APPLICATION

For

GRANT OF CERTIFICATION

FOR

MODEL:

GWX 68
Airborne Weather Radar
P/N 011-00883-xx

FOR

GARMIN INTERNATIONAL, INC.

1200 East 151st Street
Olathe, KS 66062

ROGERS LABS, INC.

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

TEST REPORT

For

APPLICATION of CERTIFICATION

For

GARMIN INTERNATIONAL, INC.

1200 East 151st Street
Olathe, KS 66062
Phone: (913) 397-8200

Mr. Van Ruggles
Director of Quality Assurance

MODEL: GWX 68 PN 011-00883-XX

Aviation Weather Radar Equipment
FREQUENCY: 9300 – 9500 MHz

FCC ID: IPH-0060200

Test Date: May 17, 2005

Certifying Engineer: Scot D Rogers

Scot D. Rogers
ROGERS LABS, INC.
4405 West 259th Terrace
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FORWARD:

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2004, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.915, 2.925, 2.926, 2.1031 through 2.1057, applicable paragraphs of Parts 15, and 87(F), 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
120 kHz	300 kHz	Peak

2.1033(c) Application for Certification

(1) Manufacturer: GARMIN INTERNATIONAL, INC.
1200 East 151st Street
Olathe, KS 66062
PHONE: (913) 397-8200

(2) FCC Identification: Model GWX 68, FCC I.D.: IPH-0060200

(3) Copy of the installation and operating manual:
Refer to exhibit for Draft Instruction Manual.

(4) Emission Types: 8M0P0N

(5) Frequency Range: 9,350 MHz (typical); 9300-9500 MHz

(6) Operating Power Level: 7,500 Watts peak power
Average Power = 3.3 watts

(7) Max Power allowed as defined in 87:
As approved from the appropriate governmental agency.

(8) Power into final amplifier:
4800 Vdc @ 4A maximum = 19,200 watts
GWX 68 = 7.5 kW peak transmitter power
0.0109% duty cycle = 0.82 Watts average
0.0436% duty cycle = 3.3 Watts average

(9) Tune Up Procedure for Output Power:
Refer to Exhibit for Transmitter Alignment Procedure.

(10) Circuit Diagrams; description of circuits, frequency stability, spurious suppression, and power and modulation limiting:
Refer to Exhibit for Circuit Diagrams and band pass filter information. Refer to Exhibit for Theory of Operation.

(11) Photograph or drawing of the Identification Plate:
Refer to Exhibit for Photograph or Drawing.

(12) Drawings of Construction and Layout:
Refer to Exhibit for Drawings of Components Layout and Chassis Drawings.

(13) Detail Description of Digital Modulation:
Refer to exhibit for description of modulation.

(14) Data required by 2.1046 through 2.1057 is reported in this document.

(15) Application for certification of an external radio power amplifier operating under part 97 of this chapter.
This specification is not applicable to this device.

(16) Application for certification of AM broadcast transmitter.
This specification is not applicable to this device.

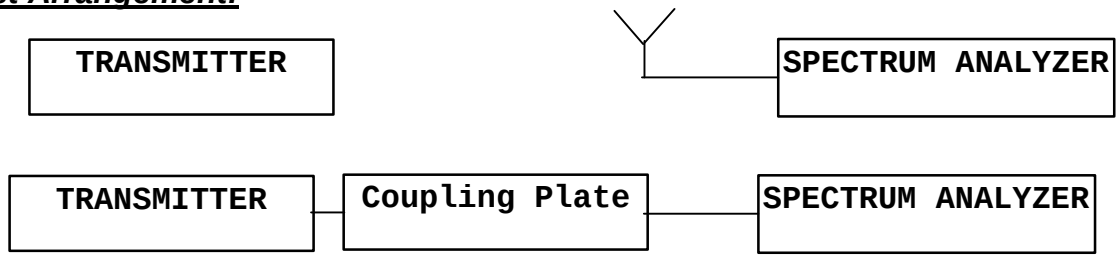
(17) A single application may be filed for a composite system that incorporates devices subject to certification under multiple rule parts; however, the appropriate fee must be included for each device.
The device is governed by CFR rule Part 80(E).

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 an open area test site with the transmitter operating in a test mode. The EUT was separated from the receiving system by a distance of three meters for maximum power output measurements. The unit was also measured by coupling the output energy through a coupling plate offering a 50-ohm termination to connect to the spectrum analyzer. The spectrum analyzer had an impedance of 50-ohm to match the impedance of the coupling plate. A HP 8562A Spectrum Analyzer was used to measure the radio frequency power both at the coupling plate output and at the three-meter distance. The data was taken in dBmV/m and effective isotropic radiated power was then calculated as shown in the following Table.

Results:

E(v/m) = 10^((dBmv/m – 120)/20) and EIRP = $(Ed)^2/30g$
Using d = 3 meters and g = 446.7 (numeric gain of 26.5B antenna)

Measured emission dBmV/m@ 3m	Antenna Factor dB/m	Calculated emission level dBmV/m@ 3m	Calculated field strength v/m	Calculated EIRP Watts
120.0	38.1	158.1	80.4	4.33

The average power output was also calculated using the duty cycle of operation.

