Transmitter Certification

<u>Test Report</u>

FCC ID: SDBTXCVRBB01

FCC Rule Part: CFR 47 Part 24 Subpart D, Part 90 Subpart I, Part 101 Subpart C

ACS Report Number: 07-0226-LD

Applicant: Sensus Metering Systems
Model: TXCVRBB01

Test Begin Date: May 31, 2007
Test End Date: June 11, 2007

Report Issue Date: June 14, 2007

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.

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This report contains <u>41</u> pages

Table of Content

Additional Exhibits Included In Filing

Internal Photographs
Tune-up Procedure
Product Labeling
Installation/Users Guide
Theory of Operation
Schematics
External Photographs
Test Setup Photographs
RF Exposure – MPE Calculations
System Block Diagram
Parts List

1.0 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 2 Subpart J, Part 24 Subpart D, Part 90 Subpart I, and Part 101 Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

Manufacturer:
Sensus Metering Systems
8601 six forks Road
Raleigh, NC 27615

Factory Contact:
Bob Davis
Sensus Metering Systems
114 Northpark Blvd
Suite 10
Covington, LA 70433
985-773-1236

The transceiver is utilized as a repeater in SMS's fixed based wireless communication network. It performs two way communications between electric, gas, and water endpoints and the corresponding base stations. The transceiver communicates within the network by one of four proprietary modulation techniques.

The TXCVRBB01 utilizes a printed circuit board for mobile applications and can be modified with an external antenna connector for use with higher gain external fixed antennas. For use with an external antenna the integral antenna is disconnected and a 50-Ohm cable is soldered (with the appropriate ground connection) to the PCB.

The two PCB variations tested (integral PCB antenna, modified with external antenna connector) and of which the test data is included in this report are identified by the following serial numbers:

07010080026 (PCB antenna)
07010080029 (External antenna connector)

1.3 Test Methodology

1.3.1 In-Band Testing Methodology

For testing in accordance with 47 CFR 2.1046-2.1057, OET/Lab recommends that the following be used to select test frequencies for licensed devices:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
10 to 100 MHz	3	1 near top, 1 near middle and 1 near bottom

The TXCVRBB01 is designed to operate in multiple bands under the requirements of CFR 47 Parts 24, 90, and 101. The following is a list of the frequency bands of operation sorted based on the FCC rule parts in which the band is associated.

CFR Title 47 Rule Part	Frequency Band of Operation (MHz)
24D	901.0 - 902.0
24D	930.0 - 931.0
24D	940.0 - 941.0
90	896.0375 - 901.0
90	935.0 - 940.0
101	928.85 - 929.0
101	932.0 - 932.5
101	941.0 - 941.5
101	959.85 - 960.0

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.

<table>
<tr><th>CFR Title 47 Rule Part</th><th>Frequency Band of Operation (MHz)</th><th>Location in the Range of Operation</th></tr>
<tr><td>90</td><td>896.0375 - 901.0</td><td rowspan="2">1 near top and 1 near bottom</td></tr>
<tr><td>24D</td><td>901.0 - 902.0</td></tr>
<tr><td>101</td><td>928.85 - 929.0</td><td>Middle</td></tr>
<tr><td>24D</td><td>930.0 - 931.0</td><td>Middle</td></tr>
<tr><td>101</td><td>932.0 - 932.5</td><td>Middle</td></tr>
<tr><td>90</td><td>935.0 - 940.0</td><td rowspan="3">1 near top and 1 near bottom</td></tr>
<tr><td>24D</td><td>940.0 - 941.0</td></tr>
<tr><td>101</td><td>941.0 - 941.5</td></tr>
<tr><td>101</td><td>959.85 - 960.0</td><td>Middle</td></tr>
</table>

The data provided in this report is sorted based on the rule part.

1.3.2 Test Configurations

The TXCVRBB01 is a module designed to be integrated into a host device therefore testing was performed on the module in a stand-alone configuration. The module was tested with a 50 Ohm non-radiating load at the RF output for intentional radiated emissions and RF conducted measurements from the transmitter. For unintentional radiated emissions and AC power line conducted emissions the TXCVRBB01 was tested with two antenna types and the worst case data provided in this report. The antennas used in testing include the following:

Integral PCB printed monopole with a gain of 0 dBi.
External Scala OGB9-900 Omnidirectional with a gain of 11dBi.

1.4 Emission Designators

The TXCVRBB01 transmitter produces four distinct modulation formats. The necessary bandwidth calculations for these formats may be found in a separate document.

The emissions designators for the four modulation types used by the TXCVRBB01 transmitter are as follows:

EMISSIONS DESIGNATORS:
Normal Mode: 9K60F2D
Half-Baudrate Mode: 4K80F2D
Boost Mode: 1K10F2D
MPass Mode: 5K90F1D

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: 200612-0

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:

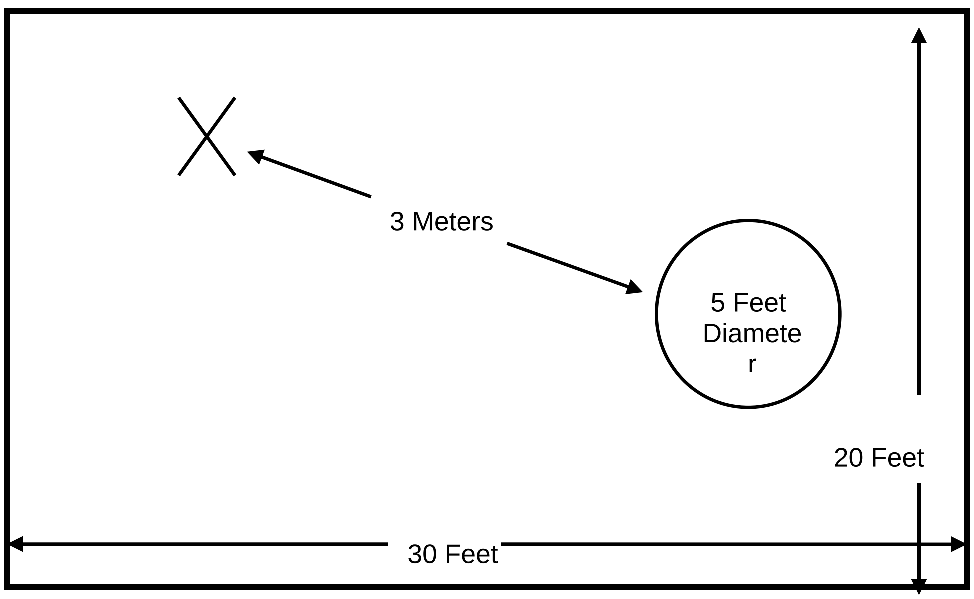

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

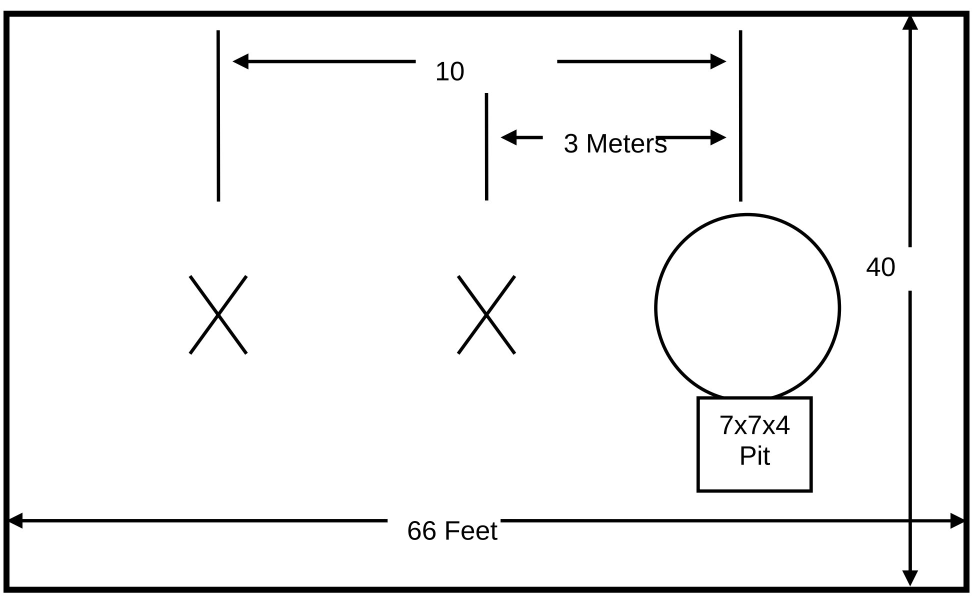

Figure 2.3-2: Open Area Test Site

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:

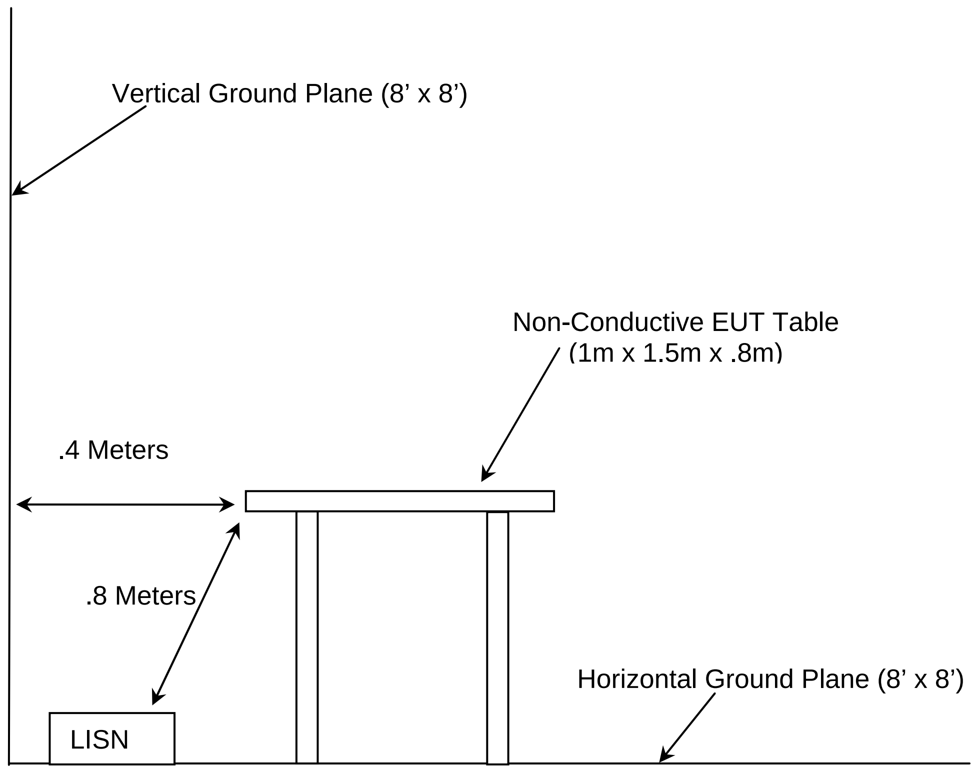

Figure 2.4-1: AC Mains Conducted EMI Site

3.0 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 9KHz to 40GHz - 2003
2 -US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures - 2006
3 - US Code of Federal Regulations (CFR): Title 47, Part 24, Subpart D: Personal Communication Service - 2006
4 - US Code of Federal Regulations (CFR): Title 47, Part 90, Subpart I: Private Land Mobile Radio Services - 2006
5 - US Code of Federal Regulations (CFR): Title 47, Part 101, Subpart C: Fixed Microwave Services – 2006
6 – TIA-603-C: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards - 2004

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4-1: Test Equipment

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
25	Chase	Bi-Log Antenna	CBL6111	1043	6/5/08
22	Agilent	Pre-Amplifier	8449B	3008A00526	4/10/08
321	Agilent	Pre-Amplifier	8447D	1937A02809	7/27/07
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	5/10/08
---	A.H. Systems	Horn Antenna	SAS-571	721	8/24/07
105	Microwave Circuits	High Pass Filter	H3G020G4	74541DC0608	3/5/08
3	Rohde & Schwarz	Receiver Display	804.8932.52	839379/011	3/5/08
4	Rohde & Schwarz	ESMI Receiver	1032.5640.53	833827/003	3/5/08
283	Rohde & Schwarz	Spectrum Analyzer	FSP	100033	11/9/08
140	Thermotron	Environmental Chamber	SM-16C	19639	8/30/07
290	Florida RF Labs	HF RF Cable	SMSE-200-72.0-SMRE	NA	5/15/08
291	Florida RF Labs	HF RF Cable	SMRE-200W-12.0-SMRE	NA	5/15/08
292	Florida RF Labs	HF RF Cable	SMR-280AW-480.0-SMR	NA	5/25/08
167	ACS	Chamber EMI Cable Set	RG6	167	1/5/08
237	Gigatronics	Signal Generator	1018	315110	4/16/08
---	Agilent	Signal Generator	E4438C	MY45082439	4/9/08

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Diagram #	Manufacturer	Equipment Type	Model Number	Serial Number	FCC ID
1	Sensus	EUT	TXCVRBB01	See Section 1.2	SBDTXCVRBB01
2	CUI Inc	AC Adapter	KSAFD1200125 W1US	R3206	None

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

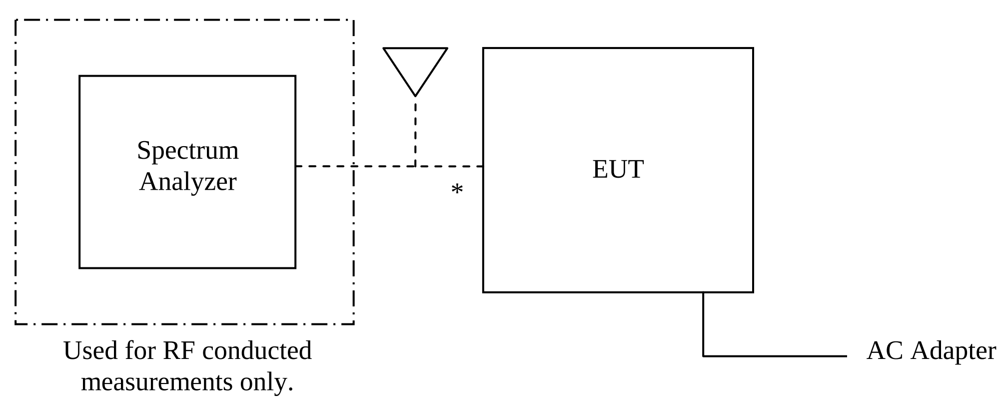

Figure 6-1: EUT Test Setup

* The TXCVRBB01 Transmitter utilizes both a printed antenna integral to the transmitter PCB and external antennas for normal operation. For use with an external antenna the integral antenna is disconnected and a 50-Ohm cable is soldered (with the appropriate ground connection) to the PCB.

