FCC & ISED CANADA CERTIFICATION

TEST REPORT

for the

3E-523E-900 WIFI RADIO

FCC ID: QVT-523N-900

IC ID: 6780A-523N-900

WLL REPORT# 16708-01 REV 1

Prepared for:

Ultra-3eTI

12410 Milestone Center Drive Suite #650

Germantown, Maryland 20876

Prepared By:

Washington Laboratories, Ltd.

4840 Winchester Boulevard

Frederick, Maryland 21703

Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Ultra-3eTI

3e-523E-900

FCC ID: QVT-523N-900

ISED ID: 6780A-523N-900

October 5, 2020

WLL Report# 16708-01 Rev 1

Prepared by:

Ryan Mascaro
RF Test Engineer

Reviewed by:

Steven Koster
President

Abstract

This report has been prepared on behalf of Ultra-3eTI to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System (DTS) Transmitter under Part 15.247 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy and under RSS-247 of Innovation, Science and Economic Development Canada (ISED). This Certification Test Report documents the test configuration and test results for the Ultra-3eTI 3e-523E-900. The information provided on this report is only applicable to device herein documented.

The radiated portion of the testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd., located at 4840 Winchester Boulevard, Frederick MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS number is 3035A 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 Ultra-3eTI 3e-523E-900 complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 and Innovation, Science and Economic Development Canada (ISED) RSS-247.

Revision History	Description of Change	Date
Rev 0	Initial Release	October 5, 2020
Rev 1	Implement ACB comments/changes	December 9, 2020

Table of Contents

1 Introduction 7
1.1 Compliance Statement 7
1.2 Test Scope 7
1.3 Occupied (DTS) Bandwidth: 8
1.3.1 Measurement Method: 8
1.4 RF Power Output: 12
1.4.1 Measurement Method: 12
1.5 Power Spectral Density 16
1.6 Conducted Spurious Emissions Compliance 20
1.6.1 Test Summary 20
1.7 Radiated Emissions 32
1.7.1 Requirements 32
1.7.2 Test Procedure 32
1.7.3 Radiated Data Reduction and Reporting 33
1.7.4 Test Data 33
1.8 AC Conducted Emissions 42
1.8.1 Requirements 42
1.8.2 Test Procedure 42
1.8.3 Conducted Data Reduction and Reporting 43
1.8.4 Test Data 43
1.9 Contract Information 44
1.10 Test and Support Personnel 44
2 Equipment Under Test 44
2.1 EUT Identification & Description 44
2.2 Test Configuration 46
2.3 Interface Cables 56
2.4 Testing Algorithm 56
2.5 Test Location 56
2.6 Measurements 57
2.6.1 References 57
2.7 Measurement Uncertainty 57
3 Test Equipment 59

List of Tables

Table 1: Test Summary Table 7
Table 2: Occupied Bandwidth Spectrum Analyzer Settings 8
Table 3: Occupied Bandwidth Results 8
Table 4: Spectrum Analyzer Settings 12
Table 5: RF Power Output Summary 12
Table 6: Power Spectral Density 16
Table 7: Spurious Emissions 20
Table 8: Radio Spurious Radiated Emissions Test Data, Low Channel (7), Yagi Antenna 34
Table 9: Radio Spurious Radiated Emissions Test Data, Center Channel (9), Yagi Antenna 35
Table 10: Radio Spurious Radiated Emissions Test Data, High Channel (10), Yagi Antenna 36
Table 11: WiFi Harmonics Radiated Emissions Test Data, Center Channel (9), Yagi Antenna 37
Table 12: Radio Spurious Radiated Emissions Test Data, Low Channel (7), Mono-Pole Antenna 38
Table 13: Radio Spurious Radiated Emissions Test Data, Center Channel (9), Mono-Pole Antenna 39
Table 14: Radio Spurious Radiated Emissions Test Data, High Channel (10), Mono-Pole Antenna 40
Table 15: WiFi Harmonics Radiated Emissions Test Data, Center Channel (9), Mono-Pole Antenna ... 41
Table 16: Conducted Emission Test Data 43
Table 17: Device Summary 45
Table 18: System Configuration List 46
Table 19: Support Equipment 46
Table 20: Cable Configuration 56
Table 21: Expanded Uncertainty List 58
Table 22: Test Equipment List 59

List of Figures

Figure 1: Occupied Bandwidth, Low Channel (7) 9
Figure 2: Occupied Bandwidth, Center Channel (9) 10
Figure 3: Occupied Bandwidth, High Channel (10) 11
Figure 4: RF Peak Power Output, Channel 7 13
Figure 5: RF Peak Power Output, Channel 9 14
Figure 6: RF Peak Power Output, Channel 10 15
Figure 7: Power Spectral Density, Low Channel (7) 17
Figure 8: Power Spectral Density, Center Channel (9) 18
Figure 9: Power Spectral Density, High Channel (10) 19
Figure 10: Low Channel (7) Conducted Spurious Plot 1 21
Figure 11: Low Channel (7) Conducted Spurious Plot 2 22
Figure 12: Low Channel (7) Conducted Spurious Plot 3 23
Figure 13: Center Channel (9) Conducted Spurious Plot 1 24
Figure 14: Center Channel (9) Conducted Spurious Plot 2 25
Figure 15: Center Channel (9) Conducted Spurious Plot 3 26
Figure 16: High Channel (10) Conducted Spurious Plot 1 27
Figure 17: High Channel (10) Conducted Spurious Plot 2 28
Figure 18: High Channel (10) Conducted Spurious Plot 3 29
Figure 19: Low Channel (7) – Band Edge 30
Figure 20: High Channel (10) – Band Edge 31
Figure 21: EUT Enclosure Configuration 47
Figure 22: EUT Enclosure Diagram 48
Figure 23: Benchtop RF Conducted Emissions Test Configuration 49
Figure 24: AC Power Conducted Emissions Test Configuration, Front View 50
Figure 25: AC Power Conducted Emissions Test Configuration, Side View 51
Figure 26: Radio Spurious Emissions Test Configuration, Yagi Antenna - Front View 52
Figure 27: Radio Spurious Emissions Test Configuration, Yagi Antenna - Rear View 53
Figure 28: Radio Spurious Emissions Test Configuration, Mono-Pole Antenna - Front View 54
Figure 29: Radio Spurious Emissions Test Configuration, Mono-Pole Antenna - Rear View 55

1 Introduction

1.1 Compliance Statement

The Ultra-3eTI 3e-523E-900 complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 and ISED Canada RSS-247.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with C63.10 "ANSI Procedures for Compliance Testing of Unlicensed Wireless Devices". The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

The Table Below shows the results of testing for compliance with a Digital Transmission System in accordance with FCC Part 15.247 10/2014 and RSS-247 Issue 2. Full test results are shown in subsequent sub-sections.

Table 1: Test Summary Table

Digital Transmission System (DTS) TX Test Summary			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247(a) (2)	RSS-247 [5.2 (1)]	6 dB Bandwidth	Pass
15.247 (b)(3)	RSS-247 [5.4 (4)]	Transmit Output Power	Pass
15.247 (e)	RSS-247 [5.2 (2)]	Power Spectral Density	Pass
15.247 (d)	RSS-247 [5.5]	Out-of-Band Emissions (Band Edge @ 20 dB below)	Pass
15.205 15.209	RSS-Gen [8.9/8.10]	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [8.8]	AC Conducted Emissions	Pass

1.3 Occupied (DTS) Bandwidth:

Occupied bandwidth was performed by monitoring the output of the EUT antenna port with a spectrum analyzer corrected for any cable/attenuator losses.

For Direct Sequence Spread Spectrum Systems, FCC Part 15.247 requires the minimum 6 dB bandwidth be at least 500 kHz.

1.3.1 Measurement Method:

Tests were performed as specified in ANSI C63.10 section 11.8 “DTS bandwidth” Option 1 (11.8.1).

Table 2: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
100 kHz	300 kHz

At full modulation, the occupied bandwidth was measured as shown in Figures 1 through 3.

Table 3 provides a summary of the Occupied Bandwidth Results.

Table 3: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Low Channel (7): 906 MHz	2.574 MHz	≥500 kHz	Pass
Center Channel (9): 916 MHz	2.568 MHz	≥500 kHz	Pass
High Channel (10): 921 MHz	2.555 MHz	≥500 kHz	Pass

Figure 1: Occupied Bandwidth, Low Channel (7)

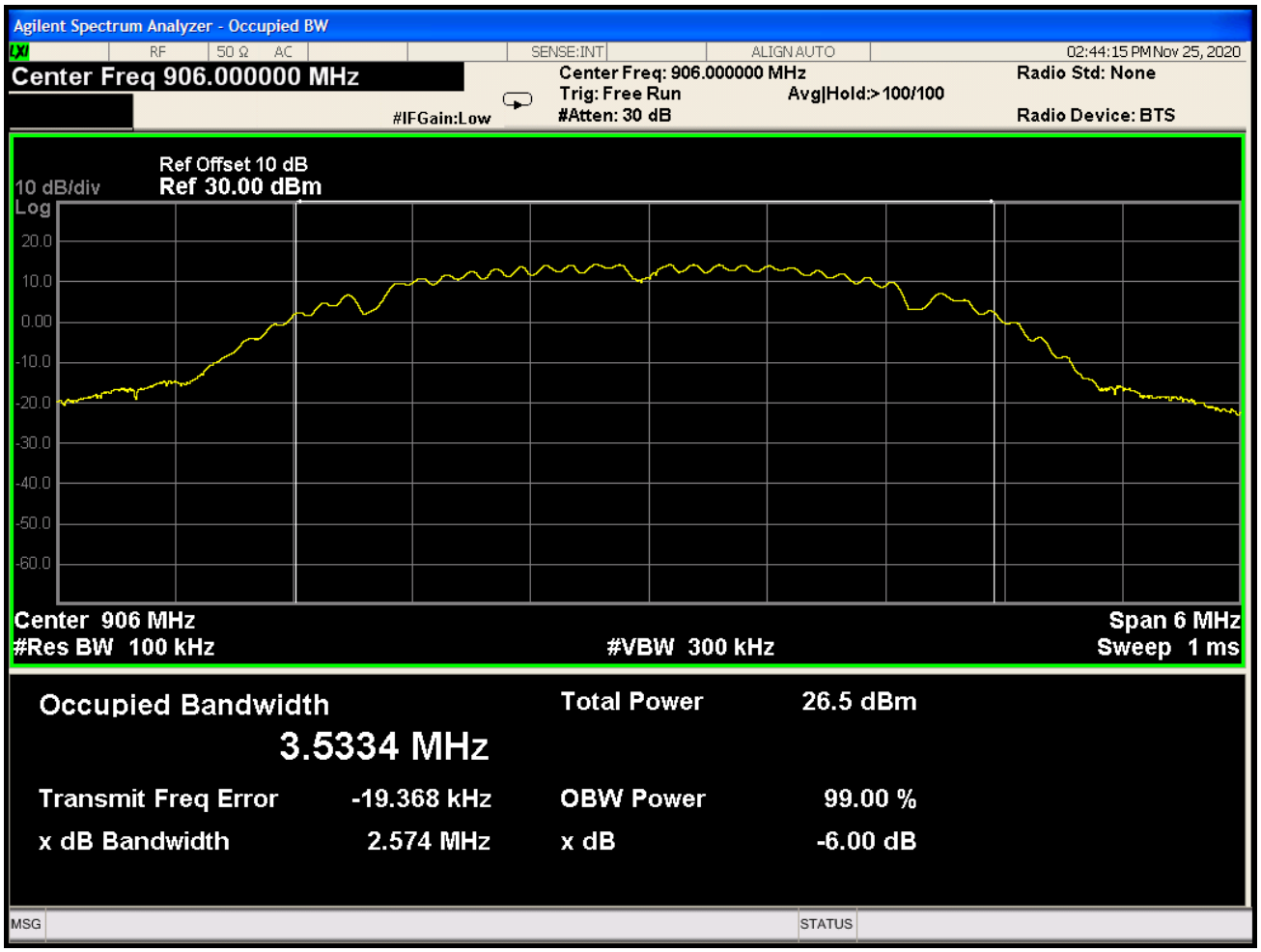


Figure 2: Occupied Bandwidth, Center Channel (9)

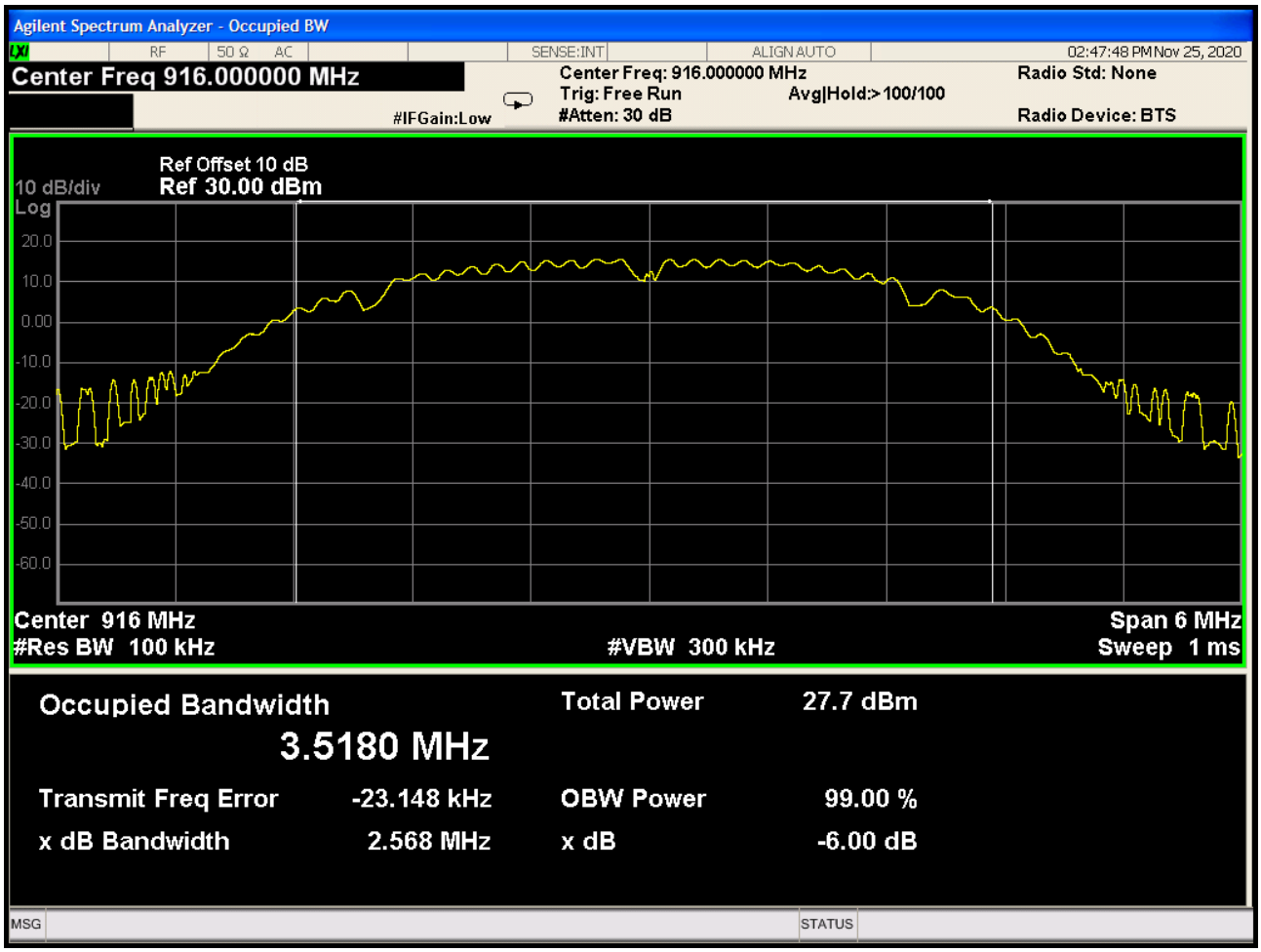
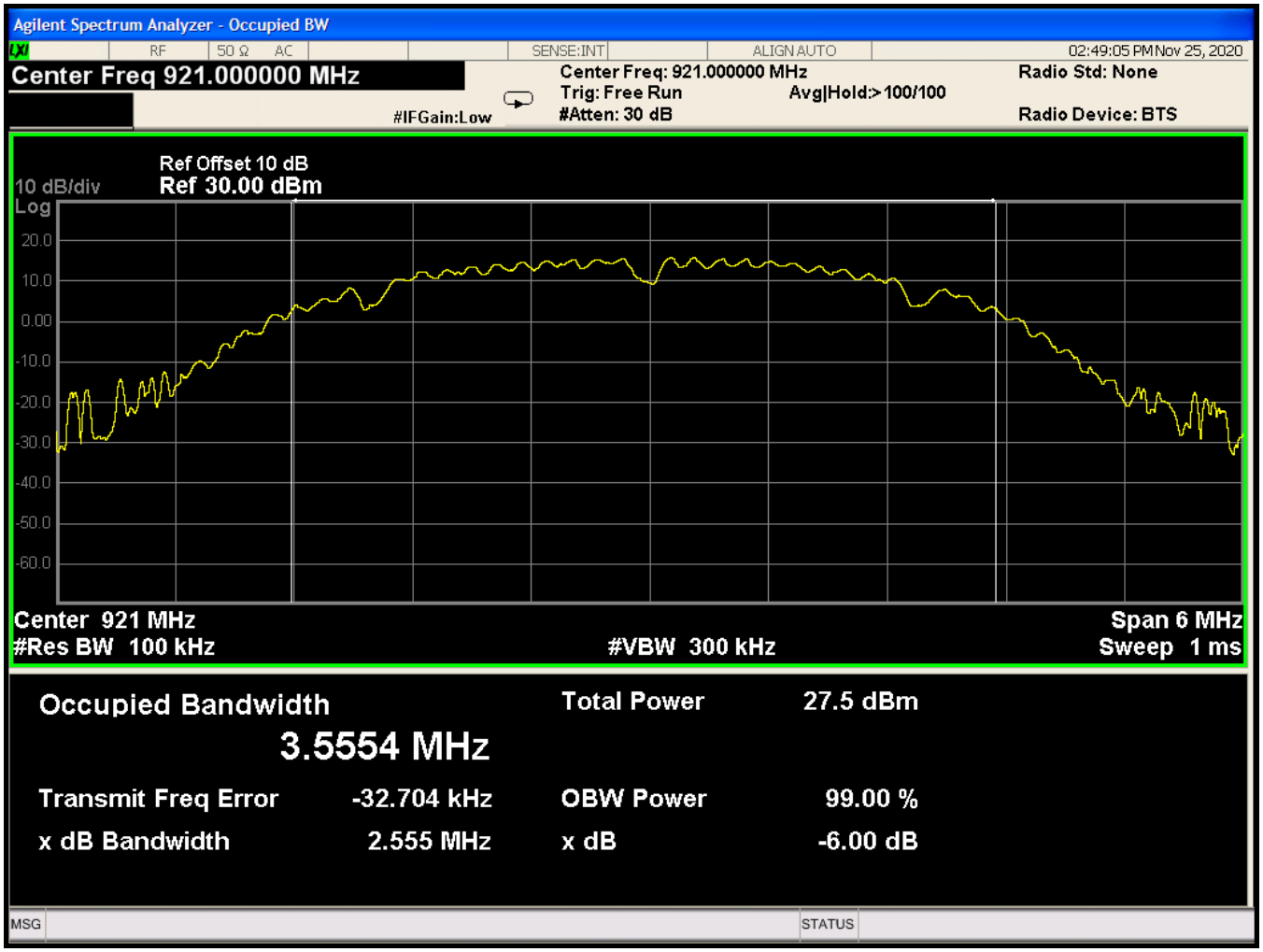


