Excellence in Compliance Testing

Certification Test Report

FCC ID: SDBS100QZ

FCC Rule Part: Part 90 Subpart I

ACS Report Number: 15-2098.W04.1A

Applicant: Sensus Metering Systems, Inc.
Model: S100QZ

Test Begin Date: October 2, 2015
Test End Date: October 14, 2015

Report Issue Date: October 26, 2015

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

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:

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

Reviewed by:

Kirby Munroe
Director, Wireless Certifications
Advanced Compliance Solutions, Inc.

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 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 permissive change is to add the 464.6625 MHz – 464.7125 MHz band to the filing. This additional frequency range is allowed by a retuning of the external duplexer. Per the manufacturer, there are no hardware nor software changes on the product.

1.2 Product Description

The S100QZ transceiver is a multi-channel, high-performance burst data radio system configured to receive three distinct modulation schemes on three adjacent frequencies in the 450 to 470 MHz frequency range.

The Transceiver RF Transmitter operates on a single configurable channel in the 461 to 464 MHz frequency ranges. The transmitter utilizes yet another type of modulation scheme, different from the ones utilized by the receiver.

The Transceiver assembles the received messages and forwards them to the RNI Network Controller via a high-speed link (ISDN, T1, etc.). The Network Controller (NC) eliminates redundant messages (i.e., messages from endpoints that were received by more than one Base Station) before forwarding them to the database server. The Transceiver also notifies the RNI of any alarm indications, such as low battery, power failure, open door, or low AC power.

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

Test Sample Serial Numbers: 3143

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 S100QZ was tested in accordance to WT Docket No. 11-56, DA 11-1316 which waives 47 CFR 90.203(j) to the test requirements for the new frequency range of 464.6625 MHz – 464.7125 MHz. The EUT was evaluated for all RF parameters except for the transient behavior of the transmitter for which compliance is documented in the original certification effort.

The S100QZ provides multiple modulations formats/modes all of which were evaluated and the worst case data are presented were applicable. For the radiated emissions, the EUT was evaluated in the orientation of typical installation.

The evaluation for unintentional emissions for the unit in the RX mode is documented separately in a verification 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	461.5625 – 461.6125
90	462.4625 – 462.5125
90	463.7375 – 463.7875
90	464.6625 – 464.7125

This evaluation effort addresses the additional band of 464.6625 MHz – 464.7125 MHz since the original certification. 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 new band 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.
90	464.6625 – 464.7125	middle	464.6875

1.4 Emission Designators

The S100QZ transmitter produces two distinct modulation formats. The emissions designators for the modulation types used by the S100QZ transmitter are as follows:

EMISSIONS DESIGNATORS:

mPass Mode (5 kbps): 5K90F1D
mPass Mode (10 kbps): 11K8F1D

2.0 TEST FACILITIES

2.1 Location

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

Site 1
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 #: 475089

Site 2
Advanced Compliance Solutions, Inc.
5015 B.U. Bowman Drive
Buford GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598
www.acstestlab.com

FCC Registration Number: 511277

2.2 Laboratory Accreditations/Recognitions/Certifications

Site 1
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.

Site 2
ACS, Buford, GA is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP).

Unless otherwise specified, all test methods described within this report are covered under the respective test site ISO/IEC 17025 scope of 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:

