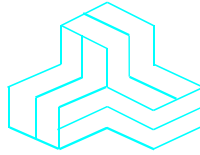


ENGINEERING TEST REPORT



pulseEKKO Pro HF 500
Model No.: THF500
FCC ID: QJQ-PE-PRO-HF500

Applicant:

Sensors & Software Inc.
1040 Stacey Court
Mississauga, ON
Canada, L4W 2X8

Tested in Accordance With

Federal Communications Commission (FCC)
PART 15, Subpart F, Section 15.509

UltraTech's File No.: SES-026FCC15UWB

This Test report is Issued under the Authority of
Tri M. Luu, Professional Engineer,
Vice President of Engineering
UltraTech Group of Labs

Date: June 15, 2005



Report Prepared by: Anca Dobre

Issued Date: June 15, 2005

Tested by: Hung Trinh, RFI/EMI Technician & David
Redman, Sensors & Software Inc.

Test Dates: May 30 – June 3, 2005

- The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
- This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.

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EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type | Description of Contents | Quality Check (OK) |
|-----------|-------------------------|--|--------------------|
| -- | Test Report | Exhibit 1: Submittal check lists Exhibit 2: Introduction Exhibit 3: Performance Assessment Exhibit 4: EUT Operation and Configuration during Tests Exhibit 5: Summary of test Results Exhibit 6: Measurement Data Exhibit 7: Measurement Uncertainty Exhibit 8: Measurement Methods | OK |
| 1 | Test Setup Photos | Radiated Emission Setup Photos | OK |
| 2 | External Photos of EUT | External EUT Photos | OK |
| 3 | Internal Photos of EUT | Internal EUT Photos | OK |
| 4 | Cover Letters | Letter from Ultratech for Certification Request | OK |
| 5 | Attestation Statements | <ul style="list-style-type: none">• Manufacturer's Declaration of acknowledgement of the Licensing Requirements under Provisions of FCC Part 90 Rules is attached with application• Manufacturer's Declaration of acknowledgement of the Requirements per FCC Section 15.525 is attached with application• Letter from the Applicant to request for Modular Transmitter Approval• Letter from the Applicant to appoint Ultratech to act as an agent• Letter from the Applicant to request for Confidentiality Filing | OK |
| 6 | ID Label/Location Info | <ul style="list-style-type: none">• ID Label• Location of ID Label | OK |
| 7 | Block Diagrams | Block Diagrams | OK |
| 8 | Schematic Diagrams | Schematics Diagram | OK |
| 9 | Parts List/Tune Up Info | Parts List | OK |
| 10 | Operational Description | Operational description | OK |
| 11 | RF Exposure Info | N/A | OK |
| 12 | Users Manual | User's Guide | OK |

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File #: SES-026FCC15UWB
June 15, 2005

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

| | |
|--|---|
| Reference: | FCC ET Docket 98-153 & FCC Part 15, Subpart F, Section 15.509 |
| Title: | Revision of Part 15 of the Commission's Rules regarding Ultra-Wideband Transmission Systems. |
| Purpose of Test: | To gain FCC Certification Authorization for Technical Requirements for Low Frequency Imaging Systems operating at 500 MHz (center frequency) . |
| Test Procedures: | Both conducted and radiated emissions measurements were conducted in accordance with FCC ET Docket 98-153 and American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| Imaging System Classification of EUT: | <u>Ground penetrating radar (GPR) system.</u> A field disturbance sensor that is designed to operate only when in contact with the ground for the purpose of detecting or obtaining the images of buried objects or determining the physical properties within the ground. The energy from the GPR is intentionally directed down into the ground for this purpose. |

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|--------------------------------------|----------------------------------|---|
| FCC CFR Parts 0-15 | 2005 | Code of Federal Regulations – Telecommunication |
| FCC ET Docket 98-153 | April 22, 2002 | FCC 02-48: Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems. |
| ANSI C63.4 | 2004 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz |
| CISPR 22 CISPR 22 +A1 EN 55022 | 2003-04-10 2004-10-14 2003 | Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement |
| CISPR 16-1-1 | 2003 | Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus |
| CISPR 16-2-1 | 2004 | Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement |
| FCC Public Notice DA 00-1407 | 2000 | Part 15 Unlicensed Modular Transmitter Approval |

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EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

| APPLICANT | |
|------------------------|--|
| Name: | Sensors & Software Inc. |
| Address: | 1040 Stacey Court Mississauga, Ontario Canada, L4W 2X8 |
| Contact Person: | Mr. David Redman Phone #: 905-624-8909 Fax #: 905-624-9365 Email Address: dr@sensoft.ca |

| MANUFACTURER | |
|------------------------|--|
| Name: | Sensors & Software Inc. |
| Address: | 1040 Stacey Court Mississauga, Ontario Canada, L4W 2X8 |
| Contact Person: | Mr. David Redman Phone #: 905-624-8909 Fax #: 905-624-9365 Email Address: dr@sensoft.ca |

