

Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|-------------------------------------|------------------------|-----------------------------|
| DASY Version | DASY5 | V52.2 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | ELI4 Flat Phantom | Shell thickness: 2 ± 0.2 mm |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Area Scan Resolution | dx, dy = 15 mm | |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 43.5 | 0.87 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 43.6 ± 6 % | 0.83 mho/m ± 6 % |
| Head TSL temperature during test | (22.0 ± 0.2) °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | condition | |
|---|--------------------|----------------------------|
| SAR measured | 398 mW input power | 1.80 mW / g |
| SAR normalized | normalized to 1W | 4.52 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 4.70 mW / g ± 18.1 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|----------------------------|
| SAR measured | 398 mW input power | 1.19 mW / g |
| SAR normalized | normalized to 1W | 2.99 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 3.09 mW / g ± 17.6 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 56.7 | 0.94 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 54.1 ± 6 % | 0.90 mho/m ± 6 % |
| Body TSL temperature during test | (22.0 ± 0.2) °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 398 mW input power | 1.74 mW / g |
| SAR normalized | normalized to 1W | 4.37 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 4.47 mW / g ± 18.1 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 398 mW input power | 1.15 mW / g |
| SAR normalized | normalized to 1W | 2.89 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 2.96 mW / g ± 17.6 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 57.7 Ω - 7.4 $j\Omega$ |
| Return Loss | - 20.1 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 55.6 Ω - 8.8 $j\Omega$ |
| Return Loss | - 20.1 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.353 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.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

| | |
|-----------------|-----------------|
| Manufactured by | SPEAG |
| Manufactured on | August 15, 2008 |

DASY5 Validation Report for Head TSL

Date/Time: 15.09.2012 13:00:34

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1061

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1

Medium: HSL450

Medium parameters used: $f = 450$ MHz; $\sigma = 0.83$ mho/m; $\epsilon_r = 43.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.62, 6.62, 6.62); Calibrated: 30.04.2010
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 23.04.2010
- Phantom: Flat Phantom 4.4 ; Type: Flat Phantom 4.4; Serial: 1002
- Measurement SW: DASY52, V52.2 Build 0, Version 52.2.0 (163)
- Postprocessing SW: SEMCAD X, V14.2 Build 2, Version 14.2.2 (1685)

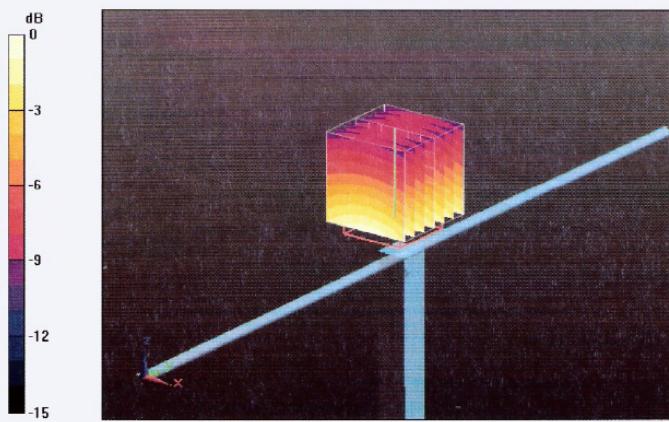
Pin=398mW/d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 49.8 V/m; Power Drift = -0.022 dB

Peak SAR (extrapolated) = 2.76 W/kg

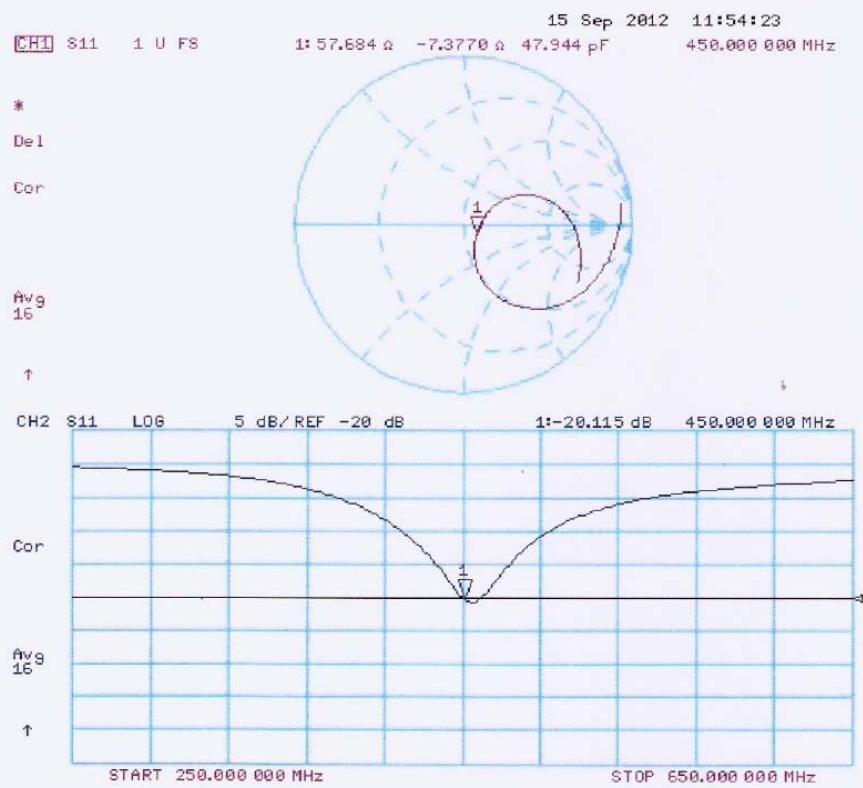
SAR(1 g) = 1.8 mW/g; SAR(10 g) = 1.19 mW/g

