TEST REPORT

No.I18N00243-SAR

For

Doro AB

Doro 4G LTE Clamshell phone

Model Name: DFC-0190

With

Hardware Version: 3011

Software Version: CALM01A-S01A_DFC0190_120_180321094522

FCC ID: WS5DFC0190

Issued Date: 2018-04-10

Designation Number: CN1210

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 SAICT.

Test Laboratory:

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REPORT HISTORY

Report Number	Revision	Issue Date	Description
I18N00243-SAR	Rev.0	2018-04-10	Initial creation of test report

TABLE OF CONTENT

1 Test Laboratory

1.1 Testing Location

Company Name:	Shenzhen Academy of Information and Communications Technology
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Postal Code:	518026
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1.2 Testing Environment

Temperature:	18°C~25 °C
Relative humidity:	30%~ 70%
Ground system resistance:	<4Ω
Ambient noise & Reflection:	< 0.012 W/kg

1.3 Project Data

Testing Start Date:	March 16, 2018
Testing End Date:	March 18, 2018

1.4 Signature

李用富

Li Yongfu

(Prepared this test report)

Zhang Yunzhuan

(Reviewed this test report)

Cao Junfei

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 Doro AB Doro 4G LTE Clamshell phone DFC-0190 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)	PCS1900	0.18	PCE
	UMTS FDD 2	0.32	
	LTE Band 7	0.61	
	WLAN 2.4GHz	0.51	DTS
Body (Separation Distance 10mm)	PCS1900	0.59	PCE
	UMTS FDD 2	**1.03**	
	LTE Band 7	0.38	
	WLAN 2.4GHz	0.22	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**: 1.03W/kg (1g).**

Table 2.2: The sum of reported SAR values for main antenna and Wi-Fi

/	**Position**	**Main antenna**	**Wi-Fi**	**Sum**
Highest reported SAR value for Head	Right Touch	0.32	0.51	**0.83**
Highest reported SAR value for Body	Rear	1.03	0.22	**1.25**

Table2.3: The sum of reported SAR values for main antenna and BT

/	**Position**	**Main antenna**	**BT***	**Sum**
Highest reported SAR value for Head	Left Touch	0.61	0.29	**0.90**
Highest reported SAR value for Body	Rear	1.03	0.16	**1.19**

BT*-Estimated SAR for Bluetooth (seethetable13.3)

According to the above tables, the highest sum of reported SAR values is **1.25W/kg (1g)**. The detail for simultaneous transmission consideration is described in chapter 13.

3 Client Information

3.1 Applicant Information

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3.2 Manufacturer Information

Company Name:	CK TELECOM LTD.
Address /Post:	Technology Road. High-Tech Development Zone. Heyuan, Guangdong, P.R. China
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4 Equipment Under Test (EUT) and Ancillary Equipment (AE)

4.1 About EUT

Description:	Doro 4G LTE Clamshell phone
Model Name:	DFC-0190
Operating mode(s):	GSM 1900, WCDMA 1900, LTE_FDD Band 7, BT, Wi-Fi 2.4G
Tested Tx Frequency:	1850.2 – 1910MHz (GSM 1900)
	1852.4 – 1907.6MHz (WCDMA1900 Band II)
	2502.5 – 2567.5MHz (LTE_FDD Band 7)
	2412 – 2462MHz (Wi-Fi 2.4G)
GPRS&EGPRS Multislot Class:	33
Test device Production information:	Production unit
Device type:	Portable device
Antenna type:	Integrated antenna
Hotspot mode:	Support

Note: This device supports GRPS/EGPRS mode and does not support DTM operation.

4.2 Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version
EUT1	IMEI: 352499090009521	3011	CALM01A-S01A_DFC0190_120_180321094522
EUT2	IMEI: 352499090008515	3011	CALM01A-S01A_DFC0190_120_180321094522

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

Note: It is performed to test SAR with the EUT 1, and conducted power with the EUT 2.

4.3 Internal Identification of AE used during the test

AE ID*	Description	Model	Manufacturer
AE1	Battery	DBS-1350A	Veken
AE2	Headset	150C-333E-3.5MM-28A	QUANCHENG ELECTRONIC CO., LTD
AE3	Headset	150C-333E-3.5MM-27	QUANCHENG ELECTRONIC CO., LTD

*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: Experimental Techniques.

KDB 447498 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.

KDB941225 D01 SAR test for 3G devices v03r01: SAR Measurement Procedures for 3G Devices

KDB941225 D05 SAR for LTE Devices v02r05: SAR Evaluation Considerations for LTE Devices

KDB 248227 D01 802.11 Wi-Fi SAR v02r02: SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters.

KDB 865664 D01SAR measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz.

KDB 865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations

KDB 941225 D06 Hotspot Mode v02r01: SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities

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

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

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

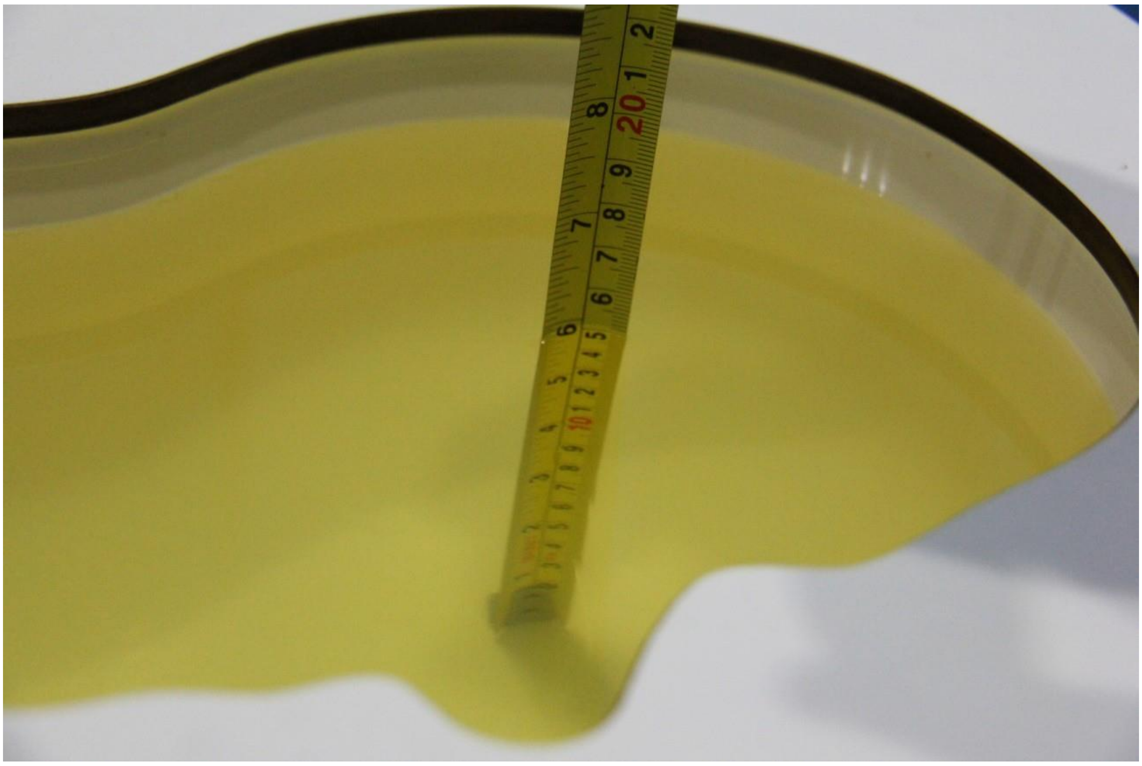
Frequency (MHz)	Liquid Type	Conductivity (σ)	± 5% Range	Permittivity (ε)	± 5% Range
1900	Head	1.40	1.33～1.47	40.00	38.0～42.0
1900	Body	1.52	1.44～1.60	53.30	50.6～56.0
2450	Head	1.80	1.71～1.89	39.20	37.2～41.2
2450	Body	1.95	1.85～2.05	52.70	50.1～55.3
2550	Head	1.91	1.81～2.01	39.07	37.1～41.0
2550	Body	2.09	1.99～2.19	52.60	50.0～55.2

7.2 Dielectric Performance

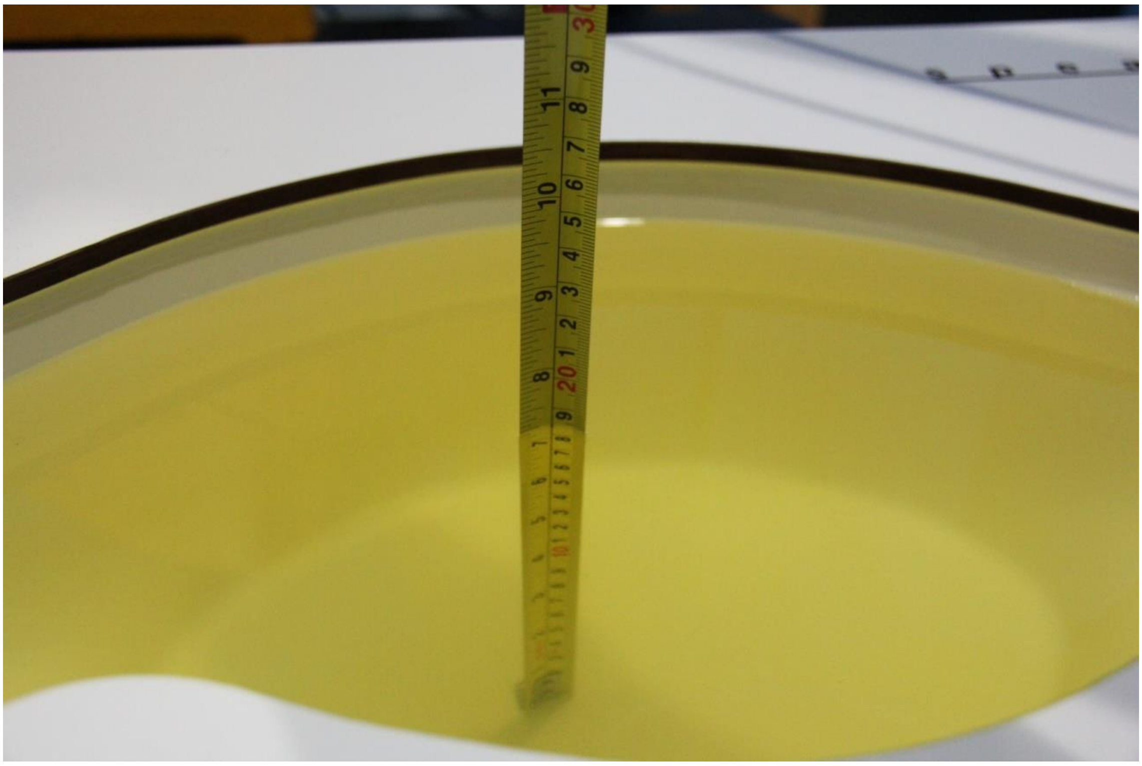
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Conductivity σ (S/m)	Drift (%)	Permittivity ε	Drift (%)
2018-3-16	Head	1900	1.396	-0.29	40.84	2.10
	Body	1900	1.565	2.96	51.77	-2.87
2018-3-18	Head	2450	1.852	2.89	38.65	-1.40
	Body	2450	1.936	-0.72	52.19	-0.97
2018-3-18	Head	2550	1.933	1.20	38.42	-1.66
	Body	2550	2.044	-2.20	51.93	-1.27

