

COMPLIANCE WORLDWIDE INC. TEST REPORT 221-19

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

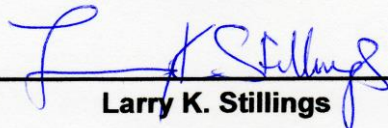
For the

Ground Penetrating Radar
Model: Zond-12e 500A

FCC ID: 2AUQQ-ZOND12E500A
IC: 25515-ZOND12E500A

Report Issued on September 3, 2019

Tested by



Larry K. Stillings

Reviewed By



Brian F. Breault

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1. Scope

This test report certifies that the SPH Engineering Zond-12e 500A, as tested, meets the FCC Part 15, Subpart F and ISSED 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.

2. Product Details

- 2.1. Manufacturer:** SPH Engineering SIA.
2.2. Model Number: Zond-12e 500A
2.3. Serial Number: Pre-production
2.4. Description: The Zond-12e 500A 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: N/A
2.8. Modulation Type: Pulse
2.9. Operating Frequency: 500 MHz, nominal
2.10. EMC Modifications: A 33 ohm resistor was placed across each of the bow-tie antenna elements.

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

3.2. EUT Hardware

Manufacturer	Model	Serial Number	Description/Function
SPH Engineering	Zond-12e 500A	Pre production	Ground Penetrating Radar

3.3. EUT Cables/Transducers

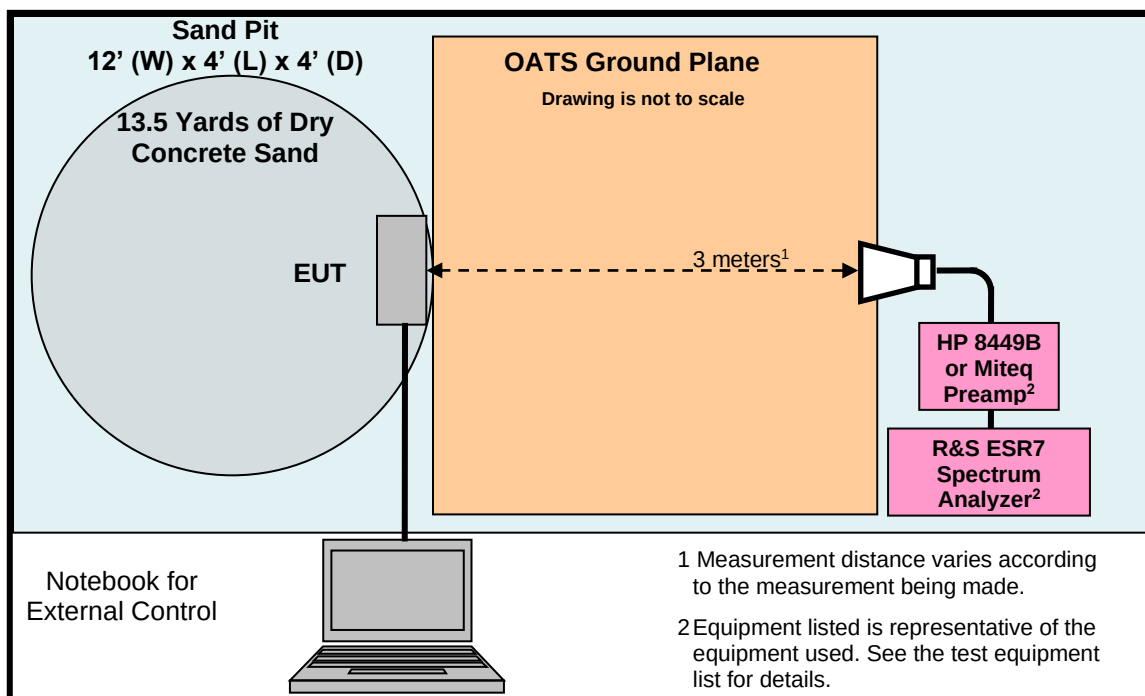
Manufacturer	Model/Part #	Length (m)	Shield Y/N	Description/Function
Any	Ethernet Cable	6	N	Cable from control notebook to GPR Antenna
Any	Power Cable	2M	N	Power Cable for Charger (conducted only)

3. Product Configuration (continued)

3.4. Support Equipment

Control System

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 - 7GHz	Rohde & Schwarz	ESR7	101156	9/10/2020	2 Years
Spectrum Analyzer	Rohde & Schwarz	FSV40	100899	9/10/2020	2 Years
Spectrum Analyzer 10 Hz to 40 GHz	Rohde & Schwarz	FSVR40	100909	5/3/2020	3 Years
Microwave Preamp	Hewlett Packard	8449B	3008A01323	9/11/2020	2 Years
Preamp 100 MHz – 7 GHz	Miteq	AFS3-01000200-10-15P-4	988773	4/17/2020	2 Years
Preamplifier 100 MHz to 18 GHz	Miteq	AMF-7D-00101800-30-10P	1953081	4/16/2020	2 Years
Bilog Antenna 30 to 2000 MHz	Com-Power	AC-220	25509	2/3/2021	3 Years
Horn Antenna 960 MHz to 18 GHz	Electro-Metrics	EM-6961	6337	10/3/2020	2 Years
Barometer – Temperature & Humidity	Control Company	4195	ID236	4/3/2020	2 Years

¹ ESR7 Firmware revision: V3.36, SP2 Date installed: 11/02/2017 Previous V3.36, installed 05/16/2017.
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 10/20/2014.

4.2. Measurement & Equipment Setup

Test Date: 8/30/2019, 9/3/2019, 9/23/2019

Test Engineer: Larry Stillings

Normal Site Temperature (15 - 35°C): 22.0

Relative Humidity (20 - 75%RH): 51

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: 300 kHz - 30 MHz to 960 MHz
3 MHz - Above 960 MHz

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, ISSED 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	Test Report Section	Result	Comment
Antenna Requirement	15.203	6.1	Compliant	The antenna is housed within a sealed enclosure with the intentional radiator.
Operational Requirements	15.509 (b)	6.2	Compliant	
UWB Bandwidth	15.503 (a) 15.509 (a)	6.3	Compliant	
Spurious Radiated Emissions	15.509 (d) 15.209	6.4	Compliant	
Radiated Emissions in GPS Bands	15.509 (e) 15.209	6.5	Compliant	
Peak Emissions in a 50 MHz Bandwidth	15.509 (f)	6.6	Compliant	
Conducted Emissions	15.207	6.7	Compliant	
Radio Frequency Exposure	FCC OET Bulletin 65	6.8	Compliant	

6. Measurement Data

6.1. Antenna Requirement (15.203)

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))

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 complies with the requirements outlined in section FCC Part 15.509 (b).