Maximum value of SAR (measured) = 1.92 mW/g



0 dB = 1.92mW/g

Impedance Measurement Plot for Head TSL



Impedance Measurement Plot for Head TSL**DASY5 Validation Report for Body TSL**

Date/Time: 15.09.2012 14:37:34

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1061

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1

Medium: MSL450

Medium parameters used: $f = 450$ MHz; $\sigma = 0.9$ mho/m; $\epsilon_r = 54.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.2, 7.2, 7.2); Calibrated: 30.04.2010
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 23.04.2010
- Phantom: Flat Phantom 4.4 ; Type: Flat Phantom 4.4; Serial: 1002
- Measurement SW: DASY52, V52.2 Build 0, Version 52.2.0 (163)
- Postprocessing SW: SEMCAD X, V14.2 Build 2, Version 14.2.2 (1685)

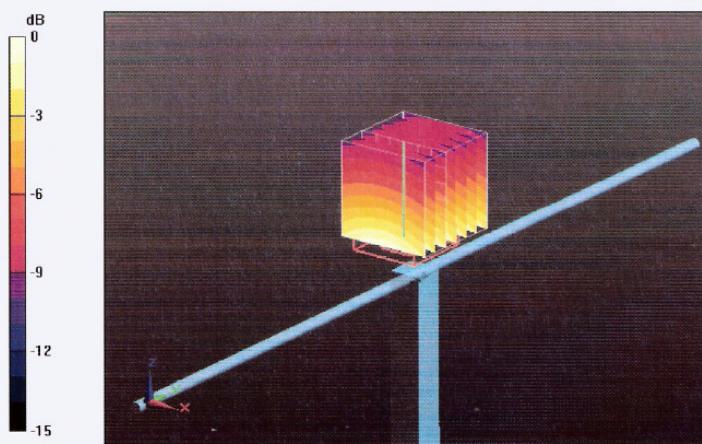
Pin=398mW/d=15mm, Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

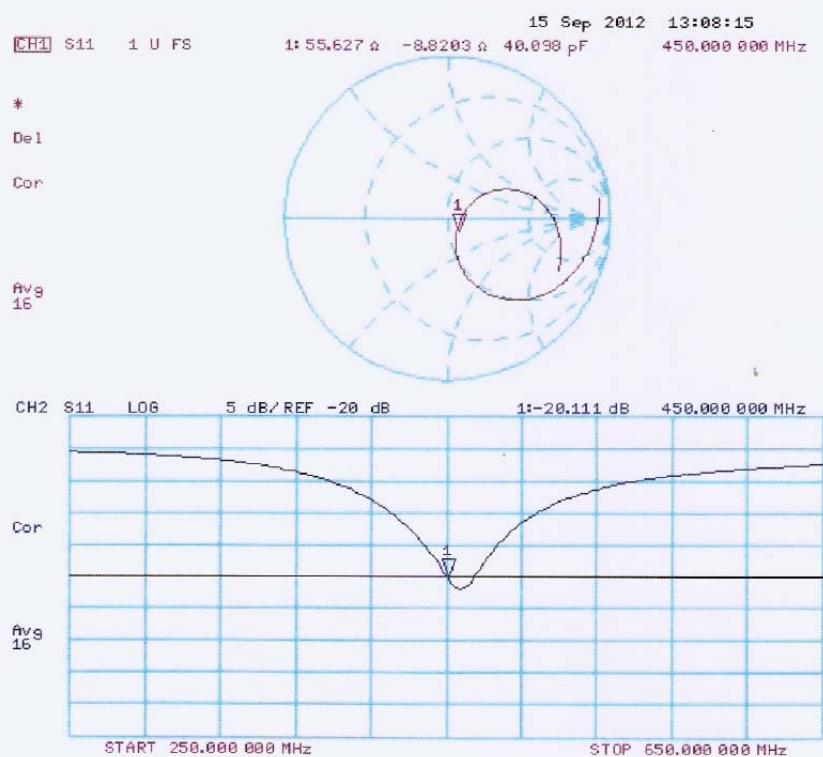
Reference Value = 46.5 V/m; Power Drift = -0.00382 dB