For RF conducted and transmitter radiated spurious emissions measurements, the TXCVRBB01 was configured with the external RF connector to the PCB. The EUT 50-Ohm cable was connected to non-radiating 50 Ohm load for transmitter radiated measurements and terminated into a spectrum analyzer for RF conducted measurements.

For unintentional radiated emissions and AC power line conducted measurements both the integral antenna and external antenna configurations were evaluated for all antenna types.

*See Test Setup photographs for additional detail.

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 RF Power Output - FCC Section 2.1046

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 20 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 in Table 7.1.2-1 and Figure 7.1.2-1 through 7.1.2-8.

7.1.2 Measurement Results

Table 7.1.2-1: Peak Output Power

Frequency (MHz)	FCC Rule Part	Output Power (dBm)
901.9875	Part 24	30.38
930.5000	Part 24	30.27
896.0375	Part 90	30.18
935.0125	Part 90	30.09
928.9250	Part 101	30.14
932.2500	Part 101	30.11
941.4875	Part 101	29.88
959.9250	Part 101	29.34

Part 24

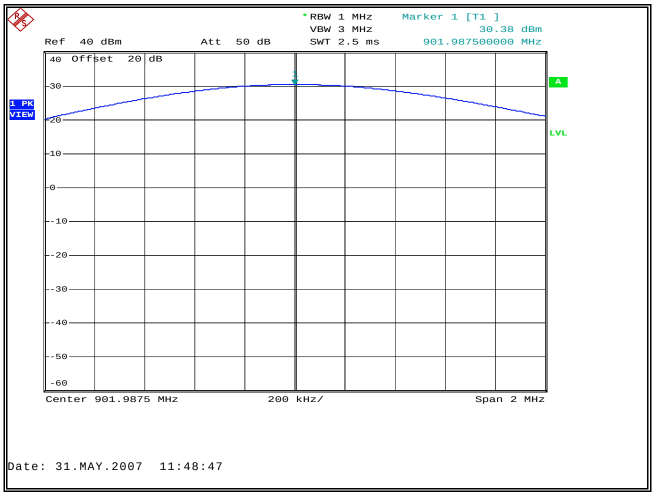

Figure 7.1.2-1: Peak Output Power 901.9875 MHz

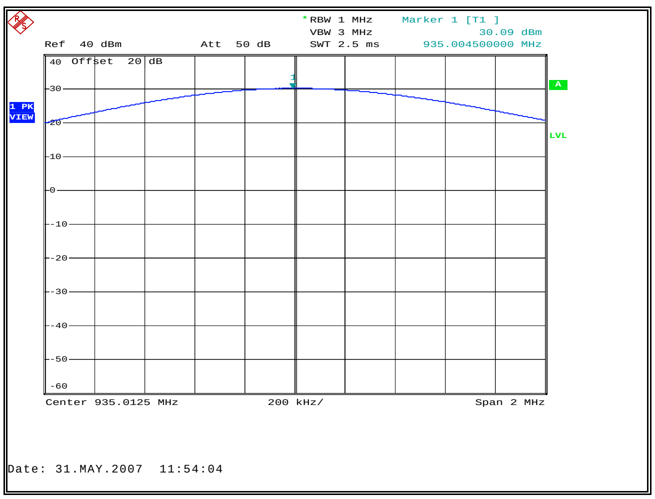

Figure 7.1.2-2: Peak Output Power 930.5 MHz

Part 90

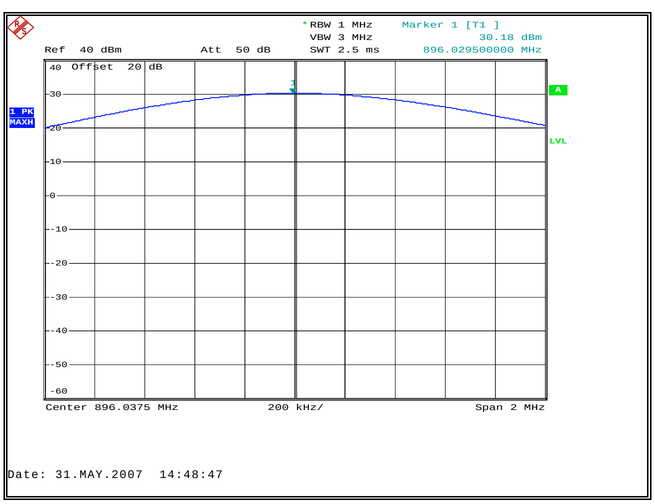

Figure 7.1.2-3: Peak Output Power 896.0375 MHz

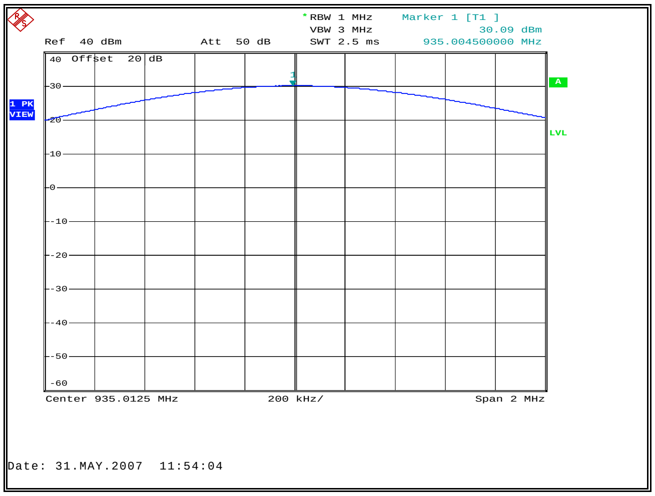

Figure 7.1.2-4: Peak Output Power 935.0125 MHz

Part 101

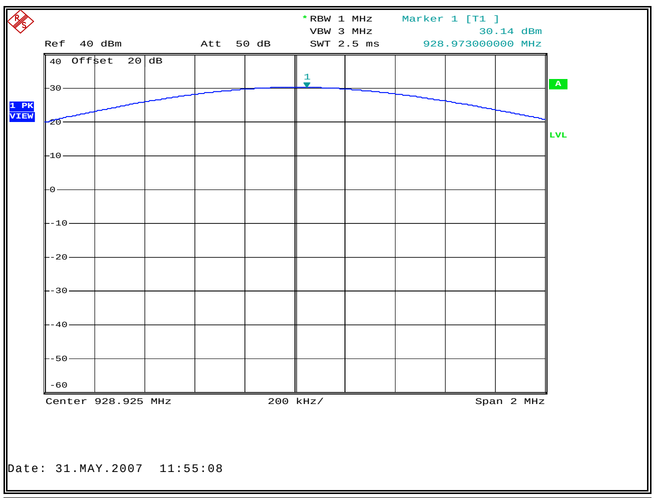

Figure 7.1.2-5: Peak Output Power 928.925 MHz

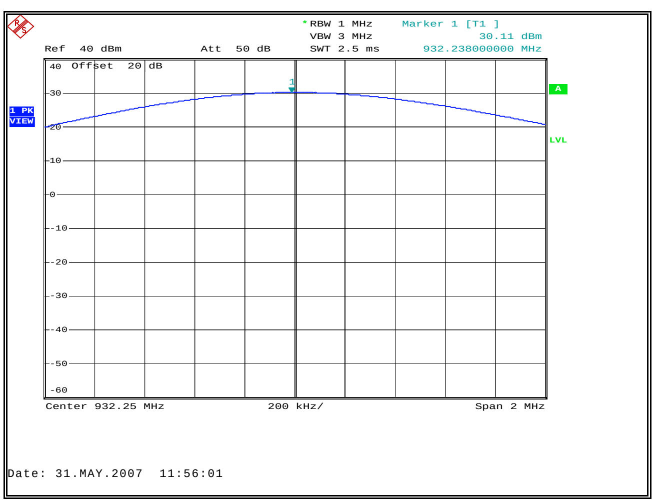

Figure 7.1.2-6: Peak Output Power 932.25 MHz

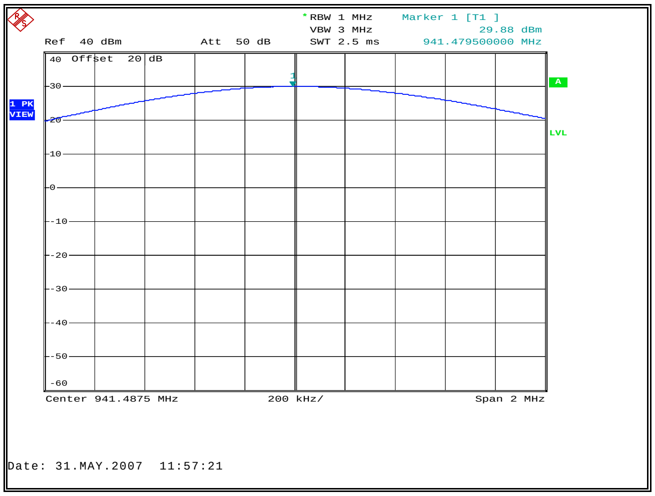

Figure 7.1.2-7: Peak Output Power 941.4875 MHz

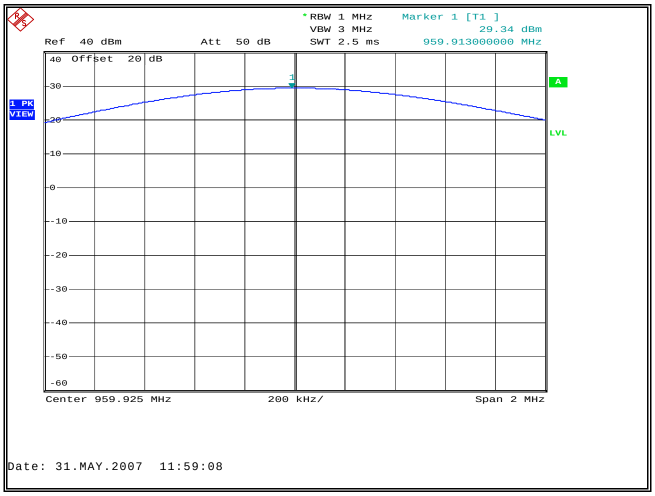

Figure 7.1.2-8: Peak Output Power 959.925 MHz

7.2 Occupied Bandwidth (Emission Limits) - FCC Section 2.1049

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 20 dB passive attenuator. The spectrum analyzer resolution and video bandwidths were set to 300 Hz. 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)

