------|-------|------------|------------------|-----|--------|---------|------------|-----------|------------|----------|
| 4800.681      | 54.2     | 4.5        | -9.4  | 49.3       | Peak [Scan]      | V   | 100    | 0       | 54.0       | -4.7      | Pass       |          |

Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission  
 NRB = Non-Restricted Band. RB = Restricted Band.

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## 8 Photographs

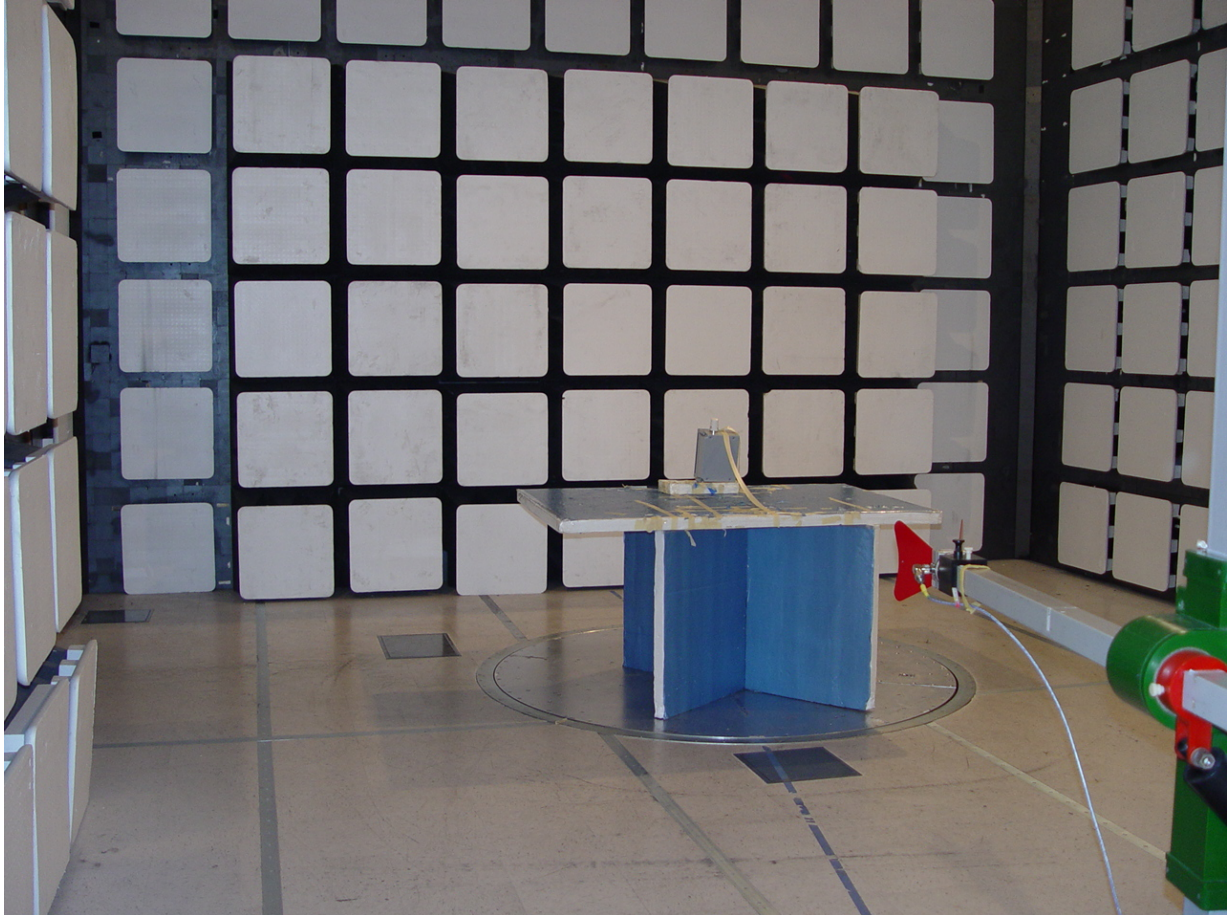
### 8.1 GPRS base station simulator setup



