## FORWARD:

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 1997, Part 2 Subpart J, Paragraphs 2.905, 2.911, 2.913, 2.925, 2.926, 2.981 through 2.1005, and Part 87, Subchapter D, Paragraphs 87.131 through 87.147 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 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 |

# 2.983 Application for Type Acceptance

a. Manufacturer: GARMIN INTERNATIONAL, INC.
1200 East 151st Street
Olathe, KS 66062

b. Identification: Model: GNS 430
FCC I.D.: IPH-0021400

Refer to attached Product Description Sheet.

c. Plan to produce quantity production.

d. (1) Emission Type: 6K00A3E

(2) Frequency Range: 118.0 - 136.990 MHz, Adjustable in 8.33 or 25 kHz steps.

(3) Operating Power Level:

15 Watts

(4) Max $P_o$: 15 Watts

(5) Power into final amplifier: 56 Watts (28.0 V @ 2.0A).

(6) Function of Each Semiconductor Device in Transmitter:

Refer to appendix for Theory of operation section 2.

(7) Circuit Diagrams:

Refer to appendix for Circuit diagrams.

(8) Instruction Book:

Draft instruction manual attached.

(9) Tune Up Procedure for Output Power:

Refer to appendix for Transceiver alignment procedure.

(10) Frequency Stabilizing:

Refer to appendix for Theory of operation section 1.

(11) Spurious and Limiting Circuits:

Refer to appendix for Theory of operation section 2.2.4.

(12) Digital Modulation:

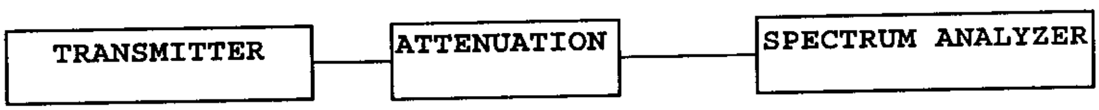
N/A.

## 2.985 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 r.f. power output was measured at the antenna terminal by replacing the antenna with a spectrum analyzer, 20 dB attenuation and cable. The spectrum analyzer had an impedance of 50Ω to match the impedance of the standard antenna. An HP 8591EM Spectrum Analyzer was used to measure the r.f. power at the antenna port. The data was taken in dBm and converted to watts as shown in the following Table. Refer to Figures 1 through 4 showing the output power of the transmitter. Data taken per Paragraph 2.985(a) and applicable parts of Part 87.

$P_{dBm}$ = power in dB above 1 milliwatt.
Milliwatts = $10^{(PdBm/10)}$
Watts = (Milliwatts)(0.001)(W/mW)

41.8 dBm = $10^{(41.8/10)}$
= 15,135.6 mW
= 15 Watts

**_Results:_**

| FREQUENCY | $P_{dBm}$ | $P_{mw}$ | $P_{w}$ |
|---|---|---|---|
| 118.0 | 41.8 | 15,135 | 15 |
| 126.5 | 42.1 | 16,218 | 16 |
| 136.975 | 41.8 | 15,135 | 15 |
| 136.990 | 41.8 | 15,135 | 15 |

The specifications of Paragraph 2.985(a) and applicable Parts of 87 are met. There are no deviations to the specifications.

