

# FCC Part 15 Subpart C Transmitter Certification

Frequency Hopping Spread Spectrum Transmitter

## Test Report

FCC ID: R7PER1S4

FCC Rule Part: 15.247

ACS Report Number: 05-0393-15C


Manufacturer: Cellnet Technology, Inc.  
Model: 25-1019

Test Begin Date: October 31, 2005  
Test End Date: November 4, 2005

Report Issue Date: January 27, 2006



FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612

Prepared by:   
J. Kirby Munroe  
Manager Wireless Certifications  
ACS, Inc.

Reviewed by:   
R. Sam Wismer  
Engineering Manager  
ACS, Inc.

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This report contains 19 pages

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## 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 EUT is a data radio used in the Utility industry for controls and automatic meter reading.

#### 1.2.2 Intended Use

It is sold to utility companies for the purpose of automating the control of remote devices and for collecting data from remote devices such as meters.

## 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

**2.3 Radiated Emissions Test Site Description**

**2.3.1 Semi-Anechoic Chamber Test Site**

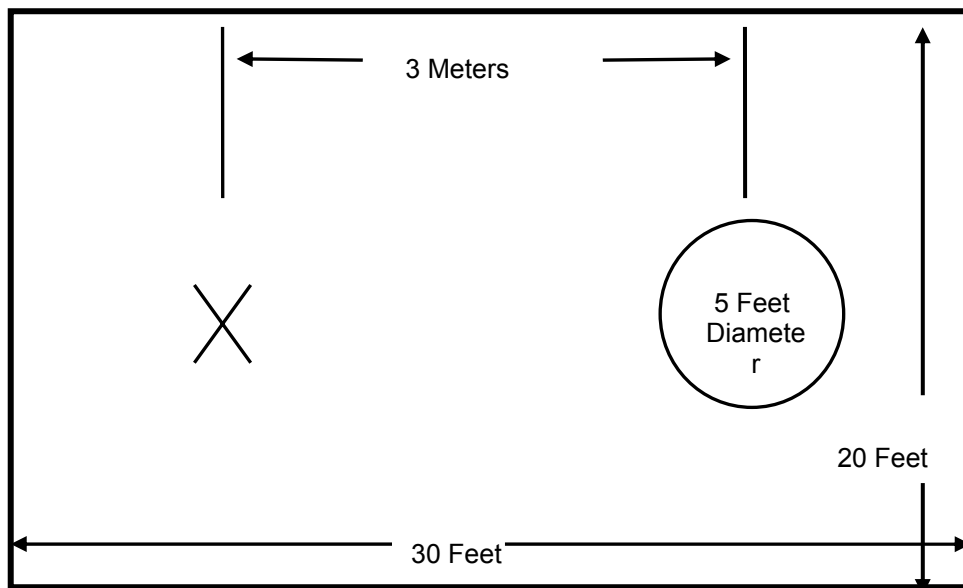
The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed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

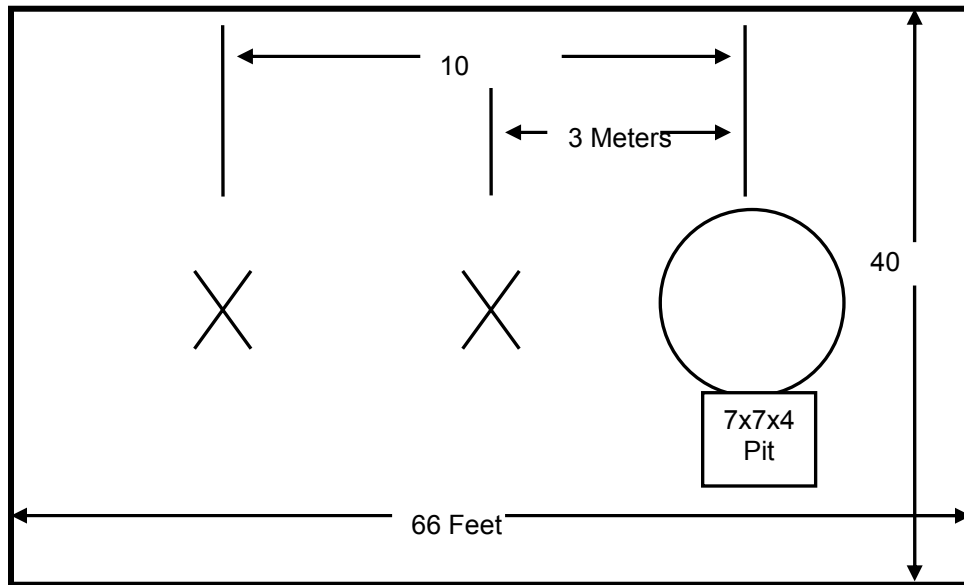
The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide 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 a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room 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 2.4-1:

