
COMPLIANCE WORLDWIDE INC. TEST REPORT 525-15

In Accordance with the Requirements of
Industry Canada RSS 220, Issue 1, March 2009
Federal Communications Commission 47 CFR Part 15, Subpart F
Technical Requirements for Ground Penetrating Radar Systems

Issued to

**Geophysical Survey Systems, Inc.
40 Simon Street
Nashua, NH 03060-3075
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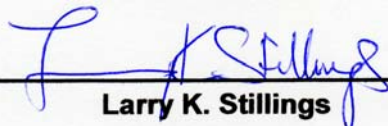
For the

350HS Antenna

**FCC ID: QF7350HS
IC: 8498A-350HS**


Report Issued on February 8, 2016

Tested by



Larry K. Stillings

Reviewed By



Brian F. Breault

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1. Scope

This test report certifies that the Geophysical Survey Systems 350HS Antenna, as tested, meets the FCC Part 15, Subpart F and Industry Canada 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:** Geophysical Survey Systems, Inc.
- 2.2. **Model Number:** 350HS
- 2.3. **Serial Number:** R2
- 2.4. **Description:** Ground Penetrating Radar – Concrete Scanner
- 2.5. **Power Source:** 10.8V Li-On Battery Powered
- 2.6. **Hardware Revision:** N/A
- 2.7. **Software Revision:** N/A
- 2.8. **Modulation Type:** 25 nS Impulse 120 kHz PRF
- 2.9. **Operating Frequency:** 400 MHz Nominal
- 2.10. **EMC Modifications:** None

3. Product Configuration

3.1 Operational Characteristics & Software

Turn on the 350HS and allow the unit to boot up.

Software Setup:

For normal operation:

1. After boot up start the unit scanning by selecting the System menu and select 120 kHz PRF.

3.2. EUT Hardware

Manufacturer	Model	Serial Number	Description/Function
GSSI	350HS	R2	GPR 400 MHz Antenna

3.3. EUT Cables/Transducers

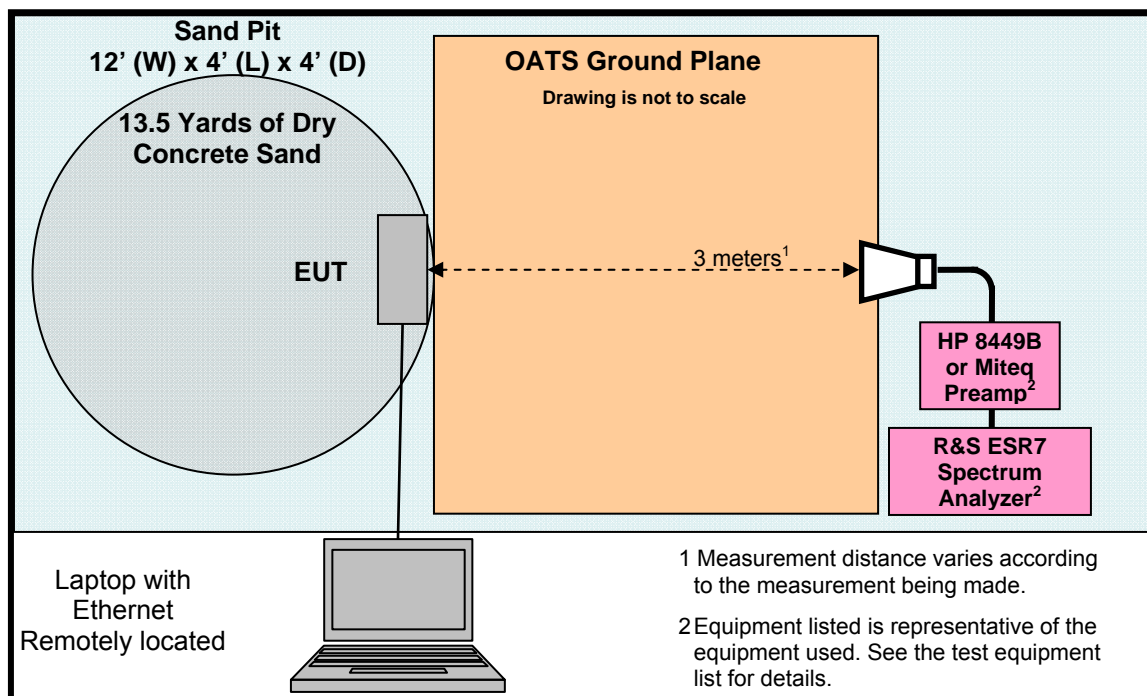
Manufacturer	Model/Part #	Length (m)	Shield Y/N	Description/Function
GSSI	AC Detect Cable	0.1	Y	AC Detection Accessory
GSSI	Ethernet Cable	30	N	Control cable for Controlling Unit
GSSI	Battery Cable	0.1	N	Connection to Battery

3.4. Support Equipment

Laptop

3. Product Configuration (continued)

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	7/23/2017	2 Yr
Spectrum Analyzer	Rohde & Schwarz	FSV40	100899	7/23/2017	2 Yr
Microwave Preamp	Hewlett Packard	8449B	3008A01323	7/23/2017	2 Yr
Preamp 100 MHz – 7 GHz	Miteq	AFS3-01000200-10-15P-4	257561	6/19/2016	1 Yr
Bilog Antenna 30 to 1000 MHz	Com-Power	AC-220	25509	8/31/2016	1 Yr
Horn Antenna 1 to 18 GHz	Electro-Metrics	RGA 50/60	2813	7/15/2016	2 Yr
Barometer – Temperature & Humidity	Control Company	4195	ID236	10/8/2017	2 Yr