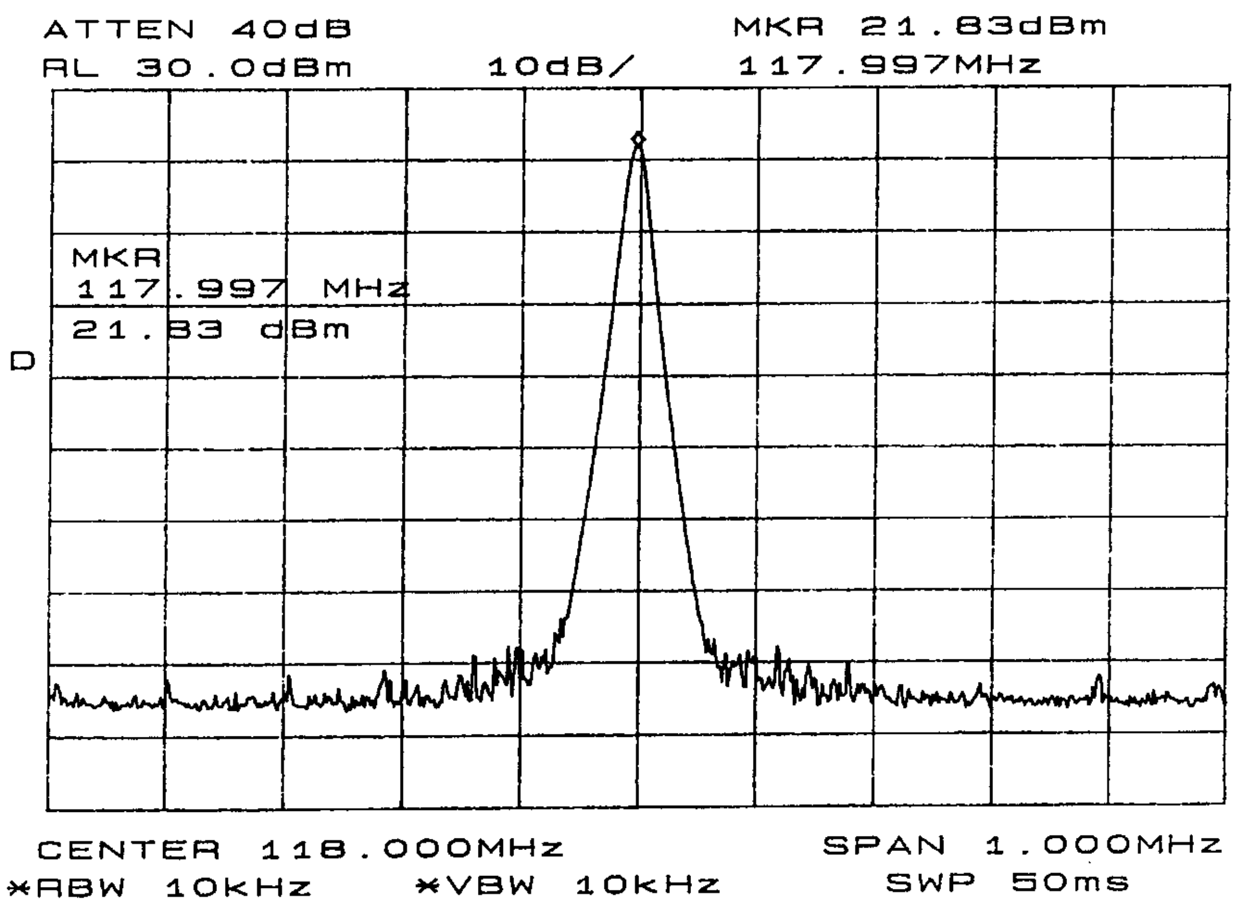



Figure 1: Power Output Channel 118.0

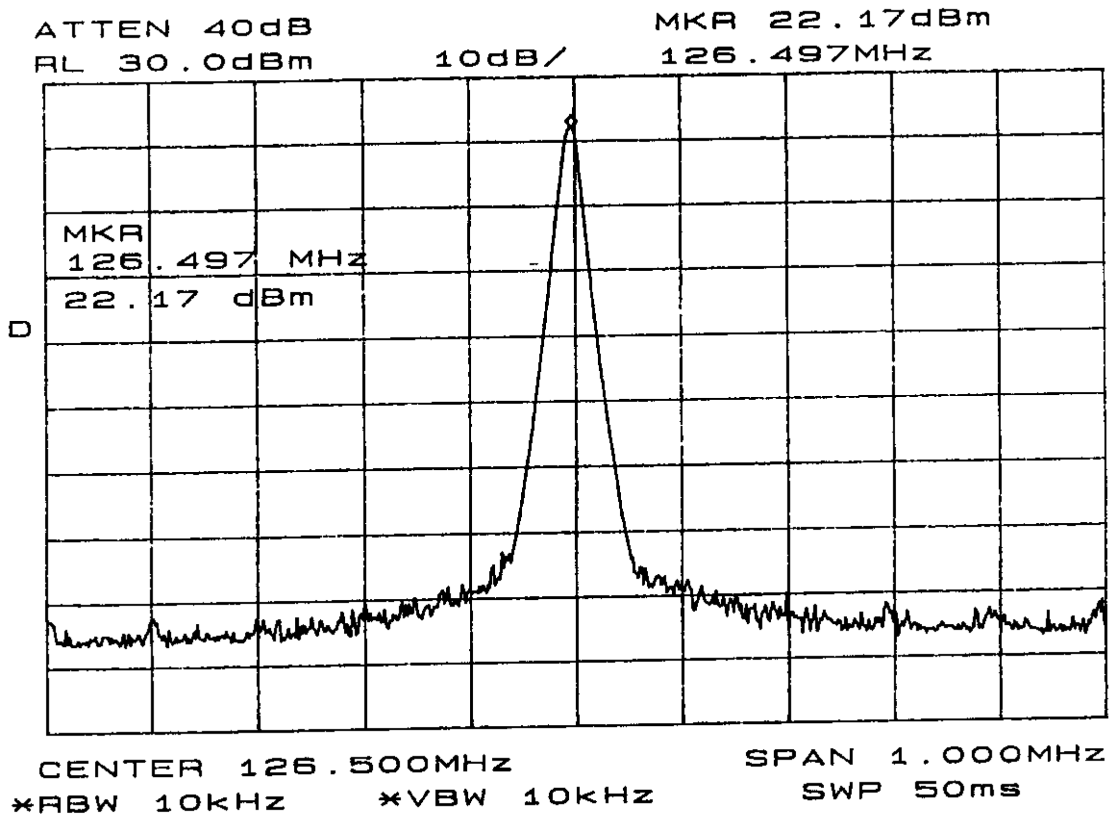



Figure 2: Power Output Channel 126.5

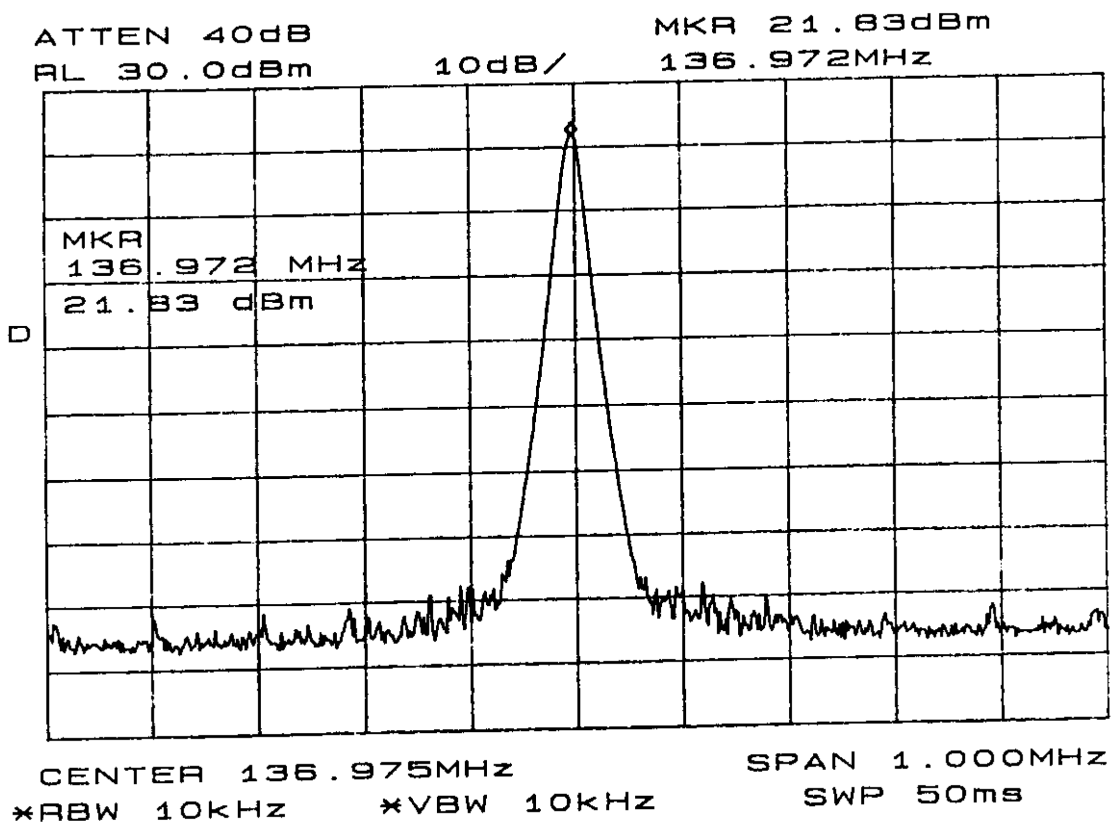



Figure 3: Power Output Channel 135.975

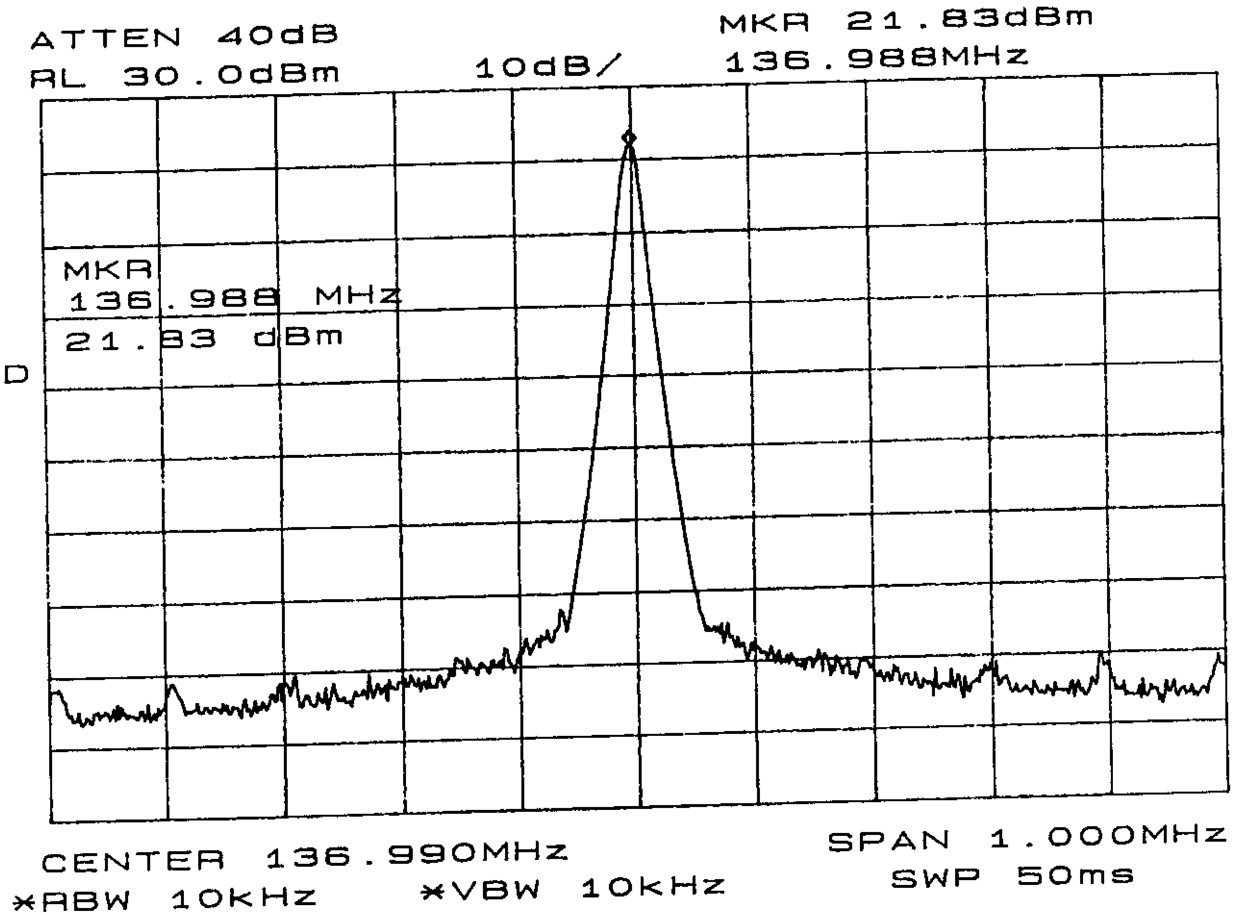


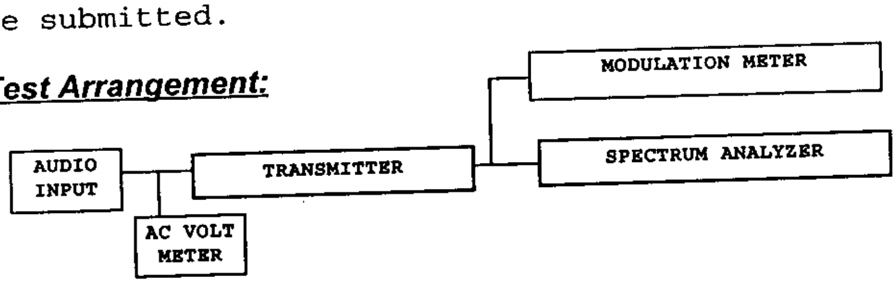

Figure 4: Power Output Channel 136.990

## 2.987 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 r.f. output was coupled to a HP Spectrum Analyzer and a modulation meter. The spectrum analyzer was used to observe the r.f. spectrum with the transmitter operating in its various modes. The modulation meter was used to measure the percent deviation.

