SAR TEST REPORT

No. I17Z61226-SEM02

For

TCL Communication Ltd.

UMTS/GSM Smartphone

Model Name: VFD 310/VFD 311

With

Hardware Version: PIO

Software Version: 010 01

FCC ID: 2ACCJB096

Issued Date: 2017-8-28

TESTING
NVLAP LAB CODE 600118-0

Note:

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Test Laboratory:

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REPORT HISTORY

Report Number	Revision	Issue Date	Description
I17Z61226-SEM02	Rev.0	2017-8-28	Initial creation of test report

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1 Test Laboratory

1.1 Testing Location

Company Name:	CTTL(Shouxiang)
Address:	No. 51 Shouxiang Science Building, Xueyuan Road, Haidian District, Beijing, P. R. China100191

1.2 Testing Environment

Temperature:	18°C~25°C,
Relative humidity:	30%~ 70%
Ground system resistance:	< 0.5 Ω
Ambient noise & Reflection:	< 0.012 W/kg

1.3 Project Data

Project Leader:	Qi Dianyuan
Test Engineer:	Lin Xiaojun
Testing Start Date:	August 4, 2017
Testing End Date:	August 7, 2017

1.4 Signature

Lin Xiaojun

(Prepared this test report)

Qi Dianyuan

(Reviewed this test report)

Lu Bingsong

Deputy Director of the laboratory

(Approved this test report)

2 Statement of Compliance

The VFD 311 is a variant product of VFD 310. According to the client request, we share the test results of original sample and do the spot check in the ANNEX I.:

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	0.75	PCE
	PCS 1900	0.50	
	WLAN 2.4GHz	0.52	DTS
Body-worn (Separation Distance 10mm)	GSM 850	0.97	PCE
	PCS 1900	0.74	
	WLAN 2.4GHz	0.24	DTS

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 10 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..97W/kg (1g).**

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

	Position	**Main antenna**	**WiFi**	**Sum**
Highest reported SAR value for Head	Left hand, Touch cheek	0.75	0.52	**1.27**
Highest reported SAR value for Body	Rear	0.97	0.24	**1.21**

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

	Position	**Main antenna**	**BT***	**Sum**
Highest reported SAR value for Head	Left hand, Touch cheek	0.75	0.09[1]	**0.84**
Highest reported SAR value for Body	Rear	0.97	0.05[1]	**1.02**

BT* - Estimated SAR for Bluetooth (see the table 13.3)
According to the above tables, the highest sum of reported SAR values is **1.27 W/kg (1g)**. The detail for simultaneous transmission consideration is described in chapter 13.

3 Client Information

3.1 Applicant Information

Company Name:	TCL Communication Ltd
Address /Post:	5F, C building, No. 232, Liang Jing Road ZhangJiang High-Tech Park, Pudong Area Shanghai, P.R. China. 201203
Contact:	Gong Zhizhou
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Fax:	0086-21-61460602

3.2 Manufacturer Information

Company Name:	TCL Communication Ltd
Address /Post:	5F, C building, No. 232, Liang Jing Road ZhangJiang High-Tech Park, Pudong Area Shanghai, P.R. China. 201203
Contact:	Gong Zhizhou
Email:	zhizhou.gong@tcl.com
Telephone:	0086-21-31363544
Fax:	0086-21-61460602

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

4.1 About EUT

Description:	UMTS/GSM Smaretphone
Model Name:	VFD 310/VFD 311
Operating mode(s):	GSM 850/900/1800/1900 WCDMA900/2100, BT, WLAN
Tested Tx Frequency:	825 – 848.8 MHz (GSM 850)
	1850.2 – 1910 MHz (GSM 1900)
	2402 – 2480 MHz (Bluetooth)
GPRS Multislot Class:	12
GPRS capability Class:	B
Device type:	Portable device
Antenna type:	Integrated antenna
Accessories/Body-worn configurations:	Headset

4.2 Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version
EUT1	359933080003386	PIO	010 01
EUT2	352187090004713	PIO	010 01
EUT3	359933080003279	PIO	010 01
EUT4	352187090004812	PIO	010 01

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

Note: It is performed to test SAR with the EUT1&2 and conducted power with the EUT 3&4.

4.3 Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
AE1	Battery	CAB1500045C1	/	BYD
AE2	Headset	CCB0046A15C4	/	MEIHAO
AE3	Headset	CCB0046A15C1	/	JUWEI

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

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: Measurement Techniques.

KDB447498 D01: General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB648474 D04 Handset SAR v01r03: SAR Evaluation Considerations for Wireless Handsets.

KDB865664 D01SAR measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz.

KDB865664 D02 RF Exposure Reporting v01r02: 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:

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

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

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

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

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

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

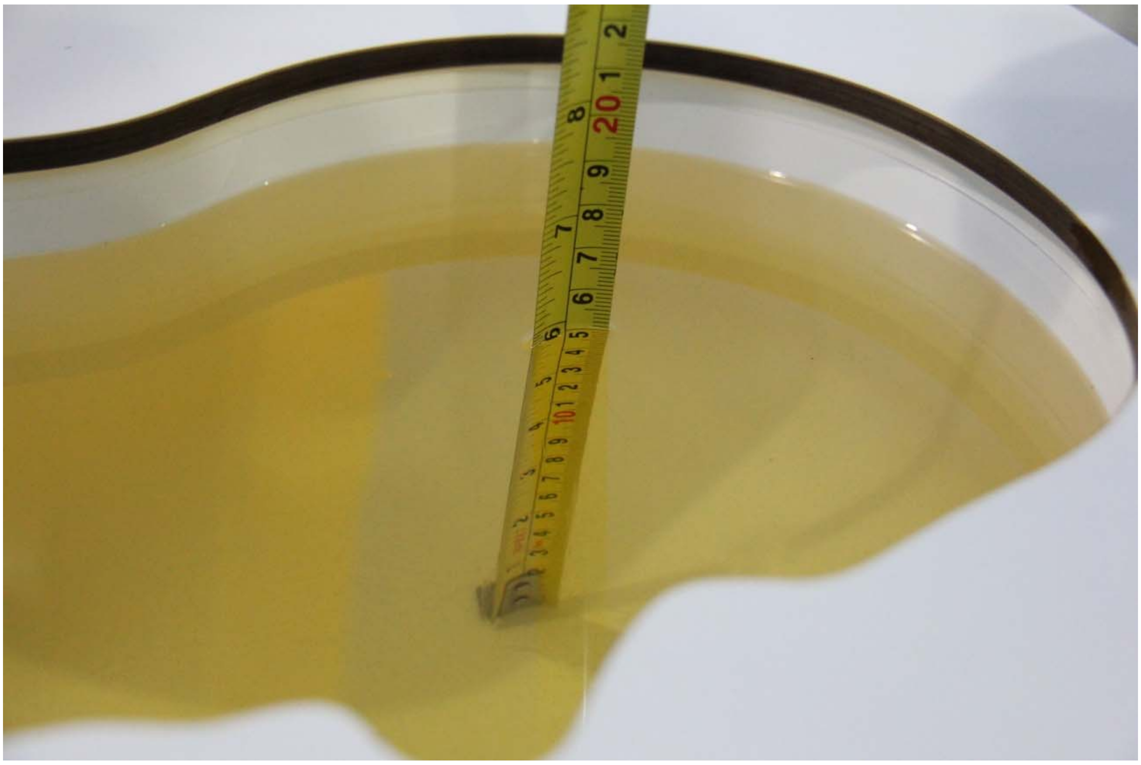
Table 7.1: Targets for tissue simulating liquid

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

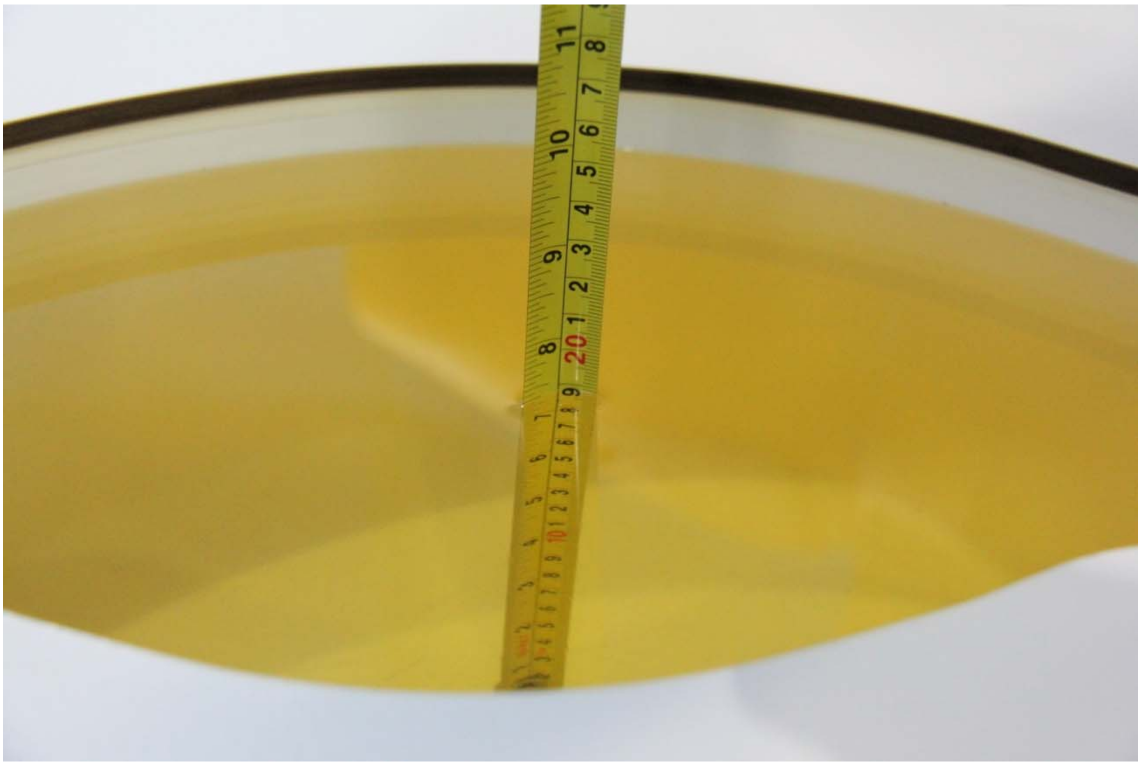
7.2 Dielectric Performance

Table 7.2: Dielectric Performance of Tissue Simulating Liquid

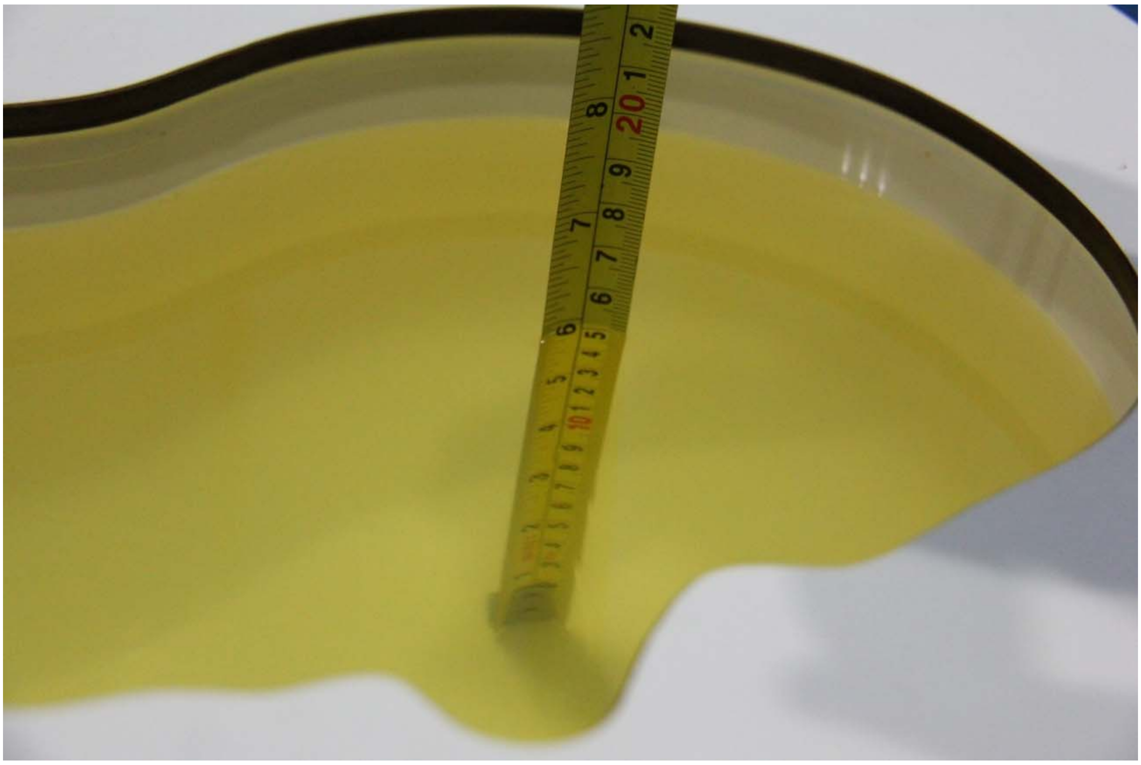
Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2017-8-4	Head	835 MHz	40.89	-1.47	0.903	0.33
	Body	835 MHz	56.08	1.59	0.971	0.10
2017-8-5	Head	1900 MHz	39.78	-0.55	1.386	-1.00
	Body	1900 MHz	53.36	0.11	1.527	0.46
2017-8-7	Head	2450 MHz	39.64	1.12	1.83	1.67
	Body	2450 MHz	53.28	1.10	1.976	1.33



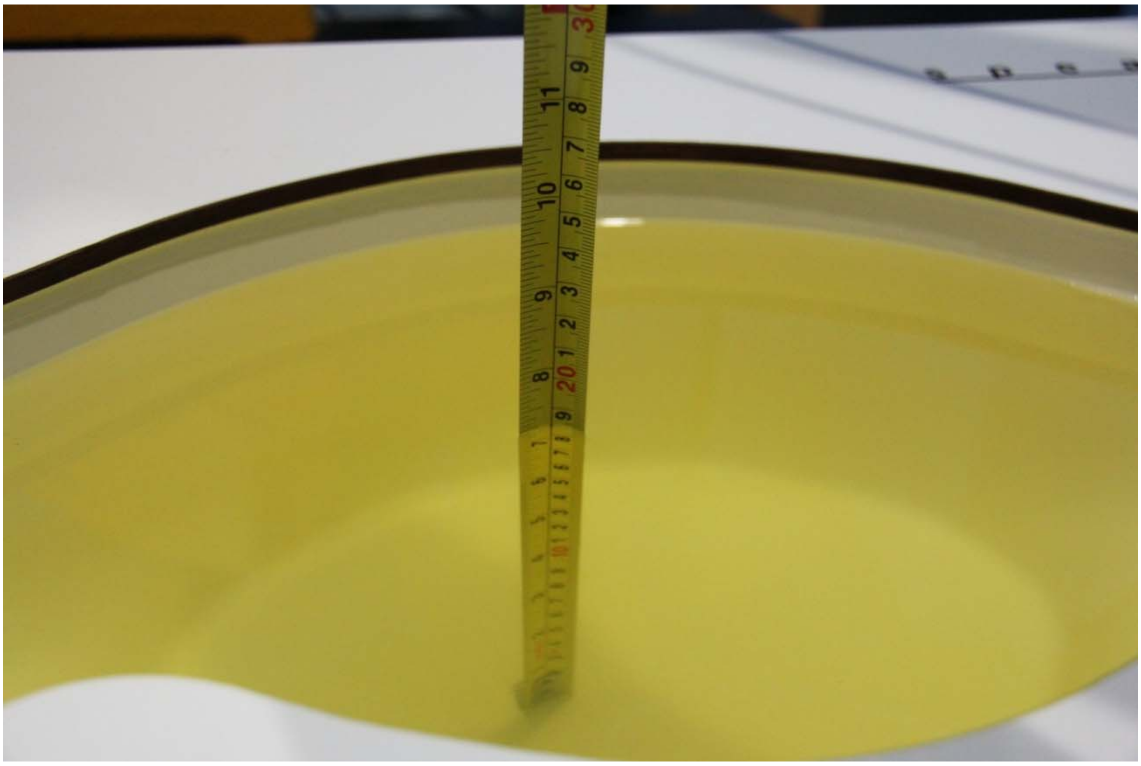
Picture 7-1: Liquid depth in the Head Phantom (835MHz)



