

Certification Test Report

FCC ID: SDBFMT450

FCC Rule Part: Part 90 Subpart I

ACS Report Number: 15-2096.W04.1A

Applicant: Sensus Metering Systems, Inc.
Model: FMT450

Test Begin Date: September 25, 2015
Test End Date: October 21, 2015

Report Issue Date: November 13, 2015



For The Scope of Accreditation Under Certificate Number AT-1533

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

Project Manager:

A handwritten signature in black ink, appearing to read "Thierry Jean-Charles".

Thierry Jean-Charles
EMC Engineer
Advanced Compliance Solutions, Inc.

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This report contains 18 pages

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1.0 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 2 Subpart J, and Part 90 Subpart I of the FCC's Code of Federal Regulations for a Class 2 Permissive Change.

The purpose of the Class 2 Permissive change is to add the 464.6625 MHz - 464.7125 MHz band to the filing. There are no hardware or power changes on the product.

1.2 Product Description

The FMT450 is a transceiver operating from 451 MHz - 464 MHz. The Sensus FlexNet Micro-Transceivers (FMTs) are compatible devices for use within the Sensus FlexNet System, a 2-way fixed AMR network where RF modules communicate directly to Tower Gateway Base Stations (TGBs) or other FlexNet SmartPoint modules. The FMTs are used in conjunction with the Sensus Buddy Monitor software to remotely communicate to FlexNet SmartPoint devices and send setup or status commands to the SmartPoint devices.

The FMTs can also be integrated with other devices using the appropriate Serial Protocols. There are no additional installation requirements to setup the devices to use on the Sensus FlexNet system.

The USB Micro-Transceiver connects to a PC or other USB 2.0 host (Master) device using a regular USB receptacle connector. The FMT operates in slave (peripheral) mode.

Manufacturer Information:
Sensus Metering Systems, Inc.
639 Davis Drive
Morrisville, NC 27560

Test Sample Serial Numbers: 1718 (RF Conducted), 1709 (Radiated Emissions)

Test Sample Condition: The unit was in good operating conditions with no physical damages.

1.3 Test Methodology

1.3.1 Configurations and Justification

The FMT450 was tested in accordance to WT Docket No. 11-56, DA 11-1316 which waives FCC 47 CFR 90.203(j) from the test requirements. The new frequency band of 464.6625 MHz - 464.7125 MHz was evaluated for all the RF parameters except for the transient frequency behavior of the transmitter for which compliance is documented in the original certification effort.

The FMT450 provides multiple modulations formats/modes all of which were evaluated and the worst case data are presented were applicable. For the RF conducted measurements, the EUT was modified with a temporary RF connector at the antenna port. For the radiated emissions, the unit was tested in the orientation of typical use.

The evaluation for unintentional emissions is documented separately in a Declaration of Conformity (DOC) report.

1.3.2 In-Band Testing Methodology

The EUT band of operation is provided in the table below.

| CFR Title 47 Rule Part | Frequency Band of Operation (MHz) |
|------------------------|-----------------------------------|
| 90 | 451.0375 – 454.0 |
| 90 | 456.0 – 462.5375 |
| 90 | 462.7375 – 463.7875 |
| 90 | 464.6625 – 464.7125 |

Based on the requirements set forth in accordance 47 CFR 2.1046-2.1057 as stated above, the methodology in selecting the places to test in the available bands of operation is outlined in the following table.

| CFR Title 47 Rule Part | Frequency Band of Operation (MHz) | Location in the Range of Operation | Approx. Test Freq. (MHz) |
|------------------------|-----------------------------------|------------------------------------|--------------------------|
| 90 | 464.6625 – 464.7125 | middle | 464.6875 |

1.4 Emission Designators

The FMT450 transmitter produces three distinct modulation formats. The emissions designators for the modulation types used by the FMT450 transmitter are as follows:

EMISSIONS DESIGNATORS:

- MPass Mode (5 kbps): 5K90F1D
- MPass Mode (10 kbps): 11K8F1D
- MPass Mode (12.5 kbps): 14K8F1D

2.0 TEST FACILITIES

2.1 Location

Unless otherwise noted, the radiated and conducted emissions test sites are located at the following addresses.

