# APPLICATION

For

# FCC

And

# INDUSTRY CANADA

# GRANT OF CERTIFICATION

FOR

Models:

011-01487-00 and 011-001487-02

Marine Radar Equipment
GPN's 011-01487-00 and 011-001487-02

FOR

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

Test Report Number: 061128

# *ROGERS LABS, INC.*

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


# TEST REPORT
# For
# APPLICATION of CERTIFICATION

Marine transmitter

(CFR47 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: 011-01487-00 and 011-001487-02
GPN's: 011-01487-00 and 011-001487-02

Marine Radar Equipment
FREQUENCY: 9300 – 9500 MHz

FCC ID: IPH-GMR18
IC: 1792A-GMR18

Test Date: November 28, 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.

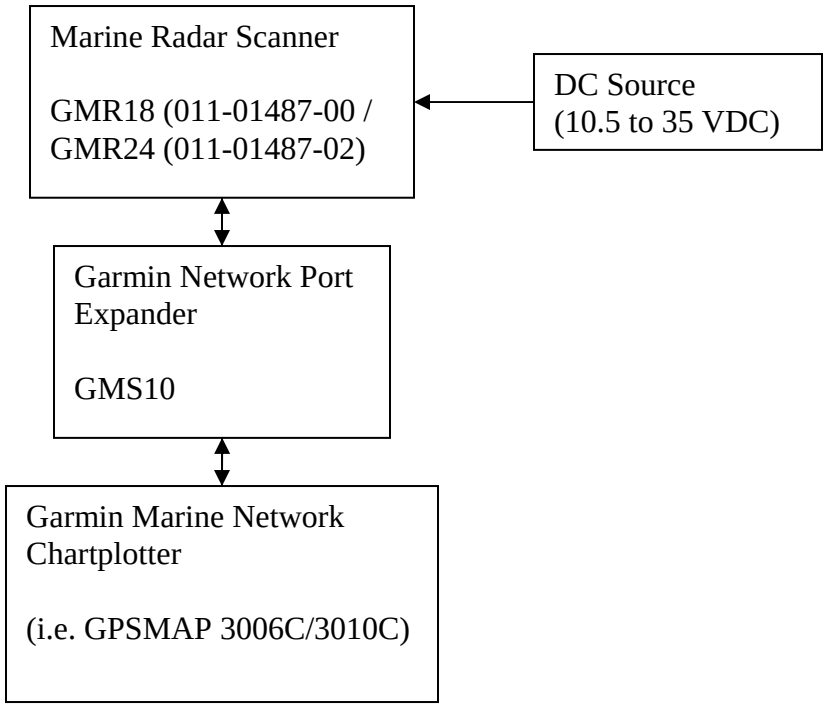
## List of Test Equipment

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.

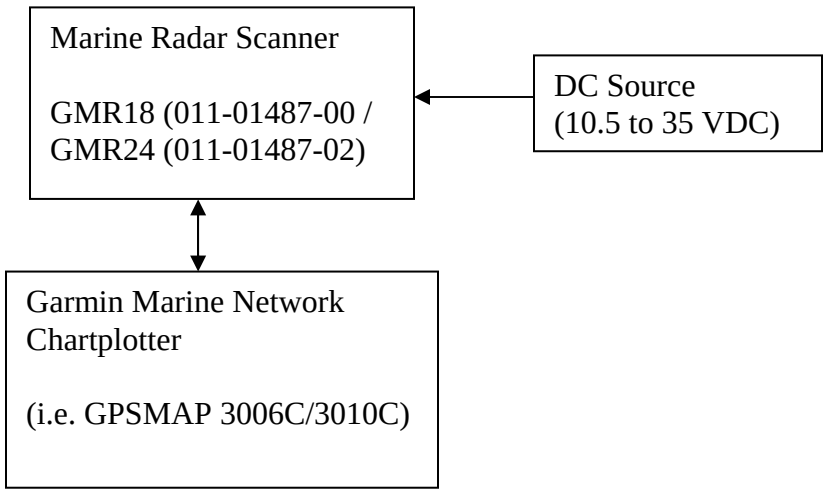
| HP 8591EM SPECTRUM ANALYZER SETTINGS | | |
|---|---|---|
| CONDUCTED EMISSIONS | | |
| RBW | AVG. BW | DETECTOR FUNCTION |
| 9 kHz | 30 kHz | Peak/Quasi Peak |
| RADIATED EMISSIONS (30 – 1000 MHz) | | |
| RBW | AVG. BW | DETECTOR FUNCTION |
| 120 kHz | 300 kHz | Peak/Quasi Peak |
| HP 8562A SPECTRUM 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

1. GMR18 / GMR24 with Network Port Expander and Chartplotter.




2. GMR18 / GMR24 with Chartplotter only.



## 2.1033(c) Application for Certification

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

(2) FCC and IC Identification: Models 011-01487-00 AND 011-001487-02, FCC I.D.: IPH-GMR18 IC: 1792A-GMR18

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

(4) Emission Type: 15M5P0N

(5) Frequency Range: 9,410 MHz (typical); 9300-9500 MHz

(6) Operating Power Level: 4,000 Watts peak power
Maximum 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:
3600 Vdc @ 3.0A maximum = 10,800 watts
4 kW peak transmitter power, calculated averages
100ns pulse = 0.922 Watts average
120ns pulse = 0.553 Watts average
250ns pulse = 1.576 Watts average
970ns pulse = 2.235 Watts average
1000ns pulse = 1.152 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. This data 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 CFR47 rule Part 80(E).

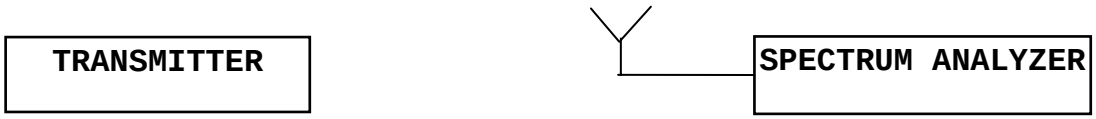
## 2.1046 RF Power Output

### *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 (011-01487-00 and 011-001487-02).

E(v/m) = 10^((dBμV/m – 120)/20) and EIRP = $(Ed)^2/30g$
Using d = 10 meters and g = 166 (numeric gain of 22.2 dB antenna)

011-01487-00 (18-inch 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 Peak EIRP Watts |
|---|---|---|---|---|---|
| 24 NM | 117.7 | 38.1 | 155.8 | 61.7 | 76.4 |
| 1/8 NM | 108.5 | 38.1 | 146.6 | 21.4 | 9.2 |

E(v/m) = 10^((dBμV/m – 120)/20) and EIRP = $(Ed)^2/30g$
Using d = 10 meters and g = 234(numeric gain of 23.7 dB antenna)

011-001487-02 (24-inch 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 Peak EIRP Watts |
|---|---|---|---|---|---|
| 24 NM | 121.5 | 38.1 | 159.6 | 95.5 | 129.9 |

