Excellence in Compliance Testing

# Certification Test Report

**FCC ID: SDBCL100**
**IC: 2220A-CL100**

**FCC Rule Part: 15.209**
**IC Radio Standards Specification: RSS-210**

**ACS Report Number: 09-0356.W06.22.A**

Applicant: Sensus Metering Systems
Model: CL100

Test Begin Date: October 26, 2009
Test End Date: October 30, 2009

Report Issue Date: December 16, 2010

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

**Reviewed by:**
**Kirby Munroe**
**Director, Wireless Certifications**
**ACS, Inc.**



**This report contains 16 pages**

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# 1 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 and Industry Canada's Radio Standards Specification RSS-210.

## 1.2 Product description

The CommandLink CL100 is a device that is used for installing and walk-by reading of RF devices which are installed in conjunction with water, gas, and electric meters via a wireless link. Typically the CL100 is used by the Utility or third party professional installation personnel. The CL100 will communicate to the RF devices either through an 895 kHz inductive transmitter interface or a 900 MHz licensed band RF link. This report addresses the 895 kHz inductive transmitter only. A separate report will address the 900 MHz licensed operation.

Technical Specifications:
Operating Frequency: 895 kHz
Modulation: AM (OOK)
Antenna: Inductive Coupler

Manufacturer Information:
Sensus Metering Systems, Inc.
400 Perimeter Park Drive, Suite K
Morrisville, NC 27560

Test Sample Serial Numbers: 245

Test Sample Condition: The test samples were provided in good working order with no visible defects.

## 1.3 Test Methodology and Considerations

The EUT is a handheld/body worn device therefore radiated emissions were performed with the EUT positioned in multiple orientations. Data representing the worst case orientation is provided in this report.

The EUT firmware turns OFF the 895 KHz Inductive transmitter when the external wall supply is plugged in and the batteries are charging; therefore the power supply was included in the unintentional radiated emissions and AC power line conducted emissions testing only.

# 2 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

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

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.

FCC Registration Number: 894540
Industry Canada Lab Code: IC 4175A-1
VCCI Member Number: 1831

