



# SAR TEST REPORT

**Applicant** ZTE Corporation  
**FCC ID** SRQ-MO-01K  
**Product** LTE/WCDMA Dual-Mode Digital Mobile Phone  
**Model** MO-01K  
**Report No.** RXC1706-0185SAR01R1  
**Issue Date** September 30, 2017

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **IEEE 1528-2013, ANSI/ IEEE C95.1-1992**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

*Jiang peng Lan*

*Performed by: Jiangpeng Lan*

*Kai Xu*

*Approved by: Kai Xu*

**TA Technology (Shanghai) Co., Ltd.**

*No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China*

*TEL: +86-021-50791141/2/3*

*FAX: +86-021-50791141/2/3-8000*

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# 1 Test Laboratory

## 1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above. This report must not be used by the client to claim product certification, approval, or endorsement by any government agencies.

## 1.2 Test facility

### **CNAS (accreditation number:L2264)**

TA Technology (Shanghai) Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

### **FCC (recognition number is 428261)**

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

### **IC (recognition number is 8510A)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Canada to perform electromagnetic emission measurement.

### **VCCI (recognition number is C-4595, T-2154, R-4113, G-10766)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Japan to perform electromagnetic emission measurement.

### **A2LA (Certificate Number: 3857.01)**

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

### 1.3 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.  
Address: No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China  
City: Shanghai  
Post code: 201201  
Country: P. R. China  
Contact: Xu Kai  
Telephone: +86-021-50791141/2/3  
Fax: +86-021-50791141/2/3-8000  
Website: <http://www.ta-shanghai.com>  
E-mail: [xukai@ta-shanghai.com](mailto:xukai@ta-shanghai.com)

### 1.4 Laboratory Environment

|                                                                                                                                                                                                 |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Temperature                                                                                                                                                                                     | Min. = 18°C, Max. = 25 °C |
| Relative humidity                                                                                                                                                                               | Min. = 30%, Max. = 70%    |
| Ground system resistance                                                                                                                                                                        | < 0.5 $\Omega$            |
| Ambient noise is checked and found very low and in compliance with requirement of standards.<br>Reflection of surrounding objects is minimized and in compliance with requirement of standards. |                           |

## 2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for the EUT are as follows:

Table 2.1: Highest Reported SAR

| Mode                                                                                                                                                                                                                                                                              | Highest Reported SAR (W/kg) |                                    |                                  |                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------|----------------------------------|--------------------------------------------|
|                                                                                                                                                                                                                                                                                   | 1g SAR Head                 | 1g SAR Body-worn (Separation 10mm) | 1g SAR Hotspot (Separation 10mm) | Product Specific 10-g SAR (Separation 0mm) |
| WCDMA Band V                                                                                                                                                                                                                                                                      | 0.662                       | 0.974                              | 0.974                            | NA                                         |
| Wi-Fi (2.4G)                                                                                                                                                                                                                                                                      | 0.872                       | 0.297                              | 0.307                            | NA                                         |
| Bluetooth                                                                                                                                                                                                                                                                         | 0.065                       | NA                                 | NA                               | NA                                         |
| Date of Testing:                                                                                                                                                                                                                                                                  | June 13, 2017~ July 7, 2017 |                                    |                                  |                                            |
| Note: The device is in compliance with SAR for Uncontrolled Environment /General Population exposure limits (1.6 W/kg and 4.0 W/kg) specified in ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013. |                             |                                    |                                  |                                            |

Table 2.2: Highest Simultaneous Transmission SAR

| Exposure Configuration                                                                        | 1g SAR Head | 1g SAR Body-worn (Separation 10mm) | 1g SAR Hotspot (Separation 10mm) | Product Specific 10-g SAR (Separation 0mm) |
|-----------------------------------------------------------------------------------------------|-------------|------------------------------------|----------------------------------|--------------------------------------------|
| Highest Simultaneous Transmission SAR (W/kg)                                                  | 1.501       | 1.481                              | 1.481                            | NA                                         |
| Note: 1. The detail for simultaneous transmission consideration is described in chapter 10.4. |             |                                    |                                  |                                            |

### 3 Description of Equipment under Test

#### Client Information

|                             |                                                                                                                |
|-----------------------------|----------------------------------------------------------------------------------------------------------------|
| <b>Applicant</b>            | ZTE Corporation                                                                                                |
| <b>Applicant address</b>    | ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China |
| <b>Manufacturer</b>         | ZTE Corporation                                                                                                |
| <b>Manufacturer address</b> | ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China |

#### General Technologies

|                      |                                                                                                                 |
|----------------------|-----------------------------------------------------------------------------------------------------------------|
| Application Purpose: | Original Grant                                                                                                  |
| EUT Stage            | Identical Prototype                                                                                             |
| Model:               | MO-01K                                                                                                          |
| IMEI:                | 865202030007526                                                                                                 |
| Hardware Version:    | P840D01HW1.0                                                                                                    |
| Software Version:    | DCM_JP_P840D01V0.0.0B02                                                                                         |
| Antenna Type:        | Internal Antenna                                                                                                |
| Device Class:        | B                                                                                                               |
| Wi-Fi Hotspot        | Wi-Fi 2.4G                                                                                                      |
| Power Class:         | UMTS Band V: 3                                                                                                  |
| Power Level          | UMTS Band V:all up bits                                                                                         |
| EUT Accessory        |                                                                                                                 |
| Battery              | Manufacturer: Harbin Coslight Power Co., Ltd.<br>Model: Li3928T44P8h475371<br>Ratings: 3.85Vdc, 2800mAh, 10.8Wh |

| Difference Configuration Statement                 |                                            |                      |
|----------------------------------------------------|--------------------------------------------|----------------------|
| Test Configuration                                 | TC 1                                       | TC 2                 |
| LCD Model                                          | 98-03050-6423B                             | BV050HDM-L00-3K13    |
| LCD Manufacturer                                   | Shenzhen DJN Optronics Technology Co., Ltd | BOE HYUNDAI LCD Inc. |
| Others                                             | The same                                   | The same             |
| The difference between the two EUT is only the LCD |                                            |                      |

**Wireless Technology and Frequency Range**

| Wireless Technology |                                                                                                   | Modulation     | Operating mode                                            | Tx (MHz)   |
|---------------------|---------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------------------|------------|
| UMTS                | Band V                                                                                            | QPSK           | Release: 8<br>Downlink Category: 24<br>Uplink Category: 6 | 824 ~ 849  |
| BT                  | 2.4G                                                                                              | Version 4.2 LE |                                                           | 2402 ~2480 |
| Wi-Fi               | 2.4G                                                                                              | DSSS, OFDM     | 802.11b/g/n (HT20/HT40)                                   | 2412 ~2472 |
|                     | Does this device support MIMO <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |                |                                                           |            |





## 4 Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE 1528- 2013, ANSI/IEEE C95.1-1992, the following FCC Published RF exposure KDB procedures:

248227 D01 802.11 Wi-Fi SAR v02r02  
447498 D01 General RF Exposure Guidance v06  
648474 D04 Handset SAR v01r03  
865664 D01 SAR measurement 100 MHz to 6 GHz v01r04  
865664 D02 RF Exposure Reporting v01r02  
941225 D01 3G SAR Procedures v03r01  
941225 D06 Hotspot Mode v02r01

## 5 Operational Conditions during Test

### 5.1 Test Positions

#### 5.1.1 Against Phantom Head

Measurements were made in “cheek” and “tilt” positions on both the left hand and right hand sides of the phantom.

The positions used in the measurements were according to IEEE 1528 - 2013 "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques".

#### 5.1.2 Body Worn Configuration

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations.

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per FCC KDB Publication 648474 D04, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is  $> 1.2$  W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

## 5.2 Measurement Variability

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

- 1) When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
- 2) A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
- 3) A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .
- 4) Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg

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.

## 5.3 Test Configuration

### 5.3.1 3G Test Configuration

#### 3G SAR Test Reduction Procedure

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  $\leq 1.2$  W/kg, SAR measurement is not required for the secondary mode.<sup>3</sup> 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.

### 5.3.1.1 WCDMA Test Configuration

#### 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.

#### Head SAR

SAR for next to the ear head exposure 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 AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest reported SAR configuration in 12.2 kbps RMC for head exposure.

#### Body-Worn Accessory SAR

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. Otherwise, SAR is measured using an applicable RMC configuration with the corresponding spreading code or DPDCHn, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When more than 2 DPDCHn are supported by the handset, it may be necessary to configure additional DPDCHn using FTM (Factory Test Mode) or other chipset based test approaches with parameters similar to those used in 384 kbps and 768 kbps RMC.

#### Handsets with Release 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the "Release 5 HSDPA Data Devices" section of this document, for the highest reported SAR body-worn accessory exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

HSDPA should be configured according to the UE category of a test device. The number of HSDSCH/HS-PDSCHs, HARQ 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 conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors ( $\beta_c$ ,  $\beta_d$ ), and HS-DPCCH power offset parameters ( $\Delta_{ACK}$ ,  $\Delta_{NACK}$ ,  $\Delta_{CQI}$ ) should be set according to values indicated in the Table below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

**Table 5.2: Subtests for UMTS Release 5 HSDPA**

| Sub-set | $\beta_c$         | $\beta_d$         | $\beta_d$<br>(SF) | $\beta_c/\beta_d$ | $\beta_{hs}$<br>(note 1, note 2) | CM(dB)<br>(note 3) | MPR(dB) |
|---------|-------------------|-------------------|-------------------|-------------------|----------------------------------|--------------------|---------|
| 1       | 2/15              | 15/15             | 64                | 2/15              | 4/15                             | 0.0                | 0.0     |
| 2       | 12/15<br>(note 4) | 15/15<br>(note 4) | 64                | 12/15<br>(note 4) | 24/15                            | 1.0                | 0.0     |
| 3       | 15/15             | 8/15              | 64                | 15/8              | 30/15                            | 1.5                | 0.5     |
| 4       | 15/15             | 4/15              | 64                | 15/4              | 30/15                            | 1.5                | 0.5     |

Note1:  $\Delta_{ACK}, \Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$   
 Note2: CM=1 for  $\beta_c/\beta_d = 12/15, \beta_{hs}/\beta_c = 24/15$ .  
 Note3: For subtest 2 the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period(TF1,TF0) is achieved by setting the signaled gain factors for the reference TFC (TFC1,TF1) to  $\beta_c=11/15$  and  $\beta_d=15/15$ .

**HSUPA Test Configuration**

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the “Release 6 HSPA Data Devices” section of this document, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn accessory measurements is tested for next to the ear head exposure.

Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the  $\beta$  values indicated in Table 2 and other applicable procedures described in the ‘WCDMA Handset’ and ‘Release 5 HSDPA Data Devices’ sections of this document

**Table 5.3: Sub-Test 5 Setup for Release 6 HSUPA**

| Sub-set | $\beta_c$            | $\beta_d$            | $\beta_d$<br>(SF) | $\beta_c/\beta_d$    | $\beta_{hs}^{(1)}$ | $\beta_{ec}$ | $\beta_{ed}$                               | $\beta_{ed}$<br>(SF) | $\beta_{ed}$<br>(codes) | CM <sup>(2)</sup><br>(dB) | MPR<br>(dB) | AG <sup>(4)</sup><br>Index | E-TFCI |
|---------|----------------------|----------------------|-------------------|----------------------|--------------------|--------------|--------------------------------------------|----------------------|-------------------------|---------------------------|-------------|----------------------------|--------|
| 1       | 11/15 <sup>(3)</sup> | 15/15 <sup>(3)</sup> | 64                | 11/15 <sup>(3)</sup> | 22/15              | 209/225      | 1039/225                                   | 4                    | 1                       | 1.0                       | 0.0         | 20                         | 75     |
| 2       | 6/15                 | 15/15                | 64                | 6/15                 | 12/15              | 12/15        | 94/75                                      | 4                    | 1                       | 3.0                       | 2.0         | 12                         | 67     |
| 3       | 15/15                | 9/15                 | 64                | 15/9                 | 30/15              | 30/15        | $\beta_{ed1} 47/15$<br>$\beta_{ed2} 47/15$ | 4                    | 2                       | 2.0                       | 1.0         | 15                         | 92     |
| 4       | 2/15                 | 15/15                | 64                | 2/15                 | 4/15               | 2/15         | 56/75                                      | 4                    | 1                       | 3.0                       | 2.0         | 17                         | 71     |
| 5       | 15/15 <sup>(4)</sup> | 15/15 <sup>(4)</sup> | 64                | 15/15 <sup>(4)</sup> | 30/15              | 24/15        | 134/15                                     | 4                    | 1                       | 1.0                       | 0.0         | 21                         | 81     |

Note 1:  $\Delta_{ACK}, \Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$ .

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.

Note 3: For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .

Note 4: For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Figure 5.1g.

Note 6:  $\beta_{ed}$  can not be set directly; it is set by Absolute Grant Value.

**Table 5.4: HSUPA UE category**

| 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<br>(No DPDCH)   | 4                               | 8                        | 2              | 2 SF2 & 2 SF4            | 11484                              | 5.76            |
|                   | 4                               | 4                        | 10             |                          | 20000                              | 2.00            |
| 7<br>(No DPDCH)   | 4                               | 8                        | 2              | 2 SF2 & 2 SF4            | 22996                              | ?               |
|                   | 4                               | 4                        | 10             |                          | 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 supports QPSK only. UE Category 7 supports QPSK and 16QAM. (TS25.306-7.3.0)

## HSPA, HSPA+ and DC-HSDPA Test Configuration

Measurement is required for HSPA, HSPA+ or DC-HSDPA, a KDB inquiry is required to confirm that the wireless mode configurations in the test setup have remained stable throughout the SAR measurements.<sup>35</sup> Without prior KDB confirmation to determine the SAR results are acceptable, a PBA is required for TCB approval.

SAR test exclusion for HSPA, HSPA+ and DC-HSDPA is determined according to the following:

1) The HSPA procedures are applied to configure 3GPP Rel. 6 HSPA devices in the required sub-test mode(s) to determine SAR test exclusion.

2) SAR is required for Rel. 7 HSPA+ when SAR is required for Rel. 6 HSPA; otherwise, the 3G SAR test reduction procedure is applied to (uplink) HSPA+ with 12.2 kbps RMC as the primary mode.<sup>36</sup> Power is measured for HSPA+ that supports uplink 16 QAM according to configurations in Table C.11.1.4 of 3GPP TS 34.121-1 to determine SAR test reduction.

3) 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 secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.

