| | |
|---|---|
| Project: | **04RT08419** |
| File: | **MC1884** |
| Report: | **040210C** |
| Date: | **December 15, 2004**<br>(Revised February 8, 2005) |
| Model: | **MP9310 Low-Power RFID Reader Device** |

# Test Report

# On

# Electromagnetic Compatibility Testing

## SAMSys Technologies

**Durham, NC  27713**

## Test Report Details:

| | |
|---|---|
| Tests Performed By: | **Underwriters Laboratories Inc.**<br>**12 Laboratory Drive**<br>**Research Triangle Park, NC 27709** |
| Tests Performed For: | **SAMSys Technologies, Inc.**<br>**2525 Meridian Parkway, Lake Level Suite 60**<br>**Durham, NC 27713 USA** |
| Applicant Contact: | **Michael Koch**<br>**Phone: +1 (919) 281-1576**<br>**Fax: +1 (919) 1551**<br>**Email: Michael.koch@samsys.com** |
| Test Report Number: | **040210** |
| Test Report Date: | **December 15, 2004** - Initial Release<br>(Revision A – 1/31/2005 to include 9 dBi antenna data)<br>(Revision B – 2/3/2005 Revised MPE information)<br>(Revision C – 2/8/2005 TCB requested modifications) |
| Product Type: | **Radio Frequency ID reader** |
| Model Number: | **MP9310** |
| Sample Serial Number: | **unserialized sample** |
| Sample Tag Number: | **S04LB259** |
| EUT Category: | **Transmitter - Low Powered** |
| EUT Type: | **Component** |
| Sample Receive Date: | **November 12, 2004** |
| Testing Start Date: | **November 12, 2004** |
| Date Testing Complete: | **December 15, 2004** |

Underwriters Laboratories Inc. reports apply only to the specific samples tested under stated test conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. Underwriters Laboratories Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from Underwriters Laboratories Inc. issued reports. This report shall not be used to claim, constitute or imply product certification, approval, or endorsement by NVLAP, A2LA, or any agency of the US government.

This report may contain test results that are not covered by the NVLAP or A2LA accreditation. The scope of accreditation is limited to the specific tests that are listed on the NVLAP and/or A2LA certificates provided at the end of this report. Complaints or inquiries regarding the information within this report shall be brought to the attention of the report's author.

## Summary of Testing:

| Test # | Test Name<br>Test Requirement/Specification | Comply | Does Not Comply | See Remark |
|---|---|---|---|---|
| 1 | Conducted Disturbance Emissions - AC Voltage<br>47 CFR Part 15, Subpart B / CISPR 22:1997 Class A | N/A | N/A | 5 |
| 2 | Radiated Spurious Emissions / Unintentional Emissions - 30 to 1000 MHz<br>47 CFR Part 15.247 / 47 CFR Part 15.209 and Part 15.247 (Restricted Band and Spurious)<br>47 CFR Part 15, Subpart B / 47 CFR Part 15, Subpart B, Class B (Unintentional) | X | - | 8 |
| 3 | Radiated Spurious Emissions - Above 1 GHz<br>47 CFR Part 15.247 / 47 CFR Part 15.209 and Part 15.247 (Restricted Band and Spurious) | X | - | 8 |
| 4 | Bandedge<br>47 CFR Part 15 Subpart C / 47 CFR Part 15.247 | X | - | |
| 5 | Conducted Power, Conducted Spurious, and Occupied Bandwidth<br>47 CFR Part 15.247 / ANSI C63.4:2001 | X | - | |
| 6 | Radiated Disturbance Emissions - Peak-to-Average Ratio<br>47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.247 | - | - | 6 |
| 7 | Frequency Hopping Channels, Channel Spacing, and Dwell Time<br>47 CFR Part 15.247 / ANSI C63.4:2001 | X | - | |
| 8 | Maximum Permissible Exposure<br>47 CFR Part 1 Subpart I / 47 CFR Part 1.1307 | X | - | |

**Remarks:**

1) OEM Installation: This device is installed into the host device at the point of manufacture.

2) Environment: The host device for this printer is not intended for residential environment. Class A limits apply for the digital portions of this device.

3) Antenna Connector: Antenna is attached with SMA-type connector that is considered to be “readily available”, however this device will be imbedded within other devices with antenna in the final product.

4) Antennas Tested: Two antennas were used for test:

   a. Minus 2.5 dBi antenna.
   b. Plus 9 dBi antenna.

5) Power: The RFID device is DC powered, therefore AC Conducted Emissions test is not applicable. Voltage is regulated within the device.

6) Peak-to-Average Ratio: No limit apples for Peak-to-Average ratio, however results are used to calculate average emissions.

7) Modifications: These modifications were required to comply:

   a. The manufacturer improved the case design to comply with radiated spurious harmonics.

   b. A shielded Ethernet 10-base-T cable was required to comply with radiated spurious emissions. It is required to instruct the user of this requirement.

8) Restricted Bands: From results of Tests 2 and 3, it is shown that the requirement for compliance with General Limits found in 15.209 is met in all restricted bands found in 15.205.

10) Similar Models: The MP 9310 is available with an optional Ethernet daughter board. All testing was performed with the Ethernet daughter board installed. The data is considered to be applicable to the non-Ethernet product as well without additional testing.

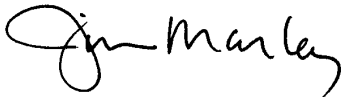
11) Composite Device: This device contains digital electronics subject to FCC Part 15 Subpart B rules. This device was found to comply with FCC Part 15 Subpart B, Class B limits. As testing was performed at a NVLAP-

accredited laboratory, the manufacturer may choose to use a Declaration of Conformity, rather than certification, for this portion of the device.

**Conclusion:**

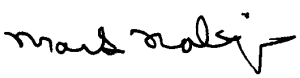
The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

Prepared By:



Jim Marley
NARTE Certified EMC Engineer
EMC-002278-NE
+1 (919) 549-1408
e-mail: james.r.marley@us.ul.com

Reviewed By:



Mark Nolting
NARTE Certified EMC Test Lab Engineer
ATL-0340-E
+1 (919) 549-1584
e-mail: mark.nolting@us.ul.com

## Test Facilities:

**Test Location A) 10-Meter Anechoic Chamber (Industry Canada - IC 2953, NVLAP - 200246-0, VCCI - R-722)**

Constructed by Lindgren RF Enclosures, this room consists of a 17.9 by 12 by 8.3 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones covering the floor between the EUT and antenna are provided when RF immunity testing is performed.

Room is provided with a 4.0 m diameter embedded turntable and a 1.2 by 2.1 m and 2.4 by 2.4 m double knife edge doors for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a permanently mounted video surveillance camera. A remotely controllable antenna mast is located in the room for positioning the measuring antenna from 1 to 4 m above the ground plane.

**Test Location B) Compact Anechoic Chamber**

Constructed by Lindgren RF Enclosures, this room consists of a 6 by 3 by 2.9 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor, and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones cover the floor between the EUT and antenna.

Room is provided with a 1.2 by 2.1 m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a video camera.

**Test Location C) RF Shielded Room (VCCI - C-744, NVLAP - 200246-0)**

Constructed by Lindgren RF Enclosures, this room consists of a 7.3 by 4.3 by 2.7 m (inside clearance) shielded room. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. Room is provided with a 1.2 by 2.1m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a portable video surveillance camera.

**Test Location D) Ground Reference Plane # 1 (VCCI - C-742, NVLAP - 200246-0)**

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m. It is located and bonded next to one vertical wall of the Control Room and is, therefore, provided with a 3.0 by 3.6 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

**Test Location E) Ground Reference Plane # 2 (VCCI - C-743, NVLAP - 200246-0)**

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 4.3 by 5.2 m. It is located and bonded next to one vertical wall of the RFD Shielded Room and is, therefore, provided with a 4.3 by 2.8 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

**Test Location F) Ground Reference Plane # 3**

Horizontal floor ground reference plane constructed of galvanized sheet steel measuring 3.0 by 3.6 m x 2.5mm thick.

**Test Location G) Ground Reference Plane # 4 (Automotive)**

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

**Test Location I) Harmonic Current Test Area -** Located in front of Standard Source Impedance Power Supply.

**Test Location J) Magnetic Field Ground Reference Plane**

Horizontal floor ground reference plane constructed of 1.5 mm thick aluminum measuring 3.6 by 2.4 m.

**Test Location P) Ground Reference Plane # 5**

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

**Test Location R) Ground Reference Plane # 6**

Ground reference plane constructed of galvanized sheet steel measuring 3.0 m x 3.6 m x 2.5 mm thick. CDNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

**Test Location Q) CISPR 12 Outdoor Site**

30 meter diameter non-reflective area located behind the UL-RTP EMC Lab. Test area is used for CISPR 12 testing.

**Test Location X) Other -** As described in the Comments Section of Test Results.

## EUT Information:

**Equipment Used During Test:**

| Use* | Product Type | Manufacturer | Model | Comments |
|---|---|---|---|---|
| EUT | RFID Transmitter | SAMSys Technologies | MP9310 | |
| ACC | Laptop Computer | Dell | - | |
| ACC | Antenna #1 | | | RFID antenna (Minus 2.5 dBi gain) |
| ACC | Antenna #2 | | | RFID antenna (Plus 9 dBi gain) |

* Use = EUT - Equipment Under Test, ACC - Accessory (Not Subjected to Test), or SIM - Simulator (Not Subjected to Test)

**Input/Output Ports:**

| Port # | Name | Type* | Cable Max. >3m | Cable Shielded | Comments |
|---|---|---|---|---|---|
| 0 | Enclosure | N/E | No | No | |
| 1 | DC Power/Serial Interface | DC | No | No | Devices is powered from a single cable from printer host with both DC power and serial I/O |
| 2 | Antenna | N/E | No | No | Connects RFID device to antenna |
| 3 | Ethernet | I/O | Yes | No | Auxiliary I/O (optional). Terminated in Laptop 10-Base-T port |
| | | | | | |

* AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
PMC = Process Measurement and Control Port

**Product Description:**

The device under test is a Radio Frequency Identification (RFID) reader designed to be used with printers. The RFID reader is designed such that it operates as a self-contained device with no dependencies on the host printer. The RFID reader contains onboard voltage regulation to minimize the effects of DC voltage variations supplied by the printer.

The RFID reader requires a 9 dBi gain antenna (or lower gain antenna of the same antenna family) that is external to the RFID reader, however it is mounted within the printer and already installed at the factory. Therefore no installation will be required beyond the normal installation of the printer. If the antenna gain is greater than 8.7 dBi, then output power must be reduced to ensure that no more than 4 Watts EIRP is produced. If antenna gain is greater than 7.5 dBi, then a caution must be provided to the end user to maintain spacing of 23 cm in installation.

The RFID reader operates in the 902-928 MHz band as a frequency hopping spread spectrum device. The hopping algorithm and other information regarding the operation of the device is located in the Operational Description exhibit.

**Canadian Emissions Designator:**

Device is pulse modulated CW signal. Maximum Bandwidth from Test 5 is 145.6 kHz.

Emissions Designator = 146KG1D.

**EUT Internal Operating Frequencies:**

| Frequency (MHz)* | Description |
|---|---|
| 903.1 - 926.9 | Operating Band |
| 10 | Digital Clock |
| | |

| Frequency (MHz)* | Description |
|---|---|
| | |
| | |
| | |

**Power Interface:**

| Mode # | Voltage (V) | Current (A) | Power (W) | Frequency (DC/AC-Hz) | Phases (#) | Comments |
|---|---|---|---|---|---|---|
| Rated | 120 | - | - | 60 | 1 | AC voltage supplied to host |
| 1 | 5 | - | - | DC | 1 | Voltage supplied to RFID device |
| | | | | | | |

**EUT Operation Modes:**

| Mode # | Description |
|---|---|
| 1 | RFID transmitter is transmitting on low channel. Device operating at full output power. |
| 2 | RFID transmitter is transmitting on mid channel. Device operating at full output power. |
| 3 | RFID transmitter is transmitting on high channel. Device operating at full output power. |
| 4 | RFID transmitter is transmitting while hopping normally. Device operating at full output power. |
| 5 | RFID transmitter is powered on, however the RF carrier is turned off. |
| | |

**EUT Configuration Modes:**

| Mode # | Description |
|---|---|
| 1 | RFID transmitter is located on a non-conductive table. The laptop is connected to the RFID device (device interface/power) and laptop computer (serial port). The RFID body is located in the x orientation (flat). The highest gain orientation of the transmit antenna is pointed toward the receive antenna during rotation. **Minus 2.5 dBi antenna** attached. |
| 2 | Same as 1, except RFID body is located in the y orientation (on side). |
| 3 | Same as 1, except RFID body is located in the z orientation (on end). |
| 4 | RFID transmitter is located on a non-conductive table. The laptop is connected to the RFID device (device interface/power) and laptop computer (serial port). The RFID body is located in the x orientation (flat). The highest gain orientation of the transmit antenna is pointed toward the receive antenna during rotation. **9 dBi antenna** attached. |
| 5 | Same as 4, except RFID body is located in the y orientation (on side). |
| 6 | Same as 4, except RFID body is located in the z orientation (on end). |
| | |

## Test 1: Conducted Disturbance Emissions - Voltage

**Test Requirement:** 47 CFR Part 15, Subpart B

**Test Specification:** CISPR 22:1997 Class B

**Test Procedure:**

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was connected to the proper supply source via a Line Impedance Stabilization Network (LISN). The Measuring Receiver was connected to the Port under test via the LISN. A peak measurement was first made at the test point across the test frequency range over a one minute test period. Then, Quasi-Peak or Average measurements were taken and recorded under Discrete Data. This was repeated for each conductor of the test port except for equipment grounding.

Conducted Disturbance Emission Limits For
Mains Terminals of Class A Equipment

| Frequency (MHz) | Quasi-Peak Limit dB μV | Average Limit dB μV |
|---|---|---|
| 0.15 to 0.50 | 79 | 66 |
| 0.50 to 5 | 73 | 60 |
| 5 to 30 | 73 | 60 |

**Note:**

Test is not applicable. Equipment under test is DC powered.

## Test 2: Radiated Spurious Emissions/Unintentional Emissions - 30 to 1000 MHz

**Test Requirement:** 47 CFR Part 15.247

**Test Specification:** ANSI C63.4:2001

**Test Procedure:**

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was placed inside the anechoic chamber on a non-conductive table with a fresh battery installed or operating at nominal voltage. The EUT was rotated from 0 to 360 degrees with the receive antenna scanned from 1 to 4 meters in height in vertical and horizontal polarities. All emissions close to the applicable limit were then measured with the appropriate detector (quasi-peak or average). All peak emissions were verified to be below the limits below.

Radiated Disturbance Limits for Spread Spectrum Transmitters - Section 15.247

| Fundamental Frequency (MHz) | Hopping Channels | Permissible Output Power (milliwatts) | Permissible Output Power (dBm) | Permissible Spurious Emissions (milliwatts) | Permissible Spurious Emissions (dBm) |
|---|---|---|---|---|---|
| 902 – 928 | 25 to 49 | 250 | 24 | 25 | 14 |
| | 50 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |
| 2400 – 2483 | 15 to 74 | 125 | 21 | 12.5 | 11 |
| | 75 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |
| 5725 – 5850 | 75 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |

Other than fixed point-to-point applications, power adjustment for antenna gain is as follows:

Gain of 6 dBi or less . . . . . No reduction is required
Gain greater than 6 dBi . . . . . Reduce the maximum output power by 1 dB for each 1 dB of antenna gain above 6 dBi

Radiated Disturbance Limits for Class B Equipment
at a measuring distance of 3m.

| Frequency Range MHz | Quasi-Peak Limits μV/m | Quasi-Peak Limits dBμV/m |
|---|---|---|
| 30 to 88 | 100 | 40.00 |
| 88 to 216 | 150 | 43.52 |
| 216 to 960 | 200 | 46.02 |
| Above 960 | 500 | 53.97 |

**Test Deviations:**

None

**Test Setup:** Only the following ports were tested. See EUT Information for details.

| Test Item | Port # | Port Name | EUT Operation Mode | EUT Configuration | Power Interface |
|---|---|---|---|---|---|
| A | 0 | Enclosure | 5 (RF Off, Unintentional Emissions, -2.5 dBi antenna) | 1 | 1 |
| B | 0 | Enclosure | 4 (Rf On, 800-1000 Spurious, matched load) | 1 | 1 |
| C | 0 | Enclosure | 5 (RF Off, Unintional Emissions, 9 dBi antenna) | 4 | 1 |

**Test 2 - Results:** Radiated Spurious Emissions/Unintentional Emissions - 30 to 1000 MHz

**Test Results Summary:**

| Test Item | Test Location | Humidity (%) | Temperature (ºC) | Pressure (kPa) | Pass/Fail (P/F) | Date Completed | Comment # |
|---|---|---|---|---|---|---|---|
| A | A | 41 | 24 | 100 | P | 12/14/04 | 1 |
| B | A | 33 | 24 | 102 | P | 11/15/04 | |
| C | A | 36 | 24 | 101 | P | 1/20/05 | 1 |

The EUT was considered to **Pass** the Requirements.

