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## 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

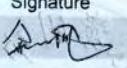
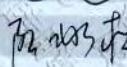
**TTL** In Collaboration with **SPeag**  
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
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**IAIC-MRA** **CNAS**  
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		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity&lt;70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p>			
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	06-July-15 (CTTL, No:J15X04257)	July-16
Calibrated by:	Name	Function	Signature
	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



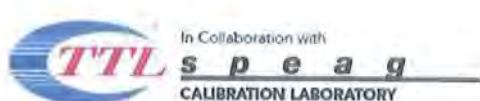
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E-mail: ctll@chinatll.com Http://www.chinatll.cn

**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 =  $6.1\mu V$ , full range = -100...+300 mV  
Low Range: 1LSB =  $61\mu V$ , 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	$317.5^\circ \pm 1^\circ$
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## F.3 Dual Logo-CTTL-SPEAG-certificates

Schmid &amp; 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  
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ShenZhen, GuangDong Province,  
P. R. China

Email: [tulang@baluntek.com](mailto: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 &amp; Partner Engineering AG

**s p e a g**

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Dr. Katja Pokovic  
Director Laboratory & Services

## F.4 Dipole Performance Measurement Report

**SAR Dipole**  
**Performance**  
**Measurement**  
**Report**

ISSUED BY  
Shenzhen BALUN Technology Co., Ltd.

FOR  
Validation Dipoles



Tested by: Tu Lang (Engineer)	Report No.: LW-SZ15C0264-701
Approved by: Wei Yanquan (Chief Engineer)	EUT Type: SAR Validation Dipole
	Model Name: D835V2, D1750V2
	D1900V2, D2450V2
	D2600V2, D5GHzV2
	Brand Name: Speag
	Test 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.

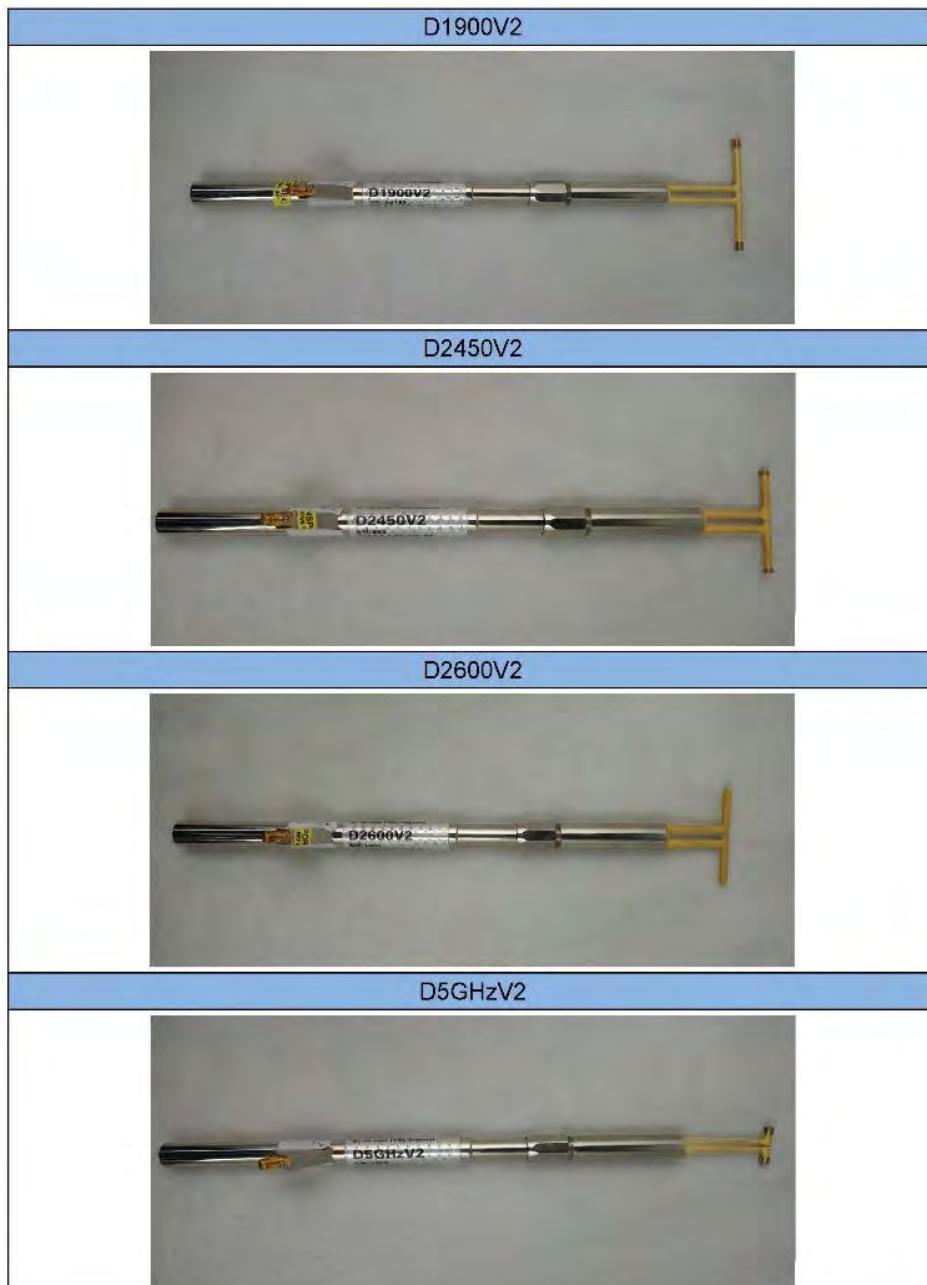
### 1.2 General Description for Equipment under Test (EUT)

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







## 2 SIMULATING LIQUID VERIFICATION

Liquid Type	Fre. (MHz)	Meas. Conductivity ( $\sigma$ ) (S/m)	Meas. Permittivity ( $\epsilon$ )	Target Conductivity ( $\sigma$ ) (S/m)	Target Permittivity ( $\epsilon$ )	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



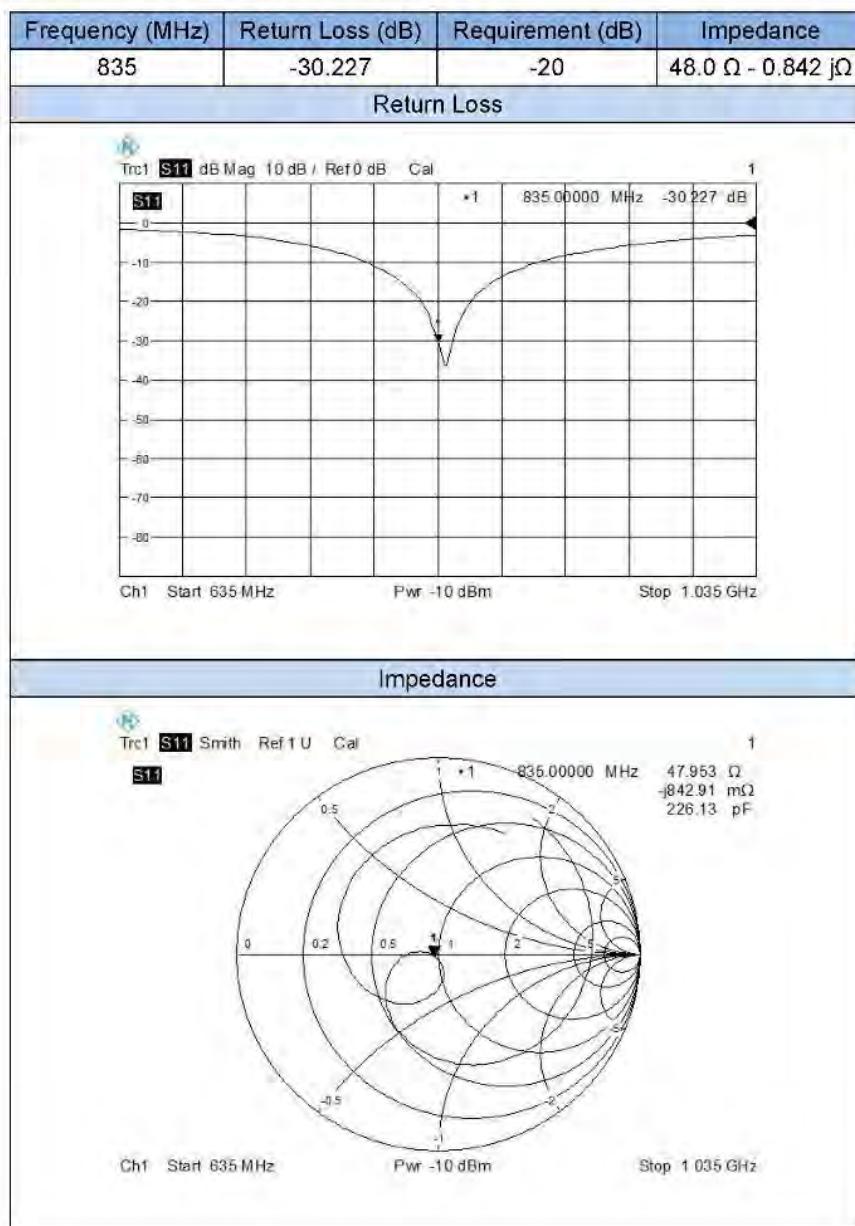
### 3 DIPOLE IMPEDANCE AND RETURN LOSS

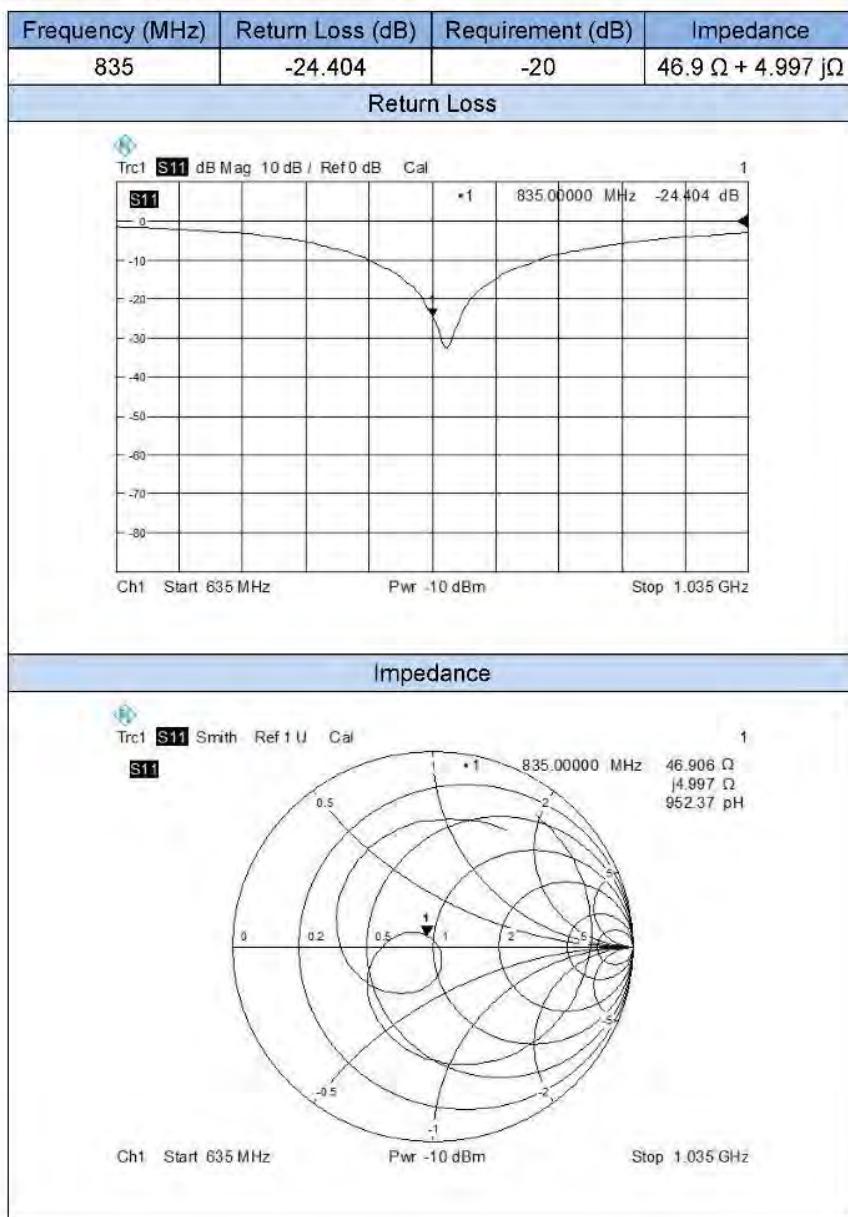
The dipoles are designed to have low return loss when presented against a flat phantom at the specified distance. A Vector Network Analyser was used to perform a return loss measurement on the specific dipole when in the measurement location against the phantom and the distance was specified by the manufacturer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

