# FCC SAR TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

## VR GOGGLES

ISSUED TO
Guangzhou EHang Intelligent Technology Co., Ltd.

Room 402, 4th Floor, 11 Aoti Road, Tianhe District, Guangzhou, China

| | |
|---|---|
| Report No.: | BL-SZ15C0314-701 |
| EUT Type: | VR GOGGLES |
| Model Name: | GVR-200W |
| Brand Name: | EHANG |
| FCC ID: | 2ADPF-GVR-200W |
| Test Standard: | FCC 47 CFR Part 2.1093 |
| | ANSI C95.1: 2005 |
| | IEEE 1528: 2013 |
| Maximum SAR: | Head (1 g): 0.052 W/kg |
| Test Conclusion: | Pass |
| Test Date: | Feb. 26, 2016 |
| Date of Issue: | Jun. 8, 2016 |

Tested by: Tu Lang
Tu Lang
(Engineer)
Date: Jun. 8, 2016

Approved by: Wei Yanquan
Wei Yanquan
(Chief Engineer)
Date: Jun. 8, 2016

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**Revision History**

| Version | Issue Date | Revisions Content |
|---|---|---|
| Rev. 01 | Jun. 3, 2016 | Initial Issue |
| Rev. 02 | Jun. 8, 2016 | The section 6, test position configurations, was amended<br>The section 7.3, test position configurations, was amended.<br>Added the description about 5.8 GHz for SAR test exclusion in section 4.2.<br>Added the required distances in the section 9.1<br>Added the exclusion distance table based on the maximum output power in section 9.2. |

## TABLE OF CONTENTS


1 GENERAL INFORMATION ..... 5

1.1 Identification of the Testing Laboratory ..... 5

1.2 Identification of the Responsible Testing Location ..... 5

1.3 Test Environment Condition ..... 5

1.4 Announce ..... 6

2 PRODUCT INFORMATION ..... 7

2.1 Applicant ..... 7

2.2 Manufacturer ..... 7

2.3 Factory Information ..... 7

2.4 General Description for Equipment under Test (EUT) ..... 7

2.5 Ancillary Equipment ..... 8

2.6 Technical Information ..... 8

3 SUMMARY OF TEST RESULT ..... 9

3.1 Test Standards ..... 9

3.2 Device Category and SAR Limit ..... 10

3.3 Test Result Summary ..... 11

3.4 Test Uncertainty ..... 12

4 MEASUREMENT SYSTEM ..... 13

4.1 Specific Absorption Rate (SAR) Definition ..... 13

4.2 DASY SAR System ..... 14

5 SYSTEM VERIFICATION ..... 22
5.1 Purpose of System Check ..... 22
5.2 System Check Setup ..... 22
6 TEST POSITION CONFIGURATIONS ..... 23
6.1 Head Exposure Conditions ..... 23
7 MEASUREMENT PROCEDURE ..... 24
7.1 Measurement Process Diagram ..... 24
7.2 SAR Scan General Requirement ..... 25
7.3 Measurement Procedure ..... 26
7.4 Area & Zoom Scan Procedure ..... 26
8 CONDUCTED RF OUPUT POWER ..... 27
8.1 2.4GHz FHSS ..... 27
8.2 WLAN ..... 27
9 TEST EXCLUSION CONSIDERATION ..... 28
9.1 Antenna Pattern ..... 28
9.2 SAR Test Exclusion Consideration Table ..... 30
10 TEST RESULT ..... 31
10.1 2.4GHz FHSS ..... 31
11 SAR Measurement Variability ..... 32
12 SIMULTANEOUS TRANSMISSION ..... 33
12.1 Simultaneous Transmission Mode Consider ..... 33
12.2 Estimated SAR Calculation ..... 34
12.3 Sum SAR of Simultaneous Transmission ..... 35
13 TEST EQUIPMENTS LIST ..... 36
ANNEX A SIMULATING LIQUID VERIFICATION RESULT ..... 37
ANNEX B SYSTEM CHECK RESULT ..... 38
ANNEX C TEST DATA ..... 40
ANNEX D EUT EXTERNAL PHOTOS ..... 41
ANNEX E SAR TEST SETUP PHOTOS ..... 41
ANNEX F CALIBRATION REPORT ..... 42
F.1 E-Field Probe ..... 42
F.2 Data Acquisition Electronics ..... 53

F.3 Dual Logo-CTTL-SPEAG Certificates ..... 56

F.4 2450MHz Dipole ..... 57

F.5 Dipole Performance Measurement Report ..... 65

# 1 GENERAL INFORMATION

## 1.1 Identification of the Testing Laboratory

| | |
|---|---|
| Company Name | Shenzhen BALUN Technology Co.,Ltd. |
| Address | Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province,P. R. China |
| Phone Number | +86 755 6685 0100 |
| Fax Number | +86 755 6182 4271 |

## 1.2 Identification of the Responsible Testing Location

| | |
|---|---|
| Test Location | Shenzhen BALUN Technology Co., Ltd. |
| Address | Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China |
| Accreditation Certificate | The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1.<br>The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625.<br>The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791. |
| Description | All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055 |

## 1.3 Test Environment Condition

| | |
|---|---|
| Ambient Temperature | 20 to 22℃ |
| Ambient Relative Humidity | 38 to 52% |
| Ambient Pressure | 100 to 102KPa |

## 1.4 Announce

(1) The test report reference to the report template version v2.1.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

# 2 PRODUCT INFORMATION

## 2.1 Applicant

| | |
|---|---|
| Applicant | Guangzhou EHang Intelligent Technology Co., Ltd. |
| Address | Room 402, 4th Floor, 11 Aoti Road, Tianhe District, Guangzhou, China |

## 2.2 Manufacturer

| | |
|---|---|
| Manufacturer | Guangzhou EHang Intelligent Technology Co., Ltd. |
| Address | Room 402, 4th Floor, 11 Aoti Road, Tianhe District, Guangzhou, China |

## 2.3 Factory Information

| | |
|---|---|
| Factory | Guangzhou EHang Intelligent Technology Co., Ltd. |
| Address | Buliding #3, No.72, 2nd Nanxiang Road, Science City, Huangpu Development Zone, Guangzhou, China |

## 2.4 General Description for Equipment under Test (EUT)

| | |
|---|---|
| EUT Type | VR GOGGLES |
| Model Name Under Test | GVR-200W |
| Series Model Name | N/A |
| Description of Model Name Differentiation | N/A |
| Hardware Version | V1.0 |
| Software Version | V1.0 |
| Dimensions (Approx.) | 162 × 40 × 31 mm |
| Weight (Approx.) | 255 g |
| Network and Wireless connectivity | WLAN; 2.4 GHz FHSS, 5.8 G |

Note:

1. The wireless capability for the EUT contains 2.4G WLAN, 2.4G FHSS and 5.8G video transmission. The antenna type for WLAN is PCB inside. There are two antennas for 2.4G FHSS: internal antenna (PIFA) and external antenna (dipole), and these two 2.4G FHSS antennas cannot transmit simultaneously.
2. The antenna for 5.8 GHz is external antenna (dipole) and only can work as a receiver, it was accepted in the FCC KDB guidance. so it wasn't considered for RF Exposure.
3. Please refer to user guide for more info.

## 2.5 Ancillary Equipment

| | | |
|---|---|---|
| Ancillary Equipment 1 | Battery | |
| | Brand Name | N/A |
| | Model No. | GEB 702382 |
| | Serial No. | N/A |
| | Capacitance | 1700 mAh |
| | Rated Voltage | 3.7 V |
| | Limit Charge Voltage | 4.25 V |
| Ancillary Equipment 2 | Charger | |
| | Brand Name | N/A |
| | Model No. | GAT-200 |
| | Serial No. | N/A |
| | Rated Input | 100-240 V~, 2000mA, 50/60 Hz |
| | Rated Output Port 1 | 16.8 V⎓, 3500 mA |
| | Rated Output Port 2 | 5 V⎓, 2000 mA |

## 2.6 Technical Information

The requirement for the following technical information of the EUT was tested in this report:

| | | |
|---|---|---|
| Operating Mode | 2.4GHz FHSS; WLAN | |
| Frequency Range | 2.4GHz FHSS Antenna 1 (Internal antenna) | 2405.5 MHz ~ 2475 MHz |
| | 2.4GHz FHSS Antenna 2 (External antenna) | 2405.5 MHz ~ 2475 MHz |
| | WLAN | 2400 MHz~2483.5 MHz |
| Channels for 2.4GHz FHSS | Low(2405.5MHz)/ Middle(2440.0MHz)/ High(2475.0MHz) | |
| Channels for WLAN | 1 (2412MHz)/ 6 (2437MHz)/ 11 (2462MHz) | |
| Antenna Type | 2.4G FHSS Antenna 1: PIFA Antenna<br>2.4G FHSS Antenna 2: Dipole Antenna<br>WLAN: PCB Antenna | |
| Exposure Category | General Population/Uncontrolled exposure | |
| EUT Stage | Portable Device | |
| Product | Type | |
| | ☒ Production unit | ☐ Identical prototype |

# 3 SUMMARY OF TEST RESULT

## 3.1 Test Standards

| No. | Identity | Document Title |
|---|---|---|
| 1 | FCC 47 CFR Part 2.1093 | Frequency Allocations and Radio Treaty Matters; General Rules and Regulations |
| 2 | ANSI/IEEE Std. C95.1-2005 | IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz |
| 3 | IEEE Std. 1528-2013 | Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques |
| 4 | FCC KDB 447498 D01 v06 | Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies |
| 5 | FCC KDB 865664 D01 v01r04 | SAR Measurement 100 MHz to 6 GHz |
| 6 | FCC KDB 865664 D02 v01r02 | RF Exposure Reporting |

## 3.2 Device Category and SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user.

Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

Table of Exposure Limits:

| Body Position | SAR Value (W/Kg) | |
|---|---|---|
| | General Population/ Uncontrolled Exposure | Occupational/ Controlled Exposure |
| Whole-Body SAR (averaged over the entire body) | 0.08 | 0.4 |
| Partial-Body SAR (averaged over any 1 gram of tissue) | 1.60 | 8.0 |
| SAR for hands, wrists, feet and ankles (averaged over any 10 grams of tissue) | 4.0 | 20.0 |

NOTE:

**General Population/Uncontrolled Exposure:** Locations where there is the exposure of individuals who have no knowledge or control of their exposure. 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.

