SAR TEST REPORT

No. I15N01101-SAR

For

TCL Communication Ltd.

GSM Quad band &UMTS Dual band mobile phone

Mode Name: 2045X

With

Hardware Version: PIO

Software Version: V1.0

FCC ID: 2ACCJB038

Issued Date: 2015-10-25

Note:

The test results in this test report relate only to the devices specified in this report.This report shall not be reproduced except in full without the written approval of CTTL.

Test Laboratory:

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REPORT HISTORY

Report Number	Revision	Issue Date	Description
I15N01101-SAR	Rev.0	2015-10-25	Initial creation of test report

TABLE OF CONTENT

1 Test Laboratory

1.1 Testing Location

Company Name:	CTTL(South Branch)
Address:	TCL International E city No. 1001 Zhongshanyuan Road, Nanshan District, Shenzhen, Guangdong, China 518000

1.2 Testing Environment

Temperature:	Min. = 15 °C, Max. = 30 °C
Relative humidity:	Min. = 30%, Max. = 70%
Ground system resistance:	< 0.5 Ω
Ambient noise & Reflection:	< 0.012 W/kg

1.3 Project Data

Project Leader:	Cao Junfei
Test Engineer:	He Guanyi
Testing Start Date:	October 24, 2015
Testing End Date:	October 24, 2015

1.4 Signature

He Guanyi

(Prepared this test report)

Cao Junfei

(Reviewed this test report)

Zhang Bojun

Deputy Director of the laboratory

(Approved this test report)

2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for TCL Communication Ltd. GSM Quad band &UMTS Dual band mobile phone 2045X are as follows:

Table 2.1: Highest Reported SAR (1g)

Exposure Configuration	Technology Band	Highest Reported SAR 1g (W/Kg)	Equipment Class
Head (Separation Distance 0mm)	GSM 850	0.50	PCE
	PCS 1900	0.40	
Body-worn (Separation Distance 15mm)	GSM 850	0.82	PCE
	PCS 1900	**0.89**	

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1992.

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance of 15 mm between this device and the body of the user. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report.

The highest reported SAR value is obtained at the case of **(Table 2.1),** and the values are**: 0.89 W/kg (1g).**

Table 2.2: The sum of reported SAR values for main antenna and Bluetooth

	Position	Main antenna	BT*	Sum
Highest reported SAR value for Head	Left hand, Touch cheek	0.40	0.17	**0.57**
	Right hand, Touch cheek	0.50	0.17	**0.67**
Highest reported SAR value for Body	Rear	0.89	0.06	**0.95**

BT* - Estimated SAR for Bluetooth (see the table 13.3)

3 Client Information

3.1 Applicant Information

Company Name:	TCL Communication Ltd.
Address /Post:	5F, C-Tower, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area,Shanghai,201003,P.R.China
City:	Shanghai
Postal Code:	201003
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3.2 Manufacturer Information

Company Name:	TCL Communication Ltd.
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Fax:	+86(0)21 6146 0600

4 Equipment Under Test (EUT) and Ancillary Equipment (AE)

4.1 About EUT

Description:	GSM Quad band &UMTS Dual band mobile phone
Mode Name:	2045X
Marketing Name:	/
Operating mode(s):	GSM 850/900/1800/1900, WCDMA 900/2100, BT,
Tested Tx Frequency:	825 – 848.8 MHz (GSM 850)
	1850.2 – 1910 MHz (GSM 1900)
GPRS Multislot Class:	10
GPRS capability Class:	B
Release Version:	GSM: Rel4
	GPRS: Rel4
Test device Production information:	Production unit
Device type:	Portable device
Antenna type:	Integrated antenna
Accessories/Body-worn configurations:	Headset
Hotspot mode:	/
Form factor:	104.4 mm ×51.9 mm

4.2 Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version
EUT1	355626060090605	PIO	V1.0

*EUT ID: is used to identify the test sample in the lab internally.

4.3 Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
AE1	Battery	CAB3120000C1	/	BYD
AE2	Headset	CCB0010A11C7	/	JIAYIKANG
AE3	Headset	CCB0010A10C7	/	JIAYIKANG

*AE ID: is used to identify the test sample in the lab internally.

Note:

AE3 and AE2 are the same, so they can use the same results.

5 TEST METHODOLOGY

5.1 Applicable Limit Regulations

ANSI C95.1–1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2 Applicable Measurement Standards

IEEE 1528–2013: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Experimental Techniques.

KDB447498 D01: General RF Exposure Guidance v05r02: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB648474 D04 Handset SAR v01r02: SAR Evaluation Considerations for Wireless Handsets.

KDB941025 D06: SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities

KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03: SAR Measurement Requirements for 100 MHz to 6 GHz

KDB 865664 D02 RF Exposure Reporting v01r01: RF Exposure Compliance Reporting and Documentation Considerations

6 Specific Absorption Rate (SAR)

6.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

6.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$SAR = \frac{d}{dt}(\frac{dW}{dm}) = \frac{d}{dt}(\frac{dW}{\rho dv})$$

SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c(\frac{\delta T}{\delta t})$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7 Tissue Simulating Liquids

7.1 Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

Frequency (MHz)	Liquid Type	Conductivity (σ)	± 5% Range	Permittivity (ε)	± 5% Range
835	Head	0.90	0.86～0.95	41.5	39.4～43.6
835	Body	0.97	0.92～1.02	55.2	52.4～58.0
1900	Head	1.40	1.33～1.47	40.0	38.0～42.0
1900	Body	1.52	1.44～1.60	53.3	50.6～56.0

7.2 Dielectric Performance

Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2015-10-24	Head	835 MHz	41.32	-0.43	0.93	3.33
2015-10-24	Body	835 MHz	53.50	-3.08	0.97	0.00
2015-10-24	Head	1900 MHz	40.85	2.13	1.39	-0.71
2015-10-24	Body	1900 MHz	50.79	-4.71	1.54	1.32

Note: The liquid temperature is 22.0 $^{\circ}$C
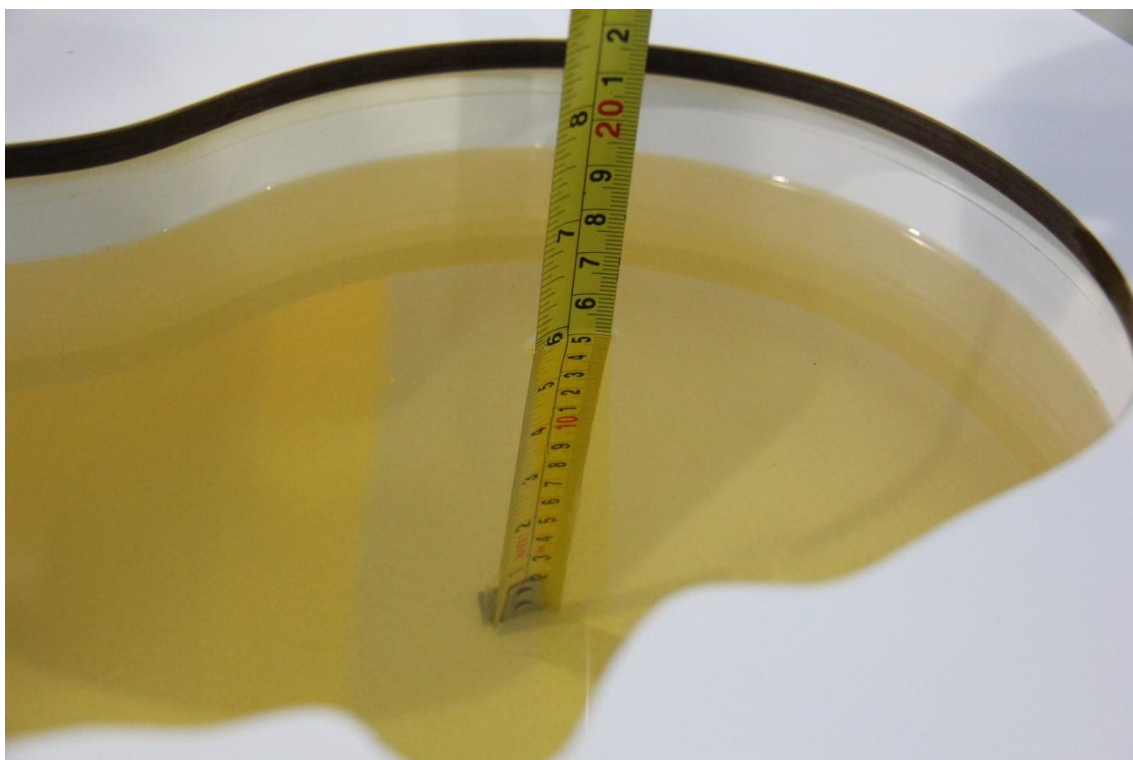
Picture 7-1: Liquid depth in the Head Phantom (835 MHz)
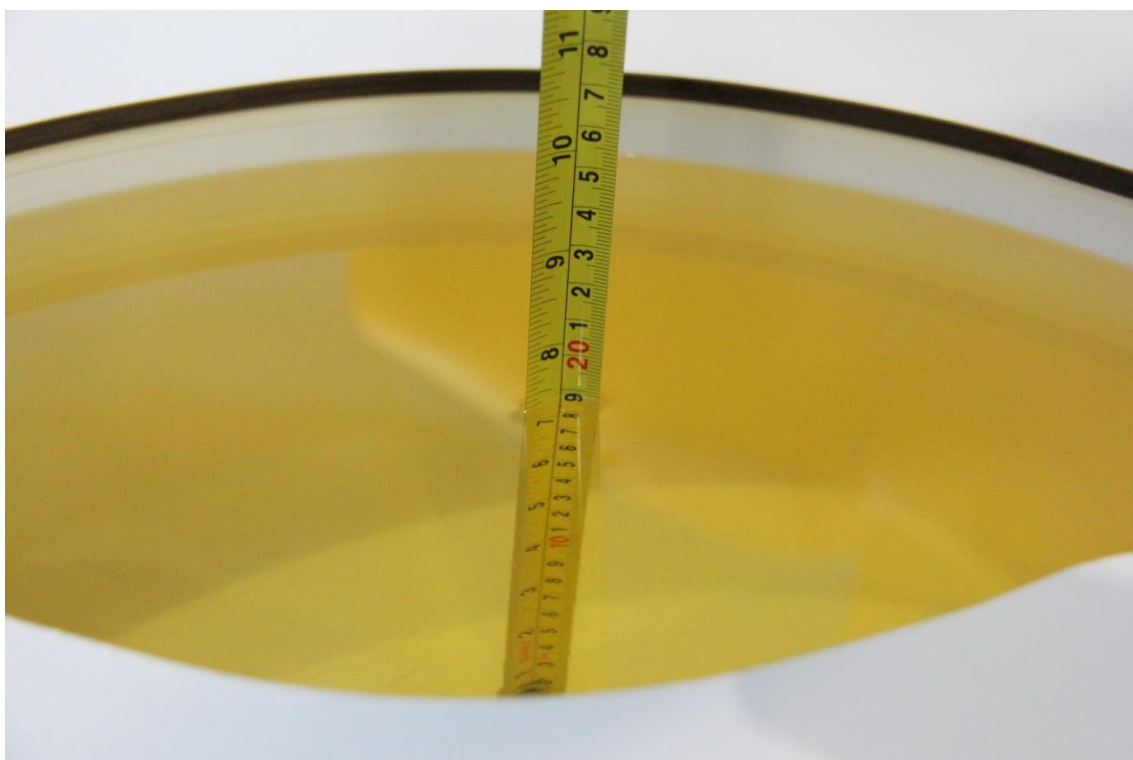
Picture 7-2: Liquid depth in the Flat Phantom (835 MHz)