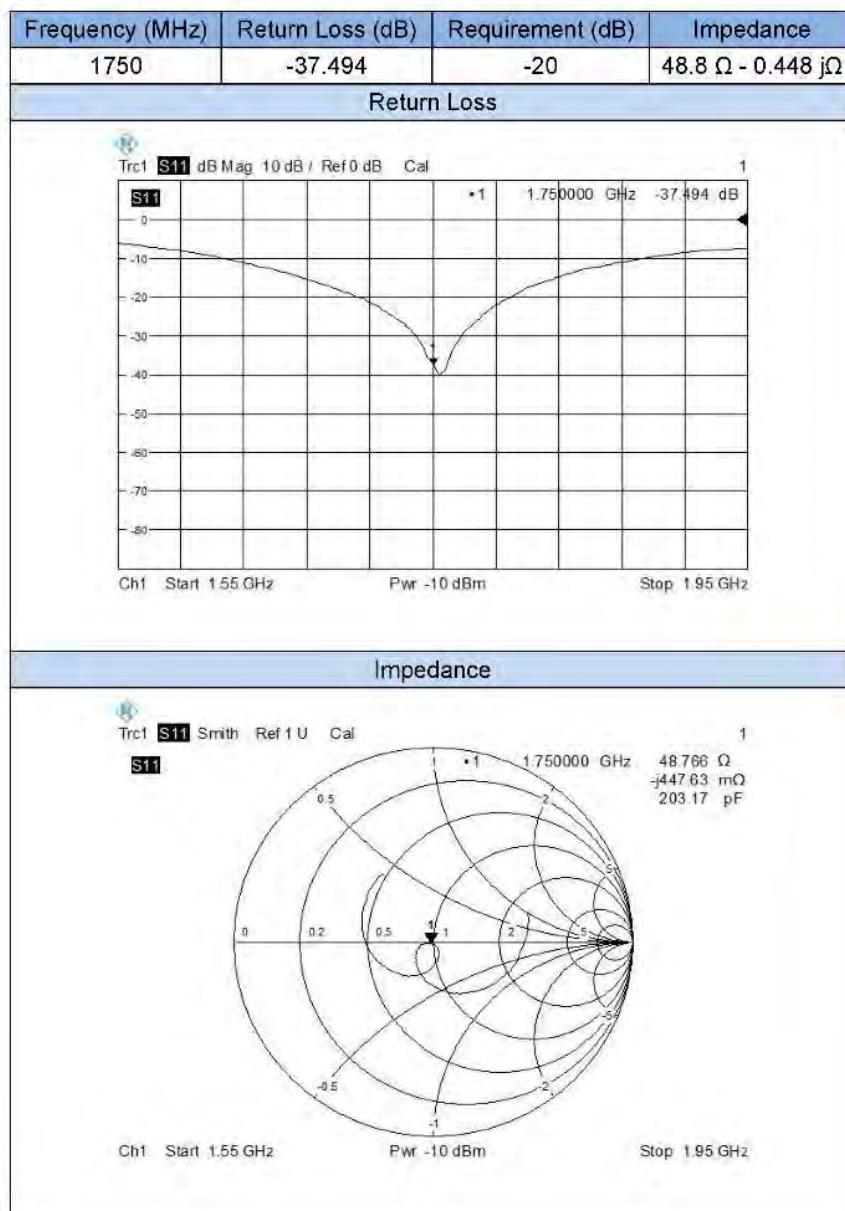


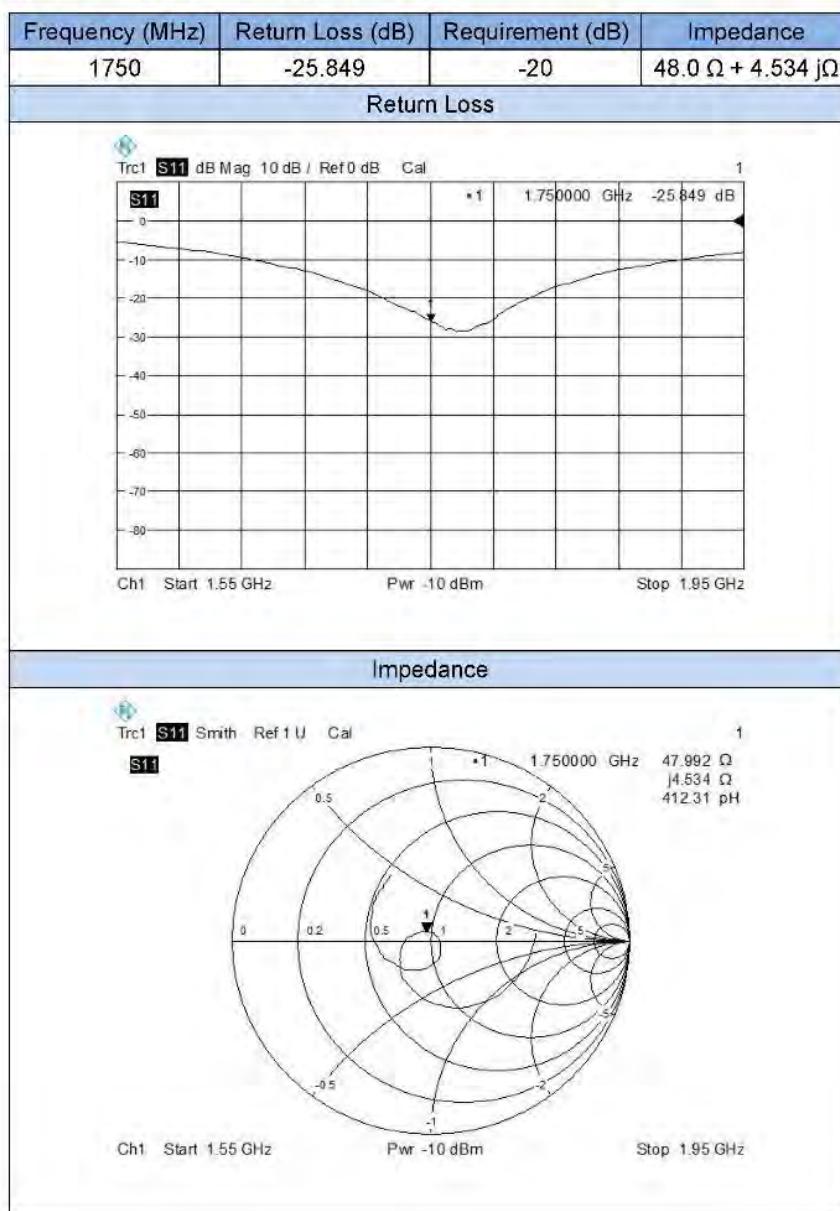
**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



