EMITECH LE MANS

RE052-12-106218-1/A Ed. 0

SAR TEST REPORT

According to the standard:
EN 62209-1: 2006

Equipment under test:
Antenna patch for mobile phone
FAZUP
Tested with an Apple iPhone 5 (A1429)

Company:
-

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EQUIPMENT UNDER TEST:	Antenna patch for mobile phone
Reference 1:	FAZUP (antenna patch)
Serial number:	-
Reference 2:	Apple iPhone 5 Model A1429 (mobile phone)
Serial number:	IMEI 013350006699429
MANUFACTURER:	-
APPLICANT:	
Company:	-
Address:	Mr. Antoine SAMAKH and Mr. Mathieu SAMAKH FRANCE
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DATE(S) OF TEST(S):	November 12, 13 and 16, 2012
TEST SITE:	EMITECH laboratory at Le Mans (72) - FRANCE
TEST(S) OPERATOR(S):	Emmanuel TOUTAIN

SUMMARY

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1. INTRODUCTION

In this test report, Specific Absorption Rate (SAR) measurements for the mobile phone Apple iPhone 5 Model A1429 used with the antenna patch FAZUP are presented.

The measurements were made according to the EN 62209-1 standard for evaluating the SAR level attenuation provided by the patch.
Full SAR testing according to the EN 62209-1 standard is not required by the applicant; the testing program is described in §7. MEASUREMENT RESULTS.

2. REFERENCE DOCUMENTS

The reference documents referred throughout this report are listed below.
These reference documents are applicable to the entire report, although extensions (version, date and amendment) are not repeated.

Reference	Document title	Date
EN 62209-1	Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz) (IEC 62209-1:2005).	2006
IEC 62209-1	Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz).	2005

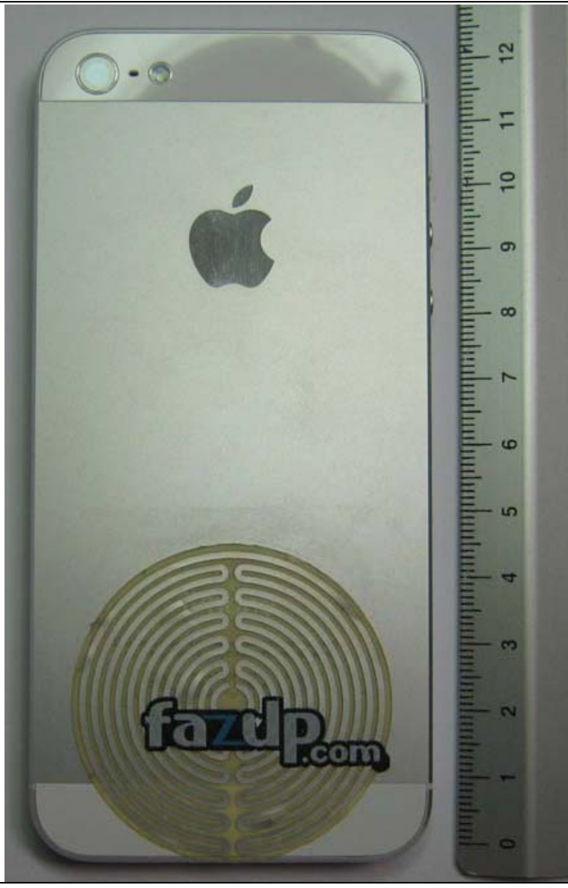
3. PRESENTATION OF EQUIPMENT FOR TESTING PURPOSES

The photographs of the mobile phone Apple iPhone 5 Model A1429 and the antenna patch FAZUP are shown in Fig. 1.
The standard used by the mobile phone for this test is the GSM in the 900MHz and 1800MHz frequency band, the antenna is integrated.

The antenna patch FAZUP was placed on the rear side of the mobile phone by the applicant.

FAZUP (antenna patch)

Apple iPhone 5 Model A1429
(mobile phone)



Apple iPhone 5 Model A1429 and FAZUP

Mobile phone marking

Fig. 1: Photographs of equipment under test

4. TESTS RESULTS SUMMARY

Configuration	SAR level attenuation	
	GSM900 Channel 038 897.6 MHz	GSM1800 Channel 699 1747.6 MHz
Apple iPhone 5 Model A1429 + FAZUP	52.03%	75.61%

This test report only relates to SAR measurements; radiated performances evaluation of the mobile phone with and without the protective device is not part of this report.

5. ENVIRONNEMENTAL CONDITIONS

Condition	Measured Value
Liquid Temperature	*See Graphical Representations*
Ambient Temperature	*See Graphical Representations*

6. EQUIPMENT USED FOR THE TESTING

Platform ID	Platform	Equipment	Type	Manufacturer	Internal Number	Software Version
1	BTS Simulator	CMU200	Radio tester	Rohde-Schwarz	7361	
		922	Thermometer	Testo	6980	
2	DASY4	DASY4	Software	Speag	7321	V4.5 Build 19
		ES3DV3	E-Field Probe	Speag	9485	
		DAE3	Data acquisition	Speag	7192	
		D900V2	Dipole 900MHz	Speag	7194	
		D1800V2	Dipole 1800MHz	Speag	7193	
		SAM	Phantom	Speag	7204	
3	Liquid Measure	HP85070C	Software	Hewlett-Packard	-	C1.01
		HP8753D	Network analyzer	Hewlett-Packard	7216	
		HP85070C	Dielectric probe	Hewlett-Packard	7218	
4	System Validation	2024	Signal generator	Marconi	7215	
		ZHL42	Amplifier	Mini-circuits	7209	
		PMC18-2	Power Supply	Kikusui	7214	
		NRVS	Power meter	Rohde-Schwarz	7212	
		NRV-Z31	Probe power meter	Rohde-Schwarz	7211	
		3877	Coupler	Suhner	7208	
		RK100	Coupler	MEB	7210	
		33-3-34	Attenuator	Weinschel Engineering	7213	
		R411810124 R411806124	Attenuator	Radiall	7315	
		909A	50 ohms load	HP	7314	
		R404563000	50 ohms load	Radiall	7313	

7. MEASUREMENT RESULTS

The output power and frequency are controlled using a base station simulator. The mobile phone is set to transmit at its highest output peak power level.

