

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	$60.8 \Omega + 1.1 j\Omega$
Return Loss	- 20.1 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	$55.2 \Omega - 4.7 j\Omega$
Return Loss	- 23.6 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	$54.6 \Omega + 2.1 j\Omega$
Return Loss	- 26.3 dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	$51.8 \Omega - 12.5 j\Omega$
Return Loss	- 18.2 dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	$47.1 \Omega - 2.7 j\Omega$
Return Loss	- 27.8 dB

### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	$56.8 \Omega + 6.9 j\Omega$
Return Loss	- 20.9 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 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	August 28, 2003



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

## DASY5 Validation Report for Head TSL

Date: 14.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1008**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz  
 Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 4.65 \text{ mho/m}$ ;  $\epsilon_r = 36.1$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 4.96 \text{ mho/m}$ ;  $\epsilon_r = 35.6$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 5.27 \text{ mho/m}$ ;  $\epsilon_r = 35.1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 04.03.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 64.135 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 29.6850

**SAR(1 g) = 8.01 mW/g; SAR(10 g) = 2.28 mW/g**

Maximum value of SAR (measured) = 17.959 mW/g

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 65.059 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 34.0090

**SAR(1 g) = 8.56 mW/g; SAR(10 g) = 2.41 mW/g**

Maximum value of SAR (measured) = 19.656 mW/g

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 60.602 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 32.7510

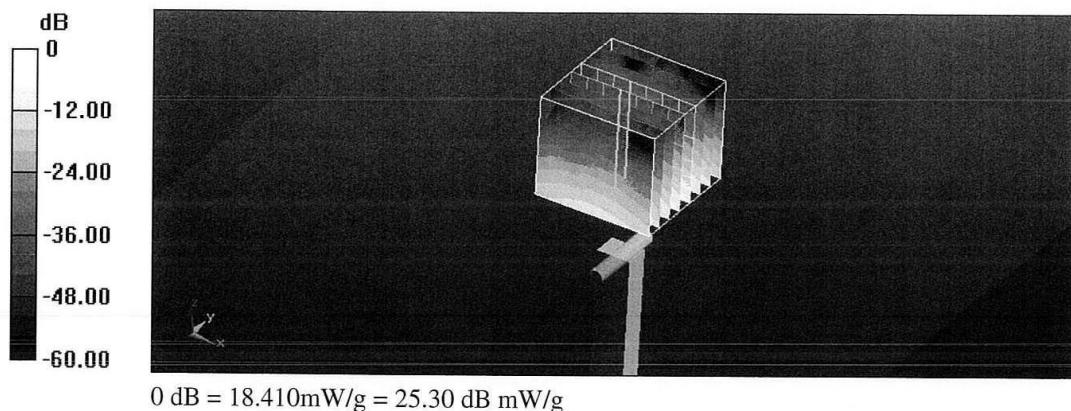
**SAR(1 g) = 7.79 mW/g; SAR(10 g) = 2.2 mW/g**

