NVLAP Lab Code 200087-0

Application For Grant of Certification

FOR

FOR

Model: BLUMOO
2402-2480 MHz
Frequency Hopping Spread Spectrum Transmitter
FCC ID: 2ABHQ-BSHECP01

FOR

Flyover Innovations LLC

8820 Hillside Drive
Lenexa, KS 66227

Test Report Number: 140115

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP Lab Code 200087-0

ROGERS LABS, INC.

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

Engineering Test Report For Grant of Certification Application

FOR

CFR 47, PART 15C - Intentional Radiators
CFR 47 Paragraph 15.247 and
Industry Canada RSS-210
License Exempt Intentional Radiator

For

Flyover Innovations LLC

8820 Hillside Drive
Lenexa, KS 66227

Frequency Hopping Spread Spectrum Transmitter
Model: BLUMOO
Frequency Range 2402-2480 MHz
FCC ID#: 2ABHQ-BSHECP01
IC: 1792A-02276

Test Date: January 15, 2014

Certifying Engineer: Scot D Rogers

Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
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Revisions

Revision 3 Issued February 13, 2014 – added text addressing 47CFR 15.247 requirements (pages 20-21)
Revision 2 Issued January 31, 2014
Revision 1 Issued January 29, 2014

Forward

The following information is submitted for consideration in obtaining Grant of Certification for License Exempt Frequency Hopping Spread Spectrum Intentional Radiator operating under CFR 47 Paragraph 15.247 and Industry Canada RSS-210, operation in the 2400 – 2483.5 MHz band.

Name of Applicant: Flyover Innovations LLC
8820 Hillside Drive
Lenexa, KS 66227

Model: BLUMOO

FCC I.D.: 2ABHQ-BSHECP01
Frequency Range: 2402-2480 MHz with power level 0.02 Watt
Occupied Bandwidth: 6-dB occupied bandwidth 327.3 kHz

Opinion / Interpretation of Results

Tests Performed	Margin (dB)	Results
Emissions as per CFR 47 paragraphs 2 and 15.205	-7.3	Complies
Emissions as per CFR 47 paragraphs 2 and 15.207	-16.3	Complies
Emissions as per CFR 47 paragraphs 2 and 15.209	-19.7	Complies
Harmonic Emissions per CFR 47 15.247	-7.3	Complies

Equipment Tested

Equipment	Model / PN	Serial Number
EUT (sample #1)	BLUMOO	ENG1

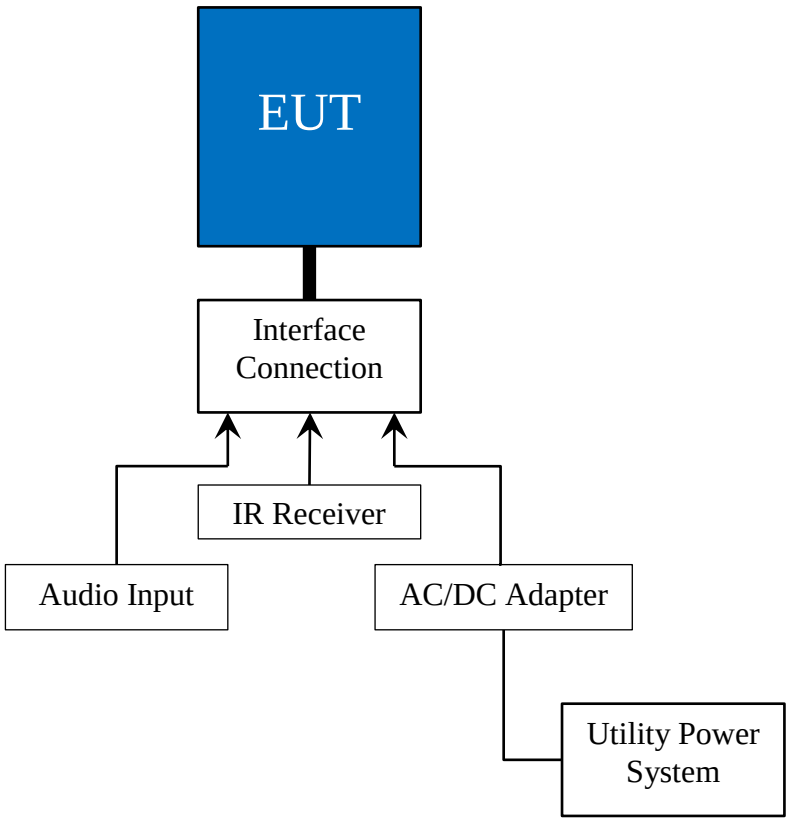
Test results in this report relate only to the items tested.

Equipment Function and Configuration

The EUT is a 2402-2480 MHz wireless transceiver for use with home entrainment systems. The design operates from direct current power supplied from the manufacturer provided AC/DC adapter. The Blumoo receives audio input form connected home entertainment equipment and broadcasts wirelessly to compliant equipment. The EUT provides interface ports for external direct current power, stereo audio input, and optional external Infrared receiver for auxiliary

equipment. The design utilizes internal fixed antenna system and offers no provision for antenna replacement or modification. The EUT was arranged as described by the manufacturer emulating typical use configuration for testing purposes. The EUT offers no other interface connections than those in the configuration options shown below. For testing purposes, the EUT received powered from manufacturer supplied AC/DC power adapter and was configured to operate in available modes. During testing all interface connections were appropriately terminated. 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.

Equipment Configuration



Application for Certification

(1) Manufacturer: Flyover Innovations LLC
8820 Hillside Drive
Lenexa, KS 66227

(2) Identification: Model: BLUMOO

FCC I.D.: 2ABHQ-BSHECP01

(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) List of Peripheral Equipment Necessary for operation: The equipment operates from direct current power supplied from authorized AC/DC adapter. Additional optional accessory interface capabilities are provided for audio and infrared. The EUT offers no other connection ports than those presented in this filing.

(9) Transition Provisions of CFR47 15.37 are not requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2013, 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 15.247, and RSS-210 the following information is submitted. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in ANSI C63.4-2009 and/or ANSI C63.10-2009. The system operates from direct current power supplied through authorized AC/DC adapter. Testing of the AC line-conducted emissions were performed as defined in section 6 of ANSI C63.10-2009. Testing of the radiated emissions was performed as defined in sections 6 and 7 of ANSI C63.10-2009.