### 3.2 D1750V2

#### RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

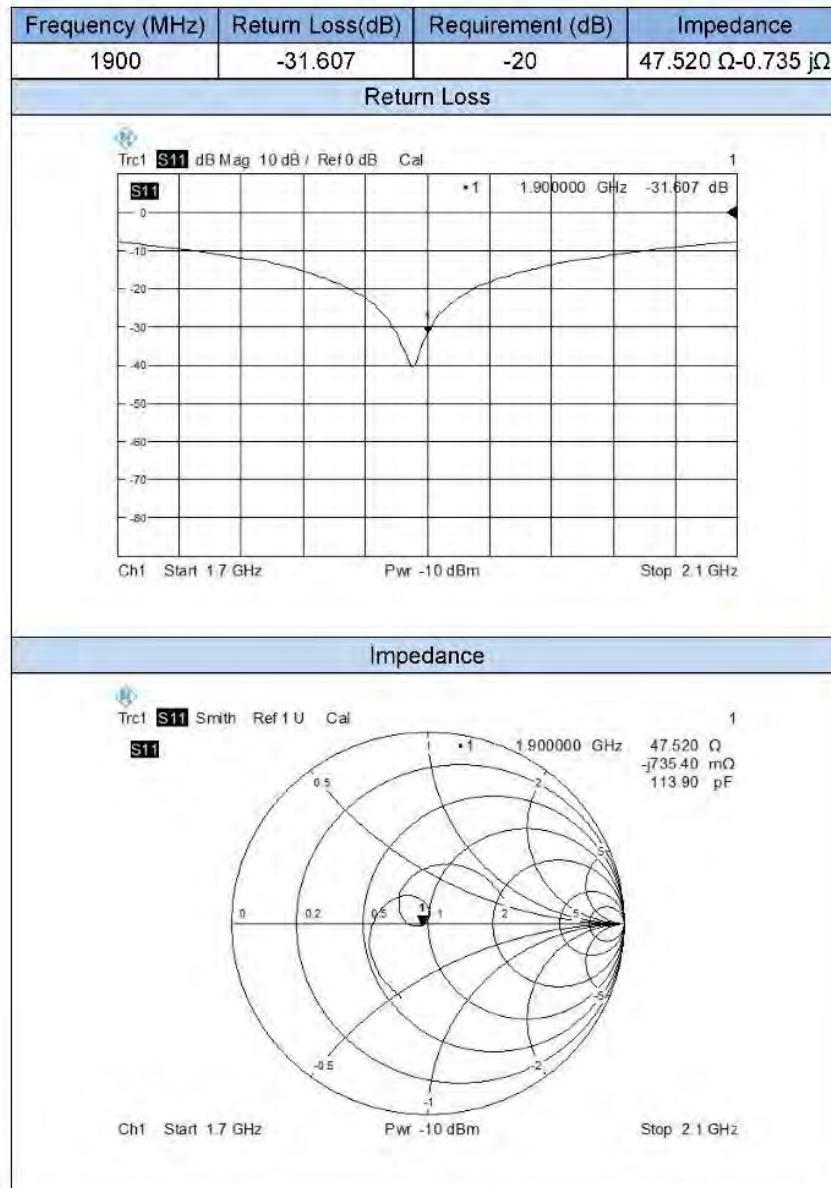


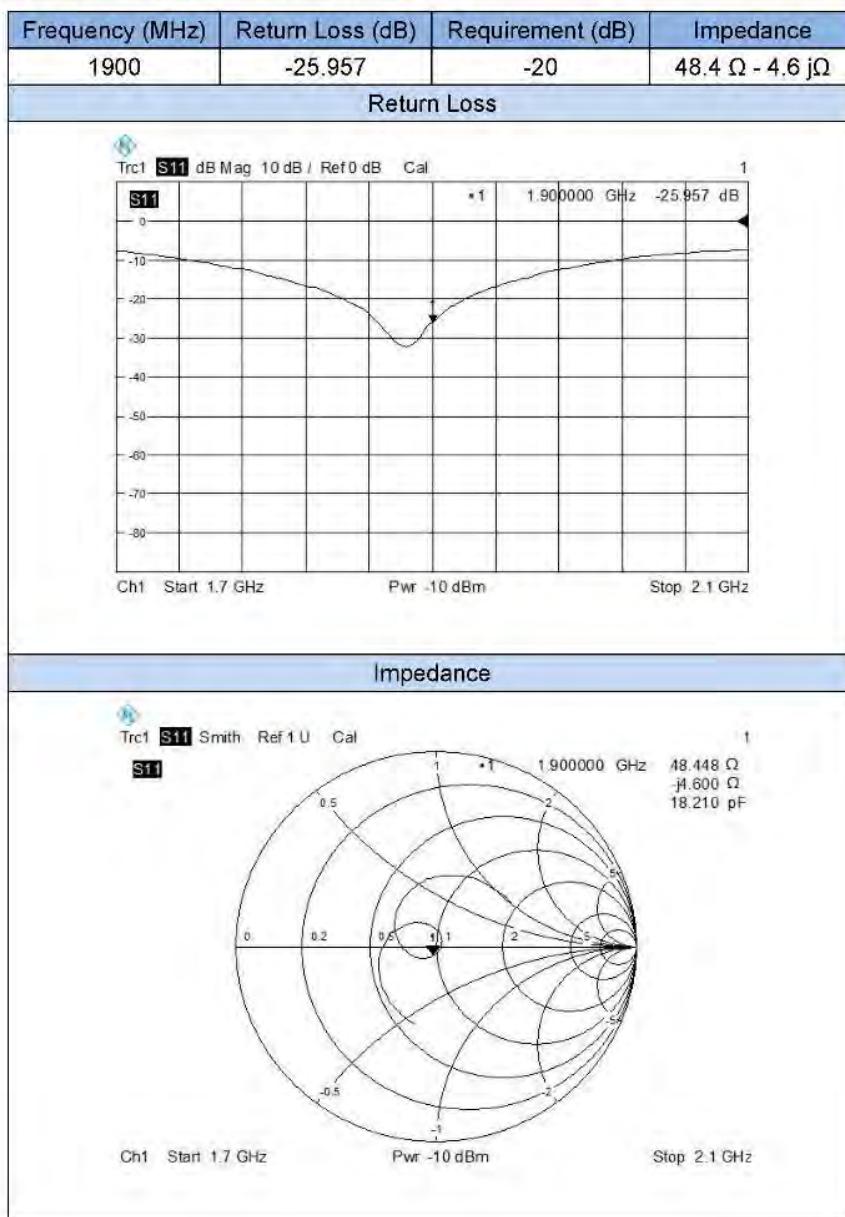
**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



### 3.3 D1900V2

#### RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

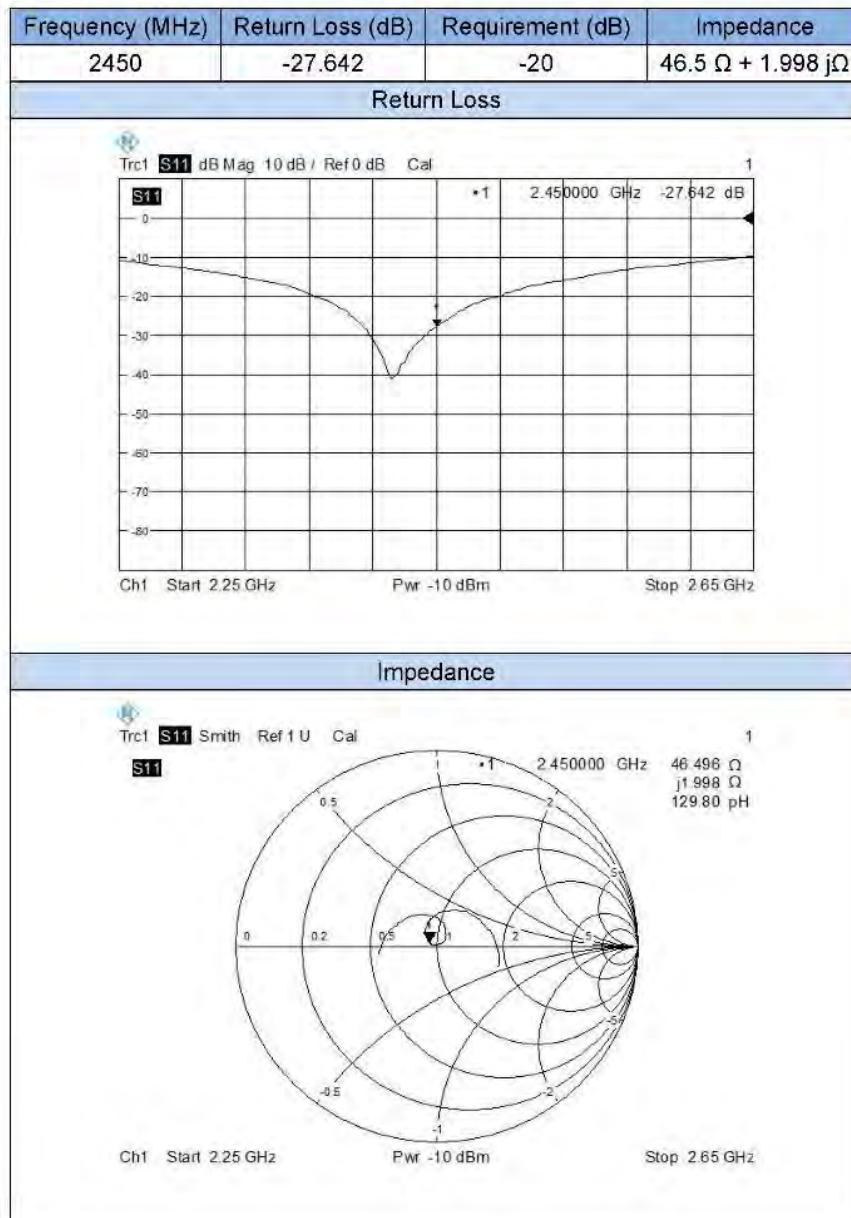


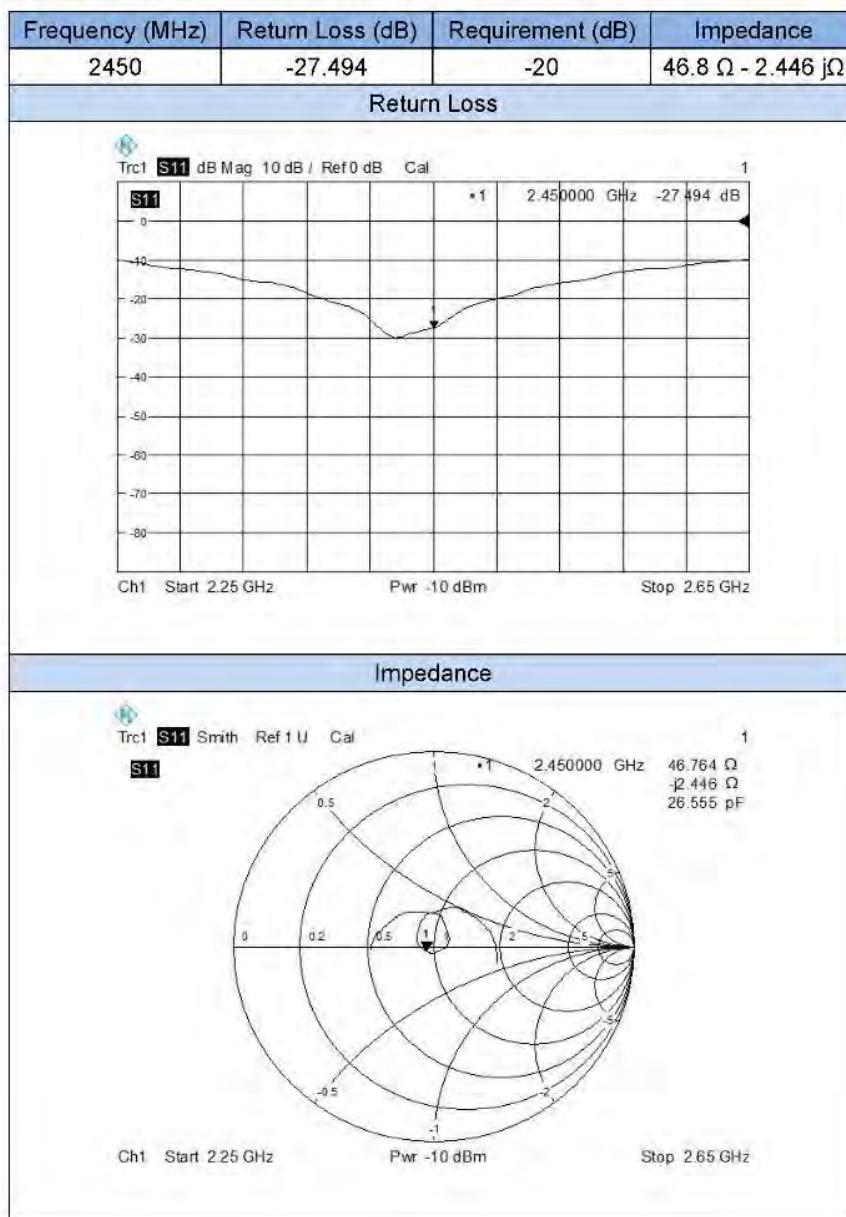
**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



