FCC & ISED CANADA CERTIFICATION

TEST REPORT

for the

FREDERICK ENERGY PRODUCTS, LLC

FCC ID: QUI-DDAC-AM-SM

IC ID: 11625A-DDACAMSM

WLL REPORT# 16830-01 REV 2

Prepared for:

Frederick Energy Products, LLC

1769 Jeff Road

Huntsville, Alabama 35806

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Frederick, Maryland 21703

Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Frederick Energy Products, LLC

Area Monitor & Structure Monitor

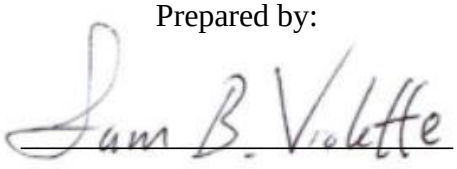
FCC ID: QUI-DDAC-AM-SM

ISED ID: 11625A-DDACAMSM

February 4, 2021

WLL Report# 16830-01 Rev 2

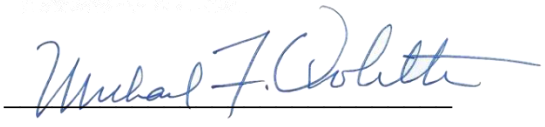
Prepared by:



Samuel Violette

Vice President

Reviewed by:



Mike F. Violette, P.E.

CEO

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 15.231 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 of Innovation, Science and Economic Development Canada. This Certification Test Report documents the test configuration and test results for the Frederick Energy Products, LLC Area Monitor & Structure Monitor. The information provided on this report is only applicable to device herein documented.

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 number is 3035A for Washington Laboratories, Ltd.

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 Area Monitor & Structure Monitor complies with the limits for an Intentional Radiator device under FCC Part 15.231 and RSS-210 of Innovation, Science and Economic Development Canada (ISED).

Revision History	Description of Change	Date
Rev 0	Initial Release	February 4, 2021
Rev 1	ACB comments	April 6, 2021
Rev 2	ACB comments	April 13, 2021

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC Area Monitor & Structure Monitor complies with the limits for an Intentional Radiator device under FCC Part 15.231 and ISED Canada RSS-210.

TX Test Summary (Low Power Transmitter)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.231 (a)	RSS-210	Transmission Length	Pass
15.231 (b)	RSS-210	Field Strength Limits	Pass
15.231 ©	RSS-210	20dB Bandwidth	Pass
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	Pass

1.2 Test Scope

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

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	Samuel Violette
Customer Representative	Andrew Nicholas

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Frederick Energy Products, LLC
FCC ID:	QUI-DDAC-AM-SM
ISED ID:	11625A-DDACAMSM
Model:	Area Monitor & Structure Monitor
HVIN(s)	DDAC-AMDC 1323261 DDAC-SM 1323260
Serial Number of Unit Tested	AMDC00572
FCC Rule Parts:	§15.231
ISED Rule Parts:	RSS-210
Frequency Range:	Fixed
Maximum Output Power:	5mW
Modulation:	FM
Occupied Bandwidth (20dB):	111.7 kHz
FCC Emission Designator:	F1N
ISED Emissions Designators:	F1N
Number of Channels:	1
Power Output Level	Fixed
Antenna Connector	PCB
Antenna Type	Monopole
Interface Cables:	N/a
Maximum Data Rate:	N/a
Power Source & Voltage:	DC 12Vdc, 1.5A; Tested with a provided SMPS

2.2 EUT Description

The Frederick Energy Products, LLC Area Monitor & Structure Monitor 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 indicates that the Area Monitor or Structure Monitor needs to send an output signal to control the action of a peripheral device; such as lights, gates, horns or other devices in a designated area. It does not send an alert to the vehicle with HIT-NOT® Magnetic Field Generator system.

2.3 Test Configuration

The Area Monitor & Structure Monitor were configured in a stand-alone configuration. Pre-liminary scans were used to determine which EUT (Area Monitor & Structure Monitor) would best represent worst case emissions. The **Area Monitor** test data was selected to represent the **worst-case emissions** for certification.

