FCC & ISED CANADA CERTIFICATION

TEST REPORT

for the

FREDERICK ENERGY PRODUCTS, LLC

FCC ID: QUI-HN-RANADJ

IC ID: 11625A-HNRANADJ

WLL REPORT# 16832-01 REV 2

Prepared for:

Frederick Energy Products, LLC

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Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Frederick Energy Products, LLC

MFG Range Adjust Tool

FCC ID: QUI-HN-RANADJ

ISED ID: 11625A-HNRANADJ

February 22, 2021

WLL Report# 16832-01 Rev 2

Prepared by:

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CEO

Reviewed by:

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President

Abstract

This report has been prepared on behalf of Frederick Energy Products, LLC to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.249 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy and under RSS-210 Issue 10 of Innovation, Science and Economic Development Canada (ISED). This Certification Test Report documents the test configuration and test results for the Frederick Energy Products, LLC MFG Range Adjust Tool. The information provided on this report is only applicable to device herein evaluated.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Boulevard, Frederick MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS numbers are 3035A. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Frederick Energy Products, LLC MFG Range Adjust Tool complies with the limits for an intentional radiator under FCC Part 15.249 and Innovation, Science and Economic Development Canada (ISED) RSS-210.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 22, 2021
Rev 1	Address ACB comments	March 3, 2021

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC MFG Range Adjust Tool complies with the limits for an intentional radiator under FCC Part 15.249 and ISED Canada RSS-210 Issue 10.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2013 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Table 1: Test Summary Table

Frequency Hopping Spread Spectrum - TX Test Summary			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
2.1049	RSS-GEN Section 4.6.(1)	Occupied Bandwidth	Pass
15.249 (a) 15.209	RSS-210 A2.9 (a)	General Field Strength Limits	Pass
15.207	RSS-GEN Section 7.2.4	AC Conducted Emissions	Pass

1.3 Contract Information

Customer:	Frederick Energy Products, LLC
Purchase Order Number:	9088
Quotation Number:	72461

1.4 Test and Support Personnel

Washington Laboratories, LTD	Sam Violette
Customer Representative	Andrew Nichols

2 Equipment Under Test

2.1 EUT Identification & Description

Table 2: Device Summary

Manufacturer:	Frederick Energy Products, LLC
FCC ID:	QUI-HN-RANADJ
ISED ID:	11625A-HNRANADJ
HVIN:	HN-RANADJ
Model:	MFG Range Adjust Tool
Serial Number of Unit Tested	NA
FCC Rule Parts:	§15.249
ISED Rule Parts:	RSS-210
Frequency Range:	916.5 MHz
Maximum Output Power:	43840.9 uV/m @ 3m
Modulation:	GFSK
Occupied Bandwidth (99%):	186 kHz
FCC Emission Designator:	186KF1N
ISED Emissions Designator:	186KF1N
Keying:	Automatic
Type of Information:	Data
Number of Channels:	One
Highest TX Spurious Emission:	318.2 uV/m @ 9165 MHz (Average)
Highest RX Spurious Emission:	NA
Antenna Connector	NA
Antenna Type	Internal Monopole
Interface Cables:	NA
Power Source & Voltage:	DC powered (rechargeable)

The Frederick Energy Products, LLC MFG Range Adjust Tool is used with the Frederick Energy “Hit Not” system.

The Frederick Energy Products, LLC MFG Range Adjust Tool detects the presence of a 73 kHz electromagnetic field generated by vehicles or machinery equipped with a HIT-NOT® Magnetic Field Generator system and determines if the field strength level detected needs to be adjusted for best functional range. The MFG Range Adjust Tool has two buttons that can be keyed to increase or decrease the magnetic field.

A useful video of the system can be found here: https://hitnot.com/#facility

2.2 Test Configuration

The MFG Range Adjust Tool was configured in typical operating mode. Range adjust buttons were toggled to adjust a magnetic field (73kHz) of a support generator.

Table 3: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Revision
MFG Range Adjust	HN-RANDJ	NA	NA	NA

Table 4: Support Equipment

Item	**Model/Part Number**	**Serial Number**
Magnetic Field Generator	DDAC-PDS-C	DDAC082390

Figure 1: Test Configuration

2.3 Interface Cables

Table 5: Cable Configuration

None

2.4 Testing Algorithm

The MFG Range Adjust Tool was tested by measuring the transmit signal in the presence of the magnetic field generator.

