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Certification Test Report

FCC ID: SDBM400V01
IC: 2220A-M400V01

FCC Rule Part: CFR 47 Part 24 Subpart D
IC Radio Standards Specification: RSS 134

ACS Report Number: 12-2105.W06.1A

Applicant: Sensus Metering Systems, Inc.
Model: M400XCVR-01

Test Begin Date: August 17, 2012
Test End Date: September 6, 2012

Report Issue Date: September 13, 2012

For The Scope of Accreditation Under Certificate Number AT-1533

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 ACLASS, NVLAP, 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.

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This report contains 27 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, Part 24 Subpart D of the FCC's Code of Federal Regulations, and Industry Canada Radio Standards Specifications RSS-134.

1.2 Product Description

The Sensus FlexNet M400XCVR-01 Transceiver consists of two circuit cards mounted in an aluminum chassis to form a complete XCVR. The M400XCVR-01 uses an External PA module to provide a full 8W of TX power. The unit also includes a duplexer which provides the necessary TX to RX isolation as well as a very narrow pre-selection filter for the RX and additional harmonic filtering on the TX.

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

Test Sample Serial Numbers: 185

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 M400XCVR-01 was tested with the external PA module and duplexer for radiated and RF conducted measurements for low power and high power operation.

The RF conducted measurements were performed at the duplexer antenna port for all available modes of operation. The radiated spurious emissions were performed up to the 10^{th} harmonic for the mode of operation leading to the highest emissions.

In order to meet the unintentional emissions requirements, the unit was modified as follows.
FAIR-RITE model 0461164181 Ferrite on Ethernet Cables (2 Passes)
FAIR-RITE model 0461164181 Ferrite on Serial Alarm Cable (2 Passes)
FAIR-RITE model 0461164181 Ferrite on Power Cable (2 Passes)

The evaluation for unintentional emission is documented separately in a verification report.

1.3.2 In-Band Testing Methodology

Based on the requirements set forth in accordance 47 CFR 2.1046-2.1057, 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.
24D	940.0 - 941.0	Middle	940.5

1.4 Emission Designators

The M400XCVR-01 transmitter produces 4 distinct modulation formats. The emissions designators for the modulation types used by the M400XCVR-01 transmitter are as follows:

EMISSIONS DESIGNATORS:

mPass mode (5 kbps): 5K90F1D
mPass mode (10 kbps): 11K8F1D
m4Pass mode (10 kbps): 8K75F1D
m4Pass mode (20 kbps): 17K5F1D

2.0 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

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

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

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 ACLASS 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:

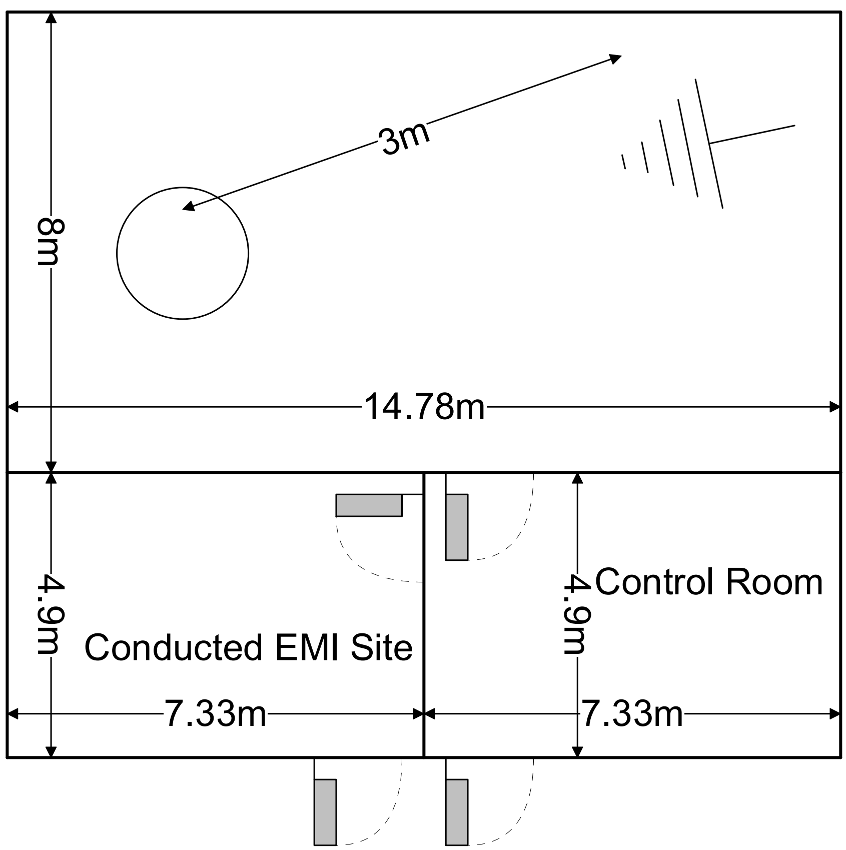


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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. As per ANSI C63.4 2003 requirements, the data were 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 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, to filter conducted noise from the generator.

