

## IMPORTANT NOTICE

### USAGE OF THE DAE4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange:** The battery cover of the DAE4 unit is fixed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

**Shipping of the DAE:** Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures:** Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair:** Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**DASY Configuration Files:** Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 M $\Omega$  is given in the corresponding configuration file.

**Important Note:**

**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**

**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.**

**Important Note:**

**To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.**



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Multilateral Agreement for the recognition of calibration certificates

Client **BTL**

Accreditation No.: **SCS 0108**

Certificate No: **DAE4-1289\_May22**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 1289**

Calibration procedure(s) **QA CAL-06.v30**  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **May 31, 2022**

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	31-Aug-21 (No:31368)	Aug-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23
Calibrator Box V2.1	SE UMS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23

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

Signature

Approved by: Name **Sven Kühn** Function **Technical Manager**

Signature

Issued: May 31, 2022

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Accreditation No.: SCS 0108

## 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.

## 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	$404.553 \pm 0.02\% \text{ (k=2)}$	$405.041 \pm 0.02\% \text{ (k=2)}$	$404.946 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.96702 \pm 1.50\% \text{ (k=2)}$	$3.99715 \pm 1.50\% \text{ (k=2)}$	$3.99277 \pm 1.50\% \text{ (k=2)}$

## Connector Angle

Connector Angle to be used in DASY system	$256.0^\circ \pm 1^\circ$
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## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	200035.07	0.68	0.00
Channel X + Input	20007.89	1.77	0.01
Channel X - Input	-20005.05	0.94	-0.00
Channel Y + Input	200030.32	-4.17	-0.00
Channel Y + Input	20006.71	0.72	0.00
Channel Y - Input	-20006.13	-0.03	0.00
Channel Z + Input	200030.94	-4.00	-0.00
Channel Z + Input	20005.13	-0.73	-0.00
Channel Z - Input	-20005.98	0.17	-0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2001.07	-0.39	-0.02
Channel X + Input	201.30	-0.14	-0.07
Channel X - Input	-198.58	-0.03	0.01
Channel Y + Input	2001.16	-0.13	-0.01
Channel Y + Input	200.52	-0.67	-0.33
Channel Y - Input	-198.90	-0.14	0.07
Channel Z + Input	2001.34	0.01	0.00
Channel Z + Input	200.46	-0.84	-0.42
Channel Z - Input	-199.20	-0.51	0.26

### 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	15.06	13.21
	- 200	-12.13	-14.16
Channel Y	200	-23.90	-24.15
	- 200	23.20	22.81
Channel Z	200	0.71	0.75
	- 200	-1.89	-2.12

### 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	-	0.90	-3.05
Channel Y	200	8.17	-	2.70
Channel Z	200	9.83	5.09	-

#### 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	16022	13346
Channel Y	15836	17727
Channel Z	15737	14196

#### 5. Input Offset Measurement

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

Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.49	-0.85	2.34	0.55
Channel Y	-0.05	-1.64	1.47	0.62
Channel Z	0.43	-1.67	2.20	0.56

#### 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



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Accreditation No.: SCS 0108

Client

BTL

Certificate No

EX-7678\_Aug22

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:7678

Calibration procedure(s) QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5,  
QA CAL-25.v7  
Calibration procedure for dosimetric E-field probes

Calibration date August 30, 2022

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 NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-21 (OCP-DAK3.5-1249_Oct21)	Oct-22
OCP DAK-12	SN: 1016	20-Oct-21 (OCP-DAK12-1016_Oct21)	Oct-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by	Aidonia Georgiadou	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: August 30, 2022

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## Glossary

TS	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta=0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

## Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)x,y,z = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCPx,y,z**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to  $NORM<sub>x,y,z</sub> * ConvF$  whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

## Parameters of Probe: EX3DV4 - SN:7678

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.64	0.58	0.55	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	107.1	104.3	107.7	$\pm 4.7\%$

### Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc <sup>E</sup> k = 2
0	CW	X	0.00	0.00	1.00	0.00	163.2	$\pm 2.5\%$	$\pm 4.7\%$
		Y	0.00	0.00	1.00		159.0		
		Z	0.00	0.00	1.00		179.5		

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%.

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5).

<sup>B</sup> Linearization parameter uncertainty for maximum specified field strength.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

## Parameters of Probe: EX3DV4 - SN:7678

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	151.6°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

**Note:** Measurement distance from surface can be increased to 3–4 mm for an *Area Scan* job.

**Parameters of Probe: EX3DV4 - SN:7678****Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity <sup>F</sup> (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unc (k = 2)
750	41.9	0.89	11.14	11.14	11.14	0.49	0.83	±12.0%
835	41.5	0.90	10.73	10.73	10.73	0.51	0.81	±12.0%
900	41.5	0.97	10.60	10.60	10.60	0.46	0.85	±12.0%
1750	40.1	1.37	8.63	8.63	8.63	0.41	0.86	±12.0%
1900	40.0	1.40	8.55	8.55	8.55	0.41	0.86	±12.0%
2300	39.5	1.67	8.53	8.53	8.53	0.36	0.90	±12.0%
2450	39.2	1.80	8.34	8.34	8.34	0.34	0.90	±12.0%
2600	39.0	1.96	8.11	8.11	8.11	0.36	0.90	±12.0%
3500	37.9	2.91	7.10	7.10	7.10	0.30	1.35	±13.1%
3700	37.7	3.12	7.06	7.06	7.06	0.30	1.35	±13.1%
5200	36.0	4.66	5.67	5.67	5.67	0.40	1.80	±13.1%
5300	35.9	4.76	5.50	5.50	5.50	0.40	1.80	±13.1%
5600	35.5	5.07	4.95	4.95	4.95	0.40	1.80	±13.1%
5800	35.3	5.27	5.00	5.00	5.00	0.40	1.80	±13.1%

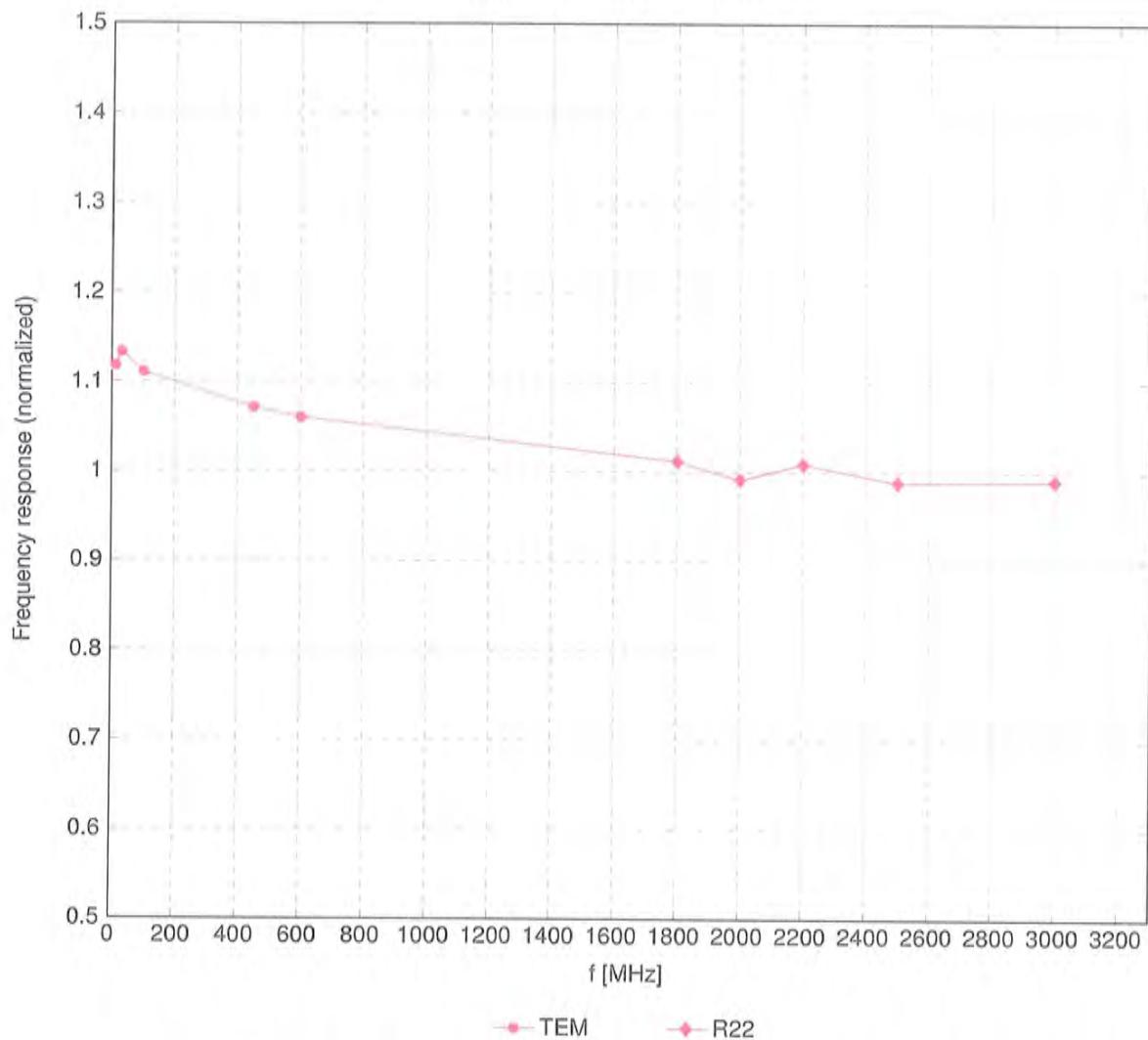
<sup>C</sup> Frequency validity above 300 MHz of ±100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ±50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ±10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4–9 MHz, and ConvF assessed at 13 MHz is 9–19 MHz. Above 5 GHz frequency validity can be extended to ±110 MHz.