### 3.4 D2450V2

#### RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

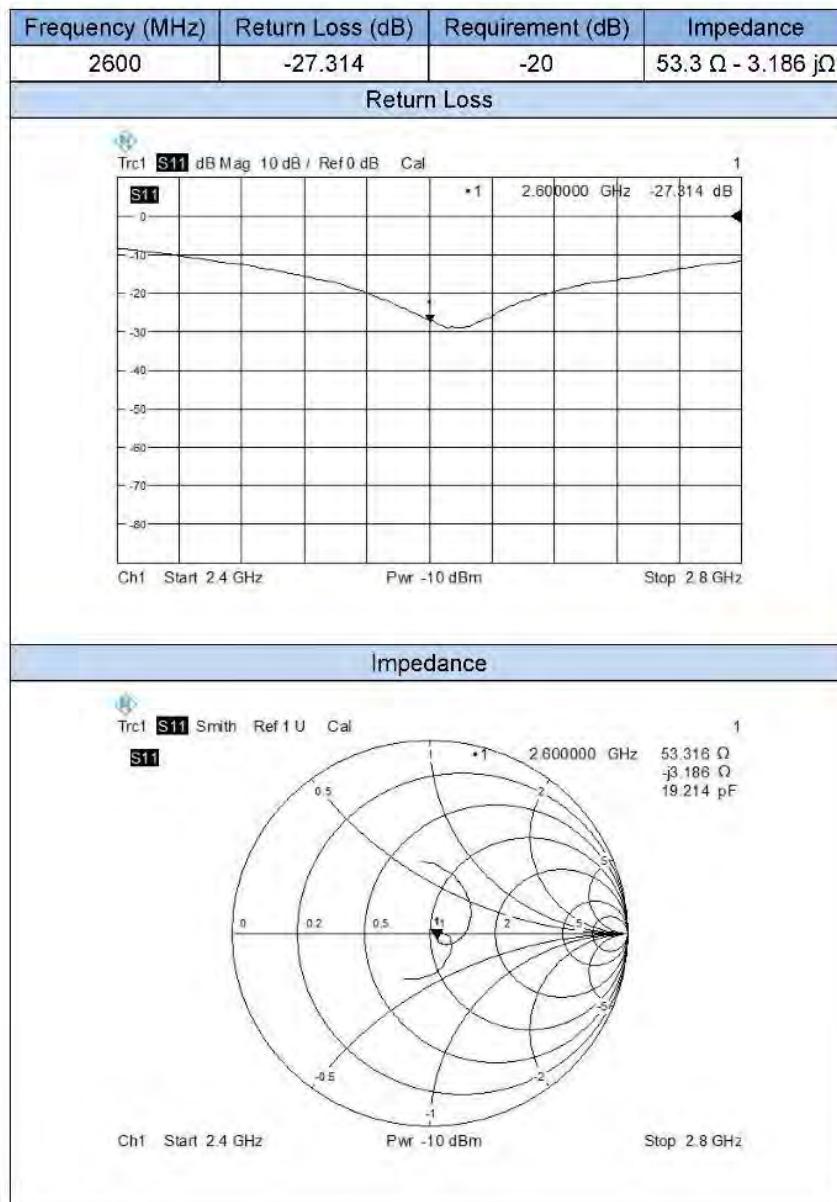


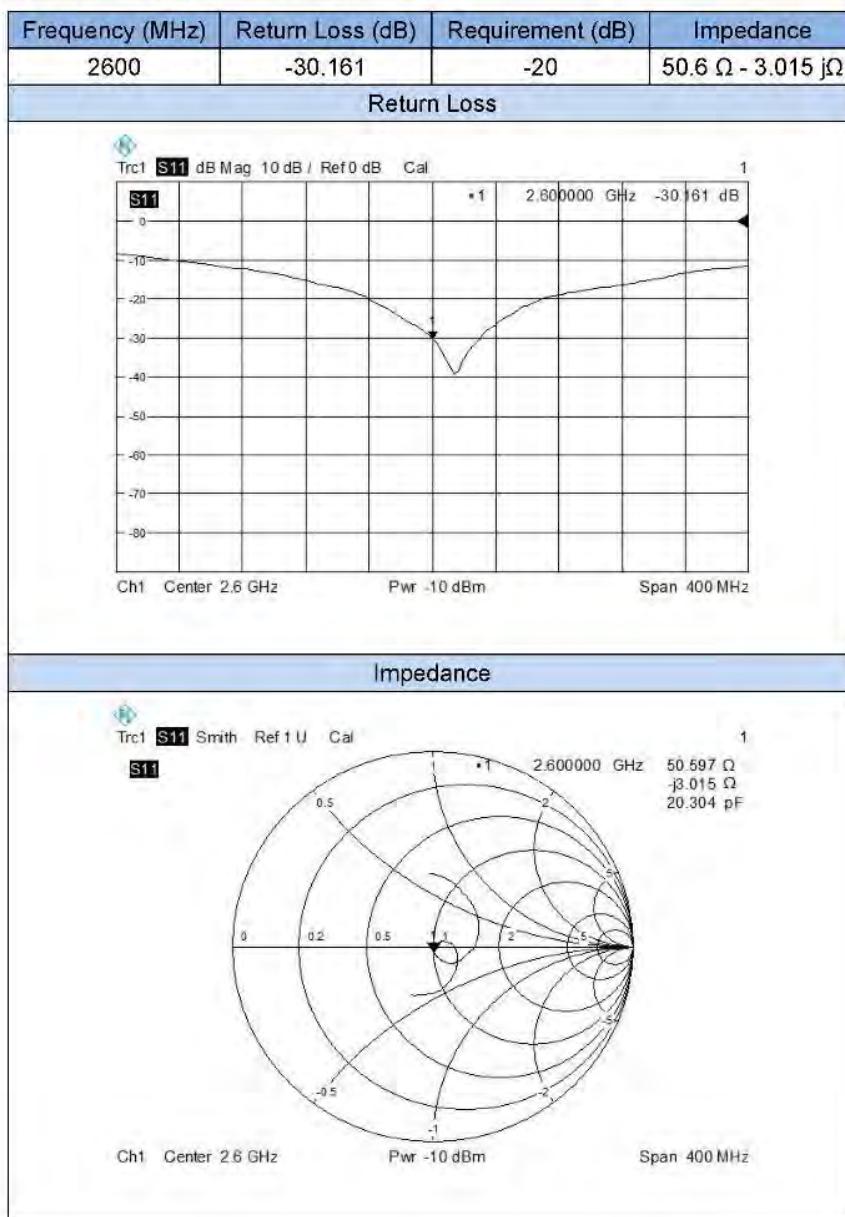
**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



### 3.5 D2600V2

#### RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

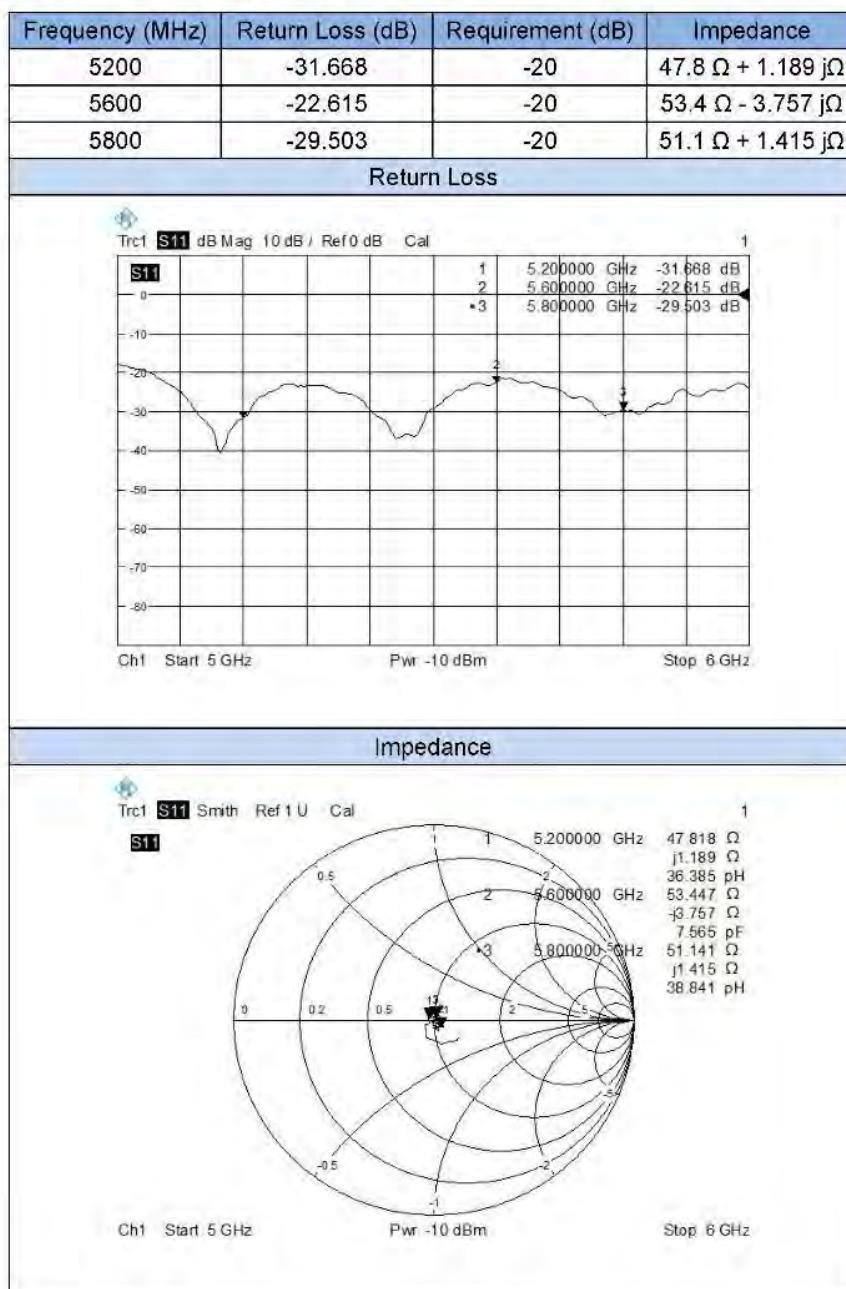


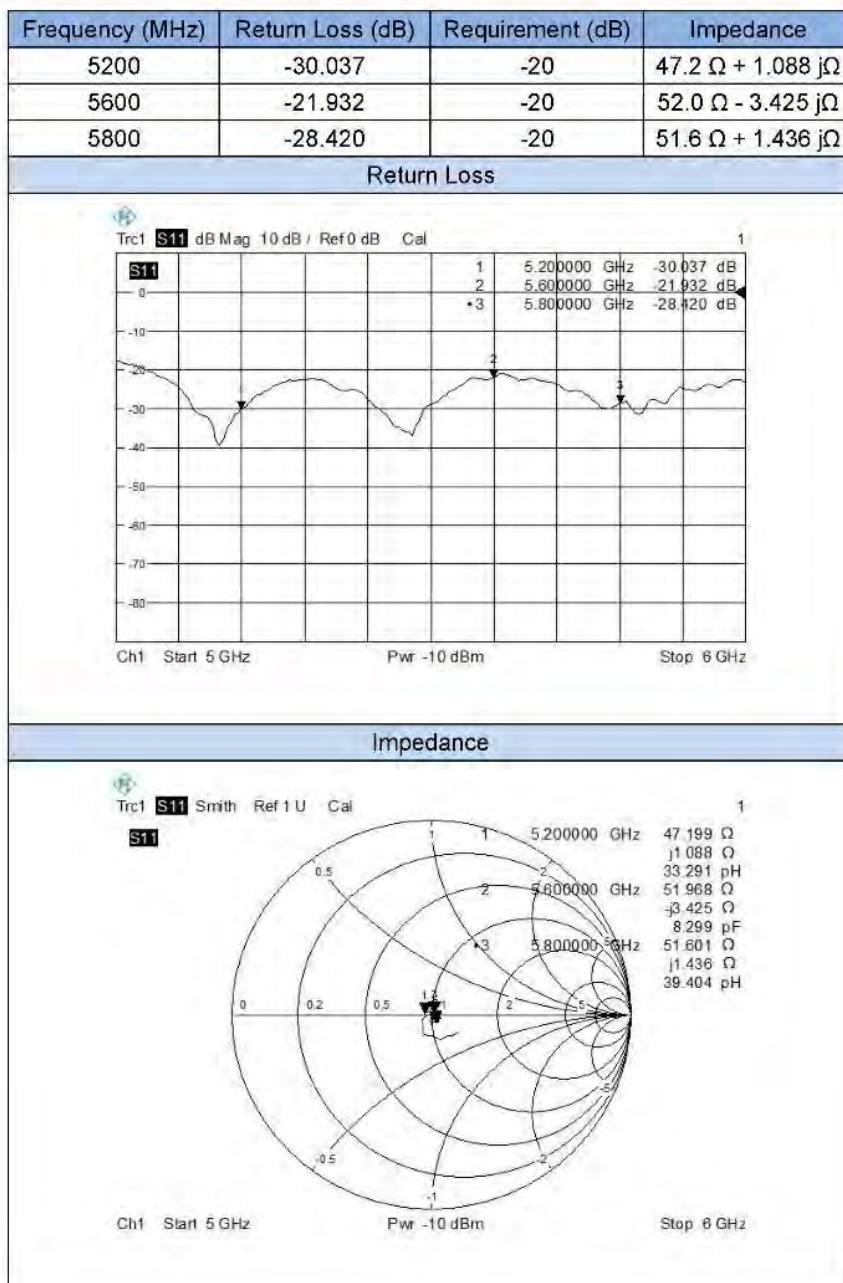
**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



