Prepared (also subject responsible if other)		No.		
EAB/TFE Davide Colombi		EAB-11:048101 Uen		
Approved	Checked	Date	Rev	Reference
		2011-09-27	PA5	

SAR Measurements on a terminal antenna connected to the Ericsson F5521gw Mobile Broadband Module for GPRS 850 for GPRS 850

Executive summary

In this report SAR measurement results are given for a terminal antenna connected to the Ericsson F5521gw Mobile Broadband Module (MBM) transmitting at the maximum output power level for the GPRS 850 (2 TS)[1] mode. The SAR measurements were conducted with the front of the antenna facing the phantom at a phantom-antenna separation distance of 40 mm.

The purpose of this report together with reports [1] (CETECOM report No: 1-2205-03-02/10) and [2] (Ericsson report No: EAB-11:028990) is to determine under which conditions the rules in FCC KDB 616217 D03 and FCC KDB 447498 D01 regarding approval of a transmitter for use in multiple host platforms can be applied. According to FCC KDB 616217 D03 and FCC KDB 447498 D01 the measured 1g averaged SAR for a reference case shall be less than 1/4th of the true FCC SAR limits for the multiple host platform approval rules to be applied. This is the reason why the results obtained in this report are compared with 1/4th of the true FCC SAR limits and not the true FCC SAR limits.

This report is complementary to [1] (CETECOM report No: 1-2205-03-02/10) and [2] (Ericsson report No: EAB-11:028990) where measurements on the same module were conducted, for the same purpose, for other bands, antenna model and antenna-phantom separation distances.

The results presented in this report, together with [1] and [2] show that the maximum 1g and 10g averaged SAR is below 1/4th of the applicable SAR limits at the considered phantom-antenna separation distance for all tested antennas and bands.

Although this is not an ordinary compliance test report, measurements have been conducted in accordance with applicable international standards and national regulations. The rest of this report is written in a similar way as an ordinary compliance test report produced by the Ericsson EMF Research Laboratory.

[1] Two active uplink time slots.

1 Table of Contents

2 Summary of Report[2]

2.1 Equipment under test (EUT)

Description	A coupling type terminal antenna connected to Notebook PC with built-in Ericsson F5521gw Mobile Broadband Module
Brand / model names	Antenna designed by Yageo. Dell Inspiron mini (host device); Ericsson F5521gw (wireless module)
Identification number (host device)	D-1011-32-851
Type number (wireless module)	KRD 131 18/2
IMEI / Serial Number (wireless module)	004401700665835 / C370024JES
FCC ID / IC Canada reg. number (wireless module)	VV7-MBMF5521GW1 / 287AG-MBMF5521GW1

Frequency Band	GSM 850	WCDMA V	GSM 900	WCDMA VIII	DCS 1800	PCS 1900	WCDMA II	WCDMA I
Modes	GPRS EDGE	UMTS HSPA	GPRS EDGE	UMTS HSPA	GPRS EDGE	GPRS EDGE	UMTS HSPA	UMTS HSPA
Supported	☑	☑	☑	☑	☑	☑	☑	☑
Covered by report	☑	☐	☐	☐	☐	☐	☐	☐
Data and connectivity	*GPRS cap. class B,*							
Exposure environment	*General public / Occupational*							

2.2 Results

Antenna / Test position	Separation distance (mm)	Mode	f (MHz)	Measured SAR (W/kg)	
				SAR_{1g}	SAR_{10g}
Ant #2 / Front facing phantom	40	GPRS (2TS), CH 128	824.2	0.100	0.077
Ant #2 / Front facing phantom	40	GPRS (2TS), CH 190	836.6	0.096	0.074
Ant #2 / Front facing phantom	40	GPRS (2TS), CH 251	848.8	0.122	0.094

[2] This page contains a summary of the test results. The full report provides a complete description of all test details and results.

3 General information

The SAR measurement results reported in this document have been obtained in accordance with the International standard IEC 62209-2 [10], the FCC OET Bulletin 65 Supplement C [3] and IEEE 1528 [13]. The purpose of this work was to determine whether or not the SAR levels were below 1/4th of the relevant SAR limits [3]-[9] at an antenna to phantom separation distance of 40 mm for the antennas under test.

One host device (identification number D-1011-32-851) was used for the measurements. The host device was equipped with the KRD 131 18/2 F5521gw module which was connected to the terminal antenna.

4 Equipment under test

The tables below summarize the technical data for the equipment under test (EUT). Photographs of the antennas, the wireless module, and the host device are presented in Appendix A.

Description	A coupling type terminal antenna connected to Notebook PC with built-in Ericsson F5521gw Mobile Broadband Module	
Brand Names	Antenna designed by Yageo. Dell inc. (host device); Ericsson (wireless module)	
Model Names	Inspiron mini (host device); F5521gw (wireless module)	
Identification number (host device)	D-1011-32-851	
Type number (wireless module)	KRD 131 18/2	
IMEI Number (wireless module)	004401700665835	
Serial Number (wireless module)	C370024JES	
FCC ID Number (wireless module)	VV7-MBMF5521GW1	
IC Canada reg. Number (wireless module)	287AG-MBMF35521GW1	
Hardware status (wireless module)	FP1.1	
Mode(s) covered by this report and nominal output power levels	GSM/GPRS 850	33 dBm
Data and connectivity	GPRS multislot/capability class: 10/B;	
Transmitter frequency range (MHz)	GSM 850: 824.2 – 848.8	

Mode	**Measured output power level[3] (dBm)**		
	Low ch	**Mid ch**	**High ch**
GPRS 850[4]	32.2	32.3	32.4

5 Test equipment

5.1 Dosimetric system

The SAR measurements were conducted using the DASY5 professional near-field scanner by Schmid & Partner Engineering AG. The system includes a high precision 6-axis robot, liquid-filled plastic phantoms and miniature electric field probes. The dosimetric probe is sensitive to E-fields and incorporates three small dipoles arranged so that the overall response is close to isotropic. The probe sensors are covered by an outer protective shell made of plastic.