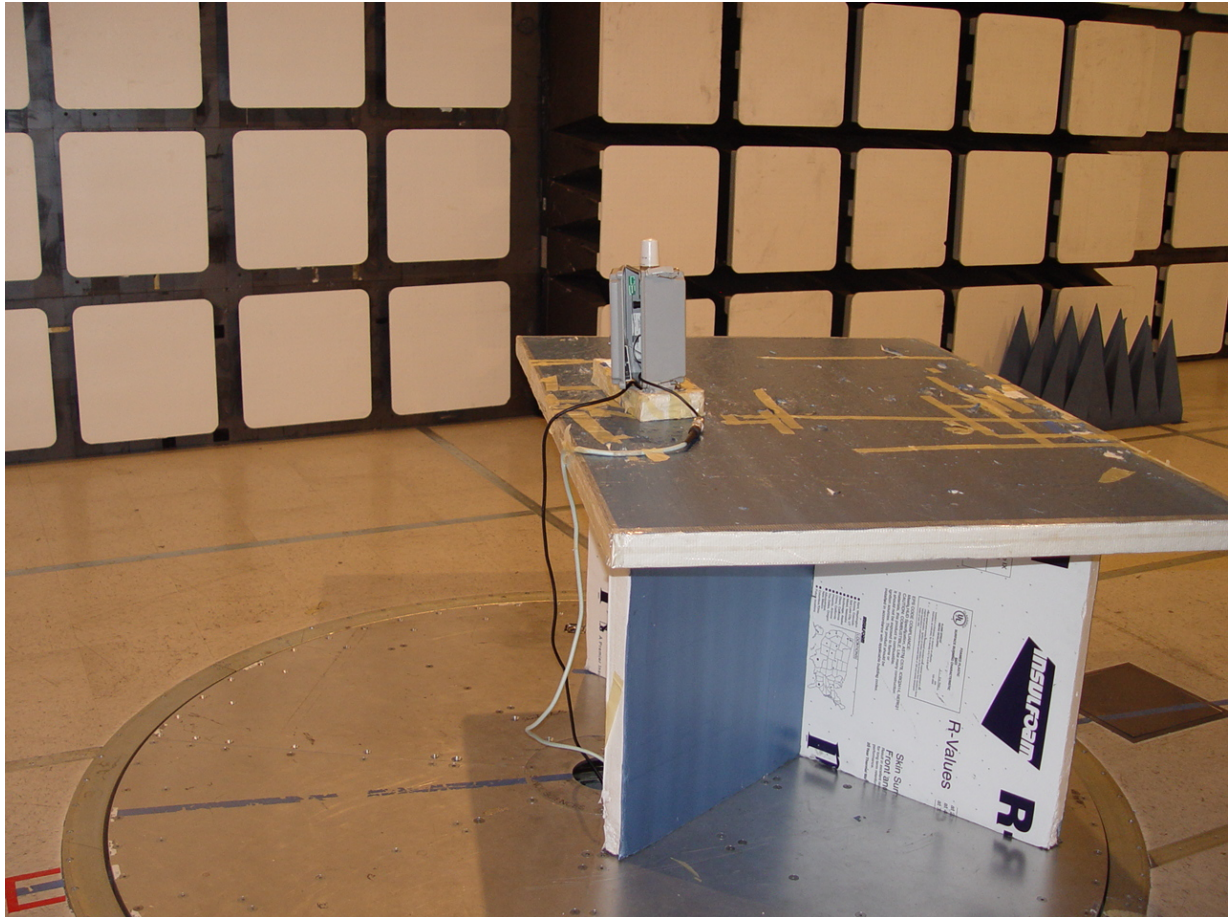
## 8.2 Navicomm with F4 Radio; Emissions 30 - 1000 MHz