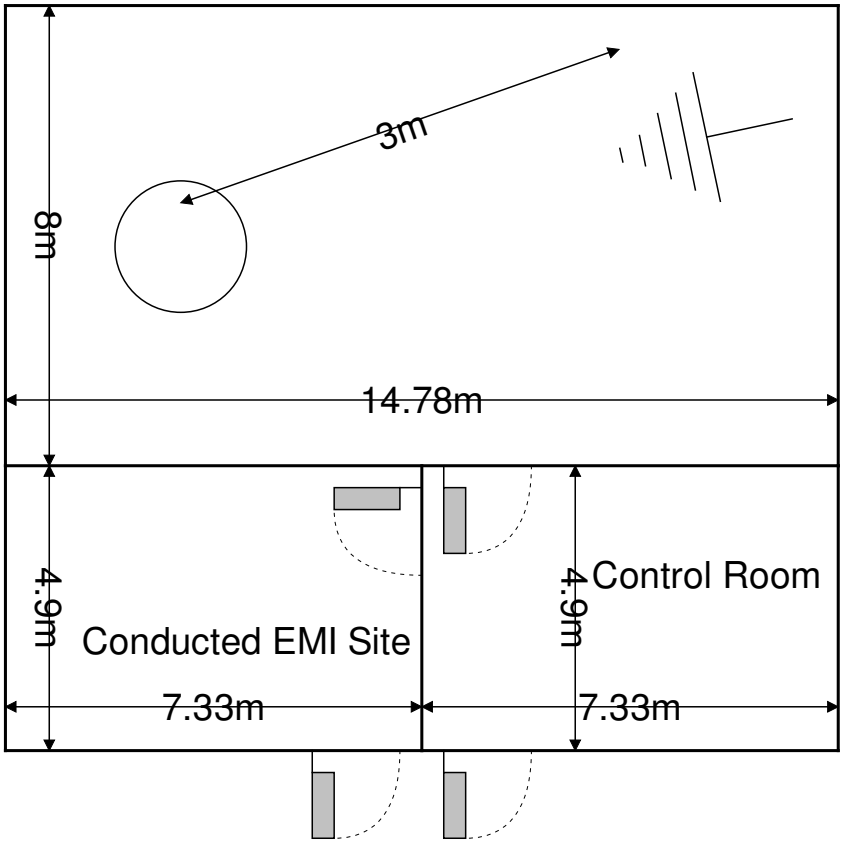

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. 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 220 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B.