The mobile phone is test in the “cheek” position on right side of the phantom at the centre frequency of GSM900 and GSM1800 operating band with and without FAZUP.

Measurement results for GSM900 (SAR values averaged over a mass of 10g):

Configuration	Phantom	Position	SAR 10g (W/kg) Channel 038 897.6 MHz
Mobile phone without FAZUP	Right Side	Cheek	0.369
Mobile phone with FAZUP	Right Side	Cheek	0.177

Measurement results for GSM1800 (SAR values averaged over a mass of 10g):

Configuration	Phantom	Position	SAR 10g (W/kg) Channel 699 1747.6 MHz
Mobile phone without FAZUP	Right Side	Cheek	0.529
Mobile phone with FAZUP	Right Side	Cheek	0.129

8. GRAPHICAL REPRESENTATIONS OF THE COARSE SCAN

The graphical representations of the coarse scan are shown in Fig. 2 to Fig. 5.

DUT: Apple iPhone 5 (Model A1429)

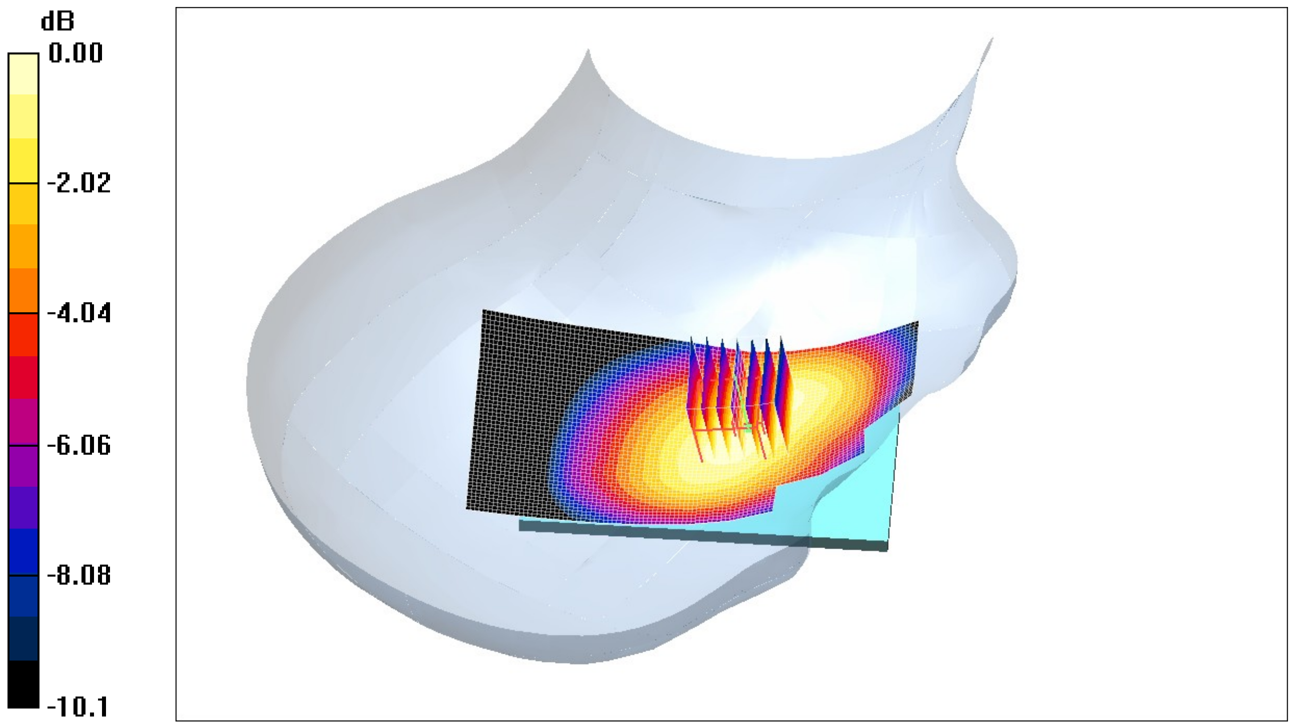
Communication System: E-GSM 900; Frequency: 897.6 MHz; Duty Cycle: 1:8.3
Medium parameters used: $\sigma = 0.93$ mho/m, $\varepsilon_r = 39.8$; $\rho = 1000$ kg/m^3
Phantom section: Right Section

Program Notes: Ambient temperature: 21.4°C, Liquid temperature: 19.4°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.97, 5.97, 5.97); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Cheek Position - Middle/Area Scan (51x101x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.513 mW/g

Cheek Position - Middle/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.24 V/m; Power Drift = -0.083 dB
Peak SAR (extrapolated) = 0.663 W/kg
SAR(1 g) = 0.503 mW/g; SAR(10 g) = 0.369 mW/g
Maximum value of SAR (measured) = 0.532 mW/g