4.2. Measurement & Equipment Setup

Test Date: 11/6/2015
 Test Engineer: Larry Stillings
 Normal Site Temperature (15 - 35°C): 21.6
 Relative Humidity (20 - 75%RH): 35
 Frequency Range: 30 MHz to 4 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 Procedure

Test measurements were made in accordance FCC Part 15.509, 15.521, IC RSS-220 Issue I, 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	IC Rule Requirement	Test Report Section	Result	Comment
Antenna Requirement	15.203	RSS-GEN 7.1.4	6.1	Compliant	The antenna is housed within a sealed enclosure with the intentional radiator.
Operational Requirements	15.509 (b)	RSS-220 6	6.2	Compliant	
UWB Bandwidth	15.503 (a)	RSS-220 6.2.1 (a)	6.3	Compliant	
Spurious Radiated Emissions	15.509 (d) 15.209	RSS-220 3.4 RSS-220 6.2(c) & 6.2(d)	6.4	Compliant	
Radiated Emissions in GPS Bands	15.509 (e) 15.209	RSS-220 6.2(e)			
Peak Emissions in a 50 MHz Bandwidth	15.509 (f)	RSS-220 6.2(g)	6.5	Compliant	
Conducted Emissions	15.207	RSS-GEN	6.6	Compliant	EUT is battery powered
Radio Frequency Exposure	FCC OET Bulletin 65	RSS-GEN	6.7	Compliant	

6. Measurement Data

6.1. Antenna Requirement (15.203), RSS-GEN Section 7.1.4

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

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 Sec 6

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.

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)), RSS-220 Section 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 $2 * (f_H - f_L) / (f_H + f_L)$.

6.3.1. Measurement Data (Values in GHz)

f_M	The highest emission peak	0.202250
f_L	10 dB below the highest peak	0.178850
f_H	10 dB above the highest peak	0.408630
f_C	Calculated: $(f_H + f_L)/2$	0.293740
Bandwidth	Calculated: $(f_H - f_L)$	0.229780
Fractional BW	Calculated: $2*(f_H - f_L)/(f_H + f_L)$	0.782256

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.