P(ave) = Po x duty cycle

Example:
Power calculation for the shortest range of operation.
P(ave) = 7500 watts x 0.000109
P(ave) = 0.82 watts

Power calculation for the longest operational range.
P(ave) = 7500 watts x 0.000436
P(ave) = 3.3 watts

GWX 68 calculated output power

P(ave) Watts	P(peak)	Duty Cycle
0.82	7.50E+03	0.0109%
3.3	7.50E+03	0.0436%

Refer to figure one displaying the spectrum analyzer screen with the analyzer connected to the coupling plate.

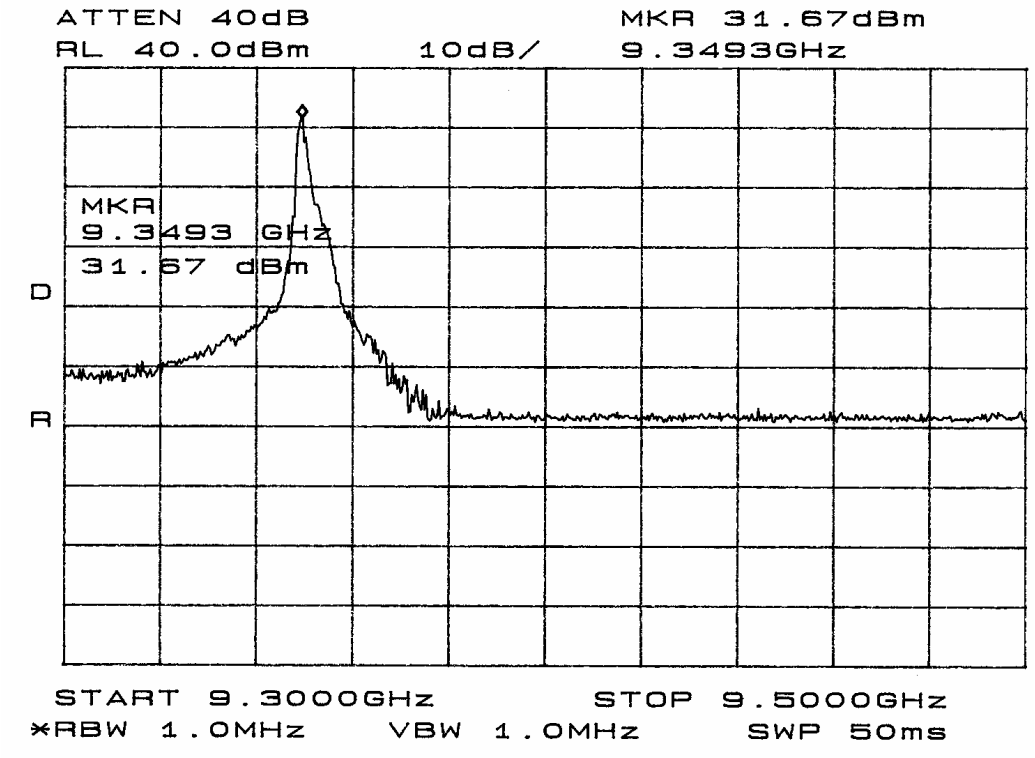


Figure one Plot of analyzer screen showing power output.

Data was taken per Paragraph 2.1046(a) and applicable parts of Part 87. The specifications of Paragraph 2.1046(a) and applicable Parts of 87 are met. There are no deviations to the specifications.

2.1047 Modulation Characteristics

Measurements Required:

A curve or equivalent data, which 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 EUT transmits no message and uses no modulation. Therefore, no curves are supplied.

Results:

The EUT transmits no message and uses no modulation. Therefore, no curves are supplied. The specifications of Paragraph 2.1047 and applicable parts of 87 are met.

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.

Test Arrangement:

The occupied bandwidth was measured by coupling the output energy through a coupling plate offering a 50-ohm termination to connect the spectrum analyzer. The spectrum analyzer had an impedance of 50-ohm to match the impedance of the coupling plate termination. A HP 8562A Spectrum Analyzer was used to measure the 20-dB occupied bandwidth at the coupling plate.

Results:

f_c (MHz)	O.B.(MHz)
9350.0	8.00

A spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in a normal mode. The power ratio in dB representing the 20 dB bandwidth was recorded from the spectrum analyzer. Data for the occupied bandwidth was taken using the coupling plate cover and connecting the output to the spectrum analyzer. Refer to figure two displaying the analyzer screen with the analyzer connected to the coupling plate.