0 dB = 0.532mW/g

Fig. 2: SAR distribution for GSM900 of the mobile phone alone:
channel 38 (897.6 MHz), cheek position, right side

DUT: Apple iPhone 5 (Model A1429) + FAZUP

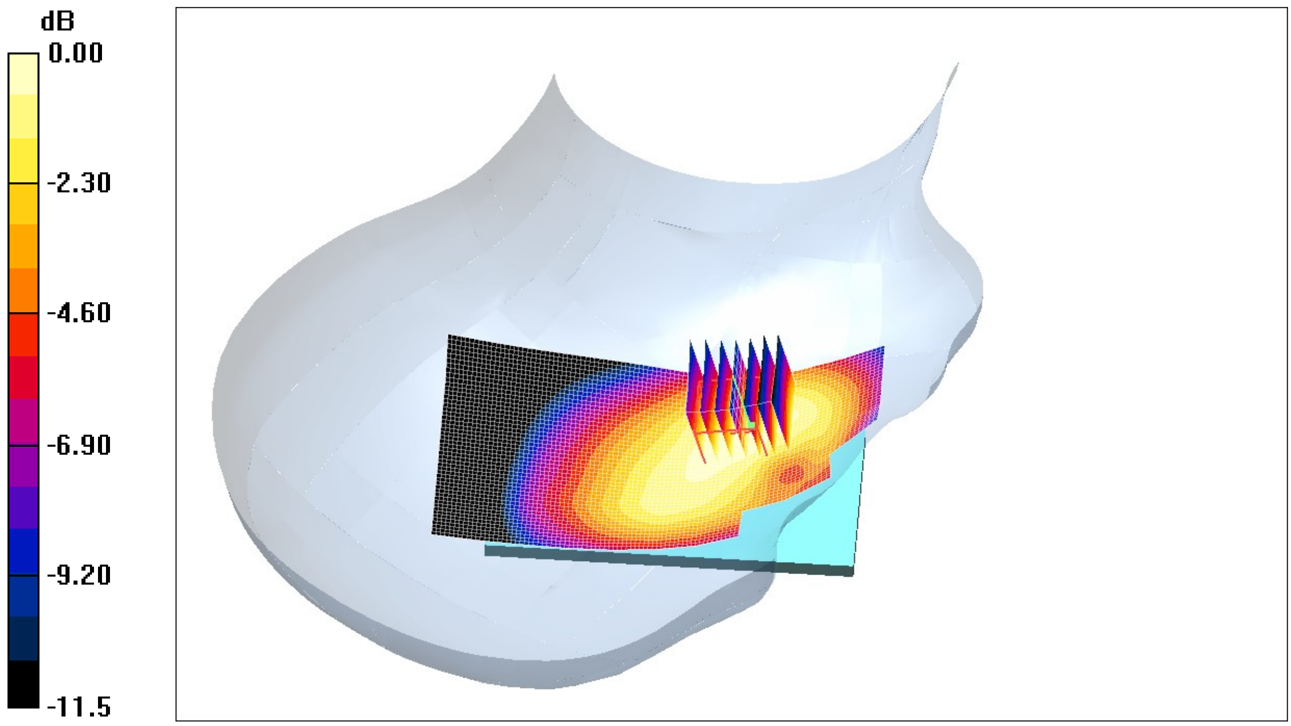
Communication System: E-GSM 900; Frequency: 897.6 MHz; Duty Cycle: 1:8.3
Medium parameters used: $\sigma = 0.93$ mho/m, $\varepsilon_r = 39.8$; $\rho = 1000$ kg/m^3
Phantom section: Right Section

Program Notes: Ambient temperature: 21.2°C, Liquid temperature: 19.5°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.97, 5.97, 5.97); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Cheek Position - Middle/Area Scan (51x101x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.281 mW/g

Cheek Position - Middle/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.48 V/m; Power Drift = 0.109 dB
Peak SAR (extrapolated) = 0.363 W/kg
SAR(1 g) = 0.261 mW/g; SAR(10 g) = 0.177 mW/g
Maximum value of SAR (measured) = 0.279 mW/g



0 dB = 0.279mW/g

Fig. 3: SAR distribution for GSM900 of the mobile phone with FAZUP: channel 38 (897.6 MHz), cheek position, right side

DUT: Apple iPhone 5 (Model A1429)