4) Regardless of whether a PBA is required, the following information must be verified and included in the SAR report for devices supporting HSPA, HSPA+ or DC-HSDPA: a) The output power measurement results and applicable release version(s) of 3GPP TS 34.121.

i) Power measurement difficulties due to test equipment setup or availability must be resolved between the grantee and its test lab.

b) The power measurement results are in agreement with the individual device implementation and specifications. When Enhanced MPR (E-MPR) applies, the normal MPR targets may be modified according to the Cubic Metric (CM) measured by the device, which must be taken into consideration.

c) The UE category, operating parameters, such as the  $\beta$  and  $\Delta$  values used to configure the device for testing, power setback procedures described in 3GPP TS 34.121 for the power measurements, and HSPA/HSPA+ channel conditions (active and stable) for the entire duration of the measurement according to the required E-TFCI and AG index values.

5) When SAR measurement is required, the test configurations, procedures and power measurement results must be clearly described to confirm that the required test parameters are used, including E-TFCI and AG index stability and output power conditions.



**Table 5.5: HS-DSCH UE category**

**Table 5.1a: FDD HS-DSCH physical layer categories**

| HS-DSCH category      | Maximum number of HS-DSCH codes received | Minimum inter-TTI interval | Maximum number of bits of an HS-DSCH transport block received within an HS-DSCH TTI<br>NOTE 1 | Total number of soft channel bits | Supported modulations without MIMO operation or dual cell operation | Supported modulations with MIMO operation and without dual cell operation | Supported modulations with dual cell operation     |
|-----------------------|------------------------------------------|----------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------|
| Category 1            | 5                                        | 3                          | 7298                                                                                          | 19200                             | QPSK, 16QAM                                                         | Not applicable (MIMO not supported)                                       | Not applicable (dual cell operation not supported) |
| Category 2            | 5                                        | 3                          | 7298                                                                                          | 28800                             |                                                                     |                                                                           |                                                    |
| Category 3            | 5                                        | 2                          | 7298                                                                                          | 28800                             |                                                                     |                                                                           |                                                    |
| Category 4            | 5                                        | 2                          | 7298                                                                                          | 38400                             |                                                                     |                                                                           |                                                    |
| Category 5            | 5                                        | 1                          | 7298                                                                                          | 57600                             |                                                                     |                                                                           |                                                    |
| Category 6            | 5                                        | 1                          | 7298                                                                                          | 67200                             |                                                                     |                                                                           |                                                    |
| Category 7            | 10                                       | 1                          | 14411                                                                                         | 115200                            |                                                                     |                                                                           |                                                    |
| Category 8            | 10                                       | 1                          | 14411                                                                                         | 134400                            |                                                                     |                                                                           |                                                    |
| Category 9            | 15                                       | 1                          | 20251                                                                                         | 172800                            |                                                                     |                                                                           |                                                    |
| Category 10           | 15                                       | 1                          | 27952                                                                                         | 172800                            |                                                                     |                                                                           |                                                    |
| Category 11           | 5                                        | 2                          | 3630                                                                                          | 14400                             | QPSK                                                                | Not applicable (dual cell operation not supported)                        |                                                    |
| Category 12           | 5                                        | 1                          | 3630                                                                                          | 28800                             | QPSK, 16QAM, 64QAM                                                  |                                                                           |                                                    |
| Category 13           | 15                                       | 1                          | 35280                                                                                         | 259200                            |                                                                     |                                                                           |                                                    |
| Category 14           | 15                                       | 1                          | 42192                                                                                         | 259200                            | QPSK, 16QAM                                                         |                                                                           |                                                    |
| Category 15           | 15                                       | 1                          | 23370                                                                                         | 345600                            |                                                                     |                                                                           |                                                    |
| Category 16           | 15                                       | 1                          | 27952                                                                                         | 345600                            | QPSK, 16QAM, 64QAM                                                  |                                                                           | -                                                  |
| Category 17<br>NOTE 2 | 15                                       | 1                          | 35280                                                                                         | 259200                            |                                                                     |                                                                           |                                                    |
|                       |                                          |                            | 23370                                                                                         | 345600                            | -                                                                   |                                                                           |                                                    |
| Category 18<br>NOTE 3 | 15                                       | 1                          | 42192                                                                                         | 259200                            | QPSK, 16QAM, 64QAM                                                  |                                                                           | -                                                  |
|                       |                                          |                            | 27952                                                                                         | 345600                            | -                                                                   |                                                                           | QPSK, 16QAM                                        |
| Category 19           | 15                                       | 1                          | 35280                                                                                         | 518400                            | QPSK, 16QAM, 64QAM                                                  |                                                                           |                                                    |
| Category 20           | 15                                       | 1                          | 42192                                                                                         | 518400                            |                                                                     |                                                                           |                                                    |
| Category 21           | 15                                       | 1                          | 23370                                                                                         | 345600                            | -                                                                   | -                                                                         | QPSK, 16QAM                                        |
| Category 22           | 15                                       | 1                          | 27952                                                                                         | 345600                            |                                                                     |                                                                           |                                                    |
| Category 23           | 15                                       | 1                          | 35280                                                                                         | 518400                            |                                                                     |                                                                           |                                                    |
| Category 24           | 15                                       | 1                          | 42192                                                                                         | 518400                            |                                                                     |                                                                           | QPSK, 16QAM, 64QAM                                 |

**5.3.2 Wi-Fi Test Configuration**

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test



configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported SAR* for the *initial test position* is:

- $\leq 0.4$  W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported SAR* is  $\leq 0.8$  W/kg or all required test positions are tested.
  - ✧ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - ✧ When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported SAR* is  $> 0.8$  W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported SAR* is  $\leq 1.2$  W/kg or all required test channels are considered.
  - ✧ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered the worst case position; thus used as the initial test position.

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.

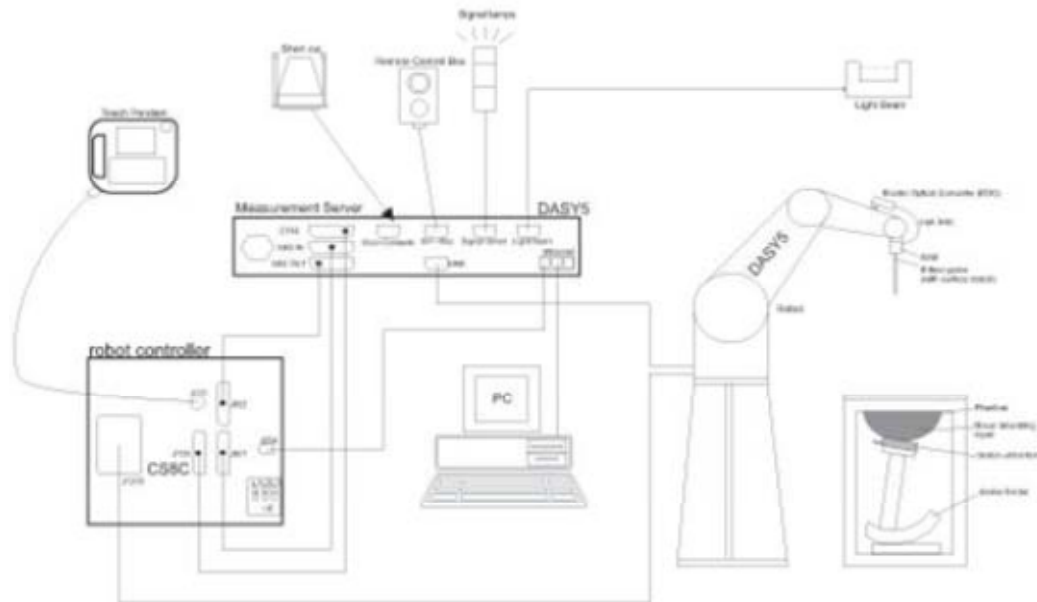
### 5.3.3 BT Test Configuration

For BT SAR testing, BT engineering testing software installed on the EUT can provide continuous transmitting RF signal with maximum output power. And the CBT control the EUT operating with hopping off and data rate set for 3DH5. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.

## 6 SAR Measurements System Configuration

### 6.1 SAR Measurement Set-up

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 6.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

### EX3DV4 Probe Specification

|               |                                                                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)                                                |
| Calibration   | ISO/IEC 17025 calibration<br>service available                                                                                                                                                             |
| Frequency     | 10 MHz to > 6 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 6 GHz)                                                                                                                                          |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                                                                        |
| Dynamic Range | 10 $\mu$ W/g to > 100 mW/g Linearity:<br>$\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)                                                                                                                     |
| Dimensions    | Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm)<br>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%. |



### E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy was evaluated and found to be better than  $\pm 0.25$ dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based



temperature probe is used in conjunction with the E-field probe.

$$\text{SAR} = C \Delta T / \Delta t$$

Where:  $\Delta t$  = Exposure time (30 seconds),

$C$  = Heat capacity of tissue (brain or muscle),

$\Delta T$  = Temperature increase due to RF exposure.

Or

$$\text{SAR} = |E|^2 \sigma / \rho$$

Where:  $\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density ( $\text{kg}/\text{m}^3$ ).

### 6.3 SAR Measurement Procedure

#### Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

#### Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                        | ≤ 3 GHz                                                                                                                                                                                                                                                           | > 3 GHz                                                    |
|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm                                                                                                                                                                                                                                                          | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$ |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              | 30° ± 1°                                                                                                                                                                                                                                                          | 20° ± 1°                                                   |
| Maximum area scan spatial resolution:<br>$\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$              | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm                                                                                                                                                                                                                            | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm                   |
|                                                                                                        | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                            |

### Zoom Scan

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |                                                                                      | ≤3GHz                          | > 3 GHz                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------------|
| Maximum zoom scan spatial resolution: $\Delta x_{zoom}$<br>$\Delta y_{zoom}$                                                                                                                                                                                                                                                                                                                                                                          |                                    |                                                                                      | ≤2GHz: ≤8mm<br>2 – 3GHz: ≤5mm* | 3 – 4GHz: ≤5mm*<br>4 – 6GHz: ≤4mm*                    |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                                                                                                                                                                       | Uniform grid: $\Delta z_{zoom}(n)$ |                                                                                      | ≤5mm                           | 3 – 4GHz: ≤4mm<br>4 – 5GHz: ≤3mm<br>5 – 6GHz: ≤2mm    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Graded grid                        | $\Delta z_{zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | ≤4mm                           | 3 – 4GHz: ≤3mm<br>4 – 5GHz: ≤2.5mm<br>5 – 6GHz: ≤2mm  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    | $\Delta z_{zoom}(n > 1)$ : between subsequent points                                 | ≤1.5• $\Delta z_{zoom}(n-1)$   |                                                       |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                                                                                                                                                              | X, y, z                            |                                                                                      | ≥30mm                          | 3 – 4GHz: ≥28mm<br>4 – 5GHz: ≥25mm<br>5 – 6GHz: ≥22mm |
| <p>Note: <math>\delta</math> is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.</p> <p>* When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4W/kg, ≤8mm, ≤7mm and ≤5mm zoom scan resolution may be applied, respectively, for 2GHz to 3GHz, 3GHz to 4GHz and 4GHz to 6GHz.</p> |                                    |                                                                                      |                                |                                                       |

### Volume Scan Procedures

The volume scan is used to assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

### Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

## 7 Main Test Equipment

| Name of Equipment                   | Manufacturer    | Type/Model | Serial Number | Last Cal.  | Cal. Due Date |
|-------------------------------------|-----------------|------------|---------------|------------|---------------|
| Network analyzer                    | Agilent         | E5071B     | MY42404014    | 2017-05-20 | 2018-05-19    |
| Dielectric Probe Kit                | HP              | 85070E     | US44020115    | 2017-05-20 | 2018-05-19    |
| Power meter                         | Agilent         | E4417A     | GB41291714    | 2017-05-21 | 2018-05-20    |
| Power sensor                        | Agilent         | N8481H     | MY50350004    | 2017-05-21 | 2018-05-20    |
| Power sensor                        | Agilent         | E9327A     | US40441622    | 2017-05-20 | 2018-05-19    |
| Dual directional coupler            | Agilent         | 778D-012   | 50519         | 2017-05-21 | 2018-05-20    |
| Dual directional coupler            | Agilent         | 777D       | 50146         | 2017-05-20 | 2018-05-19    |
| Amplifier                           | INDEXSAR        | IXA-020    | 0401          | 2017-05-20 | 2018-05-19    |
| Wideband radio communication tester | R&S             | CMW 500    | 113645        | 2017-05-20 | 2018-05-19    |
| BT Base Station Simulator           | R&S             | CBT        | 100271        | 2017-05-14 | 2018-05-13    |
| E-field Probe                       | SPEAG           | EX3DV4     | 3677          | 2017-01-23 | 2018-01-22    |
| DAE                                 | SPEAG           | DAE4       | 1317          | 2016-08-02 | 2017-08-01    |
| Validation Kit 835MHz               | SPEAG           | D835V2     | 4d020         | 2014-08-28 | 2017-08-27    |
| Validation Kit 2450MHz              | SPEAG           | D2450V2    | 786           | 2014-09-01 | 2017-08-31    |
| Temperature Probe                   | Tianjin jinming | JM222      | AA1009129     | 2017-05-20 | 2018-05-19    |
| Hygrothermograph                    | Anymetr         | NT-311     | 20150732      | 2016-07-15 | 2017-07-14    |

## 8 Tissue Dielectric Parameter Measurements & System Verification

### 8.1 Tissue Verification

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance.