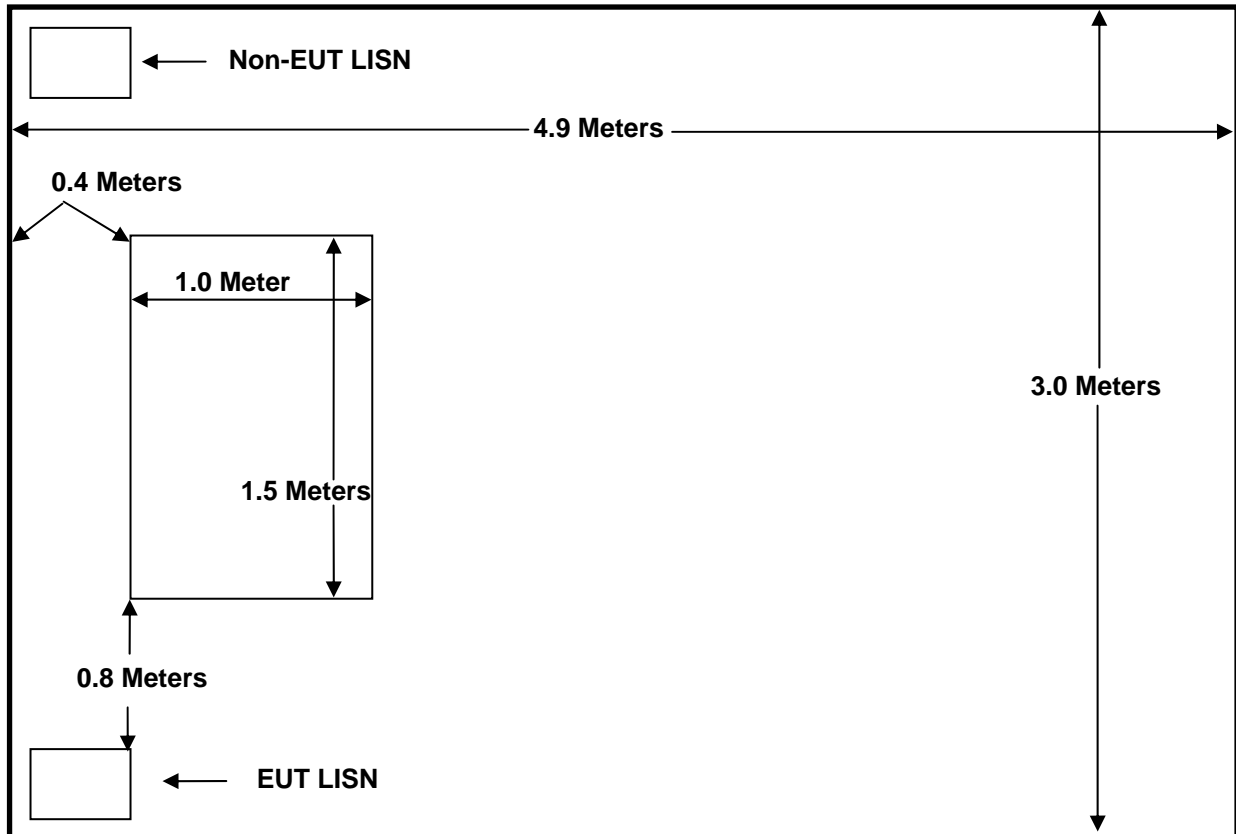


Figure 2.4-1: AC Mains Conducted EMI Site

**3.0 APPLICABLE STANDARD REFERENCES**

The following standards were used:

- 1 - ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the 9 KHz to 40GHz
- 2 - US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators
- 3 - FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

**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**

<b>Equipment Calibration Information</b>					
<b>ACS#</b>	<b>Mfg.</b>	<b>Eq. type</b>	<b>Model</b>	<b>S/N</b>	<b>Cal. Due</b>
25	Chase	Bi-Log Antenna	CBL6111	1043	05/23/06
152	EMCO	LISN	3825/2	9111-1905	01/18/06
165	ACS	Conducted EMI Cable Set	RG8	165	01/06/06
22	Agilent	Pre-Amplifier	8449B	3008A00526	05/06/06
73	Agilent	Pre-Amplifier	8447D	272A05624	05/18/06
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	05/09/06
NA	EMCO	Horn Antenna	3115	9512-4636	NA
105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	06/09/06
1	Rohde & Schwarz	Receiver	804.8932.52	833771/007	02/26/06
2	Rohde & Schwarz	Receiver	1032.5640.53	839587/003	02/26/06
3	Rohde & Schwarz	ESMI Receiver	804.8932.52	839379/011	12/15/05
4	Rohde & Schwarz	ESMI Receiver	1032.5640.53	833827/003	12/15/05
NA	Agilent	Spectrum Analyzer	E4440A	MY43362209	09/08/06
204	ACS	Cable	RG8	204	12/29/05
6	Harbour Industries	HF RF Cable	LL-335	00006	03/16/06
7	Harbour Industries	HF RF Cable	LL-335	00007	03/16/06
208	Harbour Industries	HF RF Cable	LL142	00208	06/24/06
167	ACS	Chamber EMI Cable Set	RG6	167	12/29/05
204	ACS	Chamber EMI RF cable	RG8	204	01/07/06

**5.0 SUPPORT EQUIPMENT****Table 5-3: Support Equipment**

<b>Item #</b>	<b>Manufacturer</b>	<b>Equipment Type</b>	<b>Model Number</b>	<b>Serial Number</b>	<b>FCC ID</b>
1	Cellnet	EUT	25-1019	NA	R7PER1S4
2	Hewlett Packard	DC Power Supply	6286A	2109A-06095	None
3	OK Industries	DC Power Supply	PS73C	36095	None
4	IBM	Laptop PC	Thinkpad – 9547	78-TFN16 96/12	ANOGCF2704AT

