# FCC Part 15 Subpart C
# Transmitter Certification

## Direct Sequence Spread Spectrum Transmitter

# Test Report

## FCC ID: R7PCWE-WALL

## FCC Rule Part: 15.247

## ACS Report Number: 06-0096 - 15C

Manufacturer: Cellnet Technology, Inc.
Model: Cellnet Water Endpoint 6060 Remote

Test Begin Date: March 6, 2006
Test End Date: March 9, 2006

Report Issue Date: July 26, 2006

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612


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**This report contains 16 pages**

# Table of Contents

## 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 Cellnet Water Endpoint (CWE) is a battery-powered radio transmitter operating in the 902-928 MHz unlicensed ISM band. It is designed to be connected to a variety of residential water meters and will periodically transmit water consumption information. This information is gathered by a Cellnet proprietary cellular network infrastructure.

There are two versions of the Cellnet Water Endpoint (CWE). The Pit version is designed for use in water meter pits installed at or below ground level. The Wall version, model Cellnet Water Endpoint 6060 Remote, is designed to be mounted on a wall in close proximity to the water meter. Documentation supplied with this report for the purpose of equipment authorization may make reference to both versions but the purpose of this report and the supporting documentation is to show compliance for the Wall unit only. The Pit unit is addressed in a separate report and filing.