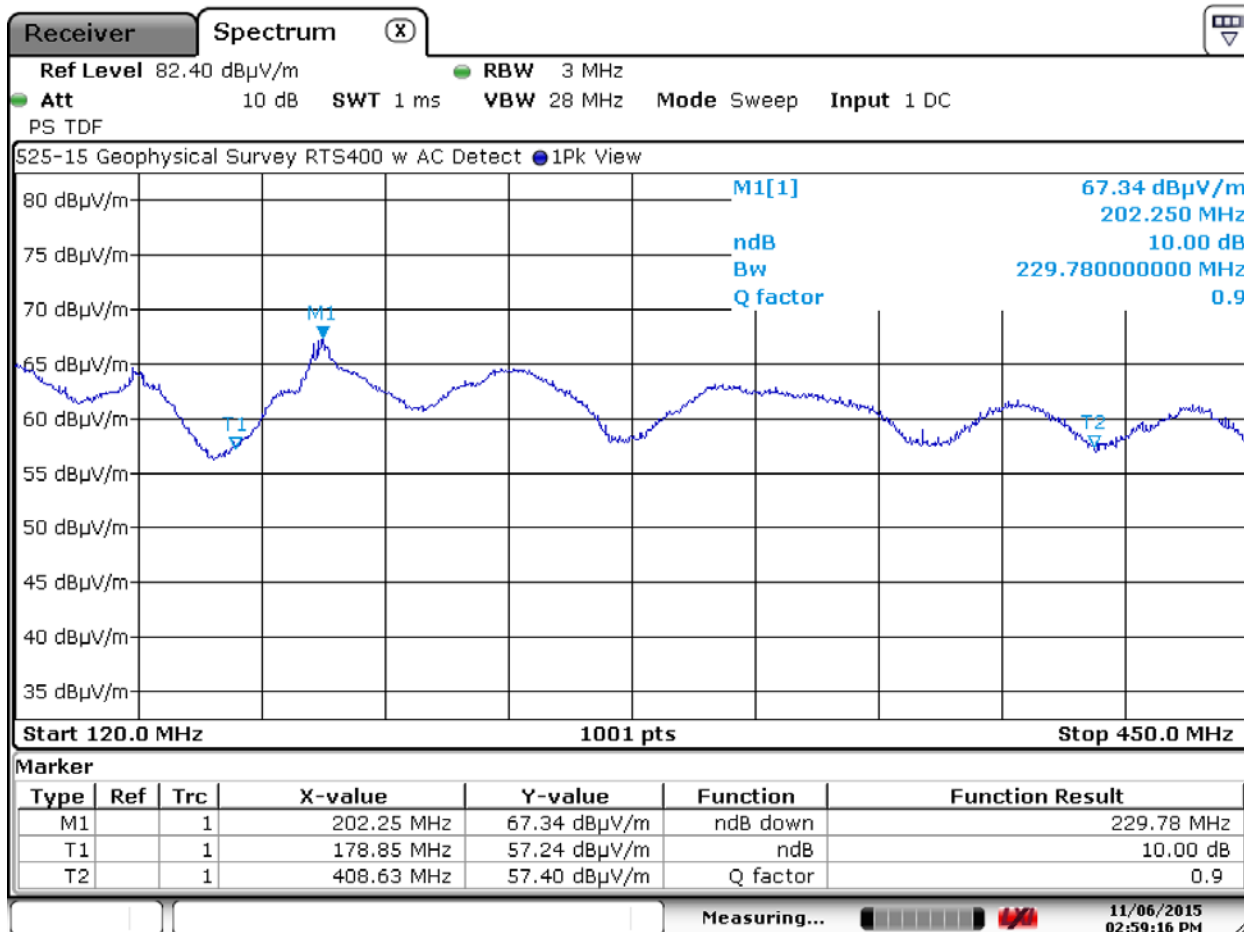
Test Number: 525-15

Issue Date: 2/8/2016

6. Measurement Data (continued)

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

6.3.2. Measurement Plot of 10 dB BW on GPR Site = 229.78 MHz



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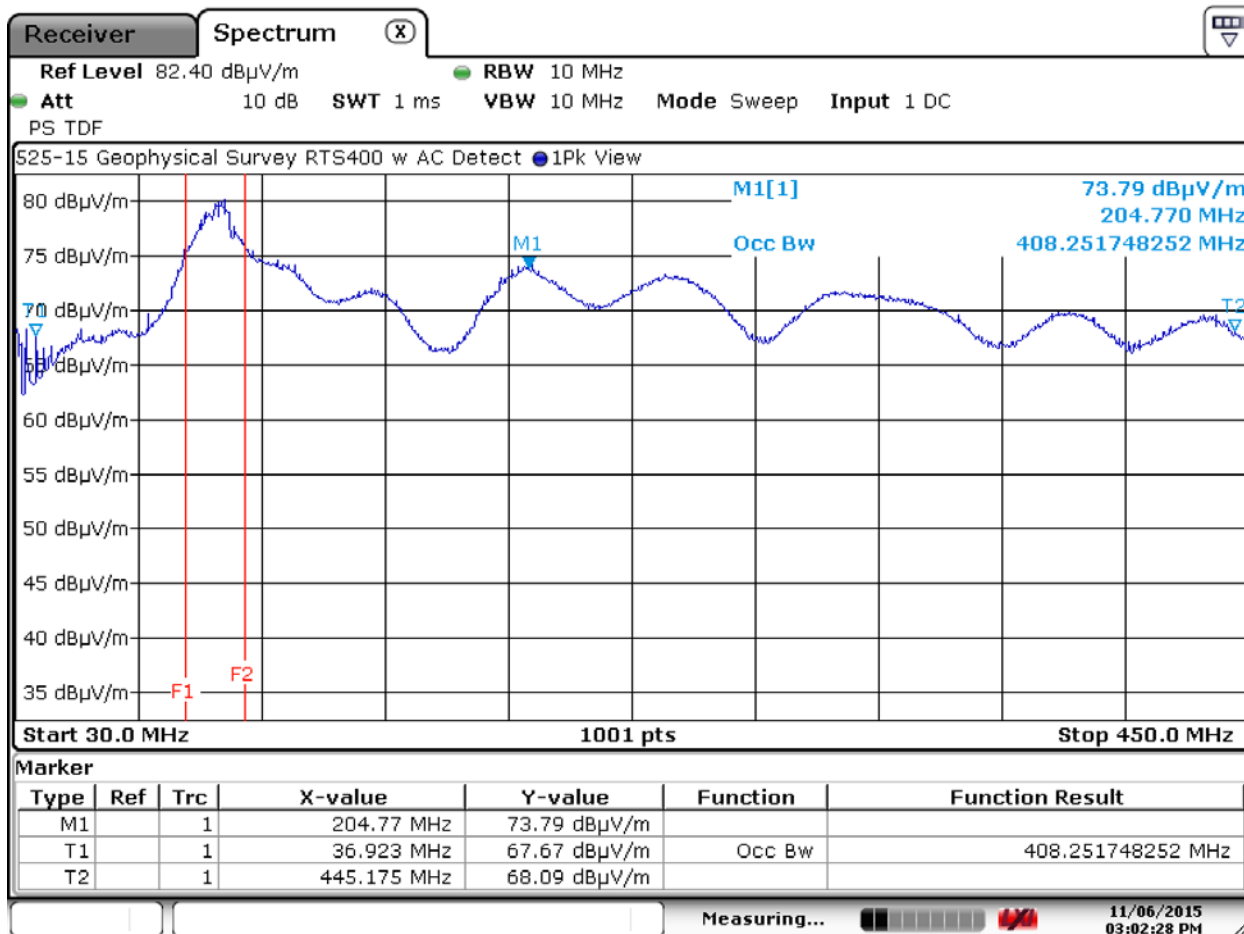
Test Number: 525-15

Issue Date: 2/8/2016

6. Measurement Data (continued)

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

6.3.3. Measurement Plot of 99% BW on GPR Site = 408.25 MHz



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Note: Markers F1 and F2 denote the FM band.

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(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 (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

Spurious Radiated Emissions in GPS Bands

(15.509 (e), 15.209, RSS-220 Section 6.2(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. Limits are converted from EIRP (dBm) to field strength at 3 meters using a conversion factor of 95.2 when measured with 1 kHz.

Frequency (MHz)	EIRP (dBm)	Field Strength (dBμV/m)
1164 - 1240	-75.3	19.9
1559 - 1610	-75.3	19.9

Radiated Emissions Field Strength Limits at 3 Meters

(Section 15.209, RSS-GEN, RSS-220 Section 3.4)

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 (15.509 (d), 15.209, RSS-220 Section 6.1(d))

6.4.1. 30 MHz to 960 MHz, measured at 3 Meters

Geophysical Survey, 350HS

Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi-Peak	Quasi-Peak				
128.90	26.56	21.94	43.5	-21.56	H	100	90
136.91	28.18	23.80	43.5	-19.70	H	100	90
197.33	29.14	24.95	43.5	-18.55	H	100	90
342.92	29.82	25.62	46.0	-20.38	H	150	90
418.30	31.49	26.21	46.0	-19.79	H	150	90
474.58	32.71	28.35	46.0	-17.65	H	150	90
717.53	31.33	19.82	46.0	-26.18	H	150	90
830.62	31.73	20.94	46.0	-25.06	H	100	90
857.09	30.26	21.01	46.0	-24.99	H	100	90
957.09	32.90	22.03	46.0	-23.97	H	100	90

