FCC & ISED CANADA CERTIFICATION TEST REPORT

for the

FREDERICK ENERGY PRODUCTS, LLC
PERSONAL ALARM DEVICE

FCC ID: QUI-BC-PAD-2
IC ID: 11625A-BCPAD2

WLL REPORT# 18052-01 REV 2

Prepared for:

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Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Frederick Energy Products, LLC

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March 31, 2023

WLL Report# 18052-01 Rev 2

Prepared by:

Ryan Mascaro
RF Test 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 Personal Alarm Device. 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, Personal Alarm Device complies with the requirements for an Intentional Radiator under FCC Part 15.231 and RSS-210 Issue 10 (6/2019).

Revision History	Description of Change	Date
Rev 0	Initial Release	March 31, 2023
Rev 1	TCB Comments, Dated: 4/27/2023	April 28, 2023
Rev 2	TCB Comments, Dated: 6/2/2023	June 3, 2023
Rev 3	TCB Comments. Update HVIN	June 11, 2023

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1 Introduction

1.1 Compliance Statement

The Frederick Energy Products, LLC, Personal Alarm Device complies with the limits for an Intentional Radiator device under FCC Part 15.231 and ISED Canada RSS-210 Issue 10.

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:	FEP10639
Quotation Number:	73688

1.4 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Will Murrey

1.5 Test Dates

3/21/2023 to 3/23/2023

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Frederick Energy Products, LLC	
FCC ID:	QUI-BC-PAD-2	
ISED ID:	11625A-BCPAD2	
EUT Marketed Name:	Product #1	Frederick Energy Products PAD
	Product #2	Raymond iWarehouse PAD
HVIN:	Product #1	BC-PAD-2
	Product #2	1329196/001
FCC Rule Parts:	FCC: §15.231	ISED: RSS-210
FCC Emission Designator:	39K5F1DXN (recommended, or TCB to correct)	
IC Emission Designator:	97K0F1DXN (recommended, or TCB to correct)	
Fixed Frequency:	916.475 MHz	
Occupied Bandwidth:	20dB	39.48 kHz
	99%	97.60 kHz
Keying:	Automatic	
Modulation or Protocol:	FM, FSK	
Type of Information:	Proximity, Telemetry	
Number of Channels:	1	
3m Radiated Field Strength:	Peak: 48,585 uV/m	Average: 5,030 uV/m
Transmitter Power (from 3m FS):	Peak: 0.72 mW	Average: 0.008 mW
Worst Spurious Emission:	None Detected (see Page 25 of 59)	
Antenna Type:	Linx, ANT-916-JJB-HT-T (Internal to EUT Housing)	
Maximum Antenna Gain:	-12.3 dBi	
Test Software/Firmware:	Proprietary Test Mode, V. 0-665	
Power Source & Voltage:	Battery Powered (Cannot Charge and Transmit Simultaneously)	

The Frederick Energy Products, LLC, Personal Alarm Device (PAD) is a proximity alarm device, used for collision avoidance. The PAD has the ability to detect a 73 kHz H-Field, from a Generator device, in three distinct proximity zones. These zones, as defined in the product user's manual, cause the EUT to go into different transmit modes. For the purposes of testing and evaluation, the three modes are referred to as follows: (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 the output power from the 916.5 MHz transmitter, and the radiated field strength, is not affected by the changing of modes. Moreover, during a transmission in any of the modes, the type of data (number/size of packets) does not change. The only transmitter variation that occurs is the duration of the pulsed emission. The three modes were investigated to determine the worst-case timing.

The PAD is battery powered, and was provided with a 120 VAC, USB-style wall charging unit. The PAD cannot transmit while it is charging.

2.2 Testing Algorithm

The Personal Alarm Device was tested in a powered-on, steady state, with the transmitter enabled as appropriate. The worst-case mode is the Danger mode. When the transmitter is in this mode, the pulsed emissions are set to transmit at their highest duty cycle. In this regard, this mode also yields the lowest duty cycle correction factor (DCCF). The 19.7 dB DCCF, as denoted in the table below, shall be employed when averaging the Peak field strength of the device radiated emissions. Overall, worst-case emissions are provided throughout this report. Table 2 provides a summary of the worst-case transmit modes, their duty cycle information.

Table 2: TX Mode Summary with DCCF

Proximity to Generator	Transmit Mode	Duty Cycle	DCCF
≥ 8-meters *	Health	8.7 %	21.2 dB
~ 7m to 8m *	Warning	9.7 %	20.2 dB
≤ 7-meters *	Danger	10.3 %	19.7 dB

** note: these distances were solely used for testing purposes. Actual zone/mode distance may vary, as defined by the manufacturer's theory of operation, or user's manual.*

2.3 Test Configuration

The Personal Alarm Device was tested in a stand-alone configuration. As necessary, the EUT was positioned in proximity to a 73 kHz generator (MFG) as a means to trigger the 916.5 MHz radio. The MFG was not introduced onto the test site. The MFG did not influence the testing results.

Table 3: System Configuration List

Name / Description	HVIN	Part Number	Serial Number	Revision
Frederick Energy Products PAD	BC-PAD-2	N/A	N/A	N/A
Raymond iWarehouse PAD	1329196/001	N/A	N/A	N/A

Table 4: Support Equipment

Item	Model/Part Number	Serial Number
USB Wall-Wart	N/A	N/A
73 kHz Generator	MFG	N/A

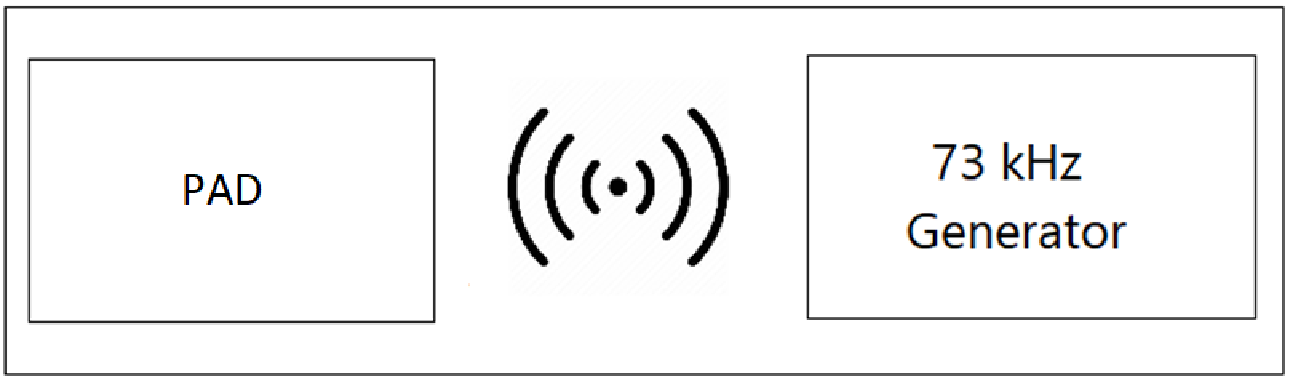
Table 5: Cable Configuration

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
Charging	USB-style	< 0.5m	Y	AC Mains

2.4 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.

Figure 1: Test Configuration (Example Only)



2.5 Measurements

2.5.1 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

2.5.2 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)

2.6 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

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

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 6 below.

Table 6: 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 7: Transmitter Testing to 15.231 – 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	Pass
15.35(c)	RSS-GEN	100ms Duty Cycle	Completed

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 Personal Alarm Device stopped transmitting within the required time period. A 10-second sweep was made, during which time, the transmitter was triggered from Danger Mode into Health Mode. By moving the EUT away from the Generator, the transmitter was triggered into a mode that periodically deactivates transmission. Figure 2 and Figure 3 provide 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 < 1.7 seconds.

Figure 2: Deactivation of Transmitter (BC-PAD-2)

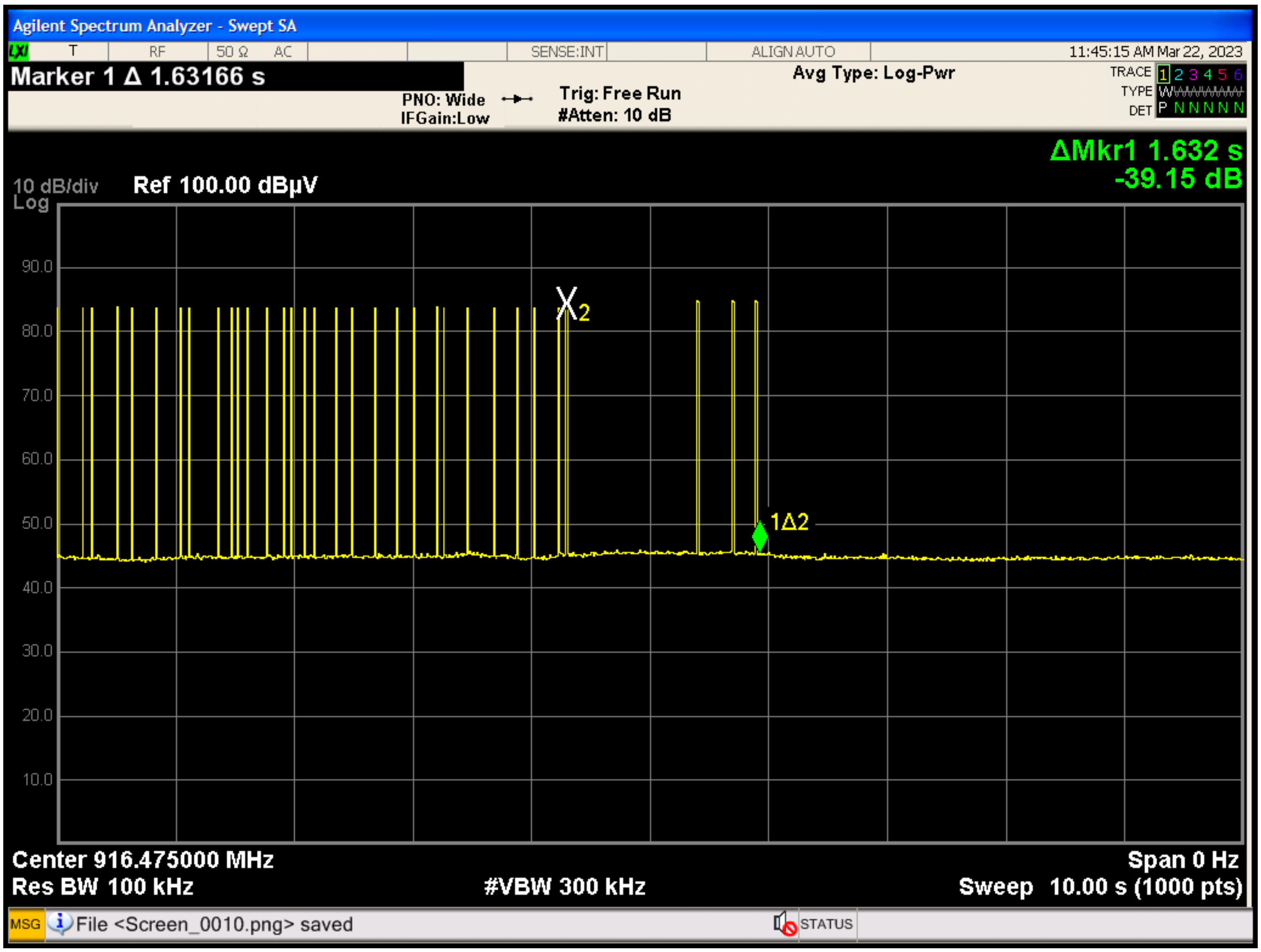
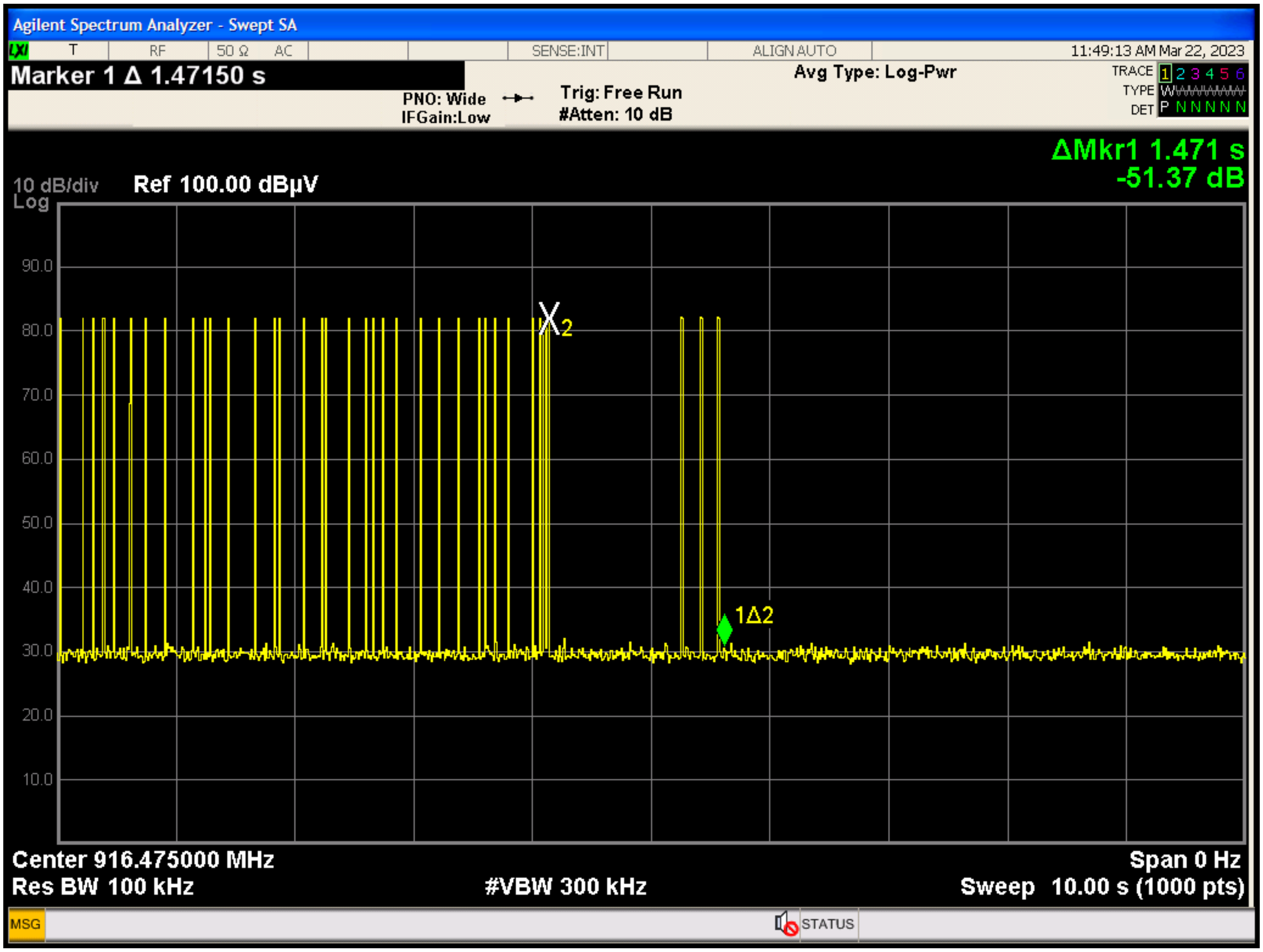


Figure 3: Deactivation of Transmitter (1329196)



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 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.

When the PAD is in a polling mode, (Health), it only transmits once every 40-seconds. During this mode, each transmission is ~ 8.7 ms, resulting in a total of 0.8 seconds per hour of polling transmissions.

The EUT complies with the requirements of this rule part.

4.4 Occupied Bandwidth – FCC Part §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. The OBW is determined at the points 20 dB down from the peak of the transmitter carrier. The EUT complies with the requirements of this section.