Table 2: System Configuration List

Name / Description	Model Number	Serial Number	Revision
Area Monitor	DDAC-AM-DC	AMDC00572	
Structure Monitor	DDAC-SM	SMDCO1297	

Table 3: Support Equipment

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

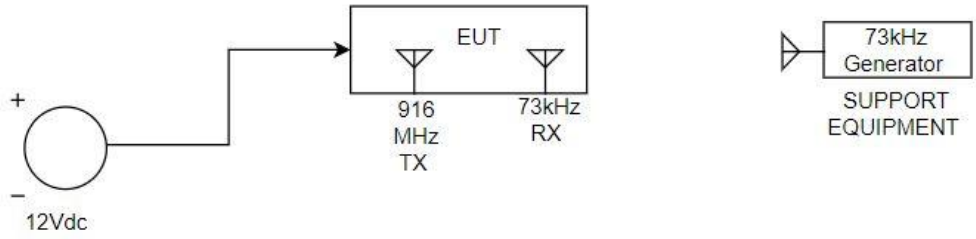


Figure 1: EUT Test Configuration – Structure Monitor

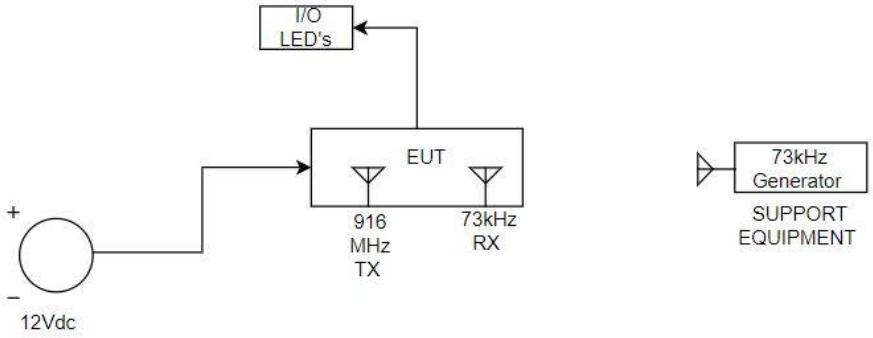


Figure 2: EUT Test Configuration – Area Monitor

*Area Monitor has additional I/O ports to add warning lights to the alarm system, TX/RX circuitry path are identical.

2.4 Interface Cables

Table 4: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
EUT Power	2-Pin, DC Jack	>3m	N	AC Mains / EUT Power Jack

2.5 Testing Algorithm

The Area Monitor & Structure Monitor was configured to transmit constantly at 916.48MHz for radiated measurements. Worst case emission levels are provided in the test results.

2.6 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 number is 3035A for Washington Laboratories, Ltd. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.7 Measurements

2.7.1 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

2.8 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 5 below.

Table 5: 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 6 shows a list of the test equipment used for measurements along with the calibration information.

Table 6: 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**
00644	SUNOL SCIENCES CORPORATION	JB1 925-833-9936	5/7/2021
00942	AGILENT	MXA-N9020A	9/1/2021
00559	HP	8447D	6/1/2021
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00885	UTIFLEX MICRO COAX	UFA2108-0-360-100300	6/19/2021
00644	SUNOL SCIENCES CORPORATION	JB1 925-833-9936	8/31/2021