**Comments:**

| Comment # | Description |
|---|---|
| 1 | Note: Data recorded with RFID body in the x-orientation (flat). From preliminary testing, emissions in this frequency range were not affected significantly by the orientation of the RFID body. |
| | |
| | |
| | |

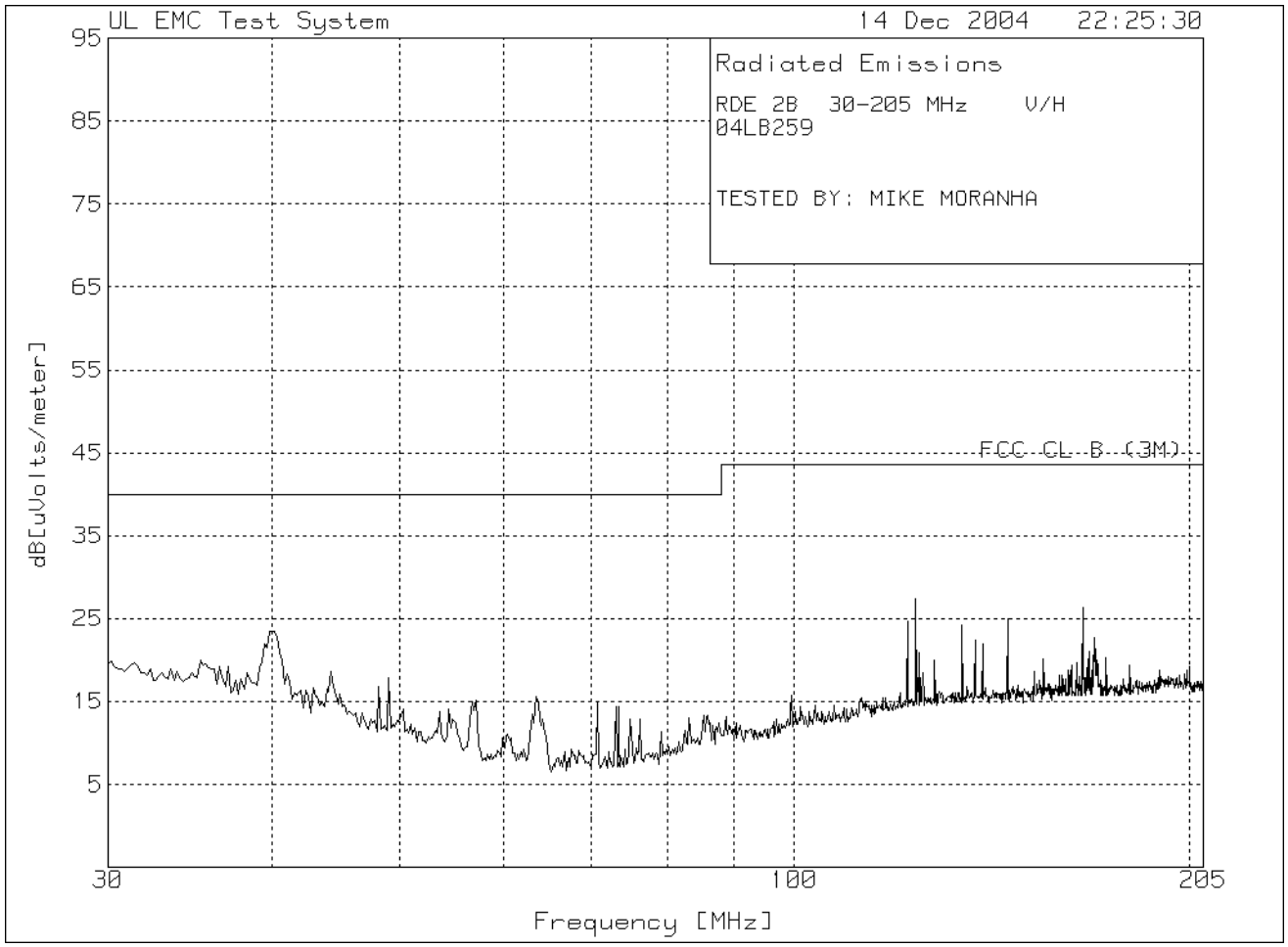
**Test 2 - Test Equipment Used:** Radiated Spurious Emissions/Unintentional Emissions - 30 to 1000 MHz

| Equipment ID | Description | Manufacturer | Model Number | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| AT0025 | Biconical Antenna, 30 to 300 MHz | Schaffner, EMC | VBA6106A | 3/22/04 | 3/31/05 |
| AT0030 | Log periodic Antenna, 200 MHz to 1000 MHz | Schaffner, EMC | 3160-07 | 2/9/04 | 2/28/05 |
| ATA084 | Attenuator 6 dB, 2 GHz | Pasternack | PE7002-6 | 3/11/04 | 3/31/05 |
| ATA085 | Attenuator 6 dB, 2 GHz | Pasternack | PE7002-6 | 3/11/04 | 3/31/05 |
| ATA096 | 50 ft, N male - N male | Micro-Coax | Coaxial Cable | 3/11/04 | 3/31/05 |
| ATA124 | RF Amplifier, 1 to 1000 MHz | Miteq | AM-3A-000110-N | 3/11/04 | 3/31/05 |
| ATA125 | RF Amplifier, 1 to 1000 MHz | Miteq | AM-3A-000110-N | 3/11/04 | 3/31/05 |
| ATA140 | RG214 Ferrite Cable | EMC Eupen | N/A | 3/11/04 | 3/31/05 |
| ATA143 | Cable, 6ft., N-male to N-male | Micro-Coax | N/A | 3/11/04 | 3/31/05 |
| ATA167 | RG214 Ferrite Cable | EMC Eupen | N/A | 3/11/04 | 3/31/05 |
| SAR001 | Spectrum Analyzer / Receiver | Hewlett-Packard | 8572A | 2/2/04 | 2/28/05 |
| | | | | | |

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

**Test 2, Item A - Peak Plot (Amplitude in dBuV/m):**

Radiated Spurious Emissions/Unintentional Emissions - 30 to 200 MHz
(RF Off, Unintentional Emissions)



**Test 2, Item A - Discrete Data:**

Radiated Spurious Emissions/Unintentional Emissions - 30 to 200 MHz

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Quasi-Peak Limit (dBuV/m) | Spec Margin (dB) | See Comment (#)** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | V | 3 | 121.967 | 40.15 | -15.5 | 24.65 | 43.5 | -18.85 | |
| A | P | V | 3 | 123.718 | 42.65 | -15.2 | 27.45 | 43.5 | -16.05 | |
| A | P | V | 3 | 134.229 | 38.81 | -14.6 | 24.21 | 43.5 | -19.29 | |
| A | P | V | 3 | 137.382 | 36.99 | -14.5 | 22.49 | 43.5 | -21.01 | |
| A | P | V | 3 | 145.440 | 39.25 | -14.2 | 24.95 | 43.5 | -18.55 | |
| A | P | H | 3 | 165.936 | 40.38 | -14.0 | 26.38 | 43.5 | -17.12 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

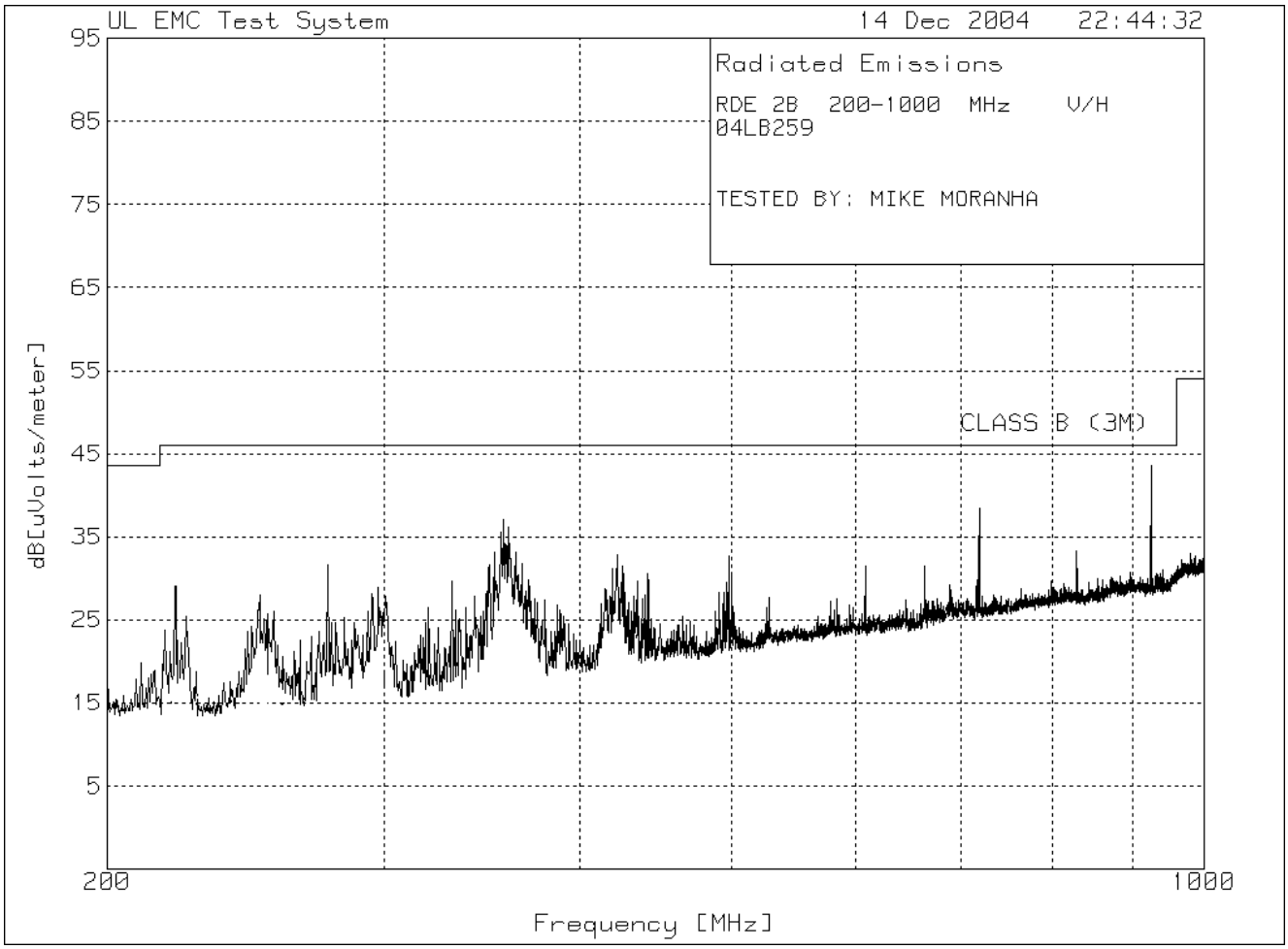
** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Test 2, Item A - Peak Plot (Amplitude in dBuV/m):**

Radiated Spurious Emissions/Unintentional Emissions - 200 to 1000 MHz – Minus 2.5 dBi antenna
(RF Off, Unintentional Emissions)



**Test 2, Item A - Discrete Data:**

Radiated Spurious Emissions/Unintentional Emissions - 200 to 1000 MHz – Minus 2.5 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Quasi-Peak Limit (dBuV/m) | Spec Margin (dB) | See Comment (#)** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | H | 3 | 220.810 | 45.6 | -16.5 | 29.1 | 46 | -16.9 | |
| A | P | H | 3 | 276.438 | 45.9 | -14.3 | 31.6 | 46 | -14.4 | |
| A | P | H | 3 | 357.279 | 48.8 | -11.8 | 37.0 | 46 | -9.0 | |
| A | P | H | 3 | 422.911 | 43.1 | -10.2 | 32.9 | 46 | -13.1 | |
| A | P | H | 3 | 497.749 | 40.4 | -8.1 | 32.3 | 46 | -13.7 | |
| A | P | H | 3 | 719.059 | 42.5 | -4.1 | 38.4 | 46 | -7.6 | |
| A | P | H | 3 | 829.515 | 35.9 | -2.7 | 33.2 | 46 | -12.8 | |
| A | P | H | 3 | 924.762 | 45.4 | -1.8 | 43.6 | 46 | -2.4 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

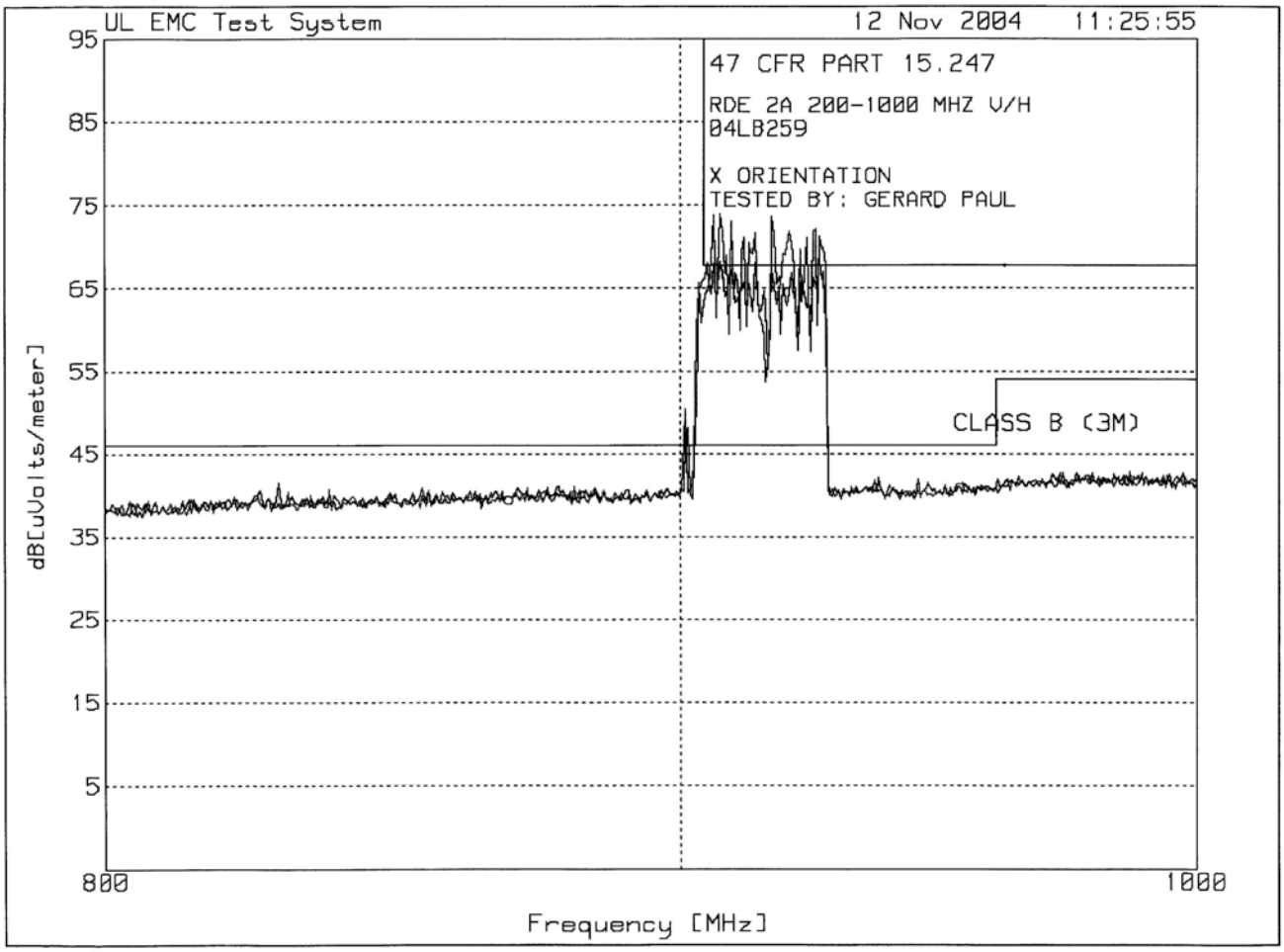
** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Test 2, Item B - Peak Plot:**

Radiated Spurious Emissions/Unintentional Emissions - 800 to 1000 MHz – Matched Load
(RF On, Spurious Emissions near transmit frequency)




Quasi-peak measurement at 901.200 MHz

| Frequency (MHz) | Meter Reading (dBuV) | Cable/Amplifier Factor (dB) | Antenna Factor (dB/m) | Field Strength (dBuV/m) | Gerenal Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 901.200 | -0.56 | 11.7 | 23.7 | 34.84 | 46 | -11.16 |