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

FCC Test Firm Registration Number: 475089

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS, Boca Raton, Florida, is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1533 in recognition of this accreditation.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with metallic loaded springs. An EMCO Model 1051 Multi-device Controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

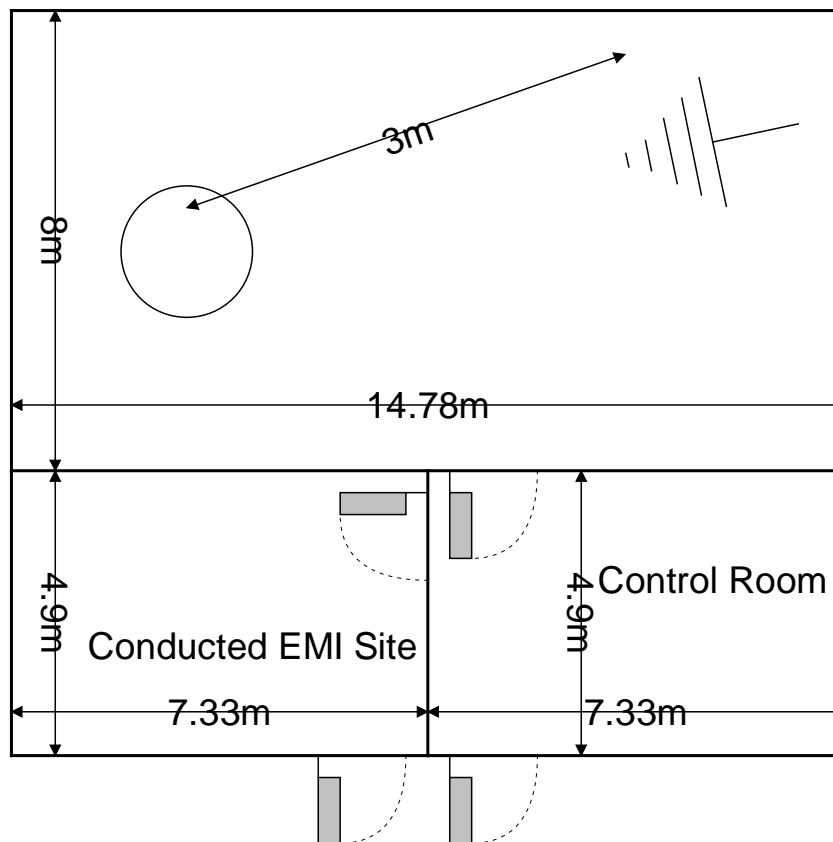


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m³. Power line conducted emission data is taken using two LISNs; a Solar Model 8028-50 50 Ω/50 μH and an EMCO Model 3825, which are installed as shown in Photograph 3. For evaluations requiring 230 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/230 V EDGAR variable frequency generator, Model 1001B.

A diagram of the room is shown below in figure 2.3.2-1:

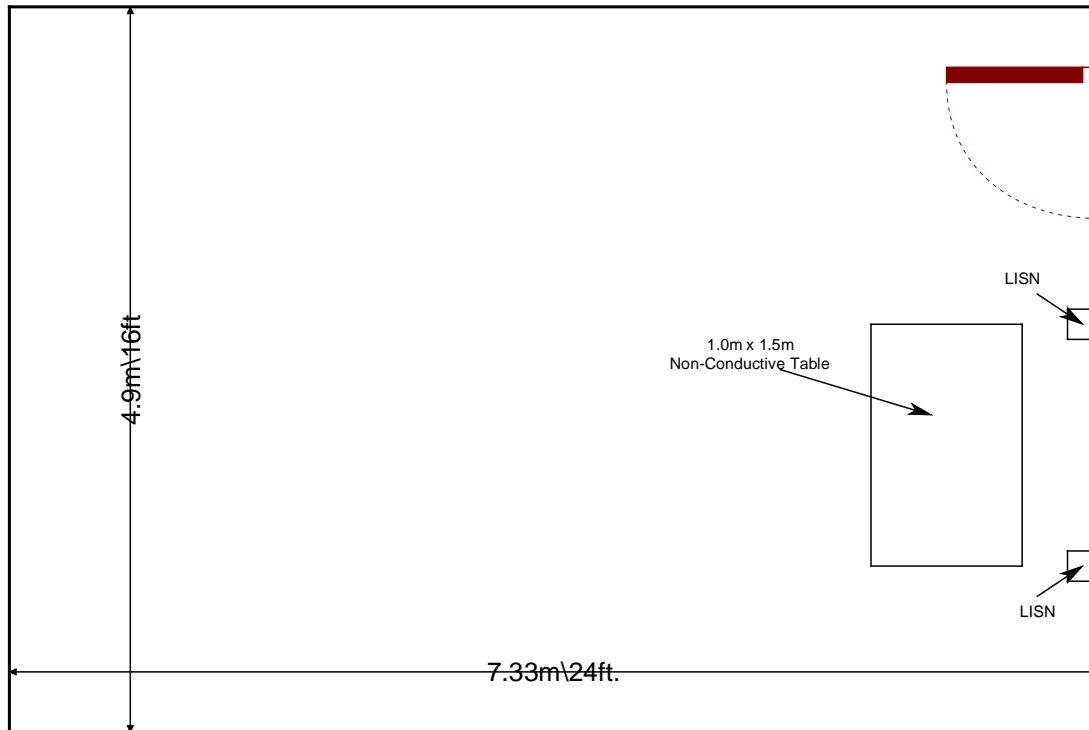


Figure 2.3.2-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- 1 - US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures - 2015
- 2 - US Code of Federal Regulations (CFR): Title 47, Part 90, Subpart I: Private Land Mobile Radio Services – 2015
- 3 – TIA-603-C: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards – 2004

4.0 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: ACS Test Equipment

| AssetID | Manufacturer | Model # | Equipment Type | Serial # | Last Calibration Date | Calibration Due Date |
|---------|----------------------------|------------------------|-----------------------|--------------------------|-----------------------|----------------------|
| 523 | Agilent | E7405 | Spectrum Analyzers | MY45103293 | 12/26/2014 | 12/26/2016 |
| 2002 | EMCO | 3108 | Antennas | 2147 | 11/22/2013 | 11/22/2015 |
| 2004 | EMCO | 3146 | Antennas | 1385 | 11/22/2013 | 11/22/2015 |
| 2006 | EMCO | 3115 | Antennas | 2573 | 4/14/2015 | 4/14/2017 |
| 2007 | EMCO | 3115 | Antennas | 2419 | 1/27/2014 | 1/27/2016 |
| 2011 | Hewlett-Packard | HP 8447D | Amplifiers | 2443A03952 | 12/31/2014 | 12/31/2015 |
| 2073 | Mini Circuits | NHP-800 | Filter | 10247 | 12/31/2014 | 12/31/2015 |
| 2075 | Hewlett Packard | 8495B | Attenuators | 2626A11012 | 1/1/2015 | 1/1/2016 |
| 2089 | Agilent Technologies, Inc. | 83017A | Amplifiers | 3123A00214 | 12/12/2014 | 12/12/2015 |
| 2094 | Mini Circuits | SHP-1000+ | Filter | R UU27401137 | 3/27/2015 | 3/27/2016 |
| 2095 | ETS Lindgren | TILE4! - Version 4.2.A | Software | 85242 | NCR | NCR |
| 2102 | Test Equity | 115 | Environmental Chamber | 150892 | 3/13/2015 | 3/13/2016 |
| 2108 | Fluke | 115 | Digital MultiMeter | 99211160 | 4/2/2015 | 4/2/2016 |
| 2112 | Teledyne Storm Products | 921-0101-036 | Cables | 12-06-698 | 12/31/2014 | 12/31/2015 |
| 2121 | ACS Boca | Radiated Cable Set | Cable Set | 2121 | 8/22/2015 | 8/22/2016 |
| 2122 | ACS Boca | Radiated Cable Set | Cable Set | 2122 | 8/29/2015 | 8/29/2016 |
| RE563 | Hewlett Packard | 8673D | Signal Generators | 3034A01078 | 4/2/2015 | 4/2/2016 |
| RE597 | BK Precision | 1692 | Power Supplies | S940035931 | NCR | NCR |
| RE619 | Rhode & Schwarz | ESU | Spectrum Analyzers | 1302.6005K26 Ser. 100190 | 11/5/2014 | 11/5/2016 |

NCR=No Calibration Required

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

| Item # | Type Device | Manufacturer | Model/Part # | Serial # |
|--------|-----------------------|-------------------------------|----------------|------------------------------|
| 1 | EUT | Sensus Metering Systems, Inc. | FMT450 | 1709 |
| 2 | Laptop | DELL | Latitude E6400 | 8KF60M1 |
| 3 | 19.5 VDC Power Supply | DELL | FA90PE1-00 | CN-0CM889-73245-04F-8885-A01 |
| 4 | Mouse | DELL | MS111-P | CN-0356WK-71581-1AD-0793 |
| 5 | Flash drive | HP | N/A | N/A |
| 6 | Headphone | Maxell | N/A | N/A |

Table 5-2: Cable Description

| Cable # | Cable Type | Length | Shield | Termination |
|---------|-----------------|--------|--------|--------------------------|
| A | USB | 0.24 m | No | EUT to Laptop |
| B | DC Power | 1.8 m | No | Power Supply to Laptop |
| C | AC power | 0.9 m | No | Power Supply to AC Mains |
| D | USB | 1.86 m | No | Mouse to Laptop |
| E | Extension cable | 1.82 m | No | AC adapter to AC Mains |
| F | audio cable | 0.95 m | No | Laptop to Headphone |