Measurements are conducted in a metal screen room, which is designed to provide shielding from external radiofrequency signals and to prevent devices under test from interfering with local wireless networks. The ambient noise level is kept low so that the 1-gram averaged SAR is below 12 mW/kg when the device under

[3] As given in separate test report by CETECOM [1] (measured at module main port).
[4] Average power level per time slot.

test (DUT) is turned off. The electromagnetic field reflections in the shielded chamber are kept low using RF absorbers.

Figure 1 shows the SAR measurement system components.

Figure 1. The SAR measurement system.

An uncertainty budget including combined standard uncertainty (k=1) and expanded uncertainty (k=2) for 1g and 10g SAR assessments is given in Section 8.

The equipment list is given below. In Appendix E calibration certificates for the SAR test probe(s) are attached and in Appendix F calibration certificate(s) of the validation dipoles are attached [11].

Description	Serial number	Calibration due date	Calibration interval
Probe electronics, DAE3	S/N 422	2012-04-21	12 months
Dipole validation kit, D835V2	S/N 413	2013-01-14	36 months
ELI-4 flat phantom	S/N 1003	NA	NA

5.2 Additional equipment

Description	Serial number	Calibration due date	Calibration interval
Dielectric probe kit, HP 85070C	S/N US99360060	NA	NA
Network analyzer, Agilent E5071C	MY46104892	2012-06-02	12 months
Power meter, Agilent N1911A	MY45100381	2011-12-14	12 months
Power sensor, Agilent N1921A	MY45240486	2011-11-29	12 months
Universal radio communication tester, R&S CMU 200	S/N 107639	2012-07-04	12 months
Thermometer, EBRO TFX-392SKWT	S/N 10130918	2011-10-19	12 months

6 Electrical parameters of the tissue simulating liquids

The parameters of the tissue simulating liquids were measured with a dielectric probe kit prior to the SAR measurements and the results are shown below. The measured values were within 5% of the specified values in [10] and [3] and the mass density of the liquid entered into the DASY5 software was 1000 kg/m^3. The depth of the tissue simulating liquid was in the range 15.0-15.5 cm. Pictures of liquid depth for FCC band liquids are shown below.

Measured level (153 mm) of 835 MHz muscle tissue simulating liquid in the ELI-4 phantom

f (MHz)	Tissue type	Measured/Specification	ε_r	σ (S/m)	Temp (°C)
835	Body (Muscle)	Measured	54.4	0.96	21.9
		Specified value [3]	55.2	0.97	-
		Difference (%)	-1.5	-1	-

7 SAR system performance check

System performance check of the SAR test system was conducted at 835 MHz prior to the SAR measurements using the D835V2 dipole validation kits and the obtained results are shown in the table below. The forward power was measured using the R&S power meter. Thereafter the dipole was connected via a directional coupler and the return power was measured at the return port in order to determine the radiated power of the dipole. The radiated power was for all cases 160 mW as shown in the table below. The measured 1g and 10g averaged SAR was normalized to 1 W and compared with the nominal values [12], [13]. SAR distribution plots from the system performance checks are given in Appendix C. The results were within 10% of the nominal values [12], [13] . The temperature of the test facility during the system performance checks was in the range 20°C to 25°C.

f (MHz)	Tissue type	Measured/ Reference	Radiated power (mW)	SAR 1g (W/kg), norm. to 1 W	SAR 10g (W/kg), norm. to 1 W	ε_r	σ (S/m)	Liquid temp (°C)	Date
835	Body (muscle)	Measured	160	9.06	5.94	54.4	0.96	21.9	110814
		Reference [12]	-	9.75	6.39	55.2	0.97	-	-
		Difference (%)	-	-7	-7	-1.5	-1	-	-