Figure 3: Occupied Bandwidth, High Channel (10)



1.4 RF Power Output:

To measure the output power, the unit was set to dwell on the low, middle, and high channels with a continuous 100% duty cycle. Testing was performed using the method from C63.10 section 11.9.1.1 "RBW ⩾ DTS bandwidth" at the antenna port as follows:

a) Set the RBW ⩾ DTS bandwidth.

b) Set VBW ⩾ [3 × RBW].

c) Set span ⩾ [3 × RBW].

d) Sweep time = auto couple.

e) Detector = peak.

f) Trace mode = max hold.

g) Allow trace to fully stabilize.

h) Use peak marker function to determine the peak amplitude level.

1.4.1 Measurement Method:

ANSI C63.10 section "11.9.1 Maximum peak conducted output power" subsection "11.9.1.1 RBW > DTS bandwidth"

Table 4: Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
3 MHz	≥ 9 MHz

Table 5: RF Power Output Summary

Frequency	Level (dBm)	Limit (dBm)	Pass/Fail
Low Channel (7): 906 MHz	25.38	30	Pass
Center Channel (9): 916 MHz	26.64	30	Pass
High Channel (10): 921 MHz	26.26	30	Pass

Figure 4: RF Peak Power Output, Channel 7

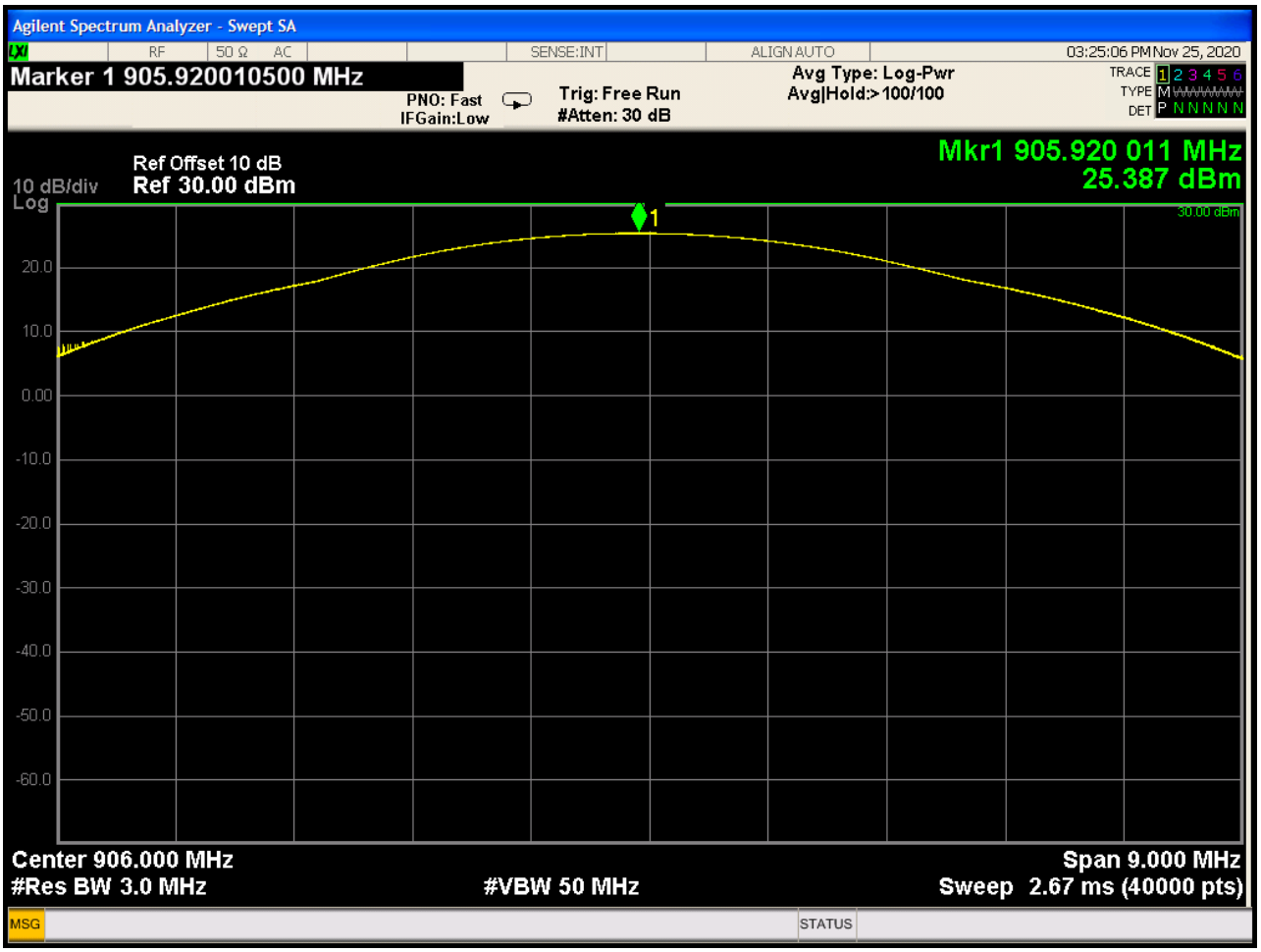


Figure 5: RF Peak Power Output, Channel 9

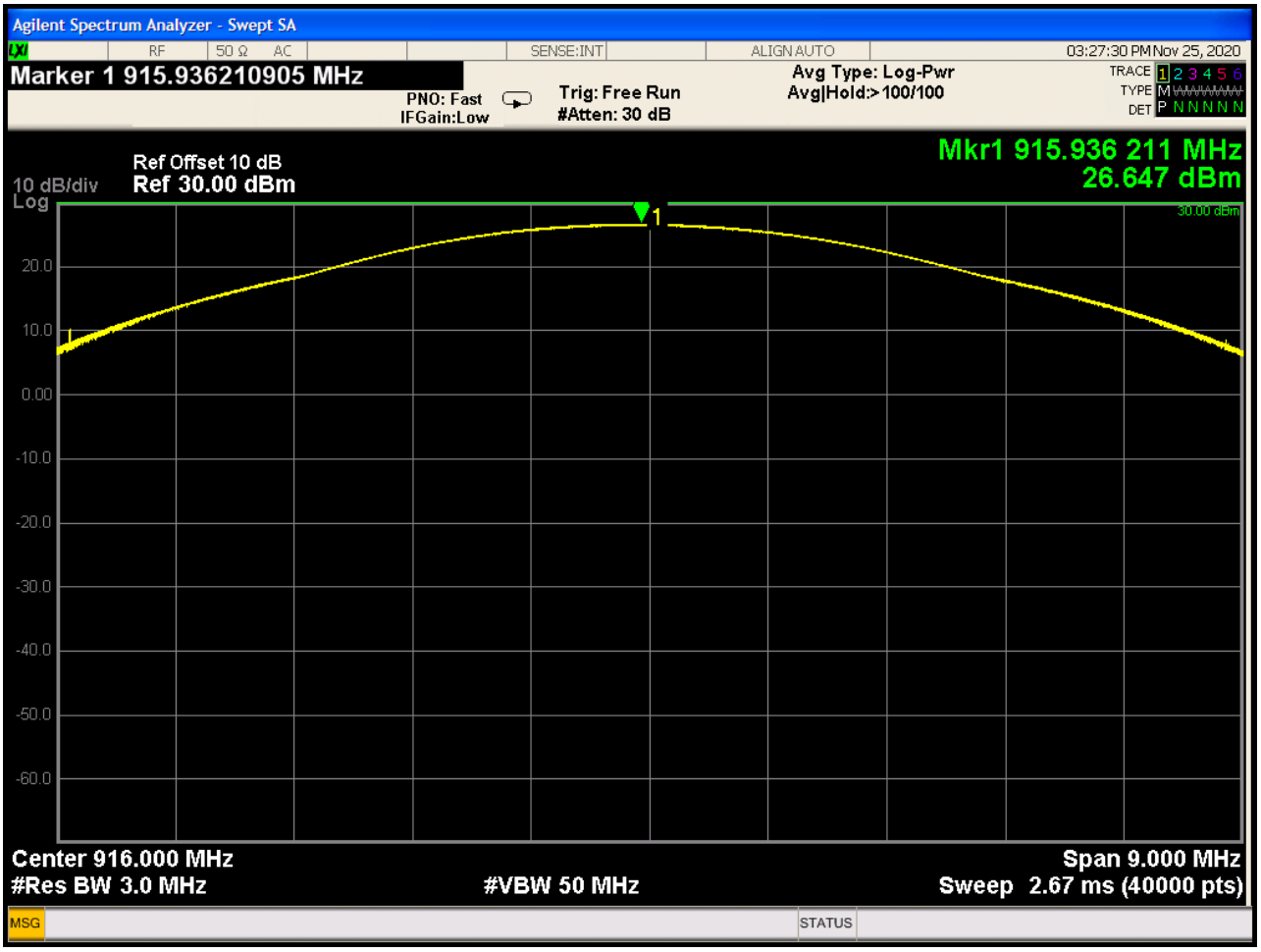
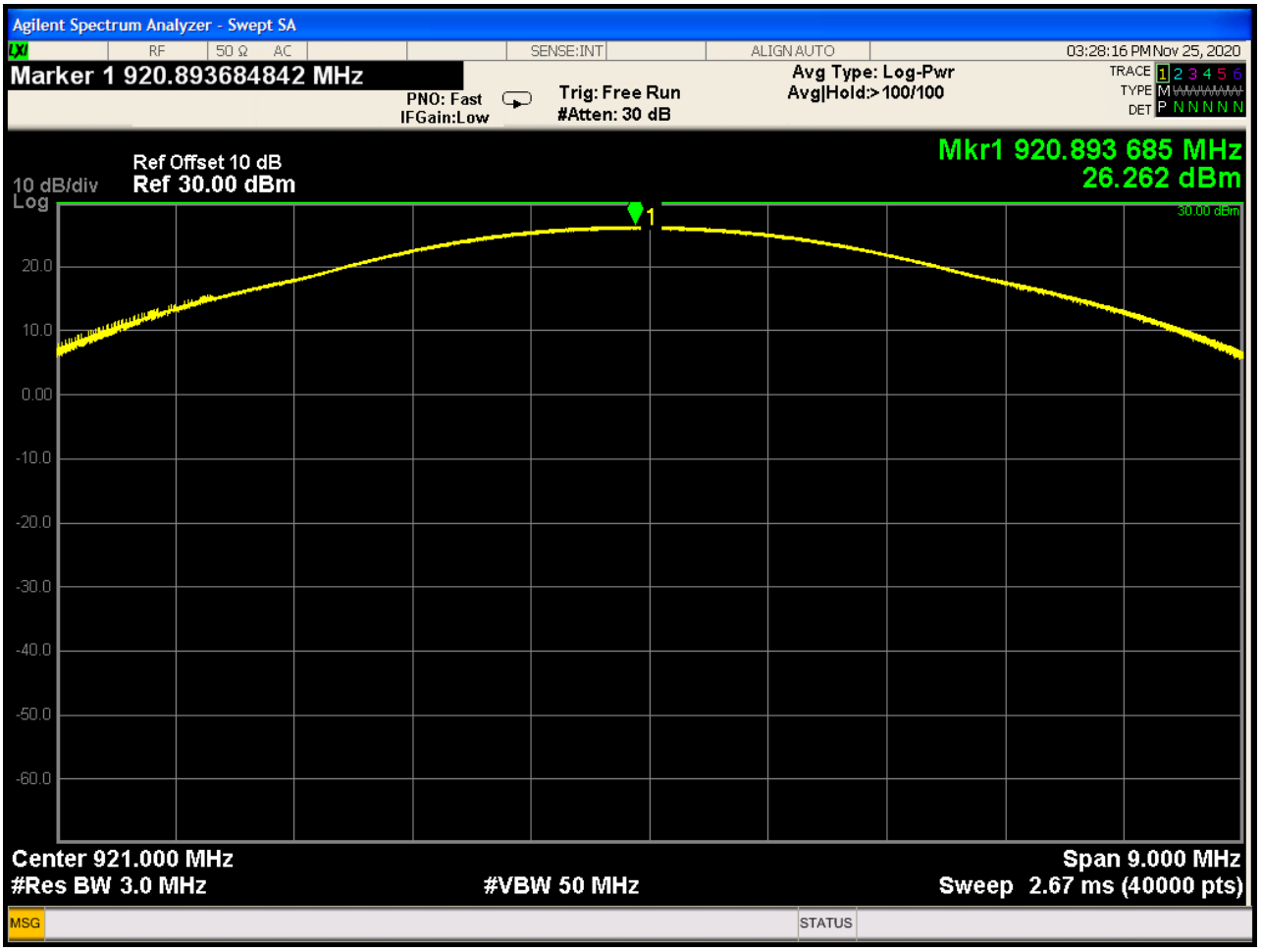


Figure 6: RF Peak Power Output, Channel 10



1.5 Power Spectral Density

Measurements for power spectral density were taken at the antenna port in accordance with ANSI C63.10. The spectrum analyzer was set to peak detect mode with a RBW of 3 kHz, VBW of 300 kHz across a span 1.5X the DTS bandwidth using an auto sweep time.

4.3.1 Measurement Method:

ANSI C63.10 SECTION 11.10 “Maximum power spectral density level in the fundamental emission subsection 11.10.2 “Method PKPSD (peak PSD)”

The highest level detected across any 3 kHz band for continuous transmission was then recorded and compared to the limit 8dBm. The following table and plots give the results for power spectral density testing.

