



FCC SAR Compliance Test Report

Project Name: cdma2000 Digital Mobile Phone; Asura

Model : HUAWEI M881, M881

FCC ID : QISM881

Report No. : SYBH(Z-SAR)037012013-2

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DATE	2013-04-25	2013-04-25	2013-04-25

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Table of Contents

1	General Information	4
1.1	Statement of Compliance	4
1.2	RF exposure limits	4
1.3	EUT Description	5
1.3.1	General Description	6
1.4	Test specification(s)	7
1.5	Testing laboratory	7
1.6	Applicant and Manufacturer	7
1.7	Application details	7
1.8	Ambient Condition	7
2	SAR Measurement System	8
2.1	SAR Measurement Set-up	8
2.2	Test environment	9
2.3	Data Acquisition Electronics description	9
2.4	Probe description	10
2.5	Phantom description	11
2.6	Device holder description	11
2.7	Test Equipment List	12
3	SAR Measurement Procedure	13
3.1	Scanning procedure	13
3.2	Spatial Peak SAR Evaluation	14
3.3	Data Storage and Evaluation	15
4	System Verification Procedure	17
4.1	Tissue Verification	17
4.2	System Check	19
4.3	System check Procedure	20
5	Measurement Uncertainty Evaluation	21
5.1	Measurement uncertainty evaluation for SAR test	21
5.2	Measurement uncertainty evaluation for system check	22
6	SAR Test Configuration	23
6.1	CDMA Test Configuration	23
6.1.1	CDMA 1x Devices	23
6.1.2	CDMA EV-DO Devices	24
6.2	WiFi Test Configuration	24
7	SAR Measurement Results	25
7.1	Conducted power measurements	25
7.1.1	Conducted power measurements CDMA BC0	25
7.1.2	Conducted power measurements CDMA BC1	25
7.1.3	Conducted power measurements BT	26
7.1.4	Conducted power measurements WiFi	26
7.2	SAR measurement Result	27
7.2.1	SAR measurement Result of CDMA BC0	27
7.2.2	SAR measurement Result of CDMA BC1	29
7.2.3	SAR measurement Result of WiFi	31
7.3	Multiple Transmitter Evaluation	32
7.3.1	Stand-alone SAR test exclusion	33
7.3.2	Simultaneous Transmission Possibilities	34
7.3.3	SAR Summation Scenario	34
	Appendix A. System Check Plots	37
	Appendix B. SAR Measurement Plots	37
	Appendix C. Calibration Certificate	37
	Appendix D. Photo documentation	37

※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2013-04-19	GongZhong
Rev.1.1	Correct the calibration data of dipole D1900V2 the target SAR on Page19,Table 6	2013-04-25	GongZhong

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI M881, M881 are as below Table 1.

Band	Position*	MAX Reported SAR _{1g} (W/kg)
CDMA BC0	Head	0.619
	Body Worn(15mm)	0.740
	Hotspot(10mm)	0.937
CDMA BC1	Head	0.995
	Body Worn(15mm)	0.649
	Hotspot(10mm)	0.892
WiFi	Head	0.134
	Body Worn(15mm)	0.076
	Hotspot(10mm)	0.154
The highest simultaneous SAR is 1.161W/kg per KDB690783 D01		

Table 1:Summary of test result

Note: *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 that positions the handset a minimum of 15 mm from the body. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

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 C95.1:1992, the NCRP Report Number 86 for uncontrolled environment, according to 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
Spatial Peak SAR* (Brain/Body/Arms/Legs)	1.60 mW/g	8.00 mW/g
Spatial Average SAR** (Whole Body)	0.08 mW/g	0.40 mW/g
Spatial Peak SAR*** (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:	cdma2000 Digital Mobile Phone; Asura		
Type Identification:	HUAWEI M881, M881		
FCC ID:	QISM881		
SN No.:	P9L01A92C1400539		
Device Type :	portable device		
Device Phase:	Identical Prototype		
Sample Dimension:	117mm×62mm×12.4mm		
Exposure Category:	uncontrolled environment / general population		
Hardware Version :	HC1C886M		
Software Version :	M881 V100R001C378B943		
Antenna Type :	internal antenna		
Others Accessories	Headset		
Device Operating Configurations:			
Supporting Mode(s)	CDMA BC0/BC1, WiFi (tested);		
Test Modulation	QPSK		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	CDMA BC0	824-849	869-894
	CDMA BC1	1850-1910	1930-1990
	WiFi	2412-2462	2412-2462
	Bluetooth	2402-2480	2402-2480
Power Class:	Tested with power control all up (CDMA BC0)		
	Tested with power control all up (CDMA BC1)		
Test Channels (low-mid-high):	1013-384-777 (CDMA BC0)		
	25-600-1175 (CDMA BC1)		
	1-6-11 (WiFi 2450)		

Table 3:Device information and operating configuration

1.3.1 General Description

cdma2000 Digital Mobile Phone- HUAWEI M881, M881 is subscriber equipment in the CDMA/EVDO system. The frequency band is US Cellular and N. American PCS, Their band test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, CDMA2000 1x and 1xEV-DO protocol processing, voice, MMS service, GPS, AGPS and WIFI etc. Externally it provides micro SD card interface, earphone port (to provide voice service). 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.

