



7.4 Multiple Transmitter Evaluation

7.4.1 Simultaneous SAR test evaluation

Simultaneous Transmission

NO.	Simultaneous Transmission Configuration	Head	Body worn
1	FRS+ BT	Yes	Yes

7.4.2 Estimated SAR

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion:

• $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})} / x] \text{ W/kg}$
for test separation distances $\leq 50 \text{ mm}$;

Where $x = 7.5$ for 1-g SAR, and $x = 18.75$ for 10-g SAR.

• 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is $> 50 \text{ mm}$.

Estimated SAR Result

Freq. Band	Frequency (GHz)	Test Position	max. power(dBm)	Test Separation (mm)	Estimated
					1g SAR (W/kg)
Bluetooth	2.48	Head	1	25	0.011
		Body-worn	1	5	0.053



SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch

Report No.: SZEM171201279101

Rev : 01

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1) Simultaneous Transmission SAR Summation Scenario for head

WWAN Band	Exposure position	①MAX.FRS SAR(W/kg)	② MAX.BT SAR(W/kg)	Summed SAR①+②	Case NO.
FRS	Front face	1.13	0.011	1.141	No

2) Simultaneous Transmission SAR Summation Scenario for body worn

WWAN Band	Exposure position	①MAX.FRS SAR(W/kg)	② MAX.BT SAR(W/kg)	Summed SAR①+②	Case NO.
FRS	Back side	1.28	0.053	1.333	No



8 Equipment list

Test Platform		SPEAG DASY5 Professional				
Location		SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch				
Description		SAR Test System (Frequency range 300MHz-6GHz)				
Software Reference		DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)				
Hardware Reference						
Equipment		Manufacturer	Model	Serial Number	Calibration Date	Due date of calibration
☑	Robot	Staubli	RX90L	F03/5V32A1/A01	NCR	NCR
☑	Twin Phantom	SPEAG	SAM2	1913	NCR	NCR
☑	DAE	SPEAG	DAE4	1374	2017-08-31	2018-08-30
☑	E-Field Probe	SPEAG	EX3DV4	3789	2017-01-30	2018-01-29
☑	Validation Kits	SPEAG	D450V2	1149	2015-11-25	2018-11-24
☑	Agilent Network Analyzer	Agilent	E5071C	MY46523590	2017-03-06	2018-03-05
☑	Dielectric Probe Kit	Agilent	85070E	US01440210	NCR	NCR
☑	RF Bi-Directional Coupler	Agilent	86205-60001	MY31400031	NCR	NCR
☑	Signal Generator	Agilent	N5171B	MY53050736	2017-03-06	2018-03-05
☑	Preamplifier	Mini-Circuits	ZHL-42W	15542	NCR	NCR
☑	Power Meter	Agilent	E4416A	GB41292095	2017-03-06	2018-03-05
☑	Power Sensor	Agilent	8481H	MY41091234	2017-03-05	2018-03-04
☑	Power Sensor	R&S	NRP-Z92	100025	2017-03-06	2018-03-05
☑	Attenuator	SHX	TS2-3dB	30704	NCR	NCR
☑	Coaxial low pass filter	Mini-Circuits	VLF-2500(+)	NA	NCR	NCR
☑	Coaxial low pass filter	Microlab Fxr	LA-F13	NA	NCR	NCR
☑	50 Ω coaxial load	Mini-Circuits	KARN-50+	00850	NCR	NCR
☑	DC POWER SUPPLY	SAKO	SK1730SL5A	NA	NCR	NCR
☑	Speed reading thermometer	MingGao	T809	NA	2017-03-08	2018-03-07
☑	Humidity and Temperature Indicator	KIMTOKA	KIMTOKA	NA	2017-03-08	2018-03-07

9 Calibration certificate

Please see the Appendix C

10 Photographs

Please see the Appendix D



Appendix A: Detailed System Validation Results

Appendix B: Detailed Test Results

Appendix C: Calibration certificate

Appendix D: Photographs

---END---



Appendix A

Detailed System Validation Results

1. System Performance Check for Head
System Performance Check 450 MHz Head
2. System Performance Check for Body
System Performance Check 450 MHz Body

Test Laboratory: SGS-SAR Lab

System Performance Check 450 MHz Head

DUT: D450V3; Type: D450V3; Serial: 1072

Communication System: UID 0, CW (0); Frequency: 450 MHz; Duty Cycle: 1:1

Medium: HSL450; Medium parameters used: $f = 450$ MHz; $\sigma = 0.888$ S/m; $\epsilon_r = 42.829$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: EX3DV4 - SN3789; ConvF(9.49, 9.49, 9.49); Calibrated: 2017-1-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = -2.0, 31.0$
- Electronics: DAE4 Sn1374; Calibrated: 2017-8-31
- Phantom: ELI v4.0; Type: ELI; Serial: 1123
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Head/d=15mm, Pin=250mV/Area Scan (11x21x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (measured) = 1.22 W/kg

