

NCL CALIBRATION LABORATORIES

Calibration File No.: 1364-1375

Client.: IAC

CERTIFICATE OF CALIBRATION

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.: 500-00273

Calibration Procedure: D01-032-E020-V2, D22-012-Tissue, D28-002-Dipole

Project No: ISL-E020-5612

Calibrated: 1st October 2011

Released on: 5th October 2011

Approved By: Stuart Nicol

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

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 meteorological 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

NCL Calibration Laboratories

Division of APREL Inc.

Conditions

Probe 500-00273 was a recalibration.

The probe was received in good working order, although at 1900MHz the uncertainty was higher than our standard (see note)

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, 2012

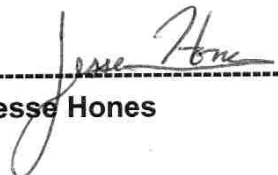
Attestation

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

Probe Summary

Probe Type:	E-Field Probe E020
Serial Number:	500-00273
Frequency:	As presented on 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

NCL Calibration Laboratories

Division of APREL Inc.

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	X	X	X	X	X
750 B	Body	X	X	X	X	X
850 H	Head	42.86	0.95	3.5	3.4	6.5
850 B	Body	53.71	1.04	3.5	3.4	6.4
900 H	Head	41.5	0.99	3.5	3.4	6.1
900 B	Body	53.25	1.04	3.5	3.4	6.3
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	X	X	X	X	X
1750 B	Body	X	X	X	X	X
1800 H	Head	36.85	1.35	3.5	2.7	5.5
1800 B	Body	52.38	1.5	3.5	2.7	5.4
1900 H	Head	38.21	1.46	3.5	2.7	5.7
1900 B	Body	52.1	1.59	3.5	2.7	5.4
2000 H	Head	X	X	X	X	X
2000 B	Body	X	X	X	X	X
2100 H	Head	39.8	1.49	3.5	2.9	5.0
2100 B	Body	53.0	1.58	3.5	2.9	4.9
2300 H	Head	X	X	X	X	X
2300 B	Body	X	X	X	X	X
2450 H	Head	38.2	1.84	3.5	3.5	4.65
2450 B	Body	50.63	1.99	3.5	3.5	4.4
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 M Ω .

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.

**1800MHz Head was evaluated at close to the 10% allowable deviation; the deviation has now been normalized to within 2%.

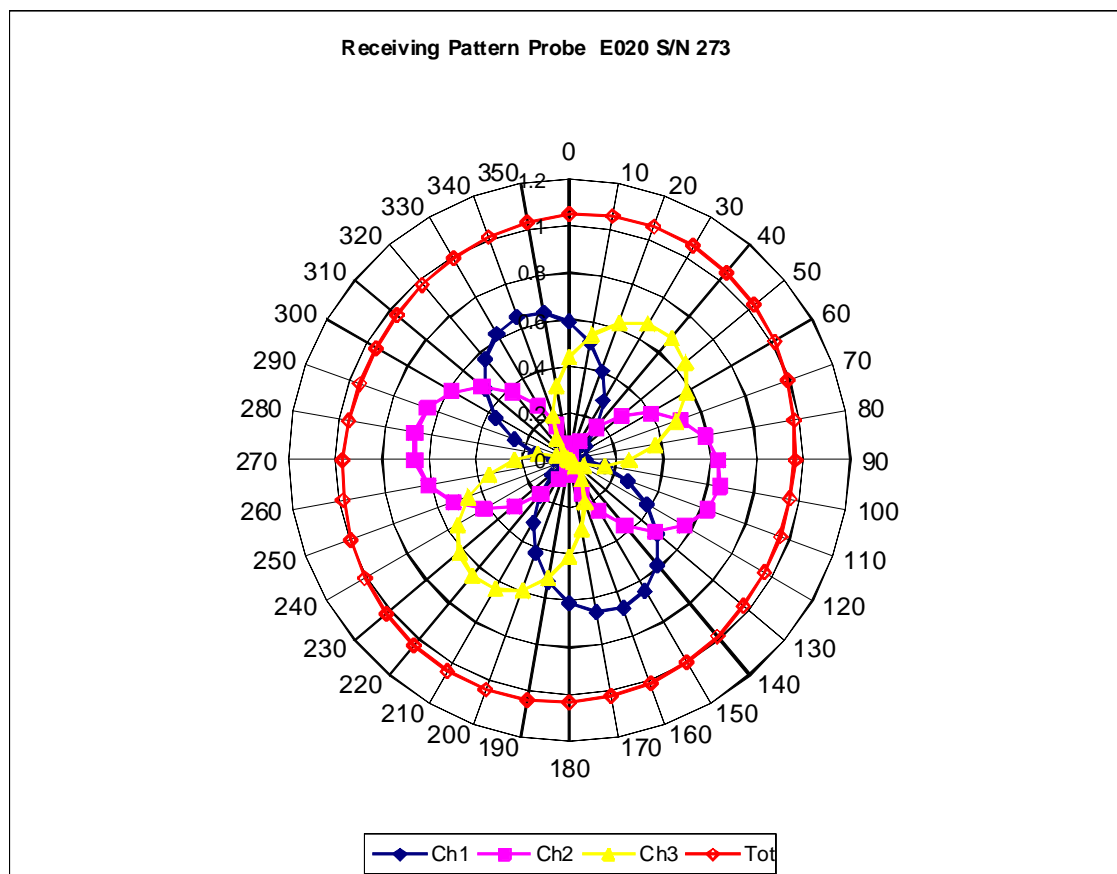
***1800MHz Body was evaluated at close to the 10% allowable deviation; the deviation has now been normalized to within 2%.

****1900MHz Body was evaluated at close to the 10% allowable deviation; the deviation has now been normalized to within 2%.

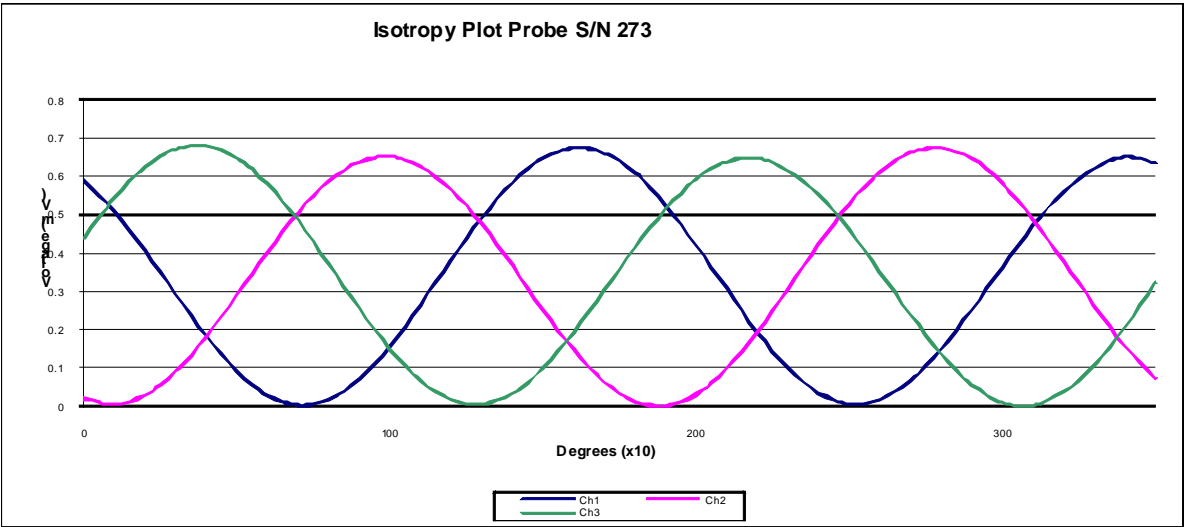
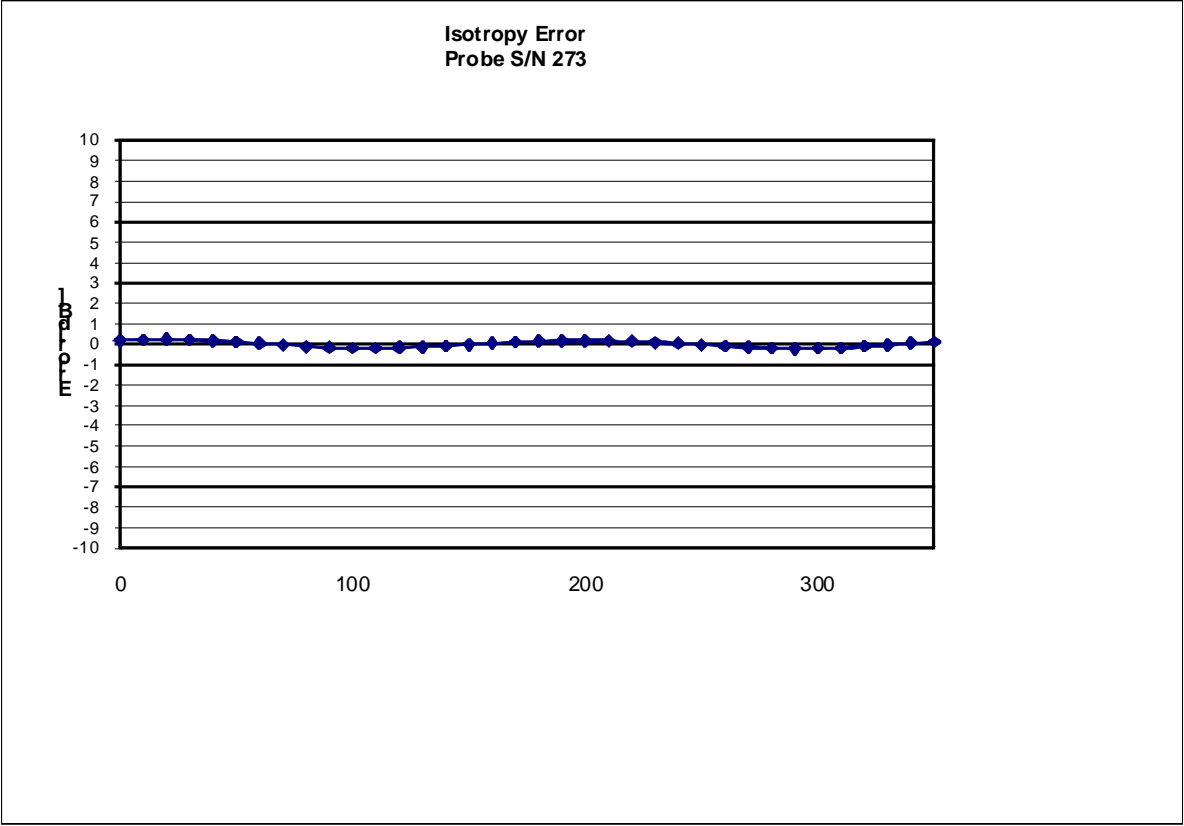
*****2450MHz Head was evaluated at close to the 10% allowable deviation; the deviation has now been normalized to within 2%.

