FCC & ISED CANADA CERTIFICATION TEST REPORT

for the

FREDERICK ENERGY PRODUCTS, LLC

FCC ID: QUI-DDAC-PAD-WC

IC ID: 11625A-DDACPADWC

WLL REPORT# 19048-01 REV 1

Prepared for:

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Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

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January 29, 2025

WLL Report# 19048-01 Rev 1

Prepared by:

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Reviewed by:

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President

Abstract

This test 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 current at the time of testing and Innovation, Science and Economic Development (ISED) Canada Spectrum Management and Telecommunications Policy. This certification test report documents the test configuration and test results for the Frederick Energy Products, LLC DDAC-PAD-WC. The information provided on this report is only applicable to device herein documented as the EUT.

Radiated testing was performed in the Free-space Anechoic Chamber Test-site (FACT) 3m chamber of Washington Laboratories, Ltd., located at 4840 Winchester Boulevard, Suite 5., 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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory (ISED Canada number 3035A).

The Frederick Energy Products, LLC., DDAC-PAD-WC complies with the requirements for an Intentional Radiator under FCC Part 15.231 and RSS-210 Issue 11 (6/2024).

Revision History	Description of Change	Date
Rev 0	Initial Release	January 29, 2025
Rev 1	ACB Comments, dated: 2/18/2025	February 25, 2025

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC., DDAC-PAD-WC complies with the requirements for an Intentional Radiator under FCC Part 15.231 and RSS-210 Issue 11 (6/2024).

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 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 for Washington Laboratories, Ltd. 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.

1.4 Contract Information

Customer:	Frederick Energy Products, LLC
Purchase Order Number:	FMI11312
Quotation Number:	74980

1.5 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Will Murrey

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Frederick Energy Products, LLC	
FCC ID:	QUI-DDAC-PAD-WC	
ISED ID:	11625A-DDACPADWC	
Model:	DDAC-PAD-WC	
HVIN:	DDAC-PAD-WC	
FCC Rule Parts:	FCC: §15.231	ISED: RSS-210
Emission Designator:	FCC: 111KF1DXN	ISED: 123KF1DXN
Occupied Bandwidth:	20dB: 110.7 kHz	99% 123.3 kHz
Transmit Frequency:	916.48 MHz (fixed, single channel)	
3-meter Radiated Field Strength:	81283.1 uV/m Peak	8156.4 uV/m Average
Antenna:	PCB mounted, internal to EUT housing	
Modulation or Protocol:	FM, FSK	
Type of Information:	Proximity, Telemetry	
Keying:	Automatic	
Test Software/Firmware:	FEPL Proprietary Software/Firmware	
Power Source & Voltage:	Battery Powered (Cannot Charge and Transmit Simultaneously)	
Testing Dates:	1/8/2025 to 1/15/2025	

The DDAC-PAD-WC is a proximity alarm device, used for collision avoidance. The PAD can detect a 73 kHz H-Field, from a generator device, in three distinct proximity zones. These zones cause the EUT to go into different transmit modes. The three modes are (1) Health Mode, (2) Warning Mode, and (3) Danger Mode. The PAD is triggered into these modes based on its proximity to a generator. Please note that output power from the 916.48 MHz transmitter is not affected by the changing of modes. The EUT is powered by a self-contained Li-ion battery. The EUT battery is charged via wireless charging only. The EUT sample provided to the test laboratory did not have any USB style ports. The EUT cannot charge and transmit simultaneously. The EUT is not sold with a charger, and the end user sources their own generally available wireless charger.

2.2 Testing Algorithm

The DDAC-PAD-WC was tested in a powered-on, steady state, with the transmitter enabled as appropriate. The EUT was positioned in proximity to a 73 kHz generator as a means to trigger the 916.48 MHz radio. A continuous transmit sample was also provided for testing purposes. All of the EUT modes were evaluated for power, bandwidth, and timing do determine to worst-case modes. The Warning mode was the worst-case mode for radiated transmitter power, while the Danger mode produced the worst-case DCCF. The worst-case emissions are provided throughout this report.

2.3 Test Configuration

The DDAC-PAD-WC was tested in a stand-alone configuration.

Table 2: EUT Device Configuration List

Name / Description	Model Number	Part Number	Serial Number	Revision
PAD	DDAC-PAD-WC	--	--	--

Table 3: Support Equipment

Item	Description	Serial Number
MFG	73kHz generator	--
Wireless Charger	Generic	--

Table 4: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
N/A	N/A	N/A	N/A	N/A

2.4 Measurements

2.4.1 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 (Sep-2020) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.4.2 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 a linear amplitude, then compared to the FCC limit.

