APPLICATION

For

FCC

And

INDUSTRY CANADA

GRANT OF CERTIFICATION

FOR

Model: GMR 40X

Model numbers

GMR 404 AND GMR 406
Marine Radar Equipment
P/N 011-01272-2x

Test Report Number: 060406

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

Marine transmitter

(CFR 47 part 80, RSS-138)

For

GARMIN INTERNATIONAL, INC.

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

Mr. Van Ruggles
Director of Quality Assurance

MODELS: **GMR 404 AND GMR 406**
GPN: 011-01272-2x

Marine Radar Equipment
FREQUENCY: 9300 – 9500 MHz

FCC ID: IPH-00991
IC: 1792A-00991

Test Date: April 6, 2006

Certifying Engineer: Scot D Rogers

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

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FORWARD

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2005, 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, 80(E), and RSS-138 the following information 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.

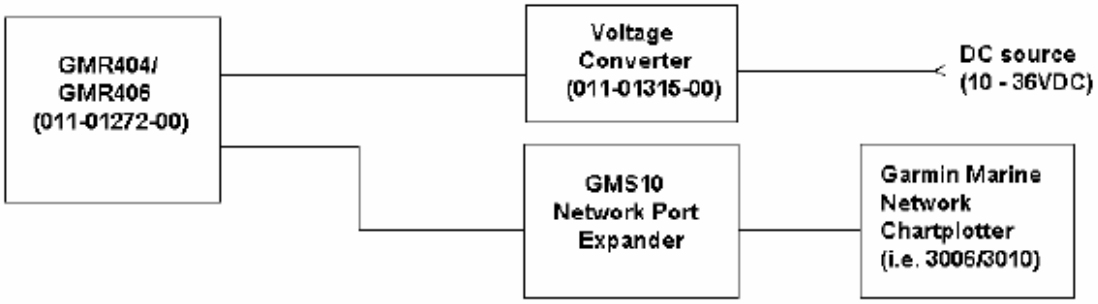
HP 8591EM SPECTRUM ANALYZER SETTINGS		
CONDUCTED EMISSIONS:		
RBW	AVG. BW	DETECTOR FUNCTION
9 kHz	30 kHz	Peak/Quasi Peak
RADIATED EMISSIONS (30 – 1000 MHz):		
RBW	AVG. BW	DETECTOR FUNCTION
120 kHz	300 kHz	Peak/Quasi Peak
HP 8562A SPECTRUM ANALYZER SETTINGS		
RADIATED EMISSIONS (1 – 40 GHz):		
RBW	AVG.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

Equipment Configuration

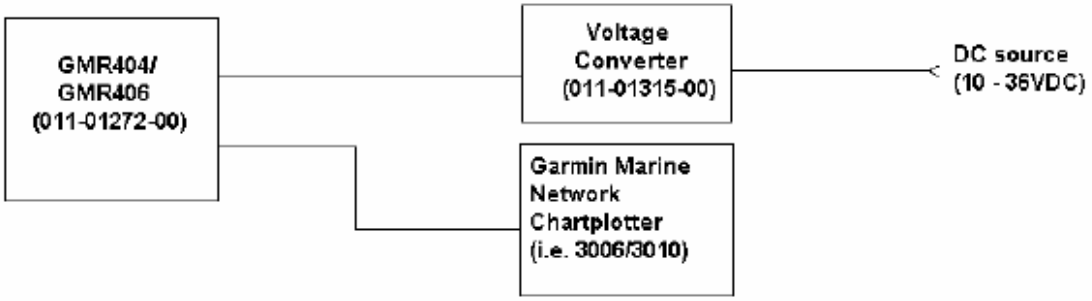
GARMIN®

Configurations for the GMR404 / GMR406

1. Use of network expander (GMS10) in Marine Network.



1. GMR404 / GMR406 with display only.



NOTE: A computer with:
- a network interface
- appropriate software
- a switch pulling marine network pins 4 and 5 to ground can be used in place of the chartplotter.

Frequencies generated by GMR404 / GMR406
200kHz
250kHz
16MHz
25MHz

2.1033(c) Application for Certification

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

(2) FCC and IC Identification: Model GMR 404 AND GMR 406, FCC I.D.: IPH-00991 IC: 1792A-00991

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

(4) Emission Type: 80M0P0N

(5) Frequency Range: 9,407 MHz (typical); 9300-9500 MHz

(6) Operating Power Level: 4,000 Watts peak power
Average Power = 2.3 watts

(7) Max Power allowed as defined in 80.215(M)(3):
20.0 Watts EIRP.

