

FCC Part 15.247 Transmitter Certification

Frequency Hopping Spread Spectrum Transmitter

Test Report

FCC ID: R7PER1R1S4

FCC Rule Part: 15.247

ACS Report Number: 06-0384-15C

Manufacturer: Cellnet Technology, Inc.
Model: L&G Focus-2 Utilinet Endpoint


Test Begin Date: October 12, 2006
Test End Date: October 27, 2006


Report Issue Date: November 27, 2006



FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not to be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.


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This report contains 23 pages

Table of Contents

| | |
|---|----|
| 1.0 General | 3 |
| 1.1 Purpose | 3 |
| 1.2 Product Description | 3 |
| 1.2.1 General | 3 |
| 1.2.2 Intended Use | 3 |
| 1.3 Test Methodology and Considerations | 3 |
| 2.0 Test Facilities | 4 |
| 2.1 Location | 4 |
| 2.2 Laboratory Accreditations/Recognitions/Certifications | 4 |
| 2.3 Radiated Emissions Test Site Description | 5 |
| 2.3.1 Semi-Anechoic Chamber Test Site | 5 |
| 2.3.2 Open Area Tests Site (OATS) | 6 |
| 2.4 Conducted Emissions Test Site Description | 7 |
| 3.0 Applicable Standards and References | 7 |
| 4.0 List of Test Equipment | 8 |
| 5.0 Support Equipment | 9 |
| 6.0 EUT Setup Block Diagram | 9 |
| 7.0 Summary of Tests | 10 |
| 7.1 Section 15.203 - Antenna Requirement | 10 |
| 7.2 Section 15.207 – Power Line Conducted Emissions | 10 |
| 7.2.1 Test Methodology | 10 |
| 7.2.2 Test Results | 10 |
| 7.3 Section 15.109 - Radiated Emissions (Unintentional Radiation) | 11 |
| 7.3.1 Test Methodology | 11 |
| 7.3.2 Test Results | 11 |
| 7.4 Section 15.247(b) – Peak Output Power | 12 |
| 7.4.1 Test Methodology | 12 |
| 7.4.2 Test Results | 12 |
| 7.5 Section 15.247(a) – Channel Usage | 14 |
| 7.5.1 Section 15.247(a) - Carrier Frequency Separation | 14 |
| 7.5.1.1 Test Methodology | 14 |
| 7.5.1.2 Test Results | 14 |
| 7.5.2 Section 15.247(a) – Number of Hopping Channels | 15 |
| 7.5.3 Section 15.247(a) – Channel Dwell Time | 16 |
| 7.5.4 Section 15.247(a) – 20dB Bandwidth | 16 |
| 7.5.4.1 Test Methodology | 16 |
| 7.5.4.2 Test Results | 16 |
| 7.6 Section 15.247(d) – Band-edge Compliance and Spurious Emissions | 18 |
| 7.6.1 Band-edge Compliance of RF Conducted Emissions | 18 |
| 7.6.1.1 Test Methodology | 18 |
| 7.6.1.2 Test Results | 18 |
| 7.6.2 RF Conducted Spurious Emissions | 19 |
| 7.6.2.1 Test Methodology | 19 |
| 7.6.2.2 Test Results | 19 |
| 7.6.3 Radiated Spurious Emissions (Restricted Bands) | 22 |
| 7.6.3.1 Test Methodology | 22 |
| 7.6.3.2 Test Results | 22 |
| 7.6.3.3 Sample Calculations | 23 |
| 8.0 CONCLUSION | 23 |

Additional Exhibits Included In Filing

Internal Photographs

External Photographs

Test Setup Photographs

Product Labeling

RF Exposure – MPE Calculations

Installation/Users Guide

Theory of Operation

BOM (Parts List)

System Block Diagram

Schematics

1.0 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15, Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

1.2.1 General

The L&G Focus 2 UtiliNet module was designed for integration into the L&G Focus electric meter. With the addition of the Focus 2 UtiliNet endpoint module, this meter is enabled for deployment in the UtiliNet AMR system, allowing electric meter data access over the UtiliNet frequency hopping spread spectrum (FHSS) fixed mesh network. The network operates in the 900MHz ISM band (902~928MHz), with a typical RF output power of +16dBm.

The L&G Focus 2 UtiliNet module was developed on a single, 4-layer PCB, with a 10 pin interface connector for the interface to the Focus electric meter. The Focus 2 module also includes an integrated slot antenna on the Focus 2 UtiliNet module PCB design, and the module includes a shield to reduce spurious emissions from the radio sections of the module.

Manufacturer Information:

Cellnet
30000 Mill Creek Avenue
Suite 100
Alpharetta, GA 30022
USA

Detailed photographs of the EUT are filed separately with this filing.

1.2.2 Intended Use

The L&G Focus 2 UtiliNet module was designed for integration into the L&G Focus electric meter to enable wireless data access.

1.3 Test Methodology and Considerations

The L&G Focus-2 Utilinet Endpoint is a module designed to be integrated into a host device therefore testing was performed on the module in a stand-alone configuration with the exception of AC power line conducted emissions. AC power line conducted emissions was performed with the module installed into a typical host device.

2.0 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment. In addition, ACS is compliant to ISO 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450

