

20140314_System Check_Dipole835V2 SN4d120

Frequency: 835 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C

Medium parameters used: $f = 835.3$ MHz; $\sigma = 0.948$ mho/m; $\epsilon_r = 56.7$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(7.7, 7.7, 7.7); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-1; Type: SAM V4.0; Serial: TP-1150

Body/Pin=100mW, d=15mm/Area Scan (9x13x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 1.15 mW/g

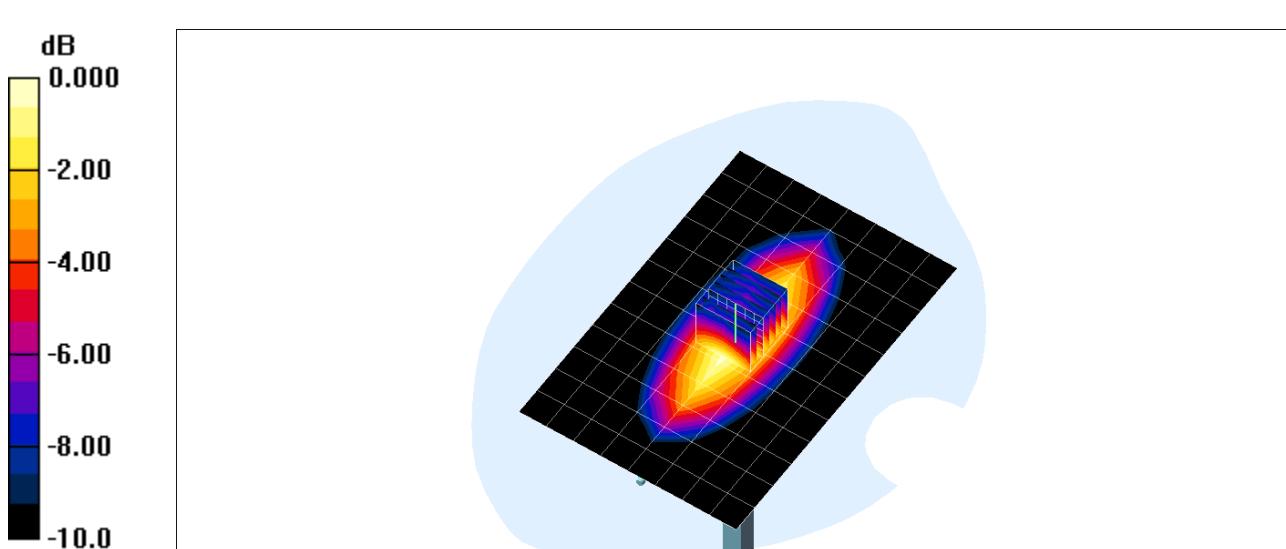
Body/Pin=100mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 35.5 V/m; Power Drift = -0.020 dB

Peak SAR (extrapolated) = 1.36 W/kg

SAR(1 g) = 0.923 mW/g; SAR(10 g) = 0.614 mW/g

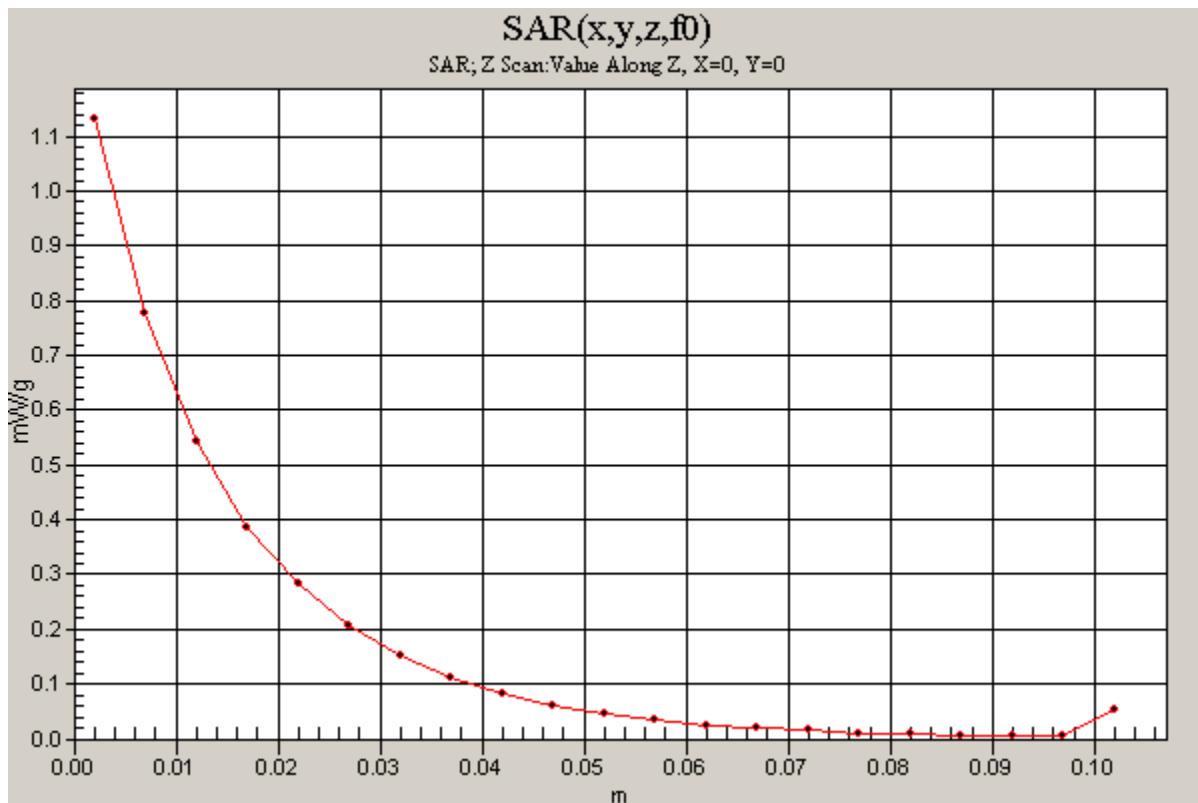
Maximum value of SAR (measured) = 1.17 mW/g



0 dB = 1.17mW/g

20140314_System Check_Dipole835V2 SN4d120

Frequency: 835 MHz; Duty Cycle: 1:1

Body/Pin=100mW, d=15mm/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.13 mW/g

