FCC & ISED CANADA CERTIFICATION

TEST REPORT

FOR THE

Frederick Energy Products, LLC
Hit-Not Magnetic Field Generator (DDAC-PDS-C-2)

FCC ID: QUI-DDAC-PDS-GEN2
IC ID: 11625A-DDACPDSGEN2

WLL REPORT# 16955-01 REV 5

Prepared for:

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Testing Certificate AT-1448

FCC & ISED Canada Certification

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May 5, 2021

WLL Report# 16955-01 Rev 5

Prepared by:

Richard Quarcoo

Compliance Engineer

Reviewed by:

Steven D. Koster

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 15.231 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 Hit-Not Magnetic Field Generator (DDAC-PDS-C-2). 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.

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 Hit-Not Magnetic Field Generator (DDAC-PDS-C-2) complies with the limits for an Intentional Radiator under FCC Part 15.231 and RSS-210 Issue 10 (12/2019).

Revision History	Description of Change	Date
Rev 0	Initial Release	May 5, 2021
Rev 1	Corrected FCC and ISED Numbers	May 26 2021
Rev 2	ACB Comments #ATCB026996	July 8, 2021
Rev 3	ACB Comments #ATCB026996 (v2)	July 13, 2021
Rev 4	Update Transmitter Reference per ACB	July 15, 2021
Rev 5	ACB Comments: Dated July 28, 2021	August 9, 2021

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC Hit-Not Magnetic Field Generator (DDAC-PDS-C-2) complies with the limits for an Intentional Radiator device under FCC Part 15.231 and ISED Canada RSS-210 Issue 10 (12/2019).

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 (c)	RSS-210	20dB Bandwidth	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:	9147
Quotation Number:	72593

1.4 Test and Support Personnel

Washington Laboratories, LTD	Richard Quarcoo
Customer Representative	Andrew Nichols

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Frederick Energy Products, LLC
FCC ID:	QUI-DDAC-PDS-GEN2
ISED ID:	11625A-DDACPDSGEN2
Model:	DDAC-PDS-C-2
EUT Model:	Hit-Not Magnetic Field Generator (DDAC-PDS-C-2)
Test Dates:	2/23/2021 to 2/25/2021
FCC Rule Parts:	§15.231
ISED Rule Parts:	RSS-210
IC Emission Designator:	357KF1DAN
FCC Emission Designator:	152KF1DAN
99% Occupied Bandwidth:	357.4 kHz
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Monopole
Software/Firmware:	Normal Mode (no special settings or details)
Interface Cables:	N/A
Power Source & Voltage:	12-15 VDC

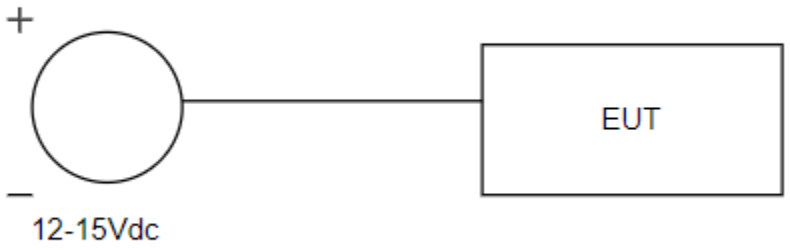
2.2 Test Configuration

Hit-Not Magnetic Field Generator (DDAC-PDS-C-2) was configured in a stand-alone configuration.

Table 2: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Revision
Hit-Not Magnetic Field Generator	DDAC-PDS-C-2	N/A	N/A	0

Figure 1: Test Configuration



2.3 Support Equipment

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
N/A	N/A	N/A

2.4 Interface Cables

Table 4: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
DC Power	F70-2	<3m	N	Pos/Neg

2.5 Testing Algorithm

The Hit-Not Magnetic Field Generator (DDAC-PDS-C-2) was tested in a continuous tramsmit operation. All transmitters, to include BLE, were set to a transmit enabled mode during the testing. The highest frequency range was investigated per KDB 996369 D04 "Module Integration Guide". The EUT emissions were evaluated to the 10th harmonic of the BLE radio. Worst case emissions are provided throughout the report.

