

# Application for Grant of Certification

## FCC CFR47 Part 87

GMN-00862

Market Label: GDL 88

978 MHz (UAT)

Universal Access Transceiver (UAT)

1030 MHz (Traffic Alert & Collision Avoidance System (TCAS))

FCC ID: IPH-01246

For

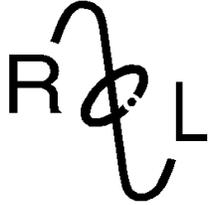
Garmin International, Inc.

1200 East 151st Street

Olathe, KS 66062

Test Report Number 111107

Authorized Signatory:   
Scot D. Rogers



# 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

Mr. Van Ruggles  
Director of Quality Assurance

Universal Access Transceiver (UAT)  
Market Label: GDL 88  
Frequency Range: 978 MHz (UAT) and 1030 MHz (TCAS)

FCC ID: IPH-01246

Test Date: November 7, 2011

Certifying Engineer: *Scot D Rogers*

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## Forward

In accordance with the Federal Communications, Code of Federal Regulations dated October 1, 2011, 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 the following information is submitted for consideration in obtaining grant of certification.

## Opinion / Interpretation of Results

Tests Performed	Results
Requirements per CFR47 paragraphs 2.1031-2.1057	Complies
Requirements per CFR47 paragraphs 87.131	Complies
Requirements per CFR47 paragraphs 87.133 (d)	Complies
Requirements per CFR47 paragraphs 87.135	Complies
Requirements per CFR47 paragraphs 87.139	Complies
Requirements per CFR47 paragraphs 87.141	Complies

## Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2011, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057 the following is submitted for consideration in obtaining Grant of Certification. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.4-2009 and/or TIA/EIA 603-C (2004).

## Environmental Conditions

Ambient Temperature            20.5° C

Relative Humidity                40%

Atmospheric Pressure           1018.9 mb

## Application for Certification

(1) Manufacturer:

Garmin International, Inc.  
1200 East 151st Street  
Olathe, KS 66062

(2) Identification: FCC I.D.: IPH-01246

(3) Instruction Book: Refer to exhibit for Draft Instruction Manual.

(4) Emission Type: Emissions designator 1M30F1D (UAT), 4M33V1D (TCAS)

(5) Frequency Range: 978 MHz (UAT), 1030 MHz (TCAS)

(6) Operating Power Level: 978 MHz - 40 Watts peak, 0.16 Watts (Average Power),  
1030 MHz – 0.0009 Watts

(7) Maximum Po: Maximum Po: 40 Watts (nominal peak power, not to exceed 40 W delivered to antenna) and 0.16-Watts average delivered from this EUT. Maximum power output as determined by appropriate standards during certification per CFR 47 paragraph 87.131. The specification in table 2-2 of RTCA DO-282B section 2.1.12 is 40 watts (+46 dBm) at the antenna; minimum power is 16 watts (+42 dBm).

(8) Power into final amplifying circuitry: Final amplifier 28 volts with pulses driving the current to 2.68 amps (75 watts peak) with quiescent current in micro amps.

(9) Tune Up Procedure for Output Power: Refer to Exhibit for Alignment Procedure.

(10) Circuit Diagrams; description of circuits, frequency stability, spurious suppression, and power and modulation limiting: Refer to Exhibit for Circuit Diagrams and 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: The modulation for the transmitted pulses is defined in RTCA DO-282B sections 2.2.2.2 and 2.2.2.3: Continuous Phase 2FSK, modulation index 0.6, frequency deviation  $\pm 312.5$  kHz from carrier nominal (binary 1 shift up, binary 0 shift down), nominal modulation rate 1.041667 Mbps.

(14) Data required by CFR47 paragraphs 2.1046 through 2.1057 are contained in the report.



NVLAP Lab Code 200087-0

- (15) External power amplifier requirements do not apply to this device or application.
- (16) AM broadcast requirements do not apply to this device or application.
- (17) Requirements of CFR47 paragraph 25.129 do not apply to this device or application.
- (18) The device is not a software-defined radio and requirements of 2.944 do not apply to this application.



## System Description

The EUT is an Aviation Universal Access Transceiver (UAT) functioning as part of the Automatic Dependent Surveillance – Broadcast (ADS-B) system, allowing aircraft and certain equipped surface vehicles to share position, velocity, and other information with one another by way of radio broadcast techniques. UAT is a multi-purpose aeronautical data link intended to support not only ADS-B, but also Flight Information Service – Broadcast (FIS-B), Traffic Information Service – Broadcast (TIS-B), and supplementary ranging and positioning capability. The GMN-00862 supports the 978 MHz UAT data link for both transmit and receive, with an additional 1090 MHz extended squitter receive-only function. The unit incorporates a low power 1030 MHz transmitter function for own-ship interrogation in TCAS service.

## Units of Measurements

AC Line Conducted EMI      Data is in dB $\mu$ V; dB referenced to one microvolt.

Radiated EMI                Data is in dB $\mu$ V/m; dB/m referenced to one microvolt per meter

Antenna Conducted      Data is in dBm, dB referenced to one milliwatt

## Test Site Locations

Conducted EMI            The conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.

Radiated EMI             The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS.

Site Registration         Refer to Annex for FCC Site Registration Letter, # 90910, and Industry Canada Site Registration Letter, IC3041A-1.

## List of Test Equipment

A Rohde & Schwarz ESU 40 and/or Hewlett Packard 8591EM was used as the measuring device for emissions testing of frequencies below 1 GHz. A Rohde & Schwarz ESU 40 and/or Hewlett Packard 8562A was used as the measuring device for testing emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of test equipment.

Emissions at Frequencies below 1000 MHz		
Conducted Emissions		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Radiated Emissions		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Emissions at Frequencies above 1000 MHz		
RBW	Video BW	Detector Function
1 MHz	1 MHz	Peak / Average

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Calibration Date</u>	<u>Due</u>
LISN	Comp. Design	FCC-LISN-2-MOD.CD	10/11	10/12
Antenna	ARA	BCD-235-B	10/11	10/12
Antenna	EMCO	3147	10/11	10/12
Antenna	Sunol	JB6	10/11	10/12
Antenna	Com Power	AH-118	10/11	10/12
Antenna	EMCO	3143	5/11	5/12
Analyzer	HP	8591EM	5/11	5/12
Analyzer	HP	8562A	5/11	5/12
Analyzer	Rohde & Schwarz	ESU40	5/11	5/12

