

## EMISSIONS TEST REPORT

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Project Number: 3067958

Date: December 16, 2004  
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Evaluation of the Ground Penetration Radar  
Model number: 5101

To

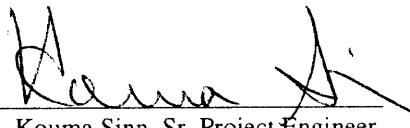
CFR 47 Part 15 Subpart F

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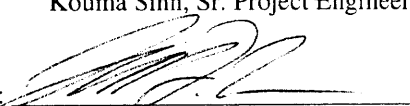
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**EXECUTIVE SUMMARY**

Testing performed for Geophysical Survey Systems, Inc.  
Model Number: 5101

<b>Test Description</b>	<b>FCC Rules Section</b>	<b>Results</b>	<b>Page #</b>
UWB bandwidth <960MHz GPR operated by law enforcement, etc. Eligible for licensing (Part 90) Cease operation 10 seconds after release	15.509 (a)-(c)	PASS	10
Quasi-peak emissions IAW 15.209	15.509(d)	PASS	13
RMS emissions >960MHz	15.509(d)	PASS	16
RMS emissions in GPS bands	15.509(e)	PASS	18
Emission at frequency of highest emission	15.509(f)	PASS	11
Label indicating restricted operation	15.509(g)	PASS	23
Prohibited use Unique antenna Frequency of maximum emission within UWB bandwidth Measurement frequency range	15.521	Client informed	10
Coordination with FCC and NTIA	15.525	Client informed	24

## **1. INTRODUCTION**

### **1.1. Client Information**

Geophysical Survey Systems, Inc.  
13 Klein Drive  
P.O. Box 97  
Salem, NH 03079

Contact: Alan Schutz  
Title: Engineering Director

### **1.2. Test Plan Reference**

47 CFR Part 15 Subpart F – Ultra-wideband operation

### **1.3. Equipment Under Test (EUT)**

The Equipment Under Test (EUT) is a low frequency imaging device operating as a Ground Penetrating Radar (GPR). It is designed to be operated in contact with ground. The EUT is powered by survey controller. A model designated serial number EN1 was received in good condition on December 15, 2004.

#### **1.3.1 System Support Equipment**

Description: Survey controller  
Model: SIR20  
Serial: 1

#### **1.3.2 System Block Diagram**

Figure 1.3-1 shows a block diagram of the test setup.

#### **1.3.3 Justification**

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C63.4 (2001).

The system was rotated every 45°, the antenna height was varied from 1 meter to 4 meters above the ground, and the antenna polarization was changed. The EUT azimuth of maximum emissions was recorded.

This step by step procedure for maximizing emissions led to the data in this report. For measurements using the horn antenna, the horn was tilted to aim at the EUT. At antenna height of 1-4m, the horn was angled at 10° below horizontal (25° if antenna distance =1m). At antenna height of 2.5-4m, the horn was angled at 35° below horizontal (55° if antenna distance =1m).

Radiated emissions were tested in the frequency range up to 10GHz.

#### **1.3.4 Mode(s) of Operation**

The EUT was configured above a sandpit of approximately 3m x 3m x 1.2m. The EUT was set to transmit continuously with its normal operational characteristics. The EUT was operated at a pulse repetition rate (PRR) of 200kHz.

**1.4. Modifications required for compliance**

No modifications were made to the EUT by Intertek Testing Services during these tests.

## 2. TEST ENVIRONMENT

### 2.1. Test facility

The test site used during testing was made in according with FCC Part 15 Subpart F. The test site was constructed with a dimension of 9 ft x 9 ft x 48 inches deep. The whole area was filled with dry sand. The equipment under test (EUT) was placed directly on the sand while the receiving antenna was placed on the blacktop at a distance of 3m from the closest point of the EUT. A groundplane with a dimension of 96.0625 inch X 144.250 inch was placed between the EUT and receiving antenna and connected to earth ground via a ground rod.

### 2.2. Test Equipment

A table of test equipment is presented in Section 9.

### 2.3. Sample Calculations

The following sample calculations were performed to determine compliance with the respective requirements.

#### 2.3.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF + NG - AG$$

where FS = Field Strength in dB $\mu$ V/m

RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB/m

AG = Amplifier Gain in dB

NG = No Groundplane Factor in dB (0dB if ground plane is used)

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB, cable factor of 1.6 dB, and no groundplane factor of 4.7 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 36.7 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB/m}$$

$$CF = 1.6 \text{ dB}$$

$$NG = 4.7 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 36.7 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = [10^{(36.7 \text{ dB}\mu\text{V/m})/20}] = 68.4 \mu\text{V/m}$$

**2.3.2 EIRP Calculation**

In the frequency range above 960MHz, the field strength in dBμV/m measured at 1m and 3m is converted to EIRP in dBm as follows:

$$\text{dBm/m}^2 = \text{dB}\mu\text{V/m} - 90 - 10*\log 377$$

$$\text{dBm} = \text{dBm/m}^2 + 10*\log(4*\pi*3^2) = \text{dB}\mu\text{V/m} - 90 - 10*\log 377 + 10*\log(4*\pi*3^2)$$

$$\text{dBm} = \text{dB}\mu\text{V/m} - 95.2$$

**2.3.3 Spectrum Analyzer Setup**

All RMS measurements >960MHz were taken with the following spectrum analyzer settings:

RBW = 1MHz (or 1kHz in GPS band)

VBW = 3MHz

Detector = RMS

Sweep time = 200 ms



#### **2.4. Measurement Uncertainty**

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.

