



FCC SAR Compliance Test Report

Project Name: HUAWEI Ascend Y 201 Pro; Skyline mini;HSDPA/UMTS/GPRS/GSM/EDGE Mobile Phone with Bluetooth

Model : HUAWEI U8666E-1,U8666E-1

FCC ID : QISU8666E-1

Report No. : SYBH(Z-SAR) 026072012-2

	APPROVED	CHECKED	PREPARED
BY	<i>Liu Chunlin</i>	<i>Alwinway</i>	<i>Yang Hang</i>
DATE	2012-08-01	2012-08-01	2012-08-01

The test results of this test report relate exclusively to the item(s) tested , The HUAWEI does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of HUAWEI.

Reliability Laboratory of Huawei Technologies Co., Ltd.

Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian,
Longgang District, Shenzhen, 518129, P.R.C
Tel: +86 755 28780808 Fax: +86 755 89652518

Table of Contents

1	General Information	4
1.1	Statement of Compliance	4
1.2	RF exposure limits.....	5
1.3	EUT Description	6
1.3.1	General Description	7
1.4	Test specification(s)	8
1.5	Testing laboratory.....	8
1.6	Applicant and Manufacturer	8
1.7	Application details	8
1.8	Ambient Condition.....	8
2	SAR Measurement System.....	9
2.1	SAR Measurement Set-up.....	9
2.2	Test environment.....	10
2.3	Data Acquisition Electronics description.....	10
2.4	Probe description	11
2.5	Phantom description	12
2.6	Device holder description.....	12
2.7	Test Equipment List	13
3	SAR Measurement Procedure	14
3.1	Scanning procedure.....	14
3.2	Spatial Peak SAR Evaluation	15
3.3	Data Storage and Evaluation.....	16
4	System Verification Procedure.....	18
4.1	Tissue Verification	18
4.2	System Check.....	20
4.3	Validation Procedure.....	21
5	Measurement Uncertainty Evaluation.....	22
5.1	Measurement uncertainty evaluation for SAR test.....	22
5.2	Measurement uncertainty evaluation for system validation	23
6	SAR Test Configuration	24
6.1	GSM Test Configuration.....	24
6.2	WiFi Test Configuration.....	24
7	SAR Measurement Results	25
7.1	Conducted power measurements.....	25
7.1.1	Conducted power measurements GSM850.....	25
7.1.2	Conducted power measurements GSM1900.....	26
7.2	SAR measurement Result.....	27
7.2.1	SAR measurement Result of GSM850.....	27
7.2.2	SAR measurement Result of GSM1900.....	28
7.2.3	SAR measurement Result of WiFi.....	29
7.3	Multiple Transmitter Evaluation.....	30
7.3.1	Stand-alone SAR	32
7.3.2	SAR Summation Scenario	32
	Appendix A. System Check Plots	33
	Appendix B. SAR Measurement Plots	33
	Appendix C. Calibration Certificate	33
	Appendix D. Photo documentation.....	33

※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2012-08-01	Yang Hang

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI U8666E-1, U8666E-1 are as below Table 1

Band	Position	Measured MAX SAR _{1g} (W/kg)	Conducted Power (dBm)	Tune-up Power(dBm)	Extrapolated Result(W/kg)
GSM 850	Head	0.083	32.52	33.00	0.093
	Body Worn(10mm)	0.405	30.09	31.00	0.499
	Hotspot(10mm)	0.405	30.09	31.00	0.499
GSM 1900	Head	0.372	29.72	30.00	0.397
	Body Worn(10mm)	0.578	27.04	28.00	0.721
	Hotspot(10mm)	0.578	27.04	28.00	0.721
WiFi	Head	0.065	16.10	/	/
	Body Worn(10mm)	0.051	16.10	/	/
	Hotspot(10mm)	0.051	16.10	/	/
Simultaneous SAR _{Max} is 0.629W/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
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:	HUAWEI Ascend Y 201 Pro; Skyline mini; HSDPA/UMTS/GPRS/GSM/EDGE Mobile Phone with Bluetooth;		
Type Identification:	HUAWEI U8666E-1,U8666E-1		
FCC ID:	QISU8666E-1		
IMEI:	864449010002636		
Device Type :	portable device		
Exposure Category:	uncontrolled environment / general population		
Hardware Version :	HD2U8655M		
Software Version :	U8666E-1V100R001C00B918		
Antenna Type :	internal antenna		
Others Accessories	Headset		
Device Operating Configurations:			
Supporting Mode(s)	GSM850/1900, WiFi (tested)		
Test Modulation	GSM(GMSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM850	824-849	869-894
	GSM1900	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	
Power Class:	4, tested with power level 5(GSM850)		
	1, tested with power level 0(GSM1900)		
Test Channels (low-mid-high):	128-190-251 (GSM850)		
	512-661-810 (GSM1900)		
	1-6-11 (WiFi 2450)		

