

NCL CALIBRATION LABORATORIES

Calibration File No: DC-1613
Project Number: ISL-D-cal-5785

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 (Body)

Manufacturer: APREL Laboratories

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

Frequency: 2450 MHz

Serial No: 220-00753

Customer: ISL

Calibrated: 12th January 2015
Released on: 15th January 2015

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

Released By:



Art Brennan, Quality Manager

NCL CALIBRATION LABORATORIES

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NCL Calibration Laboratories

Division of APREL Laboratories.

Conditions

Dipole 220-00753 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
Agilent Signal Generator	MY45094463	Dec. 2015

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

Calibration Results Summary

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

Mechanical Dimensions

Length	Height
51.5 mm	30.4 mm

Tissue Validation

Tissue	Frequency	Dielectric constant, ϵ_r	Conductivity, σ [S/m]
Body	2450 MHz	53.26	1.96

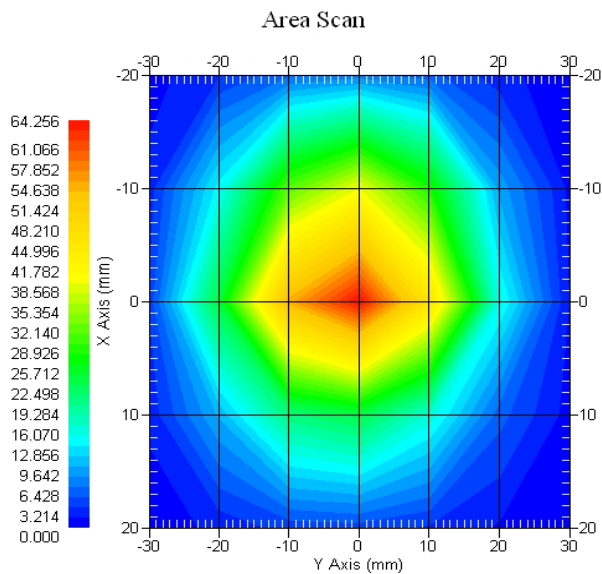
Electrical Specification

Tissue	Frequency	SWR:	Return Loss	Impedance
Body	2450 MHz	1.03 U	-36.635 dB	49.353 Ω

System Validation Results

Tissue	Frequency	1 Gram	10 Gram
Body	2450 MHz	53.46	24.89

Body



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 220-00753. 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 266.

References

- IEEE Standard 1528:2013
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 62209-2:2010
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)
- D22-012-Tissue dielectric tissue calibration procedure
- D28-002-Dipole procedure for validation of SAR system using a dipole
- IEEE 1309 Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9kHz to 40GHz

Conditions

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

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

Dipole Calibration uncertainty

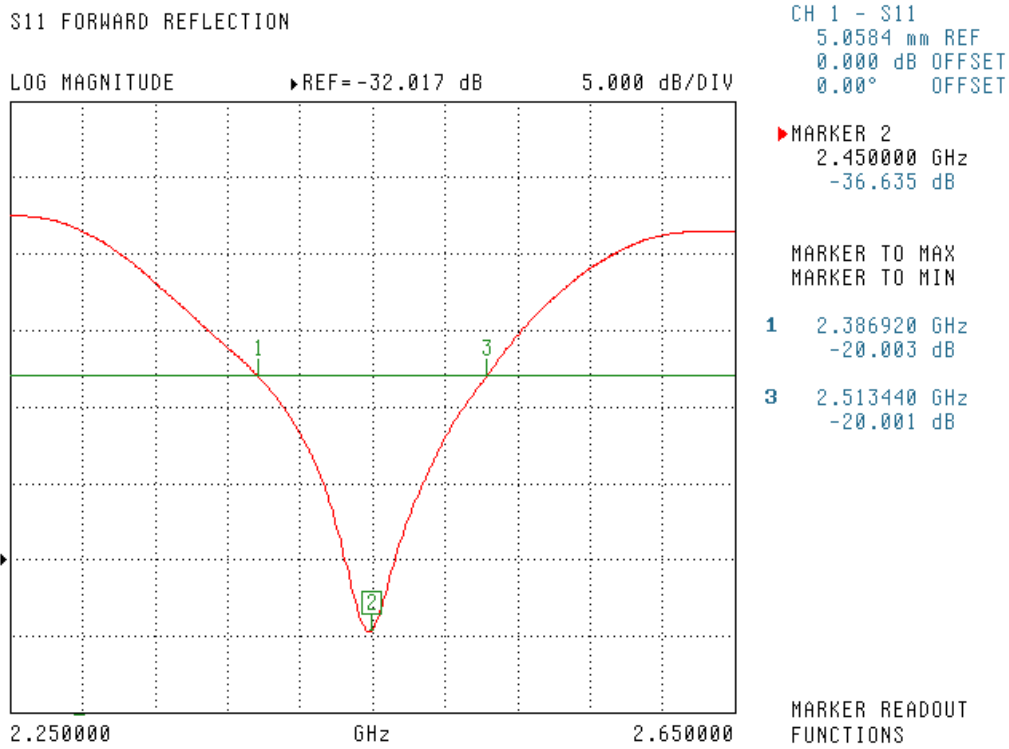
The calibration uncertainty for the dipole is made up of various parameters presented below.