### 8.3 Navicomm with F4 Radio; Emissions above 1 GHz



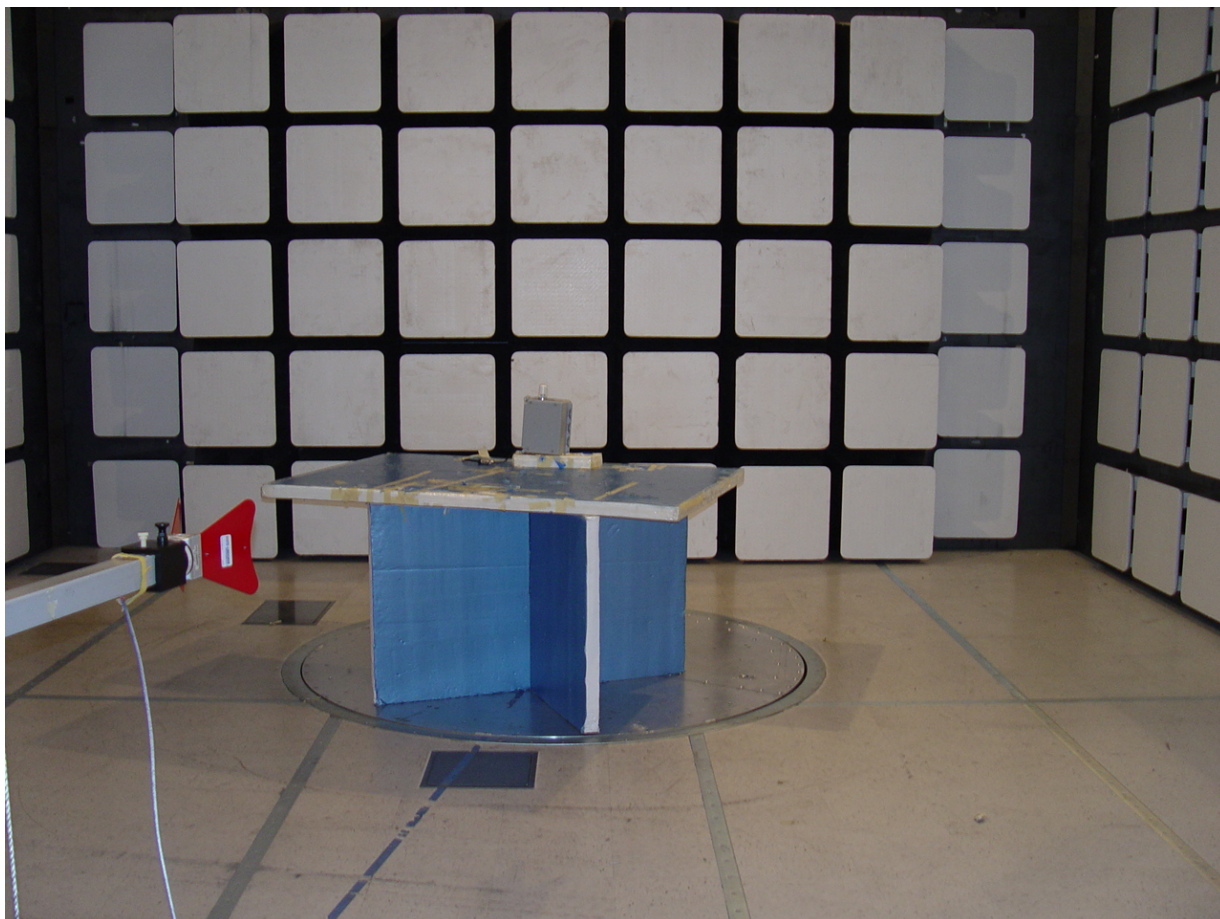
#### 8.4 Navicomm with G2 Radio; Emissions 30 - 1000 MHz



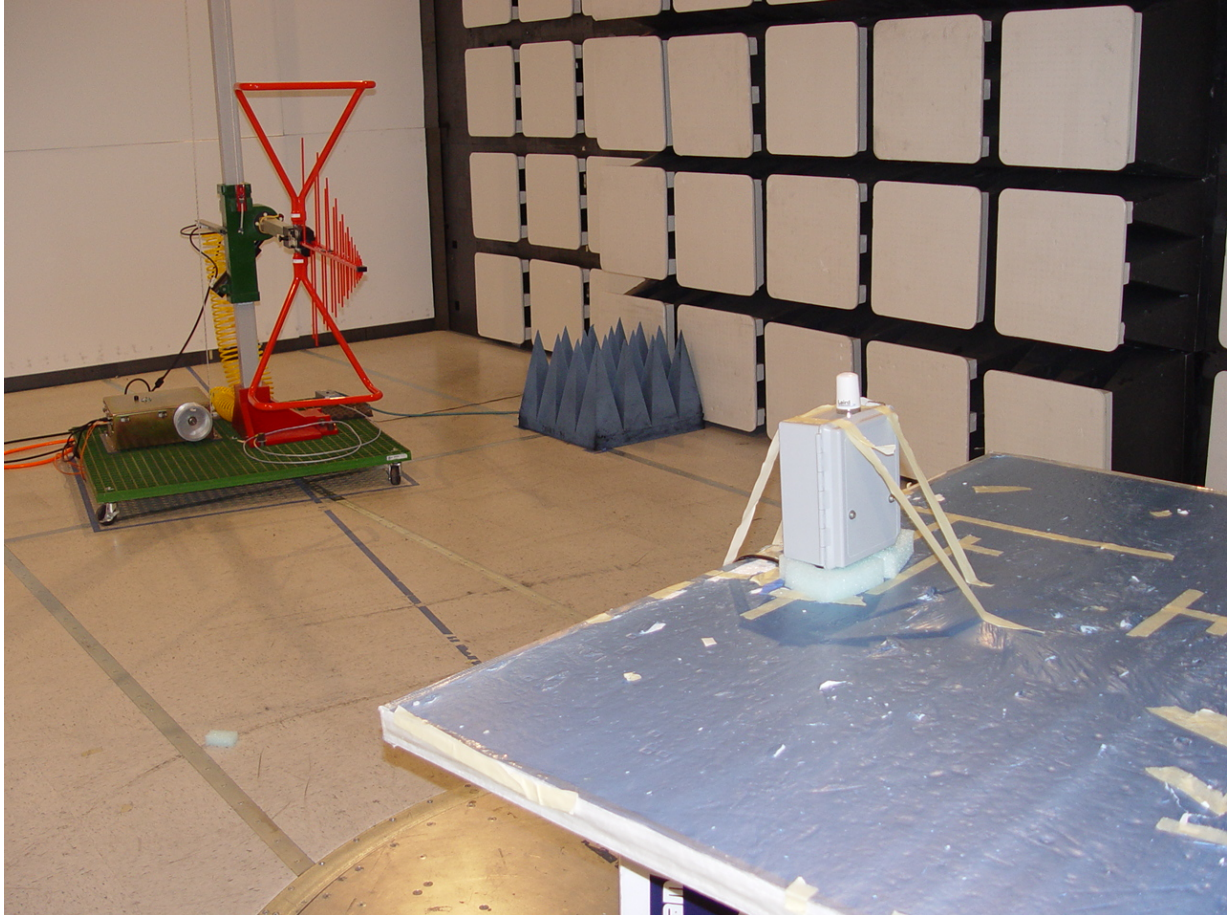
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## 8.5 Navicomm with G2 Radio; Emissions above 1 GHz