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

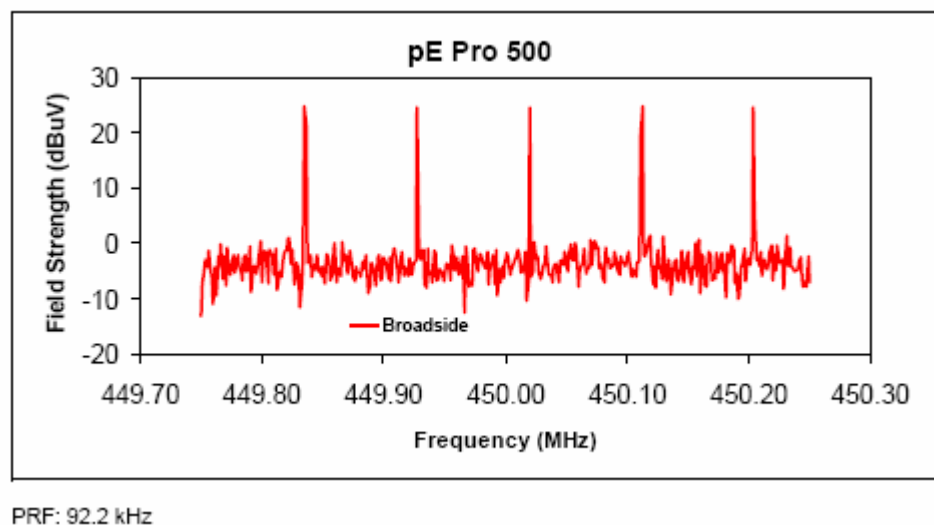
| | |
|---------------------------------------|---|
| Brand Name: | Sensors & Software Inc. |
| Product Name: | pulseEKKO Pro HF 500 |
| Model Name or Number: | THF500 |
| Serial Number: | Preproduction |
| Type of Equipment: | Low Frequency Imaging Systems (GPR) |
| Input Power Supply Type: | External 12V battery |
| Primary User Functions of EUT: | <u>Ground penetrating radar (GPR) system.</u> A field disturbance sensor that is designed to operate only when in contact with the ground for the purpose of detecting or obtaining the images of buried objects or determining the physical properties within the ground. The energy from the GPR is intentionally directed down into the ground for this purpose. |

3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|--|---|
| Power Supply Requirement: | 12 Vdc battery |
| E-Field of the Fundamental RF Carrier: | 41.65 dB μ V/m @ 3 meters |
| Operating Frequency Range: | 10 kHz – 581.1 MHz |
| Pulse Voltage Rating: | Setting is 185 V which produces pulse voltage of 200 V |
| RF Output Impedance: | 50 Ohms |
| Channel Spacing: | N/A |
| Pulse Repetition Frequency (PRF): | 92.2 kHz. Please refer to the Pulse Repetition Frequency measurement plot below for details of measurements. |
| Pulse Width: | 1 ns |
| 10 dB Bandwidth: | 541.5 MHz |
| Modulation Type: | No modulation |
| *Emission Designation: | 541M5N0N |
| Oscillators' Frequencies: | 7.37 MHz |
| Antenna Connector Type: | Integral, permanently attached (the module to be certified incorporates both transmitter and antenna) and sealed inside the final product |
| Antenna Description: | Manufacturer: Sensors & Software Inc. Type: Dipole Frequency Range: UWB – Center Frequency 500 MHz |

* Per 47 CFR § 2.201 and §2.202

Plot 1: Pulse Repetition Frequency measurement



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3.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|-------------|---|---------------------------|----------------|------------------------------------|
| 1 | 12 Vdc external battery supply, RSS-232, QSPI (high speed serial) | 1 | DB37 | Shielded |

3.5. ANCILLARY EQUIPMENT

None.

3.6. GENERAL TEST SETUP

Remark: All tests were performed with the EUT's antenna placed on the 20" thick sand as its intended operation configuration.

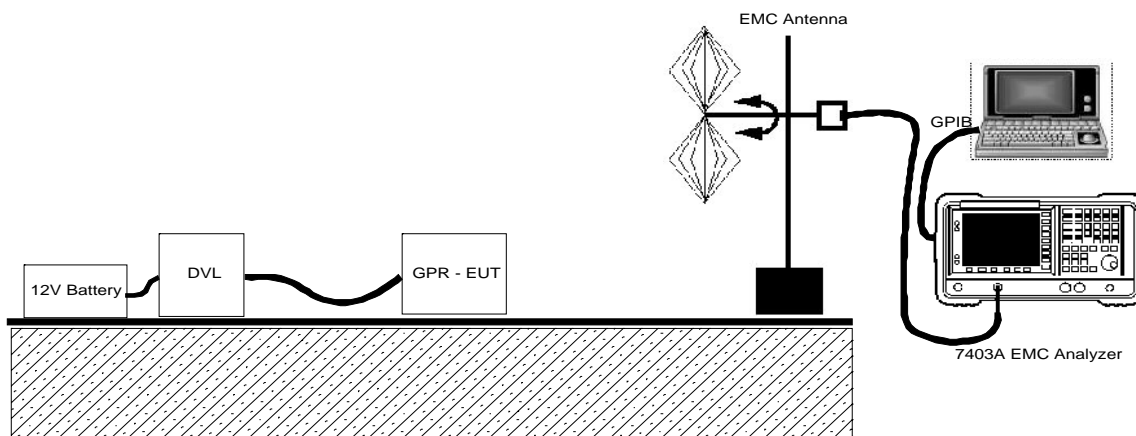


EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---------------------|----------------|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 12 Vdc battery |

