

## FCC SAR Compliance Test Report

Project Name: cdma2000 Digital Mobile Phone; Asura

Model : HUAWEI H881C, H881C

FCC ID : QISH881C

Report No. : SYBH(Z-SAR)003112012-2

|      | APPROVED           | CHECKED         | PREPARED         |
|------|--------------------|-----------------|------------------|
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| DATE | 2012-11-14         | 2012-11-14      | 2012-11-14       |

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※ ※ **Modified History** ※ ※

| REV.    | DESCRIPTION     | ISSUED DATE | REMARK    |
|---------|-----------------|-------------|-----------|
| Rev.1.0 | Initial Release | 2012-11-14  | GongZhong |
|         |                 |             |           |
|         |                 |             |           |
|         |                 |             |           |
|         |                 |             |           |

## 1 General Information

### 1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI H881C, H881C are as below Table 1.

| Band                                      | Test Configuration | Test Mode  | Measured MAX SAR1g (W/kg) | MAX Conducted Power (dBm) | Tune-up Power (dBm) | Extrapolated Result (W/kg) |
|-------------------------------------------|--------------------|------------|---------------------------|---------------------------|---------------------|----------------------------|
| CDMA BC0                                  | Head               | RC3 SO55   | 0.725                     | 24.50                     | 24.75               | 0.768                      |
|                                           | Body-Worn (15mm)   | EVDO Rev.A | <b>0.741</b>              | 23.90                     | 24.75               | 0.901                      |
| CDMA BC1                                  | Head               | RC3 SO55   | <b>0.917</b>              | 24.31                     | 24.75               | 1.015                      |
|                                           | Body-Worn(15mm)    | EVDO Rev.A | 0.669                     | 23.51                     | 24.75               | 0.890                      |
| WiFi                                      | Head               | 802.11 b   | 0.126                     | 14.75                     | /                   | /                          |
|                                           | Body-Worn (15mm)   | 802.11 b   | 0.060                     | 14.75                     | /                   | /                          |
| The Highest Simultaneous SAR is 1.018W/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 95.1:1992, the NCRP Report Number 86 for uncontrolled environment, according to the Industry Canada Radio Standards Specification RSS-102 for General Population/Uncontrolled exposure, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2003& IEEE Std 1528a-2005 and FCC OET Bulletin 65 Supplement C Edition 01-01 .

## 1.2 RF exposure limits

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

Table 2: RF exposure limits

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

### Notes:

- \* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time
- \*\* The Spatial Average value of the SAR averaged over the whole body.
- \*\*\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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

### 1.3 EUT Description

|                                  |                                                                                                                                                                                                                                                                                                                                                                                           |           |           |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|
| Device Information:              |                                                                                                                                                                                                                                                                                                                                                                                           |           |           |
| DUT Name:                        | cdma2000 Digital Mobile Phone; Asura                                                                                                                                                                                                                                                                                                                                                      |           |           |
| Type Identification:             | HUAWEI H881C, H881C                                                                                                                                                                                                                                                                                                                                                                       |           |           |
| FCC ID :                         | QISH881C                                                                                                                                                                                                                                                                                                                                                                                  |           |           |
| MEID No:                         | 268435462603529580                                                                                                                                                                                                                                                                                                                                                                        |           |           |
| Device Type :                    | portable device                                                                                                                                                                                                                                                                                                                                                                           |           |           |
| Exposure Category:               | uncontrolled environment / general population                                                                                                                                                                                                                                                                                                                                             |           |           |
| Hardware Version :               | HC1H881CM                                                                                                                                                                                                                                                                                                                                                                                 |           |           |
| Software Version :               | H881C V100R001C378B943                                                                                                                                                                                                                                                                                                                                                                    |           |           |
| Antenna Type :                   | Internal                                                                                                                                                                                                                                                                                                                                                                                  |           |           |
| Battery Options :                | Huawei Technologies Co., Ltd.<br>Rechargeable Li-ion<br>Battery Model: HB4W1H;<br>Rated capacity: 1750mAh;<br>Nominal Voltage:  +3.7V;<br>Charging Voltage:  +4.2V.<br>1#:SN-MPCC902919Y0407<br>2#: SN-MAIC903XXXX00055 |           |           |
| Others Accessories               | Headset                                                                                                                                                                                                                                                                                                                                                                                   |           |           |
| Device Operating Configurations: |                                                                                                                                                                                                                                                                                                                                                                                           |           |           |
| Supporting Mode(s)               | CDMA BC0, CDMA BC1,WiFi (Tested) ; Bluetooth                                                                                                                                                                                                                                                                                                                                              |           |           |
| Test Modulation                  | QPSK                                                                                                                                                                                                                                                                                                                                                                                      |           |           |
| Operating Frequency Range(s)     | Band                                                                                                                                                                                                                                                                                                                                                                                      | Tx (MHz)  | Rx (MHz)  |
|                                  | CDMA BC0                                                                                                                                                                                                                                                                                                                                                                                  | 824~849   | 869 ~894  |
|                                  | CDMA BC1                                                                                                                                                                                                                                                                                                                                                                                  | 1850-1910 | 1930-1990 |
|                                  | Bluetooth                                                                                                                                                                                                                                                                                                                                                                                 | 2402-2480 |           |
|                                  | WiFi                                                                                                                                                                                                                                                                                                                                                                                      | 2412-2462 |           |
| Power Class :                    | Tested with power control all up (CDMA BC0)                                                                                                                                                                                                                                                                                                                                               |           |           |
|                                  | Tested with power control all up (CDMA BC1)                                                                                                                                                                                                                                                                                                                                               |           |           |
| Test Channels (low-mid-high) :   | 1013-384-777 (CDMA BC0)                                                                                                                                                                                                                                                                                                                                                                   |           |           |
|                                  | 25-600-1175 (CDMA BC1)                                                                                                                                                                                                                                                                                                                                                                    |           |           |
|                                  | 1-6-11(WiFi)                                                                                                                                                                                                                                                                                                                                                                              |           |           |