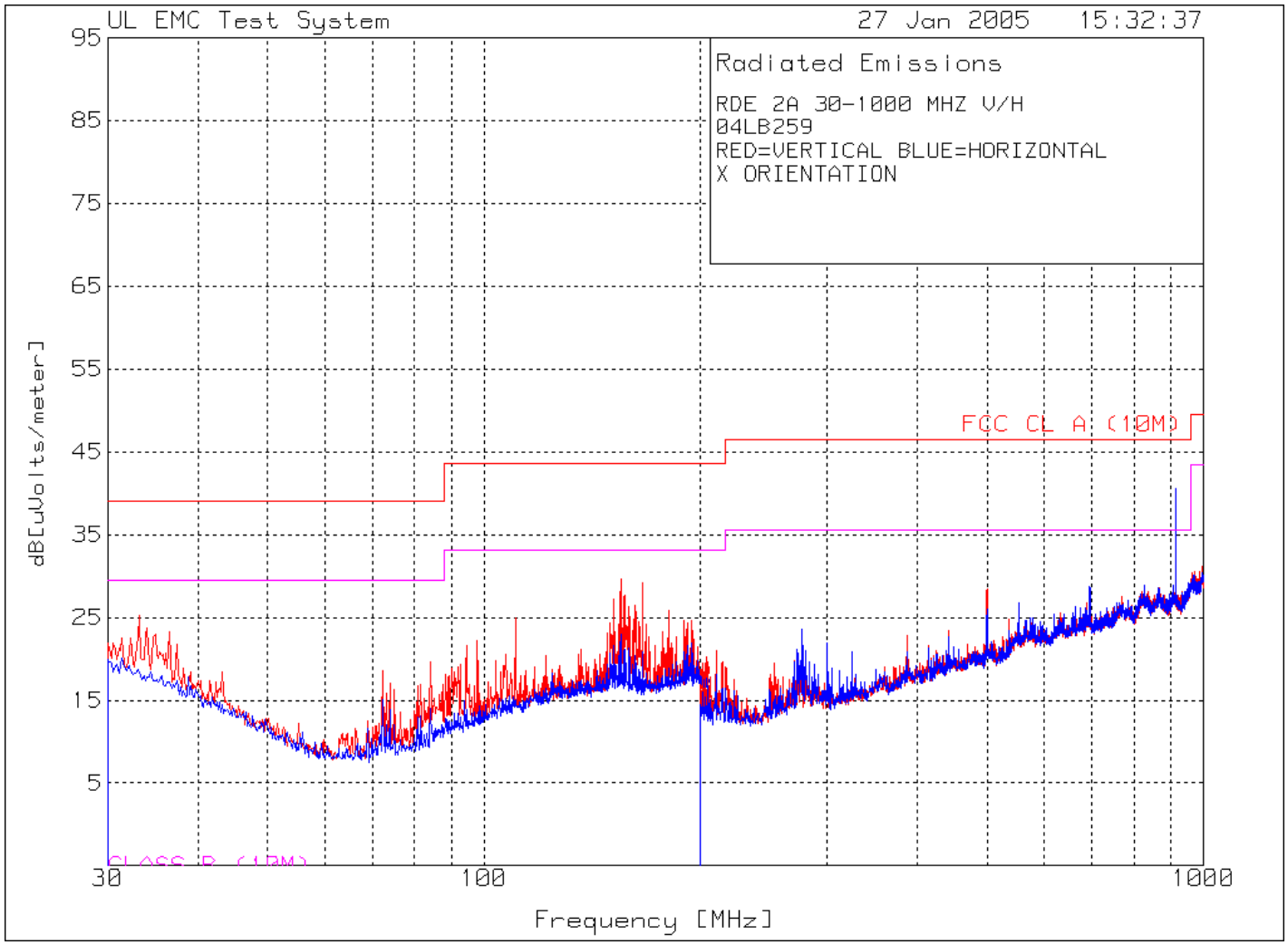
Note: In this range the antenna was replaced with a match impedance load so that radiated emissions near the transmit frequency could be observed. All measurements with significant spurious emissions (multiples of transmit frequency) was measured with antenna in place.

Peak emission observed at 901.2 MHz (just outside band edge) was a momentary emission present only during hopping that was measured below the general limit when measured with a quasi-peak detector.

Product in X-orientation shown. Y-orientation and Z-orientation performed similarly.

**Test 2, Item C - Peak Plot:**

Radiated Spurious Emissions/Unintentional Emissions - 30 to 1000 MHz – 9 dBi antenna
(RF Off, Unintentional Emissions)




Note: Measurement performed at 10 meter distance with Class B limit extrapolated as 20 dB/decade. Emission from transmitter local oscillator in 902-928 MHz band is disregarded.

**Test 2, Item C - Discrete Data:**

Radiated Spurious Emissions/Unintentional Emissions - 30 to 1000 MHz – 9 dBi Antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Quasi-Peak Limit (dBuV/m) | Spec Margin (dB) | See Comment (#)** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | V | 10 | 33.1532 | 37.0 | -11.8 | 25.2 | 29.5 | -4.3 | |
| A | P | V | 10 | 110.580 | 40.9 | -14.0 | 24.9 | 33.1 | -8.2 | |
| A | P | V | 10 | 155.000 | 43.3 | -13.6 | 29.7 | 33.1 | -3.4 | |
| A | P | V | 10 | 500.150 | 38.6 | -10.1 | 28.5 | 35.6 | -7.1 | |
| A | P | H | 10 | 915.157 | 44.7 | -4.2 | 40.5 | 35.6 | +4.9 | 2 |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Comments:**

| Comment # | Description |
|---|---|
| 1 | Data recorded with RFID body in the x-orientation (flat). From preliminary testing, emissions in this frequency range were not affected significantly by the orientation of the RFID body. |
| 2 | Measurement performed at 10 meter distance with Class B limit extrapolated as 20 dB/decade. Emission from transmitter local oscillator in 902-928 MHz band is disregarded |
| | |
| | |

**Test 2, Item A - Test Set-Up Photo - Maximum Emissions Configuration:**

Radiated Spurious Emissions/Unintentional Emissions - 30 MHz to 10 GHz – Minus 2.5 dBi antenna


Laptop computer is not visible behind easel. See next page.

**Test 2, Item A - Test Set-Up Photo - Maximum Emissions Configuration:**

Radiated Spurious Emissions/Unintentional Emissions - 30 MHz to 10 GHz – Minus 2.5 dBi antenna


Note: Styrofoam added below EUT to reduce reflection of emissions from wooden tabletop at high frequencies. EUT is shown in the “X Orientation” or flat. Antenna is positioned to be pointed with direction of maximum gain toward receive antenna. Measurements were also performed with EUT positioned on side and on end as shown below:

X – Orientation  Y – Orientation  Z – Orientation

**Test 2, Item C - Test Set-Up Photo - Maximum Emissions Configuration:**

Radiated Spurious Emissions/Unintentional Emissions - 30 MHz to 10 GHz – 9 dBi antenna

**Test 2, Item C - Test Set-Up Photo - Maximum Emissions Configuration:**

Radiated Spurious Emissions/Unintentional Emissions - 30 MHz to 10 GHz – 9 dBi antenna

## Test 3: Radiated Spurious Emissions - Above 1 GHz

**Test Requirement:** 47 CFR Part 15.247

**Test Specification:** ANSI C63.4:2001

**Test Procedure:**

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was placed inside the anechoic chamber on a non-conductive table with a fresh battery installed or operating at nominal voltage. The EUT was rotated from 0 to 360 degrees with the receive antenna scanned from 1 to 4 meters in height in vertical and horizontal polarities. All emissions close to the applicable limit were then measured with the appropriate detector (quasi-peak or average). All peak emissions were verified to be below the limits below.

Radiated Disturbance Limits for Spread Spectrum Transmitters - Section 15.247

| Fundamental Frequency (MHz) | Hopping Channels | Permissible Output Power (milliwatts) | Permissible Output Power (dBm) | Permissible Spurious Emissions (milliwatts) | Permissible Spurious Emissions (dBm) |
|---|---|---|---|---|---|
| 902 – 928 | 25 to 49 | 250 | 24 | 25 | 14 |
| | 50 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |
| 2400 – 2483 | 15 to 74 | 125 | 21 | 12.5 | 11 |
| | 75 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |
| 5725 – 5850 | 75 or more | 1000 | 30 | 100 | 20 |
| | Digital Modulation | 1000 | 30 | 100 | 20 |

Other than fixed point-to-point applications, power adjustment for antenna gain is as follows:

Gain of 6 dBi or less . . . . . No reduction is required
Gain greater than 6 dBi . . . . . Reduce the maximum output power by 1 dB for each 1 dB of antenna gain above 6 dBi

Radiated Disturbance Limits for Class B Equipment at a measuring distance of 3m.

| Frequency Range MHz | Quasi-Peak Limits μV/m | Quasi-Peak Limits dBμV/m |
|---|---|---|
| 30 to 88 | 100 | 40.00 |
| 88 to 216 | 150 | 43.52 |
| 216 to 960 | 200 | 46.02 |
| Above 960 | 500 | 53.97 |

**Test Setup:** Only the following ports were tested. See EUT Information for details.

| Test Item | Port # | Port Name | EUT Operation Mode | EUT Configuration | Power Interface |
|---|---|---|---|---|---|
| Items A-C performed with Minus 2.5 dBi antenna | | | | | |
| A | 0 | Enclosure | 4 (Hopping Normally) | 1 (X-orientation) | 1 |
| B | 0 | Enclosure | 4 (Hopping Normally) | 2 (Y-orientation) | 1 |
| C | 0 | Enclosure | 4 (Hopping Normally) | 3 (Z-orientation) | 1 |
| Items D-F performed with 9 dBi antenna | | | | | |
| D | 0 | Enclosure | 4 (Hopping Normally) | 1 (X-orientation) | 1 |
| E | 0 | Enclosure | 4 (Hopping Normally) | 2 (Y-orientation) | 1 |
| F | 0 | Enclosure | 4 (Hopping Normally) | 3 (Z-orientation) | 1 |

**Test 3 - Results:** Radiated Spurious Emissions - Above 1 GHz

**Test Results Summary:**

| Test Item | Test Location | Humidity (%) | Temperature (ºC) | Pressure (kPa) | Pass/Fail (P/F) | Date Completed | Comment # |
|---|---|---|---|---|---|---|---|
| A - C | A | 41 | 24 | 100 | P | 12/14/04 | 1 |
| D – F | A | 36 | 24 | 101 | P | 1/20/05 | 2 |

The EUT was considered to **Pass** the Requirements.

**Comments:**

| Comment # | Description |
|---|---|
| 1 | Testing from 1 to 10 GHz was performed in two frequency bands. 1 to 4 GHz used a notch filter to suppress the 902-928 MHz carrier. 4 to 10 GHz used a high pass filter with an approximate 3 GHz cutoff frequency. |
| 2 | Same comment as #1, however a 3 GHz breakpoint was used. |
| | |
| | |

**Test 3 - Test Equipment Used:** Radiated Spurious Emissions - Above 1 GHz

| Equipment ID | Description | Manufacturer | Model Number | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| AT0026 | Horn Antenna, 1 to 18 GHz | EMC Test Systems | 3115 | 6/8/04 | 6/30/05 |
| ATA096 | 50 ft, N male - N male | Micro-Coax | Coaxial Cable | 3/11/04 | 3/31/05 |
| ATA143 | Cable, 6ft., N-male to N-male | Micro-Coax | N/A | 3/11/04 | 3/31/05 |
| ATA144 | Amplifier, 0.1 to 18 GHz | Miteq | AFS42-00101800-2 | 3/11/04 | 3/31/05 |
| ATA152 | 27 ft. N male - N male low loss cable | Micro-Coax | UFB293C-0-3149-50504 | 2/21/04 | 2/29/05 |
| SAR001 | Spectrum Analyzer / Receiver | Hewlett-Packard | 8572A | 2/2/04 | 2/28/05 |
| Filters used for Minus 2.5 dBi antenna testing | | | | | |
| ATA163 | High Pass Filter, 3.6 GHz cutoff frequency, N-male to N-female | UL | N/A | See Note* | See Note* |
| ZATA31 | Notch filter, Tunable 900 to 2.5 GHz | Eastern Wireless | - | See Note* | See Note* |
| Filters used for 9 dBi antenna testing | | | | | |
| ATA185 | High Pass Filter, 1.1 GHz cutoff frequency, SMA-male to SMA-fem. | Microcircuits | VHF-1320 | 11/29/04 | 11/30/05 |
| ATA187 | High Pass Filter, 3 GHz cutoff frequency, SMA-male to SMA-fem. | Microcircuits | VHF-2275 | 11/29/04 | 11/29/05 |

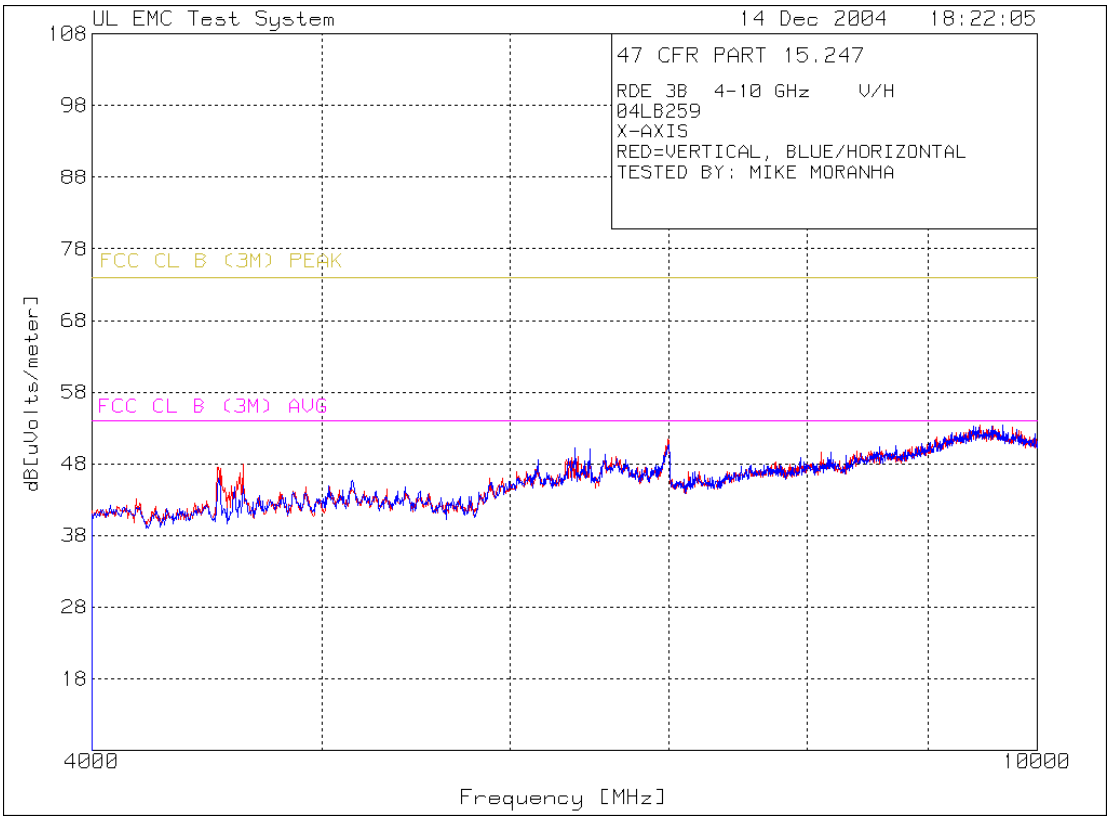
The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

* Insertion Loss measured prior to test.

**Test 3, Item A - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (X-Orientation) – Minus 2.5 dBi antenna


Note: Broad emission from 1000 to 1400 MHz is due to mathematical correction for notch filter loss. No spurious emission was observed in this band.




Note floor for measurement system approached limit at 9500 MHz. It was verified that no spurious emission was present by repositioning receive antenna to a 1 meter distance with no increase in emissions observed.

**Test 3, Item A - Discrete Data (X-Orientation):**

Radiated Spurious Emissions - Above 1 GHz – Minus 2.5 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | H | 3 | 2777.778 | 45.57 | -0.9 | 44.67 | 54 | -9.33 | |
| A | P | H | 3 | 3623.123 | 45.52 | 5.3 | 50.82 | 54 | -3.18 | |
| A | P | V | 3 | 4516.344 | 39.28 | 8.3 | 47.58 | 54 | -6.42 | |
| A | P | V | 3 | 4628.419 | 39.83 | 8.1 | 47.93 | 54 | -6.07 | |
| A | P | V | 3 | 5148.766 | 35.64 | 10.1 | 45.74 | 54 | -8.26 | |
| A | P | H | 3 | 6389.593 | 37.81 | 12.5 | 50.31 | 54 | -3.69 | |
| A | P | H | 3 | 6989.993 | 36.83 | 14.6 | 51.43 | 54 | -2.57 | Noise Floor |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

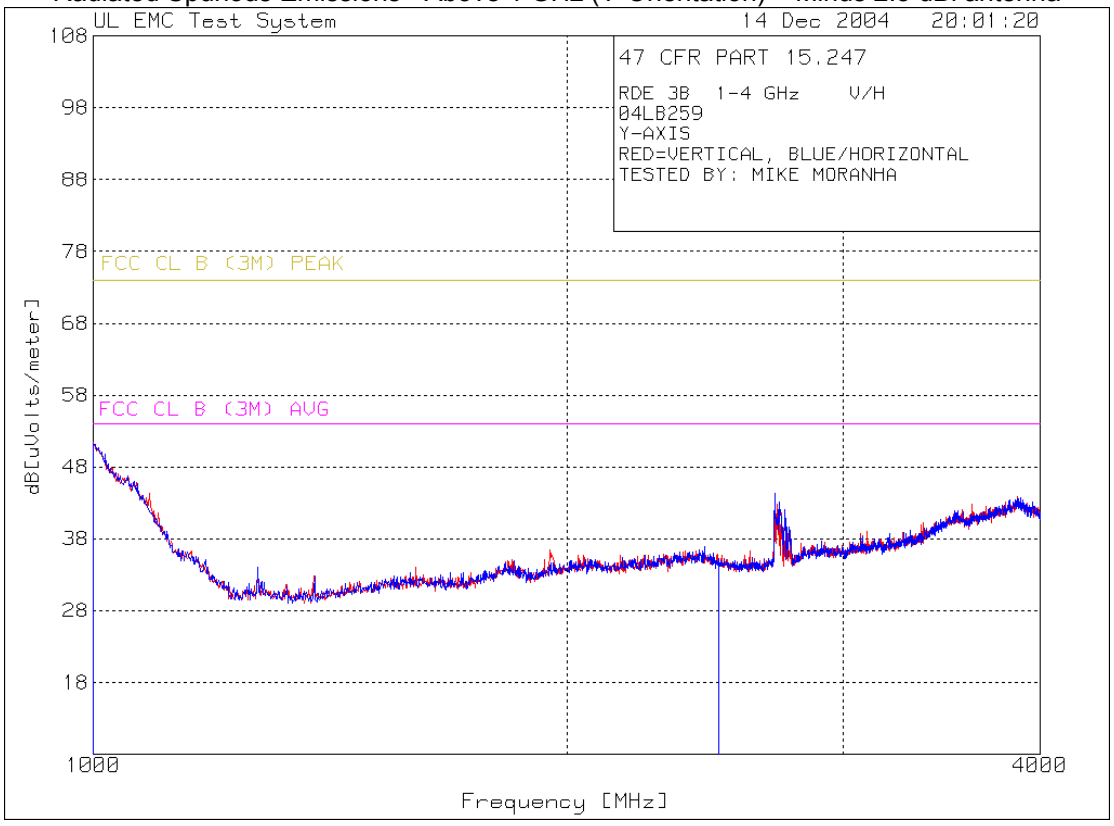
*** # = See Comment Number Under This Test's Comments Section.

