

Application Submittal Report  
For  
FCC Grant Of Certification  
Low Power Communication Device Transmitter

FOR

Model: Astro 320  
2402 - 2479 MHz Transmitter

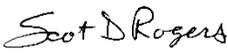
FCC ID: IPH-01848

FOR

**GARMIN INTERNATIONAL, INC.**

1200 East 151st Street  
Olathe, KS 66062

Test Report Number: 110420

Authorized Signatory:   
Scot D. Rogers



## **ROGERS LABS, INC.**

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

# Engineering Test Report For Grant Of Certification Application Submittal

CFR47, Part 15C - Intentional Radiators Paragraph 15.249

Low Power Transmitter

For

## **Garmin International, Inc.**

1200 East 151st Street  
Olathe, KS 66062  
Phone: (913) 397-8200  
Mr. Van Ruggles  
Director of Quality Assurance

## **Model: Astro 320**

Frequency 2402 - 2479 MHz  
FCC ID#: IPH-01848

Test Date: April 20, 2011

Certifying Engineer:   
Scot D. Rogers  
Rogers Labs, Inc.  
4405 West 259<sup>th</sup> Terrace  
Louisburg, KS 66053  
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## Forward

The following information is submitted for consideration in obtaining Grant of Certification for a license exempt low power intentional radiator operating under CFR47 Paragraph 15.249.

Name of Applicant: Garmin International, Inc.  
1200 East 151st Street  
Olathe, KS 66062

Model: Astro 320

FCC I.D.: IPH-01848                      Frequency Range: 2402 - 2479 MHz

Operating Power: Peak emission of 83.6 dB $\mu$ V/m and average emission of 40.2 dB $\mu$ V/m  
(3 meter radiated measurement), 99% Occupied Bandwidth 1,233.97  
kHz

## Applicable Standards & Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2010, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15, Part 15C Paragraph 15.249 the following information is submitted. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI C63.4-2009 and appropriate FCC documents DA00-1407 and DA00-705 and/or TIA/EIA 603-1.

## Opinion / Interpretation of Results

Test Performed	Minimum Margin (dB)	Results
Antenna requirement per CFR 47 15.203	N/A	Complies
Restricted Bands Emissions as per CFR 47 15.205	-11.1	Complies
AC Line Conducted Emissions as per CFR 47 15.207	-11.8	Complies
Radiated Emissions as per CFR 47 15.209	-10.0	Complies
Radiated Emissions per CFR 47 15.249	-53.8	Complies

## Application for Certification

- (1) Manufacturer: Garmin International, Inc.  
1200 East 151st Street  
Olathe, KS 66062
- (2) Identification: Model: Astro 320  
FCC I.D.: IPH-01848
- (3) Instruction Book: Refer to Exhibit for Instruction Manual.
- (4) Description of Circuit Functions: Refer to Exhibit of Operational Description.
- (5) Block Diagram with Frequencies: Refer to Exhibit of Operational Description.
- (6) Report of Measurements: Report of measurements follows in this Report.
- (7) Photographs: Construction, Component Placement, etc.: Refer to Exhibit for photographs of equipment.
- (8) Peripheral equipment or accessories for the equipment. Optional equipment available for the EUT includes DC cigarette adapter and USB cable for computer interface. The available configuration options were investigated for this and other reports in compliance with required standards with worst-case data presented.
- (9) Transition Provisions of 15.37 are not being requested.
- (10) Equipment is not a scanning receiver and this section is not applicable.
- (11) The equipment does not operate in the 59 – 64 GHz frequency band and this section is not applicable.
- (12) The equipment is not software defined and this section is not applicable.

## Statement of Modifications and Deviations

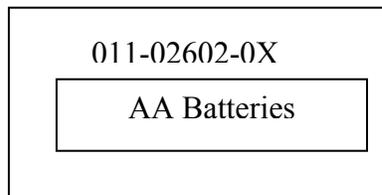
No modifications to the EUT were required for the equipment to demonstrate compliance with CFR47 Part 15C requirements. There were no deviations or modification to the specifications.

## Equipment Tested

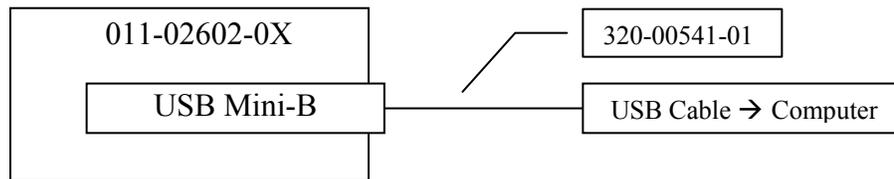
<u>Equipment</u>	<u>Model / PN</u>	<u>Serial Number</u>
(EUT)	Astro 320	ENG1
USB Cable	320-00541-01	N/A
CLA	320-00239-24	N/A
Computer	Dell / Studio XPS	921LBN1

## Equipment and Cable Configurations

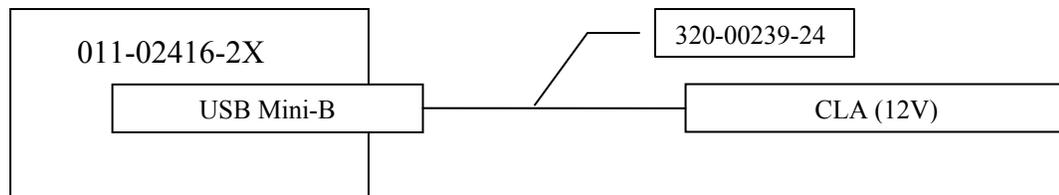
- 011-02602-0X operating off internal batteries



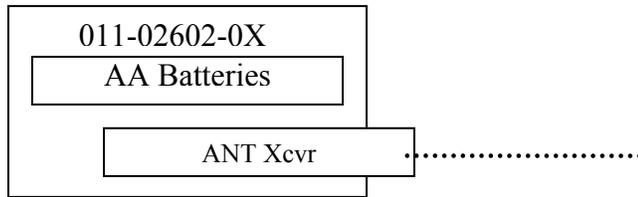
- 011-02602-0X connected to (and powered by) computer through USB cable (GPN: 320-00541-01).



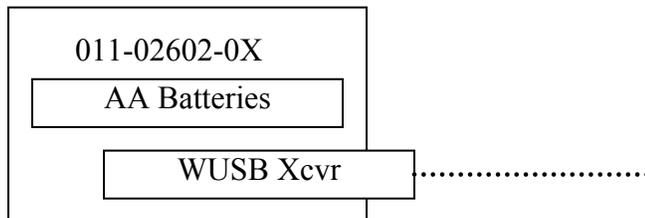
- 011-02602-0X connected to (and powered by) a car cigarette lighter - mini-B cable (GPN: 320-00239-24)



4. 011-02602-0X wireless ANT communication – transmitting data and powered by internal batteries.



5. 011-02602-0X wireless USB communication – transmitting data and powered by internal batteries.



### Environmental Conditions

Ambient Temperature	21.9° C
Relative Humidity	39%
Atmospheric Pressure	1023.4 mb

### Units of Measurements

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.

### Test Site Locations

Conducted EMI	The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259 <sup>th</sup> 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. 259 <sup>th</sup> Terrace, Louisburg, KS.
Site Approval	Refer to Annex for FCC Site Registration Letter, # 90910, and Industry Canada Site Registration Letter, IC3041A-1.

## Equipment Function and Testing Procedures

The EUT is a GPS receiver and display unit offering reception and display of location, navigation, and other information for the user. The EUT incorporates two (2) low power transmitters with operation capability in the 2402-2479 MHz frequency band (ANT operation as DXX, Low Power Communication Device Transmitter) and 2402-2480 MHz frequency band (WUSB operation as DXT, Low Power Transceiver equipment). The equipment offers communications to other 2400-2483.5 MHz compliant equipment. Two samples were supplied for testing one production design and the other modified for testing purposes replacing integral antenna with RF connection port for this and other reports and documentation. This modification offered testing facility ability to connect transmitter antenna port to test equipment for antenna port transmitter conducted emissions testing. The EUT was arranged as typical user equipment configurations for testing purposes. The transmitter offers no other interface connections than those in the configuration options shown above. The unit operates from internal battery only and offers no provision for connection to utility power system. Some configurations shown above are not applicable for this report and have been tested and documented in other relevant documentation. As requested by the manufacturer and required by regulations, the equipment was tested for emissions compliance using the available configurations with the worst-case data presented. Test results in this report relate only to the products described in this report.

### ***AC Line Conducted Emission Test Procedure***

Testing for the AC line-conducted emissions was performed as defined in sections 7.2.4 and 13 of ANSI C63.4-2009. The test setup, including the EUT, was arranged in the test configurations as shown above during testing. The test configuration was placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50- $\mu$ Hy choke. EMI was coupled to the spectrum analyzer through a 0.1  $\mu$ F capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to photographs in exhibits for EUT placement used during testing.

### **Radiated Emission Test Procedure**

Testing for the radiated emissions was performed as defined in sections 8.3 and 13.1 of ANSI C63.4-2009. The EUT was arranged in the test configurations as shown above during testing. The test configuration was placed on a rotating 1 x 1.5-meter wooden platform 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. EMI energy was maximized by equipment placement, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before final data was taken using a spectrum analyzer. Refer to photographs in exhibits for EUT placement used during testing.

### **List of Test Equipment**

A Rohde & Schwarz ESU40 and/or Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde & Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the 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.