*****2450MHz Body was evaluated at close to the 10% allowable deviation; the deviation has now been normalized to within 2%.

Receiving Pattern Air



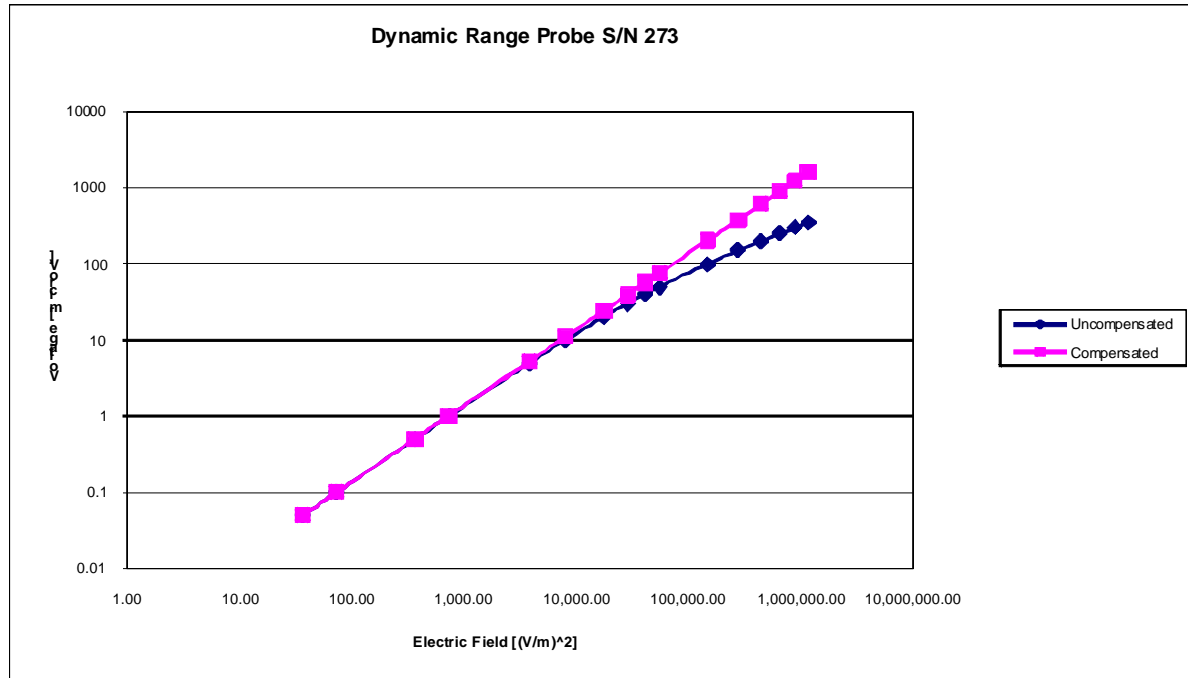
Isotropy Error Air



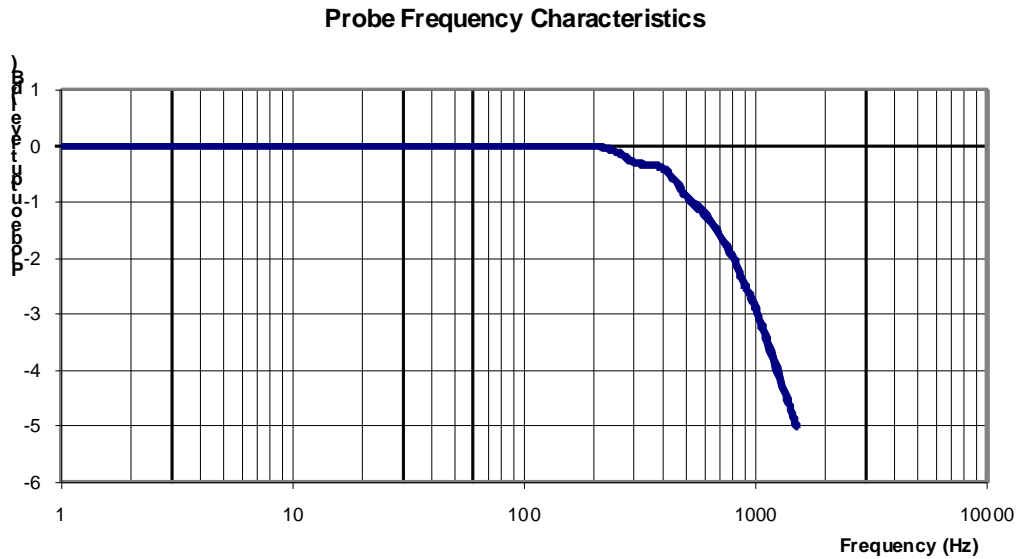
Isotropy Tissue:

0.10 dB

Dynamic Range



Video Bandwidth



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 May 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1217/18
Project Number: SGL-IAC-DC-5582-93

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.

Validation Dipole
835MHz Head & Body

Manufacturer: APREL Laboratories

Part number: ALS-D-835-S-2

Frequency: 835MHz

Serial No: 180-00556

Customer: IAC

Calibrated: 17th May 2011

Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
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FAX: (613) 435-8306

Conditions

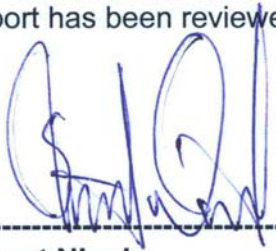
Dipole 180-00556 was a re-calibration.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	90025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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

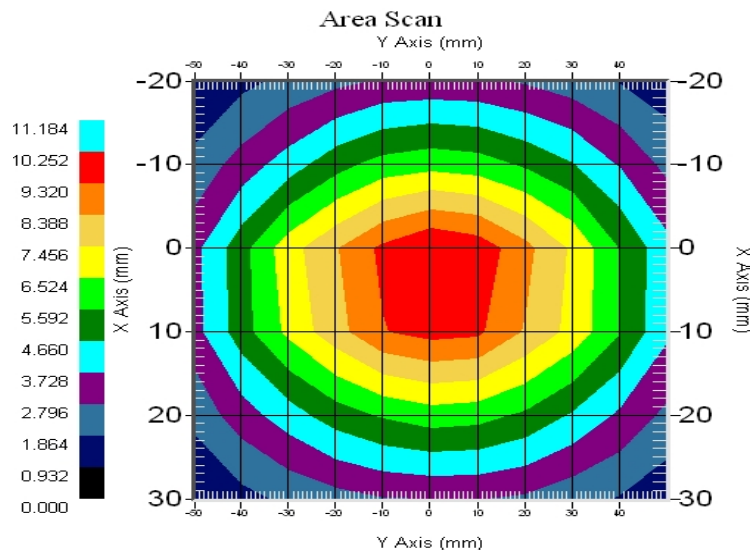
Electrical Specification 835MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-26.655	51.666	1.102U
Body	-22.106	57.482	1.177U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	835 MHz	9.590	6.003	15.013
Body	835 MHz	9.981	6.006	15.013

835MHz



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 180-00556. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 180-00556 was a re-calibration.

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

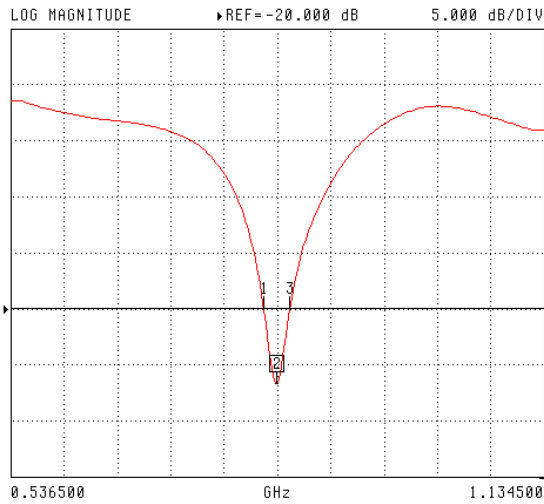
Electrical Calibration

Electrical Specification 835MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	53.15	0.95