(8) Power into final amplifier:
3650 Vdc @ 3.1A maximum = 11,315 watts
GMR 40X = 4 kW peak transmitter power
65ns pulse = 0.601 Watts average
80ns pulse = 0.739 Watts average
200ns pulse = 0.925 Watts average
250ns pulse = 1.156 Watts average
500ns pulse = 1.152 Watts average
800ns pulse = 1.873 Watts average
1000ns pulse = 2.304 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.

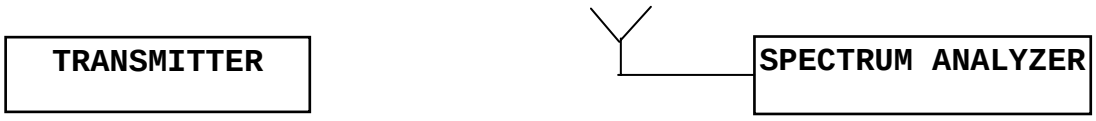
(17) A single application may be filed for a composite system that incorporates devices subject to certification under multiple rule parts; however, the appropriate fee must be included for each device.
The device is governed by CFR rule Part 80(E).

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 ten meters for maximum power output measurements. The spectrum analyzer had an impedance of

50Ω to match the impedance of the receiving antenna. A HP 8562A Spectrum Analyzer was used to measure the radio frequency power at a ten-meter distance. The data was taken in dBµV/m and effective isotropic radiated power was then calculated as shown in the following Table for the two antenna options.

E(v/m) = 10^((dBµV/m – 120)/20) and EIRP = $(Ed)^2/30g$
Using d = 10 meters and g = 708 (numeric gain of 28.5 dB antenna)
GMR 404 (4-foot antenna)

Transmitter Range Setting	Measured emission dBµV/m@10m	Antenna Factor dB/m	Calculate emission level dBµV/m@10m	Calculated field strength v/m	Calculated EIRP Watts
24 NM	122.3	38.1	160.4	104.7	51.6
3 NM	117.0	38.1	155.1	56.9	15.2
1/8 NM	111.5	38.1	149.6	30.2	4.3

E(v/m) = 10^((dBµV/m – 120)/20) and EIRP = $(Ed)^2/30g$
Using d = 10 meters and g = 1122 (numeric gain of 30.5 dB antenna)
GMR 406 (6-foot antenna)

Transmitter Range Setting	Measured emission dBµV/m@10m	Antenna Factor dB/m	Calculate emission level dBµV/m@10m	Calculated field strength v/m	Calculated EIRP Watts
24 NM	124.4	38.1	162.5	133.4	52.8
3 NM	118.5	38.1	156.6	67.6	13.6
1/8 NM	113.3	38.1	151.4	37.2	4.1

The average power output was also calculated using the pulse width and pulse repetition frequency, which define the duty cycle.

P(ave) = Po x duty factor
Duty factor = Pulse width (PW) x Pulse repetition (PRF)
Example:
P(ave) = 4000 watts x 65nS (PW) x 2310 (PRF)
P(ave) = 0.601 watts

GMR 404 and GMR 406 output power

Range (Nm)	Pulse Width (ns)	Pulse Repition Frequency (Hz)	Calculated Average Power (Watts)
0.125	65	2310	0.601
0.250	65	2310	0.601
0.500	80	2310	0.739
0.750	200	1156	0.925
1.000	250	1156	1.156
1.500	500	576	1.152
2.000	500	576	1.152
3.000	800	576	1.843
4.000	800	576	1.843
6.000	1000	576	2.304
8.000	1000	576	2.304
12.000	1000	576	2.304
16.000	1000	576	2.304
24.000	1000	576	2.304
36.000	1000	576	2.304
48.000	1000	288	1.152
64.000	1000	288	1.152
72.000	1000	288	1.152

Plots were taken of the spectrum analyzer display showing the peak output power as measured at 10 meters distance on the OATS.

Data was taken per Paragraph 2.1046(a) and applicable parts of Part 80. The specifications of Paragraph 2.1046(a) and applicable Parts of 80.215 and RSS-138 are met. There are no deviations to the specifications.