Table 6: Power Spectral Density

Frequency	Peak Level (dBm)	Limit (dBm)	Pass/Fail
Low Channel (7): 906 MHz	5.83	8	Pass
Center Channel (9): 916 MHz	7.02	8	Pass
High Channel (10): 921 MHz	6.71	8	Pass

Figure 7: Power Spectral Density, Low Channel (7)

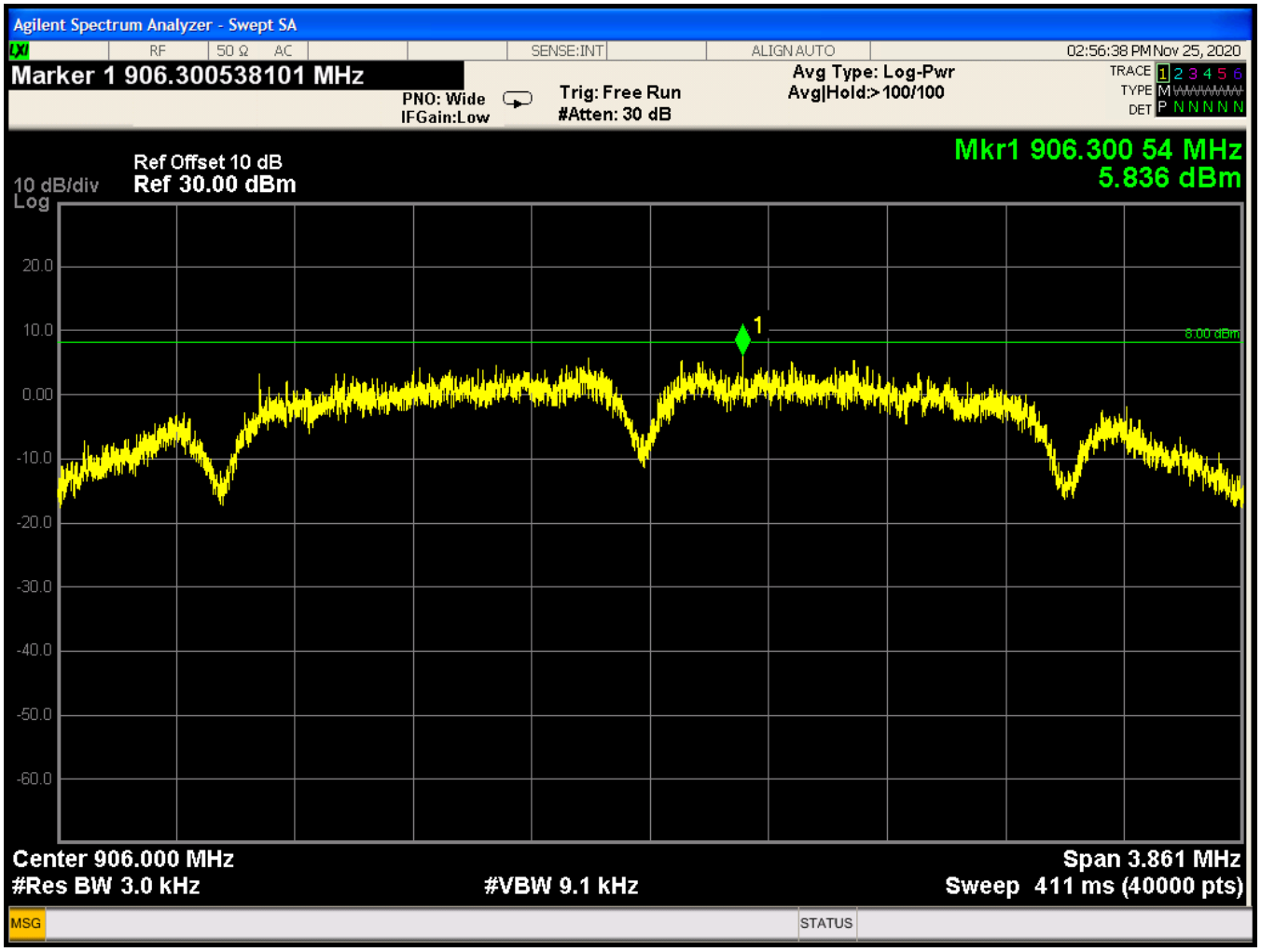


Figure 8: Power Spectral Density, Center Channel (9)

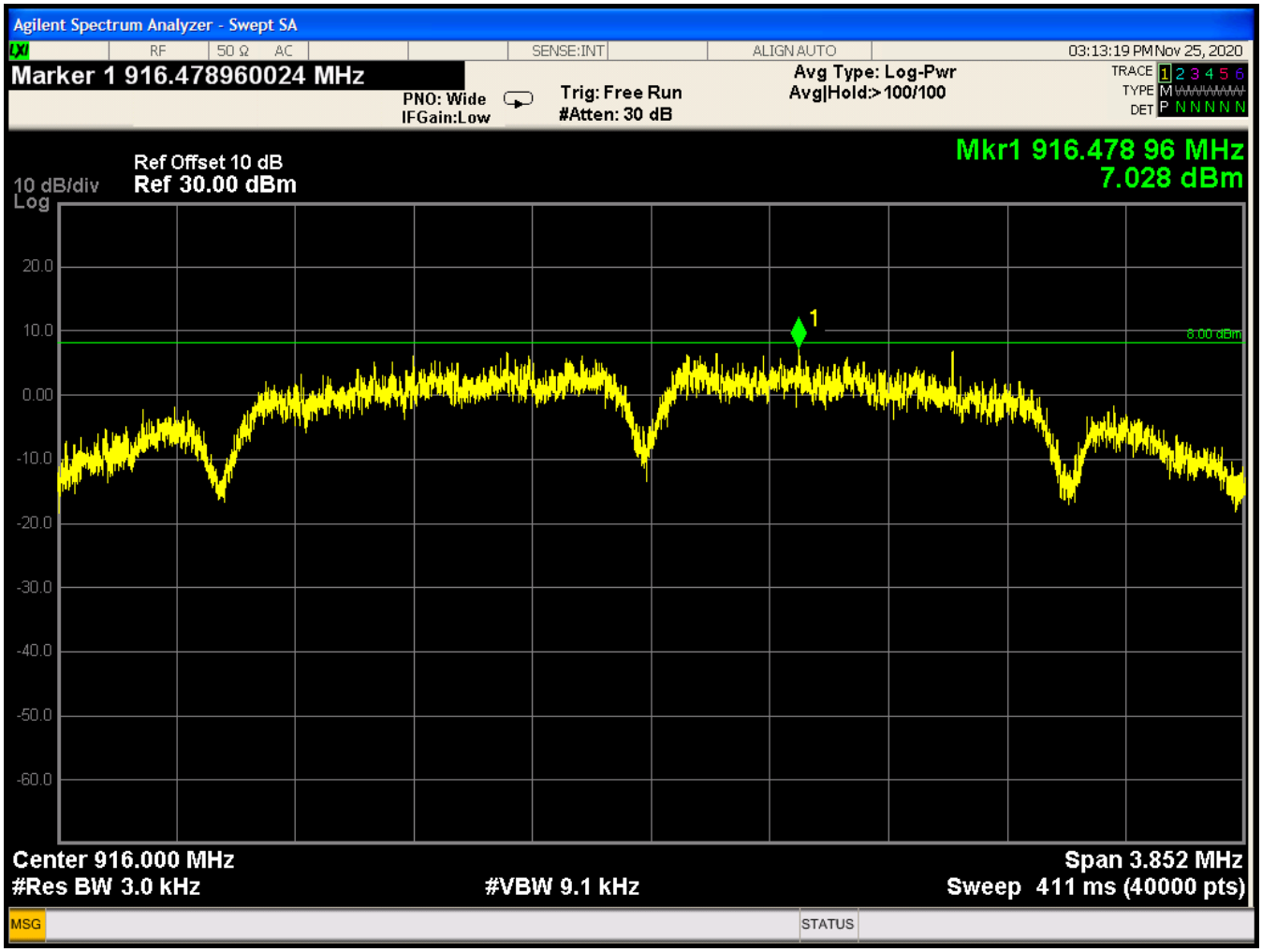
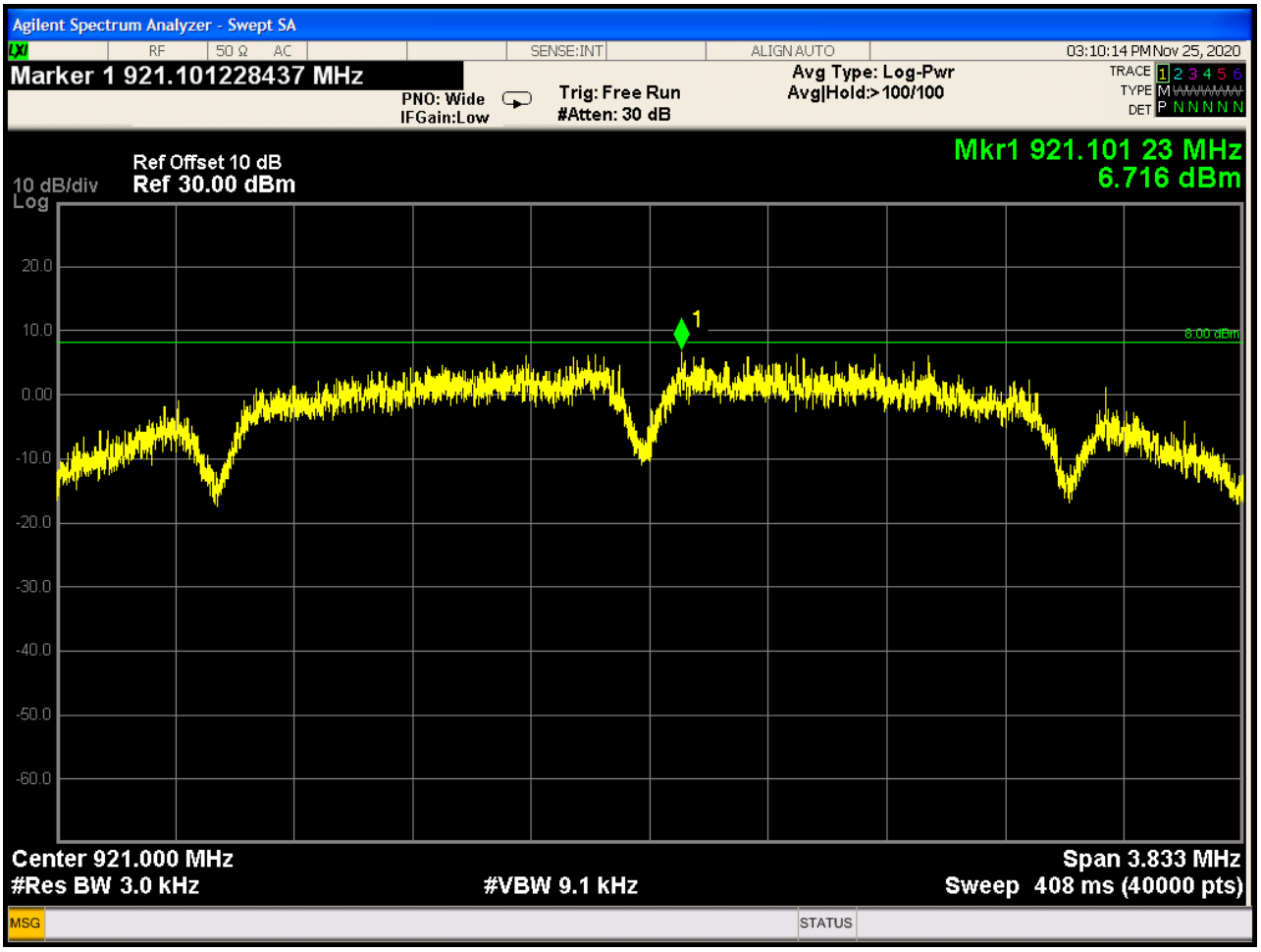


Figure 9: Power Spectral Density, High Channel (10)



1.6 Conducted Spurious Emissions Compliance

The EUT must comply with requirements for spurious emissions. Per §15.247(d) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

Per ANSI C63.10 section 11.11 "Emissions in non-restricted frequency bands" this test may be performed in an antenna port conducted manner. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

As per ANSI C63.10 section 11.11.2 the center channel has the highest PSD in a 100 kHz bandwidth and the limit for all channels was based on this level.

The following table shows the spurious emissions data.

1.6.1 Test Summary

The EUT complied with the requirements for Spurious emissions at the antenna port.

Table 7: Spurious Emissions

Frequency	Pass/Fail
Low Channel (7): 906 MHz	Pass
Center Channel (9): 916 MHz	Pass
High Channel (10): 921 MHz	Pass

