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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 10.09   | 10.09   | 10.09   | 0.30               | 0.90                    | ± 12.1%     |
| 835                  | 55.2                               | 0.97                            | 9.88    | 9.88    | 9.88    | 0.19               | 1.32                    | ± 12.1%     |
| 900                  | 55.0                               | 1.05                            | 9.82    | 9.82    | 9.82    | 0.23               | 1.15                    | ± 12.1%     |
| 1750                 | 53.4                               | 1.49                            | 8.24    | 8.24    | 8.24    | 0.24               | 1.06                    | ± 12.1%     |
| 1900                 | 53.3                               | 1.52                            | 7.97    | 7.97    | 7.97    | 0.19               | 1.24                    | ± 12.1%     |
| 2100                 | 53.2                               | 1.62                            | 8.18    | 8.18    | 8.18    | 0.19               | 1.39                    | ± 12.1%     |
| 2300                 | 52.9                               | 1.81                            | 7.88    | 7.88    | 7.88    | 0.55               | 0.80                    | ± 12.1%     |
| 2450                 | 52.7                               | 1.95                            | 7.53    | 7.53    | 7.53    | 0.46               | 0.89                    | ± 12.1%     |
| 2600                 | 52.5                               | 2.16                            | 7.38    | 7.38    | 7.38    | 0.52               | 0.80                    | ± 12.1%     |
| 5250                 | 48.9                               | 5.36                            | 4.93    | 4.93    | 4.93    | 0.45               | 1.80                    | ± 13.3%     |
| 5600                 | 48.5                               | 5.77                            | 4.19    | 4.19    | 4.19    | 0.48               | 1.90                    | ± 13.3%     |
| 5750                 | 48.3                               | 5.94                            | 4.52    | 4.52    | 4.52    | 0.48               | 1.95                    | ± 13.3%     |

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequency 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



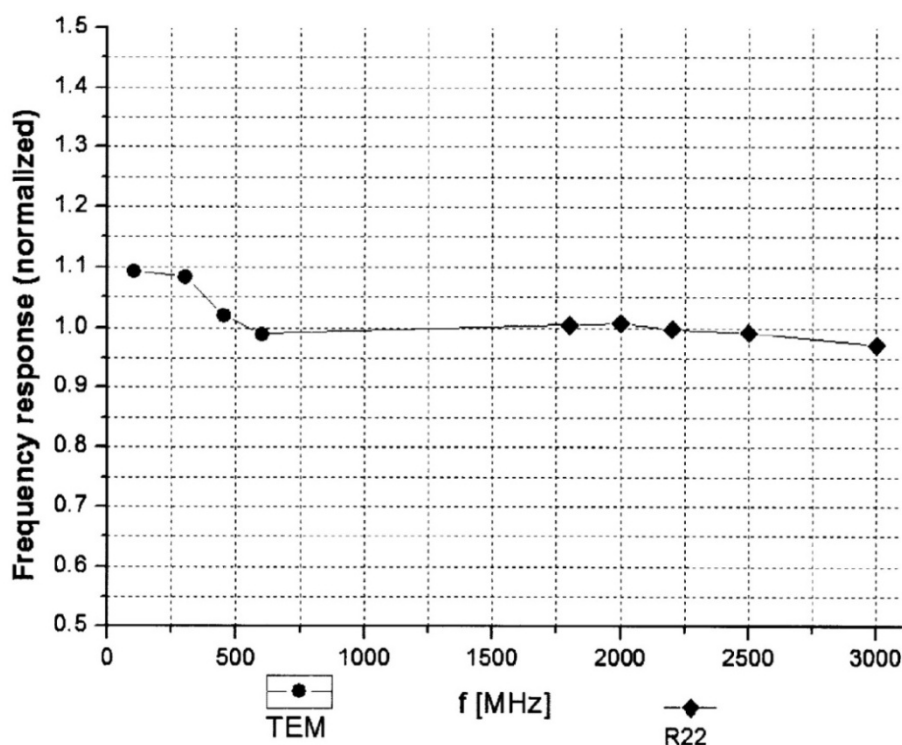


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## Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 7.4\%$  ( $k=2$ )