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
0.835000 GHz
-26.655 dB

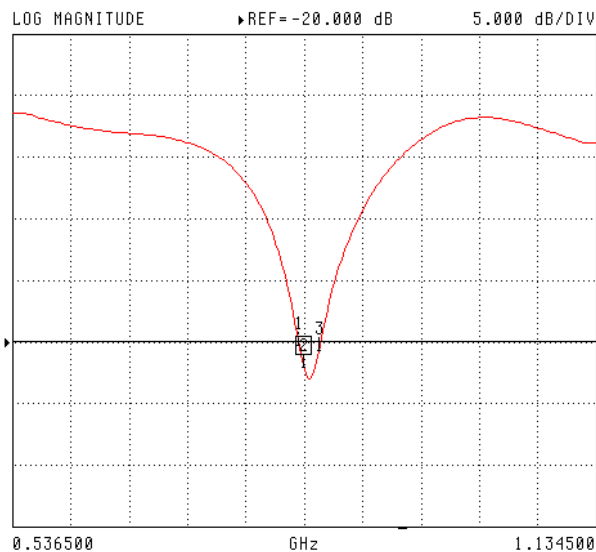
MARKER TO MAX
MARKER TO MIN

1 0.820034 GHz
-20.001 dB
3 0.849726 GHz
-20.001 dB

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
0.835000 GHz
-22.106 dB

MARKER TO MAX
MARKER TO MIN

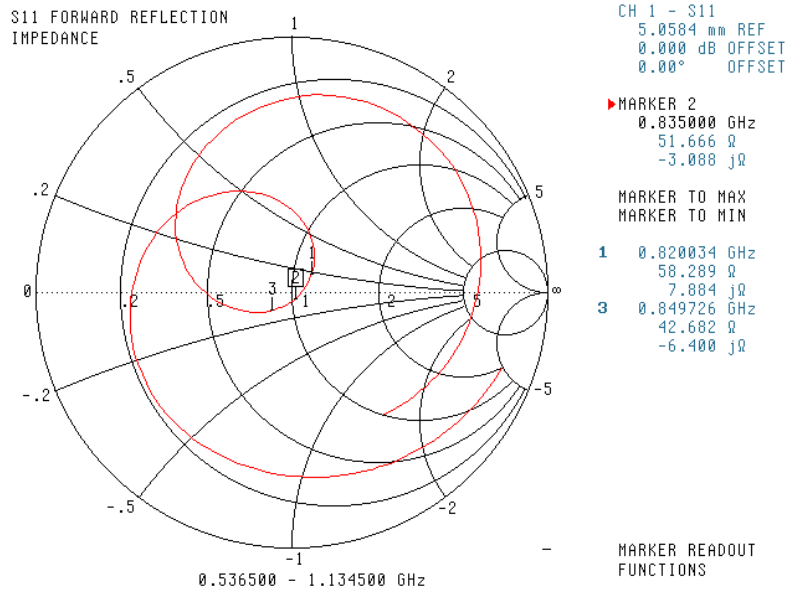
1 0.830132 GHz
-20.270 dB
3 0.850690 GHz
-20.742 dB

MARKER READOUT
FUNCTIONS

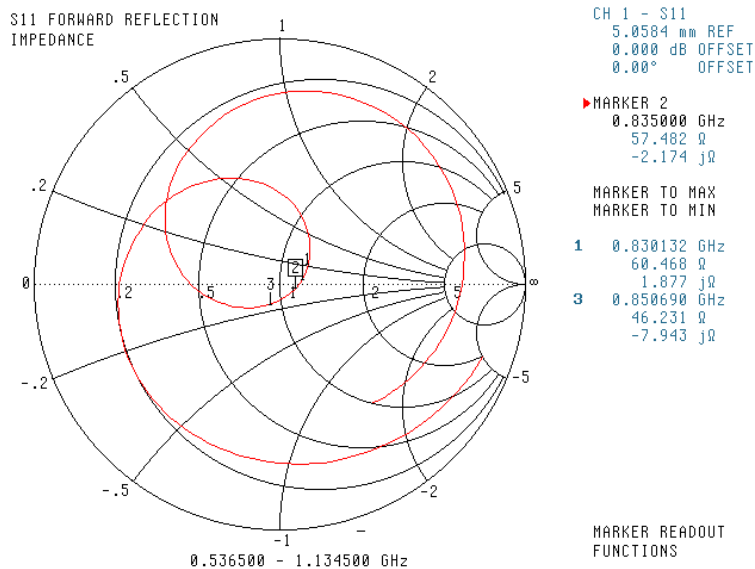
Electrical Specification 835MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	53.15	0.95

Head Tissue



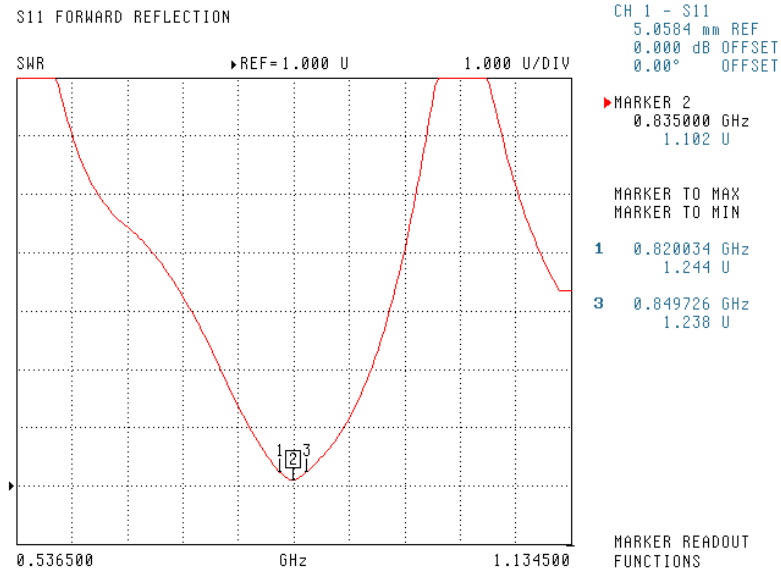
Body Tissue



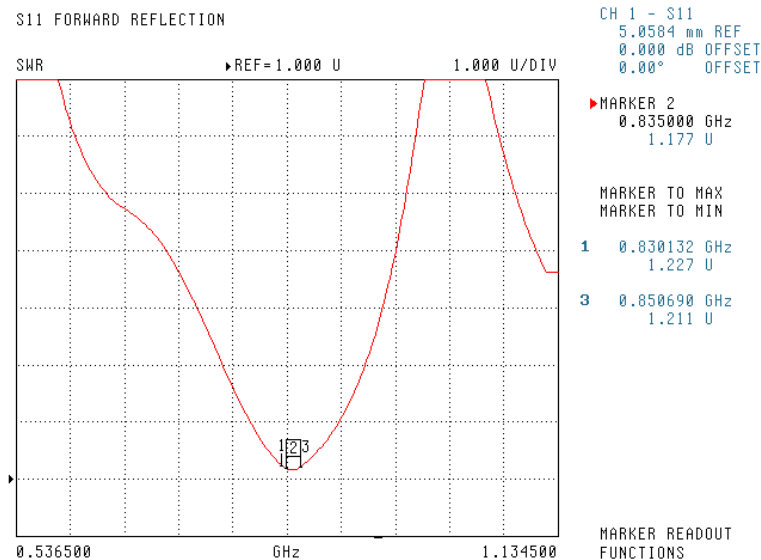
Electrical Specification 835MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	41.09	0.89
Body	53.15	0.95

Head Tissue



Body Tissue



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 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1219/20
Project Number: SGL-IAC-DC-5582-93

CERTIFICATE OF CALIBRATION

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.

Validation Dipole
900MHz Head and Body

Manufacturer: APREL Laboratories

Part number: ALS-D-900-S-2

Frequency: 900MHz

Serial No: 190-00606

Customer: IAC

Calibrated: 17th May 2011

Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
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Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

Conditions

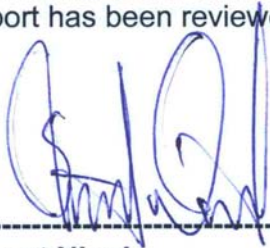
Dipole 190-00606 was a re-calibration.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	90025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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

Mechanical Dimensions

Length: 149 mm
Height: 83.3 mm

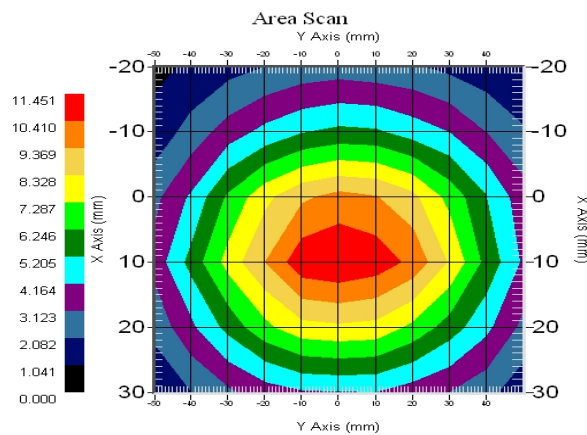
Electrical Specification 900MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-27.083	47.024	1.177U
Body	-23.506	49.945	1.146

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	900 MHz	10.693	6.631	17.015
Body	900 MHz	10.954	6.874	18.010

900MHz



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 190-00606. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 190-00606 was a re-calibration.

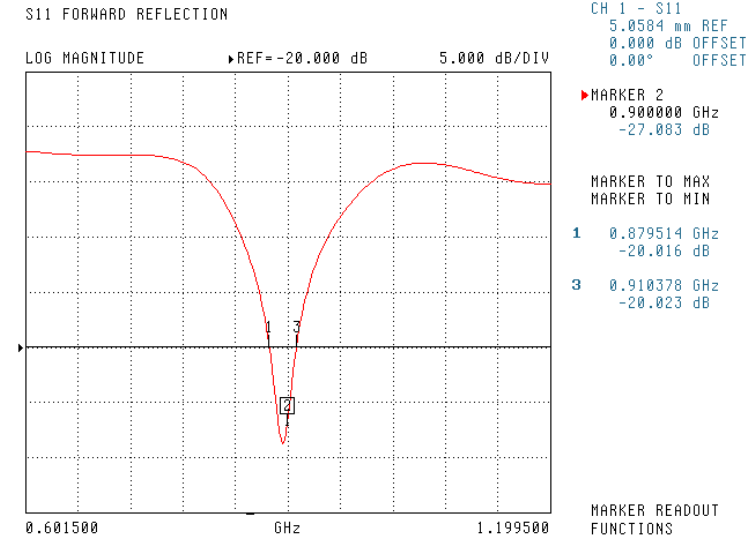
Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