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

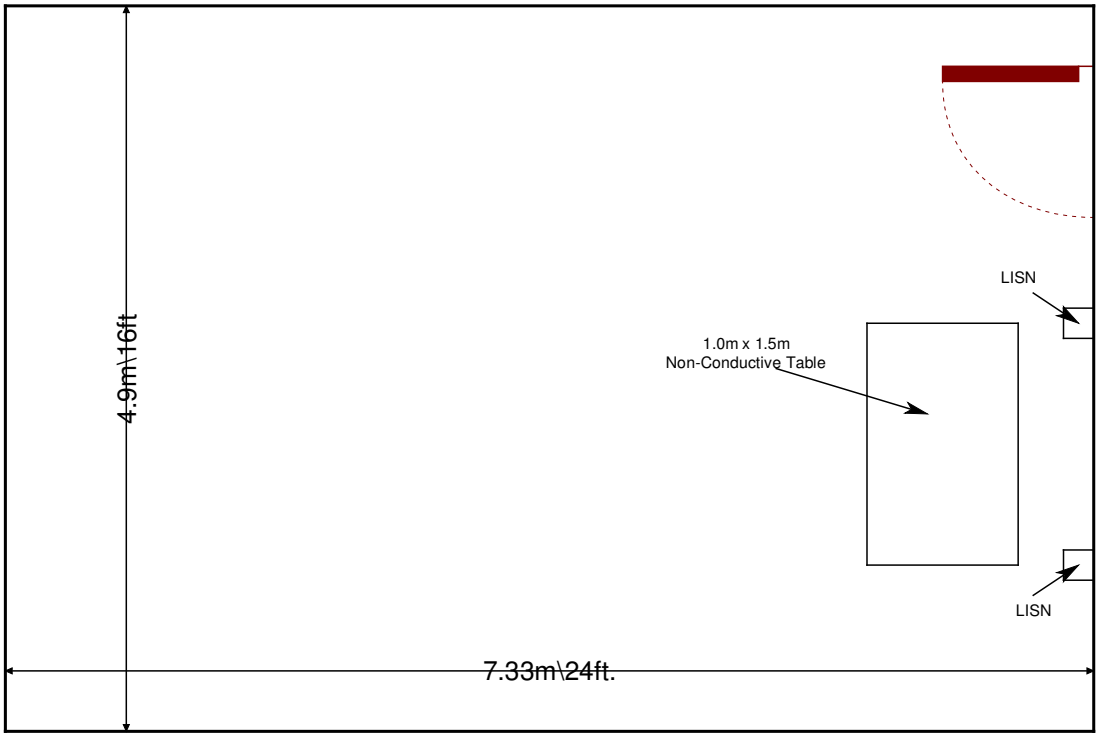

Figure 2.3.2-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

1 - ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz to 40GHz - 2003
2 - US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures - 2015
3 - US Code of Federal Regulations (CFR): Title 47, Part 90, Subpart I: Private Land Mobile Radio Services – 2015
4 – 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
426	Thermotron	S-8 Mini Max	Environmental Chamber	25-2888-10	7/15/2015	7/15/2016
523	Agilent	E7405	Spectrum Analyzers	MY45103293	12/26/2014	12/26/2016
562	United Microwave Products, Inc.	AA-190-00.48.0	Cables	562	7/14/2015	7/14/2016
615	Fairview Microwave Inc.	SA4N100-20	Attenuators	N/A	9/10/2015	9/10/2017
622	Rohde & Schwarz	FSV40	Analyzers	101338	7/15/2015	7/15/2016
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
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
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR
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
RE571	Narda	26298	Attenuators	A500	7/2/2015	7/2/2016
RE563	Hewlett Packard	8673D	Signal Generators	3034A01078	4/2/2015	4/2/2016
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	S100QZ	3143
2	Duplexer	Sensus Metering Systems	CMD862	000101
3	27 VDC EUT Power Supply	Lineage Power	J2007003 L102	10KZ47016361
4	20dB Attenuator	Narda	26298	A500
5	50-ohm load	Narda	376BNF	9401
6	Ethernet Switch	Netgear	GS105v5	3TL15256099BA
7	Power Supply	Netgear	AD2015F23	31150531Y1070203DX
8	DC Power Supply	MPJA	HY5003	003700278
9	GPS Antenna	TRIMBLE	57860-00	18880022

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	N-type RF cable	1.44 m	Yes	EUT TX to Duplexer
B	Power	1.2 m	No	EUT to Power Supply
C	N-type RF cable	1.4 m	Yes	EUT to 20dB Attenuator
D	RF coax cable	1.8 m	Yes	EUT to GPS Antenna
E	Ethernet cable	2.1 m	Yes	EUT to Ethernet Switch
F	Power	1.88 m	No	Ethernet Switch to Power supply
G	Twisted Pair Power	1.3 m	No	Duplexer to DC Power Supply
H	Serial Alarm	0.55 m	No	None
I	POTS	1.22 m	No	None
J	POTS	2 m	No	None
K	Power	2.3 m	No	EUT Power Supply to AC Mains
L	Power	1.8 m	No	DC Power Supply to AC Mains
M	BNC Type RF cable	1.8 m	Yes	EUT RX to Duplexer