Table 8: Occupied Bandwidth Results (Worst-Case)

TX Frequency	Bandwidth	Limit	Results
916.475 MHz	39.48 kHz	4.582 MHz	Pass

Figure 4: Occupied Bandwidth (BC-PAD-2)

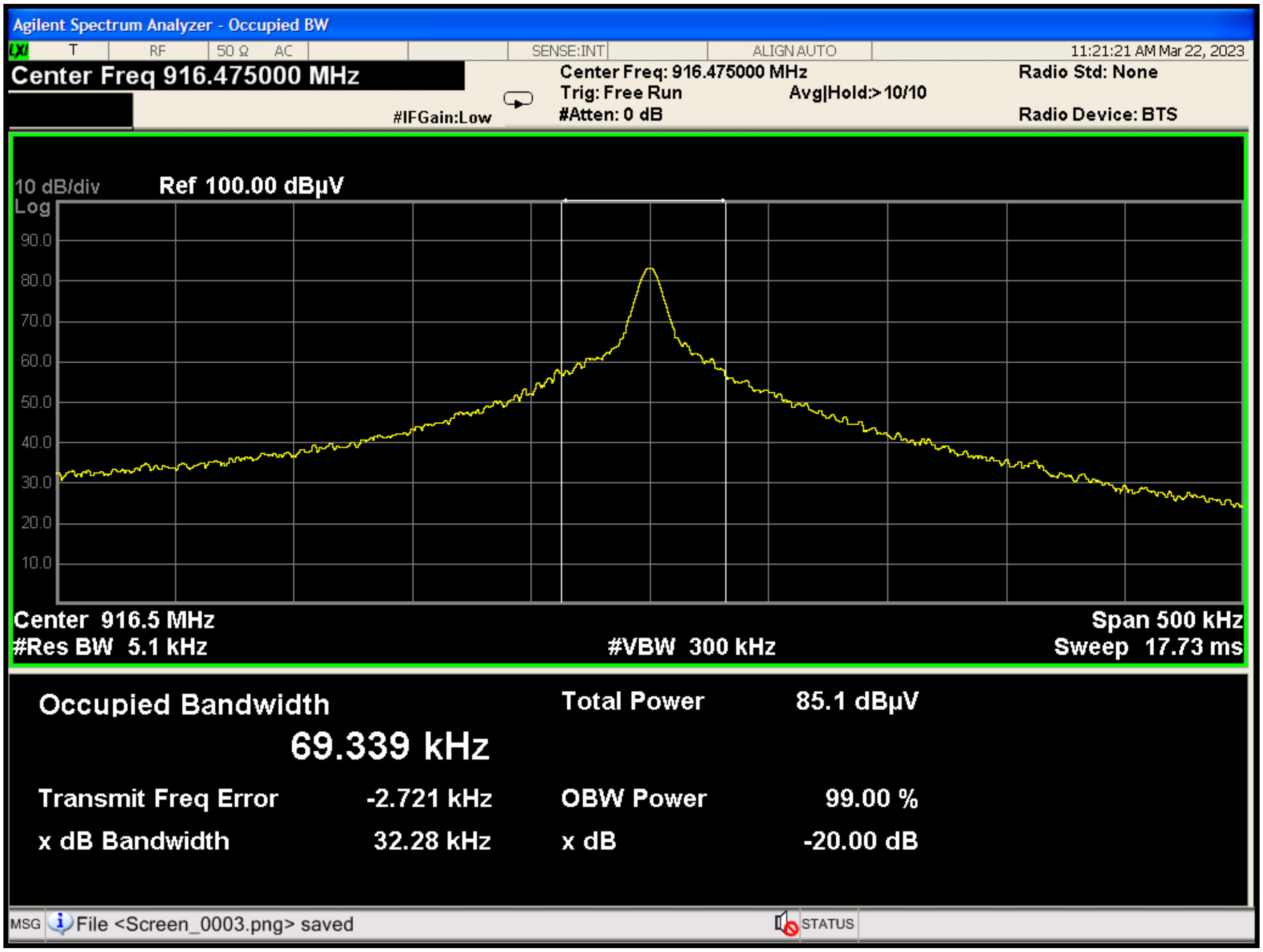
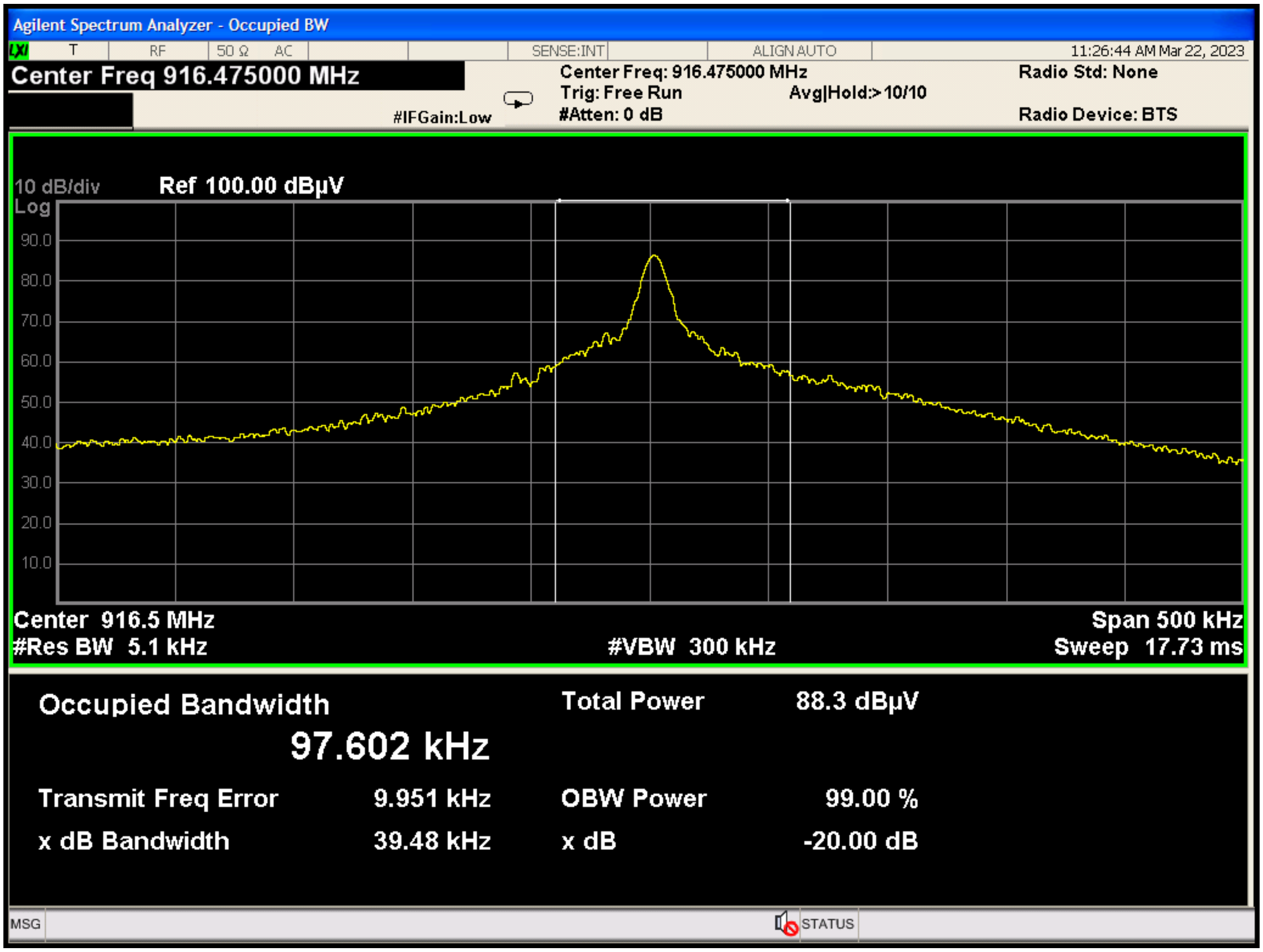


Figure 5: Occupied Bandwidth (1329196)



4.5 Radiated Emissions, Fundamental Transmitter – FCC Part §15.231(b)

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

Fundamental Frequency (MHz)	Field Strength of Fundamental (µV/m)
40.66 – 40.70	2250
70 – 130	1250
130 – 174	1250 to 3750
174 – 260	3750
260 – 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 18.4 dB shall be applied to the Peak Field Strength in order to obtain the Average Field Strength and compared to limits in the table above.

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 3-meters. 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 916.5 MHz radio emissions were measured. the horizontal and vertical field components were measured, to determine the worst-case levels. The detector function was set to peak mode, for measurements of the fundamental. 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 complies with the requirements of this section.

The EUT was evaluated at three orthogonal axes (X, Y, Z) to determine the orientation that yielded the highest radiated field strength. The worst-case emissions are reported below.

The final test data appears on the next page.

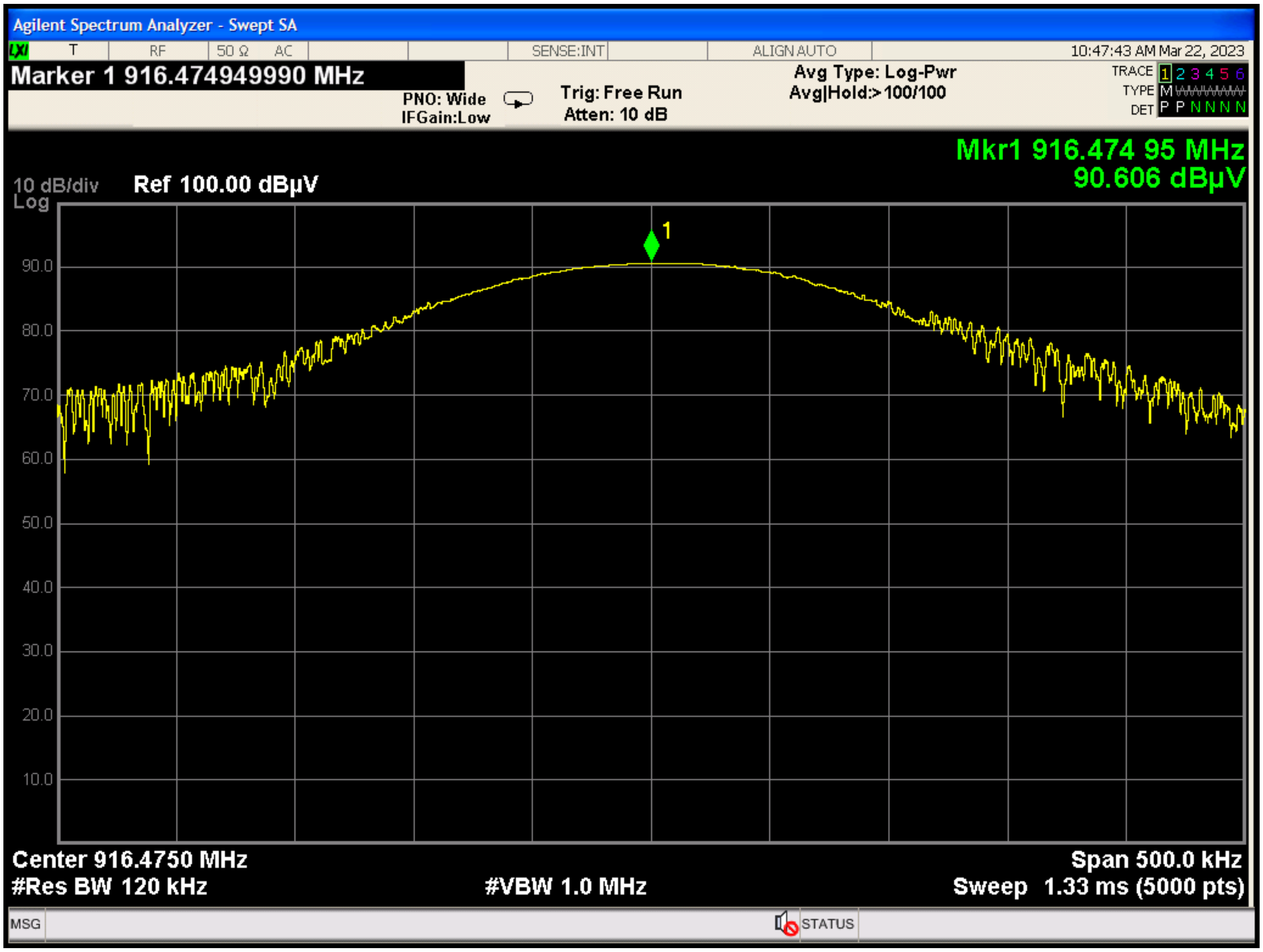
Table 9: Fundamental Field Strength, Test Results (BC-PAD-2)

RX Antenna (Polarity)	EUT Axis (Orthogonal)	Table (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr. Factors (dB/m)	DCCF (dB)	Corr. FS (uV/m)	Limit (uV/m)	Margin (dB)	Emission (Type)
V	Y	25	120	85.63	3.12	0.0	27384.2	125000	-13.20	Peak
V	Y	25	120	85.63	3.12	-19.7	2834.7	12500	-12.90	AVG
H	X	0	100	84.20	3.12	0.0	23227.4	125000	-14.60	Peak
H	X	0	100	84.20	3.12	-19.7	2404.4	12500	-14.30	AVG

Table 10: Fundamental Field Strength, Test Results (1329196)

RX Antenna (Polarity)	EUT Axis (Orthogonal)	Table (Degree)	Ant. Height (cm)	SA Level (dBuV)	Corr. Factors (dB/m)	DCCF (dB)	Corr. FS (uV/m)	Limit (uV/m)	Margin (dB)	Emission (Type)
V	Y	344	100	88.72	3.12	0.0	39084.1	125000	-10.10	Peak
V	Y	344	100	88.72	3.12	-19.7	4045.8	12500	-9.80	AVG
H	X	135	100	90.61	3.12	0.0	48584.8	125000	-8.20	Peak
H	X	135	100	90.61	3.12	-19.7	5029.2	12500	-7.90	AVG

Figure 6: Worst-Case Fundamental, 3-meter Field Strength



* for Table 9 and Table 10, the device was set to transmit at full power in the Danger Mode. All three orthogonal planes were investigated. All three proximity modes (timing) were investigated. The data provided in these tables is final and represents the highest possible fundamental field strength from the transmitter. Figure 6 provides the worst-case data point and supports Table 10. The level of 90.61 dBuV is uncorrected, and taken at a measurement distance of 3-meters.

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 3m:

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

The limits for the field strength of the spurious emissions, in the above table, are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) 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.

Because the device transmitter is pulsed, the harmonic spurious emissions (if detected) shall be measured using only a Peak Detector, and then corrected using a DCCF, in order to calculate the Average Field Strength and compare to the limits in the table above. The uncorrected Peak Field Strength shall not be more than 20 dB over the Average limit.

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 area test site (OATS). 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. 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 10 GHz were measured, which covers the tenth harmonic of the fundamental. Both the horizontal and vertical field components were measured. The detector function was set to 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.

The EUT complies with the requirements of this section.

The EUT was evaluated at three orthogonal axes (X, Y, Z) to determine the orientation that yielded the highest radiated field strength. The worst-case position was maintained during the test. The worst-case emissions are reported below.