Analyzer Settings		
AC Line Conducted Emissions:		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak/Quasi Peak
Radiated Emissions 30-1000 MHz		
RBW	AVG. BW	Detector Function
100 kHz	100 kHz	Peak
120 kHz	300 kHz	Peak/Quasi Peak
Radiated Emissions 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	10/10	10/11
Antenna	ARA	BCD-235-B	10/10	10/11
Antenna	Sunol	JB6	10/10	10/11
Antenna	EMCO	3147	10/10	10/11
Antenna	EMCO	3143	5/10	5/11
Analyzer	HP	8591EM	5/10	5/11
Analyzer	HP	8562A	5/10	5/11
Analyzer	Rohde & Schwarz	ESU40	5/10	5/11

## **General Emissions (Unintentional Radiators)**

### ***AC Line Conducted EMI Procedure***

The EUT was arranged in typical equipment configuration (#2) as offered by manufacturer. Testing was performed with the EUT placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. Testing for the line-conducted emissions were the procedures of ANSI C63.4 paragraphs 13.1.3 and 7.2.4. The AC adapter for the CPU was connected to the LISN for line-conducted emissions testing. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1  $\mu$ F capacitor, internal to the LISN. Power line conducted emissions testing was carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequencies of each of the emissions, which demonstrated the highest amplitudes. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then data was recorded with maximum conducted emissions levels. Refer to figures one and two showing plots of the worst-case AC Line conducted emissions of the CPU AC Adapter while communicating with the EUT.

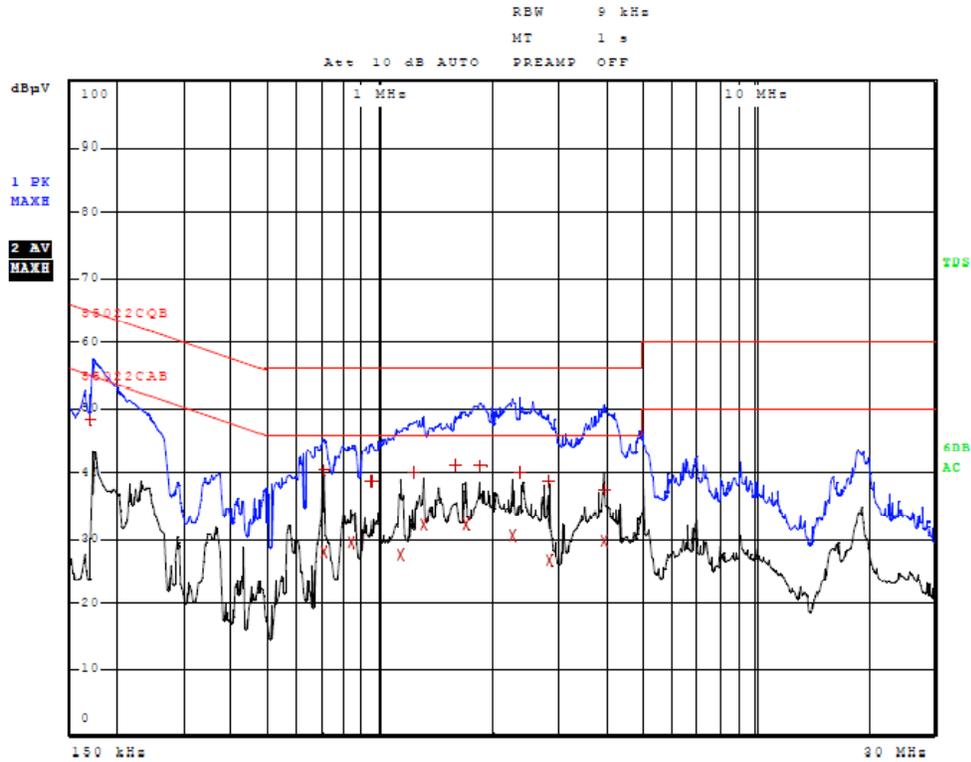


Figure One AC Line Conducted emissions of EUT line 1 (Configuration #2 CPU AC)

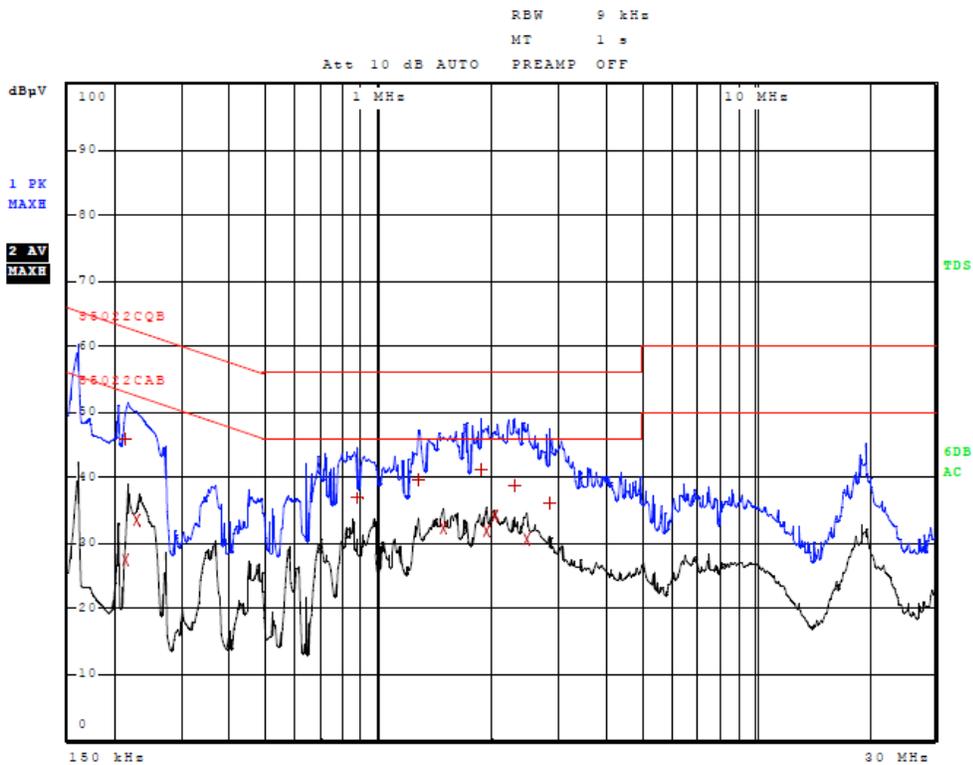


Figure Two AC Line Conducted emissions of EUT line 2 (Configuration #2 CPU AC)



### Data AC Line Conducted Emissions

Line 1 (EUT USB CPU)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	170.00000000 kHz	48.23	Quasi Peak	-16.73
1	706.00000000 kHz	40.45	Quasi Peak	-15.55
2	706.00000000 kHz	28.04	Average	-17.96
2	834.00000000 kHz	29.51	Average	-16.49
1	942.00000000 kHz	38.85	Quasi Peak	-17.15
2	1.130000000 MHz	27.64	Average	-18.36
1	1.230000000 MHz	39.97	Quasi Peak	-16.03
2	1.298000000 MHz	32.34	Average	-13.66
1	1.590000000 MHz	41.20	Quasi Peak	-14.80
2	1.690000000 MHz	32.31	Average	-13.69
1	1.842000000 MHz	41.12	Quasi Peak	-14.88
2	2.250000000 MHz	30.65	Average	-15.35
1	2.354000000 MHz	39.93	Quasi Peak	-16.07
1	2.802000000 MHz	38.80	Quasi Peak	-17.20
2	2.818000000 MHz	26.81	Average	-19.19
1	3.938000000 MHz	37.42	Quasi Peak	-18.58
2	3.938000000 MHz	29.77	Average	-16.23

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

Line 2 (EUT USB CPU)

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	214.00000000 kHz	45.90	Quasi Peak	-17.15
2	214.00000000 kHz	27.31	Average	-25.74
2	230.00000000 kHz	33.52	Average	-18.92
1	870.00000000 kHz	36.95	Quasi Peak	-19.05
1	1.274000000 MHz	39.60	Quasi Peak	-16.40
2	1.486000000 MHz	32.16	Average	-13.84
1	1.866000000 MHz	41.32	Quasi Peak	-14.68
2	1.930000000 MHz	31.85	Average	-14.15
2	2.026000000 MHz	34.12	Average	-11.88
1	2.286000000 MHz	38.77	Quasi Peak	-17.23
2	2.478000000 MHz	30.49	Average	-15.51
1	2.834000000 MHz	36.01	Quasi Peak	-19.99

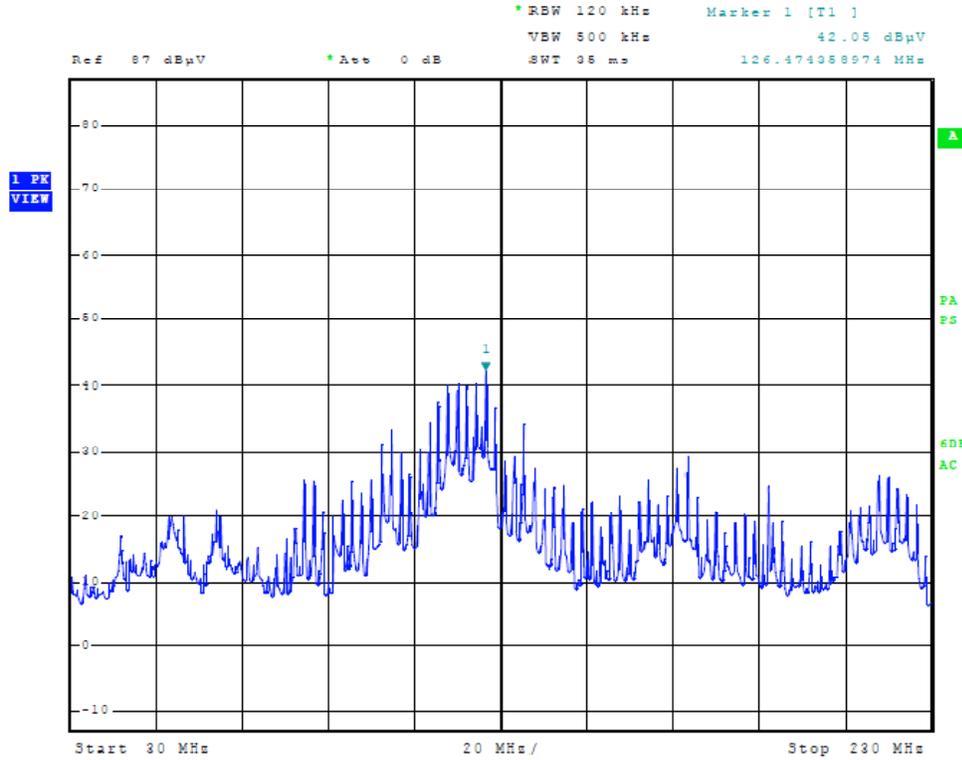
Other emissions present had amplitudes at least 20 dB below the limit.