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

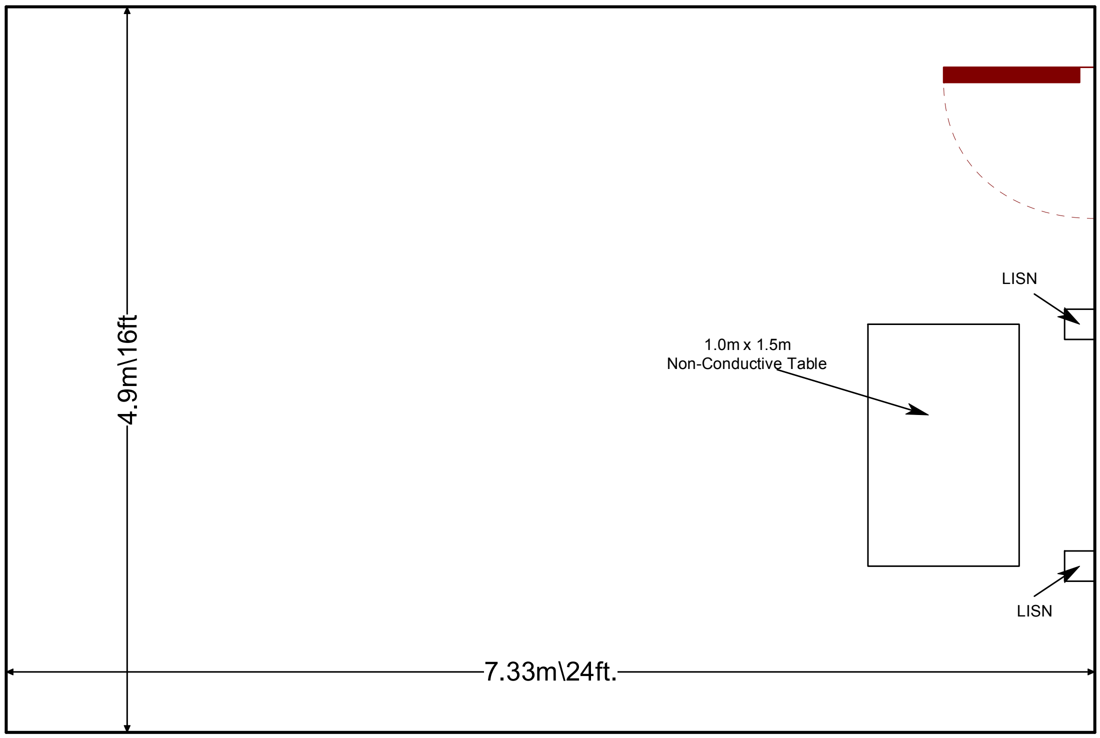


Figure 2.3.2-1: AC Mains Conducted EMI Site

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 - 2012
3 - US Code of Federal Regulations (CFR): Title 47, Part 24, Subpart D: Personal Communications Services – 2012
4 – TIA-603-C: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards – 2004
5 – Industry Canada Radio Standards Specification: RSS-134 - 900 MHz Narrow Band Personal Communication Service, Issue 1, March 2000

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: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/5/2011	1/5/2013
524	Chase	CBL6111	Antennas	1138	1/7/2011	1/7/2013
2002	EMCO	3108	Antennas	2147	11/30/2011	11/30/2013
2004	EMCO	3146	Antennas	1385	11/30/2011	11/30/2013
2006	EMCO	3115	Antennas	2573	3/2/2011	3/2/2013
2007	EMCO	3115	Antennas	2419	1/18/2012	1/18/2014
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	1/2/2012	1/2/2013
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	1/2/2012	1/2/2013
RE587	Fairview Microwave Inc.	SA3N511-15	Attenuators	RE587	4/18/2012	4/18/2013
2075	Hewlett Packard	8495B	Attenuators	2626A11012	1/2/2012	1/2/2013
2082	Teledyne Storm Products	90-010-048	Cables	2082	5/31/2012	5/31/2013
2091	Agilent Technologies, Inc.	8573A	Spectrum Analyzers	2407A03233	12/12/2011	12/12/2013
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/22/2011	12/22/2012
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	8/1/2012	8/1/2013
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	8/2/2012	8/2/2013
426	Thermotron	S-8 Mini Max	Environmental Chamber	25-2888-10	8/2/2012	8/2/2013
562	United Microwave Products, Inc.	AA-190-00.48.0	Cables	562	7/31/2012	7/31/2013

NCR=No Calibration Required

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Sensus	M400XCVR-01	185
2	PA	Sensus	QQ1204H	TS0I43MM009
3	Duplexer	Sensus	CMD644-01	0000596
4	24 VDC Power Supply	V-Infinity	ETSA2402700	N/A
5	D-Link Switch	D-Link	DES-105	QBJP1C1000055
6	5 VDC Power Supply	D-Link	FPS005USA-050100	5011
7	50 Ohm Load	Narda	376BNF	9401
8	GPS Antenna	Trimble	57860-00	289102012
9	Ferrite	FAIR-RITE	0461164281	N/A
10	Ferrite	FAIR-RITE	0461164181	N/A
11	Ferrite	FAIR-RITE	0461164181	N/A
12	Ferrite	FAIR-RITE	0461164181	N/A

Table 5-2: Interconnecting Cables

Cable #	Cable Type	Length	Shield	Termination
A	Twisted Pair	0.8m	No	PA to EUT
B	Twisted Pair	0.6,m	No	PA to EUT
C	Coaxial	0.5m	Yes	EUT to PA
D	Coaxial	0.23m	Yes	EUT to Duplexer
E	Coaxial	0.5m	Yes	PA to Duplexer
F	Coaxial	2.13m	Yes	EUT to GPS Antenna
G	Ground Strap	1.5m	No	EUT to Ground
H	Serial Alarm	1.3m	No	None
I	Power	1.37m	No	Power Supply to EUT
J	Ethernet	1.93m	Yes	EUT to Ethernet Switch
K	Ethernet	1.93m	Yes	EUT to Ethernet Switch
L	Power	1.48m	No	Power Supply to AC Mains
M	Power	1.83m	No	Power Supply to AC Mains