6.3. UWB Bandwidth (15.503 (a), 15.509 (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)

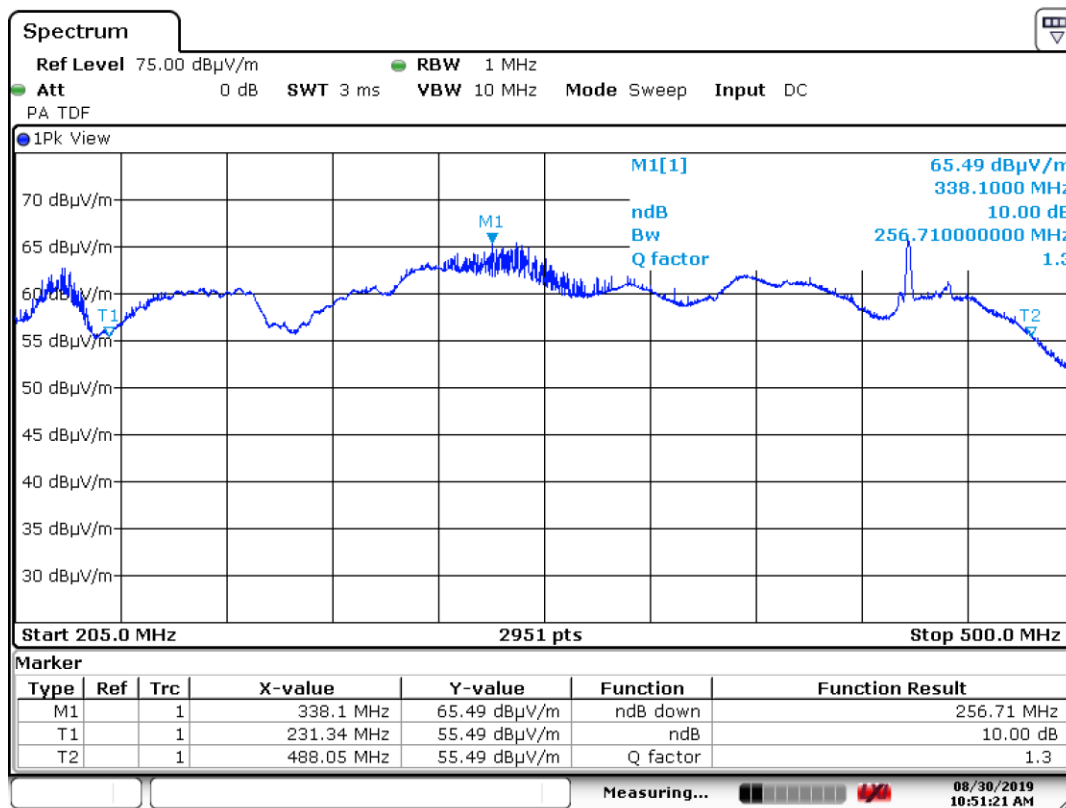
6.3. UWB Bandwidth (15.503 (a), 15.509 (a) continued)

6.3.1. Measurement Data (Values in GHz)

f_M	The highest emission peak	0.33810
f_L	10 dB below the highest peak	0.23124
f_H	10 dB above the highest peak	0.48805
f_C	Calculated: $(f_H + f_L)/2$	0.35965
Bandwidth	Calculated: $(f_H - f_L)$	0.25681
Fractional BW	Calculated: $2*(f_H - f_L)/(f_H + f_L)$	0.71407

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 on GPR Site = 350.3 MHz



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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209)

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 (dBμV/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)

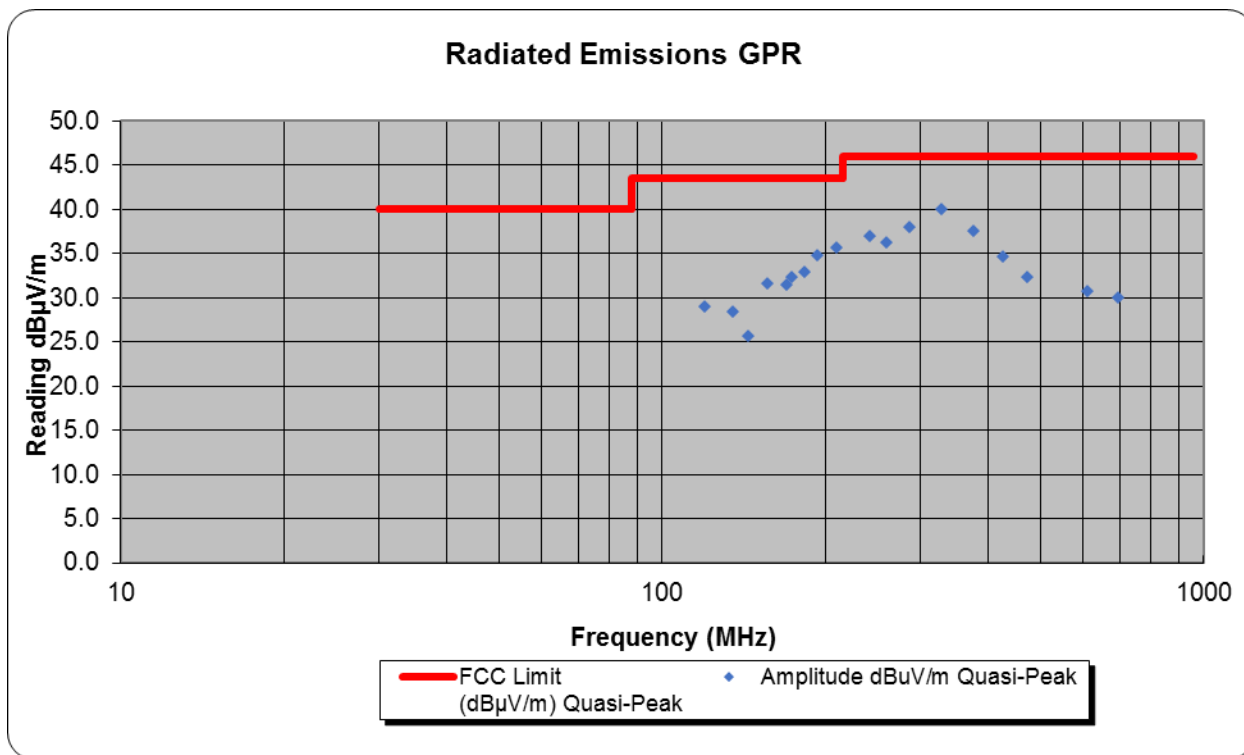
Frequency (MHz)	Field Strength (dBμV/m)
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0

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

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.1. 30 MHz to 960 MHz, Horizontal Plot