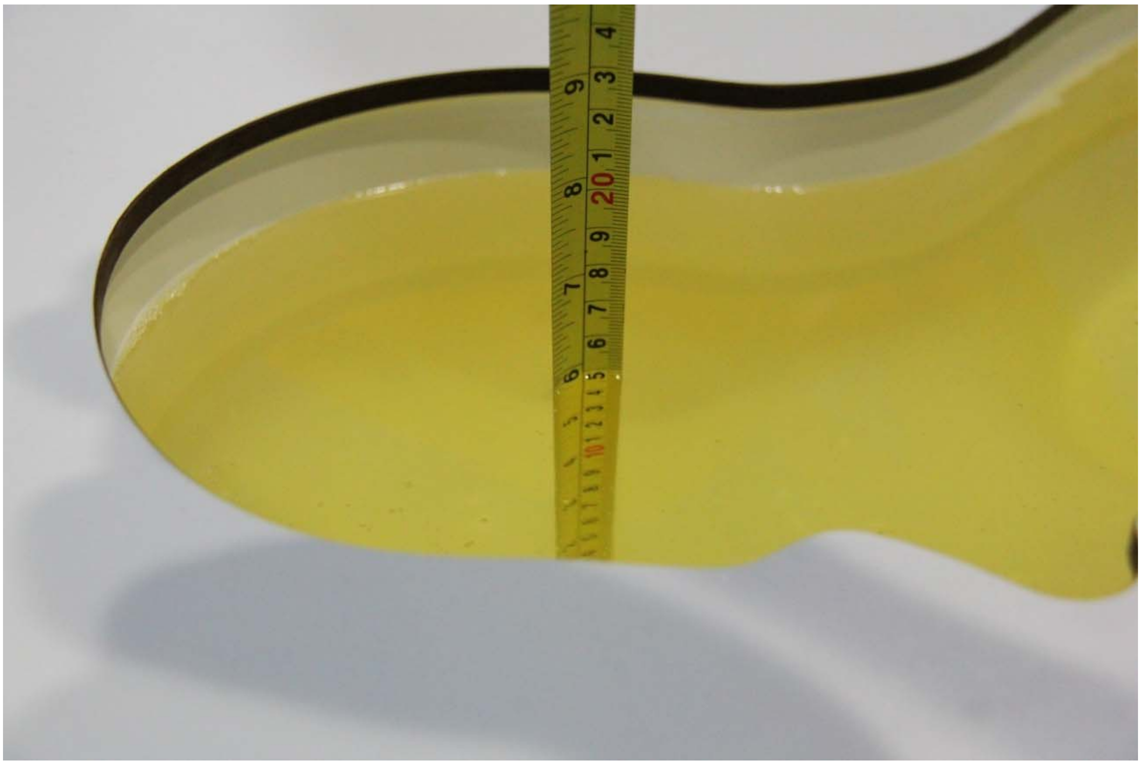
Picture 7-2: Liquid depth in the Flat Phantom (835MHz)



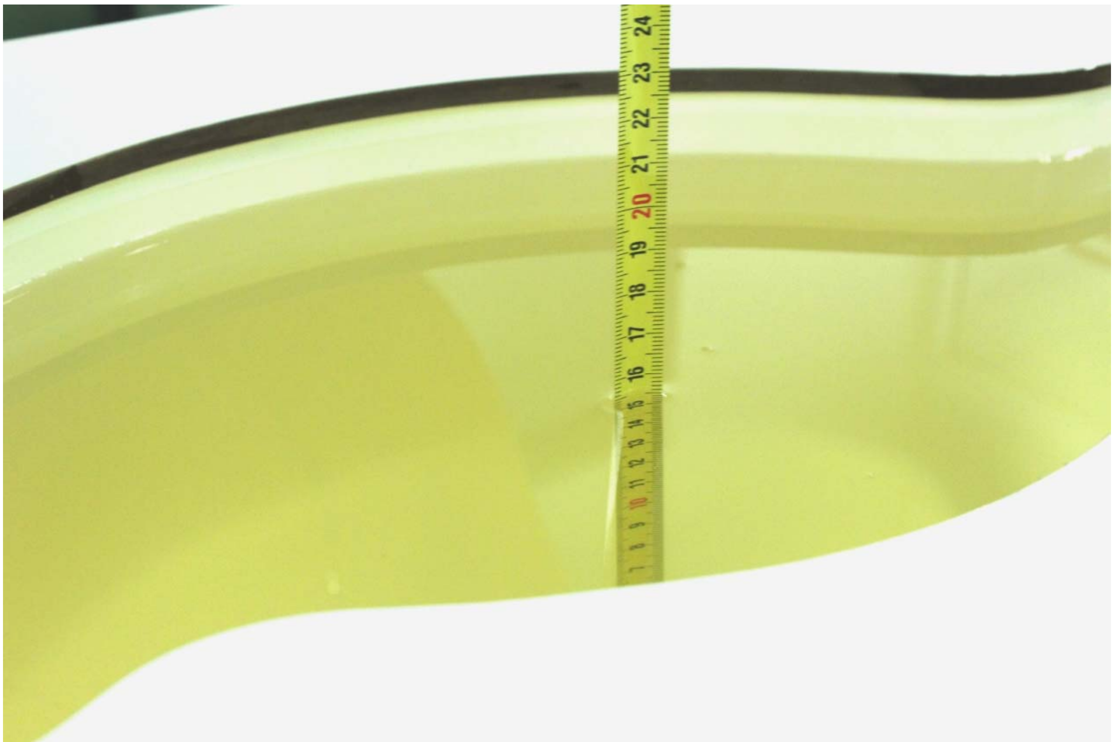
Picture 7-3: Liquid depth in the Head Phantom (1900 MHz)



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



Picture 7-5 Liquid depth in the Head Phantom (2450MHz)

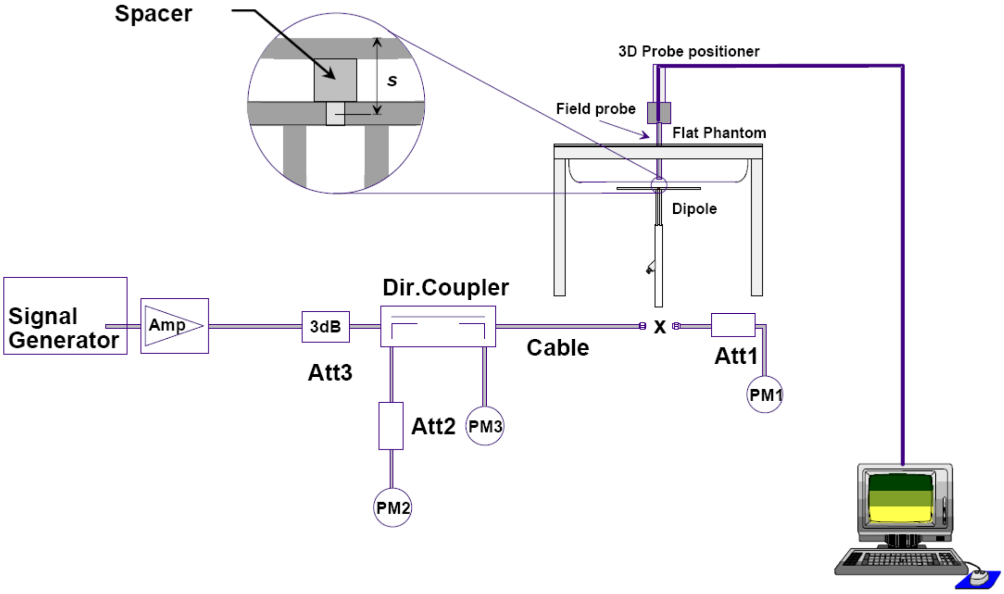


Picture 7-6 Liquid depth in the Flat Phantom (2450MHz)

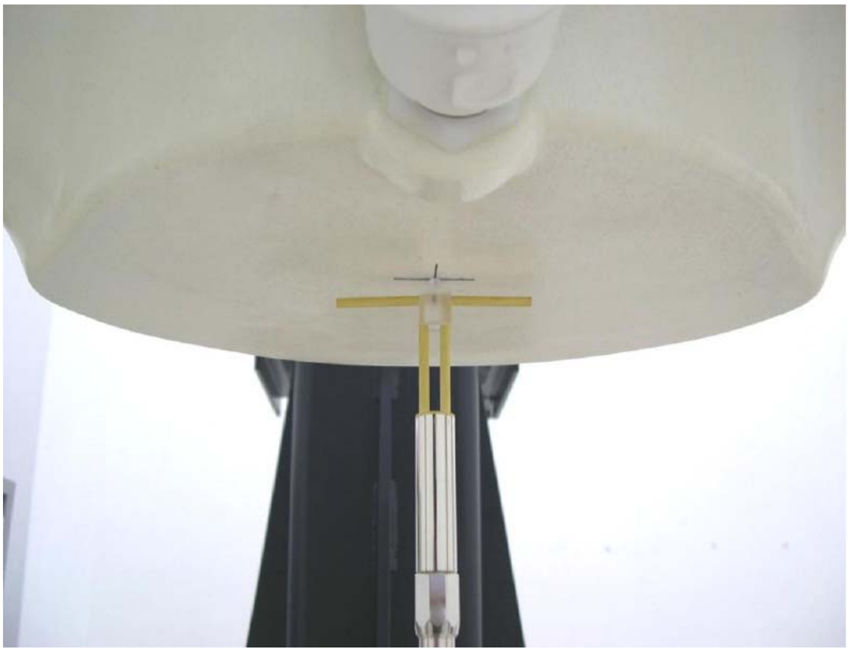
8 System verification

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
2017-8-4	835 MHz	6.06	9.37	6.08	9.4	0.33%	0.32%
2017-8-5	1900 MHz	21.0	40.0	20.88	39.8	-0.57%	-0.50%
2017-87	2450 MHz	24.7	52.2	24.64	52.2	-0.24%	0.00%

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
2017-8-4	835 MHz	6.12	9.41	6.2	9.4	1.31%	-0.11%
2017-8-5	1900 MHz	21.5	40.5	21.6	40.36	0.47%	-0.35%
2017-87	2450 MHz	23.8	50.4	24.08	51.36	1.18%	1.90%

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.

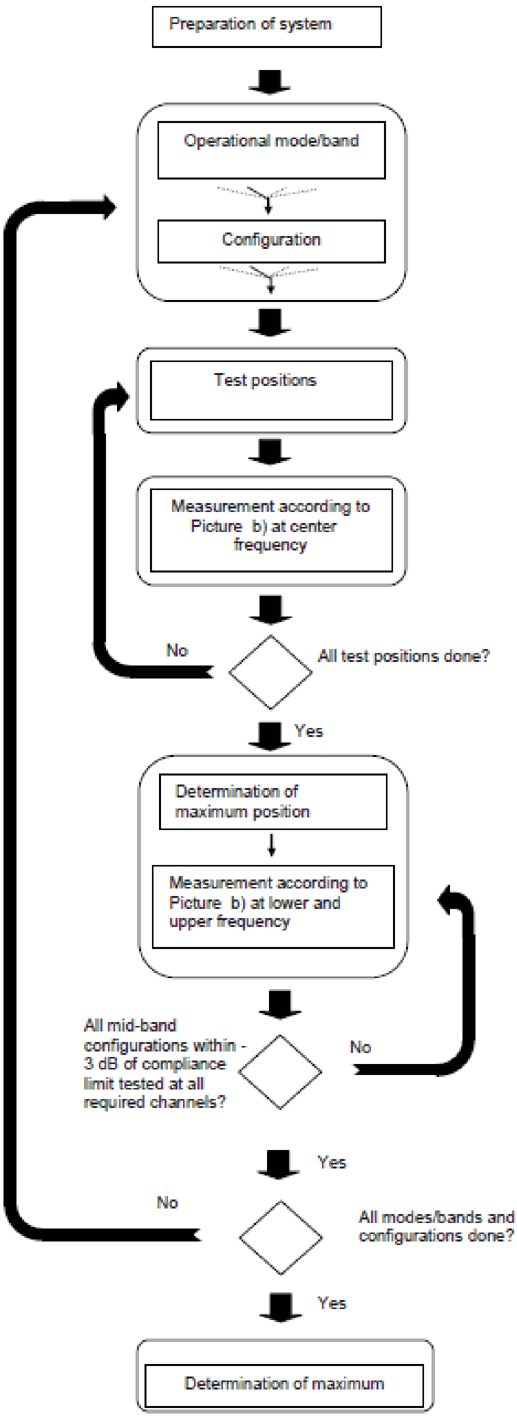
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

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.

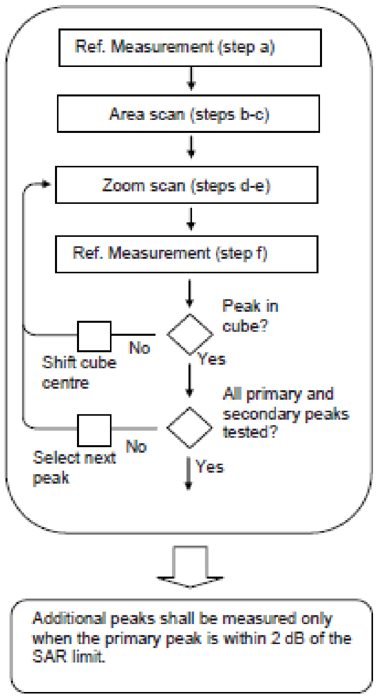
If more than three frequencies need to be tested according to 11.1 (i.e., $N_c > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

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 within3 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 a – Tests to be performed



Picture b – General procedure

Picture 9.1Block 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.

<table>
<tr><td colspan="3"></td><td>$\leq$ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>$\leq$ 2 GHz: $\leq$ 15 mm
2 – 3 GHz: $\leq$ 12 mm</td><td>3 – 4 GHz: $\leq$ 12 mm
4 – 6 GHz: $\leq$ 10 mm</td></tr>
<tr><td colspan="2">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 $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>$\leq$ 2 GHz: $\leq$ 8 mm
2 – 3 GHz: $\leq$ 5 mm*</td><td>3 – 4 GHz: $\leq$ 5 mm*
4 – 6 GHz: $\leq$ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>$\leq$ 5 mm</td><td>3 – 4 GHz: $\leq$ 4 mm
4 – 5 GHz: $\leq$ 3 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>$\leq$ 4 mm</td><td>3 – 4 GHz: $\leq$ 3 mm
4 – 5 GHz: $\leq$ 2.5 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>$\geq$ 30 mm</td><td>3 – 4 GHz: $\geq$ 28 mm
4 – 5 GHz: $\geq$ 25 mm
5 – 6 GHz: $\geq$ 22 mm</td></tr>
<tr><td colspan="5">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 <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 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.</td></tr>
</table>

9.3 Bluetooth Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. 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.

