



## FCC SAR Compliance Test Report

Project Name: HSPA/UMTS/GPRS/GSM/EDGE Mobile Phone with Bluetooth; Apollo

Model : HUAWEI U8867Z, U8867Z

FCC ID : QISU8867Z

Report No. : SYBH(Z-SAR)005082012-2

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DATE	2012-08-30	2012-08-30	2012-08-30

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**※ ※ Modified History ※ ※**

<b>REV.</b>	<b>DESCRIPTION</b>	<b>ISSUED DATE</b>	<b>REMARK</b>
Rev.1.0	Initial Test Report Release	2012-08-08	Yang Hang
Rev.1.1	Revised the term from "WCDMA" to "UMTS"	2012-08-30	Yang Hang

# 1 General Information

## 1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI U8867Z are as below Table 1.

Band	Position	Measured MAX SAR <sub>1g</sub> (W/kg)	Conducted Power (dBm)	Tune-up Power(dBm)	Extrapolated Result(W/kg)
GSM 850	Head	0.235	32.88	33.30	0.259
	Body Worn(15mm)	0.539	29.67	30.60	0.668
	Hotspot(10mm)	0.716			0.887
GSM 1900	Head	0.189	29.71	30.30	0.217
	Body Worn(15mm)	0.457	29.58	30.40	0.552
	Hotspot(10mm)	0.802			0.969
UMTS Band V	Head	0.160	23.22	24.00	0.191
	Body Worn(15mm)	0.401			0.480
	Hotspot(10mm)	0.546			0.653
UMTS Band IV	Head	0.282	23.05	23.70	0.328
	Body Worn(15mm)	0.669			0.777
	Hotspot(10mm)	0.944			1.091
UMTS Band II	Head	<b>0.367</b>	22.87	23.70	0.444
	Body Worn(15mm)	<b>0.861</b>			1.042
	Hotspot(10mm)	<b>1.130</b>			1.365
WiFi	Head	0.021	14.76	/	/
	Body Worn(15mm)	0.022		/	/
	Hotspot(10mm)	0.044		/	/
Simultaneous SAR <sub>Max</sub> is <b>1.174</b> W/kg					

Table 1:Summary of test result

The device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits of 1.6 W/Kg as averaged over any 1 g tissue according to the FCC rule §2.1093, the ANSI/IEEE C 95.1:1999, the NCRP Report Number 86 for uncontrolled environment, according to the Health Canada’s Safety Code 6 and the Industry Canada Radio Standards Specification RSS-102 for General Population/Uncontrolled exposure, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2003 & IEEE Std 1528a-2005 and FCC OET Bulletin 65 Supplement C Edition 01-01.

## 1.2 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
<b>Spatial Peak SAR*</b> (Brain/Body/Arms/Legs)	<b>1.60 mW/g</b>	8.00 mW/g
<b>Spatial Average SAR**</b> (Whole Body)	0.08 mW/g	0.40 mW/g
<b>Spatial Peak SAR***</b> (Hands/Feet/Ankle/Wrist)	4.00 mW/g	20.00 mW/g

Table 2: RF exposure limits

The limit applied in this test report is shown in **bold** letters

### Notes:

\* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

\*\* The Spatial Average value of the SAR averaged over the whole body.

\*\*\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

**Uncontrolled Environments** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

**Controlled Environments** are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

### 1.3 EUT Description

Device Information:			
DUT Name:	HSPA/UMTS/GPRS/GSM/EDGE Mobile Phone with Bluetooth; Apollo		
Type Identification:	HUAWEI U8867Z, U8867Z		
FCC ID:	QISU8867Z		
IMEI:	865029010005794		
Device Type :	portable device		
Exposure Category:	uncontrolled environment / general population		
Hardware Version :	HD2U8867ZM		
Software Version :	U8867Z V100R001USAC189B824		
Antenna Type :	internal antenna		
Others Accessories	Headset		
Device Operating Configurations:			
Supporting Mode(s)	GSM 850/1900,UMTS Band V/IV/II,WiFi(tested)		
Test Modulation	GSM(GMSK), UMTS(QPSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM850	824-849	869-894
	GSM1900	1850-1910	1930-1990
	UMTS Band V	824-849	869-894
	UMTS Band IV	1713-1753	2113-2153
	UMTS Band II	1850-1910	1930-1990
	WiFi	2400-2483.5	2400-2483.5
GPRS Multislot Class(10)	Max Number of Timeslots in Uplink:	2	
	Max Number of Timeslots in Downlink:	4	
	Max Total Timeslot:	5	
EGPRS Multislot Class(10)	Max Number of Timeslots in Uplink:	2	
	Max Number of Timeslots in Downlink:	4	
	Max Total Timeslot:	5	
HSDPA UE Category	10		
HSUPA UE Category:	6		
Power Class:	4, tested with power level 5(GSM850)		
	1, tested with power level 0(GSM900)		
	3, tested with power control "all 1"(UMTS Band V)		
	3, tested with power control "all 1"(UMTS Band IV)		
	3, tested with power control "all 1"(UMTS Band II)		
Test Channels (low-mid-high):	128-190-251 (GSM850)		
	512-661-810 (GSM1900)		
	4132-4182-4233 (UMTS Band V )		
	1312-1413-1513 (UMTS Band IV )		
	9262-9400-9538 (UMTS Band II )		
	1-6-11 (WiFi 2450)		
Battery Options :	Huawei Technologies Co., Ltd. Rechargeable Li-ion Battery Model:HB5N1HA Rated capacity: 1650mAh Nominal Voltage: $\text{---}$ +3.7V; Charging Voltage: $\text{---}$ +4.2V SN:UWDC320XBGN00116(1#) SN:MAIC523X03600626(2#)		

Table 3:Device information and operating configuration

### 1.3.1 General Description

HUAWEI U8867Z, U8867Z subscriber equipment in the WCDMA/GSM system. The HSPA/UMTS frequency band is Band I and Band II and Band IV and Band V, but only Band II and Band IV and Band V test data included in this report. The GSM/GPRS/EDGE frequency band includes GSM850 and GSM900 and DCS1800 and PCS1900, but only GSM850 and PCS1900 test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, HSPA/UMTS and GSM/GPRS/EDGE protocol processing, voice, video, MMS service, GPS,AGPS and WIFI etc. Externally it provides micro SD card interface, earphone port (to provide voice service) and USIM card interface. It also provides Bluetooth module to synchronize data between a PC and the phone, or to use the built-in modem of the phone to access the Internet with a PC, or to exchange data with other Bluetooth devices.

### 1.4 Test specification(s)

IEEE Std C95.1 – 1999	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.
IEEE Std 1528-2003	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
IEEE Std 1528a-2005	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques Amendment 1: CAD File for Human Head Model (SAM Phantom)
OET Bulletin No. 65, Supplement C– 2001	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields---Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions
Canada's Safety Code 6	Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz (99-EHD-237)
RSS-102	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands (Issue 4 of March 2010)
KDB941225 D01	SAR test for 3G devices v02
KDB941225 D03	SAR Test Reduction GSM GPRS EDGE vo1
KDB648474 D01	SAR Handsets Multi Xmitter and Ant v01r05
KDB 248227 D01	SAR meas for 802.11 a/b/g v01r02
KDB941225 D06	Hot Spot SAR v01

### 1.5 Testing laboratory

Test Site	The Reliability Laboratory of Huawei Technologies Co., Ltd.
Test Location	Zone K3,Huawei Industrial Base, Bantian Industry Area, Longgang District, Shenzhen, Guangdong, China
Telephone	+86 755 28780808
Fax	+86 755 89652518
State of accreditation	The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310 ; A2LA CERT #2174.01

## 1.6 Applicant and Manufacturer

Company Name	HUAWEI TECHNOLOGIES CO., LTD
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

## 1.7 Application details

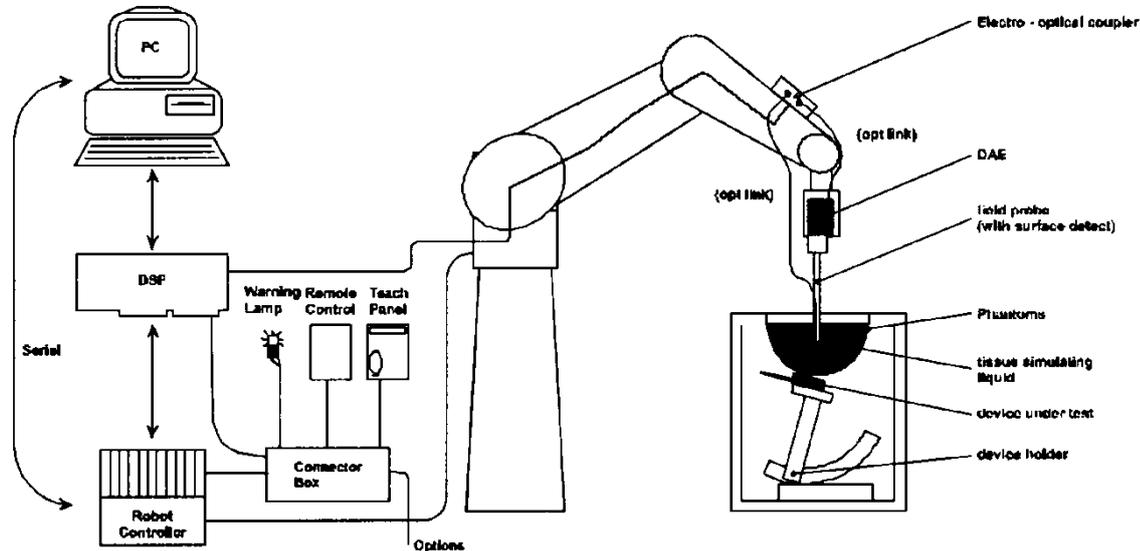
Start Date of test	2012/07/31
End Date of test	2012/08/04

## 1.8 Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

## 2 SAR Measurement System

### 2.1 SAR Measurement Set-up



The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronic (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.
- A unit to operate the optical surface detector which is connected to the EOC.
- The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
- The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows XP.
- DASY5 software and SEMCAD data evaluation software.
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- System validation dipoles allowing to validate the proper functioning of the system.

