

COMPLIANCE WORLDWIDE INC. TEST REPORT 349-21R3

In Accordance with the Requirements of

**Federal Communications Commission 47 CFR Part 15, Subpart F
Technical Requirements for Ground Penetrating Radar Systems**

**ISED RSS-220, Issue 1 (March 2009) + Amendment 1 (July 2018)
Devices Using Ultra-Wideband (UWB) Technology**

Issued to

**SPH Engineering SIA
Dzirnavu iela 62-9
Riga, LV-1050 Latvia**

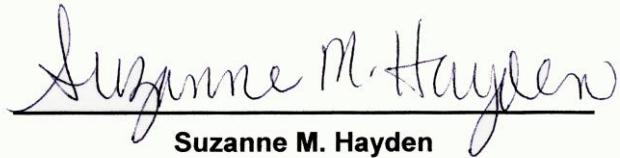
For the

**Ground Penetrating Radar
Model: Zond Aero 500**

**FCC ID: 2AUQQ-ZONDAERO500
IC: 25515-ZONDAERO500**

**Original Report Issued on January 13, 2022
Revision R1 Issued on March 21, 2022
Revision R2 Issued on April 22, 2022
Revision R3 Issued on April 29, 2022**

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1. Scope

This test report certifies that the SPH Engineering Zond Aero 500, as tested, meets the FCC Part 15, Subpart F and ISED RSS-220 requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required. Revision R1 remeasured the 10 dB bandwidth and performed measurements above 960 MHz with the GPR device active and not transmitting. Revision R2 adds an additional section 6.2.1 on page 8 for RSS-220 6.2.1 (b) requirement. Revision R3 adds a timing plot to section 6.2.1 and updated the peak power in a 50 MHz RBW in section 6.6 for the RF Exposure in section 6.9.

2. Product Details

2.1. Manufacturer:	SPH Engineering SIA.
2.2. Model Number:	Zond Aero 500
2.3. Serial Number:	0008
2.4. Description:	The Zond Aero 500 is a 500 MHz GPR antenna used for analyzing various below surface environments.
2.5. Power Source:	11.1 VDC Battery Powered, rechargeable using the supplied Mascot Charger.
2.6. Hardware Revision:	N/A
2.7. Software Revision:	Prism V2.70.05
2.8. Modulation Type:	Pulse
2.9. Operating Frequency:	500 MHz, nominal
2.10. EMC Modifications:	None

3. Product Configuration

3.1 Operational Characteristics & Software

1. Turn on the notebook and start up the Prism 2 software.
2. Turn on the GPR antenna and allow the unit to boot up.
3. Configure the GPR antenna to perform a scan, by pressing start in the software. Software will respond with a verbal "lets go"
4. To stop of the device from transmitting its UWB signal press stop in the software. Software will respond with a verbal "stop it"

3.2. EUT Hardware

Manufacturer	Model	Serial Number	Description/Function
SPH Engineering	Zond Aero 500	0008	Ground Penetrating Radar

3.3. EUT Cables/Transducers

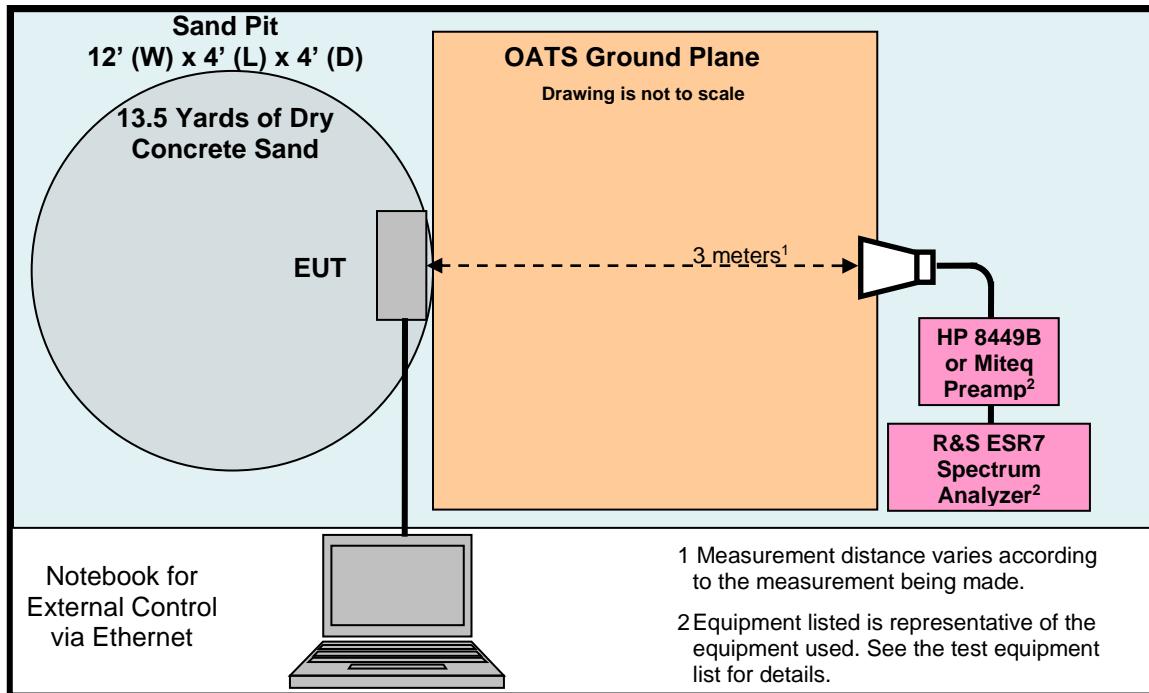
Manufacturer	Model/Part #	Length (m)	Shield Y/N	Description/Function
Any	Ethernet Cable	6	N	Cable from control notebook to GPR Antenna
Any	Power Cable	2M	N	Power Cable for Charger (conducted only)

3. Product Configuration (continued)

3.4. Support Equipment

Notebook computer containing PRISM software and Ethernet interface.

3.5. Test Setup Diagram



4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Cal Interval
EMI Test Receiver, 9kHz to 7GHz ¹	Rohde & Schwarz	ESR7	101156	10/26/2023	2 years
EMI Test Receiver, 10 Hz to 7GHz ¹	Rohde & Schwarz	ESR7	101770	7/23/2023	2 years
Spectrum Analyzer 20 Hz to 40 GHz ²	Rohde & Schwarz	FSV40	100899	8/12/2022	2 years
Spectrum Analyzer 9 kHz to 40 GHz ³	Rohde & Schwarz	FSVR40	100909	9/18/2022	2 years
Preamp 100 MHz – 7 GHz	Miteq	AFS3-01000200-10-15P-4	988773	1/9/2022	2 years
Preamplifier 100 MHz to 18 GHz	Miteq	AMF-7D-00101800-30-10P	1953081	1/6/2022	2 years
Bilog Antenna 30 to 2000 MHz	Com-Power	AC-220	25509	12/13/2022	3 years
Horn Antenna 960 MHz to 18 GHz	ETS-Lindgren	3117	00227631	12/4/2022	3 years
Barometric Pressure / Humidity / Temperature Data Logger	Extech Instruments	SD700	Q590483	10/14/2022	1 year

¹ ESR7 Firmware revision: V3.48 SP3, Date installed: 09/30/2020

Previous V3.48 SP2, installed 07/23/2020.

² FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016

Previous V2.30 SP1, installed 10/22/2014.

³ FSVR40 Firmware revision: V2.23 SP1, Date installed: 08/19/2016

Previous V2.23, installed 10/22/2014.

4.2. Measurement & Equipment Setup

Test Date:	11/10/2021, 11/16/2021, 1/12/2022, 3/3/2022, 4/27/2022
Test Engineer:	Sean Defelice, Larry Stillings
Normal Site Temperature (15 - 35°C):	19.0
Relative Humidity (20 - 75%RH):	47
Frequency Range:	30 MHz to 5 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	120 kHz - 30 MHz to 960 MHz 1 MHz - Above 960 MHz
EMI Receiver Avg Bandwidth:	≥ 3 * RBW or IF(BW)
Detector Function:	Peak, Quasi-Peak, EMI Average and RMS Average

4. Measurements Parameters (continued)

4.3. Measurement Procedures

Test measurements were made in accordance FCC Part 15.509, 15.521, ISED RSS-220 Issue I, RSS-Gen, Issue 5, ANSI C63.10:2013 Clause 10 and KDB Publication 393764 D01 UWB FAG v01, dated July 31, 2015.

The test methods used to generate the data in this test report is in accordance with ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

In accordance with ANSI C63.10:2013, Section 10.2.2, the device under test was placed on a bed of dry sand and rotated through 16 azimuth angles (per Clause 5.4) to determine which produced the highest emission relative to the limit. The azimuth that produced the highest emission relative to the limit was used for all radiated emission measurements.

