Emissions Testing
Performed
on the

Geophysical Survey Systems, Inc.
Ultra-Wideband Ground Penetrating Radar
Model: 5100
To
FCC Part 15 Subpart F

Date of Test: May 22 and 23, 2002 and June 5, 2002

Project: 3025094

Contact: Mr. Alan Schutz

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This report is designed to show compliance with the FCC Part 15F for Ultra-Wideband Transmission Systems. The test procedures, as described in American National Standards Institute C63.4-1992, and FCC Part 15F were employed. A description of the product and operating configuration, the various provisions of the rules, the methods for determining compliance, and a detailed summary of the results are included within this test report.

1.0 Introduction and Conclusions

On May 22 and 23, and June 5, 2002, we tested the Ultra-Wideband Ground Penetrating Radar, Model: 5100, to determine if it was in compliance with the FCC Part 15 Subpart F emissions limits. We found that the unit met the FCC Part 15F requirements when tested as received.

Conclusion:

In summary, this report verifies that the Ultra-Wideband Ground Penetrating Radar, Model: 5100, met the FCC Part 15F requirements when production units conform to the initial sample. Please address all questions and comments concerning this report to Scott Lambert, Engineering Team Leader.

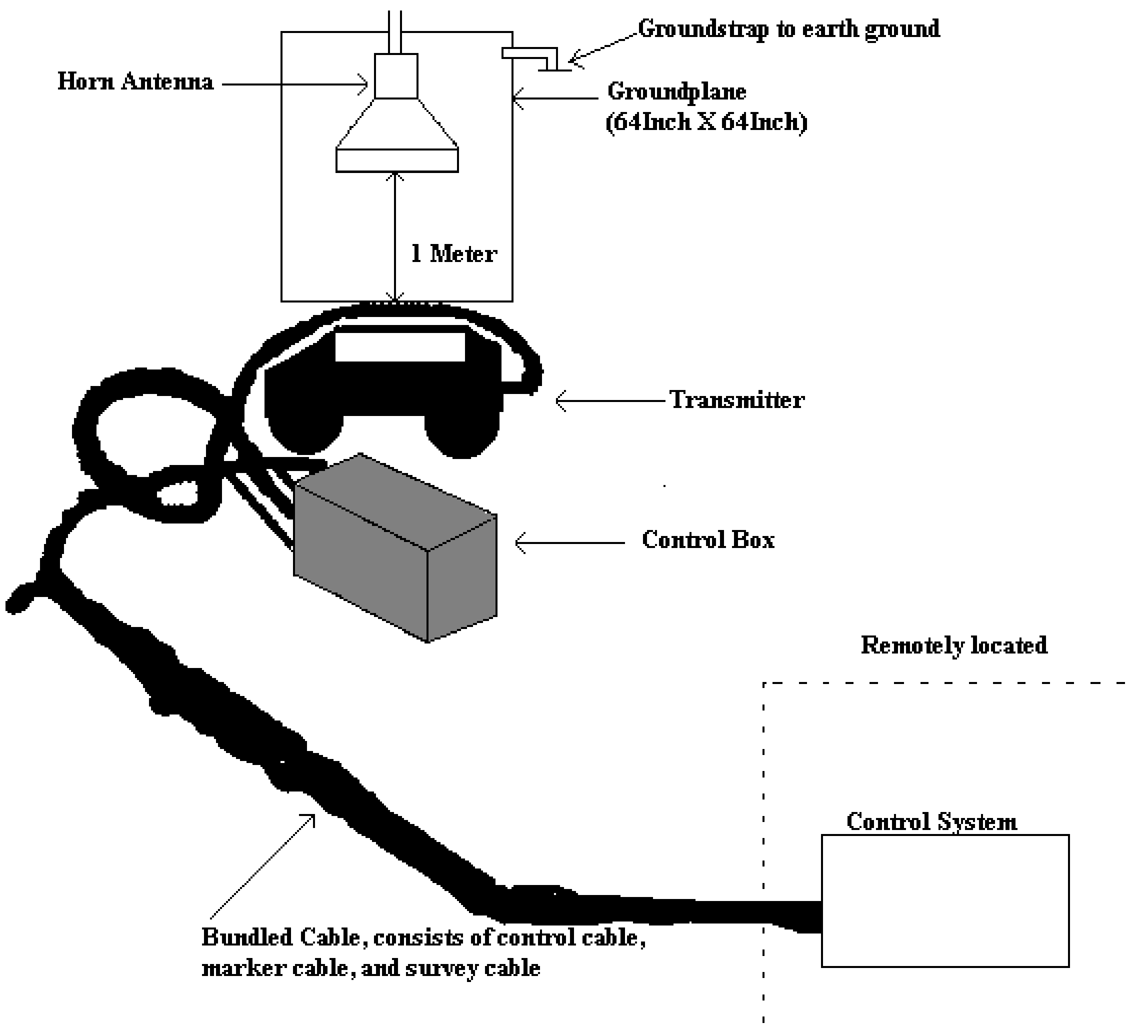
2.0 Description of the Product

2.1 Brief Description and Received Condition

The equipment under test (EUT) is an Ultra-Wideband Ground Penetrating Radar
A production version of the sample was received on May 22, 2002 in good condition.

2.2 System Block Diagram

The diagram shown below details the placement of the equipment under test on the sand pit. The horn antenna and biconolog antenna were mounted on antenna mast at 1 meter above the ground. Please note that measurements were made at 3 meters for frequencies below 960MHz and the groundplane was not used.



2.3 System Test Configuration

Equipment Under Test: Ultra-Wideband Ground Penetrating Radar

Model No.: 5100

Serial No.: 1091

FCC Identifier: Not Labelled

Support Equipment:

Description: Control System
Manufacturer: Geophysical Survey Systems, Inc.
Model No.: Not Labeled
Serial No.: Not Applicable

Description: Survey Systems AC Adapter
Manufacturer: Sceptre
Part No.: PS-1586A
Serial No.: SPU130-106

Cables:

QTY	Description	Shield Description	Hood Description	Length (m)
1	AC Power cord	None	Plastic	2
1	AC Adapter cable	None	Plastic	2
1	Control Cable (from control box to transmitter)	Braid	Metal/360º Termination	1
1	Control Cable*	Braid	Metal/360º Termination	15

*Bundled cable, consists of control cable, marker cable, and survey cable.

2.4 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 (1992).

Initial testing was performed to maximize emissions. 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 and all subsequent testing was performed with the EUT in that position.

During final testing, the antenna height was varied from 1 meter to 4 meters above the ground, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data in this report.

Radiated emissions were tested in the range of 30 MHz to 9.6 GHz.

2.5 Description of how EUT was exercised during test

The unit was transmitting RF energy directly into the sand to detect buried objects. The unit was operated and monitored remotely. The unit was set to a PRF of 200kHz.

2.6 Modifications Required for Compliance

No modifications were installed by Intertek Testing Services. (Please note that this does not include changes made specifically by Geophysical Survey Systems prior to compliance testing).

3.0 Radiated Emission

3.1 Radiated Emissions Limits

The following table shows the radiated emission limits for FCC Part 15F

Frequency (MHz)	Imaging, below 960MHz	Imaging, Mid-Frequency	Imaging, High Frequency	Indoor Applications	Hand held, including outdoor	Vehicular radar
30-960	§15.209	§15.209	§15.209	§15.209	§15.209	§15.209
960-1610	-65.3	-53.3	-65.3	-75.3	-75.3	-75.3
1610-1990	-53.3	-51.3	-53.3	-53.3	-63.3	-61.3
1990-3100	-51.3	-41.3	-51.3	-51.3	-61.3	-61.3
3100-10600	-51.3	-41.3	-41.3	-41.3	-41.3	-61.3
10600-22000	-51.3	-51.3	-51.3	-51.3	-61.3	-61.3
22000-29000	-51.3	-51.3	-51.3	-51.3	-61.3	-41.3
Above 29000	-51.3	-51.3	-51.3	-51.3	-61.3	-51.3
1164 – 1240	-75.3	-63.3	-75.3	-85.3	-85.3	-85.3
1559 – 1610	-75.3	-63.3	-75.3	-85.3	-85.3	-85.3

Note1: At frequencies below 960MHz, the limits are specified in µV/m Quasi-Peak, measured with a 120kHz resolution bandwidth (RBW)
Note 2: at frequencies above 960MHz, the limits are specified in terms of RMS levels of dBm EIRP, measured with a 1MHz RBW.
Note 3: For the frequency bands 1164-1240 MHz and 1559-1610 MHz, the limits are specified in tems of RMS levels of dBm EIRP, measured with a 1kHz RBW.

