APPENDIX 3 : Test instruments

1. Equipment used

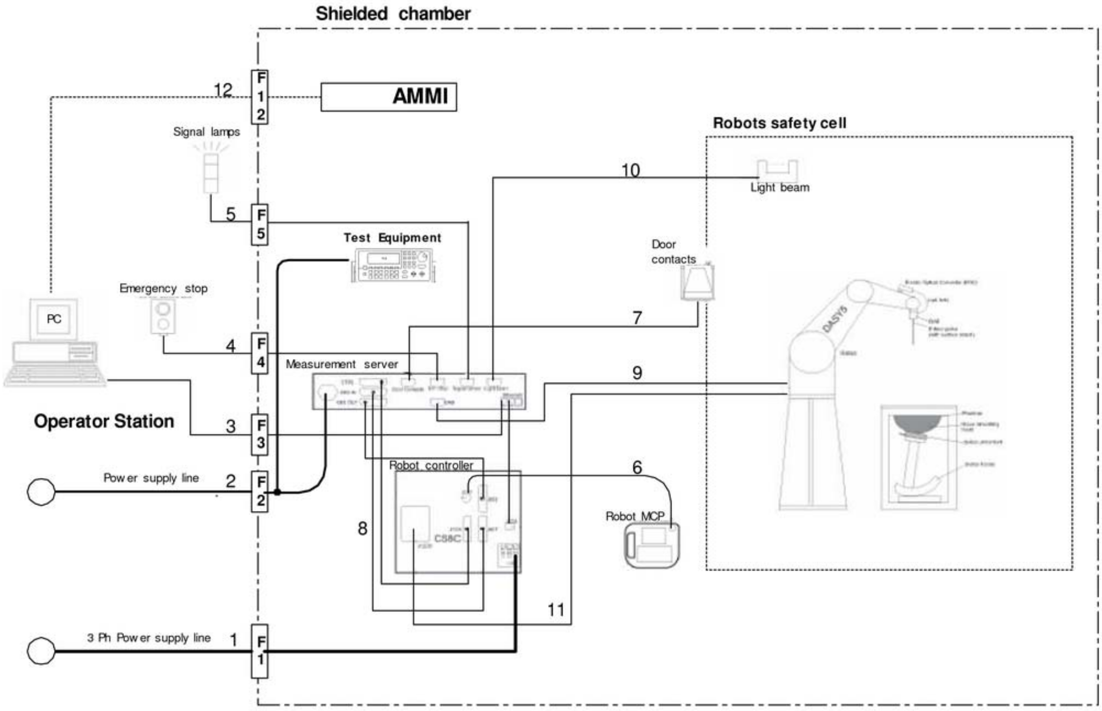
Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MPM-12	Power Meter	Anritsu	ML2495A	0825002	Power Measurement	2010/08/20 * 12
MPSE-17	Power sensor	Anritsu	MA2411B	0738285	Power Measurement	2010/08/20 * 12
MCC-46	Microwave Cable	Murata	MXGS83RK3000	-	Power Measurement	2010/07/26 * 12
MAT-22	Attenuator(10dB) 1-18GHz	Orient Microwave	BX10-0476-00	-	Power Measurement	2011/03/14 * 12
MOS-14	Thermo-Hygrometer	Custom	CTH-201	-	Power Measurement	2011/02/23 * 12
MPM-01	Power Meter	Agilent	E4417A	GB41290639	SAR	2011/02/01 * 12
MPSE-01	Power Sensor	Agilent	E9300B	US40010300	SAR	2011/01/28 * 12
MPSE-03	Power sensor	Agilent	E9327A	US40440576	SAR	2011/02/02 * 12
MAT-15	Attenuator(30dB)	Agilent	8498A	US40010300	SAR	2011/02/16 * 12
MSG-10	Signal Generator	Agilent	N5181A	MY47421098	SAR	2010/09/08 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	MY39500780	SAR	2011/03/10 * 12
MRFA-08	Pre Amplifier	TSJ	TCBP0206	-	SAR	2011/03/27 * 12
MHDC-11	Dual Directional Coupler	Hewlett Packard	778D	16605	SAR	Pre Check
MHDC-12	Dual Directional Coupler	Hewlett Packard	772D	2839A0016	SAR	Pre Check
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	SAR	2010/08/19 * 12
MDPK-01	Dielectric probe kit	Agilent	85070D	702	SAR	2010/10/25 * 36
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	SAR	2010/08/10 * 12
MPB-03	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV3	3507	SAR	2011/03/16 * 12
MRENT-96	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	539	SAR	2010/09/13 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY52.6.1.408	-	SAR	-
MRENT-96	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	539	SAR	2010/09/13 * 12
COTS-MSAR-02	S-Parameter Network Analyzer	Agilent	—	—	SAR	-
MDA-07	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	713	SAR	2010/09/06 * 36
MDA-08	Dipole Antenna	Schmid&Partner Engineering AG	D5GHzV2	1020	SAR	2009/08/19 * 24
MPF-02	2mmOval Flat Phantom ERI 4.0	Schmid&Partner Engineering AG	QD VA 001B (ERI4.0)	1045	SAR	2011/04/01 * 12
MOS-26	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q29	SAR	2011/05/26 * 12

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MOS-10	**Digtal thermometer**	**HANNA**	**Checktemp-2**	**MOS-10**	**SAR**	**2010/08/02 * 12**
MBM-13	**Barometer**	**Sunoh**	**SBR121**	**837**	**SAR**	**2011/03/14 * 36**
MSL 3-6GHz					**Daily check**	**Target value ± 5 or 10%**
MSL 2450MHz					**Daily check**	**Target value ± 5%**
SAR room					**Daily check Ambient Noise<0.012W/kg**	

The expiration date of the calibration is the end of the expired month.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

2. Configuration and peripherals



The DASY5 system for performing compliance tests consist of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
   An arm extension for accommodating the data acquisition electronics (DAE).

2. An isotropic field probe optimized and calibrated for the targeted measurement.

3. A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

4. The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.
   The EOC is connected to the measurement server.

5. The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.

6. The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

7. A computer running WinXP and the DASY5 software.

8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

9. The phantom, the device holder and other accessories according to the targeted measurement.

3. System components

EX3DV3 Probe Specification

Construction:
Symmetrical design with triangular core
Built-in shielding against static charges
PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)

Calibration(S/N 3507):
Basic Broad Band Calibration in air : 10-3000 MHz

Frequency:
10 MHz to > 6GHz; Linearity: +/-0.2 dB(30 MHz to 3 GHz)

Directivity:
+/-0.3 dB in HSL (rotation around probe axis)
+/-0.5 dB in tissue material (rotation normal probe axis)

Dynamic Range:
10uW/g to > 100 mW/g;Linearity: +/-0.2 dB(noise: typically < 1uW/g)

Dimensions:
Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5mm (Body: 12 mm)
Typical distance from probe tip to dipole centers: 1 mm

Application:
Highprecision dosimetric measurement in any exposure scenario
(e.g., very strong gradient fields).Only probe which enables compliance
testing for frequencies up to 6GHz with precision of better 30%.

EX3DV3 E-field Probe

<2mm Flat phantom ERI4.0>

Description
Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles.

Shell Thickness
2.0 ± 0.2 mm (sagging: <1%)

Filling Volume
approx. 30 liters

Dimensions

Major ellipse axis	: 600 mm
Minor axis	: 400 mm

Compatibilities
- Standard: IEC 62209 Part II (Draft 0.9 and higher)
- Software release: DASY 4.5 or higher
- SPEAG standard phantom table
- all SPEAG dosimetric probes and dipoles

Device Holder
For this measurement, the urethane foam was used as device holder.