**Occupational/Controlled Exposure:** Locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, 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. This 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.

## 3.3 Test Result Summary

### 3.3.1 Highest SAR (1 g Value)

| Band | Antenna | Maximum Report SAR (W/kg) | Limit (W/kg) |
|---|---|---|---|
| | | Head | |
| 2.4G FHSS | 2 | 0.052 | 1.6 |
| Verdict | Pass | | |

### 3.3.2 Highest Simultaneous SAR

| Simultaneous Mode | Simultaneous Configuration | Simultaneous SAR (W/kg) | Limit (W/kg) | Verdict |
|---|---|---|---|---|
| Antenna 1 | 2.4GHz FHSS + WLAN | 0.187 | 1.6 | Pass |
| Antenna 2 | 2.4GHz FHSS + WLAN | 0.092 | 1.6 | Pass |

## 3.4 Test Uncertainty

According to KDB 865664 D01, When the highest measured 1 g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis is not required in SAR reports submitted for equipment approval.

The maximum 1 g SAR for the EUT in this report is 0.052 W/kg, which is lower than 1.5 W/kg, so the the extensive SAR measurement uncertainty analysis is not required in this report.

# 4 MEASUREMENT SYSTEM

## 4.1 Specific Absorption Rate (SAR) Definition

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathbf{SAR} = \frac{d}{\mathrm{dt}}\left(\frac{d\mathrm{W}}{\mathrm{dm}}\right) = \frac{d}{\mathrm{dt}}\left(\frac{d\mathrm{W}}{\rho \mathrm{dv}}\right)$$

SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

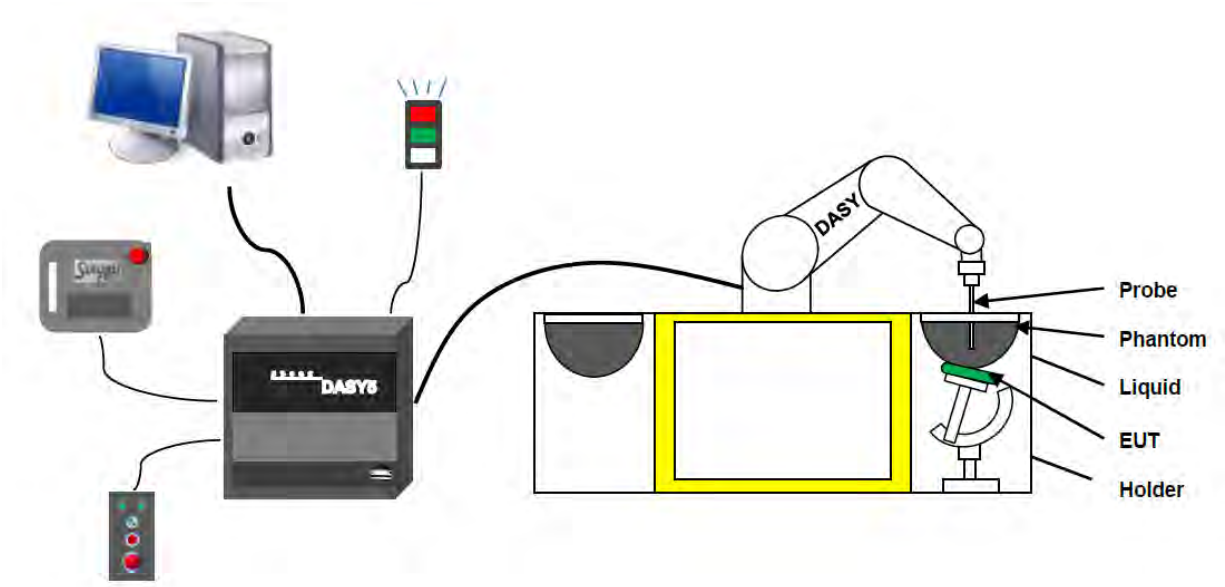
$$\mathbf{SAR} = \frac{\sigma \mathrm{E}^2}{\rho}$$

Where: σ is the conductivity of the tissue,

ρis the mass density of the tissue and E is the RMS electrical field strength.

## 4.2 DASY SAR System

### 4.2.1 DASY SAR System Diagram




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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. A unit to operate the optical surface detector which is connected the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from t to he optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

### 4.2.2 Robot

The Dasy SAR system uses the high precision robots. Symmetrical design with triangular core Built-in optical fiber for surface detection system For the 6-axis controller system, Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents). The robot series have many features that are important for our application:

- High precision
  (repeatability ±0.02 mm)
- High reliability
  (industrial design)
- Low maintenance costs
  (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements
  (brush less synchron motors; no stepper motors)
- Low ELF interference
  (motor control _elds shielded via the closed metallic construction shields)

### 4.2.3 E-Field Probe

The probe is specially designed and calibrated for use in liquids with high permittivities for the measurements the Specific Dosimetric E-Field Probe EX3DV4-SN:7340 with following specifications is used.

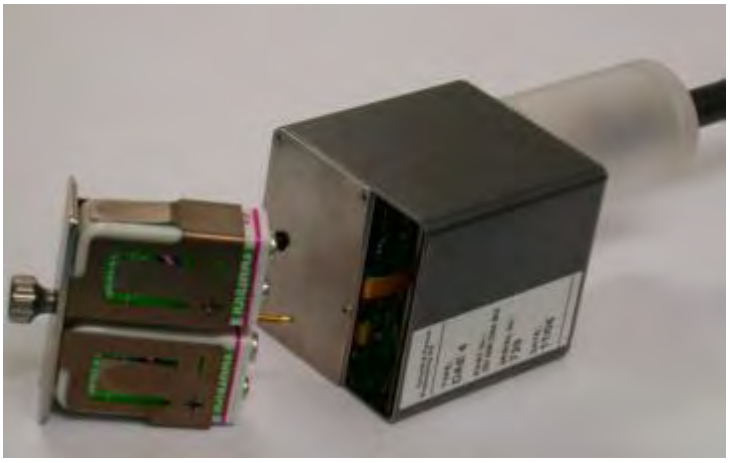
| | |
|---|---|
| Construction | Symmetrical design with triangular core Built-in optical fiber for surface detection systemBuilt-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether) |
| Calibration | ISO/IEC 17025 calibration service available |
| Frequency | 10 MHz to 6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| Directivity | ± 0.2 dB in HSL (rotation around probe axis) ; ± 0.4 dB in HSL (rotation normal to probe axis) |
| Dynamic range | 5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB |
| Dimensions | Overall length: 337 mm (Tip: 9 mm) Tip diameter: 2.5 mm (Body: 10 mm) Distance from probe tip to dipole centers: 1.0 mm |
| Application | General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (EX3DV4) |

**E-Field Probe Calibration Process**

Probe calibration is realized, in compliance with CENELEC EN 62209-1/-2 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 62209-1/2 annexe technique using reference guide at the five frequencies.

### 4.2.4 Data Acquisition Electronics

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



- Input Impedance: 200MOhm
- The Inputs: Symmetrical and Floating
- Commom Mode Rejection: Above 80dB

### 4.2.5 Phantoms

For the measurements the Specific Anthropomorphic Mannequin (SAM) defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. It enables the dosimetric evaluation of left and right phone usage and includes an additional flat phantom part for the simplified performance check. The phantom set-up includes a cover, which prevents the evaporation of the liquid.

- Left hand
- Right hand
- Flat phantom

**Photo of Phantom SN1857**

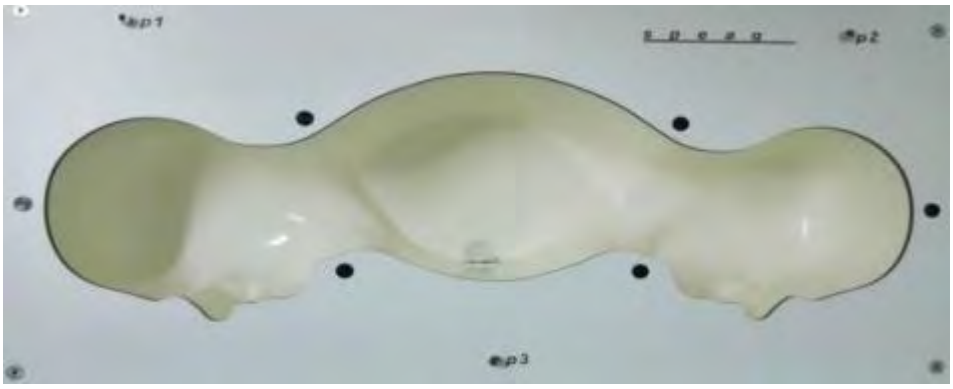
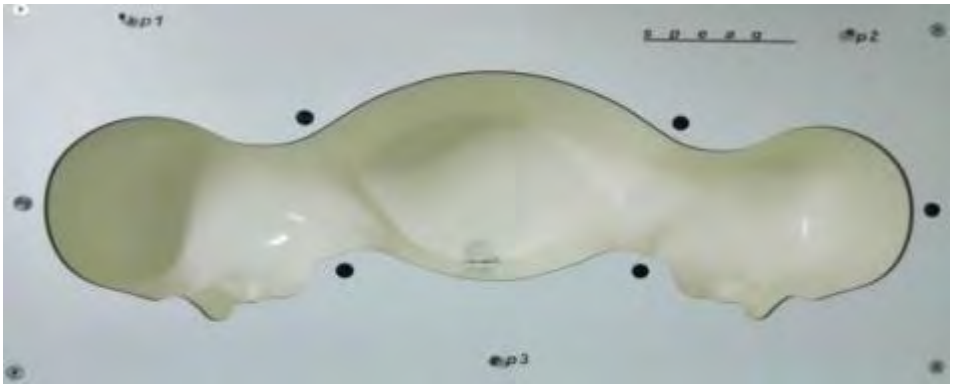


