

ES3DV3- SN:3036

August 20, 2015

### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3036

#### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth (mm) <sup>G</sup>	Unc (k=2)
150	52.3	0.76	7.06	7.06	7.06	0.05	1.20	± 13.3 %
450	43.5	0.87	6.58	6.58	6.58	0.19	1.90	± 13.3 %
750	41.9	0.89	6.13	6.13	6.13	0.25	2.28	± 12.0 %
835	41.5	0.90	5.96	5.96	5.96	0.31	1.86	± 12.0 %
1750	40.1	1.37	5.10	5.10	5.10	0.58	1.37	± 12.0 %
1900	40.0	1.40	4.90	4.90	4.90	0.71	1.22	± 12.0 %
2450	39.2	1.80	4.34	4.34	4.34	0.59	1.44	± 12.0 %
3700	37.7	3.12	3.84	3.84	3.84	0.35	2.20	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3036

#### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth (mm) <sup>G</sup>	Unc (k=2)
150	61.9	0.80	6.82	6.82	6.82	0.08	1.20	± 13.3 %
450	56.7	0.94	6.69	6.69	6.69	0.14	1.20	± 13.3 %
750	55.5	0.96	6.10	6.10	6.10	0.40	1.64	± 12.0 %
835	55.2	0.97	6.00	6.00	6.00	0.49	1.55	± 12.0 %
1750	53.4	1.49	4.75	4.75	4.75	0.51	1.48	± 12.0 %
1900	53.3	1.52	4.56	4.56	4.56	0.48	1.60	± 12.0 %
2450	52.7	1.95	4.19	4.19	4.19	0.80	1.09	± 12.0 %
3700	51.0	3.55	3.58	3.58	3.58	0.50	2.12	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

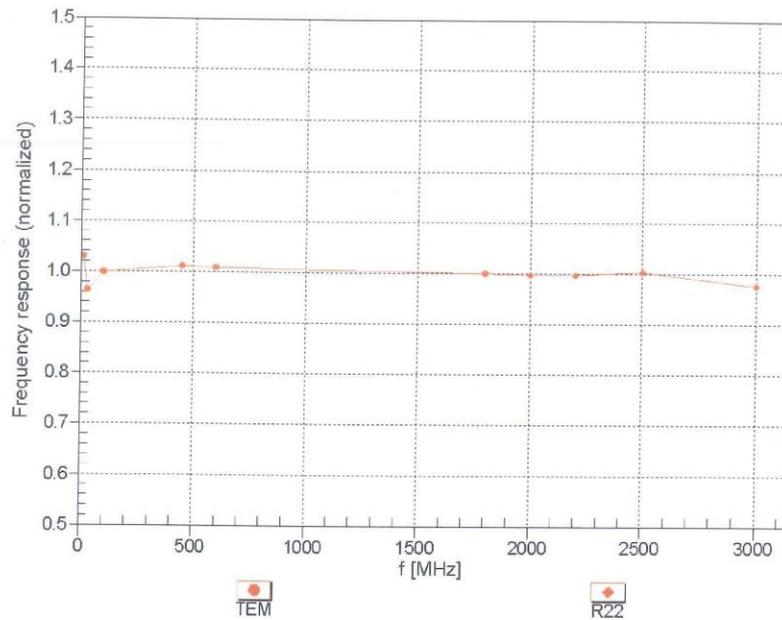
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

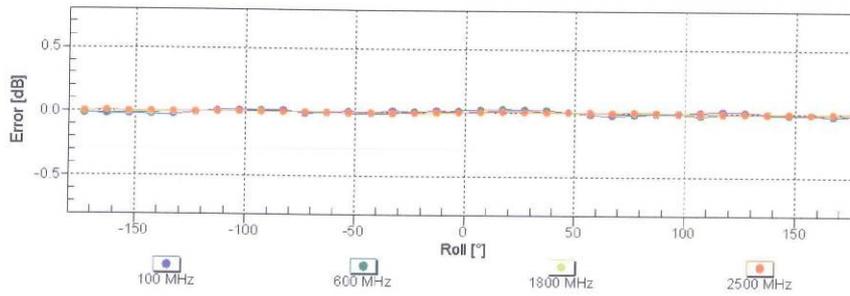
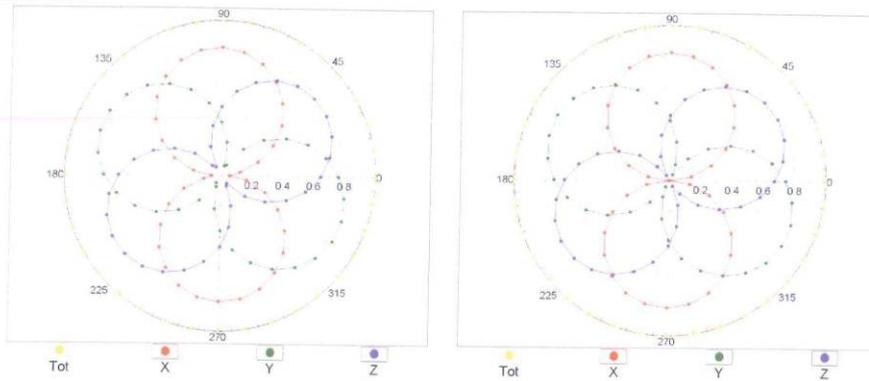
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### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$