**Summary of Results for AC Line Conducted Emissions**

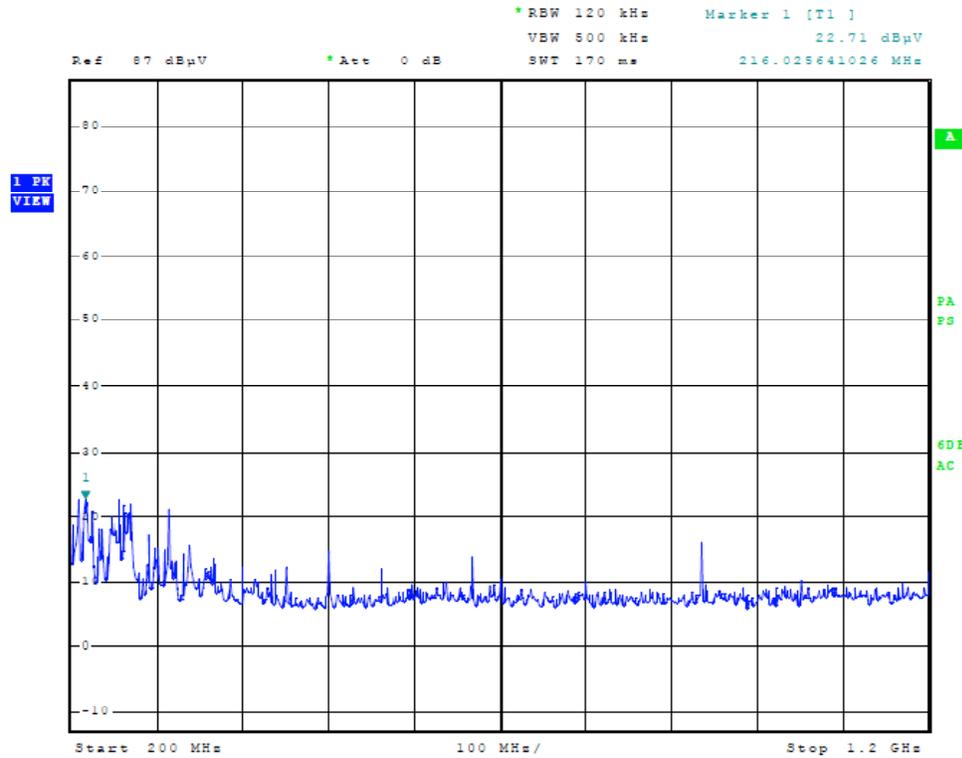
The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of CFR 47 Part 15B and other applicable standards. The EUT worst-case configuration demonstrated a minimum margin of -11.8 dB below the limit. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

**Radiated EMI**

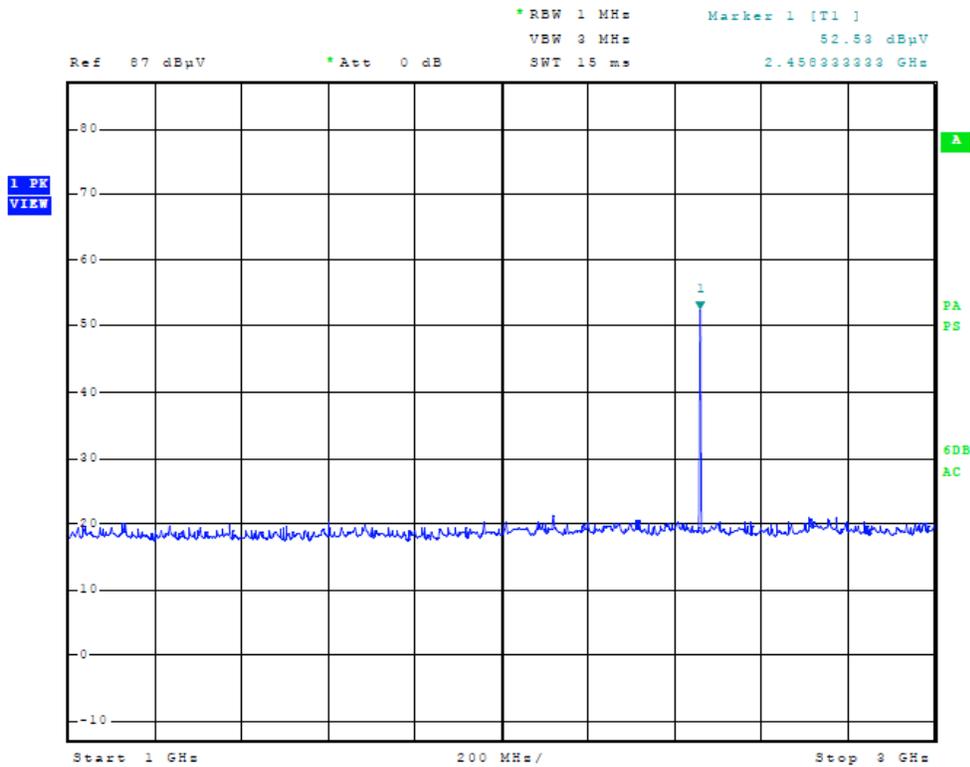
The EUT was arranged in typical equipment configurations and operated through all various modes. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Configuration #3 presented worst-case radiated transmitter operation emissions spectrum and was used during transmitter radiated emissions testing. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Plots were made of the radiated frequency spectrum from 30 MHz to 25,000 MHz for the preliminary testing. Refer to figures three through nine showing plots of the radiated emissions spectrum taken in the screen room. Each radiated emission was then re-maximized at the OATS location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 25,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Biconilog from 30 to 6,000 MHz, and/or Log Periodic from 200 MHz to 5 GHz, Double Ridge Horn or pyramidal horns and mixers from 4 GHz to 25 GHz, notch filters and appropriate amplifiers were utilized.



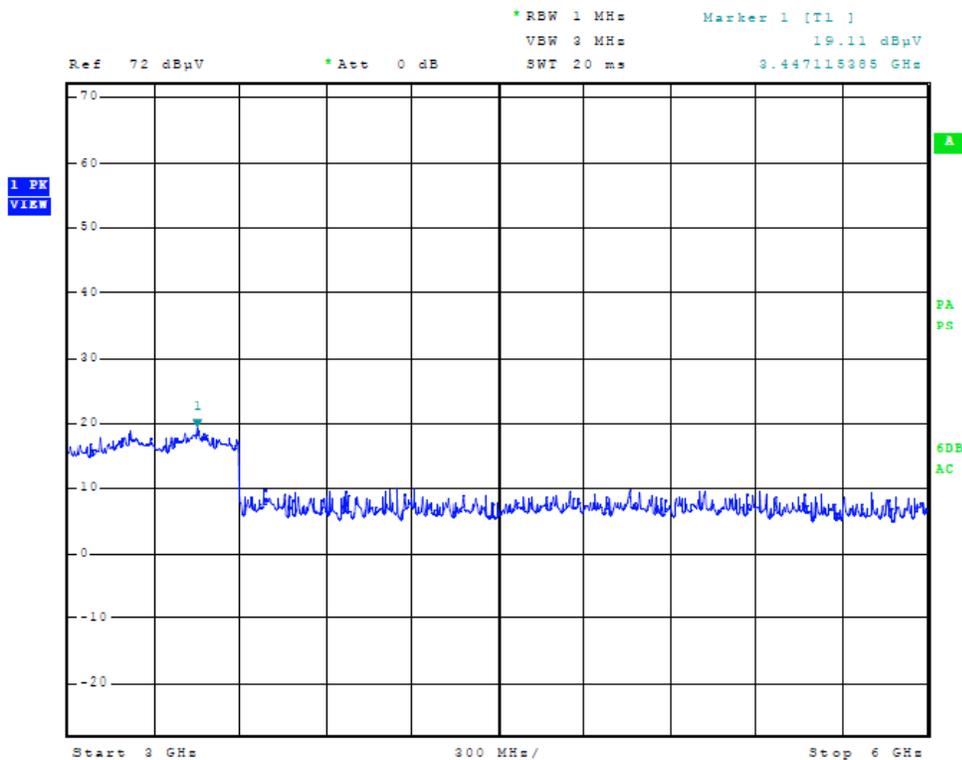
**Figure Three Plot of General Radiated Emissions**