3.2 50MHz Bandwidth

Frequency (MHz)	50 MHz Bandwidth Limit (dBm EIRP)[1]
Highest Peak Frequency	0.0

[1]In accordance with Subpart F Appendix F, measurements were made using a 3MHz RBW. A factor of 20*log(50/3) is added to all measurement results in order to compare the values measured with a 3MHz RBW to the limit specified with a 50MHz RBW.

3.3 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 dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB/m
AG = Amplifier Gain in dB
NG = No Groundplane Factor in dB

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 dBµV 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 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 52.0 dBµV
AF = 7.4 dB/m
CF = 1.6 dB
NG = 4.7 dB
AG = 29.0 dB
FS = 36.7 dBµV/m

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

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

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

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

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

At each frequency measured above 960MHz (where RMS values are specified) the spectrum analyzer was set up with the appropriate measurement bandwidth (1MHz or 1kHz) in 'zero-span' mode. The maximum signal level was captured and the waveform was downloaded to the computer. A total of 1000 points were acquired at each frequency. The RMS level at the measurement frequency was calculated as follows:

$mW_{RMS} = \text{sqrt}((P_1^2 + P_2^2 + \ldots + P_x^2)/x)$ where:

mW_{RMS} = RMS power in a 20msec interval at measurement frequency
x =1 to 1000 (number of analyzer samples)
P_x = Power at each time sample (20ms/1000 = 20μsec)

In order to reduce the time over which the RMS is calculated, the time (0-20ms) at which the maximum signal is present was recorded as Tmax. RMS calculations were then performed from Tmax-0.5ms to Tmax+0.5ms using the number of samples recorded in that time. This results in an integration time of 1ms. Using this RMS power at the analyzer, EIRP at each frequency was calculated as described above.

3.3 Configuration Photographs

Worst-Case Radiated Emission Below 960MHz

Worst-Case Radiated Emission Above 960MHz

3.5 Test Data

The following results were obtained when the device was tested as described in this report.

Radiated Emissions / Interference Below 960MHz

Table: 1

Company:	Geophysical Survey Systems, Inc.			Tested by:	Kouma Sinn
Model #:	5100	Serial #:	1091	Location:	EMI Site 2
Project #:	3025094	Pressure:	None	Detector:	HP 8542E
Date:	05/22/02	Temp:	19.3C	Antenna:	LOG2
Standard:	FCC Part 15F	Humidity:	20%	PreAmp:	PRE8
Class:	None	Group:	None	Cable(s):	CBLSHF203.cab CBLSHF103.cab
Notes:	Unit was running at 200kHz during test.			Distance:	3 meters

Abbreviations: pk - peak readings, qp - quasi-peak readings, nf - noise floor, NG - no groundplane

Unit was placed on the sand pit, the control cable was placed away from the antenna mast.