Battery

Name	Manufacture	Serials number	Description
Rechargeable Li-ion	Huawei Technologies Co., Ltd.	1#: MPCCA25919100599 2#: MAICB01X19102161	Battery Model: HB4W1H Rated capacity: 1750mAh Nominal Voltage:  +3.7V Charging Voltage:  +4.2V

1.4 Test specification(s)

ANSI Std C95.1-1992	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991)
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 Edition 01-01– 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
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 D06	Hot Spot SAR v01
KDB248227 D01	SAR meas for 802.11 a/b/g v01r02
KDB447498 D01	General RF Exposure Guidance v05
KDB648474 D04	SAR Handsets Multi Xmitter and Ant v01
KDB865664 D01	SAR measurement 100 MHz to 6 GHz v01
KDB865664 D02	SAR Reporting v01
KDB450824 D01	SAR Probe Calibration and System Verification v01
KDB450824 D02	Dipole SAR Validation Verification 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 TESTING 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

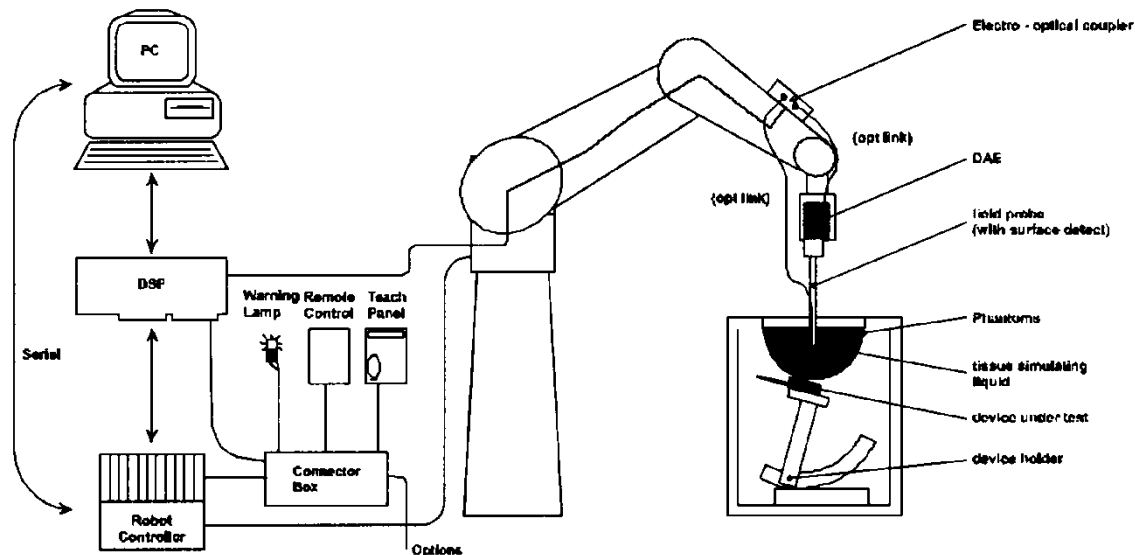
Start Date of test	2013-01-30
End Date of test	2013-02-01

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 check 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 m³, 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 m² 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.

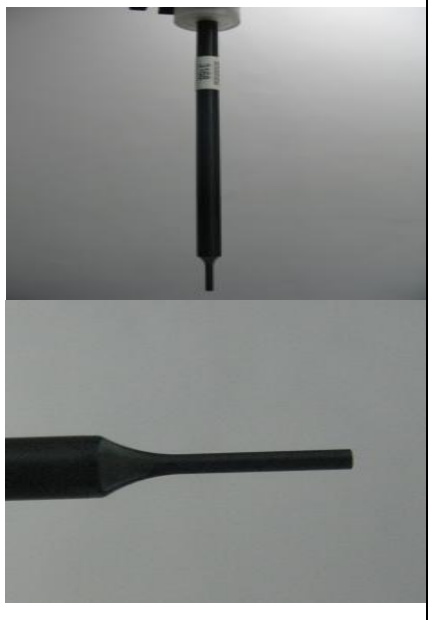
DAE4

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

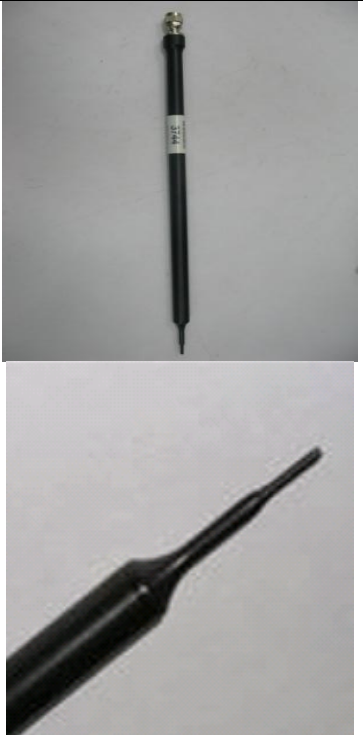
2.4 Probe description

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 (± 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: ± 0.2 dB (30 MHz to 4 GHz)	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)	
Dynamic range	5 μ W/g to > 100 mW/g; Linearity: ± 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 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; Linearity: ± 0.2 dB (30 MHz to 6 GHz)	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic range	10 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB(noise:typically<1 μ W/g)	
Dimensions	Overall length: 337 mm (Tip:20 mm) Tip diameter:2.5 mm (Body:12 mm) 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%	

