

FCC/ ISED Certification Test Report
For the
Frederick Energy Products LLC
DDAC-PDS Magnetic Field Generator
with Collision Avoidance

FCC ID: QUI-DDAC-C-PDS
ISED: 11625A-DDACCPDS

WLL JOB# 14742-02 Rev 1
September 30, 2016
Updated January 3, 2017

Prepared for:
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1769 Jeff Road
Huntsville, AL 35806

Prepared By:
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Gaithersburg, Maryland 20879



Testing Certificate AT-1448

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Prepared by:



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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 (10/2015) of the FCC Rules and Regulations and Industry Canada RSS210 issue 9 Annex A. This Certification Test Report documents the test configuration and test results for a Frederick Energy Products LLC DDAC-PDS Magnetic Field Generator with Collision Avoidance.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. 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 Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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 DDAC-PDS Magnetic Field Generator with Collision Avoidance complies with the limits for an Intentional Radiator device under FCC Part 15.231 and RSS210 annex A.

Revision History	Description of Change	Date
Rev 0	Initial Release	September 30, 2016
Rev 1	Corrected IC Number	January 3, 2017

Table of Contents

Abstract iii

1 Introduction 1

 1.1 Compliance Statement 1

 1.2 Test Scope 1

 1.3 Contract Information 1

 1.4 Test Dates 1

 1.5 Test and Support Personnel 1

 1.6 Abbreviations 2

2 Equipment Under Test 3

 2.1 EUT Identification & Description 3

 2.2 Test Configuration 4

 2.3 Testing Algorithm 4

 2.4 Test Location 4

 2.5 Measurements 4

 2.5.1 References 4

 2.6 Measurement Uncertainty 4

3 Test Equipment 7

4 Test Results 8

 4.1 Duty Cycle Correction 8

 4.2 Transmit Turnoff Time (FCC Part §15.231(a) (2)) 12

 4.3 Periodic Transmissions Compliance 13

 4.4 Occupied Bandwidth: (FCC Part §2.1049) 15

 4.5 Radiated Emissions: (FCC Part §2.1053) 17

 4.5.1 Test Procedure 17

 4.6 Conducted Emissions (AC Power Line) 21

 4.7 Receiver Emissions 21

List of Tables

Table 1: Device Summary 3

Table 2: Expanded Uncertainty List 6

Table 3: Test Equipment List 7

Table 4: Radiated Emissions Limits 17

Table 5: Radiated Emission Test Data, 916.49MHz (Fundamental) 19

Table 6: Radiated Emission Data, Spurious Emissions <1GHz 20

Table 7: Radiated Emissions Data >1GHz 21

List of Figures

Figure 1: Duty Cycle Plot – Alarm Mode 100ms Worst Case..... 9
Figure 2: Duty Cycle Plot – Alarm Mode Pulse Width 10
Figure 3: Duty Cycle Plot – Periodic TX Mode 100ms Worst Case 11
Figure 4: EUT Turnoff Time 12
Figure 5: Periodic Transmission Timing 13
Figure 6: Single Pulse Time..... 14
Figure 7: Occupied Bandwidth 20dB..... 15
Figure 8: Occupied Bandwidth 99%..... 16

1 Introduction

1.1 Compliance Statement

The Frederick Energy Products LLC DDAC-PDS Magnetic Field Generator with Collision Avoidance complies with the limits for an Intentional Radiator device under FCC Part 15.231 and IC RSS210 issue 9.

1.2 Test Scope

Tests for radiated were performed. All measurements were performed in accordance with FCC part 15.231, IC RSS 210, and ANSI C63.10:2013. 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
1769 Jeff Road
Huntsville, AL 35806

Quotation Number: 68839

PO Number 6137

1.4 Test Dates

Testing was performed on the following date(s): 9/26/2016-9/28/2016

1.5 Test and Support Personnel

Washington Laboratories, LTD

James Ritter

Customer Representative(s)

David Estill, Ishmael Chigumira

1.6 Abbreviations

A	Ampere
ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	BandWidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	deciBel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10⁹ multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10³ multiplier
LISN	Line Impedance Stabilization Network
M	Mega - prefix for 10⁶ multiplier
m	meter
μ	micro - prefix for 10⁻⁶ multiplier
NB	Narrowband
QP	Quasi-Peak
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Frederick Energy Products LLC DDAC-PDS Magnetic Field Generator with Collision Avoidance is a vehicle mounted that operates in conjunction with the Frederick Energy products PAD and other generator units. The DDAC-PDS Magnetic Field Generator with Collision Avoidance produces a 73 kHz proximity field (certified under a separate report). When a user wearing a PAD unit enters this field it causes the PAD unit to visually and audibly alarm. In addition the PAD unit sends its serial number back to the Magnetic Field Generator (received on 916.49MHz) that causes the generator to visibly and audibly alarm. The DDAC-PDS Magnetic Field Generator with Collision Avoidance device also monitors for other field generators and when in the presents of their magnetic fields alarms and generates a 916.49MHz (tested in this report) signal that will cause the other generator to also alarm.

The PAD unit is a separate transmitter already certified.

The generator device is typically mounted on a vehicle, the PAD units are worn by personnel to warn both the equipment operators and people in the proximity of this equipment of possibly dangerous conditions.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Frederick Energy Products LLC
FCC ID:	QUI-DDAC-C-PDS
IC:	11625A-DDACCPDS
Model:	DDAC-PDS-CAM
FCC Rule Parts:	§15.231
IC Rule Parts:	RSS210 Annex 1
Emission Designator:	244KF1D
Maximum Field Strength	37620uV/m Peak at 3m , 3849.6 uV/m average at 3m
Modulation:	FM
Occupied Bandwidth:	171.1 kHz (20dB), 243.5kHz (99%)
Keying:	Automatic
Type of Information:	data
Number of Channels:	1 (916.49MHz)
Power Output Level	Fixed
Antenna Connector	integral
Antenna Type	Grounded Line Planar Antenna
Interface Cables:	None
Power Source & Voltage:	13VDC Vehicle Battery
Receiver	73kHz (exempt from certification)

2.2 Test Configuration

The EUT is a standalone unit..