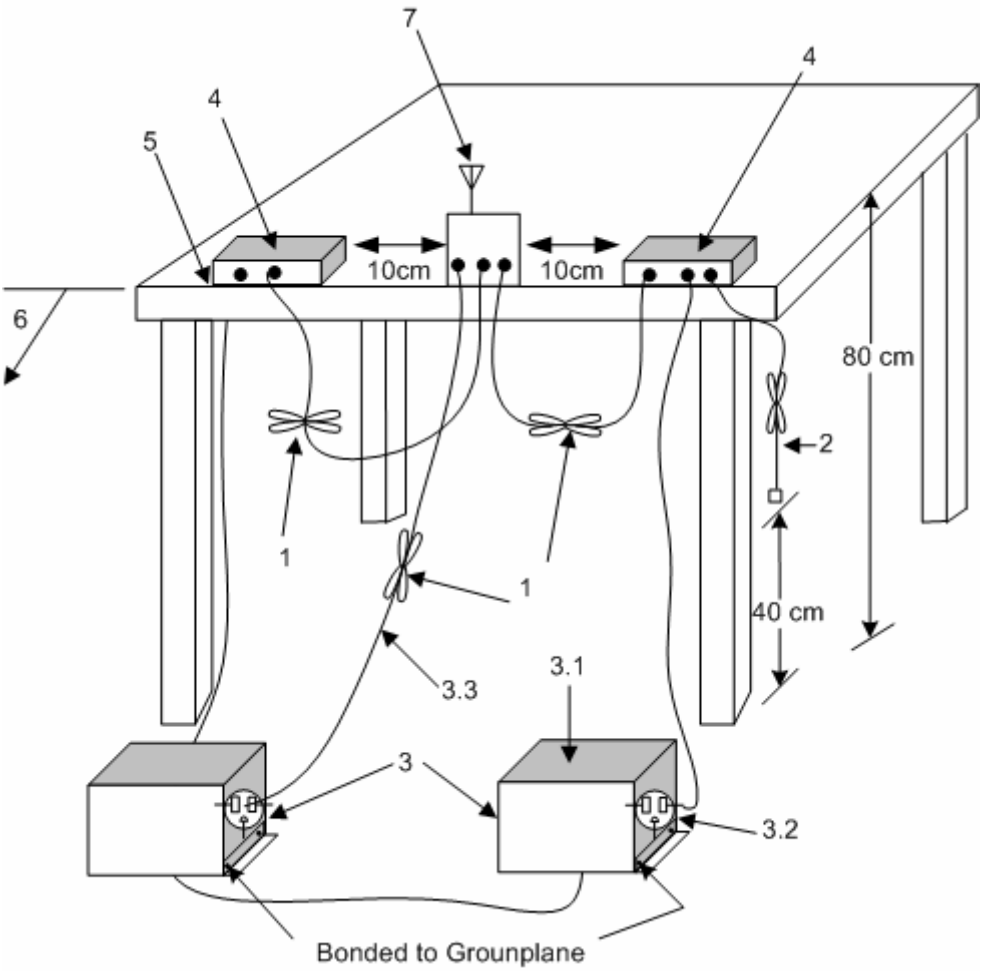
Equipment Testing Procedures

AC Line Conducted Emission Test Procedure

Testing for the AC line-conducted emissions was performed as defined in ANSI C63.10-2009. The test setup, including the EUT, was arranged in the test configurations as presented 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-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF 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 diagram 1 showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

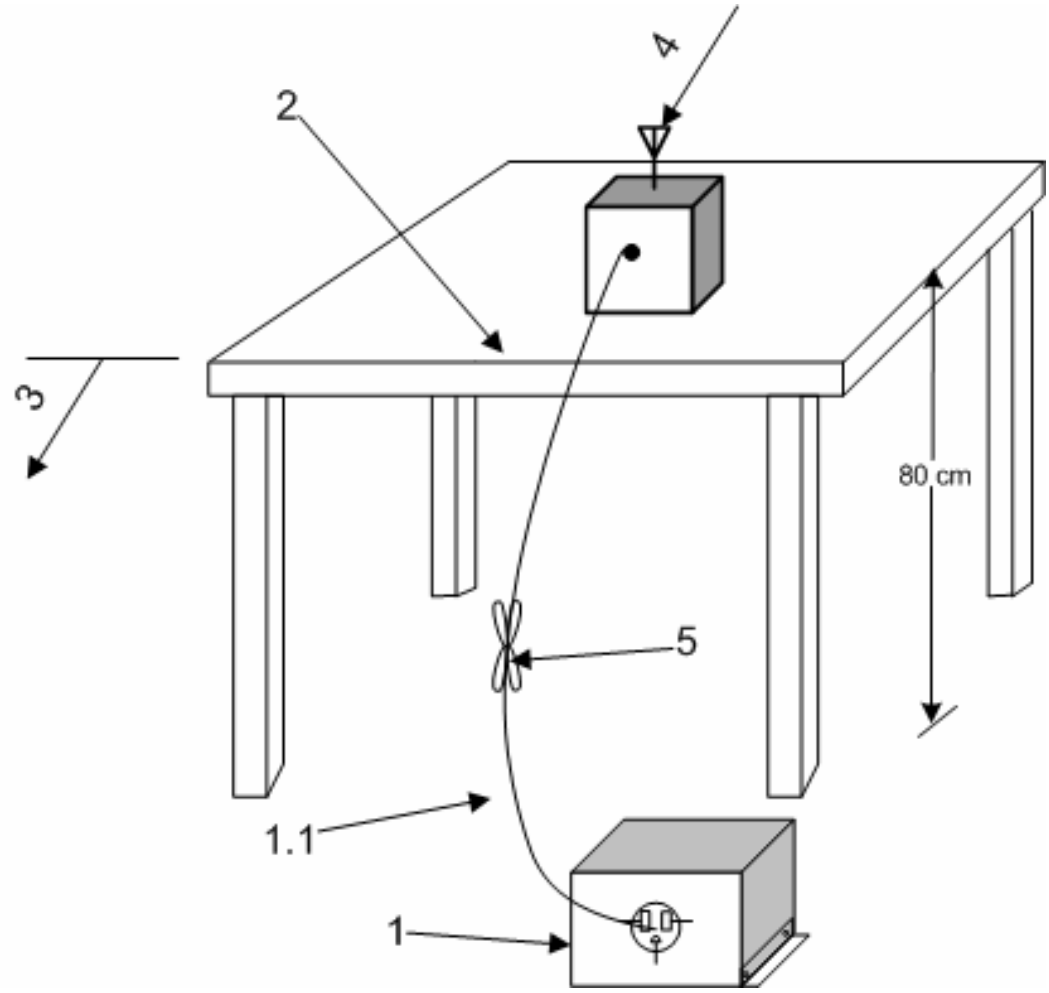
Radiated Emission Test Procedure

The EUT 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. Radiated emissions testing was performed as required in CFR47 15, RSS-210 and specified in sections 6 and 7 of ANSI C63.10-2009. 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 data was taken using a spectrum analyzer. The frequency spectrum from 9 kHz to 25,000 MHz was searched for during preliminary investigation. Refer to diagrams 2 and 3 showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.



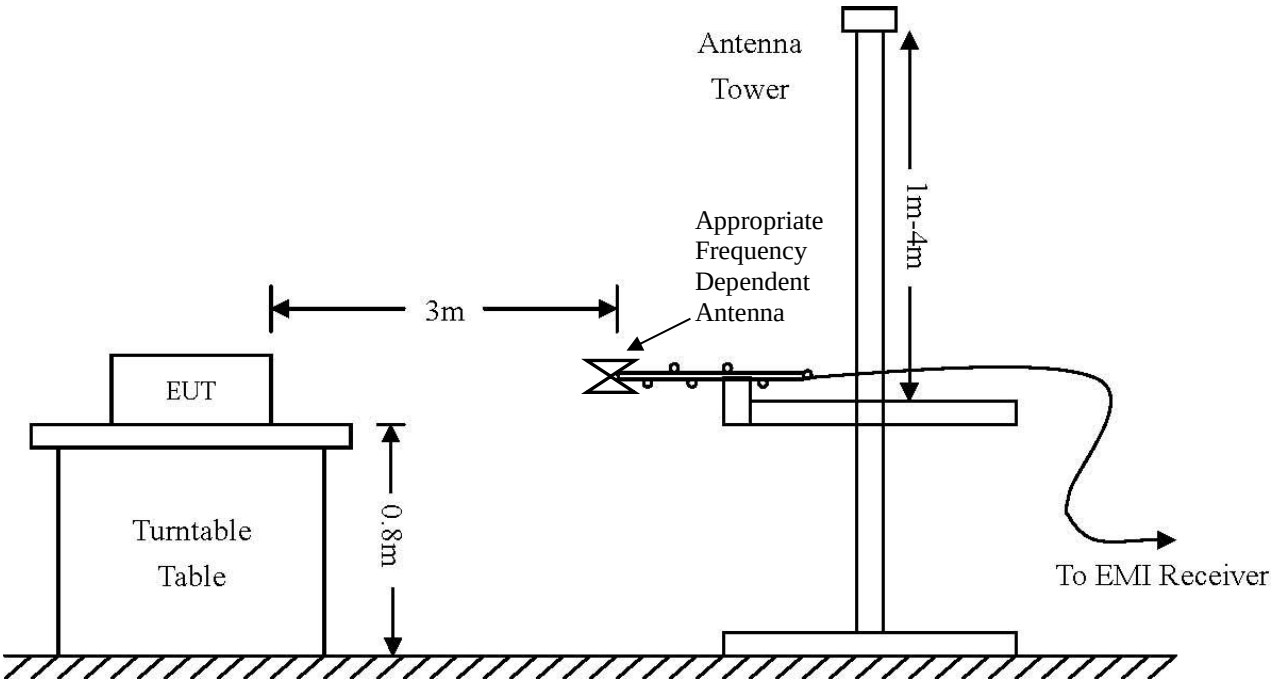
1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
   3.1 All other equipment powered from additional LISN(s).
   3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Non-EUT components of EUT system being tested.
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

Diagram 1 Test arrangement for Conducted emissions



1. A LISN is optional for radiated measurements between 30 MHz to 1000 MHz, but not allowed for measurements below 30 MHz and above 1000 MHz. (See 6.4.3, 6.5.1, and 6.6.3.) If used, connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50Ω. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3.1).
   1.1 LISN spaced at least 80 cm from nearest part of EUT chassis.
2. The EUT shall be placed in the center of the table to the extent possible. (See 6.2.3.1 and 6.3.4).
3. A vertical conducting plane, if used for conducted tests per 6.2.2, shall be removed for radiated emission tests.
4. Antenna may be integral or detachable, depending on the EUT.
5. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.

