

ROGERS LABS, INC.

4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214

Test Report For Application of Certification

For

TRANSCORE
AMTECH TECHNOLOGY CENTER
8600 Jefferson Street, NE
Albuquerque, NM 87113
Phone: (505) 856-8101

MODEL:
AI 1401
LMS Transmitter

FREQUENCY: 902-928 MHz

FCC ID: FIH AI140105616
IC: 1584A-05616

Test Date: October 9, 2004

Certifying Engineer: *Scot D Rogers*

Scot D. Rogers
ROGERS LABS, INC.
4405 W. 259th Terrace
Louisburg, KS 66053
Phone: (913) 837-3214
FAX: (913) 837-3214

This report shall not be reproduced except in full, without the written approval of the laboratory. This report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

TABLE OF CONTENTS

FORWARD:	3
LIST OF TEST EQUIPMENT	3
2.1033(C) APPLICATION FOR CERTIFICATION	4
2.1046 RF POWER OUTPUT	7
<u>Measurements Required:</u>	7
<u>Test Arrangement:</u>	7
<u>Results:</u>	7
2.1047 MODULATION CHARACTERISTICS	8
<u>Measurements Required:</u>	8
<u>Test Arrangement:</u>	8
<u>Results:</u>	9
2.1049 OCCUPIED BANDWIDTH	9
<u>Measurements Required:</u>	9
<u>Test Arrangement:</u>	9
<u>Results:</u>	9
2.1051 SPURIOUS EMISSIONS AT ANTENNA TERMINALS	10
<u>Measurements Required:</u>	10
<u>Test Arrangement:</u>	10
<u>Results:</u>	11
2.1053 FIELD STRENGTH OF SPURIOUS RADIATION	13
<u>Measurements Required:</u>	13
<u>Test Arrangement:</u>	13
<u>Results:</u>	15
Radiated (4 Highest Emissions General Emissions)	15
2.1055 FREQUENCY STABILITY	16
<u>Measurements Required:</u>	16
<u>Test Arrangement:</u>	16
<u>Results:</u>	18
APPENDIX	19

FORWARD:

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2003, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057; 90.201 through 90.217, 90.350 through 90.363 the following is submitted:

List of Test Equipment

A Hewlett Packard 8591EM and or 8562A Spectrum Analyzer was used as the measuring device for the emissions testing. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of Test Equipment.

HP 8591EM SPECTRUM ANALYZER SETTINGS		
CONDUCTED EMISSIONS:		
RBW	AVG. BW	DETECTOR FUNCTION
9 kHz	30 kHz	Peak/Quasi Peak
RADIATED EMISSIONS (30 - 1000 MHz):		
RBW	AVG. BW	DETECTOR FUNCTION
120 kHz	300 kHz	Peak/Quasi Peak
HP 8562A SPECTRUM ANALYZER SETTINGS		
RADIATED EMISSIONS (1 - 40 GHz):		
RBW	AVG. BW	DETECTOR FUNCTION
1 MHz	1 MHz	Peak/Average
ANTENNA CONDUCTED EMISSIONS:		
RBW	AVG. BW	DETECTOR FUNCTION
100 kHz	300 kHz	Peak

2.1033(c) Application for Certification

1. Manufacturer: TRANSCORE
AMTECH TECHNOLOGY CENTER
8600 Jefferson Street, NE
Albuquerque, NM 87113
2. Identification: Model: AI 1401

FCC I.D.: FIH AI140105616
3. A copy of the installation and operating instructions furnished to the end user. Refer to the instruction manual furnished with this application for details.
4. Emission Type: Continuous wave (CW)

Continuous Wave Emission Designator. NON
5. Frequency Range:

902 - 928 MHz
6. Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power. The output power is factory set to 1.6 Watt (nominal).
7. Maximum power rating as defined in the applicable part(s) of the rules. As stated in CFR 47, 90.205(j), the maximum permissible output power allowed is 30 watts.
8. The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range. The EUT final amplification stage runs at 12.5 volts with 700 mA current for a power requirement of 8.75 W.
9. Provide the tune-up procedure over the power range, or at specific operating power levels. Refer to the tune-up procedure furnished with this application for details.