**Photo of Phantom SN1859**



| Serial Number | Material | Length | Height |
|---|---|---|---|
| SN 1857 SAM1 | Vinylester, glass fiber reinforced | 1000 | 500 |
| SN 1859 SAM2 | Vinylester, glass fiber reinforced | 1000 | 500 |

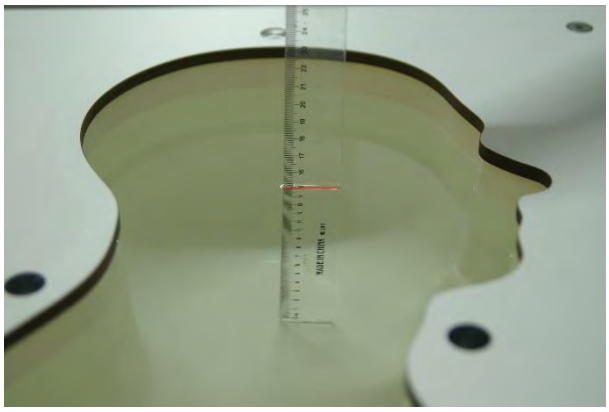
### 4.2.6 Device Holder

The DASY5 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA"s only. If necessary an additional support of polystyrene material is used. Larger DUT"s (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values. Therefore those devices are normally only tested at the flat part of the SAM.

The positioning system allows obtaining cheek and tilting position with a very good accuracy. Incompliance with CENELEC, the tilt angle uncertainty is lower than 1°.

### 4.2.7 Simulating Liquid

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5%.

| Head Liquid Depth | Body Liquid Depth |
|---|---|
|  | |

The following table gives the recipes for tissue simulating liquid and the theoretical Conductivity/Permittivity.

| Head (Reference IEEE1528) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity σ (S/m) | Permittivity ε |
| 750 | 41.1 | 57.0 | 0.2 | 1.4 | 0.2 | 0 | 0.89 | 41.9 |
| 835 | 40.3 | 57.9 | 0.2 | 1.4 | 0.2 | 0 | 0.90 | 41.5 |
| 900 | 40.3 | 57.9 | 0.2 | 1.4 | 0.2 | 0 | 0.97 | 41.5 |
| 1800, 1900, 2000 | 55.2 | 0 | 0 | 0.3 | 0 | 44.5 | 1.4 | 40.0 |
| 2450 | 55.0 | 0 | 0 | 0.1 | 0 | 44.9 | 1.80 | 39.2 |
| 2600 | 54.9 | 0 | 0 | 0.1 | 0 | 45.0 | 1.96 | 39.0 |
| Frequency (MHz) | Water (%) | Hexyl Carbitol (%) | | | Triton X-100 (%) | | Conductivity σ (S/m) | Permittivity ε |
| 5200 | 62.52 | 17.24 | | | 17.24 | | 4.66 | 36.0 |
| 5800 | 62.52 | 17.24 | | | 17.24 | | 5.27 | 35.3 |
| **Body (From instrument manufacturer)** | | | | | | | | |
| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity σ (S/m) | Permittivity ε |
| 750 | 51.7 | 47.2 | 0 | 0.9 | 0.1 | 0 | 0.96 | 55.5 |
| 835 | 50.8 | 48.2 | 0 | 0.9 | 0.1 | 0 | 0.97 | 55.2 |
| 900 | 50.8 | 48.2 | 0 | 0.9 | 0.1 | 0 | 1.05 | 55.0 |
| 1800, 1900, 2000 | 70.2 | 0 | 0 | 0.4 | 0 | 29.4 | 1.52 | 53.3 |
| 2450 | 68.6 | 0 | 0 | 0.1 | 0 | 31.3 | 1.95 | 52.7 |
| 2600 | 68.2 | 0 | 0 | 0.1 | 0 | 31.7 | 2.16 | 52.5 |

| Frequency(MHz) | Water | DGBE (%) | Salt (%) | Conductivity σ (S/m) | Permittivity ε |
|---|---|---|---|---|---|
| 5200 | 78.60 | 21.40 | / | 5.54 | 47.86 |
| 5800 | 78.50 | 21.40 | 0.1 | 6.0 | 48.20 |

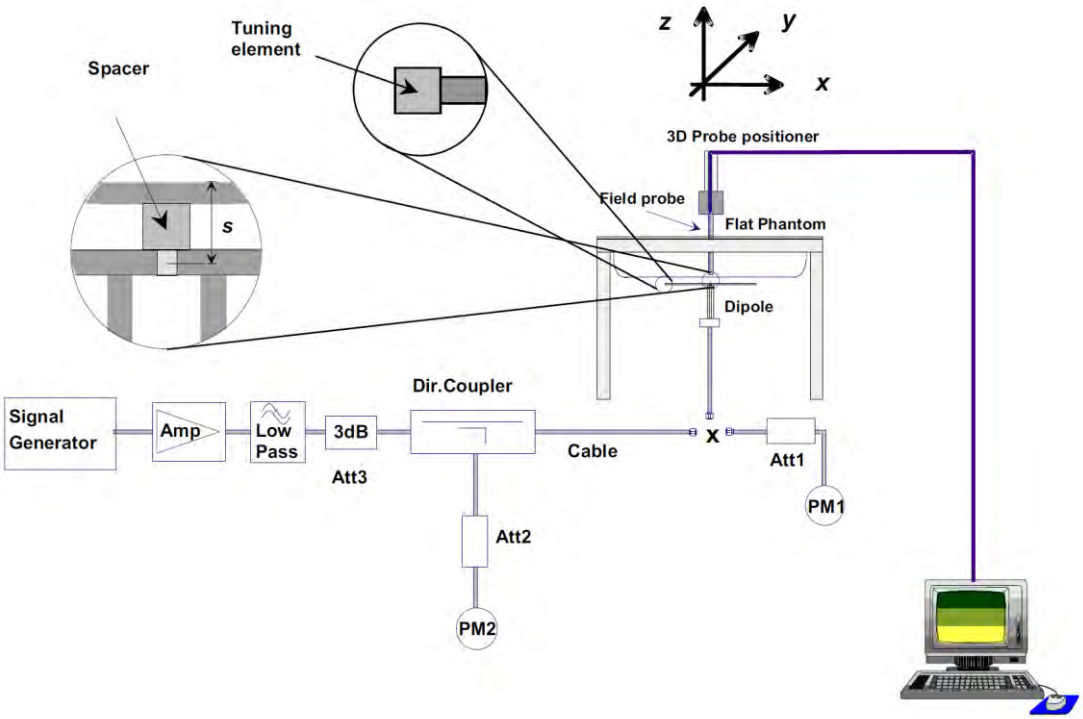
# 5 SYSTEM VERIFICATION

## 5.1 Purpose of System Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source.This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

## 5.2 System Check Setup

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:



# 6 TEST POSITION CONFIGURATIONS

## 6.1 Head Exposure Conditions

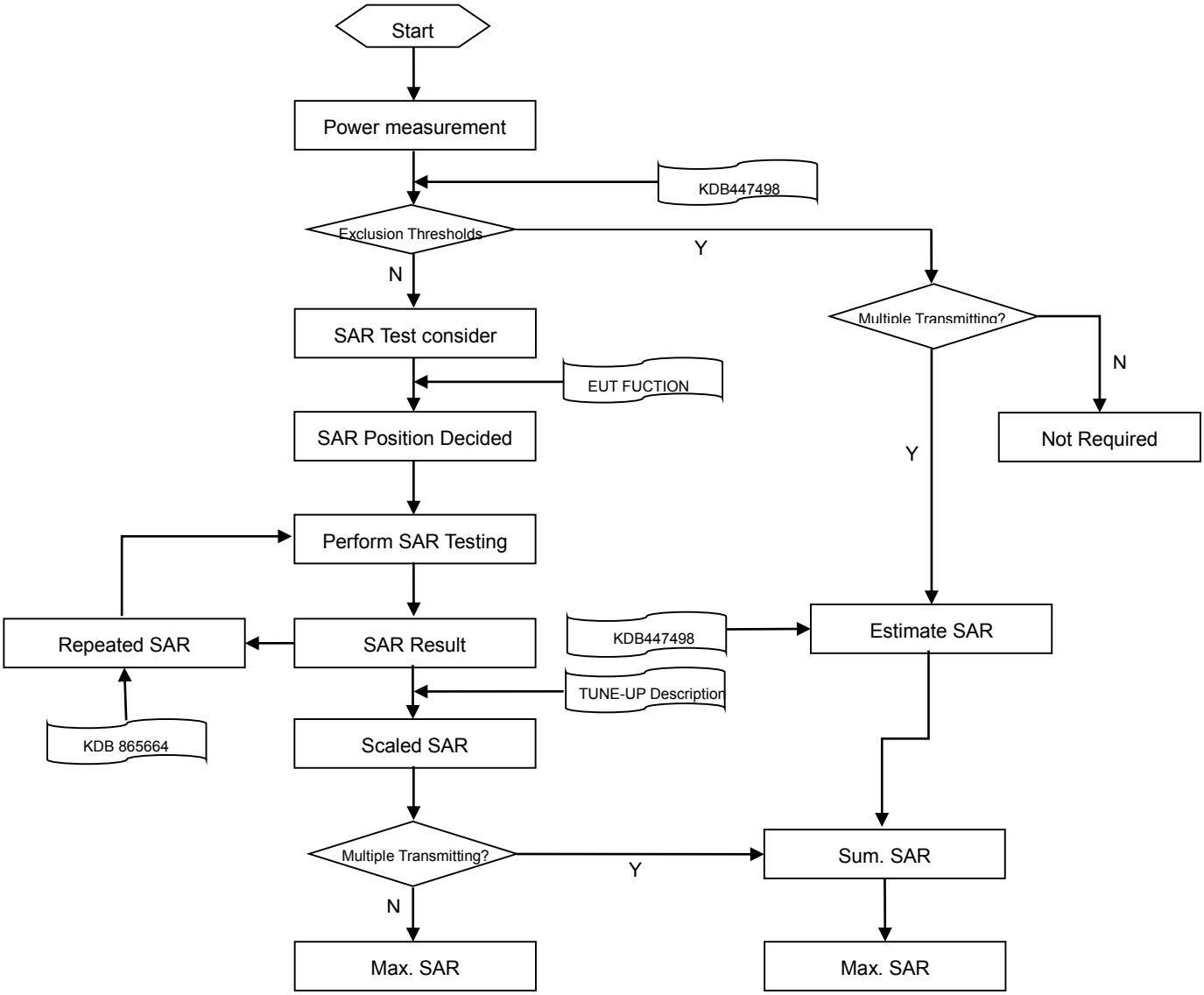
Head exposure is limited to next to the ear mode operations. Generally, head SAR compliance is tested according to the test positions defined in IEEE Std 1528 using the SAM phantom.

