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

MODEL: GTX 330D, 011-00455-( )

FREQUENCY: 1090 MHz

FCC ID: IPH-0046400

Test Date: March 26, 2002

Certifying Engineer: Scot D Rogers

Scot D. Rogers
ROGERS LABS, INC.
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FORWARD:

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2001, Part 2 Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057; 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

Equipment Tested

EQUIPMENT	MODEL/PART NUMBER	SERIAL NUMBER
EUT	GTX 300D, 011-00455–( )	203
IFR	ATC-1400A	204006871
IFR	S-1403C	3300
Power Supply	Topward 6303A	682872

Test results in this report relate only to the items tested.

Equipment and Cable Configuration

Test Setup

The EUT was arranged in a typical engineering test setup configuration. The EUT was connected to a dc power supply for power and a coaxial cable was connected to the antenna output terminal. The output signal of the EUT was split by a directional coupler and connected to a spectrum analyzer and the IFR test box. This provided a 50-ohm load and response signals to exercise the EUT. On the attenuated output port of the directional coupler a notch filter, attenuation and spectrum analyzer was connected. The notch filter was used at the spectrum analyzer input to attenuate the fundamental frequency centered at 1090 MHz. Refer to Figure 1 for a diagram of the test setup.

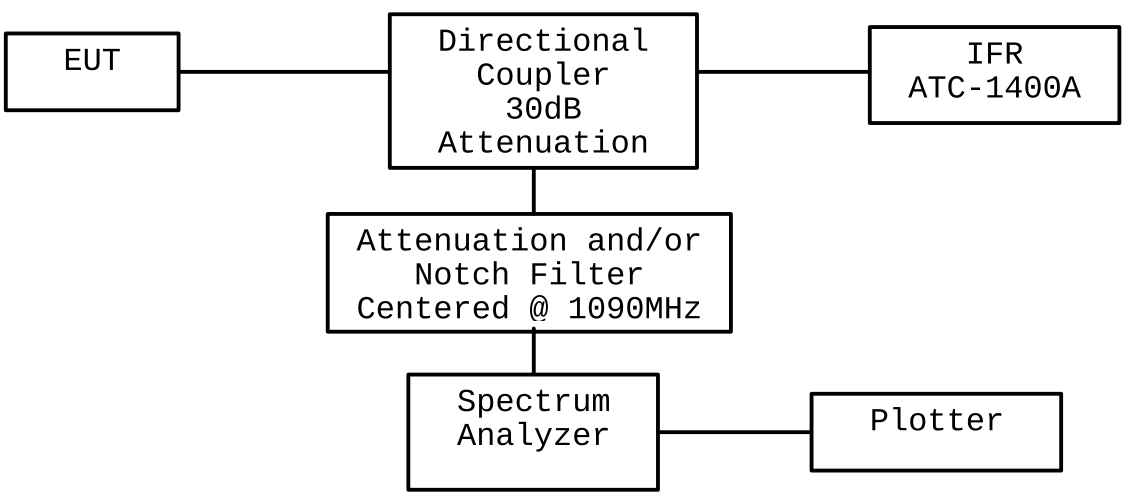


Figure 1 Test Setup

2.1033(c) Application for Certification

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

2. Identification: Model: GTX 330D
   FCC I.D.: IPH-0046400

3. Refer to Exhibit for Installation and Operating Instructions Manual.

4. Emission Type: 12M0M1D

5. Frequency Range: 1090 MHz.

6. Operating Power Level:

   RPS = Replies Per Second (maximum of 1200)

   PR = Pulse Reply Rate (maximum of 15)

   PW = Pulse Width

   Duty Factor = 1200 RPS X 15 PR X (0.45×10^{-6}) PW

   Duty Factor = 0.0081

   Nominal Average Power = P_o(PEP) X Duty Factor

   250 W PEP X 0.0081 = 2.0 W Ave

7. Max P_o: 250 watts PEP (peak envelope power).

8. Power into final amplifier: 625 Watts PEP (53V @ 11.8A).

9. Tune Up Procedure for Output Power:

   Refer to tune-up procedures for GTX 330D in the equipment manual exhibit.