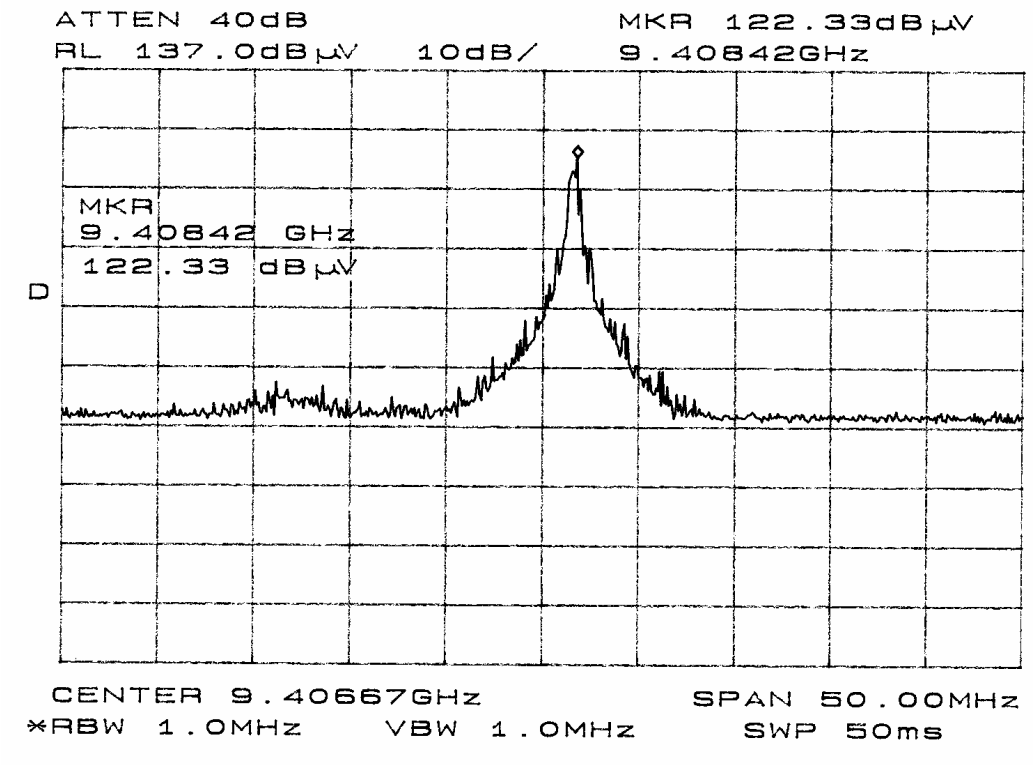


Figure 1
Plot of analyzer screen showing power output at 10 meters distance.

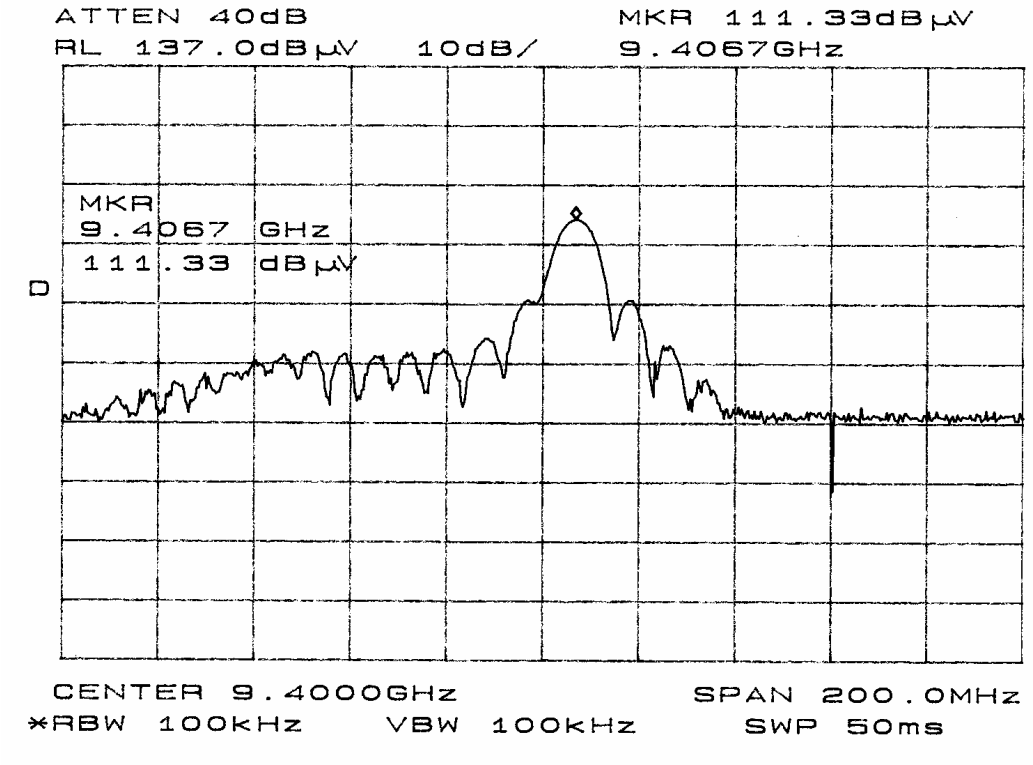


Figure2
Plot of analyzer screen showing power output at 10 meters distance.

