# FCC SAR TEST REPORT

For

## SHENZHEN GIEC DIGITAL CO., LTD

**No.1 Building,Factory,No.7 District,Dayang Development Areas,FuYongStreet,Baoan,Shenzhen,China**

**Product Name** : Tablet PC

**Model No.** : TM800A710M, GK-MWQ8004

**FCC ID** : 2AHYK-TM800A710M

**Date of Receipt** : 9th May. 2017

**Date of Test** : 9th May. 2017

**Issued Date** : 11st May. 2017

**Report No.** : TS201705003

**Report Version** : V1.0

**Issue By**

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## 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing are as follows.

**<Highest SAR Summary>**

| Exposure Position | Frequency Band | 1g-SAR (W/kg) |
|---|---|---|
| **Body (0mm Gap)** | WLAN2.4G | **0.033** |

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.

## 2. SAR Evaluation compliance

| | |
|---|---|
| **Product Name:** | Tablet PC |
| **Brand Name:** | / |
| **Model Name:** | TM800A710M, GK-MWQ8004 |
| **Applicant:** | SHENZHEN GIEC DIGITAL CO., LTD |
| **Address:** | No.1 Building,Factory,No.7 District,Dayang Development Areas,FuYongStreet,Baoan,Shenzhen,China |
| **Manufacturer:** | SHENZHEN GIEC DIGITAL CO., LTD |
| **Address:** | No.1 Building,Factory,No.7 District,Dayang Development Areas,FuYongStreet,Baoan,Shenzhen,China |
| **Applicable Standard:** | FCC 47 CFR Part 2 (2.1093)<br>ANSI/IEEE C95.1-1992<br>IEEE 1528-2013<br>FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04<br>FCC KDB 865664 D02 SAR Reporting v01r02<br>FCC KDB 447498 D01 General RF Exposure Guidance v06<br>FCC KDB 648474 D04 Handset SAR v01r03<br>FCC KDB 248227 D01 Wi-Fi SAR v02r02<br>FCC KDB 616217 D04 SAR for laptop and tablets v01r02 |
| **Performed Date:** | 11st May. 2017 |
| **Test Engineer:** | Li.zhao |
| **Reviewed By** | Tommy. Liu |
| **Performed Location:** | Shenzhen Sunway Communication CO.,LTD Testing Center<br>1/F,BuildingA，SDG Info Port, KefengRoad，Hi-Tech Park, Nanshan District,Shenzhen , Guangdong, China 518104<br>Tel: +86-755- 36615880<br>Fax: +86-755- 86525532 |

# 3. General Information:

3.1 EUT Description:

| EUT Information | |
|---|---|
| **Product Name** | Tablet PC |
| **Brand Name** | / |
| **Model Name** | TM800A710M, GK-MWQ8004 |
| **Hardware Version** | / |
| **Software Version** | / |
| **Tx Frequency** | WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz<br>Bluetooth: 2402 MHz ~ 2480 MHz |
| **Mode** | 802.11b/g/n HT20 HT40<br>Bluetooth v2.1+EDR Bluetooth v3.0+EDR Bluetooth v4.0 LE |
| **Remark:**<br>1. The tablet pc not supported Voice mode. | |

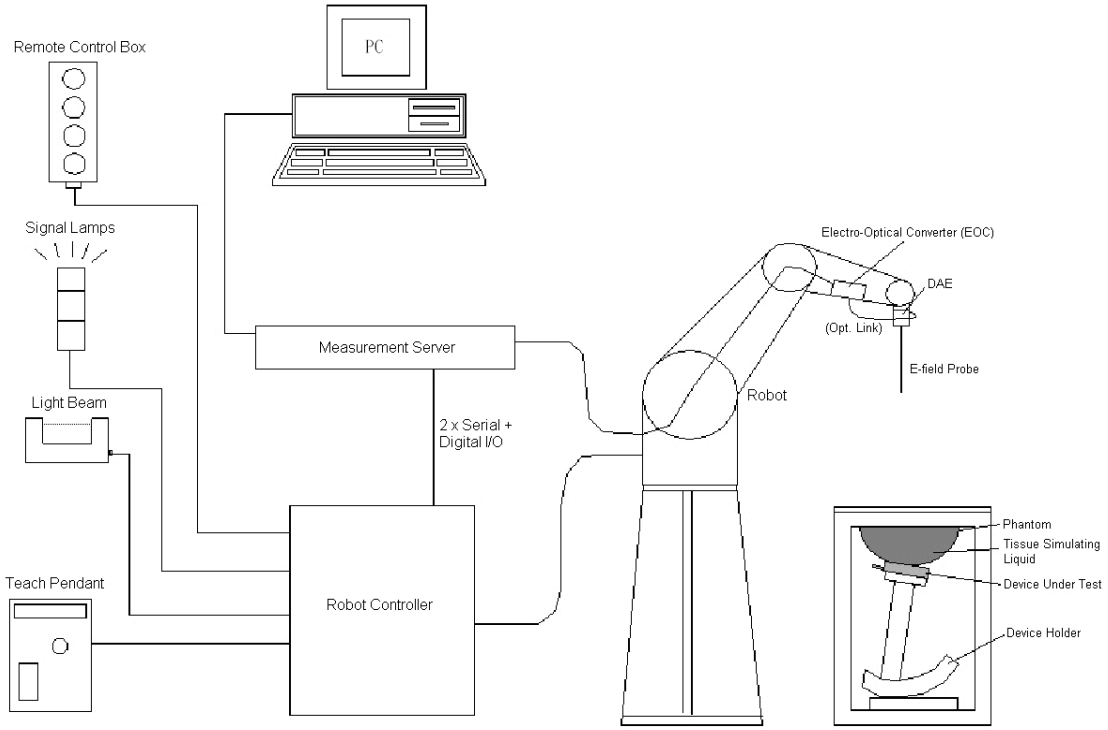
3.2 Test Environment:

Ambient conditions in the SAR laboratory:

| Items | Required | Actual |
|---|---|---|
| **Temperature (℃)** | 18-25 | 22~23 |
| **Humidity (%RH)** | 30-70 | 55~65 |

# 4. SAR Measurement System:

4.1 Dasy System Description:




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).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7 or Windows XP.
- DASY software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

## 5. System Components:

- DASY5 Measurement Server:

The DASY5 measurement server is based on a PC/104 CPU board with a 166MHz low-power pentium, 32MB chipdisk and 64MB RAM. The necessary circuits for communication with either the DAE4 (or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

- DATA Acquisition Electronics (DAE):

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

- Dosimetric Probes:

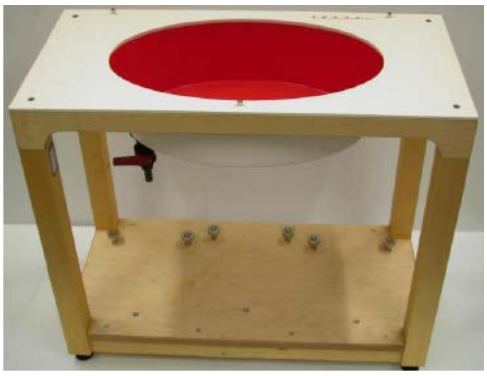
Model: EX3DV3,
Frequency: 10MHz to 3G, Linearity:±0.2dB,
Dynamic Range: 10 µW/g to100 mW/g
Directivity:
± 0.3 dB in HSL (rotation around probe axis)
± 0.5 dB in tissue material (rotation normal to probe axis)

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

- Light Beam unit:

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm.

- ELI4 Phantom:



The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.
Shell Thickness: 2 ± 0.2 mm (sagging: <1%)
Filling Volume: Approx. 30 liters
Dimensions: Major ellipse axis: 600 mm
Minor axis: 400 mm

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

- Device Holder for SAM Twin Phantom:

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity "=3 and loss tangent _=0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered

## 6. EUT Test Position:

This EUT was tested in three different positions. They are front/rear/ edge2 of the EUT with phantom 0 mm gap,