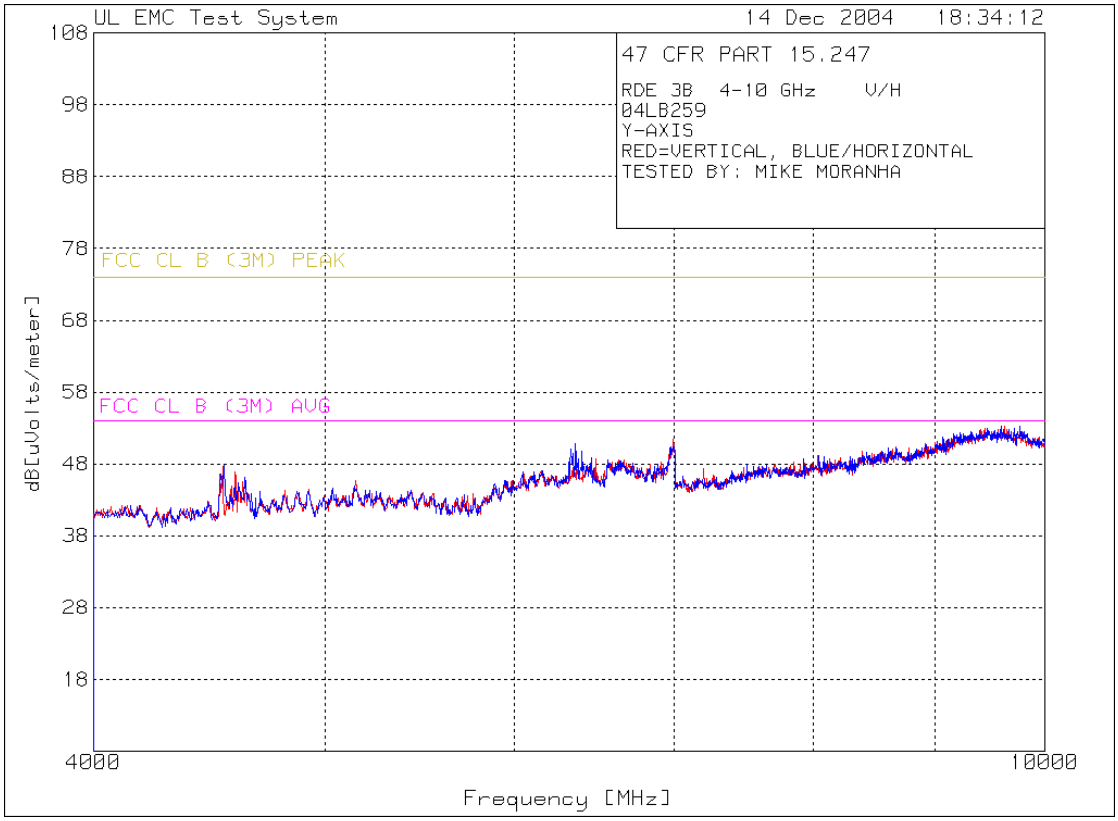
Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Test 3, Item B - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (Y-Orientation) – Minus 2.5 dBi antenna



**Test 3, Item B - Discrete Data (Y-Orientation):**

Radiated Spurious Emissions - Above 1 GHz (Y-Orientation) – Minus 2.5 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | H | 3 | 2713.213 | 45.39 | -1.0 | 44.39 | 54 | -9.61 | |
| A | P | V | 3 | 4528.352 | 38.35 | 9.3 | 47.65 | 54 | -6.35 | |
| A | P | V | 3 | 4584.390 | 38.35 | 8.6 | 46.95 | 54 | -7.05 | |
| A | P | H | 3 | 6361.574 | 38.51 | 12.3 | 50.81 | 54 | -3.19 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

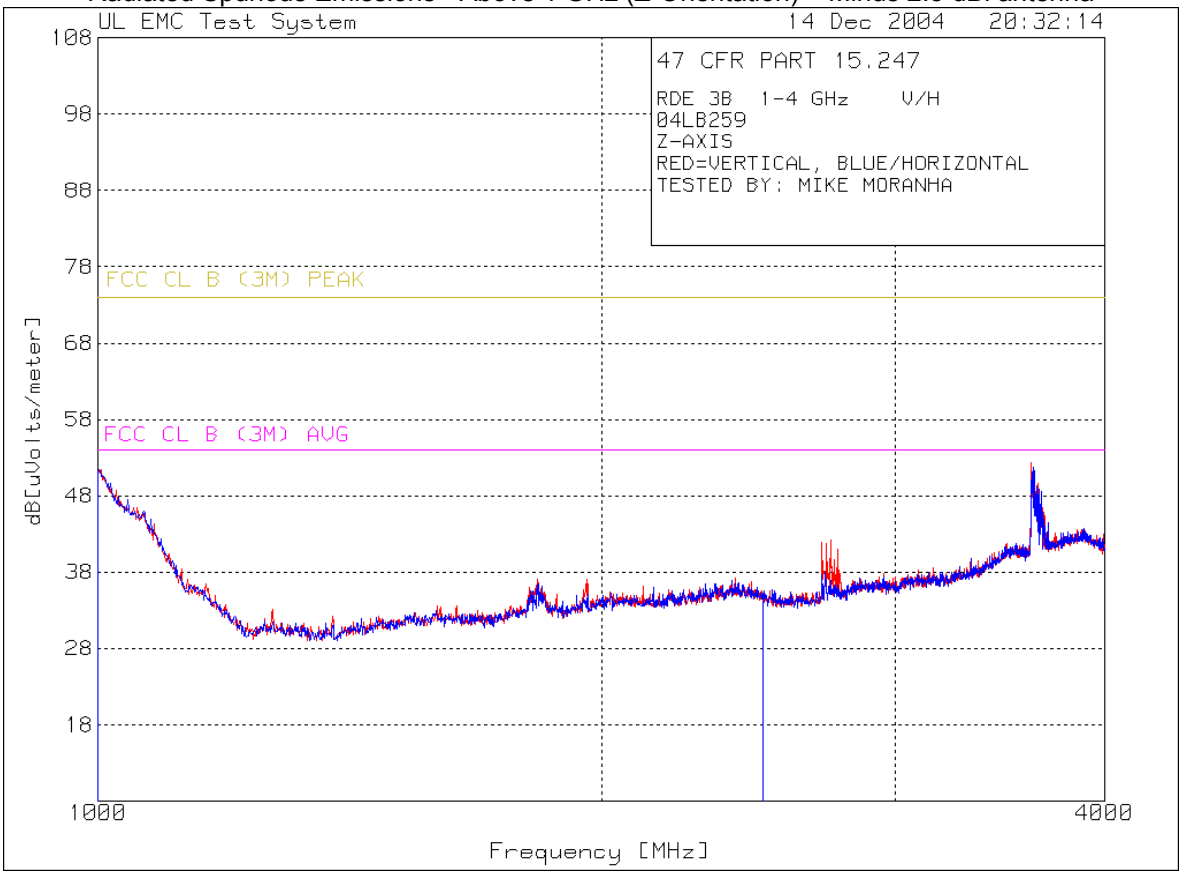
*** # = See Comment Number Under This Test's Comments Section.

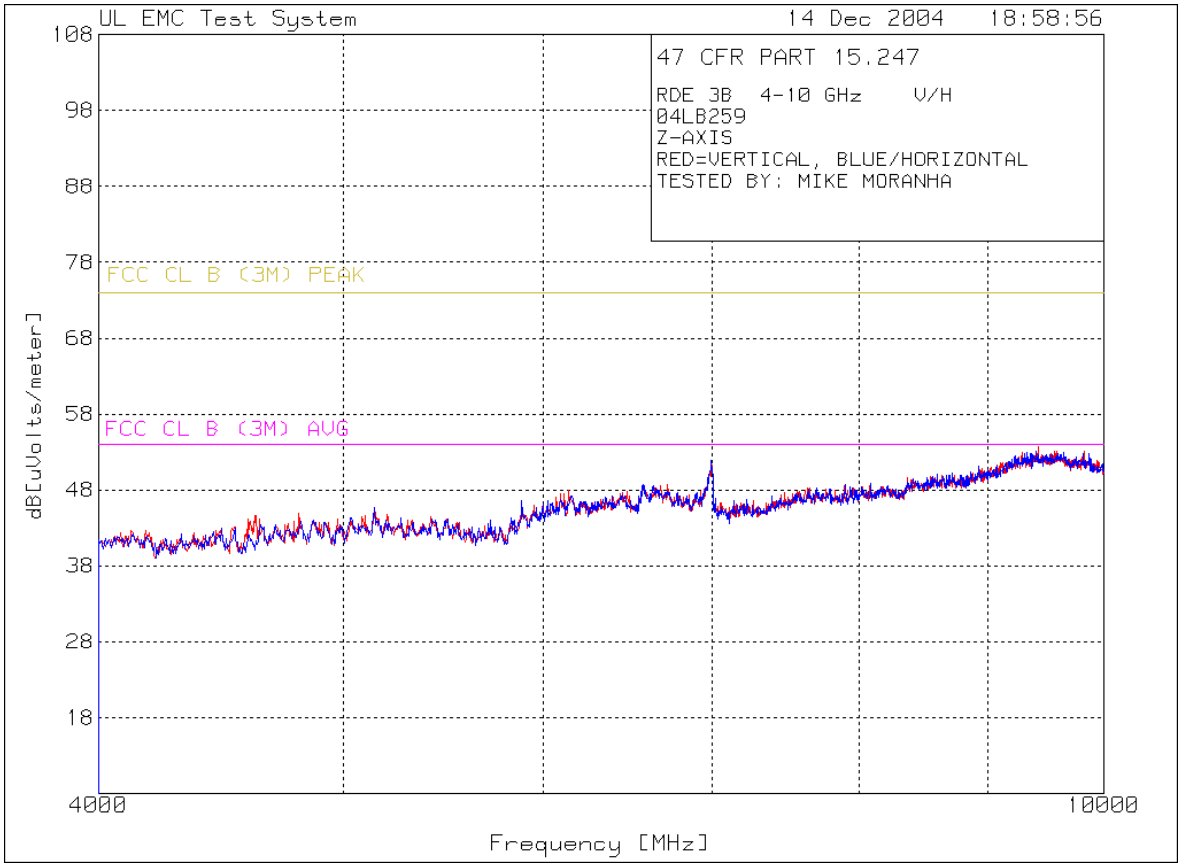
Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Test 3, Item C - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (Z-Orientation) – Minus 2.5 dBi antenna



**Test 3, Item C - Discrete Data (Z-Orientation):**

Radiated Spurious Emissions - Above 1 GHz (Z-Orientation) - Minus 2.5 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | V | 3 | 1831.832 | 40.97 | -3.9 | 37.07 | 54 | -16.93 | |
| A | P | V | 3 | 2741.742 | 43.41 | -1.2 | 42.21 | 54 | -11.79 | |
| A | P | V | 3 | 3615.616 | 47.21 | 5.2 | 52.41 | 54 | -1.59 | |
| A | P | V | 3 | 4616.411 | 37.39 | 7.3 | 44.69 | 54 | -9.31 | |
| A | P | V | 3 | 6137.425 | 35.84 | 12.1 | 47.94 | 54 | -6.06 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

*** # = See Comment Number Under This Test's Comments Section.

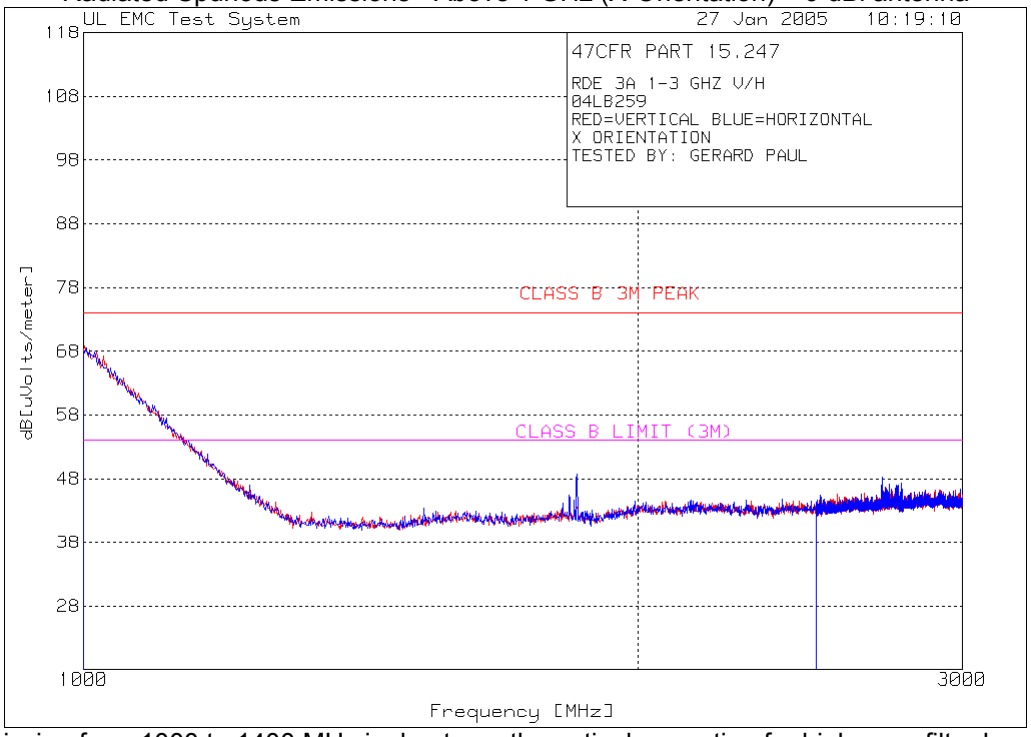
Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

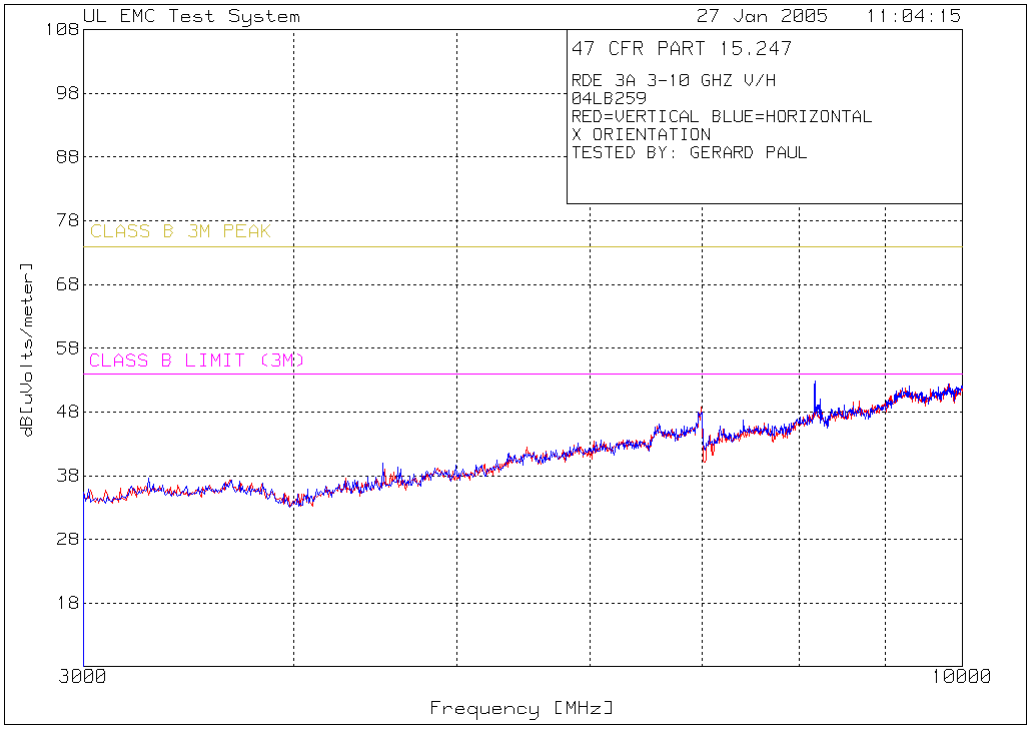
| Comment # | Description |
|---|---|
| | |

**Test 3, Item D - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (X-Orientation) – 9 dBi antenna




Note: Broad emission from 1000 to 1400 MHz is due to mathematical correction for high-pass filter loss. No spurious emission was observed in this band.