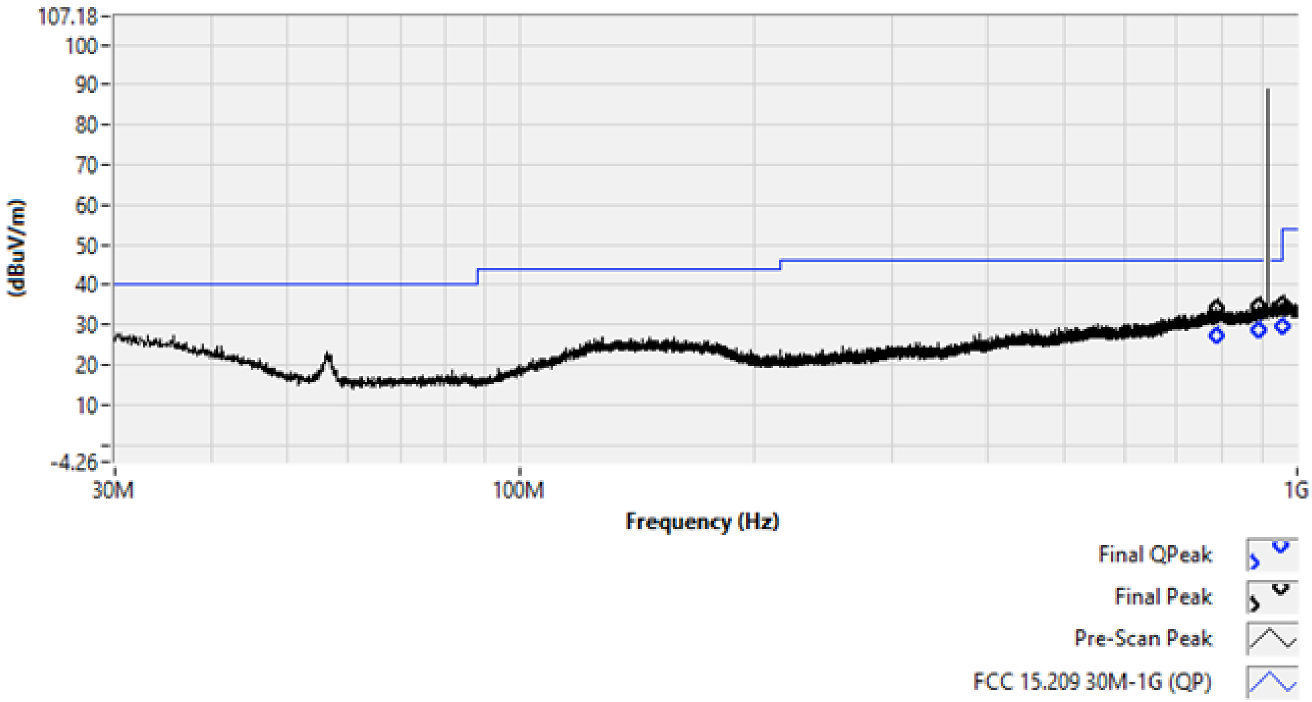
When evaluated at 3-meters, no unwanted emissions were detected from the EUT in the frequency range of 30MHz to 10GHz, which covers the tenth harmonic of the fundamental.

All measurements were made at the noise floor of the measurement system.

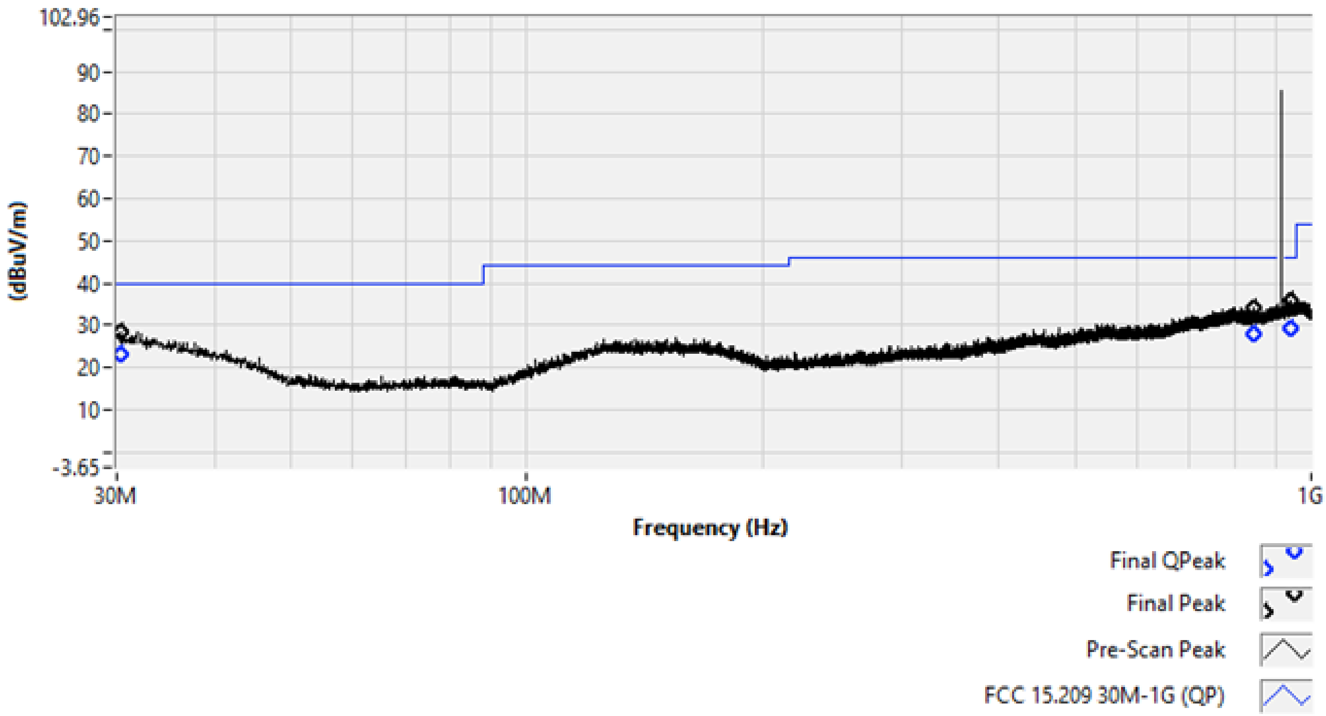
Table 11: 3m Radiated Emissions Test Data (BC-PAD-2)

Frequency (MHz)	Detector	Corr. Meas. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
30.300	Peak	28.577	--	--	0	Horiz, 100
	QP	23.201	40	-16.799	0	Horiz, 100
785.375	Peak	34.363	--	--	25	Vert, 120
	QP	27.538	46	-18.462	25	Vert, 120
842.732	Peak	33.993	--	--	0	Horiz, 100
	QP	27.871	46	-18.129	0	Horiz, 100
891.260	Peak	34.926	--	--	25	Vert, 120
	QP	28.610	46	-17.390	25	Vert, 120
944.053	Peak	35.723	--	--	0	Horiz, 100
	QP	29.391	46	-16.609	0	Horiz, 100
957.026	Peak	35.287	--	--	25	Vert, 120
	QP	29.634	46	-16.366	25	Vert, 120
7079.00	Peak	54.102	74	-19.898	25	Vert, 150
	Avg	38.434	54	-15.566	25	Vert, 150
8240.00	Peak	54.341	74	-19.659	25	Vert, 150
	Avg	39.344	54	-14.656	25	Vert, 150
9346.00	Peak	56.932	74	-17.068	0	Horiz, 150
	Avg	44.200	54	-9.800	0	Horiz, 150
9884.00	Peak	57.33	74	-16.67	0	Horiz, 150
	Avg	44.825	54	-9.175	0	Horiz, 150

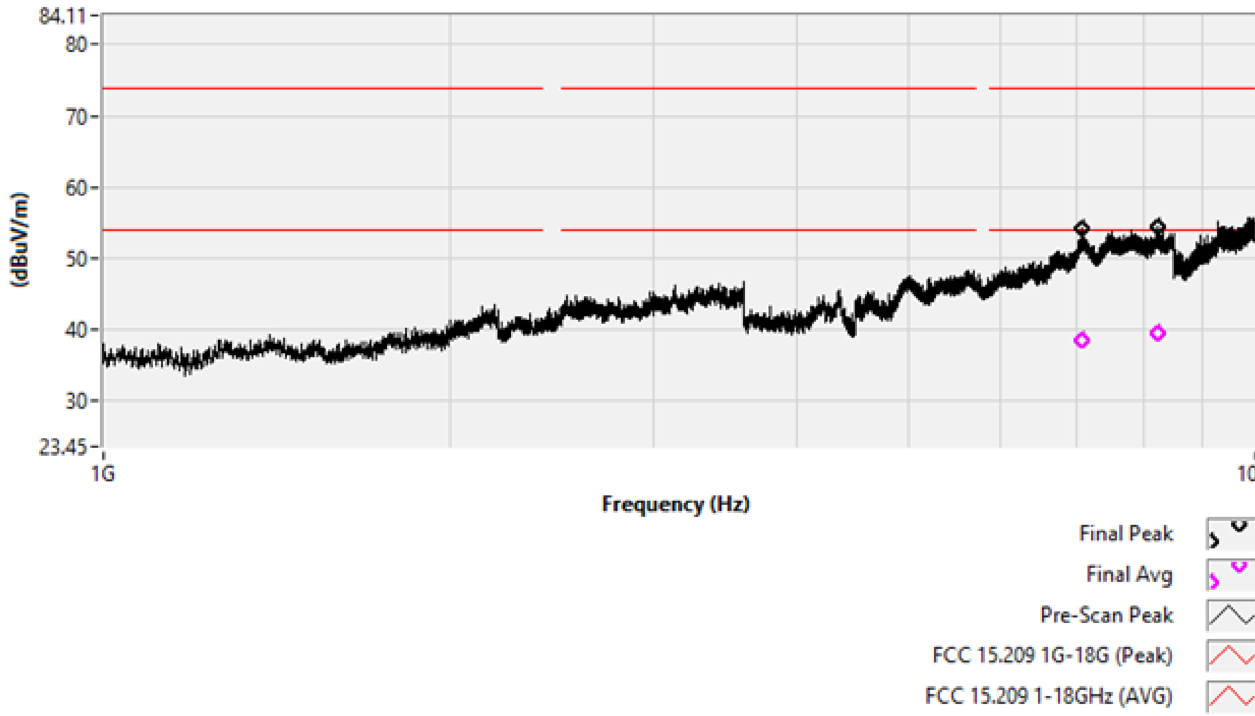
BC-PAD-2, Pre-scan and Final Data (Vertical)



BC-PAD-2, Pre-scan and Final Data (Horizontal)



BC-PAD-2, Pre-scan and Final Data (Vertical)



BC-PAD-2, Pre-scan and Final Data (Horizontal)