## 2.2 Test environment

The DASY4 measurement system is placed at the head end of a room with dimensions: 5 x 2.5 x 3 m<sup>3</sup>, the SAM phantom is placed in a distance of 75 cm from the side walls and 1.1m from the rear wall. Above the test system a 1.5 x 1.5 m<sup>2</sup> array of pyramid absorbers is installed to reduce reflections from the ceiling.

Picture 1 of the photo documentation shows a complete view of the test environment.

The system allows the measurement of SAR values larger than 0.005 mW/g.

## 2.3 Data Acquisition Electronics description

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte 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.

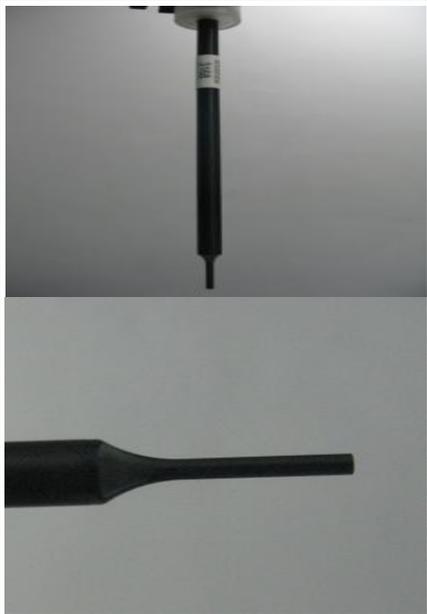
### DAE4

Input Impedance	200MOhm	
The Inputs	symmetrical and floating	
Common mode rejection	above 80 dB	

## 2.4 Probe description

These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor ( $\pm 2$  dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

### Isotropic E-Field Probe ES3DV3 for Dosimetric Measurements

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to 4 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)	
Directivity	$\pm 0.2$ dB in HSL (rotation around probe axis) $\pm 0.3$ dB in tissue material (rotation normal to probe axis)	
Dynamic range	5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm	
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones	

### Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to >6 GHz (dosimetry); Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)	
Directivity	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)	
Dynamic range	10 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)	
Dimensions	Overall length: 337 mm (Tip: 20mm) Tip length: 2.5 mm (Body: 12mm) Typical distance from probe tip to dipole centers: 1mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

## 2.5 Phantom description

### SAM Twin Phantom

Shell Thickness	2mm +/- 0.2 mm; The ear region: 6mm	
Filling Volume	Approximately 30 liters	
Dimensions	Length:1000mm; Width:500mm; Height: adjustable feet	
Measurement Areas	Left hand Right hand Flat phantom	

The bottom plate contains three pairs of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to cover the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on top of this phantom cover are possible. Three reference marks are provided on the phantom counter. These reference marks are used to teach the absolute phantom position relative to the robot.

### ELI4 Phantom

Shell Thickness	2mm +/- 0.2 mm	
Filling Volume	Approximately 30 liters	
Dimensions	Length:1000mm; Width:500mm; Height: adjustable feet	
Measurement Areas	Flat phantom	

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209-2 and all known tissue simulating liquids.

## 2.6 Device holder description

The DASY5 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA's only. If necessary an additional support of polystyrene material is used.



Larger DUT's (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values.

Therefore those devices are normally only tested at the flat part of the SAM.

## 2.7 Test Equipment List

This table gives a complete overview of the SAR measurement equipment  
 Devices used during the test described are marked ☒

	Manufacturer	Device	Type	Serial number	Date of last calibration )*
<input type="checkbox"/>	SPEAG	Dosimetric E-Field Probe	EX3DV4	3736	2012-04-26
<input checked="" type="checkbox"/>	SPEAG	Dosimetric E-Field Probe	EX3DV4	3661	2012-01-27
<input checked="" type="checkbox"/>	SPEAG	835 MHz Validation Dipole	D835V2	4d126	2011-11-07
<input checked="" type="checkbox"/>	SPEAG	1800 MHz Validation Dipole	D1800V2	2d184	2011-03-08
<input checked="" type="checkbox"/>	SPEAG	1900 MHz Validation Dipole	D1900V2	5d143	2011-09-26
<input type="checkbox"/>	SPEAG	2300 MHz Validation Dipole	D2300V2	1016	2011-11-22
<input checked="" type="checkbox"/>	SPEAG	2450 MHz Validation Dipole	D2450V2	860	2011-03-08
<input type="checkbox"/>	SPEAG	2600 MHz Validation Dipole	D2600V2	1021	2011-11-21
<input checked="" type="checkbox"/>	SPEAG	Data acquisition electronics	DAE4	679	2011-12-23
<input checked="" type="checkbox"/>	SPEAG	Software	DASY 5	N/A	N/A
<input checked="" type="checkbox"/>	SPEAG	Twin Phantom	SAM1	TP-1475	N/A
<input checked="" type="checkbox"/>	SPEAG	Twin Phantom	SAM2	TP-1474	N/A
<input type="checkbox"/>	SPEAG	Twin Phantom	SAM3	TP-1597	N/A
<input type="checkbox"/>	SPEAG	Twin Phantom	SAM4	TP-1620	N/A
<input type="checkbox"/>	SPEAG	Flat Phantom	ELI 4.0	TP-1038	N/A
<input type="checkbox"/>	SPEAG	Flat Phantom	ELI 4.0	TP-1111	N/A
<input checked="" type="checkbox"/>	R & S	Universal Radio Communication Tester	CMU 200	113989	2012-06-07
<input checked="" type="checkbox"/>	Agilent)*	Network Analyser	E5071B	MY42404956	2012-02-14
<input checked="" type="checkbox"/>	Agilent	Dielectric Probe Kit	85070E	2484	N/A
<input checked="" type="checkbox"/>	Agilent	Signal Generator	N5181A	MY47420989	2012-02-14
<input checked="" type="checkbox"/>	MINI-CIRCUITS	Amplifier	ZHL-42W	QA0746001	N/A
<input checked="" type="checkbox"/>	Agilent	Power Meter	E4417A	MY45101339	2012-02-14
<input checked="" type="checkbox"/>	Agilent	Power Meter Sensor	E9321A	MY44420359	2012-02-14

Note: All the test equipments are calibrated once a year, except the dipoles, which are calibrated every three years. Moreover, we have self-calibration every year to the dipoles.

1) Per KDB 450824 D02 requirements for dipole calibration, Huawei SAR lab has adopted three years calibration interval. But each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.

- a) There is no physical damage on the dipole;
- b) System validation with specific dipole is within 10% of calibrated value;
- c) Return-loss is within 10% of calibrated measurement;
- d) Impedance is within  $5\Omega$  from the previous measurement.

2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

### 3 SAR Measurement Procedure

#### 3.1 Scanning procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.
- The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above  $\pm 0.1\text{mm}$ ). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within  $\pm 30^\circ$ .)
- The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension. If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in Appendix B.
- A “7x7x7 zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine 7x7 grid where the robot additionally moves the probe in 7 steps along the z-axis away from the bottom of the Phantom. Grid spacing for the cube measurement is 5 mm in x and y-direction and 5 mm in z-direction. DASY5 is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form in chapter 7.2.
- A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth. A z-axis scan of the measurement with maximum SAR value is shown in Appendix B.

### 3.2 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 7 x 7 x 7 points. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

#### Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

#### Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

#### Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

#### Advanced Extrapolation

DASY5 uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

### 3.3 Data Storage and Evaluation

#### Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension "DAE4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

#### Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Norm <sub>i</sub> , a <sub>10</sub> , a <sub>11</sub> , a <sub>12</sub>
	- Conversion factor	ConvF <sub>i</sub>
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf/dcp_i$$

with  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $U_i$  = input signal of channel i (i = x, y, z)  
 cf = crest factor of exciting field (DASY parameter)  
 $dcp_i$  = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:  $E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$   
H-field probes:  $H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2) / f$

- with  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $Norm_i$  = sensor sensitivity of channel i (i = x, y, z)  
[mV/(V/m)<sup>2</sup>] for E-field Probes  
ConvF = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
f = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_x^2 + E_y^2 + E_z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (E_{tot}^2 \cdot \sigma) / (\rho \cdot 1000)$$

- with SAR = local specific absorption rate in mW/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

- with  $P_{pwe}$  = equivalent power density of a plane wave in mW/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m  
 $H_{tot}$  = total magnetic field strength in A/m

## 4 System Verification Procedure

### 4.1 Tissue Verification

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within  $\pm 5\%$  of the target values.