**Test 3, Item D - Discrete Data (X-Orientation):**

Radiated Spurious Emissions - Above 1 GHz – 9 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | H | 3 | 8171.171 | 35.4 | 17.5 | 52.9 | 54 | -1.1 | |
| A | P | H | 3 | 9292.092 | 30.5 | 21.6 | 52.1 | 54 | -1.9 | |
| A | P | H | 3 | 9810.811 | 29.1 | 23.3 | 52.4 | 54 | -1.6 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

*** # = See Comment Number Under This Test's Comments Section.

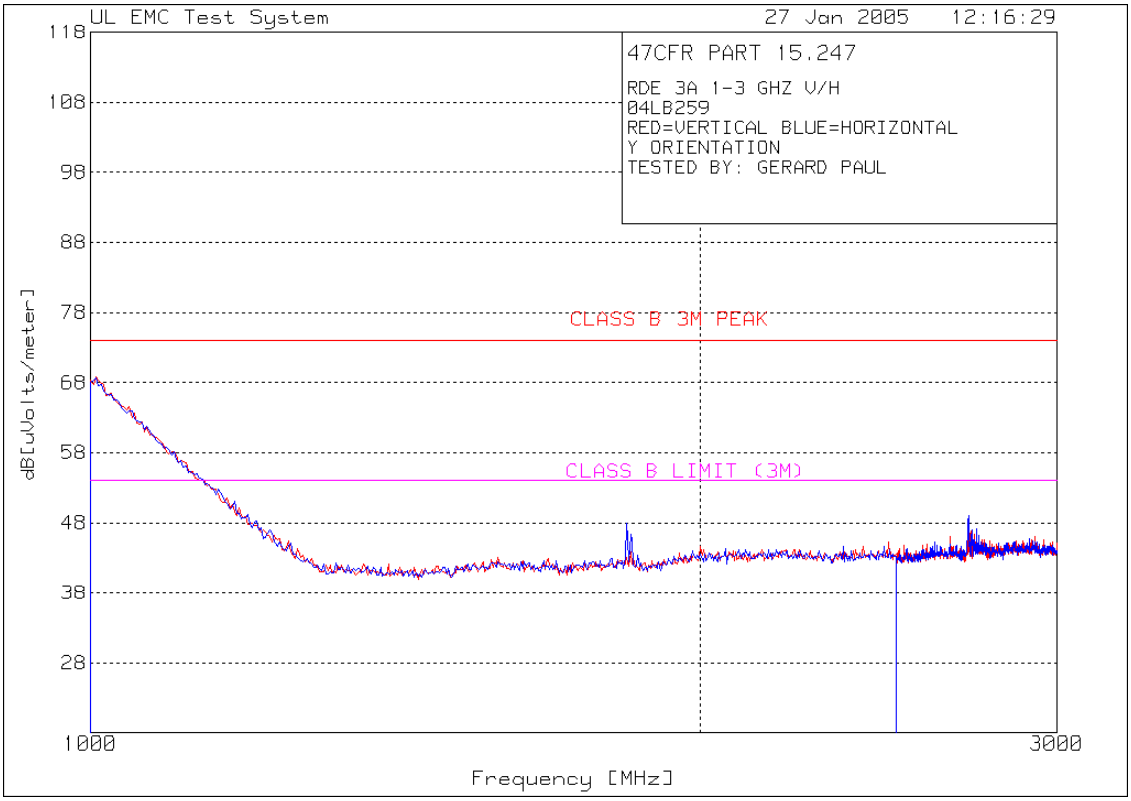
Sample Calculation: Corrected Value = Measured Value + Equip Correction

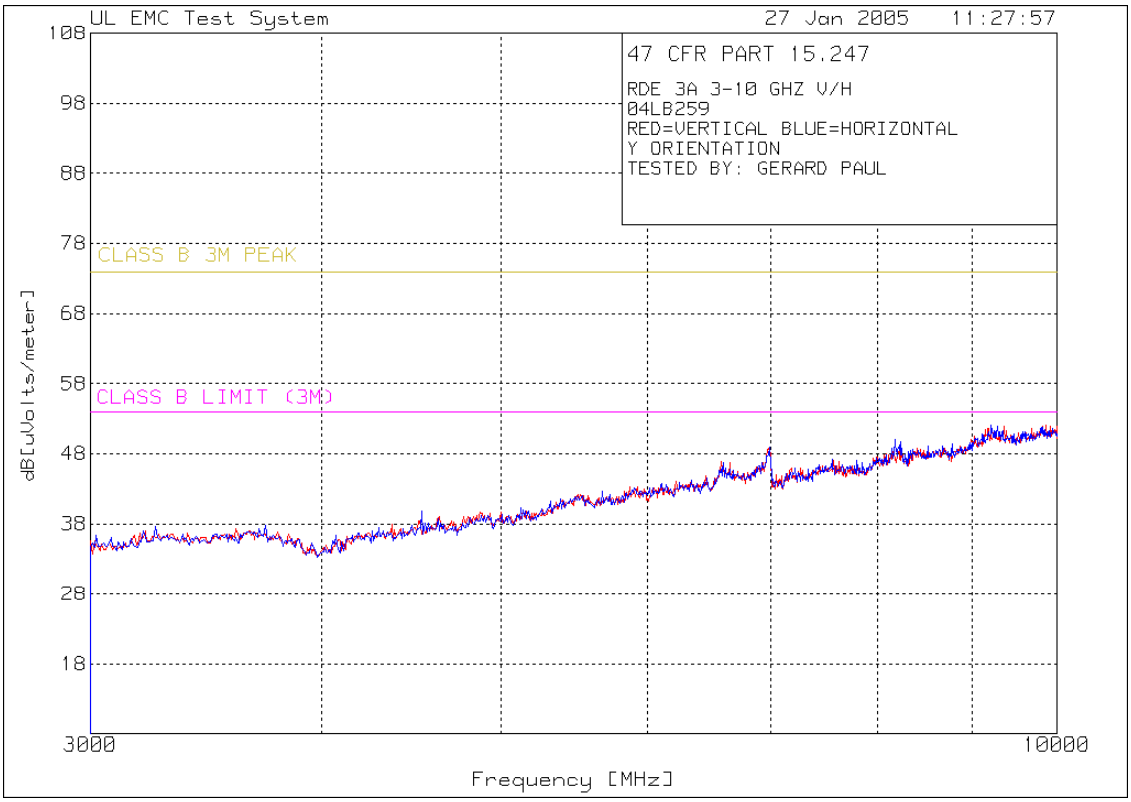
Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

| Comment # | Description |
|---|---|
| 1 | Closest spurious emission to limit. 52.9 dBuV/m, or in linear units, 441.6 uV/m, at 8171 MHz. |

**Test 3, Item E - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (Y-Orientation) – 9 dBi antenna



**Test 3, Item E - Discrete Data (Y-Orientation):**

Radiated Spurious Emissions - Above 1 GHz (Y-Orientation) – 9 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | V | 3 | 3595.596 | 36.0 | 1.3 | 37.3 | 54 | -16.7 | |
| A | P | V | 3 | 6580.581 | 36.7 | 10.2 | 46.9 | 54 | -7.1 | |
| A | P | H | 3 | 8171.171 | 32.5 | 17.5 | 50.0 | 54 | -4.0 | |
| A | P | H | 3 | 9215.215 | 30.4 | 21.7 | 52.1 | 54 | -1.9 | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

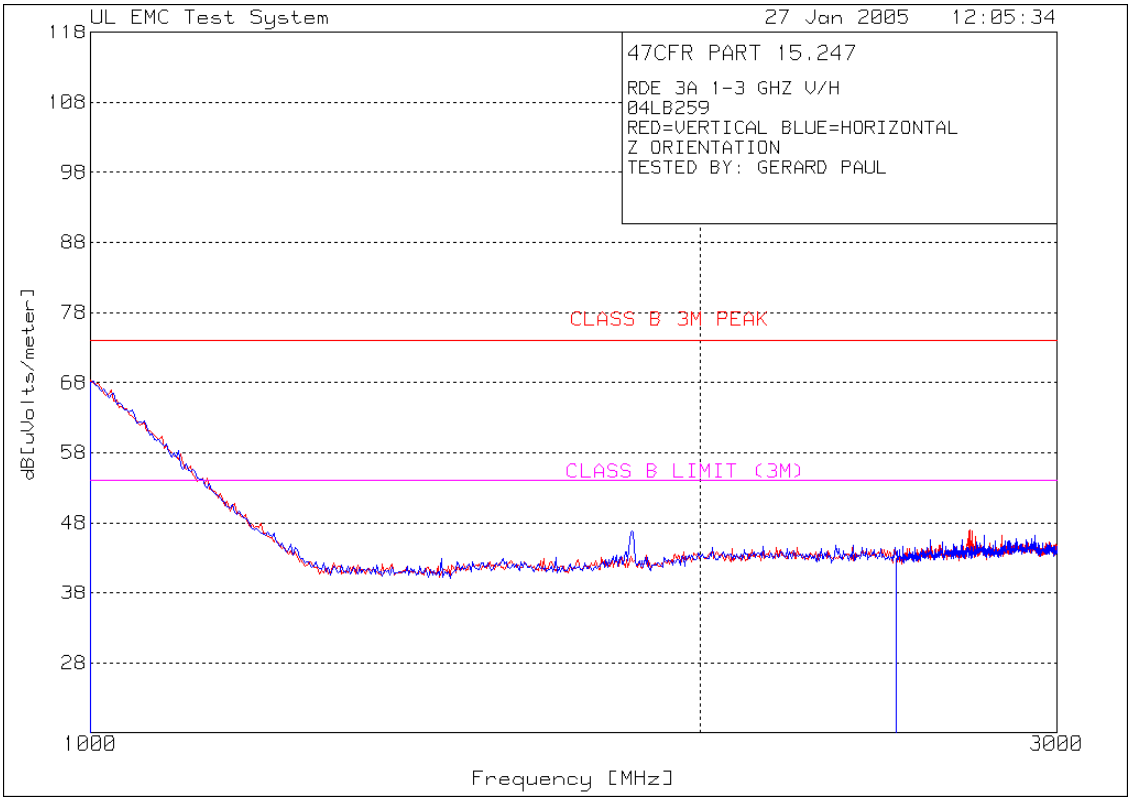
*** # = See Comment Number Under This Test's Comments Section.

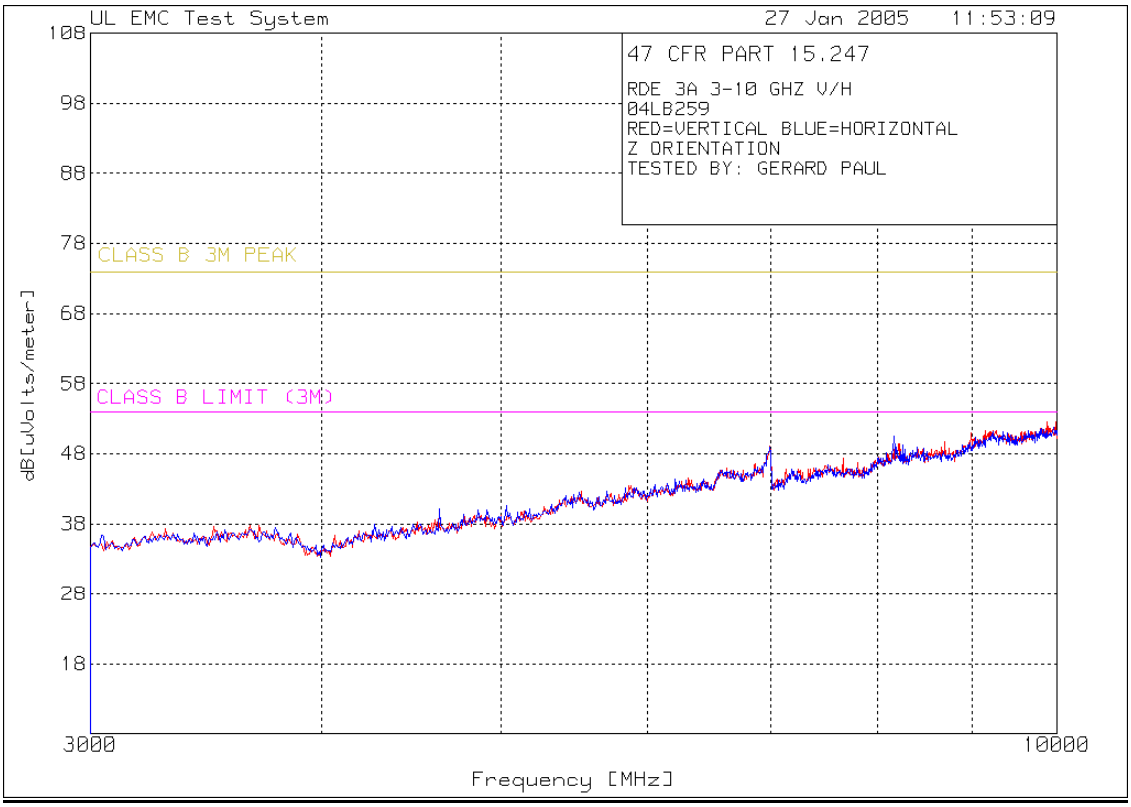
Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

**Test 3, Item F - Peak Plot:**

Radiated Spurious Emissions - Above 1 GHz (Z-Orientation) – 9 dBi antenna



**Test 3, Item F - Discrete Data (Z-Orientation):**

Radiated Spurious Emissions - Above 1 GHz (Z-Orientation) - 9 dBi antenna

| Test Item (A-Z) | Detector Type* (P/Q/A) | Antenna Polarity (H/V) | Antenna Distance (m) | Measured Frequency (MHz) | Measured Value (dBuV) | Equip Correction (dB/m) | Corrected Value (dBuV/m) | Average Limit** (dBuV/m) | Spec Margin (dB) | See Comment (#)*** |
|---|---|---|---|---|---|---|---|---|---|---|
| A | P | H | 3 | 4632.633 | 36.1 | 4.0 | 40.1 | 54 | -13.9 | |
| A | P | H | 3 | 6993.994 | 36.9 | 2.0 | 48.9 | 54 | -5.1 | |
| A | P | H | 3 | 8157.157 | 33.2 | 17.4 | 50.6 | 54 | -3.4 | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

* P = Peak, Q = Quasi-Peak, A = Average.

** No peak-to-average reduction applied.

*** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

| Comment # | Description |
|---|---|
| | |

## Test 4: Bandedge

**Test Requirement:** 47 CFR Part 15 Subpart C

**Test Specification:** 47 CFR Part 15.247

**Test Procedure:**

All testing was performed on an open test area covered by a ground plane. The spectrum analyzer Resolution Bandwidth and Video Bandwidth were set to 10 kHz for the measurement. A plot of the spectrum analyzer display screen is produced with marker points displaying the center frequency and the left and right side points that are 20 dB below the field strength at the center frequency.

The spectrum analyzer frequency is positioned such that the left or right bandedge frequency and the edge of the nearest channel are observed on the display. The device is considered to comply if all emissions at the bandedge and outside the

Limits - FCC Part 15.247

| Bandedge | Frequency |
|---|---|
| Lower | 902 MHz |
| Upper | 928 MHz |

**Test Deviations:**

None

**Test Setup:** Only the following ports were tested. See EUT Information for details.

| Test Item | Port # | Port Name | EUT Operation Mode | EUT Configuration | Power Interface |
|---|---|---|---|---|---|
| A | 2 | Antenna | 1 (Low Channel, lower edge) | 1 | 1 |
| B | 2 | Antenna | 2 (High Channel, upper edge) | 1 | 1 |

**Test 4 - Results:** Bandedge

**Test Results Summary:**

| Test Item | Test Location | Humidity (%) | Temperature (ºC) | Pressure (kPa) | Pass/Fail (P/F) | Date Completed | Comment # |
|---|---|---|---|---|---|---|---|
| A - B | D | 33 | 24 | 102 | P | 11/15/04 | |
| | | | | | | | |
| | | | | | | | |

The EUT was considered to **Pass** the Requirements.

