FCC SAR Compliance Test Report

Product Name:	Smart Phone; HUAWEI Ascend G630
Model:	HUAWEI G630-U20, G630-U20
Report No.:	SYBH(Z-SAR)020022014-2
FCC ID:	QISG630-U20

	APPROVED (Lab Manager)	PREPARED (Test Engineer)
BY	Alvinway	gongzhong
DATE	2014-03-12	2014-03-12

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※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2014-03-12	Gong Zhong

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI G630-U20, G630-U20 are as below Table 1.

Band	Max Reported SAR(W/kg)		
	1-g Head	1-g Body-worn (15mm) *	1-g Hotspot (10mm)
GSM850	0.242	0.342	0.452
GSM1900	0.209	**0.431**	**1.085**
WiFi	**1.152**	0.154	0.344
The highest simultaneous SAR value is 1.426W/kg per KDB690783 D01			

Table 1:Summary of test result

Note:

1)* 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 15mm 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/uncontraolled exposure limits 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.

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

<table>
<tr><td colspan="4">Device Information：</td></tr>
<tr><td>DUT Name:</td><td colspan="3">Smart Phone; HUAWEI Ascend G630</td></tr>
<tr><td>Type Identification:</td><td colspan="3">HUAWEI G630-U20, G630-U20</td></tr>
<tr><td>FCC ID :</td><td colspan="3">QISG630-U20</td></tr>
<tr><td>SN No.:</td><td colspan="3">Z3S01A9412200354</td></tr>
<tr><td>Device Type :</td><td colspan="3">Portable device</td></tr>
<tr><td>Exposure Category:</td><td colspan="3">Uncontrolled environment / general population</td></tr>
<tr><td>Hardware Version :</td><td colspan="3">HD1G630M</td></tr>
<tr><td>Software Version :</td><td colspan="3">G630-U20V100R001C00B105</td></tr>
<tr><td>Antenna Type :</td><td colspan="3">Internal antenna</td></tr>
<tr><td>Others Accessories</td><td colspan="3">Headset</td></tr>
<tr><td colspan="4">Device Operating Configurations:</td></tr>
<tr><td>Supporting Mode(s)</td><td colspan="3">GSM850/1900,WiFi (tested),BT</td></tr>
<tr><td>Test Modulation</td><td colspan="3">GSM(GMSK/8PSK), UMTS(QPSK),WIFI(BPSK)</td></tr>
<tr><td>Device Class</td><td colspan="3">B</td></tr>
<tr><td rowspan="6">Operating Frequency Range(s)</td><td>Band</td><td>Tx (MHz)</td><td>Rx (MHz)</td></tr>
<tr><td>GSM850</td><td>824-849</td><td>869-894</td></tr>
<tr><td>GSM1900</td><td>1850-1910</td><td>1930-1990</td></tr>
<tr><td>BT</td><td colspan="2">2402-2480</td></tr>
<tr><td>WiFi</td><td colspan="2">2412-2462</td></tr>
<tr><td>NFC</td><td colspan="2">13.56</td></tr>
<tr><td rowspan="3">GPRS Multislot Class(12)</td><td colspan="2">Max Number of Timeslots in Uplink:</td><td>4</td></tr>
<tr><td colspan="2">Max Number of Timeslots in Downlink:</td><td>4</td></tr>
<tr><td colspan="2">Max Total Timeslot:</td><td>5</td></tr>
<tr><td rowspan="3">EGPRS Multislot Class(12)</td><td colspan="2">Max Number of Timeslots in Uplink:</td><td>4</td></tr>
<tr><td colspan="2">Max Number of Timeslots in Downlink:</td><td>4</td></tr>
<tr><td colspan="2">Max Total Timeslot:</td><td>5</td></tr>
<tr><td rowspan="2">Power Class:</td><td colspan="3">4,tested with power level 5(GSM850)</td></tr>
<tr><td colspan="3">1,tested with power level 0(GSM1900)</td></tr>
<tr><td rowspan="3">Test Channels (low-mid-high):</td><td colspan="3">128-190-251 (GSM850)</td></tr>
<tr><td colspan="3">512-661-810 (GSM1900)</td></tr>
<tr><td colspan="3">1-6-11 (WiFi 2450)</td></tr>
</table>

Table 3:Device information and operating configuration

1.3.1 General Description

HUAWEI G630-U20, G630-U20 is subscriber equipment in the WCDMA/GSM system. The HSPA+/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, HSPA+/UMTS and GSM/GPRS/EDGE protocol processing, voice, video MMS service, GPS, NFC,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#:SN-SUCD321925300191 2#:SN-SUDB18925346463	Battery Model: HB3742A0EBC Rated capacity: 2000mAh Nominal Voltage: ⎓ +3.8V Charging Voltage: ⎓ +4.35V

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)
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
KDB941225 D06	Hot Spot SAR v01r01
KDB447498 D01	General RF Exposure Guidance v05r02
KDB648474 D04	SAR Handsets Multi Xmiter and Ant v01r02
KDB248227 D01	SAR meas for 802.11 a/b/g v01r02
KDB865664 D01	SAR measurement 100 MHz to 6 GHz v01r03
KDB865664 D02	SAR Reporting v01r01
KDB690783 D01	SAR Listings on Grants v01r03

