Applicant Name: Remote MDX

Applicant Address: 150 West Civic Centre Drive
Suite 400
Sandy, Utah
84070

Project Number: RMDB-OTD-5224

Test/Analysis Date: 22nd May 2006

DUT Type	Cellular 850 and PCS
Antenna Type	Internal
Project Name	Offender Tracking Device
Received Status	Pre Production Model
DUT Serial Number	2b.4-0006284
FCC ID	TPO-OTD300-0
Experimental/Compliance	Compliance
Tx Frequency	824-849MHz Cellular 850 1850-1910MHz PCS
Max Tx Power	**26.75** dBm Cellular GSM (ERP) 29.51dBm PCS (EIRP)
Conservative Averaged SAR (RF Exposure)	0.034 W/kg Cellular GSM Intended Use 0.058W/kg PCS Intended Use

We the undersigned of APREL Laboratories, located at 51 Spectrum Way, Ottawa, Ontario, Canada, K2R-1E6, on the date indicated attest that the Device Under Test as detailed within this test report has been tested and found to be compliant with the Uncontrolled Environment RF exposure rules and regulations as defined by the methodologies, procedures, and standards as described in this document.

APREL Laboratories is an ISO 17025 accredited facility registered under Standards Council Canada lab 48.

Art Brennan, 25/05/06
Certification Administration — Date

Stuart Nicol, 23-MAY-2006.
Director Product Development — Date

Dr Jacek J. Wojcik, March 23/06
P. Engineer — Date

LICENSED PROFESSIONAL ENGINEER J.J. WOJCIK PROVINCE OF ONTARIO

Telecommunications Approval Board - Spectrum Sciences Institute
SAR Certified APREL Laboratories OTD

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1.0 Introduction

Tests were conducted at APREL Laboratories within the ISO 17025 accredited SAR facility to establish the conservative exposure value associated with the Device Under Test as detailed within this test report. Assessments were made in line with the guidelines contained in the reference documents. The method used for assessment was the ALSAS-10U (APREL Laboratories SAR Assessment System-10 Universal). All practices along with standards and scientific methodologies which have been utilized during the assessment of the Device Under Test (DUT) are detailed within this test report.

APREL Laboratories employees currently hold senior and executive positions in multiple international standards organizations, including IEC, IEEE, among others, and work closely with several national regulators, including the FCC. Through the IEC, we have a liaison with CENELEC, and informal links to other national and international standards organizations.

1.2 Device Description

The Device Under Test (DUT) is the Offender Tracking Device (OTD) designed to operate at Cellular 850 and PCS frequencies. The device is capable of receiving SMS, GPRS and voice calls but will not transmit using GPRS routines. The device has been designed to be worn around the ankle at all times and includes an internal battery. The device can be operated with both the internal battery and external battery source, although the internal battery has not been designed to support transmit operations greater than 2 minutes, and as such the external battery pack has been used for the SAR testing. The OTD is designed in such a way that it can not be removed by the wearer once attached to the ankle and in the event that it is removed a signal is sent to the monitoring station which identifies that an exception has been made and the appropriate authority is informed. The device as worn would be located at a touch position on the ankle with the front of the device facing the other leg. It has been found that at a separation distance of greater than 10mm the touch position of the OTD yields the highest SAR.

It has been found that the maximum SAR value was measured at 1909.8MHz for all the test conditions reported in this document. **With a separation distance 0mm the SAR** is 0.058 W/kg for a 10g average and at these distances the scenario tested will comply with both FCC and IC.

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2.0 Applicable Documents

ANSI/IEEE C95.1-1999, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

IEEE 1528 "Recommended Practice for Determining the Peak Spatial Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communication Devices: Experimental Techniques."

ICNIRP Guidelines "GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS (UP TO 300 GHz)"

IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
Part 1: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)"

IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
Part 2 *Draft*: "Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)"

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3.0 ALSAS-10U System Description

APREL Laboratories ALSAS-10-U (APREL Laboratories SAR Assessment System) is fully optimized for the dosimetric evaluation of a broad range of wireless transceivers and antennas. It is an easy-to-use development and compliance tool, which provides excellent application flexibility. Developed in line with the latest methodologies it is fully compliant with the technical and scientific requirements of IEEE 1528, IEC 62212, CENELEC, ARIB, ACA, and the Federal Communications Commission. The system comprises of a six axes articulated robot which utilizes a dedicated controller.

ALSAS-10U has been developed with a strong engineering focus, and with custom modular software/hardware for the broadest range of applications, including dosimetry research and measurements in various Phantoms – SAM Phantom, UniPhantom™ Universal Phantom, Universal Flat Phantom and others.

Free space E-Field measurements of mobile devices and base station antennas can also be executed using ALSAS. With the current ALSAS configuration, several phantoms and setups can be arranged around the system – and since the phantoms are designed to be light and easy to move for interchanging between test frequencies.

ALSAS-10U has been developed using the latest methodologies and FDTD modeling to provide a platform which is repeatable with minimum uncertainty.

The ongoing commitment from APREL Laboratories to the field of Dosimetric research and development will ensure that the ALSAS-10-U measurement system can easily be upgraded to accommodate changes to wireless technologies, and scientific methodologies.

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3.1 Applications

Predefined measurement procedures compliant with the guidelines of CENELEC, IEEE, IEC, FCC, etc are utilized during the assessment for the device. Automatic detection for all SAR maxima are embedded within the core architecture for the system, ensuring that peak locations used for centering the zoom scan are within a 1mm resolution and a 0.05mm repeatable position. A little less than 10 min per device position measurement completion time, (depending of DUT size) ensures minimum power drift during the assessment. No user interaction is required during the measurement processes: area scan, evaluation of cube maximal search, fine cube measurements and device power drift measurement. System operation range currently available up-to 6 GHz in simulated tissue.

ALSAS-10U can be used for all analog and digital devices, including wideband, spread spectrum and pulsed systems, etc.: handsets, handhelds, wireless data, electronic article surveillance, accessories, wireless access points, WLAN, cordless, radio, etc.

3.2 Visualization and reporting

2/3D isoline distribution, scatter graphics, polar graphics, and vector reproduction. Device representation and phantom visualization in 2/3D graphics with measurement data overlaid (in color plot format). Freely configurable output graphic formats with automatic title, data and legend generation which includes all relevant information relating to the measurement process. Uncertainty analysis and budget calculated and reported drawing on active device drift assessment, and tissue simulation values.

3.3 Field scans

ALSAS-10U can provide multiple scan types including Measurements along lines (X, Y, Z), multiple planes, curved surfaces (normalize probe to surface), volumes in free space or restricted volumes (phantoms). Cube measurements with surface extrapolation and spatial SAR evaluation for 1g and/or 10g. Time measurements (source power drift). Probe rotation measurements (isotropy) and many others in line with the requirements of any given standard or procedure.

3.3.1 Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a $10mm^2$ step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

A maximum area scan size is set at 280mm x 200mm which can be changed to a smaller size dependent on the filed distribution of the device under test. The area scan size is documented within the SAR report which is delivered by the SAR system software.

Where the system identifies multiple SAR peaks (which are within 2dB of each peak value) the system will provide the user with the option of assessing each peak location individually for zoom scan averaging.

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3.3.2 Zoom Scan (Cube Scan Averaging)

The averaging zoom scan volume utilized in the ALSAS-10U software is in the shape of a cube and the side dimension of a 1 g or 10 g mass is dependent on the density of the liquid representing the simulated tissue. A density of 1 000 kg/m^3 is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

When the cube intersects with the surface of the phantom, it is oriented so that 3 vertices touch the surface of the shell or the centre of a face is tangent to the surface. The face of the cube closest to the surface is modified in order to conform to the tangent surface. The centre of the cube and the tangential angle associated defines each face of the cube so that all transitional points follow this tangential angle.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications (including FCC) utilize a physical step of 5x5x9 (8mmx8mmx4mm Fx <3GHz) and 9x9x17 (4mmx4mmx2mm Fx>3GHz) providing a volume of 32mm in the X & Y axis, and 32mm in the Z axis. All points remain tangential to the surface by utilizing the normalize (probe tilt) feature so as to reduce measurement uncertainty.

3.4 Operator settings

Multiple access levels (password protected) for parametric modifications/test scenarios in line with selected standards, including the FCC. Any number of predefined settings (probes, phantoms, liquids, devices, measurement procedures, etc.) can be stored for future use and repeatable assessments.

3.5 ALSAS-10U Interpolation and Extrapolation Uncertainty

The overall uncertainty for the methodology and algorithms that are used during the SAR calculation was evaluated using the data from IEEE 1528 based on the example f3 algorithm:

$$f_3(x,y,z) = A\,\frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2}\cdot\left(e^{-\frac{2z}{a}} + \frac{a^2}{2(a+2z)^2}\right)$$

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4.0 ALSAS-10U Hardware

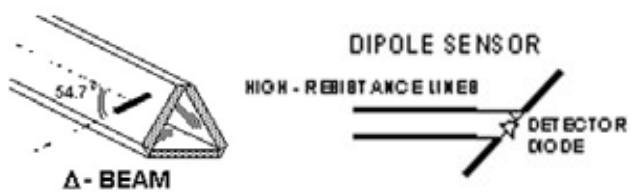
The ALSAS-10U comprises of hardware designed exclusively by APREL Laboratories based on methodologies presented in IEEE 1528, IEC 62212, CENELEC and FCC supplement C OET bulletin 65.

4.1 Isotropic E-Field Probe

The isotropic E-Field probe used by APREL Laboratories, has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change. APREL Laboratories utilize a number of methods for calibrating probes, and these are outlined in the table below.

Calibration Frequency (MHz)	Air Calibration	Tissue Calibration
300	TEM Cell	Temperature
450	TEM Cell	Temperature
835	TEM Cell	Temperature
900	TEM Cell	Temperature
1800	TEM Cell	Temperature
1900	TEM Cell	Temperature
2450	Waveguide	Temperature
5200	Waveguide	Waveguide
5800	Waveguide	Waveguide

The APREL Laboratories E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below.



SAR is assessed with a calibrated probe which moves at a default height of 5mm from the centre of the diode, which is mounted to the sensor, to the phantom surface (in the Z Axis). The 5mm offset height has been selected so as to minimize any resultant boundary effect due to the probe being in close proximity to the phantom surface.

The following algorithm is an example of the function used by the system for linearization of the output from the probe when measuring complex modulation schemes.

$$V_i = U_i + U_i^{\,2} \cdot \frac{cf}{dcp_i}$$

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4.2 Isotropic E-Field Probe Specification

Calibration in Air	Frequency Dependent Below 2GHz Calibration in air performed in a TEM Cell Above 2GHz Calibration in air performed in waveguide
Sensitivity	0.60 µV/(V/m)^2 to 1.25 µV/(V/m)^2
Dynamic Range	0.01 W/kg to 100 W/kg
Isotropic Response	Better than 0.2dB in air Better than 0.05dB in tissue
Diode Compression Point (DCP)	Calibrated for Specific Frequency typically 95mV +/- 10%
Probe Tip Radius	<5mm
Sensor Offset	1.56 (+/-0.02mm)
Probe Length	290mm
Video Bandwidth	@ 500 Hz: 1 dB @ 1.02 KHz: 3 dB
Boundary Effect	Less than 2% for distances greater than 2.4mm
Spatial Resolution	Better than 2.5mm

4.3 Boundary Detection Unit and Probe Mounting Device

ALSAS-10U incorporates a boundary detection unit with a sensitivity of 0.05mm for detecting all types of surfaces. The robust design allows for detection during probe tilt (probe normalize) exercises, and utilizes a second stage emergency stop. The signal electronics are fed directly into the robot controller for high accuracy surface detection in lateral and axial detection modes (X, Y, & Z).

The probe is mounted directly onto the Boundary Detection unit for accurate tooling and displacement calculations controlled by the robot kinematics. The probe is connect to an isolated probe interconnect where the output stage of the probe is fed directly into the amplifier stage of the Daq-Paq.

4.4 Daq-Paq (Analog to Digital Electronics)

ALSAS-10U incorporates a fully calibrated Daq-Paq (analog to digital conversion system) which has a 4 channel input stage, sent into an amplifier module. The input signal is amplified accordingly so as to offer a dynamic range from 5µV to 800mV. Integration of the fields measured is carried out at board level utilizing a Co-Processor which then sends the measured fields down into the main computational module in digitized form via an RS232 communications port. Probe linearization and duty cycle compensation is carried out within the main Daq-Paq module.

ADC	16 Bit
Amplifier Range	30 µV to +200 mV (16 bit resolution: 4µV, 400mV)
Field Integration	Local Co-Processor utilizing proprietary integration algorithms
Number of Input Channels	4 in total 3 dedicated and 1 spare
Communication	Packet data via RS232

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4.5 Axis Articulated Robot

ALSAS-10U utilizes a six axis articulated robot, which is controlled using a Pentium based real-time movement controller. The movement kinematics engine utilizes proprietary (Thermo CRS) interpolation and extrapolation algorithms, which allow full freedom of movement for each of the six joints within the working envelope. Utilization of joint 6 allows for full probe rotation with a tolerance better than 0.05mm around the central axis.

Robot/Controller Manufacturer	Thermo CRS
Number of Axis	Six independently controlled axis
Positioning Repeatability	0.05mm
Controller Type	Single phase Pentium based C500C
Robot Reach	710mm
Communication	RS232 and LAN compatible

4.6 ALSAS Universal Workstation

ALSAS Universal workstation was developed with a strong engineering focus taking into consideration flexibility and engineering needs, and the necessity to have integrated system which will allow for repeatability and fast adaptability. ALSAS workstation technology is stable and robust in structure, but at the same time flexible so that users can do calibration, testing and measurements using different types of phantoms with one set up, which significantly speeds up the measurement process.

The workstation incorporates a modular structure which can be easily adapted to specific engineering requirements and needs. Phantoms which are self contained modular units are easily located, removable and swappable. Three fully configurable shelves allow for setting up of a test device in a way which can either utilize the APREL Laboratories device positioner, or custom designed units. When using the modular shelf for positioning of a device, additional loading characteristics have been avoided.

The workstation has been constructed entirely out of composite wood and Canadian maple, with all metallic fasteners kept at a compliant distance from the Device under test.

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4.7 Universal Device Positioner

The APREL Laboratories universal device positioner has been developed so as to allow complete freedom of movement of the DUT. Developed to hold a DUT in a free-space scenario any additional loading attributable to the material used in the construction of the positioner has been eliminated. Repeatability has been enhanced through the linear scales which form the design used to indicate positioning for any given test scenario in all major axes. A 15° tilt indicator has been included for the of aid cheek to tilt movements for head SAR analysis. Overall uncertainty for measurements have been reduced due to the design of the Universal device positioner, which allows positioning of a device in as near to a free-space scenario as possible, and by providing the means for complete repeatability.

Length	201mm
Width	140mm
Height	222mm
Weight	1.95kg
Number of Axis	6 axis freedom of movement
Translation Along MB Line	+/- 76.2mm
Translation Along NF Line	+/- 38.1mm
Translation Along Z Axis	+/- 25.4mm (expandable to 500mm)
Rotation Around MB Line (yaw)	+/- 10°
Rotation Around NF Line (pitch)	+/- 30°
Rotation Around Z Axis (roll)	360° full circle
Minimum Grip Range	0mm
Maximum Grip	152mm
Maximum Distance from Device to Positioner Material	40mm
Tilt Movement	Full movement with predefined 15° guide

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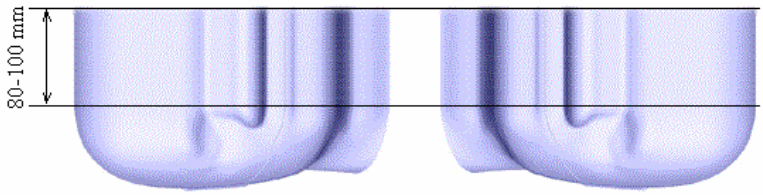
4.8 Phantom Types

The ALSAS-10U has been designed so as to allow the integration of multiple phantom types. This includes but is not limited to the APREL Laboratories SAM Phantoms fully compliant with IEEE 1528, Universal Phantom, and Universal Flat.

4.8.1 APREL SAM Phantoms

The APREL Laboratories SAM phantoms have been designed so as to aid repeatability and positioning for any DUT. Developed using the IEEE SAM CAD file they are fully compliant with the requirements for both IEEE 1528 and FCC Supplement C. Both the left and right SAM phantoms are interchangeable, transparent and include the IEEE 1528 grid with visible NF and MB lines.



Compliant Standards	IEEE-1528, IEC 62212, CENELEC, and others
Manufacturing Process	Injection molded
Material	Composite urethane
Manufacturing Tolerance	+/- 0.2mm
Frame Material	Corian
Tissue Simulation Volume	7 ltr with 15cm tissue
Thickness	2mm nominally 6mm at NF/MB intersection
Loss Tangent	<0.05
Relative Permittivity	<5
Resistant to Solvents	Resistant to all solvents detailed in IEEE 1528
Load Deflection	<1mm with sugar water compositions

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4.8.2 APREL Laboratories Universal Phantom

The APREL Laboratories Universal Phantom has been developed as an engineering tool for both compliance and development. It is also used on the ALSAS-10U as a system validation phantom. The unique design allows repeatable measurements for all devices, including handsets, PDA units, laptop computers, and validation dipoles. The APREL Laboratories Universal Phantom has been fully validated both experimentally from 800MHz to 6GHz and numerically using XFDTD numerical software. The shell thickness is 2mm overall, with a 4mm spacer located at the NF/MB intersection providing an overall thickness of 6mm in line with the requirements of IEEE-1528. The design allows for fast and accurate measurements, of handsets, by allowing the conservative SAR to be evaluated at on frequency for both left and right head experiments in one measurement. The phantom is surrounded by a Corian frame, which adds additional support and load bearing characteristics.