The following materials are used for producing the tissue-equivalent materials.

Ingredients (% of weight)	Head Tissue					
Frequency Band (MHz)	450	835	900	1800	1900	2450
Water	38.56	41.45	40.92	52.64	55.242	62.7
Salt (NaCl)	3.95	1.45	1.48	0.36	0.306	0.5
Sugar	56.32	56.0	56.5	0.0	0.0	0.0
HEC	0.98	1.0	1.0	0.0	0.0	0.0
Bactericide	0.19	0.1	0.1	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	0.0	47.0	44.542	36.8
Ingredients (% of weight)	Body Tissue					
Frequency Band (MHz)	450	835	900	1800	1900	2450
Water	51.16	52.4	56.0	69.91	69.91	73.2
Salt (NaCl)	1.49	1.40	0.76	0.13	0.13	0.04
Sugar	46.78	45.0	41.76	0.0	0.0	0.0
HEC	0.52	1.0	1.21	0.0	0.0	0.0
Bactericide	0.05	0.1	0.27	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	0.0	29.96	29.96	26.7

Table 4: Tissue Dielectric Properties

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16M $\Omega$ + resistivity  
 HEC: Hydroxyethyl Cellulose; DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]  
 Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		$\epsilon_r$ (+/-5%)	$\sigma$ (S/m) (+/-5%)	$\epsilon_r$	$\sigma$ (S/m)		
835H	825	41.60 (39.52~43.68)	0.90 (0.86~0.95)	41.54	0.92	21.4°C	2012-08-03
	835	41.50 (39.43~43.58)	0.90 (0.86~0.95)	41.46	0.92		
	850	41.50 (39.43~43.58)	0.92 (0.87~0.96)	41.55	0.93		
835B	825	55.20 (52.44~57.96)	0.97 (0.92~1.02)	52.90	0.97	21.4°C	2012-07-31
	835	55.20 (52.44~57.96)	0.97 (0.92~1.02)	52.83	0.97		
	850	55.20 (52.44~57.96)	0.99 (0.94~1.04)	52.73	0.99		
1800H	1710	40.10 (38.10~42.10)	1.35 (1.28~1.42)	40.93	1.36	21.4°C	2012-08-03
	1730	40.10 (38.10~42.10)	1.36 (1.29~1.43)	40.69	1.37		
	1750	40.10 (38.10~42.10)	1.37 (1.31~1.43)	40.67	1.39		

	1800	40.00 (38.00~42.00)	1.40 (1.33~1.47)	40.46	1.44		
1800B	1710	53.50 (50.83~56.18)	1.46 (1.39~1.53)	53.08	1.45	21.4°C	2012-08-02
	1730	53.50 (50.83~56.18)	1.48 (1.41~1.55)	52.93	1.48		
	1750	53.40 (50.73~56.07)	1.49 (1.42~1.56)	52.91	1.50		
	1800	53.30 (50.64~55.97)	1.52 (1.44~1.60)	52.78	1.54		
1900H	1850	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.51	1.36	21.4°C	2012-08-03
	1880	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.30	1.39		
	1900	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.33	1.41		
	1910	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.24	1.42		
1900B	1850	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.63	1.52	21.4°C	2012-08-01
	1880	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.58	1.56		
	1900	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.54	1.58		
	1910	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.53	1.59		
2450H	2410	39.30 (37.34~41.26)	1.76 (1.67~1.85)	38.47	1.79	21.4°C	2012-08-04
	2435	39.20 (37.24~41.16)	1.79 (1.70~1.88)	38.50	1.84		
	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	38.38	1.83		
	2460	39.20 (37.24~41.16)	1.81 (1.72~1.90)	38.31	1.85		
2450B	2410	52.80 (50.16~55.44)	1.91 (1.81~2.00)	52.48	1.96	21.4°C	2012-08-04
	2435	52.70 (50.07~55.34)	1.94 (1.84~2.04)	52.32	2.00		
	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	51.28	2.00		
	2460	52.70 (50.07~55.34)	1.96 (1.86~2.06)	52.28	2.04		
$\epsilon_r$ = Relative permittivity, $\sigma$ = Conductivity							

Table 5: Measured Tissue Parameter

Note:

- 1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
- 2) KDB 450824 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
- 3) The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

## 4.2 System Check

The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system validation is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows validation results for all frequency bands and tissue liquids used during the tests (Graphic Plot(s) see Appendix A).

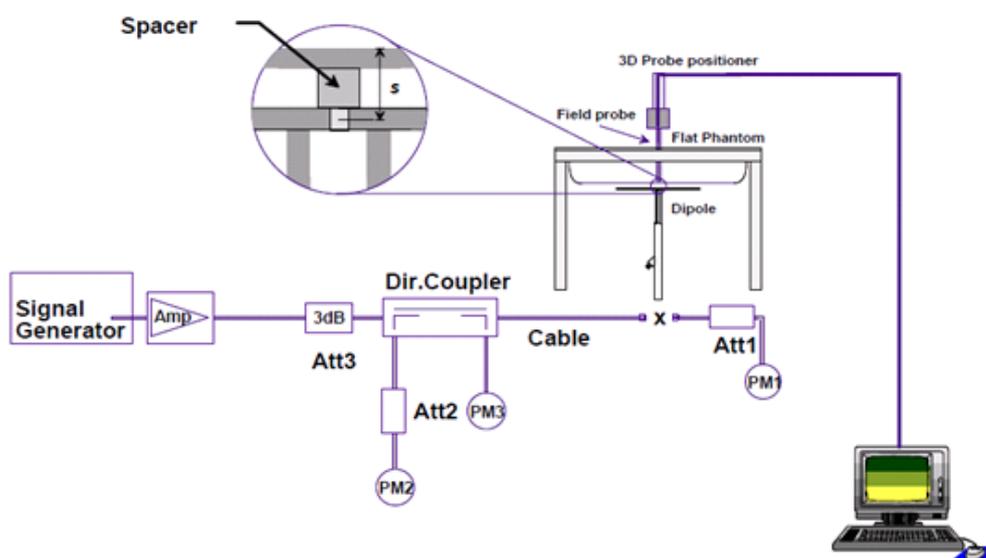
System Check	Target SAR (1W) (+/-10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (mW/g)	10-g (mW/g)	1-g (mW/g)	10-g (mW/g)		
D835V2 Head	9.40 (8.46~10.34)	6.16 (5.54~6.78)	10.00	6.52	21.4°C	2012-08-03
D1800V2 Head	39.10 (35.19~43.01)	20.30 (18.27~22.38)	39.88	20.64	21.4°C	2012-08-03
D1900V2 Head	40.60 (36.54~44.66)	21.20 (19.08~23.32)	37.00	19.56	21.4°C	2012-08-03
D2450V2 Head	53.70 (48.33~59.07)	24.90 (22.41~27.39)	52.40	23.48	21.4°C	2012-08-04
D835V2 Body	9.54 (8.59~10.49)	6.29 (5.66~6.92)	10.04	6.56	21.4°C	2012-07-31
D1800V2 Body	38.80 (34.92~42.68)	20.40 (18.36~22.44)	40.80	21.00	21.4°C	2012-08-02
D1900V2 Body	41.40 (37.26~45.54)	21.80 (19.62~23.98)	43.60	22.00	21.4°C	2012-08-01
D2450V2 Body	52.80 (47.52~58.08)	24.50 (22.05~26.95)	55.20	24.68	21.4°C	2012-08-04

Table 6: System Check Results

### 4.3 Validation Procedure

The validation is performed by using a validation dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250 mW. To adjust this power a power meter is used. The power sensor is connected to the cable before the validation to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the validation to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

Validation results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system.



## 5 Measurement Uncertainty Evaluation

### 5.1 Measurement uncertainty evaluation for SAR test

The overall combined measurement uncertainty of the measurement system is  $\pm 10.9\%$  ( $K=1$ ).

The expanded uncertainty ( $k=2$ ) is assessed to be  $\pm 21.9\%$

This measurement uncertainty budget is suggested by IEEE P1528 and determined by Schmid & Partner Engineering AG. The breakdown of the individual uncertainties is as follows:

Error Sources	Uncertainty Value	Probability Distribution	Divisor	$c_i$ 1g	$c_i$ 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>								
Probe calibration	$\pm 6.0\%$	Normal	1	1	1	$\pm 6.0\%$	$\pm 6.0\%$	$\infty$
Axial isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	$\infty$
Hemispherical isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	$\infty$
Spatial resolution	$\pm 0.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.0\%$	$\pm 0.0\%$	$\infty$
Boundary effects	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Probe linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
System detection limits	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Readout electronics	$\pm 0.3\%$	Normal	1	1	1	$\pm 0.3\%$	$\pm 0.3\%$	$\infty$
Response time	$\pm 0.8\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$	$\infty$
Integration time	$\pm 2.6\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.5\%$	$\pm 1.5\%$	$\infty$
RF ambient conditions	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
Probe positioner	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	$\infty$
Probe positioning	$\pm 2.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
Max. SAR evaluation	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
<b>Test Sample Related</b>								
Device positioning	$\pm 2.9\%$	Normal	1	1	1	$\pm 2.9\%$	$\pm 2.9\%$	145
Device holder uncertainty	$\pm 3.6\%$	Normal	1	1	1	$\pm 3.6\%$	$\pm 3.6\%$	5
Power drift	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.9\%$	$\pm 2.9\%$	$\infty$
<b>Phantom and Set-up</b>								
Phantom uncertainty	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	$\infty$
Liquid conductivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	$\infty$
Liquid conductivity (meas.)	$\pm 2.5\%$	Normal	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.1\%$	$\infty$
Liquid permittivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	$\infty$
Liquid permittivity (meas.)	$\pm 2.5\%$	Normal	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.2\%$	$\infty$
<b>Combined Uncertainty</b>	$u_c = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$					$\pm 10.9\%$	$\pm 10.7\%$	387
<b>Expanded Std. Uncertainty</b>	$U_e = 2u_c$	<b>Normal</b>	<b>k=2</b>			<b><math>\pm 21.9\%</math></b>	<b><math>\pm 21.4\%</math></b>	

Table 7: Measurement uncertainties

## 5.2 Measurement uncertainty evaluation for system validation

The overall combined measurement uncertainty of the measurement system is  $\pm 9.5\%$  ( $K=1$ ).