10. Description of Circuitry and Devices Provided for Determining and Stabilizing Frequency, for Suppression of Spurious Radiation, Modulation, and Power:

    All components including the PCB material, trimmer capacitors, etc. are very stable. A five-pole elliptic topology filter for the second and third harmonics and quarter-wave stubs are incorporated into the output of the power amplifier. Please refer to schematic diagrams for the GTX 330D Transponder.

    The transponder uses the standard pulse format as required by ICAO, Annex 10 for both A and C modes of operation. A pulse train from the airborne unit is emitted after being interrogated by the ground unit. Each pulse has a width of 0.45 microseconds spaced 1.45 microseconds apart. Pulse train width between F1 and F2 is 20.3 microseconds. Rise time and fall time of the pulses is typically 75 nanoseconds.

11. FCC ID Label:
Refer to Exhibit for FCC Label Identification information.

12. Photographs of Equipment.
Refer to exhibit for photographs of equipment.

13. Description of Digital Modulation:
The modulator receives interrogation trigger pulses from the XILINX IC. The modulator circuitry applies control pulses to the collector of the RF driver transistor, and simultaneously to the collector of the power amplifier. The exact timing of the modulator pulses along with the wave shaping provided by the modulator circuitry provide excellent control of all aspects of the transmitter characteristics. The unit conforms to ATCRBS and TSO Standards.

a) ATCRBS
   1. Pulse Duration – 0.45 ± 0.10 microseconds.
   2. Rise time – 0.05 to 0.1 μ second.
   3. Decay time – 0.05 to 0.2 μ second.
   4. Pulse amplitude variation ± 1 dB max.
   5. Reply Rate – factory adjusted to 1200 replies/second maximum in accordance with TSO C74C.
   6. Reply group pulse content – 2 to 15 pulses.
   7. Pulse spacing – 1.45 ± 0.1 μSec except for the special position identification (SPI) which shall follow the last reply pulse by 4.35 ± 0.1 μSec.

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 splitter, appropriate attenuation, a spectrum analyzer, cable, and test equipment (37 dB attenuation).
The spectrum analyzer had impedance of 50W to match the impedance of the standard antenna. A 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 Figure 2 showing the output power of the transmitter. Data was taken per Paragraph 2.1046 and applicable paragraphs of Part 87.

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

54.0 dBm = $10^{(54.0/10)}$
= 251,190 mW
= 251 Watts (PEP)
Watts (PEP) X Duty Factor
= 251 x 0.0081
= 2.0 Watts (PEP)

Results:

FREQUENCY	P_{dBm}	OUTPUT POWER WATTS (PEP)	OUTPUT POWER IN WATTS (PEP)
1090	54.0	251	2.0

The specifications of Paragraph 2.1046 and applicable Parts of 87.131 are met. There are no deviations to the specifications.