However, the SAM (head) phantom is generally unacceptable for testing SAR of other head and body exposure conditions.

The EUT tested in the reported is a VR goggle. According to guide from the KDB inquiry, the EUT should be placed against the flat phantom filled with head tissue simulating liquid to simulate the head exposure conditions. Please refer to section 10 for more detail test position and configuration.

# 7 MEASUREMENT PROCEDURE

## 7.1 Measurement Process Diagram



## 7.2 SAR Scan General Requirement

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Boththe probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1 g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013.

<table>
<tr><th colspan="3"></th><th>≤3GHz</th><th>>3GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5±1 mm</td><td>½·δ·ln(2)±0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30°±1°</td><td>20°±1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx Area , Δy Area</td><td>≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm</td><td>3–4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom</td><td>≤ 2 GHz: ≤ 8 mm<br>2 –3 GHz: ≤ 5 mm*</td><td>3–4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="6">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2" rowspan="3">uniform grid: Δz Zoom (n)</td><td rowspan="3">≤ 5 mm</td><td>3–4 GHz: ≤ 4 mm</td></tr>
<tr><td>4–5 GHz: ≤ 3 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="3">graded grid</td><td rowspan="2">Δz Zoom (1): between 1st two points closest to phantom surface</td><td rowspan="2">≤ 4 mm</td><td>3–4 GHz: ≤ 3 mm</td></tr>
<tr><td>4–5 GHz: ≤ 2.5 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td>Δz Zoom (n>1): between subsequent points</td><td colspan="2">≤ 1.5·Δz Zoom (n-1)</td></tr>
<tr><td rowspan="3">Minimum zoom scan volume</td><td colspan="2" rowspan="3">x, y, z</td><td rowspan="3">≥30 mm</td><td>3–4 GHz: ≥ 28 mm</td></tr>
<tr><td>4–5 GHz: ≥ 25 mm</td></tr>
<tr><td>5–6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note:<br>1. δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.<br>2. * When zoom scan is required and the reported SAR from the area scan based 1 g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

## 7.3 Measurement Procedure

The following steps are used for each test position

a. During the measurement, the EUT was set to transmit continuously at the max. power level, and the test channels and mode were referred to section 8 and section 9.

b. Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.

c. Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.

d. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 *32 mm is assessed by measuring 5 or 8 * 5 or 8*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

## 7.4 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01r04 quoted below.

When the 1 g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

# 8 CONDUCTED RF OUPUT POWER

## 8.1 2.4GHz FHSS

Antenna 1 (Internal antenna)

| Band (GHz) | Mode | Channel | Freq. (MHz) | Peak Power (dBm) |
|---|---|---|---|---|
| 2.4 G (2.405-2.475) | FHSS | Low | 2405.5 | 12.71 |
| | | Middle | 2440.0 | 14.07 |
| | | High | 2475.0 | **14.87** |

Antenna 2 (External antenna)

| Band (GHz) | Mode | Channel | Freq. (MHz) | Peak Power (dBm) |
|---|---|---|---|---|
| 2.4 G (2.405-2.475) | FHSS | Low | 2405.5 | 12.31 |
| | | Middle | 2440.0 | 14.06 |
| | | High | 2475.0 | **14.86** |

| Mode | Channel | Power Tolerance Range (dBm) |
|---|---|---|
| 2.4 GHz FHSS Antenna 1 | Low | 12.50~13.50 |
| | Middle | 14.00~15.00 |
| | High | 14.00~15.00 |
| 2.4 GHz FHSS Antenna 2 | Low | 12.50~13.50 |
| | Middle | 14.00~15.00 |
| | High | 14.00~15.00 |

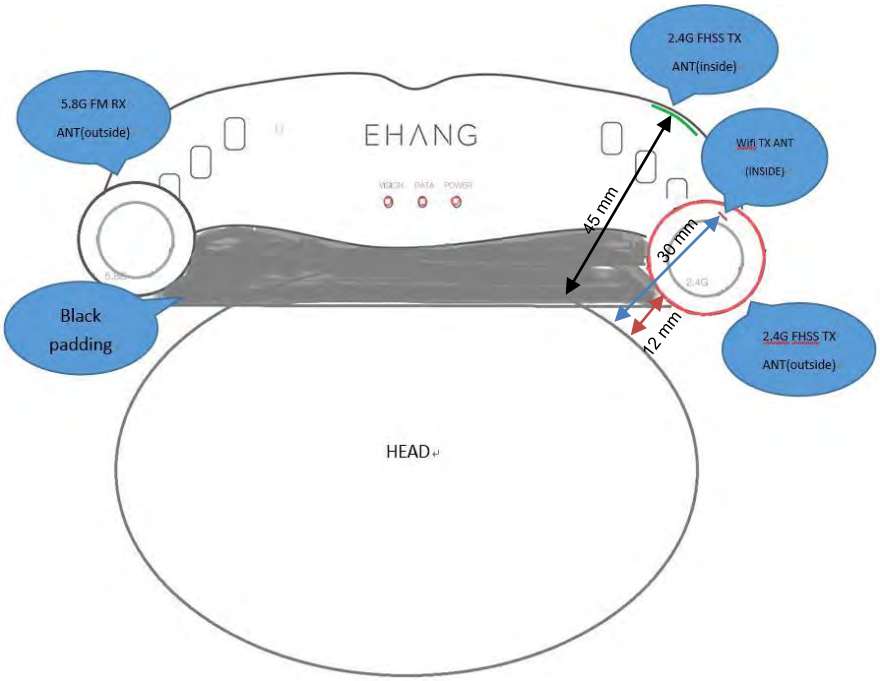
## 8.2 WLAN

| Band (GHz) | Mode | Channel | Freq. (MHz) | Peak Power (dBm) |
|---|---|---|---|---|
| 2.4G (2.4~2.4835) | 802.11 b | 1 | 2412 | 7.20 |
| | | 6 | 2437 | **7.53** |
| | | 11 | 2462 | 7.15 |

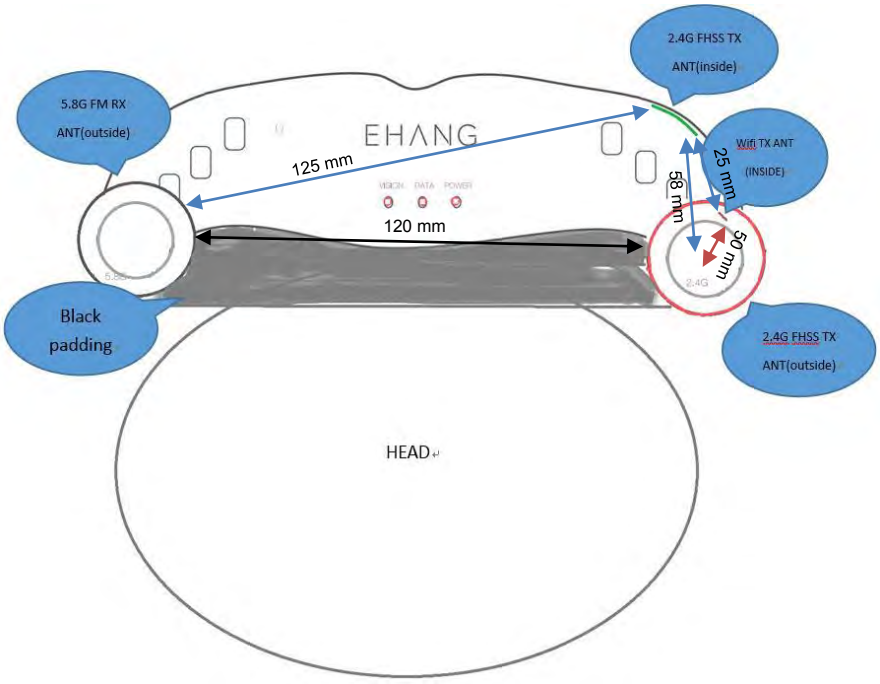
| Mode | Power Tolerance Range (dBm) |
|---|---|
| 802.11 b | 7.00 ~ 7.60 |