Table 3: Device information and operating configuration

#### 1.3.1 General Description

cdma2000 Digital Mobile Phone- HUAWEI H881C, H881C is subscriber equipment in the CDMA/EVDO system. The frequency band is US Cellular and N. American PCS, Their band test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, CDMA2000 1x and 1xEV-DO protocol processing, voice, MMS service, GPS, AGPS and WIFI etc. Externally it provides micro SD card interface, earphone port (to provide voice service). It also provides Bluetooth module to synchronize data between a PC and the phone, or to use the built-in modem of the phone to access the Internet with a PC, or to exchange data with other Bluetooth devices.

#### 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<br>Amendment 1: CAD File for Human Head Model (SAM Phantom)           |
| OET Bulletin No. 65,<br>Supplement C Edition<br>01-01– 2001 | Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields---Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions |
| RSS-102                                                     | Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands (Issue 4 of March 2010)                                                                                                                                       |
| KDB941225 D01                                               | SAR test for 3G devices v02                                                                                                                                                                                                                            |
| KDB248227 D01                                               | SAR Measurement Procedures for 802.11 a,b,g Transmitters                                                                                                                                                                                               |
| KDB648474 D01                                               | SAR Handsets Multi Xmitter and Ant v01r05                                                                                                                                                                                                              |
| KDB450824 D01                                               | SAR Probe Calibration and System Verification                                                                                                                                                                                                          |
| KDB450824 D02                                               | Dipole SAR System check Verification v01                                                                                                                                                                                                               |

#### 1.5 Testing laboratory

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

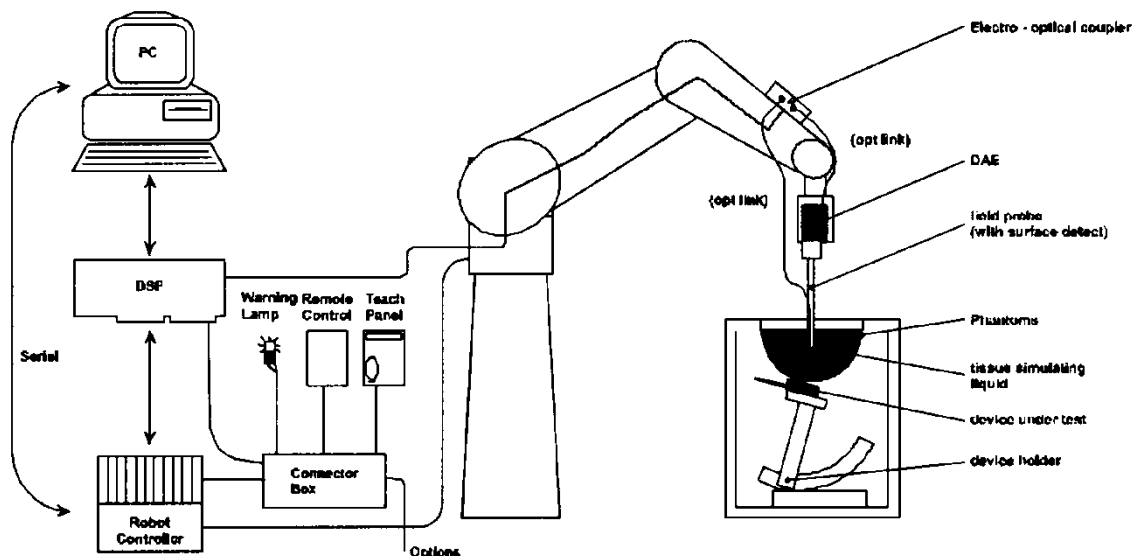
|                    |            |
|--------------------|------------|
| Start Date of test | 2012-11-07 |
| End Date of test   | 2012-11-08 |

