FCC §15.255 AND ISED CANADA RSS-210

CERTIFICATION TEST REPORT

for the

MEGARADAR V1

FCC ID: 2A6OYMEGA1

IC ID: 28582-MEGA1

WLL REPORT# 17410-01 REV 2

Prepared for:

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Testing Certificate AT-1448

FCC §15.255 and ISED Canada RSS-210

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for the

OmniSight, Inc.

MegaRadar V1

FCC ID: 2A6OYMEGA1

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April 15, 2022

WLL Report# 17410-01 Rev 2

Prepared by:

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Abstract

This report has been prepared on behalf of OmniSight, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Fixed Field Disturbance Sensor (Radar) Transmitter under Part 15.255 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy and under RSS-210, Issue 10 (12/2019) of Innovation, Science and Economic Development Canada (ISED). This Certification Test Report documents the test configuration and test results for the OmniSight, Inc. MegaRadar V1, in the High Power Mode. The information provided on this report is only applicable to device herein documented, as the EUT.

Radiated testing below 40 GHz 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 are currently being reported to 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 Testing Certificate AT-1448 as an independent FCC test laboratory.

The Washington Laboratories, Ltd. ISED Canada number is 3035A.

The OmniSight, Inc. MegaRadar V1 complies with the limits and requirements for a Fixed Field Disturbance Sensor (Radar) Transmitter under Part 15.255 of the FCC Rules and Regulations and Innovation, Science and Economic Development Canada (ISED) RSS-210, Annex J, Issue 10 (12/2019).

Revision History	Description of Change	Date
Rev 0	Initial Release	April 15, 2022
Rev 1	Amendments per ACB Comments, dated: 9/29/2022	October 24, 2022
Rev 2	Amendments to the EUT Block Diagram, per ACB Comments	November 7, 2022

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1 Introduction

1.1 Compliance Statement

The OmniSight, Inc. MegaRadar V1 complies with the limits and requirements for a Fixed Field Disturbance Sensor (Radar) Transmitter under Part 15.255 of the FCC Rules and Regulations and Innovation, Science and Economic Development Canada (ISED) RSS-210, Annex J, Issue 10 (12/2019).

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed in accordance with C63.10-2013 "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 the compliance testing for a Fixed Field Disturbance Sensor (Radar) Transmitter, that occupies 500 MHz or less of bandwidth, and that is contained wholly within the frequency band 61.0 to 61.5 GHz. Full test results are shown in subsequent sub-sections.

Table 1: Test Summary Table (High Power Mode)

FCC Rule Part	ISED Rule Part	Description	Result
§15.207(a)	RSS-Gen(8.8)	AC Mains Conducted Emissions	Pass
§15.255(a)(2)	RSS-210(J.1)	Fixed Installation and Use	Pass
§15.255(c)(2)	RSS-210(J.2.1)(a)	≤ 500 MHz Transmitter Occupied Bandwidth	Pass
§15.255(c)(2)	RSS-210(J.2.1)(a)	Transmitter Operating Frequency Range	Pass
§15.255(c)(2)	RSS-210(J.2.1)(a)	Transmitter Power (EIRP) Within the Operating Band	Pass
§15.255(e)	RSS-210(J.4)(a)	Peak Transmitter Output Power	Pass
§15.255(c)(2)	RSS-210(J.2.1)(a)	Transmitter Power (EIRP) Outside the Operating Band	Pass
§15.255(d)(1) §15.255(d)(3)	RSS-210(J.3)(a) RSS-210(J.3)(c)	Unwanted and Spurious Emissions Outside of the 57 GHz – 71 GHz Band	Pass
§15.255(d)(2) §15.209(a)	RSS-210(J.3)(b) RSS-Gen(8.9)	Unwanted and Spurious Emissions Below 40 GHz	Pass
§15.255(f)	RSS-210(J.6)	Frequency Stability	Pass
§15.35(c)	RSS-Gen(8.2)	100ms Duty Cycle	Evaluated

1.3 Contract Information

Customer:	Truck Specialized Trucking Services (OmniSight USA, Inc.)
Purchase Order Number:	Advance Deposit Terms; 50%
Quotation Number:	73105

1.4 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	Carl Rundell

1.5 Test Dates

3/10/2022 – 4/8/2022 (also see Section 4 of this report)

1.6 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory. The Washington Laboratories, Ltd. ISED Canada number is 3035A.

1.7 EUT Digital Emissions

Please know that the digital portion of the EUT is authorized under the SDoC procedure.
The applicant shall maintain the declaration of conformity as provided in Test Report # 17516-01.
The Class B SDoC was competed on 3/24/2022.

2 Test Results

2.1 AC Mains Conducted Emissions

2.1.1 Requirements

Compliance Standard: FCC Part §15.207(a) and RSS-Gen(8.8).

FCC Compliance Limits		
Frequency Range	**Quasi-peak**	**Average**
0.15 – 0.5 MHz	66 to 56 dBµV	56 to 46 dBµV
0.5 – 5 MHz	56 dBµV	46 dBµV
0.5 – 30 MHz	60 dBµV	50 dBµV

2.1.2 Test Procedure

The requirements of FCC Part 15 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 §15.207 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:	19 °C
Relative Humidity:	45 %

2.1.3 Conducted Data Reduction and Reporting

The comparison between the AC voltage conducted emission levels 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 = VdBµV + LISN dB + CF dB

2.1.4 Test Data

The EUT complies with the Class B, AC Conducted Emissions requirements.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

The final test data appears in Table 2.

Table 2: AC Mains Conducted Emissions Test Data

NEUTRAL										
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)**
0.154	37.8	24.0	10.2	0.6	48.5	34.8	65.8	55.8	-17.2	-18.0
0.184	34.0	21.0	10.2	0.5	44.7	31.7	64.3	54.3	-19.7	-22.6
0.200	32.4	20.5	10.2	0.5	43.0	31.2	63.6	53.6	-20.6	-22.4
0.220	29.6	19.2	10.2	0.5	40.2	29.8	62.8	52.8	-22.6	-23.1
0.234	29.1	17.9	10.2	0.4	39.7	28.5	62.3	52.3	-22.6	-23.8
0.601	29.1	21.3	10.3	0.3	39.6	31.8	56.0	46.0	-16.4	-14.2
3.578	19.8	9.4	10.4	0.4	30.6	20.2	56.0	46.0	-25.4	-25.8
26.220	12.2	5.2	11.7	2.5	26.4	19.5	60.0	50.0	-33.6	-30.5
PHASE										
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)**
0.152	38.0	23.8	10.2	0.5	48.6	34.4	65.9	55.9	-17.2	-21.5
0.157	36.4	23.0	10.2	0.4	47.0	33.6	65.6	55.6	-18.6	-22.0
0.175	33.7	21.5	10.2	0.4	44.2	32.1	64.7	54.7	-20.5	-22.6
0.190	32.5	20.4	10.2	0.4	43.0	30.9	64.0	54.0	-21.0	-23.1
0.209	31.6	19.8	10.2	0.3	42.1	30.3	63.2	53.2	-21.2	-23.0
0.601	28.2	20.0	10.3	0.3	38.8	30.5	56.0	46.0	-17.2	-15.5
3.500	20.5	9.8	10.4	0.4	31.2	20.5	56.0	46.0	-24.8	-25.5
26.820	11.7	5.0	11.8	2.3	25.8	19.1	60.0	50.0	-34.2	-30.9

2.2 RDR255 – Fixed Use Operation

2.2.1 Requirements

Compliance Standard: FCC Part §15.255(a)(2) and RSS-210(J.1).

KDB Publication 388624 D02: Pre-Approval Guidance List, v17r05 requires that applications for Field Disturbance Sensors and/or Radar Devices, to be filed under FCC Section §15.255, must maintain an Operational Description exhibit that includes a detailed explanation of how the fixed operation requirement of Section §15.255(a)(2) is satisfied. If certification is being requested for non-fixed operation as a Short-Range Interactive Motion Sensor (SRIMS), then a comprehensive justification shall be provided in the Operational Description exhibit.

2.2.2 Compliance

The applicant has declared that this device is for Fixed Use Only.

The EUT shall be mounted in a fashion that provides a minimum separation distance that is ≥ the compliance distance that has been demonstrated in the RF Exposure (MPE) Exhibit.

2.3 Transmitter Occupied Bandwidth

2.3.1 Requirements

Compliance Standard: FCC Part §15.255(c)(2) and RSS-210(J.2.1)(a).

Under this provision, the Occupied Bandwidth of the fundamental, modulated transmitter, shall be less than 500 MHz. Additionally, when in a fully modulated mode, the transmitter shall be contained wholly within the frequency band of 61.0 GHz – 61.5 GHz.

2.3.2 Test Procedure

The OBW measurement was performed in accordance with ANSI C36.10-2013, Section 6.9: "Occupied bandwidth tests". In this case, the 99% and the 20dB bandwidth measurements were taken. This test was performed as a radiated test, at a distance of 1-meter.

2.3.3 Test Data

The EUT complies with the requirements this section.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

Table 3 and Figure 1 through Figure 3 provide the final test data.

Table 3: Occupied Bandwidth Test Results

Center Frequency	20dB OBW	99% OBW	Limit	Results
61.25 GHz	469.008 MHz	443.933 MHz	500 MHz	Pass

Figure 1: Transmitter Occupied Bandwidth

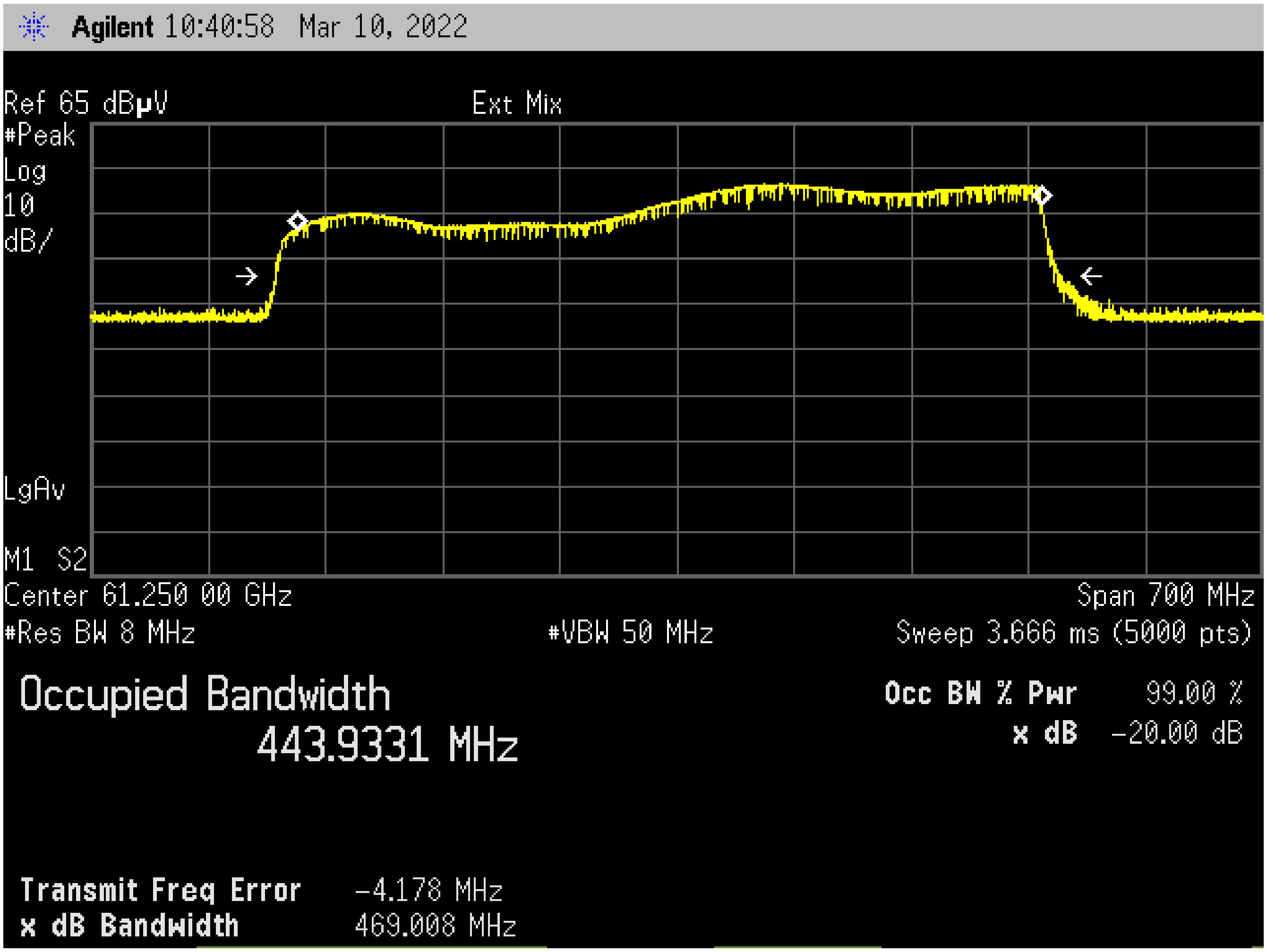


Figure 2: Lower Bandedge Compliance

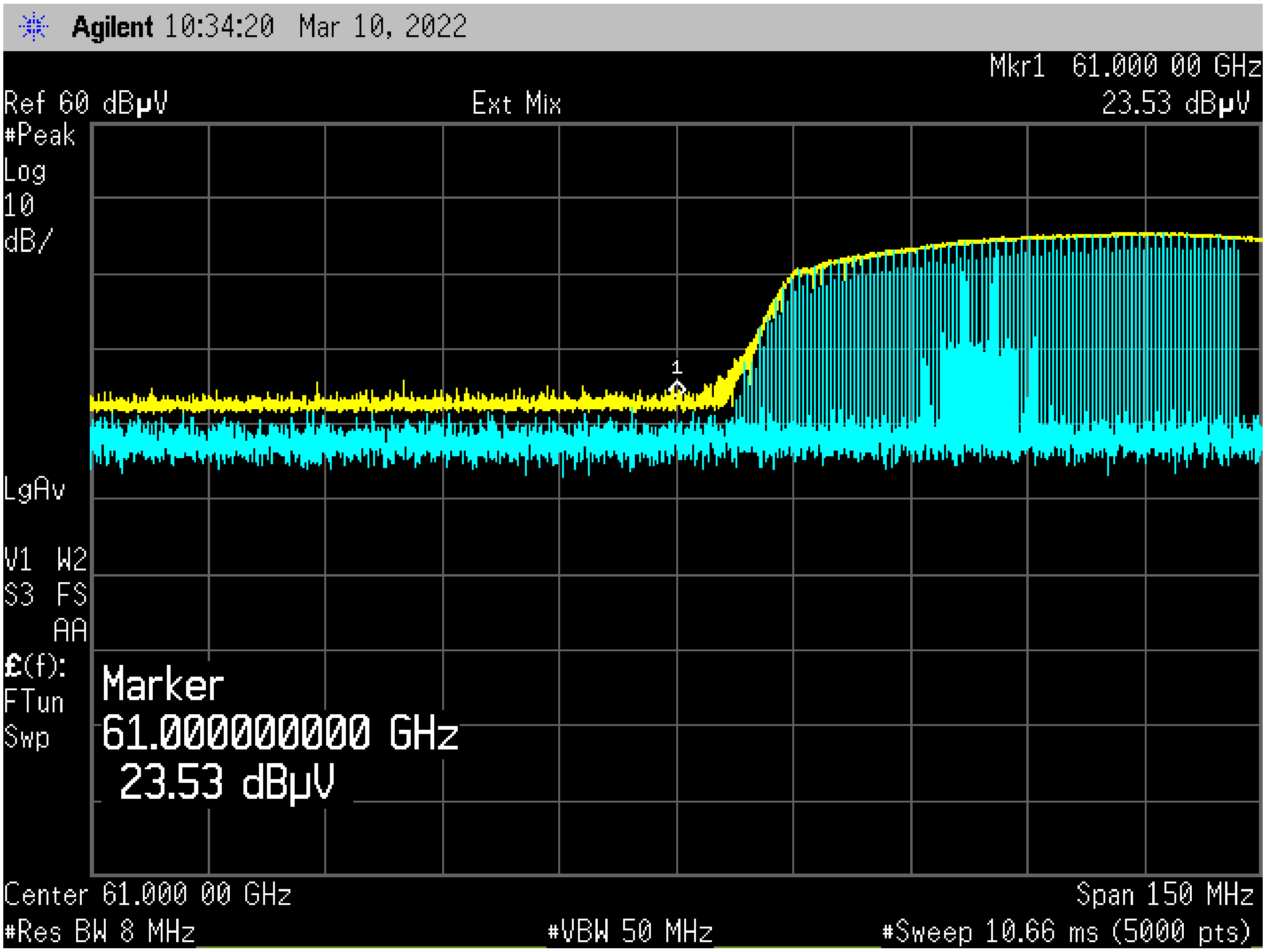
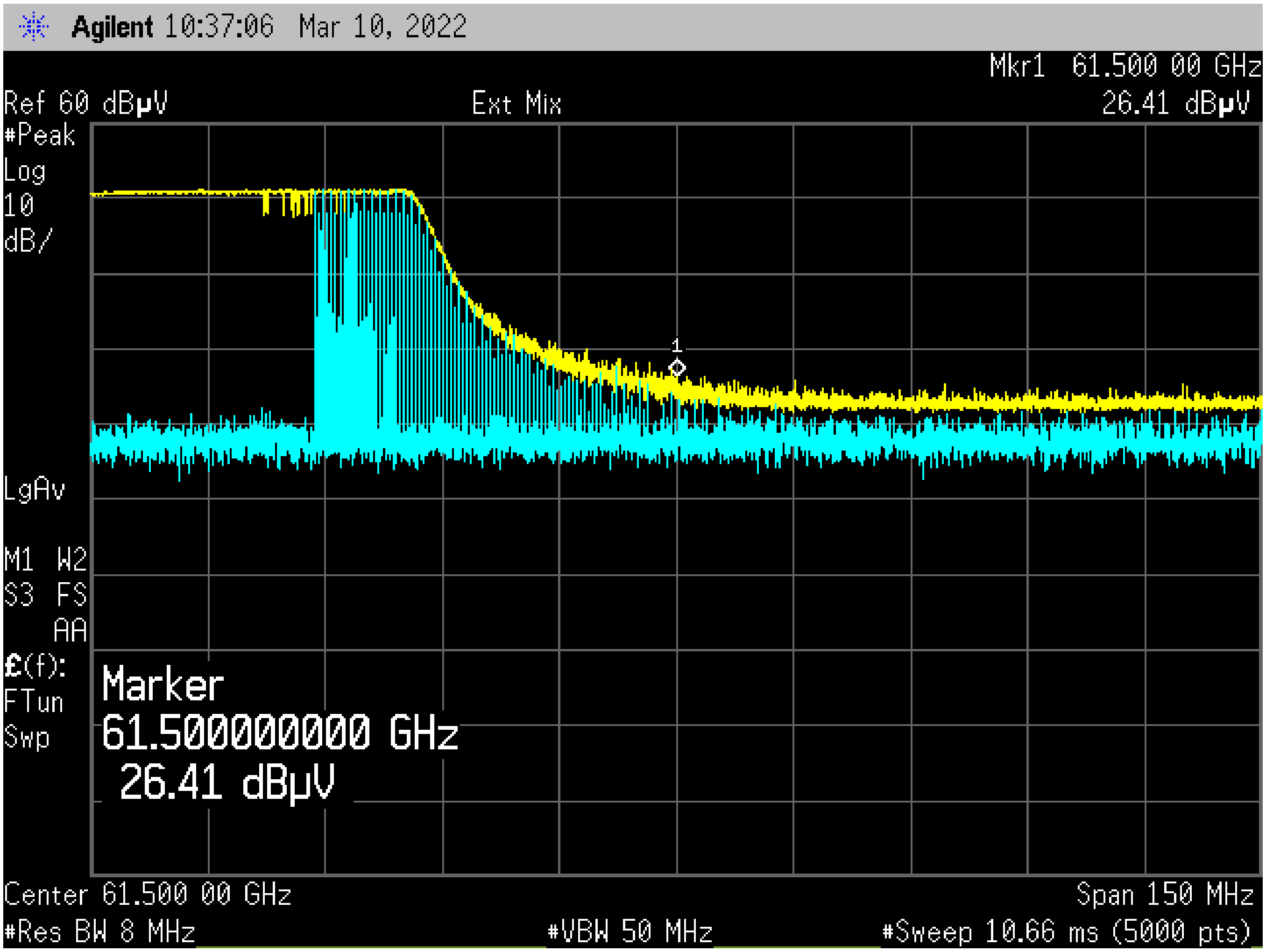


Figure 3: Upper Bandedge Compliance



2.4 Transmitter Power Within the Operational Band

2.4.1 Requirements

Compliance Standard: FCC Part §15.255(c)(2) and RSS-210(J.2.1)(a).