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

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

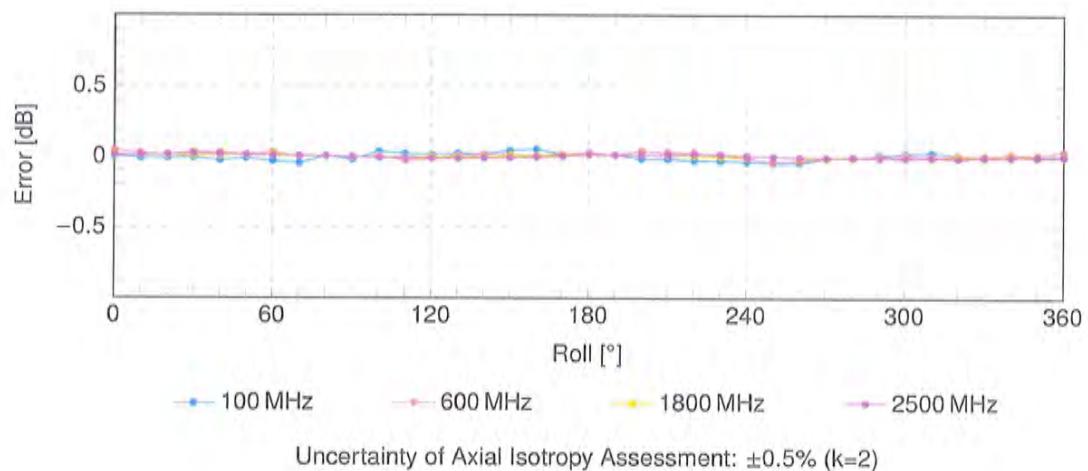
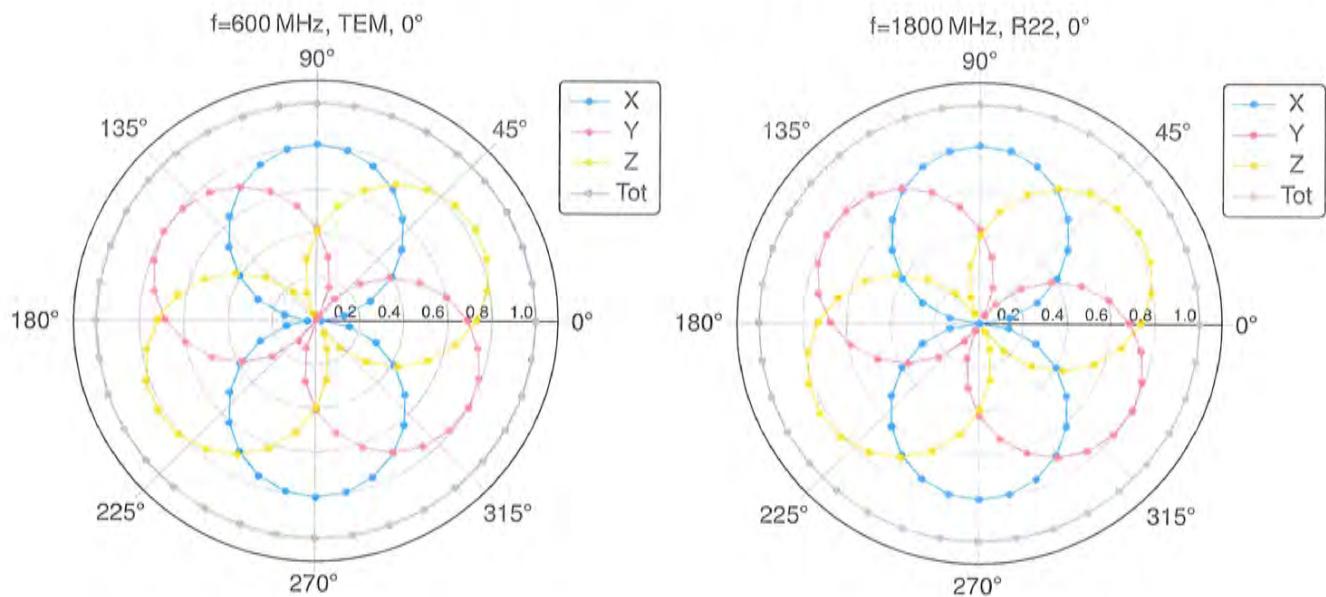
### Frequency Response of E-Field

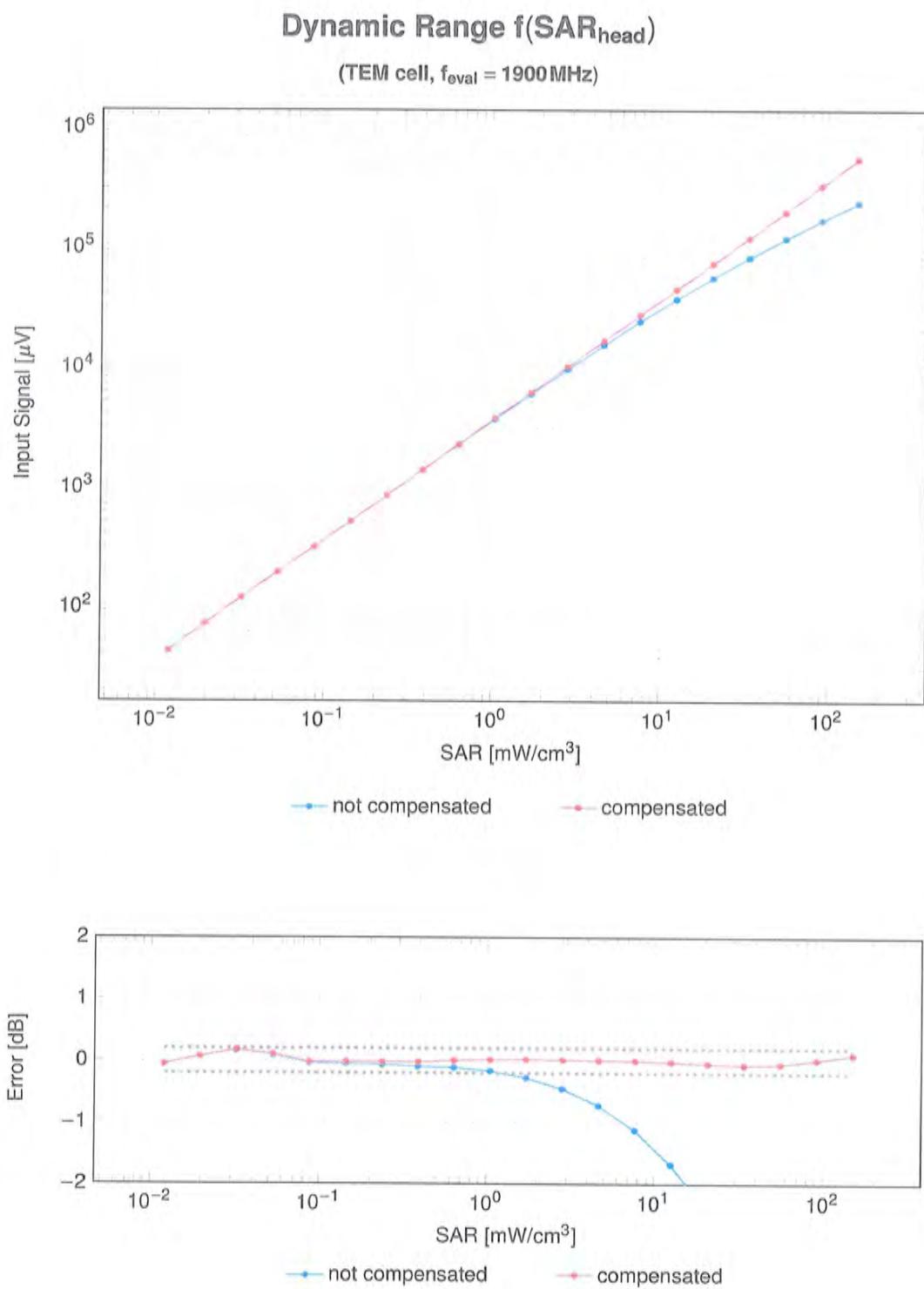
(TEM-Cell:ifi110 EXX, Waveguide:R22)