9.4 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 section 14 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-gSAR 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 55wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm mare 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 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 11.5: 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)
	32.38	32.34	32.28
Tune up	33	33	33
GSM 1900MHz	Conducted Power(dBm)		
	Channel 810(1909.8MHz)	Channel 661(1880MHz)	Channel 512(1850.2MHz)
	29.34	29.26	29.19
Tune up	30	30	30

Table 11.6: The conducted power measurement results for GPRS

GSM 850 GPRS (GMSK)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**251**	**190**	**128**		**251**	**190**	**128**
1 Txslot	33	32.38	32.34	32.26	-9.03	23.35	23.31	23.23
2 Txslots	**30.5**	**29.91**	**29.89**	**29.88**	**-6.02**	**23.89**	**23.87**	**23.86**
3Txslots	28.5	27.92	27.92	27.91	-4.26	23.66	23.66	23.65
4 Txslots	27.5	26.83	26.82	26.82	-3.01	23.82	23.81	23.81
GSM 850 GPRS (EGPRS)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**251**	**190**	**128**		**251**	**190**	**128**
1 Txslot	33	32.37	32.35	32.28	-9.03	23.34	23.32	23.25
2 Txslots	**30.5**	**29.93**	**29.91**	**29.91**	**-6.02**	**23.91**	**23.89**	**23.89**
3Txslots	28.5	27.95	27.93	27.92	-4.26	23.69	23.67	23.66
4 Txslots	27.5	26.80	26.81	26.82	-3.01	23.79	23.80	23.81
GSM 850 GPRS (8PSK)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**251**	**190**	**128**		**251**	**190**	**128**
1 Txslot	26	25.59	25.61	25.69	-9.03	16.56	16.58	16.66
2 Txslots	25	24.21	24.28	24.43	-6.02	18.19	18.26	18.41
3Txslots	22.5	21.72	21.76	21.84	-4.26	17.46	17.50	17.58
4 Txslots	21	20.54	20.49	20.50	-3.01	17.53	17.48	17.49
PCS1900 GPRS (GMSK)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**810**	**661**	**512**		**810**	**661**	**512**
1 Txslot	30	29.31	29.24	29.14	-9.03	20.28	20.21	20.11
2 Txslots	**27**	**26.79**	**26.73**	**26.68**	**-6.02**	**20.77**	**20.71**	**20.66**
3Txslots	25	24.81	24.73	24.68	-4.26	20.55	20.47	20.42
4 Txslots	24	23.74	23.69	23.63	-3.01	20.73	20.68	20.62

PCS1900 GPRS (EGPRS)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**810**	**661**	**512**		**810**	**661**	**512**
1 Txslot	30	29.30	29.23	29.16	-9.03	20.27	20.20	20.13
2 Txslots	**27**	**26.79**	**26.73**	**26.68**	**-6.02**	**20.77**	**20.71**	**20.66**
3Txslots	25	24.81	24.73	24.67	-4.26	20.55	20.47	20.41
4 Txslots	24	23.77	23.70	23.63	-3.01	20.76	20.69	20.62
PCS1900 GPRS (8PSK)		Measured Power (dBm)			calculation	Averaged Power (dBm)		
	Tune up	**810**	**661**	**512**		**810**	**661**	**512**
1 Txslot	25	24.57	24.65	24.75	-9.03	15.54	15.62	15.72
2 Txslots	24.5	23.77	23.89	24.00	-6.02	17.75	17.87	17.98
3Txslots	22.5	21.80	21.95	22.08	-4.26	17.54	17.69	17.82
4 Txslots	21.5	20.70	20.88	21.02	-3.01	17.69	17.87	18.01

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

3TX-slots = 3 transmit time slots out of 8 time slots=> conducted power divided by (8/3) => -4.26dB

4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.01dB

According to the conducted power as above, the body measurements are performed with 2Txslots for GSM850 and 3Txslots for PCS1900.

11.3 BT&WiFi Measurement result

The output power of BT antenna is as following:

Condition	GFSK			EDR2M-4_DQPSK			EDR3M-8DPSK		
	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78	Channel 0	Channel 39	Channel 78
Peak Output Power(dBm)									
Hopping OFF	3.06	2.78	3.10	2.66	2.37	2.67	2.75	2.44	2.73
Tune up	3.50	3.50	3.50	3.00	3.00	3.00	3.00	3.00	3.00

The output power of WiFi antenna is as following:

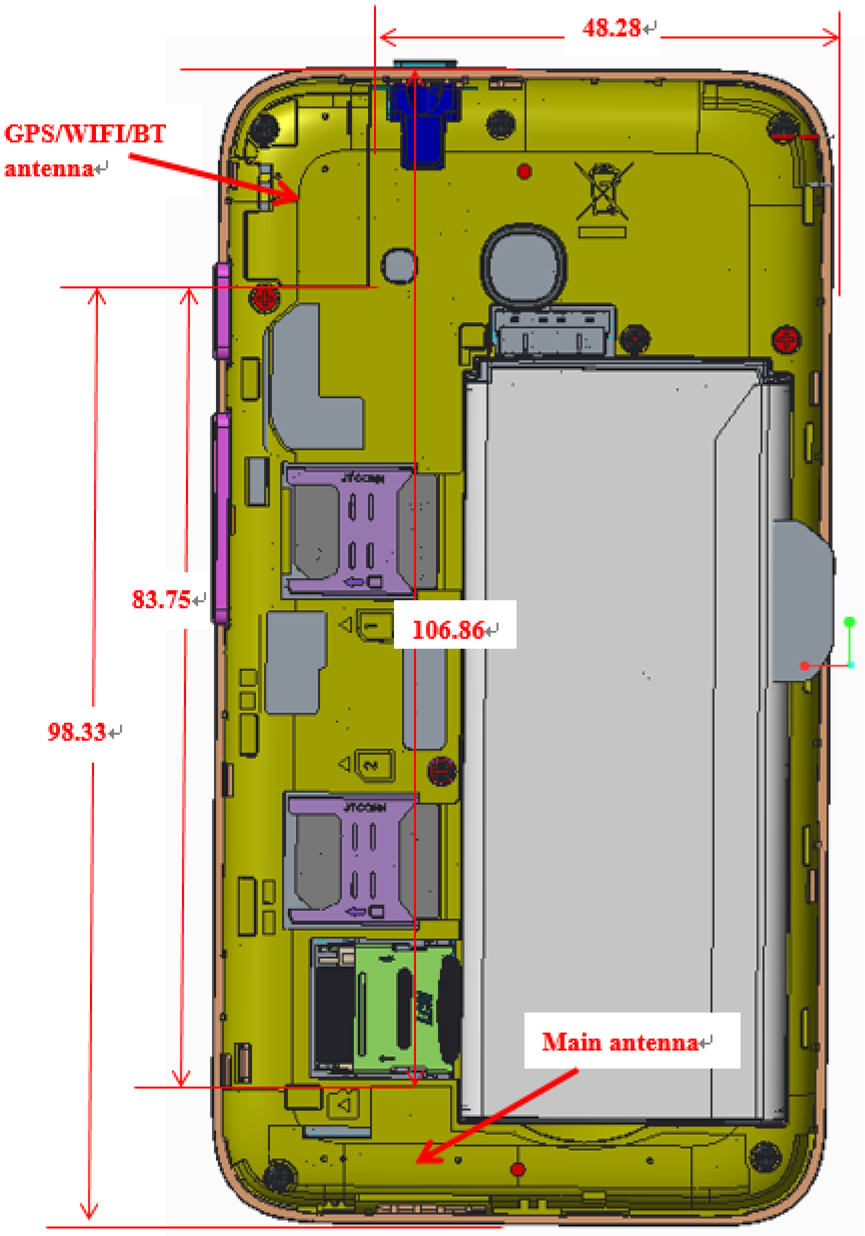
FCC									
802.11b(dBm)									
Channel\data rate	1Mbps	2Mbps	5.5Mbps	11Mbps	TuneUp				
1(2412MHz)	15.24	/	/	/	16.50				
6(2437MHz)	15.31	/	/	/	16.50				
11(2462MHz)	15.32	15.29	15.24	15.21	16.50				
802.11g(dBm)									
Channel\data rate	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps	TuneUp
1(2412MHz)	10.40	/	/	/	/	/	/	/	11.50
6(2437MHz)	12.99	12.97	12.94	12.84	12.73	12.61	12.54	12.50	14.00
11(2462MHz)	12.89	/	/	/	/	/	/	/	14.00
802.11n(dBm)-20MHz									
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	TuneUp
1(2412MHz)	10.38	/	/	/	/	/	/	/	11.50
6(2437MHz)	12.59	12.49	12.18	12.34	11.98	11.89	11.84	11.79	13.50
11(2462MHz)	12.47	/	/	/	/	/	/	/	13.50
802.11n(dBm)-40MHz									
Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	TuneUp
3(2422MHz)	12.49	/	/	/	/	/	/	/	13.50
6(2437MHz)	12.52	12.40	12.27	11.88	11.69	11.53	11.07	11.03	13.00
9(2452MHz)	12.32	/	/	/	/	/	/	/	13.50

12 Simultaneous TX SAR Considerations

12.1 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 Bluetooth devices which may simultaneously transmit with the licensed transmitter.
For this device, the BT can transmit simultaneous with other transmitters.

12.2 Transmit Antenna Separation Distances



Picture 12.1 Antenna Locations

12.3 SAR Measurement Positions

According to the KDB941225 D06 Hot Spot SAR v01, the edges with less than 2.5 cm distance to the antennas need to be tested for SAR.

SAR measurement positions						
Mode	Front	Rear	Left edge	Right edge	Top edge	Bottom edge
Main antenna	Yes	Yes	Yes	Yes	No	Yes
WLAN	Yes	Yes	No	Yes	Yes	No

12.4 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 12.1: 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	3.5	2.24	Yes
		Body	19.20	3.5	2.24	Yes
2.4GHz WLAN 802.11b	2.45	Head	9.58	15.5	35.48	No
		Body	19.17	15.5	35.48	No

13 Evaluation of Simultaneous

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

	Position	Main antenna	WiFi	Sum
Highest reported SAR value for Head	Left hand, Touch cheek	0.68	0.52	**1.20**
Highest reported SAR value for Body	Rear	0.83	0.24	**1.07**

Table 13.2: 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	0.68	0.09[1]	**0.77**
Highest reported SAR value for Body	Rear	0.83	0.05[1]	**0.88**

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

Table 13.3: Estimated SAR for Bluetooth

Position	F (GHz)	Distance (mm)	Upper limit of power *		Estimated$_{1g}$ (W/kg)
			dBm	mW	
Head	2.441	5	3.5	2.24	0.09
Body	2.441	10	3.5	2.24	0.05

* - 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 10mm 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-gSAR 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:

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

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& PCS1900	1:4
WiFi	1:1

14.1 SAR results for Fast SAR

Note: H1:CCB0046A15C4 H2:CCB0046A15C1

Table 14.1-1: SAR Values (GSM 850 MHz Band - Head)

Ambient Temperature: 22.5 ºC Liquid Temperature: 22.0 ºC											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
848.8	251	L	Cheek	**Fig.1**	32.28	33	0.580	**0.68**	0.436	**0.51**	-0.06
836.6	190	L	Cheek	/	32.34	33	0.472	**0.55**	0.349	**0.41**	0.03
824.2	128	L	Cheek	/	32.28	33	0.369	**0.44**	0.275	**0.32**	0.05
836.6	190	L	Tilt	/	32.34	33	0.151	**0.18**	0.111	**0.13**	-0.01
836.6	190	R	Cheek	/	32.34	33	0.358	**0.42**	0.263	**0.31**	0.02
836.6	190	R	Tilt	/	32.34	33	0.287	**0.33**	0.220	**0.26**	0.01

Table 14.1-2: SAR Values (GSM 850 MHz Band-Body)

Ambient Temperature: 22.5 ℃ Liquid Temperature: 22.0 ℃											
Frequency		Mode (number of timeslots)	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
836.6	190	GPRS (2)	Front	/	29.89	30.5	0.542	**0.62**	0.413	**0.48**	0.02
848.8	251	GPRS (2)	Rear	**Fig.2**	29.91	30.5	0.726	**0.83**	0.554	**0.63**	-0.14
836.6	190	GPRS (2)	Rear	/	29.89	30.5	0.598	**0.69**	0.449	**0.52**	0.01
824.2	128	GPRS (2)	Rear	/	29.88	30.5	0.564	**0.65**	0.424	**0.49**	-0.04
836.6	190	GPRS (2)	Left	/	29.89	30.5	0.350	**0.40**	0.249	**0.29**	0.03
836.6	190	GPRS (2)	Right	/	29.89	30.5	0.296	**0.34**	0.210	**0.24**	-0.01
836.6	190	GPRS (2)	Bottom	/	29.89	30.5	0.094	**0.11**	0.061	**0.07**	0.02
848.8	251	EGPRS (2)	Rear	/	29.93	30.5	0.715	**0.82**	0.549	**0.63**	0.08

Note1: The distance between the EUT and the phantom bottom is 10mm.

Table 14.1-3: SAR Values (GSM1900 MHz Band - Head)

Ambient Temperature: 22.5 ℃ Liquid Temperature: 22.0 ℃											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
1909.8	810	L	Cheek	/	29.34	30	0.406	**0.47**	0.259	**0.30**	0.06
1880	661	L	Cheek	**Fig.3**	29.26	30	0.419	**0.50**	0.271	**0.32**	0.18
1850.2	512	L	Cheek	/	29.19	30	0.371	**0.45**	0.243	**0.29**	0.03
1880	661	L	Tilt	/	29.26	30	0.135	**0.16**	0.093	**0.11**	0.12
1880	661	R	Cheek	/	29.26	30	0.323	**0.38**	0.210	**0.25**	0.07
1880	661	R	Tilt	/	29.26	30	0.173	**0.21**	0.110	**0.13**	0.05

Table 14.1-4: SAR Values (GSM 1900 MHz Band-Body)

Ambient Temperature: 22.5 ℃ Liquid Temperature: 22.0 ℃											
Frequency		Mode (number of timeslots)	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
1880	661	GPRS (2)	Front	/	26.73	27	0.465	**0.49**	0.281	**0.30**	0.01
1909.8	810	GPRS (2)	Rear	/	26.79	27	0.630	**0.66**	0.358	**0.38**	0.02
1880	661	GPRS (2)	Rear	/	26.73	27	0.621	**0.66**	0.352	**0.38**	-0.05
1850.2	512	GPRS (2)	Rear	**Fig.4**	26.68	27	0.650	**0.70**	0.370	**0.40**	0.02
1880	661	GPRS (2)	Left	/	26.73	27	0.098	**0.10**	0.057	**0.06**	0.03
1880	661	GPRS (2)	Right	/	26.73	27	0.167	**0.18**	0.095	**0.10**	0.01
1880	661	GPRS (2)	Bottom	/	26.73	27	0.582	**0.62**	0.300	**0.32**	-0.04
1850.2	512	EGPRS (2)	Rear	/	26.68	27	0.59	**0.64**	0.351	**0.38**	0.02

Note1: The distance between the EUT and the phantom bottom is 10mm.