Under this provision, Fixed Field Disturbance Sensors that occupy less than 500 MHz and are wholly contained within the frequency band of 61.0 GHz – 61.5 GHz shall not exceed the following power limitations: 40 dBm Average; 43 dBm Peak, when measured during a transmission interval within the band of 61.0 GHz – 61.5 GHz.

2.4.2 Test Procedure

The transmitter power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be measured over the actual time period during which transmission occurs. The EUT was placed on an 80cm high, 1m X 1.5m non-conductive test-table in a Free-space Anechoic Chamber Test-site (FACT) Chamber. Overall, this test was performed in accordance with the procedure outlined in ANSI C63.10 (2013), Section 9.11, "Measurement of the fundamental emission using an RF detector".

2.4.3 Test Data

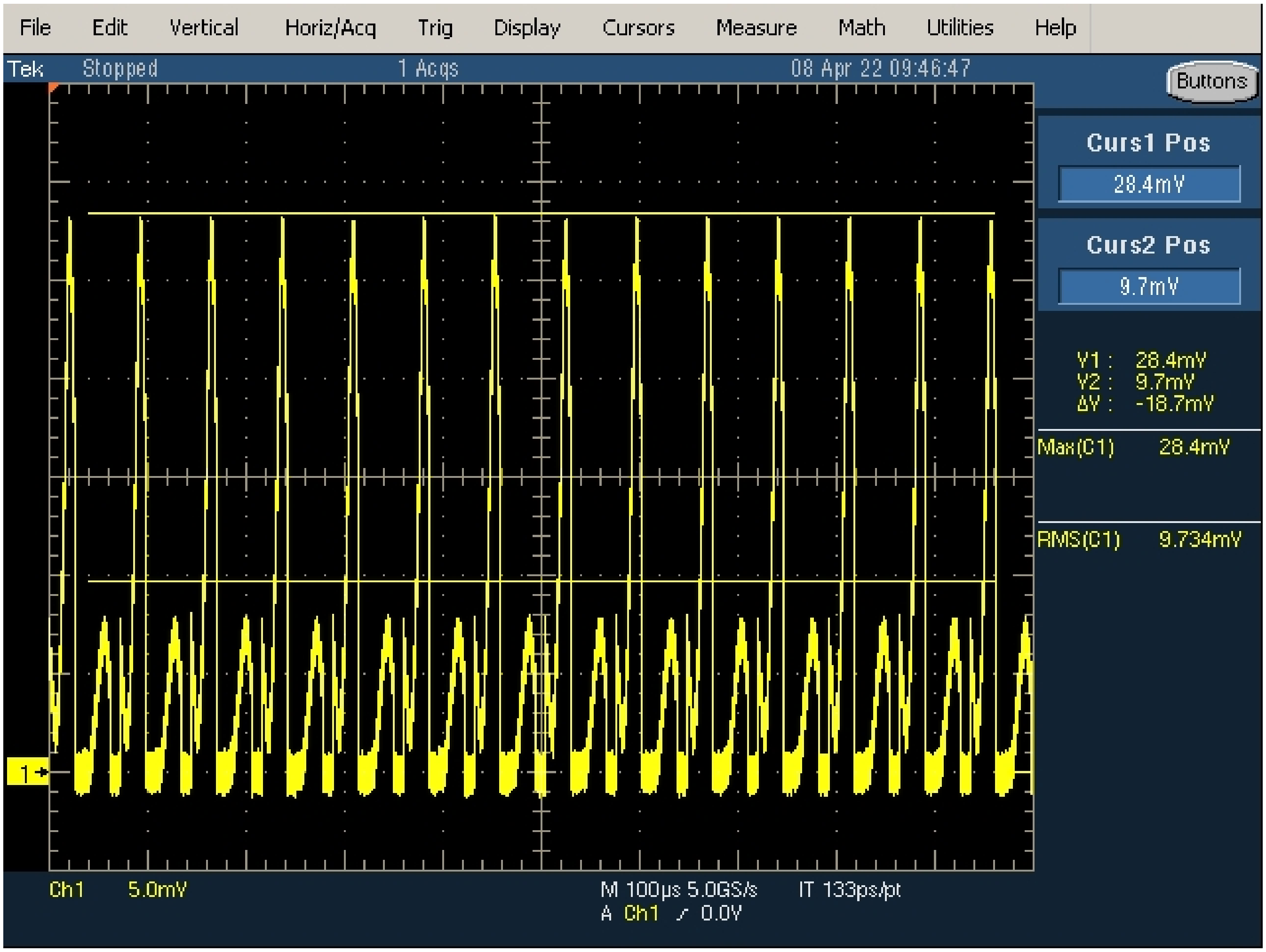
The EUT complies with the requirements this section.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

Table 4: Transmitter Power (EIRP) Test Results

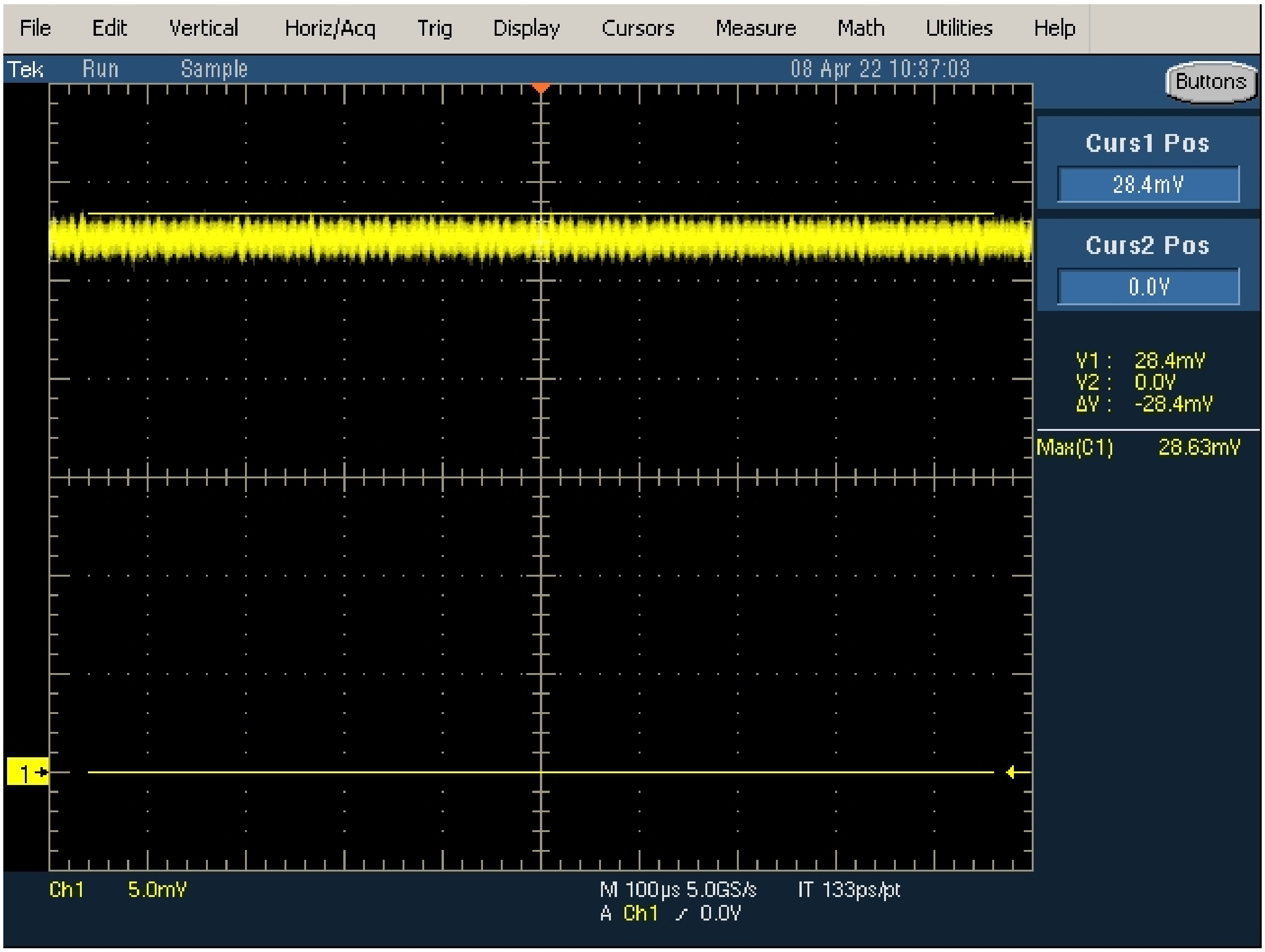
Frequency (GHz)	DSO Level (mV)	Substitution Signal Generator (dBm)	EUT Antenna Gain (dBi)	Corrected EIRP (dBm)	Limit (dBm)	Margin (dB)	Emission Type
61.250	28.4	2.55	7.0	9.55	43.0	-30.45	Peak
61.250	9.7	-3.75	7.0	3.25	40.0	-36.75	AVG

Figure 4: EUT Transmitter Power – Peak and Average via RF Detector



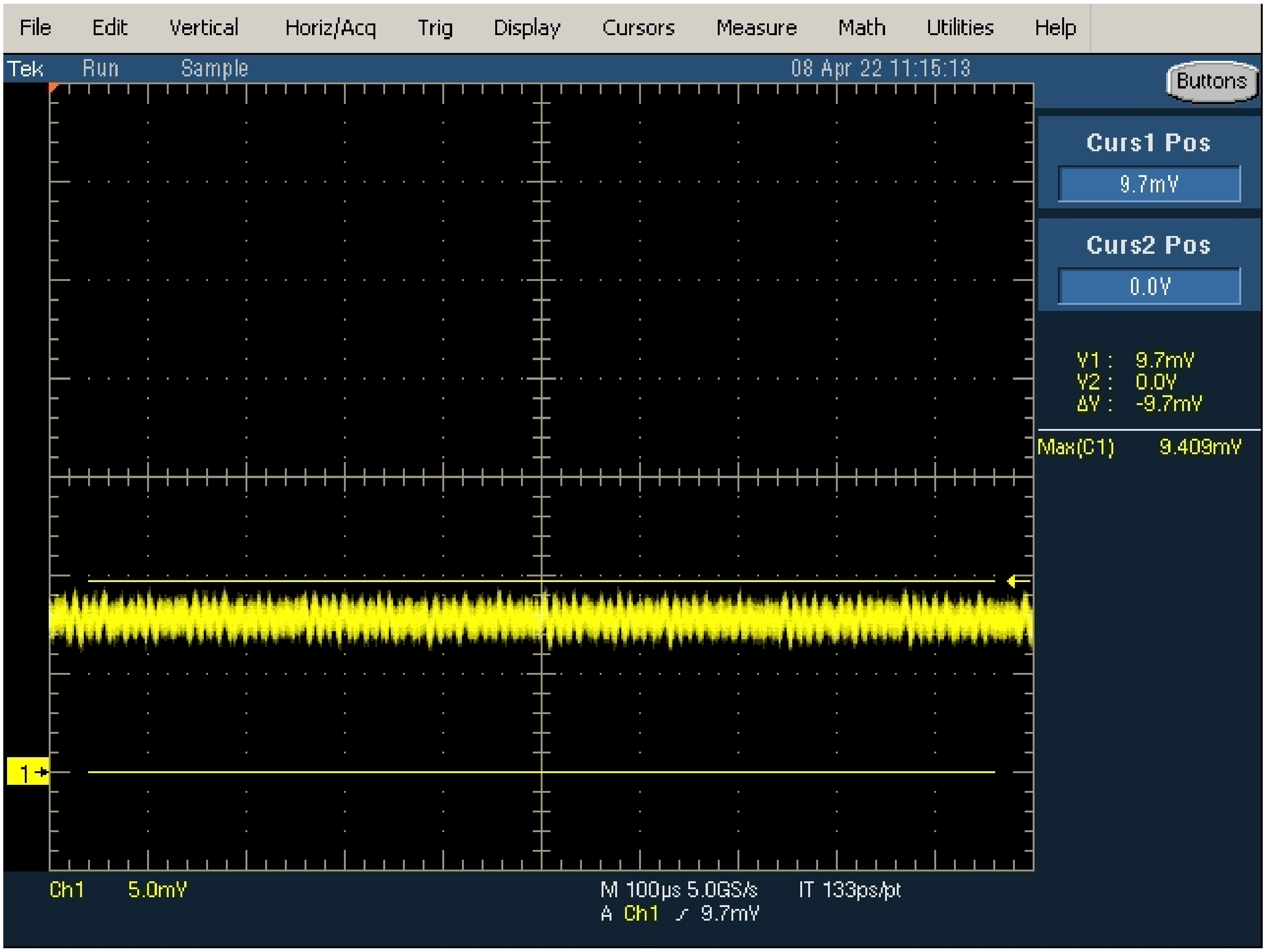
This plot represents the time-domain amplitude that was measured on the DSO, when the mmWave test equipment was placed in the main beam of the 61.250 GHz transmitter. In this case, the test distance was 5mm. This distance produced the highest voltage reading on the DSO: 28.4mV Peak and 9.7mV AVG.

Figure 5: Substitution Method – Peak Level via RF Detector from Signal Generator



This plot represents the time-domain amplitude that was measured on the DSO, when the mmWave test equipment was connected directly to the substitution source. The source (a signal generator) was set to output a CW at 61.250 GHz. The output of the signal generator was connected to the input of the mmWave test equipment, and the amplitude was increased until the voltage reading on the DSO matched 28.4mV. Once the DSO reached the equivalent peak level, the output power of the signal generator was recorded. In this case, the amplitude was +2.55 dBm (see Table 4).

Figure 6: Substitution Method – Average Level via RF Detector from Signal Generator



This plot represents the time-domain amplitude that was measured on the DSO, when the mmWave test equipment was connected directly to the substitution source. The source (a signal generator) was set to output a CW at 61.250 GHz. The output of the signal generator was connected to the input of the mmWave test equipment, and the amplitude was increased until the voltage reading on the DSO matched 9.7mV. Once the DSO reached the equivalent average level, the output power of the signal generator was recorded. In this case, the amplitude was -3.75 dBm (see Table 4).

2.5 Peak Transmitter Conducted Output Power

2.5.1 Requirements

Compliance Standard: FCC Part §15.255(e) and RSS-210(J.4)(a).

Under this provision, the peak transmitter conducted output power shall not exceed 500 mW (27 dBm).

2.5.2 Test Procedure

The transmitter power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The EUT was placed on an 80cm high, 1m X 1.5m non-conductive test-table in a Free-space Anechoic Chamber Test-site (FACT) Chamber. Overall, this test was performed in accordance with the procedure outlined in ANSI C63.10 (2013), Section 9.11, "Measurement of the fundamental emission using an RF detector".

2.5.3 Test Data

The EUT complies with the requirements this section.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

Conducted Power = EIRP – Antenna Gain

Table 5: Peak Transmitter Conducted Output Power – Test Results

Frequency (GHz)	Corrected EIRP (dBm)	EUT Antenna Gain (dBi)	Peak Power (dBm)	Limit (dBm)	Margin (dB)	Emission Type
61.250	9.55	7.0	2.55	27.0	-24.45	Peak
61.250	3.25	7.0	N/A	N/A	N/A	AVG

2.6 Transmitter Power Outside the Operational Band

2.6.1 Requirements

Compliance Standard: FCC Part §15.255(c)(2) and RSS-210(J.2.1)(a).

Under this provision, the average power of any emission outside of the 61.0 GHz – 61.50 GHz band, measured during the transmit interval, but still within the 57.0 GHz – 71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

2.6.2 Test Procedure

Radiated spurious emissions within the frequency range of 57.0 GHz – 61.0 GHz and 61.5 GHz – 71 GHz shall be measured at a test distance of 50 cm. The EUT was placed on an 80cm high, non-conductive testing surface. The EUT shall be positioned in accordance with the field strength evaluation described in Section 3.2 of this report, as a means to produce the worst-case emissions.