**Comments:**

| Comment # | Description |
|---|---|
| | |
| | |
| | |
| | |

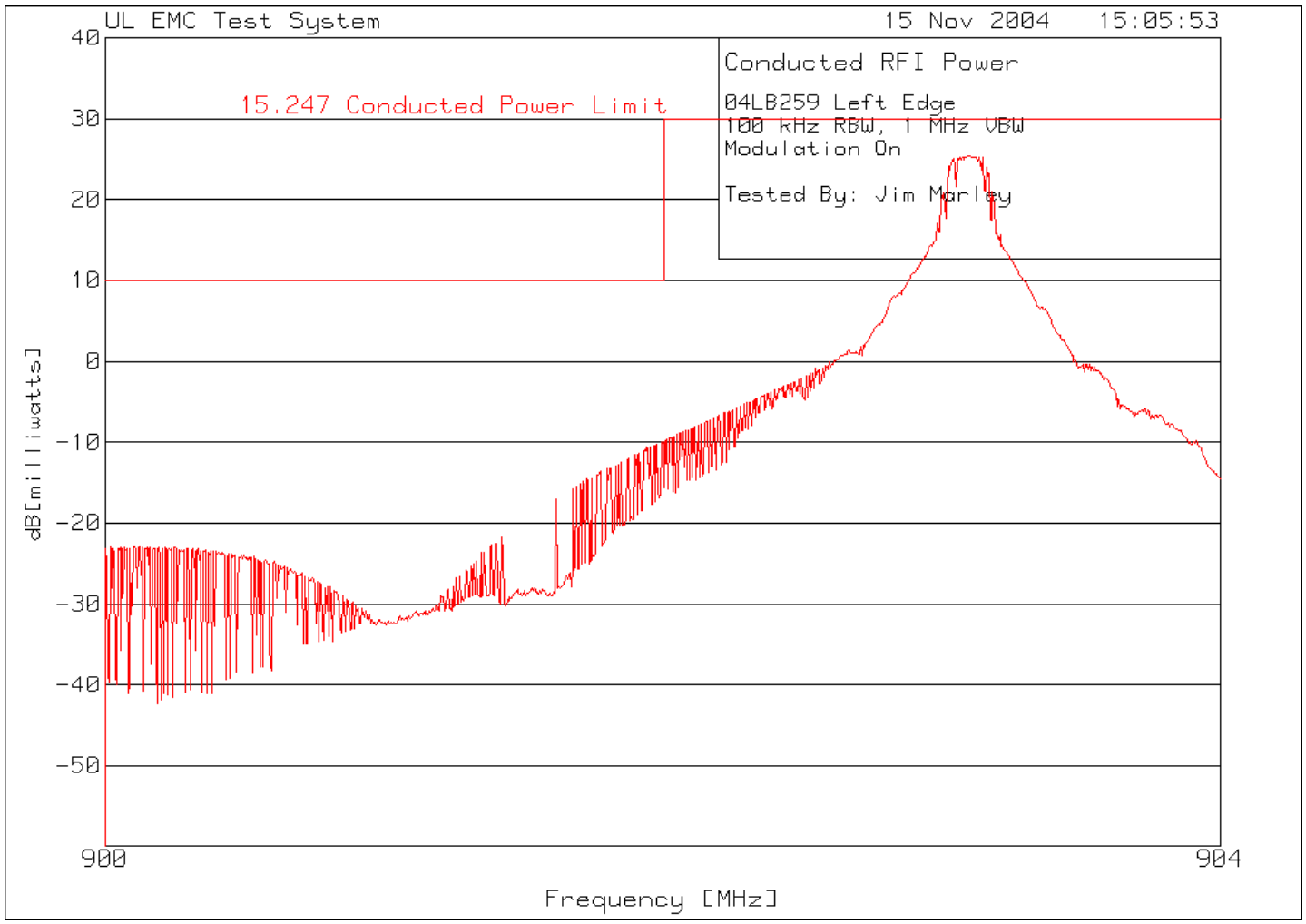
**Test 4 - Test Equipment Used:** Bandedge

| Equipment ID | Description | Manufacturer | Model Number | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| ATA160 | RF Attenuator, 30 dB | Weinshel | 47-30-43 | 8/25/04 | 8/30/05 |
| SAR001 | Spectrum Analyzer / Receiver | Hewlett-Packard | 8572A | 2/2/04 | 2/28/05 |
| | | | | | |

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

**Test 4, Item A - Peak Plot (Amplitude in dBuV):**

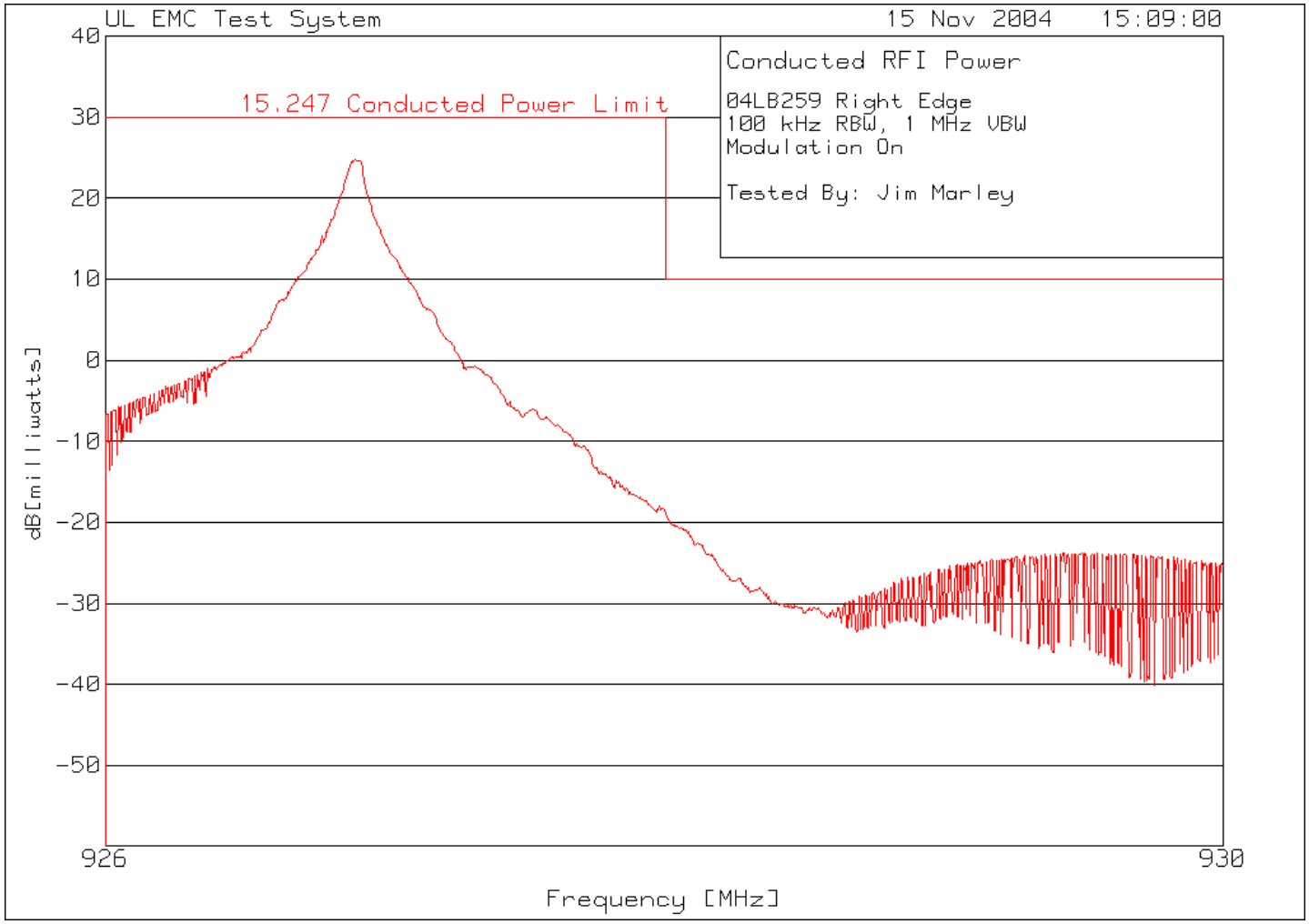
Bandedge - Lower Edge




Left Bandedge at 902 MHz is shown to be >30 dB below lowest channel carrier. Requirement is >20 dB.

**Test 4, Item B - Peak Plot (Amplitude in dBuV):**

Bandedge - Upper Edge




Right Bandedge at 928 MHz is shown to be >30 dB below lowest channel carrier. Requirement is >20 dB.

## Test 5: Conducted Power, Conducted Spurious, and Occupied Bandwidth

**Test Requirement:** 47 CFR Part 15.247

**Test Specification:** ANSI C63.4:2001

**Test Procedure:**

The EUT was tested per ANSI C63.4:2001 as a conducted measurement. The output of the transmitter was connected to the input of the measurement spectrum analyzer via a calibrated attenuator.

Conducted Power: The spectrum analyzer Resolution Bandwidth is set to 100 kHz and Video Bandwidth to 1 MHz or higher. The peak measurements for low, middle, and high channels are reported.

Occupied Bandwidth: The spectrum analyzer Resolution Bandwidth and Video Bandwidth were set to 10 kHz for the measurement. A plot of the spectrum analyzer display screen is produced with marker points displaying the center frequency and the left and right side points that are 20 dB below the field strength at the center frequency.

Limits - FCC Part 15.247 - Frequency Hopping

| Frequency of Operation / Channels | Maximum Conducted Power | Maximum Bandwidth |
|---|---|---|
| 902 - 928 MHz, >50 channels | 1000 mW* | 200 kHz |

*for antenna with gain of 6 dBi or less

**Test Deviations:**

None

**Test Setup:** Only the following ports were tested. See EUT Information for details.

| Test Item | Port # | Port Name | EUT Operation Mode | EUT Configuration | Power Interface |
|---|---|---|---|---|---|
| A | 2 | Antenna | 1 (low channel power) | 1 | 1 |
| B | 2 | Antenna | 2 (mid channel power) | 1 | 1 |
| C | 2 | Antenna | 3 (high channel power) | 1 | 1 |
| D | 2 | Antenna | 4 (hopping normally, conducted spurious) | 1 | 1 |
| E | 2 | Antenna | 1 (low channel occupied bandwidth) | 1 | 1 |
| F | 2 | Antenna | 2 (mid channel occupied bandwidth) | 1 | 1 |
| G | 2 | Antenna | 3 (high channel occupied bandwidth) | 1 | 1 |

**Test 5 - Results:** Conducted Power, Conducted Spurious, and Occupied Bandwidth

**Test Results Summary:**

| Test Item | Test Location | Humidity (%) | Temperature (ºC) | Pressure (kPa) | Pass/Fail (P/F) | Date Completed | Comment # |
|---|---|---|---|---|---|---|---|
| A - C | D | 39 | 23 | 101 | P | 12/15/04 | |
| D | D | 33 | 24 | 102 | P | 11/15/04 | |
| E - G | D | 39 | 23 | 101 | P | 12/15/04 | 1 |

The EUT was considered to **Pass** the Requirements.

**Comments:**

| Comment # | Description |
|---|---|
| 1 | No output power reduction is required for antenna gain less than or equal to 8.7 dBi. For output greater than 8.7 dBi, output power must be reduced such that: Maximum Output Power (27.3 dBm) + Antenna Gain (in dBi) ≤ 36 dBm |
| | |
| | |
| | |

**Test 5 - Test Equipment Used:** Conducted Power and Occupied Bandwidth

| Equipment ID | Description | Manufacturer | Model Number | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| **Conducted Power:** | | | | | |
| PAR010 | Power Meter | Rohde & Schwarz | NRVD | 4/7/04 | 4/30/05 |
| PAR006 | Thermal Sensor | Rohde & Schwarz | NRV-Z51 | 2/5/04 | 2/28/05 |
| ATA130 | RF Attenuator, 10 dB | N-male to N-female | - | 8/25/04 | 8/31/05 |
| **Conducted Spurious/Occupied Bandwidth:** | | | | | |
| SAR001 | Spectrum Analyzer / Receiver | Hewlett-Packard | 8572A | 2/2/04 | 2/28/05 |
| ATA160 | RF Attenuator, 30 dB | Weinshel | 47-30-43 | 8/25/04 | 8/30/05 |

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

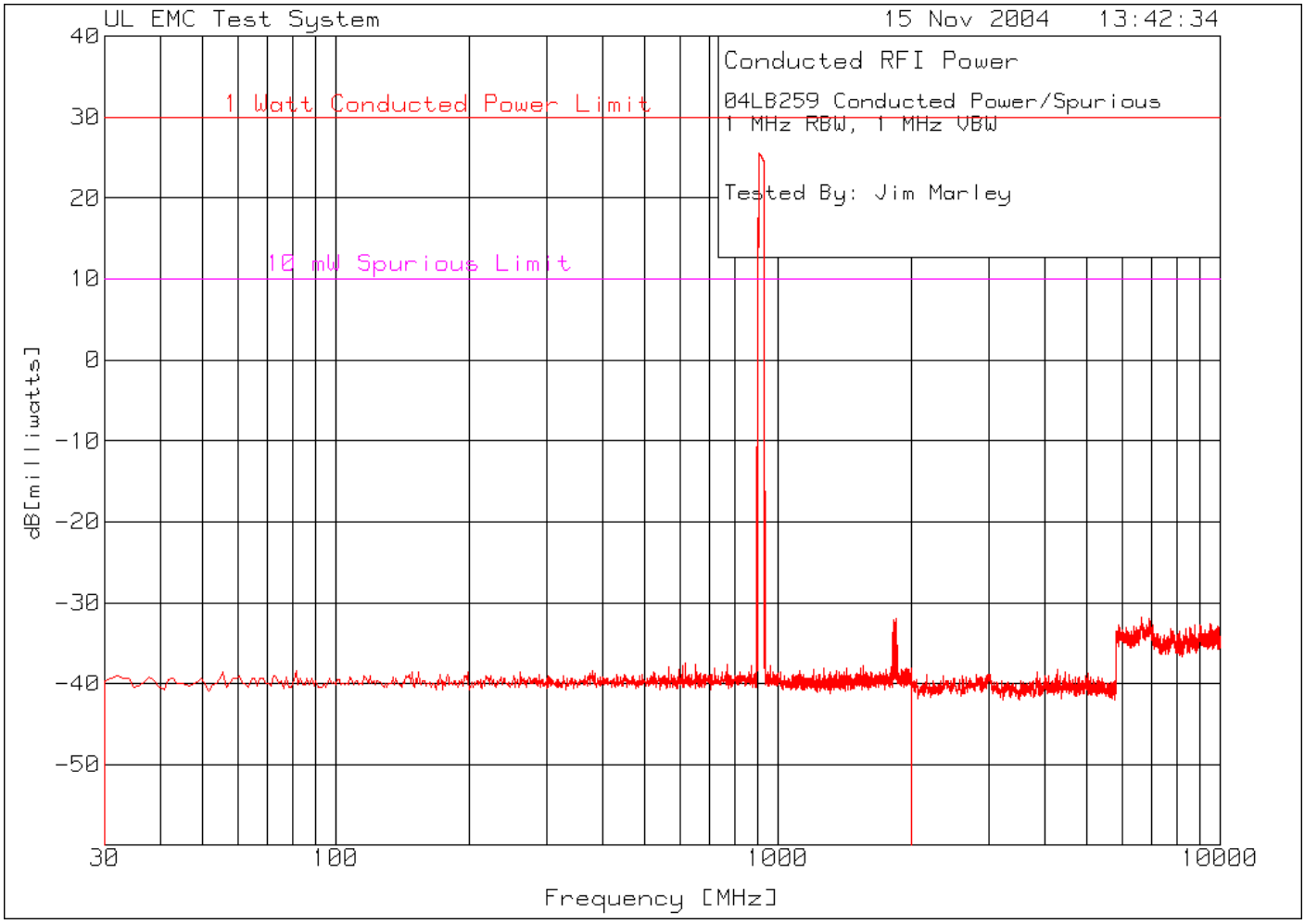
**Test 5, Item A-C - Peak Plot (Amplitude in dBuV):**

Conducted Power - Low, Mid, and High channels

| Measured Frequency (MHz) | Measured Power - Receiver (dBm) | Attenuator Loss (dB) | Corrected Power (dBm) | Corrected Power (mW) | Limit (mW) | Pass/Fail (P/F) | Comments (#) |
|---|---|---|---|---|---|---|---|
| 903.1 (Lowest Channel) | 17.48 | 9.8 | 27.28 | 535 | 1000 | P | |
| 915.1 (Middle Channel) | 17.11 | 9.8 | 26.91 | 491 | 1000 | P | |
| 926.9 (Highest Channel) | 16.74 | 9.8 | 26.54 | 451 | 1000 | P | |