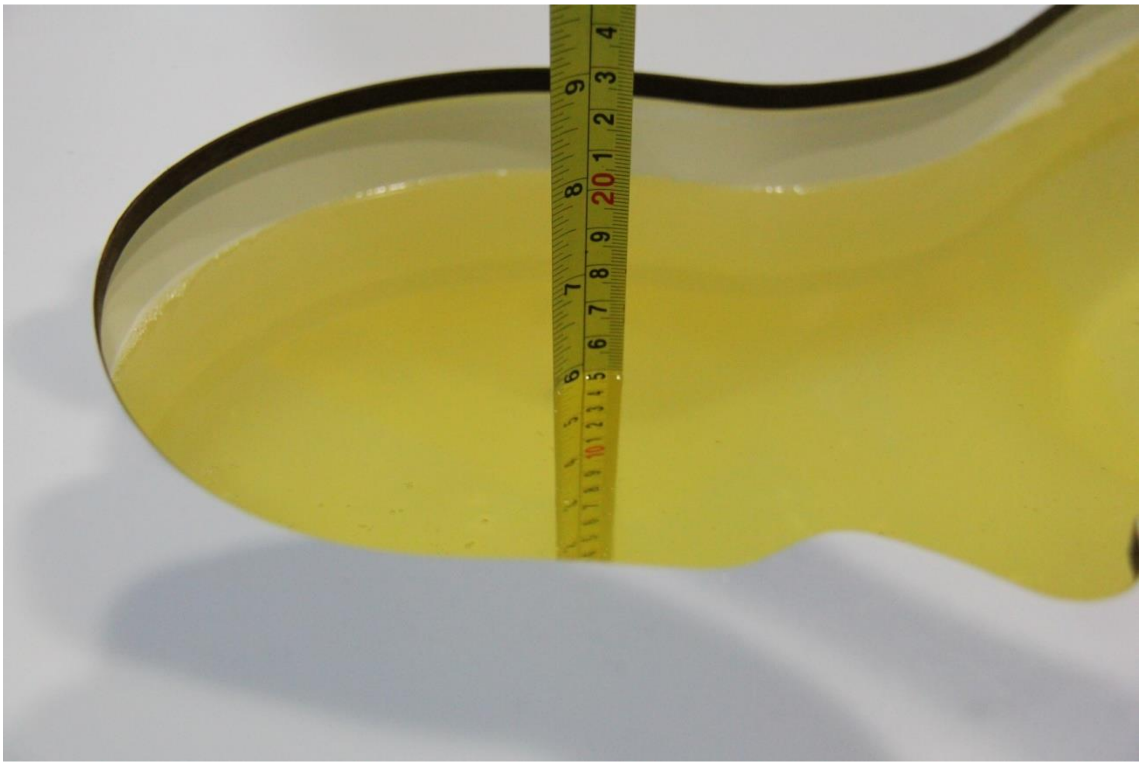
Note: The liquid temperature is 22.0°C



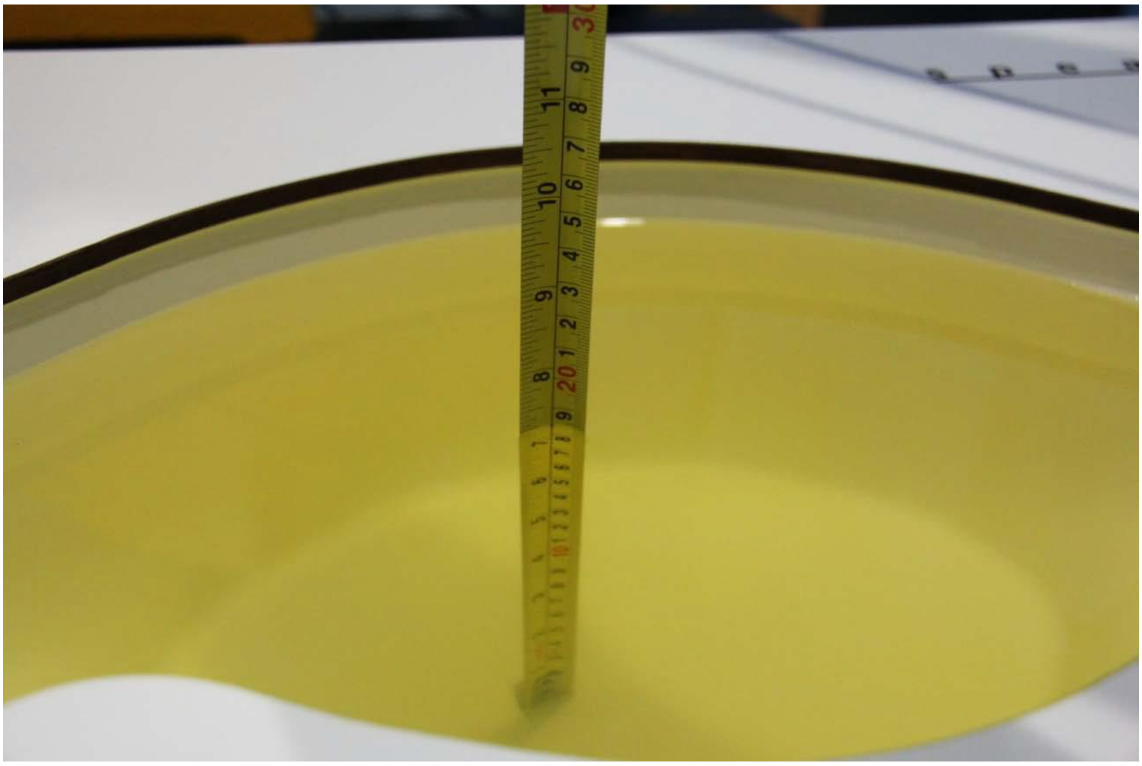
Picture 7-1: Liquid depth in the Head Phantom (1900 MHz)



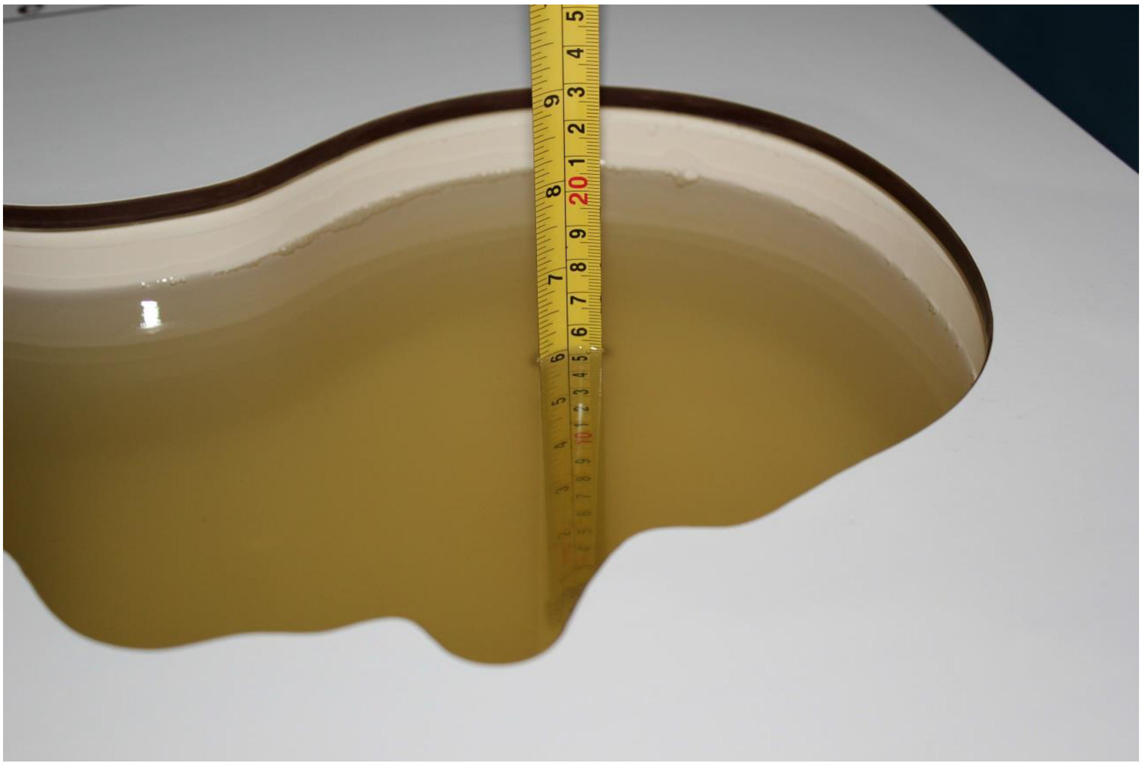
Picture 7-2: Liquid depth in the Flat Phantom (1900MHz)



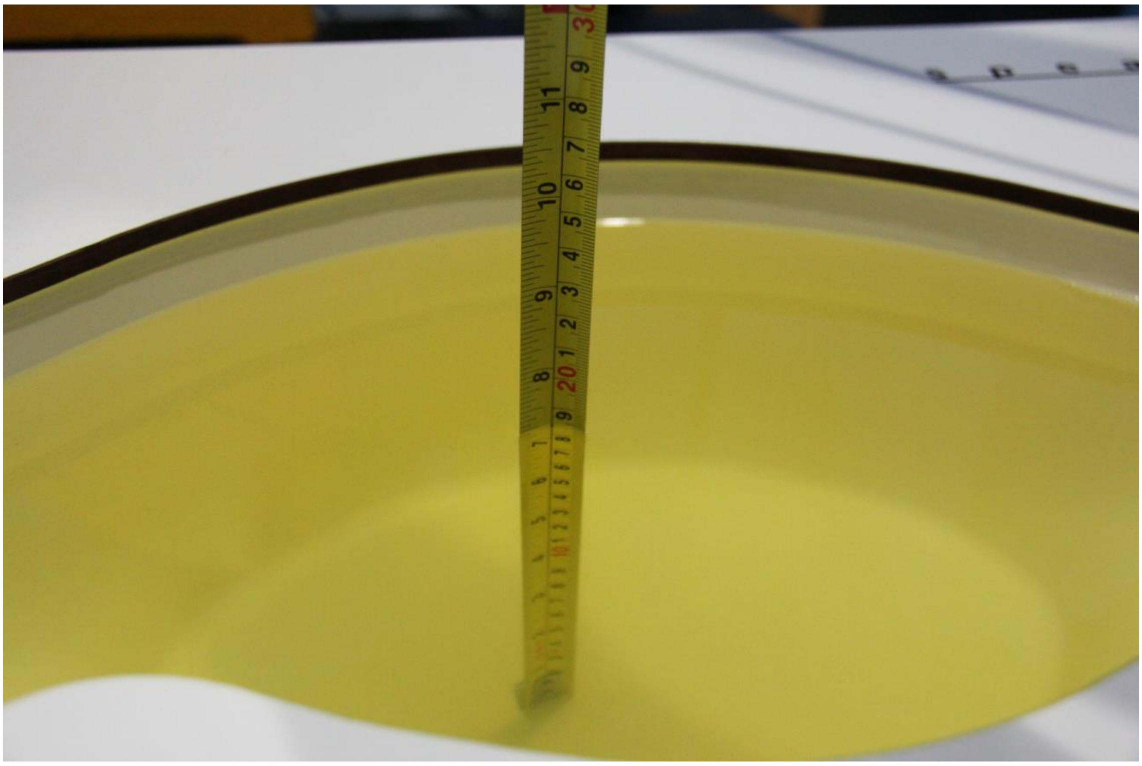
Picture 7-3: Liquid depth in the Head Phantom(2450MHz)



Picture 7-4: Liquid depth in the Flat Phantom(2450MHz)



Picture 7-5: Liquid depth in the Head Phantom(2550MHz)

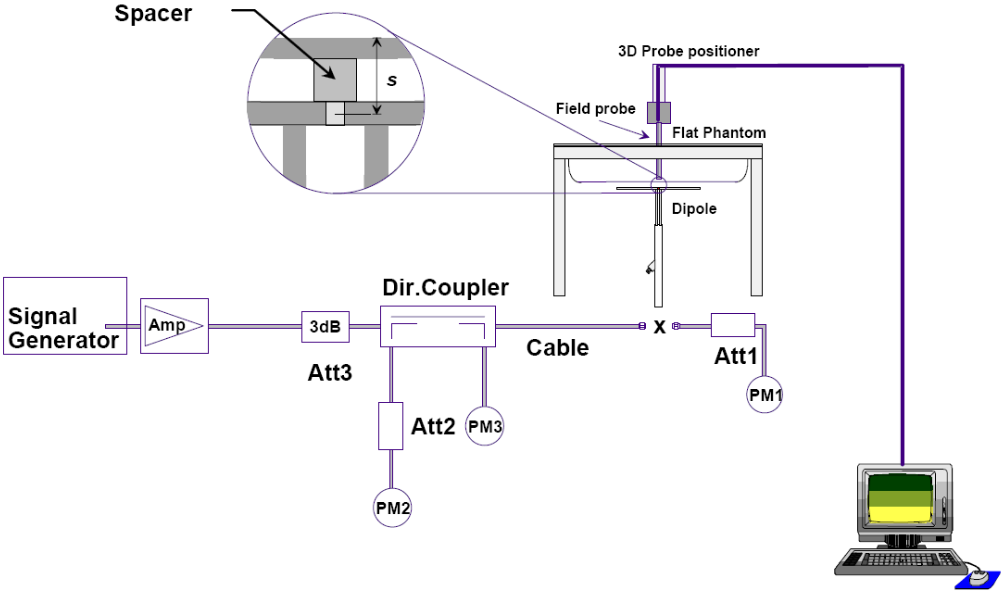


Picture 7-6: Liquid depth in the Flat Phantom(2550MHz)

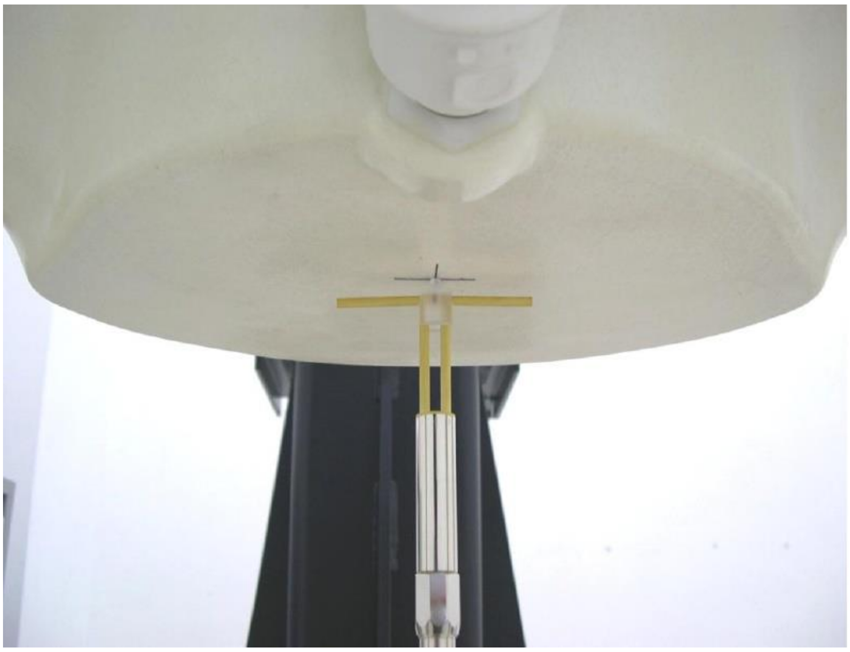
8 System verification

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
2018-3-16	1900 MHz	21.0	40.8	20.72	39.80	-1.33	-2.45
2018-3-18	2450 MHz	24.1	52.5	24.48	53.60	1.58	2.10
2018-3-18	2550 MHz	26.2	57.2	26.32	58.00	0.46	1.40

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
2018-3-16	1900 MHz	21.3	41.1	21.76	42.40	2.16	3.16
2018-3-18	2450 MHz	24.4	52.3	24.12	50.40	-1.15	-3.63
2018-3-18	2550 MHz	25.1	54.8	25.56	56.40	1.83	2.92

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.