2.6.3 Test Data

The EUT complies with the requirements this section.

There were no significant transmitter spurious emissions detected in this frequency range.

The data provided below represents measurements of the energy taken at the noise floor.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

Table 6 and Figure 7 through Figure 12 provide the final test data.

Table 6: Radiated Spurious Emissions Test Results (57 GHz – 71 GHz)

Transmit Channel	Spurious Frequency (GHz)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	EIRP (dBm)	AVG Limit (dBm)	Margin (dB)	Detector
Low	57.5626	12.91	74.2	87.1	-23.7	10.0	-33.7	Peak
	65.6765	13.52	74.2	87.7	-23.1	10.0	-33.1	Peak
Center	57.1460	12.62	74.2	86.8	-24.00	10.0	-34.0	Peak
	68.5493	13.23	74.2	87.4	-23.39	10.0	-33.4	Peak
High	59.3587	12.85	74.2	87.1	-23.77	10.0	-33.8	Peak
	63.6155	13.33	74.2	87.5	-23.29	10.0	-33.3	Peak

Spurious EIRP levels were calculated from the following formula:
$EIRP = FS_{dBuV/m} + 20LOG(D_{Measure}) – 104.8$

where:
$FS_{dBuV/m}$ is the corrected field strength
$D_{Measure}$ is the measurement distance (e.g., 50 cm)

Worst case calculation at 65.6765 GHz (spurious):
EIRP = 13.52 + 20LOG(0.5) – 104.8
EIRP = -23.1 dBm (peak)

Figure 7: Low Channel – Out-of-Band Spurious Emissions (Plot 1)

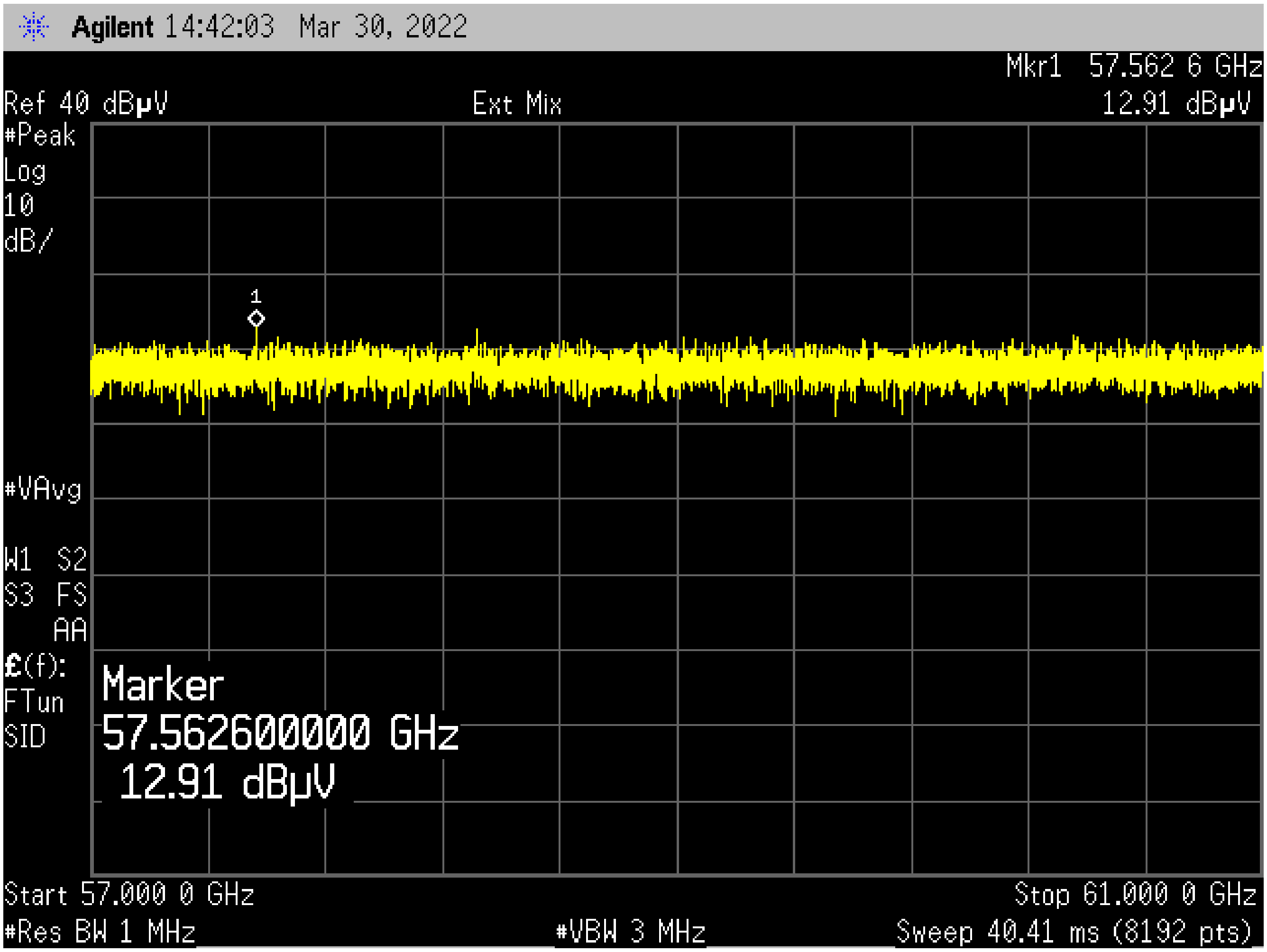


Figure 8: Low Channel – Out-of-Band Spurious Emissions (Plot 2)

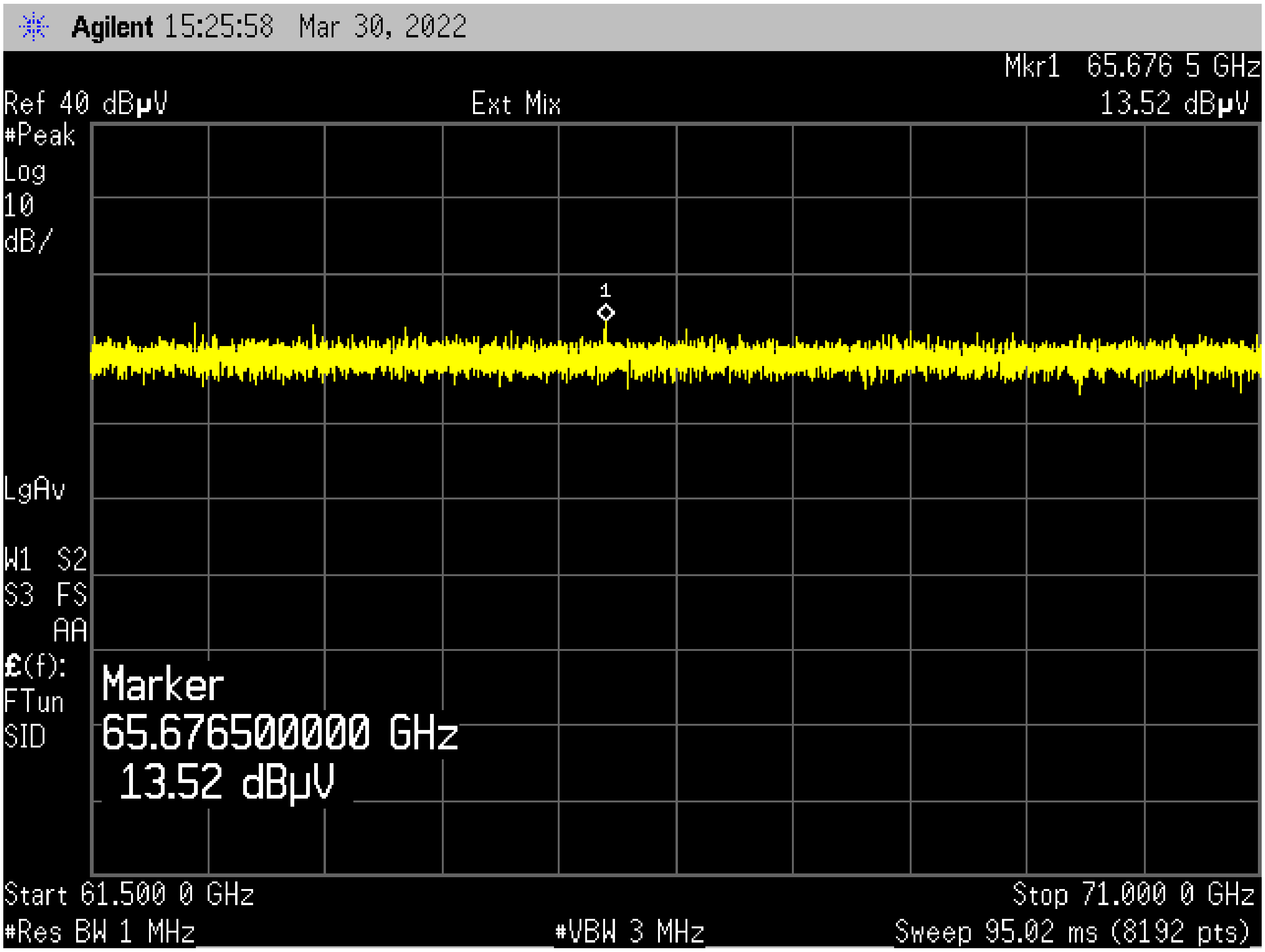


Figure 9: Center Channel – Out-of-Band Spurious Emissions (Plot 1)

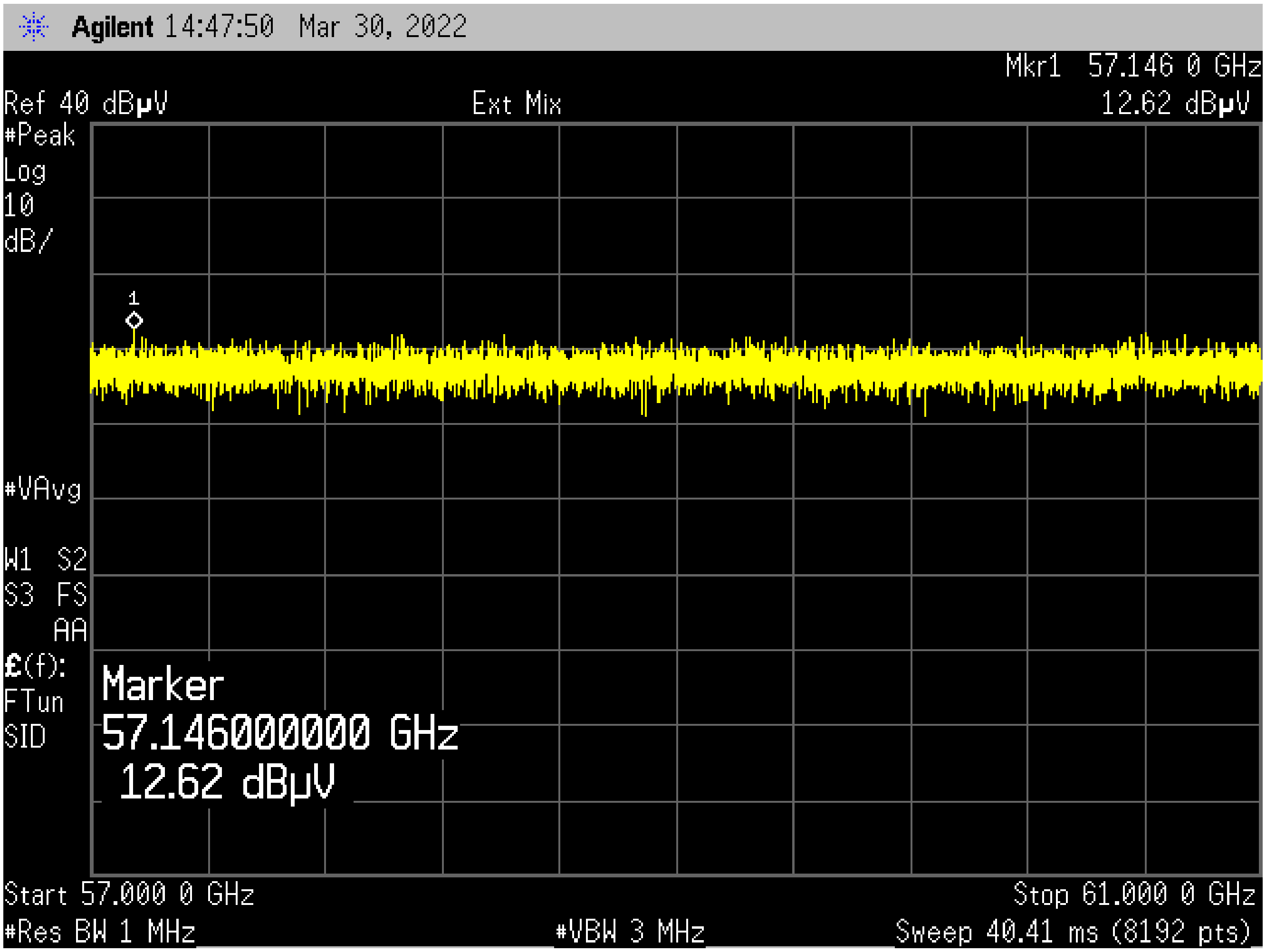


Figure 10: Center Channel – Out-of-Band Spurious Emissions (Plot 2)

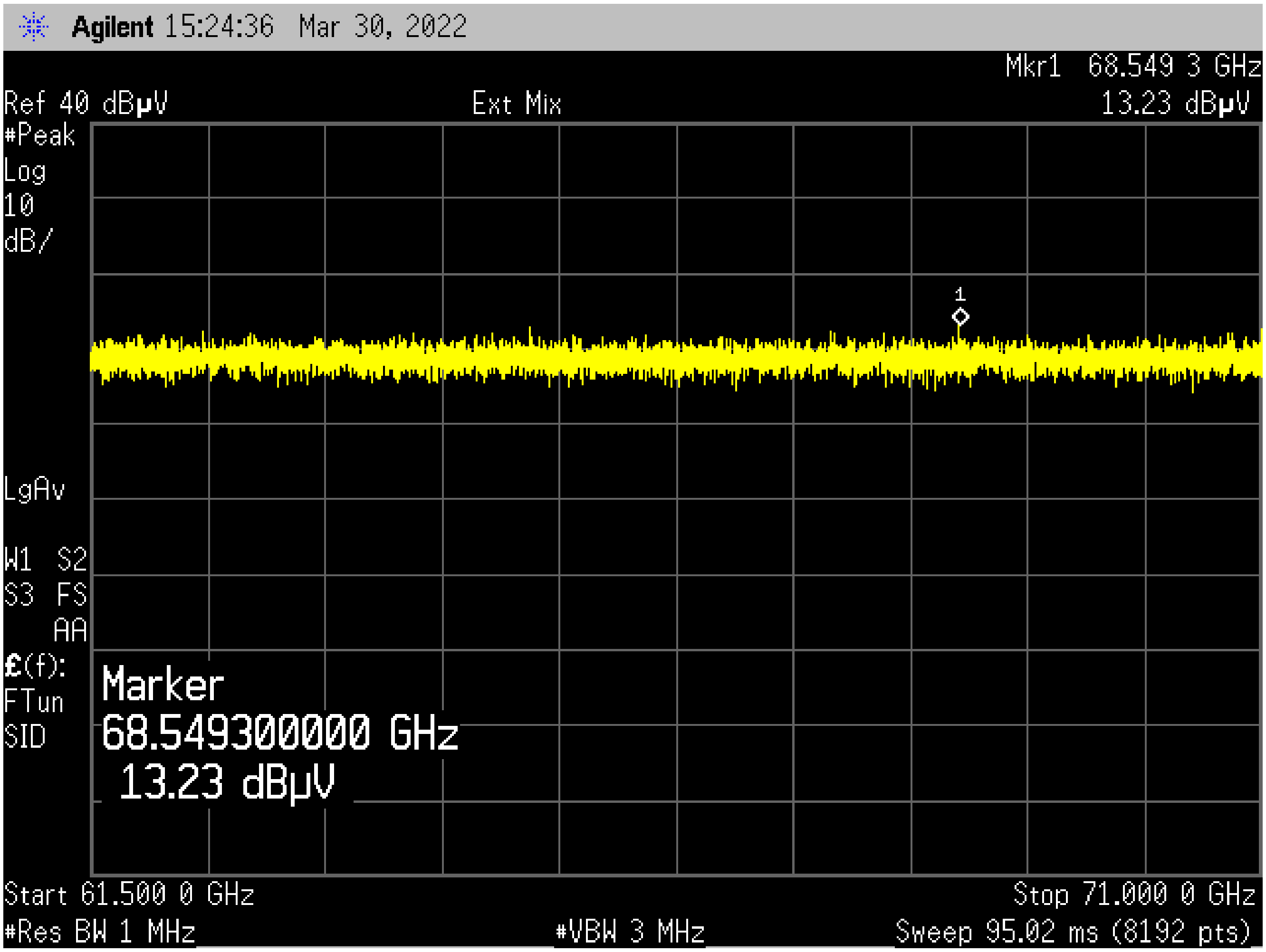


Figure 11: High Channel – Out-of-Band Spurious Emissions (Plot 1)