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 14.2-1: SAR Values (GSM 850 MHz Band - Head)

Ambient Temperature: 22.5 °C Liquid Temperature: 22.0 °C											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
848.8	251	L	Cheek	**Fig.1**	32.28	33	0.580	**0.68**	0.436	**0.51**	-0.06

Table 14.2-2: SAR Values (GSM 850 MHz Band-Body)

Ambient Temperature: 22.5 °C Liquid Temperature: 22.0 °C											
Frequency		Mode (number of timeslots)	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
848.8	251	GPRS (2)	Rear	**Fig.2**	29.91	30.5	0.726	**0.83**	0.554	**0.63**	-0.14

Note1: The distance between the EUT and the phantom bottom is 10mm.

Table 14.2-3: SAR Values (GSM1900 MHz Band - Head)

Ambient Temperature: 22.5 °C Liquid Temperature: 22.0 °C											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
1880	661	L	Cheek	**Fig.3**	29.26	30	0.419	**0.50**	0.271	**0.32**	0.18

Table 14.2-4: SAR Values (GSM 1900 MHz Band-Body)

Ambient Temperature: 22.5 °C Liquid Temperature: 22.0 °C											
Frequency		Mode (number of timeslots)	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
1850.2	512	GPRS (2)	Rear	**Fig.4**	26.68	27	0.650	**0.70**	0.370	**0.40**	0.02

Note1: The distance between the EUT and the phantom bottom is 10mm.

14.3 WLAN Evaluation

According to the KDB248227 D01, SAR is measured for 2.4GHz 802.11b DSSS using the initial test position procedure.

Head Evaluation

Table 14.3-1: SAR Values (WLAN - Head) – 802.11b 1Mbps (Fast SAR)

Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
2462	11	L	Cheek	/	15.32	16.5	0.381	**0.50**	0.183	**0.24**	0.15
2462	11	L	Tilt	/	15.32	16.5	0.208	**0.27**	0.101	**0.13**	-0.19
2462	11	R	Cheek	/	15.32	16.5	0.184	**0.24**	0.098	**0.13**	-0.10
2462	11	R	Tilt	/	15.32	16.5	0.134	**0.18**	0.068	**0.09**	-0.05

As shown above table, the initial test position for head is “Left Cheek”. So the head SAR of WLAN is presented as below:

Table 14.3-2: SAR Values (WLAN - Head) – 802.11b 1Mbps (Full SAR)

Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃											
Frequency		Side	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.										
2462	11	L	Cheek	**Fig.5**	15.32	16.5	0.394	**0.52**	0.182	**0.24**	0.15
2462	11	L	Tilt	/	15.32	16.5	0.219	**0.29**	0.100	**0.13**	-0.19

According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. The scaled reported SAR is presented as below:

Table 14.3-3: SAR Values (WLAN - Head) – 802.11b 1Mbps (Scaled Reported SAR)

Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃							
Frequency		Side	Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g) (W/kg)	Scaled reported SAR (1g) (W/kg)
MHz	Ch.						
2462	11	Left	Touch	99.52%	100%	**0.52**	**0.52**

SAR is required for OFDM because the 802.11b adjusted SAR <1.2 W/kg.

Body Evaluation

Table 14.3-4: SAR Values (WLAN - Body) – 802.11b 1Mbps (Fast SAR)

Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃										
Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g)(W/kg)	Power Drift (dB)
MHz	Ch.									
2462	11	**Front**	**/**	15.32	16.5	0.053	**0.07**	0.028	**0.04**	0.03
2462	11	Rear	/	15.32	16.5	0.147	**0.19**	0.073	**0.10**	0.09
2462	11	Right	/	15.32	16.5	0.128	**0.17**	0.064	**0.08**	0.08
2462	11	Top	/	15.32	16.5	0.041	**0.05**	0.023	**0.03**	0.05

As shown above table, the initial test position for body is "Front". So the body SAR of WLAN is presented as below:

Table 14.3-5: SAR Values (WLAN - Body) – 802.11b 1Mbps (Full SAR)

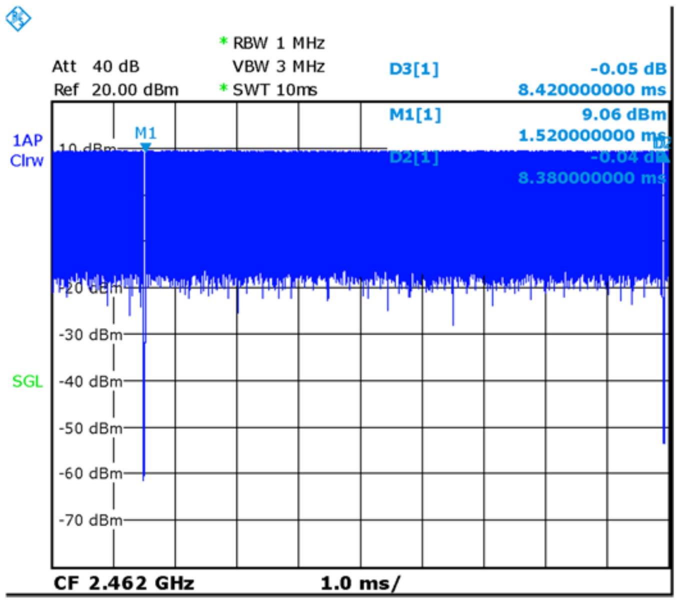
Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃										
Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g)(W/kg)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Power Drift (dB)
MHz	Ch.									
2462	11	Rear	**Fig.6**	15.32	16.5	0.181	**0.24**	0.084	**0.11**	0.09

According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. The scaled reported SAR is presented as below.

Table 14.3-6: SAR Values (WLAN - Body) – 802.11b 1Mbps (Scaled Reported SAR)

Ambient Temperature: 22.2℃ Liquid Temperature: 21.7℃						
Frequency		Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g) (W/kg)	Scaled reported SAR (1g) (W/kg)
MHz	Ch.					
2462	11	Rear	99.52%	100%	**0.24**	**0.24**

SAR is not required for OFDM because the 802.11b adjusted SAR ≤ 1.2 W/kg.



Picture 14.1 The plot of duty factor for 802.11b

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; steps2) 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 ≥ 1.45W/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	6.0	N	1	1	1	6.0	6.0	∞
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	RFambient 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	∞
12	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		$u_c^{'} = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$						9.55	9.43	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						19.1	18.9	

16.2 Measurement Uncertainty for Normal SAR Tests (3~6GHz)

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	6.55	N	1	1	1	6.55	6.55	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	2.0	R	$\sqrt{3}$	1	1	1.2	1.2	∞
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	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
12	Probe positioning with respect to phantom shell	B	6.7	R	$\sqrt{3}$	1	1	3.9	3.9	∞
13	Post-processing	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
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		$u_c^{'} = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$						10.7	10.6	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						21.4	21.1	

16.3 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	6.0	N	1	1	1	6.0	6.0	∞
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	∞
12	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		$u_c' = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$						10.4	10.3	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						20.8	20.6	

16.4 Measurement Uncertainty for Fast SAR Tests (3~6GHz)

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	6.55	N	1	1	1	6.55	6.55	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	2.0	R	$\sqrt{3}$	1	1	1.2	1.2	∞
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	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
12	Probe positioning with respect to phantom shell	B	6.7	R	$\sqrt{3}$	1	1	3.9	3.9	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
14	Fast SAR z-Approximation	B	14.0	R	$\sqrt{3}$	1	1	8.1	8.1	∞
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		$u_c^{'} = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$						13.5	13.4	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						27.0	26.8	

17 MAIN TEST INSTRUMENTS

Table 17.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 13,2017	One year
02	Power meter	NRVD	102083	September 22,2016	One year
03	Power sensor	NRV-Z5	100595		
04	Signal Generator	E4438C	MY49071430	January 13,2017	One Year
05	Amplifier	25S1G6	0344445	No Calibration Requested	
06	BTS	E5515C	MY50263375	January16, 2017	One year
07	E-field Probe	SPEAG EX3DV4	3846	January 13,2017	One year
08	DAE	SPEAG DAE4	1331	January 19, 2017	One year
09	Dipole Validation Kit	SPEAG D835V2	4d069	July 19,2017	One year
10	Dipole Validation Kit	SPEAG D1900V2	5d101	July 26,2017	One year
10	Dipole Validation Kit	SPEAG D2450V2	823	July 21,2017	One year

END OF REPORT BODY

ANNEX A Graph Results

850 Left Cheek High

Date: 2017-8-4
Electronics: DAE4 Sn1331
Medium: Head 850 MHz
Medium parameters used (interpolated): f = 848.8 MHz; σ = 0.918 mho/m; εr = 40.21;ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: GSM 850 Frequency: 848.8 MHz Duty Cycle: 1:8.3
Probe: EX3DV4 - SN3846 ConvF(9.33, 9.33, 9.33)

Area Scan (71x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.633 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.677 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.731 W/kg
SAR(1 g) = 0.580 W/kg; SAR(10 g) = 0.436 W/kg
Maximum value of SAR (measured) = 0.629 W/kg

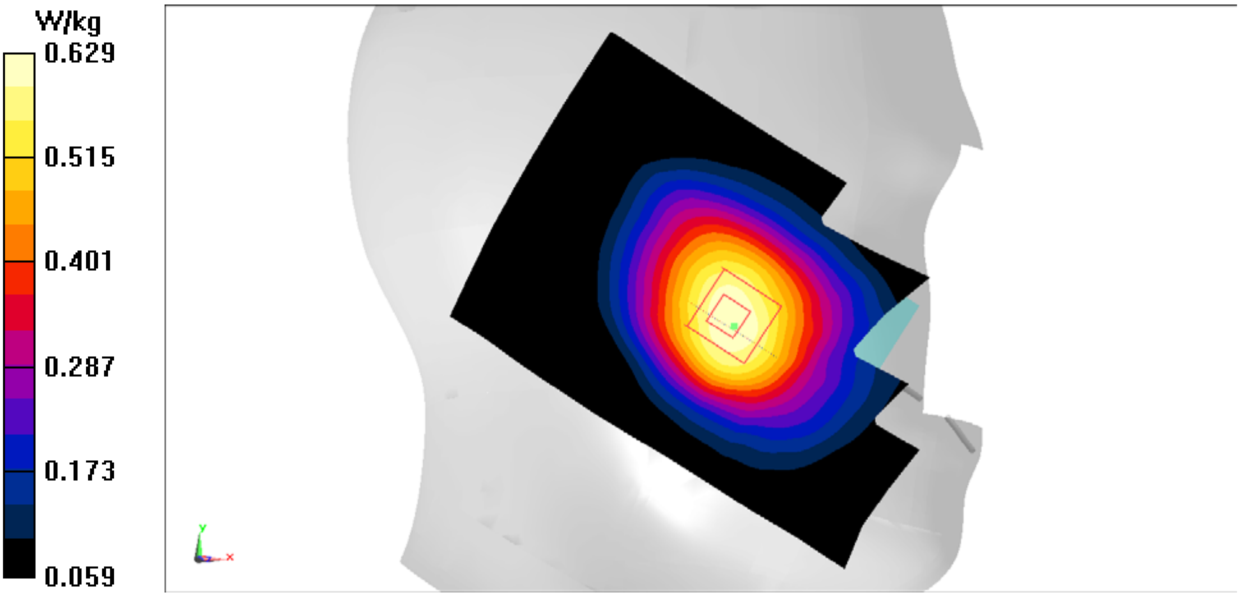


Fig.1 850MHz

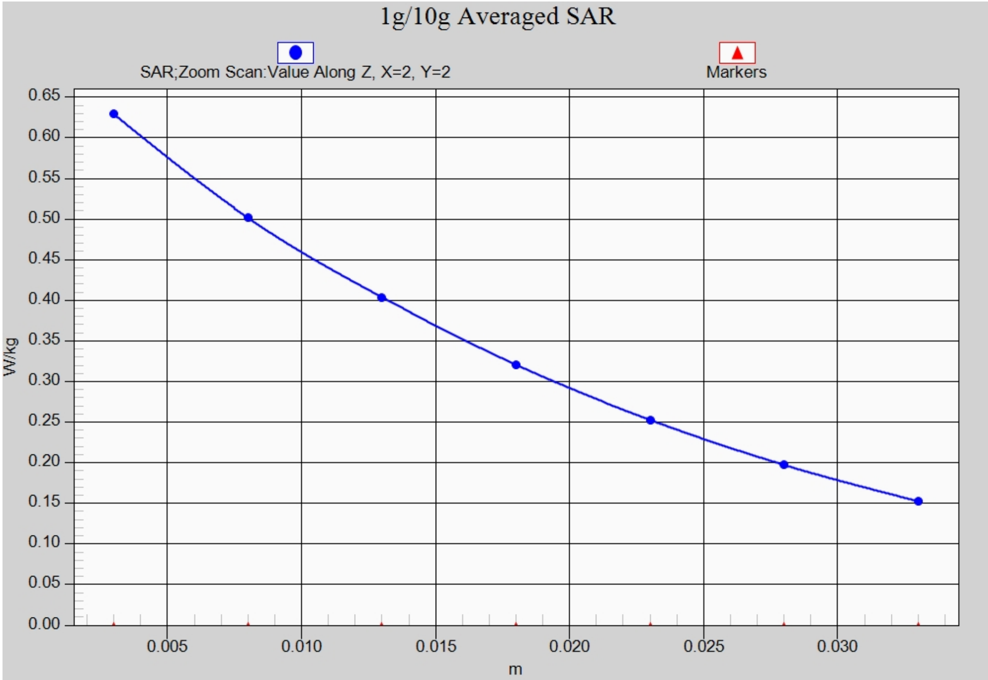


Fig. 1-1 Z-Scan at power reference point (850 MHz)

850 Body Rear High
Date: 2017-8-5
Electronics: DAE4 Sn1331
Medium: Body 850 MHz
Medium parameters used (interpolated): f = 848.8 MHz; σ = 0.987 mho/m; εr = 55.15; ρ = 1000 kg/m³
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: GSM 850 GPRS Frequency: 848.8 MHz Duty Cycle: 1:4
Probe: EX3DV4 - SN3846 ConvF(9.52, 9.52, 9.52)

Area Scan (101x71x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.800 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 27.26 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 0.898 W/kg
SAR(1 g) = 0.726 W/kg; SAR(10 g) = 0.554 W/kg
Maximum value of SAR (measured) = 0.763 W/kg