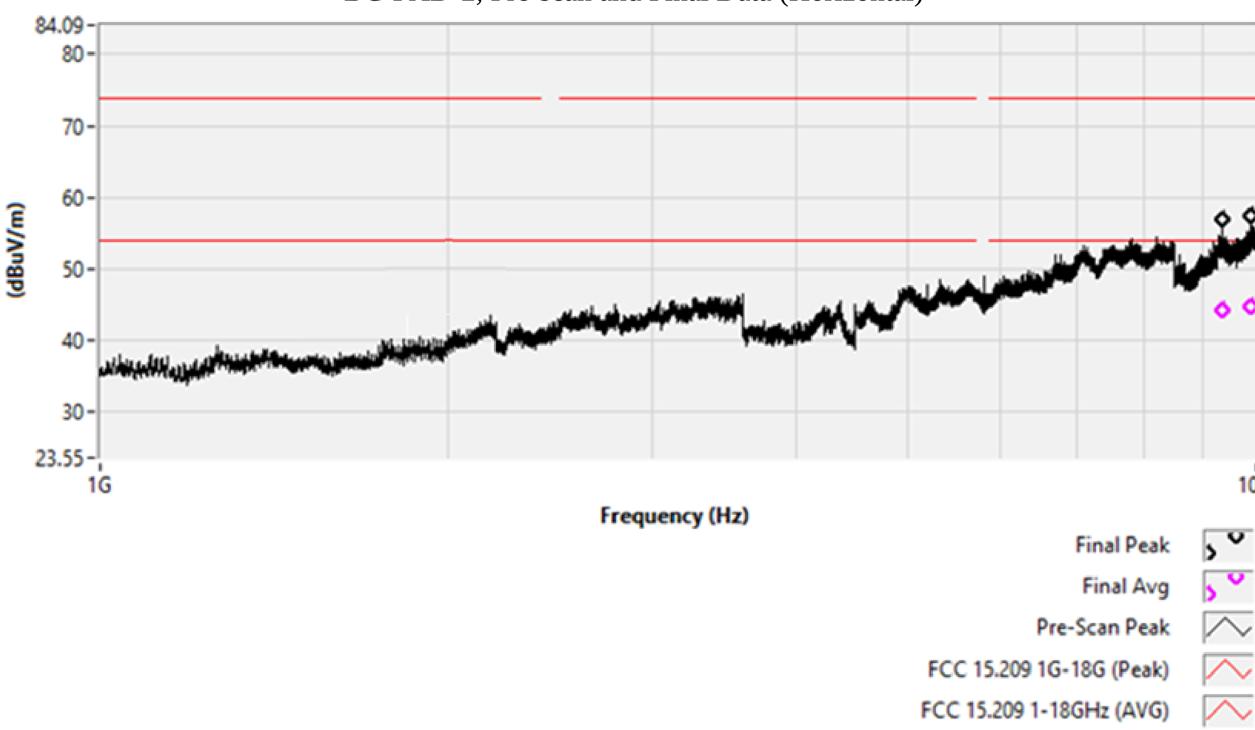


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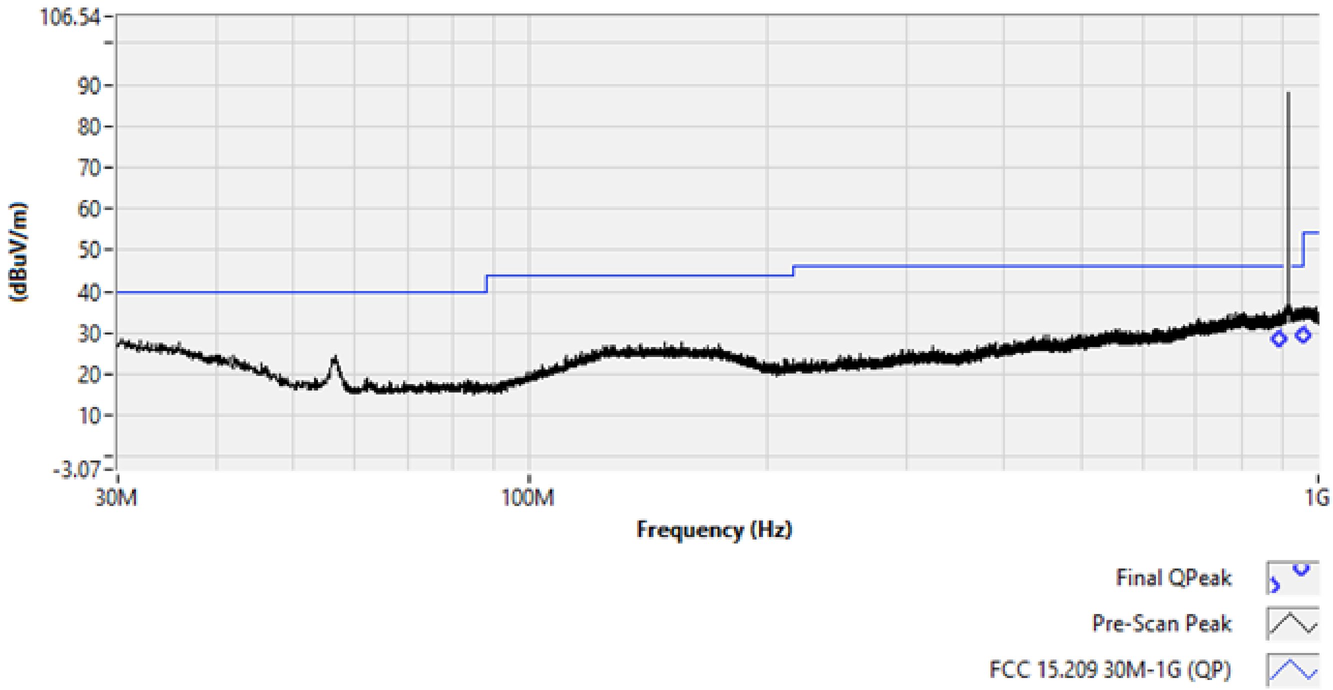
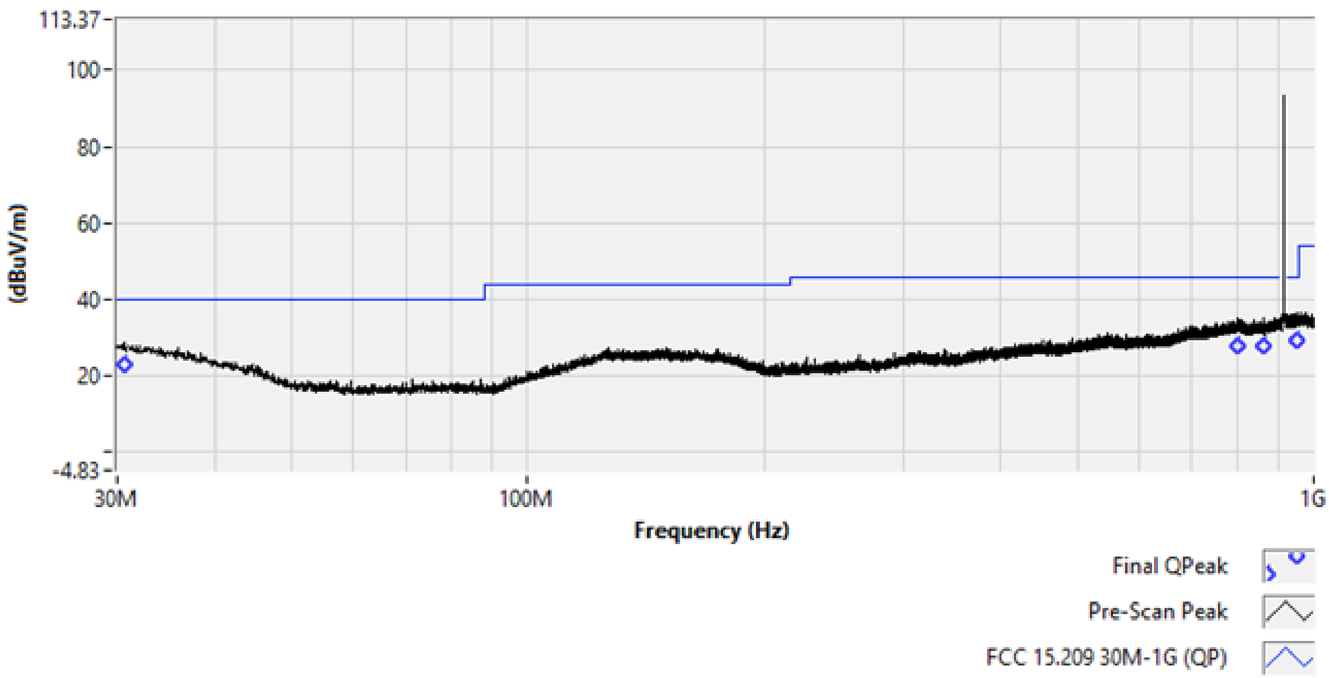
Table 12: 3m Radiated Emissions Test Data (1329196)

Frequency (MHz)	Detector	Corr. Meas. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
30.661	Peak	28.782	--	--	135	Horiz, 100
	QP	22.992	40	-17.008	135	Horiz, 100
800.149	Peak	34.829	--	--	135	Horiz, 100
	QP	27.900	46	-18.100	135	Horiz, 100
861.591	Peak	34.829	--	--	135	Horiz, 100
	QP	27.884	46	-18.116	135	Horiz, 100
892.402	Peak	35.178	--	--	344	Vert, 100
	QP	28.614	46	-17.386	344	Vert, 100
949.699	Peak	36.358	--	--	135	Horiz, 100
	QP	29.406	46	-16.594	135	Horiz, 100
957.627	Peak	36.221	--	--	344	Vert, 100
	QP	29.601	46	-16.399	344	Vert, 100
7578.00	Peak	55.056	74	-18.944	135	Horiz, 150
	Avg	38.205	54	-15.795	344	Vert, 150
9302.00	Peak	56.616	74	-17.384	344	Vert, 150
	Avg	43.771	54	-10.229	344	Vert, 150
9967.00	Peak	58.481	74	-15.519	135	Horiz, 150
	Avg	45.283	54	-8.717	135	Horiz, 150

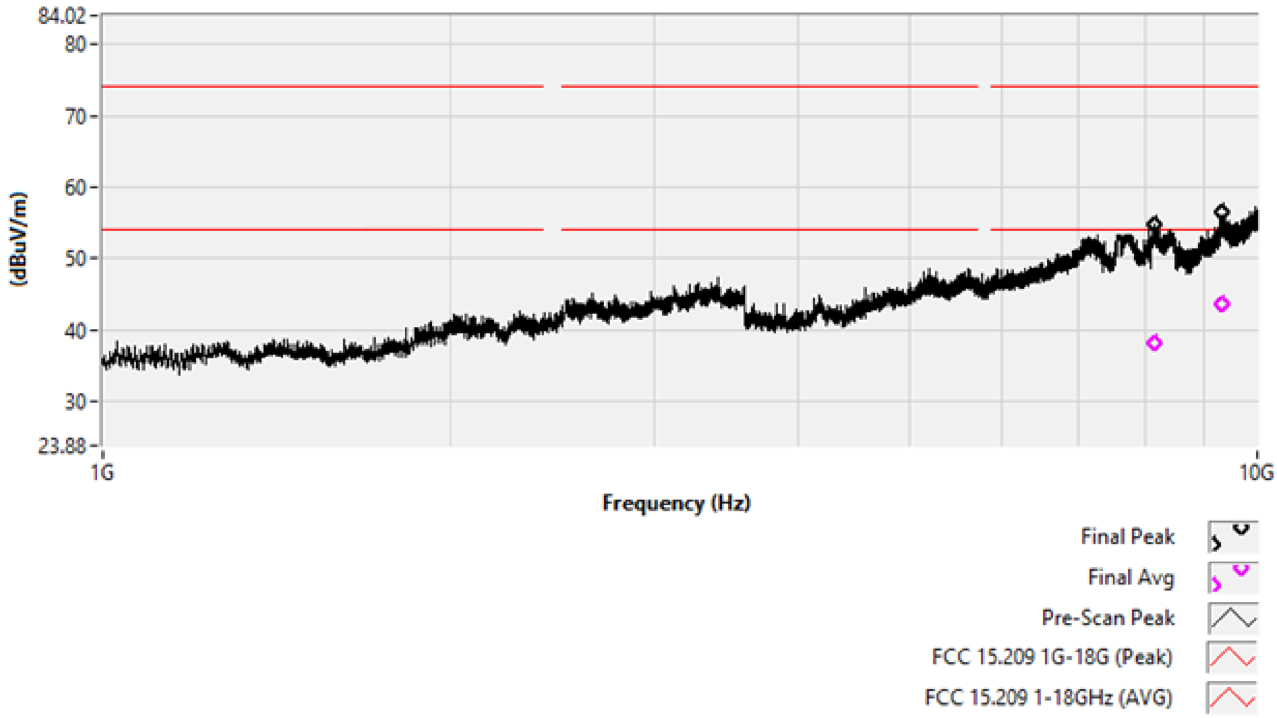
1329196, Pre-scan and Final Data (Vertical)



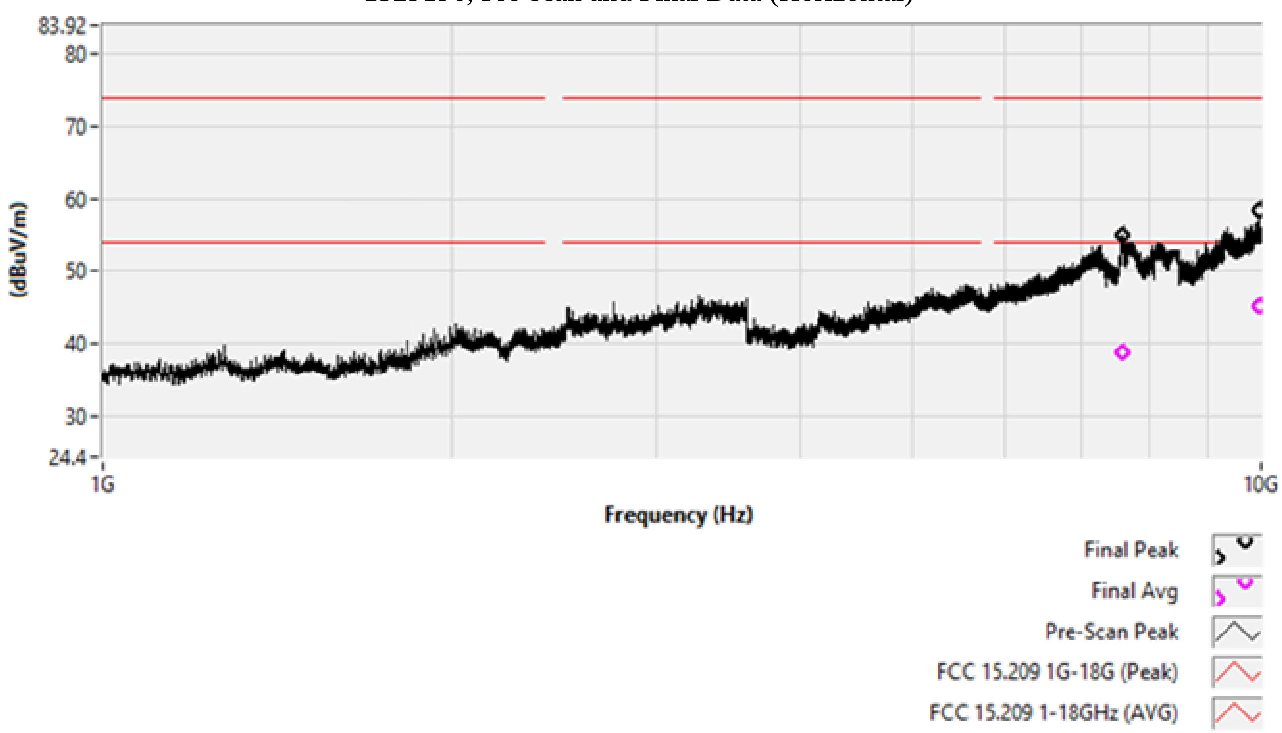
1329196, Pre-scan and Final Data (Horizontal)



1329196, Pre-scan and Final Data (Vertical



1329196, Pre-scan and Final Data (Horizontal)



4.7 AC Power Conducted Emissions, Voltage

Compliance Standard: FCC Part 15, Class B

FCC Compliance Limits				
Frequency Range	Class A Device		Class B Device	
	Quasi-peak	Average	Quasi-peak	Average
0.15 – 0.5 MHz	79 dBµV	66 dBµV	66 to 56 dBµV	56 to 46 dBµV
0.5 – 5 MHz	79 dBµV	66 dBµV	56 dBµV	46 dBµV
0.5 – 30 MHz	73 dBµV	60 dBµV	60 dBµV	50 dBµV

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on an 80cm-high 1 X 1.5-meter 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.

These emissions must meet the limits specified in §15.107 for quasi-peak and average measurements.

Environmental Conditions During Conducted Emissions Testing

Ambient Temperature:	22.1 °C
Relative Humidity:	56 %

4.7.1 Conducted Data Reduction and Reporting

The comparison between the Conducted emissions level and the FCC limit is calculated as shown in the following example:

Spectrum Analyzer Voltage: VdBµV(raw)

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Voltage: VdBµV = V dBµV (raw) + LISN dB + CF dB

4.7.2 Test Data

The EUT complies with the Class B Conducted Emissions requirements.

These emissions are not related to the transmitter, as the EUT cannot charge and transmit at the same time.

The Conducted Emissions test data is provided in the tables below.

<u>This data is for Charging, non-TX mode.</u>

Table 13: AC Powerline Conducted Emissions Test Data (BC-PAD-2)

NEUTRAL (Non-TX Mode)										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.162	38.7	21.8	9.9	0.6	49.2	32.3	65.4	55.4	-16.1	-20.0
0.199	32.0	18.2	9.9	0.5	42.4	28.6	63.7	53.7	-21.2	-25.0
0.227	47.0	15.5	9.9	0.4	57.4	25.9	62.6	52.6	-5.2	-26.7
0.394	30.9	20.5	9.9	0.3	41.2	30.8	58.0	48.0	-16.8	-17.2
0.789	23.5	13.0	9.9	0.3	33.7	23.2	56.0	46.0	-22.3	-22.8
1.309	18.0	7.8	10.0	0.3	28.2	18.0	56.0	46.0	-27.8	-28.0
7.384	16.0	9.4	10.5	0.6	27.1	20.5	60.0	50.0	-32.9	-29.5
PHASE / L1 (Non-TX Mode)										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.164	36.7	20.0	9.9	0.4	47.1	30.4	65.3	55.3	-18.2	-24.9
0.175	35.4	18.0	9.9	0.4	45.7	28.3	64.7	54.7	-19.0	-26.4
0.184	32.6	17.5	9.9	0.4	42.9	27.8	64.3	54.3	-21.4	-26.5
0.245	25.2	15.6	9.9	0.3	35.5	25.9	61.9	51.9	-26.5	-26.1
0.420	32.7	30.1	9.9	0.3	42.9	40.3	57.4	47.4	-14.5	-7.1
7.297	20.0	10.0	10.5	0.5	31.0	21.0	60.0	50.0	-29.0	-29.0

Table 14: AC Powerline Conducted Emissions Test Data (1329196)

NEUTRAL (Non-TX Mode)										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.151	39.6	22.7	9.9	0.6	50.2	33.3	65.9	55.9	-15.8	-19.7
0.160	37.2	20.4	9.9	0.6	47.7	30.9	65.5	55.5	-17.7	-24.5
0.221	27.1	14.1	9.9	0.5	37.5	24.5	62.8	52.8	-25.3	-28.3
0.391	30.0	21.5	9.9	0.3	40.3	31.8	58.0	48.0	-17.8	-16.3
0.443	29.9	23.4	9.9	0.3	40.2	33.6	57.0	47.0	-16.8	-13.4
0.691	22.0	10.5	9.9	0.3	32.2	20.7	56.0	46.0	-23.8	-25.3
8.732	20.4	9.5	10.6	0.6	31.6	20.7	60.0	50.0	-28.4	-29.3
PHASE / L1 (Non-TX Mode)										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Avg Corr (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.163	35.6	19.2	9.9	0.4	46.0	29.6	65.3	55.3	-19.3	-25.7
0.169	36.2	18.2	9.9	0.4	46.5	28.5	65.0	55.0	-18.5	-26.5
0.183	32.0	17.3	9.9	0.4	42.3	27.6	64.3	54.3	-22.0	-26.7
0.420	33.0	30.5	9.9	0.3	43.2	40.7	57.4	47.4	-14.2	-6.7
0.442	33.0	31.2	9.9	0.3	43.2	41.4	57.0	47.0	-13.8	-5.6
0.834	23.5	18.0	9.9	0.3	33.7	28.2	56.0	46.0	-22.3	-17.8
7.325	20.1	10.5	10.5	0.5	31.1	21.5	60.0	50.0	-28.9	-28.5

4.8 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.