The expanded uncertainty ( $k = 2$ ) for radiated emissions from 30 to 1000 MHz has been determined to be:

±4.2 dB at 10m

±5.5 dB at 3m

The expanded uncertainty ( $k = 2$ ) for radiated emissions from 1 to 18 GHz has been determined to be:

±4.6 dB at 3m

±4.5 dB at 1m

The expanded uncertainty ( $k = 2$ ) for radiated emissions from 18 to 40 GHz has been determined to be:

±4.2 dB at 1m

The expanded uncertainty ( $k = 2$ ) for mains conducted emissions from 150 kHz to 30 MHz has been determined to be:

±2.6 dB

### **3. ULTRA WIDEBAND OPERATION**

#### **3.1. Operational Limitations (section 15.521)**

The EUT is subject to the following limitations related to GPR. The client has been informed of these requirements.

- a. pursuant to 15.203 and 15.204, the EUT must use a permanently attached antenna or an antenna that uses a unique connector. Additionally, no ‘after-market’ amplifiers or antenna modifications may be made without further demonstration of system compliance.
- b. Emissions not intended to be radiated from the transmitter’s antenna must comply with section 15.209
- c. Manufacturer (or representative) is responsible for ensuring that EUT is marketed only to:
  - law enforcement
  - fire or emergency organizations
  - scientific research institutes
  - commercial mining companies
  - construction companies

#### **3.2. UWB Bandwidth (section 15.503(a))**

The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated UWB emission. 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  $f_M$ .

##### **3.2.1 Requirement (low-frequency imaging systems)**

The UWB bandwidth of low frequency imaging systems must be contained below 960MHz.

##### **3.2.2 Test Procedure**

- 1) With the EUT set up as specified in 1.3 above, set up the log periodic antenna at a distance of 3m from the EUT. Using the analyzer/receiver, measure emissions from the EUT at frequencies above 30MHz.
- 2) Maximize the emissions by rotating the EUT in 45° increments.
- 3) Maximize the emissions by varying the antenna height from 1 – 4m and changing antenna polarization.
- 4) Record all emissions from the EUT. Due to the broadband nature of the emissions, significant care must be taken to capture the true spectrum of the emission. This may require measurements with extremely narrow sweep widths.
- 5) Verify that the measured spectrum allows resolution of levels 10dB below the maximum level, both above and below the frequency of maximum emission.

##### **3.2.3 Test Results**

The model 5101 complies with the requirement. The frequency of maximum emission ( $f_M$ ) is 242.2525 MHz. The lower boundary frequency ( $f_L$ ) is 212.5632 MHz. The upper boundary frequency ( $f_H$ ) is 480.0982 MHz.

The following table shows the final results of measurements made in accordance with FCC Subpart 15.503 and the above procedure. A plot of the final data is shown in Figure 3.2-1A and 3.2-1B.

**3.3. Center Frequency (section 15.503(b))**

The center frequency,  $f_C$ , of a UWB device is defined as  $(f_H + f_L)/2$ .

**3.3.1 Requirement**

The center frequency,  $f_C$ , is used to define the fractional bandwidth as well as the minimum required measurement band.

**3.3.2 Test Procedure**

The center frequency,  $f_C$ , is determined from the data obtained in 3.2 above.

**3.3.3 Test Results**

From 3.2:

$f_L = 212.5632$  MHz

$f_H = 480.0982$  MHz

The center frequency  $f_C = (212.5632 + 480.0982)/2 = 346.3307$  MHz

**3.4. Fractional Bandwidth (section 15.503(c-d))**

The fractional bandwidth of a device is defined as:

$$BW_f = (f_H - f_L)/f_C$$

**3.4.1 Requirement**

A UWB transmitter is one that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

**3.4.2 Test Procedure**

The fractional bandwidth is determined using the frequencies defined in 3.2 and 3.3 above.

**3.4.3 Test Results**

From 3.2 and 3.3:

$f_L = 212.5632$  MHz

$f_H = 480.0982$  MHz

$f_C = 346.3307$  MHz

The fractional bandwidth  $BW_f = 0.7725$ . The unit complies with the requirement for fractional bandwidth.

**3.5. Peak Emissions 50MHz Resolution Bandwidth (Section 15.509(f))**

The peak emission as defined by this section is the emission (in EIRP) contained within a 50MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ .

Peak radiated emission measurements shall be made using a spectrum analyzer with a 3 MHz resolution bandwidth and no less than a 3 MHz video bandwidth. The analyzer should be used in a maximum-hold trace mode. The peak power level expressed in a 3 MHz bandwidth and the frequency at which this level was measured shall be reported in the application for certification.

**3.5.1 Limit**

The peak emission in a 50MHz bandwidth centered on  $f_M$  must be limited to a maximum of 0dBm EIRP.