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 80 and RSS-138 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.

Results

f_c (MHz)	Observed Occupied Bandwidth(MHz)
9406.0	12.3

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 observed at the RLI OATS using appropriate antennas. Refer to figure three displaying the analyzer screen with the analyzer connected to the receiving antenna. Data for the occupied bandwidth was also taken by RF Metrics

Corporation; refer to measurement report for references. The specifications of Paragraph 2.1047 and applicable parts of 80 and RSS-138 are met.

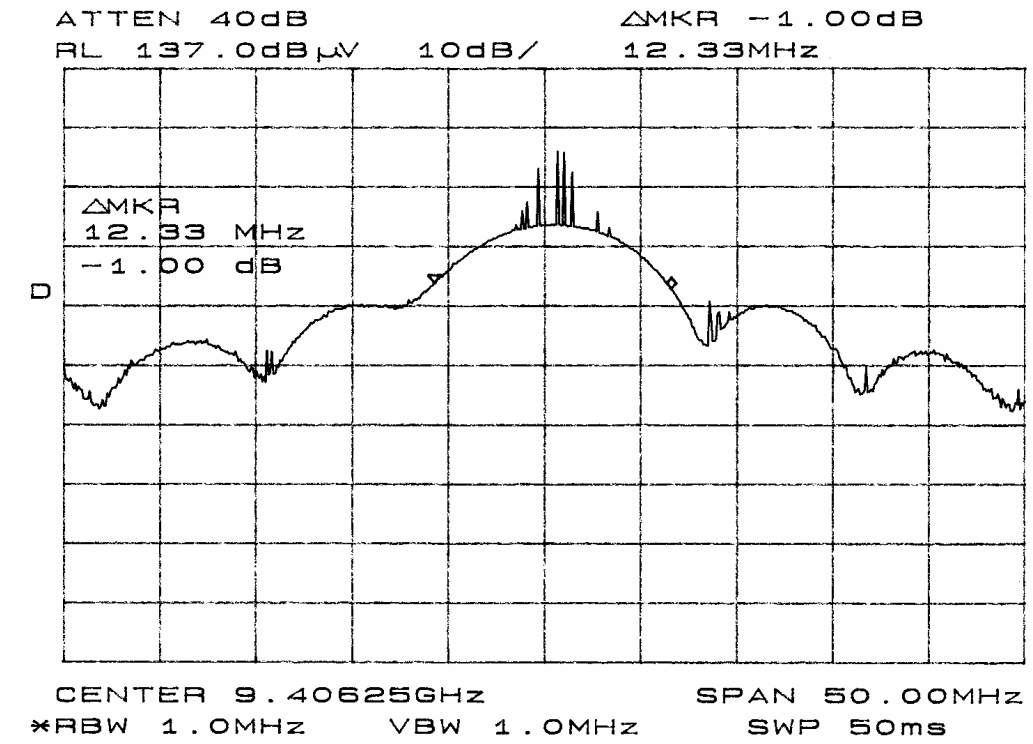


Figure three Plot of analyzer screen showing occupied bandwidth.

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

Results

The EUT has no provision to connect directly to the output of the transmitter. Therefore, compliance to the specifications is shown in other data presented with this report. The specifications of Paragraph 2.1047 and applicable parts of 80 and RSS-138 are met.

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 was placed on a platform at a distance of 3 meters from the FSM antenna. With the EUT radiating into a 50-ohm load attached to the antenna port, 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 four through nine showing general radiated emission levels taken in the screen room.