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

## 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:

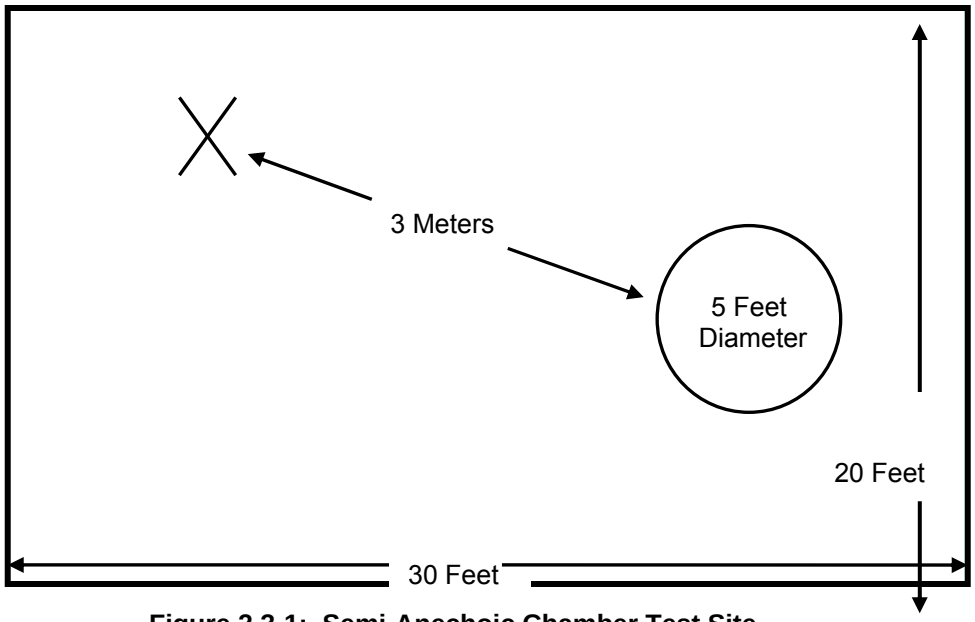



**Figure 2.3-1: Semi-Anechoic Chamber Test Site**

### 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:

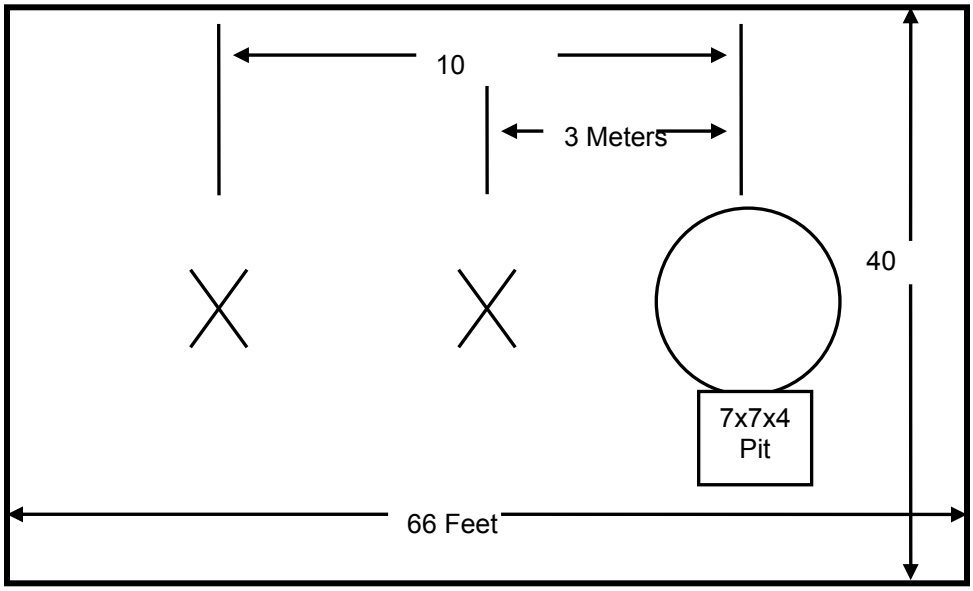



**Figure 2.3-2: Open Area Test Site**

### 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:

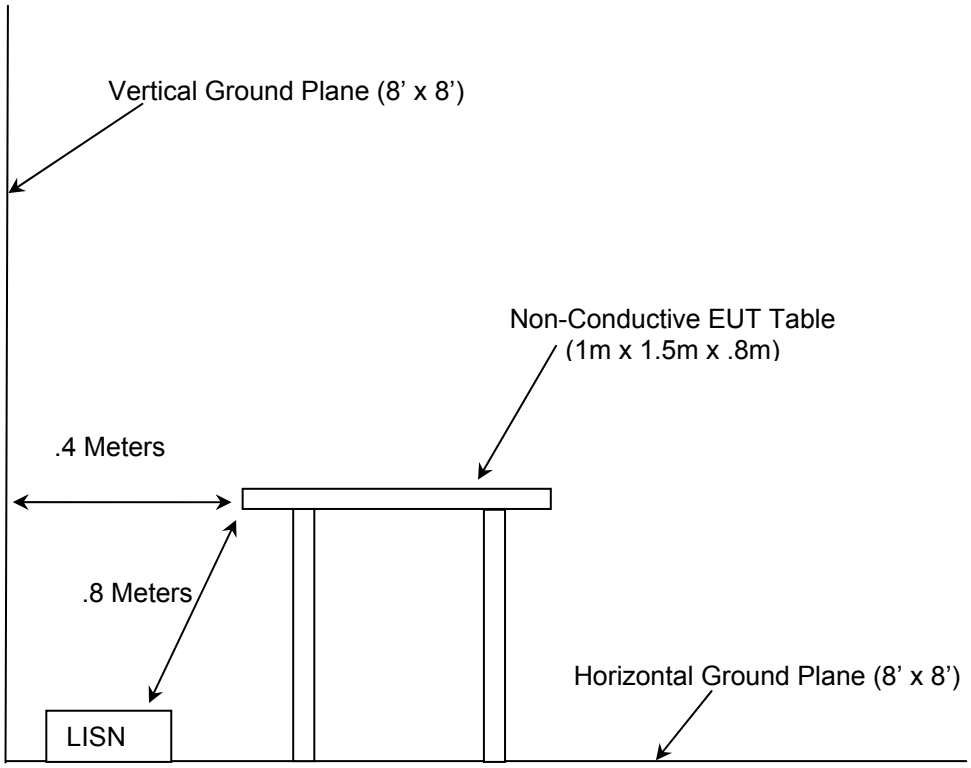



**Figure 2.4-1: AC Mains Conducted EMI Site**

## 3 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, 2010
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2010
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8 June 2010
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, Dec 2010.

## 4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

**Table 4-1: Test Equipment**

| Equipment Calibration Information | | | | | |
|---|---|---|---|---|---|
| **ACS#** | **Mfg.** | **Eq. type** | **Model** | **S/N** | **Cal. Due** |
| 1 | Rohde & Schwarz | Spectrum Analyzers | ESMI - Display | 833771/007 | 09-21-2010 (See Note3) |
| 2 | Rohde & Schwarz | Spectrum Analyzers | ESMI-Receiver | 839587/003 | 09-21-2010 (See Note3) |