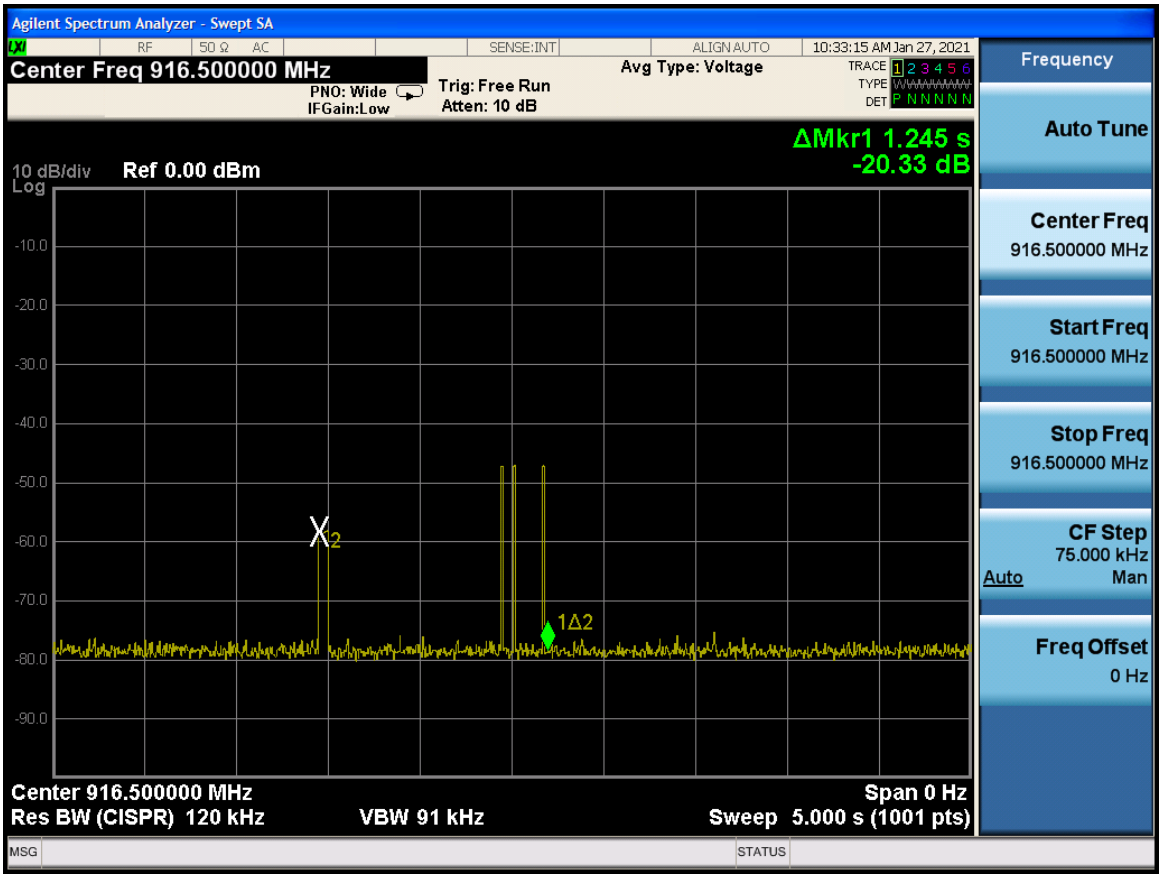
4 Test Results

4.1 Transmission Cessation from Time of Release (FCC Part §15.231(a), RSS210 A.1.1 (b)

FCC Part 15.231 states that a periodic intentional radiator shall cease transmission within a five second period from release of automatic or manual keying of operation.

Testing was done to verify that the Area Monitor & Structure Monitor stopped transmitting within the required time period. A 5 second sweep was made, during which the control toggle was activated and released, and the time to transmission end was measured Figure 3 shows the indicated time from un-keying the device until cessation of transmission. **The EUT complies with the requirements for this section.**

Figure 3: Time Period: Release to Termination of Transmission



*Note: Transmission ceased at 1.245 Seconds, meets 5 Second TX Off requirements.

4.2 Occupied Bandwidth (FCC Part §2.1049 and RSS-Gen [4.6.1]):

According to FCC §15.231, periodic operation: c), the bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier. Thus, the following are the data obtained.

Test Method: ANSI C63.10:2013

Test Procedure: Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. Using the occupied bandwidth settings of the Spectrum Analyzer, at full modulation, the low channel OBW power at 99% was measured as shown in Figure 2. As required, the bandwidth limits are displayed at the points 20 dB down from the modulated carrier in Figure 2.