Electrical Calibration

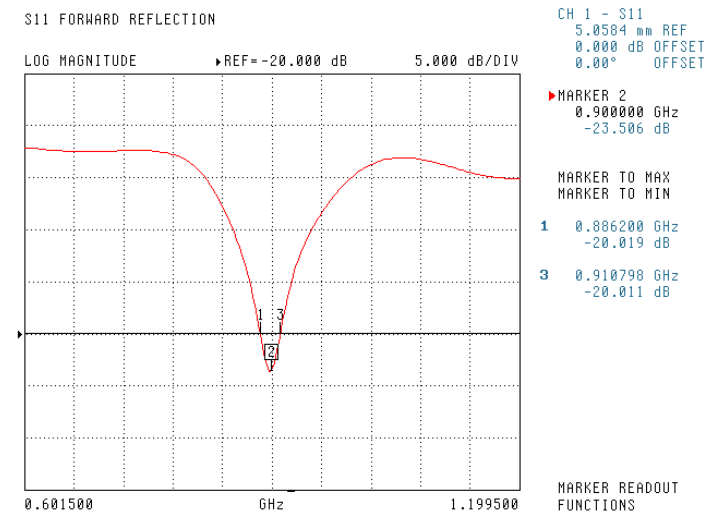
Electrical Specification 900MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	40.19	0.95
Body	53.89	0.98

Head Tissue



Body Tissue

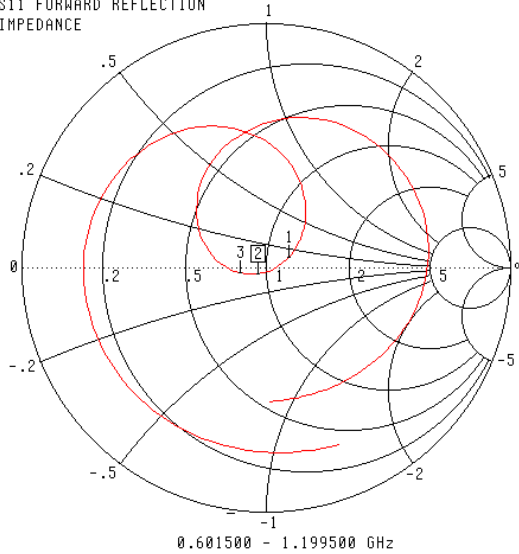


Electrical Specification 900MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	40.19	0.95
Body	53.89	0.98

Head Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
0.900000 GHz
47.024 Ω
-2.666 jΩ

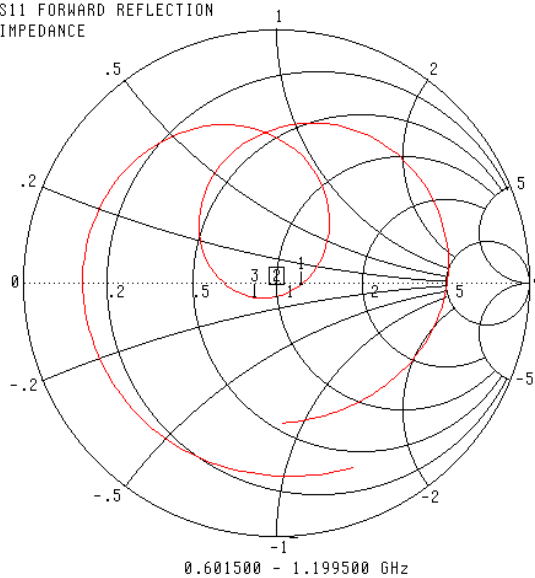
MARKER TO MAX
MARKER TO MIN

1 0.879514 GHz
60.700 Ω
5.018 jΩ
3 0.910378 GHz
40.592 Ω
-1.985 jΩ

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
0.900000 GHz
49.945 Ω
-5.753 jΩ

MARKER TO MAX
MARKER TO MIN

1 0.886200 GHz
61.111 Ω
-1.376 jΩ
3 0.910798 GHz
42.173 Ω
-5.142 jΩ

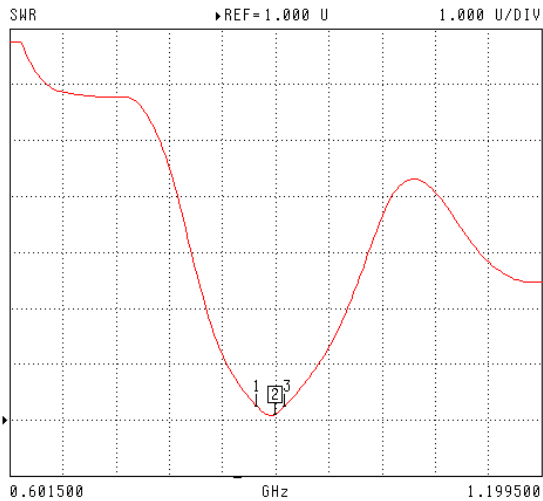
MARKER READOUT
FUNCTIONS

Electrical Specification 900MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	40.19	0.95
Body	53.89	0.98

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
0.900000 GHz
1.106 U

MARKER TO MAX
MARKER TO MIN

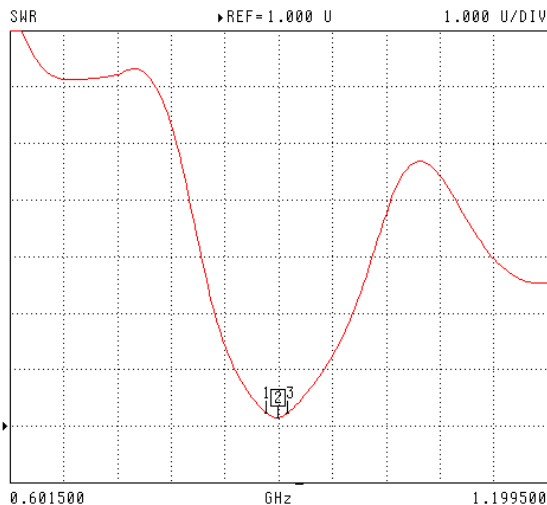
1 0.879514 GHz
1.244 U

3 0.910378 GHz
1.241 U

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
0.900000 GHz
1.146 U

MARKER TO MAX
MARKER TO MIN

1 0.886200 GHz
1.236 U

3 0.910798 GHz
1.234 U

MARKER READOUT
FUNCTIONS

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 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1221/2
Project Number: SGL-IAC-DC-5582-93

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.

Validation Dipole
1800MHz Head

Manufacturer: APREL Laboratories

Part number: ALS-D-1800-S-2

Frequency: 1800MHz

Serial No: 200-00657

Customer: IAC

Calibrated: 19th May 2011
Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
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CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

Conditions

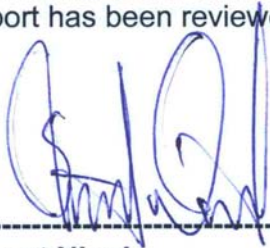
Dipole 200-00657 was a re-calibration.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	180025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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

Mechanical Dimensions

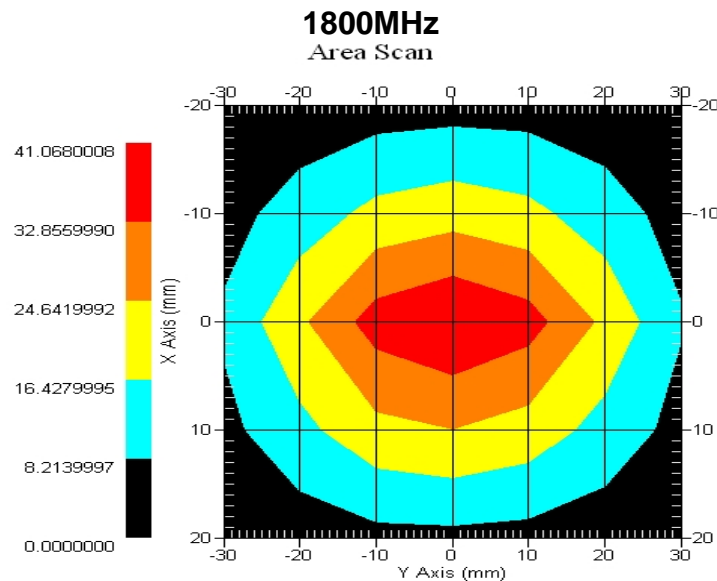
Length: 72.0 mm
Height: 41.2 mm

Electrical Specification 1800MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-29.524	52.089	1.090U
Body	-24.182	56.089	1.133U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	1800 MHz	37.852	19.248	68.029
Body	1800 MHz	38.102	19.897	70.011



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 200-00657. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 200-00657 was a re-calibration.

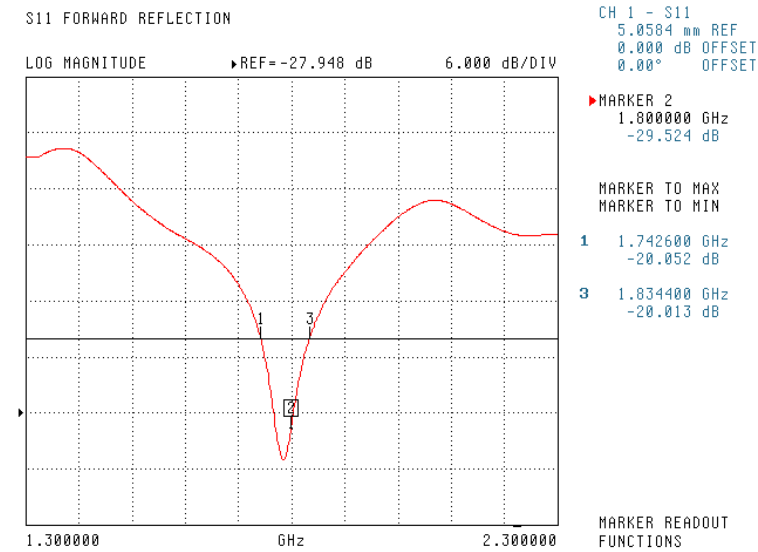
Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