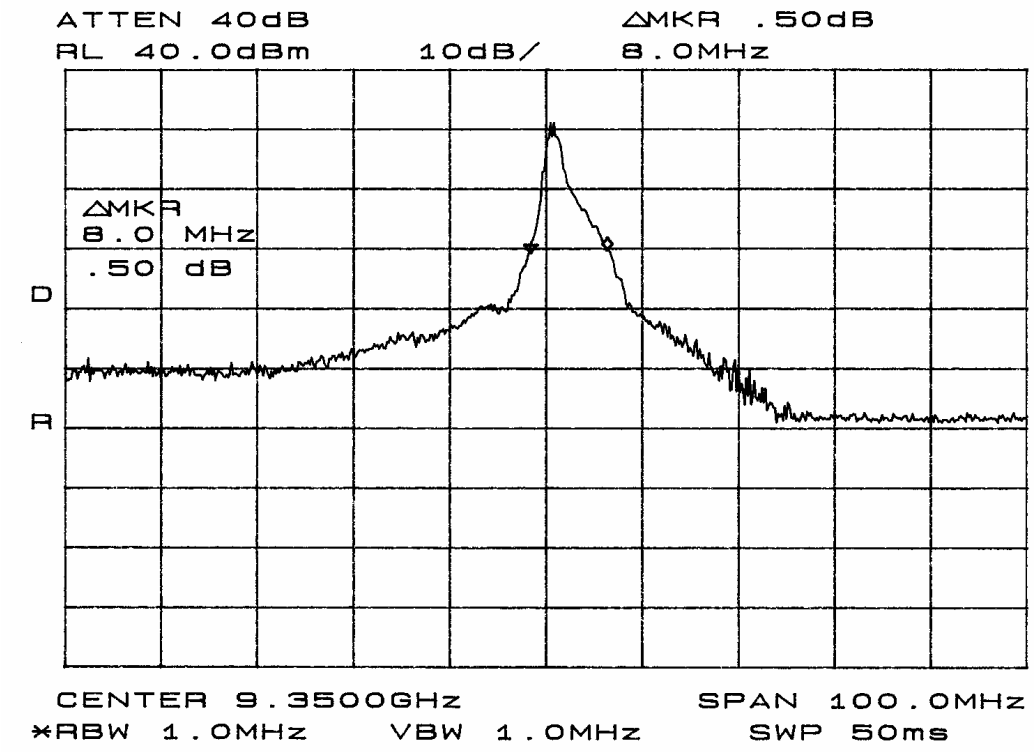


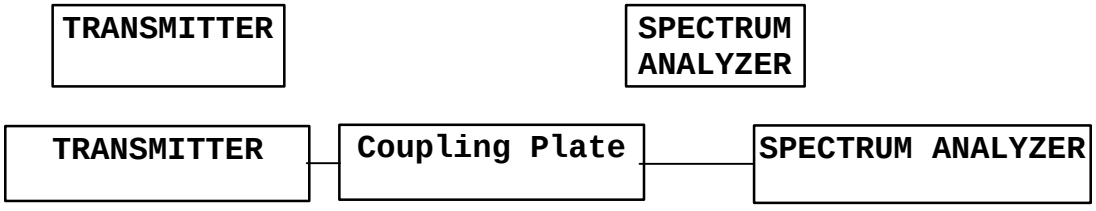
Figure two Plot of analyzer screen showing occupied bandwidth.

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 spurious emission of the second harmonic was measured using the coupling plate and harmonics up to the tenth were measured at an open area test site with the transmitter operating in a test mode. The EUT was separated from the receiving system by a distance of three meters for spurious emission measurements. A HP 8562A Spectrum Analyzer was used to measure

Results:

The EUT has no provision to connect directly to the output of the transmitter. The use of the coupling plate was used to view the output of the transmitter for the fundamental and first harmonic. Spurious frequency emissions were measured at the OATS at a distance of three meters. Refer to figures three and four showing the analyzer screen display of the fundamental and first harmonic output as measured through the coupling plate.