| 3 | Rohde & Schwarz | Spectrum Analyzers | ESMI - Display | 839379/011 | 02-02-2010 (See Note3) |
| 4 | Rohde & Schwarz | Spectrum Analyzers | ESMI - Receiver | 833827/003 | 02-02-2010 (See Note3) |
| 22 | Agilent | Amplifiers | 8449B | 3008A00526 | 09-21-2010 |
| 25 | Chase | Antennas | CBL6111 | 1043 | 09-02-2010 (See Note3) |
| 73 | Agilent | Amplifiers | 8447D | 2727A05624 | 07-15-2010 |
| 78 | EMCO | Antennas | 6502 | 9104-2608 | 01-20-2010 (See Note3) |
| 152 | EMCO | LISN | 703125 | 9111-1905 | 03-25-2010 |
| 167 | ACS | Cable Set | Chamber EMI Cable Set | 167 | 02-06-2010 (See Note1) |
| 168 | Hewlett Packard | Attenuators | 11947A | 44829 | 02-10-2010 (See Note2) |
| 283 | Rohde & Schwarz | Spectrum Analyzers | FSP40 | 1000033 | 09-21-2010 |
| 291 | Florida RF Cables | Cables | SMRE-200W-12.0-SMRE | None | 11-24-2009 (See Note1) |
| 292 | Florida RF Cables | Cables | SMR-290AW-480.0-SMR | None | 11-24-2009 (See Note1) |
| 324 | ACS | Cables | Belden | 8214 | 07-15-2010 (See Note1) |
| 329 | A.H.Systems | Antennas | SAS-571 | 721 | 08-04-2010 (See Note3) |
| 422 | Florida RF | Cables | SMS-200AW-72.0-SMR | 805 | 02-05-2010 (See Note1) |

