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16. Abstract:

In this project, the prototyped air-coupled and ground-coupled GPRs, that were developed by the Project 0-4820, have been upgraded. Special antenna shielding structures have been developed to guide the electromagnetic energy down into ground, so that to prevent the GPRs from radiating into the air. After repeating the "testing-and-modifing" process on the GPR devices several times, both the air-coupled and ground-coupled GPR are now completely compliant with FCC requirements. The FCC testing reports by Nemko Inc. are included in the appendix part of this report. The testing reports and other documents for FCC certificate applications have been submitted to FCC and the GPR certificates are expected in a few weeks.

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Implementation of an FCC Compliant Radar-Part 1: Radar Development and FCC Testing

by

Richard Liu, Jing Li, Ying Wang, and Wei Ren

Technical Report 5-4820-01-1

Project Number: 5-4820-01
Project Title: Implementation of an FCC Compliant Radar

Performed in Cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

by the

Subsurface Sensing Laboratory
Department of Electrical and Computer Engineering
University of Houston

November 2007

DISCLAIMERS

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

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CHAPTER 1 INTRODUCTION

Two types of GPRs, an air-coupled GPR and a ground-coupled GPR, have been developed by the Project 0-4820. The air-coupled GPR is for asphalt and shallow concrete pavement measurement, and the ground-coupled GPR is for thicker concrete pavement and base layer detection. But they do not have FCC certification yet.

The main task of this project is to upgrade the circuit and antenna design of the developed GPRs so that the two types of GPRs can meet all FCC requirements while maintaining original performances. FCC testing is very strict. Fig. 1 shows FCC radiation limits received at a distance of 3m from the GPR set in the frequency range of 30MHz to 1GHz. The measurement must be carried out in all directions around the GPR set. If the radiation at any azimuth angle on any frequency exceeds the FCC limit, the GPR fails to get FCC certified.

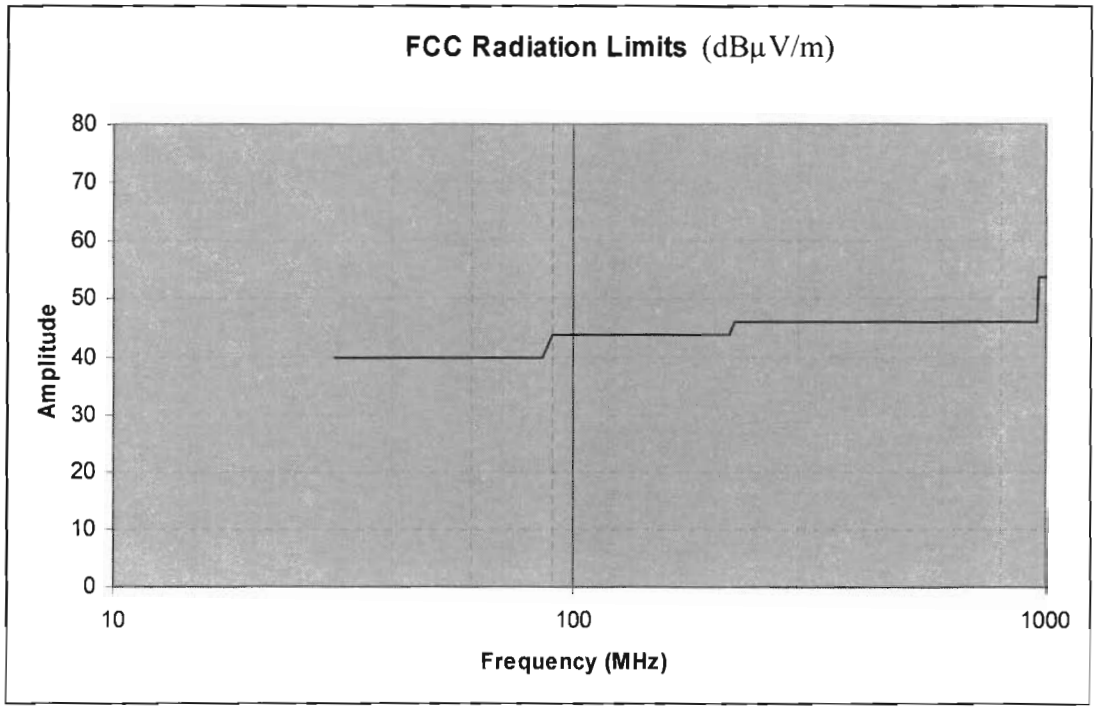

Figure1 FCC Radiation Limit

It can be seen from Figure 1 that the FCC radiation level is about 40 dBμV/m. If converted Volts it equals 0.0001V/m. This magnitude is even lower than the thermal noise level of general instruments. It is too hard to use microwave energy of this level to detect underground targets. The only solution is to design effective shielding structures to guide the GPR energy into ground and prevent the energy from radiating into the space above the ground. In this project, besides the design of the shielding devices, the GPR radiation power is also optimized. If the radiation power is too high, it will certainly exceed FCC limits, even with shielding devices. On the other hand, if the radiation power is too low, the GPR penetrating depth will be limited and fail to detect the targets.

CHAPTER 2 UPGRADED RECEIVER AND TRANSMITTER

2.1. Upgraded GPR Receiver Circuitry

In this project, the three parts of the receiver, power supply, time delay line, and sampling bridge, have been redesigned. Figures 2 and 3 show the developed PCB boards of the receiver.

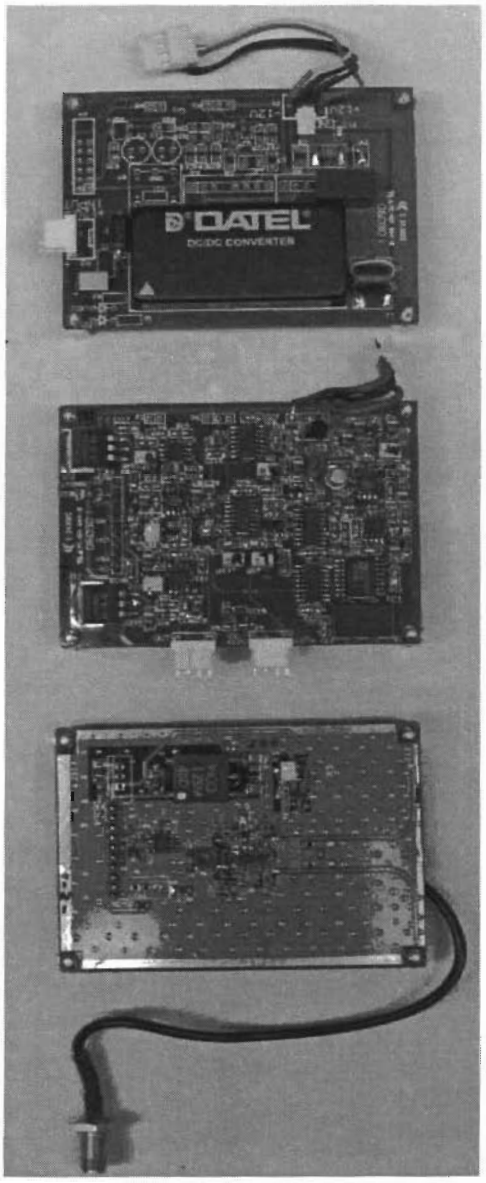

Fig. 2 Top view of receiver PCBs

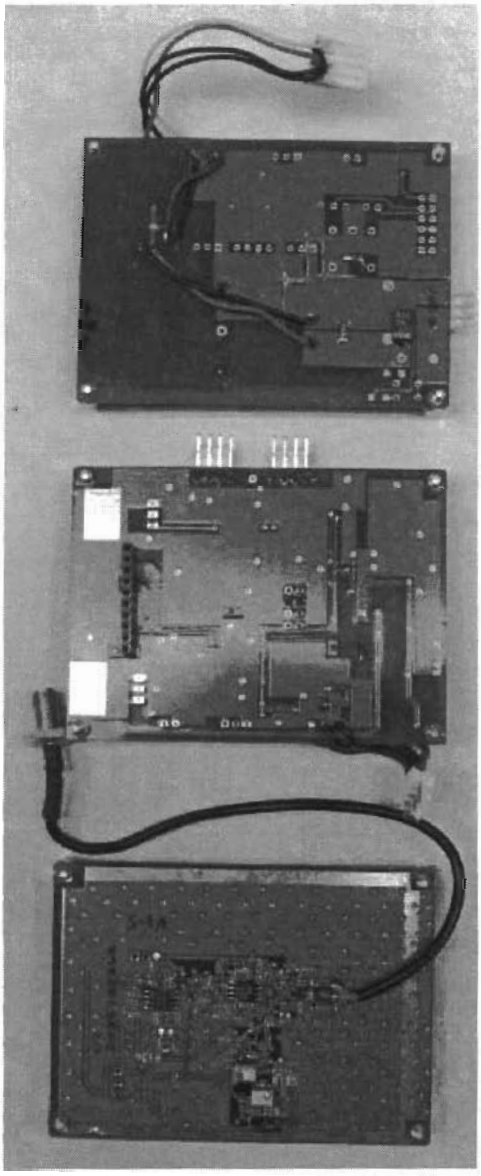

Fig. 3 Bottom view of receiver PCBs

2.2 Installation of the PCB Boards

For the convenience of implementation, the developed receiver PCBs are stacked up and installed in a metal box to block them from outside electromagnetic interference.

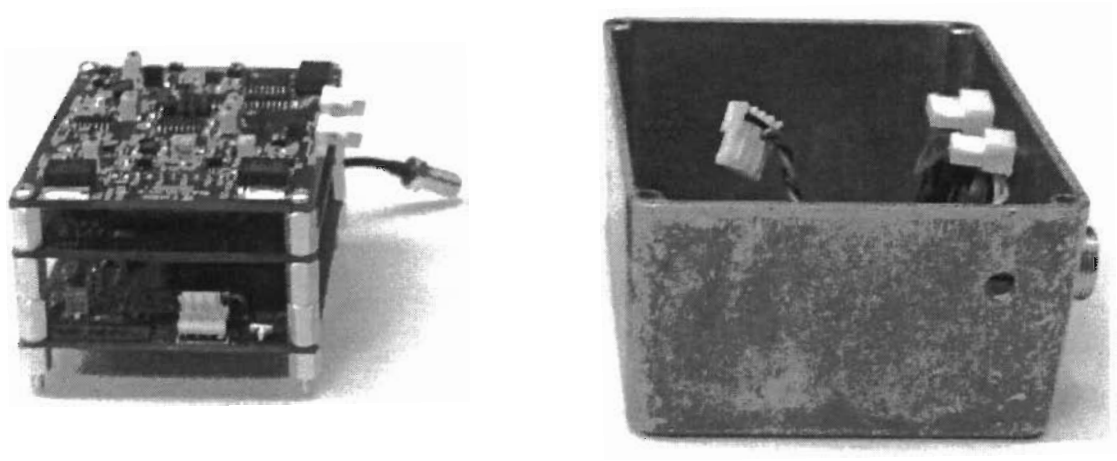

Figure 4 PCBs stacked up for installation

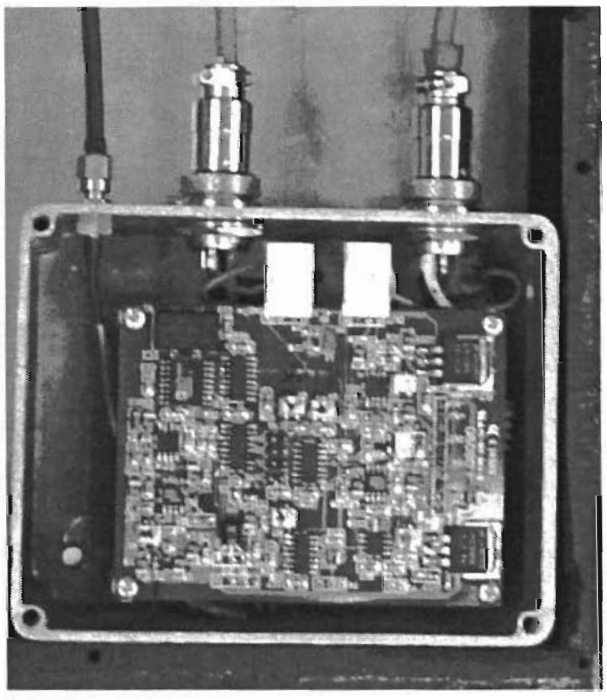

Figure 5 Circuit boards installed in the aluminum box

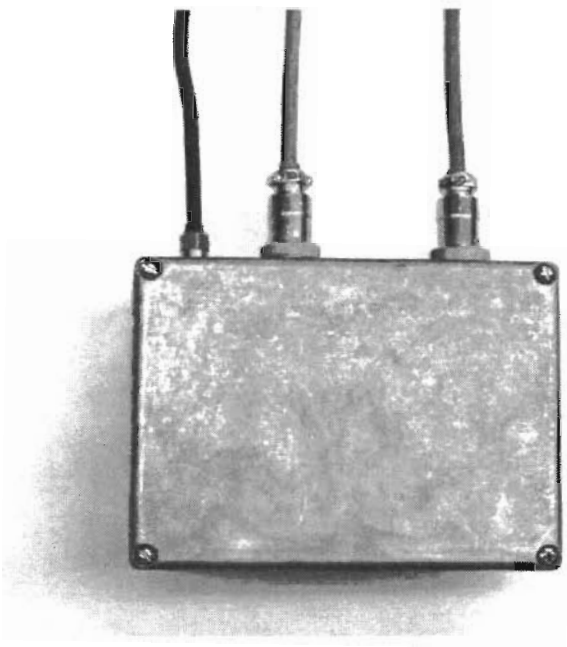

Figure 6 the receiver box is sealed

2. 3 GPR Transmitter Board

Figure 7 and Figure 8 show the upgraded transmitter. In this design, the pulse shaping circuits re modified and the pulse width can be easily adjusted between 1ns to 8ns.

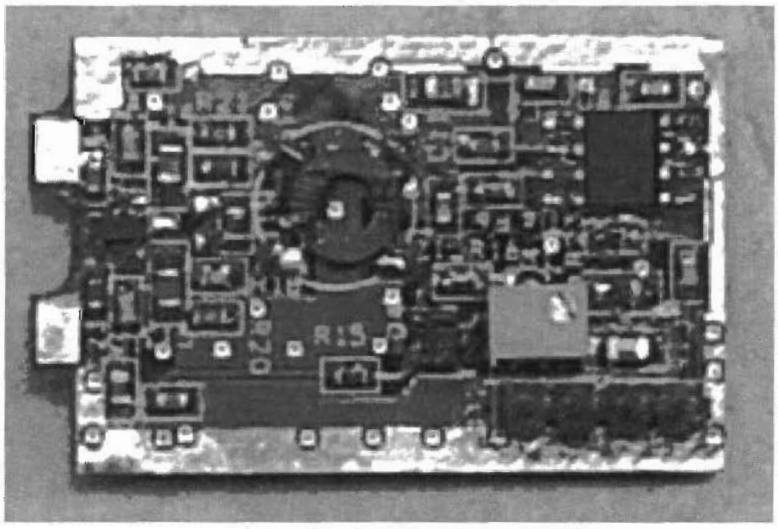

Figure7 Top view of the transmitter board

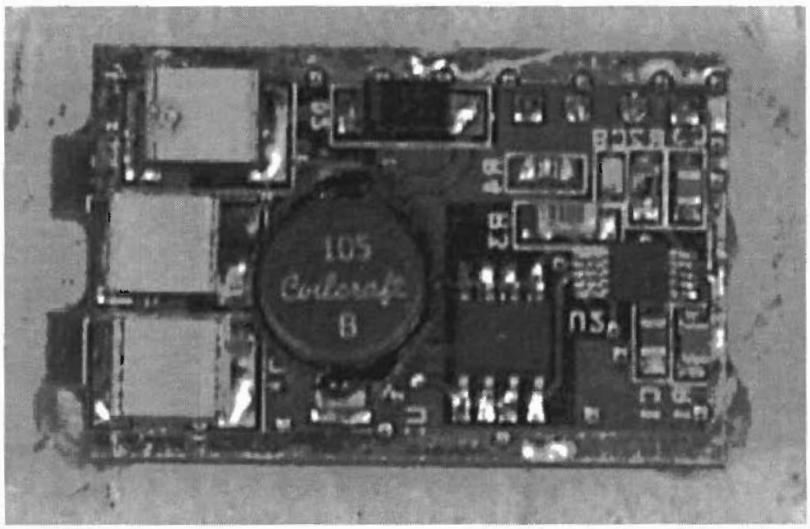

Figure 8 Bottom view of the transmitter board

2. 4 Ground-Coupled GPR

By installing the above receiver and transmitter with bow-tie antennas into a box, the ground-coupled GPR set is built, as shown in Figure 9.

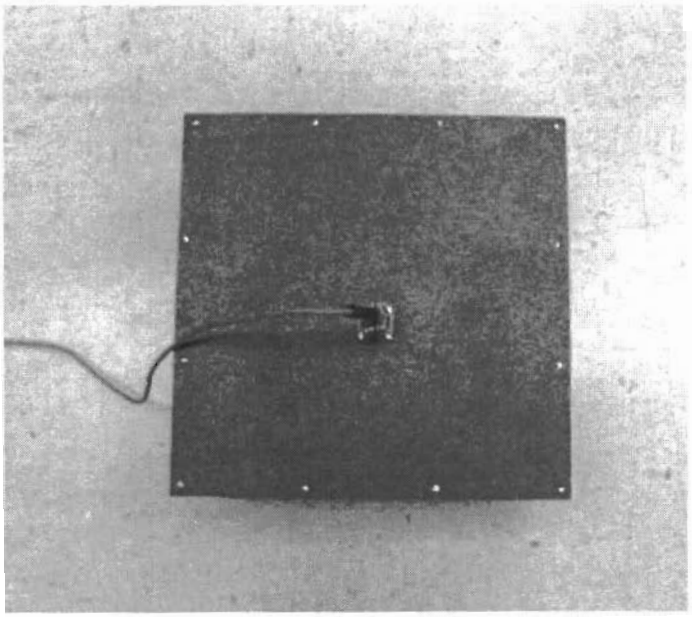

Figure 9 Developed Ground-coupled GPR

Figure 10 shows the electrical connection of the GPR system. Once the power is supplied, the GPR starts to work and the measured data can be stored in the laptop computer. When the GPR system is set up in a pushcart, it is ready to use, as shown in Figure 11.

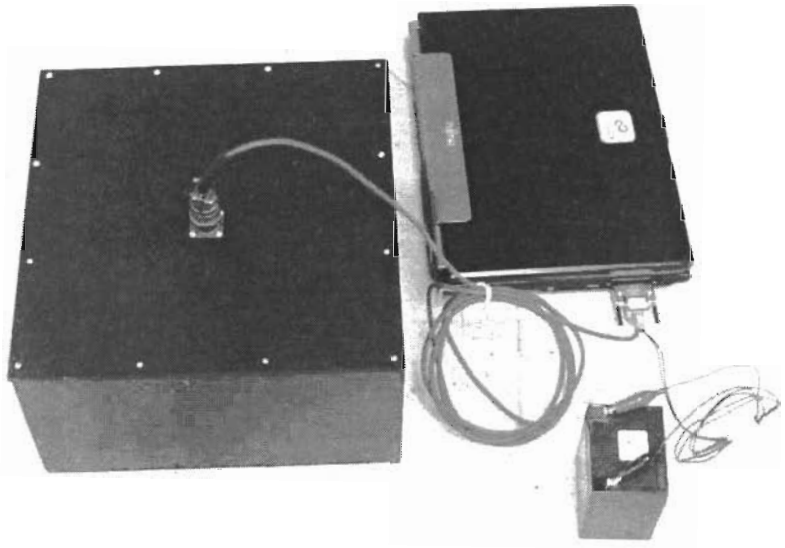

Figure 10 Electrical connection of the whole GPR system

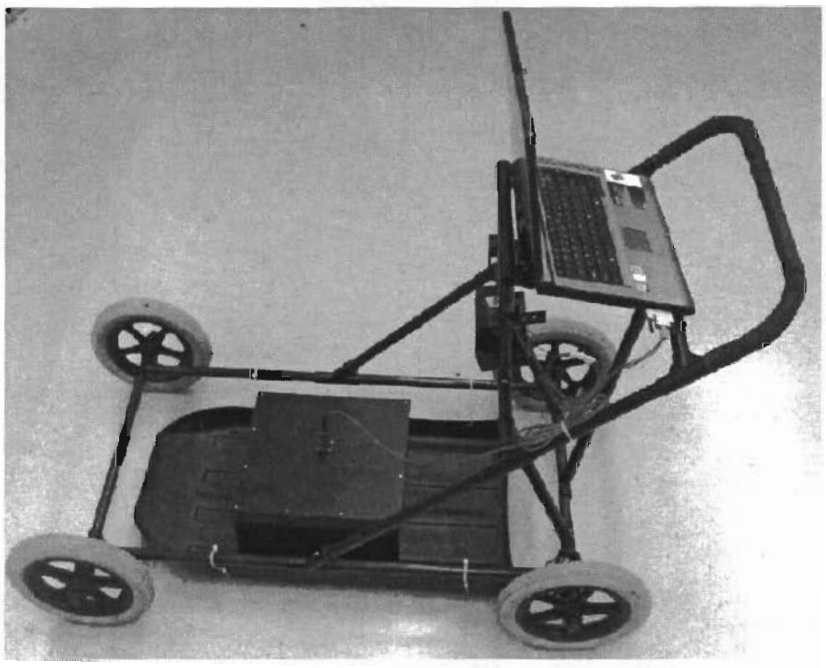

Figure 11 GPR application setup

2.5 Air-Coupled GPR

By installing the above receiver and transmitter with TEM horn antennas into a box, and adjusting the transmitting pulse to about 1ns, an air-coupled GPR system can be built, as shown in Figure 12.