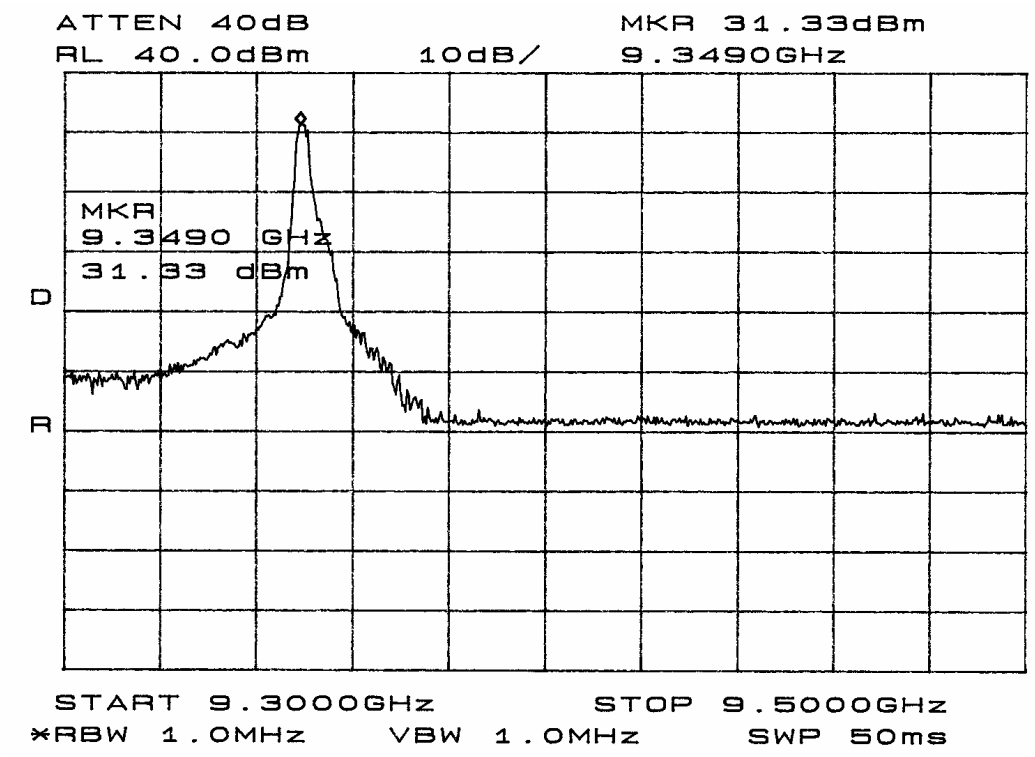


Figure three Plot of analyzer screen showing fundamental output.

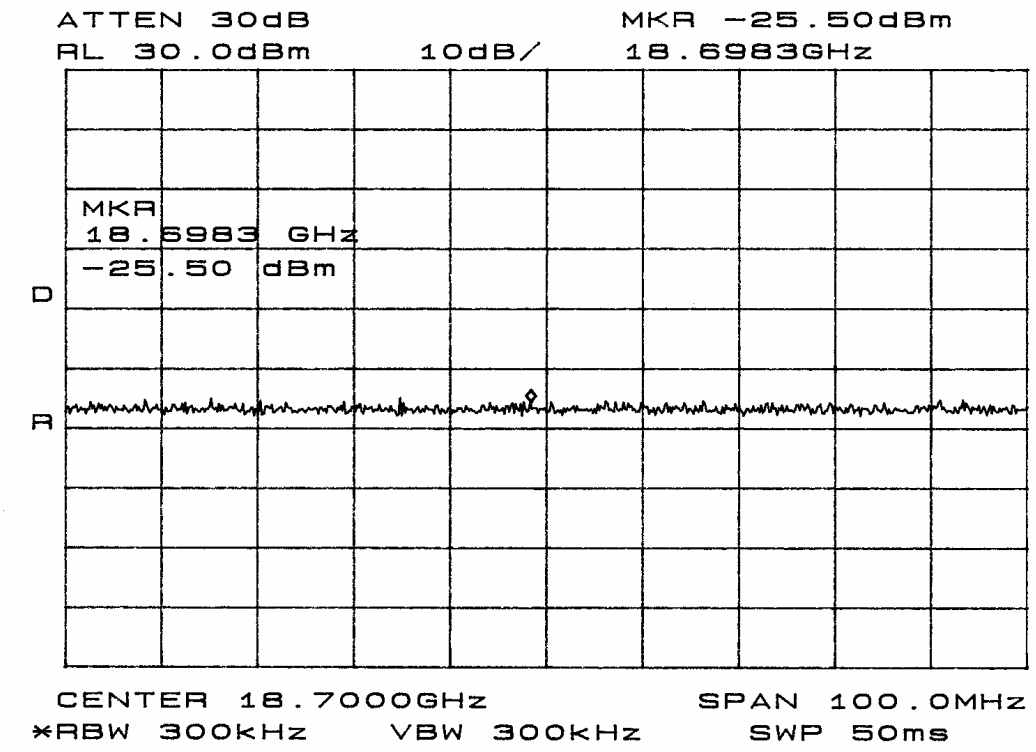


Figure four Plot of analyzer screen showing first harmonic output.

FCC Limit:
3.3 Watt = 43 + 10 LOG(P_o)
= 43 + 10 LOG(3.3)
= 48.2

3.3 Watt Average Output

CHANNEL MHz	SPURIOUS FREQ. (MHz)	LEVEL BELOW CARRIER (dB)
9,350	18,700	-56.8

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:

TRANSMITTER **ANTENNA** **SPECTRUM ANALYZER**

The transmitter was placed on a platform at a distance of 3 meters from the FSM antenna. With the EUT radiating into the standard attached antenna, the receiving antenna was raised and lowered to obtain the maximum reading of spurious radiation from the EUT on the spectrum analyzer. The platform was rotated though 360 degrees to locate the position registering the highest amplitude of emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter. The amplitude of each spurious emission was maximized by raising and lowering the FSM antenna, and rotating the EUT before final data was recorded. Data presented below demonstrates the general emissions from the EUT and support equipment and harmonic spurs. Plots were made of the spectrum analyzer display showing emission levels recorded at a one-meter distance in a screen room. Refer to figures five through nine showing general radiated emission levels taken in the screen room.