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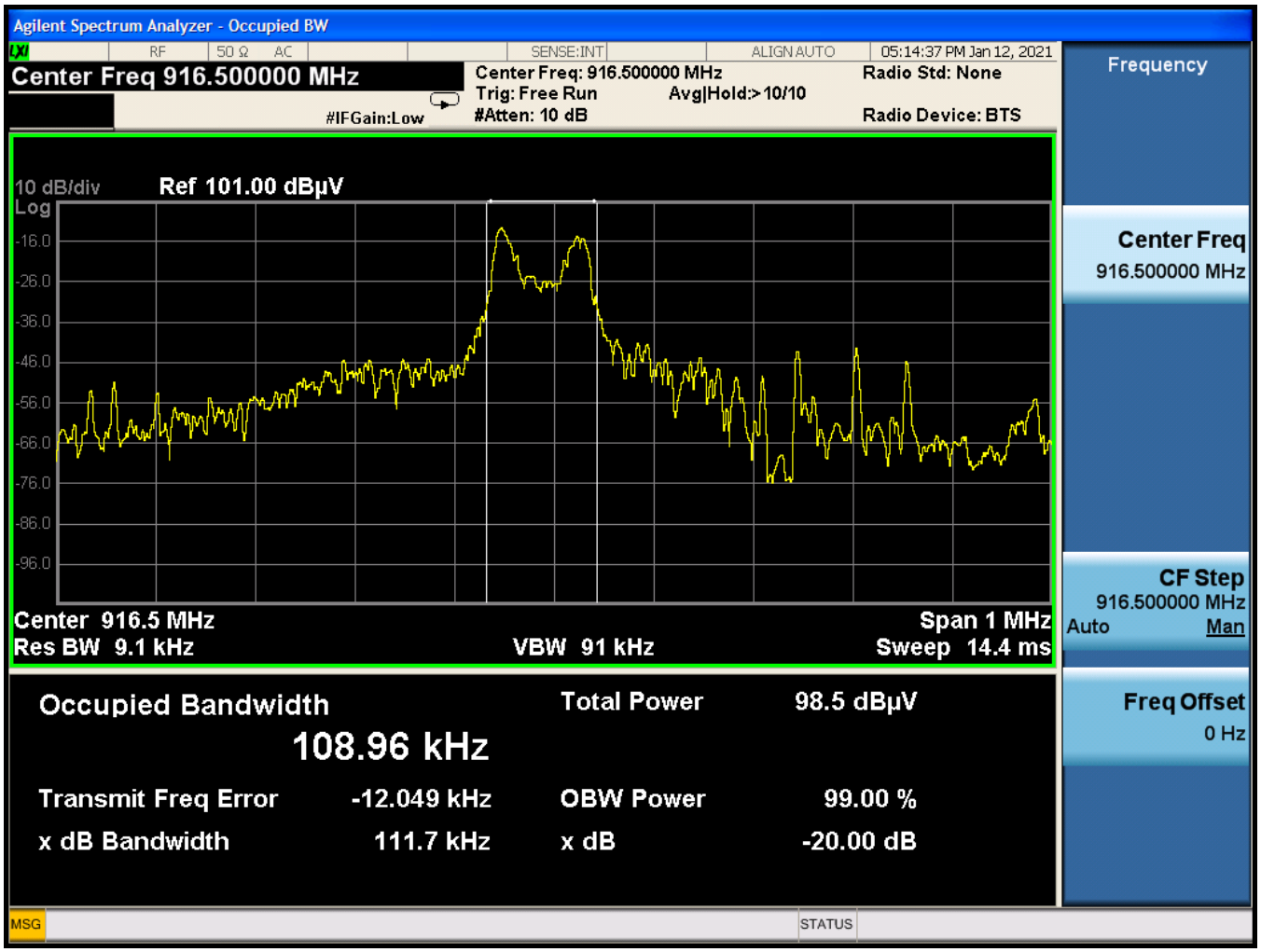
Table 7: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
9.1 kHz	91 kHz

Table 8: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Result
(20dB) Fixed Channel: 916.48 MHz	111.7 kHz	4.58 MHz	Pass
(99%) Fixed Channel: 916.4 8MHz	108.9 kHz	N/a	N/a

Figure 4: Occupied Bandwidth, Low Channel



4.3 Radiated Spurious Emissions: (FCC Part §15.231(b), RSS210 A.1.2)

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. To account for the highest emission levels for all 3 orthogonal plane orientations of the EUT, the highest emission levels were initially determined for each orientation as specified above. Below are the radiated emissions test data for the EUT orientations with highest emission levels.