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

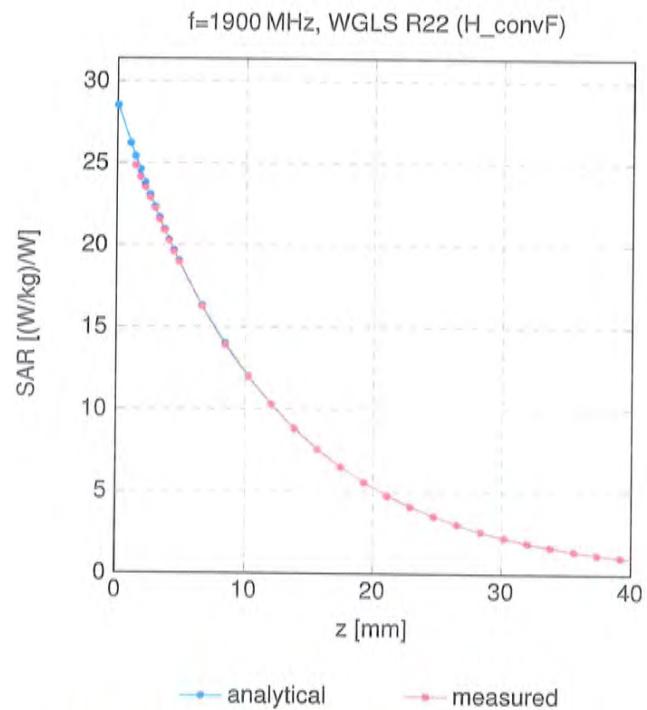
### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



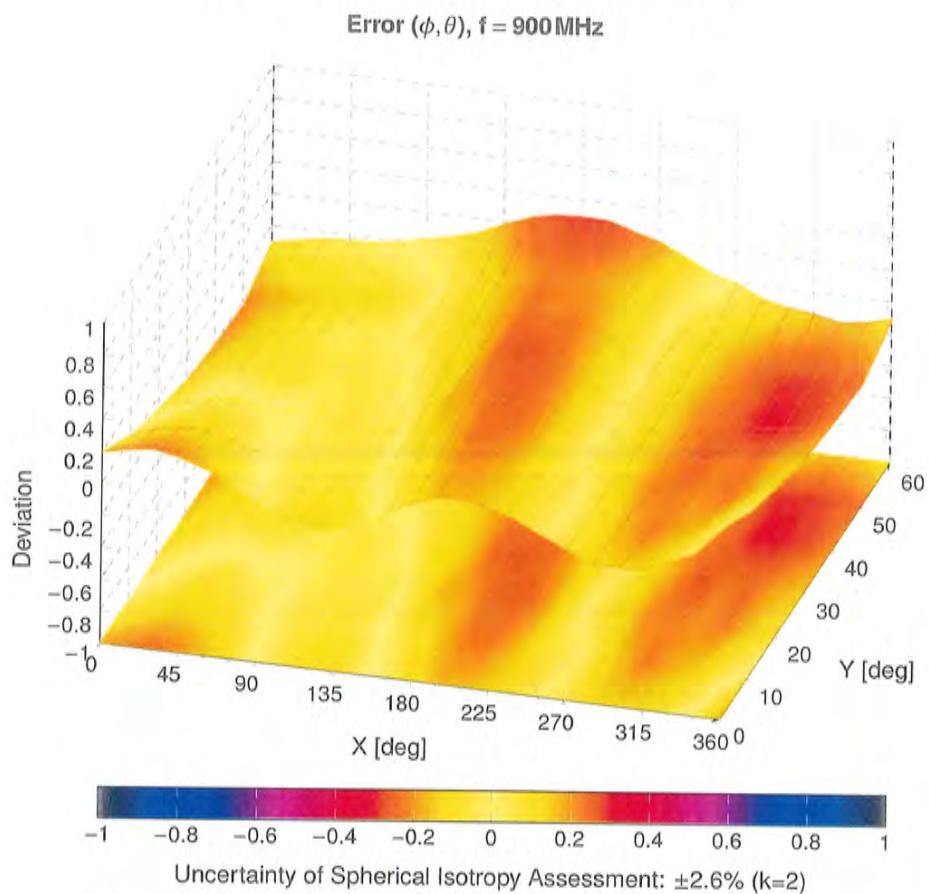


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid





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Client **BTL (Auden)**

Accreditation No.: **SCS 0108**

Certificate No: **D2450V2-973\_Feb21**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:973**

Calibration procedure(s) **QA CAL-05.v11**  
 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz

Calibration date: **February 08, 2021**

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 NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by:	Name	Function	Signature
	Leif Klysnér	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 11, 2021

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Accreditation No.: **SCS 0108**

**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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- e) 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	V52.10.4
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	38.1 $\pm$ 6 %	1.86 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.5 W/kg <math>\pm</math> 17.0 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.4 W/kg <math>\pm</math> 16.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.1 $\Omega$ + 1.9 $j\Omega$
Return Loss	- 27.2 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 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
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# DASY5 Validation Report for Head TSL

Date: 08.02.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:973**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.86$  S/m;  $\epsilon_r = 38.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