Maximum value of SAR (measured) = 18.411 mW/g



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

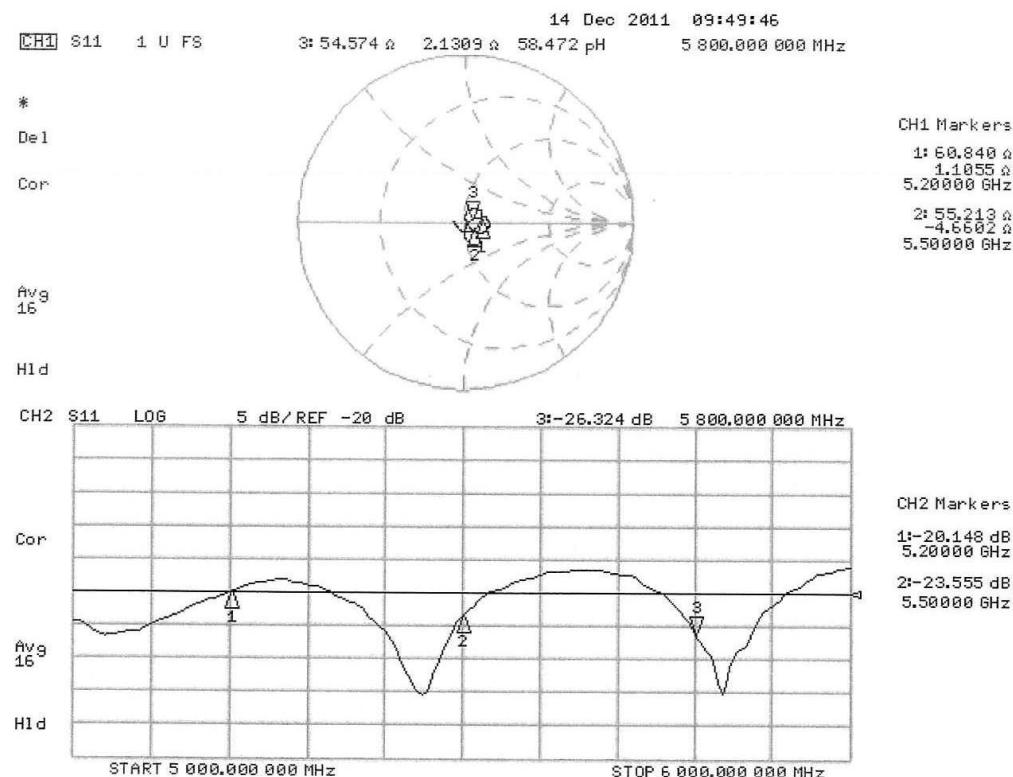
**This document shall only be reproduced in full, with the exception of the certificate on p3**



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

## Impedance Measurement Plot for Head TSL



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

## DASY5 Validation Report for Body TSL

Date: 13.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1008**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz  
 Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 5.44 \text{ mho/m}$ ;  $\epsilon_r = 49.6$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 5.86 \text{ mho/m}$ ;  $\epsilon_r = 49$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 6.28 \text{ mho/m}$ ;  $\epsilon_r = 48.4$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 04.03.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

### Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 58.776 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 29.4610

**SAR(1 g) = 7.54 mW/g; SAR(10 g) = 2.1 mW/g**

Maximum value of SAR (measured) = 17.191 mW/g

### Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 59.224 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 35.0790

**SAR(1 g) = 8.2 mW/g; SAR(10 g) = 2.26 mW/g**

Maximum value of SAR (measured) = 19.300 mW/g

### Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

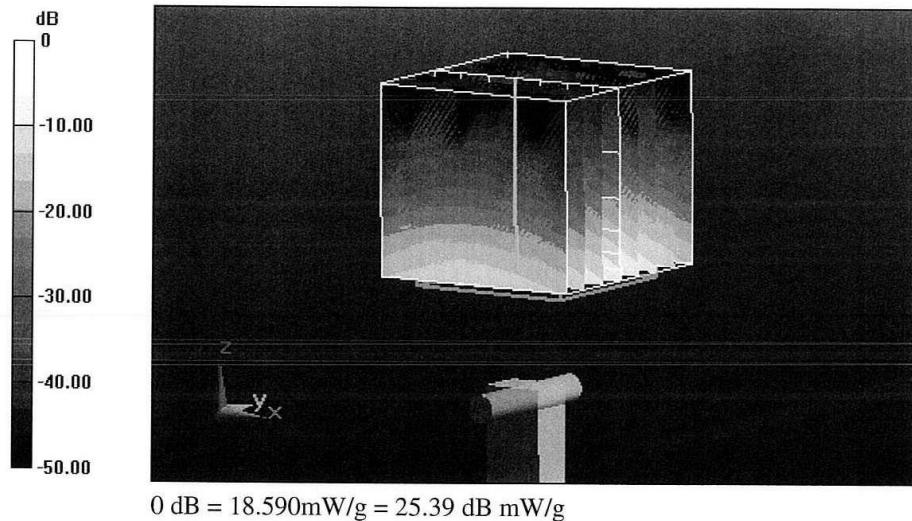
Reference Value = 55.474 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 35.6620