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 100nS (PW) x 2303 (PRF)
P(ave) = 0.992 watts

011-01487-00 and 011-001487-02 output power

| Range (nm) | Pulse Width (ns) | Pulse Repetition frequency (+/-5%) | | | * Calculated Average Power (Watts) |
|---|---|---|---|---|---|
| | | nominal (Hz) | min (Hz) | max (Hz) | |
| 0.125 - 0.25 | 100 | 2303.935121 | 2188 | 2420 | 0.922 |
| 0.5 | 120 | 2303.935121 | 2188 | 2420 | 1.106 |
| 0.75 | 120 | 1151.967561 | 1094 | 1210 | 0.553 |
| 1.0 | 120 | 1151.967561 | 1094 | 1210 | 0.553 |
| 1.5 - 2.0 | 250 | 576.0036864 | 547 | 605 | 0.576 |
| 3.0 - 4.0 | 250 | 576.0036864 | 547 | 605 | 0.576 |
| 6.0 - 12.0 | 970 | 576.0036864 | 547 | 605 | 2.235 |
| 16.0 - 24.0 | 970 | 576.0036864 | 547 | 605 | 2.235 |
| 36.0 | 1000 | 288.0018432 | 273 | 303 | 1.152 |

*** Calculated Average Power = 4000W x Pulse Width (in sec.) x Pulse Repetition Frequency (in Hz)**

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.

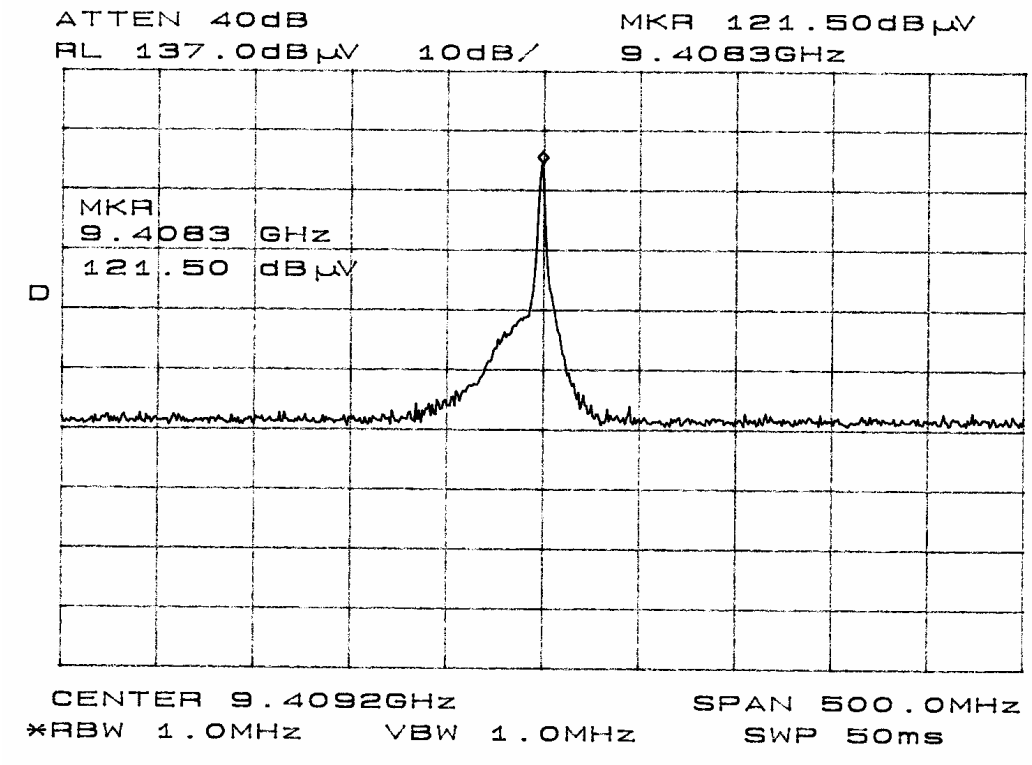



Figure 1
Plot of analyzer screen showing power output at 10 meters distance.

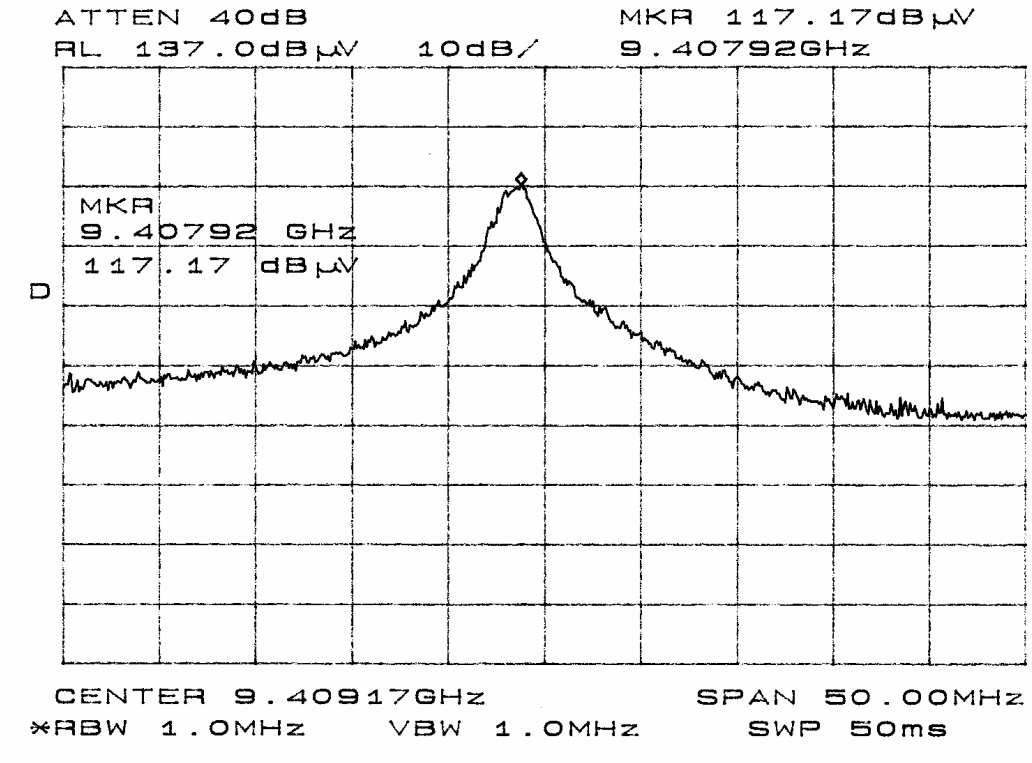



Figure2
Plot of analyzer screen showing power output at 10 meters distance.

## 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) |
|---|---|
| 9410.0 | 15.5 |

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 figures three and four showing the analyzer display screen with the analyzer connected to the receiving antenna. The specifications of Paragraph 2.1047 and applicable parts of 80 and RSS-138 are met.