Compliant Standards	IEEE-1528, IEC 62212, CENELEC, and others
Frequency Range	800MHz to 6GHz
Material	Vivac
Manufacturing Tolerance	+/- 0.2mm
Frame Material	Corian
Tissue Simulation Volume	8 ltr with 15cm tissue
Thickness	2mm nominally 6mm at NF/MB intersection
Loss Tangent	<0.05
Relative Permittivity	<5
Resistant to Solvents	Resistant to all solvents detailed in IEEE 1528
Load Deflection	<1% Length with sugar water compositions
Dimensions	Length 220mm x breadth 170mm

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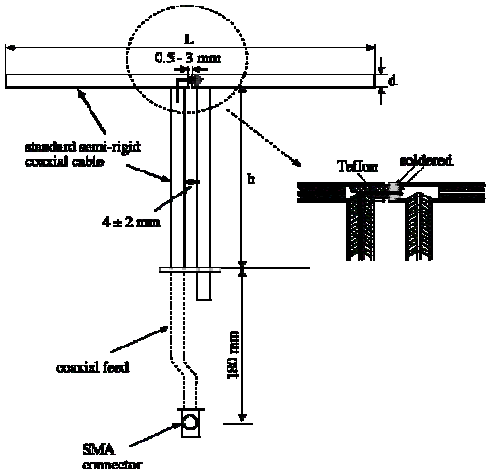
4.9 Validation Dipoles

APREL Laboratories utilize dipoles based on the IEEE-1528 standard, and have ensured that they comply with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical specifications for the dipoles used by APREL Laboratories.

Body validation target numbers have been derived using XFDTD numerical software, and validated experimentally.



APREL Laboratories have developed high frequency dipoles based on current scientific research carried both experimentally and numerically here at the APREL Laboratories site. Mechanical and electrical parameters for the dipoles have been established using experimental and numerical techniques, and target SAR values have been established following IEC methodologies. The results of the experimental and numerical research have been published and released for peer review.

Frequency (MHz)	*L* (mm)	*h* (mm)	*d* (mm)
300	396.0	250.0	6.0
450	270.0	166.7	6.0
835	161.0	89.8	3.6
900	149.0	83.3	3.6
1450	89.1	51.7	3.6
1800	72.0	41.7	3.6
1900	68.0	39.5	3.6
2000	64.5	37.5	3.6
2450	51.5	30.4	3.6
3000	41.5	25.0	3.6
5200	23.6	14	3.6
5800	21.6	13	3.6
5190-5900	23.1	20.7	3.6

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5.0 Tissue Simulation Fluid

Tissue simulation fluids in the frequency range of 450MHz to 2450MHz are based on IEEE-1528 and FCC Supplement C guidelines. All fluids meet the dielectric specifications as outlined in the above standards (within allowable tolerances) and are calibrated on a regular basis, to maintain stability. The recipes used along with the dielectric target values are included in the table below.

Ingredients (% Weight)	450 MHz Head	835 MHz Head	915 MHz Head	1900 MHz Head	2450 MHz Head
Water	38.56	41.45	41.05	54.9	62.7
Salt	3.95	1.45	1.35	0.18	0.5
Sugar	56.32	56.0	56.5	x	x
HEC	0.98	1.0	1.0	x	x
Bactericide	0.19	0.1	0.1	0.1	X
Triton-X	X	X	X	X	36.8
DGBE	X	X	X	44.92	x
ε^r	43.42	42.54	42.0	39.9	39.8
δ	0.85	0.91	1.0	1.42	1.88

Ingredients (% Weight)	450 MHz Body	835 MHz Body	915 MHz Body	1900 MHz Body	2450 MHz Body
Water	51.16	52.4	56.0	40.4	73.2
Salt	1.49	1.4	0.76	0.5	0.04
Sugar	46.78	45.0	41.76	58.0	X
HEC	0.52	1.0	1.21	1.0	X
Bactericide	0.05	0.1	0.27	0.1	X
Triton-X	X	X	X	X	X
DGBE	X	X	X	X	26.7
ε^r	58.0	56.1	56.8	54.0	52.5
δ	0.83	0.95	1.07	1.45	1.78

NOTE. Recipes are based on those presented in FCC Supplement C Page 36.

For frequencies above 2450MHz recipes will be presented as and when requested by a designated body.

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5.1 Tissue Calibration Procedure Using a Coaxial Probe

The VNA (Vector Network Analyzer) is configured and calibrated for the frequency of the simulated tissue which has to be assessed. The Coaxial probe is then calibrated in line with the tissue frequency using an open, short, and De-Ionized water routine. The sample of simulated tissue is placed into a non-metallic container for use during the calibration. The temperature of the simulated tissue sample is measured. The probe head is then completely immersed in the simulated tissue sample (the probe is held in place using a non metallic probe holder). The simulated tissue sample is then measured to assess the permittivity and conductivity.

5.2 Tissue Calibration Results

Tissue used during the SAR assessment is calibrated prior to use in the measurement process. APREL Laboratories use the co-axial probe method for all tissue calibration exercises. Tissue which is being used over a period of 24 hours is re-calibrated to ensure that no change to the dielectric properties will affect the SAR measurement process. The table below provides details of the results from the tissue equivalent dielectric calibration.

Calibrated By	Calibration Date	Frequency MHz	Tissue Type	Epsilon (ε^r)	Sigma (δ)
Anna Noworaj	22-05-06	835	Body	52.20	0.97
Anna Noworaj	23-05-06	1900	Body	52.13	1.53

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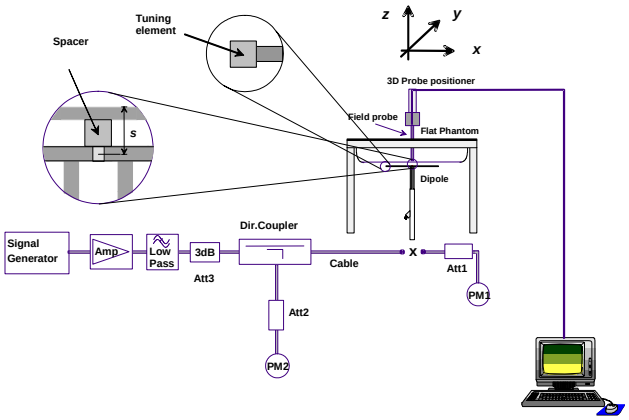
6.0 System Validation

ALSAS-10U is fully validated prior to the SAR assessment of the DUT following methodologies presented in IEEE-1528 section 8. The system is validated using tissue which has been calibrated within a 24 hour period. When the measurement process exceeds a 24 hour period a secondary system validation is executed and the results presented within this test report. The graphic plots resulting from the system validation are included in Appendix A SAR plots.



Date	Validation Frequency (MHZ)	Dipole Separation Distance mm	Power W	Dipole	SAR 1g W/kg	Target 1g W/kg	Delta %
22-05-06	835	15	1.0	x	9.4	9.5	1.0
23-05-06	1900	10	1.0	x	38.2	39.7	4.0

Currently no standards are in place for validating a system while using body tissue. APREL Laboratories have conducted research using XFDTD to assess the target validation numbers while using body tissue. It should be noted that the target validation numbers presented in IEEE-1528 have been derived using FDTD methodologies.

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6.1 Experimental Results Summary

The results for each experimental assessment are contained within this section. Where any deviation has been made from the given procedures contained within IEEE-1528 or FCC Supplement C this has been described accordingly.

6.2 SAR Measurement Procedure

The ALSAS-10U calculates SAR using the following equation,

$$SAR = \frac{\sigma |E|^2}{\rho}$$

σ: represents the simulated tissue conductivity
ρ: represents the tissue density

The DUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The DUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at $1mm^2$) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at $1mm^3$).

6.3 SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 "Uncontrolled Environments" limits. These limits apply to a location which is deemed as "Uncontrolled Environment" which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

The OTD has been tested to the 4.00 W/kg 10g Limit in line with the intended use position.

Type of Exposure	**Uncontrolled Environment Limit**
Spatial Peak SAR (1g cube tissue for brain or body)	**1.60 W/kg**
Spatial Average SAR (whole body)	**0.08 W/kg**
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	**4.00 W/kg**

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6.4 Equipment List

APREL Laboratories utilize the following equipment.

Equipment Description	Asset/Serial Number	Calibration Due Date
ALSAS-10U	301571	Prior to Test
Boundary Detection Unit	301572	Calibrated Once
Daq-Paq	301573	January 2007
Pentium 4 Workstation	301574	Not Required
Signal Generator	301468	September 2006
Gigatronics Power Meter	301393	August 2006
Gigatronics Broad Band Power Sensor	301394	August 2006
HP-Directional Coupler	100251	October 2006
APREL Laboratories 800-4200MHz 12W Amplifier	301577	Prior to Test
APREL Laboratories 2450MHz Validation Dipole	301581	November 2006
APREL Laboratories E-020 E-Field Probe	209	August 2006
40MHz -20GHz VNA	301382	August 2006
TRL Calibration Kit	301582	January 2007
APREL Laboratories Coaxial Probe (Dielectric Probe Kit)	100757	Prior to Test
APREL Laboratories Universal Phantom	301511	Calibrated Once
APREL Laboratories SAM Phantom LHS	301500	Calibrated Once
APREL Laboratories SAM Phantom RHS	301501	Calibrated Once
APREL Laboratories 15mm Dipole Separation Kit	301546	Calibrated Once
APREL Laboratories 10mm Dipole Separation Kit	301547	Calibrated Once
APREL Laboratories 5-6GHz 2 W Amplifier	NYA	March 2007
APREL Laboratories MMW Directional Coupler	NYA	March 2007
APREL Laboratories 835MHz Validation Dipole	x	March 2007
APREL Laboratories 1900MHz Validation Dipole	x	March 2007
ALSAS-10 Device Positioner ALS-H-E-SET-2	ALS-H-E-SET-2-LAB1	Not Required

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6.5 SAR Measurement Results

Remote MDX OTD Cellular 850

Power	26.75dBm
DUT Position	Back
Separation	0mm
Antenna Type	Internal
Antenna Manufacturer	Universe
Antenna Location	LHS
Power Mode	Battery
Tx Frequency	824-849MHz
Duty Cycle	8
Epsilon	52.20
Sigma	0.97
Tissue Depth	15cm
Phantom Type	Universal
DUT Workstation Location	Centre
Device Positioner	HESET1
Test Date	22-05-2006
Test Engineer	Stuart Nicol

Mode	**Separation Distance (mm)**	**Channel**	**Frequency MHz**	**10g SAR W/kg**
C850	0	128	824	0.034
C850	0	190	837.4	0.032
C850	0	251	849	0.028

SAR Limit	**Conservative Measured SAR**
1.6 W/kg 1gram Average Maximum	0.034 W/kg 10gram Average

SAR Plot for Conservative SAR Included in Appendix A.

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Remote MDX OTD PCS

Power	29.51dBm
DUT Position	Back
Separation	0mm
Antenna Type	Internal
Antenna Manufacturer	Universe
Antenna Location	LHS
Power Mode	Battery
Tx Frequency	1850-1910MHz
Duty Cycle	8
Epsilon	52.13
Sigma	1.53
Tissue Depth	10cm
Phantom Type	Universal
DUT Workstation Location	Centre
Device Positioner	HESET1
Test Date	23-05-06
Test Engineer	Stuart Nicol

Mode	**Separation Distance (mm)**	**Channel**	**Frequency MHz**	**10g SAR W/kg**
PCS	0	512	1850.2	0.048
PCS	0	661	1880	0.058
PCS	0	810	1909.8	0.046

SAR Limit	**Conservative Measured SAR**
1.6 W/kg 1gram Average Maximum	0.058 W/kg 10gram Average

SAR Plot for Conservative SAR Included in Appendix A.

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6.6 Additional Information

The OTD was tested back and front and it was found that the conservative SAR for the front of the device was lower than the maximum measured value for the intended use position at 10mm of separation. The data below relates to the front of the device touching the phantom and is NOT representative of a normal use condition. **This data has been included for information purposes only.**

Mode	Separation Distance (mm)	Channel	Frequency MHz	10g SAR W/kg
C850	0	128	824	0.348
C850	0	190	837.4	0.232
C850	0	251	849	0.456

Mode	Separation Distance (mm)	Channel	Frequency MHz	10g SAR W/kg
PCS	0	512	1850.2	0.693
PCS	0	661	1880	0.361
PCS	0	810	1909.8	0.238

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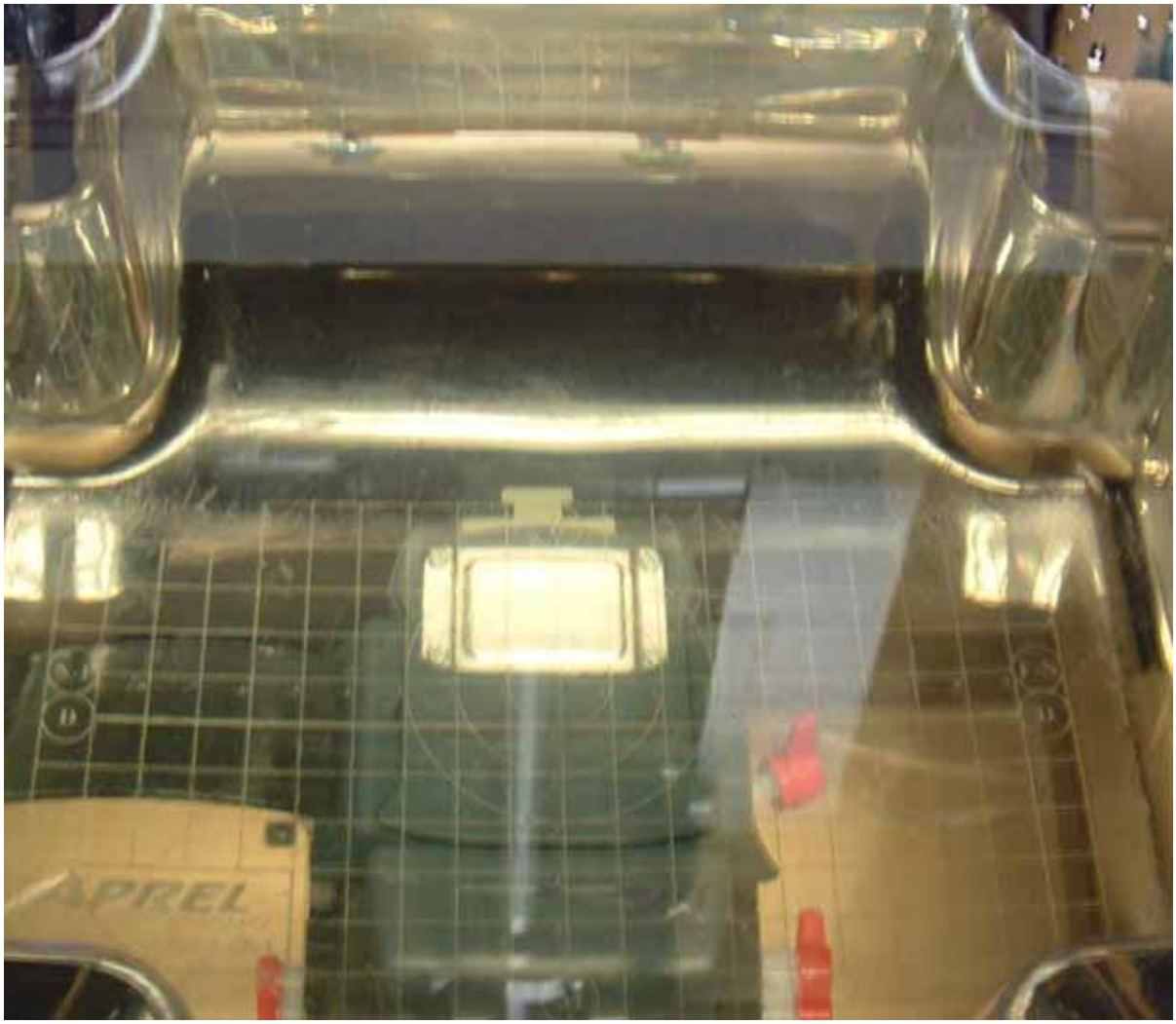

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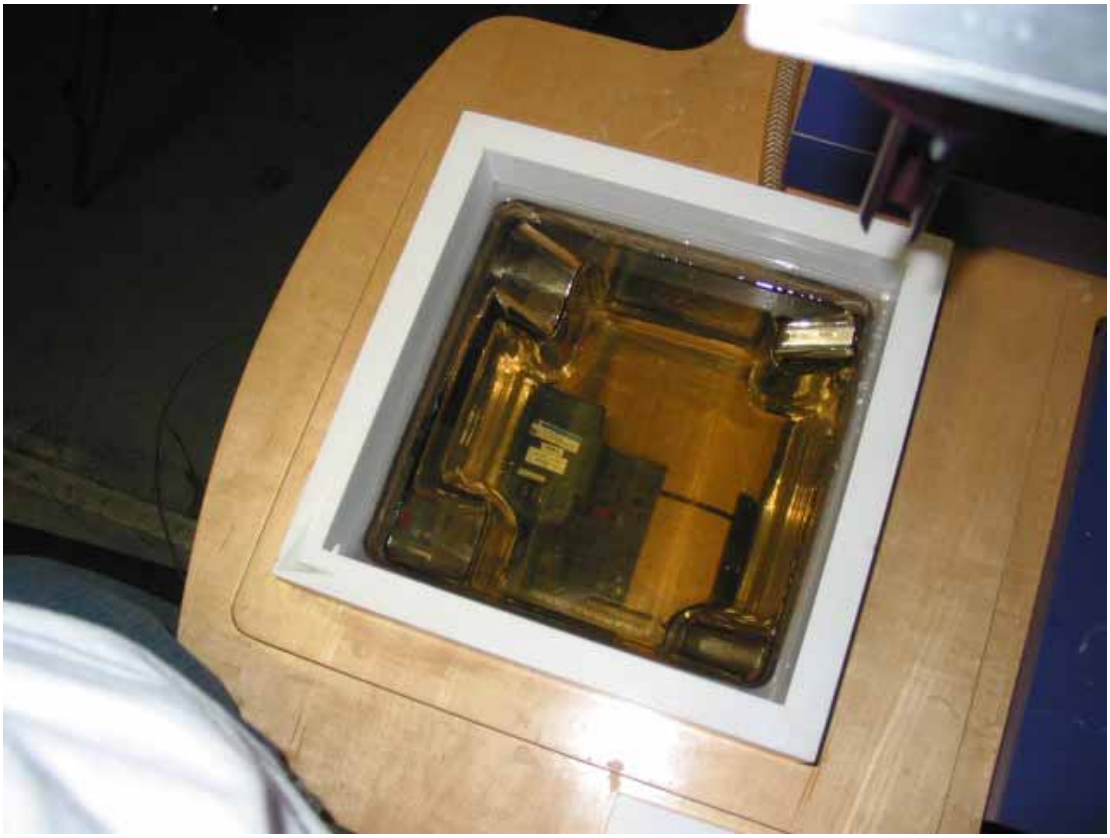

