



In Collaboration with
s p e a g
CALIBRATION LABORATORY

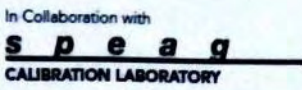
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

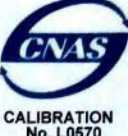
DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7340

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	130.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

F.2 Data Acquisition Electronics



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CALIBRATION
No. L0570

Client : **baluntek** Certificate No: **Z15-97195**

CALIBRATION CERTIFICATE

Object: **DAE4 - SN: 1454**

Calibration Procedure(s): **FD-Z11-2-002-01
Calibration Procedure for the Data Acquisition Electronics (DAEx)**

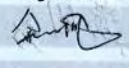
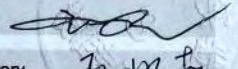
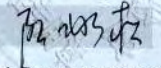
Calibration date: **December 08, 2015**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	06-July-15 (CTTL, No:J15X04257)	July-16

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: December 09, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: Z15-97195
Page 1 of 3



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Glossary:

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V, full range = -100...+300 mV
Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.175 $\pm$ 0.15% (k=2)	403.666 $\pm$ 0.15% (k=2)	403.739 $\pm$ 0.15% (k=2)
Low Range	4.01281 $\pm$ 0.7% (k=2)	3.9916 $\pm$ 0.7% (k=2)	3.99929 $\pm$ 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	317.5° $\pm$ 1°
---	-----------------

F.3 Dual Logo-CTTL-SPEAG-certificates

Schmid & Partner Engineering AG

s p e a g

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Tolan Tu
Shenzhen BALUN Technology Co., Ltd.
Block B, FL 1, Baisha Science and Technology
Park, Shahe Xi Road, Nanshan District,
Shenzhen, Guangdong Province,
P. R. China

Email: tulang@baluntek.com

Zurich, March 4, 2016/ kp

To whom it may concern:

Schmid & Partner Engineering AG (SPEAG), established and reputable manufacturers of dosimetry equipment at Zeughausstrasse 43 CH - 8004 Zurich Switzerland, do hereby certify that below listed calibration certificates have been approved for release under CTTL-SPEAG dual-logo as per QAP4CAL agreement between SPEAG and CTTL Beijing SAR calibration lab.

Certificate No. Z15-97195 (calibration of DAE4 – SN: 1454)
Certificate No. Z15-97196 (calibration of EX3DV4 – SN: 7340)

Yours sincerely,

Schmid & Partner Engineering AG

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Dr. Katja Pokovic
Director Laboratory & Services

1/1

F.4 Dipole Performance Measurement Report

SAR Dipole

Performance
Measurement
ReportISSUED BY
Shenzhen BALUN Technology Co., Ltd.FOR
Validation Dipoles

Tested by:

Tu Lang
(Engineer)

Approved by:

Wei Yanqian
(Chief Engineer)Report No.: LW-SZ15C0264-701
EUT Type: SAR Validation Dipole
Model Name: D835V2, D1750V2
D1900V2, D2450V2
D2600V2, D5GHzV2
Brand Name: SpeagTest Conclusion: Pass
Test Date: Oct. 23, 2015 ~ Oct. 26, 2015
Date of Issue: Oct. 29, 2015

NOTE: This test report can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. BALUN Laboratory. Any objections should be raised within thirty days from the date of issue. To validate the report, please visit BALUN website.



1 GENERAL INFORMATION

1.1 Introduction

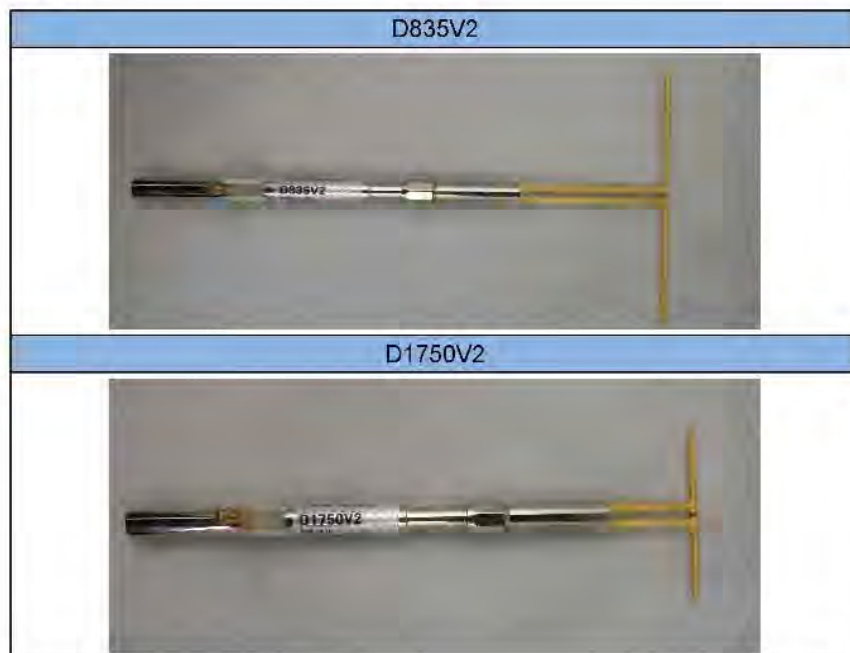
This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDB 865664 D01 for reference dipoles used for SAR measurement system validations. Instead of the typical annual calibration recommended by measurement standards, the reference dipoles were demonstrated that the SAR target, impedance and return loss have remain stable, so the longer calibration interval is acceptable.

1.2 General Description for Equipment under Test (EUT)

EUT Type	DASY 52 Reference Dipoles
Manufacturer	Speag

Parameter	EUT 1	EUT 2	EUT 3	EUT 4	EUT 5	EUT 6
Model	D835V2	D1750V2	D1900V2	D2450V2	D2600V2	D5GHzV2
Frequency	835 MHz	1750 MHz	1900 MHz	2450 MHz	2600 MHz	5GHz-6GHz
Serial Number	SN 4d187	SN 1130	SN 5d193	SN 952	SN 1095	SN 1200
Product Condition (New/ Used)	Used	Used	Used	Used	Used	Used
Last Cal. Date	2014/11/26	2014/11/28	2014/11/28	2014/11/27	2014/11/27	2014/12/4

1.3 EUT Photos





D1900V2

D2450V2

D2600V2

D5GHzV2




2 SIMULATING LIQUID VERIFICATION

Liquid Type	Fre. (MHz)	Meas. Conductivity (σ) (S/m)	Meas. Permittivity (ϵ)	Target Conductivity (σ) (S/m)	Target Permittivity (ϵ)	Conductivity Tolerance (%)	Permittivity Tolerance (%)
Head	835	0.89	41.83	0.90	41.50	-1.11	0.80
Body	835	0.98	53.88	0.97	55.20	1.03	-2.39
Head	1750	1.38	39.23	1.37	40.10	0.73	-2.17
Body	1750	1.45	51.75	1.49	53.40	-2.68	-3.09
Head	1900	1.43	39.44	1.40	40.00	2.14	-1.40
Body	1900	1.55	51.61	1.52	53.30	1.97	-3.17
Head	2450	1.84	38.53	1.80	39.20	2.22	-1.71
Body	2450	1.99	51.17	1.95	52.70	2.05	-2.90
Head	2600	1.97	38.09	1.96	39.00	0.51	-2.33
Body	2600	2.20	50.81	2.16	52.50	1.85	-3.22
Head	5200	4.78	36.52	4.66	35.99	2.58	1.47
Body	5200	5.38	48.74	5.30	49.01	1.51	-0.55
Head	5600	5.20	35.06	5.07	35.53	2.56	-1.32
Body	5600	5.72	46.31	5.77	48.47	-0.87	-4.46
Head	5800	5.42	34.40	5.27	35.30	2.85	-2.55
Body	5800	5.92	46.06	6.00	48.20	-1.33	-4.44



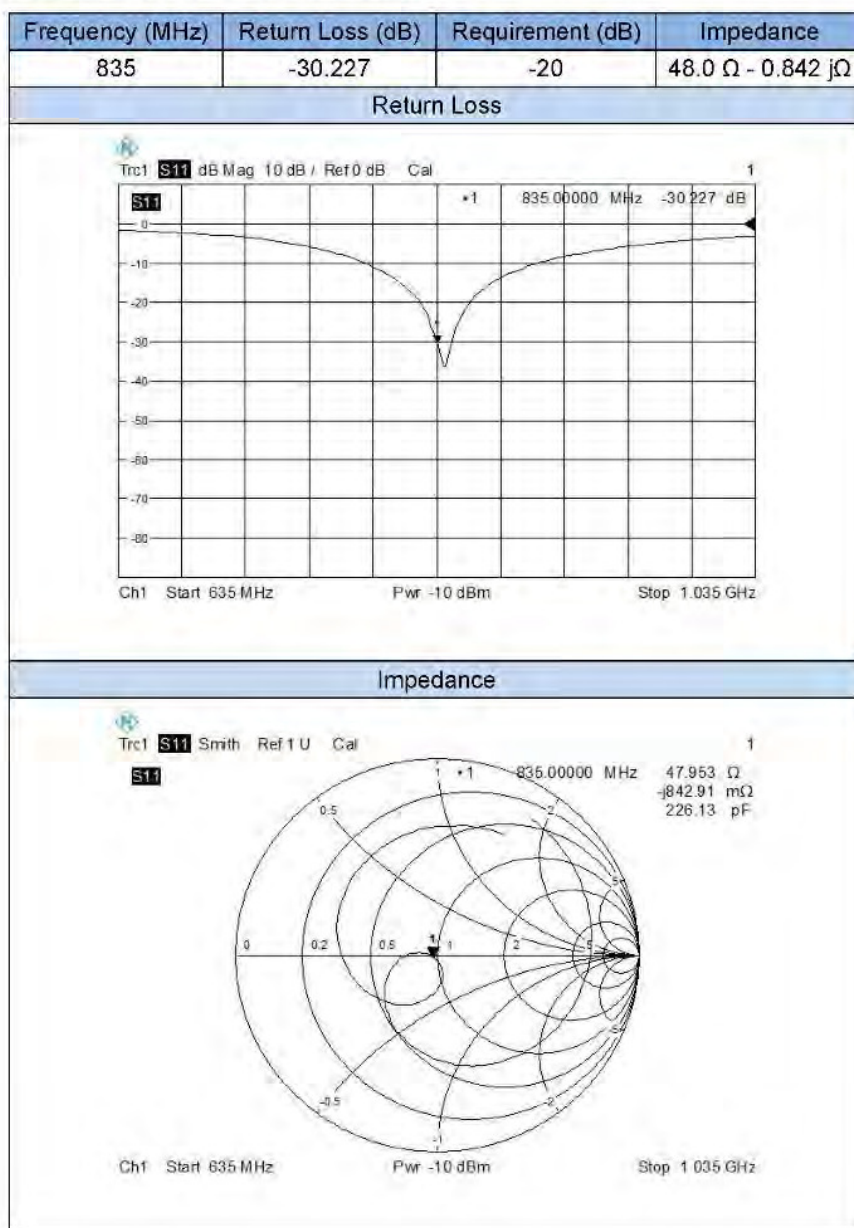
3 DIPOLE IMPEDANCE AND RETURN LOSS

The dipoles are designed to have low return loss when presented against a flat phantom at the specified distance. A Vector Network Analyser was used to perform a return loss measurement on the specific dipole when in the measurement location against the phantom and the distance was specified by the manufacturer with a special, low loss and low relative permittivity spacer.

The impedance was measured at the SMA-connector with the network analyser.