Electrical Calibration

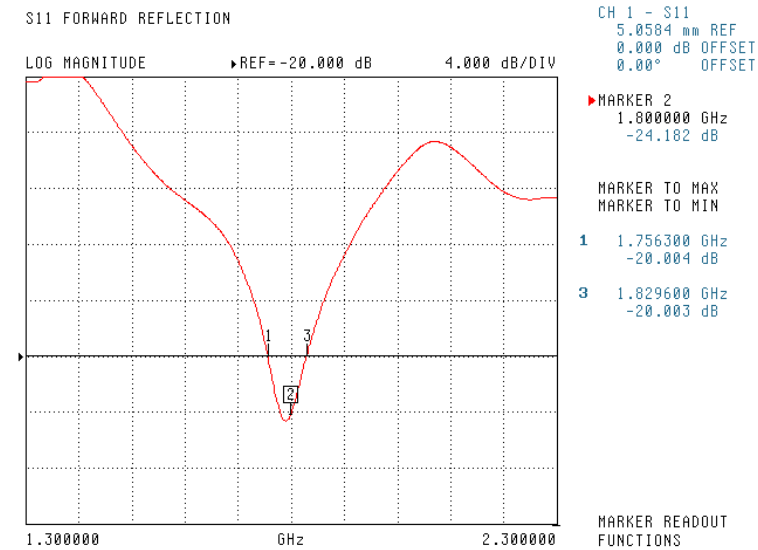
Electrical Specification 1800MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.21	1.37
Body	52.16	1.56

Head Tissue



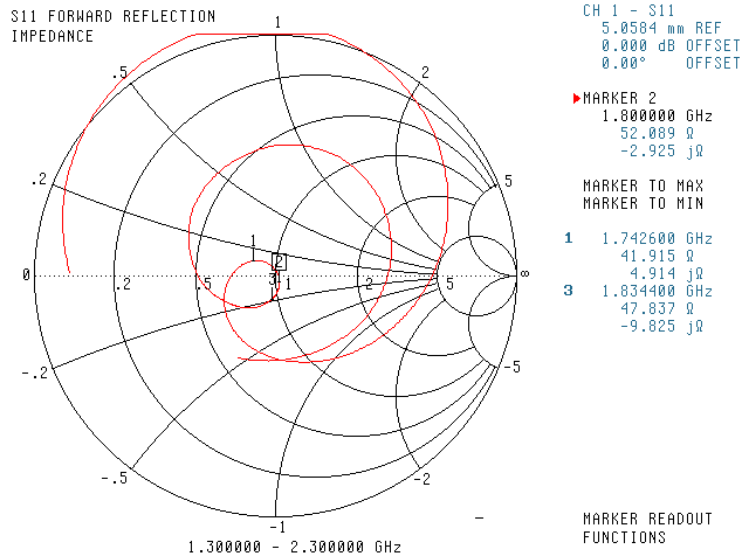
Body Tissue



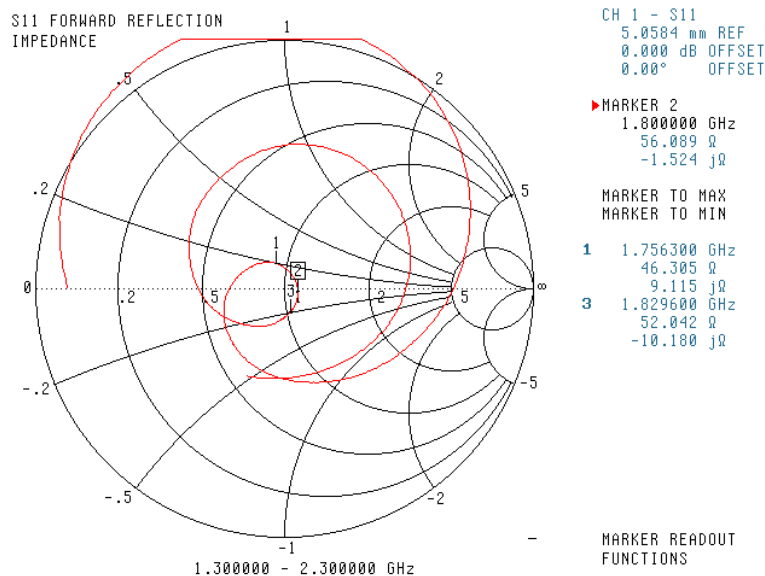
Electrical Specification 1800MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.21	1.37
Body	52.16	1.56

Head Tissue



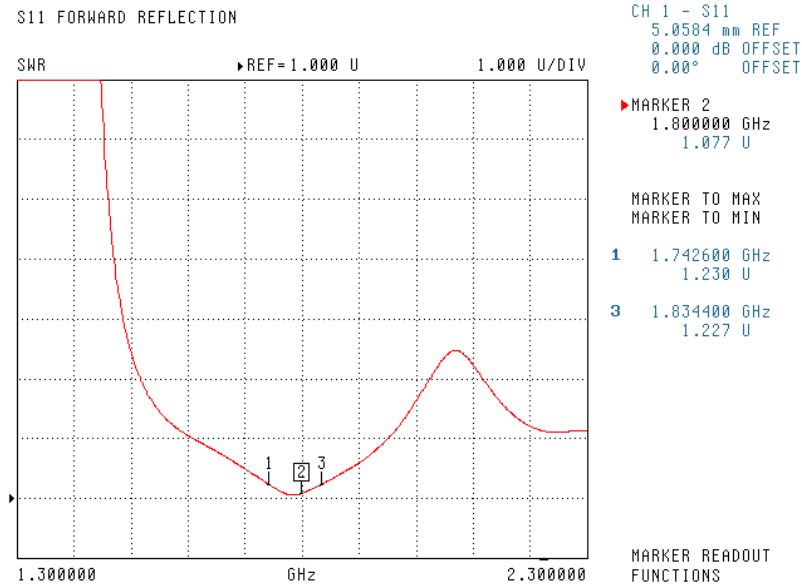
Body Tissue



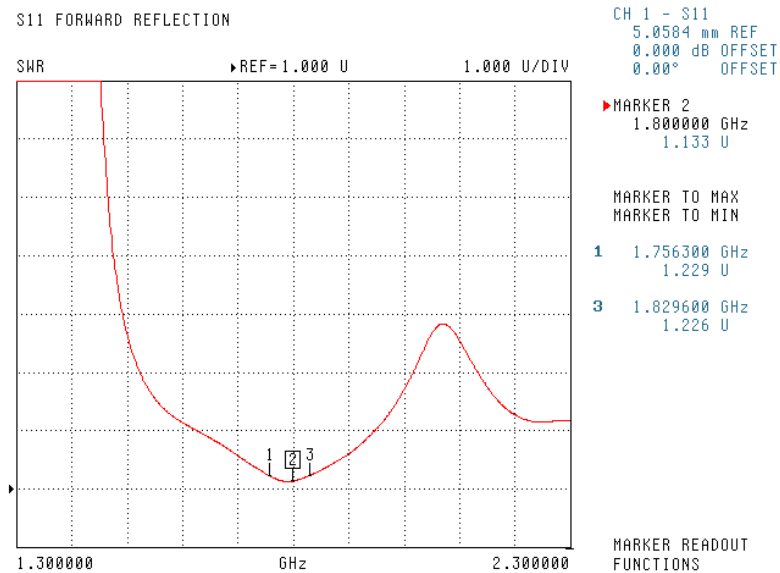
Electrical Specification 1800MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.21	1.37
Body	52.16	1.56

Head Tissue



Body Tissue



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 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1224/5
Project Number: SGL-IAC-DC-5582-93

CERTIFICATE OF CALIBRATION

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.

Validation Dipole
1900MHz Head & Body

Manufacturer: APREL Laboratories

Part number: ALS-D-1900-S-2

Frequency: 1900MHz

Serial No: 210-00707

Customer: IAC

Calibrated: 16th May 2011
Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

Conditions

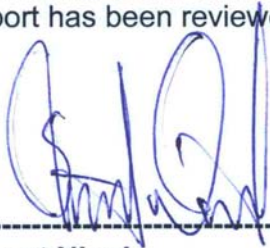
Dipole 210-00707 was a new dipole taken from stock.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	190025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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: 67.1 mm

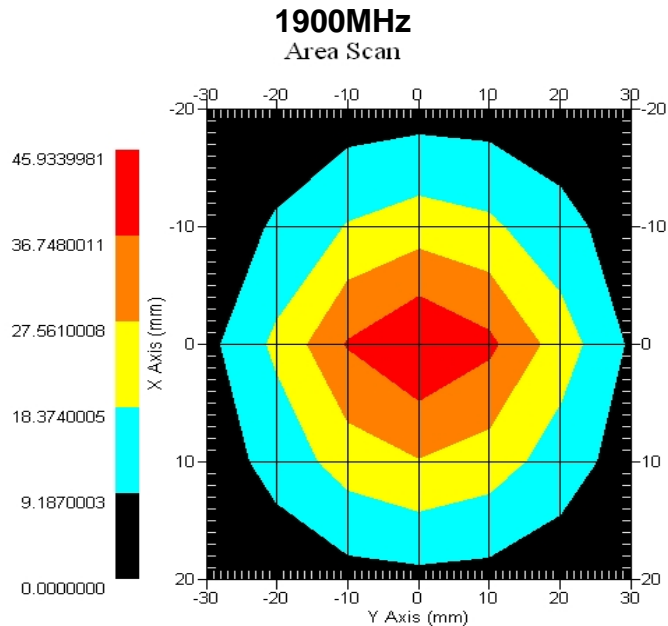
Height: 38.9 mm

Electrical Specification 1900MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-31.943	51.262	1.055U
Body	-25.099	57.750	1.119U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	1900 MHz	39.378	19.668	77.268
Body	1900 MHz	39.654	19.668	77.268



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 210-00707. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 210-00707 was a new dipole taken from stock.