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(d))

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

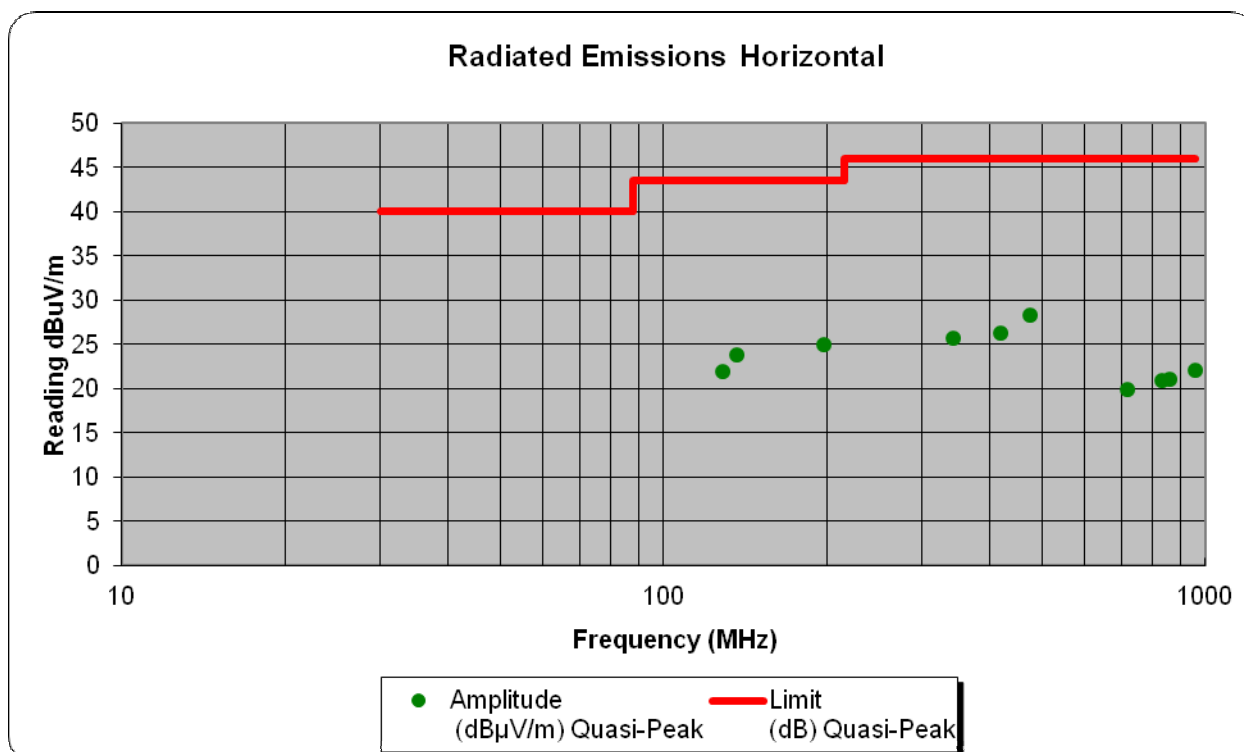
Geophysical Survey, 350HS

Frequency (MHz)	Amplitude (dBµV/m)		Limit (dB)	Margin (dB)	Polarity (H/V)	Antenna Height (cm)	Azimuth (Dev.)
	Peak	Quasi-Peak	Quasi-Peak				
30.38	37.99	35.27	40.0	-4.73	V	100	90
42.49	33.69	28.55	40.0	-11.45	V	100	90
53.32	34.62	30.34	40.0	-9.66	V	100	90
81.37	33.13	29.76	40.0	-10.24	V	100	90
110.56	35.14	34.12	43.5	-9.38	V	100	90
116.32	39.28	37.56	43.5	-5.94	V	100	90
154.26	35.79	34.09	43.5	-9.41	V	100	90
191.21	39.90	38.24	43.5	-5.26	V	100	90
197.33	40.59	38.51	43.5	-5.03	V	100	90
207.08	39.82	37.64	43.5	-5.86	V	100	90
250.16	38.05	35.60	46.0	-10.40	V	100	90
336.07	38.26	34.55	46.0	-11.45	V	100	90
384.04	36.69	33.58	46.0	-12.42	V	100	90
432.10	34.67	30.67	46.0	-15.33	V	100	90
537.71	32.92	27.63	46.0	-18.37	V	100	90
673.18	35.19	30.92	46.0	-15.08	V	100	90
822.63	34.80	27.91	46.0	-18.09	V	100	90
850.00	32.88	26.30	46.0	-19.70	V	100	90
909.90	36.66	29.59	46.0	-16.41	V	100	90
950.66	35.52	35.52	46.0	-10.48	V	100	90

6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(d))