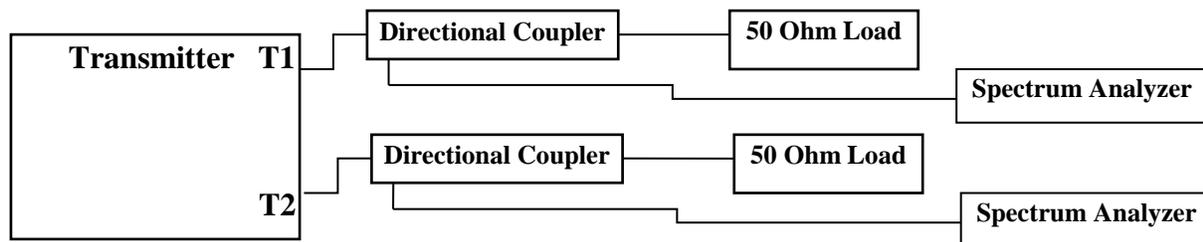
## Radio Frequency Power Output

### 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:

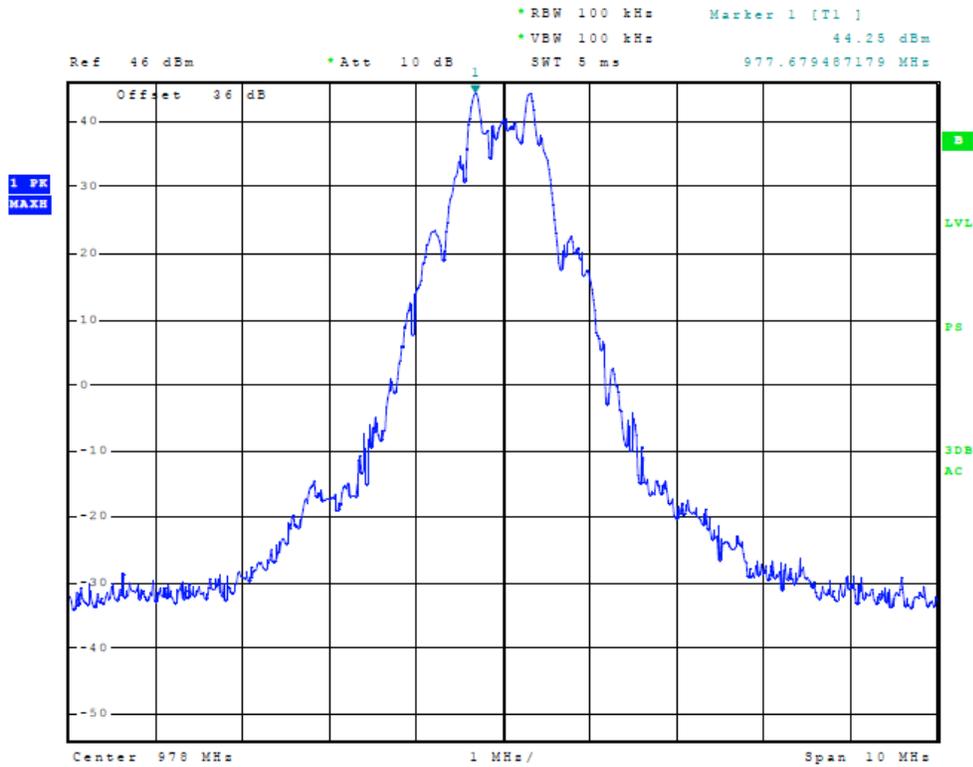
If the power output is adjustable, measurements shall be made for the highest and lowest power levels.

### Test Arrangement



The radio frequency power output was measured at the antenna terminal by placing appropriate attenuation in the antenna line and observing the emission with the spectrum analyzer. The spectrum analyzer had an impedance of 50Ω to match the impedance of the standard antenna. A Rohde Schwarz ESU-40 and/or HP 8562A 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 CFR47 Paragraph 2.1046(a) and applicable paragraphs of Part 87.

PdBm	= power in dB above 1 milliwatt.
Milliwatts	= $10^{(PdBm/10)}$
Watts	= (Milliwatts) (0.001)(W/mW)
Milliwatts	= $10^{(46/10)}$
	= 39,810.7 mW
	= 40 Watts Peak power



**Figure 1 Maximum Power Output**

**Radio Frequency Power Output Results**

Frequency (MHz)	Antenna Port	P (dBm)	P (mw)	P (Watts)
978.0	T1	45.82	38,194.4	40
978.0	T2	45.80	38,018.9	40
1030.0	T1	-30.50	0.0009	890 nW
1030.0	T2	-30.31	0.0009	930 nW

The specifications of CFR47 Paragraph 2.1046(a) and applicable Parts of 2 and 87.131 are met. There are no deviations to the specifications.



## **Modulation Characteristics**

### ***Measurements Required***

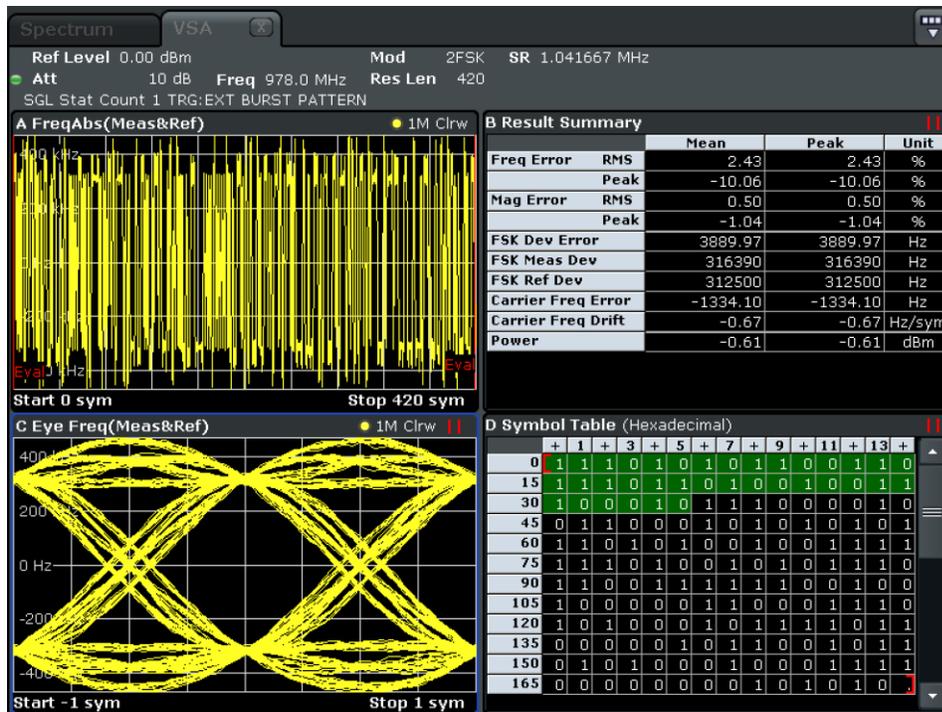
A curve or equivalent data, which shows that the equipment will meet the modulation requirements of the rules, under which the equipment is to be licensed, shall be submitted.

The modulation specifications are defined by RTCA DO-282B sections 2.2.2.2 and 2.2.2.3: Continuous Phase 2FSK, modulation index 0.6, frequency deviation  $\pm 312.5$  kHz from carrier nominal (binary 1 shift up, binary 0 shift down), nominal modulation rate 1.041667 Mbps.

There are two message lengths: Short ADS-B, which is 264.96  $\mu$ S long (276 bits \* 960 nS per bit), and Long ADS-B which is 403.2  $\mu$ S (420 bits \* 960 nS per bit). Pulse repetition frequency is 1 second.

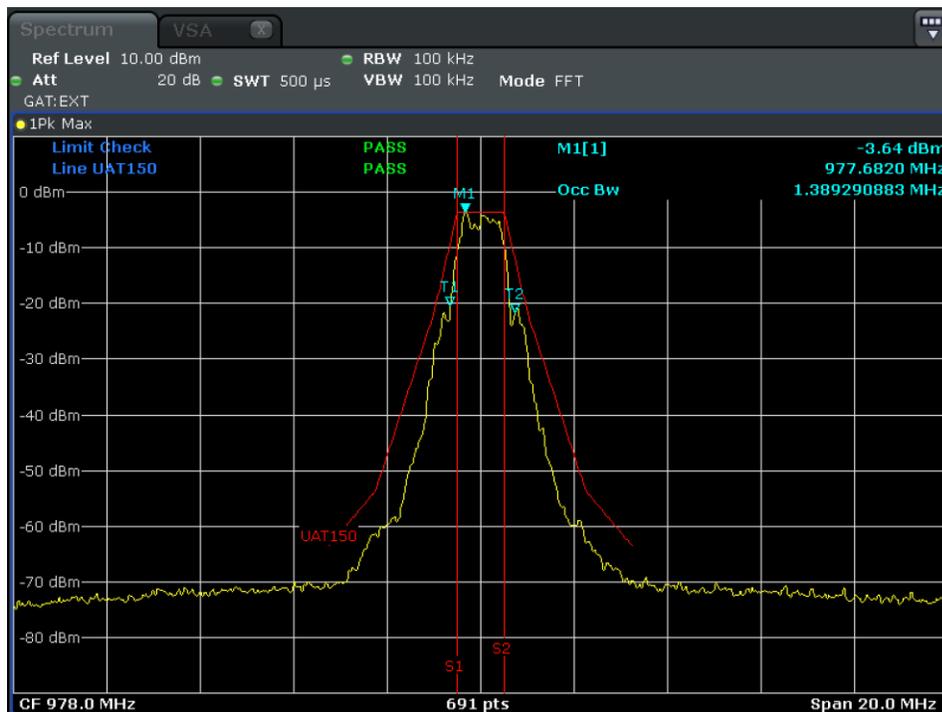
### ***Modulation Characteristics Results***

Figures 2 and 3 represent operation for long message while equipment operational in normal mode. The requirements of CFR47 2.1049(c)(1) and applicable paragraphs of Part 87.141 are met. There are no deviations to the specifications.