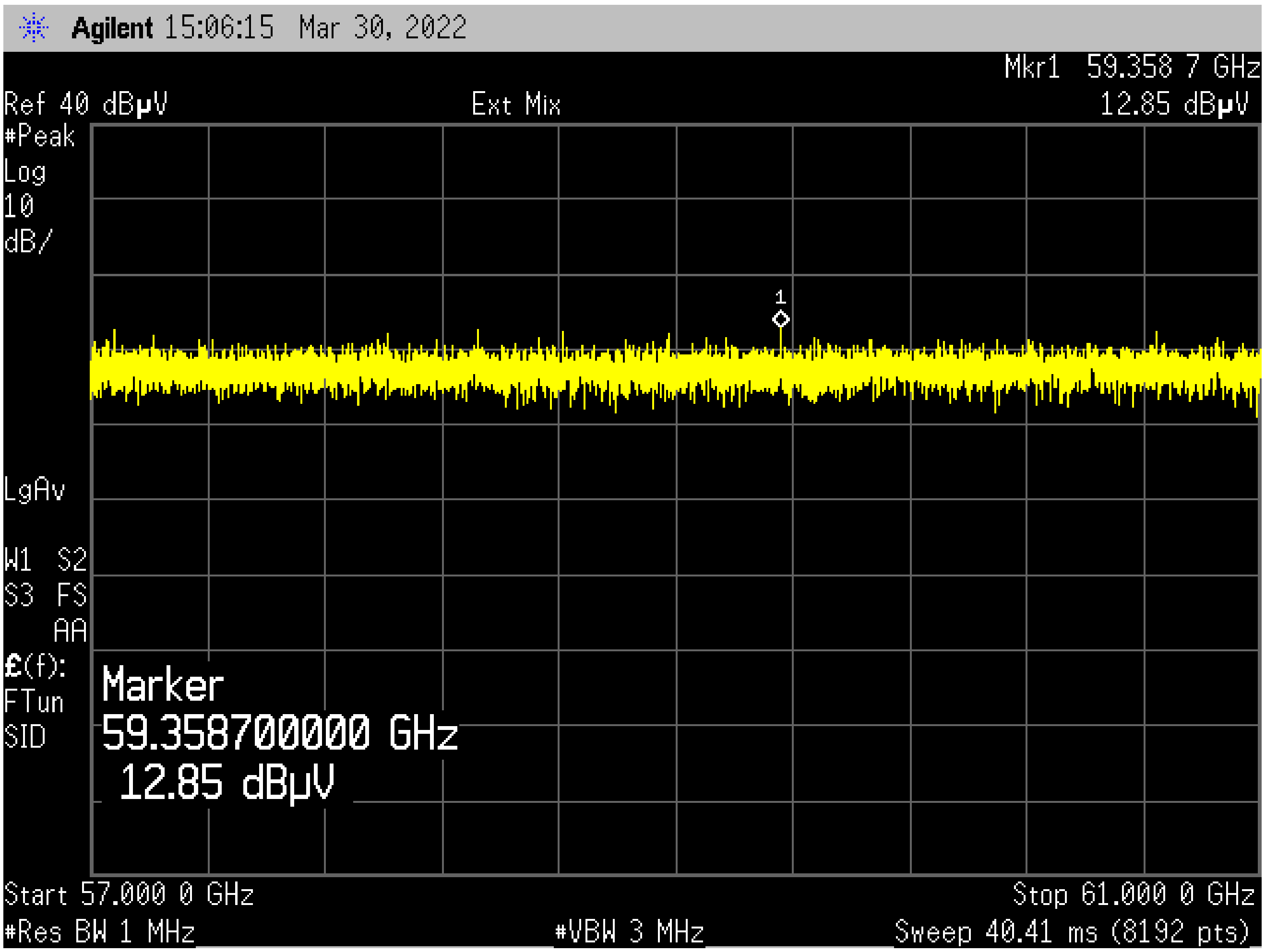
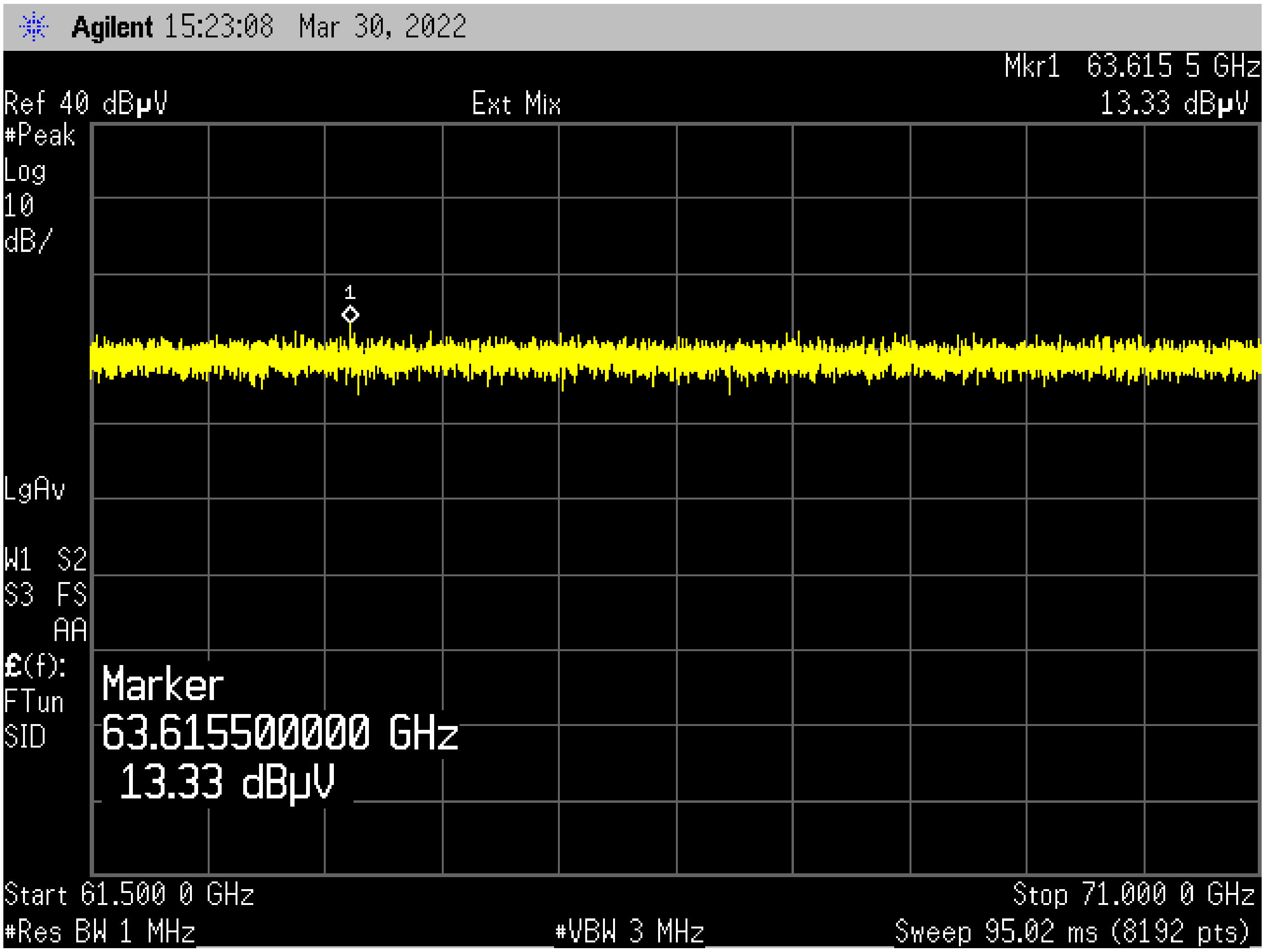


Figure 12: High Channel – Out-of-Band Spurious Emissions (Plot 2)



2.7 Spurious Emissions, 40 GHz – 200 GHz

2.7.1 Requirements

Compliance Standard: FCC Part §15.255(d)(1), §15.255(d)(3), and RSS-210(J.3)(a), RSS-210(J.3)(c).

Under this provision, the power density of any emissions outside of the 57 GHz – 71 GHz band shall consist solely of spurious emissions. The level of emissions above 40 GHz shall not exceed 90 pW/cm^2 when measured at a distance of 3-meters.

2.7.2 Test Procedure

Radiated spurious emissions shall be evaluated and measured withing the frequency range of 40 GHz – 57 GHz and 71 GHz – 200 GHz. The EUT was placed on an 80cm high, non-conductive testing surface. The EUT shall be positioned in accordance with the field strength evaluation described in Section 3.2 of this report, as a means to produce the worst-case emissions.

2.7.3 Test Data

The EUT complies with the requirements this section.

There were no significant transmitter spurious emissions detected in this frequency range.

The data provided below represents measurements of the energy taken at the noise floor.

The EUT was set to transmit a CW for this test.

Table 9 and Figures 13 through Figure 24 provide the final test data.

To achieve the desired sensitivity at these frequencies, a reduced test distance was employed. We have calculated that a test distance of 50 cm is adequate for measurements below 90 GHz, and a test distance of 10 cm is adequate for measurements above 90 GHz. As the frequency increases, the near-field far-field intersection collapses in a linear fashion. These prescribed measurement distances remain in the far-field of the radiating element, with regard to frequency wavelength and free space impedance.

For convenience, we will present the power density limits (pico-watts per square centimeter) in terms of microvolts per meter. This allows us to perform analysis using field strength rather than power density.

First, the relationship between power density S (W/m^2) and field strength (volts per meter) is:

$S = E^2/Z_o\ W/m^2$

where, $Z_o = 377$ ohms

Thus, $E = SQRT(Z_o * S)$ V/m

The limit is expressed as 90 pW/cm^2

Therefore,
90 pW = 90 E-12 Watts

And,
$1cm^2 = 1e\text{-}4\ m^2$

Therefore,
$90\ pW/cm^2 = 90e\text{-}12/1e\text{-}4 = 90e\text{-}8\ W/m^2$

E = SQRT(377 X 90E-8) V/m

E = 0.01842 V/m

E = 18420.1 uV/m

E = 20LOG(18420.1) = 85.3 dBuV/m at 3m

The field strength readings can be converted to a distance other than 3m by the following equation:

Distance Correction Factor (dB) = 20LOG($D_{Measure}$ ÷ 3m)

Where $D_{Measure}$ is the actual test distance of the measurement.

To convert the radiated electric energy, as measured on the spectrum analyzer, from dBuV to dBuV/m, the Antenna Factor (dB/m) is added to the voltage in dBuV.

Standard gain horns were used with nominal mid-band gain of 10dBi.

To convert the antenna gain to an antenna factor, the following equation is employed:

AF (dB/m) = 10LOG(9.73 ÷ λ * SQRT(G(*numeric*))

The AF of the standard gain horns, as they relate to frequency are provided below.

Table 7: Standard Gain Antennas – Antenna Factors

Frequency (GHz)	**Ant Gain (dBi)**	**Antenna Gain (numeric)**	**Antenna Factor (dB/m)**
50.0	10	10	42.0
70.0	10	10	43.4
120.0	10	10	45.8
180.0	10	10	47.5

The mid-band mixer losses are provided below.

Table 8: Mid-band Mixer Losses

Frequency (GHz)	**Mixer Loss (dB)**
50.0	32
70.0	43
120.0	47
180.0	59

Finally, the radiated field strength values at the measurement distances shown are provided in the following table.

Table 9: Radiated Spurious Emissions Test Results (40 GHz – 200 GHz)

Frequency (GHz)	SA Level (dBuV)	Antenna Factor (dB/m)	Mixer Loss (dB)	Corr. Level (dBuV/m)	3m Limit (dBuV/m)	Measurement Distance	Distance Correction Factor (dB)	Corrected Level (dBuV/m)	Margin dB
40.30	20.0	42.0	32.0	94.0	85.3	0.050	35.6	58.5	-27
122.76	16.2	45.8	47.0	108.9	85.3	0.010	49.5	59.4	-26
140.84	21.2	47.5	59.0	127.7	85.3	0.010	49.5	78.2	-7

All measurements were made using a Peak detector.

The measured frequencies provided above were selected based on the worst-case emission, from their respective evaluation band. That is, there are four evaluation mm-wave bands (U, E, F, and G) to get from 40 GHz to 220 GHz. The emission, or noise-floor energy, with the highest amplitude was elected to show compliance.

The measurement distance from 40 GHz to 90 GHz was 50cm.

The measurement distance from 90 GHz to 200 GHz was 10cm.

Lastly, there were no EUT spurious emissions that exceeded the level of the fundamental transmitter.

Figure 13: Low Channel, Spurious Emissions (40 – 60 GHz)

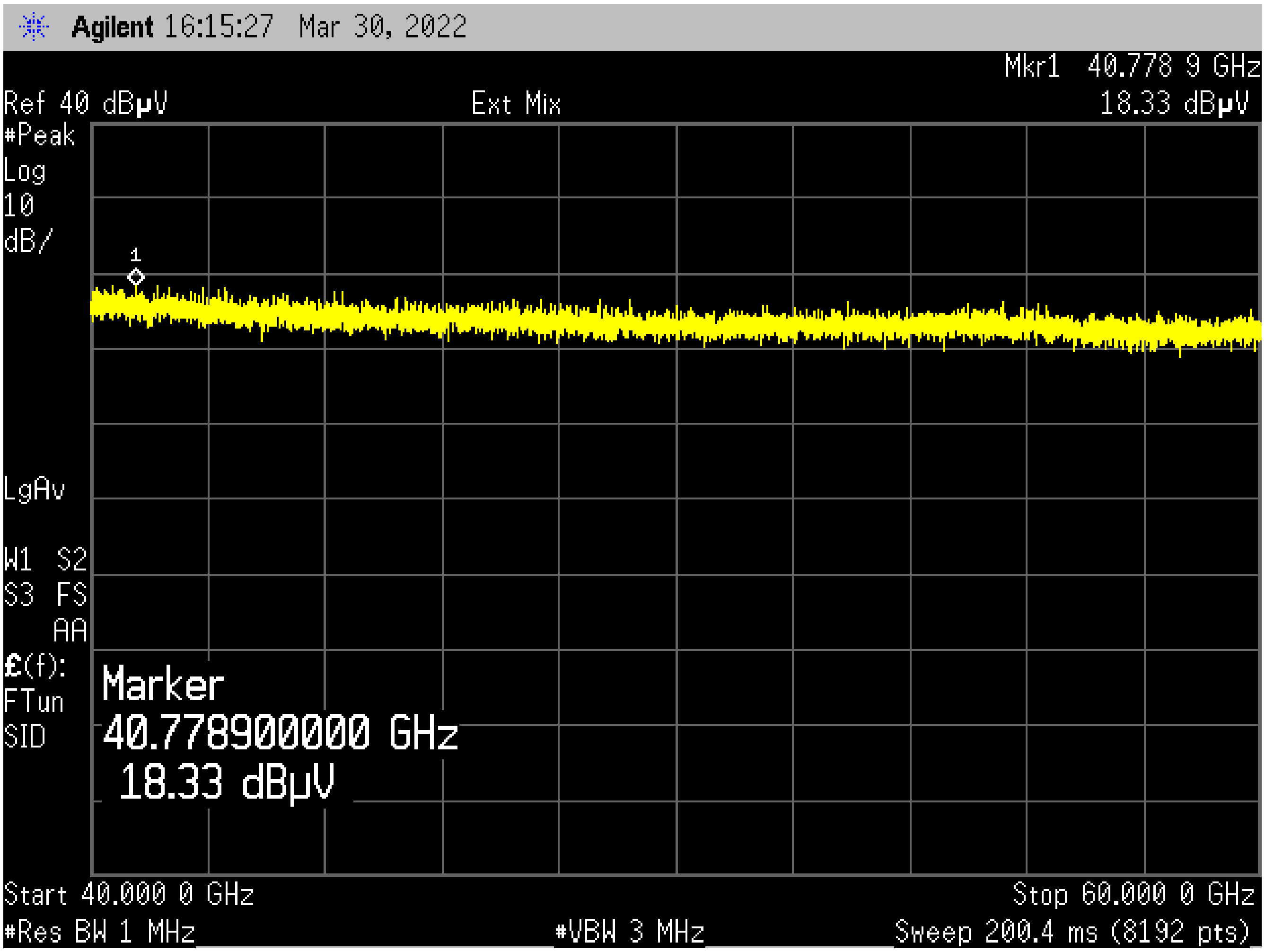


Figure 14: Low Channel, Spurious Emissions (60 – 90 GHz)

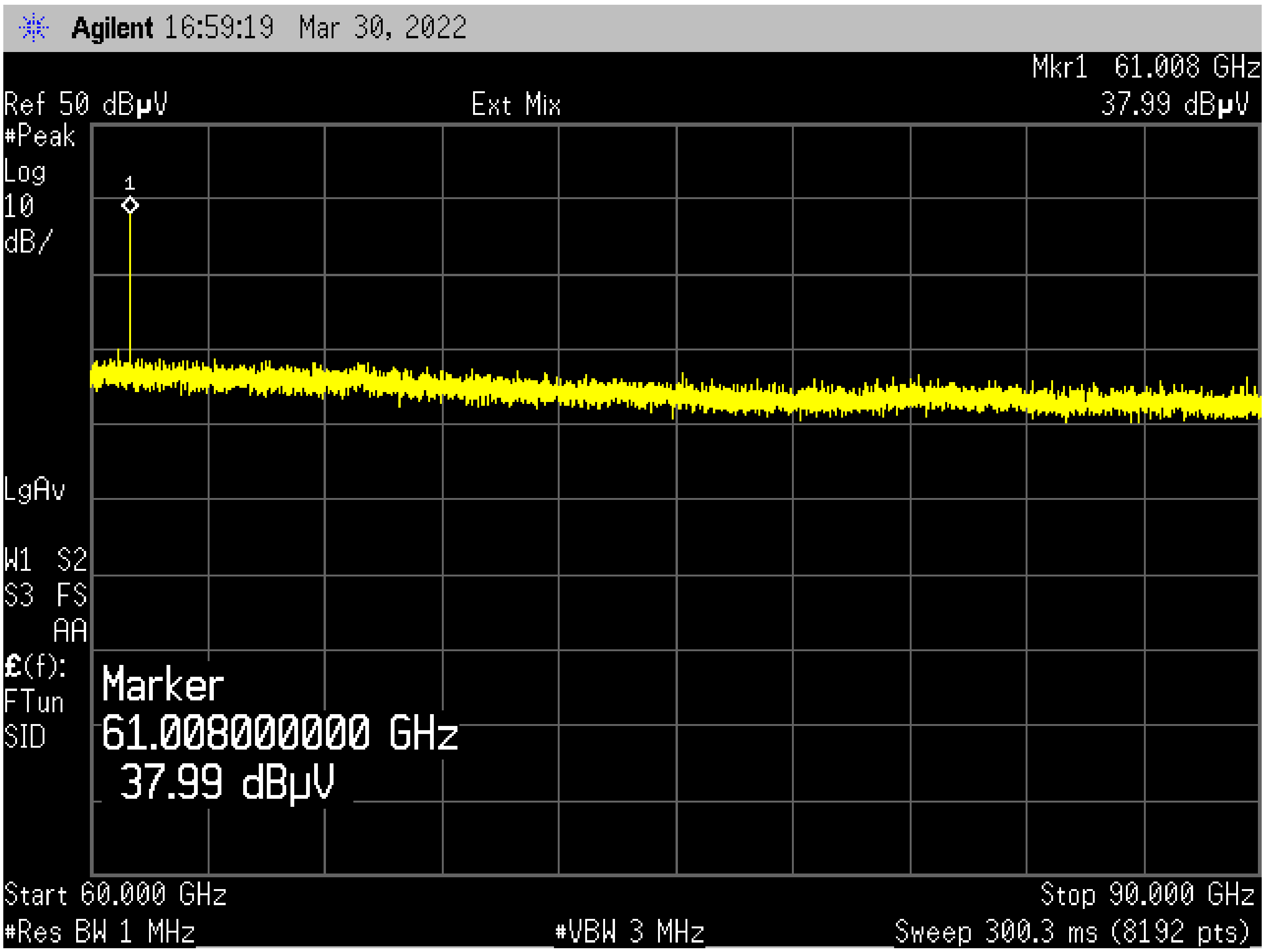


Figure 15: Low Channel, Spurious Emissions (90 – 140 GHz)