## 8.6 Navicomm with 900MHz Radio; Emissions 30 - 1000 MHz



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## 8.7 Navicomm with 900 MHz Radio; Emissions 30 - 1000 MHz



## 8.8 Navicomm emissions on AC Line



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## 9 TEST EQUIPMENT DETAILS

| Asset # | Instrument                 | Manufacturer                  | Model #               | Serial #   |
|---------|----------------------------|-------------------------------|-----------------------|------------|
| 0072    | Signal Generator           | Hewlett Packard               | HP 83640A             | 2927A00105 |
| 0075    | Environmental Chamber      | Theratron                     | SE-300-2-2            | 27946      |
| 0338    | Antenna (30M-3GHz)         | Sunol Sciences                | JB3                   | A052907    |
| 0083    | Coupler                    | Hewlett Packard               | HP 87301D             | 3116A00389 |
| 0287    | EMI Receiver               | Rhode & Schwartz              | ESIB 40               | 100201     |
| 0098    | Oscilloscope               | Hewlett Packard               | 54810A                | US38100105 |
| 0335    | Horn Antenna               | The Electro-Mechanics Company | 3117                  | 00066580   |
| 0116    | Power Sensor               | Hewlett Packard               | 8485A                 | 3318A19694 |
| 0117    | Power Sensor               | Hewlett Packard               | 8487D                 | 3318A00371 |
| 0134    | Amplifier                  | ComPower                      | PA-122                | 181910     |
| 0158    | Barometer /Thermometer     | Control Co.                   | 4196                  | E2844      |
| 0193    | EMI Receiver               | Rhode & Schwartz              | ESI 7                 | 838496/007 |
| 0223    | Power Meter                | Hewlett Packard               | HP EPM-442A           | US37480256 |
| 0252    | K-Cable                    | Megaphase                     | Sucoflex 104          | Unknown    |
| 0253    | K-Cable                    | Megaphase                     | Sucoflex 104          | Unknown    |
| 0256    | K-Cable                    | Megaphase                     | Sucoflex 104          | Unknown    |
| 0251    | K-Cable                    | Megaphase                     | Sucoflex 104          | Unknown    |
| 0305    | 20M-2GHz Amplifier         | ML                            | ML001                 | 001        |
| 0310    | 2m SMA Cable               | Micro-Coax                    | UFA210A-0-0787-3G03G0 | 209089-001 |
| 0312    | 3m SMA Cable               | Micro-Coax                    | UFA210A-1-1181-3G0300 | 209092-001 |
| 0313    | Coupler                    | Hewlett Packard               | 86205A                | 3140A01285 |
| 0314    | 30 dB N-Type Attenuator    | ARRA                          | N944-30               | 1623       |
| Dipole  | 20MHz-1GHz Dipole Antennas | EMCO                          | 3121C                 | 9009-505   |

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