



## APPENDIX E - MEASURED FLUID DIELECTRIC PARAMETERS

# Title

## SubTitle

February 7, 2014 11:35 AM

| Frequency       | e'     | e''     |
|-----------------|--------|---------|
| 2.400000000 GHz | 51.460 | 14.4178 |
| 2.402000000 GHz | 51.449 | 14.4426 |
| 2.404000000 GHz | 51.438 | 14.4395 |
| 2.406000000 GHz | 51.440 | 14.4470 |
| 2.408000000 GHz | 51.423 | 14.4647 |
| 2.410000000 GHz | 51.418 | 14.4780 |
| 2.412000000 GHz | 51.417 | 14.4931 |
| 2.414000000 GHz | 51.401 | 14.4948 |
| 2.416000000 GHz | 51.402 | 14.5135 |
| 2.418000000 GHz | 51.380 | 14.5350 |
| 2.420000000 GHz | 51.369 | 14.5457 |
| 2.422000000 GHz | 51.366 | 14.5552 |
| 2.424000000 GHz | 51.356 | 14.5687 |
| 2.426000000 GHz | 51.339 | 14.5900 |
| 2.428000000 GHz | 51.328 | 14.6118 |
| 2.430000000 GHz | 51.324 | 14.6185 |
| 2.432000000 GHz | 51.318 | 14.6243 |
| 2.434000000 GHz | 51.308 | 14.6443 |
| 2.436000000 GHz | 51.285 | 14.6583 |
| 2.438000000 GHz | 51.284 | 14.6777 |
| 2.440000000 GHz | 51.274 | 14.6977 |
| 2.442000000 GHz | 51.259 | 14.7057 |
| 2.444000000 GHz | 51.261 | 14.7400 |
| 2.446000000 GHz | 51.261 | 14.7417 |
| 2.448000000 GHz | 51.254 | 14.7499 |
| 2.450000000 GHz | 51.244 | 14.7583 |
| 2.452000000 GHz | 51.240 | 14.7654 |
| 2.454000000 GHz | 51.230 | 14.7852 |
| 2.456000000 GHz | 51.225 | 14.7955 |
| 2.458000000 GHz | 51.218 | 14.8002 |
| 2.460000000 GHz | 51.207 | 14.8032 |
| 2.462000000 GHz | 51.192 | 14.8251 |
| 2.464000000 GHz | 51.197 | 14.8142 |
| 2.466000000 GHz | 51.200 | 14.8325 |
| 2.468000000 GHz | 51.184 | 14.8423 |

|                |         |         |
|----------------|---------|---------|
| 2.470000000 Gf | 51.177% | 14.8469 |
| 2.472000000 Gf | 51.167% | 14.8413 |
| 2.474000000 Gf | 51.170% | 14.8408 |
| 2.476000000 Gf | 51.152% | 14.8451 |
| 2.478000000 Gf | 51.151% | 14.8680 |
| 2.480000000 Gf | 51.160% | 14.8614 |
| 2.482000000 Gf | 51.143% | 14.8591 |
| 2.484000000 Gf | 51.144% | 14.8669 |
| 2.486000000 Gf | 51.143% | 14.8693 |
| 2.488000000 Gf | 51.135% | 14.8664 |
| 2.490000000 Gf | 51.132% | 14.8725 |
| 2.492000000 Gf | 51.115% | 14.8702 |
| 2.494000000 Gf | 51.125% | 14.8839 |
| 2.496000000 Gf | 51.115% | 14.8867 |
| 2.498000000 Gf | 51.104% | 14.8868 |
| 2.500000000 Gf | 51.090% | 14.8813 |



## **APPENDIX F – PHANTOM CERTIFICATE OF CONFORMITY**

**Certificate of conformity / First Article Inspection**

|                       |                                                                          |
|-----------------------|--------------------------------------------------------------------------|
| Item                  | SAM Twin Phantom V4.0                                                    |
| Type No               | QD 000 P40 C                                                             |
| Series No             | TP-1150 and higher                                                       |
| Manufacturer / Origin | Untersee Composites<br>Hauptstr. 69<br>CH-8559 Fruthwilen<br>Switzerland |

**Tests**

The series production process used allows the limitation to test of first articles.

Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

| Test                 | Requirement                                                                                                                                  | Details                                                              | Units tested                             |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------|
| Shape                | Compliance with the geometry according to the CAD model.                                                                                     | IT'IS CAD File (*)                                                   | First article, Samples                   |
| Material thickness   | Compliant with the requirements according to the standards                                                                                   | 2mm +/- 0.2mm in specific areas;<br>6mm +/- 0.2mm at ERP             | First article, Samples                   |
| Material parameters  | Dielectric parameters for required frequencies                                                                                               | 200 MHz – 3 GHz<br>Relative permittivity < 5<br>Loss tangent < 0.05. | Material sample<br>TP 104-5              |
| Material resistivity | The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions | DEGMBE based<br>simulating liquids                                   | Pre-series,<br>First article,<br>Samples |

**Standards**

[1] CENELEC EN 50361

[2] IEEE Std 1528-200x Draft CD 1.1 (Dec 02)