Date: 26.NOV.2011 21:11:21

Figure 2 VSA Display of Long Message



Date: 26.NOV.2011 21:13:35

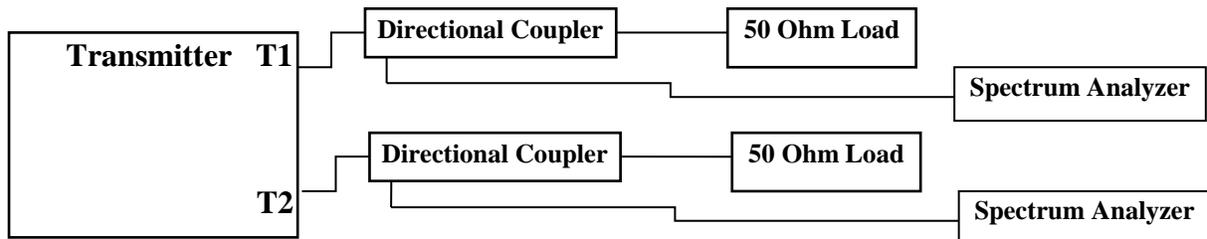
Figure 3 Spectrum Plot of Long Message

## 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 each equal to 0.5 percent of the total mean power radiated by a given emission.

### Test Arrangement



A Rohde & Schwarz ESU 40 spectrum analyzer was used to observe the radio frequency spectrum with the transmitter operating in all normal modes. The EUT was set to transmit in typical mode while measurements were made.

The power ratio in dB representing 99% of the total mean power was recorded from the spectrum analyzer. Refer to figures four and five showing the plot of the 99% power occupied bandwidth.

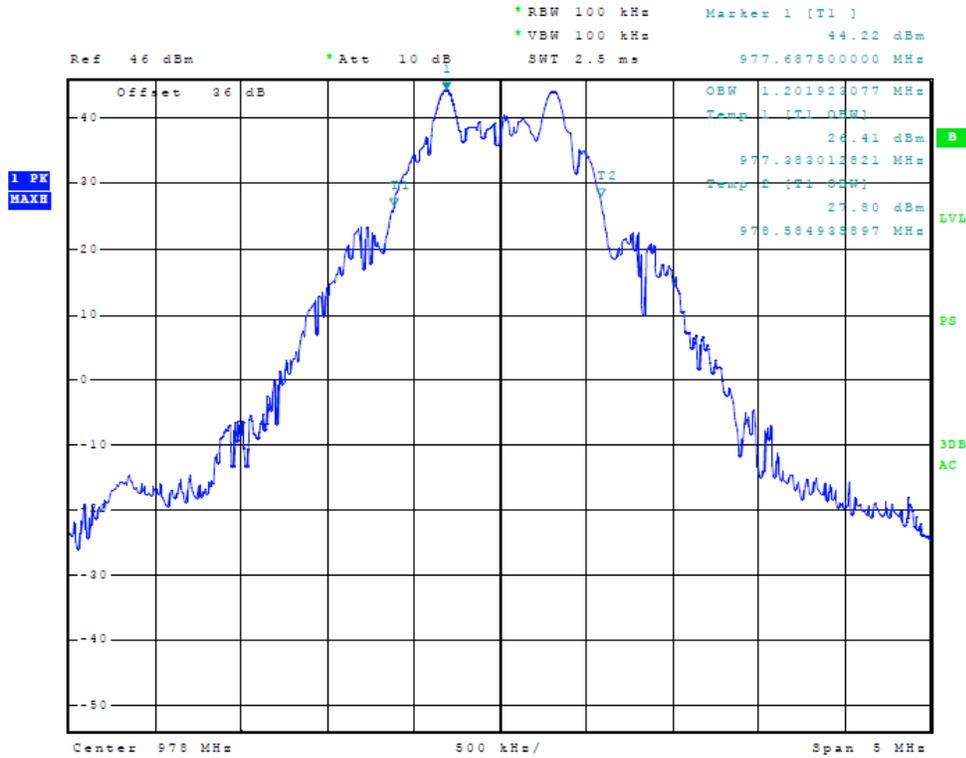


Figure 4 Occupied Band Width, Carrier frequency 978.00 MHz

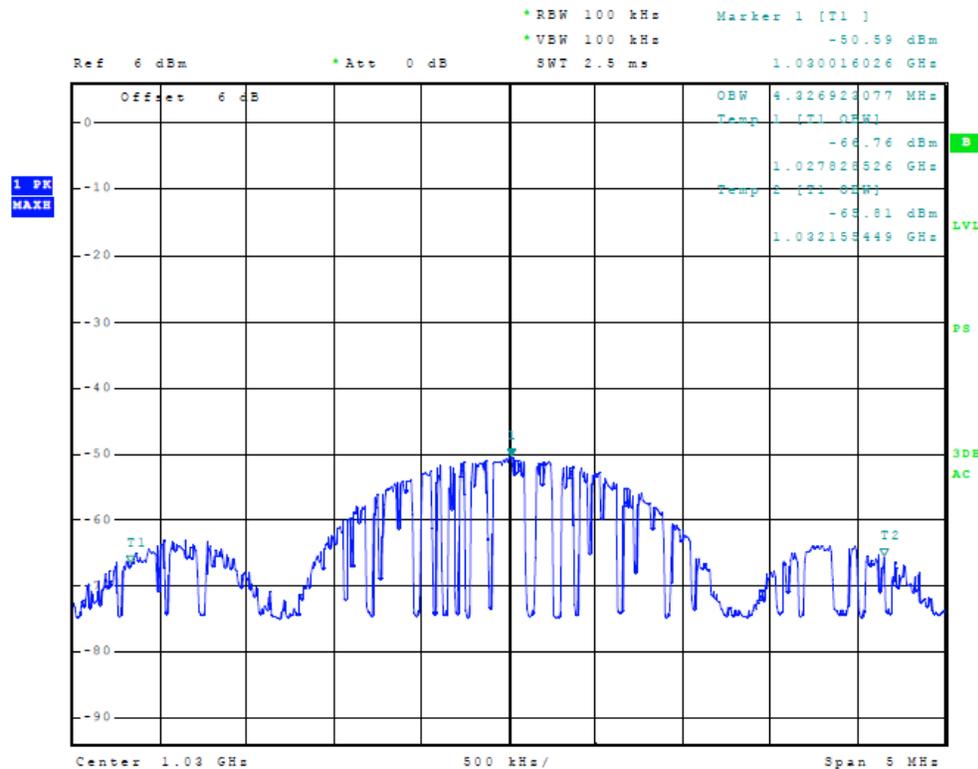


Figure 5 Occupied Band Width, Carrier frequency 1030.00 MHz

### Occupied Bandwidth Results

Frequency (MHz)	Occupied bandwidth(MHz)
978.00	1.3 MHz
1030.0	4,326.9

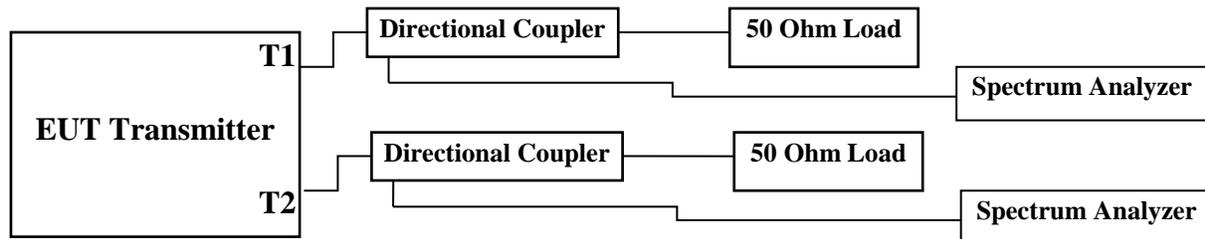
The requirements of CFR47 2.1049(h) and applicable paragraphs of Part 87.135 are met. There are no deviations to the specifications.

### 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 Rohde & Schwarz ESU 40 Spectrum Analyzer. The spectrum analyzer was used to observe the radio frequency spectrum with the transmitter modulated per section 2.1049 and operated in all normal modes. The frequency spectrum from 30 MHz to 12,000 MHz was observed and plots produced of the frequency spectrum. Figures six through 14 represents data for the worst-case antenna spurious emissions of the GMN-00862. Data was taken per CFR47 2.1051, 2.1057, and applicable paragraphs of Part 87.139.



### ***Antenna Port Spurious Emissions Results***

The output of the unit was coupled to a Rohde & Schwarz ESU 40 Spectrum Analyzer and the frequency emissions were measured. Data was taken as per CFR47 2.1051 and applicable paragraphs of Part 87. Specifications of Paragraphs 2.1051, 2.1057 and applicable paragraphs of part 87.139 are met. There are no deviations to the specifications.