Picture 7-3: Liquid depth in the Head Phantom (1900 MHz)
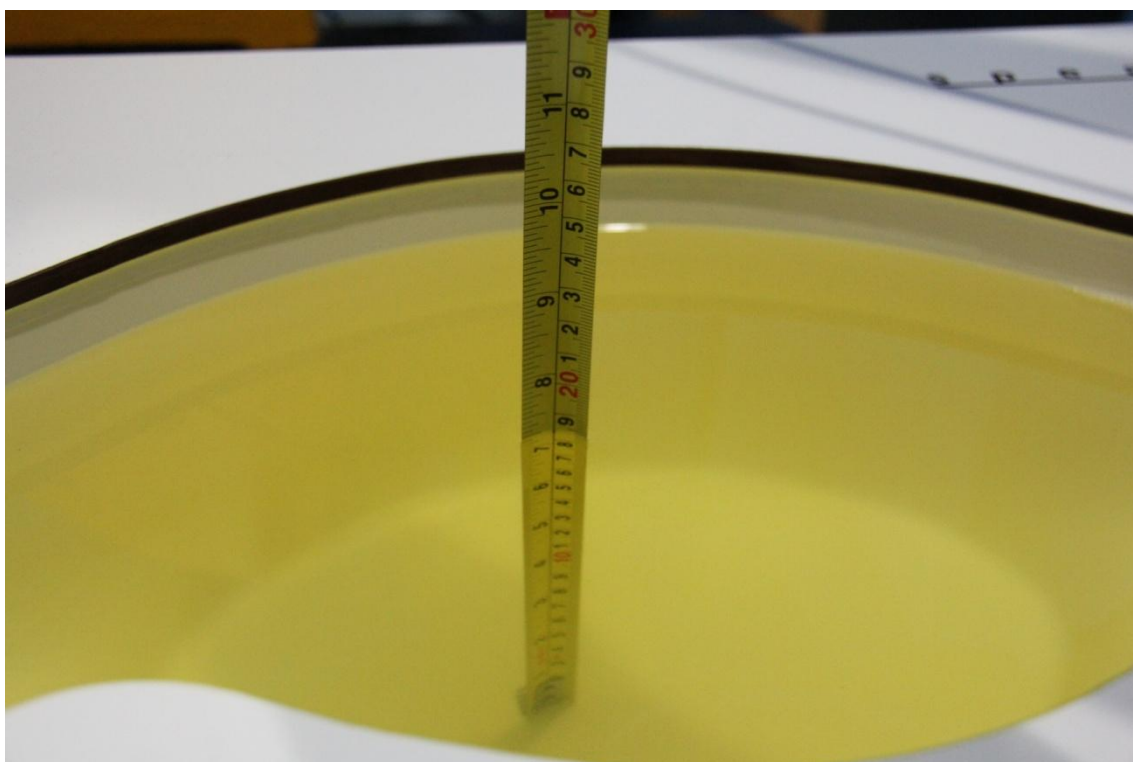
Picture 7-4 Liquid depth in the Flat Phantom (1900MHz)

8 System verification

8.1 System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:
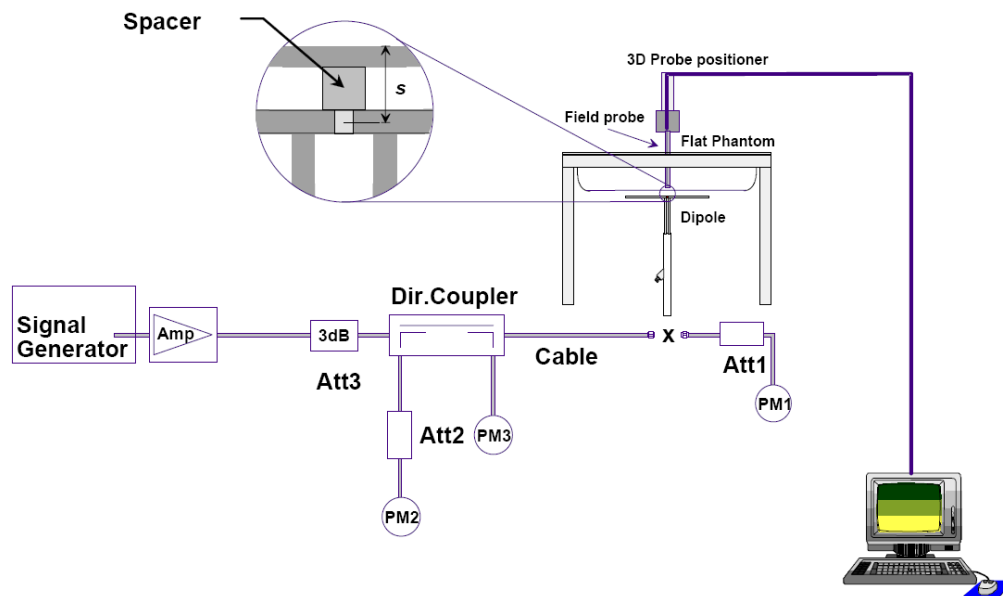
Picture 8.1 System Setup for System Evaluation

Picture 8.2 Photo of Dipole Setup

8.2 System Verification

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

The system verification results are required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR. The details are presented in annex B.

Table 8.1: System Verification of Head

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value (W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2015-10-24	835 MHz	6.2	9.5	6.2	9.76	0.00%	2.74%
2015-10-24	1900 MHz	20.9	40.5	20.4	40.64	-2.39%	0.35%

Table 8.2: System Verification of Body

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value (W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2015-10-24	835 MHz	6.4	9.5	6.32	9.84	-1.25%	3.58%
2015-10-24	1900 MHz	21.5	41.1	22.16	41.2	3.07%	0.24%

9 Measurement Procedures

9.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),
b) all configurations for each device position in a), e.g., antenna extended and retracted, and
c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., N_c > 3), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.
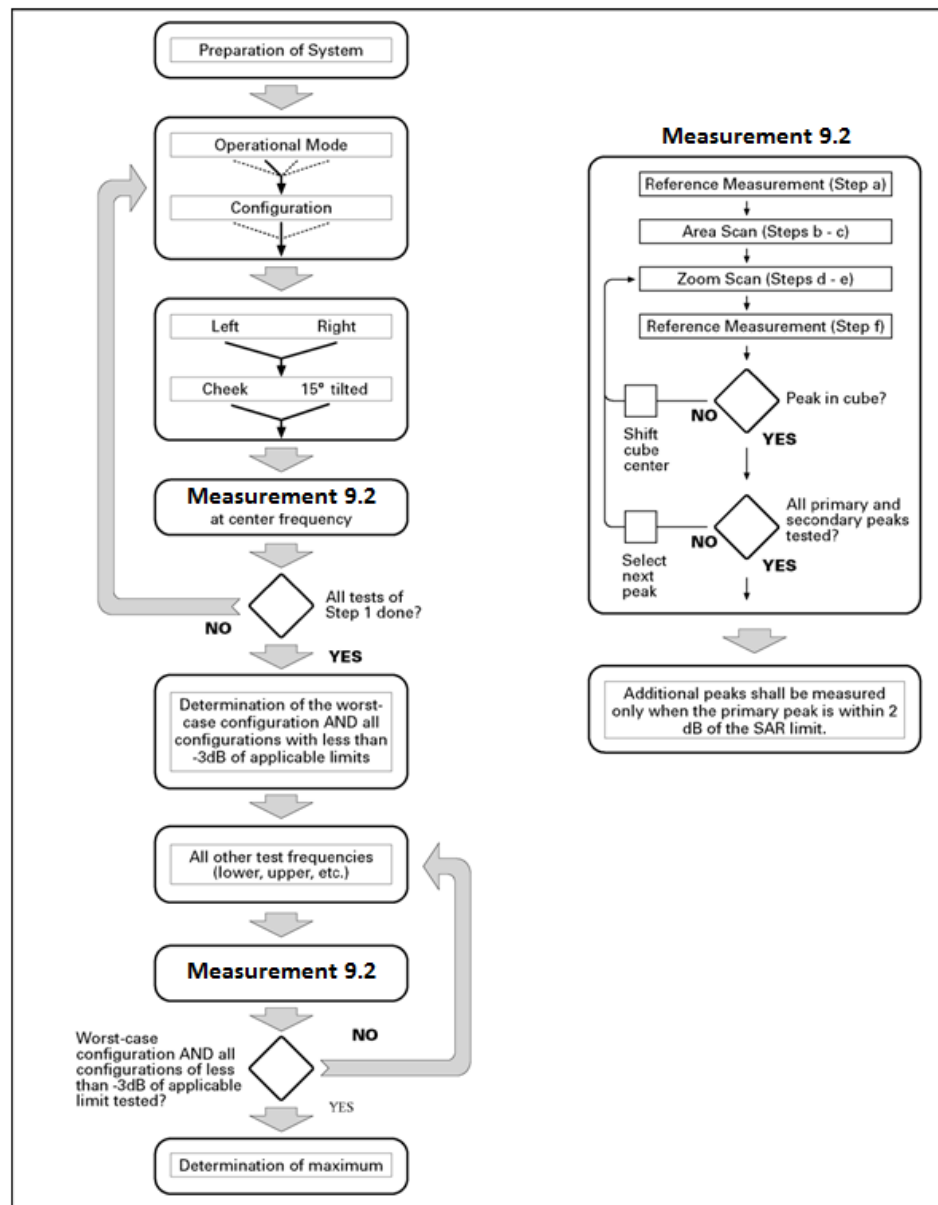
Picture 9.1 Block diagram of the tests to be performed

9.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results

when all the measurement parameters in the following table are not satisfied.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
		When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}	≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid — $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
	graded grid — $\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

9.4 Bluetooth Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of BT. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.5 Power Drift

To control the output power stability during the SAR test, DASY4 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 14.2 to Table 14.23 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10 Area Scan Based 1-g SAR

10.1 Requirement of KDB

According to the KDB447498 D01 v05, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is ≤ 1.2 W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

10.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1- and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1- and 10-g averaged SAR, respectively. The paper describing the algorithm in detail is expected to be published in August 2004 within the Special Issue of Transactions on MTT.

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit whereby the frequency validity was extended to cover the range 30-6000MHz. Details of this study can be found in the BEMS 2007 Proceedings.

Both algorithms are implemented in DASY software.

11 Conducted Output Power

11.1 Manufacturing tolerance

Table 11.1: GSM Speech

Channel	Channel 251	Channel 190	Channel 128
GSM 850			
Channel	Channel 251	Channel 190	Channel 128
Target (dBm)	32.0	32.0	32.0
Tolerance ±(dB)	1	1	1
GSM 1900			
Channel	Channel 810	Channel 661	Channel 512
Target (dBm)	29	29	29
Tolerance ±(dB)	1	1	1

Table 11.2: GPRS

	Channel	251	190	128
GSM 850 GPRS				
	Channel	251	190	128
1 Txslot	Target (dBm)	32.0	32.0	32.0
	Tolerance ±(dB)	1	1	1
2 Txslots	Target (dBm)	31	31	31
	Tolerance ±(dB)	1	1	1
GSM 1900 GPRS				
	Channel	810	661	512
1 Txslot	Target (dBm)	29	29	29
	Tolerance ±(dB)	1	1	1
2 Txslots	Target (dBm)	28	28	28
	Tolerance ±(dB)	1	1	1

Table 11.3: Bluetooth

Mode	Target (dBm)	Tolerance ±(dB)
GFSK	4	2
EDR2M-4_DQPSK	3	2
EDR3M-8DPSK	3	2

11.2 GSM Measurement result

During the process of testing, the EUT was controlled via Agilent Digital Radio Communication tester (E5515C) to ensure the maximum power transmission and proper modulation. This result contains conducted output power for the EUT. In all cases, the measured peak output power should be greater and within 5% than EMI measurement.

Table 11.6: The conducted power measurement results for GSM850/1900

GSM 850MHz	Conducted Power (dBm)		
	Channel 251(848.8MHz)	Channel 190(836.6MHz)	Channel 128(824.2MHz)
	32.15	32.20	32.16
GSM 1900MHz	Conducted Power (dBm)		
	Channel 810(1909.8MHz)	Channel 661(1880MHz)	Channel 512(1850.2MHz)
	29.00	29.02	29.08

Table 11.7: The conducted power measurement results for GPRS

GSM 850 GPRS (GMSK)	Measured Power (dBm)			calculation	Averaged Power (dBm)		
	251	**190**	**128**		**251**	**190**	**128**
1 Txslot	32.15	32.20	32.16	-9.03dB	23.10	23.17	23.13
2 Txslots	31.39	31.45	31.40	-6.02dB	**25.37**	**25.43**	**25.38**
PCS1900 GPRS (GMSK)	Measured Power (dBm)			calculation	Averaged Power (dBm)		
	810	**661**	**512**		**810**	**661**	**512**
1 Txslot	29.00	29.02	29.08	-9.03dB	19.97	19.99	20.05
2 Txslots	28.03	27.97	27.96	-6.02dB	**22.01**	**21.95**	**21.94**

NOTES:

1) Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.03dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.02dB

According to the conducted power as above, the body measurements are performed with 2Txslots for GSM 850 and GSM 1900.