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

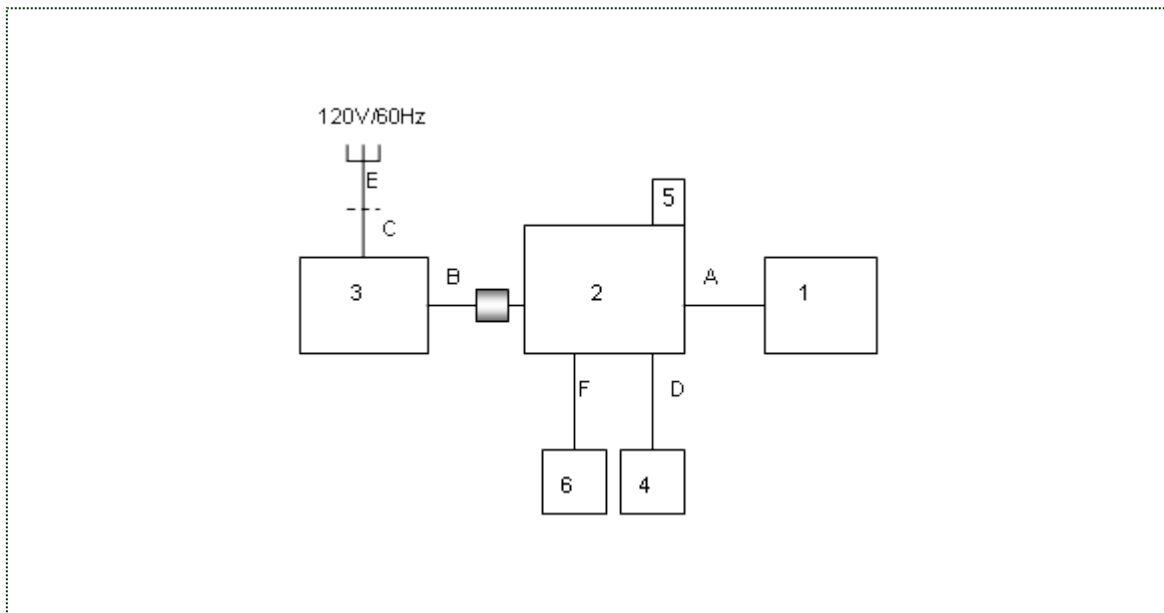


Figure 6-1: EUT Test Setup

7.0 SUMMARY OF TESTS

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

Table 7-1: Test Results Summary

| Test Parameter | Test Summary |
|---|--------------|
| RF Power Output | Pass |
| Occupied Bandwidth (Emissions Limits) | Pass |
| Spurious Emissions at Antenna Terminals | Pass |
| Field Strength of Spurious Emissions | Pass |
| Frequency Stability | Pass |

7.1 RF Power Output

7.1.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The resolution and video bandwidths of the spectrum analyzer were set at sufficient levels, >> signal bandwidth, to produce accurate results. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results are shown below.

7.1.2 Measurement Results

Part 90.205

Table 7.1.2-1: Peak Output Power

| Frequency (MHz) | FCC Rule Part | Output Power (dBm) |
|-----------------|---------------|--------------------|
| 464.6875 | 90 | 20.48 |