All spurious emissions must be attenuated at least  $43 + 10\log(P)$  [P=Average Transmitter power] below the fundamental emission power level. The following equations represent the calculated attenuation levels for the equipment.

Spurious Emissions Limit shall be attenuated at least 35 dB below fundamental carrier

$$= 43 + 10 \text{ Log}(P)$$

$$= 43 + 10 \text{ Log}(0.16)$$

$$= 35.0$$



Antenna Port T1

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dB)
978.00	1956.0	-31.2	-77.1
	2934.0	-33.1	-78.9
	3912.0	-30.4	-76.2
	4890.0	-30.0	-75.9
	5868.0	-31.7	-77.5
	6846.0	-31.0	-76.9
	7824.0	-31.1	-76.9
	8802.0	-30.4	-76.3
	9780.0	-30.9	-76.7

Antenna Port T2

Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dB)
978.00	1956.0	-34.3	-79.9
	2934.0	-34.8	-80.3
	3912.0	-30.7	-76.3
	4890.0	-30.3	-75.9
	5868.0	-30.7	-76.3
	6846.0	-30.3	-75.9
	7824.0	-31.5	-77.1
	8802.0	-30.6	-76.2
	9780.0	-30.2	-75.7

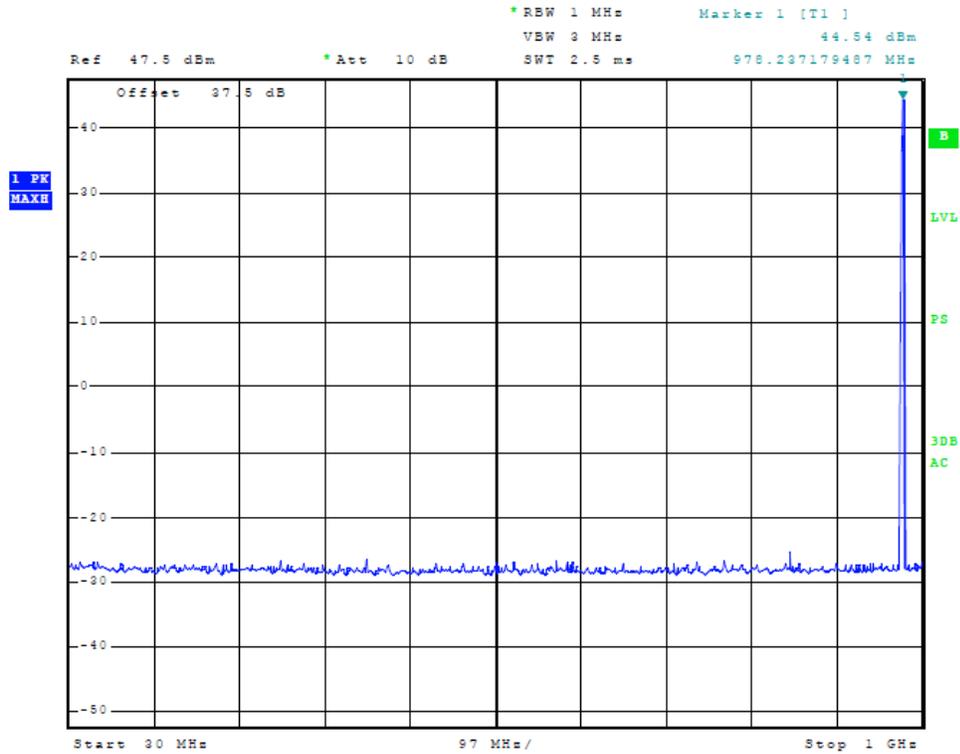


Antenna Port T1

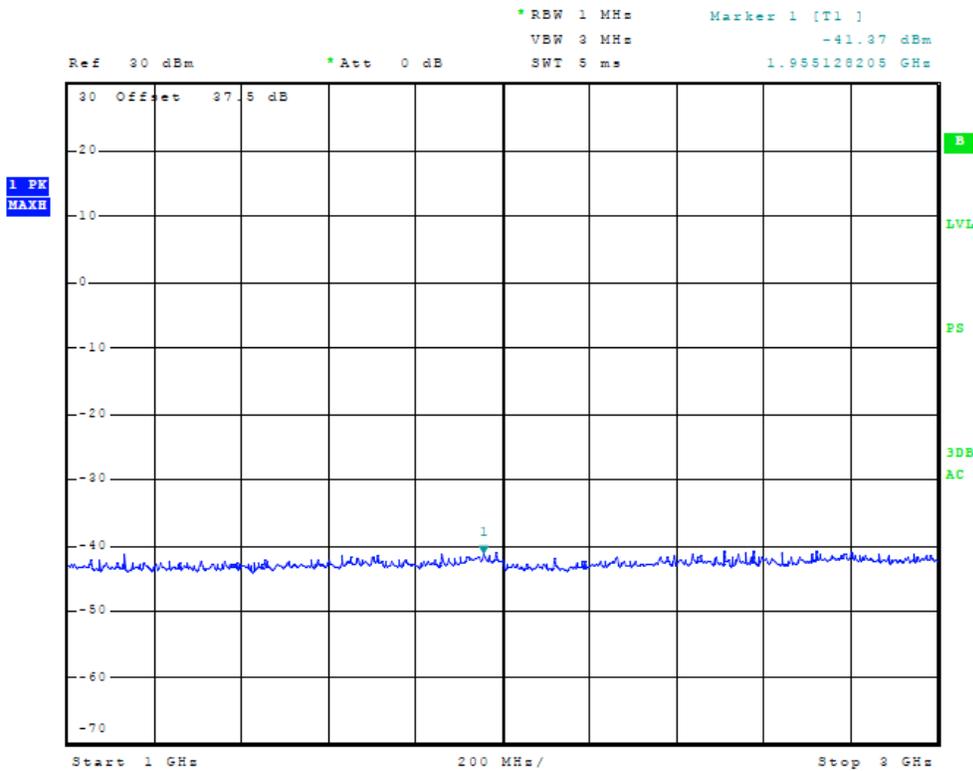
Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dB)
1030.00	2060.0	-78.1	-47.6
	3090.0	-78.1	-47.6
	4120.0	-77.7	-47.2
	5150.0	-77.5	-47.0
	6180.0	-76.4	-45.9
	7210.0	-77.6	-47.1
	8240.0	-77.7	-47.2
	9270.0	-76.5	-46.0
	10300.0	-76.8	-46.3

Antenna Port T2

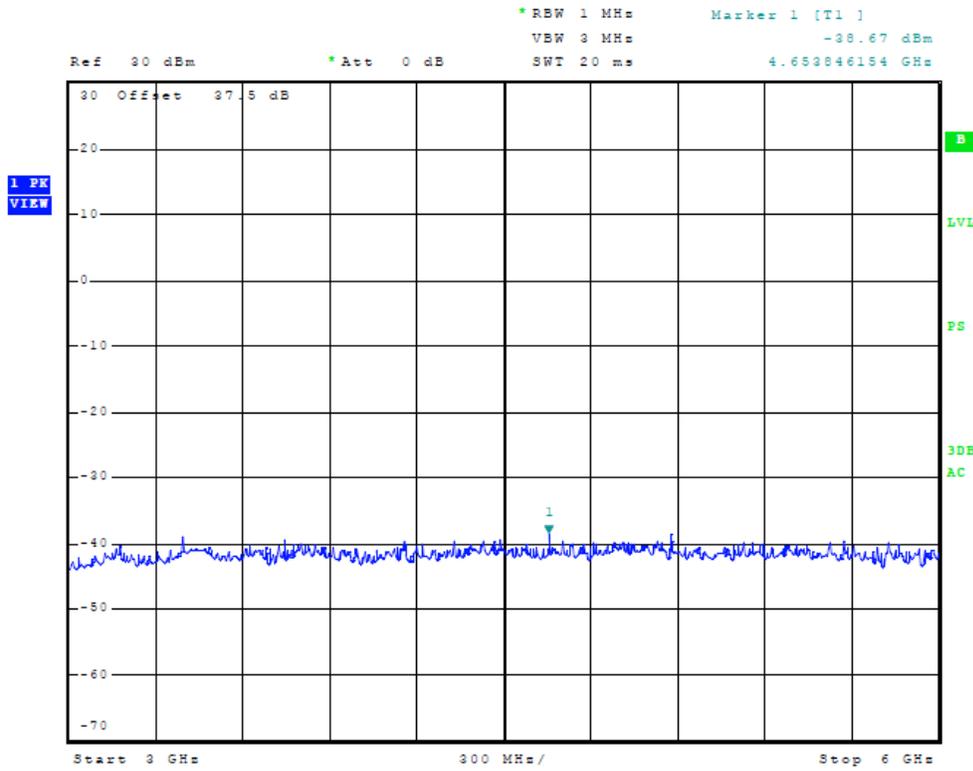
Channel MHz	Spurious Freq. (MHz)	Measured Level (dBm)	Level Below Carrier (dB)
1030.00	2060.0	-73.1	-42.8
	3090.0	-72.7	-42.4
	4120.0	-73.2	-42.9
	5150.0	-73.2	-42.8
	6180.0	-73.3	-42.9
	7210.0	-72.9	-42.6
	8240.0	-73.6	-43.2
	9270.0	-73.2	-42.9
	10300.0	-73.3	-43.0