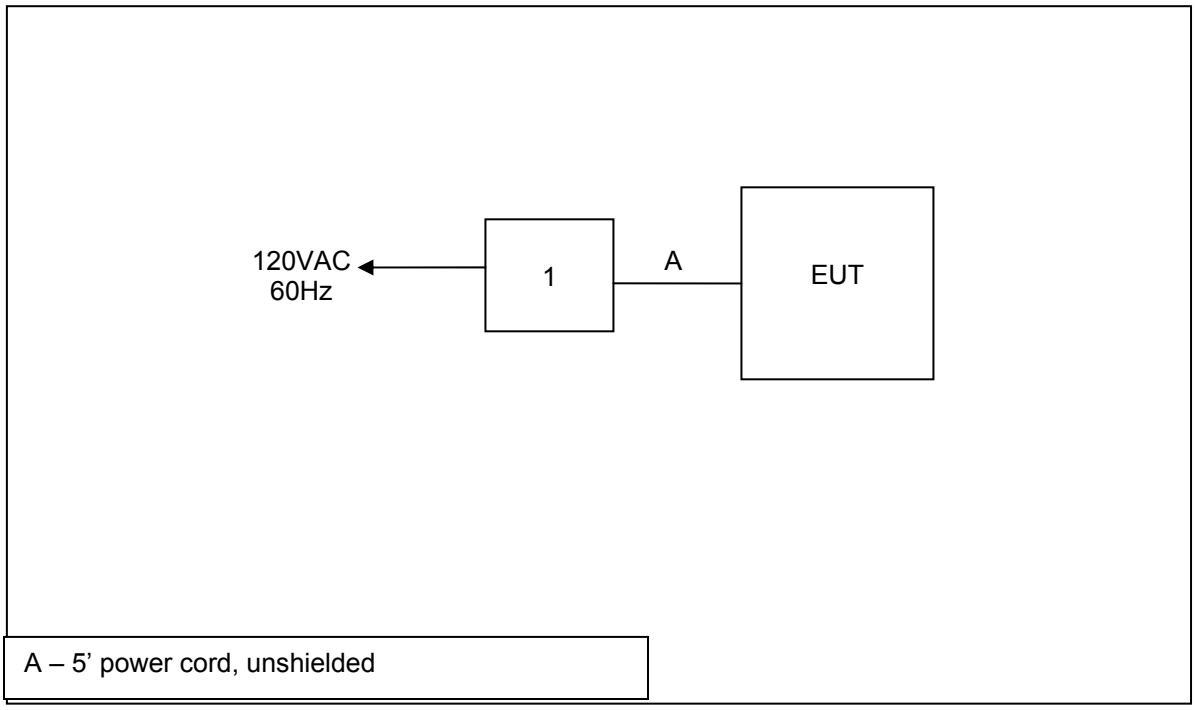
**Note1:** Items characterized on an annual cycle. The date shown indicates the next characterization due date.
**Note2:** Items verified on an annual cycle. The date shown indicates the next verification due date.
**Note3:** Items calibrated on a two year calibration cycle.

## 5 SUPPORT EQUIPMENT

**Table 5-1: Support Equipment**

| Diagram # | Manufacturer | Equipment Type | Model Number | Serial Number |
|---|---|---|---|---|
| 1 | Wall Industries, Inc. | Power Supply | GP5U15U-1 | NA |

## 6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM




Note: The firmware turns OFF the 895 KHz Inductive transmitter when the external wall supply is plugged in and the batteries are charging; therefore the power supply was included in the unintentional radiated emissions and AC power line conducted emissions testing only.

# 7 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 antenna is a permanent 22uH coil thus satisfying Part 15.203.

## 7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.2

### 7.2.1 Measurement Procedure

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 Measurement Results

Results of the test are shown below in and Table 7.2.2-1 to 7.2.2.2.