20140314_System Check_Dipole1900V2 SN5d056

Frequency: 1900 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C

Medium parameters used (interpolated): $f = 1900$ MHz; $\sigma = 1.51$ mho/m; $\epsilon_r = 51.1$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(6.52, 6.52, 6.52); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-2; Type: SAM V4.0; Serial: TP-1150

Body/Pin=100mW, d=15mm/Area Scan (9x13x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 5.35 mW/g

Body/Pin=100mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

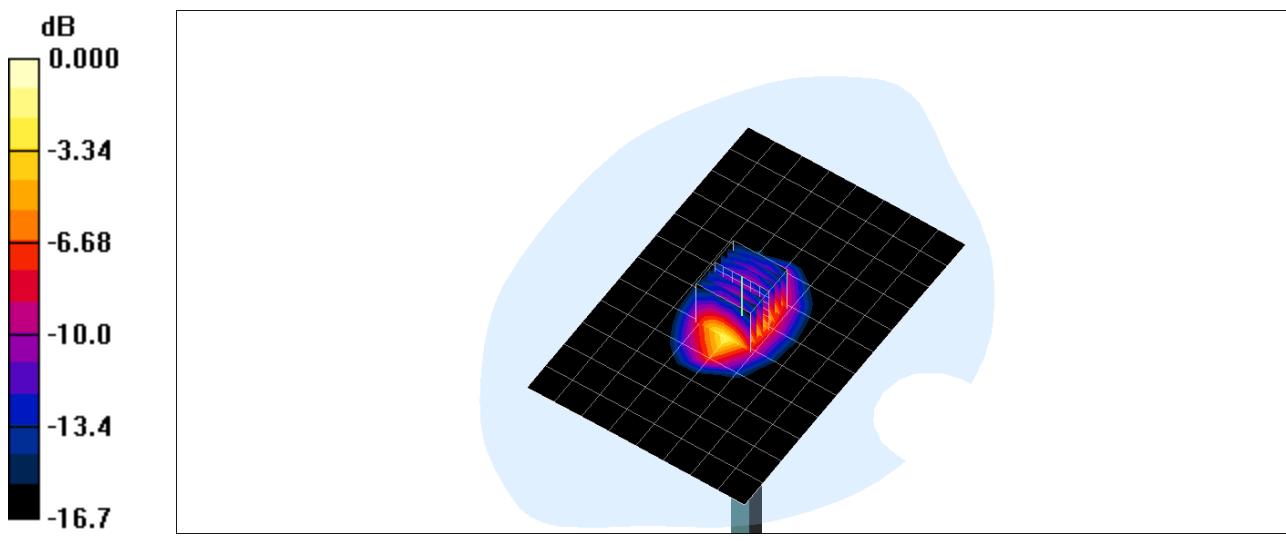
Reference Value = 60.7 V/m; Power Drift = 0.004 dB

Peak SAR (extrapolated) = 7.11 W/kg

SAR(1 g) = 4.04 mW/g; SAR(10 g) = 2.12 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 5.73 mW/g



0 dB = 5.73mW/g

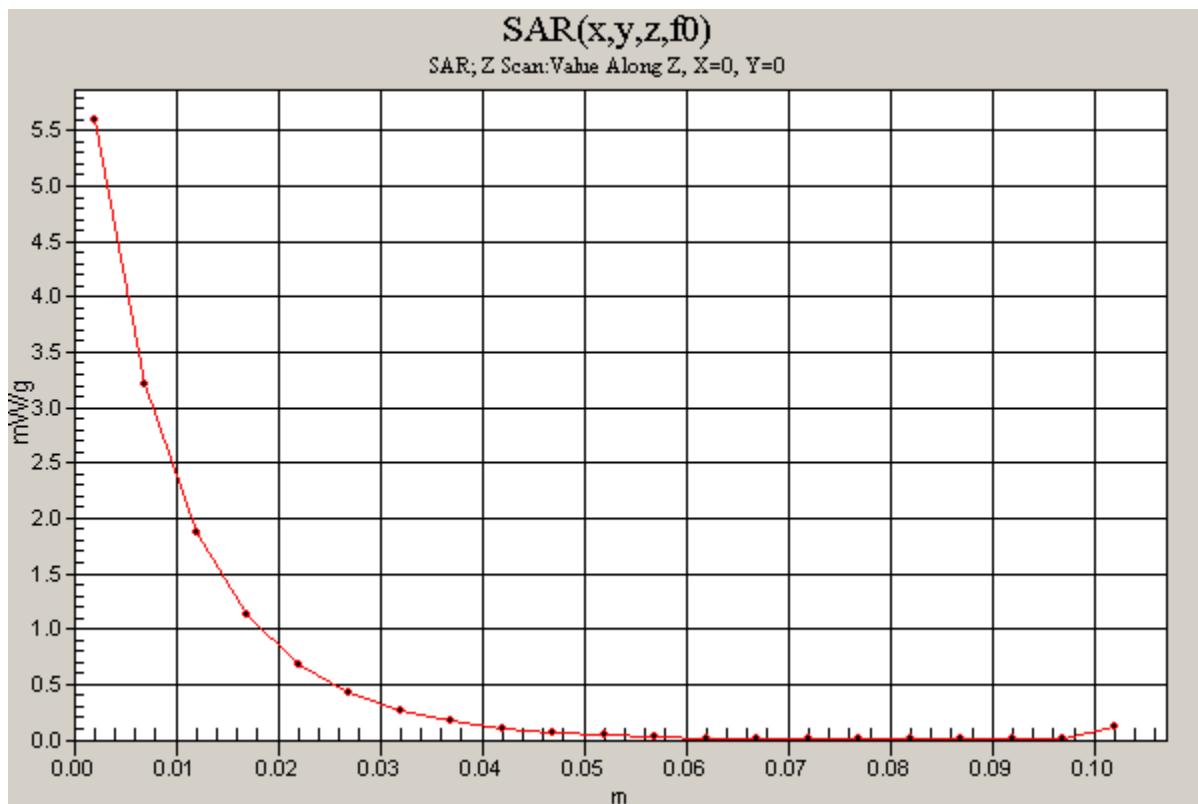
20140314_System Check_Dipole1900V2 SN5d056

Frequency: 1900 MHz; Duty Cycle: 1:1

Body/Pin=100mW, d=15mm/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 5.60 mW/g