#### 1.2.2 Manufacturer
Cellnet Technology, Inc.
30000 Mill Creek Avenue
Suite 100
Alpharetta, GA 30022
USA

## 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:

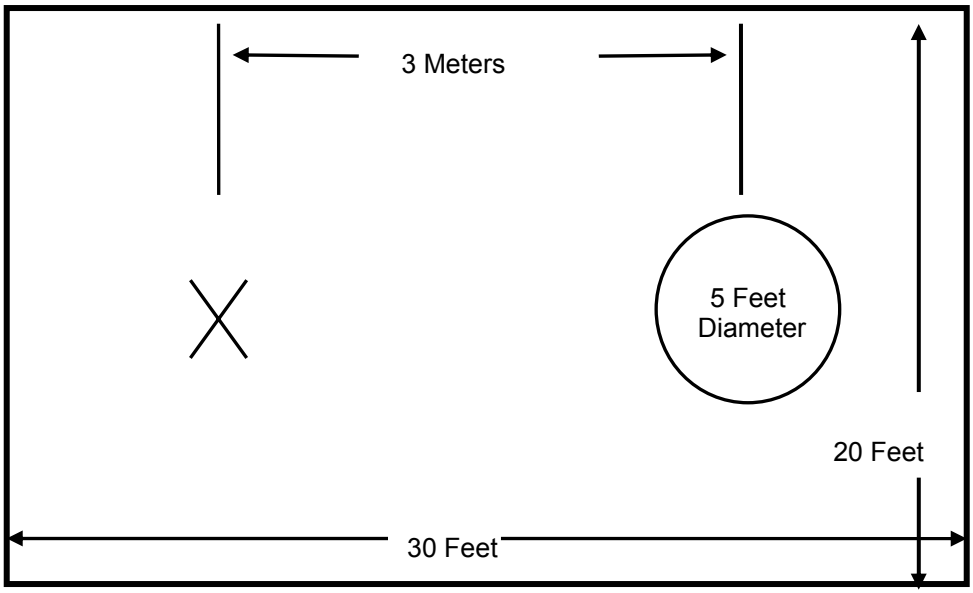


**Figure 2.3-1: Semi-Anechoic Chamber Test Site**

### 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:

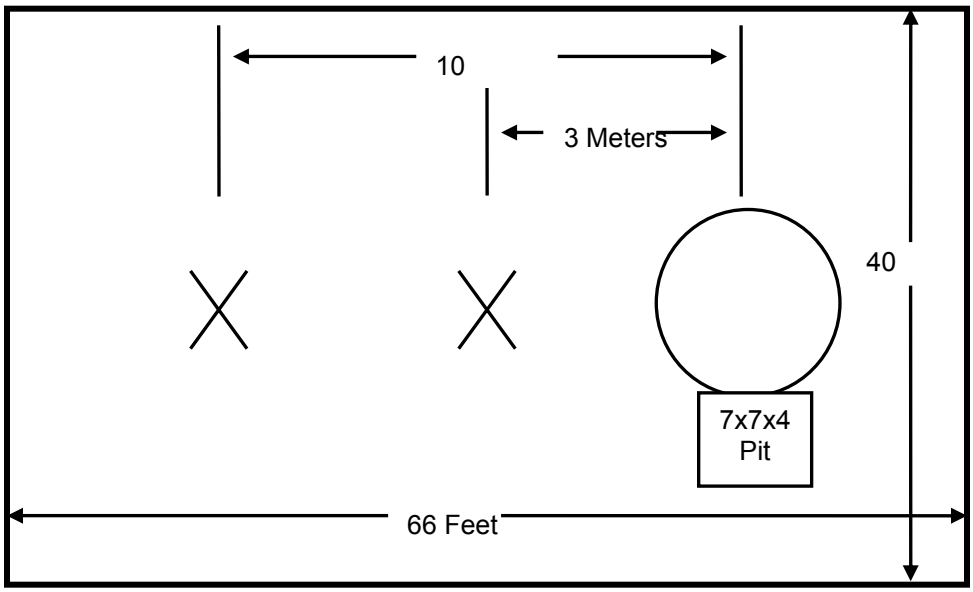


**Figure 2.3-2: Open Area Test Site**

**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:

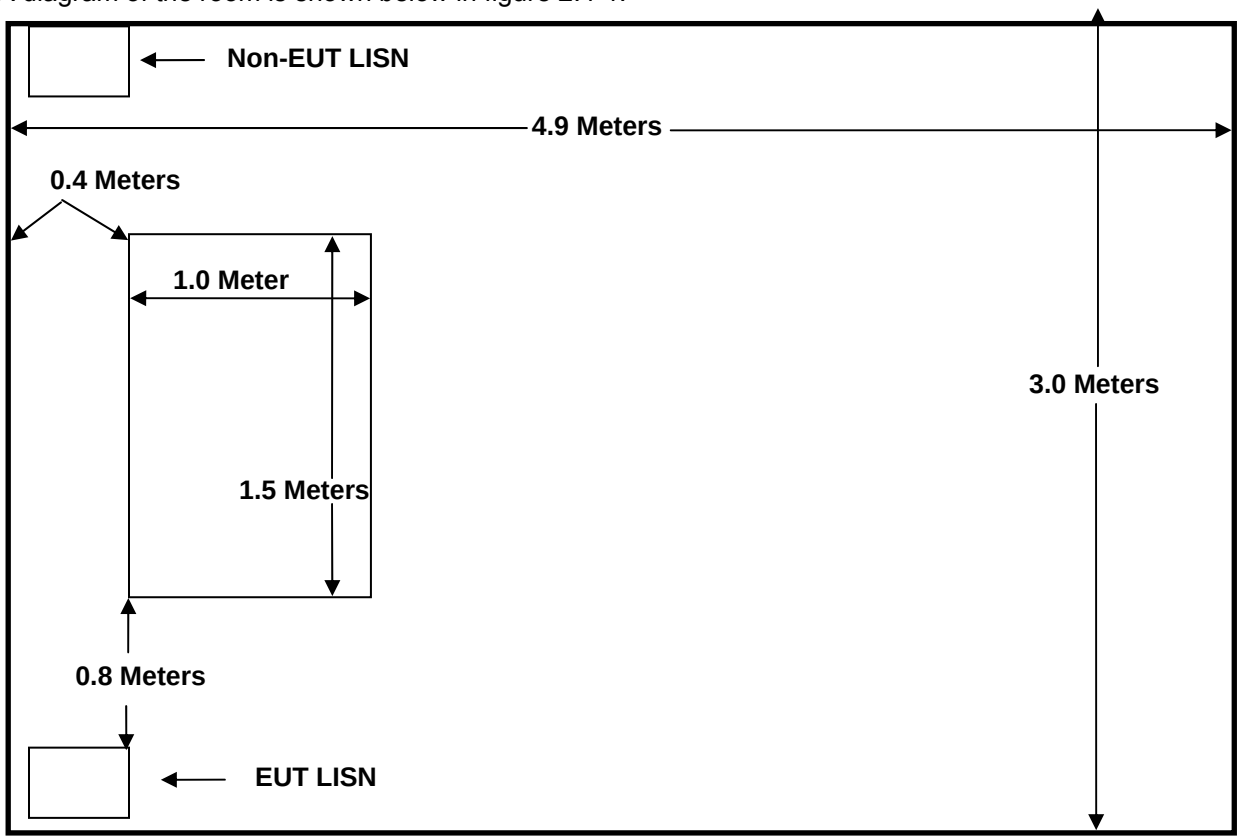


**Figure 2.4-1: AC Mains Conducted EMI Site**

**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**

| Equipment Calibration Information | | | | | |
|---|---|---|---|---|---|
| **ACS#** | **Mfg.** | **Eq. type** | **Model** | **S/N** | **Cal. Due** |
| ☒ 25 | Chase | Bi-Log Antenna | CBL6111 | 1043 | 5/23/06 |