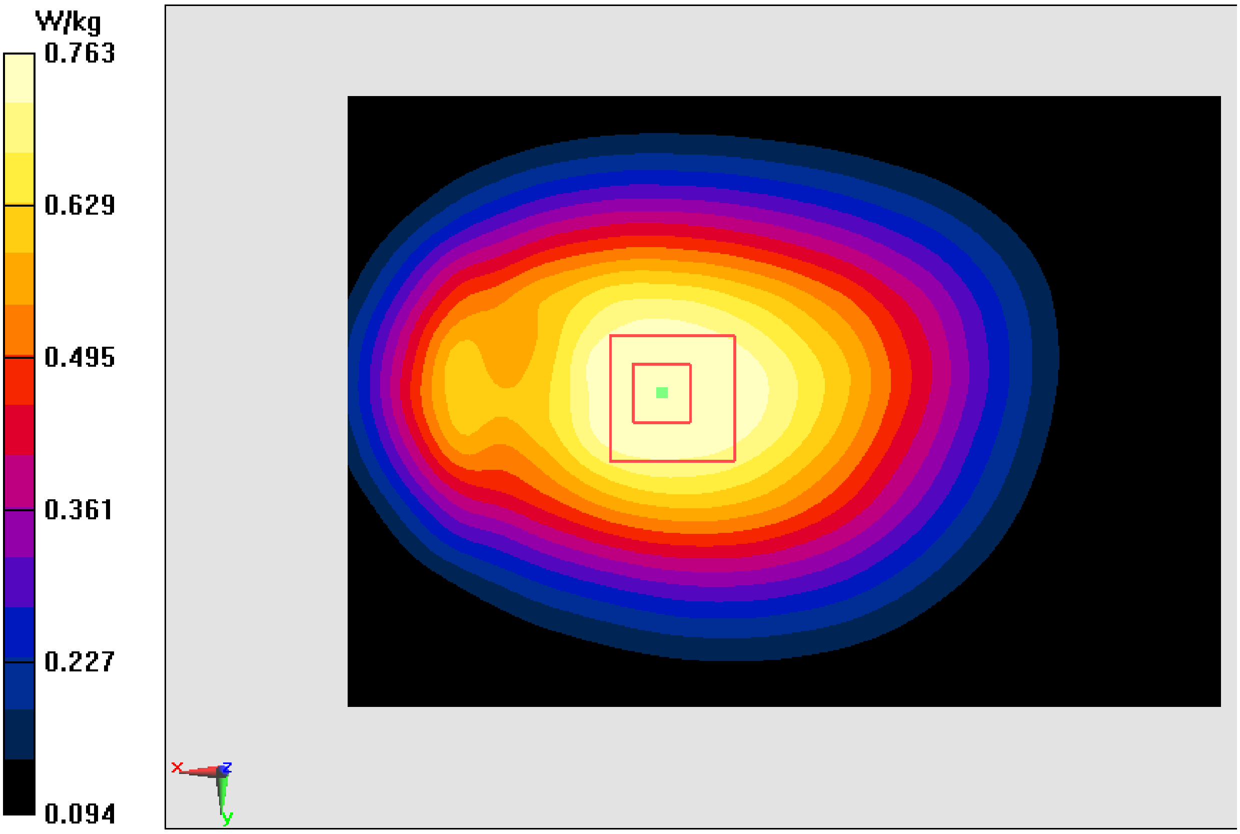


Fig.2 850 MHz

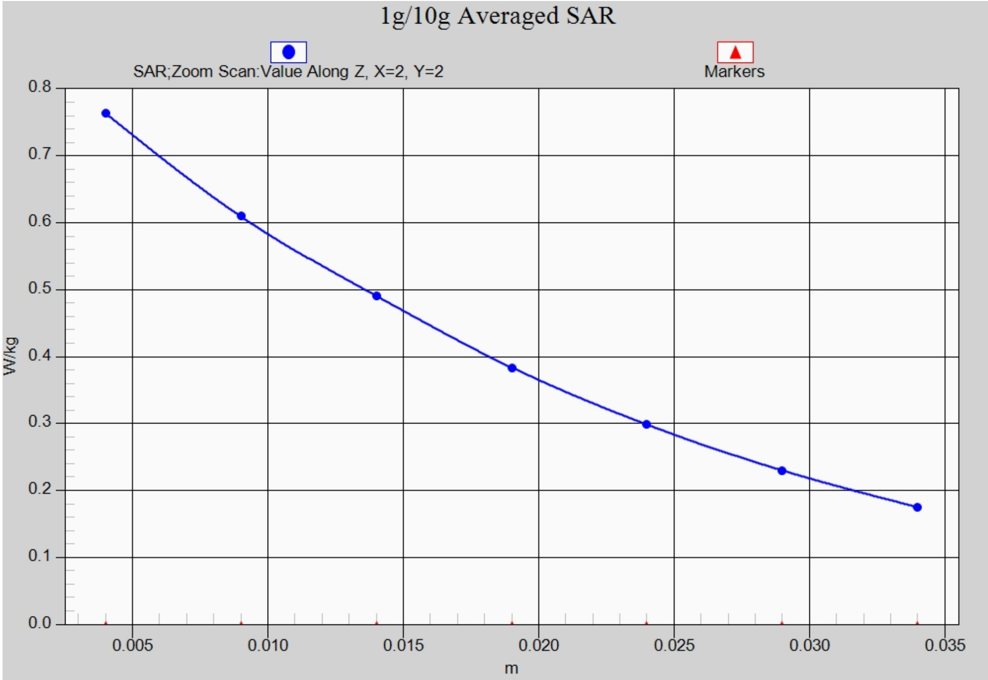


Fig. 2-1 Z-Scan at power reference point (850 MHz)

1900 Left Cheek Middle
Date: 2017-8-5
Electronics: DAE4 Sn1331
Medium: Head 1900 MHz
Medium parameters use (interpolated): f = 1880 MHz; σ = 1.371 mho/m; εr = 40.20; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: GSM 1900MHz Frequency: 1880 MHz Duty Cycle: 1:8.3
Probe: EX3DV4 - SN3846 ConvF(7.89, 7.89, 7.89)

Area Scan (71x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.517 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.812 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 0.604 W/kg
SAR(1 g) = 0.419 W/kg; SAR(10 g) = 0.271 W/kg
Maximum value of SAR (measured) = 0.479 W/kg

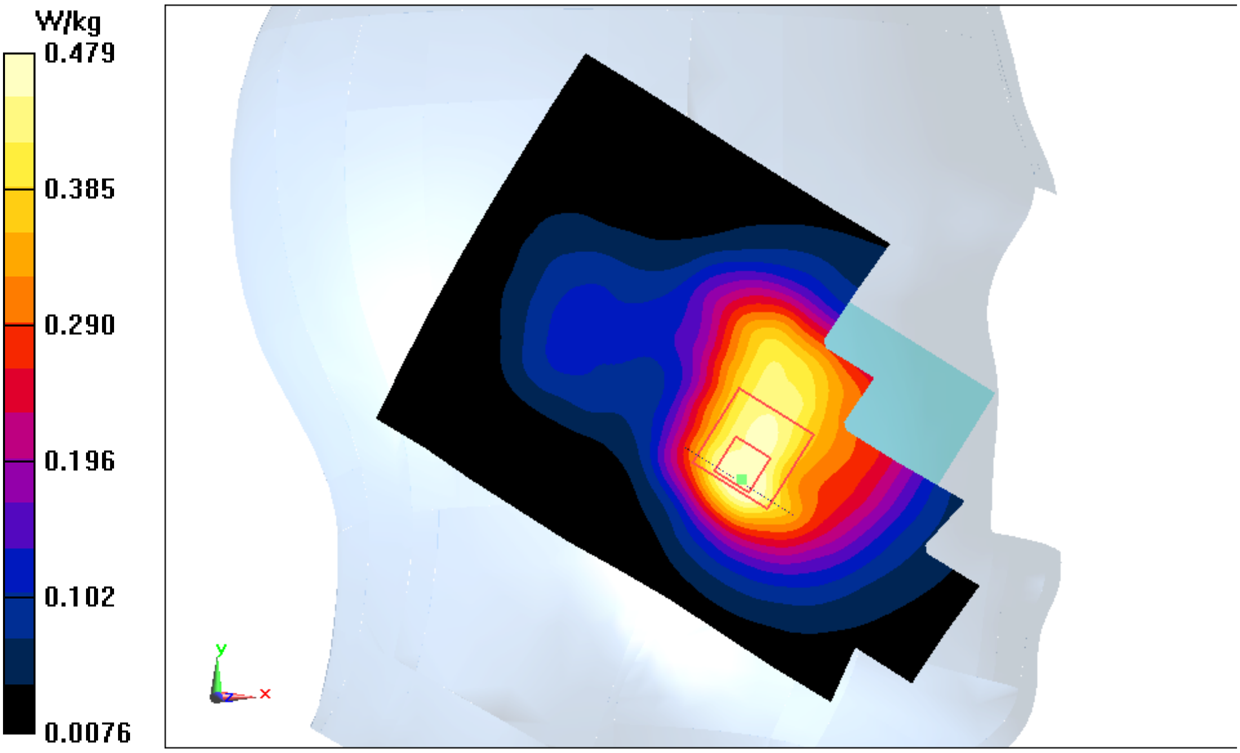


Fig.3 1900 MHz

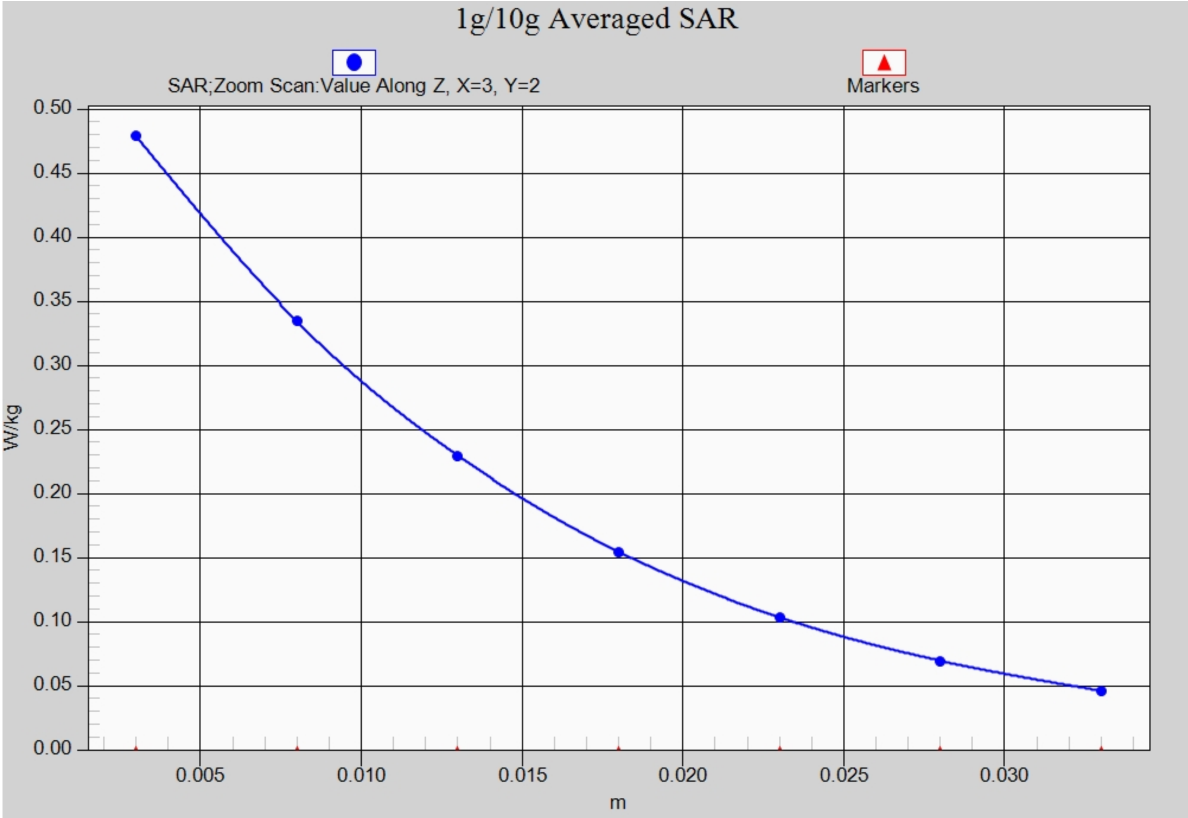


Fig. 3-1 Z-Scan at power reference point (1900 MHz)

1900 Body Rear Low
Date: 2017-8-5
Electronics: DAE4 Sn1331
Medium: Body 1900 MHz
Medium parameters used (interpolated): f = 1850.2 MHz; σ = 1.487 mho/m; εr = 54.76; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: GSM 1900MHz GPRS Frequency: 1850.2 MHz Duty Cycle: 1:4
Probe: EX3DV4 - SN3846 ConvF(7.57, 7.57, 7.57)

Area Scan (111x71x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.800 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.75 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 1.08 W/kg
SAR(1 g) = 0.650 W/kg; SAR(10 g) = 0.370 W/kg
Maximum value of SAR (measured) = 0.724 W/kg

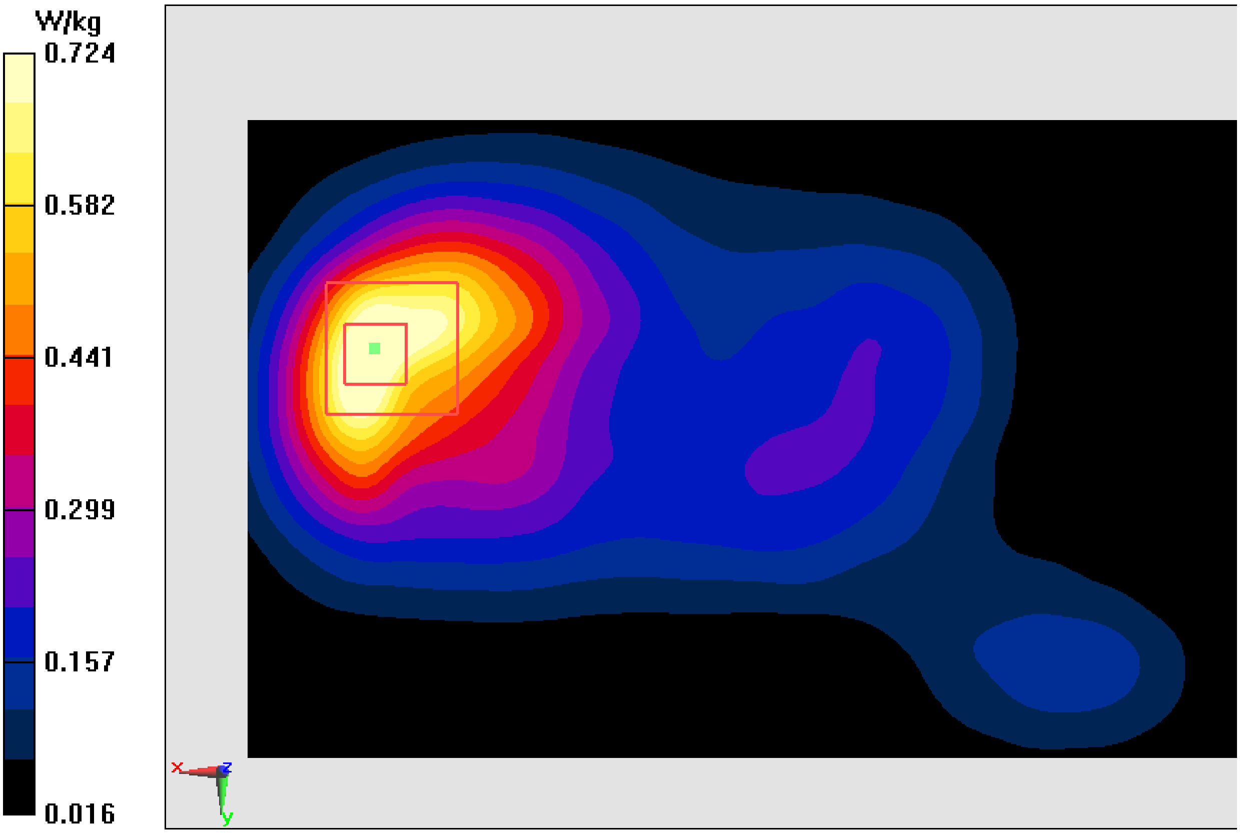


Fig.4 1900 MHz

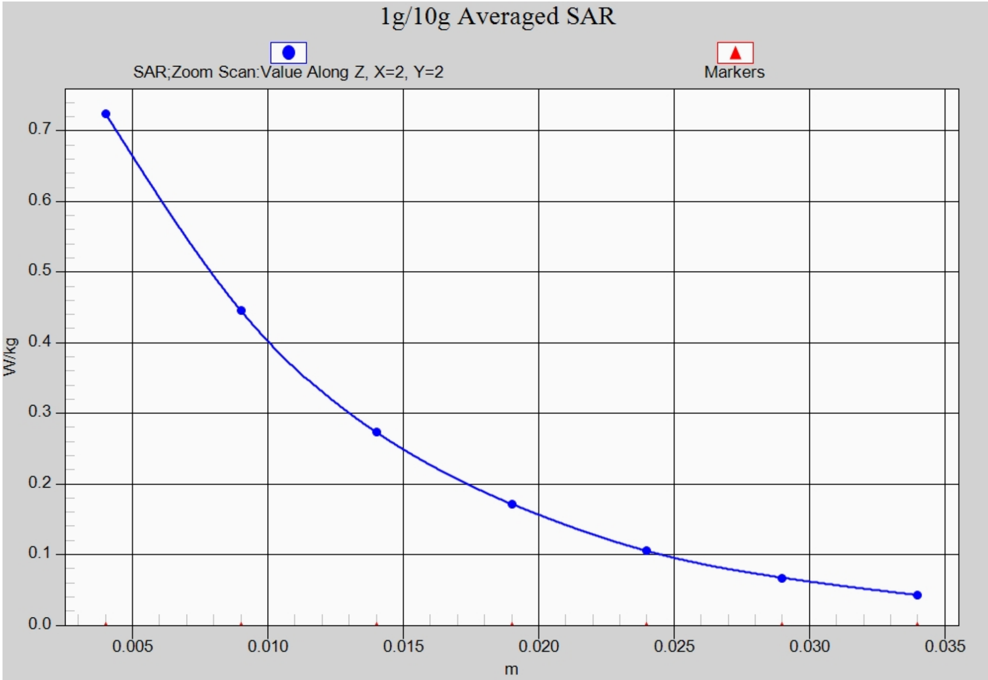


Fig.4-1 Z-Scan at power reference point (1900 MHz)