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

| | |
|----------------------------------|--|
| Operating Modes: | The transmitter was turned and placed on the sand. |
| Special Test Software: | None. |
| Special Hardware Used: | None. |
| Transmitter Test Antenna: | The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna. |

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

| FCC Section(s) | Test Requirements | Compliance (Yes/No) |
|--|--|---------------------------------|
| 15.509(a), (b), (c)&(g) | Compliance with General Requirements for Low Frequency Imaging Systems | Yes |
| 15.207 | AC Power Line Conducted Emissions Measurements (Transmit & Receive) | N/A for battery operated device |
| 15.509(a) | UBW 10 dB Bandwidth | Yes |
| 15.509(d)&(e) | Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious | Yes |
| The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices. The engineering test report can be provided upon FCC requests. | | |

5.2. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. COMPLIANCE WITH GENERAL REQUIREMENTS FOR LOW FREQUENCY IMAGING SYSTEMS [§ 15.509 (a) (b) (c)]

6.1.1. FCC Requirements & Compliance Statements

| FCC 15.509 | Requirements | Compliance Statements |
|------------|---|--|
| (a) | The UWB bandwidth of an imaging system operating under the provisions of this Section must be below 10.6 GHz | Conforms |
| (b) | <p>Operation under the provisions of this section is limited to GPRs and wall imaging systems operated for purposes associated with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction.</p> <p>(1) Parties operating this equipment must be eligible for licensing under the provisions of part 90 of this chapter.</p> <p>(2) The operation of imaging systems under this section requires coordination, as detailed in § 15.525.</p> | <p>Conforms.</p> <p>This device is a GPR operated for purposes associated with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction</p> <p>Please refer to Manufacturer's acknowledgement of compliance with this rule.</p> <p>Please refer to Manufacturer's acknowledgement of compliance with this rule.</p> |
| (c) | A GPR that is designed to be operated while being hand held and a wall imaging system shall contain a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. In lieu of a switch located on the imaging system, it is permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 seconds of the remote switch being released by the operator. | Not applicable since this GPR is not a handheld device. |

6.2. 10 dB OCCUPIED BANDWIDTH [§15.509 (a)]

6.2.1. Limits

§15.509 The upper 10 dB point of UWB bandwidth of an imaging system operating under the provisions of this section must be below 10.6 GHz.

6.2.2. Method of Measurements

The 10 dB BW was measured with the EUT's antenna placed on the 20" thick sand as its intended operation configuration.

- The spectrum analyzer shall be set as follows:
 - Span: Minimum span to fully display the entire emission, approximately 3 x emission BW.
 - Resolution RBW: 1 MHz
 - Video VBW: 3 MHz
 - EMI Detector: Peak
 - Sweep Time: AUTO
 - Trace: Max-hold
 - Frequency span is large enough to display a full spectrum of the RF emission (fundamental)
- The spectrum analyzer was pre-entered with the following correction factors:
 - Antenna correction factor
 - Cable loss
 - Pre-amplifier gain

and all measurements were corrected to these calibrated values

The EUT was located at 3 meters distance away from the measuring antenna and the RF emissions bandwidth was maximized by the following methods:

- (1) Place the measuring antenna in horizontal polarization
- (2) The EUT was initially placed in the manner that its antenna is in parallel with the measuring antenna.
- (3) The measuring antenna was moved up and down from 1 to 4 meters high to search for the maximum 10 dB BW.
- (4) At the maximum 10 dB BW with respect to the antenna height, the EUT was manually rotated in 360 degrees until the maximum 10 dB BW was observed.
- (5) The measuring antenna gain was moved up and down from 1 to 4 meters again to ensure the maximum 10 dB BW measured.
- (6) Change measuring antenna to vertical polarization and repeated steps (1) through (6) while the Spectrum Analyzer was still in MAXHOLD.
- (7) Plot the 10 dB rf emission bandwidth in both horizontal and vertical polarization.

6.2.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|------------------------------------|-----------------|---------------|------------|---------------------------------------|
| Spectrum Analyzer/ EMI Receiver | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz with external mixer |
| Biconilog Antenna | EMCO | 3142 | 10005 | 30 MHz to 2 GHz |
| Active Loop Antenna | EMCO | 6502 | 9104-2611 | 1 kHz – 30 MHz |

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6.2.4. Test Data

| Transmitter's Antenna Type | Rx Antenna Polarization (V/H) | Zoom-in Peak Frequency (Peak/QP) | 10 dB Bandwidth V + H (MHz) | Lower and Upper Frequencies at 10 dB Down Markers | | Peak E-field @ 3m (V+H) | PASS/FAIL |
|----------------------------------|-------------------------------------|---|--------------------------------------|---|----------------|------------------------------------|-----------|
| | | | | Lower (MHz) | Upper (MHz) | (dB μ V/m) Per 1 MHz RBW | |
| 500 MHz | V & H | 293.80 | 541.5 | 39.6 | 581.1 | 41.65 | Pass* |

* The upper 10 dB point with 500 MHz antenna was found to be below 10.6 GHz.

See plots #2 & 3 for measurement details.

Plot 2: 10 dB BW Measurements for Model THF500 (Antenna at Vertical & Horizontal Polarizations)

Note: No signal was found from 10 kHz to 30 MHz.