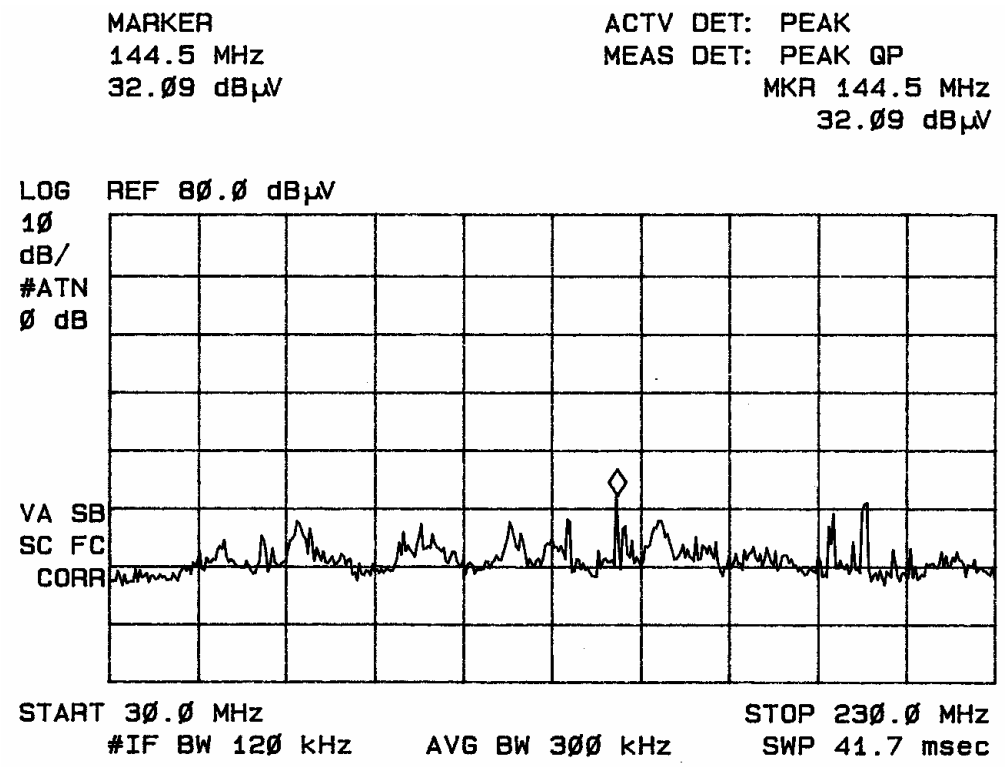


Figure five Plot of analyzer display showing emissions at 1 meter.

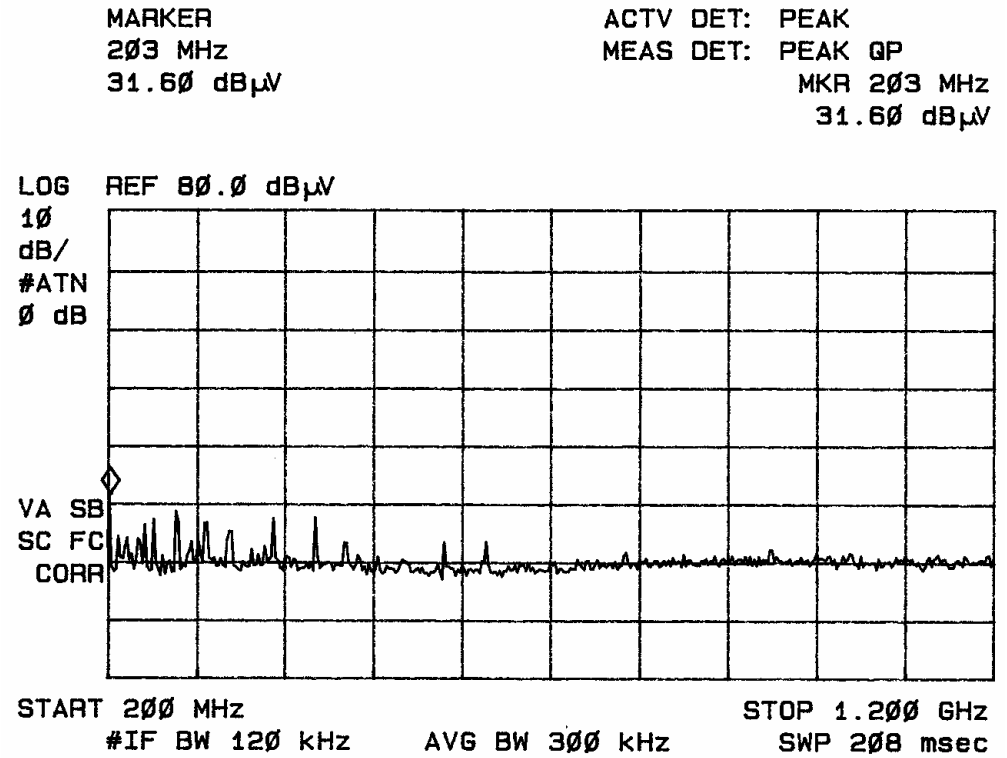


Figure six Plot of analyzer display showing emissions at 1 meter.