Industry Canada Lab Code: IC 4175

VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

NVLAP Lab Code: 200612-0

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

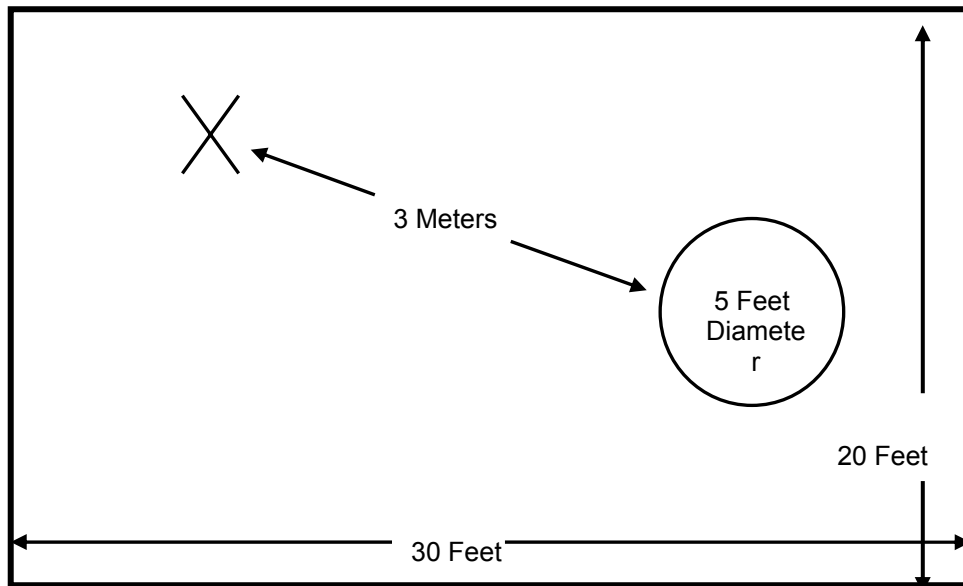


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

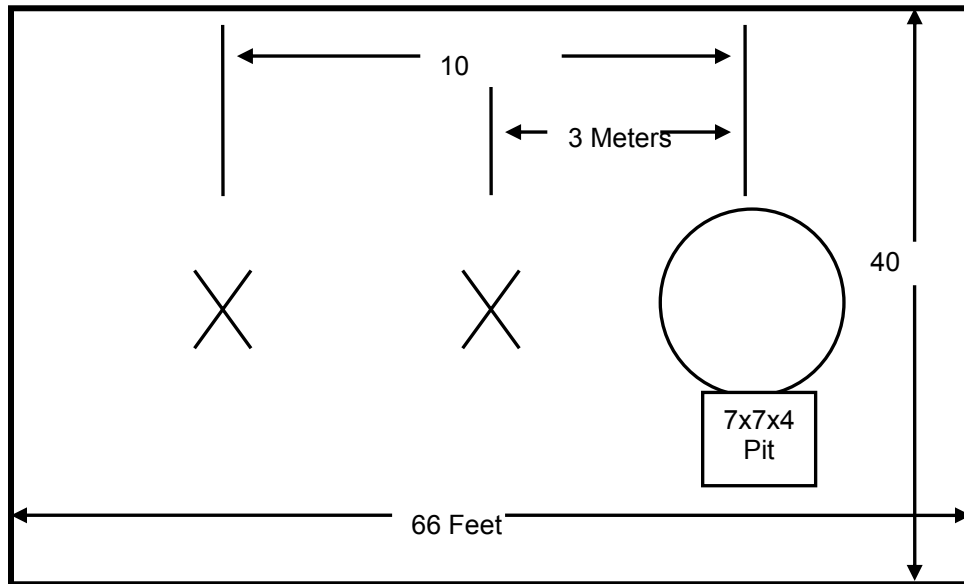


Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal group reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

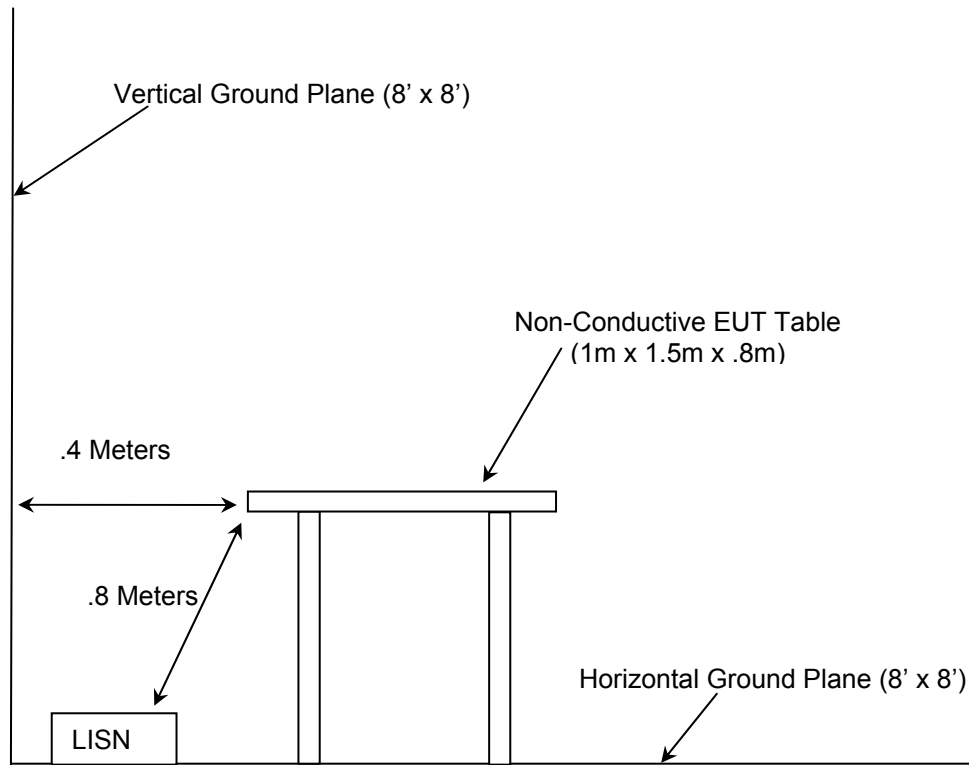


Figure 2.4-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ❖ ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2005
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2005
- ❖ FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, 2001
- ❖ FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, March 30, 2000

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4.0-1: Test Equipment

| Equipment Calibration Information | | | | | |
|--|-----------------------|--------------------------|---------------------|--------------|-----------------|
| ACS# | Mfg. | Eq. type | Model | S/N | Cal. Due |
| <input checked="" type="checkbox"/> 152 | EMCO | LISN | 3825/2 | 9111-1905 | 2/8/07 |
| <input checked="" type="checkbox"/> 153 | EMCO | LISN | 3825/2 | 9411-2268 | 12/5/06 |
| <input checked="" type="checkbox"/> 165 | ACS | Conducted EMI Cable Set | RG8 | 165 | 3/07/07 |
| <input checked="" type="checkbox"/> 168 | Hewlett Packard | Pulse Limiter | 11947A | 3107A02268 | 3/7/07 |
| <input checked="" type="checkbox"/> 167 | ACS | Chamber EMI Cable Set | RG6 | 167 | 1/7/07 |
| <input checked="" type="checkbox"/> 16 | ACS | Conducted Emission Cable | Cable | 16 | 5/10/07 |
| <input checked="" type="checkbox"/> 25 | Chase | Bi-Log Antenna | CBL6111 | 1043 | 5/30/07 |
| <input checked="" type="checkbox"/> 22 | Agilent | Pre-Amplifier | 8449B | 3008A00526 | 5/06/07 |
| <input checked="" type="checkbox"/> 73 | Agilent | Pre-Amplifier | 8447D | 272A05624 | 5/18/07 |
| <input checked="" type="checkbox"/> 30 | Spectrum Technologies | Horn Antenna | DRH-0118 | 970102 | 5/12/07 |
| <input checked="" type="checkbox"/> 331 | Microwave Circuits | High Pass Filter | H1G513G1 | 31417 DC0633 | 8/29/07 |
| <input checked="" type="checkbox"/> 283 | Rohde & Schwarz | Spectrum Analyzer | FSP | 100033 | 3/24/07 |
| <input checked="" type="checkbox"/> 1 | Rohde & Schwarz | Receiver Display | 804.8932.52 | 833771/007 | 3/01/07 |
| <input checked="" type="checkbox"/> 2 | Rohde & Schwarz | ESMI Receiver | 1032.5640.53 | 839587/003 | 3/01/07 |
| <input checked="" type="checkbox"/> 290 | Florida RF Labs | HF RF Cable | SMSE-200-72.0-SMRE | NA | 5/08/07 |
| <input checked="" type="checkbox"/> 291 | Florida RF Labs | HF RF Cable | SMRE-200W-12.0-SMRE | NA | 5/08/07 |
| <input checked="" type="checkbox"/> 292 | Florida RF Labs | HF RF Cable | SMR-280AW-480.0-SMR | NA | 5/24/07 |
| <input checked="" type="checkbox"/> 167 | ACS | Chamber EMI Cable Set | RG6 | 167 | 1/7/07 |

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

| Item | Equipment Type | Manufacturer | Model Number | Serial Number | FCC ID |
|---|----------------|--------------|--------------|---------------|--------|
| The EUT was tested as a stand alone device and no support equipment was utilized. | | | | | |