Wifi 802.11n Left Cheek Channel 11
Date: 2017-8-7
Electronics: DAE4 Sn1331
Medium: Head 2450 MHz
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.839 S/m; ε_r = 39.45; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: WLan 2450 Frequency: 2462 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.22, 7.22, 7.22)

Area Scan (81x131x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.547 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.138 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 0.845 W/kg
SAR(1 g) = 0.394 W/kg; SAR(10 g) = 0.182 W/kg
Maximum value of SAR (measured) = 0.511 W/kg

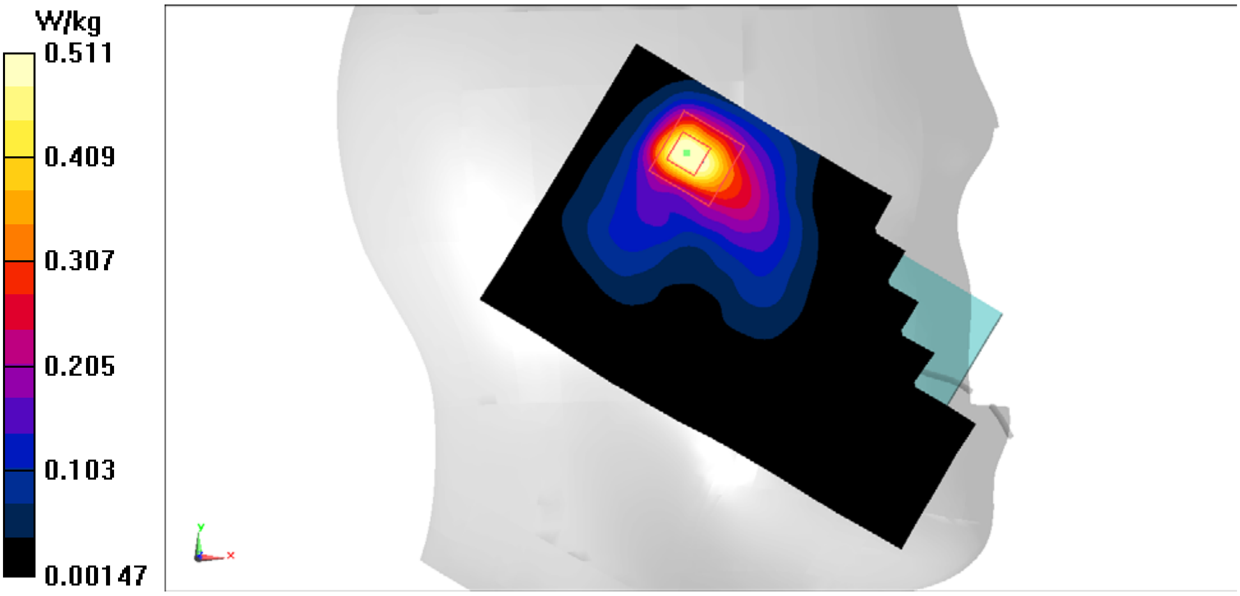


Fig.5 2450 MHz

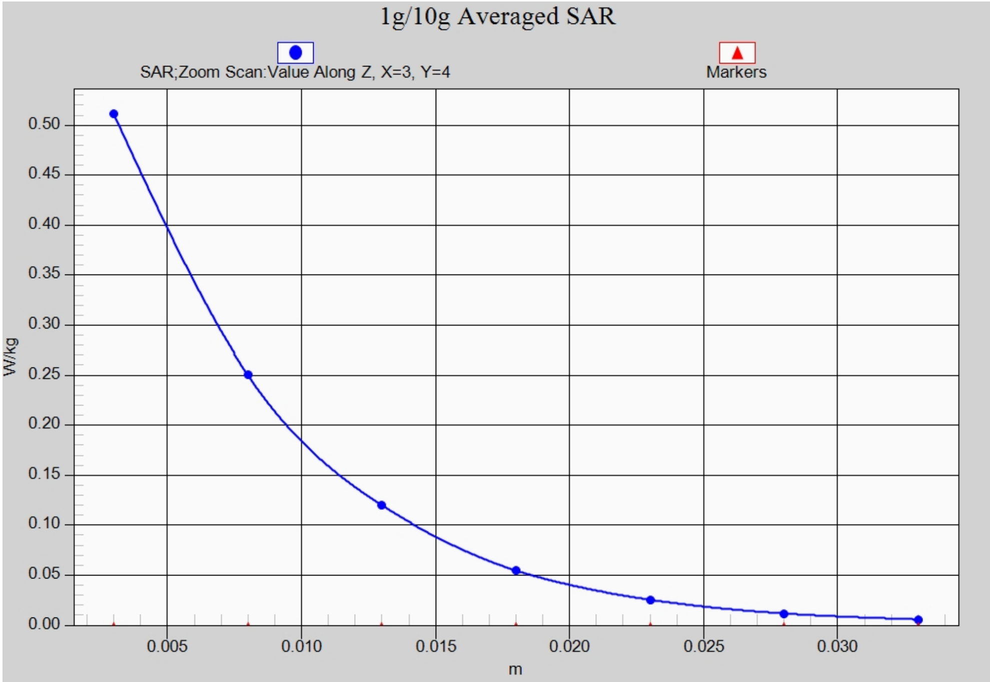


Fig. 5-1 Z-Scan at power reference point (2450 MHz)

Wifi 802.11b Body Rear Channel 11
Date: 2017-8-7
Electronics: DAE4 Sn1331
Medium: Body 2450 MHz
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.986 S/m; ε_r = 53.02; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: WLan 2450 Frequency: 2462 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.31, 7.31, 7.31)

Area Scan (101x61x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.196 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.752 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 0.377 W/kg
SAR(1 g) = 0.181 W/kg; SAR(10 g) = 0.084 W/kg
Maximum value of SAR (measured) = 0.208 W/kg

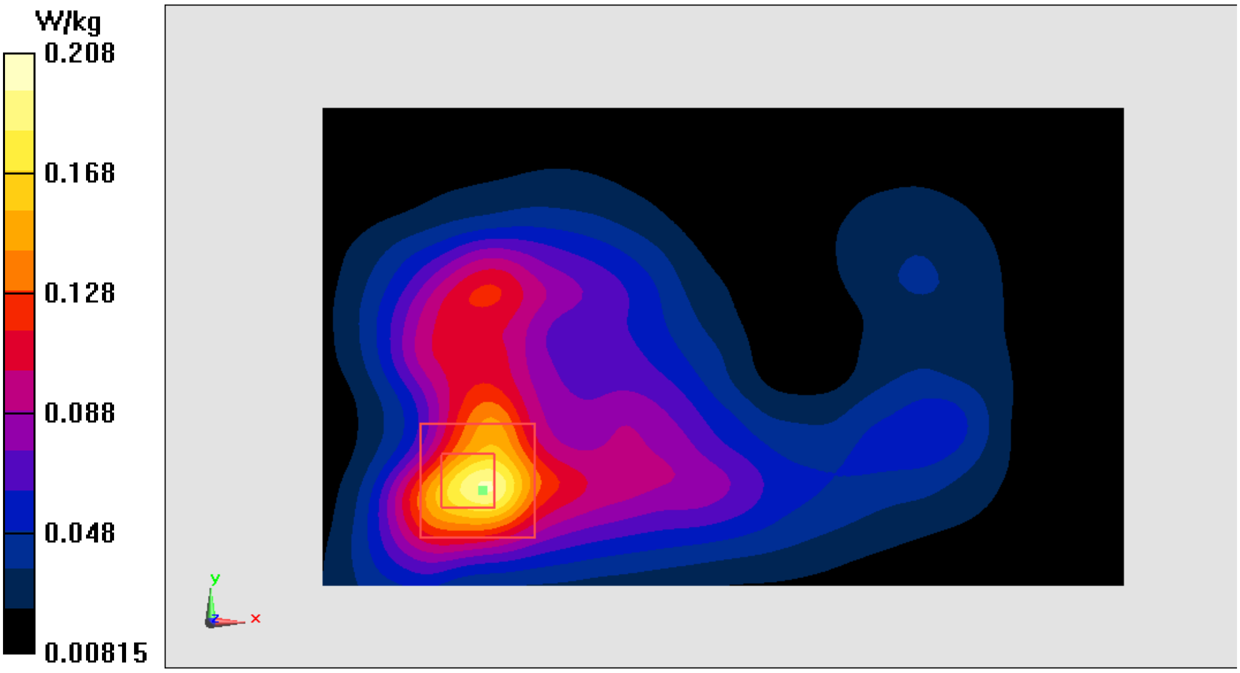


Fig.6 2450 MHz

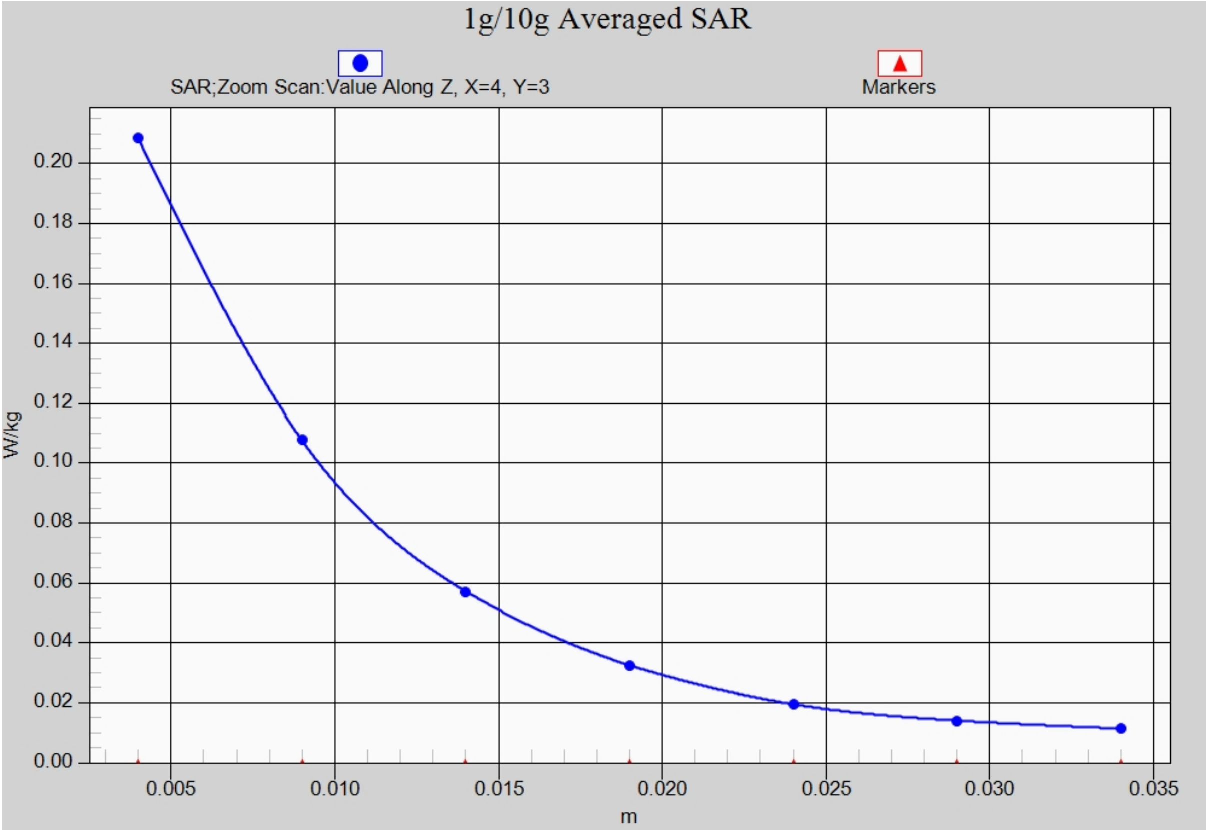


Fig. 6-1 Z-Scan at power reference point (2450 MHz)

ANNEX B SystemVerification Results

835 MHz

Date: 8/4/2017
Electronics: DAE4 Sn1331
Medium: Head 835 MHz
Medium parameters used: f = 835 MHz; σ =0.903 mho/m; ε_r = 40.89; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(9.33,9.33,9.33)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 60.93 V/m; Power Drift = 0.04