The expanded uncertainty ( $k=2$ ) is assessed to be  $\pm 18.9\%$

This measurement uncertainty budget is suggested by IEEE P1528 and determined by Schmid & Partner Engineering AG. The breakdown of the individual uncertainties is as follows:

Error Sources	Uncertainty Value	Probability Distribution	Divisor	$c_i$ 1g	$c_i$ 10g	Standard Uncertainty 1g	Standard Uncertainty 10g	$v_i^2$ or $v_{eff}$
<b>Measurement System</b>								
Probe calibration	$\pm 6.0\%$	Normal	1	1	1	$\pm 6.0\%$	$\pm 6.0\%$	$\infty$
Axial isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
Hemispherical isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 0.0\%$	$\pm 0.0\%$	$\infty$
Boundary effects	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Probe linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
System detection limits	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Readout electronics	$\pm 0.3\%$	Normal	1	1	1	$\pm 0.3\%$	$\pm 0.3\%$	$\infty$
Response time	$\pm 0.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.0\%$	$\pm 0.0\%$	$\infty$
Integration time	$\pm 0.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.0\%$	$\pm 0.0\%$	$\infty$
RF ambient conditions	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Probe positioner	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	$\infty$
Probe positioning	$\pm 2.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
Max. SAR evaluation	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
<b>Dipole</b>								
Deviation of experimental dipole	$\pm 5.5\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 3.2\%$	$\pm 3.2\%$	$\infty$
Dipole axis to liquid distance	$\pm 2.0\%$	Rectangular	1	1	1	$\pm 1.2\%$	$\pm 1.2\%$	$\infty$
Power drift	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
<b>Phantom and Set-up</b>								
Phantom uncertainty	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	$\infty$
Liquid conductivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	$\infty$
Liquid conductivity (meas.)	$\pm 2.5\%$	Normal	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.1\%$	$\infty$
Liquid permittivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	$\infty$
Liquid permittivity (meas.)	$\pm 2.5\%$	Normal	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.2\%$	$\infty$
<b>Combined Uncertainty</b>	$u_c = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$					<b><math>\pm 9.5\%</math></b>	<b><math>\pm 9.2\%</math></b>	
<b>Expanded Std. Uncertainty</b>	$u_e = 2u_c$	<b>Normal</b>		<b>k=2</b>		<b><math>\pm 18.9\%</math></b>	<b><math>\pm 18.4\%</math></b>	

Table 8: Measurement uncertainties

## 6 SAR Test Configuration

### 6.1 GSM Test Configuration

SAR tests for GSM850 and GSM1900, a communication link is set up with a base station by air link. Using CMU200 the power lever is set to “5”and “0” in SAR of GSM850 and GSM 1900. The tests in the band of GSM850 and GSM1900 are performed in the mode of GPRS/EGPRS function. Since the GPRS class is 10 for this EUT, it has at most 2 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. The EGPRS class is 10 for this EUT, it has at most 2 timeslots in uplink, and at most 4 timeslots in downlink, the maximum total timeslot is 5.

When SAR tests for EGPRS mode is necessary, GMSK modulation should be used to minimize SAR measurement error due to higher peak-to-average power (PAR) ratios inherent in 8-PSK.

According to specification 3GPP TS 51.010, the maximum power of the GSM can do the power reduction for the multi-slot.

The allowed power reduction in the multi-slot configuration is as following:

Number of timeslots in uplink assignment		Reduction of maximum output power, (dB)		
Band	Time Slots	GPRS (GMSK)	EGPRS (GMSK)	EGPRS (8PSK)
GSM850	1 TX slot	0	0	0
	2 TX slots	2.7	2.8	0
GSM1900	1 TX slot	0	0	0
	2 TX slots	3	3	0

Table 9: The allowed power reduction in the multi-slot configuration of GSM

### 6.2 UMTS Test Configuration

#### 1) RMC

As the SAR body tests for UMTS Band II , UMTS Band IV and UMTS Band V, we established the radio link through call processing. The maximum output power were verified on high, middle and low channels for each test band according to 3GPP TS 34.121 with the following configuration:

- 1) 12.2kbps RMC, 64,144,384 kbps RMC with TPC set to ‘all 1’.
- 2) Test loop Mode 1.

For the output power, the configurations for the DPCCH and DPDCH<sub>1</sub> are as followed (EUT do not support the DPDCH<sub>2-n</sub>)

	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	Spreading Factor	Spreading Code Number	Bits/Slot
DPCCH	15	15	256	0	10
DPDCH <sub>1</sub>	15	15	256	64	10
	30	30	128	32	20
	60	60	64	16	40
	120	120	32	8	80
	240	240	16	4	160
	480	480	8	2	320
	960	960	4	1	640
DPDCH <sub>n</sub>	960	960	4	1, 2, 3	640

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits configured to all “1s”. SAR for other spreading codes and multiple DPDCHn, when supported by the EUT, are not required when the maximum average outputs of each RF channel, for each spreading code and DPDCHn configuration, are less than ¼ dB higher than those measured in 12.2 kbps RMC.

2) HSDPA

SAR for body exposure configurations is measured according to the “Body SAR Measurements” procedures of 3G device. In addition, body SAR is also measured for HSDPA when the maximum average outputs of each RF channel with HSDPA active is at ¼ dB higher than that measured without HSDPA using 12.2kbps RMC or the maximum SAR 12.2kbps RMC is above 75% of the SAR limit. Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration in 12.2 kbps RMC without HSDPA.

HSDPA should be configured according to UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HAPRQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission condition, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. The  $\beta_c$  and  $\beta_d$  gain factors for DPCCH and DPDCH were set according to the values in the below table,  $\beta_{hs}$  for HS-DPCCH is set automatically to the correct value when  $\Delta ACK, \Delta NACK, \Delta CQI = 8$ . The variation of the  $\beta_c / \beta_d$  ratio causes a power reduction at sub-tests 2 - 4.

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c / \beta_d$	$\beta_{hs}$ (1)	CM(dB)(2)	MPR (dB)
1	2/15	15/15	64	2/15	4/15	0.0	0
2	12/15(3)	15/15(3)	64	12/15(3)	24/15	1.0	0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Note 1:  $\Delta ACK, \Delta NACK$  and  $\Delta CQI = 8$ .  $A_{hs} = \beta_{hs} / \beta_c = 30/15$ .  $\beta_{hs} = 30/15 * \beta_c$

Note 2: CM=1 for  $\beta_c / \beta_d = 12/15, \beta_{hs} / \beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 3: For subtest 2 the  $\beta_c / \beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$

Table 10: Sub-tests for UMTS Release 5 HSDPA

The measurements were performed with a Fixed Reference Channel (FRC) and H-Set 1 QPSK.

Parameter	Value
Nominal average inf. bit rate	534 kbit/s
Inter-TTI Distance	3 TTI's
Number of HARQ Processes	2 Processes
Information Bit Payload	3202 Bits
MAC-d PDU size	336 Bits
Number Code Blocks	1 Block
Binary Channel Bits Per TTI	4800 Bits
Total Available SMLs in UE	19200 SMLs
Number of SMLs per HARQ Process	9600 SMLs
Coding Rate	0.67
Number of Physical Channel Codes	5

Table 11: settings of required H-Set 1 QPSK acc. to 3GPP 34.121

HS-DSCH Category	Maximum HS-DSCH Codes Received	Minimum Inter-TTI Interval	Maximum HS-DSCH Transport Block Bits/HS-DSCH TTI	Total Soft Channel Bits
1	5	3	7298	19200
2	5	3	7298	28800
3	5	2	7298	28800
4	5	2	7298	38400
5	5	1	7298	57600
6	5	1	7298	67200
7	10	1	14411	115200
8	10	1	14411	134400
9	15	1	25251	172800
10	15	1	27952	172800
11	5	2	3630	14400
12	5	1	3630	28800
13	15	1	34800	259200
14	15	1	42196	259200
15	15	1	23370	345600
16	15	1	27952	345600

Table 12:HSDPA UE category

### 3) HSUPA

Body SAR is also measured for HSDPA when the maximum average outputs of each RF channel with HSDPA active is at ¼ dB higher than that measured without HSDPA using 12.2kbps RMC or the maximum SAR 12.2kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-set 1 and QPSK for FRC and 12.2kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.2 kbps RMC without HSPA.

