

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

Van Ruggles
Director of Quality Assurance

VHF AVIATION TRANSCEIVER

Model: GNS430A

Part Number: 010-00286-() which includes the 011-00836-()

Frequency: 118 - 136.992 MHz

FCC ID: IPH-0061100

Test Date: November 19, 2001

Certifying Engineer: *Scot D Rogers*

Scot D. Rogers
ROGERS LABS, INC.
4405 West 259th Terrace
Louisburg, KS 66053
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FORWARD:

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2000, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.915, 2.925, 2.926, 2.1031 through 2.1057, and Part 87, Subchapter D, Paragraphs 87.131 through 87.147, and applicable paragraphs of Part 15, 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	100 kHz	Peak

2.1033(c) Application for Certification

- (1) Manufacturer: GARMIN INTERNATIONAL, INC.
1200 East 151st Street
OLATHE, KS 66062
- Marketer/Vendor: GARMIN INTERNATIONAL, INC.
1200 East 151st Street
OLATHE, KS 66062
- (2) Identification: Model: GNS430A
FCC I.D.: IPH-0061100
- (3) Instruction Book: Refer to exhibit for Draft Instruction Manual.
- (4) Emission Type: Emissions designator 6K00A3E. Dual side band amplitude modulated, single channel, analog information sound broadcasting.
- (5) Frequency Range: 118.000 – 136.992 MHz
- (6) Operating Power Level: 20 Watts (Maximum Power) delivered from the EUT.
- (7) Maximum P_o: 20 Watts delivered from the EUT. Maximum power output of 55 Watts allowed in CFR 47, paragraph 87.131.
- (8) Power into final amplifier: 82.5 Watts (27.5 V @ 3.0 A)
- (9) Tune Up Procedure for Output Power: Refer to Exhibit for Transceiver Alignment Procedure.
- (10) Circuit Diagrams; description of circuits, frequency stability, spurious suppression, and power and modulation limiting:
Refer to Exhibit for Circuit Diagrams.
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: Not applicable.

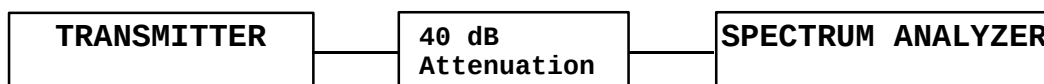
2.1046 RF Power Output

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 terminal by replacing the antenna with a directional coupler of 40 dB attenuation, spectrum analyzer, and cables. The spectrum analyzer had an impedance of 50Ω to match the impedance of the standard antenna. A HP 8591EM 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 maximum output power of the transmitter. Data was taken per Paragraph 2.1046(a) and applicable paragraphs of Part 87.

P_{dBm} = power in dB above 1 milliwatt.

Milliwatts = $10^{(P_{dBm}/10)}$

Watts = (Milliwatts)(0.001)(W/mW)

32.69 dBm = $10^{(42.66/10)}$
 = 18,450.15 mW
 = 18.5 Watts

43.09 dBm = $10^{(43.09/10)}$
 = 20,370.42 mW
 = 20.3 Watts

Results:

FREQUENCY	P_{dBm}	P_{mw}	P_w
118.000	42.66	18,450.15	18.5
127.000	42.97	19,815.27	19.8
136.000	43.09	20,370.42	20.3

The specifications of Paragraph 2.1046(a) and applicable Parts of 2 and 87 are met. There are no deviations to the specifications.