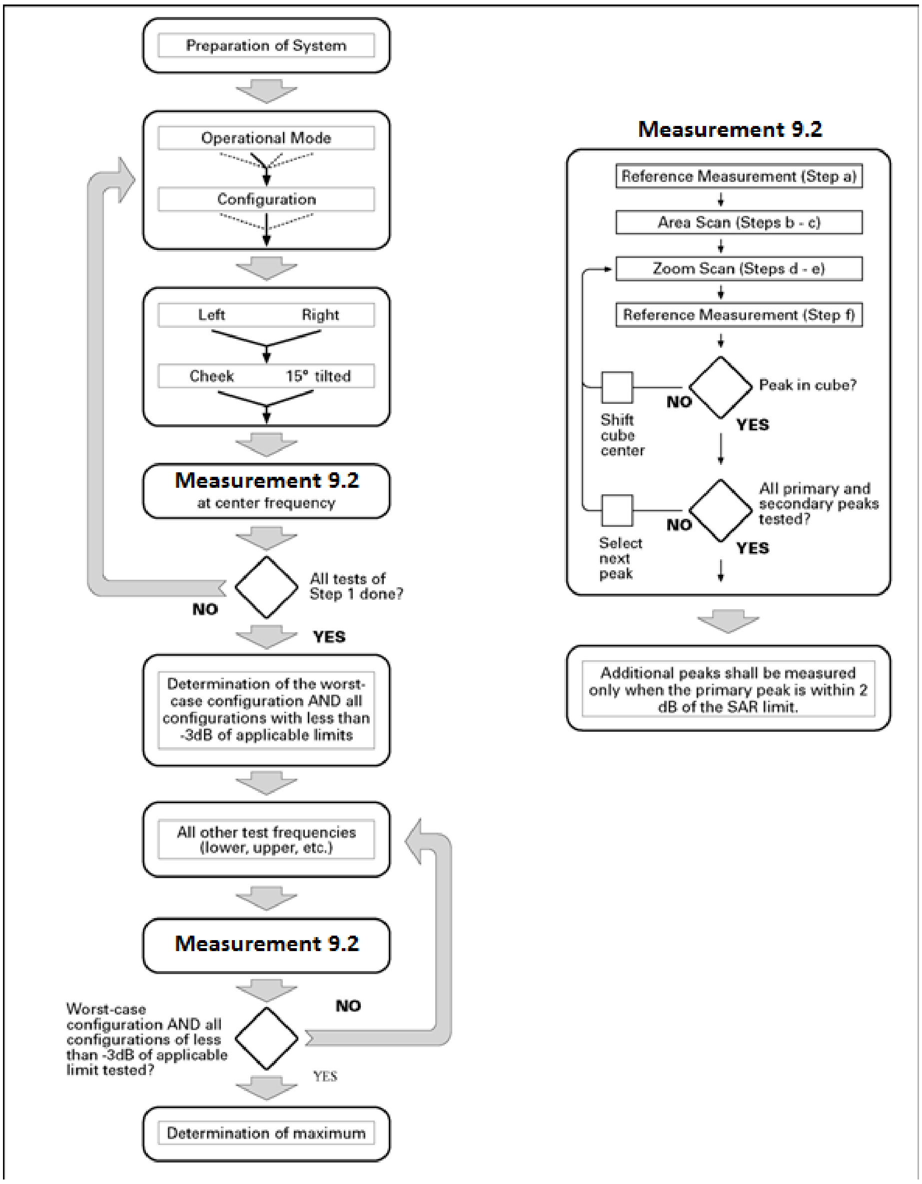
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the center of the transmit frequency band (f_c) for:

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 1528-2013. 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
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
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.

9.3 WCDMA Measurement Procedures for SAR

The following procedures are applicable to WCDMA handsets operating under 3GPP Release99, Release 5 and Release 6. The default test configuration is to measure SAR with an established radio link between the DUT and a communication test set using a 12.2kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH & $DPDCH_n$), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Both uplink and downlink should be configured with the same RMC or AMR, when required. SAR for Release 5 HSDPA and Release 6 HSPA are measured using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified according to applicable versions of 3GPP TS 34.121 and SAR must be measured according to these maximum output conditions. When Maximum Power Reduction (MPR) is not implemented according to Cubic Metric (CM) requirements for Release 6 HSPA, the following procedures do not apply.

For Release 5 HSDPA Data Devices:

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs}	CM/dB
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15	15/15	64	12/15	24/25	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5

For Release 6 HSPA Data Devices

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs}	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (dB)	MPR (dB)	AG Index	E-TFCI
1	11/15	15/15	64	11/15	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	12/15	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	4/15	56/75	4	1	3.0	2.0	17	71
5	15/15	15/15	64	15/15	24/15	30/15	134/15	4	1	1.0	0.0	21	81

9.4 Bluetooth & WI-FI 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.

9.5 SAR Measurement for LTE

SAR tests for LTE are performed with a base station simulator, Anristu MT8820C. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. All powers were measured with the Anristu MT8820C.It is performed for conducted power and SAR based on the KDB941225 D05.

SAR is evaluated separately according to the following procedures for the different test positions in each exposure condition – head, body, body-worn accessories and other use conditions. The procedures in the following subsections are applied separately to test each LTE frequency band.

1) QPSK with 1 RB allocation
   Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required for 1 RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.
2) QPSK with 50% RB allocation
   The procedures required for 1 RB allocation in 1) are applied to measure the SAR for QPSK with 50% RB allocation.
3) QPSK with 100% RB allocation
   For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in 1) and 2) are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

9.6 Power Drift

To control the output power stability during the SAR test, DASY5 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, 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 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 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 11.1: The conducted power measurement results for GSM1900

GSM1900MHz	Tune up	Conducted Power(dBm)		
		Channel 810 (1909.8MHz)	Channel 661 (1880MHz)	Channel 512 (1850.2MHz)
	30.5	29.86	30.01	30.07

Table 11.2: The conducted power measurement results for GPRS and EGPRS

GPRS 1900	Tune up	Measured Power (dBm)			calculation	Average Power (dBm)		
		810	661	512		810	661	512
1Tx-slots	**30.5**	**29.80**	**29.96**	**30.02**	-9.03dB	**20.77**	**20.93**	**20.99**
2Tx-slots	**27.5**	26.59	26.68	26.78	-6.02dB	20.57	20.66	20.76
3Tx-slots	**25.5**	24.68	24.82	24.90	-4.26dB	20.42	20.56	20.64
4Tx-slots	**24**	23.25	23.43	23.36	-3.01dB	20.24	20.42	20.35
EGPRS 1900 (8PSK)	**Tune up**	Measured Power (dBm)			calculation	Measured Power (dBm)		
		810	661	512		810	661	512
1Tx-slots	**26**	25.09	25.12	25.17	-9.03dB	16.06	16.09	16.14
2Tx-slots	**24**	23.43	23.47	23.57	-6.02dB	17.41	17.45	17.55
3Tx-slots	**22**	21.29	21.28	21.33	-4.26dB	17.03	17.02	17.07
4Tx-slots	**20**	18.98	19.05	19.06	-3.01dB	15.97	16.04	16.05

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 1Tx-slots for 1900.

11.2 WCDMA Measurement result

Table 11.3: The conducted Power for WCDMA1900

Item	band	FDD Band 2 result			
	ARFCN	Tune up	9538 (1907.6MHz)	9400 (1880MHz)	9262 (1852.4MHz)
WCDMA	\	22.5	**21.8**	**22.1**	**22.1**
HSUPA	1	21	20.8	20.6	20.6
	2	20.5	19.3	19.3	20.3
	3	21	20.3	20.1	20.1
	4	21.5	19.8	21.1	20.9
	5	22	21.3	21.6	21.3
HSDPA	1	22	20.8	21.3	21.2
	2	22	20.8	21.3	21.2
	3	22	20.4	20.9	20.8
	4	22	20.4	21.0	20.7

11.3 LTE-FDD Measurement result

Table 11.4: The conducted Power for LTE

LTE-FDD Band 7				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
5 MHz				2567.4MHz	2535MHz	2502.5MHz	
	1RB	High	QPSK	22.12	22.23	21.96	23
			16QAM	20.86	21.10	20.82	22
		Middle	QPSK	22.14	22.28	22.14	23
			16QAM	20.99	21.05	21.00	22
		Low	QPSK	22.00	22.01	21.95	23
			16QAM	20.52	20.72	20.55	22
	12RB	High	QPSK	21.19	21.40	21.23	22
			16QAM	20.16	20.16	20.10	21
		Middle	QPSK	21.31	21.37	21.17	22
			16QAM	20.15	20.21	20.15	21
		Low	QPSK	21.20	21.24	21.08	22
			16QAM	19.97	20.18	20.03	21
	25RB	/	QPSK	21.22	21.29	21.11	22
			16QAM	20.06	20.30	20.15	21
10 MHz				2565MHz	2535MHz	2505MHz	/
	1RB	High	QPSK	22.23	22.37	22.20	23
			16QAM	20.93	20.77	20.61	22
		Middle	QPSK	22.19	22.46	22.38	23
			16QAM	21.13	20.86	21.41	22
		Low	QPSK	22.00	22.25	21.99	23
			16QAM	20.73	20.82	20.56	22
	25RB	High	QPSK	21.19	21.38	21.25	22
			16QAM	20.33	20.35	20.15	21
		Middle	QPSK	21.21	21.39	21.34	22
			16QAM	20.46	20.32	20.36	21
		Low	QPSK	21.17	21.27	21.20	22
			16QAM	20.20	20.49	20.22	21
	50RB	/	QPSK	21.25	21.32	21.20	22
			16QAM	20.34	20.44	20.32	21

LTE-FDD Band 7				Actual output Power (dBm)			Tune up
Band-width	RB allocation	RB offset	Modulation	High	Middle	Low	
15 MHz				2562.5MHz	2535MHz	2507.5MHz	
	1RB	High	QPSK	22.17	22.18	22.15	**23**
			16QAM	20.91	20.87	20.55	**22**
		Middle	QPSK	22.17	22.36	22.31	**23**
			16QAM	20.92	20.95	20.92	**22**
		Low	QPSK	22.11	22.13	21.86	**23**
			16QAM	20.75	20.74	20.69	**22**
	25RB	High	QPSK	21.25	21.45	21.27	**22**
			16QAM	20.40	20.46	20.31	**21**
		Middle	QPSK	21.18	21.33	21.21	**22**
			16QAM	20.44	20.39	20.32	**21**
		Low	QPSK	21.10	21.20	21.15	**22**
			16QAM	20.19	20.21	20.25	**21**
	50RB	/	QPSK	21.24	21.28	21.26	**22**
			16QAM	20.33	20.38	20.36	**21**
20 MHz				2560MHz	2535MHz	2510MHz	/
	1RB	High	QPSK	22.17	22.29	22.16	**23**
			16QAM	20.60	20.98	20.80	**22**
		Middle	QPSK	22.29	**22.41**	22.37	**23**
			16QAM	20.98	21.09	21.09	**22**
		Low	QPSK	22.23	21.91	22.03	**23**
			16QAM	20.78	20.68	20.69	**22**
	50RB	High	QPSK	21.24	21.33	21.30	**22**
			16QAM	20.22	20.35	20.33	**21**
		Middle	QPSK	21.23	**21.40**	21.25	**22**
			16QAM	20.23	20.50	20.36	**21**
		Low	QPSK	21.14	21.20	21.14	**22**
			16QAM	20.23	20.38	20.25	**21**
	100RB	/	QPSK	21.22	21.19	21.23	**22**
			16QAM	20.30	20.27	20.23	**21**

11.4 Wi-Fi and BT Measurement result

Table 11.5: The conducted Power measurement results for BT

BT	Tune up	Averaged Power (dBm)		
Mode		Ch0 (2402 MHz)	Ch39 (2441 MHz)	Ch78 (2480 MHz)
GFSK	**8.5**	7.23	8.01	8.22
EDR2M-4_DQPSK	**7.5**	5.95	6.77	6.98
EDR3M-8DPSK	**7.5**	5.96	6.78	6.98
BLE	**Tune up**	Ch0（2402MHz）	Ch19（2441MHz）	Ch39（2480MHz）
	8.5	7.19	7.95	8.20

Table 11.6: The conducted Power measurement results for 2.4G WIFI

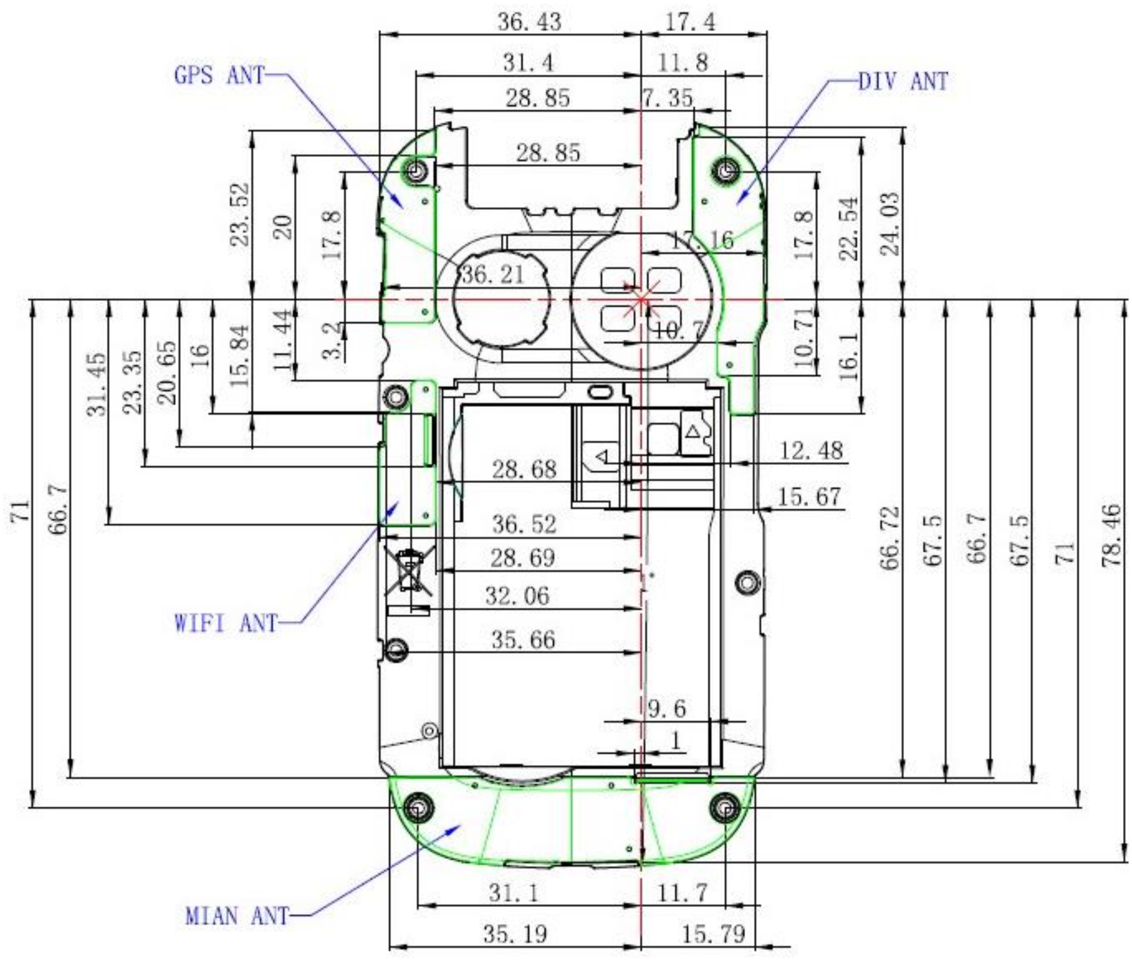
WiFi 2.4GHz	Tune up	Averaged Power (dBm)		
Mode		Ch 1(2412 MHz)	Ch 6(2437Mhz)	Ch 11(2462MHz)
802.11b	**16**	15.27	15.43	15.38
802.11g	**13**	12.83	12.65	12.47
802.11n(20MHz)	**13**	12.68	12.63	12.58

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 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.