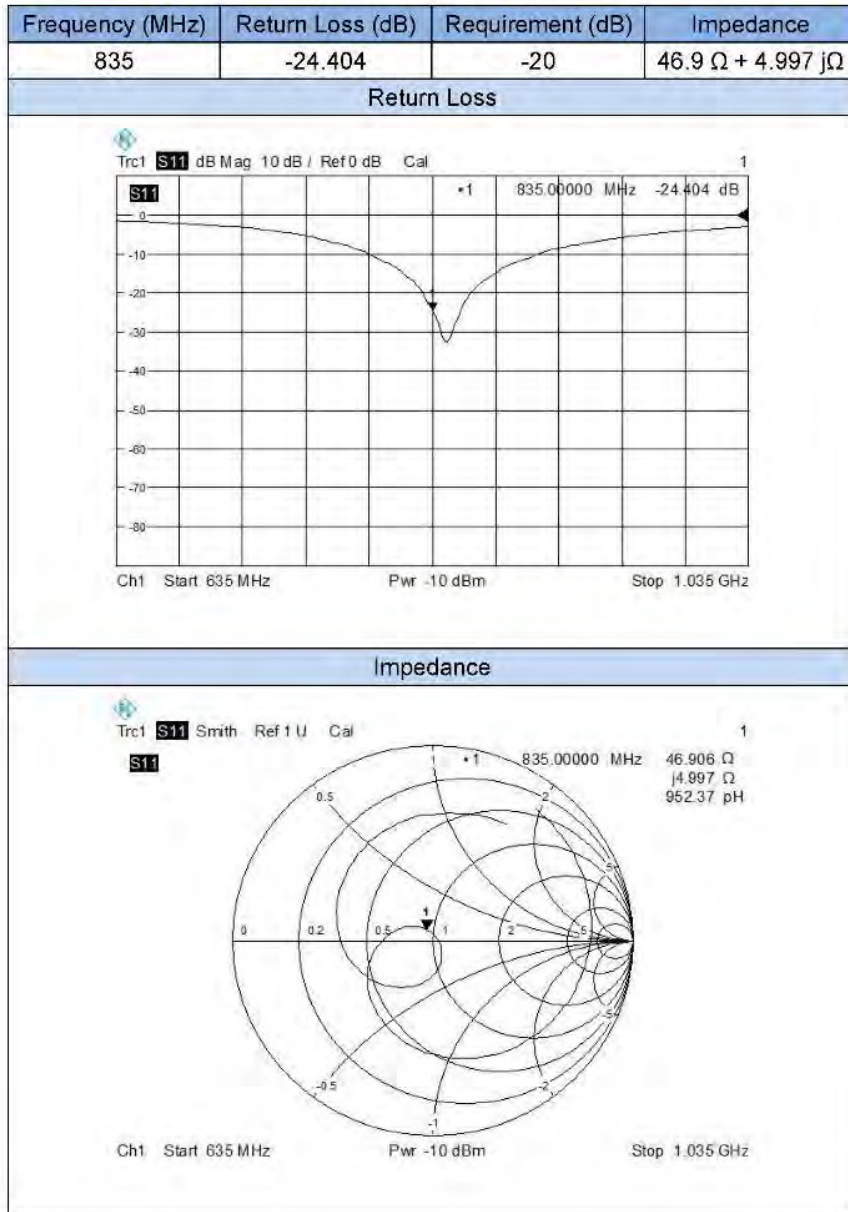
3.1 D835V2

RETURN LOSS AND IMPEDANCE IN HEAD LIQUID





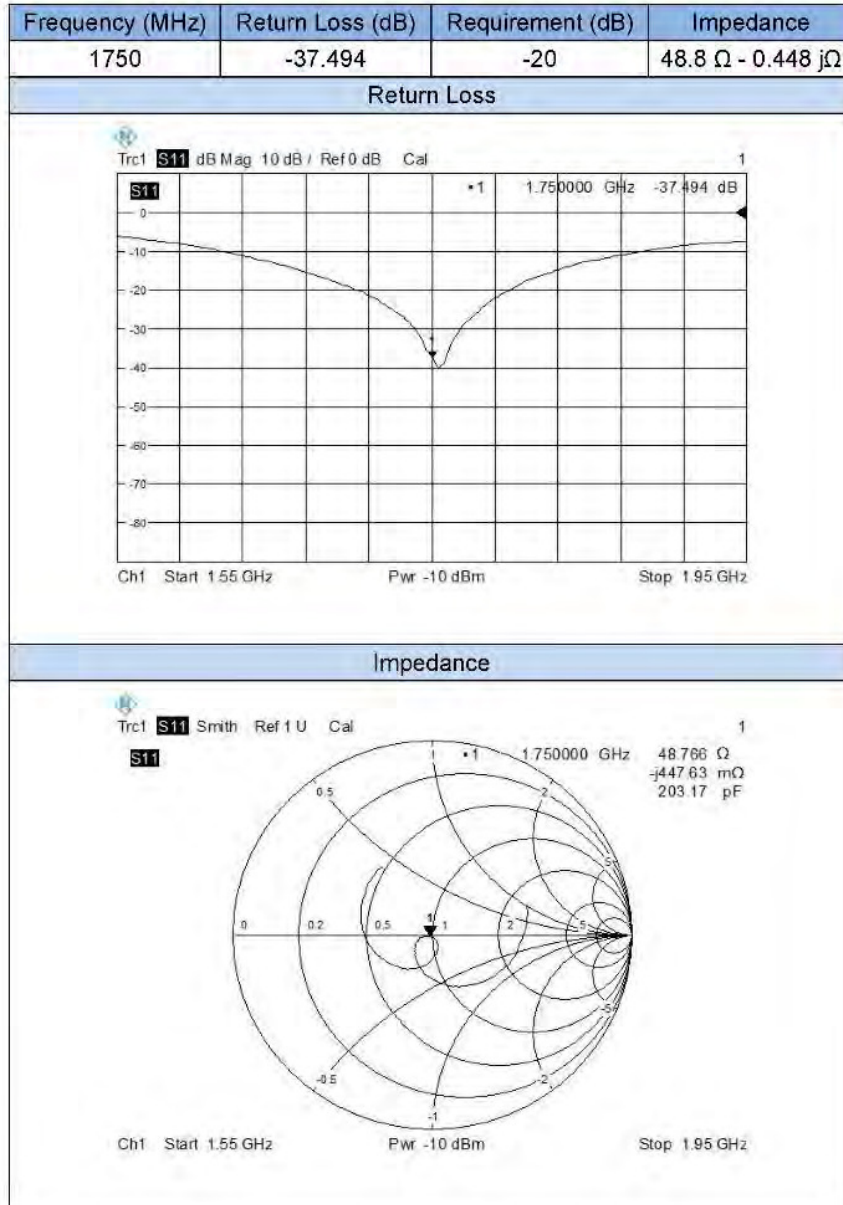
RETURN LOSS AND IMPEDANCE IN BODY LIQUID





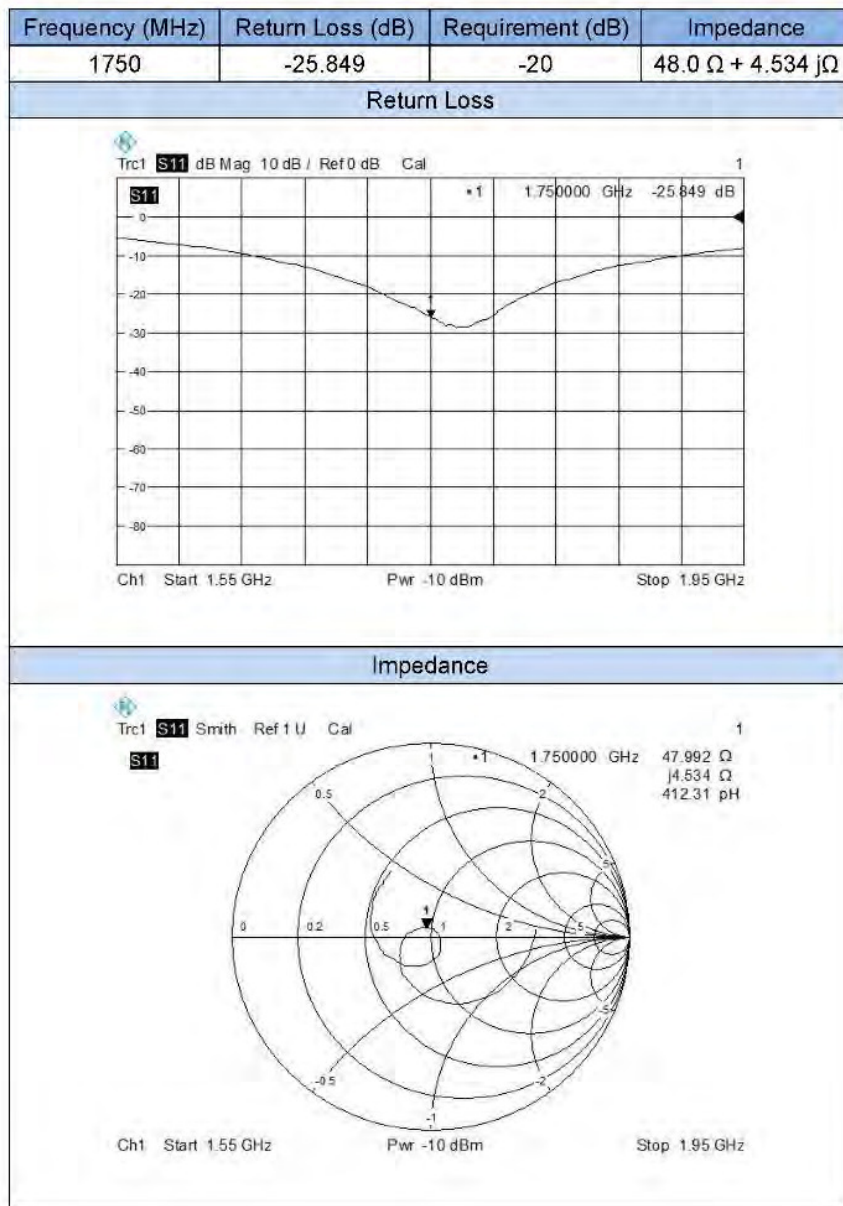
3.2 D1750V2

RETURN LOSS AND IMPEDANCE IN HEAD LIQUID





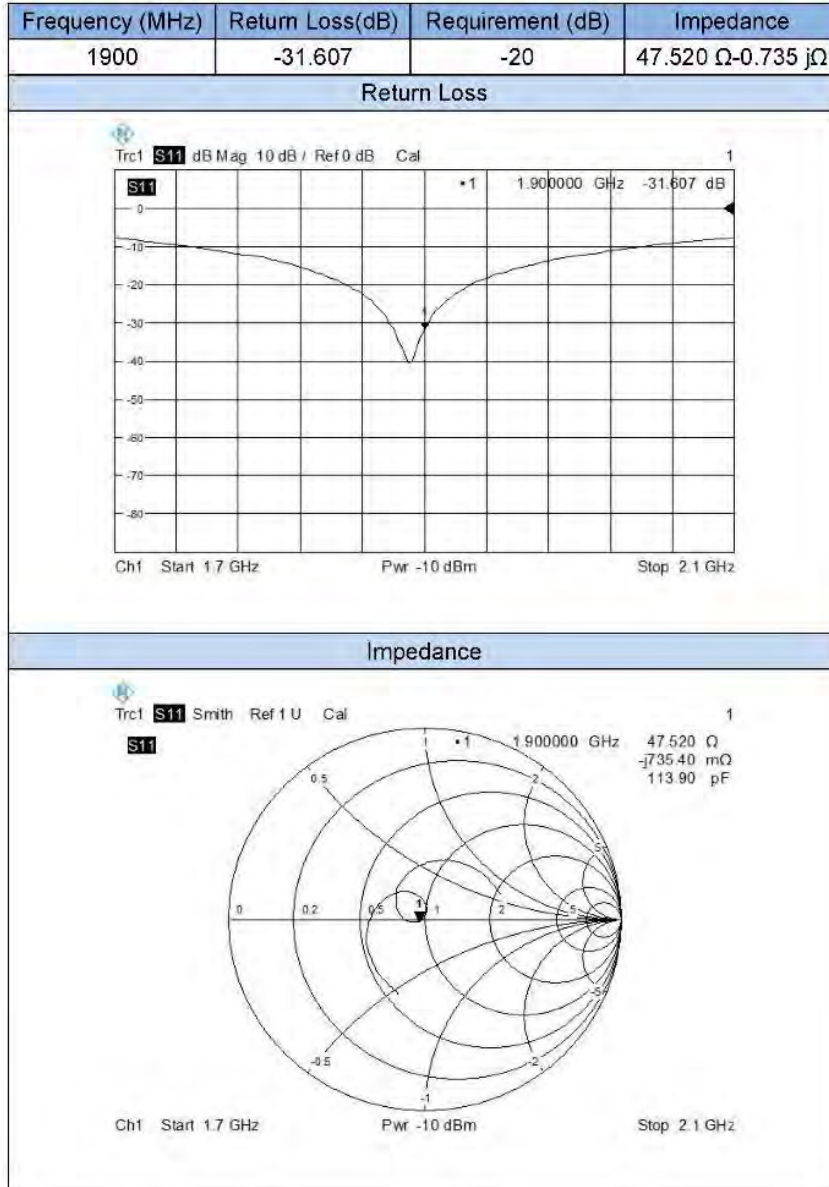
RETURN LOSS AND IMPEDANCE IN BODY LIQUID