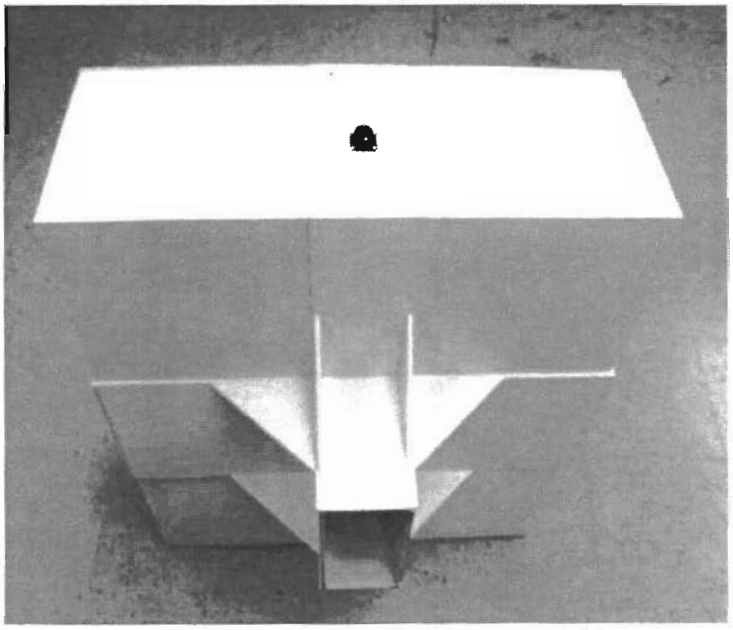

Figure 12 Top view of the air-coupled GPR

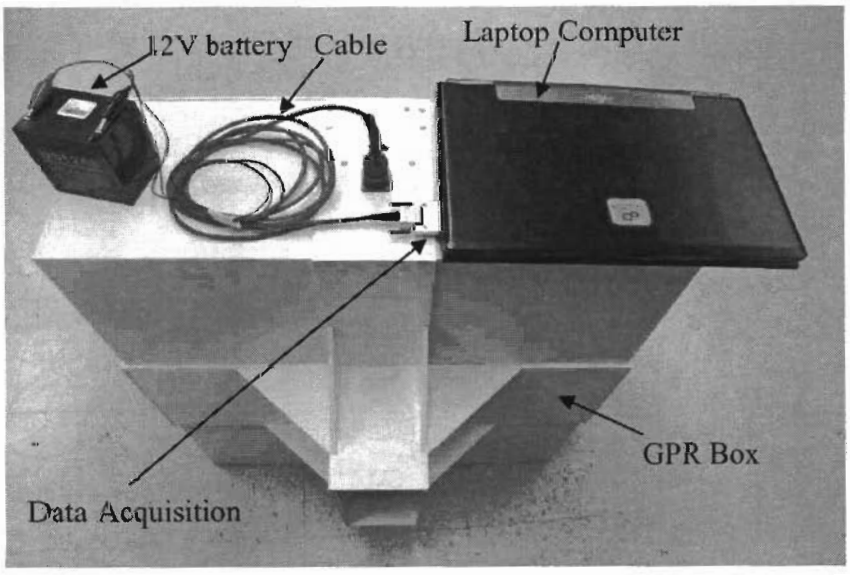

Figure 13 Electrical connection of the GPR system

Figure 14 Air-coupled GPR mounted on a vehicle in application

2.5 Current Status of the GPR Systems

By now, both the air-coupled and ground-coupled GPR systems have been upgraded and they are working. After searching for FCC testing agencies nationwide, The Nemko USA Inc. was selected, because 1) Nemko has had experience in GPR compliance testing; 2) Nemko is located in Dallas, TX, which facilitates our trips to do changes in case the GPR does not comply. The testing results will be given in the next chapter.

CHAPTER 3 FCC TESTING AND RESULTS

FCC testing is very time-consuming job. The digital signals coupled onto the GPR cables or leaking energy from the edges or slots of the GPR shielding cover can easily fail the GPR testing. After modify the GPR circuits, the shielding covers, the low-pass filters, and the absorbing materials several times, the unwanted radiation from low frequency digital noise was finally eliminated. Both the ground-coupled GPR and air-coupled GPR have complied with FCC rules and past all kinds of FCC testing. The FCC certificates will be obtained in about two months.

3.1 EMC Test of the Ground-Coupled GPR

Figure 15 shows the Nemko outdoor EMC test site with the GPR antenna sitting on a rotation table. The receiving antenna is mounted on a post three meters away from the GPR set. The measurement will be conducted for each angle from 0 to 360 degrees, and throughout the frequency range of 30MHz to 4GHz. If measured GPR signal strengths exceed FCC limits at any frequency at any antenna orientation angle, the GPR fails the testing. The GPR must be modified and all tests redone. Table 1 shows part of the final testing results.

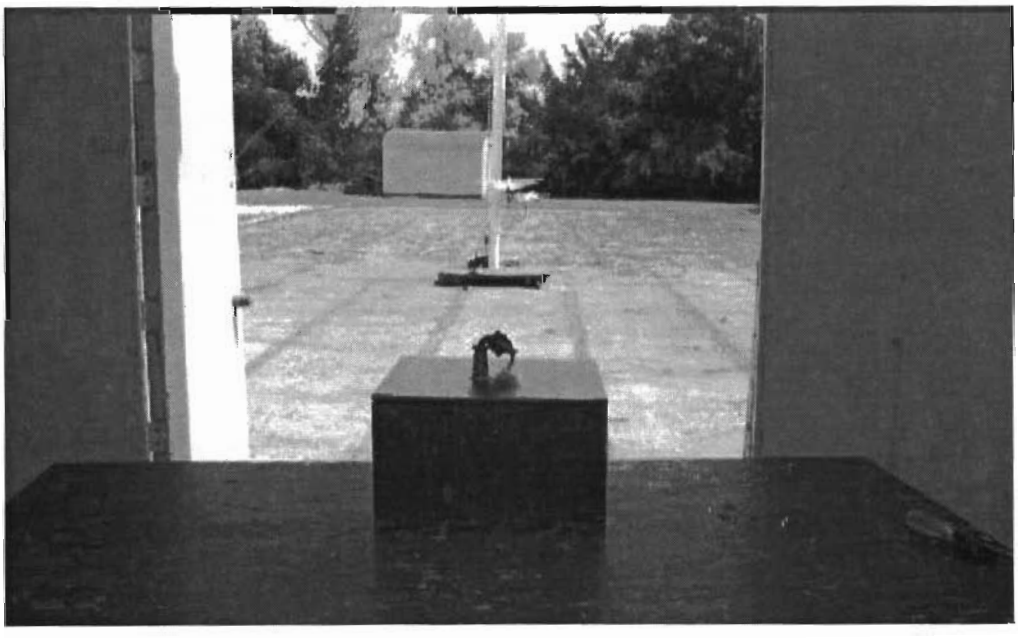

Figure 15 Nemko outdoor test site for EMC testing

Table 1 Part of the EMC test data for the ground-coupled GPR set

Nemko

CFR 47, PART 15, SUBPART A
CLASS A VERIFICATION
REPORT NO.: 4451EUS1
EQUIPMENT: Ground Penetrating Radar

Test Data –Radiated Emissions, Electric Field, Test#REHE-01(cont)

Radiated Emissions Data

Complete X
Preliminary

Job # : 4451 Test # : REHE-01
Page 2 of 2

Client Name: University of Houston
EUT Name : Ground Penetrating Radar
EUT Model # : U7W400
EUT Part # : U7W400
EUT Serial # : None
EUT Config. : Stand Alone

Specification : CFR47 Part 15, Subpart B, Class A Reference :

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
200	H	0	37.6	14.8	5.5	27.9	30.0	43.5	-13.5	Pass	PEAK
240	H	0	39.5	15.7	5.9	27.9	33.2	46.4	-13.2	Pass	PEAK
285	H	0	41	18.2	6.4	27.8	37.8	46.4	-8.6	Pass	PEAK
49.1	H	0	34	9.6	2.3	28.5	17.4	39.0	-21.6	Pass	PEAK
313	V	0	38.9	15	6.8	27.9	32.8	46.4	-13.6	Pass	
327	V	0	39.1	14.8	6.8	27.9	32.8	46.4	-13.6	Pass	
385	V	0	34.3	15.6	7.4	27.7	29.6	46.4	-16.8	Pass	
457	V	0	33.6	16.9	8.5	28.1	30.9	46.4	-15.5	Pass	
508	V	0	30	17.4	8.9	28.1	28.2	46.4	-18.2	Pass	
563	V	0	31	18.4	9.5	27.8	31.1	46.4	-15.3	Pass	
816	V	0	32	19	9.7	27.9	32.8	46.4	-13.6	Pass	
820	V	0	29	22.3	11.8	27.5	35.6	46.4	-10.8	Pass	
310	H	0	44.9	15	6.8	27.9	38.8	46.4	-7.6	Pass	
356	H	0	45.3	14.3	7.4	27.7	39.3	46.4	-7.1	Pass	
438	H	0	43.6	15.9	8.0	27.8	39.7	46.4	-6.7	Pass	
547	H	0	40.7	18.9	8.9	28.1	40.4	46.4	-6.0	Pass	

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3.2 Wireless Testing of the Ground-Coupled GPR

To conduct wireless radiation tests, the GPR antenna should sit on a certified sand pit as shown in Figure 16. The receiving antenna is still 3m away from the GPR antenna. The testing frequency range is 30MHz to 4000 MHz., and the GPR set must turn 360^0 for each frequency step.

Figure 16 Nemko outdoor test site for wireless radiation testing

The first part of the measured results are shown in Table 2. The full testing results can be found in the Nemko testing report.

Table 2 Wireless radiation test data for the ground-coupled GPR Set

Test Data – Radiated Emissions

Radiated Emissions Data

Complete	X			Job # :	5113	Test # :	REHE-01
Preliminary				Page	1	of	11
Client Name	University of Houston						
EUT Name .	Ground Coupled Radar						
EUT Model # :	U7W400						
EUT Part # :							
EUT Serial # :							
EUT Config. .	Transmitting over sand pit						
Specification :	CFR47 Part 15, Subpart B, Class B			Reference :	15.209/15.509		
Rod. Ant. #:		Temp. (deg. C) :	22		Date :	10/11/07	
Bicon Ant.#:	1306	Humidity (%) :	40		Time :	9:00	
Log Ant.#:	759	EUT Voltage :	12		Staff :	David Light	
Bilog Ant.#		EUT Frequency :	dc		Photo ID:		
Dipole Ant.#:		Phase:	0		QP Bandwidth:	120 KHz	
Cable#:	1522	Location:	Sand Pit				
Preamp#:	782	Distance:	3 Meters				
Limiter#:	na	Barometric pressure:	1016				
Atten #:	na						
Detector#:	1659						

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 degrees
73.7	V	0	41.8	8.9	3.1	27.5	26.3	40.0	-13.7	Pass	
86	V	0	32.5	9.6	3.5	27.4	18.2	40.0	-21.8	Pass	
110.6	V	0	48	11.4	3.8	27.6	35.6	43.5	-7.9	Pass	
122.9	V	0	46	11.9	3.8	27.6	34.1	43.5	-9.4	Pass	
135.2	V	0	44.8	12.7	4.2	27.7	34.0	43.5	-9.5	Pass	
147.4	V	0	46.8	13.5	4.2	27.7	36.8	43.5	-6.7	Pass	
196.6	V	0	49	14.7	5.1	27.9	40.9	43.5	-2.6	Pass	
209.9	V	0	48	14.9	5.5	27.9	38.5	43.5	-5.0	Pass	
258.1	V	0	42.4	17.1	6.2	27.9	37.8	46.0	-8.2	Pass	
73.7	H	0	40.9	8.9	3.1	27.5	25.4	40.0	-14.6	Pass	
86	H	0	35	9.6	3.5	27.4	20.7	40.0	-19.3	Pass	
110.6	H	0	35	11.4	3.8	27.6	22.6	43.5	-20.9	Pass	
196.6	H	0	43	14.7	5.1	27.9	34.9	43.5	-8.6	Pass	
209.9	H	0	40.7	14.9	5.5	27.9	33.2	43.5	-10.3	Pass	
245.8	H	0	44.2	16.5	5.9	27.9	38.7	46.0	-7.3	Pass	

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3.3 EMC Test of the Air-Coupled GPR

Figure 17 shows the set up for the air-coupled GPR EMC testing. Table 3 gives the first part of the final testing results.

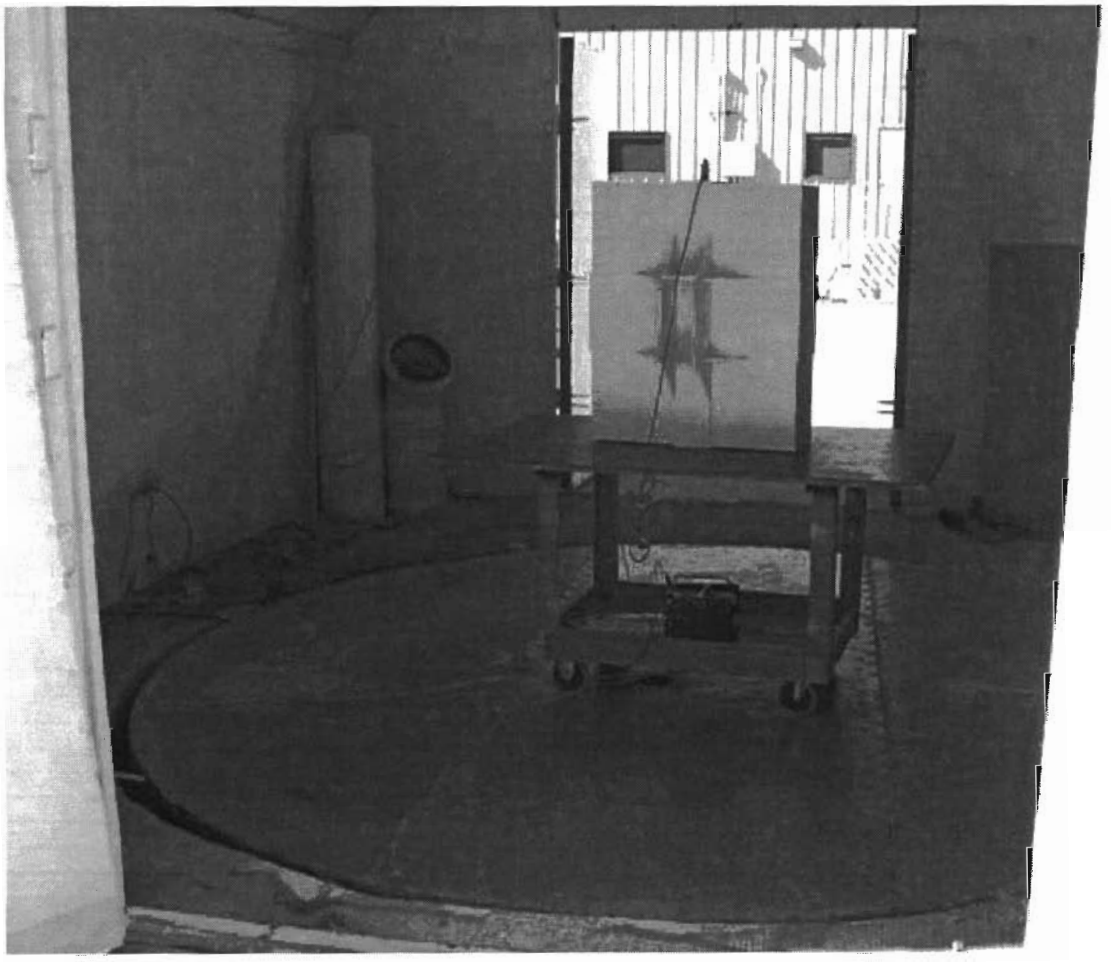

Figure 17 Set up for the EMC testing of air-coupled GPR

Table 3 Wireless radiation test data for the ground-coupled GPR set

Nemko

CFR 47, PART 15, SUBPART A
CLASS A VERIFICATION

EQUIPMENT: U7W900 REPORT NO.: 5113EUS1

Test Data –Radiated Emissions

Meas Freq (MHz)	Ant Pol (H/V)	Atten (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec limit (dBuV/m)	CRSL Diff (dB)	Pass Fail Unc.	Comment
36.8	V	0	42	12.9	2.2	28.5	28.6	39.0	-10.4	Pass	
73.7	V	0	47	8.9	3.1	27.5	31.5	39.0	-7.5	Pass	
86	V	0	47	9.6	3.5	27.4	32.7	39.0	-6.3	Pass	
147.4	V	0	32.4	13.5	4.2	27.7	22.4	43.5	-21.1	Pass	
73.7	H	0	31	8.9	3.1	27.5	15.5	39.0	-23.5	Pass	
86	H	0	32	9.6	3.5	27.4	17.7	39.0	-21.3	Pass	
122.9	H	0	32	11.9	3.8	27.6	20.1	43.5	-23.4	Pass	
245.8	H	0	33	16.5	5.9	27.9	27.5	46.4	-18.9	Pass	

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The spectrum was searched from 30 MHz to 1000 MHz. No digital emissions were detected beyond 245.8 MHz.

Analyzer Settings: RBW=VBW=100 kHz Peak detector

3.4 Wireless Radiation Test of Air-Coupled GPR

Figure 18 shows the set up for the air-coupled GPR wireless radiation testing. Table 4 gives the first part of the final testing results.

Figure 18 set up for the air-coupled GPR wireless radiation testing

Table 19 Wireless radiation test data for the air-coupled GPR set

Nemko USA, Inc. FCC PART 15, SUBPART F, Paragraph 15.509
Ultra Wide Band Operation
EQUIPMENT: U7W900 Test Report No.: 5113RUS2

Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete: X
Preliminary:
Job # : 5113 Page 1
Test # : REHE-01 of 5

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B
Reference : 15.509
Rod. Ant. #:
Bicon Ant.#: 760
Log Ant.#: 1034
Bilog Ant.#:
Dipole Ant.#:
Cable#: 1522
Preamp#: 762
Limiter#: na
Atten #: na
Detector#: 1036
Temp. (deg. C) : 24
Humidity (%) : 35
EUT Voltage : 12
EUT Frequency : dc
Phase: na
Location: DOATS
Distance: 3 m
Barometric pressure: 1016
Date : 10/29/07
Time : 8:00
Staff : D. Light
Photo ID: na
Peak Bandwidth: 100 KHz
Video Bandwidth 100 KHz
QP Bandwidth: 120 KHz

Note: All measurements are Peak unless otherwise noted

Meas Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 degrees
43.6	V	0	47.5	12.2	2.3	28.5	33.5	40.0	-6.5	Pass	
74.4	V	0	50.3	8.1	3.1	27.5	34.0	40.0	-6.0	Pass	
189.6	V	0	47	14.6	5.1	27.9	38.8	43.5	-4.7	Pass	
35.2	H	0	47.4	12.4	2.2	28.5	33.5	40.0	-6.5	Pass	
36.8	H	0	48	12.3	2.2	28.5	34.0	40.0	-6.0	Pass	
74.9	H	0	39	8.1	3.1	27.5	22.7	40.0	-17.3	Pass	
183	H	0	40	14.4	5.1	27.9	31.6	43.5	-11.9	Pass	
											45 degrees
38	V	0	44	12	2.2	28.5	29.7	40.0	-10.3	Pass	
42	V	0	46.4	12.1	2.3	28.5	32.3	40.0	-7.7	Pass	
43.6	V	0	46.8	12.2	2.3	28.5	32.8	40.0	-7.2	Pass	
47.7	V	0	46.5	12	2.3	28.5	32.3	40.0	-7.7	Pass	
72.3	V	0	48.8	8	3.1	27.5	32.4	40.0	-7.6	Pass	
189	V	0	46	14.6	5.1	27.9	37.8	43.5	-5.7	Pass	
35.2	H	0	46	12.4	2.2	28.5	32.1	40.0	-7.9	Pass	
40	H	0	46	12	2.3	28.5	31.8	40.0	-8.2	Pass	
50	H	0	40	11.6	2.7	27.9	26.4	40.0	-13.6	Pass	
155	H	0	30	14.3	4.7	27.8	21.2	43.5	-22.3	Pass	
178	H	0	36	14	5.1	27.9	27.2	43.5	-16.3	Pass	
207	H	0	38	15.6	5.5	27.9	31.2	43.5	-12.3	Pass	
280	H	0	35	20	6.4	27.8	33.6	46.0	-12.4	Pass	

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CHAPTER 4 CONCLUSIONS

This is a mid-term report for the two-year project. In this project, the preveously prototyped air-coupled and ground-coupled GPRs have been upgraded. Special antenna shielding structures have been developed to guide the electromagnetic energy down into ground and prevent the GPR energy from radiating into the air. Two types of low-pass filters have also been designed and developed to eliminate the digital signals coupled onto the cables. After repeating the "testing-and-modifing" process on the GPR devices for several times, both the air-coupled and ground-coupled GPR are now completely compliant with FCC requirements. The FCC testing reports by Nemko Inc. are included in the appendix part of this report. The testing reports and other documents for FCC certificate applications have been submitted to the FCC and the GPR certificates are expected to be received in a few weeks.

Appendix

FCC Testing Reports by Nemko Inc.