[3] IEC 62209/CD (Nov 02)

(\*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

**Conformity**

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date

7.8.2003

Signature / Stamp

**s p e a g**

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## APPENDIX G - DAE CALIBRATION CERTIFICATE



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 **MET Laboratories**

Certificate No: **DAE3-584\_Jul13**

## CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 584**

Calibration procedure(s) **QA CAL-06.v26**  
**Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **July 18, 2013**

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 ( $22 \pm 3$ )°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        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 07-Jan-13 (in house check) | In house check: Jan-14 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 07-Jan-13 (in house check) | In house check: Jan-14 |

|                |                   |                          |           |
|----------------|-------------------|--------------------------|-----------|
|                | Name              | Function                 | Signature |
| Calibrated by: | Dominique Steffen | Technician               |           |
| Approved by:   | Fin Bomholt       | Deputy Technical Manager |           |

Issued: July 18, 2013

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 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.

## 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          | 404.662 $\pm$ 0.02% (k=2) | 404.844 $\pm$ 0.02% (k=2) | 404.267 $\pm$ 0.02% (k=2) |
| Low Range           | 3.93273 $\pm$ 1.50% (k=2) | 3.98110 $\pm$ 1.50% (k=2) | 3.97938 $\pm$ 1.50% (k=2) |

## Connector Angle

|                                           |                   |
|-------------------------------------------|-------------------|
| Connector Angle to be used in DASY system | 141.0 ° $\pm$ 1 ° |
|-------------------------------------------|-------------------|

## Appendix

### 1. DC Voltage Linearity

| High Range |         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|------------|---------|---------------------------|------------------------------|-----------|
| Channel X  | + Input | 199996.51                 | -1.40                        | -0.00     |
| Channel X  | + Input | 20001.72                  | 1.16                         | 0.01      |
| Channel X  | - Input | -19998.74                 | 2.23                         | -0.01     |
| Channel Y  | + Input | 199995.49                 | -2.08                        | -0.00     |
| Channel Y  | + Input | 20001.55                  | 1.15                         | 0.01      |
| Channel Y  | - Input | -19997.38                 | 3.75                         | -0.02     |
| Channel Z  | + Input | 199996.10                 | -1.20                        | -0.00     |
| Channel Z  | + Input | 19999.08                  | -1.38                        | -0.01     |
| Channel Z  | - Input | -19999.72                 | 1.40                         | -0.01     |

| Low Range |         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-----------|---------|---------------------------|------------------------------|-----------|
| Channel X | + Input | 2002.82                   | 1.92                         | 0.10      |
| Channel X | + Input | 202.17                    | 0.93                         | 0.46      |
| Channel X | - Input | -198.65                   | -0.18                        | 0.09      |
| Channel Y | + Input | 2002.22                   | 1.54                         | 0.08      |
| Channel Y | + Input | 200.42                    | -0.71                        | -0.35     |
| Channel Y | - Input | -199.73                   | -1.09                        | 0.55      |
| Channel Z | + Input | 2000.94                   | 0.28                         | 0.01      |
| Channel Z | + Input | 200.01                    | -1.13                        | -0.56     |
| Channel Z | - Input | -200.29                   | -1.60                        | 0.80      |

### 2. Common mode sensitivity

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

|           | Common mode<br>Input Voltage (mV) | High Range<br>Average Reading ( $\mu\text{V}$ ) | Low Range<br>Average Reading ( $\mu\text{V}$ ) |
|-----------|-----------------------------------|-------------------------------------------------|------------------------------------------------|
| Channel X | 200                               | 3.04                                            | 1.31                                           |
|           | - 200                             | -0.45                                           | -1.35                                          |
| Channel Y | 200                               | 3.69                                            | 2.42                                           |
|           | - 200                             | -3.59                                           | -3.54                                          |
| Channel Z | 200                               | -7.37                                           | -7.51                                          |
|           | - 200                             | 5.30                                            | 5.09                                           |

### 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                | -                           | -0.18                       | -3.67                       |
| Channel Y | 200                | 6.93                        | -                           | -0.17                       |
| Channel Z | 200                | 7.39                        | 5.46                        | -                           |

## IMPORTANT NOTICE

### USAGE OF THE DAE 3

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 DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

**Shipping of the DAE:** Before shipping the DAE to SPEAG for calibration the customer shall 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 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, 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.**

#### 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 | 16109            | 15852           |
| Channel Y | 16158            | 16754           |
| Channel Z | 16279            | 16611           |

## 5. Input Offset Measurement

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

Input  $10\text{M}\Omega$

|           | Average ( $\mu\text{V}$ ) | min. Offset ( $\mu\text{V}$ ) | max. Offset ( $\mu\text{V}$ ) | Std. Deviation ( $\mu\text{V}$ ) |
|-----------|---------------------------|-------------------------------|-------------------------------|----------------------------------|
| Channel X | 1.30                      | -0.50                         | 3.30                          | 0.53                             |
| Channel Y | -0.18                     | -1.65                         | 1.35                          | 0.50                             |
| Channel Z | -0.26                     | -1.48                         | 1.14                          | 0.47                             |

## 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                |