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

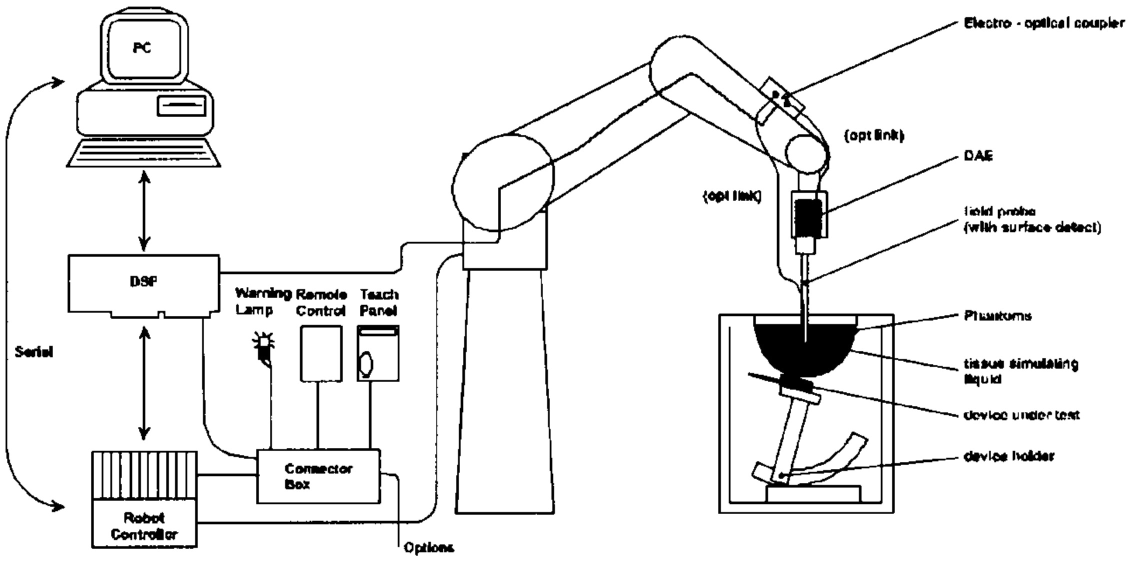
Start Date of test	2014-02-21
End Date of test	2014-03-03

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 7.
- 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

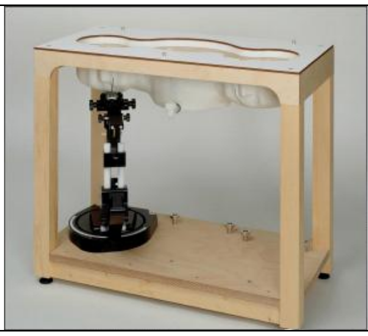
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic range	5 µW/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

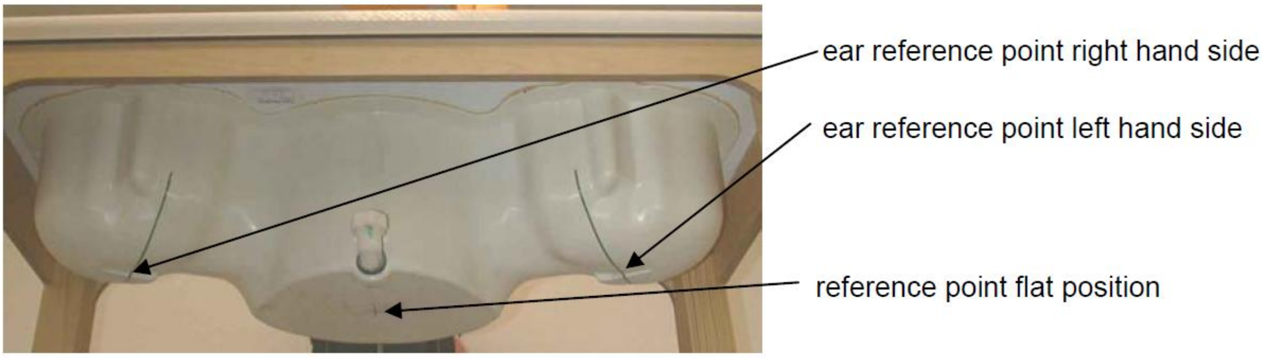
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic range	10 µW/g to > 100 mW/g; Linearity: ± 0.2 dB(noise:typically<1µW/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

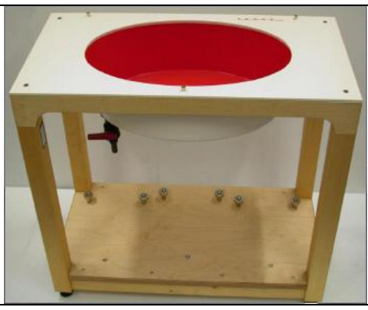
SAM Twin Phantom

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.		

The following figure shows the definition of reference point:



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.		

The phantom shell material is resistant to all ingredients used in the tissue-equivalent liquid recipes. The shell of the phantom including ear spacers is constructed from low permittivity and low loss material, with a relative permittivity ≤5 and a loss tangent ≤0.05.

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.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent σ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.
The device holder permits the device to be positioned with a tolerance of ±1° in the tilt angle.