10. A schematic diagram and a description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power. Refer to the schematics furnished with this application for details.
11. A photograph or drawing of the equipment identification plate, or label showing the information to be placed thereon shall be provided. Refer to the FCC identification label information furnished with this application for details.
12. Photographs (8'' x 10'') of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Insofar as these requirements are met by photographs or drawings contained in instruction manuals supplied with the certification request, additional photographs are necessary only to complete the required showing. Refer to the exhibits of this report and or additional information furnished with the application for details.
13. For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the response characteristics (frequency, phase, and amplitude) of any filters provided, and a description of the modulating wave train, shall be submitted for the maximum rated conditions under which the equipment will be operated. This unit uses a continuous wave frequency only and has no digital modulation.
14. The data required by Sections 2.1046 through 2.1057, inclusive, measured in accordance with the procedures set out in Section 2.1041.

15. The application for certification of an external radio frequency power amplifier under Part 97 of this chapter need not be accompanied by the data required by Paragraph (b)(14) of this section. In lieu thereof, measurements shall be submitted to show compliance with the technical specifications in Subpart C of Part 97 of this chapter and such information as required by Section 2.1060 of this part. This paragraph does not apply to this equipment.
16. An application for certification of an AM broadcast stereophonic exciter-generator intended for interfacing with existing certified, or formerly type accepted or notified transmitters must include measurements made on a complete stereophonic transmitter. The instruction book must include complete specifications and circuit requirements for interconnecting with existing transmitters. The instruction book must also provide a full description of the equipment and measurement procedures to monitor modulation and to verify that the combination of stereo exciter-generator and transmitter meets the emission limitations of section 73.44. This paragraph does not apply to this equipment.
17. A single application may be filed for a composite system that incorporates devices subject to certification under multiple rule parts; however, the appropriate fee must be included for each device. Separate applications must be filed if different FCC Identifiers will be used for each device.

2.1046 RF Power Output

Measurements Required:

Measurements shall be made to establish the radio frequency power delivered by the transmitter into the standard output termination. The power output shall be monitored and recorded and no adjustment shall be made to the transmitter after the test has begun, except as noted below:

If the power output is adjustable, measurements shall be made for the highest and lowest power levels.

Test Arrangement:



The radio frequency power output was measured at the antenna terminals by replacing the antenna with a spectrum analyzer, 10dB Attenuator, and 2 dB cable loss. The spectrum analyzer had impedance of 50 Ω to match the impedance of the standard antenna. A HP 8562A Spectrum Analyzer was used to measure the radio frequency power at the antenna port. The data was taken in dBm and converted to watts as shown in the following Table. Refer to Figure 1 showing the output power of the transmitter. Data was taken per Paragraph 2.1046(a) and applicable parts of Part 90.

$$\begin{aligned}
 P_{\text{dBm}} &= \text{power in dB above 1 milliwatt.} \\
 \text{Milliwatts} &= 10^{(P_{\text{dBm}}/10)} \\
 \text{Watts} &= (\text{Milliwatts})(0.001)(\text{W/mW})
 \end{aligned}$$

Results:

FREQUENCY	P _{dBm}	P _{mw}	P _w
902.25	32.3	1,698.2	1.7
915.00	32.0	1,584.9	1.6
921.50	32.0	1,584.9	1.6

The specifications of Paragraph 2.1046(a) and 90.205 are met. There are no deviations to the specifications.