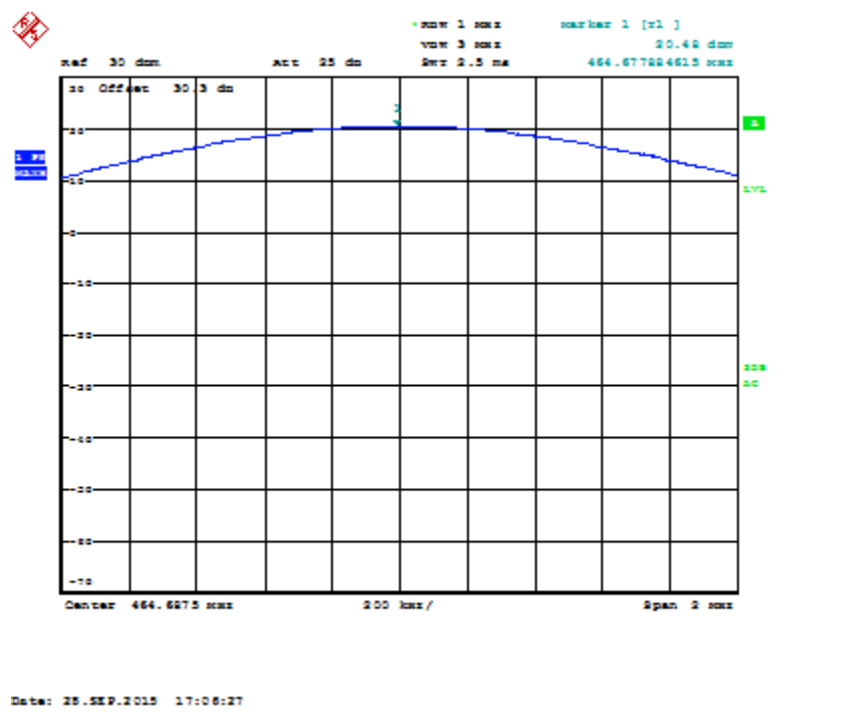


Figure 7.1.2-1: Peak Output Power – 464.6875 MHz

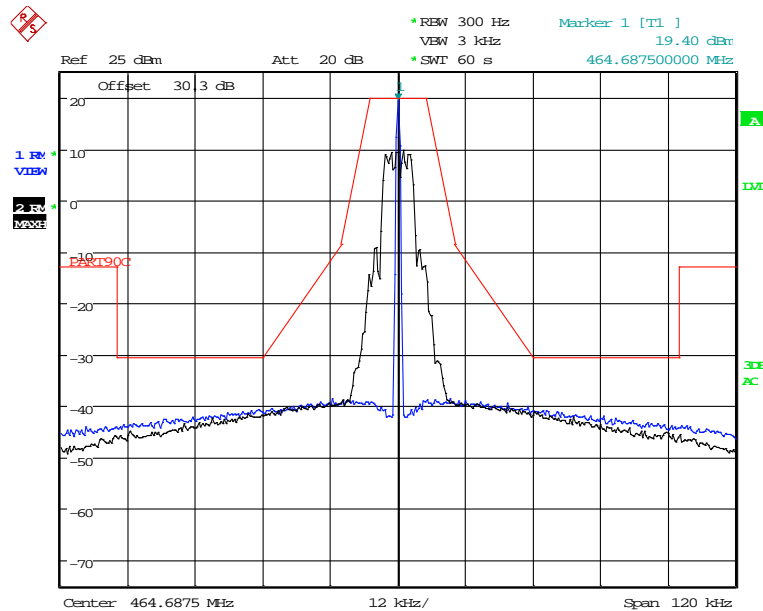
7.2 Occupied Bandwidth (Emission Limits)

7.2.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The spectrum analyzer resolution and video bandwidths were set to 300 Hz and 3000 Hz respectively. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results of the test are shown below for all modes of operation.

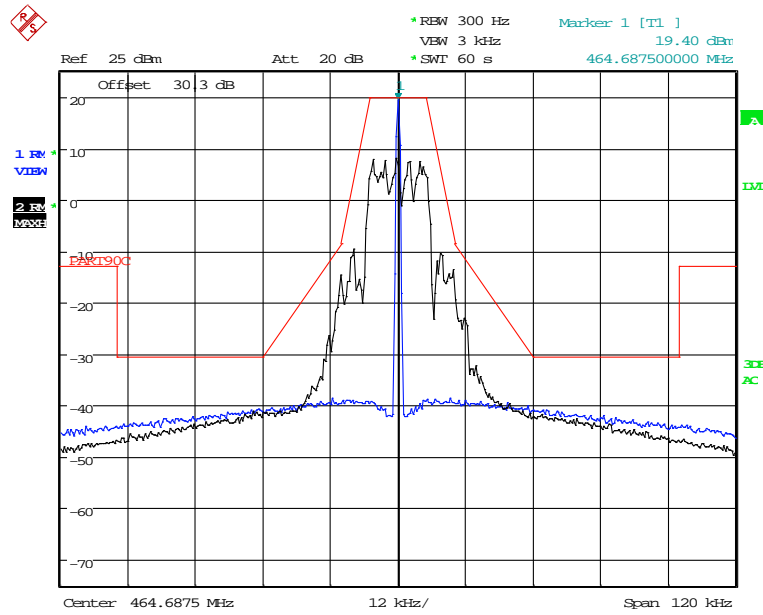
7.2.2 Measurement Results

Part 90.210(c)