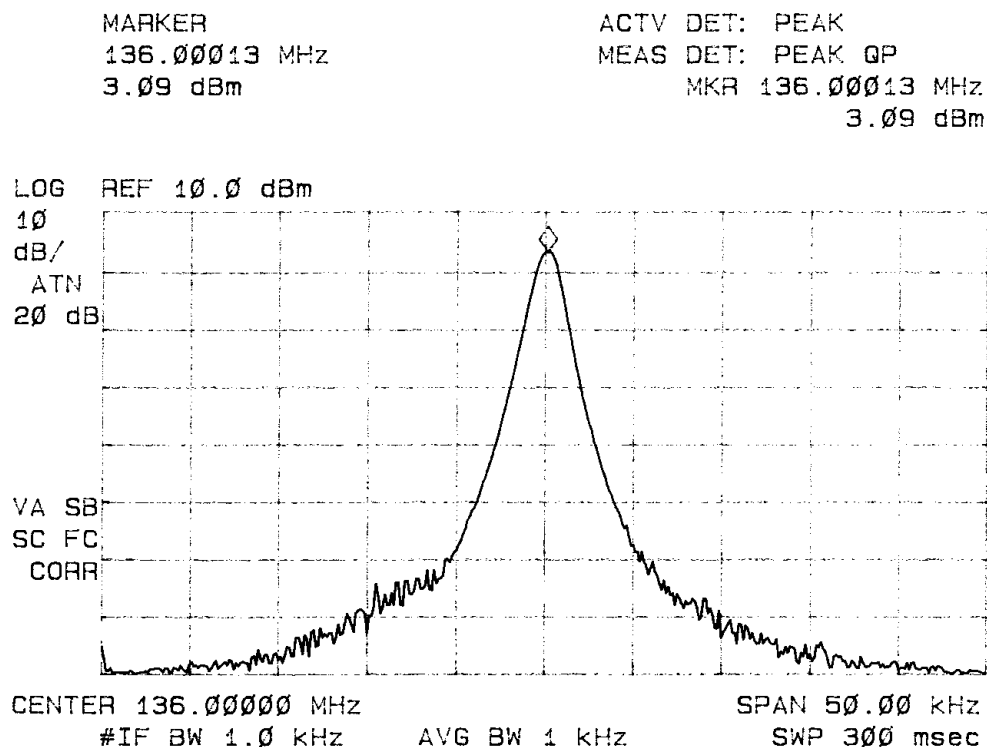


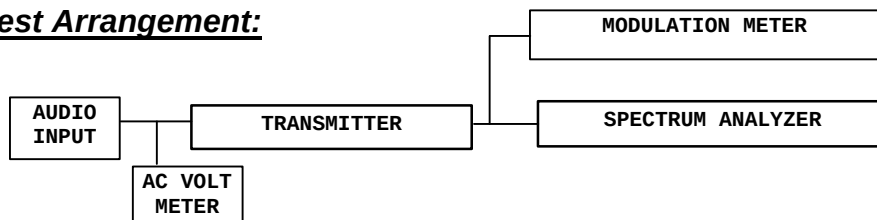
Figure 1: Maximum Power Output.

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.

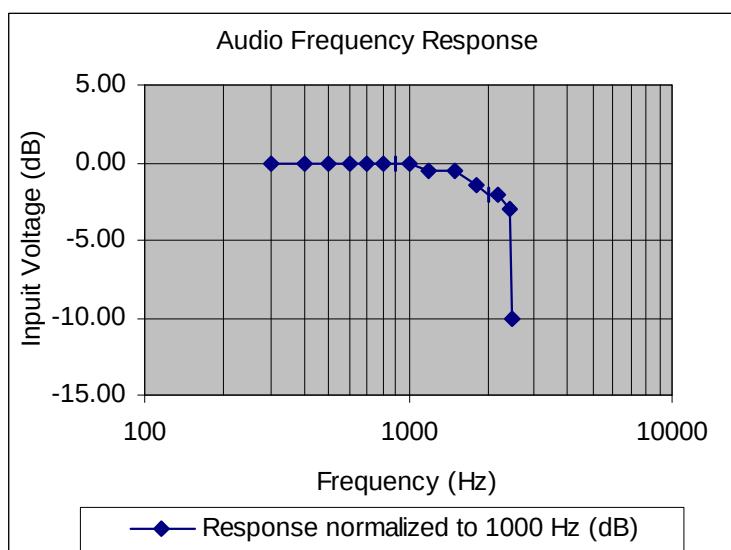
Test Arrangement:



The radio frequency output was coupled to a HP Spectrum Analyzer and a modulation meter. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in its various modes. The modulation meter was used to measure the percent modulation.

Results:

Figure 2 displays the graph made showing the audio frequency response of the modulator. The frequency generator was set to 1 kHz frequency and injected into the audio input port of the EUT. The input voltage amplitude was adjusted to obtain 50% modulation at 1000 Hz. This level was then taken as the 0-dB reference. The frequency of the generator was then varied and the output voltage level was adjusted to maintain the 50% modulation. The output level required for 50% modulation was then recorded. This level was normalized to the level required for 50% modulation at 1000 Hz.



Audio Frequency (Hz)	Response normalized to 1KHz
300	0.00
400	0.00
500	0.00
600	0.00
700	0.00
800	0.00
900	0.00
1000	0.00
1200	-0.50
1500	-0.50
1800	-1.50
2000	-2.00
2200	-2.00
2400	-3.00
2500	-10.00

Figure 2: Audio Frequency Response Characteristics.

Figure 3 shows the modulation characteristics each of five frequencies while the input voltage was varied. The frequency is held constant and the percent modulation is read from the modulation meter.