Figure 10: Low Channel (7) Conducted Spurious Plot 1

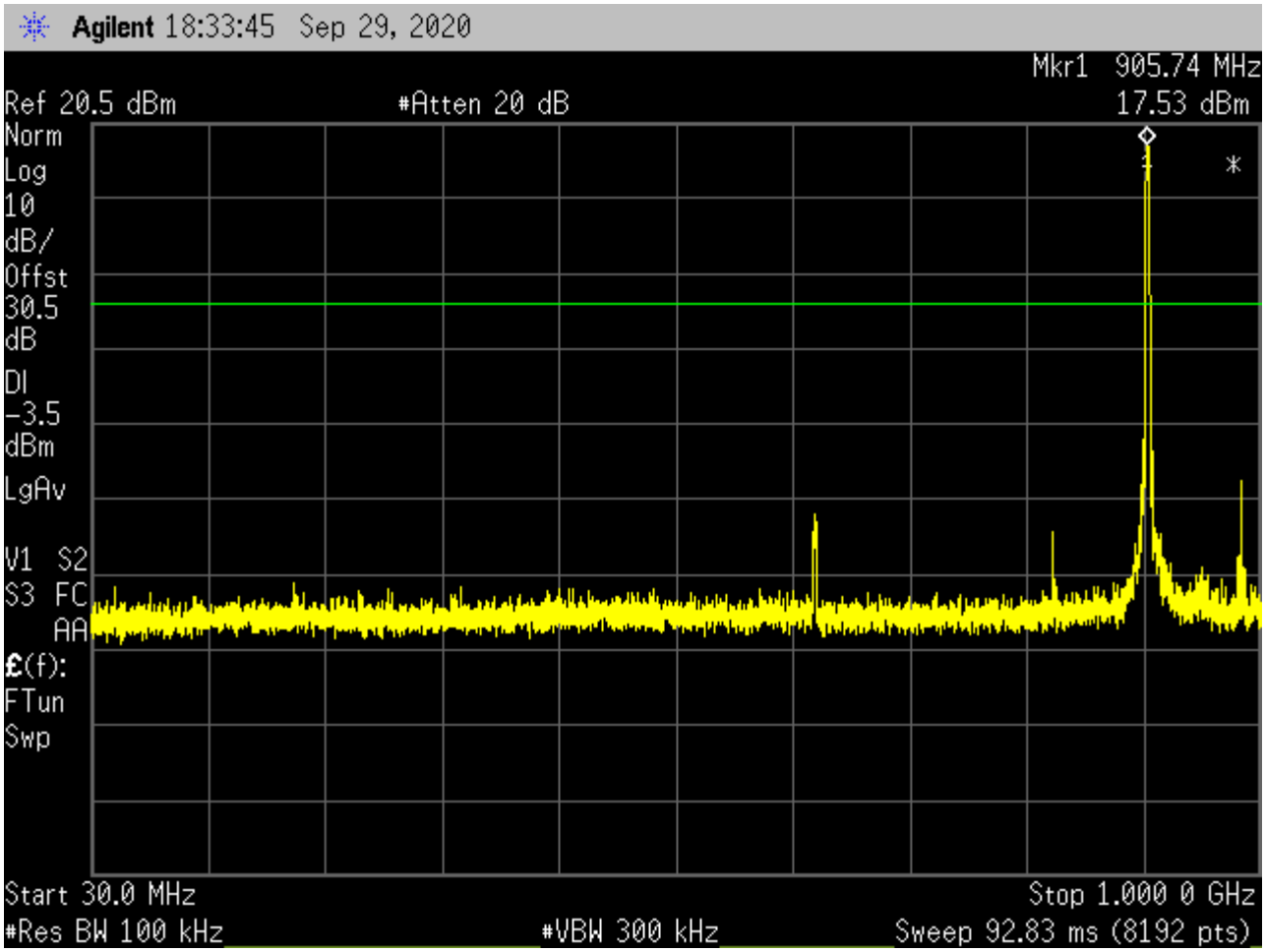


Figure 11: Low Channel (7) Conducted Spurious Plot 2

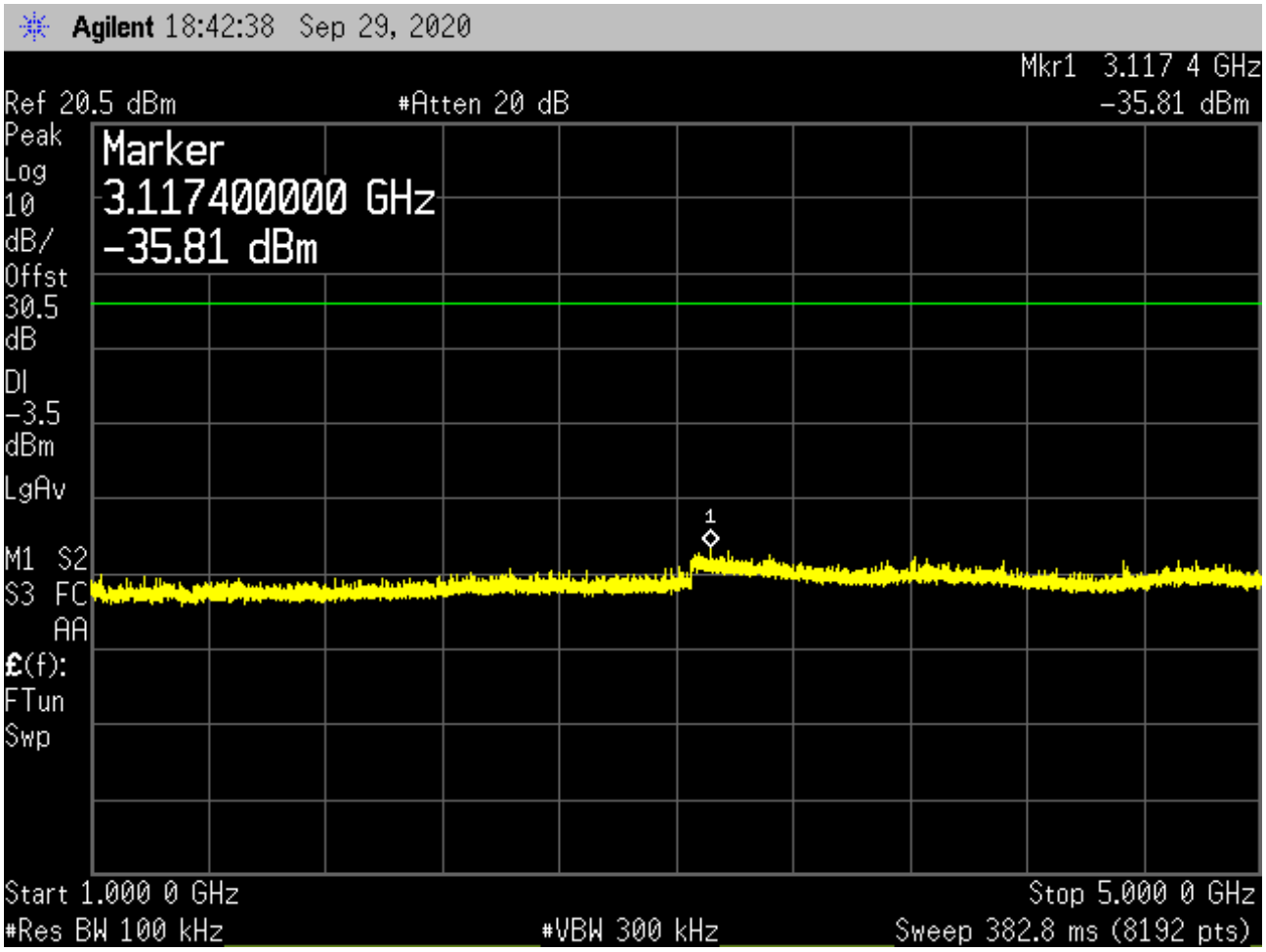


Figure 12: Low Channel (7) Conducted Spurious Plot 3

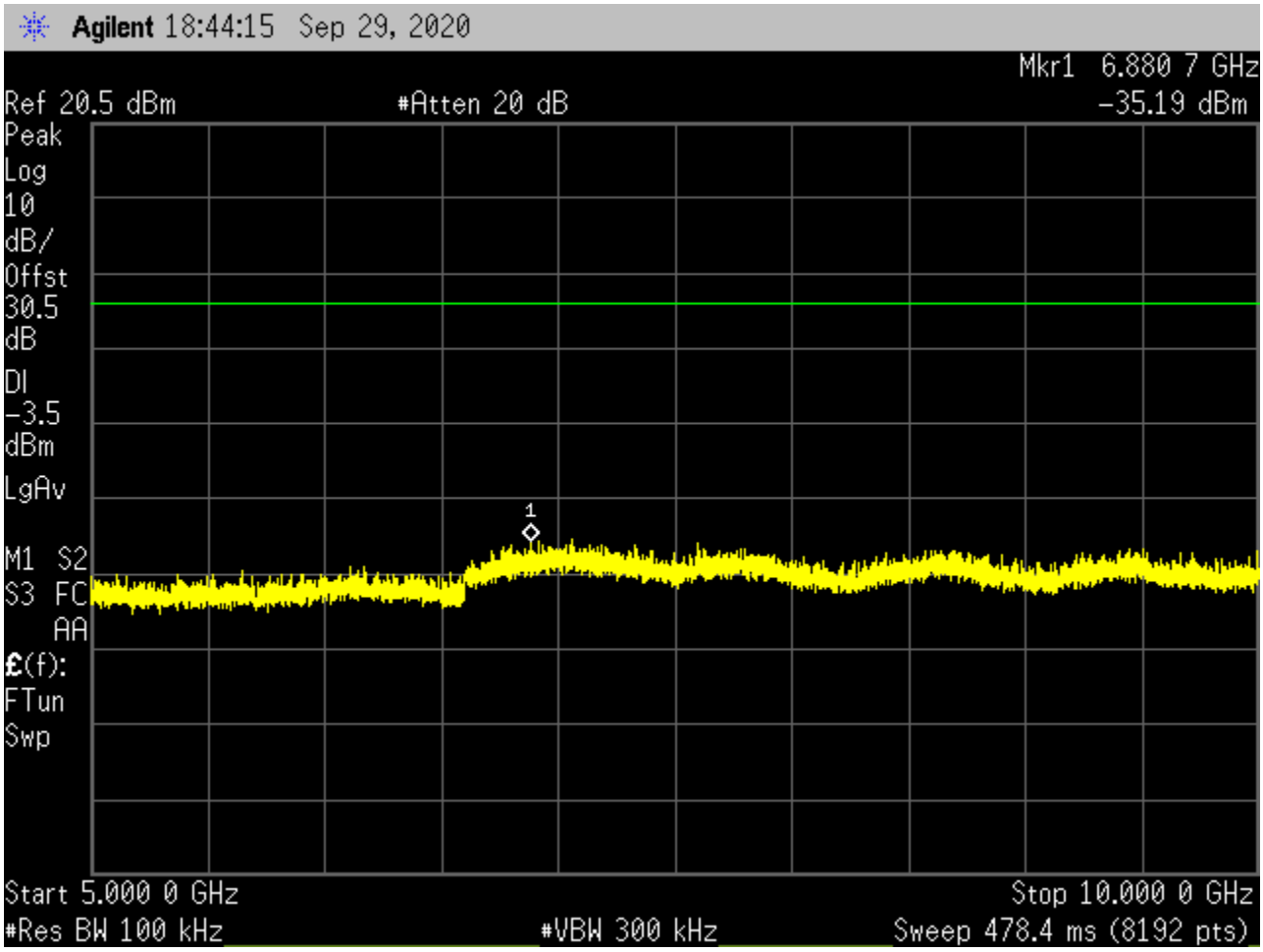


Figure 13: Center Channel (9) Conducted Spurious Plot 1

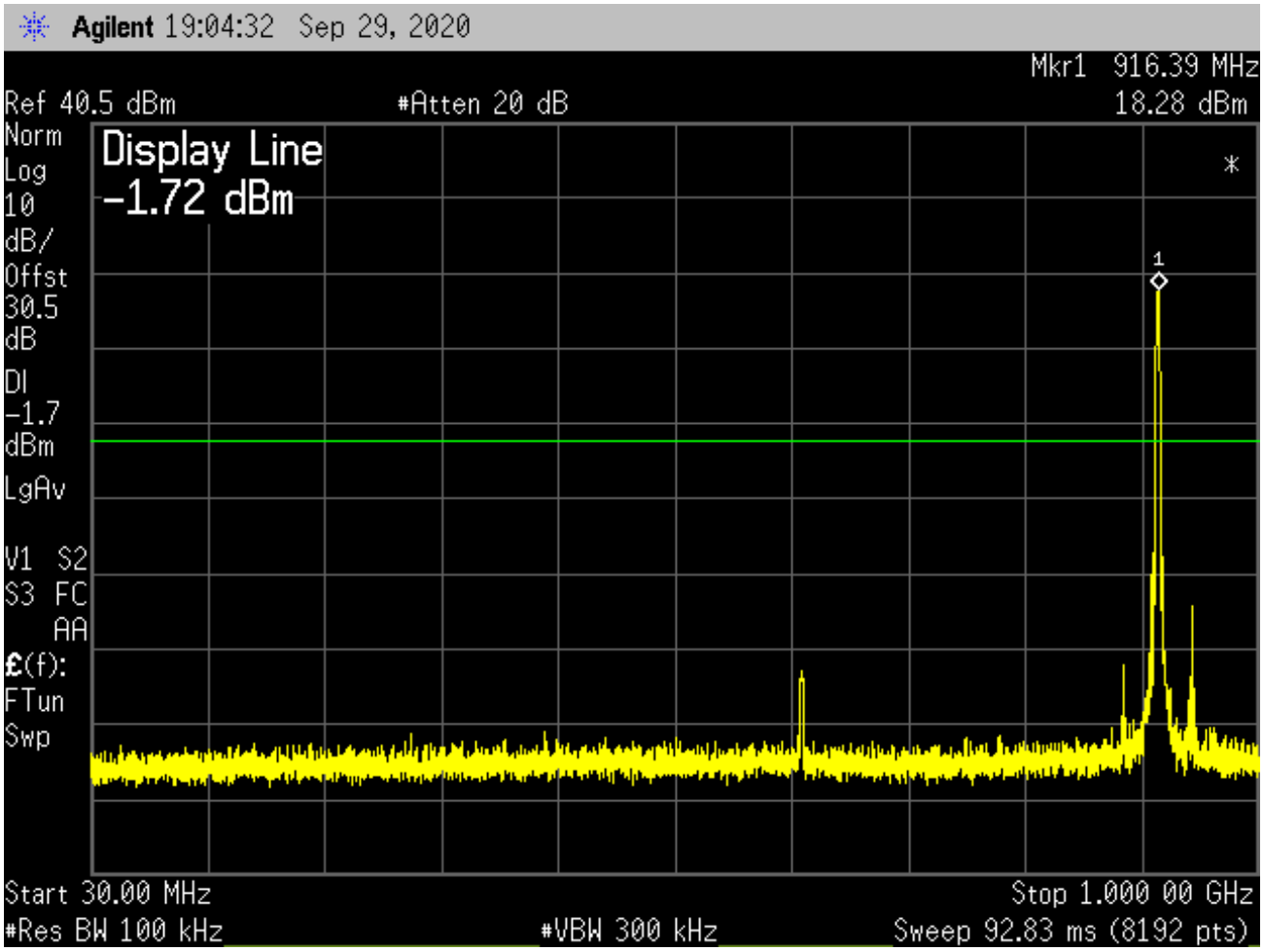


Figure 14: Center Channel (9) Conducted Spurious Plot 2

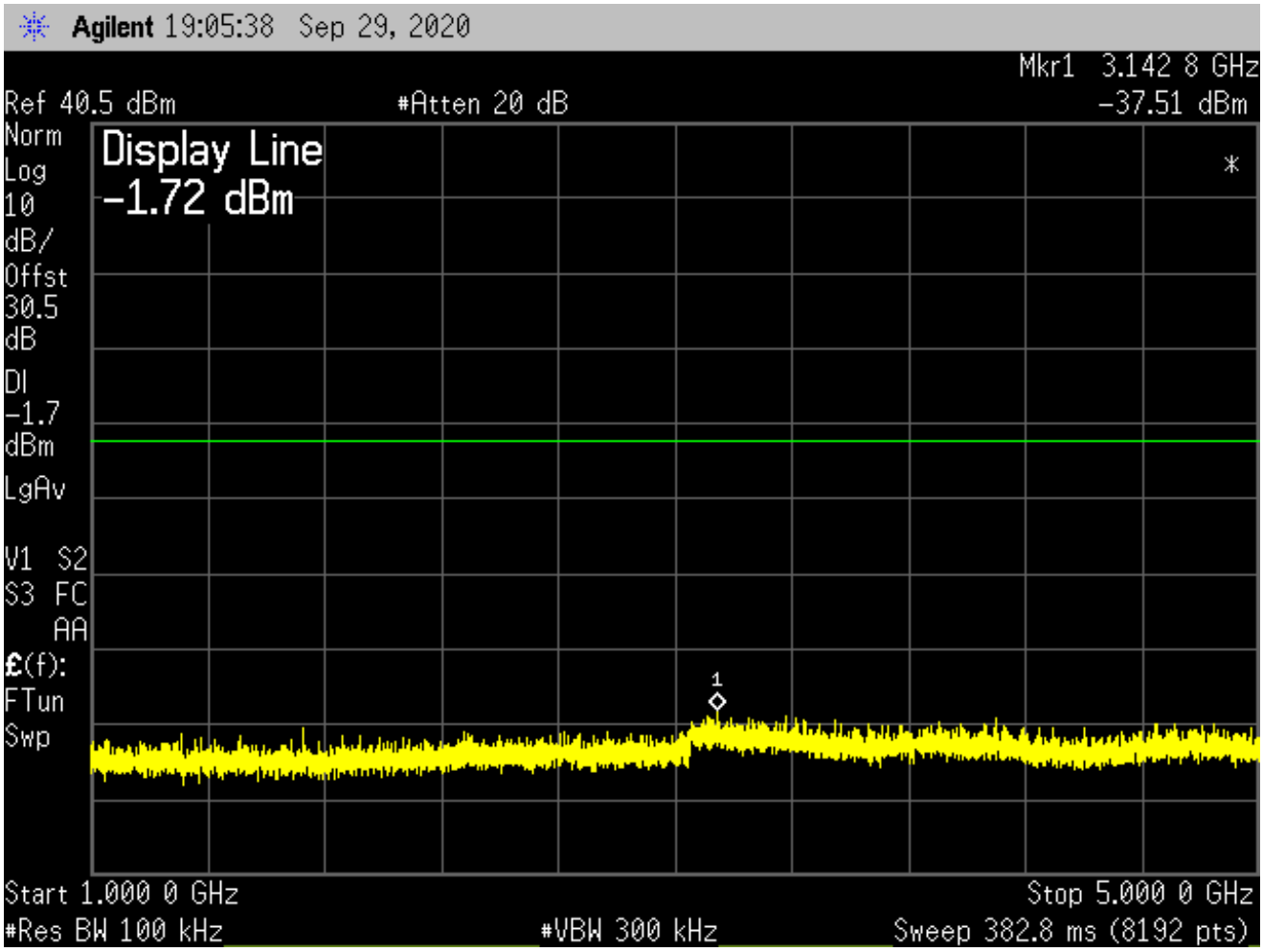