## 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 = 121.4 V/m; Power Drift = -0.06 dB

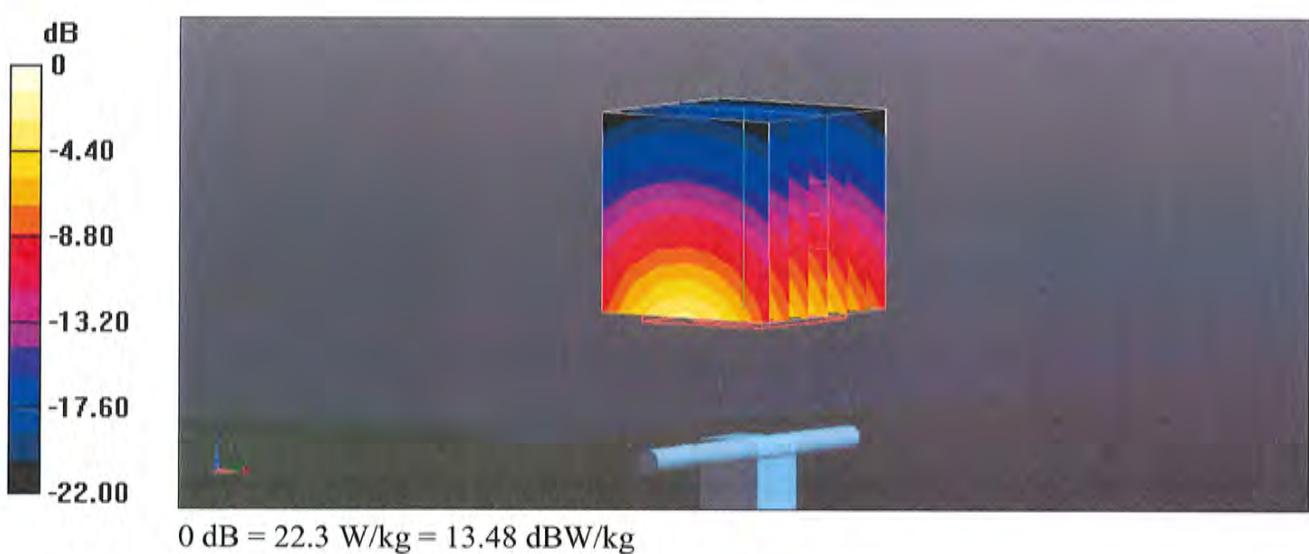
Peak SAR (extrapolated) = 27.0 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.18 W/kg**

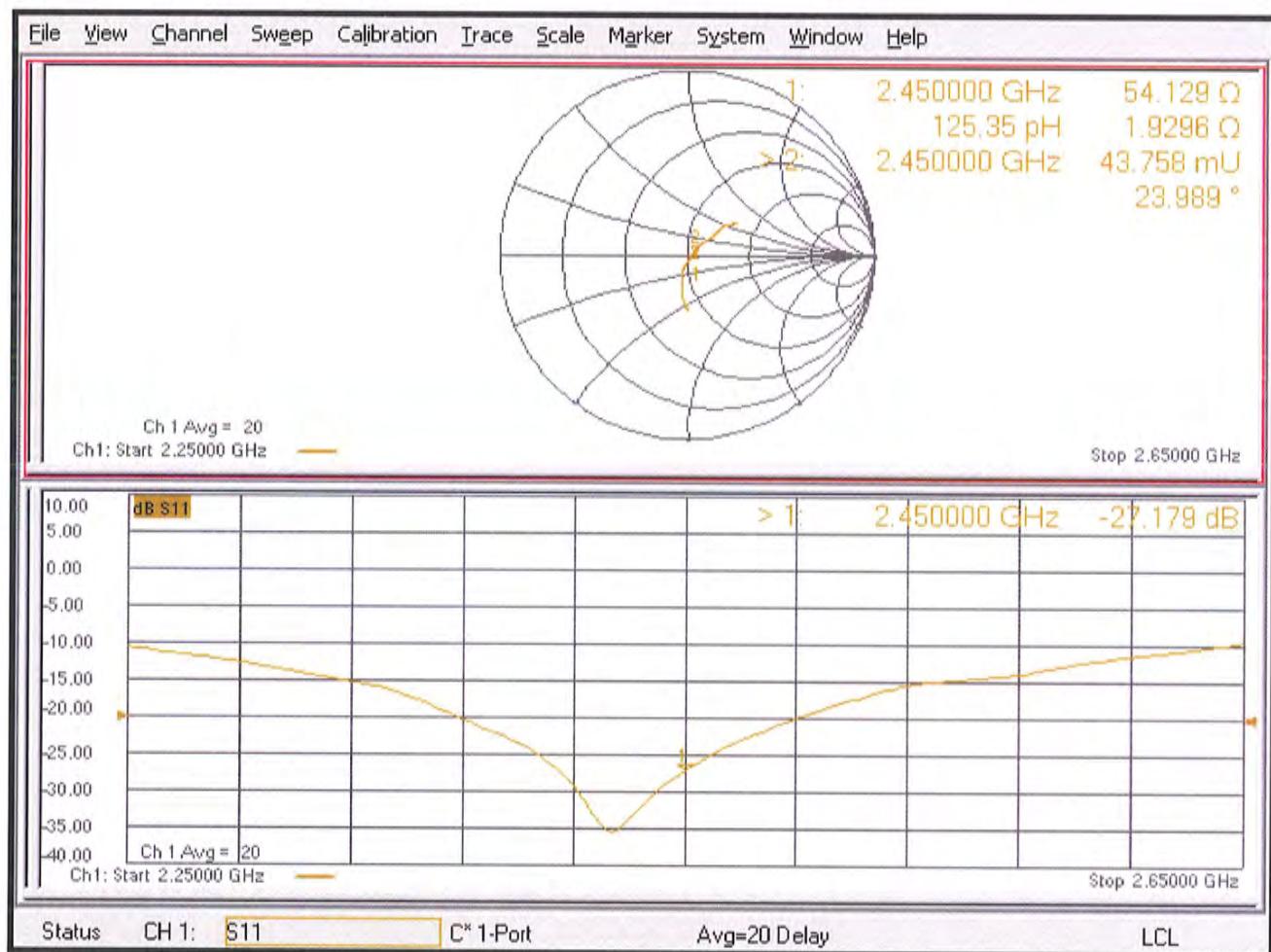
Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 49.5%

Maximum value of SAR (measured) = 22.3 W/kg



## Impedance Measurement Plot for Head TSL





## Dipole Internal Calibration Record

Asset No. :	E-434	Model No. :	D2450V2	Serial No. :	973
Environmental	22.9°C, 52 %	Original Cal. Date :	February 8, 2021	Next Cal. Date :	February 7, 2024

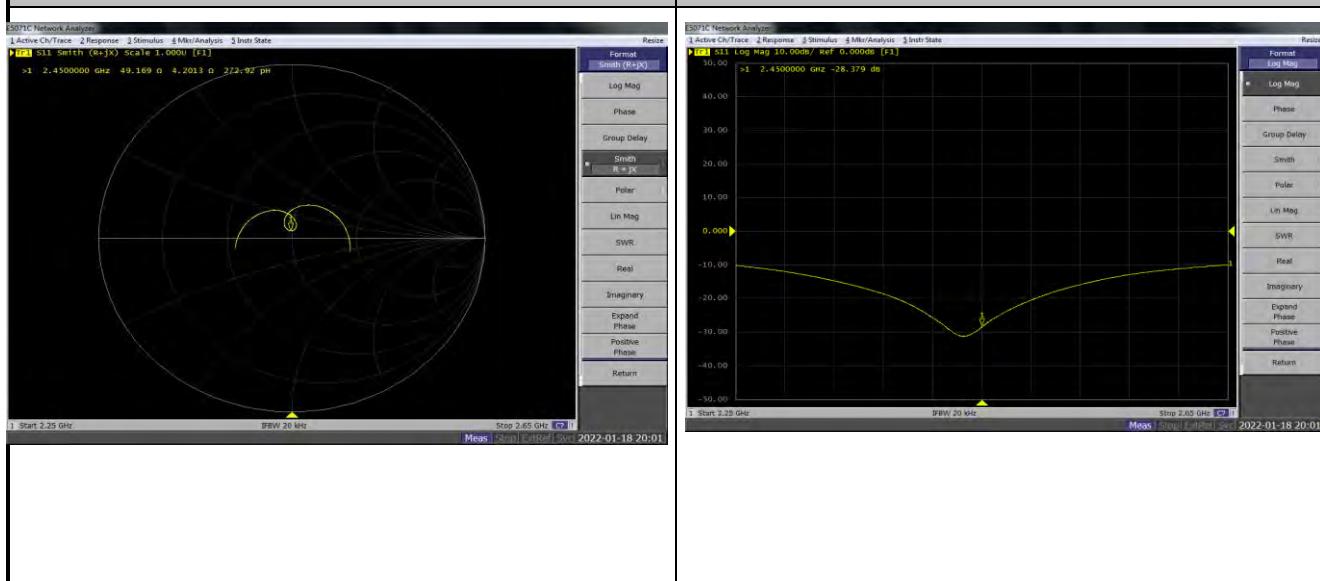
### Standard List

1	IEEE Std 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorptiion Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013
2	IEC 62209-2	Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body(frequency range of 30 MHz to 6 GHz),
3	KDB865664	SAR Measurement Requirements for 100 MHz to 6 GHz