4. Test system specifications

Robot TX60L

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manuafacture	:	Stäubli Unimation Corp. Robot Model: TX60L

DASY5 Measurement server

Features	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
Dimensions	:	(L x W x H): 440 x 241 x 89 mm
Manufacture	:	Schimid & Partner Engineering AG

Data Acquisition Electronic (DAE)

Features	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) 2 step probe touch detector for mechanical surface detection and emergency robot stop (not in -R version)
Measurement Range	:	1 µV to > 200 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset voltage	:	< 1 µV (with auto zero)
Input Resistance	:	200 MΩ
Battery Power	:	> 10 h of operation (with two 9 V battery)
Dimension	:	60 x 60 x 68 mm
Manufacture	:	Schimid & Partner Engineering AG

Software

Item	:	Dosimetric Assesment System DASY5
Type No.	:	SD 000 401A, SD 000 402A
Software version No.	:	DASY52, Version 52.6 (1)
Manufacture / Origin	:	Schimid & Partner Engineering AG

E-Field Probe

Model	:	EX3DV3
Serial No.	:	3507
Construction	:	Symmetrical design with triangular core
Frequency	:	10 MHz to 6 GHz
Linearity	:	+/-0.2 dB (30 MHz to 3 GHz)
Manufacture	:	Schimid & Partner Engineering AG

Phantom

Type	:	SAM Twin Phantom V4.0
Shell Material	:	Fiberglass
Thickness	:	2.0 +/-0.2 mm
Volume	:	Approx. 25 liters
Manufacture	:	Schimid & Partner Engineering AG

Type	:	2mm Flat phantom ERI4.0
Shell Thickness	:	2.0 ± 0.2 mm (sagging: <1%)
Filling Volume	:	approx. 30 liters
Dimensions	:	Major ellipse axis: 600 mm Minor axis: 400 mm
Manufacture	:	Schimid & Partner Engineering AG

5. Simulated Tissues Composition

5-a 5GHz

Ingredient	MiXTURE(%) Muscle 5800MHz
Water	78.0
Mineral Oil	11.0
Emulsifiers	9.0
Additives and salt	2.0

5-b 2450MHz

Ingredient	MIXTURE(%) Muscle 2450MHz
Water	68.64
DGMBE	31.37

Note:DGMBE(Diethylenglycol-monobuthyl ether)

6. Simulated Tissue Liquid Parameter confirmation

The dielectric parameters were checked prior to assessment using the HP85070D dielectric probe kit.
The dielectric parameters measurement are reported in each correspondent section.

6-a Decision on Simulated Tissues

In the current standards (e.g., IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given at 3000MHz and 5800MHz. As an intermediate solution, dielectric parameters for the frequencies between 5000 to 5800 MHz were obtained using linear interpolation.
Therefore the dielectric parameters of 5200MHz and 5300MHz(The frequency for the validation) were decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	ε r	σ [mho/m]	ε r	σ [mho/m]	
3000	38.5	2.40	52.0	2.73	Standard
5800	35.3	5.27	48.2	6.00	Standard
5000	36.2	4.45	49.3	5.07	Interpolated
5100	36.1	4.55	49.1	5.18	Interpolated
5200	36.0	4.66	49.0	5.30	Interpolated
5300	35.9	4.76	48.9	5.42	Interpolated
5400	35.8	4.86	48.7	5.53	Interpolated
5500	35.6	4.96	48.6	5.65	Interpolated
5600	35.5	5.07	48.5	5.77	Interpolated
5700	35.4	5.17	48.3	5.88	Interpolated

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 3000 to 5800MHz.

6-b Muscle 5GHz

Type of liquid : **Muscle 5GHz**
Ambient temperature (deg.c.) : **25.0 (5-Jul and 8-Jul)**
Relative Humidity (%) : **47 (5-Ju1), 44(8-Jul)**
Liquid depth (cm) : **15.0**

DIELECTRIC PARAMETERS MEASUREMENT RESULTS								
Date	Frequency [MHz]	Liquid Temp [deg.c]		Parameters	Target Value*1	Measured	Deviation [%]	Limit [%]
		Before	After					
5-Jul	5200	24.5	24.5	Relative Permittivity εr	49.0	46.6	-4.9	+/-5
				Coductivity σ [mho/m]	5.30	5.26	-0.8	+/-5
5-Jul	5300	24.5	24.5	Relative Permittivity εr	48.9	46.5	-4.9	+/-5
				Coductivity σ [mho/m]	5.42	5.4	-0.4	+/-5
8-Jul	5800	24.5	24.5	Relative Permittivity εr	48.2	46.0	-4.6	+/-5
				Coductivity σ [mho/m]	6.00	6.28	4.7	+/-5

*1 The target values are a parameter defined in FCC OET 65.

DIELECTRIC PARAMETERS MEASUREMENT RESULTS								
Date	Frequency [MHz]	Liquid Temp [deg.c]		Parameters	Target Value*2	Measured	Deviation [%]	Limit [%] *3
		Before	After					
5-Jul	5200	23.0	23.0	Relative Permittivity εr	48.2	46.6	-3.3	+/-6
				Coductivity σ [mho/m]	5.46	5.26	-3.7	+/-6
8-Jul	5800	23.5	23.5	Relative Permittivity εr	46.9	46.0	-1.9	+/-6
				Coductivity σ [mho/m]	6.21	6.28	1.1	+/-6

*2 The target values are the calibrated dipole MSL parameters. (D5GHzV2 SN:1020, measured Body TSL parameters)
*3 The limit is for deviation provided by manufacture.

6-c Muscle 2450 MHz

Type of liquid : **Muscle 2450 MHz**
Ambient temperature (deg.c.) : **25.0**
Relative Humidity (%) : **45**
Liquid depth (cm) : **15.0**

DIELECTRIC PARAMETERS MEASUREMENT RESULTS								
Date	Frequency	Liquid Temp [deg.c]		Parameters	Target Value *1	Measured	Deviation [%]	Limit [%]
		Before	After					
4-Jul	2450	24.5	24.5	Relative Permittivity εr	52.7	50.4	-4.4	+/-5
				Coductivity σ [mho/m]	1.95	2.03	4.1	+/-5
4-Jul	2412	24.5	24.5	Relative Permittivity εr	52.7	50.7	-3.8	+/-5
				Coductivity σ [mho/m]	1.95	1.96	0.5	+/-5
4-Jul	2437	24.5	24.5	Relative Permittivity εr	52.7	50.5	-4.2	+/-5
				Coductivity σ [mho/m]	1.95	2.01	3.1	+/-5
4-Jul	2462	24.5	24.5	Relative Permittivity εr	52.7	50.3	-4.6	+/-5
				Coductivity σ [mho/m]	1.95	2.04	4.6	+/-5

*1 The target values is a parameter defined in FCC OET 65.

DIELECTRIC PARAMETERS MEASUREMENT RESULTS								
Date	Frequency	Liquid Temp [deg.c]		Parameters	Target Value *2	Measured	Deviation [%]	Limit [%] *3
		Before	After					
4-Jul	2450	24.5	24.5	Relative Permittivity εr	52.5	50.4	-4.0	+/-6
				Coductivity σ [mho/m]	1.95	2.03	4.1	+/-6

*2 The target value is the calibrated dipole Body TSL parameters. (D2450V2 SN:713,Measured Body TSL parameters)
*3 The limit is for deviation provided by manufacture.

7. System validation data

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of +/-10%. The validation results are in the table below. Please refer to APPENDIX3.

System validation of 5GHz

Type of liquid	:	**Head 5GHz**
Ambient temperature (deg.c.)	:	**25.0 (5-Jul and 8-Jul)**
Relative Humidity (%)	:	**47 (5-Ju1), 44(8-Jul)**
Dipole	:	**D5GHzV2 SN:1020**
Power	:	**100mW**

SYSTEM PERFORMANCE CHECK											
Liquid (Muscle 5100-5800 MHz)								System dipole validation target & measured			
Date	Frequency	Liquid Temp [deg.c.]		Relative Permittivity εr		Conductivity σ [mho/m]		SAR 1g [W/kg]		Deviation [%]	Limit [%]
		Before	After	Target*1	Measured	Target*1	Measured	Target*2	Measured		
5-Jul	5200	24.5	24.5	48.2	46.6	5.43	5.40	7.75	7.41	-4.4	+/-10
8-Jul	5800	24.5	24.5	46.9	46.0	6.16	6.28	7.13	7.70	8.0	+/-10

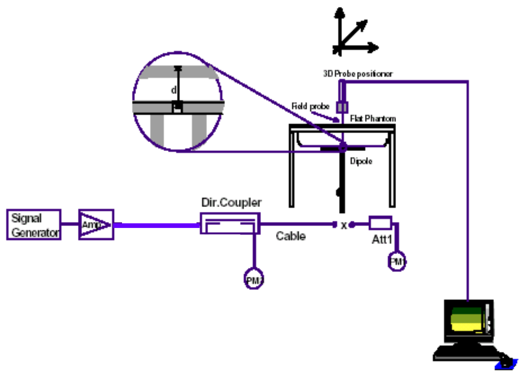
*1 The target value is the calibrated dipole Body TSL parameters. (D5GHzV2 SN:713)
*2 The target value is 1/10 values of 1g SAR (normalizes to 1W) in manufacturer calibrated dipole (D5GHzV2 SN:713),because the forward power of the dipole was checked with 100mW.
Note: Please refer to Attachment for the result representation in plot format