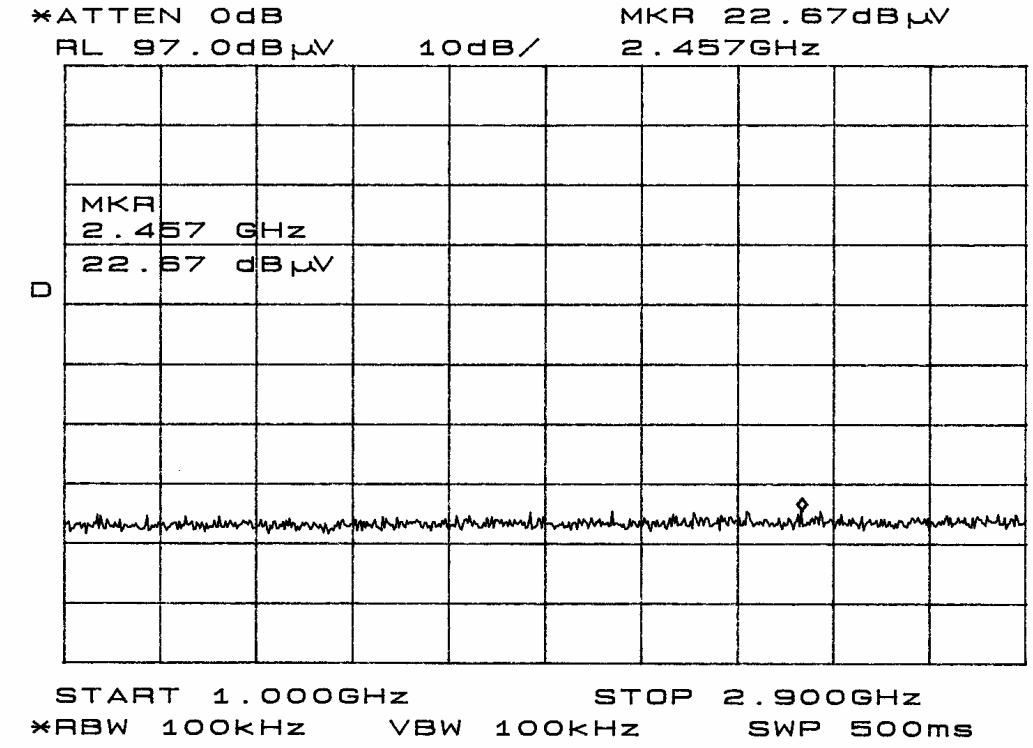


Figure seven Plot of analyzer display showing emissions at 1 meter.

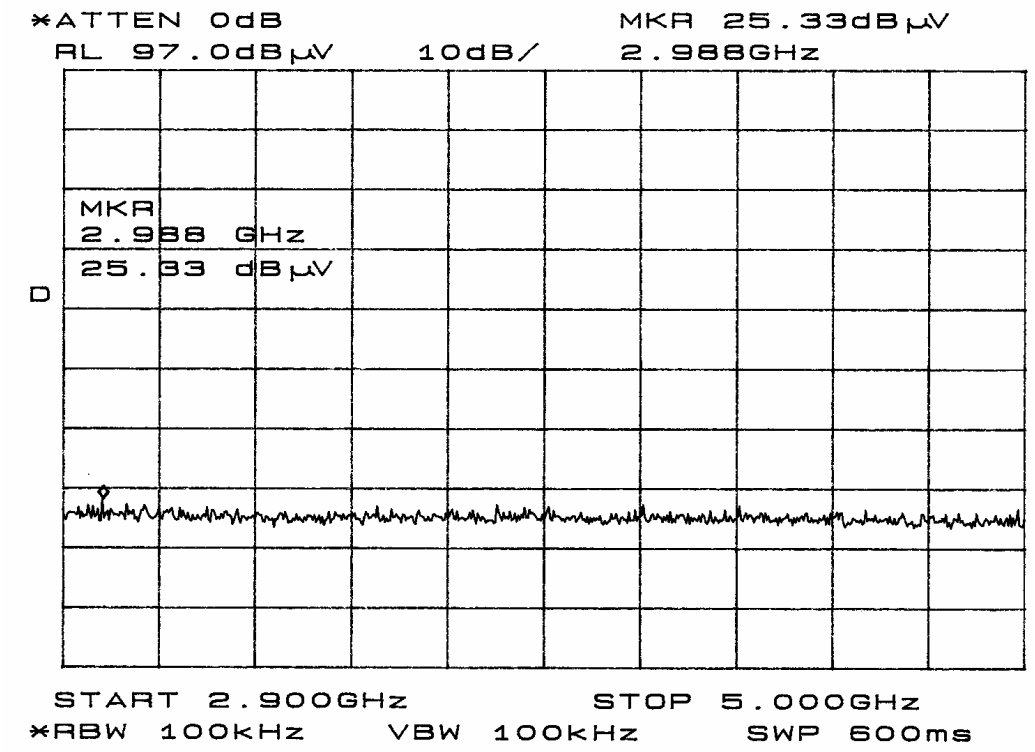


Figure eight Plot of analyzer display showing emissions at 1 meter.