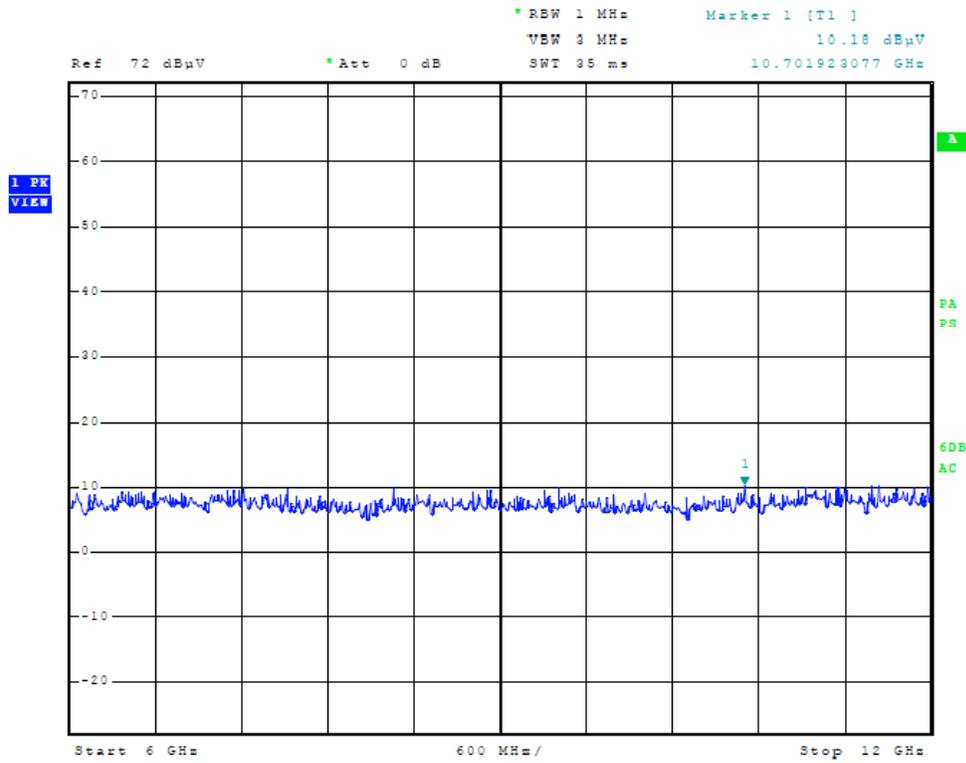
**Figure Four Plot of General Radiated Emissions**



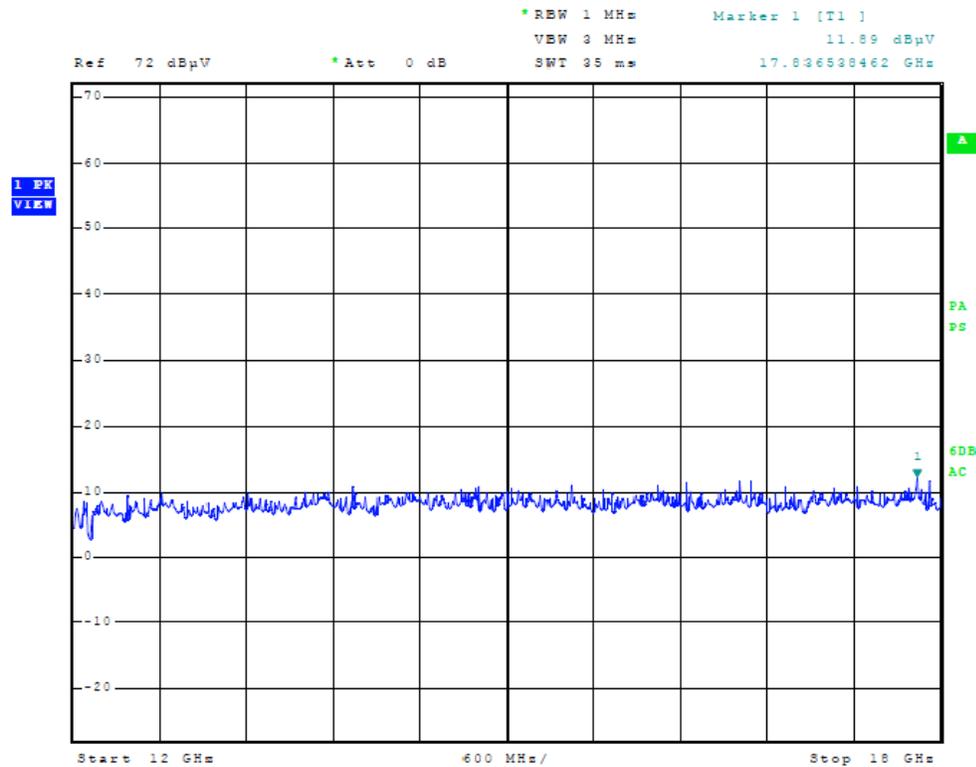
**Figure Five Plot of General Radiated Emissions**



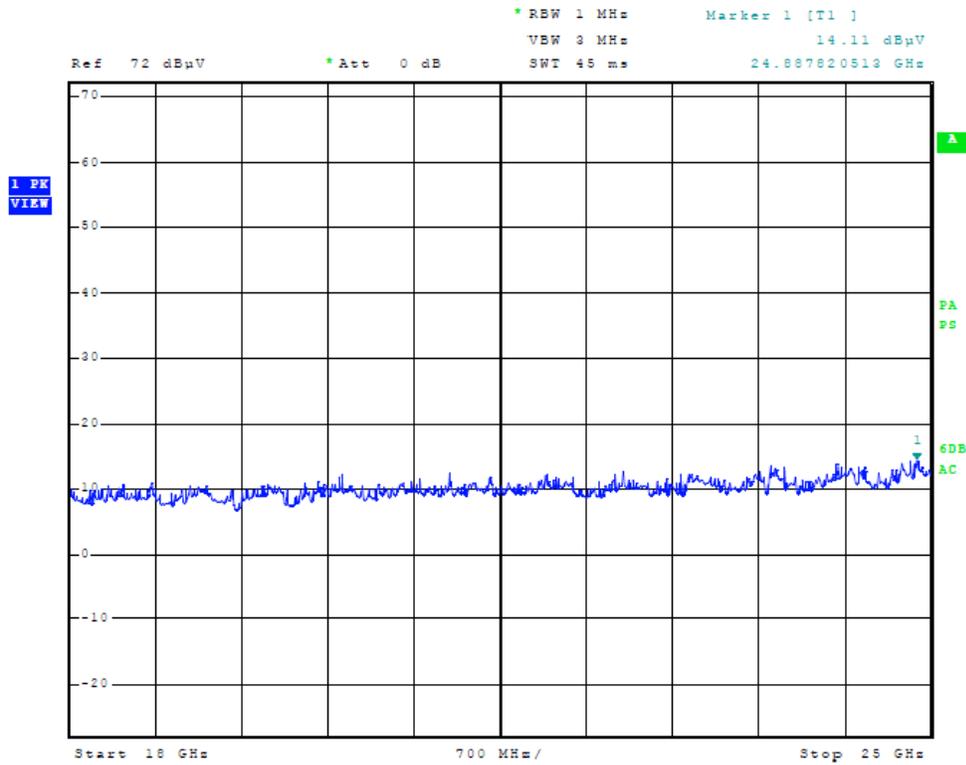
**Figure Six Plot of General Radiated Emissions**



**Figure Seven Plot of General Radiated Emissions**



**Figure Eight Plot of General Radiated Emissions**



**Figure Nine Plot of General Radiated Emissions**

**General Radiated Emissions Data from EUT**

Frequency in MHz	FSM Horz. (dB $\mu$ V)	FSM Vert. (dB $\mu$ V)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dB $\mu$ V/m)	RFS Vert. @ 3m (dB $\mu$ V/m)	Limit @ 3m (dB $\mu$ V/m)
113.1	36.7	37.6	13.2	30	19.9	20.8	43.5
115.4	34.9	34.5	13.2	30	18.1	17.7	43.5
117.7	34.7	34.6	13.7	30	18.4	18.3	43.5
119.8	36.3	36.5	13.7	30	20.0	20.2	43.5
122.0	39.1	39.3	13.7	30	22.8	23.0	43.5
124.3	41.2	41.5	13.6	30	24.8	25.1	43.5
126.4	47.7	48.1	13.6	30	31.3	31.7	43.5
128.7	49.9	49.6	13.6	30	33.5	33.2	43.5
131.0	44.3	44.2	13.5	30	27.8	27.7	43.5
133.1	46.4	46.8	13.5	30	29.9	30.3	43.5
135.3	45.7	46.3	13.5	30	29.2	29.8	43.5
170.8	41.9	40.7	12.3	30	24.2	23.0	43.5
173.1	43.1	39.6	11.9	30	25.0	21.5	43.5
217.4	49.3	41.8	11.1	30	30.4	22.9	43.5

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

**Summary of Results for Radiated Emissions**

The EUT demonstrated compliance with requirements of CFR47 15C requirements. The EUT demonstrated a minimum margin of -10.0 dB below requirements. Other emissions were present with amplitudes at least 20 dB below the limit.



## **Intentional Radiators Emissions**

As per CFR47 Part 15, Subpart C, paragraphs 15.203, 15.205, 15.209, 15.249 the following information is submitted.

### ***Antenna Requirements***

The unit is produced with a permanently attached antenna and has no provision for user service, replacement, or antenna modification. The requirements of 15.203 are fulfilled and there are no deviations or exceptions to the specification.

### ***Restricted Bands of Operation***

Spurious emissions falling in the restricted frequency bands of operation were measured at a distance of three meters at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were checked at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. No other significant emission was observed which fell into the restricted bands of operation.