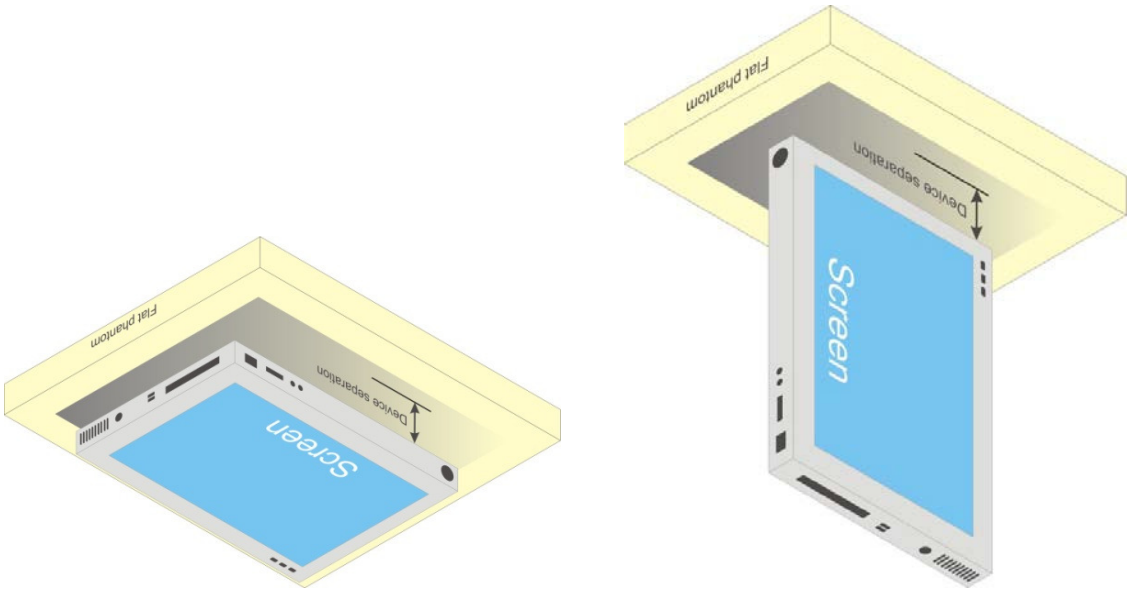



**Illustration for Lap-touching Position**

**<DUT Setup Photos>**

Rear with Phantom 0 mm Gap

Front with Phantom 0 mm Gap

Edge 2 with Phantom 0 mm Gap

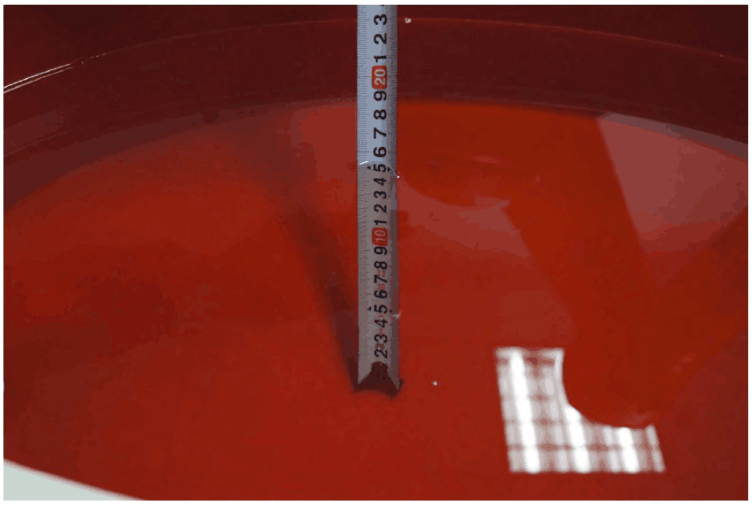
## 7. Tissue Simulating Liquid

7.1 The composition of the tissue simulating liquid:
The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity (σ) | Permittivity (εr) |
|---|---|---|---|---|---|---|---|---|
| **For Body** | | | | | | | | |
| 2450 | 68.6 | 0 | 0 | 0 | 0 | 31.4 | 1.95 | 52.7 |

7.2 Tissue Calibration Result:

| Frequency (MHz) | Description | Dielectric Parameters | | Tissue Temp. (℃) | Date |
|---|---|---|---|---|---|
| | | Permittivity (εr ) | Conductivity (σ) | | |
| 2450 (Body) | Reference | 52.7±5% (50.065~55.335) | 1.95±5% (1.8525~2.0475) | NA | 2017/05/09 |
| | Measurement | 50.7 | 1.902 | 22.3 | |

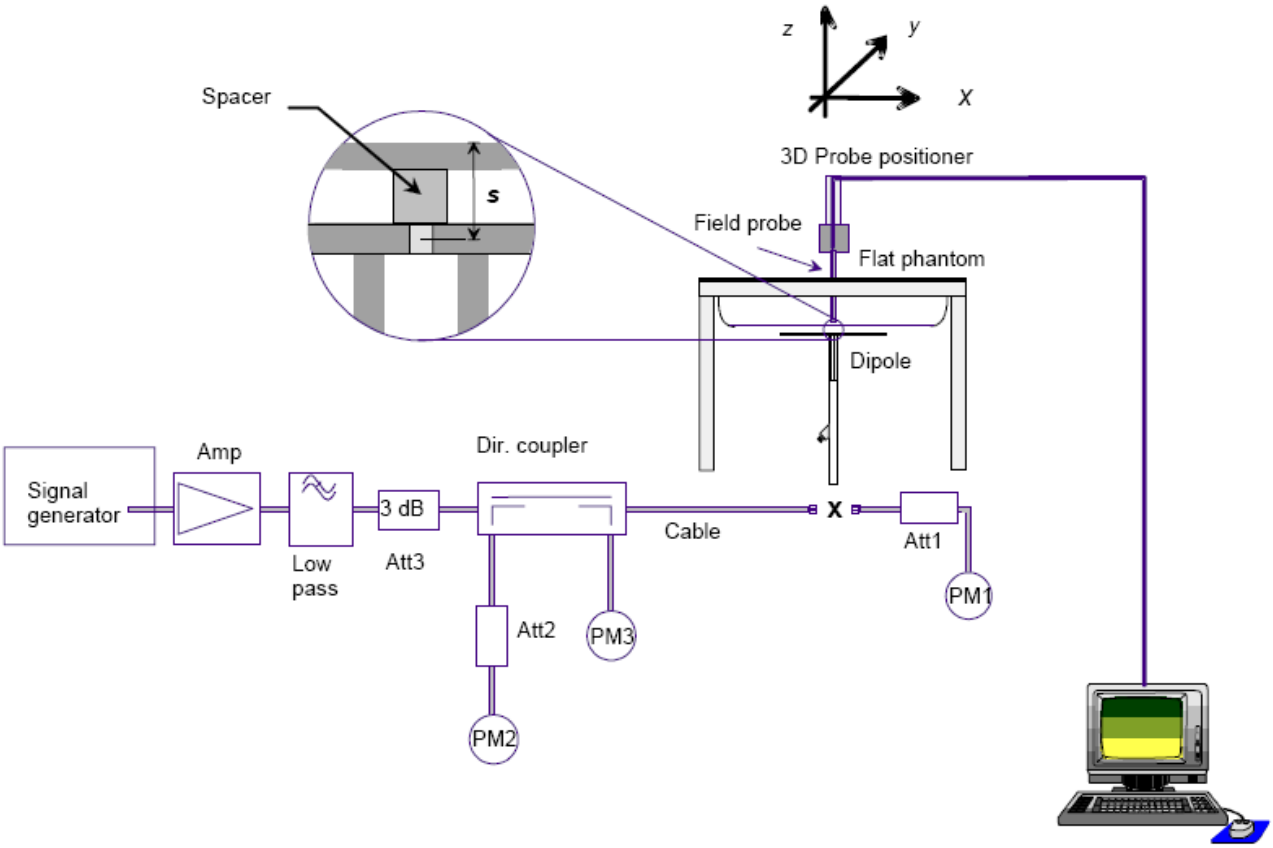


**Liquid depth in the ELI4 Phantom (2450 MHz) (depth>15cm)**

## 8. SAR System Validation

8.1 Validation System:

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:




8.2 Validation Dipoles:

The dipoles used is based on the IEEE-1528/EN62209-1 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE-1528/EN62209-1 and FCC Supplement C.

8.3 Validation Result:

| Frequency (MHz) | Description | SAR(1g) W/Kg | SAR(10g) W/Kg | Tissue Temp. (℃) | Date |
|---|---|---|---|---|---|
| 2450 (Body) | Reference | 51.8±10% (46.62~56.98) | 24.2±10% (21.78~26.62) | NA | 2017/05/09 |
| | Measurement | 53.6 | 25.28 | 22.3 | |