**SAR(1 g) = 7.65 mW/g; SAR(10 g) = 2.1 mW/g**

Maximum value of SAR (measured) = 18.593 mW/g

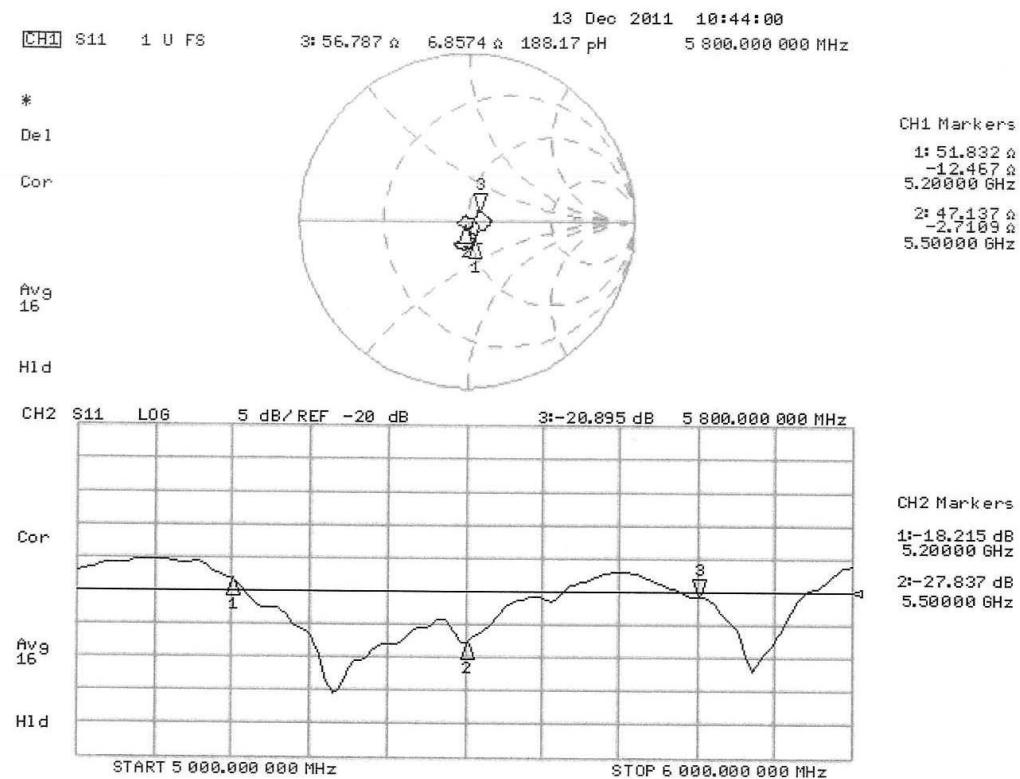




This