11.3 BT Measurement result

The output power of BT antenna is as following:

Mode	Conducted Power (dBm)		
	Channel 0 (2402MHz)	Channel 39 (2441MHz)	Channel 78 (2480MHz)
GFSK	4.81	4.80	4.74
EDR2M-4_DQPSK	3.79	3.90	4.00
EDR3M-8DPSK	3.69	3.85	3.93

10 Simultaneous TX SAR Considerations

10.1 Introduction

The following procedures adopted from "FCC SAR Considerations for Cell Phones with Multiple Transmitters" are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g and Bluetooth devices which may simultaneously transmit with the licensed transmitter.
For this device, the BT and Wi-Fi can transmit simultaneous with other transmitters.

10.2 Transmit Antenna Separation Distances
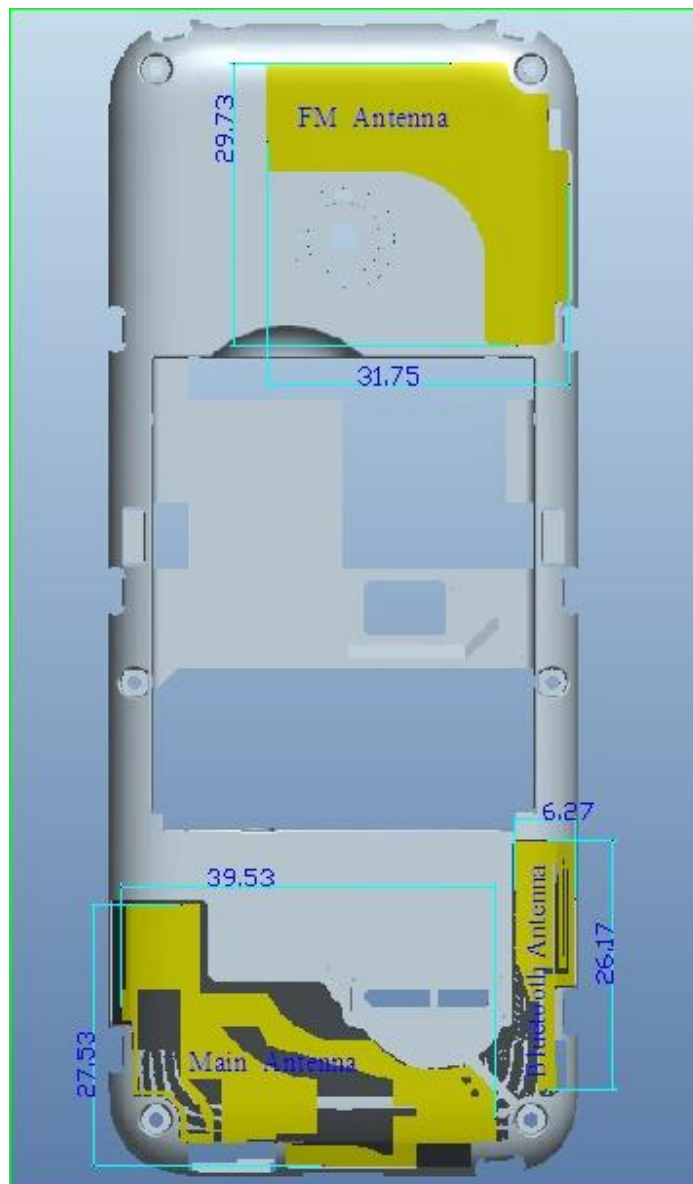
Picture 10.1 Antenna Locations

10.3 Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied. The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

Table 10.1: Standalone SAR test exclusion considerations

Band/Mode	F(GHz)	Position	SAR test exclusion threshold (mW)	RF output power		SAR test exclusion
				dBm	mW	
Bluetooth	2.441	Head	9.60	4.81	3.03	Yes
		Body	19.20	4.81	3.03	Yes

13 Evaluation of Simultaneous

Table 13.1: The sum of reported SAR values for main antenna and Bluetooth

	Position	Main antenna	BT*	Sum
Highest reported SAR value for Head	Left hand, Touch cheek	0.40	0.17	**0.57**
	Right hand, Touch cheek	0.50	0.17	**0.67**
Highest reported SAR value for Body	Rear	0.89	0.06	**0.95**

BT* - Estimated SAR for Bluetooth (see the table 13.2)

Table 13.2: Estimated SAR for Bluetooth

Position	F (GHz)	Distance (mm)	Upper limit of power *		Estimated$_{1g}$ (W/kg)
			dBm	mW	
Head	2.441	5	6	3.98	0.17
Body	2.441	15	6	3.98	0.06

* - Maximum possible output power declared by manufacturer

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

(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]·[√f(GHz)/x] W/kg for test separation distances ≤ 50 mm;

where x = 7.5 for 1-g SAR.

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

Conclusion:

According to the above tables, the sum of reported SAR values is < 1.6W/kg. So the simultaneous transmission SAR with volume scans is not required.

14 SAR Test Result

It is determined by user manual for the distance between the EUT and the phantom bottom.
The distance is 15mm and just applied to the condition of body worn accessory.
It is performed for all SAR measurements with area scan based 1-g SAR estimation (Fast SAR). A
zoom scan measurement is added when the estimated 1-g SAR is the highest measured SAR in
each exposure configuration, wireless mode and frequency band combination or > 1.2W/kg.
The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(P_{Target} - P_{Measured})/10}$$

Where P_{Target} is the power of manufacturing upper limit;

$P_{Measured}$ is the measured power in chapter 11.

Table 14.1: Duty Cycle

Mode	Duty Cycle
Speech for GSM850/1900	1:8.3
GPRS for GSM850	1:4
BT	1:1

14.1 SAR results for Fast SAR

Table 14.1: SAR Values (GSM 850 MHz Band - Head)

Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.										
836.6	190	Left	Touch	/	32.20	33.0	0.249	**0.30**	0.368	**0.44**	-0.10
836.6	190	Left	Tilt	/	32.20	33.0	0.119	**0.14**	0.173	**0.21**	-0.02
848.8	251	Right	Touch	Fig.1	32.15	33.0	0.301	**0.37**	0.416	**0.50**	-0.01
836.6	190	Right	Touch	/	32.20	33.0	0.259	**0.31**	0.385	**0.46**	0.13
824.2	128	Right	Touch	/	32.16	33.0	0.222	**0.27**	0.329	**0.40**	-0.05
836.6	190	Right	Tilt	/	32.20	33.0	0.167	**0.20**	0.247	**0.30**	0.02

Table 14.2: SAR Values (GSM 850 MHz Band - Body)

Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
836.6	190	Front	/	31.45	32	0.330	**0.37**	0.481	**0.55**	-0.05
848.8	251	Rear	/	31.39	32	0.473	**0.54**	0.686	**0.79**	0.10
836.6	190	Rear	Fig.2	31.45	32	0.530	**0.60**	0.721	**0.82**	-0.02
824.2	128	Rear	/	31.40	32	0.475	**0.55**	0.691	**0.79**	0.09
836.6	190	Rear Headset	/	32.20	33.0	0.285	**0.34**	0.415	**0.50**	0.16

Note1: The distance between the EUT and the phantom bottom is 15mm

Table 14.3: SAR Values (GSM 1900 MHz Band - Head)

Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.										
1909.8	810	Left	Touch	/	29.00	30.0	0.162	**0.20**	0.286	**0.36**	0.10
1880	661	Left	Touch	/	29.02	30.0	0.187	**0.23**	0.310	**0.39**	-0.13
1850.2	512	Left	Touch	Fig.3	29.08	30.0	0.195	**0.24**	0.323	**0.40**	-0.04
1880	661	Left	Tilt	/	29.02	30.0	0.094	**0.10**	0.155	**0.19**	-0.01
1880	661	Right	Touch	/	29.02	30.0	0.149	**0.19**	0.243	**0.30**	-0.16
1880	661	Right	Tilt	/	29.02	30.0	0.101	**0.13**	0.177	**0.22**	0.04

Ambient Temperature: 22.4 °C   Liquid Temperature: 21.9 °C

Table 14.4: SAR Values (GSM 1900 MHz Band - Body)

Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
1880	661	Front	/	27.97	29.0	0.152	**0.19**	0.252	**0.32**	-0.05
1909.8	810	Rear	/	28.03	29.0	0.373	**0.47**	0.625	**0.78**	0.14
1880	661	Rear	/	27.97	29.0	0.420	**0.53**	0.682	**0.86**	0.00
1850.2	512	Rear	Fig.4	27.96	29.0	0.441	**0.56**	0.697	**0.89**	-0.09
1850.2	512	Rear Headset	/	29.08	30.0	0.294	**0.36**	0.476	**0.59**	0.06

Note1: The distance between the EUT and the phantom bottom is 15mm.

14.2 SAR results for Standard procedure

There is zoom scan measurement to be added for the highest measured SAR in each exposure configuration/band.

Table 14.5: SAR Values (GSM 850 MHz Band - Head)

Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.										
848.8	251	Right	Touch	Fig.1	32.15	33.0	0.301	**0.37**	0.416	**0.50**	-0.01

Ambient Temperature: 22.5 °C   Liquid Temperature: 22.0 °C

Table 14.6: SAR Values (GSM 850 MHz Band - Body)

Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
836.6	190	Rear	Fig.2	31.45	32	0.530	**0.60**	0.721	**0.82**	-0.02

Note1: The distance between the EUT and the phantom bottom is 15mm

Table 14.7: SAR Values (GSM 1900 MHz Band - Head)

Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.										
1850.2	512	Left	Touch	Fig.3	29.08	30.0	0.195	**0.24**	0.323	**0.40**	-0.04

Ambient Temperature: 22.4 °C   Liquid Temperature: 21.9 °C

Table 14.8: SAR Values (GSM 1900 MHz Band - Body)

Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
1850.2	512	Rear	Fig.4	27.96	29.0	0.441	**0.56**	0.697	**0.89**	-0.09

Note1: The distance between the EUT and the phantom bottom is 15mm.

15 SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

16 Measurement Uncertainty

16.1 Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system									
1	Probe calibration	B	5.5	N	1	1	1	5.5	5.5	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	N	1	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. restrictions	B	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∞
10	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Test sample related									
14	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
15	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
16	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up									
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
19	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
20	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty	$u_c^{'} = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$							9.25	9.10	257
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$							18.5	18.2	

16.2 Measurement Uncertainty for Fast SAR Tests (300MHz~3GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system										
1	Probe calibration	B	5.5	N	1	1	1	5.5	5.5	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. Restrictions	B	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∞
10	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
14	Fast SAR z-Approximation	B	7.0	R	$\sqrt{3}$	1	1	4.0	4.0	∞
Test sample related										
15	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
16	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
17	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
18	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
19	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
20	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
21	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
22	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty	$u_c^{'} = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$							10.1	9.95	257
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$							20.2	19.9	

17 MAIN TEST INSTRUMENTS

Table 17.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	Agilent E5071C	MY46103759	December 17,2014	One year
04	Power meter	NRVD	101053	March 5,2015	One year
05	Power sensor	NRV-Z5	100333		
07	Signal Generator	E4438C	MY45095825	January 13, 2015	One year
08	Amplifier	VTL5400	0404	No Calibration Requested	
10	BTS	E5515C	GB46110723	May 20, 2015	One year
10	E-field Probe	SPEAG EX3DV4	3633	January 30, 2015	One year
13	DAE	SPEAG DAE4	786	November 20, 2014	One year
17	Dipole Validation Kit	SPEAG D835V2	4d057	November 4, 2014	One year
18	Dipole Validation Kit	SPEAG D1900V2	873	November 5, 2014	One year

END OF REPORT BODY

ANNEX A   Graph Results

850 Right Cheek High

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: 900 Head

Medium parameters used (interpolated): f = 848.8 MHz; σ = 0.906 S/m; ε_r = 42.139; ρ = 1000 kg/m^3

Ambient Temperature:22.0^{o}C   Liquid Temperature:21.5^{o}C

Communication System: UID 0, GSM Frequency: 848.8 MHz Duty Cycle: 1:8.3

Probe: EX3DV4 - SN3633 ConvF(8.95, 8.95, 8.95); Calibrated: 2015-1-30

Right Cheek High/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.445 W/kg

Right Cheek High/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.006 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.525 W/kg