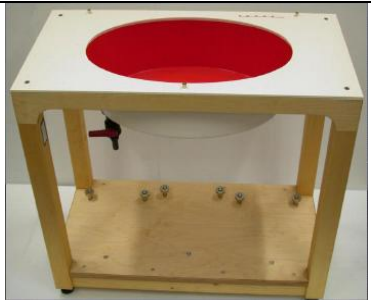
2.5 Phantom description

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)*	Valid period
☐	SPEAG	Dosimetric E-Field Probe	EX3DV4	3736	2012-04-26	One year
☐	SPEAG	Dosimetric E-Field Probe	EX3DV4	3744	2012-07-27	One year
☒	SPEAG	Dosimetric E-Field Probe	ES3DV3	3168	2012-10-02	One year
☒	SPEAG	835 MHz Dipole	D835V2	4d126	2011-11-07	Three years
☐	SPEAG	1800 MHz Dipole	D1800V2	2d184	2011-03-08	Three years
☒	SPEAG	1900 MHz Dipole	D1900V2	5d143	2011-09-26	Three years
☐	SPEAG	2000 MHz Dipole	D2000V2	1052	2011-03-10	Three years
☐	SPEAG	2300 MHz Dipole	D2300V2	1016	2011-11-22	Three years
☒	SPEAG	2450 MHz Dipole	D2450V2	860	2011-03-08	Three years
☐	SPEAG	2600 MHz Dipole	D2600V2	1021	2011-11-22	Three years
☐	SPEAG	Data acquisition electronics	DAE4	852	2012-11-22	One year
☒	SPEAG	Data acquisition electronics	DAE4	851	2012-07-25	One year
☒	SPEAG	Software	DASY 5	N/A	N/A	N/A
☐	SPEAG	Twin Phantom	SAM1	TP-1475	N/A	N/A
☐	SPEAG	Twin Phantom	SAM2	TP-1474	N/A	N/A
☒	SPEAG	Twin Phantom	SAM3	TP-1597	N/A	N/A
☒	SPEAG	Twin Phantom	SAM4	TP-1620	N/A	N/A
☐	SPEAG	Flat Phantom	ELI 4.0	TP-1038	N/A	N/A
☐	SPEAG	Flat Phantom	ELI 4.0	TP-1111	N/A	N/A
☒	R & S	Universal Radio Communication Tester	CMU 200	113989	2012-06-07	One year
☒	Agilent)*	Network Analyser	E5071B	MY42404956	2012-02-14	One year
☒	Agilent	Dielectric Probe Kit	85070E	2484	N/A	N/A
☒	Agilent	Signal Generator	N5181A	MY47420989	2012-02-14	One year
☒	MINI-CIRCUITS	Amplifier	ZHL-42W	QA0746001	N/A	N/A
☒	Agilent	Power Meter	E4417A	MY45101339	2012-02-14	One year
☒	Agilent	Power Meter Sensor	E9321A	MY44420359	2012-02-14	One year

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.

- There is no physical damage on the dipole;
- System check with specific dipole is within 10% of calibrated value;
- Return-loss is within 10% of calibrated measurement;
- Impedance is within 5Ω 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 system check. 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 ($\leq 2\text{GHz}$), 12 mm in x- and y- dimension (2-4 GHz) and 10mm in x- and y- dimension (4-6GHz). 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 “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution: $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}} \leq 4\text{GHz} - \leq 5\text{ mm}$ and $4-6\text{ GHz} - \leq 4\text{ mm}$; $\Delta z_{\text{zoom}} \leq 3\text{GHz} - \leq 5\text{ mm}$, $3-4\text{ GHz} - \leq 4\text{ mm}$ and $4-6\text{GHz} - \leq 2\text{mm}$ where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY 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 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm 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 $7 \times 7 \times 7$ 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 ($20 \times 20 \times 20$) 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 _i , a _{i0} , a _{i1} , a _{i2}
	- Conversion factor	ConvF _i
	- 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)
 $[mV/(V/m)^2]$ 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
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm³

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/cm²
 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	1800	1900	2450	2600
Water	38.56	41.45	52.64	55.242	62.7	55.242
Salt (NaCl)	3.95	1.45	0.36	0.306	0.5	0.306
Sugar	56.32	56.0	0.0	0.0	0.0	0.0
HEC	0.98	1.0	0.0	0.0	0.0	0.0
Bactericide	0.19	0.1	0.0	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	47.0	44.542	36.8	44.452
Ingredients (% of weight)	Body Tissue					
Frequency Band (MHz)	450	835	1800	1900	2450	2600
Water	51.16	52.4	69.91	69.91	73.2	64.493
Salt (NaCl)	1.49	1.40	0.13	0.13	0.04	0.024
Sugar	46.78	45.0	0.0	0.0	0.0	0.0
HEC	0.52	1.0	0.0	0.0	0.0	0.0
Bactericide	0.05	0.1	0.0	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	29.96	29.96	26.7	32.252

Table 4: Tissue Dielectric Properties

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16M Ω + 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
		ϵ_r (+/-5%)	σ (S/m) (+/-5%)	ϵ_r	σ (S/m)		
835H	825	41.60 (39.52~43.68)	0.90 (0.86~0.95)	40.87	0.871	21.4°C	2013-01-31
	835	41.50 (39.43~43.58)	0.90 (0.86~0.95)	40.73	0.883		
	850	41.50 (39.43~43.58)	0.92 (0.87~0.96)	40.41	0.888		
835B	825	55.20 (52.44~57.96)	0.97 (0.92~1.02)	56.82	0.990	21.4°C	2013-01-31
	835	55.20 (52.44~57.96)	0.97 (0.92~1.02)	56.70	0.986		
	850	55.20 (52.44~57.96)	0.99 (0.94~1.04)	56.49	1.011		
1900H	1850	40.0 (38.00~42.00)	1.40 (1.33~1.47)	40.25	1.403	21.4°C	2013-01-30
	1880	40.0 (38.00~42.00)	1.40 (1.33~1.47)	40.18	1.433		
	1900	40.0 (38.00~42.00)	1.40 (1.33~1.47)	40.13	1.453		
	1910	40.0 (38.00~42.00)	1.40 (1.33~1.47)	40.11	1.464		

1900B	1850	53.3 (50.64~55.97)	1.52 (1.44~1.60)	51.13	1.492	21.4°C	2013-01-30
	1880	53.3 (50.64~55.97)	1.52 (1.44~1.60)	51.02	1.527		
	1900	53.3 (50.64~55.97)	1.52 (1.44~1.60)	51.05	1.539		
	1910	53.3 (50.64~55.97)	1.52 (1.44~1.60)	50.97	1.547		
2450H	2410	39.30 (37.34~41.26)	1.76 (1.67~1.85)	39.46	1.748	21.4°C	2013-02-01
	2435	39.20 (37.24~41.16)	1.79 (1.70~1.88)	39.24	1.781		
	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	39.17	1.788		
	2460	39.20 (37.24~41.16)	1.81 (1.72~1.90)	39.11	1.786		
2450B	2410	52.80 (50.16~55.44)	1.91 (1.81~2.00)	52.49	1.942	21.4°C	2013-02-01
	2435	52.70 (50.07~55.34)	1.94 (1.84~2.04)	52.36	1.968		
	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	52.27	1.982		
	2460	52.70 (50.07~55.34)	1.96 (1.86~2.06)	52.23	1.995		
ε _r = Relative permittivity, σ= 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 check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests (Graphic Plot(s) see Appendix A).