6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

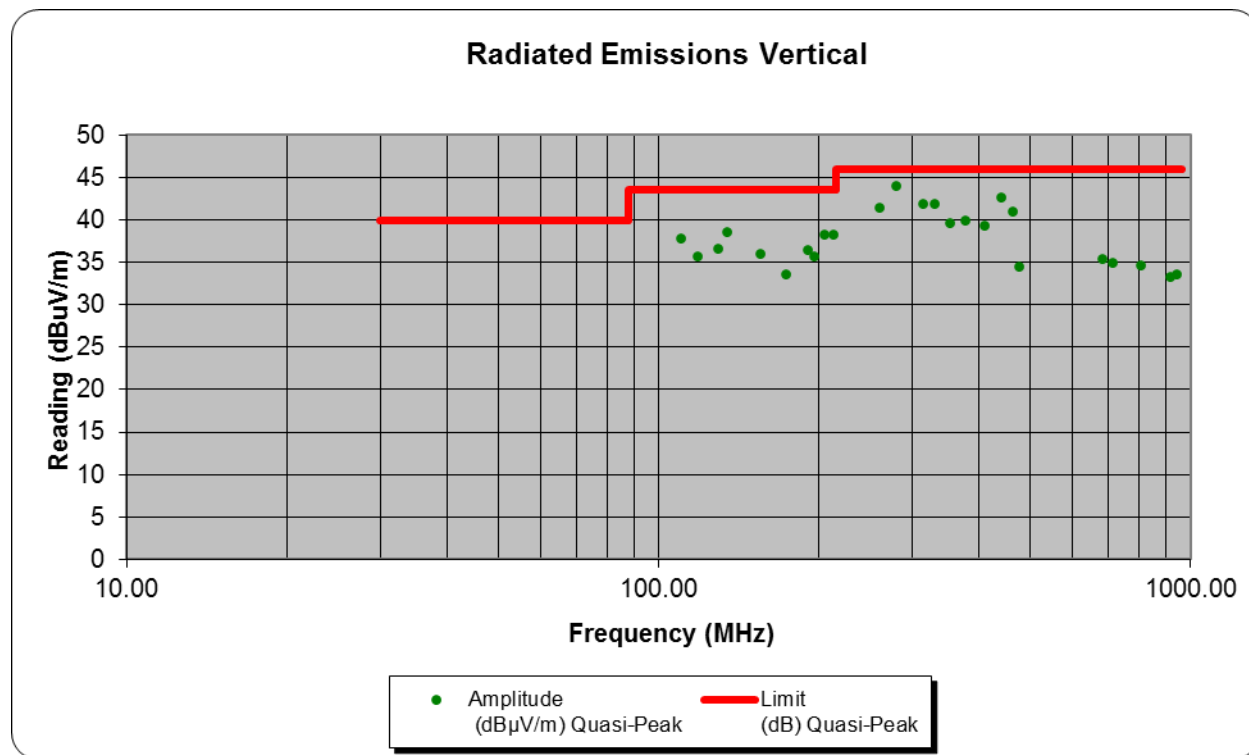
6.4.2. 30 MHz to 960 MHz, Horizontal measured at 3 Meters

Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi- Peak	Quasi- Peak				
119.92	29.07	29.02	43.5	-14.48	H	200	270
135.42	30.11	28.38	43.5	-15.12	H	200	270
143.84	27.49	25.72	43.5	-17.78	H	200	270
156.69	32.85	31.65	43.5	-11.85	H	275	270
169.95	33.79	31.54	43.5	-11.96	H	275	270
173.98	33.55	32.38	43.5	-11.12	H	275	270
183.50	34.34	32.94	43.5	-10.56	H	300	270
193.74	35.65	34.80	43.5	-8.70	H	300	270
210.22	37.64	35.75	43.5	-7.75	H	325	270
242.01	41.11	36.93	46.0	-9.07	H	325	270
259.40	41.32	36.27	46.0	-9.73	H	175	270
286.25	42.87	37.94	46.0	-8.06	H	175	270
327.99	43.83	40.01	46.0	-5.99	H	175	270
375.80	41.05	37.59	46.0	-8.41	H	175	270
427.00	37.57	34.74	46.0	-11.26	H	125	270
471.28	35.25	32.28	46.0	-13.72	H	200	270
610.52	33.16	30.71	46.0	-15.29	H	150	270
696.80	33.57	30.09	46.0	-15.91	H	150	270

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.3. 30 MHz to 960 MHz, Vertical Plot



6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.209 continued)

6.4.4. 30 MHz to 960 MHz, Vertical measured at 3 Meters

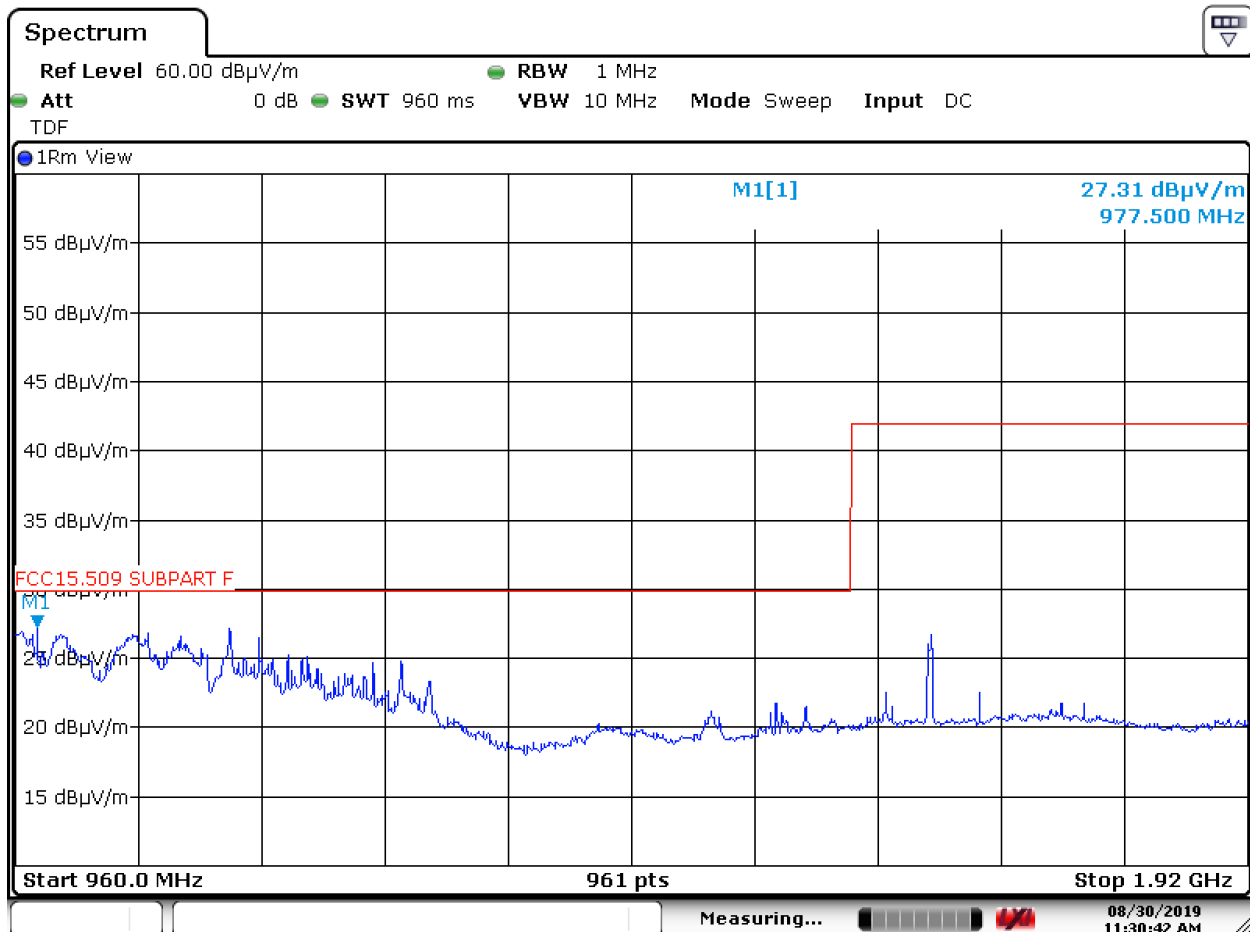
Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi- Peak	Quasi- Peak				
110.13	39.99	37.76	43.5	-5.74	V	100	0
118.27	40.38	35.67	43.5	-7.83	V	100	0
129.34	40.31	36.63	43.5	-6.87	V	100	0
134.70	43.05	38.60	43.5	-4.90	V	100	0
155.63	40.98	36.06	43.5	-7.44	V	100	0
173.12	38.90	33.66	43.5	-9.84	V	100	0
190.50	40.13	36.46	43.5	-7.04	V	100	0
196.50	41.86	35.67	43.5	-7.83	V	100	0
204.73	41.24	38.27	43.5	-5.23	V	100	0
213.07	43.09	38.27	43.5	-5.23	V	100	0
259.76	44.32	41.44	46.0	-4.56	V	100	0
279.81	45.61	44.05	46.0	-1.95	V	100	0
314.50	47.04	41.93	46.0	-4.07	V	100	0
330.65	48.35	41.89	46.0	-4.11	V	100	0
352.40	45.75	39.63	46.0	-6.37	V	100	0
376.04	45.07	39.91	46.0	-6.09	V	100	0
409.73	45.12	39.27	46.0	-6.73	V	100	0
439.68	43.96	42.65	46.0	-3.35	V	100	0
461.72	41.25	41.04	46.0	-4.96	V	100	0
475.22	38.22	34.49	46.0	-11.51	V	100	0
683.88	39.90	35.41	46.0	-10.59	V	100	0
714.84	37.79	35.01	46.0	-10.99	V	100	0
806.24	38.45	34.69	46.0	-11.31	V	100	0
917.19	37.32	33.24	46.0	-12.76	V	100	0
940.22	40.37	33.65	46.0	-12.35	V	100	0