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	3744	2013-07-26	One year
☐	SPEAG	Dosimetric E-Field Probe	EX3DV4	3736	2013-05-10	One year
☒	SPEAG	Dosimetric E-Field Probe	ES3DV3	3168	2013-09-30	One year
☒	SPEAG	835 MHz Dipole	D835V2	4d059	2013-05-02	Three years
☐	SPEAG	1800 MHz Dipole	D1800V2	2d157	2013-11-27	Three years
☒	SPEAG	1900 MHz Dipole	D1900V2	5d143	2011-09-26	Three years
☐	SPEAG	2300 MHz Dipole	D2300V2	1016	2011-11-22	Three years
☒	SPEAG	2450 MHz Dipole	D2450V2	735	2013-06-11	Three years
☐	SPEAG	2600 MHz Dipole	D2600V2	1021	2011-11-22	Three years
☐	SPEAG	5GHz Dipole	D5GHzV2	1155	2013-06-04	Three years
☐	SPEAG	Data acquisition electronics	DAE4	851	2013-07-31	One year
☒	SPEAG	Data acquisition electronics	DAE4	852	2013-11-27	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	2013-06-08	One year
☐	R & S	Universal Radio Communication Tester	CMU 200	111379	2013-08-09	One year
☒	Agilent	Network Analyser	E5071B	MY42404956	2014-01-11	One year
☒	Agilent	Dielectric Probe Kit	85070E	2484	N/A	NA
☒	Agilent	Signal Generator	N5181A	MY47420989	2014-01-18	One year
☒	MINI-CIRCUITS	Amplifier	ZHL-42W	QA1123001	N/A	NA
☐	MINI-CIRCUITS	Amplifier	ZVE-8G+	129601322	N/A	NA
☒	AR	Directional Coupler	DC7144M1	311190	2013-05-13	One year
☒	SHX	Directional Coupler	DDTO/4/20	07122401	2013-10-17	One year
☒	R & S	Power Meter	NRP	MY44420359	2013-08-28	One year
☒	R & S	Power Meter Sensor	NRP-Z11	100740	2013-08-28	One year
☒	Agilent	Power Meter	E4417A	MY45101339	2014-01-18	One year
☒	Agilent	Power Meter Sensor	E9321A	MY44420359	2014-01-18	One year

Note:

1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. 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 check with specific dipole is within 10% of calibrated value;

c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.

d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually 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 ± 0.1mm). 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 ± 30°.)

- 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(≤2GHz)，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: Δx_{zoom}, Δy_{zoom}≤ 2GHz - ≤8mm, 2-4GHz - ≤5 mm and 4-6 GHz-≤4mm; Δz_{zoom} ≤3GHz - ≤5 mm, 3-4 GHz- ≤4mm and 4-6GHz-≤2mm 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 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.

The following table summarizes the area scan and zoom scan resolutions per FCC KDB 865664D01:

Frequency	Maximun Area Scan resolution (Δx_{area}, Δy_{area})	Maximun Zoom Scan spatial resolution (Δx_{Zoom}, Δy_{Zoom})	Maximun Zoom Scan spatial resolution			Minimum zoom scan volume (x,y,z)
			Uniform Grid	Graded Grad		
			$\Delta z_{Zoom}(n)$	$\Delta z_{Zoom}(1)$*	$\Delta z_{Zoom}(n>1)$*	
≤2GHz	≤15mm	≤8mm	≤5mm	≤4mm	≤1.5*Δz_{Zoom}(n-1)	≥30mm
2-3GHz	≤12mm	≤5mm	≤5mm	≤4mm	≤1.5*Δz_{Zoom}(n-1)	≥30mm
3-4GHz	≤12mm	≤5mm	≤4mm	≤3mm	≤1.5*Δz_{Zoom}(n-1)	≥28mm
4-5GHz	≤10mm	≤4mm	≤3mm	≤2.5mm	≤1.5*Δz_{Zoom}(n-1)	≥25mm
5-6GHz	≤10mm	≤4mm	≤2mm	≤2mm	≤1.5*Δz_{Zoom}(n-1)	≥22mm

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 5 x 5 x 7 points(with 8mm horizontal resolution) or 7 x 7 x 7 points(with 5mm horizontal resolution) or 8 x 8 x 7 points(with 4mm horizontal resolution). 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 compansate 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/cm^3

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

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

with
- P_{pwe} = equivalent power density of a plane wave in mW/cm^2
- 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 dielectic parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ± 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, 16MΩ+ 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
		εr (+/-5%)	σ (S/m) (+/-5%)	εr	σ (S/m)		
835H	825	41.60 (39.52~43.68)	0.90 (0.86~0.95)	42.51	0.914	21.6°C	2014-02-21
	835	41.50 (39.43~43.58)	0.90 (0.86~0.95)	42.24	0.931		
	850	41.50 (39.43~43.58)	0.92 (0.87~0.96)	42.15	0.939		
835B	825	55.20 (52.44~57.96)	0.97 (0.92~1.02)	53.31	0.956	21.8°C	2014-02-21
	835	55.20 (52.44~57.96)	0.97 (0.92~1.02)	53.52	0.955		
	850	55.20 (52.44~57.96)	0.99 (0.94~1.04)	53.02	0.976		
1900H	1850	40.00 (38.00~42.00)	1.40 (1.33~1.47)	40.72	1.367	21.4°C	2014-02-26
	1880	40.00 (38.00~42.00)	1.40 (1.33~1.47)	40.51	1.396		
	1900	40.00 (38.00~42.00)	1.40 (1.33~1.47)	40.54	1.413		
	1910	40.00 (38.00~42.00)	1.40 (1.33~1.47)	40.45	1.422		

1900B	1850	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.59	1.504	21.4°C	2014-02-26
	1880	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.59	1.526		
	1900	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.53	1.550		
	1910	53.30 (50.64~55.97)	1.52 (1.44~1.60)	51.44	1.562		
2450H	2410	39.30 (37.34~41.26)	1.76 (1.67~1.85)	38.95	1.782	21.4°C	2014-03-03
	2435	39.20 (37.24~41.16)	1.79 (1.70~1.88)	38.98	1.827		
	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	38.86	1.823		
	2460	39.20 (37.24~41.16)	1.81 (1.72~1.90)	38.79	1.840		
2450B	2410	52.80 (50.16~55.44)	1.91 (1.81~2.00)	51.18	1.965	21.5°C	2014-02-28
	2435	52.70 (50.07~55.34)	1.94 (1.84~2.04)	51.28	1.998		
	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	51.17	2.013		
	2460	52.70 (50.07~55.34)	1.96 (1.86~2.06)	51.10	2.025		
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 865664 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).