12.2 Transmit Antenna Separation Distances



Picture 12.1 Antenna Locations

12.3 SAR Measurement Positions

According to the KDB941225 D06 Hot Spot SAR, 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	8.5	7.08	Yes
		Body	19.20	8.5	7.08	Yes
2.4GHz WLAN	2.45	Head	9.58	16	39.81	No
		Body	19.17	16	39.81	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	Right Touch	0.32	0.51	**0.83**
Highest reported SAR value for Body	Rear	1.03	0.22	**1.25**

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 Touch	0.61	0.29	**0.90**
Highest reported SAR value for Body	Rear	1.03	0.16	**1.19**

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	9	7.08	0.29
Body	2.441	10	9	7.08	0.16

* - 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-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:

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

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 GSM1900	1:8.3
GPRS for GSM1900	1:8.3
WCDMA1900	1:1
FDD_LTE Band 7	1:1

14.1 SAR results

Table 14.2: SAR Values (GSM 1900 - Head)

Ambient Temperature: 22.7°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
1880	661	Speech	Left Touch	**Fig.1**	30.1	30.5	**0.164**	**0.18**	0.09
1880	661	Speech	Left Tilt	/	30.1	30.5	0.055	**0.06**	0.01
1880	661	Speech	Right Touch	/	30.1	30.5	0.129	**0.14**	-0.02
1880	661	Speech	Right Tilt	/	30.1	30.5	0.040	**0.04**	0.07

Table 14.3: SAR Values (GSM 1900 - Body)

Ambient Temperature: 22.7°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
Hotspot & Body Worn Test Data (10mm)									
1880	661	GPRS	Front	/	29.96	30.5	0.082	**0.09**	0.07
1880	661	GPRS	Rear	**Fig.2**	29.96	30.5	**0.523**	**0.59**	0.01
1880	661	GPRS	Left	/	29.96	30.5	0.075	**0.09**	0.09
1880	661	GPRS	Right	/	29.96	30.5	0.059	**0.07**	0.03
1880	661	GPRS	Bottom	/	29.96	30.5	0.309	**0.35**	-0.05

Table 14.4: SAR Values (WCDMA1900 - Head)

Ambient Temperature: 22.7°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
1880	9400	RMC	Left Touch	/	22.1	22.5	0.275	**0.30**	0.01
1880	9400	RMC	Left Tilt	/	22.1	22.5	0.043	**0.05**	0.06
1880	9400	RMC	Right Touch	**Fig.3**	22.1	22.5	**0.295**	**0.32**	0.08
1880	9400	RMC	Right Tilt	/	22.1	22.5	0.041	**0.04**	0.01

Table 14.5: SAR Values (WCDMA1900 - Body)

Ambient Temperature: 22.7°C Liquid Temperature: 22.2°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
Hotspot & Body Worn Test Data (10mm)									
1880	9400	RMC	Front	/	22.1	22.5	0.098	**0.11**	0.03
1880	9400	RMC	Rear	/	22.1	22.5	0.749	**0.82**	0.04
1880	9400	RMC	Left	/	22.1	22.5	0.121	**0.13**	-0.03
1880	9400	RMC	Right	/	22.1	22.5	0.116	**0.13**	-0.04
1880	9400	RMC	Bottom	/	22.1	22.5	0.496	**0.54**	0.05
1907.6	9538	RMC	Rear	**Fig.4**	21.8	22.5	**0.880**	**1.03**	0.04
1850.4	9262	RMC	Rear	/	22.1	22.5	0.748	**0.82**	0.10

Table 14.6: SAR Values (LTE Band 7 - Head)

Ambient Temperature: 22.2°C Liquid Temperature: 21.7°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
2535	21100	1RB_Mid	Left Touch	**Fig.5**	22.41	23	**0.529**	**0.61**	-0.17
2535	21100	50RB_Mid	Left Touch	/	21.40	22	0.378	**0.43**	0.05
2535	21100	1RB_Mid	Left Tilt	/	22.41	23	0.076	**0.09**	0.06
2535	21100	50RB_Mid	Left Tilt	/	21.40	22	0.057	**0.07**	-0.09
2535	21100	1RB_Mid	Right Touch	/	22.41	23	0.236	**0.27**	0.06
2535	21100	50RB_Mid	Right Touch	/	21.40	22	0.176	**0.20**	0.04
2535	21100	1RB_Mid	Right Tilt	/	22.41	23	0.065	**0.07**	0.09
2535	21100	50RB_Mid	Right Tilt	/	21.40	22	0.051	**0.06**	0.06

Table 14.7: SAR Values (LTE Band 7 - Body)

Ambient Temperature: 22.2°C Liquid Temperature: 21.7°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
Hotspot & Body Worn Test Data (10mm)									
2535	21100	1RB_Mid	Front	/	22.41	23	0.121	**0.14**	0.04
2535	21100	50RB_Mid	Front	/	21.40	22	0.100	**0.11**	0.09
2535	21100	1RB_Mid	Rear	**Fig.6**	22.41	23	**0.331**	**0.38**	0.04
2535	21100	50RB_Mid	Rear	/	21.40	22	0.264	**0.30**	0.08
2535	21100	1RB_Mid	Left	/	22.41	23	0.139	**0.16**	0.01
2535	21100	50RB_Mid	Left	/	21.40	22	0.119	**0.14**	0.05
2535	21100	1RB_Mid	Right	/	22.41	23	0.065	**0.07**	0.06
2535	21100	50RB_Mid	Right	/	21.40	22	0.050	**0.06**	-0.03
2535	21100	1RB_Mid	Bottom	/	22.41	23	0.185	**0.21**	-0.07
2535	21100	50RB_Mid	Bottom	/	21.40	22	0.139	**0.16**	-0.09

14.2 WLAN Evaluation for 2.4G

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

Head Evaluation

Table 14.8: SAR Values (WLAN - Head)–802.11b 1Mbps

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
2437	6	802.11 b	Left Touch	/	15.43	16	0.166	**0.19**	0.01
2437	6	802.11 b	Left Tilt	/	15.43	16	0.060	**0.07**	0.02
2437	6	802.11 b	Right Touch	**Fig.7**	15.43	16	**0.445**	**0.51**	0.03
2437	6	802.11 b	Right Tilt	/	15.43	16	0.058	**0.07**	0.03

Note1:For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

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. A maximum transmission duty factor of 100% is achievable for WLAN in this project and the scaled reported SAR is presented as below.

Table 14.9: SAR Values (WLAN - Head) – 802.11b 1Mbps (Scaled Reported SAR)

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C							
Frequency		Side	Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g)(W/kg)	Scaled reported SAR (1g)(W/kg)
MHz	Ch.						
2437	6	Left	Touch	100%	100%	0.19	**0.19**
2437	6	Right	Touch	100%	100%	0.51	**0.51**

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

Body Evaluation

Table 14.10: SAR Values (WLAN - Body)– 802.11b 1Mbps

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C									
Frequency		Test Mode	Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift(dB)
MHz	Ch.								
Hotspot & Body Worn Test Data (10mm)									
2437	6	802.11 b	Front	/	15.43	16	0.095	**0.11**	0.08
2437	6	802.11 b	Rear	**Fig.8**	15.43	16	**0.191**	**0.22**	-0.06
2437	6	802.11 b	Right	/	15.43	16	0.151	**0.17**	0.05
2437	6	802.11 b	Top	/	15.43	16	0.030	**0.03**	-0.03

Note1:For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

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. A maximum transmission duty factor of 100% is achievable for WLAN in this project and the scaled reported SAR is presented as below.

Table 14.11: SAR Values (WLAN - Body) – 802.11b 1Mbps (Scaled Reported SAR)

Ambient Temperature: 22.5°C Liquid Temperature: 22.0°C						
Frequency		Test Position	Actual duty factor	maximum duty factor	Reported SAR (1g)(W/kg)	Scaled reported SAR (1g)(W/kg)
MHz	Ch.					
2437	6	Rear	100%	100%	0.22	**0.22**

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

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.

Table 15.4: SAR Measurement Variability for Body –WCDMA1900

Frequency		Test Position	Original	1st Repeated	Ratio	2nd Repeated
MHz	Ch.		SAR (W/kg)	SAR (W/kg)		SAR (W/kg)
1907.6	9538	Rear	0.880	0.862	1.02	/

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	12	N	2	1	1	6.0	6.0	∞
2	Axial isotropy	B	4.7	R	$\sqrt{3}$	√0.5	√0.5	1.9	1.9	∞
3	Hemispherical isotropy	B	9.6	R	$\sqrt{3}$	√0.5	√0.5	3.9	3.9	∞
4	Boundary effect	B	1.1	R	$\sqrt{3}$	1	1	0.6	0.6	∞
5	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
6	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
7	Modulation response	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
8	Readout electronics	B	1.0	N	1	1	1	1.0	1.0	∞
9	Response time	B	0.0	R	$\sqrt{3}$	1	1	0.0	0.0	∞
10	Integration time	B	1.7	R	$\sqrt{3}$	1	1	1.0	1.0	∞
11	RF ambient conditions-noise	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
12	RF ambient conditions-reflection	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Probe positioned mech. restrictions	B	0.35	R	$\sqrt{3}$	1	1	0.2	0.2	∞
14	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
15	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Test sample related										
16	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	5
17	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
18	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
19	Phantom uncertainty	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
20	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
21	Liquid conductivity (meas.)	A	1.3	N	1	0.64	0.43	0.83	0.56	9
22	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
23	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	0.96	0.78	521
Combined standard uncertainty		$u_c' = \sqrt{\sum_{i=1}^{23} c_i^2 u_i^2}$						10.2	10.1	527
Expanded uncertainty (Confidence interval of 95 %)		$u_e = 2u_c$						20.4	20.2	

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	12	N	2	1	1	6.0	6.0	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	√0.5	√0.5	1.9	1.9	∞
3	Boundary effect	B	1.1	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	Modulation response	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
7	Readout electronics	B	1.0	N	1	1	1	1.0	1.0	∞
8	Response time	B	0.0	R	$\sqrt{3}$	1	1	0.0	0.0	∞
9	Integration time	B	1.7	R	$\sqrt{3}$	1	1	1.0	1.0	∞
10	RF ambient conditions-noise	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
11	RF ambient conditions-reflection	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
12	Probe positioned mech. Restrictions	B	0.35	R	$\sqrt{3}$	1	1	0.2	0.2	∞
13	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
14	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
15	Fast SAR z-Approximation	B	7.0	R	$\sqrt{3}$	1	1	4.0	4.0	∞
Test sample related										
16	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	5
17	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
18	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
19	Phantom uncertainty	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
20	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
21	Liquid conductivity (meas.)	A	1.3	N	1	0.64	0.43	0.83	0.56	43
22	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
23	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	0.96	0.78	521
Combined standard uncertainty		$u_c^{'} = \sqrt{\sum_{i=1}^{23} c_i^2 u_i^2}$						10.6	10.5	257
Expanded uncertainty (Confidence interval of 95 %)		$u_e = 2u_c$						21.2	21.0	

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	2017-11-17	One year
02	Signal Generator	E8257D	MY47461211	2017-06-06	One year
03	Amplifier	VTL5400	0404	/	
04	Dielectric probe	85070E	MY44300317	/	
05	Power meter	NRP	102603	2018-01-04	One year
06	Power sensor	NRP-Z51	102211		
07	Power meter	NRP	101460	2018-02-05	One year
08	Power sensor	NRP-Z91	100553		
09	DAE	SPEAG DAE4	786	2017-11-22	One year
10	E-field Probe	SPEAG ES3DV3	3151	2017-12-13	One year
11	Dipole Validation Kit	SPEAG D1900V2	5d088	2015-11-04	Three year
12	Dipole Validation Kit	SPEAG D2450V2	873	2015-10-30	Three year
13	Dipole Validation Kit	SPEAG D2550V2	1010	2015-07-24	Three year
14	BTS	E5515C	GB46110722	2018-02-19	One year
15	Radio Communication Analyzer	Anristu MT8820C	6201341853	2018-03-08	One year
16	Temperature indicator	51 II	99250045	2018-07-19	One year

END OF REPORT BODY

ANNEX A Graph Results

GSM1900 Head

Date: 2018-3-16

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used: f = 1880 MHz; σ = 1.378 S/m; ε_r = 40.933; ρ = 1000 kg/m^3

Ambient Temperature: 22.2°C   Liquid Temperature: 21.7°C

Communication System: UID 0, GSM (0) Frequency: 1880 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Left Cheek Middle/Area Scan (61x111x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.218 W/kg

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

Reference Value = 10.30 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.267 W/kg

SAR(1 g) = 0.164 W/kg; SAR(10 g) = 0.093 W/kg

Maximum value of SAR (measured) = 0.171 W/kg

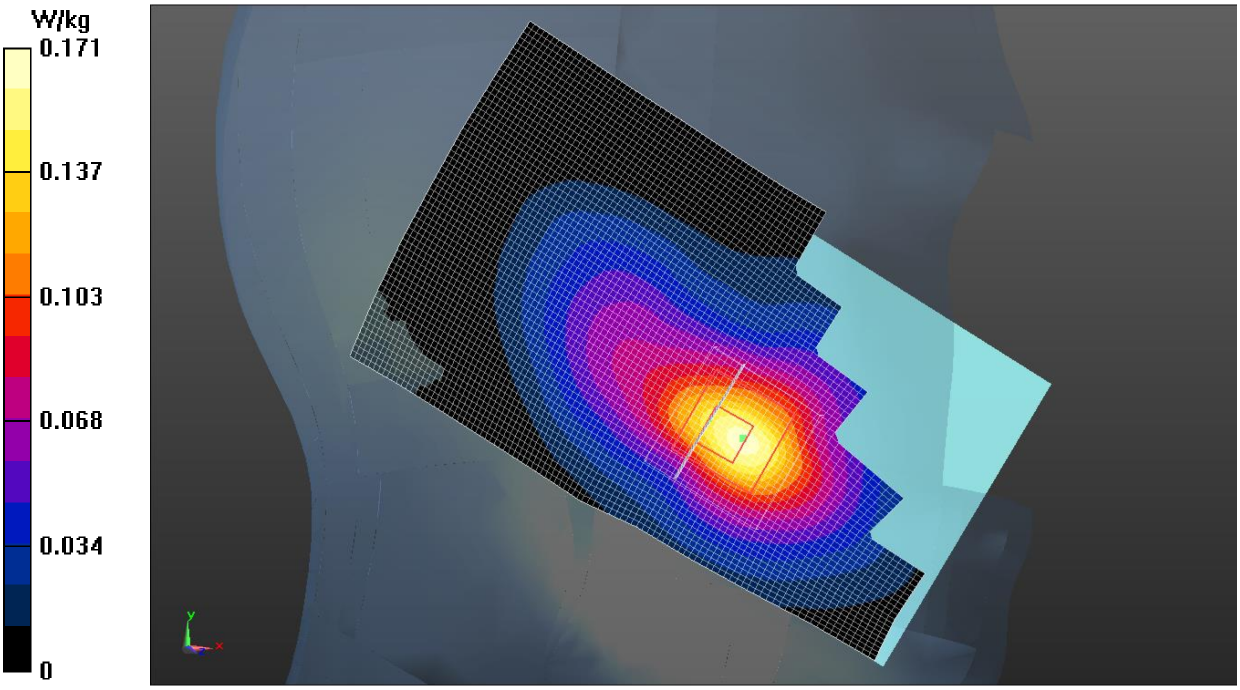


Fig.1 GSM 1900 MHz

GSM1900 Body

Date: 2018-3-16

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used: f = 1880 MHz; σ = 1.546 S/m; ε_r = 51.822; ρ = 1000 kg/m^3