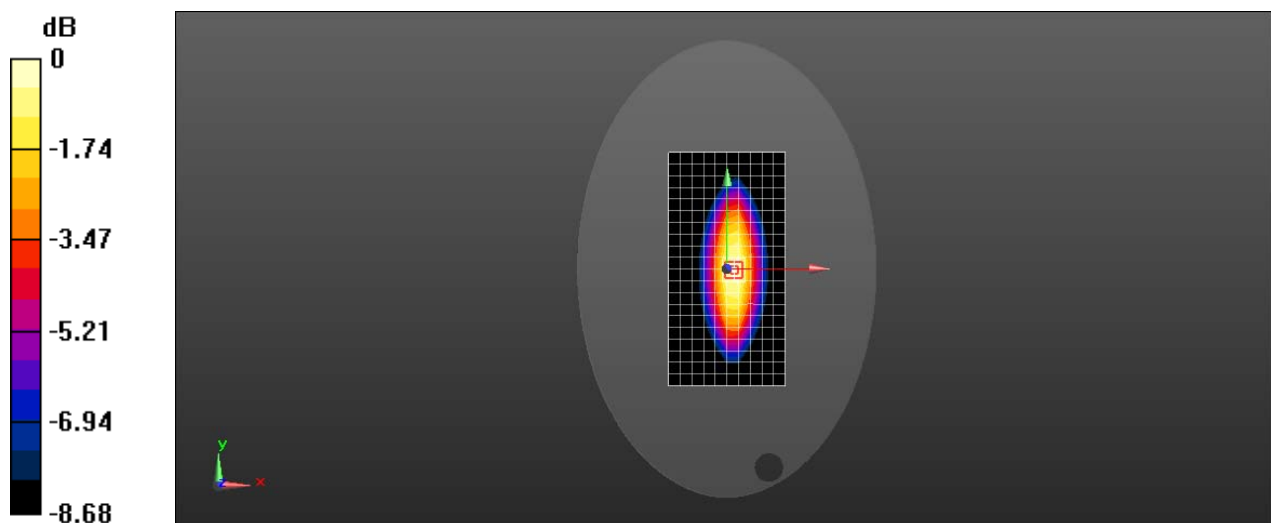
Head/d=15mm, Pin=250mV/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 38.19 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 1.76 W/kg

SAR(1 g) = 1.18 W/kg; SAR(10 g) = 0.769 W/kg

Maximum value of SAR (measured) = 1.31 W/kg



0 dB = 1.47 W/kg = 1.67 dBW/kg

Test Laboratory: SGS-SAR Lab

System Performance Check 450 MHz Body

DUT: D450V3; Type: D450V3; Serial: 1072

Communication System: UID 0, CW (0); Frequency: 450 MHz; Duty Cycle: 1:1

Medium: MSL450; Medium parameters used: $f = 450$ MHz; $\sigma = 0.97$ S/m; $\epsilon_r = 55.484$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: EX3DV4 - SN3789; ConvF(9.65, 9.65, 9.65); Calibrated: 2017-1-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = -2.0, 31.0$
- Electronics: DAE4 Sn1374; Calibrated: 2017-8-31
- Phantom: ELI v4.0; Type: ELI; Serial: 1123
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Body/d=15mm, Pin=398mW/Area Scan (11x21x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (measured) = 1.24 W/kg

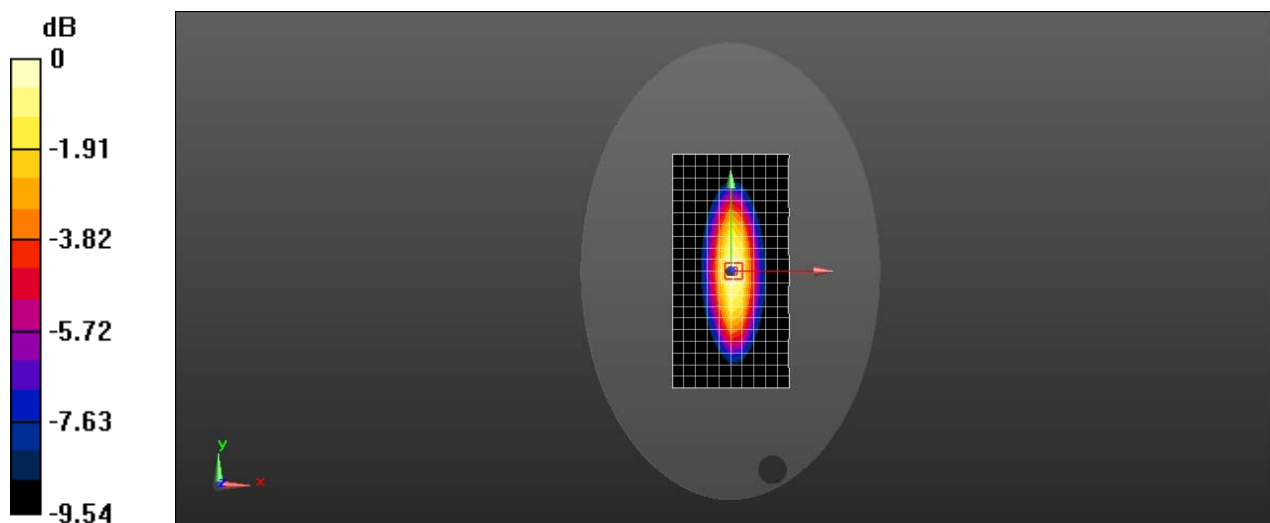
Body/d=15mm, Pin=398mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 32.11 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 2.05 W/kg

SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.762 W/kg

Maximum value of SAR (measured) = 1.31 W/kg





Appendix B

Detailed Test Results

1. FM

Test Laboratory: SGS-SAR Lab

XMDJJ01FY FRS CH1 Front side 25mm

DUT: XMDJJ01FY; Type: Mi Walkie-Talkie; Serial: N/A

Communication System: UID 0, PTT-Analog (0); Frequency: 462.563 MHz; Duty Cycle: 1:1

Medium: HSL450; Medium parameters used: $f = 463 \text{ MHz}$; $\sigma = 0.899 \text{ S/m}$; $\epsilon_r = 42.554$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: EX3DV4 - SN3789; ConvF(9.49, 9.49, 9.49); Calibrated: 2017-1-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = -2.0, 31.0$
- Electronics: DAE4 Sn1374; Calibrated: 2017-8-31
- Phantom: ELI v4.0; Type: ELI; Serial: 1123
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Configuration/Head/Area Scan (7x15x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
Maximum value of SAR (measured) = 2.04 W/kg