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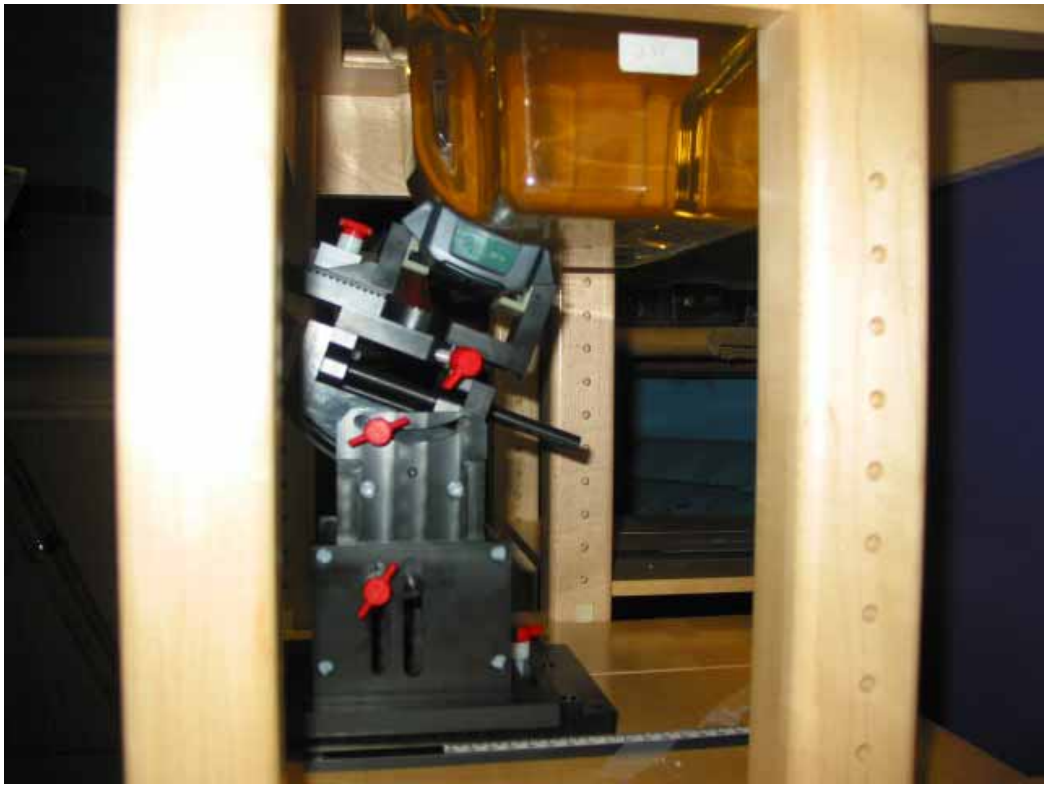

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Appendix A
SAR Plots

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SAR Test Report

Report Date : 22-May-2006
By Operator : Stuart Nicol
Measurement Date : 22-May-2006
Starting Time : 22-May-200 610:34:58 AM
End Time : 22-May-200 611:03:38 AM
Scanning Time : 1720 secs

Product Data
Device Name : OTD-Front
Serial No. : 0006284
Type : Other
Model : OTD
Frequency : Cellular 850
Max. Transmit Pwr : 2 W
Drift Time : 0 min(s)
Length : 85 mm
Width : 105 mm
Depth : 35 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.026 W/kg
Power Drift-Finish: 0.026 W/kg
Power Drift (%) : -2.179
Picture : OTD-Front

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Define Data

Tissue Data
Type : BODY
Serial No. : 835B
Frequency : 835.00 MHz
Last Calib. Date : 22-May-2006
Temperature : 22.00 °C
Ambient Temp. : 22.00 °C
Humidity : 55.00 RH%
Epsilon : 55.20 F/m
Sigma : 0.97 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : APREL Probe 212
Model : E020
Type : E-Field Triangle
Serial No. : 212
Last Calib. Date : 10-Mar-2006
Frequency : 835.00 MHz
Duty Cycle Factor: 8
Conversion Factor: 7
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

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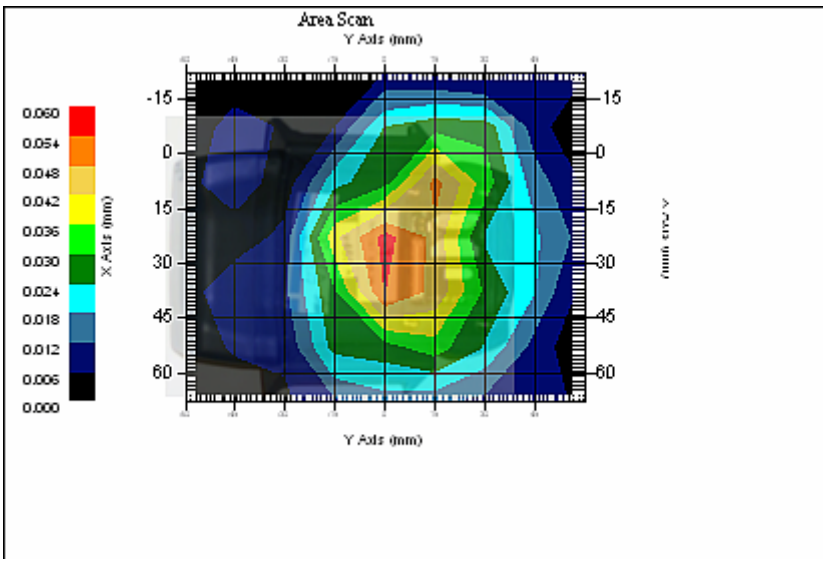
Measurement Data
Crest Factor : 8
Scan Type : Complete
Tissue Temp. : 23.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 08-Jun-2006
Set-up Time : 10:15:42 AM
Area Scan : 7x9x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Low - 824



10 gram SAR value : 0.031 W/kg
Zoom Scan Peak SAR : 0.070 W/kg

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Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	2.2	rectangular	•3	1	1	1.3	1.3
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	0.0	normal	1	0.7	0.5	0.0	0.0
Liquid Permittivity(target)	5.0	rectangular	•3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	0.0	normal	1	0.6	0.5	0.0	0.0
Combined Uncertainty		RSS				9.3	9.2
Combined Uncertainty (coverage factor=2)		Normal(k=2)				18.6	18.3

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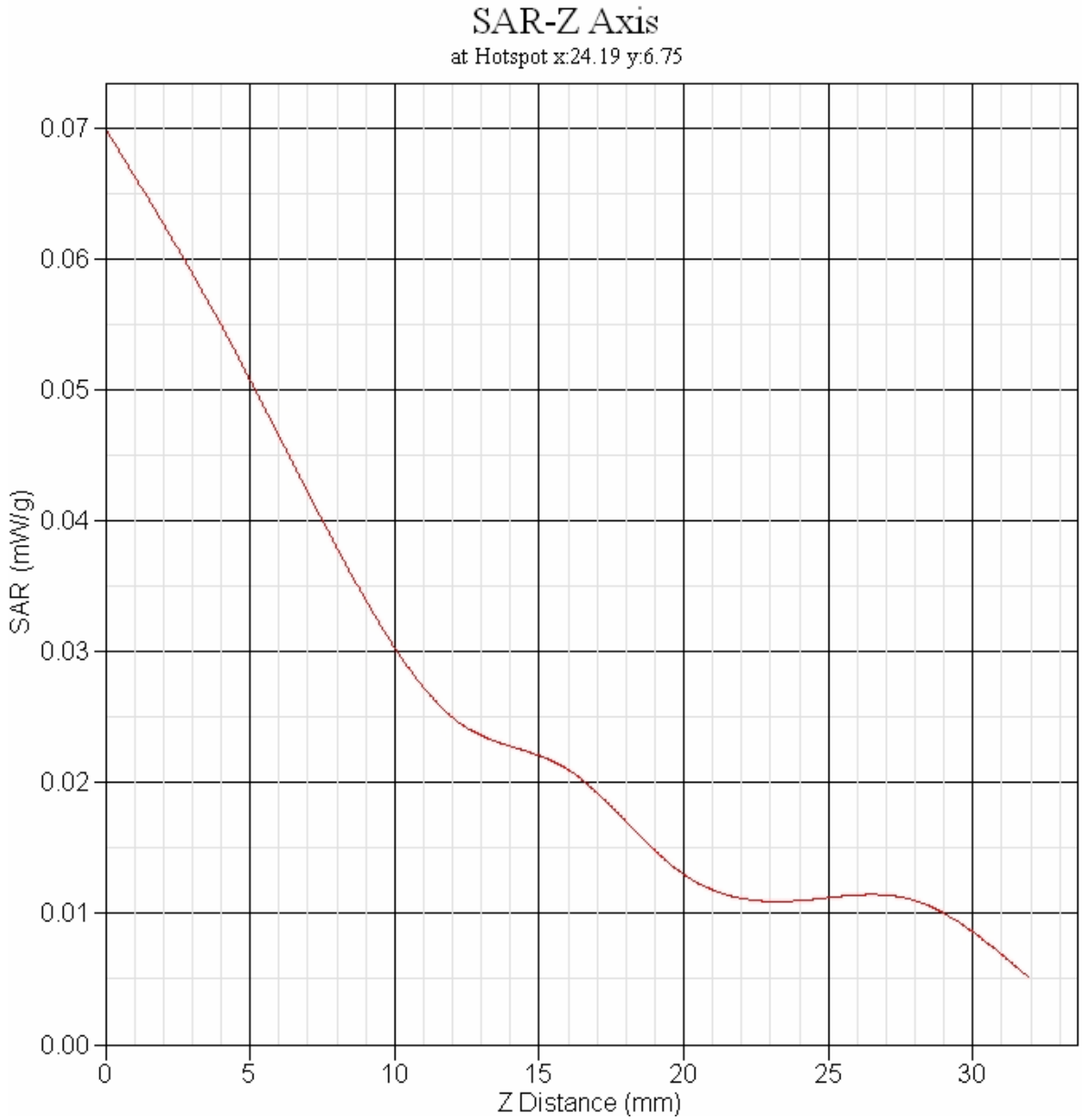

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SAR Test Report

Report Date : 22-May-2006
By Operator : 123
Measurement Date : 22-May-2006
Starting Time : 22-May-2006 11:10:22 AM
End Time : 22-May-2006 11:30:23 AM
Scanning Time : 1201 secs

Product Data
Device Name : OTD-Front
Serial No. : 0006284
Type : Other
Model : OTD
Frequency : Cellular 850
Max. Transmit Pwr : 2 W
Drift Time : 0 min(s)
Length : 85 mm
Width : 105 mm
Depth : 35 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.400 W/kg
Power Drift-Finish: 0.392 W/kg
Power Drift (%) : -2.114
Picture : OTD-Front

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Define Data

Tissue Data
Type : BODY
Serial No. : 835B
Frequency : 835.00 MHz
Last Calib. Date : 22-May-2006
Temperature : 22.00 °C
Ambient Temp. : 22.00 °C
Humidity : 55.00 RH%
Epsilon : 55.20 F/m
Sigma : 0.97 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : APREL Probe 212
Model : E020
Type : E-Field Triangle
Serial No. : 212
Last Calib. Date : 10-Mar-2006
Frequency : 835.00 MHz
Duty Cycle Factor: 8
Conversion Factor: 7
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

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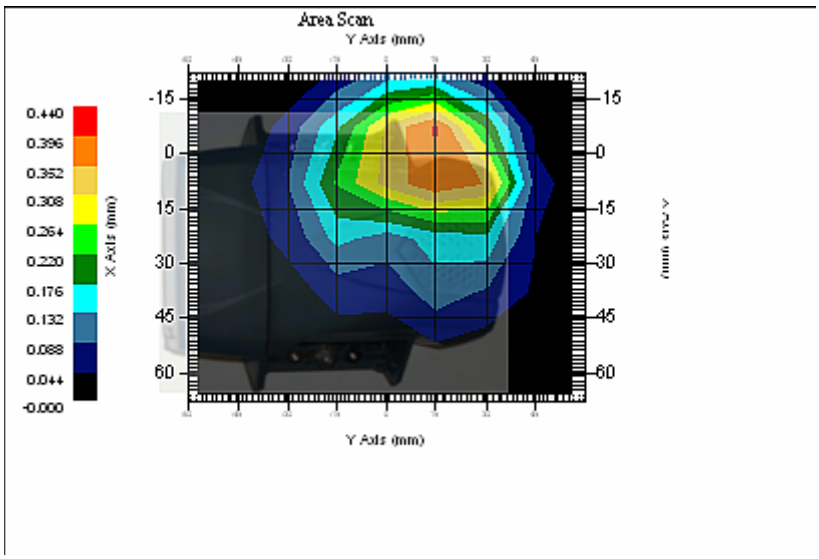
Measurement Data
Crest Factor : 8
Scan Type : Complete
Tissue Temp. : 23.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 22-May-2006
Set-up Time : 11:05:29 AM
Area Scan : 7x9x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Mid - 837



10 gram SAR value : 0.232 W/kg
Zoom Scan Peak SAR : 0.760 W/kg

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Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	2.1	rectangular	•3	1	1	1.2	1.2
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	0.0	normal	1	0.7	0.5	0.0	0.0
Liquid Permittivity(target)	5.0	rectangular	•3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	0.0	normal	1	0.6	0.5	0.0	0.0
Combined Uncertainty		RSS				9.3	9.1
Combined Uncertainty (coverage factor=2)		Normal(k=2)				18.6	18.3

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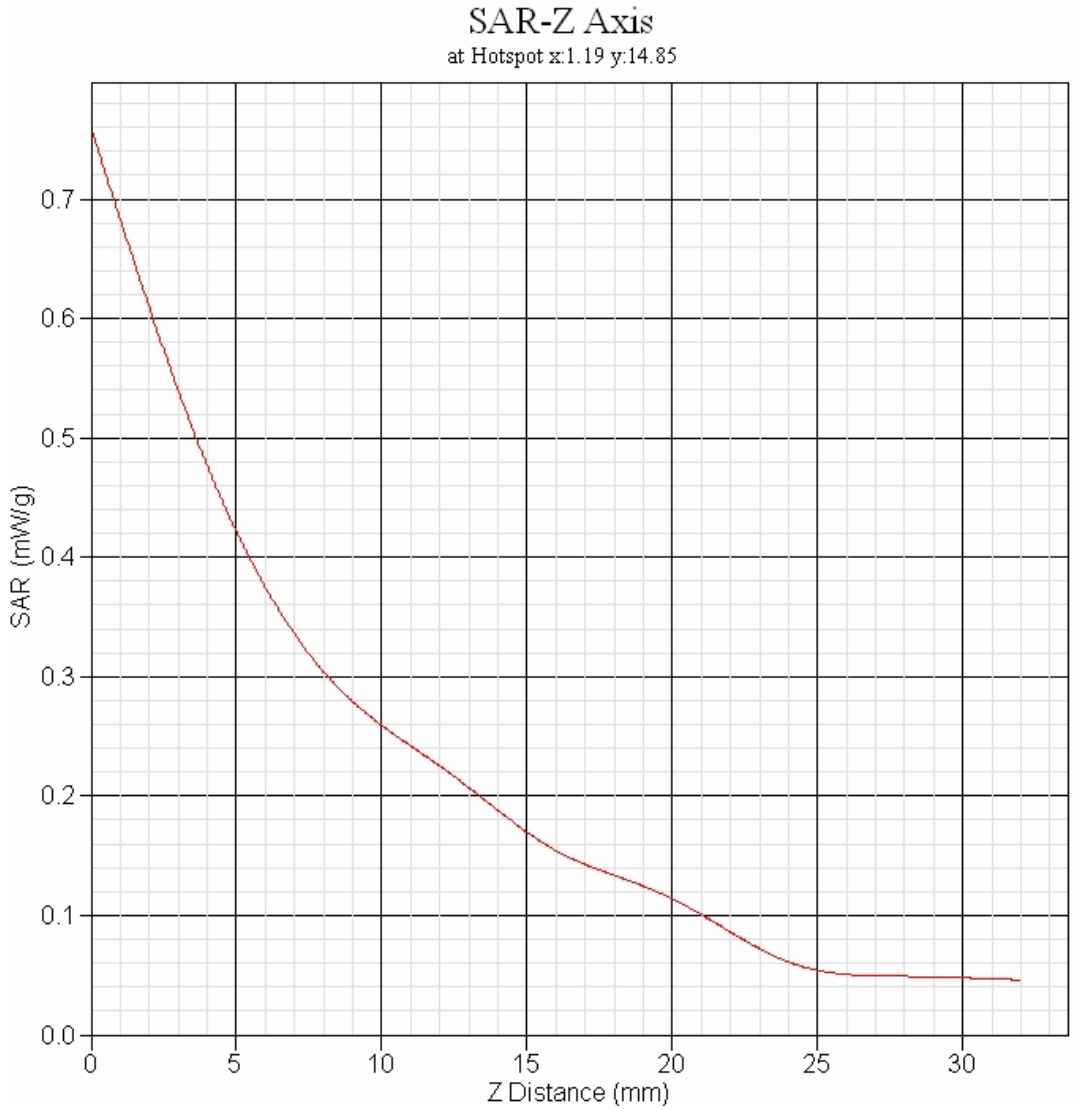

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SAR Test Report

Report Date : 23-May-2006
By Operator : Stuart Nicol
Measurement Date : 23-May-2006
Starting Time : 23-May-2006 09:35:25 AM
End Time : 23-May-2006 10:00:59 AM
Scanning Time : 1534 secs

Product Data
Device Name : OTD-Front
Serial No. : 0006284
Type : Other
Model : OTD
Frequency : PCS
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 85 mm
Width : 105 mm
Depth : 35 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.001 W/kg
Power Drift-Finish: 0.000 W/kg
Power Drift (%) : 0.000
Picture : OTD-Front