Ambient Temperature: 22.2°C   Liquid Temperature: 21.7°C

Communication System: UID 0, GPRS 1Txslot (0) Frequency: 1880 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

Rear side Middle/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.599 W/kg

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

Reference Value = 12.83 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.896 W/kg

SAR(1 g) = 0.523 W/kg; SAR(10 g) = 0.307 W/kg

Maximum value of SAR (measured) = 0.569 W/kg

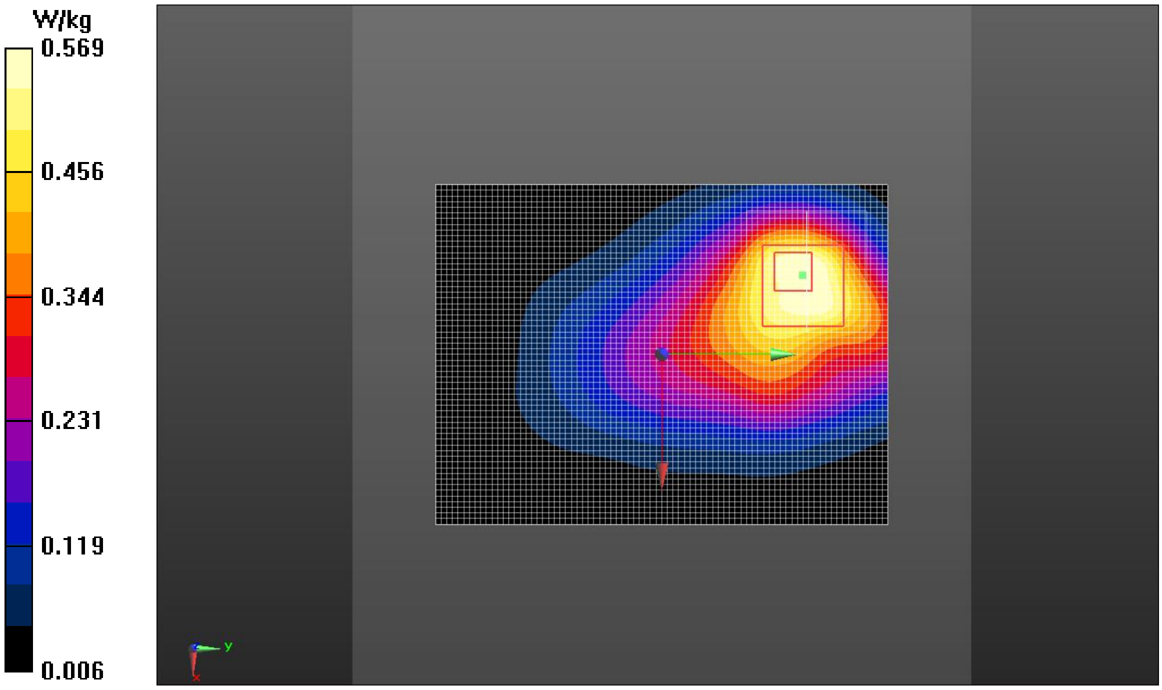


Fig.2 GSM 1900 MHz

WCDMA 1900 Head

Date: 2018-3-16

Electronics: DAE4 Sn786

Medium: Head 1900 MHz

Medium parameters used: f = 1880 MHz; σ = 1.378 S/m; ε_r = 40.933; ρ = 1000 kg/m^3

Ambient Temperature: 21.8^{o}C　　　Liquid Temperature: 21.3^{o}C

Communication System: UID 0, WCDMA (0) Frequency: 1880 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Right Cheek Mid/Area Scan (61x111x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.310 W/kg

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

Reference Value = 2.808 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.470 W/kg

SAR(1 g) = 0.295 W/kg; SAR(10 g) = 0.176 W/kg

Maximum value of SAR (measured) = 0.313 W/kg

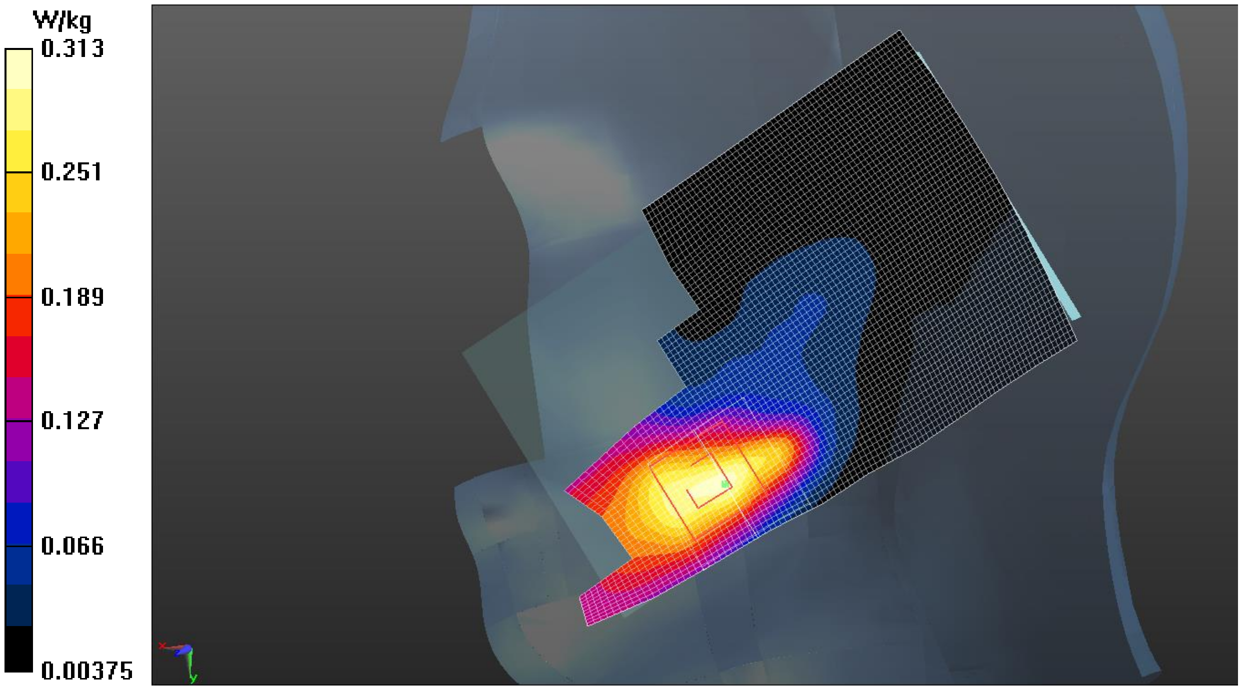


Fig.3　WCDMA 1900

WCDMA 1900 Body

Date: 2018-3-16

Electronics: DAE4 Sn786

Medium: Body 1900 MHz

Medium parameters used: f = 1908 MHz; σ = 1.573 S/m; ε_r = 52.756; ρ = 1000 kg/m^3

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: UID 0, WCDMA (0) Frequency: 1907.6 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

Rear side High/Area Scan (61x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.08 W/kg

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

Reference Value = 14.73 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 1.45 W/kg

SAR(1 g) = 0.880 W/kg; SAR(10 g) = 0.504 W/kg

Maximum value of SAR (measured) = 0.963 W/kg

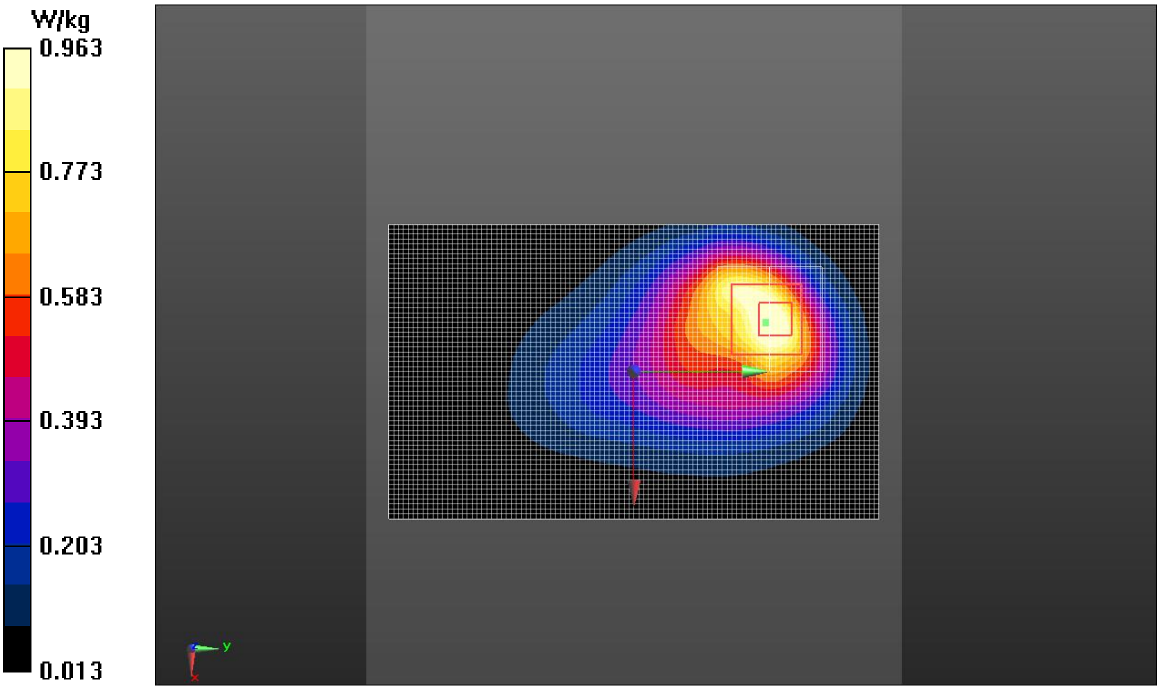


Fig.4 WCDMA 1900

LTE Band 7 Head

Date: 2018-3-2
Electronics: DAE4 Sn786
Medium: Head 2550 MHz
Medium parameters used (interpolated): f = 2535 MHz; σ = 1.914 S/m; ε_r = 38.486; ρ = 1000 kg/m^3
Ambient Temperature: 22.3°C   Liquid Temperature: 21.8°C
Communication System: UID 0, LTE_FDD (0) Frequency: 2535 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.53, 4.53, 4.53);

Left Cheek Mid 1RB_Mid/Area Scan (61x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.607 W/kg

Left Cheek Mid 1RB_Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.822 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 1.08 W/kg
SAR(1 g) = 0.529 W/kg; SAR(10 g) = 0.247 W/kg
Maximum value of SAR (measured) = 0.582 W/kg

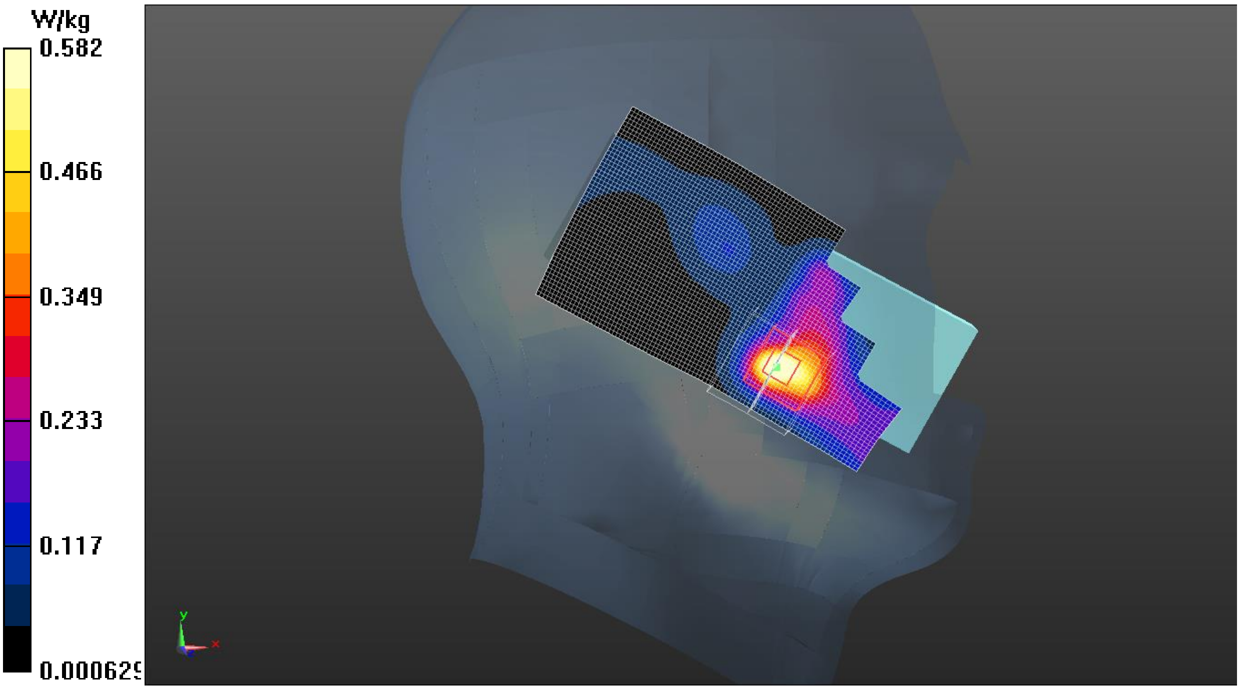


Fig.5 LTE Band 7

LTE Band 7 Body

Date: 2018-3-2

Electronics: DAE4 Sn786

Medium: Body 2550 MHz

Medium parameters used (interpolated): f = 2535 MHz; σ = 2.023 S/m; εr = 51.982; ρ = 1000 kg/m^3