WCDMA Band II

Frequency: 1907.6 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used: $f = 1907.8$ MHz; $\sigma = 1.52$ mho/m; $\epsilon_r = 51.1$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(6.52, 6.52, 6.52); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-2; Type: SAM V4.0; Serial: TP-1150

Front Side/WCDMA Band V/Ch9538/Area Scan (6x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.158 mW/g

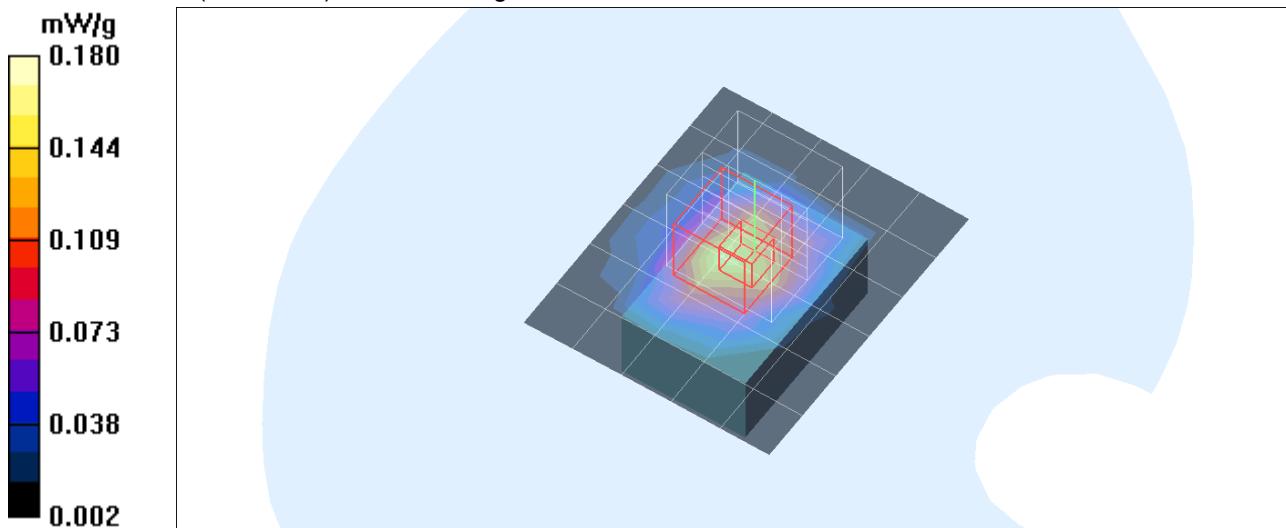
Front Side/WCDMA Band V/Ch9538/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 11.1 V/m; Power Drift = -0.151 dB

Peak SAR (extrapolated) = 0.214 W/kg

SAR(1 g) = 0.137 mW/g; SAR(10 g) = 0.076 mW/g

Maximum value of SAR (measured) = 0.180 mW/g

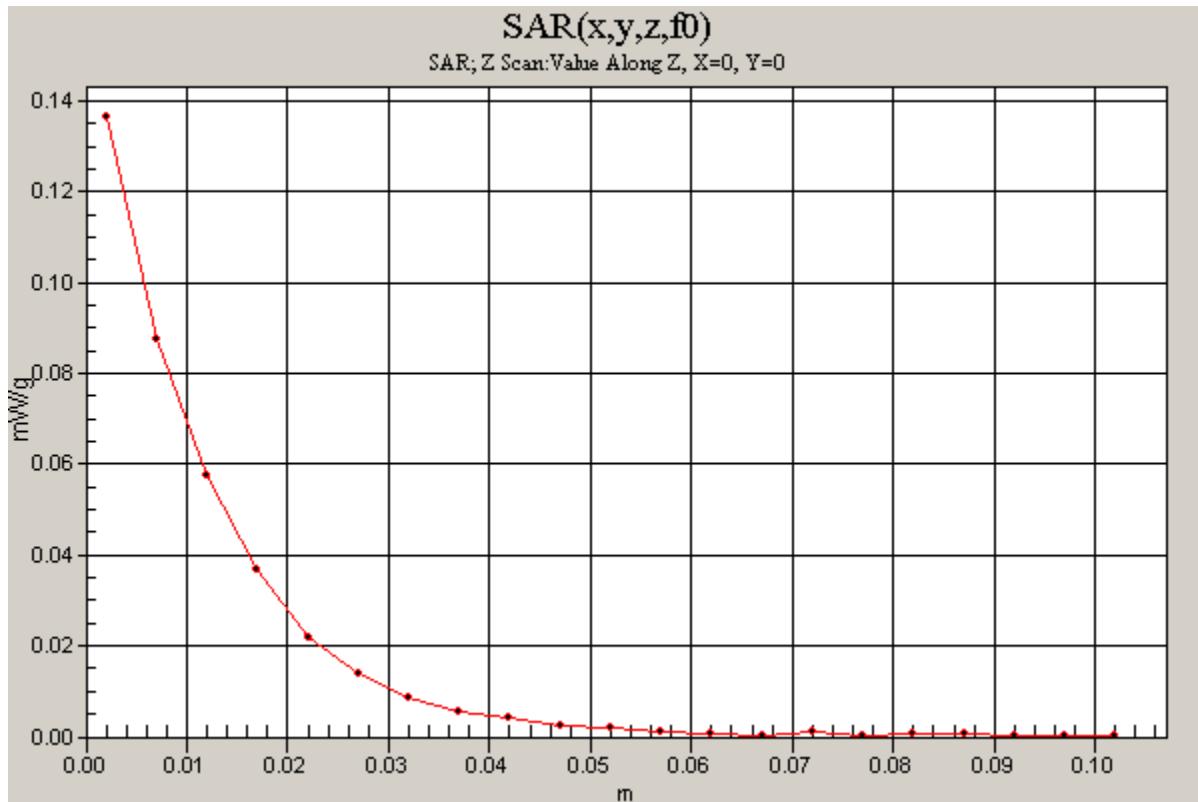


WCDMA Band II

Frequency: 1907.6 MHz; Duty Cycle: 1:1

Front Side/WCDMA Band V/Ch9538/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Maximum value of SAR (measured) = 0.137 mW/g



WCDMA Band II

Frequency: 1907.6 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used: $f = 1907.8$ MHz; $\sigma = 1.52$ mho/m; $\epsilon_r = 51.1$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(6.52, 6.52, 6.52); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used))Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-2; Type: SAM V4.0; Serial: TP-1150