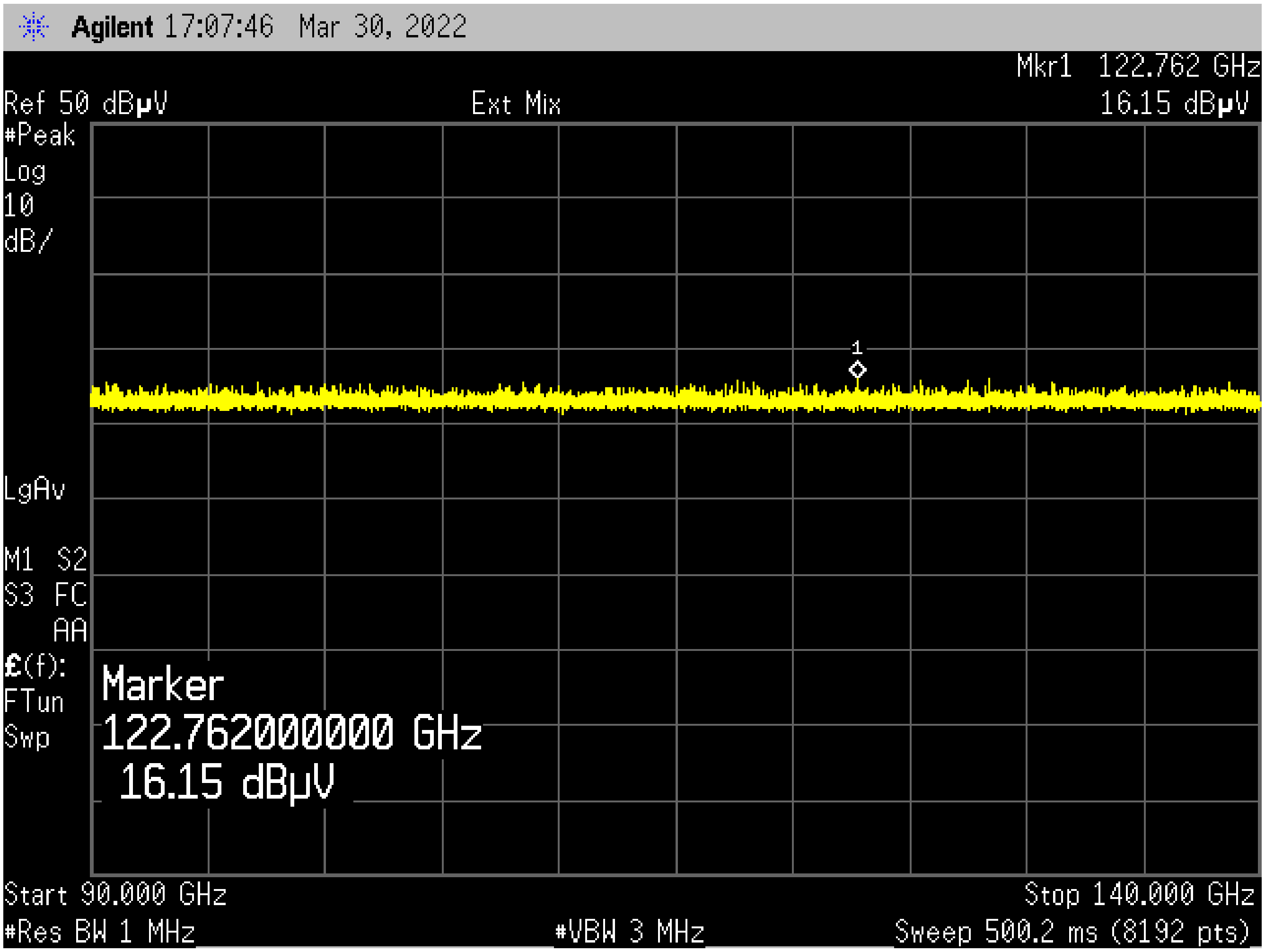


Figure 16: Low Channel, Spurious Emissions (140 – 220 GHz)

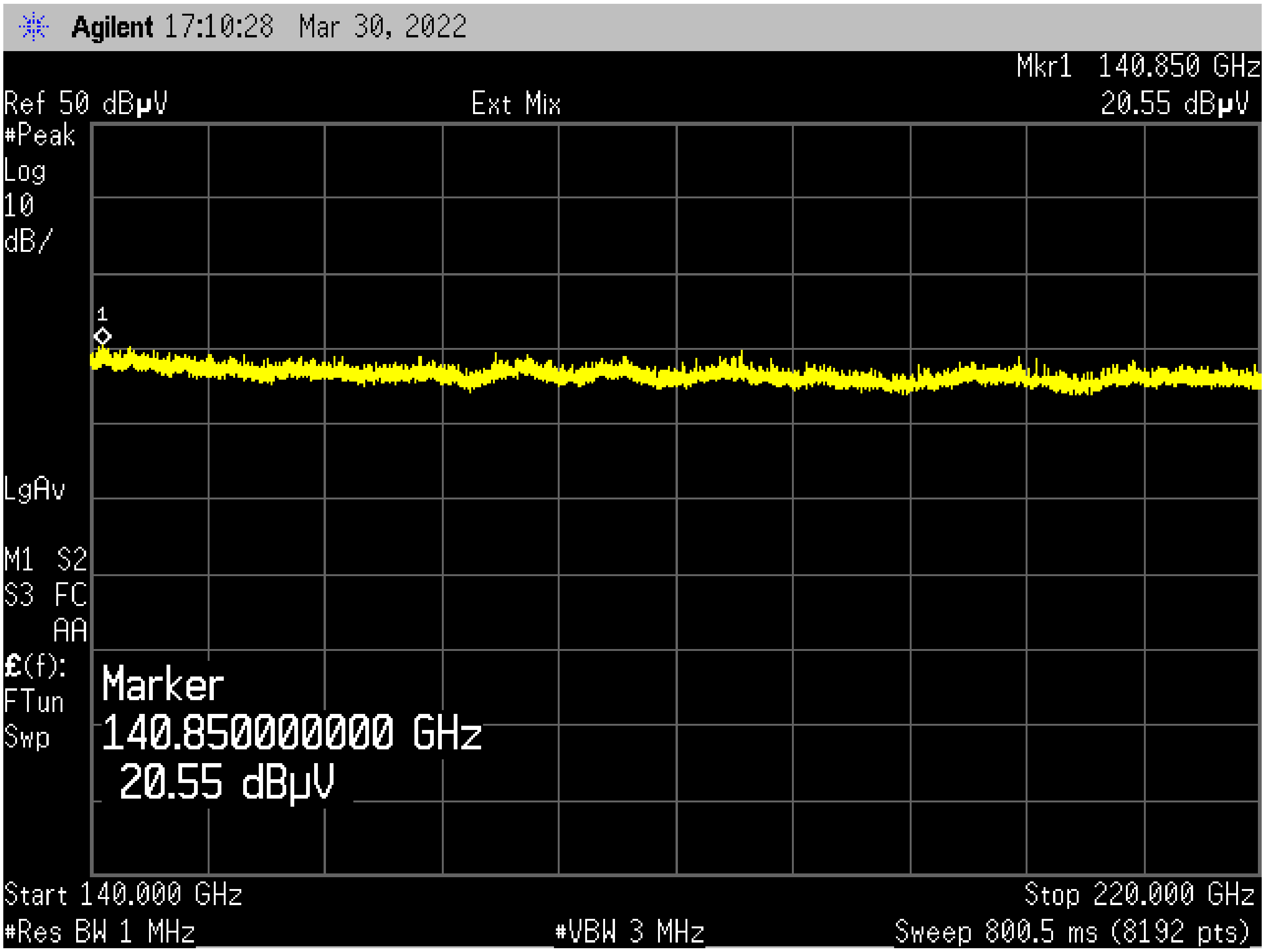


Figure 17: Center Channel, Spurious Emissions (40 – 60 GHz)

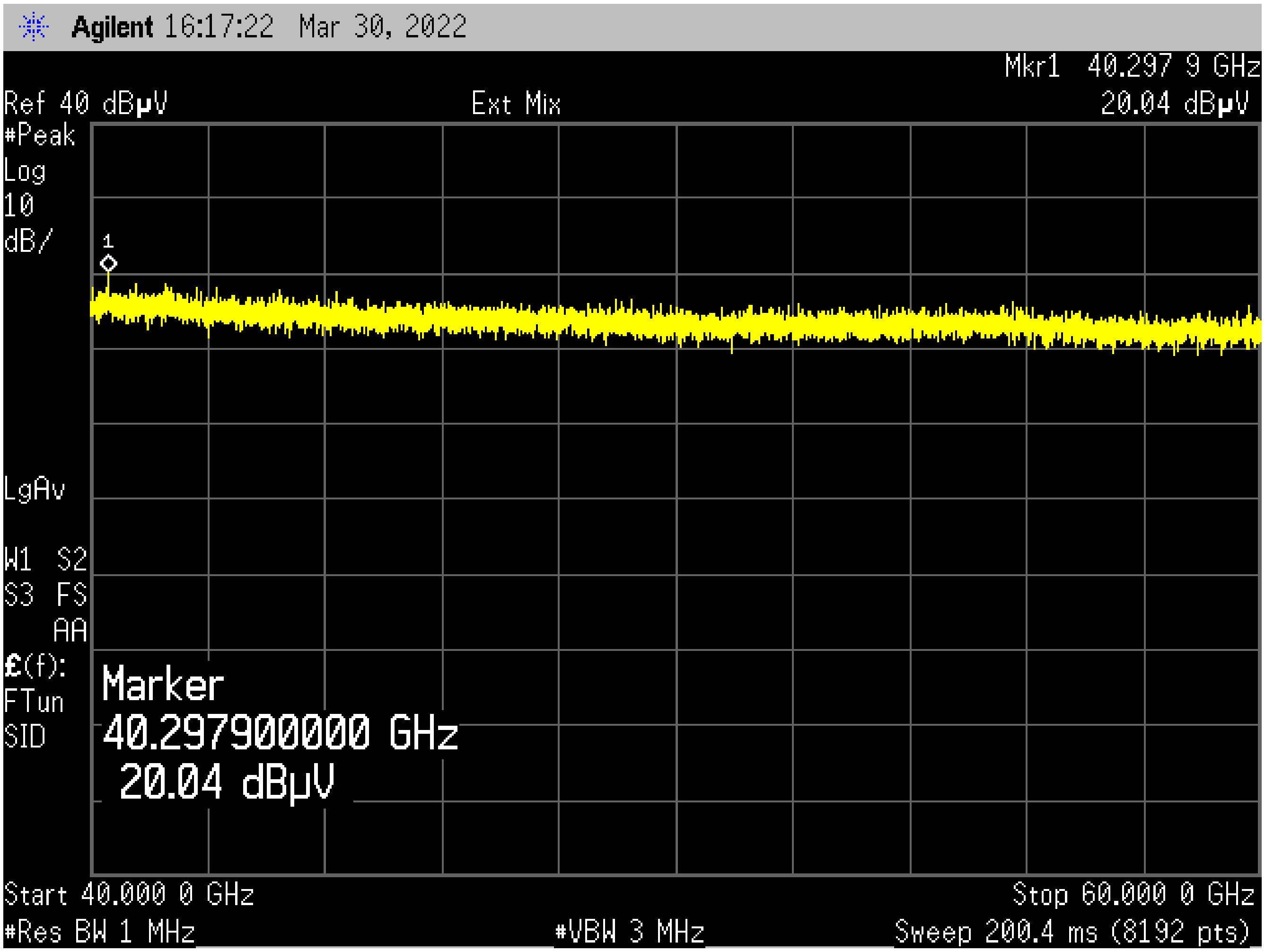


Figure 18: Center Channel, Spurious Emissions (60 – 90 GHz)

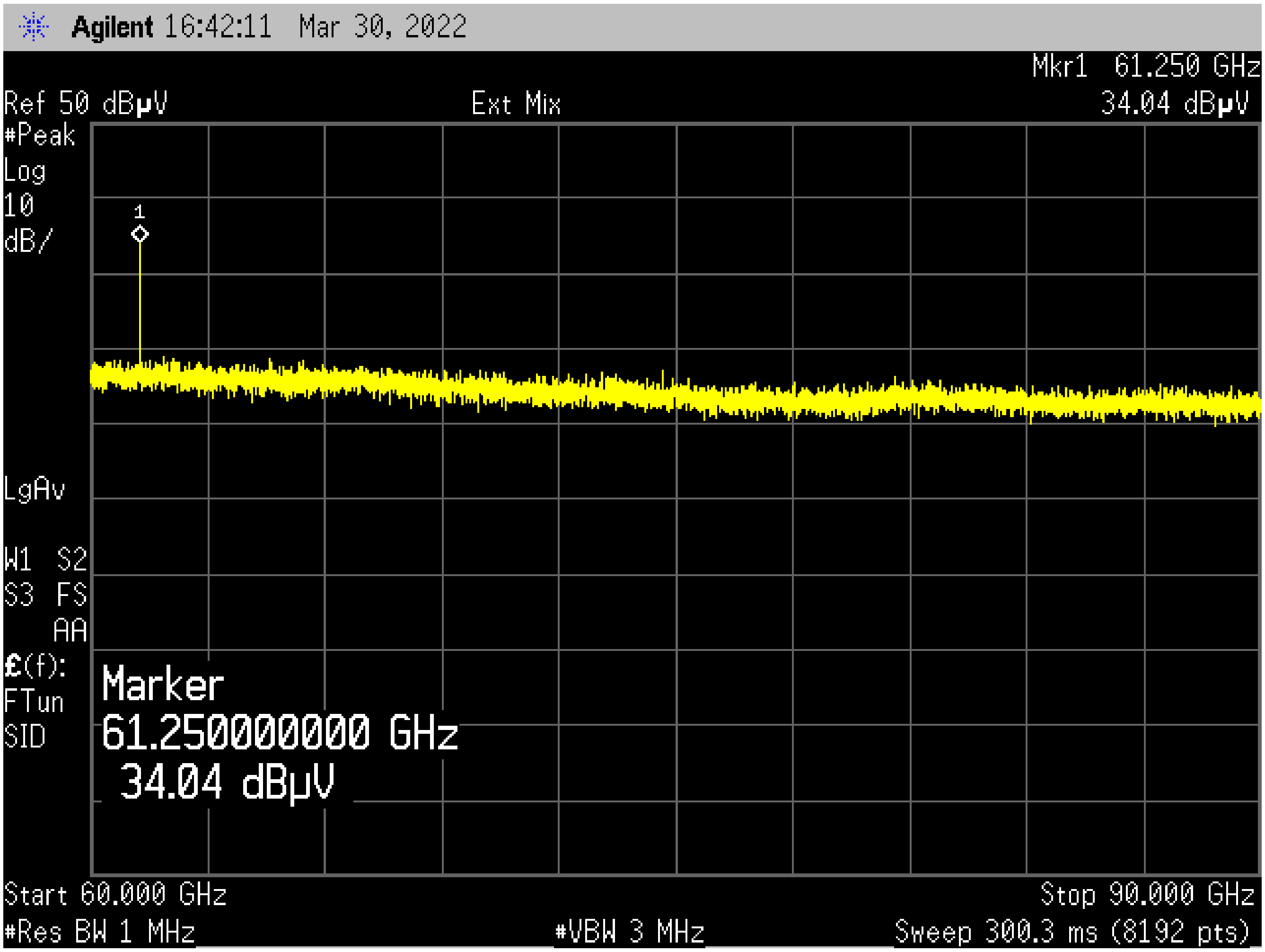


Figure 19: Center Channel, Spurious Emissions (90 – 140 GHz)