System validation of 2450MHz

Type of liquid	:	**Muscle 2450MHz**
Frequency	:	**2450MHz**
Ambient temperature (deg.c.)	:	**25.0**
Relative Humidity (%)	:	**45**
Dipole	:	**D2450V2 SN:713**
Power	:	**250mW**

SYSTEM PERFORMANCE CHECK										
Date	Liquid (Body 2450MHz)						System dipole validation target & measured			
	Liquid Temp [deg.c.]		Relative Permittivity εr		Conductivity σ [mho/m]		SAR 1g [W/kg]		Deviation [%]	Limit [%]
	Before	After	Target*1	Measured	Target*1	Measured	Target*2	Measured		
4-Jul	24.5	24.5	52.5	50.4	1.95	2.03	13.0	14.1	8.6	+/-10

*1 The target value is the calibrated dipole Body TSL parameters. (D2450V2 SN:713)
*2 The target value is 1/4 values of 1g SAR (normalizes to 1W) in manufacturer calibrated dipole (D2450V2 SN:713),because the forward power of the dipole was checked with 250mW.
Note: Please refer to Attachment for the result representation in plot format



Test system for the system performance check setup diagram

8. Validation uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[6] and is given in the following Table.

Error Description	Uncertainty value ± %	Probability distribution	divisor	(ci) 1g	Standard Uncertainty (1g)	vi or veff
Measurement System						
Probe calibration	±6.55	Normal	1	1	±6.55	∞
Axial isotropy of the probe	±4.7	Rectangular	√3	1	±2.7	∞
Spherical isotropy of the probe	±9.6	Rectangular	0	0	0	∞
Boundary effects	±1.0	Rectangular	√3	1	±1.2	∞
Probe linearity	±4.7	Rectangular	√3	1	±2.7	∞
Detection limit	±1.0	Rectangular	√3	1	±0.6	∞
Readout electronics	±0.3	Normal	1	1	±0.3	∞
Response time	0	Rectangular	√3	1	0	∞
Integration time	0	Rectangular	√3	1	0	∞
RF ambient Noise	±1.0	Rectangular	√3	1	±1.7	∞
RF ambient Reflections	±1.0	Rectangular	√3	1	±1.7	∞
Probe Positioner	±0.8	Rectangular	√3	1	±0.5	∞
Probe positioning	±6.7	Rectangular	√3	1	±3.9	∞
Algorithms for Max.SAR Eval.	±2.0	Rectangular	√3	1	±1.2	∞
Dipole						
Deviation of exp.dipole	±5.5	Rectangular	√3	1	±3.2	∞
Dipole Axis to Liquid Distance	±2.0	Rectangular	√3	1	±1.2	∞
Input power and SAR drift meas.	±3.4	Rectangular	√3	1	±2.7	∞
Phantom and Setup						
Phantom uncertainty	±4.0	Rectangular	√3	1	±2.3	∞
SAR correction	±1.9	Rectangular	√3	1	±1.1	
Liquid conductivity (target)	±5.0	Rectangular	√3	0.78	±2.3	∞
Liquid conductivity (meas.)	±5.0	Rectangular	1	0.26	±1.3	∞
Liquid permittivity (target)	±5.0	Rectangular	√3	0.78	±2.3	∞
Liquid permittivity (meas.)	±5.0	Rectangular	1	0.23	±1.2	∞
Combined Standard Uncertainty					**±11.01**	
Expanded Uncertainty (k=2)					**±22.02**	

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Body/ 5200MHz System Validation / Dipole5GHz / Forward Conducted Power : 100mW

Dipole 5800 MHz; Type: D5GHzV2 SN:1020

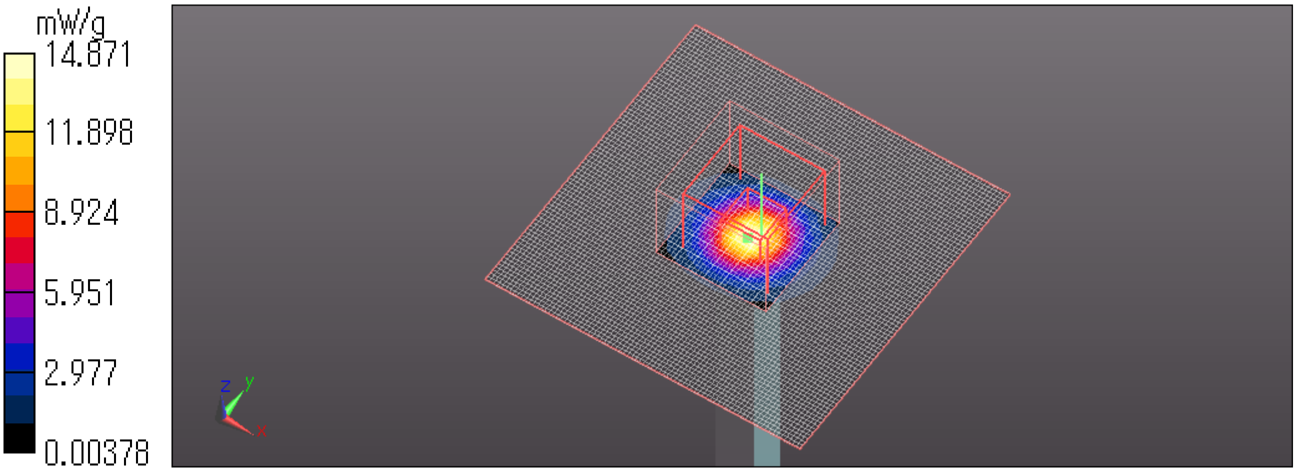
Communication System: WLAN 11a/b/g/n ; Communication System Band: 11a/n; Frequency: 5200 MHz;;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.26 mho/m; ε_r = 46.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:
Probe: EX3DV3 - SN3507; ConvF(4.36, 4.36, 4.36);
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn539; Calibrated: 2010/09/13
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.6 (1);

/Area Scan (81x81x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.965 mW/g

/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 60.056 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 28.679 W/kg

SAR(1 g) = 7.41 mW/g; SAR(10 g) = 2.07 mW/g
Maximum value of SAR (measured) = 14.871 mW/g

Date: 2011/07/05
Ambient Temp. : 24.5 degree.C. Liquid Temp.; 24.8degree.C.



Body/ 5800MHz System Validation / Dipole5GHz / Forward Conducted Power : 100mW

Dipole 5800 MHz; Type: D5GHzV2 SN:1020

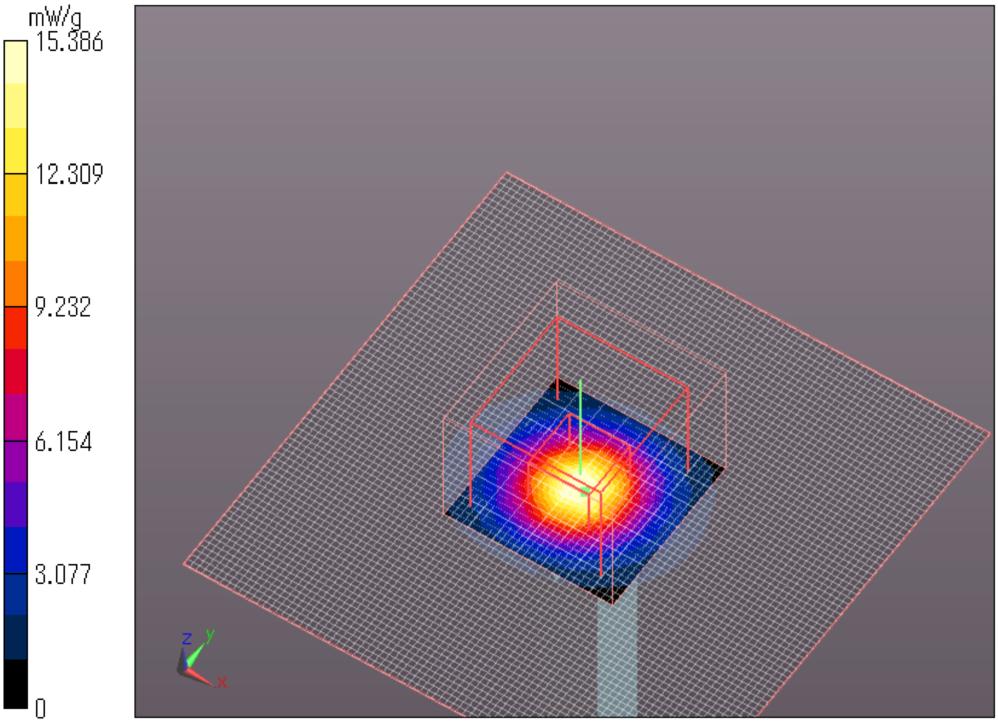
Communication System: WLAN 11a/b/g/n ; Communication System Band: 11a/n; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.28 mho/m; εr = 46.0; ρ = 1000 kg/m3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:
Probe: EX3DV3 - SN3507; ConvF(3.69, 3.69, 3.69);
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn539; Calibrated: 2010/09/13
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.6 (1);

/Area Scan (81x81x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.975 mW/g

/Zoom Scan (4x4x2.5mm), dist=2mm 2 2 (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 60.387 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 33.351 W/kg

SAR(1 g) = 7.7 mW/g; SAR(10 g) = 2.16 mW/g
Maximum value of SAR (measured) = 15.386 mW/g

Date: 2011/07/08
Ambient Temp. : 24.5 degree.C. Liquid Temp.; 24.5 degree.C.