4.8.1 BC-PAD-2, Danger Mode (worst-case)

Figure 7: BC-PAD-2 Transmitter Pulse On-Time (1) – Danger Mode

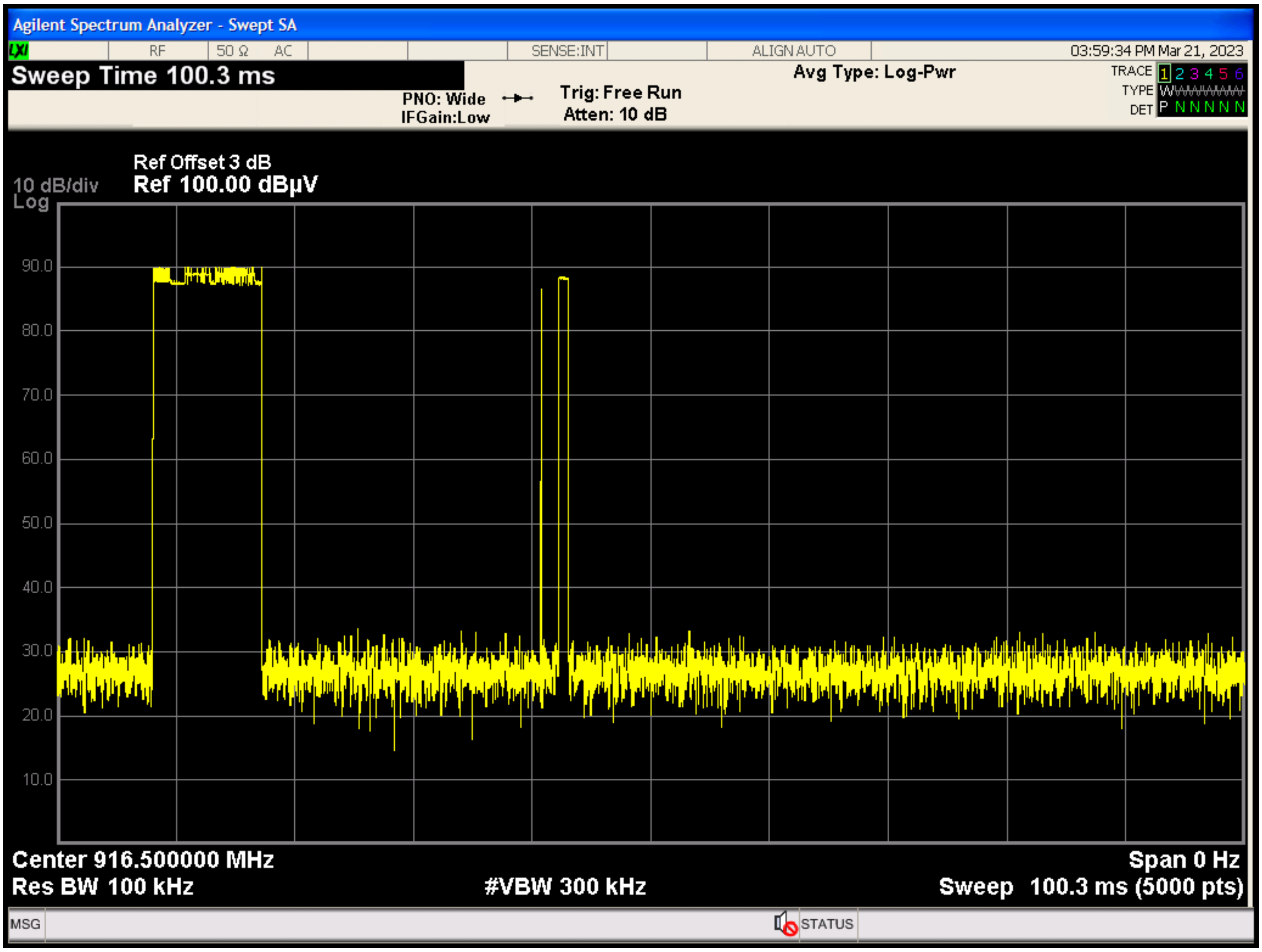


Figure 8: BC-PAD-2 Transmitter Pulse On-Time (2) – Danger Mode

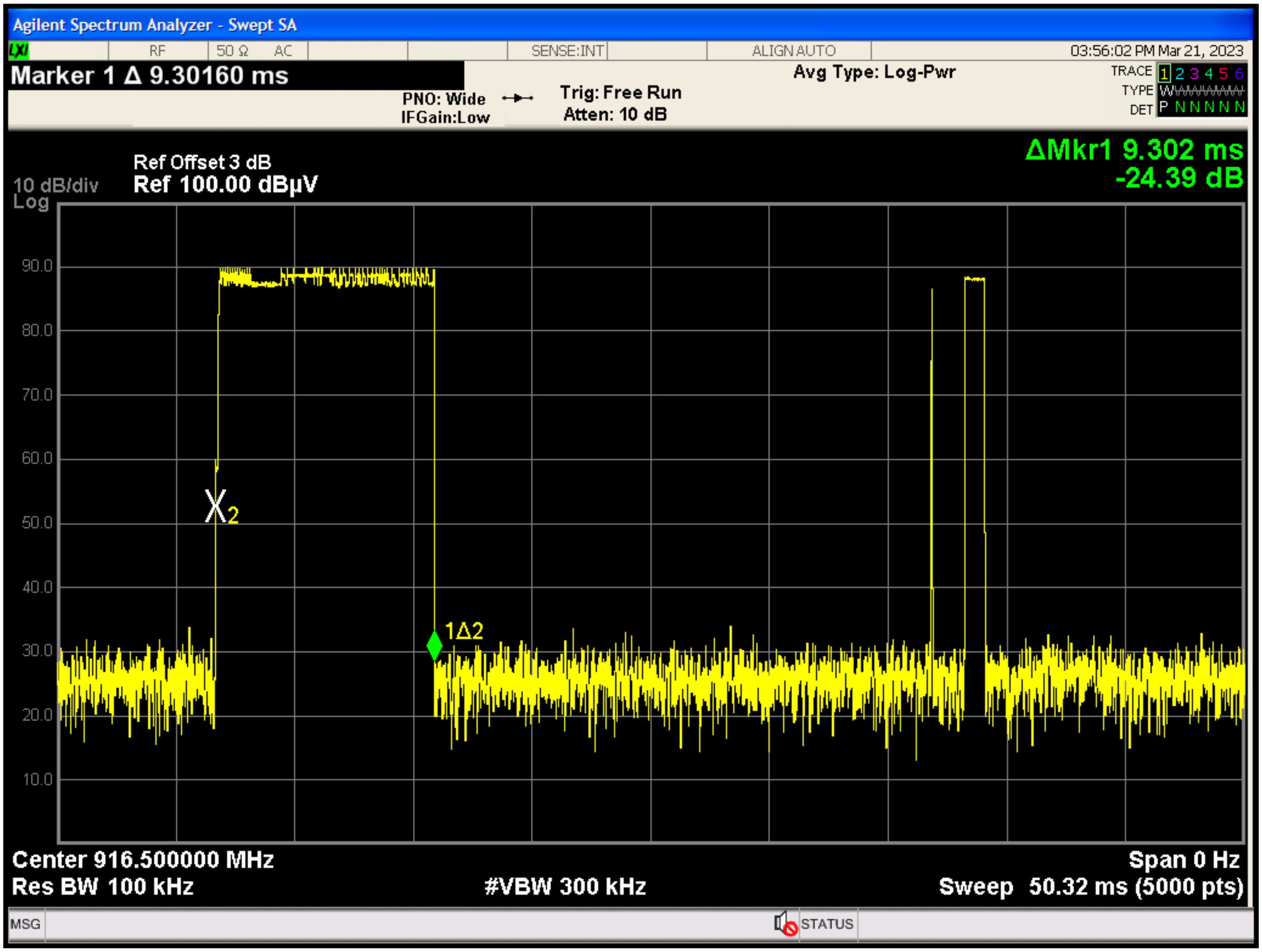
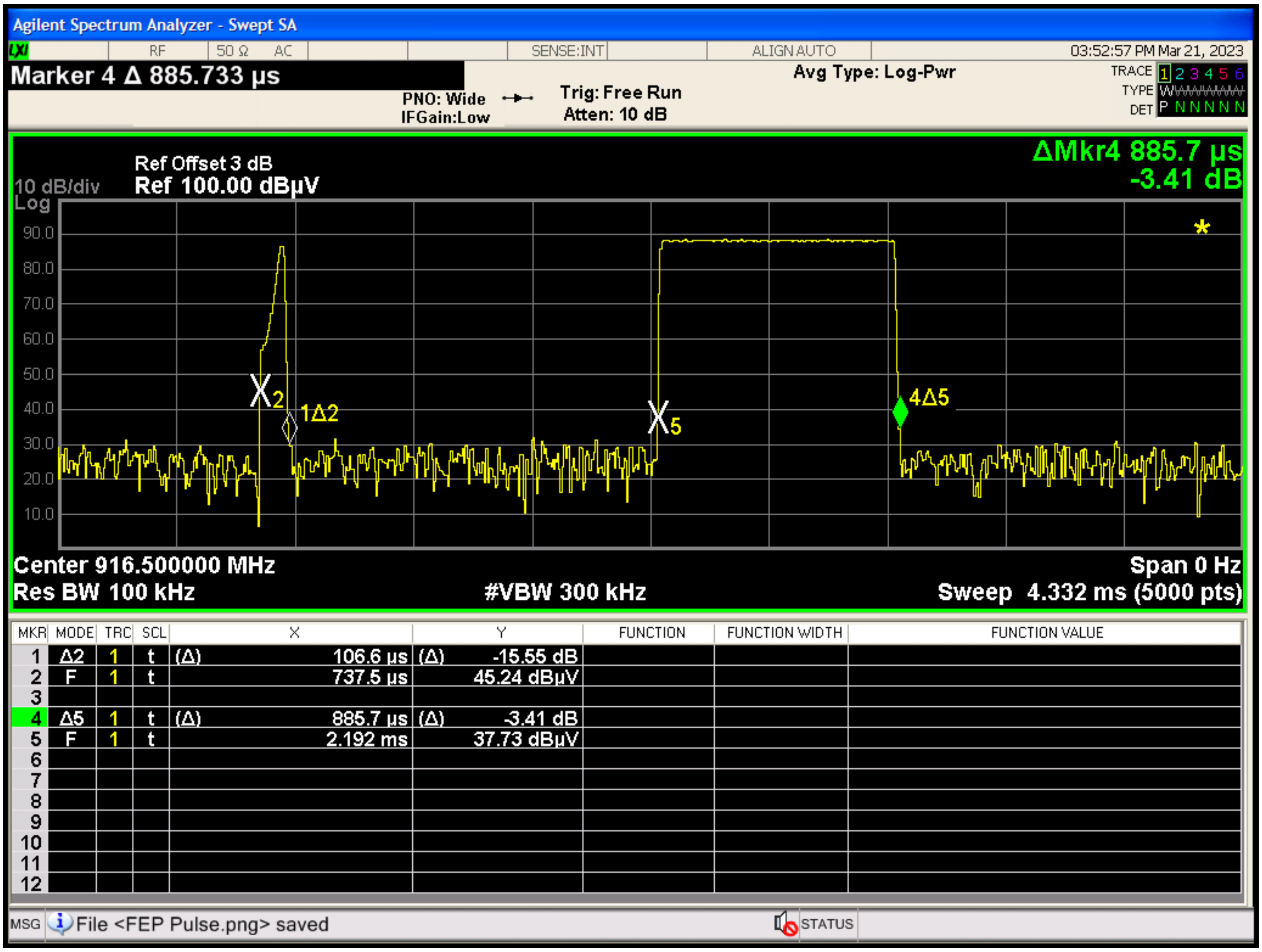


Figure 9: BC-PAD-2 Transmitter Pulse On-Time (3) – Danger Mode



The Danger Mode 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.

The total transmitter on-time is made of three sub-pulses. The longer sub-pulse measures 9.302 ms.

The sweep time in Figure 9 was set to ~5 ms, to make an accurate measurement of the individual, shorter sub-pulses.

As such, the on-time ($t$on) is: 9.302 + 0.1066 + 0.8857 = 10.294 ms (worst-case).

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

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

$10.29 \div 100 = 0.103$

$\Delta = 10.3\%$

Where Δ is the final duty cycle.

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

$20LOG(\Delta) = \delta$

$20LOG(0.103) = -19.75$

$\delta = 19.7$ dB (worst-case)

Where δ is the final DCCF for the Danger Mode.