Peak SAR (extrapolated) = 2.75 W/kg

SAR(1 g) = 1.74 mW/g; SAR(10 g) = 1.15 mW/g

Maximum value of SAR (measured) = 1.86 mW/g



Impedance Measurement Plot for Head TSL**Impedance Measurement Plot for Body TSL**

6.3. DAE4 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 **CIQ SZ (Auden)**Certificate No: **DAE4-1315_Feb13**

CALIBRATION CERTIFICATE

| | |
|--------|---------------------------------|
| Object | DAE4 - SD 000 D04 BJ - SN: 1315 |
|--------|---------------------------------|

| | |
|--------------------------|---|
| Calibration procedure(s) | QA CAL-06.v24 Calibration procedure for the data acquisition electronics (DAE) |
|--------------------------|---|

| | |
|-------------------|-------------------|
| Calibration date: | February 27, 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 $(22 \pm 3)^\circ\text{C}$ 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 | 28-Sep-12 (No:11450) | Sep-13 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Calibrator Box V2.1 | SE UWS 053 AA 1001 | 05-Jan-12 (in house check) | In house check: Jan-13 |

| | | | |
|----------------|-----------------------|------------------------|---------------|
| Calibrated by: | Name Andrea Guntli | Function Technician | Signature |
|----------------|-----------------------|------------------------|---------------|

| | | | |
|--------------|-------------|--------------|--|
| Approved by: | Fin Bomholt | R&D Director | |
|--------------|-------------|--------------|--|

Issued: February 27, 2013

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

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



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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 = $6.1\mu\text{V}$, full range = $-100...+300\text{ mV}$ Low Range: 1LSB = 61nV , 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 | $405.194 \pm 0.1\% \text{ (k=2)}$ | $405.031 \pm 0.1\% \text{ (k=2)}$ | $405.006 \pm 0.1\% \text{ (k=2)}$ |
| Low Range | $4.00179 \pm 0.7\% \text{ (k=2)}$ | $3.99504 \pm 0.7\% \text{ (k=2)}$ | $4.00535 \pm 0.7\% \text{ (k=2)}$ |

Connector Angle

| | |
|---|--------------------------|
| Connector Angle to be used in DASY system | $20.0^\circ \pm 1^\circ$ |
|---|--------------------------|

Appendix

1. DC Voltage Linearity

| High Range | Reading (µV) | Difference (µV) | Error (%) |
|-------------------|--------------|-----------------|-----------|
| Channel X + Input | 199993.07 | -0.46 | -0.00 |
| Channel X + Input | 19998.21 | 0.29 | 0.00 |
| Channel X - Input | -19997.04 | 5.94 | -0.03 |
| Channel Y + Input | 199992.78 | -1.05 | -0.00 |
| Channel Y + Input | 19995.99 | -1.88 | -0.01 |
| Channel Y - Input | -20001.41 | 1.50 | -0.01 |
| Channel Z + Input | 199996.23 | 3.02 | 0.00 |
| Channel Z + Input | 19996.75 | -0.72 | -0.00 |
| Channel Z - Input | -20003.50 | -0.24 | 0.00 |

| Low Range | Reading (µV) | Difference (µV) | Error (%) |
|-------------------|--------------|-----------------|-----------|
| Channel X + Input | 1999.32 | -1.73 | -0.09 |
| Channel X + Input | 200.22 | -1.03 | -0.51 |
| Channel X - Input | -198.55 | 0.32 | -0.16 |
| Channel Y + Input | 1997.53 | -3.28 | -0.16 |
| Channel Y + Input | 199.64 | -1.21 | -0.60 |
| Channel Y - Input | -199.77 | -0.78 | 0.39 |
| Channel Z + Input | 1997.90 | -2.04 | -0.10 |
| Channel Z + Input | 199.23 | -1.21 | -0.61 |
| Channel Z - Input | -200.63 | -1.12 | 0.56 |

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 | -1.10 | -3.09 |
| | -200 | 4.35 | 3.23 |
| Channel Y | 200 | -22.09 | -22.46 |
| | -200 | 21.74 | 22.31 |
| Channel Z | 200 | -4.46 | -4.92 |
| | -200 | 3.65 | 2.86 |

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 | - | -2.62 | -3.29 |
| Channel Y | 200 | 6.73 | - | -2.17 |
| Channel Z | 200 | 8.11 | 5.38 | - |

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 | 16132 | 15682 |
| Channel Y | 16251 | 15151 |
| Channel Z | 15551 | 15659 |