(Four reports included)

1. EMC Testing Report for 400MHz Ground-Coupled GPR
2. Wireless Radiation Testing Report for 400MHz Ground-Coupled GPR
3. EMC Testing Report for 900MHz Air-Coupled GPR
4. Wireless Radiation Testing Report for 900MHz Air-Coupled GPR

ENGINEERING TEST REPORT

NUMBER: 4451EUS1

ON

Model No.(s):

Ground Penetrating Radar

IN ACCORDANCE WITH:
CFR 47, PART 15, SUBPART B,
CLASS A VERIFICATION

TESTED FOR:
University of Houston
4800 Calhoun Road
Houston, Texas 77004

TESTED BY:
Nemko USA, Inc.
802 N. Kealy
Lewisville, Texas 75057-3136

Total Number of Pages: 20

TESTED BY: _____ DATE: 5/04/07
Arturo Ruvalcaba, EMC Engineer

APPROVED BY: _____ DATE: 5/07/07
Brian Boyea, EMC Engineer

NVLAP
LAB CODE: 100426-0

Table of Contents

Section 1. Summary of Test Results

General:

All measurements are traceable to national standards.

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47, Part 15, Subpart B for Class A Digital Devices.

These tests were conducted using measurement procedures of ANSI C63.4-2003.

The equipment was tested for conducted emissions from 0.150 MHz to 30 MHz using a 50 microhenry line impedance stabilization network (L.I.S.N.) as described in ANSI C63.4-2003. Peripheral equipment was also operated through a 50 microhenry L.I.S.N.

The equipment was tested for radiated emissions from 30 MHz to 1000 MHz in accordance with the requirements of CFR 47, Part 15, Subpart B. Equipment with oscillator frequencies above 107 MHz were tested to the fifth harmonic or in accordance with the requirements of CFR 47, Part 15.33. Frequencies were initially identified in a large shielded room. Amplitude measurements were made on an outdoor Open Area Test Site. Details of the outdoor site are on file with the FCC.

Abstract:

Name of Test	Basic Standard	Results
Conducted Emissions (Mains port)	CFR 47, Part 15, Subpart B Para. No. 15.107	N/A
Radiated Emissions	CFR 47, Part 15, Subpart B Para. No. 15.109	Complies
Microwave Radiated Emissions	CFR 47, Part 15, Subpart B, Para. No. 15.109	N/A

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE: **NONE**

Section 2. Equipment Under Test (E.U.T.)

Manufacturer:	University of Houston
Name:	Ground Penetrating Radar
Model Number:	U7W400
Serial Number:	None
Part Number:	U7W400
Production Status:	Production
E.U.T. Arrival Date:	05/02/07

Description of E.U.T.:
The impulse GPR is a device that is intentionally designed to directionally and locally radiate very small average electromagnetic power downwards into the ground to be detected. The developed GPR is composed of a pulse transmitter, a receiver, a transmitter antenna, a receiver antenna, and a laptop computer. Except the computer, all the components are installed in a plastic box. Once a 12VDC power is supplied, the GPR starts to work. To facilitate the FCC testing (Part 15), the GPR working environment and parameters are described below. When the GPR is at work, it is always setup on the ground surface to maximize the energy coupling into ground. The parameters of the developed GPR are given below:

(1.) Dimension: 13.5 × 13.5 × 7.5 inch3;
(2.) Power supply: 12 VDC @ 370mA;
(3.) Center frequency: 400MHz;
(4.) Radiation pulse time duration: 2.5ns
(5.) Radiation pulse P-P amplitude: 500mV;
(6.) System Clock: 50KHz

Clock, Oscillator, Highest Frequencies Utilized:
3.57MHz

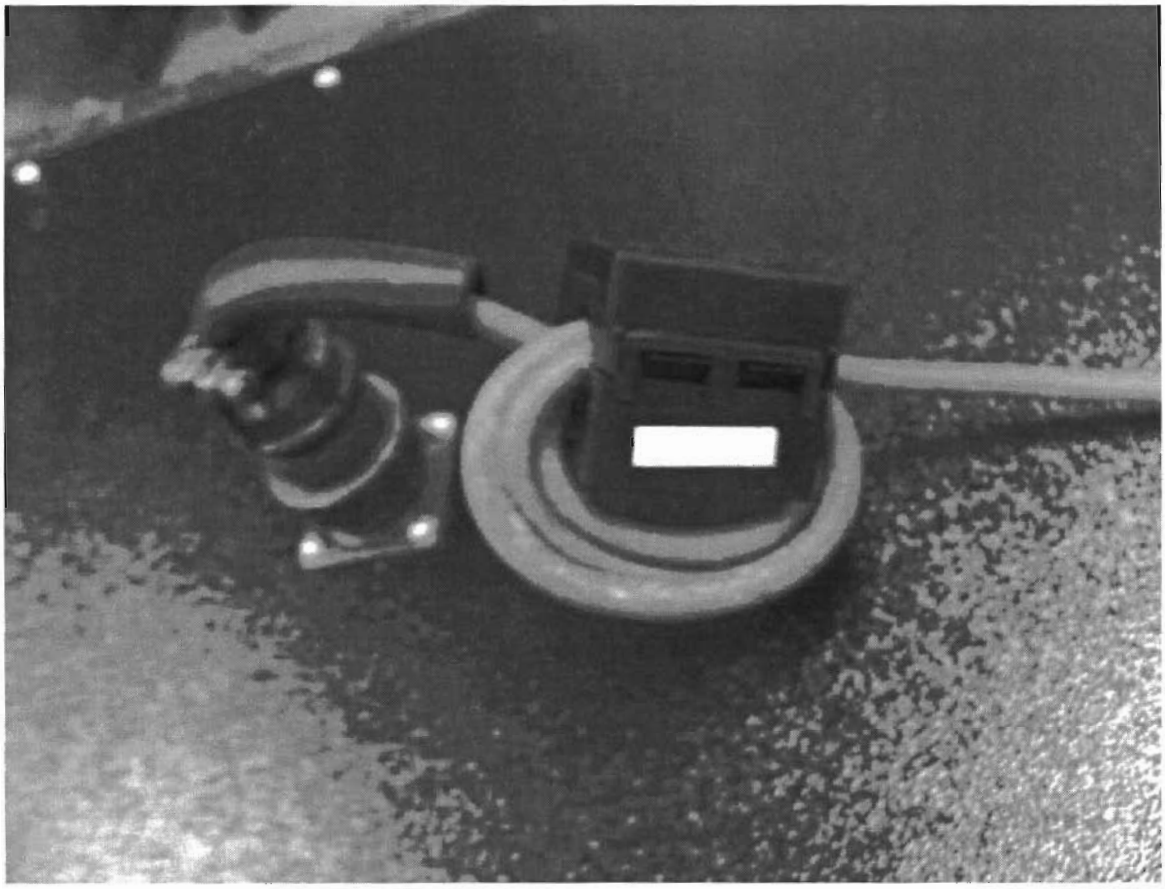
Modifications Incorporated in E.U.T.:
See Following Page.

Modification Mod-01

Job #: 4451 Company Name: University of Houston

Date	Tech Int'ls	Mod. #	Details	Photograph	Include In Report
5/3/2007	ART	Mod 1	Installed ferrite on cable.	☑	☑ Yes ☐ No
				☐	☐ Yes ☐ No
				☐	☐ Yes ☐ No
				☐	☐ Yes ☐ No
				☐	☐ Yes ☐ No
				☐	☐ Yes ☐ No

Photos: Mod-01



Justification:
The E.U.T. was configured for testing as per typical installation. Position and bundling of cables were investigated to establish maximum amplitude of emissions.

The following combinations were investigated to establish worst-case configuration:

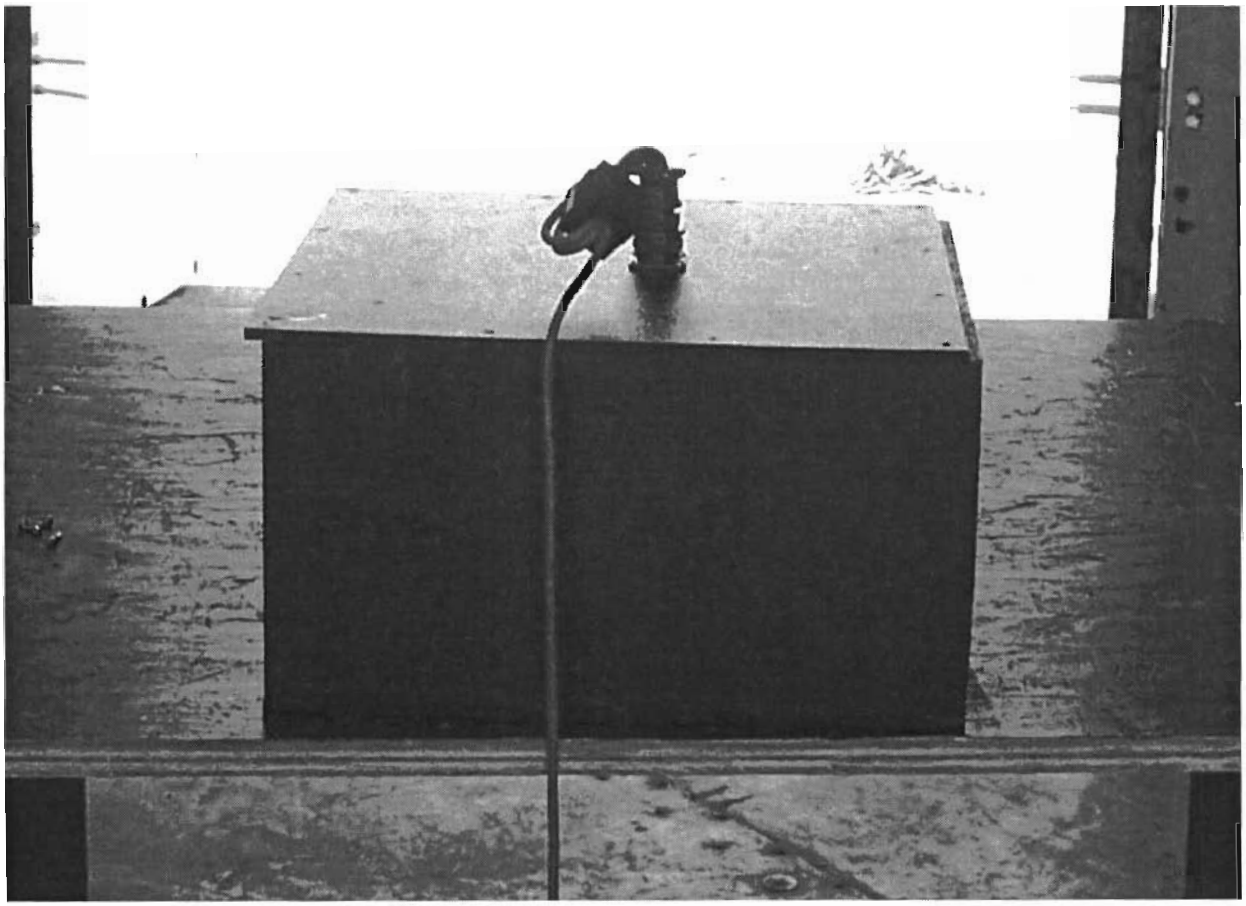
Stand Alone

Exercise Program:
The E.U.T. exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to typical use.

The EUT was in the following exercise mode:

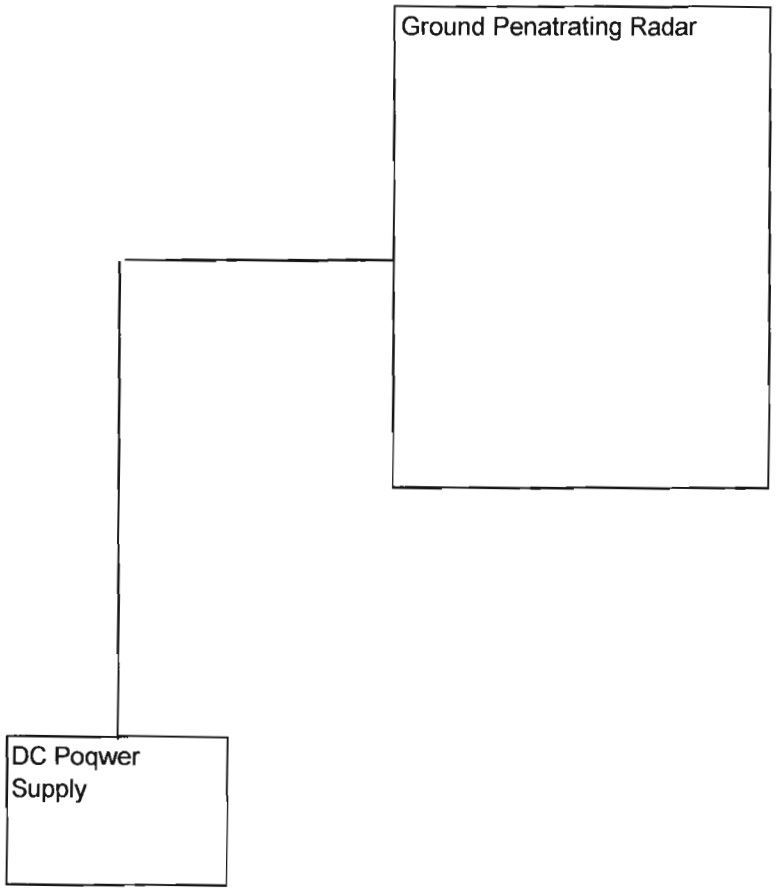
Powered on, continuously transmitting.

E.U.T. Photographs:



Section 3. Equipment Configuration

Configuration of the Equipment Under Test (E.U.T.):



Section 4. Conducted Emissions (Mains ports)

Note: Test Not Applicable. No AC Mains.

Purpose:

The test is intended to demonstrate the compliance of the Equipment Under Test (E.U.T.) to the limits for conducted disturbance as defined by CFR 47, Part 15, Subpart B, Class A.

Specification Limits:

Limits for conducted disturbance at the mains ports

Frequency Range (MHz)	Quasi-peak Limits (dBuV)	Average Limits (dBuV)
0.15 to 0.50	79	66
0.50 to 30	73	60

Method of Measurement (Procedure ANSI C63.4-2003):

Measurements were made using a spectrum analyzer with 10 kHz RBW, Peak detector. Any emissions that are close to the limit are measured using a test receiver with 9 or 10 kHz bandwidth, CISPR Quasi-Peak detector.

See Sections 7 and 8.

Section 5. Radiated Emissions

Purpose:

The tests are intended to demonstrate the compliance of the Equipment Under Test (E.U.T.) to the limits for radiated emissions as defined by CFR 47, Part 15, Subpart B, Class A.

Specification Limits:

Limits for radiated disturbance of Class A

Frequency Range (MHz)	10m Limits (dBuV)
30-88	39.1
88-216	43.5
216-960	46.4
Above 960	49.5

Notes:
1. The lower limit shall apply at the transition frequency.
2. Additional provisions may be required for cases where interference occurs.
3. The 3m limits are calculated as follows: $L_3 = L_{10} * 10/3$ where L_{10} is the limit at 10m specified in ?V/m

Method of Measurement (Procedure ANSI C63.4-2003):

The equipment was prescanned in a shielded room using a spectrum analyzer and broadband antenna. A list of frequencies was compiled for investigation in the open field. The equipment was then moved to an open area test site where amplitude measurements were made at a distance of 10 meters. The bandwidth was set to 100 kHz and the detector function was CISPR Quasi-Peak.

Any emissions above 1 GHz were measured with a horn antenna and low noise pre-amplifier at a distance of 3 meters.

See Sections 7 and 8.

Test #: REHE-01

Tested By: Art Ruvalcaba

Date of Tests: 5/03/07

Test Conditions:

Test Voltage: 5VDC

Temperature: 32°C

Humidity: 41%

Test Results:

The E.U.T. complies.

TEST EQUIPMENT

Asset Number	Description	Manufacturer	Model Number	Serial Number	Last Cal	Cal Due
1284	Analyzer	Hp	8566B	1811A00 223	3/58/07	3/28/08
1195	ANTENNA,BIC ONICAL	A.H. SYSTEMS	SAS-200/542	235	3/30/2007	3/29/2008
1311	ANTENNA, LOG PERIODIC	EMCO	3146	1753	1/18/2007	1/18/2008
1522	Cable Assy, LAB 5 - D OATS	Nemko USA, Inc.	Site D OATS	N/A	5/9/2006	5/9/2007
1025	PREAMP, 25dB	Nemko USA, Inc.	LNA25	399	9/29/2006	9/29/2007
D Oats	Open Area Test Site	Nemko USA	None	D	03/28/07	03/28/08

Test Data –Radiated Emissions, Electric Field, Test#REHE-01

Radiated Emissions Data

Complete: X
Preliminary:

Job #: 4451 Test # : REHE-01
Page 1 of 2

Client Name : University of Houston
EUT Name : Ground Penetrating Radar
EUT Model # : U7W400
EUT Part # : U7W400
EUT Serial # . None
EUT Config. : Stand Alone

Specification . CFR47 Part 15, Subpart B, Class A
Reference :

Rod. Ant. #:	na	Temp. (deg. C) :	28	Date :	05/03/07
Bicon Ant.#:	1195	Humidity (%) .	45	Time :	9:30
Log Ant.#:	1311	EUT Voltage :	12 VDC	Staff :	Art Ruvalcaba
Bilog Ant.#:	na	EUT Frequency :	N/A	Photo ID:	4451
Dipole Ant.#:	na	Phase:	N/A	Peak Bandwidth:	100 KHz
Cable#:	1522	Location:	D OATS	Video Bandwidth	100 KHz
Preamp#:	1025	Distance:	10m	QP Bandwidth:	120 KHz
Limiter#:	na	Barometric pressure:	1016		
Atten #:	na				
Detector#:	1284				

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
46.6	V	0	38.2	9.6	2.3	28.5	21.6	39.0	-17.4	Pass	PEAK
50	V	0	46	9	2.7	27.9	29.8	39.0	-9.2	Pass	PEAK
52	V	0	52.7	9	2.7	27.9	36.5	39.0	-2.5	Pass	PEAK
53.2	V	0	58.6	9	2.7	27.9	42.4	39.0	3.4	Fail	REFER TO QP
53.21	V	0	53.7	9	2.7	27.9	37.5	39.0	-1.5	Unc.	QP readings
57	V	0	52.8	8.8	2.7	27.9	36.4	39.0	-2.6	Pass	PEAK
60.8	V	0	48.6	8.5	3.0	27.8	32.3	39.0	-6.7	Pass	PEAK
61.7	V	0	50.2	8.5	3.0	27.8	33.9	39.0	-5.1	Pass	PEAK
49.1	V	0	58	9.6	2.3	28.5	41.4	39.0	2.4	Fail	REFER TO QP
49.1	V	0	56	9.6	2.3	28.5	39.4	39.0	0.4	Unc.	QP readings
											FERRITE ON CABLE
49.1	V	0	48.4	9.6	2.3	28.5	31.8	39.0	-7.2	Pass	PEAK
58.62	V	0	44.5	8.8	2.7	27.9	28.1	39.0	-10.9	Pass	PEAK
70	V	0	46	8.3	3.1	27.5	29.9	39.0	-9.1	Pass	PEAK
75	V	0	47.5	8.8	3.1	27.5	31.9	39.0	-7.1	Pass	PEAK
33.6	V	0	45.5	12.5	2.2	28.5	31.7	39.0	-7.3	Pass	PEAK
150	V	0	35.3	12.8	4.7	27.8	25.0	43.5	-18.5	Pass	PEAK
211	V	0	43.7	15.1	5.5	27.9	36.4	43.5	-7.1	Pass	PEAK
295	V	0	36	18.2	6.4	27.8	32.8	46.4	-13.6	Pass	PEAK

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Test Data –Radiated Emissions, Electric Field, Test#REHE-01(cont)

Radiated Emissions Data

Complete X
Preliminary

Job # : 4451 Test # : REHE-01
Page 2 of 2

Client Name : University of Houston
EUT Name : Ground Penetrating Radar
EUT Model # : U7W400
EUT Part # : U7W400
EUT Serial # : None
EUT Config. : Stand Alone

Specification : CFR47 Part 15, Subpart B, Class A Reference :

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
200	H	0	37.6	14.8	5.5	27.9	30.0	43.5	-13.5	Pass	PEAK
240	H	0	39.5	15.7	5.9	27.9	33.2	46.4	-13.2	Pass	PEAK
295	H	0	41	18.2	6.4	27.8	37.8	46.4	-8.6	Pass	PEAK
49.1	H	0	34	9.6	2.3	28.5	17.4	39.0	-21.6	Pass	PEAK
313	V	0	38.9	15	6.8	27.9	32.8	46.4	-13.6	Pass	
327	V	0	39.1	14.6	6.8	27.9	32.6	46.4	-13.8	Pass	
385	V	0	34.3	15.6	7.4	27.7	29.6	46.4	-16.8	Pass	
457	V	0	33.6	16.9	8.5	28.1	30.9	46.4	-15.5	Pass	
508	V	0	30	17.4	8.9	28.1	28.2	46.4	-18.2	Pass	
563	V	0	31	18.4	9.5	27.8	31.1	46.4	-15.3	Pass	
616	V	0	32	19	9.7	27.9	32.8	46.4	-13.6	Pass	
820	V	0	29	22.3	11.8	27.5	35.6	46.4	-10.8	Pass	
310	H	0	44.9	15	6.8	27.9	38.8	46.4	-7.6	Pass	
356	H	0	45.3	14.3	7.4	27.7	39.3	46.4	-7.1	Pass	
438	H	0	43.6	15.9	8.0	27.8	39.7	46.4	-6.7	Pass	
547	H	0	40.7	18.9	8.9	28.1	40.4	46.4	-6.0	Pass	