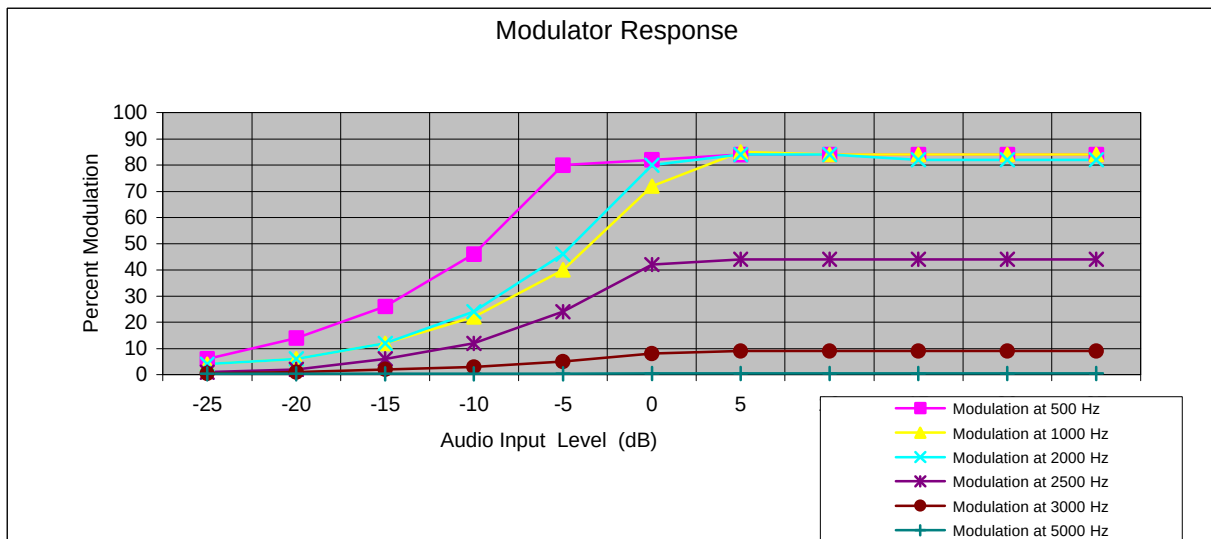


Figure 3: Modulation characteristics.

Figure 4 shows the frequency response of the audio lowpass filter. The specifications of Paragraph 2.1047 and applicable parts of paragraph 87 are met.

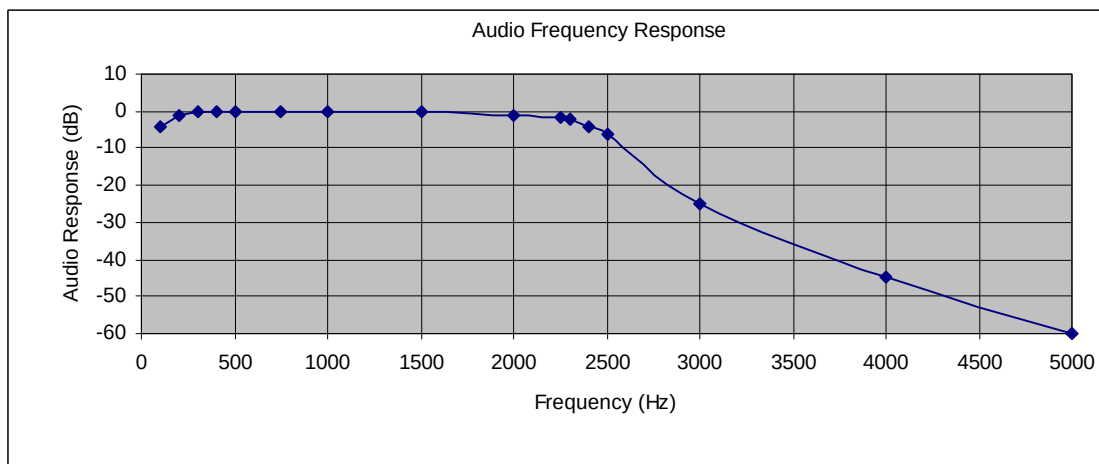
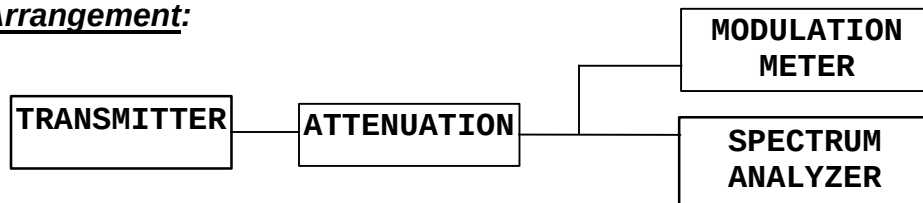


Figure 4: Frequency Response of Audio Lowpass Filter.

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:**Results:**

Channel spacing	f_c (MHz)	O.B.(kHz)
25 kHz	127.000	5.75
8.333 kHz	136.99175	5.70

A spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in a normal mode, modulated by a frequency of 2500 Hz at a level 16 dB above 50% modulation. The power ratio in dB representing 99.5% of the total mean power was recorded from the spectrum analyzer. Refer to figures 4 and 5 for plots showing the occupied bandwidth of the 99.5% power.

Requirements of 2.1049(c)(1) and applicable paragraphs of Part 87 are met. There are no deviations to the specifications.