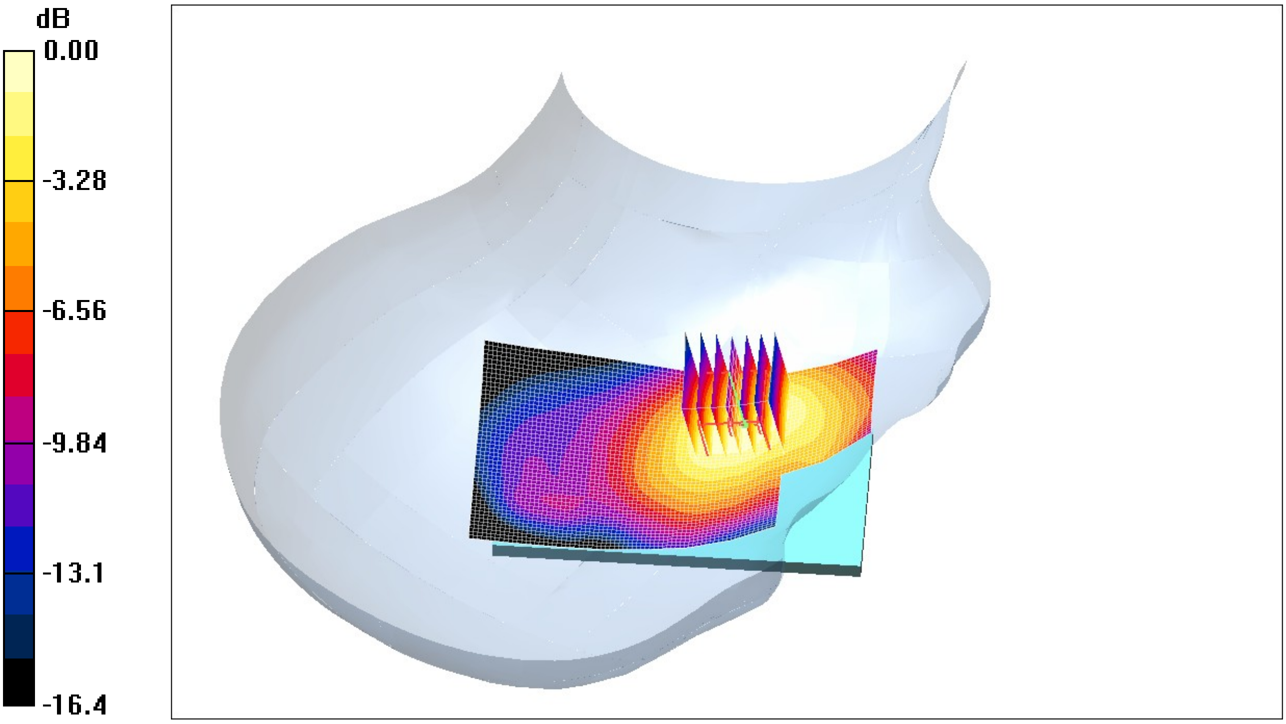
Communication System: GSM 1800; Frequency: 1747.6 MHz; Duty Cycle: 1:8.3
Medium parameters used: $\sigma = 1.36$ mho/m, $\varepsilon_r = 38.3$; $\rho = 1000$ kg/m^3
Phantom section: Right Section

Program Notes: Ambient temperature: 20.6°C, Liquid temperature: 19.6°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.22, 5.22, 5.22); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Cheek Position - Middle/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.929 mW/g

Cheek Position - Middle/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.56 V/m; Power Drift = 0.037 dB
Peak SAR (extrapolated) = 1.22 W/kg
SAR(1 g) = 0.845 mW/g; SAR(10 g) = 0.529 mW/g
Maximum value of SAR (measured) = 0.920 mW/g



0 dB = 0.920mW/g

Fig. 4: SAR distribution for GSM1800 of the mobile phone alone: channel 699 (1747.6MHz), cheek position, right side

DUT: Apple iPhone 5 (Model A1429) + FAZUP

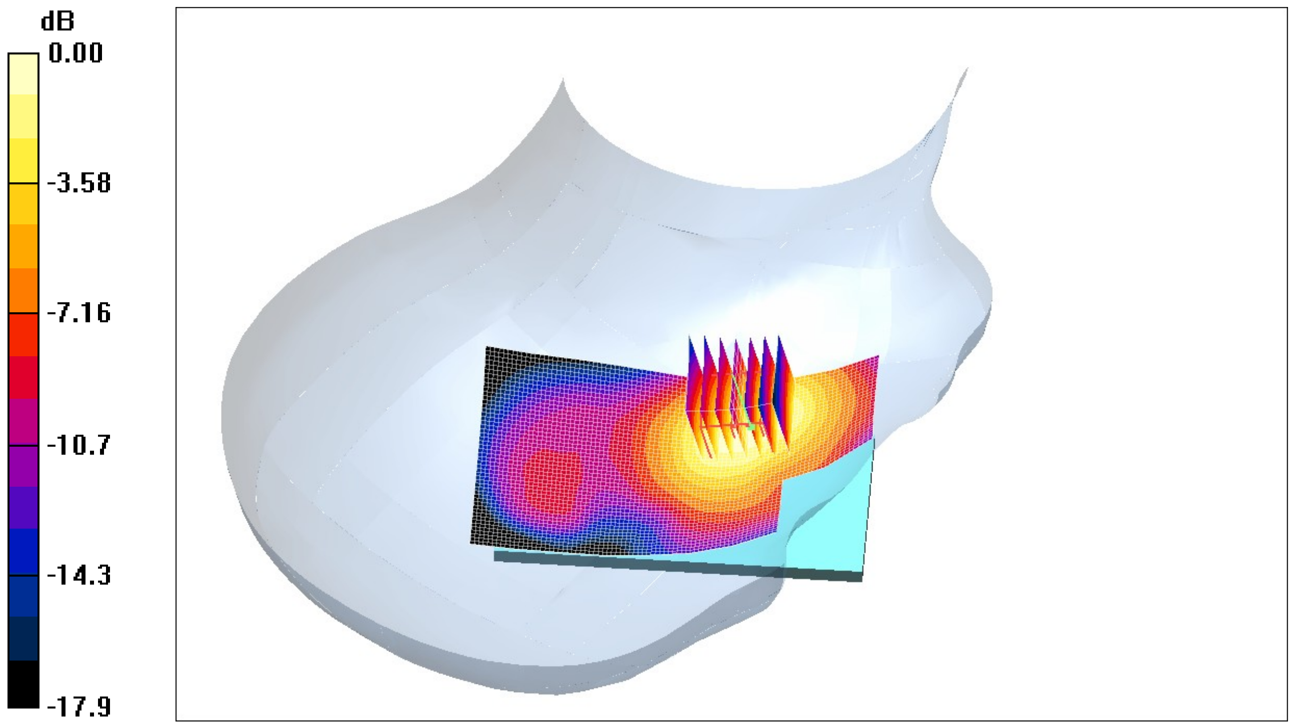
Communication System: GSM 1800; Frequency: 1747.6 MHz; Duty Cycle: 1:8.3
Medium parameters used: σ = 1.36 mho/m, ε_r = 38.3; ρ = 1000 kg/m^3
Phantom section: Right Section