| ☒ 22 | Agilent | Pre-Amplifier | 8449B | 3008A00526 | 5/06/06 |
| ☒ 73 | Agilent | Pre-Amplifier | 8447D | 272A05624 | 5/18/06 |
| ☒ 30 | Spectrum Technologies | Horn Antenna | DRH-0118 | 970102 | 5/09/06 |
| ☒ 105 | Microwave Circuits | High Pass Filter | H1G810G1 | 2123-01 DC0225 | 9/13/06 |
| ☒ 3 | Rohde & Schwarz | Receiver Display | 804.8932.52 | 839379/011 | 11/02/06 |
| ☒ 4 | Rohde & Schwarz | ESMI Receiver | 1032.5640.53 | 833827/003 | 11/02/06 |
| ☒ --- | Agilent | Spectrum Analyzer | E7405A | US39110103 | 6/6/06 |
| ☒ 6 | Harbour Industries | HF RF Cable | LL-335 | 00006 | 3/16/06 |
| ☒ 7 | Harbour Industries | HF RF Cable | LL-335 | 00007 | 3/16/06 |
| ☒ 208 | Harbour Industries | HF RF Cable | LL142 | 00208 | 6/24/06 |
| ☒ 167 | ACS | Chamber EMI Cable Set | RG6 | 167 | 1/7/07 |
| ☒ 204 | ACS | Chamber EMI RF cable | RG8 | 204 | 3/16/06 |