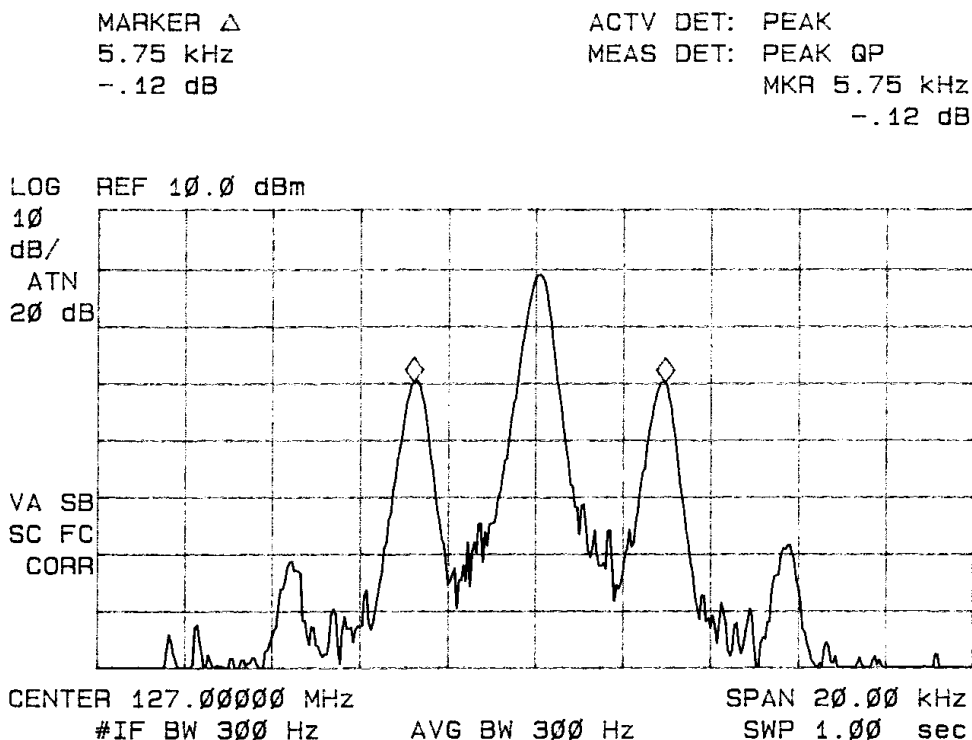


Figure 4: Occupied Band Width, Channel spacing 25 kHz

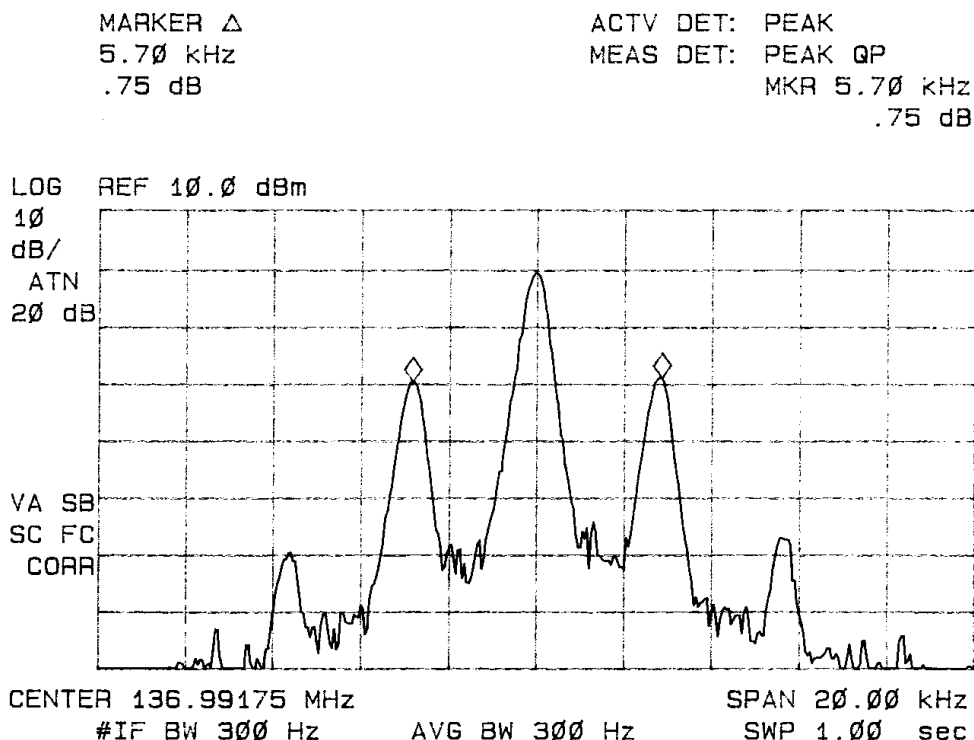


Figure 5: Occupied Band Width, Channel spacing 8.3 kHz

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 8591EM Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operated in a normal mode. The frequency spectrum from 10 MHz to 1500 MHz was observed and a plot produced of the frequency spectrum. Figure 6 represents data for the spurious emissions of the GNS430A. Data was taken per 2.1051, 2.1057, and applicable paragraphs of Part 87.