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

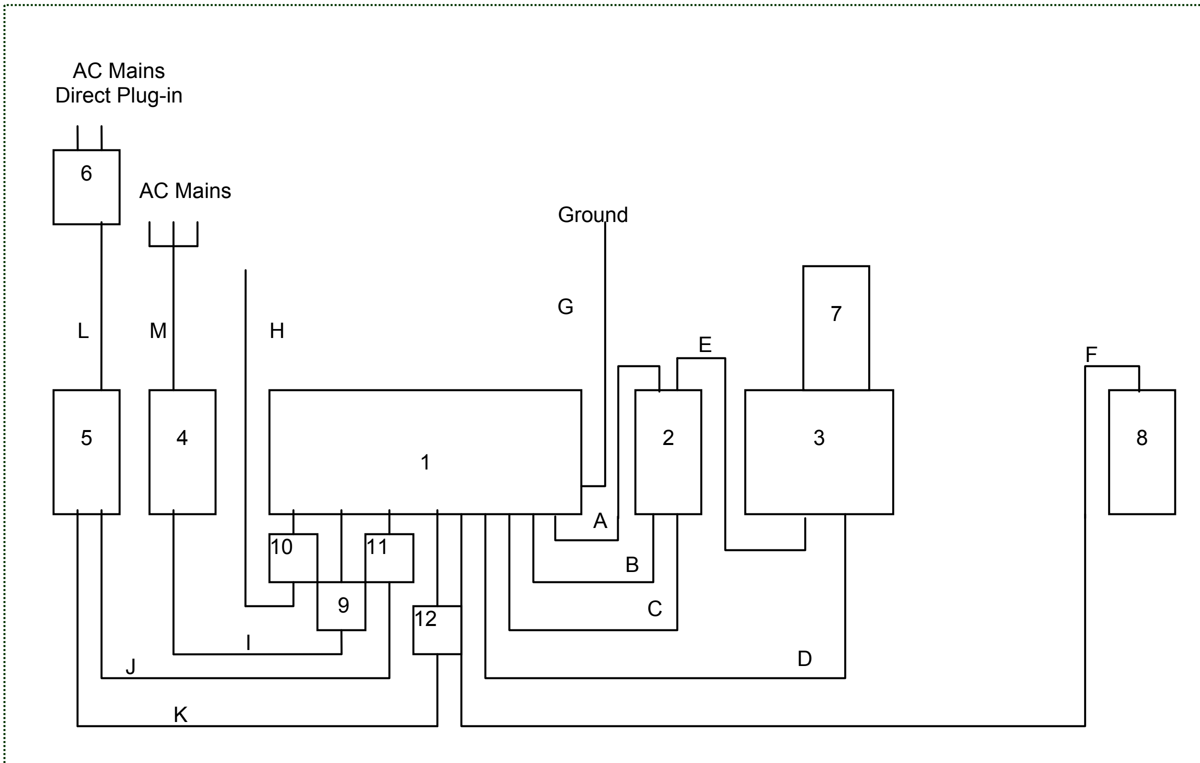


Figure 6-1: EUT Test Setup

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 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 a 35 dB passive attenuator. 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 (Low Power) (dBm)	Output Power (High Power) (dBm)
940.5	24D	29.78	38.71

Part 24.132 / RSS-134 5.4(a)

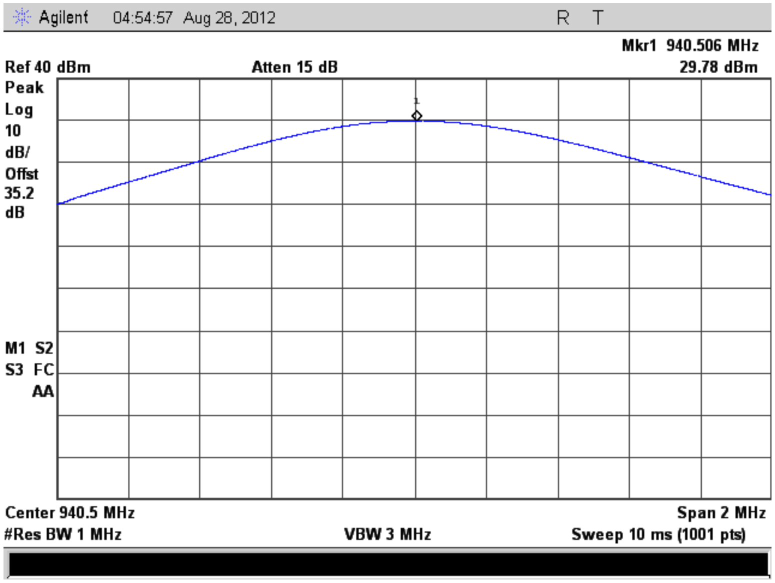


Figure 7.1.2-1: Peak Output Power 940.5 MHz (Low Power)

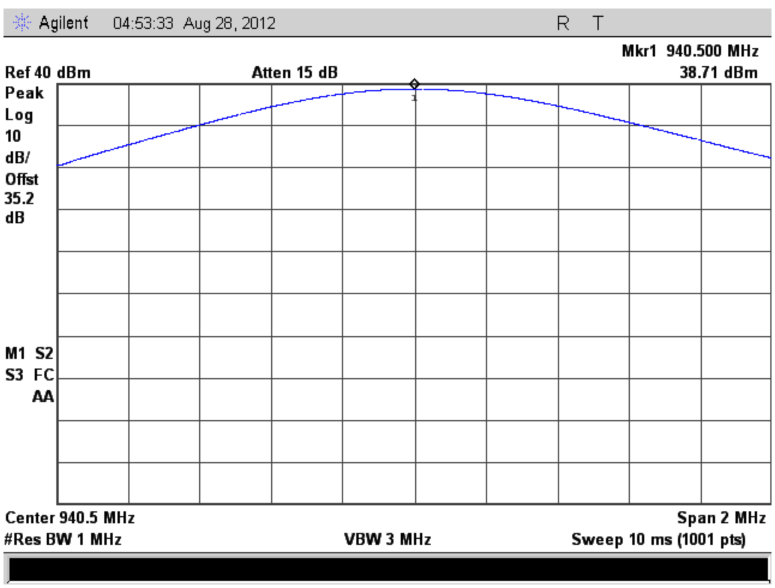


Figure 7.1.2-2: Peak Output Power 940.5 MHz (High Power)

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 a 35 dB passive attenuator. 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 24.133 a(1), a(2), IC RSS-134 6.3(i), (ii)