f=600 MHz,TEM

f=1800 MHz,R22

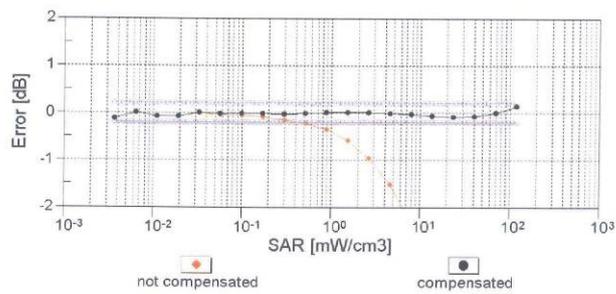
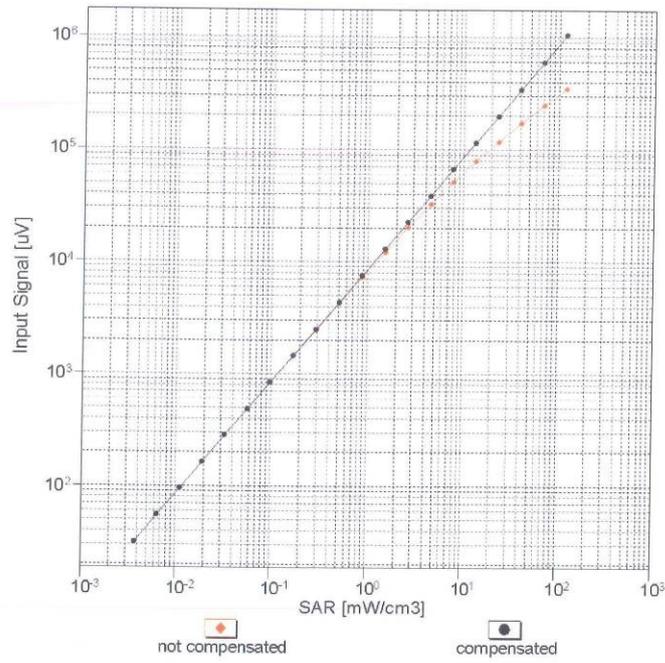


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f<sub>eval</sub>= 1900 MHz)

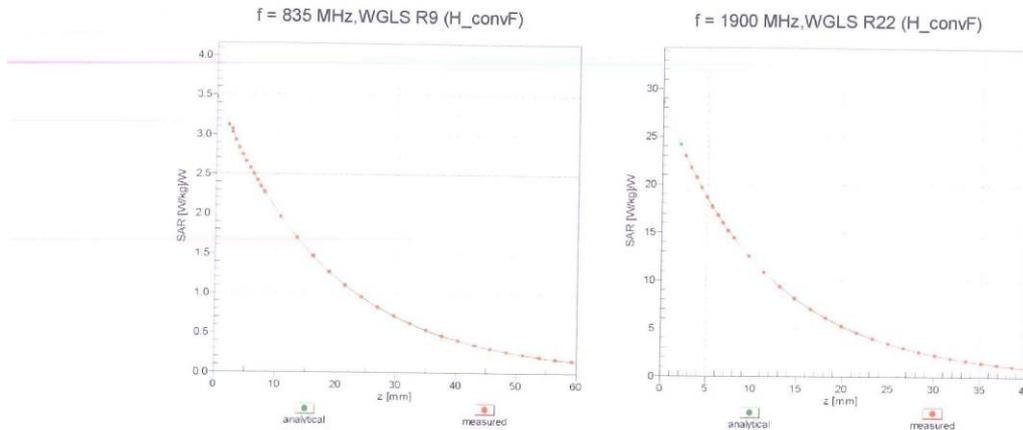


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

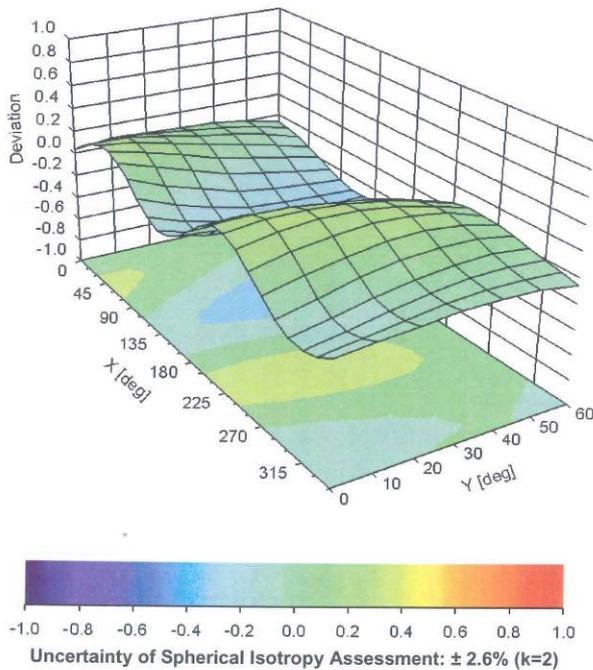
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### Conversion Factor Assessment



### Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



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### DASY/EASY - Parameters of Probe: ES3DV3 - SN:3036

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	17.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

## APPENDIX C DIPOLE CALIBRATION CERTIFICATES

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### NCL CALIBRATION LABORATORIES

Calibration File No: DC-1599  
Project Number: BAC-dipole-cal-5779

## 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(Head and Body)

Manufacturer: APREL Laboratories

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

Frequency: 835 MHz

Serial No: 180-00558

Customer: Bay Area Compliance Laboratory (China)

Calibrated: 8<sup>th</sup> October 2014  
Released on: 8<sup>th</sup> October 2014

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

Released By: \_\_\_\_\_



Art Brennan, Quality Manager

### **NCL** CALIBRATION LABORATORIES

Suite 102, 303 Terry Fox Dr.  
Kanata, ONTARIO  
CANADA K2K 3J1

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conditions**

Dipole 180-00558 was received with a damaged connection for a re-calibration.

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

**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 subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.



Art Brennan, Quality Manager



Maryna Nesterova Calibration Engineer

**Primary Measurement Standards**

Instrument	Serial Number	Cal due date
Tektronix USB Power Meter	11C940	May 14, 2015
Network Analyzer Anritsu 37347C	002106	Feb. 20, 2015

This page has been reviewed for content and attested to by signature within this document.

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Calibration Results Summary**

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

**Mechanical Dimensions**

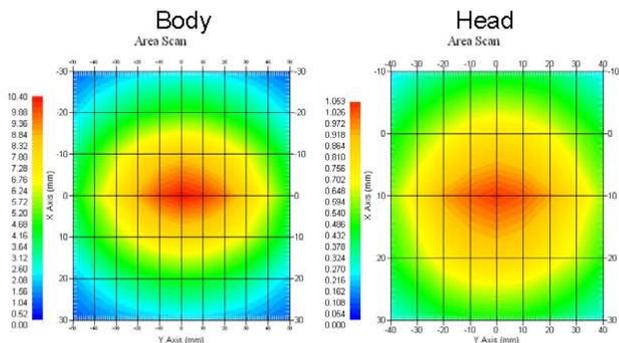
Length: 162.2 mm  
 Height: 89.4 mm

**Electrical Specification**

Tissue	Frequency	SWR:	Return Loss	Impedance
Head	835 MHz	1.066 U	-30.344 dB	49.001 Ω
Body	835 MHz	1.089 U	-28.118 dB	53.117 Ω

**System Validation Results**

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	835 MHz	9.773	6.174	14.713
Body	835 MHz	9.736	6.297	14.513



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**NCL Calibration Laboratories**

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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 180-00558. 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 30 MHz to 6 GHz E-Field Probe Serial Number 225.