Due to inner loop power control requirements in HSDPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSDPA should be configured according to the values indicated below as well as other applicable procedures described in the 'UMTS Handset' and 'Release 5 HSDPA Data Device' sections of 3G device.

Sub - test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs(1)}$	$\beta_{ec}$	$\beta_{ed}$	$\beta_{c(1)}$ (S F)	$\beta_{ed(1)}$ (code)	CM (dB)	MP R (dB)	AG (Index)	E-TFC I
1	11/15 <sup>(3)</sup>	15/15 <sup>(3)</sup>	64	11/15 <sup>(3)</sup>	22/15	209/25	1039/25	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed1}:47/15$ $\beta_{ed2}:47/15$	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 <sup>(4)</sup>	15/15 <sup>(4)</sup>	64	15/15 <sup>(4)</sup>	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta ACK, \Delta NACK$  and  $\Delta CQI = 8, A_{hs} = \beta_{hs}/\beta_c = 30/15, \beta_{hs} = 30/15 * \beta_c$

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15, \beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference

Note 3 : For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$

Note 4 : For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$

Note 5 : Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g

Note 6:  $\beta_{ed}$  can not be set directly; it is set by Absolute Grant Value.

Table 13:Subtests for UMTS Release 6 HSUPA

UE E-DCH Category	Maximum E-DCH Codes Transmitted	Number of HARQ Processes	E-DCH TTI(ms)	Minimum Spreading Factor	Maximum E-DCH Transport Block Bits	Max Rate (Mbps)
1	1	4	10	4	7110	0.7296
2	2	8	2	4	2798	1.4592
	2	4	10	4	14484	
3	2	4	10	4	14484	1.4592
4	2	8	2	2	5772	2.9185
	2	4	10	2	20000	2.00
5	2	4	10	2	20000	2.00
6 (No DPDCH)	4	8	10	2SF2&2SF	11484	5.76
	4	4	2	4	20000	2.00
7 (No DPDCH)	4	8	2	2SF2&2SF	22996	?
	4	4	10	4	20000	?

NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4. UE categories 1 to 6 support QPSK only. UE category 7 supports QPSK. (TS25.306-7.3.0).

Table 14:HSUPA UE category

The power reduction in mobile hotspot mode is as following:

Mode(s) of Operation	Reduction of maximum output power(dB)	
	UMTS Band IV	UMTS Band II
Reduced Maximum Output Power Setting (dBm)	22.7	22.7
Power Reduction Amount (dB)	1.5	1.5

Table 15: The power reduction in mobile hotspot mode.

### 6.3 WiFi Test Configuration

For the 802.11b/g /nSAR tests, a communication link is set up with the test mode software for WiFi mode test. The Absolute Radio Frequency Channel Number(ARFCN) is allocated to 1 ,6 and 11 respectively in the case of 2450 MHz.During the test,at the each test frequency channel, the EUT is operated at the RF continuous emission mode. Each channel should be tested at the lowest data rate.

802.11b/g/n operating modes are tested independently according to the service requirements in each frequency band. 802.11b/g/n modes are tested on channel 1, 6, 11; however,if output power reduction is necessary for channels 1 and/or 11 to meet restricted band requirements the highest output channel closest to each of these channels must be tested instead.

SAR is not required for 802.11g/n channels when the maximum average output power is less than 0.25dB higher than that measured on the corresponding 802.11b channels.

Mode	GHz	Channel	Turbo Channel	“Default Test Channels”			
				§15.247		UNII	
				802.11b	802.11g		
802.11 b/g	2.412	1 <sup>#</sup>		√	▽		
	2.437	6	6	√	▽		
	2.462	11 <sup>#</sup>		√	▽		

## 7 SAR Measurement Results

### 7.1 Conducted power measurements

For the measurements a Rohde & Schwarz Radio Communication Tester CMU 200 was used.

SAR drift measured at the same position in liquid before and after each SAR test as below 7.2 chapter.

Note: CMU200 measures GSM peak and average output power for active timeslots. For SAR the timebased average power is relevant. The difference in between depends on the duty cycle of the TDMA signal :

No. of timeslots	1	2	3	4
Duty Cycle	1:8	1:4	1:2.66	1:2
timebased avg. power compared to slotted avg. power	-9dB	-6dB	-4.25dB	-3dB

The signalling modes differ as follows:

mode	coding scheme	modulation
GPRS	CS1 to CS4	GMSK
EDGE	MCS1 to MCS4	GMSK
EDGE	MCS5 to MCS9	8PSK

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements.

### 7.1.1 Conducted power measurements GSM850

GSM850		Burst-Averaged output Power (dBm)			Division Factors	Frame-Averaged output Power (dBm)		
		128CH	190CH	251CH		128CH	190CH	251CH
GSM (CS)		32.68	32.88	32.61	-9	23.68	23.88	23.61
GPRS (GMSK)	1 Tx Slot	32.68	32.84	32.54	-9	23.68	23.84	23.54
	2 Tx Slot	29.86	29.67	29.68	-6	23.86	23.67	23.68
EDGE (GMSK)	1 Tx Slot	32.66	32.84	32.52	-9	23.66	23.84	23.52
	2 Tx Slot	29.85	29.67	29.62	-6	23.85	23.67	23.62
EDGE (8PSK)	1 Tx Slot	26.53	26.60	26.54	-9	17.53	17.60	17.54
	2 Tx Slot	26.38	26.41	26.46	-6	20.38	20.41	20.46

Table 16: Test results conducted power measurement GSM 850MHz

Note: 1. The conducted power of GSM850 is measured with RMS detector.

2. Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.

### 7.1.2 Conducted power measurements GSM1900

GSM1900		Burst-Averaged output Power (dBm)			Division Factors	Frame-Averaged output Power (dBm)		
		512CH	661CH	810CH		512CH	661CH	810CH
GSM (CS)		29.81	29.71	29.26	-9	20.81	20.71	20.26
GPRS (GMSK)	1 Tx Slot	29.85	29.67	29.28	-9	20.85	20.67	20.28
	2 Tx Slot	26.35	26.31	26.11	-6	20.35	20.31	20.11
EDGE (GMSK)	1 Tx Slot	29.80	29.58	29.24	-9	20.80	20.58	20.24
	2 Tx Slot	26.27	26.35	26.07	-6	20.27	20.35	20.07
EDGE (8PSK)	1 Tx Slot	25.52	25.55	25.40	-9	16.52	16.55	16.40
	2 Tx Slot	25.51	25.51	25.39	-6	19.51	19.51	19.39

Table 17: Test results conducted power measurement GSM 1900MHz

Note: 1. The conducted power of GSM1900 is measured with RMS detector.

2. Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.

### 7.1.3 Conducted power measurements UMTS Band V

UMTS Band V		Conducted Power (dBm)		
		4132CH	4182CH	4233CH
WCDMA	12.2kbps RMC	23.50	23.22	23.25
	64kbps RMC	23.44	23.16	23.20
	144kbps RMC	23.40	23.14	23.15
	384kbps RMC	23.37	23.09	23.11
HSDPA	Subtest 1	23.54	23.34	23.29
	Subtest 2	23.31	23.27	23.24
	Subtest 3	22.69	22.67	22.62
	Subtest 4	22.73	22.75	22.66
HSUPA	Subtest 1	23.06	23.27	23.27
	Subtest 2	21.76	21.60	21.66
	Subtest 3	22.95	23.17	22.14
	Subtest 4	21.76	21.47	21.54
	Subtest 5	22.89	23.11	23.11

Table 18: Test results conducted power measurement UMTS Band V

### 7.1.4 Conducted power measurements UMTS Band IV

UMTS Band IV		Conducted Power (dBm)		
		1312CH	1413CH	1513CH
WCDMA	12.2kbps RMC	23.06	23.05	22.83
	64kbps RMC	23.02	23.01	22.80
	144kbps RMC	22.98	22.98	22.76
	384kbps RMC	22.92	22.95	22.73
HSDPA	Subtest 1	23.34	23.21	22.98
	Subtest 2	23.25	23.20	22.71
	Subtest 3	22.31	22.51	22.10
	Subtest 4	22.42	22.48	21.90
HSUPA	Subtest 1	22.32	23.10	22.56
	Subtest 2	21.47	21.30	20.82
	Subtest 3	22.00	22.88	22.34
	Subtest 4	21.51	21.00	21.33
	Subtest 5	22.21	22.85	22.31

Table 19:Test results conducted power measurement UMTS Band IV (Hotspot disable)

UMTS Band IV		Conducted Power (dBm)		
		1312CH	1413CH	1513CH
WCDMA	12.2kbps RMC	21.62	21.57	21.35
	64kbps RMC	21.57	21.54	21.36
	144kbps RMC	21.54	21.51	21.28
	384kbps RMC	21.5	21.48	21.26
HSDPA	Subtest 1	21.89	21.78	21.52
	Subtest 2	21.85	21.74	21.27
	Subtest 3	20.88	21.05	20.66
	Subtest 4	20.95	21.02	20.47
HSUPA	Subtest 1	21.25	21.66	21.08
	Subtest 2	20.25	20.13	19.67
	Subtest 3	20.56	21.42	20.86
	Subtest 4	20.22	20.07	19.89
	Subtest 5	21.11	20.79	21.36