#### Target values

| Frequency (MHz) | Water (%) | Salt (%) | Sugar (%) | Glycol (%) | Preventol (%) | Cellulose (%) | $\epsilon_r$ | $\sigma$ (s/m) |      |
|-----------------|-----------|----------|-----------|------------|---------------|---------------|--------------|----------------|------|
| Head            | 835       | 41.45    | 1.45      | 56         | 0             | 0.1           | 1.0          | 41.5           | 0.90 |
|                 | 2450      | 62.7     | 0.5       | 0          | 36.8          | 0             | 0            | 39.2           | 1.80 |
| Body            | 835       | 52.5     | 1.4       | 45         | 0             | 0.1           | 1.0          | 55.2           | 0.97 |
|                 | 2450      | 73.2     | 0.1       | 0          | 26.7          | 0             | 0            | 52.7           | 1.95 |

#### Measurements results

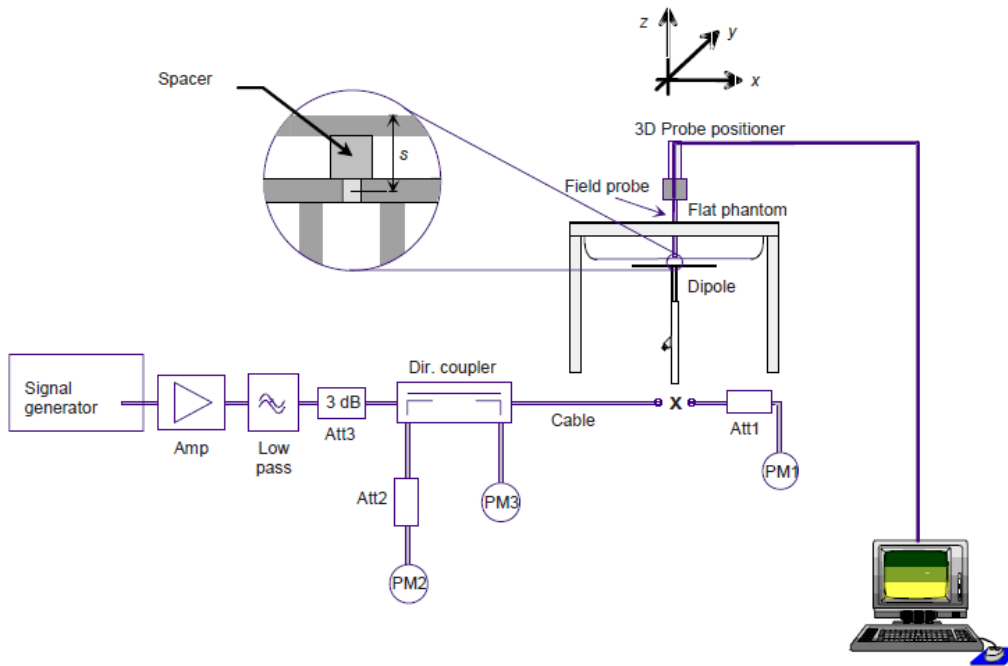
| Frequency (MHz) | Test Date | Temp °C   | Measured Dielectric Parameters |                | Target Dielectric Parameters |                | Limit (Within ±5%)   |                  |      |
|-----------------|-----------|-----------|--------------------------------|----------------|------------------------------|----------------|----------------------|------------------|------|
|                 |           |           | $\epsilon_r$                   | $\sigma$ (s/m) | $\epsilon_r$                 | $\sigma$ (s/m) | Dev $\epsilon_r$ (%) | Dev $\sigma$ (%) |      |
| 835             | Head      | 6/16/2017 | 21.5                           | 42.5           | 0.94                         | 41.5           | 0.90                 | 2.41             | 4.44 |
|                 | Body      | 6/13/2017 | 21.5                           | 55.4           | 1.00                         | 55.2           | 0.97                 | 0.36             | 3.09 |
| 2450            | Head      | 7/6/2017  | 21.5                           | 40.6           | 1.82                         | 39.2           | 1.80                 | 3.57             | 1.11 |
|                 | Body      | 7/7/2017  | 21.5                           | 51.1           | 1.95                         | 52.7           | 1.95                 | -3.04            | 0.00 |

Note: The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.

## 8.2 System Performance Check

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured using the dielectric probe kit and the network analyzer. A system check measurement for every day was made following the determination of the dielectric parameters of the Tissue simulates, using the dipole validation kit. The dipole antenna was placed under the flat section of the twin SAM phantom.

System check is performed regularly on all frequency bands where tests are performed with the DASY system.



Picture 1 System Performance Check setup



Picture 2 Setup Photo



**Justification for Extended SAR Dipole Calibrations**

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (< - 20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB 865664 D01:

| Dipole                        |                | Date of Measurement | Return Loss(dB) | $\Delta$ % | Impedance ( $\Omega$ ) | $\Delta\Omega$ |
|-------------------------------|----------------|---------------------|-----------------|------------|------------------------|----------------|
| Dipole<br>D835V2<br>SN: 4d020 | Head<br>Liquid | 8/28/2014           | -30.1           | /          | 48.6                   | /              |
|                               |                | 8/27/2015           | -31.1           | 3.3%       | 49.7                   | 1.1 $\Omega$   |
|                               |                | 8/26/2016           | -32.2           | -3.4%      | 49.8                   | 0.1 $\Omega$   |
|                               | Body<br>Liquid | 8/28/2014           | -23.3           | /          | 54.0                   | /              |
|                               |                | 8/27/2015           | -23.9           | 2.6%       | 53.5                   | 0.5 $\Omega$   |
|                               |                | 8/26/2016           | -24.2           | -1.2%      | 53.1                   | 0.4 $\Omega$   |
| Dipole<br>D2450V2<br>SN: 786  | Head<br>Liquid | 9/1/2014            | -23.6           | /          | 57.1                   | /              |
|                               |                | 8/31/2015           | -23.9           | 1.3%       | 57.4                   | 0.3 $\Omega$   |
|                               |                | 8/30/2016           | -23.3           | 2.6%       | 57.7                   | 0.3 $\Omega$   |
|                               | Body<br>Liquid | 9/1/2014            | -23.7           | /          | 56.0                   | /              |
|                               |                | 8/31/2015           | -24.0           | 1.3%       | 55.8                   | 0.2 $\Omega$   |
|                               |                | 8/30/2016           | -24.4           | -1.6%      | 55.1                   | 0.7 $\Omega$   |

**System Check results**

| Frequency (MHz) |      | Test Date | Temp °C | 250mW Measured SAR <sub>1g</sub> (W/kg) | 1W Normalized SAR <sub>1g</sub> (W/kg) | 1W Target SAR <sub>1g</sub> (W/kg) | Δ % (Limit ±10%) | Plot No. |
|-----------------|------|-----------|---------|-----------------------------------------|----------------------------------------|------------------------------------|------------------|----------|
| 835             | Head | 6/16/2017 | 21.5    | 2.44                                    | 9.76                                   | 9.54                               | 2.31             | 1        |
|                 | Body | 6/13/2017 | 21.5    | 2.41                                    | 9.64                                   | 9.54                               | 1.05             | 2        |
| 2450            | Head | 7/6/2017  | 21.5    | 13.70                                   | 54.80                                  | 52.50                              | 4.38             | 3        |
|                 | Body | 7/7/2017  | 21.5    | 12.50                                   | 50.00                                  | 52.40                              | -4.58            | 4        |

Note: Target Values used derive from the calibration certificate Data Storage and Evaluation.

## 9 Normal and Maximum Output Power

KDB 447498 D01 at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

### 9.1 WCDMA Mode

The following tests were completed according to the test requirements outlined in the 3GPP TS34.121 specification.

| WCDMA          |          | Band V(dBm) |       |       |                     |
|----------------|----------|-------------|-------|-------|---------------------|
| Tx Channel     |          | 4132        | 4183  | 4233  | Tune-up Limit (dBm) |
| Frequency(MHz) |          | 826.4       | 836.6 | 846.6 |                     |
| RMC            | 12.2kbps | 24.35       | 24.43 | 24.33 | 25.00               |
|                | 64kbps   | 24.28       | 24.29 | 24.27 | 25.00               |
|                | 144kbps  | 24.27       | 24.28 | 24.17 | 25.00               |
|                | 384kbps  | 24.26       | 24.27 | 24.16 | 25.00               |
| HSDPA          | Sub 1    | 24.25       | 24.26 | 24.17 | 25.00               |
|                | Sub 2    | 24.19       | 24.27 | 24.16 | 25.00               |
|                | Sub 3    | 23.68       | 23.87 | 23.74 | 24.50               |
|                | Sub 4    | 23.69       | 23.86 | 23.76 | 24.50               |
| HSUPA          | Sub 1    | 24.18       | 24.35 | 24.25 | 25.00               |
|                | Sub 2    | 22.43       | 22.51 | 22.41 | 23.00               |
|                | Sub 3    | 23.25       | 23.33 | 23.23 | 24.00               |
|                | Sub 4    | 22.44       | 22.52 | 22.42 | 23.00               |
|                | Sub 5    | 24.23       | 24.31 | 24.21 | 25.00               |
| DC-HSDPA       | Sub 1    | 24.22       | 24.30 | 24.20 | 25.00               |
|                | Sub 2    | 24.31       | 24.28 | 24.19 | 25.00               |
|                | Sub 3    | 23.80       | 23.77 | 23.68 | 24.50               |
|                | Sub 4    | 23.79       | 23.76 | 23.67 | 24.50               |

Note: 1.Per KDB 941225 D01, SAR for Head / Hotspot / Body-worn exposure is measured using a 12.2 kbps AMR with TPC bits configured to all "1's".  
 2. 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  $\leq 1.2$  W/kg, SAR measurement is not required for the secondary mode.

## 9.2 WLAN Mode

| Wi-Fi 2.4G Mode | Channel | Frequency (MHz) | Average Conducted Power (dBm) for Data Rates (bps) | Tune-up Limit (dBm) | TX Power Setting level |
|-----------------|---------|-----------------|----------------------------------------------------|---------------------|------------------------|
| 802.11b         | 1       | 2412            | 1M<br>14.14                                        | 15.00               | 14                     |
|                 | 6       | 2437            | 14.30                                              | 15.00               | 16                     |
|                 | 11      | 2462            | 13.34                                              | 15.00               | 14                     |
|                 | 12      | 2467            | 11.31                                              | 15.00               | 14                     |
|                 | 13      | 2472            | 12.21                                              | 15.00               | 14                     |
| Mode            | Channel | Frequency (MHz) | 6M                                                 | Tune-up Limit (dBm) | TX Power Setting level |
| 802.11g         | 1       | 2412            | 12.59                                              | 13.00               | 12                     |
|                 | 6       | 2437            | 11.30                                              | 13.00               | 14                     |
|                 | 11      | 2462            | 11.28                                              | 13.00               | 12                     |
|                 | 12      | 2467            | 11.48                                              | 13.00               | 12                     |
|                 | 13      | 2472            | 10.33                                              | 13.00               | 10                     |
| Mode            | Channel | Frequency (MHz) | 6.5M                                               | Tune-up Limit (dBm) | TX Power Setting level |
| 802.11n (HT20)  | 1       | 2412            | 11.68                                              | 12.00               | 11                     |
|                 | 6       | 2437            | 10.26                                              | 12.00               | 13                     |
|                 | 11      | 2462            | 10.45                                              | 12.00               | 11                     |
|                 | 12      | 2467            | 10.62                                              | 12.00               | 11                     |
|                 | 13      | 2472            | 7.59                                               | 12.00               | 7                      |
| Mode            | Channel | Frequency (MHz) | 13.5M                                              | Tune-up Limit (dBm) | TX Power Setting level |
| 802.11n (HT40)  | 3       | 2422            | 11.82                                              | 13.00               | 11                     |
|                 | 6       | 2437            | 12.61                                              | 13.00               | 14                     |
|                 | 9       | 2452            | 12.83                                              | 13.00               | 11                     |
|                 | 10      | 2457            | 12.41                                              | 13.00               | 11                     |
|                 | 11      | 2462            | 12.11                                              | 13.00               | 10                     |

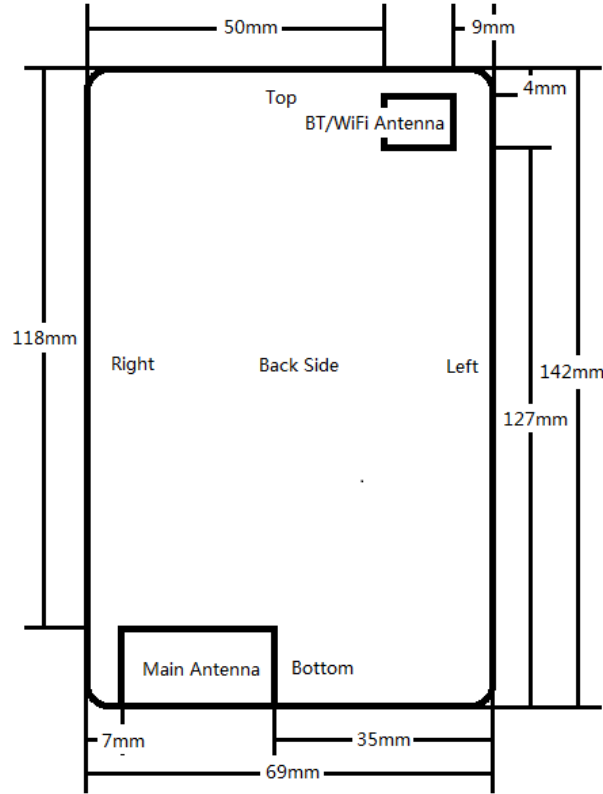
Note. 1. SAR is not required for OFDM when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.

### 9.3 Bluetooth Mode

| BT            | Conducted Power(dBm)   |                       |                       | Tune-up Limit (dBm)        |
|---------------|------------------------|-----------------------|-----------------------|----------------------------|
|               | Channel/Frequency(MHz) |                       |                       |                            |
|               | Ch 0/2402 MHz          | Ch 39/2441 MHz        | Ch 78/2480 MHz        |                            |
| GFSK          | 7.800                  | 8.641                 | 6.707                 | 9.00                       |
| $\pi/4$ DQPSK | 8.572                  | 9.447                 | 7.512                 | 10.00                      |
| 8DPSK         | 9.020                  | 9.891                 | 7.909                 | 10.00                      |
| <b>BLE</b>    | <b>Ch 0/2402 MHz</b>   | <b>Ch 19/2440 MHz</b> | <b>Ch 39/2480 MHz</b> | <b>Tune-up Limit (dBm)</b> |
| GFSK          | -1.200                 | 0.350                 | -1.460                | 1.00                       |

## 10 Measured and Reported (Scaled) SAR Results

### 10.1 EUT Antenna Locations



Overall (Length x Width): 142 mm x 69 mm  
 Overall Diagonal: 156 mm/Display Diagonal: 128mm

Distance of the Antenna to the EUT surface/edge

| Antenna          | Back Side | Front side | Left Edge | Right Edge | Top Edge | Bottom Edge |
|------------------|-----------|------------|-----------|------------|----------|-------------|
| Main-Antenna     | 0         | 0          | 35        | 7          | 118      | 0           |
| BT/Wi-Fi Antenna | 0         | 0          | 9         | 50         | 4        | 127         |

| Hotspot mode, Positions for SAR tests |           |            |           |            |          |             |
|---------------------------------------|-----------|------------|-----------|------------|----------|-------------|
| Mode                                  | Back Side | Front side | Left Edge | Right Edge | Top Edge | Bottom Edge |
| UMTS Band V                           | Yes       | Yes        | N/A       | Yes        | N/A      | Yes         |
| 2.4GHz WLAN                           | Yes       | Yes        | Yes       | N/A        | Yes      | N/A         |

Note: 1. Per KDB 941225 D06, when the overall device length and width are  $\geq 9\text{cm} \times 5\text{cm}$ , the test distance is 10mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge.