	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	NG Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	
	V	30.000	10.4	18.1	0.5	0.0	4.7	33.7	40.0	-6.3	qp
	V	31.480	11.0	17.2	0.5	0.0	4.7	33.4	40.0	-6.6	pk
	V	35.450	15.1	14.8	0.5	0.0	4.7	35.1	40.0	-4.9	pk
	V	39.760	15.1	12.1	0.6	0.0	4.7	32.5	40.0	-7.5	pk
	V	44.700	9.2	10.4	0.6	0.0	4.7	24.9	40.0	-15.1	pk
	V	50.100	11.7	8.6	0.6	0.0	4.7	25.6	40.0	-14.4	pk
	V	56.200	18.2	7.7	0.6	0.0	4.7	31.3	40.0	-8.7	pk
	V	63.055	18.2	7.0	0.8	0.0	4.7	30.6	40.0	-9.4	pk
	V	70.130	14.6	6.5	0.9	0.0	4.7	26.7	40.0	-13.3	pk
	V	79.400	15.6	6.2	0.9	0.0	4.7	27.4	40.0	-12.6	pk
	V	89.290	17.0	7.1	1.0	0.0	4.7	29.8	43.5	-13.7	pk
	V	100.300	42.1	8.0	1.1	22.5	4.7	33.4	43.5	-10.1	pk
	V	112.300	28.2	7.5	1.2	22.5	4.7	19.1	43.5	-24.4	qp
	V	126.000	29.0	7.1	1.3	22.5	4.7	19.6	43.5	-23.9	qp
	V	141.000	27.4	7.8	1.3	22.5	4.7	18.8	43.5	-24.7	qp
	V	158.000	27.0	9.3	1.5	22.5	4.7	20.0	43.5	-23.5	qp
	V	178.000	27.1	9.9	1.6	22.5	4.7	20.8	43.5	-22.7	qp
	V	200.000	27.4	10.0	1.8	22.5	4.7	21.4	43.5	-22.1	qp
	V	224.000	23.7	11.5	1.9	22.4	4.7	19.4	46.0	-26.6	qp
	V	251.000	17.9	13.1	2.0	22.4	4.7	15.3	46.0	-30.7	qp
	V	282.000	18.9	13.5	2.1	22.4	4.7	16.8	46.0	-29.2	qp
	V	315.900	16.8	14.7	2.1	22.4	4.7	15.9	46.0	-30.1	qp
	V	355.100	15.4	15.9	2.2	22.4	4.7	15.8	46.0	-30.2	qp
nf	V	398.000	15.8	16.7	2.5	22.4	4.7	17.3	46.0	-28.7	qp
nf	V	447.000	15.7	17.0	2.7	22.4	4.7	17.7	46.0	-28.3	qp
	V	500.900	20.7	18.2	2.7	22.3	4.7	24.0	46.0	-22.0	qp
	V	562.000	22.9	19.4	3.0	22.3	4.7	27.7	46.0	-18.3	qp
	V	631.100	20.2	21.2	3.4	22.2	4.7	27.3	46.0	-18.7	qp
	V	708.000	20.0	21.8	3.6	22.2	4.7	28.0	46.0	-18.0	qp
	V	794.100	17.6	22.6	4.1	22.1	4.7	26.9	46.0	-19.1	qp
	V	889.500	18.2	24.1	4.5	22.1	4.7	29.4	46.0	-16.6	qp
	V	960.000	16.1	24.3	4.9	22.0	4.7	28.0	46.0	-18.0	qp

Radiated Emissions/Interference Above 960MHz

Table 2

Company:	Geophysical Survey Systems, Inc.			Tested by:	Kouma Sinn
Model #:	5100	Serial #:	1091	Location:	EMI Site 2
Project #:	3025094	Pressure:		Detector:	Tek 2784
Date:	06/06/02	Temp:		Antenna:	Horn 1
Standard:	FCC Part 15F	Humidity:		PreAmp:	CCT
Class:	None	Group:	None	Cable(s):	CBLSHF203.cab CBLSHF103.cab
Notes:	Unit was running at 200kHz during test.			Distance:	1 meters

ground plane between EUT and measuring antenna

Unit was placed on the sand pit, the control cable was placed away from the antenna mast.

RBW=1MHz; >=960MHz

	mWRMS	dBm	AF	preamp	cable loss	distance correction	dBuV/m	EIRP (RMS)	limit (EIRP)	margin	
960	1.58E-07	-68.02	24.30	35.00	2.60	-9.50	21.34	-73.86	-65.30	8.56	
1028	2.76E-07	-65.58	24.40	37.90	2.60	-9.50	20.97	-74.23	-65.30	8.93	
1088	3.76E-07	-64.25	24.40	37.90	2.60	-9.50	22.31	-72.89	-65.30	7.59	
1141	1.82E-07	-67.41	24.40	37.90	2.60	-9.50	19.15	-76.05	-65.30	10.75	
1580	7.91E-08	-71.02	25.70	38.00	2.60	-9.50	16.74	-78.46	-65.30	13.16	*
2000	8.53E-08	-70.69	27.70	38.10	4.20	-9.50	20.57	-74.63	-53.10	21.53	*
2510	8.89E-08	-70.51	28.70	37.90	4.20	-9.50	21.95	-73.25	-53.10	20.15	*
3160	7.79E-08	-71.08	30.60	37.80	5.20	-9.50	24.37	-70.83	-53.10	17.73	*
3980	7.75E-08	-71.11	31.80	38.10	5.20	-9.50	25.25	-69.95	-53.10	16.85	*
5010	5.56E-08	-72.55	34.00	37.60	5.20	-9.50	26.51	-68.69	-53.10	15.59	*
6310	9.03E-08	-70.45	34.80	37.00	5.20	-9.50	30.01	-65.19	-53.10	12.09	*
7940	4.97E-08	-73.04	37.10	35.60	5.20	-9.50	31.12	-64.08	-53.10	10.98	*
9600	5.43E-08	-72.65	38.10	35.00	5.20	-9.50	33.11	-62.09	-53.10	8.99	*