ULTRATECH 3M OATS 13:49:30 JAN 13, 2005

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 25.35 MHz
35.36 dB μ V/m

LOG REF 90.0 dB μ V/m

10
dB/
ATN
10 dB

VA VB
SC FC
ACORR

START 10 kHz STOP 30.00 MHz
IF BW 9.0 kHz AVG BW 30 kHz SWP 2.50 sec

RF&IF OVERLOAD

*

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Plot 3: 10 dB BW Measurements for Model THF500 (Antenna at Vertical & Horizontal Polarizations)

Notes:

- Marker for peak frequency / peak E-field was at 293.8 MHz / 41.65 dB μ V/m.
- Lower frequency: 39.6 MHz
- Upper frequency: 581.1 MHz



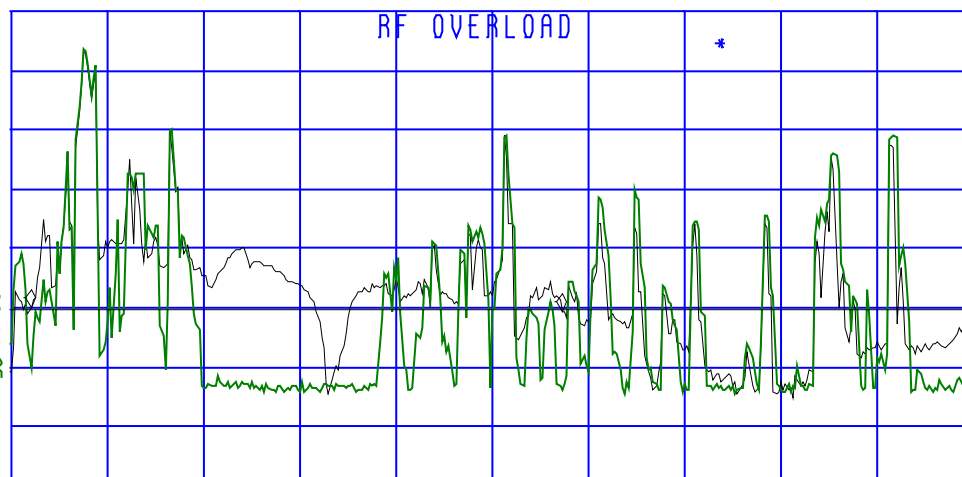
MARKER
581.1 MHz
29.32 dB μ V

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 581.1 MHz
29.32 dB μ V

LOG REF 80.0 dB μ V

10
dB/
#ATN
0 dB

DL
29.7
dB μ V
VA VB
SC FC
CORR



START 20.0 MHz STOP 1.0000 GHz
#IF BW 1.0 MHz #AVG BW 3 MHz SWP 20.0 msec

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6.3. TRANSMITTER SPURIOUS RADIATED EMISSIONS @ 3 METERS [§15.509 (d)(e)(f)]

6.3.1. Limits

§15.509(d): The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits measured using a resolution bandwidth of 1 MHz.

FCC CFR 47, Part 15, Subpart C, Sec. 15.209 (a) - Limits for Frequency below 960 MHz

| Frequency (MHz) | Field strength Limits (microvolts/m) | Measuring RBW | Distance (Meters) |
|-----------------|--------------------------------------|---------------|-------------------|
| 0.009 - 0.490 | 2,400 / F (KHz) | 1 kHz | 300 |
| 0.490 - 1.705 | 24,000 / F (KHz) | 9 kHz | 30 |
| 1.705 - 30.0 | 30 | 9 kHz | 30 |
| 30 - 88 | 100 | 120 kHz | 3 |
| 88 - 216 | 150 | 120 kHz | 3 |
| 216 - 960 | 200 | 120 kHz | 3 |

FCC CFR 47, Part 15, Subpart F, Sec. 15.509 (d) - Limits for Frequency above 960 MHz

| Frequency in MHz | EIRP Limits in dBm (1 MHz BW) | Alternative E-Field Limits in dBm @ 3m (1 MHz BW) |
|------------------|-------------------------------|---|
| 960-1610 | -65.3 | 29.9 |
| 1610-1990 | -53.3 | 41.9 |
| 1990-3100 | -51.3 | 43.9 |
| 3100-10600 | -41.3 | 53.9 |
| Above 10600 | -51.3 | 43.9 |

§15.509(e): In addition to the radiated emissions limits specified in the above table, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz.

FCC CFR 47, Part 15, Subpart F, Sec. 15.509 (e) - Limits for Frequency above 960 MHz

| Frequency in MHz | EIRP Limits in dBm (1 kHz BW) | Alternative E-Field Limits in dBm @ 3m (1 KHz BW) |
|------------------|-------------------------------|---|
| 1164-1240 | -75.3 | 19.9 |
| 1559-1610 | -75.3 | 19.9 |

§15.509(f): For UWB devices where the frequency at which the highest radiated emission occurs, f_M , is above 960 MHz, there is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on f_M . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in § 15.521.

§15.521(g): When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs, f_M . If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be $20 \log (RBW/50)$ dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using $E(\text{dB}\mu\text{V/m}) = P(\text{dBm EIRP}) + 95.2$. If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

6.3.2. Method of Measurements

Refer to Exhibit 8 of this test report, FCC ET Docket 98-152 and ANSI 63.4 for detailed radiated emissions measurement procedures.