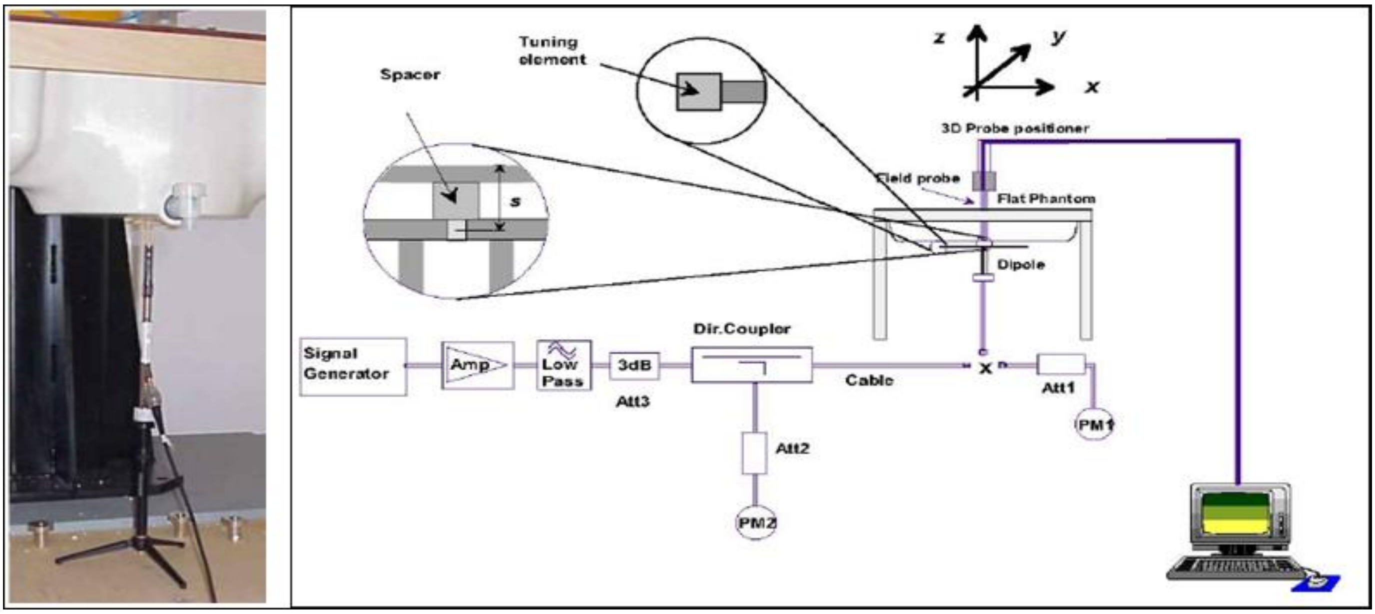
System Check	Target SAR (1W) (+/-10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (mW/g)	10-g (mW/g)	1-g (mW/g)	10-g (mW/g)		
D835V2 Head	9.49 (8.54~10.44)	6.18 (5.56~6.80)	9.44	6.12	21.6°C	2014-02-21
D1900V2 Head	40.60 (36.54~44.66)	21.20 (19.08~23.32)	40.40	21.12	21.4°C	2014-02-26
D2450V2 Head	52.60 (47.34~57.86)	24.60 (22.14~27.06)	56.40	25.68	21.4°C	2014-03-03
D835V2 Body	9.42 (8.48~10.36)	6.19 (5.57~6.80)	10.04	6.60	21.8°C	2014-02-21
D1900V2 Body	41.40 (37.26~45.54)	21.80 (19.62~23.98)	42.00	21.76	21.4°C	2014-02-26
D2450V2 Body	51.9 (46.71~57.09)	24.2 (21.78~26.62)	56.00	25.60	21.5°C	2014-02-28

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(below 5GHz) or 100mW(above 5GHz). 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 SAR measurement variability and uncertainty

5.1 SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r03, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ⩾ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ⩾ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ⩾ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 7.2.

5.2 SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03,when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

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 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. The EGPRS class is 12 for this EUT, it only supports 4 timeslots in downlink, the maximum total timeslot is 5.

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
	2TX slots	3	3	0
	3 TX slots	4	4	2
	4 TX slots	5	5	3
GSM1900	1 TX slot	0	0	0
	2TX slots	2	2	1
	3 TX slots	3	3	2
	4 TX slots	4	4	4

Table 7: The allowed power reduction in the multi-slot configuration of GSM.