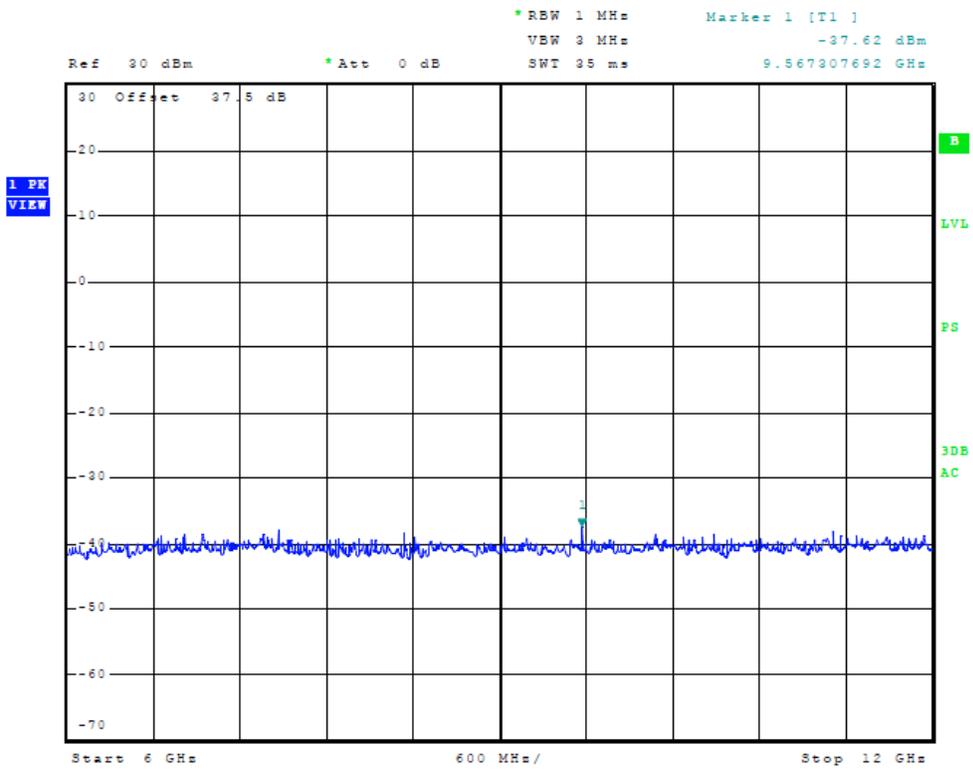
**Figure 6 Spurious Emissions at Antenna Terminal (UAT 978 MHz T1)**



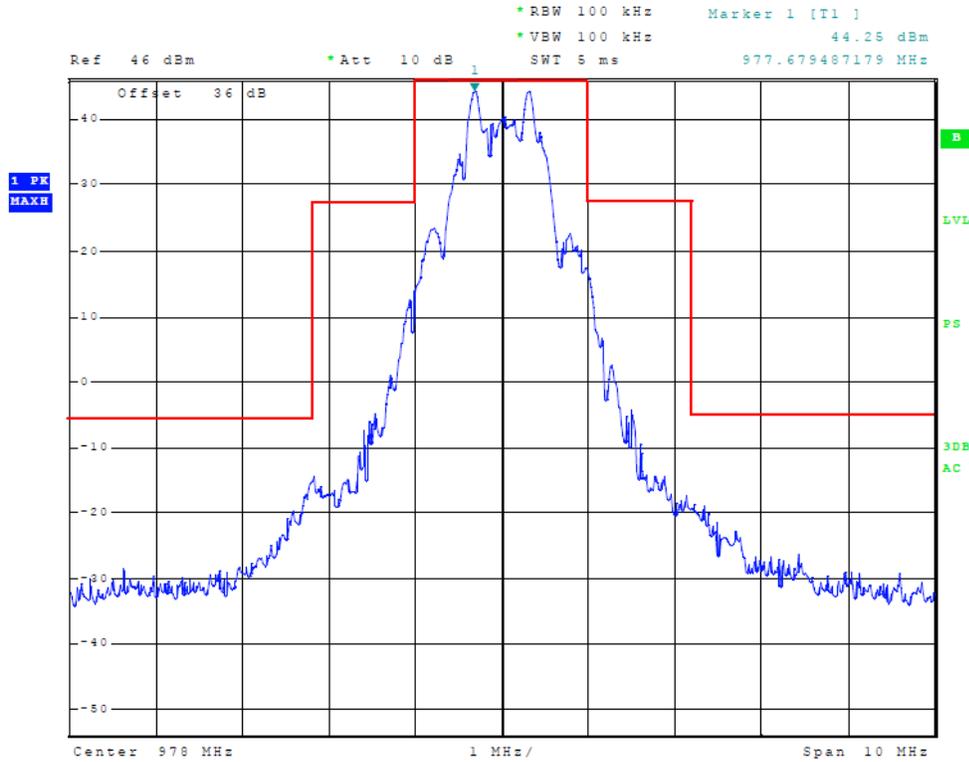
**Figure 7 Spurious Emissions at Antenna Terminal (UAT 978 MHz T1)**



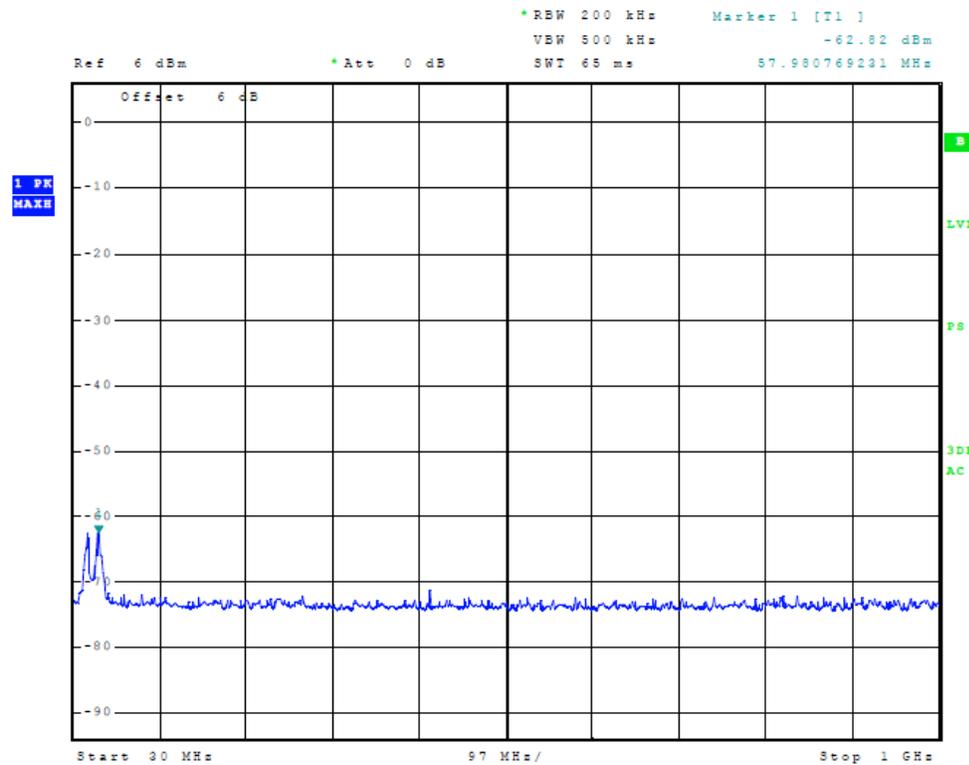
**Figure 8 Spurious Emissions at Antenna Terminal (UAT 978 MHz T1)**