Diagram 2 Test arrangement for radiated emissions of tabletop equipment



Frequency: 9 kHz-30 MHz	Frequency: 30 MHz- 1 GHZ	Frequency: Above 1 GHz
Loop Antenna	Broadband Biconilog	Horn
RBW = 9 kHz	RBW = 120 kHz	RBW = 1 MHz
VBW = 30 kHz	VBW = 120 kHz	VBW = 1 MHz
Sweep time = Auto	Sweep time = Auto	Sweep time = Auto
Detector = PK, QP	Detector = PK, QP	Detector = PK, AV

Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)

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. 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 Site Registration Letters

NVLAP Accreditation — Lab code 200087-0

List of Test Equipment

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

AC Line Conducted Emissions (0.150 -30 MHz)		
RBW	AVG. BW	Detector Function
9 kHz	30 kHz	Peak / Quasi Peak
Emissions (30-1000 MHz)		
RBW	AVG. BW	Detector Function
120 kHz	300 kHz	Peak / Quasi Peak
Emissions (Above 1000 MHz)		
RBW	Video BW	Detector Function
100 kHz	100 kHz	Peak
1 MHz	1 MHz	Peak / Average

Equipment	Manufacturer	Model (SN)	Band	Cal Date	Due
☒ LISN	Comp. Design	FCC-LISN-2-MOD.CD(126).	15-30MHz	10/13	10/14
☒ Cable	Time Microwave	750HF290-750 (L10M)	9kHz-40 GHz	10/13	10/14
☒ Cable	Belden	RG-58 (L1-CAT3-11509)	9kHz-30 MHz	10/13	10/14
☒ Cable	Belden	RG-58 (L2-CAT3-11509)	9kHz-30 MHz	10/13	10/14
☐ Antenna	ARA	BCD-235-B (169)	20-350MHz	10/13	10/14
☐ Antenna	EMCO	3147 (40582)	200-1000MHz	10/13	10/14
☒ Antenna	Com Power	AH-118 (10110)	1-18 GHz	10/13	10/14
☒ Antenna	Com Power	AH-840 (101046)	18-40 GHz	5/13	5/14
☒ Antenna	EMCO	6509 (9502-1374)	.001-30 MHz	10/13	10/14
☒ Antenna	Sunol	JB-6 (A100709)	30-1000 MHz	10/13	10/14
☒ Antenna	Standard	FXRY638A (621786)	10-18 GHz	5/13	5/14
☐ Antenna	EMCO	3143 (9607-1277)	20-1200 MHz	5/13	5/14
☐ Analyzer	HP	8591EM (3628A00871)	9kHz-1.8GHz	5/13	5/14
☐ Analyzer	HP	8562A (3051A05950)	9kHz-110GHz	5/13	5/14
☒ Analyzer	Rohde & Schwarz	ESU40 (100108)	20Hz-40GHz	5/13	5/14
☒ Amplifier	Com-Power	PA-010 (171003)	100Hz-30MHz	10/13	10/14
☒ Amplifier	Com-Power	CPPA-102 (01254)	1-1000 MHz	10/13	10/14
☒ Amplifier	Com-Power	PAM-118A (551014)	0.5-18 GHz	10/13	10/14

Units of Measurements

Conducted EMI Data is in dBµV; dB referenced to one microvolt

Radiated EMI Data is in dBµV/m; dB/m referenced to one microvolt per meter

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses

RFS (dBµV/m @ 3m) = FSM (dBµV) + A.F. (dB) - Gain (dB)

Environmental Conditions

Ambient Temperature	20.3° C
Relative Humidity	33%
Atmospheric Pressure	1018.5 mb

Intentional Radiators

As per CFR47, Subpart C, paragraph 15.247 and RSS-210 the following information is submitted.

Antenna Requirements

The EUT incorporates integral antenna system and offers no provision for connection to alternate system. The antenna connection point complies with the unique antenna connection requirements. The unique antenna connection requirements are fulfilled. 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 the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were investigated at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Test procedures of ANSI C63.10-2009 paragraph 6 were used during testing. No other significant emission was observed which fell into the restricted bands of operation. Computed emission values take into account the received radiated field strength, receive antenna correction factor, amplifier gain stage, and test system cable losses.

Table 1 Harmonic Radiated Emissions in Restricted Bands Data

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)	Limit @ 3m (dBµV/m)
2390.0	56.0	N/A	32.2	52.3	N/A	29.9	54.0
2483.5	45.3	N/A	32.0	51.2	N/A	37.7	54.0
4804.0	44.5	N/A	40.3	50.0	N/A	44.9	54.0
4882.0	44.3	N/A	41.2	45.9	N/A	43.4	54.0
4960.0	47.2	N/A	39.9	43.4	N/A	41.5	54.0
7206.0	50.9	N/A	44.6	495.6	N/A	46.4	54.0
7323.0	51.7	N/A	44.8	52.4	N/A	45.5	54.0
7440.0	50.5	N/A	42.3	52.0	N/A	46.7	54.0
12010.0	48.8	N/A	36.4	47.9	N/A	34.9	54.0
12205.0	49.9	N/A	38.5	47.3	N/A	35.1	54.0
12400.0	50.4	N/A	38.8	49.2	N/A	36.8	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for Radiated Emissions in Restricted Bands

The EUT demonstrated compliance with the radiated emissions requirements of CFR 47 Part 15C and RSS-210 Intentional Radiators. The EUT demonstrated a worst-case minimum harmonic margin of -7.3 dB below the radiated emissions requirements and general emission of -6.3 dB below requirements in restricted frequency bands. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

AC Line Conducted EMI Procedure

The EUT was arranged in typical equipment configurations 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 C63.10-2009 paragraph 6. The AC adapter for the EUT 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 µF 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 AC Adapter while charging the EUT.