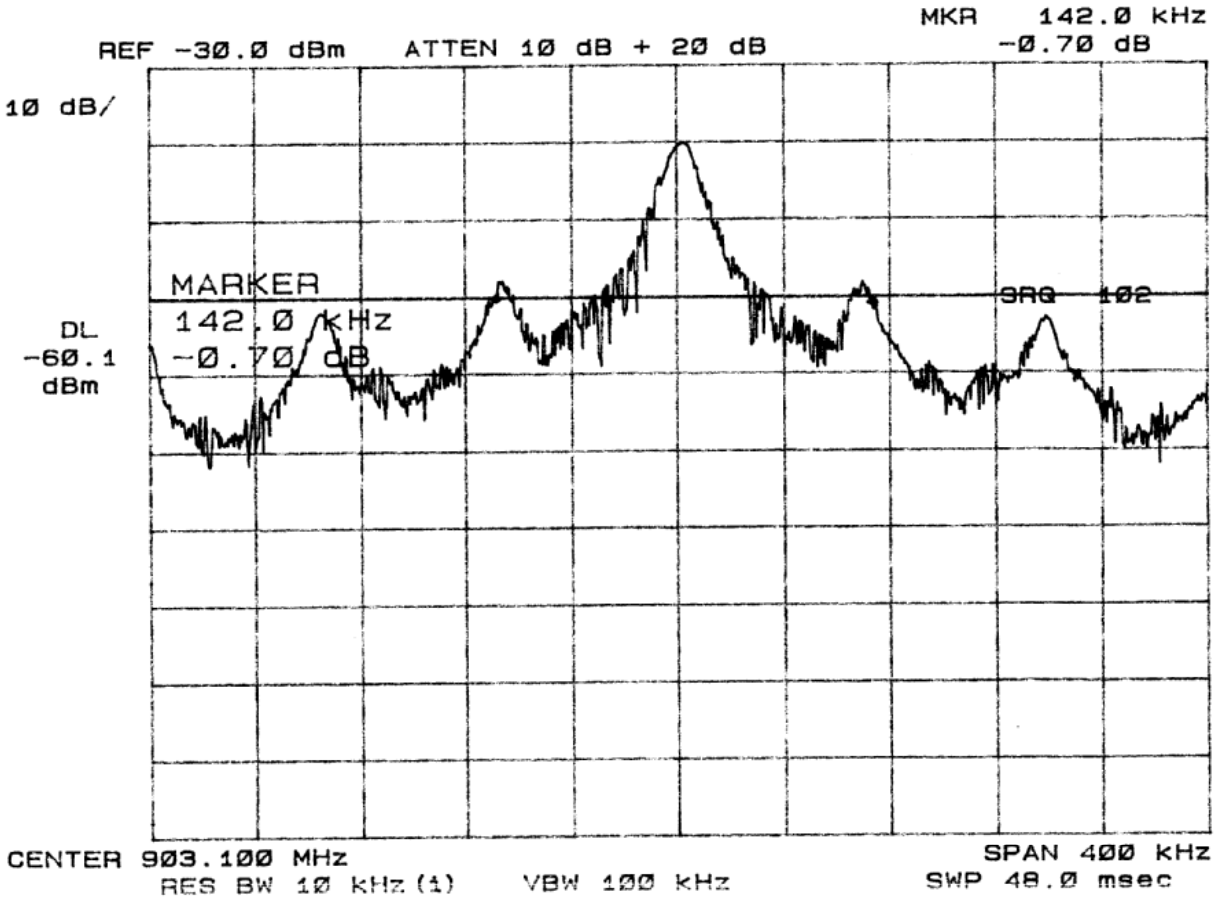
**Test 5, Item D - Peak Plot:**

Conducted Spurious Emissions



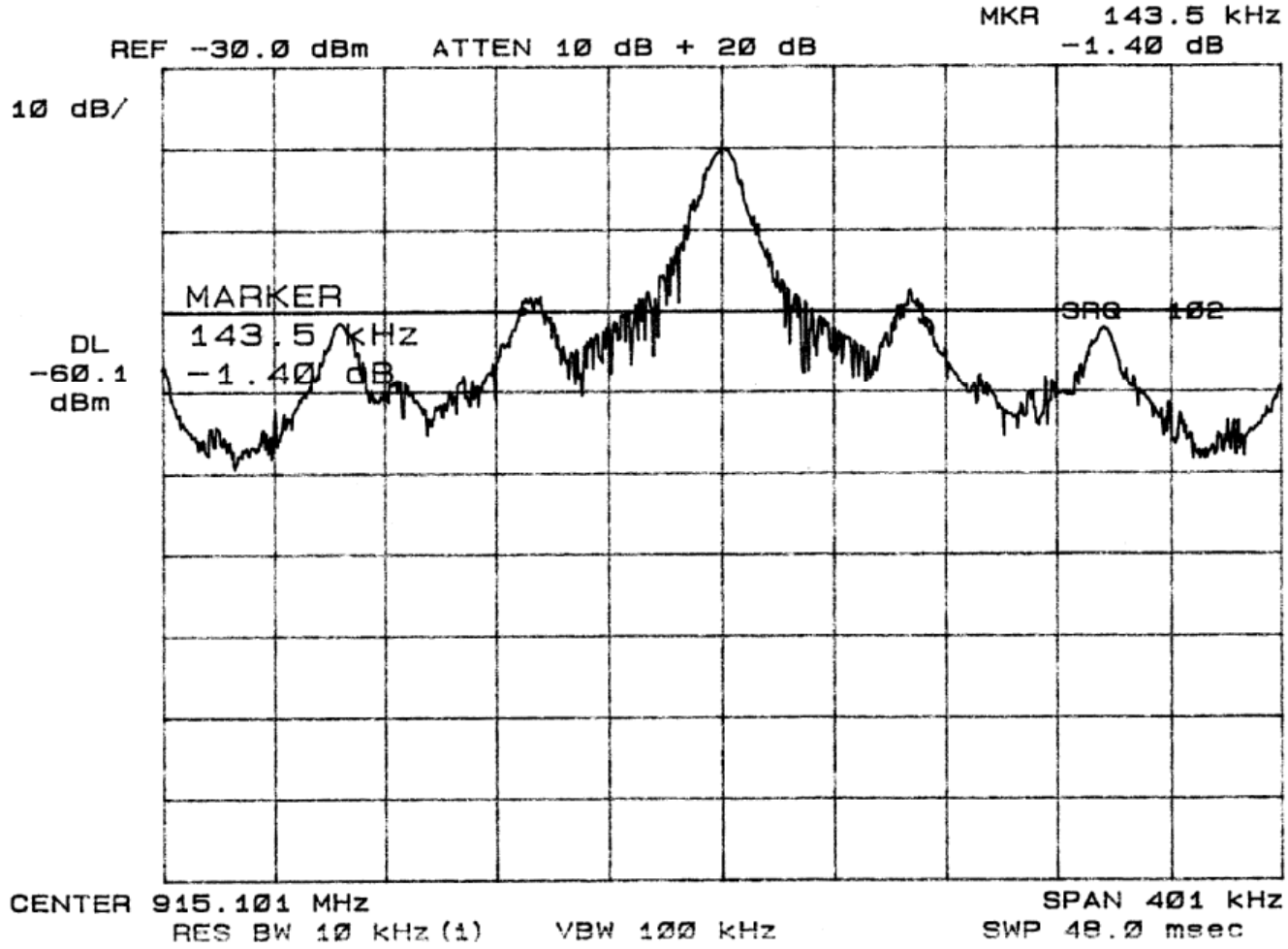
**Test 5, Item E - Occupied Bandwidth:**

Occupied Bandwidth Measurement - Low Channel



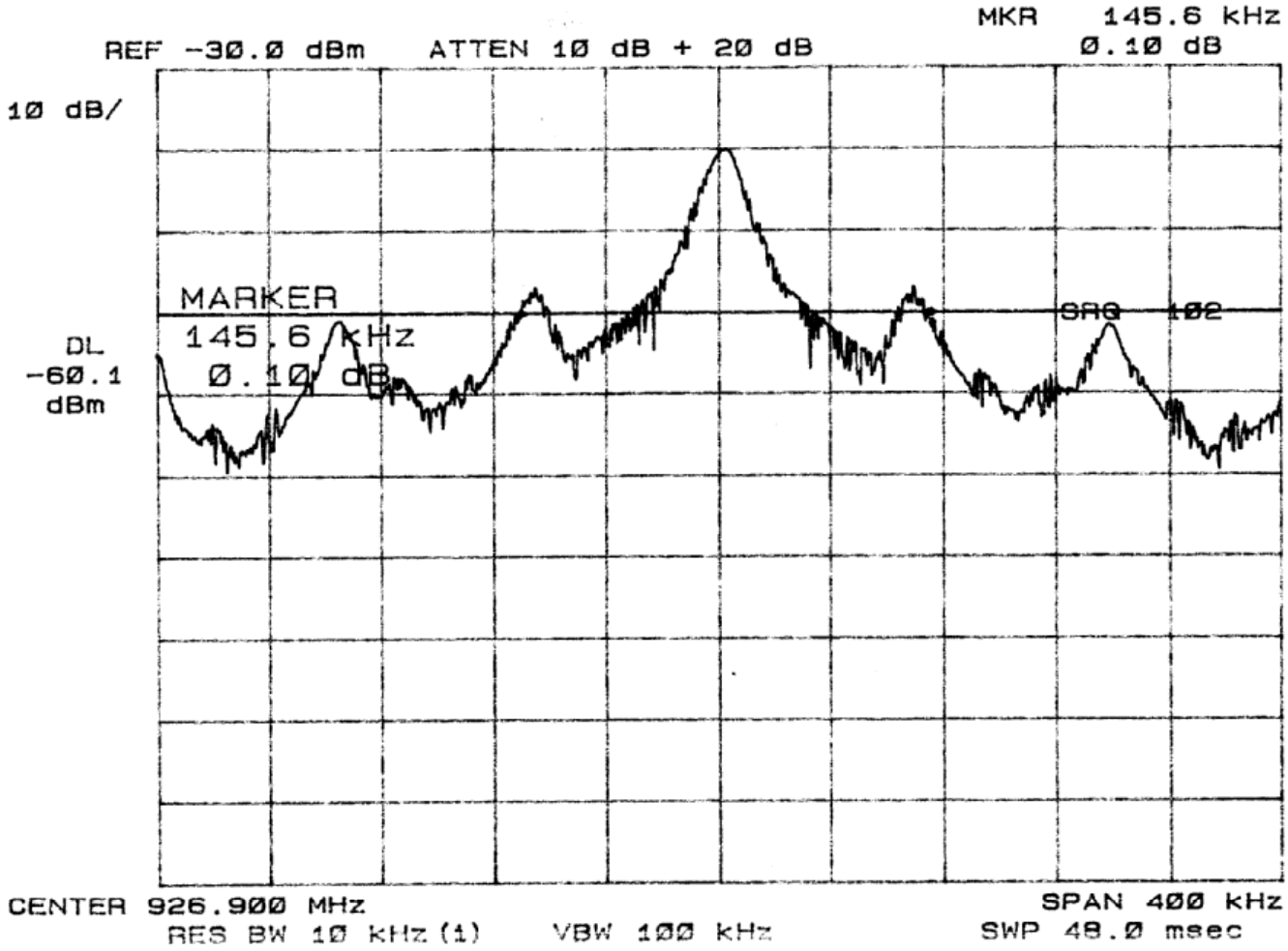
**Test 5, Item F - Occupied Bandwidth:**

Occupied Bandwidth Measurement - Mid Channel



**Test 5, Item G - Occupied Bandwidth:**

Occupied Bandwidth Measurement - High Channel



## Test 6: Radiated Disturbance Emissions - Peak-to-Average Ratio

**Test Requirement:** 47 CFR Part 15, Subpart C

**Test Specification:** 47 CFR Part 15, Subpart C, Section 15.247

**Test Procedure:**

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. This test may be performed as a radiated or conducted measurement. This test was performed as a conducted measurement.

The measurement spectrum analyzer is centered on the EUT's transmit frequency and span is reduced to 0 Hz to obtain a time domain measurement. The period of one complete transmit cycle is recorded. Next each button on the transmitter is depressed in sequence to determine which button produces the largest duty cycle. The duration of each pulse in the cycle is recorded and the percentage of time the EUT is transmitting is calculated.

No limit is expressed in Section 15.247 for this test, however the result of this test is used to calculate average values for the remaining measurements.

**Test Deviations:**

None

**Test Results:**

As this RFID device transmits a CW nearly continuously, the peak-to-average ratio is assumed to be zero. No average reduction may be applied to peak measurements.

## Test 7: Frequency Hopping Channels, Channel Spacing, and Dwell Time

**Test Requirement:** 47 CFR Part 15.247

**Test Specification:** ANSI C63.4:2001

**Test Procedure:**

Testing is performed with a measurement spectrum analyzer connected directly from the output stage of the antenna to the antenna. An impedance matching network is installed if needed.

Measurements are performed to document the number of hopping channels, the spacing (in kHz) of the channel centers, and the duration (in ms) of each channel occupied.

Duration on each hopping channel shall not exceed 0.4 seconds and be randomly (or pseudo-randomly) distributed.

**Test Deviations:**

None

**Test Setup:** Only the following ports were tested. See EUT Information for details.

| Test Item | Port # | Port Name | EUT Operation Mode | EUT Configuration | Power Interface |
|---|---|---|---|---|---|
| A | 2 | Antenna | 4 (hopping normally) | 1 | 1 |
| | | | | | |

**Test 7 - Results**: Frequency Hopping Channels, Channel Spacing, and Dwell Time

**Test Results Summary:**

| Test Item | Test Location | Humidity (%) | Temperature (ºC) | Pressure (kPa) | Pass/Fail (P/F) | Date Completed | Comment # |
|---|---|---|---|---|---|---|---|
| A | D | 33 | 24 | 102 | P | 11/15/04 | |
| | | | | | | | |

The EUT was considered to **Pass** the Requirements.

**Comments:**

| Comment # | Description |
|---|---|
| | |
| | |
| | |
| | |

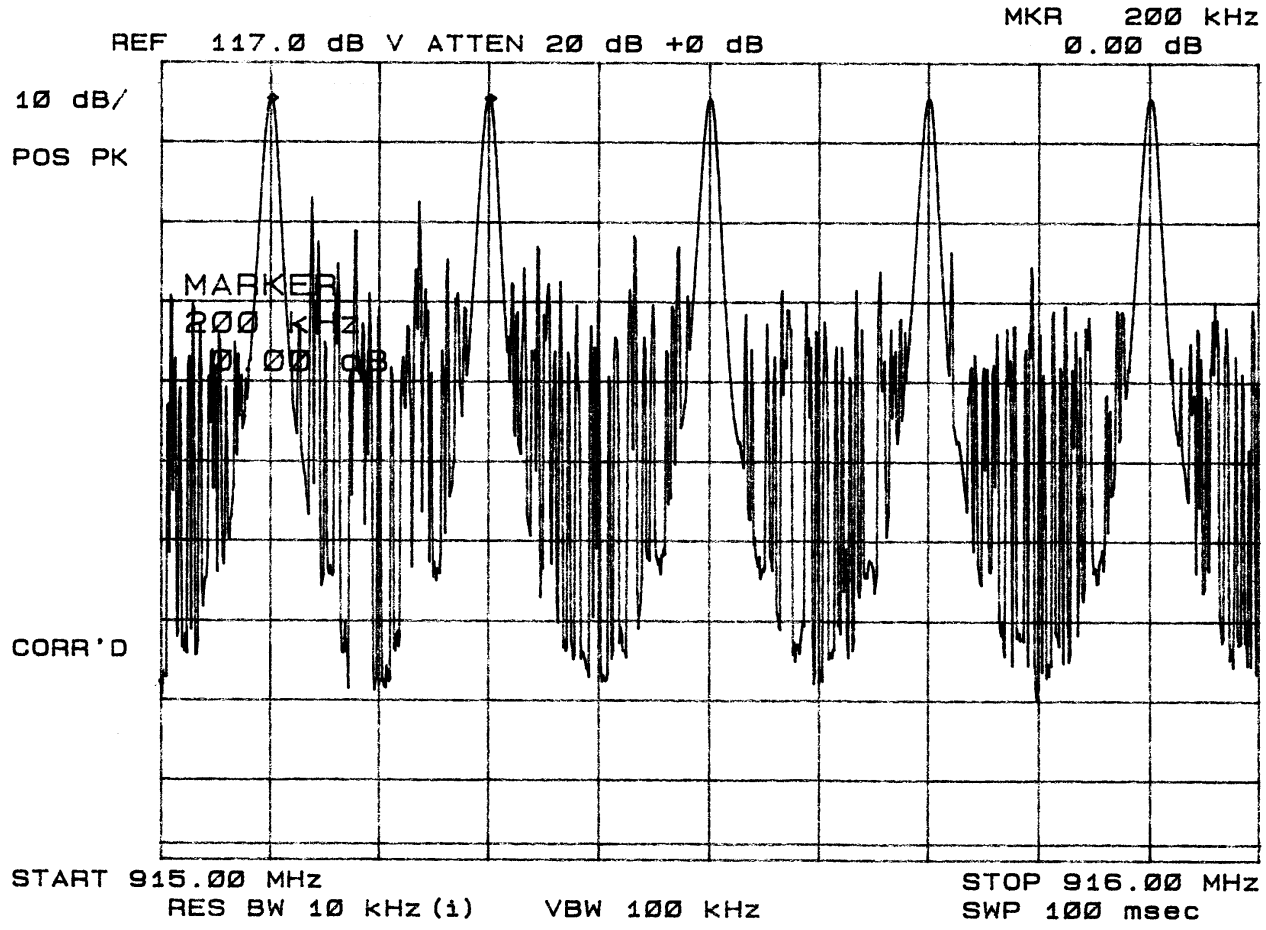
**Test Equipment Used:**

| Equipment ID | Description | Manufacturer | Model Number | Last Cal. | Next Cal. |
|---|---|---|---|---|---|
| SAR003 | EMC Receiver (channels) | Rohde & Schwarz | 1088.7490K40 | 11/10/03 | 11/30/04 |
| SAR001 | Spectrum Analyzer / Receiver (channel spacing, hop duration) | Hewlett-Packard | 8572A | 2/2/04 | 2/28/05 |
| ATA160 | RF Attenuator, 30 dB | Weinshel | 47-30-43 | 8/25/04 | 8/30/05 |
| | | | | | |