Sample Calculation:

$$\text{RFS (dB}\mu\text{V/m @ 3m)} = \text{FSM (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} - \text{Amplifier Gain (dB)}$$

**Radiated Emissions Data in Restricted Bands**

Frequency in MHz	FSM Horz. (dBµV)	FSM Vert. (dBµV)	A.F. (dB/m)	Amp. Gain (dB)	RFS Horz. @ 3m (dBµV/m)	RFS Vert. @ 3m (dBµV/m)	Limit @ 3m (dBµV/m)
666.3	36.3	41.3	20.2	30	26.5	31.5	46.0
820.3	28.3	28.2	22.0	30	20.3	20.2	46.0
1200.0	21.2	21.3	25.0	25	21.2	21.3	54.0
1636.6	19.7	20.2	27.4	25	22.1	22.6	54.0
4093.7	18.3	18.4	36.9	25	30.2	30.3	54.0
4916.6	19.7	20.2	38.8	25	33.5	34.0	54.0
2390.0	26.9	26.9	30.7	25.0	32.6	32.6	54.0
2483.5	28.0	28.0	31.4	25.0	34.4	34.4	54.0
4804.0	29.5	29.4	38.4	25.0	42.9	42.8	54.0
4914.0	28.8	28.8	38.8	25.0	42.6	42.6	54.0
4958.0	29.0	29.0	38.6	25.0	42.6	42.6	54.0
7206.0	23.5	23.5	36.3	25.0	34.8	34.8	54.0
7371.0	21.6	21.6	36.4	25.0	33.0	33.0	54.0
7437.0	22.1	22.1	36.5	25.0	33.6	33.6	54.0
12010.0	22.6	22.6	40.0	25.0	37.6	37.6	54.0
12285.0	20.7	20.7	40.4	25.0	36.1	36.1	54.0
12395.0	20.7	20.7	40.7	25.0	36.4	36.4	54.0

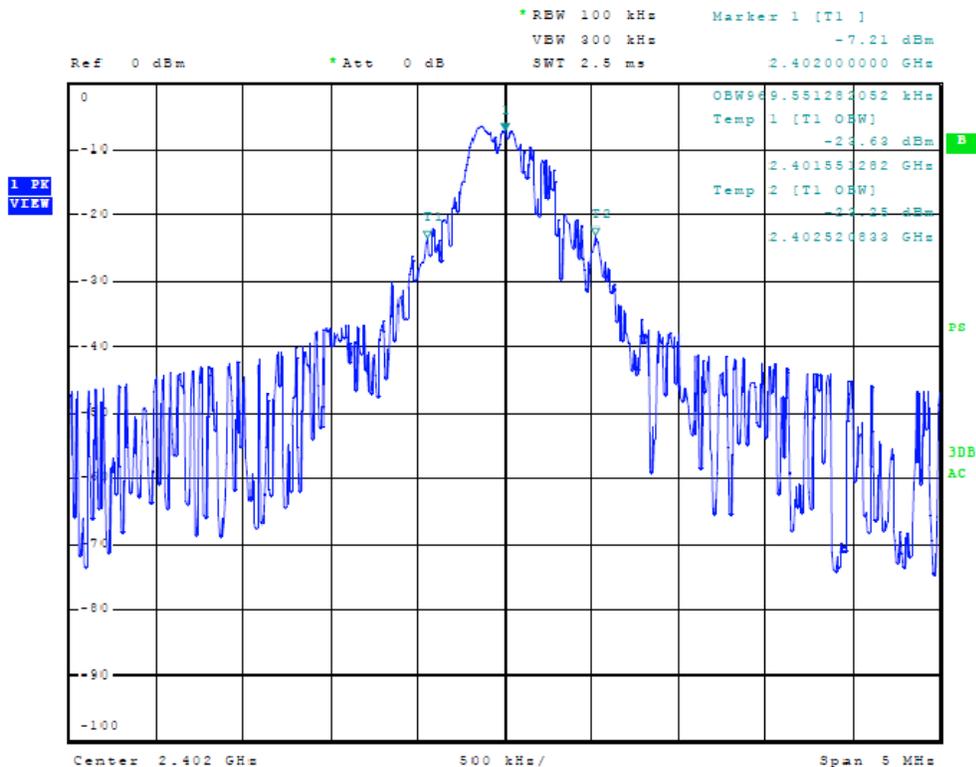
Other emissions present had amplitudes at least 20 dB below the margin.

**Summary of Results for Radiated Emissions in Restricted Bands**

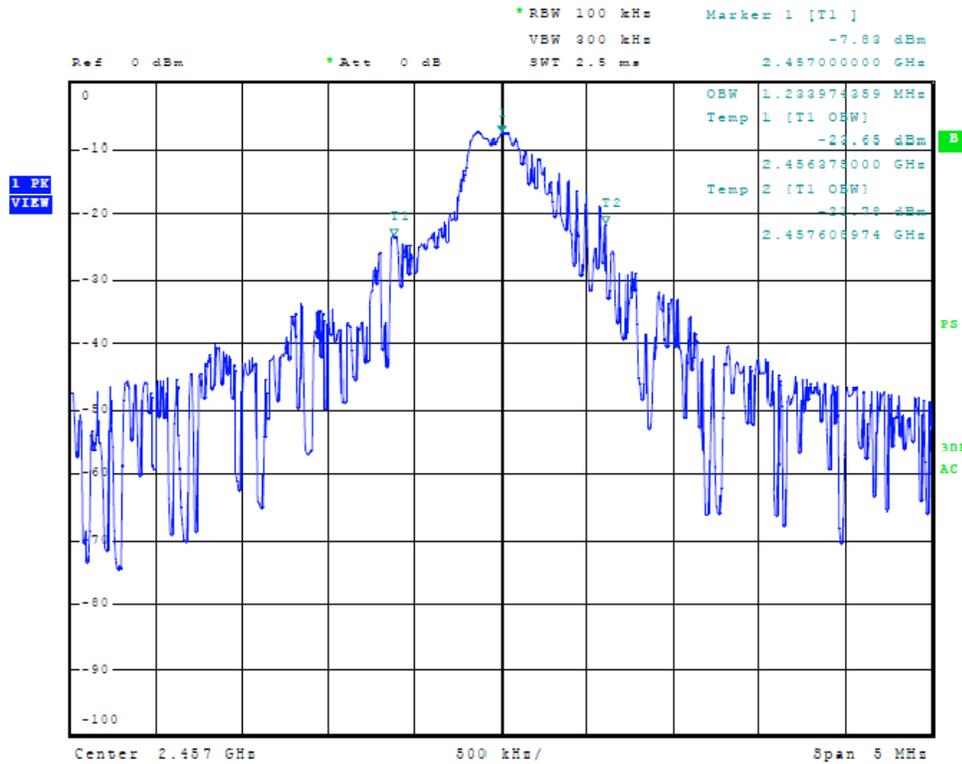
The EUT demonstrated compliance with requirements of CFR47 15C requirements. The EUT demonstrated a minimum margin of -11.1 dB below requirements. Peak and Quasi-peak amplitudes of frequencies below 1000 MHz were measured and average and peak amplitudes of frequencies above 1000 MHz were measured for demonstration of compliance with the regulations. No other significant emissions were found in the restricted frequency bands. Other emissions were present with amplitudes at least 20 dB below the FCC Limits.

### Operation in the Band 2402 - 2479 MHz

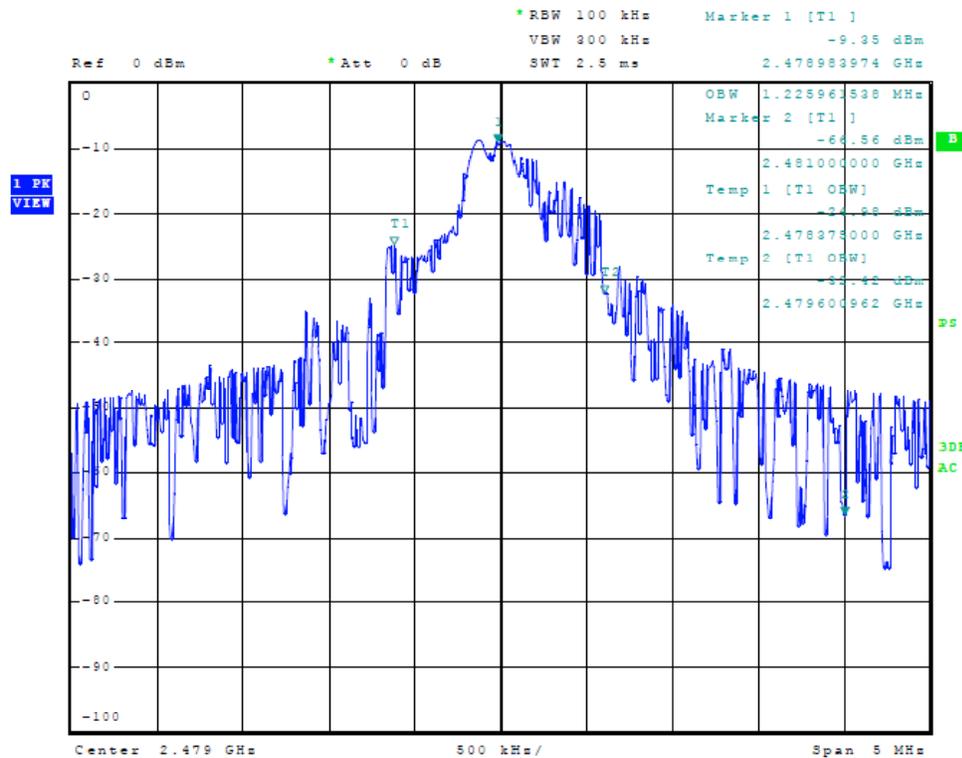
The power output was measured on an Open Area Test Site at a 3 meters distance. The EUT was placed on a wooden turntable 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. The peak and average amplitude of emissions above 1000 MHz including spurious emissions were measured using a spectrum analyzer/receiver. Data was then recorded from the analyzer display. Emissions radiated outside of the specified bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209 whichever is the lesser attenuation. The amplitude of each emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. A Biconilog Antenna was used for measuring emissions from 30 to 6000 MHz, and/or Log Periodic Antenna for 200 to 5000 MHz, Double Ridge Horn or Pyramidal Horn Antennas from 4 GHz to 25 GHz. Emissions were measured in dBμV and converted to dBμV/m @ 3 meters for comparison to requirements. Refer to figures ten through twenty-one showing the frequency and amplitude of emission displayed on the spectrum analyzer measured at the temporary test antenna port (performed on sample #2).