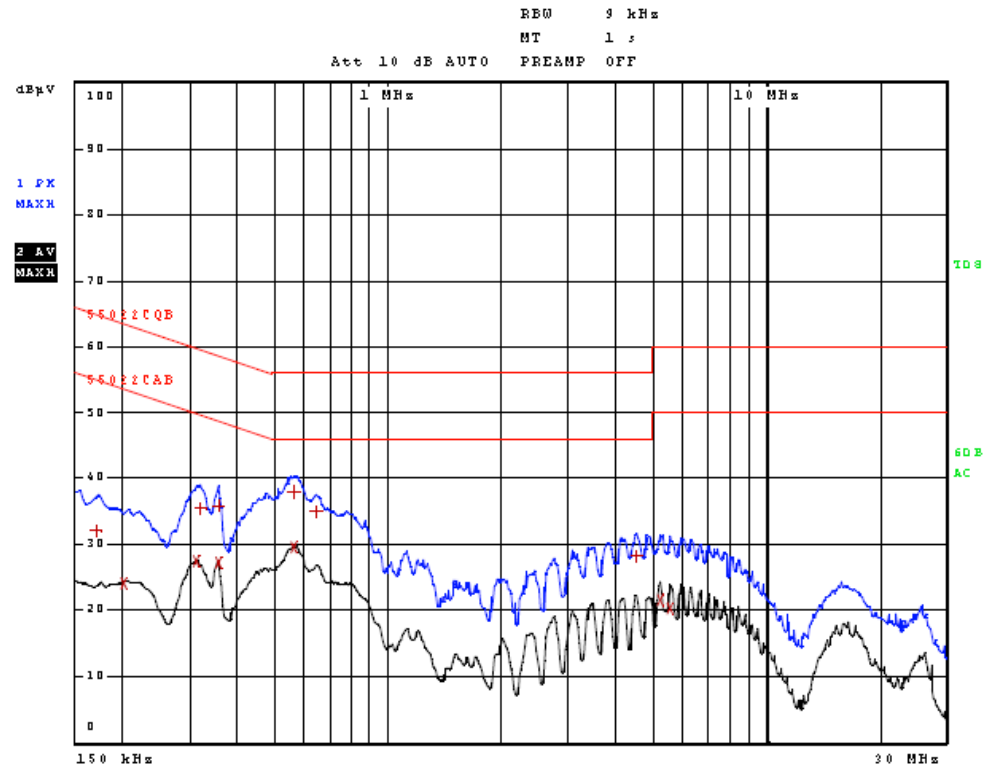


Figure 1 AC Line Conducted emissions of EUT line 1

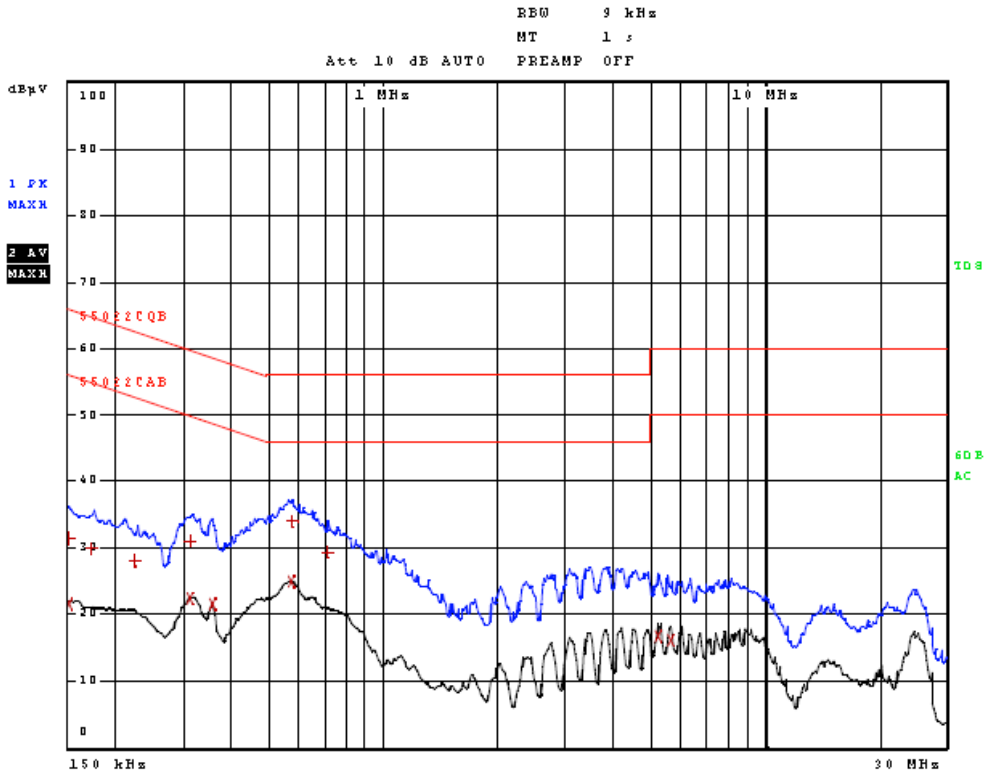


Figure 2 AC Line Conducted emissions of EUT line 2

Table 2 AC Line Conducted Emissions Data L1

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	170.000000000 kHz	32.02	Quasi Peak	-32.94
2	202.000000000 kHz	24.02	Average	-29.50
2	310.000000000 kHz	27.36	Average	-22.61
1	318.000000000 kHz	35.49	Quasi Peak	-24.27
2	354.000000000 kHz	27.15	Average	-21.71
1	354.000000000 kHz	35.79	Quasi Peak	-23.08
1	558.000000000 kHz	37.87	Quasi Peak	-18.13
2	562.000000000 kHz	29.61	Average	-16.39
1	642.000000000 kHz	35.00	Quasi Peak	-21.00
1	4.550000000 MHz	28.20	Quasi Peak	-27.80
2	5.256000000 MHz	21.53	Average	-28.47
2	5.572000000 MHz	20.34	Average	-29.66

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

Table 3 AC Line Conducted Emissions Data L2

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
1	150.000000000 kHz	31.46	Quasi Peak	-34.54
2	150.000000000 kHz	21.59	Average	-34.41
1	174.000000000 kHz	29.95	Quasi Peak	-34.82
1	226.000000000 kHz	28.03	Quasi Peak	-34.56
2	310.000000000 kHz	22.44	Average	-27.53
1	314.000000000 kHz	31.08	Quasi Peak	-28.79
2	354.000000000 kHz	21.59	Average	-27.28
2	570.000000000 kHz	24.81	Average	-21.19
1	574.000000000 kHz	34.03	Quasi Peak	-21.97
1	714.000000000 kHz	29.34	Quasi Peak	-26.66
2	5.280000000 MHz	16.62	Average	-33.38
2	5.660000000 MHz	16.13	Average	-33.87

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

Summary of Results for AC Line Conducted Emissions Results

The EUT demonstrated compliance with the AC Line Conducted Emissions requirements of CFR 47 Part 15B, 15.207, and other applicable Class B emissions requirements. The EUT AC Adapter worst-case configuration demonstrated a minimum margin of -16.3 dB below the FCC/CISPR Class B limit. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

General Radiated Emissions Procedure

The EUT was arranged in a typical equipment configuration and operated through all available modes with worst-case data recorded. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Each radiated emission was then 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 9 kHz 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 Loop from 9 kHz to 30 MHz, Broadband Biconical from 30 to 200 MHz, Biconilog from 30 to 1000 MHz, Log Periodic from 200 MHz to 1 GHz and or double Ridge or pyramidal horns and mixers from 1 GHz to 40 GHz, notch filters and appropriate amplifiers and external mixers were utilized.

Table 6 General Radiated Emissions from EUT Data (Highest 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)	Limit @ 3m (dBµV/m)
52.0	21.7	16.1	N/A	16.3	8.9	N/A	40.0
166.4	29.8	23.8	N/A	23.2	18.1	N/A	43.5
264.2	19.6	14.3	N/A	21.6	16.6	N/A	46.0
300.0	22.1	17.3	N/A	22.0	17.0	N/A	46.0
312.2	22.7	15.6	N/A	19.7	14.4	N/A	46.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency range below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Summary of Results for General Radiated Emissions

The EUT demonstrated compliance with the radiated emissions requirements of CFR47 Part 15C paragraph 15.209 and RSS-210 Intentional Radiators. The EUT demonstrated a minimum margin of -19.7 dB below the requirements. Other emissions were present with amplitudes at least 20 dB below the Limits.

Operation in the Band 2400 – 2483.5 MHz

The transmitter output power was measured with all interface ports appropriately terminated and functional. EUT radiated emissions were measured at the open area test site at a three-meter 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 quasi-peak amplitude of the frequencies below 1000 MHz were measured using a spectrum analyzer. The peak and average amplitude of emissions above 1000 MHz were measured using a spectrum analyzer. Emissions data was recorded from the measurement results. Plots were made of transmitter performance for reference purposes. Refer to figures three through ten showing plots taken of the EUT transmitter performance displaying compliance with the specifications. Test procedures as defined in publication ANSI C63.10-2009 were utilized during compliance testing. These procedures utilize measurement of maximum field strength and conversion calculation for comparison with requirements.