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

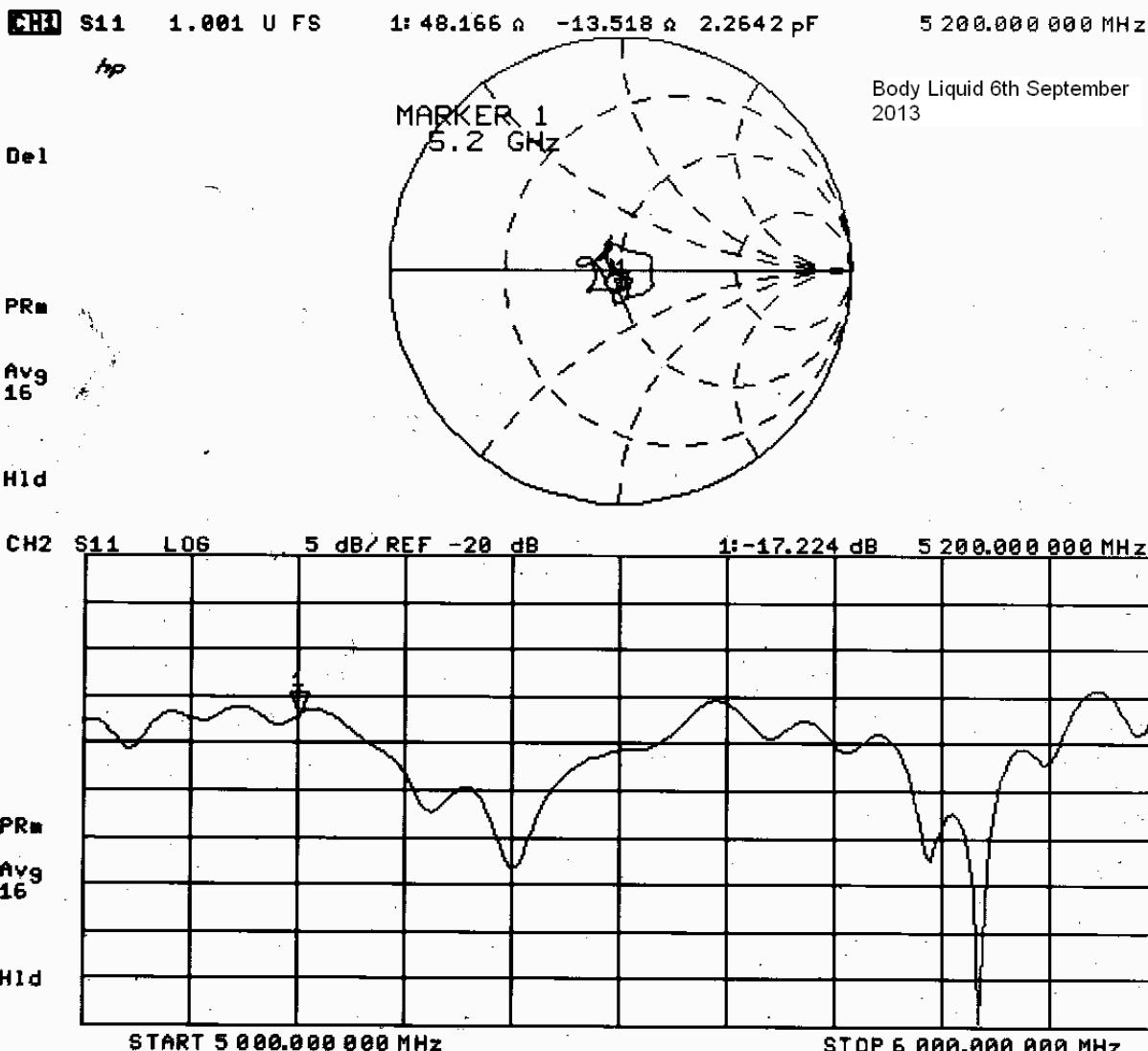
**This document shall only be reproduced in full, with the exception of the certificate on p3**