***Results:***

Figure 5 displays the graph made showing the audio frequency response of the modulator. The frequency generator was set to 1 kHz and injected into the audio input port of the EUT. The 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 level recorded while holding the input levels constant.

Figure 6 shows the modulation response for each of three tones while the input voltage was varied. The frequency is held constant the input voltage is varied and the modulation is read from the modulation meter. The specifications of Paragraph 2.987(b) and applicable parts of 87 are met.

| *Audio Frequency (Hz)* | *Response Normalized to 1000 Hz (dB)* |
|---|---|
| *100* | *-4.7* |
| *200* | *0.72* |
| *500* | *0.35* |
| *1000* | *0* |
| *2000* | *-1.2* |
| *4000* | *-4.3* |
| *8000* | *-16* |
| *16000* | *-47* |

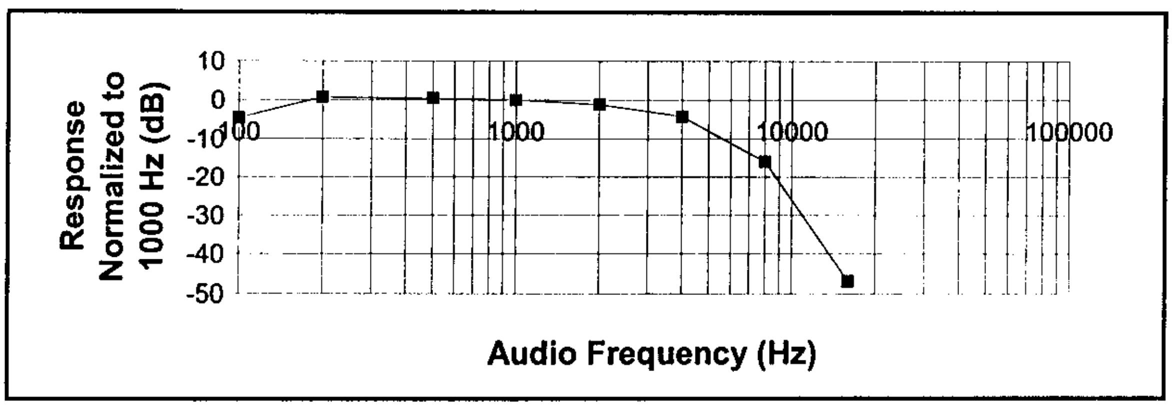



Figure 5: Audio Response Characteristics.

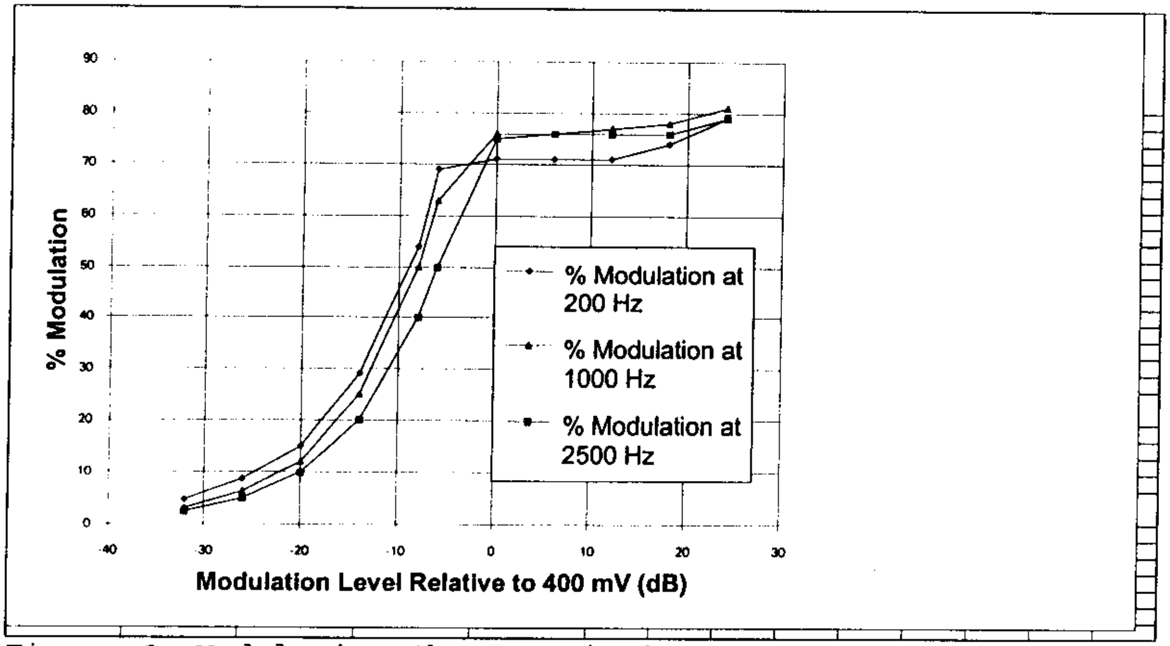


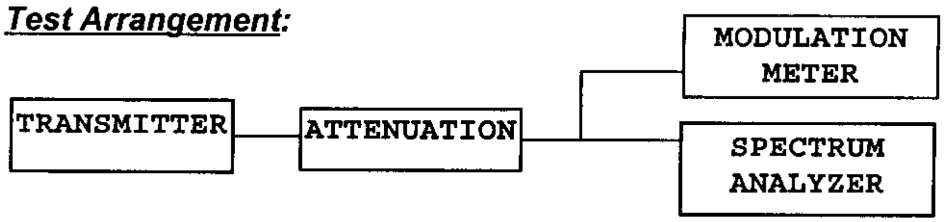

Figure 6: Modulation Characteristics.