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Body/ 2450MHz System Validation / Dipole2.4GHz / Forward Conducted Power : 250mW

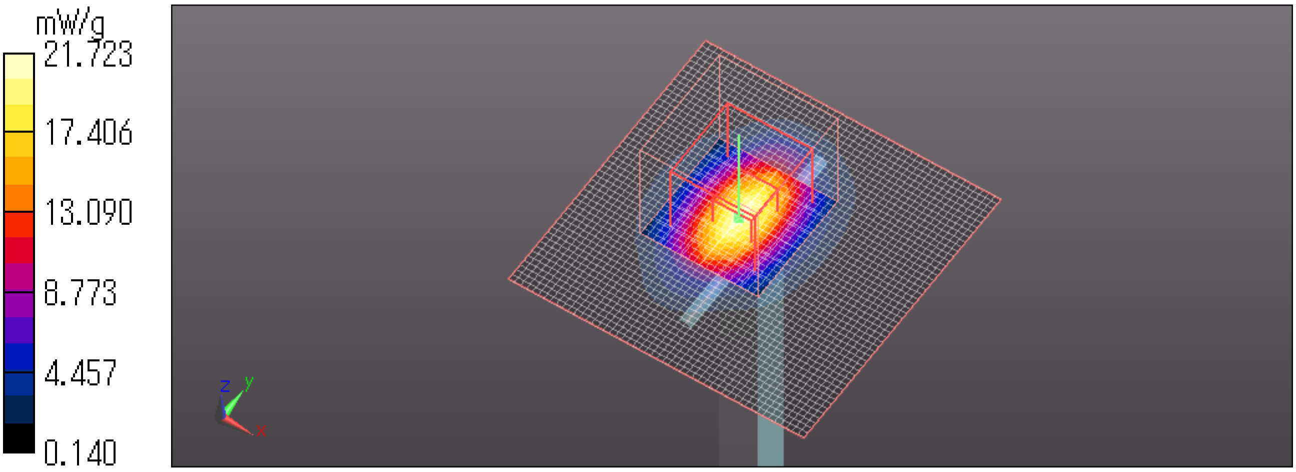
Communication System: WLAN 11a/b/g/n ; Communication System Band: WLAN 11b/g/n; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 2.03 mho/m; ε_r = 50.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:
Probe: EX3DV3 - SN3507; ConvF(7.61, 7.61, 7.61);
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn539; Calibrated: 2010/09/13
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.6 (1);

/Area Scan (51x51x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 21.495 mW/g

/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.5 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 29.546 W/kg

SAR(1 g) = 14.1 mW/g; SAR(10 g) = 6.48 mW/g
Maximum value of SAR (measured) = 21.723 mW/g

Date: 2011/07/04
Ambient Temp. : 24.5 degree.C. Liquid Temp.; 24.5 degree.C.



9. System Validation Dipole (D5GHzV2,S/N: 1020)

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **UL Japan (PTT)**

Certificate No: **D5GHzV2-1020_Aug09**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1020
Calibration procedure(s)	QA CAL-22.v1 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	August 19, 2009
Condition of the calibrated item	In Tolerance

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 EPM-442A	GB37480704	08-Oct-08 (No. 217-00898)	Oct-09
Power sensor HP 8481A	US37292783	08-Oct-08 (No. 217-00898)	Oct-09
Reference 20 dB Attenuator	SN: 5086 (20g)	31-Mar-09 (No. 217-01025)	Mar-10
Type-N mismatch combination	SN: 5047.2 / 06327	31-Mar-09 (No. 217-01029)	Mar-10
Reference Probe EX3DV4	SN: 3503	11-Mar-09 (No. EX3-3503_Mar09)	Mar-10
DAE4	SN: 601	07-Mar-09 (No. DAE4-601_Mar09)	Mar-10

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-07)	In house check: Oct-09
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: August 19, 2009

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

Certificate No: D5GHzV2-1020_Aug09 Page 1 of 14

Calibration Laboratory of
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

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:

a) IEC Std 62209 Part 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", Draft Version 0.9, December 2004
b) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

c) 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.

Measurement Conditions

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

DASY Version	DASY5	V5.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Area Scan resolution	dx, dy = 10 mm	
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 2.5 mm	
Frequency	5200 MHz ± 1 MHz 5500 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	4.65 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	condition	
SAR measured	100 mW input power	7.70 mW / g
SAR normalized	normalized to 1W	77.0 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**77.1 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.19 mW / g
SAR normalized	normalized to 1W	21.9 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**21.9 mW / g ± 19.5 % (k=2)**

[1] Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities

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Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.6 ± 6 %	4.93 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	condition	
SAR measured	100 mW input power	8.07 mW / g
SAR normalized	normalized to 1W	80.7 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**80.7 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 mW / g
SAR normalized	normalized to 1W	22.8 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**22.8 mW / g ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	5.20 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	condition	
SAR measured	100 mW input power	7.49 mW / g
SAR normalized	normalized to 1W	74.9 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**74.7 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.12 mW / g
SAR normalized	normalized to 1W	21.2 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**21.1 mW / g ± 19.5 % (k=2)**

[1] Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

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Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.2 ± 6 %	5.46 mho/m ± 6 %
Body TSL temperature during test	(22.5 ± 0.2) °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	condition	
SAR measured	100 mW input power	7.75 mW / g
SAR normalized	normalized to 1W	77.5 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**77.2 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.16 mW / g
SAR normalized	normalized to 1W	21.6 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**21.5 mW / g ± 19.5 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.4 ± 6 %	5.85 mho/m ± 6 %
Body TSL temperature during test	(22.5 ± 0.2) °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	condition	
SAR measured	100 mW input power	8.25 mW / g
SAR normalized	normalized to 1W	82.5 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**82.1 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.27 mW / g
SAR normalized	normalized to 1W	22.7 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**22.6 mW / g ± 19.5 % (k=2)**

[1] Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities

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Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 6 %	6.21 mho/m ± 6 %
Body TSL temperature during test	(22.5 ± 0.2) °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	condition	
SAR measured	100 mW input power	7.13 mW / g
SAR normalized	normalized to 1W	71.3 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**71.0 mW / g ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.96 mW / g
SAR normalized	normalized to 1W	19.6 mW / g
SAR for nominal Body TSL parameters [1]	normalized to 1W	**19.5 mW / g ± 19.5 % (k=2)**

[1] Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities

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Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.7 Ω - 9.9 jΩ
Return Loss	-19.9 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	49.5 Ω - 3.4 jΩ
Return Loss	-29.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.0 Ω - 1.3 jΩ
Return Loss	-24.8 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	49.2 Ω - 9.3 jΩ
Return Loss	-20.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	49.5 Ω - 1.7 jΩ
Return Loss	-34.9 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	55.5 Ω - 0.2 jΩ
Return Loss	-25.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns

After long term use with 40 W 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	February 05, 2004

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DASY5 Validation Report for Head TSL