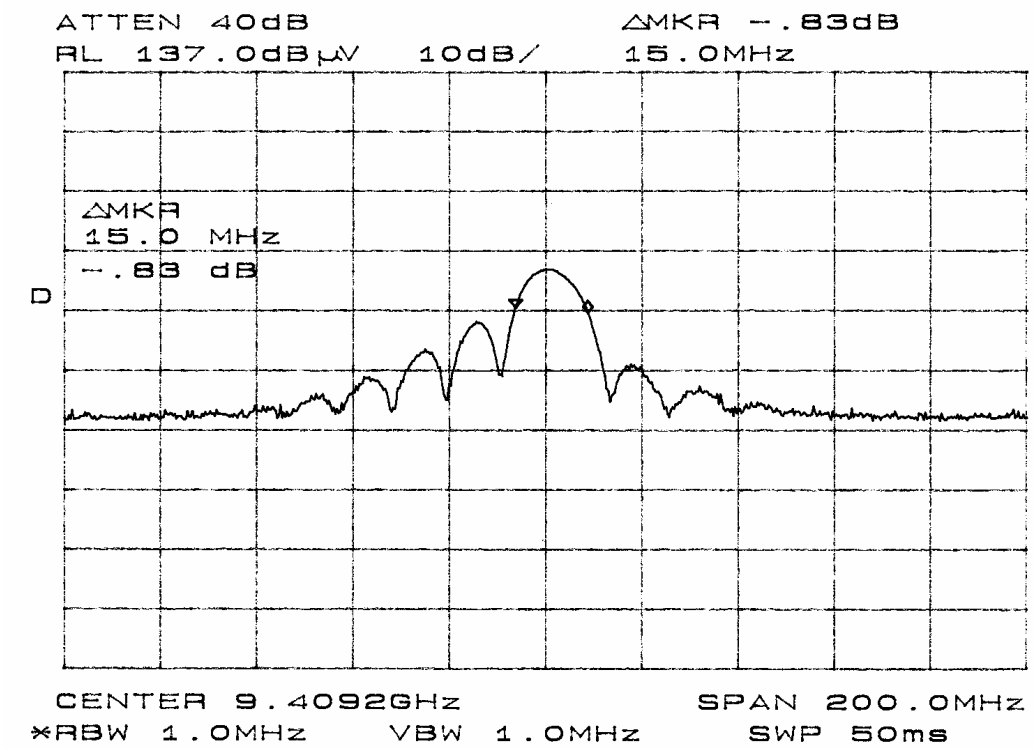



Figure three Plot of analyzer screen showing occupied bandwidth.

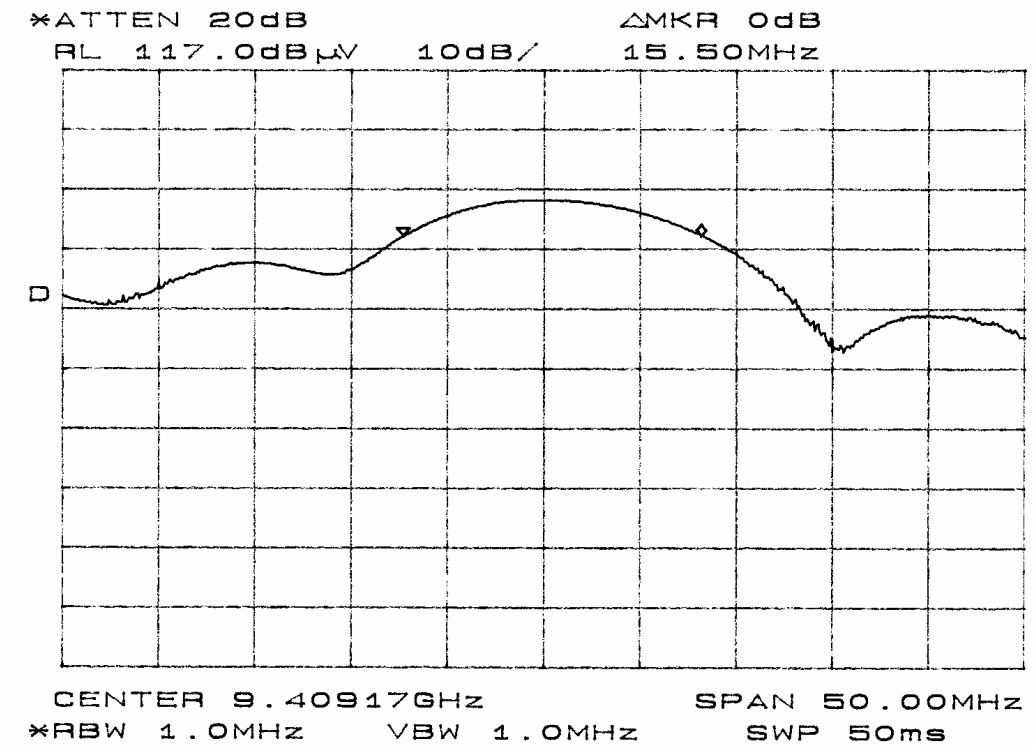



Figure four Plot of analyzer screen showing occupied bandwidth.

## 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 five through seventeen showing general radiated emission levels taken in the screen room.

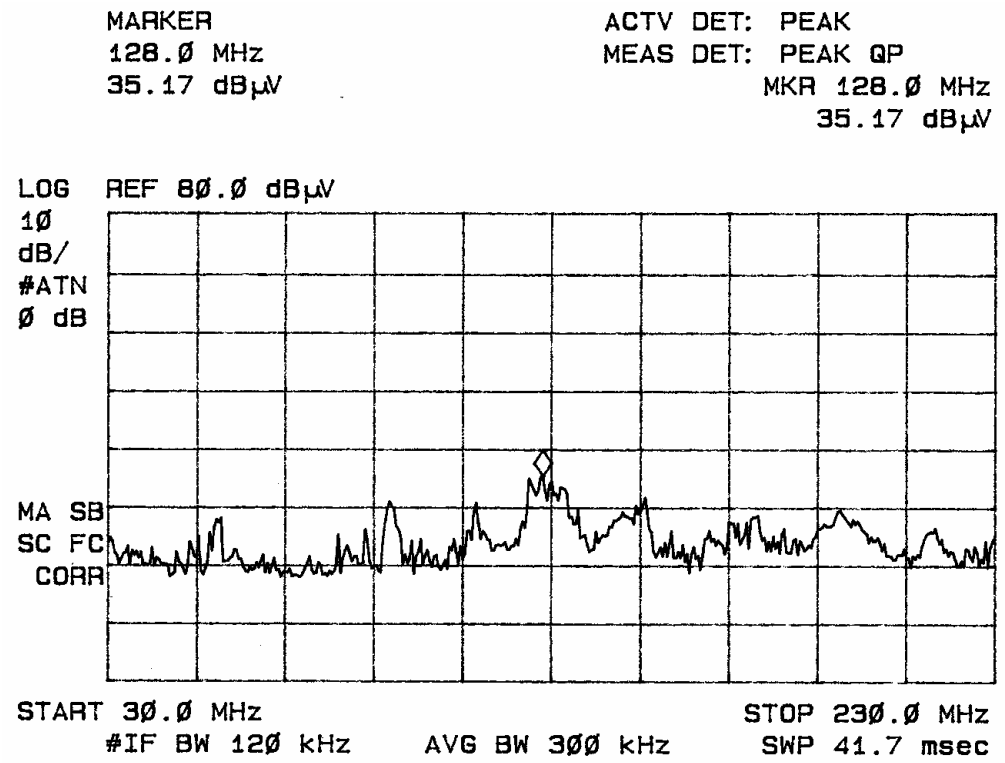



Figure five Plot of analyzer display showing emissions at 1 meter.