**3.5.2 Test Procedure**

- 1) Using the results of 3.2 above, determine the frequency of maximum emissions  $f_M$ .
- 2) With the EUT set up as specified in 1.3 above, set up the log periodic antenna at a distance of 3m from the EUT.
- 3) Using the analyzer/receiver, measure emissions from the EUT at  $f_M$ .

- 4) Place the analyzer/receiver as follows:
  - max hold
  - peak detector
  - RBW=3MHz
  - VBW=3MHz
  - Span=0
- 5) Maximize the emissions by varying the antenna height from 1 – 4m and changing antenna polarization.  
Maximize the emission by rotating the EUT in 45° increments.
- 6) Record the peak emissions from the EUT.

### 3.5.3 Test Results

The peak emission (using a 3MHz RBW) from the EUT at 979.359 MHz is 60.8 dBuV/m. The following table shows the final results of measurement made in accordance with 15.509(f).

#### Peak Emission Contains Within a 50MHz Bandwidth

Company: Geophysical Survey Systems, Inc.	Model #: 5101
Engineer: Kouma Sinn	Location: 2
Project #: 3067958	Pressure: 1015 mbar
Date: 12/15/04	Temp: 6 C
Standard: FCC Part 15 Subpart F	Humidity: 32%
Class: None	Group: None
Limit Distance: 3 meters	Test Distance: 1 meters
Voltage/Frequency: Powered from SIR20	Frequency Range: 979.359 MHz
EUT Pulse Rate: 200kHz	

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS											
Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
PK	H	979.359	60.0	27.0	2.6	19.2	9.5	60.8	95.2	-34.4	3MHz

Note: Reading includes 20\*Log(3/50) dB

#### 4. RADIATED EMISSIONS

##### 4.1. Section 5.209(d) Quasi-Peak

##### 4.1.1 Limit

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (iV/m)	Field Strength (dBV/m)	Measurement distance (m)
0.009 - 0.490	2400/f(kHz)	67.6-20*log(f(kHz))	300
0.490 - 1.705	24000/f(kHz)	87.6-20*log(f(kHz))	30
1.705 - 30.0	30	29.5	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3

- (a) In the emission table above, the tighter limit applies at the band edges.
- (b) The level of any unwanted emissions from an intentional radiator shall not exceed the level of the fundamental emission.
- (c) The limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency.

##### 4.1.2 Test Procedure

Procedures for measurement in the frequency range of below 960 MHz are those used to show compliance with FCC Section 15.209.

- 1) Set the antenna to the measurement distance specified in the applicable standard.
- 2) With the analyzer bandwidth set to 120kHz, monitor the frequency range <960 MHz using a peak detector mode. It is recommended to demodulate the received signals for convenient discrimination of ambient emissions from those emanating from the EUT.
- 3) Upon detection of a suspect signal note its amplitude and frequency.
- 4) Manipulate EUT system cables to maximize emission levels. At each measurement frequency, maximize the emission by rotating the EUT in 45° increments.
- 5) Move the antenna over the range 1m – 4m to maximize the suspected highest amplitude observation and proceed.
- 6) Change the polarity of the antenna and repeat steps (2) and (3). Compare the resulting suspected highest amplitude signal with that found for the other polarity. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.
- 7) The effects of various modes of operation shall be examined. Examine all possible operating modes and, if possible, vary the modes while steps (2) – (6) are being performed.
- 8) After completing steps (2) through (7), record the final EUT configuration, mode of operation, and cable configuration to use for the remaining radiated emission test.
- 9) Verify that all components of the measurement system (antenna, cables, and analyzer) have valid calibration tags and are within the prescribed calibration interval. If an out-of-calibration condition exists, notify the supervisor. Verify that the site is clear of reflecting objects.
- 10) Check the calibration of the analyzer, using either its internal calibration signal or an external source.
- 11) With the resolution bandwidth set to 120kHz and using peak detector mode, set the span of analyzer to that consistent with resolving individual emissions.
- 12) Re-maximize emissions from the EUT (rotating the EUT in 45° increments) at the worst-case combinations of frequency, antenna height and polarization. Use small variations in placement consistent with the applicable standard.

- 13) Increment the span of the analyzer such that the EUT spectrum <960MHz is measured. At the worst-case combinations of EUT operating mode, azimuth, frequency and antenna height and polarization, record the field strength measurements using the Peak detector mode. At least 6 emissions that are within 20dB of the applicable limit shall be recorded. (This method applies to emissions that are not intended to be radiated from the transmitter's antenna. Any emissions that are intended to be transmitted via the antenna are instead measured using the procedures of section 4.2 and 4.3 herein.) At each of these frequencies, record the final field strength measured using a Quasi-Peak detector. Record the values of the parameters listed in this paragraph.
- 14) Verify that all emissions recorded in step (13) comply with the limits shown in Section 4.1.1.
- 15) Document the final emissions configuration of the EUT, using either photographs or diagrams.

#### **4.1.3 Test Results**

The following table shows the final results of measurements made in accordance with FCC Subpart 15.209 and the above procedure. No signals detected <30MHz.