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

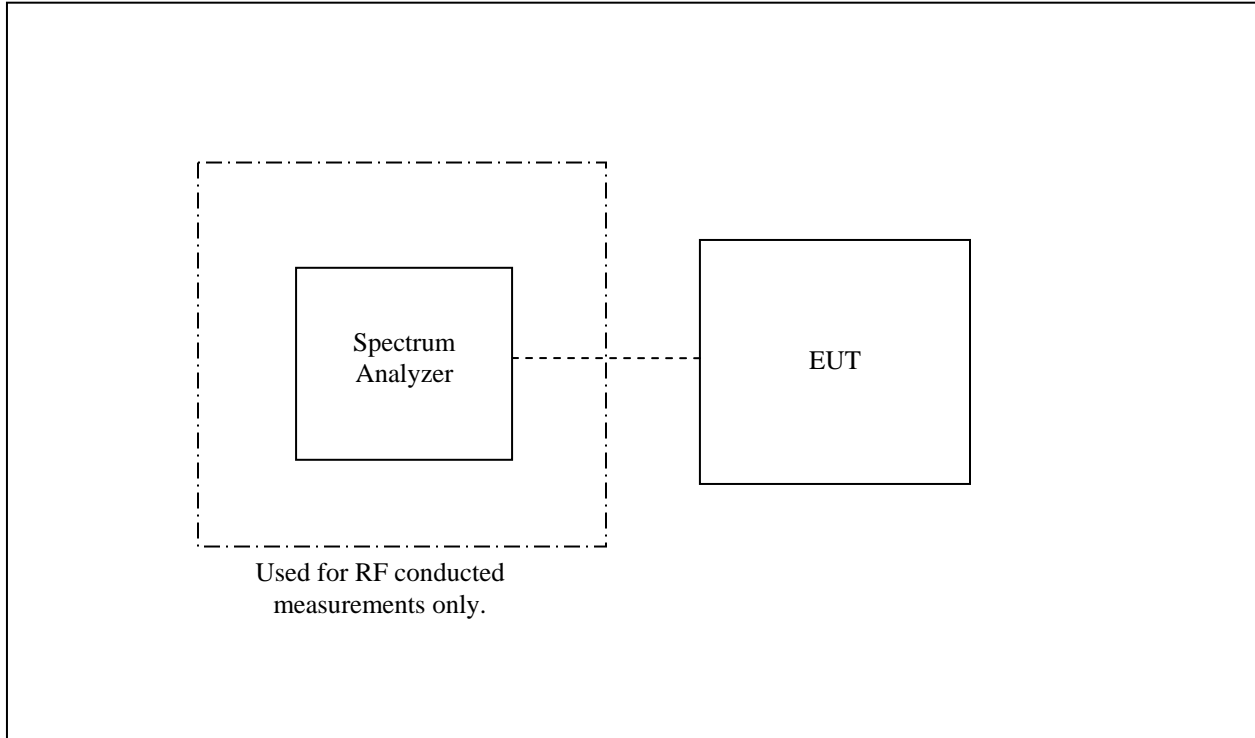


Figure 6-1: EUT Test Setup

The EUT was integrated into a typical host for the purpose of AC power line conducted emissions.

*See Test Setup photographs for additional detail.

7.0 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement - FCC Section 15.203

The L&G Focus-2 Utilinet Endpoint PCB includes an integrated loop antenna, located on the PCB surface layer on the reverse (non-component) side of the assembly. This antenna has a typical gain of ~3dBi.

7.2 Power Line Conducted Emissions - FCC Section 15.207

7.2.1 Test Methodology

The L&G Focus-2 Utilinet Endpoint PCB was integrated into a typical host device for testing. ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer’s resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss

Margin = Applicable Limit - Corrected Reading

7.2.2 Test Results

Results of the test are shown below in and Tables 7.2-1.

Table 7.2-1: Line 1 Conducted EMI Results

| Frequency (MHz) | Uncorrected Reading (dBuV) | | Total Correction Factor (dB) | Corrected Level (dBuV) | | Limit (dBuV) | | Margin (dB) | |
|-----------------|----------------------------|---------|------------------------------|------------------------|---------|--------------|---------|-------------|---------|
| | Quasi-Peak | Average | | Quasi-Peak | Average | Quasi-Peak | Average | Quasi-Peak | Average |
| Line 1 | | | | | | | | | |
| 0.3 | 18.5 | 0.6 | 9.80 | 28.30 | 10.40 | 60.24 | 50.24 | 31.9 | 39.8 |
| 0.36 | 18.1 | 0.2 | 9.80 | 27.90 | 10.00 | 58.73 | 48.73 | 30.8 | 38.7 |
| 0.4 | 17.6 | 0.2 | 9.80 | 27.40 | 10.00 | 57.85 | 47.85 | 30.5 | 37.9 |
| 1.53 | 2.5 | -2.1 | 9.80 | 12.30 | 7.70 | 56.00 | 46.00 | 43.7 | 38.3 |
| 19.66 | 13.8 | 12.7 | 10.11 | 23.91 | 22.81 | 60.00 | 50.00 | 36.1 | 27.2 |
| 26.49 | 13 | 9.2 | 10.11 | 23.11 | 19.31 | 60.00 | 50.00 | 36.9 | 30.7 |
| Line 2 | | | | | | | | | |
| 0.3 | 18.1 | 0.8 | 9.80 | 27.90 | 10.60 | 60.24 | 50.24 | 32.3 | 39.6 |
| 0.36 | 17.9 | 0.2 | 9.80 | 27.70 | 10.00 | 58.73 | 48.73 | 31.0 | 38.7 |
| 0.4 | 16.6 | 0 | 9.80 | 26.40 | 9.80 | 57.85 | 47.85 | 31.5 | 38.1 |
| 1.52 | 11.2 | 9.2 | 9.80 | 21.00 | 19.00 | 56.00 | 46.00 | 35.0 | 27.0 |
| 5.55 | 4.1 | -2.1 | 9.81 | 13.91 | 7.71 | 60.00 | 50.00 | 46.1 | 42.3 |
| 19.66 | 14.1 | 12.8 | 10.11 | 24.21 | 22.91 | 60.00 | 50.00 | 35.8 | 27.1 |
| 26.49 | 7.9 | 2.6 | 10.11 | 18.01 | 12.71 | 60.00 | 50.00 | 42.0 | 37.3 |

7.3 Radiated Emissions - FCC Section 15.109(Unintentional Radiation)

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 5 GHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements were made with the Spectrum Analyzer's resolution bandwidth set to 120 KHz for measurements above 30MHz. Average measurements are taken with the RBW and VBW were set to 1MHz and 10 Hz respectively for measurements above 1000MHz.

7.3.2 Test Results

Results of the test are given in Table 7.3-1 below:

Table 7.3-1: Radiated Emissions Tabulated Data

| Frequency (MHz) | Polarization (H/V) | Height (cm) | Azimuth (deg) | Level (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) |
|------------------|--------------------|--------------|----------------|-----------------------|-----------------------|--------------|
| 30.00 | H | 400 | 44 | 13.6 | 40 | 26.5 |
| 43.44 | V | 110 | 343 | 7.3 | 40 | 32.7 |
| 67.04 | V | 110 | 206 | 11.7 | 40 | 28.3 |
| 97.04 | V | 110 | 163 | 16.1 | 43.5 | 27.4 |
| 150.80 | V | 100 | 168 | 16.2 | 43.5 | 27.3 |
| 197.92 | V | 100 | 188 | 9.1 | 43.5 | 34.4 |
| 349.20 | V | 130 | 190 | 12.8 | 46 | 33.2 |
| 498.08 | H | 310 | 21 | 16.7 | 46 | 29.3 |
| 693.04 | H | 100 | 142 | 22.2 | 46 | 23.8 |
| 952.64 | H | 100 | 133 | 25.0 | 46 | 21.0 |

* Note: All emissions above 952.64 MHz were attenuated below the permissible limit.

7.4 Peak Output Power – FCC Section 15.247(b)(2)

7.4.1 Test Methodology (Conducted Method)

The 20dB bandwidth of the EUT was within the resolution bandwidth of spectrum analyzer, therefore the power measurement was made using the spectrum analyzer method. The resolution and video bandwidth were set to > 20 dB bandwidth of the emission measured. The device employs >50 channels therefore the power is limited to 1 Watt.