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

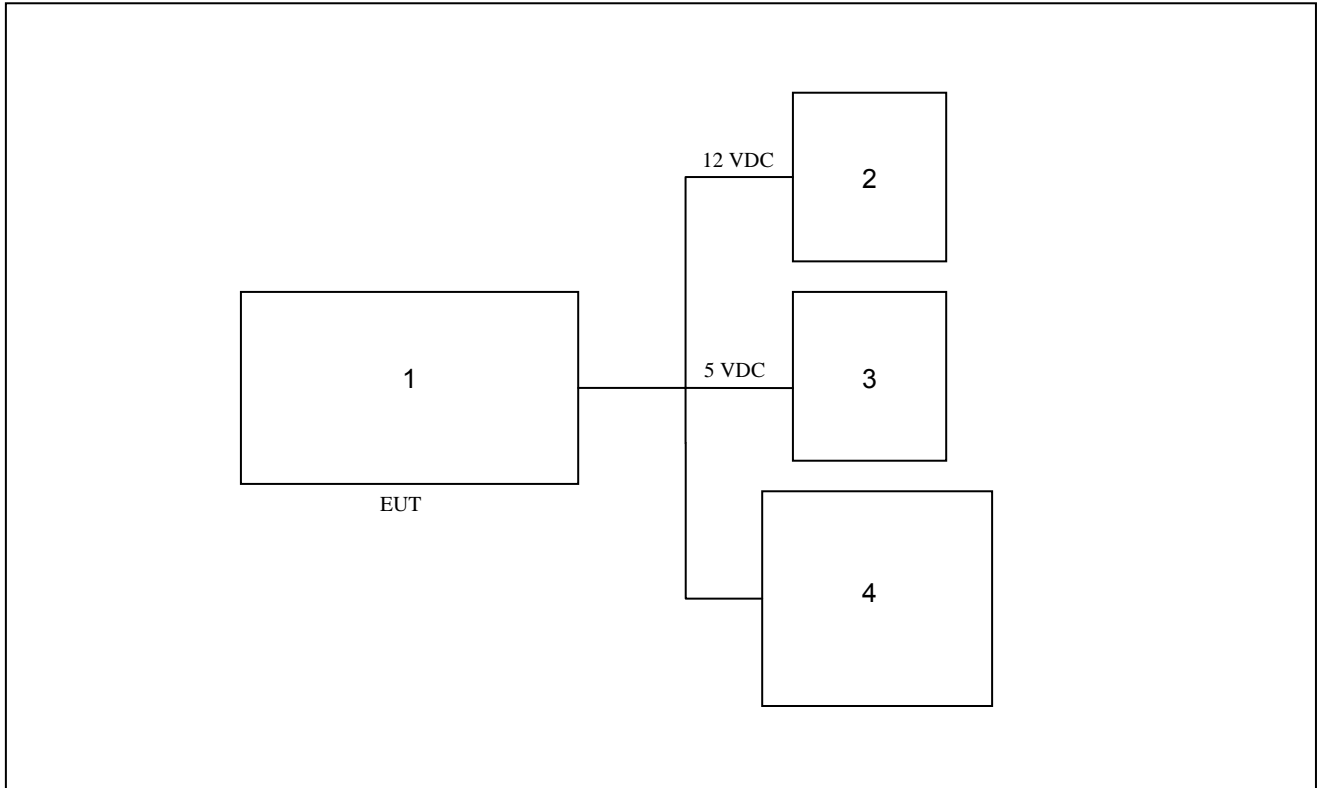


Figure 6.0-1: EUT Test Setup

**Note:** For RF conducted measurements the EUT was modified with an external 50 Ohm RF port.



## 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 25-1019 includes an integrated antenna. The antenna is a tuned slot-type integrated into the PCB and is not changeable. The antenna gain is -1dBi.

### 7.2 Power Line Conducted Emissions - FCC Section 15.207

#### 7.2.1 Test Methodology

The device under test is a modular device which acquires DC power for the host and therefore does not require power line conducted emission testing.

### 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 1 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.

#### 7.3.2 Test Results

Results of the test are given below in Table 7.3.2-1:

**Table 7.3.2-1: Radiated Emissions**

Frequency ( MHz)	Polarization	Height ( cm)	Azimuth ( deg)	Level ( dB $\mu$ V/m)	Limit ( dB $\mu$ V/m)	Margin ( dB)
30.00	HORIZONTAL	229	0	12.8	40.0	27.2
43.44	HORIZONTAL	310	14	4.8	40.0	35.2
85.68	VERTICAL	130	278	4.1	40.0	35.9
110.56	HORIZONTAL	270	98	19.4	43.5	24.1
132.16	VERTICAL	110	79	10.0	43.5	33.5
214.80	VERTICAL	110	123	7.1	43.5	36.4
345.84	VERTICAL	290	13	12.8	46.0	33.2
487.84	HORIZONTAL	330	89	18.1	46.0	27.9
703.68	HORIZONTAL	150	265	23.0	46.0	23.0
960.00	HORIZONTAL	350	141	26.4	46.0	19.6

\* Note: All emissions above 960.00 MHz were attenuated at least 20 dB below the permissible limit.

**7.4 Peak Output Power – FCC Section 15.247**

**7.4.1 Test Methodology (Conducted Method)**

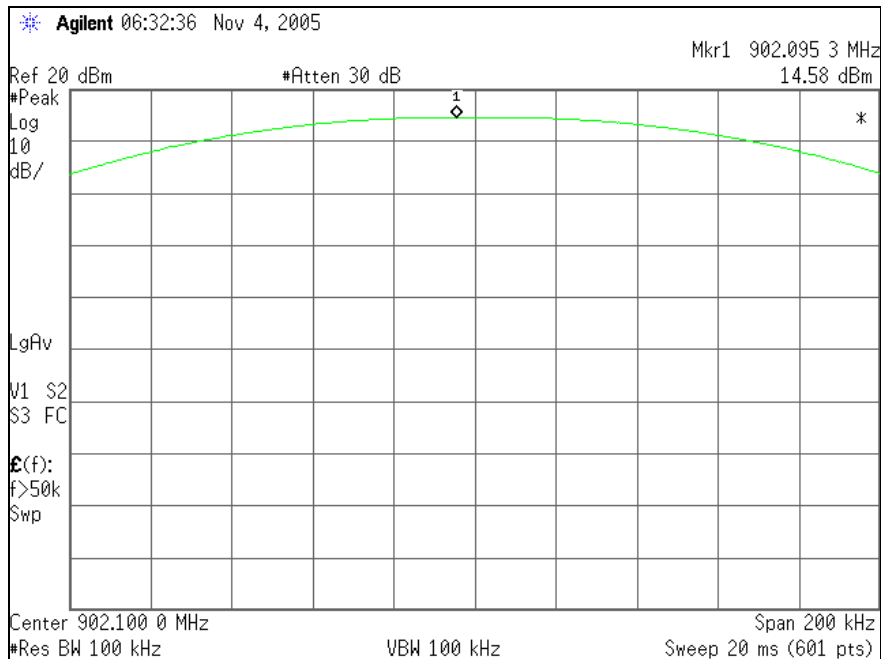
The 20dB bandwidth of the EUT was within the resolution bandwidth of spectrum analyzer, therefore the power measurement was made using the spectrum analyzer method. The resolution and video bandwidth were set to 3MHz. The device employs >50 channels therefore the power is limited to 1 Watt.