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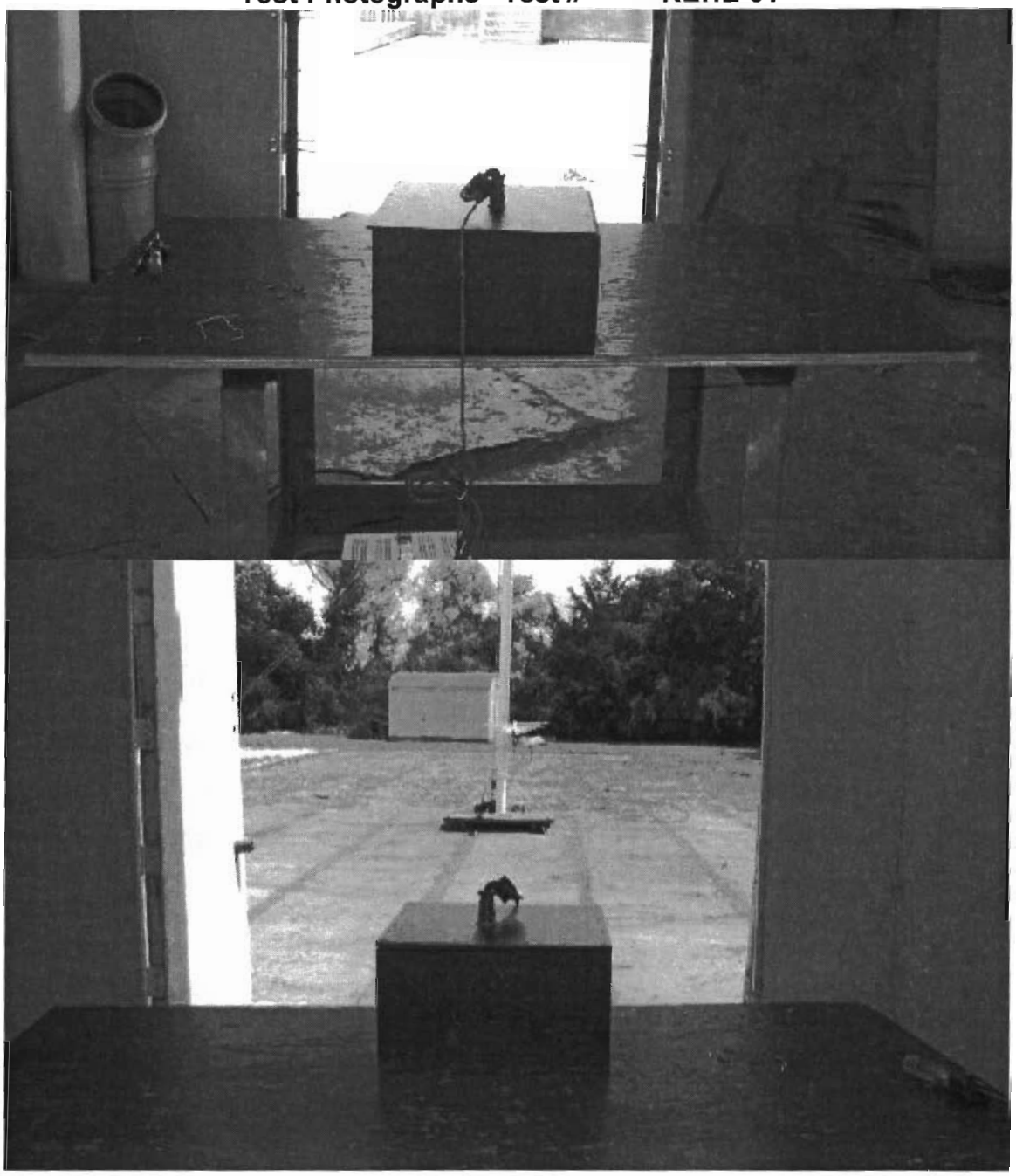
Test Photographs - Test # REHE-01



Section 6. Microwave Radiated Emissions

Note: Not Applicable, No Freq. above 107MHz

Purpose:

The tests are intended to demonstrate the compliance of the Equipment Under Test (E.U.T.) to the limits for radiated emissions as defined by CFR 47, Part 15, Subpart B, Class A.

Specification Limits:

Limits for radiated disturbance of Class A

Frequency Range (MHz)	10m Limits (dBuV)
30-88	39.1
88-216	43.5
216-960	46.4
Above 960	49.5

Notes:
1. The lower limit shall apply at the transition frequency.
2. Additional provisions may be required for cases where interference occurs.
3. The 3m limits are calculated as follows: $L_3 = L_{10} * 10/3$ where L_{10} is the limit at 10m specified in ?V/m

Method of Measurement (Procedure ANSI C63.4-2003):

The equipment was prescanned in a shielded room using a spectrum analyzer and broadband antenna. A list of frequencies was compiled for investigation in the open field. The equipment was then moved to an open area test site where amplitude measurements were made at a distance of 10 meters. The bandwidth was set to 100 kHz and the detector function was CISPR Quasi-Peak.

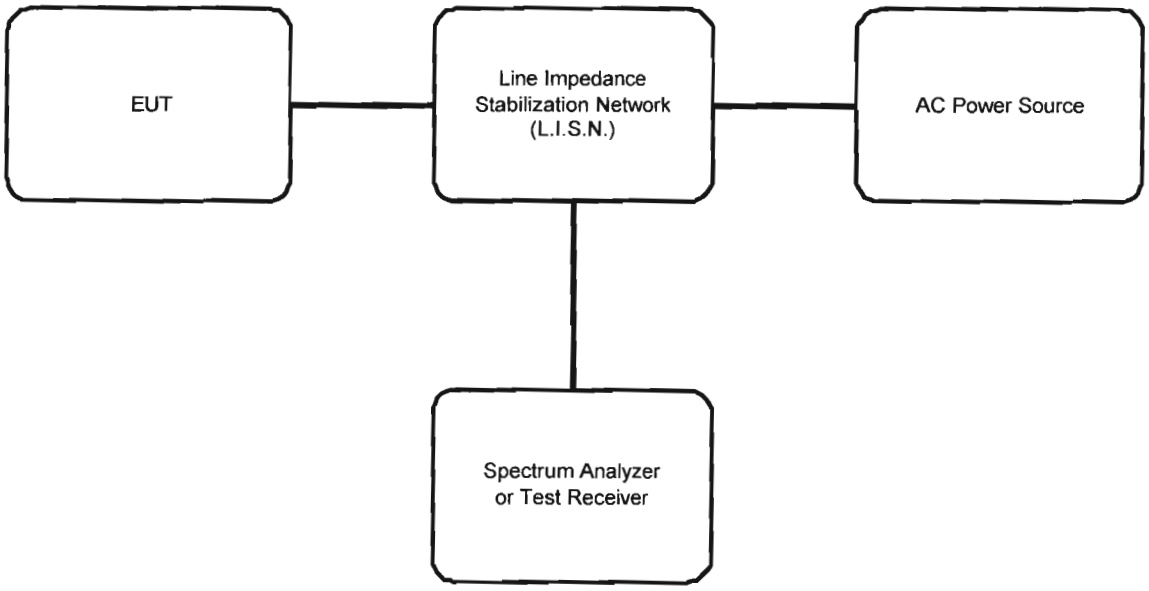
Any emissions above 1 GHz were measured with a horn antenna and low noise pre-amplifier at a distance of 3 meters. The bandwidth was set to 1 MHz and the detector function was average.

Section 7. Test Methods and Block Diagrams.

Conducted Emissions (Mains Ports)

?? Applicable Test Standard: CFR 47, FCC Pt 15, Subpart B
?? The test set-up is as per the test configuration diagram.
?? The E.U.T. is configured as typically used.
?? The E.U.T. and any accessories are operated with typical load conditions.
?? Conducted power line measurements are made from 150 kHz to 30 MHz.
?? For each current carrying conductor of each power cord associated with the E.U.T., the emission closest to the limit is recorded.
?? Initial measurements are made using a spectrum analyzer with 10 kHz RBW, peak detector. If emissions are below the Average limit, the unit is deemed to be compliant.
?? Any emissions within 6dB of the quasi peak limit are measured using a test receiver with 9 kHz bandwidth, CISPR quasi-peak detector.
?? Bandwidths used on the test receiver are those specified in CISPR 16-1.

Test Configuration - Power line Conducted Emissions:



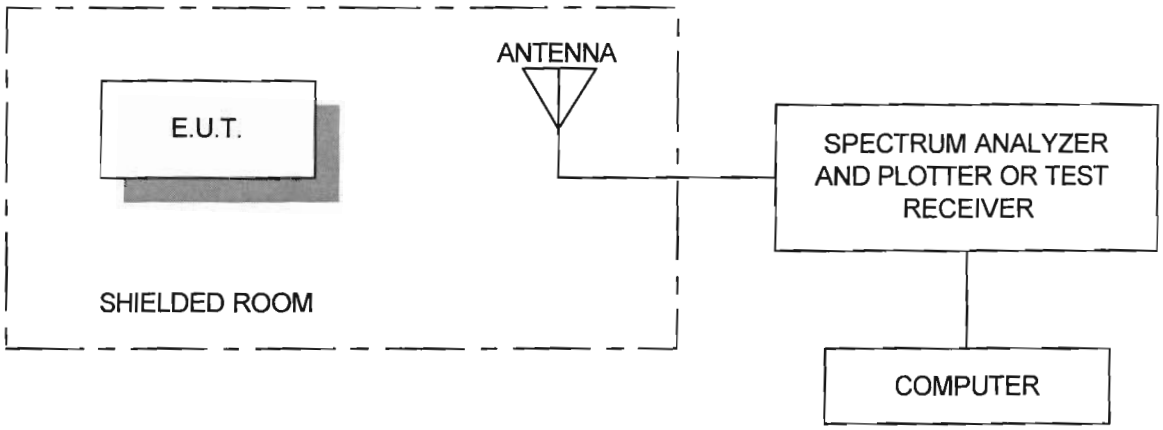
Radiated Emissions

Test Method - Radiated Emissions:

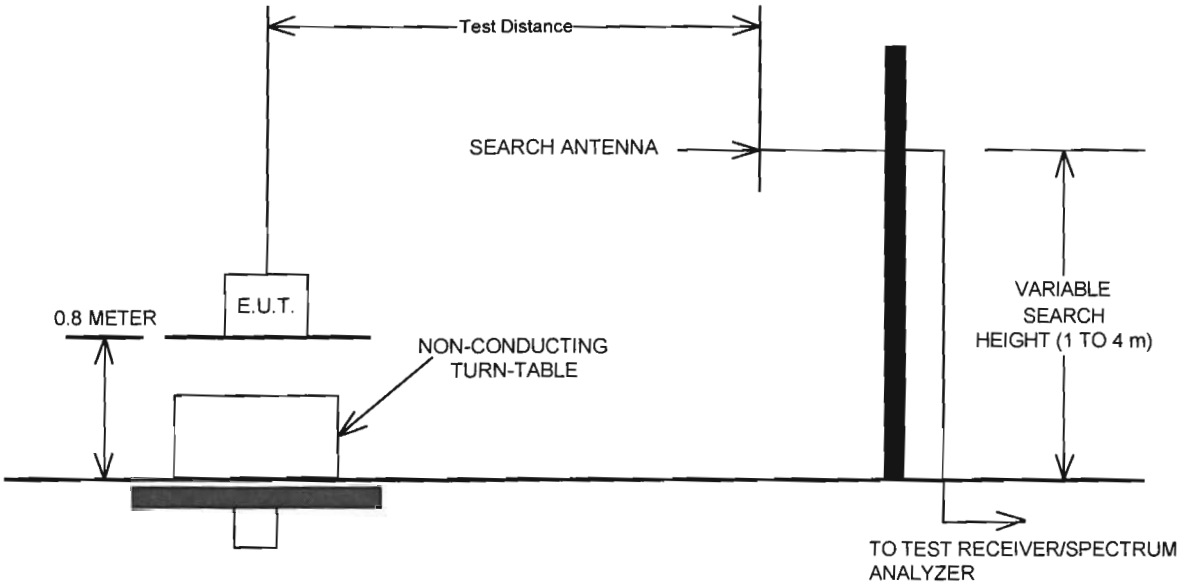
?? Applicable Test Standard: CFR47, FCC Pt 15, Subpart B
?? The test set-up in the shielded room is as per the test configuration diagram.
?? The E.U.T. is configured as typically used.
?? The E.U.T. and any accessories are operated with typical load conditions.
?? Radiated emissions measurements are made from 30 MHz to 1000 MHz.
?? The equipment was prescanned in the shielded room using a spectrum analyzer and broadband antenna to produce a list of frequencies to be investigated in the open area test site.
?? The equipment is then set-up on an open area test site.
?? Variations in antenna height, antenna polarization, and E.U.T. azimuth are explored to produce the emission that has the highest amplitude relative to the limit.
?? The frequencies noted in the preliminary test are investigated on the open-air site where amplitude measurements are made.
?? If ambient signal field strength is high at 10 meter, the measurements may be performed at 3 meter and extrapolated to the requisite distance.
?? If less than six emissions are better than 20 dB below limit, the noise level of the measuring instrument at representative frequencies is also reported.
?? Any emissions above 1 GHz are measured using a horn antenna and low noise pre-amplifier at a distance of 3 meters. The bandwidth was set to 1 MHz and the detector function was average.

Test Configuration - Radiated Emissions:

Radiated Pre-scan:



Outdoor Test Site for Radiated Emissions:



Section 8. Labeling Requirements

Your product has successfully complied with 47 CFR FCC Part 15.B Class A requirements.

FCC Class A Label:

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 to placing the above label on your product, the three items that are required to be included in your product's manual are:

(1) For a Class A digital device or peripheral, the instructions furnished to the user shall include the following or similar statement, placed in a prominent location at the front of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(2) The user's manual must caution the user that changes or modifications not expressly approved by the party responsible for compliance (you/your company) could void the user's authority to operate the equipment.

(3) The instruction manual must include appropriate instructions on the first page of the manual concerning installation of the device or special accessories (special cabling, shields, adapters) that must be used with the device. An appropriate caution statement should warn the user to utilize the special accessories supplied with the equipment for continued FCC compliance.

Nemko Test Report:	5113RUS1
Applicant:	University of Houston 4800 Calhoun Road Houston, TX 77004 USA
Equipment Under Test: **(E.U.T.)**	U7W400
In Accordance With:	**FCC Part 15, Subpart F, Paragraph 15.509** Ultra Wide Band Operation Ground Pentrating Radar
Tested By:	Nemko USA Inc. 802 N. Kealy Lewisville, TX 75057

TESTED BY: _____ **DATE:** 15 October 2007

David Light, Senior Wireless Engineer

APPROVED BY: _____ **DATE:** 19 October, 2007

Mike Cantwell, Frontline Manager

Total Number of Pages: 25

Table Of Contents

Section 1. Summary Of Test Results

Manufacturer: The University of Houston

Model No.: U7W400

Serial No.: Preproduction

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 15, Subpart C, Paragraph 15.509 for ultra wide band operation. All tests were conducted using measurement procedure ANSI C63.4-2003. Radiated Emissions were made with the antenna positioned on the ground screen of an open area test site with the EUT positioned on a 4 foot by 4 foot by 4 foot dry sand pit

☒ New Submission ☐ Production Unit

☐ Class II Permissive Change ☒ Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE. NONE
See " Summary of Test Data".

NVLAP®
LAB CODE: 100426-0

Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
Conducted Emissions	15.207	NA
Pulse Repetition Frequency	15.509	Complies
Definition of UWB	15.203(a)/15.209(a)	Complies
Radiated Emissions	15.509(d)	Complies
Radiated Emissions	15.509(e)	Complies
Peak Emission at f_M	15.509(f)	Complies

Footnotes For N/A's:

The device is battery powered.

Section 2. General Equipment Specification

Frequency Range:	Single	
Operating Frequency(ies) of Sample:	200 MHz to 460 MHz (10 dB BW)	
Tunable Bands:	Single	
20 dB Occupied Bandwidth:	260 MHz	
User Frequency Adjustment:	None	
Integral Antenna	Yes ☒	No ☐

Description of Device Tested

Ground Penetrating Radar System

System Diagram

Refer to separate exhibit.

Section 3. Radiated Emissions

NAME OF TEST: Radiated Emissions	PARA. NO.: 15.509(d)&(e)
TESTED BY: David Light	DATE: 12 October 2007

Minimum Standard: Para no. 15.509

Limits below 960 MHz (15.209 and 15.509):

Frequency (MHz)	Field Strength Limits (microvolts/m)	Measuring RBW	Distance (Meters)
0.009-0.490	2400/F(kHz)	1 kHz	300
0.490-1.705	24000/F(kHz)	10 kHz	30
1.705-30.0	30	10 kHz	30
30-88	100	100 kHz	3
88-216	150	100 kHz	3
216-960	200	100 kHz	3

Limits above 960 MHz (15.509)

Frequency (MHz)	E.I.R.P. (dBm)	Measuring RBW	Distance (Meters)
960-1610	-65.3	1 MHz	3
1610-1990	-53.3	1 MHz	3
1990-3100	-51.3	1 MHz	3
3100-10600	-41.3	1 MHz	3
Above 10600	-51.3	1 MHz	3
1164-1240	-75.3	1 kHz	3
1559-1610	-75.3	1 kHz	3

E.I.R.P limits converted from field strength during measurements per 15.521(g)

Maximizing Emission Levels:
The emissions were scanned from 30 MHz to 4000 MHz.
For measurements below 960 MHz the emissions were made using a CISPR Quasi-peak detector IF BW = 100 kHz
For Frequency above 960 MHz and outside the below frequency bands, the emissions were measured using EMI RMS detector, RBW=1MHz, VBW=10 MHz
For frequencies fall inside 1164-1240 and 1559-1610 MHz, the emissions were measured using EMI RMS Detector, RBW = 1 KHz, VBW = 1 MHz
Note: The above tests were performed with the EUT raised 5 cmfrom the ground as its intended use. The EUT was tested in 8 positions (every 45°)

Test Results: Complies

Measurement Data: See attached table(s).

Test Data – Radiated Emissions

Radiated Emissions Data

Complete	X			Job # :	5113
Preliminary				Page	1
Client Name :	University of Houston			Test # :	REHE-01
EUT Name :	Ground Coupled Radar			of	11
EUT Model # :	U7W400				
EUT Part # :					
EUT Serial # :					
EUT Config. :	Transmitting over sand pit				
Specification :	CFR47 Part 15, Subpart B, Class B			Reference :	15.209/15.509
Rod. Ant. #:		Temp. (deg. C) :	22	Date :	10/11/07
Bicon Ant.#:	1306	Humidity (%) :	40	Time :	9:00
Log Ant.#:	759	EUT Voltage :	12	Staff :	David Light
Bilog Ant.#:		EUT Frequency :	dc	Photo ID:	
Dipole Ant.#:		Phase:	0	QP Bandwidth:	120 KHz
Cable#:	1522	Location:	Sand Pit		
Preamp#:	762	Distance:	3 Meters		
Limiter#:	na	Barometric pressure:	1016		
Atten #:	na				
Detector#:	1659				

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 degrees
73.7	V	0	41.8	8.9	3.1	27.5	26.3	40.0	-13.7	Pass	
86	V	0	32.5	9.6	3.5	27.4	18.2	40.0	-21.8	Pass	
110.6	V	0	48	11.4	3.8	27.6	35.6	43.5	-7.9	Pass	
122.9	V	0	46	11.9	3.8	27.6	34.1	43.5	-9.4	Pass	
135.2	V	0	44.8	12.7	4.2	27.7	34.0	43.5	-9.5	Pass	
147.4	V	0	46.8	13.5	4.2	27.7	36.8	43.5	-6.7	Pass	
196.6	V	0	49	14.7	5.1	27.9	40.9	43.5	-2.6	Pass	
208.9	V	0	46	14.9	5.5	27.9	38.5	43.5	-5.0	Pass	
258.1	V	0	42.4	17.1	6.2	27.9	37.8	46.0	-8.2	Pass	
73.7	H	0	40.9	8.9	3.1	27.5	25.4	40.0	-14.6	Pass	
86	H	0	35	9.6	3.5	27.4	20.7	40.0	-19.3	Pass	
110.6	H	0	35	11.4	3.8	27.6	22.6	43.5	-20.9	Pass	
196.6	H	0	43	14.7	5.1	27.9	34.9	43.5	-8.6	Pass	
208.9	H	0	40.7	14.9	5.5	27.9	33.2	43.5	-10.3	Pass	
245.8	H	0	44.2	16.5	5.9	27.9	38.7	46.0	-7.3	Pass	