4.4. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency (out of band)	$\pm 1 \times 10^{-8}$
Radiated Emission of Transmitter to 10 GHz	± 4.55 dB
Radiated Emission of Receiver	± 4.55 dB
Temperature	$\pm 0.91^\circ$ C
Humidity	$\pm 5\%$

5. Measurements Summary

Test Requirement	FCC Rule Requirement	ISED Rule Requirement	Test Report Section	Result	Comment
Antenna Requirement	15.203	RSS-GEN	6.1	Compliant	The antenna is housed within a sealed enclosure with the intentional radiator.
Operational Requirements	15.509 (b)	RSS-220 6.2	6.2	Compliant	
Additional Operational Requirements	N/A	RSS-220 6.2.1(b)	6.2.1	Compliant	The notebook computer software controls the on and off functions of the UWB signal
UWB Bandwidth	15.503 (a) 15.509 (a)	RSS-220 6.2.1 (a)	6.3	Compliant	
Spurious Radiated Emissions	15.509 (d) 15.209	RSS-220 3.4, 6.2.1 (c) (d)	6.4	Compliant	
Radiated Emissions in GPS Bands	15.509 (e) 15.209	RSS-220 6.2.1 (e)	6.5	Compliant	
Peak Emissions in a 50 MHz Bandwidth	15.509 (f)	RSS-220 (g)	6.6	Compliant	
Conducted Emissions	15.207	RSS-GEN	6.7	Compliant	
Radio Frequency Exposure	FCC OET Bulletin 65	RSS-102 Issue 5	6.8	Compliant	
99% Emissions Bandwidth	N/A	RSS-GEN 6.7	6.9	Compliant	

6. Measurement Data

6.1. Antenna Requirement (15.203, RSS-GEN)

Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply

Result: The antenna utilized by the device under test is an internal, non-user replaceable unit.

6.2. Operational Requirements of the Device under Test (15.509(b), RSS-220 6.2)

Requirement: Operation under the provisions of this section is limited to GPRs and wall imaging systems operated for the purposes with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction.

Result: The manufacturer states that the device under test will be used in compliance with the requirements outlined in section FCC Part 15.509 (b) and RSS-220 6.2.

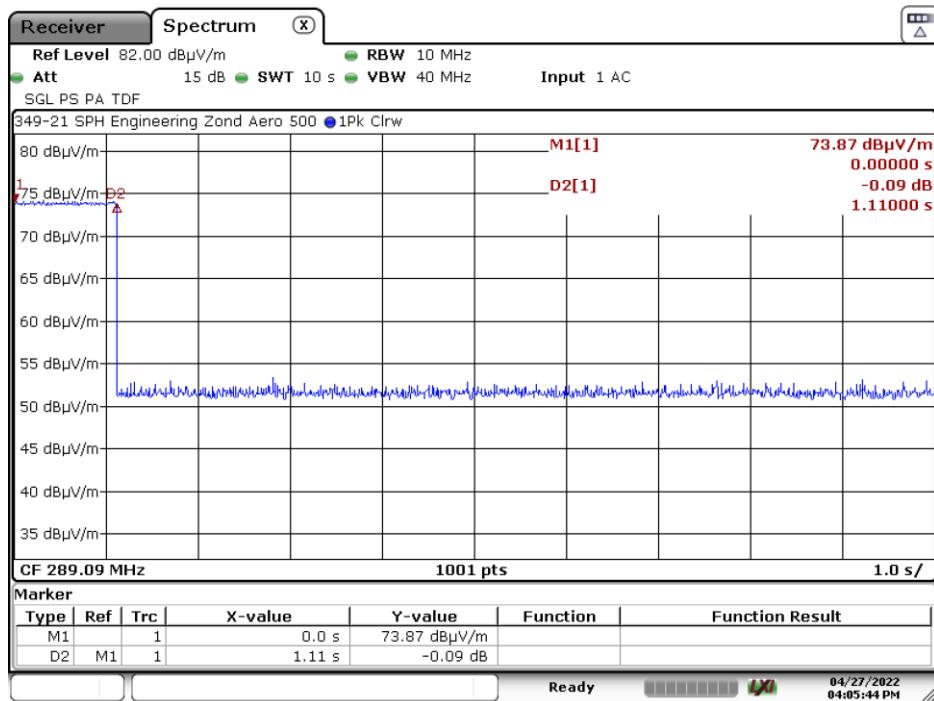
6. Measurement Data (continued)

6.2.1 Additional Operational Requirements RSS-220 6.2.1 (b)

Requirement: A device operating under the provisions of this section shall contain a mechanism that deactivates the equipment when normal use is interrupted. For manually operated hand-held devices, this mechanism shall contain a manual switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. In lieu of remotely/computer-controlled equipment with a switch located on the radar imaging device, it is permissible to operate the device by a remote-control unit provided that deactivation takes place within 10 seconds of the remote switch being released by the operator.

Result: Compliant. The software used with the GPR device immediately stops the UWB transmission when the stop button is selected. The device also contains a manual power on-off switch which immediately disables the unit from transmitting.

6.2.1.1 Plot of Ceased Transmission



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Note: Technician pressed "STOP" via the software and the unit responded with ceasing transmission within a 1/2 second.

6. Measurement Data (continued)

6.3. UWB Bandwidth (15.503 (a), 15.509 (a), RSS-220 6.2.1(a))

Requirement: The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M . The center frequency f_C , equals $(f_H + f_L) / 2$. The fractional bandwidth equals $2 * (f_H - f_L) / (f_H + f_L)$.

Result: Compliant.

Requirement: The UWB bandwidth of an imaging system operating under the provisions of this section must be below 10.6 GHz.

Result: Compliant.

6. Measurement Data (continued)

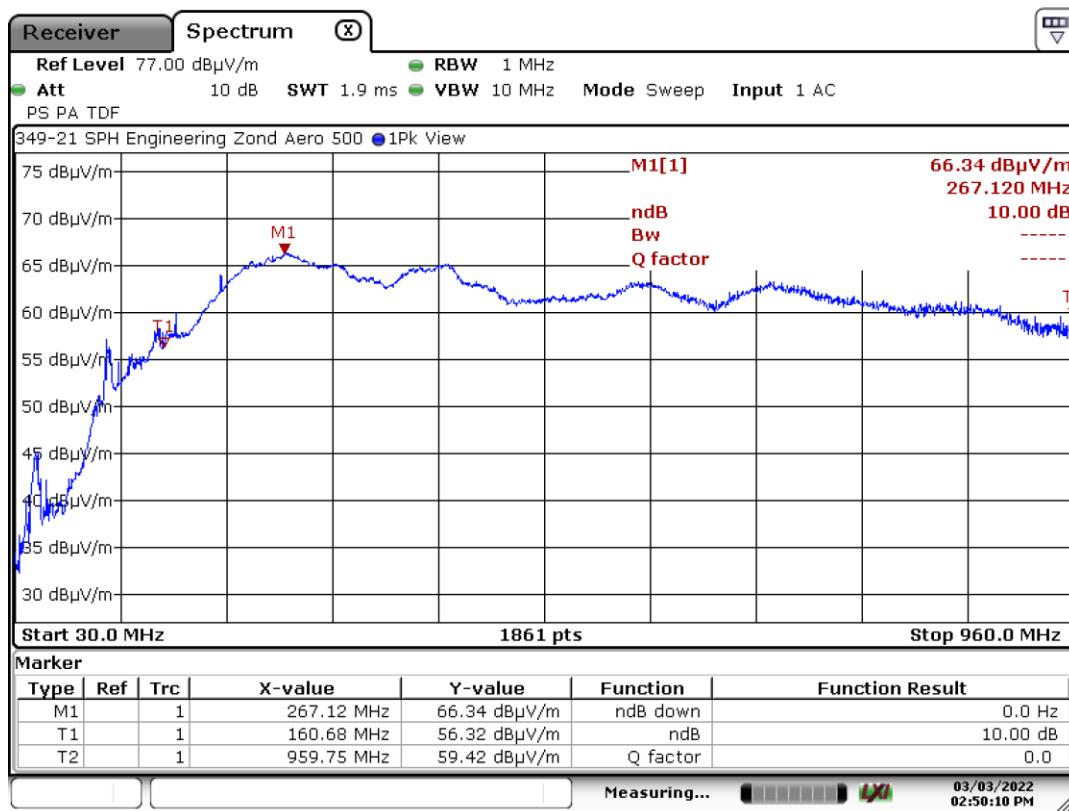
6.3. UWB Bandwidth (15.503 (a), 15.509 (a), RSS-220 6.2.1 (a) continued)

6.3.1. Measurement Data (Values in GHz)

f_M	The highest emission peak	0.26712
f_L	10 dB below the highest peak	0.16068
f_H	10 dB above the highest peak	0.95975
f_C	Calculated: $(f_H + f_L)/2$	0.56022
Bandwidth	Calculated: $(f_H - f_L)$	0.79907
Fractional BW	Calculated: $2*(f_H - f_L)/(f_H + f_L)$	1.42636

Note: The Fraction Bandwidth is greater than 0.2 and therefore the minimum UWB Bandwidth of 500 MHz requirement does not need to be met.