# 9 TEST EXCLUSION CONSIDERATION

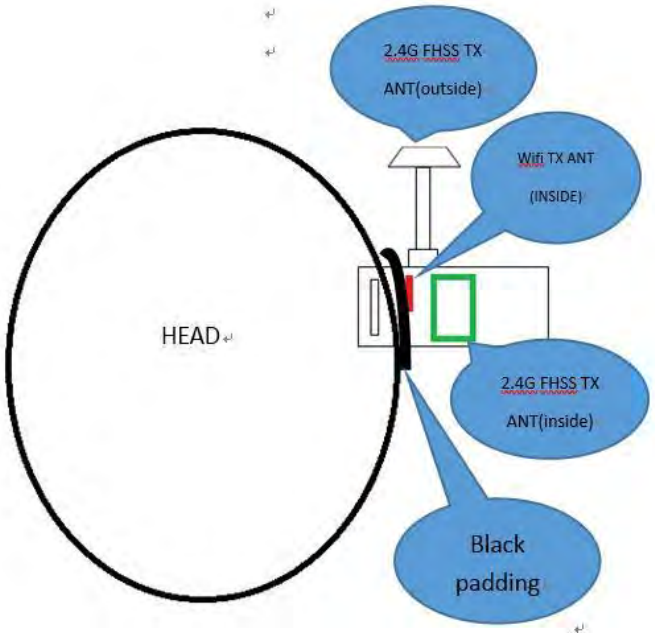
## 9.1 Antenna Pattern

| | Front side | |
|---|---|---|
| Left side |  | Right Side |
| | Back side | |

*Top side view (Including distances between antennas and human head)*

| | Front side | |
|---|---|---|
| Left side |  | Right Side |
| | Back side | |

*Top side view (Including distances between antennas)*

| | | |
|---|---|---|
| | Top side | |
| Back side |  | Front Side |
| | Down side | |
| *Right side view* | | |

## 9.2 SAR Test Exclusion Consideration Table

According with FCC KDB 447498 D01, Appendix A, <SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm> Table, this Device SAR test configurations consider as following :

| Band | Mode | Max. Peak Power | | The nearest distance between the antenna and user head | SAR Test Require |
|---|---|---|---|---|---|
| | | dBm | mW | | |
| 2.4 GHz FHSS | Antenna 1 | 15.00 | 31.62 | 45 mm | NO |
| | Antenna 2 | 15.00 | 31.62 | 12 mm | YES |
| WLAN | 802.11 b | 7.60 | 5.75 | 30 mm | NO |

Note:

1. Maximum power is the source-based time-average power and represents the maximum RF output power including tune-up tolerance among production units.
2. Per KDB 447498 D01, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D01, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold.
4. Per KDB 447498 D01, 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)] *·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   a. f(GHz) is the RF channel transmit frequency in GHz
   b. Power and distance are rounded to the nearest mW and mm before calculation
   c. The result is rounded to one decimal place for comparison
   d. For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.
   This formula is [3.0] / [√f(GHz)] *·[(min. test separation distance, mm)] = exclusion threshold of mW.
5. Per KDB 447498 D01, at 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following:
   a. [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·( f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b. [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

| Distance of exclusion SAR test | | | | |
|---|---|---|---|---|
| Band | Mode | Max. Power of Channel (mW) | Frequency (GHz) | Min. Test Separation Distance (mm) |
| 2.4 GHz FHSS | Antenna 1 | 31.62 | 2.475 | 16.6 |
| | Antenna 2 | 31.62 | 2.475 | 16.6 |
| WLAN | 802.11 b | 5.75 | 2.472 | 3.01 |

# 10 TEST RESULT

## 10.1 2.4GHz FHSS

| Mode | Position | Dist. (mm) | Ch. | Freq. (MHz) | Power Drift (%) | 1 g Meas. SAR (W/Kg) | Meas. Power (dBm) | Max. tune-up Power(dBm) | Scaling Factor | 1 g Scaled SAR (W/Kg) | Meas. No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Antenna 2** | | | | | | | | | | | |
| **Head Exposure** | | | | | | | | | | | |
| DATA | Right Edge | 0 | High | 2475.0 | -3.39 | 0.050 | 14.86 | 15.00 | 1.033 | 0.052 | 1# |

Note:

1. Refer to ANNEX C for the detailed test data for each test configuration.
2. Power Drift (%)=10^[Meas Power Drift(dB)/10]-1.
3. A flat phantom with head liquid was used to simulate the actual usage. Because only 2.4 GHz FHSS external antenna should be tested for SAR, it was tangent with the flat phantom during the test for conservative estimation.

# 11 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20, or when the original or repeated measurement is >= 1.45 W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Note: The highest measured SAR is 0.052 W/kg, which less than 0.8 W/kg, repeated measurement is not required.

# 12 SIMULTANEOUS TRANSMISSION

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR 1g of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR 1g 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR 1g is greater than the SAR limit (SAR 1g 1.6 W/kg), SAR test exclusion is determined by the SAR to Peak Location Ratio (SPLSR).

## 12.1 Simultaneous Transmission Mode Consider

| Antenna | Mode | 2.4G FHSS&2.4GWLAN |
|---|---|---|
| | | Body |
| 1 | 2.4GHz FHSS | + WLAN |
| 2 | 2.4GHz FHSS | + WLAN |

Note:

1. The device supports only data mode transmission.
2. Antenna 1 and 2 for 2.4GHz FHSS can’t transmit at the same time.

## 12.2 Estimated SAR Calculation

According to KDB 447498 D01, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following formula to result in substantially conservative SAR values of <= 0.4 W/kg to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{Max.Tune\ Up\ Power(mw)}{Min\ Test\ Separation\ Distance} * \frac{\sqrt{f_{GHz}}}{x}$$ (where $x$ = 7.5 for 1-g SAR )

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

| Band | Mode | Antenna To user (mm) | Max. Tune-up Power (dBm) | Max. Tune-up Power (mW) | Frequency (GHz) | Calculation Distance/Gap (mm) | Estimated SAR (W/kg) |
|---|---|---|---|---|---|---|---|
| 2.4G FHSS Antenna 1 | N/A | 45 | 15.00 | 31.62 | 2.475 | 45 | 0.147 |
| WLAN | 802.11b | 5 | 7.60 | 5.75 | 2.462 | 30 | 0.040 |

## 12.3 Sum SAR of Simultaneous Transmission

### 12.3.1 Sum Head SAR of Simultaneous Transmission

| Simultaneous Mode | Mode | Max. 1g SAR (W/kg) | 1g Sum SAR (W/kg) | SPLSR (Yes/No) |
|---|---|---|---|---|
| Antenna 1 2.4GHz FHSS + WLAN | 2.4GHz FHSS | 0.147 | 0.187 | No |
| | WLAN | 0.040 | | |
| Antenna 2 2.4GHz FHSS + WLAN | 2.4GHz FHSS | 0.052 | 0.092 | No |
| | WLAN | 0.040 | | |

# 13 TEST EQUIPMENTS LIST

| Description | Manufacturer | Model | Serial No. | Cal. Date | Cal. Due |
|---|---|---|---|---|---|
| PC | Dell | N/A | N/A | N/A | N/A |
| 2450MHz Validation Dipole | Speag | D2450V2 | SN: 952 | 2014/11/27 | 2017/11/26 |
| E-Field Probe | Speag | EX3DV4 | SN: 7340 | 2015/12/10 | 2016/12/09 |
| Phantom1 | Speag | SAM | SN: 1859 | N/A | N/A |
| Phantom2 | Speag | SAM | SN: 1857 | N/A | N/A |
| Data acquisition electronics | Speag | DAE4 | SN: 1454 | 2015/12/08 | 2016/12/07 |
| Signal Generator | R&S | SMBV100A | 260592 | 2015/07/16 | 2016/07/15 |
| Power Meter | Agilent | E4419B | GB40201833 | 2015/10/14 | 2016/10/13 |
| Power Sensor | R&S | NRP-Z21 | 103971 | 2015/07/16 | 2016/07/15 |
| Power Amplifier | SATIMO | 6552B | 22374 | N/A | N/A |
| Dielectric Probe Kit | SATIMO | SCLMP | SN 25/13 OCPG56 | 2015/08/17 | 2016/08/16 |
| Wireless Communication Test Set | R&S | CMW 500 | 138884 | 2015/07/16 | 2016/07/15 |
| Network Analyzer | R&S | ZVL-6 | EMY46103472 | 2015/07/16 | 2016/07/15 |
| Attenuator | COM-MW | ZA-S1-31 | 1305003187 | N/A | N/A |
| Directional coupler | AA-MCS | AAMCS-UDC | 000272 | N/A | N/A |

Note:

Per KDB 865664 D01, Dipole SAR Validation Verification, BALUN LAB has adopted 3 years calibration intervals. On annual basis, every measurement dipole has been evaluated and is in compliance with the following criteria:

1. There is no physical damage on the dipole;
2. System validation with specific dipole is within 10% of calibrated value;
3. Return-loss in within 20% of calibrated measurement.

# ANNEX A SIMULATING LIQUID VERIFICATION RESULT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an SCLMP Dielectric Probe Kit.

| Date | Liquid Type | Fre. (MHz) | Temp. (℃) | Meas. Conductivity (σ) (S/m) | Meas. Permittivity (ε) | Target Conductivity (σ) (S/m) | Target Permittivity (ε) | Conductivity Tolerance (%) | Permittivity Tolerance (%) |
|---|---|---|---|---|---|---|---|---|---|
| 2016.02.26 | Head | 2450 | 21.1 | 1.85 | 38.53 | 1.80 | 39.20 | 2.78 | -1.71 |
| Note: The tolerances limit of Conductivity and Permittivity is ± 5%. | | | | | | | | | |

# ANNEX B SYSTEM CHECK RESULT

Comparing to the original SAR value provided by SPEAG, the validation data should be within its specification of 10 %(for 1 g).

| Date | Liquid Type | Freq. (MHz) | Power (mW) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Dipole SAR (W/kg) | Tolerance (%) | Targeted SAR(W/kg) | Tolerance (%) |
|---|---|---|---|---|---|---|---|---|---|
| 2016.02.26 | Head | 2450 | 100 | 5.47 | 54.70 | 52.30 | 4.59 | 52.4 | 4.39 |
| Note: The tolerance limit of System validation ±10%. | | | | | | | | | |

# System Performance Check Data (2450MHz Head)

Date/Time: 2/26/2016

Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; $\sigma$ = 1.85 S/m; $\varepsilon_r$ = 38.53; $\rho$ = 1000 kg/m$^3$

Phantom section: Flat Section

Ambient Temperature:21.8 Liquid Temperature:21.1

DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.62, 7.62, 7.62); Calibrated: 12/10/2015;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/8/2015
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/CW2450 HEAD/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 6.26 W/kg