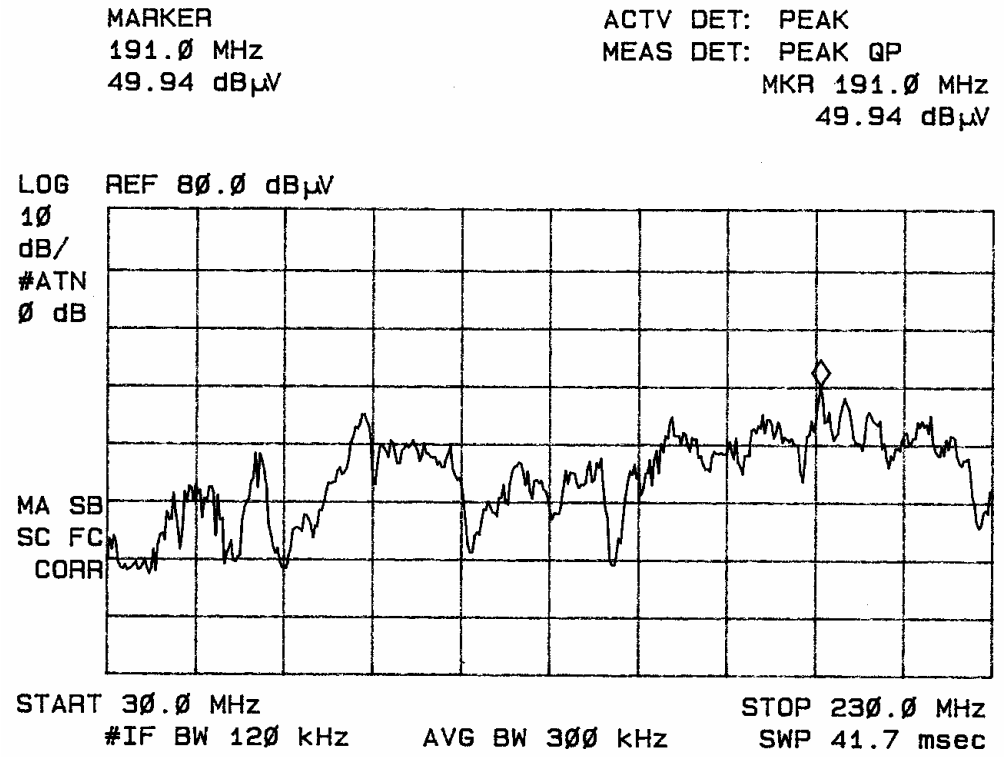


Figure four Plot of analyzer display showing emissions at 1 meter.

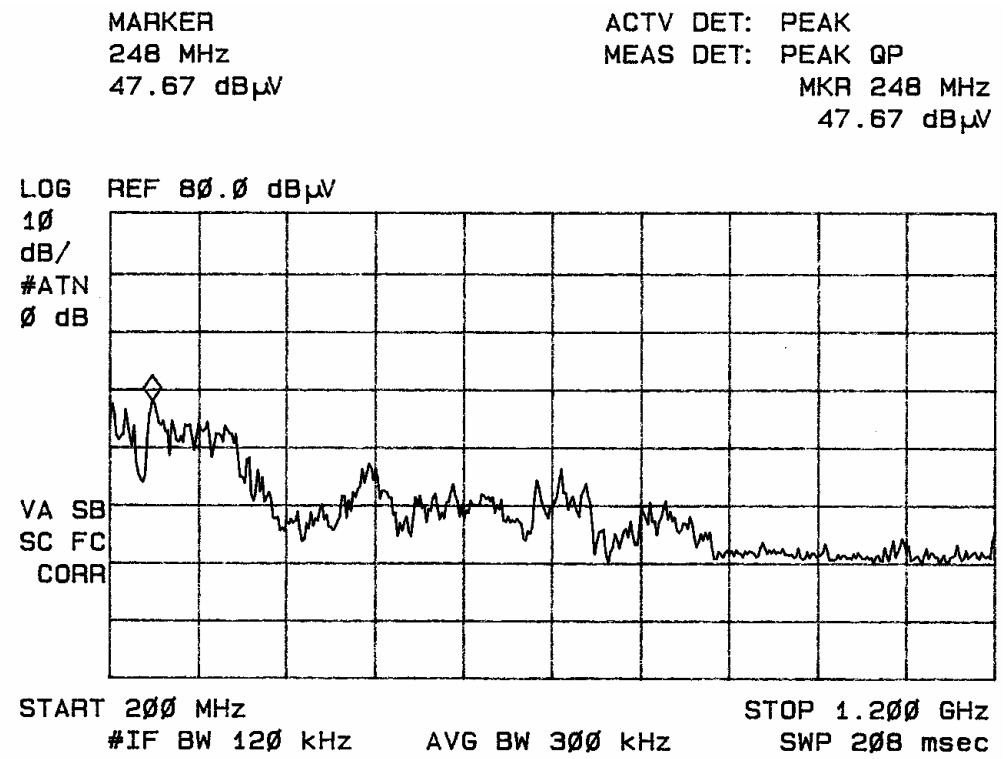


Figure five Plot of analyzer display showing emissions at 1 meter.