Date/Time: 13.08.2009 14:59:05

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1020

Communication System: CW-5GHz; Frequency: 5200 MHzFrequency: 5500 MHzFrequency: 5800 MHz;
Duty Cycle: 1:1
Medium: HSL 3-6 GHz
Medium parameters used: f = 5200 MHz; σ = 4.65 mho/m; ε_r = 36.2; ρ = 1000 kg/m^3 Medium parameters used: f = 5500 MHz; σ = 4.93 mho/m; ε_r = 35.6; ρ = 1000 kg/m^3 Medium parameters used: f = 5800 MHz; σ = 5.2 mho/m; ε_r = 35.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.36, 5.36, 5.36)ConvF(4.85, 4.85, 4.85)ConvF(4.74, 4.74, 4.74); Calibrated: 11.03.2009
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.8 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 61.5 V/m; Power Drift = 0.086 dB
Peak SAR (extrapolated) = 30.1 W/kg
SAR(1 g) = 7.7 mW/g; SAR(10 g) = 2.19 mW/g
Maximum value of SAR (measured) = 16 mW/g

d=10mm, Pin=100mW, f=5500 MHz 2/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 62 V/m; Power Drift = 0.094 dB
Peak SAR (extrapolated) = 32.8 W/kg
SAR(1 g) = 8.07 mW/g; SAR(10 g) = 2.28 mW/g
Maximum value of SAR (measured) = 16.9 mW/g

d=10mm, Pin=100mW, f=5800 MHz 2/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 59 V/m; Power Drift = 0.090 dB
Peak SAR (extrapolated) = 31.9 W/kg
SAR(1 g) = 7.49 mW/g; SAR(10 g) = 2.12 mW/g

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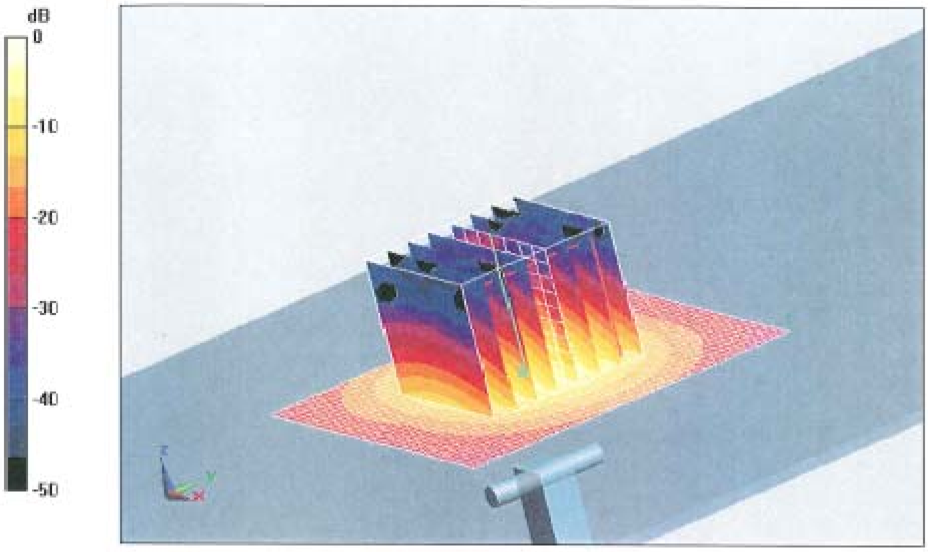

0 dB = 16mW/g

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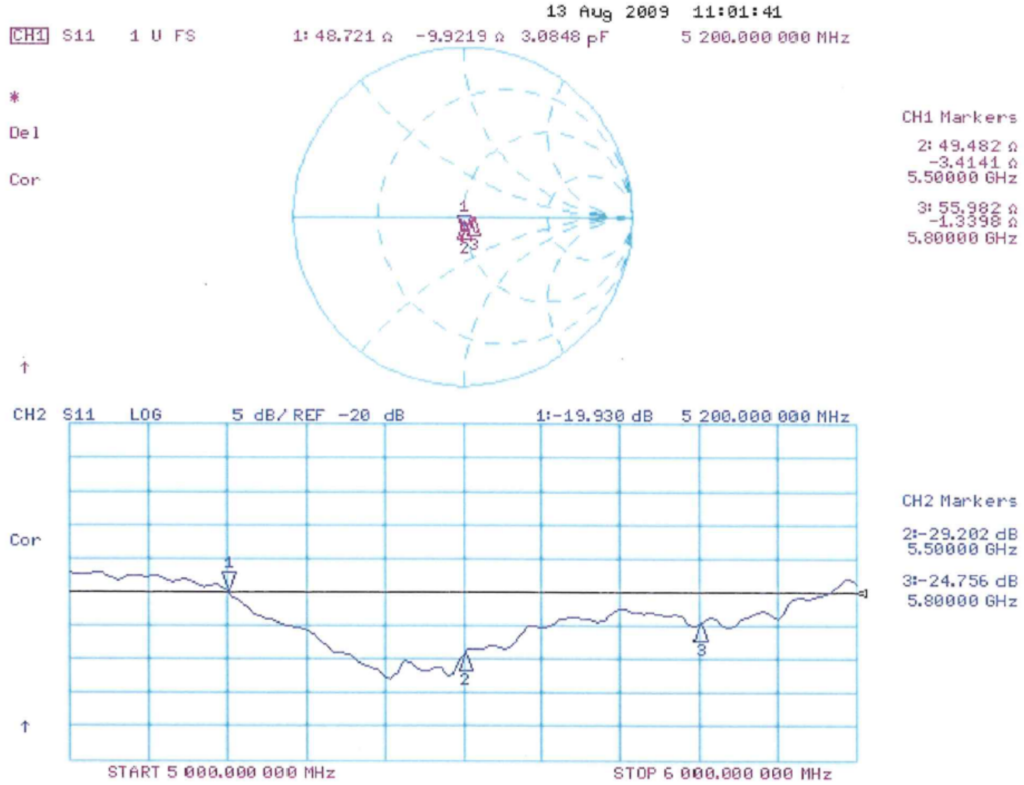

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DASY5 Validation Report for Body TSL

Date/Time: 19.08.2009 13:11:30

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1020

Communication System: CW-5GHz; Frequency: 5200 MHzFrequency: 5500 MHzFrequency: 5800 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz
Medium parameters used: f = 5200 MHz; σ = 5.43 mho/m; ε_r = 48.2; ρ = 1000 kg/m^3 Medium parameters used: f = 5500 MHz; σ = 5.82 mho/m; ε_r = 47.5; ρ = 1000 kg/m^3 Medium parameters used: f = 5800 MHz; σ = 6.17 mho/m; ε_r = 46.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.88, 4.88, 4.88)ConvF(4.37, 4.37, 4.37)ConvF(4.57, 4.57, 4.57); Calibrated: 11.03.2009
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.3 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 59.5 V/m; Power Drift = 9.72e-005 dB
Peak SAR (extrapolated) = 29.4 W/kg
SAR(1 g) = 7.75 mW/g; SAR(10 g) = 2.16 mW/g
Maximum value of SAR (measured) = 16.3 mW/g

d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 59.4 V/m; Power Drift = 0.00123 dB
Peak SAR (extrapolated) = 33.5 W/kg
SAR(1 g) = 8.25 mW/g; SAR(10 g) = 2.27 mW/g
Maximum value of SAR (measured) = 17.7 mW/g

d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 54 V/m; Power Drift = 0.00784 dB
Peak SAR (extrapolated) = 31 W/kg
SAR(1 g) = 7.13 mW/g; SAR(10 g) = 1.96 mW/g
Maximum value of SAR (measured) = 15.6 mW/g