Table 3:Device information and operating configuration

1.3.1 General Description

HUAWEI U8666E-1, U8666E-1 is subscriber equipment in the WCDMA/GSM system. The HSDPA/UMTS frequency band is Band I and Band VIII. The GSM/GPRS/EDGE frequency band includes GSM850 and GSM900 and DCS1800 and PCS1900, but only GSM850 and PCS1900 bands test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, HSDPA/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.

Battery

Name	Manufacture	Serials number	Description
Rechargeable Li-ion	Huawei Technologies Co.,Ltd.	1#: WHCC115691008469 2#: MHCBB066I4437430 3#: UAIC308X03022001 4#: UNDC707X03000013	Battery Model: HB5K1H Rated capacity: 1400mAh Nominal Voltage: $\text{---} +3.7\text{V}$ Charging Voltage: $\text{---} +4.2\text{V}$
Rechargeable Li-ion	Huawei Technologies Co.,Ltd.	5#: GAGC313Z97452046 6#: BAAC214F97400370	Battery Model: HB5K1H Rated capacity: 1250mAh Nominal Voltage: $\text{---} +3.7\text{V}$ Charging Voltage: $\text{---} +4.2\text{V}$

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 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 D03	SAR Test Reduction GSM GPRS EDGE v01
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

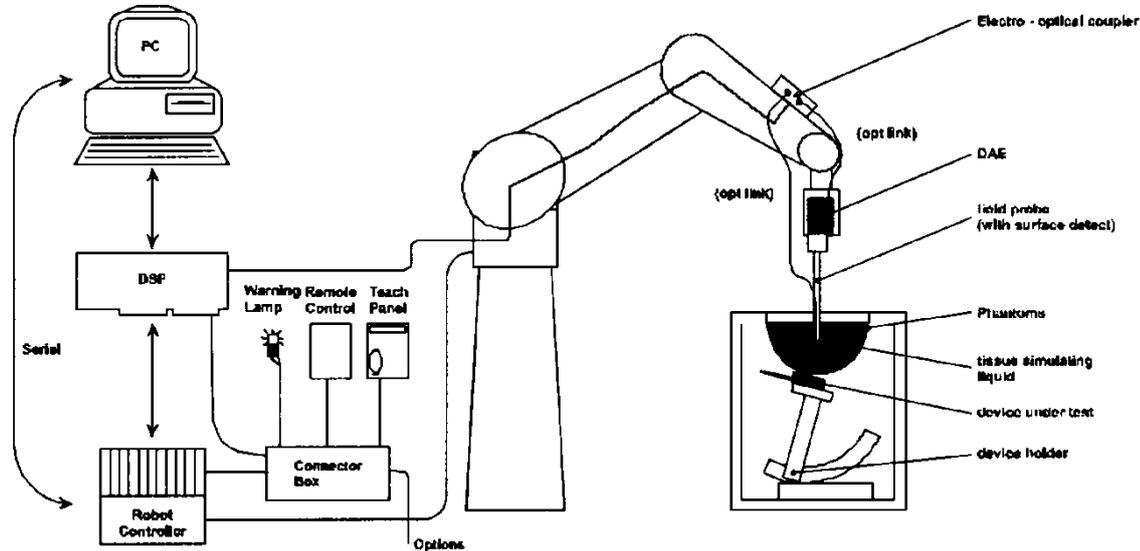
Start Date of test	2012/07/26
End Date of test	2012/07/31

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 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.

