



中国认可
国际互认
检测
TESTING
CNAS L0310



FCC SAR Compliance Test Report

Product Name: Mobile WiFi

Model: HWD36

Report No.: SYBH(Z-SAR)014092017-2

FCC ID: QISHWD36

| | | |
|------|---------------------------|-----------------------------|
| | APPROVED (Lab Manager) | PREPARED (Test Engineer) |
| BY | <i>Wei Huanbin</i> | <i>He Renqiang</i> |
| DATE | 2017-11-20 | 2017-11-20 |

Reliability Laboratory of Huawei Technologies Co., Ltd.

(Global Compliance and Testing Center of Huawei Technologies Co., Ltd)

Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District,
Shenzhen, 518129, P.R.C

Tel: +86 755 28780808 Fax: +86 755 89652518

※ ※ **Notice** ※ ※

1. The laboratory has passed the accreditation by China National Accreditation Service for Conformity Assessment (CNAS). The accreditation number is L0310.
2. The laboratory has passed the accreditation by The American Association for Laboratory Accreditation (A2LA). The accreditation number is 2174.01 & 2174.02 & 2174.03
3. The laboratory (Reliability Lab of Huawei Technologies Co., Ltd) is also named “Global Compliance and Testing Center of Huawei Technologies Co., Ltd”, the both names have coexisted since 2009.
4. The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
5. The test report is invalid if there is any evidence of erasure and/or falsification.
6. The test report is only valid for the test samples.
7. Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

Table of Contents

| | | |
|-------|--|----|
| 1 | General Information..... | 6 |
| 1.1 | Statement of Compliance | 6 |
| 1.2 | RF exposure limits..... | 7 |
| 1.3 | EUT Description | 8 |
| 1.3.1 | General Description | 9 |
| 1.4 | Test specification(s)..... | 10 |
| 1.5 | Testing laboratory | 10 |
| 1.6 | Applicant and Manufacturer | 10 |
| 1.7 | Application details..... | 10 |
| 1.8 | Ambient Condition | 10 |
| 2 | SAR Measurement System | 11 |
| 2.1 | SAR Measurement Set-up | 11 |
| 2.2 | Test environment..... | 12 |
| 2.3 | Data Acquisition Electronics description | 12 |
| 2.4 | Probe description..... | 13 |
| 2.5 | Phantom description..... | 14 |
| 2.6 | Device holder description | 15 |
| 2.7 | Test Equipment List..... | 16 |
| 3 | SAR Measurement Procedure | 17 |
| 3.1 | Scanning procedure | 17 |
| 3.2 | Spatial Peak SAR Evaluation | 18 |
| 3.3 | Data Storage and Evaluation | 19 |
| 4 | System Verification Procedure | 21 |
| 4.1 | Tissue Verification | 21 |
| 4.2 | System Check | 23 |
| 4.3 | System check Procedure..... | 24 |
| 5 | SAR measurement variability and uncertainty | 25 |
| 5.1 | SAR measurement variability | 25 |
| 5.2 | SAR measurement uncertainty | 25 |
| 6 | SAR Test Configuration..... | 26 |
| 6.1 | Test Positions Configuration | 26 |
| 6.2 | 3G SAR Test Reduction Procedure | 26 |
| 6.3 | UMTS Test Configuration..... | 26 |
| 6.4 | LTE Test Configuration..... | 32 |
| 6.5 | WiFi Test Configuration..... | 34 |
| 6.5.1 | Initial Test Position Procedure | 34 |
| 6.5.2 | Initial Test Configuration Procedure | 34 |
| 6.5.3 | Sub Test Configuration Procedure | 34 |
| 6.5.4 | WiFi 2.4G SAR Test Procedures | 35 |
| 6.5.5 | OFDM Transmission Mode SAR Test Channel Selection Requirements | 36 |
| 6.5.6 | MIMO SAR Considerations..... | 36 |
| 6.6 | Power reduction specification | 37 |
| 7 | SAR Measurement Results | 41 |
| 7.1 | Conducted power measurements | 41 |
| 7.1.1 | Conducted power measurements of UMTS Band V | 41 |
| 7.1.2 | Conducted power measurements of UMTS Band II | 42 |
| 7.1.3 | Conducted power measurements of LTE Band V | 43 |
| 7.1.4 | Conducted power measurements of LTE Band XVII | 45 |
| 7.1.5 | Conducted power measurements of WiFi 2.4G..... | 47 |
| 7.1.6 | Conducted power measurements of BT | 48 |
| 7.2 | SAR measurement Results | 49 |
| 7.2.1 | SAR measurement Result of UMTS Band V | 51 |
| 7.2.2 | SAR measurement Result of UMTS Band II | 51 |
| 7.2.3 | SAR measurement Result of LTE Band V | 52 |
| 7.2.4 | SAR measurement Result of LTE Band XVII | 52 |
| 7.2.5 | SAR measurement Result of WiFi 2.4G | 53 |
| 7.3 | Multiple Transmitter Evaluation | 55 |
| 7.3.1 | Stand-alone SAR test exclusion | 56 |
| 7.3.2 | Simultaneous Transmission Possibilities..... | 57 |

| | | |
|-------------|---|----|
| 7.3.3 | SAR Summation Scenario | 57 |
| 7.3.4 | Simultaneous Transmission Conclution..... | 57 |
| Appendix A. | System Check Plots..... | 58 |
| Appendix B. | SAR Measurement Plots..... | 58 |
| Appendix C. | Calibration Certificate | 58 |
| Appendix D. | Photo documentation..... | 58 |

※ ※ **Modified History** ※ ※

| REV. | DESCRIPTION | ISSUED DATE | REMARK |
|---------|---|----------------|-------------|
| Rev.1.0 | Initial Test Report Release | 2017-11-05 | He Renqiang |
| Rev.1.1 | Page 10: Update the test specifications list to the latest KDB version. | 2017-11-20 | He Renqiang |
| | | | |
| | | | |
| | | | |

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HWD36 are as below Table 1.

| Band | Max Reported 1-g SAR(W/kg) |
|---|----------------------------|
| | Body |
| UMTS Band V | 0.99 |
| UMTS Band II | 0.91 |
| LTE Band V | 1.04 |
| LTE Band XVII | 0.76 |
| WiFi 2.4G | 0.16 |
| The highest reported SAR for body and simultaneous transmission exposure conditions are 1.04W/kg and 1.20 W/kg respectively per KDB690783 D01. | |

Table 1:Summary of test result

Note:

The device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:1992/IEEE C95.1:1991, 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 1528-2013.

1.2 RF exposure limits

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

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: | | | |
|----------------------------------|---|-------------|-----------|
| Product Name: | Mobile WiFi | | |
| Model: | HWD36 | | |
| FCC ID : | QISHWD36 | | |
| SN.: | 1#:ACN0117821000415 2#:ACN0117821000407 | | |
| Device Type : | Portable device | | |
| Device Phase: | Identical Prototype | | |
| Exposure Category: | Uncontrolled environment / general population | | |
| Hardware Version : | CL1KD16M | | |
| Software Version : | 11.450.03.82.824 | | |
| Antenna Type : | Internal antenna | | |
| Device Operating Configurations: | | | |
| Supporting Mode(s) | UMTS Band V/II, LTE Band V/XVII, WiFi 2.4G;BT;NFC | | |
| Test Modulation | UMTS(QPSK),LTE(QPSK/16QAM/64QAM), WiFi(DSSS/OFDM),BT(GFSK) | | |
| Operating Frequency Range(s) | Band | Tx (MHz) | Rx (MHz) |
| | UMTS Band V | 824-849 | 869-894 |
| | UMTS Band II | 1850-1910 | 1930-1990 |
| | LTE Band V | 824-849 | 869-894 |
| | LTE Band XVII | 704-716 | 734-746 |
| | BT | 2400-2483.5 | |
| | WiFi 2.4G | 2400-2472 | |
| | NFC | NA | 13.56 |
| HSDPA UE Category | 14 | | |
| HSUPA UE Category | 6 | | |
| DC-HSDPA UE Category | 24 | | |
| Power Class: | 3, tested with power control “all 1”(UMTS Band V) | | |
| | 3, tested with power control “all 1”(UMTS Band II) | | |
| | 3, tested with power control all Max.(LTE Band V) | | |
| | 3, tested with power control all Max.(LTE Band XVII) | | |
| Test Channels (low-mid-high): | 4132-4182-4233(UMTS Band V) | | |
| | 9262-9400-9538(UMTS Band II) | | |
| | 20450-22525-20625(LTE Band V BW=5MHz) | | |
| | 20450-20525-20600(LTE Band V BW=10MHz) | | |
| | 23755-23790-23825(LTE Band XXVII BW=5MHz) | | |
| | 23780-23790-23800(LTE Band XXVII BW=10MHz) | | |
| | WiFi 2.4G | | |
| | 802.11b/g/n 20M:1-6-11 802.11/n 20M:3-6-9 | | |

Table 3:Device information and operating configuration

Note: NFC does not support transmit function for this device. So additional test for NFC is not required.

1.3.1 General Description

HWD36 is a LTE/UMTS mode and 2*2 WiFi Wireless mobile WiFi; it can be used as a WiFi hotspot based on standard of IEEE802.11b/g/n. It supports 3G WCDMA and 4G LTE wireless internet accessing function. About 3G WCDMA wireless mode, it supports WCDMA and HSDPA/HSUPA/HSPA+/DC-HSPA, operating in Band2, Band5; and the 4G LTE, operating in Band5, Band17.

The WiFi is 2X2 and the frequency are 2.4GHz , HWD36 supports Bluetooth, BR/EDR 2.1 and BLE4.1. HWD36 supports 1Tx2Rx for 3G WCDMA and 4G LTE,

Battery information:

| Name | Manufacture | Serials number | Description |
|---------|-------------|----------------|---|
| Battery | HUAWEI | NA | Model: HB603689EBW Rated capacity: 2750mAh Nominal Voltage: <u> </u> 3.8V Charging Voltage: <u> </u> 4.25V |

1.4 Test specification(s)

| | |
|----------------------------------|---|
| ANSI C95.1:1992 /IEEE C95.1:1991 | Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991) |
| IEEE Std 1528-2013 | Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques |
| KDB616217 D04 | SAR for laptop and tablets v01r02 |
| KDB941225 D01 | 3G SAR Procedures v03r01 |
| KDB941225 D05 | SAR for LTE Devices v02r03 |
| KDB941225 D06 | Hotspot SAR v02r01 |
| KDB447498 D01 | General RF Exposure Guidance v06 |
| KDB248227 D01 | SAR Guidance for IEEE 802 11 Wi-Fi SAR v02r02 |
| KDB865664 D01 | SAR measurement 100 MHz to 6 GHz v01r04 |
| KDB865664 D02 | SAR Reporting v01r02 |
| KDB690783 D01 | SAR Listings on Grants v01r03 |

1.5 Testing laboratory

| | |
|------------------------|--|
| Test Site | The Reliability Laboratory of Huawei Technologies Co., Ltd. |
| Test Location | NO.2 New City Avenue Songshan Lake Sci. & Tech. Industry Park, Dongguan, Guangdong, P.R.C |
| Telephone | +86 755 28780808 |
| Fax | +86 755 89652518 |
| State of accreditation | The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310 A2LA TESTING CERT #2174.01 & 2174.02 & 2174.03 |

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

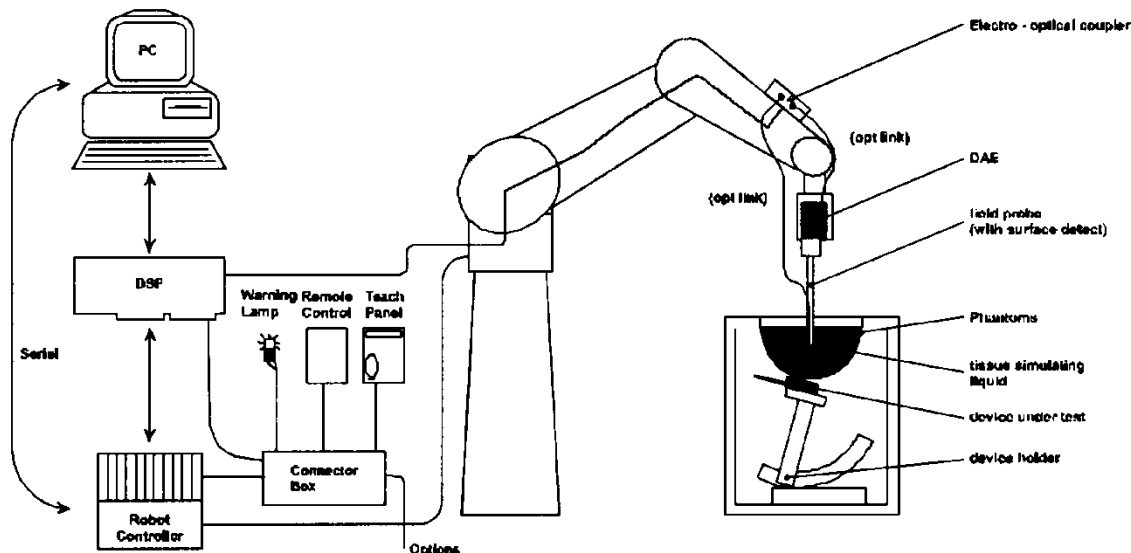
| | |
|--------------------|------------|
| Start Date of test | 2017-10-16 |
| End Date of test | 2017-10-20 |

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 DASY 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 DASY measurement server.
- The DASY measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 7.
- DASY 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 DASY measurement system is placed at the head end of a room with dimensions: 5 x 2.5 x 3 m³, the SAM phantom is placed in a distance of 75 cm from the side walls and 1.1m from the rear wall. Above the test system a 1.5 x 1.5 m² array of pyramid absorbers is installed to reduce reflections from the ceiling.