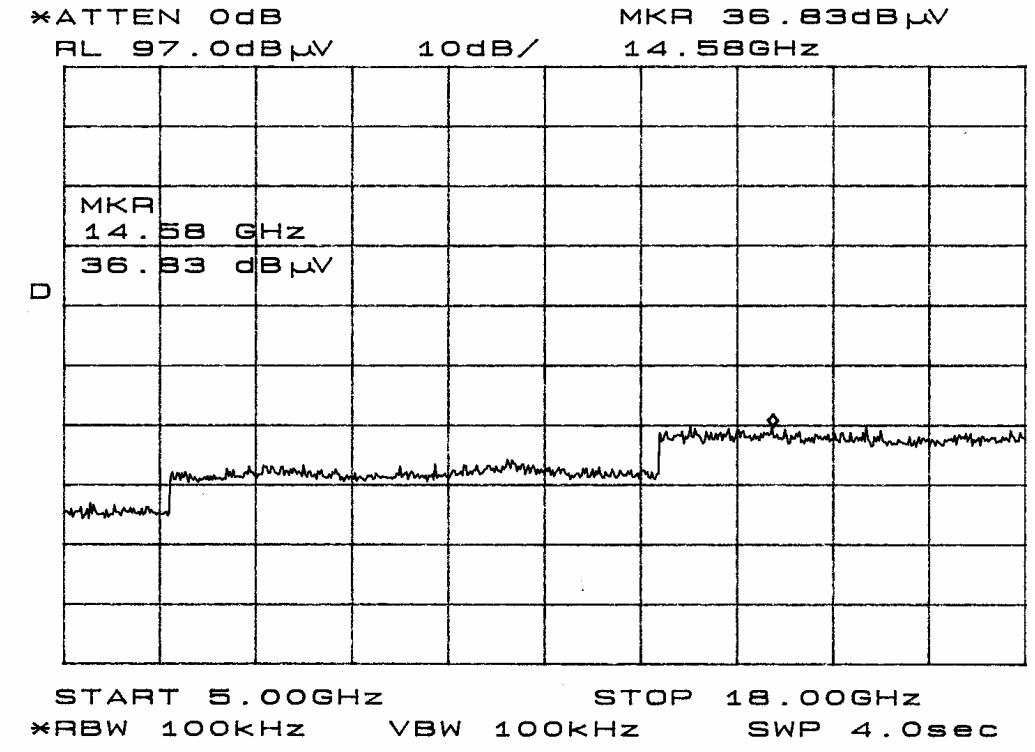


Figure nine Plot of analyzer display showing emissions at 1 meter.

Results:

The EUT was connected to the standard antenna and set to transmit in a normal test mode of operation. The amplitude of each spurious emission was then maximized and recorded. Measurements were made at a distance of three meters at the OATS.

Calculations made are as follows:

CFS = Calculated Field Strength
FSM = Field Strength Measurement
CFS = FSM + Antenna Factor – amplifier gain
Example:
CFS = 54.8 + 8.4 - 30
CFS = 33.2

The limit for harmonics emissions are defined by the following equations:

Limit = Amplitude of spurious emission must be attenuated by this amount below the level of the fundamental. Calculating the field strength at 3 meters for the transmitter was done as follows:

On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth: at least 43 + 10 Log (P_o) dB.

Attenuation = 43 + 10 $Log_{10}(P_w)$
= 43 + 10 $Log_{10}(3.3)$
= 48.2 dB

Limit = 158.5 – 48.2
= 110.3

General emissions

Freq. In MHz	FSM Hor. QP (dBµV)	FSM Vert. QP (dBµV)	Ant. Fact. (dB)	Amp. Gain (dB)	Comp. Hor. (dBµV/m) @ 3 m	Comp. Vert. (dBµV/m) @ 3 m	FCC Limit (dBµV/m) @ 3m
133.2	54.8	50.0	8.4	30	33.2	28.4	43.5
144.0	47.4	46.9	11.8	30	29.2	28.7	43.5
154.3	52.6	46.6	9.1	30	31.7	25.7	43.5
200.0	46.3	51.8	10.6	30	26.9	32.4	43.5
240.0	52.7	52.8	11.8	30	34.5	34.6	46.0
275.2	53.8	42.2	12.7	30	36.5	24.9	46.0

Other emissions present had amplitudes at least 10 dB below the limit.