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.), 3 MHz (Peak)

Table 10: Radiated Emission Test Data, Below 1 GHz

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)
30.00	V	0.0	1.5	20.4	-3.8	6.8	100.0	-23.4
45.00	V	0.0	1.5	35.6	-14.6	11.2	100.0	-19.0
50.00	V	0.0	1.5	42.5	-17.1	18.6	100.0	-14.6
60.00	V	0.0	1.5	52.2	-17.5	54.1	100.0	-5.3
65.00	V	0.0	1.5	48.5	-17.0	37.5	100.0	-8.5
215.30	V	0.0	1.5	39.7	-13.8	19.7	150.0	-17.6
225.70	V	0.0	1.5	37.9	-13.4	16.8	200.0	-21.5
916.48	**V**	**0.0**	**1.5**	**71.0**	**0.3**	**3688.7**	**12500.0**	**-10.6**
30.00	H	0.0	0.0	18.7	-3.8	5.6	100.0	-25.1
45.00	H	0.0	0.0	33.4	-14.6	8.7	100.0	-21.2
50.00	H	0.0	0.0	49.0	-17.1	39.3	100.0	-8.1
60.00	H	0.0	0.0	42.1	-17.5	16.9	100.0	-15.4
65.00	H	0.0	0.0	33.5	-17.0	6.7	100.0	-23.5
121.80	H	0.0	0.0	47.9	-11.0	70.2	150.0	-6.6
225.70	H	0.0	0.0	37.7	-13.4	16.4	200.0	-21.7
916.48	**H**	**0.0**	**0.0**	**80.9**	**0.3**	**11531.2**	**12500.0**	**-0.7**

Notes:

1.For fundamental TX (916.48MHz), a Quasi-Peak Detector was used.

2. For fundamental TX (916.48MHz), All three orthogonal planes were evaluated; maximum fundamental amplitude was recorded for reported horizontal and vertical polarities.

Table 11: Radiated Emission Test Data, Above 1 GHz

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 Type
1833.00	V	0.0	1.8	45.3	-3.5	122.6	5000.0	-32.2	Peak
1833.00	V	0.0	1.8	33.0	-3.5	29.7	500.0	-24.5	AVG
2749.50	V	0.0	1.8	46.2	0.9	226.6	5000.0	-26.9	Peak
2749.50	V	0.0	1.8	33.5	0.9	52.5	500.0	-19.6	AVG
3666.00	V	0.0	1.8	43.5	3.2	217.1	5000.0	-27.2	Peak
3666.00	V	0.0	1.8	30.3	3.2	47.5	500.0	-20.4	AVG
4582.50	V	0.0	1.8	43.3	6.0	291.0	5000.0	-24.7	Peak
4582.50	V	0.0	1.8	30.0	6.0	62.9	500.0	-18.0	AVG
5499.00	V	0.0	1.8	43.4	8.4	391.2	5000.0	-22.1	Peak
5499.00	V	0.0	1.8	30.5	8.4	88.6	500.0	-15.0	AVG
6415.50	V	0.0	1.8	42.8	9.4	408.7	5000.0	-21.8	Peak
6415.50	V	0.0	1.8	30.4	9.4	98.0	500.0	-14.2	AVG
7332.00	V	0.0	1.8	43.5	11.9	591.4	5000.0	-18.5	Peak
7332.00	V	0.0	1.8	30.4	11.9	130.9	500.0	-11.6	AVG
8248.50	V	0.0	1.8	43.5	11.8	581.4	5000.0	-18.7	Peak
8248.50	V	0.0	1.8	30.6	11.8	131.7	500.0	-11.6	AVG
9165.00	V	0.0	1.8	43.8	17.8	1201.1	5000.0	-12.4	Peak
9165.00	V	0.0	1.8	30.5	17.8	259.8	500.0	-5.7	AVG
10081.50	V	0.0	1.8	44.6	19.1	1527.3	5000.0	-10.3	Peak
10081.50	V	0.0	1.8	30.3	19.1	294.4	500.0	-4.6	AVG
1833.00	H	0.0	1.8	45.6	-3.5	126.9	5000.0	-31.9	Peak
1833.00	H	0.0	1.8	33.1	-3.5	30.1	500.0	-24.4	AVG
2749.50	H	0.0	1.8	45.7	0.9	213.9	5000.0	-27.4	Peak
2749.50	H	0.0	1.8	33.5	0.9	52.5	500.0	-19.6	AVG
3666.00	H	0.0	1.8	43.7	3.2	222.2	5000.0	-27.0	Peak
3666.00	H	0.0	1.8	30.3	3.2	47.5	500.0	-20.4	AVG
4582.50	H	0.0	1.8	43.0	6.0	281.1	5000.0	-25.0	Peak
4582.50	H	0.0	1.8	29.9	6.0	62.2	500.0	-18.1	AVG
5499.00	H	0.0	1.8	43.0	8.4	373.6	5000.0	-22.5	Peak
5499.00	H	0.0	1.8	30.4	8.4	87.6	500.0	-15.1	AVG
6415.50	H	0.0	1.8	43.7	9.4	453.3	5000.0	-20.9	Peak
6415.50	H	0.0	1.8	30.5	9.4	99.2	500.0	-14.1	AVG

