APPENDIX E - MEASURED FLUID DIELECTRIC PARAMETERS

Title

SubTitle

November 21, 2013 06:56 PM

Frequency	e'	e''
800.000000 MI	53.473	20.1925
803.000000 MI	53.428	20.1918
806.000000 MI	53.388	20.2009
809.000000 MI	53.334	20.1701
812.000000 MI	53.311	20.2121
815.000000 MI	53.284	20.1774
818.000000 MI	53.257	20.1875
821.000000 MI	53.199	20.2031
824.000000 MI	53.166	20.1932
827.000000 MI	53.148	20.2109
830.000000 MI	53.121	20.2154
833.000000 MI	53.094	20.2198
836.000000 MI	53.074	20.2272
839.000000 MI	53.037	20.2462
842.000000 MI	53.000	20.2213
845.000000 MI	52.980	20.2395
848.000000 MI	52.928	20.2150
851.000000 MI	52.901	20.2252
854.000000 MI	52.908	20.2117
857.000000 MI	52.887	20.2086
860.000000 MI	52.856	20.2089
863.000000 MI	52.829	20.1868
866.000000 MI	52.815	20.1706
869.000000 MI	52.795	20.1672
872.000000 MI	52.778	20.1416
875.000000 MI	52.741	20.0917
878.000000 MI	52.747	20.0996
881.000000 MI	52.710	20.1029
884.000000 MI	52.674	20.0532
887.000000 MI	52.692	20.0355
890.000000 MI	52.634	20.0364
893.000000 MI	52.627	19.9920
896.000000 MI	52.592	19.9689
899.000000 MI	52.586	19.9399
902.000000 MI	52.568	19.9314

905.000000 MI	52.540	19.8852
908.000000 MI	52.515	19.8997
911.000000 MI	52.489	19.8839
914.000000 MI	52.474	19.8796
917.000000 MI	52.451	19.8575
920.000000 MI	52.390	19.8404
923.000000 MI	52.384	19.8325
926.000000 MI	52.367	19.8489
929.000000 MI	52.349	19.8355
932.000000 MI	52.307	19.8619
935.000000 MI	52.271	19.8509
938.000000 MI	52.261	19.8294
941.000000 MI	52.238	19.8633
944.000000 MI	52.188	19.8529
947.000000 MI	52.151	19.8623
950.000000 MI	52.116	19.8758

Title

SubTitle

June 25, 2014 04:28 PM

Frequency	e'	e''
1.750000000 GH	54.767	14.8314
1.752000000 GH	54.890	14.8636
1.754000000 GH	54.962	14.8838
1.756000000 GH	54.976	14.8818
1.758000000 GH	54.878	14.8680
1.760000000 GH	54.768	14.8310
1.762000000 GH	54.684	14.8099
1.764000000 GH	54.680	14.8045
1.766000000 GH	54.746	14.8440
1.768000000 GH	54.854	14.8581
1.770000000 GH	54.930	14.9000
1.772000000 GH	54.868	14.9048
1.774000000 GH	54.779	14.8695
1.776000000 GH	54.688	14.8282
1.778000000 GH	54.603	14.8153
1.780000000 GH	54.641	14.8383
1.782000000 GH	54.704	14.8609
1.784000000 GH	54.821	14.9106
1.786000000 GH	54.865	14.9197
1.788000000 GH	54.812	14.8950
1.790000000 GH	54.698	14.8865
1.792000000 GH	54.608	14.8714
1.794000000 GH	54.582	14.8602
1.796000000 GH	54.605	14.8877
1.798000000 GH	54.703	14.9235
1.800000000 GH	54.797	14.9628
1.802000000 GH	54.798	14.9729
1.804000000 GH	54.732	14.9594
1.806000000 GH	54.612	14.9271
1.808000000 GH	54.539	14.9130
1.810000000 GH	54.540	14.9229
1.812000000 GH	54.595	14.9517
1.814000000 GH	54.666	14.9890
1.816000000 GH	54.729	15.0139
1.818000000 GH	54.740	15.0261

1.820000000 GH	54.622	15.0081
1.822000000 GH	54.540	14.9838
1.824000000 GH	54.484	14.9590
1.826000000 GH	54.476	14.9799
1.828000000 GH	54.563	15.0134
1.830000000 GH	54.630	15.0458
1.832000000 GH	54.683	15.0872
1.834000000 GH	54.634	15.0413
1.836000000 GH	54.558	15.0195
1.838000000 GH	54.462	15.0204
1.840000000 GH	54.435	15.0067
1.842000000 GH	54.468	15.0292
1.844000000 GH	54.535	15.0570
1.846000000 GH	54.626	15.0818
1.848000000 GH	54.628	15.0949
1.850000000 GH	54.564	15.0739

APPENDIX F – PHANTOM CERTIFICATE OF CONFORMITY

Schmid & Partner Engineering AG

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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 Hauptstr. 69 CH-8559 Fruthwilen 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; 6mm +/- 0.2mm at ERP	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample 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 simulating liquids	Pre-series, First article, 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

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APPENDIX G - DAE CALIBRATION CERTIFICATE

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **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 ± 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	i.V.

Issued: July 18, 2013

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Glossary

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

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range:	1LSB =	6.1μV ,	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 ± 0.02% (k=2)	404.844 ± 0.02% (k=2)	404.267 ± 0.02% (k=2)
Low Range	3.93273 ± 1.50% (k=2)	3.98110 ± 1.50% (k=2)	3.97938 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	141.0 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	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 (μV)	Difference (μV)	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 Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
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 (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.18	-3.67
Channel Y	200	6.93	-	-0.17
Channel Z	200	7.39	5.46	-

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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 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
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