6.3.2. Measurement Plot of 10 BW in Anechoic Chamber = 799.07 MHz



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6. Measurement Data (continued)
6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 6.2.1 (d))

Requirement: The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz. Limits are converted from EIRP (dBm) to field strength at 3 meters using a conversion factor of 95.2.

Frequency (MHz)	EIRP (dBm)	Field Strength (dB μ V/m)
960 - 1610	-65.3	29.9
1610 - 1990	-53.3	41.9
1990 - 3100	-51.3	43.9
3100 - 10600	-41.3	53.9
Above 10600	-51.3	43.9

Radiated Emissions Field Strength Limits at 3 Meters (Section 15.209, RSS-220 3.4)

Frequency (MHz)	Field Strength (dB μ V/m)
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0

Test Notes: Refer to Section 4.1 for the test equipment used and Section 4.2 for the test equipment setups.

Sample Calculation: Final Result (dB μ V/m) = Measurement Value (dB μ V) + Antenna Factor (dB/m) + Cable Loss (dB) – Pre-amplifier Gain (dB) Internal or External.

Note: All correction factors are loaded into the measurement instrument prior to testing to determine the final result.

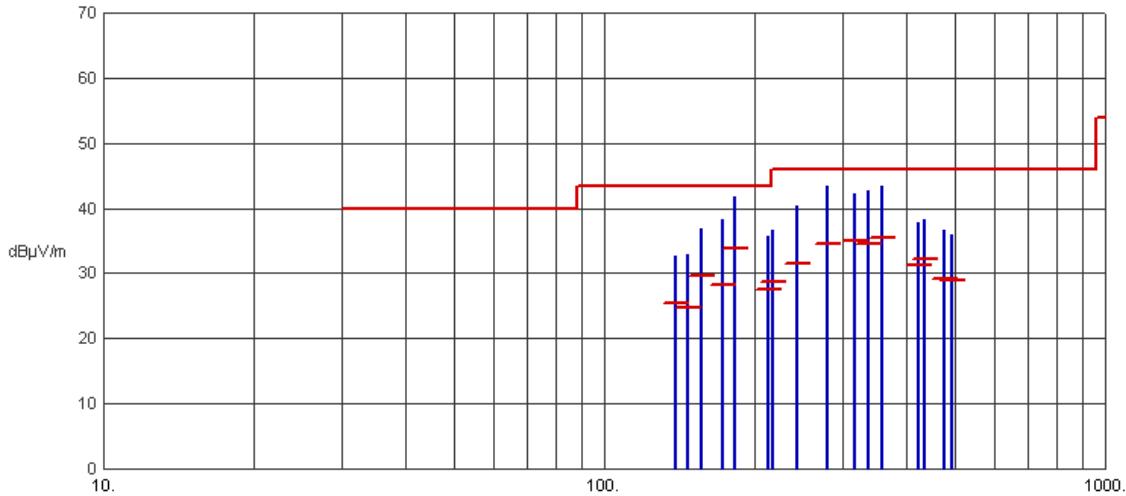
Test Number: 349-21R3
Issue Date: 4/29/2022

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued, RSS-220 3.4)

6.4.1. 30 MHz to 960 MHz, Horizontal Polarity

Test No.: 349-21, Radiated Emissions - Horizontal Polarity FCC, Class B



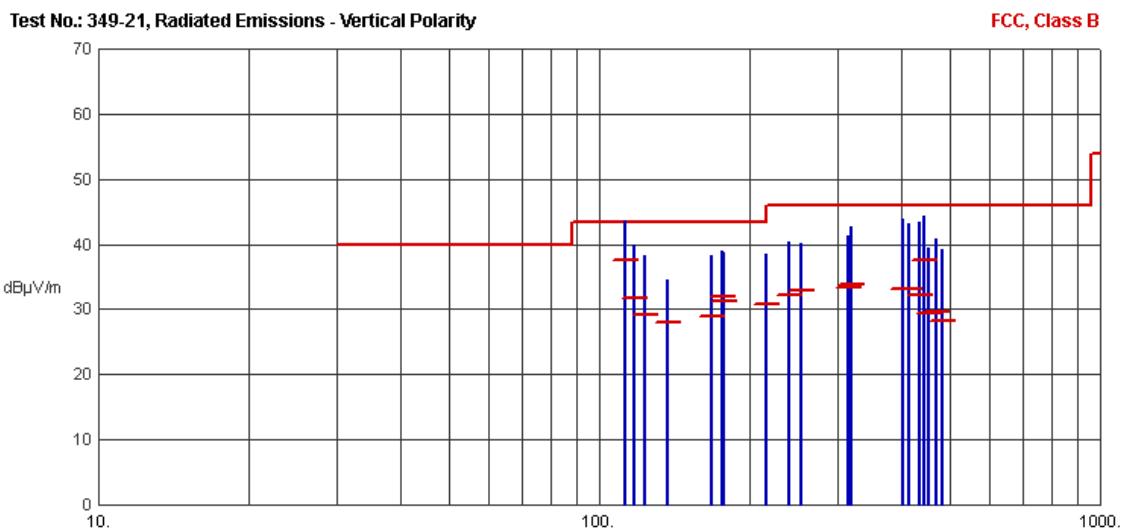
Frequency (MHz)	Pk Amp (dB μ V/m)	QP Amp (dB μ V/m)	QP Limit (dB μ V/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
139.1100	32.71	25.40	43.50	-18.10	N/A	N/A	
147.0600	33.01	24.79	43.50	-18.71	N/A	N/A	
156.7200	36.76	29.68	43.50	-13.82	N/A	N/A	
171.8100	38.38	28.32	43.50	-15.18	N/A	N/A	
181.8000	41.67	33.74	43.50	-9.76	N/A	N/A	
212.2300	35.78	27.45	43.50	-16.05	N/A	N/A	
216.4600	36.56	28.61	46.00	-17.39	N/A	N/A	
242.2600	40.45	31.51	46.00	-14.49	N/A	N/A	
279.2200	43.46	34.42	46.00	-11.58	N/A	N/A	
315.8200	42.21	34.90	46.00	-11.10	N/A	N/A	
336.2200	42.67	34.56	46.00	-11.44	N/A	N/A	
357.3700	43.30	35.38	46.00	-10.62	N/A	N/A	
425.2000	37.82	31.19	46.00	-14.81	N/A	N/A	
437.0500	38.16	32.30	46.00	-13.70	N/A	N/A	
477.9600	36.70	29.19	46.00	-16.81	N/A	N/A	
494.7900	36.00	28.92	46.00	-17.08	N/A	N/A	

Test Number: 349-21R3
Issue Date: 4/29/2022

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued, RSS-220 3.4)

6.4.2. 30 MHz to 960 MHz, Vertical Polarity



Frequency (MHz)	Pk Amp (dB μ V/m)	QP Amp (dB μ V/m)	QP Limit (dB μ V/m)	Margin (dB)	Ant Ht (cm)	Table (Deg)	Comments
112.8300	43.73	37.68	43.50	-5.82	N/A	N/A	
117.6300	40.01	31.70	43.50	-11.80	N/A	N/A	
122.9400	38.21	29.20	43.50	-14.30	N/A	N/A	
137.1600	34.45	27.94	43.50	-15.56	N/A	N/A	
167.7000	38.28	29.04	43.50	-14.46	N/A	N/A	
175.4100	39.05	31.91	43.50	-11.59	N/A	N/A	
177.4800	38.74	31.17	43.50	-12.33	N/A	N/A	
214.9900	38.40	30.81	43.50	-12.69	N/A	N/A	
239.0500	40.29	32.26	46.00	-13.74	N/A	N/A	
253.4200	40.18	32.95	46.00	-13.05	N/A	N/A	
314.2000	41.23	33.29	46.00	-12.71	N/A	N/A	
319.5400	42.75	33.90	46.00	-12.10	N/A	N/A	
404.2000	43.78	33.19	46.00	-12.81	N/A	N/A	
415.2100	43.22	33.15	46.00	-12.85	N/A	N/A	
435.3100	43.30	32.22	46.00	-13.78	N/A	N/A	
444.1000	44.27	37.59	46.00	-8.41	N/A	N/A	
456.0300	39.42	29.46	46.00	-16.54	N/A	N/A	
469.8000	40.87	29.68	46.00	-16.32	N/A	N/A	
483.4800	39.18	28.31	46.00	-17.69	N/A	N/A	