7.4.2 Test Results

Results are shown below in table 7.4-1 and the worst case was plotted and shown in figure 7.4-1 to 7.4-3 below:

Table 7.4-1: RF Output Power

| Frequency [MHz] | Level [dBm] |
|-----------------|-------------|
| 902.1 | 16.64 |
| 915.0 | 16.21 |
| 927.9 | 16.37 |

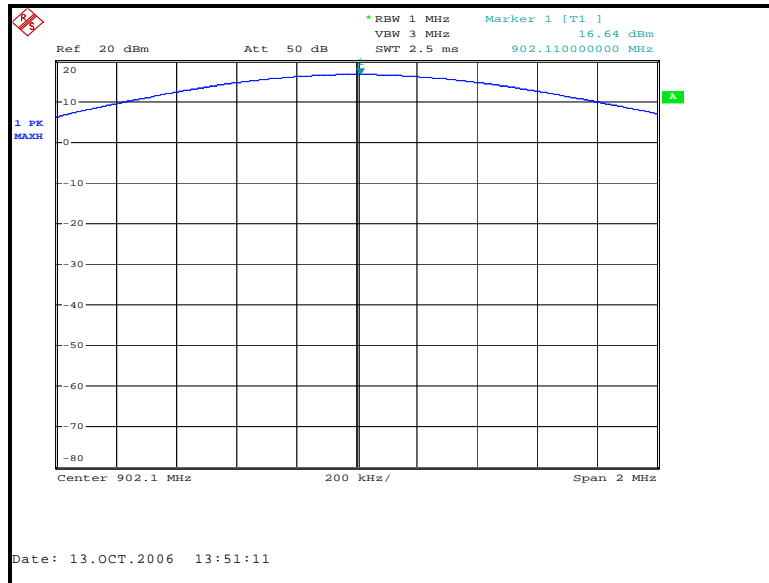


Figure 7.4-1: Output power – Low Channel

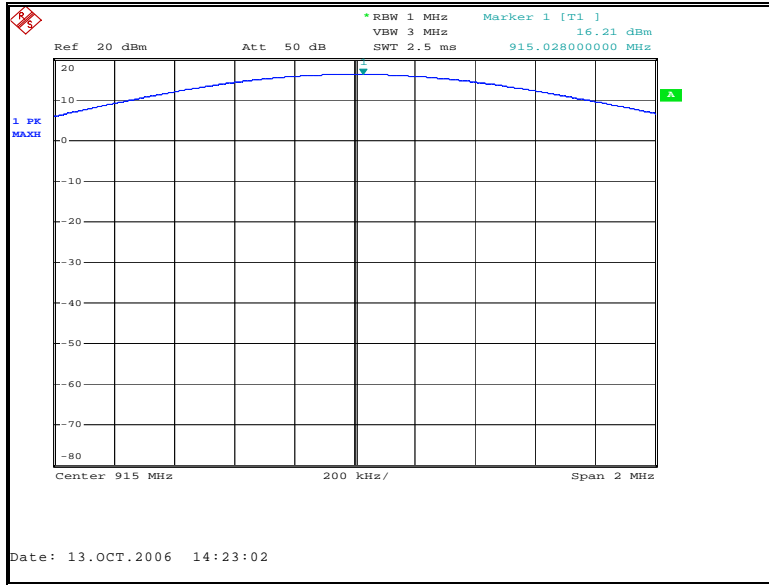


Figure 7.4-2: Output power – Mid Channel

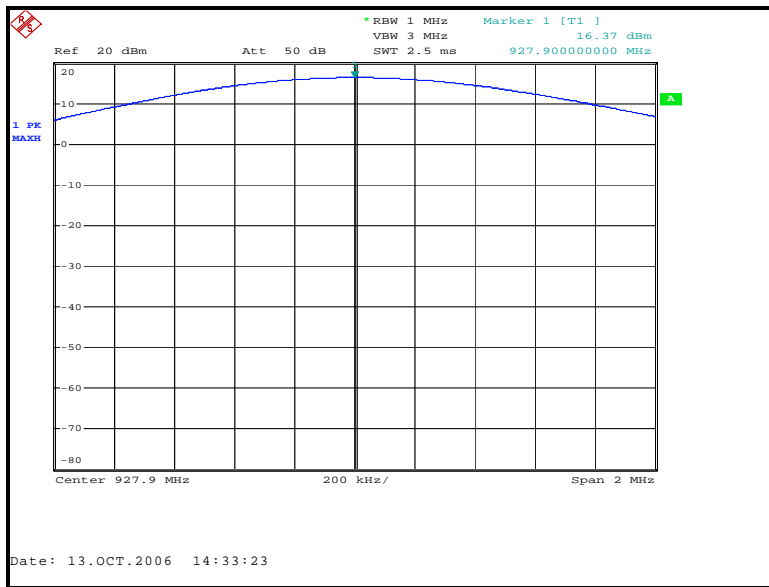


Figure 7.4-3: Output power – High Channel

7.5 Channel Usage Requirements - FCC Section 15.247(a) (1)

15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

15.247(a) (1) (i): For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

7.5.1 Carrier Frequency Separation

7.5.1.1 Test Methodology

The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to $\geq 1\%$ of the span.

7.5.1.2 Test Results

The maximum 20dB bandwidth of the hopping channel was measured to be 27.6kHz (See figure 7.5.4-1 to 7.5.4-3 below). The adjacent channel separation was measured to be 100 kHz. Results are shown in figure 7.5.1-1 below:

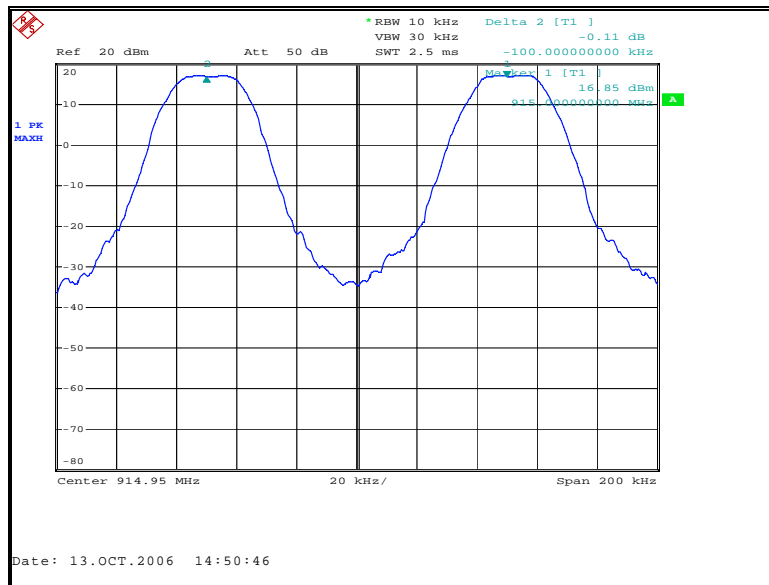


Figure 7.5.1-1: Carrier Frequency Separation

7.5.2 Number of Hopping Channels

The 20dB bandwidth of the device is less than 250 kHz. The device employs a minimum of 50 hopping channels as required. The Frequency Hopping table is shown in Table 7.5.2-1 below:

Table 7.5.2-1: Channel Hopping Sequence

| UtiliNet Frequency Hopping (FHSS) - Channel Hopping Sequence | | | | | | | | | |
|--|------------|---------|------------|---------|------------|---------|------------|---------|------------|
| Channel | Freq (MHz) | Channel | Freq (MHz) | Channel | Freq (MHz) | Channel | Freq (MHz) | Channel | Freq (MHz) |
| 86 | 910.6 | 69 | 908.9 | 252 | 927.2 | 214 | 923.4 | 208 | 922.8 |
| 211 | 923.1 | 256 | 927.6 | 200 | 922 | 28 | 904.8 | 84 | 910.4 |
| 173 | 919.3 | 176 | 919.6 | 185 | 920.5 | 158 | 917.8 | 21 | 904.1 |
| 141 | 916.1 | 52 | 907.2 | 36 | 905.6 | 77 | 909.7 | 121 | 914.1 |
| 72 | 909.2 | 134 | 915.4 | 131 | 915.1 | 124 | 914.4 | 125 | 914.5 |
| 166 | 918.6 | 242 | 926.2 | 32 | 905.2 | 61 | 908.1 | 81 | 910.1 |
| 63 | 908.3 | 228 | 924.8 | 22 | 904.2 | 147 | 916.7 | 165 | 918.5 |
| 23 | 904.3 | 187 | 920.7 | 235 | 925.5 | 191 | 921.1 | 95 | 911.5 |
| 180 | 920 | 82 | 910.2 | 222 | 924.2 | 150 | 917 | 182 | 920.2 |
| 227 | 924.7 | 174 | 919.4 | 108 | 912.8 | 171 | 919.1 | 122 | 914.2 |
| 40 | 906 | 230 | 925 | 99 | 911.9 | 41 | 906.1 | 229 | 924.9 |
| 144 | 916.4 | 241 | 926.1 | 126 | 914.6 | 188 | 920.8 | 216 | 923.6 |
| 33 | 905.3 | 133 | 915.3 | 152 | 917.2 | 89 | 910.9 | 253 | 927.3 |
| 195 | 921.5 | 169 | 918.9 | 193 | 921.3 | 220 | 924 | 204 | 922.4 |
| 154 | 917.4 | 30 | 905 | 254 | 927.4 | 127 | 914.7 | 70 | 909 |
| 190 | 921 | 136 | 915.6 | 146 | 916.6 | 20 | 904 | 44 | 906.4 |
| 236 | 925.6 | 178 | 919.8 | 34 | 905.4 | 217 | 923.7 | 259 | 927.9 |
| 149 | 916.9 | 210 | 923 | 49 | 906.9 | 114 | 913.4 | 240 | 926 |
| 143 | 916.3 | 71 | 909.1 | 255 | 927.5 | 111 | 913.1 | 48 | 906.8 |
| 181 | 920.1 | 205 | 922.5 | 129 | 914.9 | 213 | 923.3 | 66 | 908.6 |
| 232 | 925.2 | 192 | 921.2 | 209 | 922.9 | 35 | 905.5 | 79 | 909.9 |
| 123 | 914.3 | 85 | 910.5 | 94 | 911.4 | 42 | 906.2 | 132 | 915.2 |
| 233 | 925.3 | 53 | 907.3 | 140 | 916 | 172 | 919.2 | 245 | 926.5 |
| 38 | 905.8 | 202 | 922.2 | 83 | 910.3 | 25 | 904.5 | 120 | 914 |
| 118 | 913.8 | 37 | 905.7 | 257 | 927.7 | 59 | 907.9 | 67 | 908.7 |
| 60 | 908 | 43 | 906.3 | 237 | 925.7 | 87 | 910.7 | 183 | 920.3 |
| 201 | 922.1 | 54 | 907.4 | 135 | 915.5 | 168 | 918.8 | 248 | 926.8 |
| 198 | 921.8 | 243 | 926.3 | 234 | 925.4 | 196 | 921.6 | 78 | 909.8 |
| 116 | 913.6 | 64 | 908.4 | 92 | 911.2 | 223 | 924.3 | 80 | 910 |
| 91 | 911.1 | 68 | 908.8 | 57 | 907.7 | 24 | 904.4 | 93 | 911.3 |
| 212 | 923.2 | 100 | 912 | 109 | 912.9 | 225 | 924.5 | 184 | 920.4 |
| 221 | 924.1 | 239 | 925.9 | 249 | 926.9 | 103 | 912.3 | 74 | 909.4 |
| 96 | 911.6 | 29 | 904.9 | 215 | 923.5 | 151 | 917.1 | 153 | 917.3 |
| 157 | 917.7 | 177 | 919.7 | 179 | 919.9 | 203 | 922.3 | 65 | 908.5 |
| 247 | 926.7 | 139 | 915.9 | 258 | 927.8 | 197 | 921.7 | 159 | 917.9 |
| 167 | 918.7 | 117 | 913.7 | 186 | 920.6 | 219 | 923.9 | 142 | 916.2 |
| 224 | 924.4 | 148 | 916.8 | 244 | 926.4 | 97 | 911.7 | 58 | 907.8 |
| 246 | 926.6 | 75 | 909.5 | 189 | 920.9 | 51 | 907.1 | 164 | 918.4 |
| 238 | 925.8 | 206 | 922.6 | 31 | 905.1 | 98 | 911.8 | 163 | 918.3 |
| 46 | 906.6 | 226 | 924.6 | 73 | 909.3 | 45 | 906.5 | 90 | 911 |
| 39 | 905.9 | 155 | 917.5 | 130 | 915 | 156 | 917.6 | 106 | 912.6 |
| 251 | 927.1 | 47 | 906.7 | 194 | 921.4 | 101 | 912.1 | 145 | 916.5 |
| 115 | 913.5 | 62 | 908.2 | 162 | 918.2 | 50 | 907 | 76 | 909.6 |
| 128 | 914.8 | 138 | 915.8 | 119 | 913.9 | 27 | 904.7 | 199 | 921.9 |
| 110 | 913 | 231 | 925.1 | 107 | 912.7 | 207 | 922.7 | | |
| 160 | 918 | 113 | 913.3 | 88 | 910.8 | 250 | 927 | | |
| 56 | 907.6 | 137 | 915.7 | 175 | 919.5 | 102 | 912.2 | | |
| 26 | 904.6 | 55 | 907.5 | 170 | 919 | 112 | 913.2 | | |
| 161 | 918.1 | 105 | 912.5 | 218 | 923.8 | 104 | 912.4 | | |

7.5.3 Channel Dwell Time

The maximum duration of the RF transmission is 364ms during a 700ms channel dwell time. There is a minimum of 50 channels used during the hopping sequence therefore a channel will not be re-occupied until at least 35s. Therefore the average time of occupancy on any one channel in a 20 second period is 364ms.

A detailed description of the RF timing and a timing diagram are included in the theory of operation.

7.5.4 20dB Bandwidth

7.5.4.1 Test Methodology

The spectrum analyzer span was set to 2 to 3 times the estimated 20 dB bandwidth of the emission. The RBW was to $\geq 1\%$ of the estimated 20 dB bandwidth. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission. The span and RBW were examined and re-adjusted if necessary to meet the requirements of 2 to 3 times the 20 bandwidth for the span and $\geq 1\%$ of the 20 dB bandwidth for the RBW.

7.5.4.2 Test Results

The maximum 20dB bandwidth was found to be approximately 27.60kHz. Results are shown below in Table 7.5.4-1 and Figures 7.5.4-1 through 7.5.4-3.