2.3 Testing Algorithm

The DDAC-PDS Magnetic Field Generator with Collision Avoidance was configured to transmit constantly at 916.49MHz for radiated measurements. A second identical unit had been programmed with the end user program; this unit was used for the timing measurements.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, 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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

- ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation
- ANSI C63.10:2013 Procedures for Compliance Testing of Unlicensed Wireless Devices

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2012) 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

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

Where u_c = standard uncertainty

a, b, c, \dots = 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

$$U = k u_c$$

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 2 below.

Table 2: 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 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name: Radiated Emissions		Test Date: 9/28/2016	
Asset #	Manufacturer/Model	Description	Cal. Due
856	EMCO - 6507	ACTIVE LOOP 1KHZ - 30MHZ	11/12/2017
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	10/31/2016
522	HP - 8449B	PRE-AMPLIFIER 1-26.5GHZ	10/10/2016
276	ELECTROMETRICS - BPA-1000	PRE-AMPLIFIER RF 50KHZ-1GHZ	10/30/2016
626	ARA - DRG-118/A	ANTENNA HORN	4/7/2018
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	8/31/2017

4 Test Results

4.1 Duty Cycle Correction

Measurements may be adjusted where pulsed RF is utilized to find the average level associated with a quantity. This calculation is applied to limits for unlicensed devices.

- For Unlicensed Intentional Radiators under 47CFR Part 15, all duty cycle measurements are compared to a 100 millisecond period

The duty cycle correction factor is calculated by:

$$20 * \text{LOG} (\text{on time}/100 \text{ ms})$$

The measurement was performed in accordance with ANSI C63.10 section 7.5 “Procedure for determining the average value of pulsed emissions”

The following Figures show the plots of the modulated carrier. The spectrum analyzer was set to Zero Span and the video triggered to collect the pulse train of the modulation. Multiple sweeps were made to find the worst case 100ms. Calculations of the duty cycle correction factor were obtained from time data provided by the plots. The device has 2 modes of operation Alarm mode and periodic transmissions mode. As the periodic mode has a higher on time per 100ms this mode was used for duty cycle corrections.