**References**

- IEC-62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures"
- Part 2: "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)"
- 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 180-00558 was repaired prior to this calibration. The repair reliability depends upon correct usage of the dipole.

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

**Dipole Calibration uncertainty**

The calibration uncertainty for the dipole is made up of various parameters presented below.

<b>Mechanical</b>	1%
<b>Positioning Error</b>	1.22%
<b>Electrical</b>	1.7%
<b>Tissue</b>	2.2%
<b>Dipole Validation</b>	2.2%
<b>TOTAL</b>	<b>8.32% (16.64% K=2)</b>

This page has been reviewed for content and attested to by signature within this document.

**NCL Calibration Laboratories**

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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	89.4 mm

**Electrical Verification**

Tissue Type	Return Loss:	SWR:	Impedance:
Head	-30.344 dB	1.066 U	49.001Ω
Body	-28.118 dB	1.089 U	53.117 Ω □

**Tissue Validation**

	Dielectric constant, $\epsilon_r$	Conductivity, $\sigma$ [S/m]
Head Tissue 835MHz	43.42	0.94
Body Tissue 835MHz	55.77	1.01

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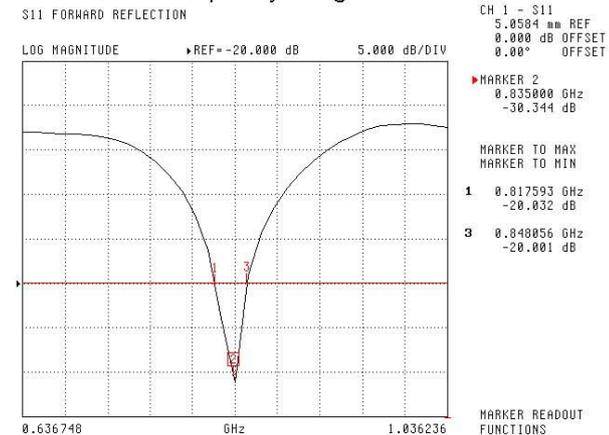
**NCL Calibration Laboratories**

Division of APREL Laboratories.

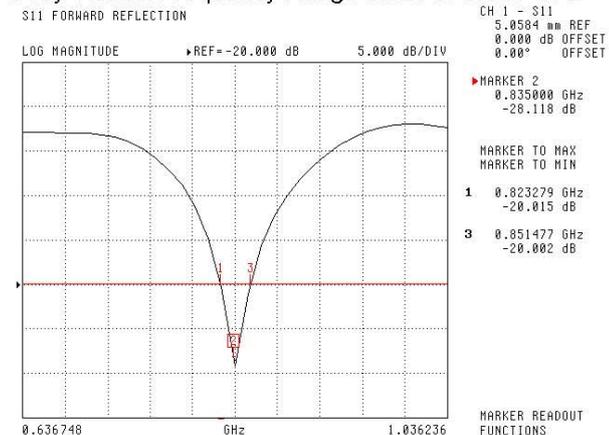
The Following Graphs are the results as displayed on the Vector Network Analyzer.

**S11 Parameter Return Loss**

Head Tissue: Frequency Range 0.817 to 0.848 GHz



Body Tissue: Frequency Range 0.823 to 0.851 GHz



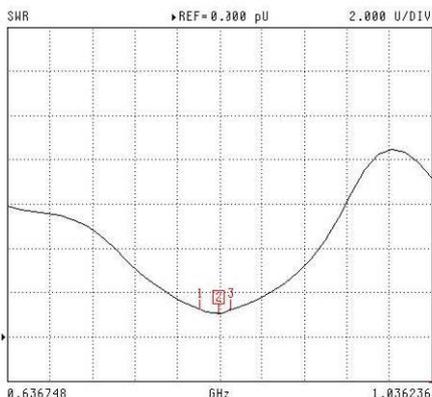
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**SWR**  
Head

S11 FORWARD REFLECTION



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

MARKER 2  
0.835000 GHz  
1.066 U

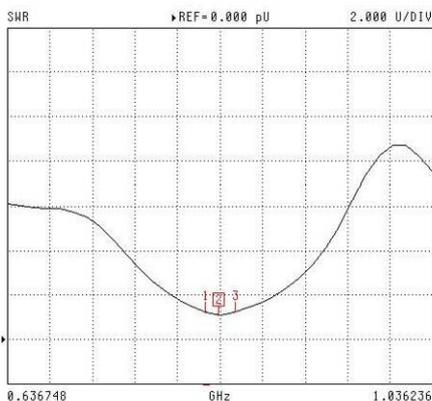
MARKER TO MAX  
MARKER TO MIN

- 1 0.817593 GHz  
1.251 U
- 3 0.848056 GHz  
1.235 U

MARKER READOUT  
FUNCTIONS

**Body**

S11 FORWARD REFLECTION



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

MARKER 2  
0.835000 GHz  
1.089 U

MARKER TO MAX  
MARKER TO MIN

- 1 0.823279 GHz  
1.226 U
- 3 0.851477 GHz  
1.234 U

MARKER READOUT  
FUNCTIONS

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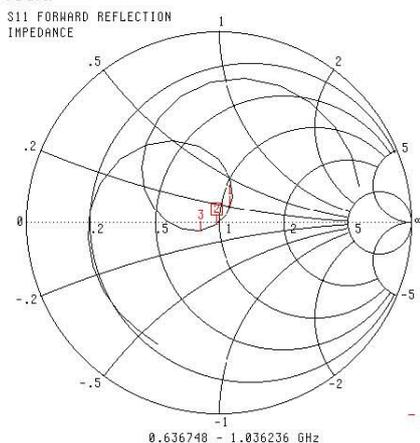
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**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Smith Chart Dipole Impedance**