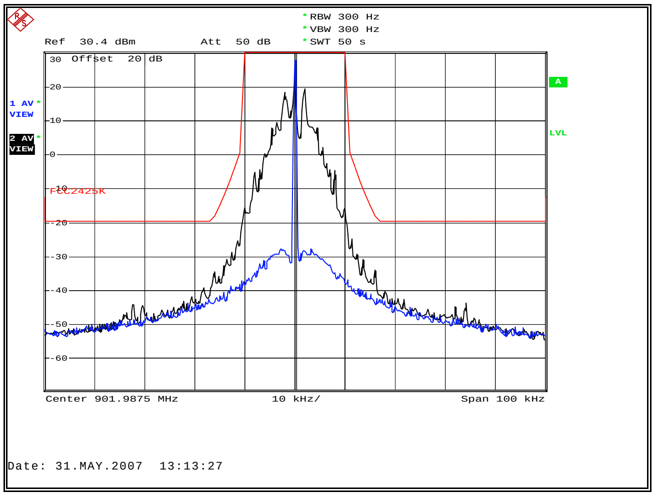

Figure 7.2.2-1: Normal Mode – 901.9875 MHz – 25 kHz Channel

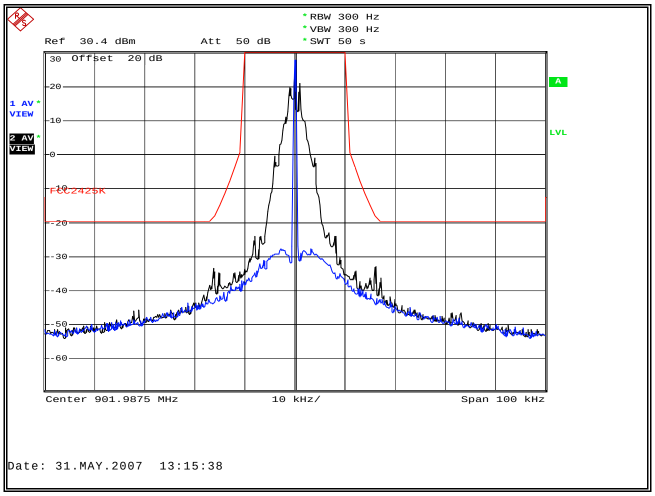

Figure 7.2.2-2: Half-Baud Rate Mode – 901.9875 MHz – 25 kHz Channel

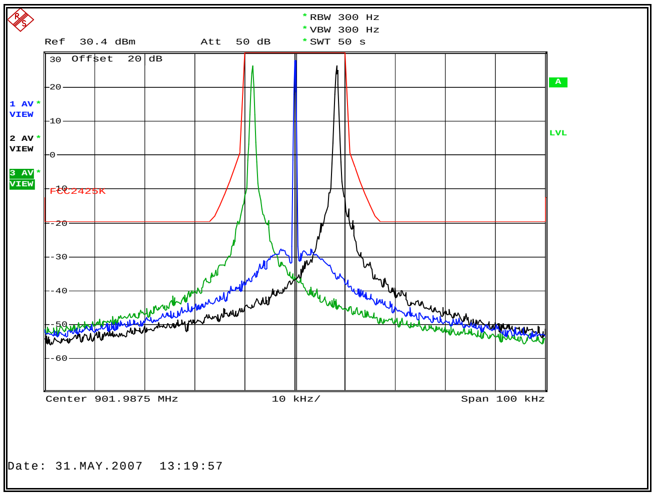

Figure 7.2.2-3: Boost Mode – 901.9875 MHz – 25 kHz Channel Offset Channel of +/- 14 (+/- 8400 Hz)

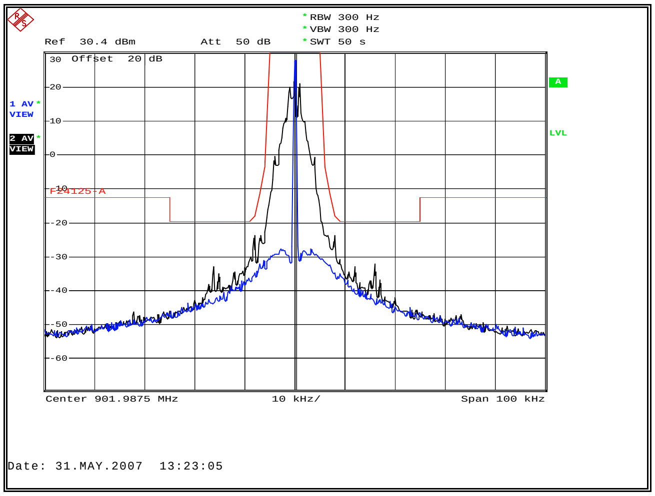

Figure 7.2.2-4: Half-Baud Rate – 901.9875 MHz – 12.5 kHz Channel

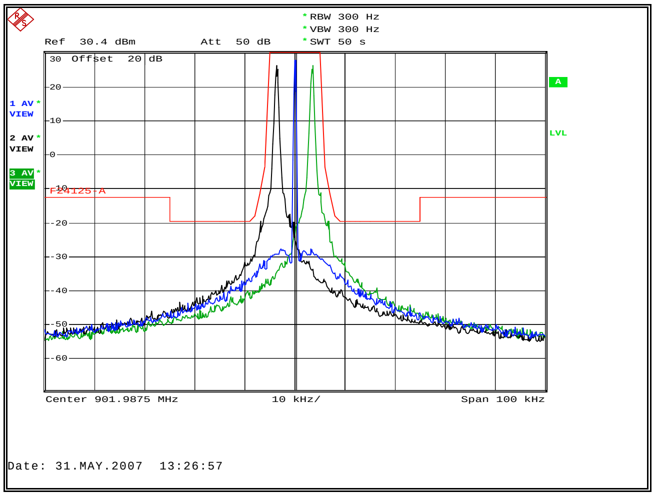

Figure 7.2.2-5: Boost Mode – 901.9875 MHz – 12.5 kHz Channel Offset Channel of +/- 6 (+/- 3600 Hz)

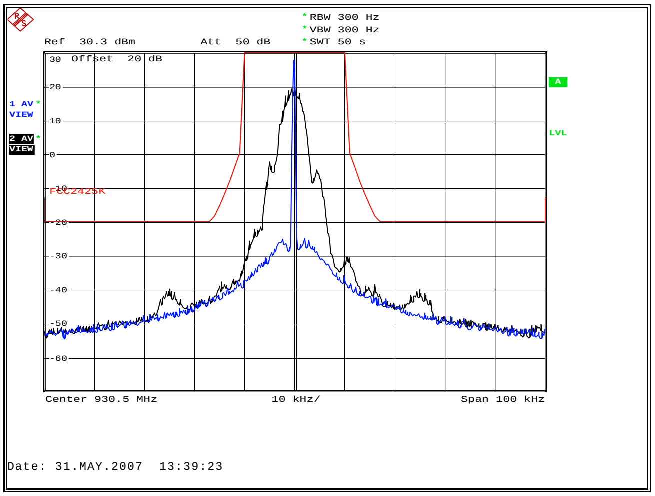

Figure 7.2.2-6: MPass Mode – 930.5 MHz – 25 kHz Channel

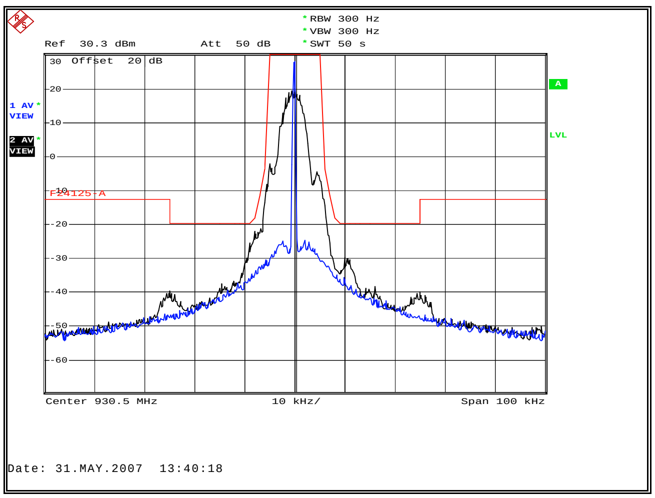

Figure 7.2.2-7: MPass Mode – 930.5 MHz – 12.5 kHz Channel

7.2.3 Measurement Results – Part 90.210 (j)

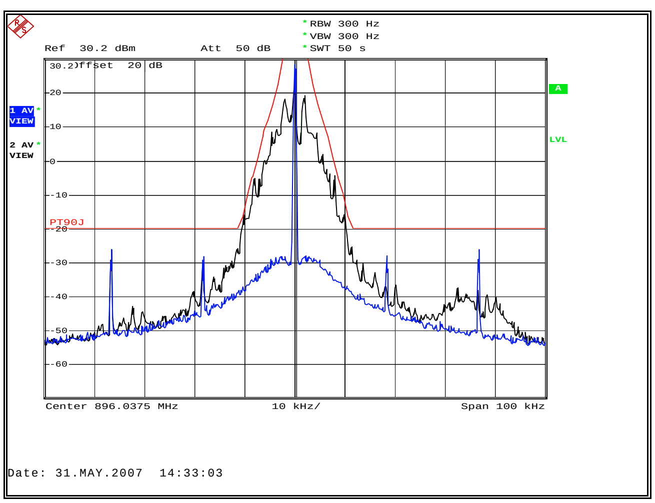

Figure 7.2.3-1: Normal Mode – 896.0375 MHz

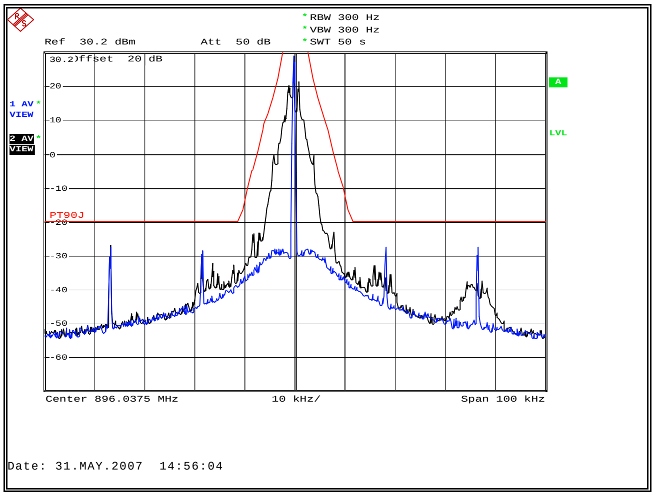

Figure 7.2.3-2: Half-Baud Rate Mode – 896.0375 MHz

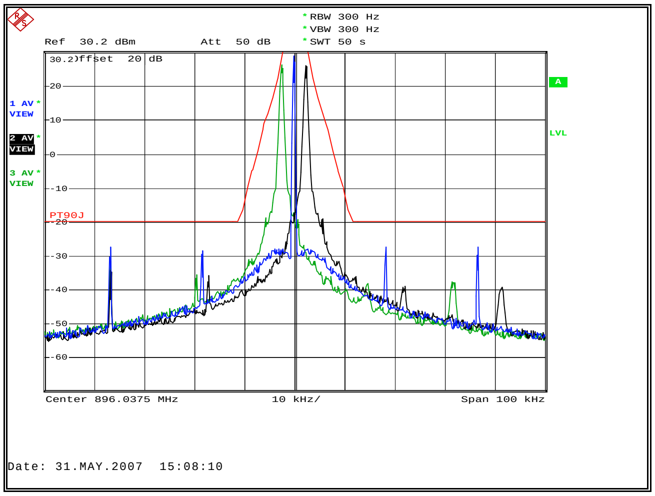

Figure 7.2.3-3: Boost Mode – 896.0375 MHz
Offset Channel of +/- 4 (+/- 2400 Hz)

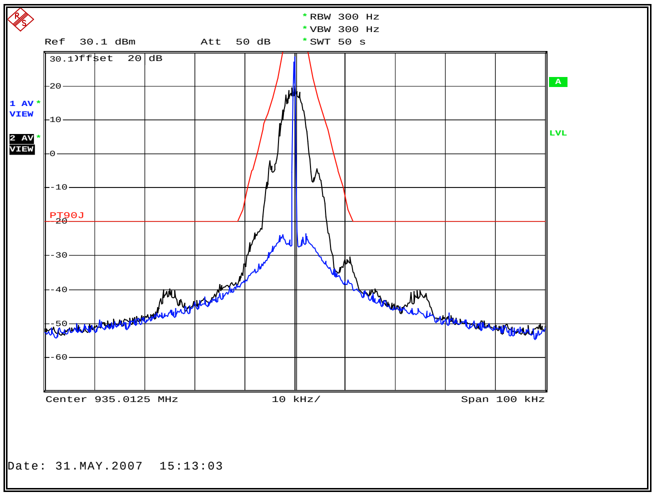

Figure 7.2.3-4: MPass Mode – 935.0125 MHz

7.2.4 <u>Measurement Results</u> – Part 101.111 a(6)