**7.4.2 Test Results**

Results are shown below in table 7.4.2-1 and in figures 7.4.2-1 to 7.4.2-3 below:

**Table 7.4.2-1: RF Output Power**

Frequency [MHz]	Level [dBm]
902.1	14.58
915.0	14.07
927.9	13.29



**Figure 7.4.2-1: Peak Output Power – Low Channel**

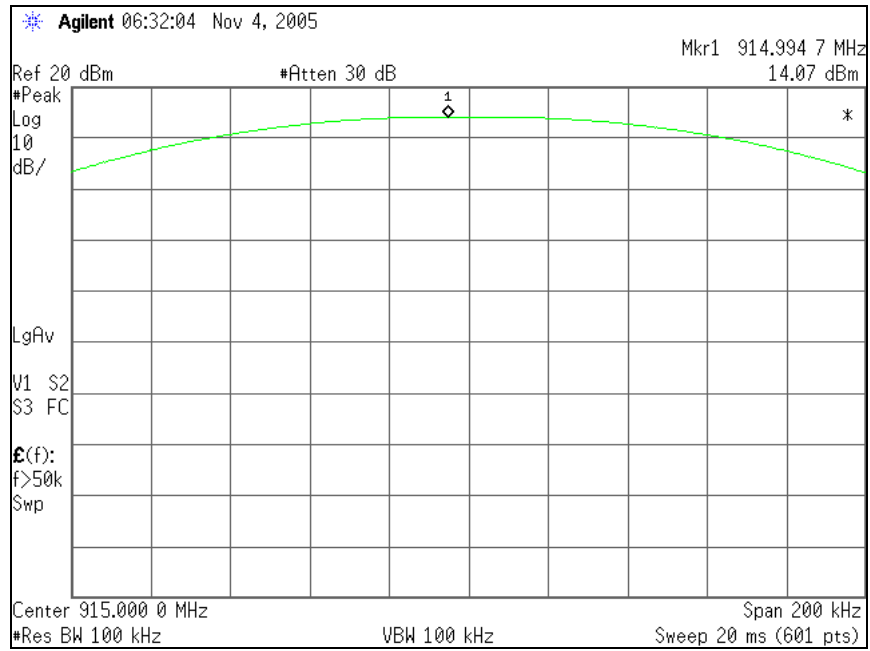


Figure 7.4.2-2: Peak Output Power – Mid Channel

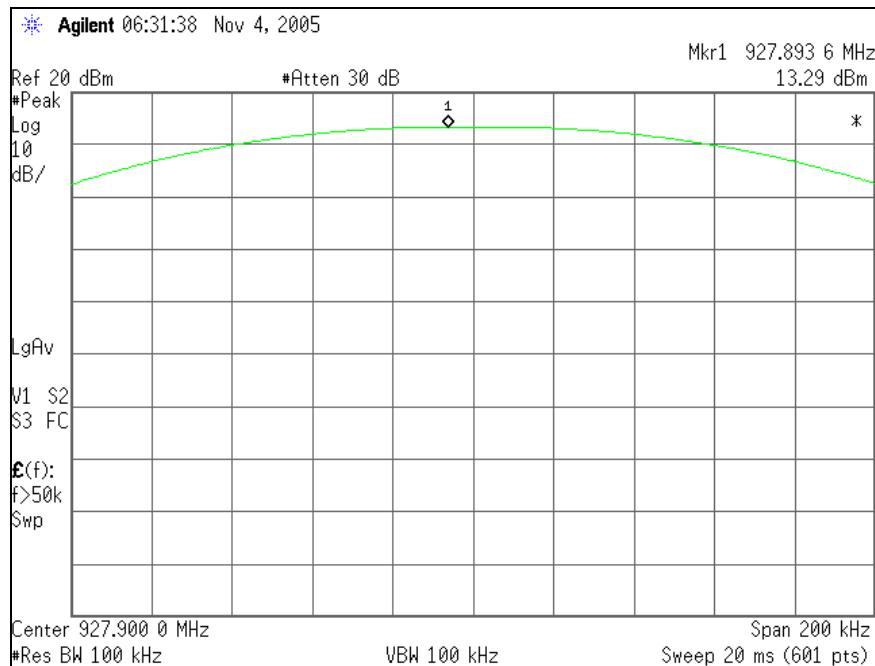


Figure 7.4.2-3: Peak Output Power – High Channel

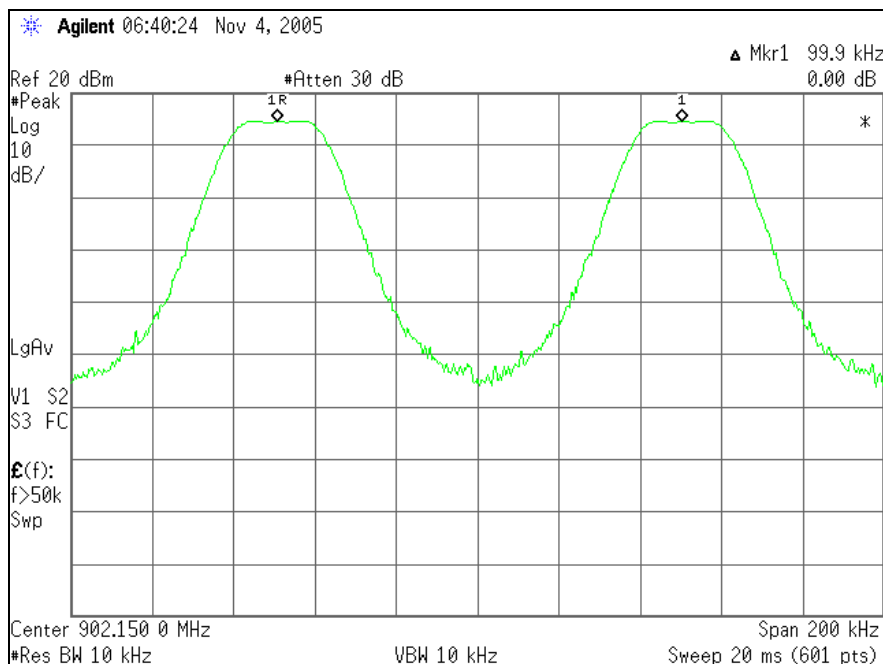
**7.5 Channel Usage Requirements - FCC Section 15.247**

**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 pseudorandomly 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**

The maximum 20dB bandwidth of the hopping channel was measured to be 41.1kHz (See figure 7.5.4.2-1 to 7.5.4.2-3 below). The adjacent channel separation was measured to be 100kHz. 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 Channels and as many as 259.

**7.5.3 Channel Dwell Time**

The UtiliNet radio firmware prohibits transmission on any one frequency from exceeding 0.4 Sec within a 20 second period. In the absence of any transmission, receivers hop frequencies every 700 mS.

7.5.4 20dB Bandwidth

7.5.4.1 Test Methodology

The 20dB bandwidth was measured in accordance with FCC Public Notice DA-00-75.