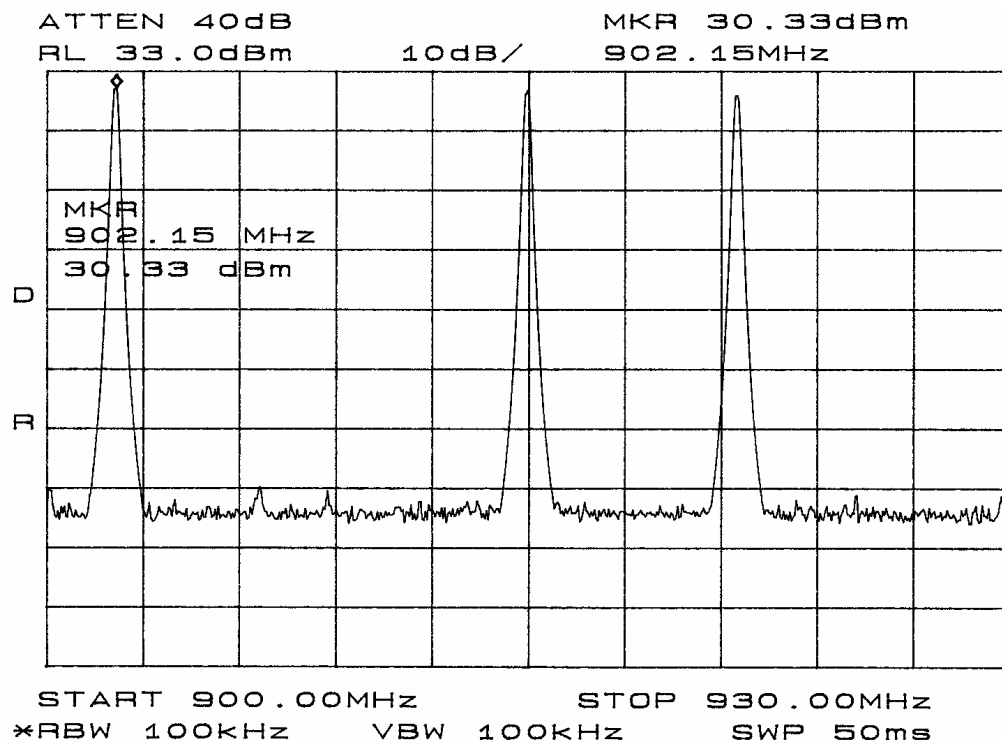


Figure 1 Power output.

2.1047 Modulation Characteristics

Measurements Required:

A curve or equivalent data that shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed shall be submitted.

Test Arrangement:



The radio frequency output was coupled to a HP 8591EM Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its normal mode.

Results:

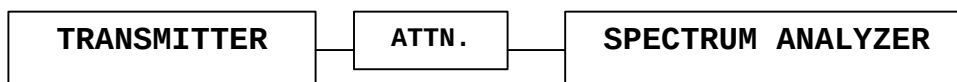
The transmitter operates in a single mode, continuous wave (CW). Specifications of Paragraphs 2.1047 and 90.211 are met. There are no deviations to the specifications.

2.1049 Occupied Bandwidth

Measurements Required:

The occupied bandwidth, that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are equal to 0.5 percent of the total mean power radiated by a given emission. Refer to figure 2 showing a plot of the occupied bandwidth measurement.

Test Arrangement:



Results:

MODE	f_c	O.B. kHz
CW	921.500	9.3

Requirements of 2.1049 and applicable parts of Paragraph 90 are met. There are no deviations to the specifications.

