FCC & Industry Canada Certification Test Report

for the

Frederick Energy Products, LLC
Mechanized Area Controller (MAC)

FCC ID: QUI-HN-MAC
ISED ID: 11625-HNMAC

WLL REPORT# 16828-01 REV 4

Prepared for:

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Testing Certificate AT-1448

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February 12, 2021

WLL Report# 16828-01 Rev 4

Prepared by:

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Michael 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 a Transmitter under Part 15.209 (10/2014) of the FCC Rules and Regulations and Industry Canada RSS-Gen issue 5 (3/2019). This Certification Test Report documents the test configuration and test results for the Frederick Energy Products LLC Magnetic Field Generator.

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, ISED and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Frederick Energy Products LLC Mechanized Area Controller complies with the limits for a Transmitter device under FCC Part 15.209 and RSS-GEN issue 5.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 12, 2021
Rev 1	ACB Comments, #ATCB027137	June 21, 2021
Rev 2	ACB Comments, #ATCB027137 v2	July 15, 2021
Rev 3	ACB Comments, Dated July 21, 2021	August 11, 2021
Rev 4	Update Requirements of 15.31(f)(2)	August 23, 2021

Table of Contents

Abstract ii
1 Introduction 6
1.1 Compliance Statement 6
1.2 Test Scope 6
1.3 Contract Information 6
1.4 Test Dates 6
1.5 Test and Support Personnel 6
2 Equipment Under Test 7
2.1 EUT Identification & Description 7
2.2 Test Configuration 8
2.3 Equipment Configuration 8
2.4 EUT Modifications 10
2.5 Testing Algorithm 10
2.6 Test Location 10
2.7 Measurements 10
2.7.1 References 10
2.8 Measurement Uncertainty 10
3 Test Equipment 12
4 Test Results 13
4.1 AC Conducted Emissions 13
4.1.1 Requirements 13
4.1.2 Test Procedure 13
4.1.3 Test Data 13
4.1.4 Conducted Data Reduction and Reporting 14
4.1.5 Test Data 14
4.2 Occupied Bandwidth: (FCC Part §2.1049, RSS –Gen) 16
4.3 Radiated Spurious Emissions: (FCC Part §15.209, RSS-Gen Table 6) 17
4.3.1 Test Procedure 17
4.3.2 Test Data for Canada 22
4.3.3 Requirements 23
4.3.4 Test Procedure 23
4.3.5 Test Data 23
4.3.6 Radiated Data Reduction and Reporting 24
4.4 Transmitter Duty Cycle (DCCF) 26

List of Tables

Table 1: Device Summary 7
Table 2: Equipment Configuration 9
Table 3: Support Equipment 9
Table 4: Interface Cables 9
Table 5: Expanded Uncertainty List 12
Table 6: Test Equipment List 12
Table 7: Conducted Emissions Data, Transmit On 15
Table 8: Radiated Emissions Limits 17
Table 9: Radiated Emissions Test Data < 30MHz (Fundamental) 20
Table 10: Radiated Emissions Test Data < 30MHz (Harmonics) 21
Table 11: 73kHz Test Data for ISED Canada 22
Table 12: Receiver Radiated Emissions Test Data > 30MHz 25

List of Figures

Figure 1: Test and Power Configuration 8
Figure 2: TX On Time per 100ms (MAC) 26

1 Introduction

1.1 Compliance Statement

The Frederick Energy Products LLC Mechanized Area Controller complies with the limits for an Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations and Industry Canada RSS-GEN Issue 5.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according with ANSI C63.4 & ANSI C63.10. The measurement equipment conforms to ANSI C63.4 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	
	Frederick Energy Products LLC 1769 Jeff Drive, Huntsville, AL, 35806
Quotation Number:	72461

1.4 Test Dates

Testing was performed on the following date(s):

12/10/2020 to 2/12/2021 & 8/11/2021 to 8/20/2021

1.5 Test and Support Personnel

Washington Laboratories, LTD	Samuel Violette
Customer Representative	Andrew Nicholas