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


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

2.3 Data Acquisition Electronics description

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

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

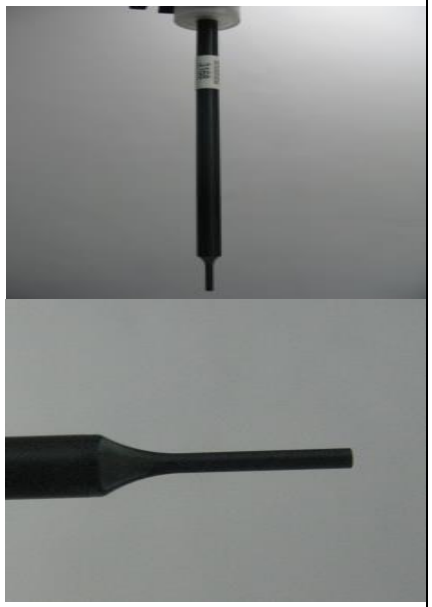
DAE4

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


2.4 Probe description

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

Isotropic E-Field Probe ES3DV3 for Dosimetric Measurements


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

Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements

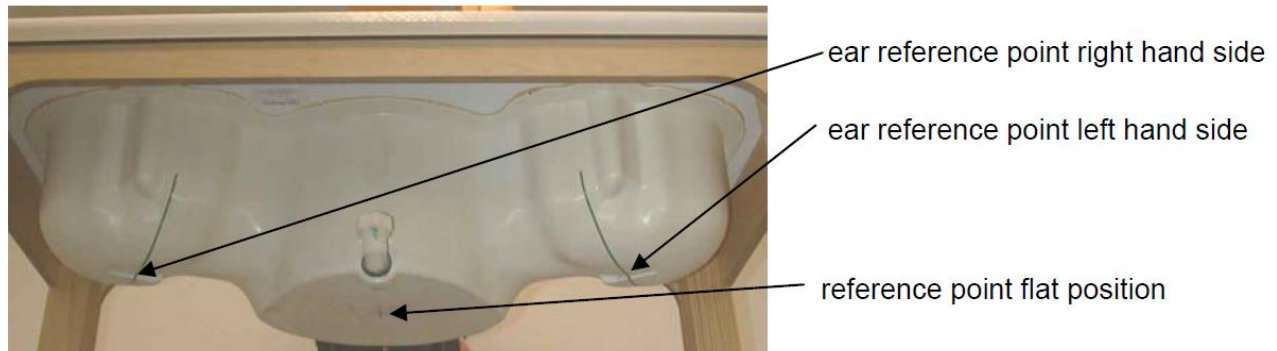
| | | |
|---------------|--|---|
| Construction | Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| Calibration | ISO/IEC 17025 calibration service available. | |
| Frequency | 10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz) | |
| Directivity | ± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis) | |
| Dynamic range | 10 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 μ W/g) | |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 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±0.2mm;The ear region:6.0±0.2mm |  |
| Filling Volume | Approximately 25 liters | |
| Dimensions | Length:1000mm; Width:500mm; Height: adjustable feet | |
| Measurement Areas | Left hand Right hand Flat phantom | |
| <p>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.</p> | | |

The following figure shows the definition of reference point:




ELI4 Phantom

| | | |
|---|-------------------------------------|---|
| Shell Thickness | 2mm±0.2mm |  |
| Filling Volume | Approximately 30 liters | |
| Dimensions | Major axis:600mm; Minor axis:400mm; | |
| Measurement Areas | Flat phantom | |
| <p>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.</p> | | |

The phantom shell material is resistant to all ingredients used in the tissue-equivalent liquid recipes. The shell of the phantom including ear spacers is constructed from low permittivity and low loss material, with a relative permittivity $2 \leq \epsilon_r \leq 5$ at ≤ 3 GHz, $3 \leq \epsilon_r \leq 4$ at > 3 GHz and a loss tangent ≤ 0.05 .

Modular Triple Flat Phantom

| | | |
|---|---|---|
| Shell Thickness (bottom plate) | 2mm±0.2mm |  |
| Filling Volume (Module) | approx. 8.1 liters (filling height: 155 mm) | |
| Dimensions | Length: 292 mm Width: 178 mm Height: 178 mm Useable area: 280 × 175 mm | |
| Measurement Areas | Flat phantom | |
| The Modular Flat Phantom consists of three identical modules that can be installed and removed separately without emptying the liquid. It is used for compliance testing of small wireless devices in body-worn configurations according to IEC 62209-2, etc. | | |

2.6 Device holder description

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



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

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

2.7 Test Equipment List

This table gives a complete overview of the SAR measurement equipment.

Devices used during the test described are marked ☒

| | Manufacturer | Device | Type | Serial number | Date of last calibration | Valid period |
|-------------------------------------|---------------|--------------------------------------|--------------------------|---------------|--------------------------|--------------|
| <input checked="" type="checkbox"/> | SPEAG | Dosimetric E-Field Probe | EX3DV4 | 3820 | 2017-06-27 | One year |
| <input checked="" type="checkbox"/> | SPEAG | Data acquisition electronics | DAE4 | 905 | 2017-06-20 | One year |
| <input checked="" type="checkbox"/> | SPEAG | 750 MHz Dipole | D750V3 | 1078 | 2017-06-20 | Three years |
| <input checked="" type="checkbox"/> | SPEAG | 835 MHz Dipole | D835V2 | 4d126 | 2015-07-23 | Three years |
| <input type="checkbox"/> | SPEAG | 900 MHz Dipole | D900V2 | 1d192 | 2016-02-02 | Three years |
| <input type="checkbox"/> | SPEAG | 1750 MHz Dipole | D1750V2 | 1145 | 2016-02-02 | Three years |
| <input checked="" type="checkbox"/> | SPEAG | 1900 MHz Dipole | D1900V2 | 5d091 | 2015-09-21 | Three years |
| <input type="checkbox"/> | SPEAG | 2000 MHz Dipole | D2000V2 | 1036 | 2016-11-23 | Three years |
| <input checked="" type="checkbox"/> | SPEAG | 2450 MHz Dipole | D2450V2 | 978 | 2016-02-08 | Three years |
| <input type="checkbox"/> | SPEAG | 2600 MHz Dipole | D2600V2 | 1119 | 2016-02-03 | Three years |
| <input checked="" type="checkbox"/> | SPEAG | Flat Phantom | Triple Flat Phantom 5.1C | 1176/1 | NCR | NCR |
| <input checked="" type="checkbox"/> | SPEAG | Software | DASY 5 | N/A | NCR | NCR |
| <input checked="" type="checkbox"/> | R & S | Universal Radio Communication Tester | CMU 200 | 111379 | 2016-12-29 | One year |
| <input checked="" type="checkbox"/> | R & S | WideBand Radio Communication Tester | CMW 500 | 126855 | 2017-05-15 | One year |
| <input checked="" type="checkbox"/> | Agilent | Network Analyser | E5071C | MY46213349 | 2016-12-30 | One year |
| <input checked="" type="checkbox"/> | Agilent | Dielectric Probe Kit | 85070E | 2484 | NCR | NCR |
| <input checked="" type="checkbox"/> | Agilent | Signal Generator | N5181A | MY50145341 | 2016-11-14 | One year |
| <input checked="" type="checkbox"/> | MINI-CIRCUITS | Amplifier | ZHL-42W | QA1402001 | NCR | NCR |
| <input checked="" type="checkbox"/> | AR | Directional Coupler | DC7144AM1 | 0423264 | 2017-04-12 | One year |
| <input checked="" type="checkbox"/> | SHX | Directional Coupler | DDTO-4-20 | 07122401 | 2017-08-07 | One year |
| <input type="checkbox"/> | MINI-CIRCUITS | Amplifier | ZVE-8G+ | N523101139 | NCR | One year |
| <input type="checkbox"/> | Agilent | Dual Directional Coupler | 772D | MY52180173 | 2017-01-03 | One year |
| <input checked="" type="checkbox"/> | Agilent | Power Meter | E4417A | MY54100027 | 2017-04-10 | One year |
| <input checked="" type="checkbox"/> | Agilent | Power Meter Sensor | E9321A | MY54130007 | 2017-04-10 | One year |
| <input checked="" type="checkbox"/> | Agilent | Power Meter Sensor | E9321A | MY54130001 | 2017-04-10 | One year |

Note:

1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.

- There is no physical damage on the dipole;
- System check with specific dipole is within 10% of calibrated value;
- The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
- The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

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

3 SAR Measurement Procedure

3.1 Scanning procedure

The DASY 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 DASY system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above $\pm 0.1\text{mm}$). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within $\pm 30^\circ$.)
- The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension ($\leq 2\text{GHz}$), 12 mm in x- and y- dimension (2-4 GHz) and 10mm in x- and y- dimension (4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in Appendix B.
- A “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution: $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}} \leq 2\text{GHz} - \leq 8\text{mm}$, 2-4GHz - $\leq 5\text{ mm}$ and 4-6 GHz- $\leq 4\text{mm}$; $\Delta z_{\text{zoom}} \leq 3\text{GHz} - \leq 5\text{ mm}$, 3-4 GHz- $\leq 4\text{mm}$ and 4-6GHz- $\leq 2\text{mm}$ where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form in chapter 7.2.
- A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth. A z-axis scan of the measurement with maximum SAR value is shown in Appendix B.

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

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

3.2 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 5 x 5 x 7 points(with 8mm horizontal resolution) or 7 x 7 x 7 points(with 5mm horizontal resolution) or 8 x 8 x 7 points(with 4mm horizontal resolution). The algorithm that finds the maximal averaged volume is separated into three different stages.