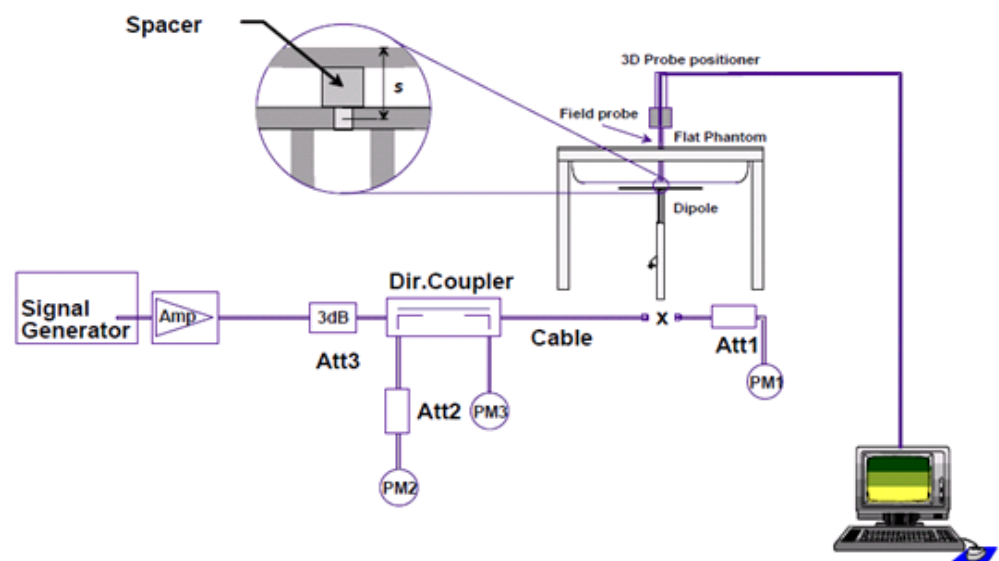
System Check	Target SAR (1W) (+/-10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (mW/g)	10-g (mW/g)	1-g (mW/g)	10-g (mW/g)		
D835V2 Head	9.40 (8.46~10.34)	6.16 (5.54~6.78)	9.76	6.36	21.4°C	2013-01-31
D1900V2 Head	40.6 (36.54~44.66)	21.2 (19.08~23.32)	38.48	20.08	21.4°C	2013-01-30
D2450V2 Head	53.70 (48.33~59.07)	24.90 (22.41~27.39)	51.20	23.56	21.4°C	2013-02-01
D835V2 Body	9.54 (8.59~10.49)	6.29 (5.66~6.92)	9.84	6.52	21.4°C	2013-01-31
D1900V2 Body	41.4 (37.26~45.54)	21.8 (19.62~23.98)	39.36	20.80	21.4°C	2013-01-30
D2450V2 Body	52.80 (47.52~58.08)	24.50 (22.05~26.95)	52.00	24.12	21.4°C	2013-02-01

Table 6: System Check Results

4.3 System check Procedure

The system check is performed by using a system check 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 system check 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 system check 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).

System check 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}
Measurement System								
Probe calibration	$\pm 6.0\%$	Normal	1	1	1	$\pm 6.0\%$	$\pm 6.0\%$	∞
Axial isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	∞
Hemispherical isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	∞
Spatial resolution	$\pm 0.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.0\%$	$\pm 0.0\%$	∞
Boundary effects	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Probe linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	∞
System detection limits	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Readout electronics	$\pm 0.3\%$	Normal	1	1	1	$\pm 0.3\%$	$\pm 0.3\%$	∞
Response time	$\pm 0.8\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$	∞
Integration time	$\pm 2.6\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.5\%$	$\pm 1.5\%$	∞
RF ambient conditions	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	∞
Probe positioner	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	∞
Probe positioning	$\pm 2.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	∞
Max. SAR evaluation	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Test Sample Related								
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	$\pm 2.9\%$	$\pm 2.9\%$	∞
Phantom and Set-up								
Phantom uncertainty	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	∞
Liquid conductivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	∞
Liquid conductivity (meas.)	$\pm 2.5\%$	Normal	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.1\%$	∞
Liquid permittivity (target)	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	∞
Liquid permittivity (meas.)	$\pm 2.5\%$	Normal	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.2\%$	∞
Combined Uncertainty	$u_c = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$					$\pm 10.9\%$	$\pm 10.7\%$	387
Expanded Std. Uncertainty	$u_e = 2u_c$	Normal	K=2			$\pm 21.9\%$	$\pm 21.4\%$	

Table 7: Measurement uncertainties

5.2 Measurement uncertainty evaluation for system check

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

Table 8: Measurement uncertainties

6 SAR Test Configuration

6.1 CDMA Test Configuration

6.1.1 CDMA 1x Devices

For SAR test, the maximum power output is very important and essential; it is identical under the measurement uncertainty. It is proper to use typical Test Mode 3(FW RC3, RVS RC3, SO55) as the worst case for SAR test.

Test Parameter setup for maximum RF output power according to section 4.4.5 of 3GPP2;

Parameter	Units	Value
I or	dBm/1.23MHz	-104
PilotE c/I or	dB	-7
TrafficE c /I or	dB	-7.4

SAR for head exposure configurations is measured in RC3 with the DUT configured to transmit at full rate using Loopback Service Option SO55. SAR for RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1 using the exposure configuration that results in the highest SAR for that channel in RC3.

SAR for body exposure configurations is measured in RC3 with the DUT configured using TDSO / SO32, to transmit at full rate on FCH with all other code channels disabled. SAR for multiple code channels (FCH + SCHn) is not required when the maximum average output of each RF channel is less than ¼ dB higher than that measured with FCH only. Otherwise, SAR is measured on the maximum output channel (FCH + SCHn) with FCH at full rate and SCH0 enabled at 9600 bps, using the exposure configuration that results in the highest SAR for that channel with FCH only. When multiple code channels are enabled, the DUT output may shift by more than 0.5 dB and lead to higher SAR drifts and SCH dropouts.

Body SAR in RC1 is not required when the maximum average output of each channel is less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1; with Loopback Service Option SO55, at full rate, using the body exposure configuration that results in the highest SAR for that channel in RC3.