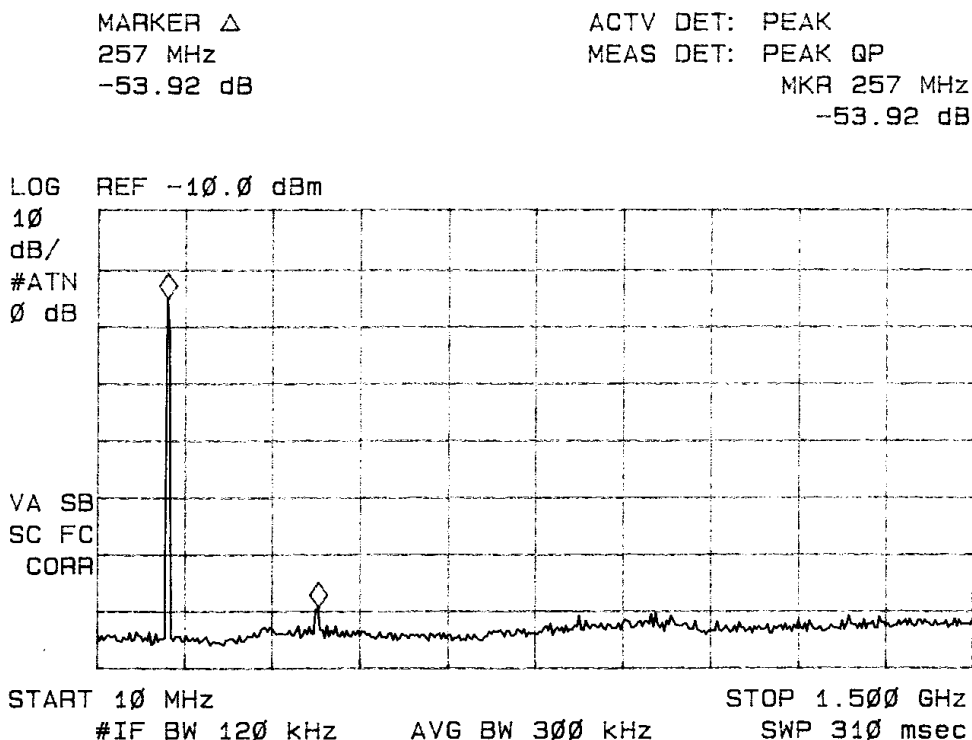


Figure 6: Emissions at Antenna Terminal

Results:

The output of the unit was coupled to a HP Spectrum Analyzer and the frequency emissions were measured. Data was taken as per 2.1051 and applicable paragraphs of Part 87. Specifications of Paragraphs 2.1051, 2.1057 and applicable paragraphs of part 87 are met. There are no deviations to the specifications.

FCC Limit: The spurious emissions must be reduced in power by at least $43 + 10 \text{ LOG}(P_o)$ below the carrier output power level.

$$\begin{aligned} 20 \text{ Watt} &= 43 + 10 \text{ LOG}(P_o) \\ &= 43 + 10 \text{ LOG}(20) \\ &= 56.0 \text{ below } 43 \text{ dBm } (-13 \text{ dBm limit}) \end{aligned}$$

CHANNEL MHZ	SPURIOUS FREQ. (MHz)	MEASURED LEVEL (dBm)	LEVEL BELOW CARRIER (dB)
118.000	236.0	-74.6	117.6
	354.0	-72.8	115.8
	472.0	-105.0	148.0
127.000	254.0	-73.9	116.9
	381.0	-74.0	117.0
	508.0	-96.0	139.0
136.000	272.0	-73.5	116.5
	408.0		-79.0
	544.0		-105.0

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 wooden turntable 0.8 meters above the ground plane and 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. The amplitude of each spurious emission was maximized by raising and lowering the FSM antenna, and rotating the turntable before final data was recorded. A biconilog antenna was used for frequency measurements of 30 to 1000 MHz. A log periodic antenna was used for frequencies of 1000 MHz to 5 GHz and pyramidal horn antennas were used for frequencies of 5 GHz to 40 GHz. Emission levels were measured and recorded from the spectrum analyzer in dBμV. This level was then added to the antenna factor less amplification stages, to calculate the field strength at 3 meters. Data was taken at the ROGERS LABS, INC. 3 meters open area test site (OATS). A description of the test facility is on file with the FCC, Reference 90910, dated December 8, 2000. The testing procedures used conform to the procedures stated in the ANSI 63.4-1992 document.

Calculations made are as follows:

CFS = Calculated Field Strength

FSM = Field Strength Measurement

CFS = FSM + Antenna Factor - Amplifier Gain

CFS = 57.9 + 11.5 - 35

CFS = 34.4

The limit for 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 20-watt transmitter was done as follows:

$$E = \frac{5.5 \sqrt{PG}}{d} \quad \text{where } E \text{ is V/m, } P \text{ is Watts, } G = 1.64 \text{ and } d \text{ is meters.}$$

$$E = \frac{5.5 \sqrt{20(1.64)}}{3} = 10.5 \text{ V/m} = 10.5\text{E}6\mu\text{V/m at 3 meters.}$$

This was converted to dBμV/m using $(20 \cdot \log \mu\text{V/m})$ for convenience.

$$20 \cdot \log(10.5\text{E}6) = 140.4 \text{ dB}\mu\text{V/m @ 3 meters}$$

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

$$\begin{aligned} \text{Attenuation} &= 43 + 10 \log_{10}(P_w) \\ &= 43 + 10 \log_{10}(20) \\ &= 56.0 \text{ dB} \end{aligned}$$

$$\begin{aligned} \text{Limit} &= 140.4 - 56.0 \\ &= 84.4 \text{ dB}\mu\text{V/m @ 3 meters} \end{aligned}$$

Results:

Channel frequency 118.000 MHz

Frequency (MHz)	FSM Horz. (dBμV)	FSM Vert. (dBμV)	Ant. Factor (dB)	Amp. Gain (dB)	CFS Horz. @ 3m (dBμV/m)	CFS Vert. @ 3m (dBμV/m)	Limit (dBμV/m)
236.0	57.9	69.4	11.5	35	34.4	45.9	84.4
354.0	57.5	59.2	15.4	35	37.9	39.6	84.4
472.0	38.4	34.6	17.8	35	21.2	17.4	84.4
590.0	49.3	46.5	19.6	35	33.9	31.1	84.4
944.0	52.6	51.8	23.8	35	41.4	40.6	84.4

Channel frequency 127.000 MHz

Frequency (MHz)	FSM Horz. (dBμV)	FSM Vert. (dBμV)	Ant. Factor (dB)	Amp. Gain (dB)	CFS Horz. @ 3m (dBμV/m)	CFS Vert. @ 3m (dBμV/m)	Limit (dBμV/m)
254.0	71.5	74.2	12.4	35	48.9	51.6	84.4
381.0	68.4	76.4	16.0	35	49.4	57.4	84.4
508.0	53.1	64.1	18.1	35	36.2	47.2	84.4
635.0	43.4	54.5	20.6	35	29.0	40.1	84.4
1016.0	42.7	43.6	24.5	35	32.2	33.1	84.4

Channel frequency 136.000 MHz

Frequency (MHz)	FSM Horz. (dBμV)	FSM Vert. (dBμV)	Ant. Factor (dB)	Amp. Gain (dB)	CFS Horz. @ 3m (dBμV/m)	CFS Vert. @ 3m (dBμV/m)	Limit (dBμV/m)
272.0	80.6	81.0	12.7	35	58.3	58.7	84.4
408.0	78.4	79.6	16.3	35	59.7	60.9	84.4
544.0	73.0	72.2	19.5	35	57.5	56.7	84.4
680.0	72.0	72.0	21.0	35	58.0	58.0	84.4
816.0	61.4	62.1	22.2	35	48.6	49.3	84.4
952.0	60.9	59.9	23.9	35	49.8	48.8	84.4

Specifications of Paragraph 2.1053, 2.1057, applicable paragraphs of part 87 are met. There are no deviations or exceptions to the specifications.

2.1055 Frequency Stability

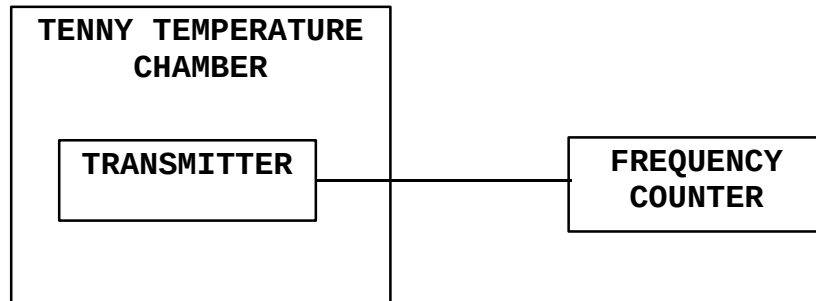
Measurements Required:

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.

The frequency stability was measured with variations in the power supply voltage from 85 to 115 percent of the nominal value. A Topward 6303A DC Power Supply was used to vary the dc voltage for the power input from 5.10 Vdc to 6.90 Vdc. The frequency was measured and the variation in parts per million was calculated. Data was taken per Paragraphs 2.1055 and applicable paragraphs of parts 22, 74, 90 and 95.

Results:

FREQ. (MHz)	FREQUENCY STABILITY VS TEMPERATURE IN PARTS PER MILLION (PPM)								
	Temperature in °C								
	-30	-20	-10	0	+10	+20	+30	+40	+50
127.000	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	0	1.0	1.0

FREQUENCY IN MHz	FREQUENCY STABILITY VS VOLTAGE VARIATION 28.0 volts nominal; RESULTS IN PPM INPUT VOLTAGE		
	23.80 V _{dc}	28.00 V _{dc}	32.20 V _{dc}
127.000	0.0	0.0	0.0