### 3.6 D5GHzV2

#### RETURN LOSS AND IMPEDANCE IN HEAD LIQUID

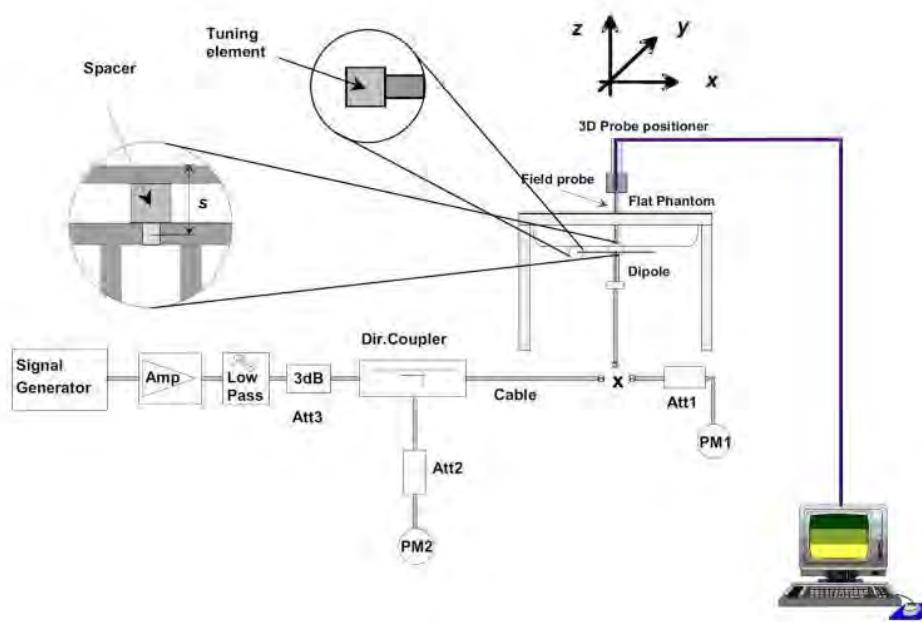


**RETURN LOSS AND IMPEDANCE IN BODY LIQUID**



## 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)	Normalized SAR (W/kg)	10 g Measured SAR (W/kg)	Normalized 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



## 4.2D835V2

### 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/m<sup>3</sup>

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**

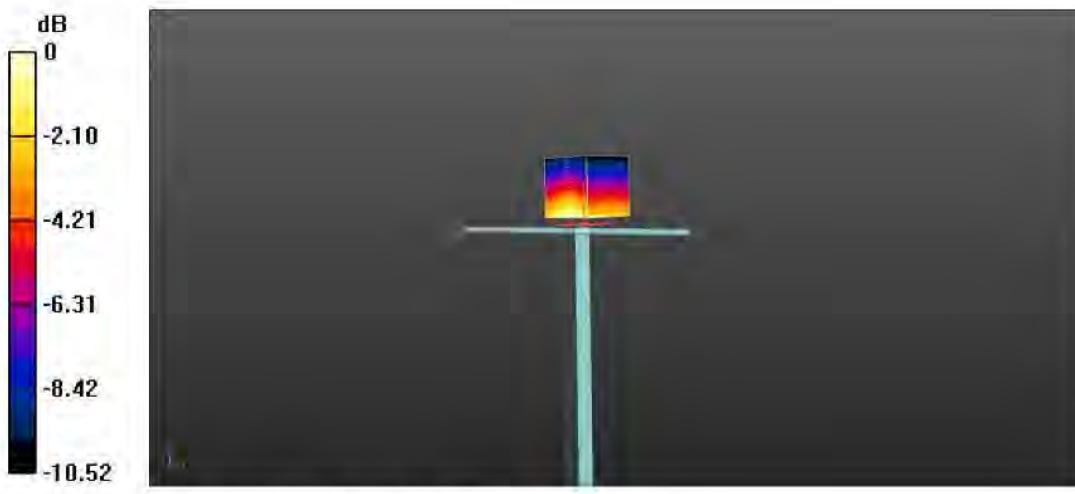
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





#### 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/m<sup>3</sup>

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**

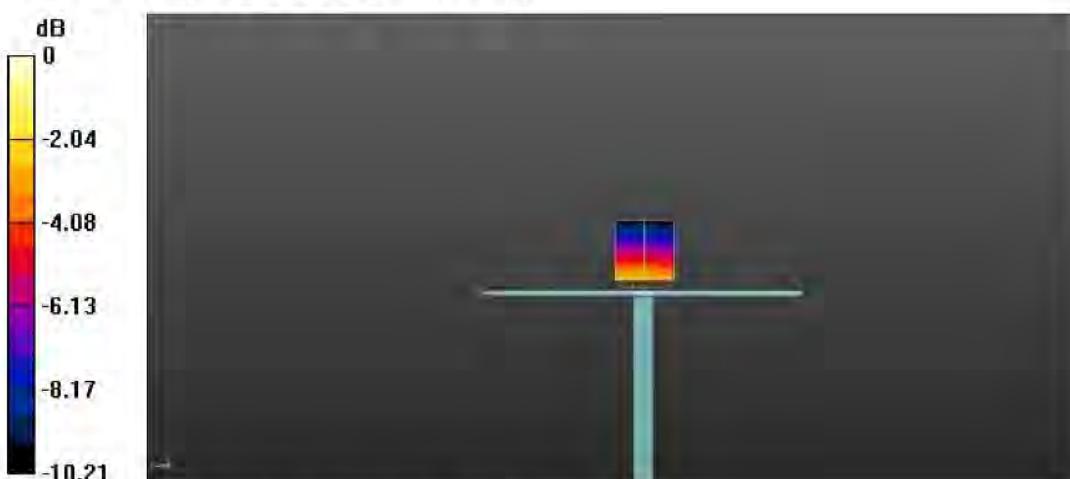
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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/m<sup>3</sup>

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**

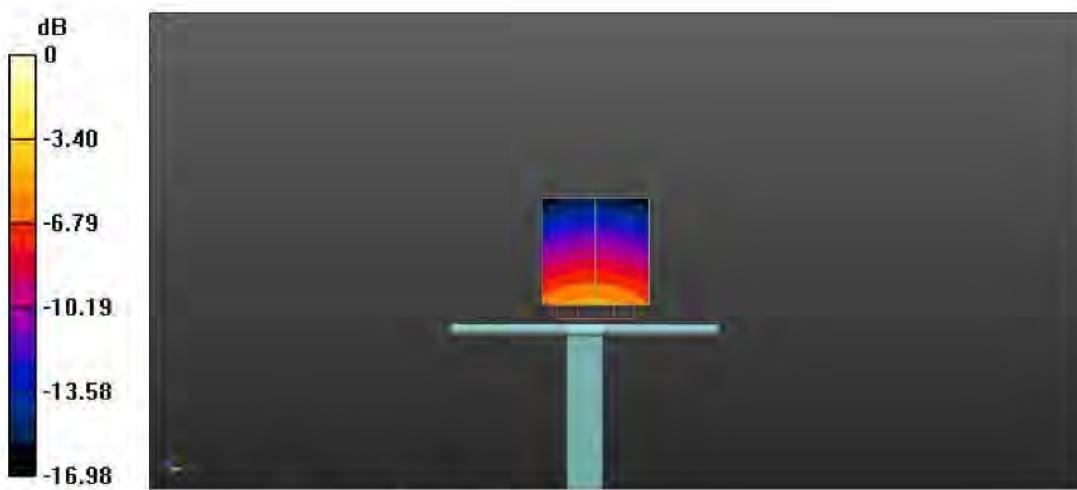
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





#### 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/m<sup>3</sup>

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**

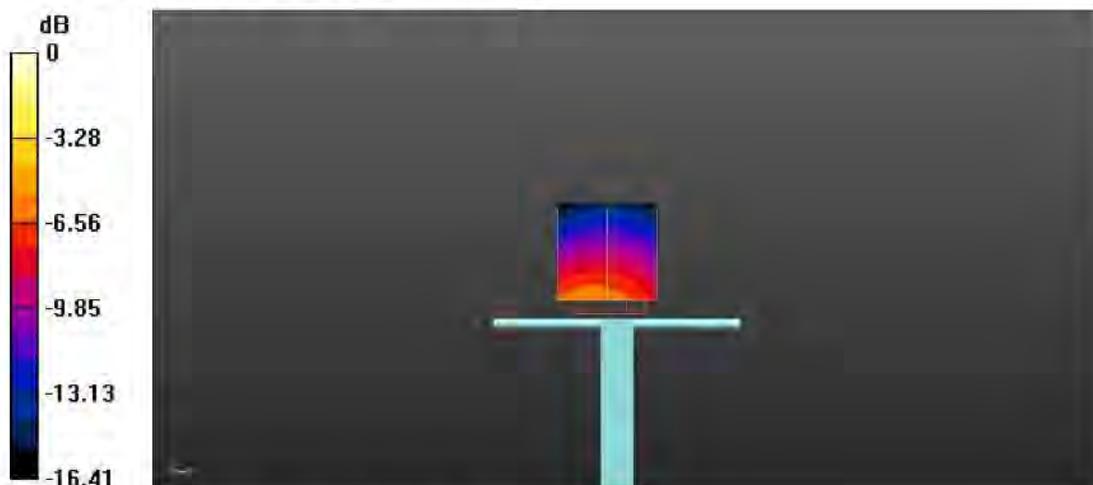
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