**Figure 9 Spurious Emissions at Antenna Terminal (UAT 978 MHz T1)**



**Figure 10 Emissions Mask (UAT 978 MHz)**



**Figure 11 Spurious Emissions at Antenna Terminal (1030 MHz)**

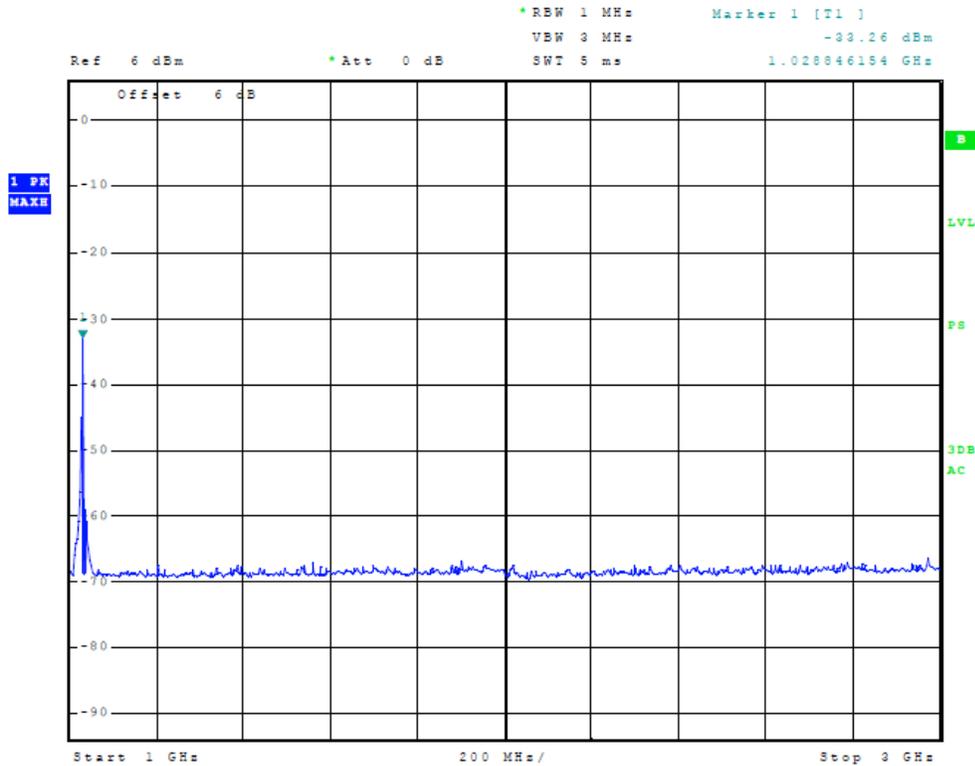


Figure 12 Spurious Emissions at Antenna Terminal (1030 MHz)

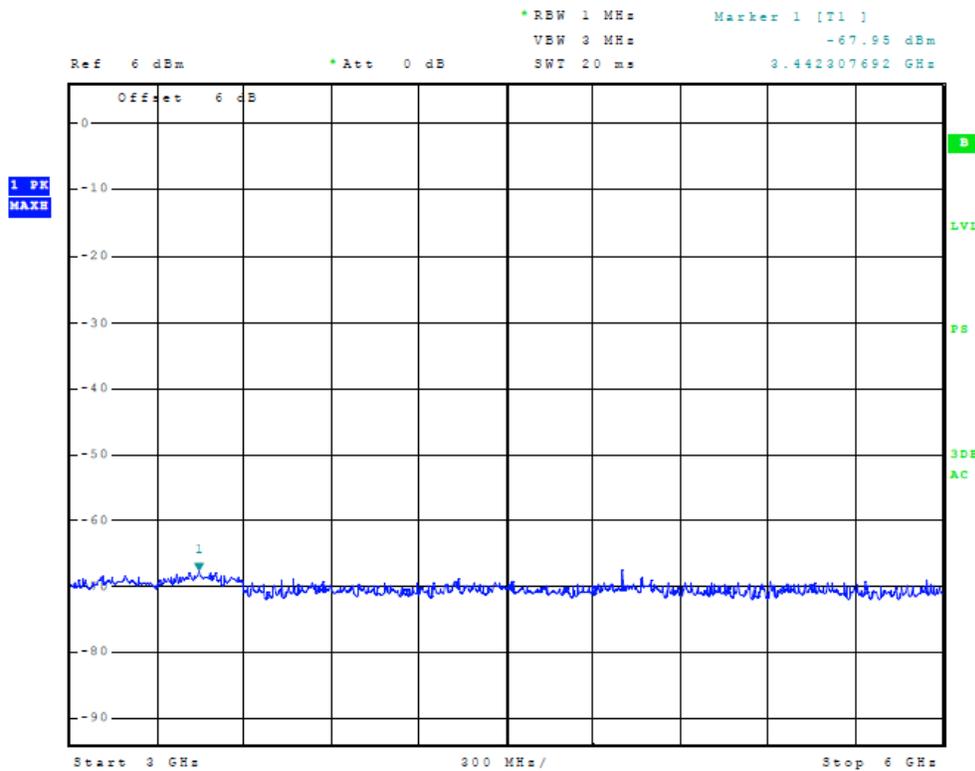
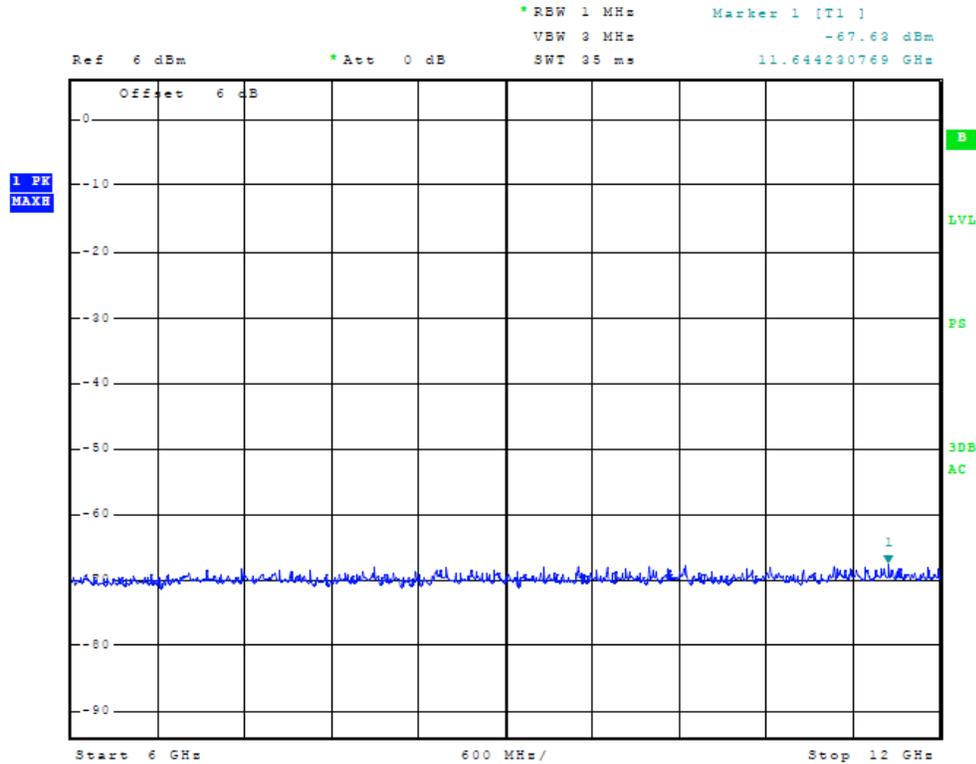


Figure 13 Spurious Emissions at Antenna Terminal (1030 MHz)



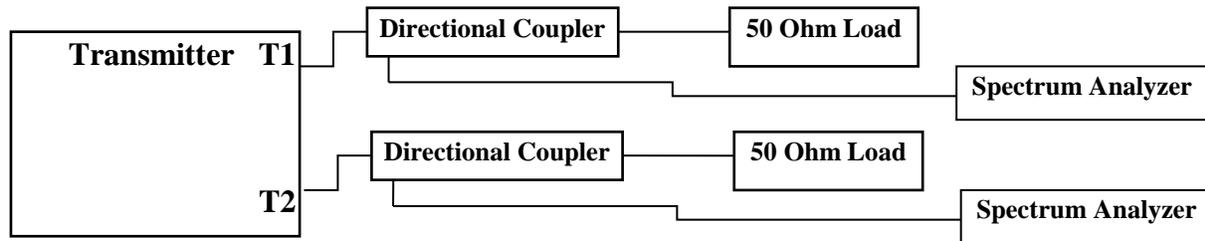
**Figure 14 Spurious Emissions at Antenna Terminal (1030 MHz)**

## 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. This equipment is typically remotely mounted and incorporated into a rack of equipment. Communications with user interface and remotely mounted antennas are connected through appropriate interface cables. Communications for transmitter control during testing was accomplished with use of laptop computer for testing support. The laptop computer offered transmitter control of the unit during testing. 50-ohm loads were connected to the transmitter antenna ports and the GPS antenna was attached to GPS input.