Low Power Results

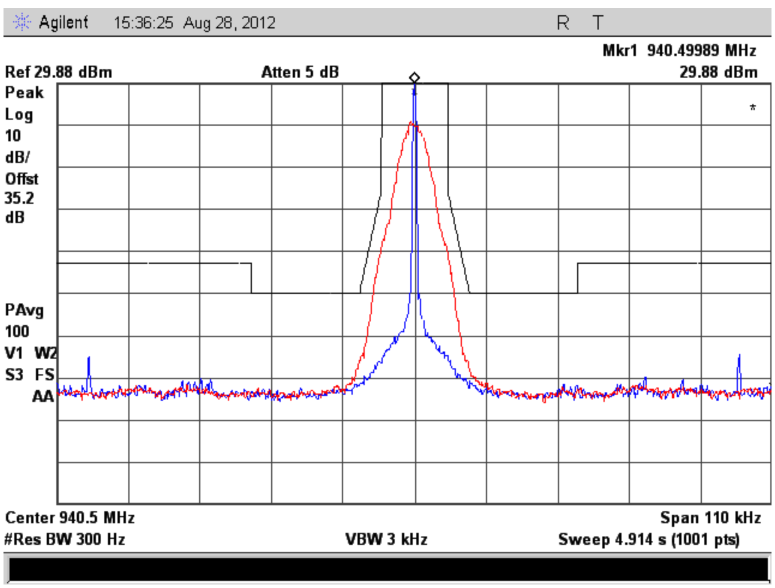


Figure 7.2.2-1: 940.5MHz – 12.5 kHz Channel Spacing – m4Pass 10k Mode

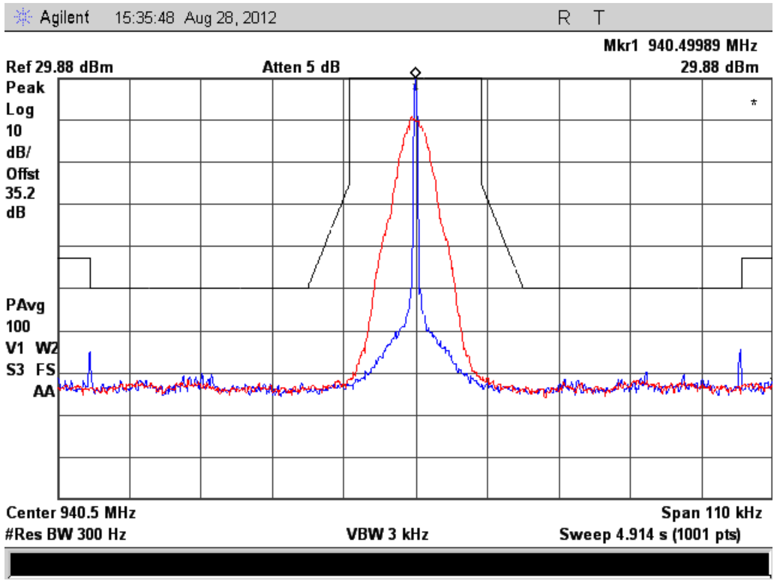


Figure 7.2.2-2: 940.5 MHz – 25 kHz Channel Spacing – m4Pass 10k Mode

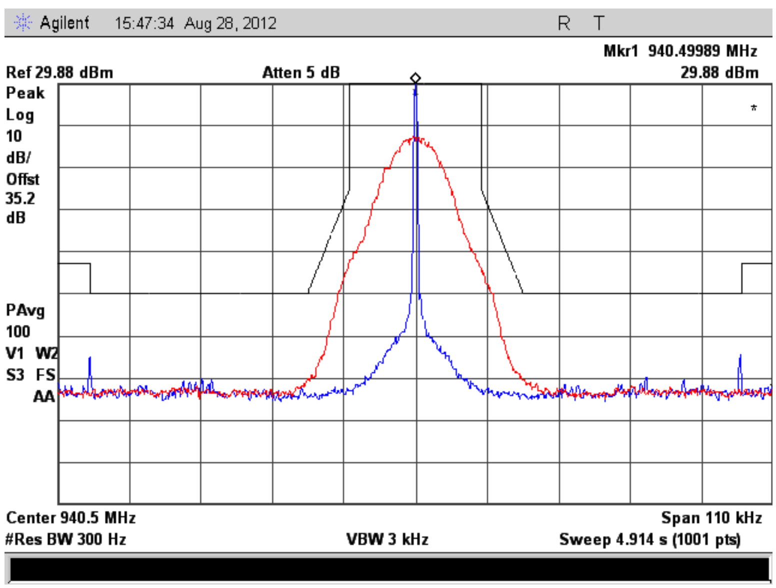


Figure 7.2.2-3: 940.5 MHz – m4Pass 20k Mode

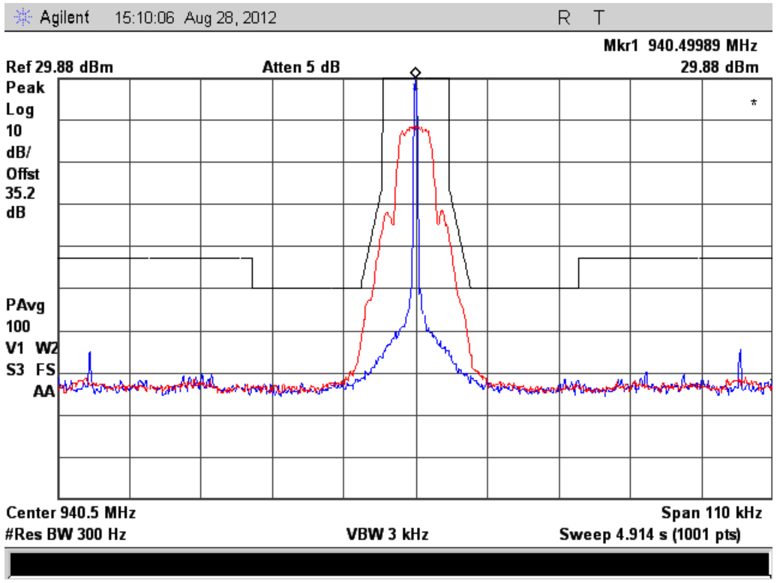


Figure 7.2.2-4: 940.5MHz – 12.5 kHz Channel Spacing – mPass 5k Mode

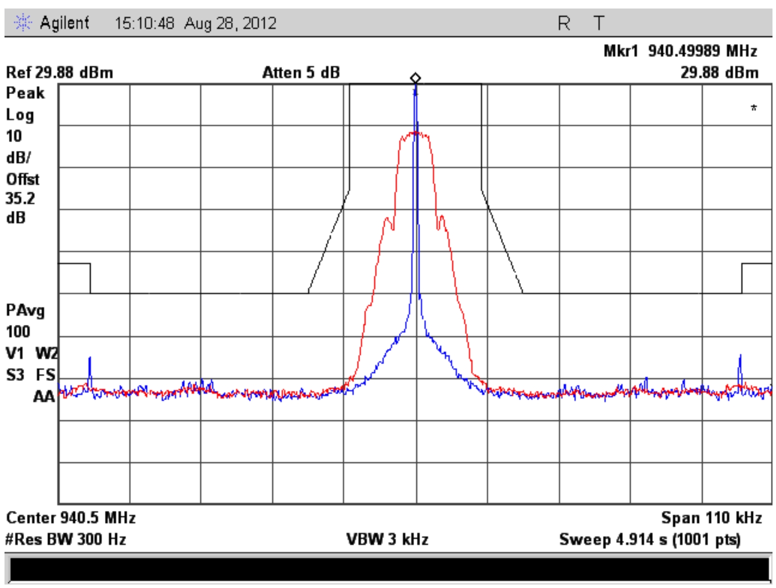