2 Equipment Under Test

2.1 EUT Identification & Description

This device is used to test a PAD to confirm that the PAD (Model HN-PAD) is operating before a user takes it in to an operational floor. The generator power is supplied by a wall adaptor providing 12VDC-15VDC usually 13.5 VDC. The field is adjusted to a desired level so as not to activate PADs that are far away not under test. To check performance, the field will be adjusted to generate a danger zone at 30' similar to the generator configuration. Then a PAD is brought within 30' of the field. The PAD tester is essentially a Generator used usually within the building near the exit to the production floor. The EUT generates a magnetic field at 73 kHz to activate the PAD alarm and receives RF signals at 916.48 MHz from the PAD and alarms. The PAD will also alarm when introduced to the magnetic field during a test. An output on the generator will activate when the Generator receives a valid PAD signal. This output can be used to open a gate or close a gate as needed.

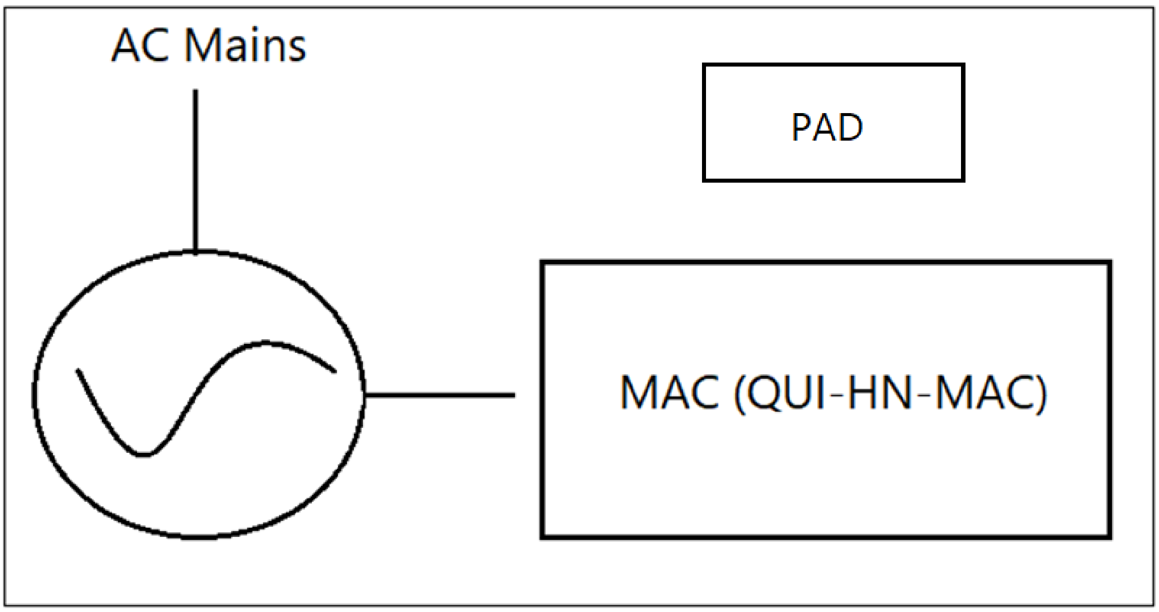
Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Frederick Energy Products LLC
FCC ID:	QUI-HN-MAC
IC:	11625-HNMAC
EUT Name:	Magnetic Field Generator w/ CAM
Model:	HN-MAC
FCC Rule Parts:	15.209
IC Rule Part	RSS-Gen Issue 5
ISED HVIN:	HN-MAC; 1323256
IC Emission Designator	8K3NON
Frequency Range:	73 kHz
99% Occupied Bandwidth:	8.302 kHz
Keying:	Automatic
Type of Information:	Pulsed CW (illumination)
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral Magnetic Induction
EUT Software/Firmware:	Normal Operating Mode (no special tune-up)
Interface Cables:	Power, warning module cable
Power Source & Voltage:	Battery (12 VDC)

2.2 Test Configuration

The Frederick Energy Products LLC Magnetic Field Generator, Equipment Under Test (EUT), was operated from a supplied AC/DC power supply.