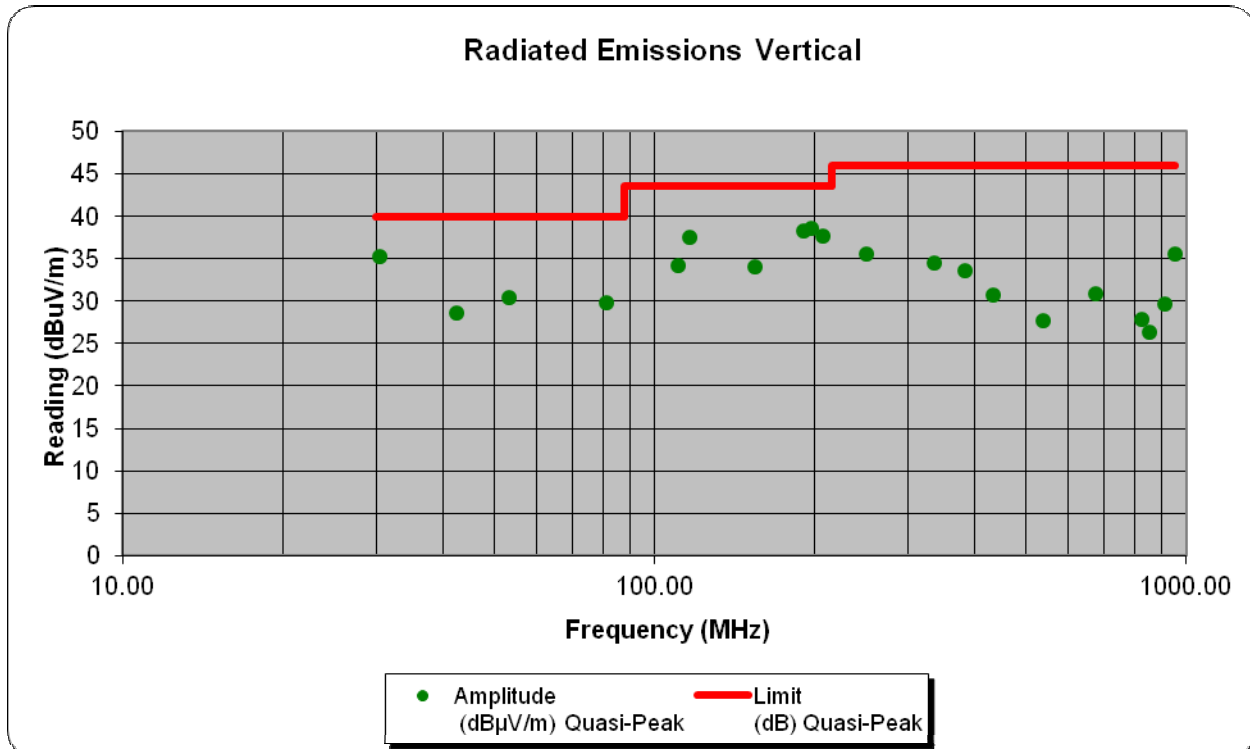
6.4.3. 30 MHz to 960 MHz, Horizontal Plot



6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(d))

6.4.4. 30 MHz to 960 MHz, Vertical Plot



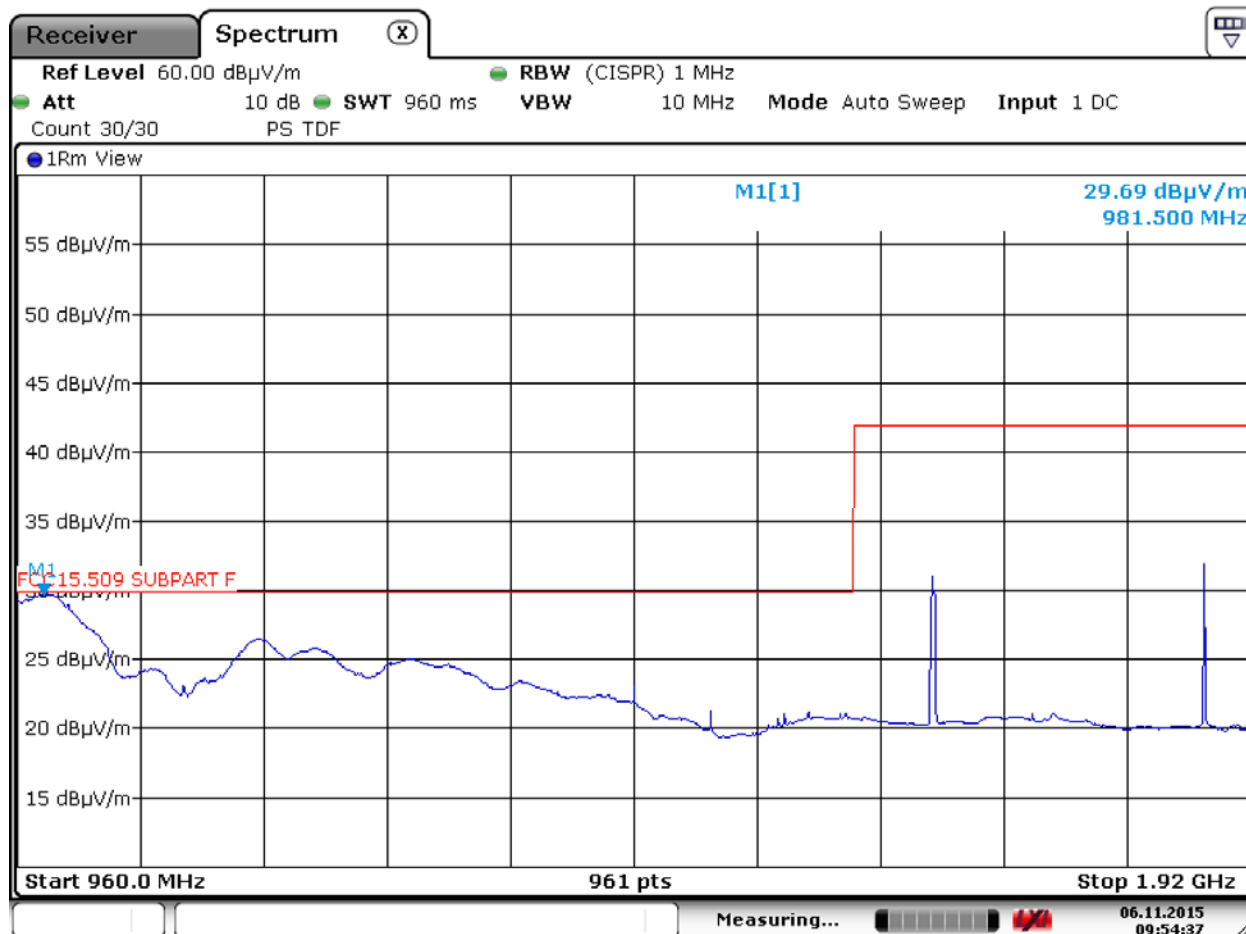
Test Number: 525-15

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6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.2(d))