This product utilizes permanently attached antenna system and offers no provision for antenna port conducted measurements. As such, the testing procedures as defined in publications KDB 558074 D01 DTS Meas Guidance v03r01, KDB 662911, and ANSI C63.10-2009 were utilized during compliance testing. These procedures provide for antenna port measurement or measurement of maximum field strength (summing horizontal and vertical for total output power) and conversion calculations for comparison with requirements.

1. Calculate the transmitter's peak power using the following equations:
   Measure and Sum emissions in both polarizations, convert to power based on antenna gain, and sum the power across the two polarizations.
   $$P = (E * d)^2 / (30 * G)$$
   Where: E = the measured maximum field strength in V/m.
   G = the numeric gain of the transmitting antenna over an isotropic radiator.
   d = the distance in meters from which the field strength was measured.
   P = the power in watts
   Setting the RBW > 6dB bandwidth of the emission or using a peak power meter
2. Emission Bandwidth was measured in compliance with KDB 558074 paragraph 8.
3. Maximum Peak Output Power was measured in compliance with KDB 558074 paragraph 9.
4. Maximum Power Spectral Density was measured in compliance with KDB 558074 paragraph 10.
5. Maximum Unwanted Emissions Levels were measured in compliance with KDB 558074 paragraph 11 and CFR47 paragraph 15C at 3-meters distance located on the OATS.

Part 15.247 (a) (1): CHANNEL SEPERATION:

Frequency hopping systems operating in the 2400-2483.5 MHz band shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

The EUT complies with the requirement, as channel separation is 1 MHz.

Part 15.247(a)(1): Equal Hopping Frequency Use

Each frequency must be used equally on the average by each transmitter

The EUT complies with the requirement as input data is supplied and separated into data packets. A data packet is transmitted and the device advances to next hop channel in the hop sequence and transmits the next data packet advancing through the hop sequence. The process is then repeated.

Part 15.247(a)(1): HOPPING SEQUENCE:

The system shall hop to channel frequencies that are selected at the system-hopping rate from a pseudo randomly ordered list of hopping frequencies.

The device complies with the requirement as it selects channel frequencies from a pseudo-randomly generated list of hopping frequencies (example shown below) at the system hop rate of 1600 hops/s.

Hop#	Freq [MHz]	Hop#	Freq [MHz]	Hop#	Freq [MHz]	Hop#	Freq [MHz]
1	2402	**21**	2429	**41**	2468	**61**	2424
2	2432	**22**	2436	**42**	2423	**62**	2462
3	2403	**23**	2445	**43**	2410	**63**	2427
4	2411	**24**	2480	**44**	2447	**64**	2428
5	2406	**25**	2426	**45**	2460	**65**	2473
6	2442	**26**	2416	**46**	2467	**66**	2420
7	2408	**27**	2439	**47**	2414	**67**	2458
8	2463	**28**	2455	**48**	2419	**68**	2478
9	2459	**29**	2466	**49**	2405	**69**	2430
10	2441	**30**	2421	**50**	2443	**70**	2472
11	2475	**31**	2474	**51**	2407	**71**	2452
12	2451	**32**	2437	**52**	2412	**72**	2438
13	2425	**33**	2453	**53**	2448	**73**	2457
14	2415	**34**	2470	**54**	2464	**74**	2431
15	2404	**35**	2435	**55**	2434	**75**	2440
16	2450	**36**	2456	**56**	2417	**76**	2454
17	2461	**37**	2477	**57**	2449	**77**	2471
18	2433	**38**	2422	**58**	2413	**78**	2476
19	2469	**39**	2409	**59**	2465	**79**	2479
20	2418	**40**	2446	**60**	2444		

Part 15.247(a)(1): System Receiver Input Bandwidth

The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters

The EUT complies with the requirement as the TI CC2564 transceiver chip is selected to match the bandwidth of the incoming transmitted signal.

Part 15.247(a)(1).: System Receiver Hopping Capability

The receiver shall shift frequencies in synchronization with the transmitted signals.

The EUT complies with the requirement as the receiver shifts frequencies around the hop sequence at the system hop rate, in synchronization with the paired transceiver.

Part 15.247(a)(1)(iii).:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

The EUT complies with the requirement by definition. The system employs 79 non-overlapping hopping channels. Utilizing the 79 hop channels in the DH1 packet type the dwell time of 400 µS occupies the channel 316 times in 31.6 seconds, equaling 130 mS, which complies with the less than 400 mS requirement.

Part 15.247 (b) (1): PEAK POWER OUTPUT:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency-hopping systems in the 5725-5850 MHz band: 1 watt

The EUT complies with the requirement, as peak power output is 20mW (less than 0.125 Watts).

Part 15.247(g) and RSS 210 A8.1

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The EUT complies with the above requirement. All channels in the hop sequence are used during transmission advancing to the next hop channel based on operational mode. The next transmission begins on the next frequency in the hop sequence.

Part 15.247(h) and RSS 210 A8.1

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

The EUT complies with the requirement. Intelligence is implemented in the TI CC2564 chip set in compliance with Bluetooth Core Specification to adapt hop set independently for frequency spectrum utilization within paired system. Intelligence may be enabled once the device is paired and connected.

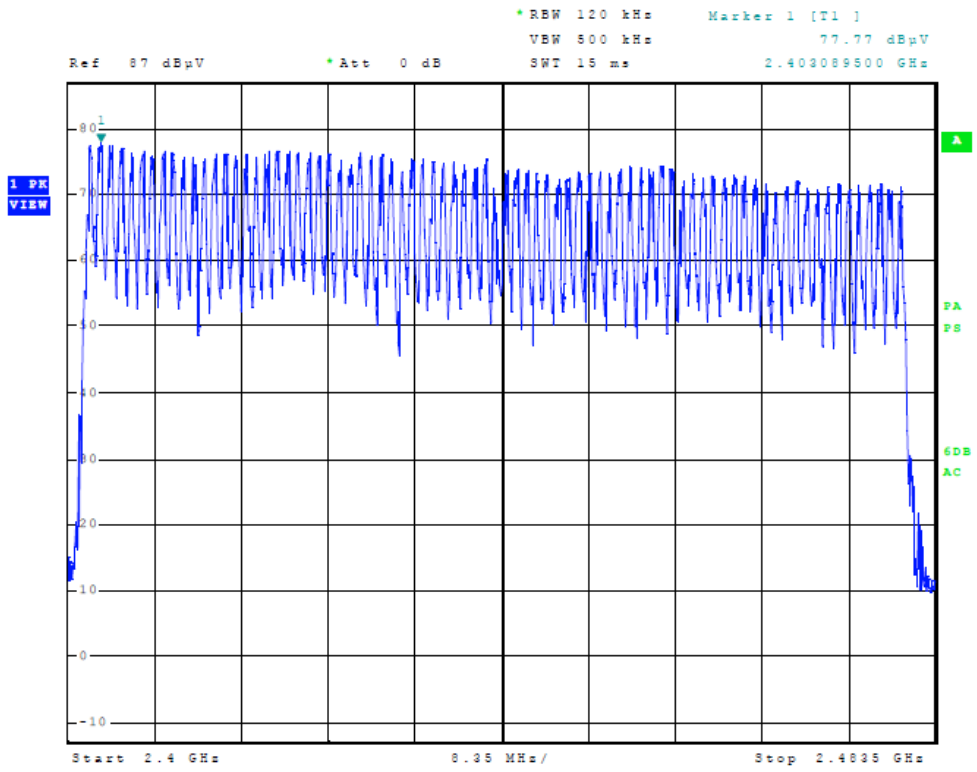


Figure 3 Plot of Transmitter Emissions in Operational Frequency (number of Hops)