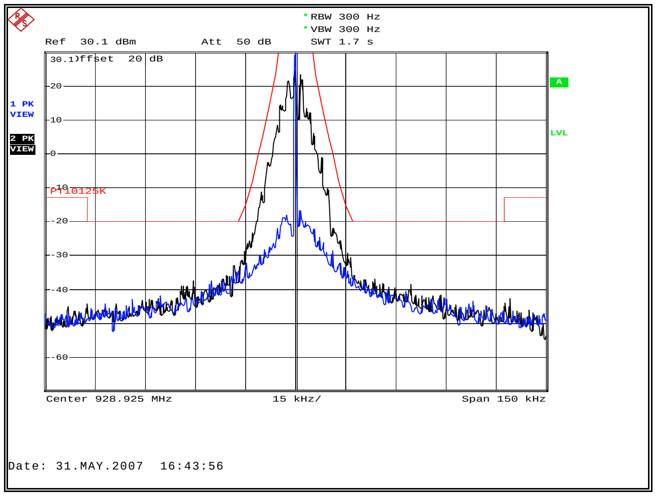

Figure 7.2.4-1: Normal Mode – 928.925 MHz

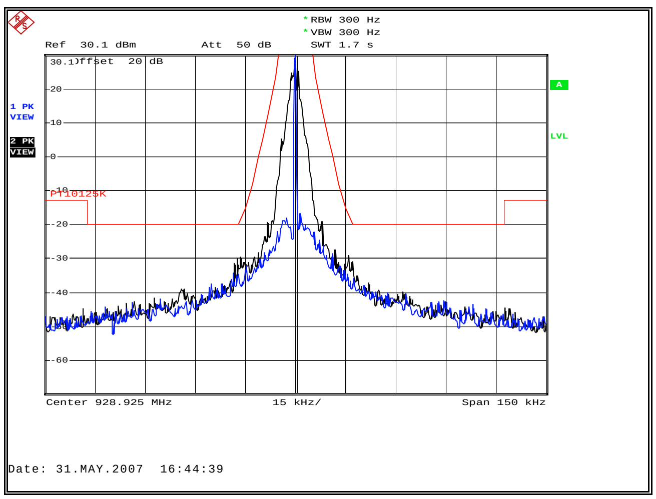

Figure 7.2.4-2: Half-Baud Rate Mode – 928.925 MHz

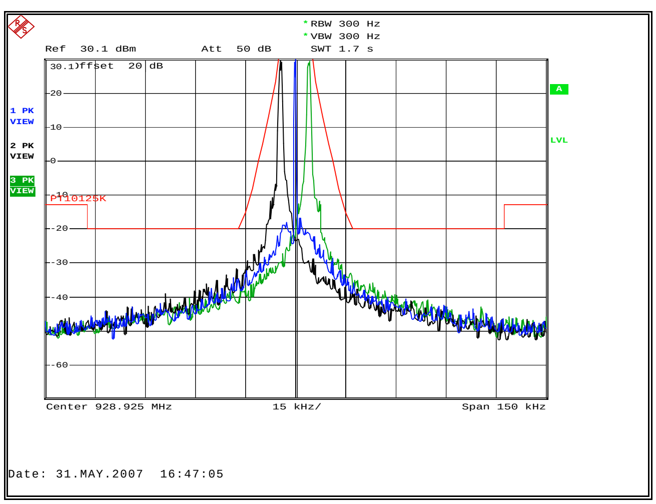

Figure 7.2.4-3: Boost Mode – 928.925 MHz
Offset Channel of +/- 7 (+/- 4200 Hz)

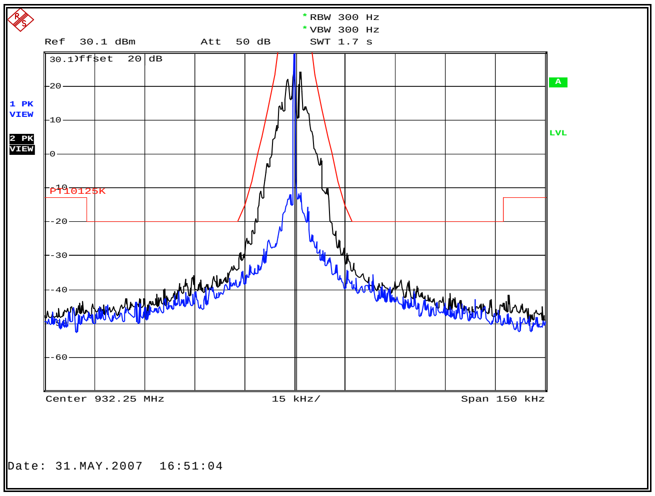

Figure 7.2.4-4: Normal Mode – 932.25 MHz

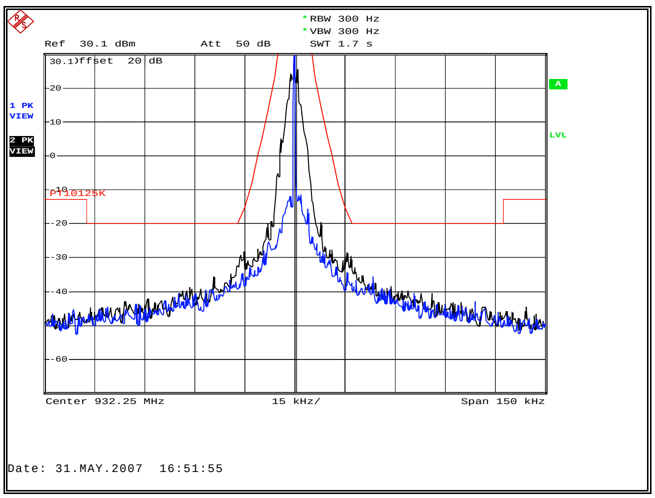

Figure 7.2.4-5: Half-Baud Rate Mode – 932.25 MHz

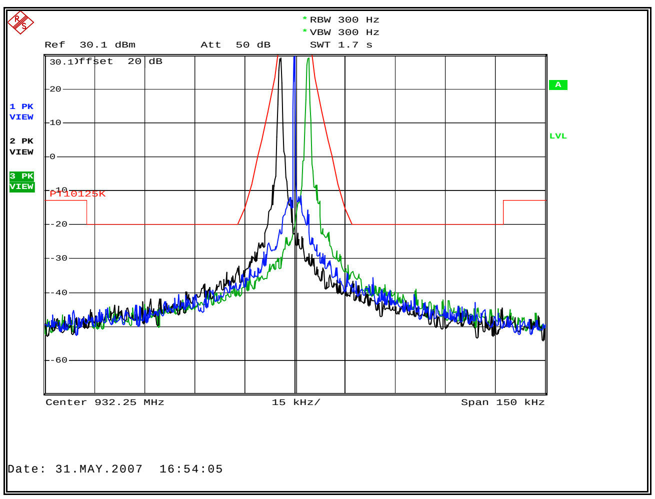

Figure 7.2.4-6: Boost Mode – 932.25 MHz
Offset Channel of +/- 7 (+/- 4200 Hz)

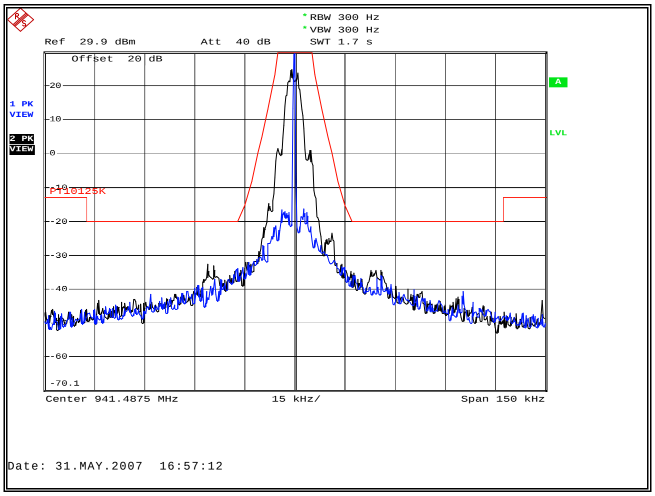

Figure 7.2.4-7: MPass Mode – 941.4875 MHz

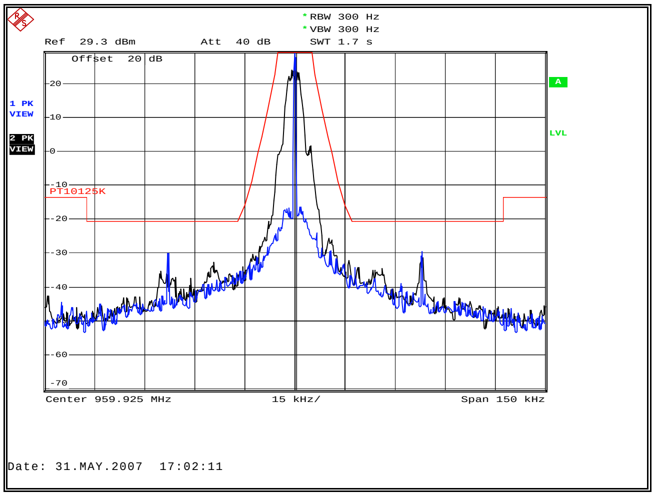

Figure 7.2.4-8: MPass Mode – 959.925 MHz

7.3 Spurious Emissions at Antenna Terminals - FCC Section 2.1051; 24.133 a(1), a(2); 90.210 (j); 101.111 a (6)

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 20 dB passive attenuator. The spectrum analyzer resolution bandwidth was set to 30 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 or attenuator losses. The spectrum was investigated in accordance to CFR 47 Part 2.1057.

7.3.2 Measurement Results

Data was collected according to Section 1.3.2 in the mode that produced the worst case emissions. Plots are supplied in Figure 7.3.2-1 through 7.3.2.16.