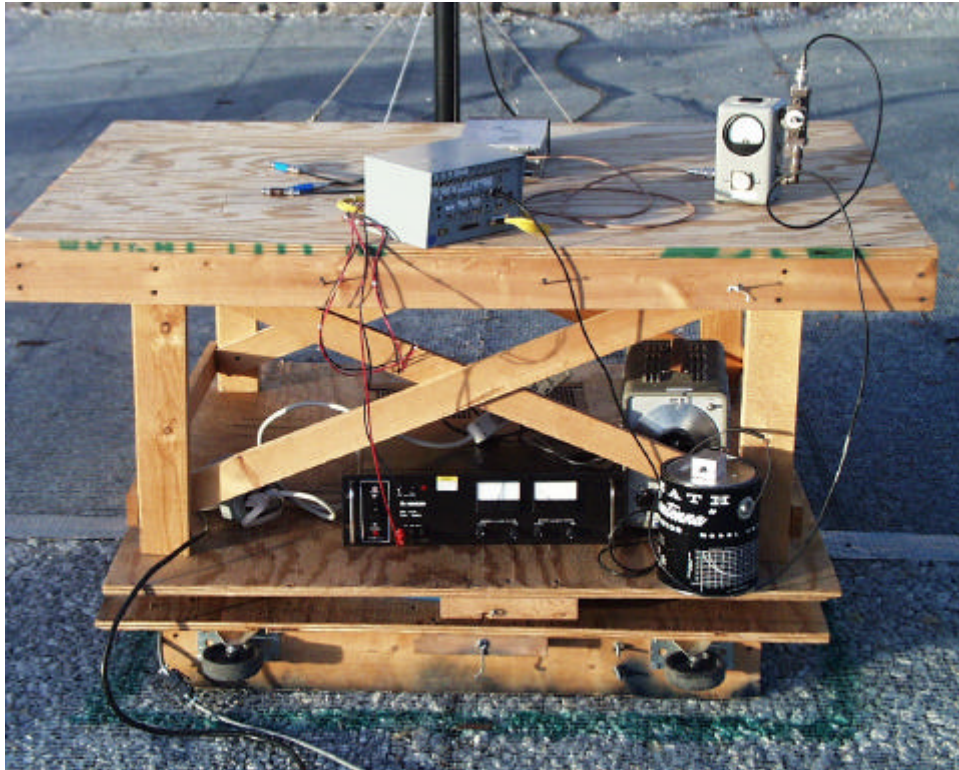
Specifications of Paragraphs 2.1055 and applicable paragraphs of part 87 are met. There are no deviations or exceptions to the specifications.

APPENDIX

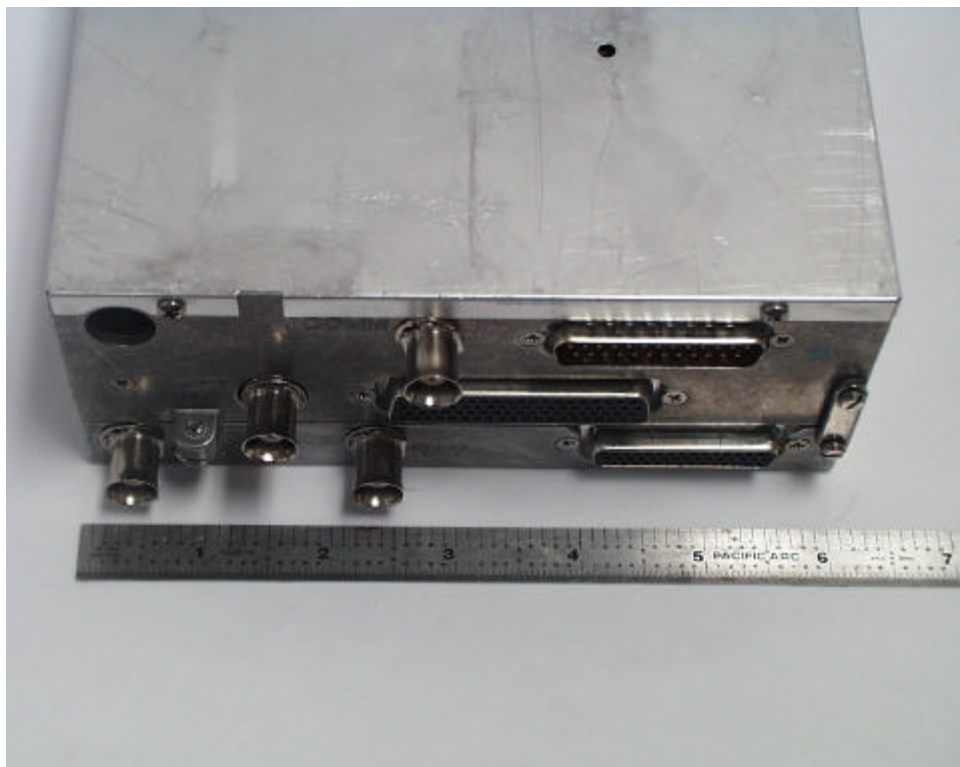
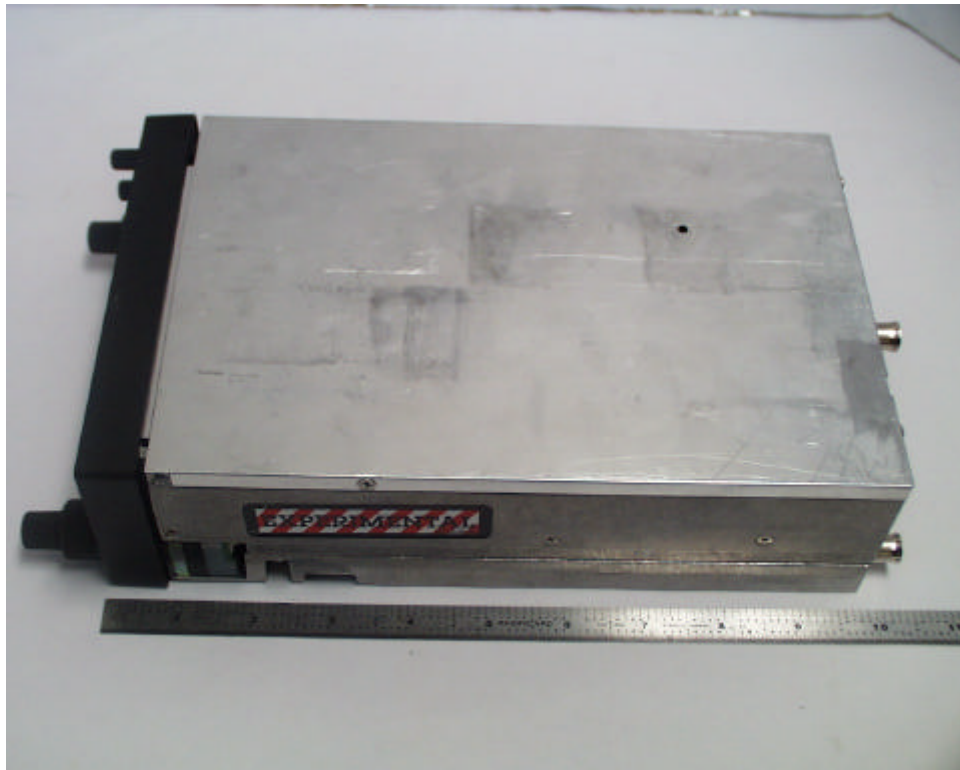
Model: GNS430A