Fast SAR: SAR(1 g) = 2.36 W/kg; SAR(10 g) = 1.5 W/kg

Maximum value of SAR (interpolated) = 3.16 W/kg

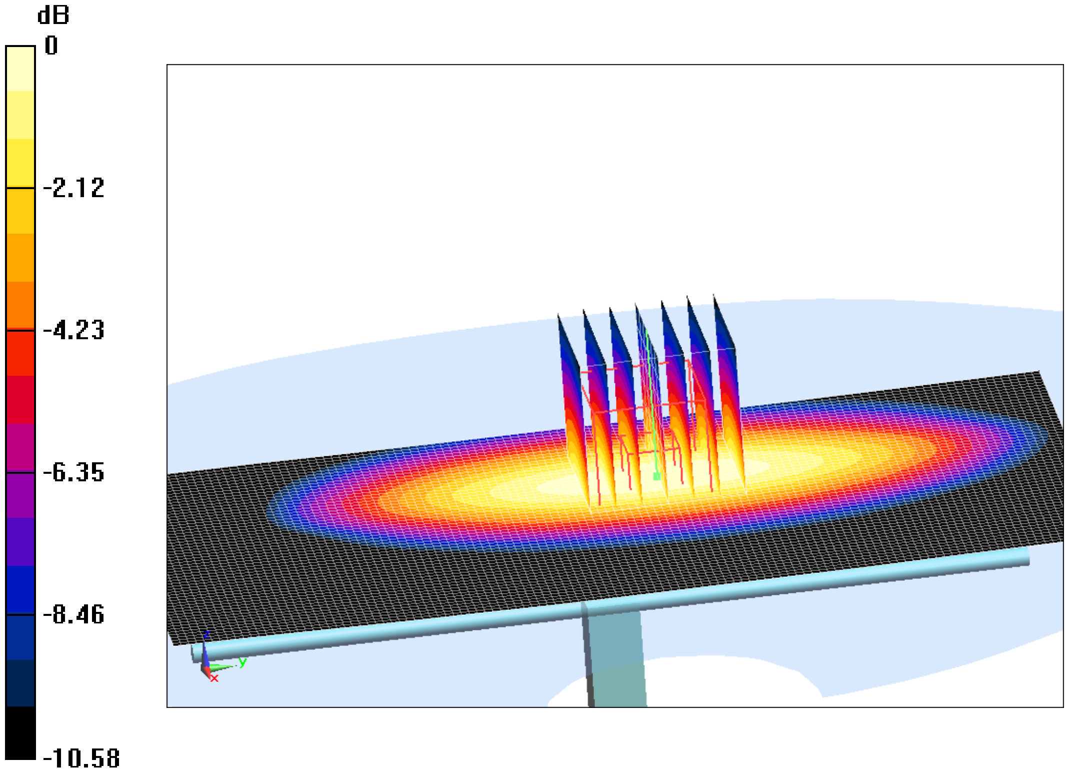
System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value =60.93 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 3.75 W/kg

SAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.52 W/kg

Maximum value of SAR (measured) = 3.2 W/kg



0 dB = 3.2 W/kg = 5.05 dB W/kg

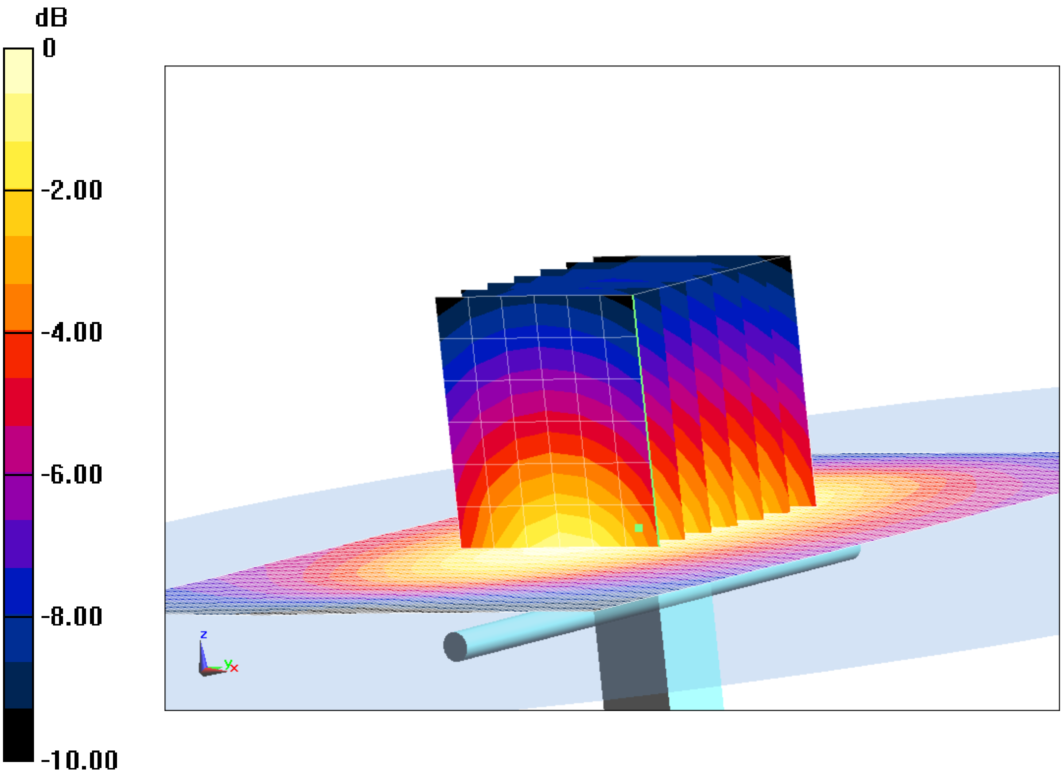
Fig.B.1 validation 835 MHz 250mW

835 MHz

Date: 8/4/2017
Electronics: DAE4 Sn1331
Medium: Body 835 MHz
Medium parameters used: f = 835 MHz; σ =0.971 mho/m; ε_r = 56.08; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(9.52,9.52,9.52)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 61.35 V/m; Power Drift = -0.05
Fast SAR: SAR(1 g) = 2.34 W/kg; SAR(10 g) = 1.54 W/kg
Maximum value of SAR (interpolated) = 3.33 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =61.35 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 3.68 W/kg
SAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.55 W/kg
Maximum value of SAR (measured) = 3.26 W/kg



0 dB = 3.26 W/kg = 5.13 dB W/kg

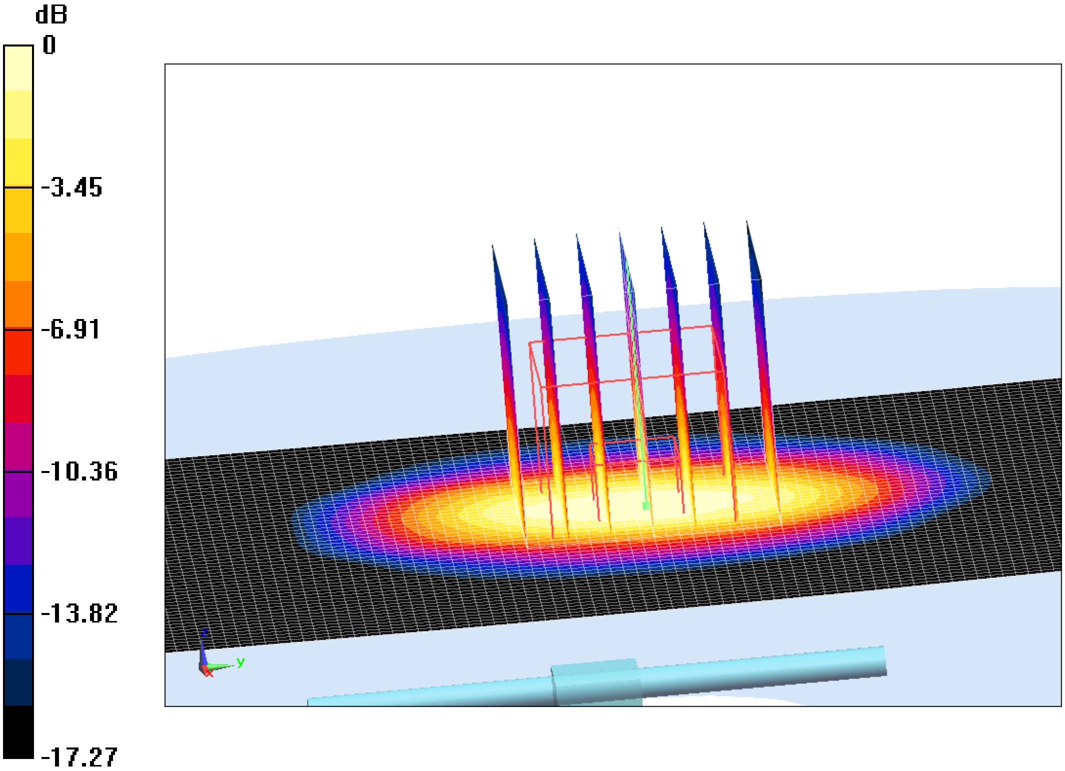
Fig.B.2 validation 835 MHz 250mW

1900 MHz

Date: 8/5/2017
Electronics: DAE4 Sn1331
Medium: Head 1900 MHz
Medium parameters used: f = 1900 MHz; σ =1.386 mho/m; ε_r = 39.78; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.89,7.89,7.89)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 109.71 V/m; Power Drift = 0.09
Fast SAR: SAR(1 g) = 10.03 W/kg; SAR(10 g) = 5.15 W/kg
Maximum value of SAR (interpolated) = 15.11 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =109.71 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 18.93 W/kg
SAR(1 g) = 9.95 W/kg; SAR(10 g) = 5.22 W/kg
Maximum value of SAR (measured) = 15.6 W/kg



0 dB = 15.6 W/kg = 11.93 dB W/kg

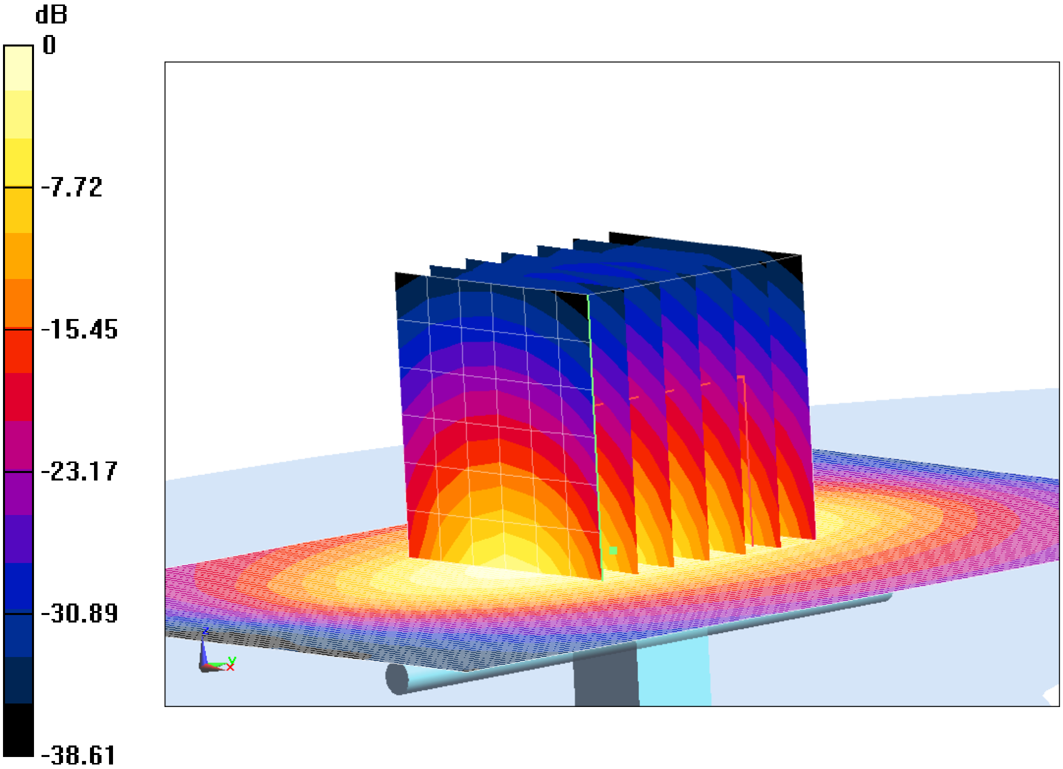
Fig.B.3 validation 1900 MHz 250mW

1900 MHz

Date: 8/5/2017
Electronics: DAE4 Sn1331
Medium: Body 1900 MHz
Medium parameters used: f = 1900 MHz; σ =1.527 mho/m; ε_r = 53.36; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.57,7.57,7.57)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 104.39 V/m; Power Drift = 0.05
Fast SAR: SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.28 W/kg
Maximum value of SAR (interpolated) = 14.92 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =104.39 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 17.78 W/kg
SAR(1 g) = 10.09 W/kg; SAR(10 g) = 5.4 W/kg
Maximum value of SAR (measured) = 14.96 W/kg



0 dB = 14.96 W/kg = 11.75 dB W/kg

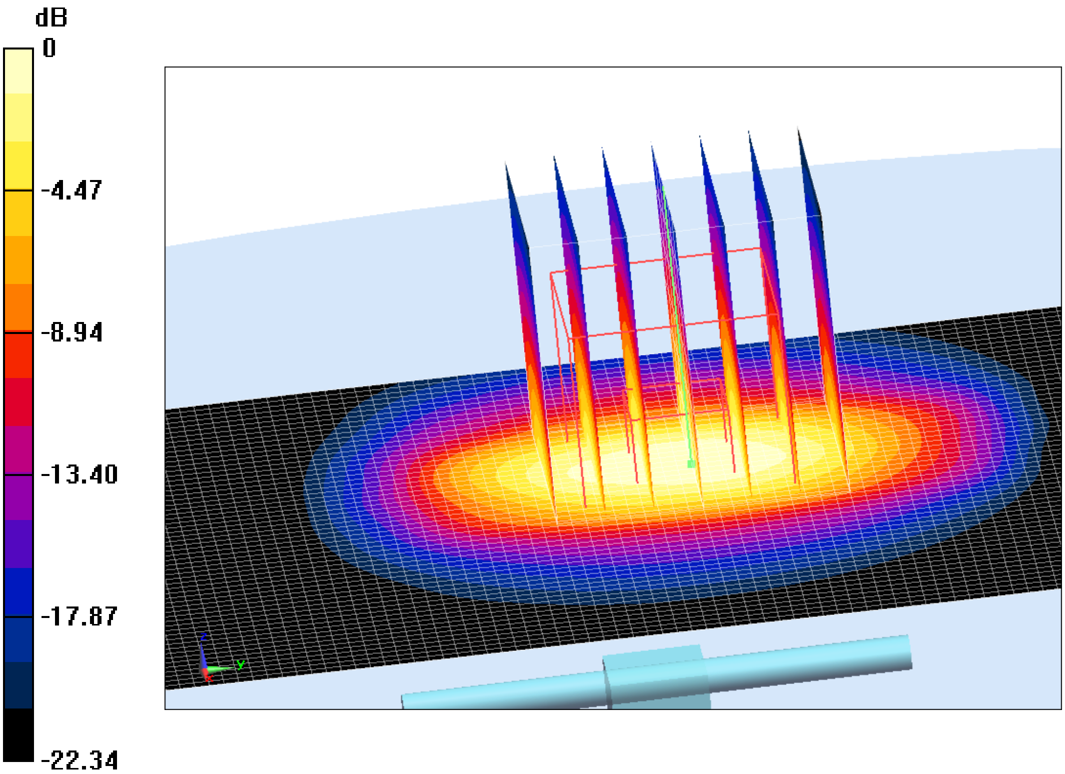
Fig.B.4 validation 1900 MHz 250mW

2450 MHz

Date: 8/7/2017
Electronics: DAE4 Sn1331
Medium: Head 2450 MHz
Medium parameters used: f = 2450 MHz; σ =1.83 mho/m; ε_r = 39.64; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.22,7.22,7.22)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 114.88 V/m; Power Drift = 0.01
Fast SAR: SAR(1 g) = 13.26 W/kg; SAR(10 g) = 6.15 W/kg
Maximum value of SAR (interpolated) = 22.91 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =114.88 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.29 W/kg
SAR(1 g) = 13.05 W/kg; SAR(10 g) = 6.16 W/kg
Maximum value of SAR (measured) = 22.03 W/kg