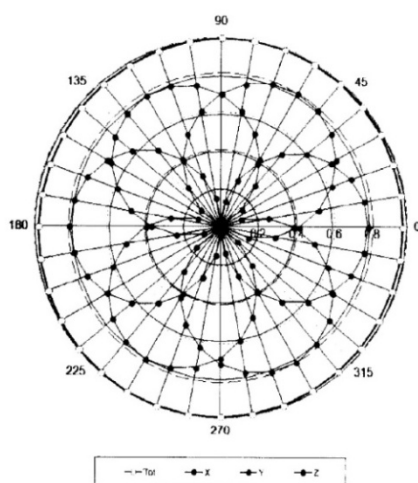




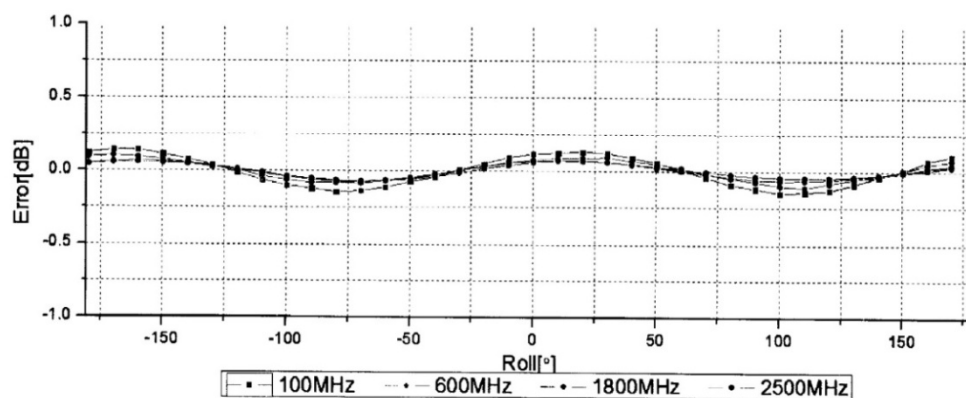
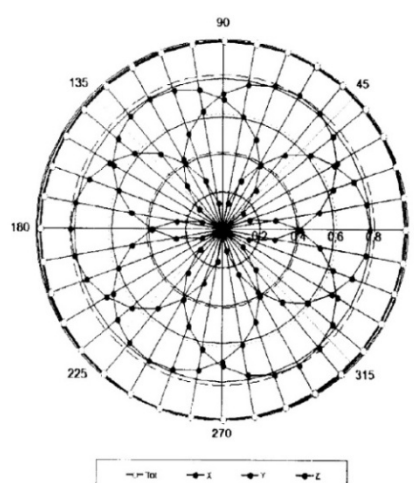
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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**



**f=1800 MHz, R22**



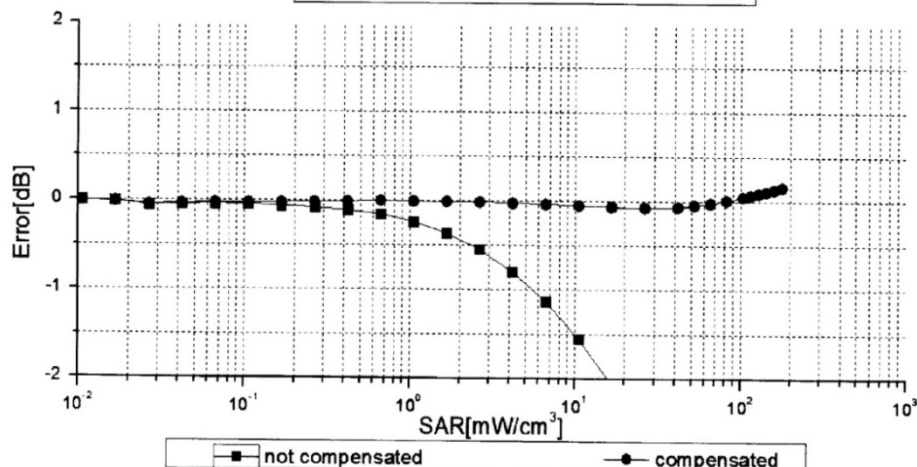
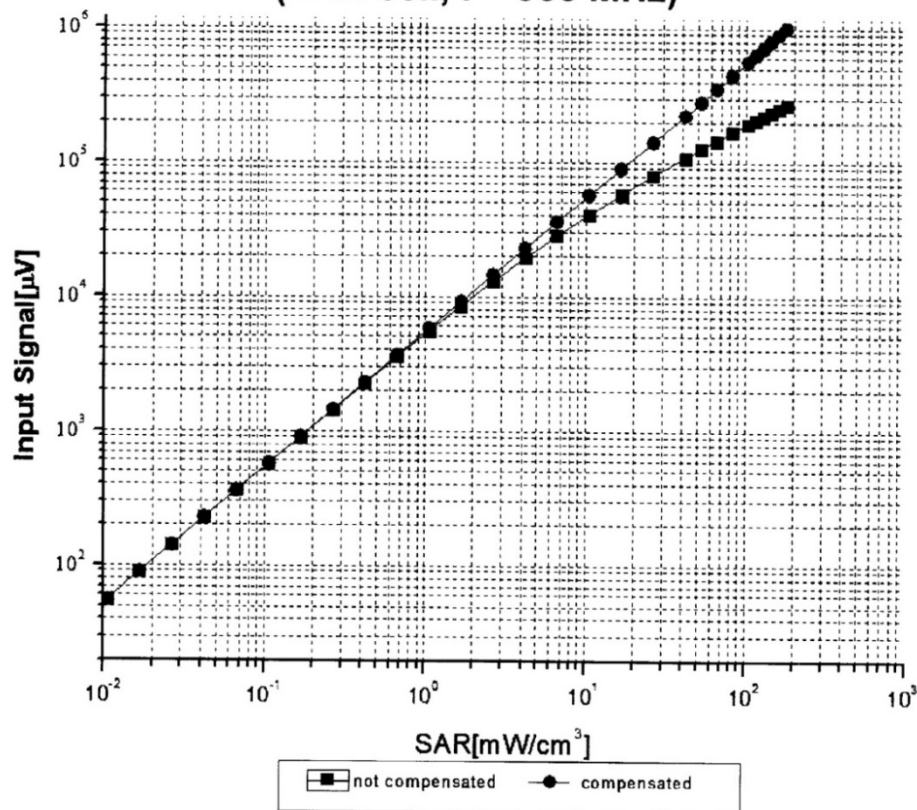
Uncertainty of Axial Isotropy Assessment:  $\pm 1.2\%$  ( $k=2$ )