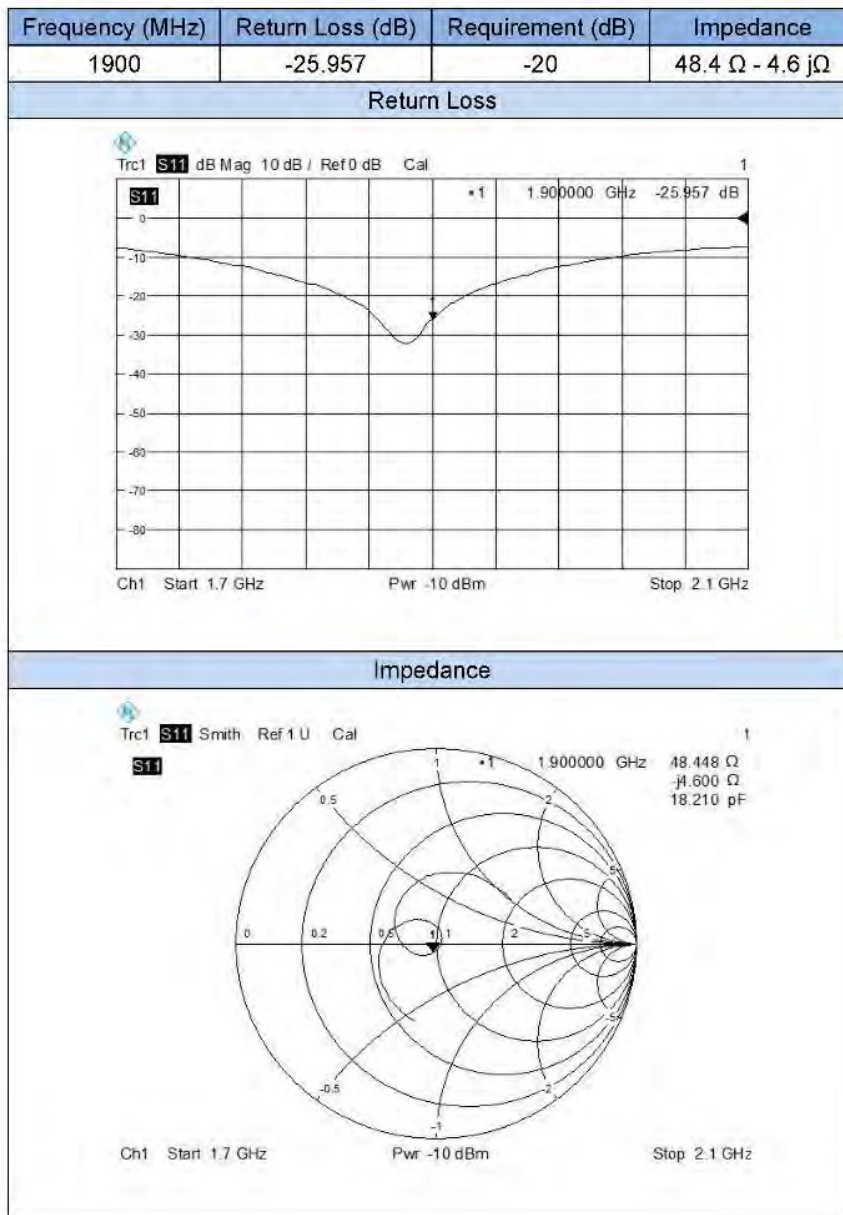
3.3 D1900V2

RETURN LOSS AND IMPEDANCE IN HEAD LIQUID





RETURN LOSS AND IMPEDANCE IN BODY LIQUID



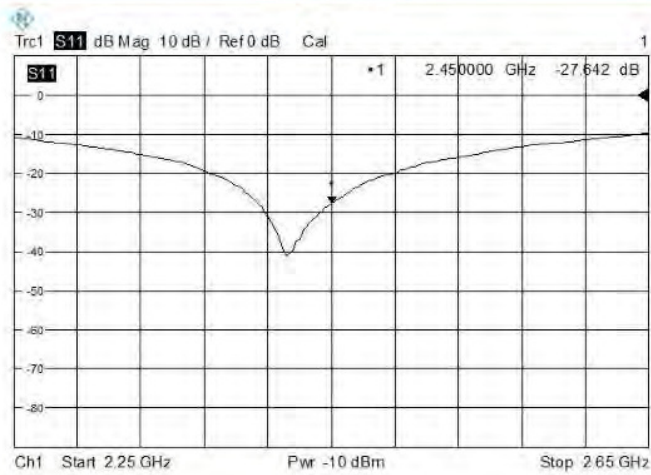


3.4 D2450V2

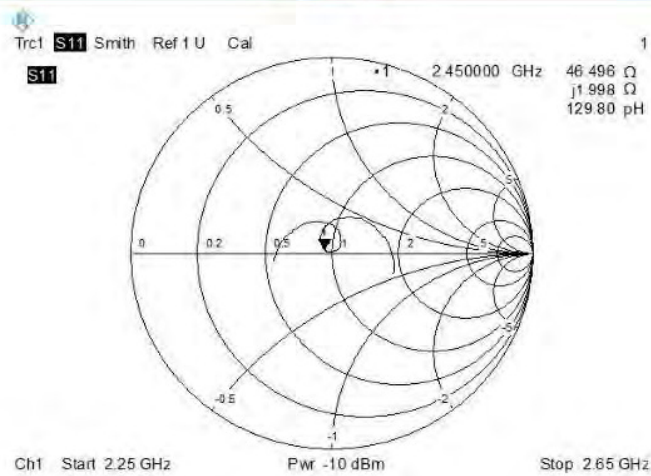
RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-27.642	-20	$46.5 \Omega + 1.998 j\Omega$

Return Loss

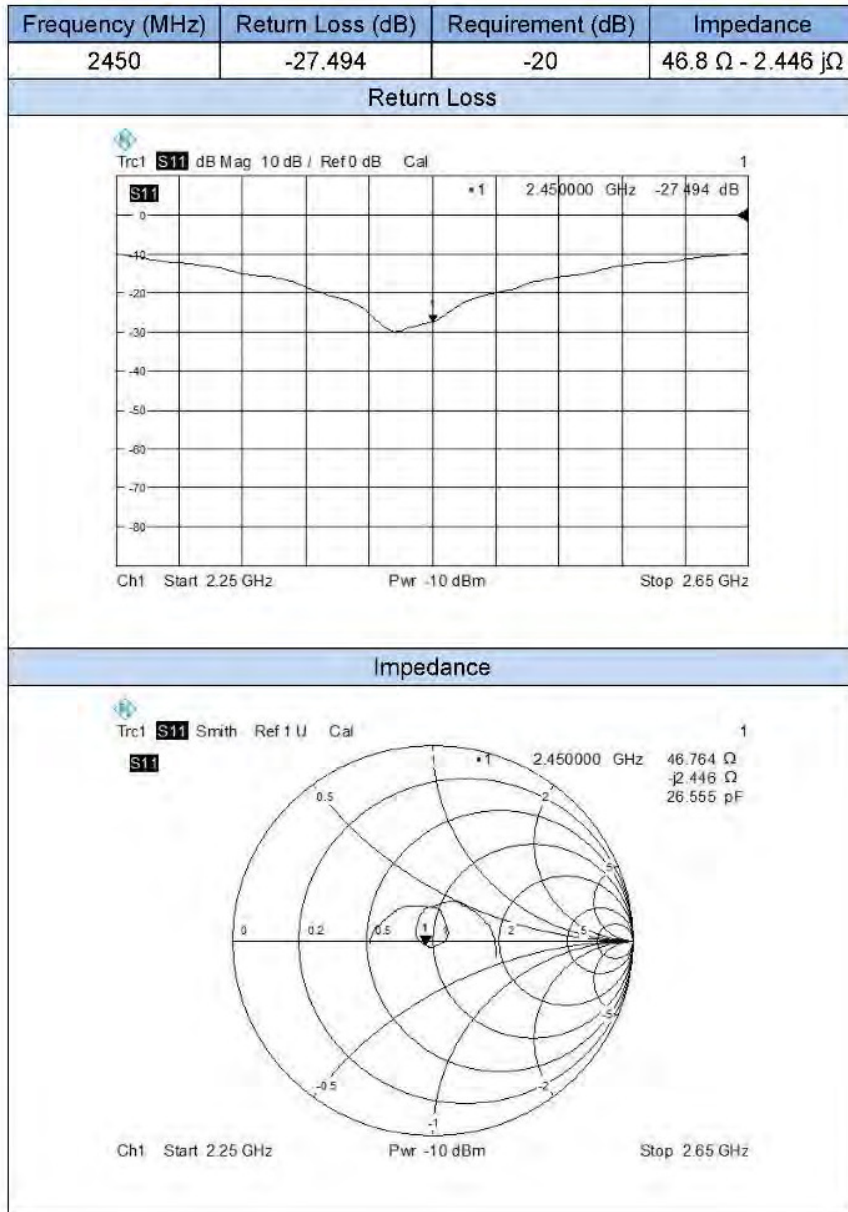


Impedance





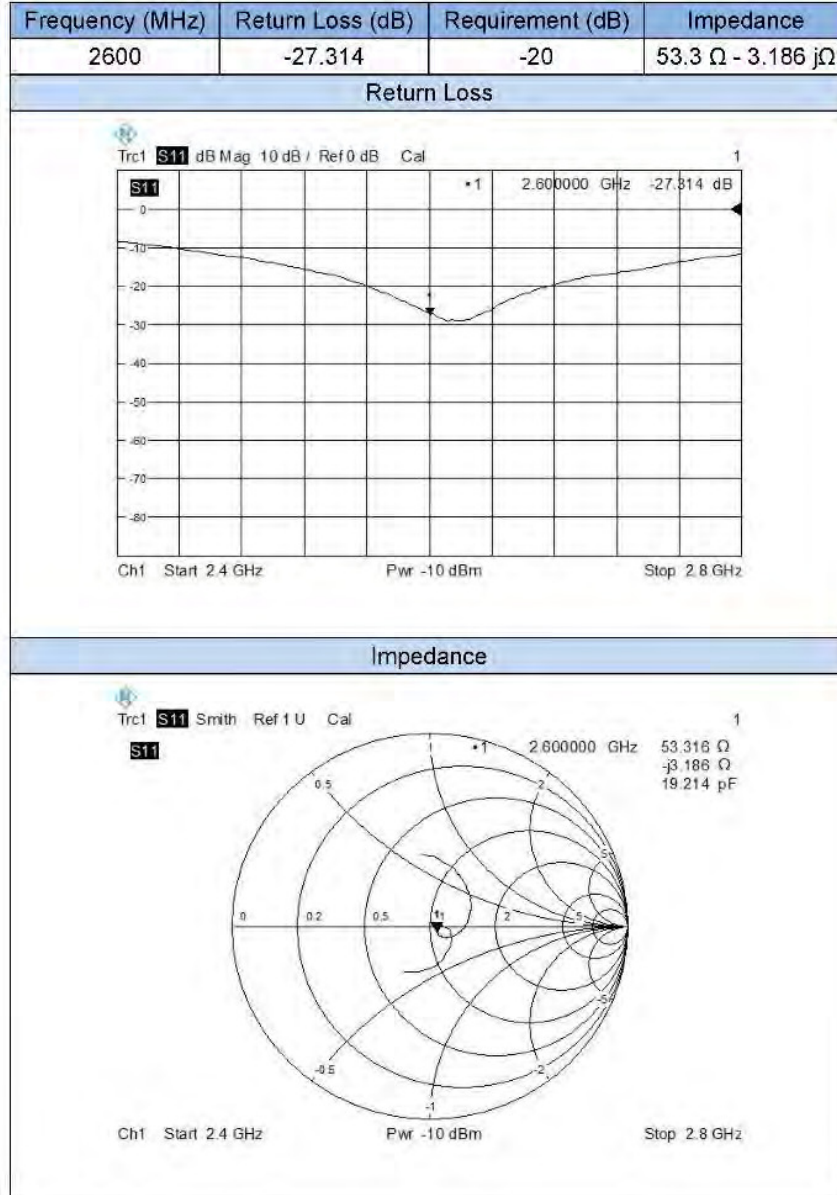
RETURN LOSS AND IMPEDANCE IN BODY LIQUID