## 5.0 SUPPORT EQUIPMENT

**Table 5-3: 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

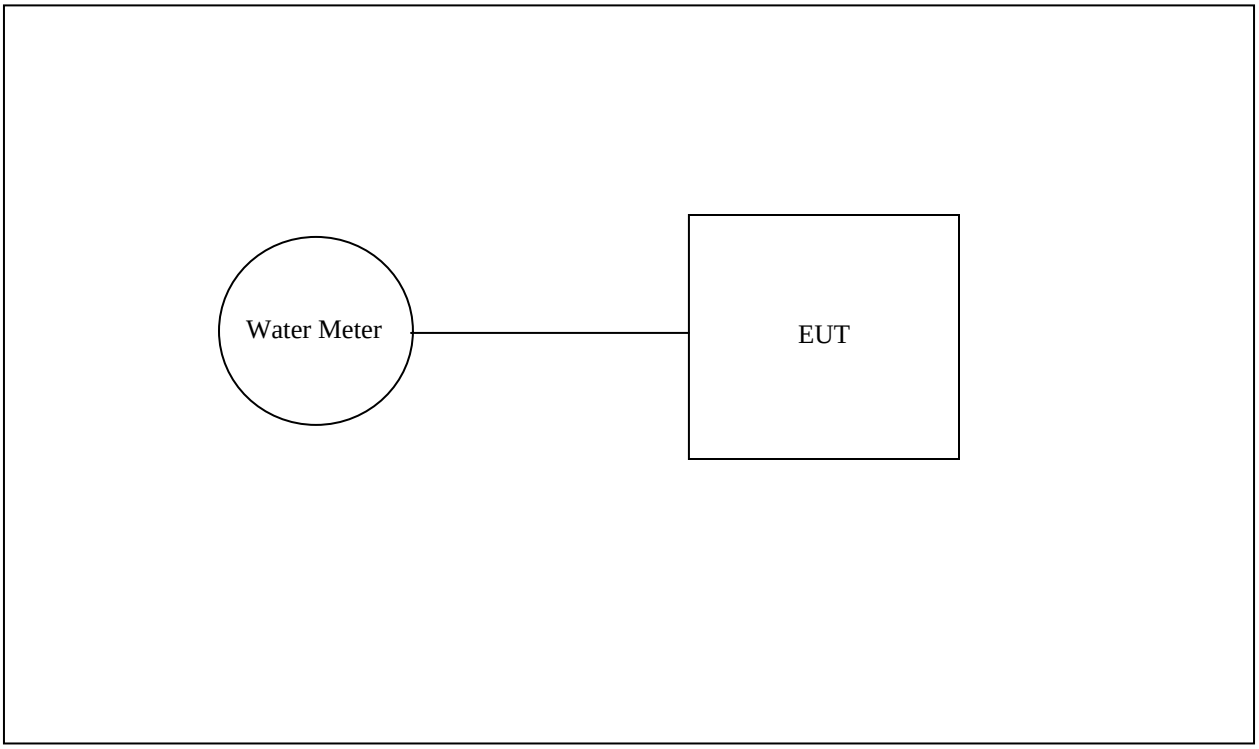


**Figure 6-1: EUT Test Setup**

The EUT was tested as attached to a standard water meter to simulate the typical installation configuration.

## 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 EUT employs an integral antenna that cannot be modified without damaging the device. The antenna type is loop, integral to the PWB, with a gain of 2.1dBi.

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

The Cellnet Water Endpoint - Wall is battery powered therefore Power Line Conducted Emissions is not required.

### 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 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 below in Table 7.3-1:

**Table 7.3-1: Radiated Emissions**

| Frequency ( MHz) | Polarization (H/V) | Height ( cm) | Azimuth ( deg) | Level ( dBµV/m) | Limit ( dBµV/m) | Margin ( dB) |
|---|---|---|---|---|---|---|
| 30 | VERTICAL | 330 | 223 | 12.1 | 40 | 27.9 |
| 43.44 | HORIZONTAL | 250 | 0 | 4.3 | 40 | 35.7 |
| 85.68 | HORIZONTAL | 190 | 0 | 2.5 | 40 | 37.5 |
| 97.12 | HORIZONTAL | 350 | 286 | 15.9 | 43.5 | 27.6 |
| 132.24 | VERTICAL | 319 | 113 | 7.9 | 43.5 | 35.6 |
| 201.2 | HORIZONTAL | 290 | 119 | 6.1 | 43.5 | 37.4 |
| 345.84 | HORIZONTAL | 231 | 44 | 11.3 | 46 | 34.7 |
| 495.92 | HORIZONTAL | 119 | 285 | 16.1 | 46 | 29.9 |
| 704.48 | HORIZONTAL | 385 | 355 | 20.2 | 46 | 25.8 |
| 929.52 | VERTICAL | 110 | 233 | 22.9 | 46 | 23.1 |

* Note: All emissions above 929.52 MHz were attenuated at least 20 dB below the permissible limit

## 7.4 6dB Bandwidth – FCC Section 15.247(a)

### 7.4.1 Test Methodology

The 6dB bandwidth was measured in accordance with the FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247". The RBW of the spectrum analyzer was set to 100 kHz and VBW 100 kHz. Span was set large enough to capture the entire emissions and >> RBW.

### 7.4.2 Test Results

Results are shown below in table 7.4.2-1 and figure 7.4.2-1:

**Table 7.4.2-1: 6dB Bandwidth**

| Frequency [MHz] | Bandwidth [MHz] | Limit | Result |
|---|---|---|---|
| 917.58 | 1.41 | ≥ 500 kHz | PASS |