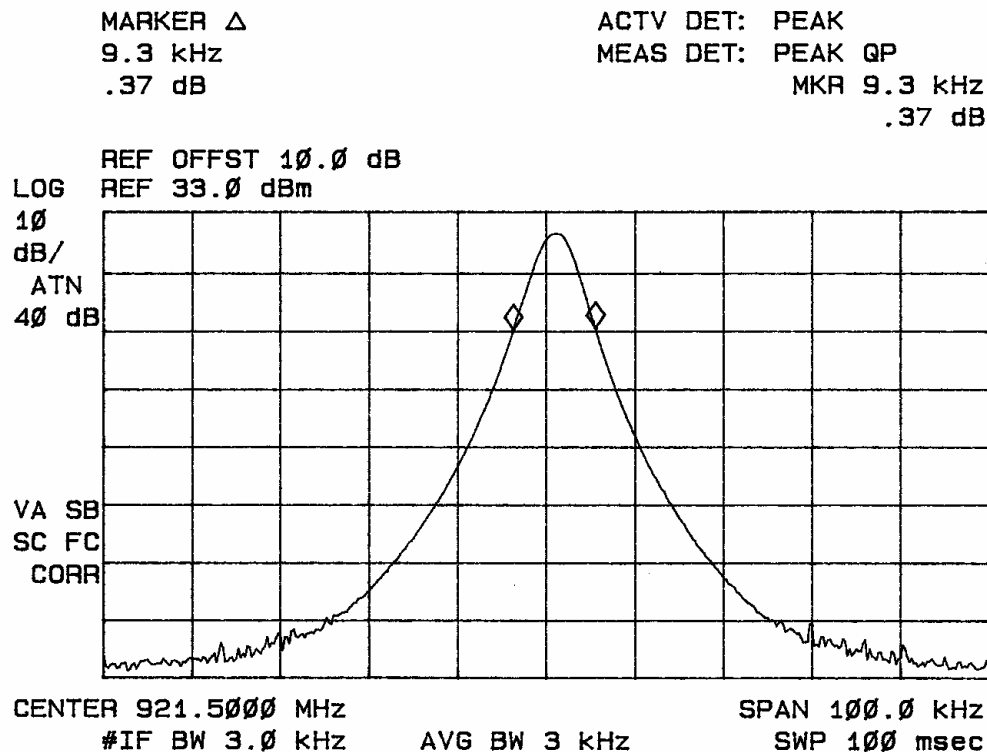


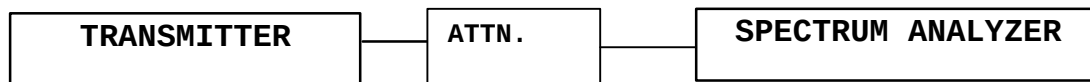
Figure 2 Occupied Bandwidth CW Operation.

2.1051 Spurious Emissions at Antenna Terminals

Measurements Required:

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna.

Test Arrangement:



The radio frequency output was coupled to a HP 8562A Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its normal mode. The frequency spectrum from 10 MHz to 10 GHz was observed and plots produced of the frequency spectrum.

Figures 3 and 4 represent plots of the spurious emissions

measurements for the EUT. Data was taken per 2.1051 and applicable parts of Part 90.

Spurious emissions must be attenuated below the peak output power by the at least $55 + 10 \log (P_o)$ dB.

1.80-watt transmitter limit specifies the level below the carrier must be suppressed more than this amount.

$$\begin{aligned}\text{Attenuation} &= 55 + 10 \log_{10}(P_w) \\ &= 55 + 10 \log_{10}(1.7) \\ &= 57.3 \text{ dB}\end{aligned}$$

Results:

FREQUENCY	SPURIOUS FREQ. (GHz)	LEVEL BELOW CARRIER (dB)
902.25	1804.5	68.6
	2706.8	73.1
	3609.0	68.3
	4511.3	63.6
	5413.5	77.6
	6315.8	76.9
	7218.0	73.0
	8120.3	74.6
915.00	1830.0	71.1
	2745.0	73.6
	3660.0	77.5
	4575.0	77.2
	5490.0	75.8
	6405.0	77.3
	7320.0	71.0
	8235.0	71.8
921.50	1843.0	72.6
	2764.5	75.3
	3686.0	76.0
	4607.5	77.3
	5529.0	76.1
	6450.5	75.2
	7372.0	70.5
	8293.5	70.6

Data was taken per 2.1051 and applicable parts of Part 90. Specifications of Paragraphs 2.1051, 2.1057 and 90.210(k)(3) are met. There are no deviations to the specifications.