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

Extrapolation

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

Interpolation

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

Volume Averaging

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

Advanced Extrapolation

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

3.3 Data Storage and Evaluation

Data Storage

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

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

Data Evaluation by SEMCAD

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

| | | |
|--------------------|---------------------------|---|
| Probe parameters: | - Sensitivity | Norm _i , a _{i0} , a _{i1} , a _{i2} |
| | - Conversion factor | ConvF _i |
| | - Diode compression point | Dcpi |
| Device parameters: | - Frequency | f |
| | - Crest factor | cf |
| Media parameters: | - Conductivity | σ |
| | - Density | ρ |

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

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

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

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

| | | | |
|------|------------------|---|------------------|
| with | V _i | = compensated signal of channel i | (i = x, y, z) |
| | U _i | = input signal of channel i | (i = x, y, z) |
| | cf | = crest factor of exciting field (DASY parameter) | |
| | dcp _i | = diode compression point | (DASY parameter) |

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

evaluated:

$$\begin{aligned} \text{E-field probes:} \quad E_i &= (V_i / \text{Norm}_i \cdot \text{ConvF})^{1/2} \\ \text{H-field probes:} \quad H_i &= (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2)/f \end{aligned}$$

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):

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

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

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

with SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm³

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

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

with P_{pwe} = equivalent power density of a plane wave in mW/cm²
 E_{tot} = total electric field strength in V/m
 H_{tot} = total magnetic field strength in A/m

4 System Verification Procedure

4.1 Tissue Verification

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

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

| Ingredients (% of weight) | Body Tissue | | | | | |
|---------------------------|-------------|------|-------|-------|------|--------|
| Frequency Band (MHz) | 750 | 835 | 1750 | 1900 | 2450 | 2600 |
| Water | 50.3 | 52.4 | 69.91 | 69.91 | 73.2 | 64.493 |
| Salt (NaCl) | 1.60 | 1.40 | 0.13 | 0.13 | 0.04 | 0.024 |
| Sugar | 47.0 | 45.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HEC | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bactericide | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Triton X-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| DGBE | 0.0 | 0.0 | 29.96 | 29.96 | 26.7 | 32.252 |

Table 4: Tissue Dielectric Properties

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, $16\text{M}\Omega$ + 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

☒ Simulating Body Liquid (MBBL600-6000MHz), Manufactured by SPEAG:

| Ingredients | (% by weight) |
|---------------------------------|---------------|
| Water | 60-80% |
| Esters, Emulsifiers, Inhibitors | 20-40% |
| Sodium salt | 0-1.5% |

| Tissue Type | Measured Frequency (MHz) | Target Tissue | | Measured Tissue | | Deviation (Within +/-5%) | | Liquid Temp. | Test Date |
|---|--------------------------|---------------|---------------------|-----------------|---------------------|---------------------------|----------------|--------------|------------|
| | | Permit-tivity | Conduc-tivity [S/m] | Permit-tivity | Conduc-tivity [S/m] | $\Delta\epsilon_r$ | $\Delta\sigma$ | | |
| 750MHz Body | 705 | 55.70 | 0.96 | 54.84 | 0.963 | 1.54% | 0.31% | 22.4°C | 2017/10/17 |
| | 710 | 55.70 | 0.96 | 54.82 | 0.965 | 1.58% | 0.49% | | |
| | 750 | 55.50 | 0.96 | 54.76 | 0.980 | 1.33% | 2.03% | | |
| 835MHz Body | 825 | 55.20 | 0.97 | 56.25 | 0.974 | 1.90% | 0.45% | 22.4°C | 2017/10/16 |
| | 835 | 55.20 | 0.97 | 56.19 | 0.977 | 1.79% | 0.76% | | |
| | 850 | 55.20 | 0.99 | 56.13 | 0.982 | 1.68% | 0.78% | | |
| 1900MHz Body | 1850 | 53.30 | 1.52 | 54.69 | 1.533 | 2.61% | 0.86% | 22.2°C | 2017/10/19 |
| | 1880 | 53.30 | 1.52 | 54.60 | 1.550 | 2.44% | 1.97% | | |
| | 1900 | 53.30 | 1.52 | 54.59 | 1.567 | 2.42% | 3.09% | | |
| | 1910 | 53.30 | 1.52 | 54.59 | 1.574 | 2.42% | 3.55% | | |
| 2450MHz Body | 2410 | 52.80 | 1.91 | 53.77 | 1.883 | 1.84% | 1.41% | 21.9°C | 2017/10/19 |
| | 2435 | 52.70 | 1.94 | 53.73 | 1.907 | 1.95% | 1.70% | | |
| | 2450 | 52.70 | 1.95 | 53.71 | 1.920 | 1.92% | 1.54% | | |
| | 2460 | 52.70 | 1.96 | 53.69 | 1.926 | 1.88% | 1.73% | | |
| ε _r = Relative permittivity, σ= Conductivity | | | | | | | | | |

Table 5: Measured Tissue Parameter

Note: 1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

2) KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.

3) The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

4.2 System Check

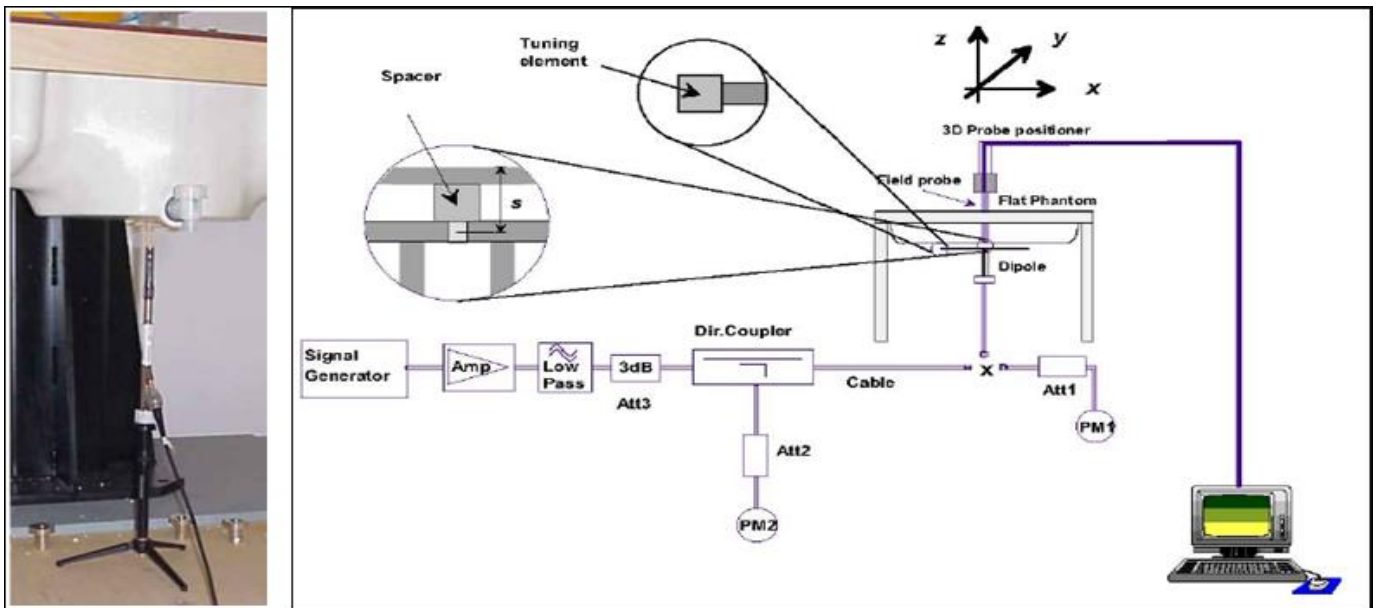
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests(Graphic Plot(s) see Appendix A).

| System Check | Target SAR (Normalized to 1W) | | Measured SAR (Normalized to 1W) | | Deviation (Within +/-10%) | | Liquid Temp. | Test Date |
|--------------|----------------------------------|----------------|------------------------------------|----------------|-------------------------------|---------------|--------------|------------|
| | 1-g (mW/g) | 10-g (mW/g) | 1-g (mW/g) | 10-g (mW/g) | Δ 1-g | Δ 10-g | | |
| 750MHz Body | 8.67 | 5.71 | 8.68 | 5.88 | 0.12% | 2.98% | 22.4°C | 2017/10/17 |
| 835MHz Body | 9.41 | 6.16 | 10.08 | 6.72 | 7.12% | 9.09% | 22.4°C | 2017/10/16 |
| 1900MHz Body | 39.90 | 21.00 | 41.60 | 22.12 | 4.26% | 5.33% | 22.2°C | 2017/10/19 |
| 2450MHz Body | 52.10 | 24.70 | 52.40 | 25.08 | 0.58% | 1.54% | 21.9°C | 2017/10/19 |

Table 6: System Check Results

4.3 System check Procedure

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250 mW(below 3GHz) or 100mW(3-6GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system check to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot). System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system.



5 SAR measurement variability and uncertainty

5.1 SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

The detailed repeated measurement results are shown in Section 7.2.

5.2 SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6 SAR Test Configuration

6.1 Test Positions Configuration

The Wi-Fi and WWAN transmitters used for hotspot mode are usually built-in within the device, such as battery-operated personal wireless routers and wireless handsets.

Per FCC KDB 941225D06, The Body SAR test separation distance for hotspot mode is determined according to device form factor. When the overall length and width of a device is $> 9\text{ cm} \times 5\text{ cm}$, a test separation distance of 10 mm is required for hotspot mode SAR measurements. A test separation distance of 5 mm or less is required for smaller devices. Hotspot mode SAR is measured for all edges and surfaces of the device with a transmitting antenna located within 25 mm from that surface or edge; for the data modes, wireless technologies and frequency bands supporting hotspot mode. The SAR results are used to determine simultaneous transmission SAR test exclusion for hotspot mode; otherwise, simultaneous transmission SAR measurement is required.

6.2 3G SAR Test Reduction Procedure

Per KDB941225 D01, in the following procedures, the mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq \frac{1}{4}$ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is $\leq 1.2\text{ W/kg}$, SAR measurement is not required for the secondary mode. This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

6.3 UMTS Test Configuration

1) Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1’s” for WCDMA/HSDPA or by applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HSDPA, HSPA) are required in the SAR report. All configurations that are not supported by the handset or cannot be measured due to technical or equipment limitations must be clearly identified.

2) WCDMA

a. Body SAR Measurements

SAR for body-worn accessory configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode

3) HSDPA

SAR for body exposure configurations is measured according to the “Body SAR Measurements” procedures of 3G device. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq \frac{1}{4}$ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode. This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

Per KDB941225 D01v03, the 3G SAR test reduction procedure is applied to HSDPA body configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures for the highest reported SAR body exposure configuration in 12.2 kbps RMC.

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

| Sub-test ¹ | β_c ² | β_d ² | β_d (SF) ² | β_c / β_d ² | β_{hs} (1) ² | CM(dB)(2) ² | MPR (dB) ² |
|-----------------------|------------------------|------------------------|-----------------------------|----------------------------------|-------------------------------|------------------------|-----------------------|
| 1 ² | 2/15 ² | 15/15 ² | 64 ² | 2/15 ² | 4/15 ² | 0.0 ² | 0 ² |
| 2 ² | 12/15(3) ² | 15/15(3) ² | 64 ² | 12/15(3) ² | 24/15 ² | 1.0 ² | 0 ² |
| 3 ² | 15/15 ² | 8/15 ² | 64 ² | 15/8 ² | 30/15 ² | 1.5 ² | 0.5 ² |
| 4 ² | 15/15 ² | 4/15 ² | 64 ² | 15/4 ² | 30/15 ² | 1.5 ² | 0.5 ² |

Note 1: ΔACK , $\Delta NACK$ and $\Delta CQI = 8$ $A_{hs} = \beta_{hs} / \beta_c = 30/15$ $\beta_{hs} = 30/15 * \beta_c$
Note 2 : CM=1 for $\beta_c / \beta_d = 12/15$, $\beta_{hs} / \beta_c = 24/15$. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.²
Note 3 : For subtest 2 the β_c / β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11/15$ and $\beta_d = 15/15$ ²

Table 7: Sub-tests for UMTS Release 5 HSDPA

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

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

Table 8: settings of required H-Set 1 QPSK acc. to 3GPP 34.121

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

Table 9: HSDPA UE category

4) HSUPA

SAR for body exposure configurations is measured according to the "Body SAR Measurements" procedures of 3G device. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq \frac{1}{4}$ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

Per KDB941225 D01v03, the 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures for the highest reported body exposure SAR configuration in 12.2 kbps RMC.