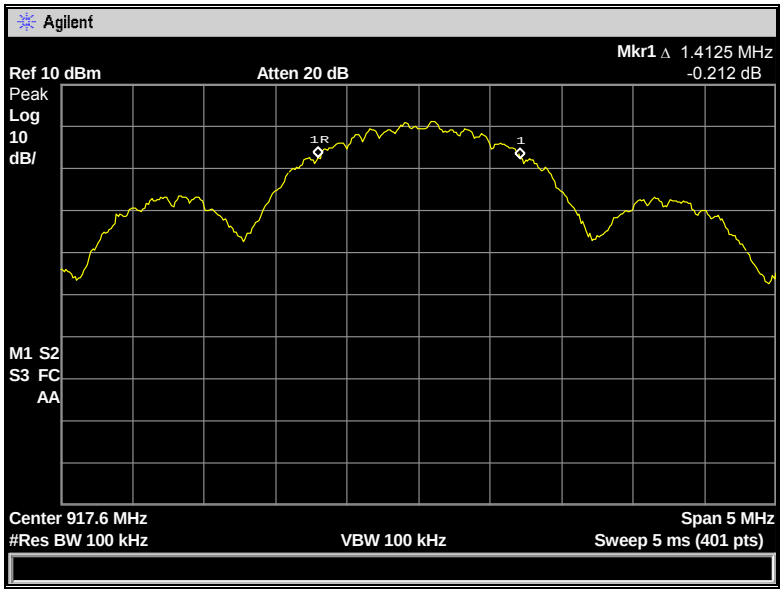


**Figure 7.4.2-1: 6dB Bandwidth Plot**

## 7.5 Peak Output Power Requirement - FCC Section 15.247(b)

### 7.5.1 Test Methodology

Antenna conducted measurements could not be performed on this device, therefore radiated tests were performed to show compliance with the peak output power limit specified in Section 15.247(b) according to the alternative test methods in the FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247".

The procedures set forth in ANSI C63.4 were followed with respect to maximizing the peak emission. The resolution bandwidth of the spectrum analyzer was set to 3 MHz which was slightly greater the 6 dB bandwidth measured in section 7.4. The video bandwidth was set to 3 MHz and a peak detector using the Max Hold function was utilized.

The power was calculated using the following equation:

$$P = \frac{(E * d)^2}{30 * G}$$

Where: G = Numeric Gain of the transmitting antenna with reference to an isotropic radiator
d = The distance in meters from which the field strength was measured
E = The measured maximum fundamental field strength in V/m

Results are shown below in Table 7.5.2-1 to Table 7.5.2-2.

### 7.5.2 Test Results

**Table 7.5.2-1: Fundamental Field Strength**

| Frequency (MHz) | Uncorrected Reading (dBµV/m) | Antenna Polarity (H/V) | Total Correction Factor (dB) | Corrected Reading (dBµV/m) |
|---|---|---|---|---|
| 917.58 | 120.61 | H | 0.77 | 121.38 |

**Table 7.5.2-2: Peak Output Power**

| Measurement Distance(d) | Antenna Gain dBi | Field Strength (V/m) | Antenna Gain Num | Power (mW) | Power (dBm) |
|---|---|---|---|---|---|
| 3 | 2.1 | 1.17 | 1.62 | 254.17 | 24.05 |

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

### 7.6.1 Band-Edge Compliance of RF Emissions

#### 7.6.1.1 Test Methodology

The EUT was investigated at 917.58 MHz to determine band-edge compliance. For this measurement the spectrum analyzer's RBW and VBW was set to 100 kHz.