Example:

Spectrum Analyzer Voltage:	VdBµV (SA)
Antenna Correction Factor:	AFdB/m
Cable Correction Factor:	CFdB
Pre-Amplifier Gain (if applicable):	GdB
Electric Field:	EdBµV/m = V dBµV (SA) + AFdB/m + CFdB - GdB
To convert to linear units of measure:	Inv Log (EdBµV/m/20)

2.5 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. 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.

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

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 Sequence and Results Summary

Table 6: Testing Series and Result Summary

FCC Rule Part	ISED Rule Part	Description	Result
15.231(a)(1)	RSS-210	Transmit Cessation from Release	Pass
15.231(a)(2)	RSS-210	Transmit Cessation from Activation	Pass
15.231(a)(3)	RSS-210	Transmission Polling	Pass
15.231(a)(4)	RSS-210	Pendency of Alarm Conditions	Adopted
15.231(c)	RSS-210	Occupied Bandwidth	Pass
15.231(b)	RSS-210	Field Strength, Fundamental	Pass
15.207(a)	RSS-GEN	AC Power Line Emissions	N/A *
15.35(c)	RSS-GEN	100ms Duty Cycle	Completed

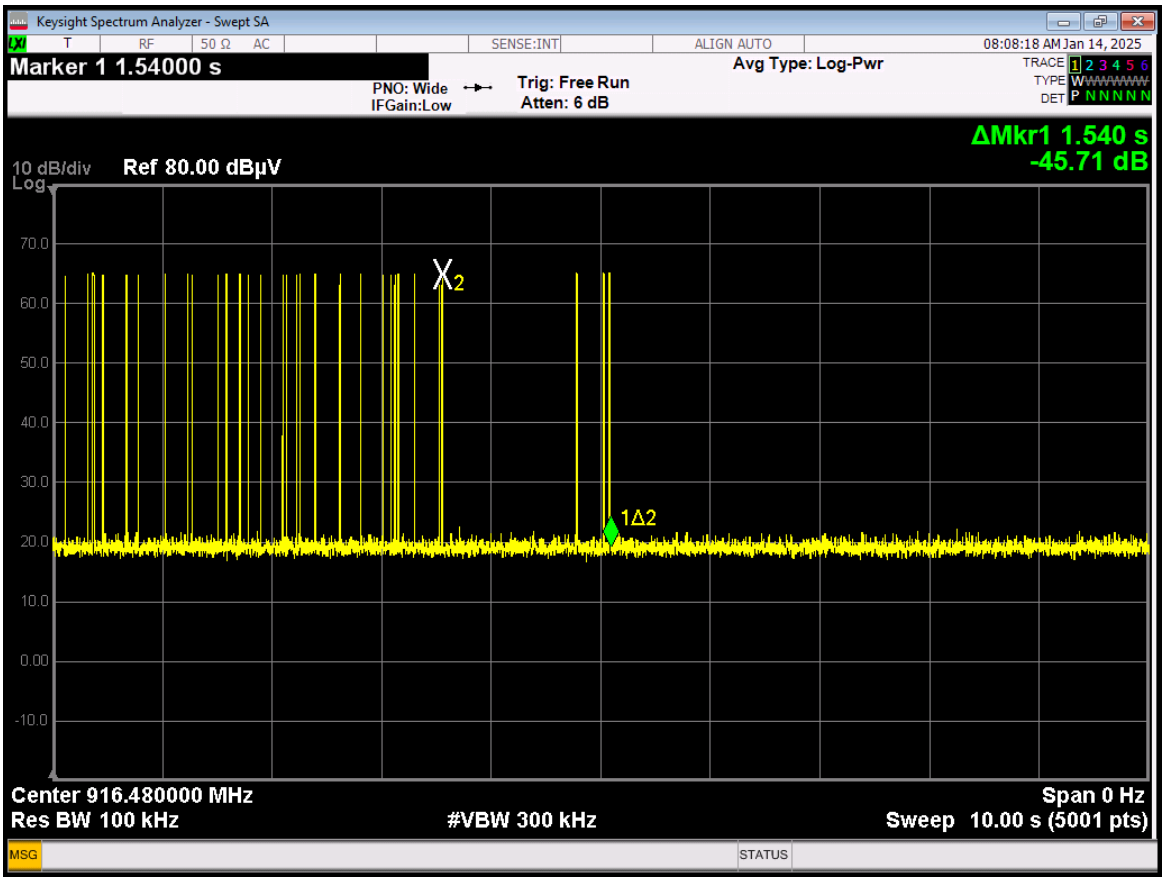
* The EUT is not subject to the requirements of AC powerline conducted emissions. The EUT is battery powered, and it is not sold with a charger. The end user provides their own COTS wireless charger.