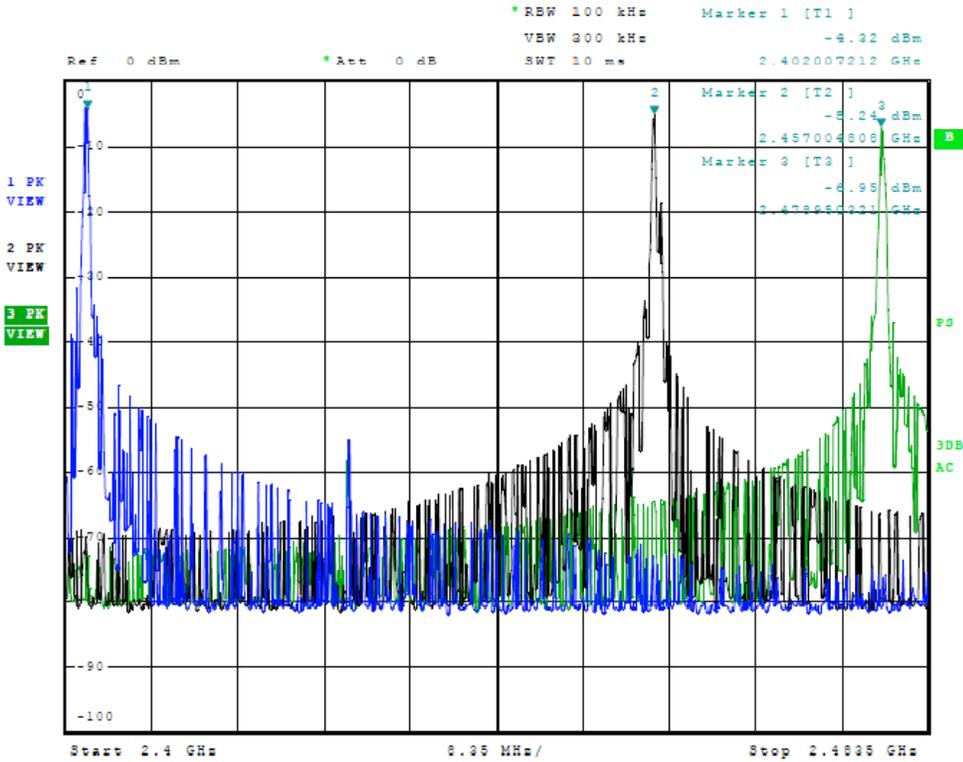
**Figure Ten Plot of 99.5% Occupied Bandwidth (Low channel)**



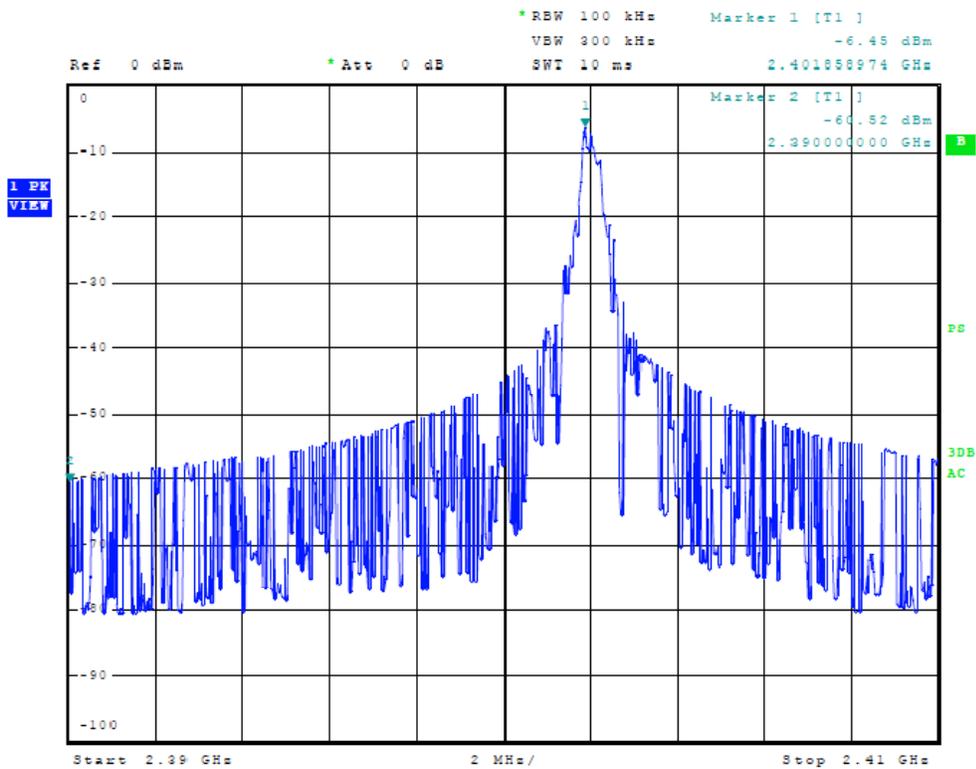
**Figure Eleven Plot of 99.5% Occupied Bandwidth (Middle channel)**



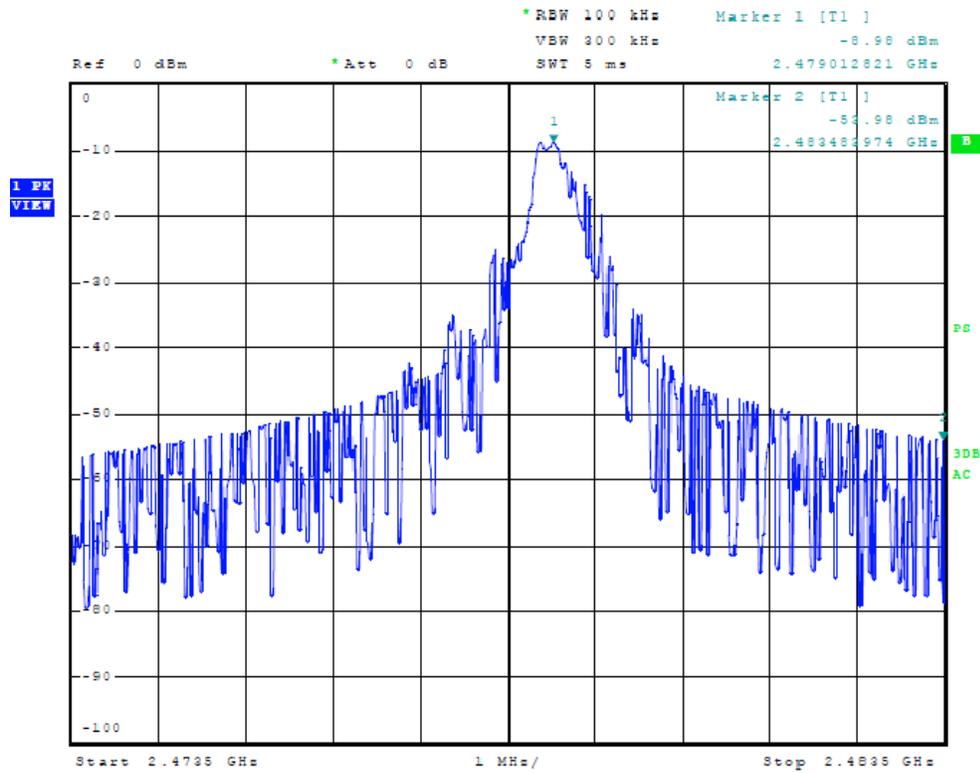
**Figure Twelve Plot of 99.5% Occupied Bandwidth (High channel)**