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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment:  $\pm 0.9\%$  ( $k=2$ )

Certificate No: Z23-98671

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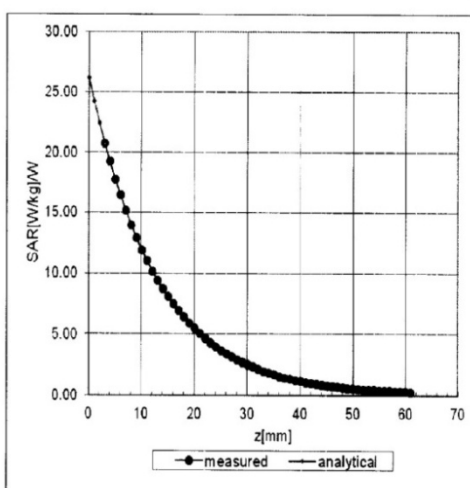
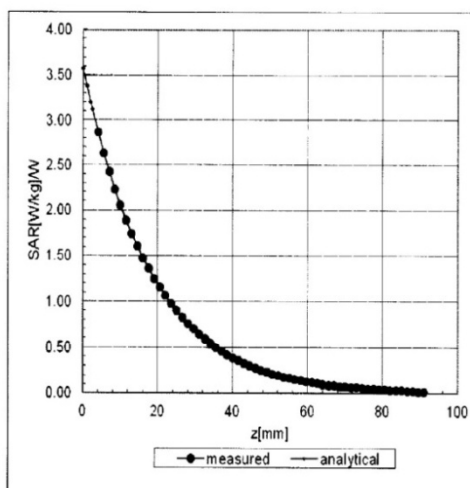


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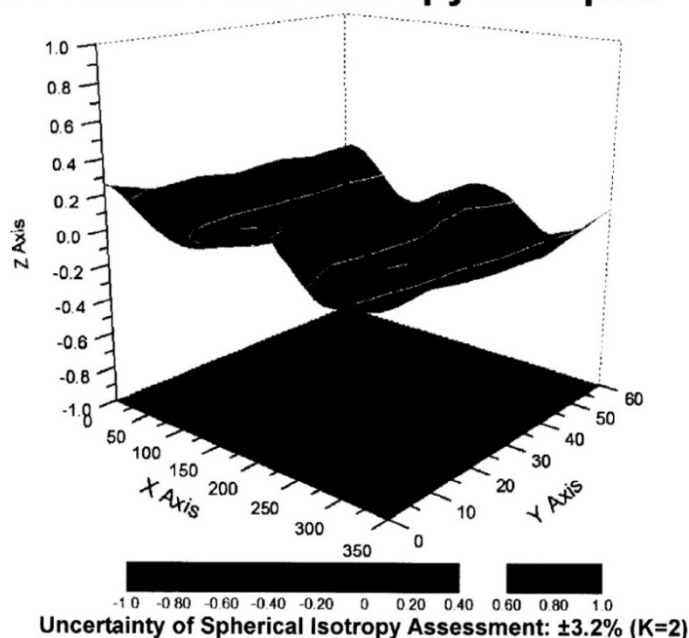
## Conversion Factor Assessment

f=900 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid





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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 156.9      |
| 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      |

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## IMPORTANT NOTICE

### USAGE OF THE DAE 4

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 closed 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 MOhm 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.**

Schmid &amp; Partner Engineering

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

Accreditation No.: **SCS 0108**

Client **Anbotek (Auden)**

Certificate No: **DAE4-387\_Sep10**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 387**