PART 24

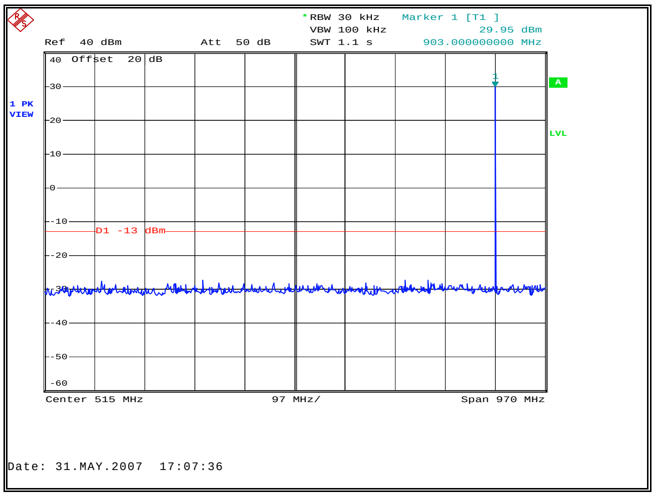

Figure 7.3.2-1: Normal Mode – 901.9875 MHz – 30MHz to 1GHz

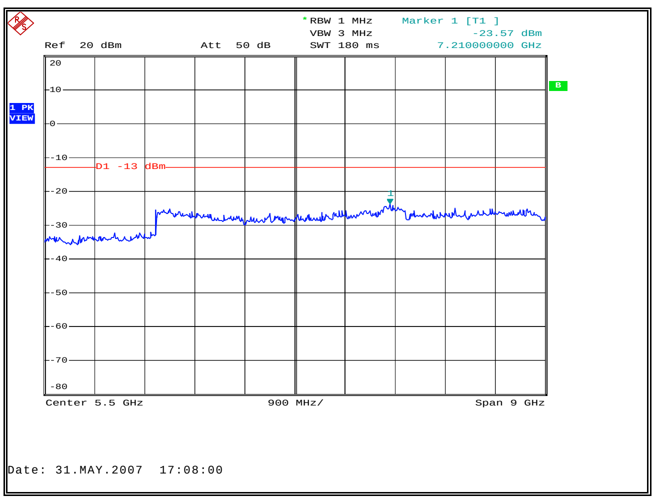

Figure 7.3.2-2: Normal Mode – 901.9875 MHz – 1GHz to 10GHz

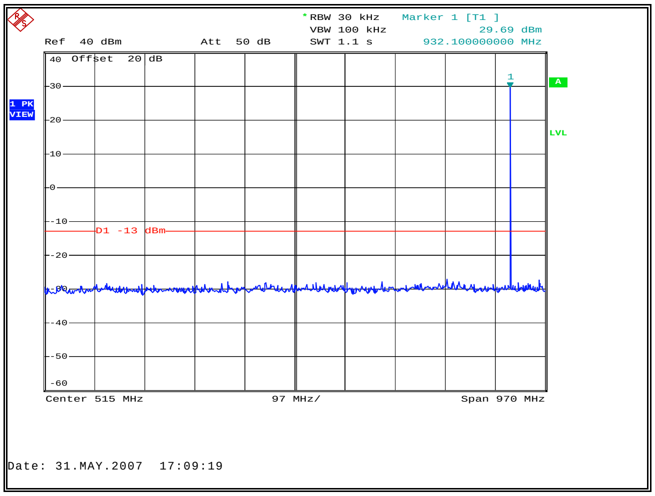

Figure 7.3.2-3: Mpass Mode – 930.5 MHz – 30MHz to 1GHz

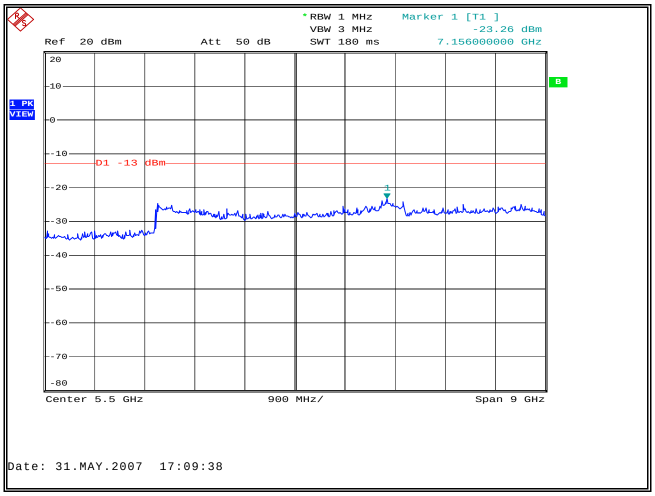

Figure 7.3.2-4: Mpass Mode – 930.5 MHz – 1GHz to 10GHz

PART 90

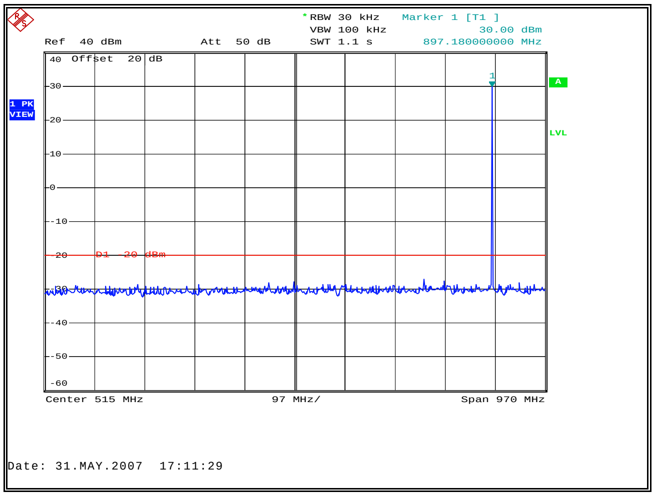

Figure 7.3.2-5: Normal Mode – 896.0375 MHz – 30MHz to 1GHz

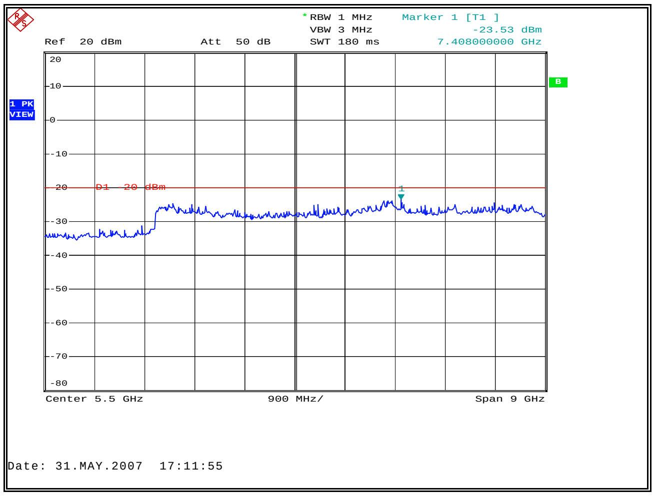

Figure 7.3.2-6: Normal Mode – 896.0375 MHz – 1GHz to 10GHz

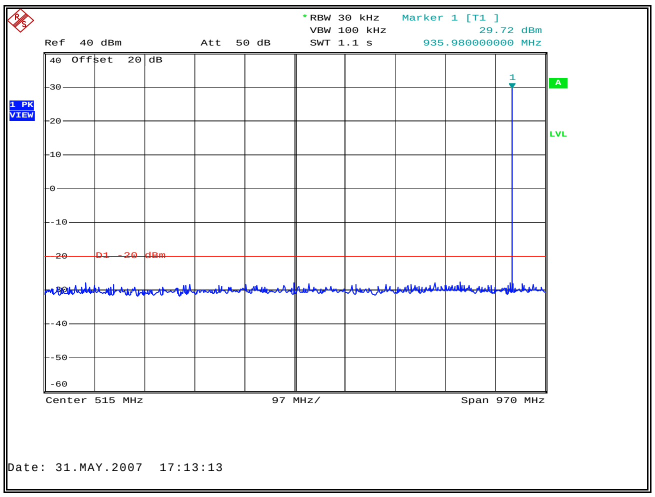

Figure 7.3.2-7: MPassMode – 935.0125 MHz – 30MHz to 1GHz

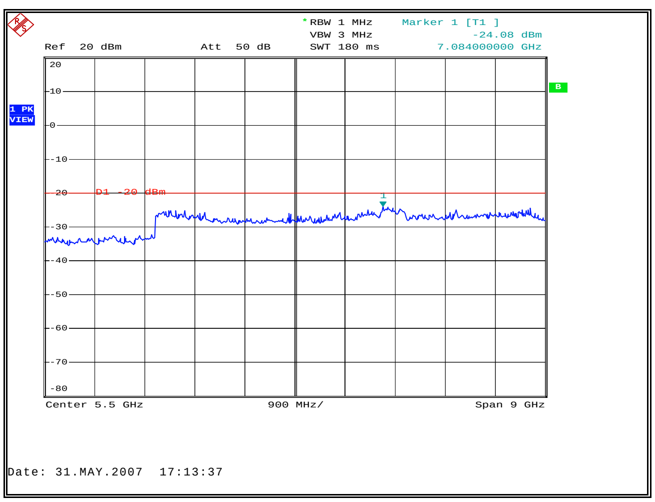

Figure 7.3.2-8: MPass Mode – 935.0125 MHz – 1GHz to 10GHz

PART 101

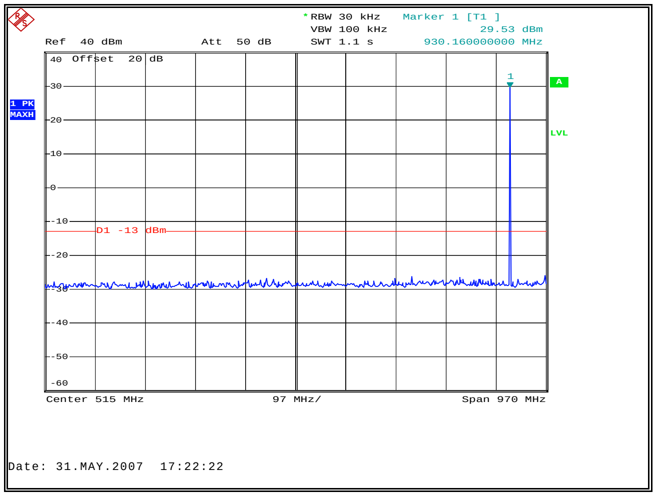

Figure 7.3.2-9: Normal Mode – 928.925 MHz – 30MHz to 1GHz

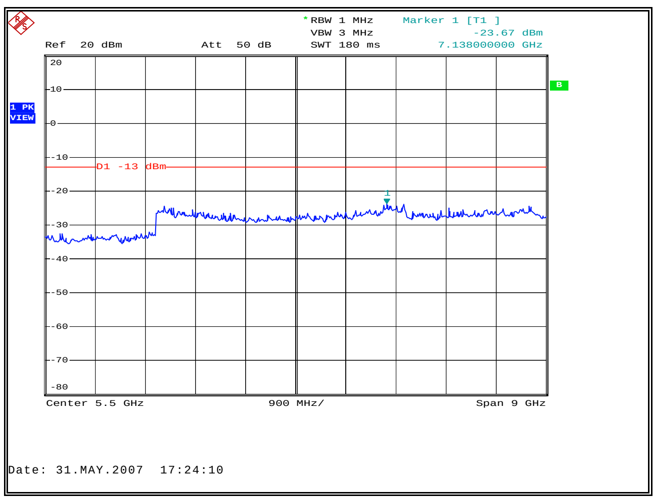

Figure 7.3.2-10: Normal Mode – 928.925 MHz – 1GHz to 10GHz

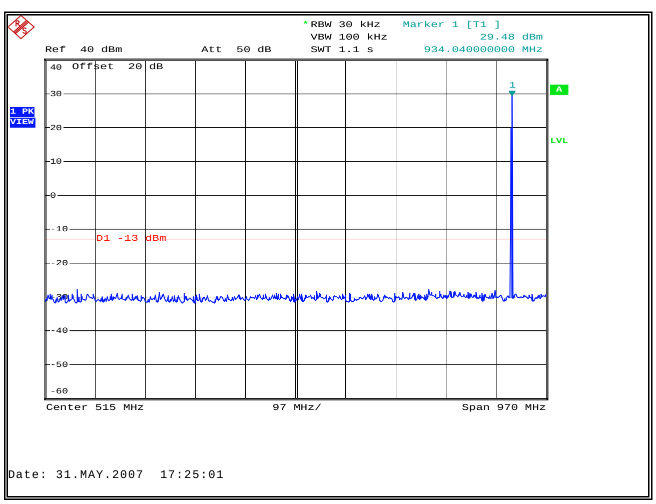

Figure 7.3.2-11: Normal Mode – 932.25 MHz – 30MHz to 1GHz

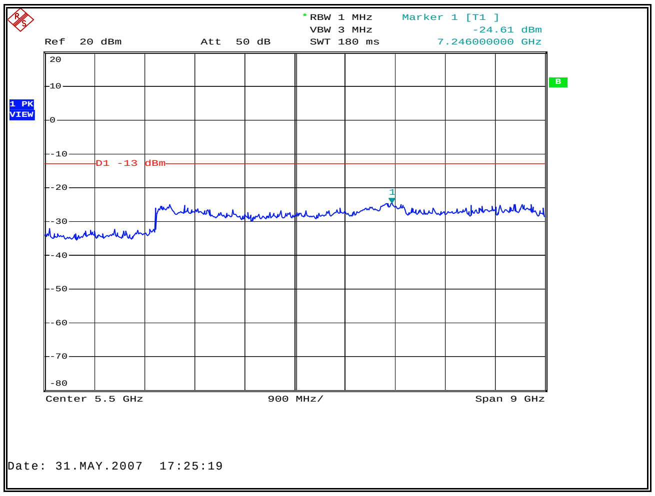

Figure 7.3.2-12: Normal Mode – 932.25 MHz – 1GHz to 10GHz

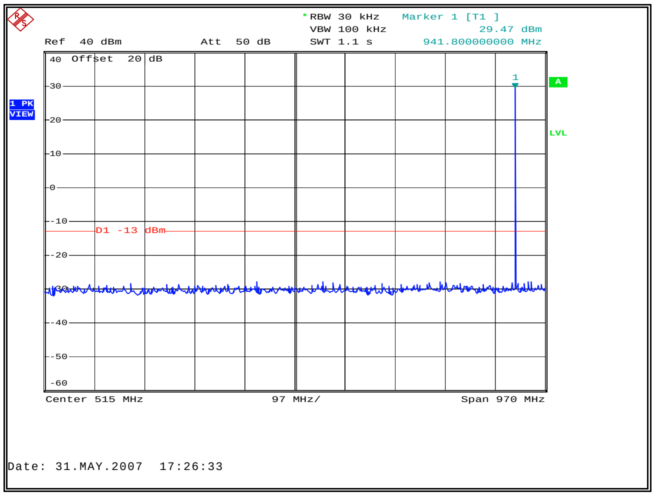

Figure 7.3.2-13: MPass Mode – 941.4875 MHz – 30MHz to 1GHz

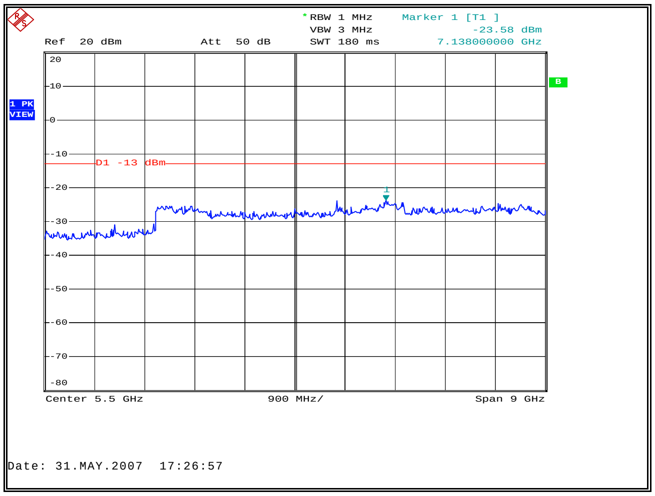

Figure 7.3.2-14: MPass Mode – 941.4875 MHz – 1GHz to 10GHz

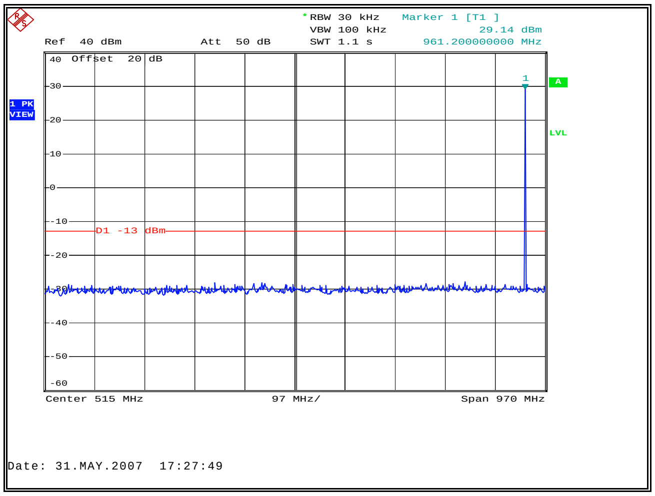

Figure 7.3.2-15: MPass Mode – 959.925 MHz – 30MHz to 1GHz

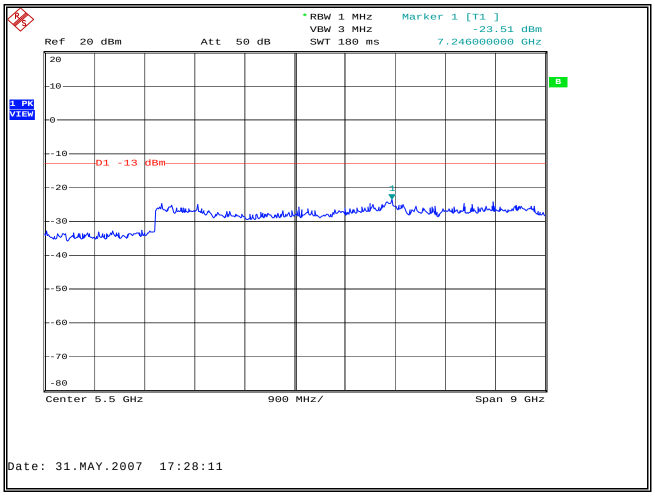

Figure 7.3.2-16: MPass Mode – 959.925 MHz – 1GHz to 10GHz

7.4 Field Strength of Spurious Emissions - FCC Section 2.1053, 24.133, 90.210, and 101.111

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.