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

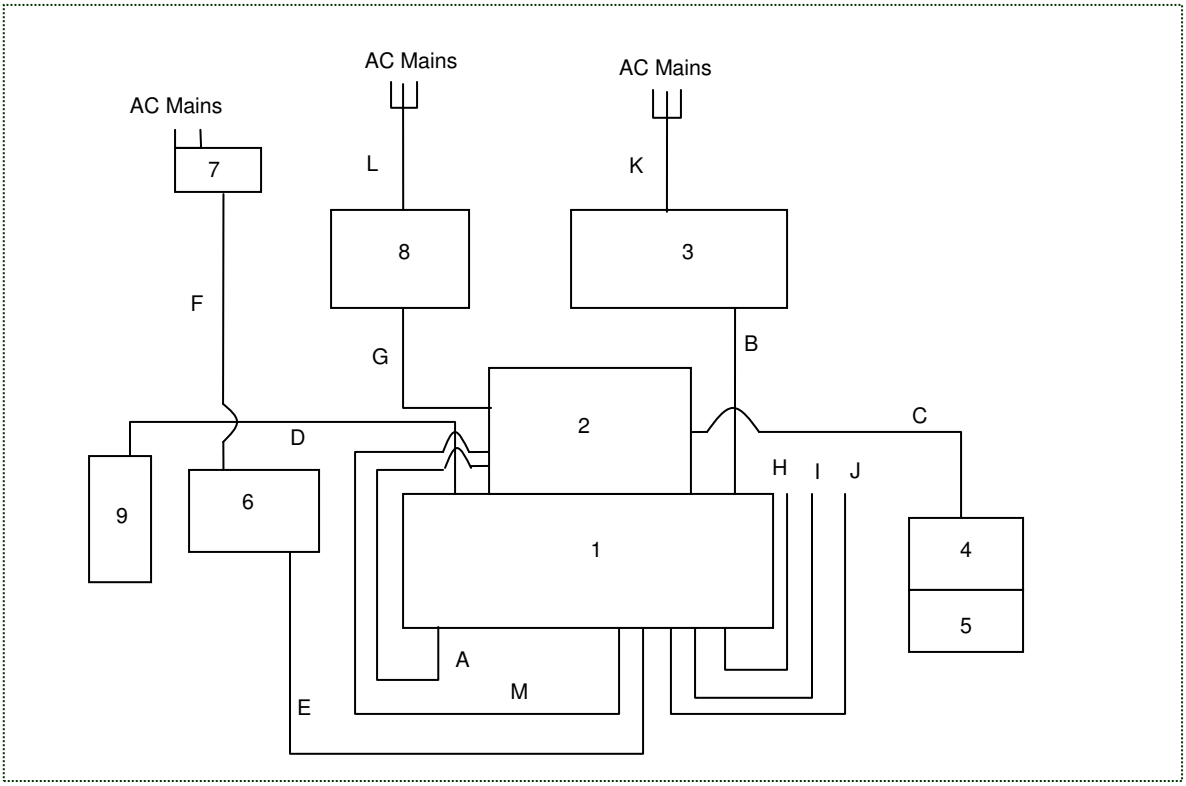

Figure 6-1: EUT Test Setup

* Note: The EUT and port terminations were configured per the customer setup instructions.

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 Site	Test Summary
RF Power Output	1	Pass
Occupied Bandwidth (Emissions Limits)	1	Pass
Spurious Emissions at Antenna Terminals	1	Pass
Field Strength of Spurious Emissions	1	Pass
Frequency Stability	2	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 50 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

Table 7.1.2-1: Peak Output Power

Frequency (MHz)	FCC Rule Part	Output Power (dBm)
464.6875	90	40.12

Part 90.205

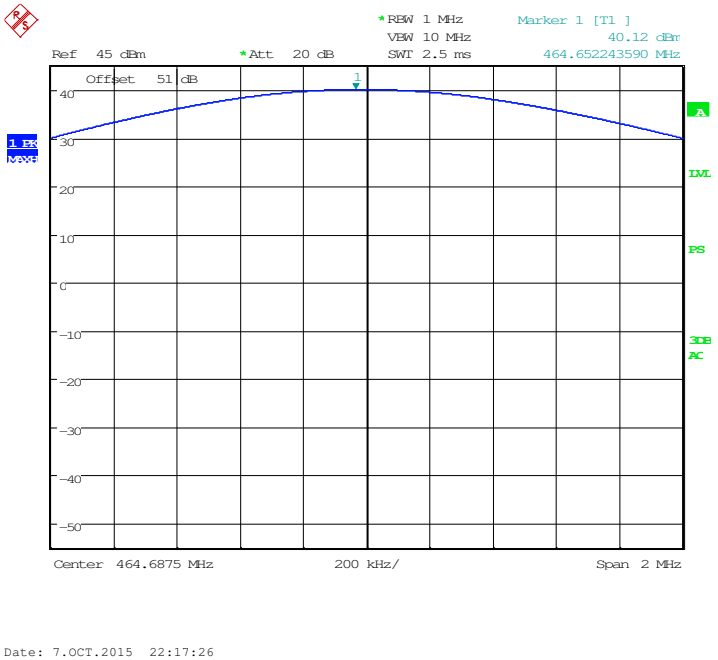

Figure 7.1.2-1: Peak Output Power – 464.6875 MHz

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 50 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)