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

**Test 7, Item A - Peak Plot (Amplitude in dBuV):**

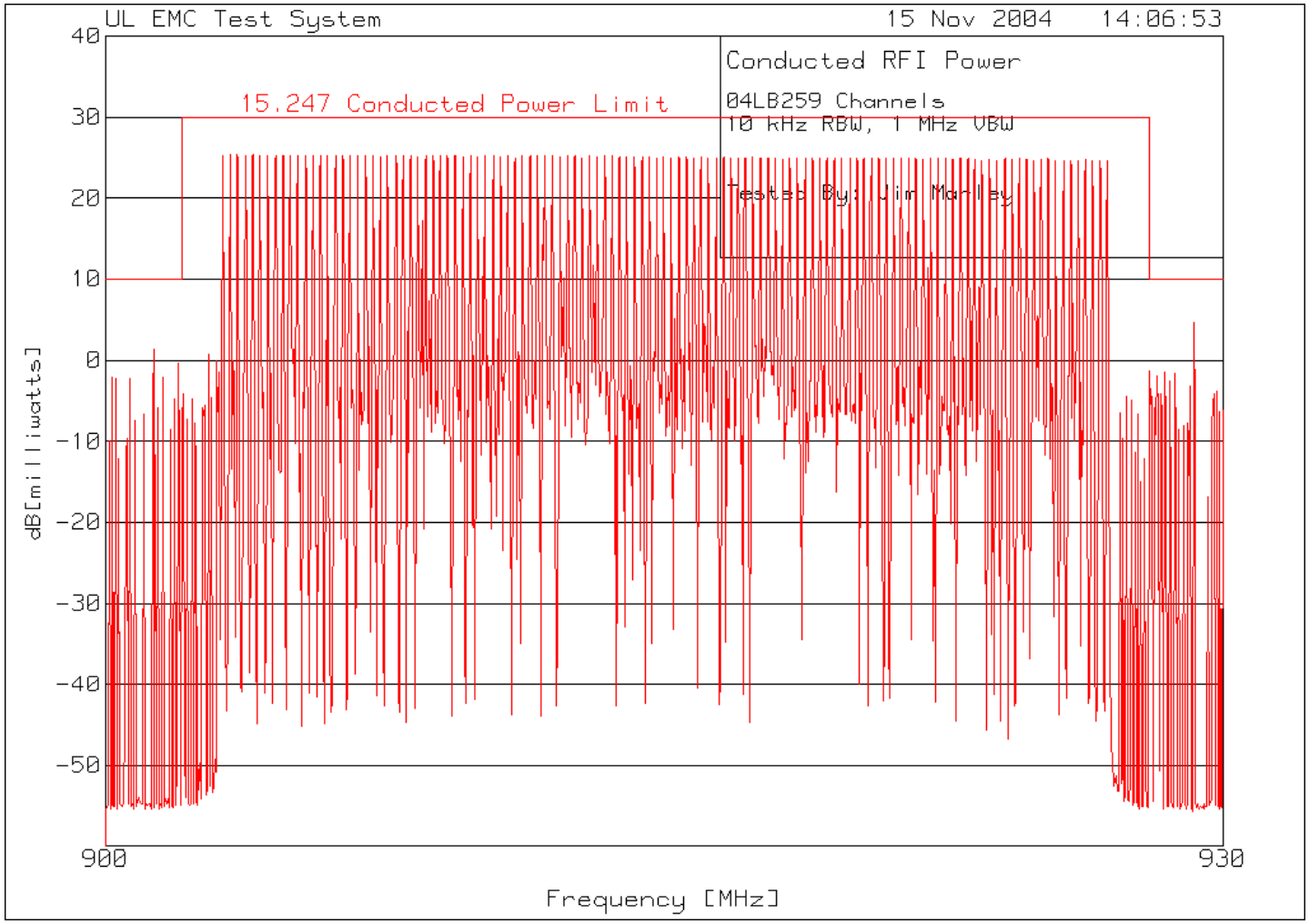
Channel Spacing




Channel spacing is 200 kHz center to center.

**Test 7, Item A - Peak Plot (Amplitude in dBuV):**

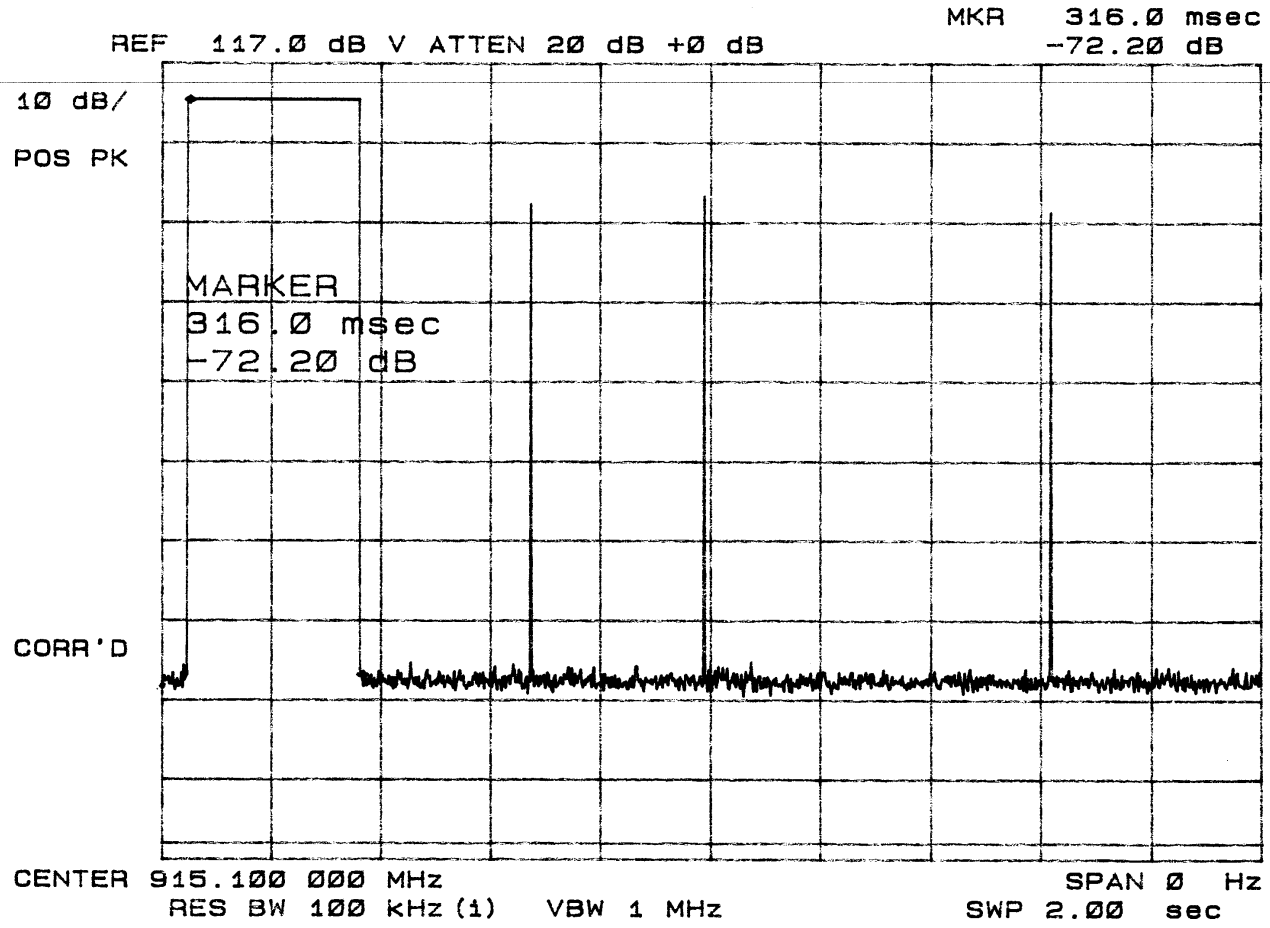
Number of Channels




The device is shown to have 120 hopping channels.

**Test 7, Item A - Peak Plot (Amplitude in dBuV):**

Hop Duration




Hop duration is 316 milliseconds at any channel.

## Test 8: Maximum Permissible Exposure

**Test Requirement:** 47 CFR Part 1

**Test Specification:** 47 CFR Part 1, Section 1.1307

**Test Procedure:**

Maximum Permissible Exposure limits are as follows:

**FCC Limits for Occupational/Controlled Exposure**

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $\|E^2\|$, $\|H^2\|$. or S (minutes) |
|---|---|---|---|---|
| 0.3 – 3.0 | 614 | 1.63 | (100)* | 6 |
| 3.0 - 30 | 1824/f | 4.89/f | ($900/f^2$)* | 6 |
| 30 - 300 | 61.4 | 0.163 | 1.0 | 6 |
| 300 – 1500 | - | - | f/300 | 6 |
| 1500 – 100,000 | - | - | 5.0 | 6 |

* Plane-wave equivalent power density

**FCC Limits for General Population/Uncontrolled Exposure**

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $\|E^2\|$, $\|H^2\|$. or S (minutes) |
|---|---|---|---|---|
| 0.3 - 1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34 - 30 | 824/f | 2.19/f | ($180/f^2$)* | 30 |
| 30 - 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 – 1500 | - | - | f/1500 | 30 |
| 1500 – 100,000 | - | - | 1.0 | 30 |

*Plane-wave equivalent power density

**Test Details:** This device is considered to possibly be located in either environment. See calculation for assumptions.

**Background:** Per the following guidance from OET Bulletin 65 Supplement C required minimum spacings are provided to the professional installer.

| Transmitter or Device Type[18] | Output[19] | Applicable Methods to Ensure Compliance[20] |
|---|---|---|
| Transmitters using indoor antennas that operate at 20 cm or more from nearby persons | >2.5 W at 915 MHz | If the MPE distance is greater than that required for normal operation of the device, operating instructions, warning instructions and/or warning labels may be used to ensure compliance by indicating the minimal separation distance to comply with MPE limits.<br><br>If the antennas are professionally installed to ensure compliance, warning instructions and warning labels are not necessary. |
| | =< 2.5 W at 915 MHz or<br>=< 4 W at 2450 MHz | Transmitters operating at 2.5 W EIRP (1.5 W ERP) or less at 915 MHz, or at 4 W EIRP (2.4 W ERP) or less at 2450 MHz, generally are not expected to exceed MPE limits when nearby persons are 20 cm or more from most antennas. Therefore, special instructions and warnings are normally not necessary to ensure compliance. |

**MPE Calculation with highest EIRP:**

Assuming the an antenna with gain of 7.5 dBi or less, it is shown that 20 cm spacing is sufficient to comply with RF Uncontrolled/General Exposure Limits at full power of the device.

$S = EIRP / (4 * Pi * R^2)$,

| |
|---|
| Power Density = EIRP / (4 * Pi * $R^2$), |
| where EIRP = Output Power * Antenna Gain |

**Uncontrolled/General Exposure – Calculation #2**
**0.535 Watt, 7.5 dBi antenna, 20 cm spacing**

| | | | |
|---|---|---|---|
| Operating Frequency | 902 MHz | | |
| Output Power (Peak) | **0.535** Watts | | |
| Antenna Gain | **7.5** dB | or (linear) | 5.623413 (unitless) |
| Separation Distance | **0.2** m | -or- | 7.874 inches |

| | | | |
|---|---|---|---|
| Peak Power Density | 5.985 $W/m^2$ | - or - | 0.5985 $mW/cm^2$ |
| Exposure % (over 6 min timespan for uncontrolled) | 100% | | |
| Transmit Duty Cycle (Peak-to-Average Ratio) | 100% | | |
| Average Power Density | **5.98526** $W/m^2$ | - or - | **0.5985** $mW/cm^2$ |
| Limit for **Uncontrolled** Exposure at Operating Frequency | **6.01333** $W/m^2$ | - or - | **0.601333** $mW/cm^2$ |

**Accreditation Certificates:**

National Institute of Standards and Technology NVLAP® National Voluntary Laboratory Accreditation Program

ISO/IEC 17025:1999
ISO 9002:1994

## Scope of Accreditation

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**ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS** **NVLAP LAB CODE 200246-0**

**UNDERWRITERS LABORATORIES, INC.**

12 Laboratory Drive
Research Triangle Park, NC 27709
Mr. Rick A. Titus
Phone: 847-272-8800 x43281 Fax: 847-509-6321
E-Mail: Rick.A.Titus@us.ul.com
URL: http://www.ul.com

| *NVLAP Code* | *Designation / Description* |
|---|---|
| **Emissions Test Methods:** | |
| 12/CIS14 | CISPR 14-1 (March 30, 2000): Limits and Methods of Measurement of Radio interference Characteristics of Household Electrical Appliances, Portable Tools and Similiar Electrical Apparatus - Part 1: Emissions |
| 12/CIS14a | EN 55014-1 (1993) with Amendments A1 (1997) & A2 (1999) |
| 12/CIS14b | AS/NZS 1044 (1995) |
| 12/CIS14c | CNS 13783-1 |
| 12/CIS22 | IEC/CISPR 22 (1997) and EN 55022 (1998): Limits and methods of measurement of radio disturbance characteristics of information technology equipment |
| 12/CIS22a | IEC/CISPR 22 (1993): Limits and methods of measurement of radio disturbance characteristics of information technology equipment, Amendment 1 (1995) and Amendment 2 (1996) |

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**UNDERWRITERS LABORATORIES, INC.**

| *NVLAP Code* | *Designation / Description* |
|---|---|
| 12/CIS22b | CNS 13438 (1997): Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment |
| 12/EM02a | IEC 61000-3-2, Edition 2.1 (2001-10), EN 61000-3-2 (2000), and AS/NZS 2279.1 (2000): Electromagnetic compatibility (EMC) Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A) |
| 12/EM03b | IEC 61000-3-3, Edition 1.1(2002-03) & EN 61000-3-3, A1(2001): EMC - Part 3-3: Limits - Limitations of voltage changes, voltage flucuations and flicker, in public low-voltage supply-systems, for equipment with rated current <=16 A per phase and not subject to conditional connections |
| 12/FCC15b | ANSI C63.4 (2001) with FCC Method - 47 CFR Part 15, Subpart B: Unintentional Radiators |
| 12/T51 | AS/NZS CISPR 22 (2002) and AS/NZS 3548 (1997): Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment |
| **Immunity Test Methods:** | |
| 12/I01 | IEC 61000-4-2, Edition 2.1 (2001) including Amds. 1 & 2 and EN 61000-4-2: Electrostatic Discharge Immunity Test |
| 12/I02 | IEC 61000-4-3, Edition 2.0 (2002-03) and EN 61000-4-3: Radiated Radio-Frequency Electromagnetic Field Immunity Test |

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| *NVLAP Code* | *Designation / Description* |
|---|---|
| 12/I03 | IEC 61000-4-4 (1995) + Amd. 1 (2000) & Amd. 2 (2001) and EN 61000-4-4: Electrical Fast Transient/Burst Immunity Test |
| 12/I04 | IEC 61000-4-5, Edition 1.1 (2001-04) and EN 61000-4-5: Surge Immunity Test |
| 12/I05 | IEC 61000-4-6, Edition 2.0 (2003-05) and EN 61000-4-6: Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields |
| 12/I06 | IEC 61000-4-8, Edition 1.1 (2001) and EN 61000-4-8: Power Frequency Magnetic Field Immunity Test |
| 12/I07 | IEC 61000-4-11, Edition 1.1 (2001-03) and EN 61000-4-11: Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests |
| **Safety Test Methods:** | |
| 12/T41 | AC/ACIF S001 (2001): Safety Requirements for Customer Equipment |
| 12/T50 | AS/NZS 3260 (1993) + Supplement 1 (1996): Safety of Information Technology Equipment Including Electrical Business Equipment |
| **Telecommunications Test Methods:** | |
| 12/1089d | GR-1089-CORE, Issue 3 (April 2002): EMC and Electrical Safety - Generic Criteria for Network Telecommunications Equipment (sections: 2.1.2.1, 2.1.2.2, 2.1.4, 2.2, 3.2, 3.3, 4.6.2, 4.6.5, 4.6.7 - 4.6.17, 4.7, 5.2, 5.3.1, 5.4, 6, 7.2 - 7.7, 8, and 9.2 - 9.12) |

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| *NVLAP Code* | *Designation / Description* |
|---|---|
| 12/76200a | SBC-TP-76200, Issue 4 (May 2003): Network Equipment Power, Grounding, Environmental, and Physical Design Requirements (sections: 6.1B, 7.1, 7.2, 7.3, 7.4, and 10.1 - 10.4B) |
| 12/GR63a | GR-63-CORE, Issue 2 (April 2002): NEBS (TM) Requirements: Physical Protection (sections: 2, 3, 4.1, 4.2.3, 4.3, 4.4.1, 4.4.3, 4.4.4, 4.5, 4.6, and 4.7) |

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**Measurement Uncertainty Statement**

| Test | Expanded Estimate of Uncertainty (k = 2, for 95% of a normal distribution) | Units |
|---|---|---|
| Radiated Disturbance Emissions: | | |
| • 3 and 10 meter measurement distances | +/- 3.8 dB | Volts/meter |
| • 1 meter measurement distance | +/- 2.3 dB | Volts/meter |
| Conducted Disturbance Emissions (9 kHz – 30 MHz): | +/- 3.4 dB | Volts |
| Electrostatic Discharge | +/- 2.2 % | Volts |
| Radiated RF Immunity (Chamber): | +/- 2.7 dB | Volts/meter |
| Electrical Fast Transients/Bursts Immunity | +/- 4.6 % | Volts |
| Surge Immunity | +/- 4.6 % | Volts |
| Conducted RF Immunity | +/- 2.8 dB | Volts |
| Power Frequency Magnetic Field Immunity | +/-13.6 % | Amps/meter |
| Voltage Dips and Short Interrupts | +/-4.2 % | Volts |
| Radiated RF Immunity (Tri-plate) | +/-3.2 % | Volts/meter |
| Disturbance Power (30 – 300 MHz) | +/-3.5% | Volts |

**CISPR 16-4:2000 Statement**

The UL-RTP estimate of expanded measurement uncertainty listed above for Conducted Disturbance (+/- 3.4 dB), Disturbance Power (+/- 3.5 dB), and Radiated Disturbance (+/-3.8 dB) are less than the Values of $U_{cispr}$ as listed in Table 1 of CISPR 16-4. Therefore:

- Compliance is deemed to occur if no measured disturbance reported exceeds the disturbance limits.
- Non-compliance is deemed to occur if any measured disturbance reported exceeds the disturbance limits.