**Head**



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

▶ MARKER 2  
 0.835000 GHz  
 49.001 Ω  
 -1.317 jΩ

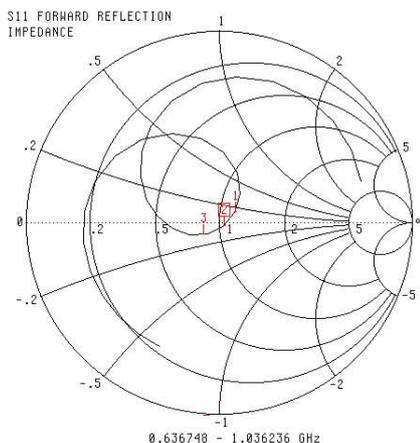
MARKER TO MAX  
 MARKER TO MIN

1 0.817593 GHz  
 55.620 Ω  
 10.003 jΩ

3 0.848056 GHz  
 41.274 Ω  
 -3.871 jΩ

MARKER READOUT FUNCTIONS

**Body**



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

▶ MARKER 2  
 0.835000 GHz  
 53.117 Ω  
 -1.024 jΩ

MARKER TO MAX  
 MARKER TO MIN

1 0.823279 GHz  
 59.000 Ω  
 6.263 jΩ

3 0.851477 GHz  
 42.412 Ω  
 -5.581 jΩ

MARKER READOUT FUNCTIONS

This page has been reviewed for content and attested to by signature within this document.

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Division of APREL Laboratories.

**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 2014.

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**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-1531  
Project Number: BACL-5745

**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.

BACL Head & Body Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-1750-S-2

Frequency: 1750 MHz

Serial No: 198-00304

Customer: ISL

Calibrated: 8<sup>th</sup> October, 2013  
Released on: 8<sup>th</sup> October, 2013

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

Released By:



Art Brennan, Quality Manager

**NCL CALIBRATION LABORATORIES**

Suite 102, 303 Terry Fox Dr,  
OTTAWA, ONTARIO  
CANADA K2K 3J1

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conditions**

Dipole 198-00304 was an original 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 subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.**



Art Brennan, Quality Manager



Constantin Teodorian, Test Engineer

This page has been reviewed for content and attested to by signature within this document.

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**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Calibration Results Summary**

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

**Mechanical Dimensions**

Length: 75 mm  
 Height: 42 mm

**Electrical Calibration**

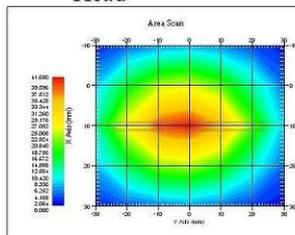
Test	Result Head	Result Body
S11 R/L	-25.567	-20.548 dB
SWR	1.111U	1.207 U
Impedance	53.637Ω	55.929 Ω

**System Validation Results, 1750 MHz**

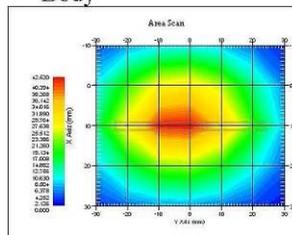
	1g	10g
Head	37.02	18.99
Body	36.65	18.85

Type	Epsilon	Sigma
Head	38.51	1.36
Body	51.79	1.53

Head



Body



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**NCL Calibration Laboratories**

Division of APREL Laboratories.

**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. 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**

- 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"
- 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)"

**Conditions**

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

This was an original calibration taken from stock.

**Dipole Calibration uncertainty**

The calibration uncertainty for the dipole is made up of various parameters presented below.

<b>Mechanical</b>	1%
<b>Positioning Error</b>	1.22%
<b>Electrical</b>	1.7%
<b>Tissue</b>	2.2%
<b>Dipole Validation</b>	2.2%
<b>TOTAL</b>	<b>8.32% (16.64% K=2)</b>

This page has been reviewed for content and attested to by signature within this document.

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**Dipole Calibration Results****Mechanical Verification**

Measured Length	Measured Height
75 mm	42 mm

**Tissue Validation**

Frequency	Permittivity $\epsilon$	Conductivity $\sigma$
1750 Head	38.23	1.38
1750 Body	52.86	1.54

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**NCL Calibration Laboratories**

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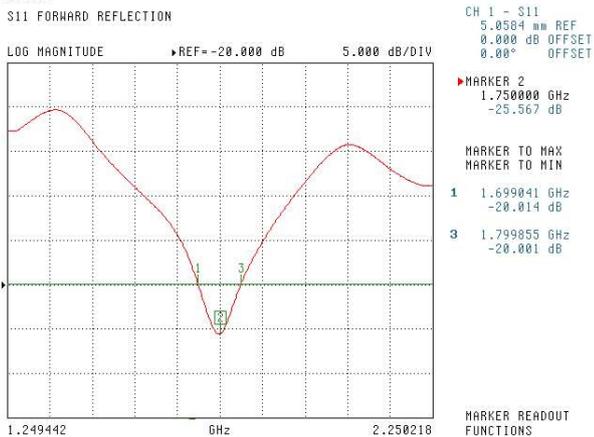
**Electrical Calibration**

Test	Result Head	Result Body
S11 R/L	-25.567	-20.548 dB
SWR	1.111U	1.207 U
Impedance	53.637Ω	55.929 Ω

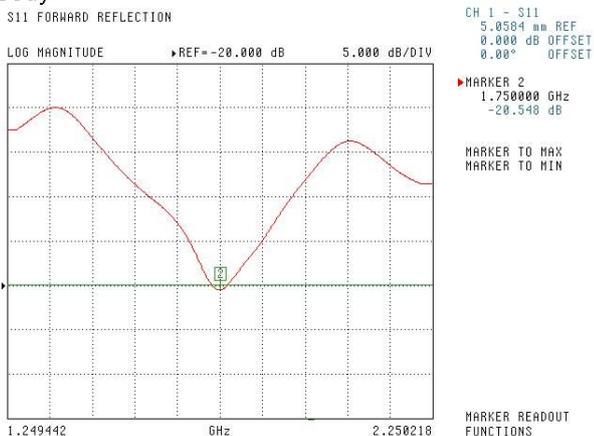
The Following Graphs are the results as displayed on the Vector Network Analyzer.