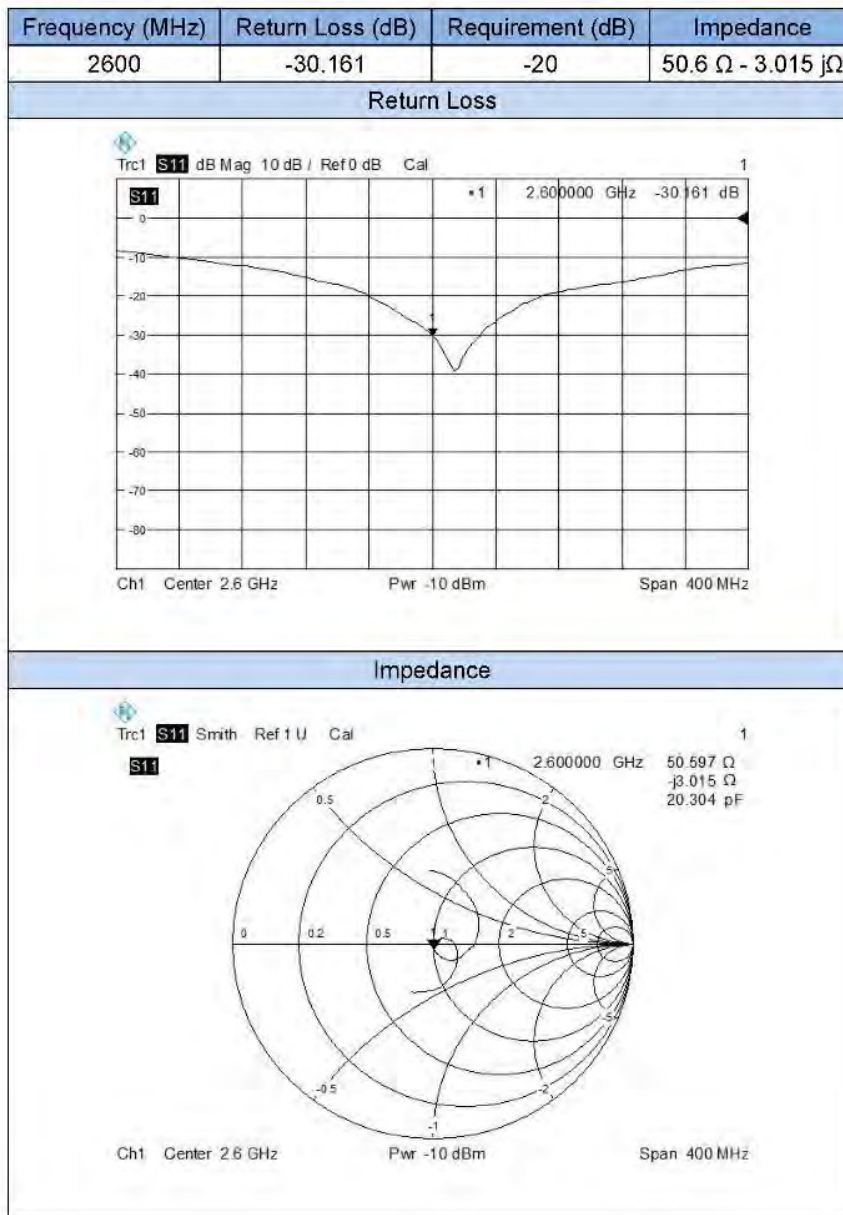
3.5 D2600V2

RETURN LOSS AND IMPEDANCE IN HEAD LIQUID





RETURN LOSS AND IMPEDANCE IN BODY LIQUID



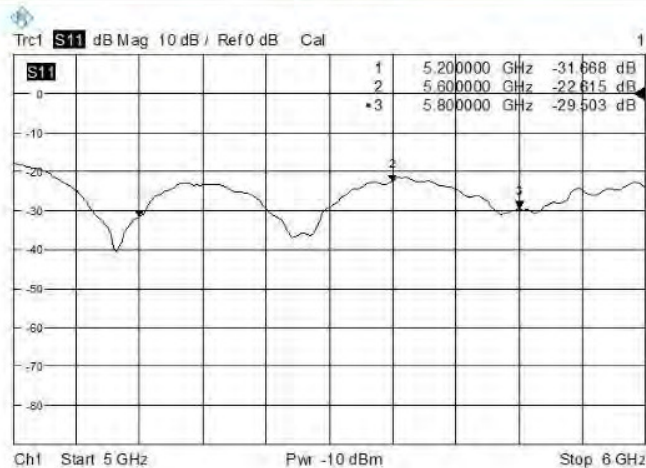


3.6 D5GHzV2

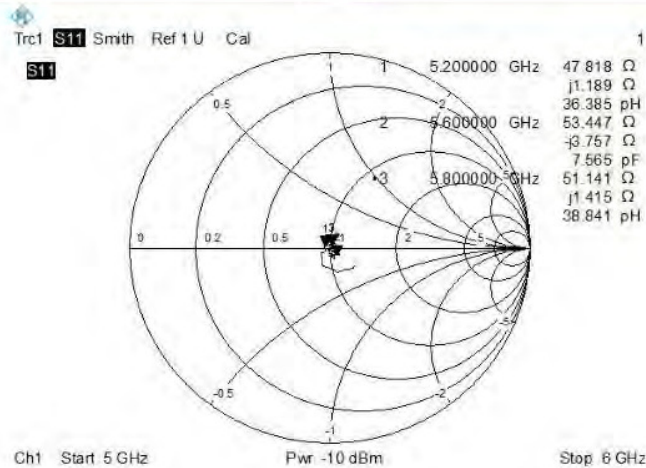
RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-31.668	-20	$47.8 \Omega + 1.189 j\Omega$
5600	-22.615	-20	$53.4 \Omega - 3.757 j\Omega$
5800	-29.503	-20	$51.1 \Omega + 1.415 j\Omega$

Return Loss



Impedance

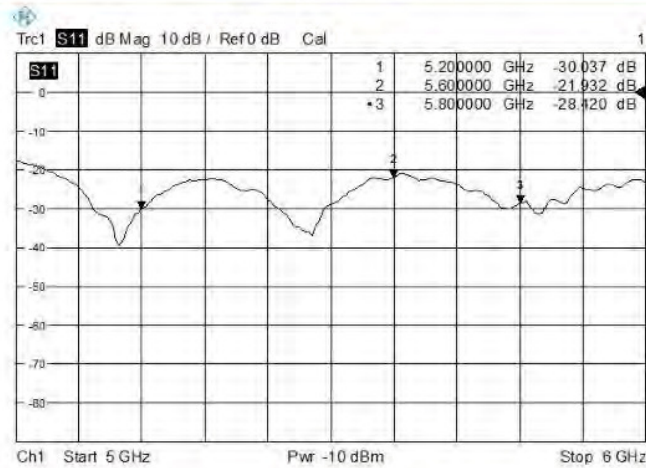




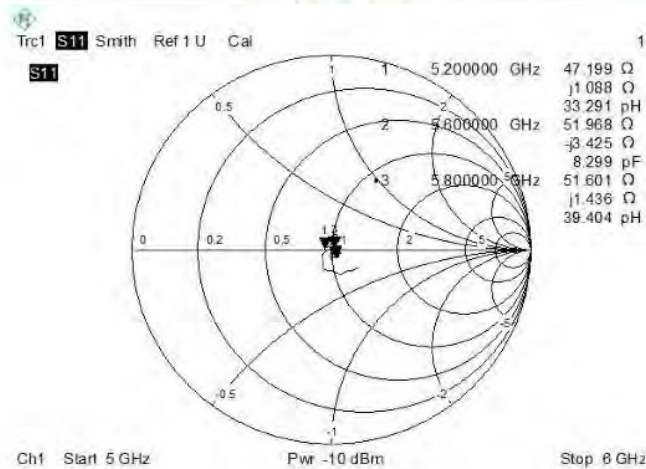
RETURN LOSS AND IMPEDANCE IN BODY LIQUID

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-30.037	-20	$47.2 \Omega + 1.088 j\Omega$
5600	-21.932	-20	$52.0 \Omega - 3.425 j\Omega$
5800	-28.420	-20	$51.6 \Omega + 1.436 j\Omega$

Return Loss



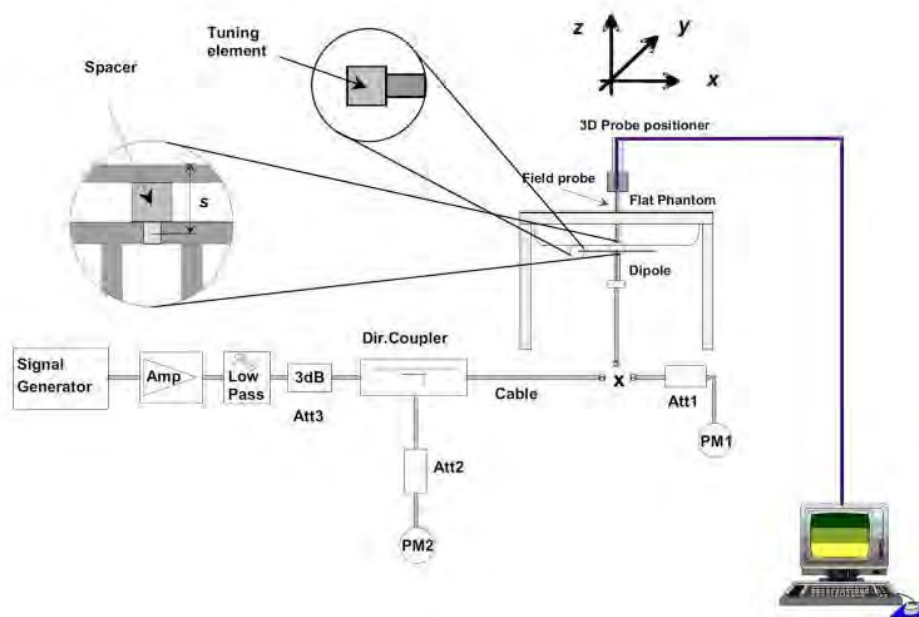
Impedance





4 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.



4.1 Dipole SAR Validation Measurement Result

Freq. (MHz)	Liquid Type	Power (mW)	1 g Measured SAR (W/kg)	Normaliz ed SAR (W/kg)	10 g Measured SAR (W/kg)	Normaliz ed SAR (W/kg)	1 g Targeted SAR (W/kg)	Tolerance (%)	10 g Targeted SAR (W/kg)	Tolerance (%)
835	Head	100	0.959	9.59	0.627	6.27	9.56	0.31	6.22	0.80
	Body	100	0.961	9.61	0.634	6.34	9.56	0.52	6.22	1.93
1750	Head	100	3.440	34.40	1.810	18.10	36.40	-5.49	19.30	-6.22
	Body	100	3.660	36.60	1.950	19.50	36.40	0.55	19.30	1.04
1900	Head	100	3.960	39.60	2.070	20.70	39.70	-0.25	20.50	0.98
	Body	100	4.010	40.10	2.090	20.90	39.70	1.01	20.50	1.95
2450	Head	100	5.260	52.60	2.410	24.10	52.40	0.38	24.00	0.42
	Body	100	5.130	51.30	2.330	23.30	52.40	-2.10	24.00	-2.92
2600	Head	100	5.410	54.10	2.360	23.60	55.30	-2.17	24.60	-4.07



	Body	100	5.580	55.80	2.420	24.20	55.30	0.90	24.60	-1.63
5200	Head	100	8.220	82.20	2.240	22.40	76.50	7.45	21.60	3.70
	Body	100	8.320	83.20	2.280	22.80	76.50	8.76	21.60	5.56
5600	Head	100	8.240	82.40	2.260	22.60				
	Body	100	8.410	84.10	2.330	23.30				
5800	Head	100	7.280	72.80	2.120	21.20	78.0	-6.67	21.90	-3.20
	Body	100	8.240	82.40	2.300	23.00	78.0	5.64	21.90	5.02



4.2 D835V2

4.2.1 Dipole 835 MHz Validation Measurement for Head Tissue

Dipole 835 MHz; Type: D835V2; Serial: D835V2-SN: 4d187

Date/Time: 10/25/2015

Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835$ MHz; $\sigma = 0.89$ S/m; $\epsilon_r = 41.83$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.4 Liquid Temperature: 20.8

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.56, 9.56, 9.56);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Head Tissue/Pin= 100mW , d=15mm/Zoom