* data above 1210MHz is instrument noise floor

RBW = 1kHz; 1160-1240; 1559-1610MHz

	mW RMS	dBm	AF	preamp	cable loss	distance correction	dBuV/m	EIRP (RMS)	limit (EIRP)	margin
1610.00	0.00	-102.28	25.70	22.12	2.60	-9.50	1.40	-93.80	-65.30	28.50
1599.00	0.00	-105.35	25.70	22.12	2.60	-9.50	-1.66	-96.86	-65.30	31.56
1589.00	0.00	-111.79	25.70	22.12	2.60	-9.50	-8.10	-103.30	-65.30	38.00
1579.00	0.00	-101.27	25.70	22.12	2.60	-9.50	2.42	-92.78	-65.30	27.48
1569.00	0.00	-106.01	25.70	22.12	2.60	-9.50	-2.33	-97.53	-65.30	32.23
1559.00	0.00	-108.08	25.70	22.12	2.60	-9.50	-4.40	-99.60	-65.30	34.30
1240.00	0.00	-102.06	24.40	22.00	2.60	-9.50	0.44	-94.76	-65.30	29.46
1224.00	0.00	-106.97	24.40	22.00	2.60	-9.50	-4.47	-99.67	-65.30	34.37
1209.00	0.00	-104.90	24.40	22.00	2.60	-9.50	-2.40	-97.60	-65.30	32.30
1194.00	0.00	-106.27	24.40	22.00	2.60	-9.50	-3.77	-98.97	-65.30	33.67
1179.00	0.00	-101.06	24.40	22.00	2.60	-9.50	1.44	-93.76	-65.30	28.46
1164.00	0.00	-100.11	24.40	22.00	2.60	-9.50	2.39	-92.81	-65.30	27.51

50MHz Bandwidth

Table: 3

Company:	Geophysical Survey Systems, Inc.			Tested by:	Kouma Sinn
Model #:	5100	Serial #:	1091	Location:	EMI Site 2
Project #:	3025094	Pressure:		Detector:	HP 8542E
Date:	05/23/02	Temp:		Antenna:	LOG2
Standard:	FCC Part 15F	Humidity:		PreAmp:	None
Class:	None	Group:	None	Cable(s):	CBLSHF103.cab CBLSHF203.cab
Notes:	measured with 3MHz BW, corrected to 50MHz			Distance:	3 meters
	ground plane between EUT and measuring antenna				

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	BW Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	
V	34.5	51.2	14.8	0.5	0	24.4	90.9	95.2	4.3	pk

4.0 AC Mains Line-Conducted Emissions

4.1 Line-Conducted Emission Limits

The following table shows the line-conducted emission limits for FCC Part 15 Subpart B Section 15.107:

Class B

Frequency (MHz)	Conducted Limit	
	µV	dBµV
0.45 to 30	250	48

4.2 Configuration Photographs - Worst-Case Line-Conducted Emission

Not Applicable

4.3 Test Data

The following results were obtained when the device was tested as described in this report.

This section was not applicable to the GSSI model 5100. The only AC power line was that for the control system which was previously found compliant with FCC Part 15B Class A devices.

5.0 Miscellaneous Information

5.1 Site Description

The test site used during testing was made in according with FCC Part 15F. 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. Groundplane was placed between the EUT and receiving antenna for measurements above 960MHz.