#### 1.8 Ambient Condition

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

## 2 SAR Measurement System

### 2.1 SAR Measurement Set-up



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

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

## 2.2 Test environment

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

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

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

## 2.3 Data Acquisition Electronics description

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

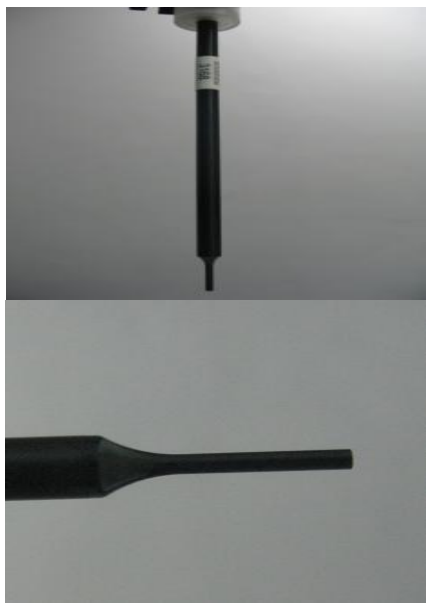
### DAE4

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

## 2.4 Probe description

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

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

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

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

|               |                                                                                                                                                                                                            |                                                                                       |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., glycolether)                                         |  |
| Calibration   | ISO/IEC 17025 calibration service available.                                                                                                                                                               |                                                                                       |
| Frequency     | 10 MHz to 6 GHz (dosimetry); Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)                                                                                                                                     |                                                                                       |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in HSL (rotation normal to probe axis)                                                                                                    |                                                                                       |
| Dynamic range | 10 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB                                                                                                                                                        |                                                                                       |
| Dimensions    | Overall length: 337 mm (Tip length: 20 mm)<br>Body diameter: 12 mm (Tip diameter: 2.5 mm)<br>Distance from probe tip to dipole centers: 1.0 mm                                                             |                                                                                       |
| 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;<br>Height: adjustable feet |                                                                                     |
| Measurement Areas | Left hand<br>Right hand<br>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;<br>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  | 3744          | 2012-07-27                  |
| <input checked="" type="checkbox"/> | SPEAG         | Dosimetric E-Field Probe             | EX3DV4  | 3736          | 2012-04-26                  |
| <input type="checkbox"/>            | SPEAG         | Dosimetric E-Field Probe             | ES3DV3  | 3168          | 2012-10-02                  |
| <input type="checkbox"/>            | SPEAG         | 750 MHz Dipole                       | D750V3  | 1044          | 2011-09-16                  |
| <input checked="" type="checkbox"/> | SPEAG         | 835 MHz Dipole                       | D835V2  | 4d126         | 2011-11-07                  |
| <input type="checkbox"/>            | SPEAG         | 1800 MHz Dipole                      | D1800V2 | 2d184         | 2011-03-08                  |
| <input checked="" type="checkbox"/> | SPEAG         | 1900 MHz Dipole                      | D1900V2 | 5d143         | 2011-09-26                  |
| <input checked="" type="checkbox"/> | SPEAG         | 2450 MHz Dipole                      | D2450V2 | 860           | 2011-03-08                  |
| <input checked="" type="checkbox"/> | SPEAG         | Data acquisition electronics         | DAE4    | 852           | 2011-11-16                  |
| <input type="checkbox"/>            | SPEAG         | Data acquisition electronics         | DAE4    | 851           | 2012-07-25                  |
| <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        | 2012-08-13                  |
| <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.

- There is no physical damage on the dipole;
- System check with specific dipole is within 10% of calibrated value;
- Return-loss is within 10% of calibrated measurement;
- Impedance is within 5Ω from the previous measurement.

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

### 3 SAR Measurement Procedure

#### 3.1 Scanning procedure

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

- The reference and drift measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT's output power and should vary max. +/- 5 %.
- The surface check measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above  $\pm 0.1\text{mm}$ ). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within  $\pm 30^\circ$ .)
- The area scan measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension. 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  $7 \times 7 \times 7$  points. The algorithm that finds the maximal averaged volume is separated into three different stages.

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

#### Extrapolation

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

#### Interpolation

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

#### Volume Averaging

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

#### Advanced Extrapolation

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

### 3.3 Data Storage and Evaluation

#### Data Storage

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

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

#### Data Evaluation by SEMCAD

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

|                    |                           |                                                                         |
|--------------------|---------------------------|-------------------------------------------------------------------------|
| Probe parameters:  | - Sensitivity             | Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub> |
|                    | - Conversion factor       | ConvF <sub>i</sub>                                                      |
|                    | - Diode compression point | Dcpi                                                                    |
| Device parameters: | - Frequency               | f                                                                       |
|                    | - Crest factor            | cf                                                                      |
| Media parameters:  | - Conductivity            | σ                                                                       |
|                    | - Density                 | ρ                                                                       |

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

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

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

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

|      |                  |                                                   |                  |
|------|------------------|---------------------------------------------------|------------------|
| with | V <sub>i</sub>   | = compensated signal of channel i                 | (i = x, y, z)    |
|      | U <sub>i</sub>   | = input signal of channel i                       | (i = x, y, z)    |
|      | cf               | = crest factor of exciting field (DASY parameter) |                  |
|      | dcp <sub>i</sub> | = 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  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

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

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

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

## 4 System Verification Procedure

### 4.1 Tissue Verification

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

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

| Ingredients (% of weight) |  | Head Tissue |       |       |       |             |
|---------------------------|--|-------------|-------|-------|-------|-------------|
| Frequency Band (MHz)      |  | 750         | 835   | 900   | 1800  | 1900 2450   |
| Water                     |  | 39.2        | 41.45 | 40.92 | 52.64 | 55.242 62.7 |
| Salt (NaCl)               |  | 2.7         | 1.45  | 1.48  | 0.36  | 0.306 0.5   |
| Sugar                     |  | 57.0        | 56.0  | 56.5  | 0.0   | 0.0 0.0     |
| HEC                       |  | 0.0         | 1.0   | 1.0   | 0.0   | 0.0 0.0     |
| Bactericide               |  | 0.0         | 0.1   | 0.1   | 0.0   | 0.0 0.0     |
| Cellulose                 |  | 1.0         | 0.0   | 0.0   | 0.0   | 0.0 0.0     |
| DGBE                      |  | 0.0         | 0.0   | 0.0   | 47.0  | 44.542 36.8 |
| Preventol                 |  | 0.1         | 0.0   | 0.0   | 0.0   | 0.0 0.0     |
| Ingredients (% of weight) |  | Body Tissue |       |       |       |             |
| Frequency Band (MHz)      |  | 750         | 835   | 900   | 1800  | 1900 2450   |
| Water                     |  | 50.3        | 52.4  | 56.0  | 69.91 | 69.91 73.2  |
| Salt (NaCl)               |  | 1.6         | 1.40  | 0.76  | 0.13  | 0.13 0.04   |
| Sugar                     |  | 47          | 45.0  | 41.76 | 0.0   | 0.0 0.0     |
| HEC                       |  | 0.0         | 1.0   | 1.21  | 0.0   | 0.0 0.0     |
| Bactericide               |  | 0.0         | 0.1   | 0.27  | 0.0   | 0.0 0.0     |
| Cellulose                 |  | 1.0         | 0.0   | 0.0   | 0.0   | 0.0 0.0     |
| DGBE                      |  | 0.0         | 0.0   | 0.0   | 29.96 | 29.96 26.7  |
| Preventol                 |  | 0.1         | 0.0   | 0.0   | 0.0   | 0.0 0.0     |