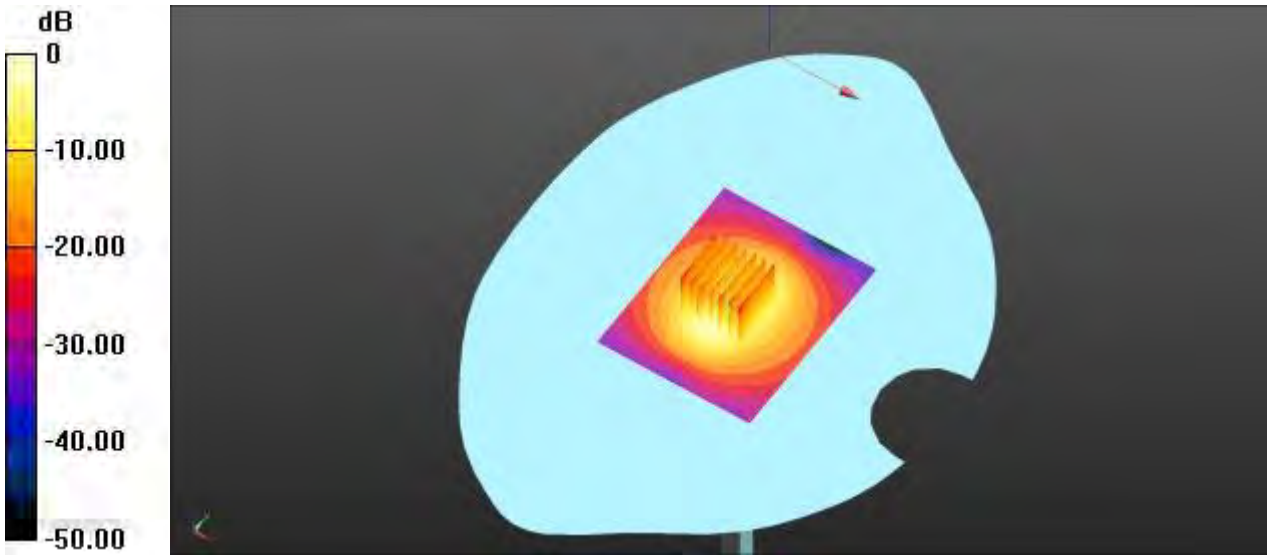
**Configuration/CW2450 HEAD/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.51 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 12.2 W/kg

**SAR(1 g) = 5.47 W/kg; SAR(10 g) = 2.50 W/kg**

Maximum value of SAR (measured) = 6.29 W/kg




0 dB = 6.29 W/kg = 7.99 dBW/kg

# ANNEX C TEST DATA

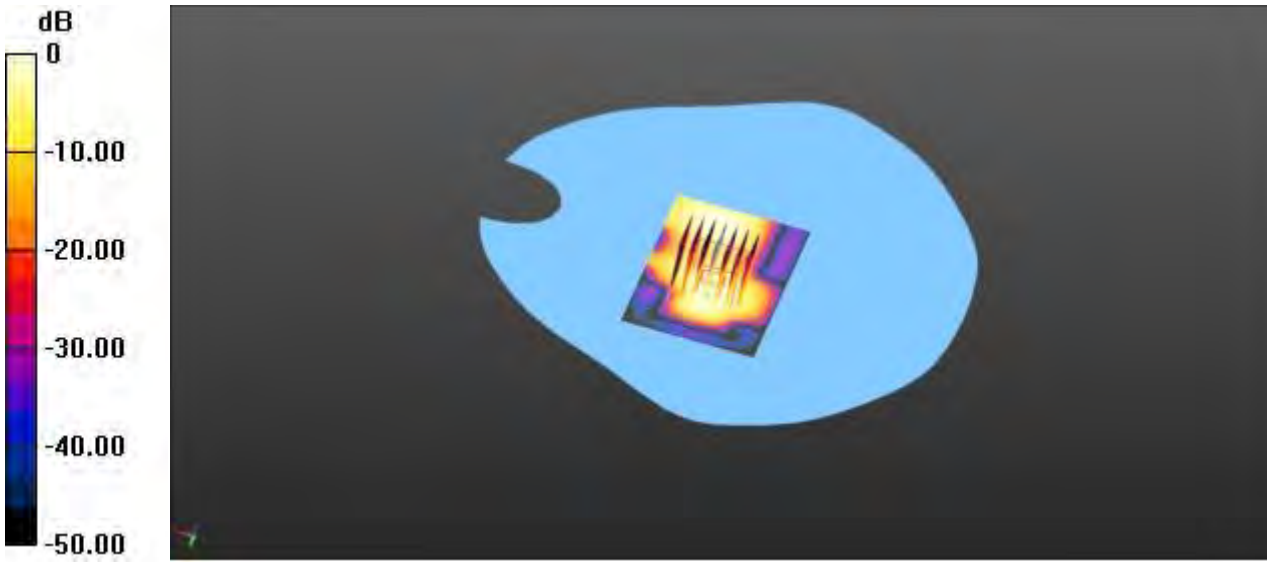
## MEAS. 1 Body Plane with Right Edge on High Channel in FHSS 2.4GHz mode with Antenna 2

Date/Time: 2/26/2016
Communication System Band: CW2440; Frequency: 2475 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2475 MHz; σ = 1.87 S/m; εr = 38.26; ρ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.8 Liquid Temperature:21.1
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.62, 7.62, 7.62); Calibrated: 12/10/2015;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/8/2015
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Configuration/FHSS 2475MHz Body Right on Antenna 2/Area Scan (51x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0729 W/kg

**Configuration/FHSS 2475MHz Body Right on Antenna 2/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.903 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 0.111 W/kg
**SAR(1 g) = 0.050 W/kg; SAR(10 g) = 0.020 W/kg**
Maximum value of SAR (measured) = 0.0612 W/kg




0 dB = 0.0612 W/kg = -12.13 dBW/kg

# ANNEX D EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ15C0314-AW.pdf”.

# ANNEX E SAR TEST SETUP PHOTOS

Please refer the document “BL-SZ15C0314-AS.pdf”.

# ANNEX F CALIBRATION REPORT

F.1 E-Field Probe

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

CALIBRATION No. L0570

Client baluntek Certificate No: Z15-97196

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:7340 |
| Calibration Procedure(s) | FD-Z11-2-004-01<br>Calibration Procedures for Dosimetric E-field Probes |
| Calibration date: | December 10, 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(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRP2 | 101919 | 01-Jul-15 (CTTL, No.J15X04256) | Jun-16 |
| Power sensor NRP-Z91 | 101547 | 01-Jul-15 (CTTL, No.J15X04256) | Jun-16 |
| Power sensor NRP-Z91 | 101548 | 01-Jul-15 (CTTL, No.J15X04256) | Jun-16 |
| Reference10dBAttenuator | 18N50W-10dB | 13-Mar-14(TMC,No.JZ14-1103) | Mar-16 |
| Reference20dBAttenuator | 18N50W-20dB | 13-Mar-14(TMC,No.JZ14-1104) | Mar-16 |
| Reference Probe EX3DV4 | SN 7307 | 27-Feb-15(SPEAG,No.EX3-7307_Feb15) | Feb-16 |
| DAE4 | SN 771 | 27-Jan-15(SPEAG, No.DAE4-771_Jan15) | Jan -16 |
| **Secondary Standards** | **ID #** | **Cal Date(Calibrated by, Certificate No.)** | **Scheduled Calibration** |
| SignalGeneratorMG3700A | 6201052605 | 01-Jul-15 (CTTL, No.J15X04255) | Jun-16 |
| Network Analyzer E5071C | MY46110673 | 03-Feb-15 (CTTL, No.J15X00728) | Feb-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: December 11, 2015

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

Certificate No: Z15-97196 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

**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: 7340

Calibrated: December 10, 2015

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

Certificate No: Z15-97196 Page 3 of 11

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7340

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm(μV/(V/m)²)[A] | 0.51 | 0.48 | 0.45 | ±10.8% |
| DCP(mV)[B] | 100.7 | 101.8 | 105.1 | |

## 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 | 194.7 | ±2.2% |
| | | Y | 0.0 | 0.0 | 1.0 | | 188.5 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 183.1 | |

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: 7340

## 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) |
|---|---|---|---|---|---|---|---|---|
| 850 | 41.5 | 0.92 | 9.56 | 9.56 | 9.56 | 0.12 | 1.42 | ±12% |
| 1750 | 40.1 | 1.37 | 8.22 | 8.22 | 8.22 | 0.22 | 1.08 | ±12% |
| 1900 | 40.0 | 1.40 | 8.15 | 8.15 | 8.15 | 0.21 | 1.09 | ±12% |
| 2450 | 39.2 | 1.80 | 7.62 | 7.62 | 7.62 | 0.48 | 0.72 | ±12% |
| 2600 | 39.0 | 1.96 | 7.42 | 7.42 | 7.42 | 0.34 | 0.98 | ±12% |
| 5200 | 36.0 | 4.66 | 5.33 | 5.33 | 5.33 | 0.39 | 1.21 | ±13% |
| 5600 | 35.5 | 5.07 | 4.70 | 4.70 | 4.70 | 0.39 | 1.20 | ±13% |
| 5800 | 35.3 | 5.27 | 4.68 | 4.68 | 4.68 | 0.39 | 1.25 | ±13% |

[C] Frequency validity 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.
[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: 7340