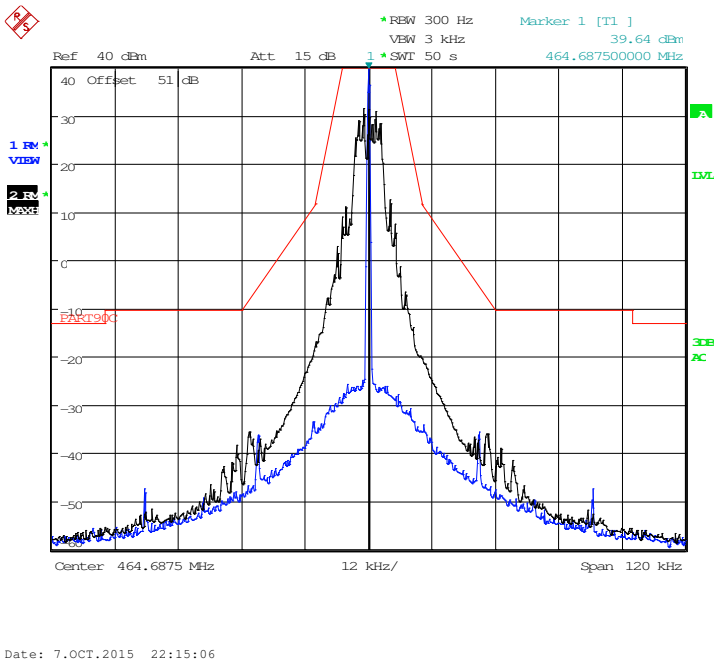

Figure 7.2.2-1: 464.6875 MHz – MPass 5k Mode

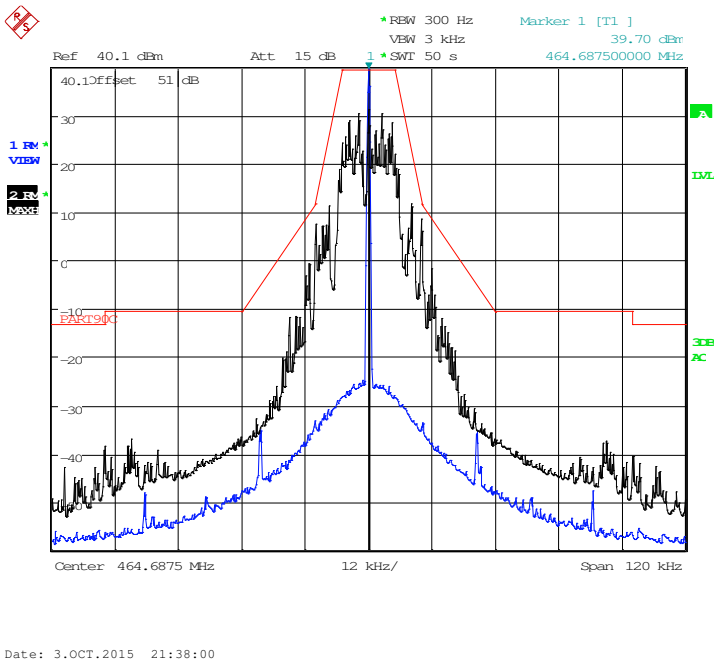

Figure 7.2.2-2: 464.6875 MHz – MPass 10k Mode

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 50 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)