Mechanical	1%
Positioning Error	1.22%
Electrical	1.7%
Tissue	2.2%
Dipole Validation	2.2%
Combined Standard Uncertainty	3.88% (7.76% K=2)

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

S11 Parameter Return Loss

Body Tissue: Frequency Range 2386.9 MHz to 2513.4 MHz

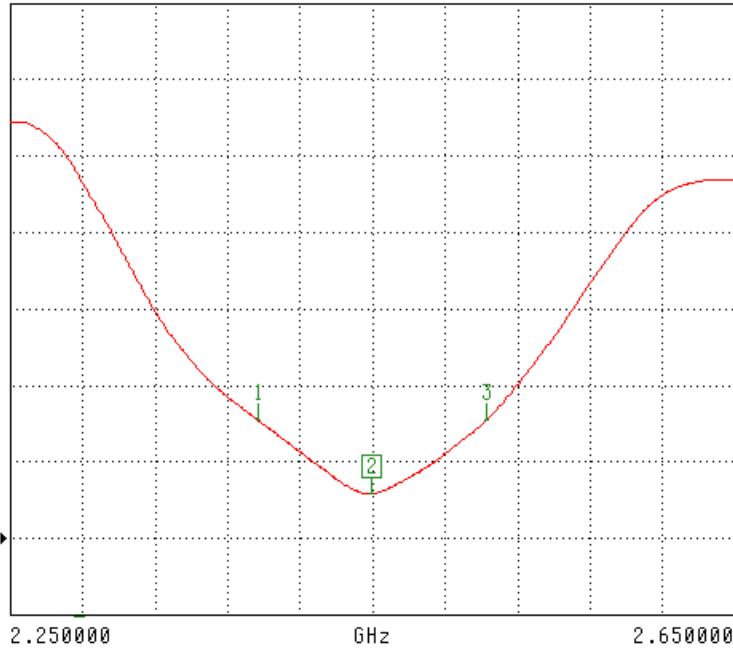


SWR

Body

S11 FORWARD REFLECTION

SWR REF=913.800 mU 200.000 mU/DIV



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

MARKER 2
2.450000 GHz
1.030 U

MARKER TO MAX
MARKER TO MIN

1 2.386920 GHz
1.223 U

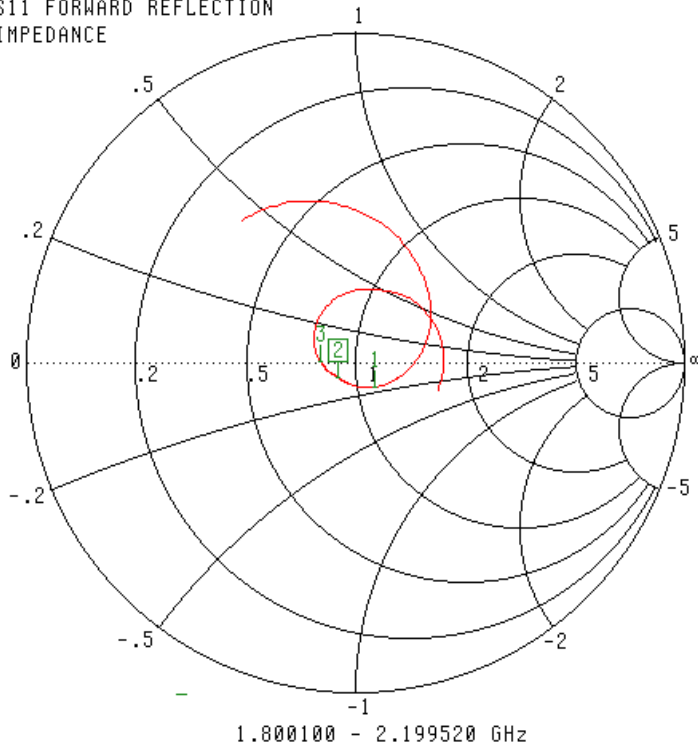
3 2.513440 GHz
1.223 U

MARKER READOUT
FUNCTIONS

Smith Chart Dipole Impedance

Body

S11 FORWARD REFLECTION
IMPEDANCE



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

▶ MARKER 2
2.000000 GHz
45.008 Ω
-4.246 jΩ

MARKER TO MAX
MARKER TO MIN

1 1.954662 GHz
55.879 Ω
-8.859 jΩ
3 2.026950 GHz
40.917 Ω
-157.369 jmΩ

MARKER READOUT
FUNCTIONS