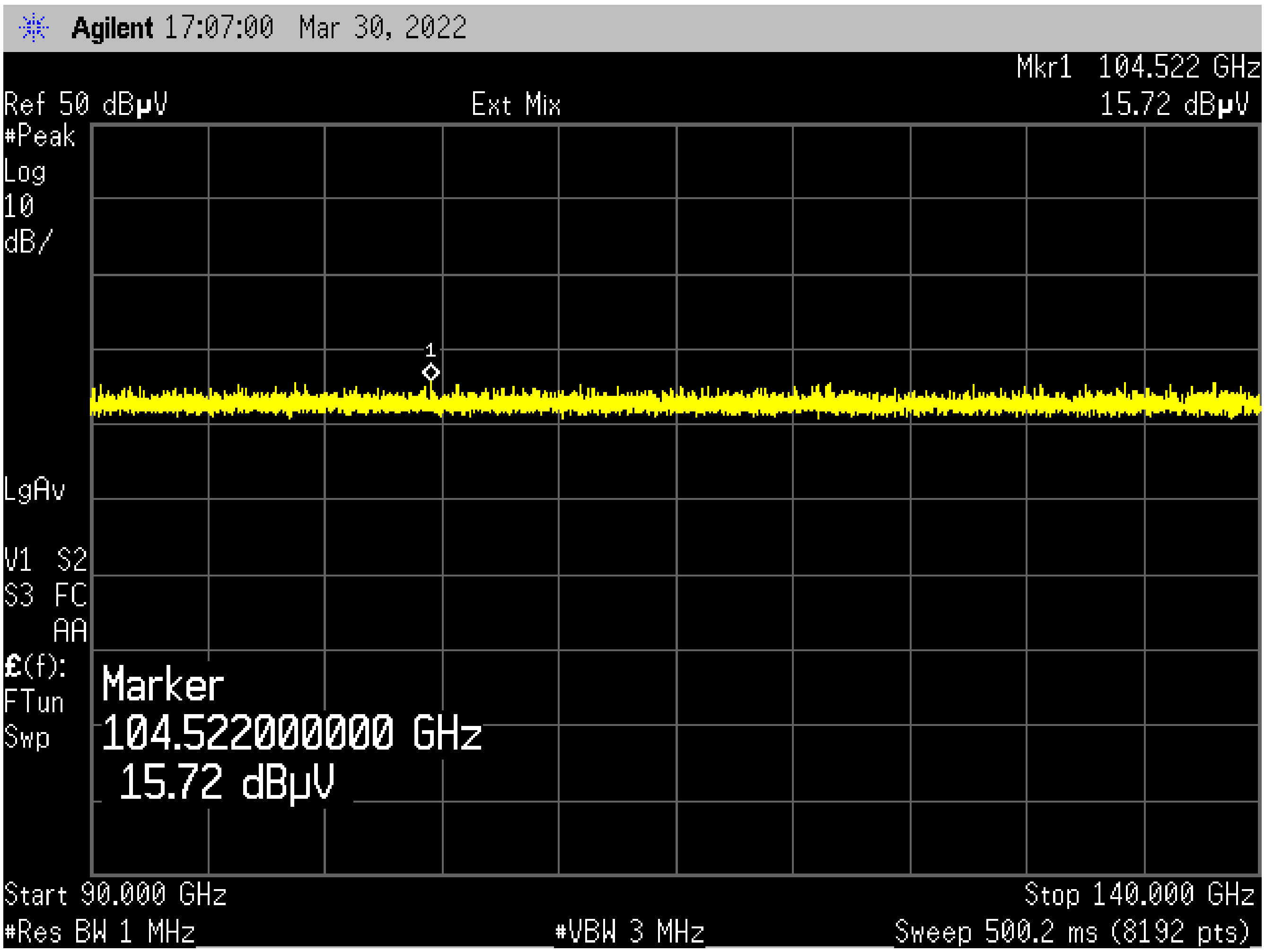


Figure 20: Center Channel, Spurious Emissions (140 – 220 GHz)

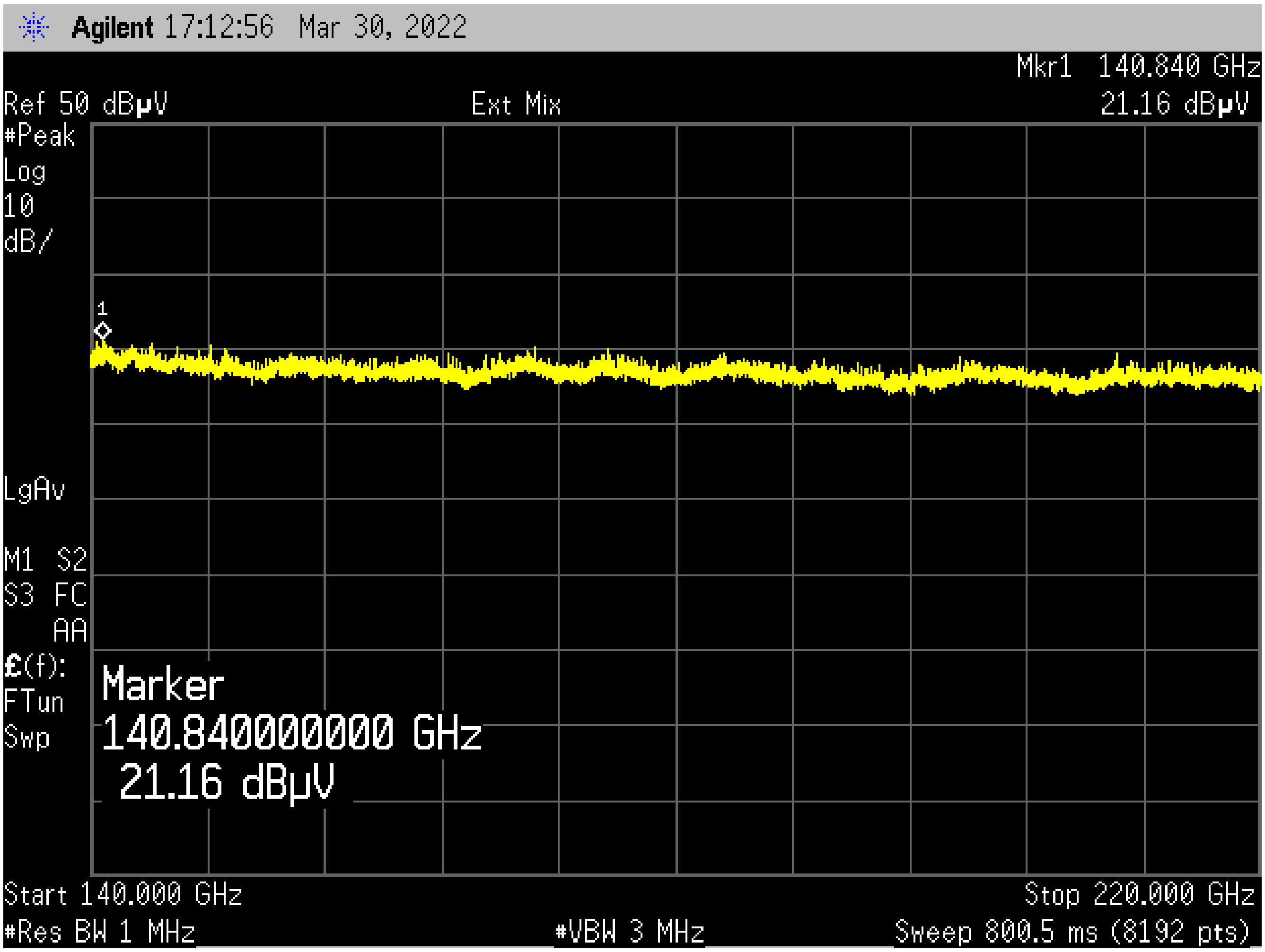


Figure 21: High Channel, Spurious Emissions (40 – 60 GHz)

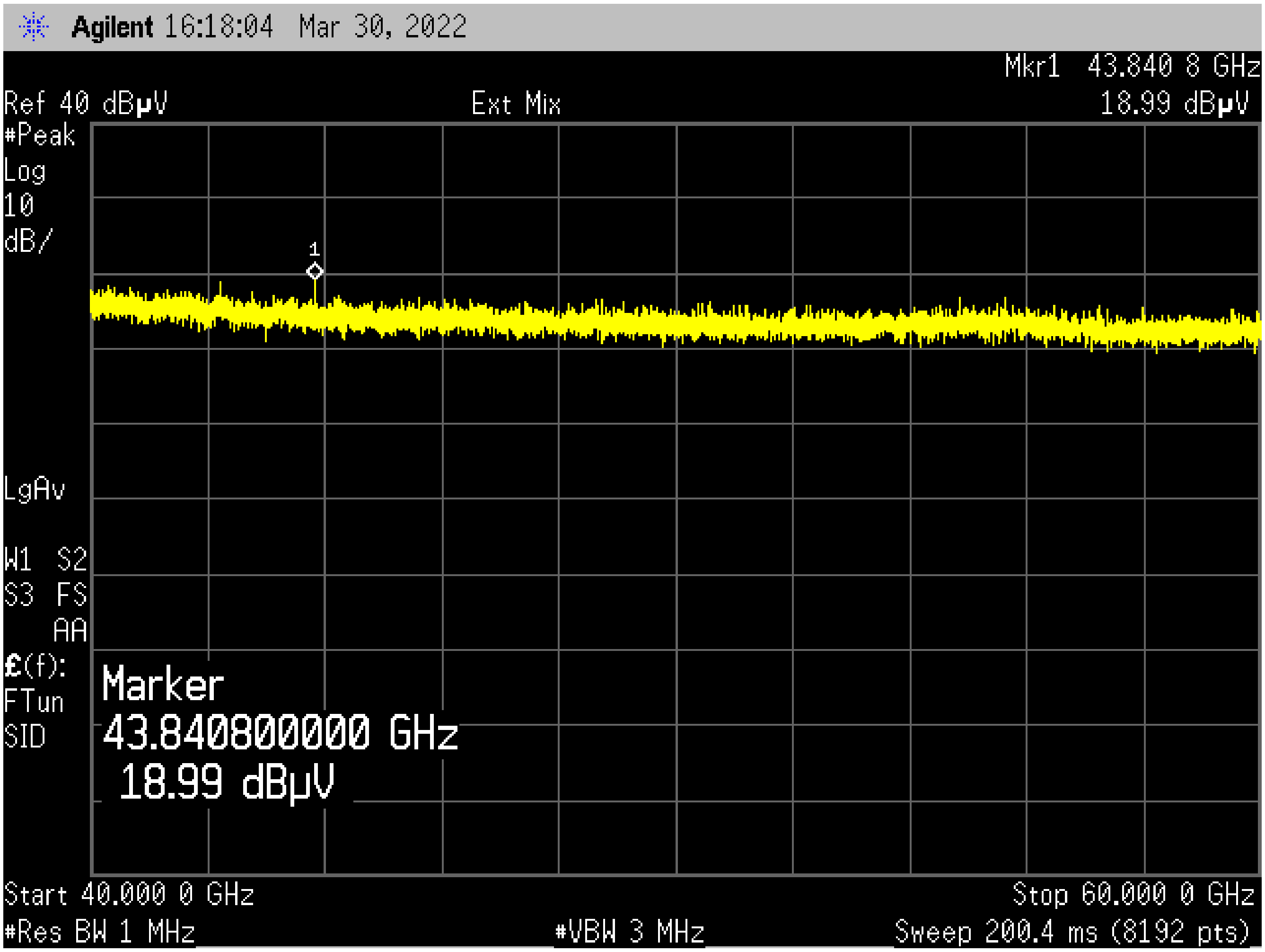


Figure 22: High Channel, Spurious Emissions (60 – 90 GHz)

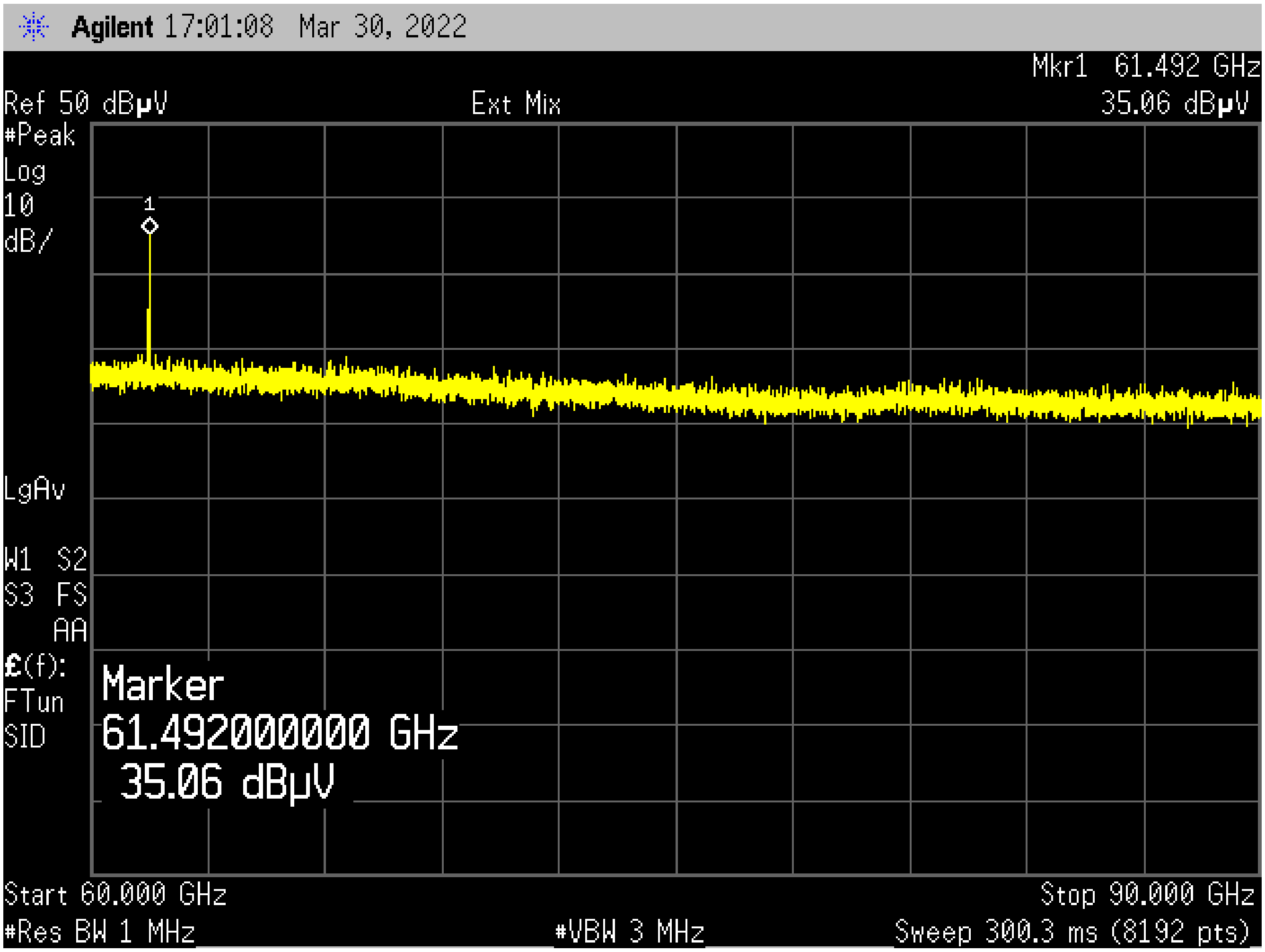


Figure 23: High Channel, Spurious Emissions (90 – 140 GHz)

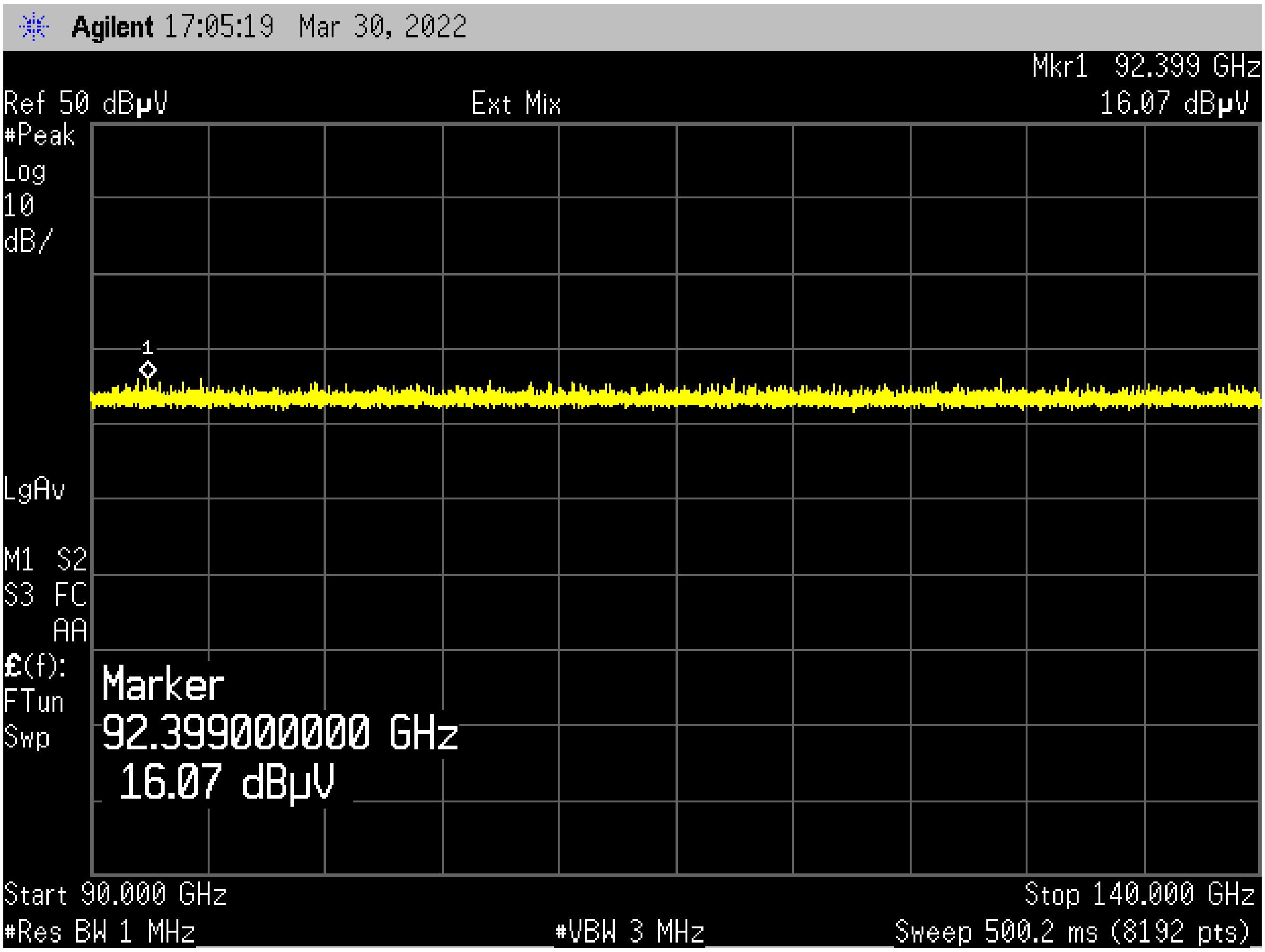
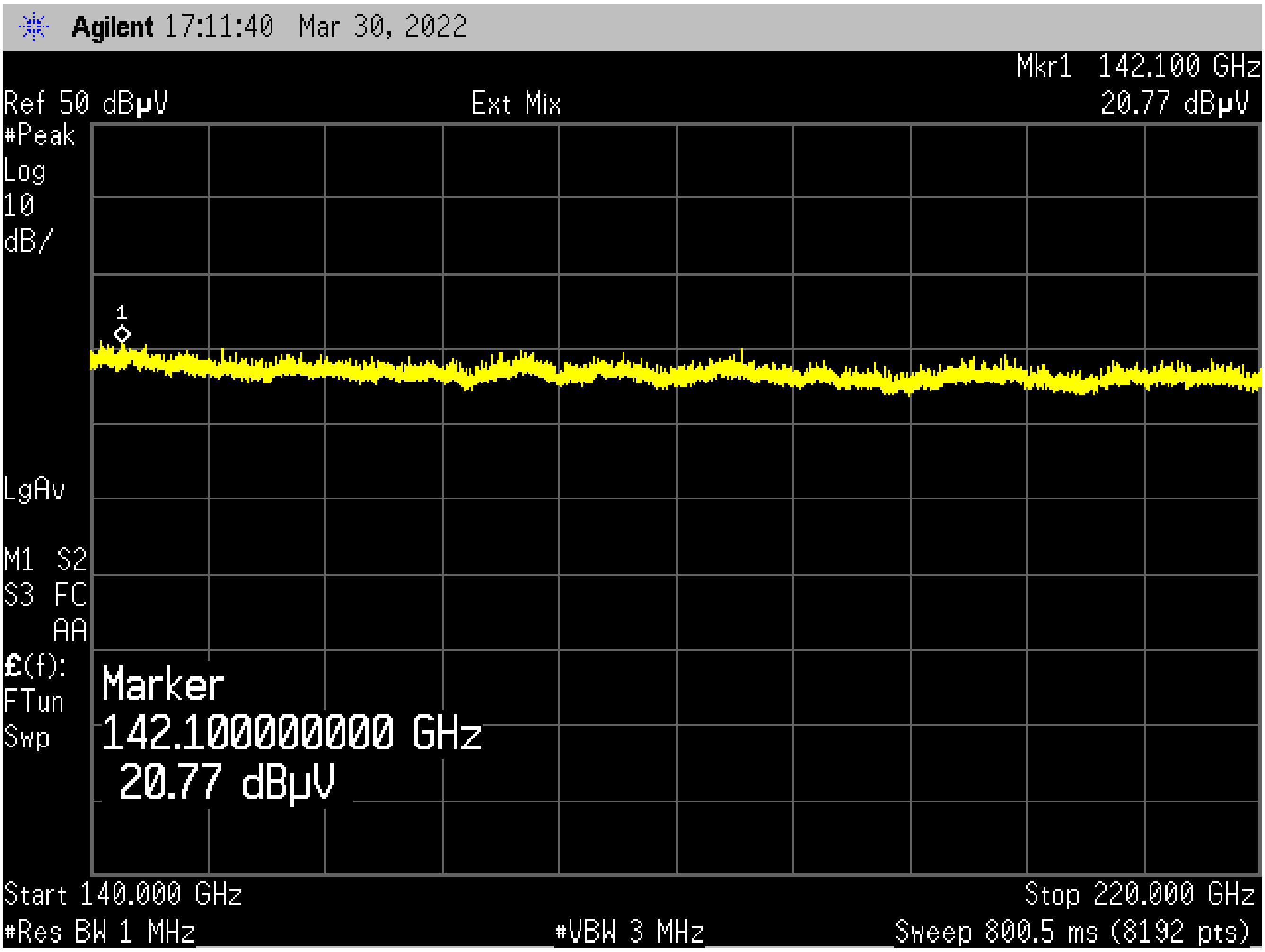