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Define Data

Tissue Data
Type : BODY
Serial No. : 1900
Frequency : 1900.00 MHz
Last Calib. Date : 07-Jun-2006
Temperature : 23.00 °C
Ambient Temp. : 25.00 °C
Humidity : 50.00 RH%
Epsilon : 52.13F/m
Sigma : 1.53 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : APREL Probe 212
Model : E020
Type : E-Field Triangle
Serial No. : 212
Last Calib. Date : 10-Mar-2006
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

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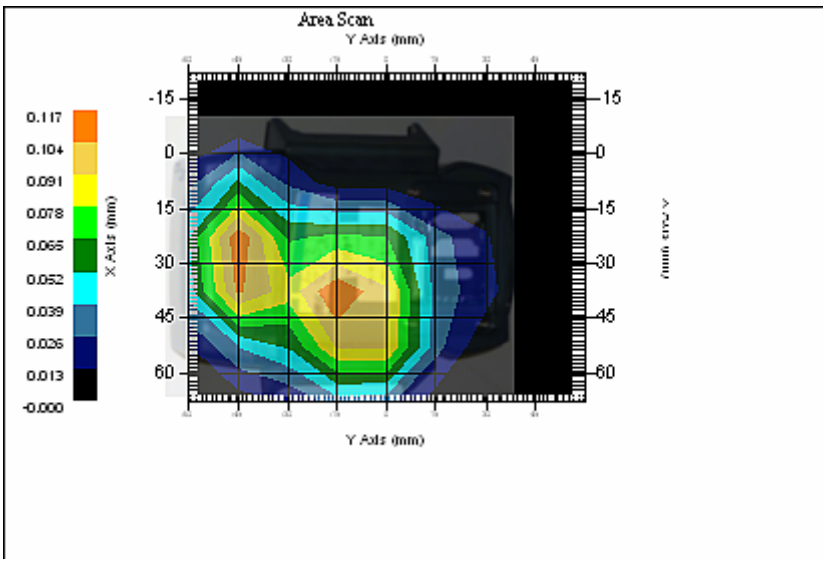
Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 23.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 23-May-2006
Set-up Time : 9:31:43 AM
Area Scan : 7x9x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Low - 1850



10 gram SAR value : 0.049 W/kg
Zoom Scan Peak SAR : 0.170 W/kg

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Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	0.0	rectangular	•3	1	1	0.0	0.0
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	3.9	normal	1	0.7	0.5	2.8	2.0
Liquid Permittivity(target)	5.0	rectangular	•3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	3.4	normal	1	0.6	0.5	2.04	1.7
Combined Uncertainty		RSS				10.54	8.5
Combined Uncertainty (coverage factor=2)		Normal(k=2)				21.08	17.0

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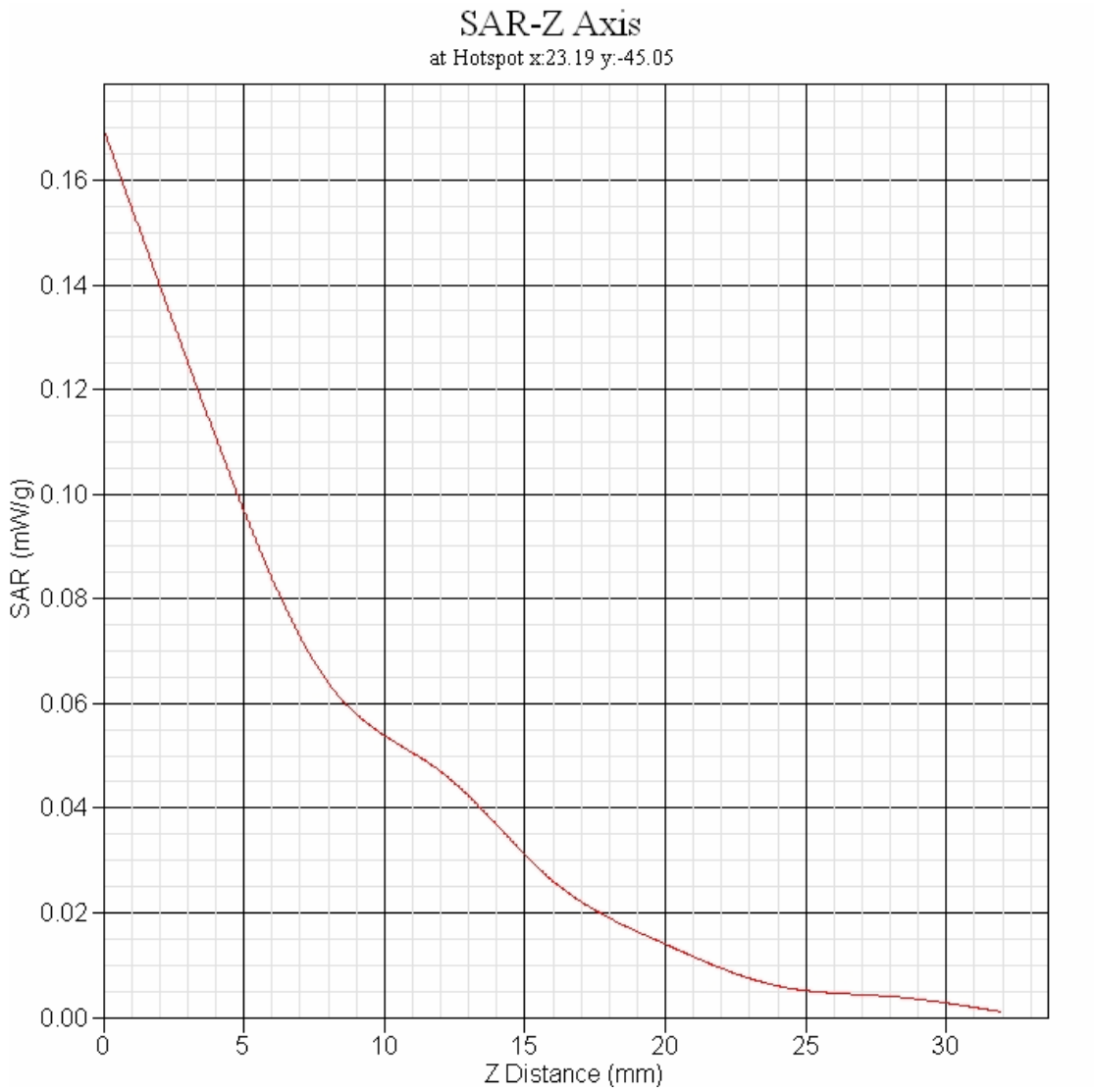

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SAR Test Report

Report Date : 23-May-2006
By Operator : Stuart Nicol
Measurement Date : 23-May-2006
Starting Time : 23-May-2006 04:40:05 PM
End Time : 23-May-2006 04:58:14 PM
Scanning Time : 1089 secs

Product Data
Device Name : OTD-Front
Serial No. : 0006284
Type : Other
Model : OTD
Frequency : 1900.00 MHz
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 85 mm
Width : 105 mm
Depth : 13 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.002 W/kg
Power Drift-Finish: 0.002 W/kg
Power Drift (%) : 17.733
Picture : OTD-Front

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Define Data

Tissue Data
Type : BODY
Serial No. : 1900
Frequency : 1900.00 MHz
Last Calib. Date : 23-May-2006
Temperature : 23.00 °C
Ambient Temp. : 25.00 °C
Humidity : 50.00 RH%
Epsilon : 52.13 F/m
Sigma : 1.53 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : APREL Probe 212
Model : E020
Type : E-Field Triangle
Serial No. : 212
Last Calib. Date : 10-Mar-2006
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

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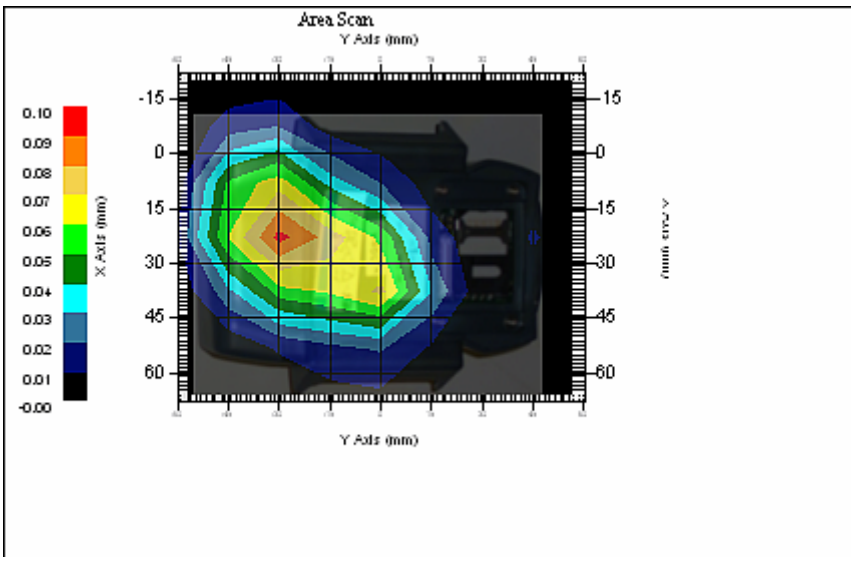
Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 23.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 23-May-2006
Set-up Time : 4:36:54 PM
Area Scan : 7x9x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Low - 1850



10 gram SAR value : 0.042 W/kg
Zoom Scan Peak SAR : 0.130 W/kg

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Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	17.7	rectangular	•3	1	1	10.2	10.2
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	3.9	normal	1	0.7	0.5	2.8	2.0
Liquid Permittivity(target)	5.0	rectangular	•3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	3.4	normal	1	0.6	0.5	2.04	1.7
Combined Uncertainty		RSS				10.54	8.5
Combined Uncertainty (coverage factor=2)		Normal(k=2)				21.08	17.0

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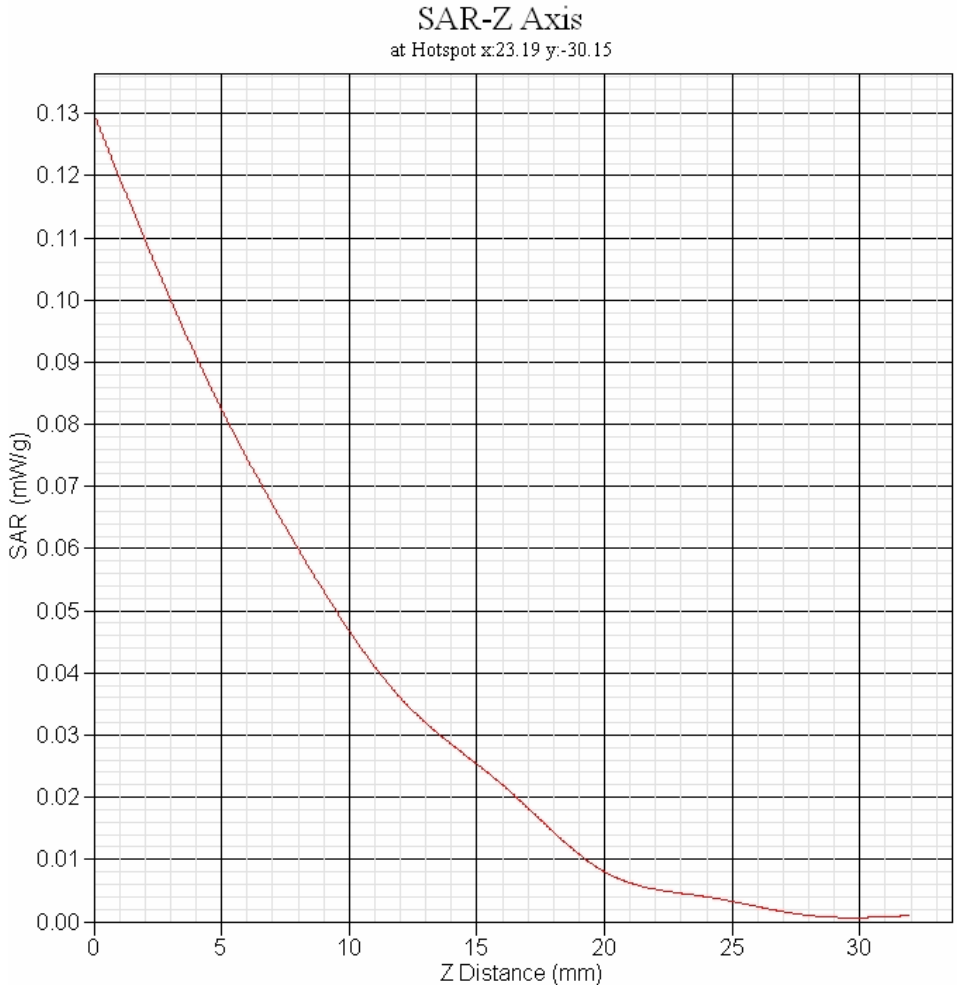

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SAR Test Report

Report Date : 23-May-2006
By Operator : Stuart Nicol
Measurement Date : 23-May-2006
Starting Time : 23-May-2006 04:13:35 PM
End Time : 23-May-2006 04:32:03 PM
Scanning Time : 1108 secs

Product Data
Device Name : OTD-Front
Serial No. : 0006284
Type : Other
Model : OTD
Frequency : PCS
Max. Transmit Pwr : 1 W
Drift Time : 0 min(s)
Length : 85 mm
Width : 105 mm
Depth : 35 mm
Antenna Type : Internal
Orientation : Touch
Power Drift-Start : 0.698 W/kg
Power Drift-Finish: 0.708 W/kg
Power Drift (%) : 1.424
Picture : OTD-Front

Phantom Data
Name : APREL-Uni
Type : Uni-Phantom
Size (mm) : 280 x 280 x 200
Serial No. : User Define
Location : Center
Description : User Define Data

Tissue Data
Type : BODY
Serial No. : 1900
Frequency : 1900.00 MHz
Last Calib. Date : 23-May-2006
Temperature : 23.00 °C
Ambient Temp. : 25.00 °C
Humidity : 50.00 RH%
Epsilon : 52.13 F/m
Sigma : 1.53 S/m
Density : 1000.00 kg/cu. m

Probe Data
Name : APREL Probe 212
Model : E020
Type : E-Field Triangle
Serial No. : 212
Last Calib. Date : 10-Mar-2006
Frequency : 1900.00 MHz
Duty Cycle Factor: 1
Conversion Factor: 5.6
Probe Sensitivity: 1.20 1.20 1.20 $\mu V/(V/m)^2$
Compression Point: 95.00 mV
Offset : 1.56 mm

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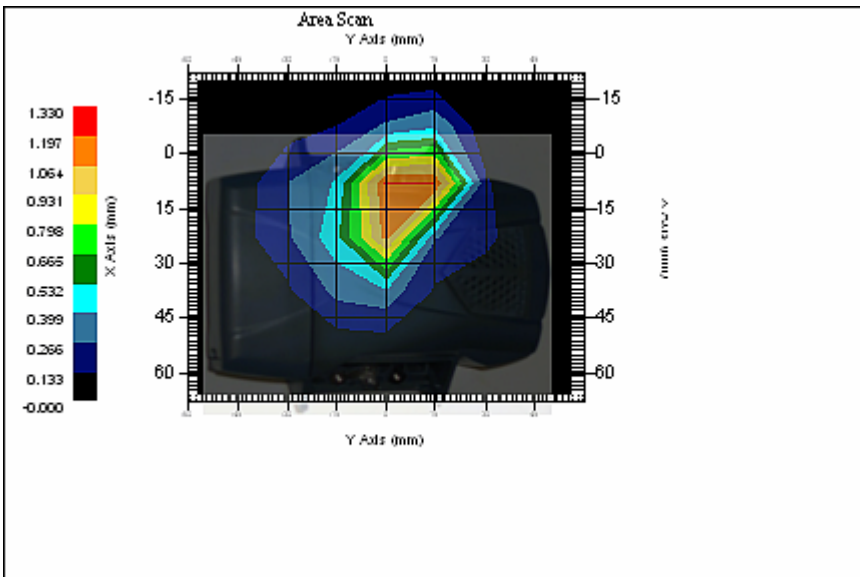
Measurement Data
Crest Factor : 1
Scan Type : Complete
Tissue Temp. : 23.00 °C
Ambient Temp. : 23.00 °C
Set-up Date : 23-May-2006
Set-up Time : 4:02:06 PM
Area Scan : 7x9x1 : Measurement x=15mm, y=15mm, z=4mm
Zoom Scan : 5x5x8 : Measurement x=8mm, y=8mm, z=4mm

Other Data
DUT Position : Touch
Separation : 0
Channel : Mid - 1850



10 gram SAR value : 0.693 W/kg
Zoom Scan Peak SAR : 2.081 W/kg

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Exposure Assessment Measurement Uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i^1 (1-g)	c_i^1 (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %
Measurement System							
Probe Calibration	3.5	normal	1	1	1	3.5	3.5
Axial Isotropy	3.7	rectangular	•3	$(1-cp)^{1/2}$	$(1-cp)^{1/2}$	1.5	1.5
Hemispherical Isotropy	10.9	rectangular	•3	•cp	•cp	4.4	4.4
Boundary Effect	1.0	rectangular	•3	1	1	0.6	0.6
Linearity	4.7	rectangular	•3	1	1	2.7	2.7
Detection Limit	1.0	rectangular	•3	1	1	0.6	0.6
Readout Electronics	1.0	normal	1	1	1	1.0	1.0
Response Time	0.8	rectangular	•3	1	1	0.5	0.5
Integration Time	1.7	rectangular	•3	1	1	1.0	1.0
RF Ambient Condition	3.0	rectangular	•3	1	1	1.7	1.7
Probe Positioner Mech.	0.4	rectangular	•3	1	1	0.2	0.2
Restriction							
Probe Positioning with respect to Phantom Shell	2.9	rectangular	•3	1	1	1.7	1.7
Extrapolation and Integration	3.7	rectangular	•3	1	1	2.1	2.1
Test Sample Positioning	4.0	normal	1	1	1	4.0	4.0
Device Holder Uncertainty	2.0	normal	1	1	1	2.0	2.0
Drift of Output Power	1.4	rectangular	•3	1	1	0.8	0.8
Phantom and Setup							
Phantom Uncertainty(shape & thickness tolerance)	3.4	rectangular	•3	1	1	2.0	2.0
Liquid Conductivity(target)	5.0	rectangular	•3	0.7	0.5	2.0	1.4
Liquid Conductivity(meas.)	3.9	normal	1	0.7	0.5	2.8	2.0
Liquid Permittivity(target)	5.0	rectangular	•3	0.6	0.5	1.7	1.4
Liquid Permittivity(meas.)	3.4	normal	1	0.6	0.5	2.04	1.7
Combined Uncertainty		RSS				10.54	8.5
Combined Uncertainty (coverage factor=2)		Normal(k=2)				21.08	17.0