6.4.5. 960 MHz to 4 GHz at 3 meters



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Note: Using: 1 MHz RBW / 10 MHz VBW and 1mS/MHz RMS Average Detector. There were no other measurable emissions between 1.92 to 4 GHz.

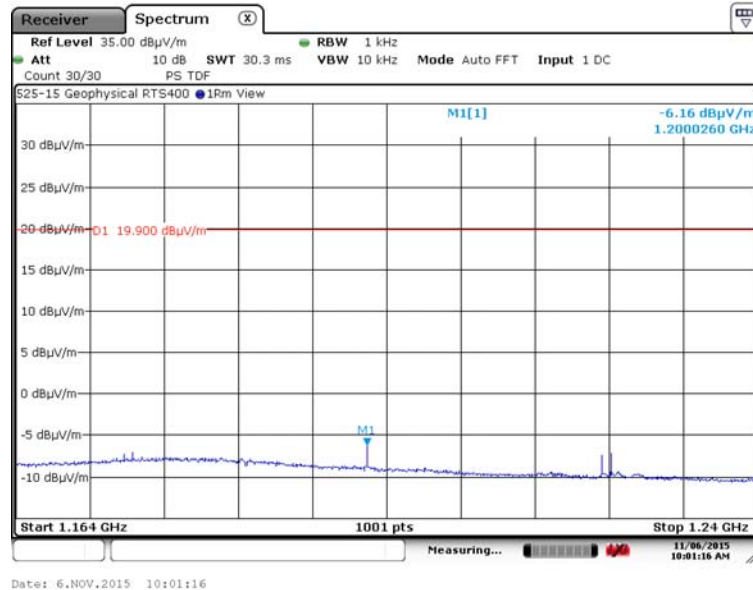
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(d))

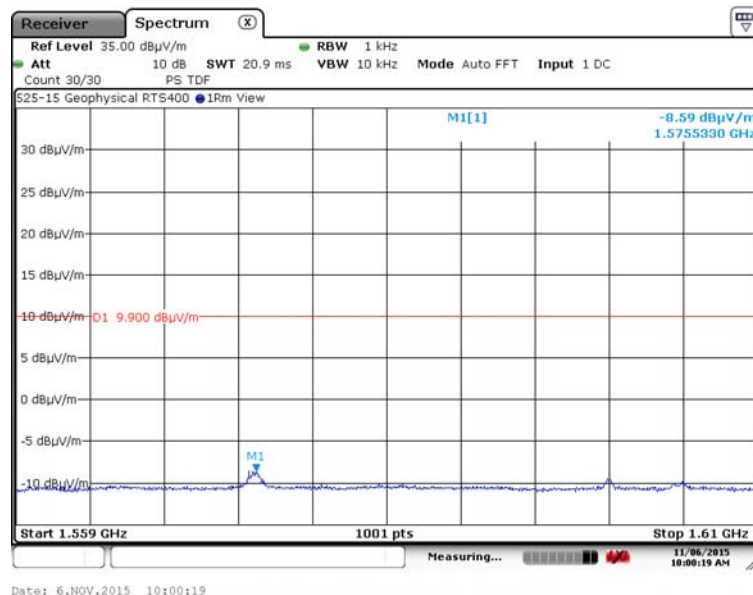
Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2(e))

Measurements were made at 3 Meters and the -75.3 dBm limit was converted to a field strength limit of 19.9 dBμV/m.

6.4.6 1164 to 1240 MHz - Horizontal



6.4.7 1559 to 1610 MHz - Horizontal



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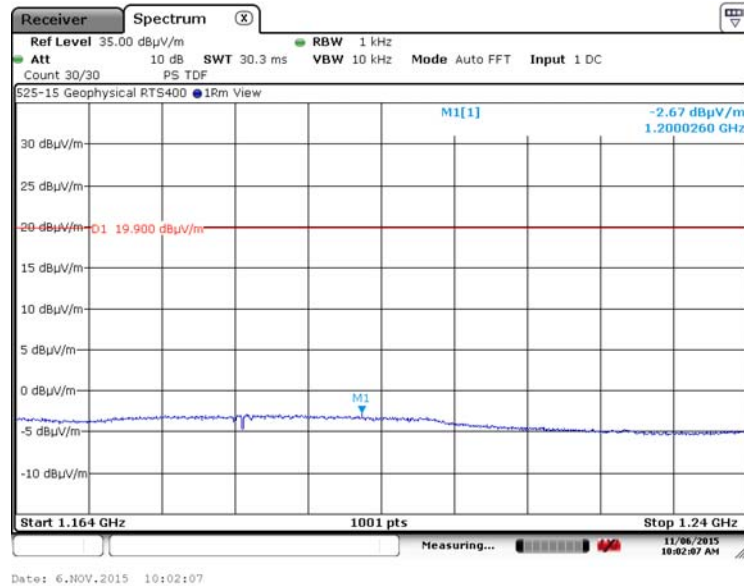
6. Measurement Data (continued)