SAR(1 g) = 0.416 W/kg; SAR(10 g) = 0.301 W/kg

Maximum value of SAR (measured) = 0.441 W/kg
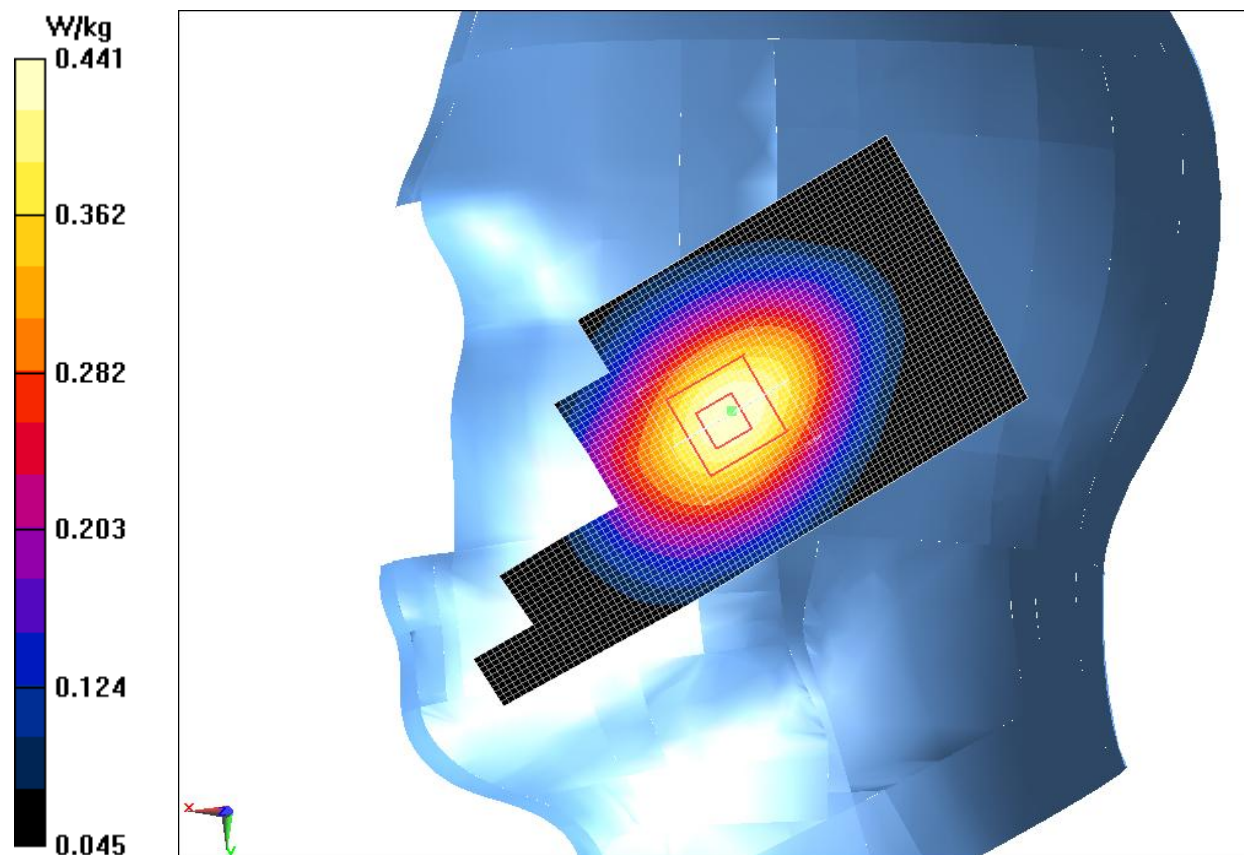
Fig.1 850MHz CH251
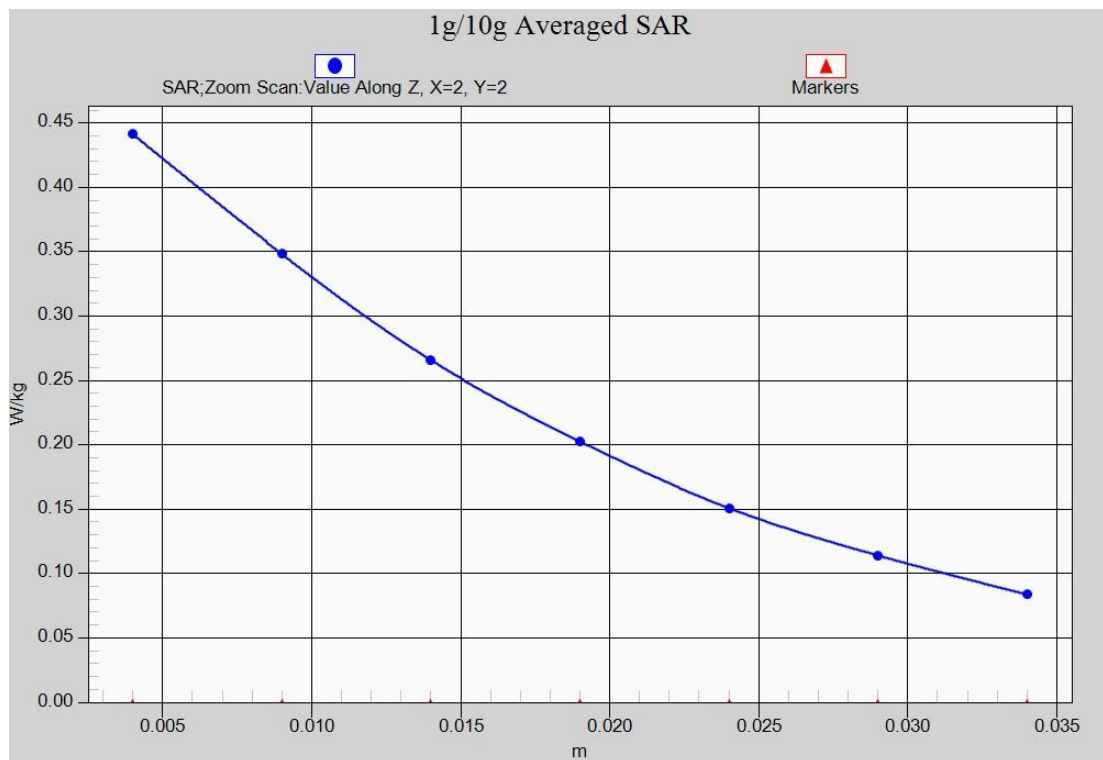
Fig. 1-1   Z-Scan at power reference point (850 MHz CH251)

850 Body Rear Middle

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: Body 850 MHz

Medium parameters used (interpolated): f = 836.6 MHz; σ = 0.971 S/m; $ε_r$ = 53.489; ρ = 1000 kg/m^3

Ambient Temperature:22.0^{o}C   Liquid Temperature:21.5^{o}C

Communication System: UID 0, 2 slot GPRS (0) Frequency: 836.6 MHz Duty Cycle: 1:4.00037

Probe: EX3DV4 - SN3633 ConvF(9.24, 9.24, 9.24); Calibrated: 2015-1-30

Rear side Middle/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.785 W/kg

Rear side Middle 03a/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 27.30 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.982 W/kg

SAR(1 g) = 0.721 W/kg; SAR(10 g) = 0.530 W/kg

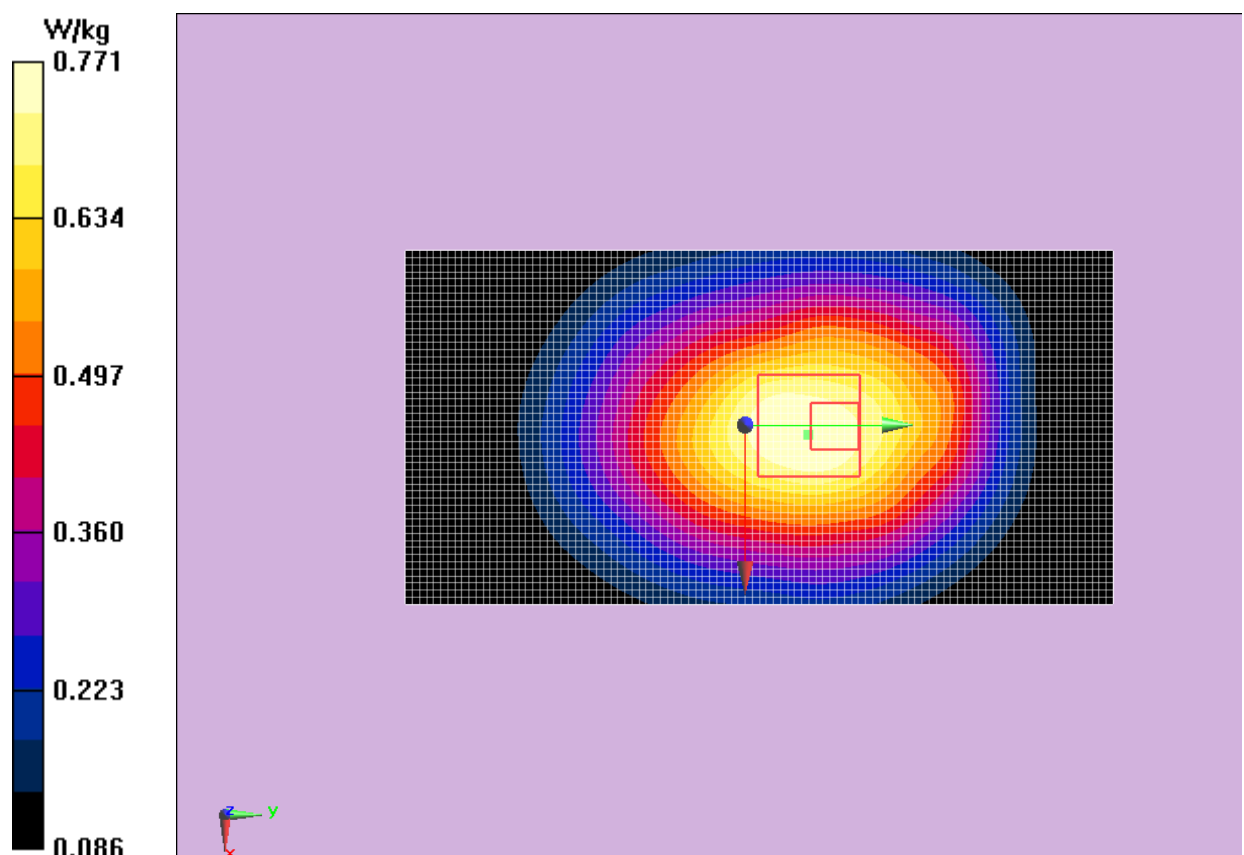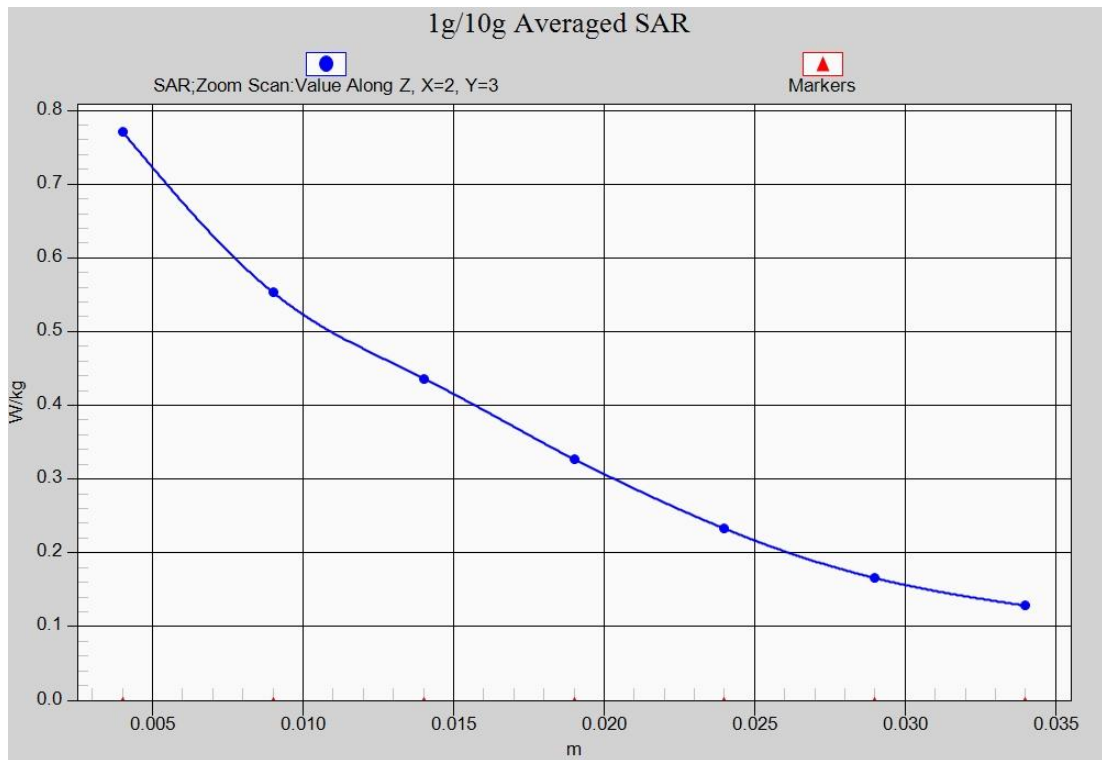Maximum value of SAR (measured) = 0.771 W/kg