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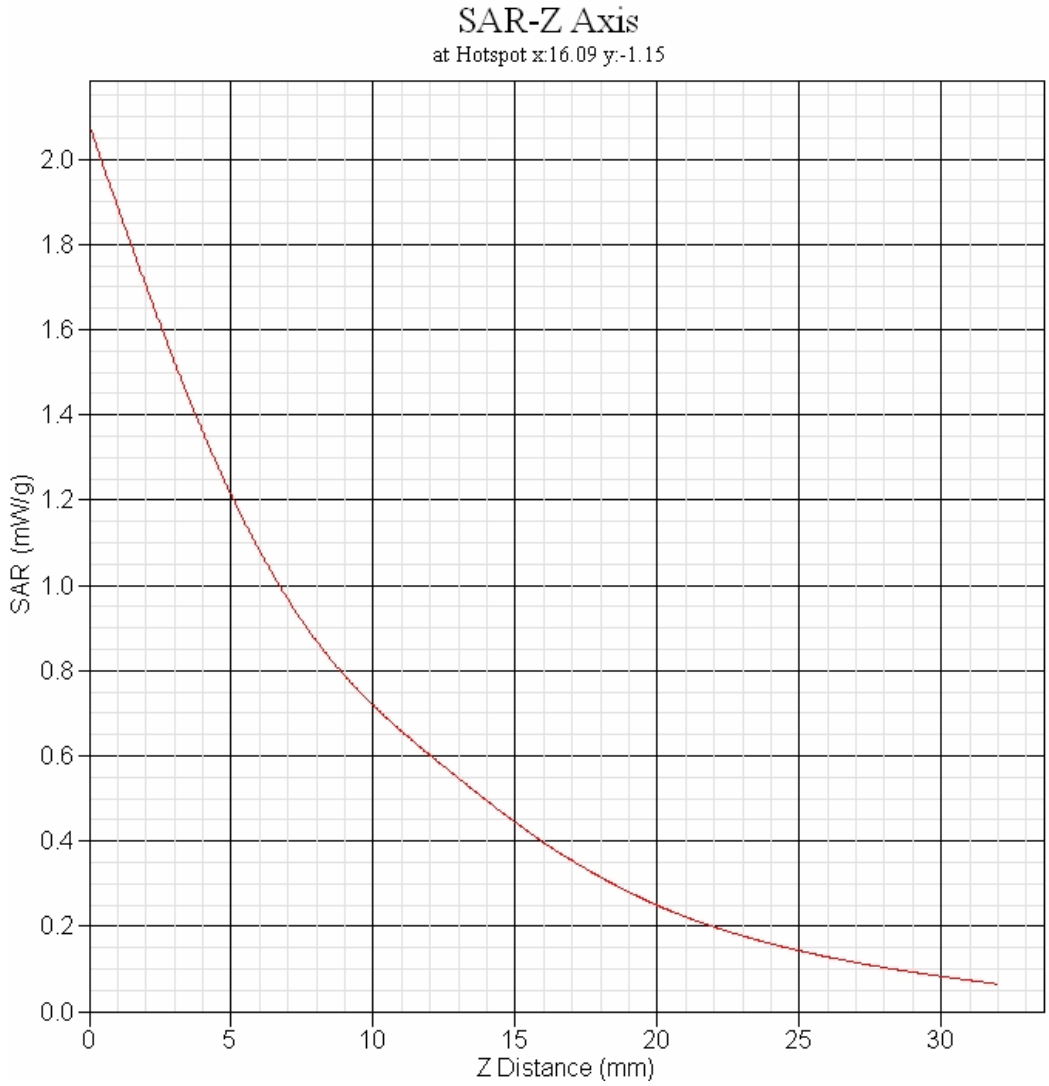

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Calibration Reports

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NCL CALIBRATION LABORATORIES

Calibration File No.: CP-474

Client.: APREL

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 835 MHz

Manufacturer: APREL Laboratories
Model No.: E-020
Serial No.: 212

BODY Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2
Project No: Internal

Calibrated: 10th March 2006
Released on: 10th March 2006

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

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Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 212.

References

SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”
SSI-TP-011 Tissue Calibration Procedure

1.1.1.1.1

1.1.1.1.2 Conditions

Probe 212 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

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We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

Director Product Development

Y. Chen

Member of Engineering Staff

(Calibration Engineer)

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Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	212
Frequency:	835 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte*
Tip Diameter:	<5 mm
Tip Length:	60 mm
Total Length:	290 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu V/(V/m)^2$
Channel Y:	1.2 $\mu V/(V/m)^2$
Channel Z:	1.2 $\mu V/(V/m)^2$
Diode Compression Point:	95 mV

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Sensitivity in Body Tissue

Frequency: 835 MHz

Epsilon: 56.1 (+/-5%) **Sigma:** 0.95 S/m (+/-10%)

ConvF

Channel X: 7.0

Channel Y: 7.0

Channel Z: 7.0

Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

Spatial Resolution:

The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

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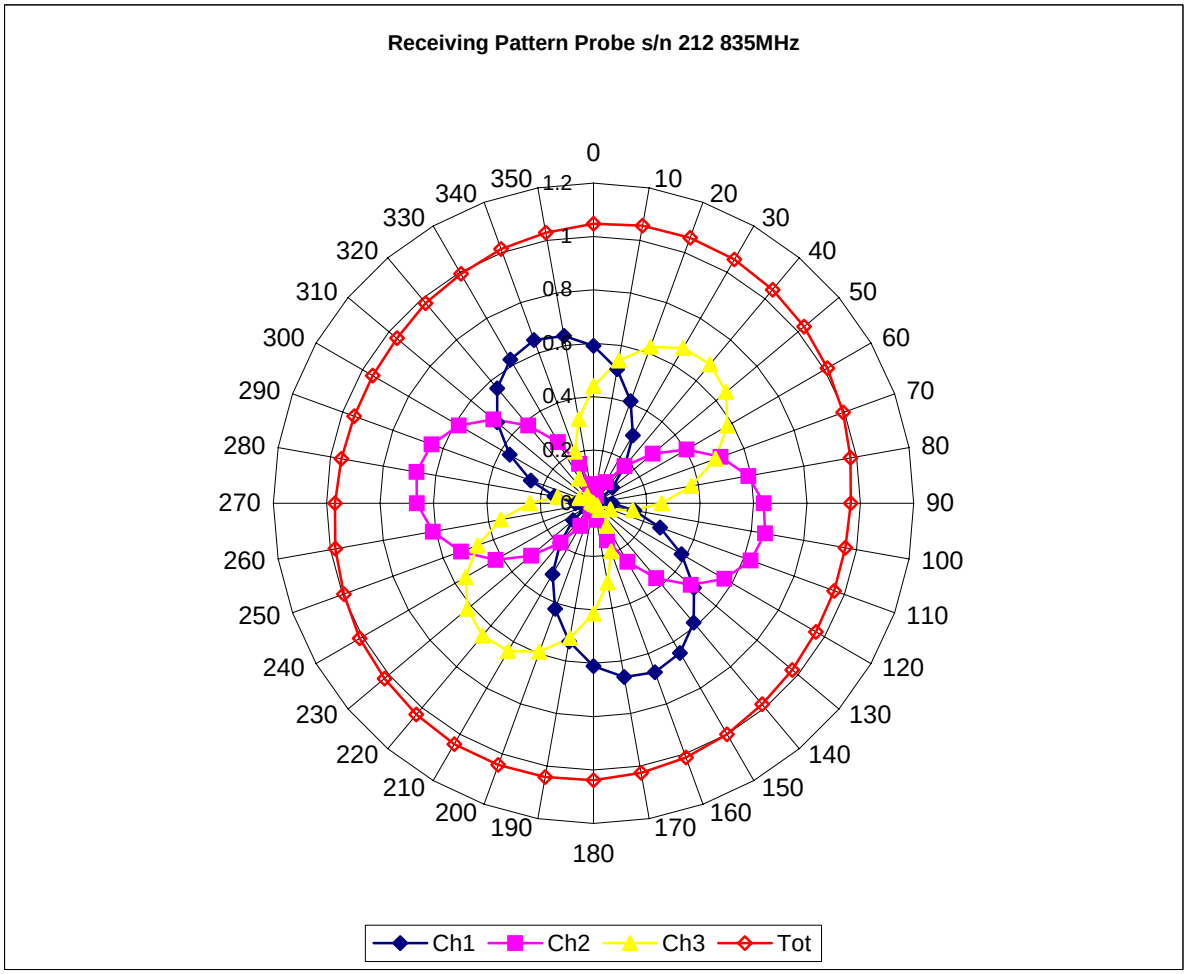
Receiving Pattern 835 MHz (Air)



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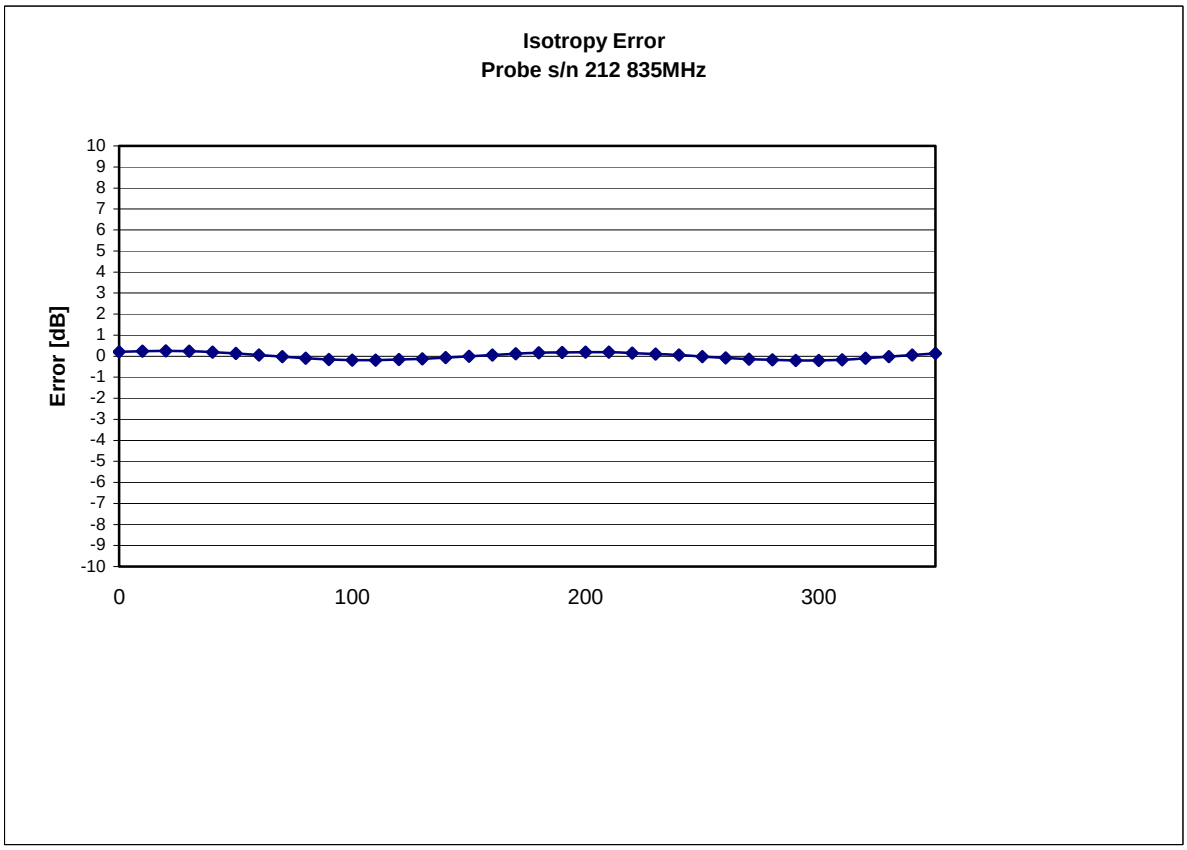
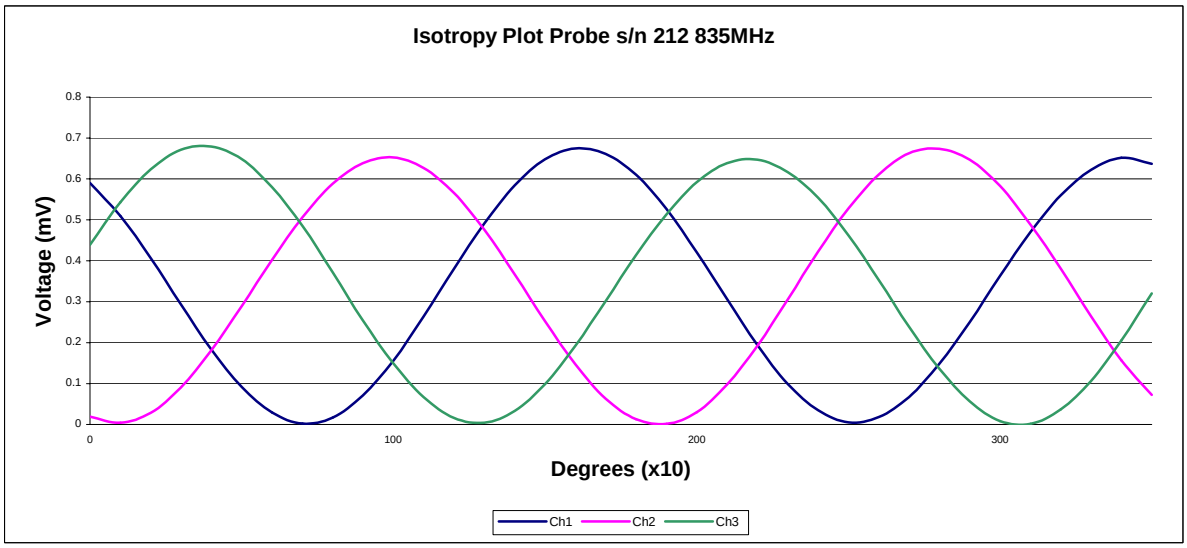
Isotropy Error 835 MHz (Air)





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Isotropicity in Tissue: 0.10 dB

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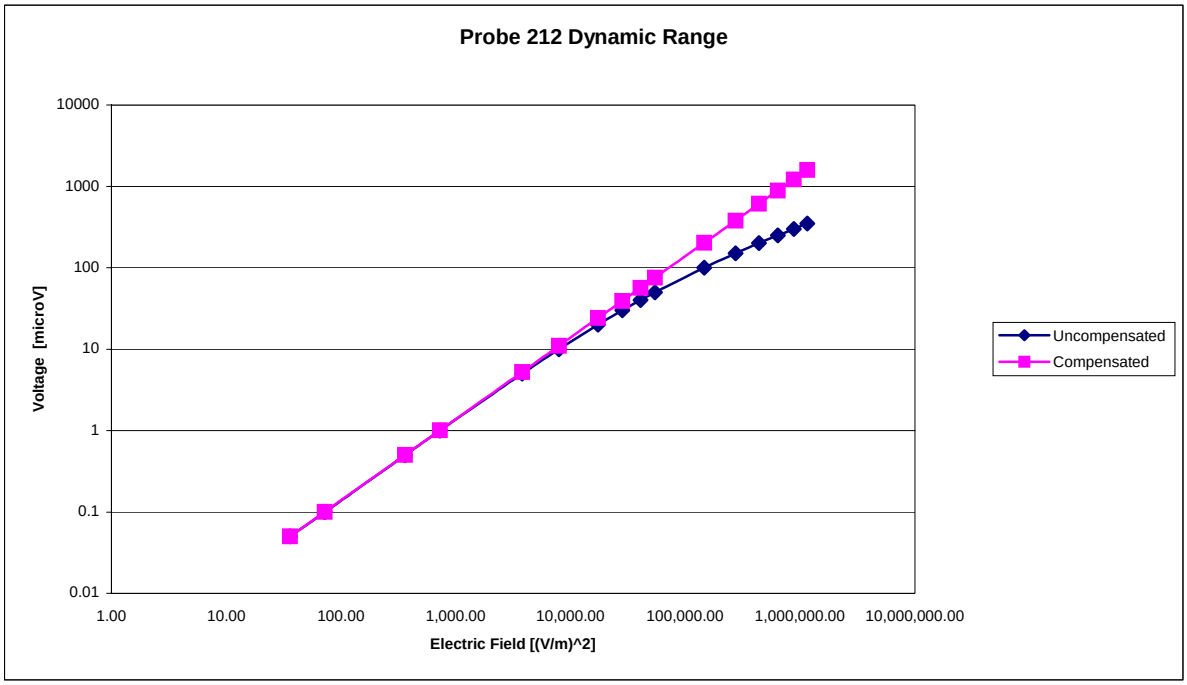
Dynamic Range



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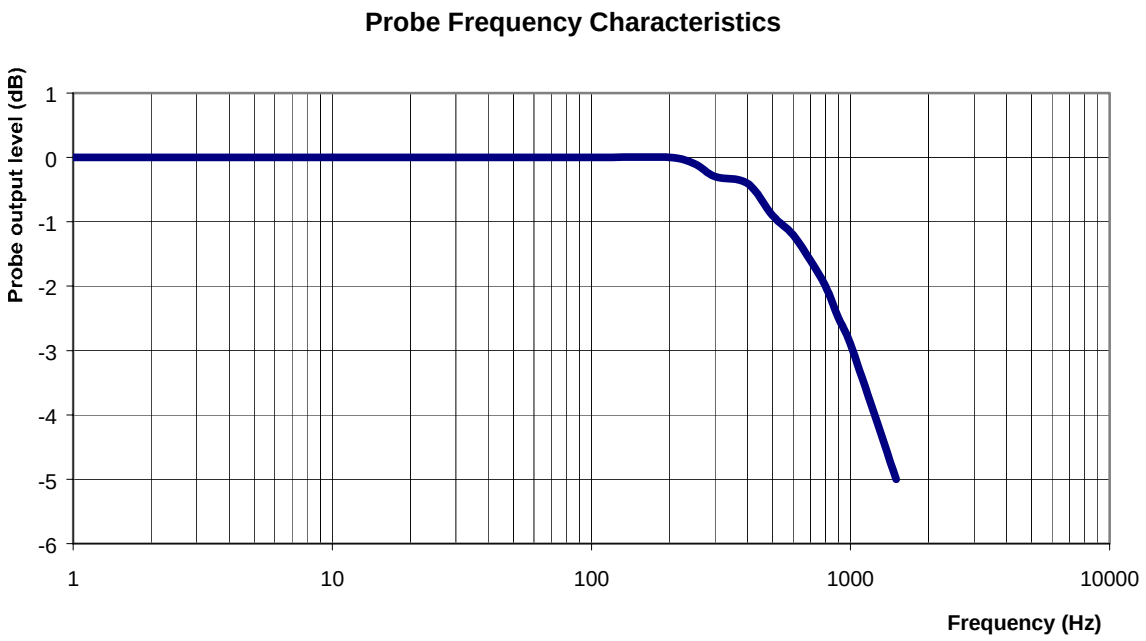
Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

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Conversion Factor Uncertainty Assessment

Frequency:		835MHz	
Epsilon:	56.1 (+/-5%)	**Sigma:**	0.95 S/m (+/-10%)
ConvF			
Channel X:	7.0	7%(K=2)	
Channel Y:	7.0	7%(K=2)	
Channel Z:	7..0	7%(K=2)	

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Boundary Effect:

For a distance of 2.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

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Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2004.