### Equipment Information

Equipment :	Manufacturer :	Model No. :	Serial No. :	Cal.Organization :	Cal. Date :
Power Amplifier	EMCI	EMC053035	980869	N/A	December 7, 2021
Power Meter	Anritsu	MA2487A	6K00004714	N/A	August 15, 2021
Power Sensor	Anritsu	MA2491A	34138	N/A	August 15, 2021
Directional Coupler	Woken	TS-PCC0M-05	107090019	N/A	N/A
Signal Generator	R & S	SMB100A	113244	N/A	August 2, 2021
ENA Network Analyzer	Agilent	E5071C	MY46524658	N/A	March 22, 2021

Model No	For Head Tissue				
	Item	Original Cal. Result	Verified on 2022/1/18	Deviation	Result
D2450V2	Impedance, transformed to feed	$54.1\Omega+1.9j\Omega$	$49.2\Omega+4.2j\Omega$	<5Ω	Pass
	Return Loss(dB)	-27.2	-28.379	-4.3%	Pass
	SAR Value for 1g(mW/g)	13.4	14.1	5.2%	Pass
	SAR Value for 10g(mW/g)	6.18	6.5	5.2%	Pass
	Impedance Test-Head				Return Loss-Head



Test Laboratory: BTL

Date: 2022/1/18

**System Check\_H2450**

Frequency: 2450 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 23.0°C; Liquid Temperature: 22.0°C  
Medium parameters used (interpolated):  $f = 2450$  MHz;  $\sigma = 1.862$  S/m;  $\epsilon_r = 40.655$ ;  $\rho = 1000$  kg/m<sup>3</sup>

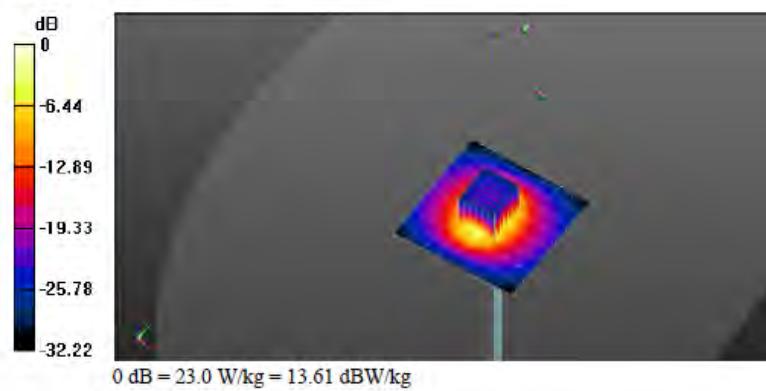
DASY5 Configuration:  
- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg  
- Electronics: DAE4 Sn1486; Calibrated: 2021/6/1  
- Probe: EX3DV4 - SN7369; ConvF(7.62, 7.62, 7.62) @ 2450 MHz; Calibrated: 2021/6/3  
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)  
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 AA; Serial: 1240

**System Performance Check at Frequencies above 1**

**GHz/Pin=250mW 4/Area Scan (9x9x1):** Measurement grid: dx=12mm, dy=12mm.  
Maximum value of SAR (measured) = 23.0 W/kg

**System Performance Check at Frequencies above 1**

**GHz/Pin=250mW 4/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 114.1 V/m; Power Drift = 0.04 dB  
Peak SAR (extrapolated) = 30.1 W/kg  
SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.5 W/kg  
Smallest distance from peaks to all points 3 dB below = 9.2 mm  
Ratio of SAR at M2 to SAR at M1 = 46.7%  
Maximum value of SAR (measured) = 24.1 W/kg



Calibrator:

Approver:



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

Client **BTL (Auden)**

Accreditation No.: **SCS 0108**

Certificate No: **D5GHzV2-1221\_Feb21**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1221**

Calibration procedure(s) **QA CAL-22.v6**  
 Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **February 09, 2021**

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 NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by:	Name	Function	Signature
	Jeffrey Katzman	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 9, 2021

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



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 0108**

### **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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### **Additional Documentation:**

- e) 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	
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom V5.0	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	5200 MHz $\pm$ 1 MHz 5300 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	34.8 $\pm$ 6 %	4.49 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	8.04 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>79.8 W/kg <math>\pm</math> 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.7 W/kg <math>\pm</math> 19.5 % (k=2)</b>

## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.9	4.76 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	34.6 ± 6 %	4.59 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5300 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	8.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>81.9 W/kg ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.4 W/kg ± 19.5 % (k=2)</b>

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.5	5.07 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	34.2 ± 6 %	4.88 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5600 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	8.53 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>84.5 W/kg ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.0 W/kg ± 19.5 % (k=2)</b>

## Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.3	5.27 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	33.9 ± 6 %	5.09 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>81.7 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.0 W/kg ± 19.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.3 $\Omega$ - 8.2 $j\Omega$
Return Loss	- 21.5 dB

### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.1 $\Omega$ - 2.4 $j\Omega$
Return Loss	- 32.3 dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	52.8 $\Omega$ - 1.7 $j\Omega$
Return Loss	- 30.0 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	53.3 $\Omega$ + 2.8 $j\Omega$
Return Loss	- 27.5 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.190 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
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# DASY5 Validation Report for Head TSL

Date: 09.02.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1221**

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 4.49 \text{ S/m}$ ;  $\epsilon_r = 34.8$ ;  $\rho = 1000 \text{ kg/m}^3$ ,

Medium parameters used:  $f = 5300 \text{ MHz}$ ;  $\sigma = 4.59 \text{ S/m}$ ;  $\epsilon_r = 34.6$ ;  $\rho = 1000 \text{ kg/m}^3$ ,

Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 4.88 \text{ S/m}$ ;  $\epsilon_r = 34.2$ ;  $\rho = 1000 \text{ kg/m}^3$ ,

Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 5.09 \text{ S/m}$ ;  $\epsilon_r = 33.9$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.49, 5.49, 5.49) @ 5300 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**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 = 78.03 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 28.2 W/kg

**SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.30 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 69.7%

Maximum value of SAR (measured) = 18.1 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 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 = 78.34 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 29.1 W/kg

**SAR(1 g) = 8.26 W/kg; SAR(10 g) = 2.37 W/kg**

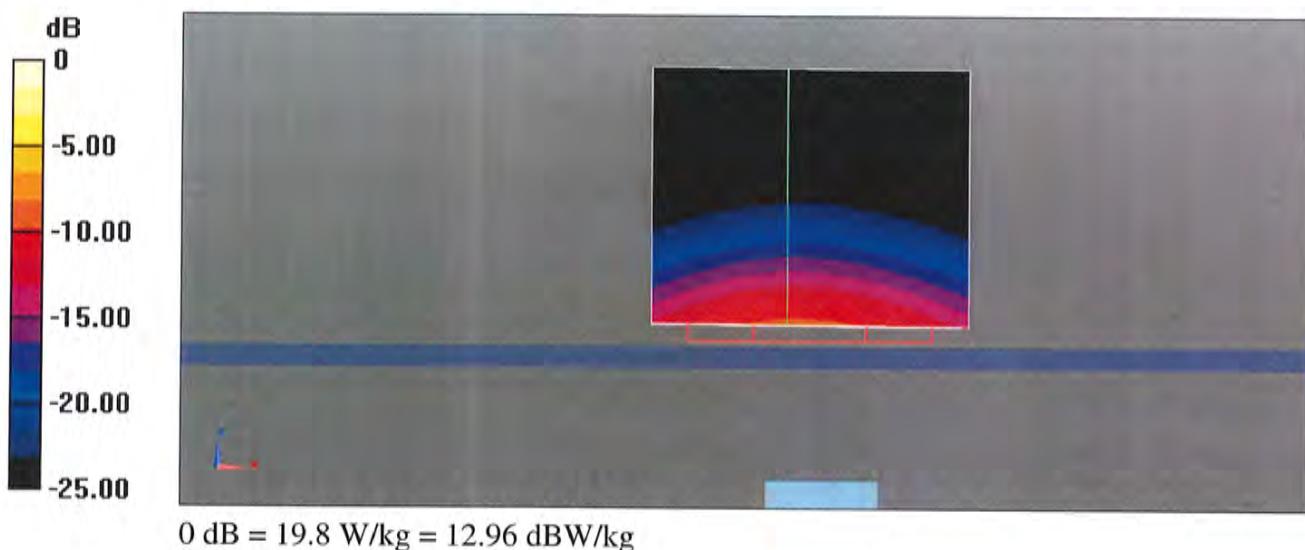
Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 70%