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d))

6.4.5. 960 MHz to 5 GHz at 1 meter

6.4.5.1 Plot of RMS Power 960 to 1920 MHz Horizontal Polarity



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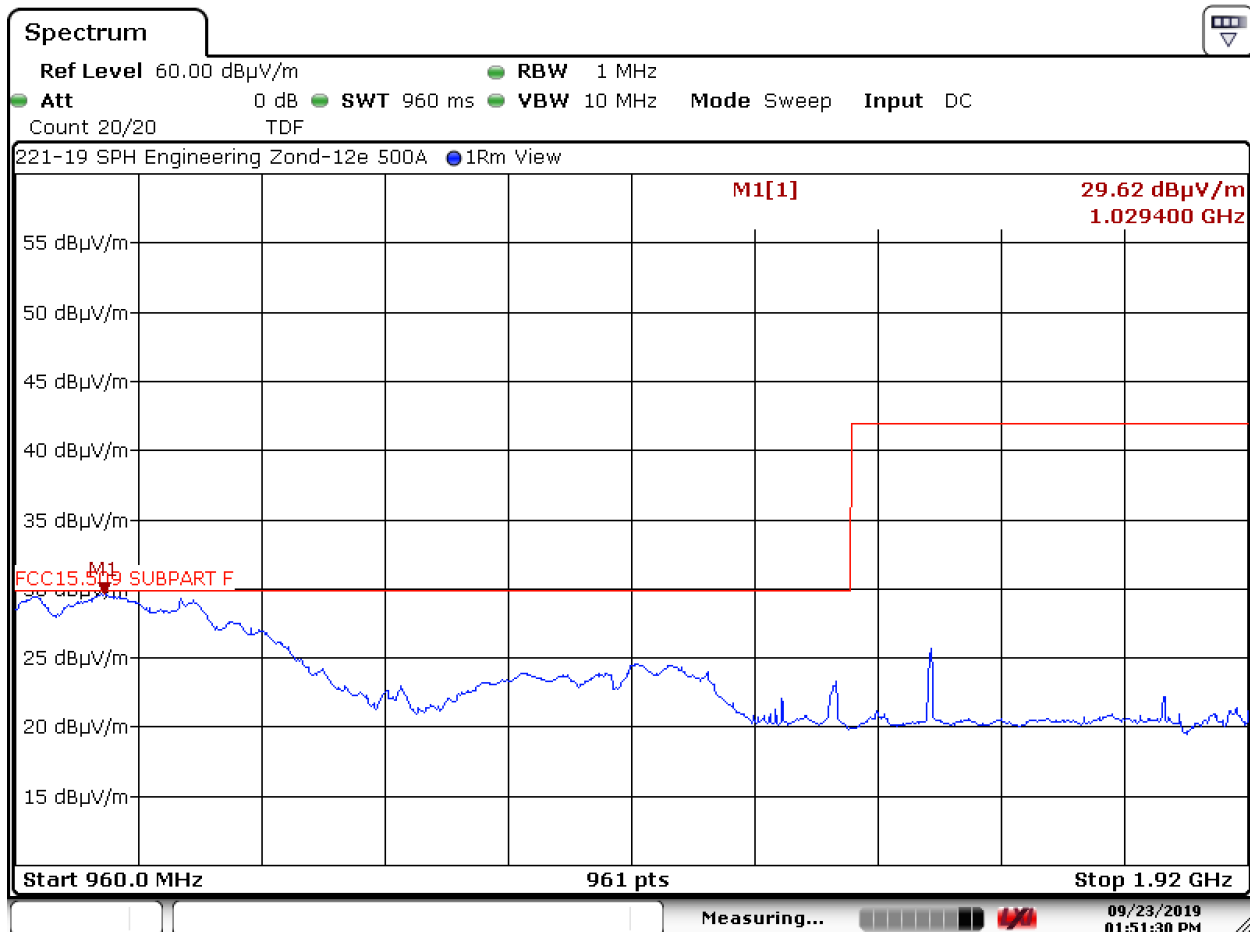
Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector. There were no measurable signals above 1.92 GHz.

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d))

6.4.5. 960 MHz to 5 GHz at 1 meter

6.4.5.2 Plot of RMS Power 960 to 5000 MHz Vertical Polarity



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Notes: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector. There were no measurable signals above 1.92 GHz.