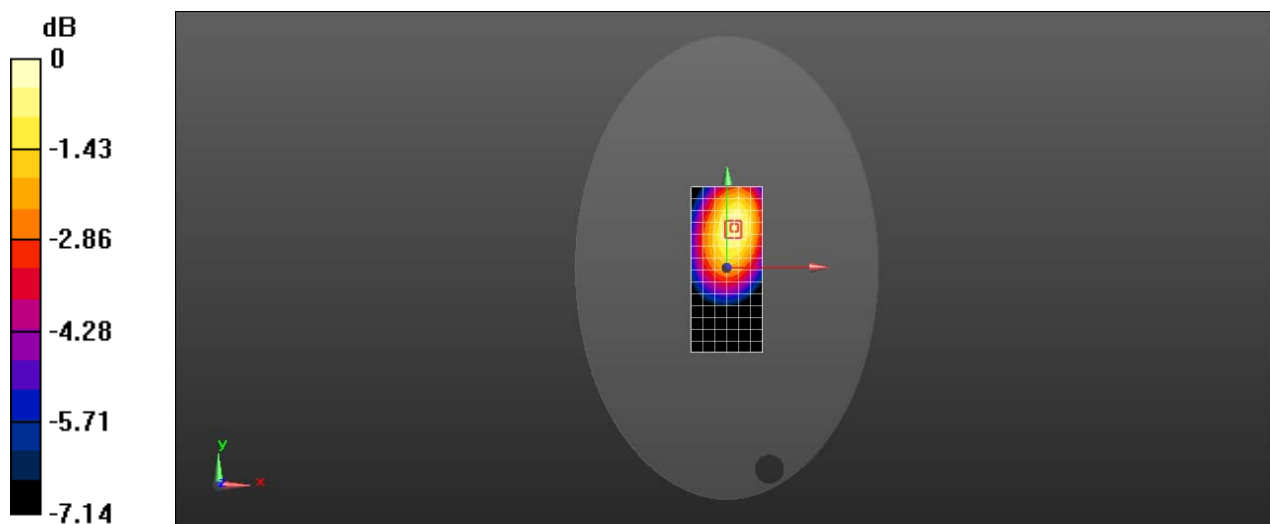
Configuration/Head/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 39.24 V/m ; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 2.54 W/kg

SAR(1 g) = 1.95 W/kg ; SAR(10 g) = 1.49 W/kg

Maximum value of SAR (measured) = 2.28 W/kg



$0 \text{ dB} = 2.28 \text{ W/kg} = 3.58 \text{ dBW/kg}$

Test Laboratory: SGS-SAR Lab

XMDJJ01FY FRS CH1 Back side 0mm with Back Cover

DUT: XMDJJ01FY; Type: Mi Walkie-Talkie; Serial: N/A

Communication System: UID 0, PTT-Analog (0); Frequency: 462.563 MHz; Duty Cycle: 1:1

Medium: MSL450; Medium parameters used: $f = 463$ MHz; $\sigma = 0.981$ S/m; $\epsilon_r = 55.273$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: EX3DV4 - SN3789; ConvF(9.65, 9.65, 9.65); Calibrated: 2017-1-30;
- Sensor-Surface: 2mm (Mechanical Surface Detection), $z = -2.0, 31.0$
- Electronics: DAE4 Sn1374; Calibrated: 2017-8-31
- Phantom: ELI v4.0; Type: ELI; Serial: 1123
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Configuration/Body/Area Scan (7x15x1): Measurement grid: $dx=15$ mm, $dy=15$ mm
Maximum value of SAR (measured) = 2.65 W/kg

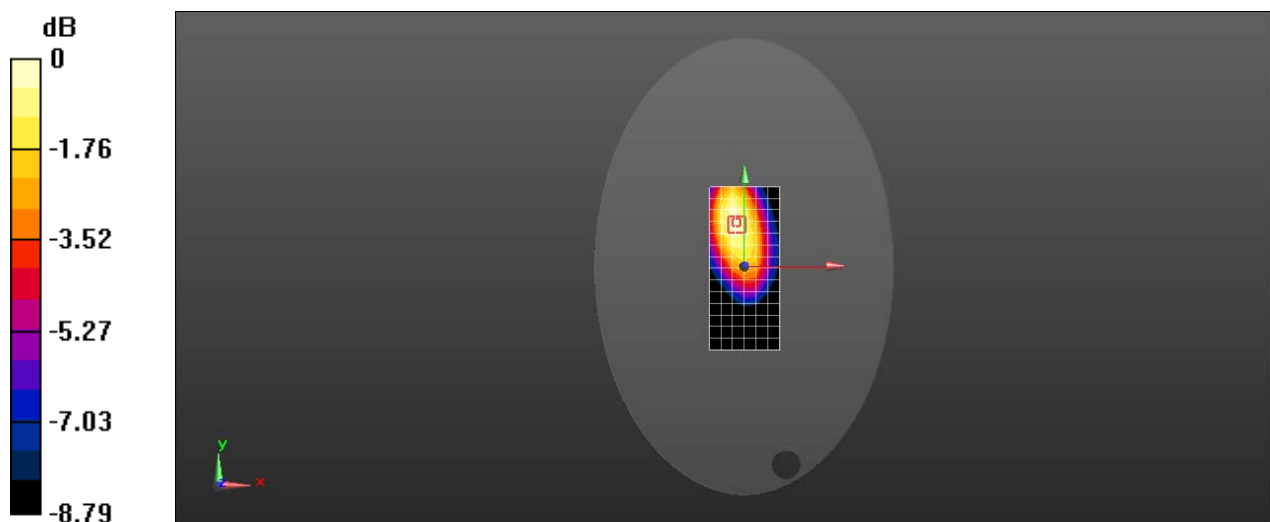
Configuration/Body/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 38.33 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 3.08 W/kg

SAR(1 g) = 2.21 W/kg; SAR(10 g) = 1.6 W/kg

Maximum value of SAR (measured) = 2.67 W/kg



0 dB = 2.67 W/kg = 4.27 dBW/kg



Appendix C

Calibration certificate

1. Dipole
D450V3-SN 1072(2015-11-25)
2. DAE
DAE4 - SN 1374(2017-08-31)
3. Probe
EX3DV4 - SN 3789(2017-1-30)



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **SGS-CN (Auden)**

Certificate No: **D450V3-1072_Nov15**

CALIBRATION CERTIFICATE

Object **D450V3 - SN: 1072**

Calibration procedure(s) **QA CAL-15.v8**
Calibration procedure for dipole validation kits below 700 MHz