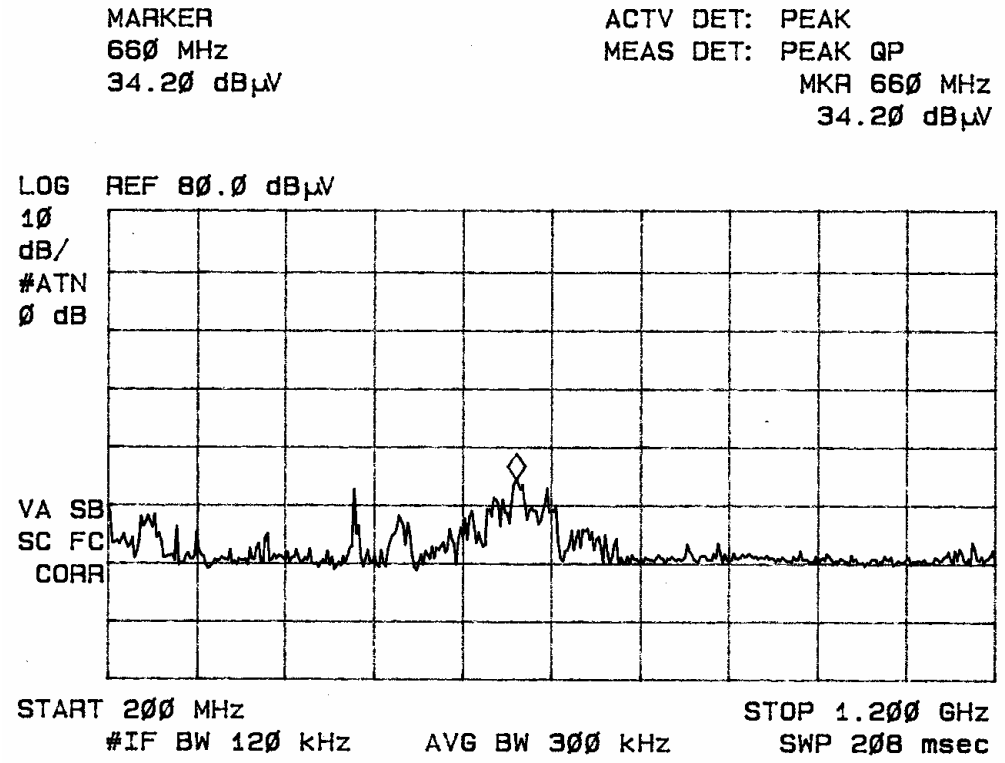



Figure six Plot of analyzer display showing emissions at 1 meter.

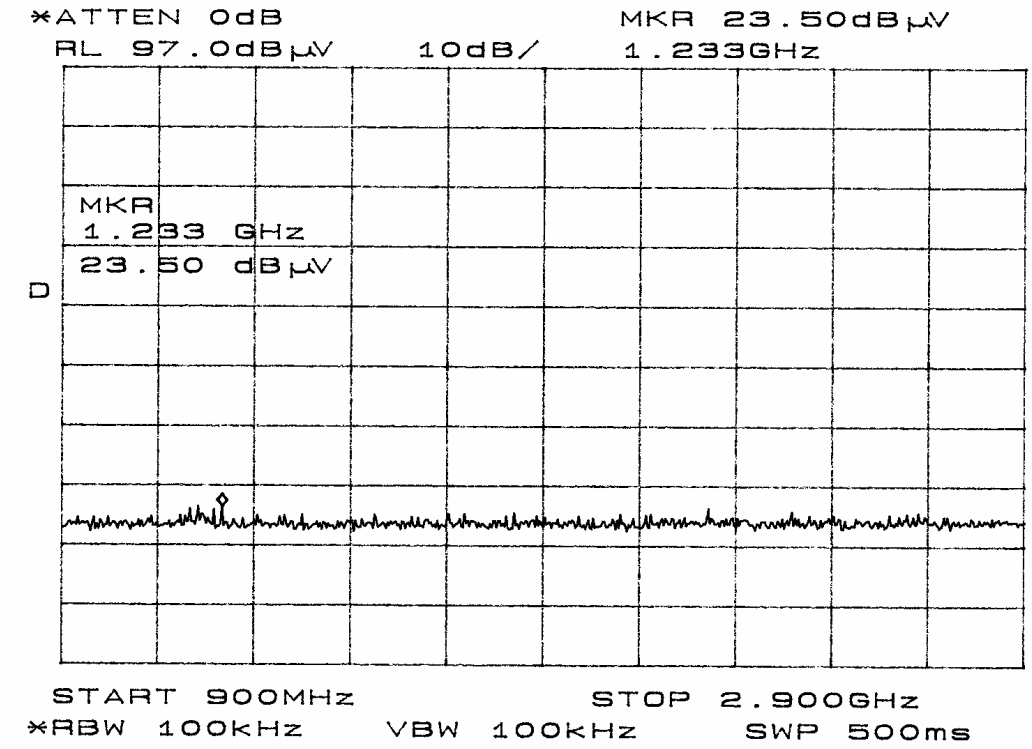



Figure seven Plot of analyzer display showing emissions at 1 meter.