## 10.2 Standalone SAR test exclusion considerations

Per KDB 447498 D01, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  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  $\leq 7.5$  for 10-g extremity SAR

- $f(\text{GHz})$  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

Per KDB 447498 D01, when the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Bluetooth | Distance (mm) | MAX Power (dBm) | Frequency (MHz) | Ratio | Evaluation |
|-----------|---------------|-----------------|-----------------|-------|------------|
| Head      | 5             | 10.00           | 2480            | 3.15  | Yes        |
| Body-worn | 10            | 10.00           | 2480            | 1.57  | No         |

### 10.3 Measured SAR Results

Table 1: UMTS Band V

| Test Position                  | Cover Type | Channel/Frequency (MHz) | Channel Type | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Scaling Factor | Reported SAR <sub>1g</sub> (W/kg) | Plot No. |
|--------------------------------|------------|-------------------------|--------------|------------|---------------------|-----------------------|------------|-----------------------------------|----------------|-----------------------------------|----------|
| <b>Head SAR</b>                |            |                         |              |            |                     |                       |            |                                   |                |                                   |          |
| Left Cheek                     | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.040      | 0.581                             | 1.14           | 0.662                             | 5        |
| Left Tilt                      | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.080      | 0.359                             | 1.14           | 0.409                             | /        |
| Right Cheek                    | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.160      | 0.495                             | 1.14           | 0.564                             | /        |
| Right Tilt                     | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.130      | 0.339                             | 1.14           | 0.387                             | /        |
| Left Cheek                     | TC 2       | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | -0.150     | 0.562                             | 1.14           | 0.641                             | /        |
| <b>Hotspot (Distance 10mm)</b> |            |                         |              |            |                     |                       |            |                                   |                |                                   |          |
| Back Side                      | standard   | 4233/846.6              | RMC 12.2K    | 1:1        | 25.00               | 24.33                 | 0.020      | 0.835                             | 1.17           | 0.974                             | 6        |
|                                |            | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.030      | 0.829                             | 1.14           | 0.945                             | /        |
|                                |            | 4132/826.4              | RMC 12.2K    | 1:1        | 25.00               | 24.35                 | 0.000      | 0.758                             | 1.16           | 0.880                             | /        |
| Front Side                     | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.030      | 0.533                             | 1.14           | 0.608                             | /        |
| Left Edge                      | N/A        | N/A                     | N/A          | N/A        | N/A                 | N/A                   | N/A        | N/A                               | N/A            | N/A                               | N/A      |
| Right Edge                     | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.000      | 0.327                             | 1.14           | 0.373                             | /        |
| Top Edge                       | N/A        | N/A                     | N/A          | N/A        | N/A                 | N/A                   | N/A        | N/A                               | N/A            | N/A                               | N/A      |
| Bottom Edge                    | standard   | 4183/836.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | 0.030      | 0.412                             | 1.14           | 0.470                             | /        |
| Back Side                      | Repeated   | 4233/846.6              | RMC 12.2K    |            | 25.00               | 24.33                 | 0.021      | 0.797                             | 1.17           | 0.930                             | /        |
| Back Side                      | TC 2       | 4233/846.6              | RMC 12.2K    | 1:1        | 25.00               | 24.43                 | -0.030     | 0.639                             | 1.14           | 0.729                             | /        |

Note: 1. The value with blue color is the maximum SAR Value of each test band.

2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s).

3. 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  $\leq 1.2$  W/kg, SAR measurement is not required for the secondary mode

4. Per FCC KDB Publication 648474 D04, SAR was evaluated without a headset connected to the device. Since the reported SAR was  $\leq 1.2$  W/kg, no additional SAR evaluations using a headset cable were required.





| Measurement Variability |                            |                                          |                                                      |       |
|-------------------------|----------------------------|------------------------------------------|------------------------------------------------------|-------|
| Test Position           | Channel/<br>Frequency(MHz) | MAX Measured SAR <sub>1g</sub><br>(W/kg) | 1 <sup>st</sup> Repeated SAR <sub>1g</sub><br>(W/kg) | Ratio |
| Back Side               | 4233/846.6                 | 0.835                                    | 0.797                                                | 1.05  |

Note: 1) When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.  
2) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).  
3) A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .  
4) Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg



Table 2: Wi-Fi (2.4G)

| Test Position                                                                  | Cover Type | Channel/Frequency (MHz) | Mode 802.11b | Duty Cycle | Area Scan Max.SAR (W/Kg) | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Scaling Factor | Reported SAR <sub>1g</sub> (W/kg) | Plot No. |
|--------------------------------------------------------------------------------|------------|-------------------------|--------------|------------|--------------------------|---------------------|-----------------------|------------|-----------------------------------|----------------|-----------------------------------|----------|
| <b>Head SAR</b>                                                                |            |                         |              |            |                          |                     |                       |            |                                   |                |                                   |          |
| Left Cheek                                                                     | standard   | 6/2437                  | DSSS         | 1:1        | 0.394                    | 15.00               | 14.30                 | 0.032      | 0.406                             | 1.17           | 0.477                             | /        |
| Left Tilt                                                                      | standard   | 6/2437                  | DSSS         | 1:1        | 0.451                    | 15.00               | 14.30                 | 0.060      | 0.469                             | 1.17           | 0.551                             | /        |
| Right Cheek                                                                    | standard   | 11/2462                 | DSSS         | 1:1        | 0.389                    | 15.00               | 13.34                 | 0.021      | 0.427                             | 1.47           | 0.626                             | /        |
|                                                                                |            | 6/2437                  | DSSS         | 1:1        | 0.692                    | 15.00               | 14.30                 | 0.054      | 0.742                             | 1.17           | 0.872                             | 7        |
|                                                                                |            | 1/2412                  | DSSS         | 1:1        | 0.410                    | 15.00               | 14.14                 | 0.023      | 0.436                             | 1.22           | 0.531                             | /        |
| Right Tilt                                                                     | standard   | 6/2437                  | DSSS         | 1:1        | 0.427                    | 15.00               | 14.30                 | 0.020      | 0.413                             | 1.17           | 0.485                             | /        |
| Right Cheek                                                                    | TC 2       | 6/2437                  | DSSS         | 1:1        | 0.673                    | 15.00               | 14.30                 | 0.012      | 0.735                             | 1.17           | 0.864                             | /        |
| <b>Hotspot (Distance 10mm)</b>                                                 |            |                         |              |            |                          |                     |                       |            |                                   |                |                                   |          |
| Back Side                                                                      | standard   | 6/2437                  | DSSS         | 1:1        | 0.236                    | 15.00               | 14.30                 | 0.170      | 0.253                             | 1.17           | 0.297                             | 8        |
| Front Side                                                                     | standard   | 6/2437                  | DSSS         | 1:1        | 0.221                    | 15.00               | 14.30                 | 0.130      | 0.233                             | 1.17           | 0.274                             | /        |
| Left Edge                                                                      | standard   | 6/2437                  | DSSS         | 1:1        | 0.131                    | 15.00               | 14.30                 | 0.026      | 0.134                             | 1.17           | 0.157                             | /        |
| Right Edge                                                                     | standard   | 6/2437                  | DSSS         | 1:1        | 0.0182                   | 15.00               | 14.30                 | -0.150     | 0.017                             | 1.17           | 0.020                             | /        |
| Top Edge                                                                       | standard   | 6/2437                  | DSSS         | 1:1        | 0.257                    | 15.00               | 14.30                 | 0.022      | 0.261                             | 1.17           | 0.307                             | 9        |
| Bottom Edge                                                                    | N/A        | N/A                     | N/A          | N/A        | N/A                      | N/A                 | N/A                   | N/A        | N/A                               | N/A            | N/A                               | N/A      |
| Top Edge                                                                       | TC 2       | 6/2437                  | DSSS         | 1:1        | 0.241                    | 15.00               | 14.30                 | 0.010      | 0.257                             | 1.17           | 0.302                             | /        |
| Note: 1. The value with blue color is the maximum SAR Value of each test band. |            |                         |              |            |                          |                     |                       |            |                                   |                |                                   |          |

| <b>MAX Adjusted SAR</b>                                                                                                                                                               |               |                        |                                       |                             |                     |                |                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------------------|---------------------------------------|-----------------------------|---------------------|----------------|-----------------------------------|
| Mode                                                                                                                                                                                  | Test Position | Channel/Frequency(MHz) | MAX Measured SAR <sub>1g</sub> (W/kg) | 802.11b Tune-up limit (dBm) | Tune-up limit (dBm) | Scaling Factor | Adjusted SAR <sub>1g</sub> (W/kg) |
| 802.11g                                                                                                                                                                               | Right Cheek   | 6/2437                 | 0.742                                 | 15.00                       | 13.00               | 0.63           | 0.468                             |
| 802.11n HT20                                                                                                                                                                          | Right Cheek   | 6/2437                 | 0.742                                 | 15.00                       | 12.00               | 0.50           | 0.372                             |
| 802.11n HT40                                                                                                                                                                          | Right Cheek   | 6/2437                 | 0.742                                 | 15.00                       | 13.00               | 0.63           | 0.468                             |
| Note: SAR is not required for OFDM 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. |               |                        |                                       |                             |                     |                |                                   |



Table 3: BT

| Test Position   | Cover Type | Channel/Frequency (MHz) | Mode | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Scaling Factor | Reported SAR <sub>1g</sub> (W/kg) | Plot No. |
|-----------------|------------|-------------------------|------|------------|---------------------|-----------------------|------------|-----------------------------------|----------------|-----------------------------------|----------|
| <b>Head SAR</b> |            |                         |      |            |                     |                       |            |                                   |                |                                   |          |
| Left Cheek      | standard   | 39/2441                 | 3DH5 | 1:1        | 10.50               | 9.891                 | 0.122      | 0.028                             | 1.15           | 0.032                             | /        |
| Left Tilt       | standard   | 39/2441                 | 3DH5 | 1:1        | 10.50               | 9.891                 | 0.029      | 0.035                             | 1.15           | 0.041                             | /        |
| Right Cheek     | standard   | 39/2441                 | 3DH5 | 1:1        | 10.50               | 9.891                 | 0.026      | 0.057                             | 1.15           | 0.065                             | 10       |
| Right Tilt      | standard   | 39/2441                 | 3DH5 | 1:1        | 10.50               | 9.891                 | 0.039      | 0.032                             | 1.15           | 0.037                             | /        |

| Band      | Configuration | Frequency (MHz) | Maximum Power (dBm) | Separation Distance (mm) | Estimated SAR (W/kg) |
|-----------|---------------|-----------------|---------------------|--------------------------|----------------------|
| Bluetooth | Body-worn     | 2480            | 10.00               | 10                       | 0.210                |

For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01 based on the formula below.

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

## 10.4 Simultaneous Transmission Analysis

| Simultaneous Transmission Configurations | Head | Body-worn | Hotspot | Product Specific 10-g SAR |
|------------------------------------------|------|-----------|---------|---------------------------|
| WCDMA(Voice) + Bluetooth(data)           | Yes  | Yes       | Yes     | N/A                       |
| WCDMA(Data) + Bluetooth(data)            | Yes  | Yes       | Yes     | N/A                       |
| WCDMA(Voice) + Wi-Fi-2.4GHz(data)        | Yes  | Yes       | Yes     | N/A                       |
| WCDMA(Data) + Wi-Fi-2.4GHz(data)         | Yes  | Yes       | Yes     | N/A                       |
| Wi-Fi-2.4GHz(data) + Bluetooth(data)     | Yes  | Yes       | Yes     | N/A                       |

### General Note:

1. The Scaled SAR summation is calculated based on the same configuration and test position.
2. Per KDB 447498 D01, simultaneous transmission SAR is compliant if,
  - i) Scalar SAR summation  $< 1.6\text{W/kg}$ , simultaneously transmission SAR measurement is not necessary.
  - ii)  $\text{SPLSR} = (\text{SAR1} + \text{SAR2})^{1.5} / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where  $(x1, y1, z1)$  and  $(x2, y2, z2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan.
  - iii) If  $\text{SPLSR} \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.

**About BT and Wi-Fi and Main- Antenna**

| SAR <sub>1g</sub> (W/kg)                                                                                                                                             |             | Main-antenna | Wi-Fi 2.4G | BT    | MAX. ΣSAR <sub>1g</sub> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|------------|-------|-------------------------|
| Test Position                                                                                                                                                        |             |              |            |       |                         |
| Left, Cheek                                                                                                                                                          |             | 0.662        | 0.477      | 0.032 | 1.171                   |
| Left, Tilt                                                                                                                                                           |             | 0.409        | 0.551      | 0.041 | 1.001                   |
| Right, Cheek                                                                                                                                                         |             | 0.564        | 0.872      | 0.065 | 1.501                   |
| Right, Tilt                                                                                                                                                          |             | 0.387        | 0.485      | 0.037 | 0.909                   |
| Body worn<br>1g                                                                                                                                                      | Back Side   | 0.974        | 0.297      | 0.210 | 1.481                   |
|                                                                                                                                                                      | Front Side  | 0.608        | 0.274      | 0.210 | 1.092                   |
| Hotspot<br>1g                                                                                                                                                        | Back Side   | 0.974        | 0.297      | 0.210 | 1.481                   |
|                                                                                                                                                                      | Front Side  | 0.608        | 0.274      | 0.210 | 1.092                   |
|                                                                                                                                                                      | Left Edge   | N/A          | 0.157      | 0.210 | 0.367                   |
|                                                                                                                                                                      | Right Edge  | 0.373        | 0.020      | 0.210 | 0.603                   |
|                                                                                                                                                                      | Top Edge    | N/A          | 0.307      | 0.210 | 0.517                   |
|                                                                                                                                                                      | Bottom Edge | 0.470        | N/A        | 0.210 | 0.680                   |
| Note: 1.The value with blue color is the maximum ΣSAR <sub>1g</sub> Value.<br>2. MAX. ΣSAR <sub>1g</sub> =Unlicensed SAR <sub>MAX</sub> +Licensed SAR <sub>MAX</sub> |             |              |            |       |                         |

MAX. ΣSAR<sub>1g</sub> = 1.501 W/kg < 1.6 W/kg, so the Simultaneous transimition SAR with volum scan are not required for BT and Wi-Fi and Main-Antenna.