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NCL CALIBRATION LABORATORIES

Calibration File No.: CP-317

Client.: APREL LABORATORIES

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 1900 MHz

Manufacturer: APREL Laboratories
Model No.: E-020
Serial No.: 212

BODY Calibration

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2
Project No: Internal

Calibrated: 10th March 2006
Released on: 10th March 2006

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
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CANADA K2R 1E6

Division of APREL Lab.
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Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 212.

References

SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”
SSI-TP-011 Tissue Calibration Procedure

Conditions

Probe 212 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

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We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

Director Product Development

Y. Chen

Member of Engineering Staff

(Calibration Engineer)

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Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	212
Frequency:	1900 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte*
Tip Diameter:	<5 mm
Tip Length:	60 mm
Total Length:	290 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu V/(V/m)^2$
Channel Y:	1.2 $\mu V/(V/m)^2$
Channel Z:	1.2 $\mu V/(V/m)^2$
Diode Compression Point:	95 mV

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Sensitivity in Body Tissue

Frequency: 1900 MHz

Epsilon: 53.3 (+/-5%) **Sigma:** 1.52 S/m (+/-10%)

ConvF

Channel X: 5.6

Channel Y: 5.6

Channel Z: 5.6

Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

Spatial Resolution:

The measured probe tip diameter is 5 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

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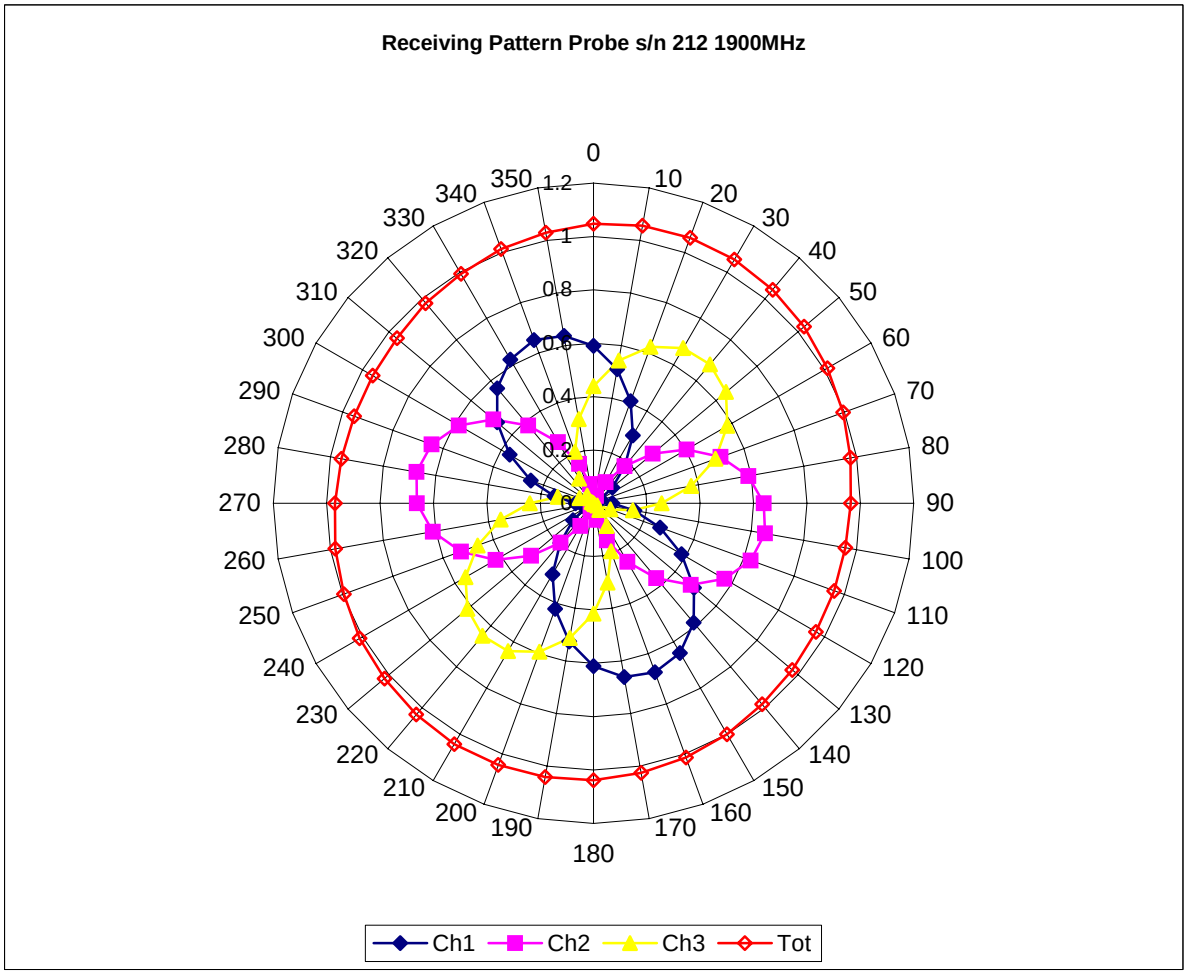
Receiving Pattern 1900 MHz (Air)



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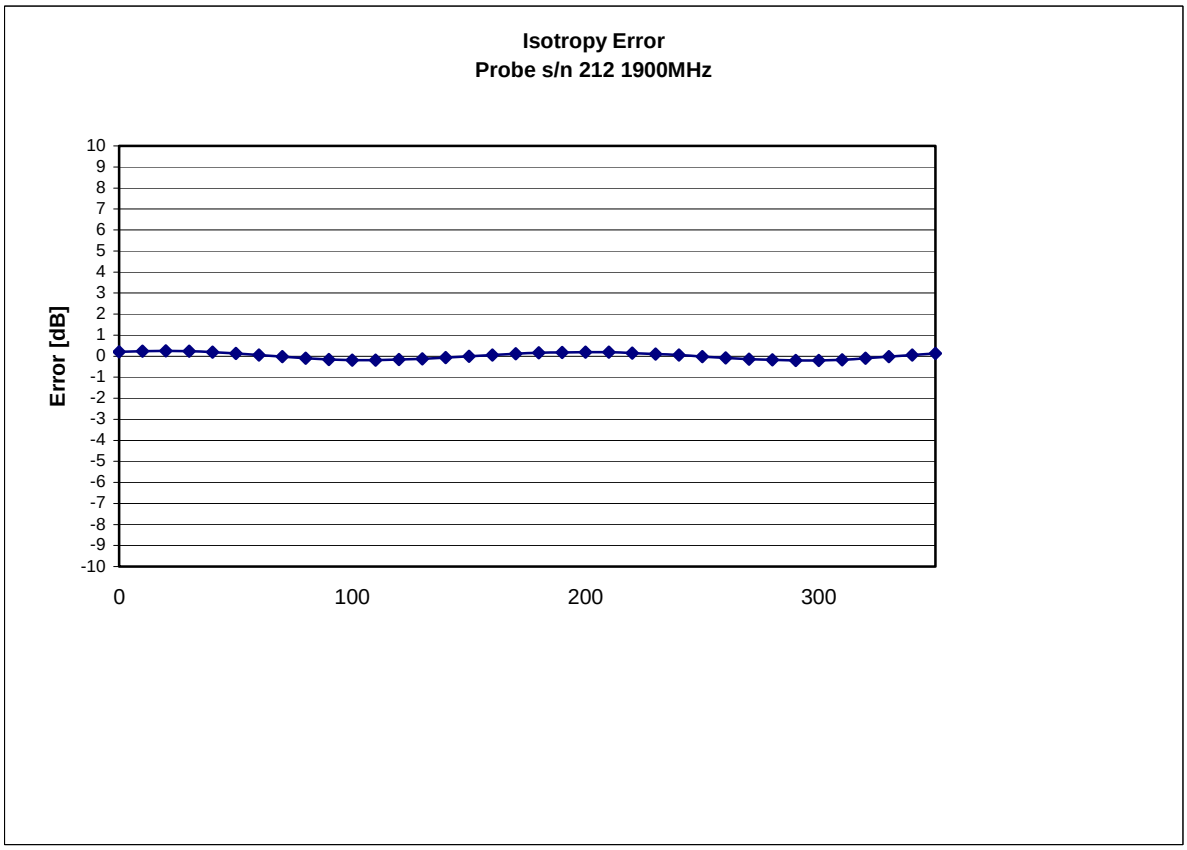
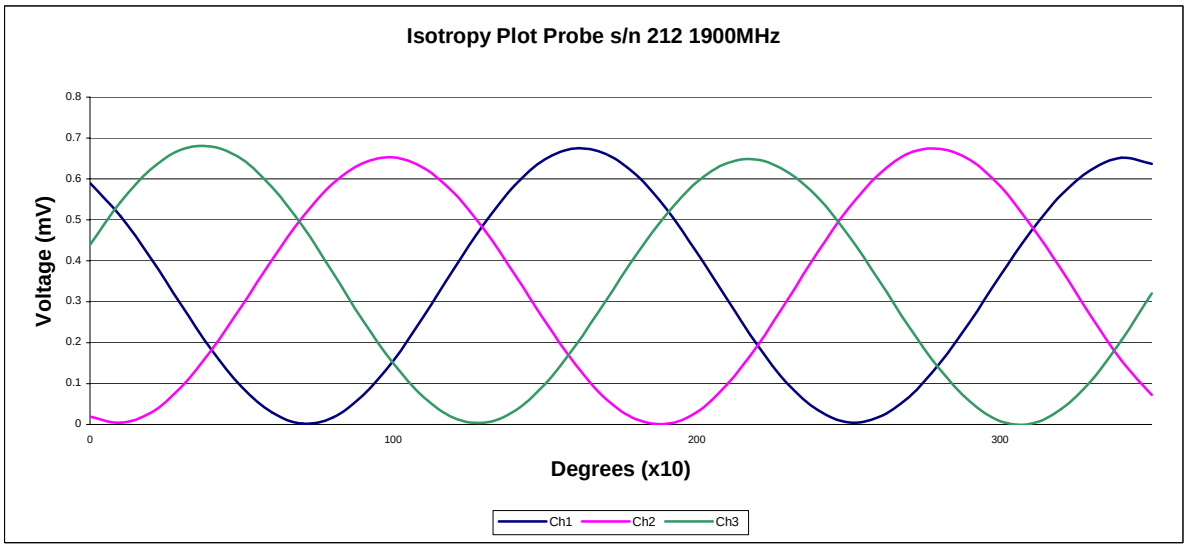
Isotropy Error 1900 MHz (Air)





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Isotropicity in Tissue: 0.10 dB

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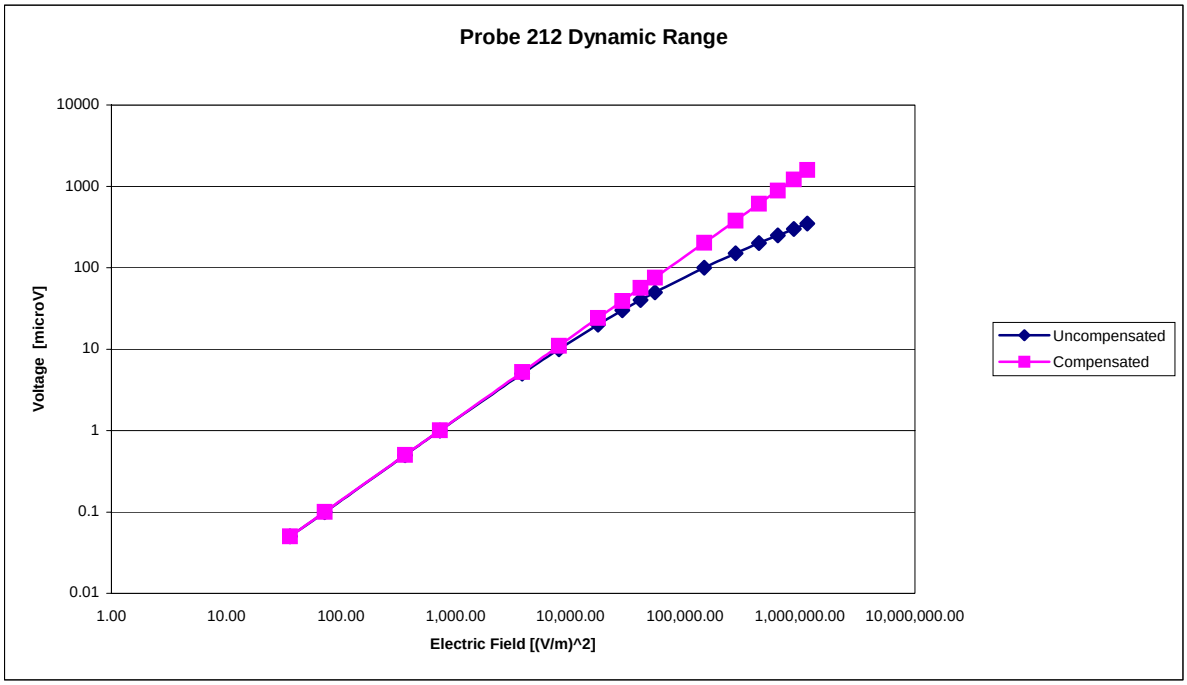
Dynamic Range



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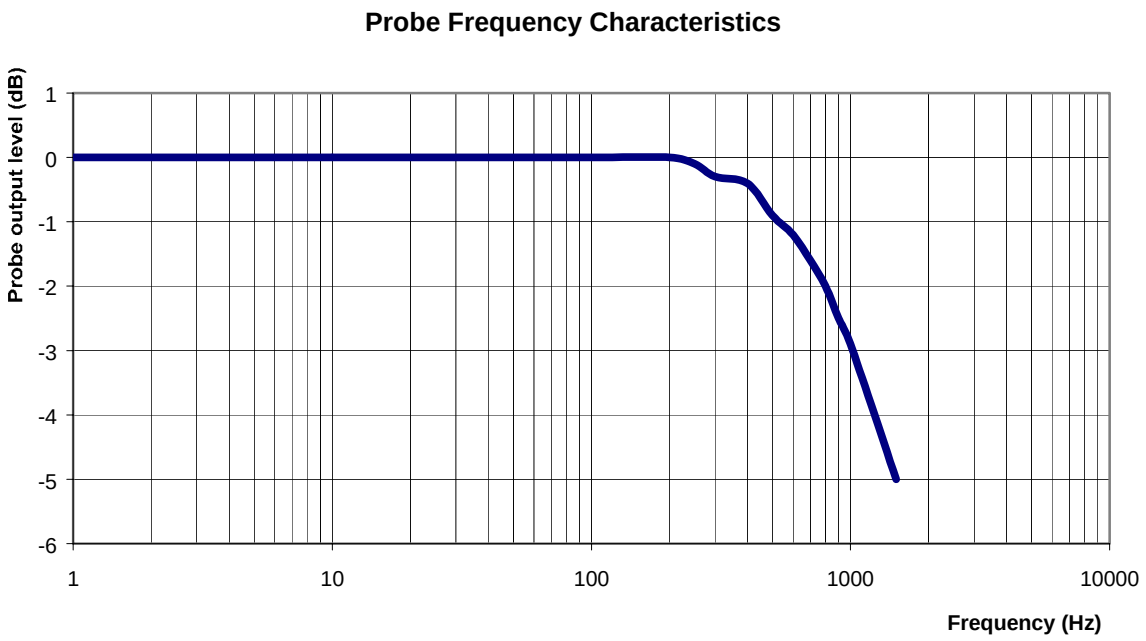
Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

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Conversion Factor Uncertainty Assessment

Frequency:		1900MHz	
Epsilon:	53.3 (+/-5%)	**Sigma:**	1.52 S/m (+/-10%)
ConvF			
Channel X:	5.6	7%(K=2)	
Channel Y:	5.6	7%(K=2)	
Channel Z:	5.6	7%(K=2)	

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Boundary Effect:

For a distance of 2.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

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Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2004.

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Appendix C
Dipole Calibration Certificate

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NCL CALIBRATION LABORATORIES

Calibration File No: DC-315
Project Number: Internal Project

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

APREL Laboratories Validation Dipole

Manufacturer: APREL Laboratories
Part number: ALS-D-835-S-2
Frequency: 835 MHz
Serial No: AL-CD07

Customer: APREL Laboratories

Calibrated: 5th November 2005
Released on: 5th November 2005

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

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Conditions

Dipole AL-CD07 was new and taken from stock prior to calibration.