## 2.989 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 | $f_c$ | O.B. kHz |
|---|---|---|
| 25 kHz | 126.500 | 5.5 |
| 8.33 kHz | 126.500 | 5.5 |

REFER TO FIGURES 7 and 8.

A spectrum analyzer was used to observe the R.F. 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.

Requirements of 2.989(c)(1) and applicable paragraphs of Part 87 are met. There are no deviations to the specifications.

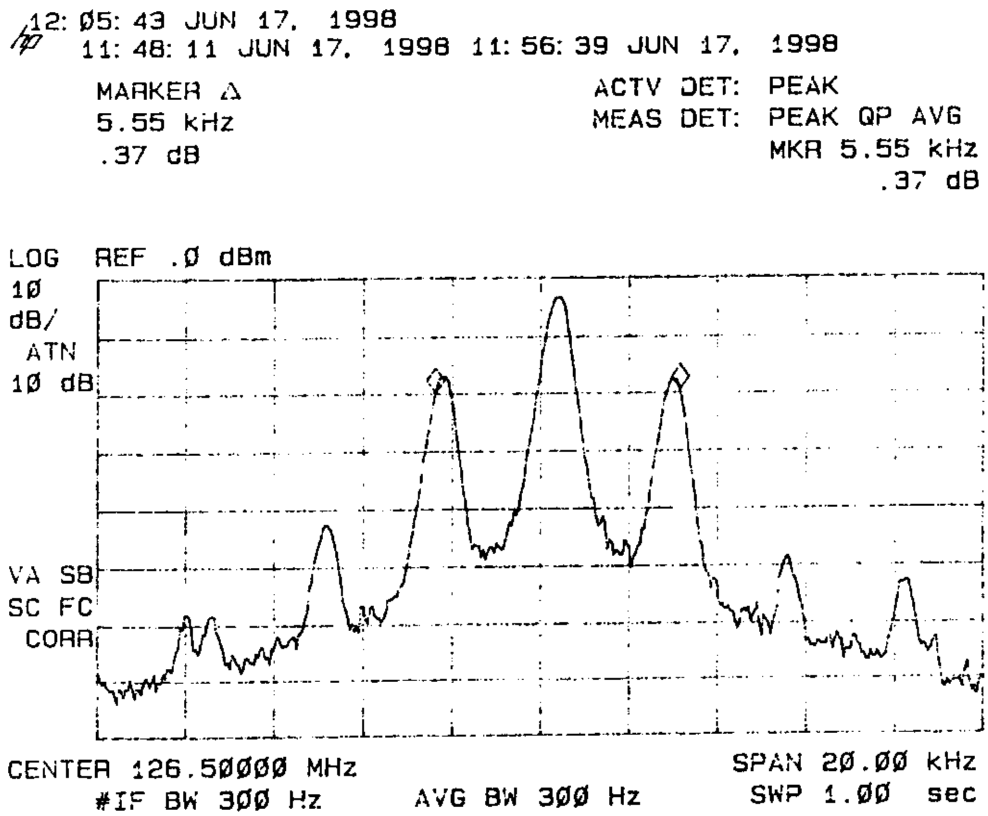



Figure 7: Occupied Band Width Channel Spacing 25 kHz

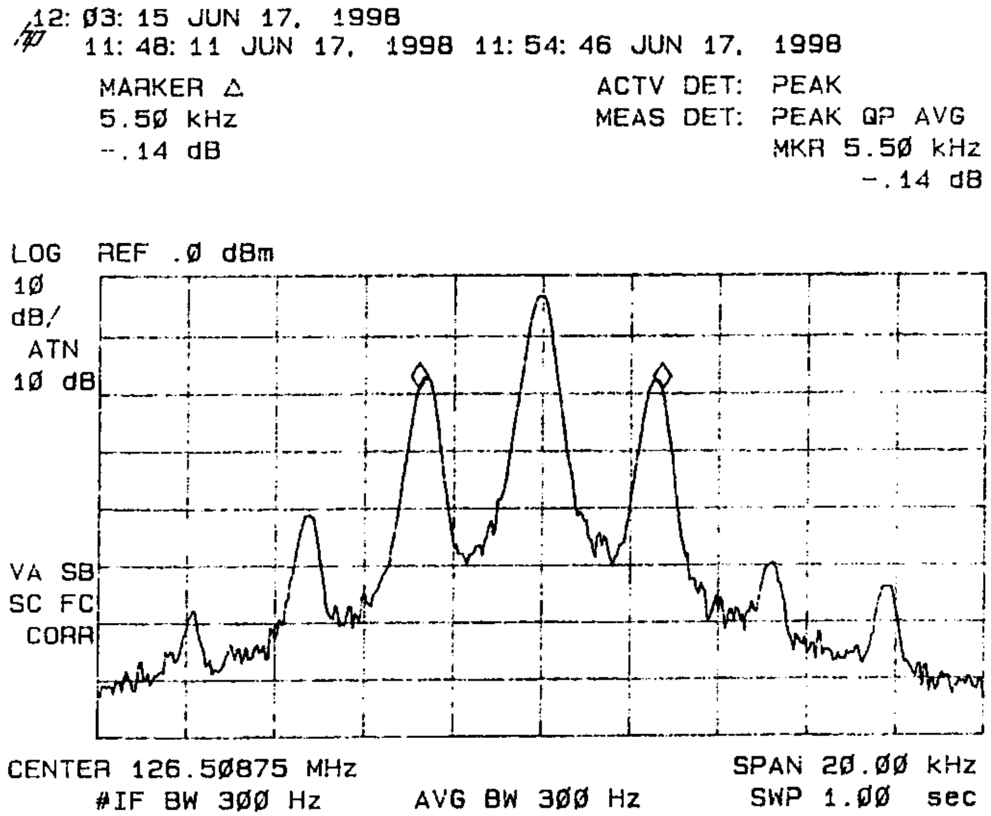


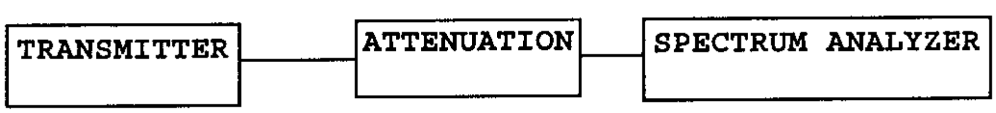

Figure 8: Occupied Band Width Channel Spacing 8.33 kHz

## 2.991 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:***

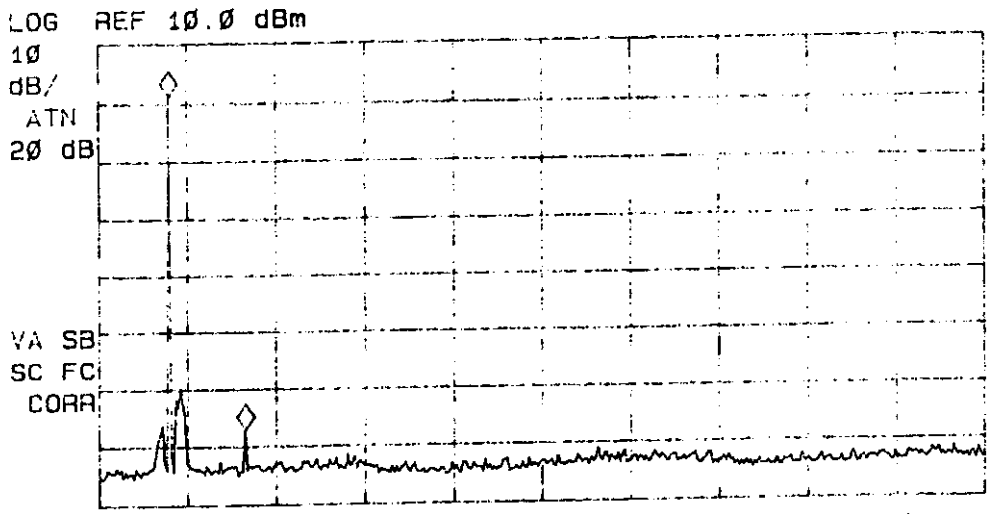



The r.f. output was coupled to an HP 8591EM Spectrum Analyzer. The spectrum analyzer was used to observe the r.f. spectrum with the transmitter operated in a normal mode. The frequency spectrum from 10 MHz to 1.5 GHz was observed and plots produced of the frequency spectrum. Figures 9 and 10 represent data for the GNS 430. Data taken per 2.991, 2.997, and applicable paragraphs of Part 87.

