

NCL CALIBRATION LABORATORIES

Calibration File No.: 1286

Client.: SGL

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

Record of Calibration

Head and Body

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 500-00282

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole
Project No: SGL-ALSAS-5610

Calibrated: 7th July, 2011

Released on: 7th July, 2011

Approved By: Stuart Nicol

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

Released By: _____

NCL CALIBRATION LABORATORIES

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NCL Calibration Laboratories

Division of APREL Inc.

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the references listed below. Calibration is performed using accepted methodologies as per the references listed below. Probes are calibrated for air, and tissue and the values reported are the results from the physical quantification of the probe through metrological practices.

Calibration Method

Probes are calibrated using the following methods.

<1000MHz

TEM Cell for sensitivity in air

Standard phantom using temperature transfer method for sensitivity in tissue

>1000MHz

Waveguide* method to determine sensitivity in air and tissue

*Waveguide is numerically (simulation) assessed to determine the field distribution and power

The boundary effect for the probe is assessed using a standard flat phantom where the probe output is compared against a numerically simulated series of data points

References

- IEEE Standard 1528 (2003) including Amendment 1
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- EN 62209-1 (2006)
Human Exposure to RF Fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures-Part 1: Procedure to measure the Specific Absorption Rate (SAR) for hand-held mobile wireless devices
- IEC 62209-2 Ed. 1.0 (2010-03)
Human exposure to RF fields from hand-held and body-mounted wireless devices - Human models, instrumentation, and procedures - Part 2: specific absorption rate (SAR) for wireless communication devices (30 MHz - 6 GHz)
- TP-D01-032-E020-V2 E-Field probe calibration procedure
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Draft Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

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Conditions

Probe 500-00282 was a new probe taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 1.5°C
Temperature of the Tissue: 21 °C +/- 1.5°C
Relative Humidity: < 60%

Primary Measurement Standards

| Instrument | Serial Number | Cal due date |
|----------------------------------|----------------------|---------------------|
| Power meter Anritsu MA2408A | 90025437 | Nov.4, 2011 |
| Power Sensor Anritsu MA2481D | 103555 | Nov 4, 2011 |
| Attenuator HP 8495A (70dB) | 1944A10711 | Sept. 14, 2011 |
| Network Analyzer Anritsu MT8801C | MB11855 | Feb. 8, 2012 |

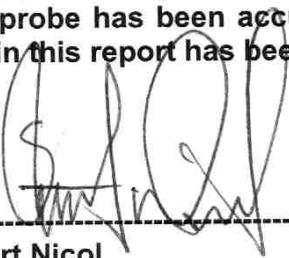
Secondary Measurement Standards

Signal Generator Agilent E4438C -506 MY55182336 June 7, 2011

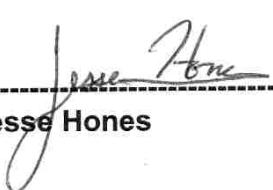
Attestation

The below named signatories have conducted the calibration and review of the data which is presented in this calibration report.

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



Jesse Hones

NCL Calibration Laboratories

Division of APREL Inc.

Probe Summary

Probe Type: E-Field Probe E020
Serial Number: 500-00282
Frequency: see page 5
Sensor Offset: 1.56
Sensor Length: 2.5
Tip Enclosure: Composite*
Tip Diameter: < 2.9 mm
Tip Length: 55 mm
Total Length: 289 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X: $1.2 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Y: $1.2 \mu\text{V}/(\text{V}/\text{m})^2$
Channel Z: $1.2 \mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression Point: 95 mV

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Calibration for Tissue (Head H, Body B)