**Radiated Emissions / Interference**

Company: Geophysical Survey Systems, Inc. Model #: 5101  
 Engineer: Kouma Sinn Location: 2 Serial #: EN1  
 Project #: 3067958 Pressure: 1015 mbar Receiver: HP 8546A  
 Date: 12/15/04 Temp: 6 C Antenna: LOG3-V3 LOG3-H3  
 Standard: FCC Part 15 Subpart F Humidity: 32% PreAmp: Internal preamp was turned on  
 Class: None Group: None Cable(s): CBLSHF103  
 Limit Distance: 3 meters Test Distance: 3 meters  
 Voltage/Frequency: Powered from SIR20 Frequency Range: 30-960MHz  
 EUT Pulse Rate: 200kHz

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	H	37.500	22.3	14.9	0.4	0.0	0.0	37.6	40.0	-2.4	120kHz
QP	V	49.330	18.9	9.2	0.4	0.0	0.0	28.6	40.0	-11.4	120kHz
QP	V	122.600	31.0	7.3	0.8	0.0	0.0	39.0	43.5	-4.5	120kHz
QP	V	158.900	13.2	9.2	0.9	0.0	0.0	23.3	43.5	-20.2	120kHz
QP	V	198.400	15.0	11.1	1.0	0.0	0.0	27.0	43.5	-16.5	120kHz
QP	V	242.500	16.0	12.5	0.9	0.0	0.0	29.4	46.0	-16.6	120kHz
QP	V	276.000	15.5	13.5	1.0	0.0	0.0	30.0	46.0	-16.0	120kHz
QP	V	279.400	13.3	13.7	1.0	0.0	0.0	28.0	46.0	-18.0	120kHz
QP	V	321.900	13.9	14.5	1.2	0.0	0.0	29.7	46.0	-16.3	120kHz
QP	V	327.000	14.0	14.6	1.3	0.0	0.0	29.8	46.0	-16.2	120kHz
QP	V	447.000	13.0	17.9	1.6	0.0	0.0	32.5	46.0	-13.5	120kHz
QP	V	561.600	13.0	19.0	1.9	0.0	0.0	33.8	46.0	-12.2	120kHz
QP	V	610.000	3.5	19.9	2.0	0.0	0.0	25.3	46.0	-20.7	120kHz
QP	V	679.900	4.4	19.8	2.1	0.0	0.0	26.3	46.0	-19.7	120kHz

SIR20 - emission from SIR20

**4.2. Section 15.509(d) RMS >960MHz****4.2.1 Limit**

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. RMS average field strength measurements, required for all frequencies above 960 MHz, shall be made using techniques to obtain true RMS average.

Frequency MHz	EIRP dBm	EIRP dBμV/m
960-1610	-65.3	29.9
1610-1990	-53.3	41.9
Above 1990	-51.3	43.9

**4.2.2 Test Procedure**

- 1) Set up the EUT above the sand at a height typical of normal installation. Record the height.
- 2) Operate the EUT in a continuous mode during all tests. (e.g. – If the EUT uses a gated transmitter, configure it such that the transmitter is gated on continuously).
- 3) Set up the log-periodic antenna in horizontal polarization at a distance of 3m from the EUT.
- 4) Rotate the EUT 45°. Set the analyzer to max hold and adjust the height of the measuring antenna from 1-4m and vary the polarization. Record the maximum level and the angle of rotation if it is higher than the level measured in the previous step. Continue to rotate the EUT in 45° increments until the maximum orientation is determined.
- 5) Set up the analyzer as follows:  
RBW=1MHz  
VBW=3MHz  
Detector=RMS  
Sweep=200ms  
Frequency=960MHz
- 6) Replace the log-periodic antenna with the EMCO 3115 horn antenna.
- 7) Rotate the antenna to an inclination of –10°.
- 8) Set the analyzer to max hold and adjust the height of the measuring antenna from 1-2.5m and vary the polarization. Maximize the emission by rotating the EUT in 45° increments. Record the maximum level.
- 9) Rotate the antenna to an inclination of –35° and adjust the height of the measuring antenna from 2.5-4m and vary the polarization.
- 10) Set the antenna height & orientation to the maximum as determined above.
- 11) Record the maximum emission.

**4.2.3 Test Results**

A table of final data follows:



**Radiated Emissions / Interference**

Company: Geophysical Survey Systems, Inc. Model #: 5101  
 Engineer: Kouma Sinn Location: 2 Serial #: EN1  
 Project #: 3067958 Pressure: 1015 mbar Receiver: Rohde & Swartz  
 Date: 12/15/04 Temp: 6 C Antenna: HORN2-V1m HORN2-H1m  
 Standard: FCC Part 15 Subpart F Humidity: 32% PreAmp: PRE8  
 Class: None Group: None Cable(s): CBLSHF103 CBLSHF102  
 Limit Distance: 3 meters Test Distance: 1 meters  
 Voltage/Frequency: Powered from SIR20 Frequency Range: 960MHz-10GHz  
 EUT Pulse Rate: 200kHz