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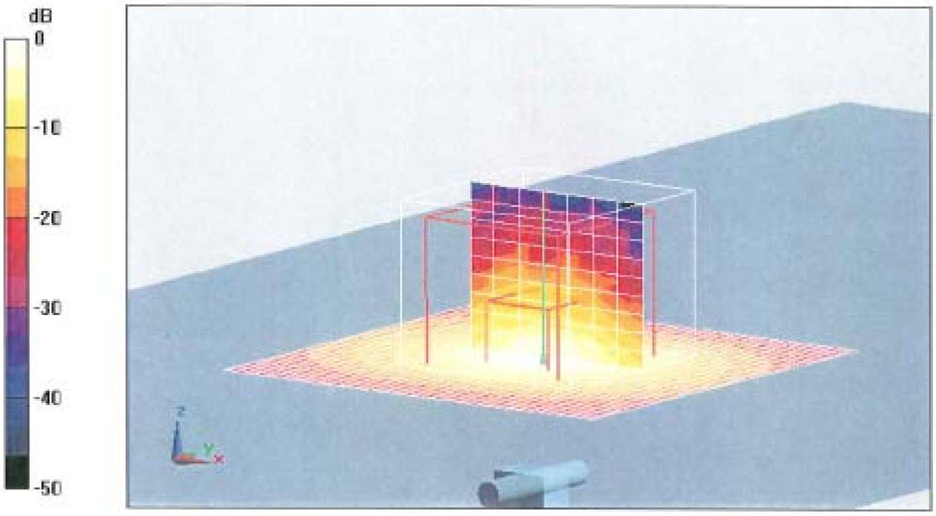
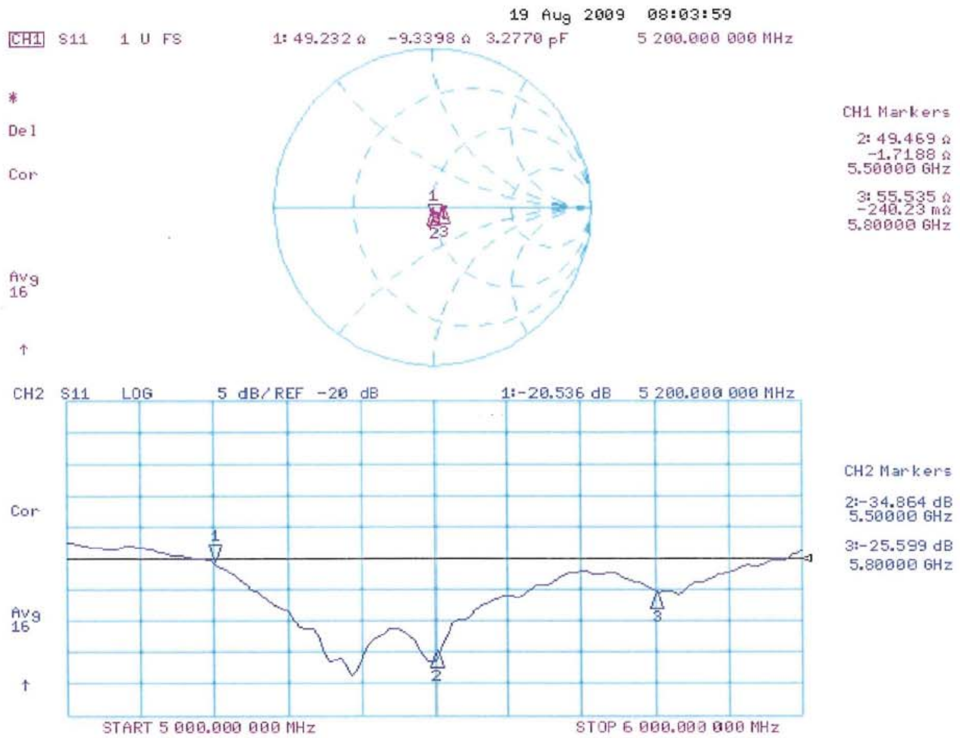


0 dB = 15.6mW/g

Impedance Measurement Plot for Body TSL



Certificate No: D5GHzV2-1020_Aug09 Page 14 of 14

10. System Validation Dipole (D2450V2,S/N: 713)

Calibration Laboratory of
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Accreditation No.: **SCS 108**

Client **UL Japan (PTT)**

Certificate No: **D2450V2-713_Sep10**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 713
Calibration procedure(s)	QA CAL-05.v7 Calibration procedure for dipole validation kits
Calibration date:	September 06, 2010

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 EPM-442A	GB37480704	06-Oct-09 (No. 217-01086)	Oct-10
Power sensor HP 8481A	US37292783	06-Oct-09 (No. 217-01086)	Oct-10
Reference 20 dB Attenuator	SN: 5086 (20g)	30-Mar-10 (No. 217-01158)	Mar-11
Type-N mismatch combination	SN: 5047.2 / 06327	30-Mar-10 (No. 217-01162)	Mar-11
Reference Probe ES3DV3	SN: 3205	30-Apr-10 (No. ES3-3205_Apr10)	Apr-11
DAE4	SN: 601	10-Jun-10 (No. DAE4-601_Jun10)	Jun-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check: Oct-11
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-09)	In house check: Oct-10

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 8, 2010

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

Certificate No: D2450V2-713_Sep10 Page 1 of 9

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Accreditation No.: **SCS 108**

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:

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
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

d) 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.

Measurement Conditions

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

DASY Version	DASY5	V52.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.0 ± 6 %	1.74 mho/m ± 6 %
Head TSL temperature during test	(21.8 ± 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.9 mW / g
SAR normalized	normalized to 1W	51.6 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**52.4 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.08 mW / g
SAR normalized	normalized to 1W	24.3 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**24.4 mW /g ± 16.5 % (k=2)**

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Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.5 ± 6 %	1.95 mho/m ± 6 %
Body TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR normalized	normalized to 1W	52.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**51.9 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.04 mW / g
SAR normalized	normalized to 1W	24.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**24.1 mW / g ± 16.5 % (k=2)**

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.0 Ω + 1.0 jΩ
Return Loss	- 30.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 Ω + 2.1 jΩ
Return Loss	- 33.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 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	July 05, 2002

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DASY5 Validation Report for Head TSL

Date/Time: 03.09.2010 15:07:26

Test Laboratory: SPEAG, Zurich, Switzerland

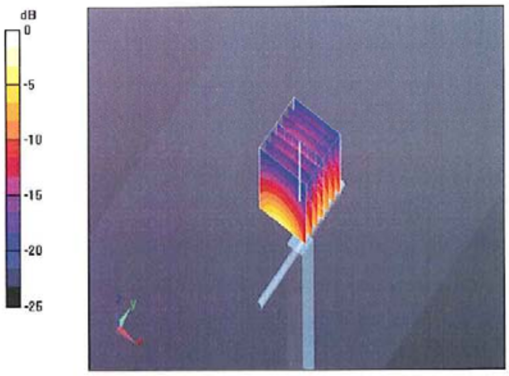
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL U12 BB
Medium parameters used: f = 2450 MHz; σ = 1.74 mho/m; ε_r = 39; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- 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)

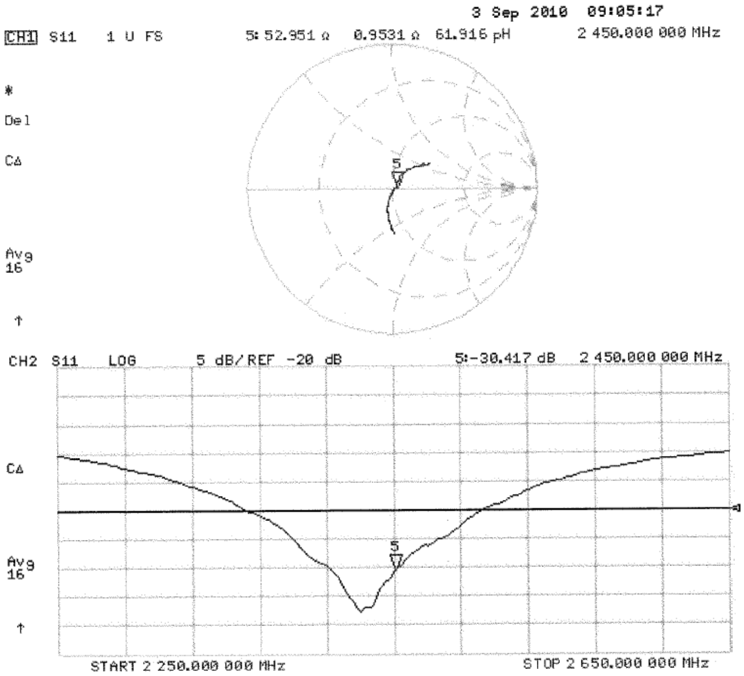
Head/d=10mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.4 V/m; Power Drift = 0.050 dB
Peak SAR (extrapolated) = 26.3 W/kg
SAR(1 g) = 12.9 mW/g; SAR(10 g) = 6.08 mW/g
Maximum value of SAR (measured) = 16.2 mW/g



0 dB = 16.2mW/g

Certificate No: D2450V2-713_Sep10 Page 6 of 9

Impedance Measurement Plot for Head TSL



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Validation Report for Body

Date/Time: 06.09.2010 13:42:13

Test Laboratory: SPEAG, Zurich, Switzerland

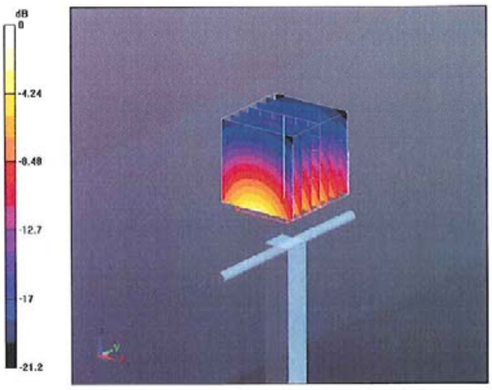
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: MSL U12 BB
Medium parameters used: f = 2450 MHz; σ = 1.95 mho/m; ε_r = 52.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.31, 4.31, 4.31); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; 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)