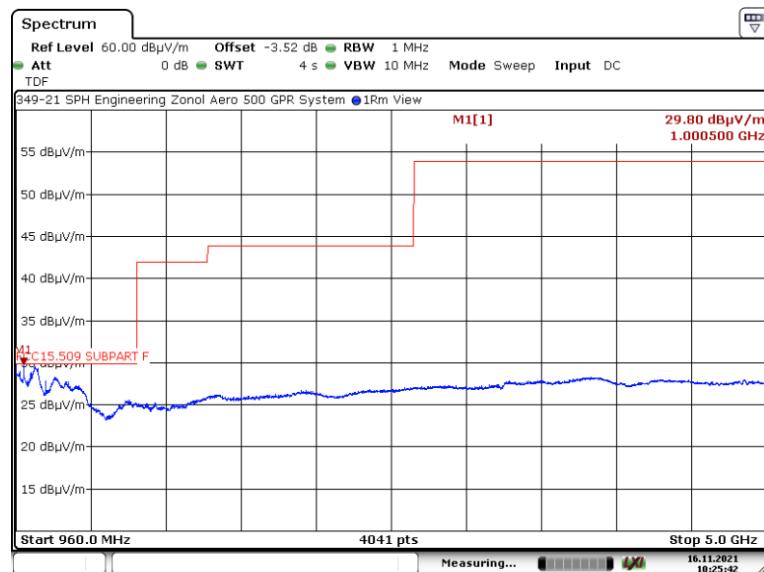
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Issue Date: 4/29/2022

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), RSS-220 6.2.1 (d))

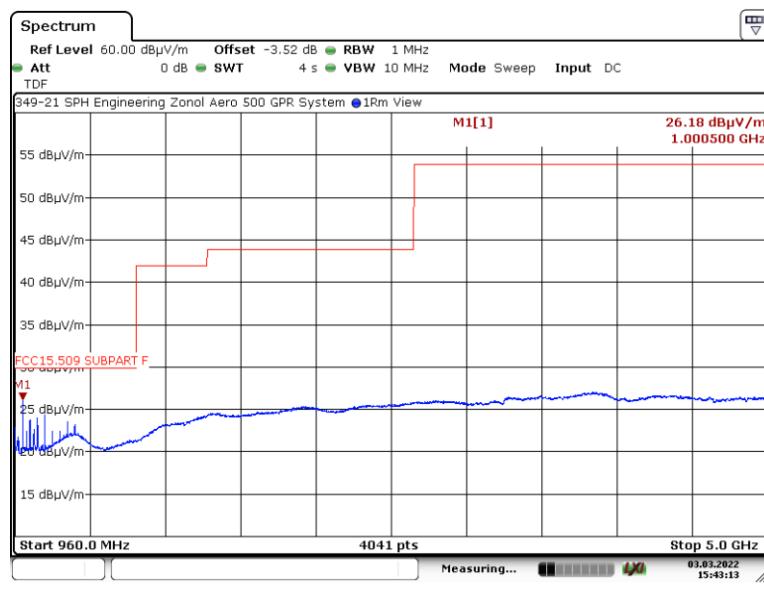
6.4.5. 960 MHz to 5 GHz at 2 meters

6.4.5.1 Plot of RMS Power 960 to 1960 MHz Horizontal Polarity UWB on



Date: 16.NOV.2021 10:25:42

6.4.5.2 Plot of RMS Power 960 to 1960 MHz Horizontal Polarity UWB off



Date: 03.MAR.2022 15:43:13

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector.
Narrowband digital signals are not subjected to the 15.509 Limit and only need to comply with the 15.209 limits.

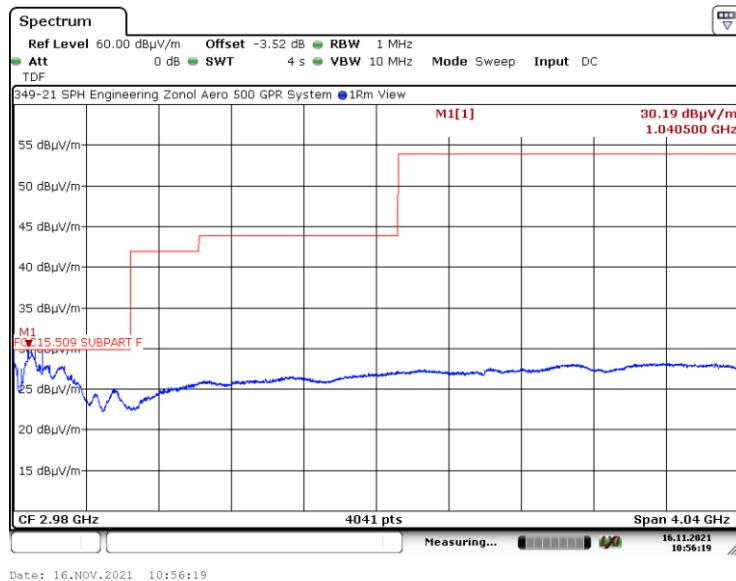
Test Number: 349-21R3
Issue Date: 4/29/2022

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), RSS-220 6.2.1 (d))

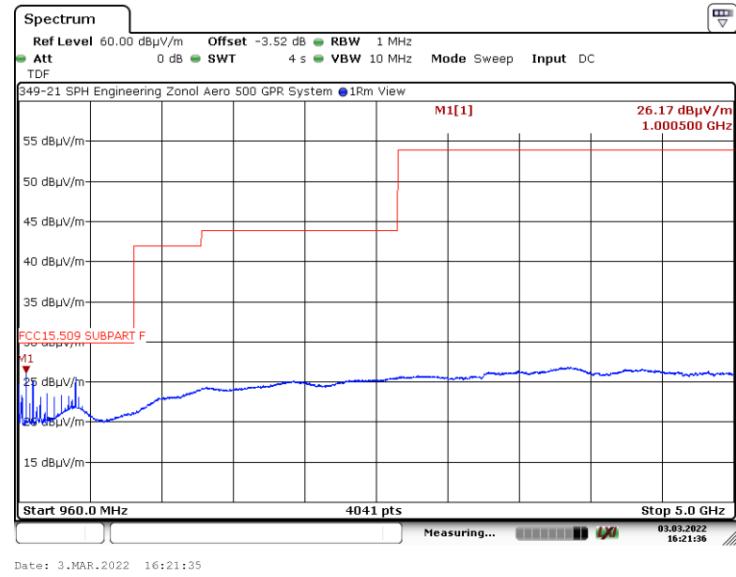
6.4.5. 960 MHz to 5 GHz at 2 meters

6.4.5.3 Plot of RMS Power 960 to 1960 MHz Vertical Polarity UWB on



Date: 16.NOV.2021 10:56:19

6.4.5.4 Plot of RMS Power 960 to 1960 MHz Vertical Polarity UWB off



Date: 3.MAR.2022 16:21:35

Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector. There were no measurable signals above 1.96 GHz.

Narrowband digital signals are not subjected to the 15.509 Limit and only need to comply with the 15.209 limits.

6. Measurement Data (continued)**6.5. Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2.1 (e))**

Requirement: In addition to the radiated emission limits specified in the table in paragraph (d) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP (dBm)	Field Strength (dB μ V/m) at 3 Meters
1164 - 1240	-75.3	19.9
1559 - 1610	-75.3	19.9

6.5.1. Measurement & Equipment Setup

EMI Receiver IF Bandwidth: 1 kHz
EMI Receiver Avg Bandwidth: 10 kHz
Detector Function: RMS Average, 1mS/point

6.5.2. Test Procedure

Test measurements were made in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

6.5.3. 1164 to 1240 MHz & 1559 to 1610 MHz

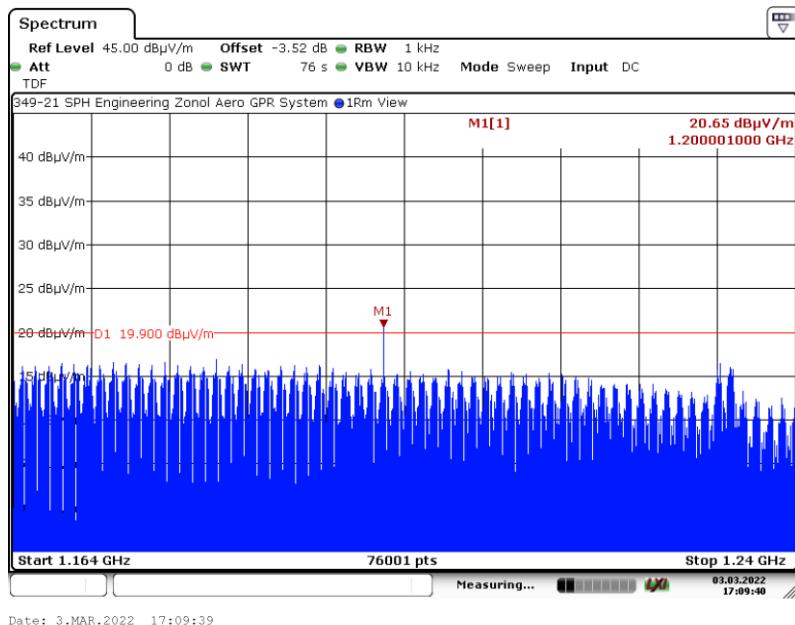
There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. The -75.3 dBm limit was converted to a field strength limit of 19.9 dB μ V/m using a distance correction factor of 95.2 at 3 meters.