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 | 1.32 | 0.22 | 2.38 | 0.46 |
| Channel Y | -1.23 | -2.04 | -0.58 | 0.36 |
| Channel Z | -1.89 | -3.56 | -1.12 | 0.39 |

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 |

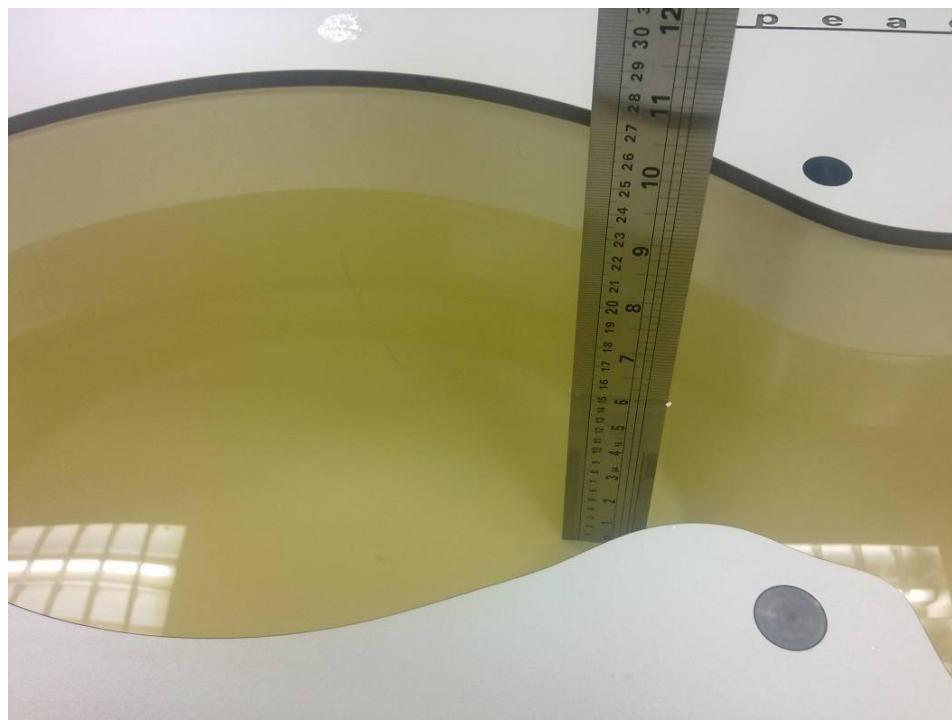
8. Low Battery Alarm Voltage (Typical values for information)

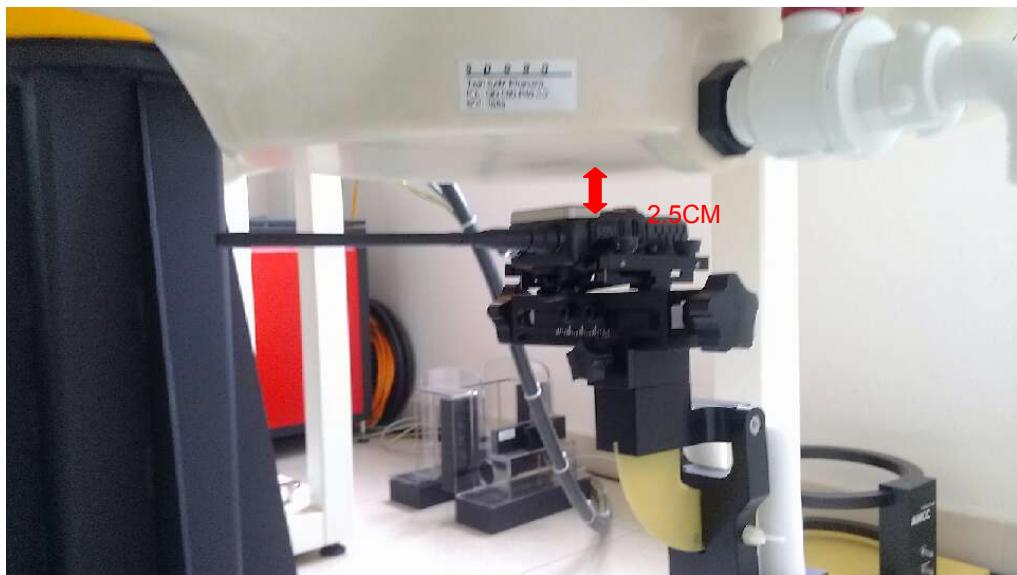
| Typical values | Alarm Level (VDC) |
|----------------|-------------------|
| Supply (+ Vcc) | +7.9 |
| Supply (- Vcc) | -7.6 |

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 |

7. Test Setup Photos





The EUT display towards phantom



The EUT display towards Ground

8. EUT Photos







.....End of Report.....