8 DASY5 uncertainty budget for assessments according to IEC 62209-2 [10]

Uncertainty component	Uncer. (%)	Prob Dist.	Div.	$C_{i,1g}$	$C_{i,10g}$	Std. Uncer. (1g) (%)	Std. Uncer. (10g) (%)	(v_i) v_{eff}
Measurement system								
Probe calibration	±6.55	N	1	1	1	±6.55	±6.55	∞
Axial isotropy	±4.7	R	√3	0.7	0.7	±1.9	±1.9	∞
Hemispherical isotropy	±9.6	R	√3	0.7	0.7	±3.9	±3.9	∞
Linearity	±4.7	R	√3	1	1	±2.7	±2.7	∞
Modulation response	±2.4	R	√3	1	1	±1.4	±1.4	∞
System detection limits	±1.0	R	√3	1	1	±0.6	±0.6	∞
Boundary effects	±2.0	R	√3	1	1	±1.2	±1.2	∞
Readout electronics	±0.3	N	1	1	1	±0.3	±0.3	∞
Response time	±0.8	R	√3	1	1	±0.5	±0.5	∞
Integration time	±2.6	R	√3	1	1	±1.5	±1.5	∞
RF ambient noise	±3.0	R	√3	1	1	±1.7	±1.7	∞
RF ambient reflections	±3.0	R	√3	1	1	±1.7	±1.7	∞
Probe positioner	±0.8	R	√3	1	1	±0.5	±0.5	∞
Probe positioning	±6.7	R	√3	1	1	±3.9	±3.9	∞
Post-processing	±4.0	R	√3	1	1	±2.3	±2.3	∞
Test Sample Related								
Device holder	±3.6	N	1	1	1	±3.6	±3.6	5
Test sample positioning	±2.9	N	1	1	1	±2.9	±2.9	145
Power scaling	±0.0	R	√3	1	1	±0.0	±0.0	∞
Power drift	±5.0	R	√3	1	1	±2.9	±2.9	∞
Phantom and setup								
Phantom uncertainty	±4.0	R	√3	1	1	±2.3	±2.3	∞
SAR correction	±1.9	R	√3	1	0.84	±1.1	±0.9	∞
Liquid conductivity (meas.)	±2.5	N	1	0.78	0.71	±2.0	±1.8	∞
Liquid permittivity (meas.)	±2.5	N	1	0.26	0.26	±0.6	±0.7	∞
Temp unc. – conductivity	±1.7	R	√3	0.78	0.71	±0.8	±0.7	∞
Temp unc. – permittivity	±0.3	R	√3	0.23	0.26	±0.0	±0.0	∞
Combined standard uncertainty						±12.0	±11.9	748
Expanded standard uncertainty (k=2)						**±23.9**	**±23.8**	

9 SAR measurement configurations

The SAR measurements were conducted on a terminal antenna (see Figure A.1) connected to the main port of the Ericsson F5521gw mobile broadband module (see Figure A.2), which was integrated in the host device (see Figure A.3). This antenna is a coupling type antenna and it is named Antenna #2 in [1] and [2].

The antenna was positioned with the front facing the phantom for a separation distance of 40 mm between the antenna and the phantom.

The SAR testing was conducted at the low, mid and high channels of GPRS 850 (2TS[5]) [14].

A universal radio communication tester (CMU-200) was used to control the device during the SAR measurements.

5 Two active uplink time slots.

10 SAR test results

The tables in this section show the measured 1g and 10g averaged SAR for the device. The flat oval ELI-4 phantom (thickness 2 ± 0.2 mm) was used for all measurements. A coarse rectangular approximately 250x150 mm large area scan (grid step 10 mm) covering the antenna under test was first used to locate the SAR maxima. Thereafter a 32x32x30 mm zoom scan (5x5x5 mm grid step) was used to determine the 1g and 10g averaged SAR in the region of maximum SAR. The measurement system uses a modified Quadratic Shepard's method for maximum search, interpolation and extrapolation to the surface of the phantom (which is unreachable due to probe case and boundary effects) in order to accurately determine the 1g and 10g averaged SAR.

The temperature of the test facility during the tests was in the range 20 to 25ºC. During the tests, the temperature of the tissue simulating liquid was within ±2ºC from the liquid temperature at system performance check.

Some of the SAR results have been corrected using formulas for SAR correction due to deviation from liquid parameter target values as required in [10]. In cases where the SAR correction formula gave a negative (-) sign no correction was made [10].

10.1 Results for the GPRS 850 modes

Antenna / Test position	Liquid temperature (°C)	Separation distance (mm)	Mode	f (MHz)	Measured SAR (W/kg)	
					SAR_{1g}	SAR_{10g}
Ant #2 / Front facing phantom	21.9	40	GPRS (2TS), CH 128	824.2	0.100	0.077
Ant #2 / Front facing phantom	21.9	40	GPRS (2TS), CH 190	836.6	0.096	0.074
Ant #2 / Front facing phantom	21.9	40	GPRS (2TS), CH 251	848.8	0.122	0.094

In Figure D.1 the SAR distribution for the channel giving the maximum SAR is shown.

11 Conclusion

The results for GPRS 850 in Section 10 show that the maximum 1g and 10g averaged SAR results for Antenna #2 are below 1/4th of the applicable SAR limits at a phantom-antenna separation distance of 40 mm.

12 References

[1] CETECOM, “Test Report No.: 1-2205-03-02/10”, February 2011.

[2] EAB-11:028990 Uen, “SAR Measurements on Four Different Terminal Antennas Connected to the Ericsson F5521gw Mobile Broadband Module”, September, 2011.

[3] FCC, “Evaluating Compliance with FCC Guidelines from Human Exposure To Radiofrequency Electromagnetic Fields”, Supplement C Edition 01-01 to OET Bulletin 65 Edition 97-01, June 2001.

[4] FCC, Code of Federal Regulations CFR title 47, part 2.1093 “Radiofrequency radiation exposure evaluation: portable devices.”, Federal Communications Commission (FCC), October 2008.

[5] ICNIRP, “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)”, International Commission on Non-Ionizing Radiation Protection (ICNIRP), Health Physics, vol. 74, pp 494-522, April 1998.