Test communication setup meet as followings:

Communication standard between mobile station and base station simulator	3GPP2 C.S0011-B
Radio configuration	RC3(Supporting CDMA 1X)
Spreading Rate	SR1
Data Rate	9600bps
Service Options	SO55(Loopback service)
Service Options	SO32(Test Data service)
Multiplex Options	The mobile station does not support this service

6.1.2 CDMA EV-DO Devices

For handsets with EV-DO capabilities, when the maximum average output of each channel in Rev.0 is less than ¼ dB higher than that measured in RC3 (1x RTT), body SAR for EV-DO is not required. Otherwise, SAR for Rev. 0 is measured on the maximum output channel at 153.6 kbps using the body exposure configuration that results in the highest SAR for that channel in RC3. SAR for Rev.A is not required when the maximum average output of each channel is less than that measured in Rev.0 or less than ¼ dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel for Rev.A using a Reverse Data Channel payload size of 4096 bits and a Termination Target of 16 slots defined for Subtype 2 Physical Layer configurations. A Forward Traffic Channel data rate corresponding to the 2-slot version of 307.2 kbps with the ACK Channel transmitting in all slots should be configured in the downlink for both Rev.0 and Rev.A.

6.2 WiFi Test Configuration

For the 802.11b/g SAR 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 operating modes are tested independently according to the service requirements in each frequency band. 802.11b/g 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	Band	GHz	Channel	“Default Test Channels”	
				802.11b	802.11g
802.11b/g	2.4 GHz	2.412	1#	√	△
		2.437	6	√	△
		2.462	11#	√	△

Notes:

√ = “default test channels”

△= possible 802.11g channels with maximum average output ¼ dB the “default test channels”

= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

802.11 Test Channels per FCC Requirements

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.

7.1.1 Conducted power measurements CDMA BC0

CDMA&EVDO BC0		Average Power (dBm)		
		1013CH	384CH	777CH
RC1	SO55	23.79	24.01	23.91
RC3	SO55	23.74	23.99	23.88
	TDSO32 (FCH)	23.77	23.93	23.70
	TDSO32 (FCH+SCH)	23.60	23.94	23.79
Rev 0	RTAP 153.6	23.69	23.95	23.86
Rev A	RETAP 4096	23.99	24.06	23.95

Table 9: Test results conducted power measurement CDMA BC0

Note: The conducted power of CDMA BC0 is measured with RMS detector.

7.1.2 Conducted power measurements CDMA BC1

CDMA&EVDO BC1		Average Power (dBm)		
		25CH	600CH	1175CH
RC1	SO55	23.94	23.90	23.62
RC3	SO55	23.86	23.72	23.65
	TDSO32 (FCH)	23.89	23.78	23.57
	TDSO32 (FCH+SCH)	23.86	23.74	23.65
Rev 0	RTAP 153.6	23.87	23.85	23.71
Rev A	RETAP 4096	23.98	24.05	23.89

Table 10: Test results conducted power measurement CDMA BC1(Hotspot disable)

Note: The conducted power of CDMA BC1 is measured with RMS detector.

CDMA&EVDO BC1		Average Power (dBm)		
		25CH	600CH	1175CH
RC1	SO55	22.25	21.95	21.92
RC3	SO55	22.22	21.90	21.99
	TDSO32 (FCH)	22.25	21.97	21.94
	TDSO32 (FCH+SCH)	22.19	21.80	21.83
Rev 0	RTAP 153.6	22.04	21.97	21.79
Rev A	RETAP 4096	22.28	22.01	21.95

Table 11: Test results conducted power measurement CDMA BC1(Hotspot activated)

Note: The conducted power of CDMA BC1 is measured with RMS detector.

7.1.3 Conducted power measurements BT

The output power of BT antenna is as following:

BT 2450	Average Conducted Power (dBm)		
	0CH	39CH	78CH
	3.56	3.79	5.44

Table 12:Test results conducted power measurement BT.

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

7.1.4 Conducted power measurements WiFi

The output power of WiFi antenna is as following:

Wi-Fi 2450	Channel	Average Power (dBm) for Data Rates (Mbps)							
		1	2	5.5	11	/	/	/	/
802.11b	1	14.07	13.92	13.78	13.62	/	/	/	/
	6	13.87	13.70	13.69	13.42	/	/	/	/
	11	13.63	13.52	13.46	13.30	/	/	/	/
802.11g	Channel	6	9	12	18	24	36	48	54
	1	11.94	11.89	11.84	11.58	11.42	11.31	11.07	10.79
	6	11.91	11.69	11.61	11.27	11.12	10.91	10.78	10.59
	11	11.76	11.55	11.40	11.21	10.97	10.60	10.43	10.45
802.11n HT20	Channel	6.5	13	19.5	26	39	52	58.5	65
	1	8.88	8.75	8.59	8.38	8.13	7.84	7.66	7.65
	6	8.82	8.62	8.41	8.18	7.94	7.68	7.49	7.37
	11	8.68	8.45	8.26	8.01	7.66	7.43	7.27	7.30

Table 13:Test results conducted power measurement WiFi .

Note:

- 1) The Average conducted power of WiFi is measured with RMS detector .
- 2) 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.