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Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 Degrees
301	V	0	34	19.6	6.8	27.9	32.5	46.0	-13.5	Pass	
326	V	0	35.8	15.9	6.8	27.9	30.6	46.0	-15.4	Pass	
432	V	0	32.2	16	8.0	27.8	28.4	46.0	-17.6	Pass	
459	V	0	33	16.3	8.5	28.1	29.7	46.0	-16.3	Pass	
301	H	0	37.5	19.6	6.8	27.9	36.0	46.0	-10.0	Pass	
321	H	0	39.3	15.9	6.8	27.9	34.1	46.0	-11.9	Pass	
371	H	0	45	15.3	7.4	27.7	40.0	46.0	-6.0	Pass	
431	H	0	45	16	8.0	27.8	41.2	46.0	-4.8	Pass	
460	H	0	37	16.8	8.5	28.1	34.2	46.0	-11.8	Pass	
490	H	0	38.3	17.9	8.5	28.1	36.6	46.0	-9.4	Pass	
536	H	0	36.8	17.6	8.9	28.1	35.2	46.0	-10.8	Pass	
688	H	0	29.5	19.9	10.4	27.8	32.0	46.0	-14.0	Pass	
750	H	0	27	20.8	11.1	27.7	31.2	46.0	-14.8	Pass	
											45 degrees
73.7	V	0	48.1	8.9	3.1	27.5	32.6	40.0	-7.4	Pass	
86	V	0	45.6	9.6	3.5	27.4	31.3	40.0	-8.7	Pass	
110.6	V	0	44.2	11.4	3.8	27.6	31.8	43.5	-11.7	Pass	
122.9	V	0	44.7	11.9	3.8	27.6	32.8	43.5	-10.7	Pass	
135.2	V	0	43.7	12.7	4.2	27.7	32.9	43.5	-10.6	Pass	
147.4	V	0	44.7	13.5	4.2	27.7	34.7	43.5	-8.8	Pass	
196.6	V	0	43.6	14.7	5.1	27.9	35.5	43.5	-8.0	Pass	
208.9	V	0	42.1	14.9	5.5	27.9	34.6	43.5	-8.9	Pass	
258.1	V	0	35.2	17.1	6.2	27.9	30.6	46.0	-15.4	Pass	
73.7	H	0	42.4	8.9	3.1	27.5	26.9	40.0	-13.1	Pass	
86	H	0	45.9	9.6	3.5	27.4	31.6	40.0	-8.4	Pass	
110.6	H	0	40	11.4	3.8	27.6	27.6	43.5	-15.9	Pass	
196.6	H	0	42.5	14.7	5.1	27.9	34.4	43.5	-9.1	Pass	
208.9	H	0	40.4	14.9	5.5	27.9	32.9	43.5	-10.6	Pass	
245.8	H	0	39.4	16.5	5.9	27.9	33.9	46.0	-12.1	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											45 degrees
301	V	0	25	19.6	6.8	27.9	23.5	46.0	-22.5	Pass	
326	V	0	30	15.9	6.8	27.9	24.8	46.0	-21.2	Pass	
432	V	0	40	16	8.0	27.8	36.2	46.0	-9.8	Pass	
459	V	0	39	16.3	8.5	28.1	35.7	46.0	-10.3	Pass	
301	H	0	41.2	19.6	6.8	27.9	39.7	46.0	-6.3	Pass	
321	H	0	41	15.9	6.8	27.9	35.8	46.0	-10.2	Pass	
340	H	0	39.9	14.9	6.8	27.9	33.7	46.0	-12.3	Pass	
431	H	0	39.7	16	8.0	27.8	35.9	46.0	-10.1	Pass	
460	H	0	43	16.8	8.5	28.1	40.2	46.0	-5.8	Pass	
490	H	0	36.5	17.9	8.5	28.1	34.8	46.0	-11.2	Pass	
536	H	0	37.6	17.6	8.9	28.1	36.0	46.0	-10.0	Pass	
688	H	0	31	19.9	10.4	27.8	33.5	46.0	-12.5	Pass	
750	H	0	30	20.8	11.1	27.7	34.2	46.0	-11.8	Pass	
											90 degrees
73.7	V	0	52	8.9	3.1	27.5	36.5	40.0	-3.5	Pass	
86	V	0	52	9.6	3.5	27.4	37.7	40.0	-2.3	Pass	
110.6	V	0	52.6	11.4	3.8	27.6	40.2	43.5	-3.3	Pass	
122.9	V	0	50.4	11.9	3.8	27.6	38.5	43.5	-5.0	Pass	
135.2	V	0	51	12.7	4.2	27.7	40.2	43.5	-3.3	Pass	
147.4	V	0	50.4	13.5	4.2	27.7	40.4	43.5	-3.1	Pass	
196.6	V	0	50	14.7	5.1	27.9	41.9	43.5	-1.6	Pass	
208.9	V	0	49.3	14.9	5.5	27.9	41.8	43.5	-1.7	Pass	
226.2	V	0	49	16	5.9	27.9	43.0	46.0	-3.0	Pass	
258.1	V	0	45.4	17.1	6.2	27.9	40.8	46.0	-5.2	Pass	
73.7	H	0	40	8.9	3.1	27.5	24.5	40.0	-15.5	Pass	
86	H	0	33	9.6	3.5	27.4	18.7	40.0	-21.3	Pass	
110.6	H	0	34	11.4	3.8	27.6	21.6	43.5	-21.9	Pass	
122.9	H	0	41	11.9	3.8	27.6	29.1	43.5	-14.4	Pass	
196.6	H	0	44.8	14.7	5.1	27.9	36.7	43.5	-6.8	Pass	
208.9	H	0	46	14.9	5.5	27.9	38.5	43.5	-5.0	Pass	
245.8	H	0	45	16.5	5.9	27.9	39.5	46.0	-6.5	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											90 Degrees
301	V	0	41	19.6	6.8	27.9	39.5	46.0	-6.5	Pass	
321	V	0	44.6	15.9	6.8	27.9	39.4	46.0	-6.6	Pass	
328	V	0	44	15.9	6.8	27.9	38.8	46.0	-7.2	Pass	
385	V	0	44.2	15.6	7.4	27.7	39.5	46.0	-6.5	Pass	
488	V	0	40.3	19.4	8.5	28.1	40.1	46.0	-5.9	Pass	
554	V	0	38.1	19.5	9.5	27.8	39.3	46.0	-6.7	Pass	
682	V	0	34.6	19.9	10.4	27.8	37.1	46.0	-8.9	Pass	
785	V	0	24	21	11.1	27.7	28.4	46.0	-17.6	Pass	
917	V	0	23	23.2	12.1	27.9	30.4	46.0	-15.6	Pass	
301	H	0	42.3	19.6	6.8	27.9	40.8	46.0	-5.2	Pass	
325	H	0	48.3	15.9	6.8	27.9	43.1	46.0	-2.9	Pass	
350	H	0	46.6	15	7.4	27.7	41.3	46.0	-4.7	Pass	
400	H	0	42.8	16.1	8.0	27.8	39.1	46.0	-6.9	Pass	
450	H	0	37.6	16.3	8.5	28.1	34.3	46.0	-11.7	Pass	
540	H	0	32	17.5	8.9	28.1	30.3	46.0	-15.7	Pass	
											135 degrees
73.7	V	0	53	8.9	3.1	27.5	37.5	40.0	-2.5	Pass	
86	V	0	50.3	9.6	3.5	27.4	36.0	40.0	-4.0	Pass	
110.6	V	0	48.1	11.4	3.8	27.6	35.7	43.5	-7.8	Pass	
122.9	V	0	47	11.9	3.8	27.6	35.1	43.5	-8.4	Pass	
135.2	V	0	50	12.7	4.2	27.7	39.2	43.5	-4.3	Pass	
147.4	V	0	49.5	13.5	4.2	27.7	39.5	43.5	-4.0	Pass	
196.6	V	0	45.5	14.7	5.1	27.9	37.4	43.5	-6.1	Pass	
208.9	V	0	44	14.9	5.5	27.9	36.5	43.5	-7.0	Pass	
226.2	V	0	43.4	16	5.9	27.9	37.4	46.0	-8.6	Pass	
258.1	V	0	40	17.1	6.2	27.9	35.4	46.0	-10.6	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											135 degrees
73.7	H	0	40.6	8.9	3.1	27.5	25.1	40.0	-14.9	Pass	
86	H	0	39	9.6	3.5	27.4	24.7	40.0	-15.3	Pass	
110.6	H	0	38.2	11.4	3.8	27.6	25.8	43.5	-17.7	Pass	
122.9	H	0	37	11.9	3.8	27.6	25.1	43.5	-18.4	Pass	
196.6	H	0	37.4	14.7	5.1	27.9	29.3	43.5	-14.2	Pass	
208.9	H	0	37.6	14.9	5.5	27.9	30.1	43.5	-13.4	Pass	
245.8	H	0	42.5	16.5	5.9	27.9	37.0	46.0	-9.0	Pass	
301	V	0	45	19.6	6.8	27.9	43.5	46.0	-2.5	Pass	
321	V	0	46	15.9	6.8	27.9	40.8	46.0	-5.2	Pass	
328	V	0	46.5	15.9	6.8	27.9	41.3	46.0	-4.7	Pass	
385	V	0	46	15.6	7.4	27.7	41.3	46.0	-4.7	Pass	
488	V	0	38.6	19.4	8.5	28.1	38.4	46.0	-7.6	Pass	
554	V	0	35.4	19.5	9.5	27.8	36.6	46.0	-9.4	Pass	
682	V	0	34	19.9	10.4	27.8	36.5	46.0	-9.5	Pass	
785	V	0	26	21	11.1	27.7	30.4	46.0	-15.6	Pass	
917	V	0	31	23.2	12.1	27.9	38.4	46.0	-7.6	Pass	
301	H	0	44	19.6	6.8	27.9	42.5	46.0	-3.5	Pass	
325	H	0	48.3	15.9	6.8	27.9	43.1	46.0	-2.9	Pass	
350	H	0	46.8	15	7.4	27.7	41.5	46.0	-4.5	Pass	
400	H	0	46.7	16.1	8.0	27.8	43.0	46.0	-3.0	Pass	
450	H	0	40.6	16.3	8.5	28.1	37.3	46.0	-8.7	Pass	
540	H	0	36.6	17.5	8.9	28.1	34.9	46.0	-11.1	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											180 Degrees
73.7	V	0	43.4	8.9	3.1	27.5	27.9	40.0	-12.1	Pass	
86	V	0	36	9.6	3.5	27.4	21.7	40.0	-18.3	Pass	
110.6	V	0	39.4	11.4	3.8	27.6	27.0	43.5	-16.5	Pass	
122.9	V	0	39.5	11.9	3.8	27.6	27.6	43.5	-15.9	Pass	
135.2	V	0	42	12.7	4.2	27.7	31.2	43.5	-12.3	Pass	
147.4	V	0	47	13.5	4.2	27.7	37.0	43.5	-6.5	Pass	
196.6	V	0	44.1	14.7	5.1	27.9	36.0	43.5	-7.5	Pass	
208.9	V	0	45	14.9	5.5	27.9	37.5	43.5	-6.0	Pass	
258.1	V	0	39.8	17.1	6.2	27.9	35.2	46.0	-10.8	Pass	
73.7	H	0	38.5	8.9	3.1	27.5	23.0	40.0	-17.0	Pass	
86	H	0	33.9	9.6	3.5	27.4	19.6	40.0	-20.4	Pass	
110.6	H	0	37.4	11.4	3.8	27.6	25.0	43.5	-18.5	Pass	
122.9	H	0	34.8	11.9	3.8	27.6	22.9	43.5	-20.6	Pass	
135.2	H	0	33.7	12.7	4.2	27.7	22.9	43.5	-20.6	Pass	
172	H	0	32.1	14.3	4.7	27.8	23.3	43.5	-20.2	Pass	
196.6	H	0	40.1	14.7	5.1	27.9	32.0	43.5	-11.5	Pass	
208.9	H	0	39.4	14.9	5.5	27.9	31.9	43.5	-11.6	Pass	
245.8	H	0	44.2	16.5	5.9	27.9	38.7	46.0	-7.3	Pass	
258	H	0	47.8	17.1	6.2	27.9	43.2	46.0	-2.8	Pass	
270.6	H	0	46	18.1	6.2	27.9	42.4	46.0	-3.6	Pass	
282.9	H	0	46	18.7	6.4	27.8	43.3	46.0	-2.7	Pass	
295.2	H	0	44	18.8	6.4	27.8	41.4	46.0	-4.6	Pass	
301	V	0	35.2	19.6	6.8	27.9	33.7	46.0	-12.3	Pass	
325	V	0	33.7	15.9	6.8	27.9	28.5	46.0	-17.5	Pass	
368	V	0	33.1	15.1	7.4	27.7	27.9	46.0	-18.1	Pass	
490	V	0	32.7	17.9	8.5	28.1	31.0	46.0	-15.0	Pass	
301	H	0	39.1	19.6	6.8	27.9	37.6	46.0	-8.4	Pass	
330	H	0	46	15.3	6.8	27.9	40.2	46.0	-5.8	Pass	
392	H	0	44.5	15.9	7.4	27.7	40.1	46.0	-5.9	Pass	
460	H	0	45.6	16.8	8.5	28.1	42.8	46.0	-3.2	Pass	
544	H	0	42.6	17.5	8.9	28.1	40.9	46.0	-5.1	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
73.7	V	0	51.8	8.9	3.1	27.5	36.3	40.0	-3.7	Pass	225 degrees
86	V	0	49.3	9.6	3.5	27.4	35.0	40.0	-5.0	Pass	
110.6	V	0	50.8	11.4	3.8	27.6	38.4	43.5	-5.1	Pass	
122.9	V	0	49.9	11.9	3.8	27.6	38.0	43.5	-5.5	Pass	
135.2	V	0	48.2	12.7	4.2	27.7	37.4	43.5	-6.1	Pass	
147.4	V	0	46.3	13.5	4.2	27.7	36.3	43.5	-7.2	Pass	
196.6	V	0	46.7	14.7	5.1	27.9	38.6	43.5	-4.9	Pass	
208.9	V	0	44	14.9	5.5	27.9	36.5	43.5	-7.0	Pass	
258.1	V	0	37.8	17.1	6.2	27.9	33.2	46.0	-12.8	Pass	
73.7	H	0	42.3	8.9	3.1	27.5	26.8	40.0	-13.2	Pass	
86	H	0	32.3	9.6	3.5	27.4	18.0	40.0	-22.0	Pass	
110.6	H	0	36	11.4	3.8	27.6	23.6	43.5	-19.9	Pass	
122.9	H	0	37	11.9	3.8	27.6	25.1	43.5	-18.4	Pass	
135.2	H	0	36.2	12.7	4.2	27.7	25.4	43.5	-18.1	Pass	
172	H	0	37	14.3	4.7	27.8	28.2	43.5	-15.3	Pass	
196.6	H	0	38.5	14.7	5.1	27.9	30.4	43.5	-13.1	Pass	
208.9	H	0	36	14.9	5.5	27.9	28.5	43.5	-15.0	Pass	
245.8	H	0	39.8	16.5	5.9	27.9	34.3	46.0	-11.7	Pass	
258	H	0	42.2	17.1	6.2	27.9	37.6	46.0	-8.4	Pass	
270.6	H	0	42	18.1	6.2	27.9	38.4	46.0	-7.6	Pass	
282.9	H	0	42.6	18.7	6.4	27.8	39.9	46.0	-6.1	Pass	
295.2	H	0	43.8	18.8	6.4	27.8	41.2	46.0	-4.8	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											225 degrees
301	V	0	35.2	19.6	6.8	27.9	33.7	46.0	-12.3	Pass	
325	V	0	42.5	15.9	6.8	27.9	37.3	46.0	-8.7	Pass	
368	V	0	40.6	15.1	7.4	27.7	35.4	46.0	-10.6	Pass	
490	V	0	38.3	17.9	8.5	28.1	36.6	46.0	-9.4	Pass	
301	H	0	41.3	19.6	6.8	27.9	39.8	46.0	-6.2	Pass	
330	H	0	45	15.3	6.8	27.9	39.2	46.0	-6.8	Pass	
392	H	0	46.2	15.9	7.4	27.7	41.8	46.0	-4.2	Pass	
460	H	0	43.9	16.8	8.5	28.1	41.1	46.0	-4.9	Pass	
544	H	0	41.5	17.5	8.9	28.1	39.8	46.0	-6.2	Pass	
730	H	0	34.5	20.8	10.7	27.6	38.4	46.0	-7.6	Pass	
830	H	0	22	22.5	11.8	27.5	28.8	46.0	-17.2	Pass	
											270 degrees
73.7	V	0	39.6	8.9	3.1	27.5	24.1	40.0	-15.9	Pass	
86	V	0	36	9.6	3.5	27.4	21.7	40.0	-18.3	Pass	
110.6	V	0	42	11.4	3.8	27.6	29.6	43.5	-13.9	Pass	
122.9	V	0	46	11.9	3.8	27.6	34.1	43.5	-9.4	Pass	
135.2	V	0	44	12.7	4.2	27.7	33.2	43.5	-10.3	Pass	
147.4	V	0	45.8	13.5	4.2	27.7	35.8	43.5	-7.7	Pass	
159.8	V	0	42.6	14.3	4.7	27.8	33.8	43.5	-9.7	Pass	
172.1	V	0	43.4	14.3	4.7	27.8	34.6	43.5	-8.9	Pass	
184.4	V	0	40	14.6	5.1	27.9	31.8	43.5	-11.7	Pass	
196.6	V	0	44.5	14.7	5.1	27.9	36.4	43.5	-7.1	Pass	
208.9	V	0	43.4	14.9	5.5	27.9	35.9	43.5	-7.6	Pass	
221.4	V	0	40	15.7	5.5	27.9	33.3	46.0	-12.7	Pass	
233.7	V	0	39.2	16.2	5.9	27.9	33.4	46.0	-12.6	Pass	
258.1	V	0	37.5	17.1	6.2	27.9	32.9	46.0	-13.1	Pass	
270.6	V	0	37.5	18.1	6.2	27.9	33.9	46.0	-12.1	Pass	
282.9	V	0	38.4	18.7	6.4	27.8	35.7	46.0	-10.3	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											270 degrees
73.7	H	0	39.3	8.9	3.1	27.5	23.8	40.0	-16.2	Pass	
86	H	0	35	9.6	3.5	27.4	20.7	40.0	-19.3	Pass	
110.6	H	0	34.6	11.4	3.8	27.6	22.2	43.5	-21.3	Pass	
122.9	H	0	34.5	11.9	3.8	27.6	22.6	43.5	-20.9	Pass	
196.6	H	0	41.5	14.7	5.1	27.9	33.4	43.5	-10.1	Pass	
208.9	H	0	37.3	14.9	5.5	27.9	29.8	43.5	-13.7	Pass	
245.8	H	0	33.9	16.5	5.9	27.9	28.4	46.0	-17.6	Pass	
258	H	0	35.2	17.1	6.2	27.9	30.6	46.0	-15.4	Pass	
295.2	H	0	43.1	18.8	6.4	27.8	40.5	46.0	-5.5	Pass	
301	V	0	33.3	19.6	6.8	27.9	31.8	46.0	-14.2	Pass	
333	V	0	40.4	15.3	6.8	27.9	34.6	46.0	-11.4	Pass	
350	V	0	42.9	15	7.4	27.7	37.6	46.0	-8.4	Pass	
400	V	0	40.2	16.1	8.0	27.8	36.5	46.0	-9.5	Pass	
488	V	0	38.9	19.4	8.5	28.1	38.7	46.0	-7.3	Pass	
616	V	0	38	18.9	9.7	27.9	38.7	46.0	-7.3	Pass	
730	V	0	34	20.8	10.7	27.6	37.9	46.0	-8.1	Pass	
950	V	0	28	23.6	12.9	27.5	37.0	46.0	-9.0	Pass	
301	H	0	35	19.6	6.8	27.9	33.5	46.0	-12.5	Pass	
325	H	0	42	15.9	6.8	27.9	36.8	46.0	-9.2	Pass	
350	H	0	41.3	15	7.4	27.7	36.0	46.0	-10.0	Pass	
400	H	0	44.8	16.1	8.0	27.8	41.1	46.0	-4.9	Pass	
480	H	0	42	19.4	8.5	28.1	41.8	46.0	-4.2	Pass	
516	H	0	37.5	17.3	8.9	28.1	35.6	46.0	-10.4	Pass	
616	H	0	37	18.9	9.7	27.9	37.7	46.0	-8.3	Pass	
750	H	0	29	20.8	11.1	27.7	33.2	46.0	-12.8	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											315 degrees
73.7	V	0	52	8.9	3.1	27.5	36.5	40.0	-3.5	Pass	
86	V	0	51	9.6	3.5	27.4	36.7	40.0	-3.3	Pass	
110.6	V	0	47	11.4	3.8	27.6	34.6	43.5	-8.9	Pass	
122.9	V	0	49.6	11.9	3.8	27.6	37.7	43.5	-5.8	Pass	
135.2	V	0	45	12.7	4.2	27.7	34.2	43.5	-9.3	Pass	
147.4	V	0	45.6	13.5	4.2	27.7	35.6	43.5	-7.9	Pass	
159.8	V	0	39	14.3	4.7	27.8	30.2	43.5	-13.3	Pass	
172.1	V	0	40.6	14.3	4.7	27.8	31.8	43.5	-11.7	Pass	
184.4	V	0	43.6	14.6	5.1	27.9	35.4	43.5	-8.1	Pass	
196.6	V	0	48	14.7	5.1	27.9	39.9	43.5	-3.6	Pass	
208.9	V	0	45.8	14.9	5.5	27.9	38.3	43.5	-5.2	Pass	
221.4	V	0	41.2	15.7	5.5	27.9	34.5	46.0	-11.5	Pass	
233.7	V	0	39.9	16.2	5.9	27.9	34.1	46.0	-11.9	Pass	
258.1	V	0	35.5	17.1	6.2	27.9	30.9	46.0	-15.1	Pass	
270.6	V	0	31.2	18.1	6.2	27.9	27.6	46.0	-18.4	Pass	
282.9	V	0	26.9	18.7	6.4	27.8	24.2	46.0	-21.8	Pass	
73.7	H	0	40	8.9	3.1	27.5	24.5	40.0	-15.5	Pass	
86	H	0	36	9.6	3.5	27.4	21.7	40.0	-18.3	Pass	
110.6	H	0	32	11.4	3.8	27.6	19.6	43.5	-23.9	Pass	
122.9	H	0	34	11.9	3.8	27.6	22.1	43.5	-21.4	Pass	
196.6	H	0	37.8	14.7	5.1	27.9	29.7	43.5	-13.8	Pass	
208.9	H	0	40.5	14.9	5.5	27.9	33.0	43.5	-10.5	Pass	
245.8	H	0	42.4	16.5	5.9	27.9	36.9	46.0	-9.1	Pass	
258	H	0	41.6	17.1	6.2	27.9	37.0	46.0	-9.0	Pass	
295.2	H	0	41.8	18.8	6.4	27.8	39.2	46.0	-6.8	Pass	