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

4.8.2 BC-PAD-2, Warning Mode (for reference only)

Figure 10: BC-PAD-2 Transmitter Pulse On-Time (1) – Warning Mode

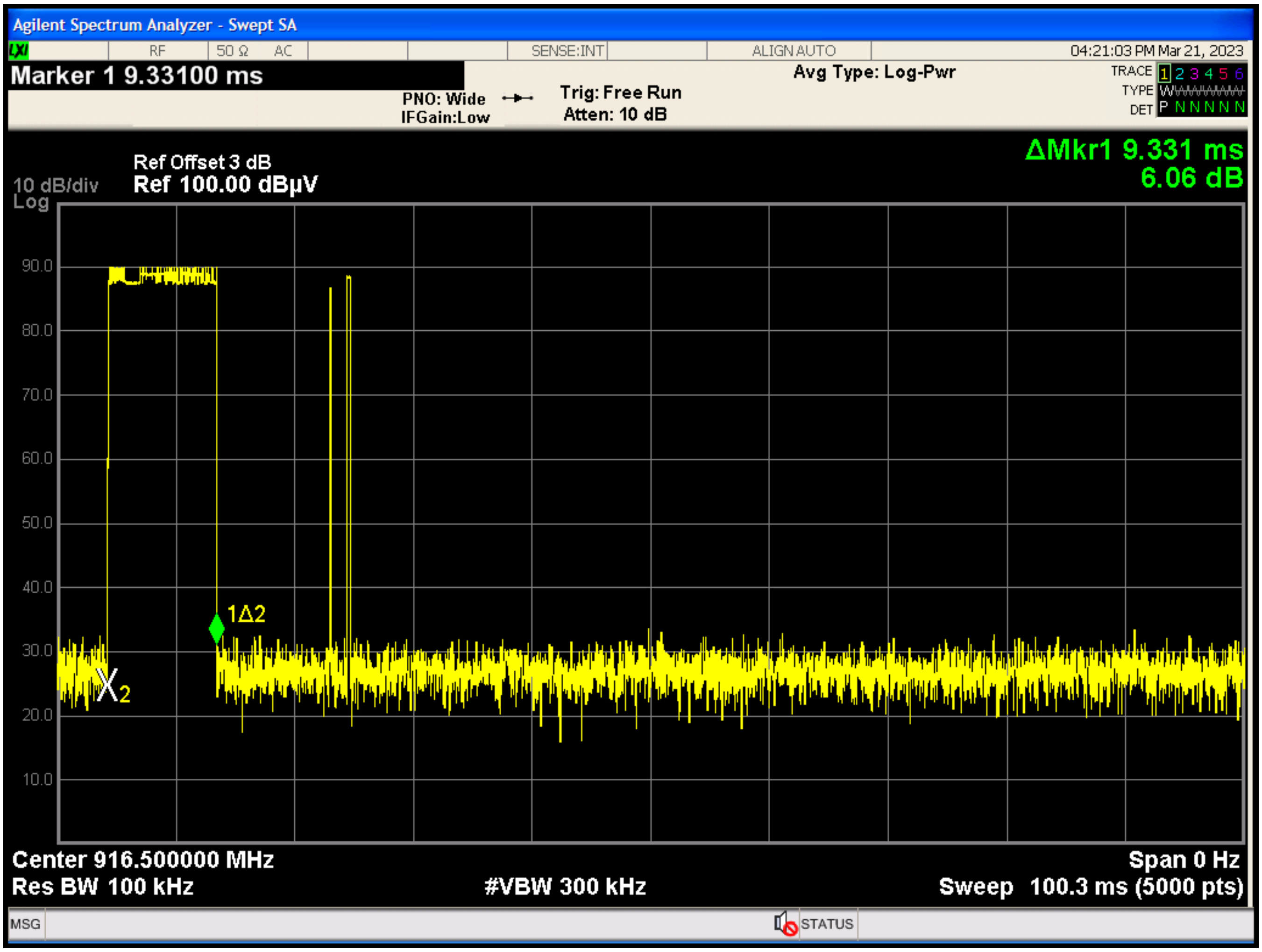


Figure 11: BC-PAD-2 Transmitter Pulse On-Time (2) – Warning Mode

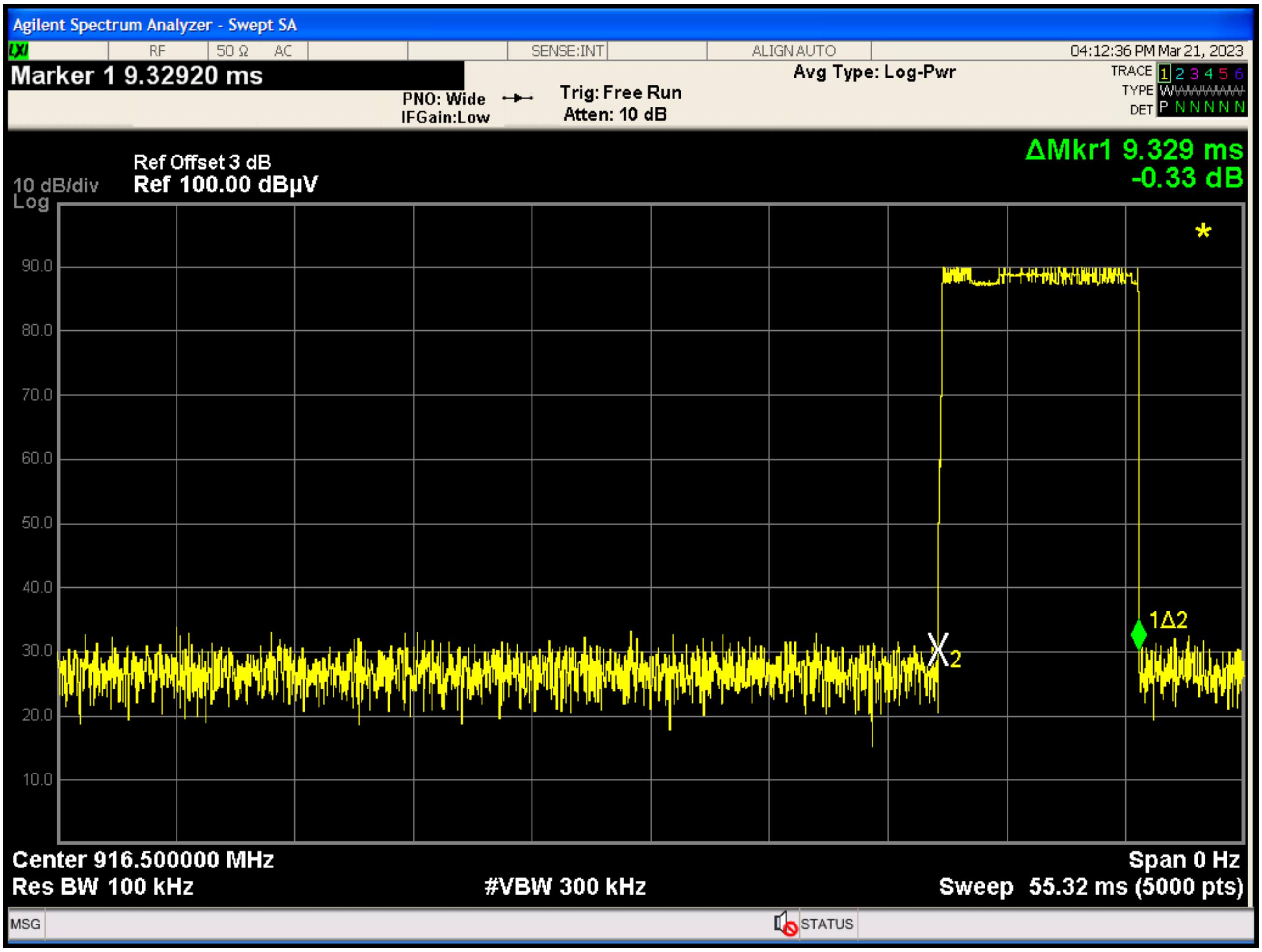
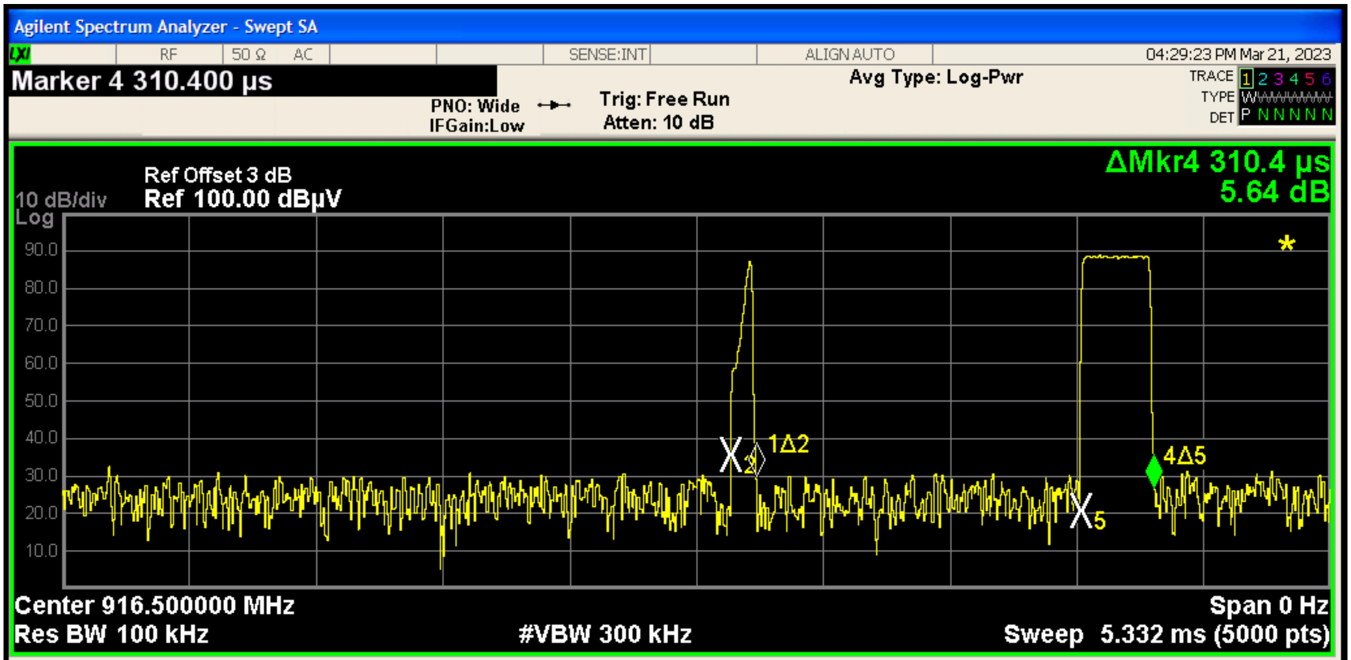


Figure 12: BC-PAD-2 Transmitter Pulse On-Time (2) – Warning Mode



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	1	t	(Δ) 106.7 µs	(Δ) -6.51 dB			
2	F	1	t	2.811 ms	35.73 dBµV			
3								
4	Δ5	1	t	(Δ) 310.4 µs	(Δ) 5.64 dB			
5	F	1	t	4.279 ms	20.68 dBµV			
6								
7								
8								
9								
10								
11								
12								

The Warning Mode 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.

The total transmitter on-time is made of three sub-pulses. The longer sub-pulse measures 9.329 ms.

The sweep time in Figure 12 was set to ~5 ms, to make an accurate measurement of the individual, shorter sub-pulses.

As such, the on-time ($t$on) is: 9.329 + 0.1067 + 0.3104 = 9.746 ms.

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

$t$on ÷ Tcycle = Δ

9.75 ÷ 100 = 0.097

Δ = 9.7%

Where Δ is the final duty cycle.

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

20LOG(Δ) = δ

20LOG(0.097) = –20.22

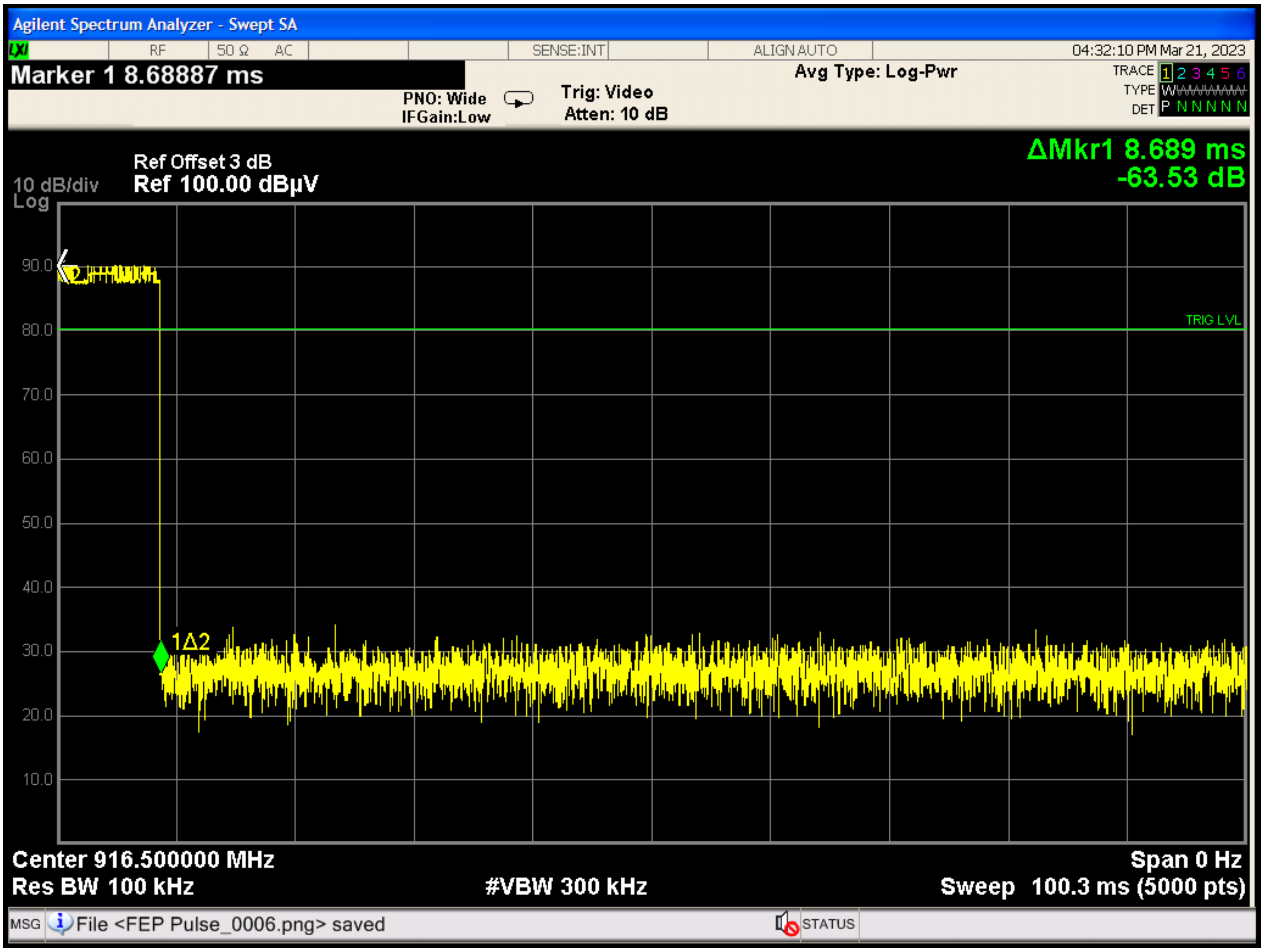
δ = 20.2 dB

Where δ is the final DCCF for the Warning Mode.

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

4.8.3 BC-PAD-2, Health Mode (for Section 4.3 of this report)

Figure 13: BC-PAD-2 Transmitter Pulse On-Time – Health Mode



The sweep time in Figure 13 was set to 100ms, and the Health Mode pulsed transmitter on-time was observed. In this case, the full pulse train is greater than the measurement period. As such, the cycle time (Tcycle) shall be declared as 100 ms.

Any given individual Health Mode transmitter pulse, measures 8.689 ms. As such, the on-time ($t$on) is 8.689 ms.

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

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

$8.689 \div 100 = 0.0869$

$\Delta = 8.7\%$

Where Δ is the final duty cycle.

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

$20LOG(\Delta) = \delta$

$20LOG(0.087) = -21.2$

$\delta = 21.2$ dB

Where δ is the final DCCF (Health Mode)

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

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4.8.4 1329196, Danger Mode (worst-case)