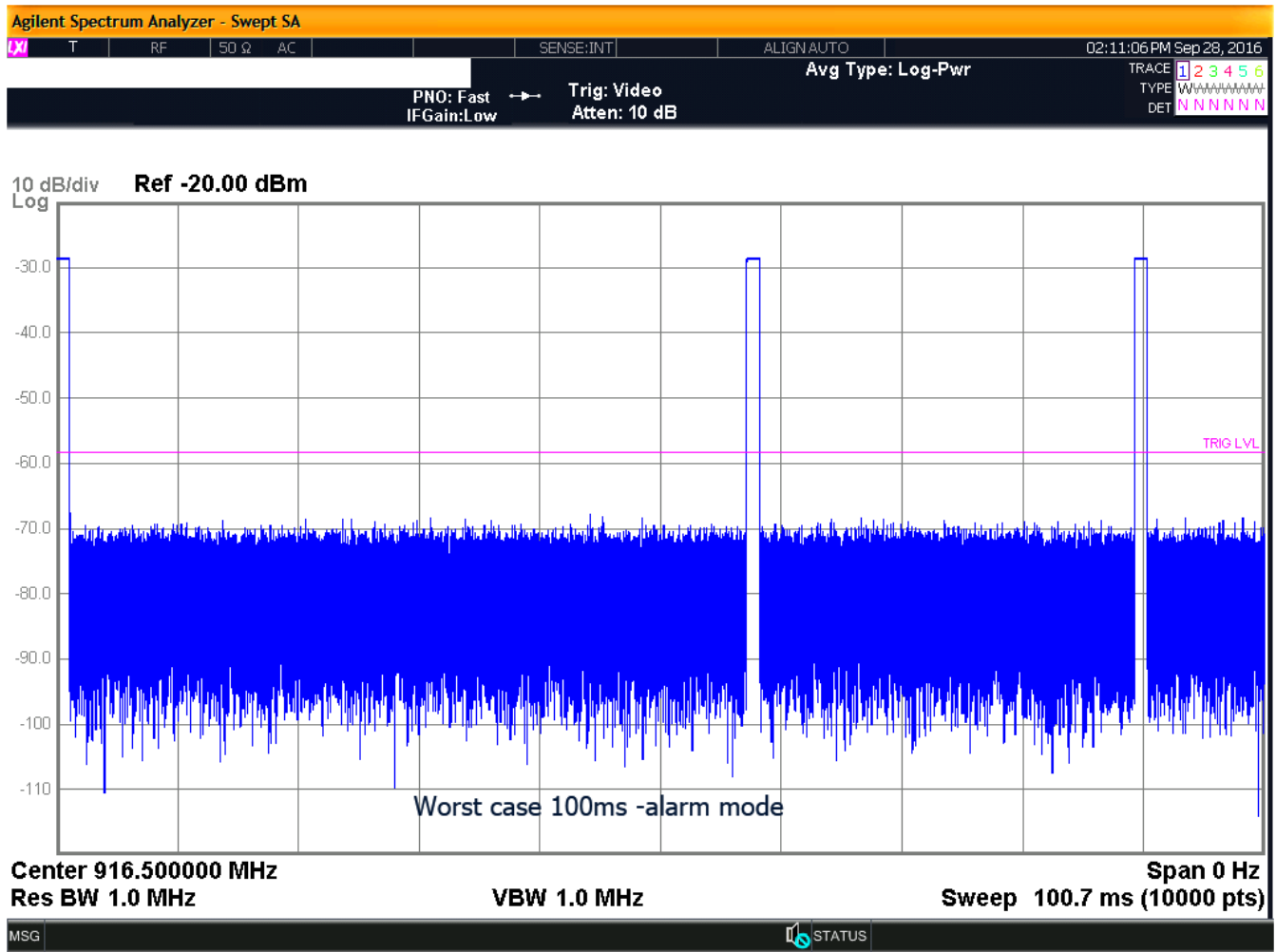


Figure 1: Duty Cycle Plot – Alarm Mode 100ms Worst Case

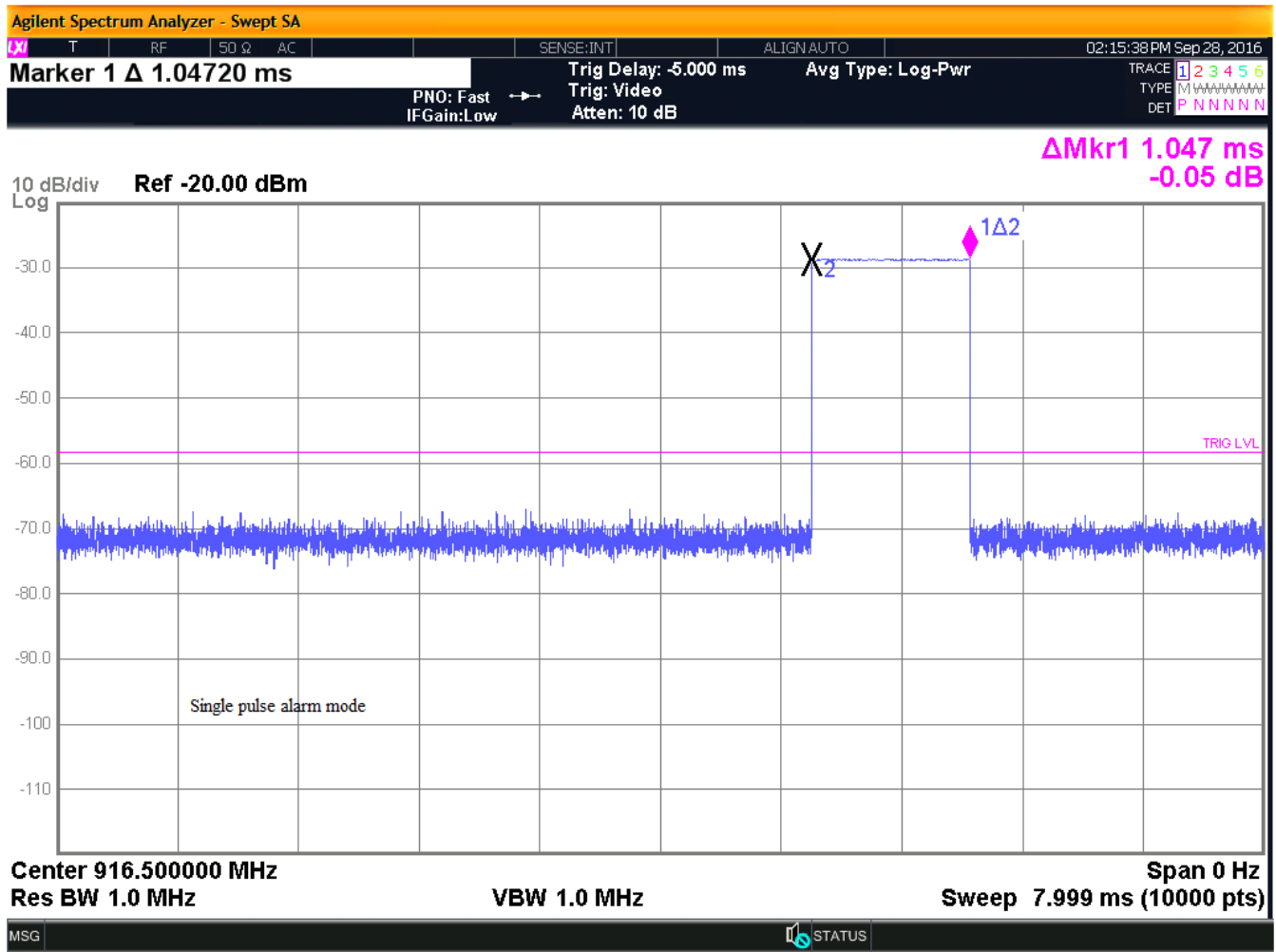


Figure 2: Duty Cycle Plot – Alarm Mode Pulse Width

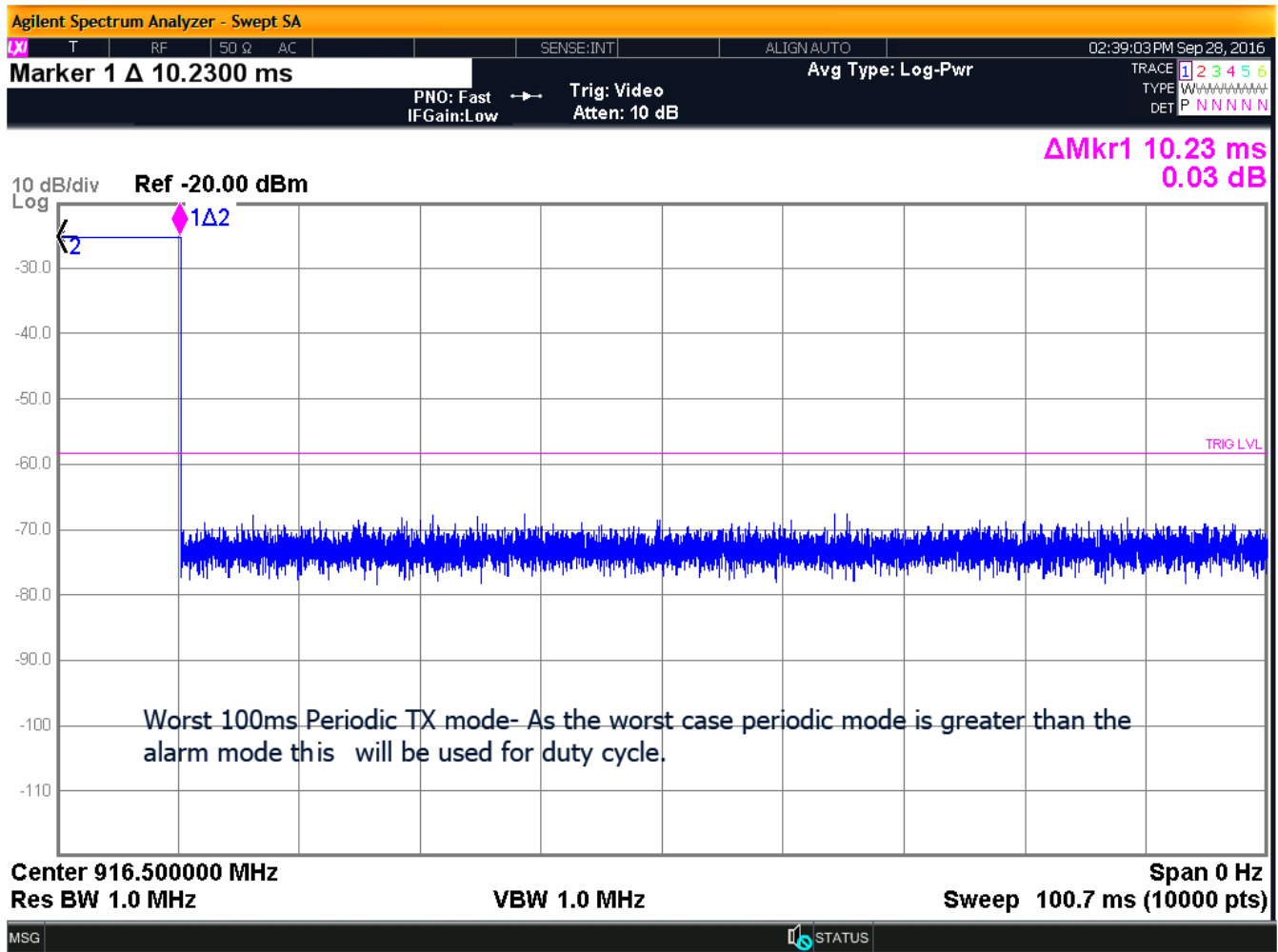


Figure 3: Duty Cycle Plot – Periodic TX Mode 100ms Worst Case

From the data in Figure 3 the following calculations are made.

The worst case on time was comprised of one 10.23 ms long pulse

On Time Per 100ms (worst case):

10.23ms

Duty cycle calculation:

$20 \cdot \text{LOG} (10.23\text{ms}/100\text{ms}) = 20 \cdot \text{LOG} (0.1023) = -19.8\text{dB}$ duty cycle correction