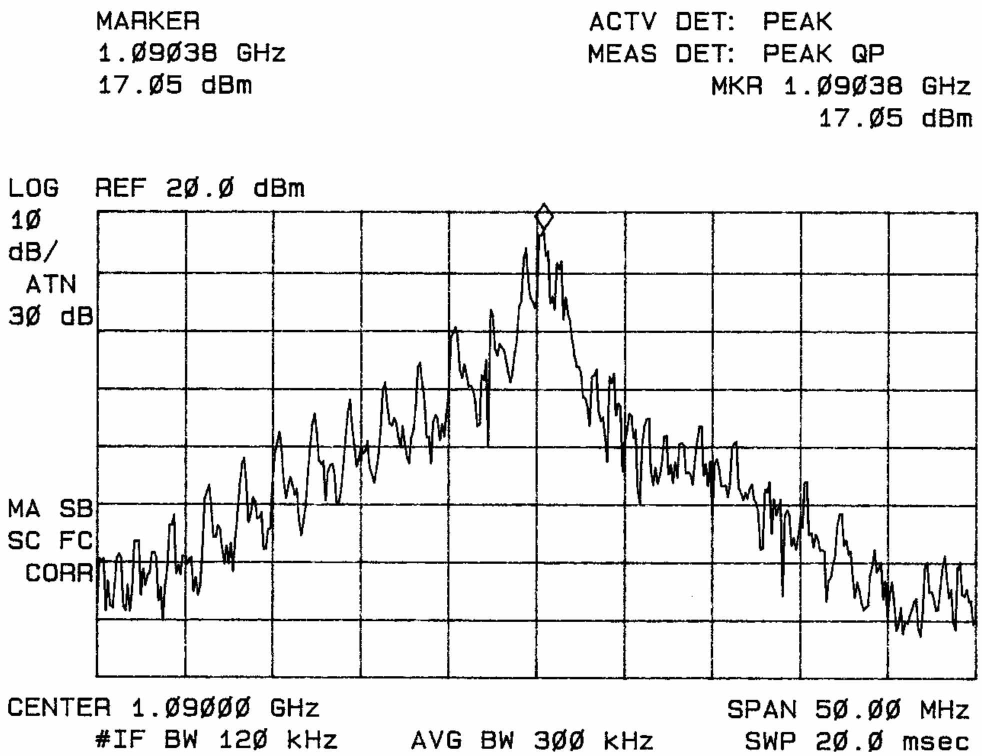


Figure 2 Power Output

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, test equipment and an oscilloscope. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in a normal mode. The oscilloscope was used to measure the pulse data.

Results:

ATCRBS	SPECIFICATIONS IN μ SEC.
Rise Time	0.05 to 0.10
Pulse Duration	0.45 ± 0.10
Decay Time	0.05 to 0.20
Pulse Amplitude Variation	1 dB Maximum
Reply Rate	1200 PPS
Pulse Content	2-15 pulses
Pulse Spacing	1.45 ± 0.10

The specifications of Paragraph 2.1047 and applicable Parts of 87.141 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.

Test Arrangement:

The occupied bandwidth was measured at the antenna terminal by replacing the antenna with a splitter, appropriate attenuation, a spectrum analyzer, cable, and test equipment. The spectrum analyzer had impedance of 50 W to match the impedance of the standard antenna. A HP 8591EM Spectrum Analyzer was used to measure the occupied bandwidth of the transmitter at the antenna port. The data was taken for the minimum and maximum response pulses.

Results:

RESPONSE	f_c (MHz)	O.B. (MHz)
0000	1090.0	10.63
7777	1090.0	10.75

Refer to figures 3 and 4 for Plots of the Occupied Bandwidth.

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 99% of the total mean power was recorded from the spectrum analyzer.