7.5.4.2 Test Results

Results are shown below in table 7.5.4.2-1 and the worst case is shown in figures 7.5.4.2-1 to 7.5.4.2-3 below:

Table 7.5.4.2-1: 20dB Bandwidth

Frequency [MHz]	Bandwidth [kHz]	Limit [kHz]	Result
902.1	40.9	500	Pass
915.0	40.7	500	Pass
927.9	41.1	500	Pass

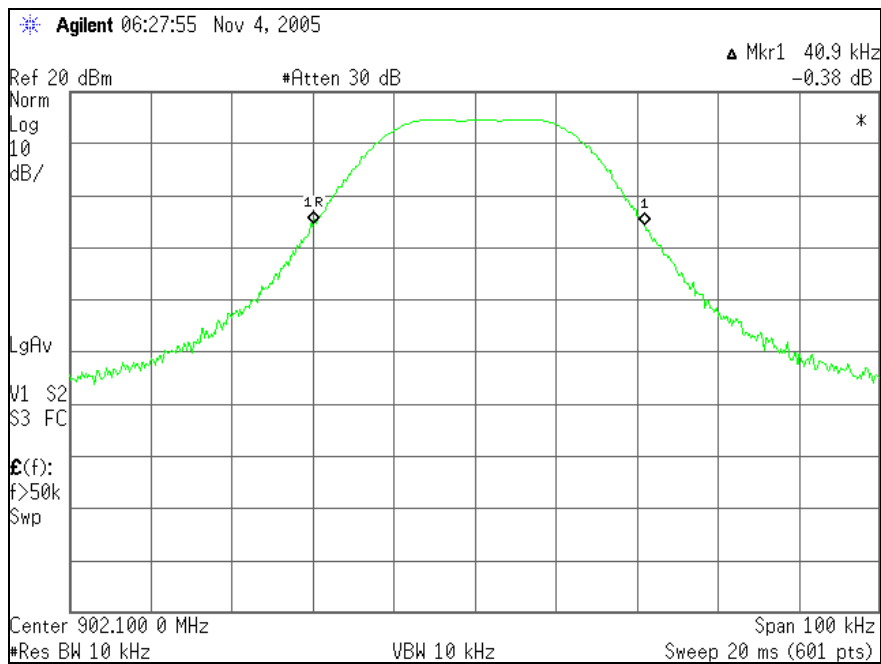
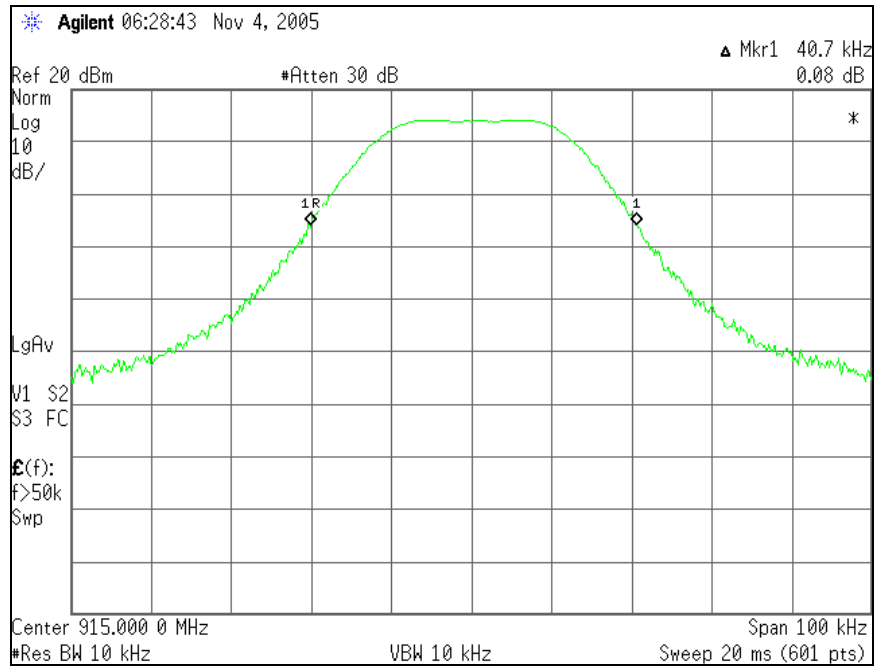
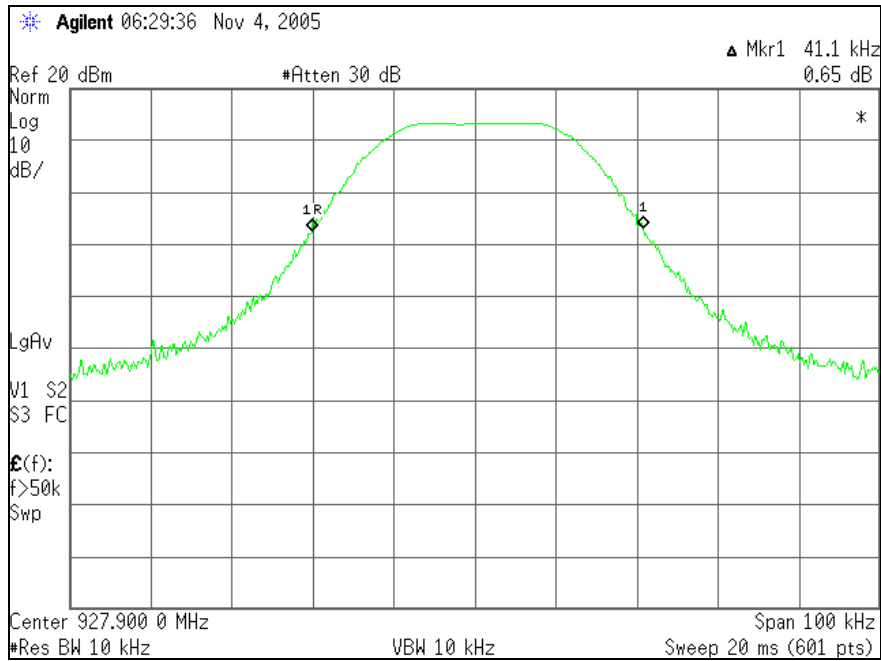


Table 7.5.4.2-1: 20dB Bandwidth – Low Channel



**Table 7.5.4.2-2: 20dB Bandwidth – Mid Channel**



**Table 7.5.4.2-3: 20dB Bandwidth – High Channel**

## 7.6 Band-Edge Compliance and Spurious Emissions

### 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.

#### 7.6.1.2 Test Results

The radio frequency power that was produced by the EUT is at least 20 dB below that in the band that contains the highest level of desired power. Band-edge compliance is displayed in Figures 7.6.1.2-1 and 7.6.1.2-2.