#### 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 Figure 7.6.1.2-1.

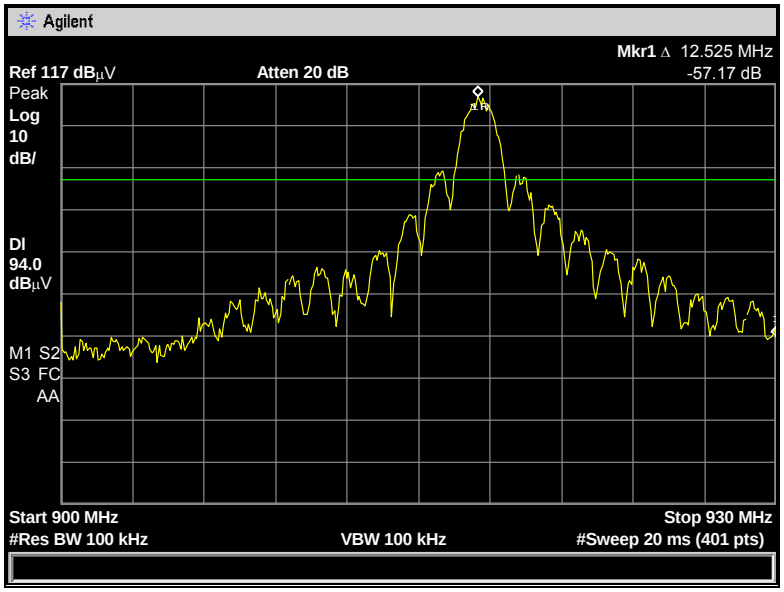


**Figure 7.6.1.2-1: Band-edge**

### 7.6.2 RF Conducted Spurious Emissions

#### 7.6.2.1 Test Methodology

Antenna conducted measurements could not be performed on this device, therefore radiated tests were performed to show compliance with the spurious RF conducted limit specified in Section 15.247(d) according to FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247".

For each measurement, the spectrum analyzer's RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak detector and Max Hold function of the analyzer were utilized. The field strength of both the fundamental emission and all spurious emissions were measured with these settings. Procedures in ANSI C63.4 with respect to maximizing the emissions were followed. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247(d).

#### 7.6.2.2 Test Results

The magnitude of all emissions are reported in section 7.6.3 with the appropriate limit as referenced to 20 dB below the fundamental frequency field strength. Emissions that fell within the restricted bands were referenced to the radiated emissions limit set forth in Section 15.209 which is more stringent than that called out in 15.247(d).

### 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, peak measurements were made using an RBW of 1 MHz and a VBW of 3 MHz and the average emission was calculated by correcting for the duty cycle of the EUT. For those frequencies that fell outside the restricted bands as defined in 15.205, the FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247" for conducted spurious emissions was followed using a RBW of 100 kHz and VBW of 300 kHz.

#### 7.6.3.2 Duty Cycle Correction

For average radiated measurements, the measured level was reduced by a factor 18.42dB to account for the duty cycle of the EUT. The EUT transmits for approximately 12mS within a 100ms period. Therefore the duty cycle is 12%. The duty cycle correction factor is determined using the formula: 20log (0.12) = -18.42dB.

### 7.6.3.3 Test Results

Using the procedures set forth in the FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247", radiated spurious emissions and conducted spurious emissions found in the band of 30MHz to 10GHz are reported in Table 7.6.3-1. 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. Those spurious emissions outside the restricted bands were compared to the limits of 15.247(d), 20 dB below the fundamental frequency field strength.

**Table 7.6.3.3-1: Radiated Spurious Emissions**

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity | Correction Factors | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | pk | avg | (H/V) | (dB) | pk | avg | pk | avg | pk | avg | |
| **Fundamental Frequency** | | | | | | | | | | | |
| **917.58** | 113.70 | --------- | H | 0.77 | 114.47 | --------- | --------- | --------- | --------- | --------- | 100kHz |
| **917.58** | 107.20 | --------- | V | 0.97 | 108.17 | --------- | --------- | --------- | --------- | --------- | 100kHz |
| **Spurious Emissions** | | | | | | | | | | | |
| **1835.16** | 71.87 | 71.87 | H | -1.85 | 70.02 | ---------- | 94.47 | --------- | 24.45 | --------- | 100kHz |
| **1835.16** | 65.47 | 65.47 | V | -1.85 | 63.62 | ---------- | 94.47 | --------- | 30.85 | --------- | 100kHz |
| **2752.74** | 69.00 | 69.00 | H | 2.39 | 71.39 | 52.97 | 74 | 54 | 2.61 | 1.03 | 1MHz |
| **2752.74** | 66.28 | 66.28 | V | 2.39 | 68.67 | 50.25 | 74 | 54 | 5.33 | 3.75 | 1MHz |
| **3670.32** | 56.38 | 56.38 | H | 5.91 | 62.29 | 43.87 | 74 | 54 | 11.71 | 10.13 | 1MHz |
| **3670.32** | 49.90 | 49.90 | V | 5.91 | 55.81 | 37.39 | 74 | 54 | 18.19 | 16.61 | 1MHz |
| **4587.9** | 57.55 | 57.55 | H | 7.98 | 65.53 | 47.12 | 74 | 54 | 8.47 | 6.88 | 1MHz |
| **4587.9** | 57.88 | 57.88 | V | 7.98 | 65.86 | 47.45 | 74 | 54 | 8.14 | 6.55 | 1MHz |
| **6423.06** | 46.40 | 46.40 | H | 12.86 | 59.26 | ---------- | 94.47 | --------- | 35.22 | --------- | 100kHz |
| **7340.64** | 48.20 | 48.20 | H | 15.72 | 63.92 | 45.50 | 74 | 54 | 10.08 | 8.50 | 1MHz |