7.2 SAR measurement Result

- 1) Per KDB447498 D01v05,testing of other required channels within the operating mode of a frequency band is not required when the reported(Scaled) SAR for the middle channel or highest output power channels is $\leq 0.8\text{W/kg}$. When the maximum output power variation across the required test channels is $> \frac{1}{2}$ dB, instead of the middle channel, the highest output power channel must be used.
- 2) Per KDB865664 D01v01,for each frequency band,repeated SAR measurent is required only when the measured SAR is $\geq 0.8\text{W/Kg}$; if the deciation among the repeated measurement is $\leq 20\%$,and the measured SAR $< 1.45\text{W/Kg}$,only one repeated measurement is required.
- 3).Per KDB648474 D04v01,SAR is evaluated without a headset connected to the device.When the standalone reported SAR is $\leq 1.2\text{ W/kg}$, no additional SAR evaluations using a headset are required.
- 4) Per KDB941225 D06, the DUT Dimension is 117mmx62mm, which is bigger than 9 cm x 5 cm, so 10mm is chosen as Hotspot mode test separation distance.
- 5) Per KDB248227, for each frequency band of WiFi, SAR test 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.
- 6) All measurement SAR result is scaled-up to account for tune-up tolerance is compliant

7.2.1 SAR measurement Result of CDMA BC0

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	384/836.52	RC3 SO55	0.494	0.360	-0.010	23.99	24.75	0.588	21.4°C
Left Hand Tilted 15°	384/836.52	RC3 SO55	0.350	0.262	-0.100	23.99	24.75	0.417	21.4°C
Right Hand Touched	384/836.52	RC3 SO55	0.514	0.385	-0.050	23.99	24.75	0.612	21.4°C
Right Hand Tilted 15°	384/836.52	RC3 SO55	0.385	0.289	-0.070	23.99	24.75	0.459	21.4°C
Tested at worst position with the battery 2#									
Right Hand Touched	384/836.52	RC3 SO55	0.520	0.386	-0.120	23.99	24.75	0.619	21.4°C

Table 14: Test results head SAR CDMA BC0

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	384/836.52	RC3 SO32	0.517	0.392	-0.190	23.93	24.75	0.624	21.4°C
Towards Ground	384/836.52	RC3 SO32	0.585	0.436	-0.180	23.93	24.75	0.707	21.4°C
Towards Ground	384/836.52	Rev.0	0.553	0.402	-0.130	23.95	24.75	0.665	21.4°C
Towards Ground	384/836.52	Rev.A	0.622	0.457	-0.110	24.06	24.75	0.729	21.4°C
Tested at worst position with the battery 2#									
Towards Ground	384/836.52	Rev.A	0.631	0.474	-0.100	24.06	24.75	0.740	21.4°C

Table 15: Test results Body-Worn SAR CDMA BC0

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	384/836.52	Rev.0	0.553	0.419	-0.170	23.95	24.75	0.665	21.4°C
Towards Ground	777/848.31	Rev.0	0.683	0.510	0.130	23.86	24.75	0.838	21.4°C
Towards Ground	384/836.52	Rev.0	0.702	0.519	0.030	23.95	24.75	0.844	21.4°C
Towards Ground	1013/824.7	Rev.0	0.655	0.493	0.040	23.69	24.75	0.836	21.4°C
Left edge	384/836.52	Rev.0	0.435	0.300	-0.080	23.95	24.75	0.523	21.4°C
Right edge	384/836.52	Rev.0	0.479	0.335	-0.140	23.95	24.75	0.576	21.4°C
Bottom edge	384/836.52	Rev.0	0.157	0.088	0.040	23.95	24.75	0.189	21.4°C
Towards Ground	384/836.52	Rev.A	0.799	0.585	-0.090	24.06	24.75	0.937	21.4°C
Towards Ground	384/836.52	RC3 SO32	0.745	0.549	-0.170	23.93	24.75	0.900	21.4°C
Tested at worst position with the battery 2#									
Towards Ground	384/836.52	Rev.A	0.795	0.590	-0.130	24.06	24.75	0.932	21.4°C

Table 16: Test results Hotspot SAR CDMA BC0

Note:

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

7.2.2 SAR measurement Result of CDMA BC1

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	1175/1908.75	RC3 SO55	0.765	0.457	-0.180	23.65	24.75	0.986	21.4°C
Left Hand Touched	600/1880	RC3 SO55	0.740	0.447	0.190	23.72	24.75	0.938	21.4°C
Left Hand Touched	25/1851.25	RC3 SO55	0.811	0.490	0.150	23.86	24.75	0.995	21.4°C
Left Hand Touched*	25/1851.25	RC3 SO55	0.762	0.462	0.070	23.86	24.75	0.935	21.4°C
Left Hand Tilted 15°	600/1880	RC3 SO55	0.261	0.162	-0.010	23.72	24.75	0.331	21.4°C
Right Hand Touched	600/1880	RC3 SO55	0.402	0.265	-0.110	23.72	24.75	0.510	21.4°C
Right Hand Tilted 15°	600/1880	RC3 SO55	0.270	0.157	-0.090	23.72	24.75	0.342	21.4°C
Tested at worst position with the battery 2#									
Left Hand Touched	25/1851.25	RC3 SO55	0.773	0.469	-0.020	23.86	24.75	0.949	21.4°C

Table 17: Test results head SAR CDMA BC1

Note: * - repeated at the highest SAR measurement according to the FCC KDB 865664

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	600/1880	RC3 SO32	0.500	0.324	-0.020	23.78	24.75	0.625	21.4°C
Towards Ground	600/1880	RC3 SO32	0.488	0.314	0.050	23.78	24.75	0.610	21.4°C
Towards Phantom	600/1880	Rev.0	0.463	0.297	-0.050	23.85	24.75	0.570	21.4°C
Towards Phantom	600/1880	Rev.A	0.552	0.343	0.120	24.05	24.75	0.649	21.4°C
Tested at worst position with the battery 2#									
Towards Phantom	600/1880	Rev.A	0.542	0.347	0.080	24.05	24.75	0.637	21.4°C

Table 18: Test results Body-Worn SAR CDMA BC1

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR _{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	600/1880	Rev.0	0.512	0.318	0.020	21.97	22.75	0.613	21.4°C
Towards Ground	600/1880	Rev.0	0.543	0.339	0.130	21.97	22.75	0.650	21.4°C
Left edge	600/1880	Rev.0	0.227	0.136	-0.070	21.97	22.75	0.272	21.4°C
Right edge	600/1880	Rev.0	0.052	0.030	-0.020	21.97	22.75	0.062	21.4°C
Bottom edge	600/1880	Rev.0	0.666	0.355	0.020	21.97	22.75	0.797	21.4°C
Bottom edge	600/1880	Rev.A	0.751	0.400	0.170	22.01	22.75	0.891	21.4°C
Bottom edge	600/1880	RC3 SO32	0.656	0.350	-0.100	21.97	22.75	0.785	21.4°C
Tested at worst position with the battery 2#									
Bottom edge	600/1880	Rev.A	0.752	0.397	-0.120	22.01	22.75	0.892	21.4°C