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 OATS 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.

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:	**Radiated Emissions**	Test Date:	**02/23/2021**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00942	AGILENT	SIG. ANALYZER	10/30/2021
00559	HP	RF AMP.	5/18/2021
00627	AGILENT	RF AMP.	8/31/2021
00093	KIKISUI	POWER SUPPLY	CNR
00425	ARA	HORN ANT.	8/18/2022
00382	SUNOL SCIENCES	LOG PERIOD ANT.	6/1/2021

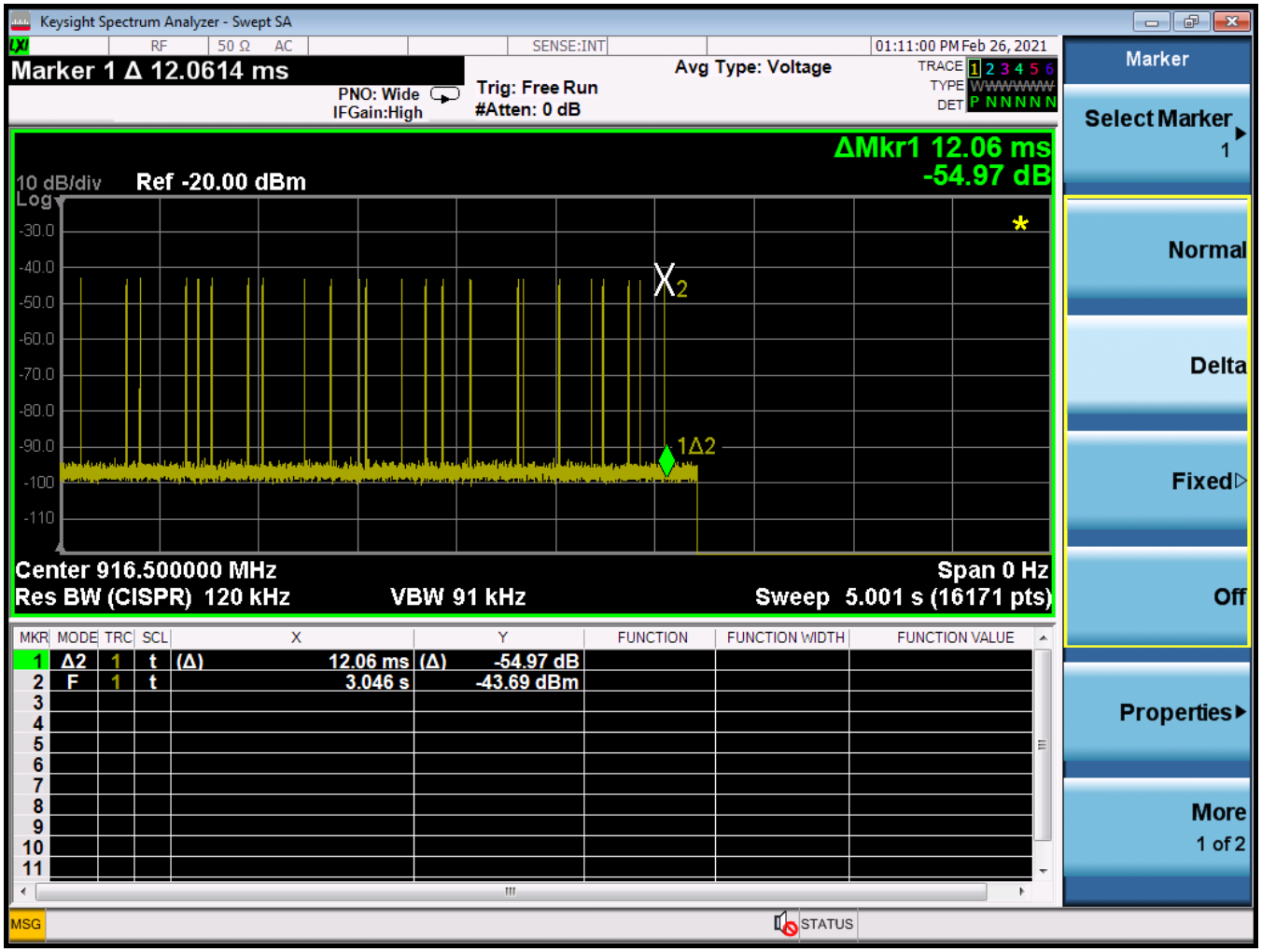
4 Test Results

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

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 Hit-Not Magnetic Field Generator (DDAC-PDS-C-2) stopped transmitting within the required time period. A 5 second sweep was made, during which the control