Fig.2 850 MHz CH190

Fig. 2-1　Z-Scan at power reference point (850 MHz CH190)

GSM1900 Left Cheek Low

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: 1900 Head

Medium parameters used (interpolated): f = 1850.2 MHz; σ = 1.371 S/m; $ε_r$ = 38.323; ρ = 1000 kg/m^3

Ambient Temperature:22.0^{o}C   Liquid Temperature:21.5^{o}C

Communication System: UID 0, GSM (0) Frequency: 1850.2 MHz Duty Cycle: 1:8.3

Probe:EX3DV4 - SN3633 ConvF(7.72, 7.72, 7.72);

Left Cheek Low /Area Scan (61x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.413 W/kg

Left Cheek Low /Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.210 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.461 W/kg

SAR(1 g) = 0.323 W/kg; SAR(10 g) = 0.195 W/kg

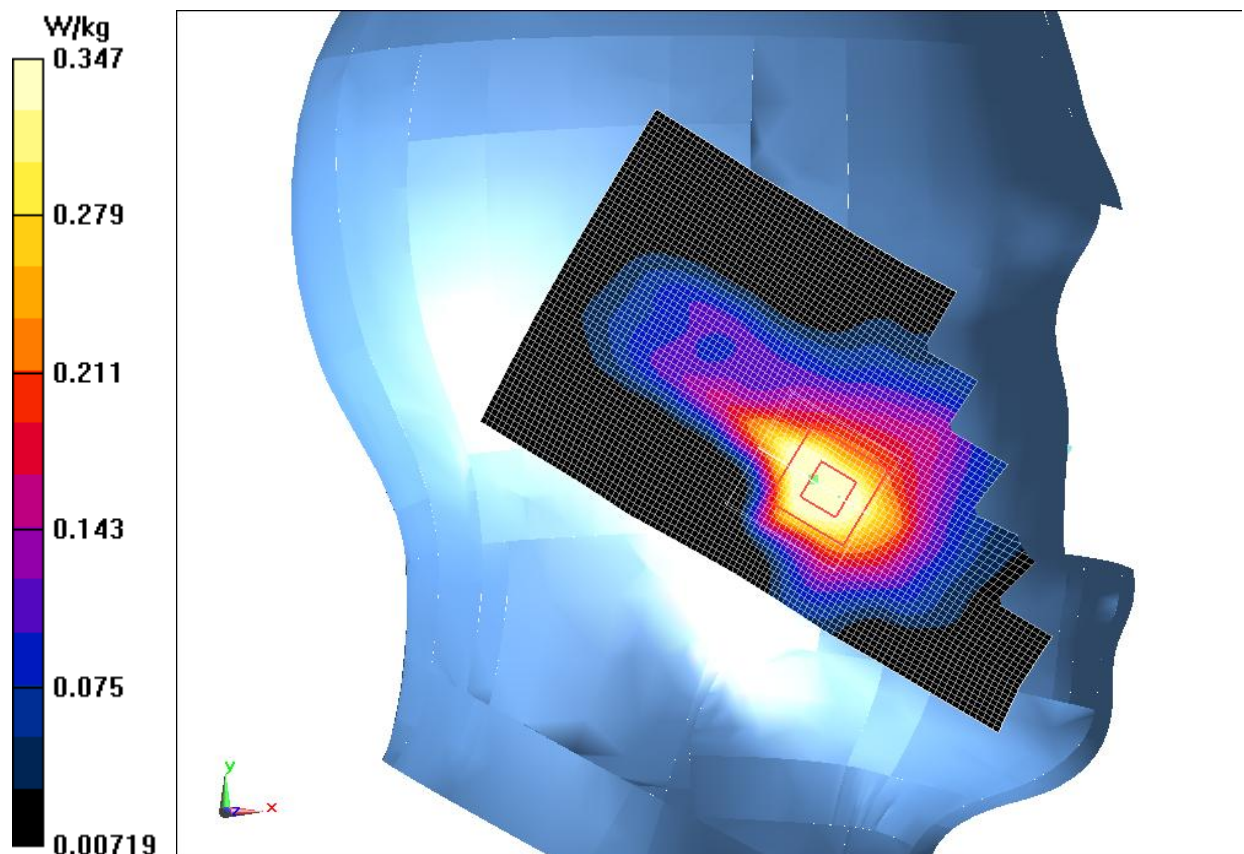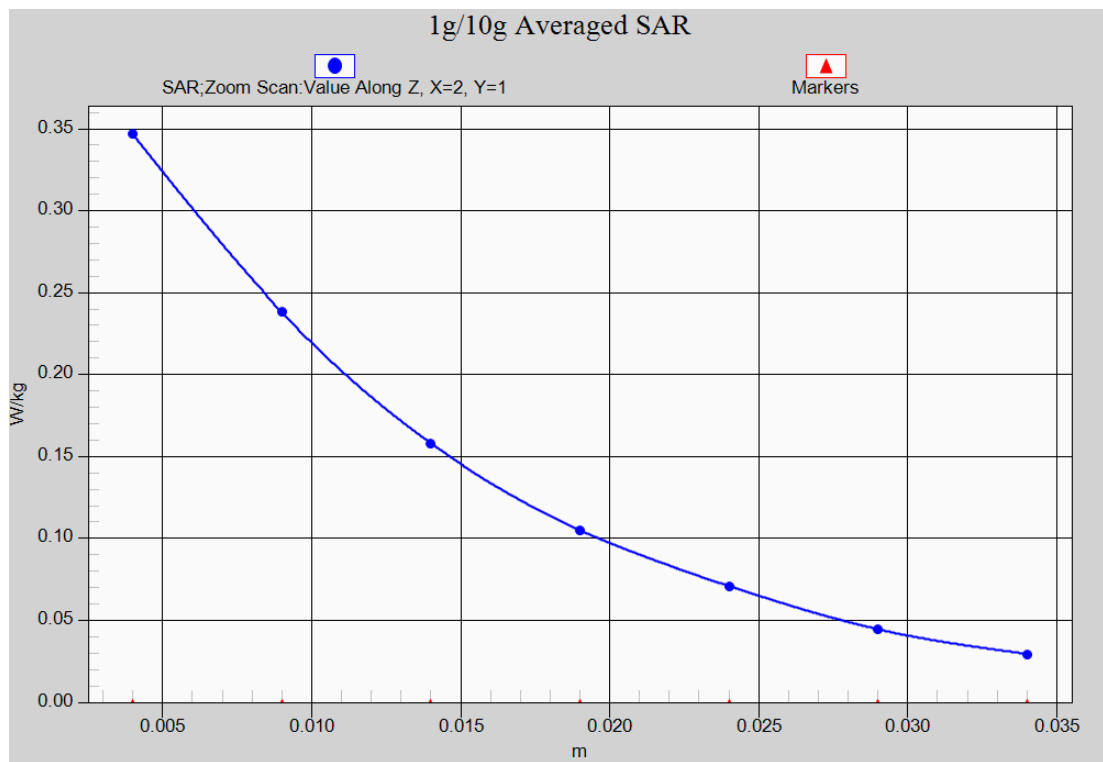Maximum value of SAR (measured) = 0.347 W/kg

Fig.3 1900 MHz CH512

Fig. 3-1   Z-Scan at power reference point (1900 MHz CH512)

GSM1900 Body Rear Low

Date/Time: 2015/10/24

Electronics: DAE4 Sn786

Medium: Body1900 MHz

Medium parameters used (interpolated): f = 1850.2 MHz; σ = 1.518 S/m; ε_r = 53.54; ρ = 1000 kg/m^3

Ambient Temperature:22.0^{o}C   Liquid Temperature:21.5^{o}C

Communication System: UID 0, 2 slot GPRS (0) Frequency: 1850.2 MHz Duty Cycle: 1:4.00037

Probe:EX3DV4 - SN3633 ConvF(7.36, 7.36, 7.36);

Rear side Low/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.773 W/kg

Rear side Low/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.099 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 1.13 W/kg

SAR(1 g) = 0.697 W/kg; SAR(10 g) = 0.441 W/kg
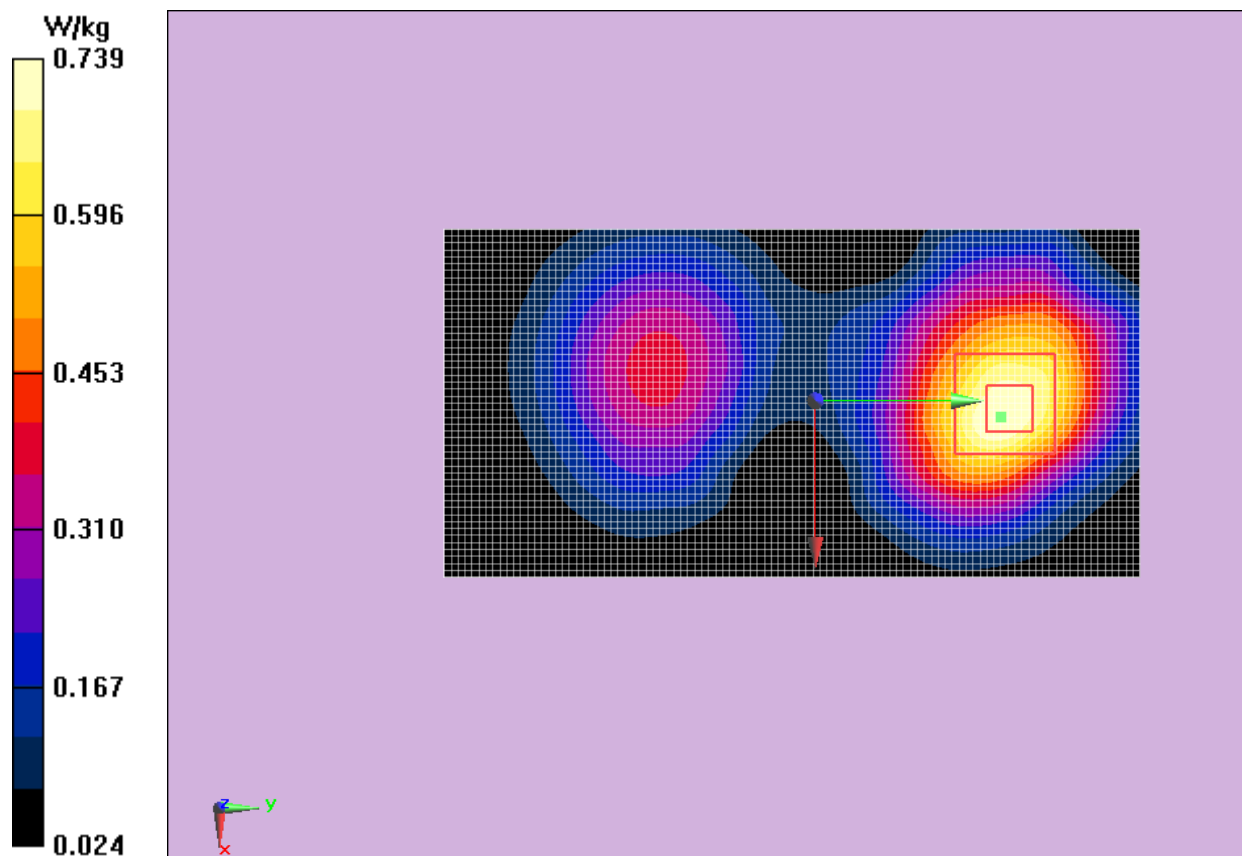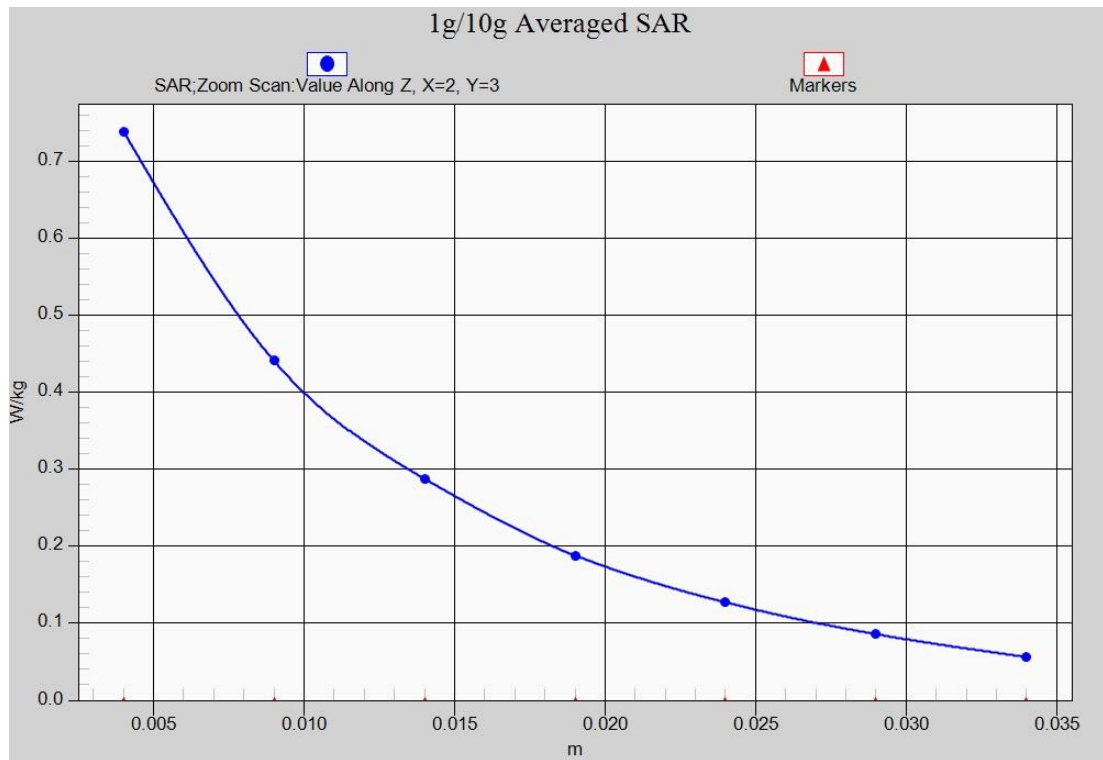
Maximum value of SAR (measured) = 0.739 W/kg