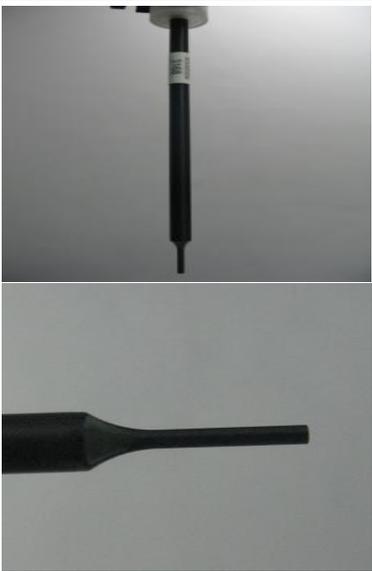
DAE4

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 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: ± 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: 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 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	111379	2011-08-06
<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 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 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 _i , a ₁₀ , a ₁₁ , a ₁₂
	- 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 of the dielectric parameter 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 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)	42.35	0.916	21.4°C	2012-07-27
	835	41.50 (39.43~43.58)	0.90 (0.86~0.95)	42.20	0.931		
	850	41.50 (39.43~43.58)	0.92 (0.87~0.96)	42.14	0.939		
835B	825	55.20 (52.44~57.96)	0.97 (0.92~1.02)	53.15	0.968	21.4°C	2012-07-29
	835	55.20 (52.44~57.96)	0.97 (0.92~1.02)	53.08	0.971		
	850	55.20 (52.44~57.96)	0.99 (0.94~1.04)	52.99	0.988		
1900H	1850	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.51	1.394	21.4°C	2012-07-26
	1880	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.35	1.439		
	1900	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.33	1.441		

	1910	40.00 (38.00~42.00)	1.40 (1.33~1.47)	39.24	1.450		
1900B	1850	53.30 (50.64~55.97)	1.52 (1.44~1.60)	52.26	1.510	21.4°C	2012-07-28
	1880	53.30 (50.64~55.97)	1.52 (1.44~1.60)	52.07	1.549		
	1900	53.30 (50.64~55.97)	1.52 (1.44~1.60)	52.06	1.567		
	1910	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.97	1.588		
2450H	2410	39.30 (37.34~41.26)	1.76 (1.67~1.85)	39.80	1.772	21.4°C	2012-07-27
	2435	39.20 (37.24~41.16)	1.79 (1.70~1.88)	39.71	1.798		
	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	39.64	1.814		
	2460	39.20 (37.24~41.16)	1.81 (1.72~1.90)	39.60	1.825		
2450B	2410	52.80 (50.16~55.44)	1.91 (1.81~2.00)	52.90	1.916	21.4°C	2012-07-30
	2435	52.70 (50.07~55.34)	1.94 (1.84~2.04)	52.83	1.946		
	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	52.78	1.963		
	2460	52.70 (50.07~55.34)	1.96 (1.86~2.06)	52.75	1.977		
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 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).

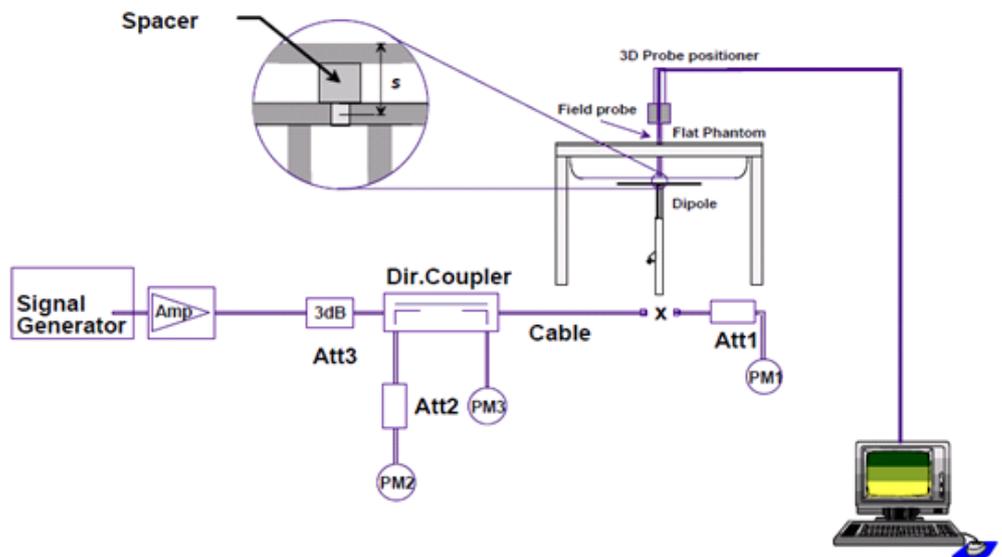
System Check	Target SAR (1W) (+/-10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (mW/g)	10-g (mW/g)	1-g (mW/g)	10-g (mW/g)		
D835V2 Head	9.40 (8.46~10.34)	6.16 (5.54~6.78)	9.64	6.28	21.4°C	2012-07-27
D1900V2 Head	40.60 (36.54~44.66)	21.20 (19.08~23.32)	38.04	19.44	21.4°C	2012-07-26
D2450V2 Head	53.70 (48.33~59.07)	24.90 (22.41~27.39)	52.00	23.28	21.4°C	2012-07-27
D835V2 Body	9.54 (8.59~10.49)	6.29 (5.66~6.92)	9.92	6.52	21.4°C	2012-07-29
D1900V2 Body	41.40 (37.26~45.54)	21.80 (19.62~23.98)	42.40	21.32	21.4°C	2012-07-28
D2450V2 Body	52.80 (47.52~58.08)	24.50 (22.05~26.95)	50.00	22.24	21.4°C	2012-07-30