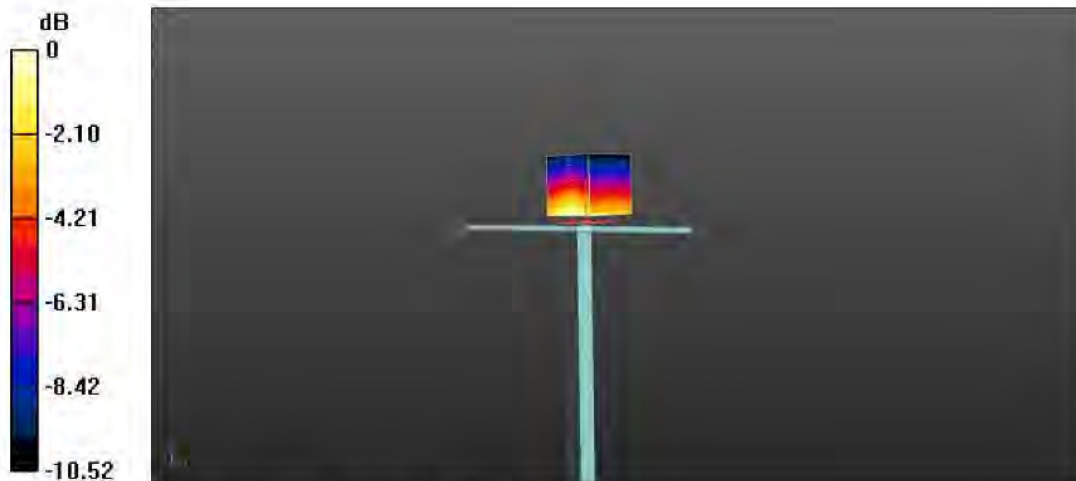
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 34.03 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.44 W/kg

SAR(1 g) = 0.959 W/kg; SAR(10 g) = 0.627 W/kg

Maximum value of SAR (measured) = 1.03 W/kg



0 dB = 1.03 W/kg = 0.13 dBW/kg



4.2.2 Dipole 835 MHz Validation Measurement for Body Tissue

Dipole 835 MHz; Type: D835V2; Serial: D835V2-SN: 4d187

Date/Time: 10/25/2015

Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835$ MHz; $\sigma = 0.98$ S/m; $\epsilon_r = 53.88$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 22.4 Liquid Temperature: 21.8

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.83, 9.83, 9.83);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW , d=15mm /Zoom

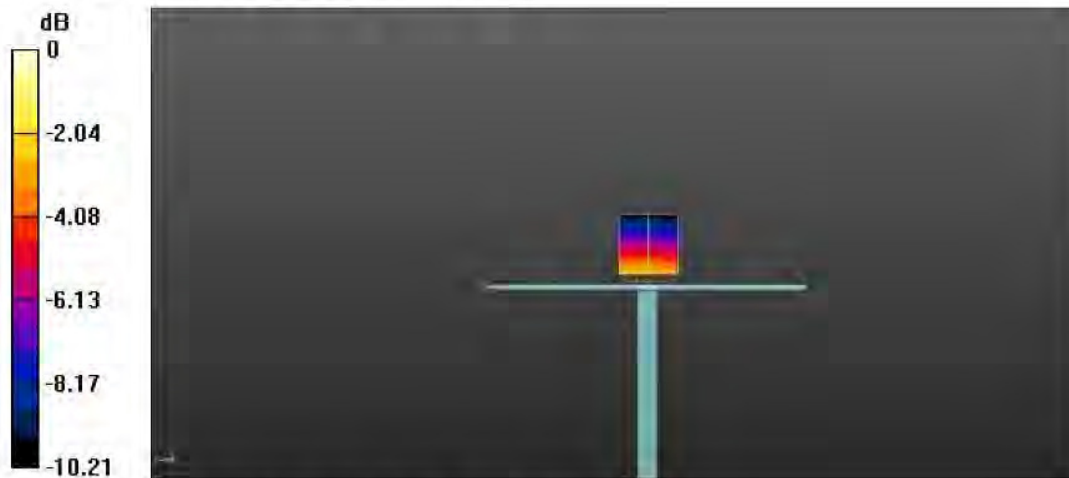
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 31.63 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 1.40 W/kg

SAR(1 g) = 0.961 W/kg; SAR(10 g) = 0.634 W/kg

Maximum value of SAR (measured) = 1.04 W/kg



0 dB = 1.04 W/kg = 0.17 dBW/kg



4.3D1750V2

4.3.1 Dipole 1750 MHz Validation Measurement for Head Tissue

Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2-SN: 1130

Date/Time: 10/23/2015

Communication System Band: D1750 (1750.0 MHz); Frequency: 1750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 39.23$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.8 Liquid Temperature: 21.2

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.13, 9.13, 9.13);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom

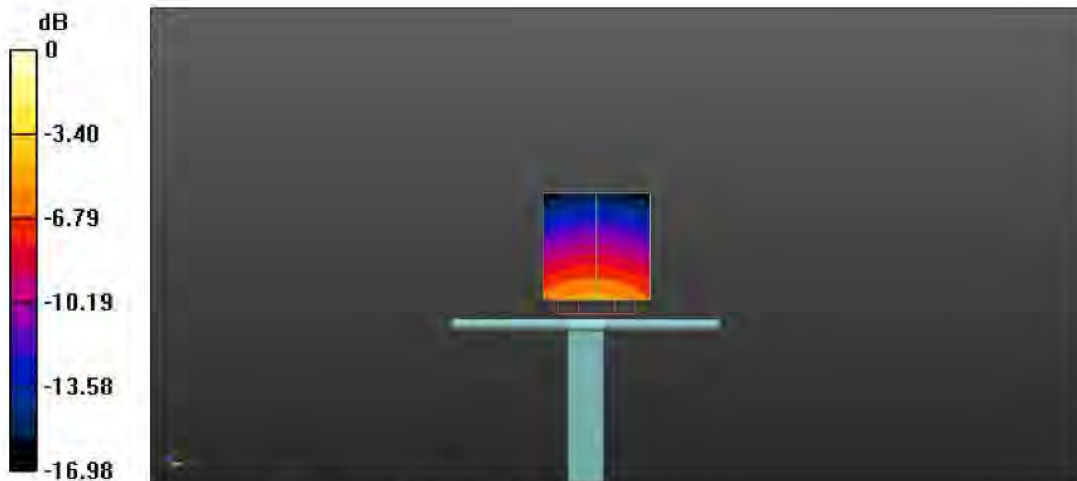
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 40.68 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 6.42 W/kg

SAR(1 g) = 3.44 W/kg; SAR(10 g) = 1.81 W/kg

Maximum value of SAR (measured) = 3.87 W/kg



0 dB = 3.87 W/kg = 5.88 dBW/kg



4.3.2 Dipole 1750 MHz Validation Measurement for Body Tissue

Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2-SN: 1130

Date/Time: 10/22/2015

Communication System Band: D1750 (1750.0 MHz); Frequency: 1750 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.45$ S/m; $\epsilon_r = 51.75$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.8 Liquid Temperature: 21.2

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.87, 7.87, 7.87);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom

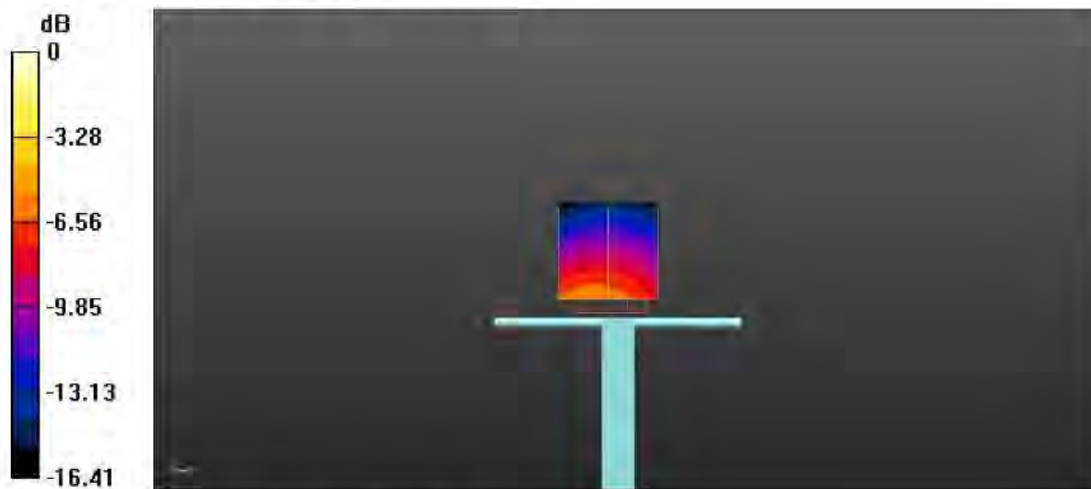
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 38.41 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 6.61 W/kg

SAR(1 g) = 3.66 W/kg; SAR(10 g) = 1.95 W/kg

Maximum value of SAR (measured) = 4.14 W/kg



0 dB = 4.14 W/kg = 6.17 dBW/kg



4.4D1900V2

4.4.1 Dipole 1900 MHz Validation Measurement for Head Tissue

Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2-SN: 5d193

Date/Time: 10/25/2015

Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.43$ S/m; $\epsilon_r = 39.75$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.7 Liquid Temperature: 20.9

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(8.15, 8.15, 8.15);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom

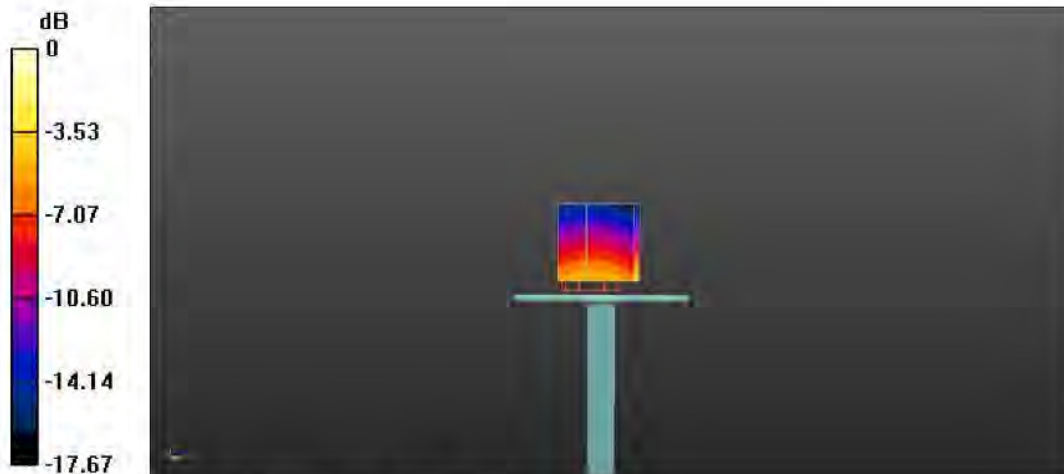
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 48.36 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 7.33 W/kg

SAR(1 g) = 3.96 W/kg; SAR(10 g) = 2.07 W/kg

Maximum value of SAR (measured) = 4.40 W/kg



0 dB = 4.40 W/kg = 6.43 dBW/kg



4.4.2 Dipole 1900 MHz Validation Measurement for Body Tissue

Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2-SN: 5d193

Date/Time: 10/25/2015

Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.55$ S/m; $\epsilon_r = 51.61$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.7 Liquid Temperature: 20.9

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.51, 7.51, 7.51);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom

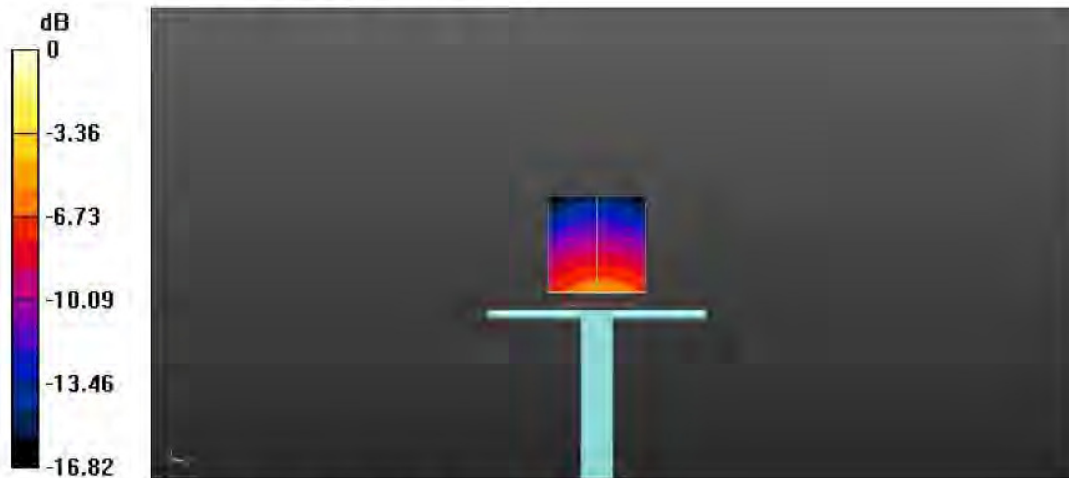
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 48.99 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 7.27 W/kg