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

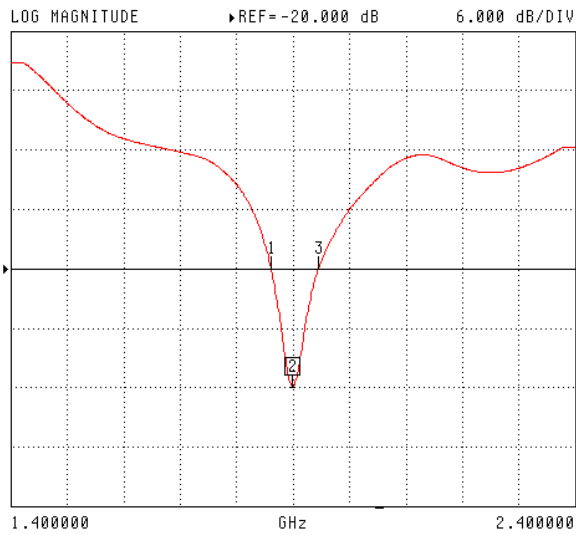
Electrical Calibration

Electrical Specification 1900MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	38.12	1.41
Body	51.52	1.57

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

▶ MARKER 2
1.900000 GHz
-31.943 dB

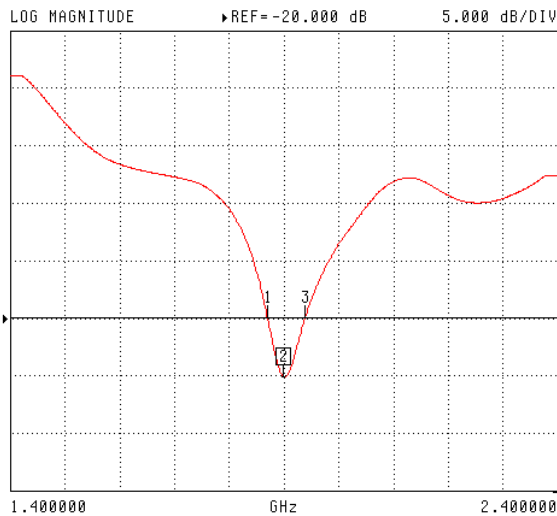
MARKER TO MAX
MARKER TO MIN

1 1.861600 GHz
-20.021 dB
3 1.946000 GHz
-20.003 dB

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

▶ MARKER 2
1.900000 GHz
-25.099 dB

MARKER TO MAX
MARKER TO MIN

1 1.870600 GHz
-20.005 dB
3 1.939500 GHz
-20.009 dB

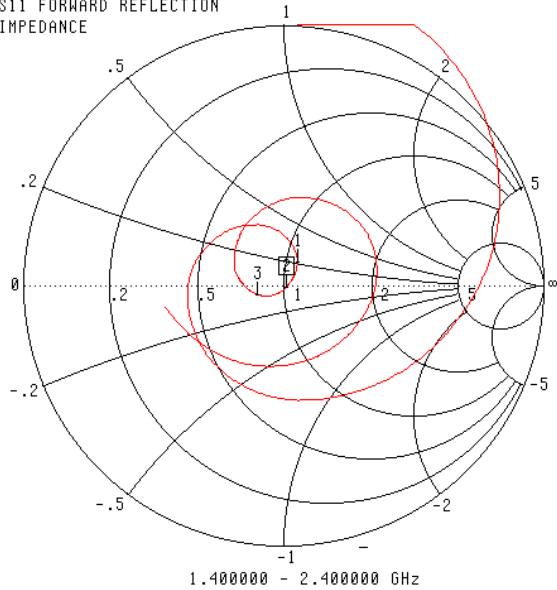
MARKER READOUT
FUNCTIONS

Electrical Specification 1900MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	38.12	1.41
Body	51.52	1.57

Head Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

►MARKER 2
1.900000 GHz
51.262 Ω
-1.179 jΩ

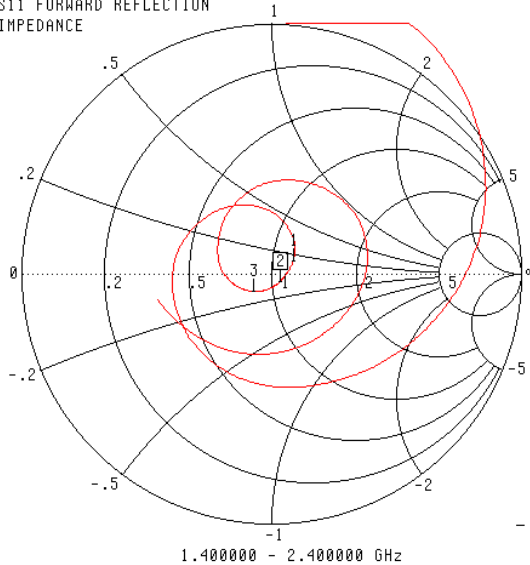
MARKER TO MAX
MARKER TO MIN

1 1.861600 GHz
55.137 Ω
9.602 jΩ
3 1.946000 GHz
41.175 Ω
-3.077 jΩ

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

►MARKER 2
1.900000 GHz
53.750 Ω
-3.685 jΩ

MARKER TO MAX
MARKER TO MIN

1 1.870600 GHz
59.559 Ω
5.588 jΩ
3 1.939500 GHz
43.052 Ω
-6.409 jΩ

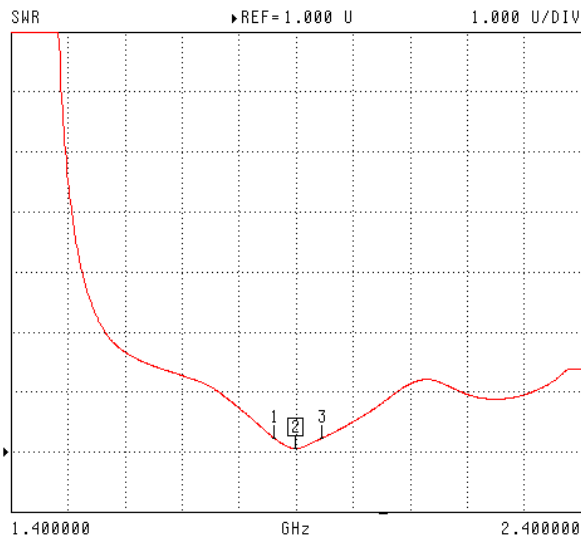
MARKER READOUT
FUNCTIONS

Electrical Specification 1900MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	38.12	1.41
Body	51.52	1.57

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
1.900000 GHz
1.055 U

MARKER TO MAX
MARKER TO MIN

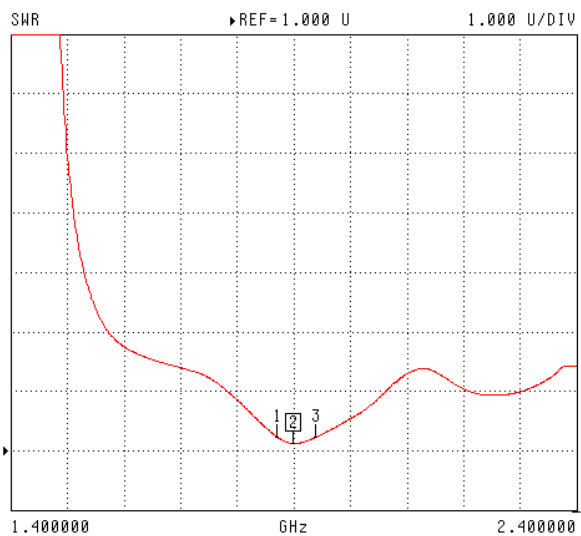
1 1.861600 GHz
1.234 U

3 1.946000 GHz
1.227 U

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
1.900000 GHz
1.119 U

MARKER TO MAX
MARKER TO MIN

1 1.870600 GHz
1.232 U

3 1.939500 GHz
1.226 U

MARKER READOUT
FUNCTIONS

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 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1227/8
Project Number: SGL-IAC-DC-5582-93

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.

Validation Dipole
2100MHz Head & Body

Manufacturer: APREL Laboratories

Part number: ALS-D-2100-S-2

Frequency: 2100MHz

Serial No: 215-00800

Customer: IAC

Calibrated: 16th May 2011
Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

Conditions

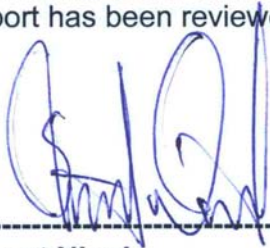
Dipole 215-00800 was a re-calibration.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	210025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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

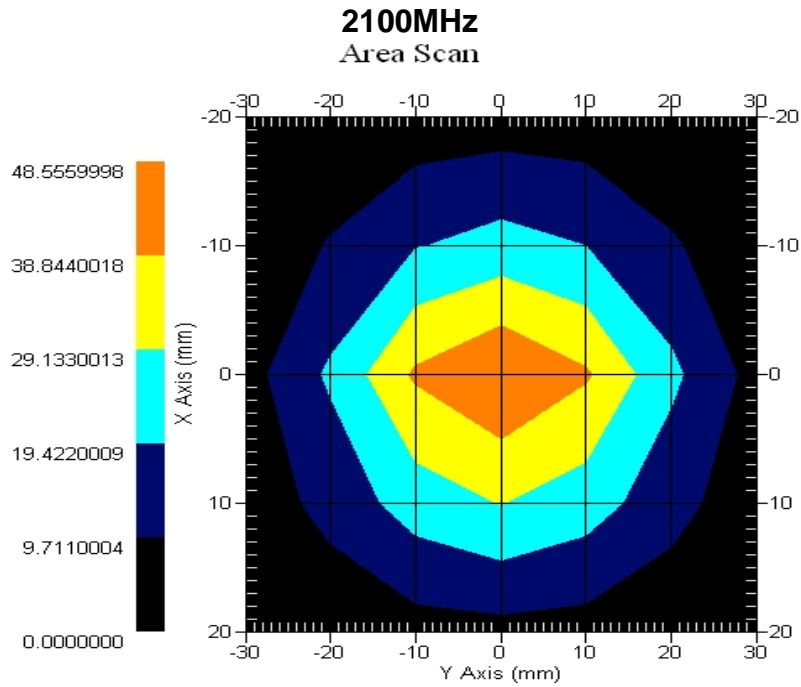
Length: 65.4 mm
Height: 37.5 mm

Electrical Specification 2100MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-28.958	47.271	1.078U
Body	-23.704	44.198	1.141U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	2100 MHz	43.872	21.004	84.025
Body	2100 MHz	44.210	21.201	84.405



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 215-00800. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 215-00800 was a re-calibration.