Table 4: Tissue Dielectric Properties

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

| Tissue Type | Measured Frequency (MHz) | Target Tissue         |                        | Measured Tissue |                | Liquid Temp. | Test Date  |
|-------------|--------------------------|-----------------------|------------------------|-----------------|----------------|--------------|------------|
|             |                          | $\epsilon_r$ (+/-5%)  | $\sigma$ (S/m) (+/-5%) | $\epsilon_r$    | $\sigma$ (S/m) |              |            |
| 835H        | 825                      | 41.6<br>(39.52~43.68) | 0.90<br>(0.86~0.95)    | 41.88           | 0.926          | 21.4°C       | 2012-11-07 |
|             | 835                      | 41.5<br>(39.43~43.58) | 0.90<br>(0.86~0.95)    | 41.80           | 0.927          |              |            |
|             | 850                      | 41.5<br>(39.43~43.58) | 0.92<br>(0.87~0.96)    | 41.90           | 0.937          |              |            |
| 835B        | 825                      | 55.2<br>(52.44~57.96) | 0.97<br>(0.92~1.02)    | 55.57           | 0.982          | 21.4°C       | 2012-11-07 |
|             | 835                      | 55.2<br>(52.44~57.96) | 0.97<br>(0.92~1.02)    | 55.50           | 0.984          |              |            |
|             | 850                      | 55.2<br>(52.44~57.96) | 0.99<br>(0.94~1.04)    | 55.48           | 0.994          |              |            |
| 1900H       | 1850                     | 40.0<br>(38.00~42.00) | 1.40<br>(1.33~1.47)    | 40.36           | 1.384          | 21.4°C       | 2012-11-08 |
|             | 1880                     | 40.0<br>(38.00~42.00) | 1.40<br>(1.33~1.47)    | 40.15           | 1.414          |              |            |
|             | 1900                     | 40.0<br>(38.00~42.00) | 1.40<br>(1.33~1.47)    | 40.19           | 1.430          |              |            |
|             | 1910                     | 40.0<br>(38.00~42.00) | 1.40<br>(1.33~1.47)    | 40.09           | 1.440          |              |            |

|                                                         |      |                       |                     |       |       |        |            |
|---------------------------------------------------------|------|-----------------------|---------------------|-------|-------|--------|------------|
| 1900B                                                   | 1850 | 53.3<br>(50.64~55.97) | 1.52<br>(1.44~1.60) | 53.63 | 1.450 | 21.4°C | 2012-11-08 |
|                                                         | 1880 | 53.3<br>(50.64~55.97) | 1.52<br>(1.44~1.60) | 53.58 | 1.482 |        |            |
|                                                         | 1900 | 53.3<br>(50.64~55.97) | 1.52<br>(1.44~1.60) | 53.54 | 1.503 |        |            |
|                                                         | 1910 | 53.3<br>(50.64~55.97) | 1.52<br>(1.44~1.60) | 53.53 | 1.513 |        |            |
| 2450H                                                   | 2410 | 39.3<br>(37.34~41.26) | 1.76<br>(1.67~1.85) | 39.80 | 1.772 | 21.4°C | 2012-11-08 |
|                                                         | 2435 | 39.2<br>(37.24~41.16) | 1.79<br>(1.70~1.88) | 39.71 | 1.798 |        |            |
|                                                         | 2460 | 39.2<br>(37.24~41.16) | 1.81<br>(1.72~1.90) | 39.60 | 1.825 |        |            |
|                                                         | 2450 | 39.2<br>(37.24~41.16) | 1.80<br>(1.71~1.89) | 39.64 | 1.814 |        |            |
| 2450B                                                   | 2410 | 52.8<br>(50.16~55.44) | 1.91<br>(1.81~2.00) | 52.72 | 1.969 | 21.4°C | 2012-11-08 |
|                                                         | 2435 | 52.7<br>(50.07~55.34) | 1.94<br>(1.84~2.04) | 52.50 | 1.989 |        |            |
|                                                         | 2460 | 52.7<br>(50.07~55.34) | 1.96<br>(1.86~2.06) | 52.24 | 2.011 |        |            |
|                                                         | 2450 | 52.7<br>(50.07~55.34) | 1.95<br>(1.85~2.05) | 52.51 | 2.005 |        |            |
| ε <sub>r</sub> = Relative permittivity, σ= Conductivity |      |                       |                     |       |       |        |            |

Table 5: Measured Tissue Parameter

Note:

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

## 4.2 System Check

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

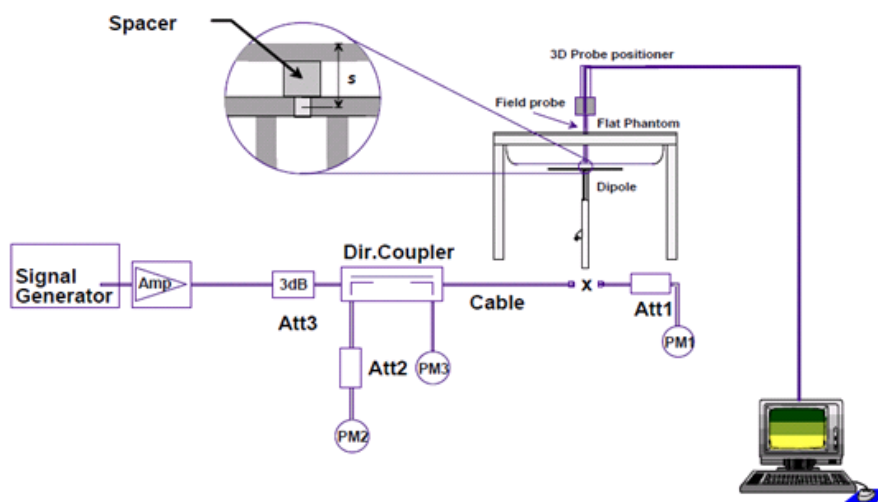
| System Check | Target SAR (1W) (+/-10%) |                        | Measured SAR (Normalized to 1W) |             | Liquid Temp. | Test Date  |
|--------------|--------------------------|------------------------|---------------------------------|-------------|--------------|------------|
|              | 1-g (mW/g)               | 10-g (mW/g)            | 1-g (mW/g)                      | 10-g (mW/g) |              |            |
| D835V2 Head  | 9.40<br>(8.46~10.34)     | 6.16<br>(5.54~6.78)    | 9.64                            | 6.36        | 21.4°C       | 2012-11-07 |
| D1900V2 Head | 40.60<br>(36.54~44.66)   | 21.20<br>(19.08~23.32) | 39.52                           | 20.00       | 21.4°C       | 2012-11-08 |
| D2450V2 Head | 53.70<br>(48.33~59.07)   | 24.90<br>(22.41~27.39) | 57.60                           | 25.76       | 21.4°C       | 2012-11-08 |
| D835V2 Body  | 9.54<br>(8.59~10.49)     | 6.29<br>(5.66~6.92)    | 10.44                           | 6.80        | 21.4°C       | 2012-11-07 |
| D1900V2 Body | 41.40<br>(37.26~45.54)   | 21.80<br>(19.62~23.98) | 40.80                           | 20.60       | 21.4°C       | 2012-11-08 |
| D2450V2 Body | 52.80<br>(47.52~58.08)   | 24.50<br>(22.05~26.95) | 52.80                           | 23.52       | 21.4°C       | 2012-11-08 |

Table 6: System Check Results

### 4.3 System check Procedure

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

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



## 5 Measurement Uncertainty Evaluation

### 5.1 Measurement uncertainty evaluation for SAR test

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

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

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

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

Table 7: Measurement uncertainties

## 5.2 Measurement uncertainty evaluation for system check

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

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

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

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

Table 8: Measurement uncertainties

## 6 SAR Test Configuration

### 6.1 CDMA Test Configuration

#### 6.1.1 CDMA 1x Devices

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

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

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

SAR for head exposure configurations is measured in RC3 with the DUT configured to transmit at full rate using Loopback Service Option SO55. SAR for RC1 is not required when the maximum average output of each channel is less than  $\frac{1}{4}$  dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1 using the exposure configuration that results in the highest SAR for that channel in RC3.

SAR for body exposure configurations is measured in RC3 with the DUT configured using TDSO / SO32, to transmit at full rate on FCH with all other code channels disabled. SAR for multiple code channels (FCH + SCHn) is not required when the maximum average output of each RF channel is less than  $\frac{1}{4}$  dB higher than that measured with FCH only. Otherwise, SAR is measured on the maximum output channel (FCH + SCHn) with FCH at full rate and SCH0 enabled at 9600 bps, using the exposure configuration that results in the highest SAR for that channel with FCH only. When multiple code channels are enabled, the DUT output may shift by more than 0.5 dB and lead to higher SAR drifts and SCH dropouts.

Body SAR in RC1 is not required when the maximum average output of each channel is less than  $\frac{1}{4}$  dB higher than that measured in RC3. Otherwise, SAR is measured on the maximum output channel in RC1; with Loopback Service Option SO55, at full rate, using the body exposure configuration that results in the highest SAR for that channel in RC3.

Test communication setup meet as followings:

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

### 6.1.2 CDMA EV-DO Devices

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

## 6.2 WiFi Test Configuration

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

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

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

| Mode      | Band    | GHz   | Channel | “Default Test Channels” |         |
|-----------|---------|-------|---------|-------------------------|---------|
|           |         |       |         | 802.11b                 | 802.11g |
| 802.11b/g | 2.4 GHz | 2.412 | 1#      | √                       | △       |
|           |         | 2.437 | 6       | √                       | △       |
|           |         | 2.462 | 11#     | √                       | △       |

**Notes:**

√ = “default test channels”

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

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

### 802.11 Test Channels per FCC Requirements

## 7 SAR Measurement Results

### 7.1 Conducted power measurements

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

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

#### 7.1.1 Conducted power measurements CDMA BC0

| CDMA&EVDO BC0 |                  | Average Power (dBm) |              |       |
|---------------|------------------|---------------------|--------------|-------|
|               |                  | 1013CH              | 384CH        | 777CH |
| RC1           | SO55             | 24.38               | <b>24.69</b> | 24.40 |
| RC3           | SO55             | 24.27               | 24.50        | 24.34 |
|               | TDSO32 (FCH)     | 24.21               | 24.60        | 24.28 |
|               | TDSO32 (FCH+SCH) | 24.20               | 24.35        | 24.24 |
| Rev 0         | RTAP 153.6       | 23.87               | 23.94        | 23.83 |
| Rev A         | RETAP 4096       | 23.88               | 23.90        | 23.85 |