Test Data – Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											315 degrees
301	V	0	37.5	19.6	6.8	27.9	36.0	46.0	-10.0	Pass	
333	V	0	36	15.3	6.8	27.9	30.2	46.0	-15.8	Pass	
350	V	0	36.3	15	7.4	27.7	31.0	46.0	-15.0	Pass	
400	V	0	38.4	16.1	8.0	27.8	34.7	46.0	-11.3	Pass	
488	V	0	39.5	19.4	8.5	28.1	39.3	46.0	-6.7	Pass	
616	V	0	39	18.9	9.7	27.9	39.7	46.0	-6.3	Pass	
730	V	0	35.3	20.8	10.7	27.6	39.2	46.0	-6.8	Pass	
950	V	0	25.5	23.6	12.9	27.5	34.5	46.0	-11.5	Pass	
301	H	0	38.4	19.6	6.8	27.9	36.9	46.0	-9.1	Pass	
325	H	0	44.3	15.9	6.8	27.9	39.1	46.0	-6.9	Pass	
350	H	0	45.8	15	7.4	27.7	40.5	46.0	-5.5	Pass	
400	H	0	41	16.1	8.0	27.8	37.3	46.0	-8.7	Pass	
480	H	0	40	19.4	8.5	28.1	39.8	46.0	-6.2	Pass	
516	H	0	43.3	17.3	8.9	28.1	41.4	46.0	-4.6	Pass	
616	H	0	37	18.9	9.7	27.9	37.7	46.0	-8.3	Pass	
750	H	0	30	20.8	11.1	27.7	34.2	46.0	-11.8	Pass	

Test Data – Radiated Emissions

Radiated Emissions Data

Complete: X
Preliminary:
Job # : 5113 Page 1
Test # : REHE-01 of 1

Client Name : University of Houston
EUT Name : Ground Coupled Radar
EUT Model # : U7W400
EUT Part # :
EUT Serial # :
EUT Config. : Transmitting over sand pit

Specification : CFR 47, Paragraph 15.509
Reference : 15.209/15.509

Rod. Ant. #:		Temp. (deg. C) :	22
Bicon Ant.#:		Humidity (%) :	40
Log Ant.#:		EUT Voltage :	12
Bilog Ant.#:		EUT Frequency :	dc
Horn Ant.#:	993	Phase:	0
Cable#:	1019	Location:	Sand Pit
Preamp#:	1016	Distance:	3 Meters
Limiter#:		Barometric pressure:	1016
Atten #:			
Detector#:	1036		

Date : 09/20/07
Time : 9:00
Staff : David Light
Photo ID:

Meas. Freq. (MHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	EIRP Correction	EIRP (dBm)		Spec. limit (dBm)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
1050	33	22.7	0.2	29.8	95.2	-69.1		-65.3	-3.8	Pass	
1540	37	24.3	0.2	32.9	95.2	-66.6		-65.3	-1.3	Pass	
1620	33.4	24.3	1	32.9	95.2	-69.4		-53.3	-16.1	Pass	
1920	33.2	28.5	1	33.1	95.2	-65.6		-53.3	-12.3	Pass	
2060	32.7	28.5	1	33.1	95.2	-66.1		-51.3	-14.8	Pass	
2940	32.6	29.7	1.2	33.3	95.2	-65.0		-51.3	-13.7	Pass	
3120	32.1	29.7	1.2	33.3	95.2	-65.5		-41.3	-24.2	Pass	
3910	31.8	31.6	1.3	33.6	95.2	-64.1		-41.3	-22.8	Pass	
1167	15.4	22.7	0.2	29.8	95.2	-86.7		-75.3	-11.4	Pass	
1230	1	22.7	0.2	29.8	95.2	-101.1		-75.3	-25.8	Pass	
1560	20	24.3	1	32.9	95.2	-82.8		-75.3	-7.5	Pass	
1608	3.5	24.3	1	32.9	95.2	-99.3		-75.3	-24.0	Pass	

The spectrum was searched to 4 GHz
The EUT was rotated and a reading taken at every 45 degrees
Worst case data is presented

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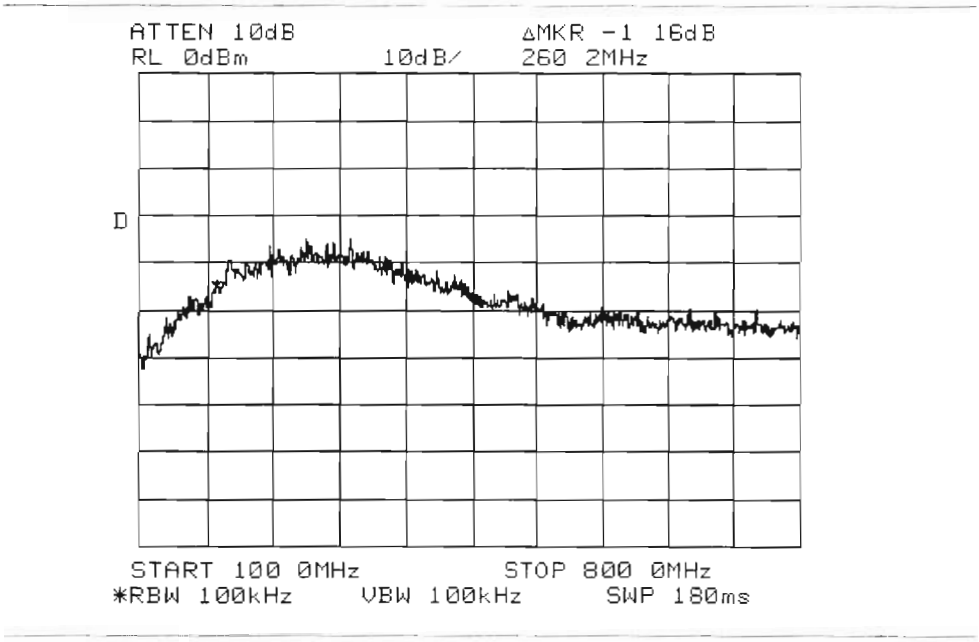
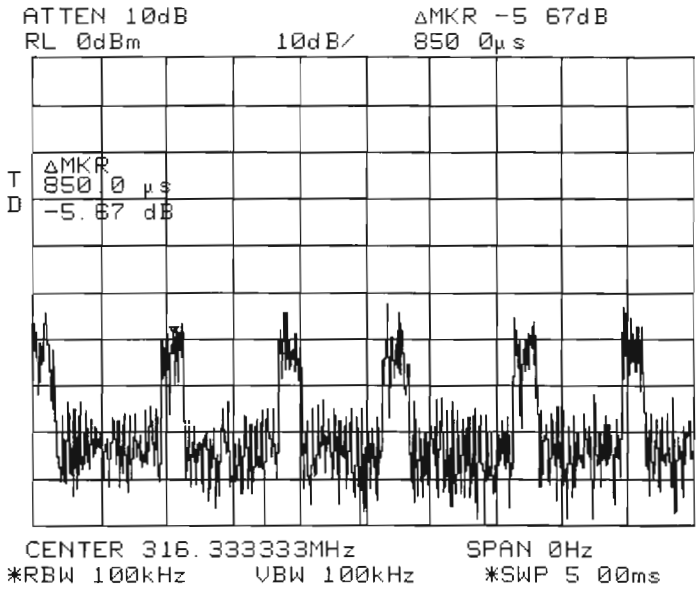
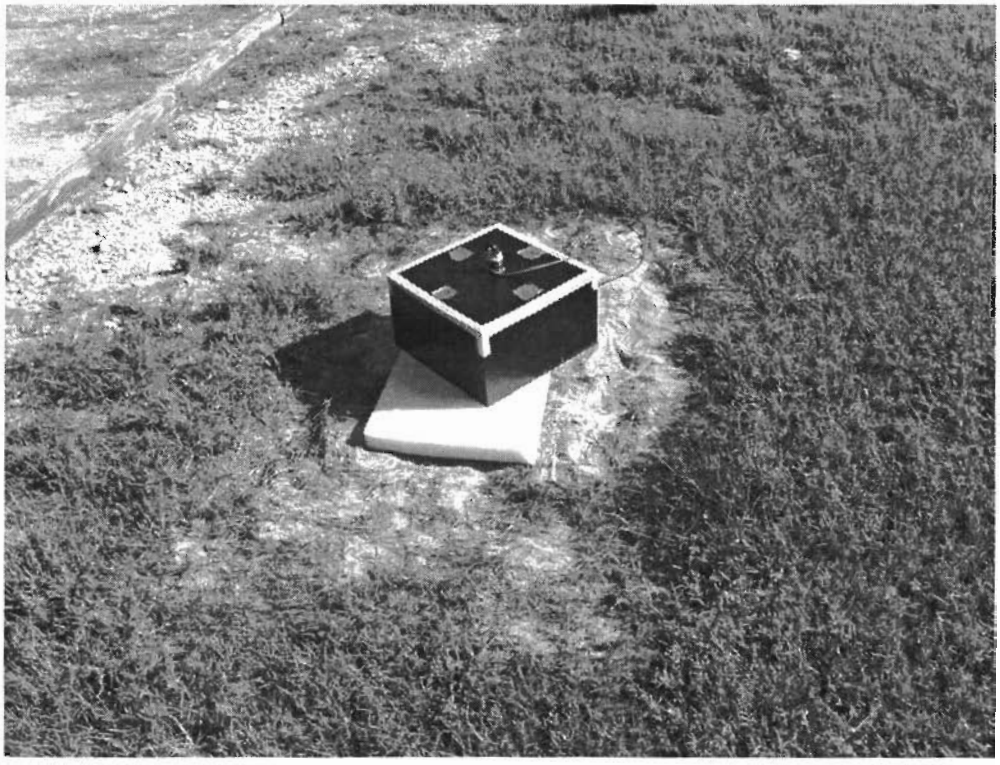
10 dB Bandwidth



Pulse Repetition



Test Setup Photographs



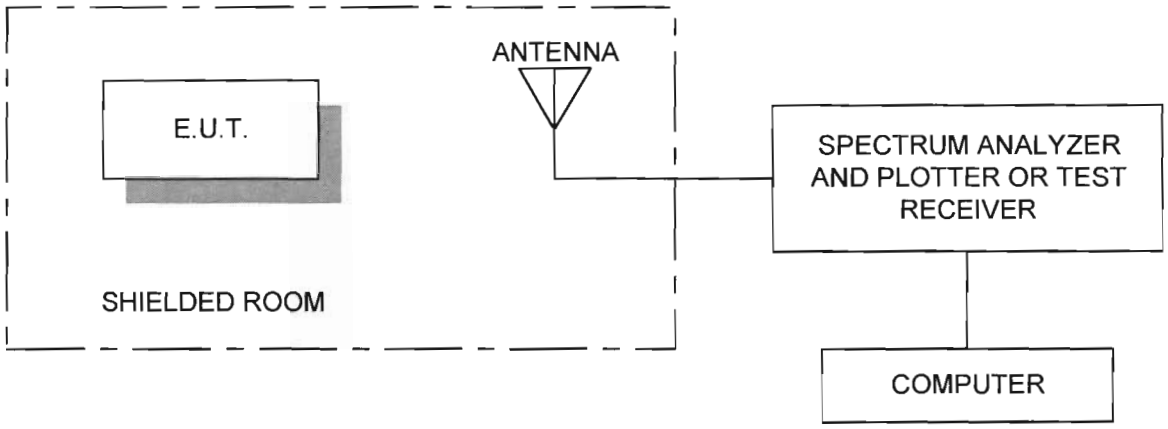
Section 4. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1306	Antenna biconical	Nemko USA, Inc. BCON 30300	212	03/30/07	03/29/08
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	03/30/07	03/29/08
1522	Cable Assy, LAB 5 - D OATS	Nemko USA, Inc. Site D OATS	N/A	11/01/06	11/01/07
762	27dB GAIN PREAMP	Nemko USA, Inc. 27dB LNA	946	10/15/06	10/15/07
1629	CABLE, 6 ft	MEGAPHASE 10311 1GVT4	N/A	03/05/07	03/04/08
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	05/26/06	05/26/08
1659	Spectrum Analyzer	Rhode & Schwarz FSP	973353	01/24/07	01/24/09
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/31/07	08/31/09
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	05/01/07	04/30/08

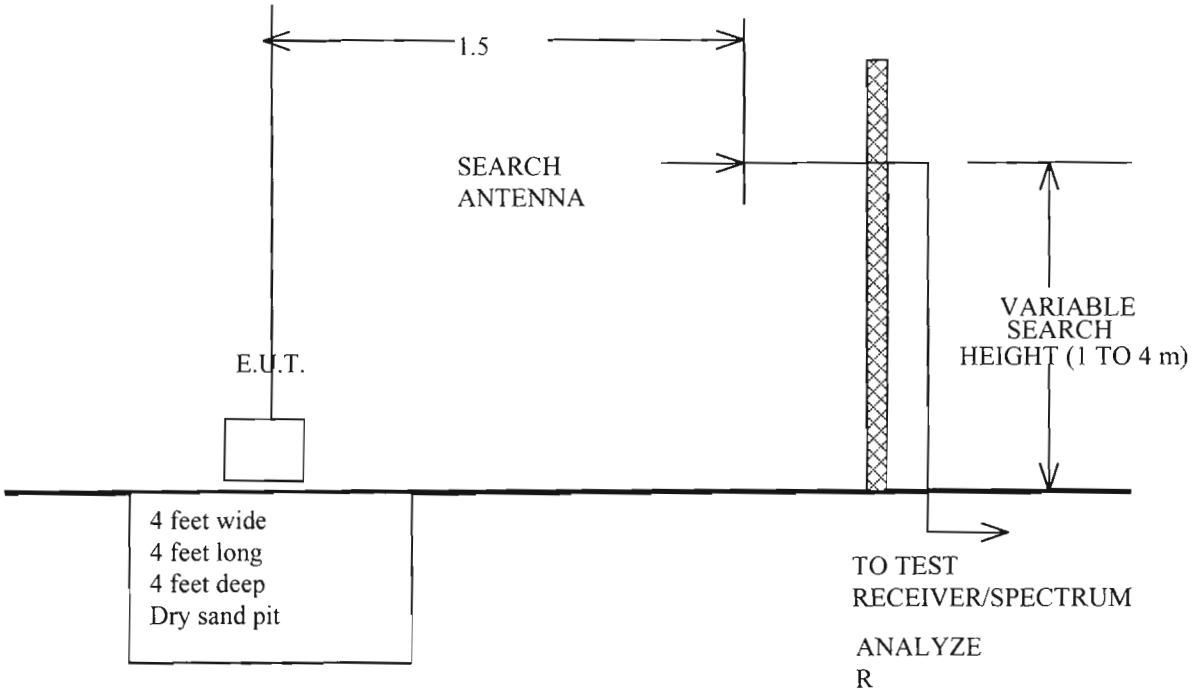
ANNEX A

TEST DIAGRAMS

Radiated Prescan



Test Site For Radiated Emissions



ENGINEERING TEST REPORT

NUMBER: 5113EUS1

ON

Model No.: U7W900

IN ACCORDANCE WITH:
CFR 47, PART 15, SUBPART B,
CLASS A VERIFICATION

TESTED FOR:
University of Houston
4800 Calhoun Road
Houston, Texas 77004

TESTED BY:
Nemko USA, Inc.
802 N. Kealy
Lewisville, Texas 75057-3136

Total Number of Pages: 20

TESTED BY: _____ DATE: 10/30/07
David Light, Senior Wireless Engineer

APPROVED BY: _____ DATE: 11/19/07
Arturo Ruvalcaba, EMC Engineer

NVLAP®
LAB CODE: 100426-0

Table of Contents

Section 1. Summary of Test Results

General:

All measurements are traceable to national standards.

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47, Part 15, Subpart B for Class A Digital Devices.

These tests were conducted using measurement procedures of ANSI C63.4-2003.

The equipment was tested for radiated emissions from 30 MHz to 1000 MHz in accordance with the requirements of CFR 47, Part 15, Subpart B., Paragraph 15.33. Frequencies were initially identified in a large shielded room. Amplitude measurements were made on an outdoor Open Area Test Site. Details of the outdoor site are on file with the FCC.

Abstract:

Name of Test	Basic Standard	Results
Conducted Emissions (Mains port)	CFR 47, Part 15, Subpart B Para. No. 15.107	N/A
Radiated Emissions	CFR 47, Part 15, Subpart B Para. No. 15.109	Complies

Note: The EUT is powered by a 12 Vdc battery

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE: **NONE**

Section 2. Equipment Under Test (E.U.T.)

Manufacturer:	University of Houston
Name:	U7W900
Model Number:	U7W900
Serial Number:	None
Production Status:	Prototype

Description of E.U.T.:

The impulse GPR is a device that is intentionally designed to directionally and locally radiate very small average electromagnetic power downwards into the ground to be detected.
The developed GPR is composed of a pulse transmitter, a receiver, a transmitter antenna, a receiver antenna, and a laptop computer. Except the computer, all the components are installed in a plastic box. Once a 12VDC power is supplied, the GPR starts to work.

Clock, Oscillator, Highest Frequencies Utilized:

50 kHz, 12.28 MHz

Justification:
The E.U.T. was configured for testing as per typical installation. Position and bundling of cables were investigated to establish maximum amplitude of emissions.

The following combinations were investigated to establish worst-case configuration:

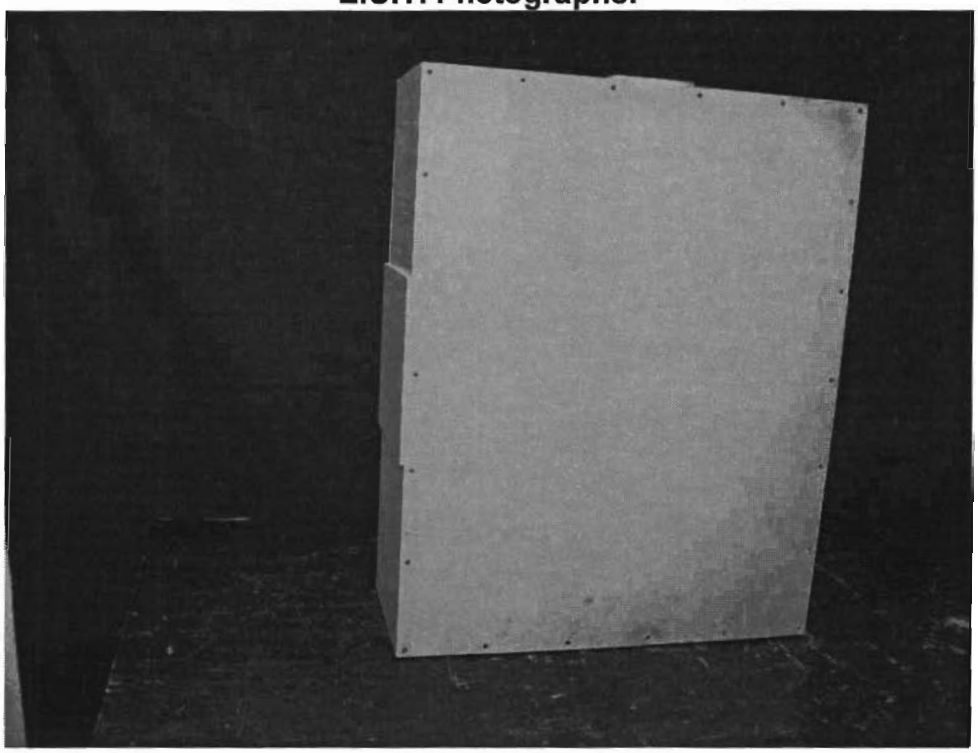
Stand Alone

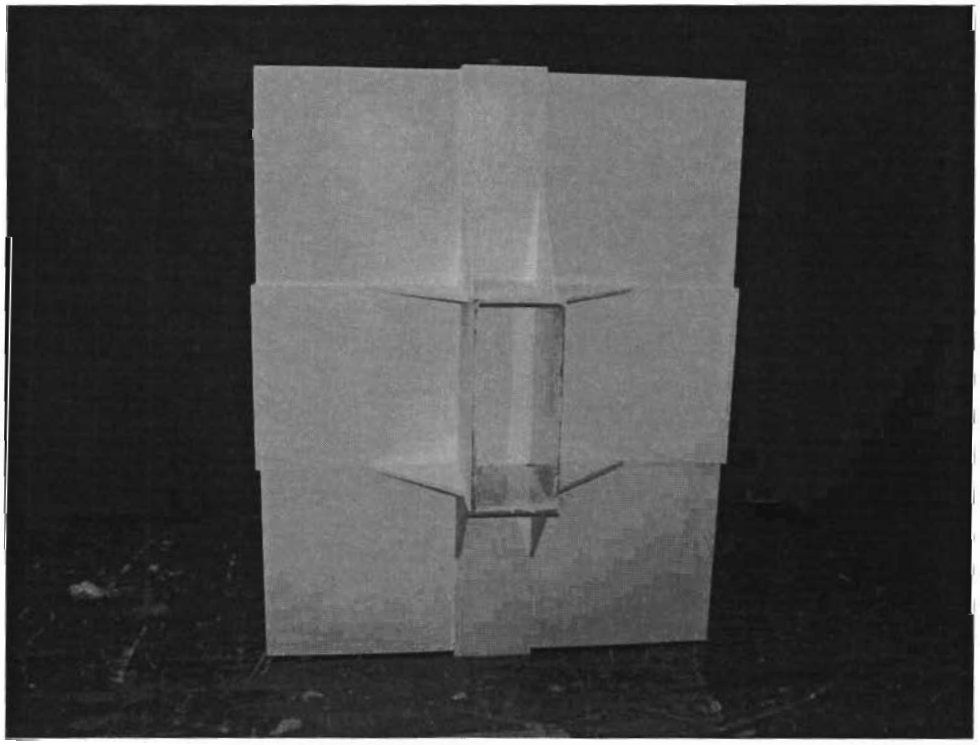
Exercise Program:
The E.U.T. exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to typical use.

The EUT was in the following exercise mode:

Powered on, continuously transmitting.