SAR(1 g) = 4.01 W/kg; SAR(10 g) = 2.09 W/kg

Maximum value of SAR (measured) = 4.55 W/kg



0 dB = 4.55 W/kg = 6.58 dBW/kg



4.5 D2450V2

4.5.1 Dipole 2450 MHz Validation Measurement for Head Tissue

Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2-SN: 952

Date/Time: 10/24/2015

Communication System Band: CD2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.84$ S/m; $\epsilon_r = 38.53$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 22.1 Liquid Temperature: 21.2

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.62, 7.62, 7.62);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

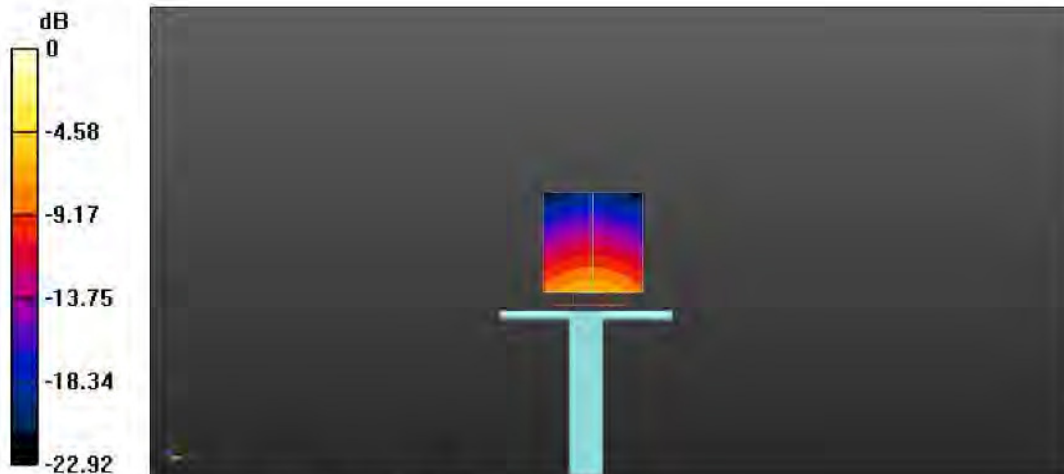
Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.74 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 11.3 W/kg

SAR(1 g) = 5.26 W/kg; SAR(10 g) = 2.41 W/kg

Maximum value of SAR (measured) = 6.00 W/kg



0 dB = 6.00 W/kg = 7.78 dBW/kg



4.5.2 Dipole 2450 MHz Validation Measurement for Body Tissue

Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2-SN: 952

Date/Time: 10/24/2015

Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.99$ S/m; $\epsilon_r = 51.17$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 22.1 Liquid Temperature: 21.2

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom

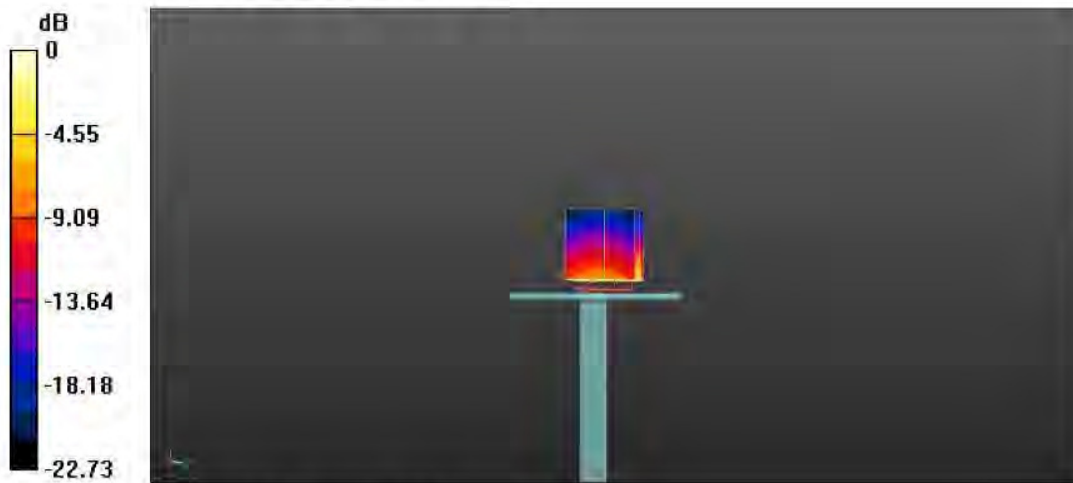
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 50.42 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 10.8 W/kg

SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.33 W/kg

Maximum value of SAR (measured) = 5.91 W/kg



0 dB = 5.91 W/kg = 7.72 dBW/kg



4.6 D2600V2

4.6.1 Dipole 2600 MHz Validation Measurement for Head Tissue

Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2-SN: 1095

Date/Time: 10/24/2015

Communication System Band: D2600 (2600.0 MHz); Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 1.97$ S/m; $\epsilon_r = 38.09$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.5 Liquid Temperature: 20.6

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.64, 7.64, 7.64);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom

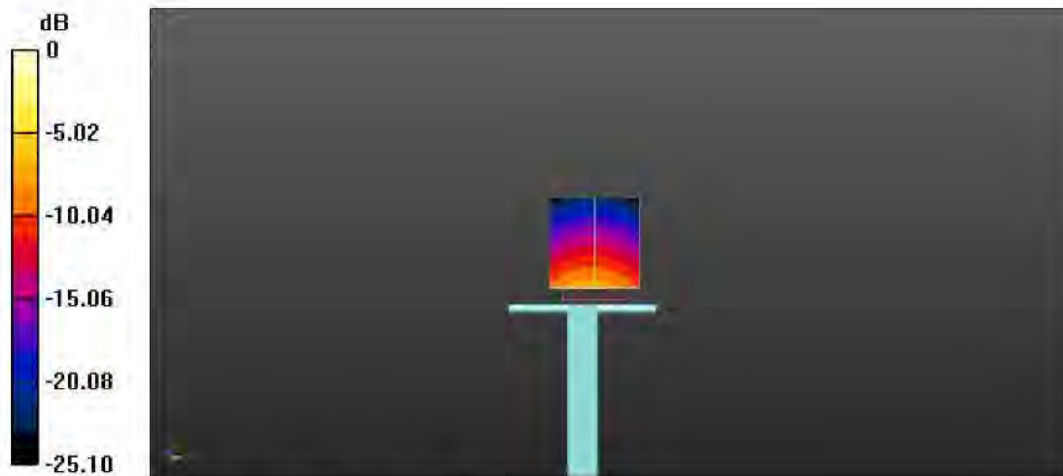
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.69 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 12.2 W/kg

SAR(1 g) = 5.41 W/kg; SAR(10 g) = 2.36 W/kg

Maximum value of SAR (measured) = 6.17 W/kg



0 dB = 6.17 W/kg = 7.90 dBW/kg



4.6.2 Dipole 2600 MHz Validation Measurement for Body Tissue

Dipole 2600 MHz; Type: D2600V2; Serial: D835V2-SN: 1095

Date/Time: 10/24/2015

Communication System Band: D2600 (2600.0 MHz); Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.20$ S/m; $\epsilon_r = 50.81$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 21.5 Liquid Temperature: 20.6

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.11, 7.11, 7.11);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom

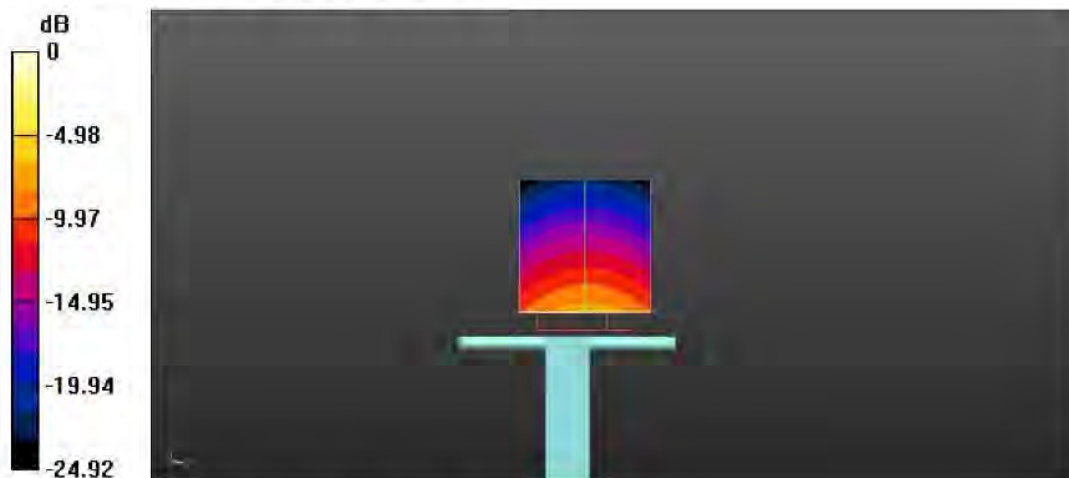
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.33 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 12.3 W/kg

SAR(1 g) = 5.58 W/kg; SAR(10 g) = 2.42 W/kg

Maximum value of SAR (measured) = 6.45 W/kg



0 dB = 6.45 W/kg = 8.10 dBW/kg



4.7 D5GHzV2

4.7.1 Dipole 5 GHz Validation Measurement for Head Tissue

Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2-SN: 1200

Date/Time: 10/26/2015

Communication System Band: D5GHz (5000.0 - 6000.0 MHz);

Frequency: 5200 MHz;

Frequency: 5600 MHz;

Frequency: 5800 MHz;

Duty Cycle: 1:1

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.78$ S/m; $\epsilon_r = 36.52$; $\rho = 1000$ kg/m³ , Medium

parameters used: $f = 5600$ MHz; $\sigma = 5.20$ S/m; $\epsilon_r = 35.06$; $\rho = 1000$ kg/m³ , Medium parameters

used: $f = 5800$ MHz; $\sigma = 5.42$ S/m; $\epsilon_r = 34.40$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature:22.0 Liquid Temperature:20.3

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(5.33, 5.33, 5.33); ConvF(4.70, 4.70, 4.70); ConvF(4.68, 4.68, 4.68);
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

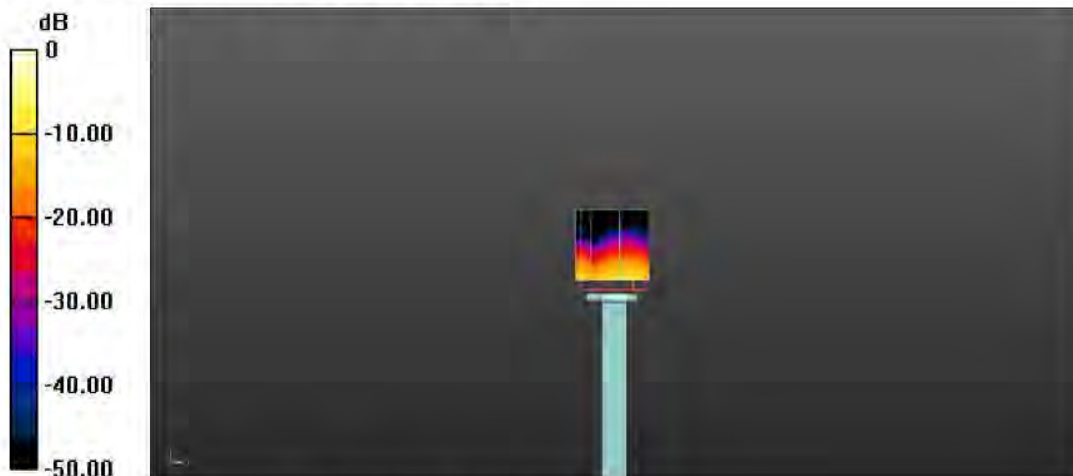
Dipole validation measurement for Head Tissue/Pin= 100mW ,dist=10mm,f=5200 MHz /Zoom Scan (7x7x21)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 45.80 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 25.9 W/kg

SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 9.71 W/kg



0 dB = 9.71 W/kg = 9.87 dBW/kg



Dipole validation measurement for Head Tissue/Pin= 100mW ,dist=10mm,f=5600

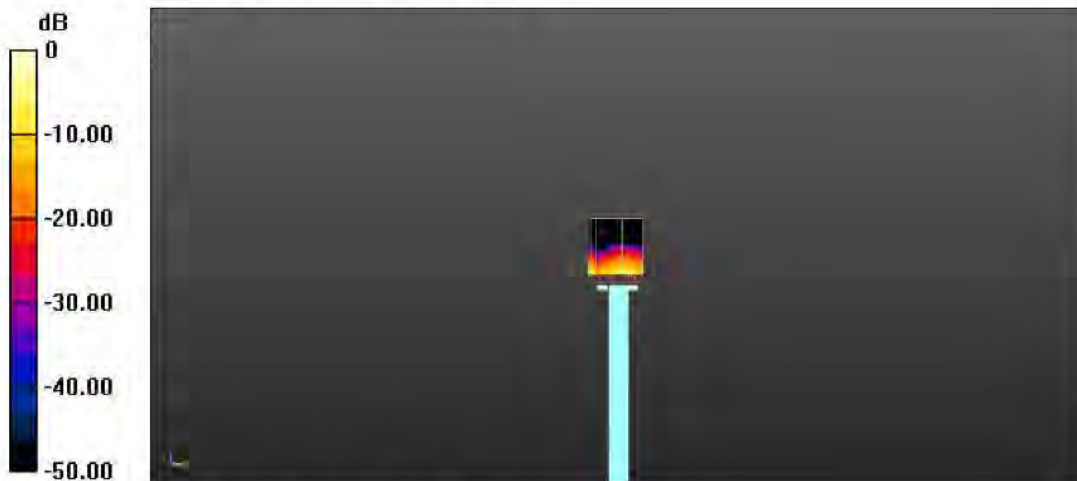
MHz /Zoom Scan (7x7x21)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 44.02 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 28.3 W/kg

SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 9.45 W/kg



0 dB = 9.45 W/kg = 9.75 dBW/kg

Dipole Calibration for Head Tissue/Pin= 100mW ,dist=10mm,f=5800 MHz /Zoom

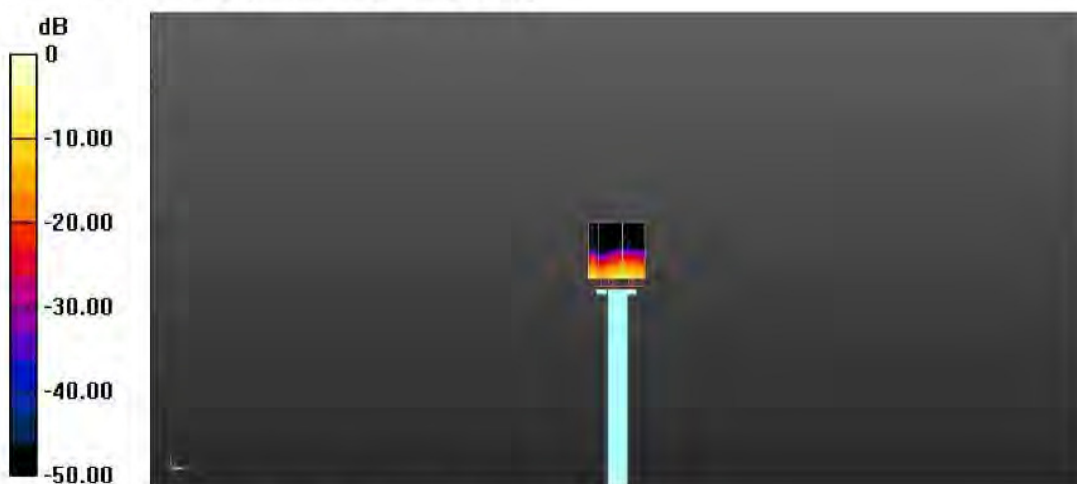
Scan (7x7x21)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 39.70 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 24.4 W/kg

SAR(1 g) = 7.28 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 8.38 W/kg



0 dB = 8.79 W/kg = 9.44 dBW/kg



4.7.2 Dipole 5 GHz Validation Measurement for Body Tissue

Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2-SN: 1200

Date/Time: 10/26/2015

Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5200 MHz; Frequency: 5600 MHz; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.38$ S/m; $\epsilon_r = 48.74$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.72$ S/m; $\epsilon_r = 46.31$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.92$ S/m; $\epsilon_r = 46.06$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(4.56, 4.56, 4.56);ConvF(3.98, 3.98, 3.98); ConvF(4.15, 4.15, 4.15);
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Dipole validation measurement for Body Tissue/Pin= 100mW ,dist=10mm,f=5200

MHz /Zoom Scan (7x7x21)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 45.58 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.28 W/kg

Maximum value of SAR (measured) = 9.86 W/kg



0 dB = 9.86 W/kg = 9.94 dBW/kg



Dipole validation measurement for Body Tissue/Pin= 100mW , dist=10mm,f=5600 MHz /Zoom Scan (7x7x21)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 47.14 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 35.1 W/kg

SAR(1 g) = 8.41 W/kg; SAR(10 g) = 2.33 W/kg

Maximum value of SAR (measured) = 10.3 W/kg



0 dB = 10.3 W/kg = 9.90 dBW/kg

Dipole validation measurement for Body Tissue/Pin= 100mW , dist=10mm,f=5800 MHz /Zoom Scan (7x7x21)/Cube 0:

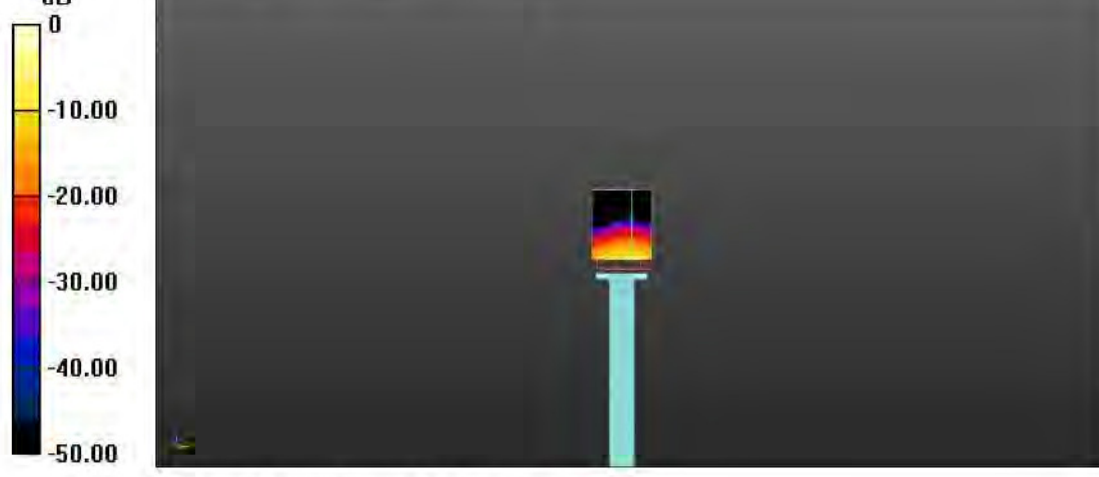
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 41.88 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 28.9 W/kg

SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.3 W/kg

Maximum value of SAR (measured) = 9.33 W/kg



0 dB = 9.33 W/kg = 9.70 dBW/kg

--END OF REPORT--

F.5 835MHz Dipole

Calibration Laboratory of
Schmid & Partner
Engineering AG
 Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Dgieie (Vitec)**

Certificate No: **D835V2-4d187_Nov14**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d187**

Calibration procedure(s) **QA CAL-05.v9**
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **November 26, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
 The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205 Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Jeton Kastrati** **Laboratory Technician**

Approved by: **Katja Poković** **Technical Manager**

Issued: November 28, 2014

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D835V2-4d187_Nov14

Page 1 of 8

**Calibration Laboratory of
Schmid & Partner
Engineering AG**
Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.2 $\pm$ 6 %	0.91 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.15 W/kg $\pm$ 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.50 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.95 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.5 $\pm$ 6 %	1.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.17 W/kg $\pm$ 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.55 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.04 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	51.5 Ω - 3.6 j Ω
Return Loss	- 28.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.9 Ω - 4.9 j Ω
Return Loss	- 24.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.394 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 24, 2014

DASY5 Validation Report for Head TSL

Date: 26.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d187

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.91 \text{ S/m}$; $\epsilon_r = 41.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, $d=15\text{mm}$ /Zoom Scan (7x7x7)/Cube 0:

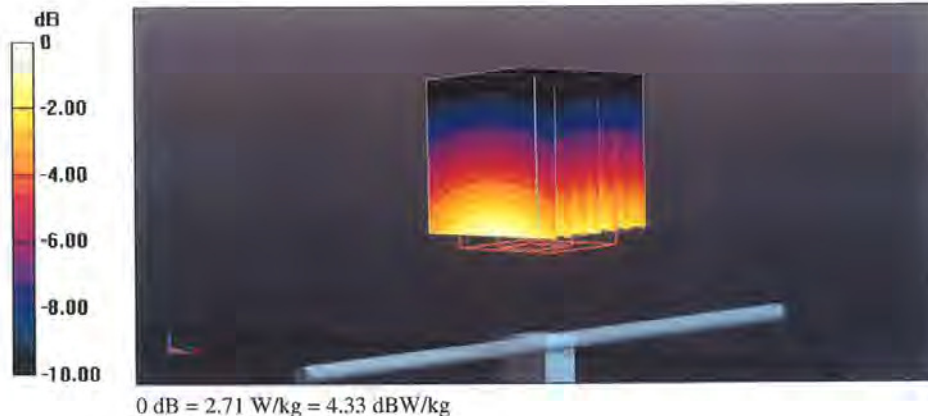
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 56.30 V/m; Power Drift = -0.00 dB

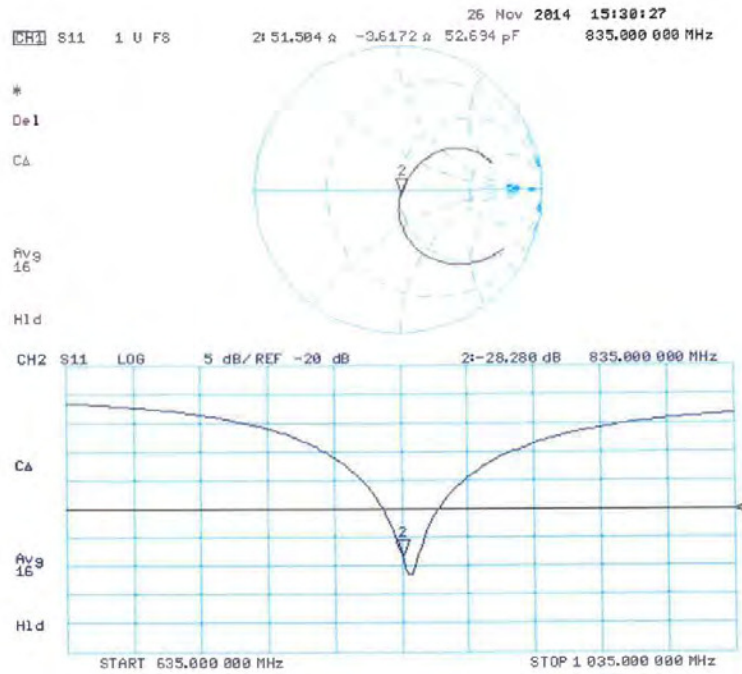
Peak SAR (extrapolated) = 3.44 W/kg

SAR(1 g) = 2.31 W/kg; SAR(10 g) = 1.5 W/kg

Maximum value of SAR (measured) = 2.71 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 26.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d187

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 1.01$ S/m; $\epsilon_r = 54.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.07 V/m; Power Drift = -0.00 dB