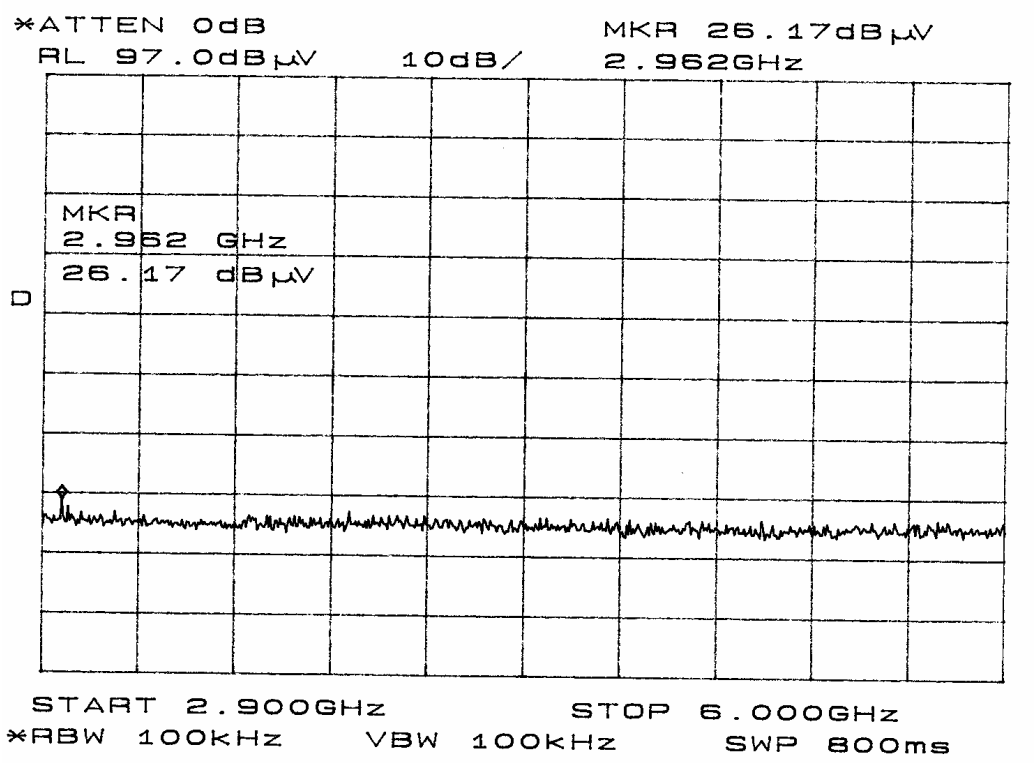



Figure eight Plot of analyzer display showing emissions at 1 meter.

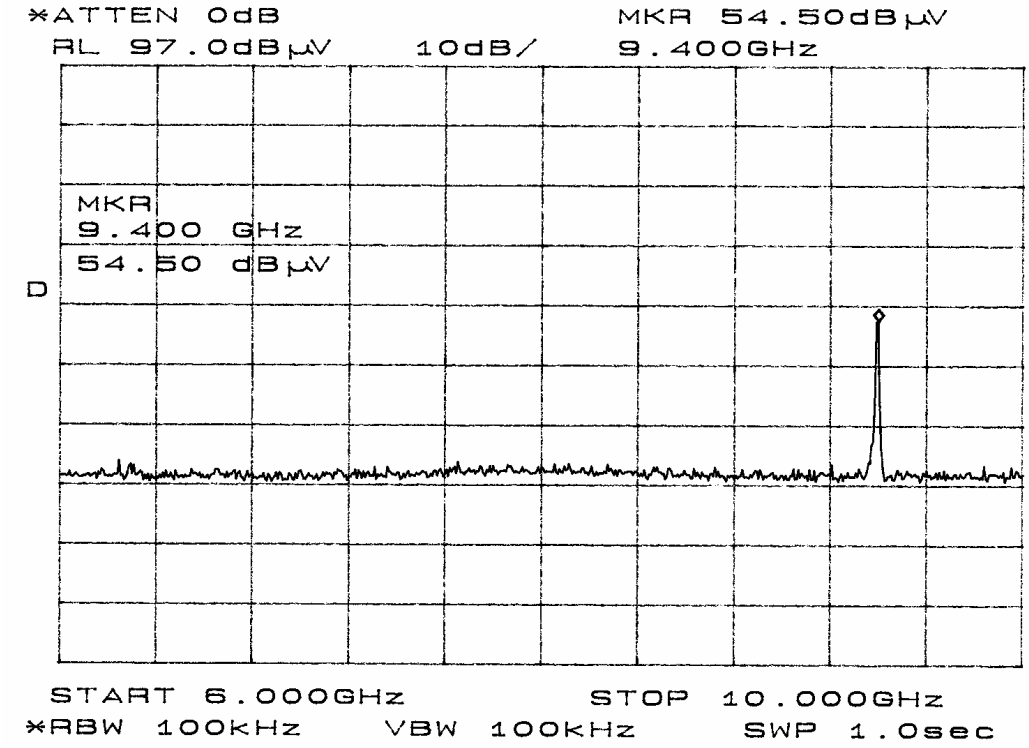



Figure nine Plot of analyzer display showing emissions at 1 meter.

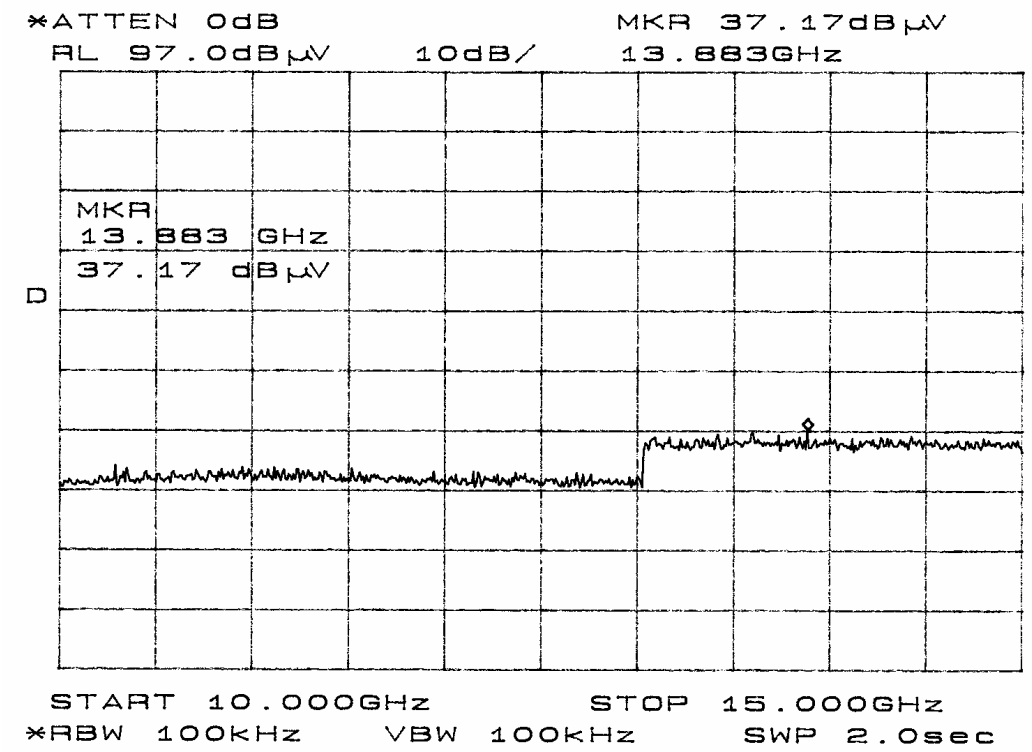



Figure ten Plot of analyzer display showing emissions at 1 meter.