### Test Arrangement



The test setup was assembled in a screen room for preliminary screening. The transmitter was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 1 meter from the receive antenna, plots were made of the radiated emissions. During final radiated emissions, testing the transmitter was placed on a wooden turntable 0.8 meters above the ground plane and at a distance of 3 meters from the Field Strength Measuring (FSM) antenna. With the EUT modulated and radiating into a 50Ω load. The receiving antenna was raised and lowered from 1m to 4m in height to obtain the maximum reading of spurious radiation from the EUT, cabinet, and interface cabling. The turntable was rotated through 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, interface cabling, and test setup. The amplitude of each spurious emission was maximized by raising and lowering the FSM antenna, and rotating the turntable before final data was recorded. The frequency spectrum from 9 kHz to 12,000 MHz was investigated during radiated emissions testing. A Biconilog antenna was used for frequency measurements of 30 to 1000 MHz. A double-ridge horn antenna was used for frequencies of 1000 MHz to 12,000 MHz. Emission levels were measured and recorded from the spectrum analyzer in dBμV. Data was taken at the Rogers Labs, Inc. 3 meters open area test site (OATS).

### **Radiated Spurious Emissions Results**

The EUT was connected to power and antenna load as required and operated in all available normal modes while radiated emissions testing were performed. The amplitude of each spurious emission was maximized and amplitude levels recorded while operating at the open area test site at a distance of 3-meters.

#### General Radiated Emissions

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Quasi-Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Quasi-Peak (dBµV/m)	Vertical Average (dBµV/m)	General Emissions Limit @ 3m (dBµV/m)
100.0	35.1	31.8	N/A	35.3	31.3	N/A	43.5
150.0	31.5	26.8	N/A	28.5	24.4	N/A	43.5
200.0	36.4	33.0	N/A	34.8	30.8	N/A	43.5
225.0	35.1	32.7	N/A	36.1	32.9	N/A	46.0
275.0	34.1	32.7	N/A	31.9	30.0	N/A	46.0
300.0	32.5	29.1	N/A	36.9	33.5	N/A	46.0
525.0	38.9	37.7	N/A	37.0	35.1	N/A	46.0
575.0	39.9	37.9	N/A	37.8	35.7	N/A	46.0
750.0	39.9	37.7	N/A	35.5	33.4	N/A	46.0
975.0	43.9	42.3	N/A	41.8	40.0	N/A	54.0
1000.0	42.3	37.2	N/A	39.8	34.7	N/A	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.

Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Channel Frequency 978.00 MHz

Frequency of Emission (MHz)	Amplitude of EUT Spurious emission		Signal level to substitution antenna required to reproduce		Emission level below carrier		CFR47 Limit dBc
	Horizontal dB $\mu$ V/m	Vertical dB $\mu$ V/m	Horizontal dBm	Vertical dBm	Horizontal dBc	Vertical dBc	
1956.0	40.8	40.5	-51.93	-52.23	-98	-98	35.0
2934.0	28.2	28.3	-62.23	-62.13	-108	-108	35.0
3912.0	25.7	25.7	-63.63	-63.63	-110	-110	35.0
4890.0	29.1	28.8	-58.23	-58.53	-104	-105	35.0
5868.0	23.6	23.7	-63.33	-63.23	-109	-109	35.0
6846.0	25.0	24.8	-59.63	-59.83	-106	-106	35.0
7824.0	24.0	24.1	-59.03	-58.93	-105	-105	35.0
8802.0	22.2	22.3	-61.03	-60.93	-107	-107	35.0
9780.0	23.5	23.4	-58.43	-58.53	-104	-105	35.0

Other Emissions present with amplitudes at least 20 dB below limit.

Channel Frequency 1030.00 MHz

Frequency in MHz	Horizontal Peak (dB $\mu$ V/m)	Horizontal Quasi-Peak (dB $\mu$ V/m)	Horizontal Average (dB $\mu$ V/m)	Vertical Peak (dB $\mu$ V/m)	Vertical Quasi-Peak (dB $\mu$ V/m)	Vertical Average (dB $\mu$ V/m)	General Average Emissions Limit @ 3m (dB $\mu$ V/m)
1030.0	66.2	N/A	31.4	72.8	N/A	31.5	54.0
2060.0	44.3	N/A	31.2	44.3	N/A	31.1	54.0
3090.0	45.5	N/A	32.6	46.0	N/A	32.4	54.0
4120.0	46.8	N/A	34.4	46.9	N/A	34.1	54.0
5150.0	49.7	N/A	36.1	48.7	N/A	36.0	54.0
6180.0	48.3	N/A	35.3	48.4	N/A	35.4	54.0
7210.0	47.6	N/A	34.3	47.0	N/A	34.1	54.0
8240.0	46.1	N/A	33.1	46.8	N/A	33.1	54.0

Other emissions present had amplitudes at least 20 dB below the limit.

Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.

Average amplitude emissions are recorded above for frequency range above 1000 MHz.

Specifications of CFR47 Paragraph 2.1053, 2.1057, applicable paragraphs of part 87.139 are met. There are no deviations or exceptions to the specifications.

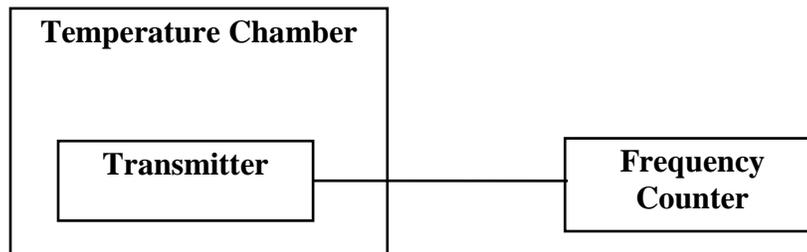
## Frequency Stability

### Measurements Required

The frequency stability shall be measured with variations of ambient temperature from  $-30^{\circ}$  to  $+50^{\circ}$  centigrade. Measurements shall be made at the extremes of the temperature range and at intervals not exceeding  $10^{\circ}$  centigrade through the range. A period 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.
- (2) 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 located in the temperature chamber the temperature of the chamber shall be adjusted to  $+25^{\circ}$  C. After a temperature stabilization period of one hour at  $+25^{\circ}$  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 at full radio frequency power output at the duty cycle, for which it is rated, for 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,  $-30^{\circ}$  C to  $+50^{\circ}$  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. The frequency was measured and the variation in parts per million calculated. Data was taken per CFR47 Paragraphs 2.1055 and applicable paragraphs of part 87.133. CFR47 87.133 requires stability maintained at least 20 ppm.

**Frequency Stability Results**

Frequency 978.31258 (MHz)	Frequency Stability Vs Temperature In Parts Per Million (PPM)								
Temperature °C	-30	-20	-10	0	+10	+20	+30	+40	+50
Change (Hz)	20	520	220	250	590	490	150	190	220
PPM	0	1	0	0	1	1	0	0	0
%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Frequency 978.31258 (MHz)	Frequency Stability Vs Voltage Variation 14 or 28 volts nominal		
Voltage Vdc	11.9	14.0	16.1
Change (Hz)	0	0	0
Voltage Vdc	23.80	28.00	32.20
Change (Hz)	0	0	0

Specifications of CFR47 Paragraphs 2.1055 and applicable paragraphs of part 87.133 are met. There are no deviations or exceptions to the specifications.