6. Measurement Data (continued)

6.5. Spurious Radiated Emissions in GPS Bands (15.509 (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.

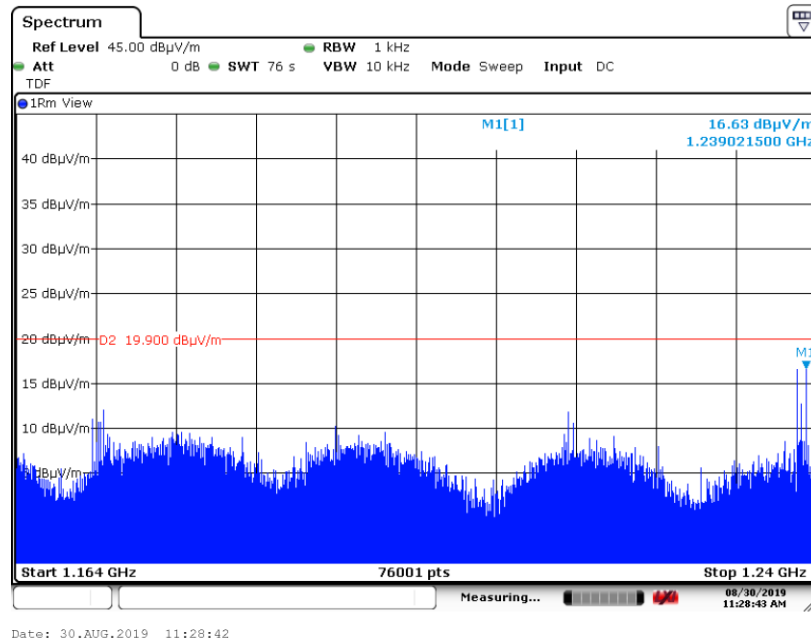
6.5.3. 1164 to 1240 MHz & 1559 to 1610 MHz

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.

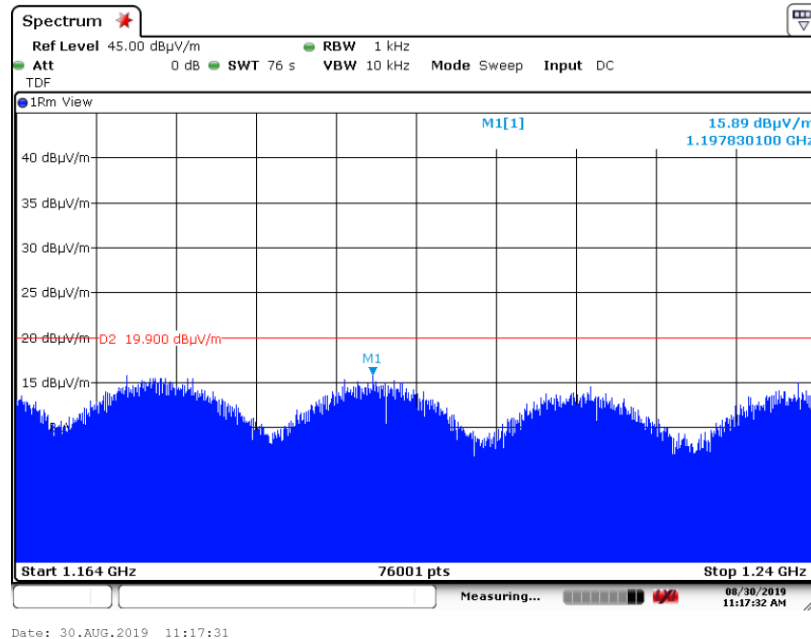
6. Measurement Data (continued)

6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.1 1164 to 1240 MHz - Horizontal



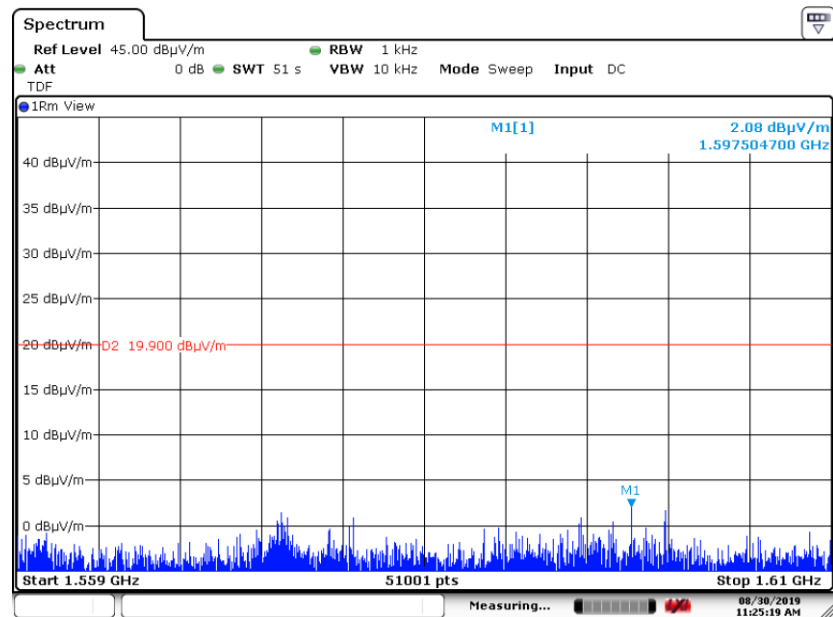
6.5.4.2 1164 to 1240 MHz - Vertical



6. Measurement Data (continued)

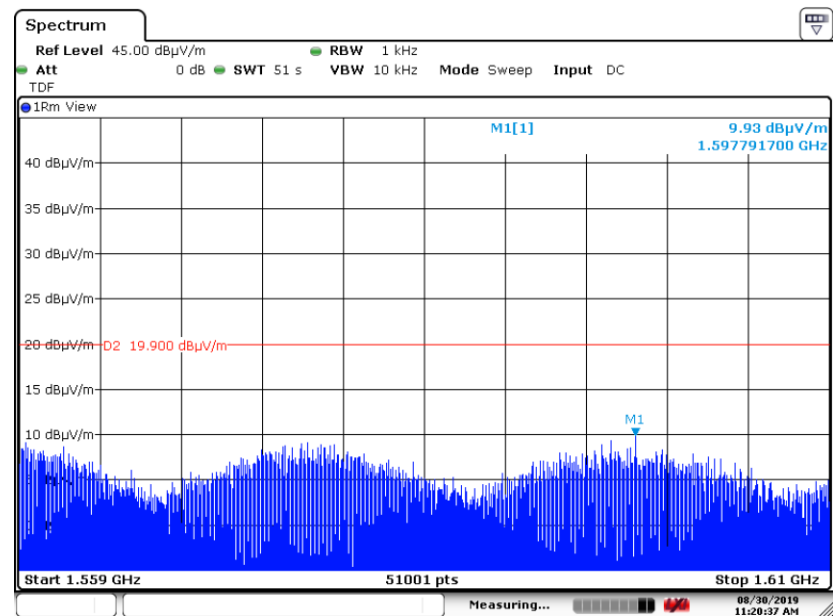
6.5.4 Spurious Radiated Emissions in GPS Bands (15.509 (e) continued)

6.5.4.3 1559 to 1610 MHz - Horizontal



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6.5.4.4 1559 to 1610 MHz - Vertical