Figure 15: Center Channel (9) Conducted Spurious Plot 3

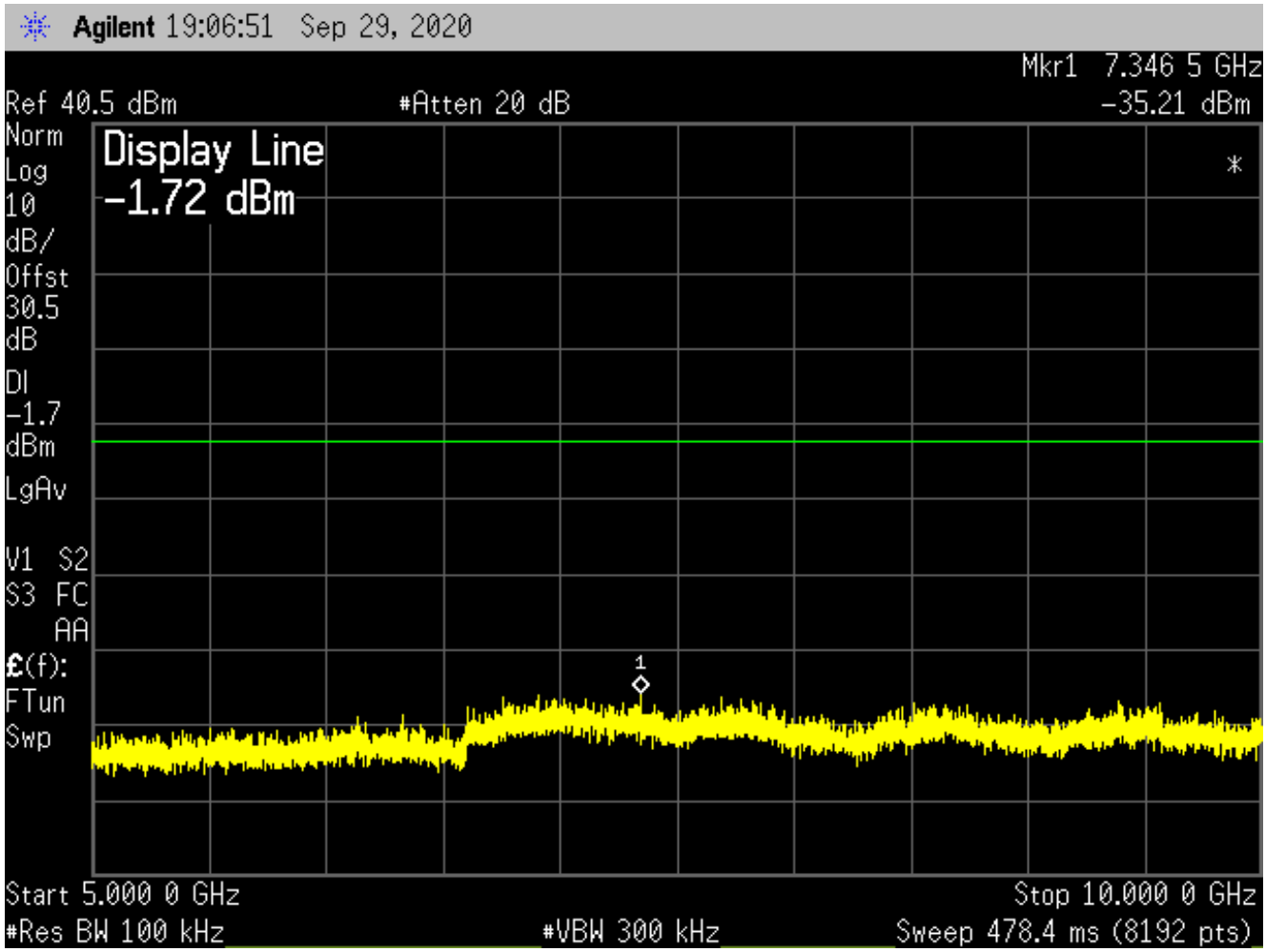


Figure 16: High Channel (10) Conducted Spurious Plot 1

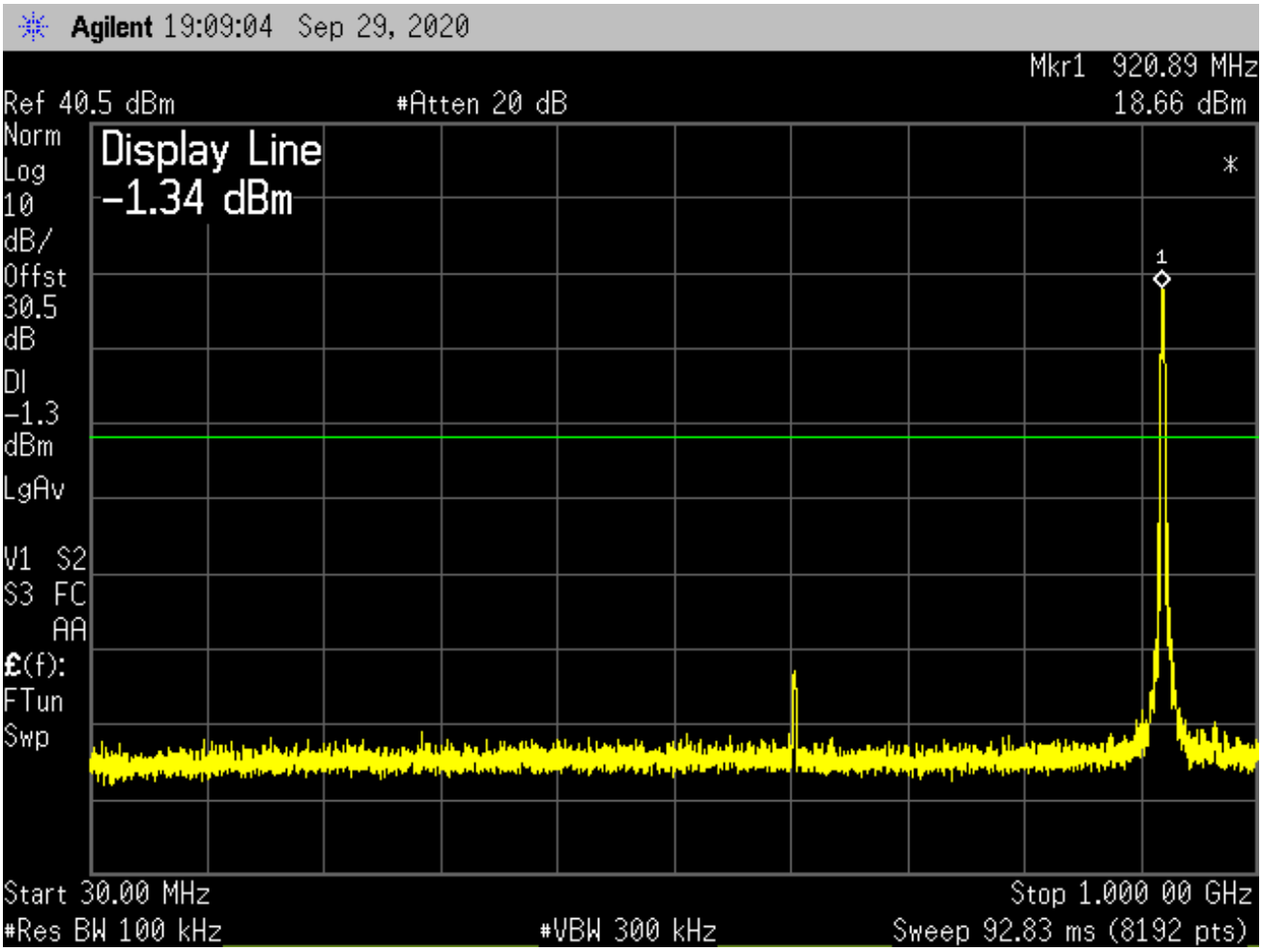


Figure 17: High Channel (10) Conducted Spurious Plot 2

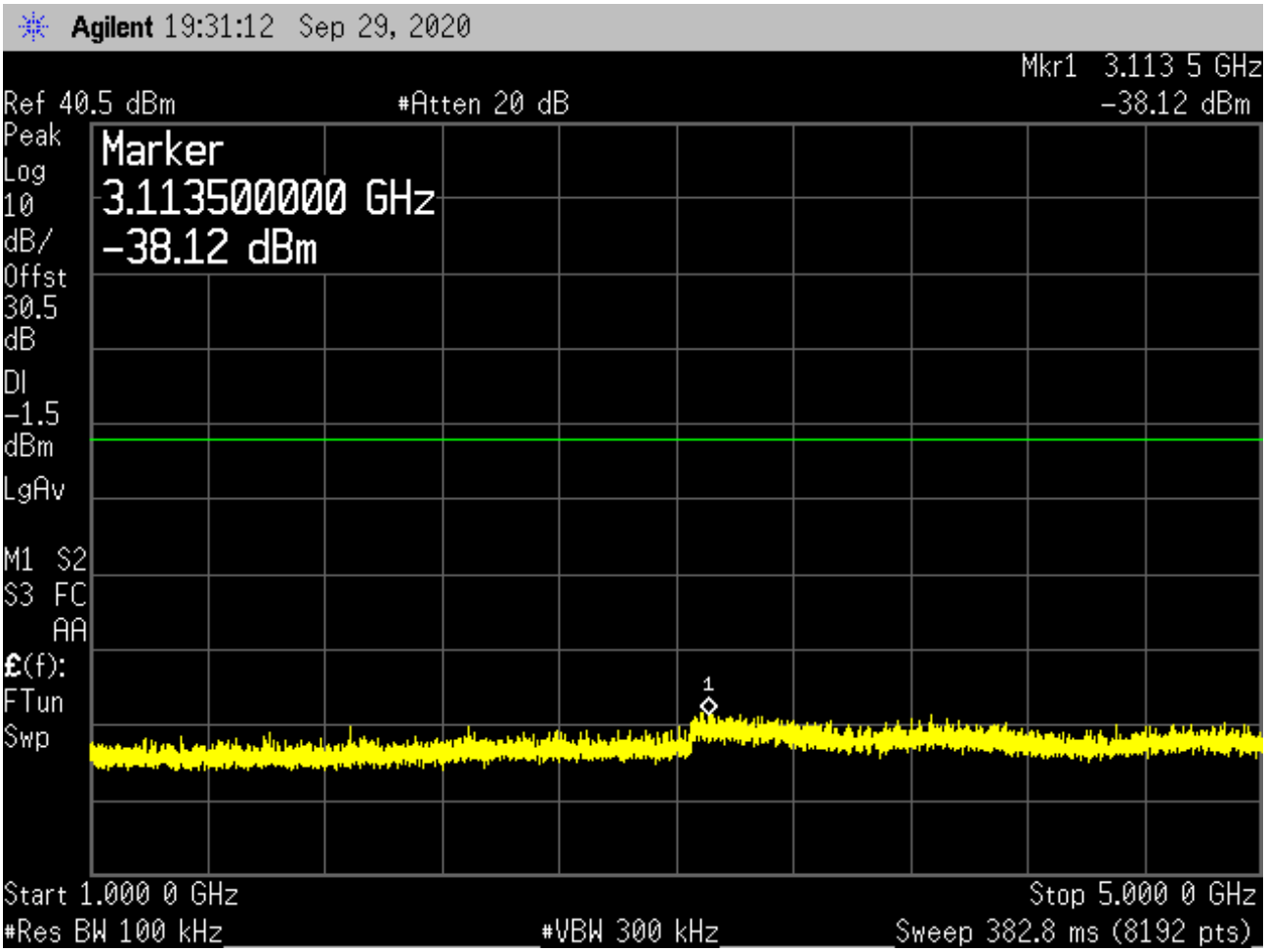


Figure 18: High Channel (10) Conducted Spurious Plot 3

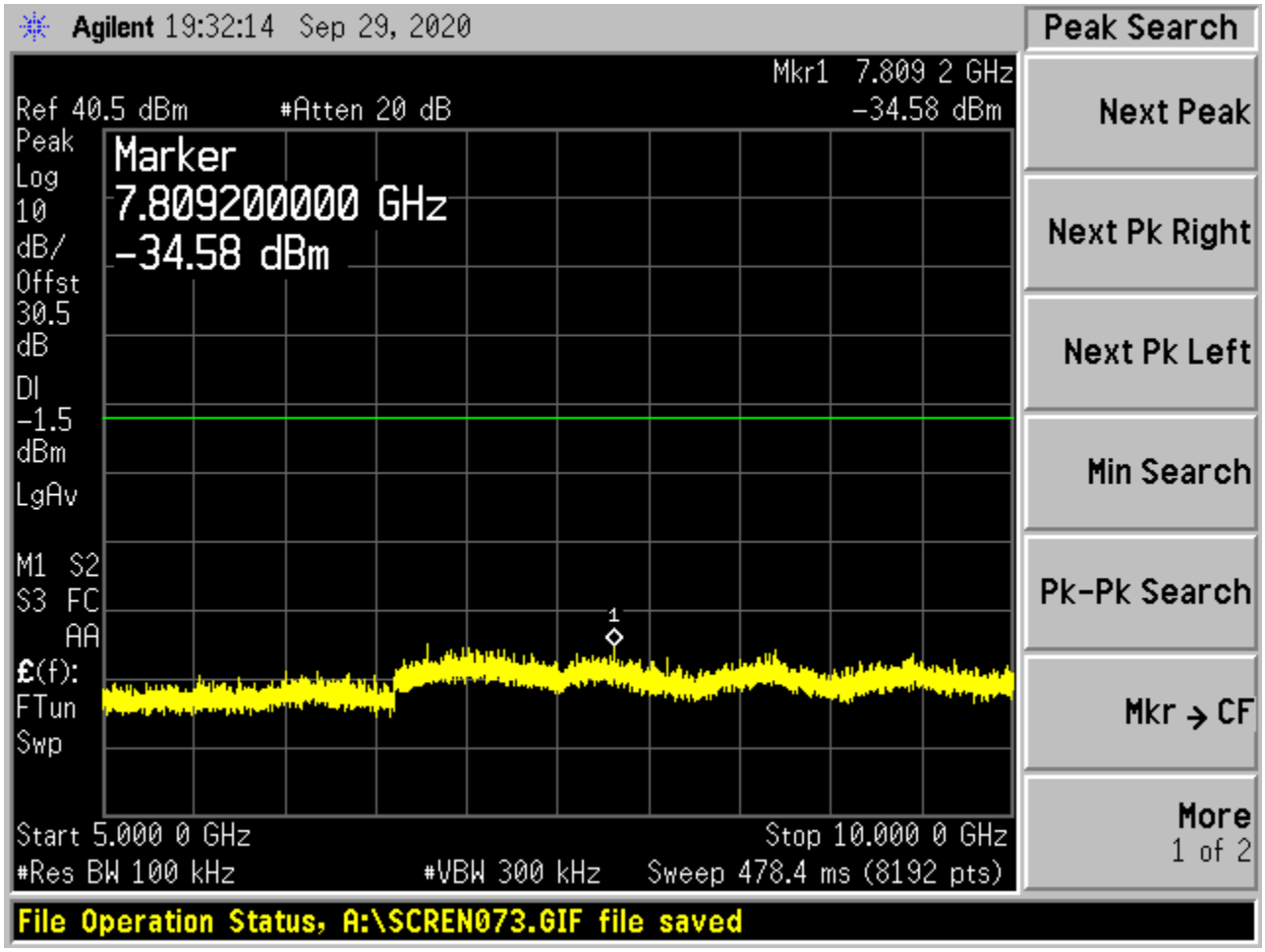


Figure 19: Low Channel (7) – Band Edge

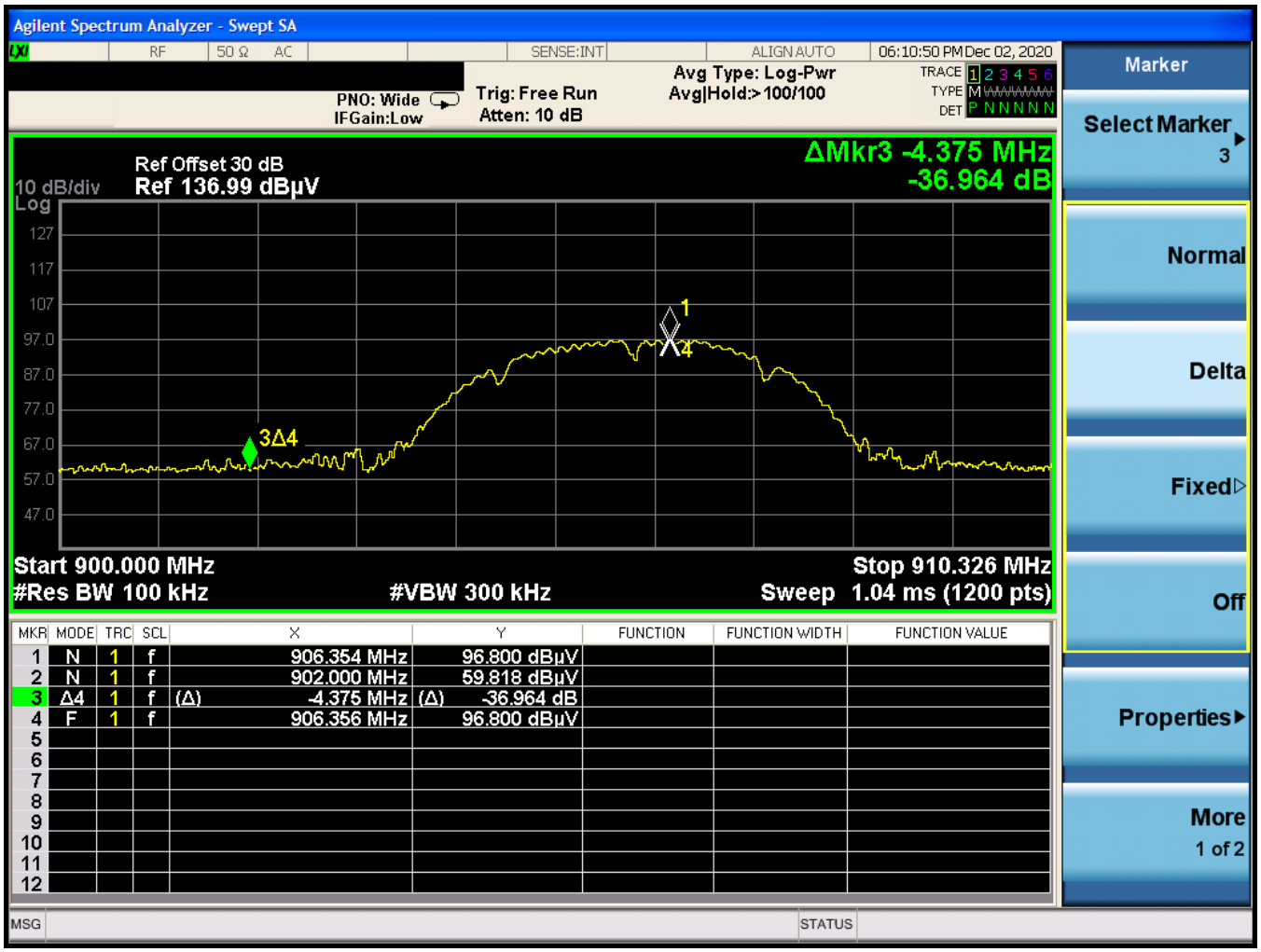
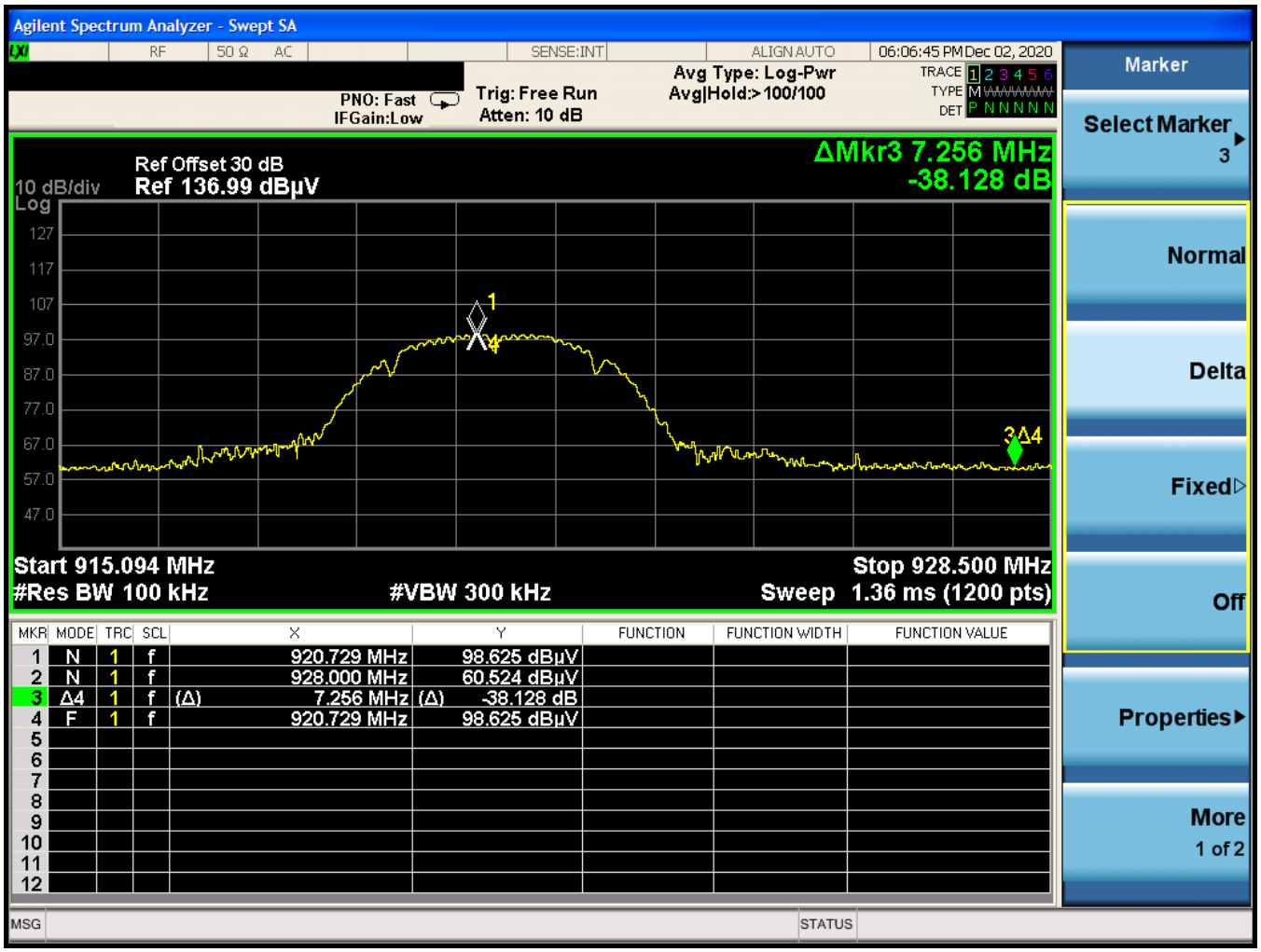