**S11 Parameter Return Loss**

**Head**



**Body**

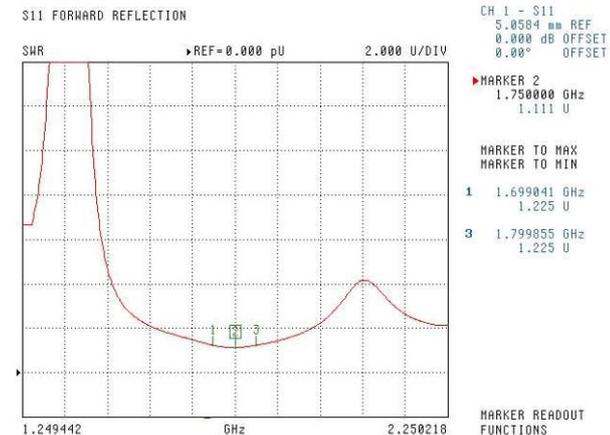


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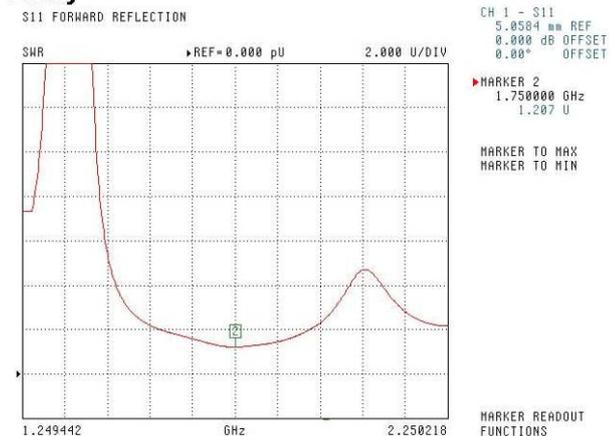
**NCL Calibration Laboratories**

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**SWR  
Head**



**Body**



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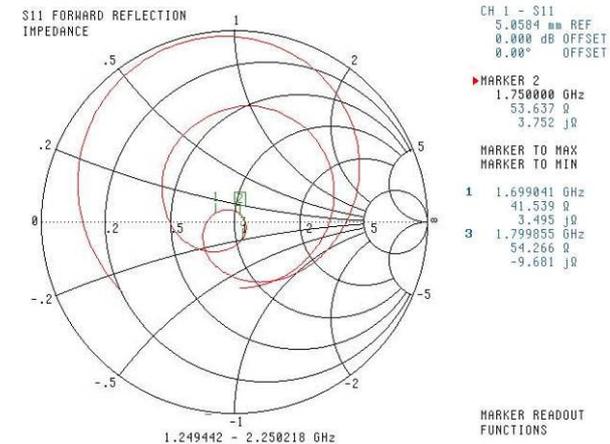
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**NCL Calibration Laboratories**

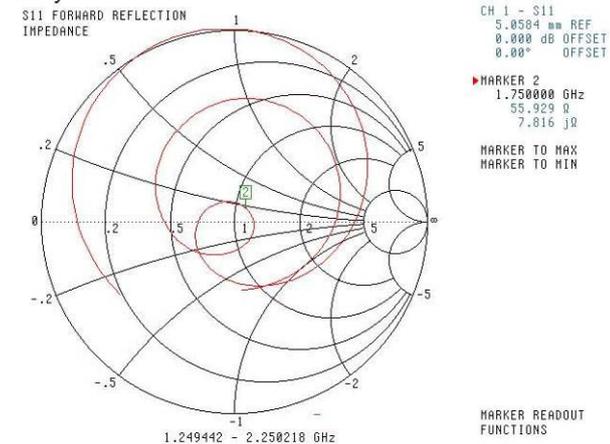
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**Smith Chart Dipole Impedance**

**Head**



**Body**



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**NCL Calibration Laboratories**

Division of APREL Laboratories.

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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 2013

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**NCL CALIBRATION LABORATORIES**

Calibration File No: DC-1601  
Project Number: BAC-dipole -cal-5779

**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 (Head & Body)

Manufacturer: APREL Laboratories  
Part number: ALS-D-1900-S-2  
Frequency: 1900 MHz  
Serial No: 210-00710

Customer: Bay Area Compliance Laboratory (China)

Calibrated: 9<sup>th</sup> October, 2014  
Released on: 9<sup>th</sup> October, 2014

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

Released By:



Art Brennan, Quality Manager

**NCL CALIBRATION LABORATORIES**

Suite 102, 303 Terry Fox Dr.  
Kanata, ONTARIO  
CANADA K2K 3J1

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

**NCL Calibration Laboratories**

Division of APREL Laboratories.

**Conditions**

Dipole 210-00710 was received in good condition and was a re-calibration.

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

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

**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 subject has been accurately conducted and that all information contained within the results pages have been reviewed for accuracy.



Art Brennan, Quality Manager



Maryna Nesterova Calibration Engineer

**Primary Measurement Standards**

Instrument	Serial Number	Cal due date
Tektronix USB Power Meter	11C940	May 14, 2015
Network Analyzer Anritsu 37347C	002106	Feb. 20, 2015

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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**

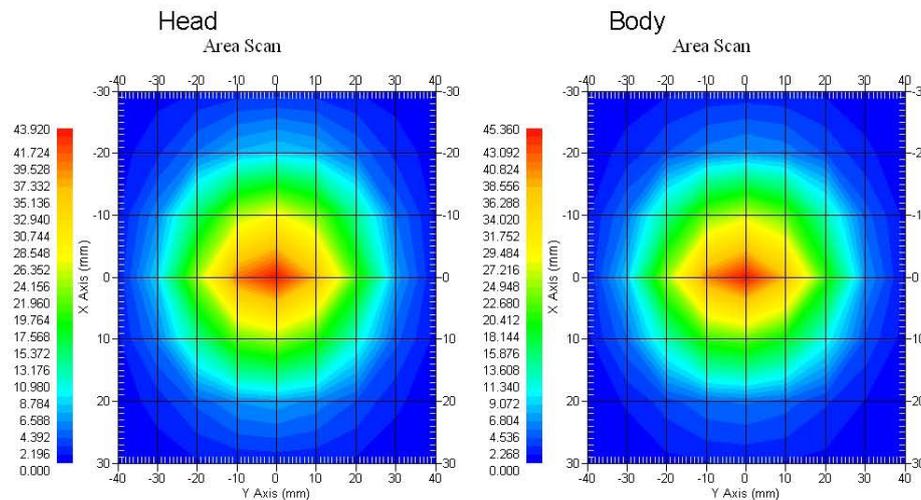
**Length:** 67.1 mm  
**Height:** 38.9 mm

**Electrical Specification**

Tissue	Frequency	SWR:	Return Loss	Impedance
Head	1900MHz	1.084 U	-27.92 dB	52.247 Ω
Body	1900MHz	1.128 U	-24.40 dB	52.618 Ω

**System Validation Results**

Tissue	Frequency	1 Gram	10 Gram	Peak
Head	1900 MHz	39.481	20.44	73.364
Body	1900 MHz	39.715	20.552	73.565



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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 210-00710. 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 30 MHz to 6 GHz E-Field Probe Serial Number 225.