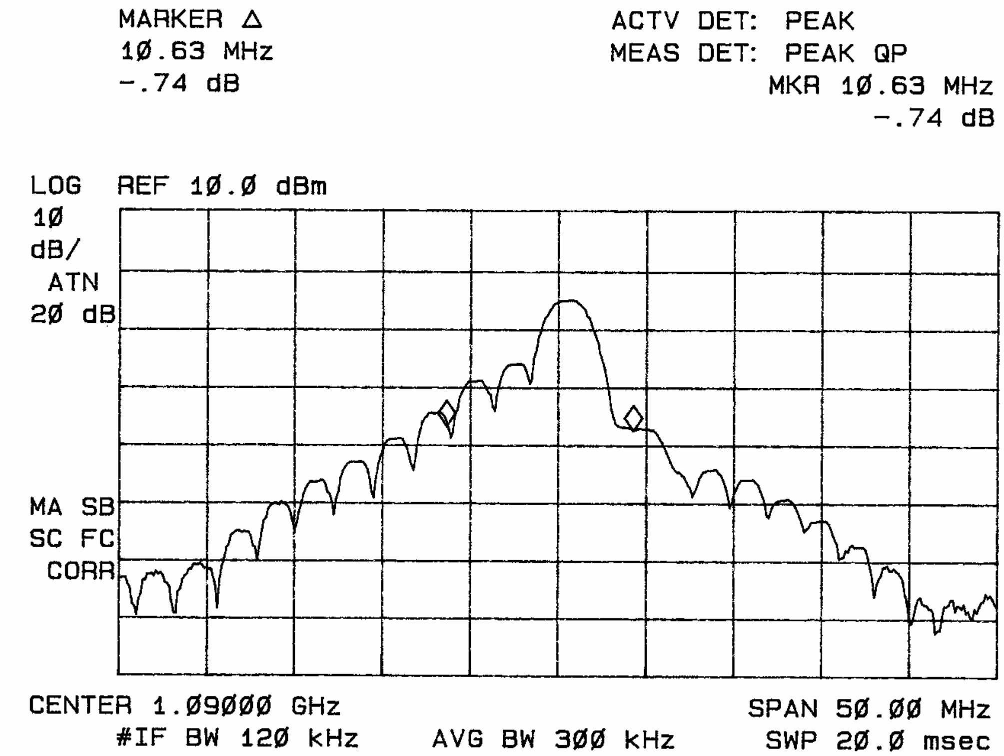


Figure 3 Occupied BandWidth (0000 response).

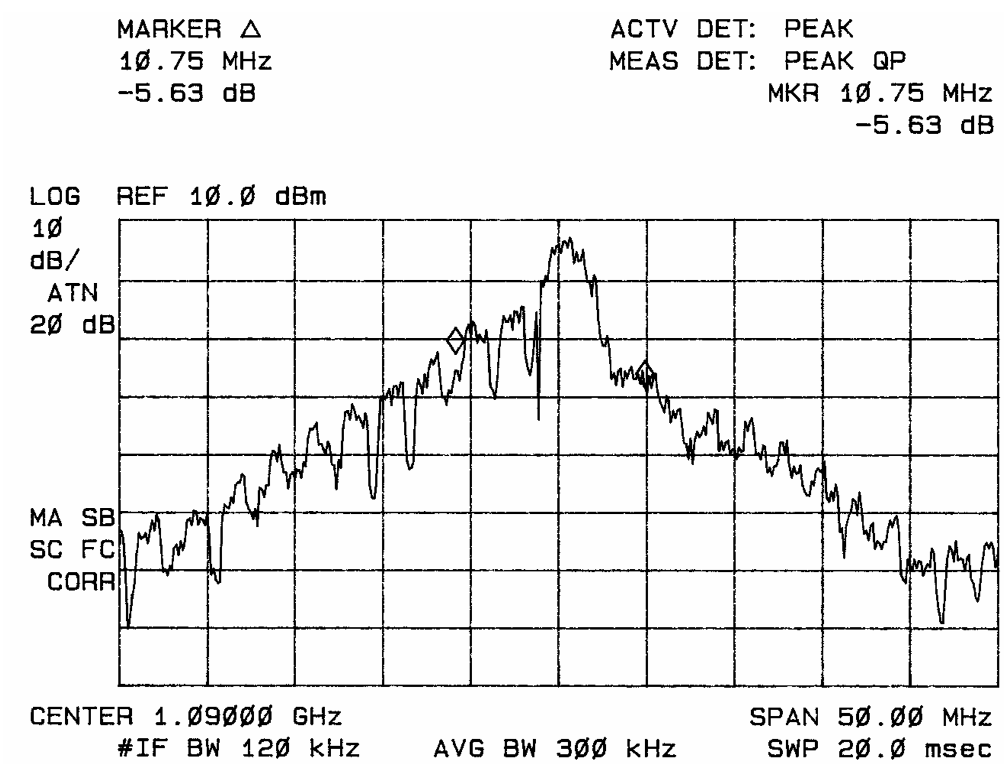


Figure 4 Occupied BandWidth (7777 response).

Requirements of 2.1049(c)(1) and 87.135 are met. There are no deviations to the specifications.

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 operated in a normal mode. The frequency spectrum from 0 MHz to 15 GHz was observed and plots produced of the frequency spectrum. Figures 5 and 6 represent data for the GTX 330D. Data taken per 2.1049, 2.1051, 2.1057, and 87.139.