## 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/m<sup>3</sup>

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

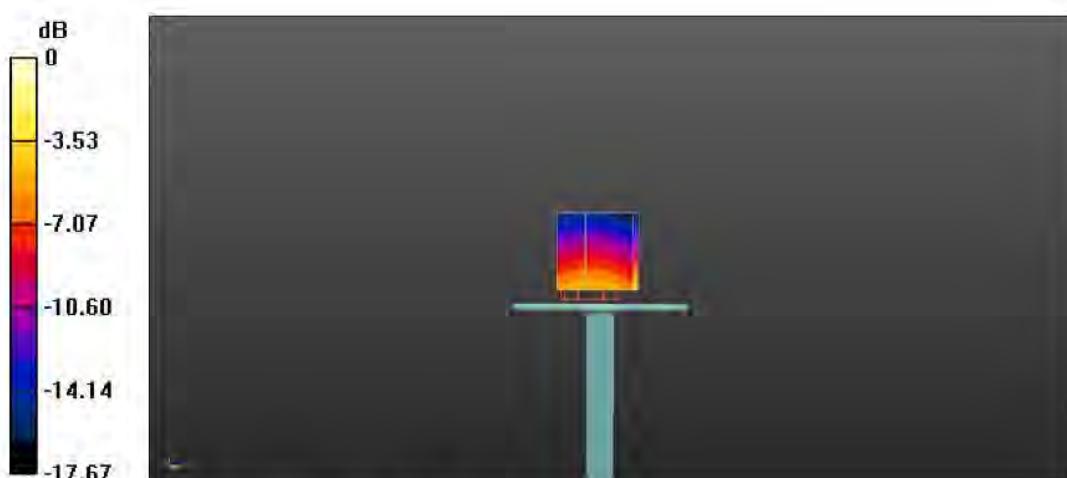
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





#### 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/m<sup>3</sup>

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**

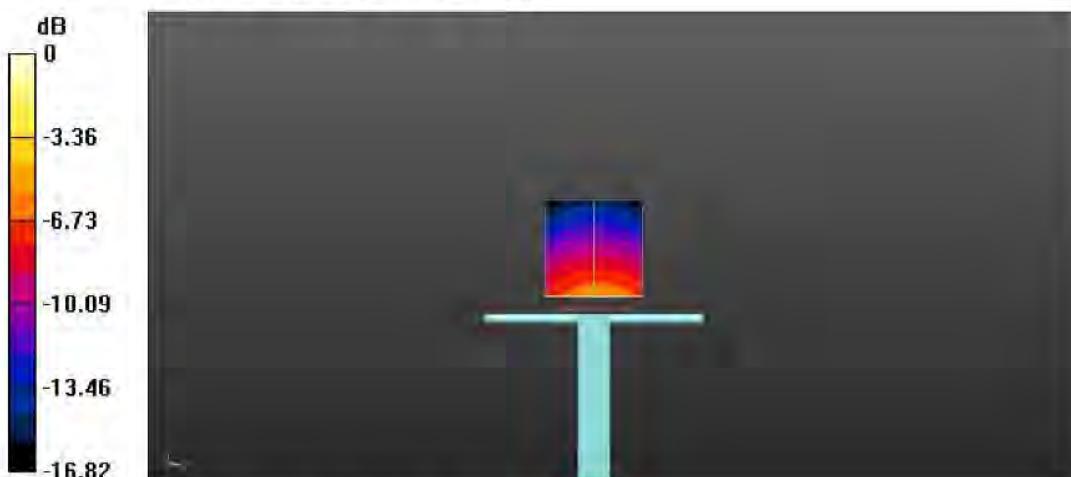
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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/m<sup>3</sup>

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

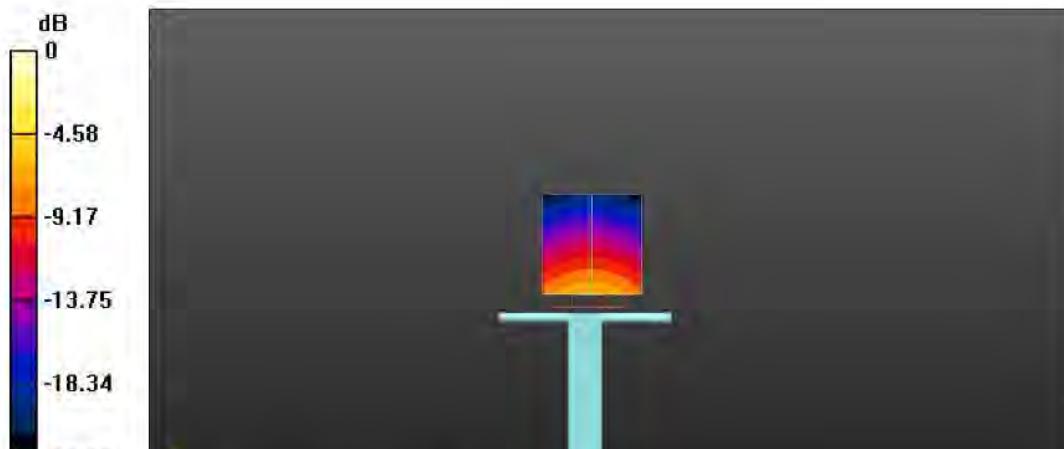
Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





#### 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/m<sup>3</sup>

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**

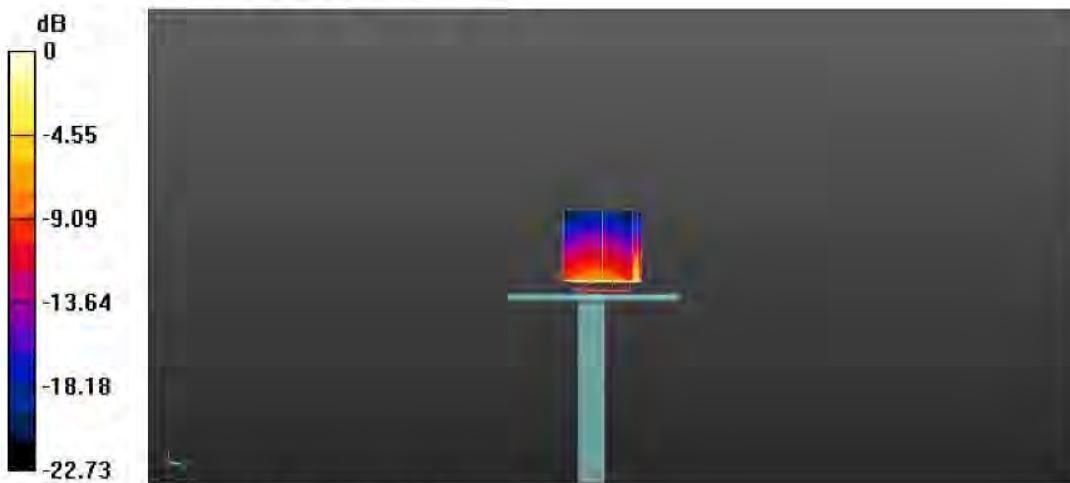
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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/m<sup>3</sup>

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**

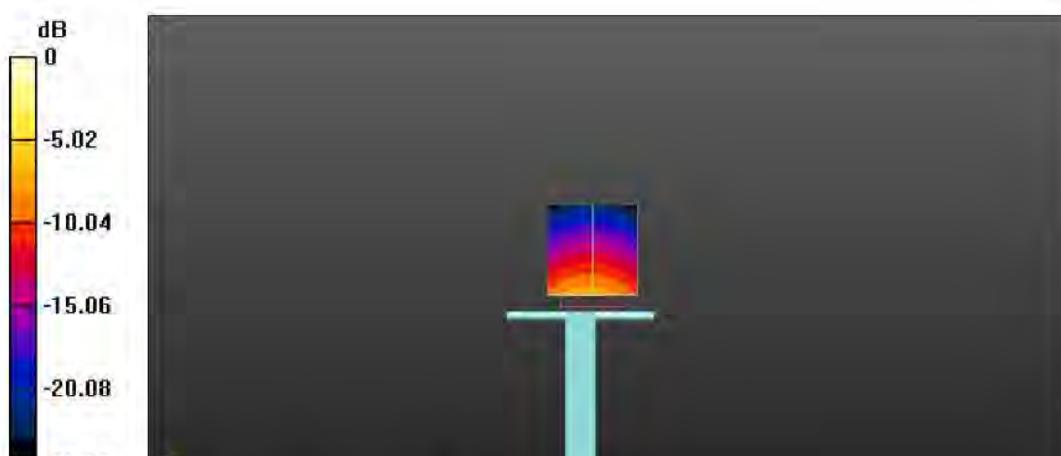
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





#### 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/m<sup>3</sup>

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**

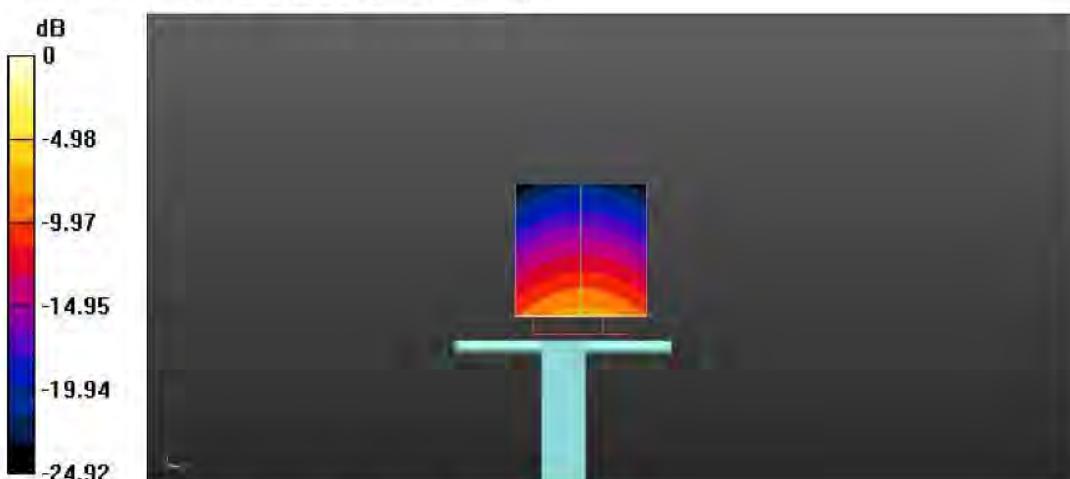
**Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

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





## 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/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.20$  S/m;  $\epsilon_r = 35.06$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.42$  S/m;  $\epsilon_r = 34.40$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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**

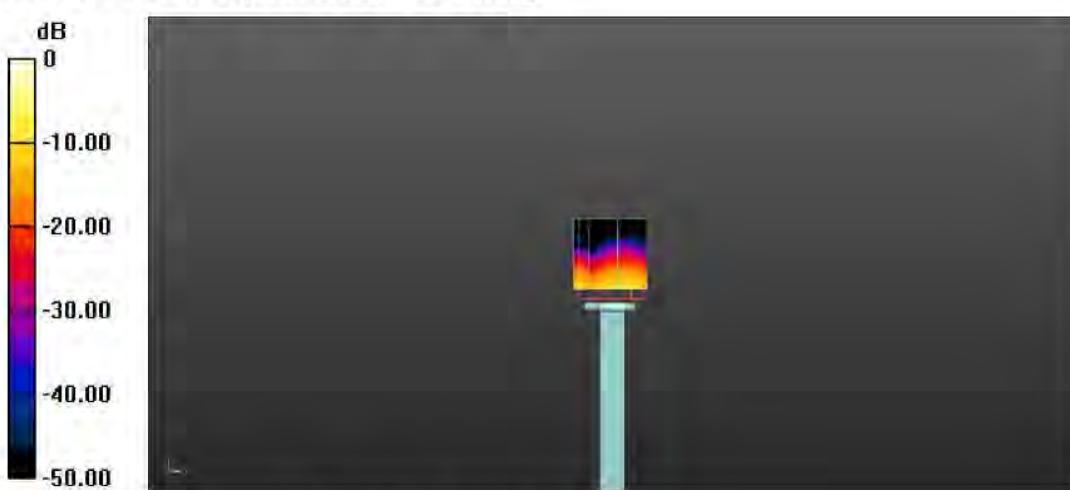
**MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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