4 Test Results

4.1 Transmission Cessation from Time of Release, FCC Part §15.231(a)(1)

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 DDAC-PAD-WC stopped transmitting within the required time period. A 10-second sweep was made, during which time, the transmitter was triggered from Warning Mode into Health Mode. By moving the EUT away from the Generator, the transmitter was triggered into a mode that periodically deactivates transmission. Figure 1 shows the indicated period from un-keying the device until cessation of transmission. The EUT complies with the requirements of this section, as the cessation time is 1.54 seconds. Changing of the modes has no impact on this measurement. The all modes were evaluated, the EUT is compliant.

Figure 1: Deactivation of Transmitter (TX Cessation)



4.2 Transmission Cessation from Time of Activation, FCC Part §15.231(a)(2)

Under this provision, a periodic transmitter, that is activated automatically, shall cease transmission within 5 seconds after activation.

Given the safety of life of this device, and how the proximity detection is incorporated into the transmitter operation, it is important to note that the transmitter remains enabled for the duration of the alarm condition, specifically for safety of life application. However, when the alarm condition is cleared, the EUT reverts back to a polling Health mode. When this occurs, the transmitter is disabled as shown above.

Under the exception of §15.231(a)(4), the EUT complies with the requirements of this rule part.

4.3 Transmission Polling, FCC Part §15.231(a)(3)

Under this provision, polling transmissions, or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed. However, the total duration of transmissions shall not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

If the PAD determines that the field strength indicates the individual is not in a Warning or Danger area, it will transmit a "health status" data packet every 40 seconds via the 916.48 MHz transmitter. Each "health status" transmission is about 8 to 9 milliseconds long, resulting in a total of 0.8 sec/hr of scheduled transmissions.

The EUT complies with the requirements of this rule part.

See Section 4.7 for a summary of the transmitter timing.

4.4 Occupied Bandwidth, FCC Part §15.231(c)

For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. The OBW is determined at the points 20 dB down from the peak of the transmitter carrier. The 99% bandwidth shall also be recorded. This limit is 0.005 * 916.48 = 4.58 MHz.

Table 7: Occupied Bandwidth Test Results

TX Fundamental (MHz)	Mode	Auxiliary Data Carrier	20dB OBW (kHz)	99% OBW (kHz)
916.48	Health	Yes	110.7	114.23
916.48	Warning	Yes	110.5	123.30
916.48	Danger	No	30.0	67.06