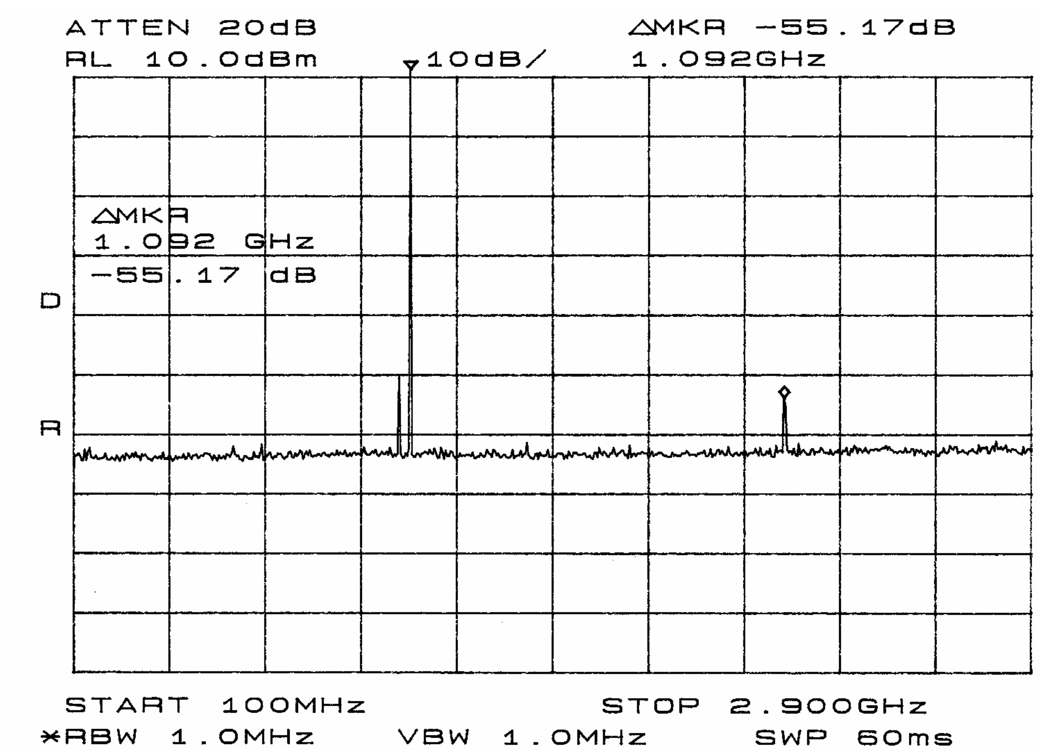


Figure 5 Emissions at Antenna Terminal.