Figure 1: Test and Power Configuration



2.3 Equipment Configuration

The EUT was set up as outlined in Figure 1. The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Table 2: Equipment Configuration

Name / Description	Manufacturer	Model	Serial Number	Revision
Mechanized Area Controller	Frederick Energy LLC	HN-MAC	MACDCA200185	N/a

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
PAD	HN-PAD	PD01163

Table 4: Interface Cables

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
AC Mains	IEC – 3 Prong	1m	N	AC Mains – EUT
1	10AWG	N/A-Inductor – 110ft simulated cable length	N	2

2.4 EUT Modifications

No modifications were performed in order to meet the test requirements.

2.5 Testing Algorithm

The EUT operates continuously when power is applied.

Worst case emission levels are provided in the test results data. PAD support unit was brought within range of the generator to activate receive warning alarms.

2.6 Test Location

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, ISED and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

2.7 Measurements

2.7.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 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

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 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

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

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a,\ b,\ c}$ = 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

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = 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, CISPR14, FCC Part 15	± 2.63 dB
Radiated Emissions	CISPR11, CISPR22, 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:	**Radiated Emissions**	Test Date:	**See Section 1.4**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORPORATION JB1	ANTENNA BICONLOG	12/31/2020
00031	EMCO 6502	ANTENNA ACTIVE LOOP	3/17/2021
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00558	HP 8447D	AMPLIFIER	5/18/2021

Test Name:	**Conducted Emissions**	Test Date:	**See Section 1.4**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT N9010A	EXA SPECTRUM ANALYZER	5/7/2021
00125	SOLAR 8028-50-TS-24-BNC	LISN	9/10/2021
00126	SOLAR 8028-50-TS-24-BNC	LISN	9/10/2021

4 Test Results

4.1 AC Conducted Emissions

4.1.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Part 15 (10/2014), 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

4.1.2 Test Procedure

The requirements of FCC Part 15 and RSS-Gen 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 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 C63.4. 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.

4.1.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 7 provides the test results for phase and neutral line power line conducted emissions.

4.1.4 Conducted Data Reduction and Reporting

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
Voltage:	EdBµV = V dBµV + LISN dB + CF dB

4.1.5 Test Data

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

Conducted Emissions was tested with the radio in the “transmit on” state.