7332.00	H	0.0	1.8	43.5	11.9	591.4	5000.0	-18.5	Peak
7332.00	H	0.0	1.8	30.3	11.9	129.4	500.0	-11.7	AVG
8248.50	H	0.0	1.8	43.9	11.8	608.8	5000.0	-18.3	Peak
8248.50	H	0.0	1.8	30.6	11.8	131.7	500.0	-11.6	AVG
9165.00	H	0.0	1.8	44.3	17.8	1272.3	5000.0	-11.9	Peak
9165.00	H	0.0	1.8	30.5	17.8	259.8	500.0	-5.7	AVG
10081.50	H	0.0	1.8	44.2	19.1	1458.5	5000.0	-10.7	Peak
10081.50	H	0.0	1.8	30.2	19.1	291.0	500.0	-4.7	AVG

4.4 AC Conducted Emissions

The requirements of FCC Part 15 (10/2014) and ICES-003 call for the EUT to be 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 W/50 mH 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 C63.4-2014. Power and data cables were moved about to obtain maximum emissions.

4.4.1 Test Procedure

The 50 W 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.

These emissions must meet the limits specified in §15.207 for quasi-peak and average measurements. At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

Table 5 provides a summary of the Conducted Emissions results.

Table 12: Conducted Emission Test Data

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)**
0.156	45.2	29.7	10.2	0.7	56.1	40.6	65.7	55.7	-9.5	-15.1
0.183	37.9	24.4	10.2	1.1	49.1	35.6	64.3	54.3	-15.2	-18.7
0.210	32.1	21.0	10.2	0.9	43.1	32.0	63.2	53.2	-20.1	-21.2
0.234	29.2	18.7	10.2	0.9	40.2	29.7	62.3	52.3	-22.1	-22.6
0.261	26.7	17.2	10.2	0.9	37.8	28.2	61.4	51.4	-23.7	-23.2
0.449	30.6	22.7	10.2	0.8	41.6	33.6	56.9	46.9	-15.3	-13.3
0.620	22.5	15.0	10.3	0.8	33.5	26.0	56.0	46.0	-22.5	-20.0
15.672	24.5	10.6	11.4	2.2	38.0	24.1	60.0	50.0	-22.0	-25.9
16.703	23.6	9.9	11.4	2.2	37.1	23.5	60.0	50.0	-22.9	-26.5

PHASE										
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)**
0.156	44.9	29.4	10.2	1.5	56.6	41.0	65.7	55.7	-9.1	-14.6
0.183	37.5	24.3	10.2	1.3	49.0	35.8	64.3	54.3	-15.4	-18.6
0.210	31.6	20.9	10.2	1.3	43.0	32.3	63.2	53.2	-20.2	-20.9
0.234	28.8	18.7	10.2	1.2	40.2	30.1	62.3	52.3	-22.2	-22.2
0.261	26.2	17.2	10.2	1.1	37.5	28.5	61.4	51.4	-23.9	-22.9
0.449	30.7	22.8	10.2	1.0	41.9	34.0	56.9	46.9	-15.0	-12.9
0.620	20.7	13.1	10.3	0.9	31.8	24.2	56.0	46.0	-24.2	-21.8
15.672	24.8	10.8	11.4	3.1	39.2	25.2	60.0	50.0	-20.8	-24.8
16.703	24.9	10.6	11.4	3.2	39.4	25.1	60.0	50.0	-20.6	-24.9