**Table 7.2.2-1: Line 1 Conducted EMI Results**

| Frequency (MHz) | Level (dBuV) | Transducer (dB) | Limit (dBuV) | Margin (dB) | Line | PE | Detector |
|---|---|---|---|---|---|---|---|
| 0.192 | 29.8 | 9.9 | 64 | 34.2 | L1 | FLO | QP |
| 0.36 | 14.3 | 10 | 59 | 44.4 | L1 | FLO | QP |
| 0.492 | 17.7 | 10 | 56 | 38.4 | L1 | FLO | QP |
| 0.516 | 24.7 | 10 | 56 | 31.3 | L1 | FLO | QP |
| 11.064 | 21 | 9.9 | 60 | 39 | L1 | FLO | QP |
| 11.55 | 22.3 | 9.8 | 60 | 37.7 | L1 | FLO | QP |
| 11.598 | 22.4 | 9.8 | 60 | 37.6 | L1 | FLO | QP |
| 11.682 | 22.3 | 9.8 | 60 | 37.7 | L1 | FLO | QP |
| 11.874 | 21.8 | 9.8 | 60 | 38.2 | L1 | FLO | QP |
| 12.33 | 21.8 | 9.9 | 60 | 38.2 | L1 | FLO | QP |
| 0.252 | 18.4 | 10 | 52 | 33.3 | L1 | FLO | AVG |
| 0.354 | 10.8 | 10 | 49 | 38.1 | L1 | FLO | AVG |
| 0.492 | 14.8 | 10 | 46 | 31.4 | L1 | FLO | AVG |
| 0.546 | 12.7 | 10 | 46 | 33.3 | L1 | FLO | AVG |
| 11.064 | 18.4 | 9.9 | 50 | 31.6 | L1 | FLO | AVG |
| 11.472 | 19.8 | 9.8 | 50 | 30.2 | L1 | FLO | AVG |
| 11.694 | 19.6 | 9.8 | 50 | 30.4 | L1 | FLO | AVG |
| 11.868 | 19.3 | 9.8 | 50 | 30.8 | L1 | FLO | AVG |
| 11.946 | 19.2 | 9.8 | 50 | 30.8 | L1 | FLO | AVG |
| 12.246 | 19.5 | 9.9 | 50 | 30.5 | L1 | FLO | AVG |

**Table 7.2.2-2: Line 2 Conducted EMI Results**

| Frequency (MHz) | Level (dBuV) | Transducer (dB) | Limit (dBuV) | Margin (dB) | Line | PE | Detector |
|---|---|---|---|---|---|---|---|
| 0.15 | 34.6 | 9.9 | 66 | 31.4 | L2 | FLO | QP |
| 0.486 | 20.1 | 10 | 56 | 36.1 | L2 | FLO | QP |
| 0.516 | 28.2 | 10 | 56 | 27.8 | L2 | FLO | QP |
| 1.206 | 10.5 | 10 | 56 | 45.5 | L2 | FLO | QP |
| 1.344 | 10.1 | 10 | 56 | 45.9 | L2 | FLO | QP |
| 2.46 | 11.3 | 10 | 56 | 44.7 | L2 | FLO | QP |
| 4.008 | 17.3 | 9.9 | 56 | 38.7 | L2 | FLO | QP |
| 4.098 | 18.6 | 9.9 | 56 | 37.4 | L2 | FLO | QP |
| 4.44 | 16.1 | 10 | 56 | 39.9 | L2 | FLO | QP |
| 4.65 | 18.2 | 10 | 56 | 37.8 | L2 | FLO | QP |
| 0.192 | 25.6 | 9.9 | 54 | 28.3 | L2 | FLO | AVG |
| 0.48 | 17.2 | 10 | 46 | 29.1 | L2 | FLO | AVG |
| 0.528 | 26.1 | 10 | 46 | 19.9 | L2 | FLO | AVG |
| 1.17 | 7.7 | 10 | 46 | 38.3 | L2 | FLO | AVG |
| 1.386 | 7.2 | 10 | 46 | 38.8 | L2 | FLO | AVG |
| 2.544 | 7.5 | 10 | 46 | 38.5 | L2 | FLO | AVG |
| 4.068 | 15.1 | 9.9 | 46 | 30.9 | L2 | FLO | AVG |
| 4.14 | 15.6 | 9.9 | 46 | 30.4 | L2 | FLO | AVG |
| 4.404 | 11.6 | 10 | 46 | 34.4 | L2 | FLO | AVG |
| 4.722 | 13.9 | 10 | 46 | 32.1 | L2 | FLO | AVG |

## 7.3 Radiated Emissions – FCC CFR 47 Part 15.209 / RSS-210 Section 2.6

### 7.3.1 Measurement Procedure

Section 15.33(a)(4) specifies, if the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to frequency specified in 15.33(b)(1) for unintentional radiators. The upper frequency range for the digital device is 1000MHz which greater than the $10^{th}$ harmonic of the fundamental frequency. The upper frequency range measured was 1000MHz.