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}
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						$\pm 10.9\%$	$\pm 10.7\%$	387
Expanded Std. Uncertainty						$\pm 21.9\%$	$\pm 21.4\%$	

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}
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						$\pm 9.5\%$	$\pm 9.2\%$	
Expanded Std. Uncertainty						$\pm 18.9\%$	$\pm 18.4\%$	

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 GSM1900. 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	2	0
GSM1900	1 TX slot	0	0	0
	2 TX slots	2	2	0

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

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 frquency 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	GHz	Channel	Turbo Channel	“Default Test Channels”		UNII	
				§15.247			
				802.11b	802.11g		
802.11 b/g	2.412	1 [#]		√	∇		
	2.437	6	6	√	∇		
	2.462	11 [#]		√	∇		

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)		32.48	32.52	32.58	-9	23.48	23.52	23.58
GPRS (GMSK)	1 Tx Slot	32.47	32.53	32.57	-9	23.47	23.53	23.57
	2 Tx Slots	30.07	30.06	30.10	-6	24.07	24.06	24.10
EDGE (GMSK)	1 Tx Slot	32.50	32.51	32.55	-9	23.50	23.51	23.55
	2 Tx Slots	30.06	30.09	30.09	-6	24.06	24.09	24.09
EDGE (8PSK)	1 Tx Slot	27.24	27.31	27.36	-9	18.24	18.31	18.36
	2 Tx Slots	27.16	27.27	27.29	-6	21.16	21.27	21.29

Table 10: 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)		30.01	29.72	29.52	-9	21.01	20.72	20.52
GPRS (GMSK)	1 Tx Slot	30.00	29.70	29.53	-9	21.00	20.70	20.53
	2 Tx Slots	27.32	27.04	26.87	-6	21.32	21.04	20.87
EDGE (GMSK)	1 Tx Slot	29.99	29.71	29.52	-9	20.99	20.71	20.52
	2 Tx Slots	27.29	27.02	26.85	-6	21.29	21.02	20.85
EDGE (8PSK)	1 Tx Slot	26.66	26.32	26.16	-9	17.66	17.32	17.16
	2 Tx Slots	26.63	26.27	26.12	-6	20.63	20.27	20.12

Table 11: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.

7.2 SAR measurement Result

7.2.1 SAR measurement Result of GSM850

Test Position of Head	Test Mode	Test channel /Frequency	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	GSM	190/836.6	0.066	0.050	-0.120	32.52	21.4°C
Left Hand Tilted 15°	GSM	190/836.6	0.063	0.048	-0.130		21.4°C
Right Hand Touched	GSM	190/836.6	0.083	0.062	-0.150		21.4°C
Right Hand Tilted 15°	GSM	190/836.6	0.071	0.054	-0.010		21.4°C
Tested data with other batteries							
Right Hand Touched-2#	GSM	190/836.6	0.081	0.062	-0.080	32.52	21.4°C
Right Hand Touched-3#	GSM	190/836.6	0.080	0.061	0.170		21.4°C
Right Hand Touched-4#	GSM	190/836.6	0.081	0.062	0.190		21.4°C
Right Hand Touched-5#	GSM	190/836.6	0.080	0.062	0.080		21.4°C
Right Hand Touched-6#	GSM	190/836.6	0.078	0.060	-0.120		21.4°C
							21.4°C