[6] Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 HZ to 300 GHz) (Official Journal L 197 of 30 July 1999).

[7] ARPANSA, “Radiation Protection Standard for Maximum Exposure Levels for Radiofrequency Fields – 3 kHz to 300 GHz (2002)”, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), May 2002.

[8] Radio Standard Specification (RSS) 102, (Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Industry Canada, 2009.

[9] IEEE Std C95.1-2005 (Revision of IEEE Std C95.1-1991), "Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz", The Institute of Electrical and Electronics Engineers Inc., New York, 2006.

[10] IEC 62209-2, "Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010.

[11] FCC KDB450824 D01. "SAR Probe Calibration and System Verification Considerations for Measurements at 150 MHz – 3 GHz", Rev. 1.1, January 2007.

[12] EAB/TF-03:090, "Calculation of reference SAR values for system performance checks with muscle tissue simulating liquid", Ericsson technical report, December 2006.

[13] IEEE, Standard 1528, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.", The Institute for Electrical and Electronics Engineers (IEEE) Inc., June 2003.

[14] FCC KDB941225 D03. "Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE", v01, December 2008.

[15] FCC KDB941225 D01. "SAR Measurement Procedures for 3G Devices – CDMA 2000 / Ev-Do – WCDMA / HSDPA / HSPA-, v02, October 2007.

APPENDIX A: Photographs of the EUT

Figure A.1 Antenna #2.

Figure A.2 The Ericsson F5521gw mobile broadband module.

Figure A.3 The Dell inspiron mini host device.

APPENDIX B: Photographs of the antennas when positioned for SAR measurements

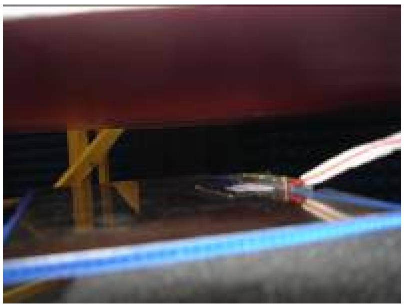


Figure B.1 Antenna #2 positioned with the front facing the ELI 4 phantom at 40 mm separation distance.

APPENDIX C: SAR distribution plots for the system performance checks

System performance check at 835 MHz conducted on the 14th of August

Date/Time: 2011-08-14 10:49:00, Date/Time: 2011-08-14 10:44:52

-Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
-Medium: Body 835 MHz Medium parameters used (interpolated): f = 835 MHz; σ = 0.97 mho/m; ε_r = 55.2; ρ = 1000 kg/m^3

DASY4 Configuration:
-Probe: ES3DV3 - SN3113; ConvF(5.82, 5.82, 5.82)
-Electronics: DAE3 Sn422
-Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1014
-; SEMCAD X Version 14.4.2 (2595)

Dipole 835V2 – SN: 413, Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.700 mW/g

Dipole 835V2 – SN: 413, Zoom Scan /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 42.493 V/m; Power Drift = -0.45 dB
Peak SAR (extrapolated) = 2.129 W/kg
SAR(1 g) = 1.45 mW/g; SAR(10 g) = 0.951 mW/g

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.687 mW/g

0 dB = 1.700mW/g

APPENDIX D: SAR distribution plots

Date/Time: 2011-08-14 21:13:43, Date/Time: 2011-08-14 21:47:04

-Communication System: GPRS 850 (2ts); Frequency: 848.8 MHz;Duty Cycle: 1:4.14954
-Medium: Body 835 MHz Medium parameters used (interpolated): f = 836.6 MHz; σ = 0.97 mho/m; ε_r = 55.2; ρ = 1000 kg/m^3

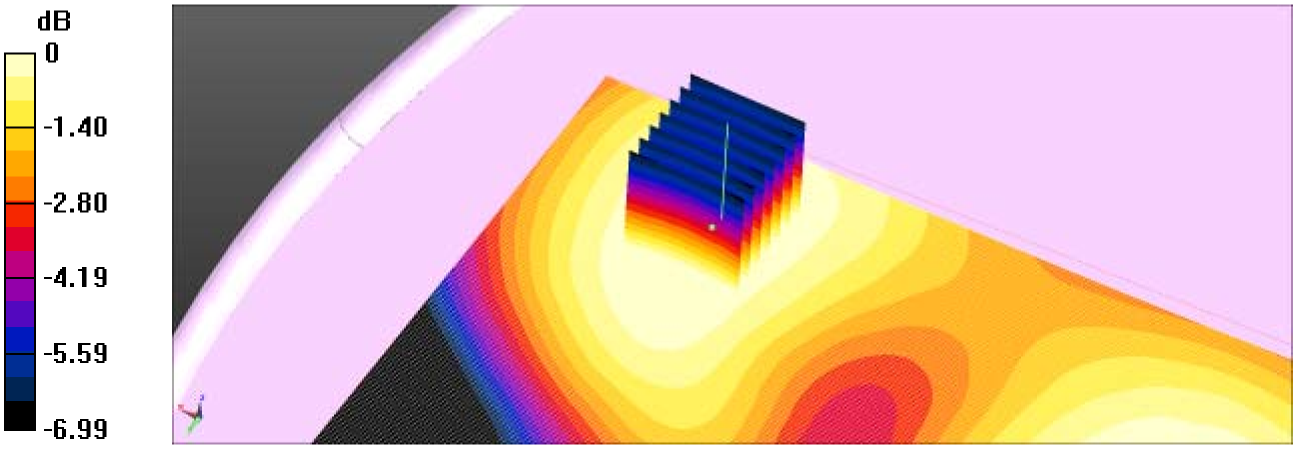
DASY4 Configuration:
-Probe: ES3DV3 - SN3113; ConvF(5.82, 5.82, 5.82)
-Electronics: DAE3 Sn422
-Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1014
-; SEMCAD X Version 14.4.2 (2595)