Ambient Temperature: 22.7°C　　　Liquid Temperature: 22.2°C

Communication System: UID 0, 4G_LTE_FDD (0) Frequency: 2535 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.24, 4.24, 4.24);

Rear Side Mid 1RB_ Mid/Area Scan (71x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.377 W/kg

Rear Side Mid 1RB_ Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.791 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.542 W/kg
SAR(1 g) = 0.331 W/kg; SAR(10 g) = 0.190 W/kg
Maximum value of SAR (measured) = 0.358 W/kg

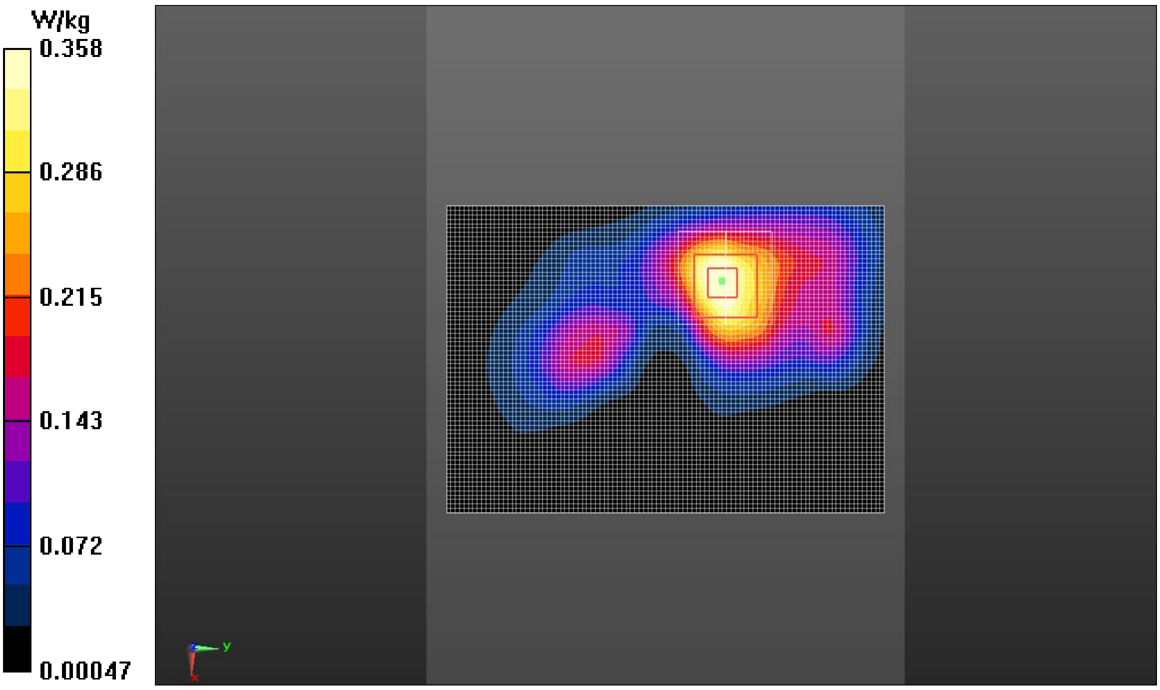


Fig.6　LTE Band 7

Wi-Fi 2.4G Head

Date: 2018-3-18

Electronics: DAE4 Sn786

Medium: Head 2450 MHz

Medium parameters used (interpolated): f = 2437 MHz; σ = 1.838 S/m; ε_r = 38.704; ρ = 1000 kg/m^3

Ambient Temperature: 22.2^{o}C Liquid Temperature: 21.7^{o}C

Communication System: UID 0, Wi-Fi (0) Frequency: 2437 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.57, 4.57, 4.57);

Right Cheek Mid/Area Scan (61x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.536 W/kg

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

Reference Value = 3.866 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.908 W/kg

SAR(1 g) = 0.445 W/kg; SAR(10 g) = 0.222 W/kg

Maximum value of SAR (measured) = 0.486 W/kg

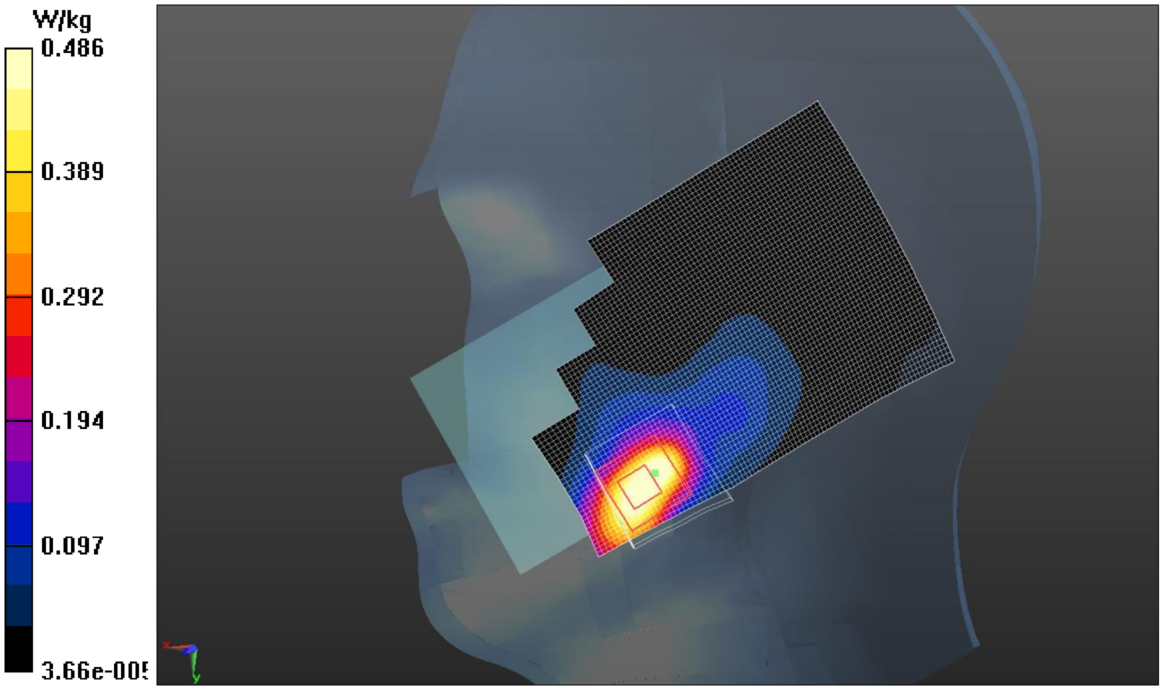


Fig.7 Wi-Fi 2.4G

Wi-Fi 2.4G Body

Date: 2018-3-18

Electronics: DAE4 Sn786

Medium: Body 2450 MHz

Medium parameters used (interpolated): f = 2437 MHz; σ = 1.922 S/m; ε_r = 52.237; ρ = 1000 kg/m^3

Ambient Temperature: 22.3°C   Liquid Temperature: 21.8°C

Communication System: UID 0, Wi-Fi (0) Frequency: 2437 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (4.46, 4.46, 4.46);

Rear Side Mid/Area Scan (51x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.217 W/kg

Rear Side Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 6.581 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 0.369 W/kg

SAR(1 g) = 0.191 W/kg; SAR(10 g) = 0.095 W/kg

Maximum value of SAR (measured) = 0.204 W/kg

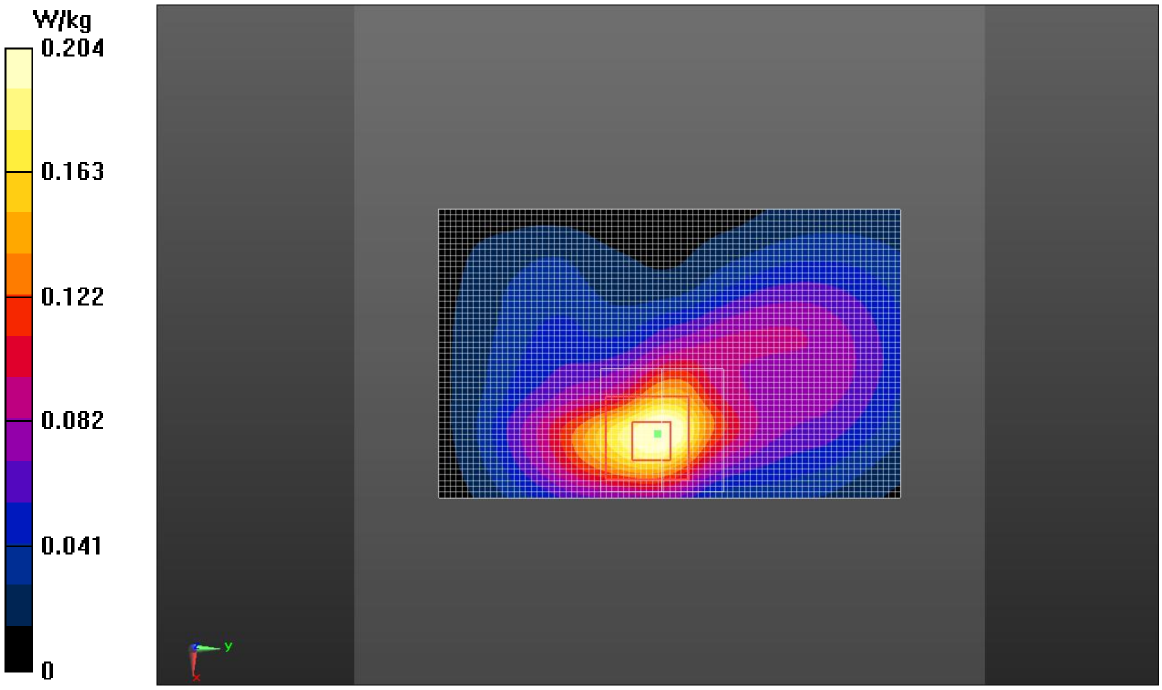


Fig.8 Wi-Fi 2.4G

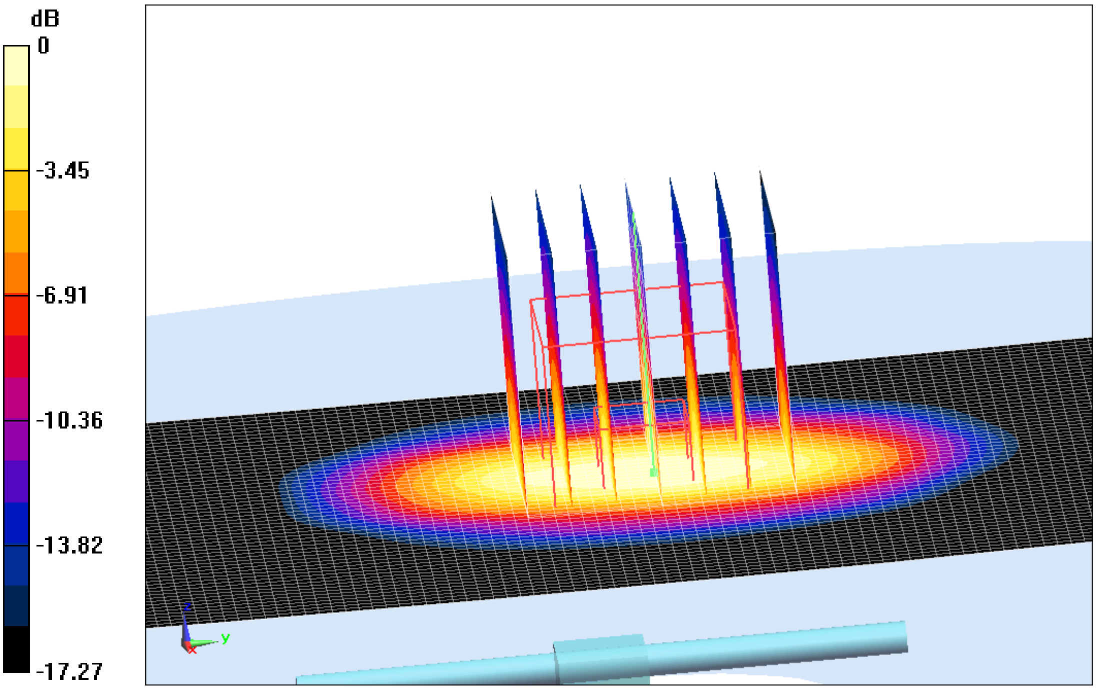
ANNEX B SystemVerification Results

1900MHz

Date: 2018-3-16
Electronics: DAE4 Sn786
Medium: Head 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.396 S/m; ε_r = 40.84; ρ = 1000 kg/m^3
Ambient Temperature: 22.9^{o}C Liquid Temperature: 22.5^{o}C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

System Validation /Area Scan (81x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 91.224 V/m; Power Drift = -0.03 dB
Fast SAR: SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.21 W/kg
Maximum value of SAR (interpolated) = 12.5 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 91.224 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 18.4 W/kg
SAR(1 g) = 9.95 W/kg; SAR(10 g) = 5.18 W/kg
Maximum value of SAR (measured) = 12.1 W/kg