Table 20:Test results Hotspot conducted power measurement UMTS 1700MHz(Hotspot activated)

### 7.1.5 Conducted power measurements UMTS Band II

UMTS Band II		Conducted Power (dBm)		
		9262CH	9400CH	9538CH
WCDMA	12.2kbps RMC	22.82	22.87	22.53
	64kbps RMC	22.76	22.82	22.49
	144kbps RMC	22.73	22.81	22.45
	384kbps RMC	22.70	22.79	22.41
HSDPA	Subtest 1	22.66	23.08	22.67
	Subtest 2	22.56	22.89	22.26
	Subtest 3	21.94	22.34	21.82
	Subtest 4	22.25	22.43	21.85
HSUPA	Subtest 1	22.56	22.89	21.84
	Subtest 2	21.07	21.38	21.03
	Subtest 3	22.16	22.50	21.68
	Subtest 4	21.18	21.00	21.01
	Subtest 5	22.34	22.50	21.59

Table 21:Test results conducted power measurement UMTS Band II (Hotspot disable)

UMTS Band II		Conducted Power (dBm)		
		9262CH	9400CH	9538CH
WCDMA	12.2kbps RMC	21.36	21.38	21.07
	64kbps RMC	21.28	21.34	21.03
	144kbps RMC	21.26	21.36	20.98
	384kbps RMC	21.22	21.38	20.94
HSDPA	Subtest 1	21.53	21.61	21.27
	Subtest 2	21.42	21.5	21.31
	Subtest 3	20.69	20.92	20.78
	Subtest 4	20.78	20.97	20.76
HSUPA	Subtest 1	21.35	21.45	20.76
	Subtest 2	19.63	19.97	19.7
	Subtest 3	20.78	21.03	20.25
	Subtest 4	20.22	19.86	19.57
	Subtest 5	21.19	21.44	20.34

Table 22: Test results conducted power measurement UMTS Band II (Hotspot actived)

## 7.2 SAR measurement Result

### 7.2.1 SAR measurement Result of GSM850

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	190/836.6	GSM	0.226	0.171	0.150	32.88	21.4°C
Left Hand Tilted 15°			0.194	0.152	-0.140		21.4°C
Right Hand Touched			0.200	0.154	-0.040		21.4°C
Right Hand Tilted 15°			0.171	0.134	0.000		21.4°C
Tested data with The battery 2#							
Left Hand Touched	190/836.6	GSM	<b>0.235</b>	0.180	-0.190	32.88	21.4°C

Table 23: Test results head SAR GSM 850MHz

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	190/836.6	GPRS 1TS	0.267	0.205	-0.070	32.84	21.4°C
		GPRS 2TS	0.299	0.229	-0.190	29.67	21.4°C
Towards Ground	190/836.6	GPRS 2TS	0.534	0.399	-0.060	29.67	21.4°C
Towards Ground	190/836.6	EDGE 1TS	0.484	0.365	-0.040	32.84	21.4°C
		EDGE 2TS	0.527	0.394	-0.130	29.67	21.4°C
Towards Ground with Headset	190/836.6	GSM	0.304	0.227	-0.090	32.88	21.4°C
Tested data with The battery 2#							
Towards Ground	190/836.6	GPRS 2TS	<b>0.539</b>	0.404	-0.170	29.67	21.4°C

Table 24: Test results Body-Worn SAR GSM 850MHz

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	190/836.6	GPRS 1TS	0.293	0.228	-0.120	32.84	21.4°C
		GPRS 2TS	0.308	0.238	-0.010	29.67	21.4°C
Towards Ground	190/836.6	GPRS 2TS	0.705	0.529	0.020	29.67	21.4°C
Left edge			0.539	0.378	-0.070		21.4°C
Right edge			0.365	0.254	-0.010		21.4°C
Bottom edge			0.083	0.054	-0.030		21.4°C
Towards Ground	190/836.6	EDGE 1TS	0.650	0.492	0.040	32.84	21.4°C
		EDGE 2TS	0.704	0.527	-0.150	29.67	21.4°C
Tested data with The battery 2#							
Towards Ground	190/836.6	GPRS 2TS	<b>0.716</b>	0.536	-0.180	29.67	21.4°C

Table 25: Test results Hotspot SAR GSM 850MHz

**7.2.2 SAR measurement Result of GSM1900**

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	661/1880	GSM	0.107	0.069	-0.010	29.71	21.4°C
Left Hand Tilted 15°			0.094	0.052	0.190		21.4°C
Right Hand Touched			<b>0.189</b>	0.116	0.160		21.4°C
Right Hand Tilted 15°			0.064	0.035	-0.140		21.4°C
Tested data with The battery 2#							
Right Hand Touched	661/1880	GSM	0.169	0.105	0.180	29.71	21.4°C

Table 26:Test results head SAR GSM 1900MHz

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	661/1880	GPRS 1TS	0.129	0.078	-0.110	29.67	21.4°C
		GPRS 2TS	0.109	0.066	-0.170	26.31	21.4°C
Towards Ground	661/1880	GPRS 1TS	0.401	0.223	0.050	29.67	21.4°C
Towards Ground	661/1880	EDGE 1TS	0.437	0.246	0.050	29.58	21.4°C
		EDGE 2TS	0.386	0.215	-0.030	26.35	21.4°C
Towards Ground with Headset	661/1880	GSM	0.440	0.247	-0.110	29.71	21.4°C
Tested data with The battery 2#							
Towards Ground with Headset	661/1880	GSM	<b>0.457</b>	0.258	0.060	29.71	21.4°C

Table 27:Test results Body-Worn SAR GSM 1900MHz

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	661/1880	GPRS 1TS	0.197	0.112	0.050	29.67	21.4°C
		GPRS 2TS	0.167	0.095	0.020	26.31	21.4°C
Towards Ground	661/1880	GPRS 1TS	0.745	0.388	0.050	29.67	21.4°C
Left edge			0.100	0.057	0.170		21.4°C
Right edge			0.114	0.066	0.120		21.4°C
Bottom edge			0.632	0.331	0.140		21.4°C
Towards Ground	661/1880	EDGE 1TS	<b>0.802</b>	0.423	-0.020	29.58	21.4°C
		EDGE 2TS	0.725	0.377	-0.070	26.35	21.4°C
Tested data with The battery 2#							
Towards Ground	661/1880	EDGE 1TS	0.780	0.414	-0.030	29.58	21.4°C

Table 28:Test results Hotspot SAR GSM 1900MHz

Note: 1) The maximum SAR value of each test band is shown in **bold** letters.

2) Per KDB447498 D01,the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit (< 0.8 W/kg), testing at the high and low channels is optional.

3) Per KDB941225 D06,for the antenna-to-edge distance is greater than 2.5 cm,so the top side does not need to be tested.

**7.2.3 SAR measurement Result of UMTS Band V**

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	4182/836.4	RMC	<b>0.160</b>	0.121	0.180	23.22	21.4°C
Left Hand Tilted 15°			0.131	0.101	-0.050		21.4°C
Right Hand Touched			0.146	0.112	-0.060		21.4°C
Right Hand Tilted 15°			0.120	0.094	-0.030		21.4°C
Tested data with The battery 2#							
Left Hand Touched	4182/836.4	RMC	0.157	0.118	-0.140	23.22	21.4°C

Table 29:Test results head SAR UMTS Band V

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	4182/836.4	RMC	0.233	0.177	-0.030	23.22	21.4°C
Towards Ground			<b>0.401</b>	0.298	0.020		21.4°C
Towards Ground with Headset			0.365	0.216	0.060		21.4°C
Tested data with The battery 2#							
Towards Ground	4182/836.4	RMC	0.400	0.297	0.000	23.22	21.4°C

Table 30:Test results Body-Worn SAR UMTS Band V

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	4182/836.4	RMC	0.239	0.183	0.030	23.22	21.4°C
Towards Ground			<b>0.546</b>	0.405	0.000		21.4°C
Left edge			0.434	0.301	-0.010		21.4°C
Right edge			0.282	0.195	-0.070		21.4°C
Bottom edge			0.066	0.043	0.160		21.4°C
Tested data with The battery 2#							
Towards Ground	4182/836.4	RMC	0.542	0.403	-0.01	23.22	21.4°C

Table 31:Test results Hotspot SAR UMTS Band V

Note: 1) The maximum SAR value of each test band is shown in **bold** letters.

2) Per KDB447498 D01,the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit (< 0.8 W/kg), testing at the high and low channels is optional.

3) Per KDB941225 D06,for the antenna-to-edge distance is greater than 2.5 cm,so the top side does not need to be tested.

4) Per KDB941225 D01,Body SAR is not required for handset with HSPA when the maximum average output power of HSPA active is less than 0.25dBm higher than that measured without HSPA using 12.2kbps RMC and maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit.