Figure 2: Occupied Bandwidth, Health Mode

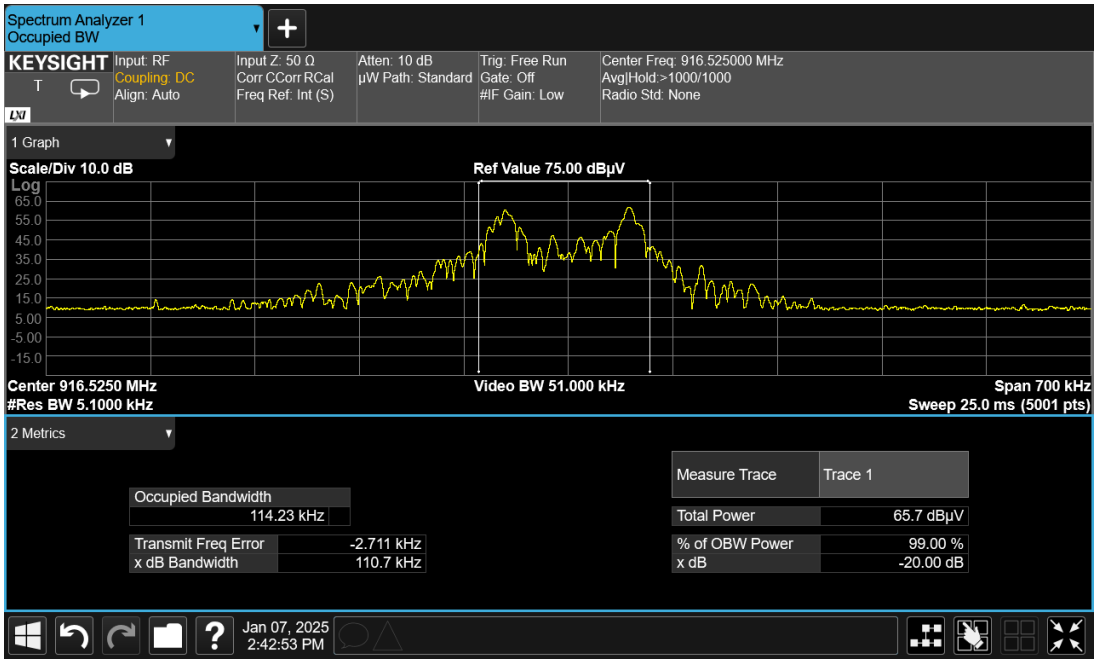


Figure 3: Occupied Bandwidth, Warning Mode

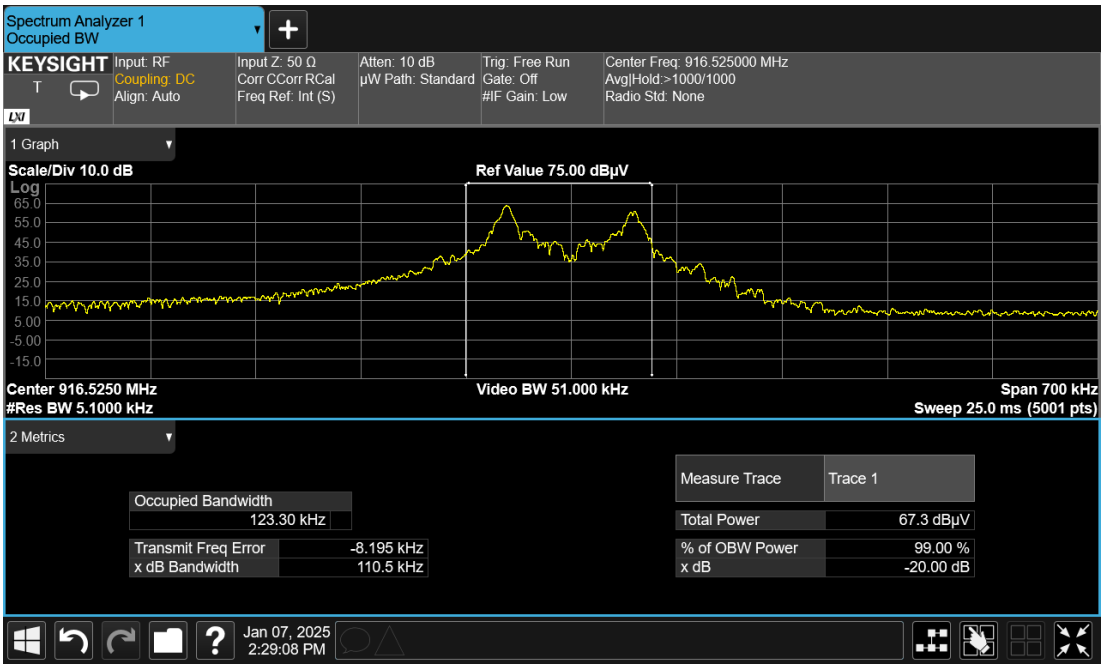
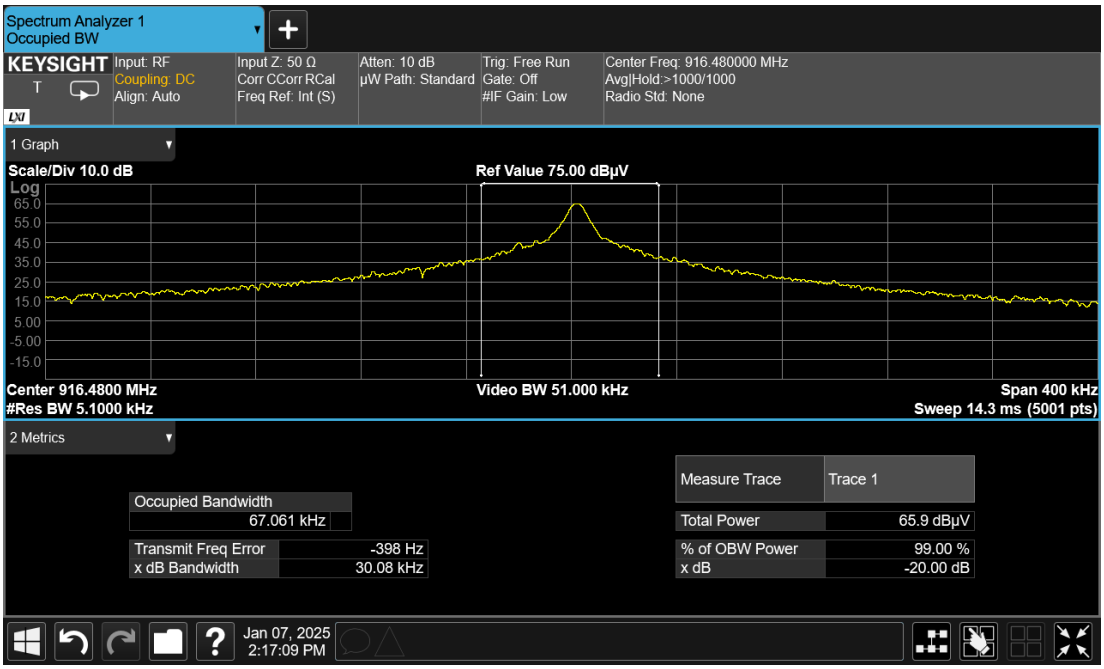