## 9. SAR Evaluation Procedures:

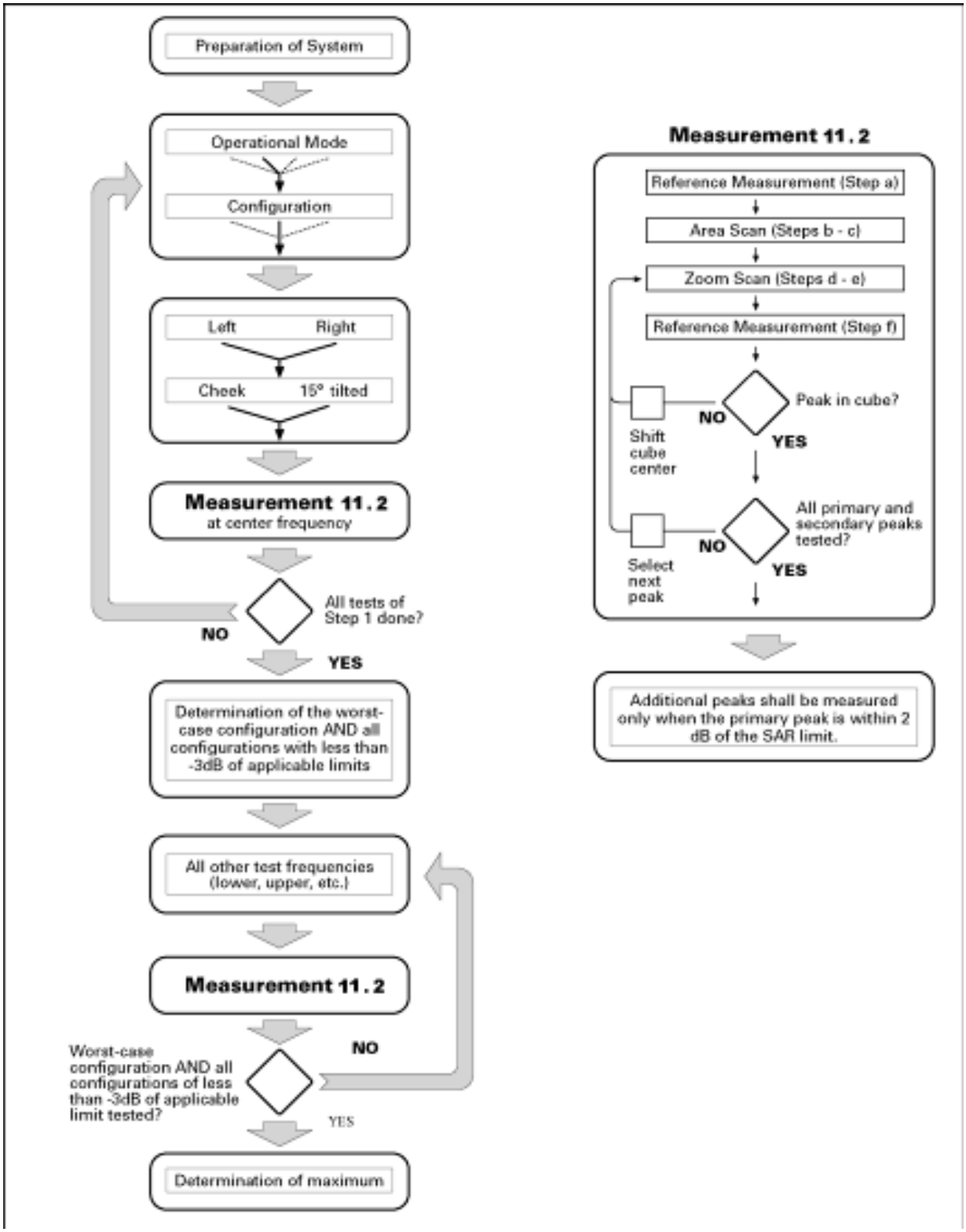
The procedure for assessing the average SAR value consists of the following steps:

- Power Reference Measurement
  The Power Reference Measurement and Power Drift Measurement jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- 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 finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY5 software can find the maximum locations even in relatively coarse grids. The scanning area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the Area Scan's property sheet is brought-up, grid settings can be edited by a user.

- Zoom Scan
  Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan measures 7 x 7 x 7 points (5mmx5mmx5mm) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure.

- Power Drift Measurement
  The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement.




**Block diagram of the tests to be performed**

## 10. SAR Exposure Limits

10.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

10.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Limits for Occupational/Controlled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.4 | 8.0 | 20.0 |

**Limits for General Population/Uncontrolled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.08 | 1.6 | 4.0 |

Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

## 11. Measurement Uncertainty:

| NO | Source | Uncert. ai（%） | Prob. Dist. | Div. k | ci (1g) | ci (10g) | Stand. Uncert. ui (1g) | Stand. Uncert. ui (10g) | *Veff* |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Repeat | 0.04 | N | 1 | 1 | 1 | 0.04 | 0.04 | 9 |
| **Instrument** | | | | | | | | | |
| 2 | Probe calibration | 7.5 | N | 2 | 1 | 1 | 3.75 | 3.75 | ∞ |
| 3 | Axial isotropy | 0.9 | R | $\sqrt{3}$ | 0.7 | 0.7 | 0.4 | 0.4 | ∞ |
| 4 | Hemispherical isotropy | 9.6 | R | $\sqrt{3}$ | 0.7 | 0.7 | 3.9 | 3.9 | ∞ |
| 5 | Boundary effect | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 6 | Linearity | 0.9 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 | ∞ |
| 7 | Detection limits | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 8 | Readout electronics | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| 9 | Response time | 0.8 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 | ∞ |
| 10 | Integration time | 2.6 | R | $\sqrt{3}$ | 1 | 1 | 1.5 | 1.5 | ∞ |
| 11 | Ambient noise | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 12 | Ambient reflections | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 13 | Probe positioner mech. restrictions | 0.4 | R | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 | ∞ |
| 14 | Probe positioning with respect to phantom shell | 2.9 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 15 | Max.SAR evaluation | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Test sample related** | | | | | | | | | |
| 16 | Device positioning | 3.8 | N | 1 | 1 | 1 | 3.8 | 3.8 | 99 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17 | Device holder | 5.1 | N | 1 | 1 | 1 | 5.1 | 5.1 | 5 |
| 18 | Drift of output power | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and set-up** | | | | | | | | | |
| 19 | Phantom uncertainty | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.3 | 2.3 | ∞ |
| 20 | Liquid conductivity (target) | 5.0 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| 21 | Liquid conductivity (meas) | 2.5 | N | 1 | 0.64 | 0.43 | 1.6 | 1.2 | ∞ |
| 22 | Liquid Permittivity (target) | 5.0 | R | $\sqrt{3}$ | 0.6 | 0.49 | 1.7 | 1.5 | ∞ |
| 23 | Liquid Permittivity (meas) | 2.5 | N | 1 | 0.6 | 0.49 | 1.5 | 1.2 | ∞ |
| 24 | Liquid conductivity—temperature uncertainty | 4.6 | R | $\sqrt{3}$ | 0.78 | 0.71 | 2.1 | 1.9 | ∞ |
| 25 | Liquid permittivity—temperature uncertainty | 4.6 | R | $\sqrt{3}$ | 0.23 | 0.26 | 0.6 | 0.7 | ∞ |
| **Combined standard** | | | RSS | $U_c = \sqrt{\sum_{i=1}^{n} C_i^2 U_i^2}$ | | | 12.4% | 12.1% | 236 |
| **Expanded uncertainty (P=95%)** | | $U = k\ U_C$ ,k=2 | | | | | **22.6%** | **22.4%** | |

## 12. Conducted Power Measurement:

**<WLAN 2.4GHz Conducted Power>**

| Mode | Channel | Frequency (MHz) | Conducted Output Power(dBm) | Test Rate Data | Duty Cycle used for SAR testing |
|---|---|---|---|---|---|
| 802.11b | 1 | 2412 | 18.17 | 1 Mbps | 100% |
| | 6 | 2437 | 17.24 | 1 Mbps | |
| | 11 | 2462 | 17.73 | 1 Mbps | |
| 802.11g | 1 | 2412 | 13.17 | 6 Mbps | |
| | 6 | 2437 | 14.58 | 6 Mbps | |
| | 11 | 2462 | 14.79 | 6 Mbps | |
| 802.11n(20MHz) | 1 | 2412 | 13.22 | 6.5 Mbps | |
| | 6 | 2437 | 14.15 | 6.5 Mbps | |
| | 11 | 2462 | 14.21 | 6.5 Mbps | |
| 802.11n(40MHz) | 3 | 2422 | 13.14 | 13.5 Mbps | |
| | 6 | 2437 | 12.85 | 13.5 Mbps | |
| | 9 | 2452 | 12.62 | 13.5 Mbps | |

**Note:**

1. Per KDB 447498 D01, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, where
- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

| Mode | Frequency (GHz) | Tune-up Power (dBm) | Max. Power (mW) | Test distance (mm) | Result | exclusion thresholds for 1-g SAR |
|---|---|---|---|---|---|---|
| 802.11b | 2.412 | 19 | 79.43 | 5 | 24.67 | 3.0 |
| 802.11g | 2.462 | 15 | 31.62 | 5 | 9.92 | 3.0 |

2. Base on the result of note1, RF exposure evaluation of 802.11 b mode is required.
3. Per KDB 248227 D01, choose the highest output power channel to test SAR and determine further SAR exclusion.
4. Per KDB 248227 D01, In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. SAR is not required for the following 2.4 GHz OFDM conditions:
   1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
   2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

**<Bluetooth Conducted Power>**

| Mode | Channel | Frequency (MHz) | Conducted Average Power (dBm) |
|---|---|---|---|
| GFSK | 0 | 2402 | 2.95 |
| | 39 | 2441 | 3.60 |
| | 78 | 2480 | 3.79 |
| π/4DQPSK | 0 | 2402 | 2.56 |
| | 39 | 2441 | 2.54 |
| | 78 | 2480 | 1.72 |
| 8DPSK | 0 | 2402 | 1.73 |
| | 39 | 2441 | 2.56 |
| | 78 | 2480 | 2.59 |
| BLE-GFSK | 0 | 2402 | -3.76 |
| | 19 | 2440 | -3.12 |
| | 39 | 2480 | -3.47 |

Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·[$\sqrt{f(GHz)}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

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

| Bluetooth turn up Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|---|---|---|---|
| 5 | 0 | 2.48 | 1.00 |