6.3.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|------------------------------------|-----------------|---------------|------------|---------------------------------------|
| Spectrum Analyzer/ EMI Receiver | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz with external mixer |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 GHz |
| Active Loop Antenna | EMCO | 6502 | 9104-2611 | 1 kHz – 30 MHz |
| Log Periodic | EMCO | 3142C | 00026873 | 10 MHz to 2 GHz |
| Horn Antenna | EMCO | 3155 | 9701-5061 | 1 GHz – 18 GHz |

6.3.4. Test Data

Remark: All tests were performed with the EUT's antenna placed on the 20" thick sand as its intended operation configuration.

6.3.4.1. Radiated Emissions at 3 meters distance

- **Test Site:** The radiated emissions tests were performed at Ultratech's OATS. The EUT was placed on 20" thick medium fine sand.
- Tests were performed with the EUT in contact with the ground as its intended use. Operation of EUT, which is elevated above the ground, is not permitted by manufacturer. Please refer to Users Manual for operation instruction.
- The emissions were scanned from 10 kHz to 2 GHz and all emissions within 20 dB below the limits were recorded.
- For frequency below 960 MHz, the emissions were measured using the EMI Quasi-Peak Detector, RBW = 120 kHz, VBW = 1 MHz
- For Frequency above 960 MHz and outside the below frequency bands, the emissions were measured using RMS Detector, RBW = 1MHz, VBW = 1MHz
- For frequencies fall inside 960-1610, 1610-1990 MHz bands, the emissions were measured using RMS Detector, RBW = 1 MHz, VBW = 1 MHz. The measurements were performed at 1 meter distance since they were not measurable at 3 meters; the results were converted to equivalence at 3 meters by a correction factor of -9.5 dB.
- For frequencies fall inside 1164-1240 and 1559-1610 MHz, the emissions were measured using RMS Detector, RBW = 1 KHz, VBW = 1 MHz. The measurements were performed at 1 meter distance since they were not measurable at 3 meters; the results were converted to equivalence at 3 meters by a correction factor of -9.5 dB.

| FREQUENCY (MHz) | RF LEVEL (dBuV/m) | EMI DETECTOR (PEAK/QP/ RMS) | RBW (MHz) | ANTENNA PLANE (H/V) | LIMIT 15.209 * 15.509 (dBuV/m) | LIMIT MARGIN (dB) | PASS/ FAIL | Distance (m) |
|-----------------|-------------------|-----------------------------|-----------|---------------------|--------------------------------|-------------------|------------|--------------|
| 293.80 | 41.65 | Peak | 0.120 | V | -- | -- | -- | 3 |
| 293.80 | 37.37 | Peak | 0.120 | H | -- | -- | -- | 3 |
| 293.80 | 32.51 | QP | 0.120 | V | 46.0 | - 13.5 | PASS | 3 |
| 293.80 | 30.11 | QP | 0.120 | H | 46.0 | - 15.9 | PASS | 3 |
| 312.75 | 40.89 | Peak | 0.120 | V | -- | -- | -- | 3 |
| 312.75 | 37.32 | Peak | 0.120 | H | -- | -- | -- | 3 |
| 312.75 | 30.71 | QP | 0.120 | V | 46.0 | - 15.3 | PASS | 3 |
| 312.75 | 30.32 | QP | 0.120 | H | 46.0 | - 15.7 | PASS | 3 |

No significant emissions were found within 1164-1240 MHz and 1559-1610 MHz frequency bands. Please refer to plots #4 and 5 for measurement details (the measurements used a RMS detector).

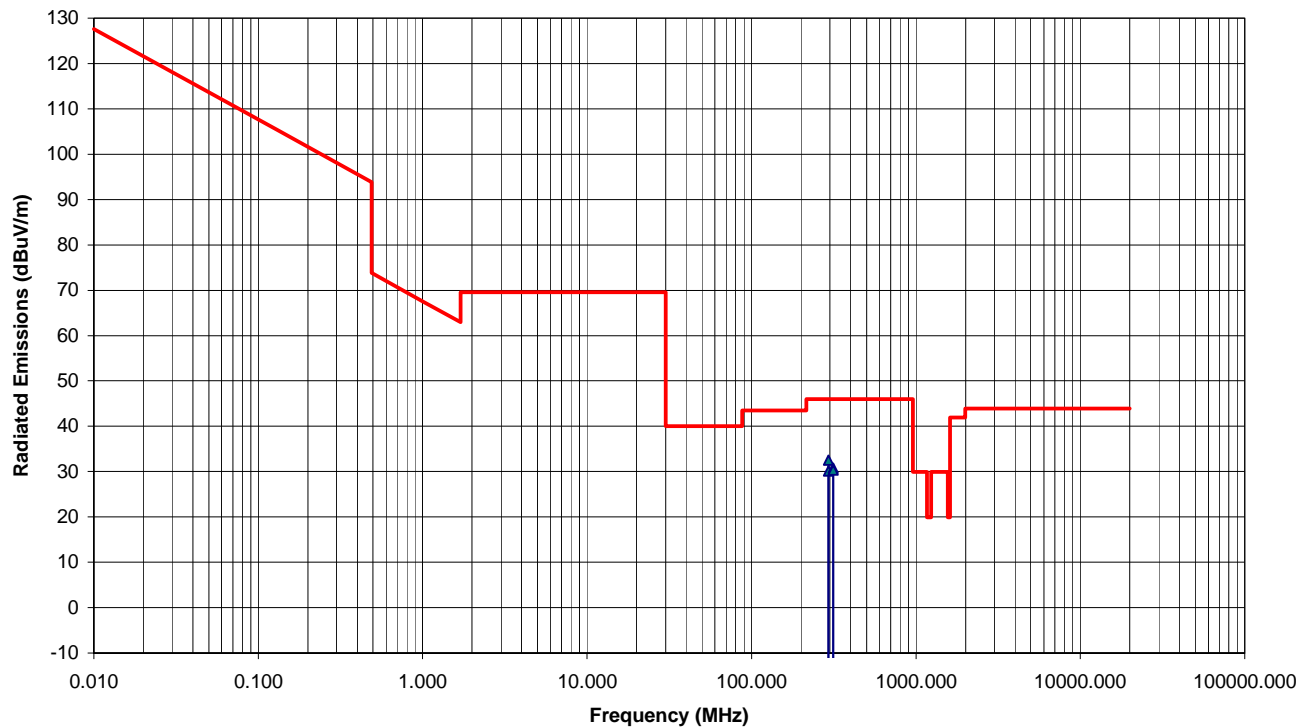
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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