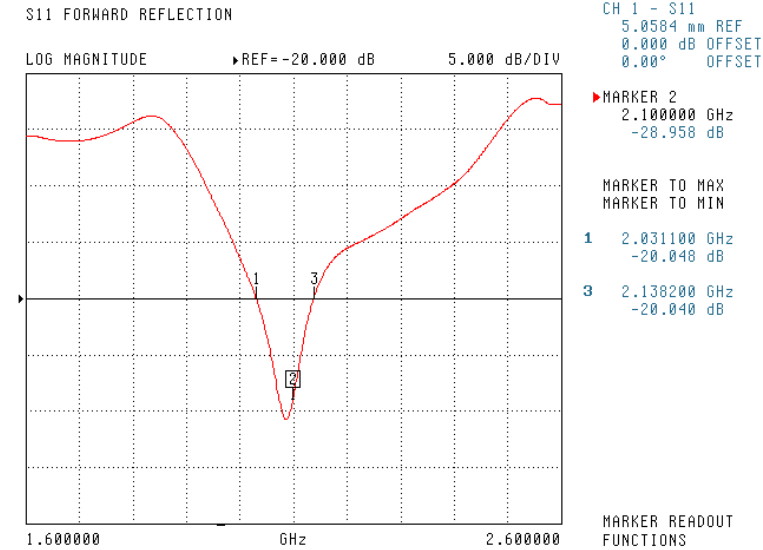
Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 20 °C +/- 0.5°C

Electrical Calibration

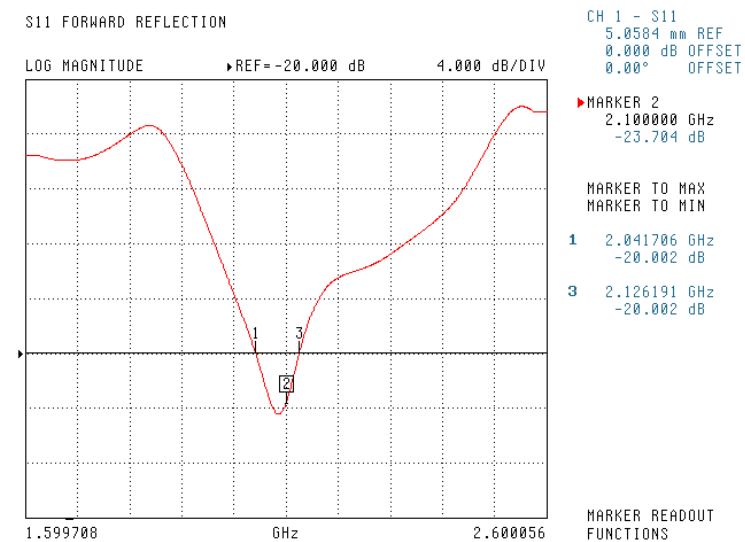
Electrical Specification 2100MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.83	1.41
Body	52.55	1.49

Head Tissue



Body Tissue

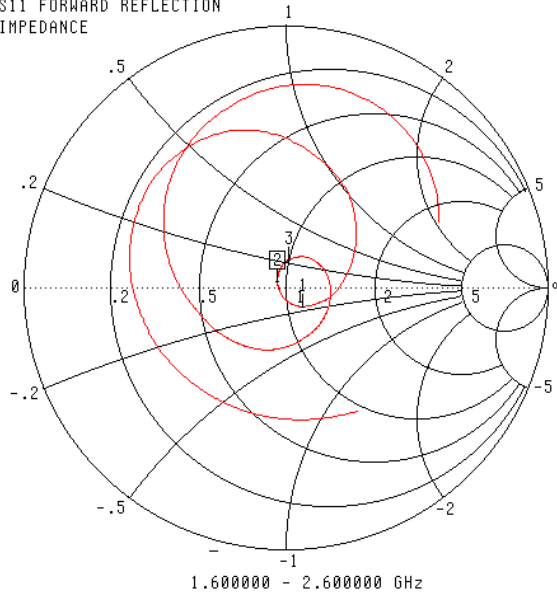


Electrical Specification 2100MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.83	1.41
Body	52.55	1.49

Head Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
2.100000 GHz
47.271 Ω
1.926 j Ω

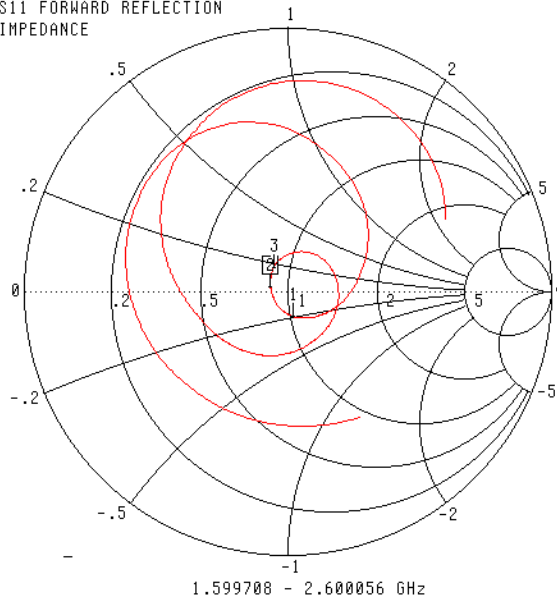
MARKER TO MAX
MARKER TO MIN

1 2.031100 GHz
56.450 Ω
-8.626 j Ω
3 2.130200 GHz
50.289 Ω
10.281 j Ω

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
2.100000 GHz
44.198 Ω
1.395 j Ω

MARKER TO MAX
MARKER TO MIN

1 2.041706 GHz
51.400 Ω
-10.192 j Ω
3 2.126191 GHz
44.635 Ω
7.988 j Ω

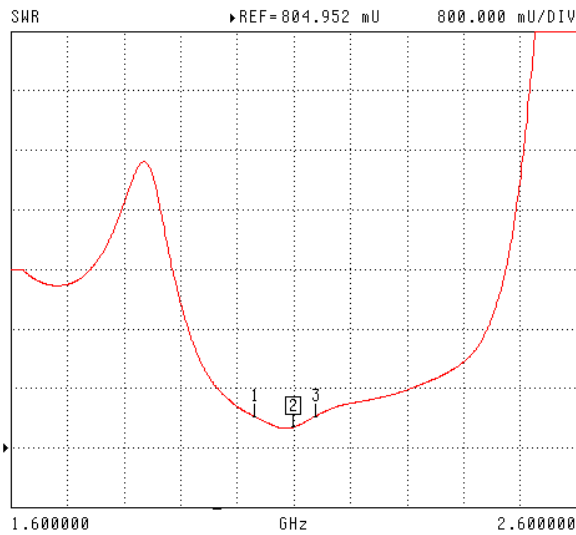
MARKER READOUT
FUNCTIONS

Electrical Specification 2100MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	39.83	1.41
Body	52.55	1.49

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
2.100000 GHz
1.078 U

MARKER TO MAX
MARKER TO MIN

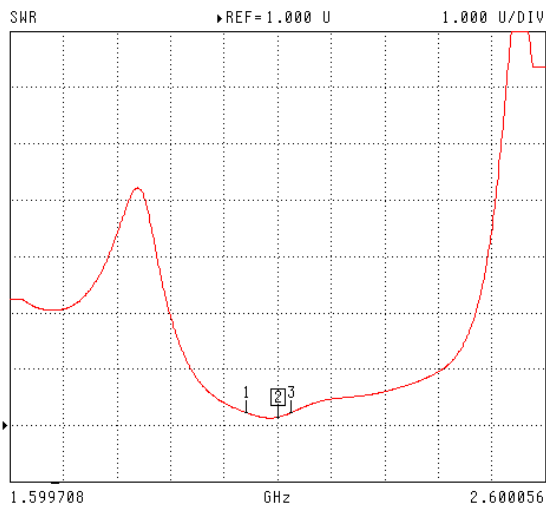
1 2.031100 GHz
1.224 U

3 2.130200 GHz
1.225 U

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
2.100000 GHz
1.141 U

MARKER TO MAX
MARKER TO MIN

1 2.041706 GHz
1.225 U

3 2.126191 GHz
1.226 U

MARKER READOUT
FUNCTIONS

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 2011.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1229/30
Project Number: SGL-IAC-DC-5582-93

CERTIFICATE OF CALIBRATION

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.

Validation Dipole
2450MHz Head & Body

Manufacturer: APREL Laboratories

Part number: ALS-D-2450-S-2

Frequency: 2450MHz

Serial No: 220-00755

Customer: IAC

Calibrated: 19th May 2011

Released on: 27th May 2011

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

Released By: _____

NCL CALIBRATION LABORATORIES

303 Terry Fox Drive, Suite 102
Kanata, Ontario
CANADA K2K 3J1

Division of APREL
TEL: (613) 435-8300
FAX: (613) 435-8306

Conditions

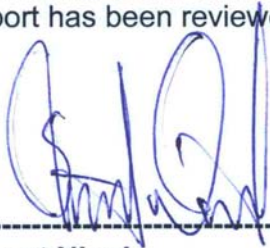
Dipole 220-00755 was a re-calibration.

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

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

Dipoles are calibrated on the ALSAS-10U with a feed power normalized to 1Watt.