12: 22: 27 JUN 17, 1998
11: 48: 11 JUN 17, 1998 12: Ø1: 34 JUN 17, 1998

MARKER Δ
127 MHz
-57.95 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 127 MHz
-57.95 dB



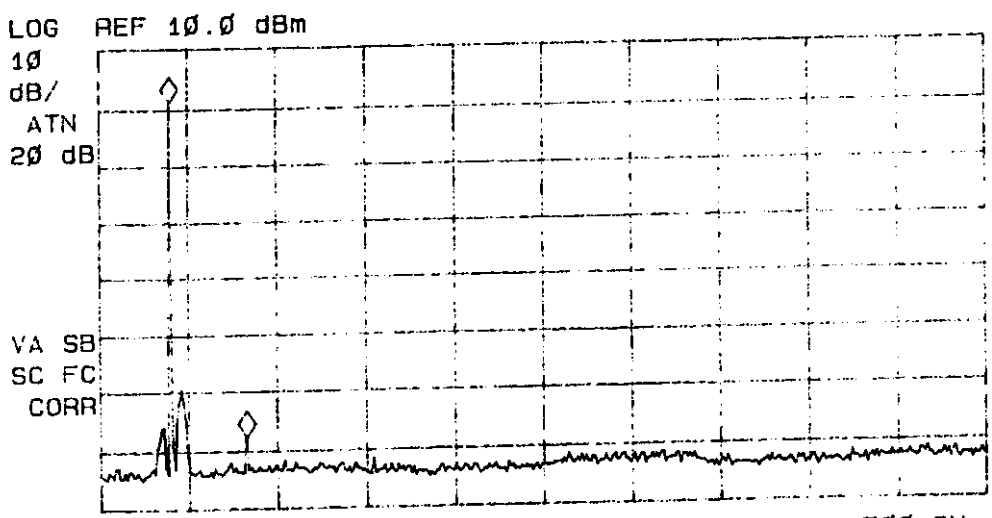

START 1Ø MHz
#IF BW 12Ø kHz AVG BW 3ØØ kHz
STOP 1.5ØØ GHz
SWP 31Ø msec

Figure 9: Emissions at Antenna Terminal 25 kHz Channel Spacing

12: 15: 11 JUN 17, 1998
11: 48: 11 JUN 17, 1998 12: Ø1: 34 JUN 17, 1998

MARKER Δ
127 MHz
-58.6Ø dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 127 MHz
-58.6Ø dB




START 1Ø MHz
#IF BW 12Ø kHz AVG BW 3ØØ kHz
STOP 1.5ØØ GHz
SWP 31Ø msec

Figure 10: Emissions at Antenna Terminal 8.33 kHz Channel Spacing

## *Results:*

Data taken per 2.991 and applicable paragraphs of Part 87. Specifications of Paragraphs 2.991, 2.997 and applicable parts of 87 are met. There are no deviations to the specifications.