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

| Sub-test ¹ | β_c ² | β_d ³ | β_d (SF) ⁴ | β_c/β_d ⁵ | β_{hs} ⁽¹⁾ | β_{ac} ⁶ | β_{ed} ⁷ | β_a ^c (SF) ⁸ | β_{ed} ^c (code) ⁹ | CM ⁽²⁾ ¹⁰ (dB) ¹¹ | MP R ¹² (dB) ¹³ | AG ⁽⁴⁾ ¹⁴ Index ¹⁵ | E-TFC I ¹⁶ |
|--|------------------------|------------------------|-----------------------------|--------------------------------|-----------------------------|---------------------------|--|--|---|--|---------------------------------------|---|-----------------------|
| 1 ¹⁷ | 11/15 ⁽³⁾ | 15/15 ⁽³⁾ | 64 ¹⁸ | 11/15 ⁽³⁾ | 22/15 ¹⁹ | 209/225 ²⁰ | 1039/225 ²¹ | 4 ²² | 1 ²³ | 1.0 ²⁴ | 0.0 ²⁵ | 20 ²⁶ | 75 ²⁷ |
| 2 ²⁸ | 6/15 ²⁹ | 15/15 ³⁰ | 64 ³¹ | 6/15 ³² | 12/15 ³³ | 12/15 ³⁴ | 94/75 ³⁵ | 4 ³⁶ | 1 ³⁷ | 3.0 ³⁸ | 2.0 ³⁹ | 12 ⁴⁰ | 67 ⁴¹ |
| 3 ⁴² | 15/15 ⁴³ | 9/15 ⁴⁴ | 64 ⁴⁵ | 15/9 ⁴⁶ | 30/15 ⁴⁷ | 30/15 ⁴⁸ | $\beta_{ed1}:47/15$ $\beta_{ed2}:47/15$ | 4 ⁴⁹ | 2 ⁵⁰ | 2.0 ⁵¹ | 1.0 ⁵² | 15 ⁵³ | 92 ⁵⁴ |
| 4 ⁵⁵ | 2/15 ⁵⁶ | 15/15 ⁵⁷ | 64 ⁵⁸ | 2/15 ⁵⁹ | 4/15 ⁶⁰ | 2/15 ⁶¹ | 56/75 ⁶² | 4 ⁶³ | 1 ⁶⁴ | 3.0 ⁶⁵ | 2.0 ⁶⁶ | 17 ⁶⁷ | 71 ⁶⁸ |
| 5 ⁶⁹ | 15/15 ⁽⁴⁾ | 15/15 ⁽⁴⁾ | 64 ⁷⁰ | 15/15 ⁽⁴⁾ | 30/15 ⁷¹ | 24/15 ⁷² | 134/15 ⁷³ | 4 ⁷⁴ | 1 ⁷⁵ | 1.0 ⁷⁶ | 0.0 ⁷⁷ | 21 ⁷⁸ | 81 ⁷⁹ |
| Note 1: ΔACK , $\Delta NACK$ and $\Delta CQI = 8$ $A_{hs} = \beta_{hs}/\beta_c = 30/15$ $\beta_{hs} = 30/15 * \beta_c$ Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference ⁸⁰ Note 3 : For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$ ⁸¹ Note 4 : For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$ ⁸² Note 5 : Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g ⁸³ Note 6: β_{ed} can not be set directly; it is set by Absolute Grant Value. ⁸⁴ | | | | | | | | | | | | | |

Table 10: Subtests for UMTS Release 6 HSUPA

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

NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4. UE categories 1 to 6 support QPSK only. UE category 7 supports QPSK and 16QAM.(TS25.306-7.3.0).

Table 11:HSUPA UE category

5) DC-HSDPA

SAR is required for Rel. 8 DC-HSDPA when SAR is required for Rel. 5 HSDPA; otherwise, the 3G SAR test reduction procedure is applied to DC-HSDPA with 12.2 kbps RMC as the primary mode. Power is measured for DC-HSDPA according to the H-Set 12, FRC configuration in Table C.8.1.12 of 3GPP TS 34.121-1 to determine SAR test reduction. A primary and a Second serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.

The following tests were completed according to procedures in section 7.3.13 of 3GPP TS 34.108 v9.5.0. A summary of these settings are illustrated below:

Downlink Physical Channels are set as per 3GPP TS34.121-1 v9.0.0 E.5.0

Table E.5.0: Levels for HSDPA connection setup

| Parameter During Connection setup | Unit | Value |
|-----------------------------------|------|-------|
| P-CPICH_Ec/lor | dB | -10 |
| P-CCPCH and SCH_Ec/lor | dB | -12 |
| PICH_Ec/lor | dB | -15 |
| HS-PDSCH | dB | off |
| HS-SCCH_1 | dB | off |
| DPCH_Ec/lor | dB | -5 |
| OCNS_Ec/lor | dB | -3.1 |

Call is set up as per 3GPP TS34.108 v9.5.0 sub clause 7.3.13

The configurations of the fixed reference channels for HSDPA RF tests are described in 3GPP TS 34.121, annex C for FDD and 3GPP TS 34.122.

The measurements were performed with a Fixed Reference Channel (FRC) H-Set 12 with QPSK

| Parameter | Value |
|----------------------------------|-------------|
| Nominal average inf. bit rate | 60 kbit/s |
| Inter-TTI Distance | 1 TTI's |
| Number of HARQ Processes | 6 Processes |
| Information Bit Payload | 120 Bits |
| Number Code Blocks | 1 Block |
| Binary Channel Bits Per TTI | 960 Bits |
| Total Available SMLs in UE | 19200 SMLs |
| Number of SMLs per HARQ Process | 3200 SMLs |
| Coding Rate | 0.15 |
| Number of Physical Channel Codes | 1 |

Table 12: settings of required H-Set 12 QPSK acc. to 3GPP 34.121

Note:

- 1.The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table above.
- 2.Maximum number of transmission is limited to 1,i.e.,retransmission is not allowed. The redundancy and constellation version 0 shall be used.

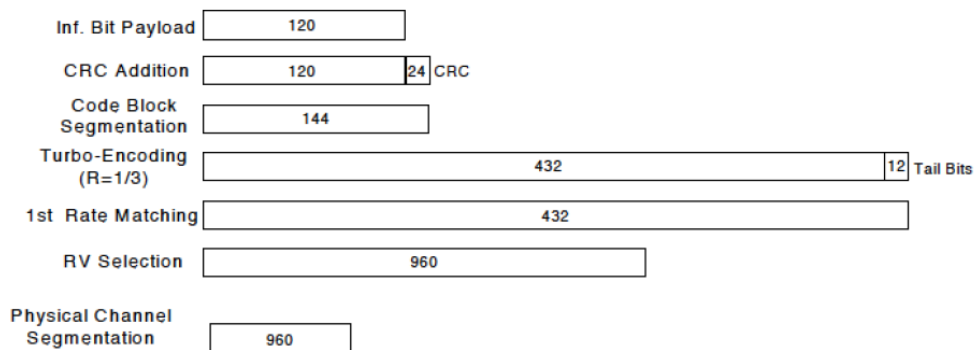


Figure C.8.19: Coding rate for Fixed reference Channel H-Set 12 (QPSK)

The following 4 Sub-tests for HSDPA were completed according to Release 5 procedures. A summary of subtest settings are illustrated below:

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

Note 1: Δ ACK, Δ NACK and Δ CQI=8 $A_{hs} = \beta_{hs}/\beta_c = 30/15$ $\beta_{hs} = 30/15 * \beta_c$
Note 2: CM=1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.
Note 3: For subtest 2 the β_c/β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11/15$ and $\beta_d = 15/15$

Up commands are set continuously to set the UE to Max power.

6.4 LTE Test Configuration

SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices v02. The CMW500 WideBand Radio Communication Tester was used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. SAR test were performed with the same number of RB and RB offsets transmitting on all TTI frames (Maximum TTI)

1) Spectrum Plots for RB configurations

A properly configured base station simulator was used for LTE output power measurements and SAR testing. Therefore, spectrum plots for RB configurations were not required to be included in this report.

2) MPR

When MPR is implemented permanently within the UE, regardless of network requirements, only those RB configurations allowed by 3GPP for the channel bandwidth and modulation combinations may be tested with MPR active. Configurations with RB allocations less than the RB thresholds required by 3GPP must be tested without MPR.

The allowed Maximum Power Reduction (MPR) for the maximum output power due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1 of the 3GPP TS36.101.

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3

| Modulation | Channel bandwidth / Transmission bandwidth (RB) | | | | | | MPR (dB) |
|------------|---|---------|-------|--------|--------|--------|----------|
| | 1.4 MHz | 3.0 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | |
| QPSK | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 1 |
| 16 QAM | ≤ 5 | ≤ 4 | ≤ 8 | ≤ 12 | ≤ 16 | ≤ 18 | ≤ 1 |
| 64 QAM | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 2 |

3) A-MPR

A-MPR (Additional MPR) has been disabled for all SAR tests by using Network Signalling Value of "NS_01" on the base station simulator.

4) LTE procedures for SAR testing

A) Largest channel bandwidth standalone SAR test requirements

i) QPSK with 1 RB allocation

Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required for 1 RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

ii) QPSK with 50% RB allocation

The procedures required for 1 RB allocation in i) are applied to measure the SAR for QPSK with 50% RB allocation.

iii) QPSK with 100% RB allocation

For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in i) and ii) are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

iv) Higher order modulations

For each modulation besides QPSK; e.g., 16-QAM, 64-QAM, apply the QPSK procedures in above sections to determine the QAM configurations that may need SAR measurement. For each configuration identified as required for testing, SAR is required only when the highest maximum output power for the configuration in the higher order modulation is $> \frac{1}{2}$ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

B) Other channel bandwidth standalone SAR test requirements

For the other channel bandwidths used by the device in a frequency band, apply all the procedures required for the largest channel bandwidth in section A) to determine the channels and RB configurations that need SAR testing and only measure SAR when the highest maximum output power of a configuration requiring testing in the smaller channel bandwidth is $> \frac{1}{2}$ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

6.5 WiFi Test Configuration

For WiFi SAR testing, a communication link is set up with the testing software for WiFi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The test procedures in KDB 248227D01v02 are applied. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The *reported* SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

6.5.1 Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is $\leq 0.4 \text{ W/kg}$, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is $\leq 0.8 \text{ W/kg}$ or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is $> 0.8 \text{ W/kg}$, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is $\leq 1.2 \text{ W/kg}$ or all required channels are tested.

6.5.2 Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01v02). SAR test reduction of subsequent highest output test channels is based on the *reported* SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the *reported* SAR of the initial test configuration is $> 0.8 \text{ W/kg}$, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the *reported* SAR is $\leq 1.2 \text{ W/kg}$ or all required channels are tested.

6.5.3 Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

When the highest reported SAR for the initial test configuration, according to the initial test position or

fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

6.5.4 WiFi 2.4G SAR Test Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions.

A) 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

- 1) When the *reported* SAR of the highest measured maximum output power channel (section 3.1 of of KDB 248227D01v02) for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
- 2) When the *reported* SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any *reported* SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

B) 2.4GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3 of of KDB 248227D01v02). SAR is not required for the following 2.4 GHz OFDM conditions.

- 1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
- 2) When the highest *reported* SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

6.5.5 OFDM Transmission Mode SAR Test Channel Selection Requirements

For 2.4 GHz, When the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations, the lower order 802.11 mode is used for SAR measurement. When the maximum output power are the same for multiple test channel, either according to the default or additional power measurement requirement, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.5.6 MIMO SAR Considerations

Per KDB 248227D01v02, simultaneous transmission provisions in KDB Publication 447498 should be used to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1-g SAR single transmission SAR measurement is $<1.6\text{W/kg}$, no additional SAR measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

6.6 Power reduction specification

1) General proximity sensor implementation description

This device uses a proximity sensor that share the same metallic electrode as the transmitting antenna to facilitate triggering in typical user interactivity with the device. Due to the operating configurations and exposure conditions required by the device, the proximity sensor is used to indicate when the tablet is held close to a user's body exposure condition. It utilizes the proximity sensor to reduce the output power in specific wireless and operating modes to ensure SAR compliance for the following scenarios: To reduce the output power of main antennas during body close to the device.

2) Power reduction triggered by capacitive proximity sensor

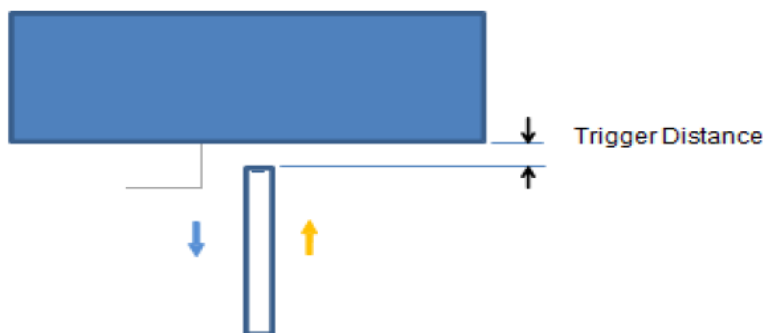
The following tables summarize the key power reduction information for proximity sensor. To ensure all production units are compliant, it is generally necessary to reduce the triggering distance determined from the triggering tests by 1 mm, or more if it is necessary, and use the smallest distance for movements to and from the phantom, minus 1 mm, as the sensor triggering distance for determining the SAR measurement distance.

| Main antenna | | |
|--------------|--|----------------------|
| Band | Sensor Trigger Distance | Power reduction (dB) |
| UMTS Band II | Front side: 18mm Back side: 18mm Left side: 18mm | 2 |

A) Procedures for determining proximity sensor triggering distances

Per FCC KDB 616217 D04v01, the device was tested by the test lab to determine the proximity sensor triggering distances. To ensure all production units are compliant, the smallest separation distance determined by the sensor triggering minus 1 mm, must be used as the test separation distance for SAR testing. These SAR tests are included in addition to the SAR tests for the device touching the SAR phantom with reduced power.