File #: SES-026FCC15UWB
June 15, 2005

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Transmitter Radiated Emissions Measurements at 3m OFTS
Sensors & Software Inc.
pulseEKKO Pro HF 500, Model: THF 500



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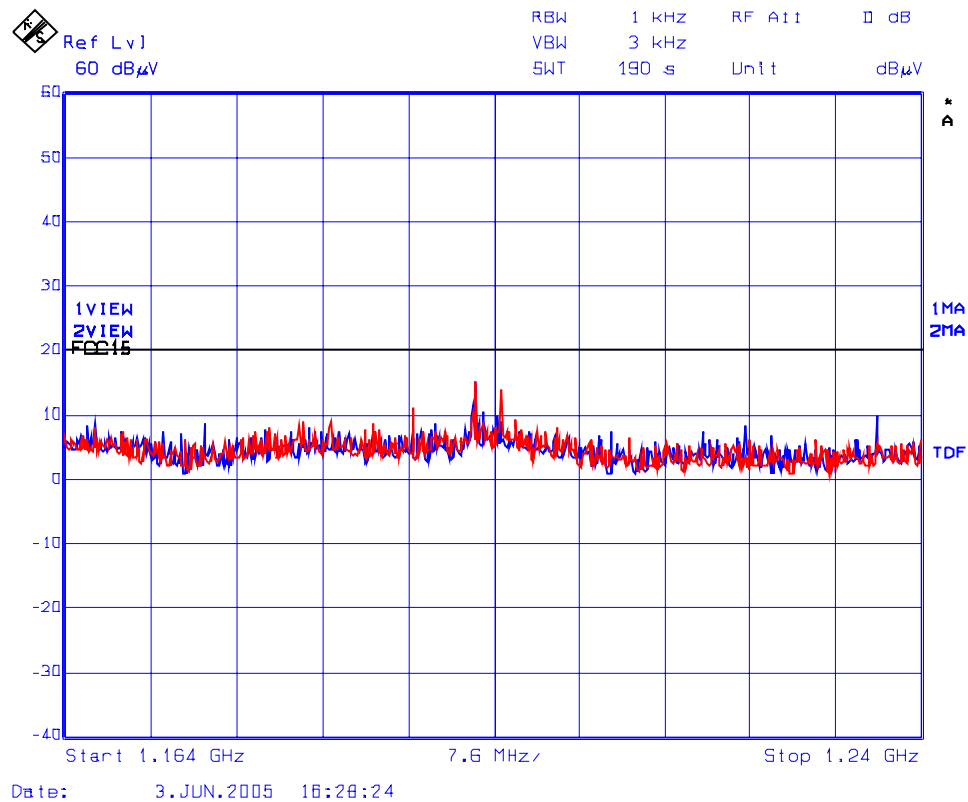
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

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Plot 4: Radiated emissions scanned within 1164 – 1240 MHz (Antenna at Vertical & Horizontal Polarizations)