Figure 7.2.2-5: 940.5 MHz – 25 kHz Channel Spacing – mPass 5k Mode

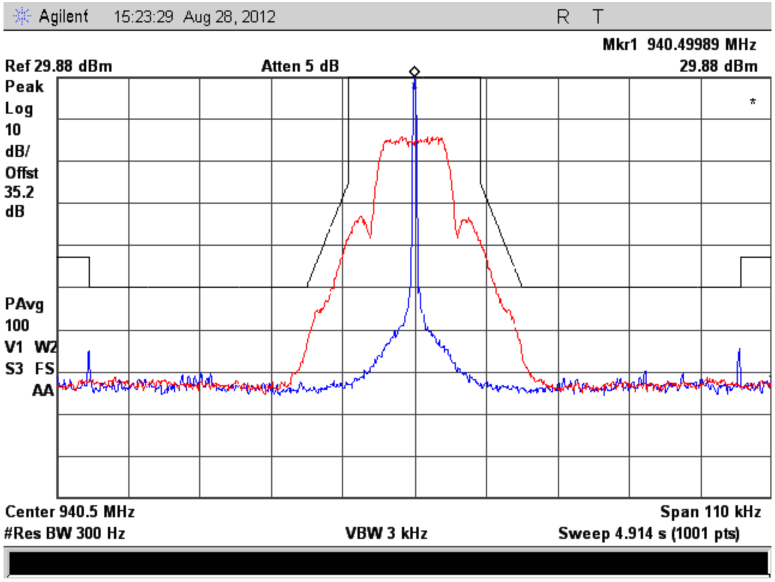


Figure 7.2.2-6: 940.5 MHz –mPass 10k Mode

High Power Results

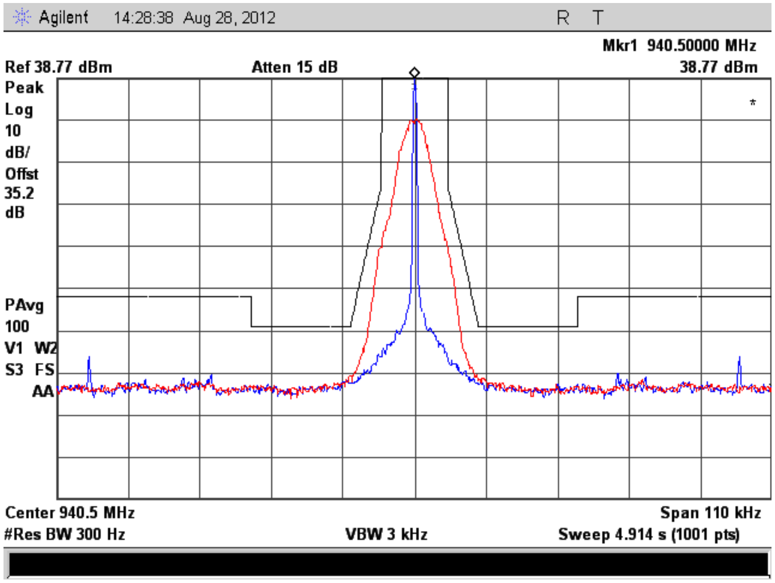


Figure 7.2.2-7: 940.5MHz – 12.5 kHz Channel Spacing – m4Pass 10k Mode

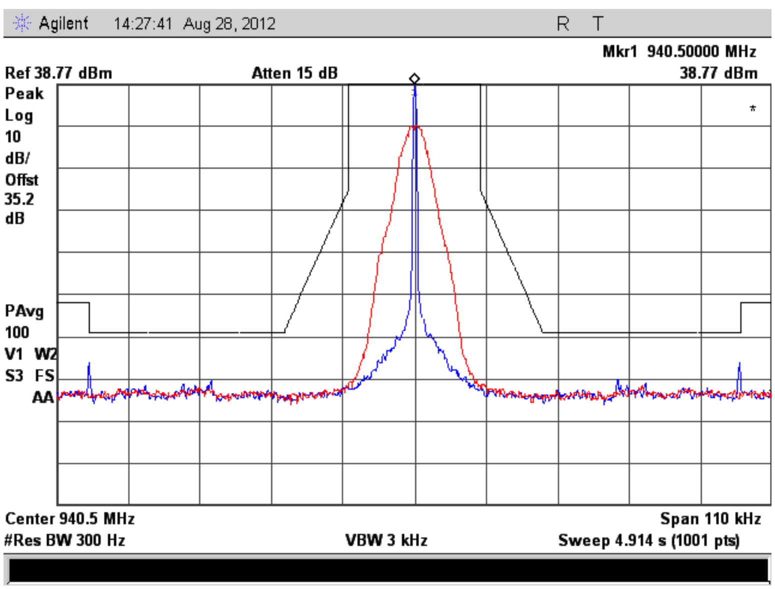


Figure 7.2.2-8: 940.5 MHz – 25 kHz Channel Spacing – m4Pass 10k Mode

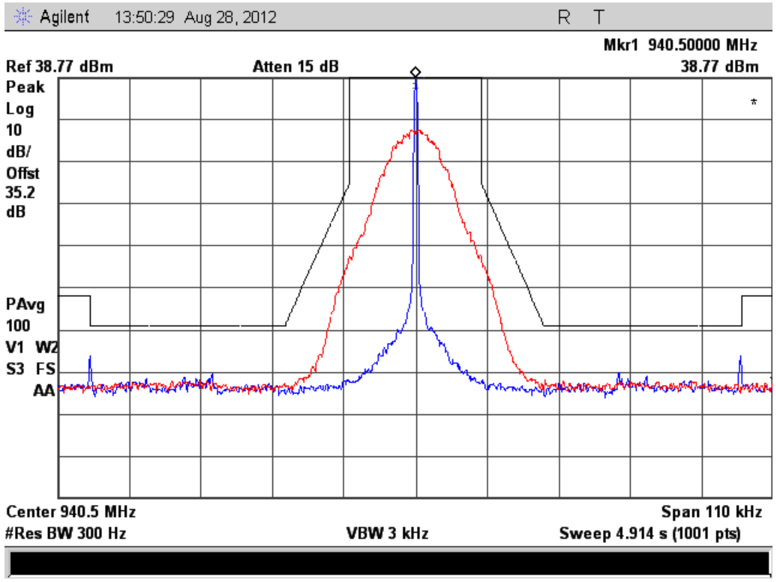


Figure 7.2.2-9: 940.5 MHz – m4Pass 20k Mode