FCC Limit:

15 Watt $= 43 + 10\ LOG(P_o)$

$= 43 + 10\ LOG(15)$

$= 54.7$

| CHANNEL MHz | SPURIOUS FREQ. (MHz) | LEVEL BELOW CARRIER (dB) |
|---|---|---|
| 118.0 | 236.0 | -58.5 |
| | 354.0 | -71.8 |
| | 472.0 | -77.6 |
| | 590.0 | -77.1 |
| | 708.0 | -77.1 |
| | 826.0 | -76.6 |

| CHANNEL MHz | SPURIOUS FREQ. (MHz) | LEVEL BELOW CARRIER (dB) |
|---|---|---|
| 126.500 | 253.0 | -58.1 |
| | 379.5 | -72.6 |
| | 506.0 | -79.3 |
| | 632.0 | -77.6 |
| | 759.0 | -78.5 |
| | 885.0 | -76.5 |

| CHANNEL MHz | SPURIOUS FREQ. (MHz) | LEVEL BELOW CARRIER (dB) |
|---|---|---|
| 136.975 | 273.9 | -59.6 |
| | 410.9 | -76.5 |
| | 547.9 | -77.1 |
| | 684.8 | -78.6 |
| | 821.8 | -75.0 |
| | 958.8 | -79.6 |
| | 1095.8 | -77.5 |

| CHANNEL MHz | SPURIOUS FREQ. (MHz) | LEVEL BELOW CARRIER (dB) |
|---|---|---|
| 126.5005 | 253.0 | -58.0 |
| | 379.5 | -70.5 |
| | 506.0 | -77.5 |
| | 632.5 | -78.3 |
| | 759.0 | -76.7 |
| | 885.5 | -77.5 |

The output of the unit was coupled to an HP Spectrum Analyzer and the frequency emissions were measured.

## 2.993 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 though 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 data was recorded. 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. Emission levels were measured and recorded from the spectrum analyzer in dBμV. This level was then added to the antenna factor to calculate the field strength at 3 meters. Data was taken at the ROGERS CONSULTING LABS, INC. 3 meters open area test site (OATS) located in Paola, KS. A description of the test facility is on file with the FCC, Reference: 31040/SIT, 1300F2, dated October 15, 1996. The testing procedures used conforms 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
CFS = 48.7 + 11.8 - 25
CFS = 35.5

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 15 watt transmitter was done as follows:

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

$E = \frac{5.5\sqrt{15(1.64)}}{3}$ = 9.09 V/m = 9.09E6μV/m at 3 meters.

This was converted to dBμV/m using (20*log μV/m) for convenience.

20*Log(9.09E6) = 139.2 dBμV/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.

Attenuation $= 43 + 10\ Log_{10}(P_w)$
$= 43 + 10\ Log_{10}(15)$
= 54.8 dB

Limit = 139.2 - 54.8
= 84.4

## *Results:*

Channel 118.0 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 |
|---|---|---|---|---|---|---|---|
| 236.0 | 48.7 | 41.4 | 11.8 | 25 | 35.5 | 28.2 | 84.4 |
| 354.0 | 48.7 | 33.0 | 15.0 | 25 | 38.7 | 23.0 | 84.4 |
| 472.0 | 31.2 | 30.6 | 17.2 | 25 | 23.4 | 22.8 | 84.4 |
| 590.0 | 41.3 | 35 | 18.5 | 25 | 34.8 | 28.5 | 84.4 |
| 708.0 | 34.9 | 35.2 | 20.7 | 25 | 30.6 | 30.9 | 84.4 |
| 826.0 | 35.1 | 29.5 | 21.8 | 25 | 31.9 | 26.3 | 84.4 |

Channel 126.5 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 |
|---|---|---|---|---|---|---|---|
| 253.0 | 50.7 | 52.9 | 12.7 | 25 | 38.4 | 40.6 | 84.4 |
| 379.5 | 47.1 | 39.1 | 15.8 | 25 | 37.9 | 29.9 | 84.4 |
| 506.0 | 42.7 | 44.1 | 17.4 | 25 | 35.1 | 36.5 | 84.4 |
| 632.0 | 39.3 | 35.6 | 19.3 | 25 | 33.6 | 29.9 | 84.4 |
| 759.0 | 27.8 | 34.9 | 51.5 | 25 | 24.3 | 31.4 | 84.4 |
| 885.0 | 30.7 | 30.1 | 22.0 | 25 | 27.7 | 27.1 | 84.4 |

Channel 126.5005 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 |
|---|---|---|---|---|---|---|---|
| 253.0 | 52.3 | 51.4 | 12.7 | 25 | 40.0 | 39.1 | 84.4 |
| 379.5 | 33.0 | 34.1 | 15.8 | 25 | 23.8 | 24.9 | 84.4 |
| 506.0 | 48.1 | 49.2 | 17.4 | 25 | 40.5 | 41.6 | 84.4 |
| 632.5 | 33.2 | 33.8 | 19.3 | 25 | 27.5 | 28.1 | 84.4 |
| 759.0 | 34.5 | 35.8 | 21.5 | 25 | 31.0 | 32.3 | 84.4 |
| 885.5 | 28.5 | 30.0 | 22.0 | 25 | 25.5 | 27.0 | 84.4 |

Channel 136.975 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 |
|---|---|---|---|---|---|---|---|
| 273.9 | 53.5 | 42.9 | 13.1 | 25 | 41.6 | 31.0 | 84.4 |
| 410.9 | 40.7 | 35.1 | 16.1 | 25 | 31.8 | 26.2 | 84.4 |
| 547.9 | 40.4 | 44.9 | 18.1 | 25 | 33.5 | 38.0 | 84.4 |
| 684.8 | 31.4 | 37.9 | 19.9 | 25 | 26.3 | 32.8 | 84.4 |
| 821.8 | 33.3 | 31.2 | 21.8 | 25 | 30.1 | 28.0 | 84.4 |
| 958.8 | 32.2 | 33.1 | 22.8 | 25 | 30.0 | 30.9 | 84.4 |

Specifications of Paragraph 2.993, 2.997 and 87.139 are met.
There are no deviations to the specifications.