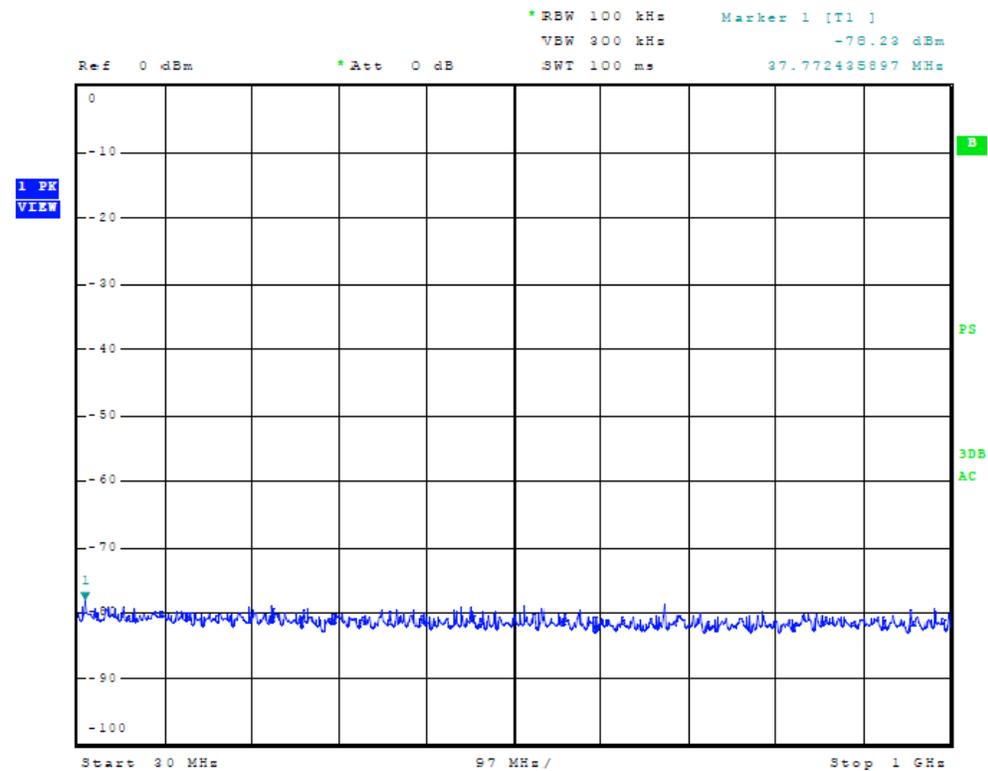
**Figure Thirteen Plot of Operation across frequency band**



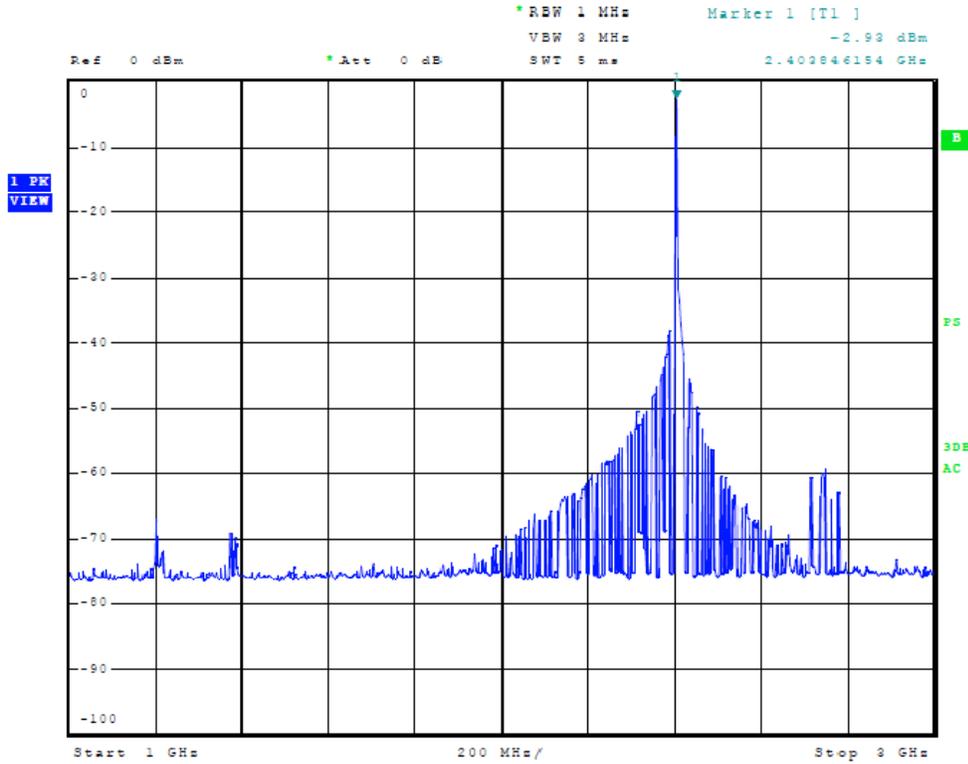
**Figure Fourteen of Low Frequency Band Edge**



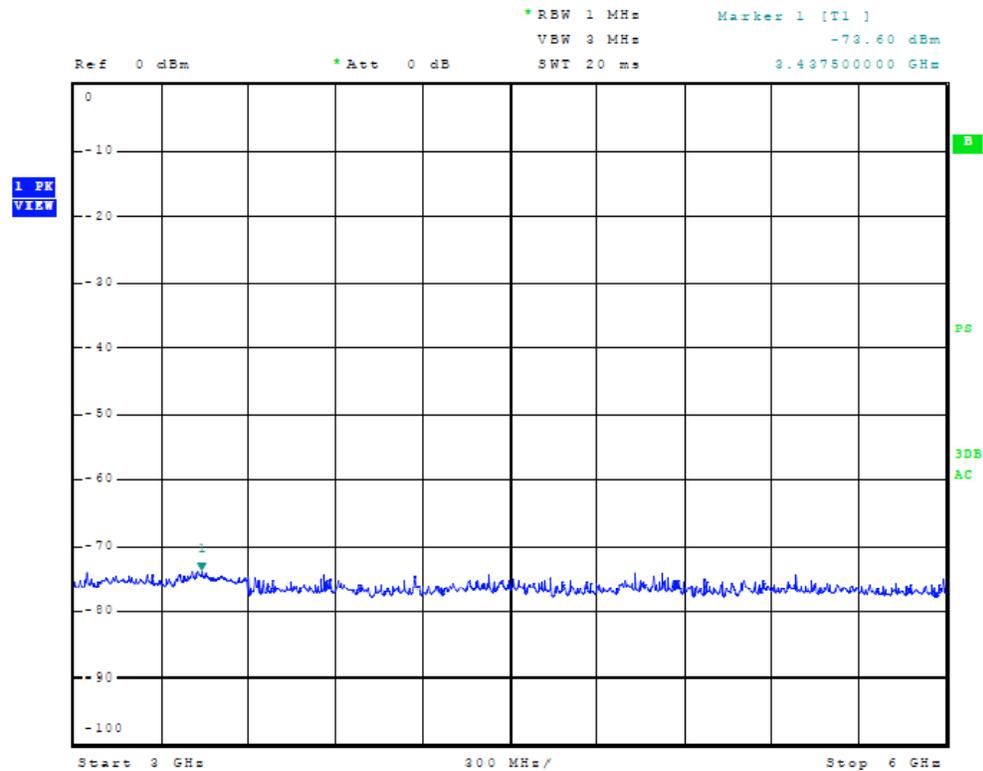
**Figure Fifteen of High Frequency Band Edge**



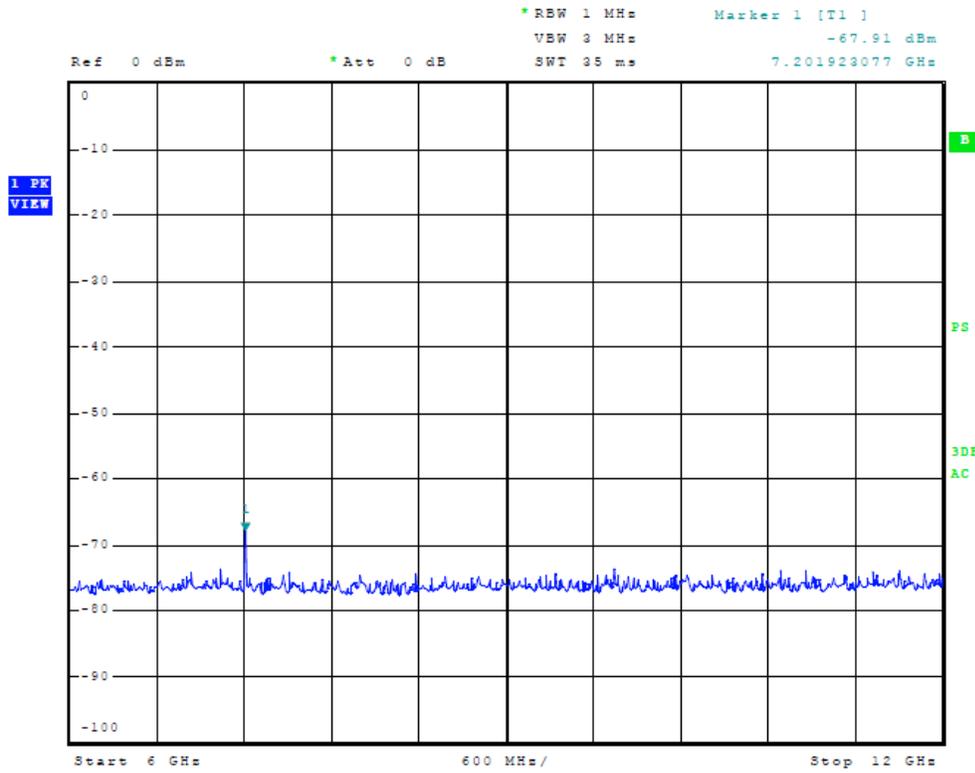
**Figure Sixteen Plot of Frequency Spectrum at Temporary Antenna Port**