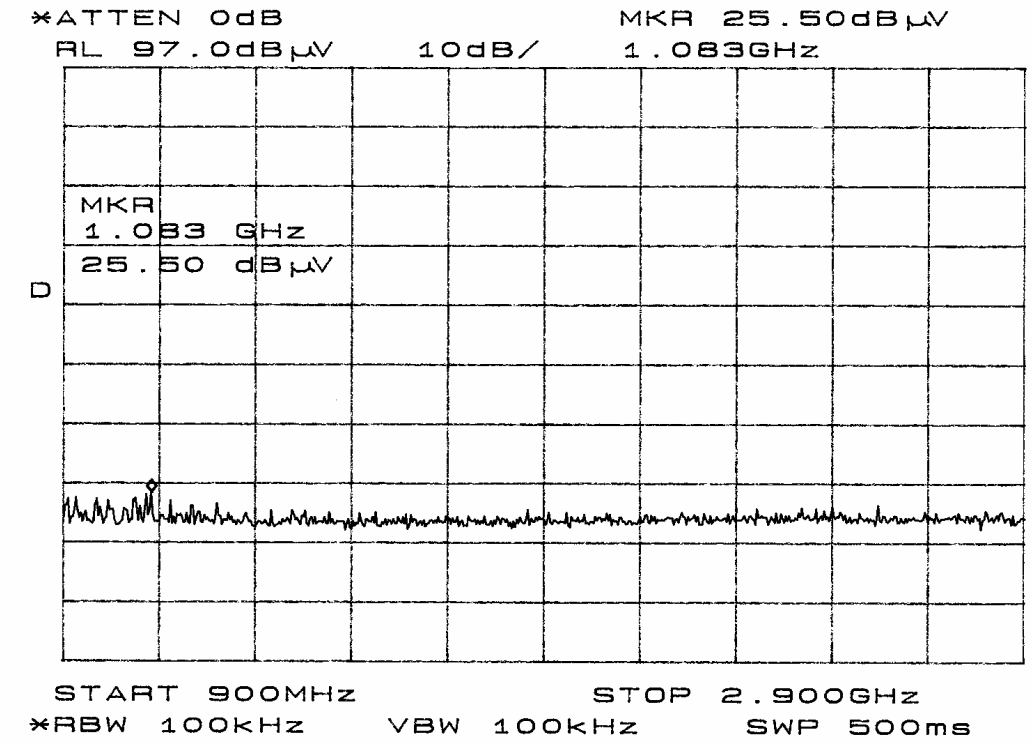


Figure six Plot of analyzer display showing emissions at 1 meter.

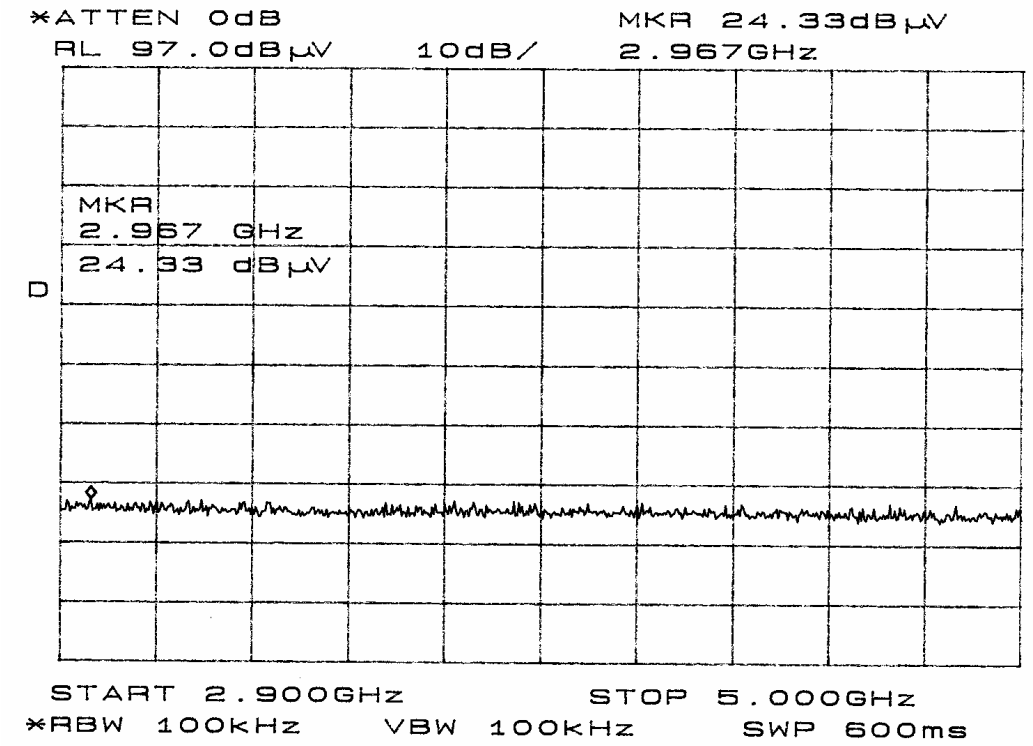


Figure seven Plot of analyzer display showing emissions at 1 meter.