Ambient Temperature of the Laboratory:	22 °C +/- 0.5°C
Temperature of the Tissue:	21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

Director Product Development

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Y. Chen

Member of Engineering Staff

(Calibration Engineer)

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Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

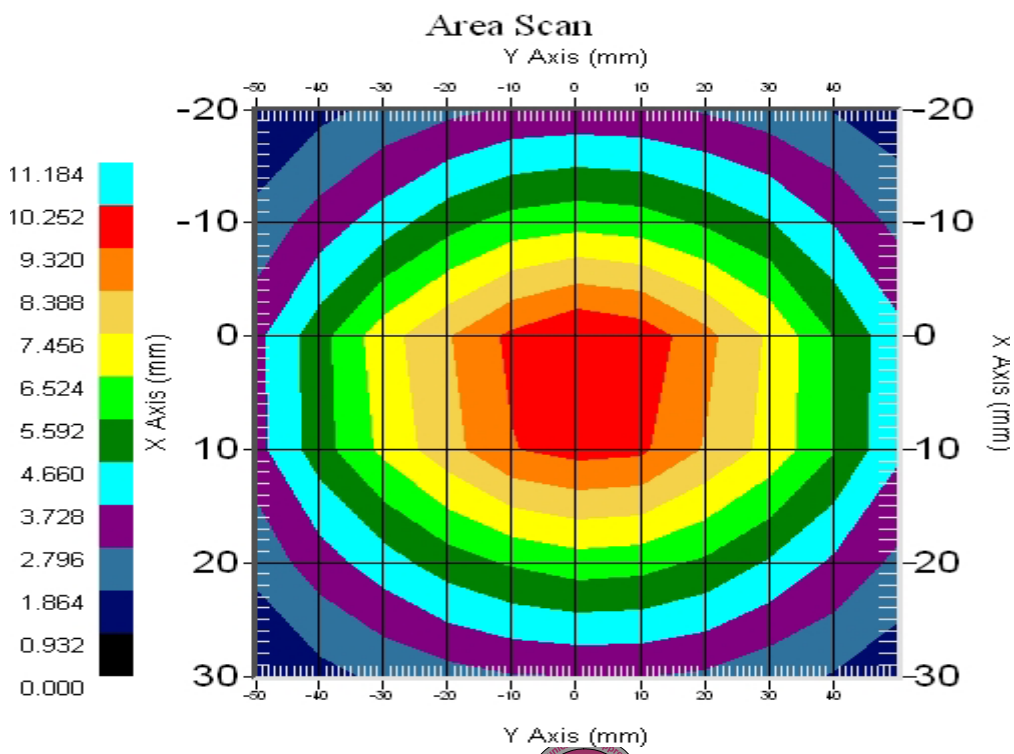
Length: 161.0 mm
Height: 89.8 mm

Electrical Specification

SWR: 1.06 U
Return Loss: -32.0 dB
Impedance: 49.9 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
835 MHz	9.49	6.1	14.21



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Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole AL-CD07. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure
SSI-TP-016 Tissue Calibration Procedure
IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

Conditions

Dipole AL-CD07 was new taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

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Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
161.0 mm	89.8 mm	162.2 mm	90.2 mm

Tissue Validation

Head Tissue 835MHz	Measured
Dielectric constant, ε_r	41.5
Conductivity, σ [S/m]	0.90

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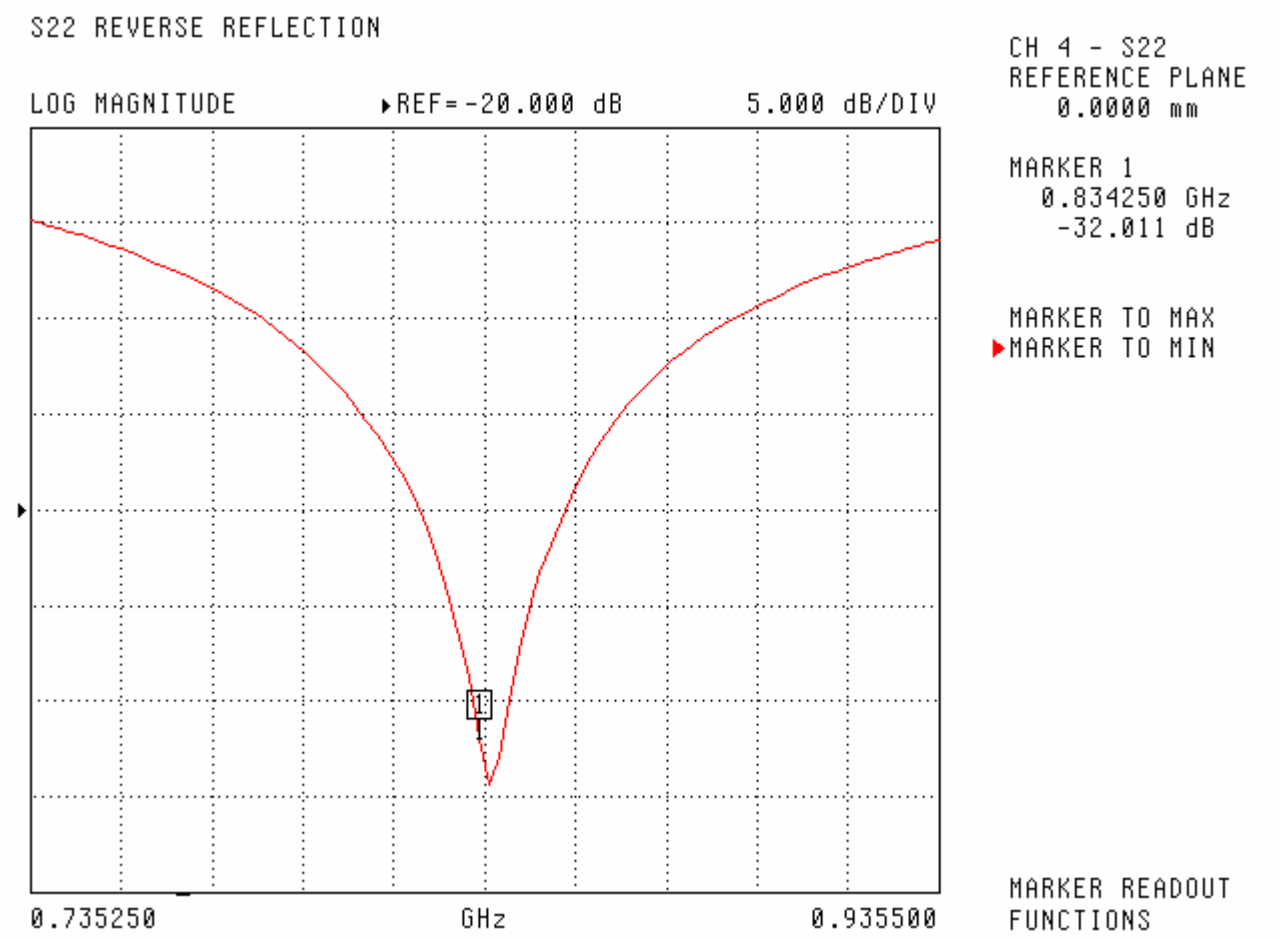
Electrical Calibration

Test	Result
S11 R/L	-32.0 dB
SWR	1.06 U
Impedance	49.9 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

S11 Parameter Return Loss



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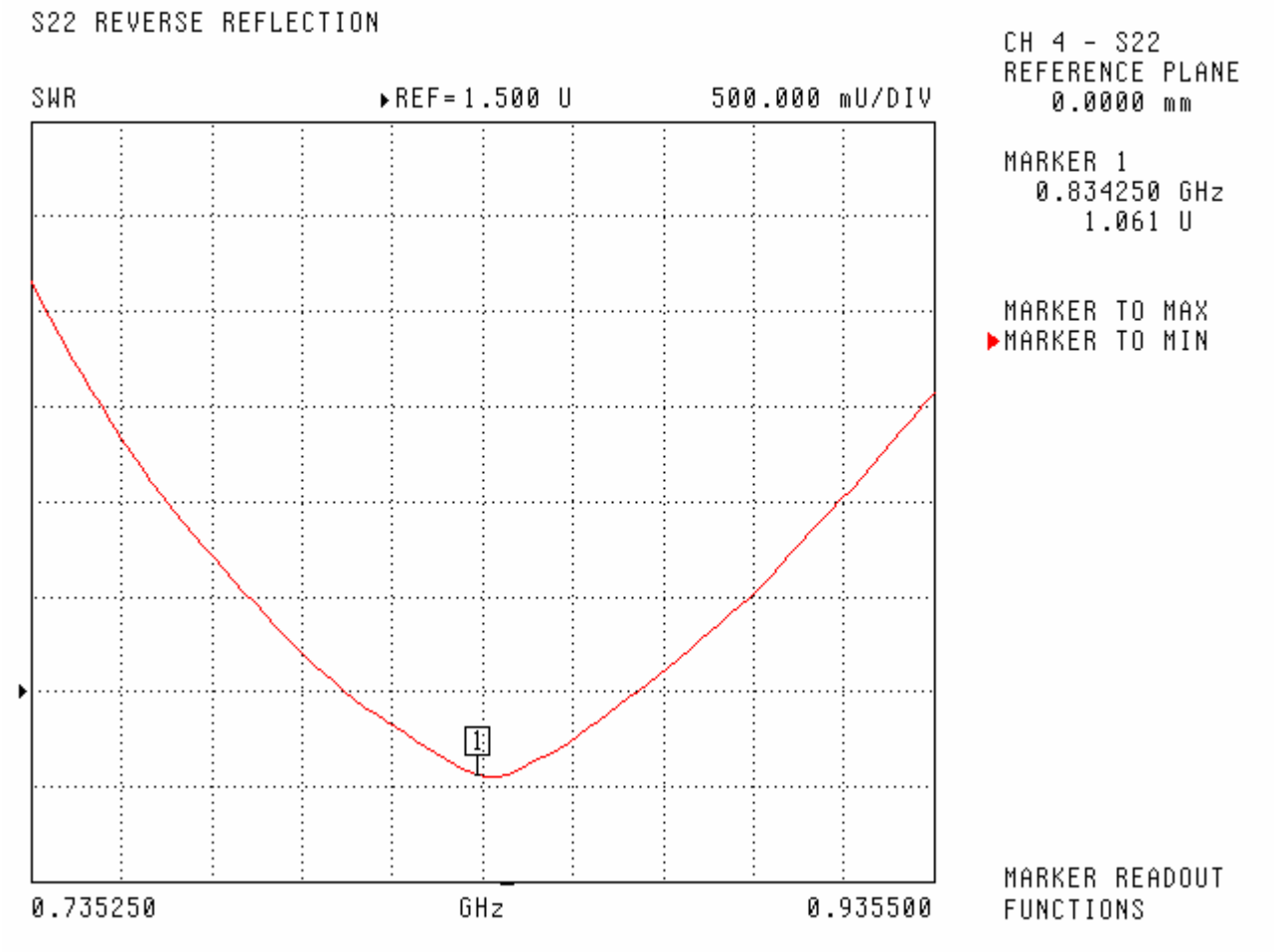
SWR



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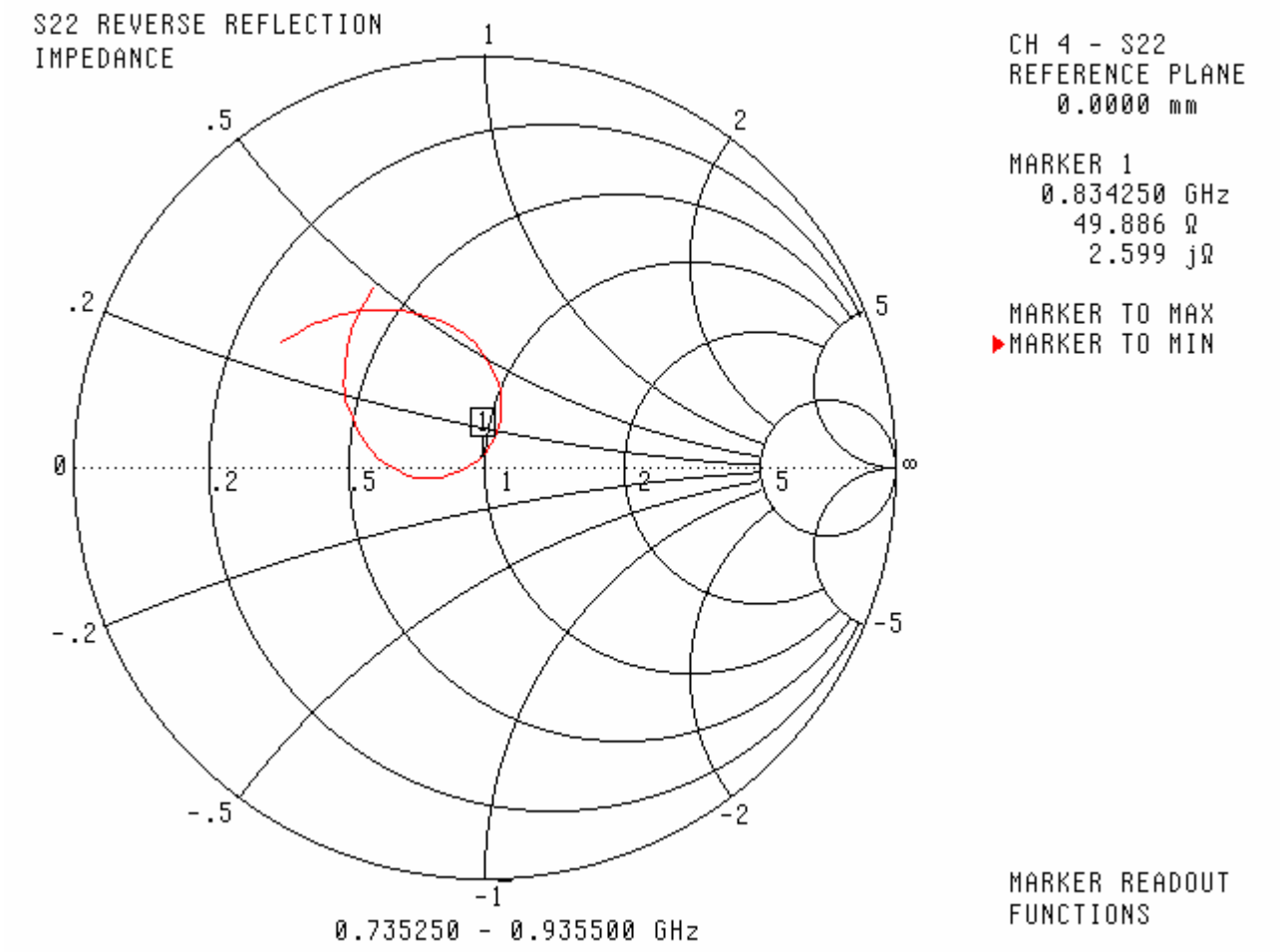
Smith Chart Dipole Impedance



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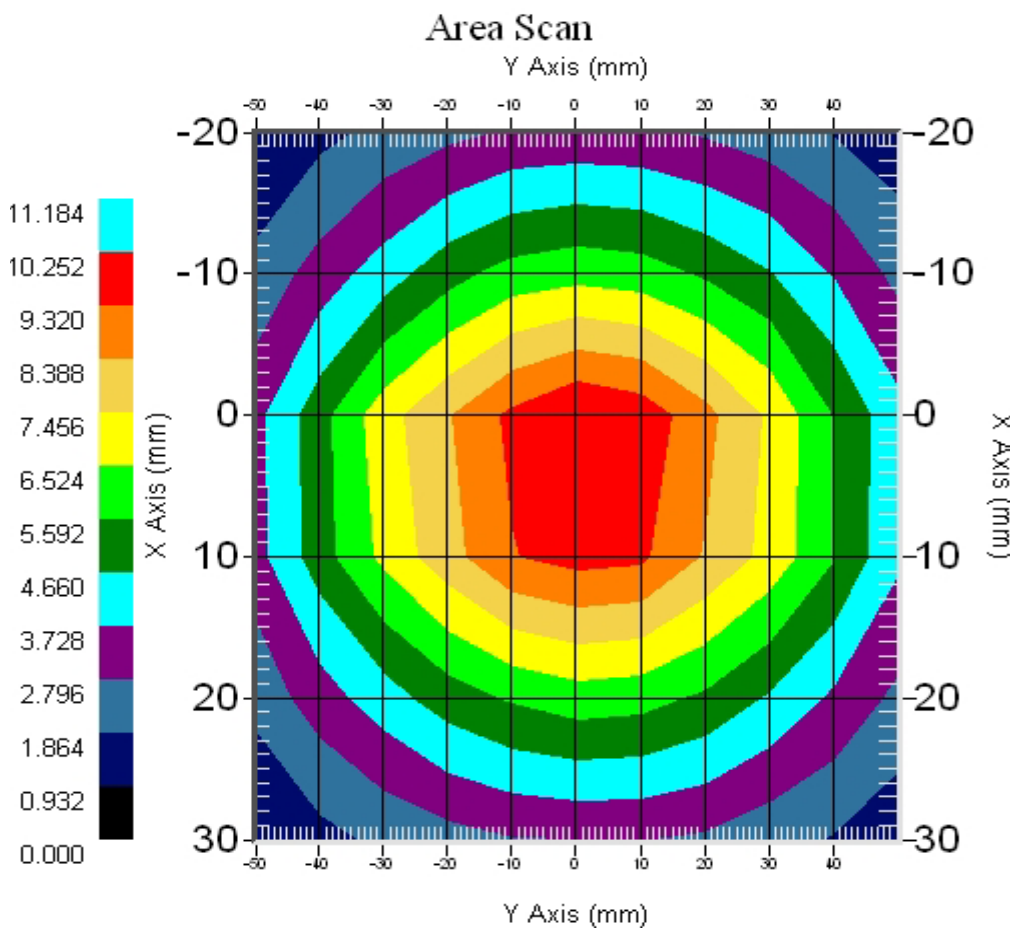
System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
835 MHz	9.49	6.1	14.21



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Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2004

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NCL CALIBRATION LABORATORIES

Calibration File No: DC-316
Project Number: Internal

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

APREL Validation Dipole

Manufacturer: APREL Laboratories
Part number: ALS-D-1900-S-2
Frequency: 1900 MHz
Serial No: AL-CD09

Customer: APREL Laboratories

Calibrated: 5th November 2005
Released on: 5th November 2005

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

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Conditions

Dipole AL-CD09 was new and taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