**References**

- IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”
- Part 2: “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)”
- 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 210-00710 was a recalibration.

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

**Dipole Calibration uncertainty**

The calibration uncertainty for the dipole is made up of various parameters presented below.

<b>Mechanical</b>	1%
<b>Positioning Error</b>	1.22%
<b>Electrical</b>	1.7%
<b>Tissue</b>	2.2%
<b>Dipole Validation</b>	2.2%
<b>TOTAL</b>	<b>8.32% (16.64% K=2)</b>

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**Dipole Calibration Results**

**Mechanical Verification**

APREL Length	APREL Height	Measured Length	Measured Height
68.0 mm	39.5 mm	67.1mm	38.9 mm

**Electrical Validation**

Tissue	Frequency	SWR:	Return Loss	Impedance
Head	1900MHz	1.084 U	-27.92 dB	52.247 $\Omega$
Body	1900MHz	1.128 U	-24.40 dB	52.618 $\Omega$

**Tissue Validation**

	Dielectric constant, $\epsilon_r$	Conductivity, $\sigma$ [S/m]
Head Tissue 1900MHz	40.20	1.38
Body Tissue 1900MHz	52.63	1.46

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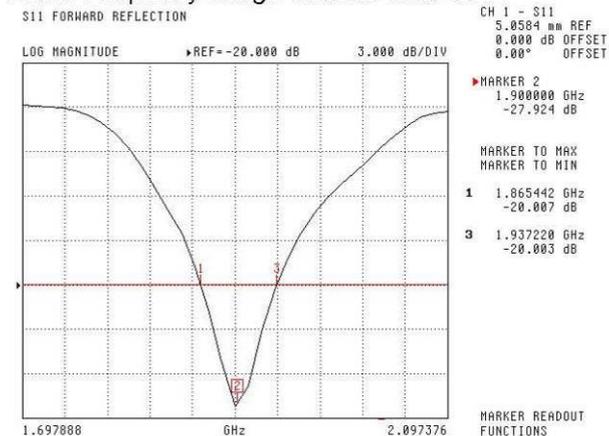
**NCL Calibration Laboratories**

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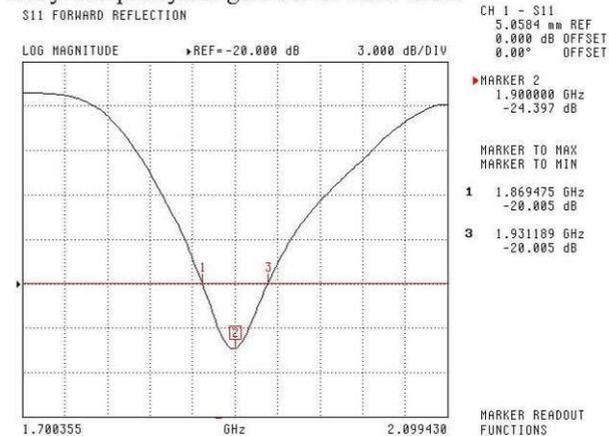
The Following Graphs are the results as displayed on the Vector Network Analyzer.

**S11 Parameter Return Loss**

Head: Frequency Range 1.865 to 1.937 GHz



Body: Frequency Range 1.869 to 1.931 MHz



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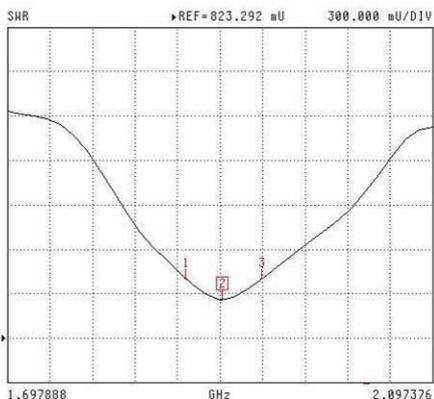
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**SWR**

**Head**

S11 FORWARD REFLECTION



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

MARKER 2  
1.900000 GHz  
1.004 U

MARKER TO MAX

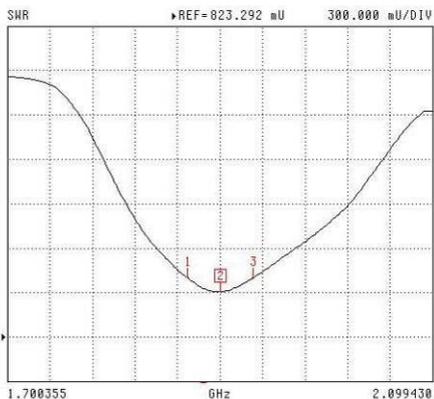
MARKER TO MIN

- 1 1.865442 GHz  
1.226 U
- 3 1.937220 GHz  
1.224 U

MARKER READOUT FUNCTIONS

**Body**

S11 FORWARD REFLECTION



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

MARKER 2  
1.900000 GHz  
1.128 U

MARKER TO MAX

MARKER TO MIN

- 1 1.869475 GHz  
1.223 U
- 3 1.931189 GHz  
1.223 U

MARKER READOUT FUNCTIONS

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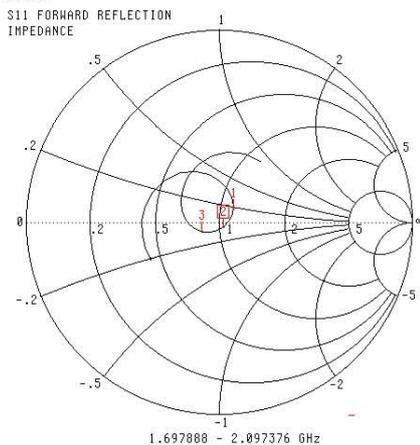
7