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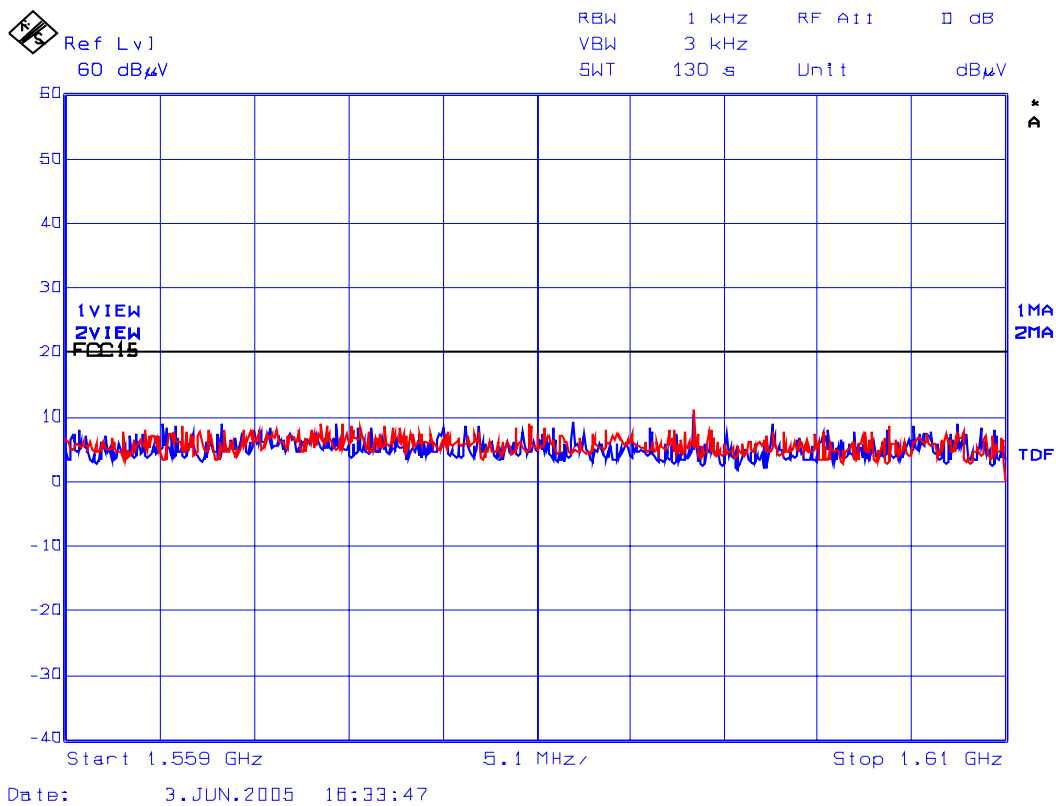
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

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Plot 5: Radiated emissions scanned within 1559-1610 MHz (Antenna at Vertical & Horizontal Polarizations)



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EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Radiated Emissions) | PROBABILITY DISTRIBUTION | UNCERTAINTY (\pm dB) | |
|--|-----------------------------|-------------------------|---------------|
| | | 3 m | 10 m |
| Antenna Factor Calibration | Normal (k=2) | ± 1.0 | ± 1.0 |
| Cable Loss Calibration | Normal (k=2) | ± 0.3 | ± 0.5 |
| EMI Receiver specification | Rectangular | ± 1.5 | ± 1.5 |
| Antenna Directivity | Rectangular | ± 0.5 | ± 0.5 |
| Antenna factor variation with height | Rectangular | ± 2.0 | ± 0.5 |
| Antenna phase center variation | Rectangular | 0.0 | ± 0.2 |
| Antenna factor frequency interpolation | Rectangular | ± 0.25 | ± 0.25 |
| Measurement distance variation | Rectangular | ± 0.6 | ± 0.4 |
| Site imperfections | Rectangular | ± 2.0 | ± 2.0 |
| Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$ (Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$ | U-Shaped | +1.1 -1.25 | ± 0.5 |
| System repeatability | Std. Deviation | ± 0.5 | ± 0.5 |
| Repeatability of EUT | | - | - |
| Combined standard uncertainty | Normal | +2.19 / -2.21 | +1.74 / -1.72 |
| Expanded uncertainty U | Normal (k=2) | +4.38 / -4.42 | +3.48 / -3.44 |

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

EXHIBIT 8. MEASUREMENT METHODS

8.1. BACKGROUND

This section describes the procedures and equipment used to perform the emissions testing performed by Ultratech Engineering Labs Inc. The focus of this measurement program was to characterize the complete emissions spectra.

Measurements were performed with the GPR transmitting antenna directly on the ground sand surface as the EUT's intended operation for measuring the unintentional radiated emissions.

8.2. TEST SITES

The radiated emissions tests were performed on a medium to fine sand test site at the facility of Ultratech Engineering Labs Inc. The emissions testing equipment was setup using a configuration similar to that shown in Figure 2-1 and Figure 2-2.

Figure 2-1: Block diagram of EMC measurement configuration for radiated emissions testing