Table 12: Test results head SAR GSM 850MHz

Test Position of Body with 10mm	Test Mode	Test channel /Frequency	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	GPRS 1TS	190/836.6	0.088	0.067	0.010	30.10	21.4°C
Towards Phantom	GPRS 2TS	190/836.6	0.110	0.083	0.040		21.4°C
Towards Ground	GPRS 2TS	190/836.6	0.332	0.244	-0.130		21.4°C
Left edge	GPRS 2TS	190/836.6	0.104	0.072	0.180		21.4°C
Right edge	GPRS 2TS	190/836.6	0.181	0.125	-0.010		21.4°C
Bottom edge	GPRS 2TS	190/836.6	0.028	0.018	-0.160		21.4°C
Towards Ground	EDGE 1TS	190/836.6	0.291	0.213	0.180	32.51	21.4°C
Towards Ground	EDGE 2TS	190/836.6	0.372	0.267	-0.140	30.09	21.4°C
Towards Ground with Headset	GSM	190/836.6	0.224	0.137	0.160	32.52	21.4°C
Tested data with other batteries							
Towards Ground-2#	EDGE 2TS	190/836.6	0.382	0.277	-0.060	30.09	21.4°C
Towards Ground-3#	EDGE 2TS	190/836.6	0.370	0.270	0.050		21.4°C
Towards Ground-4#	EDGE 2TS	190/836.6	0.395	0.288	-0.090		21.4°C
Towards Ground-5#	EDGE 2TS	190/836.6	0.405	0.296	-0.100		21.4°C
Towards Ground-6#	EDGE 2TS	190/836.6	0.392	0.287	-0.040		21.4°C
							21.4°C

Table 13: Test results Body SAR GSM 850MHz

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.

7.2.2 SAR measurement Result of GSM1900

Test Position of Head	Test Mode	Test channel /Frequency	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	GSM	661/1880	0.327	0.194	-0.150	29.72	21.4°C
Left Hand Tilted 15°	GSM	661/1880	0.100	0.059	0.140		21.4°C
Right Hand Touched	GSM	661/1880	0.254	0.159	0.170		21.4°C
Right Hand Tilted 15°	GSM	661/1880	0.113	0.063	-0.140		21.4°C
Tested data with other batteries							
Left Hand Touched-2#	GSM	661/1880	0.339	0.195	-0.120	29.72	21.4°C
Left Hand Touched-3#	GSM	661/1880	0.343	0.195	0.040		21.4°C
Left Hand Touched-4#	GSM	661/1880	0.369	0.205	0.090		21.4°C
Left Hand Touched-5#	GSM	661/1880	0.372	0.208	-0.060		21.4°C
Left Hand Touched-6#	GSM	661/1880	0.353	0.199	0.050		21.4°C

Table 14:Test results head SAR GSM 1900MHz

Test Position of Body with 10mm	Test Mode	Test channel /Frequency	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	GPRS 1TS	661/1880	0.369	0.223	0.010	29.70	21.4°C
Towards Phantom	GPRS 2TS	661/1880	0.423	0.254	-0.090	27.04	21.4°C
Towards Ground	GPRS 2TS	661/1880	0.570	0.331	0.010		21.4°C
Left edge	GPRS 2TS	661/1880	0.166	0.092	0.140		21.4°C
Right edge	GPRS 2TS	661/1880	0.072	0.042	0.150		21.4°C
Bottom edge	GPRS 2TS	661/1880	0.364	0.205	-0.160		21.4°C
Towards Ground	EDGE 1TS	661/1880	0.497	0.290	-0.030	29.71	21.4°C
Towards Ground	EDGE 2TS	661/1880	0.569	0.330	-0.060	27.02	21.4°C
Towards Ground with Headset	GSM	661/1880	0.461	0.268	-0.020	29.72	21.4°C
Tested data with other batteries							
Towards Ground-2#	GPRS 2TS	661/1880	0.552	0.321	-0.020	27.04	21.4°C
Towards Ground-3#	GPRS 2TS	661/1880	0.578	0.337	-0.060		21.4°C
Towards Ground-4#	GPRS 2TS	661/1880	0.570	0.330	-0.070		21.4°C
Towards Ground-5#	GPRS 2TS	661/1880	0.574	0.334	-0.030		21.4°C
Towards Ground-6#	GPRS 2TS	661/1880	0.570	0.330	-0.030		21.4°C