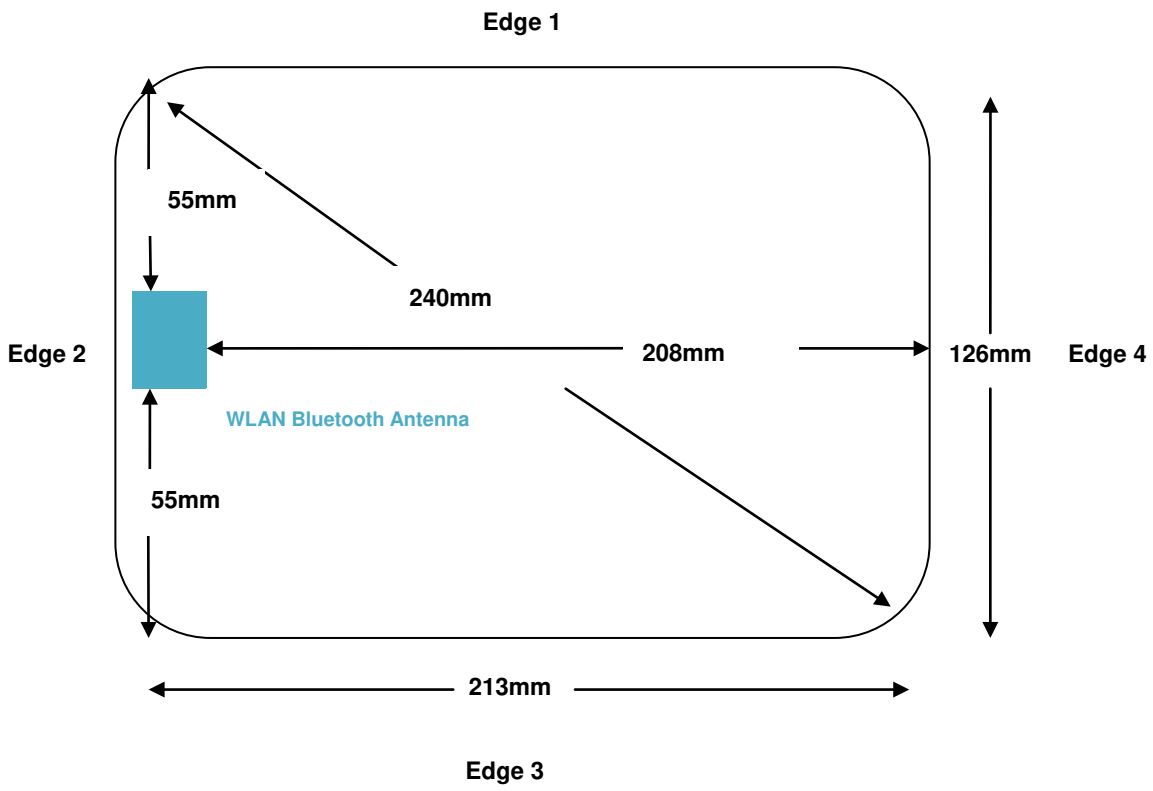
Per KDB 447498 D01v06, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 1.41 which is <= 3, SAR testing is not required.

Estimated SAR for Bluetooth

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

| Maximum Power | Exposure Position | Body |
|---|---|---|
| | Test separation | 0 mm |
| 5dBm | Estimated SAR (W/kg) | 0.133W/kg |

## 13. Antenna Location




**Front View**

| The Antenna position | | |
|---|---|---|
| Exposure Position | Wireless interface | WLAN 2.4GHz |
| | Tune-up Maximum power（dBm） | 19 |
| | Tune-up Maximum rated power（mw） | 79.43 |
| Front | Antenna to user（mm） | 5 |
| | SAR exclusion threshold（mw） | 10 |
| | SAR testing request? | YES |
| Rear | Antenna to user（mm） | 5 |
| | SAR exclusion threshold（mw） | 10 |
| | SAR testing request? | YES |
| Edge 1 | Antenna to user（mm） | 55 |
| | SAR exclusion threshold（mw） | 146 |
| | SAR testing request? | NO |
| Edge 2 | Antenna to user（mm） | 5 |
| | SAR exclusion threshold（mw） | 10 |
| | SAR testing request? | YES |
| Edge 3 | Antenna to user（mm） | 55 |
| | SAR exclusion threshold（mw） | 146 |
| | SAR testing request? | NO |
| Edge 4 | Antenna to user（mm） | 208 |
| | SAR exclusion threshold（mw） | 1676 |
| | SAR testing request? | NO |

**General Note:**

1. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
2. Per KDB 447498 D01v06, for larger devices, the test *separation distance* is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied ;if the distance of the distance of the antenna to the user is<5mm,5mm is used to determine SAR exclusion Threshold
4. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

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

□□f(GHz) is the RF channel transmit frequency in GHz

□□Power and distance are rounded to the nearest mW and mm before calculation

□□The result is rounded to one decimal place for comparison

5. Per KDB 447498 D01v06, For 100 MHz to 6 GHz and *test separation distances* > 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following

1) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

2) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance – 50 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz

## 14. Results and Test photos :

14.1 SAR result summary:

Body (0mm between DUT and Flat Phantom)

| Test Case of Body | | | Meas. Power (dBm) | Target Power (dBm) | Factor | Duty Cycle Factor | Meas. SAR (W/kg) 1g Avg. | Scale SAR (W/kg) | Power Drift <±0.2 dB | Plot |
|---|---|---|---|---|---|---|---|---|---|---|
| Band | Test Position | CH | | | | | | | | |
| WLAN 2.4G | Front | Ch1 | 18.17 | 19.00 | 1.211 | 1 | 0.019 | 0.023 | 0.01 | |
| | Rear | Ch1 | 18.17 | 19.00 | 1.211 | 1 | **0.033** | 0.040 | -0.09 | **#1** |
| | Edge 2 | Ch1 | 18.17 | 19.00 | 1.211 | 1 | 0.004 | 0.005 | -0.12 | |
| | Rear | Ch6 | 17.24 | 19.00 | 1.500 | 1 | 0.031 | 0.046 | 0.09 | |
| | Rear | Ch11 | 17.73 | 19.00 | 1.340 | 1 | 0.028 | 0.044 | 0.09 | |

Note: Referring to KDB 248227 D01 802.11 Wi-Fi SAR v02r02 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, so SAR is not required for the 2.4GHz OFDM.

14.3 DUT photos:

Front

Rear

## 15. Simultaneous TX SAR Considerations:

For the EUT,the WLAN antenna and Bluetooth antenna not support Simultaneous transmission.

## 16. Equipment List:

| NO. | Instrument | Manufacturer | Model | S/N | Cal. Date | Cal. Due Date |
|---|---|---|---|---|---|---|
| 1 | E-field Probe | Speag | EX3DV4 | 3836 | Jul 7th 2016 | Jul 6th 2017 |
| 2 | Dielectric Probe Kit | Speag | DAK | 1038 | N/A | N/A |
| 3 | DAE | Speag | DAE4 | 760 | Jun 24th 2016 | Jun 23th 2017 |
| 4 | Robot | Stabuli | TX60L | N/A | N/A | N/A |
| 5 | Device Holder | Speag | SD000H01HA | N/A | N/A | N/A |
| 6 | Vector Network | Agilent | E5071C | MY46107615 | Jul 7th 2016 | Jul 6th 2017 |
| 7 | Signal Generator | Agilent | E4438C | MY49072279 | Jul 7th 2016 | Jul 6th 2017 |
| 8 | Amplifier | Mini-circult | ZHL-42W | QA098002 | N/A | N/A |
| 9 | Power Meter | Agilent | N1419A | MY50001563 | Jul 8th 2016 | Jul 7th 2017 |
| 10 | Power Meter | Agilent | E4416A | MY45100830 | July 7th 2016 | July 6th 2017 |
| 11 | Power Sensor | Agilent | N8481H | MY51020010 | Jul 8th 2016 | Jul 7th 2017 |
| 12 | Power Sensor | Agilent | E9323A | US40410134 | July 7th 2016 | July 6th 2017 |
| 13 | Directional Coupler | Agilent | 772D | MY46151275 | Jul 7th 2016 | Jul 6th 2017 |
| 14 | Directional Coupler | Agilent | 778D | MY48220607 | Jul 7th 2016 | Jul 6th 2017 |
| 15 | Dipole 2450MHz | Speag | D2450V2 | 955 | Jan 8th 2015 | Jan 7th 2018 |

**Appendix A. System validation plots:**

Date: 5/9/2017

Test Laboratory: SUNWAY COMMUNICATION CO.,LTD.