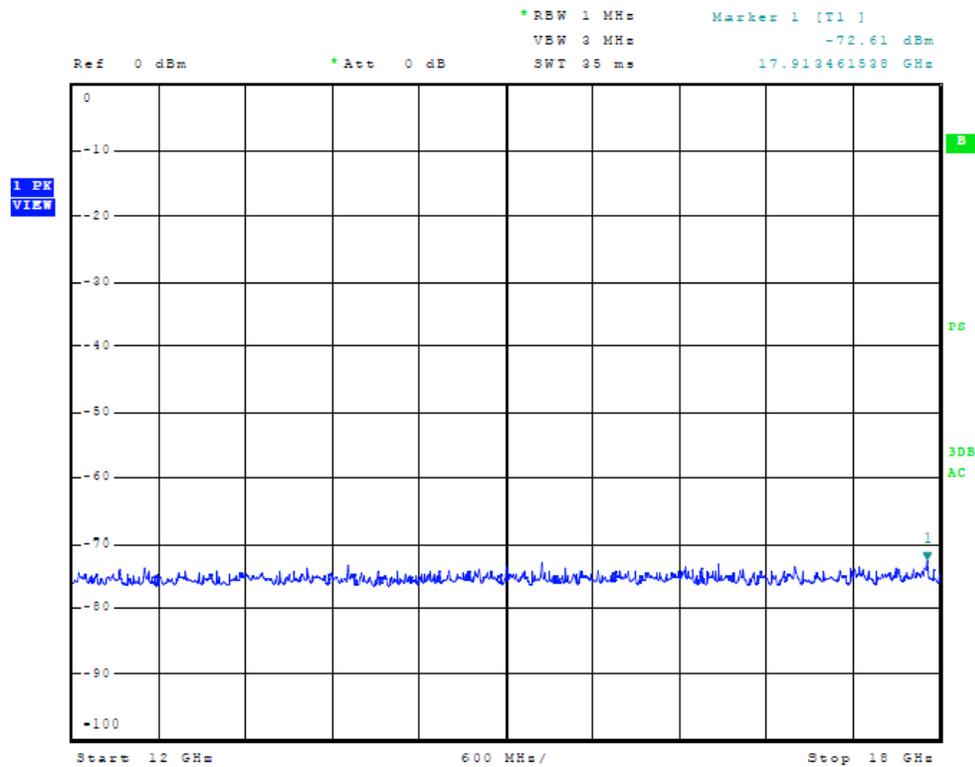
**Figure Seventeen Plot of Frequency Spectrum at Temporary Antenna Port**



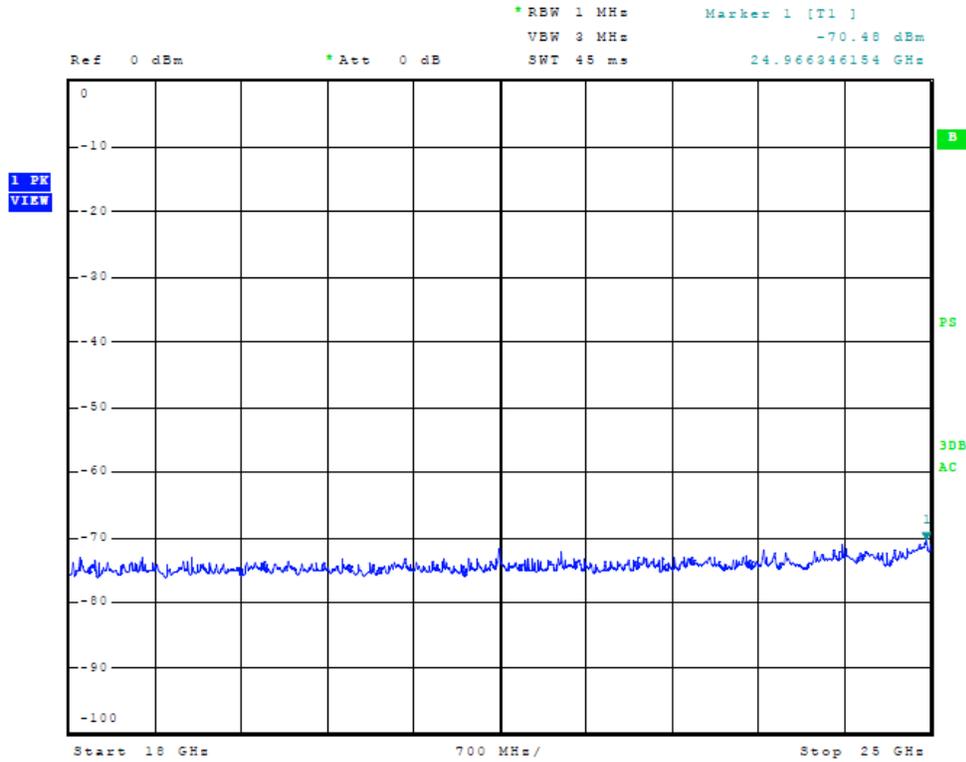
**Figure Eighteen Plot of Frequency Spectrum at Temporary Antenna Port**



**Figure Nineteen Plot of Frequency Spectrum at Temporary Antenna Port**



**Figure Twenty Plot of Frequency Spectrum at Temporary Antenna Port**



**Figure Twenty-One Plot of Frequency Spectrum at Temporary Antenna Port**

***Transmitter Emissions Data***

**Transmitter Antenna Port Conducted Emissions Data**

Frequency MHz	Antenna Conducted Output Power dBm	Occupied Bandwidth kHz
2402.0	-4.32	969.55
2457.0	-5.24	1,233.97
2479.0	-6.95	1,225.96

**Transmitter Radiated Emissions**

Frequency	FSM Hor Peak	FSM Hor Ave	FSM Vert Peak	FSM Vert Ave	AF	Amp Gain	RFS @ 3 m Hor Peak	RFS @ 3 m Hor Ave	RFS @ 3 m Vert Peak	RFS @ 3 m Vert Ave	Ave Limit
2402.0	78.0	34.6	67.3	30.2	30.6	25	83.6	40.2	72.9	35.8	94.0
4804.0	44.1	29.5	41.7	29.4	38.4	25	57.5	42.9	55.1	42.8	54.0
7206.0	36.1	23.5	36.1	23.5	36.3	25	47.4	34.8	47.4	34.8	54.0
9608.0	37.3	25.1	37.7	25.0	38.1	25	50.4	38.2	50.8	38.1	54.0
12010.0	35.2	22.6	35.2	22.6	40.0	25	50.2	37.6	50.2	37.6	54.0
2457.0	76.3	33.8	65.1	30.0	30.9	25	82.2	39.7	71.0	35.9	94.0
4914.0	41.4	28.8	41.4	28.8	38.8	25	55.2	42.6	55.2	42.6	54.0
7371.0	34.5	21.6	34.3	21.6	36.4	25	45.9	33.0	45.7	33.0	54.0
9828.0	37.4	24.4	37.3	24.3	38.2	25	50.6	37.6	50.5	37.5	54.0
12285.0	34.0	20.7	33.5	20.7	40.4	25	49.4	36.1	48.9	36.1	54.0
2479.0	74.4	32.9	65.5	29.8	31.4	25	80.8	39.3	71.9	36.2	94.0
4958.0	41.3	29.0	41.6	29.0	38.6	25	54.9	42.6	55.2	42.6	54.0
7437.0	34.5	22.1	35.3	22.1	36.5	25	46.0	33.6	46.8	33.6	54.0
9916.0	36.6	24.2	36.6	24.2	38.3	25	49.9	37.5	49.9	37.5	54.0
12395.0	33.1	20.7	33.4	20.7	40.7	25	48.8	36.4	49.1	36.4	54.0

Other emissions were present with amplitudes at least 20 dB below limits.

Note: Levels measured @ 3-meter OATS site.

**Summary of Results for Transmitter Radiated Emissions**

The EUT demonstrated compliance with the requirements and specifications of CFR47 Part 15.249 Intentional Radiators. The EUT demonstrated highest peak emission level of the fundamental of 83.6 dBµV/m with a minimum margin of -10.4 dB, and average emission of 40.2 dBµV/m with a minimum margin of -53.8 dB, as measured at 3 meters. The EUT demonstrated a minimum margin of -11.1 dB below limits for the harmonic emissions. There were no other measurable emissions greater than 20 dB below requirements than those recorded in this report.

There are no deviations or exceptions to the requirements.



NVLAP Lab Code 200087-0

## **Annex**

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

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
Spectrum Analyzer: Rohde & Schwarz ESU40	5/10
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, 11520	5/10
Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	
Spectrum Analyzer: HP 8591EM	5/10
Antenna: EMCO Biconilog Model: 3143	5/10
Antenna: Sunol Biconilog Model: JB6	10/10
Antenna: EMCO Log Periodic Model: 3147	10/10
Antenna: Antenna Research Biconical Model: BCD 235	10/10
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/10
R.F. Preamp CPPA-102	10/10
Attenuator: HP Model: HP11509A	10/10
Attenuator: Mini Circuits Model: CAT-3	10/10
Attenuator: Mini Circuits Model: CAT-3	10/10
Cable: Belden RG-58 (L1)	10/10
Cable: Belden RG-58 (L2)	10/10
Cable: Belden 8268 (L3)	10/10
Cable: Time Microwave: 4M-750HF290-750	10/10
Cable: Time Microwave: 10M-750HF290-750	10/10
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. Work experience includes six years working 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**

May 18, 2010

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 18, 2010

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 Farrish  
Industry Analyst

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

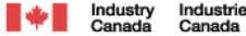
Garmin International, Inc.  
Model: Astro 320  
Test #: 110420  
Test to: FCC Parts 2 and 15.249  
File: Astro 320 DXX TstRpt 110420

FCC ID#: IPH-01848  
SN: ENGI  
Date: April 14, 2011  
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NVLAP Lab Code 200087-0

## 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](mailto: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.  
Model: Astro 320  
Test #: 110420  
Test to: FCC Parts 2 and 15.249  
File: Astro 320 DXX TstRpt 110420

FCC ID#: IPH-01848  
SN: ENGI  
Date: April 14, 2011  
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