2.5 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS number is 3035A. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.6 Measurements

2.6.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.7 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where uc = standard uncertainty
a, b, c,.. = individual uncertainty elements
Diva, b, c = the individual uncertainty element divisor based on the probability distribution
Divisor = 1.732 for rectangular distribution
Divisor = 2 for normal distribution
Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where:
U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 6 below.

Table 6: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 7 shows a list of the test equipment used for measurements along with the calibration information.

Table 7: Test Equipment List

Test Name:	**Conducted Emissions Voltage**	Test Date:	**01/12/2021**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	SOLAR 8028-50-TS-24-BNC	LISN	9/10/2021
00126	SOLAR 8028-50-TS-24-BNC	LISN	9/10/2021
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00053	HP 11947A	LIMITER TRANSIENT	2/6/2021
Test Name:	**Radiated Emissions**	Test Date:	**01/12/2021**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00004	ARA DRG-118/A	ANTENNA DRG 1-18GHZ	9/1/2021
00382	SUNOL SCIENCES CORPORATION JB1	ANTENNA BICONLOG	6/1/2021
00276	ELECTRO-METRICS BPA-1000	RF PRE-AMPLIFIER	6/19/2021
00627	AGILENT 8449B	AMPLIFIER 1-26GHZ	8/31/2021

4 Test Results

4.1 Occupied Bandwidth: (FCC Part §2.1049, RSS-GEN 4.6.1)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For FCC Part 15.249 does not define the maximum 20 dB bandwidth.

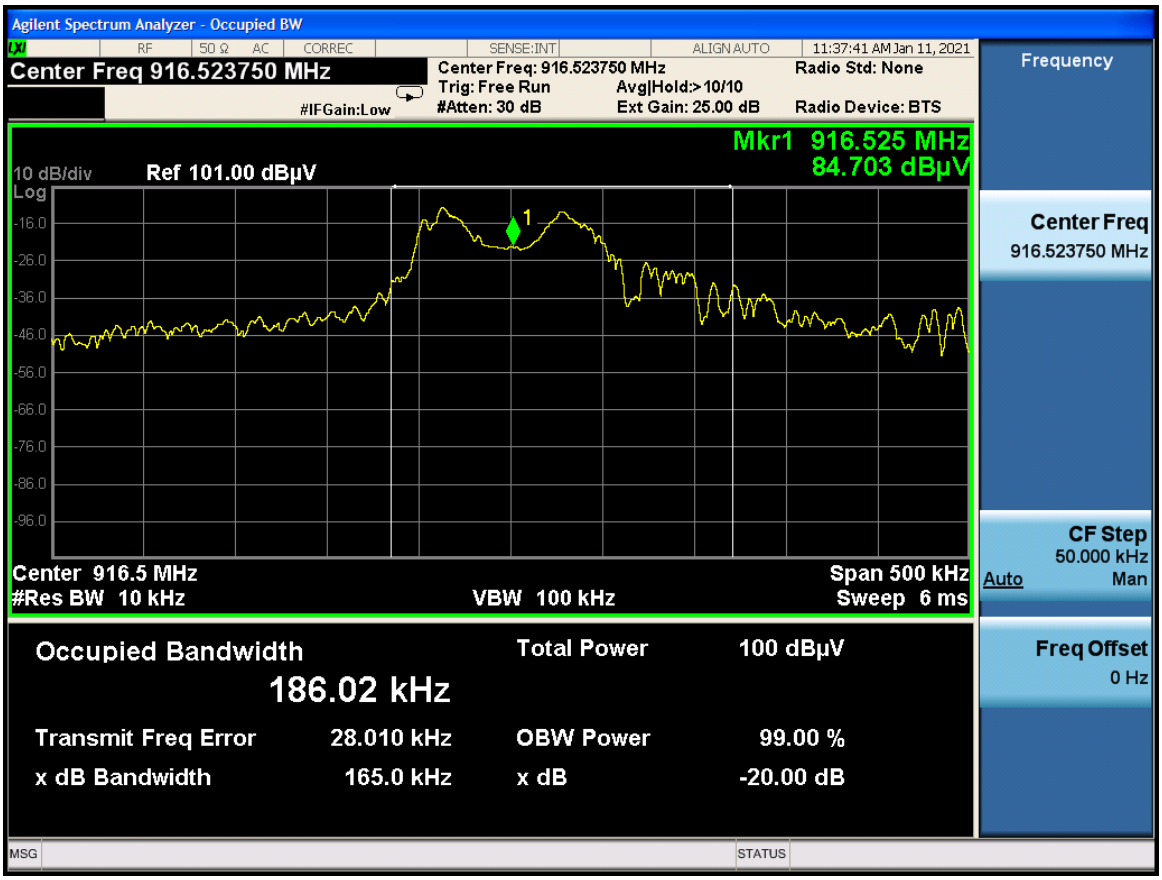
At full modulation, the occupied bandwidth was measured as shown.