6.2 WiFi 2.4G 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	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 KDB 248227

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	1:8.3	1:4.1	1:2.77	1:2.08
timebased avg. power compared to slotted avg. power	-9.19dB	-6.13dB	-4.42dB	-3.18dB

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 of GSM850

GSM850		Burst-Averaged output Power (dBm)			Division Factors	Frame-Averaged output Power (dBm)		
		128CH	190CH	251CH		128CH	190CH	251CH
GSM (CS)		33.02	33.03	32.97	-9.19	23.83	23.84	23.78
GPRS (GMSK)	1 Tx Slot	33.00	33.01	32.96	-9.19	23.81	23.82	23.77
	2 Tx Slots	30.67	30.59	30.57	-6.16	24.54	24.46	24.44
	3 Tx Slots	29.60	29.57	29.58	-4.42	25.18	25.15	25.16
	4 Tx Slots	28.49	28.47	28.49	-3.18	**25.31**	**25.29**	**25.31**
EGPRS (GMSK)	1 Tx Slot	32.67	32.79	32.68	-9.19	23.48	23.60	23.49
	2 Tx Slots	30.68	30.56	30.59	-6.16	24.55	24.43	24.46
	3 Tx Slots	29.58	29.59	29.57	-4.42	25.16	25.17	25.15
	4 Tx Slots	28.47	28.46	28.45	-3.18	25.29	25.28	25.27
EGPRS (8PSK)	1 Tx Slot	27.37	27.39	27.37	-9.19	18.18	18.20	18.18
	2 Tx Slots	27.30	27.27	27.28	-6.16	21.17	21.14	21.15
	3 Tx Slots	24.86	24.87	24.89	-4.42	20.44	20.45	20.47
	4 Tx Slots	23.67	23.69	23.68	-3.18	20.49	20.51	20.50

Table 8:Conducted power measurement results of GSM850

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 timesolts.

3) Per KDB 941225 D03v01,the bolded GPRS 4Tx mode was selected for SAR testing according to the highest frame –averaged output power table.

7.1.2 Conducted power measurements of GSM1900

GSM1900		Burst-Averaged output Power (dBm)			Division Factors	Frame-Averaged output Power (dBm)		
		512CH	661CH	810CH		512CH	661CH	810CH
GSM (CS)		30.39	30.33	30.43	-9.19	21.20	21.14	21.24
GPRS (GMSK)	1 Tx Slot	30.36	30.33	30.41	-9.19	21.17	21.14	21.22
	2 Tx Slots	27.27	27.29	27.27	-6.16	21.14	21.16	21.14
	3 Tx Slots	26.70	26.67	26.68	-4.42	22.28	22.25	22.26
	4 Tx Slots	25.61	25.64	25.62	-3.18	**22.43**	**22.46**	**22.44**
EGPRS (GMSK)	1 Tx Slot	29.87	29.89	29.88	-9.19	20.68	20.70	20.69
	2 Tx Slots	27.28	27.26	27.29	-6.16	21.15	21.13	21.16
	3 Tx Slots	26.68	26.69	26.67	-4.42	22.26	22.27	22.25
	4 Tx Slots	25.57	25.56	25.56	-3.18	22.39	22.38	22.38
EGPRS (8PSK)	1 Tx Slot	25.87	25.89	25.87	-9.19	16.68	16.70	16.68
	2 Tx Slots	25.80	25.77	25.78	-6.16	19.67	19.64	19.65
	3 Tx Slots	23.46	23.47	23.49	-4.42	19.04	19.05	19.07
	4 Tx Slots	22.17	22.19	22.18	-3.18	18.99	19.01	19.00

Table 9: Conducted power measurement results of GSM1900

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 timesolts.

3) Per KDB 941225 D03v01,the bolded GPRS 4Tx mode was selected for SAR testing according to the highest frame –averaged output power table.

7.1.3 Conducted power measurements of WiFi 2.4G

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	16.12	16.03	15.78	15.36	/	/	/	/
	6	16.02	15.72	15.41	15.17	/	/	/	/
	11	16.21	16.08	15.63	15.44	/	/	/	/
802.11g	Channel	6	9	12	18	24	36	48	54
	1	11.88	11.75	11.73	11.66	11.32	10.46	10.22	9.31
	6	11.63	11.41	11.28	11.02	10.56	10.39	10.17	9.03
	11	11.69	11.42	11.22	11.52	11.33	10.46	10.21	9.16
802.11n (HT20,800ns)	Channel	6.5	13	19.5	26	39	52	58.5	65
	1	10.06	9.68	9.37	8.89	8.44	8.57	8.03	7.35
	6	9.65	9.35	9.21	8.76	8.45	7.89	7.26	6.96
	11	9.82	9.45	9.21	8.79	8.56	8.21	7.68	7.14

Table 10: Conducted power measurement results of WiFi 2.4G.

Note:
1) The Average conducted power of WiFi is measured with RMS detector.
2) Per KDB248227, for WiFi 2.4GHz, highest average RF output power channel for the lowest data rate of 802.11b mode was selected for SAR evalutation. SAR test at higher data rates and higher order modulations (including 802.11g/n) were not required since the maximum average output power for each of these configurations is not more than 1/4dB higher than the tested channel for the lowest data rate of 802.11b mode.

7.1.4 Conducted power measurements of BT

The output power of BT antenna is as following:

BT 2450	Average Conducted Power (dBm)		
	0CH	39CH	78CH
DH5	1.65	1.97	1.90
2DH5	-0.75	-0.38	-0.68
3DH5	-0.84	-0.45	-0.72

BT 2450	Average Conducted Power (dBm)		
	0CH	19CH	39CH
BT(4.0)	-0.63	-0.79	-0.86

Table 11: Conducted power measurement results of BT.

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

7.2 SAR measurement Results

General Notes:

1) Per KDB447498 D01v05r02, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demostrate compliant.

2) Per KDB447498 D01v05r02, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is: ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.

3) Per KDB865664 D01v01r03,for each frequency band,repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg,only one repeated measurement is required.