5.2 Test Procedure Reference

For radiated and line-conducted emissions testing:

FCC Part 15 Subpart F

6.0 EUT setup

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 Tektronix 2784 spectrum analyzer and the measuring antenna for the frequency range appropriate for the stated frequency range of the EUT.
4) Set the height of the measuring antenna to ~1m.
5) Set the resolution bandwidth (RBW) of the analyzer to 1 MHz. Set the video bandwidth (VBW) greater than or equal to the 1MHz.
6) Adjust the center frequency to frequency of the maximum emission from the EUT. Record this frequency as f_m. Record the power (dBm at f_m) as P_m
7) If f_m is indeterminate due to characteristics of the operating EUT skip steps 8) through 13).
8) Adjust the frequency span such that the 15 dB bandwidth of the EUT emission is visible. (i.e. – The start frequency is at least 15 dB less than the maximum emission, and the end frequency is at least 15 dB less than the maximum emission). Note that the span may not be symmetrical around f_m.
9) Determine the frequency below f_m at which the displayed power in dBm is 10dB below P_m. Record this frequency as f_L.
10) Determine the frequency above f_m at which the displayed power in dBm is 10dB below P_m. Record this frequency as f_H.
11) Calculate and record the center frequency $f_C=(f_H+f_L)/2$
12) Calculate and record the UWB bandwidth $BW_{UWB}=(f_H-f_L)$
13) Calculate and record the fractional bandwidth $BW_{UWB}=2*(f_H-f_L)/(f_H+f_L)$.

7.0 Test Procedure – Radiated Emissions

7.1 Pre-scan

1) With the EUT operating as above, set the analyzer to max hold and adjust the height of the measuring antenna from 1-4m. Record the maximum level.
2) Rotate the EUT 45º. Set the analyzer to max hold and adjust the height of the measuring antenna from 1-4m. Record the maximum level and the angle of rotation if it is higher than the level measured in the previous step.

3) Rotate the EUT in 45º and repeat step 2) at each angle.
4) Rotate the EUT to the angle of maximum emissions.
   This is the orientation of the EUT that will be used throughout testing.

7.2 Measurement below 960 MHz

Procedures for measurement in the frequency range of 30 to 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 30 MHz-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.
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 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 spectrum of 30-960Mhz 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. 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 Table
15) Document the final emissions configuration of the EUT, using either photographs or diagrams.

7.3 Measurement above 960MHz

1) Set the EMCO 3115 antenna to the measurement distance specified in the applicable standard.
2) Determine the maximum frequency of measurement according to Table 2.
3) With the analyzer bandwidth set to 1 MHz, monitor the frequency range 960 MHz-18 GHz 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.
4) Upon detection of a suspect signal note its amplitude and frequency.
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 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 1MHz and using peak detector mode, set the span of analyzer to that consistent with resolving individual emissions.
12) Re-maximize emissions from the EUT 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 spectrum of 960-18000MHz 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. Record the five highest peaks.
14) At each of the recorded frequencies, narrow the frequency span to identify the bandwidth of the emission.
15) At the current frequency, center the peak and set the analyzer to zero span. Maximize the signal by adjusting the antenna height from 1 – 4m and changing the polarization. Set the detector to SAMPLE with a sample time of 1msec. Using the automated system, record the power levels during a transmitter pulse
16) If f_L and f_H are indeterminate due to characteristics of the operating EUT measure at a minimum of 10 logarithmically spaced frequencies from 960MHz to the maximum frequency of detectable signal. Skip to step 22).
17) Reduce the center frequency by 1 MHz and repeat steps 16)-18).
18) Repeat step 13)-17) until the measurement frequency is the lower frequency of the emission bandwidth.
19) Repeat step 13)-17) in 1 MHz increments above the peak frequency, up to the upper limit of the emission bandwidth.
20) Repeat steps 13)-17) at each of the five highest peaks.
21) Repeat steps 3)-22) in the frequency bands appropriate for the antenna listed, up to the maximum frequency as determined in step2).
22) Determine the RMS level of the emission:
    $P_{RMS}= 5*\log((S_1^2 \ldots S_N^2)/N)$
    Where S_N= amplitude (mW EIRP) of a sample
    N= total number of samples taken in 1msec

7.4 Measurement from 1164-1610MHz

1) Set the EMCO 3115 antenna to the measurement distance specified in the applicable standard.
2) Determine the maximum frequency of measurement according to Table 2.
3) With the analyzer bandwidth set to 1 MHz, monitor the frequency range 1164 MHz-1610 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.
4) Upon detection of a suspect signal note its amplitude and frequency.
5) Manipulate EUT system cables to maximize emission levels.
6) Move the antenna over the range 1m-4m to maximize the suspected highest amplitude signal. Move the antenna to the height that repeats the highest amplitude observation and proceed.
7) 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.