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
RMS	H	960.000	18.3	27.0	2.6	19.2	9.5	19.1	29.9	-10.8	1MHz
RMS	H	962.000	18.7	27.0	2.6	19.2	9.5	19.5	29.9	-10.4	1MHz
RMS	H	968.000	19.3	27.0	2.6	19.2	9.5	20.1	29.9	-9.8	1MHz
RMS	H	974.500	20.0	27.0	2.6	19.2	9.5	20.9	29.9	-9.0	1MHz
RMS	H	984.400	19.5	27.0	2.7	19.2	9.5	20.4	29.9	-9.5	1MHz
RMS	H	995.000	19.3	27.0	2.7	19.2	9.5	20.2	29.9	-9.7	1MHz
RMS	H	1164.000	17.5	25.5	3.0	19.3	9.5	17.2	29.9	-12.7	1MHz
RMS	H	1211.000	17.7	25.6	3.1	19.3	9.5	17.5	29.9	-12.4	1MHz
RMS	H	1044.000	28.9	25.4	2.9	19.2	9.5	28.4	29.9	-1.5	1MHz
RMS	H	1130.260	27.5	25.5	2.9	19.3	9.5	27.1	29.9	-2.8	1MHz
RMS	H	1272.500	27.1	25.6	3.1	19.3	9.5	26.9	29.9	-3.0	1MHz
RMS	H	1358.700	28.1	25.7	3.2	19.3	9.5	28.2	29.9	-1.7	1MHz
RMS	H	1486.900	25.3	25.8	3.4	19.4	9.5	25.5	29.9	-4.4	1MHz
RMS	H	1635.270	24.7	26.5	3.5	19.4	9.5	25.8	41.9	-16.1	1MHz

**4.3. Section 15.5509(e) RMS GPS bands****4.3.1 Limit**

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 1kHz. RMS average field strength measurements, required for all frequencies above 960 MHz, shall be made using techniques to obtain true RMS average.

Frequency MHz	EIRP dBm	EIRP dBμV/m
1164 – 1240	-75.3	19.9
1559 - 1610	-75.3	19.9

**4.3.2 Test Procedure**

- 12) Set up the EUT above the sand at a height typical of normal installation. Record the height.
- 13) Operate the EUT in a continuous mode during all tests. (e.g. – If the EUT uses a gated transmitter, configure it such that the transmitter is gated on continuously).
- 14) Set up the log-periodic antenna in horizontal polarization at a distance of 3m from the EUT.
- 15) Rotate the EUT 45°. Set the analyzer to max hold and adjust the height of the measuring antenna from 1-4m and vary the polarization. Record the maximum level and the angle of rotation if it is higher than the level measured in the previous step. Continue to rotate the EUT in 45° increments until the maximum orientation is determined.
- 16) Set up the analyzer as follows:  
RBW=1kHz  
VBW=3MHz  
Detector=RMS  
Sweep=200ms  
Frequency=960MHz
- 17) Replace the log-periodic antenna with the EMCO 3115 horn antenna.
- 18) Rotate the antenna to an inclination of –10°.
- 19) Set the analyzer to max hold and adjust the height of the measuring antenna from 1-2.5m and vary the polarization. Maximize the emission by rotating the EUT in 45° increments. Record the maximum level.
- 20) Rotate the antenna to an inclination of –35° and adjust the height of the measuring antenna from 2.5-4m and vary the polarization.
- 21) Set the antenna height & orientation to the maximum as determined above.
- 22) Record the maximum emission.

**4.3.3 Test Results**

A table of final data follows:

**Radiated Emissions / Interference**

Company: Geophysical Survey Systems, Inc. Model #: 5101  
 Engineer: Kouma Sinn Location: 2 Serial #: EN1  
 Project #: 3067958 Pressure: 1015 mbar Receiver: Rohde & Swartz  
 Date: 12/15/04 Temp: 6 C Antenna: HORN2-V1m HORN2-H1m  
 Standard: FCC Part 15 Subpart F Humidity: 32% PreAmp: PRE8  
 Class: None Group: None Cable(s): CBLSHF103 CBLSHF102  
 Limit Distance: 3 meters Test Distance: 1 meters  
 Voltage/Frequency: Powered from SIR20 Frequency Range: 1164-1240MHz and 1559-1610MHz  
 EUT Pulse Rate: 200kHz

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
RMS	H	1167.000	2.3	25.5	3.0	19.3	9.5	2.0	19.9	-17.9	1kHz
RMS	H	1192.300	3.4	25.6	3.1	19.3	9.5	3.2	19.9	-16.7	1kHz
RMS	H	1201.000	1.7	25.6	3.1	19.3	9.5	1.5	19.9	-18.4	1kHz
RMS	H	1230.700	2.1	25.6	3.1	19.3	9.5	1.9	19.9	-18.0	1kHz
RMS	H	1559.000	-1.9	26.1	3.4	19.4	9.5	-1.3	19.9	-21.2	1kHz
RMS	H	1585.400	0.6	26.2	3.5	19.4	9.5	1.4	19.9	-18.5	1kHz
RMS	H	1609.300	-0.5	26.3	3.6	19.4	9.5	0.5	19.9	-19.4	1kHz

## 5. AC MAINS CONDUCTED EMISSIONS

### 5.1.1 Limit

The following table shows the line-conducted emission limits for FCC Part 15 Subpart B Section 15.207 and CISPR 22 Amend 1- 2002:

Frequency (MHz)	Conducted Limit dBmV	
	QP	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 to 30	60	50

\*Limits decrease linearly with logarithm of the frequency.