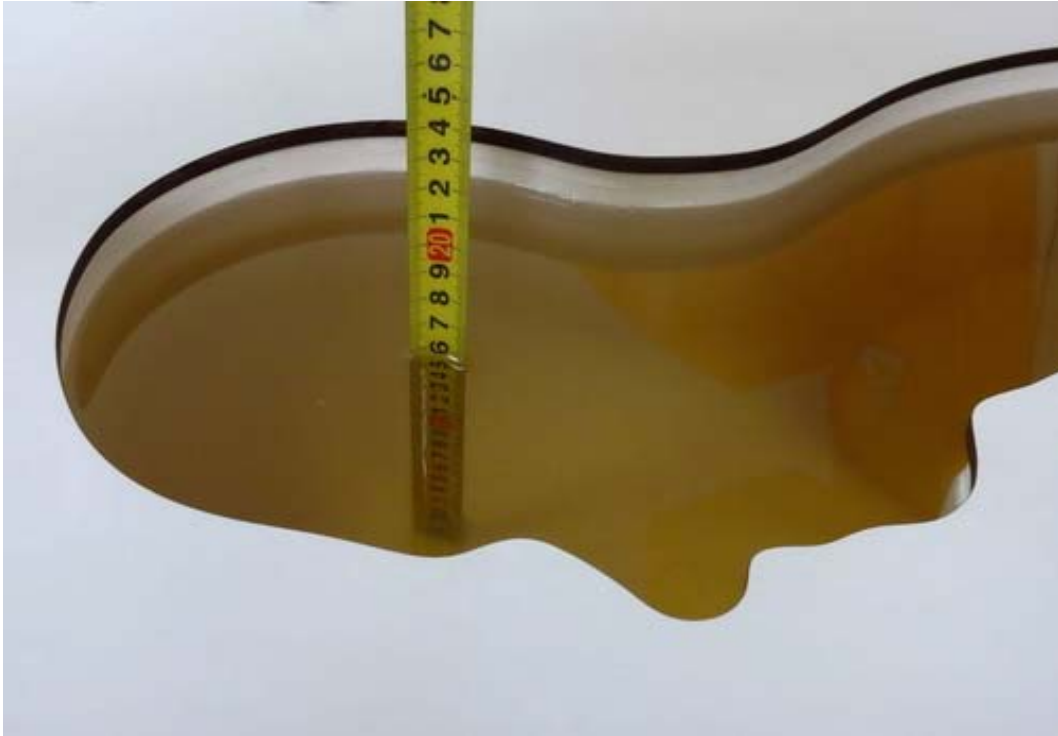


## 11 Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, 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.

## ANNEX A: Test Layout





Picture 3: Liquid depth in the head Phantom (835MHz, 15.3cm depth)

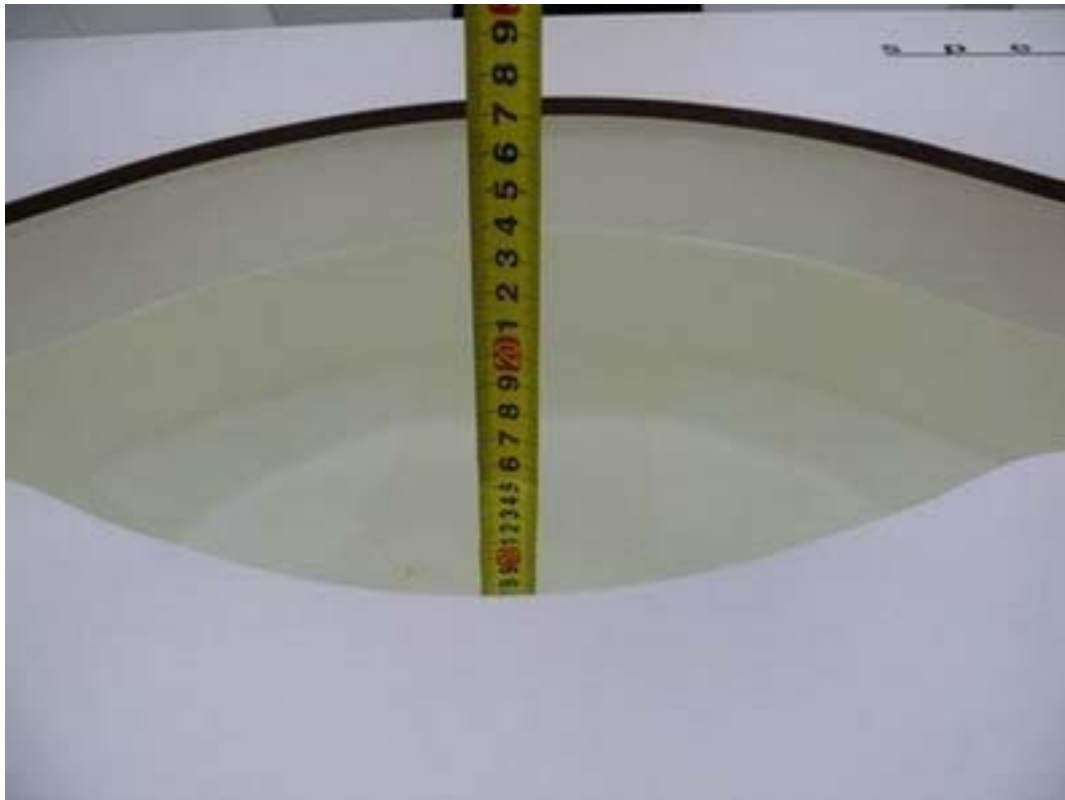


Picture 4: Liquid depth in the flat Phantom (835MHz, 15.4cm depth)





Picture 5: Liquid depth in the head Phantom (2450 MHz, 15.4cm depth)



Picture 6: Liquid depth in the flat Phantom (2450 MHz, 15.3cm depth)

## ANNEX B: System Check Results

### Plot 1 System Performance Check at 835 MHz Head TSL

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d020**

Date: 3/26/2016

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.94 \text{ mho/m}$ ;  $\epsilon_r = 42.5$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.3 \text{ }^\circ\text{C}$       Liquid Temperature:  $21.5 \text{ }^\circ\text{C}$

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(9.31, 9.31, 9.31); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=15mm, Pin=250mW/Area Scan (41x121x1):** Measurement grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) =  $2.64 \text{ mW/g}$

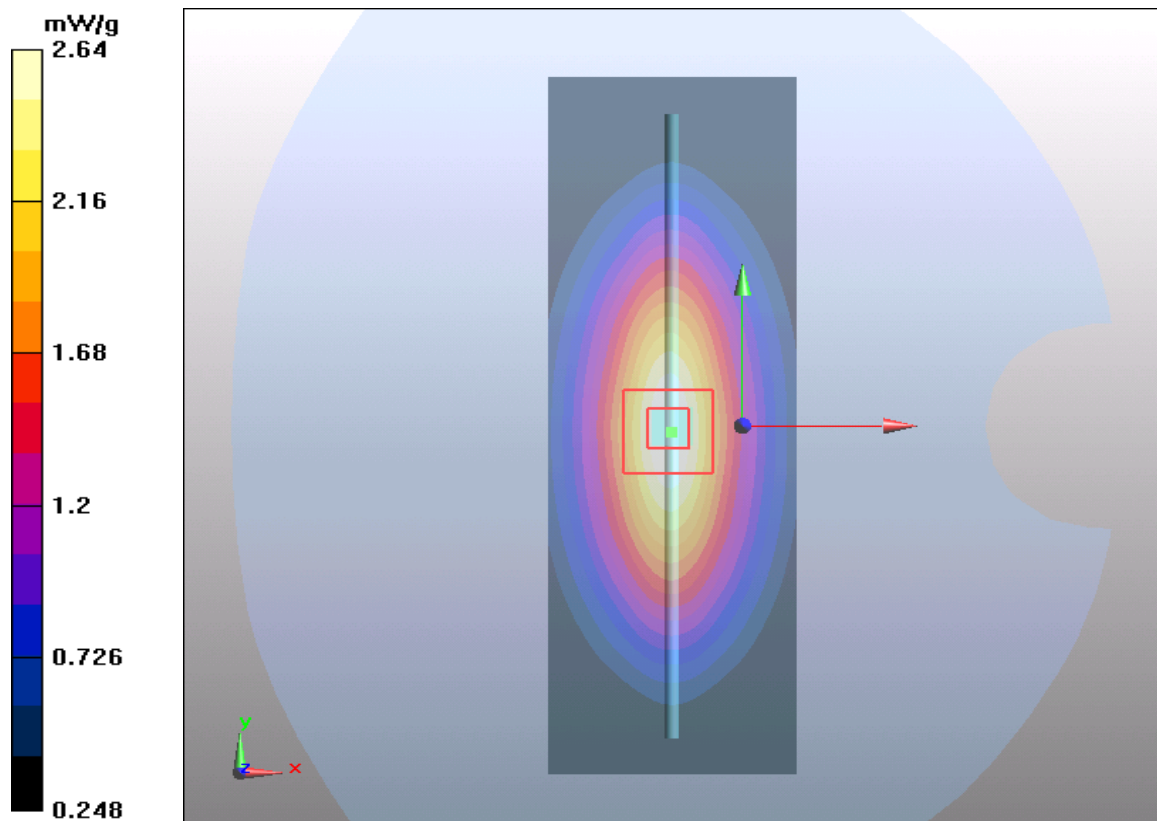
**d=15mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $54.4 \text{ V/m}$ ; Power Drift =  $-0.076 \text{ dB}$

Peak SAR (extrapolated) =  $3.67 \text{ W/kg}$

**SAR(1 g) =  $2.44 \text{ mW/g}$ ; SAR(10 g) =  $1.6 \text{ mW/g}$**

Maximum value of SAR (measured) =  $2.64 \text{ mW/g}$



**Plot 2 System Performance Check at 835 MHz Body TSL**

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d020**

Date: 3/26/2016

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.00 \text{ mho/m}$ ;  $\epsilon_r = 55.4$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(9.74, 9.74, 9.74); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=15mm, Pin=250mW/Area Scan (41x121x1):** Measurement grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 2.58 mW/g

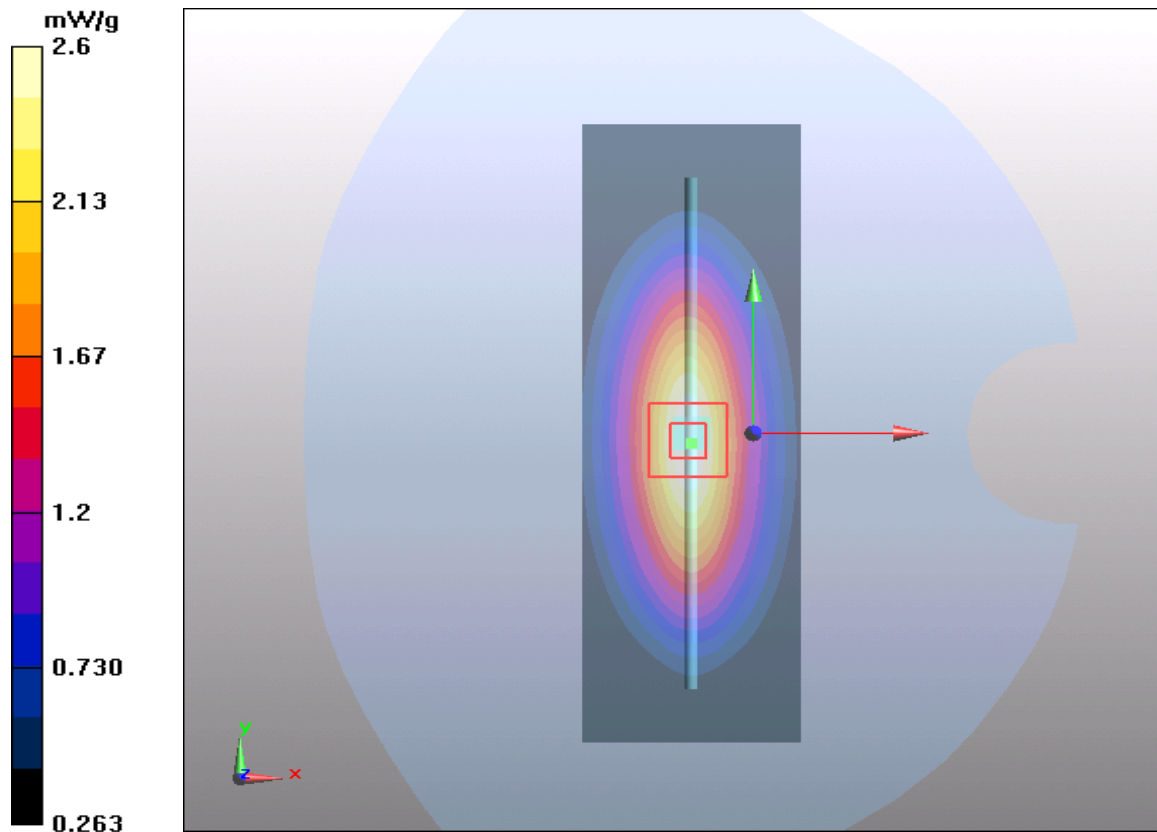
**d=15mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 51.9 V/m; Power Drift = -0.058 dB

Peak SAR (extrapolated) = 3.5 W/kg

**SAR(1 g) = 2.41 mW/g; SAR(10 g) = 1.6 mW/g**

Maximum value of SAR (measured) = 2.6 mW/g



**Plot 3 System Performance Check at 2450 MHz Head TSL**

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786**

Date: 4/11/2016

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.82$  mho/m;  $\epsilon_r = 40.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.90, 7.90, 7.90); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (41x71x1):** Measurement grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 18.2 mW/g

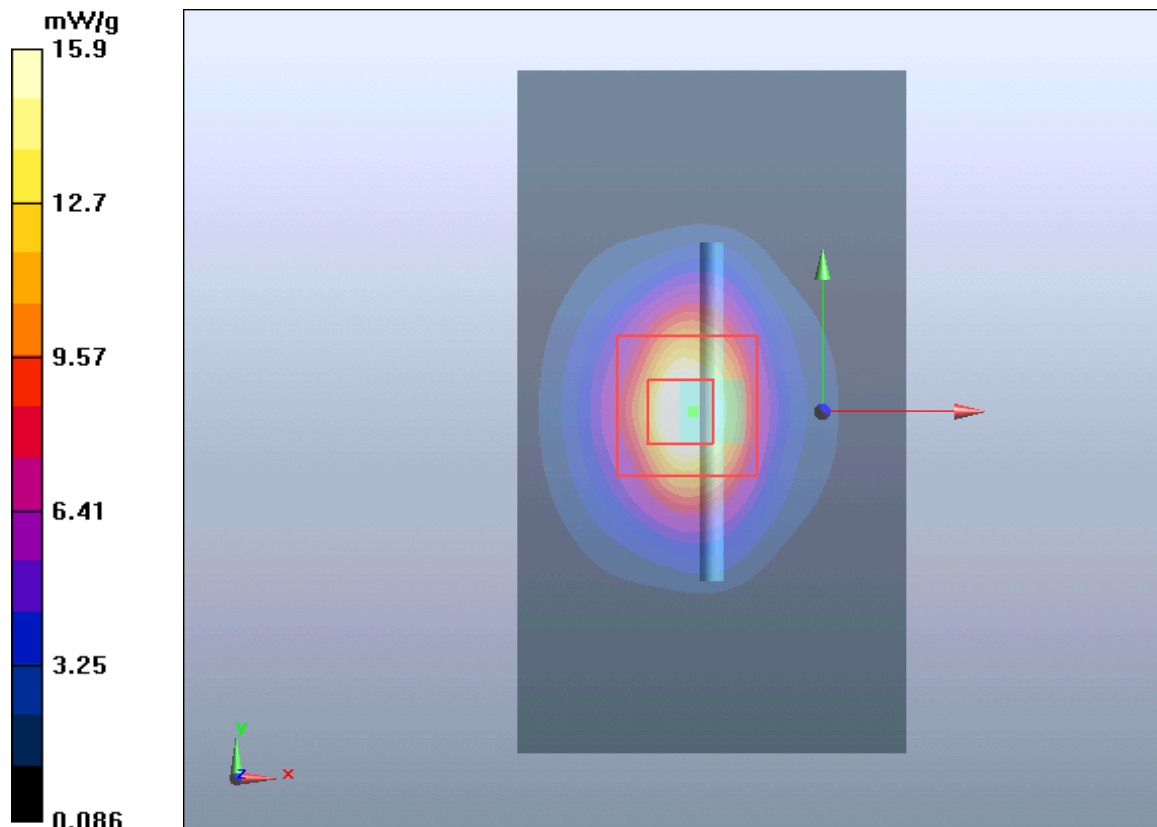
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.8 V/m; Power Drift = 0.075 dB