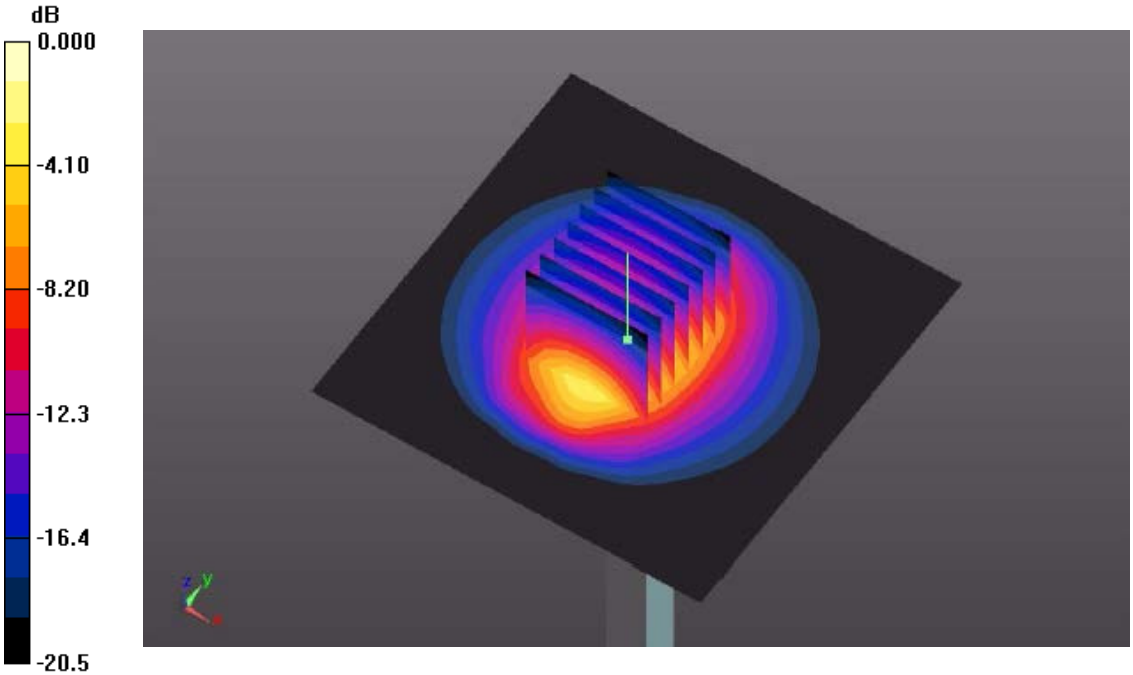
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 955**
**Program Name: System Performance Check at 2450 MHz Body**

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.902 mho/m; $\varepsilon_r$ = 50.7; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section

DASY5 Configuration:
- Probe: EX3DV4 - SN3836; ConvF(7.20, 7.20, 7.20); Calibrated: 7/7/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 6/24/2016
- Phantom: ELI4; Type: ELI4 Serial: TP-1360
- Measurement SW: DASY52 52.8.8(1222)SW: SEMCAD X 14.6.10(7331)

**d=10mm, Pin=250mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.2 mW/g

**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.6 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 27.1 W/kg
**SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.32mW/g**
Maximum value of SAR (measured) = 15.3mW/g




0 dB = 15.3mW/g

**Appendix B. SAR Test plots:**

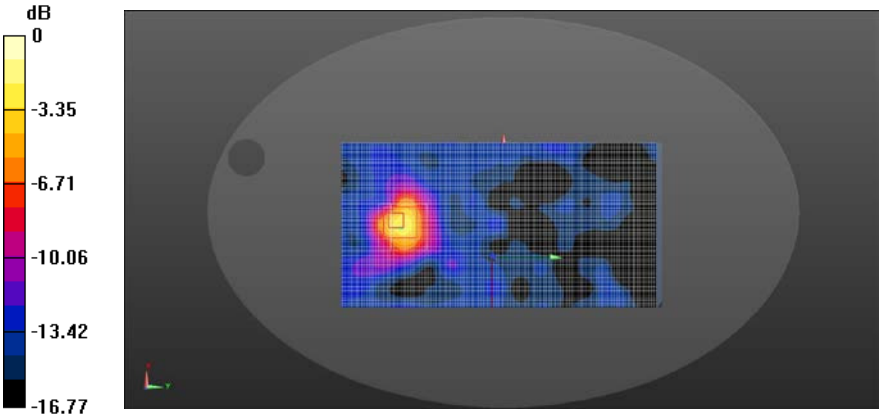
**#1**

Date: 5/9/2017
Test Laboratory: SUNWAY COMMUNICATION CO.,LTD.
**WLAN2.4G_802.11b_Rear_0mm_Ch1**
**DUT: GTS; Type: Not Specified; Serial: Not Specified**
Communication System: 802.11; Frequency: 2412 MHz
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.968 S/m; $\varepsilon_r$ = 50.861; ρ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:

- Probe: EX3DV4 - SN3836; ConvF(7.2, 7.2, 7.2); Calibrated: 7/7/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 6/24/2016
- Phantom: ELI4; Type: ELI4 Serial: TP-1360
- Measurement SW: DASY52 52.8.8(1222)SW: SEMCAD X 14.6.10(7331)

**Rear/Area Scan (81x141x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.0370 W/kg

**Rear/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.398 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.111 W/kg
**SAR(1 g) = 0.033 W/kg; SAR(10 g) = 0.014 W/kg**
Maximum value of SAR (measured) = 0.0665 W/kg




0 dB = 0.0665 W/kg = -11.77 dBW/kg

## Appendix C. Probe Calibration Data:

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CNAS L0570

Client Sunway Certificate No: Z16-97101

### CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3836 |
| Calibration Procedure(s) | FD-Z11-2-004-01<br>Calibration Procedures for Dosimetric E-field Probes |
| Calibration date: | July 07, 2016 |

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 |
| Reference10dBAttenuator | 18N50W-10dB | 13-Mar-16(CTTL,No.J16X01547) | Mar-18 |
| Reference20dBAttenuator | 18N50W-20dB | 13-Mar-16(CTTL, No.J16X01548) | Mar-18 |
| Reference Probe EX3DV4 | SN 3617 | 26-Aug-15(SPEAG,No.EX3-3617_Aug15) | Aug-16 |
| DAE4 | SN 1331 | 21-Jan-16(SPEAG, No.DAE4-1331_Jan16) | Jan -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: July 08, 2016

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

Certificate No: Z16-97101 Page 1 of 11

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**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A,B,C,D | modulation dependent linearization parameters |
| Polarization Φ | Φ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i θ=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:**

a) 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

b) 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

c) 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

d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Methods Applied and Interpretation of Parameters:**

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z* 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.
- *DCPx,y,z:* 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.
- *Ax,y,z; Bx,y,z; Cx,y,z;VRx,y,z:*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≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. 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 NORMx,y,z* 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±50MHz to±100MHz.
- *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 *NORMx* (no uncertainty required).

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# Probe EX3DV4

## SN: 3836

Calibrated: July 07, 2016

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm(μV/(V/m)$^2$)[A] | 0.40 | 0.46 | 0.43 | ±10.8% |
| DCP(mV)[B] | 93.2 | 100.2 | 98.0 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 167.8 | ±2.0% |
| | | Y | 0.0 | 0.0 | 1.0 | | 182.5 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 176.7 | |

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%.

[A] The uncertainties of Norm X, Y, Z do not affect the $E^2$-field uncertainty inside TSL (see Page 5 and Page 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly 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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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

## Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 9.43 | 9.43 | 9.43 | 0.30 | 0.80 | ±12% |
| 835 | 41.5 | 0.90 | 9.42 | 9.42 | 9.42 | 0.15 | 1.58 | ±12% |
| 900 | 41.5 | 0.97 | 9.03 | 9.03 | 9.03 | 0.15 | 1.46 | ±12% |
| 1750 | 40.1 | 1.37 | 8.04 | 8.04 | 8.04 | 0.14 | 1.63 | ±12% |
| 1900 | 40.0 | 1.40 | 7.60 | 7.60 | 7.60 | 0.16 | 1.59 | ±12% |
| 2300 | 39.5 | 1.67 | 7.45 | 7.45 | 7.45 | 0.53 | 0.68 | ±12% |
| 2450 | 39.2 | 1.80 | 7.07 | 7.07 | 7.07 | 0.54 | 0.71 | ±12% |
| 2600 | 39.0 | 1.96 | 6.96 | 6.96 | 6.96 | 0.61 | 0.66 | ±12% |
| 5200 | 36.0 | 4.66 | 5.32 | 5.32 | 5.32 | 0.40 | 1.42 | ±13% |
| 5300 | 35.9 | 4.76 | 5.13 | 5.13 | 5.13 | 0.40 | 1.40 | ±13% |
| 5500 | 35.6 | 4.96 | 4.85 | 4.85 | 4.85 | 0.40 | 1.35 | ±13% |
| 5600 | 35.5 | 5.07 | 4.59 | 4.59 | 4.59 | 0.40 | 1.45 | ±13% |
| 5800 | 35.3 | 5.27 | 4.71 | 4.71 | 4.71 | 0.40 | 1.45 | ±13% |

[C] 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.