Calibration date: **November 25, 2015**

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
Power meter E4419B	GB41293874	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe ET3DV6	SN: 1507	30-Dec-14 (No. ET3-1507_Dec14)	Dec-15
DAE4	SN: 654	08-Jul-15 (No. DAE4-654_Jul15)	Jul-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	04-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: November 25, 2015

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 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 62209-1, "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
- 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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz $\pm$ 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 $\pm$ 0.2) °C	44.0 $\pm$ 6 %	0.89 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	4.57 W/kg $\pm$ 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.778 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.07 W/kg $\pm$ 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 $\pm$ 0.2) °C	56.3 $\pm$ 6 %	0.95 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	4.48 W/kg $\pm$ 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.744 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	2.95 W/kg $\pm$ 17.6 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	57.0 Ω - 4.4 j Ω
Return Loss	- 22.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	53.6 Ω - 9.0 j Ω
Return Loss	- 20.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.356 ns
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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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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	November 25, 2009

DASY5 Validation Report for Head TSL

Date: 25.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1072

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450$ MHz; $\sigma = 0.89$ S/m; $\epsilon_r = 44$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.58, 6.58, 6.58); Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 08.07.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/ $d=15$ mm, $P_{in}=250$ mW/Zoom Scan (7x7x7)/Cube 0:

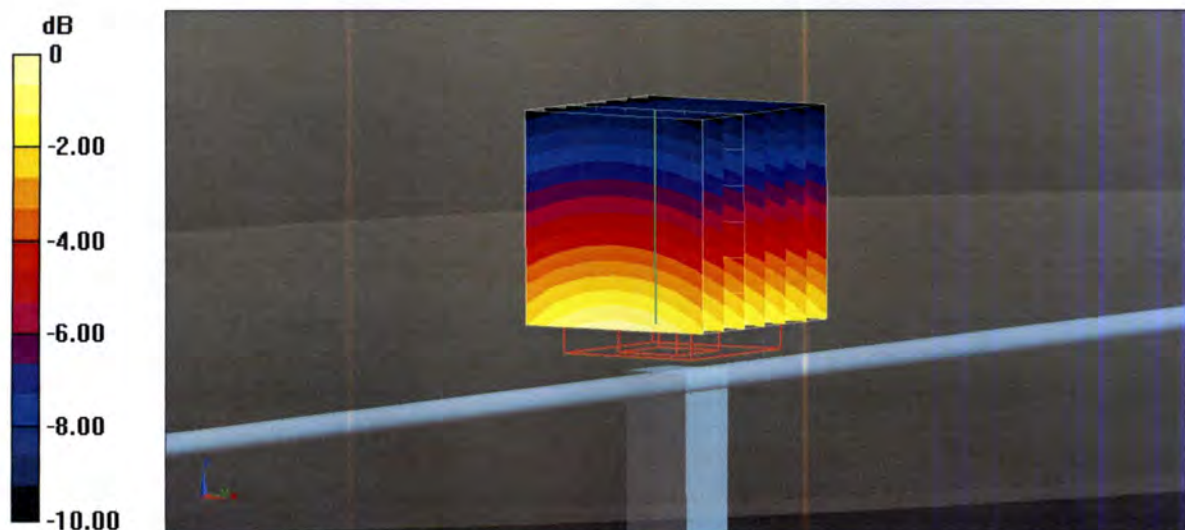
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 39.53 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 1.67 W/kg

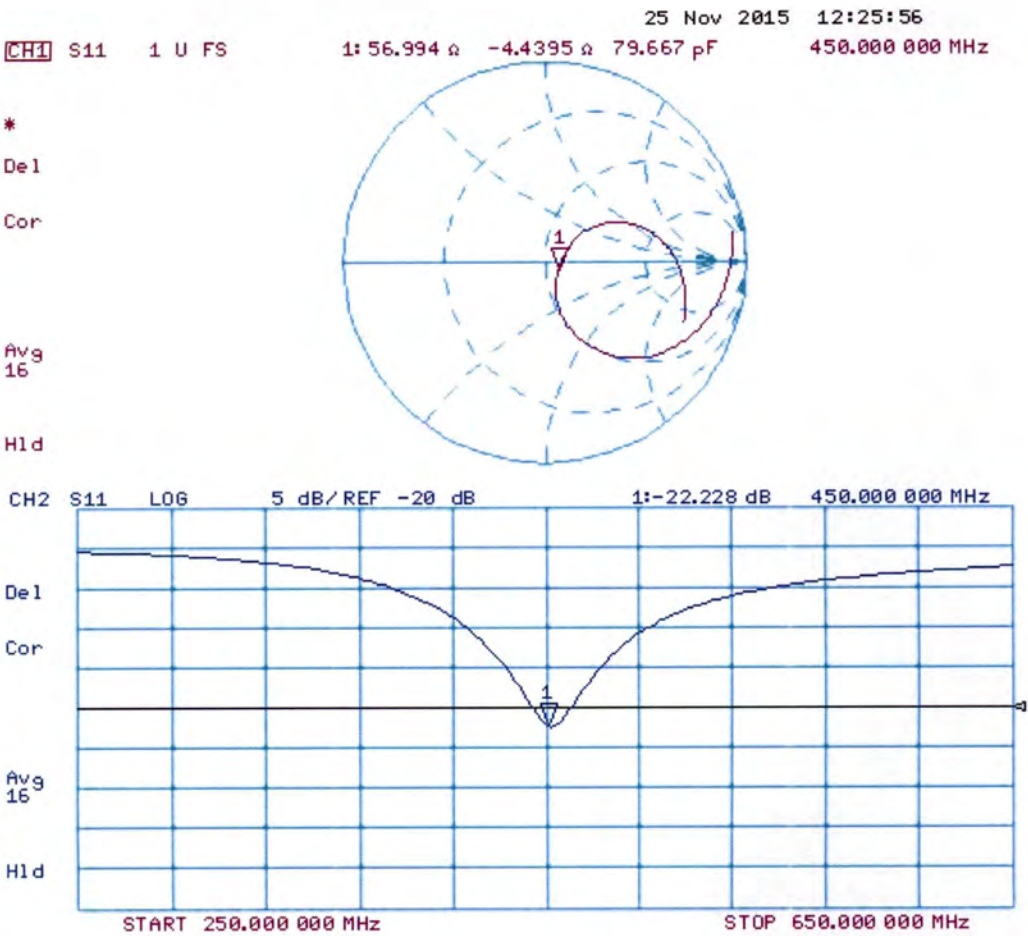
SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.778 W/kg