Table 9: Test results conducted power measurement CDMA BC0

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

#### 7.1.2 Conducted power measurements CDMA BC1

| CDMA&EVDO BC1 |                  | Average Power (dBm) |       |              |
|---------------|------------------|---------------------|-------|--------------|
|               |                  | 25CH                | 600CH | 1175CH       |
| RC1           | SO55             | 24.27               | 24.21 | <b>24.46</b> |
| RC3           | SO55             | 24.31               | 24.01 | 24.24        |
|               | TDSO32 (FCH)     | 24.28               | 24.05 | 24.10        |
|               | TDSO32 (FCH+SCH) | 24.21               | 24.03 | 24.22        |
| Rev 0         | RTAP 153.6       | 23.84               | 23.46 | 23.77        |
| Rev A         | RETAP 4096       | 23.81               | 23.51 | 23.80        |

Table 10: Test results conducted power measurement CDMA BC1

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

## 7.2 SAR measurement Result

### 7.2.1 SAR measurement Result of CDMA BC0

| Test Position of Head                                              | Test Mode | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp. |
|--------------------------------------------------------------------|-----------|-------------------------|------------------|-------|------------------|--------------|--------------|
|                                                                    |           |                         | 1-g              | 10-g  |                  |              |              |
| Tested data with the battery-MPCC902919Y0407                       |           |                         |                  |       |                  |              |              |
| Left Hand Touched                                                  | RC3 SO55  | 384/836.52              | 0.630            | 0.461 | -0.120           | 1.6          | 21.4°C       |
| Left Hand Tilted 15°                                               | RC3 SO55  | 384/836.52              | 0.432            | 0.324 | 0.050            | 1.6          | 21.4°C       |
| Right Hand Touched                                                 | RC3 SO55  | 384/836.52              | <b>0.725</b>     | 0.534 | -0.130           | 1.6          | 21.4°C       |
| Right Hand Tilted 15°                                              | RC3 SO55  | 384/836.52              | 0.441            | 0.334 | 0.040            | 1.6          | 21.4°C       |
| Tested data at the worst position with the battery-MAIC903XXX00055 |           |                         |                  |       |                  |              |              |
| Left Hand Touched                                                  | RC3 SO55  | 384/836.52              | 0.717            | 0.529 | 0.060            | 1.6          | 21.4°C       |

Table 11: Test results head SAR CDMA BC0

| Test Position of Body with 15mm                                     | Test Mode  | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp. |
|---------------------------------------------------------------------|------------|-------------------------|------------------|-------|------------------|--------------|--------------|
|                                                                     |            |                         | 1-g              | 10-g  |                  |              |              |
| Tested data with the battery-MPCC902919Y0407                        |            |                         |                  |       |                  |              |              |
| Towards Phantom                                                     | RC3 SO32   | 384/836.52              | 0.611            | 0.456 | 0.030            | 1.6          | 21.4°C       |
| Towards Ground                                                      | RC3 SO32   | 384/836.52              | 0.669            | 0.499 | -0.020           | 1.6          | 21.4°C       |
| Towards Ground                                                      | EVDO Rev.0 | 384/836.52              | 0.616            | 0.455 | 0.060            | 1.6          | 21.4°C       |
| Towards Ground                                                      | EVDO Rev.A | 384/836.52              | <b>0.741</b>     | 0.542 | -0.090           | 1.6          | 21.4°C       |
| Towards GroundwithHeadset                                           | RC3 SO55   | 384/836.52              | 0.445            | 0.330 | 0.120            | 1.6          | 21.4°C       |
| Tested data at the worst position with the battery-MAIC903XXXX00055 |            |                         |                  |       |                  |              |              |
| Towards Ground                                                      | EVDO Rev.A | 384/836.52              | 0.705            | 0.525 | -0.130           | 1.6          | 21.4°C       |

Table 12: Test results body SAR CDMA BC0

## 7.2.2 SAR measurement Result of CDMA BC1

| Test Position of Head                                               | Test Mode | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp. |
|---------------------------------------------------------------------|-----------|-------------------------|------------------|-------|------------------|--------------|--------------|
|                                                                     |           |                         | 1-g              | 10-g  |                  |              |              |
| Tested data with the battery-MPCC902919Y0407                        |           |                         |                  |       |                  |              |              |
| Left Hand Touched                                                   | RC3 SO55  | 1175/1908.75            | 0.896            | 0.512 | -0.030           | 1.6          | 21.4°C       |
|                                                                     |           | 600/1880                | 0.834            | 0.489 | 0.070            | 1.6          | 21.4°C       |
|                                                                     |           | 25/1851.25              | <b>0.917</b>     | 0.537 | -0.180           | 1.6          | 21.4°C       |
| Left Hand Tilted 15°                                                | RC3 SO55  | 600/1880                | 0.269            | 0.159 | 0.070            | 1.6          | 21.4°C       |
| Right Hand Touched                                                  | RC3 SO55  | 600/1880                | 0.466            | 0.286 | 0.050            | 1.6          | 21.4°C       |
| Right Hand Tilted 15°                                               | RC3 SO55  | 600/1880                | 0.267            | 0.150 | 0.070            | 1.6          | 21.4°C       |
| Tested data at the worst position with the battery-MAIC903XXXX00055 |           |                         |                  |       |                  |              |              |
| Left Hand Touched                                                   | RC3 SO55  | 25/1851.25              | 0.894            | 0.523 | -0.050           | 1.6          | 21.4°C       |