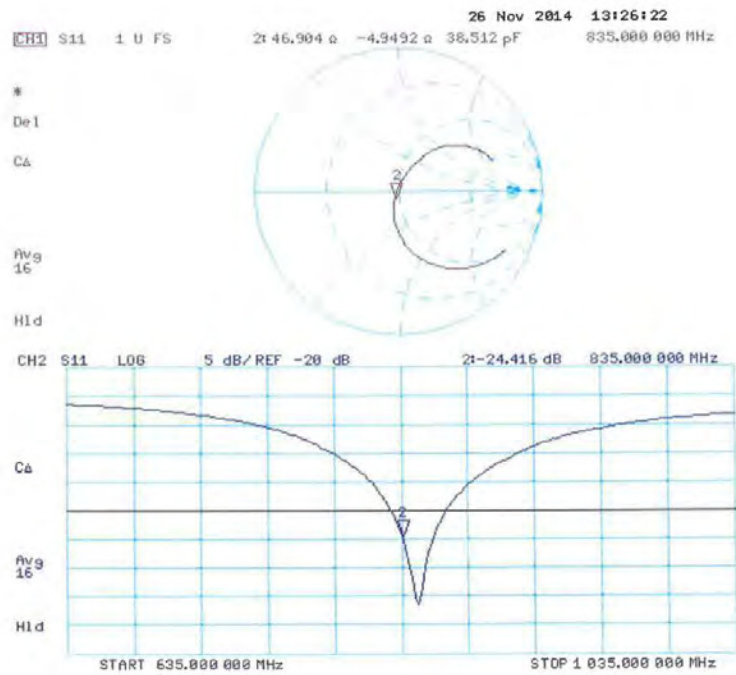
Peak SAR (extrapolated) = 3.48 W/kg

SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.55 W/kg

Maximum value of SAR (measured) = 2.77 W/kg



Impedance Measurement Plot for Body TSL



F.6 1750MHz Dipole

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Accreditation No.: **SCS 108**

Client **Dgieie (Vitec)**

Certificate No: **D1750V2-1130_Nov14**

CALIBRATION CERTIFICATE

Object **D1750V2 - SN: 1130**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **November 28, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by: **Jeton Kastrati** **Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Issued: November 28, 2014

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Certificate No: D1750V2-1130_Nov14

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.2 $\pm$ 6 %	1.37 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.4 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.3 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.1 $\pm$ 6 %	1.49 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.39 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	37.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.05 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.1 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	50.7 Ω - 1.2 j Ω
Return Loss	- 37.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.3 Ω - 0.3 j Ω
Return Loss	- 28.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.223 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 03, 2014

DASY5 Validation Report for Head TSL

Date: 28.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1130

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.37$ S/m; $\epsilon_r = 39.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.23, 5.23, 5.23); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

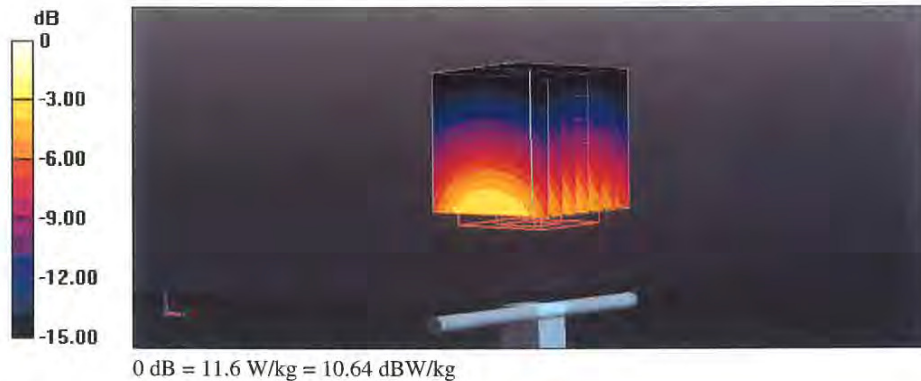
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.02 V/m; Power Drift = 0.02 dB

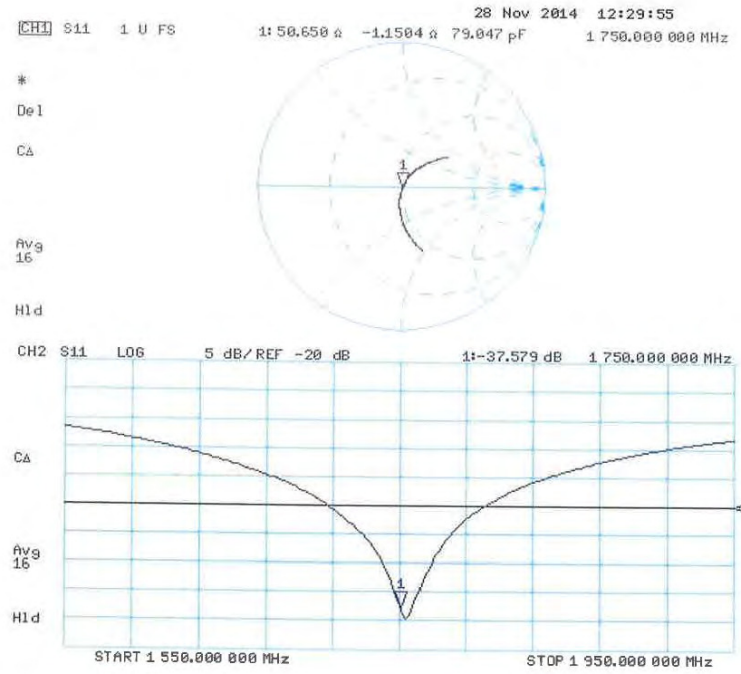
Peak SAR (extrapolated) = 16.4 W/kg

SAR(1 g) = 9.14 W/kg; SAR(10 g) = 4.85 W/kg

Maximum value of SAR (measured) = 11.6 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 28.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1130

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 52.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.89, 4.89, 4.89); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

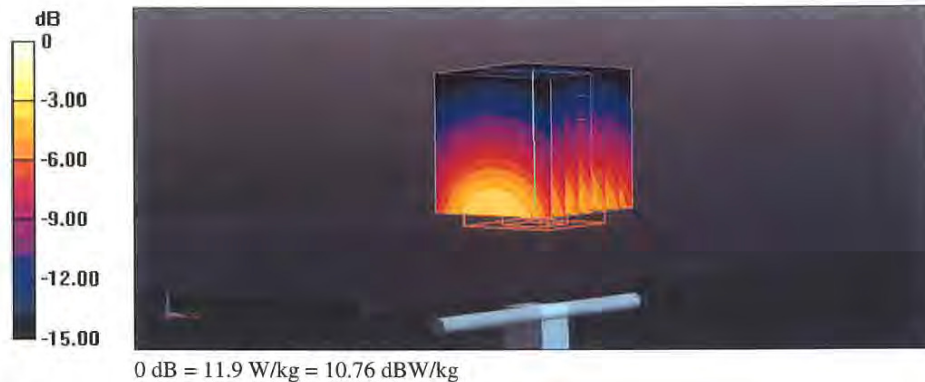
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.19 V/m; Power Drift = -0.01 dB

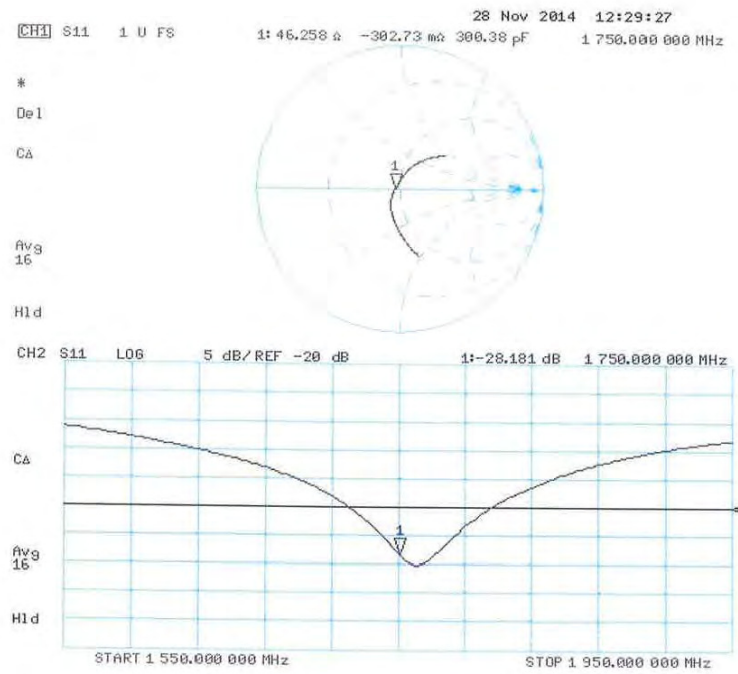
Peak SAR (extrapolated) = 16.1 W/kg

SAR(1 g) = 9.39 W/kg; SAR(10 g) = 5.05 W/kg

Maximum value of SAR (measured) = 11.9 W/kg



Impedance Measurement Plot for Body TSL



F.7 1900MHz Dipole

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Client **Dgieie (Vitec)**

Certificate No: **D1900V2-5d193_Nov14**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d193**

Calibration procedure(s) **QA CAL-05.v9**
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **November 28, 2014**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ($22 \pm 3^\circ\text{C}$) and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41082317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 08327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

Calibrated by:	Name Jeton Kastrail	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 2, 2014

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Certificate No: D1900V2-5d193_Nov14

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.1 $\pm$ 6 %	1.39 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.2 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.3 $\pm$ 6 %	1.50 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.00 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.3 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.31 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	$53.0 \Omega + 4.8 j\Omega$
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.7 \Omega + 5.1 j\Omega$
Return Loss	- 25.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	May 06, 2014

DASY5 Validation Report for Head TSL

Date: 21.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d193

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.39$ S/m; $\epsilon_r = 40.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.65 V/m; Power Drift = 0.02 dB

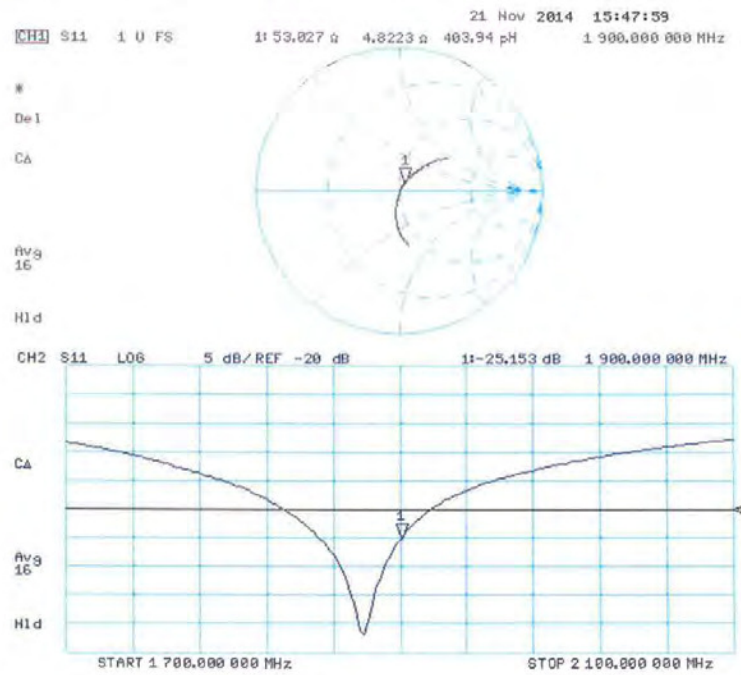
Peak SAR (extrapolated) = 18.5 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.29 W/kg

Maximum value of SAR (measured) = 12.8 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 28.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d193

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.5$ S/m; $\epsilon_r = 53.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

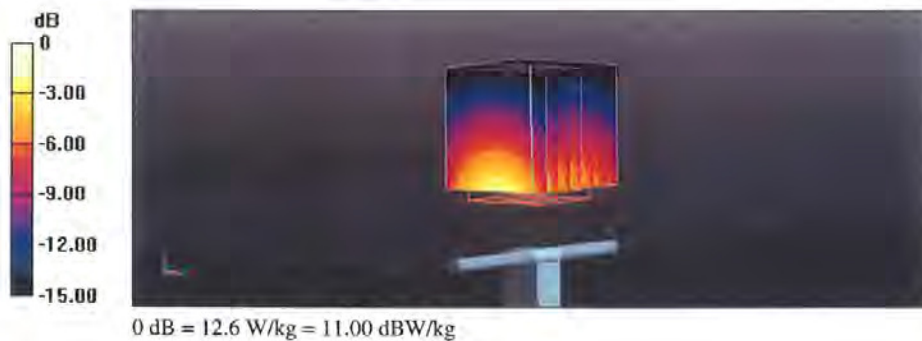
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.76 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 17.3 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.31 W/kg

Maximum value of SAR (measured) = 12.6 W/kg



Impedance Measurement Plot for Body TSL