Table 8 provides a summary of the Occupied Bandwidth Results.

Table 8: Occupied Bandwidth Results

Frequency	Bandwidth (kHz)	Limit (kHz)	Pass/Fail
Fixed Channel: 916.525MHz	186	N/A	Pass

Figure 2: Occupied Bandwidth, Fixed Channel



4.2 Band Edge: (FCC Part §2.1049(d), RSS-210 B.10)

15.249 (d) requires that emissions radiated outside of the specified frequency 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 unit was tested and found to be compliant with this requirement. Figure 3 and Figure 4 show the results.

Figure 3: Low Band Edge, Fixed Channel

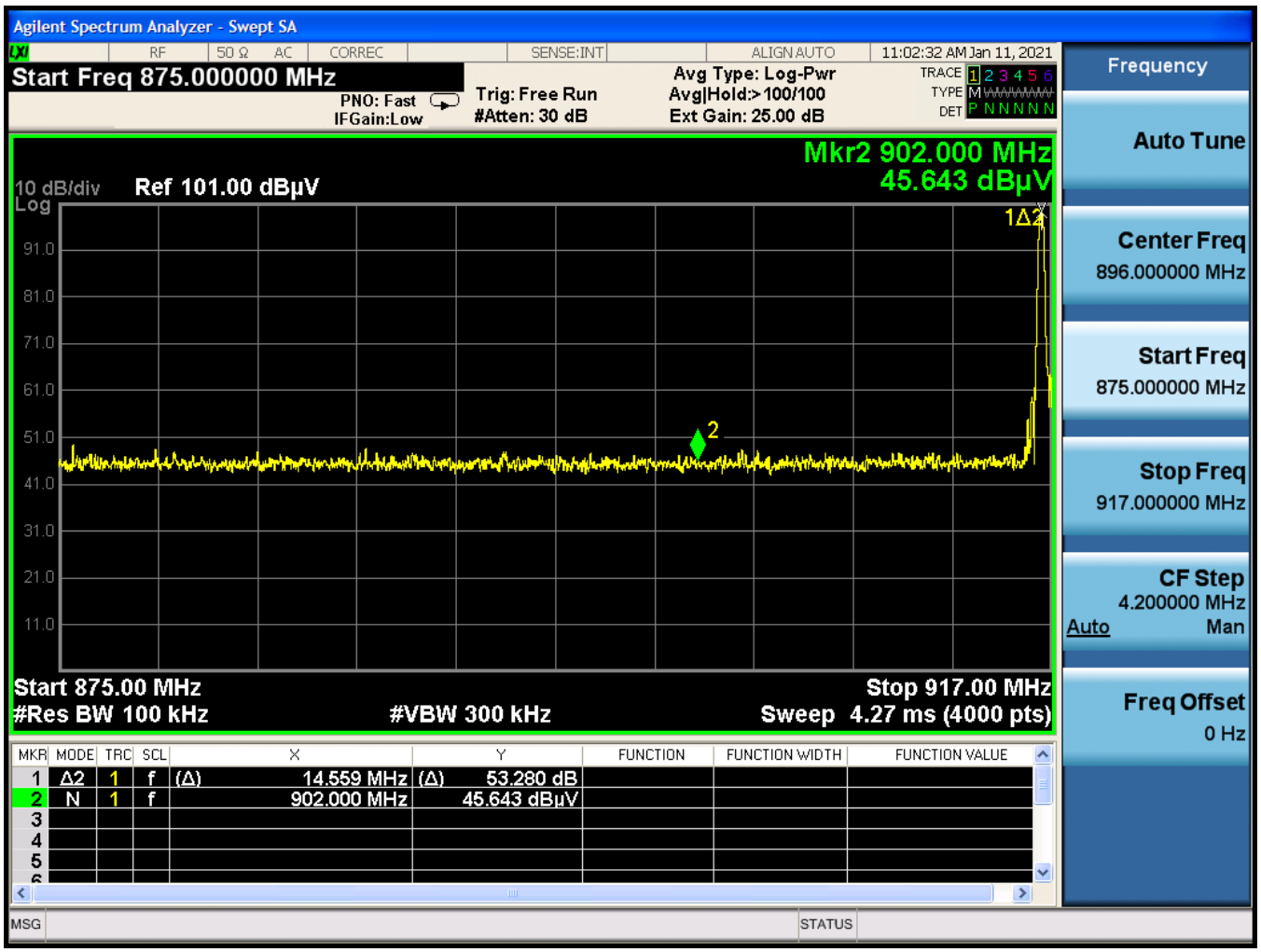
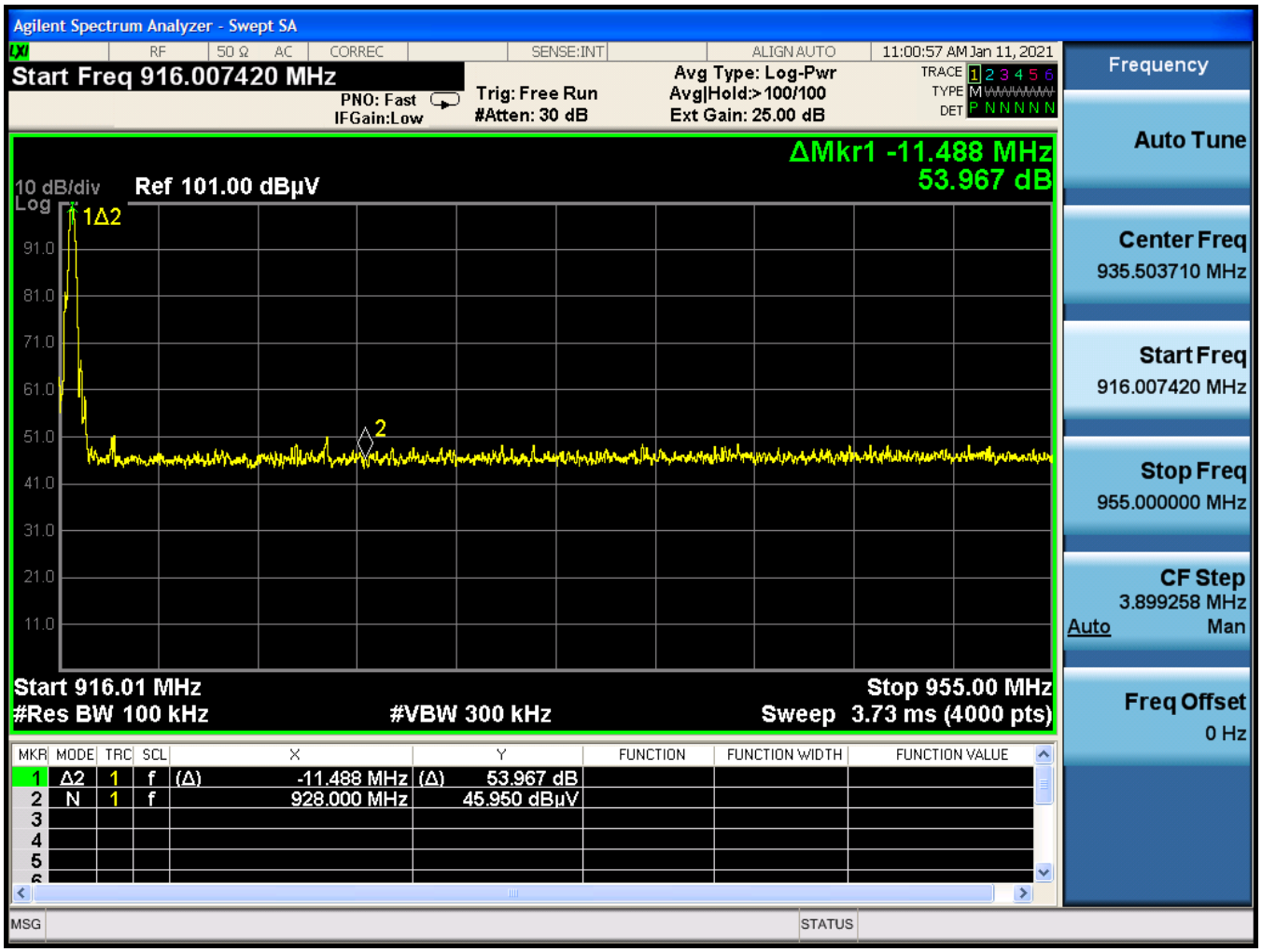