Program Notes: Ambient temperature: 20.8°C, Liquid temperature: 19.6°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.22, 5.22, 5.22); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

Cheek Position - Middle/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.236 mW/g

Cheek Position - Middle/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.78 V/m; Power Drift = 0.028 dB
Peak SAR (extrapolated) = 0.312 W/kg
SAR(1 g) = 0.211 mW/g; SAR(10 g) = 0.129 mW/g
Maximum value of SAR (measured) = 0.232 mW/g



0 dB = 0.232mW/g

Fig. 5: SAR distribution for GSM1800 of the mobile phone with FAZUP: channel 699 (1747.6MHz), cheek position, right side

9. PHOTOGRAPH OF THE MOBILE PHONE UNDER TEST

The photograph of the mobile phone under test is shown in Fig. 6.

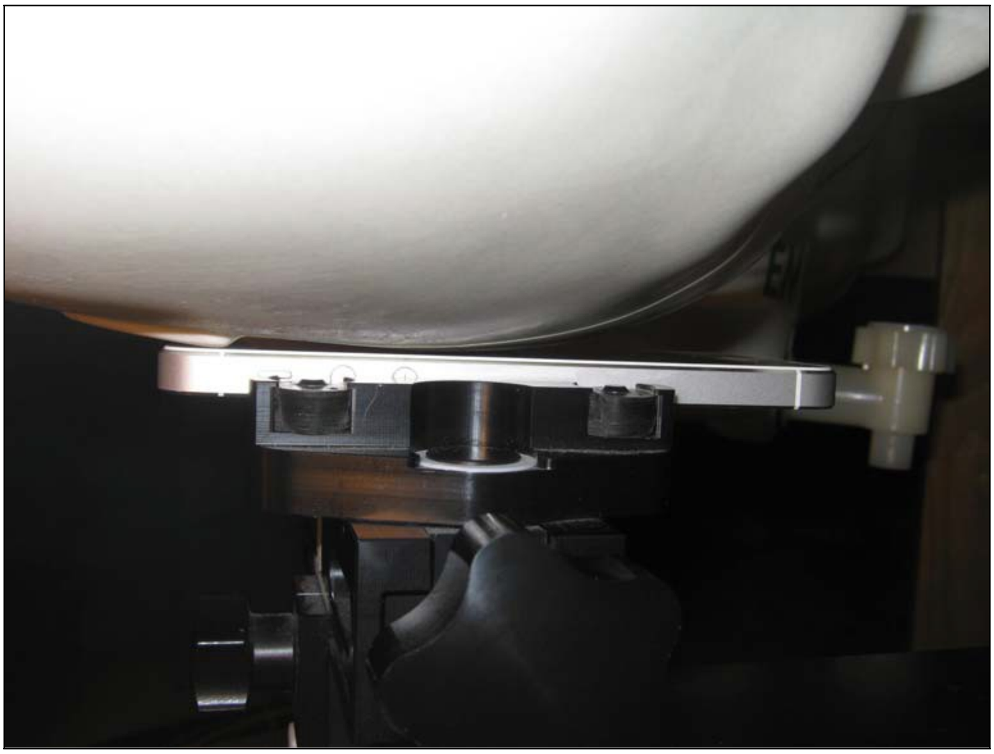


Fig. 6: Mobile phone in cheek position on right side

10. MEASUREMENT UNCERTAINTY

The expanded uncertainty with a confidence interval of 95 % shall not exceed 30 % for averaged SAR values in the range from 0.4 to 10 W/kg.

The uncertainty of the measurements was evaluated according to the EN 62209-1 and determined by Schmid & Partner Engineering AG. The expanded uncertainty is ± 21.4 %.