The proximity sensor triggering distance measurement results are as below:



Picture: Proximity sensor triggering distances assessment (Left side)

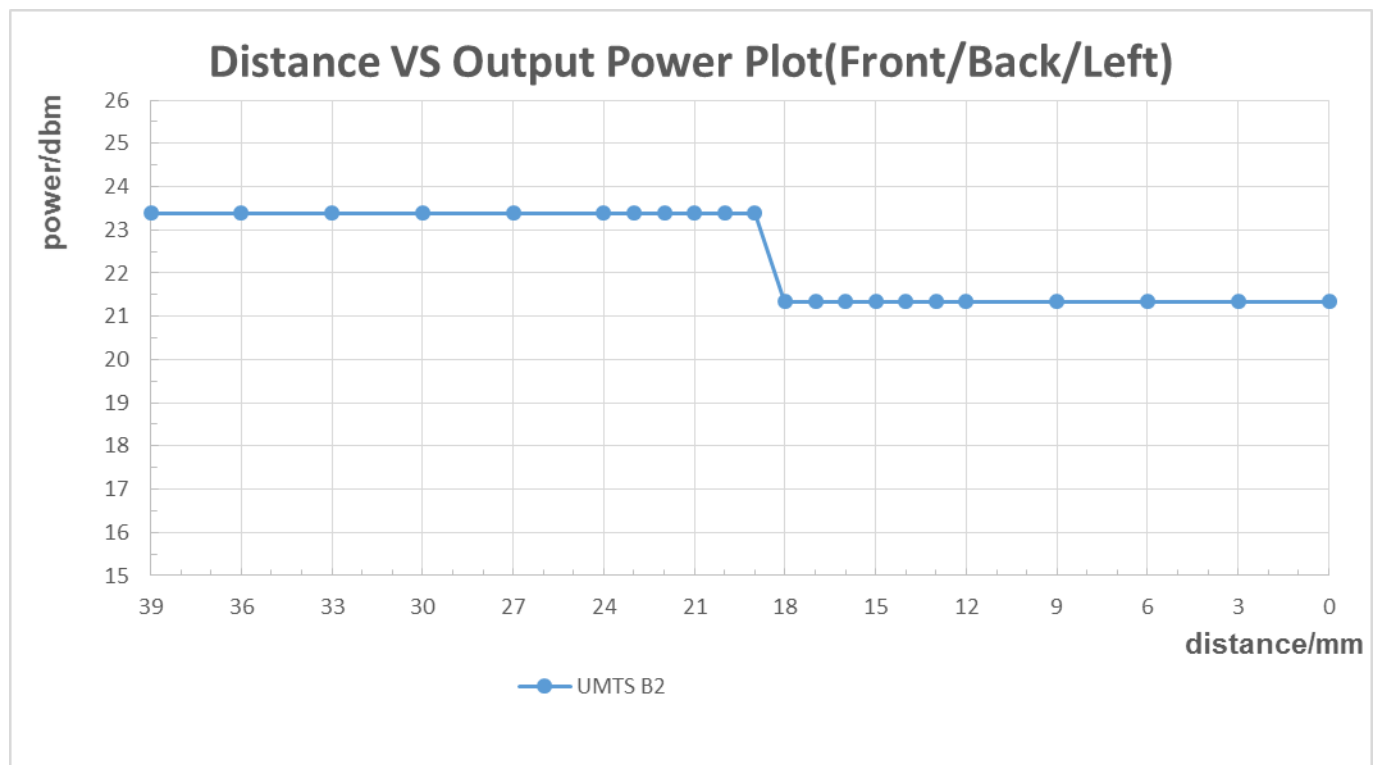


Picture: Proximity sensor triggering distances assessment (Front/Back side)

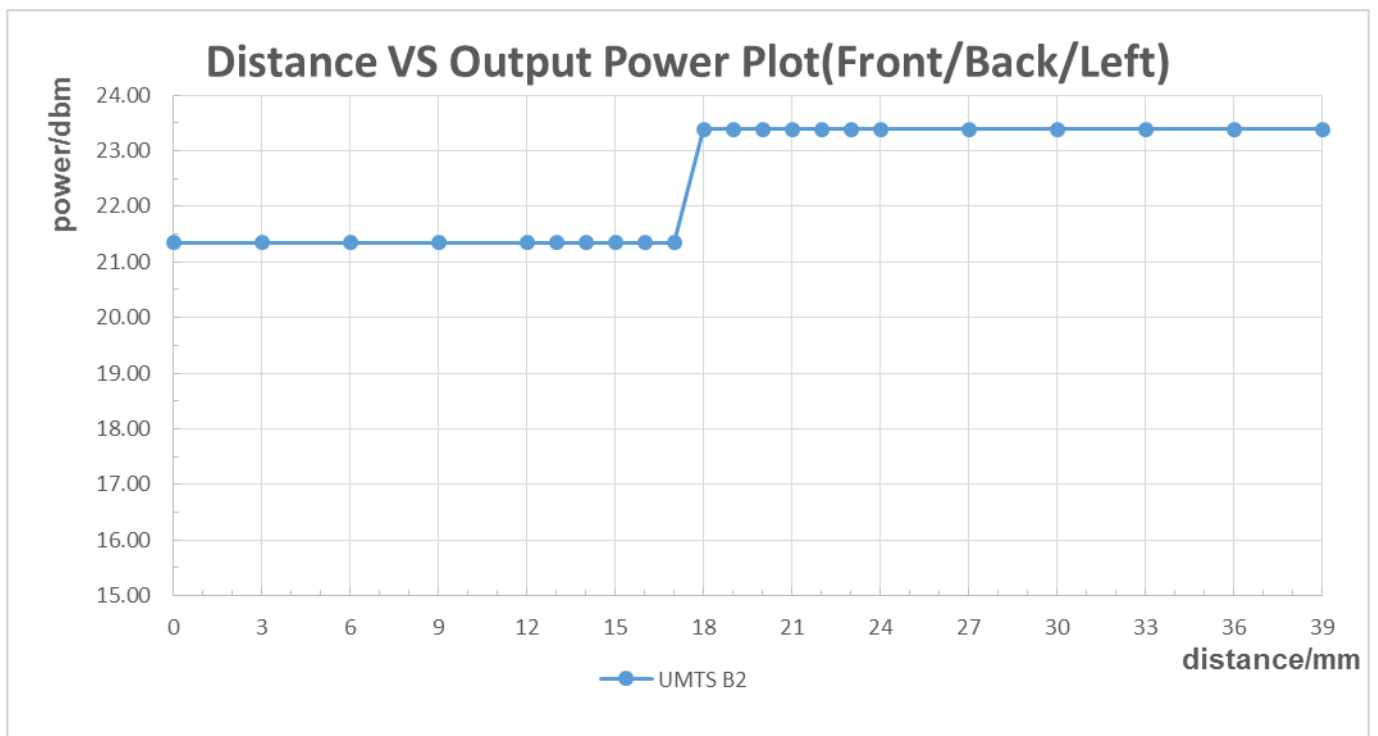
Table 13: Summary of Trigger Distances

| Band(MHz) | Trigger distance Front/ Back/Left Side | |
|--------------|--|--------------------------|
| | Moving toward phantom | Moving away from phantom |
| UMTS Band II | 18mm | 18mm |

The DUT is moved towards flat phantom (Front/Back/Left side):



The DUT is moved away from flat phantom (Front/Back/Left side):



Note:

- 1) For Front/Back/Left side, based on the most conservative measured triggering distance of 18 mm, additional SAR test is required at 17 mm with Max power level.

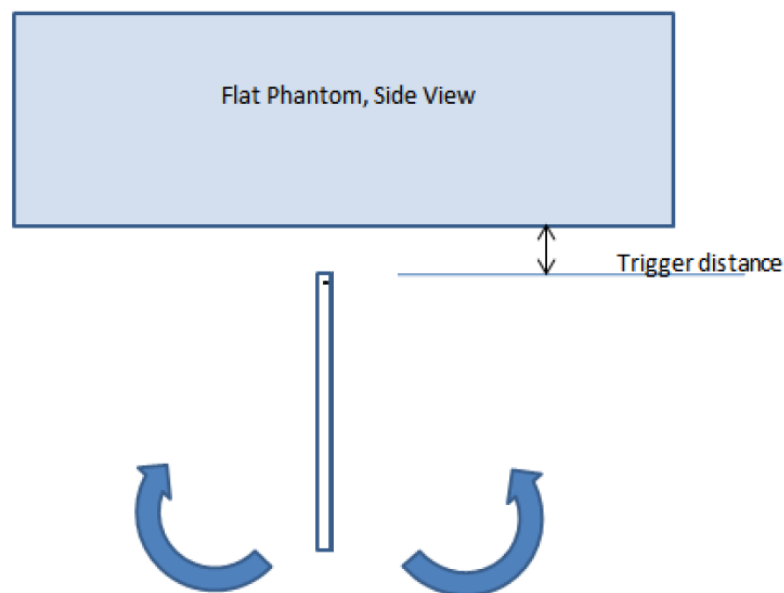
B) Procedures for determining antenna and proximity sensor coverage

There is no spatial offset between the Main antenna and the proximity sensor element, because The proximity sensor and main antenna use same metallic electrode, so procedures for determining the proximity sensor coverage does not need to be assessed.

C) Procedures for determining device tilt angle influences to proximity sensor triggering

the DUT was positioned directly below the flat phantom at the minimum measured trigger distance with each applicable edge parallel to the base of the flat phantom for each band.

The EUT was rotated about each applicable edge for angles up to $\pm 45^\circ$. If the output power increased during the rotation the DUT was moved 1mm toward the phantom and the rotation repeated. This procedure was repeated until the power remained reduced for all angles up to $\pm 45^\circ$.



Picture: Proximity sensor tilt angle assessment

| Band(MHz) | Minimum trigger distance | Minimum trigger distance at which power reduction was maintained over $\pm 45^\circ$ | Power Reduction Status | | | | | | | | | | |
|--------------|--------------------------|--|------------------------|------|------|------|-----|----|----|-----|-----|-----|-----|
| | | | -45° | -35° | -25° | -15° | -5° | 0° | 5° | 15° | 25° | 35° | 45° |
| UMTS Band II | 18mm | 18mm | on | on | on | on | on | on | on | on | on | on | on |

Table 14: Summary of Tablet Tilt Angle Influence to Proximity Sensor Triggering

7 SAR Measurement Results

7.1 Conducted power measurements

For the measurements a Rohde & Schwarz Radio Communication Tester CMU200&CMW500 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 of UMTS Band V

| UMTS Band V | | Tune-up | Conducted Power (dBm) | | |
|-------------|--------------|---------|-----------------------|--------|--------|
| | | | 4132CH | 4182CH | 4233CH |
| WCDMA | 12.2kbps RMC | 23.5 | 23.02 | 23.06 | 23.02 |
| HSDPA | Subtest 1 | 23.0 | 21.01 | 21.26 | 21.13 |
| | Subtest 2 | 23.0 | 21.74 | 21.80 | 21.38 |
| | Subtest 3 | 22.0 | 21.38 | 20.50 | 21.49 |
| | Subtest 4 | 22.0 | 20.69 | 21.11 | 20.60 |
| HSUPA | Subtest 1 | 22.5 | 21.63 | 21.68 | 21.46 |
| | Subtest 2 | 21.0 | 19.82 | 19.58 | 19.55 |
| | Subtest 3 | 22.0 | 21.38 | 20.84 | 20.50 |
| | Subtest 4 | 21.0 | 19.62 | 19.85 | 19.78 |
| | Subtest 5 | 22.5 | 21.65 | 21.40 | 21.69 |
| DC-HSDPA | Subtest 1 | 23.0 | 21.02 | 21.27 | 21.14 |
| | Subtest 2 | 23.0 | 21.75 | 21.81 | 21.39 |
| | Subtest 3 | 22.0 | 21.39 | 20.51 | 21.50 |
| | Subtest 4 | 22.0 | 20.70 | 21.12 | 20.61 |

Table 15: Conducted power measurement results of UMTS Band V

Note: 1) The conducted power of UMTS Band V is measured with RMS detector.

2) The bolded 12.2kbps RMC mode was selected for SAR testing(the primary mode).

3) Per KDB941225 D01v03, When the maximum output power and tune-up tolerance specified for production units in a Second mode is $\leq \frac{1}{4}$ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of Second to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the Second mode.