Figure 14: 1329196 Transmitter Pulse On-Time (1) – Danger Mode

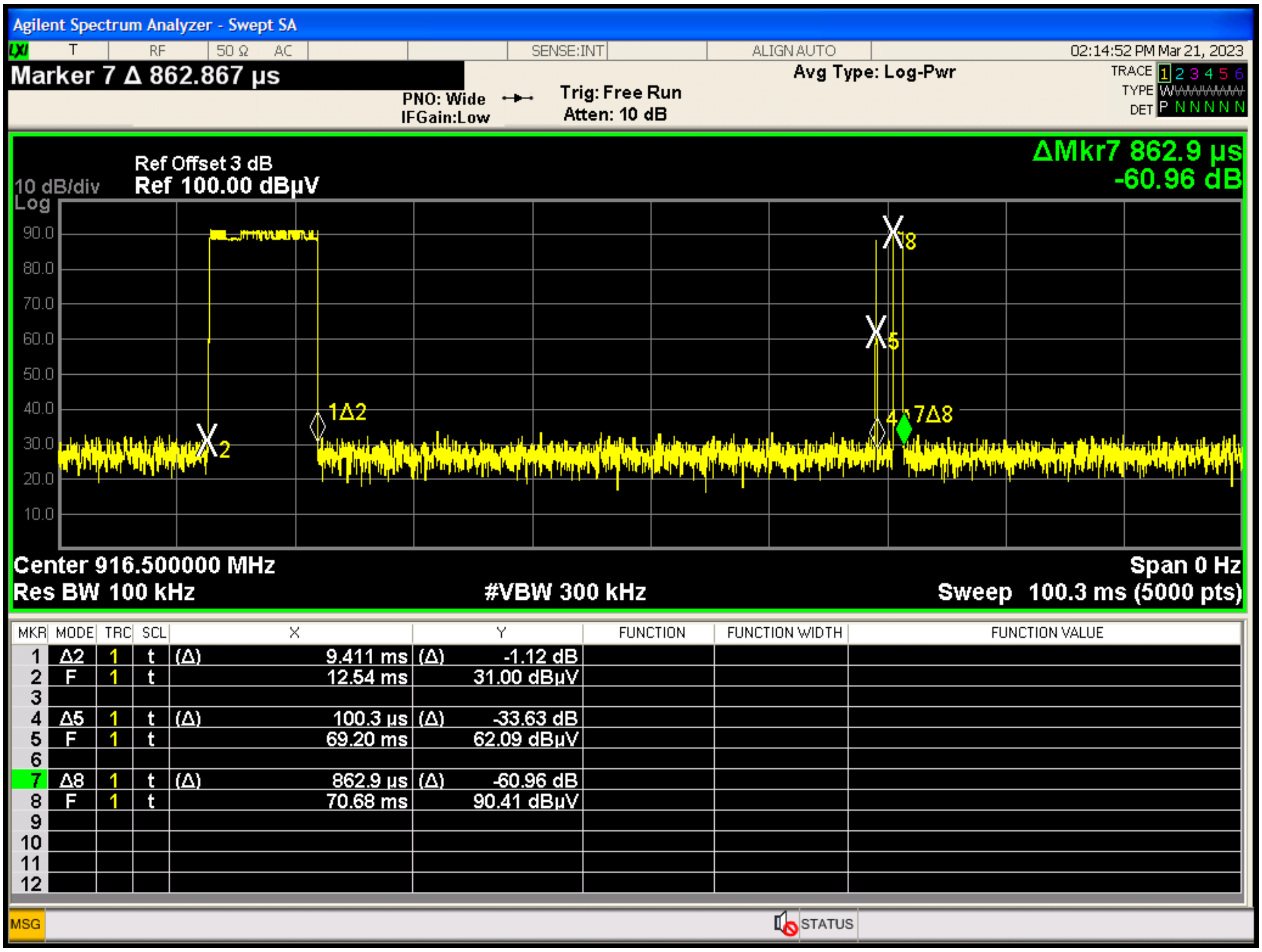


Figure 15: 1329196 Transmitter Pulse On-Time (2) – Danger Mode

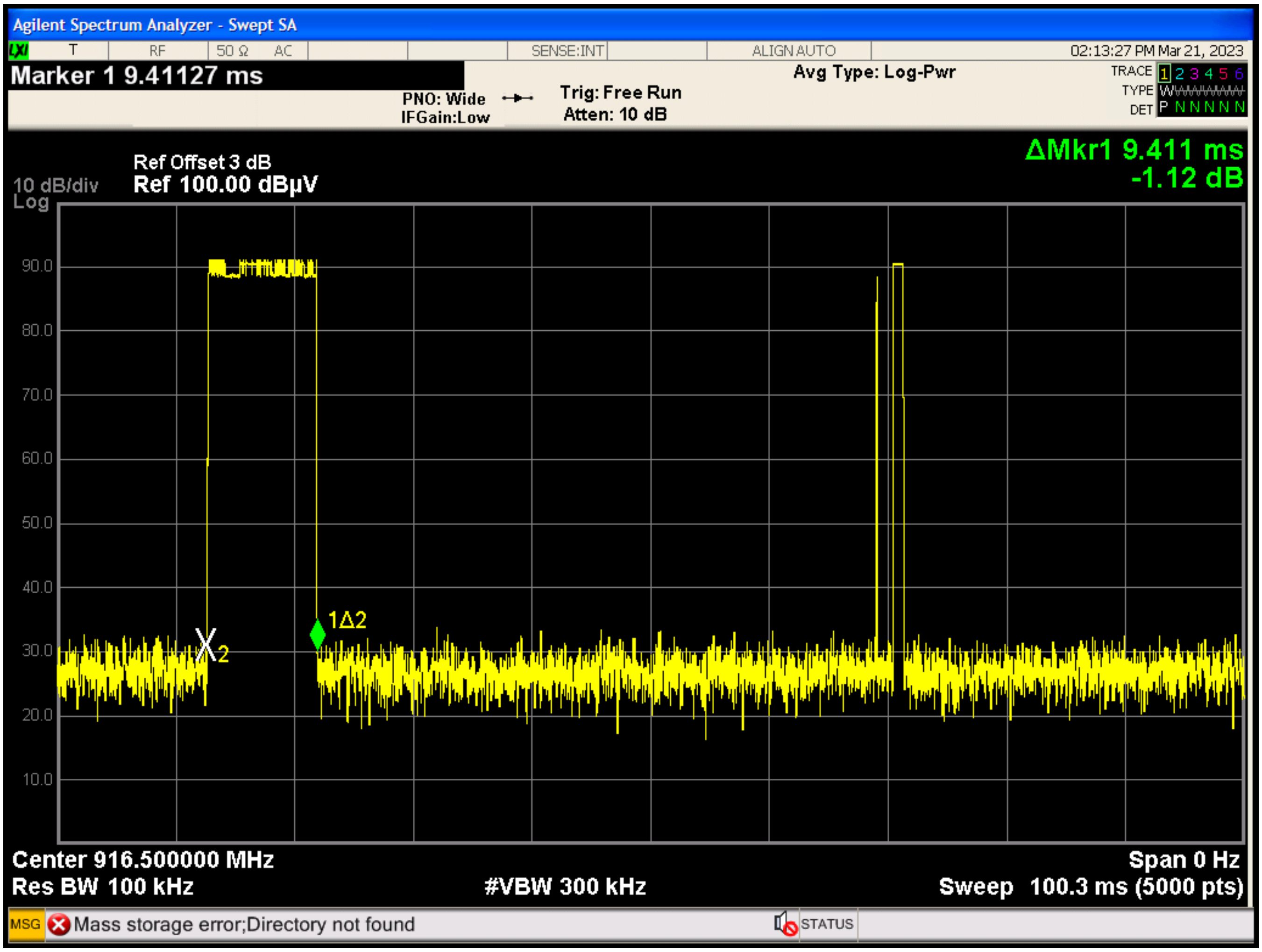
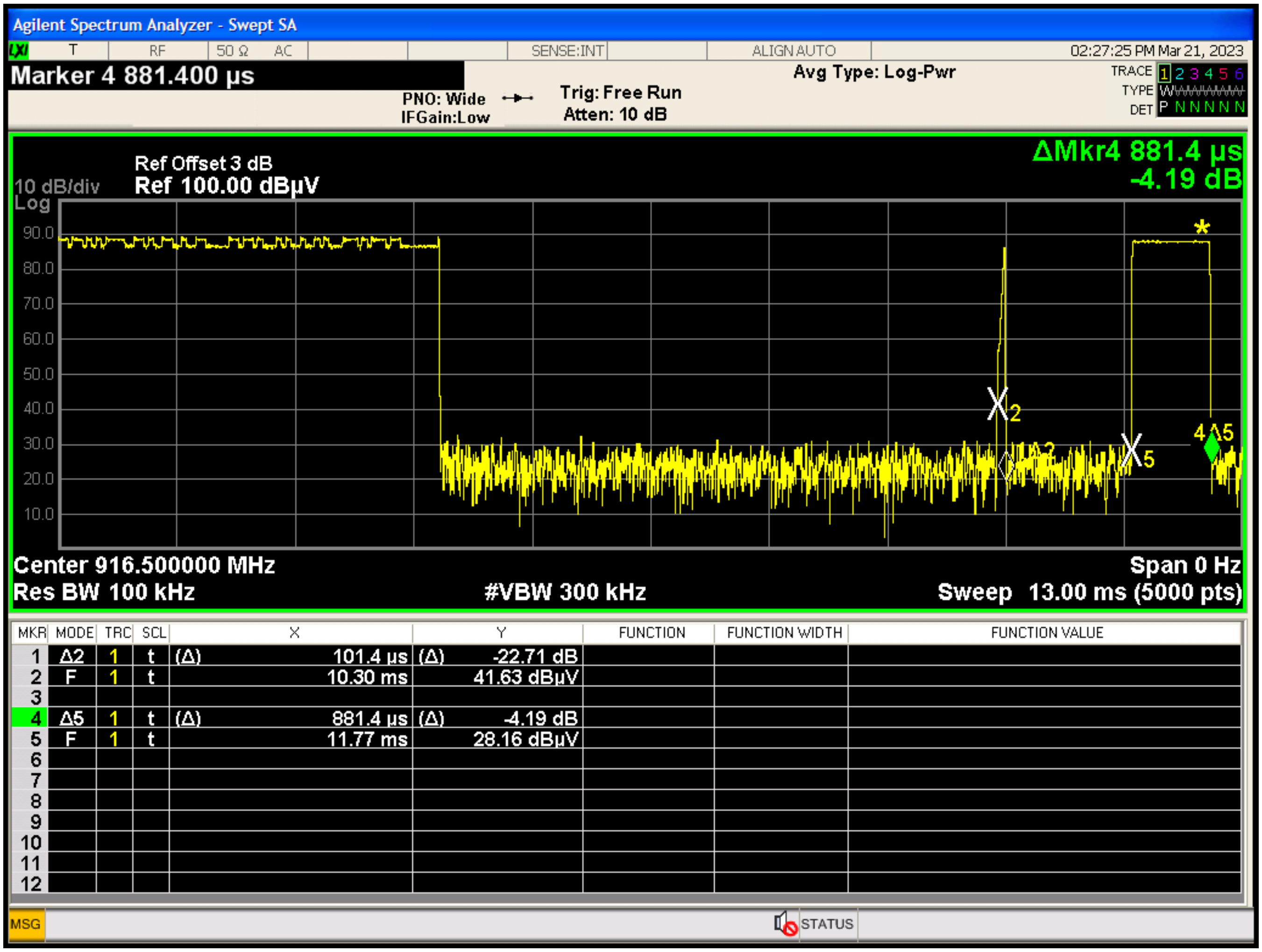


Figure 16: 1329196 Transmitter Pulse On-Time (3) – Danger Mode



The Danger Mode 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.

The total transmitter on-time is made of three sub-pulses. The longer sub-pulse measures 9.411 ms.

The sweep time in Figure 16 was set to ~ 13 ms, to make an accurate measurement of the individual, shorter sub-pulses.

As such, the on-time ($t$on) is: 9.411 + 0.1014 + 0.8814 = 10.394 ms (worst-case).

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

$t$on ÷ Tcycle = Δ

10.39 ÷ 100 = 0.104

Δ = 10.4%

Where Δ is the final duty cycle.

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

20LOG(Δ) = δ

20LOG(0.104) = –19.66

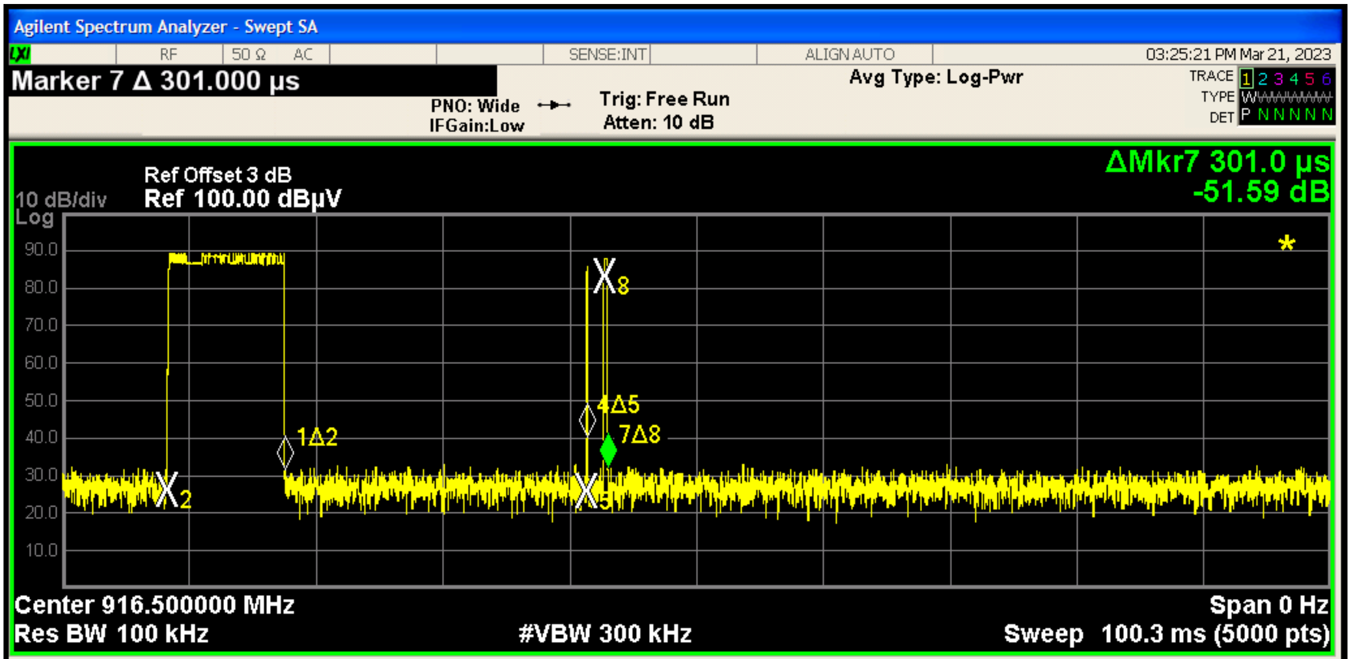
δ = 19.7 dB (worst-case)

Where δ is the final DCCF for the Danger Mode.

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

4.8.5 1329196, Warning Mode (for reference only)

Figure 17: 1329196 Transmitter Pulse On-Time (1) – Warning Mode



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	1	t	(Δ) 9.372 ms	(Δ) 4.85 dB			
2	F	1	t	8.247 ms	26.24 dBµV			
3								
4	Δ5	1	t	(Δ) 120.4 µs	(Δ) 13.61 dB			
5	F	1	t	41.37 ms	25.98 dBµV			
6								
7	Δ8	1	t	(Δ) 301.0 µs	(Δ) -51.59 dB			
8	F	1	t	42.81 ms	83.32 dBµV			
9								
10								
11								
12								