Table 13: Test results head SAR CDMA BC1

| Test Position of Body with 15mm                                     | Test Mode  | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp |
|---------------------------------------------------------------------|------------|-------------------------|------------------|-------|------------------|--------------|-------------|
|                                                                     |            |                         | 1-g              | 10-g  |                  |              |             |
| Tested data with the battery-MPCC902919Y0407                        |            |                         |                  |       |                  |              |             |
| Towards Phantom                                                     | RC3 SO32   | 600/1880                | 0.573            | 0.347 | 0.010            | 1.6          | 21.4°C      |
| Towards Ground                                                      | RC3 SO32   | 600/1880                | 0.620            | 0.371 | -0.010           | 1.6          | 21.4°C      |
| Towards Ground                                                      | EVDO Rev.0 | 600/1880                | 0.585            | 0.343 | -0.180           | 1.6          | 21.4°C      |
| Towards Ground                                                      | EVDO Rev.A | 600/1880                | 0.641            | 0.381 | -0.110           | 1.6          | 21.4°C      |
| Towards Ground with Headset                                         | RC3 SO55   | 600/1880                | 0.570            | 0.332 | 0.040            | 1.6          | 21.4°C      |
| Tested data at the worst position with the battery-MAIC903XXXX00055 |            |                         |                  |       |                  |              |             |
| Towards Ground                                                      | EVDO Rev.A | 600/1880                | <b>0.669</b>     | 0.398 | 0.180            | 1.6          | 21.4°C      |

Table 14: Test results body SAR CDMA BC1

Note: 1) The maximum SAR value of each test band is marked bold.

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 ( $< 0.8 \text{ W/kg}$ ), testing at the high and low channels is optional.

3) Per KDB941225 D01, Head SAR was tested with RC3+SO55, RC1+SO55 was not required since the average output power was not more than 0.25dB than the RC3+SO55 powers.

4) Per KDB941225 D01-Body SAR was tested with RC3+SO32 FCH, RC3+SO32 FCH+SCH and Ev-Do was not required since the average output power was not more than 0.25dB than the RC3+SO32 FCH powers.

### 7.2.3 SAR measurement Result of WiFi

| Test Position of Head                                               | Test Mode | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp. |
|---------------------------------------------------------------------|-----------|-------------------------|------------------|-------|------------------|--------------|--------------|
|                                                                     |           |                         | 1-g              | 10-g  |                  |              |              |
| Tested data with the battery-MPCC902919Y0407                        |           |                         |                  |       |                  |              |              |
| Left Hand Touched                                                   | 802.11 b  | 11/2462                 | 0.101            | 0.048 | 0.080            | 1.6          | 21.4°C       |
| Left Hand Tilted 15°                                                | 802.11 b  | 11/2462                 | 0.124            | 0.057 | 0.080            | 1.6          | 21.4°C       |
| Right Hand Touched                                                  | 802.11 b  | 11/2462                 | 0.102            | 0.050 | 0.120            | 1.6          | 21.4°C       |
| Right Hand Tilted 15°                                               | 802.11 b  | 11/2462                 | 0.126            | 0.058 | -0.130           | 1.6          | 21.4°C       |
| Tested data at the worst position with the battery-MAIC903XXXX00055 |           |                         |                  |       |                  |              |              |
| Right Hand Tilted 15°                                               | 802.11 b  | 11/2462                 | <b>0.132</b>     | 0.060 | -0.080           | 1.6          | 21.4°C       |

Table 15: Test results head SAR WiFi 2450 MHz

| Test Position of Body with 15mm                                     | Test Mode | Test channel /Frequency | SAR Value (W/kg) |       | Power Drift (dB) | Limit (W/kg) | Liquid Temp. |
|---------------------------------------------------------------------|-----------|-------------------------|------------------|-------|------------------|--------------|--------------|
|                                                                     |           |                         | 1-g              | 10-g  |                  |              |              |
| Tested data with the battery-MPCC902919Y0407                        |           |                         |                  |       |                  |              |              |
| Towards Phantom                                                     | 802.11 b  | 11/2462                 | 0.012            | 0.005 | 0.100            | 1.6          | 21.4°C       |
| Towards Ground                                                      | 802.11 b  | 11/2462                 | 0.063            | 0.033 | 0.190            | 1.6          | 21.4°C       |
| Tested data at the worst position with the battery-MAIC903XXXX00055 |           |                         |                  |       |                  |              |              |
| Towards Ground                                                      | 802.11 b  | 11/2462                 | <b>0.063</b>     | 0.032 | 0.040            | 1.6          | 21.4°C       |

Table 16: Test results body SAR WiFi 2450 MHz

Note: 1) The maximum SAR value of each test band is marked bold.

2) Per KDB248227, Tests high average RF output power channel for the lowest data rate, other modes including 802.11 g/n were not investigated since the average output powers were not greater than 0.25dB than that of the corresponding channel in the lowest data rate IEEE 802.11b mode.

3) Testing at higher data rates 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.

4) The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured for each test configuration is at least 3.0 dB lower than the SAR limit (< 0.8 W/kg), testing at the other two channels is optional.

### 7.3 Multiple Transmitter Evaluation

#### 7.3.1 Stand-alone SAR

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.