Rear Side/WCDMA Band V/Ch9538/Area Scan (6x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.124 mW/g

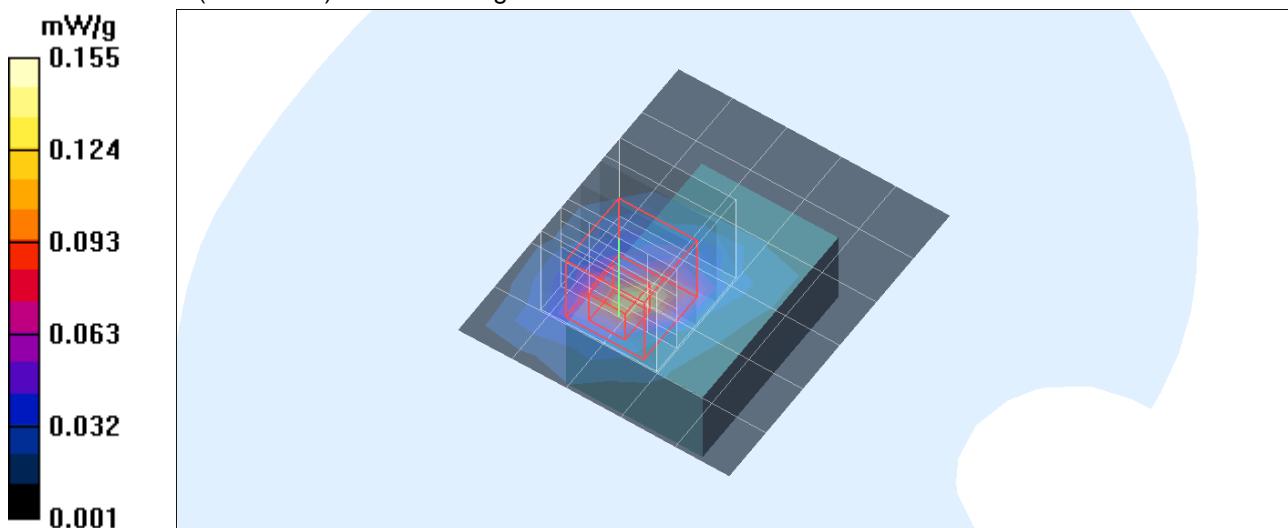
Rear Side/WCDMA Band V/Ch9538/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 5.33 V/m; Power Drift = 0.128 dB

Peak SAR (extrapolated) = 0.224 W/kg

SAR(1 g) = 0.094 mW/g; SAR(10 g) = 0.041 mW/g

Maximum value of SAR (measured) = 0.155 mW/g



WCDMA Band V

Frequency: 836.4 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used (interpolated): $f = 836.4$ MHz; $\sigma = 0.949$ mho/m; $\epsilon_r = 56.7$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(7.7, 7.7, 7.7); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-1; Type: SAM V4.0; Serial: TP-1150

Front Side/WCDMA Band V/Ch4182/Area Scan (6x7x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.089 mW/g

Front Side/WCDMA Band V/Ch4182/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

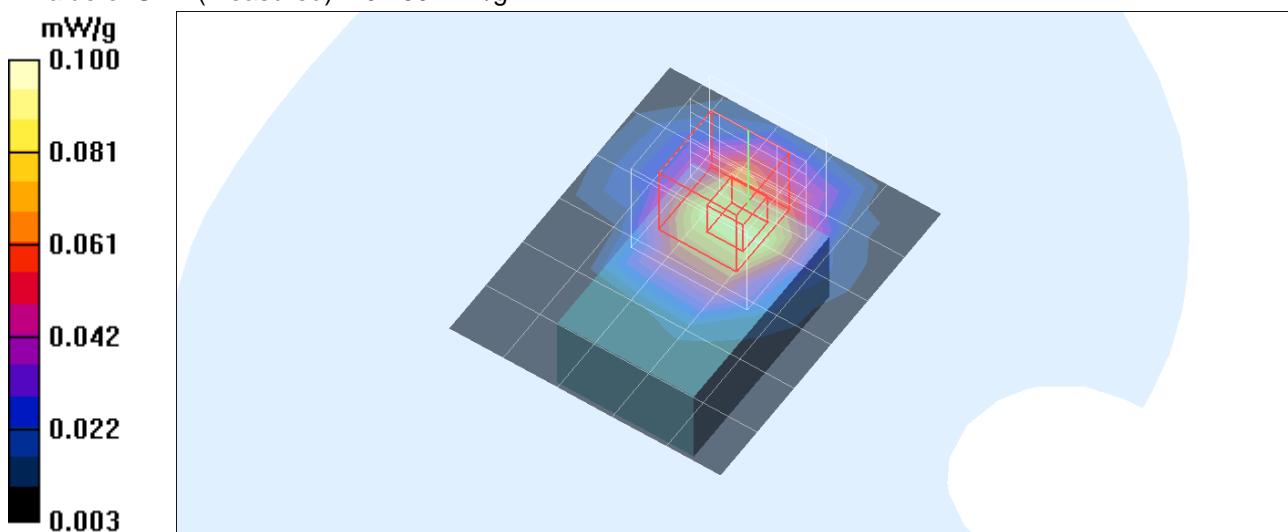
Reference Value = 8.45 V/m; Power Drift = 0.085 dB

Peak SAR (extrapolated) = 0.127 W/kg

SAR(1 g) = 0.079 mW/g; SAR(10 g) = 0.048 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.100 mW/g