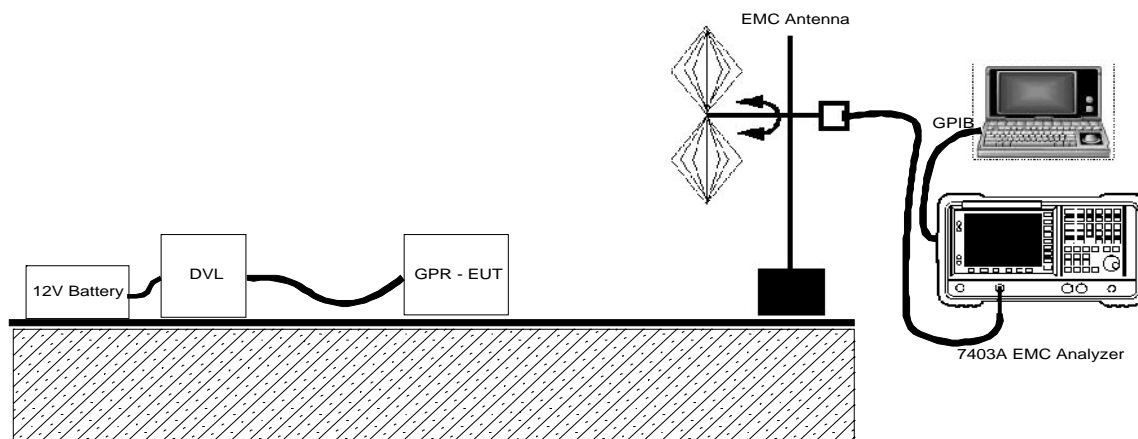
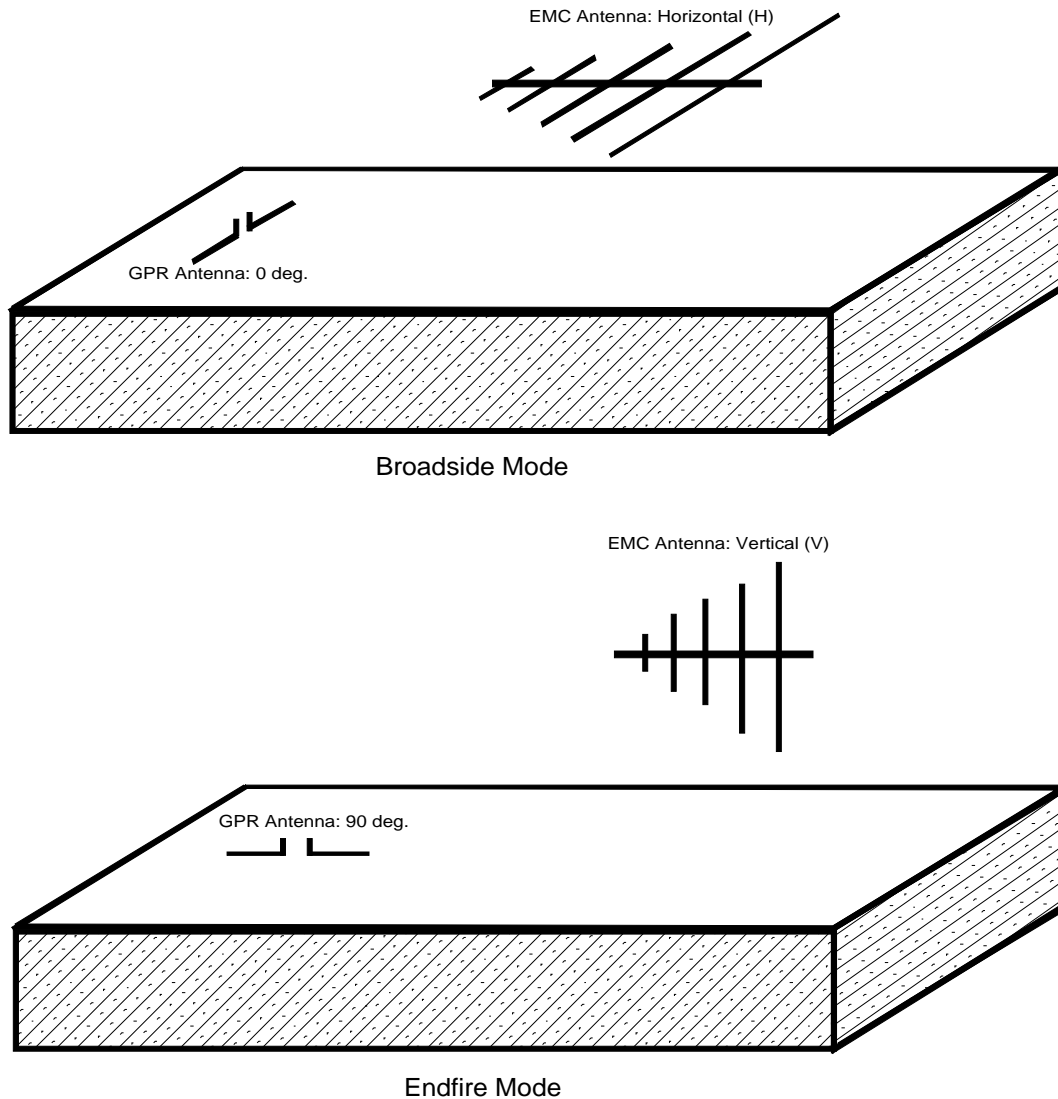


Figure 2-2: Endfire and broadside measurement modes



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8.3. EMISSIONS TEST CONFIGURATIONS

All tested GPR systems were measured using these test configurations with the GPR transmitter on (transmitting) and off (not transmitting). The GPR transmitters were operated at their highest pulse repetition frequencies (PRF). Two main antenna orientation configurations were employed during the EMC testing. In the broadside configuration the EMC antenna direction is horizontal and parallel to the GPR transmitting dipole direction. In the endfire mode the GPR transmitting dipole is horizontal and rotated 90° with respect to the direction in the broadside mode and the EMC antenna is oriented in the vertical direction as indicated in Figure 2-3.

The GPR transmitting antenna was rotated in the horizontal plane to confirm that the indicated endfire and broadside modes produced the highest emissions.

To meet the limit requirements of part 15.509(f) (0 dBm in a resolution bandwidth (RBW) of 50 MHz) a 3 MHz RBW was used. As stated in 15.521 (g) this is acceptable if the peak EIRP limit is reduced to $20 \log(\text{RBW}/50)$. The limit is reduced from 0 dBm for a 50 MHz RBW to -24.4 dBm for a 3 MHz RBW or 70.8 dBμV/m in 3 MHz BW measured at 3 meters.