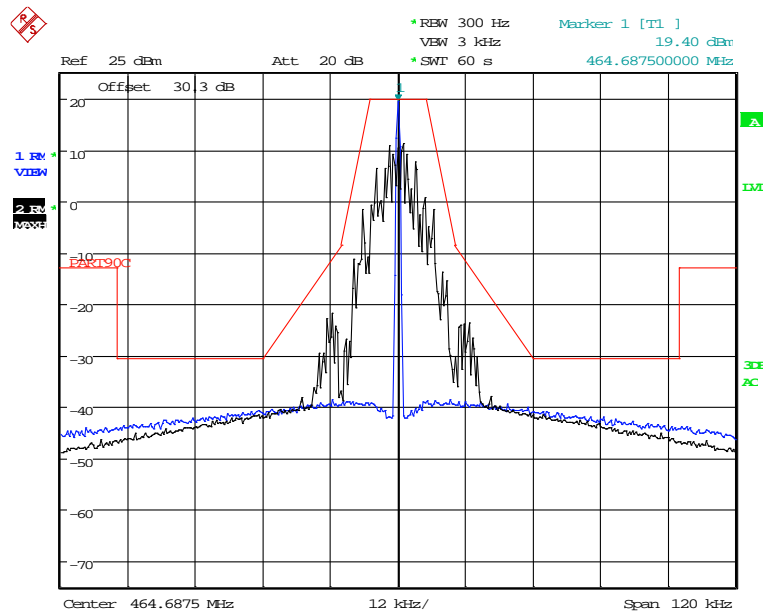
Date: 28.SEP.2015 19:32:26

Figure 7.2.2-1: 464.6875 MHz – MPass 5k Mode



Date: 28.SEP.2015 18:49:56

Figure 7.2.2-2: 464.6875 MHz – MPass 10k Mode



Date: 28.SEP.2015 20:20:11

Figure 7.2.2-3: 464.6875 MHz – MPass 12.5k Mode

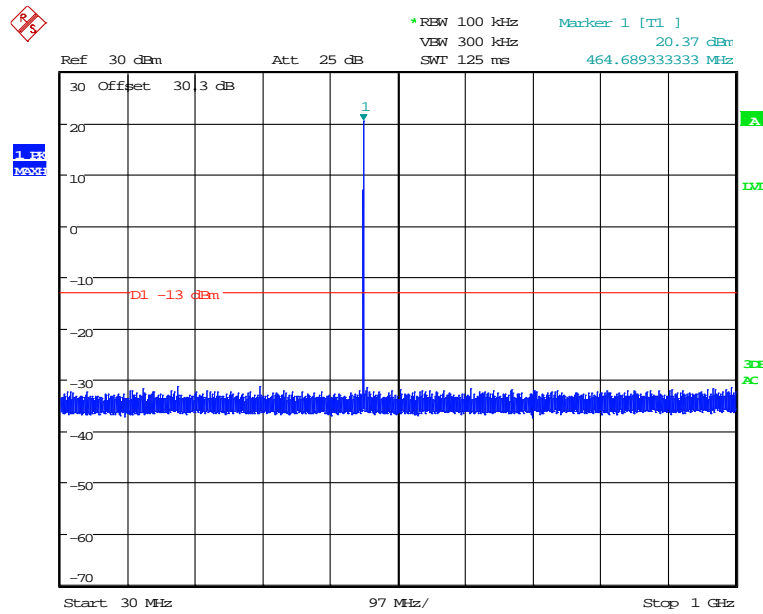
7.3 Spurious Emissions at Antenna Terminals

7.3.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The spectrum analyzer resolution bandwidth was set to 100 kHz below 1000 MHz and 1 MHz above 1000 MHz. The internal correction factors of the spectrum analyzer were employed to correct for any cable, attenuator or filter losses. The spectrum was investigated in accordance to CFR 47 Part 2.1057. Results are shown below.

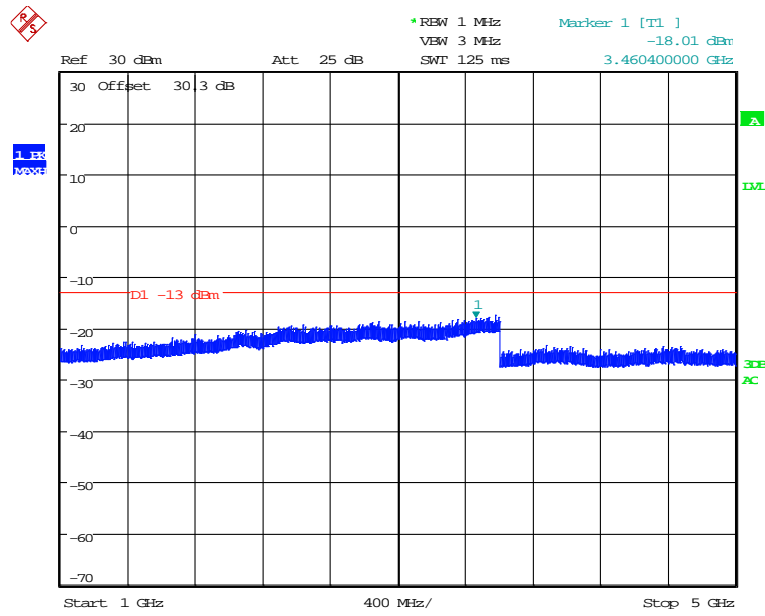
7.3.2 Measurement Results

Part 90.210(c)