Figure 4: Occupied Bandwidth, Danger Mode



4.5 Transmitter Radiated Field Strength, FCC Part §15.231(b)

The field strength of emissions from intentional radiators operating under this section shall not exceed the following limits, as measured at a distance of 3-meters:

Fundamental Frequency (MHz)	Field Strength of Fundamental (µV/m)
40.66 to 40.70	2250
70 to 130	1250
130 to 174	1250 to 3750
174 to 260	3750
260 to 470	3750 to 12500
Above 470	12500

The above limits are based on the average value of the measured emissions. The provisions in §15.35(c) for averaging pulsed emissions, and for limiting peak emissions, shall apply. The calculated DCCF of -19.97dB shall be applied to the Peak field strength readings in order to obtain the Average field strength.

The requirements for this test call for the EUT to be placed on a 1m X 1.5m non-conductive motorized turntable for radiated testing at a 3m open air test site. The height of the table shall be 80cm for testing below 1000 MHz, and 1.5m for testing above 1000 MHz, both in accordance with ANSI C63.10. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. A log periodic broadband antenna was 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 916.48 MHz transmitter was measured. The horizontal and vertical field components were measured to determine the worst-case levels. For measurements of the fundamental the detector function was set to peak mode. 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.

The EUT was set to transmit in a Warning mode and was evaluated in three orthogonal axes (x, y, z) to determine the orientation that yielded the highest radiated field strength. The worst-case emissions are reported below.

Table 8: Highest Fundamental Field Strength, Test Results

EUT Position	RX Ant. Polarity	Azimuth (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr. Factors (dB/m)	DCCF (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Emission Type
Y-Axis	V	165	115	69.26	28.94	0.0	81283.1	125000	-3.74	Peak
Y-Axis	V	165	115	69.26	28.94	-19.97	8156.4	12500	-3.71	AVG

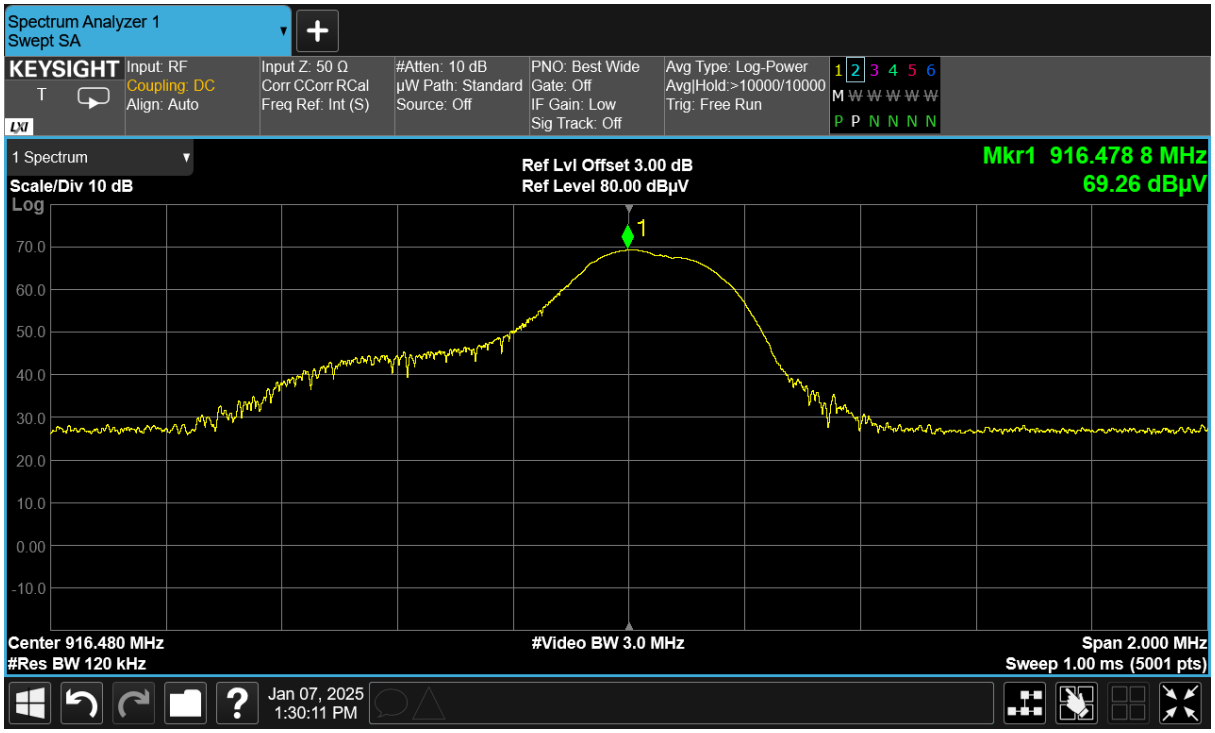
Calculations Expanded:

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

dBuV/m $= SA\ Level_{dBuV} + CF_{dB/m} + DCCF_{dB}$

$= 69.26 + 28.94 + -19.97 = 78.23$ dBuV/m = 8156.4 uV/m at 3-meters (Average)

Figure 5: Worst-Case, Peak Transmitter Radiated Field Strength (Uncorrected)



4.6 Radiated Spurious Emissions, FCC Part §15.231(b)

The field strength of spurious emissions, related to the transmitter, shall not exceed the following limits, as measured at a distance of 3 meters:

Fundamental Frequency (MHz)	Field Strength of Spurious Emissions (µV/m)
40.66 to 40.70	225
70 to 130	125
130 to 174	125 to 375
174 to 260	375
260 to 470	375 to 1250
Above 470	1250

The limits for field strength of spurious emissions are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the Average limits shown in this table, or to the general limits shown in §15.209, whichever limit permits a higher field strength. In accordance with the provisions outlined in §15.205(b), compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector, for spurious measurements made below 1000 MHz. The EUT is a pulsed transmitter device. Therefore, the peak level of any harmonic or other spurious emission shall be recorded. The average field strength shall be mathematically obtained by using DCCF. The EUT was investigated in three orthogonal axes (x, y, z). The worst-case position was maintained and the EUT was scanned for emissions from 9 kHz to 10 GHz, which covers the tenth harmonic of the fundamental. For frequencies between 9 kHz and 30 MHz, a loop antenna was mounted at a fixed-height of 1-meter and rotated about its vertical and horizontal axis in accordance with ANSI C63.10-2020, clause 6.4.6 and 6.11.2. For all other radiated testing, the EUT was placed on a 1m X 1.5m non-conductive motorized turntable for radiated testing at a 3m open air test site. The height of the table shall be 80cm for testing below 1000 MHz, and 1.5m for testing above 1000 MHz, both in accordance with ANSI C63.10. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. A log periodic broadband antenna was 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 10 GHz were measured. Both the horizontal and vertical field components were measured. The detector function was set to peak or quasi-peak for measurements below 1 GHz. 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.

Table 9: Radiated Spurious Emissions, 9kHz to 10GHz

Frequency (MHz)	Emission Type	DCCF (dB)	Corr. Level (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
914.15 ‡	Peak	0.0	42.962	81.94	-38.98	165	Vert, 115
	AVG	-19.97	22.992	61.94	-38.95	165	Vert, 115
928.00 *	Peak	0.0	32.356	81.94	-49.58	180	Vert, 120
	AVG	-19.97	12.386	61.94	-49.55	180	Vert, 120
960.00 *	Peak	0.0	30.733	81.94	-51.21	280	Horiz, 100
	AVG	-19.97	10.763	61.94	-51.18	280	Horiz, 100
1833.0 ‡	Peak	0.0	43.763	81.94	-38.18	180	Vert, 120
	AVG	-19.97	27.790	61.94	-34.15	165	Vert, 115
3666.0 ‡	Peak	0.0	50.594	81.94	-31.35	180	Vert, 120
	AVG	-19.97	30.624	61.94	-31.32	165	Vert, 115
5174.0 ‡	Peak	0.0	56.005	81.94	-25.94	180	Vert, 120
	AVG	-19.97	36.035	61.94	-25.91	165	Vert, 115
6649.0 *	Peak	0.0	55.658	81.94	-26.28	180	Vert, 120
	AVG	-19.97	35.688	61.94	-26.25	165	Vert, 115
7130.0 *	Peak	0.0	55.373	81.94	-26.57	180	Vert, 120
	AVG	-19.97	35.403	61.94	-26.54	165	Vert, 115

Test Data Expanded:

a) the 15.231 Average limit for spurious emissions is 1250 uV/m at 3-meters
b) 20LOG(1250) = 61.94 dBuV/m Average limit at 3-meters
c) ‡ indicates a transmitter spurious emission
d) * indicates an ambient condition, measurement taken at the noise floor
e) there were no EUT emissions detected in the frequency range of 9 kHz to 914 MHz
f) there were no EUT emissions detected in the frequency range of 5.18 GHz to 10 GHz

4.7 Transmitter Timing (DCCF)

Table 10: TX Mode Summary with DCCF

EUT Mode	TX On-Time per 100ms	Duty Cycle	Final DCCF	Proximity to 73kHz MFG
Health, Idle	9.0 ms	9.0 %	-20.92 dB	≥ 12-meters
Warning	9.748 ms	9.75 %	-20.22 dB	6m to 12m
Danger, Alarm	10.025 ms	10.03 %	-19.97 dB	≤ 6-meters
Continuous TX	10.25 ms	--	--	for testing only

Each of these modes was investigated by WLL.