6.4. Spurious Radiated Emissions (15.509 (d), 15.209, RSS-220 Section 6.1(d))

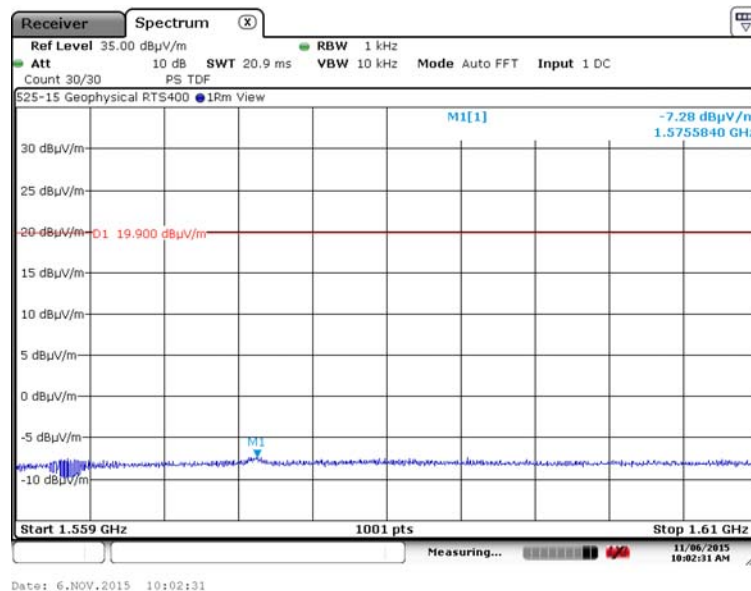
Spurious Radiated Emissions in GPS Bands (15.509 (e), RSS-220 6.2(e))

Measurements were made at 3 Meters and the -75.3 dBm limit was converted to a field strength limit of 19.9 dBμV/m.

6.4.8 1164 to 1240 MHz - Vertical



6.4.9 1559 to 1610 MHz - Vertical



6. Measurement Data (continued)

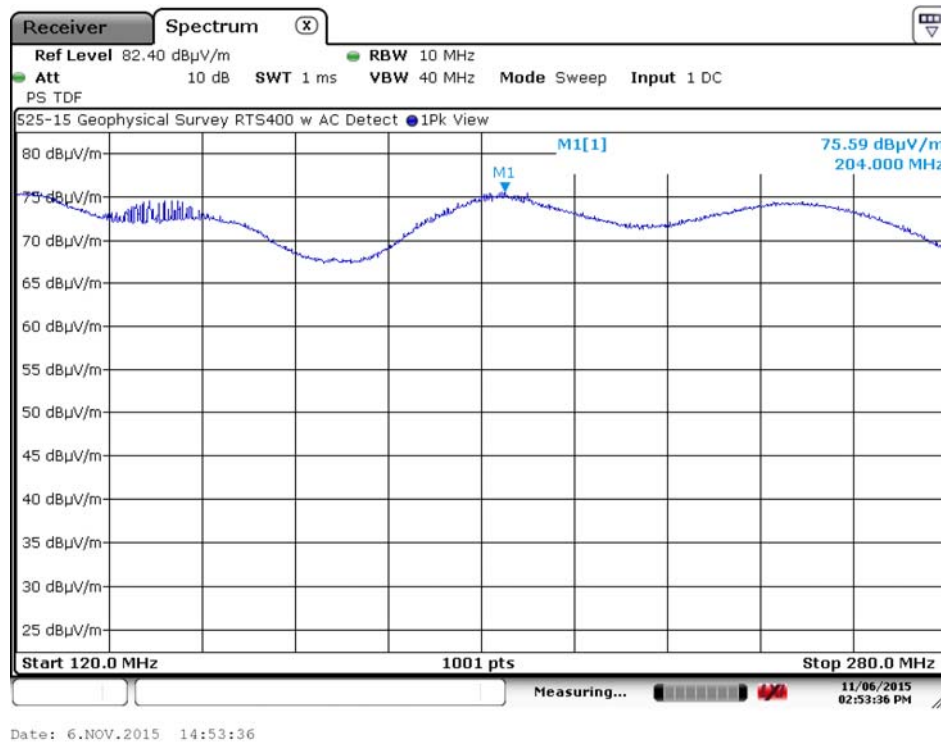
6.5. Peak Emissions in a 50 MHz Bandwidth (15.509 (f), RSS-220 Section 6.2 (g))

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 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.

Freq. (MHz)	Peak Amplitude (dB μ V/m)	Corr. Factor (dB)	Peak Amplitude (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Pol (H/V)	El. (cm)	Az. (deg)
204.000	75.59	Included	75.59	N/A	N/A	V	100	90
960.270	64.77	Included	64.77	81.22	16.45	V	100	90