Maximum value of SAR (measured) = 1.25 W/kg



0 dB = 1.25 W/kg = 0.97 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 25.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1072

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450$ MHz; $\sigma = 0.95$ S/m; $\epsilon_r = 56.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.05, 7.05, 7.05); Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 08.07.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

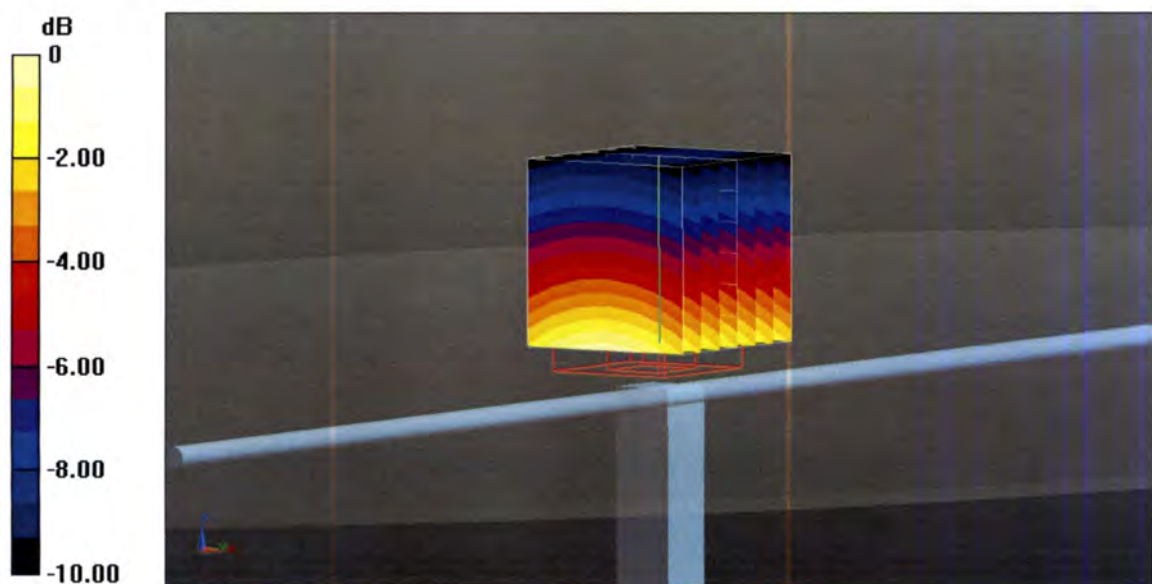
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 36.53 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.81 W/kg

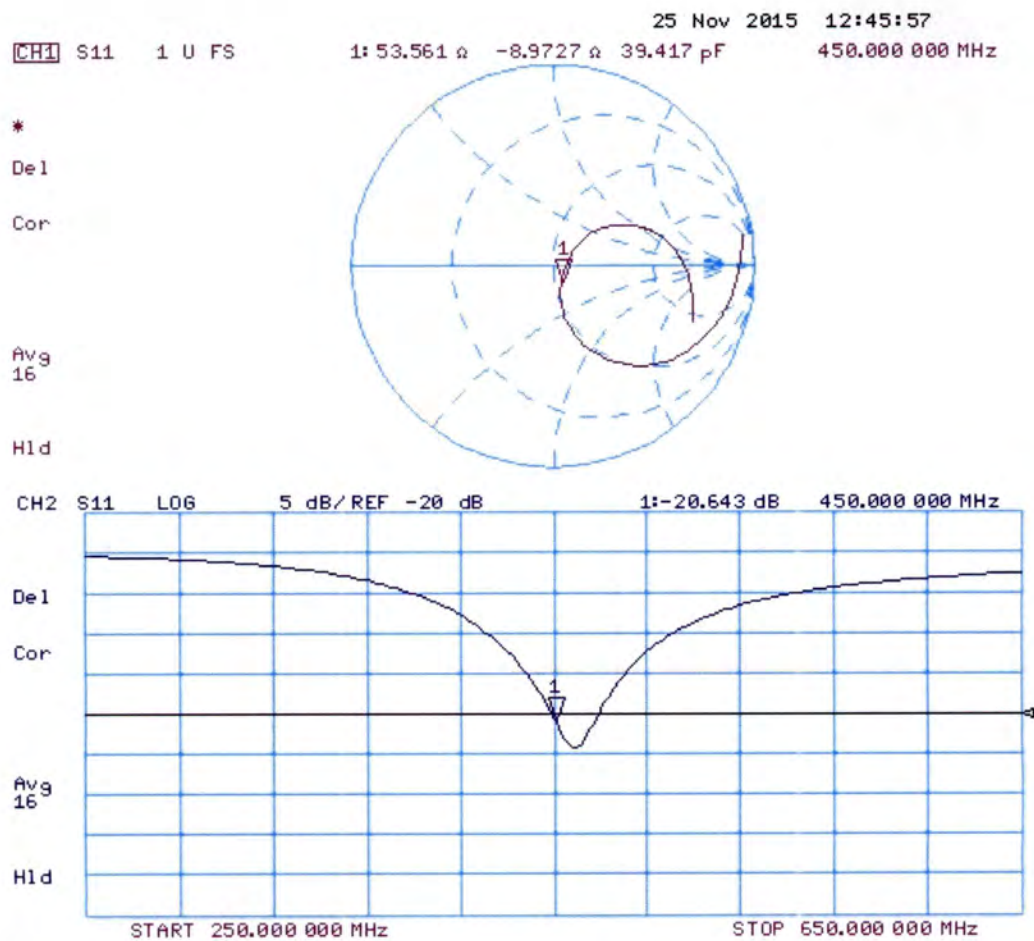
SAR(1 g) = 1.13 W/kg; SAR(10 g) = 0.744 W/kg