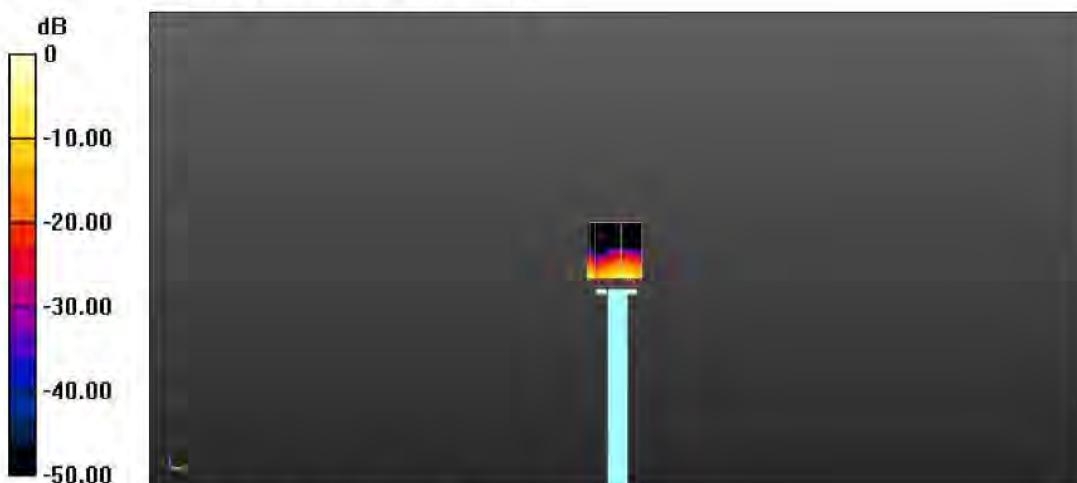
**Dipole validation measurement for Head Tissue/Pin= 100mW ,dist=10mm,f=5600****MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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

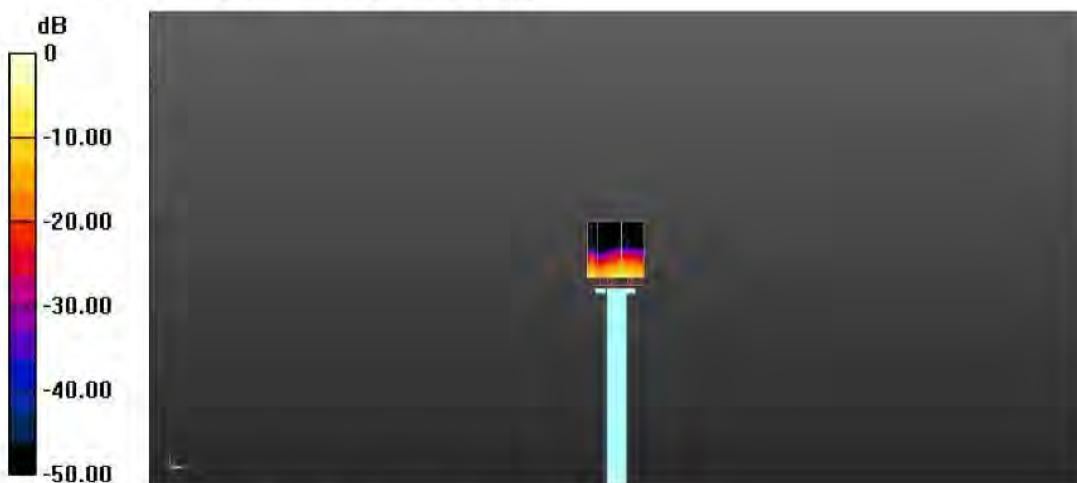
**Dipole Calibration for Head Tissue/Pin= 100mW ,dist=10mm,f=5800 MHz /Zoom****Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.72$  S/m;  $\epsilon_r = 46.31$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.92$  S/m;  $\epsilon_r = 46.06$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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**

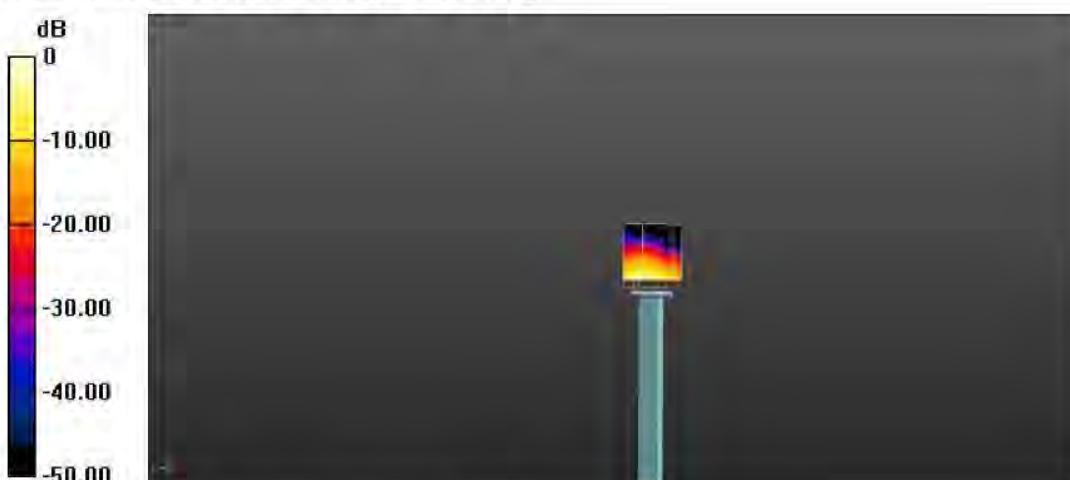
**MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

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



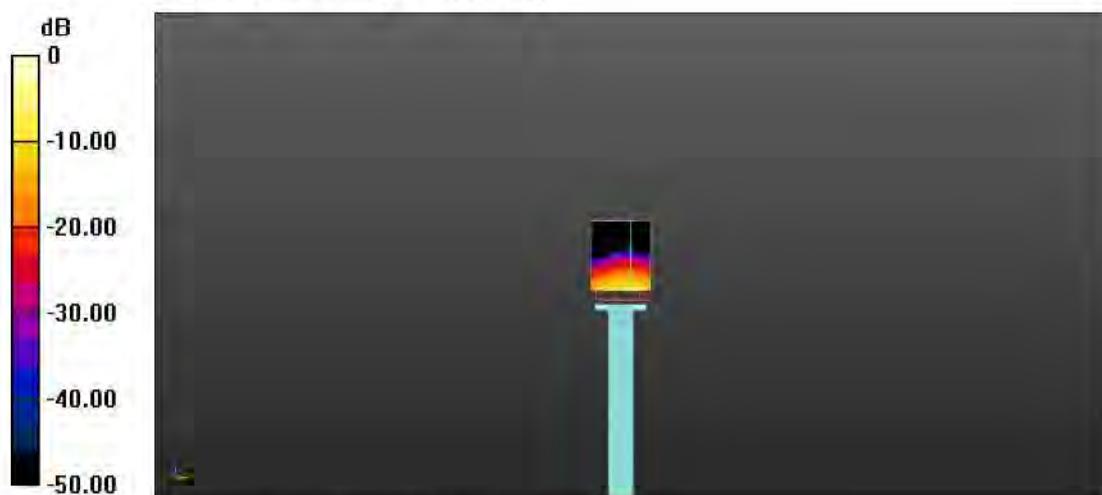
**Dipole validation measurement for Body Tissue/Pin= 100mW , dist=10mm,f=5600 MHz /Zoom Scan (7x7x21)/Cube 0:**

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



**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



--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 Dgérie (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&amp;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:	Name Jeton Kastrati	Function Laboratory Technician	Signature 
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  
**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

**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:**

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- d) 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.

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

### Head TSL parameters

The following parameters and calculations were applied.

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

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (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	<b>9.15 W/kg ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>5.95 W/kg ± 16.5 % (k=2)</b>

### Body TSL parameters

The following parameters and calculations were applied.

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

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (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	<b>9.17 W/kg ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (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	<b>6.04 W/kg ± 16.5 % (k=2)</b>

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

Impedance, transformed to feed point	51.5 $\Omega$ - 3.6 $j\Omega$
Return Loss	- 28.3 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	46.9 $\Omega$ - 4.9 $j\Omega$
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)

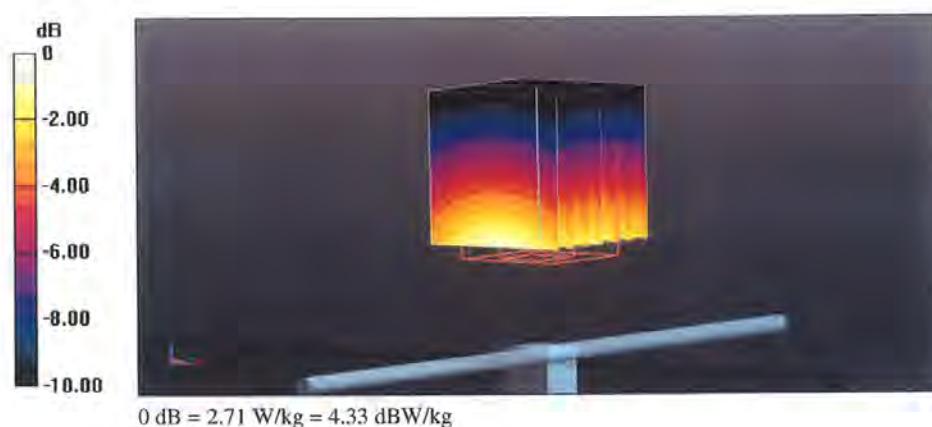
**Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

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/m<sup>3</sup>  
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:**

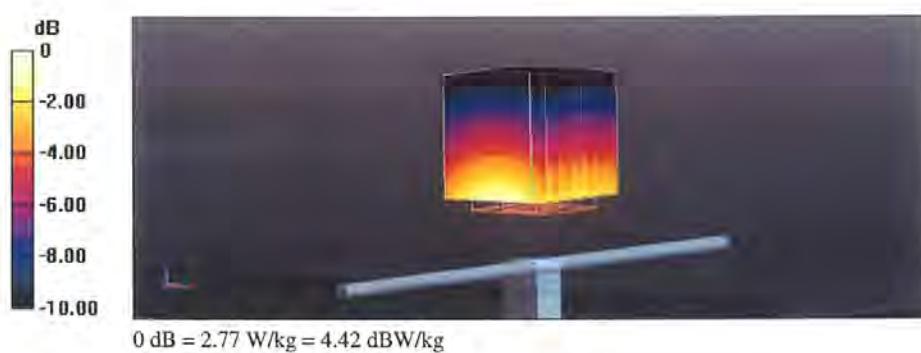
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