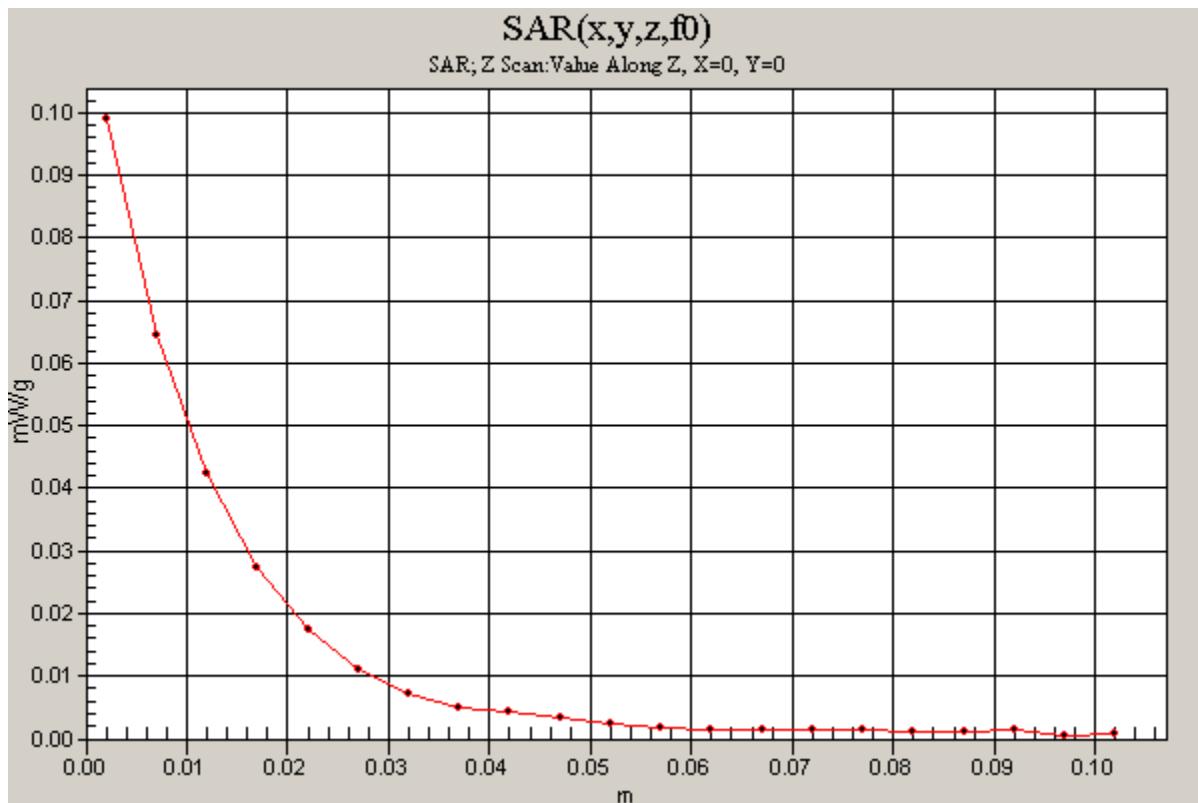
WCDMA Band V

Frequency: 836.4 MHz; Duty Cycle: 1:1

Front Side/WCDMA Band V/Ch4182/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.099 mW/g



WCDMA Band V

Frequency: 836.4 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used (interpolated): $f = 836.4$ MHz; $\sigma = 0.949$ mho/m; $\epsilon_r = 56.7$; $\rho = 1000$ kg/m³;

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Electronics: DAE4 Sn558; Calibrated: 7/25/2013
- Probe: EX3DV4 - SN3554; ConvF(7.7, 7.7, 7.7); Calibrated: 9/26/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used))Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: SAM 34-1; Type: SAM V4.0; Serial: TP-1150

Rear Side/WCDMA Band V/Ch4182/Area Scan (6x7x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.074 mW/g

Rear Side/WCDMA Band V/Ch4182/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

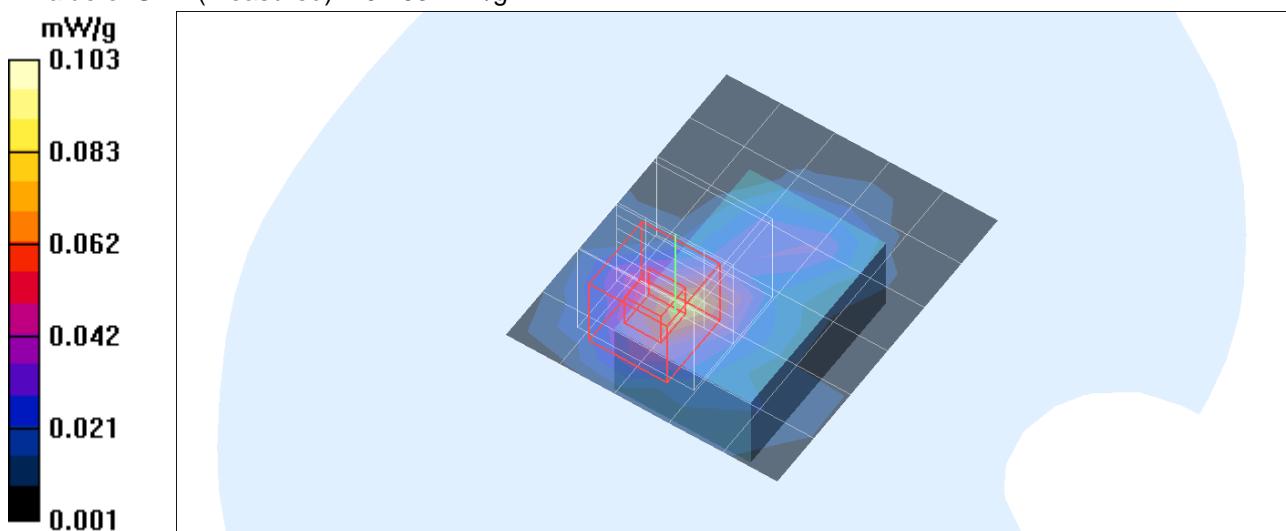
Reference Value = 5.32 V/m; Power Drift = 0.169 dB

Peak SAR (extrapolated) = 0.175 W/kg

SAR(1 g) = 0.072 mW/g; SAR(10 g) = 0.036 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.103 mW/g



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S Schweizerischer Kalibrierdienst
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Accredited by the Swiss Accreditation Service (SAS)
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **CCS-TW (Auden)**

Certificate No: **EX3-3554_Sep13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3554**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6**
Calibration procedure for dosimetric E-field probes

Calibration date: **September 26, 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
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Apr-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name	Function	Signature
	Israe El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 26, 2013

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



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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ 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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * 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 (no uncertainty required). 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
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: 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 *NORMx,y,z * 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 ± 50 MHz to ± 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.

Probe EX3DV4

SN:3554

Manufactured: July 13, 2004
Calibrated: September 26, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3554

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.40	0.46	0.38	$\pm 10.1 \%$
DCP (mV) ^B	98.6	97.6	99.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	187.4	$\pm 2.5 \%$
		Y	0.0	0.0	1.0		152.5	
		Z	0.0	0.0	1.0		182.8	

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%.