Figure 20: High Channel (10) – Band Edge



1.7 Radiated Emissions

1.7.1 Requirements

Compliance Standard: FCC Part 15, Class B

FCC Compliance Limits		
Frequency Range	Limit (distance)	
	Class A (10 meter)	Class B (3 meter)
30-88 MHz	90 µV/m	100 µV/m
88-216 MHz	150 µV/m	150 µV/m
216-960 MHz	210 µV/m	200 µV/m
>960 MHz	300 µV/m	500 µV/m

1.7.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive motorized turntable for radiated testing on a 3-meter, and 10-meter, open field test site.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 10 GHz was measured for digital unintentional radiated emissions. The frequency range of 30 MHz to 20 GHz was measured for radio spurious emissions. The peripherals were placed on the table in accordance with ANSI C63.4. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak or peak, as appropriate. Above 1 GHz average measurement are recorded. 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. Frequencies above 1GHz were performed using a measurement bandwidth of 1 MHz with a video bandwidth setting of 10 Hz for the average measurement.

Environmental Conditions during Radiated Emissions Testing

Ambient Temperature:	22.2 °C
Relative Humidity:	55 %

1.7.3 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
Antenna Correction Factor: AFdB/m
Cable Correction Factor: CFdB
Pre-Amplifier Gain (if applicable): GdB
Electric Field: EdBµV/m = V dBµV + AFdB/m + CFdB - GdB
To convert to linear units of measure: EdBµV/m/20 Inv log

1.7.4 Test Data

The EUT complies with the Radiated Emissions requirements of FCC Part 15.209.

Table 8 through Table 15 show the Radiated Spurious Emissions test data.

The frequency range of 30 MHz to 1 GHz was investigated for spurious emissions from the intentional radiator. The fundamental radio portion of the EUT has no emissions in this frequency range.

Digital Unintentional Radiated Emissions (30MHz-1GHz) was also investigated. The EUT was compliant with the Digital Class A Limits, and the results of those tests can be found in the applicant's Supplier's Declaration of Conformity.

Table 8: Radio Spurious Radiated Emissions Test Data, Low Channel (7), Yagi Antenna

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)	Peak or AVG
1812.00	V	0.0	1.2	26.9	30.9	778.3	5000.0	-16.2	Peak
1812.00	V	0.0	1.2	12.2	30.9	142.8	500.0	-10.9	AVG
2718.00	V	0.0	1.2	48.1	-0.1	252.4	5000.0	-25.9	Peak
2718.00	V	0.0	1.2	33.7	-0.1	48.0	500.0	-20.4	AVG
3624.00	V	0.0	1.2	48.0	1.9	315.6	5000.0	-24.0	Peak
3624.00	V	0.0	1.2	33.7	1.9	60.6	500.0	-18.3	AVG
4530.00	V	0.0	1.2	47.1	4.5	51.6	5000.0	-39.7	Peak
4530.00	V	0.0	1.2	33.2	4.5	76.5	500.0	-16.3	AVG
5436.00	V	0.0	1.2	47.5	7.3	550.6	5000.0	-19.2	Peak
5436.00	V	0.0	1.2	33.5	7.3	109.9	500.0	-13.2	AVG
6342.00	V	0.0	1.2	49.0	7.8	695.9	5000.0	-17.1	Peak
6342.00	V	0.0	1.2	35.1	7.8	140.1	500.0	-11.0	AVG
7248.00	V	0.0	1.2	49.6	10.8	1049.8	5000.0	-13.6	Peak
7248.00	V	0.0	1.2	35.8	10.8	214.4	500.0	-7.4	AVG
8154.00	V	0.0	1.2	46.9	10.8	765.9	5000.0	-16.3	Peak
8154.00	V	0.0	1.2	32.5	10.8	145.6	500.0	-10.7	AVG
1812.00	H	0.0	1.2	32.4	30.9	1466.1	5000.0	-10.7	Peak
1812.00	H	0.0	1.2	16.5	30.9	235.1	500.0	-6.6	AVG
2718.00	H	0.0	1.2	53.3	-0.1	458.3	5000.0	-20.8	Peak
2718.00	H	0.0	1.2	38.6	-0.1	84.4	500.0	-15.5	AVG
3624.00	H	0.0	1.2	53.9	1.9	619.7	5000.0	-18.1	Peak
3624.00	H	0.0	1.2	40.1	1.9	126.5	500.0	-11.9	AVG
4530.00	H	0.0	1.2	53.1	4.5	57.6	5000.0	-38.8	Peak
4530.00	H	0.0	1.2	39.3	4.5	154.5	500.0	-10.2	AVG
5436.00	H	0.0	1.2	53.1	7.3	1049.2	5000.0	-13.6	Peak
5436.00	H	0.0	1.2	39.3	7.3	214.2	500.0	-7.4	AVG
6342.00	H	0.0	1.2	53.7	7.8	1192.8	5000.0	-12.4	Peak
6342.00	H	0.0	1.2	39.7	7.8	238.0	500.0	-6.4	AVG
7248.00	H	0.0	1.2	55.8	10.8	2133.7	5000.0	-7.4	Peak
7248.00	H	0.0	1.2	42.2	10.8	447.8	500.0	-1.0	AVG
8154.00	H	0.0	1.2	54.6	10.8	1854.2	5000.0	-8.6	Peak
8154.00	H	0.0	1.2	40.6	10.8	370.0	500.0	-2.6	AVG

Table 9: Radio Spurious Radiated Emissions Test Data, Center Channel (9), Yagi Antenna

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)	Peak or AVG
1832.00	V	0.0	1.4	66.2	-5.0	1143.7	5000.0	-12.8	Peak
1832.00	V	0.0	1.4	52.3	-5.0	230.8	500.0	-6.7	AVG
2748.00	V	0.0	1.7	48.8	0.0	276.6	5000.0	-25.1	Peak
2748.00	V	0.0	1.7	34.6	0.0	53.9	500.0	-19.3	AVG
3664.00	V	0.0	1.7	47.7	2.0	304.7	5000.0	-24.3	Peak
3664.00	V	0.0	1.7	32.2	2.0	51.1	500.0	-19.8	AVG
4580.00	V	0.0	1.9	46.7	4.6	368.5	5000.0	-22.7	Peak
4580.00	V	0.0	1.9	31.6	4.6	64.6	500.0	-17.8	AVG
5496.00	V	0.0	1.8	47.0	7.3	515.3	5000.0	-19.7	Peak
5496.00	V	0.0	1.8	32.6	7.3	98.0	500.0	-14.2	AVG
6412.00	V	0.0	1.6	47.0	7.9	558.4	5000.0	-19.0	Peak
6412.00	V	0.0	1.6	32.3	7.9	102.9	500.0	-13.7	AVG
7328.00	V	0.0	1.8	47.5	10.7	814.3	5000.0	-15.8	Peak
7328.00	V	0.0	1.8	32.1	10.7	138.4	500.0	-11.2	AVG
8244.00	V	0.0	1.4	47.7	11.0	855.8	5000.0	-15.3	Peak
8244.00	V	0.0	1.4	32.3	11.0	144.7	500.0	-10.8	AVG
1832.00	H	0.0	1.2	70.0	-5.0	1771.3	5000.0	-9.0	Peak
1832.00	H	0.0	1.2	55.9	-5.0	351.0	500.0	-3.1	AVG
2748.00	H	0.0	1.7	50.1	0.0	321.3	5000.0	-23.8	Peak
2748.00	H	0.0	1.7	36.0	0.0	63.4	500.0	-17.9	AVG
3664.00	H	0.0	1.7	48.3	2.0	328.4	5000.0	-23.7	Peak
3664.00	H	0.0	1.7	33.0	2.0	56.2	500.0	-19.0	AVG
4580.00	H	0.0	1.9	46.7	4.6	368.5	5000.0	-22.7	Peak
4580.00	H	0.0	1.9	31.5	4.6	64.0	500.0	-17.9	AVG
5496.00	H	0.0	1.8	55.0	7.3	1291.3	5000.0	-11.8	Peak
5496.00	H	0.0	1.8	40.3	7.3	239.4	500.0	-6.4	AVG
6412.00	H	0.0	1.6	47.5	7.9	588.1	5000.0	-18.6	Peak
6412.00	H	0.0	1.6	32.3	7.9	102.8	500.0	-13.7	AVG
7328.00	H	0.0	1.8	46.9	10.7	765.2	5000.0	-16.3	Peak
7328.00	H	0.0	1.8	32.1	10.7	138.4	500.0	-11.2	AVG
8244.00	H	0.0	1.4	47.5	11.0	832.5	5000.0	-15.6	Peak
8244.00	H	0.0	1.4	32.3	11.0	144.8	500.0	-10.8	AVG

Table 10: Radio Spurious Radiated Emissions Test Data, High Channel (10), Yagi Antenna

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)	Peak or AVG
1842.00	V	0.0	1.2	21.5	31.2	431.2	5000.0	-21.3	Peak
1842.00	V	0.0	1.2	16.5	31.1	240.5	500.0	-6.4	AVG
2763.00	V	0.0	1.2	46.7	0.1	218.6	5000.0	-27.2	Peak
2763.00	V	0.0	1.2	33.1	0.1	45.7	500.0	-20.8	AVG
3684.00	V	0.0	1.2	46.5	2.0	266.8	5000.0	-25.5	Peak
3684.00	V	0.0	1.2	33.5	2.0	59.7	500.0	-18.5	AVG
4605.00	V	0.0	1.2	47.0	4.7	51.7	5000.0	-39.7	Peak
4605.00	V	0.0	1.2	33.1	4.7	78.0	500.0	-16.1	AVG
5526.00	V	0.0	1.2	47.1	7.2	519.9	5000.0	-19.7	Peak
5526.00	V	0.0	1.2	33.2	7.2	104.9	500.0	-13.6	AVG
6447.00	V	0.0	1.2	47.9	8.0	626.7	5000.0	-18.0	Peak
6447.00	V	0.0	1.2	33.8	8.0	123.6	500.0	-12.1	AVG
7368.00	V	0.0	1.2	48.2	10.7	882.7	5000.0	-15.1	Peak
7368.00	V	0.0	1.2	34.9	10.7	190.9	500.0	-8.4	AVG
8289.00	V	0.0	1.2	45.6	11.1	680.9	5000.0	-17.3	Peak
8289.00	V	0.0	1.2	32.2	11.1	145.6	500.0	-10.7	AVG
1842.00	H	0.0	1.2	29.8	31.2	1121.2	5000.0	-13.0	Peak
1842.00	H	0.0	1.2	16.5	31.2	242.5	500.0	-6.3	AVG
2763.00	H	0.0	1.2	47.1	0.1	228.9	5000.0	-26.8	Peak
2763.00	H	0.0	1.2	33.2	0.1	46.2	500.0	-20.7	AVG
3684.00	H	0.0	1.2	49.1	2.0	359.9	5000.0	-22.9	Peak
3684.00	H	0.0	1.2	34.1	2.0	64.0	500.0	-17.9	AVG
4605.00	H	0.0	1.2	46.2	4.7	50.9	5000.0	-39.8	Peak
4605.00	H	0.0	1.2	32.9	4.7	76.3	500.0	-16.3	AVG
5526.00	H	0.0	1.2	46.2	7.2	468.7	5000.0	-20.6	Peak
5526.00	H	0.0	1.2	32.7	7.2	99.1	500.0	-14.1	AVG
6447.00	H	0.0	1.2	48.5	8.0	671.6	5000.0	-17.4	Peak
6447.00	H	0.0	1.2	33.9	8.0	125.1	500.0	-12.0	AVG
7368.00	H	0.0	1.2	49.1	10.7	979.1	5000.0	-14.2	Peak
7368.00	H	0.0	1.2	34.6	10.7	184.4	500.0	-8.7	AVG
8289.00	H	0.0	1.2	46.6	11.1	764.0	5000.0	-16.3	Peak
8289.00	H	0.0	1.2	33.2	11.1	163.3	500.0	-9.7	AVG

Table 11: WiFi Harmonics Radiated Emissions Test Data, Center Channel (9), Yagi Antenna

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)	Peak or AVG
4800.00	V	0.0	1.2	48.1	6.6	541.2	5000.0	-19.3	Peak
4800.00	V	0.0	1.2	34.5	6.6	113.1	500.0	-12.9	AVG
7200.00	V	0.0	1.2	47.7	10.9	848.7	5000.0	-15.4	Peak
7200.00	V	0.0	1.2	33.7	10.9	169.3	500.0	-9.4	AVG
9600.00	V	0.0	1.2	45.6	14.7	1034.7	5000.0	-13.7	Peak
9600.00	V	0.0	1.2	31.4	14.7	201.7	500.0	-7.9	AVG
12000.00	V	0.0	1.2	45.9	17.2	1424.0	5000.0	-10.9	Peak
12000.00	V	0.0	1.2	31.9	17.2	284.1	500.0	-4.9	AVG
14400.00	V	0.0	1.2	48.5	20.3	2767.6	5000.0	-5.1	Peak
14400.00	V	0.0	1.2	30.9	20.3	364.8	500.0	-2.7	AVG
16800.00	V	0.0	1.2	47.5	19.5	2220.9	5000.0	-7.0	Peak
16800.00	V	0.0	1.2	32.0	19.5	373.7	500.0	-2.5	AVG
4800.00	H	0.0	1.2	48.7	6.6	579.9	5000.0	-18.7	Peak
4800.00	H	0.0	1.2	34.5	6.6	113.1	500.0	-12.9	AVG
7200.00	H	0.0	1.2	47.1	10.9	792.1	5000.0	-16.0	Peak
7200.00	H	0.0	1.2	34.2	10.9	179.4	500.0	-8.9	AVG
9600.00	H	0.0	1.2	46.3	14.7	1125.4	5000.0	-13.0	Peak
9600.00	H	0.0	1.2	31.5	14.7	204.1	500.0	-7.8	AVG
12000.00	H	0.0	1.2	45.5	17.2	1356.8	5000.0	-11.3	Peak
12000.00	H	0.0	1.2	32.1	17.2	290.7	500.0	-4.7	AVG
14400.00	H	0.0	1.2	48.0	20.3	2612.8	5000.0	-5.6	Peak
14400.00	H	0.0	1.2	30.8	20.3	360.7	500.0	-2.8	AVG
16800.00	H	0.0	1.2	47.1	19.5	2125.9	5000.0	-7.4	Peak
16800.00	H	0.0	1.2	31.1	19.5	336.9	500.0	-3.4	AVG

Table 12: Radio Spurious Radiated Emissions Test Data, Low Channel (7), Mono-Pole Antenna