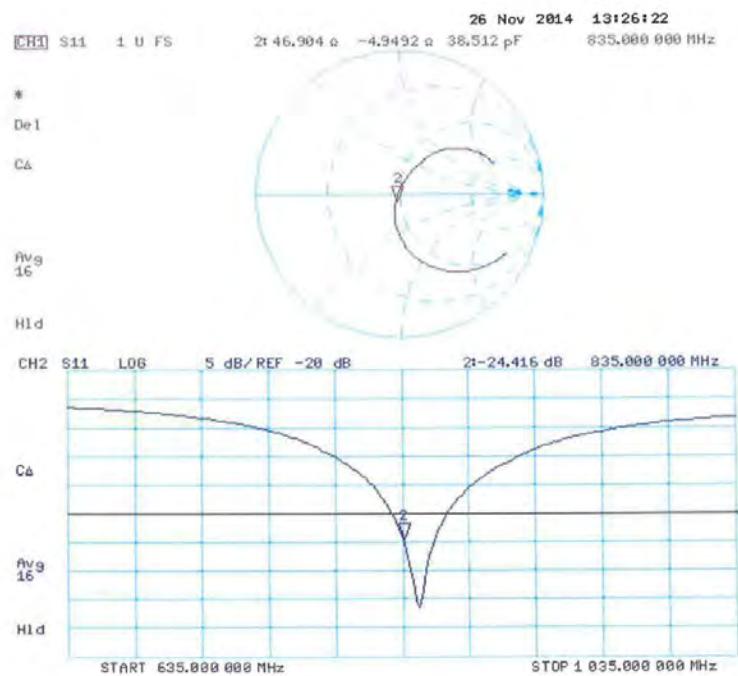
Peak SAR (extrapolated) = 3.48 W/kg

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

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client Dgérie (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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&amp;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: Name Jeton Kastrati Function Laboratory Technician



Approved by: Katja Pokovic Technical Manager

Issued: November 28, 2014

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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:**

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- d) 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 ± 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 ± 0.2) °C	39.2 ± 6 %	1.37 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (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 ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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 ± 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 ± 0.2) °C	52.1 ± 6 %	1.49 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (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 ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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 ± 16.5 % (k=2)

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

Impedance, transformed to feed point	50.7 $\Omega$ - 1.2 $j\Omega$
Return Loss	- 37.6 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	46.3 $\Omega$ - 0.3 $j\Omega$
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/m<sup>3</sup>

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:**

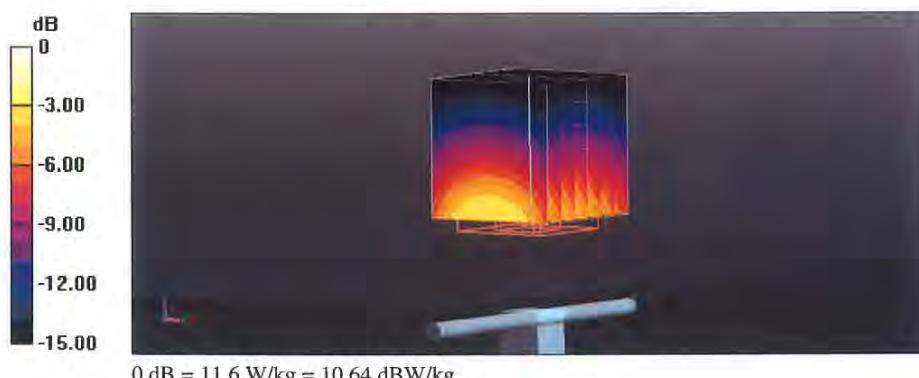
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

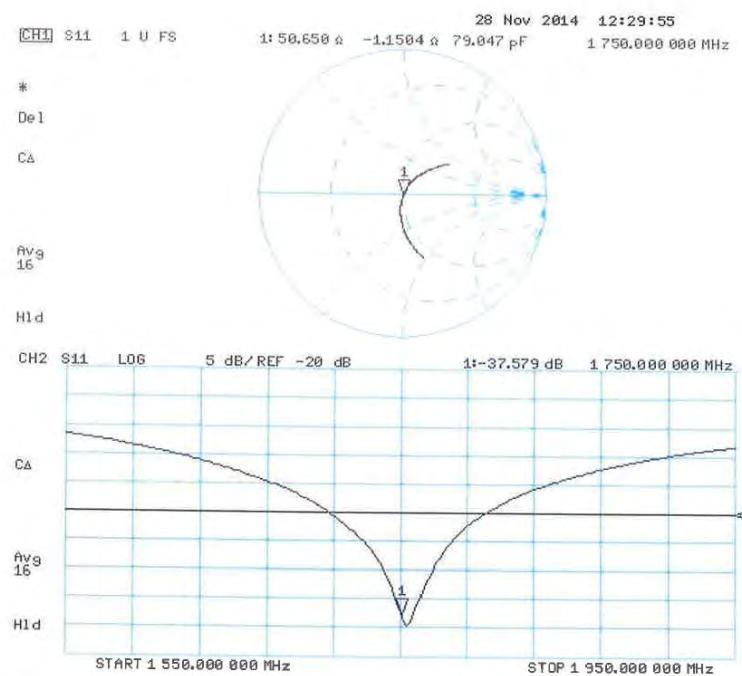
Peak SAR (extrapolated) = 16.4 W/kg

**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/m<sup>3</sup>

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:**

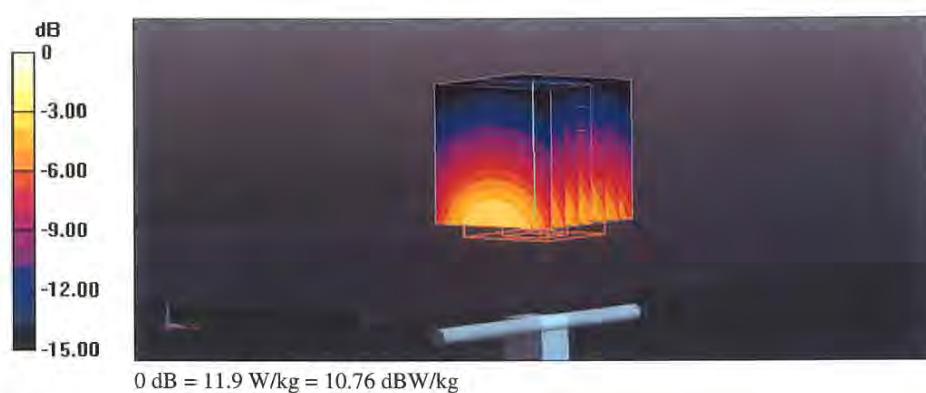
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

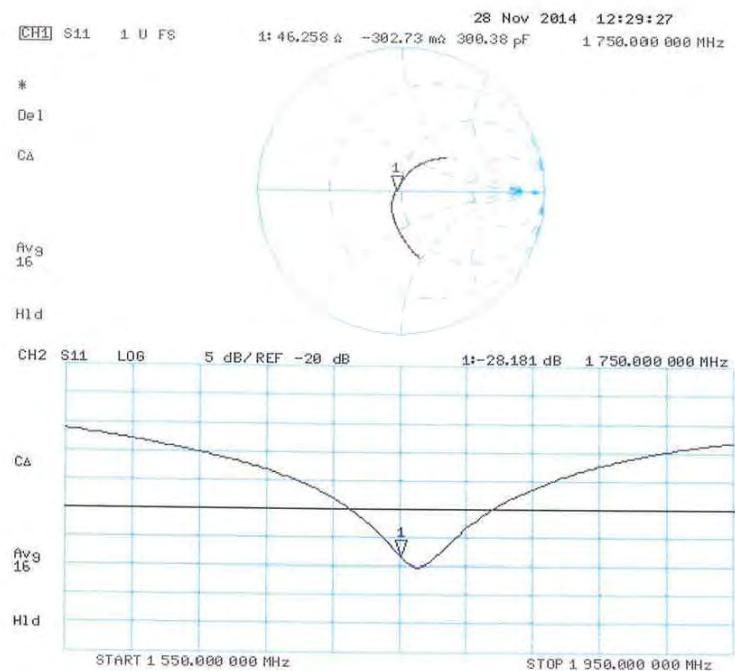
Peak SAR (extrapolated) = 16.1 W/kg

**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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Accreditation No.: SCS 108

Client Dgiele (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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&amp;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:	Name Jeton Kastrall	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 2, 2014

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Certificate No: D1900V2-5d193\_Nov14

Page 1 of 8

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Accreditation No.: **SCS 108**

**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- d) 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 ± 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 ± 0.2) °C	40.1 ± 6 %	1.39 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (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 ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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 ± 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 ± 0.2) °C	53.3 ± 6 %	1.50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (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 ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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 ± 16.5 % (k=2)

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

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

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	$48.7 \Omega + 5.1 \text{ j}\Omega$
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/m<sup>3</sup>  
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

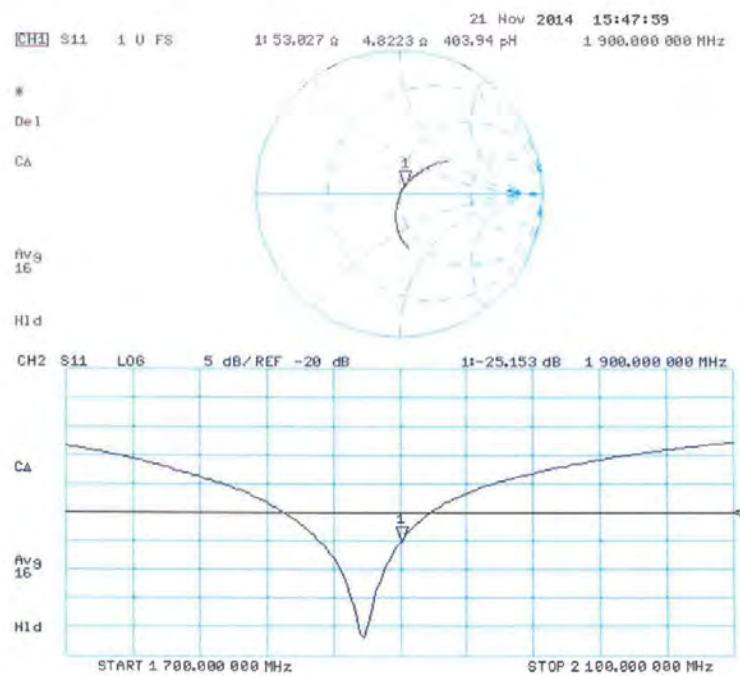
Peak SAR (extrapolated) = 18.5 W/kg

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/m<sup>3</sup>

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:**

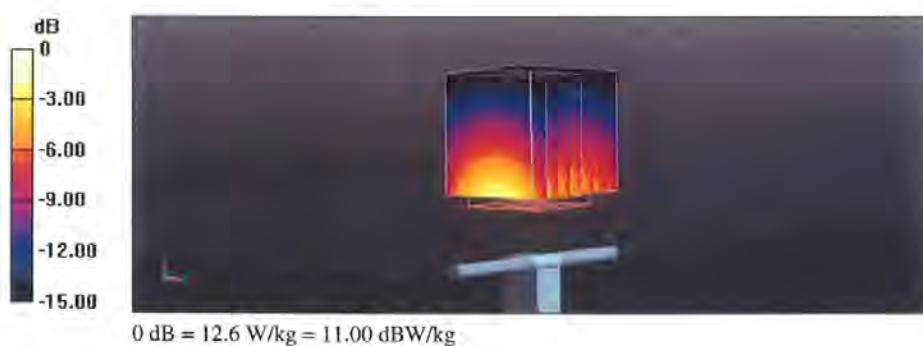
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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**