0 dB = 12.1 W/kg = 10.83 dB W/kg

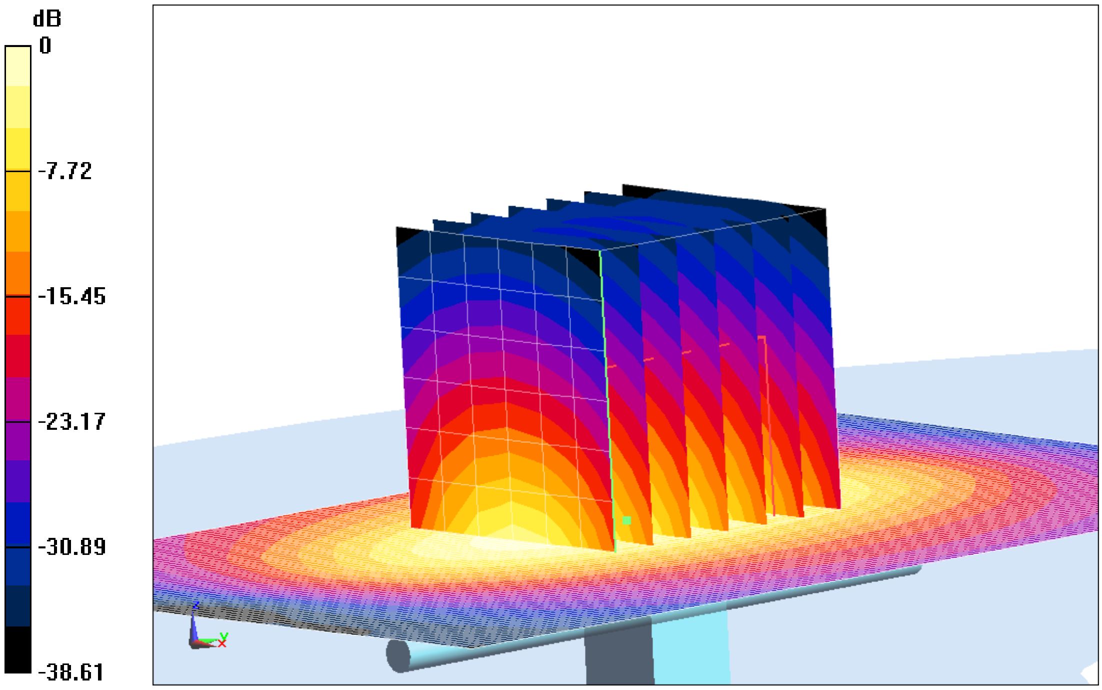
Fig.B.1. Validation 1900MHz 250mW

1900MHz

Date: 2018-3-16
Electronics: DAE4 Sn786
Medium: Body 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.565 S/m; ε_r = 51.772; ρ = 1000 kg/m^3
Ambient Temperature: 22.9^{o}C Liquid Temperature: 22.5^{o}C
Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.89, 4.89, 4.89);

System validation /Area Scan (81x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 75.182 V/m; Power Drift = 0.02 dB
Fast SAR: SAR(1 g) = 10.4 W/kg; SAR(10 g) = 5.39 W/kg
Maximum value of SAR (interpolated) = 12.8 W/kg

System validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 75.182 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 19.3 W/kg
SAR(1 g) = 10.6 W/kg; SAR(10 g) = 5.44 W/kg
Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.2 W/kg = 11.21 dB W/kg

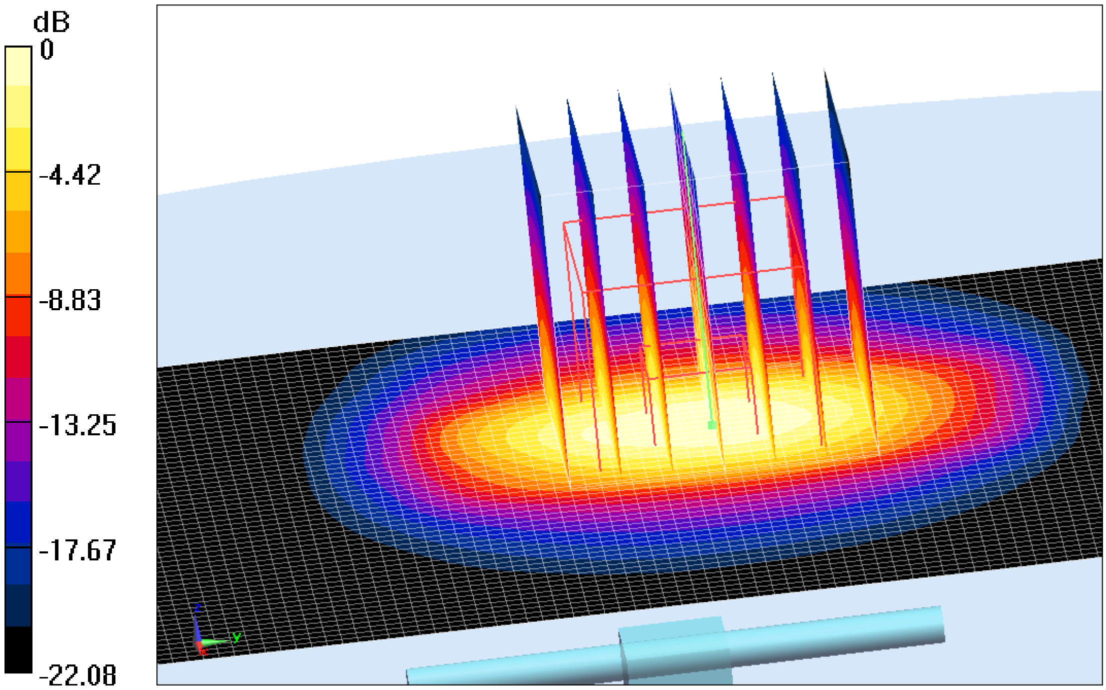
Fig.B.2. Validation 1900MHz 250mW

2450MHz

Date: 2018-3-18
Electronics: DAE4 Sn786
Medium: Head 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.852 S/m; ε_r = 38.651; ρ = 1000 kg/m^3
Ambient Temperature: 22.0^{o}C   Liquid Temperature: 21.6^{o}C
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.57, 4.57, 4.57);

System Validation /Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 84.937 V/m; Power Drift = 0.10 dB
Fast SAR: SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.07 W/kg
Maximum value of SAR (interpolated) = 15.5 W/kg

System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 84.937 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 21.9 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.12 W/kg
Maximum value of SAR (measured) = 16.2 W/kg



0 dB = 16.6 W/kg = 12.20 dB W/kg

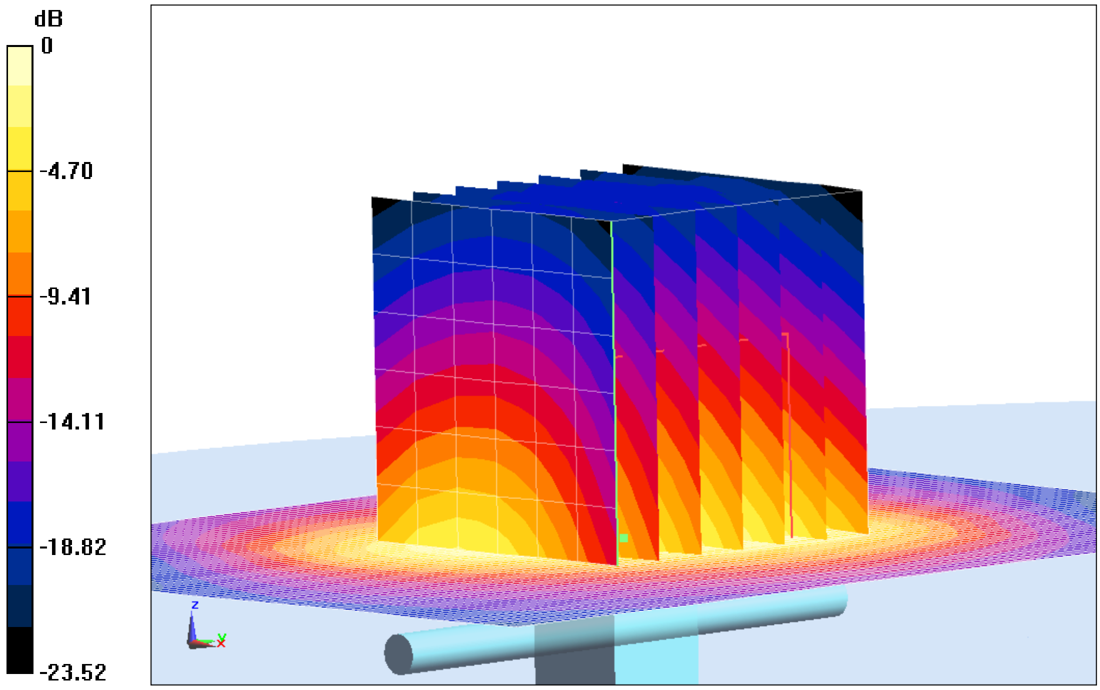
Fig.B.3. Validation 2450MHz 250mW

2450MHz

Date: 2018-3-18
Electronics: DAE4 Sn786
Medium: Body 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.936 S/m; ε_r = 52.188; ρ = 1000 kg/m^3
Ambient Temperature: 22.0^{o}C Liquid Temperature: 21.6^{o}C
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.46, 4.46, 4.46);

System Validation/Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 82.676 V/m; Power Drift = -0.05 dB
Fast SAR: SAR(1 g) = 13.0 W/kg; SAR(10 g) = 6.09 W/kg
Maximum value of SAR (interpolated) = 15.3 W/kg

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 82.676 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 20.3 W/kg
SAR(1 g) = 12.6 W/kg; SAR(10 g) = 6.03 W/kg
Maximum value of SAR (measured) = 14.7 W/kg



0 dB = 14.7 W/kg = 11.67 dB W/kg

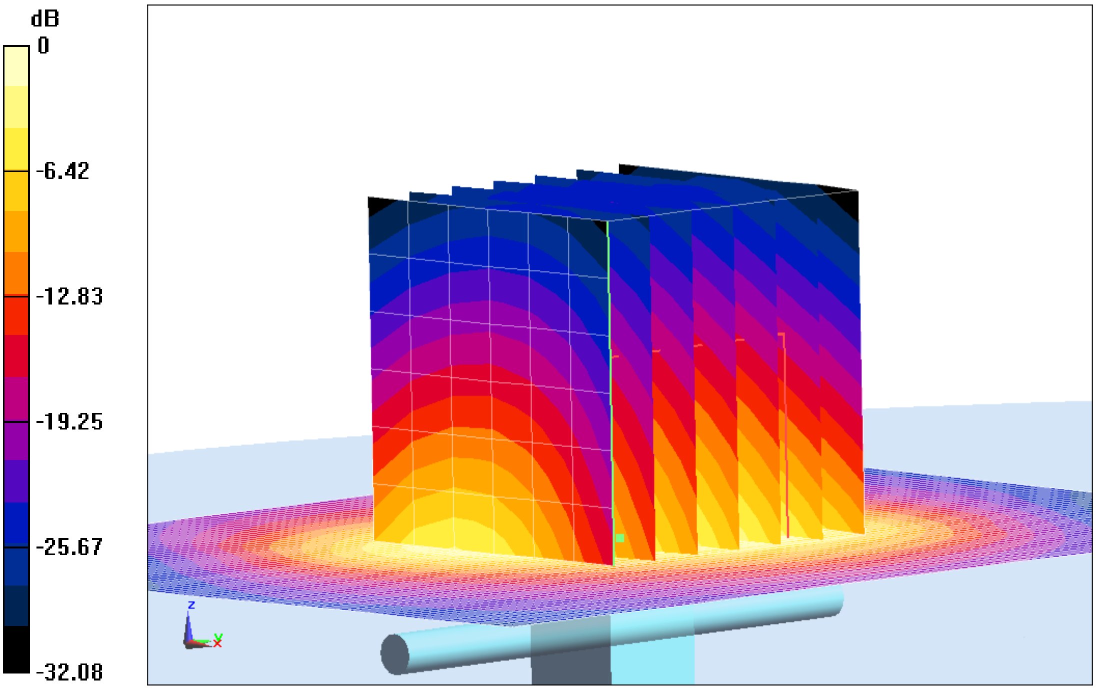
Fig.B.4. Validation 2450MHz 250mW

2550MHz

Date: 2018-3-18
Electronics: DAE4 Sn786
Medium: Head 2550 MHz
Medium parameters used: f = 2550 MHz; σ = 1.933 S/m; ε_r = 38.422; ρ = 1000 kg/m^3
Ambient Temperature: 22.0°C Liquid Temperature: 21.6°C
Communication System: CW Frequency: 2550 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.53, 4.53, 4.53);

System Validation/Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 92.874 V/m; Power Drift = 0.07 dB
Fast SAR: SAR(1 g) = 14.7 W/kg; SAR(10 g) = 6.62 W/kg
Maximum value of SAR (interpolated) = 17.2 W/kg

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 92.874 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 29.6 W/kg
SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.58 W/kg
Maximum value of SAR (measured) = 16.6 W/kg



0 dB = 16.6 W/kg = 12.20 dB W/kg

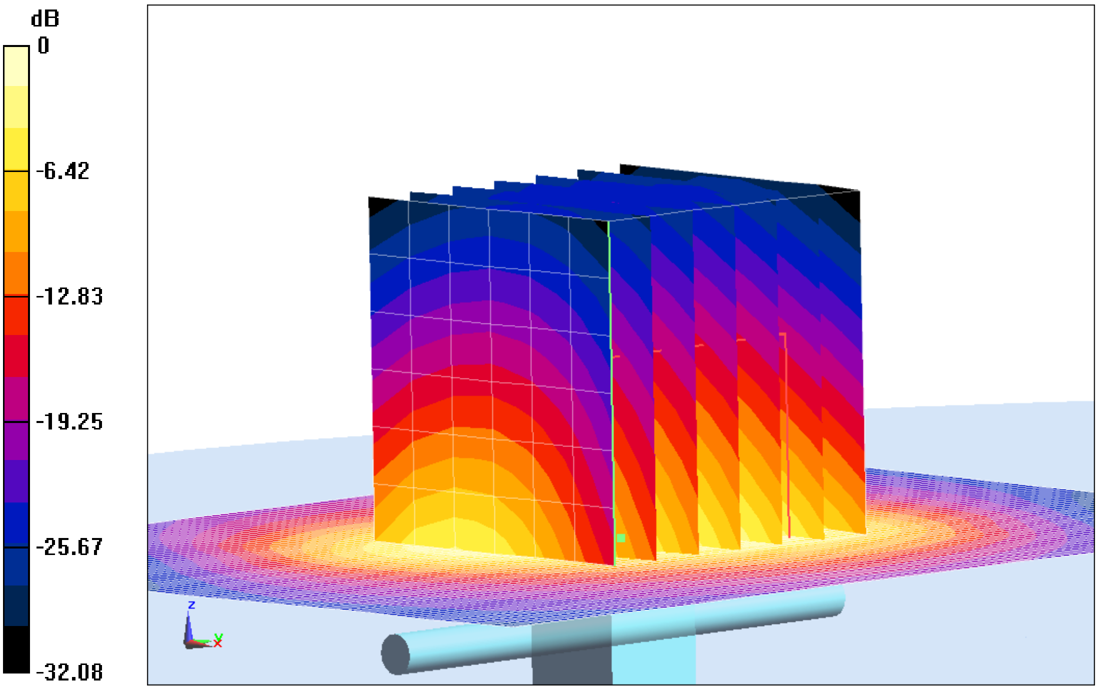
Fig.B.5. Validation 2550MHz 250mW

2550MHz

Date: 2018-3-18
Electronics: DAE4 Sn786
Medium: Body 2550 MHz
Medium parameters used: f = 2550 MHz; σ = 2.044 S/m; ε_r = 51.934; ρ = 1000 kg/m^3
Ambient Temperature: 22.0°C Liquid Temperature: 21.6°C
Communication System: CW Frequency: 2550 MHz Duty Cycle: 1:1
Probe: ES3DV3 – SN3151 ConvF (4.24, 4.24, 4.24);