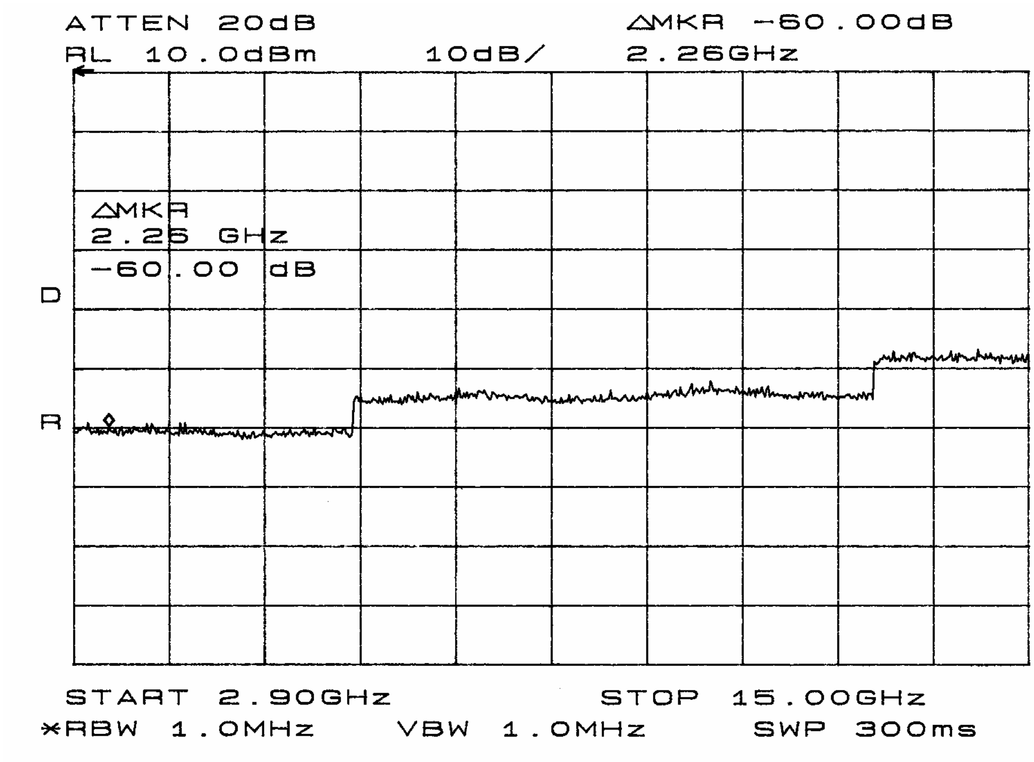


Figure 6 Emissions at Antenna Terminal.

Results:

Data was taken per 2.1051 and applicable paragraphs of Part 87. Specifications of Paragraphs 2.1051, 2.1057 and 87.139 are met. There are no deviations to the specifications.

FCC Limit:

$$= 43 + 10\ LOG(P_o\ (AVE.))$$
$$= 43 + 10\ LOG(2.0)$$
$$= 43 + 3.0$$
$$= 46.0\ dB$$

FREQUENCY MHz	SPURIOUS FREQ. (MHz)	LEVEL BELOW CARRIER (dB)
1090.0	2180.0	55.1
	3270.0	60.0

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 transmitter was activated and the frequency spectrum was observed. 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 Biconilog antenna for frequencies of 30 MHz to 1 GHz or a log periodic antenna was used for frequencies of 200 MHz to 5 GHz, and pyramidal horn antennas 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 LABS, INC. 3 meters open area test site (OATS). A description of the test facility is on file with the FCC reference number 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 = 48.5 + 6.9 - 35
CFS = 20.4

The limits 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 250-watt, (PEP)(2.0 Watt AVE.) transmitter was done as follows:

$$E = \frac{5.5\sqrt{PG}}{3}$$

where E is V/m, P is Watts, G = 1.64 and d is meters.

$$E = \frac{5.5\sqrt{2.0(1.64)}}{3} = 3.32\ \text{V/m} = 3.32 \times 10^{6}\ \mu\text{V/m @ 3 Meters}$$

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

20*log (3.32E6 µV/m) = 130.42 dBµV/m @ 3 meters.

On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth, the emissions shall be at least 43 + 10 Log P_o(AVE.) below the fundamental.

Attenuation = 43 + 10 Log (P_o AVE.)
= 43 + 10 Log (2.0)
= 46.0

The limit then is expressed as:

Limit = 130.4 – 46.0
= 84.4 dB

Results:

General Emissions

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
52.9	48.5	50.0	6.9	35	20.4	21.9	40.0
79.9	52.1	52.3	8.0	35	25.1	25.3	40.0
326.5	49.5	50.4	14.7	35	29.2	30.1	46.0
340.0	54.8	48.3	14.9	35	34.7	28.2	46.0
400.0	56.9	54.6	16.3	35	38.2	35.9	46.0
420.0	47.5	47.3	17.3	35	29.8	29.6	46.0

Channel Frequency 1090 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
2180.0	23.5	23.6	29.7	25	28.2	28.3	54.0
3270.0	24.0	23.5	36.1	25	35.1	34.6	54.0
4360.0	23.8	23.8	39.3	25	38.1	38.1	54.0
5450.0	22.3	22.3	42.5	25	39.8	39.8	54.0

Specifications of Paragraph 2.1053, 2.1057 and 87.139 are met. There are no deviations to the specifications.