Peak SAR (extrapolated) = 30 W/kg

**SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.22 mW/g**

Maximum value of SAR (measured) = 15.9 mW/g



**Plot 4 System Performance Check at 2450 MHz Body TSL**

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786**

Date: 4/11/2016

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.95$  mho/m;  $\epsilon_r = 51.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.85, 7.85, 7.85); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (41x71x1):** Measurement grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 16 mW/g

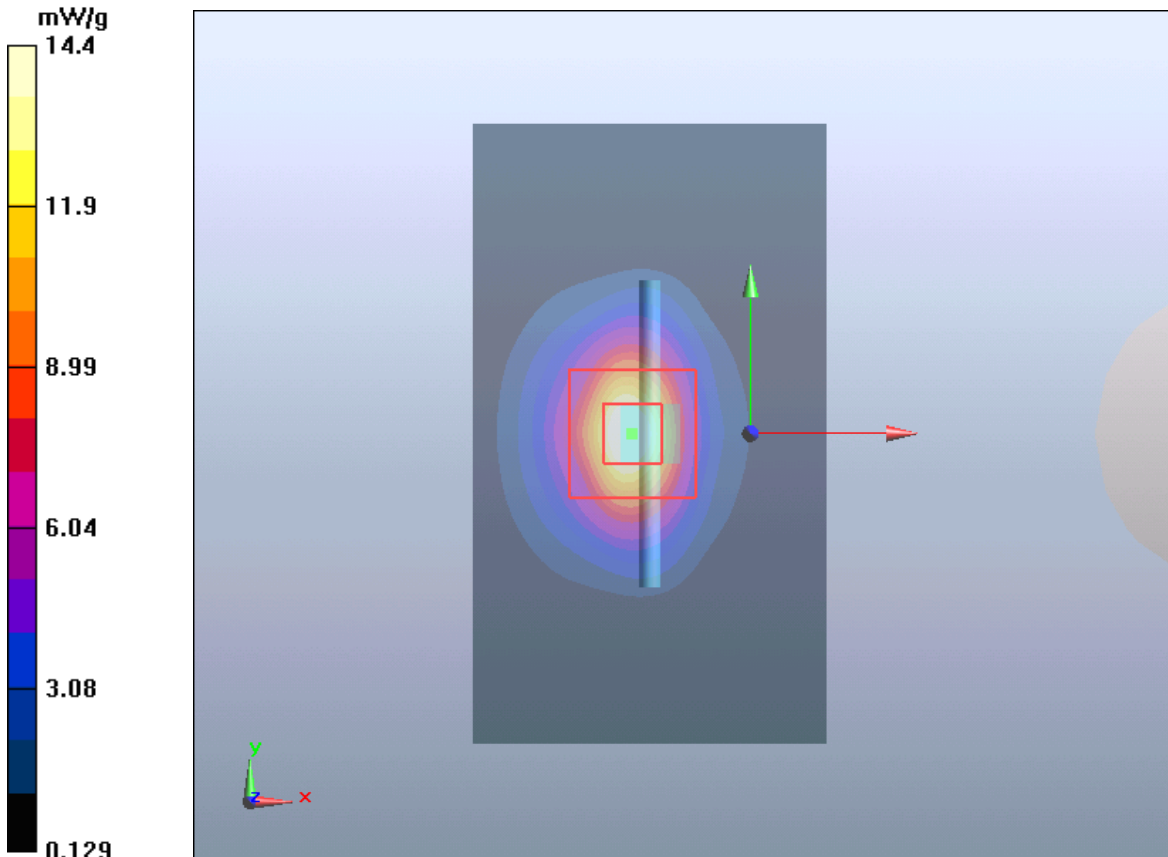
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 81.2 V/m; Power Drift = 0.003 dB

Peak SAR (extrapolated) = 25.4 W/kg

**SAR(1 g) = 12.5 mW/g; SAR(10 g) = 6.20 mW/g**

Maximum value of SAR (measured) = 14.4 mW/g



## ANNEX C: Highest Graph Results

### Plot 5 UMTS Band V Left Cheek Middle

Date: 6/16/2017

Communication System: UID 0, WCDMA V (0); Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 837$  MHz;  $\sigma = 0.936$  S/m;  $\epsilon_r = 41.859$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Left Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(9.31, 9.31, 9.31); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Left Cheek Middle/Area Scan (71x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.607 W/kg

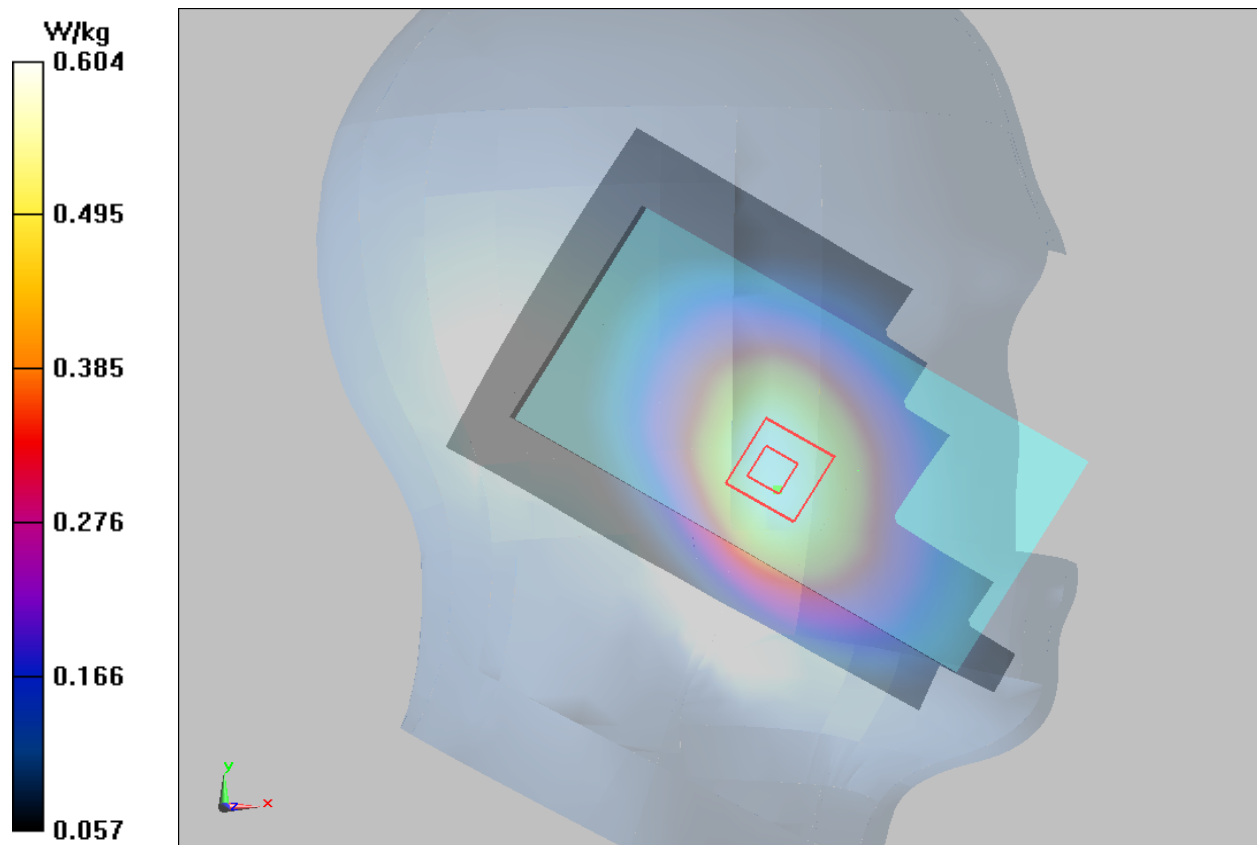
**Left Cheek Middle/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.758 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 0.727 W/kg

**SAR(1 g) = 0.581 W/kg; SAR(10 g) = 0.438 W/kg**

Maximum value of SAR (measured) = 0.604 W/kg





**Plot 6 UMTS Band V Back Side High (Distance 10mm)**

Date: 6/13/2017

Communication System: UID 0, WCDMA (0); Frequency: 846.6 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 847$  MHz;  $\sigma = 1.038$  S/m;  $\epsilon_r = 55.245$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5°C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(9.74, 9.74, 9.74); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Back Side High/Area Scan (71x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.874 W/kg

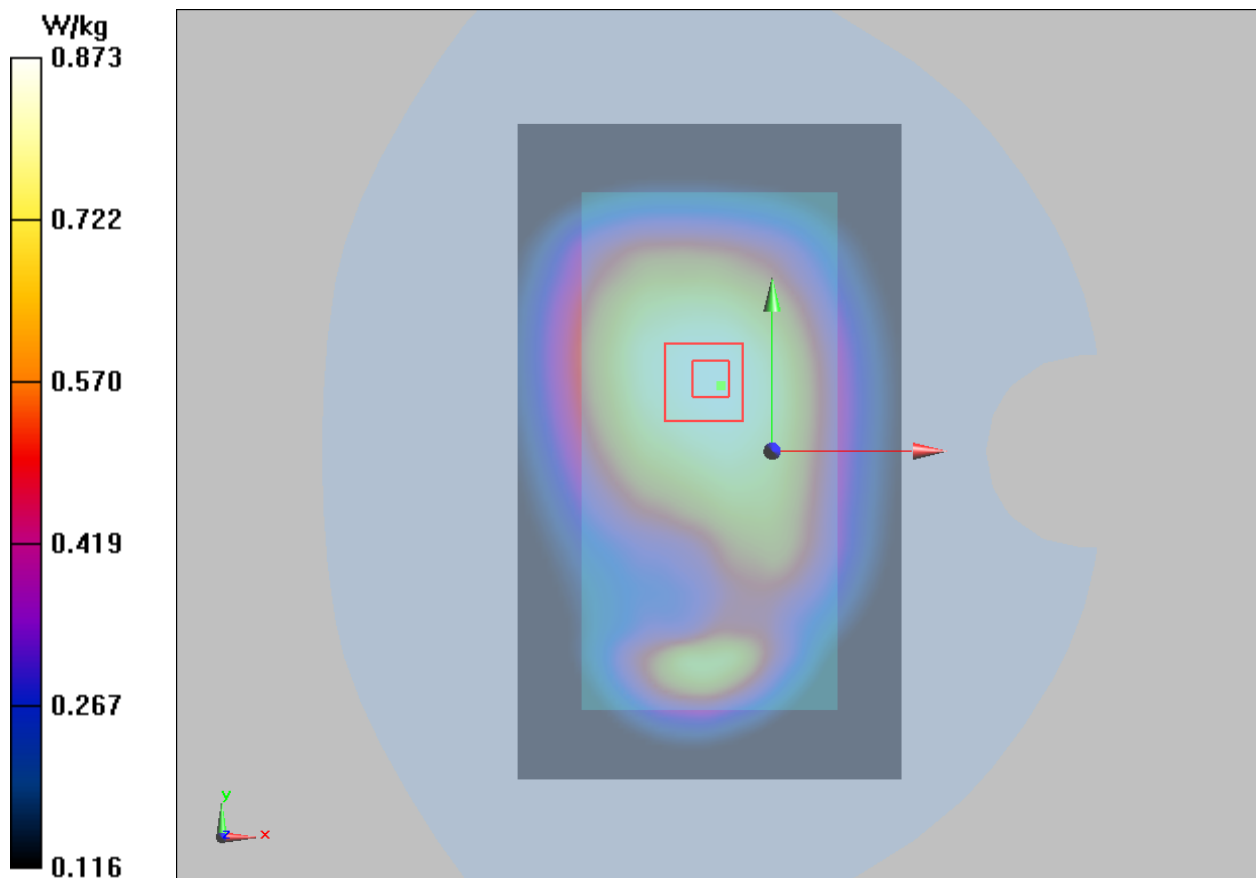
**Back Side High/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 27.87 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 1.04 W/kg

**SAR(1 g) = 0.835 W/kg; SAR(10 g) = 0.640 W/kg**

Maximum value of SAR (measured) = 0.873 W/kg



**Plot 7 802.11b Right Cheek Middle**

Date: 7/6/2017

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.867$  S/m;  $\epsilon_r = 39.435$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Right Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.90, 7.90, 7.90); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Cheek Middle/Area Scan (91x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.795 W/kg

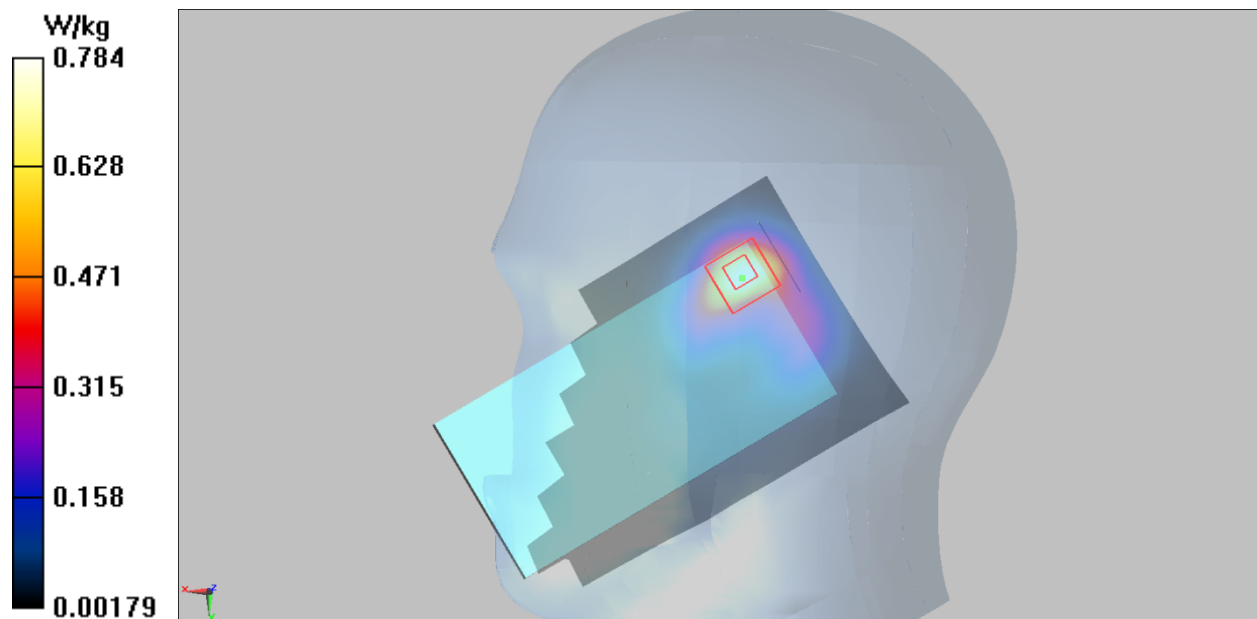
**Right Cheek Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 10.77 V/m; Power Drift = 0.054 dB