[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] 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: 3836

## Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 9.38 | 9.38 | 9.38 | 0.30 | 0.85 | ±12% |
| 835 | 55.2 | 0.97 | 9.25 | 9.25 | 9.25 | 0.17 | 1.44 | ±12% |
| 900 | 55.0 | 1.05 | 8.95 | 8.95 | 8.95 | 0.14 | 1.60 | ±12% |
| 1750 | 53.4 | 1.49 | 7.64 | 7.64 | 7.64 | 0.17 | 1.71 | ±12% |
| 1900 | 53.3 | 1.52 | 7.33 | 7.33 | 7.33 | 0.18 | 1.80 | ±12% |
| 2300 | 52.9 | 1.81 | 7.45 | 7.45 | 7.45 | 0.51 | 0.80 | ±12% |
| 2450 | 52.7 | 1.95 | 7.20 | 7.20 | 7.20 | 0.62 | 0.70 | ±12% |
| 2600 | 52.5 | 2.16 | 6.99 | 6.99 | 6.99 | 0.52 | 0.79 | ±12% |
| 5200 | 49.0 | 5.30 | 4.83 | 4.83 | 4.83 | 0.50 | 1.25 | ±13% |
| 5300 | 48.9 | 5.42 | 4.60 | 4.60 | 4.60 | 0.50 | 1.35 | ±13% |
| 5500 | 48.6 | 5.65 | 4.32 | 4.32 | 4.32 | 0.50 | 1.35 | ±13% |
| 5600 | 48.5 | 5.77 | 4.20 | 4.20 | 4.20 | 0.50 | 1.40 | ±13% |
| 5800 | 48.2 | 6.00 | 4.30 | 4.30 | 4.30 | 0.50 | 1.30 | ±13% |

[C] 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.

[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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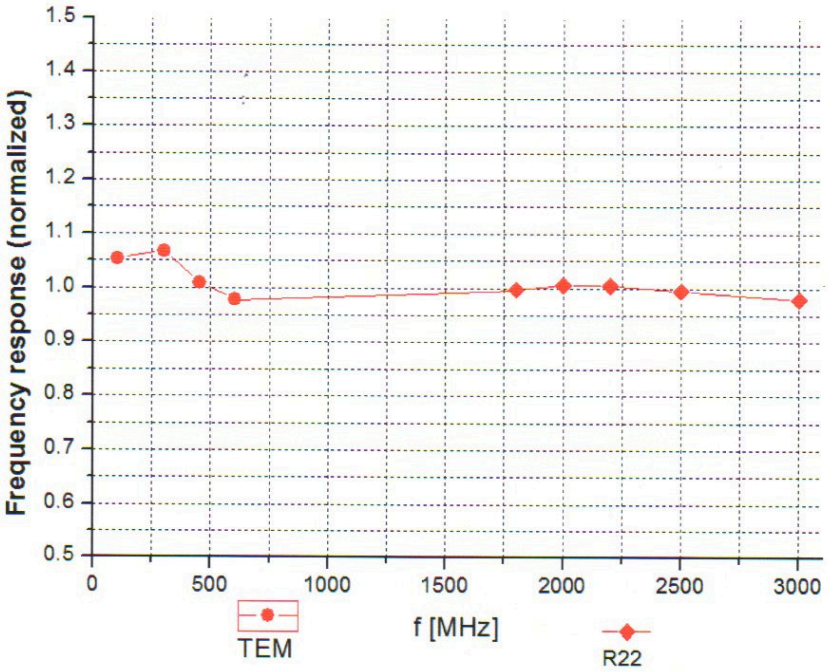
## Frequency Response of E-Field
### (TEM-Cell: ifi110 EXX, Waveguide: R22)




**Uncertainty of Frequency Response of E-field: ±7.5% (k=2)**

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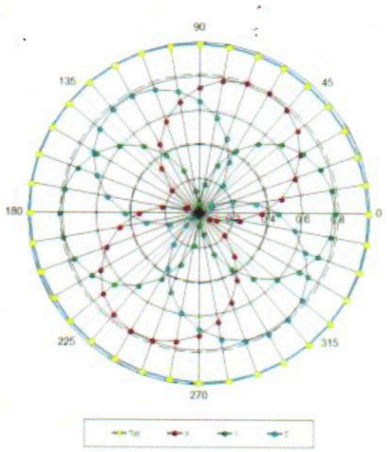
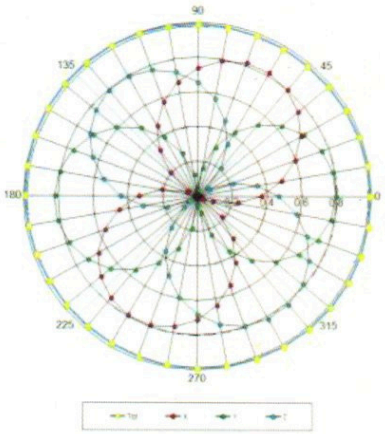
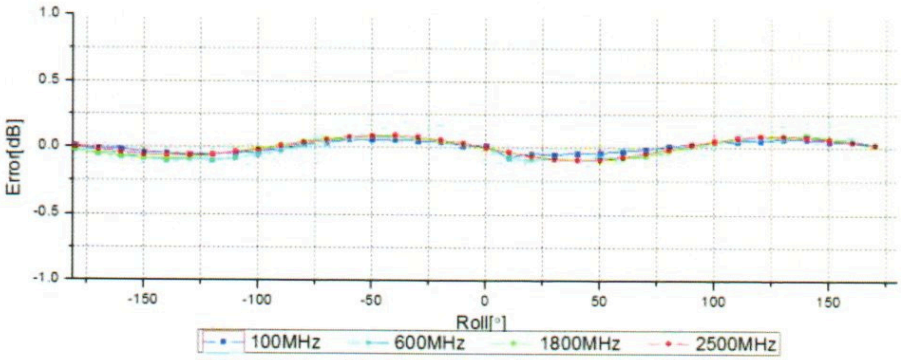
## Receiving Pattern (Φ), θ=0°

**f=600 MHz, TEM**




**f=1800 MHz, R22**




**Uncertainty of Axial Isotropy Assessment: ±0.9% (k=2)**

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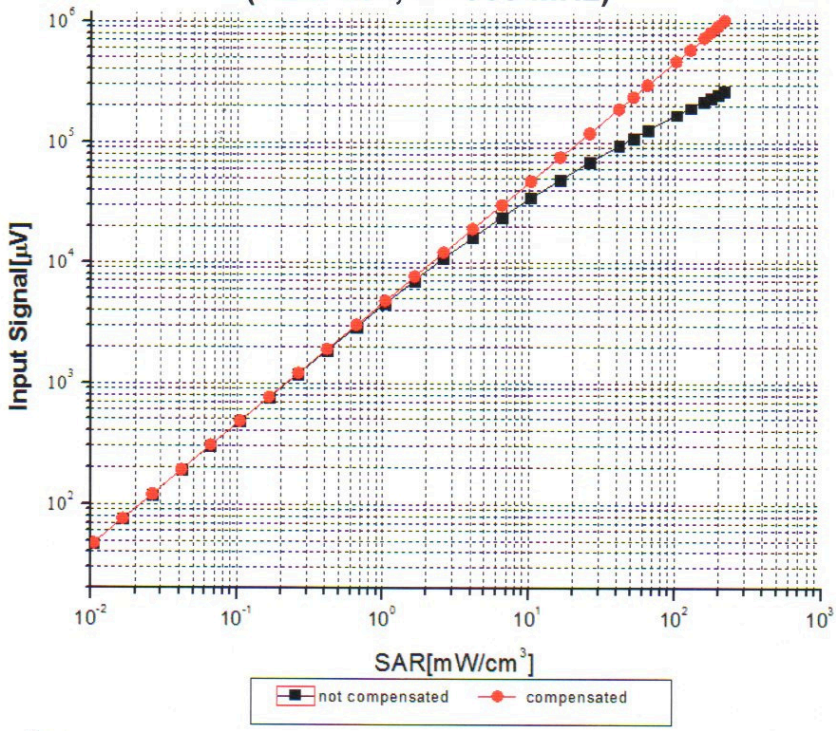
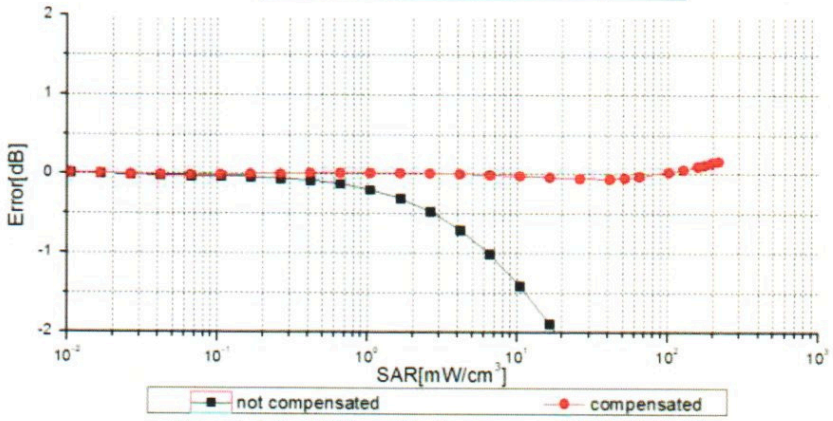
## Dynamic Range f(SAR$_{head}$)
## (TEM cell, f = 900 MHz)