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)	Peak or AVG
1812.00	V	0.0	1.4	36.2	30.9	2270.7	5000.0	-6.9	Peak
1812.00	V	0.0	1.4	18.9	30.9	309.9	500.0	-4.2	AVG
2718.00	V	0.0	1.4	47.4	-0.1	232.3	5000.0	-26.7	Peak
2718.00	V	0.0	1.4	33.5	-0.1	46.9	500.0	-20.6	AVG
3624.00	V	0.0	1.4	47.6	1.9	300.0	5000.0	-24.4	Peak
3624.00	V	0.0	1.4	33.7	1.9	60.3	500.0	-18.4	AVG
4530.00	V	0.0	1.4	52.2	4.5	682.1	5000.0	-17.3	Peak
4530.00	V	0.0	1.4	33.7	4.5	81.1	500.0	-15.8	AVG
5436.00	V	0.0	1.4	47.6	7.3	557.0	5000.0	-19.1	Peak
5436.00	V	0.0	1.4	33.7	7.3	112.4	500.0	-13.0	AVG
6342.00	V	0.0	1.4	49.1	7.8	704.0	5000.0	-17.0	Peak
6342.00	V	0.0	1.4	34.8	7.8	135.4	500.0	-11.3	AVG
7248.00	V	0.0	1.4	48.8	10.8	958.6	5000.0	-14.3	Peak
7248.00	V	0.0	1.4	35.8	10.8	215.1	500.0	-7.3	AVG
8154.00	V	0.0	1.4	45.7	10.8	668.6	5000.0	-17.5	Peak
8154.00	V	0.0	1.4	32.6	10.8	146.9	500.0	-10.6	AVG
1812.00	H	0.0	1.4	34.5	30.9	1867.1	5000.0	-8.6	Peak
1812.00	H	0.0	1.4	20.5	30.9	372.5	500.0	-2.6	AVG
2718.00	H	0.0	1.4	47.1	-0.1	224.7	5000.0	-26.9	Peak
2718.00	H	0.0	1.4	33.4	-0.1	46.4	500.0	-20.7	AVG
3624.00	H	0.0	1.4	46.7	1.9	270.5	5000.0	-25.3	Peak
3624.00	H	0.0	1.4	33.6	1.9	59.9	500.0	-18.4	AVG
4530.00	H	0.0	1.4	47.5	4.5	398.0	5000.0	-22.0	Peak
4530.00	H	0.0	1.4	33.7	4.5	81.1	500.0	-15.8	AVG
5436.00	H	0.0	1.4	47.1	7.3	525.8	5000.0	-19.6	Peak
5436.00	H	0.0	1.4	33.9	7.3	115.0	500.0	-12.8	AVG
6342.00	H	0.0	1.4	48.1	7.8	626.0	5000.0	-18.0	Peak
6342.00	H	0.0	1.4	35.1	7.8	140.1	500.0	-11.0	AVG
7248.00	H	0.0	1.4	49.5	10.8	1037.8	5000.0	-13.7	Peak
7248.00	H	0.0	1.4	35.9	10.8	216.8	500.0	-7.3	AVG
8154.00	H	0.0	1.4	46.0	10.8	688.1	5000.0	-17.2	Peak
8154.00	H	0.0	1.4	32.6	10.8	146.4	500.0	-10.7	AVG

Table 13: Radio Spurious Radiated Emissions Test Data, Center Channel (9), Mono-Pole Antenna

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)	Peak or AVG
1832.00	V	270.0	1.7	65.8	-5.0	1088.4	5000.0	-13.2	Peak
1832.00	V	270.0	1.7	51.2	-5.0	204.5	500.0	-7.8	AVG
2748.00	V	180.0	1.8	49.0	0.0	283.1	5000.0	-24.9	Peak
2748.00	V	180.0	1.8	35.0	0.0	56.2	500.0	-19.0	AVG
3664.00	V	270.0	1.9	48.7	2.0	343.1	5000.0	-23.3	Peak
3664.00	V	270.0	1.9	32.2	2.0	51.4	500.0	-19.8	AVG
4580.00	V	0.0	1.2	41.2	4.6	195.6	5000.0	-28.2	Peak
4580.00	V	0.0	1.2	33.3	4.6	78.8	500.0	-16.1	AVG
5496.00	V	180.0	1.7	41.7	7.3	280.6	5000.0	-25.0	Peak
5496.00	V	180.0	1.7	27.7	7.3	56.0	500.0	-19.0	AVG
6412.00	V	180.0	1.7	41.4	7.9	292.7	5000.0	-24.7	Peak
6412.00	V	180.0	1.7	26.9	7.9	55.2	500.0	-19.1	AVG
7328.00	V	270.0	1.4	42.3	10.7	449.0	5000.0	-20.9	Peak
7328.00	V	270.0	1.4	28.3	10.7	89.6	500.0	-14.9	AVG
8244.00	V	90.0	1.4	41.4	11.0	413.9	5000.0	-21.6	Peak
8244.00	V	90.0	1.4	28.1	11.0	89.6	500.0	-14.9	AVG
1832.00	H	270.0	1.2	60.7	-5.0	605.8	5000.0	-18.3	Peak
1832.00	H	270.0	1.2	46.4	-5.0	117.7	500.0	-12.6	AVG
2748.00	H	90.0	1.5	49.9	0.0	314.0	5000.0	-24.0	Peak
2748.00	H	90.0	1.5	35.0	0.0	56.2	500.0	-19.0	AVG
3664.00	H	0.0	1.2	47.8	2.0	307.9	5000.0	-24.2	Peak
3664.00	H	0.0	1.2	32.2	2.0	51.3	500.0	-19.8	AVG
4580.00	H	0.0	1.8	46.7	4.6	368.5	5000.0	-22.7	Peak
4580.00	H	0.0	1.8	31.8	4.6	66.3	500.0	-17.6	AVG
5496.00	H	270.0	1.2	47.2	7.3	528.5	5000.0	-19.5	Peak
5496.00	H	270.0	1.2	32.7	7.3	100.0	500.0	-14.0	AVG
6412.00	H	270.0	1.7	47.6	7.9	600.4	5000.0	-18.4	Peak
6412.00	H	270.0	1.7	32.5	7.9	105.3	500.0	-13.5	AVG
7328.00	H	270.0	1.7	48.0	10.7	868.5	5000.0	-15.2	Peak
7328.00	H	270.0	1.7	32.2	10.7	140.9	500.0	-11.0	AVG
8244.00	H	0.0	1.4	47.1	11.0	801.4	5000.0	-15.9	Peak
8244.00	H	0.0	1.4	32.6	11.0	149.9	500.0	-10.5	AVG

Table 14: Radio Spurious Radiated Emissions Test Data, High Channel (10), Mono-Pole Antenna

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)	Peak or AVG
1842.00	V	180.0	1.4	31.5	31.2	1363.5	5000.0	-11.3	Peak
1842.00	V	180.0	1.4	18.0	31.2	288.2	500.0	-4.8	AVG
2763.00	V	0.0	1.4	48.0	0.1	253.9	5000.0	-25.9	Peak
2763.00	V	0.0	1.4	34.6	0.1	54.3	500.0	-19.3	AVG
3684.00	V	180.0	1.4	46.8	2.0	276.2	5000.0	-25.2	Peak
3684.00	V	180.0	1.4	33.8	2.0	61.8	500.0	-18.2	AVG
4605.00	V	0.0	1.4	46.9	4.7	382.2	5000.0	-22.3	Peak
4605.00	V	0.0	1.4	33.1	4.7	78.0	500.0	-16.1	AVG
5526.00	V	270.0	1.4	46.7	7.2	498.8	5000.0	-20.0	Peak
5526.00	V	270.0	1.4	33.3	7.2	106.2	500.0	-13.5	AVG
6447.00	V	0.0	1.4	46.2	8.0	515.3	5000.0	-19.7	Peak
6447.00	V	0.0	1.4	45.1	8.0	454.0	500.0	-0.8	AVG
7368.00	V	0.0	1.4	48.6	10.7	920.1	5000.0	-14.7	Peak
7368.00	V	0.0	1.4	34.7	10.7	186.6	500.0	-8.6	AVG
8289.00	V	0.0	1.4	46.6	11.1	764.0	5000.0	-16.3	Peak
8289.00	V	0.0	1.4	31.1	11.1	128.6	500.0	-11.8	AVG
1842.00	H	0.0	1.8	31.9	31.2	1427.8	5000.0	-10.9	Peak
1842.00	H	0.0	1.8	19.4	31.2	338.6	500.0	-3.4	AVG
2763.00	H	0.0	1.8	47.2	0.1	230.8	5000.0	-26.7	Peak
2763.00	H	0.0	1.8	33.2	0.1	46.2	500.0	-20.7	AVG
3684.00	H	0.0	1.8	47.7	2.0	306.3	5000.0	-24.3	Peak
3684.00	H	0.0	1.8	34.1	2.0	64.0	500.0	-17.9	AVG
4605.00	H	270.0	1.8	46.7	4.7	373.5	5000.0	-22.5	Peak
4605.00	H	270.0	1.8	37.5	4.7	129.5	500.0	-11.7	AVG
5526.00	H	0.0	1.8	46.3	7.2	474.2	5000.0	-20.5	Peak
5526.00	H	0.0	1.8	37.2	7.2	166.3	500.0	-9.6	AVG
6447.00	H	90.0	1.8	47.4	8.0	591.7	5000.0	-18.5	Peak
6447.00	H	90.0	1.8	39.3	8.0	232.9	500.0	-6.6	AVG
7368.00	H	0.0	1.8	47.8	10.7	843.0	5000.0	-15.5	Peak
7368.00	H	0.0	1.8	34.9	10.7	190.9	500.0	-8.4	AVG
8289.00	H	0.0	1.8	45.8	11.1	696.7	5000.0	-17.1	Peak
8289.00	H	0.0	1.8	32.0	11.1	142.6	500.0	-10.9	AVG

Table 15: WiFi Harmonics Radiated Emissions Test Data, Center Channel (9), Mono-Pole Antenna

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)	Peak or AVG
4800.00	V	0.0	1.8	47.3	6.6	496.2	5000.0	-20.1	Peak
4800.00	V	0.0	1.8	34.2	6.6	109.7	500.0	-13.2	AVG
7200.00	V	0.0	1.8	47.9	10.9	866.5	5000.0	-15.2	Peak
7200.00	V	0.0	1.8	34.1	10.9	176.9	500.0	-9.0	AVG
9600.00	V	0.0	1.8	45.6	14.7	1034.7	5000.0	-13.7	Peak
9600.00	V	0.0	1.8	31.4	14.7	201.7	500.0	-7.9	AVG
12000.00	V	0.0	1.8	45.1	17.2	1298.7	5000.0	-11.7	Peak
12000.00	V	0.0	1.8	31.7	17.2	277.7	500.0	-5.1	AVG
14400.00	V	0.0	1.8	49.4	20.3	3069.7	5000.0	-4.2	Peak
14400.00	V	0.0	1.8	31.4	20.3	386.5	500.0	-2.2	AVG
16800.00	V	0.0	1.8	46.0	19.5	1873.0	5000.0	-8.5	Peak
16800.00	V	0.0	1.8	33.2	19.5	429.1	500.0	-1.3	AVG
4800.00	H	0.0	1.6	47.0	6.6	478.6	5000.0	-20.4	Peak
4800.00	H	0.0	1.6	34.2	6.6	109.6	500.0	-13.2	AVG
7200.00	H	0.0	1.6	47.6	10.9	839.0	5000.0	-15.5	Peak
7200.00	H	0.0	1.6	34.1	10.9	177.3	500.0	-9.0	AVG
9600.00	H	0.0	1.6	45.1	14.7	974.6	5000.0	-14.2	Peak
9600.00	H	0.0	1.6	31.6	14.7	206.4	500.0	-7.7	AVG
12000.00	H	0.0	1.6	45.5	17.2	1359.9	5000.0	-11.3	Peak
12000.00	H	0.0	1.6	31.8	17.2	280.9	500.0	-5.0	AVG
14400.00	H	0.0	1.6	48.7	20.3	2832.1	5000.0	-4.9	Peak
14400.00	H	0.0	1.6	26.2	20.3	212.4	500.0	-7.4	AVG
16800.00	H	0.0	1.6	46.7	19.5	2034.9	5000.0	-7.8	Peak
16800.00	H	0.0	1.6	32.9	19.5	414.5	500.0	-1.6	AVG

1.8 AC Conducted Emissions

1.8.1 Requirements

Compliance Standard: FCC Part 15, Class A

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

1.8.2 Test Procedure

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. At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

Environmental Conditions during Conducted Emissions Testing

Ambient Temperature:	21.6 °C
Relative Humidity:	56 %

1.8.3 Conducted Data Reduction and Reporting

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The comparison between the Conducted emissions level and the FCC limit is calculated as shown in the following example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

1.8.4 Test Data

The EUT complies with Class A Conducted Emissions requirements. None of the AC Power Conducted Emissions are related to the transmitter. The effects of the AC Conducted Emissions were compared while the EUT was in TX On and TX Off modes.

Table 16: Conducted Emission Test Data

NEUTRAL										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.154	54.29	47.57	10.2	0.2	64.7	57.9	79.0	66.0	-14.3	-8.1
0.165	53.23	46.40	10.2	0.3	63.7	56.8	79.0	66.0	-15.3	-9.2
0.19	51.10	44.24	10.2	0.2	61.5	54.6	79.0	66.0	-17.5	-11.4
.27	44.36	37.57	10.2	0.3	54.8	48.0	79.0	66.0	-24.2	-18.0
1.77	23.17	31.59	10.2	0.3	33.7	42.1	73.0	60.0	-39.3	-17.9
13.39	28.91	17.73	11.3	0.5	40.7	29.5	73.0	60.0	-32.3	-30.5
14.59	29.11	21.85	11.3	0.6	41.0	33.8	73.0	60.0	-32.0	-26.2
PHASE / L1										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Margin AVG (dB)**
0.154	54.4	47.6	10.2	0.2	64.7	58.0	79.0	66.0	-14.3	-8.0
0.183	51.7	44.8	10.2	0.1	61.9	55.0	79.0	66.0	-17.1	-11.0
0.205	49.9	42.9	10.2	0.0	60.0	53.1	79.0	66.0	-19.0	-12.9
0.302	43.8	37.2	10.2	0.2	54.1	47.6	79.0	66.0	-24.9	-18.4
2.560	32.6	20.1	10.1	0.3	43.0	30.5	73.0	60.0	-30.0	-29.5
13.319	30.4	22.1	11.3	0.4	42.1	33.8	73.0	60.0	-30.9	-26.2
15.340	27.2	15.4	11.4	0.5	39.0	27.2	73.0	60.0	-34.0	-32.8

1.9 Contract Information

Customer:	Ultra-3eTI
Purchase Order Number:	20-0335
Quotation Number:	72237

1.10 Test and Support Personnel

Washington Laboratories, LTD	Michael Violette and Ryan Mascaro
Customer Representative	Rich Brazda

2 Equipment Under Test

2.1 EUT Identification & Description

The Ultra-3eTI 3e-523E-900 is a 900 MHz version of a WiFi data access point / bridge networking wireless data transmission device. It is powered by 120VAC and offers a direct wired connection to 10/100/1000 Ethernet interface, if desired. The unit encrypts the data flowing to/from the unit to form a FIPS-validated secure network through both wired and wireless interface. 900 MHz, 1W, transmission is used for long range wireless communications. Power Level 5 was used for all testing.

Table 17: Device Summary

Manufacturer:	Ultra Electronics
FCC ID:	QVT-523N-900
ISED ID:	6780A-523N-900
Model:	3e-523E-900
Serial Number of Unit Tested	Proto_3
FCC Rule Parts:	§15.247
ISED Rule Parts:	RSS-247, Issue 2
Frequency Range:	902 – 928 MHz
Maximum Output Power:	1 W (30dBm)
Modulation:	DSSS (802.11b down converted to 900MHz)
Occupied Bandwidth (99%):	~5MHz per Channel
FCC Emission Designator:	2M54F1D
ISED Emissions Designators:	3M54F1D
Keying:	Automatic
Type of Information:	WiFi IP Packets (down converted to 900MHz)
Number of Channels:	4
Power Output Level	Fixed: 5 (as certified)
Highest TX Spurious Emission:	65.8 dBuV (Peak)
Highest RX Spurious Emission:	50.7 dBuV (Peak)
Antenna Connector	Standard N-type, bulkhead jack
Antenna Type	L-Com HG906U, 6dBi Mono-Pole L-Com HG906YE, 6dBi Yagi directional
Interface Cables:	LMR-240 (25’ or greater)
Maximum Data Rate	11 Mbps (802.11b)
Power Source & Voltage:	120VAC

2.2 Test Configuration

The 3e-523E-900 was powered by the provided 120VAC power supply. The WiFi access point radio was configured using the auxiliary computer for support. The interface between the EUT and the laptop utilized an IPv4 protocol for connectivity and a browser-based GUI. The GUI provides an operational test mode, through which the EUT can be configured. The custom software (AirGaurd) allows the 3e-523E-900 to be set in a normal/transmitting state. A shielded RJ-45 cable was connected to the 3e-523N-C.