NVLAP Lab Code 200087-0

## **Annex**

- Annex A Measurement Uncertainty Calculations
- Annex B Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Site Registration Letter
- Annex E Industry Canada Site Registration Letter

## Annex A Measurement Uncertainty Calculations

### Radiated Emissions Measurement Uncertainty Calculation

Measurement of vertically polarized radiated field strength over the frequency range 30 MHz to 1 GHz on an open area test site at 3m and 10m includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Antenna factor calibration	normal (k = 2)	±0.58
Cable loss calibration	normal (k = 2)	±0.2
Receiver specification	rectangular	±1.0
Antenna directivity	rectangular	±0.1
Antenna factor variation with height	rectangular	±2.0
Antenna factor frequency interpolation	rectangular	±0.1
Measurement distance variation	rectangular	±0.2
Site Imperfections	rectangular	±1.5
Combined standard uncertainty $u_c(y)$ is		

$$U_c(y) = \pm \sqrt{\left[\frac{1.0}{2}\right]^2 + \left[\frac{0.2}{2}\right]^2 + \left[\frac{1.0^2 + 0.1^2 + 2.0^2 + 0.1^2 + 0.2^2 + 1.5^2}{3}\right]}$$

$$U_c(y) = \pm 1.6 \text{ dB}$$

It is probable that  $u_c(y) / s(q_k) > 3$ , where  $s(q_k)$  is estimated standard deviation from a sample of  $n$  readings unless the repeatability of the EUT is particularly poor, and a coverage factor of  $k = 2$  will ensure that the level of confidence will be approximately 95%, therefore:

$$s(q_k) = \sqrt{\frac{1}{(n-1)} \sum_{k=1}^n (q_k - \bar{q})^2}$$

$$U = 2 U_c(y) = 2 \times \pm 1.6 \text{ dB} = \pm 3.2 \text{ dB}$$

#### Notes:

- 1.1 Uncertainties for the antenna and cable were estimated, based on a normal probability distribution with  $k = 2$ .
- 1.2 The receiver uncertainty was obtained from the manufacturer's specification for which a rectangular distribution was assumed.
- 1.3 The antenna factor uncertainty does not take account of antenna directivity.
- 1.4 The antenna factor varies with height and since the height was not always the same in use as when the antenna was calibrated an additional uncertainty is added.
- 1.5 The uncertainty in the measurement distance is relatively small but has some effect on the received signal strength. The increase in measurement distance as the antenna height is increased is an inevitable consequence of the test method and is therefore not considered a contribution to uncertainty.
- 1.6 Site imperfections are difficult to quantify but may include the following contributions:
  - Unwanted reflections from adjacent objects.
  - Ground plane imperfections: reflection coefficient, flatness, and edge effects.
  - Losses or reflections from "transparent" cabins for the EUT or site coverings.
  - Earth currents in antenna cable (mainly effect Biconical antennas).

The specified limits for the difference between measured site attenuation and the theoretical value ( $\pm 4$  dB) were not included in total since the measurement of site attenuation includes uncertainty contributions already allowed for in this budget, such as antenna factor.

*Conducted Measurements Uncertainty Calculation*

Measurement of conducted emissions over the frequency range 9 kHz to 30 MHz includes following uncertainty:

Contribution	Probability Distribution	Uncertainty (dB)
Receiver specification	rectangular	$\pm 1.5$
LISN coupling specification	rectangular	$\pm 1.5$
Cable and input attenuator calibration	normal (k=2)	$\pm 0.5$
Combined standard uncertainty $u_c(y)$ is		

$$U_c(y) = \pm \sqrt{\left[\frac{0.5}{2}\right]^2 + \frac{1.5^2 + 1.5^2}{3}}$$

$$U_c(y) = \pm 1.2 \text{ dB}$$

As with radiated field strength uncertainty, it is probable that  $u_c(y) / s(q_k) > 3$  and a coverage factor of  $k = 2$  will suffice, therefore:

$$U = 2 U_c(y) = 2 \times \pm 1.2 \text{ dB} = \pm 2.4 \text{ dB}$$



**Annex B Rogers Labs Test Equipment List**

List of Test Equipment	Calibration Date
Spectrum Analyzer: Rohde & Schwarz ESU40	5/11
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520	5/11
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
Spectrum Analyzer: HP 8591EM	5/11
Antenna: EMCO Biconilog Model: 3143	5/11
Antenna: Sunol Biconilog Model: JB6	10/11
Antenna: EMCO Log Periodic Model: 3147	10/11
Antenna: Antenna Research Biconical Model: BCD 235	10/11
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/11
R.F. Preamp CPPA-102	10/11
Attenuator: HP Model: HP11509A	10/11
Attenuator: Mini Circuits Model: CAT-3	10/11
Attenuator: Mini Circuits Model: CAT-3	10/11
Cable: Belden RG-58 (L1)	10/11
Cable: Belden RG-58 (L2)	10/11
Cable: Belden 8268 (L3)	10/11
Cable: Time Microwave: 4M-750HF290-750	10/11
Cable: Time Microwave: 10M-750HF290-750	10/11
Frequency Counter: Leader LDC825	2/11
Oscilloscope Scope: Tektronix 2230	2/11
Wattmeter: Bird 43 with Load Bird 8085	2/11
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/11
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/11
R.F. Power Amp 65W Model: 470-A-1010	2/11
R.F. Power Amp 50W M185- 10-501	2/11
R.F. Power Amp A.R. Model: 10W 1010M7	2/11
R.F. Power Amp EIN Model: A301	2/11
LISN: Compliance Eng. Model 240/20	2/11
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/11
Antenna: EMCO Dipole Set 3121C	2/11
Antenna: C.D. B-101	2/11
Antenna: Solar 9229-1 & 9230-1	2/11
Antenna: EMCO 6509	2/11
Audio Oscillator: H.P. 201CD	2/11
Peavey Power Amp Model: IPS 801	2/11
ELGAR Model: 1751	2/11
ELGAR Model: TG 704A-3D	2/11
ESD Test Set 2010i	2/11
Fast Transient Burst Generator Model: EFT/B-101	2/11
Field Intensity Meter: EFM-018	2/11
KEYTEK Ecat Surge Generator	2/11
Shielded Room 5 M x 3 M x 3.0 M	



## ***Annex C Rogers Qualifications***

***Scot D. Rogers, Engineer***

### **Rogers Labs, Inc.**

Mr. Rogers has approximately 17 years experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining 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.



NVLAP Lab Code 200087-0

**Annex D FCC Test Site Registration Letter**

**FEDERAL COMMUNICATIONS COMMISSION**

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

November 01, 2011

Registration Number: 90910

Rogers Labs, Inc.  
4405 West 259<sup>th</sup> Terrace,  
Louisburg, KS 66053

Attention: Scot Rogers,

Re: Measurement facility located at Louisburg  
3 & 10 meter site  
Date of Renewal: November 01, 2011

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](http://www.fcc.gov) under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Phyllis Parrish  
Industry Analyst

Rogers Labs, Inc.  
4405 West 259<sup>th</sup> Terrace  
Louisburg, KS 66053  
Phone/Fax: (913) 837-3214  
Revision 1

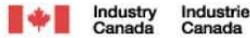
Garmin International, Inc.  
Model: GMN-00862  
Test #: 111107  
Test to: CFR47 Parts 2, 87  
File TstRpt GMN00862 GDL88 111107

Market Label: GDL 88  
SN: 22W000027  
FCC ID: IPH-01246  
Date: May 3, 2012  
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## Annex E Industry Canada Test Site Registration Letter



May 26, 2010

OUR FILE: 46405-3041  
Submission No: 140719

**Rogers Labs Inc.**  
4405 West 259<sup>th</sup> Terrace  
Louisburg, KY, 66053  
USA

**Attention:** Mr. Scot D. Rogers

Dear Sir/Madame:

The Bureau has received your application for the renewal of a 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought (**3041A-1**). Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please keep for your records the following information;

- Your primary code is: **3041**

- The company number associated to the site(s) located at the above address is: **3041A**

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 or later shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 metre OATS or 3 metre chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau 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. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;

[http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h\\_tt00052e.html](http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h_tt00052e.html).

If you have any questions, you may contact the Bureau by e-mail at [certification.bureau@ic.gc.ca](mailto:certification.bureau@ic.gc.ca) Please reference our file and submission number above for all correspondence.

Yours sincerely,

Dalwinder Gill  
For: Wireless Laboratory Manager  
Certification and Engineering Bureau  
3701 Carling Ave., Building 94  
P.O. Box 11490, Station "H"  
Ottawa, Ontario K2H 8S2  
Email: dalwinder.gill@ic.gc.ca  
Tel. No. (613) 998-8363  
Fax. No. (613) 990-4752

Rogers Labs, Inc.  
4405 West 259<sup>th</sup> Terrace  
Louisburg, KS 66053  
Phone/Fax: (913) 837-3214  
Revision 1

Garmin International, Inc.  
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Date: May 3, 2012  
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