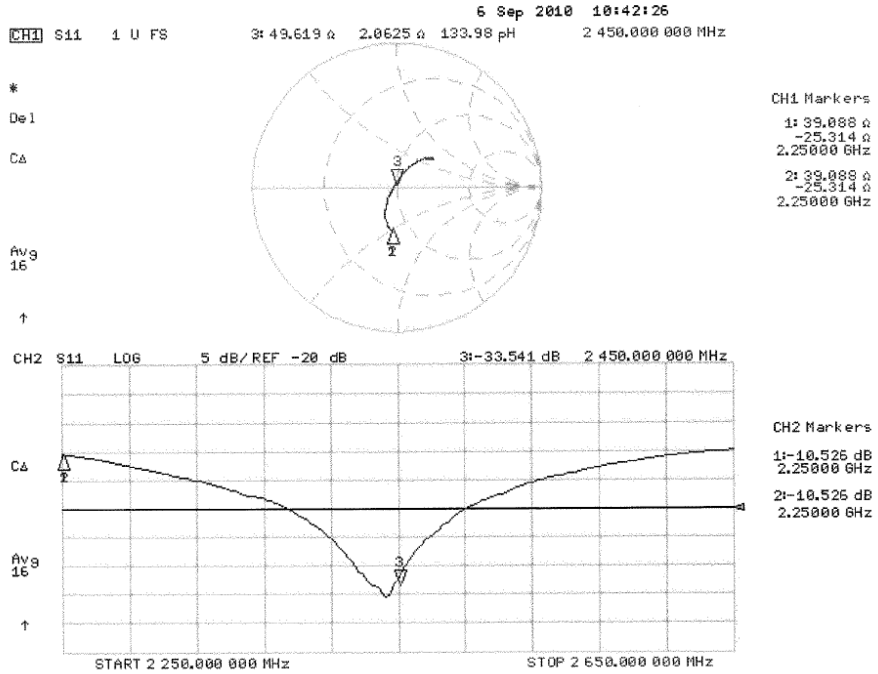
Body/d=10mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.7 V/m; Power Drift = 0.030 dB
Peak SAR (extrapolated) = 27 W/kg
SAR(1 g) = 13 mW/g; SAR(10 g) = 6.04 mW/g
Maximum value of SAR (measured) = 16.9 mW/g



0 dB = 16.9mW/g

Certificate No: D2450V2-713_Sep10 Page 8 of 9

Impedance Measurement Plot for Body TSL



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11. Dosimetric E-Field Probe Calibration (EX3DV3,S/N: 3507)

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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 **UL Japan (PTT)**

Certificate No: **EX3-3507_Mar11**

CALIBRATION CERTIFICATE

Object	EX3DV3 - SN:3507
Calibration procedure(s)	QA CAL-01.v7, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v3 Calibration procedure for dosimetric E-field probes
Calibration date:	March 16, 2011

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-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	01-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 654	23-Apr-10 (No. DAE4-654_Apr10)	Apr-11
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	[signature]
Approved by:	Fin Bomholt	R&D Director	[signature]

Issued: March 16, 2011

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

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Engineering AG
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C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

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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:

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	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., ϑ = 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 ϑ = 0 (f ≤ 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* are numerical linearization parameters in dB assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media.
- *VR:* VR is the validity range of the calibration related to the average diode voltage or DAE voltage in mV.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 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 EX3DV3

SN:3507

Manufactured: December 15, 2003
Calibrated: March 16, 2011

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

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DASY/EASY - Parameters of Probe: EX3DV3 - SN:3507

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.68	0.76	0.68	± 10.1 %
DCP (mV)[B]	101.3	100.9	100.1	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc[E] (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	106.0	±1.7 %
			Y	0.00	0.00	1.00	135.2	
			Z	0.00	0.00	1.00	107.9	

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 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: EX3DV3 - SN:3507

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)
835	41.5	0.90	10.35	10.35	10.35	0.50	0.79	± 12.0 %
900	41.5	0.97	10.15	10.15	10.15	0.59	0.76	± 12.0 %
1750	40.1	1.37	9.14	9.14	9.14	0.80	0.50	± 12.0 %
1810	40.0	1.40	8.87	8.87	8.87	0.80	0.50	± 12.0 %
1900	40.0	1.40	8.78	8.78	8.78	0.80	0.50	± 12.0 %
2000	40.0	1.40	8.71	8.71	8.71	0.80	0.54	± 12.0 %
2450	39.2	1.80	7.88	7.88	7.88	0.60	0.64	± 12.0 %
2600	39.0	1.96	7.67	7.67	7.67	0.50	0.75	± 12.0 %
5200	36.0	4.66	4.95	4.95	4.95	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.59	4.59	4.59	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.34	4.34	4.34	0.42	1.80	± 13.1 %
5600	35.5	5.07	4.07	4.07	4.07	0.42	1.80	± 13.1 %
5800	35.3	5.27	4.29	4.29	4.29	0.42	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.

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DASY/EASY - Parameters of Probe: EX3DV3- SN:3507

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)
835	55.2	0.97	10.49	10.49	10.49	0.77	0.60	± 12.0 %
900	55.0	1.05	10.18	10.18	10.18	0.69	0.65	± 12.0 %
1750	53.4	1.49	8.56	8.56	8.56	0.63	0.66	± 12.0 %
1810	53.3	1.52	8.25	8.25	8.25	0.61	0.67	± 12.0 %
1900	53.3	1.52	8.09	8.09	8.09	0.70	0.63	± 12.0 %
2000	53.3	1.52	8.21	8.21	8.21	0.56	0.68	± 12.0 %
2450	52.7	1.95	7.61	7.61	7.61	0.73	0.55	± 12.0 %
2600	52.5	2.16	7.44	7.44	7.44	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.36	4.36	4.36	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.17	4.17	4.17	0.50	1.90	± 13.1 %
5500	48.6	5.65	3.70	3.70	3.70	0.55	1.90	± 13.1 %
5600	48.5	5.77	3.50	3.50	3.50	0.60	1.90	± 13.1 %
5800	48.2	6.00	3.69	3.69	3.69	0.60	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.