DCCF = 9.0ms + 0.135ms + 0.890ms = 10.025ms in any 100ms evaluation period

10.03% = -19.97dB from 20LOG(.1003)

Figure 6: Worst-Case 100ms Period (Danger Mode)

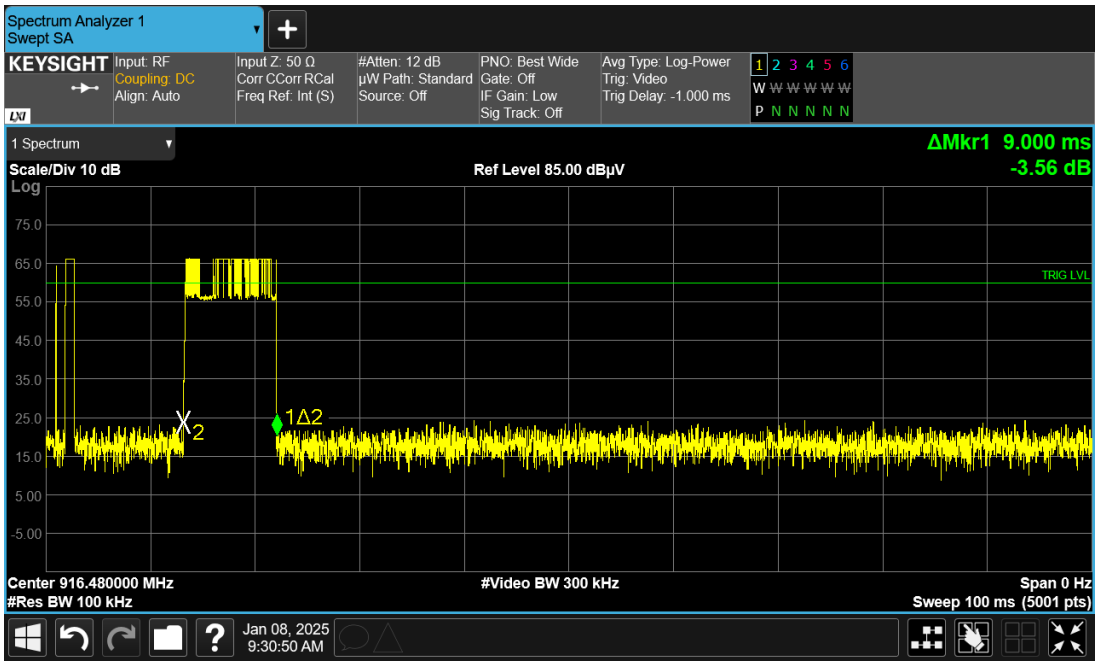


Figure 7: Sub-Pulse 1 Duration (Danger Mode)