Dipole 835V2 – SN: 413, Area Scan (251x151x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.134 mW/g

Dipole 835V2 – SN: 413, Zoom Scan /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.879 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.157 W/kg
SAR(1 g) = 0.122 mW/g; SAR(10 g) = 0.094 mW/g

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.135 mW/g



0 dB = 0.130mW/g

Figure D.1 SAR distribution of antenna #2, transmitting at the highest channel of the GSM850 band (GPRS with two active uplink timeslots). The antenna is positioned with the front facing the phantom shell with a separation distance of 40 mm.

APPENDIX E: Probe calibration certificates

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
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 Ericsson AB

Certificate No: ES3-3113_Apr11

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3113

Calibration procedure(s): QA CAL-01.v7, QA CAL-23.v4, QA CAL-25.v3
Calibration procedure for dosimetric E-field probes

Calibration date: April 13, 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	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41495277	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
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:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 14, 2011

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

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
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**

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 ES3DV3

SN:3113

Manufactured: June 3, 2006
Calibrated: April 13, 2011

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3113

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.21	1.14	1.28	± 10.1 %
DCP (mV)[B]	100.9	104.8	99.4	

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	108.0	±3.0 %
			Y	0.00	0.00	1.00	106.7	
			Z	0.00	0.00	1.00	119.7	

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 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: ES3DV3 - SN:3113

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
900	41.5	0.97	5.85	5.85	5.85	1.00	1.00	± 11.0 %
1810	40.0	1.40	5.00	5.00	5.00	0.88	1.24	± 11.0 %
2000	40.0	1.40	4.90	4.90	4.90	0.89	1.18	± 11.0 %
2450	39.2	1.80	4.27	4.27	4.27	0.84	1.24	± 11.0 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV3- SN:3113

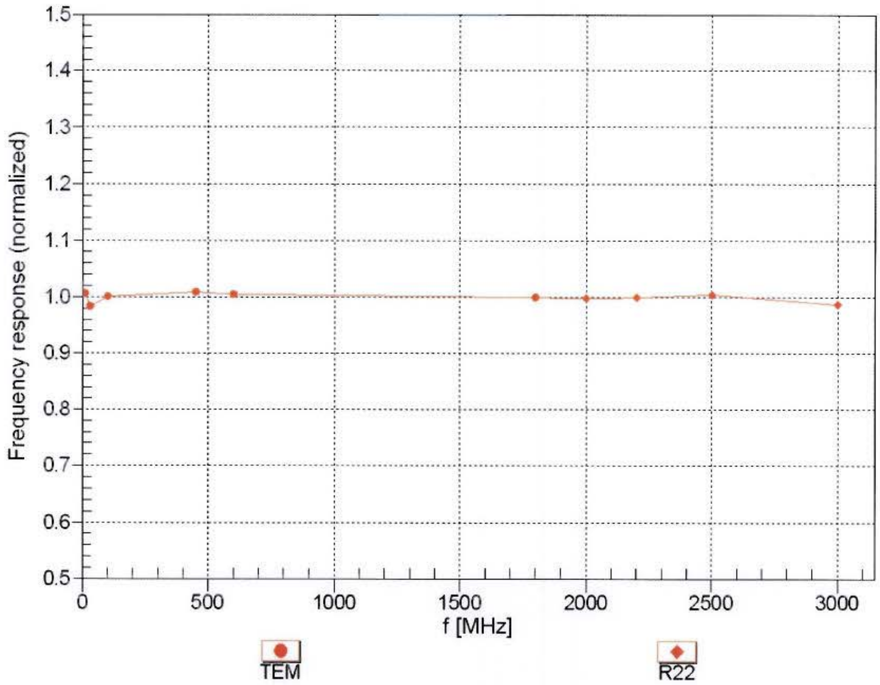
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
900	55.0	1.05	5.78	5.78	5.78	1.00	1.11	± 11.0 %
1810	53.3	1.52	4.86	4.86	4.86	0.78	1.45	± 11.0 %
2000	53.3	1.52	4.78	4.78	4.78	0.76	1.36	± 11.0 %
2450	52.7	1.95	4.31	4.31	4.31	1.00	1.05	± 11.0 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