Fig.4 1900 MHz CH512

Fig.4-1　Z-Scan at power reference point (1900 MHz CH512)

ANNEX B System Verification Results

835MHz

Date/Time: 2015-10-24

Electronics: DAE4 Sn786

Medium: Head 850

Medium parameters used (interpolated): f = 835 MHz; σ = 0.929 S/m; ε_r = 41.315;; ρ = 1000 kg/m³

Ambient Temperature:23.7°C   Liquid Temperature:23.2°C

Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3633 ConvF(8.95, 8.95, 8.95); Calibrated: 2015-1-30

Configuration/835 Head/Area Scan (61x181x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 47.034 V/m; Power Drift = 0.10 dB

Fast SAR: SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.52 W/kg

Maximum value of SAR (interpolated) = 2.46 W/kg

Configuration/835 Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 47.034 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 2.87 W/kg

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.55 W/kg
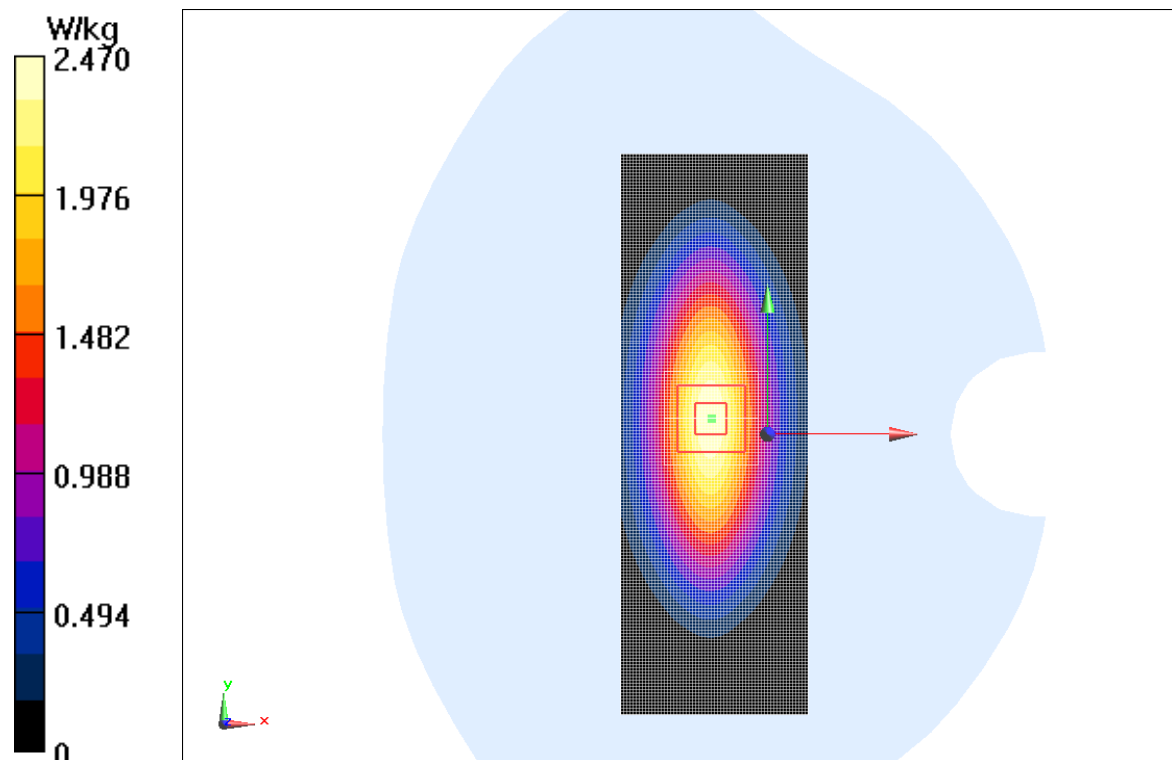
Maximum value of SAR (measured) = 2.47 W/kg

Fig.B.1 Validation 835MHz 250mW

835MHz

Date/Time: 2015-10-24

Electronics: DAE4 Sn786

Medium: Body850 MHz

Medium parameters used (interpolated): f = 835 MHz; σ = 0.97 S/m; ε_r = 53.498; ρ = 1000 kg/m^3

Ambient Temperature:22.0^{o}C   Liquid Temperature:21.5^{o}C

Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3633 ConvF(9.24, 9.24, 9.24); Calibrated: 2015-1-30

Configuration/Area Scan (61x181x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Fast SAR:SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (interpolated) = 2.64 W/kg
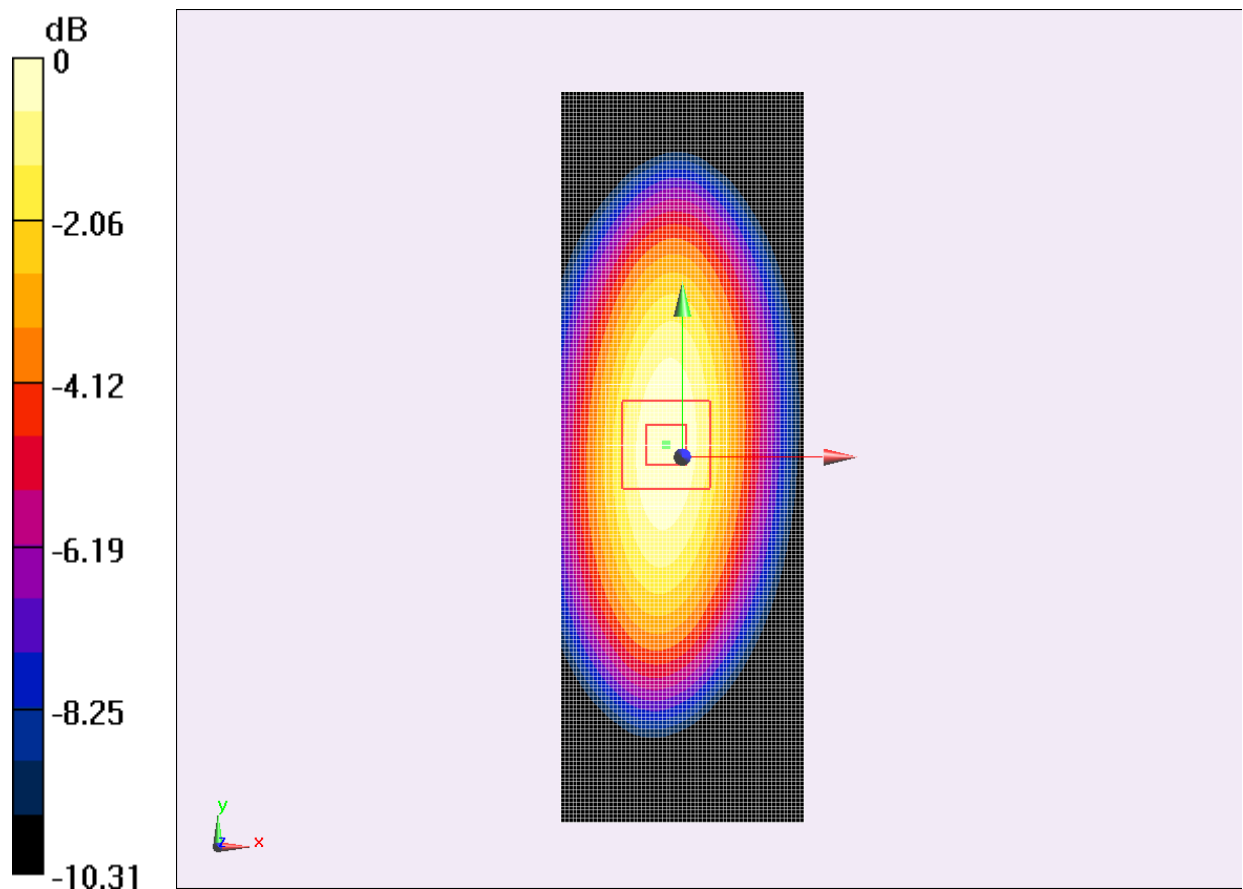

Configuration/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 51.989 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 3.60 W/kg

SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.58 W/kg

Maximum value of SAR (measured) = 2.62 W/kg

0 dB = 2.62 W/kg = 4.18 dBW/kg

Fig.B.2 validation 835MHz 250mW

1900MHz

Date: 2015-10-24

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used: f = 1900 MHz; σ = 1.387 S/m; εr = 40.848; ρ = 1000 kg/m^3

Ambient Temperature: 22.5^{o}C   Liquid Temperature: 22.0^{o}C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe:EX3DV4 - SN3633 ConvF(7.72, 7.72, 7.72);

System Validation /Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 86.259 V/m; Power Drift = -0.09 dB

Fast SAR: SAR(1 g) = 9.88 W/kg; SAR(10 g) = 5.18 W/kg

Maximum value of SAR (interpolated) = 13.5 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 86.259 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 18.4 W/kg

SAR(1 g) = 10.16 W/kg; SAR(10 g) = 5.10 W/kg

Maximum value of SAR (measured) = 11.3 W/kg

0 dB = 11.3 W/kg = 13.49 dBW/kg

Fig.B.3 validation 1900MHz 250mW

1900MHz

Date: 2015-10-24

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used: f = 1900 MHz; σ = 1.543 S/m; ε_r = 50.791; ρ = 1000 kg/m^3

Ambient Temperature: 22.3^{o}C   Liquid Temperature: 21.8^{o}C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe:EX3DV4 - SN3633 ConvF(7.36, 7.36, 7.36);

System validation /Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 60.339 V/m; Power Drift = 0.08 dB