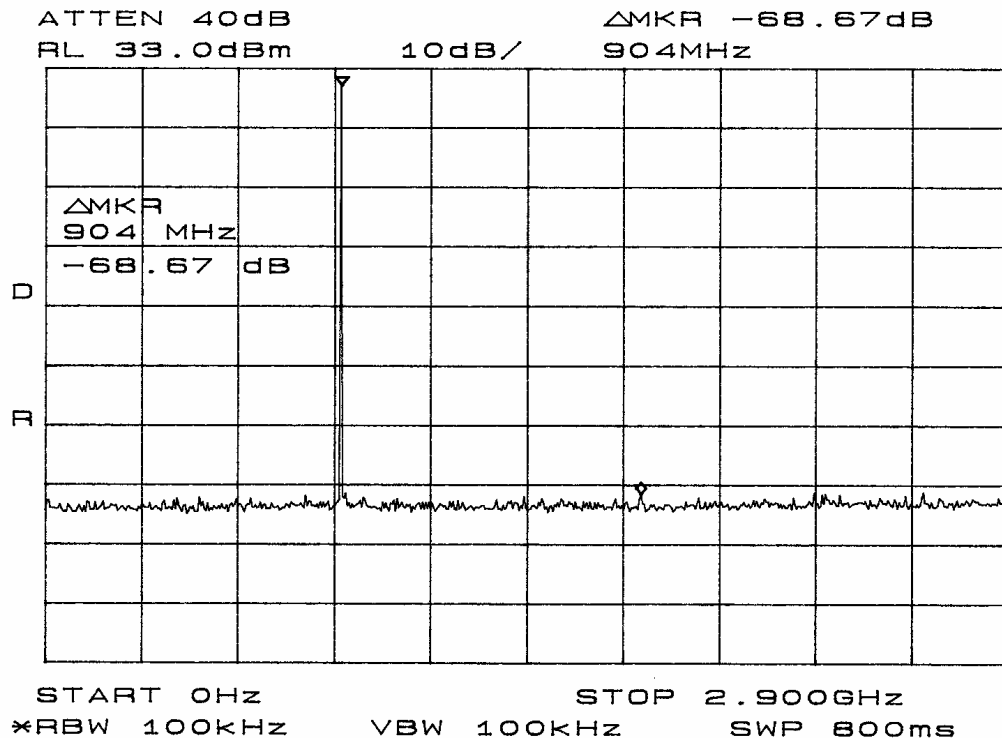


Figure 3 Emissions at Antenna Terminal

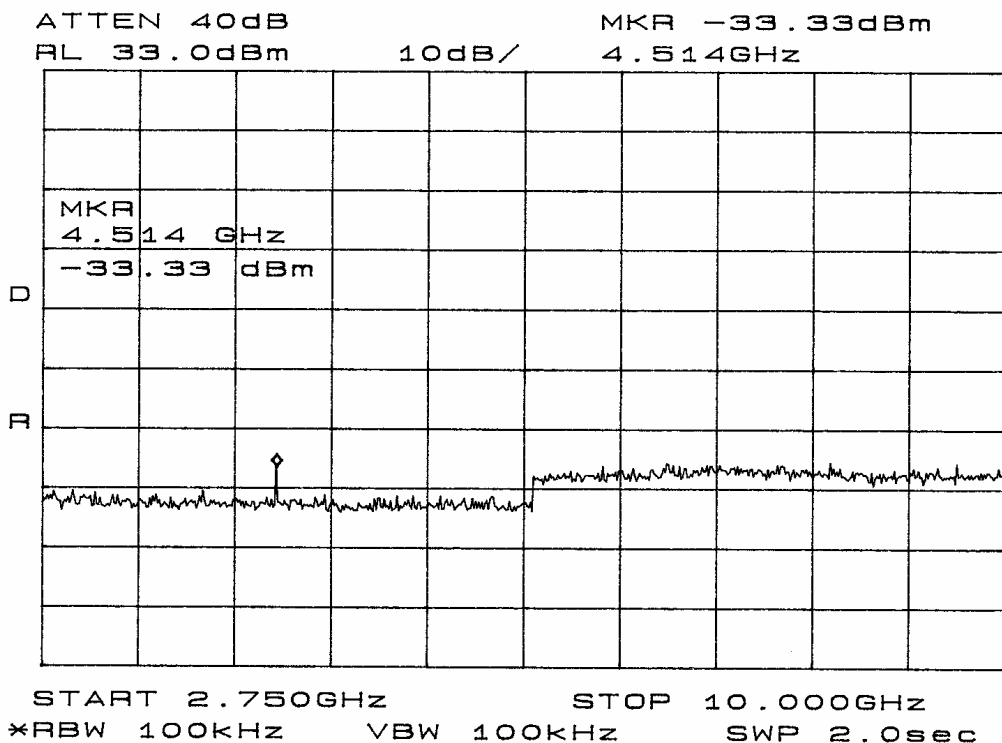


Figure 4 Emissions at Antenna Terminal

2.1053 Field Strength of Spurious Radiation

Measurements Required:

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation.

Test Arrangement:



The transmitter antenna port was connected to a 50-ohm load and placed on a wooden turntable 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. The turntable was rotated through 360 degrees to locate the position registering the highest amplitude emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter. Raising and lowering the FSM antenna and rotating the turntable to maximize the emission. Data was measured and recorded for the maximum amplitude of each spurious emission. A log periodic antenna was used for frequencies of 200 MHz to 5 GHz and pyramidal horn antennas were used for frequencies of 5 GHz to 40 GHz.

The substitution method was used to measure the spurious emissions. Emission levels from the EUT were measured and amplitude levels were recorded. The EUT transmitter was then removed and replaced with a substitution antenna, which was powered from a signal generator. The output signal from the generator was then adjusted such that the amplitude received was the same as that previously recorded for each frequency. This step was repeated for both horizontal and vertical polarizations. The power in dBm required to produce the desired signal level was then recorded from the

signal generator. The power in dBm was then calculated by reducing the previous readings by the gain in the substitution antenna. The testing procedures used conform to the procedures stated in the TIA/EIA-603 document. The limits for the spurious radiated emissions are defined by the following equation.