8) The effects of various modes of operation shall be examined. Determine all possible operating modes and, if possible, vary the modes while steps (2)-(6) are being performed.
9) 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.
10) 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.
11) Check the calibration of the analyzer, using either its internal calibration signal or an external source.
12) With the resolution bandwidth set 1kHz and using peak detector mode, set the span of the analyzer to that consistent with resolving individual emissions.
13) Re-maximize emissions from the EUT at the worst-case combinations of frequency, antenna height and polarization. Use small variations in placement consistent with the applicable standard.
14) Increment the span of the analyzer such that the spectrum of 1164MHz-1240MHz is measured.
15) 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.
16) At each of the recorded frequencies narrow the frequency span to identify the bandwidth of the emission.
17) At the current frequency, center the peak and set the analyzer to zero span. Using the automated system, record the level in mW during a transmitter pulse.
18) Determine the RMS level of the emission:
$P_{RMS}= 5*\log((S_1^2 \ldots S_N^2)/N)$
Where S_N= amplitude (mW) of a sample
N= total number of samples taken in 1msec
19) Repeat steps 15)-18) in the frequency range of 1559-1610MHz.

7.5 Measurement centered at f_m

1) Set up the measurement antenna appropriate for f_m
2) Set the resolution bandwidth of the spectrum analyzer to 3 MHz, with a video bandwidth of $\geq$3MHz.
3) With the span set to cover the range of f_L to f_H, measure and record the peak level (dBµV/m) at f_m.
4) Verify that the field strength is less than 64 dBµV/m.

8.0 Labeling – USA

Class B Labeling and Instruction Manual Requirements

Devices subject to Certification must be labeled with an FCC Identifier. Devices subject to Verification or Certification must be labeled with the following compliance statement:

> **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, for a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

> *Warning:* **Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.**
>
> *NOTE:* **This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:**

- **Reorient or relocate the receiving antenna.**
- **Increase the separation between the equipment and receiver.**
- **Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.**
- **Consult the dealer or an experienced radio TV technician for help.**

If shielded cables or other specialized accessories are necessary for the unit to achieve compliance, a statement similar to the following should be added:

> **Shielded cables must be used with this unit to ensure compliance with the Class B FCC limits.**

Subpart F Labeling and Instruction Manual Requirements

Products operating as low-frequency imaging devices under 15.509 shall be labeled as follows:

> **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.**

9.0 Labeling - Canada

Canadian Emissions Requirements

The intent of the amendment is to establish Canadian Regulations which are harmonized with the existing FCC Regulations. As such, no retesting is required and devices which have been tested and comply with the FCC Specifications (Class A or B) also comply with the Canadian Specification (Class A or B).

A record of the measurements and results shall be retained by the manufacturer or importer for a period of at least five years and made available for examination on the request of the Canadian Government.

A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other restrictions, it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement included in the user's manual.

This Class [*] digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe [*] est conforme à la norme NMB-003 du Canada.

[*] Insert either "A" or "B" but not both as appropriate for the equipment requirements.

10.0 Test Report Certification

Company Name:	Geophysical Survey Systems, Inc. P.O.Box 97 13 Klein Drive North Salem, NH 03073
Attention:	Mr. Alan Schutz
Model No.:	5100
Report Date:	August 22, 2002
Test Site Location:	Site 2C INTERTEK TESTING SERVICES NA INC. 70 Codman Hill Road Boxborough, Massachusetts 01719

We attest to the accuracy of this report:

Signature	Signature
Kouma Sinn	Robert F. Martin
Testing Performed By	Reviewer
Senior Project Engineer	Senior Technical Manager
Title	Title

11.0 Equipment List

The following equipment settings were used to make measurements for emissions testing:

Description	Manufacturer	Model	Serial #	Cal Due
EMI Receiver	Hewlett Packard	85422E	3520A00125	12/07/02
Horn Antenna	EMCO	3115	9512-4632	10/09/02
Biconnolog Antenna	EMCO	3142	9711-1223	10/08/02
Spectrum Analyzer	Tektronix	2784	B010153	01/11/03
Pre-Amp	Miteq	NSP-4000-NF	507145	09/22/02
Pre-Amp	CTT	ALM/100-5030-329	34510	04/05/03
High Frequency Cables	Huber + Suhner, Inc.	Sucoflex 104PEA	CBLSHF203	04/01/03
High Frequency Cables	Huber + Suhner, Inc.	Sucoflex 104PEA	CBLSHF103	04/01/03