0 dB = 22.03 W/kg = 13.43 dB W/kg

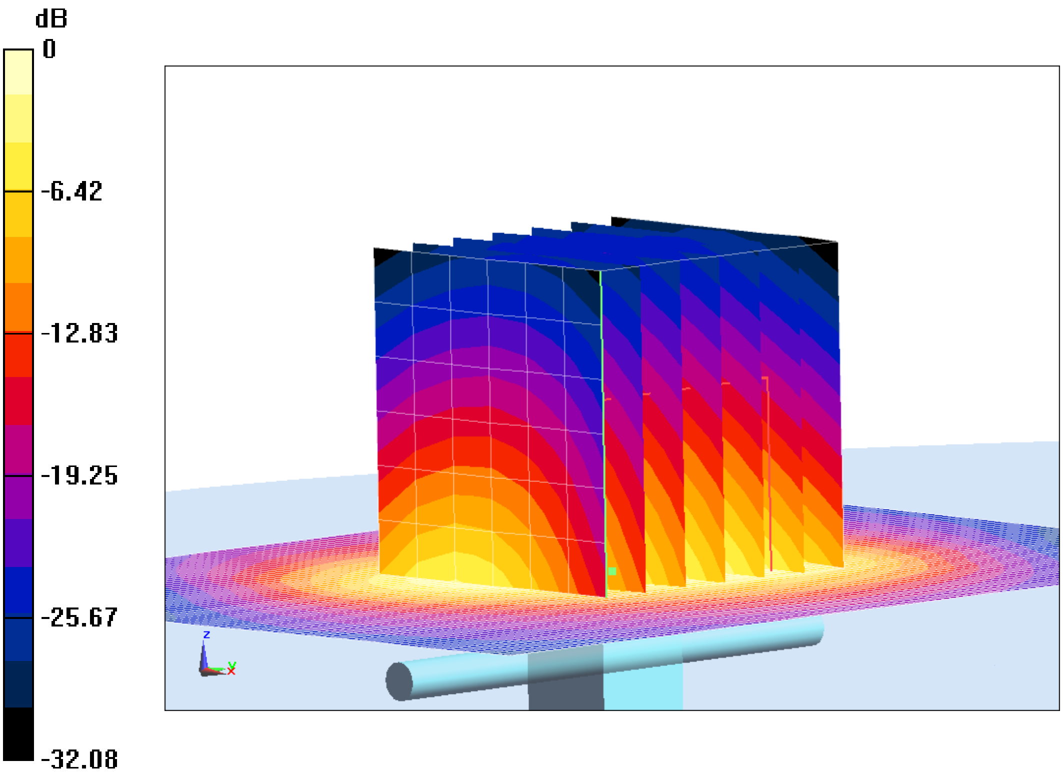
Fig.B.5 validation 2450 MHz 250mW

2450 MHz

Date: 8/7/2017
Electronics: DAE4 Sn1331
Medium: Body 2450 MHz
Medium parameters used: f = 2450 MHz; σ =1.976 mho/m; ε_r = 53.28; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C Liquid Temperature: 22.4°C
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN3846 ConvF(7.31,7.31,7.31)

System Validation /Area Scan (81x191x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 108.42 V/m; Power Drift = -0.07
Fast SAR: SAR(1 g) = 12.78 W/kg; SAR(10 g) = 6.06 W/kg
Maximum value of SAR (interpolated) = 21.77 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value =108.42 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 26.27 W/kg
SAR(1 g) = 12.84 W/kg; SAR(10 g) = 6.02 W/kg
Maximum value of SAR (measured) = 21.24 W/kg



0 dB = 21.24 W/kg = 13.27 dB W/kg

Fig.B.6 validation 2450 MHz 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.

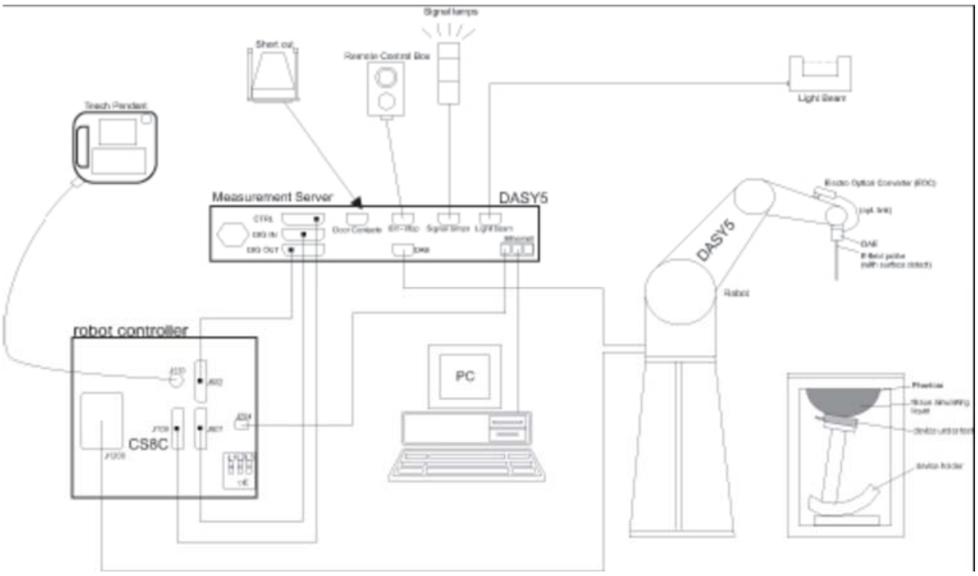
Table B.1 Comparison between area scan and zoom scan for system verification

Date	**Band**	**Position**	**Area scan (1g)**	**Zoom scan (1g)**	**Drift (%)**
2017-8-4	835	Head	2.36	2.35	0.43
	835	Body	2.34	2.35	-0.43
2017-8-5	1900	Head	10.03	9.95	0.80
	1900	Body	10.1	10.09	0.10
2017-8-7	1900	Head	13.26	13.05	1.61
	1900	Body	12.78	12.84	-0.47

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.1SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (StäubliTX=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: ± 0.2dB(30 MHz to 6 GHz) for EX3DV4
± 0.2dB(30 MHz to 4 GHz) for ES3DV3
DynamicRange: 10 mW/kg — 100W/kg
Probe Length: 330 mm
Probe Tip Length: 20 mm
Body Diameter: 12 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.5 DASY 4

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), chip disk (DASY4: 32 MB; DASY5: 128MB), RAM (DASY4: 64 MB, DASY5: 128MB). 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 pin out, 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.

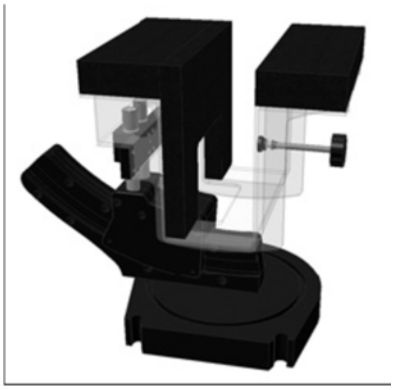
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference 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



Picture C.9-2: Laptop Extension Kit

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).

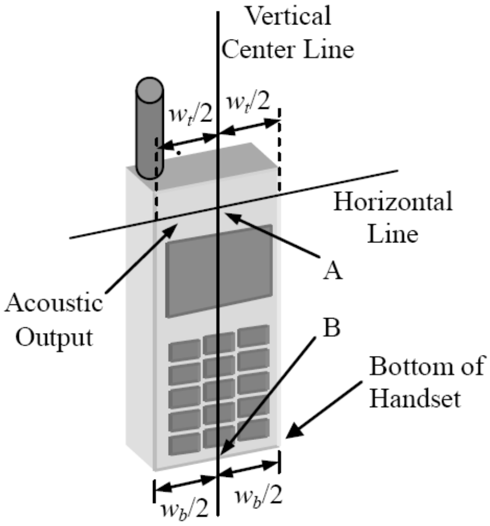
Shell Thickness: 2±0. 2 mm
Filling Volume: Approx. 25 liters
Dimensions: 810 x l000 x 500 mm (H x L x W)
Available: Special

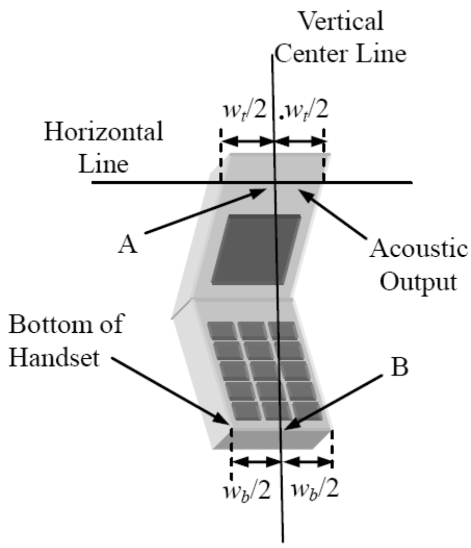
Picture C.10: SAM Twin Phantom

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.





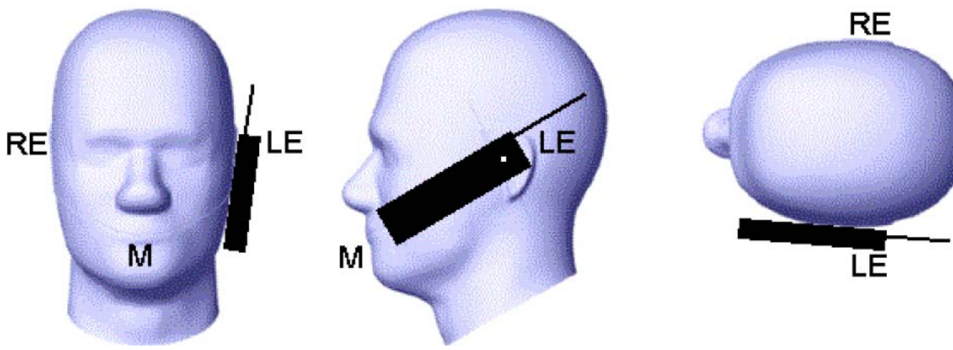
w_t Width of the handset at the level of the acoustic

w_b Width of the bottom of the handset

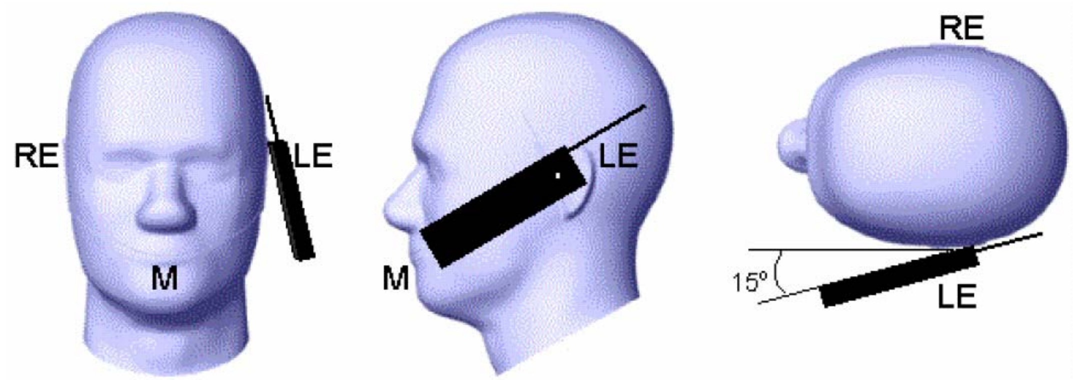
A Midpoint of the width w_t of the handset at the level of the acoustic output

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**



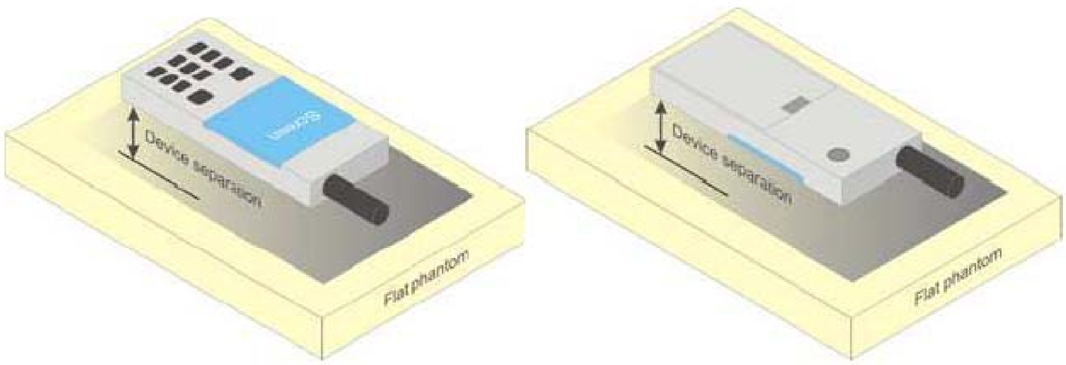
Picture D.2 Cheek position of the wireless device on the left side of SAM



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.

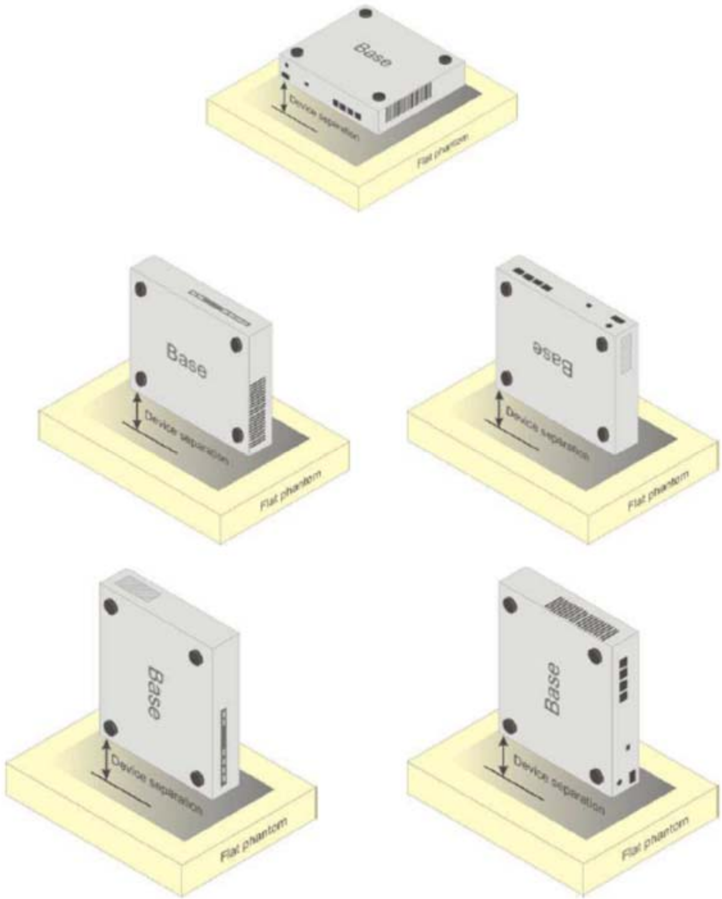


Picture D.4 Test positions for body-worn devices

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. Picture8.5 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.

TableE.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835Head	835Body	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	ε=41.5 σ=0.90	ε=55.2 σ=0.97	ε=40.0 σ=1.40	ε=53.3 σ=1.52	ε=39.2 σ=1.80	ε=52.7 σ=1.95	ε=35.3 σ=5.27	ε=48.2 σ=6.00