4.2 Transmit Turnoff Time (FCC Part §15.231(a) (2))

Per FCC part 15.231 Paragraph (a)(2) and RSS210 Annex A ‘A transmitter activated automatically shall cease transmission within 5 seconds after activation.’

The below figure shows that the turnoff time after activation is less than 5 seconds (see marker delta on plot) complying with the requirements of part 15.231(a)(2). Time to turn-off was measured at 2.018 seconds.

The EUT was measured by a spectrum analyzer through a near field antenna. The sweep was activated at the start of the EUT transmit signal.

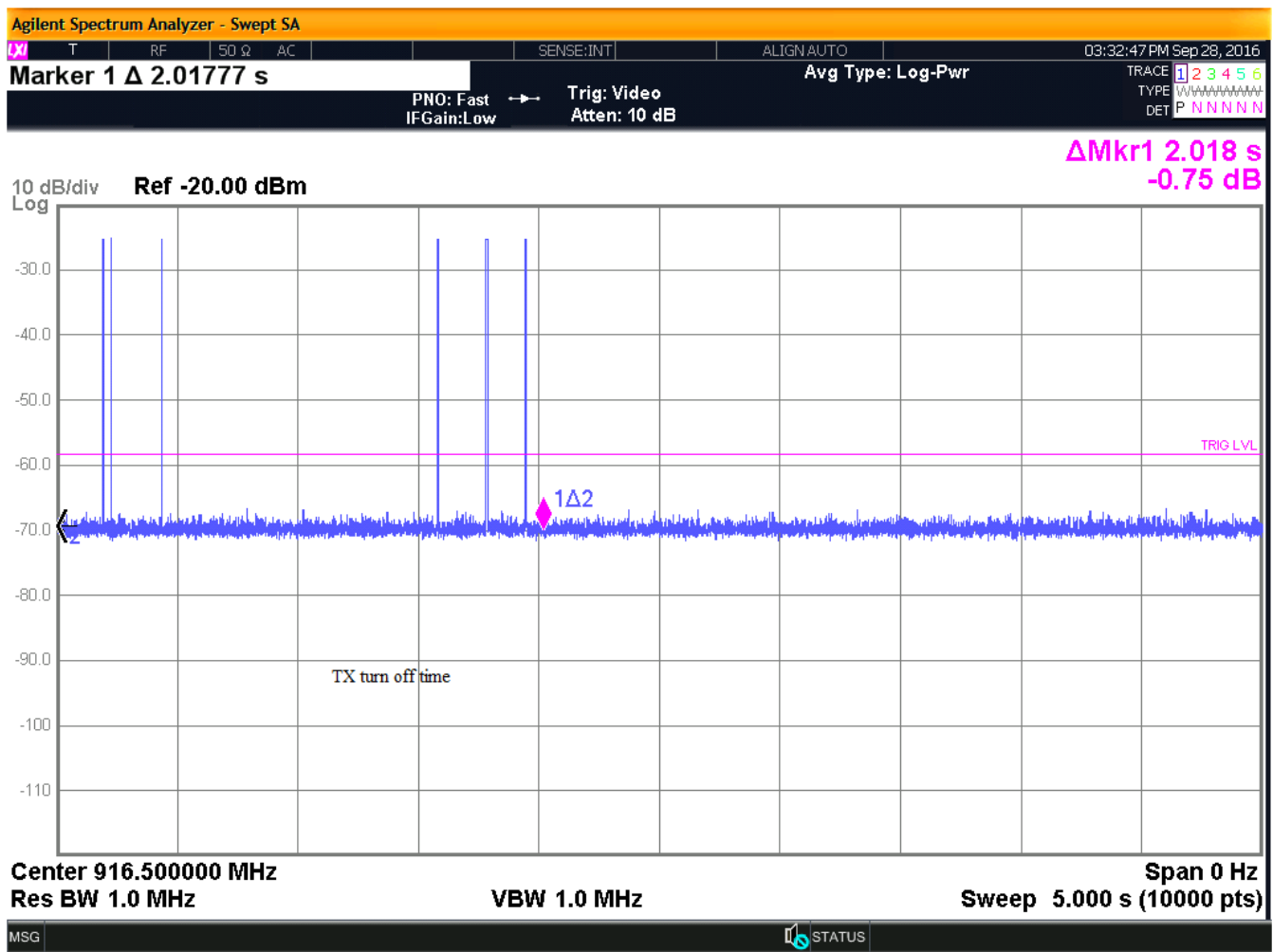


Figure 4: EUT Turnoff Time

4.3 Periodic Transmissions Compliance

Per FCC part 15.231 Paragraph (a)(3) and RSS210 Annex A 'Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does 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'

The EUT transmits periodic data consisting of its serial number and battery state. The below figures show that the periodic signal on time equals 10.23ms per 40.21 seconds or 0.916 seconds per hour. As this is used in a personnel safety application this complies with this section.