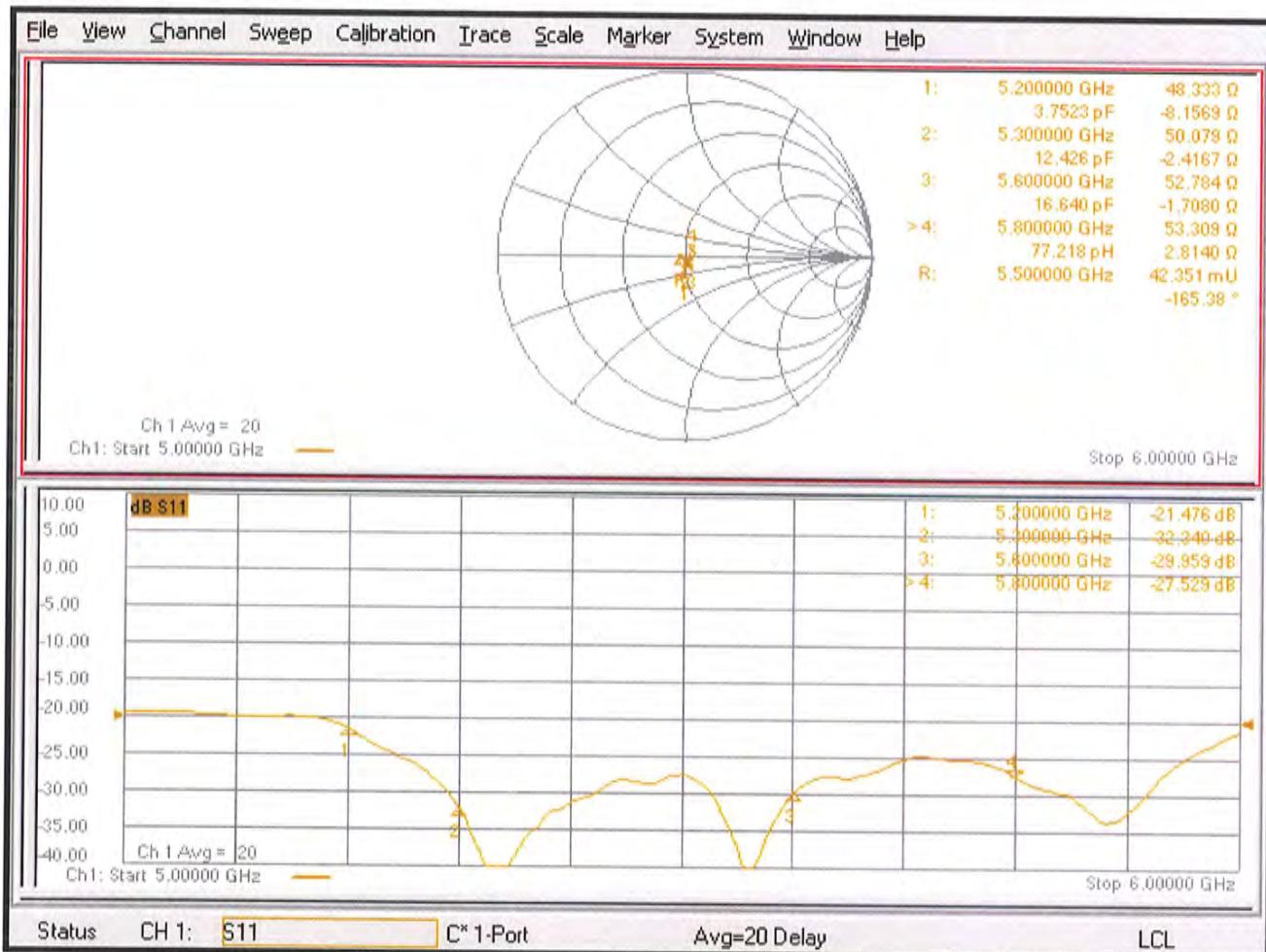
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 79.37 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 31.3 W/kg  
**SAR(1 g) = 8.53 W/kg; SAR(10 g) = 2.43 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.2 mm  
Ratio of SAR at M2 to SAR at M1 = 68.6%  
Maximum value of SAR (measured) = 19.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 76.74 V/m; Power Drift = -0.00 dB  
Peak SAR (extrapolated) = 32.4 W/kg  
**SAR(1 g) = 8.25 W/kg; SAR(10 g) = 2.33 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.2 mm  
Ratio of SAR at M2 to SAR at M1 = 66.3%  
Maximum value of SAR (measured) = 19.6 W/kg



## Impedance Measurement Plot for Head TSL





## Dipole Internal Calibration Record

				NO. :
Asset No. :	E-436	Model No. :	D5GHzV2	Cal. Date : February 9, 2021
Equipment :	ENA Network Analyzer	Serial No. :	1121	Next Cal. Date : February 8, 2024
Environmental condition :	Temp :	23.5 °C	R.H. :	51%

### Standard List

1	IEEE Std 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013
2	IEC 62209-2	Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body(frequency range of 30 MHz to 6 GHz), March 2010
3	KDB865664	SAR Measurement Requirements for 100 MHz to 6 GHz

### Equipment Information

Equipment :	Manufacturer :	Model No. :	Serial No. :	Cal.Organization :	Cal. Date :
Power Amplifier	EMCI	EMC053035	980869	N/A	December 7, 2021
Power Meter	Anritsu	MA2487A	6K00004714	N/A	August 15, 2021
Power Sensor	Anritsu	MA2491A	34138	N/A	August 15, 2021
Directional Coupler	Woken	TS-PCC0M-05	107090019	N/A	N/A
Signal Generator	R & S	SMB100A	113244	N/A	August 2, 2021
ENA Network Analyzer	Agilent	E5071C	MY46524658	N/A	March 22, 2021