| Frequency | Tissue Type | Measured Epsilon | Measured Sigma | Calibration Uncertainty | Tolerance Uncertainty for 5%* | Conversion Factor |
|---------------|-------------|------------------|----------------|-------------------------|-------------------------------|-------------------|
| 450 H | Head | X | X | X | X | X |
| 450 B | Body | X | X | X | X | X |
| 750 H | Head | 43.33 | 0.87 | 3.5 | 2.8 | 6.5 |
| 750 B | Body | 57.18 | 0.95 | 3.5 | 2.8 | 6.6 |
| 835 H | Head | 41.78 | 0.92 | 3.5 | 2.8 | 6.9 |
| 835 B | Body | 56.56 | 1.00 | 3.5 | 2.8 | 7.1 |
| 900 H | Head | 41.50 | 1.00 | 3.5 | 2.9 | 6.8 |
| 900 B | Body | 56.31 | 1.06 | 3.5 | 2.9 | 6.8 |
| 1450 H | Head | X | X | X | X | X |
| 1450 B | Body | X | X | X | X | X |
| 1500 H | Head | X | X | X | X | X |
| 1500 B | Body | X | X | X | X | X |
| 1640 H | Head | X | X | X | X | X |
| 1640 B | Body | X | X | X | X | X |
| 1750 H | Head | 38.80 | 1.35 | 3.5 | 3.1 | 4.6 |
| 1750 B | Body | 51.60 | 1.51 | 3.5 | 3.1 | 5.2 |
| 1800 H | Head | X | X | X | X | X |
| 1800 B | Body | X | X | X | X | X |
| 1900 H | Head | 38.14 | 1.43 | 3.5 | 3.1 | 5.6 |
| 1900 B | Body | 51.49 | 1.59 | 3.5 | 3.1 | 5.4 |
| 2000 H | Head | 38.48 | 1.44 | 3.5 | 3.1 | 6 |
| 2000 B | Body | 52.27 | 1.53 | 3.5 | 3.1 | 5.8 |
| 2100 H | Head | 38.11 | 1.55 | 3.5 | 3.2 | 5.9 |
| 2100 B | Body | 51.93 | 1.65 | 3.5 | 3.2 | 5.5 |
| 2300 H | Head | | X | X | X | X |
| 2300 B | Body | | X | X | X | X |
| 2450 H | Head | 38.16 | 1.86 | 3.5 | 3.25 | 5 |
| 2450B | Body | 50.52 | 2.04 | 3.5 | 3.25 | 4.8 |
| 2600 H | Head | X | X | X | X | X |
| 2600 B | Body | X | X | X | X | X |
| 3000 H | Head | X | X | X | X | X |
| 3000 B | Body | X | X | X | X | X |
| 3600 H | Head | X | X | X | X | X |
| 3600 B | Body | X | X | X | X | X |
| 5200 H | Head | X | X | X | X | X |
| 5200 B | Body | X | X | X | X | X |
| 5600 H | Head | X | X | X | X | X |
| 5600 B | Body | X | X | X | X | X |
| 5800 H | Head | X | X | X | X | X |
| 5800 B | Body | X | X | X | X | X |

Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2.1% for the distance between the tip of the probe and the tissue boundary, when less than 0.58mm.

Spatial Resolution:

The spatial resolution uncertainty is less than 1.5% for 4.9mm diameter probe.
The spatial resolution uncertainty is less than 1.0% for 2.5mm diameter probe.

DAQ-PAQ Contribution

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

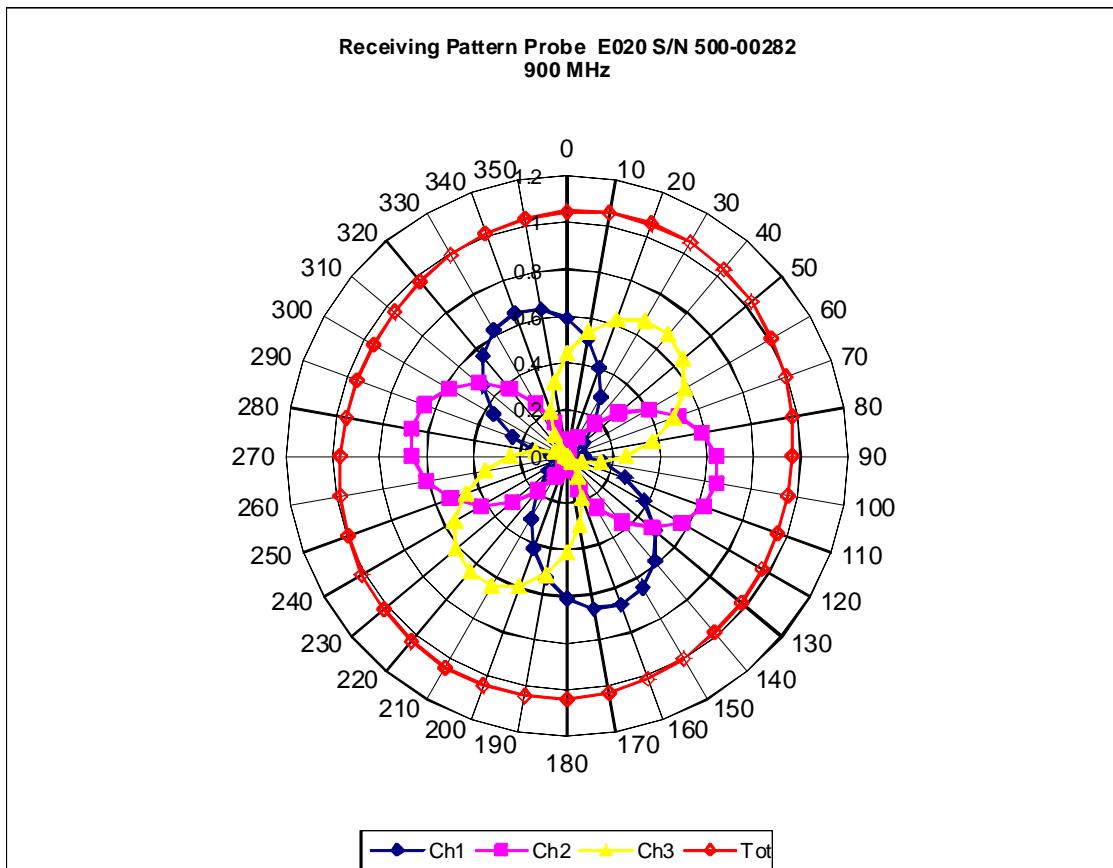
Boundary Effect:

For a distance of 0.58mm the worst case evaluated uncertainty (increase in the probe sensitivity) is less than 2.1%.

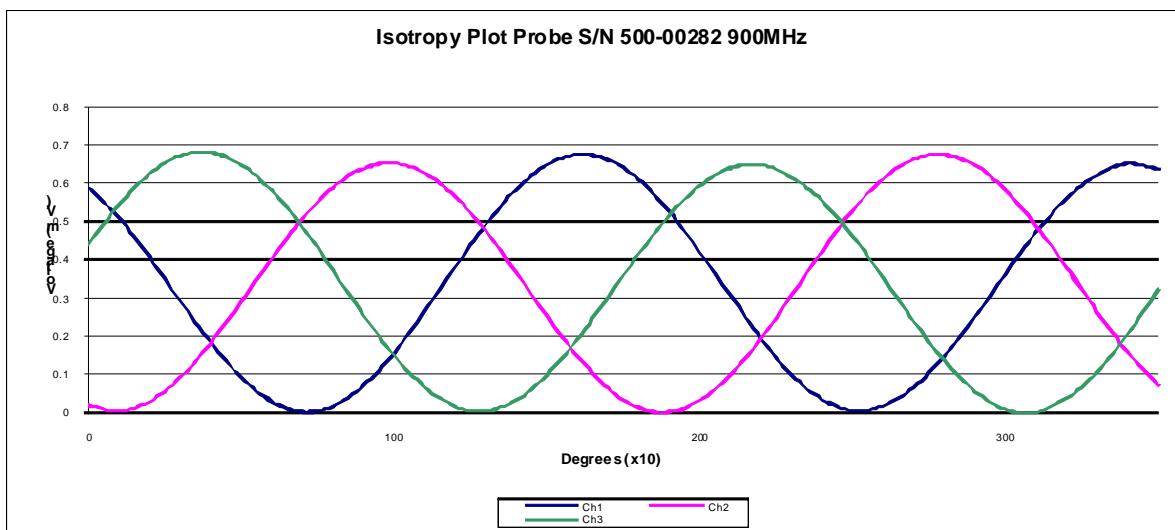
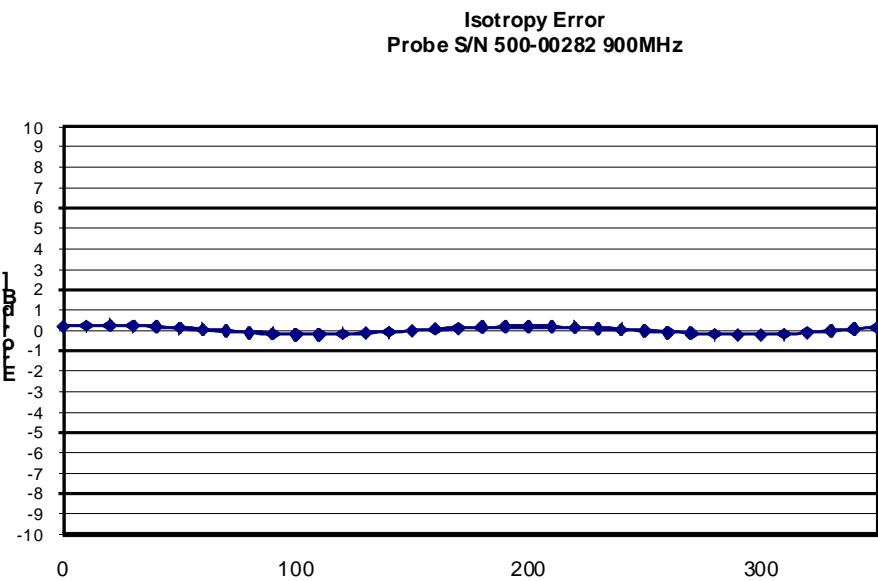
NOTES:

*The maximum deviation from the centre frequency when comparing the lower to upper range is listed.