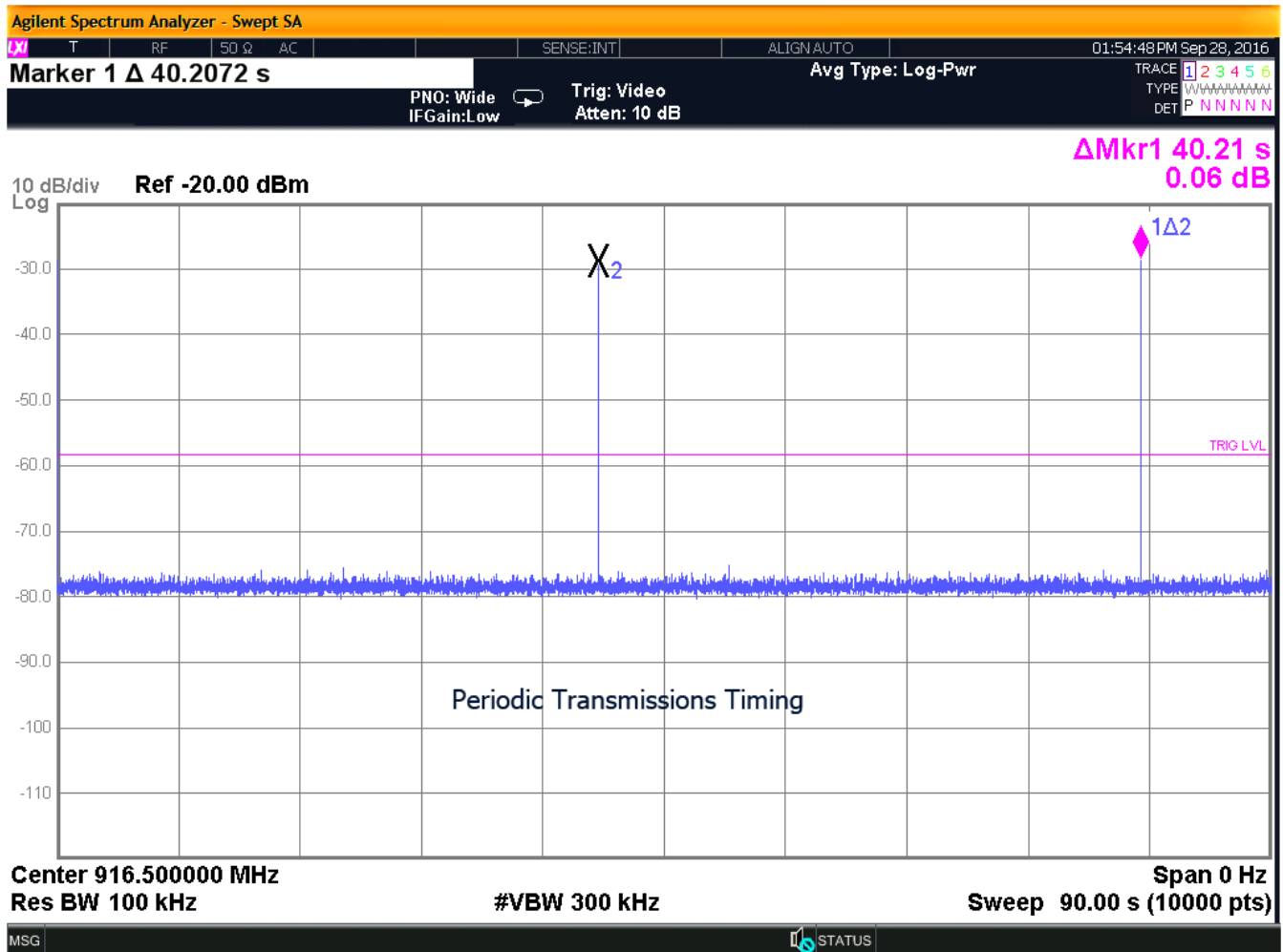


Figure 5: Periodic Transmission Timing

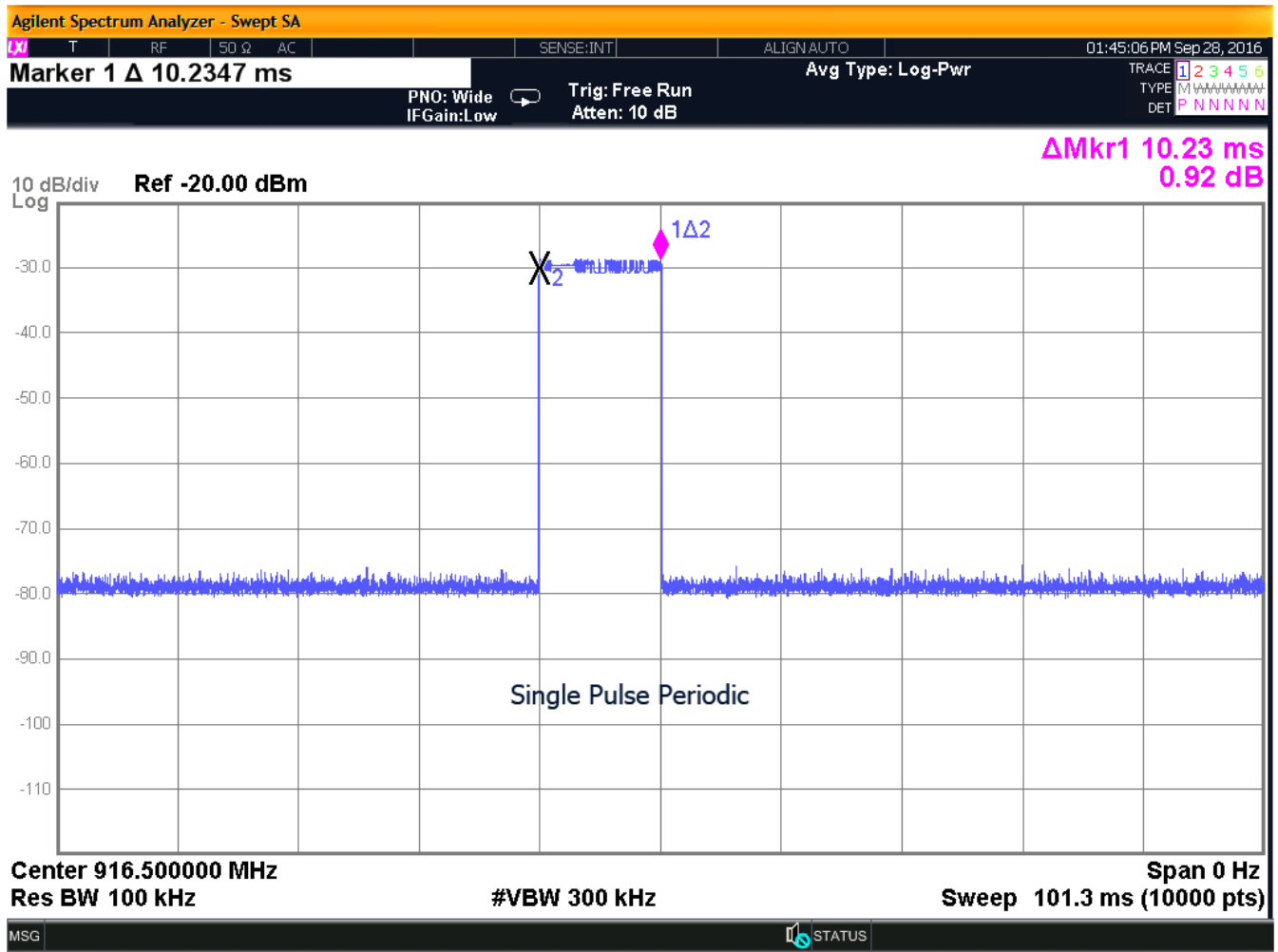


Figure 6: Single Pulse Time

4.4 Occupied Bandwidth: (FCC Part §2.1049)

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

The test was performed per ANSI C63.10 6.9.2 Occupied bandwidth—relative measurement procedure for the 20dB bandwidth and ANSI C63.10 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure (using power bandwidth function of the instrument).

According to FCC Part 15.231 & RSS210 Annex A the Occupied bandwidth (20dB) shall be:
(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. [99% for Canada]

For a system operating at 916.49MHz the maximum 20dB (99%) bandwidth is 4.58MHz.

At full modulation, the occupied bandwidth was measured at 171.1kHz for the 20dB BW and 243.5kHz for the 99% Bandwidth (as shown below):