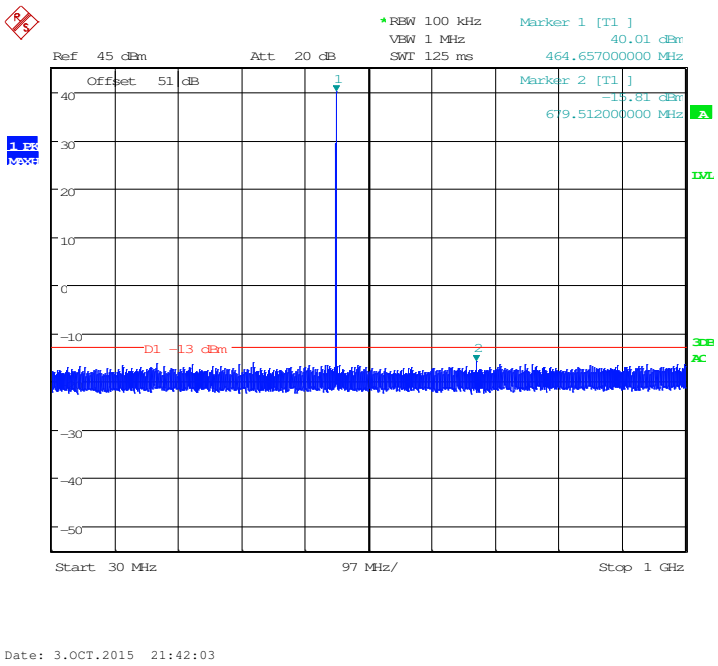

Figure 7.3.2-1: 464.6875 MHz – 30MHz to 1GHz

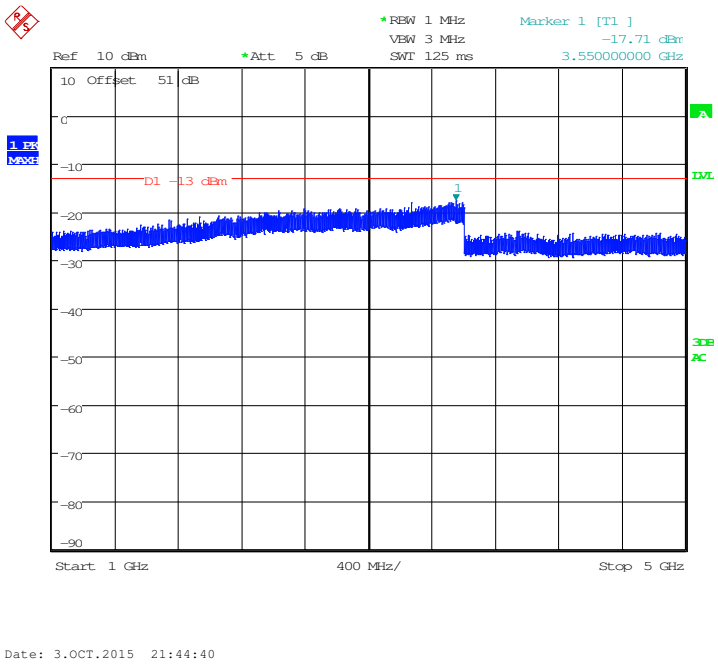

Figure 7.3.2-2: 464.6875 MHz – 1GHz to 5GHz

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 Styrofoam 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 360º 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)	Antenna Height (cm)	Angle (degrees)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
929.375	-63.54	H	174	112	-61.16	-13.00	48.16
1394.0625	-57.36	H	105	38	-70.12	-13.00	57.12
2788.125	-60.07	H	100	222	-70.15	-13.00	57.15
3252.8125	-61.48	H	173	214	-69.65	-13.00	56.65
3717.5	-57.69	H	171	157	-54.83	-13.00	41.83
4182.1875	-59.23	H	100	141	-56.60	-13.00	43.60
4646.875	-61.85	H	148	307	-58.84	-13.00	45.84
929.375	-62.49	V	137	121	-59.25	-13.00	46.25
1394.0625	-57.05	V	106	263	-69.07	-13.00	56.07
2788.125	-60.88	V	124	167	-70.26	-13.00	57.26
3252.8125	-61.18	V	112	203	-63.54	-13.00	50.54
3717.5	-58.42	V	170	164	-54.90	-13.00	41.90
4182.1875	-61.84	V	113	202	-59.97	-13.00	46.97
4646.875	-61.39	V	113	189	-58.20	-13.00	45.20

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 -30º C to +50º C and at intervals of 10º 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 20º C the measurements were performed at the endpoint voltage. The maximum variation of frequency was recorded.