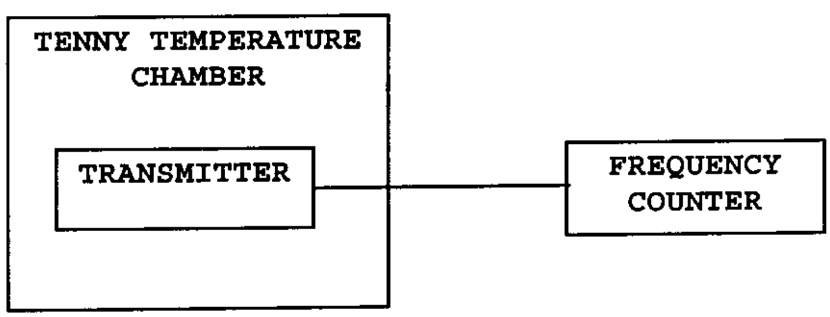
## 2.995 Frequency Stability

***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:

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 a duration of at least 5 minutes. The r.f. 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 Sorenson DC Power Supply was used to vary the dc voltage for the power input from 23.8 Vdc to 32.2 Vdc. The frequency was measured and the variation in parts per million was calculated. Data was taken per Paragraphs 2.995 and 87.133.

***Results:***

| FREQ. | FREQUENCY STABILITY VS TEMPERATURE IN PARTS PER MILLION (PPM) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (MHz) | Temperature in °C | | | | | | | | |
| | -30 | -20 | -10 | 0 | +10 | +20 | +30 | +40 | +50 |
| 118.000 | -1.6 | -2.3 | -1.6 | -1.6 | -0.8 | 0.8 | 0 | 0.8 | 2.3 |
| 126.500 | -1.6 | -2.3 | -2.3 | -1.6 | -0.8 | 0.8 | 0 | 0.8 | 2.3 |
| 136.990 | -1.4 | -1.4 | -1.4 | -1.4 | 0.7 | 0.7 | 0 | 0.7 | 2.1 |

| FREQUENCY IN MHz | STABILITY VS VOLTAGE VARIATION (±15%) IN PPM INPUT VOLTAGE | | |
|---|---|---|---|
| | 23.8 $V_{dc}$ | 28.0 $V_{dc}$ | 32.2 $V_{dc}$ |
| 118.000 | 0 | 0 | 0 |
| 126.500 | 0 | 0 | 0 |
| 136.975 | 0 | 0 | 0 |
| 136.990 | 0 | 0 | 0 |

Specifications of Paragraphs 2.995 and applicable parts of 87 are met. There are no deviations to the specifications.

# TEST EQUIPMENT LIST FOR ROGERS CONSULTING LABS, INC.

The equipment is used daily and kept in good calibration and operating condition. Calibration of critical items are checked for accuracy each time used.

| List of Test Equipment: | Calibration Date: |
|---|---|
| Scope: Tektronix 2230 | 2/98 |
| Wattmeter: Bird 43 with Load Bird 8085 | 2/98 |
| Power Supplies: Sorensen SRL 20-25, DCR 150, DCR 140 | 2/98 |
| H/V Power Supply: Fluke Model: 408B (SN:573) | 2/98 |
| R.F. Generator: Boonton 102F | 2/98 |
| R.F. Generator: HP 606A | 2/98 |
| R.F. Generator: HP 8614A | 2/98 |
| R.F. Generator: HP 8640B | 2/98 |
| Spectrum Analyzer: HP 8562A,<br>Mixers: 11517A, 11980A & 11980K<br>HP Adapters: 11518, 11519, 11520 | 2/98 |
| Spectrum Analyzer: HP 8591 EM | 6/97 |
| Frequency Counter: Weston 1255 | 2/98 |
| Frequency Counter: Leader LDC 825 | 2/98 |
| Antenna: EMCO Log Periodic | 9/97 |
| Antenna: BCD 235/BNC Antenna Research | 9/97 |
| Antenna: EMCO Dipole Set 3121C | 2/98 |
| Antenna: C.D. B-100 | 2/98 |
| Antenna: Solar 9229-1 & 9230-1 | 2/98 |
| Antenna: EMCO 6509 | 2/98 |
| Microline Freq. Meter: Model 27B | 2/98 |
| Dana Modulation Meter: Model 9008 | 2/98 |
| Audio Oscillator: H.P. 200CD | 2/98 |
| R.F. Power Amp 65W Model: 470-A-1000 | 9/97 |
| R.F. Power Amp 50W M185- 10-500 | 9/97 |
| R.F. PreAmp CPPA-102 | 9/97 |
| Shielded Room 5 M x 3 M x 2.5 M (100 dB Integrity) | |
| LISN 50 µHy/50 ohm/0.1 µf | 9/97 |
| LISN Compliance Eng. 240/20 | 2/98 |
| SCS Power Amp Model: 2350A | 2/98 |
| Power Amp A.R. Model: 10W 1000M7 | 2/98 |
| Linear Amp Mini Circuits: ZHL-1A (2 Units) | 2/98 |
| Combiner Unit Mini Circuits: ZSC-2-1 (2 Units) | 2/98 |
| ELGAR Model: 1751 | 2/98 |
| ELGAR Model: TG 704A-3D | 2/98 |
| ELGAR Model: 400SD (PB) | 2/98 |
| ESD Test Set 2000i | 10/95 |
| Fast Transient Burst Generator Model: EFT/B-100 | 10/95 |
| Current Probe: Singer CP-105 | 8/97 |
| Current Probe: Solar 9108-1N | 8/97 |
| Field Intensity Meter: EFM-018 | 10/95 |

02/01/98

# QUALIFICATIONS

of

## *SCOT D. ROGERS, ENGINEER*

**ROGERS CONSULTING LABS, INC.**

Mr. Rogers has approximately 10 years experience in the field of electronics. Six years working in the automated controls industry and 4 years working with the design and development of radio communications equipment.

**POSITIONS HELD:**

Systems Engineer: A/C Controls Mfg. Co., Inc.
6 Years

Electrical Engineer: Rogers Consulting Labs, Inc.
4 Years

**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

6/24/98
Date

1/1/98