ERROR SOURCES	Uncertainty Value (%)	Probability Distribution	Divisor	Ci	Standard Uncertainty (%)
Measurement System					
Probe Calibration	± 5.9	Normal	1	1	± 5.9
Axial Isotropy	± 4.7	Rectangular	√3	0.7	± 1.9
Hemispherical Isotropy	± 9.6	Rectangular	√3	0.7	± 3.9
Boundary Effect	± 1.0	Rectangular	√3	1	± 0.6
Linearity	± 4.7	Rectangular	√3	1	± 2.7
Detection Limits	± 1.0	Rectangular	√3	1	± 0.6
Readout Electronics	± 0.3	Normal	1	1	± 0.3
Response Time	± 0.8	Rectangular	√3	1	± 0.5
Integration Time	± 2.6	Rectangular	√3	1	± 1.5
RF Ambient Conditions-Noise	± 3.0	Rectangular	√3	1	± 1.7
RF Ambient Conditions-Reflections	± 3.0	Rectangular	√3	1	± 1.7
Probe Positioner Mechanical Restrictions	± 0.4	Rectangular	√3	1	± 0.2
Probe Positioning with respect to Phantom Shell	± 2.9	Rectangular	√3	1	± 1.7
Post-Processing	± 1.0	Rectangular	√3	1	± 0.6
Test Sample Related					
Test Sample Positioning	± 2.9	Normal	1	1	± 2.9
Device Holder Uncertainty	± 3.6	Normal	1	1	± 3.6
Drift of Output Power	± 5.0	Rectangular	√3	1	± 2.9
Phantom and Set-Up					
Phantom Uncertainty (shape and thickness tolerances)	± 4.0	Rectangular	√3	1	± 2.3
Liquid Conductivity (Target)	± 5.0	Rectangular	√3	0.43	± 1.2
Liquid Conductivity (Measurement)	± 2.5	Normal	1	0.43	± 1.1
Liquid Permittivity (Target)	± 5.0	Rectangular	√3	0.49	± 1.4
Liquid Permittivity (Measurement)	± 2.5	Normal	1	0.49	± 1.2
Combined standard uncertainty					± 10.7
Expanded uncertainty (confidence interval of 95%)					± 21.4

11. SPATIAL PEAK SAR EVALUATION

From Schmid & Partner Engineering AG, [DASY4 Manual, March 2003, Application Note: Spatial Peak SAR Evaluation].

Spatial Peak SAR

The DASY4 software includes all numerical procedures necessary to evaluate the spatial peak SAR values.
The spatial-peak SAR can be computed over any required mass.
The base for the evaluation is a “cube” measurement in a volume of 30mm3 (7x7x7 points). The measured volume includes the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan. The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes.
The algorithm to find the cube with highest averaged SAR is divided into the following stages:
1. Extraction of the measured data (grid and values) from the Zoom Scan,
2. Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters),
3. Generation of a high-resolution mesh within the measured volume,
4. Interpolation of all measured values from the measurement grid to the high-resolution grid,
5. Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface,
6. Calculation of the averaged SAR within masses of 1g and 10g.

Interpolation, Extrapolation and Detection of Maxima

The probe is calibrated at the center of the dipole sensors which is located at 2.7mm away from the probe tip. During measurements, the dipole sensors are 4mm above the phantom surface. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.
The interpolation, extrapolation and maximum search routines are all based on the modified Quadratic Shepard’s method [Robert J. Renka, “Multivariate Interpolation Of Large Sets Of Scattered Data”, University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148.].

Averaging and Determination of Spatial Peak SAR

The interpolated data is used to average the SAR over the 1g and 10g cubes by spatially discretizing the entire measured volume. The resolution of this spatial grid used to calculate the averaged SAR is 1mm or about 42875 interpolated points. The resulting volumes are defined as cubical volumes containing the appropriate tissue parameters that are centered at the location. The location is defined as the center of the incremental volume (voxel).

12. TEST CONDITIONS

The equipment is controlled during test using platform n° 1 (BTS simulator) referenced in paragraph 6 of this test report. The following test conditions are given for information; the maximum output powers were not measured.

Standard: GSM (900 & 1800 MHz)
Crest factor: 8
Modulation: GMSK
Traffic Channel: GSM 900: middle channel = 38
GSM 1800: middle channel = 699
Maximum output power: GSM 900 Class 4: Tx level 5 = 33 dBm (± 2dB)
GSM 1800 Class 1: Tx level 0 = 30 dBm (± 2dB)

Note: The tested EUT could contain an antenna diversity technology, as MIMO or MISO. The control of the antenna's scheme has not been provided by the applicant. Thus, the radiated performances of the EUT are dependent on the test set-up; an antenna diversity control could lead to different results from those reported in this test report.

13. MEASUREMENT SYSTEM DESCRIPTION

The automated near-field scanning system Dosimetric Assessment System DASY4 from Schmid & Partner Engineering AG was used. The measurement is performed using platform n° 2 referenced in paragraph 6 ("Equipment used for the testing") of this report. The system consists of a computer controlled, high precision robotics system, robot controller, extreme near-field probes and the phantom containing the liquid. The six axis robot precisely positions the probe at the points of maximum electromagnetic field. A device holder made of low-loss dielectric material is used to maintain the test position of the equipment under test against the phantom. The measurements were conducted in an RF controlled environment (i.e. anechoic room). Fig. 7 shows the system.