Note: Narrowband digital signals are not subjected to the 15.509 Limit and only need to comply with the 15.209 limits.

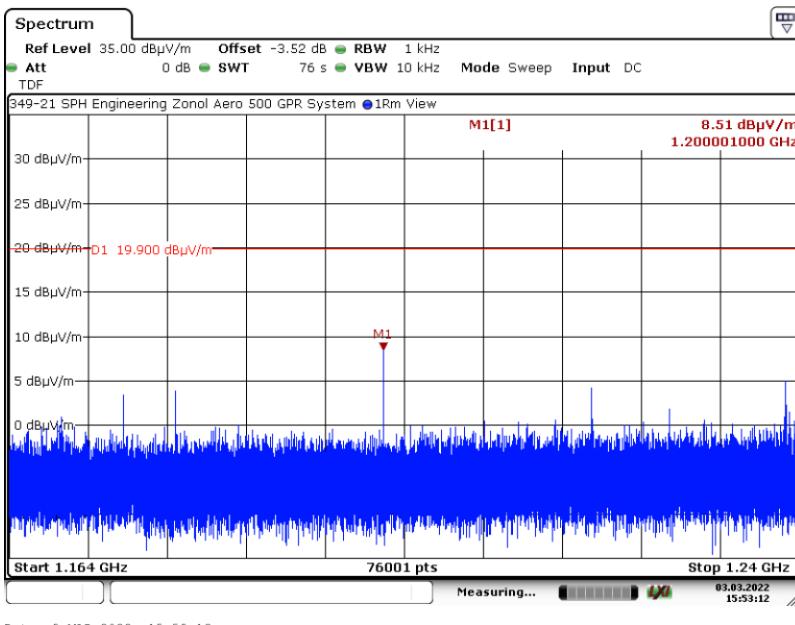
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2.1(e) cont)

6.5.4.1 1164 to 1240 MHz – Horizontal UWB on



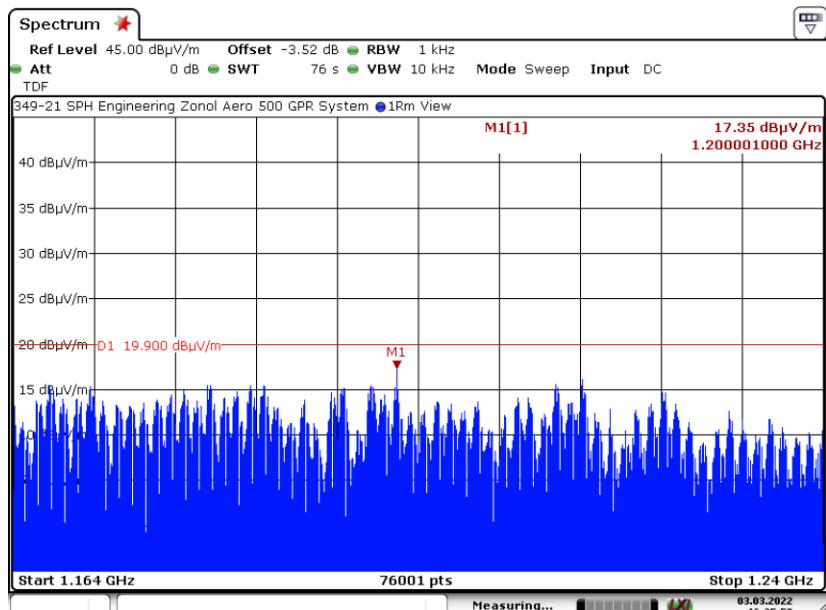
6.5.4.2 1164 to 1240 MHz – Horizontal UWB off



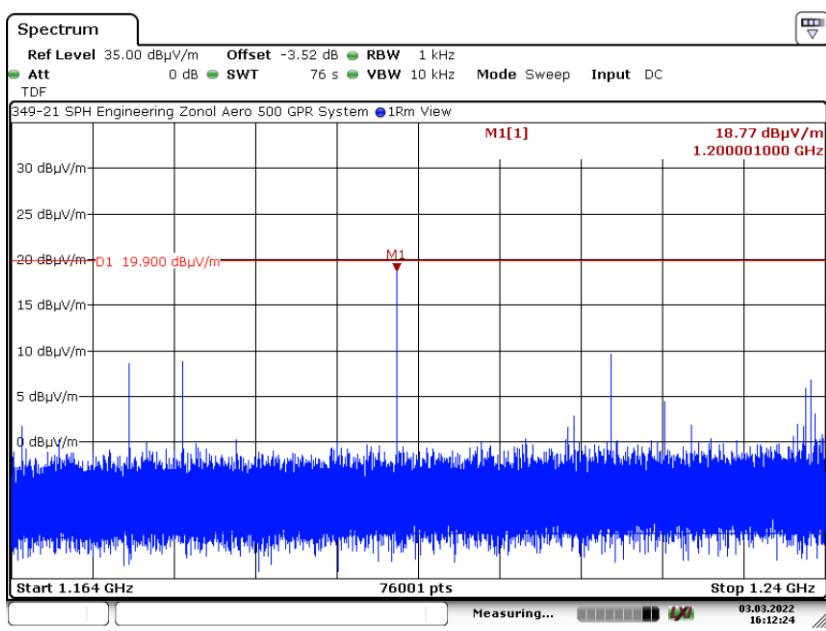
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2.1 (e) cont)

6.5.4.3 1164 to 1240 MHz – Vertical UWB on



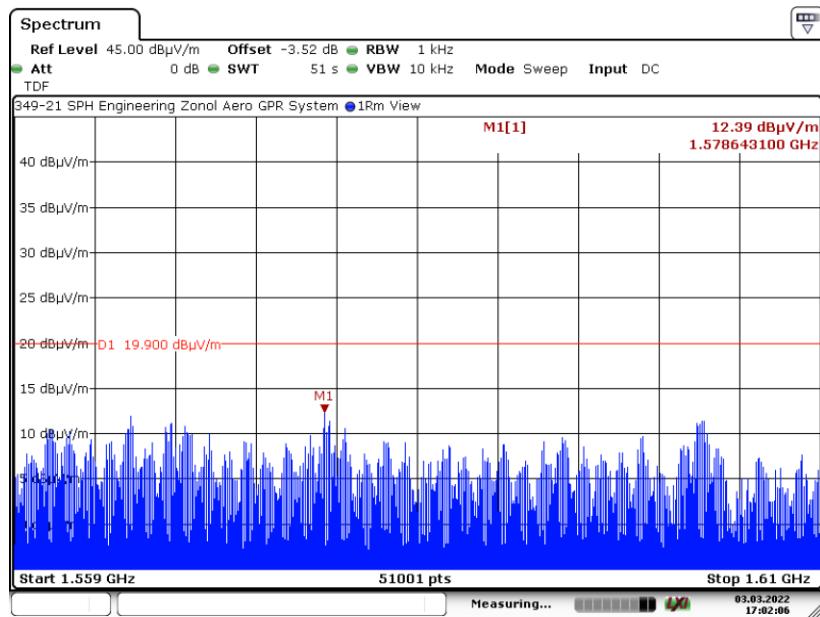
6.5.4.4 1164 to 1240 MHz – Vertical UWB off



6. Measurement Data (continued)

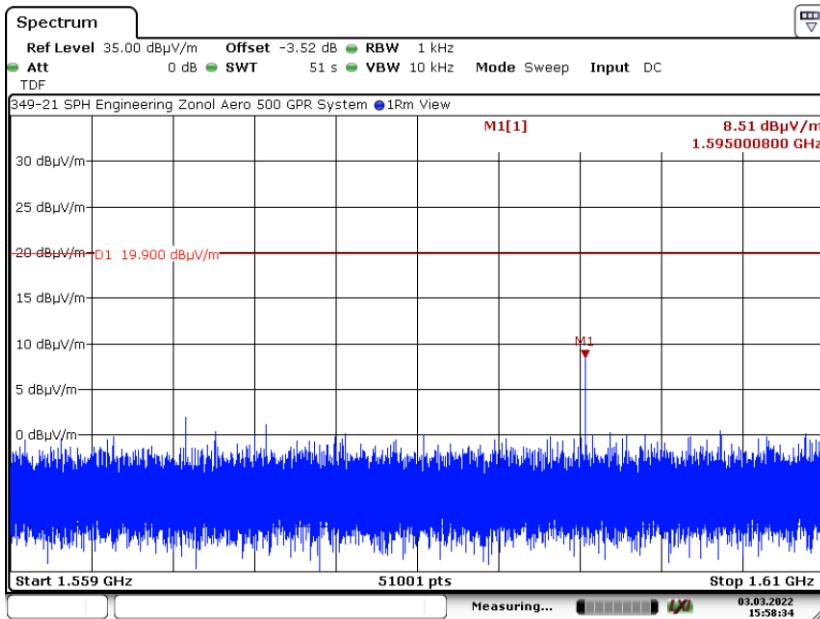
6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2.1 (e) cont)