Table 15:Test results Body 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 WiFi

Test Position of Head	Test Mode	Test channel /Frequency	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	802.11 b	11/2462	0.076	0.042	0.040	16.10	21.4°C
Left Hand Tilted 15°	802.11 b	11/2462	0.071	0.035	0.140		21.4°C
Right Hand Touched	802.11 b	11/2462	0.095	0.045	-0.040		21.4°C
Right Hand Tilted 15°	802.11 b	11/2462	0.064	0.032	0.160		21.4°C
Tested data with other batteries							
Right Hand Touched-2#	802.11 b	11/2462	0.067	0.031	0.190	16.10	21.4°C
Right Hand Touched-3#	802.11 b	11/2462	0.066	0.031	0.140		21.4°C
Right Hand Touched-4#	802.11 b	11/2462	0.067	0.031	0.060		21.4°C
Right Hand Touched-5#	802.11 b	11/2462	0.139	0.064	0.160		21.4°C
Right Hand Touched-6#	802.11 b	11/2462	0.068	0.031	0.180		21.4°C

Table 16: Test results head SAR WiFi 2450MHz

Test Position of Body with 10mm	Test Mode	Test channel /Frequency	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Liquid Temp.
			1-g	10-g			
Tested data with The battery 1#							
Towards Phantom	802.11 b	11/2462	0.021	0.010	0.160	16.10	21.4°C
Towards Ground	802.11 b	11/2462	0.040	0.017	0.110		21.4°C
Right edge	802.11 b	11/2462	0.019	0.008	0.140		21.4°C
Top edge	802.11 b	11/2462	0.013	0.005	-0.140		21.4°C
Tested data with other batteries							
Towards Ground-2#	802.11 b	11/2462	0.043	0.018	-0.080	16.10	21.4°C
Towards Ground-3#	802.11 b	11/2462	0.046	0.019	0.150		21.4°C
Towards Ground-4#	802.11 b	11/2462	0.051	0.021	0.050		21.4°C
Towards Ground-5#	802.11 b	11/2462	0.044	0.019	-0.180		21.4°C
Towards Ground-6#	802.11 b	11/2462	0.046	0.020	0.120		21.4°C

Table 17: Test results Body SAR WiFi 2450MHz

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 and Left side 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.

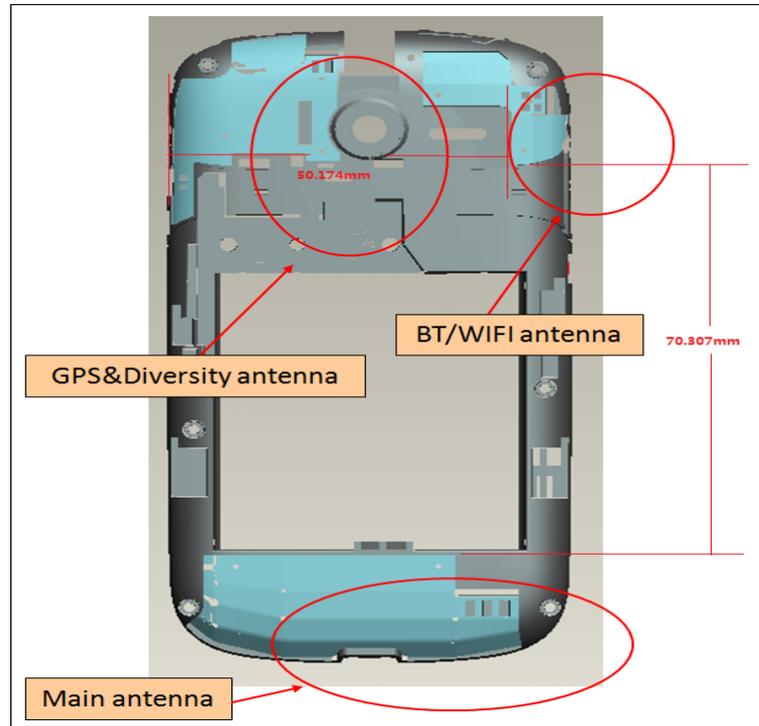
	2.45	5.15 - 5.35	5.47 - 5.85	GHz
P_{Ref}	12	6	5	mW
Device output power should be rounded to the nearest mW to compare with values specified in this table.				