Table 19:Test results Body SAR CDMA BC1

Note:

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

7.2.3 SAR measurement Result of WiFi

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	1/2412	802.11 b	0.062	0.030	0.110	14.07	16.00	0.097	21.4°C
Left Hand Tilted 15°	1/2412	802.11 b	0.079	0.037	-0.120	14.07	16.00	0.124	21.4°C
Right Hand Touched	1/2412	802.11 b	0.062	0.030	0.190	14.07	16.00	0.097	21.4°C
Right Hand Tilted 15°	1/2412	802.11 b	0.086	0.040	0.170	14.07	16.00	0.134	21.4°C
Tested at worst position with the battery 2#									
Right Hand Tilted 15°	1/2412	802.11 b	0.083	0.039	0.140	14.07	16.00	0.130	21.4°C

Table 20: Test results head SAR WiFi 2450MHz

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	1/2412	802.11 b	0.047	0.014	0.120	14.07	16.00	0.074	21.4°C
Towards Ground	1/2412	802.11 b	0.048	0.025	0.090	14.07	16.00	0.074	21.4°C
Tested at worst position with the battery 2#									
Towards Ground	1/2412	802.11 b	0.049	0.026	-0.040	14.07	16.00	0.076	21.4°C

Table 21: Test results Body-Worn SAR WiFi 2450MHz

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Limit (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Towards Phantom	1/2412	802.11 b	0.073	0.018	-0.100	14.07	16.00	0.114	21.4°C
Towards Ground	1/2412	802.11 b	0.096	0.046	0.050	14.07	16.00	0.150	21.4°C
Left edge	1/2412	802.11 b	0.032	0.016	-0.010	14.07	16.00	0.051	21.4°C
Right edge	1/2412	802.11 b	0.005	0.002	-0.050	14.07	16.00	0.008	21.4°C
Top edge	1/2412	802.11 b	0.075	0.035	0.170	14.07	16.00	0.117	21.4°C
Tested at worst position with the battery 2#									
Towards Ground	1/2412	802.11 b	0.099	0.048	0.140	14.07	16.00	0.154	21.4°C

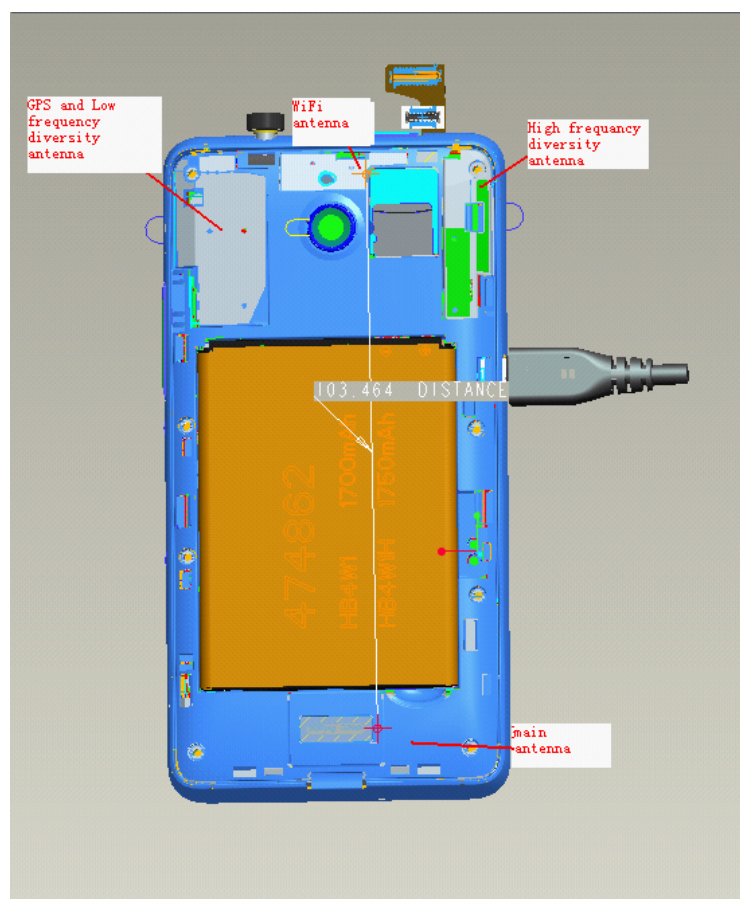
Table 22: Test results Hotspot SAR WiFi 2450MHz

Note: Per KDB941225 D06, for the antenna-to-edge distance is greater than 2.5 cm, so the Bottom edge does not need to be tested.

7.3 Multiple Transmitter Evaluation

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance v05.

The closest distance between BT/WiFi antenna and main antenna is 103.464cm, and the location of the antennas inside mobile phone is shown as below picture:



7.3.1 Stand-alone SAR test exclusion

The 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR, where:

- $f(\text{GHz})$ 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

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

a) Head position

Mode	P_{max} (dBm)*	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	Exclusion threshold	SAR test exclusion
CDMA BC0	24.75	298.54	5	0.800	53.40	3.00	No
CDMA BC1	24.75	298.54	5	1.900	82.30	3.00	No
WiFi	16.00	39.81	5	2.450	12.46	3.00	No
BT	6.00	3.98	5	2.450	1.25	3.00	Yes

Table 23: Standalone SAR test exclusion in head position

Note: * - maximum possible output power declared by manufacturer

b) Body-Worn position

Mode	P_{max} (dBm)*	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	Exclusion threshold	SAR test exclusion
CDMA BC0	24.75	298.54	15	0.800	17.80	3.00	No
CDMA BC1	24.75	298.54	15	1.900	27.43	3.00	No
WiFi	16.00	39.81	15	2.450	4.15	3.00	No
BT	6.00	3.98	15	2.450	0.42	3.00	Yes