Table 7.5.4-1

| Frequency (MHz) | 20dB Bandwidth (kHz) |
|-----------------|----------------------|
| 902.1 | 27.60 |
| 915 | 27.15 |
| 927.9 | 27.30 |

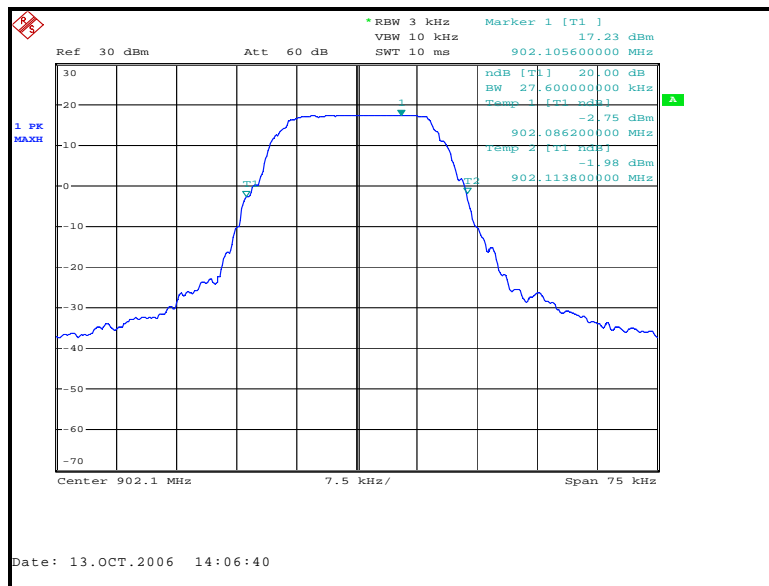


Figure 7.5.4-1: 20dB Bandwidth Low Channel

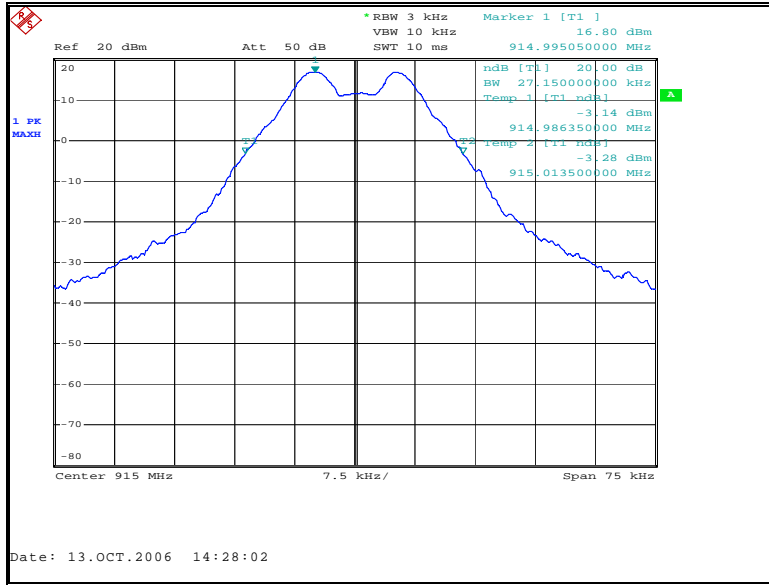


Figure 7.5.4-2: 20dB Bandwidth Mid Channel

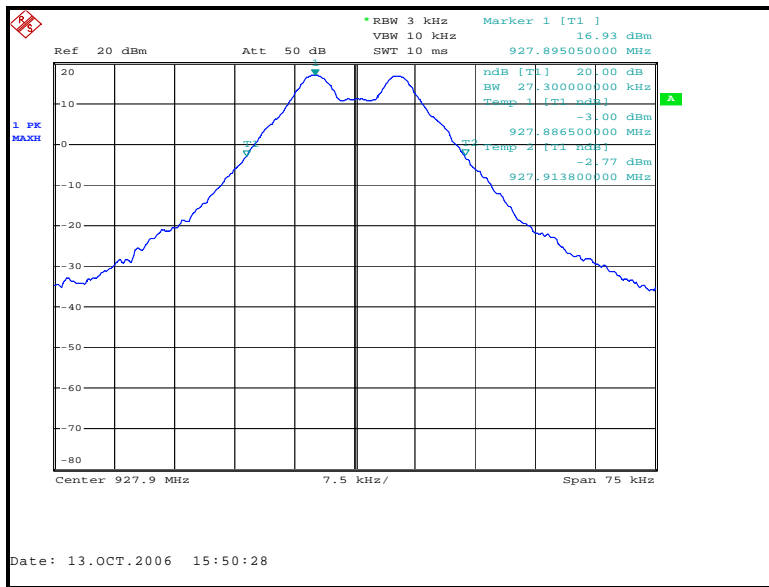


Figure 7.5.4-3: 20dB Bandwidth High Channel

7.6 Band-Edge Compliance and Spurious Emissions - FCC Section 15.247(d)

7.6.1 Band-Edge Compliance of RF Conducted Emissions

7.6.1.1 Test Methodology

The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 30 kHz, which is $\geq 1\%$ of the span, and the VBW was set to 100kHz.

7.6.1.2 Test Results

In a 100 kHz bandwidth at the lower and upper band-edge, the radio frequency power that was produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. Band-edge compliance is displayed in Figures 7.6.1-1 and 7.6.2-2

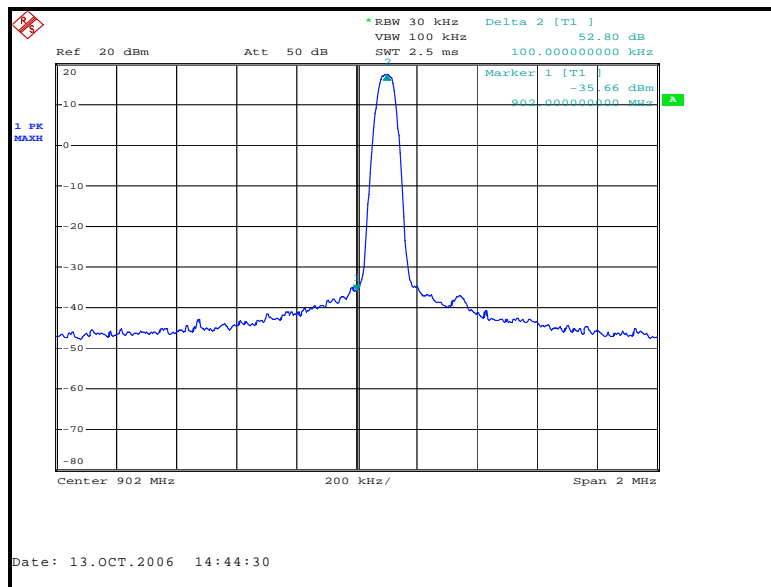


Figure 7.6.1-1: Lower Band-edge

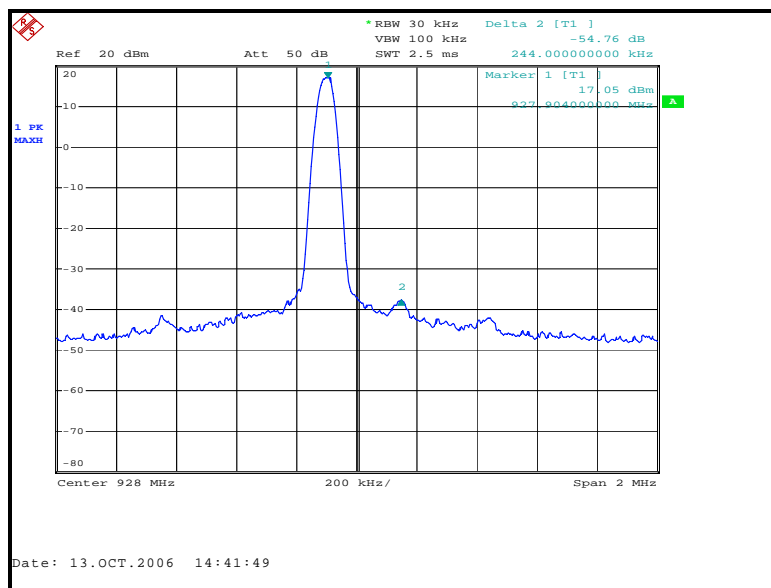


Figure 7.6.1-2: Upper Band-edge

7.6.2 RF Conducted Spurious Emissions

7.6.2.1 Test Methodology

The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100kHz. A peak detector function was used with the trace set to max hold.