Maximum value of SAR (measured) = 1.21 W/kg



0 dB = 1.21 W/kg = 0.83 dBW/kg

Impedance Measurement Plot for Body TSL





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CALIBRATION LABORATORY



中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Client : **SGS(Boce)**

Certificate No: **Z17-97130**

CALIBRATION CERTIFICATE

Object

DAE4 - SN: 1374

Calibration Procedure(s)

FF-Z11-002-01

Calibration Procedure for the Data Acquisition Electronics
(DAEx)

Calibration date:

August 31, 2017

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(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: September 02, 2017

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

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 report provide only calibration results for DAE, it does not contain other performance test results.



In Collaboration with

s p e a g

CALIBRATION LABORATORY

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Http://www.chinattl.cn

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	403.654 $\pm$ 0.15% (k=2)	403.901 $\pm$ 0.15% (k=2)	404.177 $\pm$ 0.15% (k=2)
Low Range	3.98379 $\pm$ 0.7% (k=2)	3.96900 $\pm$ 0.7% (k=2)	3.99103 $\pm$ 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	41.5° $\pm$ 1 °
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Accreditation No.: **SCS 0108**

Client **SGS-CN (Auden)**

Certificate No: **EX3-3789_Jan17**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3789**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6**
Calibration procedure for dosimetric E-field probes

Calibration date: **January 30, 2017**

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
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: February 1, 2017			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			



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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

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 62209-1, "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
- 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"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,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.
- DCP_{x,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
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,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 NORM_{x,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.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

Probe EX3DV4

SN:3789

Manufactured: February 18, 2011
Calibrated: January 30, 2017

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3789

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.44	0.50	0.49	± 10.1 %
DCP (mV) ^B	102.1	99.7	97.2	

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	152.0	±3.3 %
		Y	0.0	0.0	1.0		159.0	
		Z	0.0	0.0	1.0		137.7	

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 Norm X,Y,Z do not affect the E^2 -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:3789

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 ^G	Depth ^G (mm)	Unc (k=2)
450	43.5	0.87	9.49	9.49	9.49	0.15	1.20	± 13.3 %

^C Frequency validity above 300 MHz 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. 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to $\pm 10\%$ 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 $\pm 5\%$. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than $\pm 1\%$ for frequencies below 3 GHz and below $\pm 2\%$ for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3789

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 ^G	Depth ^G (mm)	Unc (k=2)
450	56.7	0.94	9.65	9.65	9.65	0.09	1.20	± 13.3 %

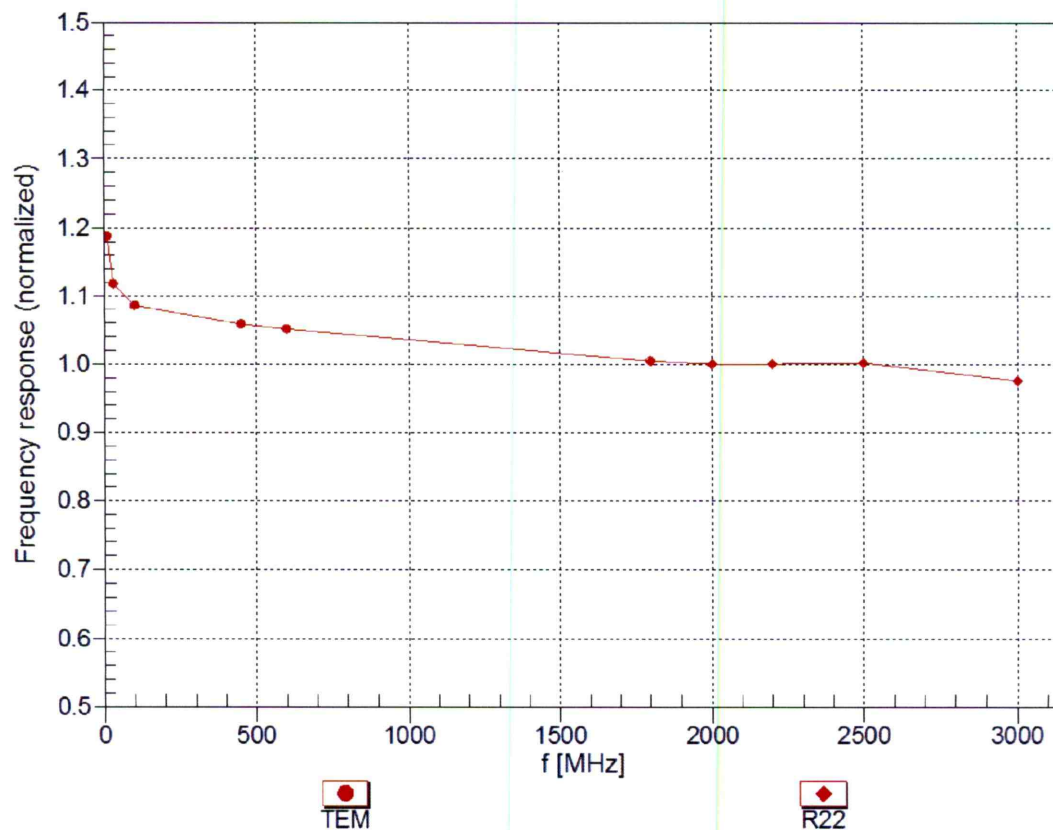
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 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.

^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.