Limit = Amplitude of the spurious emission must be attenuated by this amount below the level of the fundamental. On any frequency removed from the assigned frequency outside the assigned sub-band edges: at least $55 + 10 \log (P_o)$ dB.

1.70-watt transmitter limit specifies the level below the carrier must be suppressed more than this amount.

$$\begin{aligned}\text{Attenuation} &= 55 + 10 \log_{10}(P_w) \\ &= 55 + 10 \log_{10}(1.7) \\ &= 57.3 \text{ dB}\end{aligned}$$

The radiated spurious emission below the carrier in dB is calculated from the following equation:

$$\begin{aligned}\text{Radiated spurious emission (dB)} &= \text{RSE} \\ \text{Radiated spurious emission (dB)} &= \\ &10 \log_{10}[\text{Tx power(W)}/0.001] - \text{signal level required to reproduce example:} \\ \text{RSE} &= 10 \log_{10}[1.7/0.001] - (-63.0) = 95.0 \text{ dBc}\end{aligned}$$

Results:

Frequency of Emission (MHz)	Amplitude of EUT Spurious emission		Signal level to substitution antenna required to reproduce		Emission level below carrier		Limit
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	
	dBm	dBm	dBm	dBm	dBc	dBc	dBc
1804.50	-83.4	-83.2	-63.0	-63.0	95.0	95.0	57.3
2706.80	-83.5	-83.4	-57.4	-57.3	89.4	89.3	57.3
3609.00	-83.9	-83.5	-55.0	-54.5	87.0	86.5	57.3
4511.25	-83.4	-83.2	-51.4	-51.2	83.4	83.2	57.3
1830.00	-83.4	-83.4	-63.3	-63.2	95.3	95.2	57.3
2745.00	-83.7	-83.7	-57.4	-57.3	89.4	89.3	57.3
3660.00	-83.2	-83.5	-54.8	-55.5	86.8	87.5	57.3
4575.00	-83.7	-83.7	-51.6	-51.8	83.6	83.8	57.3
1843.00	-83.7	-83.5	-63.6	-63.3	95.6	95.3	57.3
2764.50	-83.5	-83.4	-57.3	-57.2	89.3	89.2	57.3
3686.00	-84.4	-84.5	-54.9	-54.0	86.9	86.0	57.3
4607.50	-83.5	-83.7	-51.3	-51.8	83.3	83.3	57.3