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

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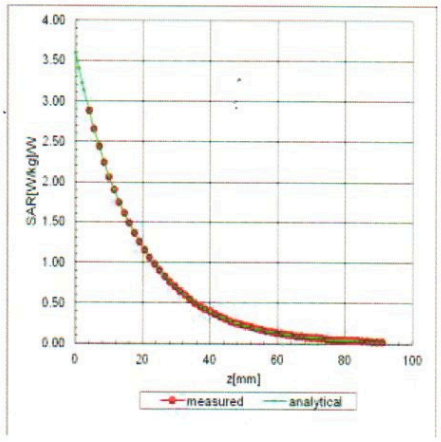
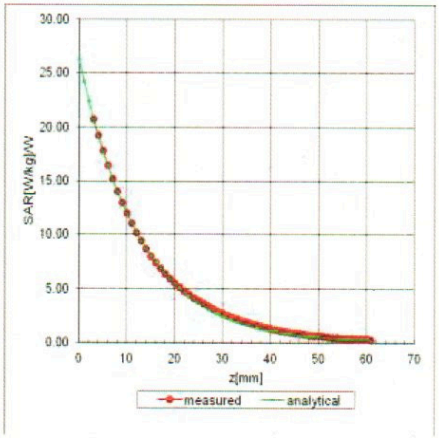
E-mail: cttl@chinattl.com Http://www.chinattl.cn

## Conversion Factor Assessment

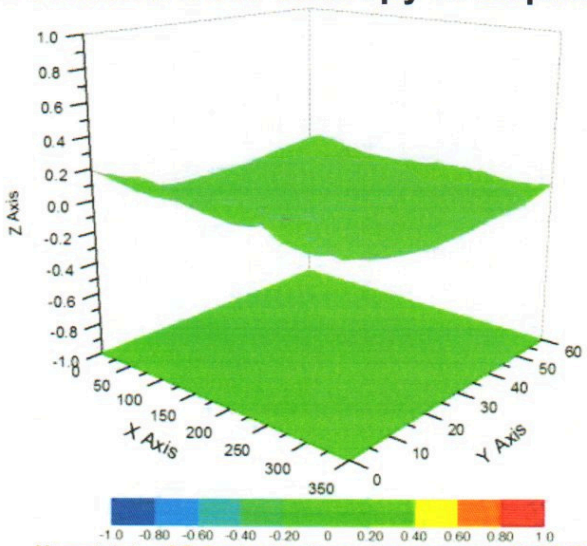
**f=900 MHz, WGLS R9(H_convF)**




**f=1900 MHz, WGLS R22(H_convF)**




## Deviation from Isotropy in Liquid




**Uncertainty of Spherical Isotropy Assessment: ±2.8% (K=2)**

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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

### Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 47.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disable |
| Probe Overall Length | 337mm |
| Probe Body Diameter | 10mm |
| Tip Length | 9mm |
| Tip Diameter | 2.5mm |
| Probe Tip to Sensor X Calibration Point | 1mm |
| Probe Tip to Sensor Y Calibration Point | 1mm |
| Probe Tip to Sensor Z Calibration Point | 1mm |
| Recommended Measurement Distance from Surface | 1.4mm |

## Appendix D. DAE Calibration Data:

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
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校准
CALIBRATION
CNAS L0570

Client : **Sunway** **Certificate No: Z16-97100**

### CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 760 |
| Calibration Procedure(s) | FD-Z11-2-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | June 24, 2016 |

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 |
|---|---|---|---|
| Process Calibrator 753 | 1971018 | 06-July-15 (CTTL, No:J15X04257) | July-16 |

| | 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: June 25, 2016

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

In Collaboration with
CTTL speag CALIBRATION LABORATORY
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E-mail: cttl@chinattl.com Http://www.chinattl.cn

**Glossary:**

| | |
|---|---|
| DAE | data acquisition electronics |
| Connector angle | information used in DASY system to align probe sensor X to the robot coordinate system. |

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.

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## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV
Low Range: 1LSB = 61nV , full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 403.785 ± 0.15% (k=2) | 405.082 ± 0.15% (k=2) | 405.373 ± 0.15% (k=2) |
| Low Range | 3.97148 ± 0.7% (k=2) | 3.98467 ± 0.7% (k=2) | 3.96141 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 248.5° ± 1 ° |

## Appendix E. Dipole Calibration Data:

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

Client **SMQ (Auden)**

Certificate No: **D2450V2-955_Jan15/2**

# CALIBRATION CERTIFICATE (Replacement of No: D2450V2-955_Jan15)

| | |
|---|---|
| Object | D2450V2 - SN: 955 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | January 08, 2015 |

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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 07-Oct-14 (No. 217-02020) | Oct-15 |
| Power sensor HP 8481A | US37292783 | 07-Oct-14 (No. 217-02020) | Oct-15 |
| Power sensor HP 8481A | MY41092317 | 07-Oct-14 (No. 217-02021) | Oct-15 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 03-Apr-14 (No. 217-01918) | Apr-15 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921) | Apr-15 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Dec-14 (No. ES3-3205_Dec14) | Dec-15 |
| DAE4 | SN: 601 | 18-Aug-14 (No. DAE4-601_Aug14) | Aug-15 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: February 10, 2015

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

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A | not applicable or not measured |

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

a) 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
b) 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 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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%.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.7 ± 6 % | 1.84 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.2 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.4 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.12 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.4 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 51.0 ± 6 % | 2.03 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.8 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **53.7 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.36 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **25.0 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS108)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 54.8 Ω + 3.5 jΩ |
| Return Loss | - 24.9 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.2 Ω + 4.9 jΩ |
| Return Loss | - 26.0 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.165 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | August 05, 2014 |

**DASY5 Validation Report for Head TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

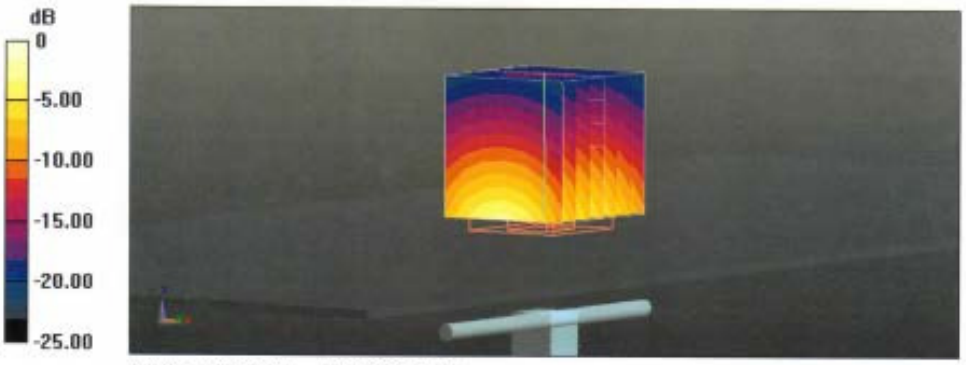
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.84 S/m; $\varepsilon_r$ = 39.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

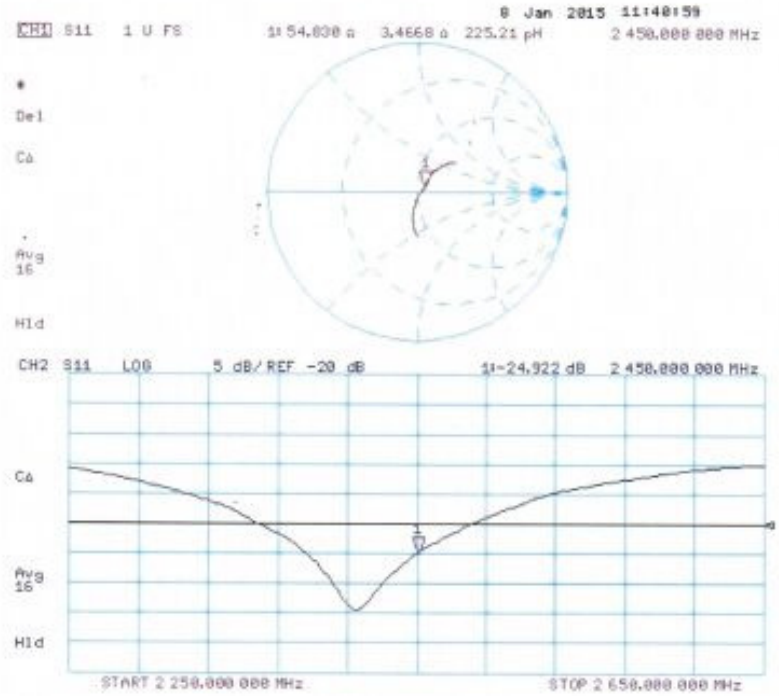
- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.2 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 27.5 W/kg
**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg**
Maximum value of SAR (measured) = 17.5 W/kg