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**Smith Chart Dipole Impedance**

**Head**



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

MARKER 2  
 1.900000 GHz  
 52.247 Ω  
 -3.103 jΩ

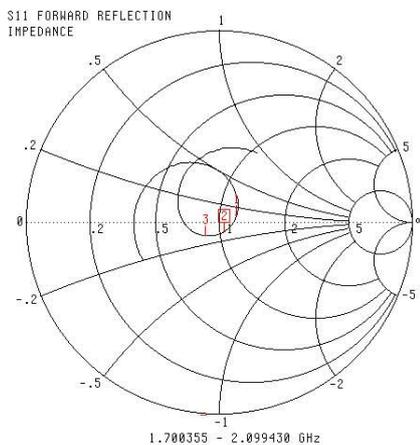
MARKER TO MAX  
 MARKER TO MIN

1 1.865442 GHz  
 57.627 Ω  
 7.644 jΩ

3 1.937220 GHz  
 41.868 Ω  
 -4.273 jΩ

MARKER READOUT FUNCTIONS

**Body**



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

MARKER 2  
 1.900000 GHz  
 52.618 Ω  
 -5.535 jΩ

MARKER TO MAX  
 MARKER TO MIN

1 1.869475 GHz  
 60.277 Ω  
 4.049 jΩ

3 1.931189 GHz  
 43.257 Ω  
 -6.479 jΩ

MARKER READOUT FUNCTIONS

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**Test Equipment**

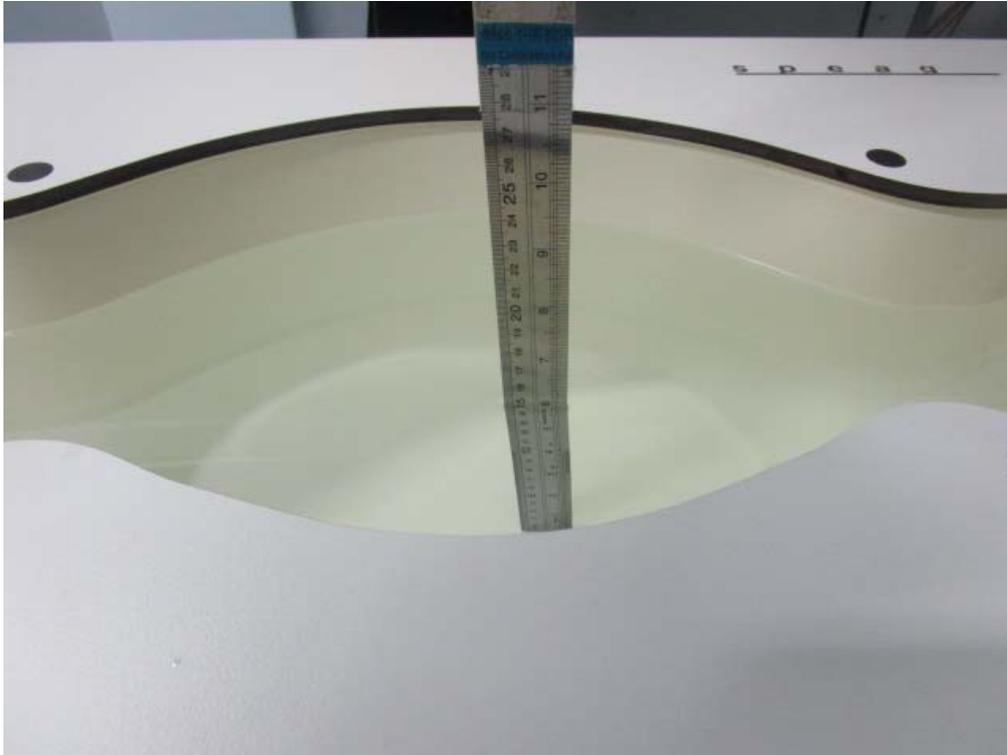
The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List 2014

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## APPENDIX D EUT TEST POSITION PHOTOS