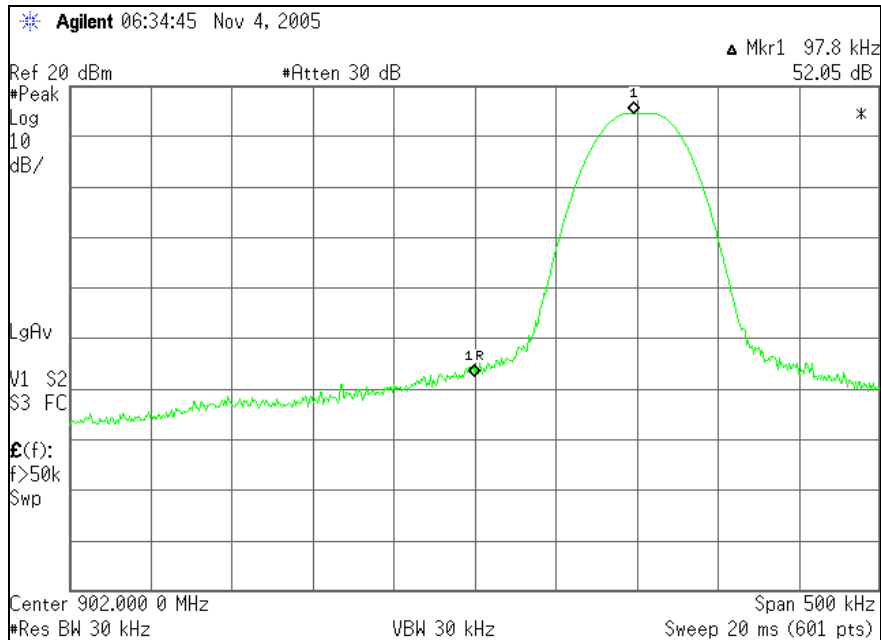


Figure 7.6.1.2-1: Lower Band-edge

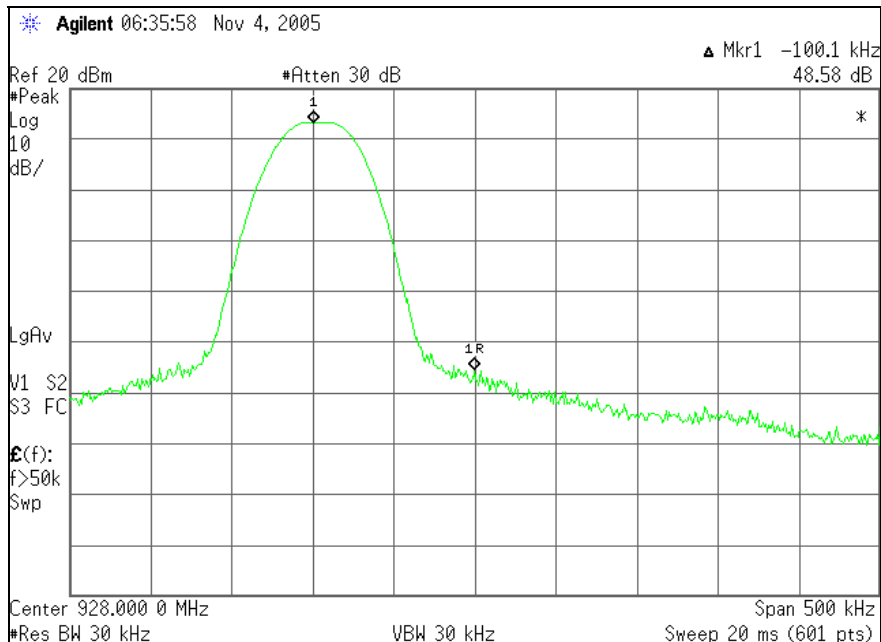


Figure 7.6.1.2-2: Upper Band-edge

7.6.2 RF Conducted Spurious Emissions

7.6.2.1 Test Methodology

The RF Conducted Spurious Emissions were measured in accordance with FCC Public Notice DA-00-75. The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. For each measurement, the spectrum analyzer's RBW was set to 100 kHz. The peak detector and Max Hold function of the analyzer were utilized.

7.6.2.2 Test Results

In a 100 kHz bandwidth, the radio frequency power that was produced by the EUT emissions is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. RF Conducted Emissions are displayed in Figures 7.6.2.2-1 through 7.6.2.2-6.