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3554

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
900	41.5	0.97	7.74	7.74	7.74	0.41	0.94	± 12.0 %
1810	40.0	1.40	6.85	6.85	6.85	0.68	0.67	± 12.0 %
1900	40.0	1.40	6.81	6.81	6.81	0.48	0.79	± 12.0 %
2000	40.0	1.40	6.80	6.80	6.80	0.76	0.62	± 12.0 %
2450	39.2	1.80	6.24	6.24	6.24	0.54	0.72	± 12.0 %
5200	36.0	4.66	4.73	4.73	4.73	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.39	4.39	4.39	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.32	4.32	4.32	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.10	4.10	4.10	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.09	4.09	4.09	0.40	1.80	± 13.1 %

^c Frequency validity 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3554

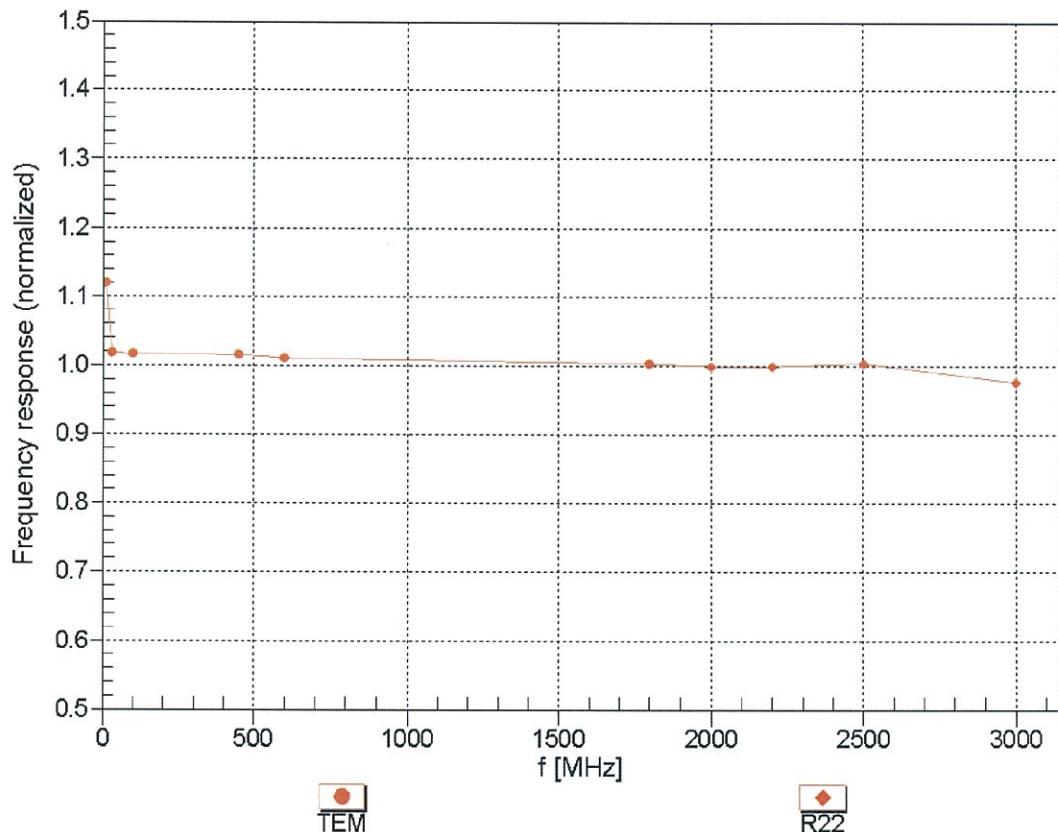
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
900	55.0	1.05	7.70	7.70	7.70	0.58	0.78	± 12.0 %
1810	53.3	1.52	6.65	6.65	6.65	0.69	0.70	± 12.0 %
1900	53.3	1.52	6.52	6.52	6.52	0.40	0.89	± 12.0 %
2000	53.3	1.52	6.63	6.63	6.63	0.80	0.64	± 12.0 %
2450	52.7	1.95	6.24	6.24	6.24	0.75	0.66	± 12.0 %
5200	49.0	5.30	4.02	4.02	4.02	0.40	1.90	± 13.1 %
5300	48.9	5.42	3.82	3.82	3.82	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.59	3.59	3.59	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.27	3.27	3.27	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.53	3.53	3.53	0.50	1.90	± 13.1 %

^C Frequency validity 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

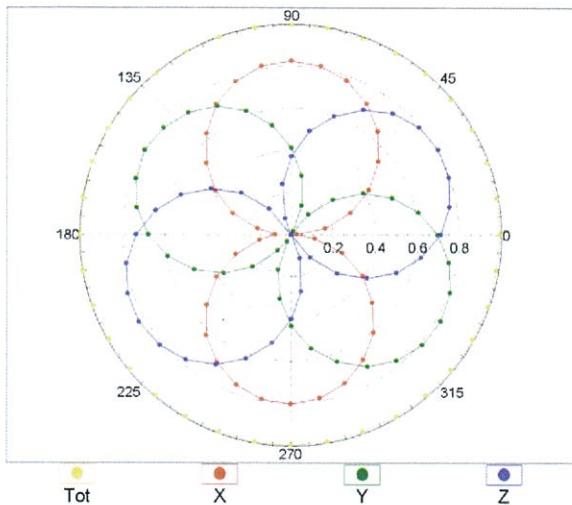
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