Fast SAR: SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.40 W/kg
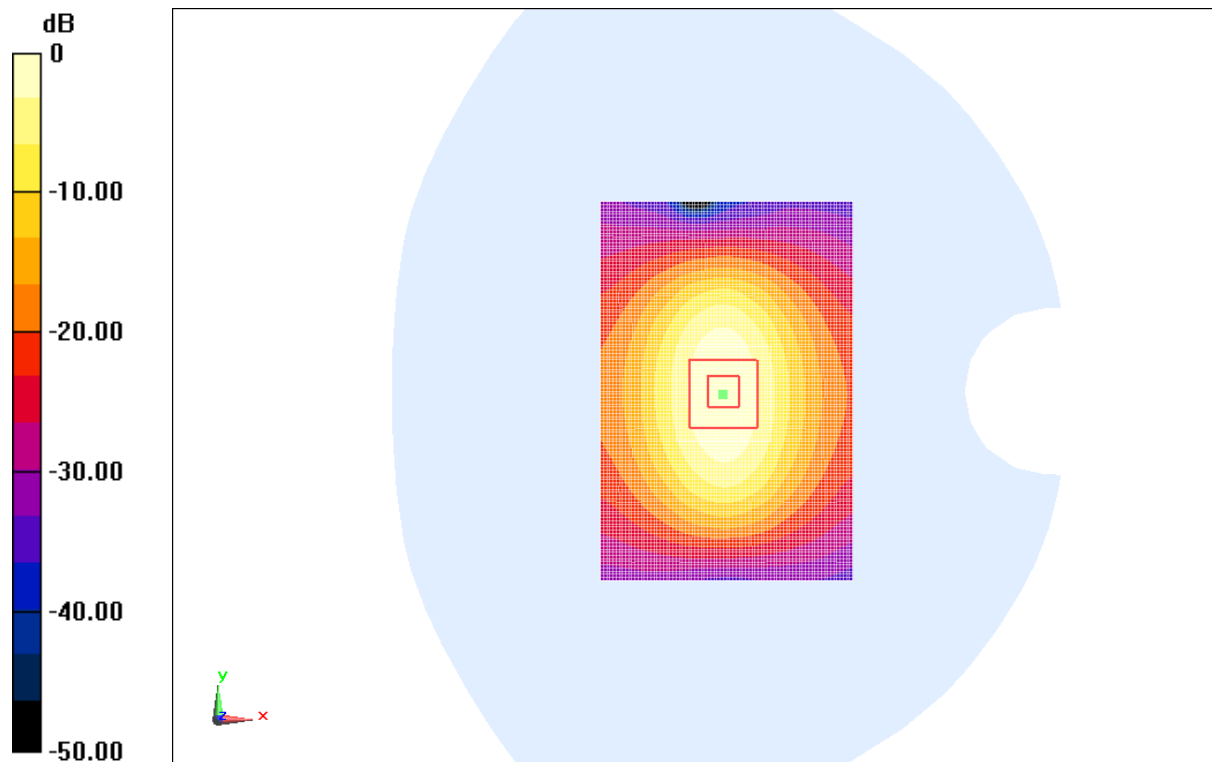
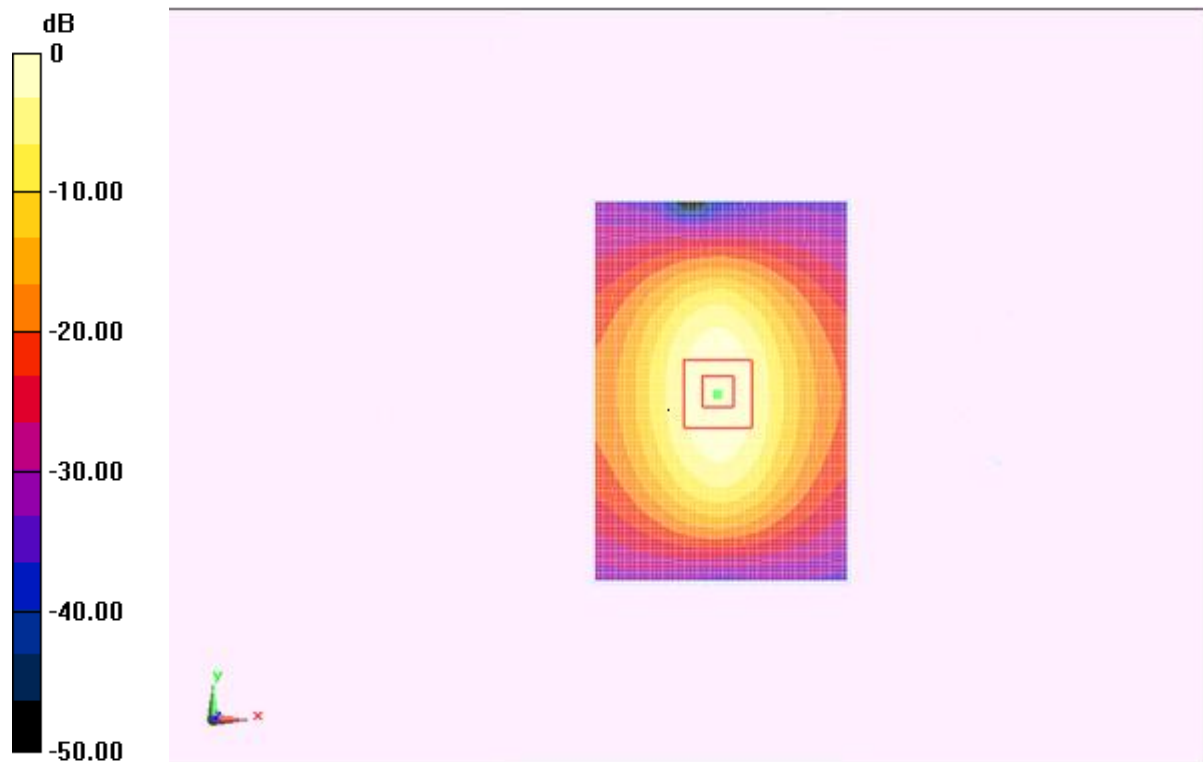Maximum value of SAR (interpolated) = 13.5 W/kg

System validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.339 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 19.3 W/kg

SAR(1 g) = 10.30 W/kg; SAR(10 g) = 5.54 W/kg

Maximum value of SAR (measured) = 10.2 W/kg

0 dB = 10.4 W/kg = 16.60 dBW/kg

Fig.B.4 validation 1900MHz 250mW

The SAR system verification must be required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR.

Table B.1 Comparison between area scan and zoom scan for system verification

Band	Position	Area scan (1g)	Zoom scan (1g)	Drift (%)
850	Head	2.42	2.44	-0.82
850	Body	2.43	2.46	-1.22
1900	Head	9.88	10.16	-2.76
1900	Body	10.1	10.3	-1.94

ANNEX C   SAR Measurement Setup

C.1 Measurement Set-up

The Dasy4 or DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:
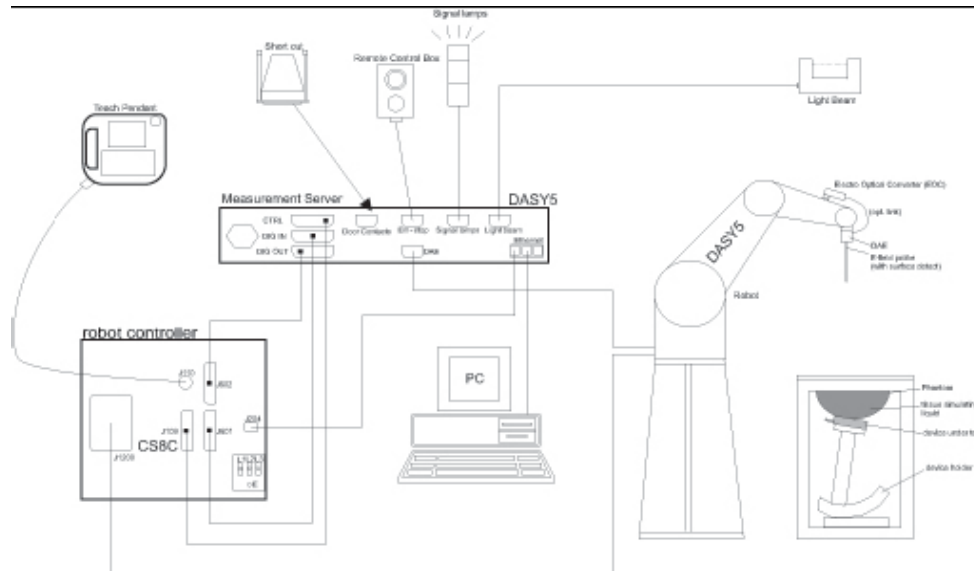
Picture C.1 SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY4 or DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as
- warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

C.2 Dasy4 or DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 or DASY5 software reads the reflection durning a software approach and looks for the maximum using 2nd ord curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:

Model:	ES3DV3, EX3DV4
Frequency Range:	10MHz — 6.0GHz(EX3DV4) 10MHz — 4GHz(ES3DV3)
Calibration:	In head and body simulating tissue at Frequencies from 835 up to 5800MHz
Linearity:	± 0.2 dB(30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB(30 MHz to 4 GHz) for ES3DV3
Dynamic Range:	10 mW/kg — 100W/kg
Probe Length:	330 mm
Probe Tip Length:	20 mm
Body Diameter:	10 mm
Tip Diameter:	2.5 mm (3.9 mm for ES3DV3)
Tip-Center:	1 mm (2.0mm for ES3DV3)
Application:	SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields

Picture C.2 Near-field Probe

Picture C.3 E-field Probe

C.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed

in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm^2.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

C.4 Other Test Equipment

C.4.1 Data Acquisition Electronics(DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

PictureC.4: DAE

C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90XL; DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

➢ High precision (repeatability 0.02mm)
➢ High reliability (industrial design)
➢ Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
➢ Jerk-free straight movements (brushless synchron motors; no stepper motors)
➢ Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Picture C.6 DASY 5

C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 108MB), RAM (DASY4: 64 MB, DASY5: 108MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

Picture C.7 Server for DASY 4

Picture C.8 Server for DASY 5

C.4.4 Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss

POM material having the following dielectric

parameters: relative permittivity ε =3 and loss tangent δ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.

Picture C.9-1: Device Holder Kit
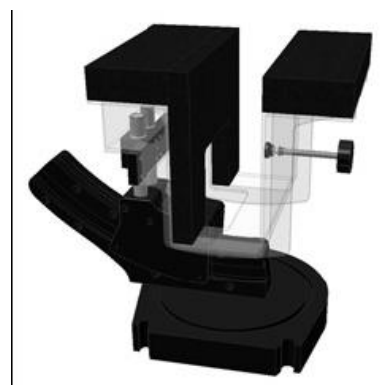
Picture C.9-2: Laptop Extension

C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90th percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness: 2 ± 0. 2 mm

Filling Volume: Approx. 25 liters

Dimensions: 810 x l000 x 500 mm (H x L x W)

Available: Special

Picture C.10: SAM Twin Phantom

ANNEX D   Position of the wireless device in relation to the phantom

D.1 General considerations

This standard specifies two handset test positions against the head phantom – the "cheek" position and the "tilt" position.
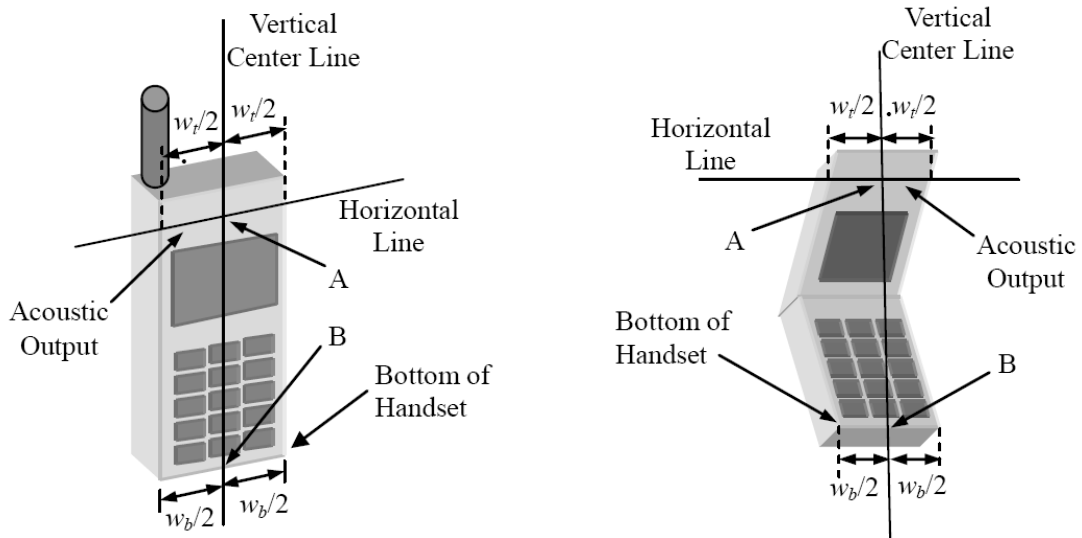
w_t	Width of the handset at the level of the acoustic
w_b	Width of the bottom of the handset
A	Midpoint of the width w_t of the handset at the level of the acoustic output
B	Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical "fixed" case handset   **Picture D.1-b Typical "clam-shell" case handset**
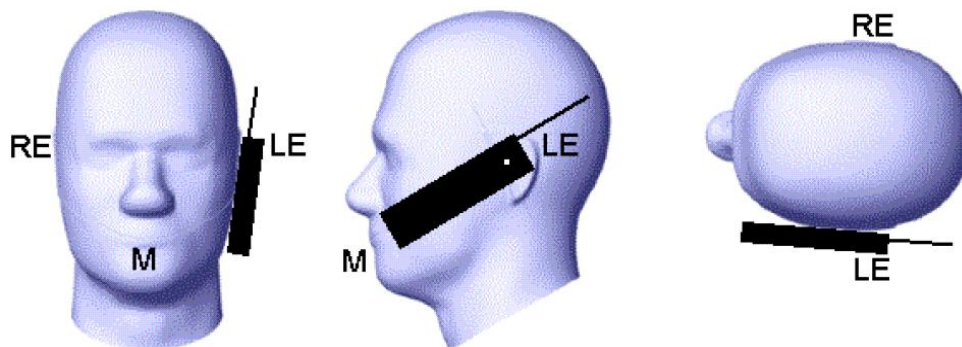
Picture D.2 Cheek position of the wireless device on the left side of SAM