Calibration procedure(s) **QA CAL-06.v29  
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **September 06, 2023**

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  |
|--------------------------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001                    | SN: 0810278        | 15-Aug-23 (No:22092)       | Aug-22                 |
| Secondary Standards                              | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit<br>Calibrator Box V2.1 | SE UWS 053 AA 1001 | 05-Jan-23 (in house check) | In house check: Jan-23 |
|                                                  | SE UMS 006 AA 1002 | 05-Jan-23 (in house check) | In house check: Jan-23 |

|                |                           |                                   |               |
|----------------|---------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br>Dominique Steffen | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Sven Kühn                 | Deputy Manager                    |               |

Issued: September 06, 2023

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Certificate No: DAE4-387\_Sep10

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## Glossary

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

## Methods Applied and Interpretation of Parameters

- DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The 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.

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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 = 61nV, full range = -1.....+3mV

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.489 $\pm$ 0.02% (k=2) | 404.852 $\pm$ 0.02% (k=2) | 404.862 $\pm$ 0.02% (k=2) |
| Low Range           | 3.97827 $\pm$ 1.50% (k=2) | 3.95875 $\pm$ 1.50% (k=2) | 3.97982 $\pm$ 1.50% (k=2) |

**Connector Angle**

|                                           |                  |
|-------------------------------------------|------------------|
| Connector Angle to be used in DASY system | 53.0 ° $\pm$ 1 ° |
|-------------------------------------------|------------------|

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## Appendix (Additional assessments outside the scope of SCS0108)

## 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200032.85                 | -3.31                        | -0.00     |
| Channel X + Input | 20007.64                  | 1.88                         | 0.01      |
| Channel X - Input | -20003.48                 | 1.18                         | -0.01     |
| Channel Y + Input | 200034.23                 | -1.43                        | -0.00     |
| Channel Y + Input | 20006.60                  | 0.91                         | 0.00      |
| Channel Y - Input | -20004.04                 | 0.72                         | -0.00     |
| Channel Z + Input | 200035.38                 | -0.83                        | -0.00     |
| Channel Z + Input | 20003.69                  | -2.11                        | -0.01     |
| Channel Z - Input | -20006.38                 | -1.59                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.63                   | 0.08                         | 0.00      |
| Channel X + Input | 202.29                    | 0.70                         | 0.35      |
| Channel X - Input | -197.90                   | 0.60                         | -0.30     |
| Channel Y + Input | 2001.33                   | -0.07                        | -0.00     |
| Channel Y + Input | 200.86                    | -0.60                        | -0.30     |
| Channel Y - Input | -199.87                   | -1.23                        | 0.62      |
| Channel Z + Input | 2001.61                   | 0.27                         | 0.01      |
| Channel Z + Input | 200.60                    | -0.70                        | -0.35     |
| Channel Z - Input | -199.51                   | -0.85                        | 0.43      |

## 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 ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 13.50                                        | 11.56                                       |
|           | - 200                          | -8.64                                        | -11.18                                      |
| Channel Y | 200                            | -0.81                                        | -1.28                                       |
|           | - 200                          | 1.05                                         | 0.09                                        |
| Channel Z | 200                            | 7.17                                         | 6.91                                        |
|           | - 200                          | -9.46                                        | -9.01                                       |

## 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -1.70                       | 0.33                        |
| Channel Y | 200                | 10.70                       | -                           | -0.38                       |
| Channel Z | 200                | 7.11                        | 7.89                        | -                           |

**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 | 15969            | 17466           |
| Channel Y | 15661            | 16162           |
| Channel Z | 15990            | 16190           |

**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 | 0.73               | -2.58                  | 3.29                   | 0.62                      |
| Channel Y | 0.41               | -0.49                  | 1.23                   | 0.40                      |
| Channel Z | -0.80              | -1.88                  | 0.30                   | 0.42                      |

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;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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Client **Anbotech (Auden)**

Certificate No: **D5GHzV2-1160\_Oct11**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1160**

Calibration procedure(s) **QA CAL-22.v2**  
**Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **October 02, 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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 07-Oct-17 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-20 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-20 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 01-Apr-21 (No. 217-02131)         | Mar-16                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-21 (No. 217-02134)         | Mar-16                 |
| Reference Probe EX3DV4      | SN: 3503           | 30-Dec-20 (No. EX3-3503_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 17-Aug-21 (No. DAE4-601_Aug15)    | Aug-16                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100972             | 18-Jun-21 (in house check Jun-15) | In house check: Jun-18 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 15-Oct-20 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: **Name**  
**Leif Klysner** **Function**  
**Laboratory Technician**

Signature

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

Issued: October 6, 2021

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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 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:**

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-2, "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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

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