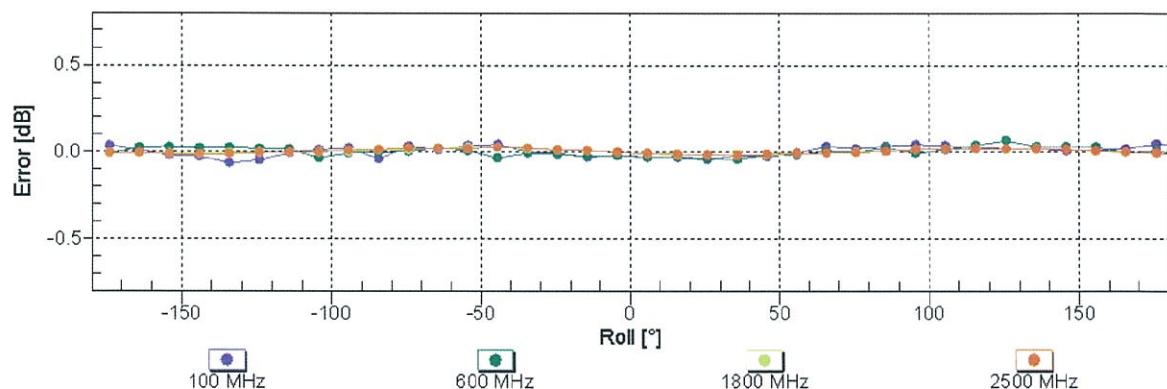
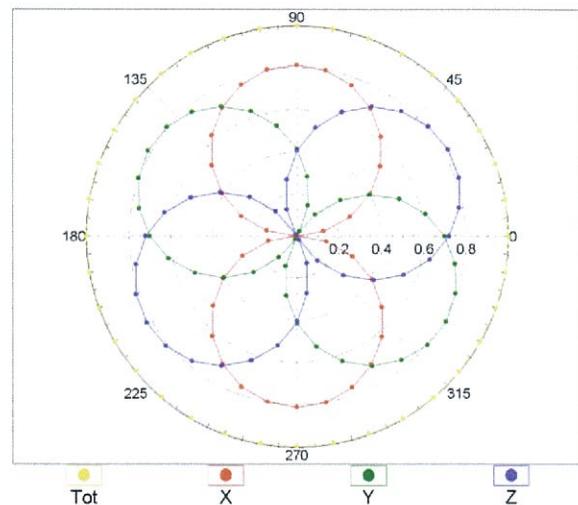
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

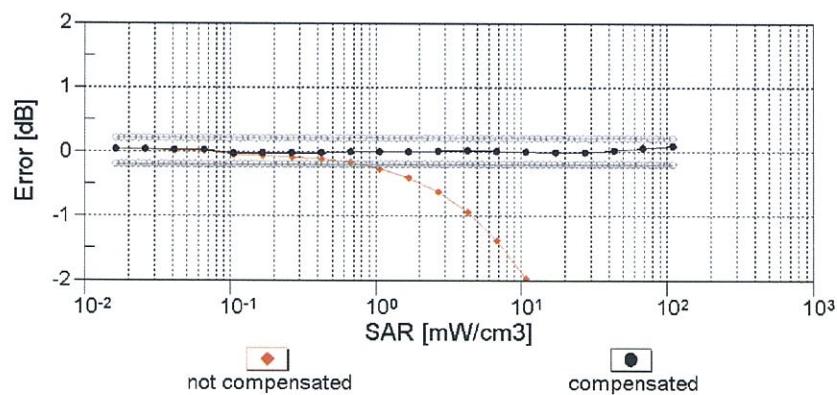
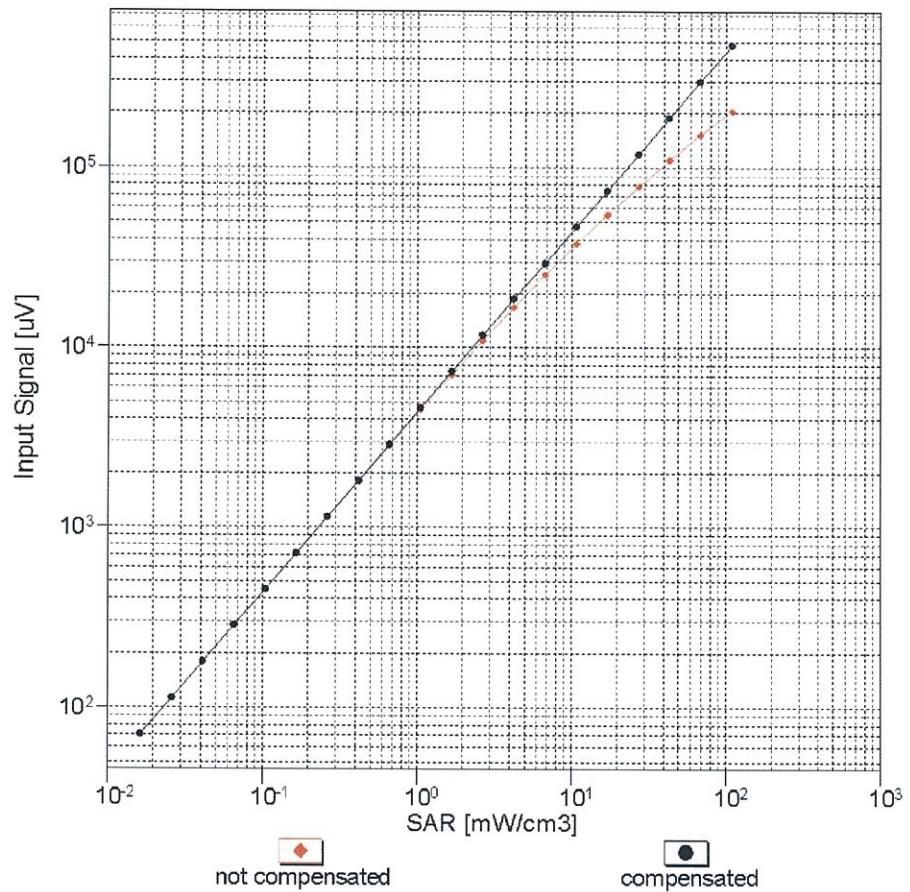
f=600 MHz, TEM



f=1800 MHz, R22

Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

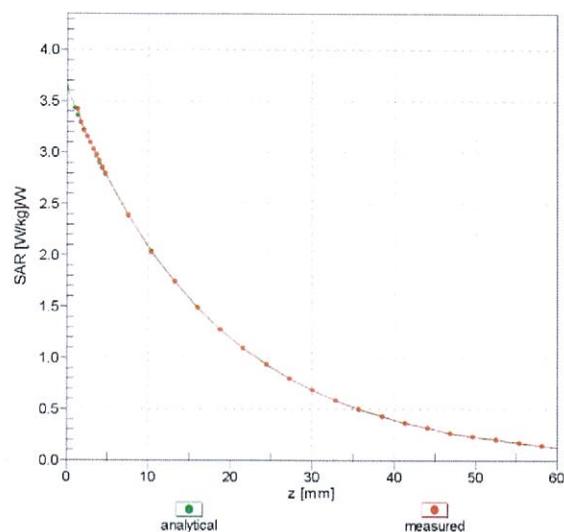
Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)