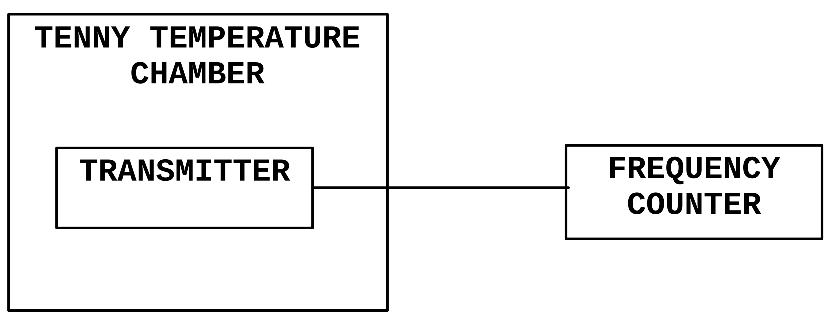
2.1055 Frequency Stability

Measurements Required:

The frequency stability shall be measured with variations of ambient temperature from -20º to +50º centigrade. Measurements shall be made at the extremes of the temperature range and at intervals of not more than 10º 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, battery 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.

<u>Test Arrangement:</u>



The measurement procedure outlined below shall be followed:

<u>Step 1:</u> 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.
<u>Step 2:</u> 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, -20°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 and at the battery end point. A Topward DC Power Supply was used to vary the dc voltage for the power input from 11.0 Vdc to 32.2 Vdc. The frequency was measured and the variation in parts per million was calculated. Data was taken per Paragraphs 2.1055(a)(2) and 87.133.

Results:

Frequency 1090.57 (MHz)	FREQUENCY STABILITY VS TEMPERATURE IN PARTS PER MILLION (PPM)								
	Temperature in °C								
	-30	-20	-10	0	+10	+20	+30	+40	+50
Frequency change	-60k	-110k	-70k	-30k	-10k	-10k	-17k	-40k	-50k
ppm	0.00005	0.0001	0.00006	0.00003	0.00001	0.00001	0.00002	0.00004	0.00005

FREQUENCY IN MHz	**STABILITY VS VOLTAGE VARIATION (±15%) IN PPM INPUT VOLTAGE**		
	11.0 V_{dc}	**27.5 V_{dc}**	**32.2 V_{dc}**
1090.57	0	0	0

Specifications of Paragraphs 2.1055 and 87.133 applicable parts of 87 are met. There are no deviations to the specifications.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to meet the CFR 47 Paragraphs 2 and 87 requirements. There were no deviations to the specifications.

APPENDIX

Model: GTX 330D

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	2/02
Wattmeter: Bird 43 with Load Bird 8085	2/02
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/02
H/V Power Supply: Fluke Model: 408B (SN: 573)	2/02
R.F. Generator: HP 606A	2/02
R.F. Generator: HP 8614A	2/02
R.F. Generator: HP 8640B	2/02
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	2/02
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	2/02
Antenna: C.D. B-101	2/02
Antenna: Solar 9229-1 & 9230-1	2/02
Antenna: EMCO 6509	2/02
Audio Oscillator: H.P. 201CD	2/02
R.F. Power Amp 65W Model: 470-A-1010	2/02
R.F. Power Amp 50W M185- 10-501	2/02
R.F. PreAmp CPPA-102	2/02
Shielded Room 5 M x 3 M x 3.0 M (101 dB Integrity)	
LISN 50 µHy/50 ohm/0.1 µf	10/01
LISN Compliance Eng. 240/20 2/02	
Peavey Power Amp Model: IPS 801	2/02
Power Amp A.R. Model: 10W 1010M7	2/02
Power Amp EIN Model: A301	2/02
ELGAR Model: 1751	2/02
ELGAR Model: TG 704A-3D	2/02
ESD Test Set 2010i	2/02
Fast Transient Burst Generator Model: EFT/B-101	2/02
Current Probe: Singer CP-105	2/02
Current Probe: Solar 9108-1N	2/02
Field Intensity Meter: EFM-018	2/02
KEYTEK Ecat Surge Generator 2/02	

02/01/2002

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

Scot D. Rogers

April 3, 2002
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