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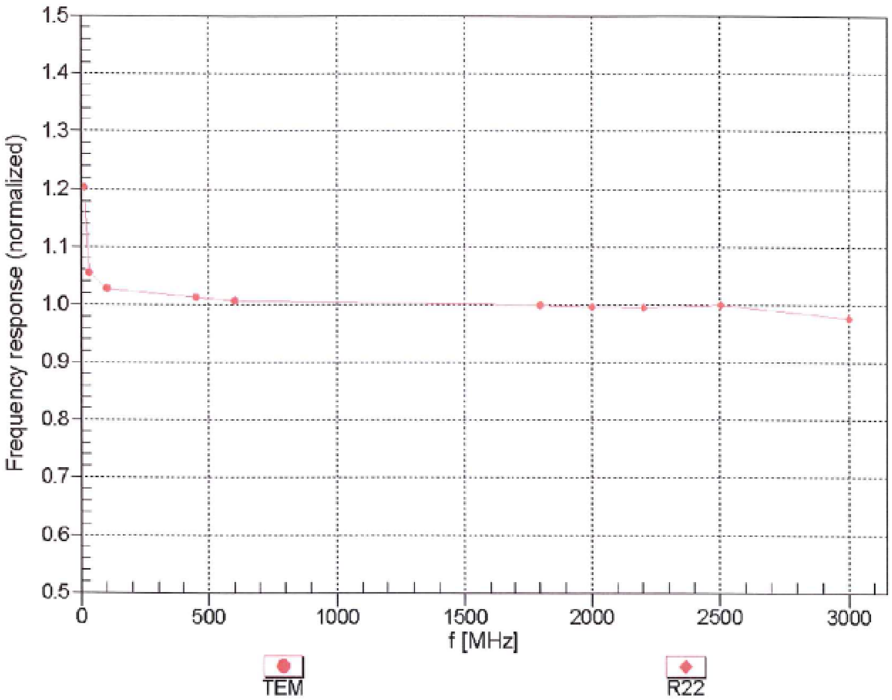
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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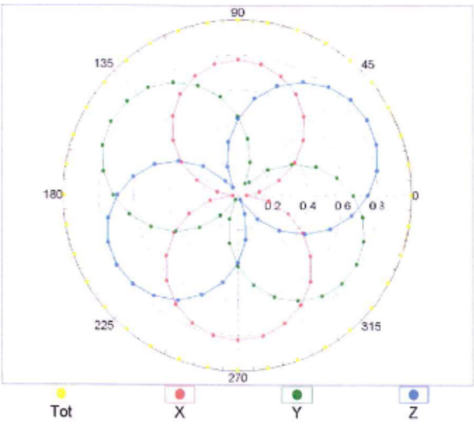
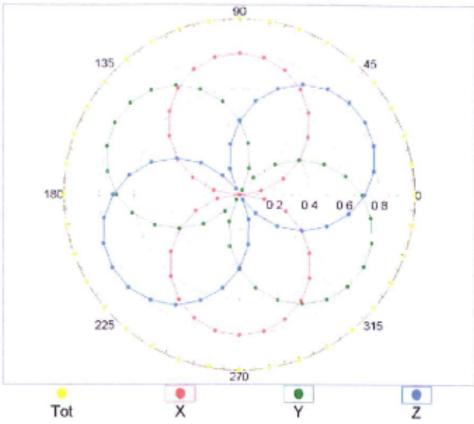
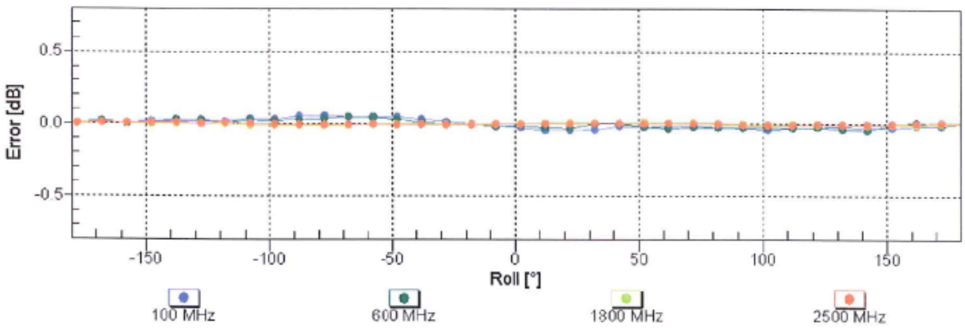
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22





Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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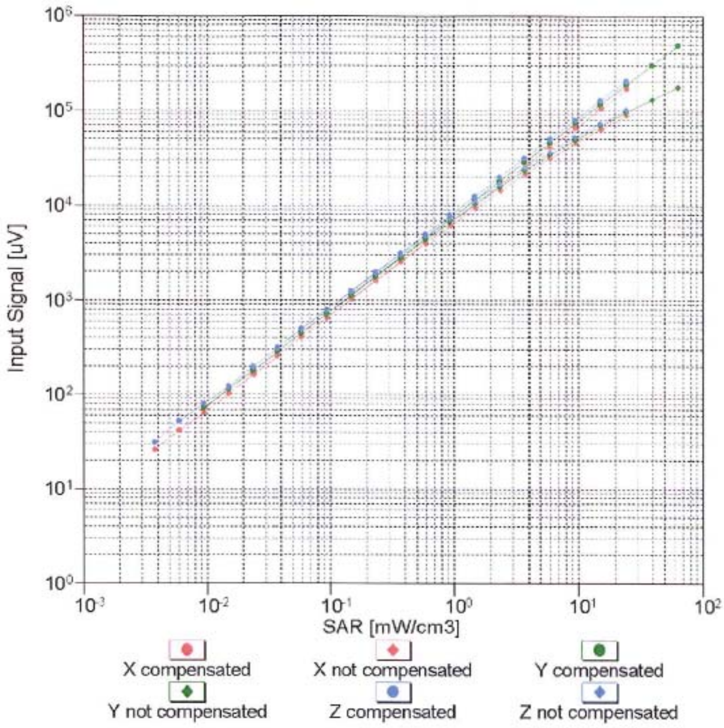
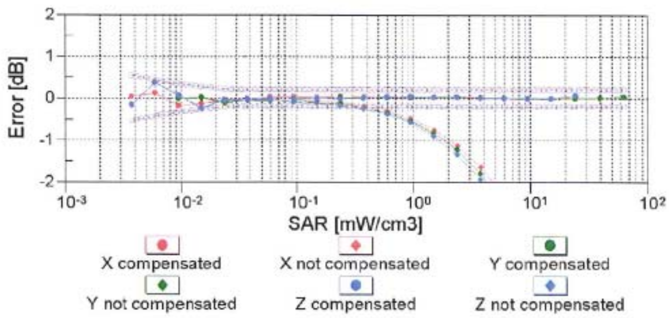
Dynamic Range f(SAR_{head})

(TEM cell , f = 900 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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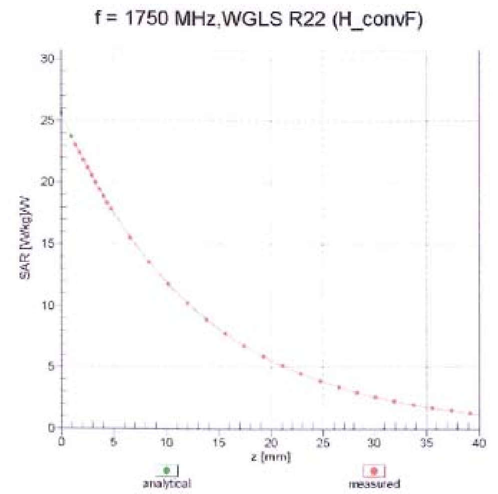
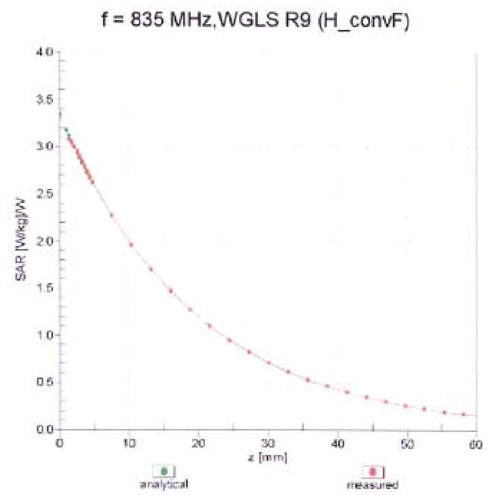
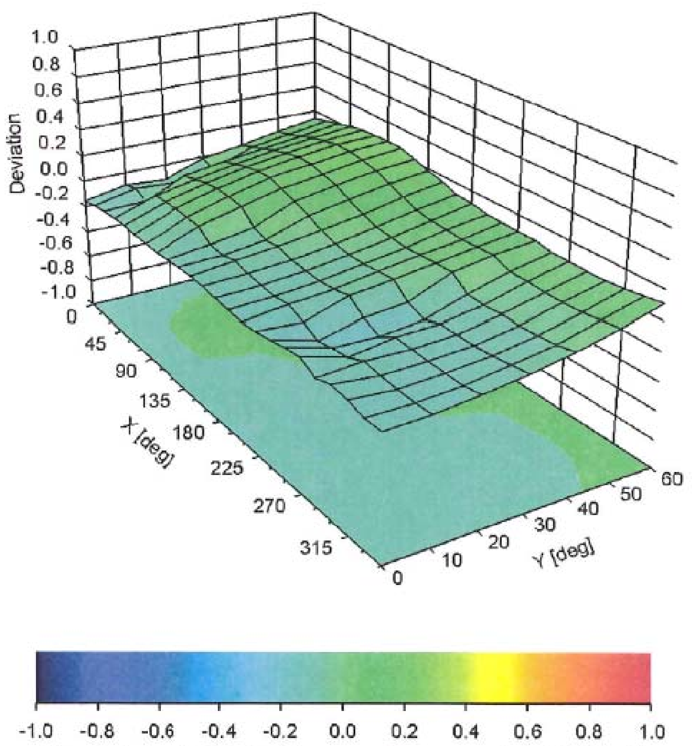
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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DASY/EASY - Parameters of Probe: EX3DV3 - SN:3507

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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

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12. References

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[2] Katja Pokovic, Thomas Schmid, and Niels Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15-17, 1997, pp. 120-124.
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[5] W. H. Press, S. A. Teukolsky,W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.
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