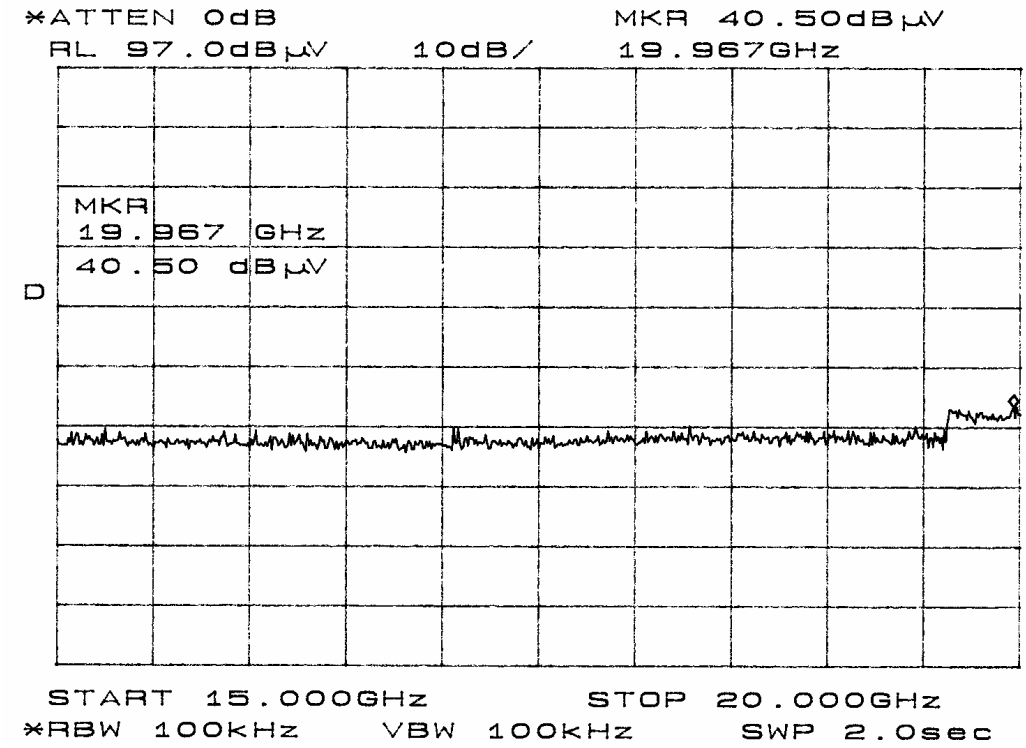



Figure eleven Plot of analyzer display showing emissions at 1 meter.

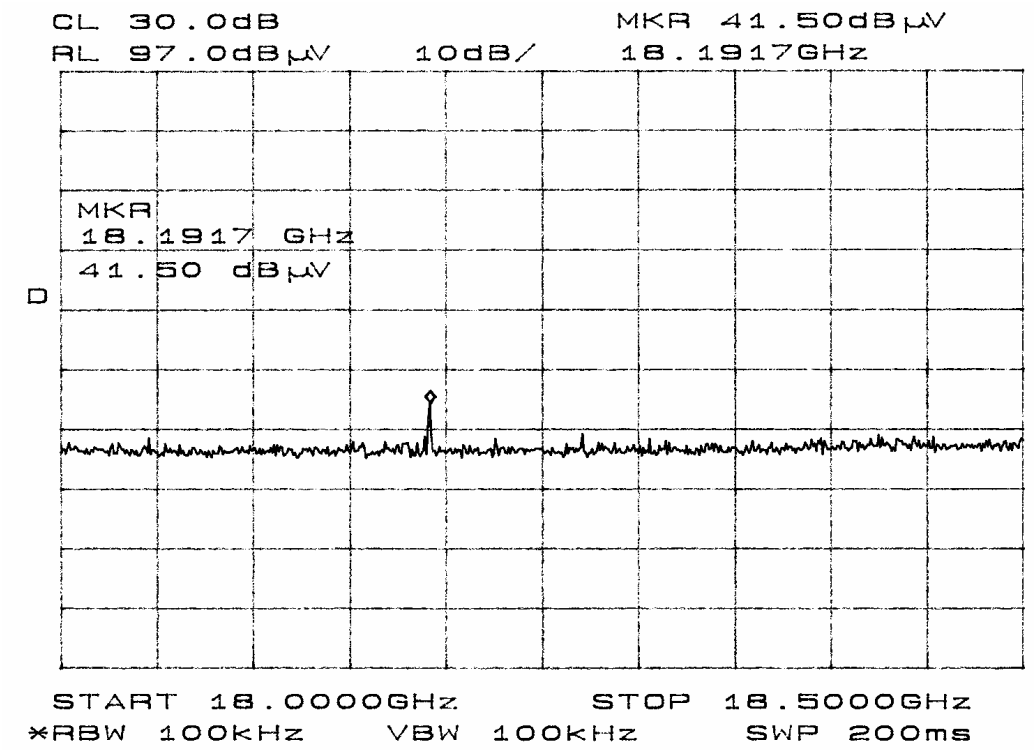



Figure twelve Plot of analyzer display showing emissions at 1 meter.

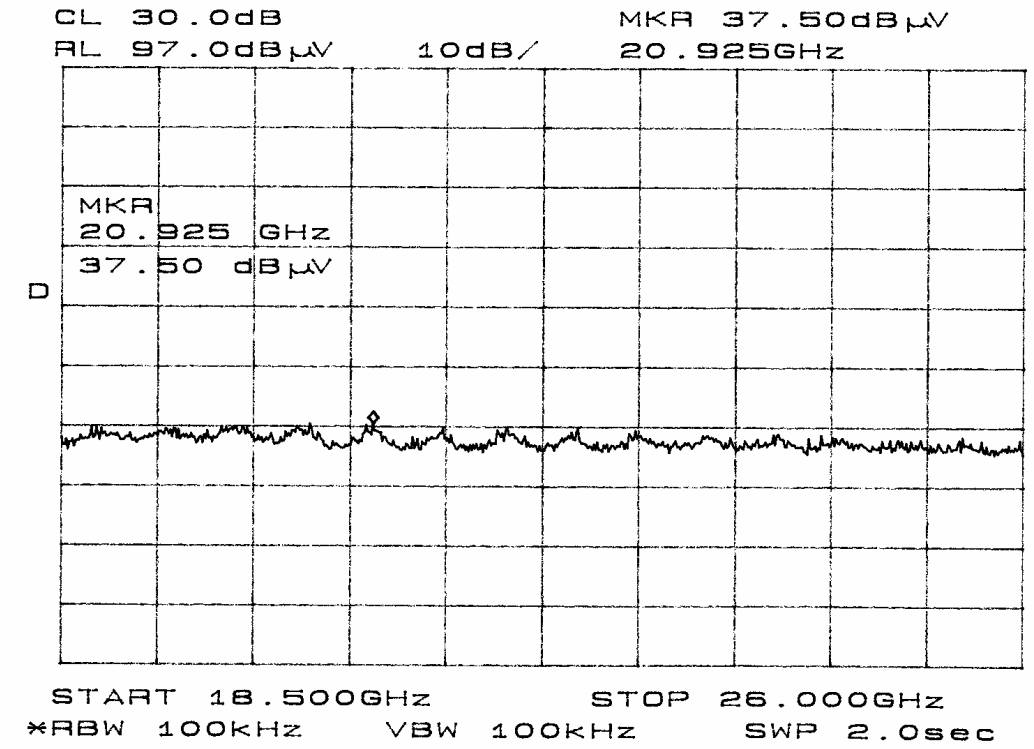



Figure thirteen Plot of analyzer display showing emissions at 1 meter.