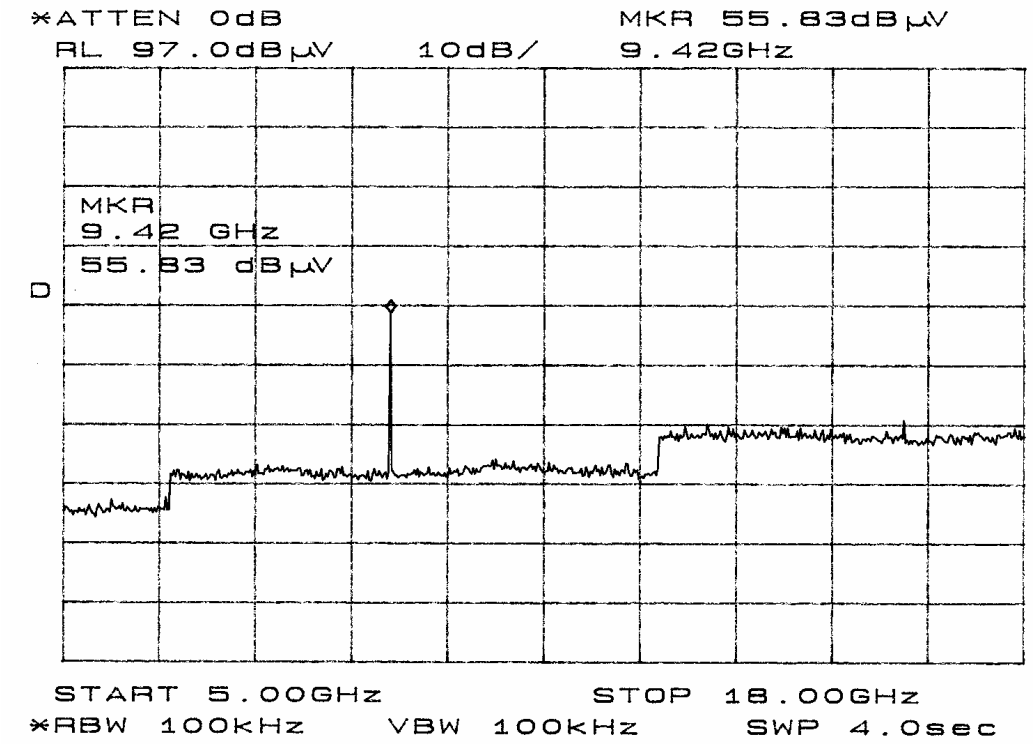


Figure eight Plot of analyzer display showing emissions at 1 meter.