Table 18: Output Power Thresholds for Unlicensed Transmitters

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

Table 19: Summary of SAR Evaluation Requirements for a Cell Phone with Multiple Transmitters

The closest distance between BT/WiFi antenna and main antenna is 7.031cm \geq 5cm, 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
	3.75	4.52	5.19

Table 20:Test results conducted power measurement BT.

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

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	14.56	14.44	14.57	14.64	/	/	/	/
	6	14.60	14.52	14.44	14.37	/	/	/	/
	11	16.10	15.58	15.21	16.00	/	/	/	/
802.11g	Channel	6	9	12	18	24	36	48	54
	1	12.42	12.8	12.30	12.15	12.49	12.32	12.27	12.52
	6	12.57	12.86	12.41	12.27	12.53	12.62	12.38	12.77
	11	12.68	12.90	12.86	12.30	12.81	12.75	12.82	12.96
802.11n HT20	Channel	6.5	13	19.5	26	39	52	58.5	65
	1	6.52	11.63	11.05	11.71	11.62	11.74	11.31	11.13
	6	6.14	11.89	11.65	11.98	11.82	11.95	11.78	12.02
	11	5.18	12.01	11.86	11.82	11.93	12.10	12.16	11.91

Table 21:Test results conducted power measurement WiFi .

Note:

1. The 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.

7.3.1 Stand-alone SAR

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

Stand-alone SAR evaluation is required for WiFi, because the output power of WiFi unlicensed transmitter is $16.10\text{dBm} \geq 24\text{mW}$ (13.8dBm).

Stand-alone SAR evaluation is not required for BT, because the Max output power of BT unlicensed transmitter is $5.19\text{dBm} < 24\text{mW}$ (13.8dBm), and its antenna(s) is $7.031\text{cm} > 5\text{cm}$ from main antenna.

7.3.2 SAR Summation Scenario

Test Position	GSM&WCDMA SAR _{Max}		WiFi SAR _{Max}	Σ1-g SAR _{max}
	GSM850	GSM1900		
Head SAR (W/kg)				
Left Hand Touched	0.066	0.372	0.076	0.448
Left Hand Tilted 15°	0.063	0.100	0.071	0.171
Right Hand Touched	0.083	0.254	0.095	0.349
Right Hand Tilted 15°	0.071	0.113	0.064	0.177
Body-Worn SAR (W/kg)				
Towards Phantom	0.110	0.423	0.021	0.444
Towards Ground	0.405	0.578	0.051	0.629
Hotspot SAR (W/kg)				
Towards Phantom	0.110	0.423	0.021	0.444
Towards Ground	0.405	0.578	0.051	0.629
Left edge	0.104	0.166	0.020	0.186
Right edge	0.181	0.072	0.000	0.181
Top edge	0.000	0.000	0.013	0.013
Bottom edge	0.028	0.364	0.000	0.364

Table 22: Simultaneous Tx Combination

Note:

For the transmitters requiring stand-alone SAR testing(GSM/WCDMA and WiFi),the KDB guidelines direct that if the sum of the 1-g SAR measured for the simultaneously transmitting antennas is less than the SAR limit, SAR evaluation for simultaneous transmission is not required.

Simultaneous Transmission SAR evaluation is not required for WiFi and GSM, because t the sum of the 1g SAR is $0.629\text{W/kg} < 1.6\text{W/kg}$ for WiFi and GSM..

Simultaneous Transmission SAR evaluation is not required for BT and GSM, because stand-alone SAR evaluation is not required for BT, and its antenna(s) is $7.031\text{cm} > 5\text{cm}$ from main antenna.

Simultaneous Transmission SAR evaluation is not required for BT and WiFi, because they share the same antenna.

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