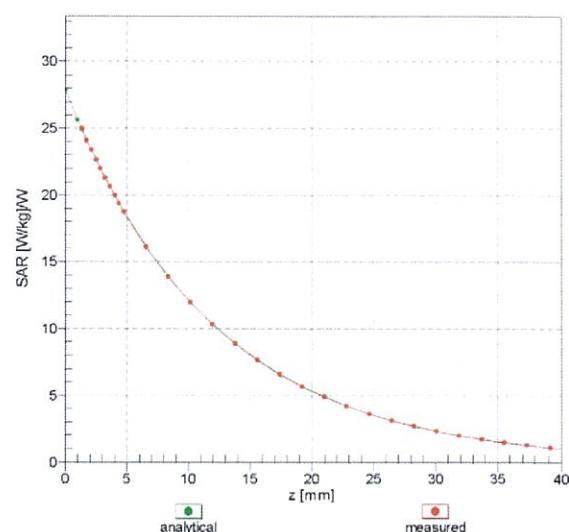
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment

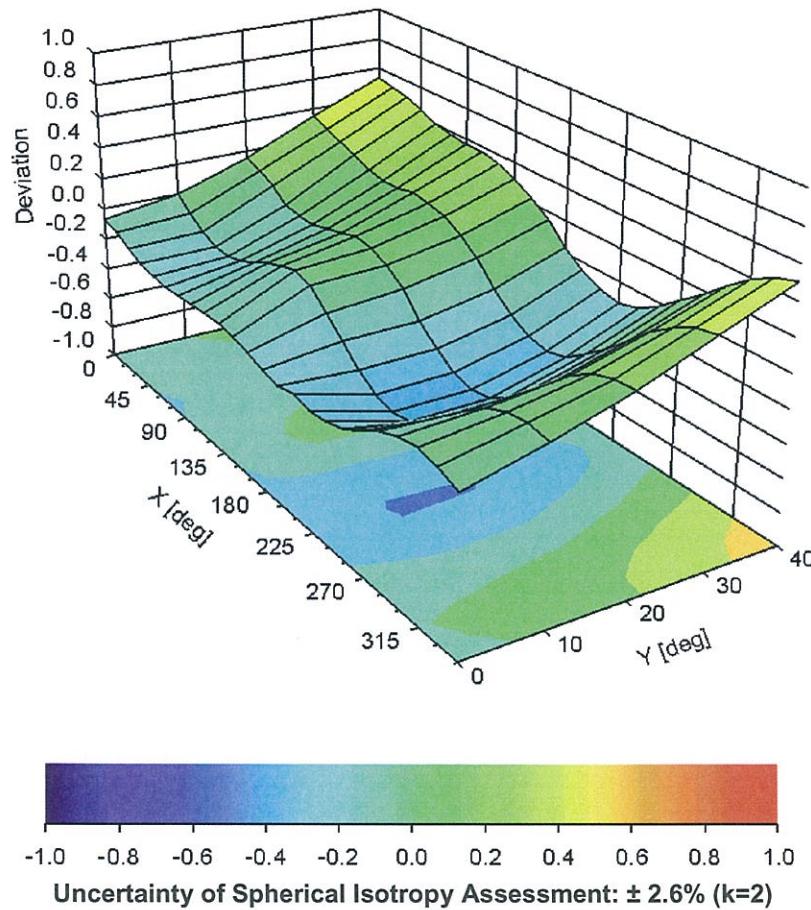
$f = 900 \text{ MHz}, \text{WGLS R9 (H_convF)}$



$f = 1810 \text{ MHz}, \text{WGLS R22 (H_convF)}$



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3554

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-34.2
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	2 mm

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 M Ω 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

Accreditation No.: **SCS 108**

Client **CCS-TW (Auden)**

Certificate No: **DAE4-558_Jul13**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 558**

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

Calibration date: **July 25, 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 Calibrator Box V2.1	SE UWS 053 AA 1001 SE UMS 006 AA 1002	07-Jan-13 (in house check) 07-Jan-13 (in house check)	In house check: Jan-14 In house check: Jan-14

Calibrated by:	Name	Function	Signature
	Dominique Steffen	Technician	

Approved by:	Name	Function	Signature
	Fin Bomholt	Deputy Technical Manager	

Issued: July 25, 2013

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



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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 μ 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	$404.834 \pm 0.02\% \text{ (k=2)}$	$404.719 \pm 0.02\% \text{ (k=2)}$	$404.888 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.96252 \pm 1.50\% \text{ (k=2)}$	$3.93898 \pm 1.50\% \text{ (k=2)}$	$3.98830 \pm 1.50\% \text{ (k=2)}$

Connector Angle

Connector Angle to be used in DASY system	$226.5^\circ \pm 1^\circ$
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Appendix

1. DC Voltage Linearity

High Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	199999.87	2.22	0.00
Channel X	+ Input	20007.13	6.49	0.03
Channel X	- Input	-19995.23	5.84	-0.03
Channel Y	+ Input	199999.72	2.06	0.00
Channel Y	+ Input	20004.76	4.02	0.02
Channel Y	- Input	-19995.40	5.45	-0.03
Channel Z	+ Input	199999.60	2.04	0.00
Channel Z	+ Input	20002.08	1.38	0.01
Channel Z	- Input	-20000.87	0.09	-0.00

Low Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	2000.97	0.18	0.01
Channel X	+ Input	201.57	0.30	0.15
Channel X	- Input	-198.13	0.50	-0.25
Channel Y	+ Input	2001.13	0.17	0.01
Channel Y	+ Input	201.02	-0.49	-0.24
Channel Y	- Input	-198.55	-0.05	0.02
Channel Z	+ Input	2000.94	-0.06	-0.00
Channel Z	+ Input	200.15	-1.21	-0.60
Channel Z	- Input	-199.64	-1.04	0.52

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 (μ V)	Low Range Average Reading (μ V)
Channel X	200	1.27	-0.63
	-200	1.15	-0.57
Channel Y	200	8.66	8.49
	-200	-9.25	-9.75
Channel Z	200	3.62	3.94
	-200	-5.72	-5.74

3. Channel separation

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

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	5.21	-0.00
Channel Y	200	9.58	-	5.96
Channel Z	200	7.07	7.92	-

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	16226	15249
Channel Y	15710	15696
Channel Z	16055	16722

5. Input Offset Measurement

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

Input 10MΩ

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.52	-0.76	1.55	0.43
Channel Y	-0.06	-1.00	1.38	0.46
Channel Z	-0.89	-1.79	0.54	0.46

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