Table 7: Conducted Emissions Data, Transmit On

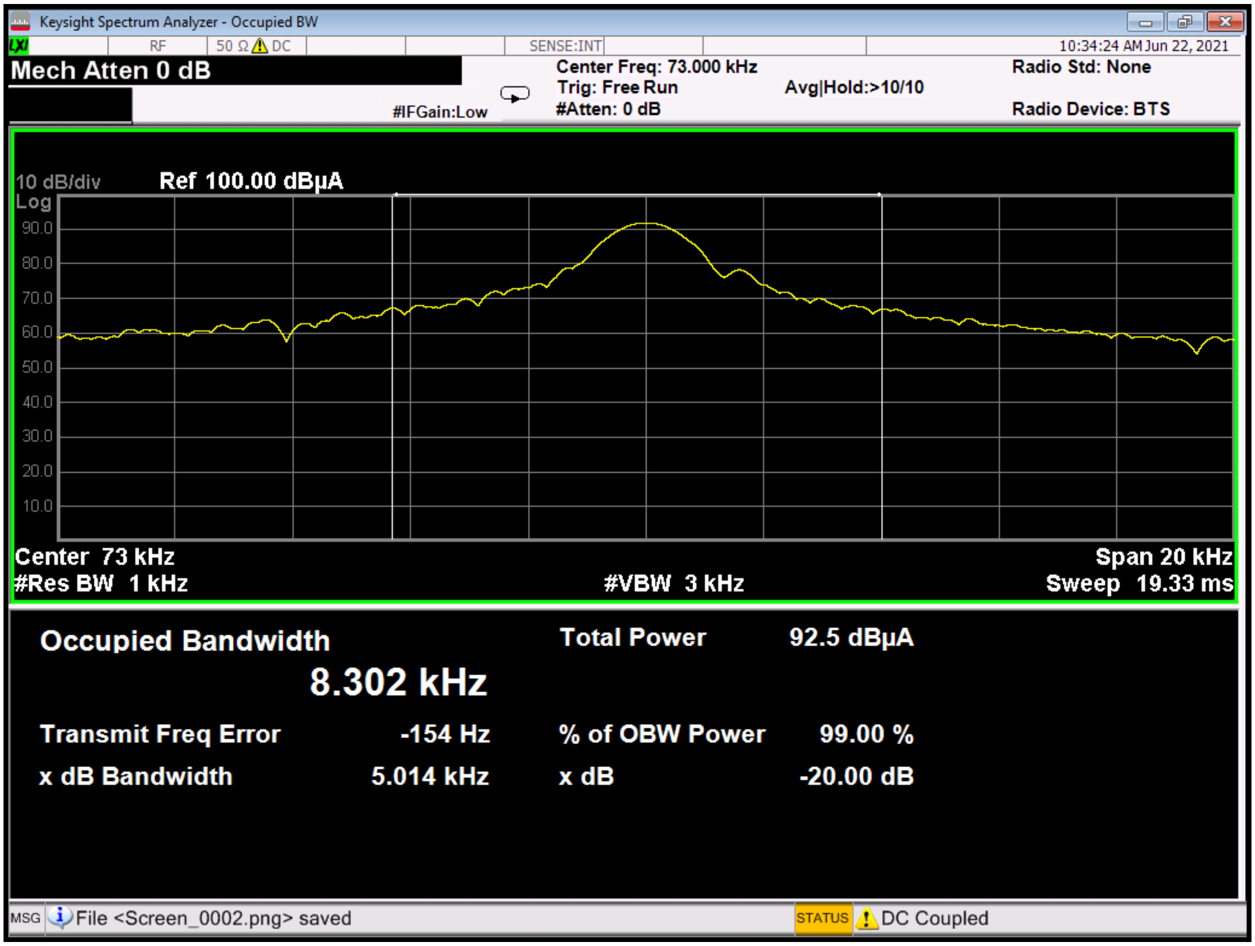
NEUTRAL										
Frequency (MHz)	**Level QP (dBμV)**	**Level AVG (dBμV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBμV)**	**Level Corr Avg (dBμV)**	**Limit QP (dBμV)**	**Limit AVG (dBμV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.152	48.7	28.3	10.2	0.9	59.8	39.4	65.9	55.9	-6.1	-16.5
0.184	49.3	25.2	10.2	1.1	60.5	36.4	64.3	54.3	-3.8	-17.9
0.803	32.5	16.7	10.3	0.7	43.5	27.8	56.0	46.0	-12.5	-18.2
1.054	32.8	16.8	10.3	0.8	43.9	27.9	56.0	46.0	-12.1	-18.1
3.871	31.6	16.7	10.5	0.8	42.9	28.0	56.0	46.0	-13.1	-18.0
13.640	40.5	24.4	11.3	2.2	54.0	37.9	60.0	50.0	-6.0	-12.1
21.380	33.9	17.6	11.6	3.3	48.7	32.5	60.0	50.0	-11.3	-17.5
25.620	32.5	16.4	11.7	3.3	47.5	31.4	60.0	50.0	-12.5	-18.6
29.860	29.6	16.1	12.0	3.3	44.9	31.4	60.0	50.0	-15.1	-18.6

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)**
0.155	40.7	24.2	10.2	1.5	52.4	35.9	65.7	55.7	-13.4	-19.8
0.158	39.8	23.7	10.2	1.5	51.4	35.4	65.6	55.6	-14.1	-20.2
0.168	40.0	26.5	10.2	1.4	51.6	38.1	65.1	55.1	-13.5	-17.0
1.237	37.3	27.4	10.3	0.9	48.5	38.6	56.0	46.0	-7.5	-7.4
13.502	37.1	18.0	11.3	2.8	51.2	32.1	60.0	50.0	-8.8	-17.9
13.660	38.3	28.2	11.3	2.8	52.4	42.3	60.0	50.0	-7.6	-7.7
21.380	34.6	25.2	11.6	3.6	49.8	40.4	60.0	50.0	-10.2	-9.6
29.925	36.0	26.2	12.0	4.6	52.6	42.8	60.0	50.0	-7.4	-7.2

4.2 Occupied Bandwidth: (FCC Part §2.1049, RSS –Gen)

Occupied bandwidth was performed by setting the EUT near the loop antenna to allow for sufficient pickup of the signal.

The transmit signal is a 73 kHz non-modulated CW signal, the OBW plot is shown below.