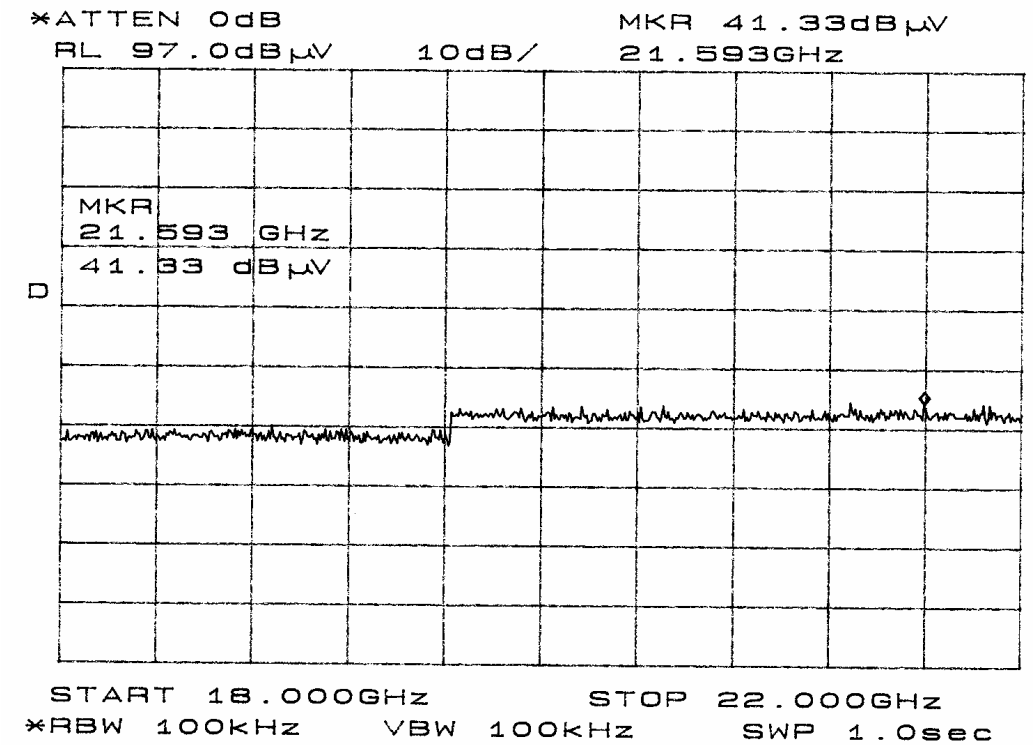


Figure nine Plot of analyzer display showing emissions at 1 meter.

Results

The EUT was connected to the standard antenna(s) 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 ten meters at the RLI OATS. Data was also taken by RF metrics Corporation for spurious emissions. 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 80.211(e), and RSS-138 are met. There are no deviations to the specifications.

Calculations made are as follows:

CFS = Calculated Field Strength
FSM = Field Strength Measurement
CFS = FSM + Antenna Factor – amplifier gain
Example:
CFS = 56.3 + 7.7 - 30
CFS = 34.0

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
87.0	56.3	57.2	7.7	30	34.0	34.9	40.0
123.0	59.1	49.5	7.6	30	36.7	27.1	43.5
151.1	59.9	50.9	9.1	30	39.0	30.0	43.5
160.1	61.2	51.9	8.8	30	40.0	30.7	43.5
179.2	58.6	53.6	9.1	30	37.7	32.7	43.5
190.9	56.4	59.0	10.4	30	36.8	39.4	43.5
214.3	55.5	50.4	10.9	30	36.4	31.3	43.5
330.3	56.6	49.7	14.4	30	41.0	34.1	46.0

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

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.

Results

The temperature stability of the unit is determined by the Magnetron. Data for the temperature stability is presented in attachments submitted with this report. This data indicates the unit will remain in the allowable frequency band during operation. Specifications of Paragraphs 2.1055, applicable paragraphs of part 80.209, and RSS-138 are met. There are no deviations to the specifications.

APPENDIX

Model: GMR 404 AND GMR 406

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.

List of Test Equipment:	Calibration Date:
Scope: Tektronix 2230	2/06
Wattmeter: Bird 43 with Load Bird 8085	2/06
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/06
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/06
R.F. Generator: HP 606A	2/06
R.F. Generator: HP 8614A	2/06
R.F. Generator: HP 8640B	2/06
Spectrum Analyzer: HP 8562A, Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W HP Adapters: 11518, 11519, 11520	2/06
Spectrum Analyzer: HP 8591 EM	5/05
Frequency Counter: Leader LDC 825	2/06
Antenna: EMCO Biconilog Model: 3143	5/05
Antenna: EMCO Log Periodic Model: 3147	10/05
Antenna: Antenna Research Biconical Model: BCD 235	10/05
Antenna: EMCO Dipole Set 3121C	2/06
Antenna: C.D. B-101	2/06
Antenna: Solar 9229-1 & 9230-1	2/06
Antenna: EMCO 6509	2/06
Audio Oscillator: H.P. 201CD	2/06
R.F. Power Amp 65W Model: 470-A-1010	2/06
R.F. Power Amp 50W M185- 10-501	2/06
R.F. PreAmp CPPA-102	2/06
LISN 50 µHy/50 ohm/0.1 µf	10/05
LISN Compliance Eng. 240/20	2/06
LISN Fischer Custom Communications FCC-LISN-50-16-2-08	6/05
Peavey Power Amp Model: IPS 801	2/06
Power Amp A.R. Model: 10W 1010M7	2/06
Power Amp EIN Model: A301	2/06
ELGAR Model: 1751	2/06
ELGAR Model: TG 704A-3D	2/06
ESD Test Set 2010i	2/06
Fast Transient Burst Generator Model: EFT/B-101	2/06
Current Probe: Singer CP-105	2/06
Current Probe: Solar 9108-1N	2/06
Field Intensity Meter: EFM-018	2/06
KEYTEK Ecat Surge Generator	2/06
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	

2/10/2006

QUALIFICATIONS

Of

SCOT D. ROGERS, ENGINEER

ROGERS LABS, INC.

Mr. Rogers has approximately 16 years experience in the field of electronics. Working for six years in the automated controls industry and the reaming 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

April 6, 2006
Date

1/11/03

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