toggle was activated and released, and **3.046 s** to transmission end was measured. Figure 2 shows the indicated time period from un-keying the device until cessation of transmission. The EUT complies with the requirements for this section.

Figure 2: Time Period: Release to Termination of Transmission



4.2 Occupied Bandwidth (FCC Part §2.1049 and RSS-210 A.1.3)

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

15.231 (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 operating 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.

Table 7: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
18 kHz	180 kHz

Table 8: 20dB Occupied Bandwidth Results

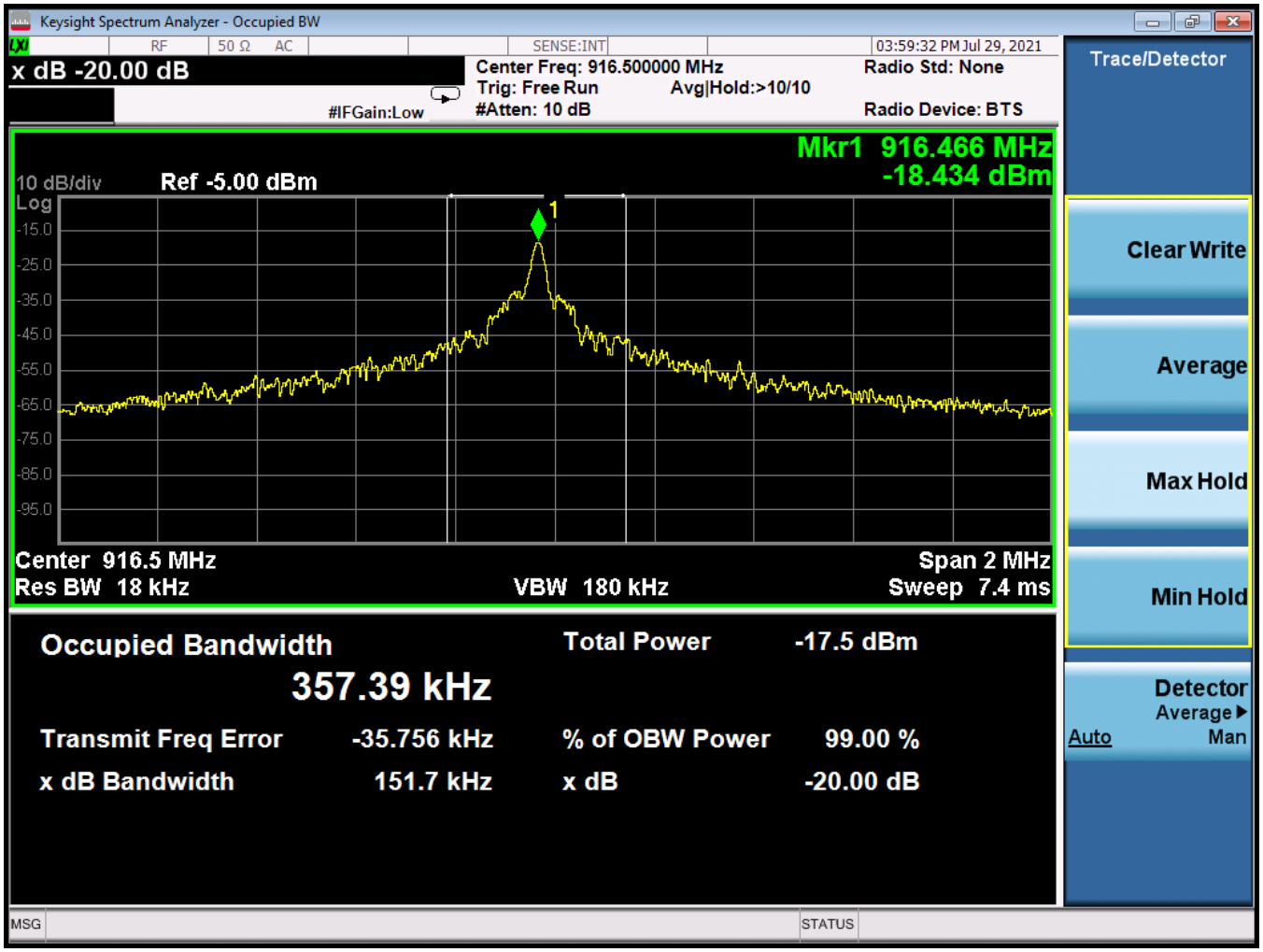
Frequency	Bandwidth	Limit	Pass/Fail
Fixed Channel: 916.5	151.7 kHz	4.58 MHz	Pass