Table 24: Standalone SAR test exclusion in body-Worn position

Note: * - maximum possible output power declared by manufacturer

c) Hotspot position

Mode	P_{max} (dBm)*	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	Exclusion threshold	SAR test exclusion
CDMA BC0	24.75	298.54	10	0.800	26.70	3.00	No
CDMA BC1	22.75	188.36	10	1.900	25.96	3.00	No
WiFi	16.00	39.81	10	2.450	6.23	3.00	No
BT	6.00	3.98	10	2.450	0.62	3.00	Yes

Table 25: Standalone SAR test exclusion in Hotspot position

Note: * - 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)] •

[$\sqrt{f(\text{GHz})/x}$] 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

Mode	Position	$P_{\max}$ (dBm)*	$P_{\max}$ (mW)	Distance (mm)	f (GHz)	X	Estimated SAR (W/Kg)*
BT	Head	6.00	3.98	5	2.450	7.5	0.166
BT	Body-Worn	6.00	3.98	15	2.450	7.5	0.055
BT	Hotspot	6.00	3.98	10	2.450	7.5	0.083

Table 26: Estimated SAR calculation for BT

Note: * - maximum possible output power declared by manufacturer

7.3.2 Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities are as below:

Simultaneous Transmission Possibilities					
Simultaneous Tx Combination	Configuration	Head	Body-Worn	Hotspot	
1	CDMA BC0 + WiFi	Yes	Yes	Yes	
2	CDMA BC1 + WiFi	Yes	Yes	Yes	
3	CDMA BC0 + BT	Yes	Yes	Yes	
4	CDMA BC1 + BT	Yes	Yes	Yes	

Table 27: Simultaneous Transmission Possibilities.

Note: The device does not support simultaneous BT and WiFi, because they share the same antenna.

7.3.3 SAR Summation Scenario

Test Position		Scaled SAR _{Max}		Σ 1-g SAR	SPLSR	Remark
		CDMA BC0	WiFi			
Head	Left Hand Touched	0.588	0.097	0.685	NA	NA
	Left Hand Tilted 15°	0.417	0.124	0.541	NA	NA
	Right Hand Touched	0.619	0.097	0.716	NA	NA
	Right Hand Tilted 15°	0.459	0.134	0.593	NA	NA
Body-Worn	Towards Phantom	0.624	0.074	0.698	NA	NA
	Towards Ground	0.740	0.076	0.816	NA	NA
Hotspot	Towards Phantom	0.665	0.114	0.779	NA	NA
	Towards Ground	0.937	0.154	1.091	NA	NA
	Left edge	0.523	0.051	0.574	NA	NA
	Right edge	0.576	0.008	0.584	NA	NA
	Top edge	0	0.117	0.117	NA	NA
	Bottom edge	0.189	0	0.189	NA	NA

Table 28: Simultaneous Tx Combination of CDMA BC0 and WiFi

Test Position		Scaled SAR _{Max}		Σ 1-g SAR	SPLSR	Remark
		CDMA BC1	WiFi			
Head	Left Hand Touched	0.995	0.097	1.092	NA	NA
	Left Hand Tilted 15°	0.331	0.124	0.455	NA	NA
	Right Hand Touched	0.510	0.097	0.607	NA	NA
	Right Hand Tilted 15°	0.342	0.134	0.476	NA	NA
Body-Worn	Towards Phantom	0.649	0.074	0.723	NA	NA
	Towards Ground	0.610	0.076	0.686	NA	NA
Hotspot	Towards Phantom	0.613	0.114	0.727	NA	NA
	Towards Ground	0.650	0.154	0.804	NA	NA
	Left edge	0.272	0.051	0.323	NA	NA
	Right edge	0.062	0.008	0.070	NA	NA
	Top edge	0	0.117	0.117	NA	NA
	Bottom edge	0.892	0	0.892	NA	NA

Table 29: Simultaneous Tx Combination of CDMA BC1 and WiFi

Test Position		Scaled SAR _{Max}		Σ 1-g SAR	SPLSR	Remark
		CDMA BC0	BT			
Head	Left Hand Touched	0.588	0.166	0.754	NA	NA
	Left Hand Tilted 15°	0.417	0.166	0.583	NA	NA
	Right Hand Touched	0.619	0.166	0.785	NA	NA
	Right Hand Tilted 15°	0.459	0.166	0.625	NA	NA
Body-Worn	Towards Phantom	0.624	0.055	0.679	NA	NA
	Towards Ground	0.740	0.055	0.795	NA	NA
Hotspot	Towards Phantom	0.665	0.083	0.748	NA	NA
	Towards Ground	0.937	0.083	1.020	NA	NA
	Left edge	0.523	0.083	0.606	NA	NA
	Right edge	0.576	0.083	0.659	NA	NA
	Top edge	0	0.083	0.083	NA	NA
	Bottom edge	0.189	0.083	0.272	NA	NA

Table 30: Simultaneous Tx Combination of CDMA BC0 and BT

Test Position		Scaled SAR _{Max}		Σ 1-g SAR	SPLSR	Remark
		CDMA BC1	BT			
Head	Left Hand Touched	0.995	0.166	1.161	NA	NA
	Left Hand Tilted 15°	0.331	0.166	0.497	NA	NA
	Right Hand Touched	0.510	0.166	0.676	NA	NA
	Right Hand Tilted 15°	0.342	0.166	0.508	NA	NA
Body-Worn	Towards Phantom	0.649	0.055	0.704	NA	NA
	Towards Ground	0.610	0.055	0.665	NA	NA
Hotspot	Towards Phantom	0.613	0.083	0.696	NA	NA
	Towards Ground	0.650	0.083	0.733	NA	NA
	Left edge	0.272	0.083	0.355	NA	NA
	Right edge	0.062	0.083	0.145	NA	NA
	Top edge	0	0.083	0.083	NA	NA
	Bottom edge	0.892	0.083	0.975	NA	NA

Table 31: Simultaneous Tx Combination of CDMA BC1 and BT

Conclusion:

Simultaneous Transmission SAR evaluation is not required for CDMA and WiFi&BT, because the highest $\Sigma 1\text{-g}$ SAR of all combinations of simultaneous transmission is $1.161\text{W/kg} < 1.6\text{W/kg}$.

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.)

End