### 5.1.2 Test Procedure

- 1) All conducted voltage measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord or calibrated extension by the use of mating plugs and receptacles on the EUT and LISN/AMN if used. Equipment shall be tested with power cords that are normally used or that have electrical and shielding characteristics that are the same as those cords normally used. For those measurements using a LISN/AMN, the 50  $\Omega$  measuring port is terminated by a 50  $\Omega$  receiver or a 50  $\Omega$  resistive load. Hence all 50  $\Omega$  measuring ports of the LISN/AMN are terminated by 50  $\Omega$ . **CAUTION: Observe safety precautions appropriate to hazardous mains or power line voltages, such as de-energizing circuits and tagging/lockout procedures.**
- 2) The EUT shall be placed 40 cm from the vertical ground plane 40 cm away from the rear of the EUT.
- 3) The EUT should be set up in its typical configuration
- 4) Each EUT current-carrying power lead, except the ground (safety) lead, shall be individually connected through a LISN/AMN to the input power source. **Note especially the supply of the appropriate power voltage and frequency.** All unused 50  $\Omega$  connectors of the LISN/AMN shall be resistively terminated when not connected to the measuring instrument. When the test configuration comprises multiple units that have their own individual power cords, AC power line conducted emissions measurements shall be performed with the line cord of the EUT connected to one LISN/AMN that is connected to the receiver. Those power cords for the units in the remainder of the configuration not under measurement shall be connected to a multiple outlet, which in turn shall be connected to a LISN/AMN different from the LISN/AMN used for the power cord of the EUT. Adapters connected between the EUT power cord plug and the LISN/AMN power socket shall be less than 20cm long and contain only one plug and one outlet.
- 5) The excess length of the lead between the EUT and the LISN/AMN receptacle (or mains outlet where a LISN/AMN cannot be used) shall be folded back and forth at the center of the lead to form a bundle not exceeding 40cm in length. If the EUT does not have a flexible power lead, it shall be placed at a distance of 80cm from the LISN/AMN (or mains outlet where a LISN/AMN cannot be used) and connected to it by a lead or appropriate connection no longer than 1m. Measurements shall be made at the LISN/AMN end of this lead or connection.
- 6) The LISN/AMN housing, receiver case ground, conducting ground plane and vertical conducting surface (if any) shall be bonded together. Care shall be taken to assure an adequate RF bonding of the LISN/AMN to the conducting ground plane.
- 7) Set the receiver bandwidth to the correct value for the measurement frequency range and monitor the entire frequency range for which a limit is specified (or a subset) using a peak detector mode.
- 8) For each mode of operation of the EUT and for each current-carrying conductor, manipulate the system cables or wires to produce the highest amplitude signal relative to the limit. Record the final EUT configuration, mode of operation, cable configuration and current-carrying conductor that produced the highest emissions relative to the test limit.
- 9) Based on the preliminary scan of the EUT, select the one EUT and cable or wire configuration and mode of operation that produced the emission with the highest amplitude relative to the applicable limit. If the EUT is relocated from a preliminary test site to a final test site, the highest emissions shall be re-maximized at the

final test location, by cable manipulation within the constraints of the applicable standard. If no preliminary scan was performed, the worst-case configuration must be determined during the course of the final scan.

- 10) Set the receiver to quasi-peak detector mode. Set the span of the receiver to the maximum consistent with resolving individual emissions. Record the six highest emissions relative to the limit for all the current-carrying conductors of the power cords that comprise the EUT, over the frequency range specified in the relevant standard.
- 11) Document the final emissions configuration of the EUT, using either photographs and/or diagrams.

#### **5.1.3 Test Results**

Conducted emissions limits are not applicable as in normal operation the unit is powered from internal battery of the survey controller.

**6. TEST SETUP PHOTOGRAPHS**

Photographs of the test setup are submitted as a separate exhibit with the filename:

5101 setup.doc

## **7. LABELING AND INSTRUCTION MANUAL**

Prior to marketing, the EUT shall be labeled in accordance with 15.19. In addition to the application of the FCC ID, the following statement shall be permanently affixed in a conspicuous location:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

In addition, the following statement shall be permanently affixed in a conspicuous location:

Operation of this device is restricted to law enforcement, fire and rescue officials, scientific research institutes, commercial mining companies, and construction companies. Operation by any other party is a violation of 47 U.S.C. § 301 and could subject the operator to serious legal penalties.

**8. OPERATING COORDINATION (15.525)**

Geophysical Survey Systems, Inc. shall inform the users of UWB devices that they are required to provide usage information to the National Telecommunication and Information Administration, including company contact information and proposed geographical area of operation. Further details of the submittals are found in 47 CFR subsection 15.525.