7.1.2 Conducted power measurements of UMTS Band II

| UMTS Band II | | Tune-up | Conducted Power (dBm) | | |
|--------------|--------------|---------|-----------------------|--------|--------|
| | | | 9262CH | 9400CH | 9538CH |
| WCDMA | 12.2kbps RMC | 21.5 | 21.35 | 21.34 | 21.36 |
| HSDPA | Subtest 1 | 21.0 | 20.50 | 20.46 | 20.49 |
| | Subtest 2 | 21.0 | 20.22 | 20.19 | 20.18 |
| | Subtest 3 | 20.0 | 19.36 | 19.33 | 19.30 |
| | Subtest 4 | 20.0 | 19.35 | 19.31 | 19.29 |
| HSUPA | Subtest 1 | 20.5 | 20.37 | 20.34 | 20.26 |
| | Subtest 2 | 19.0 | 18.43 | 18.39 | 18.33 |
| | Subtest 3 | 20.0 | 19.38 | 19.35 | 19.26 |
| | Subtest 4 | 19.0 | 18.43 | 18.39 | 18.33 |
| | Subtest 5 | 20.5 | 20.37 | 20.34 | 20.28 |
| DC-HSDPA | Subtest 1 | 21.0 | 20.54 | 20.50 | 20.53 |
| | Subtest 2 | 21.0 | 20.20 | 20.17 | 20.16 |
| | Subtest 3 | 20.0 | 19.44 | 19.41 | 19.38 |
| | Subtest 4 | 20.0 | 19.41 | 19.37 | 19.35 |

Table 16: Conducted power measurement results of UMTS Band II (Sensor ON)

| UMTS Band II | | Tune-up | Conducted Power (dBm) | | |
|--------------|--------------|---------|-----------------------|--------|--------|
| | | | 9262CH | 9400CH | 9538CH |
| WCDMA | 12.2kbps RMC | 23.5 | 23.30 | 23.38 | 23.31 |
| HSDPA | Subtest 1 | 23.0 | 22.46 | 22.53 | 22.44 |
| | Subtest 2 | 23.0 | 22.22 | 22.28 | 22.26 |
| | Subtest 3 | 22.0 | 21.80 | 21.44 | 21.39 |
| | Subtest 4 | 22.0 | 21.35 | 21.43 | 21.35 |
| HSUPA | Subtest 1 | 22.5 | 22.35 | 22.41 | 22.28 |
| | Subtest 2 | 21.0 | 20.38 | 20.46 | 20.35 |
| | Subtest 3 | 22.0 | 21.35 | 21.41 | 21.28 |
| | Subtest 4 | 21.0 | 20.28 | 20.37 | 20.25 |
| | Subtest 5 | 22.5 | 22.36 | 22.42 | 22.31 |
| DC-HSDPA | Subtest 1 | 23.0 | 22.37 | 22.48 | 22.41 |
| | Subtest 2 | 23.0 | 22.12 | 22.31 | 22.19 |
| | Subtest 3 | 22.0 | 21.64 | 21.35 | 21.41 |
| | Subtest 4 | 22.0 | 21.29 | 21.37 | 21.42 |

Table 17: Conducted power measurement results of UMTS Band II (Full power)

Note: 1) The conducted power of UMTS Band II is measured with RMS detector.

2) The bolded 12.2kbps RMC mode was selected for SAR testing(the primary mode).

3) Per KDB941225 D01v03, When the maximum output power and tune-up tolerance specified for production units in a Second mode is $\leq \frac{1}{4}$ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of Second to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the Second mode.

7.1.3 Conducted power measurements of LTE Band V

| Bandwidth | Modulation | RB size | RB offset | Tune-up | Channel | Channel | Channel |
|-----------|------------|---------|-----------|---------|---------|---------|---------|
| | | | | | 20425CH | 20525CH | 20625CH |
| 5MHz | QPSK | 1 | 0 | 23.5 | 22.35 | 22.20 | 22.14 |
| | | 1 | 13 | 23.5 | 22.37 | 22.30 | 22.14 |
| | | 1 | 24 | 23.5 | 22.28 | 22.13 | 22.06 |
| | | 12 | 0 | 22.5 | 21.26 | 21.17 | 21.13 |
| | | 12 | 6 | 22.5 | 21.26 | 21.19 | 21.12 |
| | | 12 | 13 | 22.5 | 21.26 | 21.15 | 21.05 |
| | | 25 | 0 | 22.5 | 21.26 | 21.16 | 21.11 |
| | 16QAM | 1 | 0 | 22.5 | 21.48 | 21.30 | 21.71 |
| | | 1 | 13 | 22.5 | 21.51 | 21.30 | 21.66 |
| | | 1 | 24 | 22.5 | 21.44 | 21.22 | 21.59 |
| | | 12 | 0 | 21.5 | 20.33 | 20.23 | 20.29 |
| | | 12 | 6 | 21.5 | 20.37 | 20.22 | 20.27 |
| | | 12 | 13 | 21.5 | 20.32 | 20.19 | 20.22 |
| | | 25 | 0 | 21.5 | 20.27 | 20.10 | 20.19 |
| | 64QAM | 1 | 0 | 21.5 | 21.11 | 21.31 | 21.14 |
| | | 1 | 13 | 21.5 | 20.95 | 21.05 | 21.10 |
| | | 1 | 24 | 21.5 | 21.00 | 21.14 | 21.08 |
| | | 12 | 0 | 20.5 | 20.27 | 20.25 | 20.17 |
| | | 12 | 6 | 20.5 | 20.05 | 20.41 | 20.33 |
| | | 12 | 13 | 20.5 | 20.05 | 20.28 | 20.21 |
| | | 25 | 0 | 20.5 | 20.33 | 19.78 | 20.19 |

| Bandwidth | Modulation | RB size | RB offset | Tune-up | Channel | Channel | Channel |
|-----------|------------|---------|-----------|---------|--------------|--------------|--------------|
| | | | | | 20450CH | 20525CH | 20600CH |
| 10MHz | QPSK | 1 | 0 | 23.5 | 22.20 | 22.14 | 22.22 |
| | | 1 | 25 | 23.5 | 22.11 | 22.10 | 22.15 |
| | | 1 | 49 | 23.5 | 22.03 | 22.03 | 22.11 |
| | | 25 | 0 | 22.5 | 21.19 | 21.20 | 21.15 |
| | | 25 | 13 | 22.5 | 21.17 | 21.15 | 21.18 |
| | | 25 | 25 | 22.5 | 21.13 | 21.12 | 21.10 |
| | | 50 | 0 | 22.5 | 21.17 | 21.13 | 21.13 |
| | 16QAM | 1 | 0 | 22.5 | 21.21 | 21.25 | 21.55 |
| | | 1 | 25 | 22.5 | 21.02 | 21.13 | 21.51 |
| | | 1 | 49 | 22.5 | 21.05 | 21.09 | 21.40 |
| | | 25 | 0 | 21.5 | 20.21 | 20.31 | 20.22 |
| | | 25 | 13 | 21.5 | 20.21 | 20.26 | 20.21 |
| | | 25 | 25 | 21.5 | 20.16 | 20.20 | 20.16 |
| | | 50 | 0 | 21.5 | 20.16 | 20.18 | 20.20 |
| | 64QAM | 1 | 0 | 21.5 | 21.12 | 21.37 | 21.29 |
| | | 1 | 25 | 21.5 | 20.98 | 21.19 | 21.12 |
| | | 1 | 49 | 21.5 | 21.09 | 21.00 | 21.07 |
| | | 25 | 0 | 20.5 | 20.20 | 20.25 | 20.26 |
| | | 25 | 13 | 20.5 | 20.20 | 20.29 | 20.30 |
| | | 25 | 25 | 20.5 | 20.16 | 20.15 | 20.27 |
| | | 50 | 0 | 20.5 | 20.23 | 20.23 | 20.15 |

Table 18: Conducted power measurement results of LTE Band V

7.1.4 Conducted power measurements of LTE Band XVII

| Bandwidth | Modulation | RB size | RB offset | Tune-up | Channel | Channel | Channel |
|-----------|------------|---------|-----------|---------|---------|---------|---------|
| | | | | | 23755CH | 23790CH | 23825CH |
| 5MHz | QPSK | 1 | 0 | 23.5 | 21.91 | 21.82 | 21.86 |
| | | 1 | 13 | 23.5 | 21.92 | 21.82 | 21.89 |
| | | 1 | 24 | 23.5 | 21.84 | 21.73 | 21.81 |
| | | 12 | 0 | 22.5 | 20.88 | 20.83 | 20.83 |
| | | 12 | 6 | 22.5 | 20.88 | 20.80 | 20.84 |
| | | 12 | 13 | 22.5 | 20.83 | 20.79 | 20.80 |
| | | 25 | 0 | 22.5 | 20.87 | 20.83 | 20.85 |
| | 16QAM | 1 | 0 | 22.5 | 21.07 | 20.90 | 21.38 |
| | | 1 | 13 | 22.5 | 21.13 | 20.93 | 21.50 |
| | | 1 | 24 | 22.5 | 21.03 | 20.90 | 21.40 |
| | | 12 | 0 | 21.5 | 19.97 | 19.90 | 19.98 |
| | | 12 | 6 | 21.5 | 19.99 | 19.89 | 20.00 |
| | | 12 | 13 | 21.5 | 19.93 | 19.80 | 19.95 |
| | | 25 | 0 | 21.5 | 19.90 | 19.75 | 19.94 |
| | 64QAM | 1 | 0 | 21.5 | 20.96 | 21.02 | 21.07 |
| | | 1 | 13 | 21.5 | 20.46 | 20.76 | 20.49 |
| | | 1 | 24 | 21.5 | 20.66 | 20.96 | 21.05 |
| | | 12 | 0 | 20.5 | 19.89 | 20.23 | 20.12 |
| | | 12 | 6 | 20.5 | 20.11 | 20.25 | 20.01 |
| | | 12 | 13 | 20.5 | 20.08 | 20.19 | 20.06 |
| | | 25 | 0 | 20.5 | 19.98 | 20.29 | 20.16 |

| Bandwidth | Modulation | RB size | RB offset | Tune-up | Channel | Channel | Channel |
|-----------|------------|---------|-----------|---------|---------|---------|--------------|
| | | | | | 23780CH | 23790CH | 23800CH |
| 10MHz | QPSK | 1 | 0 | 23.5 | 21.72 | 21.81 | 21.84 |
| | | 1 | 25 | 23.5 | 21.69 | 21.69 | 21.85 |
| | | 1 | 49 | 23.5 | 21.64 | 21.68 | 21.83 |
| | | 25 | 0 | 22.5 | 20.77 | 20.85 | 20.87 |
| | | 25 | 13 | 22.5 | 20.79 | 20.82 | 20.88 |
| | | 25 | 25 | 22.5 | 20.73 | 20.72 | 20.82 |
| | | 50 | 0 | 22.5 | 20.75 | 20.79 | 20.88 |
| | | 50 | 0 | 22.5 | 20.75 | 20.79 | 20.88 |
| | 16QAM | 1 | 0 | 22.5 | 20.51 | 20.75 | 20.91 |
| | | 1 | 25 | 22.5 | 20.67 | 20.65 | 20.86 |
| | | 1 | 49 | 22.5 | 20.61 | 20.62 | 20.84 |
| | | 25 | 0 | 21.5 | 19.82 | 19.88 | 19.96 |
| | | 25 | 13 | 21.5 | 19.79 | 19.85 | 19.98 |
| | | 25 | 25 | 21.5 | 19.78 | 19.76 | 19.94 |
| | | 50 | 0 | 21.5 | 19.78 | 19.81 | 19.89 |
| | | 50 | 0 | 21.5 | 19.78 | 19.81 | 19.89 |
| | 64QAM | 1 | 0 | 21.5 | 21.06 | 21.06 | 21.16 |
| | | 1 | 25 | 21.5 | 20.41 | 20.79 | 20.61 |
| | | 1 | 49 | 21.5 | 20.73 | 20.99 | 20.93 |
| | | 25 | 0 | 20.5 | 20.02 | 20.09 | 20.07 |
| | | 25 | 13 | 20.5 | 20.13 | 20.25 | 19.95 |
| | | 25 | 25 | 20.5 | 20.04 | 20.08 | 20.05 |
| | | 50 | 0 | 20.5 | 19.94 | 20.14 | 20.12 |
| | | 50 | 0 | 20.5 | 19.94 | 20.14 | 20.12 |