4) Per KDB941225 D06v01r01, the DUT Dimension is bigger than 9 cm x 5 cm, so 10mm is chosen as the test separation distance for Hotspot mode. When the antenna-to-edge distance is greater than 2.5cm,such position does not need to be tested.

5) Per KDB648474 D04v01r02, SAR is evaluated without a headset connected to the device.When the standalone reported SAR is ≤1.2 W/kg, no additional SAR evaluations using a headset are required.

GSM Notes:

1) Per KDB648474 D04v01r02, body-worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.

2) Per KDB941225 D03v01, when multiple slots can be used, the GPRS/EDGE slot configuration with the highest frame–averaged output power was selected for SAR testing.

WLAN Notes:

Per KDB248227D01v01r02 and October 2012/April 2013 FCC/TCB workshop meeting notes:

1) For WiFi 2.4GHz, highest average RF output power channel for the lowest data rate of 802.11b mode was selected for SAR evalutation. SAR test at higher data rates and higher order modulations (including 802.11g/n) were not required since the maximum average output power for each of these configurations is not more than 1/4dB higher than the tested channel for the lowest data rate of 802.11b mode.

7.2.1 SAR measurement Result of GSM850

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	190/836.6	GSM	0.217	0.166	-0.050	33.03	33.50	0.242	21.6°C
Left Hand Tilted 15°	190/836.6	GSM	0.116	0.090	0.040	33.03	33.50	0.129	21.6°C
Right Hand Touched	190/836.6	GSM	0.186	0.143	0.160	33.03	33.50	0.207	21.6°C
Right Hand Tilted 15°	190/836.6	GSM	0.108	0.083	0.020	33.03	33.50	0.120	21.6°C
Tested at worst position with the battery 2#									
Left Hand Touched	190/836.6	GSM	0.217	0.165	0.010	33.03	33.50	**0.242**	21.6°C

Table 12: Head SAR test results of GSM850

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	190/836.6	GSM	0.275	0.213	-0.010	33.03	33.50	0.306	21.8°C
Back Side	190/836.6	GSM	0.307	0.236	0.010	33.03	33.50	0.342	21.8°C
Tested at worst position with the battery 2#									
Back Side	190/836.6	GSM	0.306	0.235	-0.010	33.03	33.50	**0.341**	21.8°C

Table 13: Body-Worn SAR test results of GSM850

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	190/836.6	GPRS 4TS	0.312	0.243	0.040	28.47	29.00	0.352	21.8°C
Back Side	190/836.6	GPRS 4TS	0.396	0.308	0.170	28.47	29.00	0.447	21.8°C
Left Side	190/836.6	GPRS 4TS	0.351	0.243	0.070	28.47	29.00	0.397	21.8°C
Right Side	190/836.6	GPRS 4TS	0.266	0.183	0.100	28.47	29.00	0.301	21.8°C
Bottom Side	190/836.6	GPRS 4TS	0.113	0.066	0.180	28.47	29.00	0.128	21.8°C
Tested at worst position with the battery 2#									
Back Side	190/836.6	GPRS 4TS	0.400	0.310	0.010	28.47	29.00	**0.452**	21.8°C

Table 14: Hotspot SAR test results of GSM850

7.2.2 SAR measurement Result of GSM1900

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	661/1880	GSM	0.139	0.088	0.090	30.33	31.00	0.162	21.4°C
Left Hand Tilted 15°	661/1880	GSM	0.075	0.046	-0.020	30.33	31.00	0.088	21.4°C
Right Hand Touched	661/1880	GSM	0.173	0.111	-0.100	30.33	31.00	0.202	21.4°C
Right Hand Tilted 15°	661/1880	GSM	0.107	0.069	-0.040	30.33	31.00	0.125	21.4°C
Tested at worst position with the battery 2#									
Right Hand Touched	661/1880	GSM	0.179	0.114	0.070	30.33	31.00	**0.209**	21.4°C

Table 15: Head SAR test results of GSM1900

Test Position of Body-Worn with 15mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	661/1880	GSM	0.225	0.133	-0.040	30.33	31.00	0.263	21.4°C
Back Side	661/1880	GSM	0.369	0.213	0.110	30.33	31.00	**0.431**	21.4°C
Tested at worst position with the battery 2#									
Back Side	661/1880	GSM	0.365	0.211	0.070	30.33	31.00	0.426	21.4°C

Table 16: Body-Worn SAR test results of GSM1900

Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR_{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	661/1880	GPRS 4TS	0.429	0.241	0.040	25.64	26.50	0.523	21.4°C
Back Side	810/1909.8	GPRS 4TS	0.886	0.477	0.000	25.62	26.50	**1.085**	21.4°C
Back Side-repeated*	810/1909.8	GPRS 4TS	0.851	0.462	0.080	25.62	26.50	1.042	21.4°C
Back Side	661/1880	GPRS 4TS	0.743	0.406	0.040	25.64	26.50	0.906	21.4°C
Back Side	512/1850.2	GPRS 4TS	0.738	0.407	0.090	25.61	26.50	0.906	21.4°C
Left Side	661/1880	GPRS 4TS	0.091	0.055	0.070	25.64	26.50	0.111	21.4°C
Right Side	661/1880	GPRS 4TS	0.095	0.057	-0.010	25.64	26.50	0.116	21.4°C
Bottom Side	661/1880	GPRS 4TS	0.637	0.342	-0.110	25.64	26.50	0.776	21.4°C
Tested at worst position with the battery 2#									
Back Side	810/1909.8	GPRS 4TS	0.865	0.473	0.090	25.62	26.50	1.059	21.4°C