1. Photographs of Radiated Emissions Test Set Up.
2. Photographs Case top and back.
3. Photograph of Operator Controls
4. Photograph FCC ID Label Location.
5. Photograph Inside Case.
6. Photograph of RF Printed Circuit Board.
7. Test Equipment List.
8. Rogers Qualifications.
9. FCC Site Approval Letter.

GARMIN INTERNATIONAL, INC.
Model: GNS430A
Photographs Radiated Emissions



GARMIN INTERNATIONAL, INC.
Model: GNS430A
Photographs Case top and back



GARMIN INTERNATIONAL, INC.
Model: GNS430A
Photograph Operator Controls



GARMIN INTERNATIONAL, INC.
Model: GNS430A
FCC ID Label Location



GARMIN INTERNATIONAL, INC.
Model: GNS430A
Photographs Inside Case



GARMIN INTERNATIONAL, INC.
Model: GNS430A
Photograph RF Printed Circuit Board



Note: There are no components mounted on the bottom side of the printed circuit board.

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	2/01
Wattmeter: Bird 43 with Load Bird 8085	2/01
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/01
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/01
R.F. Generator: HP 606A	2/01
R.F. Generator: HP 8614A	2/01
R.F. Generator: HP 8640B	2/01
Spectrum Analyzer: HP 8562A,	4/01
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
HP Adapters: 11518, 11519, 11520	
Spectrum Analyzer: HP 8591 EM	7/01
Frequency Counter: Leader LDC 825	2/01
Antenna: EMCO Biconilog Model: 3143	4/01
Antenna: EMCO Log Periodic Model: 3147	10/01
Antenna: Antenna Research Biconical Model: BCD 235	7/01
Antenna: EMCO Dipole Set 3121C	2/01
Antenna: C.D. B-101	2/01
Antenna: Solar 9229-1 & 9230-1	2/01
Antenna: EMCO 6509	2/01
Audio Oscillator: H.P. 201CD	2/01
R.F. Power Amp 65W Model: 470-A-1010	2/01
R.F. Power Amp 50W M185- 10-501	2/01
R.F. PreAmp CPPA-102	2/01
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	
LISN 50 μ Hy/50 ohm/0.1 μ f	10/01
LISN Compliance Eng. 240/20	2/01
Peavey Power Amp Model: IPS 801	2/01
Power Amp A.R. Model: 10W 1010M7	2/01
Power Amp EIN Model: A301	2/01
ELGAR Model: 1751	2/01
ELGAR Model: TG 704A-3D	2/01
ESD Test Set 2010i	2/01
Fast Transient Burst Generator Model: EFT/B-101	2/01
Current Probe: Singer CP-105	2/01
Current Probe: Solar 9108-1N	2/01
Field Intensity Meter: EFM-018	2/01
KETEK Ecat Surge Generator	2/01

10/30/2001

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

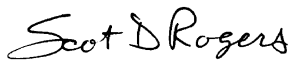
Mr. Rogers has approximately 13 years experience in the field of electronics. Six years working in the automated controls industry and 6 years working with the design, development and testing of radio communications and electronic equipment.

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 _____

November 19, 2001
Date

1/08/2001

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD. 21046

December 08, 2000

Registration Number: 90910

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

Attention: Scot D. Rogers

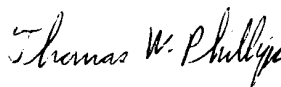
Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Listing: December 08, 2000

Gentlemen:

Your submission of the description of the subject measurement facility has been reviewed and found to be in compliance with the requirements of Section 2.948 of the FCC Rules. The description has, therefore, been placed on file and the name of your organization added to the Commission's 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 this filing must be updated for any changes made to the facility, and at least every three years from the date of listing the data on file must be certified as current.

If requested, the above mentioned facility has been added to our list of those who perform these measurement services for the public on a fee basis. An up-to-date list of such public test facilities is available on the Internet on the FCC Website at WWW.FCC.GOV, E-Filing, OET Equipment Authorization Electronic Filing.

Sincerely,



Thomas W Phillips
Electronics Engineer