### 7.2.4 SAR measurement Result of UMTS Band IV

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	1413/1732.6	RMC	0.106	0.064	-0.130	23.05	21.4°C
Left Hand Tilted 15°			0.131	0.078	0.020		21.4°C
Right Hand Touched			0.260	0.157	0.060		21.4°C
Right Hand Tilted 15°			0.196	0.112	-0.030		21.4°C
Tested data with The battery 2#							
Right Hand Touched	1413/1732.6	RMC	<b>0.282</b>	0.167	0.100	23.05	21.4°C

Table 32: Test results head SAR UMTS Band IV

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	1413/1732.6	RMC	0.171	0.106	0.120	23.05	21.4°C
Towards Ground			0.618	0.357	-0.120		21.4°C
Towards Ground with Headset			0.655	0.378	-0.050		21.4°C
Tested data with The battery 2#							
Towards Ground with Headset	1413/1732.6	RMC	<b>0.669</b>	0.384	-0.080	23.05	21.4°C

Table 33: Test results Body-Worn SAR UMTS Band IV

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	1413/1732.6	RMC	0.221	0.128	0.190	21.57	21.4°C
Towards Ground	1513/1752.6	RMC	0.853	0.454	0.050	21.35	21.4°C
	1413/1732.6		0.831	0.442	-0.050	21.57	21.4°C
	1312/1712.4		0.919	0.492	0.050	21.62	21.4°C
Left edge	1413/1732.6	RMC	0.146	0.080	0.110	21.57	21.4°C
Right edge			0.097	0.057	-0.090		21.4°C
Bottom edge			0.772	0.413	-0.020		21.4°C
Tested data with The battery 2#							
Towards Ground	1312/1712.4	RMC	<b>0.944</b>	0.501	0.000	21.57	21.4°C
Test Worst position with hotspot mode closed							
Towards Ground	1312/1712.4	RMC	1.270	0.678	0.070	23.06	21.4°C

Table 34: Test results Hotspot SAR UMTS Band IV

Note: 1) The maximum SAR value of each test band is shown in **bold** letters.

2) Per KDB447498 D01, the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit (< 0.8 W/kg), testing at the high and low channels is optional.

3) Per KDB941225 D06, for the antenna-to-edge distance is greater than 2.5 cm, so the top side does not need to be tested.

4) Per KDB941225 D01, Body SAR is not required for handset with HSPA when the maximum average output power of HSPA active is less than 0.25dBm higher than that measured without HSPA using 12.2kbps RMC and maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit.

5) The value test with hotspot mode closed is provided solely for purposes of confirming compliant power reduction operation and do not represent maximum SAR values of the product.

**7.2.5 SAR measurement Result of UMTS Band II**

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	9400/1880	RMC	0.205	0.133	0.020	22.87	21.4°C
Left Hand Tilted 15°			0.197	0.112	-0.020		21.4°C
Right Hand Touched			0.362	0.222	0.140		21.4°C
Right Hand Tilted 15°			0.143	0.080	-0.130		21.4°C
Tested data with The battery 2#							
Right Hand Touched	9400/1880	RMC	<b>0.367</b>	0.224	0.100	22.87	21.4°C

Table 35:Test results Head SAR UMTS Band II

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	9400/1880	RMC	0.252	0.154	-0.130	22.87	21.4°C
Towards Ground	9262/1852.4	RMC	0.803	0.449	0.040	22.82	21.4°C
	9400/1880		0.813	0.452	-0.010	22.87	21.4°C
	9538/1907.6		0.800	0.442	0.160	22.53	21.4°C
Towards Ground with Headset	9400/1880	RMC	<b>0.861</b>	0.473	-0.040	22.87	21.4°C
Tested data with The battery 2#							
Towards Ground with Headset	9400/1880	RMC	0.802	0.447	0.060	22.87	21.4°C

Table 36:Test results Body-Worn SAR UMTS Band II

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	9400/1880	RMC	0.245	0.138	0.070	21.38	21.4°C
Towards Ground	9538/1907.6	RMC	1.060	0.547	-0.020	21.07	21.4°C
	9400/1880		1.070	0.553	-0.110	21.38	21.4°C
	9262/1852.4		1.030	0.539	-0.070	21.36	21.4°C
			0.137	0.078	0.100	21.38	21.4°C
Right edge	9400/1880	RMC	0.128	0.075	0.110	21.38	21.4°C
Bottom edge	9538/1907.6	RMC	0.933	0.487	0.190	21.07	21.4°C
	9400/1880		1.000	0.527	0.150	21.38	21.4°C
	9262/1852.4		0.973	0.513	0.130	21.36	21.4°C
Tested data with The battery 2#							
Towards Ground	9400/1880	RMC	<b>1.130</b>	0.583	-0.100	21.38	21.4°C
Test Worst position with hotspot mode closed							
Towards Ground	9400/1880	RMC	1.490	0.774	0.000	22.87	21.4°C

Table 37:Test results Hotspot SAR UMTS Band II

Note: 1) The maximum SAR value of each test band is shown in **bold** letters.

2) Per KDB447498 D01,the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit (< 0.8 W/kg), testing at the high and low channels is optional.

3) Per KDB941225 D06,for the antenna-to-edge distance is greater than 2.5 cm,so the top side does not need to be tested.

4) Per KDB941225 D01, Body SAR is not required for handset with HSPA when the maximum average output power of HSPA active is less than 0.25dBm higher than that measured without HSPA using 12.2kbps RMC and maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of the SAR limit.

5) The value test with hotspot mode closed is provided solely for purposes of confirming compliant power reduction operation and do not represent maximum SAR values of the product.

### 7.2.6 SAR measurement Result of WiFi

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Left Hand Touched	6/2437	802.11 b	0.019	0.008	0.040	14.76	21.4°C
Left Hand Tilted 15°			0.014	0.006	0.000		21.4°C
Right Hand Touched			0.016	0.006	-0.060		21.4°C
Right Hand Tilted 15°			0.013	0.005	0.000		21.4°C
Tested data with The battery 2#							
Left Hand Touched	6/2437	802.11 b	<b>0.021</b>	0.009	-0.190	14.76	21.4°C

Table 38: Test results head SAR WiFi 2450 MHz

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	6/2437	802.11 b	0.014	0.006	-0.040	14.76	21.4°C
Towards Ground			<b>0.022</b>	0.010	-0.130		21.4°C
Tested data with The battery 2#							
Towards Ground	6/2437	802.11 b	0.014	0.007	-0.120	14.76	21.4°C

Table 39: Test results Body-Worn SAR WiFi 2450 MHz

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	6/2437	802.11 b	0.028	0.012	0.180	14.76	21.4°C
Towards Ground			<b>0.044</b>	0.021	-0.010		21.4°C
Left edge			0.036	0.017	-0.070		21.4°C
Tested data with The battery 2#							
Towards Ground	6/2437	802.11 b	0.033	0.015	-0.100	14.76	21.4°C

Table 40: Test results Hotspot SAR WiFi 2450 MHz

Note: 1) The maximum SAR value of each test band is shown in **bold** letters.

2) Per KDB447498 D01, the SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit ( $< 0.8$  W/kg), testing at the high and low channels is optional.

3) Per KDB941225 D06, for the antenna-to-edge distance is greater than 2.5 cm, so the Bottom, Top and Right sides do not need to be tested.

### 7.3 Multiple Transmitter Evaluation

These procedures were followed according to FCC "KDB648474 D01 SAR Handsets Multi Xmitter and Ant, v01r05", Sept 2008. The procedures are applicable to phones with built-in unlicensed transmitters, such as 802.11 a/b/g and Bluetooth devices.

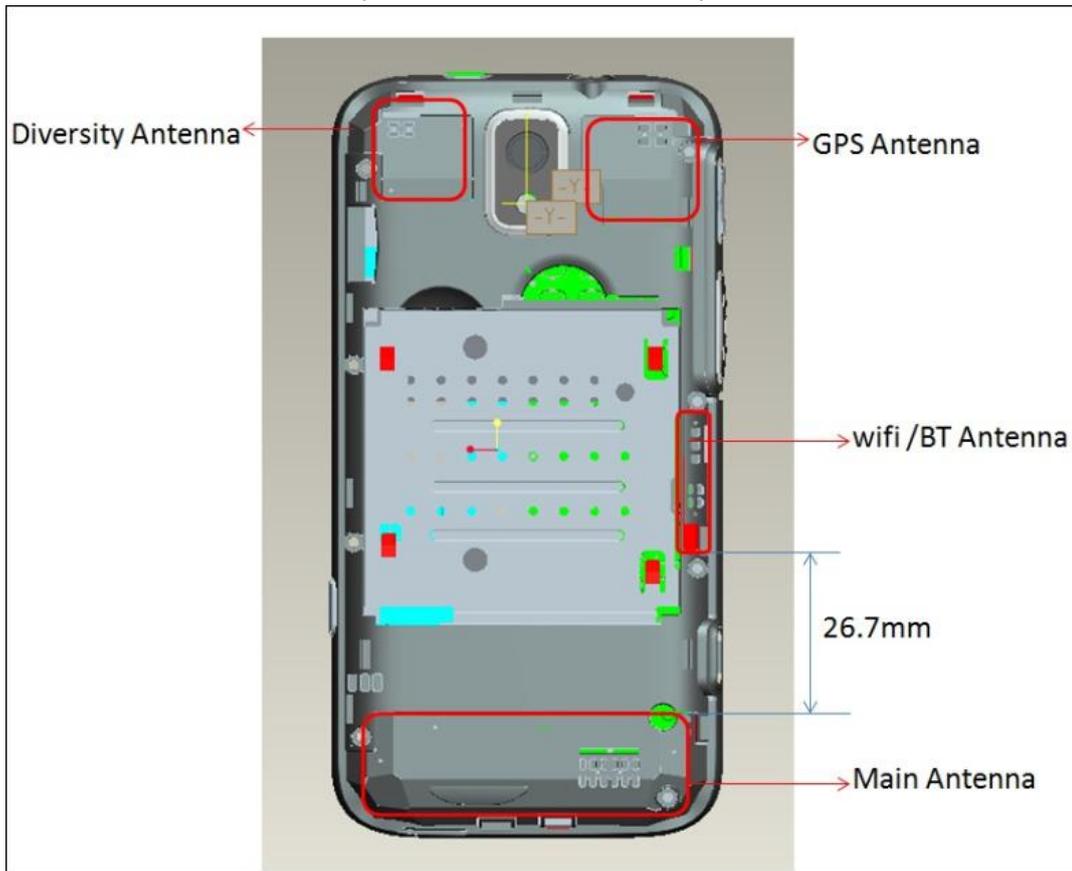
	2.45	5.15 - 5.35	5.47 - 5.85	GHz
$P_{Ref}$	12	6	5	mW
Device output power should be rounded to the nearest mW to compare with values specified in this table.				