7.5.2 Measurement Results

Part 90.213

Frequency Stability

Frequency (MHz): 464.6875

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**464.6876881**	**0.405**	100%	24.00
-20 C	**464.6876879**	**0.404**	100%	24.00
-10 C	**464.6876883**	**0.405**	100%	24.00
0 C	**464.6876880**	**0.405**	100%	24.00
10 C	**464.6876879**	**0.404**	100%	24.00
20 C	**464.6876877**	**0.404**	100%	24.00
30 C	**464.6876881**	**0.405**	100%	24.00
40 C	**464.6876881**	**0.405**	100%	24.00
50 C	**464.6876884**	**0.405**	100%	24.00
20 C	**464.6876879**	**0.404**	Endpoint	22.00

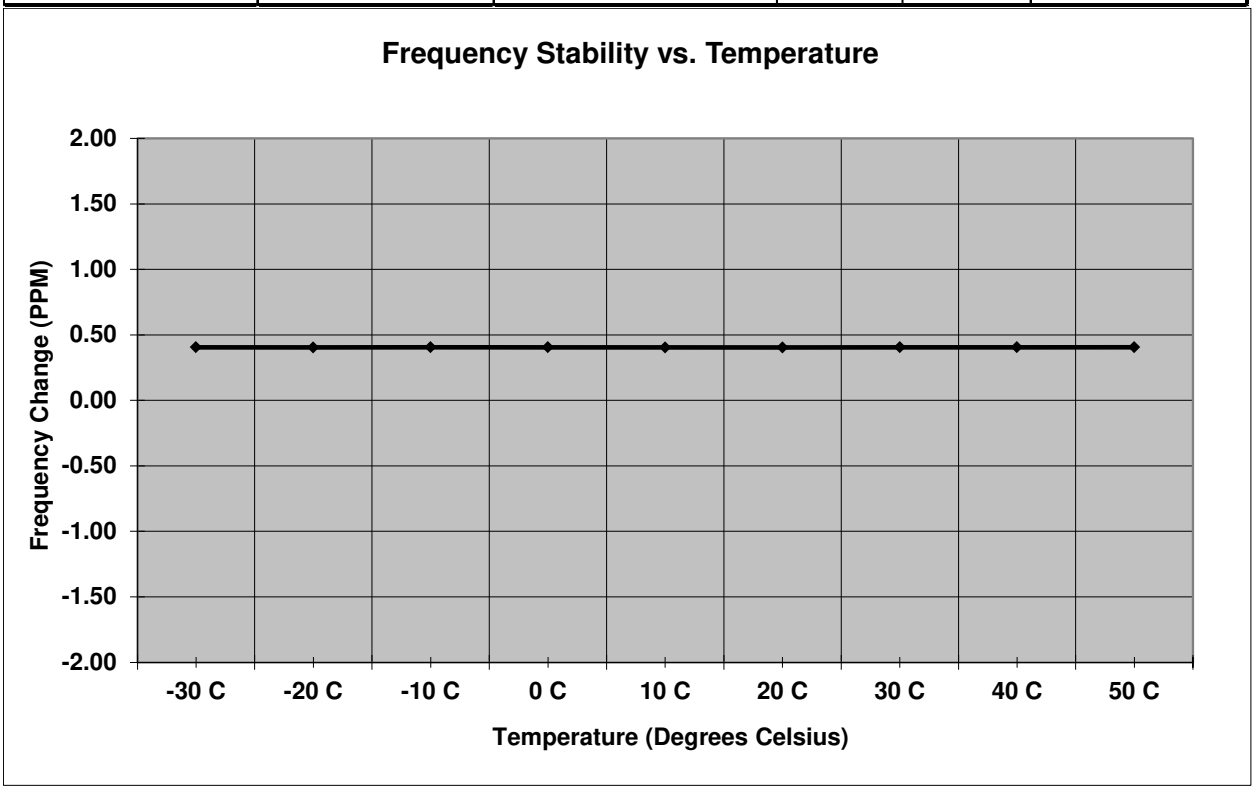

Figure 7.5.2-1: Frequency Stability – 464.6875 MHz

8.0 CONCLUSION

In the opinion of ACS, Inc. the model S100QZ, manufactured by Sensus Metering Systems, Inc., meets the requirements of FCC Part 90 Subpart I, for the test reported in this document.

End Report