Figure 4: Upper Band Edge, Fixed Channel



4.3 Radiated Spurious Emissions: (FCC Part §15.249(a), RSS210 A2.9)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

4.3.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The emissions were measured using the following resolution bandwidths:

Table 9: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	<10 Hz (Avg.), 1MHz (Peak)

Table 10: Radiated Emission Test Data, Low Frequency Data (<1GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
35.00	V	0.0	1.5	35.1	-7.3	24.6	100.0	-12.2
40.00	V	0.0	1.5	42.5	-10.7	39.0	100.0	-8.2
45.00	V	0.0	1.5	44.5	-14.1	32.9	100.0	-9.6
50.00	V	0.0	1.5	40.8	-16.8	15.8	100.0	-16.0
55.00	V	0.0	1.5	39.7	-17.8	12.4	100.0	-18.1
60.00	V	0.0	1.5	44.7	-17.6	22.6	100.0	-12.9
65.00	V	0.0	1.5	42.3	-17.1	18.1	100.0	-14.8
916.56	**V**	**0.0**	**1.5**	**84.9**	**0.0**	**17655.9**	**50000.0**	**-9.0**
35.00	H	0.0	1.5	31.9	-7.3	17.0	100.0	-15.4
40.00	H	0.0	1.5	32.3	-10.7	12.0	100.0	-18.4
45.00	H	0.0	1.5	46.8	-14.1	42.9	100.0	-7.3
50.00	H	0.0	1.5	46.8	-16.8	31.6	100.0	-10.0
55.00	H	0.0	1.5	37.8	-17.8	10.0	100.0	-20.0
60.00	H	0.0	1.5	41.7	-17.6	16.0	100.0	-15.9
65.00	H	0.0	1.5	36.5	-17.1	9.3	100.0	-20.6
916.50	**H**	**0.0**	**1.5**	**92.8**	**0.0**	**43840.9**	**50000.0**	**-1.1**

*All three orthogonal planes were evaluated; maximum fundamental amplitude was recorded for reported horizontal and vertical polarities.

Table 11: Radiated Emission Test Data, High Frequency Data >1GHz, Fixed Channel

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
1833.00	V	0.0	1.5	48.9	-4.6	164.2	5000.0	-29.7	PK
1833.00	V	0.0	1.5	35.3	-4.6	34.3	500.0	-23.3	AVG
2749.50	V	0.0	1.5	49.9	-0.3	302.1	5000.0	-24.4	PK
2749.50	V	0.0	1.5	36.8	-0.3	66.9	500.0	-17.5	AVG
3666.50	V	0.0	1.5	48.5	1.9	332.7	5000.0	-23.5	PK
3666.50	V	0.0	1.5	33.8	1.9	61.2	500.0	-18.2	AVG
4582.50	V	0.0	1.5	46.8	4.8	382.3	5000.0	-22.3	PK
4582.50	V	0.0	1.5	33.2	4.8	79.9	500.0	-15.9	AVG
5499.00	V	0.0	1.5	47.8	7.5	584.0	5000.0	-18.7	PK
5499.00	V	0.0	1.5	34.6	7.5	127.8	500.0	-11.9	AVG
6415.00	V	0.0	1.5	47.7	8.4	640.0	5000.0	-17.9	PK
6415.00	V	0.0	1.5	34.3	8.4	136.8	500.0	-11.3	AVG
7332.00	V	0.0	1.5	47.5	11.6	899.7	5000.0	-14.9	PK
7332.00	V	0.0	1.5	33.6	11.6	181.4	500.0	-8.8	AVG
8248.50	V	0.0	1.5	34.0	11.3	185.1	5000.0	-28.6	PK
8248.50	V	0.0	1.5	34.0	11.3	185.1	500.0	-8.6	AVG
9165.00	V	0.0	1.5	48.7	16.4	1789.6	5000.0	-8.9	PK
9165.00	V	0.0	1.5	33.7	16.4	318.2	500.0	-3.9	AVG
10081.50	V	0.0	1.5	48.1	16.4	1684.1	5000.0	-9.5	PK
10081.50	V	0.0	1.5	33.2	16.4	303.0	500.0	-4.4	AVG
1833.00	V	0.0	1.5	47.7	-4.6	143.0	5000.0	-30.9	PK
1833.00	V	0.0	1.5	35.3	-4.6	34.3	500.0	-23.3	AVG
2749.50	V	0.0	1.5	49.0	-0.3	272.7	5000.0	-25.3	PK
2749.50	V	0.0	1.5	36.8	-0.3	66.9	500.0	-17.5	AVG
3666.50	V	0.0	1.5	48.7	1.9	340.5	5000.0	-23.3	PK
3666.50	V	0.0	1.5	33.8	1.9	61.2	500.0	-18.2	AVG
4582.50	V	0.0	1.5	47.2	4.8	400.3	5000.0	-21.9	PK
4582.50	V	0.0	1.5	33.2	4.8	79.9	500.0	-15.9	AVG
5499.00	V	0.0	1.5	47.7	7.5	577.3	5000.0	-18.8	PK
5499.00	V	0.0	1.5	34.7	7.5	129.2	500.0	-11.8	AVG
6415.00	V	0.0	1.5	47.6	8.4	632.7	5000.0	-18.0	PK