**9. EQUIPMENT LIST**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial</b>	<b>Calibration due</b>
Preamp	Miteq	NSP4000-NF	507145	11/16/2005
Antenna	EMCO	3142	9711-1224	02/03/2005
Antenna	EMCO	3115	9602-4675	09/20/2005
Cable	Sucoflex (Huber Suhner)	104PE	CBLSHF102	06/07/2005
Cable	Sucoflex (Huber Suhner)	104PE	CBLSHF103	06/07/2005
Spectrum Analyzer	Hewlett Packard	8546A	3410A00173	04/12/2005
Spectrum Analyzer	Rohde & Swartz	FSEK30	100225	06/04/2005

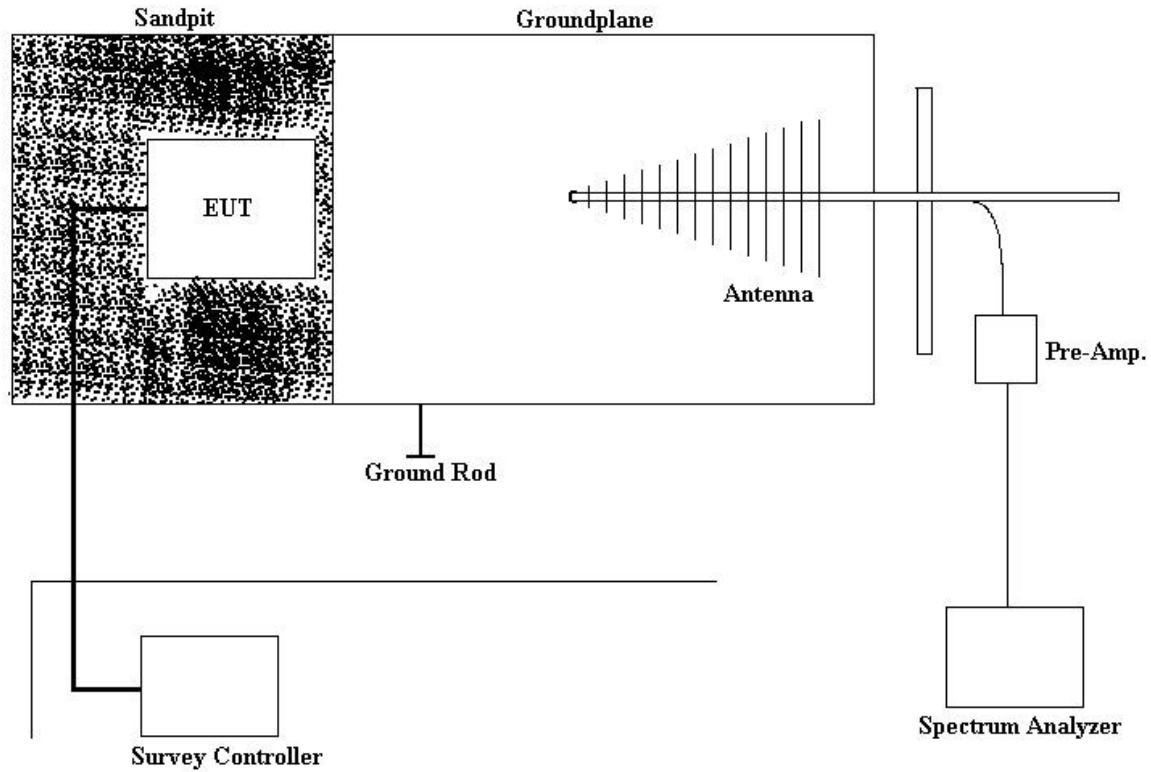


FIGURE 1.3-1 TEST SETUP BLOCK DIAGRAM (M/N 5101)

**Cables Used With EUT:**

- (1) Antenna Cable (1.5 Meters, Unshielded, Plastic Hood)
- (1) Control Cable (3 Meters, Shielded, Metal Hood)
- (1) Power Cable (2 Meters, Shielded, Metal Hood)
- (1) Deadman Switch (1 Meter, Unshielded, Coiled, Plastic Hood)