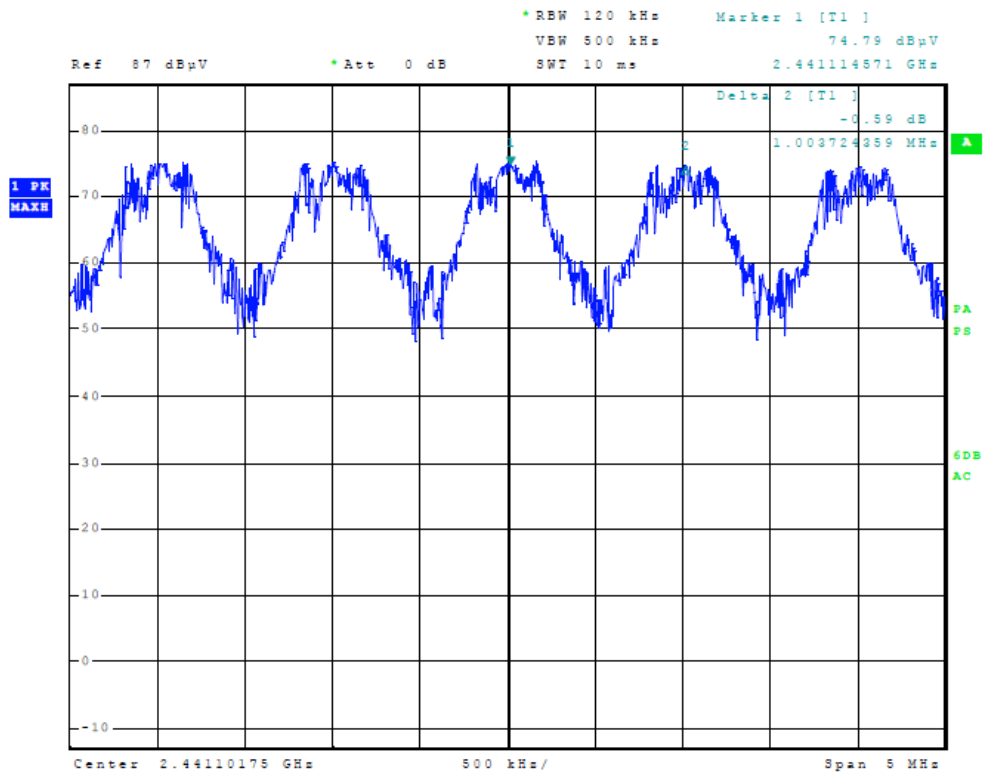


Figure 4 Plot of Transmitter Channel Spacing

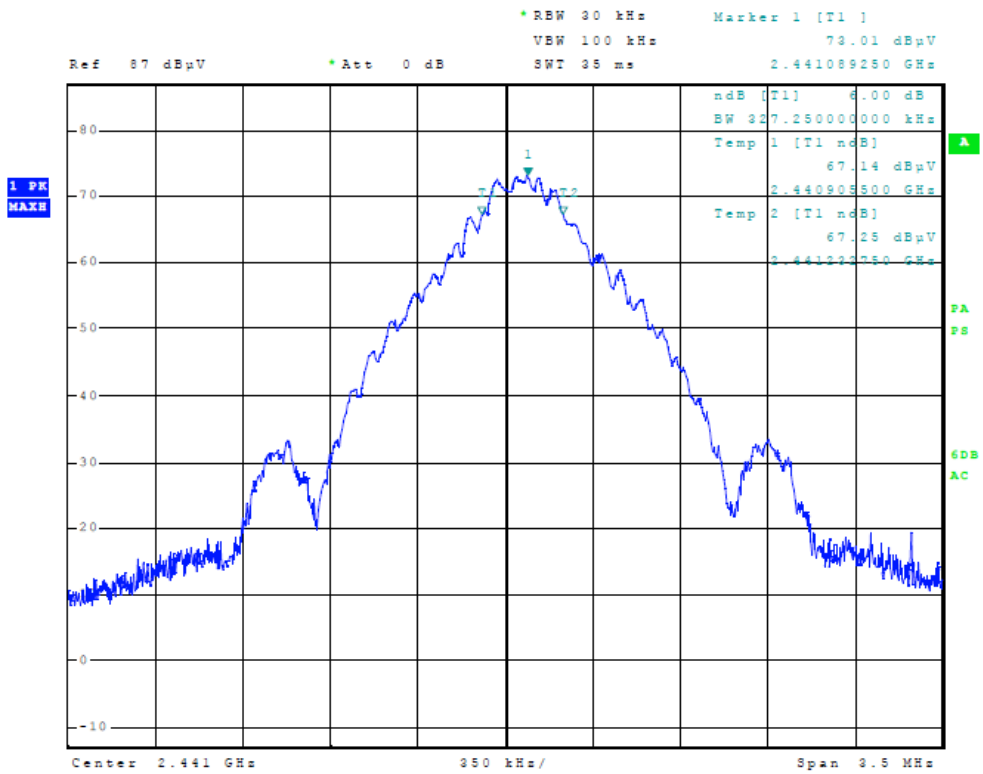


Figure 5 Plot of Transmitter Occupied Bandwidth (6-dB)

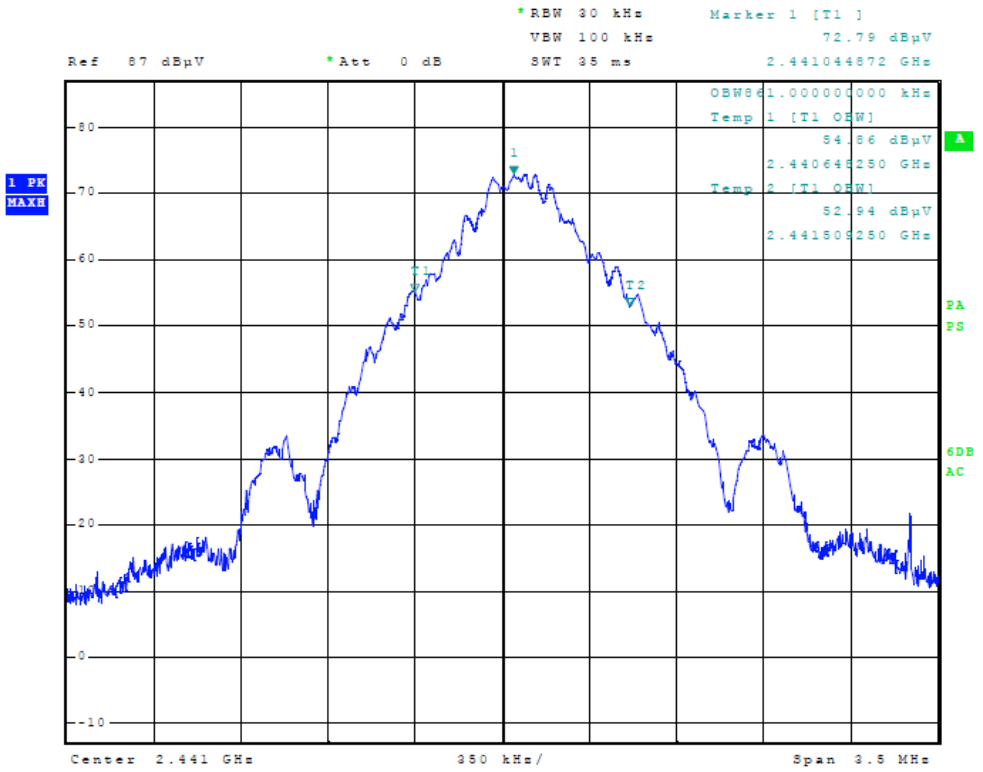


Figure 6 Plot of Transmitter Occupied Bandwidth (99.5 percent)