4.3 Radiated Spurious Emissions: (FCC Part §15.209, RSS-Gen Table 6)

Transmitters operating under §15.209 & Industry Canada RSS-GEN must comply with the radiated emissions listed in the following table:

Table 8: Radiated Emissions Limits

Frequency	Field Strength	Measurement Distance
(MHz)	**(microvolts/meter)**	**(meters)**
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

4.3.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on an open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable

For frequencies between 10 kHz and 30 MHz, a loop antenna was mounted of a tripod at height of 1 m. The Loop antenna was rotated about its vertical and horizontal axis to determine the highest emissions.

For frequencies above 30MHz the 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. Both the horizontal and vertical field components were measured.

The EUT was scanned from 10kHz to 3GHz (in order to include the 10th harmonic of the fundamental and the receiver data).

The EUT was examined in three orthogonals, and the orthogonal that demonstrated the highest emission was reported.

Transmitter fundamental and Harmonics were tested for peak emissions and compared to the Average limits, as this is a pulsed CW signal.

Resolution bandwidths used for frequencies measured between:

- 9 kHz – 150kHz, RBW = 200Hz
- 150kHz – 30MHz, RBW = 9kHz
- 30MHz – 1GHz, RBW = 120kHz

And, for frequencies measured above 1GHz:

- RBW = 1MHz

The EUT was examined in three orthogonal, and the orthogonal that demonstrated the highest emission was reported below.

Below 30 MHz radiated measurements were taken at 10 meters.

The 300m distance is interpolated to 10m, as explained on Page 19.

Test results reflect worst case emissions in regard to EUT orientation to the measurement loop antenna.

* See Table 11for the ISED Canada (uA/m) data.

<u>In accordance with FCC Rule Part 15.31(f)(2):</u>

For measurements of frequencies below 30 MHz, the measurement distance is permitted to be less than specified in the applicable limitation tables, with the field strength levels corrected using an extrapolated calculation to the specified measurement distance. This extrapolated distance-calculation is defined by making measurements at two separate distances, on the same radial, to determine the proper extrapolation factor.

As such, the field strength of the MAC transmit signal was evaluated at 10m and at 3m.

The measured field strength results were as follows:

10m: 85.1 dBµV (Raw, Peak)

3m: 114.9 dBµV (Raw, Peak)

114.9 – 85.1 = 29.8

29.8 shall be rounded to 30 dB, which is the fall-off factor for these two distances.

<u>Extrapolation Defined:</u>

The implementation of a 60 dB/decade factor, for the ratio of the two evaluation distances, produces the equivalent sum of 30 dB.

That is: 60LOG(10/3) = 31.3 (rounded to 30 dB).

<u>Extrapolation Applied for Compliance:</u>

The limit for the 73 kHz transmitter is defined at a distance of 300m.

The final radiated emissions testing was performed at 10m.

As specified for a 10m fall-off: 60LOG(300/10) = 88.6

88.6 dB shall be used to correct the field strength, prior to the final limit comparisons.

Table 9: Radiated Emissions Test Data < 30MHz (Fundamental)

Frequency (kHz)	EUT Polarity	SA Level (dBuV)	Antenna Factor (dB)	DCCF (dB)	Corr. Level (dBuV/m)	Corr. F/S (uV/m)	Limit (uV/m)	Limit (dBuV/m)	Margin (dB)	Detector
73.0	X	53.60	11.0	0.0	-24.0	0.0631	330	50.3	-74.3	Peak
73.0	X	53.60	11.0	23.9	-47.9	0.0040	33	30.3	-78.2	Peak *
73.0	Y	99.80	11.0	0.0	22.2	12.882	330	50.3	-28.1	Peak
73.0	Y	99.80	11.0	23.9	-1.7	0.8222	33	30.3	-32.0	Peak *
73.0	Z	75.20	11.0	0.0	-2.4	0.7586	330	50.3	-52.7	Peak
73.0	Z	75.20	11.0	23.9	-26.3	0.0484	33	30.3	-56.6	Peak *
note: ***** indicates this data is the corrected field strength, compared to the average limit										

Please know that the 88.6 dB, distance correction, as defined on Page 19 is inclusive of the Corrected Level in dBuV/m.