6.5.4.5 1559 to 1610 MHz – Horizontal UWB on



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6.5.4.6 1559 to 1610 MHz – Horizontal UWB off

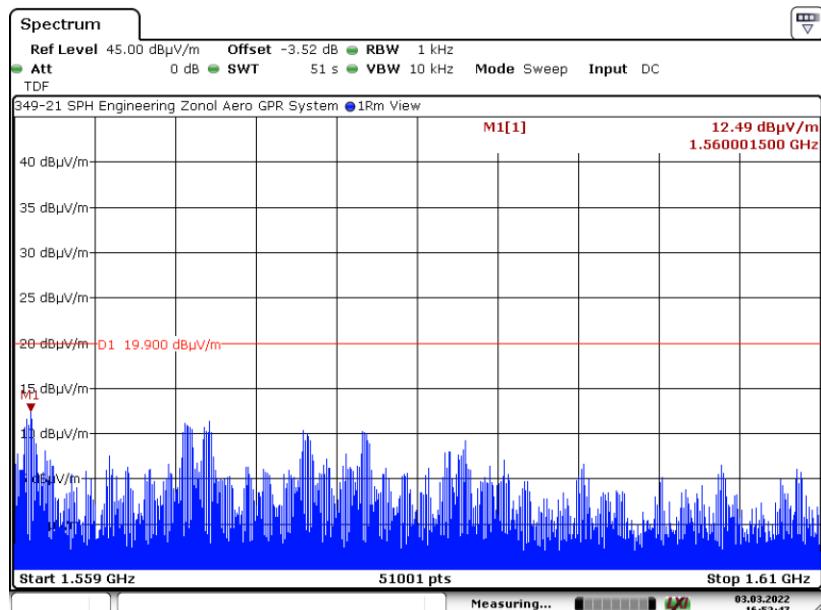


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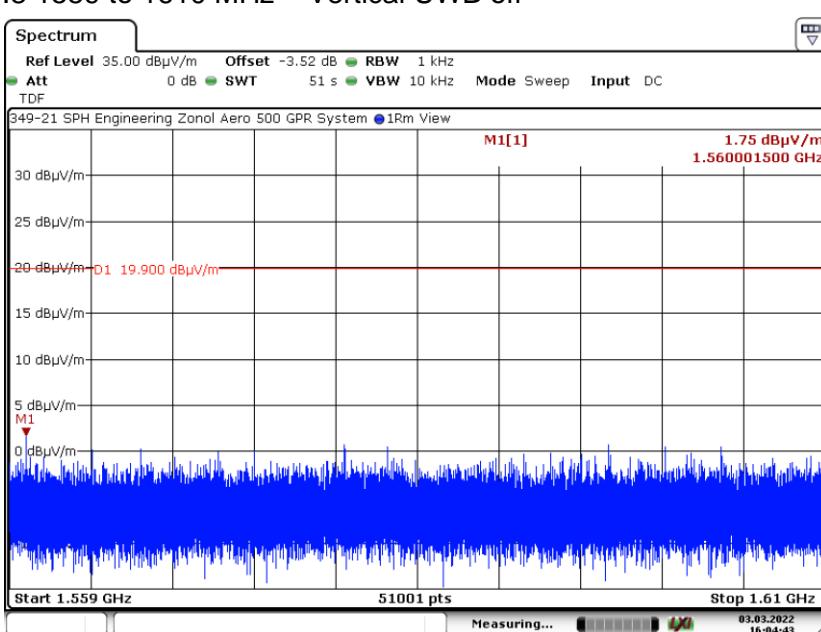
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2.1 (e) cont)

6.5.4.7 1559 to 1610 MHz – Vertical UWB on



6.5.4.8 1559 to 1610 MHz – Vertical UWB off



6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f), RSS-220 6.2.1 (g))

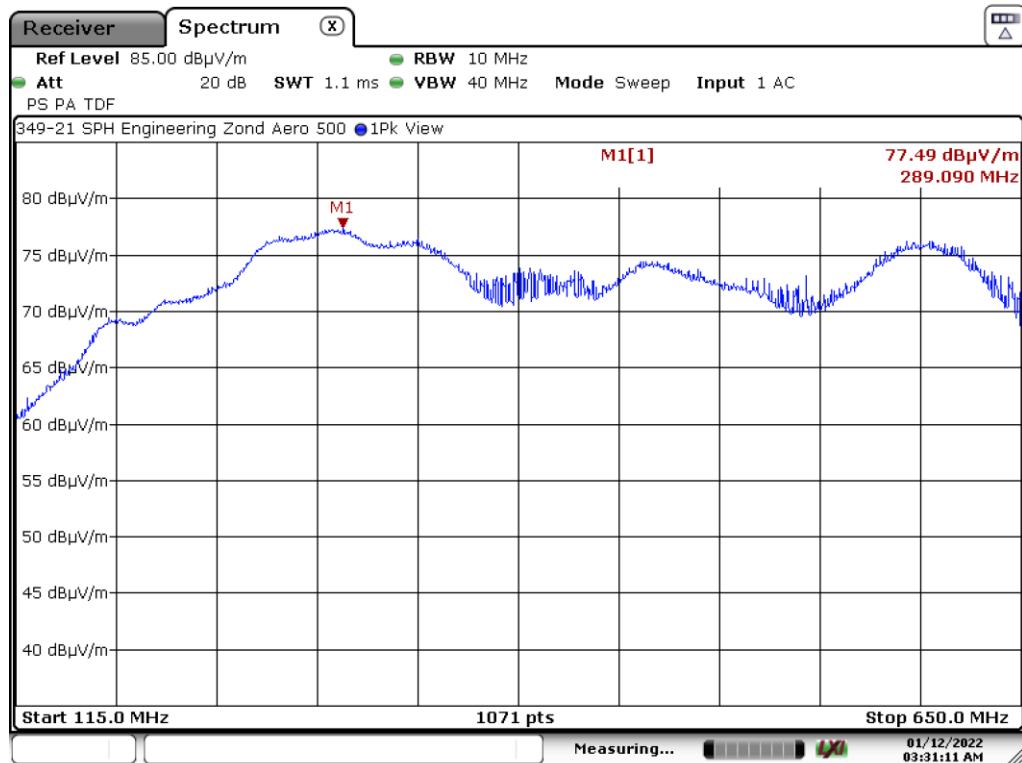
Requirement: For UWB devices where the frequency at which the highest radiated emissions occurs, f_M , is above 960 MHz, there is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency f_M . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in Section 15.521.

The 0 dBm EIRP limit is equivalent to a field strength limit of 95.2 dB μ V/m at 3 meters per 15.521 (g).

The measured peak field strength is 77.49 dB μ V/m using a 10 MHz RBW. The correction factor for RBW is $20 * \log (10 / 50) = -13.98$ dB, resulting in a peak field strength of 91.47 dB μ V/m in a 50 MHz RBW against the 95.2 dB μ V/m limit. Equivalent to -3.73 dBm EIRP

Result: Compliant, for reference only as there is no peak limit below 960 MHz.

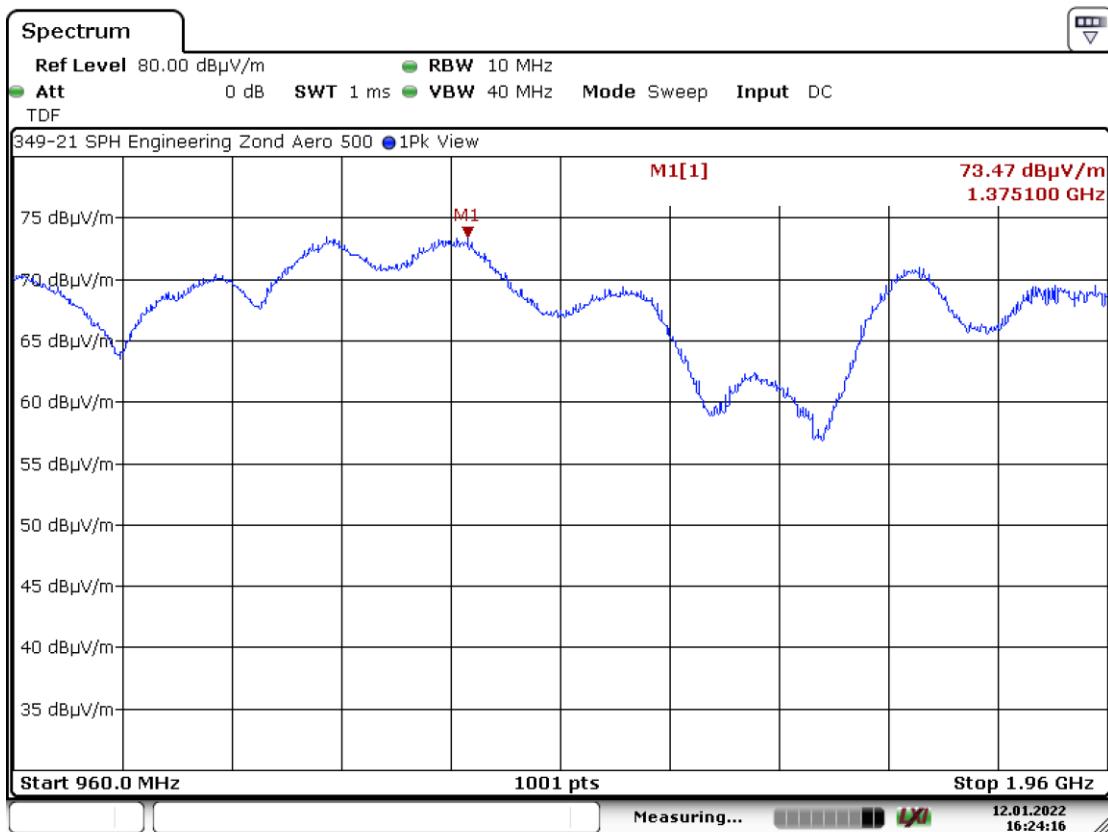
6.6.1 Plot of Peak Power below 960 MHz



6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f), RSS-220 6.2.1 (g) continued)