Measurements below 30MHz were performed in a semi-anechoic chamber with a 3 meter separation distance between the EUT and measurement antenna. The EUT was rotated 360º and the loop antenna rotated about the vertical axis to maximize each emission. The magnetic loop receiving antenna was positioned with its center 1 meter above the ground.

The spectrum analyzer's resolution and video bandwidth was set to 100 Hz and 300 Hz respectively for frequencies below 150 kHz and 9 kHz and 30 kHz respectively for frequencies above 150 kHz and below 30 MHz. For measurements in the frequency bands 9-90 kHz and 110-490 kHz, an average detector was used. When average measurements are specified, the peak emissions were also compared to a limit corresponding to 20 dB above the maximum permitted average limit according to Part 15.35. All other emissions were measured using a Quasi-peak detector. The final measurements were then corrected by antenna correction factors and cable loss for comparison to the limits.

Measurements above 30 MHz were performed in a semi-anechoic chamber with a 3 meter separation distance between the EUT and measurement antenna. 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 1000 MHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz.

### 7.3.2 Distance Correction for Measurements Below 30 MHz – Part 15.31

Radiated measurements were performed at a distance closer than 30m as required, according to Part 15.209. Therefore a correction factor was applied to account for propagation loss at the specified distance. The propagation loss was determined by using the square of an inverse linear distance extrapolation factor (40dB/decade) according to 15.31. A sample calculation of the distance correction factor is shown below for limits expressed at a 30m measurement distance.

Distance correction factor (30m Specified Test Distance) = 40*Log (Test Distance/30)
= 40*Log (3/30)
= - 40 dB

### 7.3.3 Measurement Results

Results of the test are given in Table 7.3.3-1:

**Table 7.3.3-1: Radiated Emissions Tabulated Data**

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity | Correction Factors | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pk | Qpk/Avg | (H/V) | (dB) | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| **0.895** | --------- | 64.46 | H | -15.12 | --------- | 49.34 | -------- | 68.6 | --------- | 19.3 |
| **1.79** | --------- | 52.81 | H | -15.10 | --------- | 37.71 | -------- | 69.5 | --------- | 31.8 |
| **2.685** | --------- | 37.33 | H | -15.10 | --------- | 22.23 | -------- | 69.5 | --------- | 47.3 |
| **3.58** | --------- | 23.92 | H | -15.04 | --------- | 8.88 | -------- | 69.5 | --------- | 60.6 |
| **4.475** | --------- | 20.19 | H | -14.91 | --------- | 5.29 | -------- | 69.5 | --------- | 64.2 |

* Note: All emissions from the intentional radiator above 4.48 MHz kHz were attenuated below the permissible limit.

### 7.3.4 Sample Calculation

**Example Calculation – Limit < 30MHz**

Measurement Distance 30m @ 895kHz

*Limit (dBuV/m)* = 20*Log(24000/F(kHz)) - Distance Correction Factor (Section 7.3.2)
*Limit (dBuV/m)* = 20*Log(24000/895) + 40
*Limit (dBuV/m)* = 68.6

**Example Calculation - 895kHz Fundamental (See Table 7.3.3-1)**
$R_C = R_U + CF_T$
Where:
$CF_T$ = Total Correction Factor (AF+CA+AG)
$R_U$ = Uncorrected Reading
$R_C$ = Corrected Level
AF = Antenna Factor
CA = Cable Attenuation
AG = Amplifier Gain

*Corrected Level: 64.46 - 15.12 = 49.34dBuV*
*Margin: 68.6dBuV – 49.34dBuV = 19.3 dB*

## 7.4 20dB / 99% Bandwidth – FCC: Section 15.215(c) / IC: RSS-210 Section 4.6.1

### 7.4.1 Measurement Procedure

The spectrum analyzer span was set to approximately 2 times the estimated bandwidth of the emission. The RBW was to ≥ 1% of the estimated emission 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 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission and approximately 20dB below the peak level. The RBW was to ~ 1% to 3% of the approximate emission width. The trace was set to max hold with a peak detector active. The occupied bandwidth measurement function of the analyzer was used for the 99% bandwidth.