Example:

99.8 + 11 – 88.6 = 22.2 dBuV/m

uV/m = $10^{(dBuV/m \div 20)}$

10 ^ (22.2/20) = 12.882 uV/m

Table 10: Radiated Emissions Test Data < 30MHz (Harmonics)

Frequency (kHz)	EUT Polarity	SA Level (dBuV)	Antenna Factor (dB)	DCCF (dB)	Corr. Level (dBuV/m)	Corr. F/S (uV/m)	Limit (uV/m)	Limit (dBuV/m)	Margin (dB)	Detector
146.0	X	47.60	10.5	0.0	-30.5	0.029854	160	44.3	-74.8	Peak
146.0	X	47.60	10.5	23.9	-54.4	0.001905	16	24.3	-78.7	Peak *
146.0	Y	70.40	10.5	0.0	-7.7	0.412098	160	44.3	-52.0	Peak
146.0	Y	70.40	10.5	23.9	-31.6	0.026303	16	24.3	-55.9	Peak *
146.0	Z	56.70	10.5	0.0	-21.4	0.085114	160	44.3	-65.7	Peak
146.0	Z	56.70	10.5	23.9	-45.3	0.005433	16	24.3	-69.6	Peak *
219.0	X	69.40	10.5	0.0	19.9	9.885531	110	40.8	-20.9	Peak
219.0	X	69.40	10.5	23.9	-4.0	0.630957	11	20.8	-24.8	Peak *
219.0	Y	66.70	10.5	0.0	17.2	7.244360	110	40.8	-23.6	Peak
219.0	Y	66.70	10.5	23.9	-6.7	0.462381	11	20.8	-27.5	Peak *
219.0	Z	64.50	10.5	0.0	15.0	5.623413	110	40.8	-25.8	Peak
219.0	Z	64.50	10.5	23.9	-8.9	0.358922	11	20.8	-29.7	Peak *
292.0	X	61.20	10.5	0.0	11.7	3.845918	80	38.3	-26.6	Peak
292.0	X	61.20	10.5	23.9	-12.2	0.245471	8	18.3	-30.5	Peak *
292.0	Y	60.30	10.5	0.0	10.8	3.467369	80	38.3	-27.5	Peak
292.0	Y	60.30	10.5	23.9	-13.1	0.221309	8	18.3	-31.4	Peak *
292.0	Z	59.30	10.5	0.0	9.8	3.090295	80	38.3	-28.5	Peak
292.0	Z	59.30	10.5	23.9	-14.1	0.197242	8	18.3	-32.4	Peak *
365.0	X	56.60	10.5	0.0	7.1	2.264644	70	36.9	-29.8	Peak
365.0	X	56.60	10.5	23.9	-16.8	0.144544	7	16.4	-33.2	Peak *
365.0	Y	55.30	10.5	0.0	5.8	1.949845	70	36.9	-31.1	Peak
365.0	Y	55.30	10.5	23.9	-18.1	0.124451	7	16.4	-34.5	Peak *
365.0	Z	51.20	10.5	0.0	1.7	1.216186	70	36.9	-35.2	Peak
365.0	Z	51.20	10.5	23.9	-22.2	0.077625	7	16.4	-38.6	Peak *
note: * indicates this data is the corrected field strength, compared to the average limit										

4.3.2 Test Data for Canada

The EUT complies with the requirements of this section, as shown in the data table.

The limits in CFR 47, Part 15 Subpart C, para. 15.209(a) are the same as RSS-GEN. The measurements in this section were made in terms of Electric FS, that were then then converted to a Magnetic FS, for comparison to the limit expressed as an H-Field.

The EUT was evaluated, to the 10th harmonic of the fundamental. All modules and transmitters were set to a transmit enabled mode throughout the testing.

The RSS-Gen field strength limit for the 73 kHz transmitter is .087 uA/m at 300m.