## Impedance Measurement Plot for Body TSL



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**



Accreditation No. 5292

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

CH1 S11 1.001 U FS 1: 48.787 Ω -8.9395 Ω 3.2370 pF 5 500.000 000 MHz

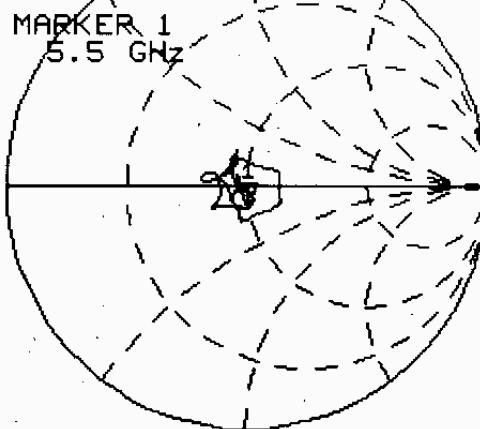
hp

Del

PRm

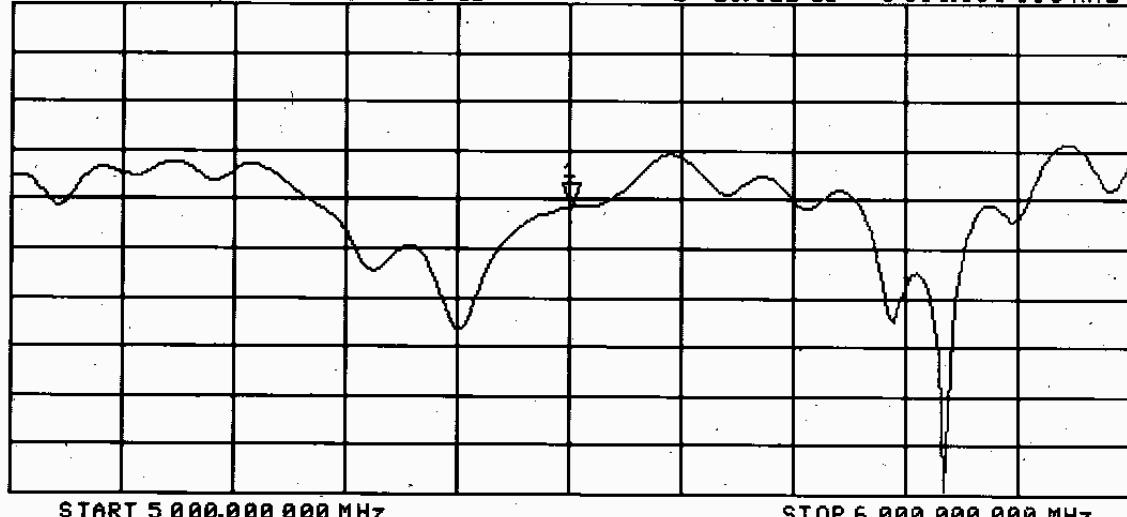
Avg 16

H1d



Body Liquid 6th September  
2013

CH2 S11 L06 5 dB/REF -20 dB 1: -20.822 dB 5 500.000 000 MHz



Accreditation No. 5292

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

CH1 S11 1.001 U FS 1: 51.846 Ω -3.1582 dB 8.6886 pF 5 800.000 000 MHz

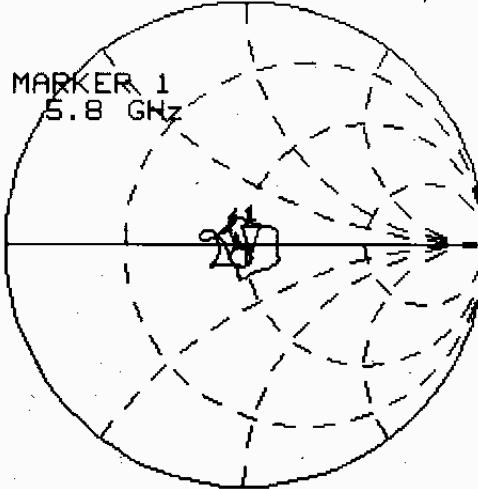
hp

Del

PRm

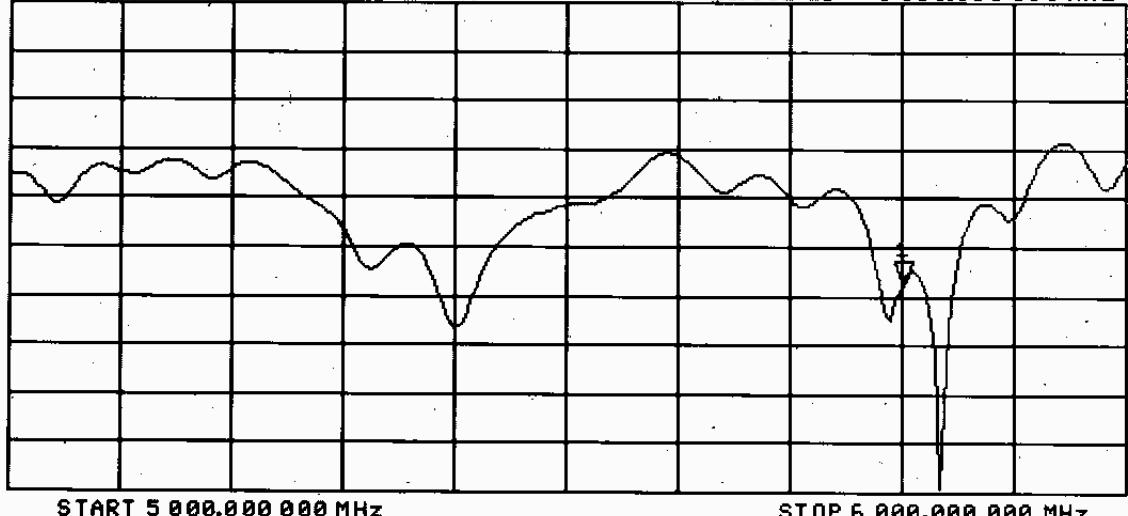
Avg 16

H1d



Body Liquid 6th September  
2013

CH2 S11 L06 5 dB/REF -20 dB 1: -28.901 dB 5 800.000 000 MHz



START 5 000.000 000 MHz

STOP 6 000.000 000 MHz



Accreditation No. 5292

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

**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 **EMC Technologies**

Certificate No: **DAE3-442\_Dec12**

## CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AE - SN: 442**

Calibration procedure(s) **QA CAL-06.v25**  
 Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **December 04, 2012**

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
Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No:12728)	Oct-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check: Jan-13

Calibrated by: **Name: Dominique Steffen** **Function: Technician** **Signature:**

Approved by: **Fin Bomholt** **R&D Director** **Signature:**

Issued: December 4, 2012

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

Certificate No: **DAE3-442\_Dec12**

Page 1 of 5



Accreditation No. 5292

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

**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

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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity*: Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity*: Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation*: Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted*: Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current*: Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance*: Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage*: Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption*: Typical value for information. Supply currents in various operating modes.



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB =  $6.1\mu\text{V}$ , full range =  $-100...+300\text{ mV}$