^G 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field

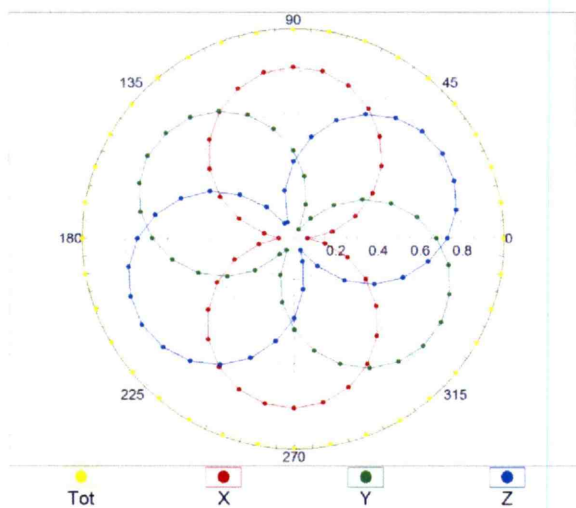
(TEM-Cell:ifi110 EXX, Waveguide: R22)



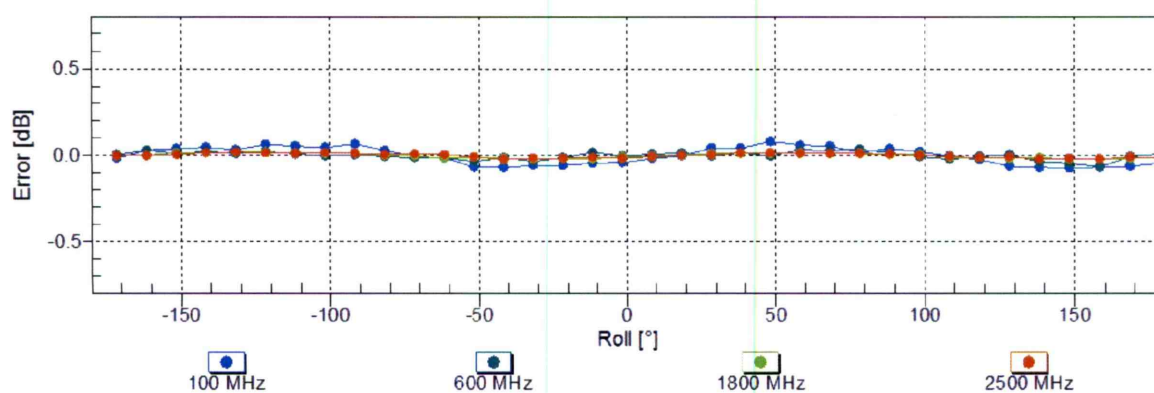
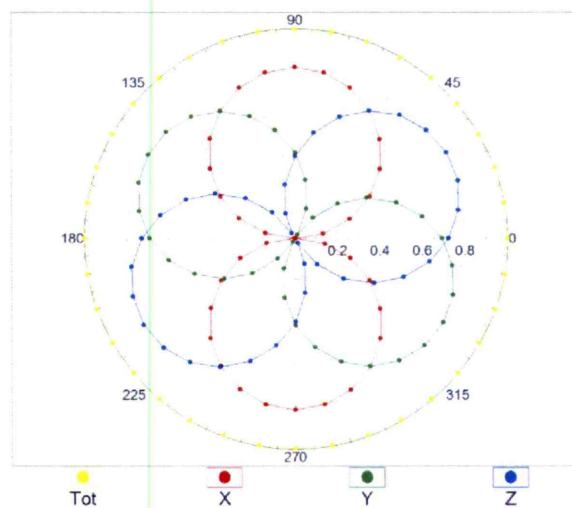
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz, TEM