Table 17: Hotspot SAR test results of GSM1900

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

7.2.3 SAR measurement Result of WiFi 2.4G

Test Position of Head	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR_{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Left Hand Touched	11/2462	802.11 b	0.652	0.322	0.170	16.21	18.00	0.985	21.4°C
Left Hand Touched	6/2437	802.11 b	0.681	0.341	0.080	16.02	18.00	1.074	21.4°C
Left Hand Touched	1/2412	802.11 b	0.620	0.312	0.020	16.12	18.00	0.956	21.4°C
Left Hand Tilted 15°	11/2462	802.11 b	0.479	0.222	-0.050	16.21	18.00	0.723	21.4°C
Right Hand Touched	11/2462	802.11 b	0.451	0.237	0.020	16.21	18.00	0.681	21.4°C
Right Hand Tilted 15°	11/2462	802.11 b	0.524	0.255	0.030	16.21	18.00	0.791	21.4°C
Tested at worst position with the battery 2#									
Left Hand Touched	6/2437	802.11 b	0.730	0.360	0.000	16.02	18.00	**1.152**	21.4°C

Table 18: Head SAR test results of 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 Power (dBm)	Scaled SAR_{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	11/2462	802.11 b	0.102	0.060	0.130	16.21	18.00	**0.154**	21.5°C
Back Side	11/2462	802.11 b	0.091	0.049	0.020	16.21	18.00	0.138	21.5°C
Tested at worst position with the battery 2#									
Front Side	11/2462	802.11 b	0.098	0.059	-0.030	16.21	18.00	0.148	21.5°C

Table 19: Body-Worn SAR test results of WiFi 2450MHz

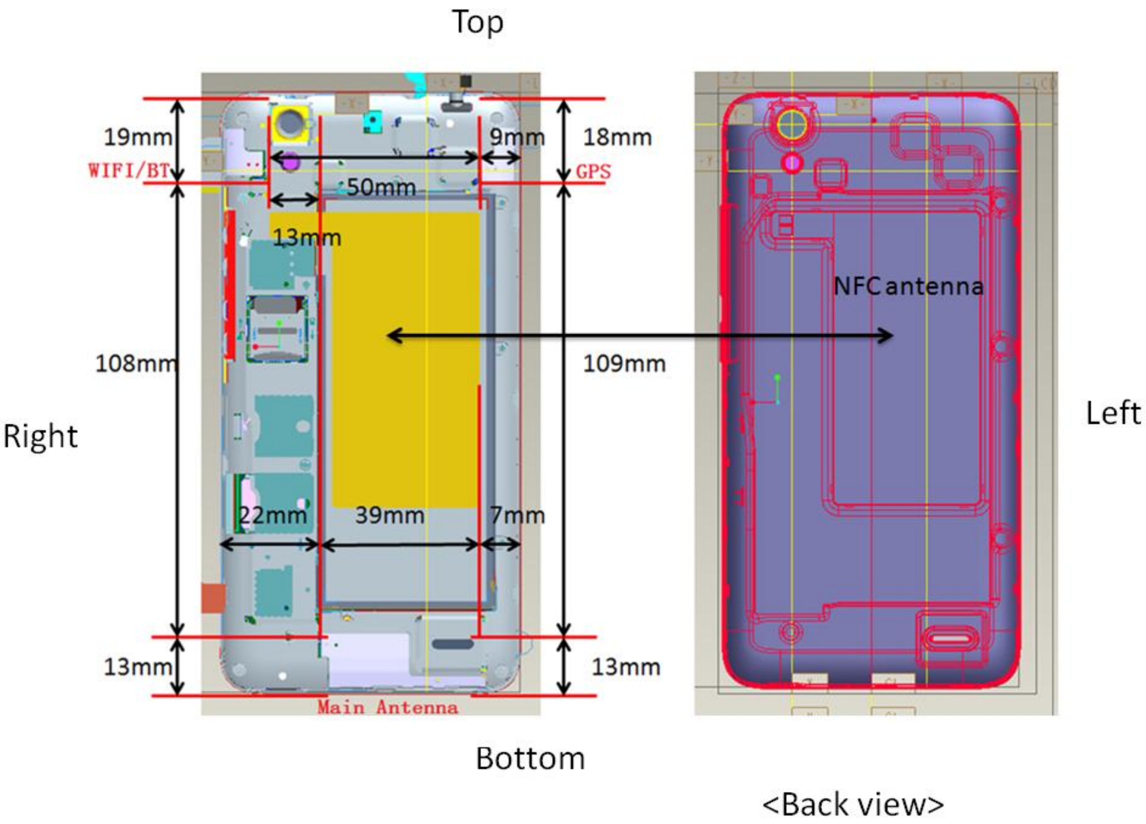
Test Position of Hotspot with 10mm	Test channel /Frequency	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR_{1-g} (W/kg)	Liquid Temp.
			1-g	10-g					
Test data with the battery 1#									
Front Side	11/2462	802.11 b	0.187	0.109	0.090	16.21	18.00	0.282	21.5°C
Back Side	11/2462	802.11 b	0.226	0.122	0.130	16.21	18.00	0.341	21.5°C
Right Side	11/2462	802.11 b	0.135	0.068	-0.030	16.21	18.00	0.204	21.5°C
Top Side	11/2462	802.11 b	0.228	0.121	0.010	16.21	18.00	**0.344**	21.5°C
Tested at worst position with the battery 2#									
Back Side	11/2462	802.11 b	0.176	0.100	0.090	16.21	18.00	0.266	21.5°C

Table 20: Hotspot SAR test results of WiFi 2450MHz

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 v05r02.