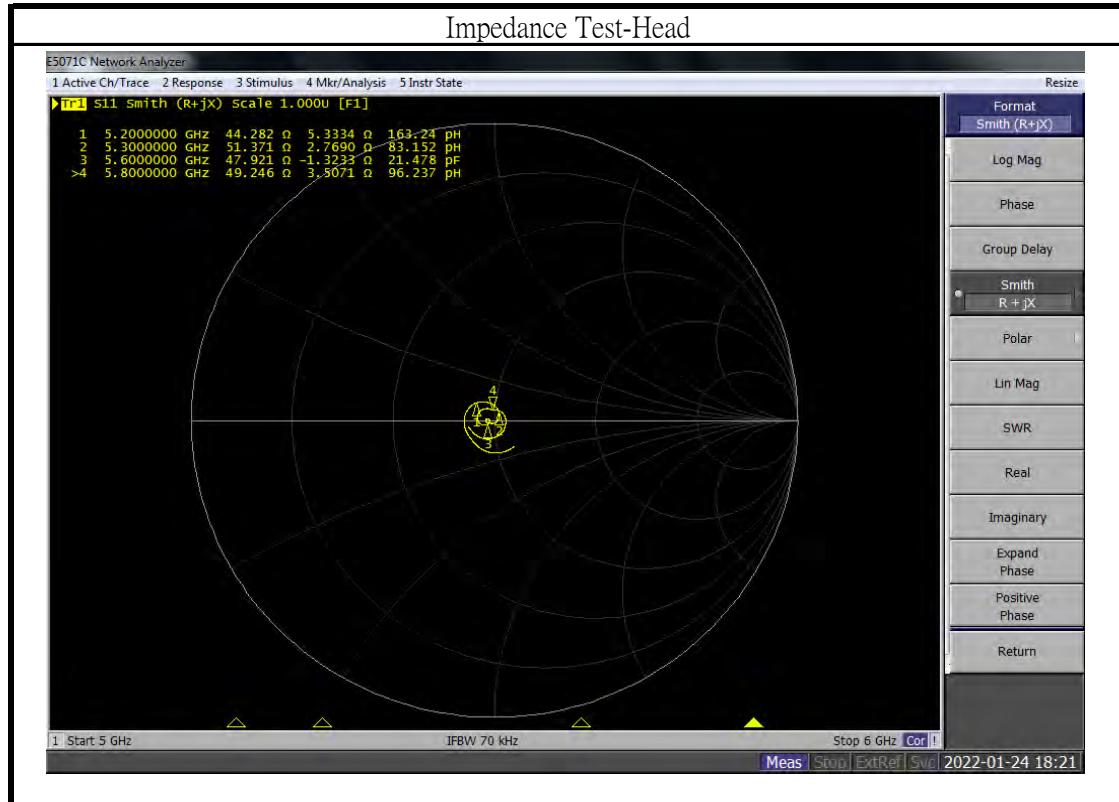
### For Head Tissue

Frequency	Item	Originak Cal. Result	Verified on 2022/1/24	Deviation	Result
5.2G	Impedance, transformed to feed point( $\Omega$ )	$48.3\Omega-8.2j\Omega$	$44.3\Omega-5.3j\Omega$	$<5\Omega$	Pass
	Return Loss(dB)	-21.5	-21.65	-0.7%	Pass
	SAR Value for 1g(mW/g)	8.04	7.83	3%	Pass
	SAR Value for 10g(mW/g)	2.3	2.26	1.7%	Pass
5.3G	Impedance, transformed to feed point	$50.1\Omega-2.4j\Omega$	$51.4\Omega+2.8j\Omega$	$<5\Omega$	Pass
	Return Loss(dB)	-32.3	-30.4	5.9%	Pass
	SAR Value for 1g(mW/g)	8.26	8.17	1.1%	Pass
	SAR Value for 10g(mW/g)	2.37	2.35	0.8%	Pass
5.6G	Impedance, transformed to feed point	$52.8\Omega-1.7j\Omega$	$47.9\Omega-1.3j\Omega$	$<5\Omega$	Pass
	Return Loss(dB)	-30	-31.78	-5.9%	Pass
	SAR Value for 1g(mW/g)	8.53	8.27	3.0%	Pass
	SAR Value for 10g(mW/g)	2.43	2.37	2.5%	Pass
5.8G	Impedance, transformed to feed point	$53.3\Omega+2.8j\Omega$	$49.2\Omega+3.5j\Omega$	$<5\Omega$	Pass
	Return Loss(dB)	-27.5	-28.83	-4.8%	Pass
	SAR Value for 1g(mW/g)	8.25	8.01	2.9%	Pass
	SAR Value for 10g(mW/g)	2.33	2.27	2.6%	Pass
Note :	SAR System Uncertainty : % , ( 95% CONFIDENCE LEVEL , Expanded uncertainty K=2 )				

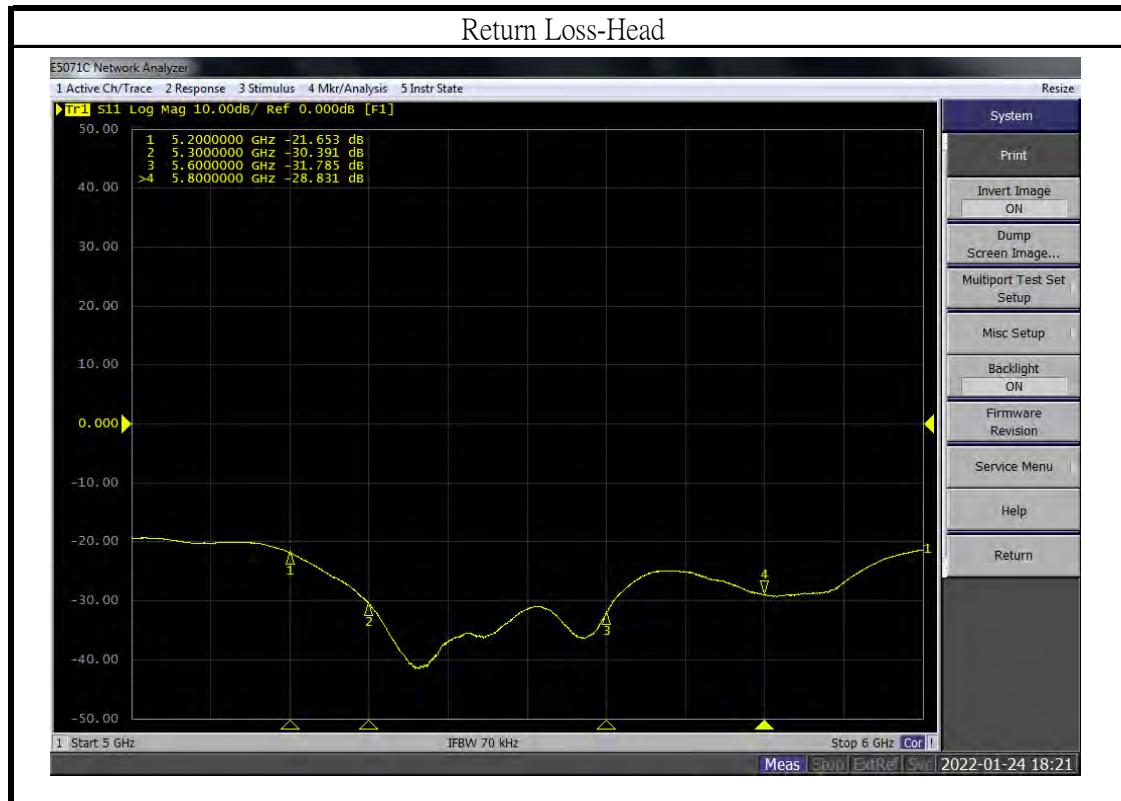
Tester :

Technical Director :

# Impedance Test-Head



## Return Loss-Head



## System Check\_H5G

Frequency: 5200 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 23.0°C; Liquid Temperature: 22.0°C

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.777$  S/m;  $\epsilon_r = 35.51$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY5 Configuration:

- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg

- Electronics: DAE4 Sn1486; Calibrated: 2021/6/1

- Probe: EX3DV4 - SN7369; ConvE(5.15, 5.15, 5.15) @ 5200 MHz; Calibrated: 2021/6/3

- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection)

- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 AA; Serial: 1240

### Configuration/Pin=100mW/Area Scan (10x10x1): Measurement grid:

$dx=10$ mm,  $dy=10$ mm

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

### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement

grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 61.34 V/m; Power Drift = 0.00 dB

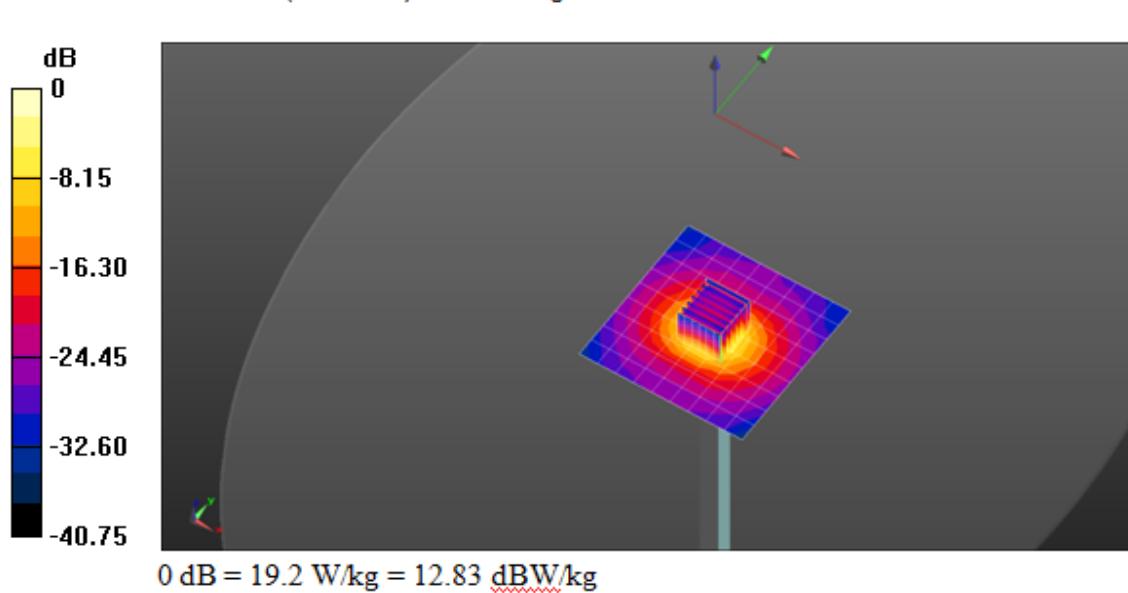
Peak SAR (extrapolated) = 29.9 W/kg

SAR(1 g) = 7.83 W/kg; SAR(10 g) = 2.26 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 56.3%