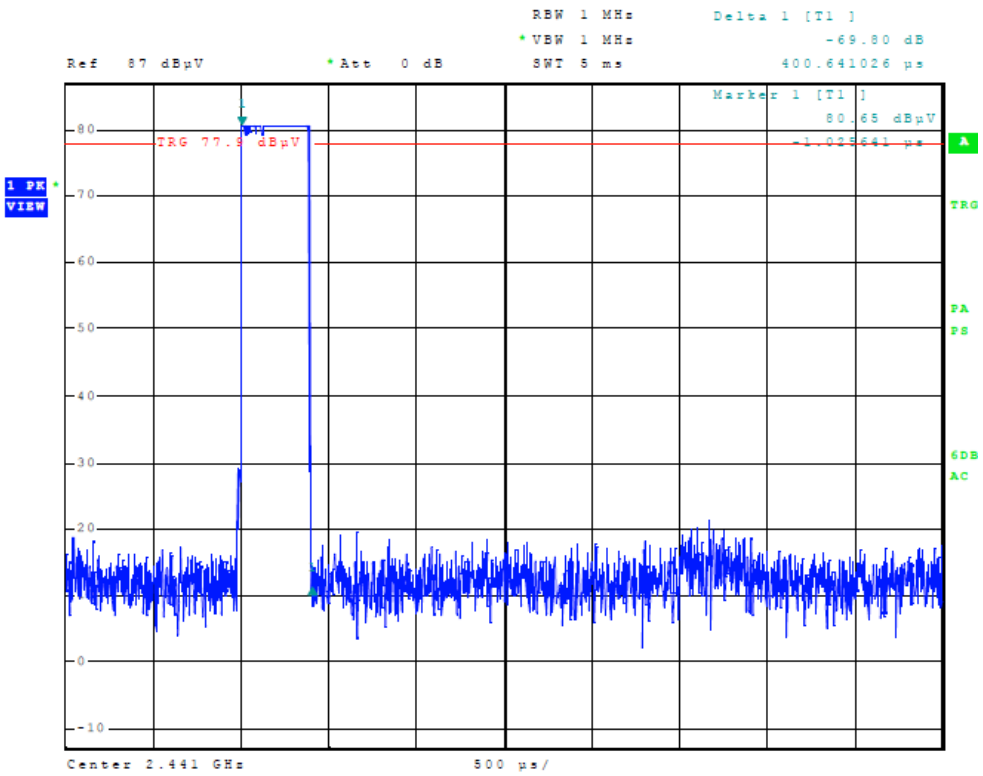


Figure 7 Plot of Transmitter Dwell Time on Channel

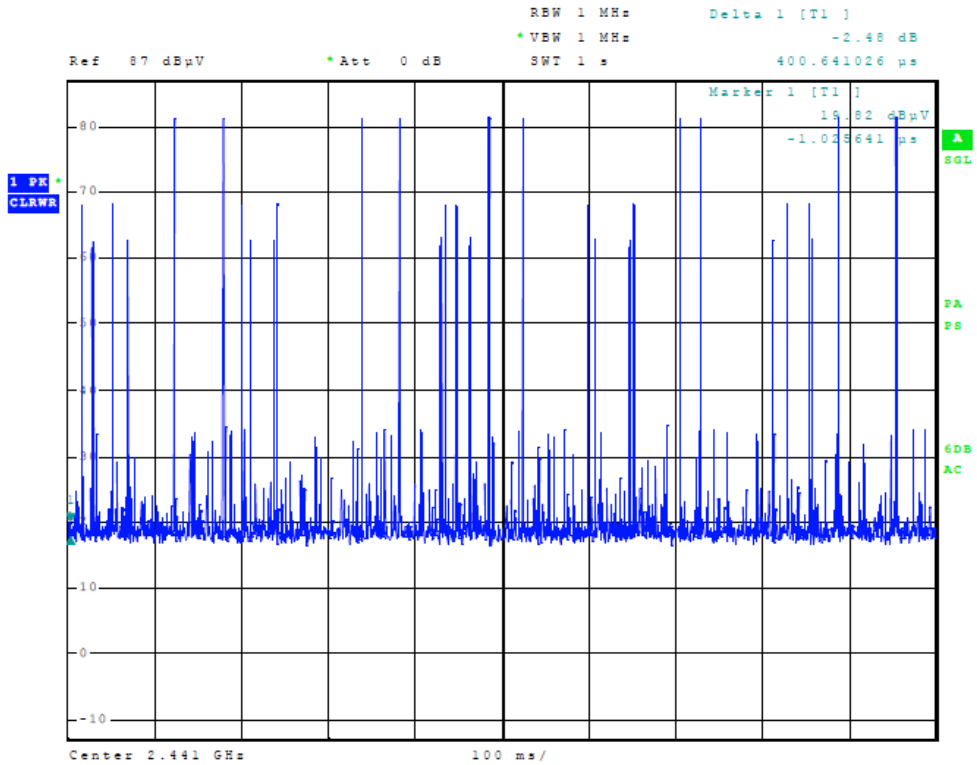


Figure 8 Plot of Number of Times Transmitter on Channel

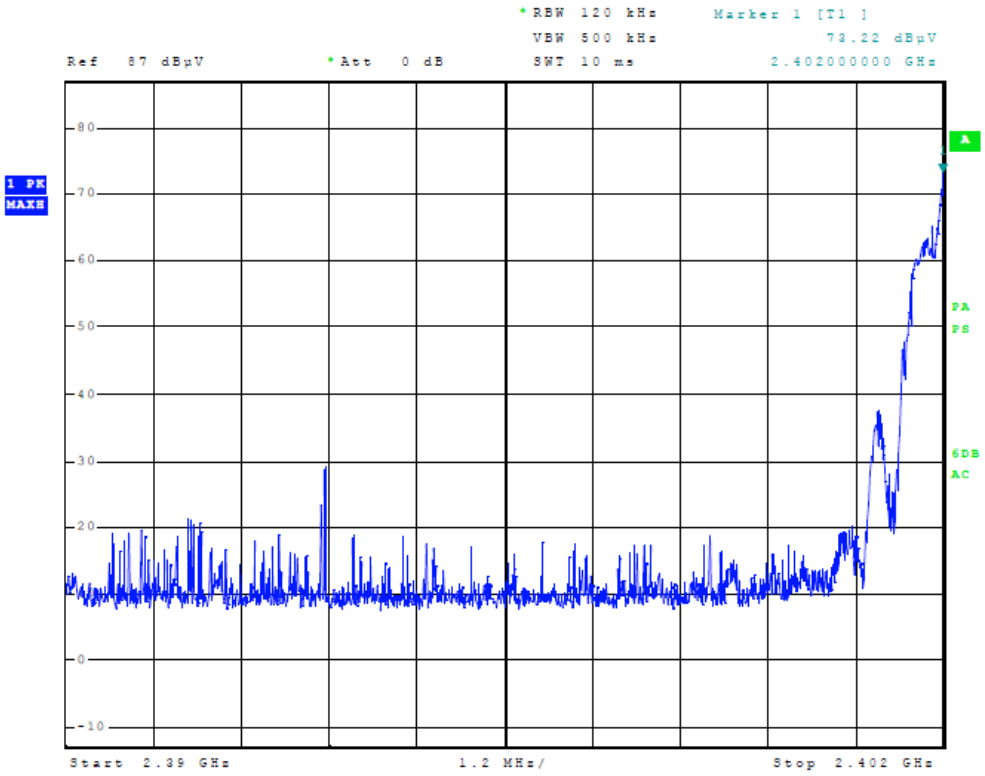


Figure 9 Plot of Transmitter Emissions Low Band Edge

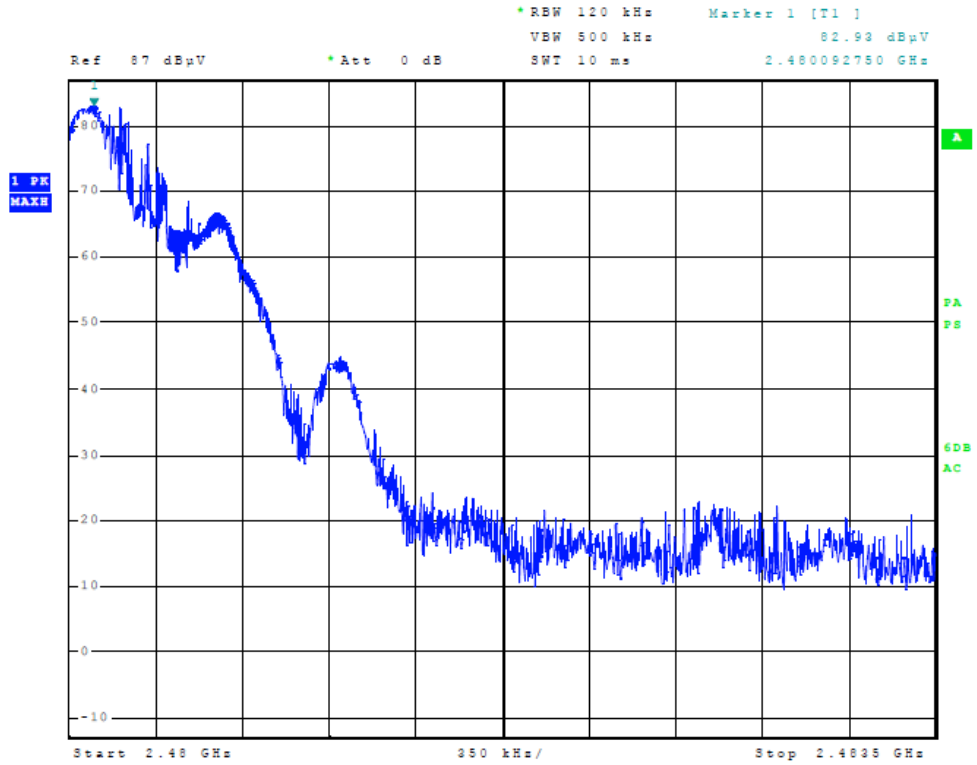


Figure 10 Plot of Transmitter High Band Edge

Transmitter Emissions Data

Table 7 Transmitter Radiated Emission

Frequency in MHz	Horizontal Peak (dBµV/m)	Horizontal Average (dBµV/m)	Vertical Peak (dBµV/m)	Vertical Average (dBµV/m)	Limit @ 3m (dBµV/m)
2402.0	108.2	107.9	106.8	106.3	--
4804.0	44.5	40.3	50.0	44.9	54.0
7206.0	50.9	44.6	495.6	46.4	54.0
9608.0	46.2	34.6	51.5	42.1	54.0
12010.0	48.8	36.4	47.9	34.9	54.0
14412.0	51.1	38.5	52.2	39.5	54.0
16814.0	48.6	35.9	48.5	35.9	54.0
2441.0	108.2	107.9	106.8	106.5	--
4882.0	44.3	41.2	45.9	43.4	54.0
7323.0	51.7	44.8	52.4	45.5	54.0
9764.0	46.8	34.2	48.4	37.4	54.0
12205.0	49.9	38.5	47.3	35.1	54.0
14646.0	53.3	40.3	53.1	40.9	54.0
17087.0	48.7	35.7	48.2	35.6	54.0
2480.0	108.4	108.0	105.7	105.3	--
4960.0	47.2	39.9	43.4	41.5	54.0
7440.0	50.5	42.3	52.0	46.7	54.0
9920.0	46.7	34.1	46.0	33.5	54.0
12400.0	50.4	38.8	49.2	36.8	54.0
14880.0	50.0	37.5	50.7	37.8	54.0
17360.0	53.1	40.8	52.9	40.8	54.0

Other emissions present had amplitudes at least 20 dB below the limit. Peak and Quasi-Peak amplitude emissions are recorded for frequency below 1000 MHz. Peak and Average amplitude emissions are recorded for frequency range above 1000 MHz.

Table 8 Transmitter Antenna Port Power

Frequency MHz	Calculated Conducted Antenna Power (dBm)	6-dB Occupied Bandwidth (kHz)	99.5% Occupied Bandwidth (kHz)
2402	12.67	322.0	848.8
2441	12.67	327.3	861.0
2480	12.77	318.5	861.0

Summary of Results for Transmitter Radiated Emissions of Intentional Radiator

The EUT demonstrated compliance with the radiated emissions requirements of CFR47 Part 15.247 and RSS-210 Frequency Hopping Spread Spectrum transmitter. The EUT demonstrated measured peak power of 12.8 dBm, 0.02 Watts for operation in 2402-2480 MHz. The EUT demonstrated a minimum margin of -7.3 dB below the harmonic emissions requirements. There were no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. There were no other deviations or exceptions to the requirements.

Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the CFR47 Part 15C and RSS-210 emission requirements. There were no deviations to the specifications.

Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs 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

Measurement uncertainty calculations were made for the laboratory. Result of measurement uncertainty calculations are recorded below for AC line conducted and radiated emission measurements.

Measurement Uncertainty	$U_{(E)}$	$U_{(lab)}$
3 Meter Horizontal 30-200 MHz Measurements	2.08	4.16
3 Meter Vertical 30-200 MHz Measurements	2.16	4.33
3 Meter Vertical Measurements 200-1000 MHz	2.99	5.97
10 Meter Horizontal Measurements 30-200 MHz	2.07	4.15
10 Meter Vertical Measurements 30-200 MHz	2.06	4.13
10 Meter Horizontal Measurements 200-1000 MHz	2.32	4.64