Data was collected at frequencies according to Section 1.3.2. Results of the test are shown below. 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.

The equipment under test was evaluated to multiple FCC rule parts with the most stringent limit applied to all measurements.

7.4.2 Measurement Results

PART 24

Table 7.4.2-1: Field Strength of Spurious Emissions – 901.9875 MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1803.975	-49.27	-49.36	H	5.10	-44.26	-20.00	24.26
1803.975	-49.8	-48.41	V	5.20	-43.21	-20.00	23.21
4509.9375	-59.93	-51.67	V	6.99	-44.68	-20.00	24.68
6313.9125	-55.54	-45.37	H	6.41	-38.96	-20.00	18.96
6313.9125	-56.1	-43.16	V	6.53	-36.63	-20.00	16.63

Note: Frequencies not reported were below the noise floor of the analyzer.

Table 7.4.2-2: Field Strength of Spurious Emissions – 930.5 MHz – MPass Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1861	-58.44	-58.04	H	4.99	-53.05	-20.00	33.05
1861	-54.88	-56.26	V	5.09	-51.17	-20.00	31.17
4652.5	-61.86	-55.48	V	6.68	-48.80	-20.00	28.80
6513.5	-56.46	-44.39	H	6.18	-38.21	-20.00	18.21
6513.5	-56.73	-45.13	V	6.38	-38.75	-20.00	18.75

Note: Frequencies not reported were below the noise floor of the analyzer.

PART 90

Table 7.4.2-3: Field Strength of Spurious Emissions – 896.0375MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1792.025	-49.22	-49.19	H	5.12	-44.07	-20.00	24.07
1792.025	-50.64	-48.54	V	5.22	-43.32	-20.00	23.32
4480.0625	-61	-51.77	H	7.17	-44.60	-20.00	24.60
4480.0625	-59.5	-55.49	V	6.98	-48.51	-20.00	28.51
6272.0875	-55.82	-45.26	H	6.45	-38.81	-20.00	18.81
6272.0875	-55.39	-45.19	V	6.56	-38.63	-20.00	18.63

Note: Frequencies not reported were below the noise floor of the analyzer.

Table 7.4.2-4: Field Strength of Spurious Emissions – 935.0125MHz – MPass Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1870.025	-57.86	-60.29	H	4.97	-55.32	-20.00	35.32
1870.025	-55.85	-55.27	V	5.07	-50.20	-20.00	30.20
4675.0625	-62.72	-53.44	H	6.86	-46.58	-20.00	26.58
4675.0625	-67.29	-57.69	V	6.63	-51.06	-20.00	31.06
6545.0875	-55.43	-52.07	H	6.15	-45.92	-20.00	25.92
6545.0875	-55.31	-51.36	V	6.34	-45.02	-20.00	25.02
7480.1	-61.15	-45.23	V	6.05	-39.18	-20.00	19.18

Note: Frequencies not reported were below the noise floor of the analyzer.

PART 101

Table 7.4.2-5: Field Strength of Spurious Emissions – 928.925MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1857.85	-56.48	-58.45	H	4.99	-53.46	-20.00	33.46
1857.85	-54.34	-55.33	V	5.09	-50.24	-20.00	30.24
4644.625	-61.96	-57.81	H	6.92	-50.89	-20.00	30.89
4644.625	-61.02	-54.56	V	6.70	-47.86	-20.00	27.86
6502.475	-55.49	-43.18	H	6.19	-36.99	-20.00	16.99
6502.475	-55.26	-42.02	V	6.39	-35.63	-20.00	15.63

Note: Frequencies not reported were below the noise floor of the analyzer.

Table 7.4.2-6: Field Strength of Spurious Emissions – 932.25MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1864.5	-56.60	-55.66	H	4.98	-50.68	-20.00	30.68
1864.5	-54.22	-55.28	V	5.08	-50.20	-20.00	30.20
2796.75	-60.72	-56.28	V	5.54	-50.74	-20.00	30.74
4661.25	-62.24	-53.98	H	6.89	-47.09	-20.00	27.09
4661.25	-61.43	-51.11	V	6.66	-44.45	-20.00	24.45
6525.75	-55.94	-44.2	H	6.17	-38.03	-20.00	18.03
6525.75	-54.59	-41.76	V	6.37	-35.39	-20.00	15.39

Note: Frequencies not reported were below the noise floor of the analyzer.

Table 7.4.2-7: Field Strength of Spurious Emissions – 941.4875MHz – MPass Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1882.975	-58.23	-57.77	H	4.94	-52.83	-20.00	32.83
1882.975	-56.63	-55.8	V	5.04	-50.76	-20.00	30.76
4707.4375	-63.05	-57.38	H	6.80	-50.58	-20.00	30.58
4707.4375	-63.56	-55.64	V	6.56	-49.08	-20.00	29.08
6590.4125	-57.59	-44.43	H	6.11	-38.32	-20.00	18.32
6590.4125	-54.9	-41.69	V	6.29	-35.40	-20.00	15.40

Note: Frequencies not reported were below the noise floor of the analyzer.

Table 7.4.2-8: Field Strength of Spurious Emissions – 959.925MHz – MPass Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1919.85	-61.81	-60.13	H	4.87	-55.26	-20.00	35.26
1919.85	-59.42	-59.13	V	4.97	-54.16	-20.00	34.16
6719.475	-59.45	-46.33	H	5.99	-40.34	-20.00	20.34
6719.475	-57.26	-44.38	V	6.15	-38.23	-20.00	18.23
8639.325	-61.78	-48.35	H	6.34	-42.01	-20.00	22.01
9599.25	-63.25	-51.43	H	6.32	-45.11	-20.00	25.11
9599.25	-62.04	-45.03	V	6.38	-38.65	-20.00	18.65

Note: Frequencies not reported were below the noise floor of the analyzer.

7.5 Frequency Stability - FCC Section 2.1055, 24.135, 90.213, 101.107

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 supply voltage was varied from 85% to 115% from the normal. The maximum variation of frequency was recorded.

Data was collected at frequencies according to Section 1.3.2. Results of the test are shown below in Figures 7.5.2-1 through 7.5.2-8.

7.5.2 Measurement Results

PART 24

Frequency Stability

Mode:
Channel:
Frequency (MHz): 901.987755
Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**901.988239**	**0.537**	100%	12.00
-20 C	**901.988135**	**0.421**	100%	12.00
-10 C	**901.988019**	**0.293**	100%	12.00
0 C	**901.988073**	**0.353**	100%	12.00
10 C	**901.988147**	**0.435**	100%	12.00
20 C	**901.987850**	**0.105**	100%	12.00
30 C	**901.987569**	**-0.206**	100%	12.00
40 C	**901.987706**	**-0.054**	100%	12.00
50 C	**901.988363**	**0.674**	100%	12.00
20 C	**901.987362**	**-0.436**	85%	10.200
20 C	**901.987383**	**-0.412**	115%	13.800

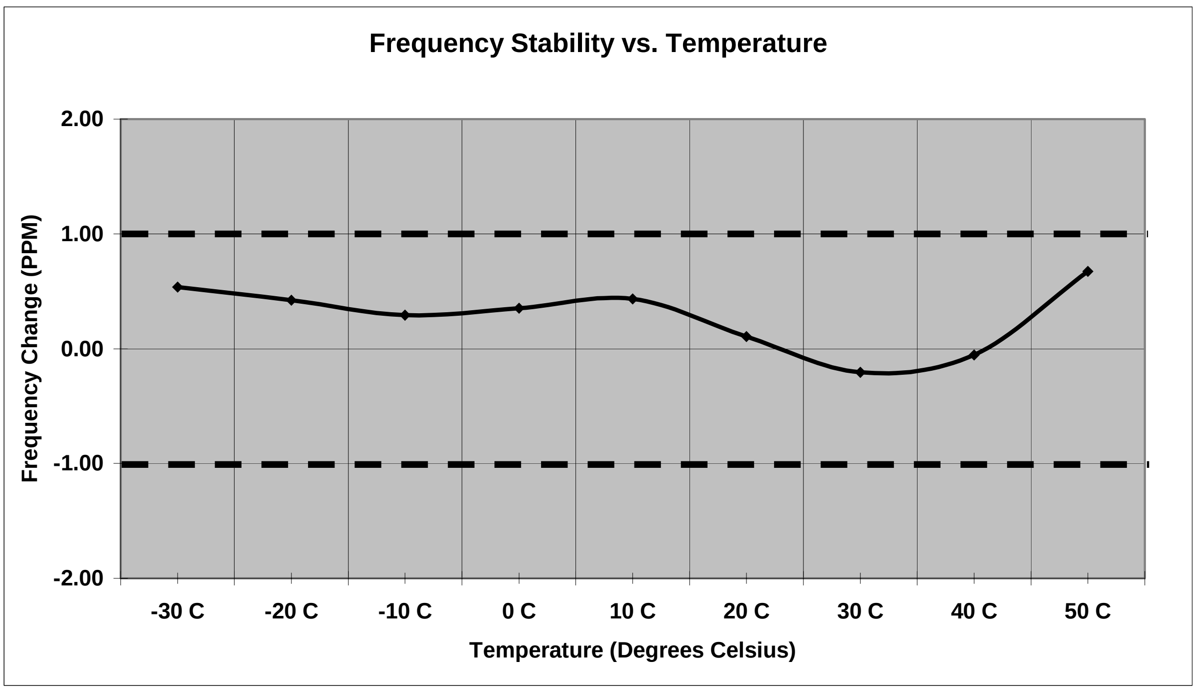

Figure 7.5.2-1: Frequency Stability – 901.9875MHz

Frequency Stability

Mode: **Frequency (MHz):** 930.500233
Channel: **Deviation Limit (PPM):** 1ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**930.500770**	**0.577**	100%	12.00
-20 C	**930.500672**	**0.472**	100%	12.00
-10 C	**930.500527**	**0.316**	100%	12.00
0 C	**930.500593**	**0.387**	100%	12.00
10 C	**930.500671**	**0.471**	100%	12.00
20 C	**930.500365**	**0.142**	100%	12.00
30 C	**930.500073**	**-0.172**	100%	12.00
40 C	**930.500232**	**-0.001**	100%	12.00
50 C	**930.500897**	**0.714**	100%	12.00
20 C	**930.499967**	**-0.286**	85%	10.200
20 C	**930.499953**	**-0.301**	115%	13.800