Table 19: Conducted power measurement results of LTE Band XVII

7.1.5 Conducted power measurements of WiFi 2.4G

The output power of WiFi antenna is as following:

| Mode | Ant | Channel | Frequency (MHz) | Data Rate (Mbps) | Tune-up | Average Power (dBm) | SAR Test (Yes/No) |
|-------------------------|------|---------|-----------------|------------------|---------|---------------------|-------------------|
| 802.11b | ANT0 | 1 | 2412 | 1Mbps | 13.5 | 12.60 | No |
| | | 6 | 2437 | | 13.5 | 12.85 | Yes |
| | | 11 | 2462 | | 13.5 | 12.78 | No |
| | ANT1 | 1 | 2412 | 1Mbps | 13.5 | 12.40 | No |
| | | 6 | 2437 | | 13.5 | 12.45 | Yes |
| | | 11 | 2462 | | 13.5 | 12.41 | No |
| 802.11g | ANT0 | 1 | 2412 | 6Mbps | 16 | 15.05 | No |
| | | 6 | 2437 | | 16 | 15.20 | No |
| | | 11 | 2462 | | 16 | 15.16 | No |
| | ANT1 | 1 | 2412 | 6Mbps | 16 | 15.54 | No |
| | | 6 | 2437 | | 16 | 15.57 | No |
| | | 11 | 2462 | | 16 | 15.51 | No |
| 802.11n 20M | ANT0 | 1 | 2412 | 6.5Mbps | 14 | Not Required | No |
| | | 6 | 2437 | | 14 | Not Required | No |
| | | 11 | 2462 | | 14 | Not Required | No |
| | ANT1 | 1 | 2412 | 6.5Mbps | 14 | Not Required | No |
| | | 6 | 2437 | | 14 | Not Required | No |
| | | 11 | 2462 | | 14 | Not Required | No |
| 802.11n 40M | ANT0 | 3 | 2422 | 13.5Mbps | 14 | Not Required | No |
| | | 6 | 2437 | | 14 | Not Required | No |
| | | 9 | 2452 | | 14 | Not Required | No |
| | ANT1 | 3 | 2422 | 13.5Mbps | 14 | Not Required | No |
| | | 6 | 2437 | | 14 | Not Required | No |
| | | 9 | 2452 | | 14 | Not Required | No |
| 802.11n- 20M MIMO | Sum | 1 | 2412 | 13Mbps | 17 | 15.93 | No |
| | | 6 | 2437 | | 17 | 15.86 | No |
| | | 11 | 2462 | | 17 | 15.97 | No |
| 802.11n- 40M MIMO | Sum | 3 | 2422 | 27Mbps | 17 | 15.44 | No |
| | | 6 | 2437 | | 17 | 15.68 | No |
| | | 9 | 2452 | | 17 | 15.75 | Yes |

Table 20: Conducted power measurement results of WiFi 2.4G.

Note: 1) The Average conducted power of WiFi is measured with RMS detector.

7.1.6 Conducted power measurements of BT

The conducted power of BT antenna is as following:

| BT 2450 | Tune-up | Average Conducted Power (dBm) | | |
|---------|---------|-------------------------------|------|------|
| | | 0CH | 39CH | 78CH |
| DH5 | 7 | 5.06 | 6.91 | 5.76 |
| 2DH5 | 4 | 1.76 | 3.89 | 2.70 |
| 3DH5 | 4 | 1.78 | 3.90 | 2.69 |

| BT 2450 | Tune-up | Average Conducted Power (dBm) | | |
|---------|---------|-------------------------------|------|------|
| | | 0CH | 19CH | 39CH |
| BT BLE | 4 | 0.69 | 1.73 | 0.90 |

Table 21 Conducted power measurement results of BT.

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

7.2 SAR measurement Results

General Notes:

- 1) Per KDB447498 D01, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.
- 2) Per KDB447498 D01, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - $\leq 0.8\text{W/kg}$ for 1-g or 2.0W/kg for 10-g respectively, when the transmission band is $\leq 100\text{MHz}$.
 - $\leq 0.6\text{ W/kg}$ or 1.5 W/kg , for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz.
 - $\leq 0.4\text{ W/kg}$ or 1.0 W/kg , for 1-g or 10-g respectively, when the transmission band is $\geq 200\text{ MHz}$.When the maximum output power variation across the required test channels is $> \frac{1}{2}\text{ dB}$, instead of the middle channel, the highest output power channel must be used.
- 3) Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is $\geq 0.8\text{W/kg}$; if the deviation among the repeated measurement is $\leq 20\%$, and the measured SAR $< 1.45\text{W/kg}$, only one repeated measurement is required.
- 4) Per KDB941225 D06, the DUT Dimension is bigger than 9 cm x 5 cm, so 10mm is chosen as the test separation distance for Hotspot mode. When the antenna-to-edge distance is greater than 2.5cm, such position does not need to be tested.
- 5) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is $> 1.5\text{ W/kg}$, or $> 7.0\text{ W/kg}$ for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing(Refer to appendix B for details).

UMTS Notes:

- 1) Per KDB941225 D01, When the maximum output power and tune-up tolerance specified for production units in a Second mode is $\leq \frac{1}{4}\text{ dB}$ higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of Second to primary mode and the adjusted SAR is $\leq 1.2\text{ W/kg}$, SAR measurement is not required for the Second mode.

LTE Notes:

- 1) The LTE test configurations are determined according to KDB941225 D05 SAR for LTE Devices .The general test procedures used for SAR testing can be found in Section 6.4.
- 2) A-MPR was disabled for all SAR test by setting NS_01 on the base station simulator.SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames(maximum TTI)

WiFi Notes:

Per KDB248227D01:

- 1) When reported SAR for the initial test position is $\leq 0.4\text{W/kg}$, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is $\leq 0.8\text{W/kg}$ or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is $> 0.8\text{ W/kg}$, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is $\leq 1.2\text{ W/kg}$ or all required channels are tested..
- 2) When the DSSS *reported* SAR of the highest measured maximum output power channel for the exposure configuration is $\leq 0.8\text{ W/kg}$, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
- 3) When the highest *reported* SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is $\leq 1.2\text{ W/kg}$, SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations
- 4) The highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

7.2.1 SAR measurement Result of UMTS Band V

| Test Position of Body | Dist. | Test channel / Freq.(MHz) | Test Mode | SAR Value (W/kg) | | Power Drift (dB) | Conducted Power (dBm) | Tune-up Power (dBm) | Reported SAR 1-g (W/kg) | Plot. |
|-----------------------|-------|---------------------------|-----------|------------------|-------|------------------|-----------------------|---------------------|-------------------------|-------|
| | | | | 1-g | 10-g | | | | | |
| Front Side | 10mm | 4182/836.4 | RMC | 0.861 | 0.633 | 0.12 | 23.06 | 23.50 | 0.953 | / |
| Front Side | 10mm | 4132/826.4 | RMC | 0.838 | 0.612 | 0.16 | 23.02 | 23.50 | 0.936 | / |
| Front Side | 10mm | 4233/846.6 | RMC | 0.859 | 0.636 | 0.17 | 23.02 | 23.50 | 0.959 | / |
| Back Side | 10mm | 4182/836.4 | RMC | 0.874 | 0.633 | 0.10 | 23.06 | 23.50 | 0.967 | / |
| Back Side | 10mm | 4132/826.4 | RMC | 0.863 | 0.619 | 0.09 | 23.02 | 23.50 | 0.964 | / |
| Back Side | 10mm | 4233/846.6 | RMC | 0.883 | 0.643 | -0.02 | 23.02 | 23.50 | 0.986 | Yes |
| Left Side | 10mm | 4182/836.4 | RMC | 0.105 | 0.059 | -0.07 | 23.06 | 23.50 | 0.116 | / |
| Top Side | 10mm | 4182/836.4 | RMC | 0.519 | 0.372 | 0.07 | 23.06 | 23.50 | 0.574 | / |
| Bottom Side | 10mm | 4182/836.4 | RMC | 0.520 | 0.368 | 0.05 | 23.06 | 23.50 | 0.575 | / |
| Back Side Repeated | 10mm | 4233/846.6 | RMC | 0.874 | 0.635 | 0.04 | 23.02 | 23.50 | 0.976 | / |

Table 22: Body SAR test results of UMTS Band V

7.2.2 SAR measurement Result of UMTS Band II

| Test Position of Body | Dist. | Test channel / Freq.(MHz) | Test Mode | SAR Value (W/kg) | | Power Drift (dB) | Conducted Power (dBm) | Tune-up Power (dBm) | Reported SAR 1-g (W/kg) | Plot. |
|-------------------------------------|-------|---------------------------|-----------|------------------|-------|------------------|-----------------------|---------------------|-------------------------|-------|
| | | | | 1-g | 10-g | | | | | |
| Front Side | 10mm | 9400/1880 | RMC | 0.841 | 0.536 | -0.14 | 21.34 | 21.50 | 0.873 | / |
| Front Side | 10mm | 9262/1852.4 | RMC | 0.868 | 0.544 | -0.01 | 21.35 | 21.50 | 0.899 | / |
| Front Side | 10mm | 9538/1907.6 | RMC | 0.791 | 0.508 | 0.05 | 21.36 | 21.50 | 0.817 | / |
| Back Side | 10mm | 9400/1880 | RMC | 0.706 | 0.477 | -0.11 | 21.34 | 21.50 | 0.732 | / |
| Left Side | 10mm | 9400/1880 | RMC | 0.759 | 0.413 | 0.11 | 21.34 | 21.50 | 0.787 | / |
| Top Side | 10mm | 9400/1880 | RMC | 0.149 | 0.091 | -0.17 | 23.38 | 23.50 | 0.153 | / |
| Bottom Side | 10mm | 9400/1880 | RMC | 0.450 | 0.278 | -0.01 | 23.38 | 23.50 | 0.463 | / |
| Front Side Repeated | 10mm | 9262/1852.4 | RMC | 0.880 | 0.563 | -0.14 | 21.35 | 21.50 | 0.911 | Yes |
| Additional SAR test with sensor off | | | | | | | | | | |
| Front Side | 17mm | 9400/1880 | RMC | 0.575 | 0.382 | 0.10 | 23.38 | 23.50 | 0.591 | / |
| Back Side | 17mm | 9400/1880 | RMC | 0.577 | 0.374 | 0.05 | 23.38 | 23.50 | 0.593 | / |
| Left Side | 17mm | 9400/1880 | RMC | 0.464 | 0.272 | 0.07 | 23.38 | 23.50 | 0.477 | / |

Table 23: Body SAR test results of UMTS Band II

7.2.3 SAR measurement Result of LTE Band V

| Test Position of Body | Dist. | Test channel / Freq.(MHz) | Test Mode | SAR Value (W/kg) | | Power Drift (dB) | Conducted Power (dBm) | Tune-up Power (dBm) | Reported SAR 1-g (W/kg) | Plot. |
|-----------------------|-------|---------------------------|-------------------|------------------|-------|------------------|-----------------------|---------------------|-------------------------|-------|
| | | | | 1-g | 10-g | | | | | |
| 1RB | | | | | | | | | | |
| Front Side | 10mm | 20600/844 | 10M QPSK 1RB#0 | 0.728 | 0.530 | 0.07 | 22.22 | 23.50 | 0.978 | / |
| Front Side | 10mm | 20450/829 | 10M QPSK 1RB#0 | 0.683 | 0.486 | 0.17 | 22.20 | 23.50 | 0.921 | / |
| Front Side | 10mm | 20525/836.5 | 10M QPSK 1RB#0 | 0.716 | 0.511 | 0.12 | 22.14 | 23.50 | 0.979 | / |
| Back Side | 10mm | 20600/844 | 10M QPSK 1RB#0 | 0.758 | 0.538 | -0.01 | 22.22 | 23.50 | 1.018 | Yes |
| Back Side | 10mm | 20450/829 | 10M QPSK 1RB#0 | 0.722 | 0.499 | 0.03 | 22.20 | 23.50 | 0.974 | / |
| Back Side | 10mm | 20525/836.5 | 10M QPSK 1RB#0 | 0.757 | 0.531 | 0.02 | 22.14 | 23.50 | 1.035 | / |
| Left Side | 10mm | 20600/844 | 10M QPSK 1RB#0 | 0.115 | 0.064 | -0.03 | 22.22 | 23.50 | 0.154 | / |
| Top Side | 10mm | 20600/844 | 10M QPSK 1RB#0 | 0.435 | 0.312 | 0.01 | 22.22 | 23.50 | 0.584 | / |
| Bottom Side | 10mm | 20600/844 | 10M QPSK 1RB#0 | 0.420 | 0.297 | 0.04 | 22.22 | 23.50 | 0.564 | / |
| 50%RB | | | | | | | | | | |
| Front Side | 10mm | 20525/836.5 | 10M QPSK 50%RB#0 | 0.579 | 0.415 | 0.05 | 21.20 | 22.50 | 0.781 | / |
| Back Side | 10mm | 20525/836.5 | 10M QPSK 50%RB#0 | 0.599 | 0.421 | -0.09 | 21.20 | 22.50 | 0.808 | / |
| Back Side | 10mm | 20450/829 | 10M QPSK 50%RB#0 | 0.588 | 0.408 | -0.02 | 21.19 | 22.50 | 0.795 | / |
| Back Side | 10mm | 20600/844 | 10M QPSK 50%RB#13 | 0.616 | 0.438 | 0.00 | 21.18 | 22.50 | 0.835 | / |
| Left Side | 10mm | 20525/836.5 | 10M QPSK 50%RB#0 | 0.084 | 0.047 | 0.17 | 21.20 | 22.50 | 0.113 | / |
| Top Side | 10mm | 20525/836.5 | 10M QPSK 50%RB#0 | 0.315 | 0.226 | 0.13 | 21.20 | 22.50 | 0.425 | / |
| Bottom Side | 10mm | 20525/836.5 | 10M QPSK 50%RB#0 | 0.315 | 0.222 | 0.02 | 21.20 | 22.50 | 0.425 | / |
| 100%RB | | | | | | | | | | |
| Front Side | 10mm | 20450/829 | 10M QPSK 100%RB#0 | 0.517 | 0.340 | -0.16 | 21.17 | 22.50 | 0.702 | / |
| Back Side | 10mm | 20450/829 | 10M QPSK 100%RB#0 | 0.587 | 0.408 | 0.08 | 21.17 | 22.50 | 0.797 | / |