Receiving Pattern Air



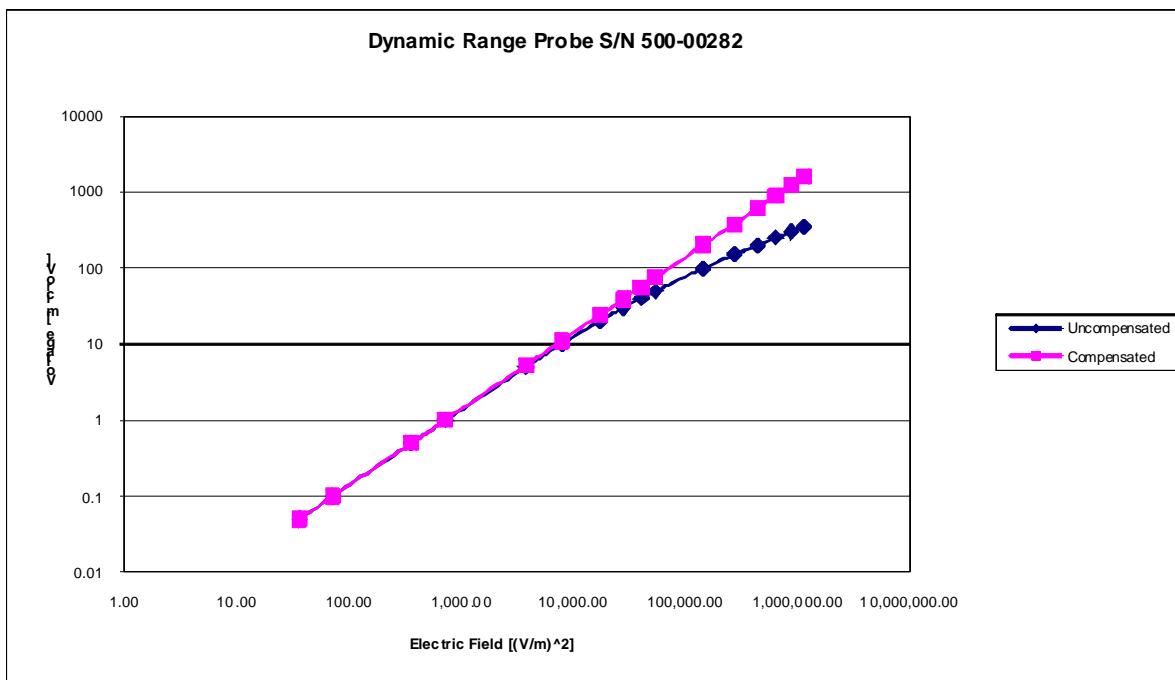
Isotropy Error 900 MHz (Air)



Isotropicity Tissue:

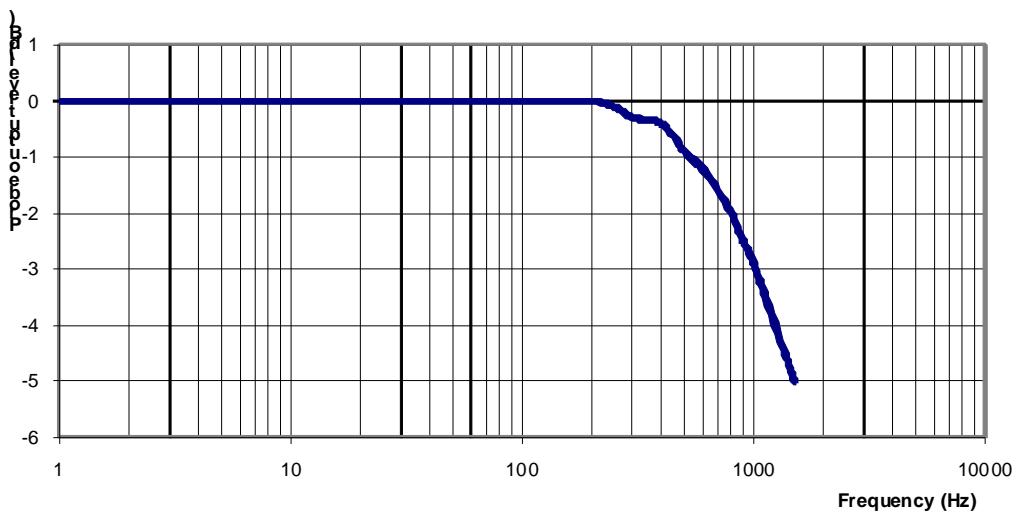
0.10 dB

Dynamic Range



Video Bandwidth

Probe Frequency Characteristics



Video Bandwidth at 500 Hz

1 dB

Video Bandwidth at 1.02 KHz:

3 dB

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.