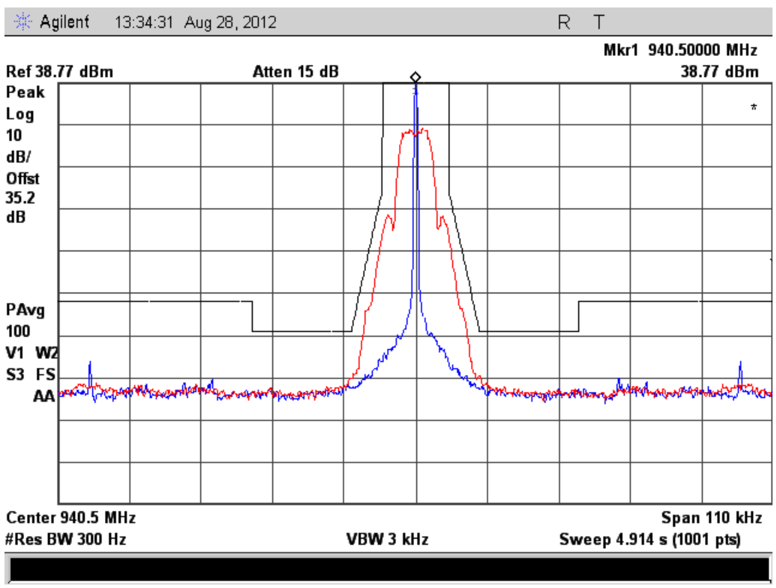


Figure 7.2.2-10: 940.5MHz – 12.5 kHz Channel Spacing – mPass 5k Mode

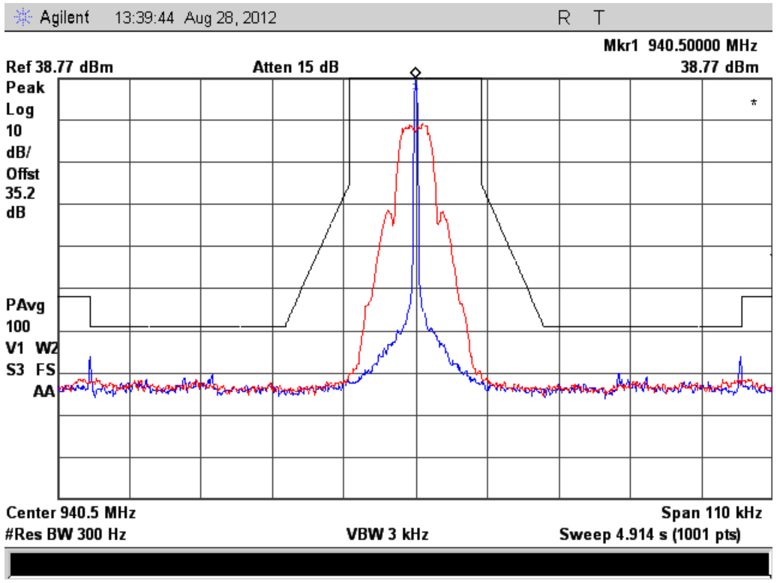


Figure 7.2.2-11: 940.5 MHz – 25 kHz Channel Spacing – mPass 5k Mode

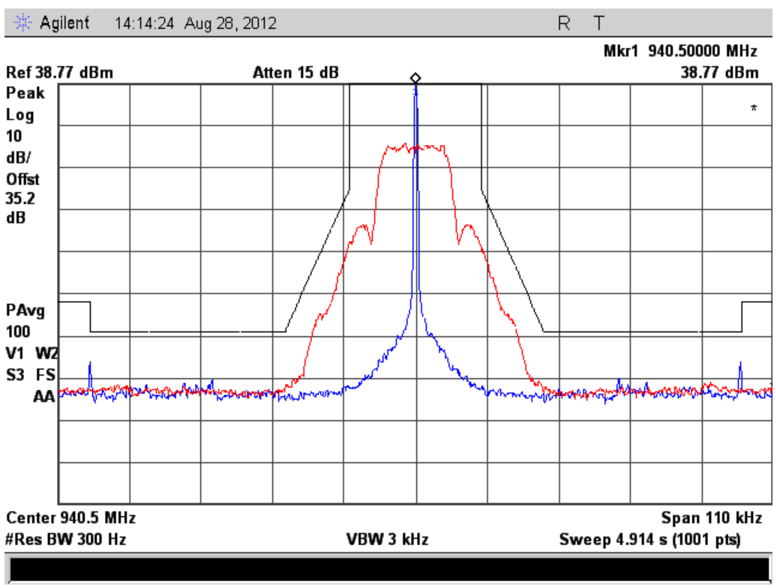


Figure 7.2.2-12: 940.5 MHz –mPass 10k Mode

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 a 35 dB passive attenuator. 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 24.133 a(1), a(2), IC RSS-134 6.3(i), (ii)