Date: 28.SEP.2015 17:24:49

Figure 7.3.2-1: 464.6875 MHz – 30MHz to 1GHz



Date: 28.SEP.2015 17:43:40

Figure 7.3.2-2: 464.6875 MHz – 1GHz to 5GHz

7.4 Field Strength of Spurious Emissions

7.4.1 Measurement Procedure

The equipment under test is placed in the Semi-Anechoic Chamber (described in section 2.3.1) on a wooden table at the turntable center. For each spurious emission, the antenna mast is raised and lowered from one (1) to four (4) meters and the turntable is rotated 360° and the maximum reading on the spectrum analyzer is recorded. This was repeated for both horizontal and vertical polarizations of the receive antenna.

The equipment under test is then replaced with a substitution antenna fed by a signal generator. The signal generator's frequency is set to that of the spurious emission recorded from the equipment under test. The antenna mast is raised and lowered from one (1) to four (4) meters to obtain a maximum reading on the spectrum analyzer. The output of the signal generator is then adjusted until the reading on the spectrum analyzer matches that obtained from the equipment under test. The signal generator level is recorded. The power in dBm of each spurious emission is calculated by correcting the signal generator level for the cable loss and gain of the substitution antenna referenced to a dipole. The spectrum was investigated in accordance to CFR 47 Part 2.1057.

The magnitude of all spurious emissions not reported were attenuated below the noise floor of the measurement system and therefore not specified in this report. Results are shown below.

7.4.2 Measurement Results

Part 90.210(c)

Table 7.4.2-1: Field Strength of Spurious Emissions – 464.6875 MHz

| Frequency (MHz) | Spectrum Analyzer Level (dBm) | Antenna Polarity (H/V) | Spurious ERP (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------------------|------------------------|--------------------|-------------|-------------|
| 929.375 | -43.03 | H | -37.13 | -13.00 | 24.13 |
| 1394.0625 | -56.42 | H | -67.16 | -13.00 | 54.16 |
| 1858.75 | -57.94 | H | -67.37 | -13.00 | 54.37 |
| 2323.4375 | -57.03 | H | -63.50 | -13.00 | 50.50 |
| 2788.125 | -48.66 | H | -46.60 | -13.00 | 33.60 |
| 3252.8125 | -57.23 | H | -58.17 | -13.00 | 45.17 |
| 3717.5 | -56.15 | H | -52.79 | -13.00 | 39.79 |
| 4182.1875 | -61.72 | H | -61.48 | -13.00 | 48.48 |
| 4646.875 | -61.83 | H | -61.32 | -13.00 | 48.32 |
| 929.375 | -48.62 | V | -42.13 | -13.00 | 29.13 |
| 1394.0625 | -56.49 | V | -68.97 | -13.00 | 55.97 |
| 1858.75 | -57.95 | V | -67.26 | -13.00 | 54.26 |
| 2323.4375 | -57.38 | V | -61.46 | -13.00 | 48.46 |
| 2788.125 | -52.12 | V | -49.73 | -13.00 | 36.73 |
| 3252.8125 | -56.22 | V | -53.06 | -13.00 | 40.06 |
| 3717.5 | -56.31 | V | -51.81 | -13.00 | 38.81 |
| 4182.1875 | -62.09 | V | -61.53 | -13.00 | 48.53 |
| 4646.875 | -62.33 | V | -61.83 | -13.00 | 48.83 |

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

7.5 Frequency Stability

7.5.1 Measurement Procedure

The equipment under test is placed inside an environmental chamber. The RF output is directly coupled to the input of the measurement equipment and a power supply is attached to the primary supply voltage.

Frequency measurements were made at the extremes of the of temperature range -30°C to $+50^{\circ}\text{C}$ and at intervals of 10°C at normal supply voltage. A period of time sufficient to stabilize all components of the equipment was allowed at each frequency measurement. At a temperature 20°C the measurements were performed at 85% and 115% of the EUT nominal voltage. The maximum variation of frequency was recorded.