Figure 18: 1329196 Transmitter Pulse On-Time (2) – Warning Mode

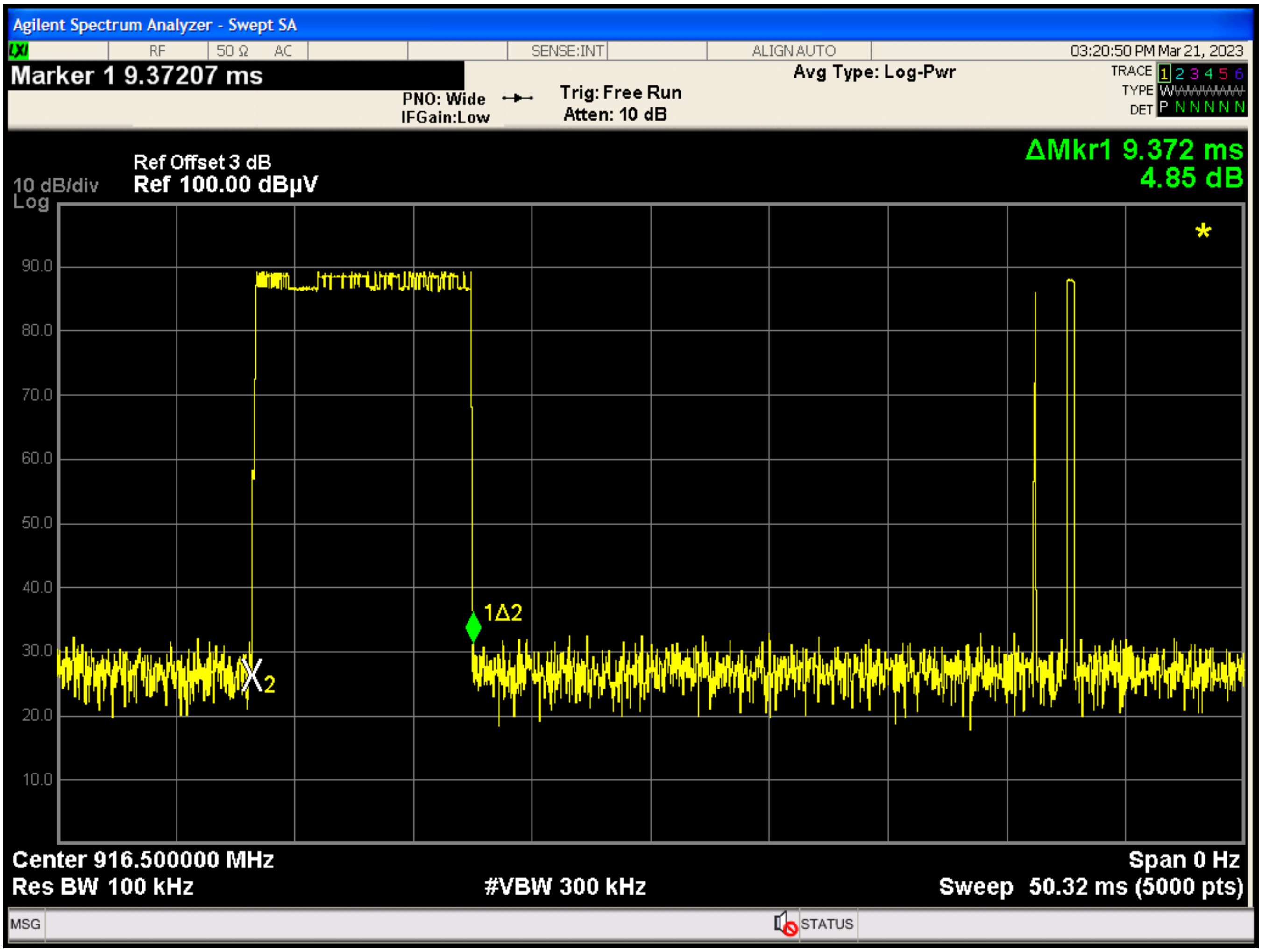
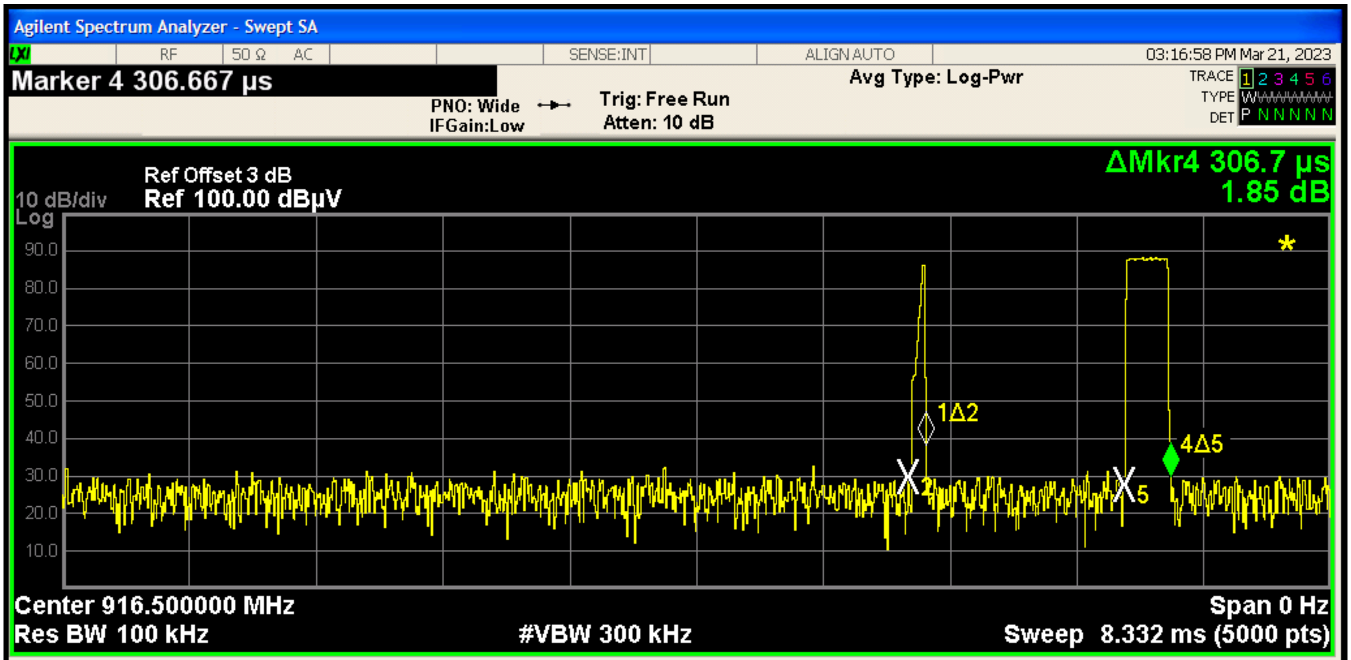


Figure 19: 1329196 Transmitter Pulse On-Time (2) – Warning Mode



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	1	t	(Δ) 121.7 µs	(Δ) 8.02 dB			
2	F	1	t	5.553 ms	29.55 dBµV			
3								
4	Δ5	1	t	(Δ) 306.7 µs	(Δ) 1.85 dB			
5	F	1	t	6.975 ms	27.48 dBµV			
6								
7								
8								
9								
10								
11								
12								

The Warning Mode 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.

The total transmitter on-time is made of three sub-pulses. The longer sub-pulse measures 9.372 ms.

The sweep time in Figure 19 was set to ~8.3 ms, to make an accurate measurement of the individual, shorter sub-pulses.

As such, the on-time ($t$on) is: 9.372 + 0.1217 + 0.3067 = 9.800 ms.

The duty cycle can be calculated from the following formula:

$t$on ÷ Tcycle = Δ

9.8 ÷ 100 = 0.098

Δ = 9.8%

Where Δ is the final duty cycle.

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

20LOG(Δ) = δ

20LOG(0.098) = –20.18

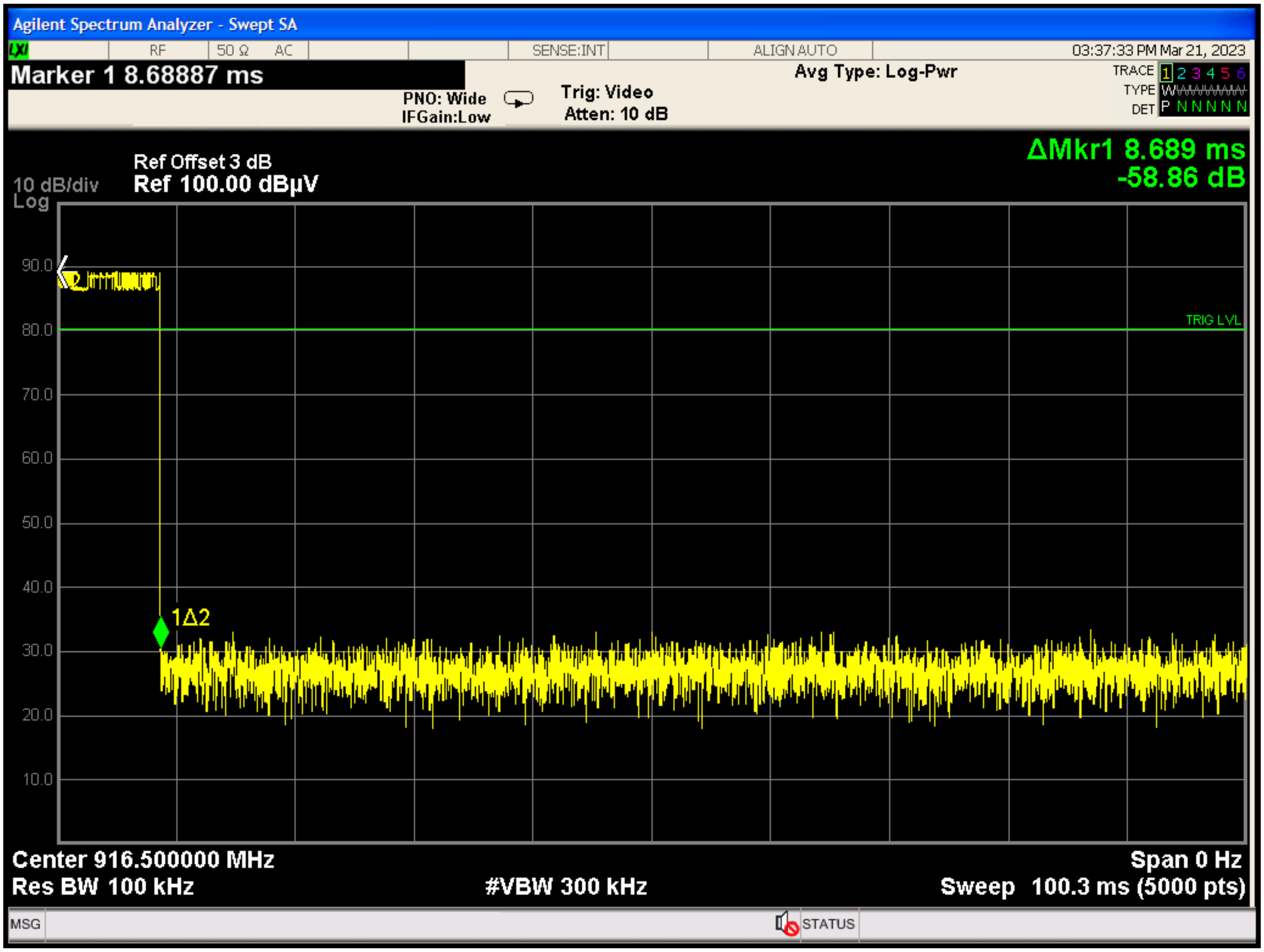
δ = 20.2 dB

Where δ is the final DCCF for the Warning Mode.

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

4.8.6 1329196, Health Mode (for Section 4.3 of this report)

Figure 20: 1329196 Transmitter Pulse On-Time – Health Mode



The sweep time in Figure 20 was set to 100ms, and the Health Mode pulsed transmitter on-time was observed. In this case, the full pulse train is greater than the measurement period. As such, the cycle time (Tcycle) shall be declared as 100 ms.

Any given individual Health Mode transmitter pulse, measures 8.689 ms. As such, the on-time ($t$on) is 8.689 ms.

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

$t$on ÷ Tcycle = Δ

8.689 ÷ 100 = 0.0869

Δ = 8.7%

Where Δ is the final duty cycle.

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

20LOG(Δ) = δ

20LOG(0.087) = –21.2

δ = 21.2 dB

Where δ is the final DCCF (Health Mode)

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

5 Test Equipment

Table 15 shows a list of the test equipment used for measurements along with the calibration information.

Table 15: Test Equipment List

Test Name:	**Radiated Emissions**	Test Date: 3/21/2023 to 3/23/2023	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT, EXA	SPECTRUM ANALYZER	5/26/2023
00644	SUNOL SCIENCES CORP.	JB1, LOGPERIOD ANTENNA	11/7/2024
00425	ARA DRG-118/A	HORN ANTENNA	11/7/2024
00955	JUNKOSHA USA	HF COAXIAL CABLE	12/28/2023
00834	UTIFLEX MICRO SMA	HF COAXIAL CABLE	12/28/2023
00280	ITC 21C-3A1	WAVEGUIDE FILTER	CNR
00721	WEINSCHEL DS109	ATTENUATOR, NOTCH	CNR

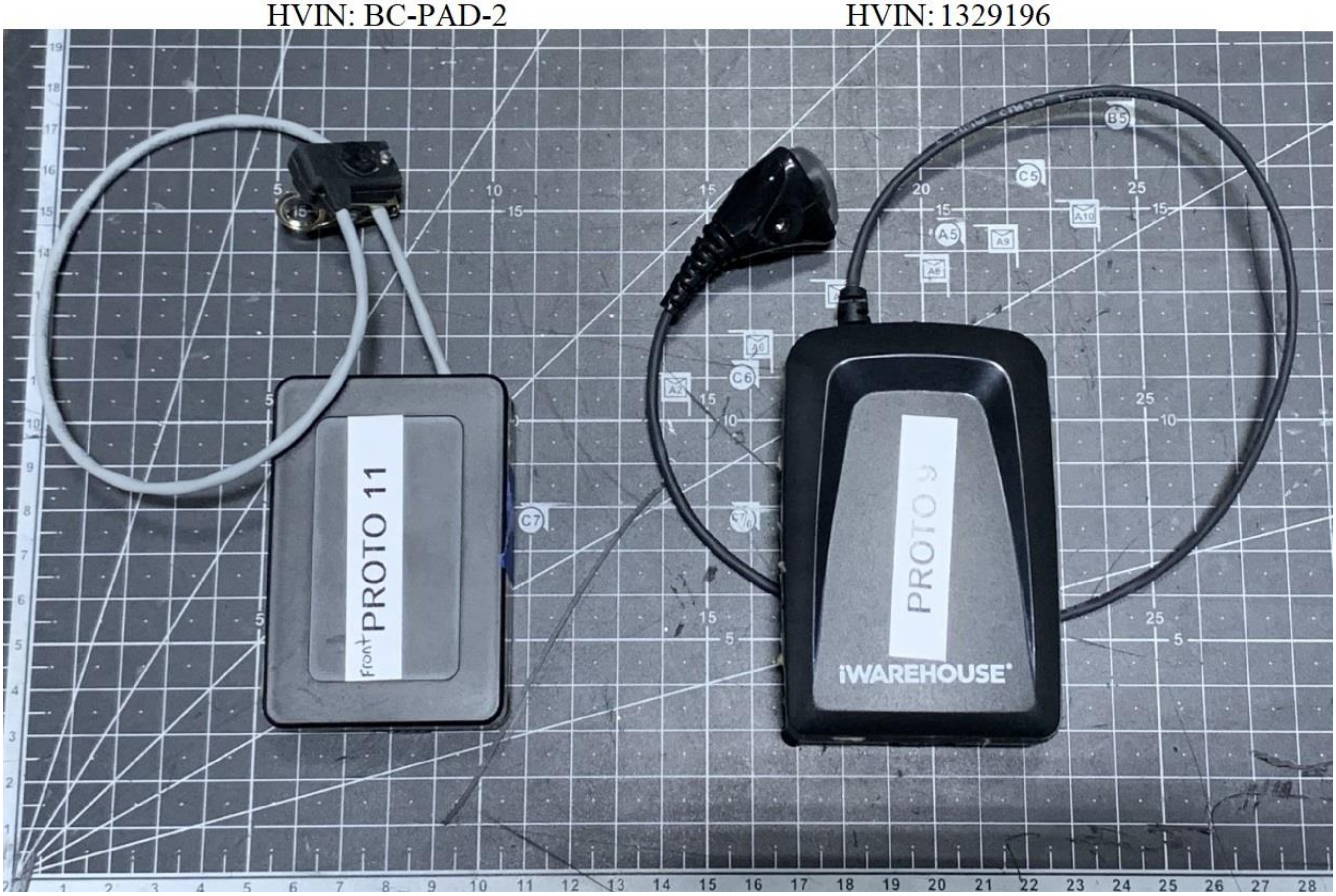
Test Name:	**Conducted Emissions Voltage**	Test Date: 3/23/2023	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00823	AGILENT, EXA	SPECTRUM ANALYZER	5/26/2023
00125	SOLAR 8028-50	LISN, BNC	9/15/2023
00126	SOLAR 8028-50	LISN, BNC	9/15/2023
00053	HP 11947A	TRANSIENT LIMITER	2/14/2024
00330	WLL RG-223	CE CABLE 1	5/6/2023
00412	WLL RG-223	CE CABLE 2	5/6/2023

ANNEX A

Figure 21: EUT Identification, Provided for Refence

Frederick Energy Products PAD
HVIN: BC-PAD-2

Raymond iWarehouse PAD
HVIN: 1329196



* this image shall not serve as a formal external photograph; it is provided for test report reference only