Low Power Results

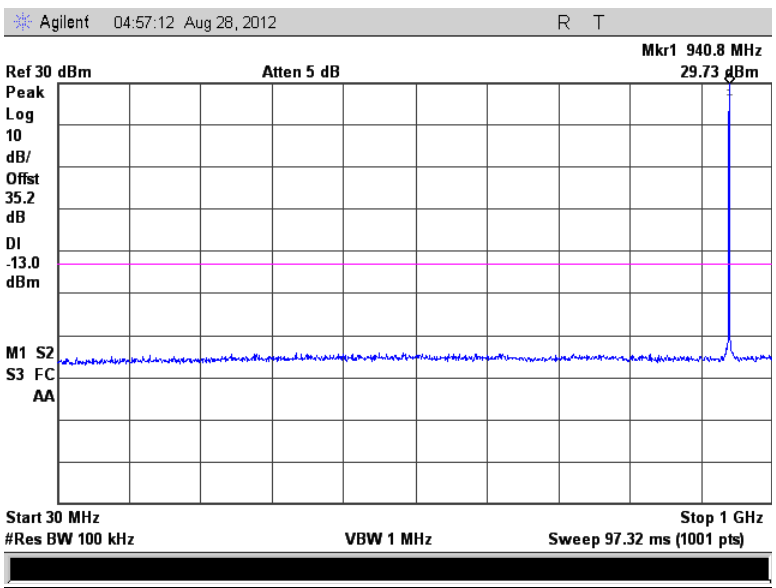


Figure 7.3.2-1: 940.5 MHz – 30MHz to 1GHz

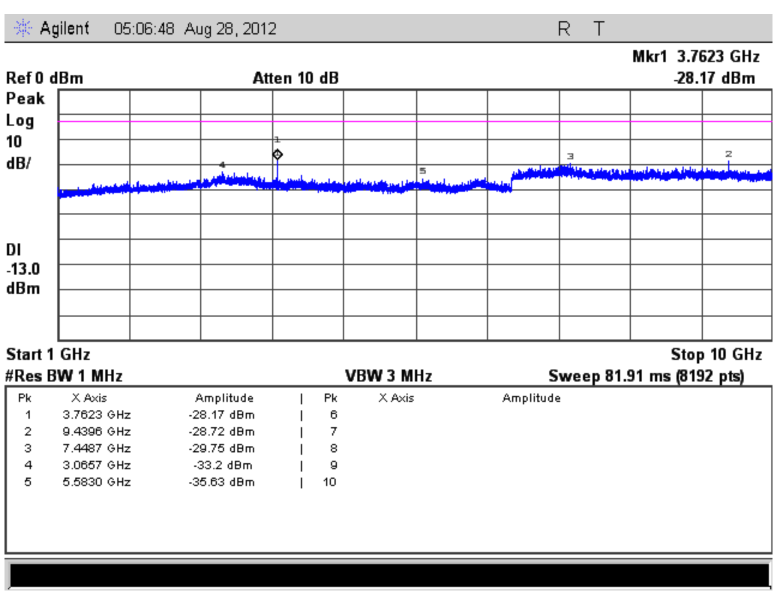


Figure 7.3.2-2: 940.5 MHz – 1GHz to 10GHz

High Power Results

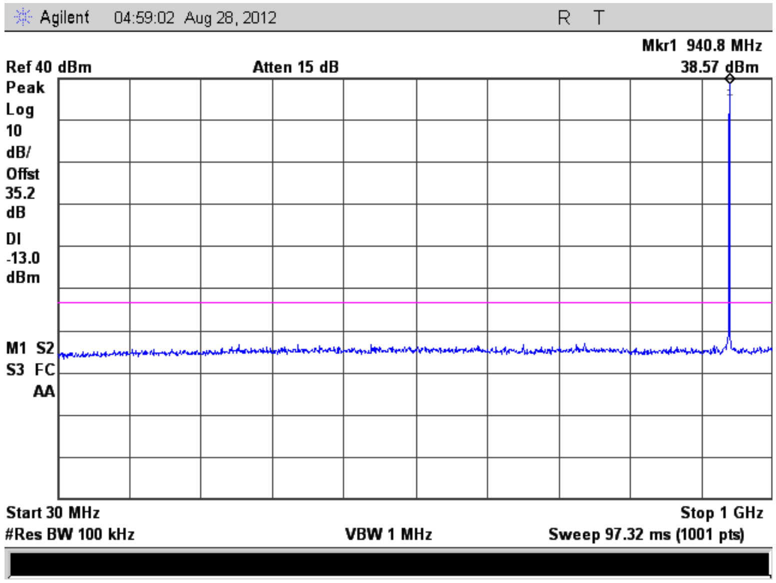
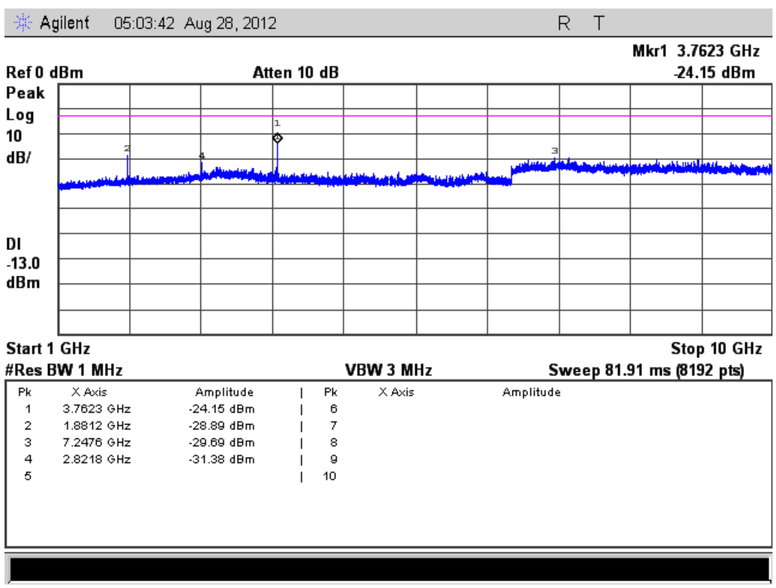


Figure 7.3.2-3: 940.5 MHz – 30MHz to 1GHz



Pk	X Axis	Amplitude	Pk	X Axis	Amplitude
1	3.7623 GHz	-24.15 dBm	6		
2	1.8812 GHz	-28.89 dBm	7		
3	7.2476 GHz	-29.69 dBm	8		
4	2.8218 GHz	-31.38 dBm	9		
5			10		

Figure 7.3.2-4: 940.5 MHz – 1GHz to 10GHz

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 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 24.133 a(1), a(2), RSS-134 6.3(i), (ii)