7.5.2 Measurement Results

Part 90.213

Frequency Stability

Frequency (MHz): 464.6875

Deviation Limit (PPM): 5

| Temperature C | Frequency MHz | Frequency Error (PPM) | Voltage (%) | Voltage (VDC) |
|------------------|------------------|--------------------------|----------------|------------------|
| -30 C | 464.687171 | -0.707 | 100% | 5.00 |
| -20 C | 464.687212 | -0.621 | 100% | 5.00 |
| -10 C | 464.687210 | -0.624 | 100% | 5.00 |
| 0 C | 464.687256 | -0.524 | 100% | 5.00 |
| 10 C | 464.687378 | -0.262 | 100% | 5.00 |
| 20 C | 464.687452 | -0.103 | 100% | 5.00 |
| 30 C | 464.687465 | -0.076 | 100% | 5.00 |
| 40 C | 464.687564 | 0.138 | 100% | 5.00 |
| 50 C | 464.687663 | 0.352 | 100% | 5.00 |
| 20 C | 464.687447 | -0.114 | 85% | 4.25 |
| 20 C | 464.687450 | -0.107 | 115% | 5.75 |

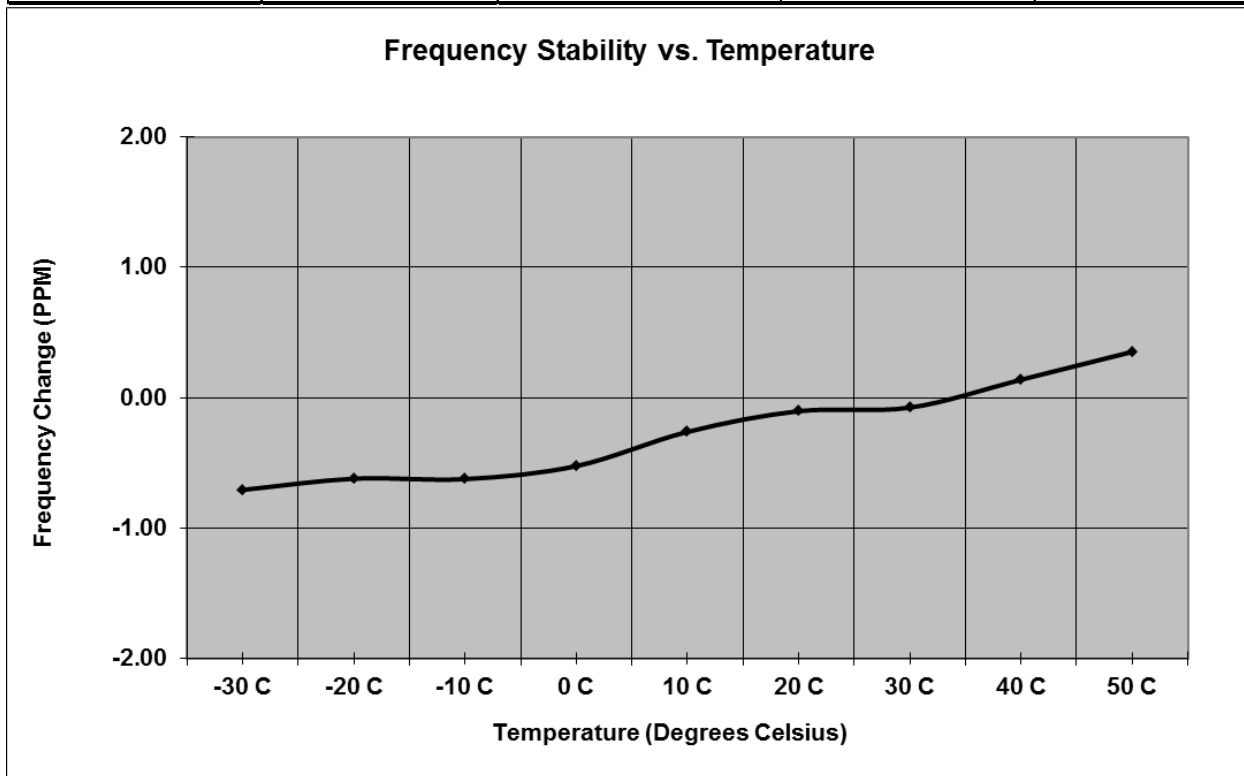


Figure 7.5.2-1: Frequency Stability – 464.6875 MHz

8.0 CONCLUSION

In the opinion of ACS, Inc. the model FMT450, manufactured by Sensus Metering Systems, Inc., meets the requirements of FCC Part 90 Subpart I for the tests reported in this document, were applicable.

End Report