## 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) |
|---|---|---|---|---|---|---|---|---|
| 850 | 55.2 | 0.99 | 9.83 | 9.83 | 9.83 | 0.15 | 1.46 | ±12% |
| 1750 | 53.4 | 1.49 | 7.87 | 7.87 | 7.87 | 0.20 | 1.16 | ±12% |
| 1900 | 53.3 | 1.52 | 7.51 | 7.51 | 7.51 | 0.18 | 1.30 | ±12% |
| 2450 | 52.7 | 1.95 | 7.38 | 7.38 | 7.38 | 0.35 | 0.97 | ±12% |
| 2600 | 52.5 | 2.16 | 6.99 | 6.99 | 6.99 | 0.34 | 1.02 | ±12% |
| 5200 | 49.0 | 5.30 | 4.56 | 4.56 | 4.56 | 0.45 | 1.31 | ±13% |
| 5600 | 48.5 | 5.77 | 3.98 | 3.98 | 3.98 | 0.48 | 1.33 | ±13% |
| 5800 | 48.2 | 6.00 | 4.15 | 4.15 | 4.15 | 0.50 | 1.18 | ±13% |

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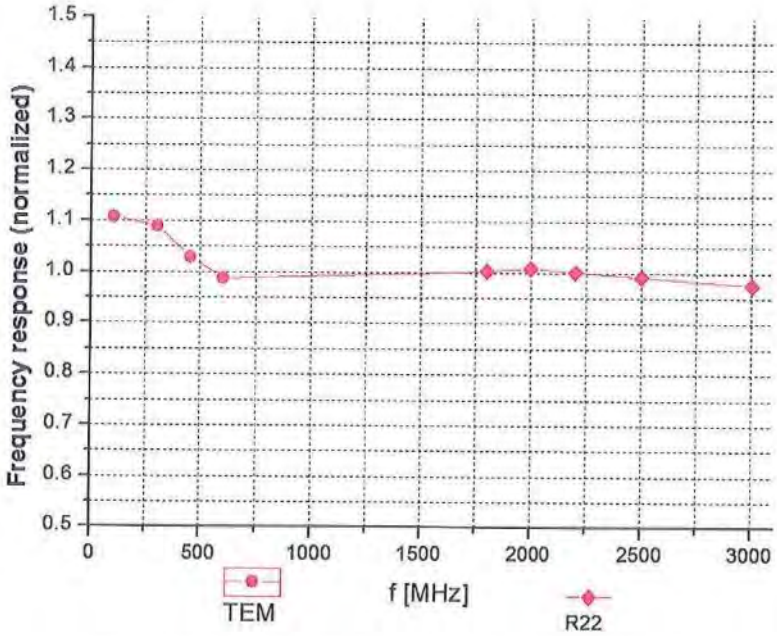
## Frequency Response of E-Field
### (TEM-Cell: ifi110 EXX, Waveguide: R22)




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

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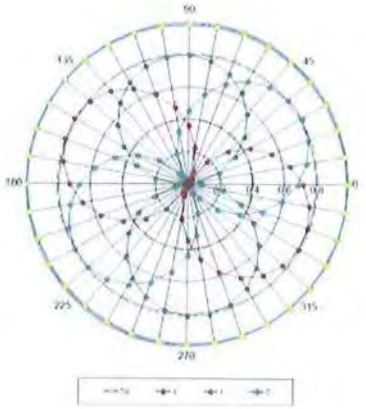
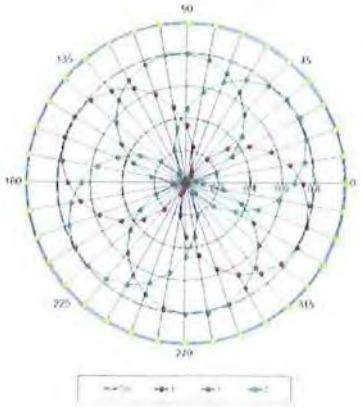
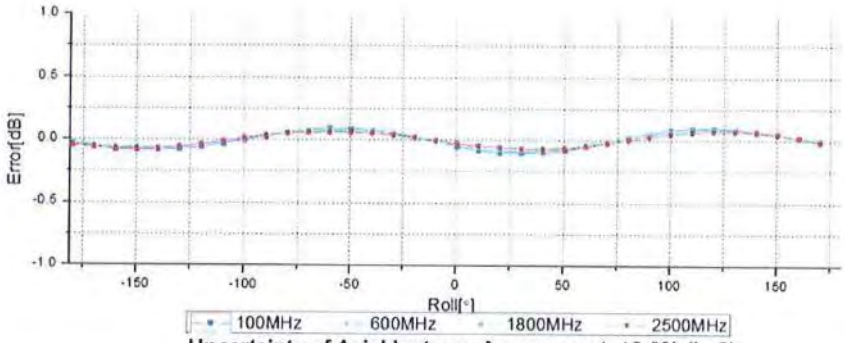
## Receiving Pattern (Φ), θ=0°

**f=600 MHz, TEM**



**f=1800 MHz, R22**






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

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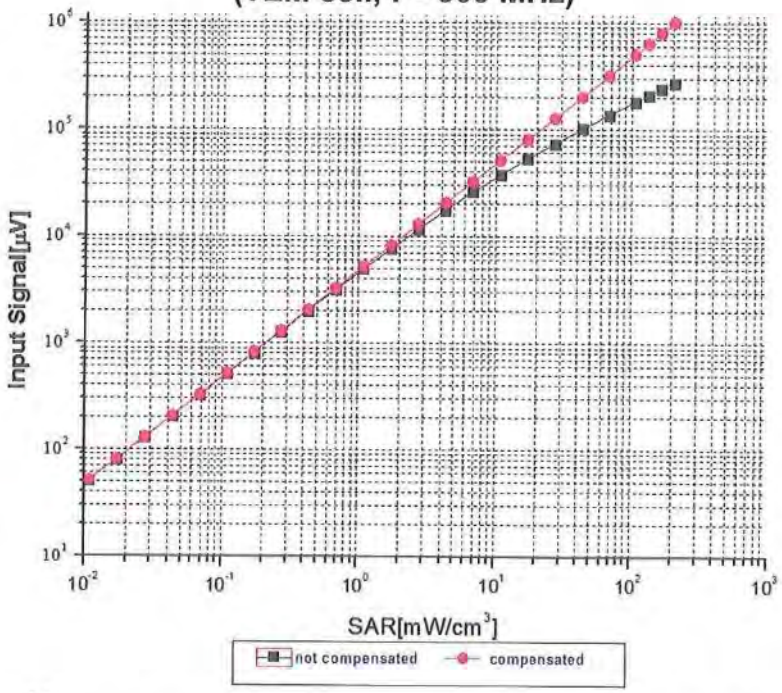
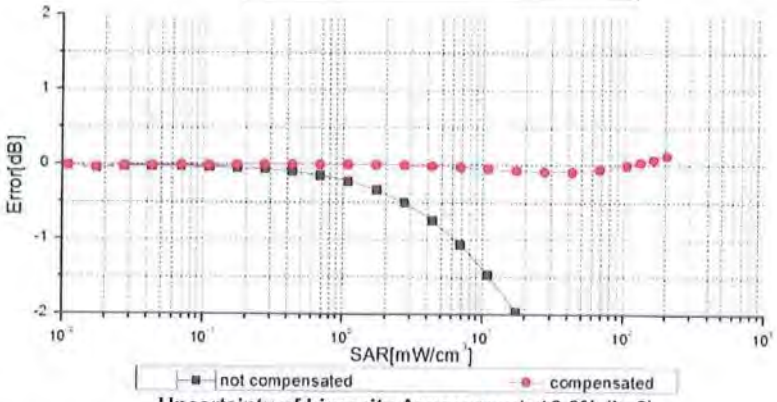
## Dynamic Range f(SAR$_{head}$)
## (TEM cell, f = 900 MHz)




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

Certificate No: Z15-97196 Page 9 of 11

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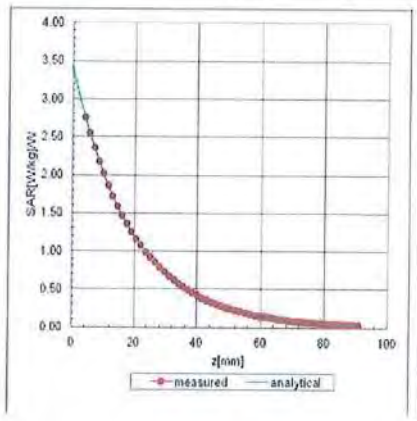
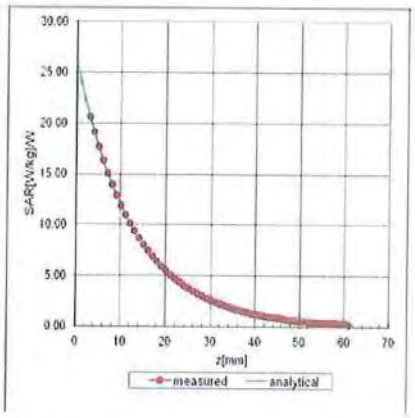
## Conversion Factor Assessment

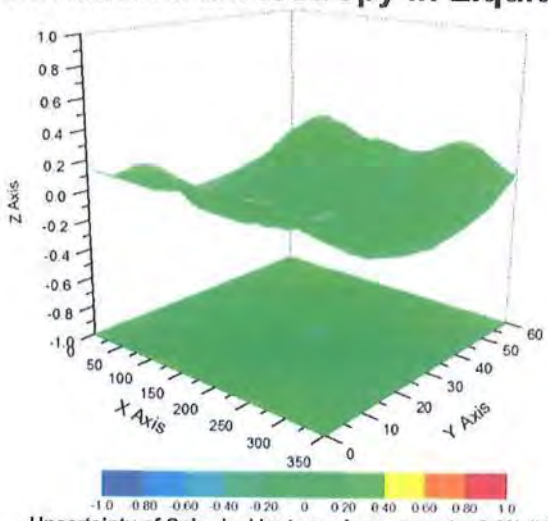
f=850 MHz, WGLS R9(H_convF)




f=1750 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: 7340

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 130.2 |
| 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 |

F.2 Data Acquisition Electronics

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Client : baluntek Certificate No: Z15-97195

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 1454 |
| Calibration Procedure(s) | FD-Z11-2-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | December 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(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: December 09, 2015

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Certificate No: Z15-97195 Page 1 of 3

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**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 | 404.175 ± 0.15% (k=2) | 403.666 ± 0.15% (k=2) | 403.739 ± 0.15% (k=2) |
| Low Range | 4.01281 ± 0.7% (k=2) | 3.9916 ± 0.7% (k=2) | 3.99929 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 317.5° ± 1 ° |

F.3 Dual Logo-CTTL-SPEAG Certificates

Schmid & Partner Engineering AG

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Tolan Tu
**Shenzhen BALUN Technology Co., Ltd.**
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Park, Shahe Xi Road, Nanshan District,
ShenZhen, GuangDong Province,
P. R. China

Email: tulang@baluntek.com

Zurich, March 4, 2016/ kp

To whom it may concern:

Schmid & Partner Engineering AG (SPEAG), established and reputable manufacturers of dosimetry equipment at Zeughausstrasse 43 CH - 8004 Zurich Switzerland, do hereby certify that below listed calibration certificates have been approved for release under CTTL-SPEAG dual-logo as per QAP4CAL agreement between SPEAG and CTTL Beijing SAR calibration lab.