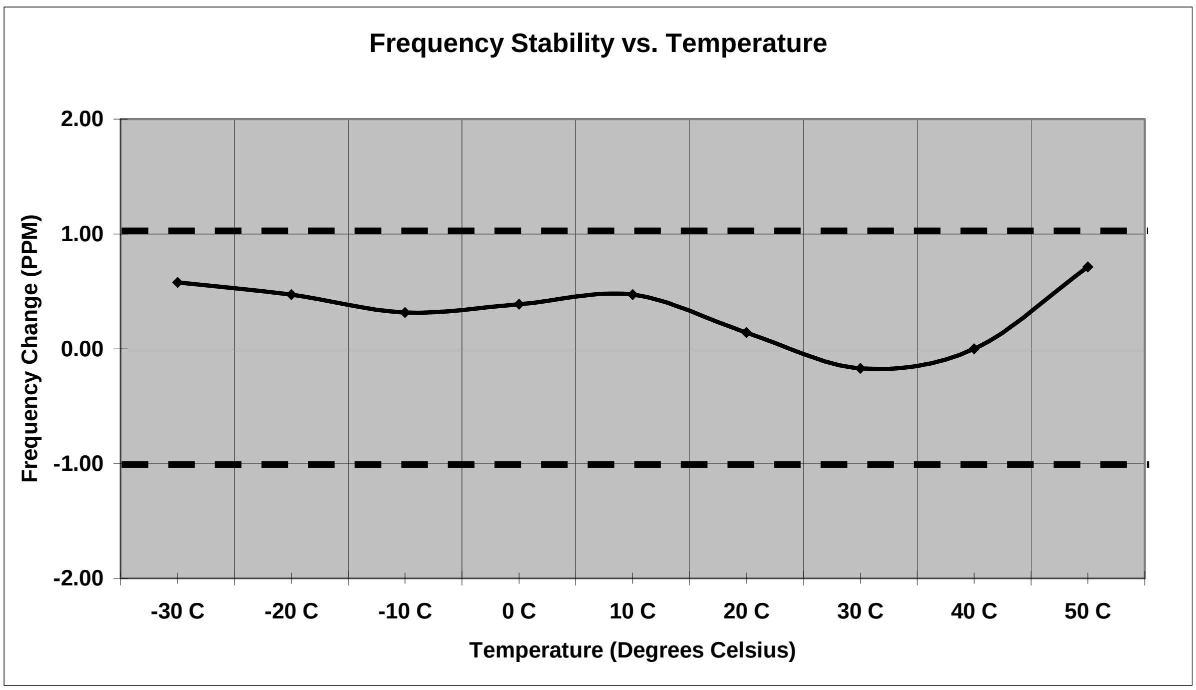

Figure 7.5.2-2: Frequency Stability – 930.5MHz

PART 90

Frequency Stability

Mode:
Channel:
Frequency (MHz): 896.037756
Deviation Limit (PPM): 1ppm

Temperature C	Frequency MHz	Frequency Error (PPM)	Voltage (%)	Voltage (VDC)
-30 C	**896.038260**	**0.562**	100%	12.00
-20 C	**896.038132**	**0.420**	100%	12.00
-10 C	**896.038007**	**0.280**	100%	12.00
0 C	**896.038067**	**0.347**	100%	12.00
10 C	**896.038147**	**0.436**	100%	12.00
20 C	**896.037849**	**0.104**	100%	12.00
30 C	**896.037570**	**-0.208**	100%	12.00
40 C	**896.037728**	**-0.031**	100%	12.00
50 C	**896.038344**	**0.656**	100%	12.00
20 C	**896.037456**	**-0.335**	85%	10.200
20 C	**896.037492**	**-0.295**	115%	13.800

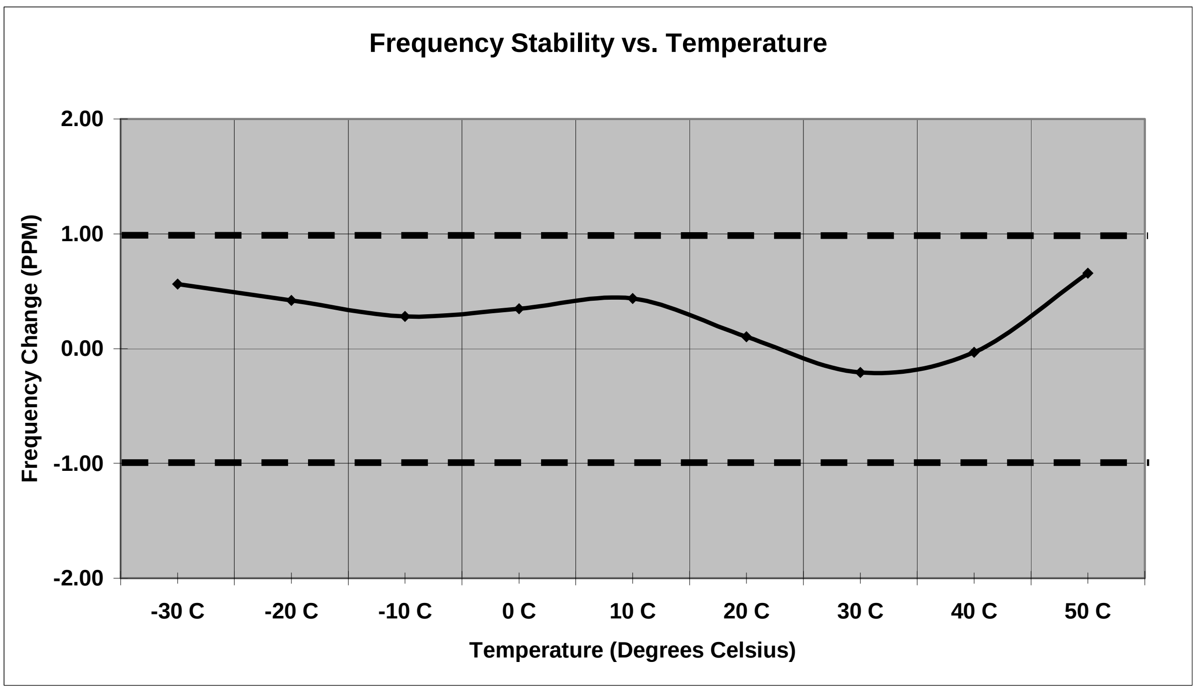

Figure 7.5.2-3: Frequency Stability – 896.0125MHz

Frequency Stability

Mode: **Frequency (MHz):** 935.012756
Channel: **Deviation Limit (PPM):** 1ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**935.013284**	**0.565**	100%	12.00
-20 C	**935.013152**	**0.424**	100%	12.00
-10 C	**935.013039**	**0.303**	100%	12.00
0 C	**935.013107**	**0.375**	100%	12.00
10 C	**935.013180**	**0.453**	100%	12.00
20 C	**935.012861**	**0.112**	100%	12.00
30 C	**935.012573**	**-0.196**	100%	12.00
40 C	**935.012745**	**-0.012**	100%	12.00
50 C	**935.013374**	**0.661**	100%	12.00
20 C	**935.012559**	**-0.211**	85%	10.200
20 C	**935.012553**	**-0.217**	115%	13.800

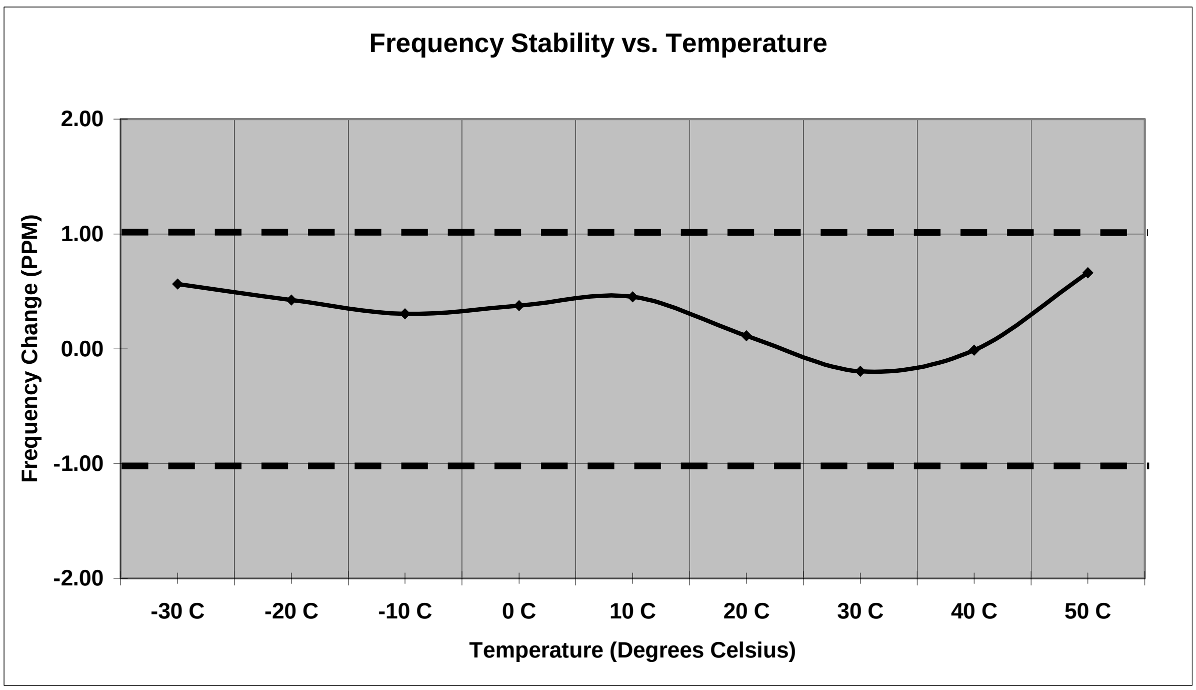

Figure 7.5.2-4: Frequency Stability – 935.0125MHz

PART 101

Frequency Stability

Mode:		**Frequency (MHz):**	928.925248
Channel:		**Deviation Limit (PPM):**	1ppm

Temperature C	Frequency MHz	Frequency Error (PPM)	Voltage (%)	Voltage (VDC)
-30 C	**928.925783**	**0.576**	100%	12.00
-20 C	**928.925645**	**0.427**	100%	12.00
-10 C	**928.925534**	**0.308**	100%	12.00
0 C	**928.925605**	**0.384**	100%	12.00
10 C	**928.925676**	**0.461**	100%	12.00
20 C	**928.925353**	**0.113**	100%	12.00
30 C	**928.925075**	**-0.186**	100%	12.00
40 C	**928.925249**	**0.001**	100%	12.00
50 C	**928.925875**	**0.675**	100%	12.00
20 C	**928.925062**	**-0.200**	85%	10.200
20 C	**928.925063**	**-0.199**	115%	13.800

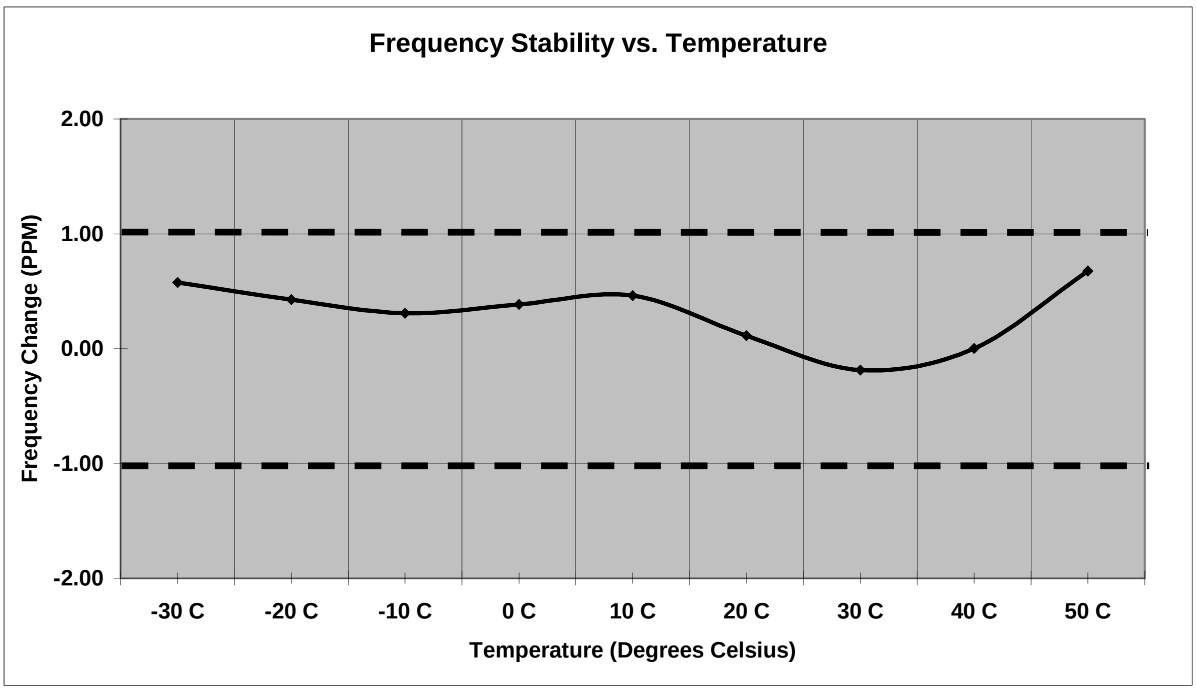

Figure 7.5.2-5: Frequency Stability – 928.925MHz

Frequency Stability

Mode: **Frequency (MHz):** 932.250245
Channel: **Deviation Limit (PPM):** 1ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**932.250808**	**0.604**	100%	12.00
-20 C	**932.250651**	**0.436**	100%	12.00
-10 C	**932.250260**	**0.016**	100%	12.00
0 C	**932.250609**	**0.390**	100%	12.00
10 C	**932.250680**	**0.467**	100%	12.00
20 C	**932.250342**	**0.104**	100%	12.00
30 C	**932.250078**	**-0.179**	100%	12.00
40 C	**932.250255**	**0.011**	100%	12.00
50 C	**932.250862**	**0.662**	100%	12.00
20 C	**932.250073**	**-0.184**	85%	10.200
20 C	**932.250073**	**-0.184**	115%	13.800