E-Field to H-field conversion is 0LOG(120pi) = 20LOG(377) = 51.5 dBΩ

Table 11: 73kHz Test Data for ISED Canada

Frequency (kHz)	EUT Polarity	SA Level (dBuV)	Antenna Factor (dB)	Distance Corr.	H-Field Corr.	DCCF (dB)	Corr. Level (dBuA/m)	Limit (uA/m)	Limit (dBuA/m)	Margin (dB)	Detector
73.0	X	53.60	11.0	88.6	51.5	0.0	-75.5	0.87	-1.2	-74.3	Peak
73.0	X	53.60	11.0	88.6	51.5	23.9	-99.4	0.087	-21.2	-78.2	Peak *
73.0	Y	99.80	11.0	88.6	51.5	0.0	-29.3	0.87	-1.2	-28.1	Peak
73.0	Y	99.80	11.0	88.6	51.5	23.9	-53.2	0.087	-21.2	-32.0	Peak *
73.0	Z	75.20	11.0	88.6	51.5	0.0	-53.9	0.87	-1.2	-52.7	Peak
73.0	Z	75.20	11.0	88.6	51.5	23.9	-77.8	0.087	-21.2	-56.6	Peak *
note: * indicates this data is the corrected field strength, compared to the average limit											

Receiver Radiated Emissions (RSS-GEN)

4.3.3 Requirements

Test Arrangement: Table Top

Compliance Standard: RSS-Gen sect 6.1

RSS-Gen Compliance Limits for Receivers	
Frequency	**Limits**
30-88 MHz	100 µV/m
88-216 MHz	150 µV/m
216-960 MHz	200 µV/m
>960MHz	500 µV/m

4.3.4 Test Procedure

The requirements of RSS-GEN, for above 30 MHz, call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive 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. Bi-conical and log periodic broadband 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 output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 3 GHz were measured. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak, peak, or average as appropriate. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

All measurements above 1 GHz were made at a distance of 3m with a Resolution Bandwidth of 1 MHz and a Video bandwidth of 10 Hz. Average readings were taken in a linear mode with zero-span.

4.3.5 Test Data

The EUT complies with the requirements of RSS 210 (RSS-GEN limits) as shown in Table 12.

4.3.6 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBμV to obtain the Radiated Electric Field in dBμV/m. This logarithm amplitude is converted to linear amplitude, and then compared to the Industry Canada limit.

Example:

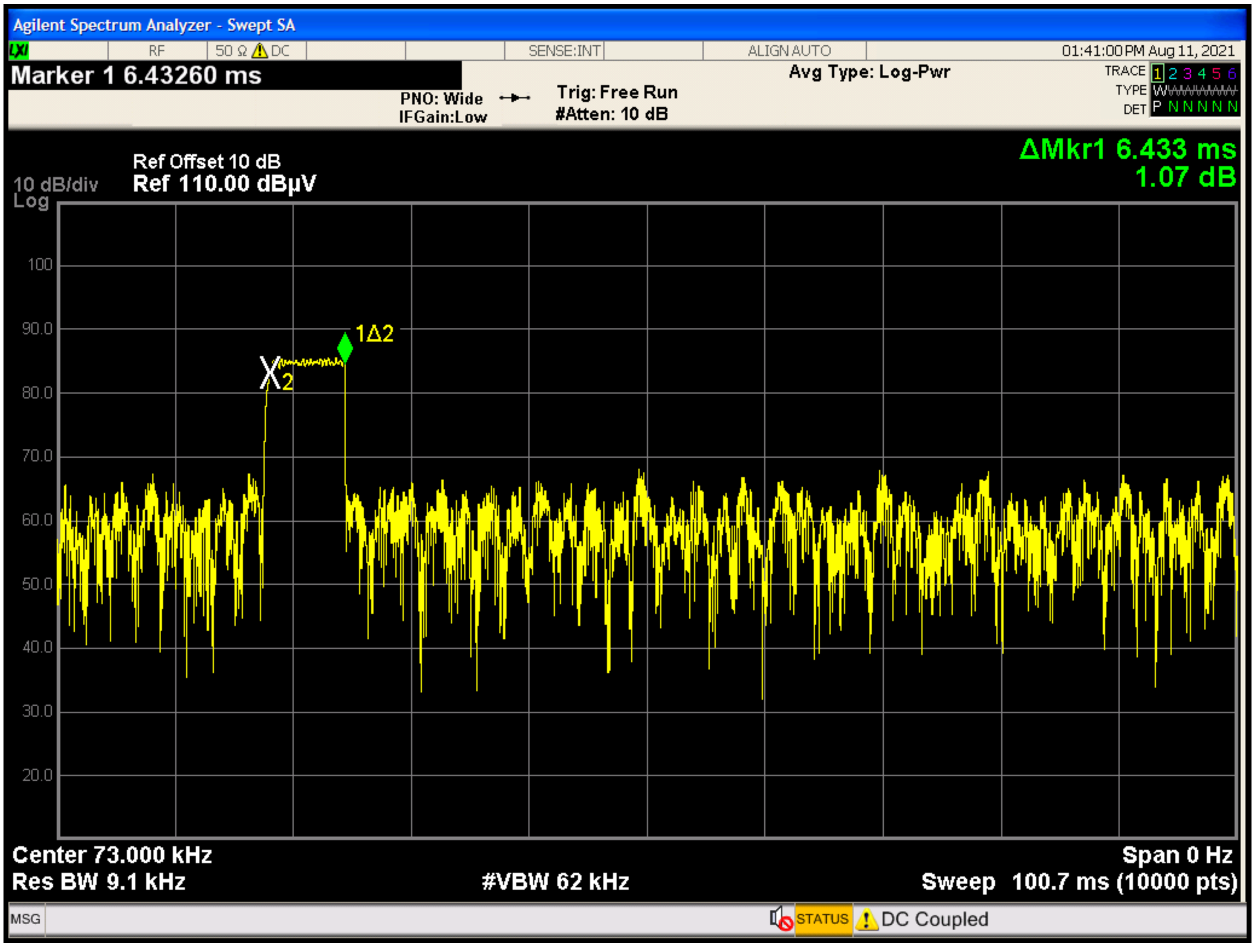
Spectrum Analyzer Voltage:	VdBμV	
Antenna Correction Factor:	AFdB/m	
Cable Correction Factor:	CFdB	
Electric Field:	EdBV/m =	V dBμV + AfdB/m + CFdB