Low Range: 1LSB =  $61\text{nV}$ , full range =  $-1.....+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$404.383 \pm 0.1\% \text{ (k=2)}$	$405.028 \pm 0.1\% \text{ (k=2)}$	$405.248 \pm 0.1\% \text{ (k=2)}$
Low Range	$3.98414 \pm 0.7\% \text{ (k=2)}$	$3.98047 \pm 0.7\% \text{ (k=2)}$	$3.99034 \pm 0.7\% \text{ (k=2)}$

### Connector Angle

Connector Angle to be used in DASY system	$57^\circ \pm 1^\circ$
---	------------------------



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

## Appendix

### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199997.32	0.83	0.00
Channel X + Input	20000.96	0.52	0.00
Channel X - Input	-19995.89	5.07	-0.03
Channel Y + Input	199991.57	-5.10	-0.00
Channel Y + Input	19999.61	-0.72	-0.00
Channel Y - Input	-20000.08	1.07	-0.01
Channel Z + Input	199994.93	-1.47	-0.00
Channel Z + Input	19998.65	-1.55	-0.01
Channel Z - Input	-20001.87	-0.86	0.00

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	1999.73	-0.93	-0.05
Channel X + Input	201.19	-0.03	-0.02
Channel X - Input	-199.11	-0.34	0.17
Channel Y + Input	2000.18	-0.58	-0.03
Channel Y + Input	200.86	-0.19	-0.09
Channel Y - Input	-199.67	-0.85	0.43
Channel Z + Input	2000.78	0.19	0.01
Channel Z + Input	199.81	-1.23	-0.61
Channel Z - Input	-199.78	-0.95	0.48

### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-9.21	-11.14
	-200	11.71	10.71
Channel Y	200	0.07	-0.24
	-200	-1.38	-1.20
Channel Z	200	-6.13	-5.79
	-200	3.22	3.35

### 3. Channel separation

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	-0.32	-3.61
Channel Y	200	8.70	-	-0.04
Channel Z	200	6.55	6.77	-



This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**

#### 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15786	17612
Channel Y	15773	16289
Channel Z	15588	16411

#### 5. Input Offset Measurement

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

Input  $10M\Omega$

	Average ( $\mu V$ )	min. Offset ( $\mu V$ )	max. Offset ( $\mu V$ )	Std. Deviation ( $\mu V$ )
Channel X	0.01	-1.83	1.76	0.64
Channel Y	-0.72	-2.19	0.91	0.48
Channel Z	-1.26	-3.00	0.08	0.62

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

#### 7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

#### 8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

#### 9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

#### 4.

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**



Accreditation No. 5292



Accreditation No. 5292

This document is issued in accordance with NATA's accreditation requirements. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

**This document shall only be reproduced in full, with the exception of the certificate on p3**