6.6.2 Plot of Peak Power above 960 MHz = 73.47 dB μ V/m in 10 MHz RBW



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Note: This peak power is not where the highest radiation occurs for this device (f_m) and is only used to demonstrate that fact.

The measured peak field strength is 73.47 dB μ V/m using a 10 MHz A correction factor for RBW is $20 * \log (10 / 50) = -13.98$ dB, resulting in a peak field strength of 87.45 dB μ V/m in a 50 MHz RBW against the 95.2 dB μ V/m limit. Equivalent to -7.75 dBm EIRP

6. Measurement Data (continued)

6.7. Conducted Emissions, Regulatory Limit: FCC Part 15.209, RSS-GEN

Frequency Range (MHz)	Limits (dB μ V)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

6.7.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due
EMI Receiver	Rohde & Schwarz	ESR7	101156	10/26/2023
LISN	EMCO	3825/2	9109-1860	1/4/2023

6.7.2. Measurement & Equipment Setup

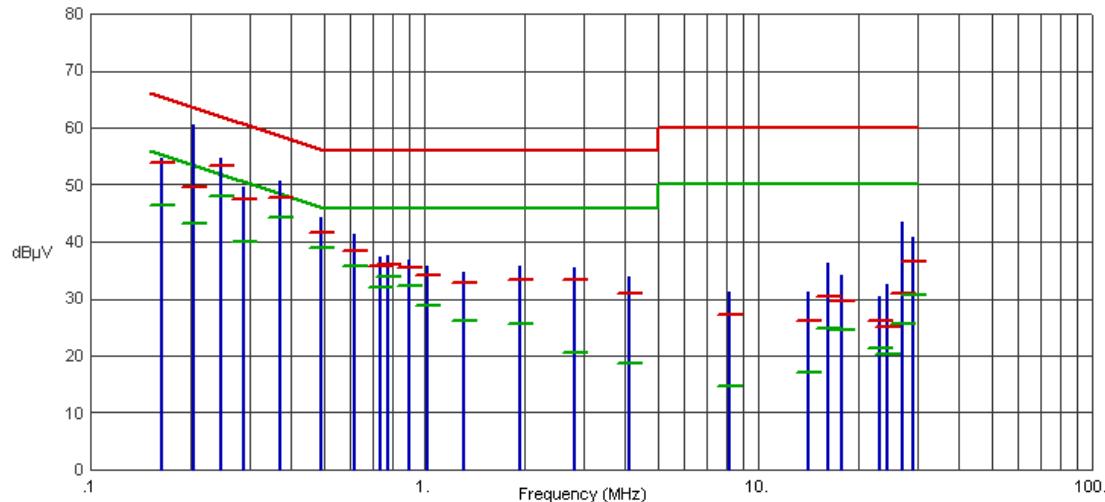
Test Date:	10/13/2021
Test Engineer:	Sean Defilice
Site Temperature (°C):	22.0
Relative Humidity (%RH):	51
Frequency Range:	0.15 MHz to 30 MHz
EMI Receiver IF Bandwidth:	9 kHz
EMI Receiver Avg Bandwidth:	≥ 3 * RBW or IF(BW)
Detector Functions:	Peak, Quasi-Peak. & Average

6.7.3. Test Procedure

Test measurements were made in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

Sample Calculation: Final Result (dB μ V) = Measurement Value (dB μ V) + LISN Factor (dB) + Cable Loss (dB).

Note: All correction factors are loaded into the measurement instrument prior to testing to determine the final result

6. Measurement Data (continued)
6.8. Conducted Emissions Test Results
6.8.1. 120 Volts, 60 Hz Phase
Test No.: 349-21, 120 Volts, 60 Hz Phase
FCC, Class B


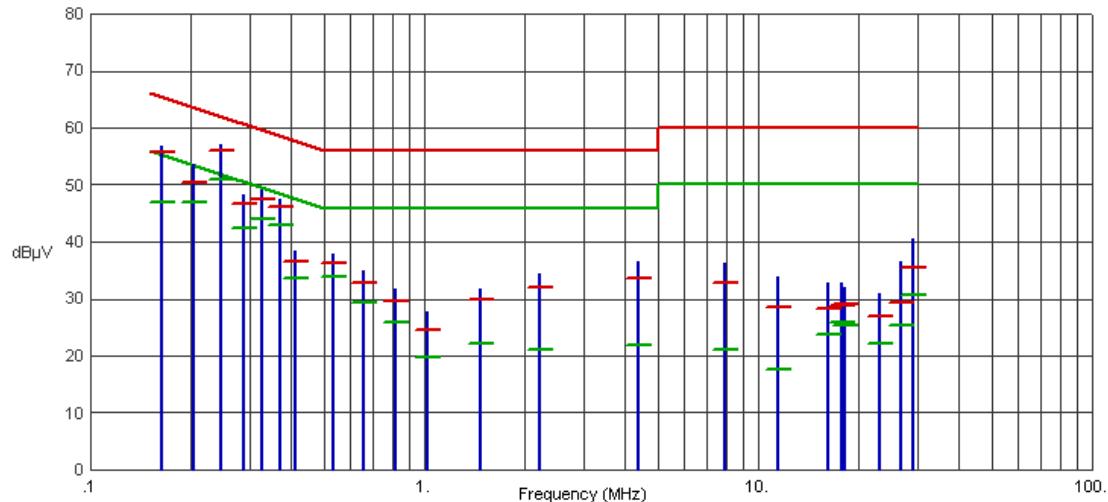
Frequency (MHz)	Pk Amp (dB μ V)	QP Amp (dB μ V)	QP Limit (dB μ V)	QP Margin (dB)	Avg Amp (dB μ V)	Avg Limit (dB μ V)	Avg Margin (dB)	Comments
.1635	54.66	53.77	65.28	-11.51	46.42	55.28	-8.86	
.2040	60.54	49.48	63.45	-13.97	43.25	53.45	-10.20	
.2468	54.59	53.22	61.86	-8.64	47.92	51.86	-3.94	
.2873	49.62	47.48	60.60	-13.12	40.10	50.60	-10.50	
.3683	50.75	47.73	58.54	-10.81	44.27	48.54	-4.27	
.4920	44.37	41.67	56.13	-14.46	38.95	46.13	-7.18	
.6158	41.36	38.36	56.00	-17.64	35.82	46.00	-10.18	
.7373	37.43	35.74	56.00	-20.26	32.03	46.00	-13.97	
.7778	37.66	36.13	56.00	-19.87	33.79	46.00	-12.21	
.9015	36.72	35.46	56.00	-20.54	32.39	46.00	-13.61	
1.0230	35.78	34.04	56.00	-21.96	28.77	46.00	-17.23	
1.3088	34.54	32.80	56.00	-23.20	26.02	46.00	-19.98	
1.9298	35.76	33.34	56.00	-22.66	25.50	46.00	-20.50	
2.8298	35.47	33.29	56.00	-22.71	20.53	46.00	-25.47	
4.1168	33.95	30.80	56.00	-25.20	18.75	46.00	-27.25	
8.2253	31.28	27.08	60.00	-32.92	14.72	50.00	-35.28	
14.1563	31.09	26.00	60.00	-34.00	17.01	50.00	-32.99	
16.2285	36.18	30.37	60.00	-29.63	24.73	50.00	-25.27	
17.6955	34.24	29.48	60.00	-30.52	24.63	50.00	-25.37	
23.1270	30.31	26.10	60.00	-33.90	21.44	50.00	-28.56	
24.3488	32.45	25.10	60.00	-34.90	20.29	50.00	-29.71	
27.1590	43.52	30.82	60.00	-29.18	25.70	50.00	-24.30	
29.2335	40.75	36.48	60.00	-23.52	30.74	50.00	-19.26	