Director Product Development

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Y. Chen

Member of Engineering Staff

(Calibration Engineer)

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Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

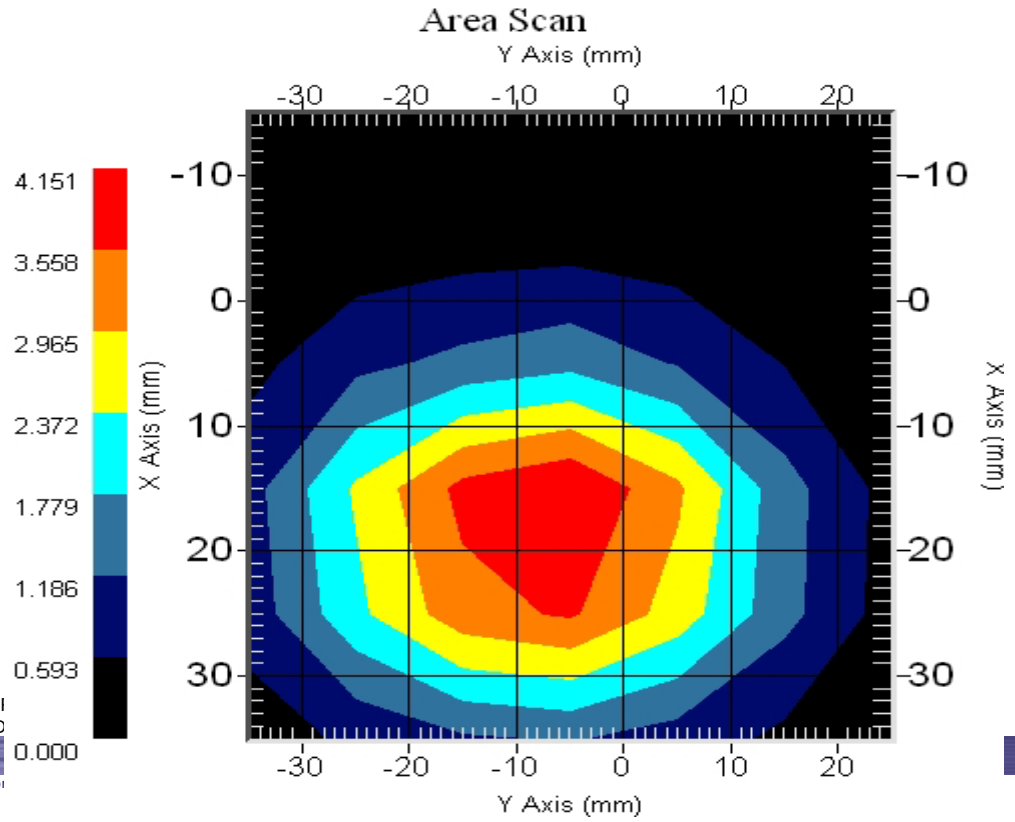
Length: 68.0 mm
Height: 39.5 mm

Electrical Specification

SWR: 1.08 U
Return Loss: -28.4 dB
Impedance: 48.9 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
1900 MHz	37.96	19.81	70.56



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Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole AL-CD09. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure
SSI-TP-016 Tissue Calibration Procedure
IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

Conditions

Dipole AL-CD09 was new taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

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Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
68.0 mm	39.5 mm	68.4 mm	40.0 mm

Tissue Validation

Head Tissue 1900 MHz	Measured
Dielectric constant, ε_r	40.0
Conductivity, σ [S/m]	1.40

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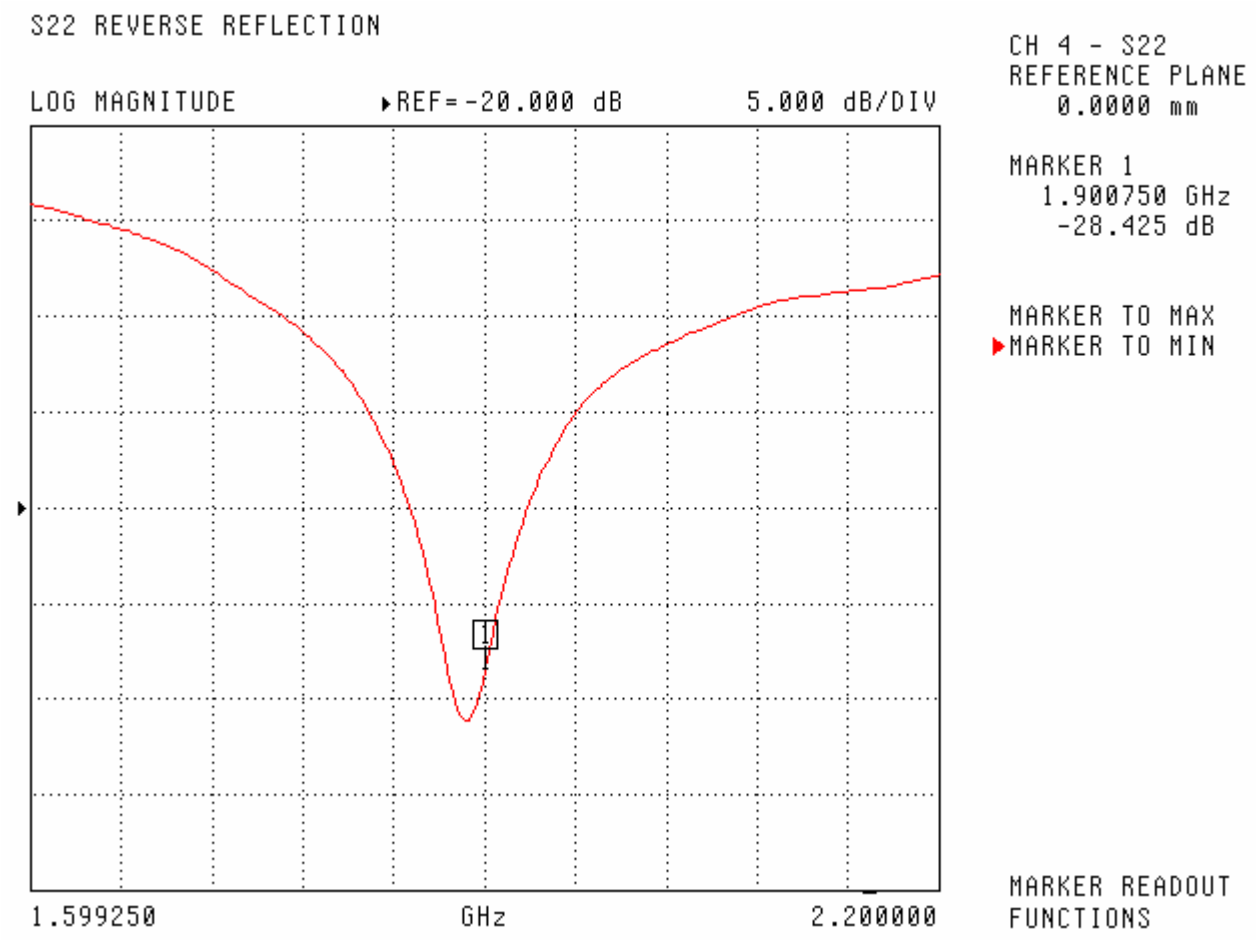
Electrical Calibration

Test	Result
S11 R/L	-28.4 dB
SWR	1.08 U
Impedance	48.9 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

S11 Parameter Return Loss



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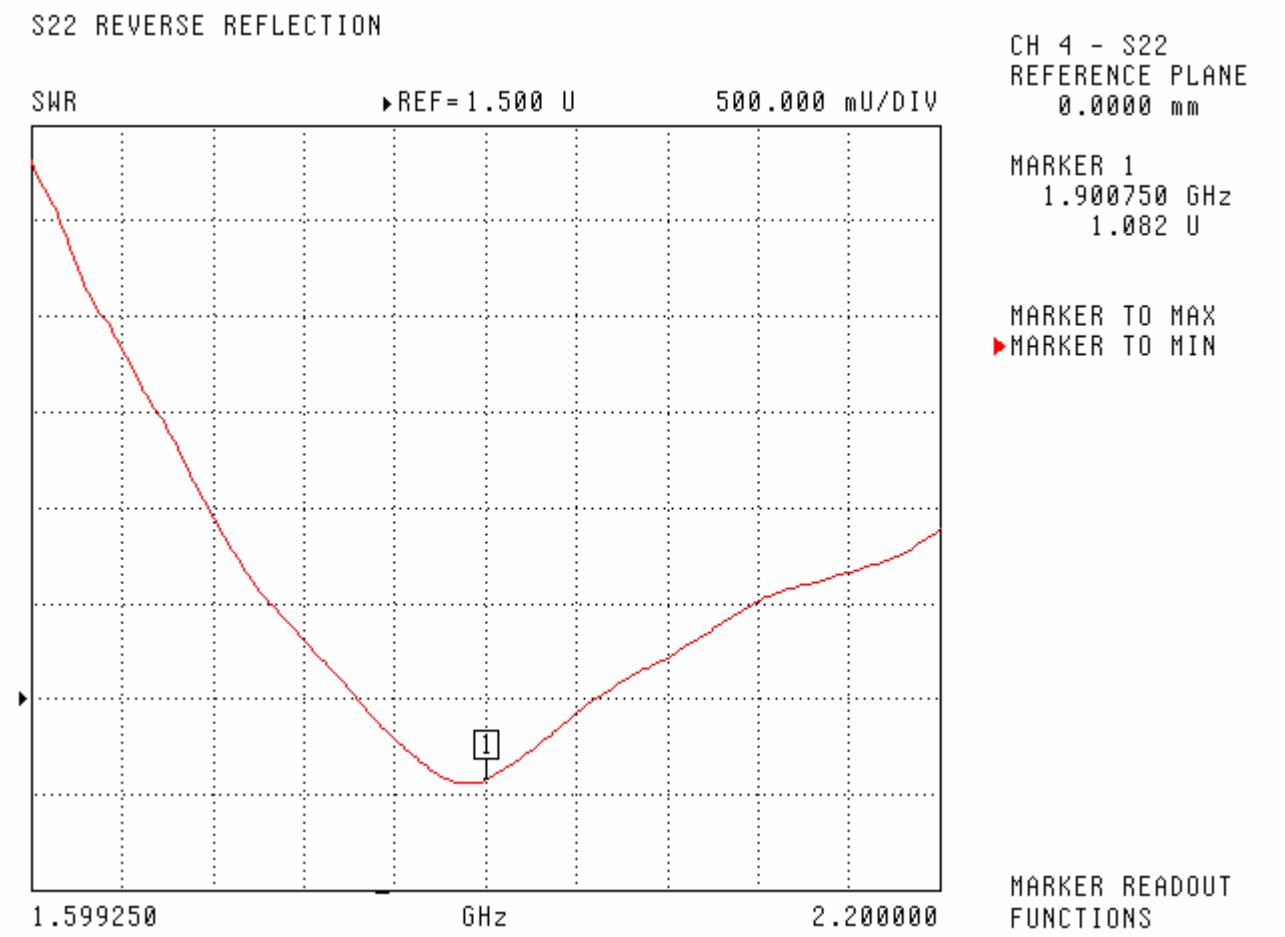
SWR



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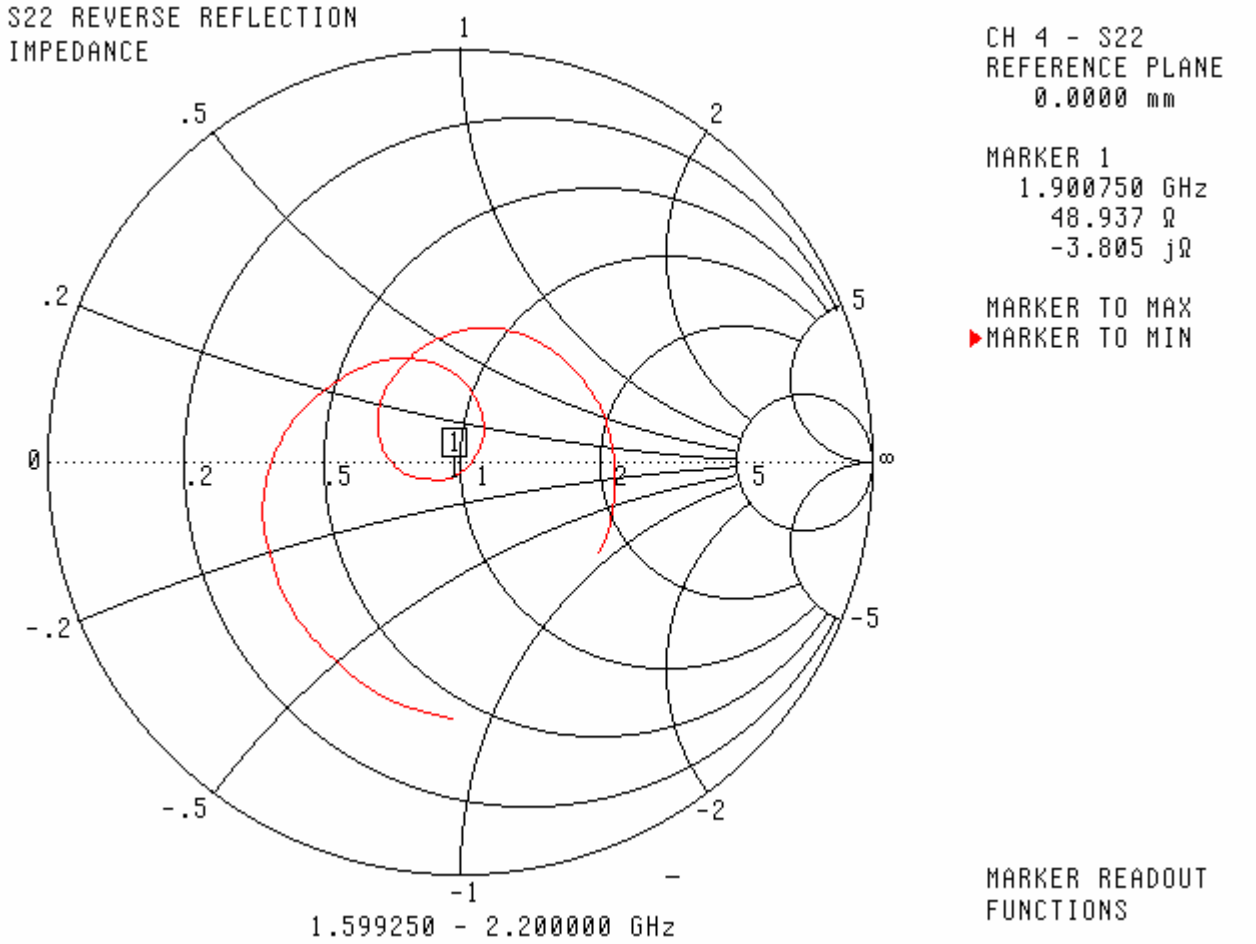
Smith Chart Dipole Impedance



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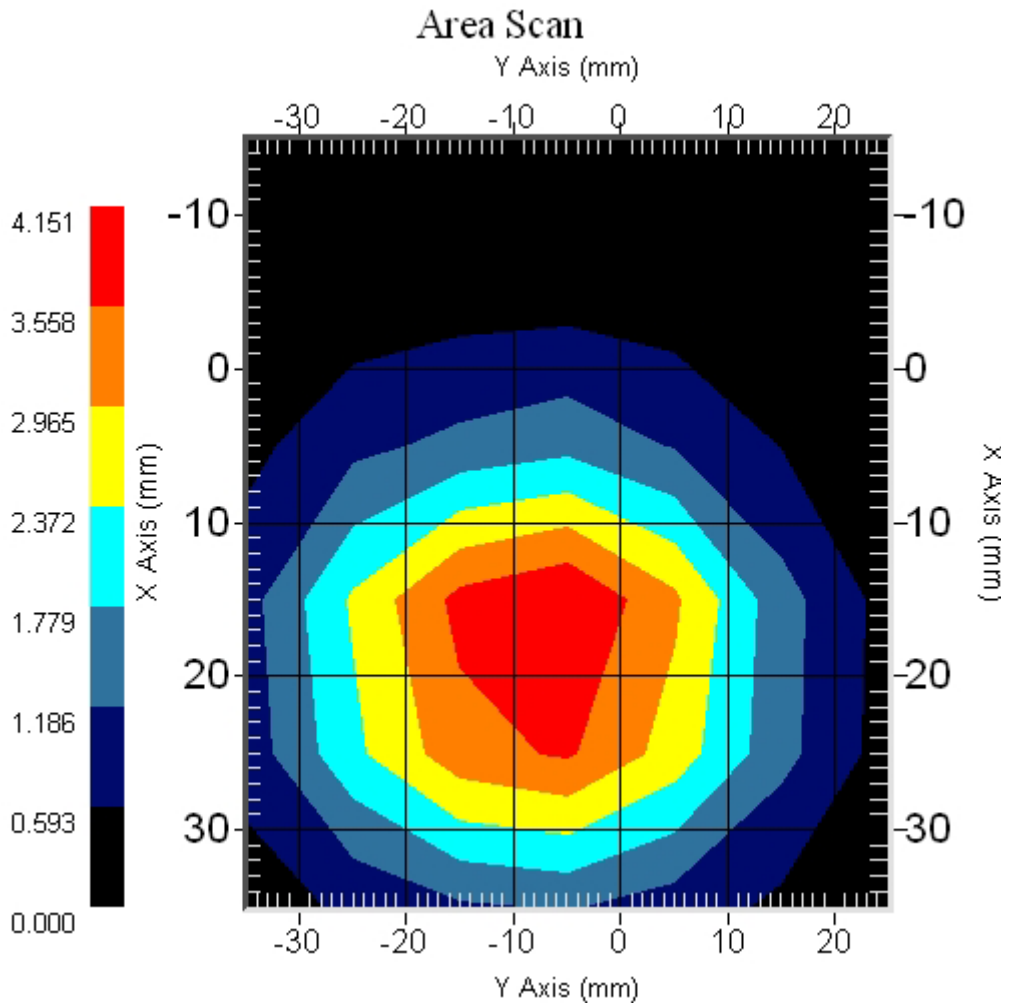
System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
1900 MHz	37.96	19.81	70.56



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