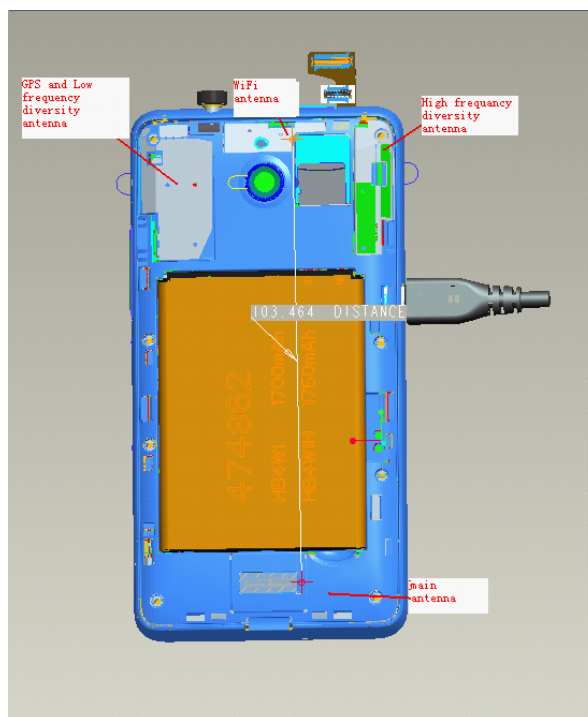
|                                                                                                         | 2.45 | 5.15 - 5.35 | 5.47 - 5.85 | GHz |
|---------------------------------------------------------------------------------------------------------|------|-------------|-------------|-----|
| $P_{Ref}$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

Table 17: Output Power Thresholds for Unlicensed Transmitters

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

Table 18: Summary of SAR Evaluation Requirements for a Cell Phone with Multiple Transmitters

The closest distance between BT/WiFi antenna and main antenna is 10.35cm > 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 2450 | Average Conducted Power (dBm) |      |      |
|---------|-------------------------------|------|------|
|         | 0CH                           | 39CH | 78CH |
|         | 3.40                          | 4.55 | 5.68 |

Table 19: Test results conducted power measurement BT 2450 MHz

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

The output power of WiFi antenna is as following:

| Wi-Fi 2450     | Channel | Average Power (dBm) for Data Rates (Mbps) |       |       |       |       |       |       |       |
|----------------|---------|-------------------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                |         | 1                                         | 2     | 5.5   | 11    | /     | /     | /     | /     |
| 802.11b        | 1       | 14.00                                     | 14.39 | 13.98 | 13.69 | /     | /     | /     | /     |
|                | 6       | 14.31                                     | 14.28 | 14.28 | 14.26 | /     | /     | /     | /     |
|                | 11      | <b>14.75</b>                              | 14.74 | 14.71 | 14.70 | /     | /     | /     | /     |
| 802.11g        | Channel | 6                                         | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
|                | 1       | 11.56                                     | 11.54 | 11.53 | 11.52 | 11.51 | 11.50 | 11.51 | 11.51 |
|                | 6       | 11.78                                     | 11.74 | 11.70 | 11.71 | 11.72 | 11.70 | 11.71 | 11.70 |
|                | 11      | 12.11                                     | 12.12 | 12.13 | 12.10 | 12.05 | 12.10 | 12.07 | 12.05 |
| 802.11n (HT20) | Channel | 6.5                                       | 13    | 19.5  | 26    | 39    | 52    | 58.5  | 65    |
|                | 1       | 11.04                                     | 11.05 | 10.54 | 10.56 | 10.51 | 10.52 | 10.47 | 10.46 |
|                | 6       | 11.26                                     | 11.24 | 11.21 | 11.2  | 11.2  | 11.21 | 11.23 | 11.23 |
|                | 11      | 11.5                                      | 11.5  | 11.49 | 11.47 | 11.45 | 11.44 | 11.42 | 11.41 |

Table 20: Test results conducted power measurement WiFi 2450 MHz

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

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

- 1) stand-alone SAR evaluation is not required for BT, because the output power of BT unlicensed is  $5.68\text{dBm} \leq 2\text{PRef}$  (13.8dBm) and antenna is  $10.35 > 5\text{cm}$  from other antenna.
- 2) Stand-alone SAR evaluation is required for WiFi, because the output power of WiFi unlicensed transmitter is  $14.75\text{dBm} \geq 24\text{mW}$  (13.8dBm).

### Simultaneous SAR

| Test Position          |                       | CDMA BC0<br>SAR(W/kg) | CDMA BC1<br>SAR(W/kg) | WiFi<br>SAR (W/kg) | $\Sigma 1\text{-g SAR}_{\text{max}}$<br>(W/kg) |
|------------------------|-----------------------|-----------------------|-----------------------|--------------------|------------------------------------------------|
| Head<br>SAR            | Left Hand Touched     | 0.630                 | 0.917                 | 0.101              | <b>1.018</b>                                   |
|                        | Left Hand Tilted 15°  | 0.432                 | 0.269                 | 0.124              | 0.556                                          |
|                        | Right Hand Touched    | 0.725                 | 0.466                 | 0.102              | 0.827                                          |
|                        | Right Hand Tilted 15° | 0.441                 | 0.267                 | 0.132              | 0.573                                          |
| Body-Worn<br>SAR(15mm) | Towards Phantom       | 0.611                 | 0.573                 | 0.012              | 0.623                                          |
|                        | Towards Ground        | 0.741                 | 0.669                 | 0.063              | 0.804                                          |

Simultaneous Transmission SAR evaluation is not required for CDMA and BT, because stand-alone SAR are not required for BT and its antenna is  $10.35 > 5.0\text{ cm}$  from main antenna

Simultaneous Transmission SAR evaluation is not required for CDMA and WiFi, because the sum of the  $1\text{g SAR}_{\text{max}}$  is  $1.018\text{W/kg} < 1.6\text{W/kg}$  for CDMA and WiFi.

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.)

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**End**