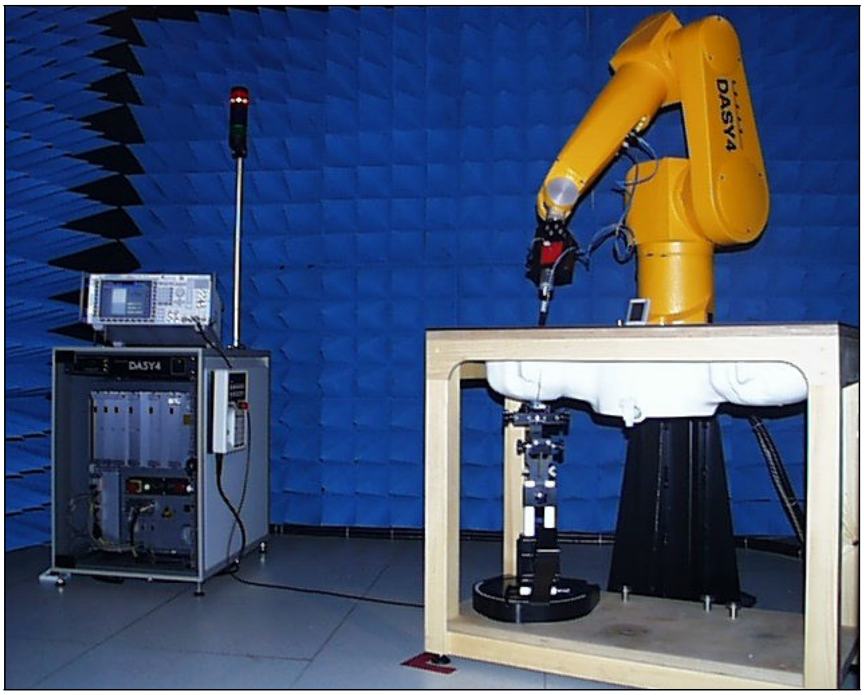


Fig. 7: The measurement setup with equipment under test

14. LIQUID MEASUREMENT: TEST CONDITIONS & RESULTS

The measurement is performed using platform n° 3 referenced in paragraph 6 (“Equipment used for the testing”) of this report. The following ingredients (in % by weight) are theoretical and given for information.

900 MHz liquid: Sucrose 56.50 %
De-ionised water 40.92 %
NaCl salt 1.48 % - HEC 1.00 % - Bactericide 0.10 %

1800 MHz liquid: Diethylenglykol-monobutylether 44.92 %
De-ionised water 54.90 %
NaCl salt 0.18 %

The dielectric parameters of the brain simulating liquid were controlled prior to assessment (contact probe method). Dielectric properties measured:

Frequency (MHz)	ε_r Targeted value	ε_r Measured value	σ (S/m) Targeted value	σ (S/m) Measured value	Liquid temperature (°C)	Ambient temperature (°C)
880	41.5 ± 5 %	40.2	0.95 ± 5 %	0.92	19.2	20.1
895	41.5 ± 5 %	39.9	0.96 ± 5 %	0.93		
900	41.5 ± 5 %	39.8	0.97 ± 5 %	0.93		
915	41.5 ± 5 %	39.7	0.97 ± 5 %	0.94		
1710	40.1 ± 5 %	38.4	1.34 ± 5 %	1.33	19.5	20.2
1750	40.1 ± 5 %	38.3	1.37 ± 5 %	1.36		
1785	40.0 ± 5 %	38.1	1.39 ± 5 %	1.39		
1800	40.0 ± 5 %	38.1	1.40 ± 5 %	1.41		

15. SYSTEM VALIDATION: TEST CONDITIONS & RESULTS

The measurement is performed using platform n° 4 referenced in paragraph 6 (“Equipment used for the testing”) of this report.

Measurement conditions: The measurements were performed in the flat section of the SAM phantom filled with liquids simulating tissue. The validation dipole input power was 250mW.
Prior to the assessment, the validation dipole were used to check whether the system was operating within its specification of ± 10 %.

Measurement results: The results are hereafter below and shown in Fig. 8 and Fig. 9.

Frequency (MHz)	SAR 1g (W/kg) Targeted value	SAR 1g (W/kg) Measured value
900	1.725 ± 10 %	1.72
1800	4.95 ± 10 %	5.01

DUT: Dipole 900 MHz

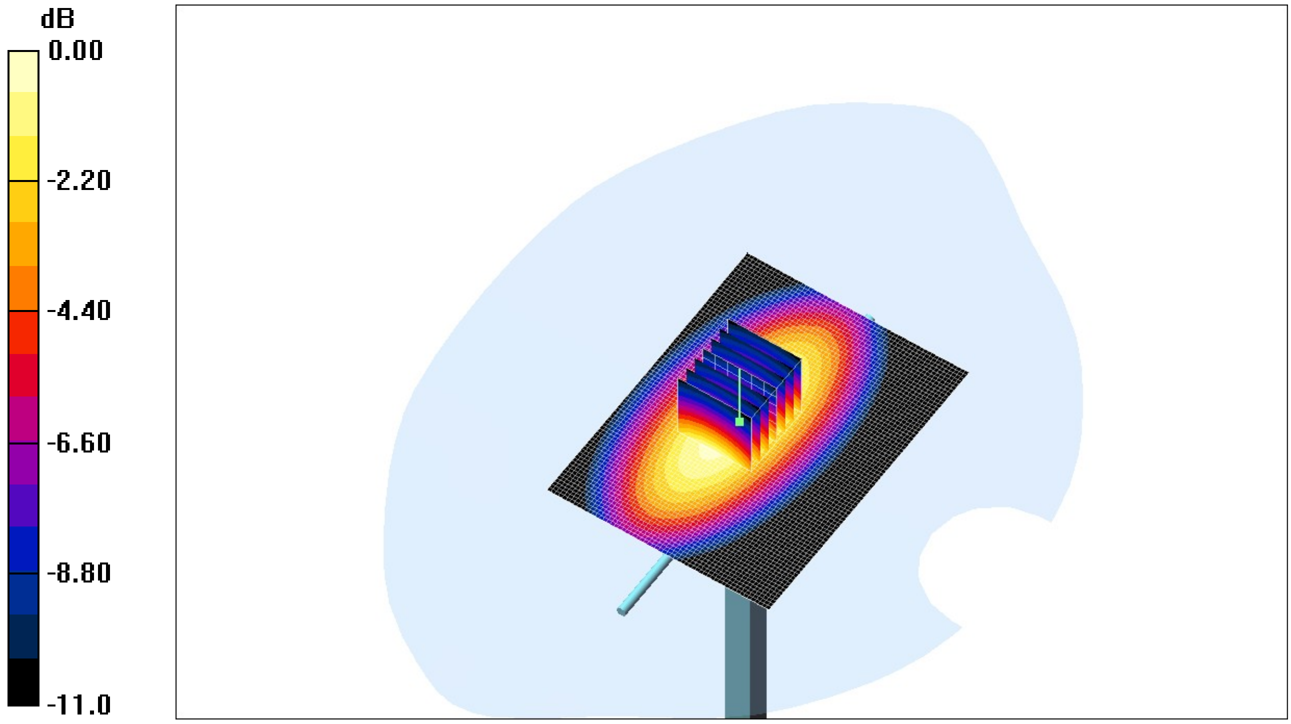
Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1
Medium parameters used: $\sigma = 0.93$ mho/m, $\varepsilon_r = 39.8$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 21.8°C, Liquid temperature: 20.1°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.97, 5.97, 5.97); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