6415.00	V	0.0	1.5	34.2	8.4	135.3	500.0	-11.4	AVG
7332.00	V	0.0	1.5	48.3	11.6	986.5	5000.0	-14.1	PK
7332.00	V	0.0	1.5	33.6	11.6	181.6	500.0	-8.8	AVG
8248.50	V	0.0	1.5	47.9	11.3	916.9	5000.0	-14.7	PK
8248.50	V	0.0	1.5	34.0	11.3	185.1	500.0	-8.6	AVG
9165.00	H	0.0	1.5	47.7	16.4	1595.0	5000.0	-9.9	PK
9165.00	H	0.0	1.5	33.4	16.4	307.4	500.0	-4.2	AVG
10081.50	H	0.0	1.5	47.9	16.4	1645.8	5000.0	-9.7	PK
10081.50	H	0.0	1.5	33.2	16.4	303.0	500.0	-4.4	AVG

4.4 AC Conducted Emissions (FCC Part §15.207)

4.4.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

FCC Compliance Limits		
Frequency	**Quasi-peak**	**Average**
0.15 - 0.5MHz	66 to 56dBµV	56 to 46dBµV
0.5 - 5MHz	56dBµV	46dBµV
5 - 30MHz	60dBµV	50dBµV

4.4.2 Test Procedure

The EUT was placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.10-2013. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements the post-detector filter was set to 10 Hz.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

4.4.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. This system runs off 120VAC or 230VAC. The following tables provide the test results for phase and neutral line power line conducted emissions.

Conducted Emissions was tested with the 915MHz radio in the "transmit off" state. When the DC jack is engaged the TX functionality is disengaged.

Table 12: Conducted Emissions Data 120VAC, Charging Mode

NEUTRAL										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.259	25.7	22.5	10.2	0.9	36.7	33.5	61.5	51.5	-24.7	-17.9
0.287	23.2	14.2	10.2	0.9	34.2	25.2	60.6	50.6	-26.4	-25.4
0.412	25.5	22.4	10.2	0.8	36.5	33.4	57.6	47.6	-21.1	-14.2
0.451	33.1	30.0	10.2	0.8	44.0	41.0	56.9	46.9	-12.8	-5.9
0.491	28.1	24.8	10.2	0.8	39.0	35.8	56.2	46.2	-17.1	-10.4
0.594	21.2	17.7	10.2	0.8	32.2	28.7	56.0	46.0	-23.8	-17.3
0.612	23.9	21.0	10.3	0.8	34.9	32.0	56.0	46.0	-21.1	-14.0
0.721	18.4	15.9	10.3	0.8	29.5	27.0	56.0	46.0	-26.5	-19.0

PHASE / L1										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.285	22.9	19.5	10.2	1.0	34.1	30.7	60.7	50.7	-26.6	-20.0
0.405	24.7	21.5	10.2	1.0	35.9	32.7	57.8	47.8	-21.9	-15.1
0.442	30.1	27.0	10.2	1.0	41.3	38.2	57.0	47.0	-15.8	-8.9
0.459	31.8	29.6	10.2	1.0	43.0	40.8	56.7	46.7	-13.7	-5.9
0.482	23.9	20.4	10.2	0.9	35.1	31.6	56.3	46.3	-21.2	-14.7
0.599	22.9	19.5	10.3	0.9	34.1	30.7	56.0	46.0	-21.9	-15.3
0.621	23.9	19.9	10.3	0.9	35.1	31.1	56.0	46.0	-20.9	-14.9
0.728	18.0	14.5	10.3	0.9	29.1	25.7	56.0	46.0	-26.9	-20.3