### 7.6.3.4 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: 69.00 + 2.39 = 71.39 dBuV
Margin: 74dBuV – 71.39 dBuV = 2.61 dB

**Example Calculation: Average**

Corrected Level: 69.00 + 2.39 – 18.42 = 52.97 dBuV
Margin: 54dBuV – 52.97 dBuV = 1.03 dB

## 7.7 Peak Power Spectral Density- FCC Section 15.247(d)

### 7.7.1 Test Methodology

The peak power spectral density was measured in accordance with the alternative test methods in the FCC publication "New Guidance on Measurements for Digital Transmission Systems in Section 15.247". The emission peaks within the pass band were located and zoomed in on. The spectrum analyzer RBW was set to 3 kHz and VBW 3 kHz. A peak detector using the Max Hold function was utilized.

The power was calculated using the following equation:

$$P = (E * d)^2 / 30 * G$$

Where: G = Numeric Gain of the transmitting antenna with reference to an isotropic radiator
d = The distance in meters from which the field strength was measured
E = The measured maximum fundamental field strength in V/m

Results are shown below in Table 7.7.2-1 to Table 7.7.2-2 and Figure 7.7.2-1.

### 7.7.2 Test Results

**Table 7.7.2-1: Fundamental Field Strength in 3 kHz bandwidth**

| Frequency (MHz) | Uncorrected Reading (dBµV/m) | Antenna Polarity (H/V) | Total Correction Factor (dB) | Corrected Reading (dBµV/m) |
|---|---|---|---|---|
| 917.58 | 102.60 | H | 0.77 | 103.37 |

**Table 7.7.2-2: Peak Power Spectral Density**

| Measurement Distance(d) | Antenna Gain dBi | Field Strength (V/m) | Antenna Gain Num | Power (mW) | Power (dBm) |
|---|---|---|---|---|---|
| 3 | 2.1 | 0.15 | 1.62 | 4.02 | 6.04 |

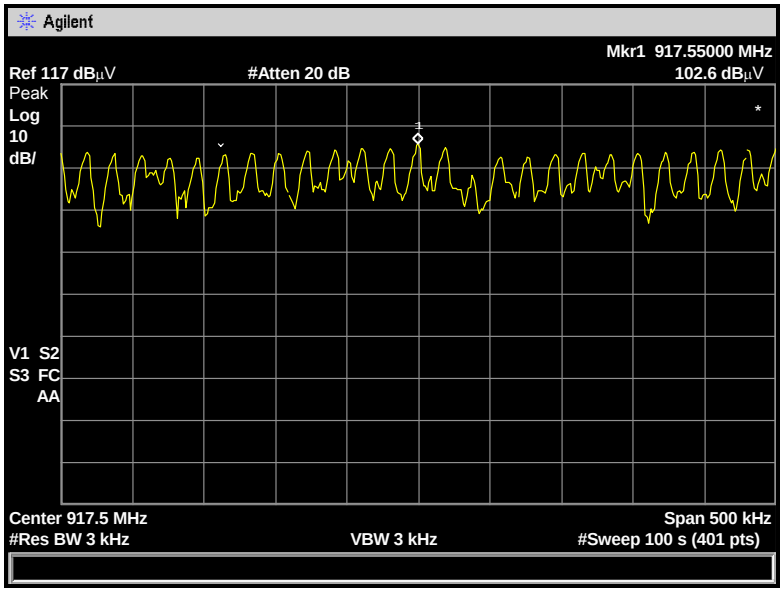


**Figure 7.7.2-1: Peak Power Spectral Density**

## 8.0 CONCLUSION

In the opinion of ACS, Inc. the Cellnet Water Endpoint 6060 Remote, manufactured by Cellnet Technology, Inc., does meet the requirements of FCC Part 15 subpart C.