d=15mm, Pin=250mW/Area Scan (61x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 2.84 mW/g

d=15mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.8 V/m; Power Drift = -0.031 dB
Peak SAR (extrapolated) = 4.11 W/kg
SAR(1 g) = 2.68 mW/g; SAR(10 g) = 1.72 mW/g
Maximum value of SAR (measured) = 2.91 mW/g



0 dB = 2.91mW/g

Fig. 8: 900 MHz validation result

DUT: Dipole 1800 MHz

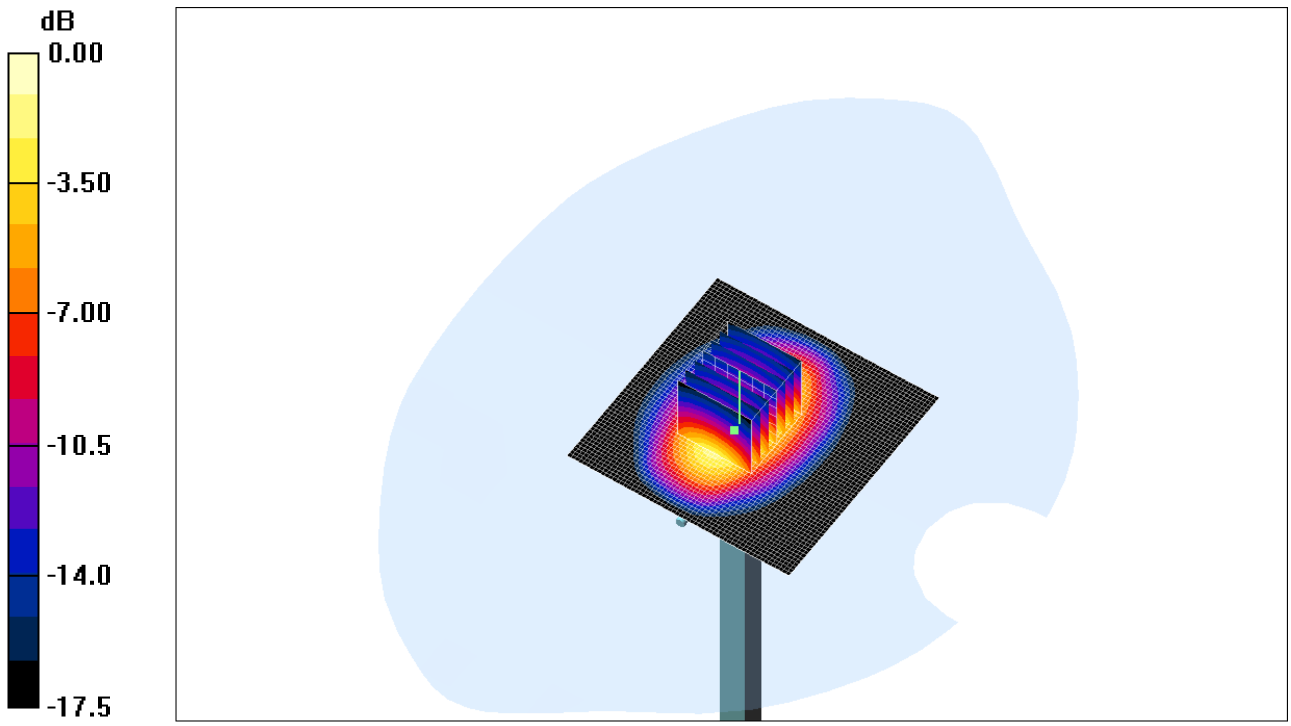
Communication System: CW; Frequency: 1800 MHz; Duty Cycle: 1:1
Medium parameters used: σ = 1.41 mho/m, ε_r = 38.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Program Notes: Ambient temperature: 21.6°C, Liquid temperature: 19.9°C

DASY4 Configuration:
- Probe: ES3DV3 - SN3303; ConvF(5.22, 5.22, 5.22); Calibrated: 7/17/2012
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn402; Calibrated: 3/9/2012
- Phantom: SAM 12; Type: QD; Serial: TP-1111
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 145

d=10mm, Pin=250mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 11.3 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.2 V/m; Power Drift = -0.022 dB
Peak SAR (extrapolated) = 17.6 W/kg
SAR(1 g) = 9.62 mW/g; SAR(10 g) = 5.01 mW/g
Maximum value of SAR (measured) = 10.9 mW/g



0 dB = 10.9mW/g

Fig. 9: 1800 MHz validation result

DDD End of report DDD