Table 7.4.2-1: Field Strength of Spurious Emissions – 940.5 MHz – Low Power

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1881	-36.00	H	-33.62	-13.00	20.62
2821.5	-38.90	H	-31.99	-13.00	18.99
3762	-43.05	H	-32.54	-13.00	19.54
4702.5	-46.55	H	-32.17	-13.00	19.17
5643	-53.65	H	-36.78	-13.00	23.78
6583.5	-55.35	H	-38.73	-13.00	25.73
1881	-36.35	V	-33.62	-13.00	20.62
2821.5	-37.40	V	-30.29	-13.00	17.29
3762	-37.55	V	-23.54	-13.00	10.54
4702.5	-44.90	V	-30.02	-13.00	17.02
5643	-45.45	V	-27.58	-13.00	14.58
6583.5	-52.50	V	-33.38	-13.00	20.38
7524	-56.30	V	-40.80	-13.00	27.80
8464.5	-55.95	V	-38.72	-13.00	25.72

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

Table 7.4.2-2: Field Strength of Spurious Emissions – 940.5 MHz – High Power

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1881	-33.50	H	-31.07	-13.00	18.07
2821.5	-34.70	H	-27.44	-13.00	14.44
3762	-38.85	H	-27.24	-13.00	14.24
4702.5	-43.85	H	-28.77	-13.00	15.77
5643	-50.25	H	-32.63	-13.00	19.63
6583.5	-56.45	H	-43.43	-13.00	30.43
1881	-34.35	V	-31.57	-13.00	18.57
2821.5	-34.50	V	-26.89	-13.00	13.89
3762	-32.95	V	-18.99	-13.00	5.99
4702.5	-43.50	V	-28.57	-13.00	15.57
5643	-41.15	V	-22.78	-13.00	9.78
6583.5	-53.70	V	-35.93	-13.00	22.93
7524	-57.20	V	-44.95	-13.00	31.95
8464.5	-57.50	V	-45.42	-13.00	32.42

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 EUT endpoint voltages. The maximum variation of frequency was recorded.

Results of the test are shown below.

7.5.2 Measurement Results

Part 24.135, RSS-134 (7)

Frequency Stability

Frequency (MHz): 940.5

Frequency MHz	Frequency Error (PPM)	Voltage (%)	Voltage (VDC)
940.499622	**-0.402**	100%	24.00
940.499819	**-0.192**	100%	24.00
940.500259	**0.275**	100%	24.00
940.500197	**0.209**	100%	24.00
940.500134	**0.142**	100%	24.00
940.499913	**-0.093**	100%	24.00
940.500120	**0.128**	100%	24.00
940.500042	**0.045**	100%	24.00
940.499891	**-0.116**	100%	24.00
940.499918	**-0.087**	85%	20.40
940.499910	**-0.096**	115%	27.60

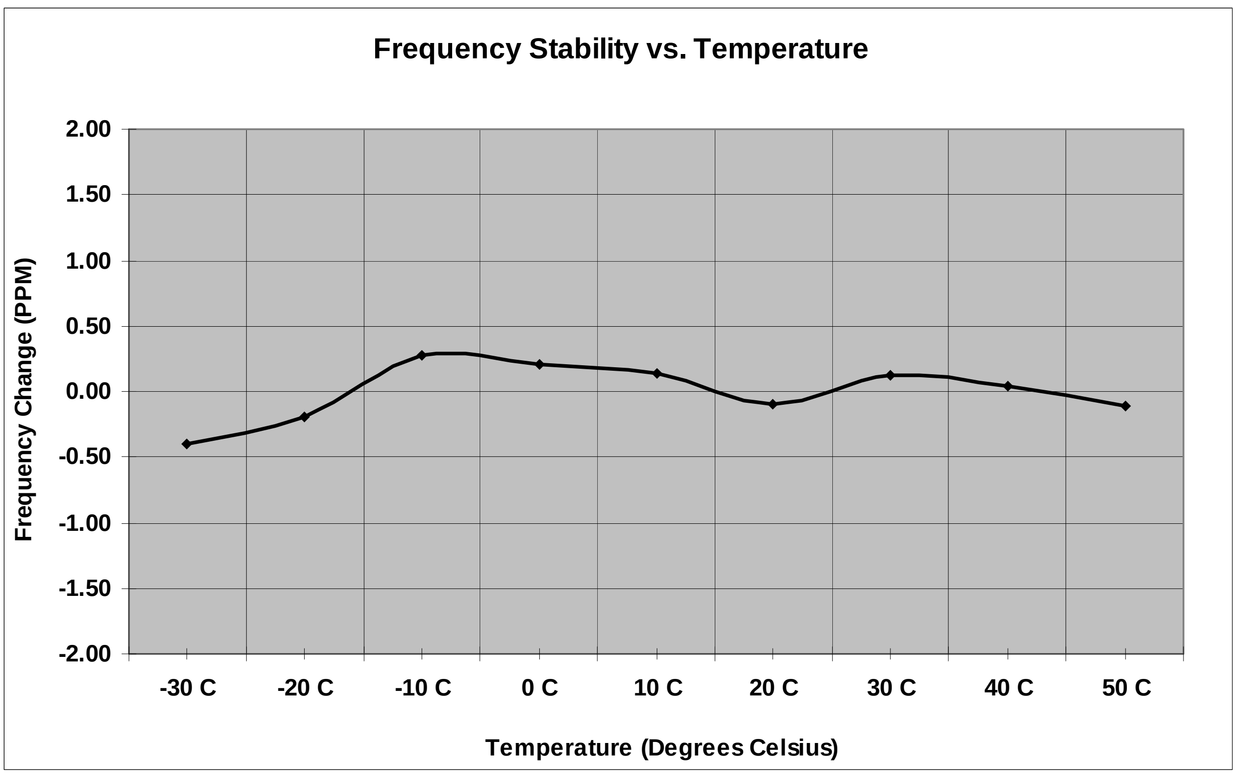


Figure 7.5.2-1: Frequency Stability – 940.5 MHz

8.0 CONCLUSION

In the opinion of ACS, Inc. the model M400XCVR-01, manufactured by Sensus Metering Systems, Inc., meets all the requirements of FCC Part 24D as well as Industry Canada RSS-134 where applicable.

End Report