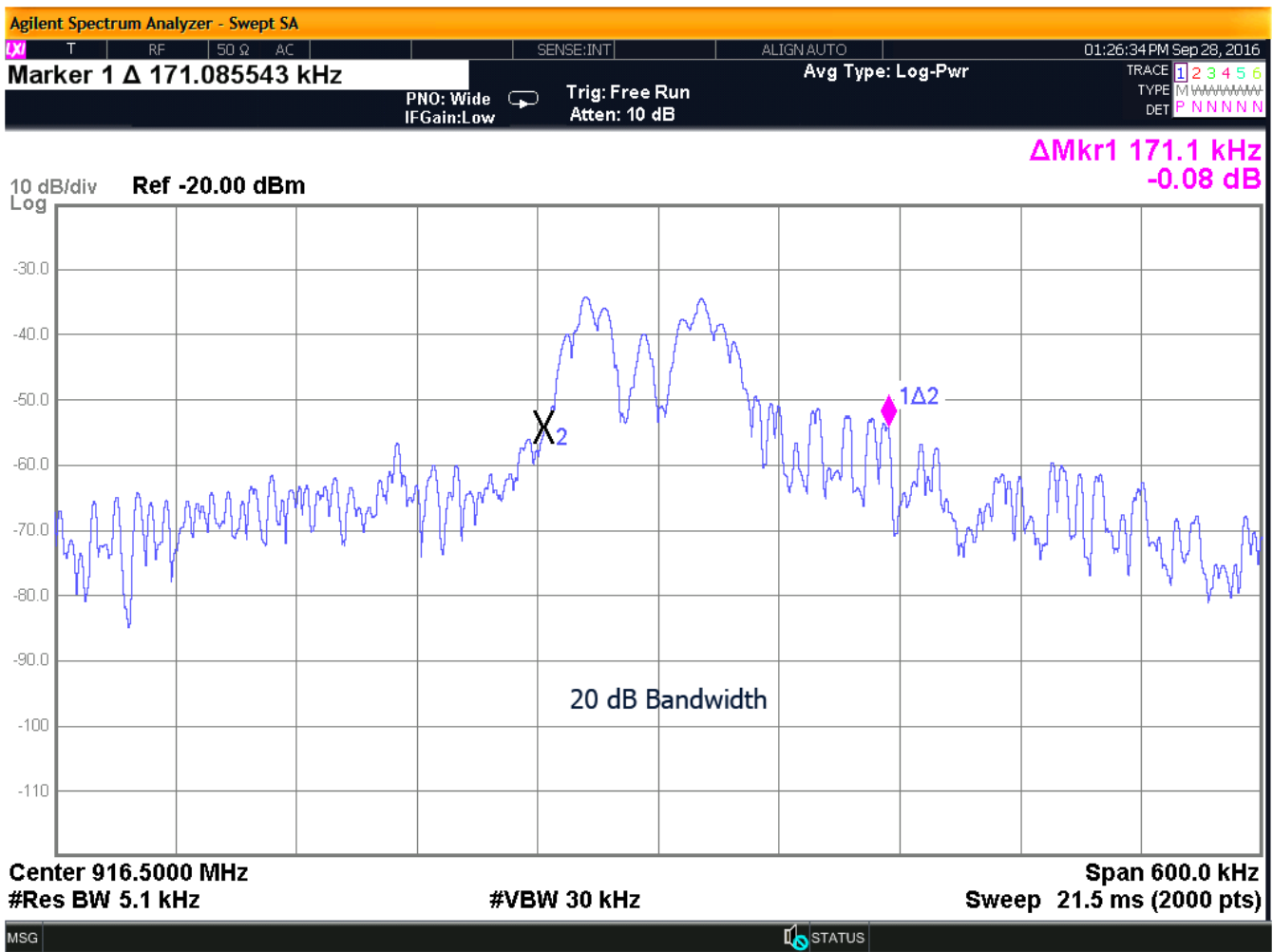


Figure 7: Occupied Bandwidth 20dB

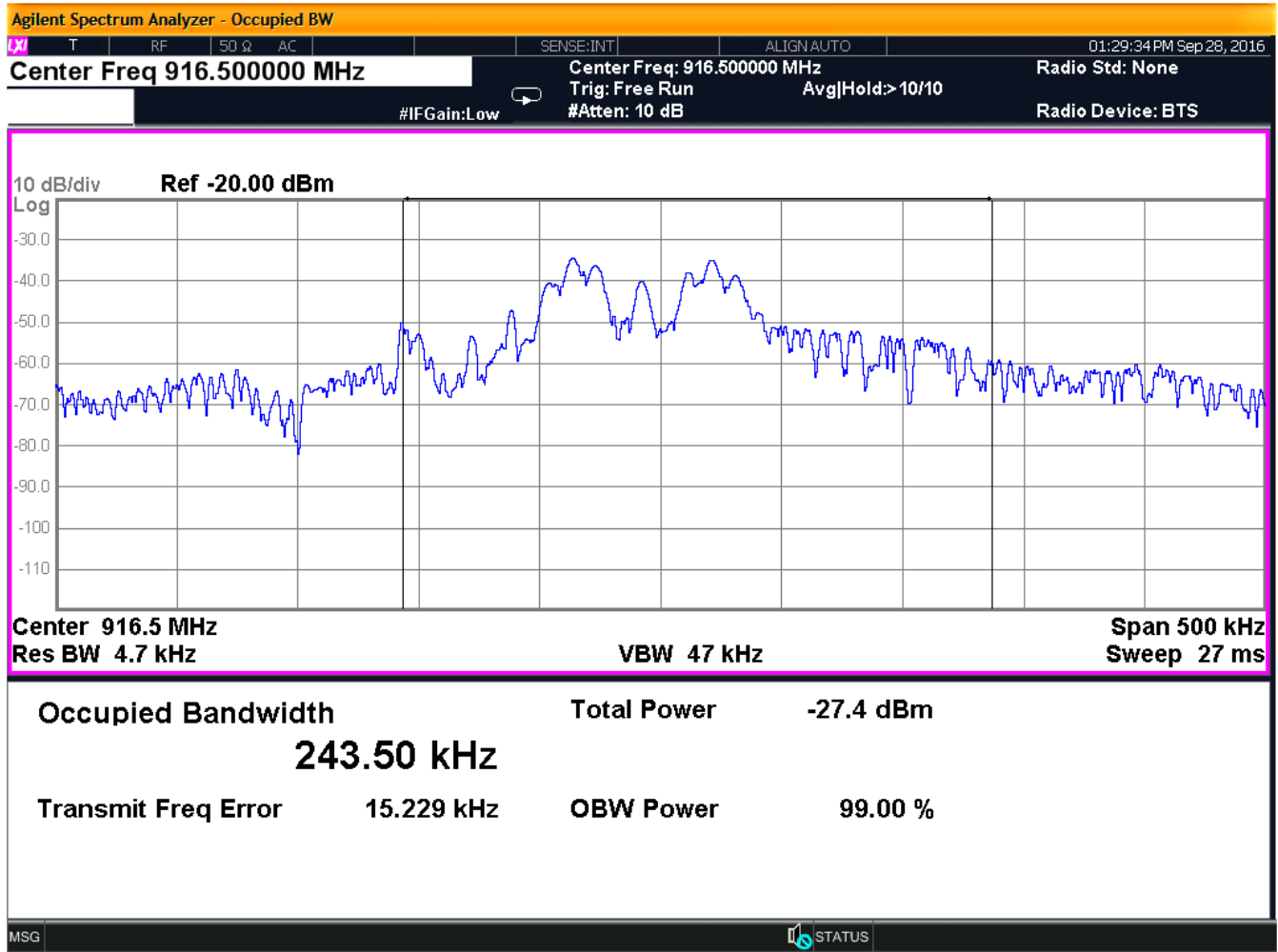


Figure 8: Occupied Bandwidth 99%

4.5 Radiated Emissions: (FCC Part §2.1053)

The EUT must comply with the radiated emission limits of 15.231(a) [RSS210 Annex A.1.2]. The limits are as shown in the following table.

Table 4: Radiated Emissions Limits

Fundamental Frequency (MHz)	Field Strength of Fundamental (µV/m)	Field Strength of Field strength of spurious emission (µV/m)
40.66-40.70	2250	225
70-130	1250	125
130-174	1250 to 3750	125 to 375
174-260	3750	375
260-470	3750 to 12500	375 to 1250
Above 470	12500	1250

Frequencies that fall in FCC part 15.205 restricted bands must be below part 15.209 limits within these bands.

In accordance with FCC part 15.35 when averaging is used the peak limit shall be 20 dB above the average limits.

4.5.1 Test Procedure

The measurement was performed in accordance with ANSI C63.10 section 6.5 “Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz” and section 6.6 “Radiated emissions from unlicensed wireless devices above 1 GHz”. Above 1 GHz RF absorber was placed between the EUT and Receive antenna. In addition above 1GHz the EUT was raised to 1.5m above the floor..

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.

In accordance with FCC part 15.35 averaging was performed by using a duty cycle correction subtracted from the peak reading. For this EUT a duty cycle correction of -19.8dB was calculated per section 4.1 of this report..

The EUT was tested in 3 orthogonal with the worst case reported (fundamental frequency is reported in all orthogonal).

Non harmonic spurious emissions peaks were tested against the average limits for compliance (no duty cycle correction was used).