Picture D.3 Tilt position of the wireless device on the left side of SAM

D.2 Body-worn device

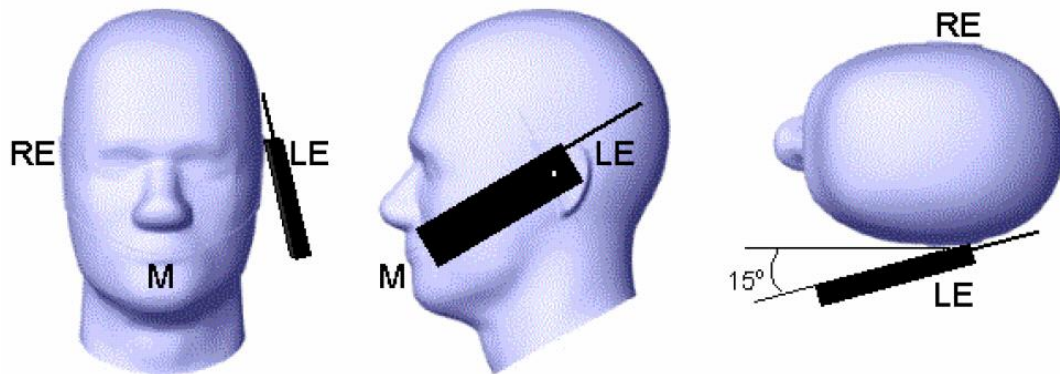A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.
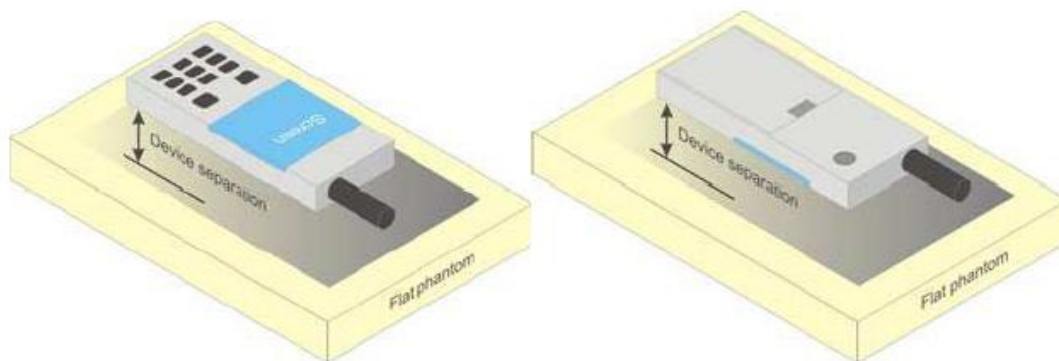
Picture D.4 Test positions for body-worn devices

D.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.
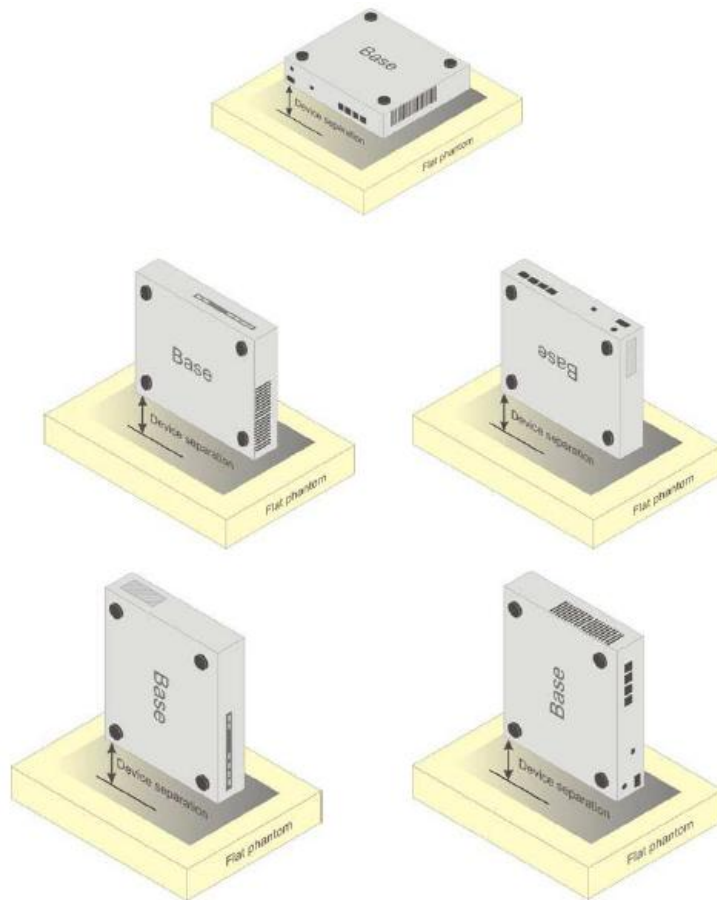
Picture D.5 Test positions for desktop devices

D.4 DUT Setup Photos

Picture D.6

ANNEX E   Equivalent Media Recipes

The liquid used for the frequency range of 800-3000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	5800 Head	5800 Body
Ingredients (% by weight)								
Water	41.45	52.5	55.242	69.91	58.79	72.60	65.53	65.53
Sugar	56.0	45.0	\	\	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18	\	\
Preventol	0.1	0.1	\	\	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22	\	\
Diethylenglycol monohexylether	\	\	\	\	\	\	17.24	17.24
Triton X-100	\	\	\	\	\	\	17.24	17.24
Dielectric Parameters Target Value	$\varepsilon=41.5$ $\sigma=0.90$	$\varepsilon=55.2$ $\sigma=0.97$	$\varepsilon=40.0$ $\sigma=1.40$	$\varepsilon=53.3$ $\sigma=1.52$	$\varepsilon=39.2$ $\sigma=1.80$	$\varepsilon=52.7$ $\sigma=1.95$	$\varepsilon=35.3$ $\sigma=5.27$	$\varepsilon=48.2$ $\sigma=6.00$

ANNEX F   System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

Table F.1: System Validation

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3633	Head 850MHz	June 10, 2015	850 MHz	OK
3633	Head 1900MHz	June 10, 2015	1900 MHz	OK
3633	Body 850MHz	June 10, 2015	850 MHz	OK
3633	Body 1900MHz	June 10, 2015	1900 MHz	OK

ANNEX G   Probe Calibration Certificate

Probe EX3DV4-SN:3633 Calibration Certificate

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ilac-MRA CNAS

CALIBRATION No. L0570

Client	CTTL(South Branch)	Certificate No: Z15-97005

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3633
Calibration Procedure(s)	FD-Z11-2-004-01 Calibration Procedures for Dosimetric E-field Probes
Calibration date:	January 30, 2015

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter	NRP2	101919	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor	NRP-Z91	101547	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor	NRP-Z91	101548	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Reference10dBAttenuator		18N50W-10dB	13-Mar-14(TMC,No.JZ14-1103)	Mar-16
Reference20dBAttenuator		18N50W-20dB	13-Mar-14(TMC,No.JZ14-1104)	Mar-16
Reference Probe EX3DV4		SN 3617	28-Aug-14(SPEAG,No.EX3-3617_Aug14)	Aug-15
DAE4		SN 777	17-Sep-14 (SPEAG, DAE4-777_Sep14)	Sep -15
Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A		6201052605	01-Jul-14 (CTTL, No.J14X02145)	Jun-15
Network Analyzer E5071C		MY46110673	15-Feb-14 (TMC, No.JZ14-781)	Feb-15

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: January 31, 2015

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

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Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization Φ	Φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i θ=0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

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 300MHz to 3GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f＞1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect 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 (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;VRx,y,z:*A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.

- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued 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±50MHz to±100MHz.

- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.

- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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Probe EX3DV4

SN: 3633

Calibrated: January 30, 2015

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm$(\mu V/(V/m)^2)$ [A]	0.41	0.41	0.39	±10.8%
DCP(mV) [B]	101.3	98.2	100.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√µV	C	D dB	VR mV	Unc [E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	173.1	±2.5%
		Y	0.0	0.0	1.0		175.8	
		Z	0.0	0.0	1.0		166.5	

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X, Y, Z do not affect the E^2-field uncertainty inside TSL (see Page 5 and Page 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz]^C	Relative Permittivity^F	Conductivity (S/m)^F	ConvF X	ConvF Y	ConvF Z	Alpha^G	Depth^G (mm)	Unct. (k=2)
835	41.5	0.90	8.95	8.95	8.95	0.22	0.93	±12%
900	41.5	0.97	8.81	8.81	8.81	0.24	0.95	±12%
1750	40.1	1.37	7.82	7.82	7.82	0.21	1.08	±12%
1900	40.0	1.40	7.72	7.72	7.72	0.20	1.18	±12%
2300	39.5	1.67	7.35	7.35	7.35	0.33	0.86	±12%
2450	39.2	1.80	7.01	7.01	7.01	0.40	0.86	±12%
2600	39.0	1.96	6.84	6.84	6.84	0.65	0.68	±12%

^{C} Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
^{F} At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
^{G} Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3633

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]^C	Relative Permittivity^F	Conductivity (S/m)^F	ConvF X	ConvF Y	ConvF Z	Alpha^G	Depth^G (mm)	Unct. (k=2)
835	55.2	0.97	9.24	9.24	9.24	0.19	1.31	±12%
1750	53.4	1.49	7.50	7.50	7.50	0.17	1.37	±12%
1900	53.3	1.52	7.36	7.36	7.36	0.17	1.39	±12%
2300	52.9	1.81	7.43	7.43	7.43	0.28	1.50	±12%
2450	52.7	1.95	7.21	7.21	7.21	0.29	1.33	±12%
2600	52.5	2.16	7.11	7.11	7.11	0.32	1.15	±12%

^{C} Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
^{F} At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
^{G} Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

In Collaboration with
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Frequency Response of E-Field
(TEM-Cell: ifi110 EXX, Waveguide: R22)
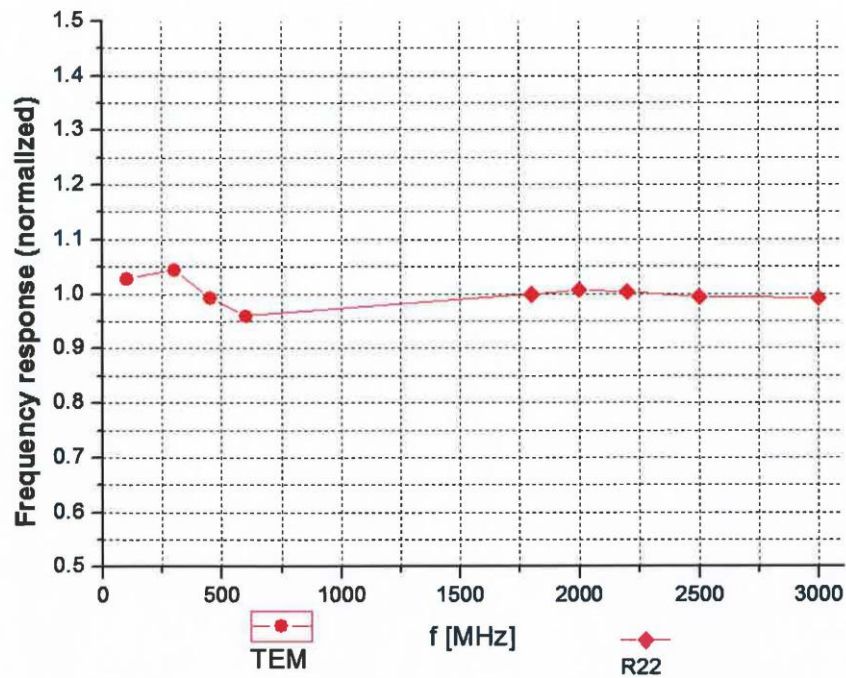
Uncertainty of Frequency Response of E-field: ±7.5% (k=2)

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