The location of the antennas inside mobile phone is shown as below picture:



Note: The NFC antenna is integrated onto the back cover. The SAR tests were performed with the back cover.

Mode	Exposure Condition	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
GSM850	Hotspot	Yes	Yes	Yes	Yes	NO	Yes
GSM1900	Hotspot	Yes	Yes	Yes	Yes	NO	Yes
WiFi	Hotspot	Yes	Yes	NO	Yes	Yes	NO

Table 21: Sides for SAR testing

Note: Per KDB 941225 D06, particular DUT edges were not required to be evaluated for Hotspot SAR if the antenna-to-edge distance is greater than 2.5cm.

7.3.1 Stand-alone SAR test exclusion

Per FCC KDB 447498D01v05, the 1-g SAR and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

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)	Calculation Result	SAR Exclusion threshold	SAR test exclusion
BT	Body-Worn	3.50	2.24	15	2.450	0.23	3.0	Yes

Table 22: Standalone SAR test exclusion for BT

Note:

1)* - maximum possible output power declared by manufacturer

2) Held to ear configurations are not applicable to Bluetooth for this device.

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] •

[√ f(GHz)/x] W/kg for test separation distances ≤ 50 mm,where x = 7.5 for 1-g SAR and x = 18.75 for 10-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	Body-worn	3.50	2.24	10	2.450	7.5	0.047

Table 23: Estimated SAR calculation for BT

Note: * - maximum possible output power declared by manufacturer

7.3.2 Simultaneous Transmission Possibilities

Per FCC KDB 447498D01v05 r02, SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions, including network hand-offs, is greater than 30 seconds.This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis.

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Head	Body-Worn	Hotspot
1	GSM 850/1900(Voice) + WiFi 2.4G	Yes	Yes	N/A
2	GPRS/EDGE 850/1900 (DATA) + WiFi 2.4G	N/A	N/A	Yes
5	GSM 850/1900(Voice) + BT	N/A	Yes	N/A

Table 24: Simultaneous Transmission Possibilities

Note:

1) BT and WiFi share the same antenna and can't transmit simultaneously.

2) The device does not support DTM function.

3) Held to ear configurations are not applicable to Bluetooth and therefore were not considered for simultaneous transmission.

7.3.3 SAR Summation Scenario

Test Position		Scaled SAR_{Max} GSM850	Scaled SAR_{Max} WiFi	ΣSAR	SPLSR	Remark
Head	Left Hand Touched	0.242	1.152	1.394	N/A	N/A
	Left Hand Tilted 15°	0.129	0.723	0.852	N/A	N/A
	Right Hand Touched	0.207	0.681	0.888	N/A	N/A
	Right Hand Tilted 15°	0.120	0.791	0.911	N/A	N/A
Body-Worn	Front Side	0.306	0.154	0.460	N/A	N/A
	Back Side	0.342	0.138	0.480	N/A	N/A
Hotspot	Front Side	0.352	0.282	0.634	N/A	N/A
	Back Side	0.452	0.341	0.793	N/A	N/A
	Left Side	0.397	/	0.397	N/A	N/A
	Right Side	0.301	0.204	0.505	N/A	N/A
	Top Side	/	0.344	0.344	N/A	N/A
	Bottom Side	0.128	/	0.128	N/A	N/A

Table 25: Simultaneous Tx Combination of GSM850 and WiFi.

Test Position		Scaled SAR_{Max}		ΣSAR	SPLSR	Remark
		GSM1900	WiFi			
Head	Left Hand Touched	0.162	1.152	1.314	N/A	N/A
	Left Hand Tilted 15°	0.088	0.723	0.811	N/A	N/A
	Right Hand Touched	0.209	0.681	0.890	N/A	N/A
	Right Hand Tilted 15°	0.125	0.791	0.916	N/A	N/A
Body-Worn	Front Side	0.263	0.154	0.417	N/A	N/A
	Back Side	0.431	0.138	0.569	N/A	N/A
Hotspot	Front Side	0.523	0.282	0.805	N/A	N/A
	Back Side	1.085	0.341	**1.426**	N/A	N/A
	Left Side	0.111	/	0.111	N/A	N/A
	Right Side	0.116	0.204	0.320	N/A	N/A
	Top Side	/	0.344	0.344	N/A	N/A
	Bottom Side	0.776	/	0.776	N/A	N/A

Table 26: Simultaneous Tx Combination of GSM1900 and WiFi.

Test Position		Scaled SAR_{Max}		ΣSAR	SPLSR	Remark
		GSM850	BT			
Body-Worn	Front Side	0.306	0.047	0.353	N/A	N/A
	Back Side	0.342	0.047	0.389	N/A	N/A

Table 27: Simultaneous Tx Combination of GSM850 and BT.

Test Position		Scaled SAR_{Max}		ΣSAR	SPLSR	Remark
		GSM1900	BT			
Body-Worn	Front Side	0.263	0.047	0.310	N/A	N/A
	Back Side	0.431	0.047	0.478	N/A	N/A

Table 28: Simultaneous Tx Combination of GSM1900 and BT.

7.3.4 Simultaneous Transmission Conlcusion

The above numeral summed SAR results and SPLSR analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore simultaneous transmission SAR with Volume Scans is not required per KDB 447498 D01v05r02.

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