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	100kHz	>300 kHz
>1000 MHz	1 MHz	3MHz (Peak)

Emissions were measured to the 10th harmonic of the transmit frequency. Worst case emission levels are reported.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level): V dBμV

Antenna Factor (Ant Corr): AFdB/m

Cable Loss Correction (Cable Corr): CCdB

Duty Cycle Correction (Average) DCCdB

Amplifier Gain: GdB

Electric Field (Corr Level): EdBμV/m = VdBμV + AFdB/m + CCdB + DCCdB - GdB

Table 5: Radiated Emission Test Data, 916.49MHz (Fundamental)

	Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factor (dB)	Duty Cycle correction (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Notes
Unit flat	916.49	V	190.00	1.50	87.83	1.4	0.0	28968.0	125000.0	-12.7	peak
	916.49	V	190.00	1.50	87.83	1.4	-19.8	2964.3	12500.0	-12.5	ave
Unit on side	916.49	H	90.00	2.00	90.10	1.4	0.0	37620.0	125000.0	-10.4	peak
	916.49	H	90.00	2.00	90.10	1.4	-19.8	3849.6	12500.0	-10.2	ave
Unit upright	916.49	V	270.00	1.60	85.90	1.4	0.0	23196.3	125000.0	-14.6	peak
	916.49	V	270.00	1.60	85.90	1.4	-19.8	2373.7	12500.0	-14.4	ave
Unit upright	916.49	H	190.00	1.80	87.80	1.4	0.0	28868.2	125000.0	-12.7	peak
	916.49	H	190.00	1.80	87.80	1.4	-19.8	2954.1	12500.0	-12.5	ave
Unit upright	916.49	V	10.00	1.00	90.00	1.4	0.0	37189.4	125000.0	-10.5	peak
	916.49	V	10.00	1.00	90.00	1.4	-19.8	3805.6	12500.0	-10.3	ave
Unit upright	916.49	H	90.00	1.90	85.10	1.4	0.0	21155.3	125000.0	-15.4	peak
	916.49	H	90.00	1.90	85.10	1.4	-19.8	2164.8	12500.0	-15.2	ave

Table 6: Radiated Emission Data, Spurious Emissions <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)
33.48	V	190.00	1.00	39.30	-7.9	37.3	100.0	-8.6
40.35	V	290.00	1.00	43.96	-12.9	35.9	100.0	-8.9
49.78	V	180.00	1.00	42.83	-18.5	16.5	100.0	-15.7
52.57	V	45.00	1.00	47.25	-19.1	25.5	100.0	-11.9
57.20	V	45.00	1.10	48.57	-19.2	29.4	100.0	-10.6
71.31	V	90.00	1.10	46.90	-17.9	28.3	100.0	-11.0
76.26	V	190.00	1.10	43.79	-17.9	19.8	100.0	-14.1
84.43	V	90.00	1.20	55.10	-18.3	69.2	100.0	-3.2
109.10	V	90.00	1.20	39.34	-13.3	20.0	150.0	-17.5
184.92	V	180.00	1.60	40.73	-13.9	22.0	150.0	-16.7
207.07	V	190.00	1.12	42.23	-13.8	26.3	150.0	-15.1
216.67	V	190.00	1.70	40.60	-14.2	20.8	200.0	-19.7
254.62	V	45.00	2.30	42.50	-13.1	29.4	200.0	-16.7
509.70	V	90.00	2.70	39.80	-5.1	54.4	200.0	-11.3
33.79	H	270.00	4.00	38.99	-8.1	35.2	100.0	-9.1
54.27	H	180.00	3.80	46.69	-19.3	23.4	100.0	-12.6
68.20	H	180.00	3.50	45.80	-18.0	24.4	100.0	-12.2
72.16	H	45.00	4.00	50.91	-17.8	45.2	100.0	-6.9
86.34	H	180.00	3.80	54.98	-18.2	69.2	100.0	-3.2
108.44	H	170.00	3.60	40.40	-13.4	22.3	150.0	-16.5
123.16	H	180.00	3.50	42.10	-11.7	32.9	150.0	-13.2
161.50	H	170.00	2.80	48.50	-13.3	57.5	150.0	-8.3
208.36	H	180.00	2.60	42.90	-14.1	27.5	150.0	-14.7
218.29	H	45.00	2.50	41.10	-14.2	22.2	200.0	-19.1
257.04	H	290.00	2.00	49.85	-12.9	70.6	200.0	-9.1

Table 7: Radiated Emissions Data >1GHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Duty Cycle Correction (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
1832.98	V	10.00	3.00	51.79	-7.4	0.0	166.6	12500.0	-37.5	pk
1832.98	V	10.00	3.00	51.79	-7.4	-19.8	17.0	1250.0	-37.3	Avg
2749.47	V	0.00	2.50	47.15	-2.7	0.0	167.5	5000.0	-29.5	pk
2749.47	V	0.00	2.50	47.15	-2.7	-19.8	17.1	500.0	-29.3	Avg
3665.96	V	10.00	2.80	45.55	-0.2	0.0	184.2	5000.0	-28.7	pk
3665.96	V	10.00	2.80	45.55	-0.2	-19.8	18.8	500.0	-28.5	Avg
4582.45	V	190.00	2.80	43.88	1.9	0.0	193.9	5000.0	-28.2	pk
4582.45	V	190.00	2.80	43.88	1.9	-19.8	19.8	500.0	-28.0	Avg
1832.98	H	45.00	3.20	49.62	-7.4	0.0	129.7	12500.0	-39.7	pk
1832.98	H	45.00	3.20	49.62	-7.4	-19.8	13.3	1250.0	-39.5	Avg
2749.47	H	60.00	2.80	46.60	-2.7	0.0	157.2	5000.0	-30.1	pk
2749.47	H	60.00	2.80	46.60	-2.7	-19.8	16.1	500.0	-29.9	Avg
3665.96	H	90.00	2.80	46.24	-0.2	0.0	199.4	5000.0	-28.0	pk
3665.96	H	90.00	2.80	46.24	-0.2	-19.8	20.4	500.0	-27.8	Avg
4582.45	H	60.00	3.40	44.20	1.9	0.0	201.1	5000.0	-27.9	pk
4582.45	H	60.00	3.40	44.20	1.9	-19.8	20.6	500.0	-27.7	Avg

No Harmonics seen above 4582.45MHz

4.6 Conducted Emissions (AC Power Line)

As this unit is only powered from a Vehicle battery no Power mains testing is required.

4.7 Receiver Emissions

As the receiver associated with this transmitter operates below 30MHz it is exempt from DOC or certification.