Radiated (4 Highest Emissions General Emissions)

Freq. In MHz	FSM Hor. (dBμV)	FSM Vert. (dBμV)	Ant. Fact. (dB)	Amp. Gain (dB)	Comp. Hor. (dB?V/m) @ 3m	Comp. Vert. (dB?V/m) @ 3 m	FCC Limit (dBμV/m) @ 3 M
160.5	39.3	39.8	8.9	30	18.2	18.7	43.5
184.0	49.5	47.7	9.6	30	29.1	27.3	43.5
272.9	44.3	37.0	12.7	30	27.0	19.7	47.0
322.7	48.2	40.5	14.6	30	32.8	25.1	47.0
341.2	46.8	40.5	15.1	30	31.9	25.6	47.0
357.8	43.7	40.3	15.3	30	29.0	25.6	47.0

Other emissions present had amplitudes at least 20 dB below the limit.

Data was taken per 2.1051 and applicable parts of Part 90. Specifications of Paragraphs 2.1051, 2.1057 and 90.211(3) are met. There are no deviations to the specifications.

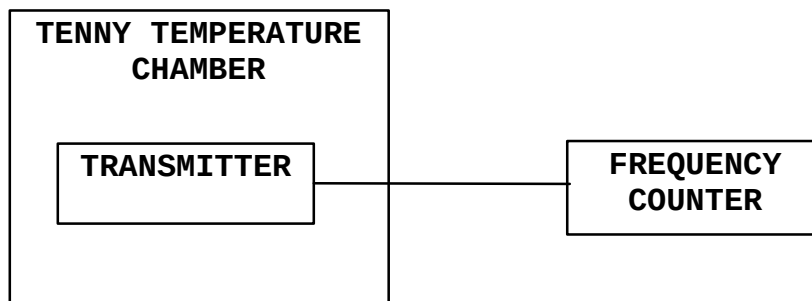
2.1055 Frequency Stability

Measurements Required:

Pursuant to 90.213(a), Note 13, frequency stability testing is not required. However, pursuant to good engineering practices, temperature stability was measured for the operating temperature range of the unit and recorded.

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
- (2) For hand carried, batteries powered equipment, reduce primary supply voltage to the battery-operating end point, which shall be specified by the manufacturer.
- (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided.

Test Arrangement:



The measurement procedure outlined below shall be followed:

Step 1: The transmitter shall be installed in an environmental test chamber whose temperature is controllable. Provision shall be made to measure the frequency of the transmitter.

Step 2: With the transmitter inoperative (power switched "OFF"), the temperature of the test chamber shall be adjusted to +25°C. After a temperature stabilization period of one hour at +25°C, the transmitter shall be switched "ON" with standard test voltage applied.

Step 3: The carrier shall be keyed "ON", and the transmitter shall be operated unmodulated at full r.f. power output at the duty cycle for which it is rated, for duration of at least 5 minutes. The radio frequency carrier frequency shall be monitored and measurements shall be recorded.

Step 4: The test procedures outlined in Steps 2 and 3, shall be repeated after stabilizing the transmitter at the environmental temperatures specified.

The frequency stability was measured with variations in the power supply voltage from 85 to 115 percent of the nominal value. An Elgar AC Power Source was used to vary the ac voltage for the power input from 102 Vac to 138 Vac. The frequency was measured and the variation in parts per million was calculated. Data was taken per Paragraphs 2.1055 and 90.213.