Figure 24: High Channel, Spurious Emissions (140 – 220 GHz)



2.8 Spurious Emissions Below 40 GHz

2.8.1 Requirements

Compliance Standard: FCC Part §15.255(d)(2), §15.209(a) and RSS-210(J.3(b), RSS-Gen(8.9).

Under this provision, radiated emissions below 40 GHz shall not exceed the general limits as defined in FCC Part §15.209(a).

FCC Compliance Limits		
Frequency Range	**3m Limit**	
30 – 88 MHz	100 µV/m (QP)	
88 – 216 MHz	150 µV/m (QP)	
216 – 960 MHz	200 µV/m (QP)	
> 960 MHz	500 µV/m (AVG)	5000 µV/m (Peak)

2.8.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on a 1m X 1.5m non-conductive motorized turntable at a height of 80cm for radiated testing of frequencies up to 1000 MHz, and a height of 1.5m for testing of frequencies above 1000 MHz. Please note that the radiated emissions measured during this testing, were performed at a distance of 3-meters.

An initial pre-scan of the EUT was performed to identify any emissions that exceed, or come within 6dB of, the applicable limit. This pre-scan was performed a with the employment of a spectrum analyzer peak detector function. The highest amplitude (worst-case) emissions noted during the pre-scan were selected for final compliance measurements.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Broadband log periodic and double-ridged horn 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 40 GHz were evaluated. The EUT 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 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. For measurements above 1 GHz, both the peak and the average levels are recorded, using a measurement bandwidth of 1 MHz. For average measurements, a video bandwidth setting of 10 Hz was used, in the case of video averaging; otherwise, an EMI AVG detector shall be employed.

2.8.3 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 antenna(s) and other measurement equipment. These factors include the antenna factor ((AF)(in dB/m)), cable loss factors ((CF)(in dB)), and the pre-amplifier gain [if applicable] ((G)(in dB)). These correction values are algebraically added to the raw Spectrum Analyzer Voltage (in dBμV) to obtain the corrected radiated electric field, which shall be the final corrected logarithm amplitude ((Corr. Meas.)(in dBμV/m)). This logarithm amplitude is then compared to the FCC limit, which has been converted to a unit of log in dBμV/m.

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 from linear units of measure:	dBuV/m = 20LOG(uV/m)
To convert FCC limits, based on $D_{Measure}$:	3m Limit = 10m Limit + 20LOG(10/3)

Environmental Conditions During Radiated Emissions Testing

Ambient Temperature:	19 °C
Relative Humidity:	44 %

2.8.4 Test Data

The EUT complies with the requirements this section.

The EUT was set to a transmit enabled, FMCW-modulated mode for this test.

There were no emissions detected in the frequency range of 18 GHz – 40 GHz.

Table 10 and Table 11, and Figure 25 and Figure 26 provide the final test data.

Figure 25: Radiated Emissions Test Data (30 MHz – 1 GHz)

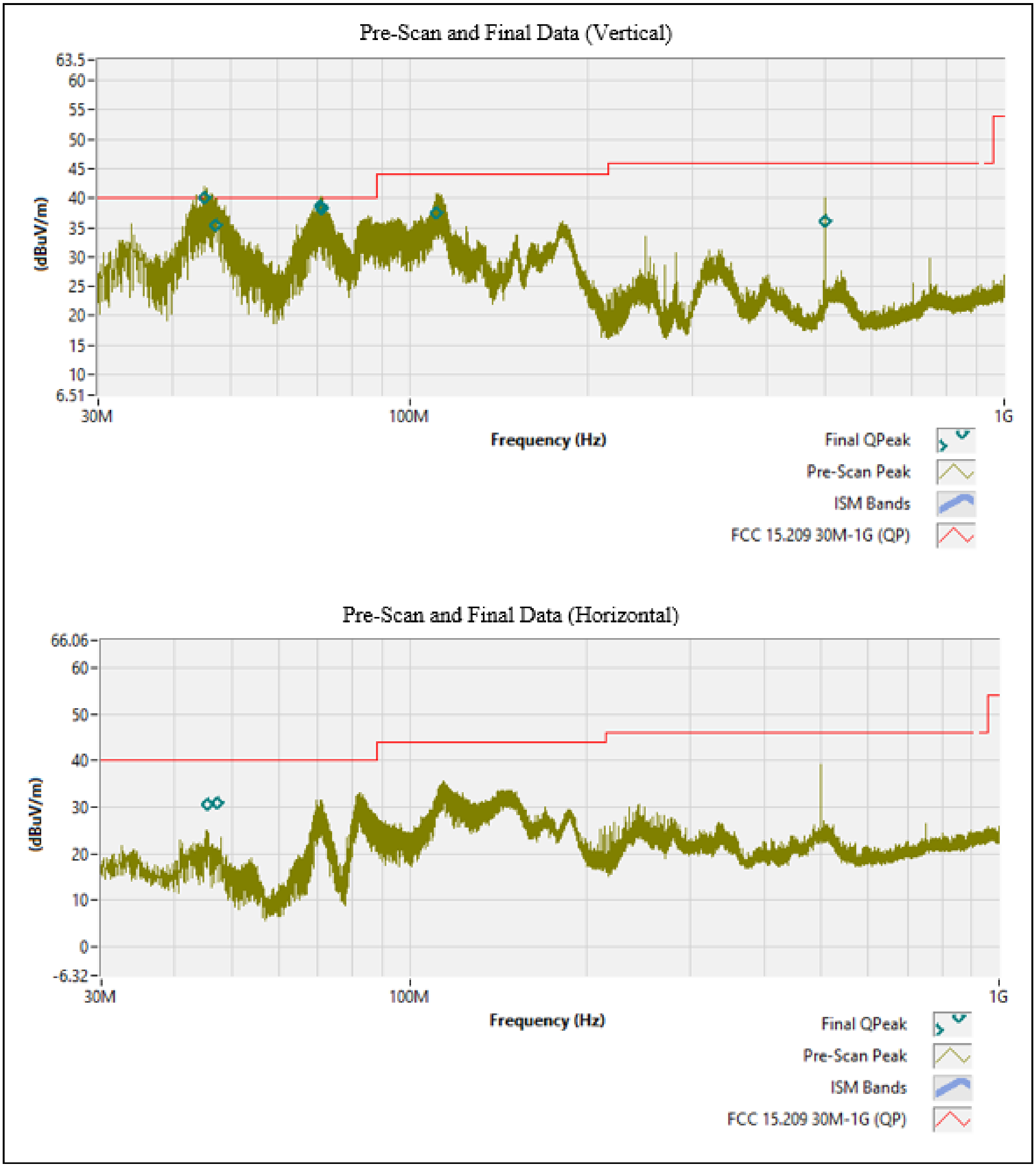


Table 10: Radiated Emission Test Data, 30 MHz – 1 GHz

Frequency (MHz)	Detector	Corr. Meas. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
45.315 *	Peak	41.943	--	--	0	Vert, 150
	QP	40.029	49	-8.971	0	Vert, 120
47.117	Peak	39.962	--	--	0	Vert, 150
	QP	35.336	40	-4.664	0	Vert, 120
70.781	Peak	39.997	--	--	180	Vert, 150
	QP	38.651	40	-1.349	0	Vert, 220
71.141	Peak	40.384	--	--	180	Vert, 150
	QP	38.102	40	-1.898	0	Vert, 220
110.781	Peak	40.762	--	--	180	Vert, 150
	QP	37.556	44	-6.444	180	Vert, 120
500.03	Peak	40.072	--	--	0	Vert, 150
	QP	36.088	46	-9.912	180	Vert, 120

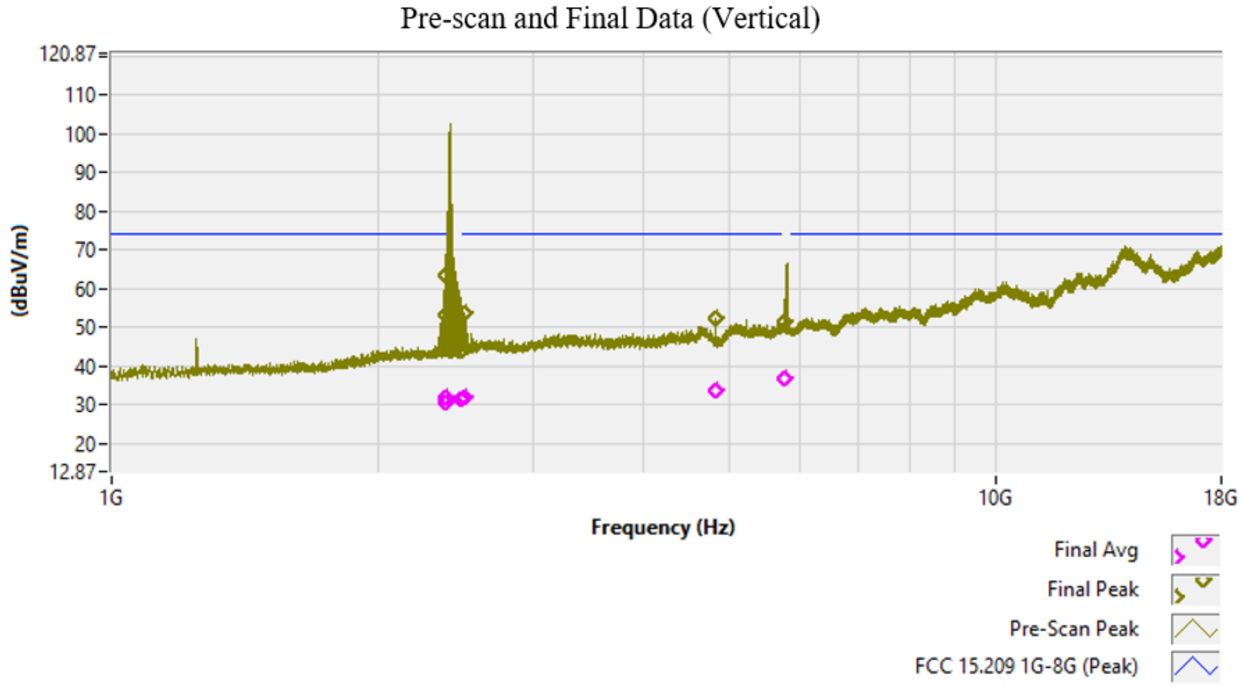
* Class A Limit shall apply for 45.315 MHz

The emission noted at 45.315 MHz is not a transmitter spurious emission. This signal is a digital unwanted emission, that is a product of the ~ +53 VDC Power Over Ethernet (POE) power input switching and voltage conditioning.

The test laboratory confirmed that this emission was not related to a transmitter of any kind. The applicant was able to disable the 60 GHz transmitter, while leaving the digital portion of the PCB powered on.

With all of the transmitters confirmed to be disabled, the 45.315 MHz emission was still present.

Figure 26: Radiated Emissions Test Data (1 GHz – 18 GHz)



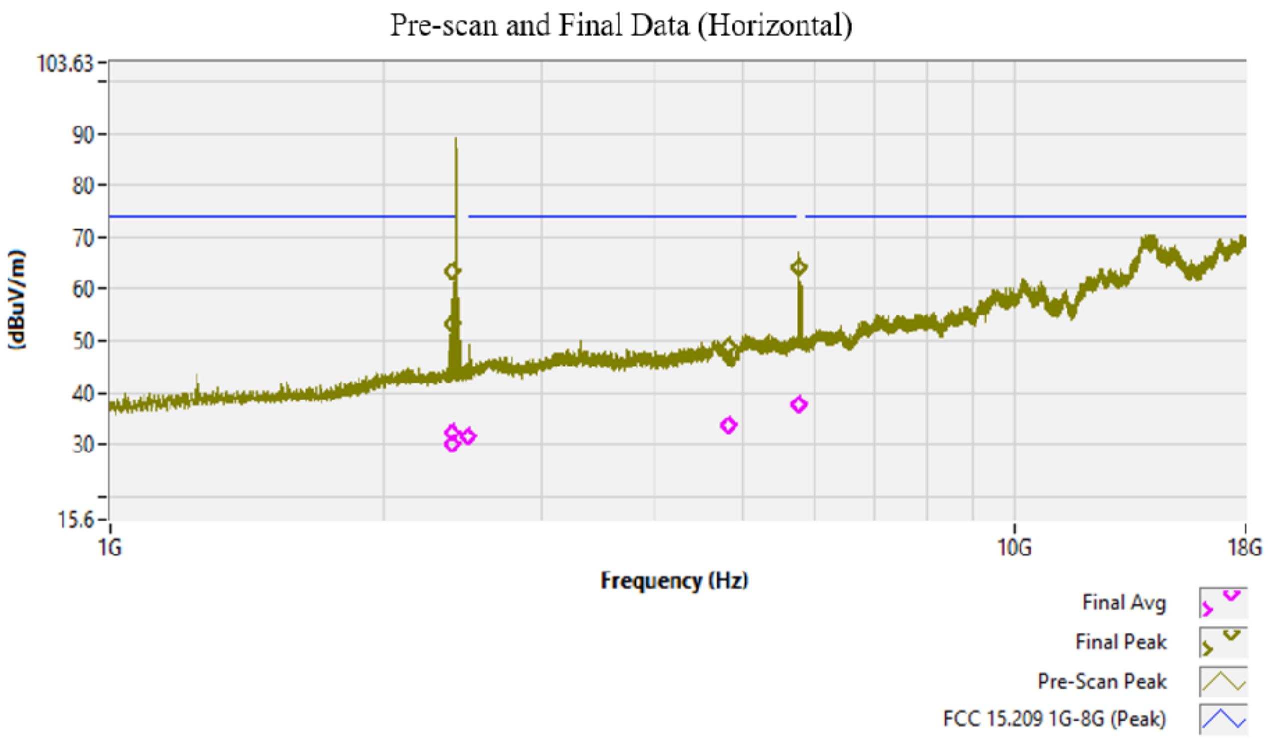


Table 11: Radiated Emission Test Data (1 GHz – 18 GHz)

Frequency (GHz)	Detector	Corr. Meas. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Turn Table (deg)	Antenna (cm)
2.3800	Peak	53.463	74	-20.537	0	Vert, 220
	AVG	30.87	54	-23.13	0	Vert, 220
2.3900	Peak	63.452	74	-10.548	0	Horiz, 120
	AVG	32.147	54	-21.853	0	Horiz, 120
2.4835	Peak	44.215	74	-29.785	0	Horiz, 220
	AVG	31.378	54	-22.622	0	Vert, 120
2.5090	Peak	53.659	74	-20.341	0	Vert, 150
	AVG	32.038	54	-21.962	0	Vert, 120
4.8240	Peak	52.358	74	-21.642	0	Vert, 150
	AVG	33.703	54	-20.297	0	Vert, 120
5.7700	Peak	64.195	74	-9.805	0	Horiz, 120
	AVG	37.533	54	-16.467	0	Horiz, 120

Please note that the amplitude of the 2.4 GHz signal was not measured. Since the radio transmitter fundamental is an intentional radiator, no limit shall apply under FCC Part 15, Subpart B (§15.109). However, because this signal was over 100 dBuV/m, it was necessary to utilize appropriate waveguide notch filters, when measuring the unwanted emissions in frequencies above 4.5 GHz. The use of band-pass notch filters allows for an accurate evaluation of the harmonics. The notch filters prevent the RF pre-amplifier from becoming saturated.

2.9 Frequency Stability

2.9.1 Requirements

Compliance Standard: FCC Part §15.255(f) and RSS-210(J.6).