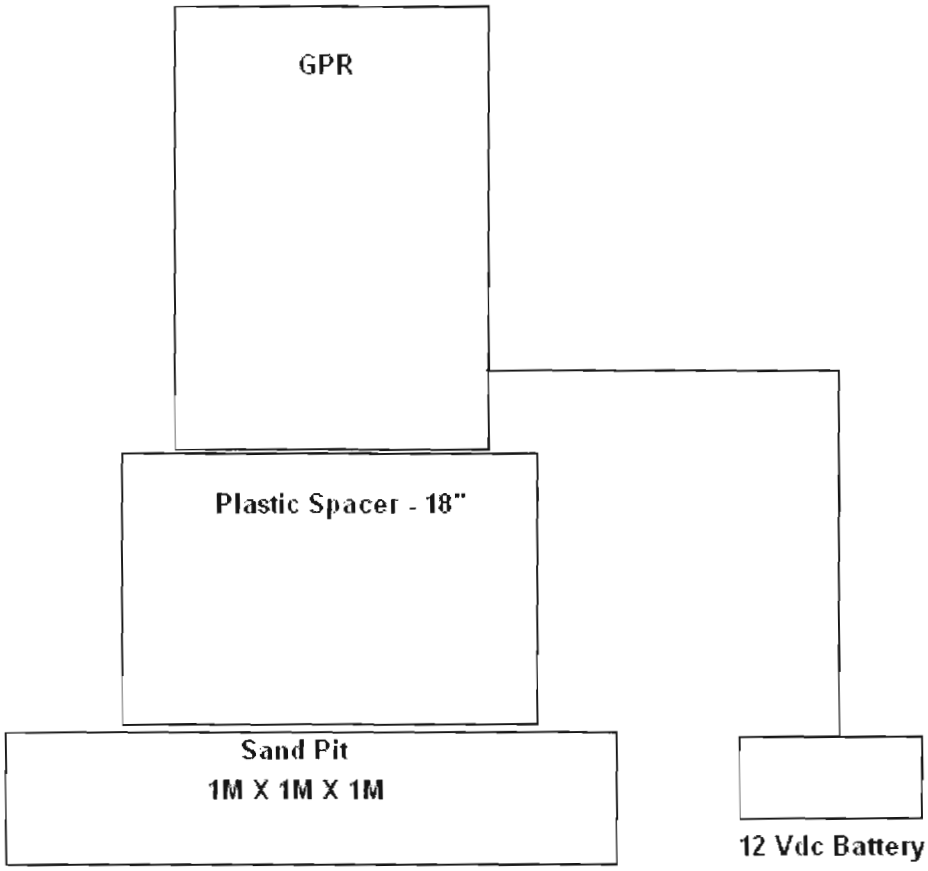
E.U.T. Photographs:





Section 3. Equipment Configuration

Configuration of the Equipment Under Test (E.U.T.):



Section 4. Radiated Emissions

Purpose:

The tests are intended to demonstrate the compliance of the Equipment Under Test (E.U.T.) to the limits for radiated emissions as defined by CFR 47, Part 15, Subpart B, Class A.

Specification Limits:

Limits for radiated disturbance of Class A

Frequency Range (MHz)	10m Limits (dBuV)
30-88	39.1
88-216	43.5
216-960	46.4
Above 960	49.5

Notes:
1. The lower limit shall apply at the transition frequency.
2. Additional provisions may be required for cases where interference occurs.
3. The 3m limits are calculated as follows: $L_3 = L_{10} * 10/3$ where L_{10} is the limit at 10m specified in μV/m

Method of Measurement (Procedure ANSI C63.4-2003):

The equipment was prescanned in a shielded room using a spectrum analyzer and broadband antenna. A list of frequencies was compiled for investigation in the open field. The equipment was then moved to an open area test site where amplitude measurements were made at a distance of 10 meters. The bandwidth was set to 100 kHz and the detector function was CISPR Quasi-Peak.

Any emissions above 1 GHz were measured with a horn antenna and low noise pre-amplifier at a distance of 3 meters.

Test #: REHE-01

Tested By: David Light

Date of Tests: 29 October 2007

Test Conditions:

Test Voltage: 12 Vdc

Temperature: 20°C

Humidity: 41%

Test Results:

The E.U.T. complies.

TEST EQUIPMENT

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1306	Antenna biconical	Nemko USA, Inc. BCON 30300	212	03/30/07	03/29/08
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	03/30/07	03/29/08
1522	Cable Assy, LAB 5 - D OATS	Nemko USA, Inc. Site D OATS	N/A	10/04/07	10/04/08
791	PREAMP, 25dB	Nemko USA, Inc. LNA25	398	05/01/07	04/30/08
1659	Spectrum Analyzer	Rhode & Schwarz FSP	973353	01/24/07	01/24/09

Test Data –Radiated Emissions

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
36.8	V	0	42	12.9	2.2	28.5	28.6	39.0	-10.4	Pass	
73.7	V	0	47	8.9	3.1	27.5	31.5	39.0	-7.5	Pass	
86	V	0	47	9.6	3.5	27.4	32.7	39.0	-6.3	Pass	
147.4	V	0	32.4	13.5	4.2	27.7	22.4	43.5	-21.1	Pass	
73.7	H	0	31	8.9	3.1	27.5	15.5	39.0	-23.5	Pass	
86	H	0	32	9.6	3.5	27.4	17.7	39.0	-21.3	Pass	
122.9	H	0	32	11.9	3.8	27.6	20.1	43.5	-23.4	Pass	
245.8	H	0	33	16.5	5.9	27.9	27.5	46.4	-18.9	Pass	

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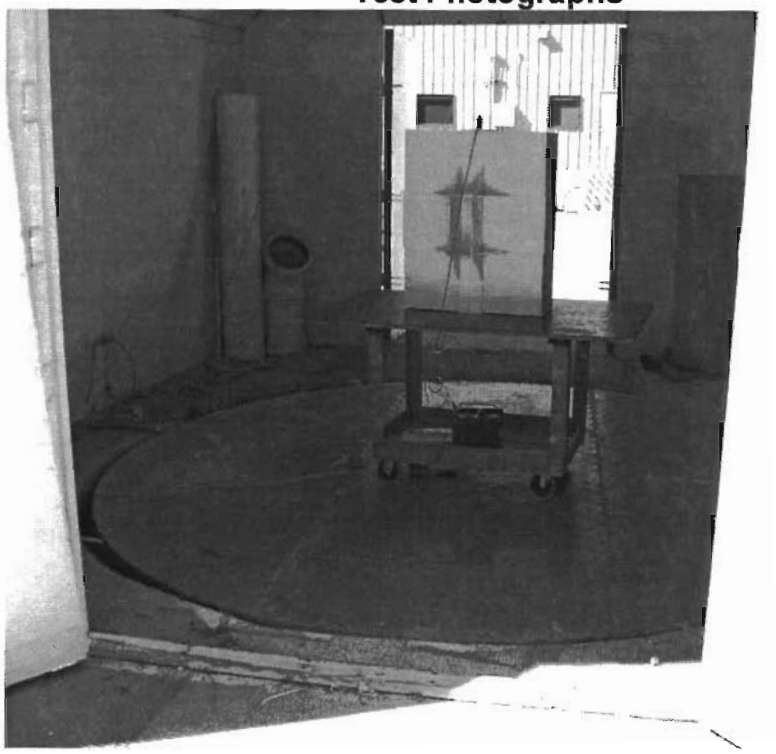
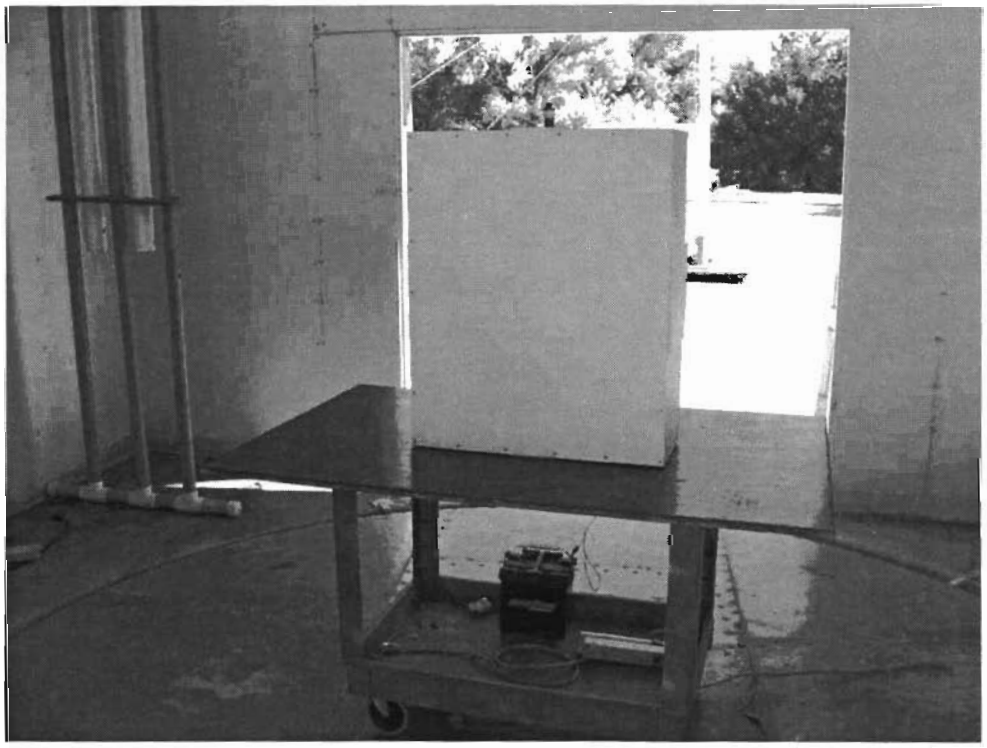
The spectrum was searched from 30 MHz to 1000 MHz. No digital emissions were detected beyond 245.8 MHz.

Analyzer Settings: RBW=VBW=100 kHz Peak detector

Test Photographs





Section 5. Test Methods and Block Diagrams.

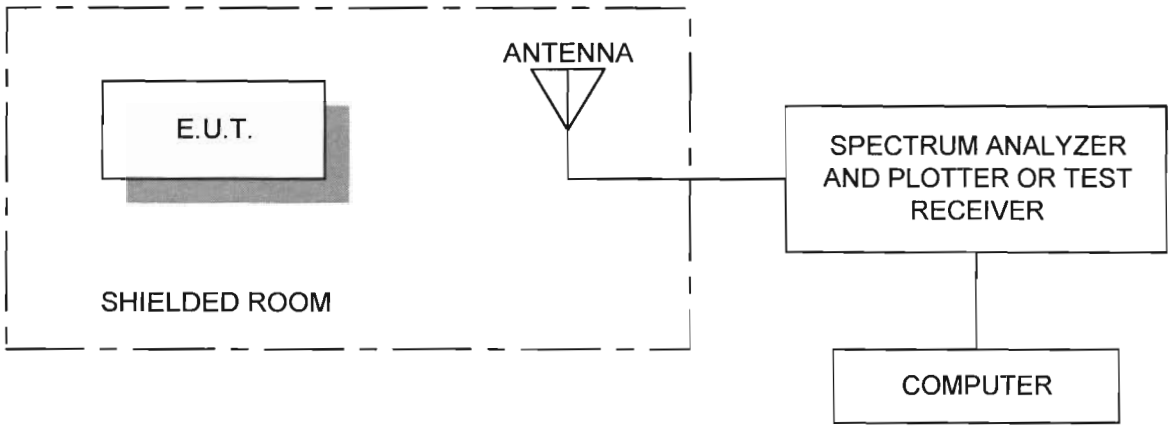
Radiated Emissions

Test Method - Radiated Emissions:

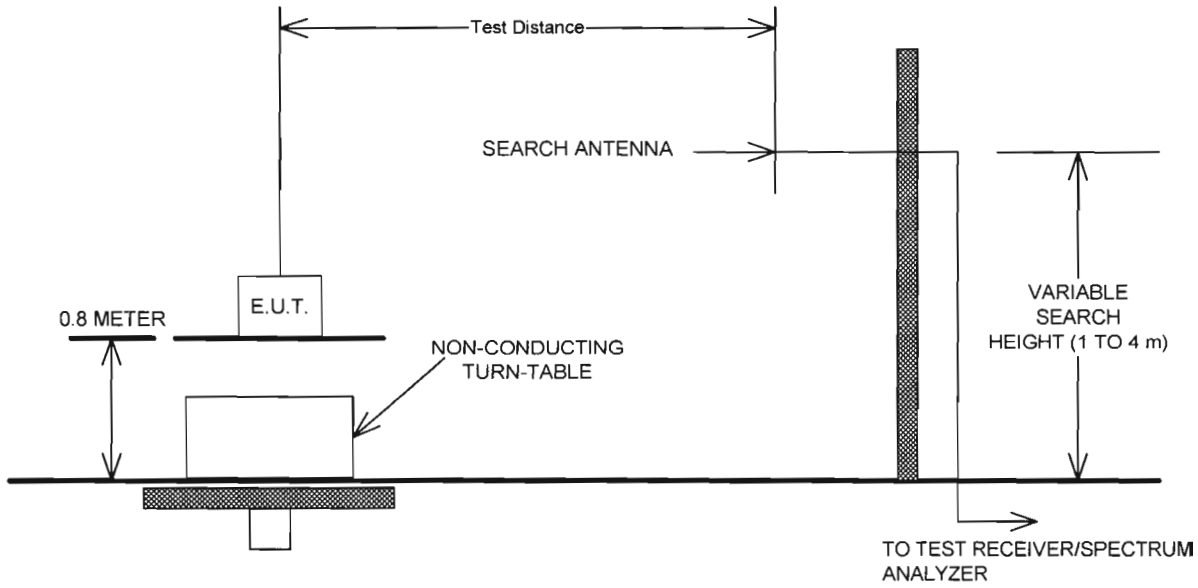
- Applicable Test Standard: CFR47, FCC Pt 15, Subpart B
- The test set-up in the shielded room is as per the test configuration diagram.
- The E.U.T. is configured as typically used.
- The E.U.T. and any accessories are operated with typical load conditions.
- Radiated emissions measurements are made from 30 MHz to 1000 MHz.
- The equipment was prescanned in the shielded room using a spectrum analyzer and broadband antenna to produce a list of frequencies to be investigated in the open area test site.
- The equipment is then set-up on an open area test site.
- Variations in antenna height, antenna polarization, and E.U.T. azimuth are explored to produce the emission that has the highest amplitude relative to the limit.
- The frequencies noted in the preliminary test are investigated on the open-air site where amplitude measurements are made.
- If ambient signal field strength is high at 10 meter, the measurements may be performed at 3 meter and extrapolated to the requisite distance.
- If less than six emissions are better than 20 dB below limit, the noise level of the measuring instrument at representative frequencies is also reported.
- Any emissions above 1 GHz are measured using a horn antenna and low noise pre-amplifier at a distance of 3 meters. The bandwidth was set to 1 MHz and the detector function was average.

Test Configuration - Radiated Emissions:

Radiated Pre-scan:



Outdoor Test Site for Radiated Emissions:



Section 6. Labeling Requirements

Your product has successfully complied with 47 CFR FCC Part 15.B Class A requirements.

FCC Class A Label:

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 to placing the above label on your product, the three items that are required to be included in your product's manual are:

(1) For a Class A digital device or peripheral, the instructions furnished to the user shall include the following or similar statement, placed in a prominent location at the front of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(2) The user's manual must caution the user that changes or modifications not expressly approved by the party responsible for compliance (you/your company) could void the user's authority to operate the equipment.

(3) The instruction manual must include appropriate instructions on the first page of the manual concerning installation of the device or special accessories (special cabling, shields, adapters) that must be used with the device. An appropriate caution statement should warn the user to utilize the special accessories supplied with the equipment for continued FCC compliance.

Nemko Test Report:	5113RUS2
Applicant:	University of Houston 4800 Calhoun Road Houston, TX 77004 USA
Equipment Under Test: (E.U.T.)	U7W900
In Accordance With:	**FCC Part 15, Subpart F, Paragraph 15.509** Ultra Wide Band Operation Ground Pentrating Radar
Tested By:	Nemko USA Inc. 802 N. Kealy Lewisville, TX 75057

TESTED BY: _____ **DATE:** 30 October 2007

David Light, Senior Wireless Engineer

APPROVED BY: _____ **DATE:** 13 November 2007

Mike Cantwell, Frontline Manager

Total Number of Pages: 19

Table Of Contents

Section 1. Summary Of Test Results

Manufacturer: The University of Houston

Model No.: U7W900

Serial No.: Preproduction

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 15, Subpart F, Paragraph 15.509 for ultra wide band operation. All tests were conducted using measurement procedure ANSI C63.4-2003. Radiated Emissions were made with the antenna positioned on the ground screen of an open area test site with the EUT positioned on a 4 foot by 4 foot by 4 foot dry sand pit

☒	New Submission	☐	Production Unit
☐	Class II Permissive Change	☒	Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE. NONE
See " Summary of Test Data".

NVLAP®
LAB CODE: 100426-0

Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
Conducted Emissions	15.207	NA
Pulse Repetition Frequency	15.509	Complies
Definition of UWB	15.203(a)/15.209(a)	Complies
Radiated Emissions	15.509(d)	Complies
Radiated Emissions	15.509(e)	Complies
Peak Emission at f_M	15.509(f)	Complies

Footnotes For N/A's:

The device is battery powered.

Section 2. General Equipment Specification

Frequency Range:	Single	
Operating Frequency(ies) of Sample:	163 to 877 MHz (10 dB BW)	
Tunable Bands:	Single	
20 dB Occupied Bandwidth:	1752 MHz	
User Frequency Adjustment:	None	
Integral Antenna	Yes ☒	No ☐

Description of Device Tested

The impulse GPR is a device that is intentionally designed to directionally and locally radiate very small average electromagnetic power downwards into the ground to be detected.
The developed GPR is composed of a pulse transmitter, a receiver, a transmitter antenna, a receiver antenna, and a laptop computer. Except for the computer, all the components are installed in a plastic box. Once a 12VDC power is supplied, the GPR starts to work.

System Diagram

Refer to separate exhibit.

Section 3. Radiated Emissions

NAME OF TEST: Radiated Emissions	PARA. NO.: 15.509(d)&(e)
TESTED BY: David Light	DATE: 29 October 2007

Minimum Standard: Para no. 15.509

Limits below 960 MHz (15.209 and 15.509):

Frequency (MHz)	Field Strength Limits (microvolts/m)	Measuring RBW	Distance (Meters)
0.009-0.490	2400/F(kHz)	1 kHz	300
0.490-1.705	24000/F(kHz)	10 kHz	30
1.705-30.0	30	10 kHz	30
30-88	100	100 kHz	3
88-216	150	100 kHz	3
216-960	200	100 kHz	3

Limits above 960 MHz (15.509)

Frequency (MHz)	E.I.R.P. (dBm)	Measuring RBW	Distance (Meters)
960-1610	-65.3	1 MHz	3
1610-1990	-53.3	1 MHz	3
1990-3100	-51.3	1 MHz	3
3100-10600	-41.3	1 MHz	3
Above 10600	-51.3	1 MHz	3
1164-1240	-75.3	1 kHz	3
1559-1610	-75.3	1 kHz	3

E.I.R.P limits converted from field strength during measurements per 15.521(g)

Maximizing Emission Levels:
The emissions were scanned from 30 MHz to 10,000 MHz.
For measurements below 960 MHz the emissions were made using a Peak or CISPR Quasi-peak detector IF BW = 100 kHz
For Frequency above 960 MHz and outside the below frequency bands, the emissions were measured using EMI RMS detector, RBW=1MHz, VBW=10 MHz
For frequencies fall inside 1164-1240 and 1559-1610 MHz, the emissions were measured using EMI RMS Detector, RBW = 1 KHz, VBW = 1 MHz
Note: The above tests were performed with the EUT raised 18 inchesfrom the ground as typical of its intended use. The EUT was tested in 8 positions (every 45°) over a sand pit, 1M x 1M X 1M

Test Results: Complies

Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X
Preliminary

Job # : 5113 Page 1 of 5
Test # : REHE-01

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B
Reference : 15.509

Rod. Ant. #:		Temp. (deg. C) :	24
Bicon Ant.#:	760	Humidity (%) :	35
Log Ant.#:	1034	EUT Voltage :	12
Bilog Ant.#:		EUT Frequency :	dc
Dipole Ant.#:		Phase:	na
Cable#:	1522	Location:	DOATS
Preamp#:	762	Distance:	3 m
Limiter#:	na	Barometric pressure:	1016
Atten #:	na		
Detector#:	1036		

Date : 10/29/07
Time : 8:00
Staff : D. Light
Photo ID: na
Peak Bandwidth: 100 KHz
Video Bandwidth 100 KHz
QP Bandwidth: 120 KHz

Note: All measurements are Peak unless otherwise noted

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 degrees
43.6	V	0	47.5	12.2	2.3	28.5	33.5	40.0	-6.5	Pass	
74.4	V	0	50.3	8.1	3.1	27.5	34.0	40.0	-6.0	Pass	
189.6	V	0	47	14.6	5.1	27.9	38.8	43.5	-4.7	Pass	
35.2	H	0	47.4	12.4	2.2	28.5	33.5	40.0	-6.5	Pass	
36.8	H	0	48	12.3	2.2	28.5	34.0	40.0	-6.0	Pass	
74.9	H	0	39	8.1	3.1	27.5	22.7	40.0	-17.3	Pass	
183	H	0	40	14.4	5.1	27.9	31.6	43.5	-11.9	Pass	
											45 degrees
38	V	0	44	12	2.2	28.5	29.7	40.0	-10.3	Pass	
42	V	0	46.4	12.1	2.3	28.5	32.3	40.0	-7.7	Pass	
43.6	V	0	46.8	12.2	2.3	28.5	32.8	40.0	-7.2	Pass	
47.7	V	0	46.5	12	2.3	28.5	32.3	40.0	-7.7	Pass	
72.3	V	0	48.8	8	3.1	27.5	32.4	40.0	-7.6	Pass	
189	V	0	46	14.6	5.1	27.9	37.8	43.5	-5.7	Pass	
35.2	H	0	46	12.4	2.2	28.5	32.1	40.0	-7.9	Pass	
40	H	0	46	12	2.3	28.5	31.8	40.0	-8.2	Pass	
50	H	0	40	11.6	2.7	27.9	26.4	40.0	-13.6	Pass	
155	H	0	30	14.3	4.7	27.8	21.2	43.5	-22.3	Pass	
178	H	0	36	14	5.1	27.9	27.2	43.5	-16.3	Pass	
207	H	0	38	15.6	5.5	27.9	31.2	43.5	-12.3	Pass	
280	H	0	35	20	6.4	27.8	33.6	46.0	-12.4	Pass	