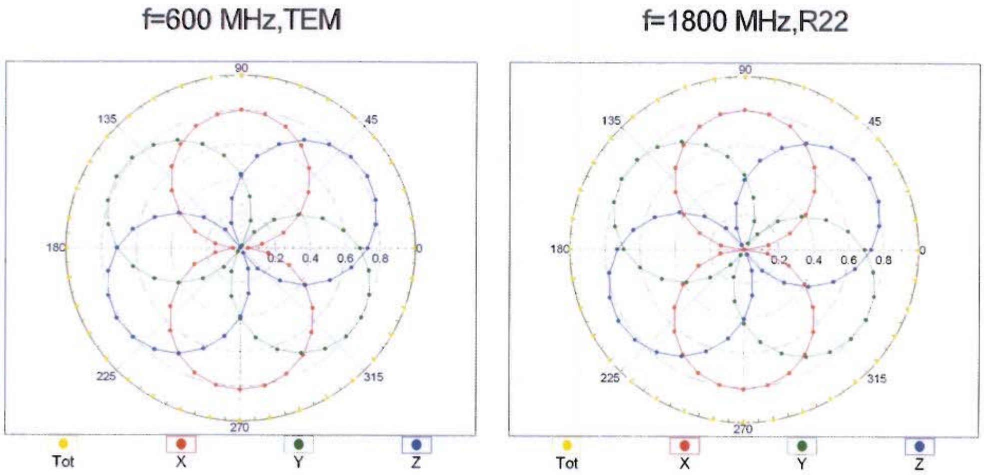
Frequency Response of E-Field

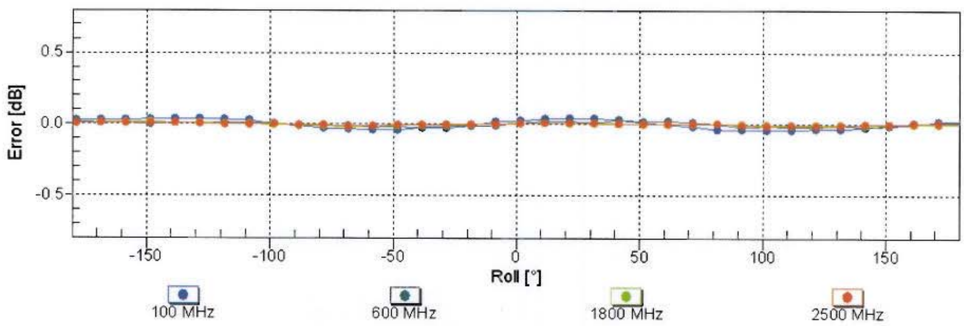
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

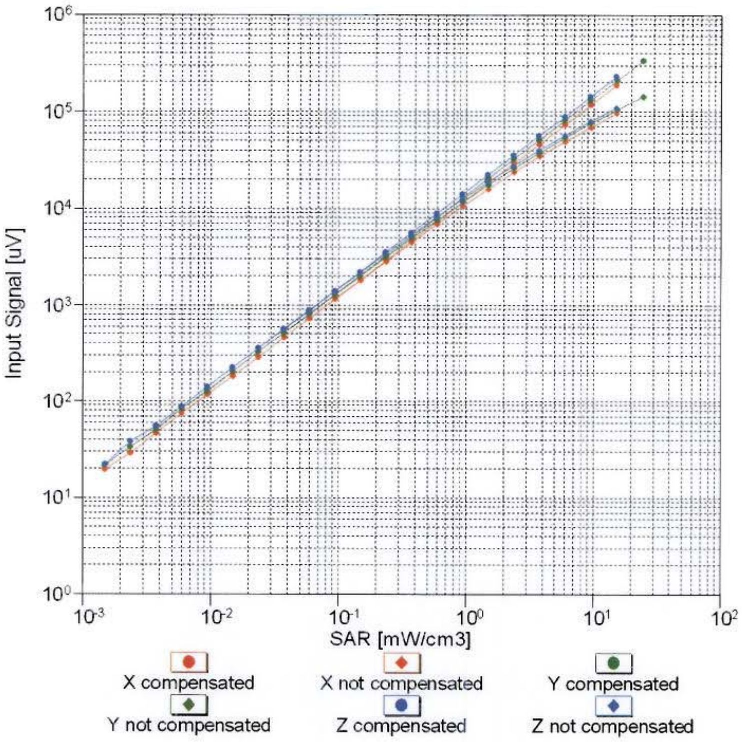
Receiving Pattern (ϕ), ϑ = 0°

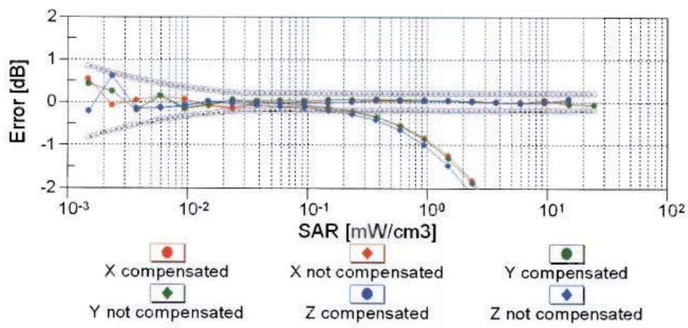




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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