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



Stuart Nicol



C. Teodorian

Primary Measurement Standards

Instrument	Serial Number	Cal due date
Power meter Anritsu MA2408A	245025437	Nov.4, 2010
Power Sensor Anritsu MA2481D	103555	Nov 4, 2010
Attenuator HP 8495A (70dB)	1944A10711	Sept. 14, 2010
Network Analyzer Anritsu MT8801C	MB11855	Feb. 8, 2011

Secondary Measurement Standards

Signal Generator Agilent E4438C -506	MY55182336	June 7, 2011
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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: 51.5 mm

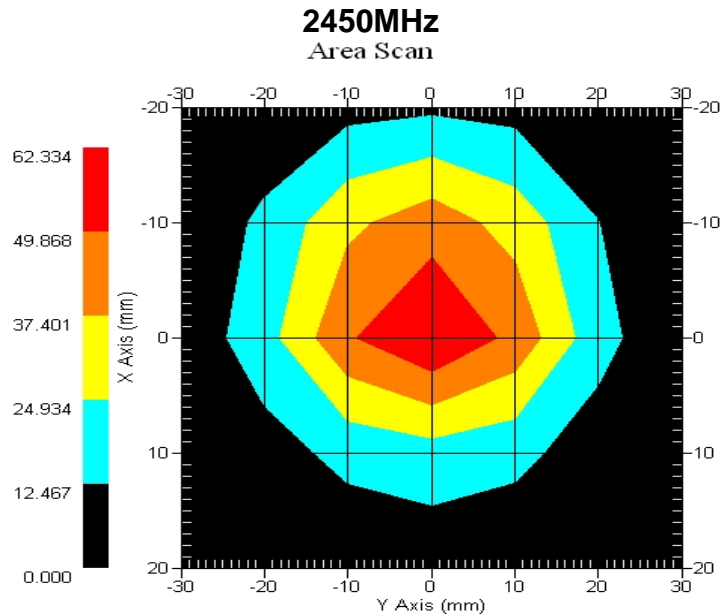
Height: 30.4 mm

Electrical Specification 2450MHz

Tissue Type	Return Loss:	Impedance:	SWR:
Head	-34.847	50.047	1.038U
Body	-32.513	50.190	1.029U

System Validation Results

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	2450 MHz	52.456	23.603	108.940
Body	2450 MHz	52.592	24.461	104.910



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 220-00755. 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-030 130 MHz to 26 GHz E-Field Probe Serial Number 215.

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

Conditions

Dipole 220-00755 was a new dipole taken from stock.

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

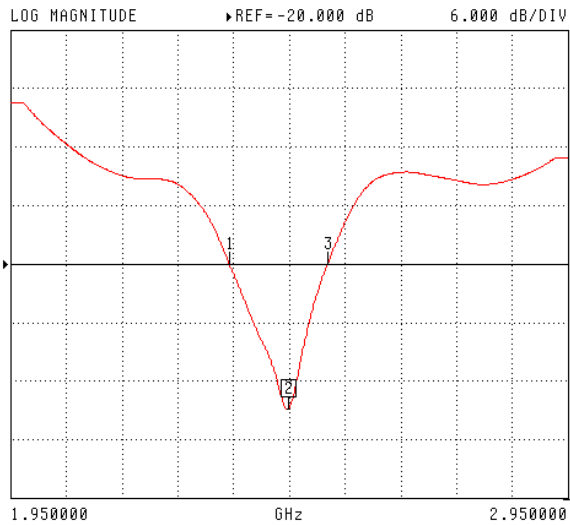
Electrical Calibration

Electrical Specification 2450MHz

Tissue Type	Measured Epsilon	Measured Sigma
Head	37.87	1.82
Body	50.84	1.92

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

▶ MARKER 2
2.450000 GHz
-34.847 dB

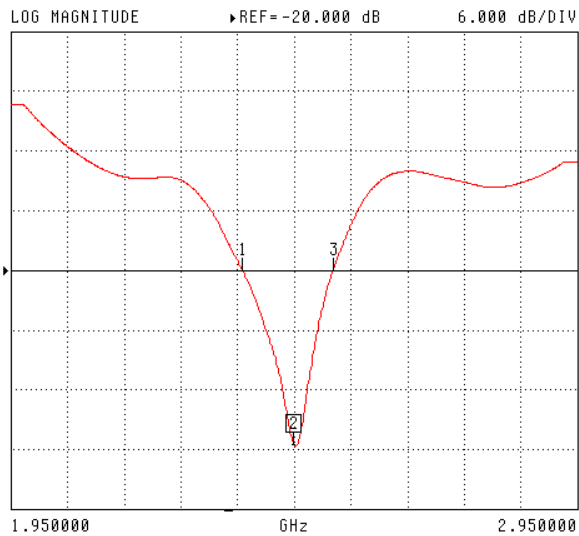
MARKER TO MAX
MARKER TO MIN

1 2.343100 GHz
-20.008 dB
3 2.519500 GHz
-20.005 dB

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

▶ MARKER 2
2.450000 GHz
-37.513 dB

MARKER TO MAX
MARKER TO MIN

1 2.359300 GHz
-20.004 dB
3 2.519600 GHz
-20.000 dB

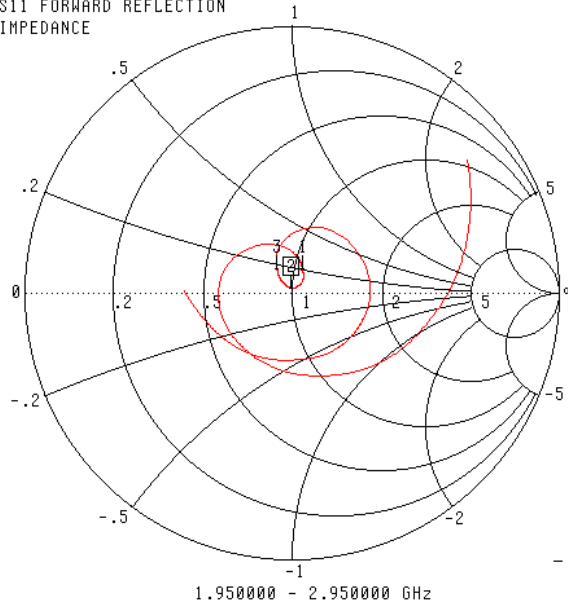
MARKER READOUT
FUNCTIONS

Electrical Specification 2450MHz Impedance

Tissue Type	Measured Epsilon	Measured Sigma
Head	37.87	1.82
Body	50.84	1.92

Head Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
2.450000 GHz
50.047 Ω
1.461 j Ω

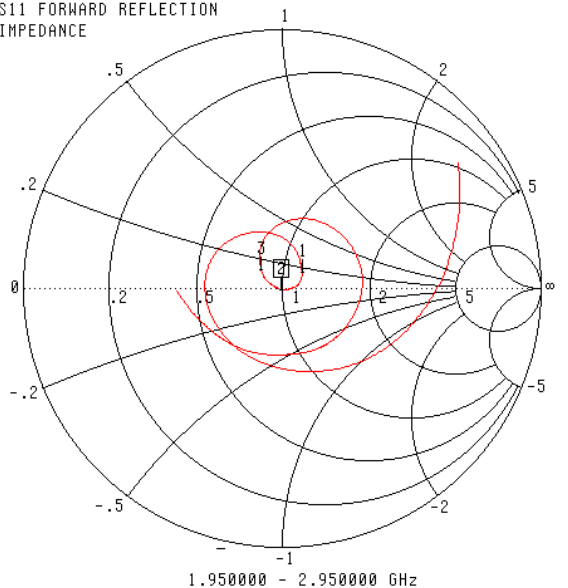
MARKER TO MAX
MARKER TO MIN

1 2.343100 GHz
53.538 Ω
9.647 j Ω
3 2.519500 GHz
44.446 Ω
7.748 j Ω

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION
IMPEDANCE



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

► MARKER 2
2.450000 GHz
50.190 Ω
-999.229 j Ω

MARKER TO MAX
MARKER TO MIN

1 2.359300 GHz
58.351 Ω
6.930 j Ω
3 2.519600 GHz
42.536 Ω
5.740 j Ω

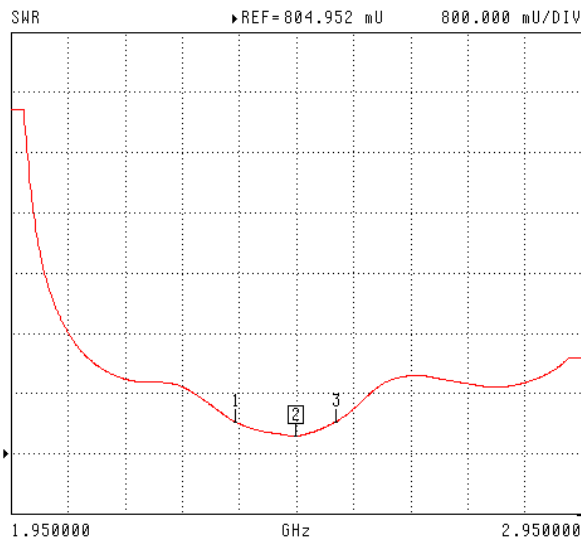
MARKER READOUT
FUNCTIONS

Electrical Specification 2450MHz Standing Wave Ratio

Tissue Type	Measured Epsilon	Measured Sigma
Head	37.87	1.82
Body	50.84	1.92

Head Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
2.450000 GHz
1.038 U

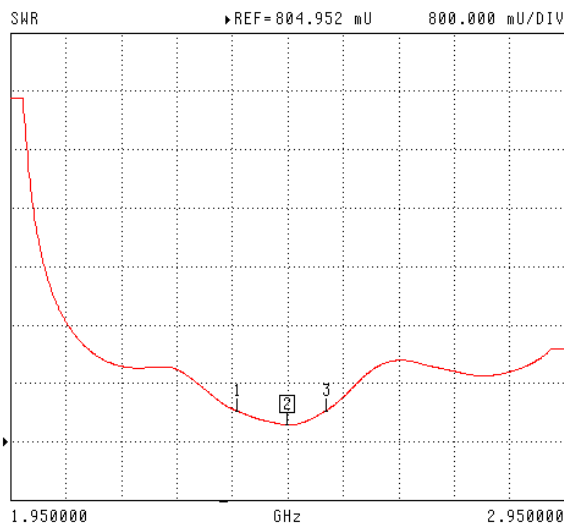
MARKER TO MAX
MARKER TO MIN

1 2.343100 GHz
1.226 U
3 2.519500 GHz
1.226 U

MARKER READOUT
FUNCTIONS

Body Tissue

S11 FORWARD REFLECTION



CH 1 - S11
5.0584 mm REF
0.000 dB OFFSET
0.00° OFFSET

MARKER 2
2.450000 GHz
1.029 U

MARKER TO MAX
MARKER TO MIN

1 2.359300 GHz
1.223 U
3 2.519600 GHz
1.227 U

MARKER READOUT
FUNCTIONS

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 2011.