Table 24: Body SAR test results of LTE Band V

7.2.4 SAR measurement Result of LTE Band XVII

| Test Position of Body | Dist. | Test channel / Freq.(MHz) | Test Mode | SAR Value (W/kg) | | Power Drift (dB) | Conducted Power (dBm) | Tune-up Power (dBm) | Reported SAR 1-g (W/kg) | Plot. |
|-----------------------|-------|---------------------------|-------------------|------------------|-------|------------------|-----------------------|---------------------|-------------------------|-------|
| | | | | 1-g | 10-g | | | | | |
| 1RB | | | | | | | | | | |
| Front Side | 10mm | 23800/711 | 10M QPSK 1RB#25 | 0.481 | 0.347 | -0.10 | 21.85 | 23.50 | 0.703 | / |
| Back Side | 10mm | 23800/711 | 10M QPSK 1RB#25 | 0.470 | 0.332 | 0.01 | 21.85 | 23.50 | 0.687 | / |
| Left Side | 10mm | 23800/711 | 10M QPSK 1RB#25 | 0.059 | 0.034 | -0.13 | 21.85 | 23.50 | 0.086 | / |
| Top Side | 10mm | 23800/711 | 10M QPSK 1RB#25 | 0.203 | 0.148 | 0.06 | 21.85 | 23.50 | 0.297 | / |
| Bottom Side | 10mm | 23800/711 | 10M QPSK 1RB#25 | 0.234 | 0.167 | 0.05 | 21.85 | 23.50 | 0.342 | / |
| 50%RB | | | | | | | | | | |
| Front Side | 10mm | 23800/711 | 10M QPSK 50%RB#13 | 0.526 | 0.382 | 0.10 | 20.88 | 22.50 | 0.764 | Yes |
| Back Side | 10mm | 23800/711 | 10M QPSK 50%RB#13 | 0.511 | 0.360 | 0.03 | 20.88 | 22.50 | 0.742 | / |
| Left Side | 10mm | 23800/711 | 10M QPSK 50%RB#13 | 0.052 | 0.030 | 0.04 | 20.88 | 22.50 | 0.075 | / |
| Top Side | 10mm | 23800/711 | 10M QPSK 50%RB#13 | 0.216 | 0.157 | 0.14 | 20.88 | 22.50 | 0.314 | / |
| Bottom Side | 10mm | 23800/711 | 10M QPSK 50%RB#13 | 0.238 | 0.170 | 0.06 | 20.88 | 22.50 | 0.346 | / |

Table 25: Body SAR test results of LTE Band XVII

7.2.5 SAR measurement Result of WiFi 2.4G

| Test Position of Body | Dist. | Test channel / Freq.(MHz) | Test Mode | SAR Value (W/kg) | | Power Drift (dB) | Conducted Power (dBm) | Tune-up Power (dBm) | Scaled 1-g SAR (W/kg) | Plot. |
|-----------------------|-------|---------------------------|-----------|-------------------|-------------------|------------------|-----------------------|---------------------|-----------------------|-------|
| | | | | Area Scan 1-g SAR | Zoom Scan 1-g SAR | | | | | |
| ANT 0 | | | | | | | | | | |
| Front Side | 10mm | 6/2437 | 802.11b | 0.138 | 0.136 | -0.04 | 12.85 | 13.50 | 0.158 | Yes |
| Back Side | 10mm | 6/2437 | 802.11b | 0.116 | / | / | 12.85 | 13.50 | / | / |
| Right Side | 10mm | 6/2437 | 802.11b | 0.028 | / | / | 12.85 | 13.50 | / | / |
| Top Side | 10mm | 6/2437 | 802.11b | 0.107 | / | / | 12.85 | 13.50 | / | / |
| ANT 1 | | | | | | | | | | |
| Front Side | 10mm | 6/2437 | 802.11b | 0.086 | / | / | 12.45 | 13.50 | / | / |
| Back Side | 10mm | 6/2437 | 802.11b | 0.092 | 0.105 | 0.00 | 12.45 | 13.50 | 0.134 | / |
| Right Side | 10mm | 6/2437 | 802.11b | 0.030 | / | / | 12.45 | 13.50 | / | / |
| Bottom Side | 10mm | 6/2437 | 802.11b | 0.073 | / | / | 12.45 | 13.50 | / | / |
| MIMO 40M | | | | | | | | | | |
| Front Side | 10mm | 9/2452 | 802.11n | 0.091 | 0.078 | -0.15 | 15.75 | 17.00 | 0.104 | / |
| Back Side | 10mm | 9/2452 | 802.11n | 0.084 | / | / | 15.75 | 17.00 | / | / |
| Right Side | 10mm | 9/2452 | 802.11n | 0.010 | / | / | 15.75 | 17.00 | / | / |
| Top Side | 10mm | 9/2452 | 802.11n | 0.049 | / | / | 15.75 | 17.00 | / | / |
| Bottom Side | 10mm | 9/2452 | 802.11n | 0.071 | / | / | 15.75 | 17.00 | / | / |

Table 26:Body SAR test results of WiFi 2.4G

According to KDB248227 D01,The reported SAR must be scaled to 100% transmission duty factor to determine compliance at maximum tune-up tolerance limit.The scaled reported SAR is presented as below.

| Test Position of Body | Test channel / Freq.(MHz) | Test Mode | Scaled SAR 1-g (W/kg) | Actual duty factor | Maximum duty factor | Reported SAR 1-g (W/kg) |
|-----------------------|---------------------------|-------------|-----------------------|--------------------|---------------------|-------------------------|
| ANT1 | | | | | | |
| Front Side | 6/2437 | 802.11b | 0.158 | 97.49% | 100% | 0.162 |
| ANT2 | | | | | | |
| Back Side | 6/2437 | 802.11b | 0.134 | 97.49% | 100% | 0.137 |
| MIMO | | | | | | |
| Front Side | 9/2452 | 40M 802.11n | 0.104 | 91.18% | 100% | 0.115 |

| WiFi 2.4G | Tune-up Limit (dBm) | Tune-up Limit (mW) | Highest Reported SAR(W/kg) | Adjusted SAR (W/kg) | SAR test |
|------------------|---------------------|--------------------|----------------------------|---------------------|----------|
| 802.11b | 13.50 | 22.39 | 0.162 | / | Yes |
| 802.11g | 16.00 | 39.81 | / | 0.288 | No |
| 802.11n 20M SISO | 14.00 | 25.12 | / | 0.182 | No |
| 802.11n 40M SISO | 14.00 | 25.12 | / | 0.182 | No |
| WiFi 2.4G | Tune-up Limit (dBm) | Tune-up Limit (mW) | Highest Reported SAR(W/kg) | Adjusted SAR (W/kg) | SAR test |
| 802.11n 20M MIMO | 17.00 | 50.12 | / | 0.115 | No |
| 802.11n 40M MIMO | 17.00 | 50.12 | 0.115 | / | Yes |

Table 27: Adjusted SAR for WiFi 2.4G

Note:

- 1) SAR is measured for WiFi 2.4G 802.11b DSSS using the initial test position procedure.
- 2) For WiFi 2.4G SISO, SAR is measured for 802.11b DSSS using the initial test position procedure. As the highest reported SAR for DSSS is adjusted by the ratio of OFDM 802.11g/n to DSSS specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for 802.11g/n is not required.
- 3) For WiFi 2.4G MIMO, SAR is measured for 802.11n 40M MIMO using the initial test position procedure according to the specified maximum output power and maximum bandwidth. As the the adjusted SAR is < 1.2 W/kg, so SAR test for OFDM 802.11n 20M MIMO is not required.

7.3.1 Stand-alone SAR test exclusion

Per FCC KDB 447498D01v06, the 1-g SAR and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

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

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

| Mode | Position | P_{max} (dBm)* | P_{max} (mW) | Distance (mm) | f (GHz) | Calculation Result | SAR Exclusion threshold | SAR test exclusion |
|------|----------|----------------------------|--------------------------|------------------|------------|-----------------------|-------------------------------|-----------------------|
| BT | Body | 7.00 | 5.01 | 10 | 2.450 | 0.79 | 3.00 | Yes |

Table 29: Standalone SAR test exclusion for BT

Note:

1)* - maximum possible output power declared by manufacturer

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

$(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})}/x] \text{ W/kg}$ for test separation distances ≤ 50 mm, where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

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

| Mode | Position | P_{max} (dBm)* | P_{max} (mW) | Distance (mm) | f (GHz) | x | Estimated SAR (W/kg)* |
|------|----------|----------------------------|--------------------------|------------------|------------|------|--------------------------|
| BT | Body | 7.00 | 5.01 | 10 | 2.450 | 7.50 | 0.105 |

Table 30: Estimated SAR calculation for BT

Note:

1)* - maximum possible output power declared by manufacturer

7.3.2 Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

| No. | Configuration | Body |
|-----|--------------------------------|------|
| 1 | UMTS/LTE + WiFi 2.4G SISO ANT1 | Yes |
| 2 | UMTS/LTE + WiFi 2.4G SISO ANT2 | Yes |
| 3 | UMTS/LTE + WiFi 2.4G MIMO | Yes |
| 4 | UMTS/LTE + BT | Yes |

Table 31: Simultaneous Transmission Possibilities

Note: The WiFi 2.4G and Bluetooth can't transmit simultaneously.

7.3.3 SAR Summation Scenario

| Test Position of Body with 10mm | Main antenna SAR _{Max} | | | | WiFi antenna SAR _{Max} | | Σ1-g SAR (1.6W/kg Limit) |
|---------------------------------|---------------------------------|--------------|------------|---------------|---------------------------------|-------|--------------------------|
| | UMTS Band V | UMTS Band II | LTE Band V | LTE Band XVII | WiFi 2.4G | BT | |
| Front side | 0.959 | 0.911 | 0.979 | 0.764 | 0.162 | 0.105 | 1.141 |
| Back side | 0.986 | 0.732 | 1.035 | 0.742 | 0.162 | 0.105 | 1.197 |
| Left side | 0.116 | 0.787 | 0.154 | 0.086 | / | / | 0.787 |
| Right side | / | / | / | / | 0.162 | 0.105 | 0.162 |
| Top side | 0.574 | 0.153 | 0.584 | 0.314 | 0.162 | 0.105 | 0.746 |
| Bottom side | 0.575 | 0.463 | 0.564 | 0.346 | 0.162 | / | 0.737 |

Table 32: SAR Simultaneous Tx Combination of Main antenna and WiFi/BT Antenna.

7.3.4 Simultaneous Transmission Conclusion

The above numeral summed SAR results and SPLSR analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore simultaneous transmission SAR with Volume Scans is not required per KDB 447498 D01v06

Appendix A. System Check Plots

(Pls See Appendix No.: SYBH(Z-SAR)014092017-2A, total: 5 pages)

Appendix B. SAR Measurement Plots

(Pls See Appendix No.: SYBH(Z-SAR)014092017-2B, total: 6 pages)

Appendix C. Calibration Certificate

(Pls See Appendix No.: SYBH(Z-SAR)014092017-2C, total: 79 pages)

Appendix D. Photo documentation

(Pls See Appendix No.: SYBH(Z-SAR)014092017-2D, total: 5 pages)

End