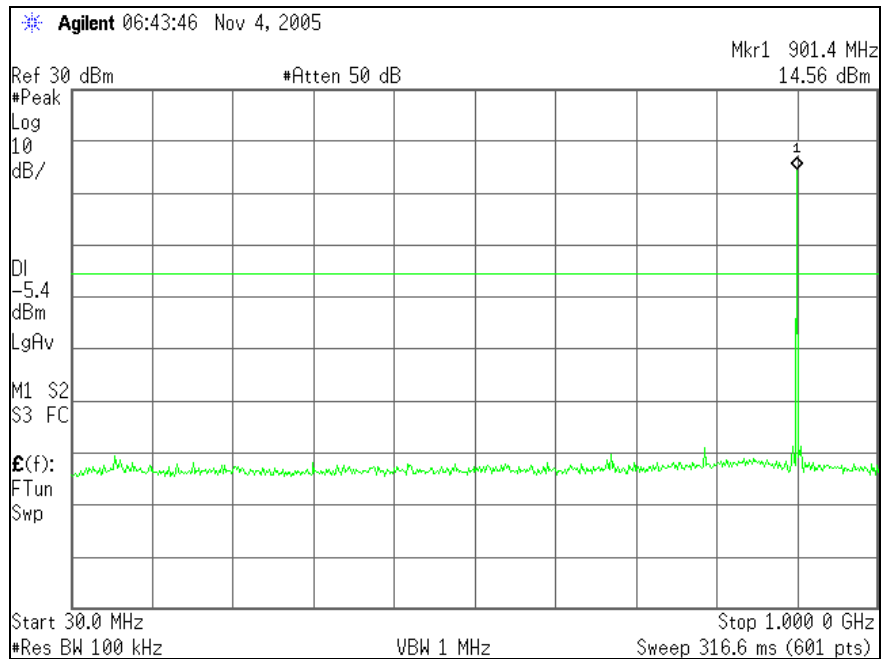


Figure 7.6.2.2-1: RF Conducted Spurious Emission – Low Channel

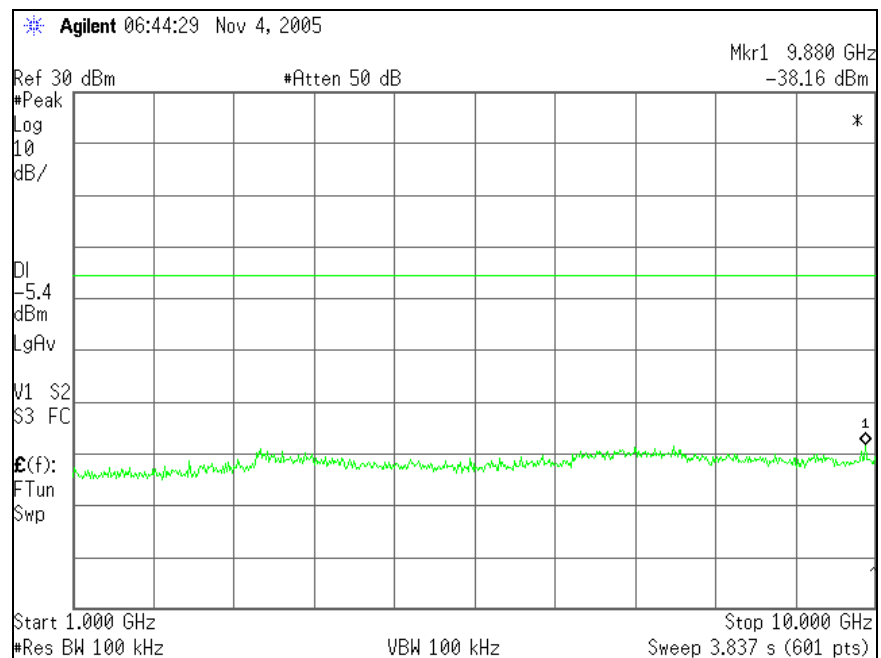


Figure 7.6.2.2-2: RF Conducted Spurious Emission – Low Channel



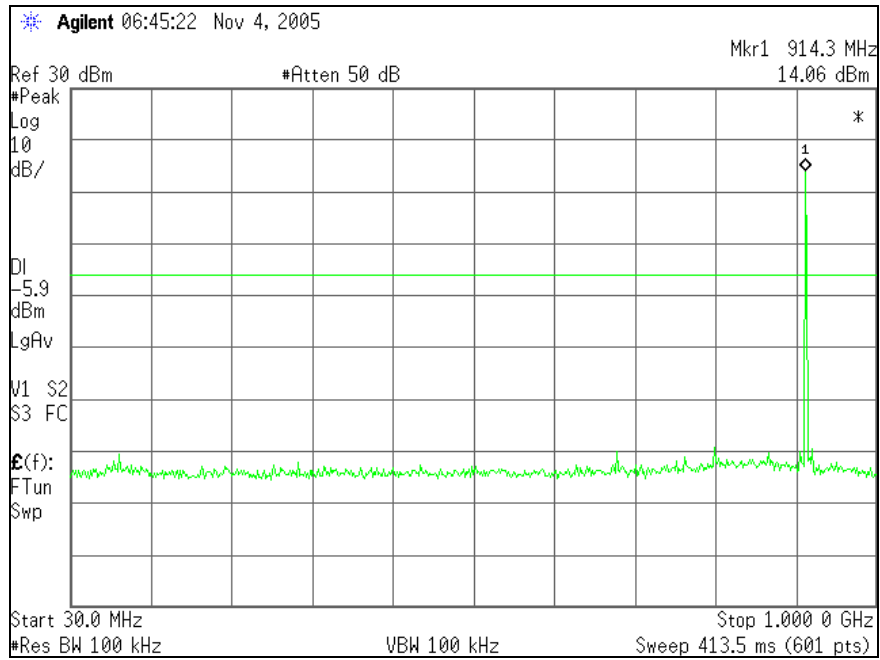


Figure 7.6.2.2-3: RF Conducted Spurious Emission – Mid Channel

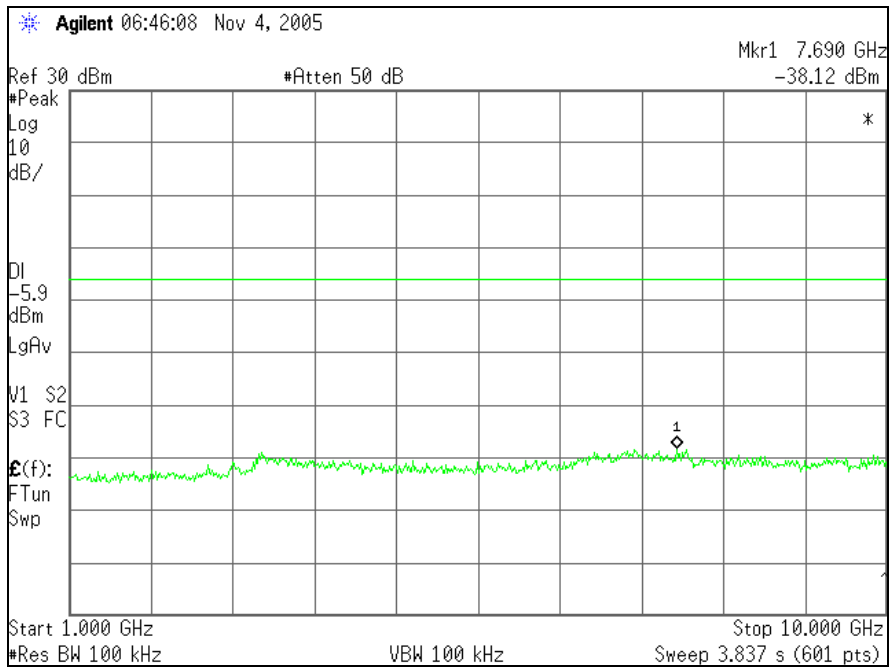


Figure 7.6.2.2-4: RF Conducted Spurious Emission – Mid Channel

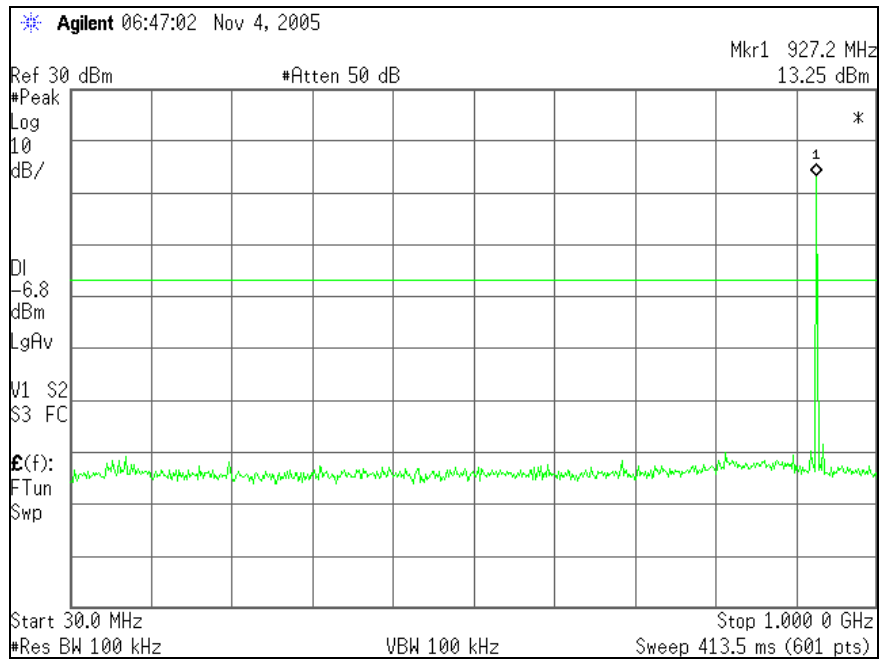


Figure 7.6.2.2-5: RF Conducted Spurious Emission – High Channel

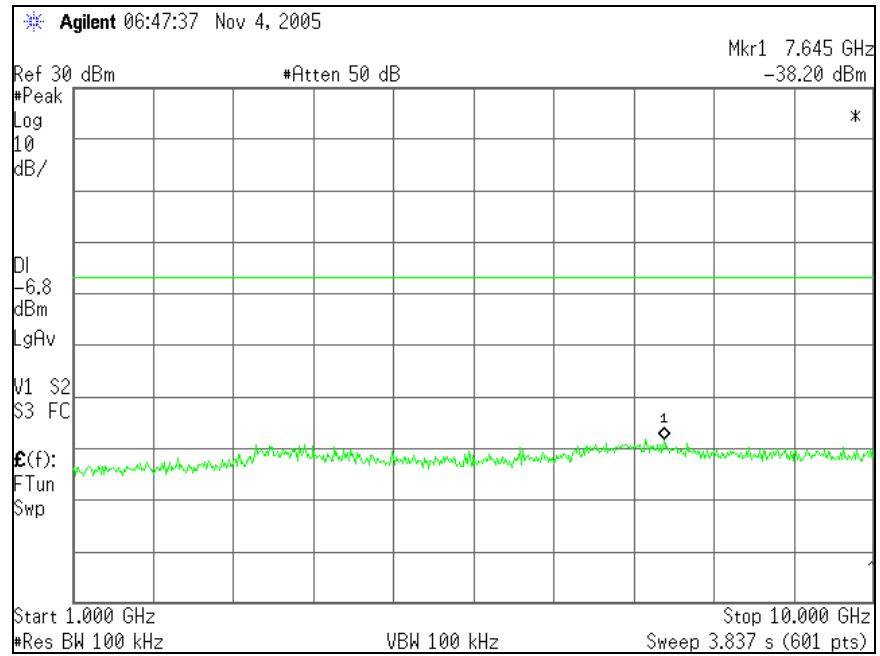


Figure 7.6.2.2-6: RF Conducted Spurious Emission – High Channel

**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 120kHz and a video bandwidth (VBW) of 300kHz. For frequencies above 1000MHz, average measurements were made using an RBW of 1MHz and a VBW of 10Hz and peak measurements were made with RBW of 1MHz and a VBW of 1MHz.

See the test setup photographs for test setup.

**7.6.3.2 Test Results**

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in Table 7.6.3.2-1. Each emission found to be in a restricted band as defined by section 15.205, was compared to the radiated emission limits for as defined in section 15.209.

**Table 7.6.3.2-1: Radiated Spurious Emissions**

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)		