Table 9: 99% Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Fixed Channel: 916.5	357.39 kHz	N/a	N/a

At full modulation, the occupied bandwidth was measured as shown

Figure 3: Occupied Bandwidth, High Channel



4.3 Radiated Spurious Emissions: (FCC Part §15.231(a), 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.

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

The emissions were measured using the following resolution bandwidths:

Table 10: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30 MHz to 1000 MHz	120 kHz	1 MHz
>1000 MHz	1 MHz	3 MHz

Table 11: Radiated Emission Test Data – Below 1000 MHz

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
31.00	V	180.0	2.7	0.0	-4.6	0.6	100.0	-44.6	QP
46.78	V	180.0	2.4	45.7	-15.7	31.3	100.0	-10.1	QP
55.24	V	135.0	2.4	39.3	-17.8	11.8	100.0	-18.6	QP
126.51	V	180.0	2.4	29.5	-10.9	8.5	150.0	-24.9	QP
215.83	V	135.0	2.4	34.5	-13.7	10.9	150.0	-22.8	QP
237.82	V	135.0	2.4	28.1	-13.0	5.7	200.0	-30.9	QP
429.00	V	180.0	2.4	33.8	-7.2	21.4	200.0	-19.4	QP
46.78	H	135.0	2.4	34.4	-15.7	8.6	100.0	-21.4	QP
55.24	H	180.0	2.4	36.2	-17.8	8.3	100.0	-21.6	QP
126.51	H	180.0	2.4	40.8	-10.9	31.4	150.0	-13.6	QP
215.83	H	180.0	2.4	43.4	-13.7	30.5	150.0	-13.8	QP
237.82	H	135.0	2.4	38.4	-13.0	18.5	200.0	-20.7	QP
429.00	H	180.0	2.4	31.9	-7.2	17.1	200.0	-21.3	QP

Table 12: Radiated Emission Test Data – Fundamental

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	DCCF (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
916.48	V	180.0	2.4	91.8	0.7	0.0	42177.7	125000.0	-9.4	Peak
916.48	V	180.0	2.4	91.8	0.7	29.9	1349.2	12500.0	-19.3	Peak *
916.48	H	135.0	2.4	91.8	0.7	0.0	42177.7	125000.0	-9.4	Peak
916.48	H	135.0	2.4	91.8	0.7	29.9	1349.2	12500.0	-19.3	Peak *