0 dB = 17.5 W/kg = 12.43 dBW/kg

**Impedance Measurement Plot for Head TSL**



**DASY5 Validation Report for Body TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

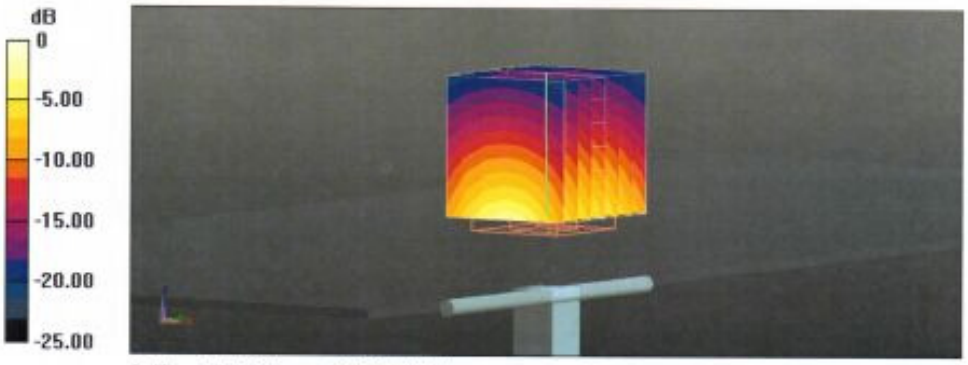
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 51; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

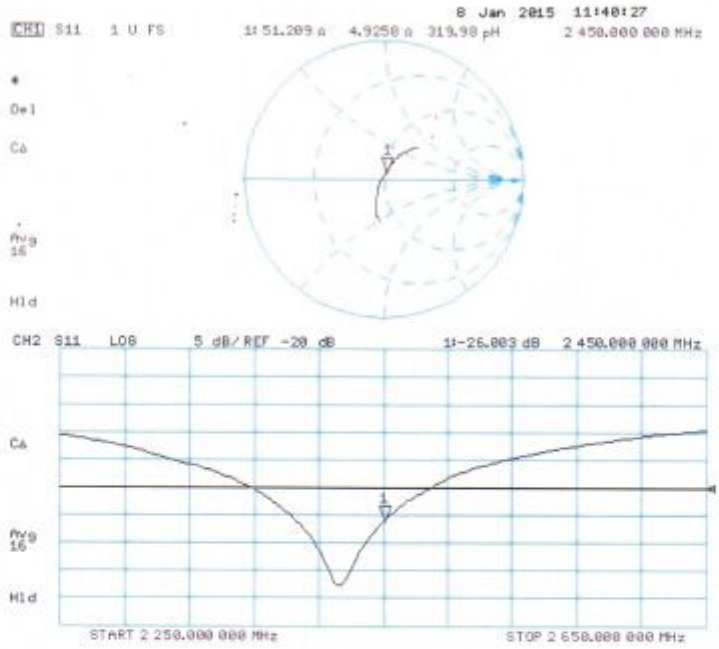
- Probe: ES3DV3 - SN3205; ConvF(4.17, 4.17, 4.17); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 97.96 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 28.8 W/kg
**SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.36 W/kg**
Maximum value of SAR (measured) = 18.3 W/kg




0 dB = 18.3 W/kg = 12.62 dBW/kg

**Impedance Measurement Plot for Body TSL**



**D2450V2, serial no. 955 Extended Dipole Calibrations**

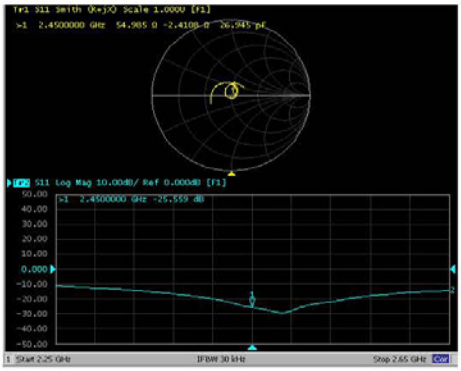
Referring to KDB 865664D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| D2450V2, serial no. 955 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2450 Head | | | | 2450 Body | | | |
| Date of Measurement | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) |
| 2015-1-8 | -24.9 | | 54.8 | | -26.0 | | 51.2 | |
| 2016-1-2 | -26.1 | -4.8 | 55.6 | 0.8 | -27.1 | -4.2 | 52.1 | 0.9 |
| 2016-12-20 | -25.6 | -2.8 | 55.0 | 0.2 | -27.8 | -6.9 | 52.6 | 1.4 |

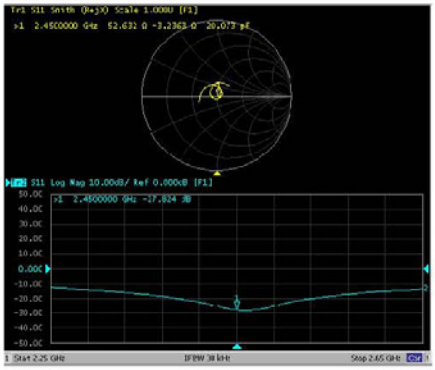
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Dipole Verification Data>- D2450V2, serial no. 955

2450MHz Head



2450MHz Body



OET

June 26, 2013

**Acceptable Conditions for SAR Measurements Using Probes and Dipoles Calibrated under the SPEAG-TMC Dual-Logo Calibration Program to Support FCC Equipment Certification**

The acceptable conditions for SAR measurements using probes, dipoles and DAEs calibrated by TMC (*Telecommunication Metrology Center of MITT in Beijing, China*), under the Dual-Logo Calibration Certificate program and quality assurance (QA) protocols established between SPEAG (*Schmid & Partner Engineering AG, Switzerland*) and TMC, to support FCC (*U.S. Federal Communications Commission*) equipment certification are defined and described in the following.

1) The agreement established between SPEAG and TMC is only applicable to calibration services performed by TMC where its clients (companies and divisions of such companies) are headquartered in the Greater China Region, including Taiwan and Hong Kong. This agreement is subject to renewal at the end of each calendar year between SPEAG and TMC. TMC shall inform the FCC of any changes or early termination to the agreement.
2) Only a subset of the calibration services specified in the SPEAG-TMC agreement, while it remains valid, are applicable to SAR measurements performed using such equipment for supporting FCC equipment certification. These are identified in the following.
   a) Calibration of dosimetric (SAR) probes EX3DVx, ET3DVx and ES3DVx.
      i) Free-space E-field and H-field probes, including those used for HAC (hearing aid compatibility) evaluation, temperature probes, other probes or equipment not identified in this document, when calibrated by TMC, are excluded and cannot be used for measurements to support FCC equipment certification.
      ii) Signal specific and bundled probe calibrations based on PMR (probe modulation response) characteristics are handled according to the requirements of KDB 865664; that is, "Until standardized procedures are available to make such determination, the applicability of a signal specific probe calibration for testing specific wireless modes and technologies is determined on a case-by-case basis through KDB inquiries, including SAR system verification requirements."
   b) Calibration of SAR system validation dipoles, excluding HAC dipoles.
   c) Calibration of data acquisition electronics DAE3Vx, DAE4Vx and DAEasyVx.
   d) For FCC equipment certification purposes, the frequency range of SAR probe and dipole calibrations is limited to 700 MHz - 6 GHz and provided it is supported by the equipment identified in the TMC QA protocol (a separate attachment to this document).
   e) The identical system and equipment setup, measurement configurations, hardware, evaluation algorithms, calibration and QA protocols, including the format of calibration certificates and reports used by SPEAG shall be applied by TMC.
   f) The calibrated items are only applicable to SPEAG DASY 4 and DASY 5 or higher version systems.

OET

June 26, 2013

3) The SPEAG-TMC agreement includes specific protocols identified in the following to ensure the quality of calibration services provided by TMC under this SPEAG-TMC Dual-Logo calibration agreement are equivalent to the calibration services provided by SPEAG. TMC shall, upon request, provide copies of documentation to the FCC to substantiate program implementation.
   a) The Inter-laboratory Calibration Evaluation (ILCE) stated in the TMC QA protocol shall be performed between SPEAG and TMC at least once every 12 months. The ILCE acceptance criteria defined in the TMC QA protocol shall be satisfied for the TMC, SPEAG and FCC agreements to remain valid.
   b) Check of Calibration Certificate (CCC) shall be performed by SPEAG for all calibrations performed by TMC. Written confirmation from SPEAG is required for TMC to issue calibration certificates under the SPEAG-TMC Dual-Logo calibration program. Quarterly reports for all calibrations performed by TMC under the program are also issued by SPEAG.
   c) The calibration equipment and measurement system used by TMC shall be verified before each calibration service according to the specific reference SAR probes, dipoles, and DAE calibrated by SPEAG. The results shall be reproducible and within the defined acceptance criteria specified in the TMC QA protocol before each actual calibration can commence. TMC shall maintain records of the measurement and calibration system verification results for all calibrations.
   d) Quality Check of Calibration (QCC) certificates shall be performed by SPEAG at least once every 12 months. SPEAG shall visit TMC facilities to verify the laboratory, equipment, applied procedures and plausibility of randomly selected certificates.
4) A copy of this document, to be updated annually, shall be provided to TMC clients that accept calibration services according to the SPEAG-TMC Dual-Logo calibration program, which should be presented to a TCB (*Telecommunication Certification Body*), to facilitate FCC equipment approval.
5) TMC shall address any questions raised by its clients or TCBs relating to the SPEAG-TMC Dual-Logo calibration program and inform the FCC and SPEAG of any critical issues.

Change Note: Revised on June 26 to clarify the applicability of PMR and Bundled probe calibrations according to the requirements of KDB 865664.

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*****END OF REPORT*****