	pk	avg			pk	avg	pk	avg	pk	avg	
<b>Fundamental Frequency</b>											
2706.3	43.10	43.10	H	2.24	45.34	45.34	74	54	28.66	8.66	
2706.3	40.80	40.80	V	2.24	43.04	43.04	74	54	30.96	10.96	
3608.4	42.10	42.10	V	5.68	47.78	47.78	74	54	26.22	6.22	
3711.6	40.90	40.90	V	6.06	46.96	46.96	74	54	27.04	7.04	

**Note:** Emissions not indicated in Table 7.6.3.2-1 were below the noise floor of the measurement equipment and therefore not reported. The peak level met the average limits.

**7.6.3.3 Sample Calculations**

$$R_C = R_U + CF_T$$

Where:

- CF<sub>T</sub> = Total Correction Factor (AF+CA+AG)-DC(Average Measurements Only)
- R<sub>U</sub> = Uncorrected Reading
- R<sub>C</sub> = Corrected Level
- AF = Antenna Factor
- CA = Cable Attenuation
- AG = Amplifier Gain
- DC = Duty Cycle Correction Factor (If applicable)

Note: Duty Cycle for this EUT is 100%. No Correction applied.

**Example Calculation: Peak**

Corrected Level: 43.10 + 2.24 = 45.34 dBuV/m

Margin: 74dBuV/m – 45.34 dBuV/m = 28.66 dB

**Example Calculation: Average**

Corrected Level: 43.10 + 2.24 = 45.34 dBuV/m

Margin: 54dBuV/m – 45.34 dBuV/m = 8.66 dB

**8.0 CONCLUSION**

In the opinion of ACS, Inc. the 25-1019 manufactured by Cellnet Technology, Inc., meets the relevant requirements of FCC Parts 2 and 15, as required.