** note: this data indicates the corrected field strength, applied to the average limit.*

Table 11 : Radiated Emission Test Data – Above 1000 MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	DCCF (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Detector
1833.00	V	180.0	1.2	56.1	-10.8	0.0	183.7	12500	-36.7	Peak
1833.00	V	180.0	1.2	56.1	-10.8	29.9	5.9	1250	-46.6	Peak *
2749.50	V	135.0	1.2	45.0	-8.8	0.0	64.3	12500	-45.8	Peak
2749.50	V	180.0	1.2	45.0	-8.8	29.9	2.1	1250	-55.7	Peak *
3666.00	V	135.0	1.2	43.2	-8.0	0.0	57.7	12500	-46.7	Peak
3666.00	V	135.0	1.2	43.2	-8.0	29.9	1.8	1250	-56.6	Peak *
4582.50	V	180.0	1.2	42.7	-8.9	0.0	49.0	12500	-48.1	Peak
4582.50	V	180.0	1.2	42.7	-8.9	29.9	1.6	1250	-58.0	Peak *
5499.00	V	180.0	1.2	41.9	-7.2	0.0	54.6	12500	-47.2	Peak
5499.00	V	180.0	1.2	41.9	-7.2	29.9	1.7	1250	-57.1	Peak *
6415.50	V	180.0	1.2	39.2	-6.9	0.0	41.3	12500	-49.6	Peak
6415.50	V	180.0	1.2	39.2	-6.9	29.9	1.3	1250	-59.5	Peak *
1833.00	H	180.0	1.1	52.7	-10.8	0.0	124.2	12500	-40.1	Peak
1833.00	H	180.0	1.1	52.7	-10.8	29.9	4.0	1250	-50.0	Peak *
2749.50	H	135.0	1.1	44.6	-8.8	0.0	61.4	12500	-46.2	Peak
2749.50	H	135.0	1.1	44.6	-8.8	29.9	2.0	1250	-56.1	Peak *
3666.00	H	180.0	1.1	43.3	-8.0	0.0	58.4	12500	-46.6	Peak
3666.00	H	180.0	1.1	43.3	-8.0	29.9	1.9	1250	-56.5	Peak *
4582.50	H	180.0	1.2	43.3	-8.9	0.0	52.6	12500	-47.5	Peak
4582.50	H	180.0	1.2	43.3	-8.9	29.9	1.7	1250	-57.4	Peak *
5499.00	H	180.0	1.2	40.0	-7.2	0.0	43.8	12500	-49.1	Peak
5499.00	H	180.0	1.2	40.0	-7.2	29.9	1.4	1250	-59.0	Peak *
6415.50	H	180.0	1.2	41.0	-6.9	0.0	50.8	12500	-47.8	Peak
6415.50	H	180.0	1.2	41.0	-6.9	29.9	1.6	1250	-57.7	Peak *

** note: this data indicates the corrected field strength, applied to the average limit.*

4.4 Transmitter, Duty Cycle Correction Factor (DCCF)

When the average-mode field strength of a pulsed transmitter is measured, a DCCF shall be applied to the Peak value, and compared to the applicable Average limits. Under the provisions of §15.35(c), the duty cycle measurement shall be made in reference to a 100 ms period.

Figure 4: Transmitter Pulse On-Time (1)