Date: 30.AUG.2019 11:20:36

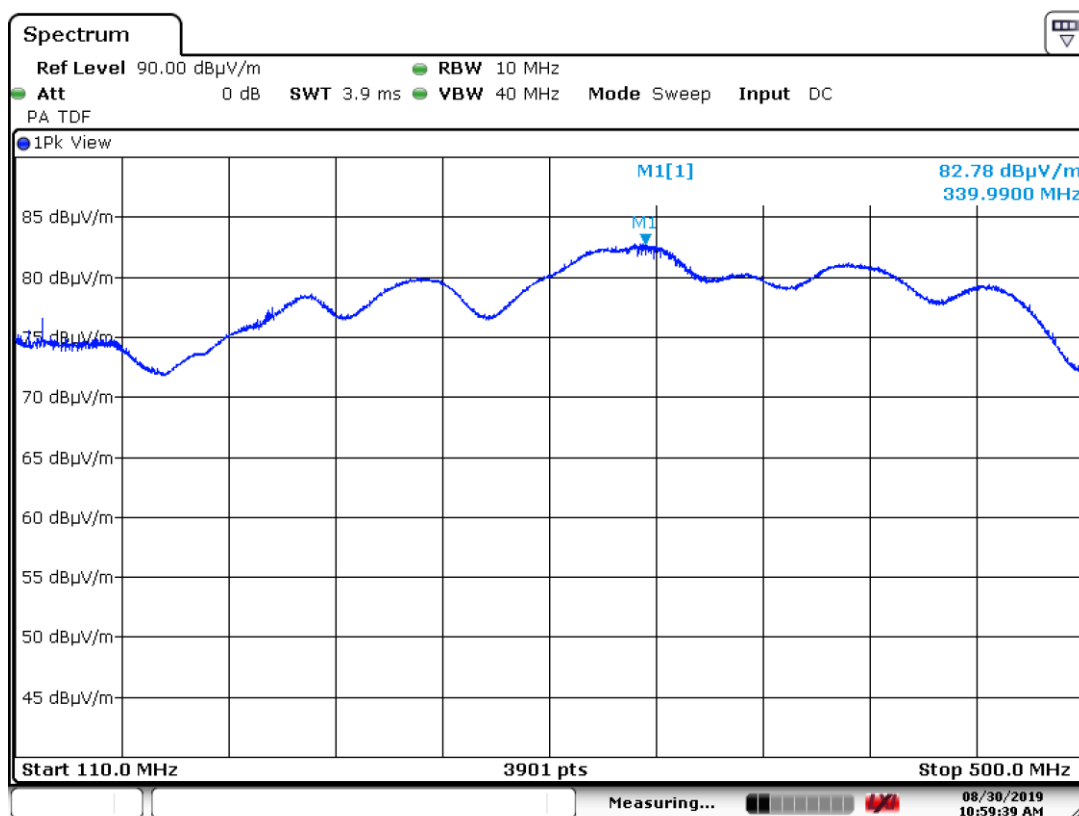
6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f))

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 limit was converted to -13.98 dBm limit when using a 10 MHz RBW. The limit was then converted to a 3 meter field strength limit of 81.22 dB μ V/m by using a conversion factor of 95.2.

Result: Compliant.

6.6.1 Plot of Peak Power below 960 MHz

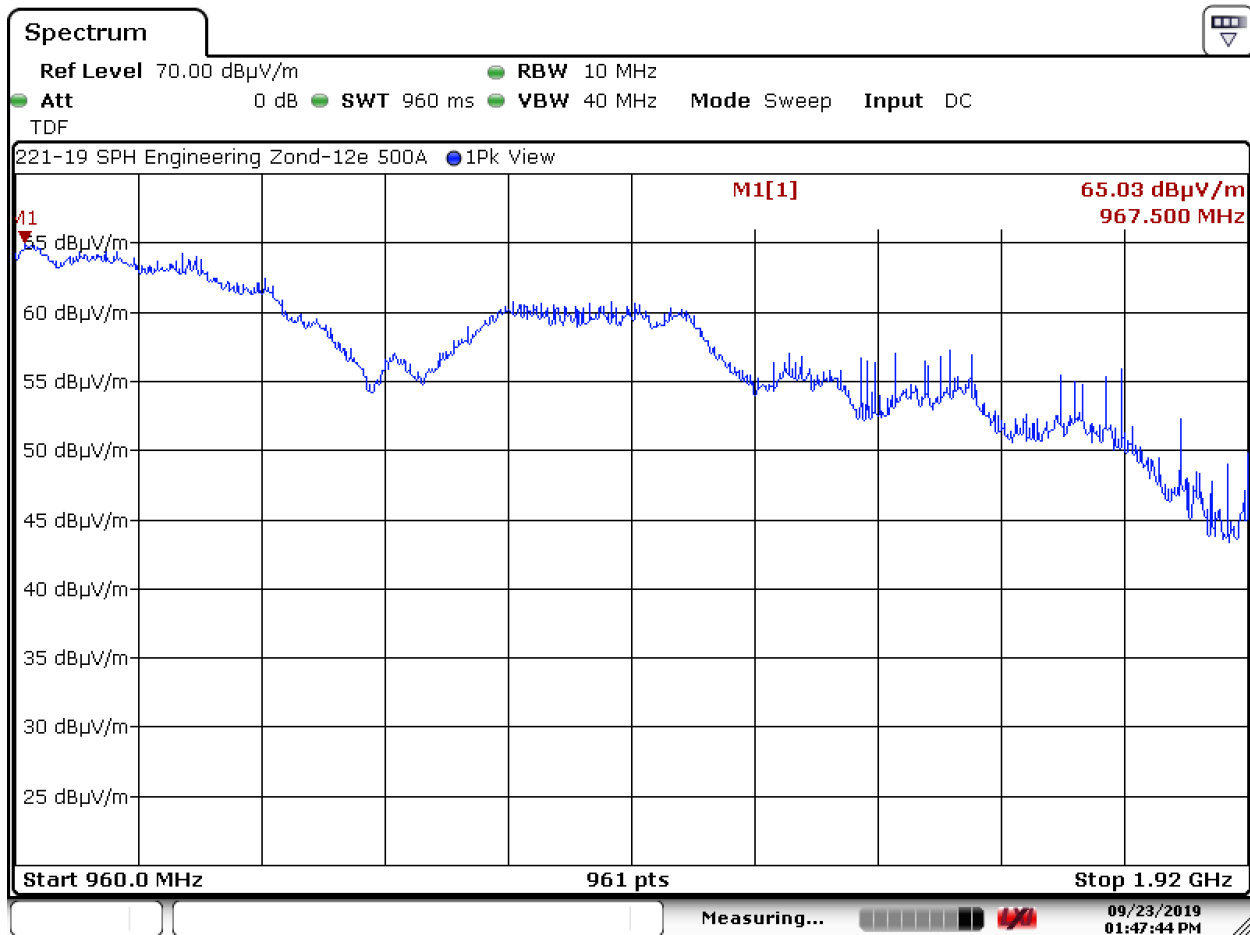


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6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.509 (f) continued)

6.6.2 Plot of Peak Power above 960 MHz = 65.03 dB μ V/m vs. 81.22 dB μ V/m limit



H_001 - Running

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6. Measurement Data (continued)

6.7. Conducted Emissions, Regulatory Limit: FCC Part 15.209

Frequency Range (MHz)	Limits (dBµV)	
	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	9/10/2020
LISN	EMCO	3825/2	9109-1860	9/10/2019

6.7.2. Measurement & Equipment Setup

Test Date:	9/3/2019
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:	30 kHz
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.