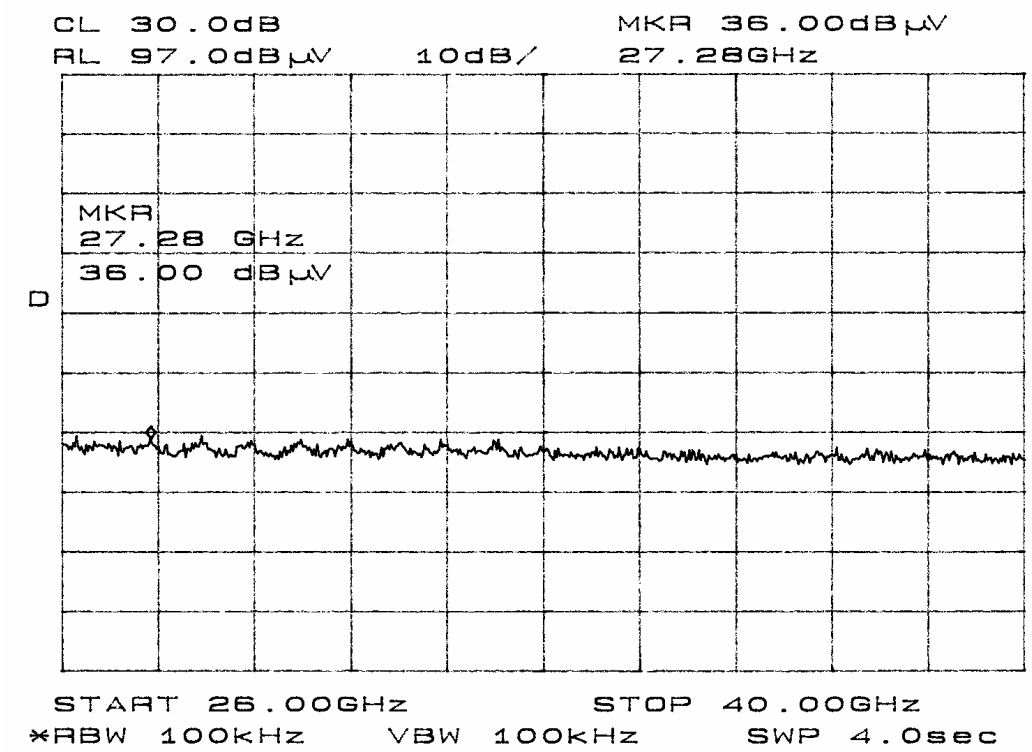



Figure fourteen Plot of analyzer display showing emissions at 1 meter.

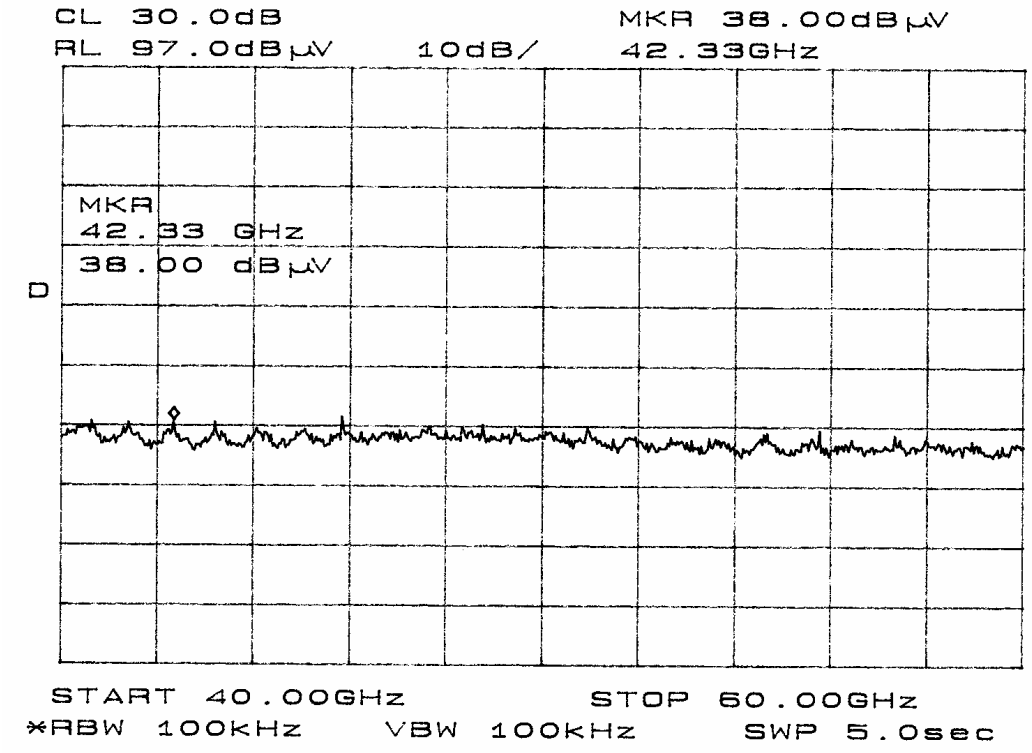



Figure fifteen Plot of analyzer display showing emissions at 1 meter.