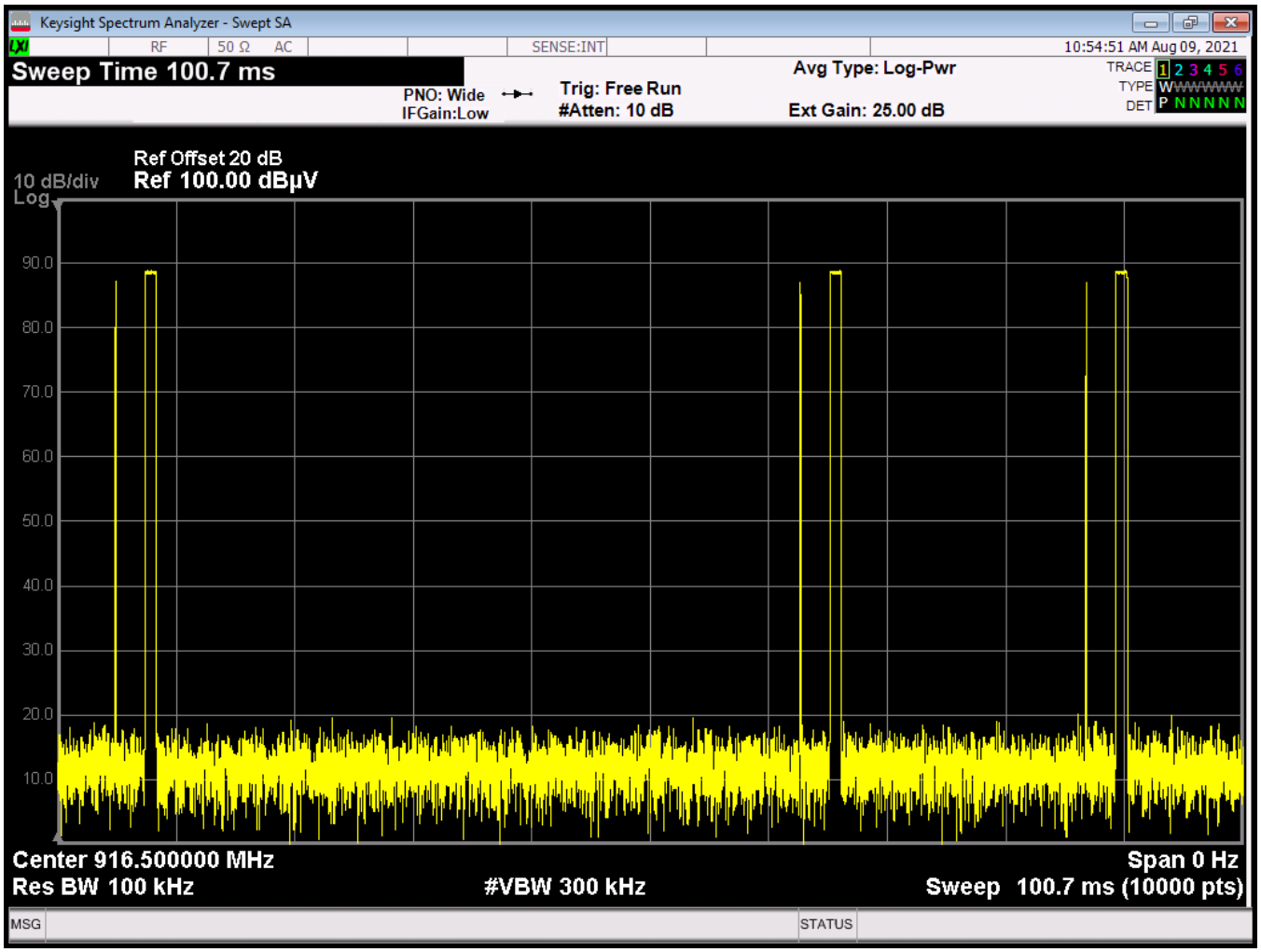
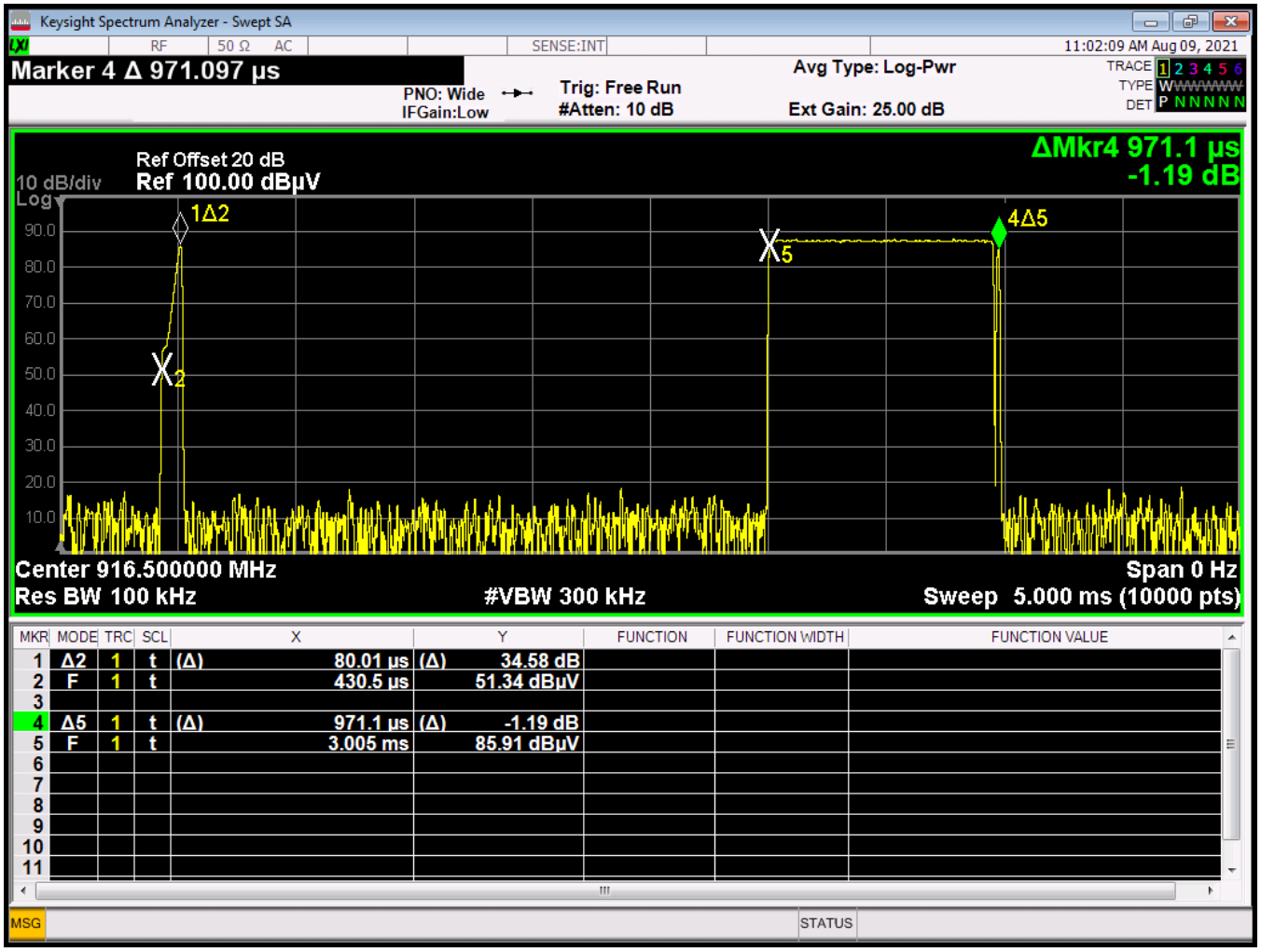


Figure 5: Transmitter Pulse On-Time (2)



The transmitter pulse train was observed over a 100 ms sweep. In this case, the total pulse train is greater than the measurement period. As such, the cycle time (Tcycle) shall be declared as 100 ms.

As depicted in Figure 4, the worst-case transmitter on-time (in any 100ms) is made of six sub-pulses. These series of pulses are not representative of a repeatable pulse train. In some cases, this measurement only yielded one set of pulses, with no distinguishable pattern.

The sweep time in Figure 5 was set to 5 ms, to make an accurate measurement of the individual sub-pulses. The longer pulse measures 971.1 us, and the shorter pulse measures 80 us.

As such, the worst case on-time ($t$on) is: 3(971.1) + 3(80) = 3.153 ms (worst-case).

The duty cycle can be calculated from the following formula:

$t\text{on} \div T\text{cycle} = \Delta$

$3.153 \div 100 = .0315$

$\Delta = 3.2\%$

Where Δ is the final duty cycle.

The duty cycle correction factor can be calculated from the following formula:

$20\text{LOG}(\Delta) = \delta$

$20\text{LOG}(0.032) = -29.897$

$\delta = 29.9$ dB (worst-case)

Where δ is the final DCCF.

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