Table 12: Receiver Radiated Emissions Test Data > 30MHz

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
30.90	V	45.0	1.1	37.3	-4.5	43.6	100.0	-7.2	QP
118.00	V	135.0	1.0	40.2	-11.2	28.1	150.0	-14.5	QP
124.00	V	180.0	1.0	39.5	-11.0	26.7	150.0	-15.0	QP
213.72	V	90.0	1.3	47.7	-13.9	48.9	150.0	-9.7	QP
239.91	V	225.0	1.1	44.6	-12.9	38.4	200.0	-14.3	QP
419.00	V	180.0	2.2	28.2	-7.4	11.0	200.0	-25.2	QP
30.90	H	45.0	1.0	33.0	-4.5	26.8	100.0	-11.4	QP
118.00	H	225.0	2.1	38.6	-11.2	23.4	150.0	-16.1	QP
124.00	H	225.0	2.6	35.0	-11.0	15.9	150.0	-19.5	QP
213.72	H	225.0	2.6	50.3	-13.9	66.2	150.0	-7.1	QP
239.91	H	225.0	2.2	51.1	-12.9	80.6	200.0	-7.9	QP
419.00	H	180.0	2.0	31.7	-7.4	16.4	200.0	-21.7	QP

4.4 Transmitter Duty Cycle (DCCF)

Figure 2: TX On Time per 100ms (MAC)



The sweep time in Figure 2 was set to 100 ms, in order to observe the pulsed transmitter on-time. In this case, the full pulse train is greater than the measurement period. As such, the cycle time (*T*cycle) shall be declared as 100 ms.

Any given individual transmitter pulse, measures 6.433 ms. As such, the worst case on-time (*t*on) is 6.433 ms.

<u>The duty cycle can be calculated from the following formula:</u>

$t_{on} \div T_{cycle} = \Delta$

$6.433 \div 100 = 0.0643$

$\Delta = 6.4\%$

Where Δ is the final duty cycle.

<u>The duty cycle correction factor can be calculated from the following formula:</u>

$20LOG(\Delta) = \delta$

$20LOG(0.064) = -23.87$

$\delta = 23.9$ dB

Where δ is the final DCCF.

(Reference ANSI C63.10-2013, Section 7.5)