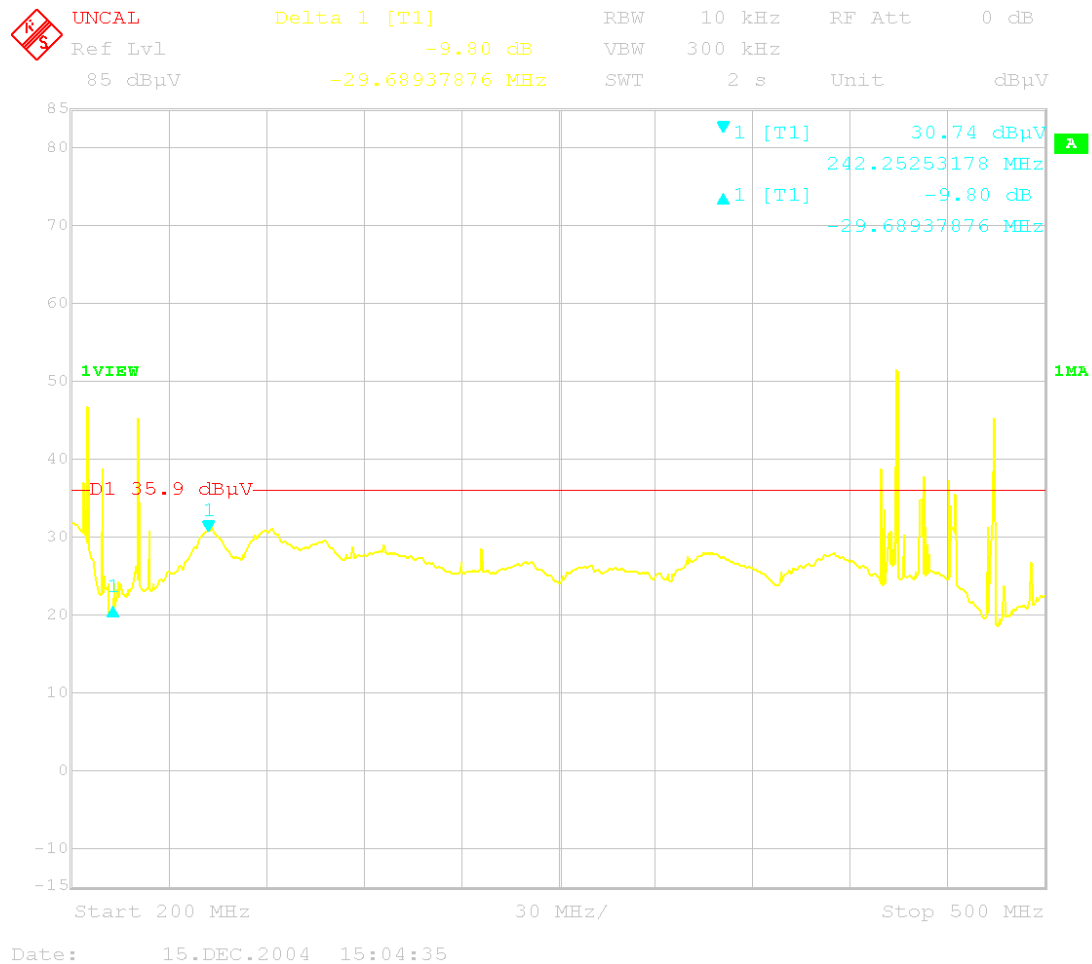


FIGURE 3.2-1A 5104 10dB BANDWIDTH

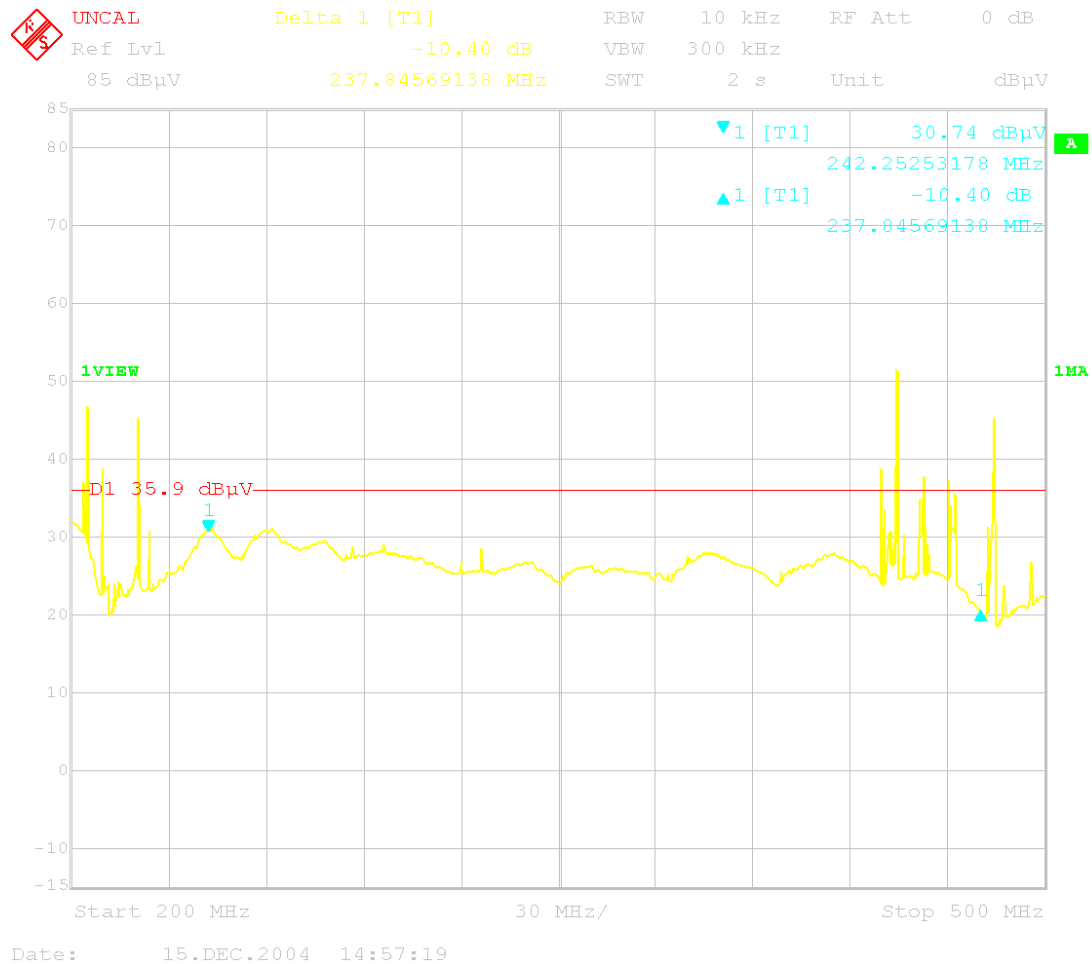


Figure 3.2-1B 510110dB BANDWIDTH

**10. REVISION HISTORY**

4 February2003	Issue date