Results:

Nominal frequency 921.50000 MHz	FREQUENCY STABILITY VS TEMPERATURE IN PARTS PER MILLION (PPM) and percent								
	Temperature in °C								
	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	-250.0	-1050	-1310	-1080	-1050	-120	100	1690	1720
PPM	-0.27	-1.14	-1.42	-1.17	-1.14	-0.13	0.11	1.83	1.87
%	-0.00003	-0.0001	-0.0001	-0.0001	-0.0001	-0.00001	0.00001	0.0002	0.0002

FREQUENCY IN MHz	STABILITY VS VOLTAGE VARIATION ±15% IN PPM		
	INPUT VOLTAGE		
	11.48 V _{dc}	13.5 V _{dc}	15.53 V _{dc}
921.50000	0	0	0

Specifications of Paragraphs 2.1055 and 90.213 are met.
There are no deviations to the specifications.

APPENDIX

Model: AI 1401

1. Test Equipment List
2. Rogers Qualifications
3. FCC Site Approval Letter

TEST EQUIPMENT LIST FOR ROGERS LABS, INC.

The test equipment used is maintained in calibration and good operating condition. Use of this calibrated equipment ensures measurements are traceable to national standards.

<u>List of Test Equipment:</u>	<u>Calibration Date:</u>
Scope: Tektronix 2230	2/04
Wattmeter: Bird 43 with Load Bird 8085	2/04
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/04
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/04
R.F. Generator: HP 606A	2/04
R.F. Generator: HP 8614A	2/04
R.F. Generator: HP 8640B	2/04
Spectrum Analyzer: HP 8562A,	2/04
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
HP Adapters: 11518, 11519, 11520	
Spectrum Analyzer: HP 8591 EM	5/04
Frequency Counter: Leader LDC 825	2/04
Antenna: EMC0 Biconilog Model: 3143	5/04
Antenna: EMC0 Log Periodic Model: 3147	10/04
Antenna: Antenna Research Biconical Model: BCD 235	10/04
Antenna: EMC0 Dipole Set 3121C	2/04
Antenna: C.D. B-101	2/04
Antenna: Solar 9229-1 & 9230-1	2/04
Antenna: EMC0 6509	2/04
Audio Oscillator: H.P. 201CD	2/04
R.F. Power Amp 65W Model: 470-A-1010	2/04
R.F. Power Amp 50W M185- 10-501	2/04
R.F. PreAmp CPPA-102	2/04
LISN 50 μ Hy/50 ohm/0.1 μ f	10/04
LISN Compliance Eng. 240/20	2/04
Peavey Power Amp Model: IPS 801	2/04
Power Amp A.R. Model: 10W 1010M7	2/04
Power Amp EIN Model: A301	2/04
ELGAR Model: 1751	2/04
ELGAR Model: TG 704A-3D	2/04
ESD Test Set 2010i	2/04
Fast Transient Burst Generator Model: EFT/B-101	2/04
Current Probe: Singer CP-105	2/04
Current Probe: Solar 9108-1N	2/04
Field Intensity Meter: EFM-018	2/04
KEYTEK Ecat Surge Generator	2/04
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	

10/1/2004

QUALIFICATIONS
of
SCOT D. ROGERS, ENGINEER
ROGERS LABS, INC.

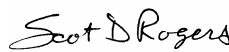
Mr. Rogers has approximately 17 years experience in the field of electronics. Six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

POSITIONS HELD:

Systems Engineer:	A/C Controls Mfg. Co., Inc. 6 Years
Electrical Engineer:	Rogers Consulting Labs, Inc. 5 Years
Electrical Engineer:	Rogers Labs, Inc. Current

EDUCATIONAL BACKGROUND:

- 1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.
- 2) Bachelor of Science Degree in Business Administration Kansas State University.
- 3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.


Scot D. Rogers

October 9, 2004
Date

1/11/02

FEDERAL COMMUNICATIONS COMMISSION

**Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046**

August 15, 2003

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053

Attention: Scot Rogers

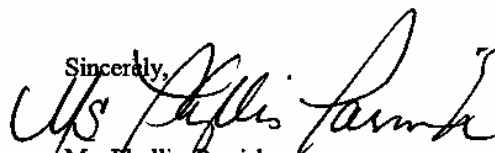
Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: August 15, 2003

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,



Ms. Phyllis Parrish
Information Technician