Table 41: Output Power Thresholds for Unlicensed Transmitters

	Individual Transmitter	Simultaneous Transmission
<b>Licensed Transmitters</b>	<u>Routine evaluation required</u>	<b>SAR not required:</b>
<b>Unlicensed Transmitters</b>	<p><b>When there is no simultaneous transmission –</b></p> <ul style="list-style-type: none"> <li>○ output <math>\leq 60/f</math>: SAR not required</li> <li>○ output <math>&gt; 60/f</math>: stand-alone SAR required</li> </ul> <p><b>When there is simultaneous transmission –</b></p> <p><u>Stand-alone SAR not required when</u></p> <ul style="list-style-type: none"> <li>○ output <math>\leq 2 \cdot P_{Ref}</math> and antenna is <math>\geq 5.0</math> cm from other antennas</li> <li>○ output <math>\leq P_{Ref}</math> and antenna is <math>\geq 2.5</math> cm from other antennas</li> <li>○ output <math>\leq P_{Ref}</math> and antenna is <math>&lt; 2.5</math> cm from other antennas, each with either output power <math>\leq P_{Ref}</math> or 1-g SAR <math>&lt; 1.2</math> W/kg</li> </ul> <p><u>Otherwise stand-alone SAR is required</u></p> <p><b>When stand-alone SAR is required</b></p> <ul style="list-style-type: none"> <li>○ test SAR on highest output channel for each wireless mode and exposure condition</li> <li>○ if SAR for highest output channel is <math>&gt; 50\%</math> of SAR limit, evaluate all channels according to normal procedures</li> </ul>	<p><u>Unlicensed only</u></p> <ul style="list-style-type: none"> <li>○ when stand-alone 1-g SAR is not required and antenna is <math>\geq 5</math> cm from other antennas</li> </ul> <p><u>Licensed &amp; Unlicensed</u></p> <ul style="list-style-type: none"> <li>○ when the sum of the 1-g SAR is <math>&lt; 1.6</math> W/kg for all simultaneous transmitting antennas</li> <li>○ when SAR to peak location separation ratio of simultaneous transmitting antenna pair is <math>&lt; 0.3</math></li> </ul> <p><b>SAR required:</b></p> <p><u>Licensed &amp; Unlicensed</u></p> <p>antenna pairs with SAR to peak location separation ratio <math>\geq 0.3</math>; test is only required for the configuration that results in the highest SAR in stand-alone configuration for each wireless mode and exposure condition</p> <p><b>Note: simultaneous transmission exposure conditions for head and body can be different for different style phones; therefore, different test requirements may apply</b></p>

Table 42: Summary of SAR Evaluation Requirements for a Cell Phone with Multiple Transmitters

The closest distance between BT/WiFi antenna and main antenna is  $5.0\text{cm} \geq 2.67\text{cm} \geq 2.5\text{cm}$ , and the location of the antennas inside mobile phone is shown as below picture:



The output power of BT antenna is as following:

BT 2450MHz	Average Conducted Power (dBm)		
	0CH	39CH	78CH
	6.41	7.16	6.55

Table 43:Test results conducted power measurement BT.

The output power of WiFi antenna is as following:

Wi-Fi 2450MHz	Channel	Average Power (dBm) for Data Rates (Mbps)							
		1	2	5.5	11	/	/	/	/
802.11b	1	14.51	14.38	14.58	14.60	/	/	/	/
	6	<b>14.76</b>	14.65	14.74	14.75	/	/	/	/
	11	14.63	14.58	14.59	14.62	/	/	/	/
802.11g	Channel	6	9	12	18	24	36	48	54
	1	12.65	12.61	12.58	12.67	12.69	12.73	12.56	12.61
	6	12.83	12.82	12.88	12.95	12.88	12.96	12.98	12.95
	11	12.96	12.99	13.03	13.02	13.04	13.06	12.46	12.37
802.11n HT20	Channel	6.5	13	19.5	26	39	52	58.5	65
	1	8.08	8.17	8.14	8.18	8.21	8.26	8.28	8.38
	6	7.95	7.98	7.96	8.04	7.96	7.98	7.99	8.15
	11	7.56	7.55	7.52	7.55	7.58	7.57	7.62	7.73

Table 44:Test results conducted power measurement WiFi .

Note: Per KDB248227, For each frequency band, Testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate.

### 7.3.1 Stand-alone SAR

According to the output power measurement results and the distance between BT/WiFi antenna and main antenna we can draw the conclusion that:

Stand-alone SAR evaluation is required for WiFi, because the output power of WiFi unlicensed transmitter is  $16.03\text{Bm} \geq 12\text{mW}$  (10.8dBm), and its antenna(s) is  $5.0\text{cm} \geq 2.67\text{cm} \geq 2.55\text{cm}$  from main antenna.

Stand-alone SAR evaluation is not required for BT, because the Max output power of BT unlicensed transmitter is  $7.16\text{dBm} < 12\text{mW}$  (10.8dBm), and its antenna(s) is  $5.0\text{cm} \geq 2.67\text{cm} \geq 2.55\text{cm}$  from main antenna.

### 7.3.2 Simultaneous Transmission Possibilities

Simultaneous Transmission Possibilities				
Simultaneous Tx Combination	Configuration	Head	Body-Worn	Hotspot
1	GSM Voice	Yes	Yes	No
2	GPRS/EGPRS	No	Yes	No
3	UMTS Voice	Yes	Yes	No
4	UMTS DATA	No	Yes	No
5	WLAN VoIP	Yes	Yes	No
6	WLAN Data	Yes	Yes	No
7	BT Data	No	Yes	No
8	GSM Voice + BT	No	Yes	No
9	GPRS/EGPRS + BT	No	Yes	No
10	GSM Voice + WLAN	Yes	Yes	No
11	GPRS/EGPRS + WLAN	No	Yes	Yes
12	UMTS Voice + WLAN	Yes	Yes	No
13	UMTS Data + WLAN	No	Yes	Yes
14	UMTS Voice + BT	Yes	Yes	No
15	UMTS Data + BT	No	Yes	No

Table 45: Simultaneous Transmission Possibilities

Note:

- 1) This mode doesn't support simultaneous voice and data with GSM and GPRS/EDGE .
- 2) This mode doesn't support simultaneous BT and WiFi, because they share the same antenna.

### 7.3.3 SAR Summation Scenario

Test Position	GSM&UMTS SAR <sub>Max</sub>					WiFi SAR <sub>Max</sub>	Σ1-g SARmax
	GSM850	GSM1900	Band V	Band IV	Band II		
<b>Head SAR (W/kg)</b>							
Left Hand Touched	<b>0.235</b>	0.107	0.160	0.106	0.205	0.021	0.256
Left Hand Tilted 15°	0.194	0.094	0.131	0.131	<b>0.197</b>	0.014	0.213
Right Hand Touched	0.200	0.189	0.146	0.282	<b>0.367</b>	0.016	0.383
Right Hand Tilted 15°	0.171	0.064	0.120	<b>0.196</b>	0.143	0.013	0.209
<b>Body-Worn SAR (W/kg)</b>							
Towards Phantom	<b>0.299</b>	0.129	0.233	0.171	0.252	0.014	0.313
Towards Ground	0.539	0.457	0.401	0.669	<b>0.861</b>	0.022	0.883
<b>Hotspot SAR (W/kg)</b>							
Towards Phantom	<b>0.308</b>	0.197	0.239	0.221	0.245	0.028	0.336
Towards Ground	0.716	0.802	0.546	0.944	<b>1.130</b>	0.044	<b>1.174</b>
Left edge	<b>0.539</b>	0.100	0.434	0.146	0.137	0.036	0.575
Right edge	<b>0.365</b>	0.114	0.282	0.097	0.128	0.000	0.365
Top edge	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bottom edge	0.083	0.632	0.066	0.772	<b>1.000</b>	0.000	1.000

Table 46: Simultaneous Tx Combination

**Appendix A. System Check Plots**  
(Pls See Appendix A.)

**Appendix B. SAR Measurement Plots**  
(Pls See Appendix B.)

**Appendix C. Calibration Certificate**  
(Pls See Appendix C.)

**Appendix D. Photo documentation**  
(Pls See Appendix D.)

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**End**