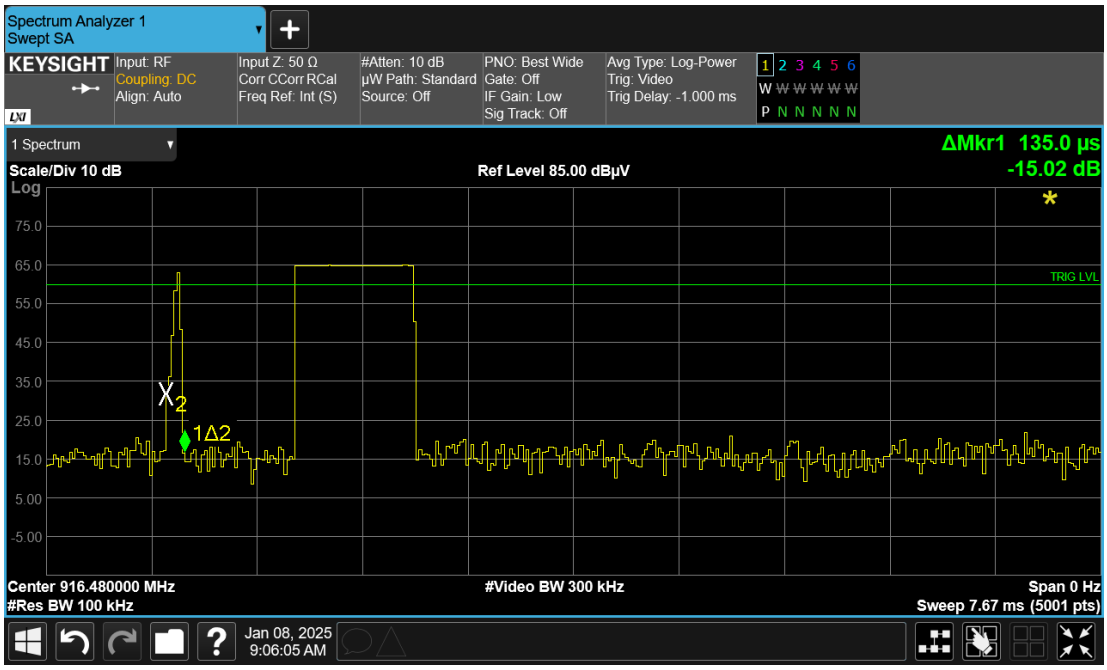
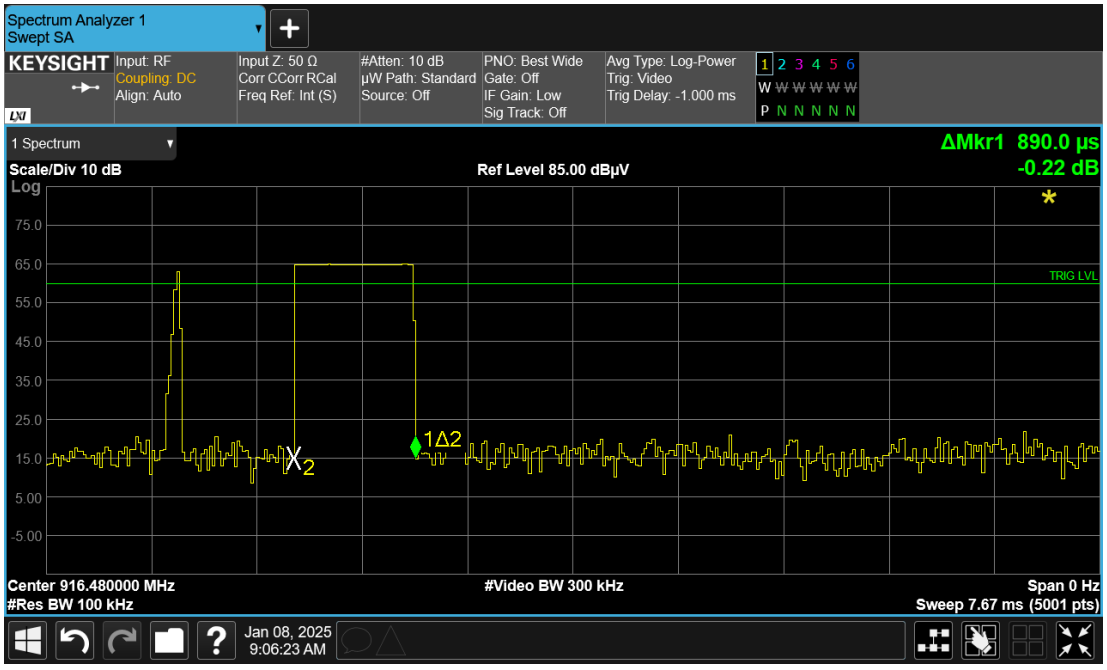


Figure 8: Sub-Pulse 2 Duration (Danger Mode)



5 Test Equipment

Table 11 shows a list of the test equipment used for measurements along with the calibration information.

Table 11: Test Equipment List

Test Name:	**Radiated Emissions**	Test Date: 1/8/2025 to 1/15/2025	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00993	KEYSIGHT, N9030B	MXA SPECTRUM ANALYZER	11/6/2025
00992	KEYSIGHT, N5173B	EXG SIGNAL GENERATOR	1/8/2028
00644	SUNOL SCIENCES CORP.	JB1, LOGPERIOD ANTENNA	12/6/2026
00559	HP, 8447D	RF PRE-AMPLIFIER	6/25/2025
00031	EMCO, 6502	ACTIVE LOOP ANTENNA	6/17/2027
00425	ARA DRG-118/A	HORN ANTENNA	2/7/2025
00955	JUNKOSHA USA	HF COAXIAL CABLE	7/1/2025
00847	ASTROLABS, K48TG	HF COAXIAL CABLE	6/20/2025
00330	WLL RG-223, BNC	6METER BNC CABLE	6/25/2025
00280	ITC, M/N: 21C-3A1	WAVEGUIDE PASS FILTER	6/27/2025
00066	HP/BZ-282525-SMA	RF PRE-AMPLIFIER 26.5GHZ	8/21/2025
00885	UTIFLEX, UFA2108	HF COAXIAL CABLE	6/25/2025
00731	NARDA, 4779-3	3DB 2W MAX, ATTENUATOR	6/20/2025
00721	WEINSCHEL DS109	ATTENUATOR, NOTCH	Cal. Before Use