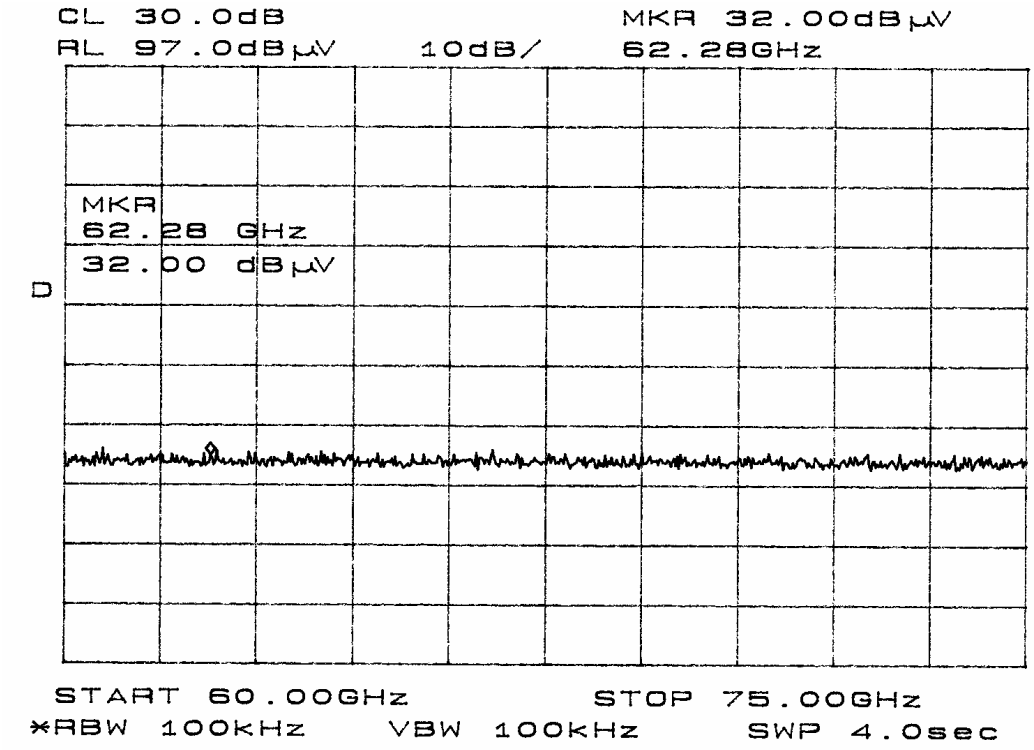



Figure sixteen Plot of analyzer display showing emissions at 1 meter.

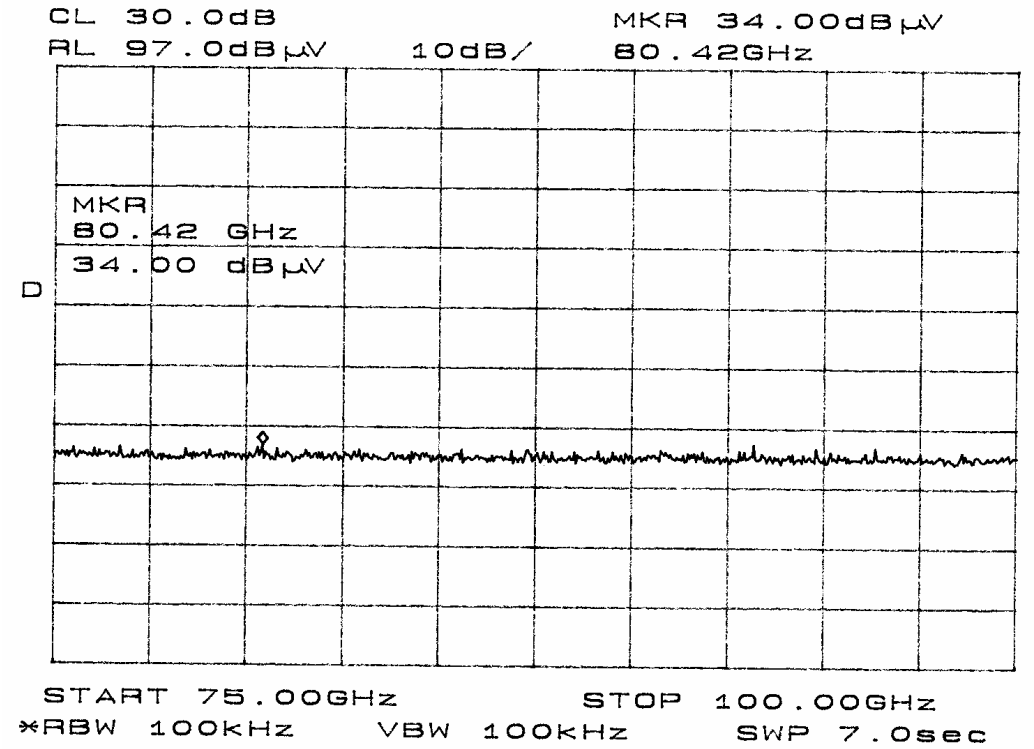



Figure seventeen Plot of analyzer display showing emissions at 1 meter.

***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 = 50.5 + 7.4 - 30
CFS = 27.9

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 |
|---|---|---|---|---|---|---|---|
| 127.8 | 50.5 | 45.8 | 7.4 | 30 | 27.9 | 23.2 | 43.5 |
| 128.9 | 49.4 | 50.5 | 7.4 | 30 | 26.8 | 27.9 | 43.5 |
| 150.4 | 51.1 | 50.8 | 10.1 | 30 | 31.2 | 30.9 | 43.5 |
| 195.5 | 58.6 | 54.7 | 9.8 | 30 | 38.4 | 34.5 | 43.5 |
| 476.0 | 51.3 | 47.8 | 18.3 | 30 | 39.6 | 36.1 | 46.0 |
| 526.2 | 47.3 | 42.3 | 18.8 | 30 | 36.1 | 31.1 | 46.0 |
| 656.0 | 40.2 | 30.5 | 20.8 | 30 | 31.0 | 21.3 | 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

Models: 011-01487-00 AND 011-001487-02

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 |
|---|---|
| Oscilloscope 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,<br>Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W<br>HP Adapters: 11518, 11519, 11520 | 2/06 |
| Spectrum Analyzer: HP 8591EM | 5/06 |
| Frequency Counter: Leader LDC825 | 2/06 |
| Antenna: EMCO Biconilog Model: 3143 | 5/06 |
| Antenna: EMCO Log Periodic Model: 3147 | 10/06 |
| Antenna: Antenna Research Biconical Model: BCD 235 | 10/06 |
| 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 | 10/06 |
| LISN Compliance Eng. 240/20 | 2/06 |
| LISN Fischer Custom Communications FCC-LISN-50-16-2-08 | 6/06 |
| 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 | |

10/18/2006

QUALIFICATIONS

Of

SCOT D. ROGERS, ENGINEER

ROGERS LABS, INC.

Mr. Rogers has approximately 17 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.<br>6 Years |
| Electrical Engineer: | Rogers Consulting Labs, Inc.<br>5 Years |
| Electrical Engineer: | Rogers Labs, Inc.<br>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

November 28, 2006
Date

Industry Canada Industrie Canada

May 23rd, 2006

OUR FILE: 46405-3041
Submission No: 115252

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

Dear Sir/Madame:

The Bureau has received your application for the Alternate Test Site or OATS and the filing is satisfactory to Industry Canada.

Please reference to the file number **(3041-1)** in the body of all test reports containing measurements performed on the site.

In the future, to obtain or renew a unique registration number, you may demonstrate that the site has been accredited to ANSI C63.4-2003 or later.

If the site is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating conformance with the ANSI standard. The Department will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to exceed two years.

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca
Please reference our file number above for all correspondence.

Yours sincerely,

Robert Corey
Manager Certification
**Certification and Engineering Bureau**
3701 Carling Ave., Building 94
Ottawa, Ontario K2H 8S2

Canada

# FEDERAL COMMUNICATIONS COMMISSION

**Laboratory Division**
**7435 Oakland Mills Road**
**Columbia, MD 21046**

May 16, 2006

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: May 16, 2006

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,

Phyllis Parrish
Information Technician