Peak SAR (extrapolated) = 1.79 W/kg

**SAR(1 g) = 0.742 W/kg; SAR(10 g) = 0.333 W/kg**

Maximum value of SAR (measured) = 0.784 W/kg





**Plot 8 802.11b Back Side Middle (Distance 10mm)**

Date: 7/7/2017

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.926$  S/m;  $\epsilon_r = 52.024$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.85, 7.85, 7.85); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM 2; Type: SAM; Serial:

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Back Side Middle/Area Scan (91x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.274 W/kg

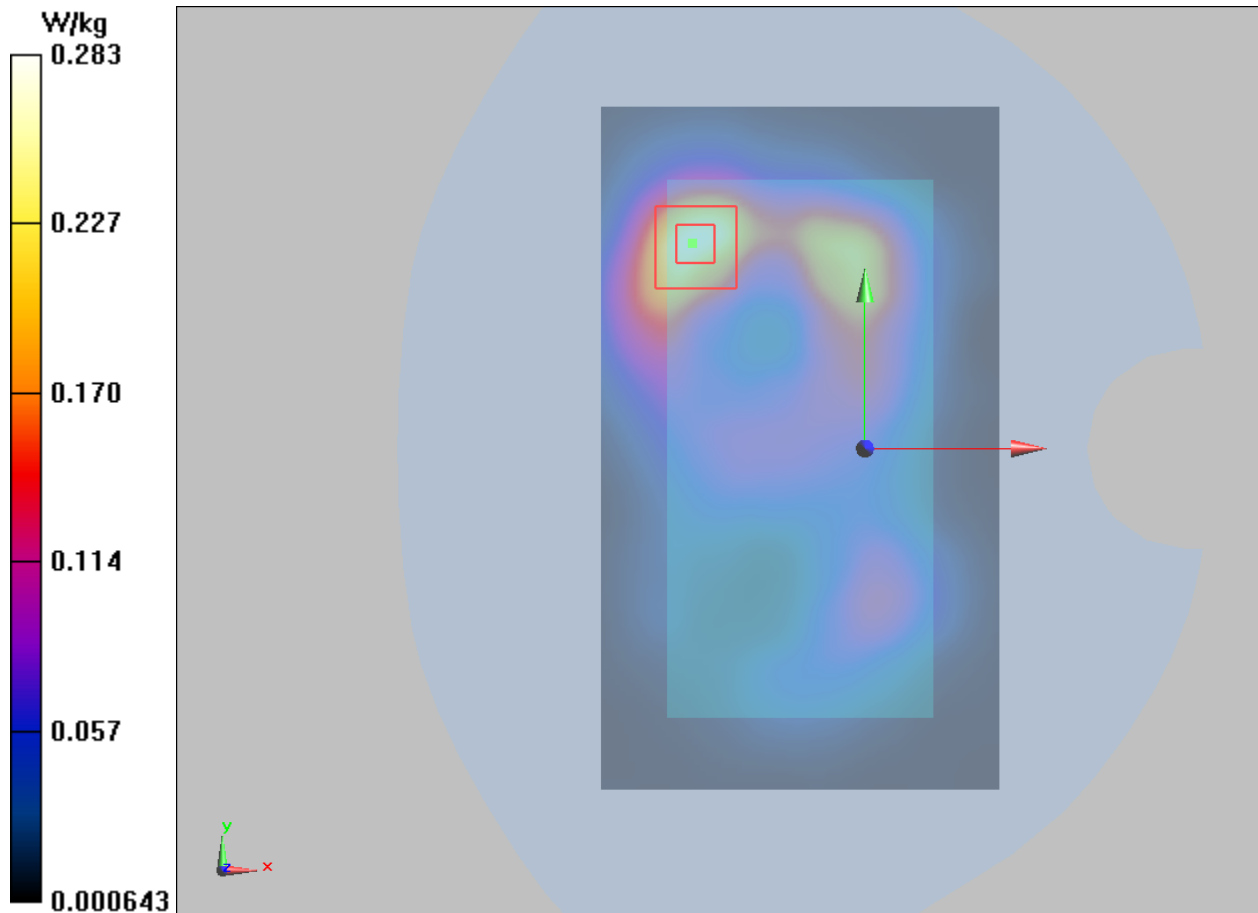
**Back Side Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 6.818 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 0.452 W/kg

**SAR(1 g) = 0.253 W/kg; SAR(10 g) = 0.133 W/kg**

Maximum value of SAR (measured) = 0.283 W/kg



**Plot 9 802.11b Top Edge Middle (Distance 10mm)**

Date: 7/7/2017

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.926$  S/m;  $\epsilon_r = 52.024$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.85, 7.85, 7.85); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Top Edge Middle/Area Scan (51x111x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.294 W/kg

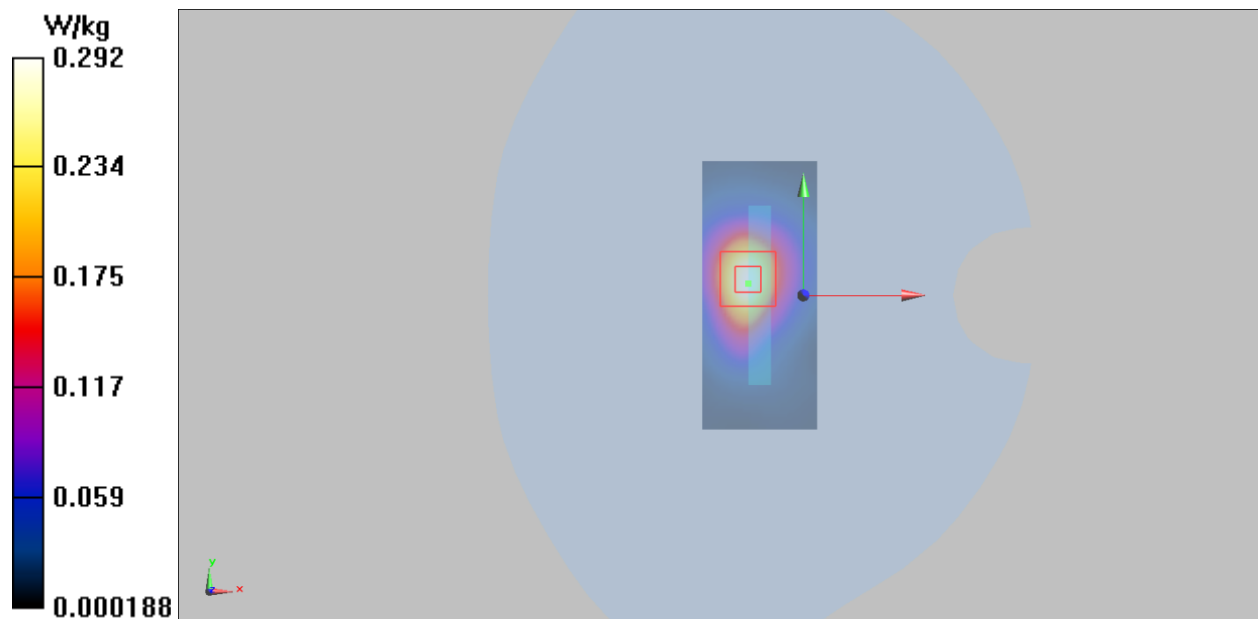
**Top Edge Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 11.17 V/m; Power Drift = 0.022 dB

Peak SAR (extrapolated) = 0.472 W/kg

**SAR(1 g) = 0.261 W/kg; SAR(10 g) = 0.135 W/kg**

Maximum value of SAR (measured) = 0.292 W/kg



**Plot 10 BT Right Cheek Middle**

Date: 7/6/2017

Communication System: UID 0, Bluetooth (0); Frequency: 2441 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2441$  MHz;  $\sigma = 1.871$  S/m;  $\epsilon_r = 39.42$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Right Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.90, 7.90, 7.90); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1317; Calibrated: 8/2/2016

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Cheek Middle/Area Scan (91x151x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.0596 W/kg

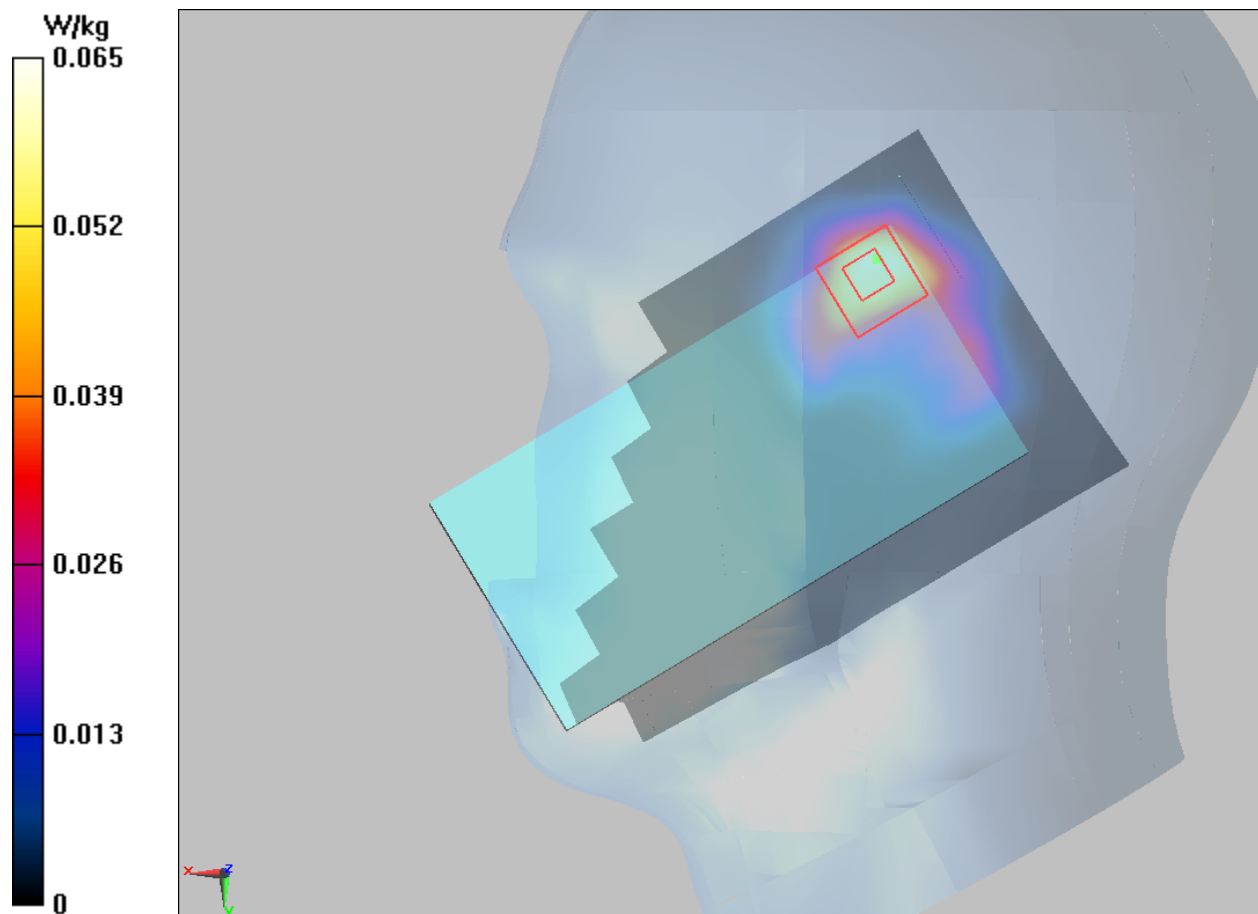
**Right Cheek Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 3.231 V/m; Power Drift = 0.026 dB

Peak SAR (extrapolated) = 0.128 W/kg

**SAR(1 g) = 0.057 W/kg; SAR(10 g) = 0.025 W/kg**

Maximum value of SAR (measured) = 0.065W/kg





# ANNEX D: Probe Calibration Certificate



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Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client **TA(Shanghai)**

Certificate No: **Z17-97012**

## CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3677**

Calibration Procedure(s): **FD-Z11-004-01  
Calibration Procedures for Dosimetric E-field Probes**

Calibration date: **January 23, 2017**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

### Calibration Equipment used (M&TE critical for calibration)

| Primary Standards        | ID #        | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|--------------------------|-------------|------------------------------------------|-----------------------|
| Power Meter NRP2         | 101919      | 27-Jun-16 (CTTL, No.J16X04777)           | Jun-17                |
| Power sensor NRP-Z91     | 101547      | 27-Jun-16 (CTTL, No.J16X04777)           | Jun-17                |
| Power sensor NRP-Z91     | 101548      | 27-Jun-16 (CTTL, No.J16X04777)           | Jun-17                |
| Reference10dBAAttenuator | 18N50W-10dB | 13-Mar-16(CTTL,No.J16X01547)             | Mar-18                |
| Reference20dBAAttenuator | 18N50W-20dB | 13-Mar-16(CTTL, No.J16X01548)            | Mar-18                |
| Reference Probe EX3DV4   | SN 7433     | 26-Sep-16(SPEAG,No.EX3-7433_Sep16)       | Sep-17                |
| DAE4                     | SN 549      | 13-Dec-16(SPEAG, No.DAE4-549_Dec16)      | Dec -17               |
| Secondary Standards      | ID #        | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGeneratorMG3700A   | 6201052605  | 27-Jun-16 (CTTL, No.J16X04776)           | Jun-17                |
| Network Analyzer E5071C  | MY46110673  | 26-Jan-16 (CTTL, No.J16X00894)           | Jan -17               |

|                | Name        | Function                          | Signature |
|----------------|-------------|-----------------------------------|-----------|
| Calibrated by: | Yu Zongying | SAR Test Engineer                 |           |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |           |
| Approved by:   | Lu Bingsong | Deputy Director of the laboratory |           |

Issued: January 24, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.