Maximum value of SAR (measured) = 19.2 W/kg



## System Check\_H5G

Frequency: 5300 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 23.0°C; Liquid Temperature: 22.0°C

Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.899$  S/m;  $\epsilon_r = 35.252$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY5 Configuration:

- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn1486; Calibrated: 2021/6/1
- Probe: EX3DV4 - SN7369; ConvF(5, 5, 5) @ 5300 MHz; Calibrated: 2021/6/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 AA; Serial: 1240

### Configuration/Pin=100mW/Area Scan (10x10x1): Measurement grid:

dx=10mm, dy=10mm

Maximum value of SAR (measured) = 12.3 W/kg

### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement

grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 62.00 V/m; Power Drift = 0.01 dB

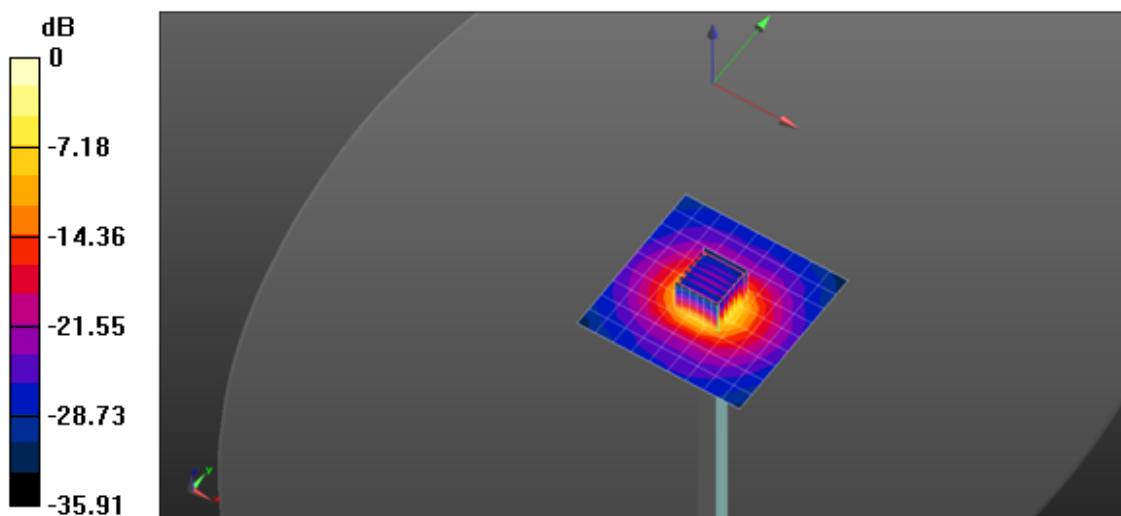
Peak SAR (extrapolated) = 32.2 W/kg

SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.35 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 55.3%

Maximum value of SAR (measured) = 20.3 W/kg



## System Check\_H5G

Frequency: 5600 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 23.0°C; Liquid Temperature: 22.0°C

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.264$  S/m;  $\epsilon_r = 34.496$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY5 Configuration:

- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg

- Electronics: DAE4 Sn1486; Calibrated: 2021/6/1

- Probe: EX3DV4 - SN7369; ConvF(4.66, 4.66, 4.66) @ 5600 MHz; Calibrated: 2021/6/3

- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection)

- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 AA; Serial: 1240

### Configuration/Pin=100mW/Area Scan (10x10x1): Measurement grid:

$dx=10$ mm,  $dy=10$ mm

Maximum value of SAR (measured) = 13.0 W/kg

### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement

grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 60.64 V/m; Power Drift = -0.00 dB

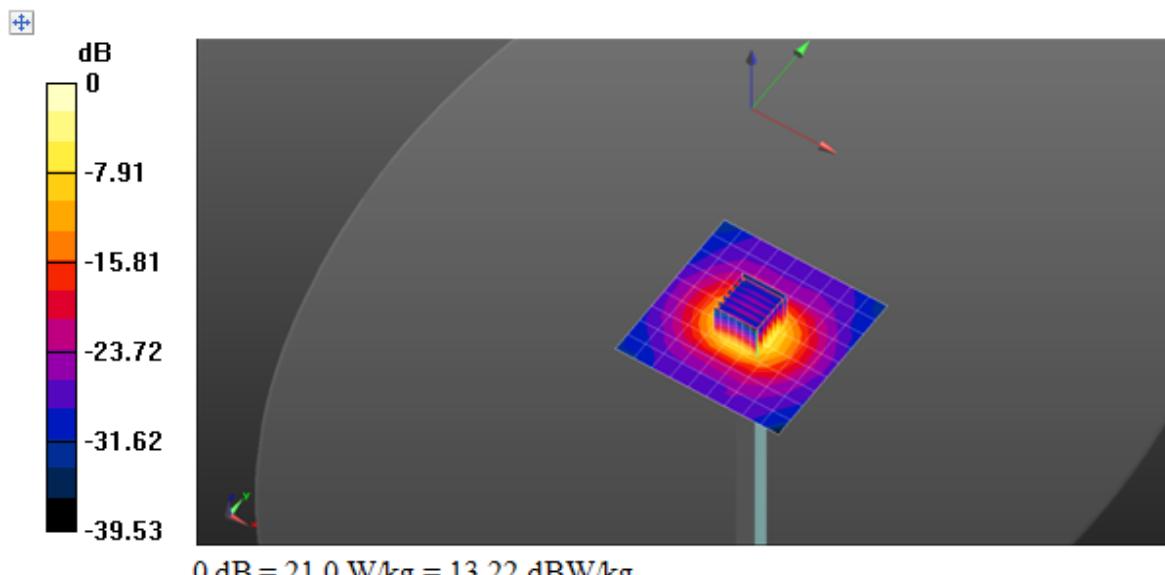
Peak SAR (extrapolated) = 34.9 W/kg

SAR(1 g) = 8.27 W/kg; SAR(10 g) = 2.37 W/kg

Smallest distance from peaks to all points 3 dB below = 7.6 mm

Ratio of SAR at M2 to SAR at M1 = 52.8%

Maximum value of SAR (measured) = 21.0 W/kg



## System Check\_H5G

Frequency: 5800 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 23.0°C; Liquid Temperature: 22.0°C

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.503$  S/m;  $\epsilon_r = 34.001$ ;  $\rho = 1000$  kg/m<sup>3</sup>

DASY5 Configuration:

- Area Scan Setting: Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg

- Electronics: DAE4 Sn1486; Calibrated: 2021/6/1

- Probe: EX3DV4 - SN7369; ConvF(4.61, 4.61, 4.61) @ 5800 MHz; Calibrated: 2021/6/3

- Sensor-Surface: 1.4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 1.4mm (Mechanical Surface Detection)

- Phantom: ELI V5.0 (20deg probe tilt); Type: QD OVA 002 AA; Serial: 1240

### Configuration/Pin=100mW/Area Scan (10x10x1): Measurement grid:

$dx=10$ mm,  $dy=10$ mm

Maximum value of SAR (measured) = 12.9 W/kg

### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement

grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 58.58 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 36.1 W/kg

**SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.27 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 50.6%

Maximum value of SAR (measured) = 21.0 W/kg