Under this provision, fundamental emissions must be contained within the frequency bands specified in FCC Part 15.255(c)(2) during all conditions of operation. The EUT shall maintain this frequency stability when operated over the temperature range of -20 to +50 degrees Celsius. Additionally, the input voltage shall be varied to the order of 85% to 115% of rated input voltage.

2.9.2 Test Procedure

The EUT transmitter center channel of 61.250 GHz shall be used for this test. To show compliance, a strict deviation/tolerance limit shall be employed. This limit is defined as 0.01% of 61.250 GHz.
Further, (0.01%)*61250000000 = 6125000 Hz = 6.125 MHz.

The frequency stability of the EUT was evaluated using an environmental chamber, capable of varying temperature across the range of –20° to +50° centigrade. Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. Only the portion of the transmitter containing the frequency determining, and stabilizing, circuitry need be subjected to the temperature variation test. The support equipment shall be removed from the temperature variation.

2.9.3 Test Data

The EUT complies with the requirements this section.

The EUT was set to transmit a CW for this test.

Table 12 provides the final test data.

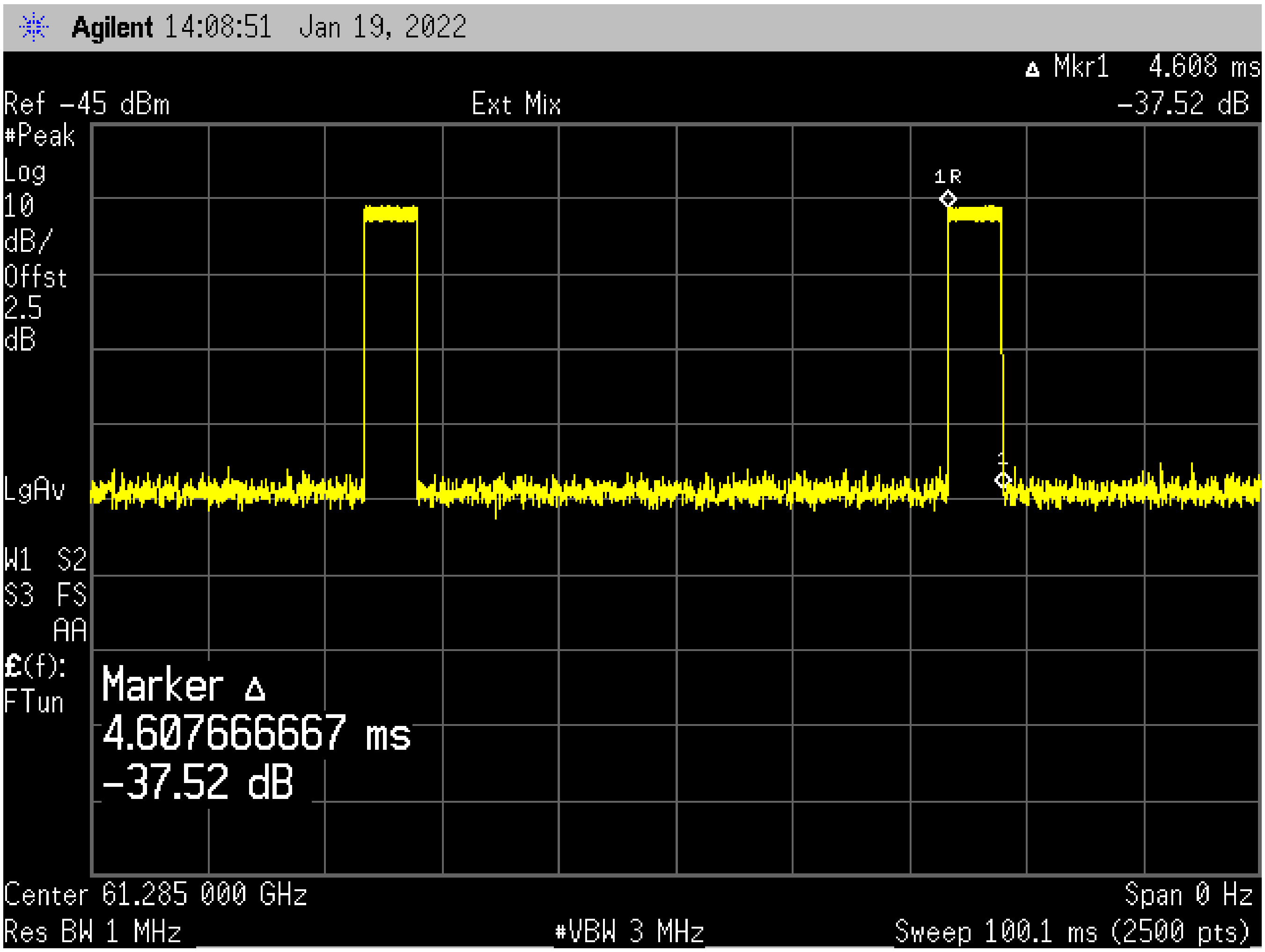
Table 12: Frequency Stability Test Data

Start-Up				
Temperature (C)	**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/- Hz)**	**Pass/Fail**
21 (ambient)	61250.000000	0	6125000	**NA**
-20	61250.920000	920000	6125000	Pass
-10	61250.750000	750000	6125000	Pass
0	61249.960000	-40000	6125000	Pass
10	61249.080000	-920000	6125000	Pass
20	61249.770000	-230000	6125000	Pass
30	61249.900000	-100000	6125000	Pass
40	61249.880000	-120000	6125000	Pass
50	61250.970000	970000	6125000	Pass
2-Minutes				
Temperature (C)	**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/- Hz)**	**Pass/Fail**
-20	61250.880000	880000	6125000	Pass
-10	61250.690000	690000	6125000	Pass
0	61248.850000	-1150000	6125000	Pass
10	61249.180000	-820000	6125000	Pass
20	61249.970000	-30000	6125000	Pass
30	61249.960000	-40000	6125000	Pass
40	61247.780000	-2220000	6125000	Pass
50	61247.220000	-2780000	6125000	Pass
5-Minutes				
Temperature (C)	**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/- Hz)**	**Pass/Fail**
-20	61249.920000	-80000	6125000	Pass
-10	61249.850000	-150000	6125000	Pass
0	61249.960000	-40000	6125000	Pass
10	61249.990000	-10000	6125000	Pass
20	61250.055000	55000	6125000	Pass
30	61250.015000	15000	6125000	Pass
40	61249.900000	-100000	6125000	Pass
50	61250.989000	989000	6125000	Pass
10-Minutes				
Temperature (C)	**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/- Hz)**	**Pass/Fail**
-20	61250.920000	920000	6125000	Pass
-10	61250.750000	750000	6125000	Pass
0	61250.010000	10000	6125000	Pass
10	61249.990000	-10000	6125000	Pass
20	61249.990000	-10000	6125000	Pass
30	61249.900000	-100000	6125000	Pass
40	61248.990000	-1010000	6125000	Pass
50	61248.880000	-1120000	6125000	Pass

2.10 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) and RSS-Gen(8.2), the duty cycle measurement shall be made in reference to a 100 ms period.

Figure 27: Transmitter Pulse On-Time (Duty Cycle)



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

As depicted in Figure 27, the total transmitter on-time is made of two sub-pulses.
The worst case on-time ($t$on) is: 2(4.61) = 9.22 ms.

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

$t$on ÷ Tcycle = Δ

9.22 ÷ 100 = 0.0922

Δ = 9.2%

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(0.092) = –20.72

δ = 20.7 dB (worst-case)

Where δ is the final DCCF.

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

3 Equipment Under Test

3.1 EUT Identification & Description

The OmniSight, Inc., MegaRadar V1 is a Frequency-Modulated Continuous-Wave (FMCW) Radar which is capable of transmitting in the 60.0 GHz range. The transmission signal is modulated in frequency and operates at a duty cycle necessary for the level of detail and range desired. Periodically the signal broadcasts, which sweeps across a set frequency range. The differences in the phase, or frequency, of the received signal is used to estimate range, doppler shift, and angle of arrival. The intended use is for infrastructure tracking of vehicles, pedestrians, or bicycles in (or around) areas of interest which may include downtown cities, parking areas, on/off ramps, intersections, and other important areas. When in the High Power Mode, the EUT is designed to operate in the 61.0 – 61.5 GHz range and occupies less than 500 MHz (bandwidth).

3.2 Testing Algorithm

The EUT was controlled and configured by the applicant via connectivity to the Internet. The EUT was tested powered on, with the transmitter enabled during each test. The EUT transmit signal was evaluated in three orthogonal planes (x, y, and z) to determine the worst-case field plane orientation. The receive-antenna/mmWave measurement equipment, denoted in Section 4 of this report, was also varied in polarity (vertical and horizontal). Based on these exploratory measurements, the measurement positioning that produced the highest fundamental amplitude was used for the final compliance/reporting test data. The worst-case emissions are provided in this report. There are no other transmitter timing schemes, or configurations, that would produce an emission that exceeds the levels of the emissions provided in this test report. This test report covers the software setting for the High Power Mode.

3.3 Test Configuration

The MegaRadar V1 is powered by ~ +53 VDC, via a POE switch, which was connected to the public mains 120 VAC, 60 Hz supply. The EUT was provided to the test laboratory in one sample, containing an operational mode that employs a continuous chirp profile that allows for the detection of objects in its field of view. The EUT was configurable through software changes only, via remote control of the device through a web-based portal.

The EUT was configured for testing, as depicted in Figure 28.

Table 13 through Table 16 provide further details pertaining to the EUT.

Table 13: EUT System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Rev. #
Jetson Nano	N/A	N/A	N/A	N/A
NO-IR Camera	RPi NoIR Camera	Unknown	N/A	2

Table 14: Support Equipment (for testing)

Name / Description	Manufacturer	Model Number	Customer Supplied Calibration Data
POE Switch	N/A	N/A	N/A

Table 15: Cable Configuration

Ref.	Port on EUT	Cable Description	Qty.	Length	Shielded	Termination
1	POE	CAT5 or CAT6	N/A	N/A	N/A	N/A

Figure 28: EUT Test Configuration Diagram

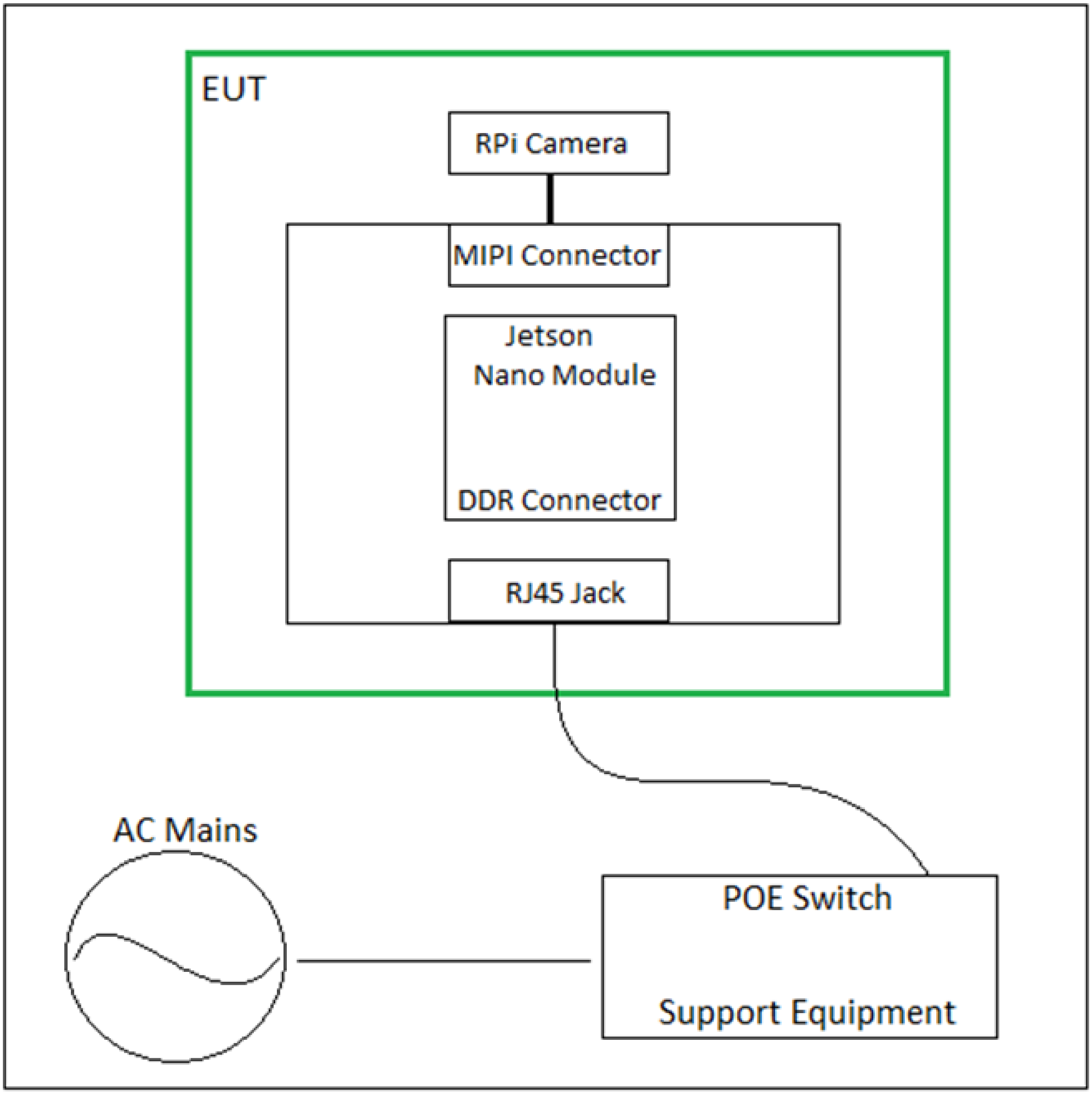


Table 16: Radio Device Summary (High Power Mode)

Manufacturer:	OmniSight, Inc.	
Marketing Brand:	Truck Specialized Parking Services	
EUT FCC ID:	2A6OYMEGA1	
IC ID:	28582-MEGA1	
EUT Name:	MegaRadar V1	
Serial Number of Unit Tested:	Not Declared by Applicant	
TX Frequency Range:	61.0 – 61.5 GHz	
Maximum Peak Power:	9.55 dBm (EIRP)	
Modulation:	FMCW	
Occupied Bandwidth:	20dB	469.008 MHz
	99%	443.933 MHz
ISED Emissions Designator:	444MF3D	
Keying:	Automatic	
Type of Information:	Radar, Ranging, Imaging	
Number of Modulated Channels:	1 FMCW Channel < 500 MHz wide	
Power Output Level Settings:	Fixed, via Software during production	
Antenna Type:	PCB Trace, Collection	
Multiple Antennas (60 GHz):	3 TX; 4 RX	
Maximum Antenna Gain (60 GHz):	7 dBi	
Maximum Data Rate	Not Declared by Applicant	
Software/Firmware:	High Power Mode (tune-up tolerance: ±2.2 dB)	
Pulsed Transmitter:	Yes	
Transmitter Timing/Duty Cycle:	9.2 %	
Power Source & Voltage:	+53 VDC via POE	
ISED – RSS-102, Annex A:	+0.063 W/m^2	
Highest Spurious Emission:	140.840 GHz at 10cm: 4.46 dBm EIRP (noise floor)	
	5.77 GHz at 3m: 64.195 dBuV/m (Peak)	

4 Measurements

4.1.1 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

4.2 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 17 below.

Table 17: 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

5 Test Equipment

Table 18 shows a list of the test equipment used for measurements, along with the calibration information.

Table 18: Test Equipment List

Test Name: **AC Mains Conducted Emissions**		Test Date:	**3/22/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	SOLAR, 8028-50-TS-24-BNC	LISN	9/14/2022
00126	SOLAR, 8028-50-TS-24-BNC	LISN	9/14/2022
00895	HP, 11947A	TRANSIENT LIMITER	2/21/2023
00823	AGILENT, EXA	SPECTRUM ANALYZER	5/27/2022
00330	WLL, CE CABLE	BNC, RF COAXIAL CABLE	5/12/2022

Test Name: **3m Radiated Emissions**		Test Date:	**3/15/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00942	AGILENT, MXA	SPECTRUM ANALYZER	9/29/2022
00644	SUNOL SCIENCES CORP.	ANTENNA, LOGPERIOD	11/9/2022
00626	ARA, DRG-118/A	ANTENNA, HORN	8/20/2023
00627	AGILENT, 8449B	RF PRE-AMPLIFIER	9/22/2022
00276	ELECTRO-METRICS, BPA-1000	RF PRE-AMPLIFIER	6/8/2022
00806	MINI-CIRCUITS, 3061	HIGH FREQUENCY CABLE, SMA	6/17/2022
00977	JUNKOSHA, USA MX-322	6M COAXIAL CABLE, SMA/N	1/3/2023

Test Name: **Fundamental Transmitter Power**		Test Date:	**4/8/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00461	TEKTRONIX	DIGITAL STORAGE OSCILLOSCOPE	6/19/2022
00967	MILLIMETER WAVE, 950V/385	BROADBAND RF DETECTOR	9/23/2024
00834	ULTIFLEX, UFA360	HF COAXIAL CABLE	12/21/2022
30692	ANRITSU, MG3696A	65 GHZ SIGNAL GENERATOR	11/11/2022
00929	MILLITECH SGH12	60-90 GHZ HORN	CNR

Test Name: **Spurious Emissions Above 40GHz**		Test Date**: 3/30/2022 – 4/1/2022**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00528	AGILENT, E4446A	SPECTRUM ANALYZER	3/25/2023
00928	VIRGINIA DIODES, WR12	SAX, DOWNCONVERTER	7/28/2023
00929	MILLITECH SGH12	60-90 GHZ HORN	CNR
00294	OML, INC DPLXX	IF/LO DIPLEXER, 12DB	CNR
00083	AGILENT, 11970U	HF MIXER, HARMONIC	CNR
00054	AGILENT, 11970V	HF MIXER, HARMONIC	CNR

Test Name: **Frequency Stability**		Test Date:	**3/7/2022**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00776	TENNY	TJR-A-WS4, CHAMBER	04/26/2022
00948	AGILENT, 8564EC	SPECTRUM ANALYZER	12/17/2022
00800	FLUKE, 87V	DIGITAL MULTIMETER	02/16/2023
00093	KIKISUI	PROGRAMABLE AC POWER	CNR