Harmonic emissions

Frequency In MHz	FSM Hor. Ave. (dBµV)	FSM Vert. Ave. (dBµV)	Ant. Fact. (dB)	Comp. Hor. (dBµV/m) @ 3 m	Comp. Vert. (dBµV/m) @ 3 m	FCC Limit (dBµV/m) @ 3m
9350	120.0	58.8	38.1	158.1	96.9	
18700	38.5	38.5	22.0	60.5	60.5	110.3
28050	33.7	33.7	24.0	57.7	57.7	110.3
37400	32.0	32.0	24.0	56.0	56.0	110.3
46750	35.0	34.7	23.0	58.0	57.7	110.3
56100	32.8	32.7	21.0	53.8	53.7	110.3
65450	31.8	31.5	34.0	35.8	35.5	110.3
74800	31.7	31.9	35.0	66.7	66.9	110.3
84150	31.4	31.7	38.0	69.4	69.7	110.3
93500	31.7	31.3	39.0	70.7	70.3	110.3

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

All other measured spurious emissions where 20 db or more below the specified limit. Specifications of Paragraph 2.1053, 2.1057, applicable paragraphs of part 87 are met. There are no deviations to the specifications.

2.1055 Frequency Stability

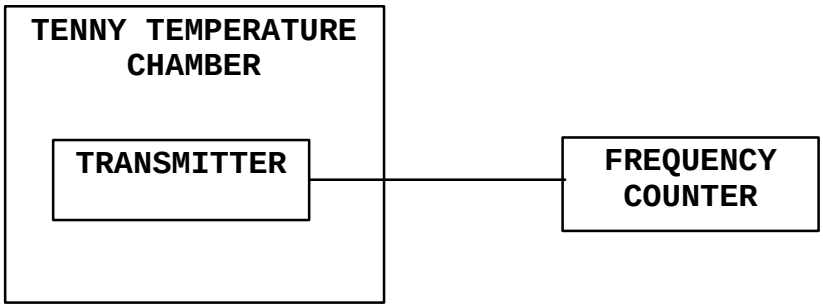
Measurements Required:

The frequency stability shall be measured with variations of ambient temperature from -30° to +50° centigrade. Measurements shall be made at the extremes of the temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. In addition to temperature stability the frequency stability shall be measured with variation of primary supply voltage as follows:

(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:

Steps 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 radio frequency power output at the duty cycle, for which it is rated, for a 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, -30°C to 50°C in 10 degree increments.

Results:

The requirements of CFR47 Part 87 subpart F require the unit to remain within the 9300-9500 MHz frequency band.

FREQ. (MHz) 9353.47	FREQUENCY STABILITY VS TEMPERATURE IN PARTS PER MILLION (PPM)								
	Temperature in ℃								
	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (MHz)	10.3	9.5	7.3	4.4	3.8	-0.02	6.2	5.7	3.6

The unit remained in the frequency band of operation during power variations and over the temperature range specified. Specifications of Paragraphs 2.1055 and applicable paragraphs of part 87 are met. There are no deviations to the specifications.

APPENDIX

Model: GWX 68

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

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

List of Test Equipment:	Calibration Date:
Scope: Tektronix 2230	2/05
Wattmeter: Bird 43 with Load Bird 8085	2/05
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/05
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/05
R.F. Generator: HP 606A	2/05
R.F. Generator: HP 8614A	2/05
R.F. Generator: HP 8640B	2/05
Spectrum Analyzer: HP 8562A, Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W HP Adapters: 11518, 11519, 11520	2/05
Spectrum Analyzer: HP 8591 EM	5/05
Frequency Counter: Leader LDC 825	2/05
Antenna: EMCO Biconilog Model: 3143	5/05
Antenna: EMCO Log Periodic Model: 3147	10/04
Antenna: Antenna Research Biconical Model: BCD 235	10/04
Antenna: EMCO Dipole Set 3121C	2/05
Antenna: C.D. B-101	2/05
Antenna: Solar 9229-1 & 9230-1	2/05
Antenna: EMCO 6509	2/05
Audio Oscillator: H.P. 201CD	2/05
R.F. Power Amp 65W Model: 470-A-1010	2/05
R.F. Power Amp 50W M185- 10-501	2/05
R.F. PreAmp CPPA-102	2/05
LISN 50 µHy/50 ohm/0.1 µf	10/04
LISN Compliance Eng. 240/20	2/05
Peavey Power Amp Model: IPS 801	2/05
Power Amp A.R. Model: 10W 1010M7	2/05
Power Amp EIN Model: A301	2/05
ELGAR Model: 1751	2/05
ELGAR Model: TG 704A-3D	2/05
ESD Test Set 2010i	2/05
Fast Transient Burst Generator Model: EFT/B-101	2/05
Current Probe: Singer CP-105	2/05
Current Probe: Solar 9108-1N	2/05
Field Intensity Meter: EFM-018	2/05
KEYTEK Ecat Surge Generator	2/05
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	

5/3/2005

QUALIFICATIONS

Of

SCOT D. ROGERS, ENGINEER

ROGERS LABS, INC.

Mr. Rogers has approximately 16 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 _____
Scot D. Rogers

May 17, 2005
Date

1/08/2003

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