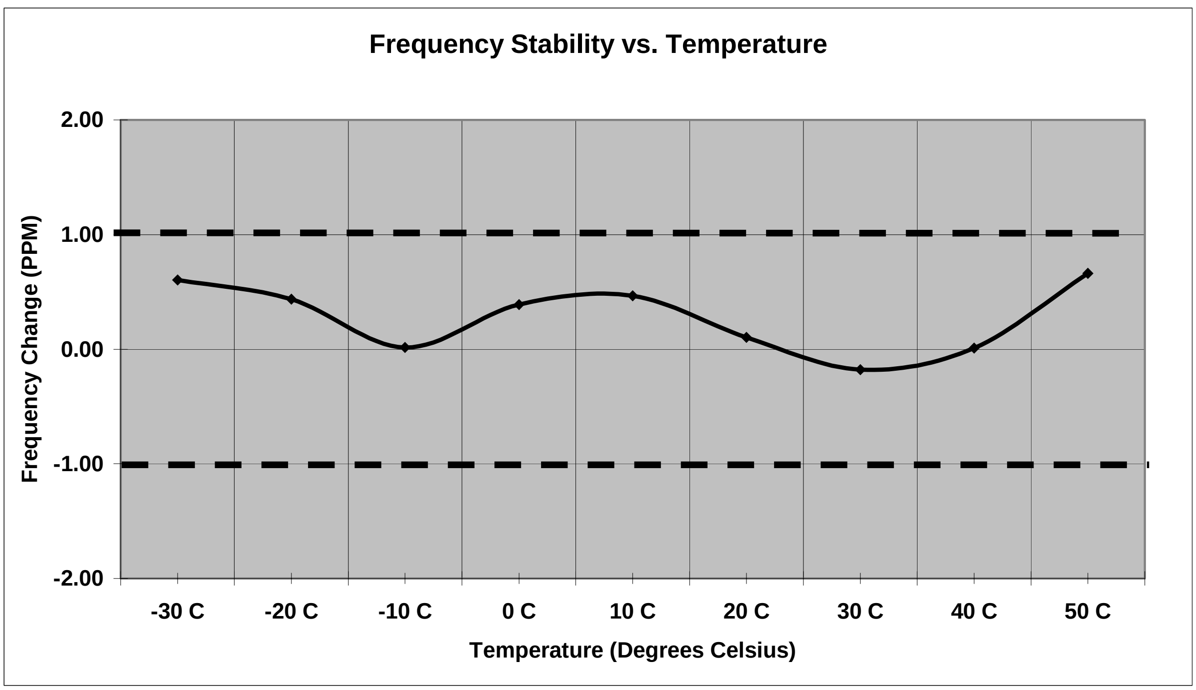

Figure 7.5.2-6: Frequency Stability – 932.5MHz

Frequency Stability

Mode: **Frequency (MHz):** 941.487756

Channel: **Deviation Limit (PPM):** 1ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**941.488319**	**0.598**	100%	12.00
-20 C	**941.488140**	**0.408**	100%	12.00
-10 C	**941.488034**	**0.295**	100%	12.00
0 C	**941.488118**	**0.384**	100%	12.00
10 C	**941.488186**	**0.457**	100%	12.00
20 C	**941.487837**	**0.086**	100%	12.00
30 C	**941.487577**	**-0.190**	100%	12.00
40 C	**941.487764**	**0.008**	100%	12.00
50 C	**941.488364**	**0.646**	100%	12.00
20 C	**941.487587**	**-0.180**	85%	10.200
20 C	**941.487588**	**-0.178**	115%	13.800

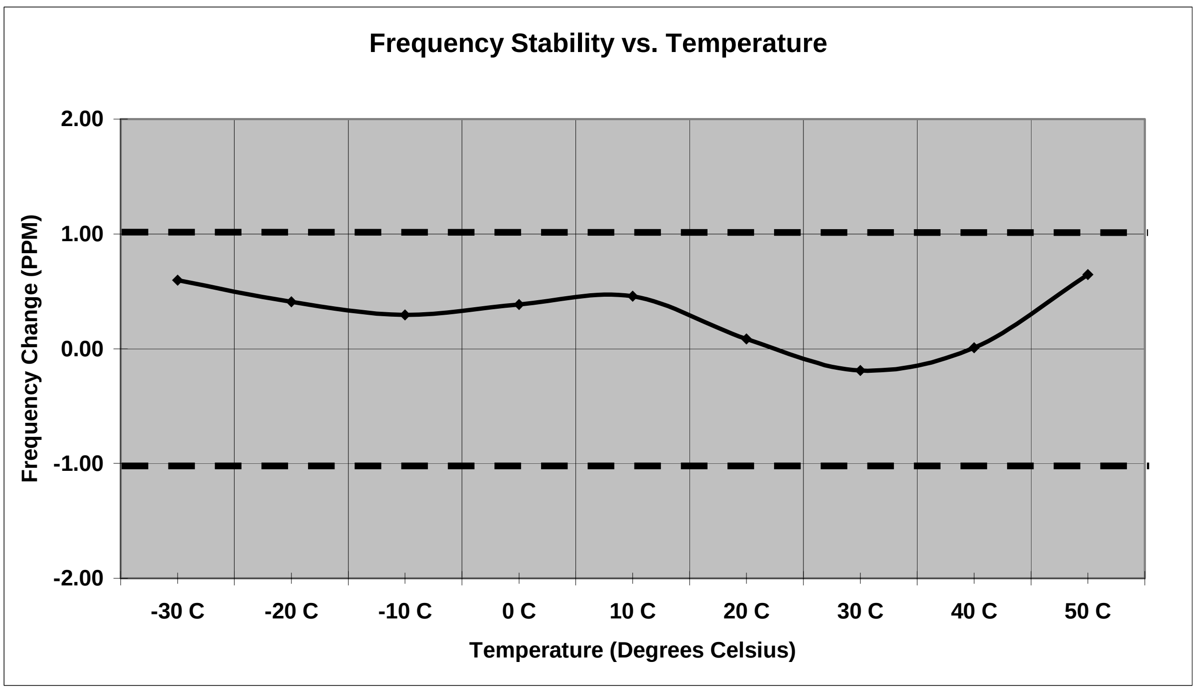

Figure 7.5.2-7: Frequency Stability – 941.4875MHz

Frequency Stability

Mode: **Frequency (MHz):** 959.925253
Channel: **Deviation Limit (PPM):** 1ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**959.925784**	**0.553**	100%	12.00
-20 C	**959.925676**	**0.441**	100%	12.00
-10 C	**959.925543**	**0.302**	100%	12.00
0 C	**959.925612**	**0.374**	100%	12.00
10 C	**959.925693**	**0.458**	100%	12.00
20 C	**959.925371**	**0.123**	100%	12.00
30 C	**959.925077**	**-0.183**	100%	12.00
40 C	**959.925232**	**-0.022**	100%	12.00
50 C	**959.925933**	**0.708**	100%	12.00
20 C	**959.925104**	**-0.155**	85%	10.200
20 C	**959.925107**	**-0.152**	115%	13.800

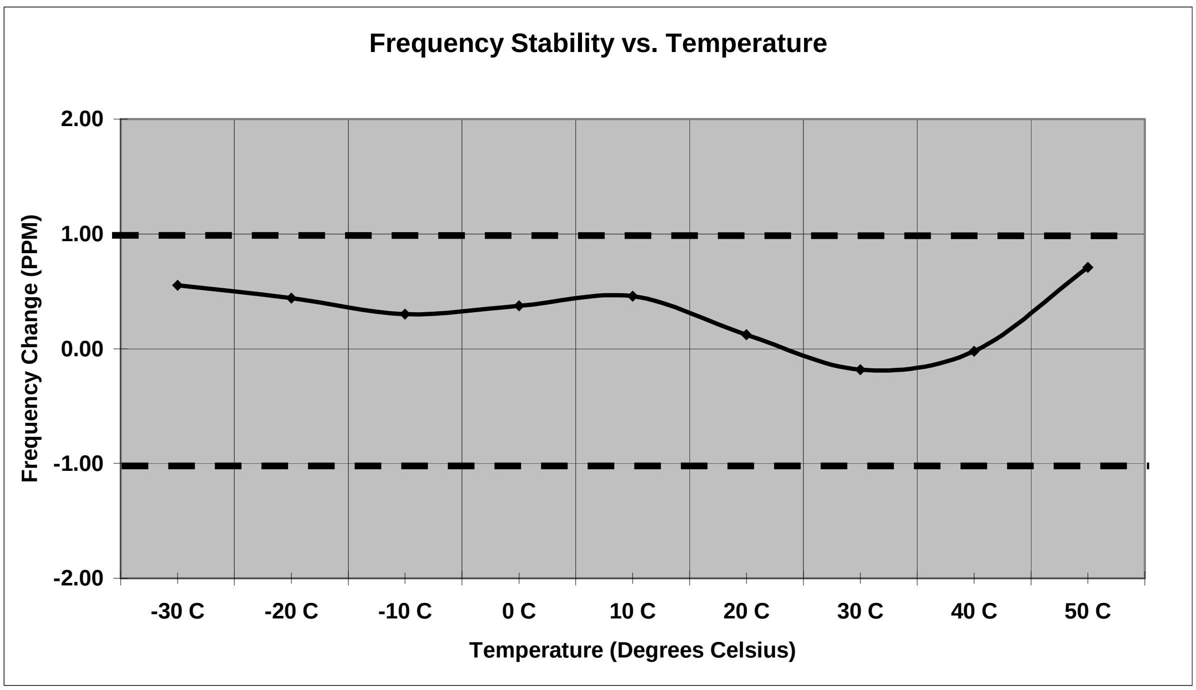

Figure 7.5.2-8: Frequency Stability – 959.925MHz

7.6 Radiated Emissions (Unintentional Radiators) - FCC Section 15.109

7.6.1 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 radiated emission, the antenna mast is raised and lowered from one (1) to four (4) meters and the turntable is rotated 360º to obtain a maximum peak reading on the spectrum analyzer. The radiated emissions are then measured using an EMI receiver employing a CISPR quasi-peak detector for frequencies below 1000 MHz and an Average detector function for frequencies above 1000 MHz. This repeated for both horizontal and vertical polarizations of the receive antenna.

The field strength of each radiated emission is calculated by correcting the EMI receiver level for cable loss, amplifier gain, and antenna correction factors.

Field Strength (dBuV/m) = EMI Receiver Level (dBuV) + Cable Loss (dB) – Amplifier Gain (dB) + Antenna Correction Factor (1/m)

Results of the test are shown below in Table 7.6.2-1.

7.6.2 Measurement Results

Table 7.6.2-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Uncorrected Reading (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (°)	Total Correction Factor (dB)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)
79.23	45.10	V	100	360	-18.34	26.76	40.0	13.24
66.27	45.05	V	100	48	-20.20	24.85	40.0	15.15
175.03	37.96	V	100	308	-14.80	23.16	43.5	20.34
85.349	39.51	V	100	202	-16.94	22.57	40.0	17.43
189.765	40.12	V	100	332	-15.20	24.92	43.5	18.58
697.688	21.80	H	100	52	-1.47	20.33	46.0	25.67

Measurements taken above 698 MHz were below the noise floor of the measurement equipment.

7.7 Power Line Conducted Emissions - FCC Section 15.107

7.7.1 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

7.7.2 Measurement Results

Results of the test are shown below in and Tables 7.7-1.

Table 7.7-1: Conducted EMI Results

Frequency (MHz)	Uncorrected Reading (dBuV)		Total Correction Factor (dB)	Corrected Level (dBuV)		Limit (dBuV)		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
Line 1									
0.17	29.7	16.4	9.80	39.50	26.20	64.96	54.96	25.5	28.8
6.02	26.5	22.5	9.80	36.30	32.30	60.00	50.00	23.7	17.7
6.32	26.1	20.9	9.81	35.91	30.71	60.00	50.00	24.1	19.3
24.99	39.3	36.1	10.21	49.51	46.31	60.00	50.00	10.5	3.7
25.29	39.5	37.5	10.20	49.70	47.70	60.00	50.00	10.3	2.3
25.59	39.5	37.5	10.21	49.71	47.71	60.00	50.00	10.3	2.3
Line 2									
0.17	29.9	14.7	9.80	39.70	24.50	64.96	54.96	25.3	30.5
6.02	26.5	22.7	9.80	36.30	32.50	60.00	50.00	23.7	17.5
6.32	25.6	20.9	9.81	35.41	30.71	60.00	50.00	24.6	19.3
24.99	39.1	36.8	10.21	49.31	47.01	60.00	50.00	10.7	3.0
25.29	39.5	37.2	10.20	49.70	47.40	60.00	50.00	10.3	2.6
25.59	39.3	37.1	10.21	49.51	47.31	60.00	50.00	10.5	2.7

8.0 CONCLUSION

In the opinion of ACS, Inc. the model TXCVRBB01, manufactured by Sensus Metering Systems, meets all the requirements of FCC Part 24, 90, and 101 as applicable.

End Report