Liquid depth  $\geq 15\text{cm}$



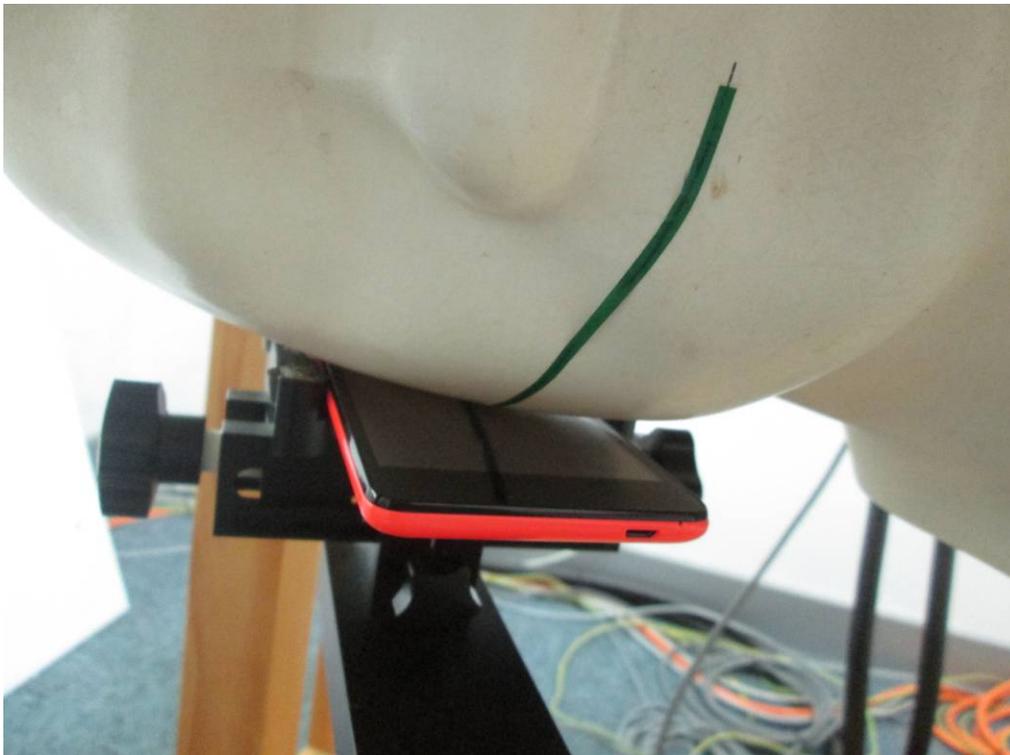
Left Head Touch Setup Photo



**Left Head Tilt Setup Photo**



**Right Head Touch Setup Photo**



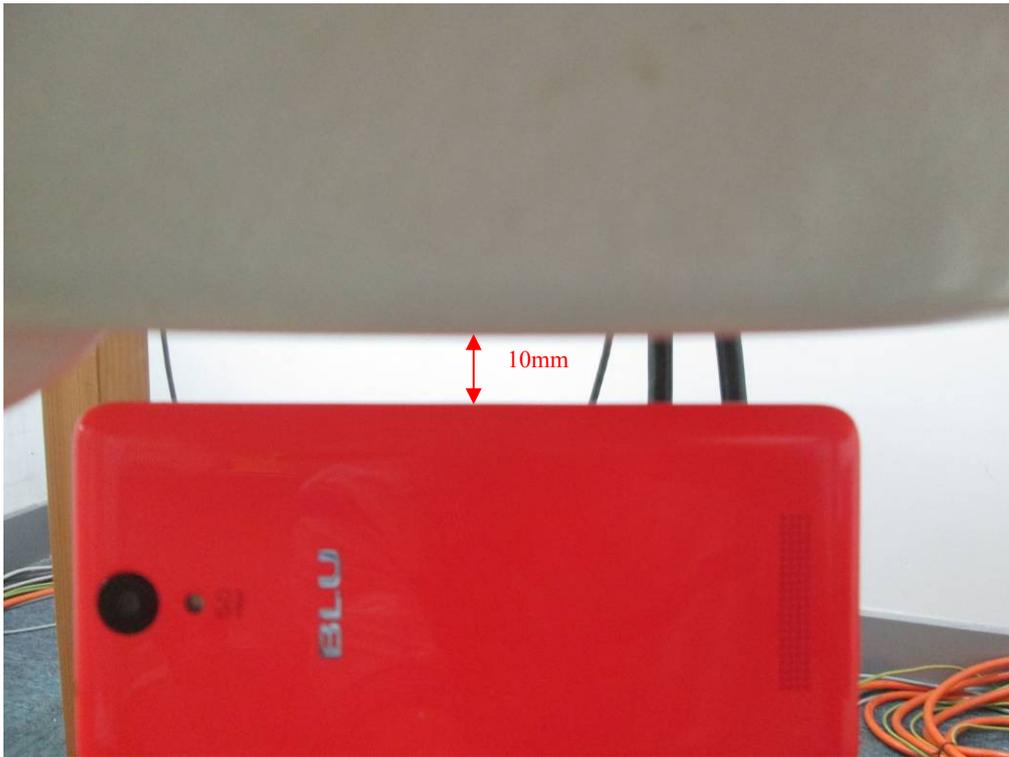
**Right Head Tilt Setup Photo**



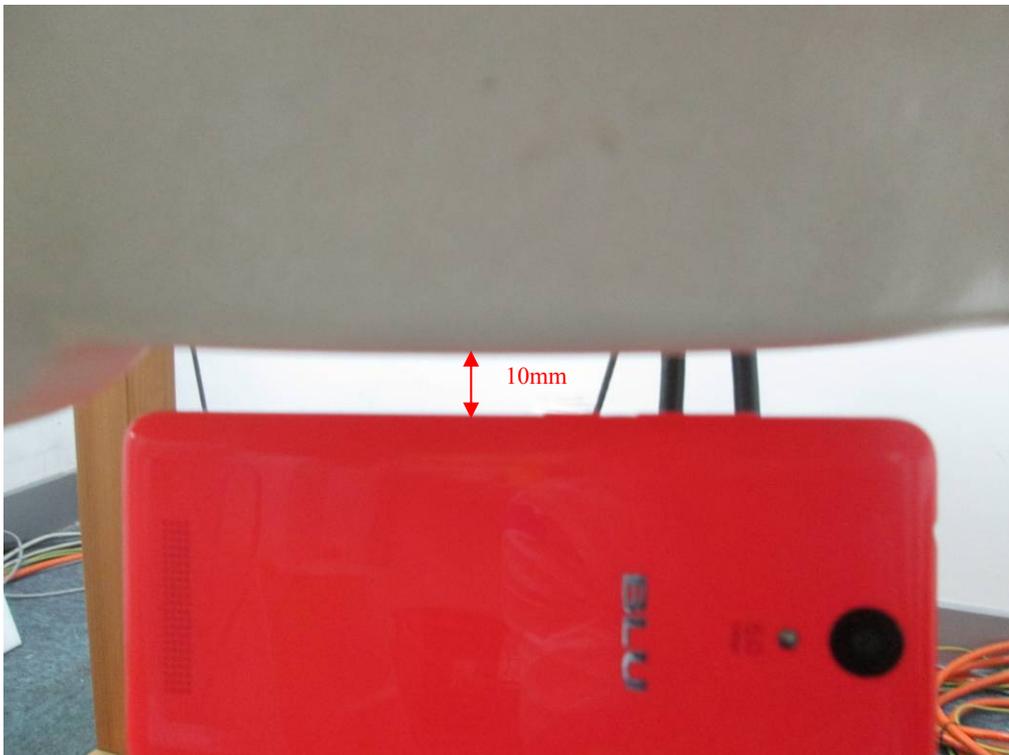
**Body-worn Back Setup Photo**



**Body-worn Left Setup Photo**



**Body-worn Right Setup Photo**



**Body-worn Bottom Setup Photo**



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## APPENDIX F INFORMATIVE REFERENCES

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- [2] David L. Means Kwok Chan, Robert F. Cleveland, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
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- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with known precision", IEEE Transactions on Communications, vol. E80-B, no. 5, pp. 645-652, May 1997.
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- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992. Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10.

\*\*\*\*\* END OF REPORT \*\*\*\*\*