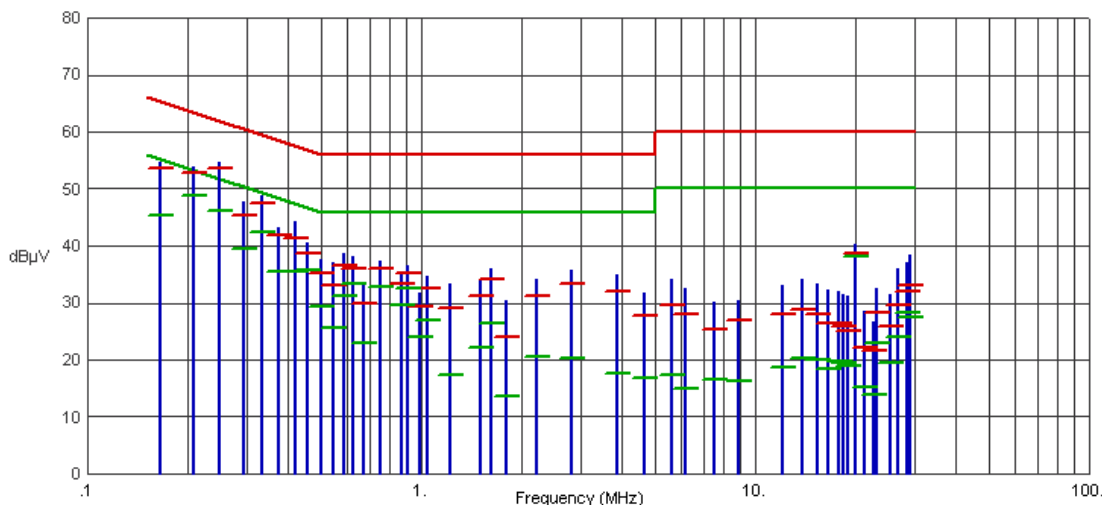
6. Measurement Data (continued)

6.8. Conducted Emissions Test Results

6.8.1. 120 Volts, 60 Hz Phase

Test No.: 221-19, 120 Volts, 60 Hz Phase

FCC, Class B



Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
.1658	54.57	53.49	65.17	-11.68	45.46	55.17	-9.71	
.2085	53.83	52.70	63.26	-10.56	48.93	53.26	-4.33	
.2490	54.74	53.59	61.79	-8.20	46.14	51.79	-5.65	
.2940	47.76	45.39	60.41	-15.02	39.42	50.41	-10.99	
.3323	48.77	47.59	59.39	-11.80	42.48	49.39	-6.91	
.3728	43.30	41.77	58.44	-16.67	35.42	48.44	-13.02	
.4200	44.16	41.27	57.45	-16.18	35.57	47.45	-11.88	
.4560	40.63	38.70	56.77	-18.07	35.67	46.77	-11.10	
.5010	37.70	35.19	56.00	-20.81	29.34	46.00	-16.66	
.5460	37.01	33.09	56.00	-22.91	25.66	46.00	-20.34	
.5865	38.61	36.58	56.00	-19.42	31.14	46.00	-14.86	
.6225	38.09	35.98	56.00	-20.02	33.23	46.00	-12.77	
.6698	33.06	29.85	56.00	-26.15	23.03	46.00	-22.97	
.7508	37.32	36.01	56.00	-19.99	32.69	46.00	-13.31	
.8723	35.27	33.42	56.00	-22.58	29.71	46.00	-16.29	
.9128	36.43	35.14	56.00	-20.86	32.41	46.00	-13.59	
.9938	31.62	29.22	56.00	-26.78	23.91	46.00	-22.09	
1.0410	34.67	32.61	56.00	-23.39	26.92	46.00	-19.08	
1.2143	33.30	29.16	56.00	-26.84	17.32	46.00	-28.68	
1.5000	33.75	31.31	56.00	-24.69	22.01	46.00	-23.99	
1.6170	36.06	34.05	56.00	-21.95	26.28	46.00	-19.72	
1.8015	30.43	24.04	56.00	-31.96	13.68	46.00	-32.32	
2.2110	34.24	31.09	56.00	-24.91	20.41	46.00	-25.59	
2.8095	35.84	33.34	56.00	-22.66	20.39	46.00	-25.61	
3.8603	34.91	32.12	56.00	-23.88	17.62	46.00	-28.38	
4.6725	31.70	27.67	56.00	-28.33	16.74	46.00	-29.26	
5.6243	34.03	29.47	60.00	-30.53	17.32	50.00	-32.68	
6.1688	32.62	28.04	60.00	-31.96	14.85	50.00	-35.15	
7.5210	30.17	25.40	60.00	-34.60	16.46	50.00	-33.54	

6. Measurement Data (continued)

6.8. Conducted Emissions Test Results

6.8.1. 120 Volts, 60 Hz Phase (Continued)

Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
8.9340	30.38	27.02	60.00	-32.98	16.18	50.00	-33.82	
12.0885	32.94	27.94	60.00	-32.06	18.56	50.00	-31.44	
13.8638	34.16	28.93	60.00	-31.07	20.38	50.00	-29.62	
15.3938	33.35	27.87	60.00	-32.13	20.08	50.00	-29.92	
16.4850	32.16	26.37	60.00	-33.63	18.52	50.00	-31.48	
17.6955	32.03	26.31	60.00	-33.69	19.81	50.00	-30.19	
18.3030	31.46	25.91	60.00	-34.09	19.37	50.00	-30.63	
18.9128	31.13	25.16	60.00	-34.84	18.84	50.00	-31.16	
19.9838	40.36	38.56	60.00	-21.44	38.16	50.00	-11.84	
21.1763	28.59	22.04	60.00	-37.96	15.28	50.00	-34.72	
22.5308	26.64	21.47	60.00	-38.53	13.89	50.00	-36.11	
23.1293	32.49	28.21	60.00	-31.79	22.88	50.00	-27.12	
25.3793	31.52	25.91	60.00	-34.09	19.56	50.00	-30.44	
26.6100	35.92	29.70	60.00	-30.30	24.05	50.00	-25.95	
28.3718	37.18	31.95	60.00	-28.05	28.21	50.00	-21.79	
29.2335	38.33	33.04	60.00	-26.96	27.36	50.00	-22.64	