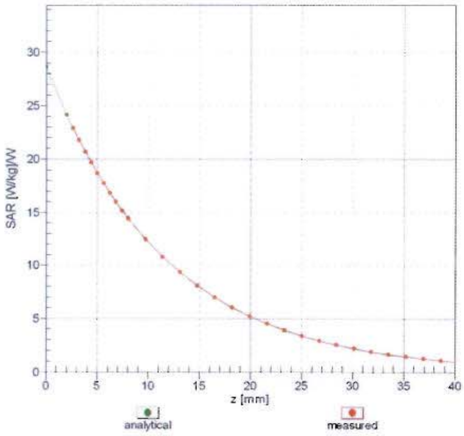


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

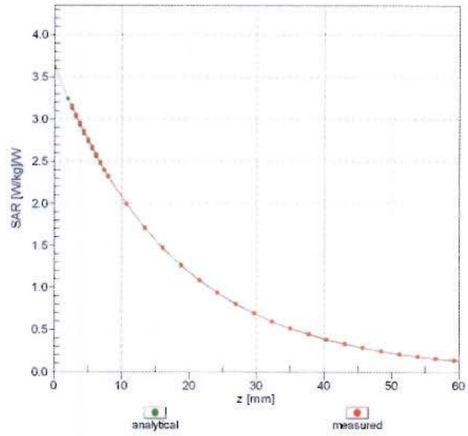
ES3DV3– SN:3113 April 13, 2011

Conversion Factor Assessment

f = 2000 MHz,WGLS R22 (H_convF)

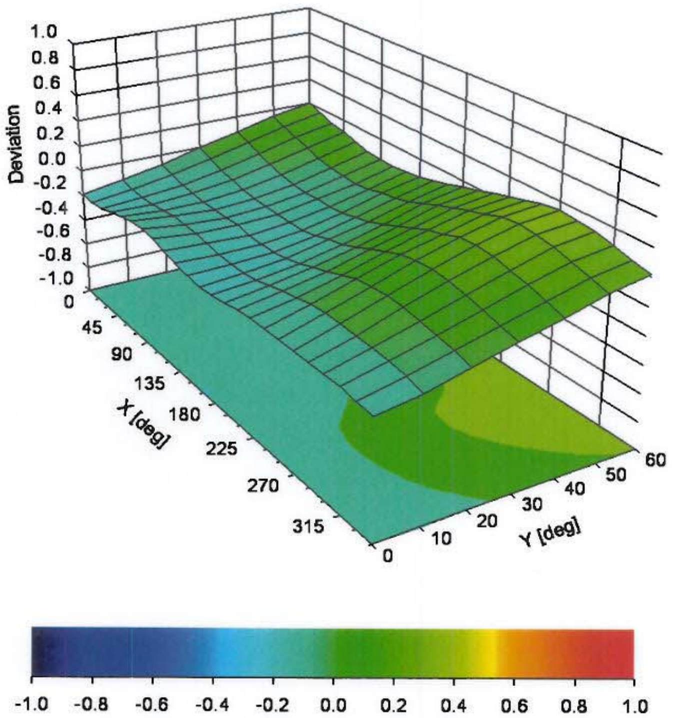


f = 900 MHz,WGLS R9 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3113

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	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

APPENDIX F: Validation dipole calibration certificates

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client Ericsson AB

Certificate No: D835V2-413_Jan10

CALIBRATION CERTIFICATE

Object	D835V2 - SN: 413
Calibration procedure(s)	QA CAL-05.v7 Calibration procedure for dipole validation kits
Calibration date:	January 14, 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)	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 ES3DV3	SN: 3205	26-Jun-09 (No. ES3-3205_Jun09)	Jun-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-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:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 15, 2010

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**

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	V5.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V4.9	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.2 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.4 ± 6 %	0.89 mho/m ± 6 %
Head TSL temperature during test	(21.5 ± 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	2.39 mW / g
SAR normalized	normalized to 1W	9.56 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**9.63 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.56 mW / g
SAR normalized	normalized to 1W	6.24 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**6.27 mW /g ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.6 ± 6 %	0.98 mho/m ± 6 %
Body TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.48 mW / g
SAR normalized	normalized to 1W	9.92 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**9.82 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.62 mW / g
SAR normalized	normalized to 1W	6.48 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**6.43 mW / g ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.2 Ω - 4.9 jΩ
Return Loss	- 26.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.0 Ω - 6.7 jΩ
Return Loss	- 21.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.423 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	October 20, 1999

DASY5 Validation Report for Head TSL

Date/Time: 11.01.2010 10:56:06

Test Laboratory: SPEAG, Zurich, Switzerland

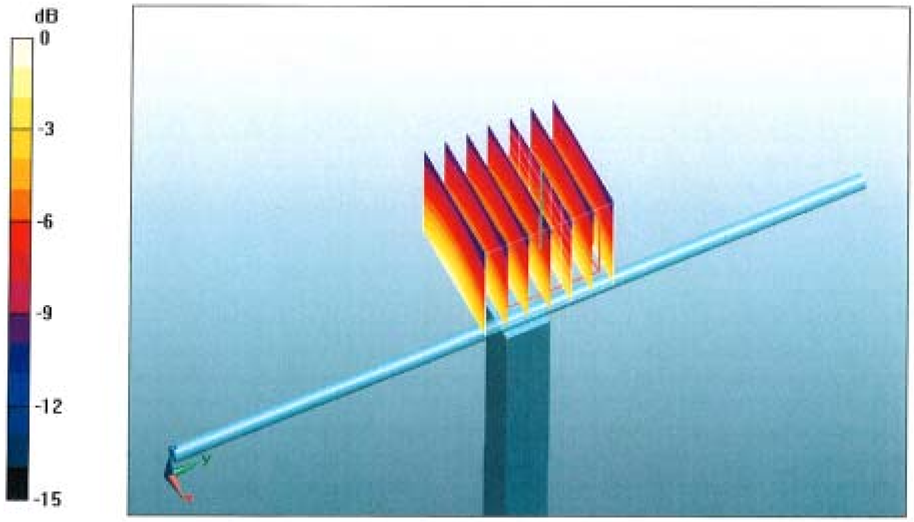
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:413