### 7.4.2 Measurement Results

Results are shown below in table 7.4.2-1 and figure 7.4.2-1 to 7.4.2-2:

**Table 7.4.2-1: 20dB / 99% Bandwidth**

| Frequency [kHz] | 20dB Bandwidth [kHz] | 99% Bandwidth [kHz] |
|---|---|---|
| 895 | 23.3 | 29.2 |

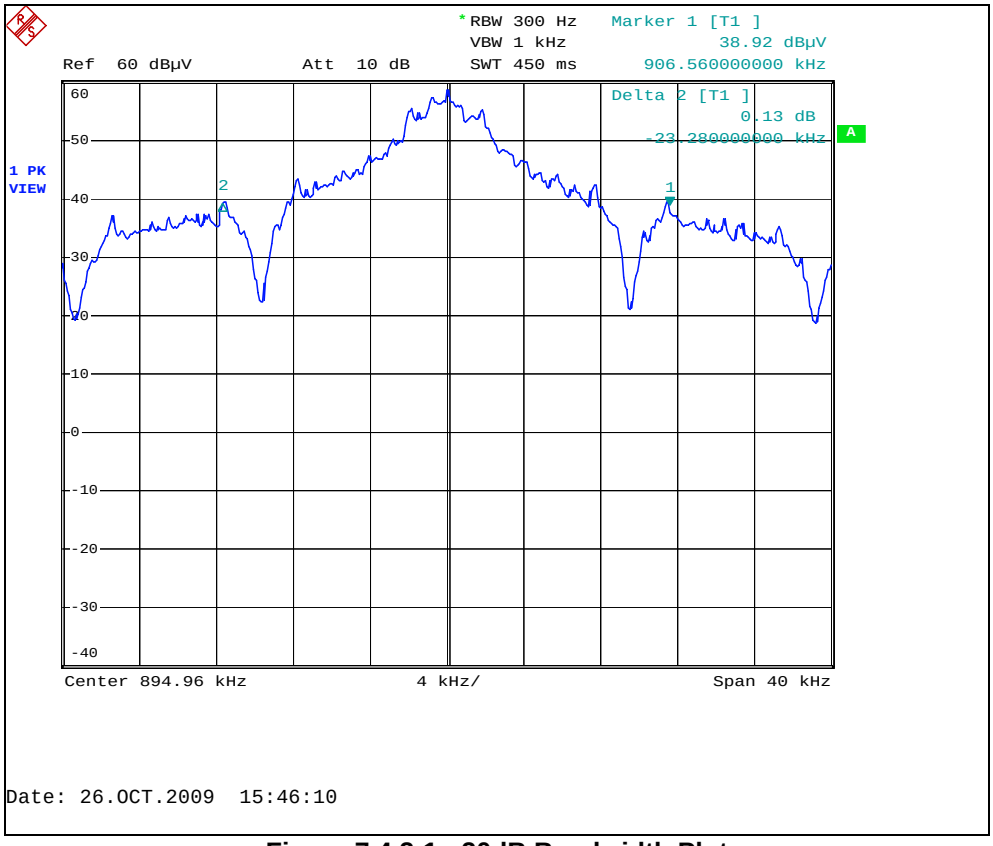



**Figure 7.4.2-1: 20dB Bandwidth Plot**

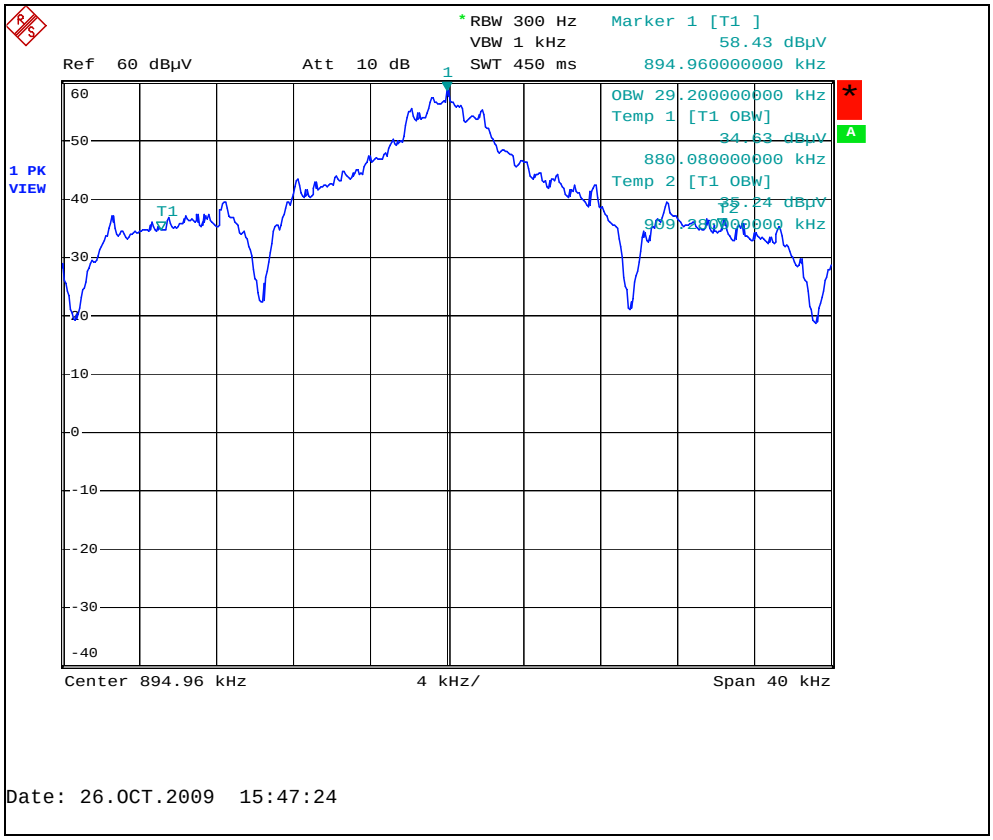



**Figure 7.4.2-2: 99% Bandwidth Plot**

### 7.5 Radiated Emissions – FCC: Section 15.109(Unintentional Radiation) IC: RSS-210 2.6

#### 7.5.1 Measurement Procedure

Radiated emissions tests were performed over the frequency range of 30MHz to 1GHz. Measurements of the radiated field strength were made at a distance of 3 m 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 above 30MHz and below 1GHz were made with the Spectrum Analyzer's resolution bandwidth set to 120 KHz using a Quasi-peak detector.

#### 7.5.2 Measurement Results

Results of the test are given in Table 7.5.2-1:

**Table 7.5.2-1: Radiated Emissions Tabulated Data**

| Frequency (MHz) | Level (dBuV) | | Antenna Polarity | Correction Factors | Corrected Level (dBuV/m) | | Limit (dBuV/m) | | Margin (dB) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pk | Qpk/Avg | (H/V) | (dB) | pk | Qpk/Avg | pk | Qpk/Avg | pk | Qpk/Avg |
| **49.89** | --------- | 39.46 | V | -17.16 | --------- | 22.30 | -------- | 40.0 | --------- | 17.70 |
| **126.4** | --------- | 30.01 | V | -12.17 | --------- | 17.84 | -------- | 43.5 | --------- | 25.66 |
| **131.36** | --------- | 43.60 | V | -12.21 | --------- | 31.39 | -------- | 43.5 | --------- | 12.11 |
| **384.02** | --------- | 39.45 | H | -7.66 | --------- | 31.79 | -------- | 46.0 | --------- | 14.21 |
| **400** | --------- | 37.22 | H | -6.80 | --------- | 30.42 | -------- | 46.0 | --------- | 15.58 |
| **416.9** | --------- | 37.98 | H | -6.88 | --------- | 31.10 | -------- | 46.0 | --------- | 14.90 |

* Note: All emissions above 416.9 MHz were attenuated below the permissible limit.

## 8 CONCLUSION

In the opinion of ACS, Inc., the CL100, manufactured by Sensus Metering Systems meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

# END REPORT