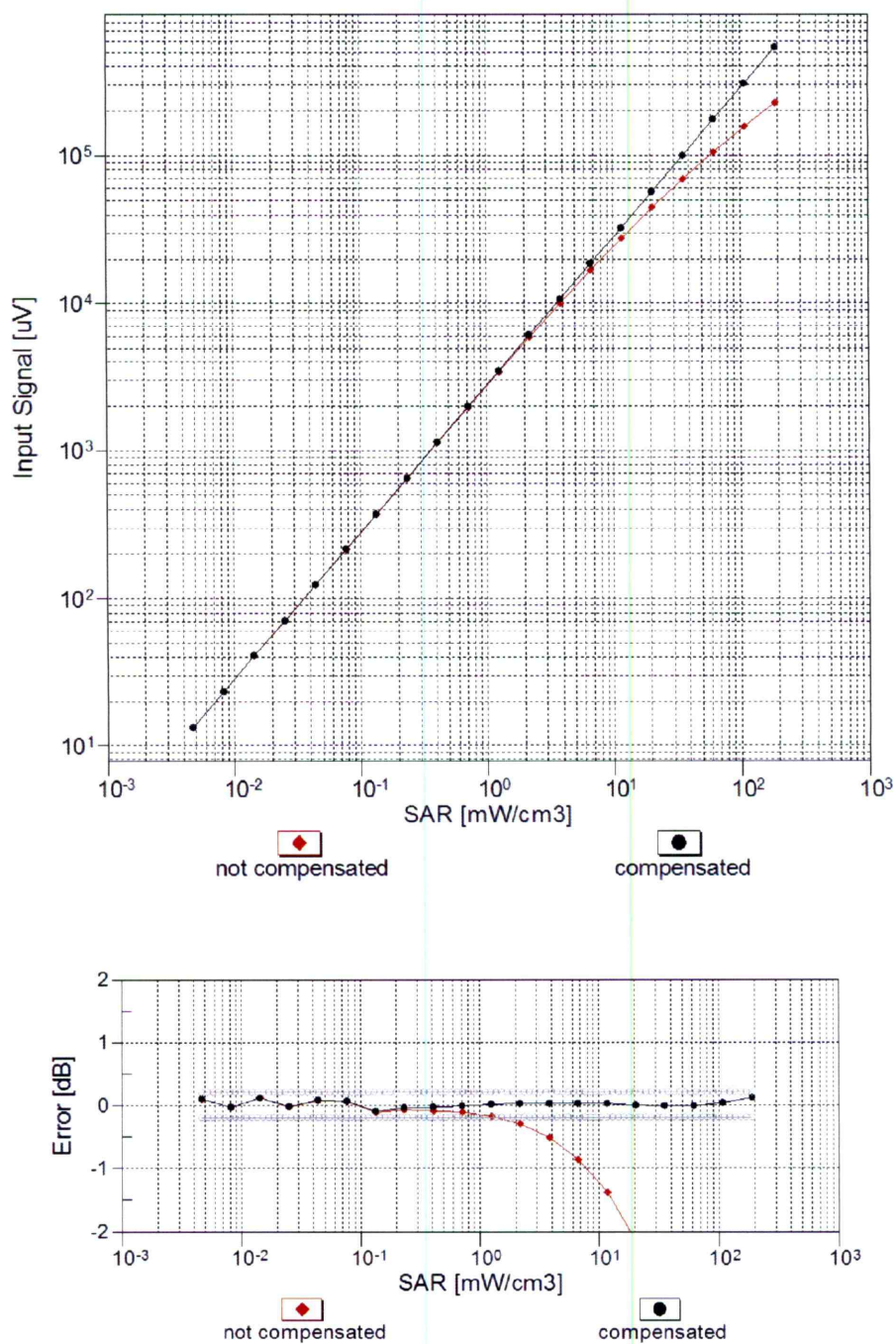


f=1800 MHz, R22



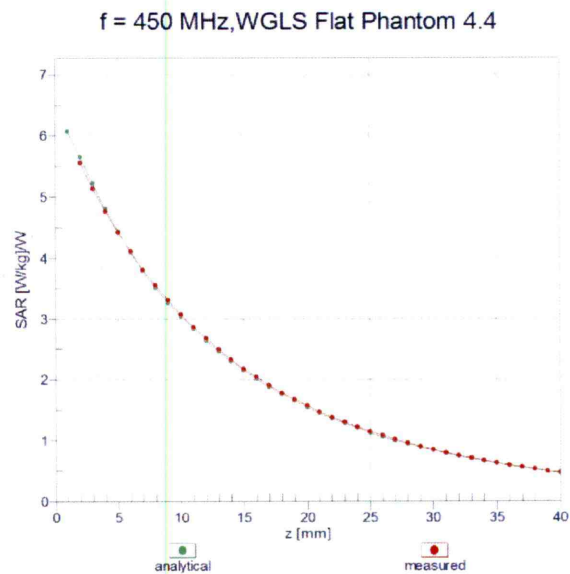
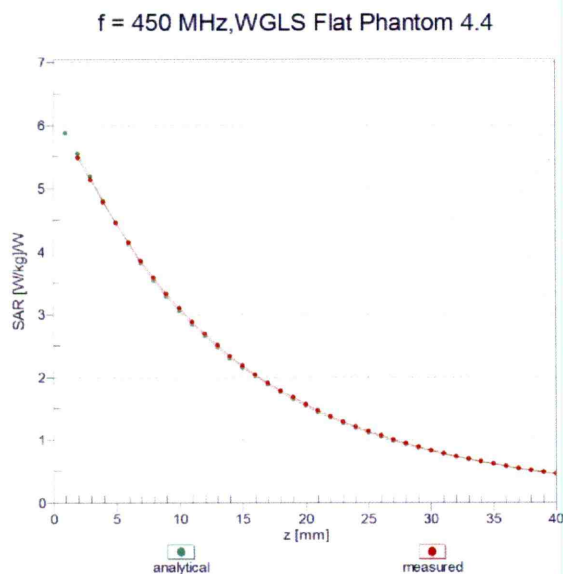
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}} = 1900 \text{ MHz}$)



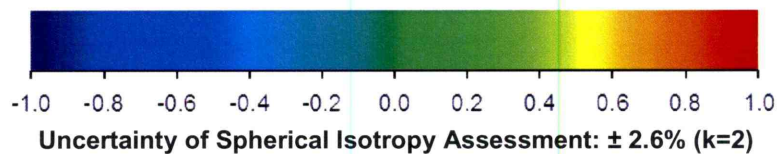
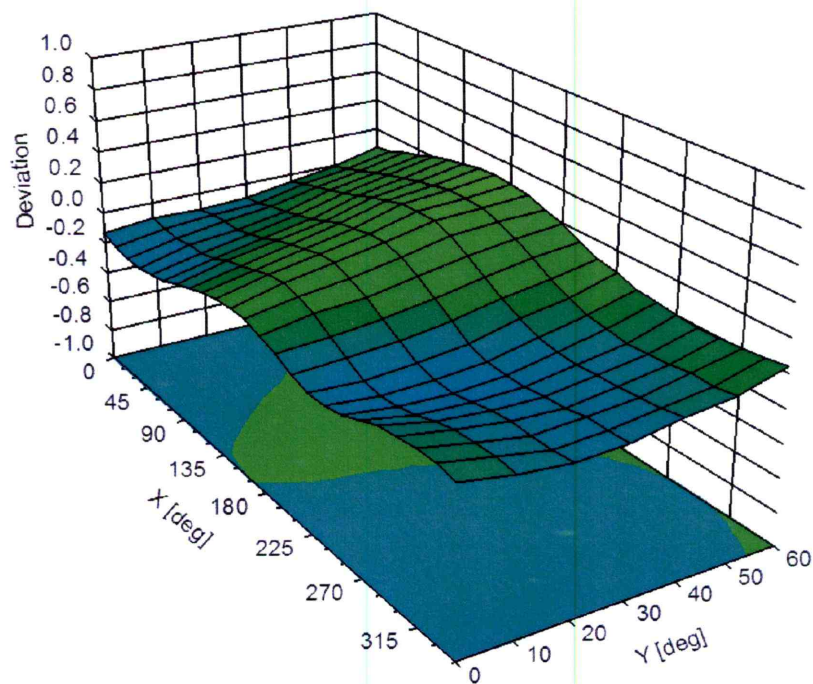
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3789

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	48.4
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	1.4 mm