Note using: 10 MHz RBW / 40 MHz VBW

6.5.1 Plot of Peak Power below 960 MHz



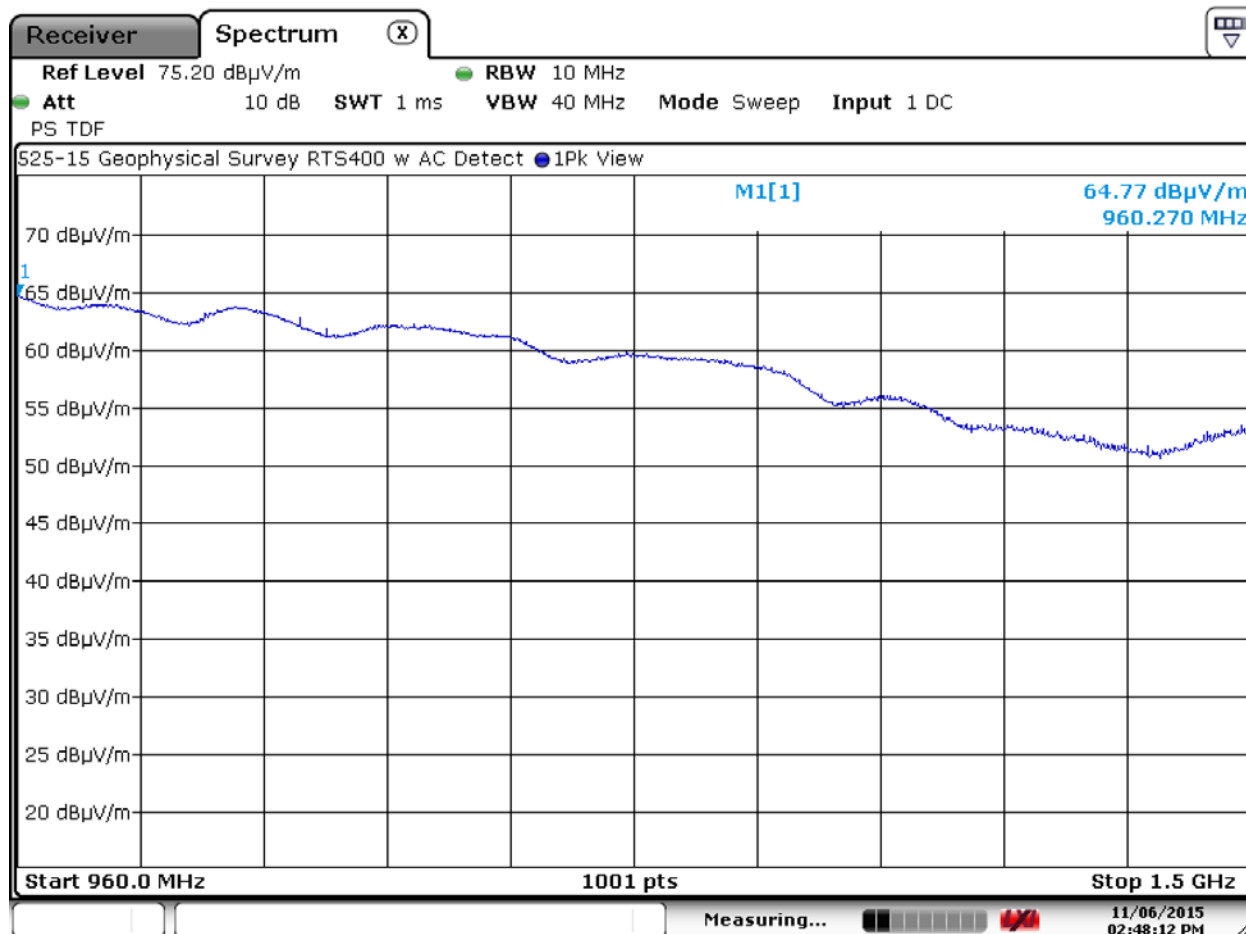
Test Number: 525-15

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6. Measurement Data (continued)

6.5. Peak Emissions in a 50 MHz Bandwidth (15.509 (f), RSS-220 Section 6.2 (g))

6.5.2 Plot of Peak Power above 960 MHz



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6. Measurement Data (continued)

6.6. Regulatory Limit: FCC Part 15.209

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.

6.6.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due
LISN	EMCO	3825/2	9109-1860	7/21/2016
EMI Receiver	Hewlett Packard	8546A	3330A00115	6/2/2016

6.6.2. Measurement & Equipment Setup

Test Date:	N/A
Test Engineer:	N/A
Site Temperature (°C):	N/A
Relative Humidity (%RH):	N/A
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

6.6.3. Test Procedure

Test measurements were made in accordance with ANSI C63.10-2013, Standard Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronics Equipment in the Range of 9 kHz to 40 GHz.

EUT is battery powered and the batteries are recharged using a separate charger not contained in the device.

6. Measurement Data (continued)

6.7. Public Exposure to Radio Frequency Energy Levels (1.1307 (b)(1)), KDB 447498 D01 v06, RSS-GEN 5.5, RSS 102

6.7.1. SAR Test Exclusion

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

The manufacturer's mechanical drawing shows the distance of the EUT's antenna to the handle is 160 mm (see attached page).

Per KDB 447498 Appendix B the approximate power exclusion is 494 mW at 160 mm and 300 MHz.

$$\text{SAR Test Exclusion} = P((\text{numeric threshold}) + (160 - 50 \text{ mm})) \times (f(\text{MHz}) / 150)$$

Per IC RSS-102, Section 2.5.1 Table 1 devices operating ≤ 300 MHz and at a separation distance ≥ 50 mm shall be at or below 345 mW.

The power of the EUT is -0.26 dBm or 0.94 mW and therefore meets the SAR Test exclusion requirements of KDB 447498 D01 and IC RSS-102.

7. Test Images

7.1. Spurious Emissions – 30 MHz – 960 MHz Front



7. Test Images

7.2. Spurious Emissions – 30 MHz – 960 MHz Rear



7. Test Images

7.3. Spurious Emissions – 960 MHz - 18 GHz Front



7. Test Images

7.4. Spurious Emissions – 960 MHz - 18 GHz Rear



8. 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 Federal Communications Commission (FCC) and Industry Canada standards. A description of the test sites is on file with the FCC (registration number **96392**) and Industry Canada (file number **IC 3023A-1**).

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.

Off of 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.

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.

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