10 Meter Vertical Measurements 200-1000 MHz	2.33	4.66
3 Meter Measurements 1-6 GHz	2.57	5.14
3 Meter Measurements 6-18 GHz	2.58	5.16
AC Line Conducted	1.72	3.43

Annex B Rogers Labs Test Equipment List

List of Test Equipment	Calibration Date
Spectrum Analyzer: Rohde & Schwarz ESU40	5/13
Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W	5/13
Spectrum Analyzer: HP 8591EM	5/13
Antenna: EMCO Biconilog Model: 3143	5/13
Antenna: Sunol Biconilog Model: JB6	10/13
Antenna: EMCO Log Periodic Model: 3147	10/13
Antenna: Com Power Model: AH-118	10/13
Antenna: Com Power Model: AH-840	10/13
Antenna: Antenna Research Biconical Model: BCD 235	10/13
Antenna: EMCO 6509	10/13
LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf	10/13
R.F. Preamp CPPA-102	10/13
Attenuator: HP Model: HP11509A	10/13
Attenuator: Mini Circuits Model: CAT-3	10/13
Attenuator: Mini Circuits Model: CAT-3	10/13
Cable: Belden RG-58 (L1)	10/13
Cable: Belden RG-58 (L2)	10/13
Cable: Belden 8268 (L3)	10/13
Cable: Time Microwave: 4M-750HF290-750	10/13
Cable: Time Microwave: 10M-750HF290-750	10/13
Frequency Counter: Leader LDC825	2/13
Oscilloscope Scope: Tektronix 2230	2/13
Wattmeter: Bird 43 with Load Bird 8085	2/13
Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140	2/13
R.F. Generators: HP 606A, HP 8614A, HP 8640B	2/13
R.F. Power Amp 65W Model: 470-A-1010	2/13
R.F. Power Amp 50W M185- 10-501	2/13
R.F. Power Amp A.R. Model: 10W 1010M7	2/13
R.F. Power Amp EIN Model: A301	2/13
LISN: Compliance Eng. Model 240/20	2/13
LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08	2/13
Antenna: EMCO Dipole Set 3121C	2/13
Antenna: C.D. B-101	2/13
Antenna: Solar 9229-1 & 9230-1	2/13
Audio Oscillator: H.P. 201CD	2/13
ELGAR Model: 1751	2/13
ELGAR Model: TG 704A-3D	2/13
ESD Test Set 2010i	2/13
Fast Transient Burst Generator Model: EFT/B-101	2/13
Field Intensity Meter: EFM-018	2/13
KEYTEK Ecat Surge Generator	2/13
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.

Scot D Rogers

Scot D. Rogers

NVLAP Lab Code 200087-0

Annex D FCC Site Registration Letter

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

June 28, 2013

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: June 28, 2013

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
Industry Analyst

NVLAP Lab Code 200087-0

Annex E Industry Canada Site Registration Letter

Industry Canada Industrie Canada

June 19, 2013

OUR FILE: 46405-3041
Submission No: 168037

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

Attention: Mr. Scot D. Rogers

Dear Sir:

The Bureau has received your application for the renewal of 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 **(Site# 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;

- The company address code 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 three 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.

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

Yours sincerely,

Bill Payn
For: Wireless Laboratory Manager
Certification and Engineering Bureau
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
Email: Bill.Payn@ic.gc.ca
Tel. No. (613) 990-3639
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