7.6.2.1 Test Results

All emission found were greater than 20dB down from the fundamental carrier. Results are shown below in Figures 7.6.2-1 through 7.6.2-6.

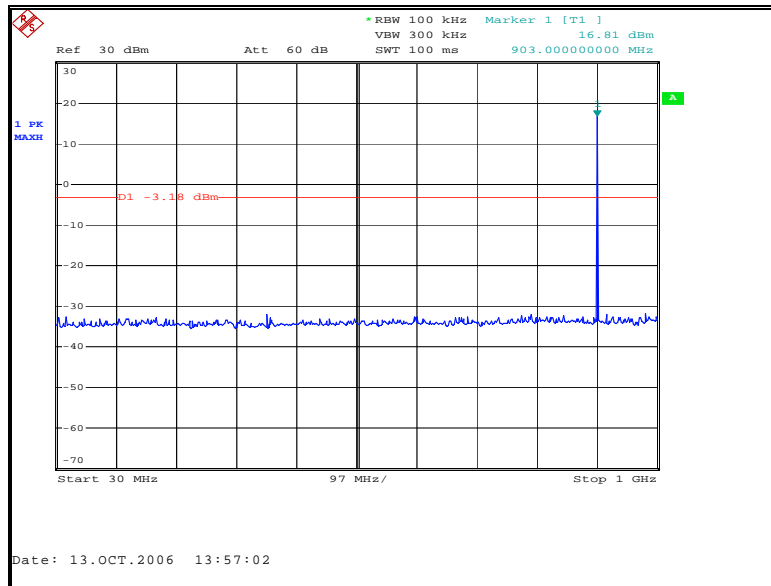


Figure 7.6.2-1 RF Conducted Spurious Emissions – Low Channel

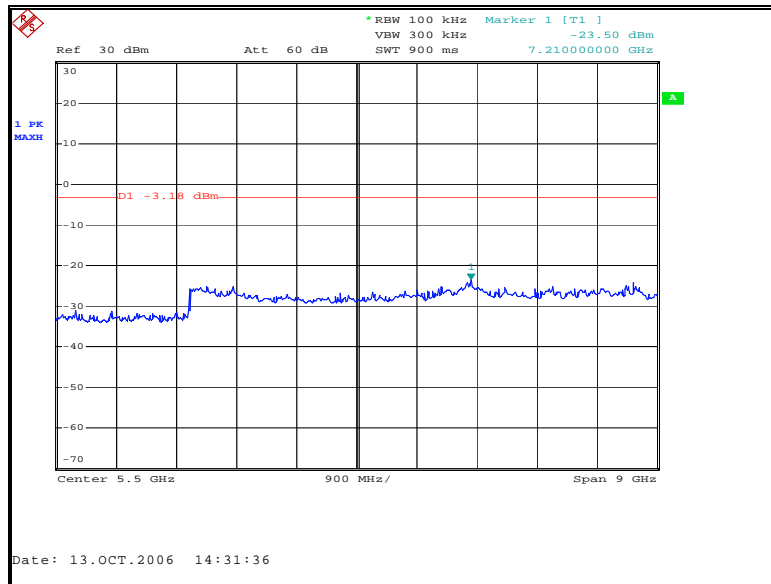


Figure 7.6.2-2 RF Conducted Spurious Emissions – Low Channel

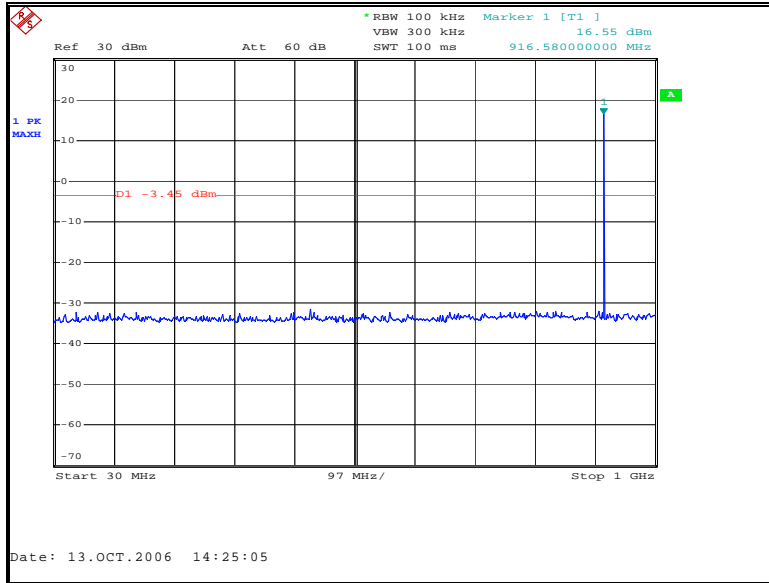


Figure 7.6.2-3 RF Conducted Spurious Emissions – Mid Channel

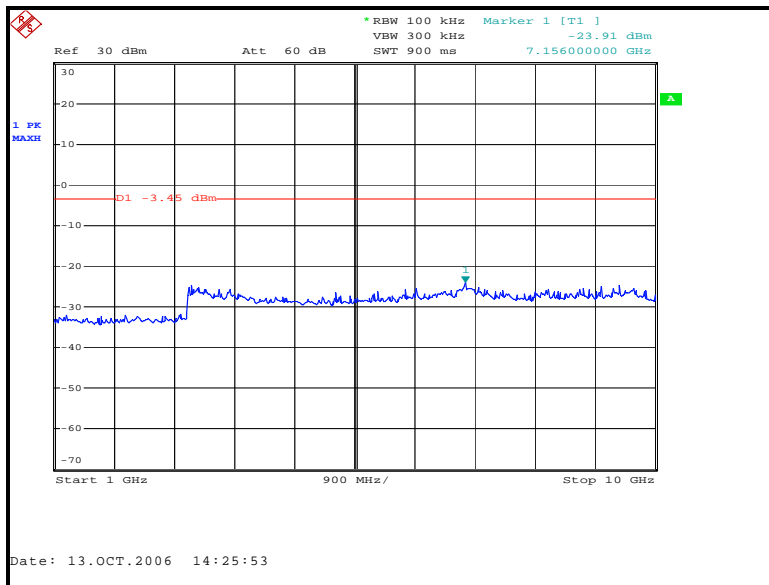


Figure 7.6.2-4 RF Conducted Spurious Emissions – Mid Channel

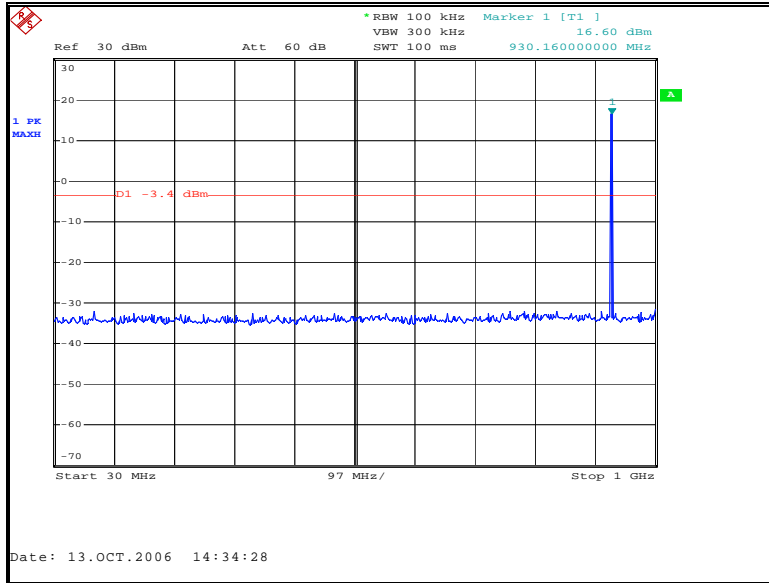


Figure 7.6.2-5 RF Conducted Spurious Emissions – High Channel

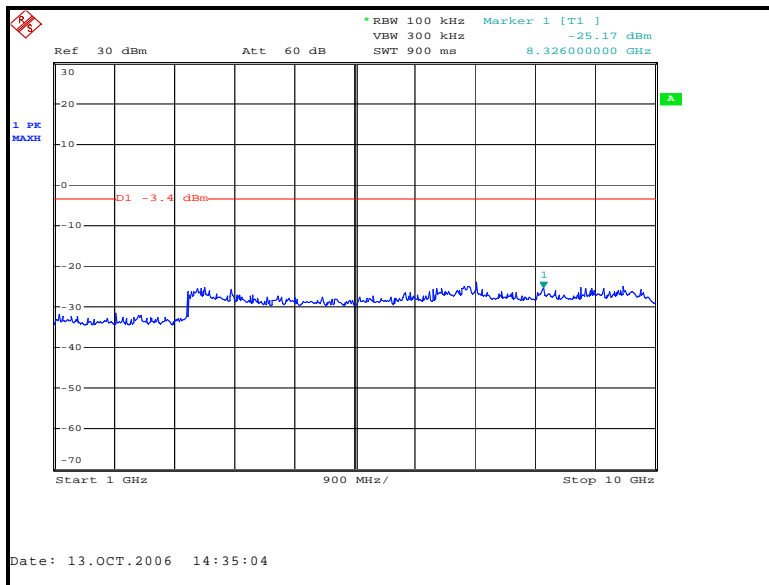


Figure 7.6.2-6 RF Conducted Spurious Emissions – High Channel

7.6.3 Radiated Spurious Emissions (Restricted Bands) - FCC Section 15.205

7.6.3.1 Test Methodology

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000MHz, average measurements were made using an RBW of 1 MHz and a VBW of 10 Hz and peak measurements were made with RBW of 1 MHz and a VBW of 1 MHz.

The EUT was caused to generate a continuous carrier signal on the hopping channel.

7.6.3.2 Test Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in Tables 7.6.3-1 through 7.6.3-3. Each emission found to be in a restricted band as defined by section 15.205, was compared to the radiated emission limits as defined in section 15.209.

Table 7.6.3-1: Radiated Spurious Emissions

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|-----------------|--------------|---------|------------------------|-------------------------|--------------------------|---------|----------------|---------|-------------|---------|
| | pk | Qpk/Avg | | | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| 2706.3 | 50.34 | 48.31 | H | 1.49 | 51.83 | 49.80 | 74.0 | 54.0 | 22.17 | 4.20 |
| 2706.3 | 48.08 | 44.55 | V | 1.26 | 49.34 | 45.81 | 74.0 | 54.0 | 24.66 | 8.19 |
| 3608.4 | 45.00 | 36.42 | H | 4.24 | 49.24 | 40.66 | 74.0 | 54.0 | 24.76 | 13.34 |
| 3608.4 | 44.42 | 31.52 | V | 4.20 | 48.62 | 35.72 | 74.0 | 54.0 | 25.38 | 18.28 |
| 9021 | 44.34 | 34.64 | H | 13.78 | 58.12 | 48.42 | 74.0 | 54.0 | 15.88 | 5.58 |
| 9021 | 45.51 | 36.22 | V | 13.78 | 59.29 | 50.00 | 74.0 | 54.0 | 14.71 | 4.00 |

* The magnitude of all emissions not reported were below the noise floor of the measurement system.

Table 7.6.3-2: Radiated Spurious Emissions