Test Number: 349-21R3
Issue Date: 4/29/2022

6. Measurement Data (continued)

6.8. Conducted Emissions Test Results (continued)

6.8.2. 120 Volts, 60 Hz Neutral

Test No.: 349-21, 120 Volts, 60 Hz Neutral
FCC, Class B


Frequency (MHz)	Pk Amp (dB μ V)	QP Amp (dB μ V)	QP Limit (dB μ V)	QP Margin (dB)	Avg Amp (dB μ V)	Avg Limit (dB μ V)	Avg Margin (dB)	Comments
.1635	56.89	55.77	65.28	-9.51	46.85	55.28	-8.43	
.2040	53.53	50.37	63.45	-13.08	46.95	53.45	-6.50	
.2468	57.11	56.06	61.86	-5.80	50.95	51.86	-0.91	
.2873	48.35	46.77	60.60	-13.83	42.31	50.60	-8.29	
.3278	49.11	47.57	59.51	-11.94	43.87	49.51	-5.64	
.3683	47.34	46.04	58.54	-12.50	42.98	48.54	-5.56	
.4088	38.37	36.58	57.67	-21.09	33.62	47.67	-14.05	
.5325	37.95	36.19	56.00	-19.81	33.97	46.00	-12.03	
.6563	34.89	32.87	56.00	-23.13	29.36	46.00	-16.64	
.8205	31.76	29.70	56.00	-26.30	25.90	46.00	-20.10	
1.0230	27.79	24.64	56.00	-31.36	19.77	46.00	-26.23	
1.4775	31.86	29.77	56.00	-26.23	22.19	46.00	-23.81	
2.2178	34.41	32.08	56.00	-23.92	21.13	46.00	-24.87	
4.3688	36.44	33.58	56.00	-22.42	21.86	46.00	-24.14	
7.9508	36.29	32.78	60.00	-27.22	21.09	50.00	-28.91	
11.4315	33.82	28.63	60.00	-31.37	17.60	50.00	-32.40	
16.2285	32.68	28.27	60.00	-31.73	23.73	50.00	-26.27	
17.6933	32.73	28.91	60.00	-31.09	25.78	50.00	-24.22	
18.2423	32.10	29.00	60.00	-31.00	25.46	50.00	-24.54	
23.1270	31.01	26.86	60.00	-33.14	22.23	50.00	-27.77	
26.6078	36.51	29.28	60.00	-30.72	25.35	50.00	-24.65	
29.2335	40.56	35.54	60.00	-24.46	30.79	50.00	-19.21	

6. Measurement Data (continued)

6.9. Public Exposure to Radio Frequency Energy Levels (1.1307 (b)(1))

6.9.1. SAR Test Exclusion for UWB transmitter

Requirement: Portable devices are subject to radio frequency radiation exposure requirements as explained in FCC KDB 447498 D01 General RF Exposure Guidance v06, dated October 23, 2015.

For a 1-g SAR, the test exclusion result must be ≤ 3.0 and ≤ 7.5 for 10-g extremity SAR.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \frac{P_{\text{MAX}}}{d_{\text{MIN}}} \times \sqrt{f_{(\text{GHz})}} \quad (1)$$

P_{MAX} mW Maximum power of channel, including tune-up tolerance

d_{MIN} mm Minimum test separation distance, mm (≤ 50 mm)

$f_{(\text{GHz})}$ GHz $f_{(\text{GHz})}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz)

Power and distance are rounded to the nearest mW and mm before calculation

The result is rounded to one decimal place for comparison

The values 3.0 and 7.5 are referred to as numeric thresholds below

Per KDB 447498 Appendix A SAR Exclusion Threshold at 50 mm is 387 mW at 150 MHz, 274 mW at 300 MHz and 224 mW at 450 MHz.

Extremity SAR is 2.5 times this value or 968 mW at 150 MHz, 685 mW at 300 MHz and 560 mW at 450 MHz.

The Peak power for this device in a 50 MHz RBW from section 6.6 of this report is -3.73 dBm or 424 mW and therefore meets the SAR Test Exclusion.

Input:	P_{MAX}	0.424	mW
	d_{MIN}	50.00	mm
	$f_{(\text{GHz})}$	0.284	GHz
Test Exclusion:	0.00452		
Limit Exemption:	7.50		

6. Measurement Data (continued)**6.9. Public Exposure to Radio Frequency Energy Levels (RSS 102, Issue 5)****6.9.2. RSS-102 Issue 5 Requirements**

Requirement: SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1. Portable devices are subject to radio frequency radiation exposure requirements.

Test Notes: The limit was taken from Table 1 of RSS-102 Issue 5.

Frequency (MHz)	Separation Distance (mm)	Maximum Power (dBm)	Maximum Power (mW)	RSS-102 Limit (mW)	Result
284.00	≤5	-3.73	0.424	73.03	

6. Measurement Data (continued)

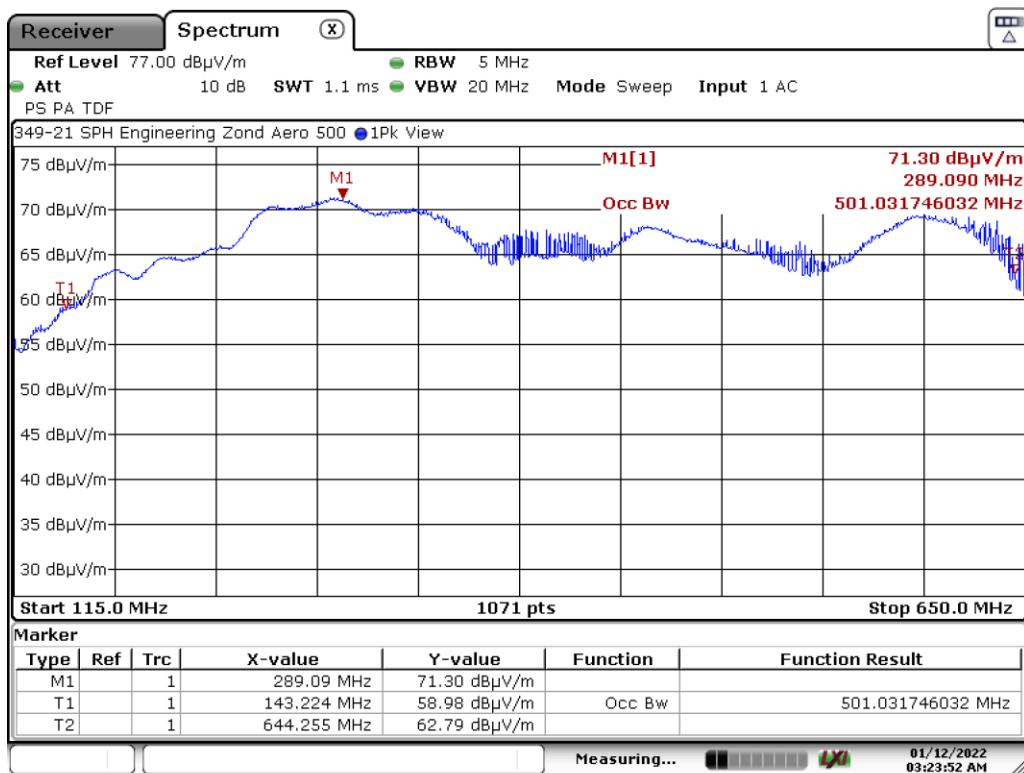
6.10. 99% Emission Bandwidth (RSS-GEN 6.7)

Requirement: The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs RSS-Gen, Section 6.7.

Test Note: The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

6.10.1 Plot of 99% Emission Bandwidth





Test Number: 349-21R3



Issue Date: 4/29/2022

7. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1**) and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

The radiated emissions test site for measurements above 1GHz is a 3 Meter open area test site (OATS) with a 3.6 by 3.6 meter anechoic absorber floor patch to achieve a quasi-free space measurement environment per ANSI C63.4/C63.10 and CISPR 16-1-4 standards.

The sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

Off the rear of the 10 Meter Enclosed Open Area Test Site a Sandpit has been added to accommodate the testing of Ground Penetrating Radar (GPR) products. The sand pit measures 12' (L) x 4' (W) x 4' (D) and is filled with 13.5 yards of dry concrete sand.

8. Test Images

8.1. Spurious Emissions – 30 MHz – 960 MHz Front



8. Test Images

8.2. Spurious Emissions – 30 MHz – 960 MHz Rear



8. Test Images

8.3. Spurious Emissions – 960 MHz – 5 GHz Front



8. Test Images

8.4. Spurious Emissions – 960 MHz – 5 GHz Rear



8. Test Images (continued)

8.5. Conducted Emissions, Front View



8. Test Images (continued)

8.6. Conducted Emissions, Rear View



8. Test Images (continued)

8.7. Radiated Emissions above 960 MHz in Semi-anechoic chamber, Front View