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: HSL900
Medium parameters used: f = 835 MHz; σ = 0.89 mho/m; ε_r = 41.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

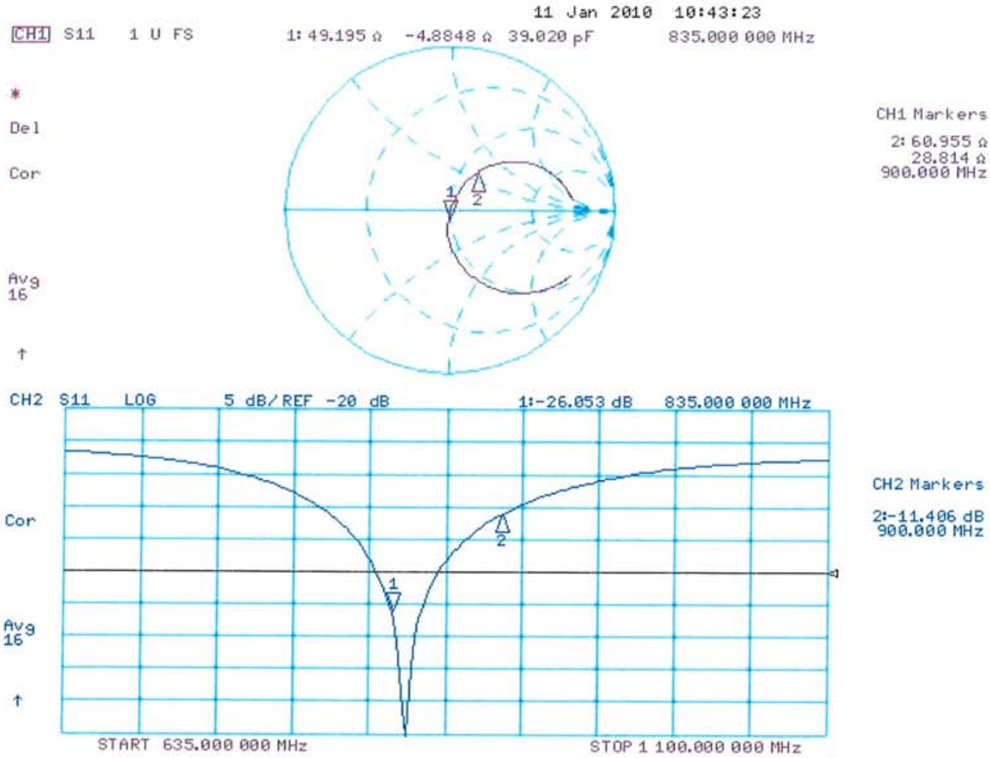
- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.3 V/m; Power Drift = 0.029 dB
Peak SAR (extrapolated) = 3.59 W/kg
SAR(1 g) = 2.39 mW/g; SAR(10 g) = 1.56 mW/g
Maximum value of SAR (measured) = 2.78 mW/g



0 dB = 2.78mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body

Date/Time: 14.01.2010 12:39:11

Test Laboratory: SPEAG, Zurich, Switzerland

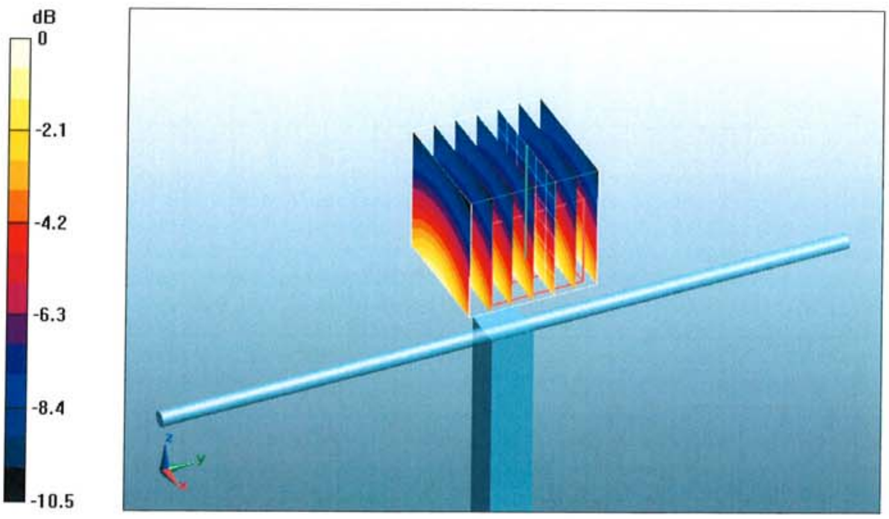
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:413

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: MSL900
Medium parameters used: f = 835 MHz; $\sigma = 0.98$ mho/m; $\varepsilon_r = 54.6$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.97, 5.97, 5.97); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

Pin250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.6 V/m; Power Drift = -0.015 dB
Peak SAR (extrapolated) = 3.65 W/kg
SAR(1 g) = 2.48 mW/g; SAR(10 g) = 1.62 mW/g
Maximum value of SAR (measured) = 2.87 mW/g



0 dB = 2.87mW/g

Impedance Measurement Plot for Body TSL