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Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X Job # : 5113 Test # : REHE-01
Preliminary Page 2 of 5

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B Reference : 15.509

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											90 degrees
38	V	0	44	12	2.2	28.5	29.7	40.0	-10.3	Pass	
42	V	0	46.7	12.1	2.3	28.5	32.6	40.0	-7.4	Pass	
46.4	V	0	44.9	12.1	2.3	28.5	30.8	40.0	-9.2	Pass	
54	V	0	39.4	10.9	2.7	27.9	25.1	40.0	-14.9	Pass	
75	V	0	48.8	8.2	3.1	27.5	32.6	40.0	-7.4	Pass	
35.4	H	0	44.3	12.4	2.2	28.5	30.4	40.0	-9.6	Pass	
42	H	0	44	12.1	2.3	28.5	29.9	40.0	-10.1	Pass	
177	H	0	38	14.3	5.1	27.9	29.5	43.5	-14.0	Pass	
206	H	0	37	15.8	5.5	27.9	30.4	43.5	-13.1	Pass	
295	H	0	35	19.5	6.4	27.8	33.1	46.0	-12.9	Pass	
											135 degrees
36.8	V	0	41.4	12.3	2.2	28.5	27.4	40.0	-12.6	Pass	
41.2	V	0	45	12.1	2.3	28.5	30.9	40.0	-9.1	Pass	
46.5	V	0	44.6	12.1	2.3	28.5	30.5	40.0	-9.5	Pass	
53.1	V	0	41.7	11.1	2.7	27.9	27.6	40.0	-12.4	Pass	
75.2	V	0	42	8.2	3.1	27.5	25.8	40.0	-14.2	Pass	
265	H	0	35.2	17.8	6.2	27.9	31.3	46.0	-14.7	Pass	
35.2	H	0	43	12.4	2.2	28.5	29.1	40.0	-10.9	Pass	
40.8	H	0	44.7	12	2.3	28.5	30.5	40.0	-9.5	Pass	
48.3	H	0	38.8	11.8	2.3	28.5	24.4	40.0	-15.6	Pass	
171	H	0	38	13.9	4.7	27.8	28.8	43.5	-14.7	Pass	
											180 degrees
37.8	V	0	37.6	12.1	2.2	28.5	23.4	40.0	-16.6	Pass	
43.3	V	0	44	12.2	2.3	28.5	30.0	40.0	-10.0	Pass	
51.6	V	0	42.6	11.3	2.7	27.9	28.7	40.0	-11.3	Pass	
71	V	0	44.8	7.9	3.1	27.5	28.3	40.0	-11.7	Pass	
195	V	0	39.8	14.4	5.1	27.9	31.4	43.5	-12.1	Pass	
35.3	H	0	39	12.4	2.2	28.5	25.1	40.0	-14.9	Pass	
42	H	0	40.1	12.1	2.3	28.5	26.0	40.0	-14.0	Pass	
50.5	H	0	35.9	11.4	2.7	27.9	22.1	40.0	-17.9	Pass	
195	H		33	14.4	5.1	27.9	24.6	43.5	-18.9	Pass	

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Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X Job # : 5113 Test # : REHE-01
Preliminary Page 3 of 5

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B Reference : 15.509

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											225 degrees
38	V	0	41	12	2.2	28.5	26.7	40.0	-13.3	Pass	
44	V	0	45	12.2	2.3	28.5	31.0	40.0	-9.0	Pass	
52	V	0	44	11.3	2.7	27.9	30.1	40.0	-9.9	Pass	
40	V	0	44	12	2.3	28.5	29.8	40.0	-10.2	Pass	
85	V	0	38.4	9.6	3.5	27.4	24.1	40.0	-15.9	Pass	
195	V	0	39.5	14.4	5.1	27.9	31.1	43.5	-12.4	Pass	
32.8	H	0	33.9	12.9	2.2	28.5	20.5	40.0	-19.5	Pass	
36	H	0	39.6	12.3	2.2	28.5	25.6	40.0	-14.4	Pass	
42.1	H	0	39.8	12.2	2.3	28.5	25.8	40.0	-14.2	Pass	
50.7	H	0	32.4	11.4	2.7	27.9	18.6	40.0	-21.4	Pass	
195	H	0	38	14.4	5.1	27.9	29.6	43.5	-13.9	Pass	
											270 degrees
37	V	0	41	12.1	2.2	28.5	26.8	40.0	-13.2	Pass	
44	V	0	45	12.2	2.3	28.5	31.0	40.0	-9.0	Pass	
51	V	0	44	11.4	2.7	27.9	30.2	40.0	-9.8	Pass	
70	V	0	42	7.9	3.1	27.5	25.5	40.0	-14.5	Pass	
113	V	0	37	11.8	3.8	27.6	25.0	43.5	-18.5	Pass	
255	V	0	32.6	17.3	6.2	27.9	28.2	46.0	-17.8	Pass	
35	H	0	43	12.4	2.2	28.5	29.1	40.0	-10.9	Pass	
41.5	H	0	43.4	12.1	2.3	28.5	29.3	40.0	-10.7	Pass	
50	H	0	39.6	11.6	2.7	27.9	26.0	40.0	-14.0	Pass	
195	H	0	40	14.4	5.1	27.9	31.6	43.5	-11.9	Pass	
											315 degrees
37	V	0	40	12.1	2.2	28.5	25.8	40.0	-14.2	Pass	
44	V	0	45	12.2	2.3	28.5	31.0	40.0	-9.0	Pass	
53	V	0	42.4	11.1	2.7	27.9	28.3	40.0	-11.7	Pass	
195	V	0	36	14.4	5.1	27.9	27.6	43.5	-15.9	Pass	
35	H	0	42	12.4	2.2	28.5	28.1	40.0	-11.9	Pass	
42	H	0	42	12.1	2.3	28.5	27.9	40.0	-12.1	Pass	
52	H	0	38	11.3	2.7	27.9	24.1	40.0	-15.9	Pass	
195	H	0	39	14.4	5.1	27.9	30.6	43.5	-12.9	Pass	

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Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X Job # : 5113 Test # : REHE-01
Preliminary Page 4 of 5

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B Reference : 15.509

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											0 degrees
320	V	0	36	18.2	6.8	27.9	33.1	46.0	-12.9	Pass	
323	V	0	37	17.6	6.8	27.9	33.5	46.0	-12.5	Pass	
800	V	0	30	17.7	11.8	27.5	32.0	46.0	-14.0	Pass	
387	H	0	33	16.2	7.4	27.7	28.9	46.0	-17.1	Pass	
445	H	0	33	17.7	8.0	27.8	30.9	46.0	-15.1	Pass	
800	H	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
											45 degrees
320	V	0	31	18.2	6.8	27.9	28.1	46.0	-17.9	Pass	
400	V	0	33	16.6	8.0	27.8	29.8	46.0	-16.2	Pass	
800	V	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
320	H	0	35	18.2	6.8	27.9	32.1	46.0	-13.9	Pass	
370	H	0	37	15.5	7.4	27.7	32.2	46.0	-13.8	Pass	
460	H	0	36.3	16.9	8.5	28.1	33.6	46.0	-12.4	Pass	
800	H	0	29	17.7	11.8	27.5	31.0	46.0	-15.0	Pass	
											90 degrees
320	V	0	29	18.2	6.8	27.9	26.1	46.0	-19.9	Pass	
400	V	0	30	16.6	8.0	27.8	26.8	46.0	-19.2	Pass	
800	V	0	29	17.7	11.8	27.5	31.0	46.0	-15.0	Pass	
320	H	0	35.6	18.2	6.8	27.9	32.7	46.0	-13.3	Pass	
400	H	0	38	16.6	8.0	27.8	34.8	46.0	-11.2	Pass	
800	H	0	30	17.7	11.8	27.5	32.0	46.0	-14.0	Pass	
											135 degrees
320	V	0	33.4	18.2	6.8	27.9	30.5	46.0	-15.5	Pass	
400	V	0	34	16.6	8.0	27.8	30.8	46.0	-15.2	Pass	
800	V	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
320	H	33		18.2	6.8	27.9	30.1	46.0	-15.9	Pass	
400	H	0	36	16.6	8.0	27.8	32.8	46.0	-13.2	Pass	
800	H	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	

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Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X
Preliminary

Job # : 5113 Test # : REHE-01
Page 5 of 5

Client Name : University of Houston
EUT Name : Air coupled ground penetrating radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Elevated 18 inches above sand pit

Specification : CFR47 Part 15, Subpart B, Class B Reference : 15.509

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
											180 degrees
320	V	0	36	18.2	6.8	27.9	33.1	46.0	-12.9	Pass	
350	V	0	35	15.4	7.4	27.7	30.1	46.0	-15.9	Pass	
400	V	0	32	16.6	8.0	27.8	28.8	46.0	-17.2	Pass	
800	V	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
320	H	0	28	18.2	6.8	27.9	25.1	46.0	-20.9	Pass	
380	H	0	32	15.7	7.4	27.7	27.4	46.0	-18.6	Pass	
420	H	0	32.5	16	8.0	27.8	28.7	46.0	-17.3	Pass	
800	H	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
											225 degrees
320	V	0	30	18.2	6.8	27.9	27.1	46.0	-18.9	Pass	
400	V	0	30	16.6	8.0	27.8	26.8	46.0	-19.2	Pass	
800	V	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
320	H	0	32	18.2	6.8	27.9	29.1	46.0	-16.9	Pass	
450	H	0	32.6	18	8.5	28.1	31.0	46.0	-15.0	Pass	
800	H	0	28.6	17.7	11.8	27.5	30.6	46.0	-15.4	Pass	
											270 degrees
320	V	0	29	18.2	6.8	27.9	26.1	46.0	-19.9	Pass	
400	V	0	30	16.6	8.0	27.8	26.8	46.0	-19.2	Pass	
800	V	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	
320	H	0	33	18.2	6.8	27.9	30.1	46.0	-15.9	Pass	
445	H	0	35	17.7	8.0	27.8	32.9	46.0	-13.1	Pass	
510	H	0	34	16.8	8.9	28.1	31.6	46.0	-14.4	Pass	
800	H	0	29	17.7	11.8	27.5	31.0	46.0	-15.0	Pass	
											315 degrees
320	V	0	31	18.2	6.8	27.9	28.1	46.0	-17.9	Pass	
445	V	0	30	17.7	8.0	27.8	27.9	46.0	-18.1	Pass	
510	V	0	31	16.8	8.9	28.1	28.6	46.0	-17.4	Pass	
800	V	0	28.7	17.7	11.8	27.5	30.7	46.0	-15.3	Pass	
320	H	0	34	18.2	6.8	27.9	31.1	46.0	-14.9	Pass	
510	H	0	34	16.8	8.9	28.1	31.6	46.0	-14.4	Pass	
800	H	0	28	17.7	11.8	27.5	30.0	46.0	-16.0	Pass	

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Measurement Data – Radiated Emissions

Radiated Emissions Data

Complete X
Preliminary

Job # : 5113 Page 1 Test # : REHE-01 of 1

Client Name : University of Houston
EUT Name : Ground Coupled Radar
EUT Model # : U7W900
EUT Part # : U7W900
EUT Serial # : None
EUT Config. : Transmitting over sand pit

Specification : CFR 47, Paragraph 15.509 Reference : 15.209/15.509

Rod. Ant. #:		Temp. (deg. C) :	24
Bicon Ant.#:		Humidity (%) :	35
Log Ant.#:		EUT Voltage :	12
Bilog Ant.#:		EUT Frequency :	dc
Horn Ant.#:	993	Phase:	na
Cable#:	1019	Location:	Sand Pit
Preamp#:	1016	Distance:	3 Meters
Limiter#:		Barometric pressure:	1016
Atten #:			
Detector#:	1036		

Date : 10/29/07
Time : 14:00
Staff : David Light
Photo ID: NA

Meas. Freq. (MHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	EIRP Correction	EIRP (dBm)		Spec. limit (dBm)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
1050	34	22.7	0.2	29.8	95.2	-68.1		-65.3	-2.8	Pass	
1559	34.2	24.3	0.2	32.9	95.2	-69.4		-65.3	-4.1	Pass	
1620	34.2	24.3	1	32.9	95.2	-68.6		-53.3	-15.3	Pass	
1920	34	28.5	1	33.1	95.2	-64.8		-53.3	-11.5	Pass	
2060	33.4	28.5	1	33.1	95.2	-65.4		-51.3	-14.1	Pass	
2940	34.5	29.7	1.2	33.3	95.2	-63.1		-51.3	-11.8	Pass	
3500	33	29.7	1.2	33.3	95.2	-64.6		-41.3	-23.3	Pass	
9500	32.2	37.1	4	33.6	95.2	-55.5		-41.3	-14.2	Pass	
1167	15	22.7	0.2	29.8	95.2	-87.1		-75.3	-11.8	Pass	
1230	14	22.7	0.2	29.8	95.2	-88.1		-75.3	-12.8	Pass	
1560	18	24.3	1	32.9	95.2	-84.8		-75.3	-9.5	Pass	
1608	20	24.3	1	32.9	95.2	-82.8		-75.3	-7.5	Pass	

The spectrum was searched to 10 GHz
The EUT was rotated and a reading taken at every 45 degrees
Maximized emissions are reported

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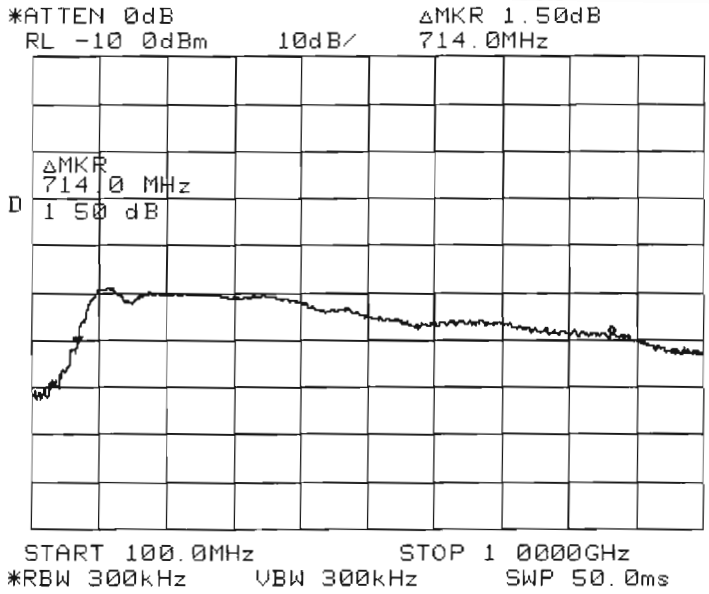
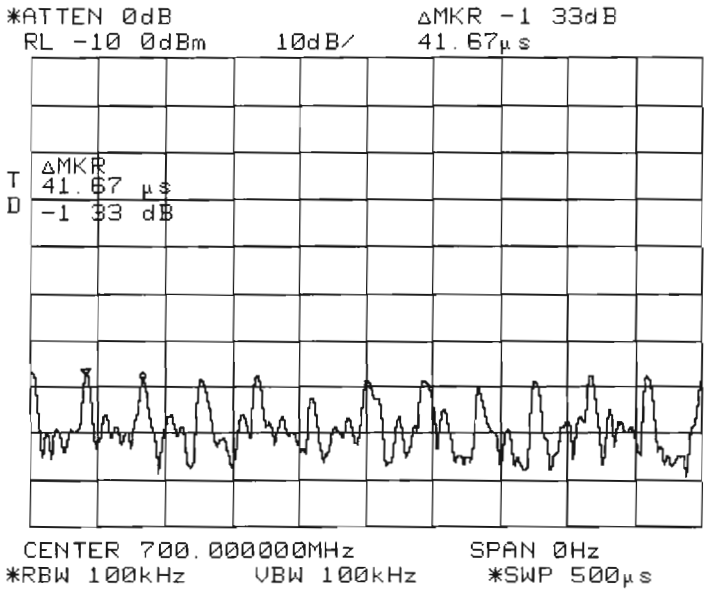
EIRP (dBm) = Meter reading (dBuV)+ AF(dB) + Path loss (dB) – Gain (dB) – 95.2 (dB)

10 dB Bandwidth

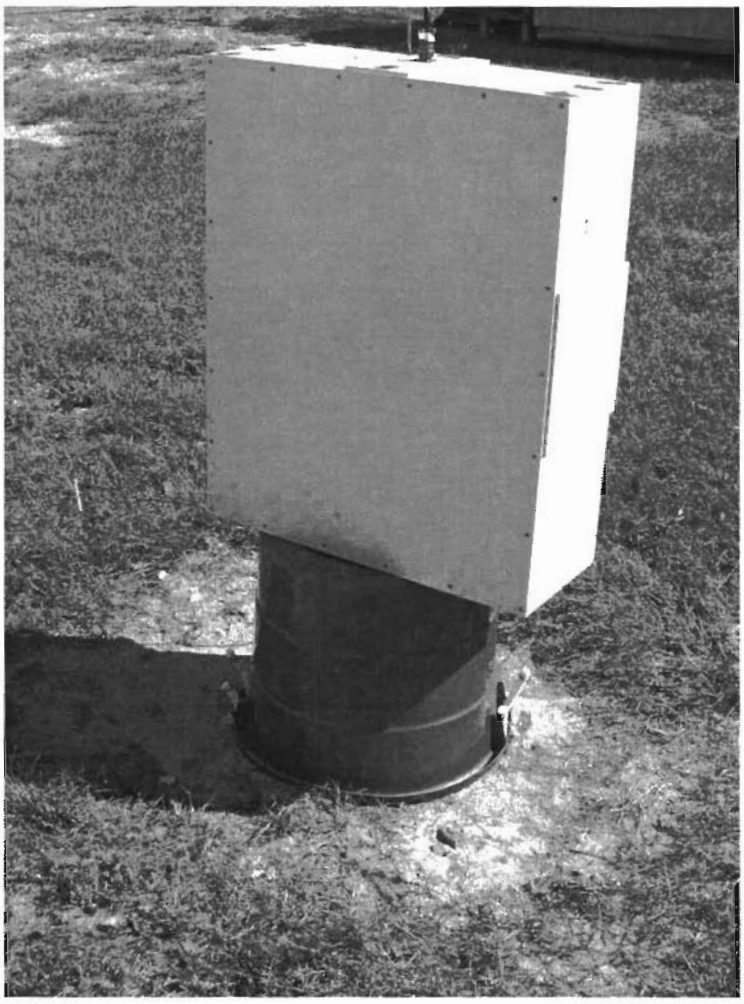


Markers at 163 MHz and 877 MHz

Pulse Repetition



Test Setup Photographs



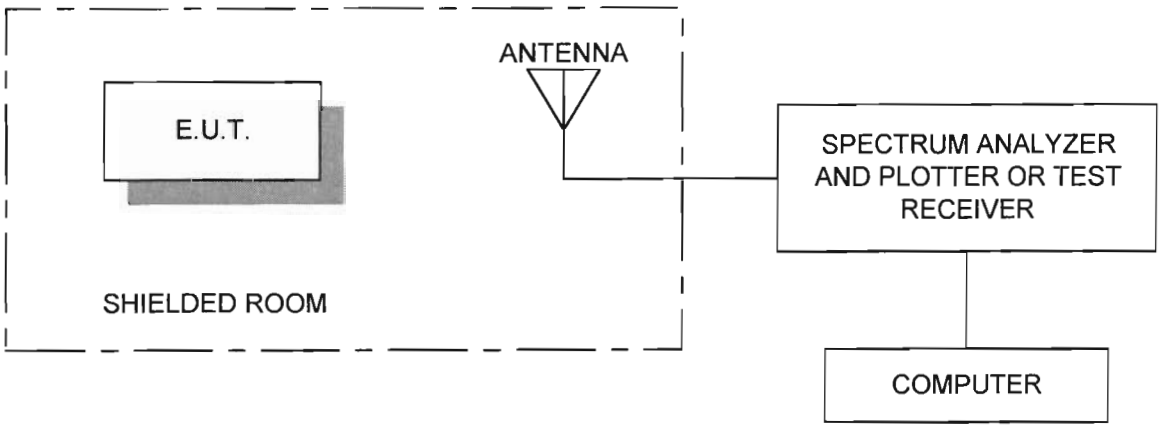
Section 4. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
760	Antenna biconical	Electro Metrics MFC-25	477	01/19/07	01/19/08
1034	ANTENNA,LP	A.H. SYSTEMS SAS-200/510	121	03/30/07	03/29/08
762	27dB GAIN PREAMP	Nemko USA, Inc. 27dB LNA	946	11/12/06	11/12/07
1522	Cable Assy, LAB 5 - D OATS	Nemko USA, Inc. Site D OATS	N/A	10/04/07	10/03/08
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/31/07	08/31/09
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	05/01/07	04/30/08
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	05/26/06	05/26/08
1019	CABLE, 9.5m	Nemko USA, Inc. RG223	N/A	CBU	N/A

ANNEX A

TEST DIAGRAMS

Radiated Prescan



Test Site For Radiated Emissions