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Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
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**Glossary:**

|                       |                                                                                                                                             |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                   | tissue simulating liquid                                                                                                                    |
| NORM <sub>x,y,z</sub> | sensitivity in free space                                                                                                                   |
| ConvF                 | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                  |
| DCP                   | diode compression point                                                                                                                     |
| CF                    | crest factor (1/duty_cycle) of the RF signal                                                                                                |
| A,B,C,D               | modulation dependent linearization parameters                                                                                               |
| Polarization $\Phi$   | $\Phi$ rotation around probe axis                                                                                                           |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i<br>$\theta=0$ is normal to probe axis |

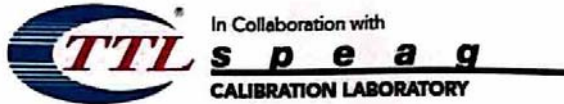
Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

**Calibration is Performed According to the Following Standards:**

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Methods Applied and Interpretation of Parameters:**

- NORM<sub>x,y,z</sub>:** Assessed for E-field polarization  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>:** DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR:** PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; A,B,C** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters:** Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- Spherical isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle:** The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
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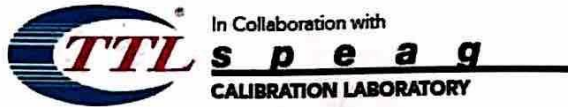
# Probe EX3DV4

## SN: 3677

Calibrated: January 23, 2017

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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 Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

### Basic Calibration Parameters

|                                      | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--------------------------------------|----------|----------|----------|-----------|
| Norm( $\mu V/(V/m)^2$ ) <sup>A</sup> | 0.39     | 0.44     | 0.38     | ±10.8%    |
| DCP(mV) <sup>B</sup>                 | 97.3     | 102.2    | 101.1    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A dB | B dB $\sqrt{\mu V}$ | C   | D dB | VR mV | Unc <sup>E</sup> (k=2) |
|-----|---------------------------|---|------|---------------------|-----|------|-------|------------------------|
| 0   | CW                        | X | 0.0  | 0.0                 | 1.0 | 0.00 | 180.5 | ±2.0%                  |
|     |                           | Y | 0.0  | 0.0                 | 1.0 |      | 195.3 |                        |
|     |                           | Z | 0.0  | 0.0                 | 1.0 |      | 177.9 |                        |

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5 and Page 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.





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 Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
 E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

### Calibration Parameter Determined in Head Tissue Simulating Media

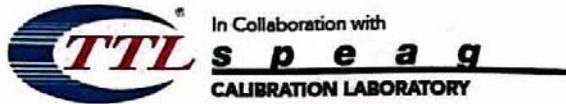
| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 41.9                               | 0.89                            | 9.58    | 9.58    | 9.58    | 0.30               | 0.75                    | ±12%        |
| 835                  | 41.5                               | 0.90                            | 9.31    | 9.31    | 9.31    | 0.11               | 1.55                    | ±12%        |
| 1750                 | 40.1                               | 1.37                            | 8.60    | 8.60    | 8.60    | 0.24               | 1.07                    | ±12%        |
| 1900                 | 40.0                               | 1.40                            | 8.39    | 8.39    | 8.39    | 0.23               | 1.10                    | ±12%        |
| 2300                 | 39.5                               | 1.67                            | 8.13    | 8.13    | 8.13    | 0.53               | 0.74                    | ±12%        |
| 2450                 | 39.2                               | 1.80                            | 7.90    | 7.90    | 7.90    | 0.61               | 0.71                    | ±12%        |
| 2600                 | 39.0                               | 1.96                            | 7.64    | 7.64    | 7.64    | 0.68               | 0.68                    | ±12%        |
| 5250                 | 35.9                               | 4.71                            | 5.66    | 5.66    | 5.66    | 0.40               | 1.20                    | ±13%        |
| 5600                 | 35.5                               | 5.07                            | 4.99    | 4.99    | 4.99    | 0.40               | 1.40                    | ±13%        |
| 5750                 | 35.4                               | 5.22                            | 5.00    | 5.00    | 5.00    | 0.40               | 1.40                    | ±13%        |

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.





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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

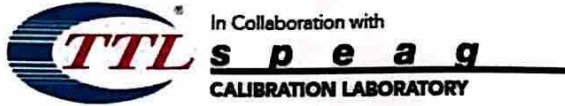
### Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 9.99    | 9.99    | 9.99    | 0.30               | 0.95                    | ± 12%       |
| 835                  | 55.2                               | 0.97                            | 9.74    | 9.74    | 9.74    | 0.14               | 1.66                    | ± 12%       |
| 1750                 | 53.4                               | 1.49                            | 8.39    | 8.39    | 8.39    | 0.21               | 1.16                    | ± 12%       |
| 1900                 | 53.3                               | 1.52                            | 7.98    | 7.98    | 7.98    | 0.22               | 1.24                    | ± 12%       |
| 2300                 | 52.9                               | 1.81                            | 7.97    | 7.97    | 7.97    | 0.55               | 0.80                    | ± 12%       |
| 2450                 | 52.7                               | 1.95                            | 7.85    | 7.85    | 7.85    | 0.50               | 0.86                    | ± 12%       |
| 2600                 | 52.5                               | 2.16                            | 7.63    | 7.63    | 7.63    | 0.44               | 0.91                    | ± 12%       |
| 5250                 | 48.9                               | 5.36                            | 5.03    | 5.03    | 5.03    | 0.50               | 1.60                    | ± 13%       |
| 5600                 | 48.5                               | 5.77                            | 4.34    | 4.34    | 4.34    | 0.54               | 1.66                    | ± 13%       |
| 5750                 | 48.3                               | 5.94                            | 4.52    | 4.52    | 4.52    | 0.57               | 1.95                    | ± 13%       |

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

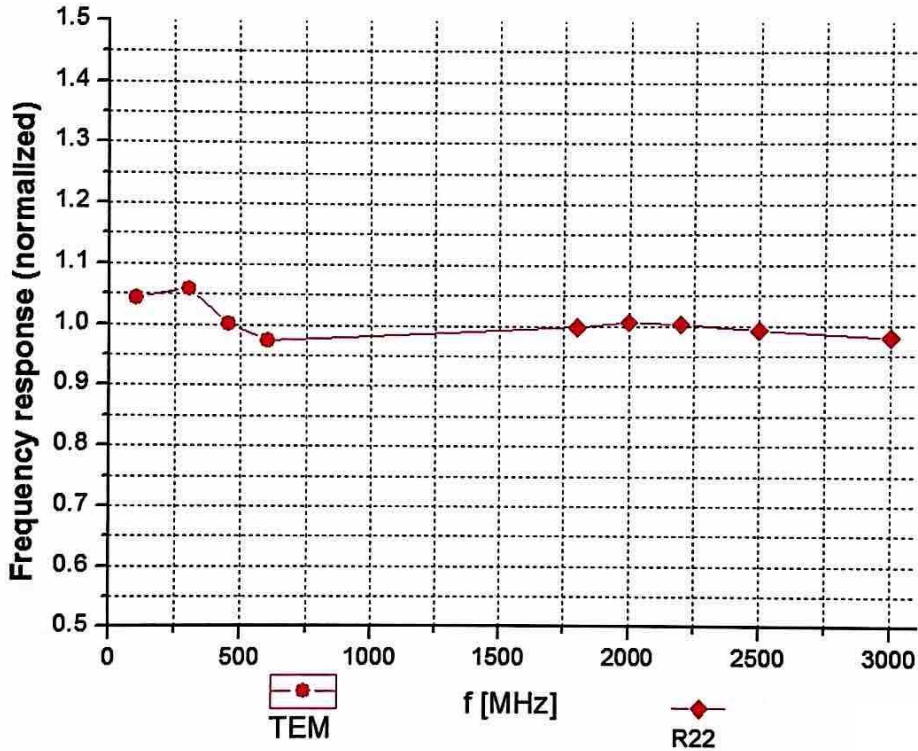
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 7.5\%$  (k=2)

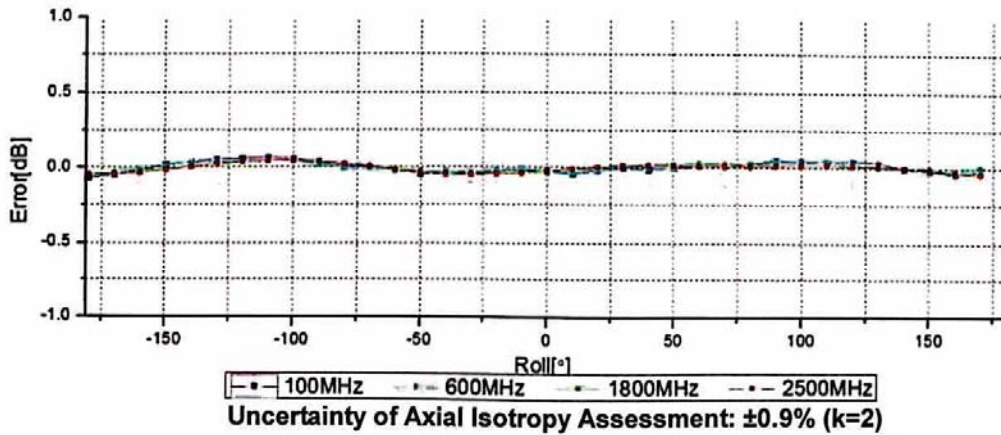
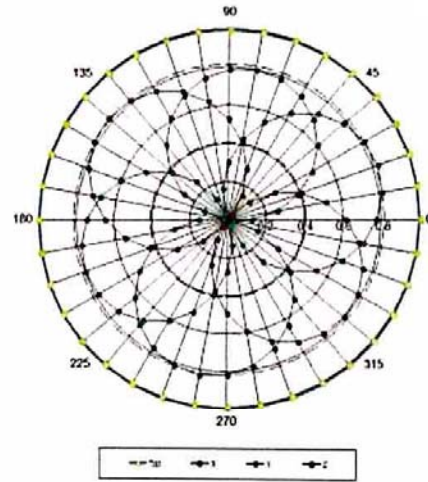
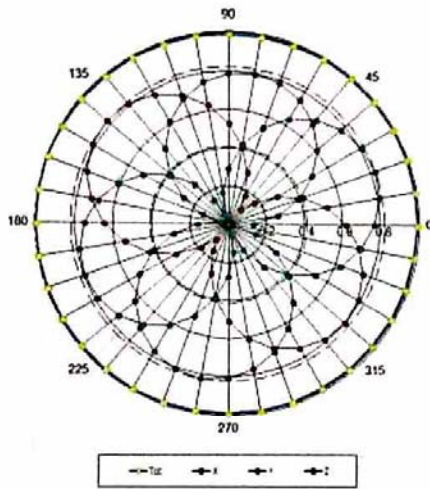


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### Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**

**f=1800 MHz, R22**

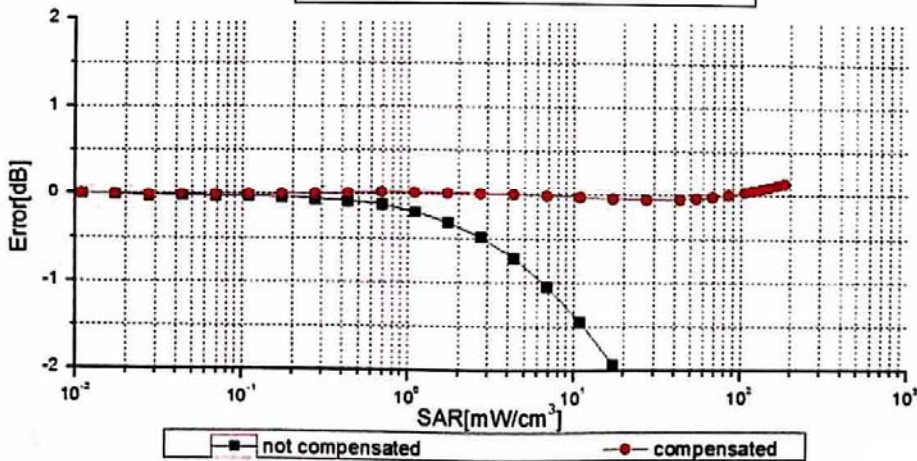
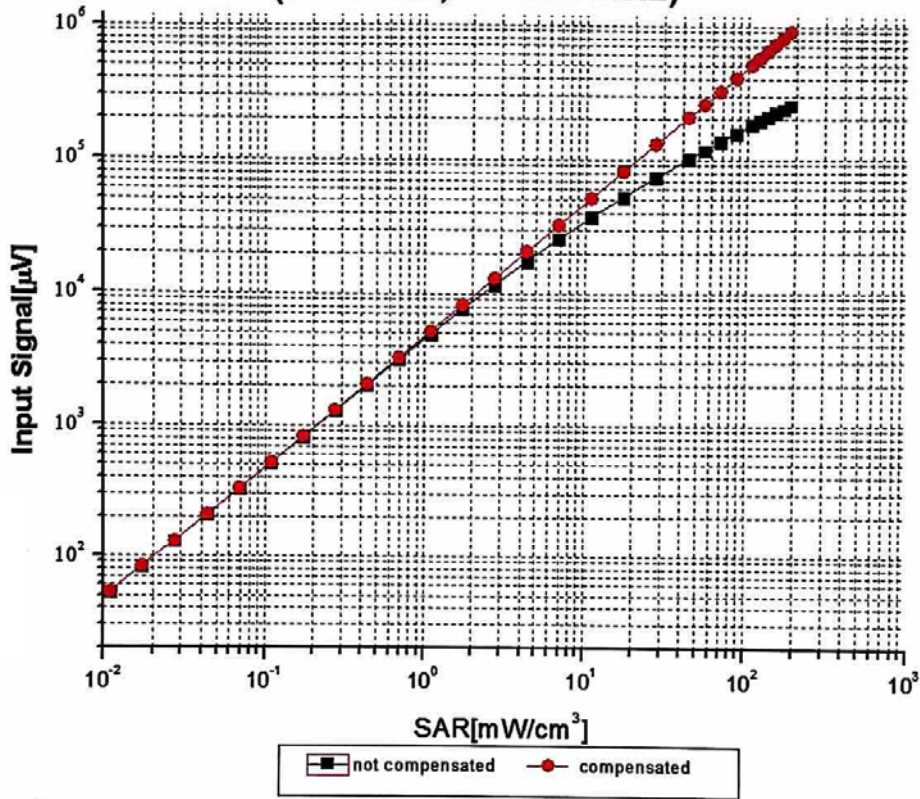






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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment: ±0.9% (k=2)