Table 18: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Revision
Access Point	3e-523N-C	242B523N1000	R23N20W3800101	n/a
Up/Down Converter	3e-900MOD	242B900M1000	PROTO_3	n/a
Test Mode Operating Software	AirGaurd	3e-local	n/a	n/a
Antenna	HG906U	Mono-Pole	n/a	n/a
Antenna	HG906YE	Yagi-Direction	n/a	n/a

Table 19: Support Equipment

Item	Model/Part Number	Serial Number
Laptop	Dell Latitude E5530	11642014585
AC Power Supply	DA130PE1-00	065-5GIC-A03
RJ-45 Ethernet Cable	n/a	n/a
Network Switch	Netgear-GS105	2731043H032BF

Figure 21: EUT Enclosure Configuration

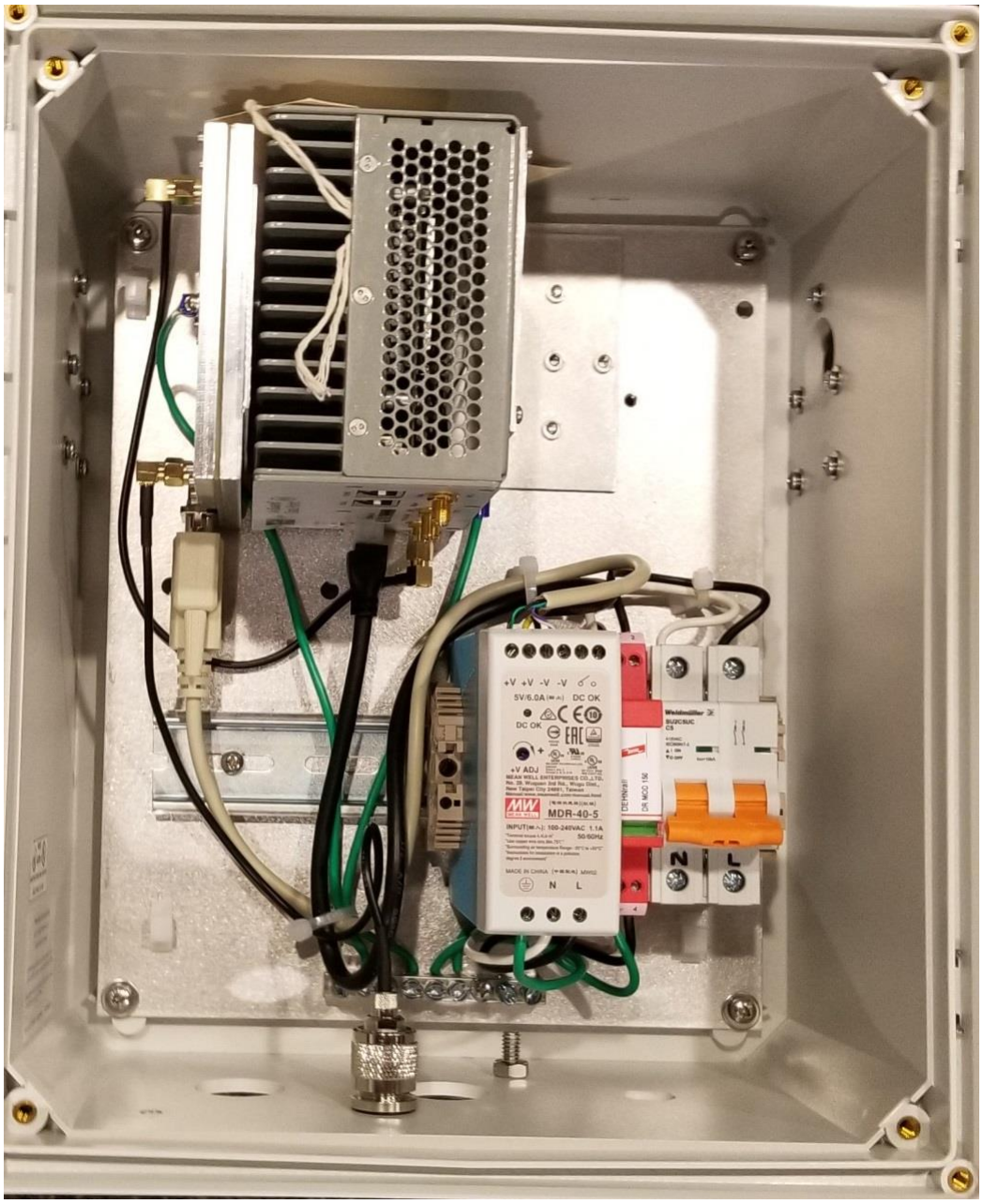


Figure 22: EUT Enclosure Diagram

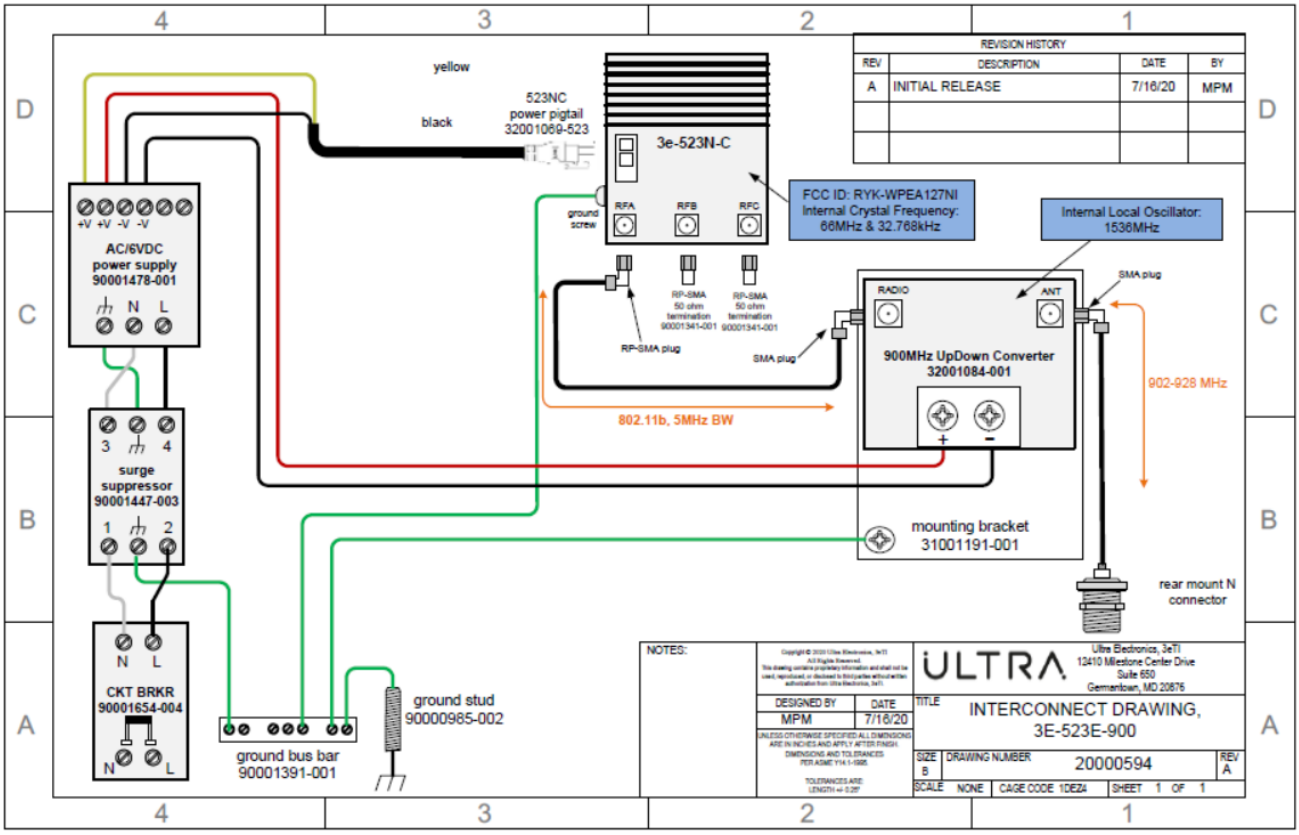


Figure 23: Benchtop RF Conducted Emissions Test Configuration

Figure 24: AC Power Conducted Emissions Test Configuration, Front View

Figure 25: AC Power Conducted Emissions Test Configuration, Side View

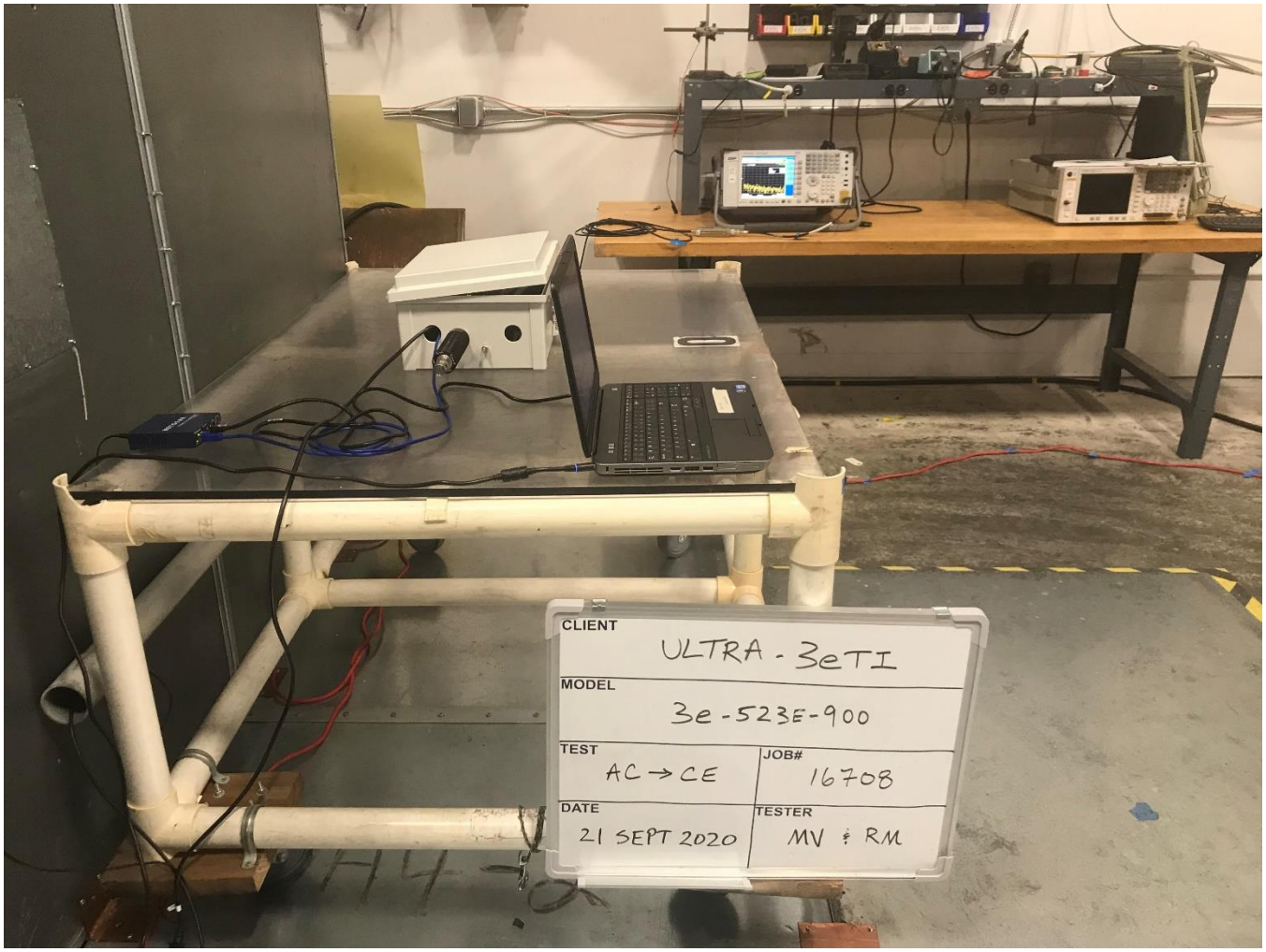
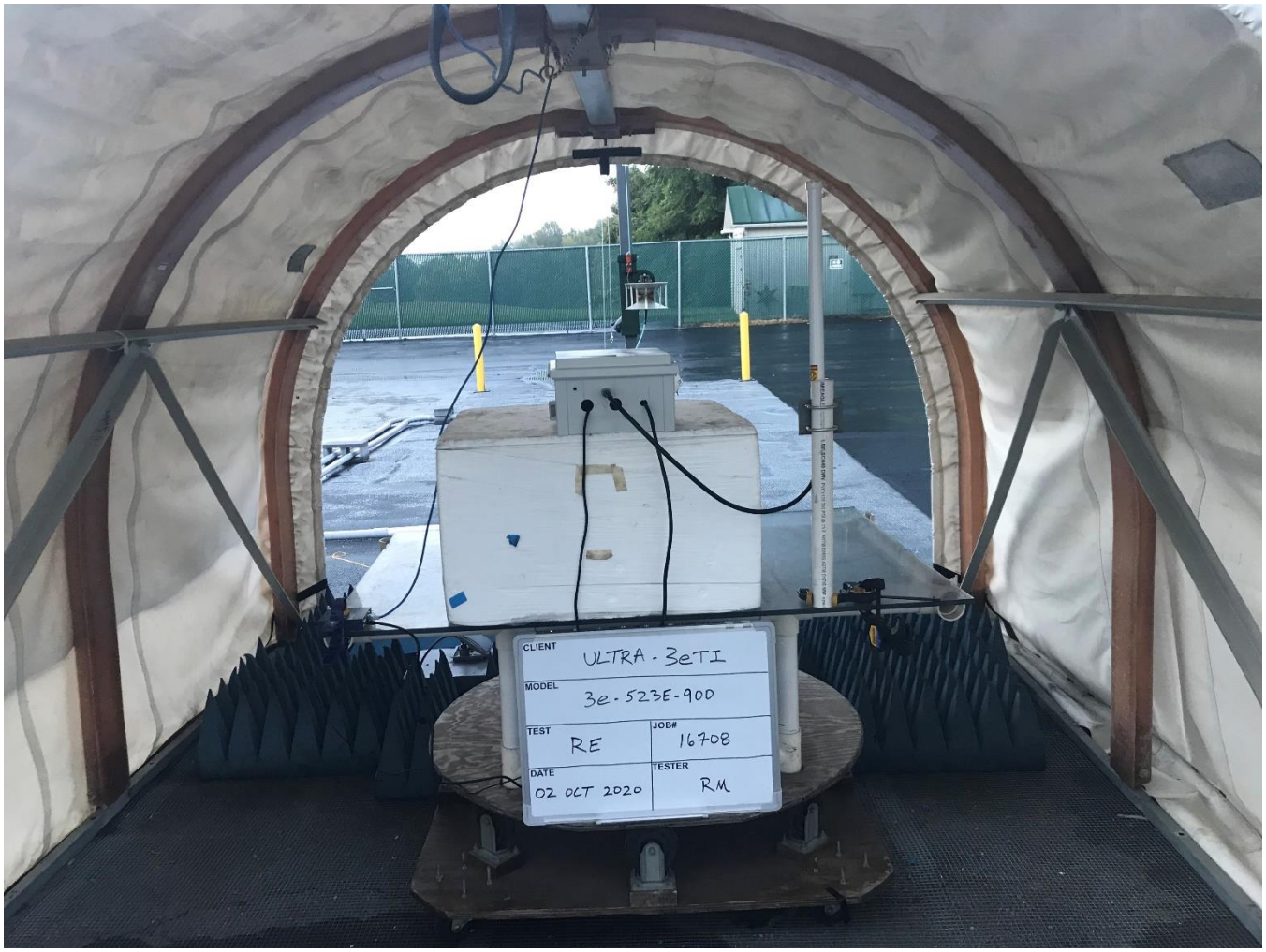


Figure 26: Radio Spurious Emissions Test Configuration, Yagi Antenna - Front View

Figure 27: Radio Spurious Emissions Test Configuration, Yagi Antenna - Rear View

Figure 28: Radio Spurious Emissions Test Configuration, Mono-Pole Antenna - Front View

Figure 29: Radio Spurious Emissions Test Configuration, Mono-Pole Antenna - Rear View



2.3 Interface Cables

Table 20: Cable Configuration

Port Identification	Connector Type	Cable Length (meters)	Shielded (Y/N)	Termination Point
None (N-type connector on bottom of enclosure)	Main RF transmit/receive port	7.62	Y	Terminates to antenna
UPLINK (Ethernet port on 3e-523N-C)	Ethernet port for comms / configuration	1	Y	Typically terminates in a junction box installed near the 3e-523E-900. Terminate shield to ground for testing.

2.4 Testing Algorithm

The 3e-523E-900, as tested, was programmed by the manufacturer, for Direct-Sequence Spread Spectrum (DSSS) [802.11b down converted to 900MHz]. The EUT was tested in a manner that produced the worst cast emission levels, which are provided in the test results data section(s) of this report.

2.5 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 is 3035A for Washington Laboratories, Ltd. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.6 Measurements

2.6.1 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

ANSI C63.26 (Dec 2015) American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

2.7 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 21 below.

Table 21: 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 22 shows a list of the test equipment used for measurements along with the calibration information.

Table 22: Test Equipment List

Test Name:	**Conducted Emissions Voltage**	Test Date:	**09/21/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	SOLAR	8028-50-TS-24-BNC	9/10/2021
00126	SOLAR	8028-50-TS-24-BNC	9/10/2021
00895	HP	11947A, LIMITER	Cal. Before Use
00330	WLL	CE CABLE	2/6/2021
00528	AGILENT	E4446A	1/21/2021
Test Name:	**Radiated Emissions**	Test Date:	**09/22/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00528	AGILENT	E4446A	1/21/2021
00382	SUNOL SCIENCES CORP.	JB1	12/1/2020
00425	ARA	DRG-118/A	8/18/2022
00276	ELECTRO-METRICS	BPA-1000	6/19/2021
00627	AGILENT	8449B	8/31/2021
00849	AH SYSTEMS	SAC-18G-16, Cable	8/31/2021
00826	MEGAPHASE	TM40-K1K5-36, Cable	Cal. Before Use
Test Name:	**Benchtop RF Conducted**	Test Date:	**11/25/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	AGILENT, SA	MXA-N9020A	10/30/2021
00846	UMP, Flex-150	AA-150-24, Cable	Cal. Before Use