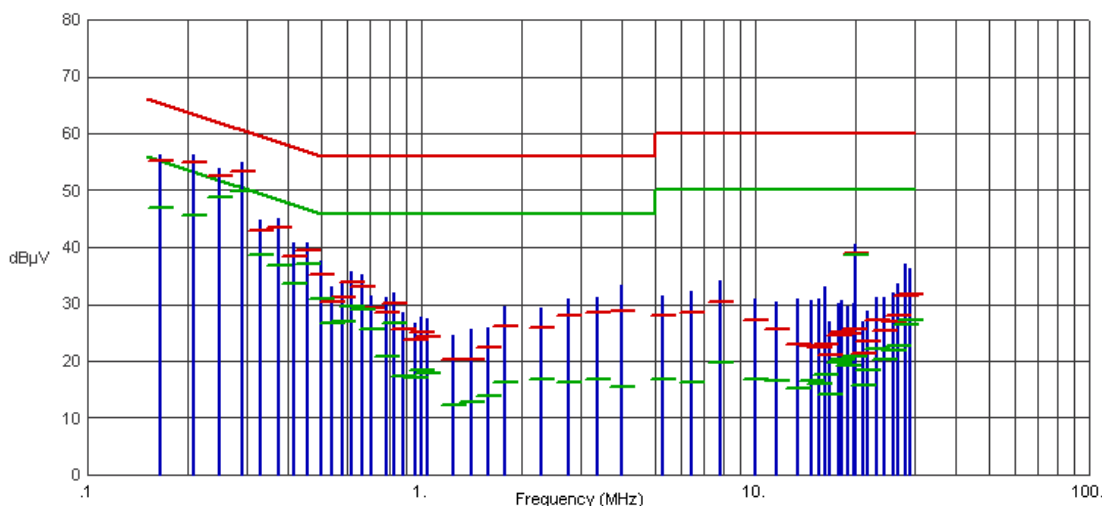
6. Measurement Data (continued)

6.8. Conducted Emissions Test Results (continued)

6.8.2. 120 Volts, 60 Hz Neutral

Test No.: 221-19, 120 Volts, 60 Hz Neutral

FCC, Class B



Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
.1658	56.28	55.08	65.17	-10.09	46.85	55.17	-8.32	
.2085	56.30	54.99	63.26	-8.27	45.49	53.26	-7.77	
.2490	53.79	52.57	61.79	-9.22	48.77	51.79	-3.02	
.2895	54.91	53.45	60.54	-7.09	49.74	50.54	-0.80	
.3300	44.72	42.91	59.45	-16.54	38.62	49.45	-10.83	
.3728	44.96	43.43	58.44	-15.01	36.80	48.44	-11.64	
.4133	40.91	38.37	57.58	-19.21	33.57	47.58	-14.01	
.4560	40.89	39.60	56.77	-17.17	37.18	46.77	-9.59	
.5010	37.64	35.07	56.00	-20.93	30.85	46.00	-15.15	
.5393	33.00	30.47	56.00	-25.53	26.69	46.00	-19.31	
.5798	33.60	31.28	56.00	-24.72	26.85	46.00	-19.15	
.6203	35.75	33.89	56.00	-22.11	29.71	46.00	-16.29	
.6675	35.14	33.20	56.00	-22.80	28.94	46.00	-17.06	
.7080	31.50	29.42	56.00	-26.58	25.72	46.00	-20.28	
.7845	31.10	28.43	56.00	-27.57	20.79	46.00	-25.21	
.8318	32.02	30.07	56.00	-25.93	26.59	46.00	-19.41	
.8790	28.51	25.68	56.00	-30.32	17.21	46.00	-28.79	
.9578	26.66	23.63	56.00	-32.37	16.99	46.00	-29.01	
1.0005	27.67	25.19	56.00	-30.81	18.32	46.00	-27.68	
1.0433	27.36	24.38	56.00	-31.62	17.78	46.00	-28.22	
1.2413	24.45	20.19	56.00	-35.81	12.17	46.00	-33.83	
1.4190	25.47	20.23	56.00	-35.77	12.77	46.00	-33.23	
1.5833	25.91	22.42	56.00	-33.58	13.92	46.00	-32.08	
1.7835	29.57	26.20	56.00	-29.80	16.33	46.00	-29.67	
2.2785	29.32	25.96	56.00	-30.04	16.84	46.00	-29.16	
2.7735	30.87	28.03	56.00	-27.97	16.19	46.00	-29.81	
3.3788	31.27	28.54	56.00	-27.46	16.82	46.00	-29.18	
3.9840	33.24	28.78	56.00	-27.22	15.35	46.00	-30.65	
5.2575	31.54	27.97	60.00	-32.03	16.67	50.00	-33.33	

6. Measurement Data (continued)

6.8. Conducted Emissions Test Results (continued)

6.8.2. 120 Volts, 60 Hz Neutral (Continued)

Frequency (MHz)	Pk Amp (dBμV)	QP Amp (dBμV)	QP Limit (dBμV)	QP Margin (dB)	Avg Amp (dBμV)	Avg Limit (dBμV)	Avg Margin (dB)	Comments
6.4748	32.24	28.44	60.00	-31.56	16.38	50.00	-33.62	
7.8473	34.25	30.47	60.00	-29.53	19.67	50.00	-30.33	
10.0523	30.95	27.26	60.00	-32.74	16.68	50.00	-33.32	
11.5868	30.48	25.56	60.00	-34.44	16.61	50.00	-33.39	
13.3958	30.86	22.84	60.00	-37.16	15.29	50.00	-34.71	
14.8043	30.73	22.79	60.00	-37.21	16.58	50.00	-33.42	
15.5648	31.01	22.51	60.00	-37.49	15.96	50.00	-34.04	
16.1633	33.01	22.97	60.00	-37.03	17.54	50.00	-32.46	
16.7348	26.97	21.06	60.00	-38.94	14.23	50.00	-35.77	
17.6933	30.06	24.64	60.00	-35.36	19.71	50.00	-30.29	
18.2423	30.56	25.06	60.00	-34.94	20.18	50.00	-29.82	
18.9150	29.54	24.78	60.00	-35.22	19.24	50.00	-30.76	
19.7093	30.11	25.47	60.00	-34.53	20.86	50.00	-29.14	
19.9860	40.56	39.06	60.00	-20.94	38.71	50.00	-11.29	
20.9918	26.86	21.28	60.00	-38.72	15.68	50.00	-34.32	
21.6623	28.77	23.46	60.00	-36.54	18.34	50.00	-31.66	
23.1270	31.11	27.16	60.00	-32.84	22.21	50.00	-27.79	
24.3510	31.08	25.35	60.00	-34.65	20.21	50.00	-29.79	
26.0160	31.96	26.89	60.00	-33.11	21.99	50.00	-28.01	
26.8530	33.65	27.95	60.00	-32.05	22.61	50.00	-27.39	
28.2885	37.06	31.55	60.00	-28.45	26.45	50.00	-23.55	
29.1413	36.37	31.67	60.00	-28.33	27.30	50.00	-22.70	

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 274 mW at 300 MHz and 224 mW at 450 MHz.

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

The EUT transmits -0.35 dBm EIRP or 0.923 mW at 340 MHz and therefore meets the SAR Test Exclusion.

Input:	P_{MAX}	0.923	mW
	d_{MIN}	50.00	mm
	$f_{\text{(GHz)}}$	0.340	GHz
Test Exclusion:		0.01076	
Limit Exemption:		7.50	

6. Measurement Data (continued)

6.9. Public Exposure to Radio Frequency Energy Levels (RSS-GEN, ISSUE 5, 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	Separation Distance	Maximum Power	RSS-102 Limit	Result
(MHz)	(mm)	(mW)	(mW)	
340.00	≤5	0.923	65.93	Compliant

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.

Both 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 of the rear of the 10 Meter Enclosed Open Area test 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