System Validation/Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 88.545 V/m; Power Drift = 0.04 dB
Fast SAR: SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.33 W/kg
Maximum value of SAR (interpolated) = 15.1 W/kg

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 88.545 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.39 W/kg
Maximum value of SAR (measured) = 16.3 W/kg



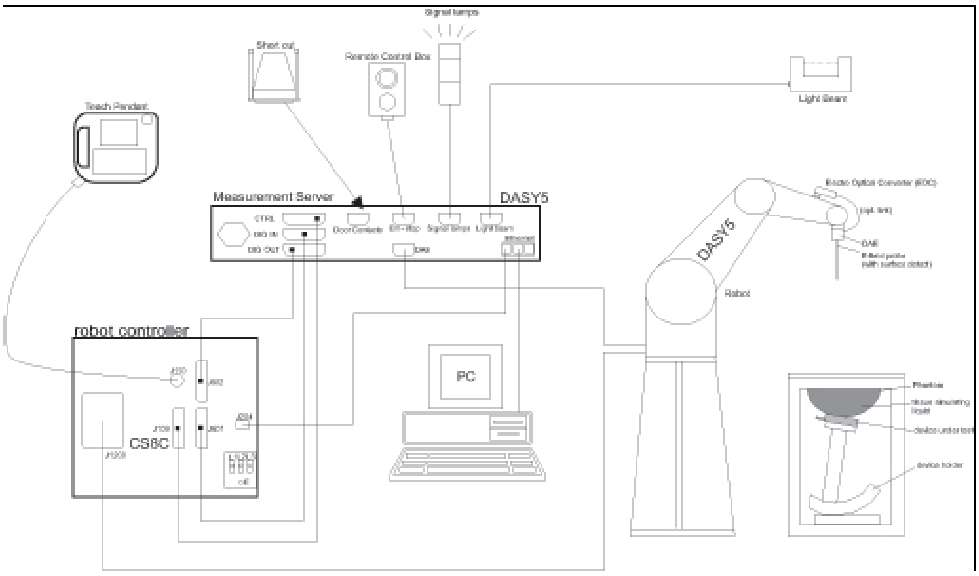
0 dB = 16.3 W/kg = 12.12 dB W/kg

Fig.B.6. Validation 2550MHz 250mW

ANNEX C SAR Measurement Setup

C.1 Measurement Set-up

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 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 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 DASY5 software reads the reflection durning a software approach and looks for the maximum using 2ndord 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: 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 (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 5

C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5:128MB), RAM (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 pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

Picture C.6 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.

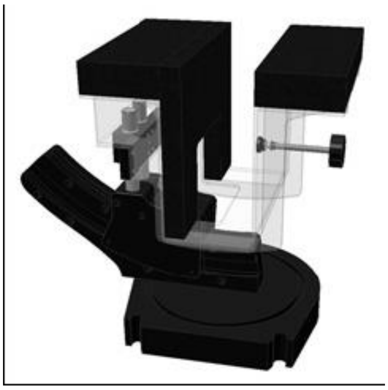
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference 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.7-1: Device Holder



Picture C.7-2: 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).

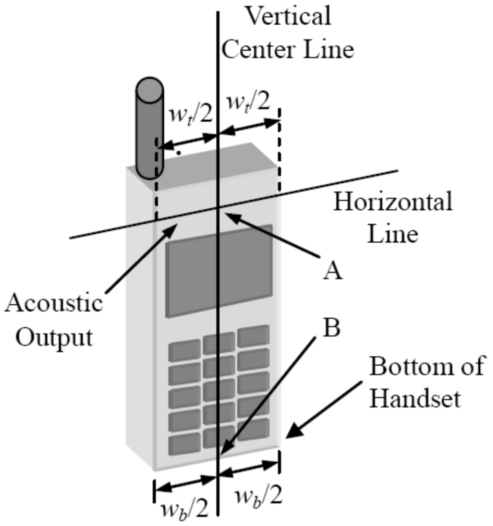
Shell Thickness: 2 ± 0. 2 mm
Filling Volume: Approx. 25 liters
Dimensions: 810 x l000 x 500 mm (H x L x W)
Available: Special

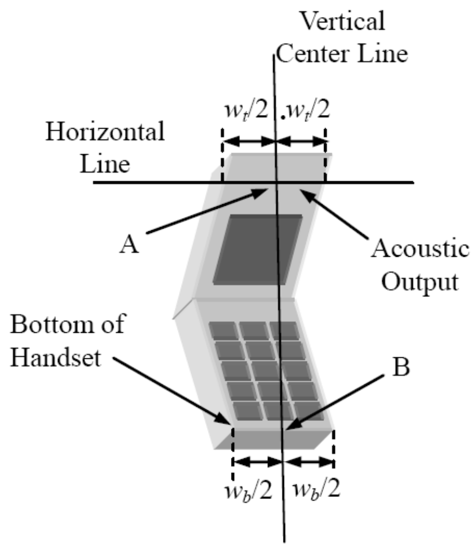
Picture C.8: SAM Twin Phantom

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

D.1 General considerations

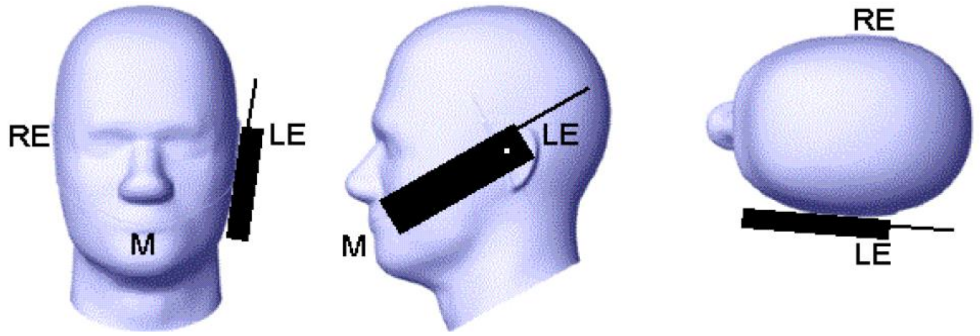
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



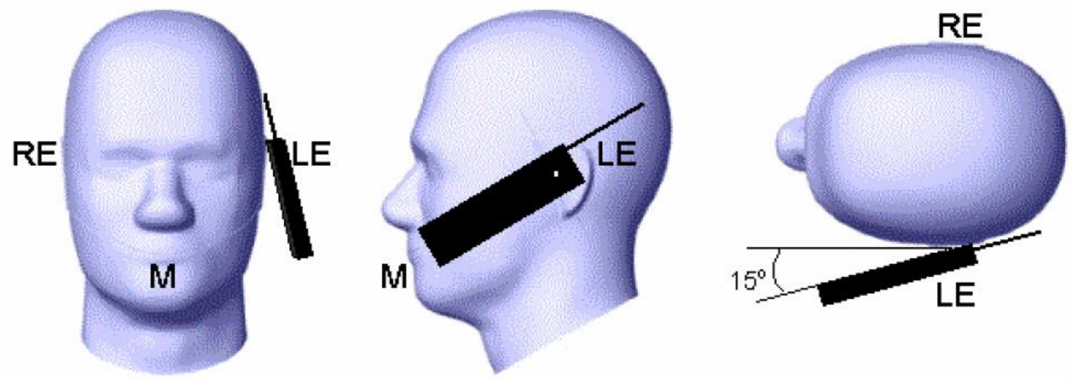


w_t	Width of the handset at the level of the acoustic
w_b	Width of the bottom of the handset
A	Midpoint of the width w_t of the handset at the level of the acoustic output
B	Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical “fixed” case handset **Picture D.1-b Typical “clam-shell” case handset**



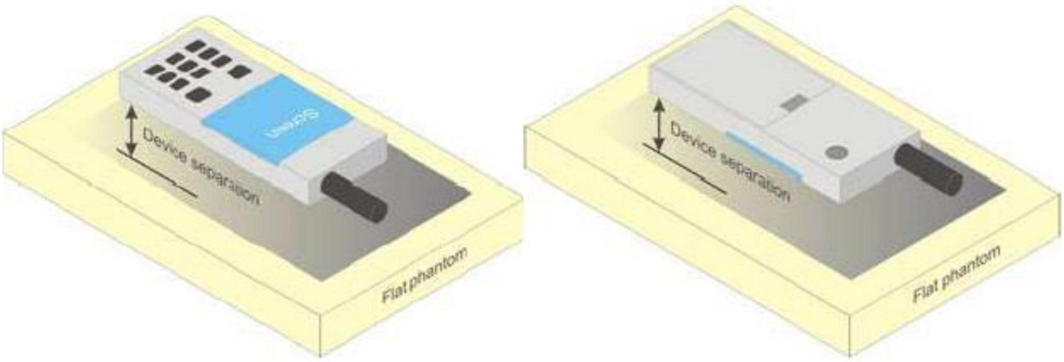
Picture D.2 Cheek position of the wireless device on the left side of SAM



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.

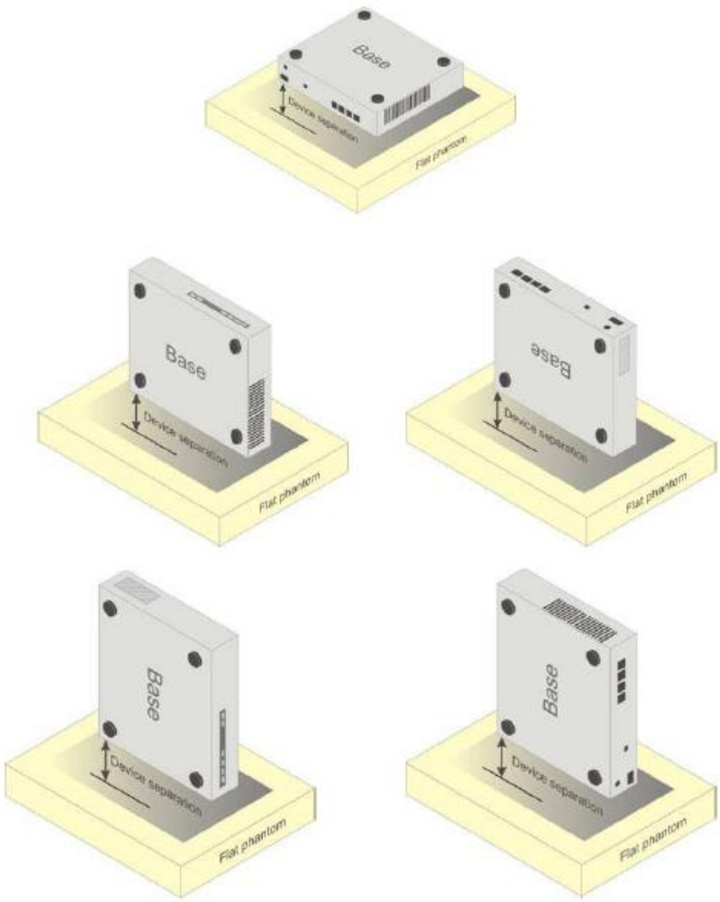


Picture D.4 Test positions for body-worn devices

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 700-6000 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	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

Note: There is a little adjustment respectively for 750, 1800, 2600, 5200, 5300, and 5600, based on the recipe of closest frequency in table E.1

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)
3151	Head 750MHz	2017-12-17	750 MHz	OK
3151	Head 835MHz	2017-12-17	835 MHz	OK
3151	Head 1800MHz	2017-12-19	1800 MHz	OK
3151	Head 1900MHz	2017-12-19	1900 MHz	OK
3151	Head 2450MHz	2017-12-20	2450 MHz	OK
3151	Head 2550MHz	2017-12-20	2550 MHz	OK
3151	Body 750MHz	2017-12-17	750 MHz	OK
3151	Body 835MHz	2017-12-17	835 MHz	OK
3151	Body 1800MHz	2017-12-19	1800 MHz	OK
3151	Body 1900MHz	2017-12-19	1900 MHz	OK
3151	Body 2450MHz	2017-12-20	2450 MHz	OK
3151	Body 2550MHz	2017-12-20	5200 MHz	OK

ANNEX G DAE Calibration Certificate

DAE4 SN: 786 Calibration Certificate

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CALIBRATION LABORATORY

中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client : CTTL(South Branch)

Certificate No: Z17-97239

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 786
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	November 22, 2017

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
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: November 25, 2017

TTL In Collaboration with s p e a g CALIBRATION LABORATORY
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Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Glossary:

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.

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E-mail: cttl@chinattl.com Http://www.chinattl.cn

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.138 ± 0.15% (k=2)	404.330 ± 0.15% (k=2)	404.714 ± 0.15% (k=2)
Low Range	3.97217 ± 0.7% (k=2)	3.97384 ± 0.7% (k=2)	3.95842 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	229.5° ± 1 °

ANNEX H Probe Calibration Certificate

Probe ES3DV3-SN: 3151 Calibration Certificate

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CALIBRATION LABORATORY

中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client CTTL(South Branch) Certificate No: Z17-97240

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3151

Calibration Procedure(s): FF-Z11-004-01
Calibration Procedures for Dosimetric E-field Probes

Calibration date: December 13, 2017

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	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101547	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101548	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Reference10dBAttenuator	18N50W-10dB	13-Mar-16(CTTL,No.J16X01547)	Mar-18
Reference20dBAttenuator	18N50W-20dB	13-Mar-16(CTTL, No.J16X01548)	Mar-18
Reference Probe EX3DV4	SN 7464	12-Sep-17(SPEAG,No.EX3-7464_Sep17)	Sep-18
DAE4	SN 549	13-Dec-16(SPEAG, No.DAE4-549_Dec16)	Dec -17
DAE4	SN 1524	13-Sep-17(SPEAG, No.DAE4-1524_Sep17)	Sep -18
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	27-Jun-17 (CTTL, No.J17X05858)	Jun-18
Network Analyzer E5071C	MY46110673	13-Jan-17 (CTTL, No.J17X00285)	Jan -18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: December 15, 2017