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|-----------------|--------------|---------|------------------------|-------------------------|--------------------------|---------|----------------|---------|-------------|---------|
| | pk | Qpk/Avg | | | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| 2745 | 47.21 | 41.32 | H | 1.61 | 48.82 | 42.93 | 74.0 | 54.0 | 25.18 | 11.07 |
| 2745 | 46.96 | 40.53 | V | 1.40 | 48.36 | 41.93 | 74.0 | 54.0 | 25.64 | 12.07 |
| 3660 | 44.50 | 33.37 | H | 4.47 | 48.97 | 37.84 | 74.0 | 54.0 | 25.03 | 16.16 |
| 3660 | 44.32 | 30.25 | V | 4.47 | 48.79 | 34.72 | 74.0 | 54.0 | 25.21 | 19.28 |
| 4575 | 44.75 | 36.83 | H | 6.75 | 51.50 | 43.58 | 74.0 | 54.0 | 22.50 | 10.42 |
| 4575 | 44.78 | 35.41 | V | 6.87 | 51.65 | 42.28 | 74.0 | 54.0 | 22.35 | 11.72 |

*The magnitude of all emissions not reported were below the noise floor of the measurement system.

Table 7.6.3-3: Radiated Spurious Emissions

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity (H/V) | Correction Factors (dB) | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|-----------------|--------------|---------|------------------------|-------------------------|--------------------------|---------|----------------|---------|-------------|---------|
| | pk | Qpk/Avg | | | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| 2783.7 | 45.46 | 39.27 | H | 1.72 | 47.18 | 40.99 | 74.0 | 54.0 | 26.82 | 13.01 |
| 2783.7 | 46.07 | 39.37 | V | 1.55 | 47.62 | 40.92 | 74.0 | 54.0 | 26.38 | 13.08 |
| 4639.5 | 45.69 | 37.39 | H | 6.99 | 52.68 | 44.38 | 74.0 | 54.0 | 21.32 | 9.62 |
| 4639.5 | 45.49 | 37.37 | V | 7.11 | 52.60 | 44.48 | 74.0 | 54.0 | 21.40 | 9.52 |

* The magnitude of all emissions not reported were below the noise floor of the measurement system.

7.6.3.3 Sample Calculation:

$$R_C = R_U + CF_T$$

Where:

| | | |
|--------|---|---|
| CF_T | = | Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only) |
| R_U | = | Uncorrected Reading |
| R_C | = | Corrected Level |
| AF | = | Antenna Factor |
| CA | = | Cable Attenuation |
| AG | = | Amplifier Gain |
| DC | = | Duty Cycle Correction Factor |

Example Calculation

PEAK:

Corrected Level: $50.34 + 1.49 = 51.83\text{dBuV}$

Margin: $74\text{dBuV} - 51.83\text{dBuV} = 22.17\text{dB}$

AVERAGE:

Corrected Level: $48.31 + 1.49 - 0 = 49.80\text{dBuV}$

Margin: $54\text{dBuV} - 49.80\text{dBuV} = 4.20\text{dB}$

8.0 CONCLUSION

In the opinion of ACS, Inc. the L&G Focus-2 Utilinet Endpoint, manufactured by Cellnet Technology, Inc. meets the requirements of FCC Part 15 subpart C.

END REPORT