Certificate No. Z15-97195 (calibration of DAE4 – SN: 1454)
Certificate No. Z15-97196 (calibration of EX3DV4 – SN: 7340)

Yours sincerely,

Schmid & Partner Engineering AG

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Dr. Katja Pokovic
Director Laboratory & Services

1/1

F.4 2450MHz Dipole

**Calibration Laboratory of**
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**Accreditation No.: SCS 108**

**Client** **Dgieie (Vitec)**

**Certificate No: D2450V2-952_Nov14**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN: 952 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | November 27, 2014 |

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-13 (No. ES3-3205_Dec13) | Dec-14 |
| 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: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 28, 2014

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Certificate No: D2450V2-952_Nov14 Page 1 of 8

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**C** Service suisse d'étalonnage
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**S** Swiss Calibration Service

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**Accreditation No.: SCS 108**

**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 | 39.0 ± 6 % | 1.86 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 | 13.3 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.3 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.5 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 | 50.9 ± 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 | 13.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **50.6 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.02 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.7 W/kg ± 16.5 % (k=2)** |

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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.4 Ω + 3.0 jΩ |
| Return Loss | - 27.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.7 Ω + 5.1 jΩ |
| Return Loss | - 25.8 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.161 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: 27.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

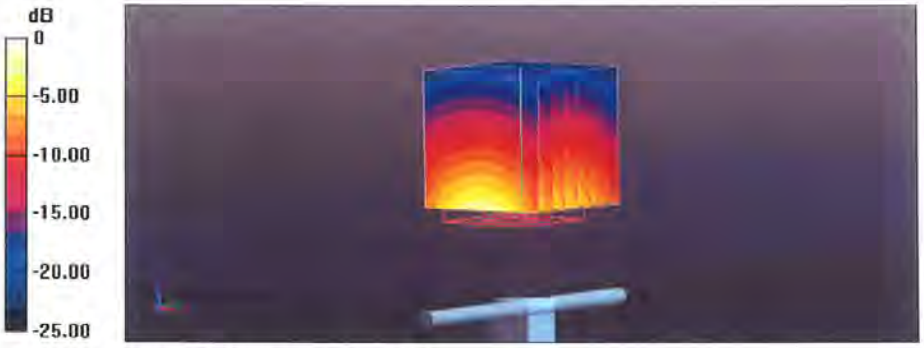
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.86 S/m; $\varepsilon_r$ = 39; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

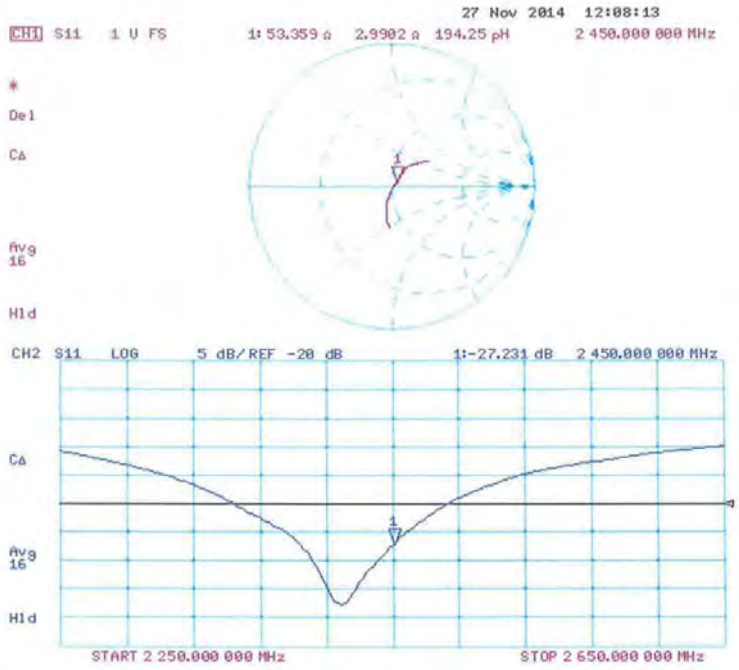
- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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 = 100.8 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.5 W/kg
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.17 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: 27.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952**

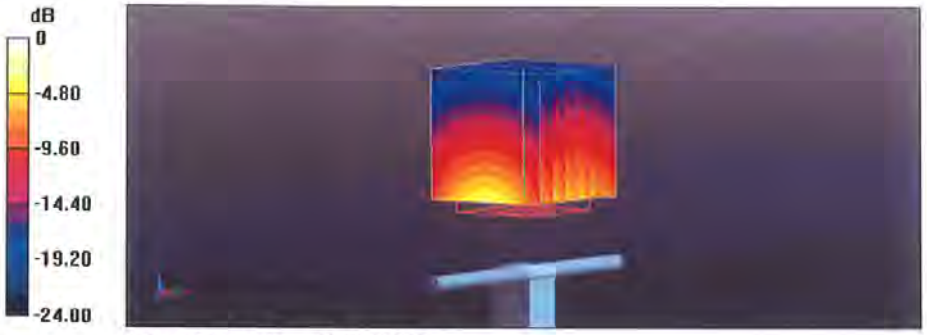
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz: $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 50.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- 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)

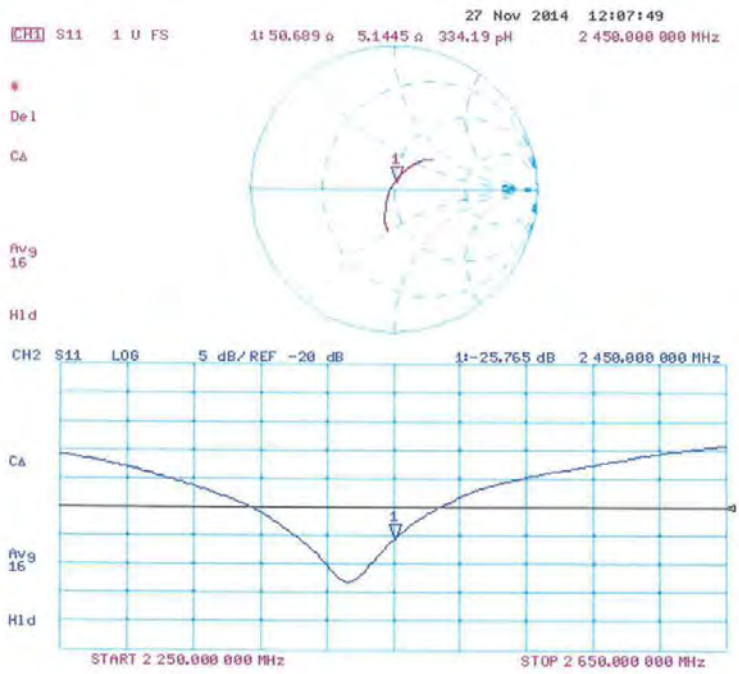
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.25 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 27.2 W/kg
**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.02 W/kg**
Maximum value of SAR (measured) = 17.3 W/kg




0 dB = 17.3 W/kg = 12.38 dBW/kg

**Impedance Measurement Plot for Body TSL**



F.5 Dipole Performance Measurement Report

# SAR Dipole

# Performance Measurement Report

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Validation Dipoles

Tested by: Tu Lang
(Engineer)

Approved by: Wei Yanquan
(Chief Engineer)

| | |
|---|---|
| Report No.: | LW-SZ15C0264-701 |
| EUT Type: | SAR Validation Dipole |
| Model Name: | D835V2, D1750V2<br>D1900V2, D2450V2<br>D2600V2, D5GHzV2 |
| Brand Name: | Speag |
| Test Conclusion: | Pass |
| Test Date: | Oct. 23, 2015 ~ Oct. 26, 2015 |
| Date of Issue: | Oct. 29, 2015 |

*NOTE: This test report can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. BALUN Laboratory. Any objections should be raised within thirty days from the date of issue. To validate the report, please visit BALUN website.*

# 1 GENERAL INFORMATION

## 1.1 Introduction

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDB 865664 D01 for reference dipoles used for SAR measurement system validations. Instead of the typical annual calibration recommended by measurement standards, the reference dipoles were demonstrated that the SAR target, impedance and return loss have remain stable, so the longer calibration interval is acceptable.

## 1.2 General Description for Equipment under Test (EUT)

| | |
|---|---|
| EUT Type | DASY 52 Reference Dipoles |
| Manufacturer | Speag |

| Parameter | EUT 1 | EUT 2 | EUT 3 | EUT 4 | EUT 5 | EUT 6 |
|---|---|---|---|---|---|---|
| Model | D835V2 | D1750V2 | D1900V2 | D2450V2 | D2600V2 | D5GHzV2 |
| Frequency | 835 MHz | 1750 MHz | 1900 MHz | 2450 MHz | 2600 MHz | 5GHz-6GHz |
| Serial Number | SN 4d187 | SN 1130 | SN 5d193 | SN 952 | SN 1095 | SN 1200 |
| Product Condition (New/ Used) | Used | Used | Used | Used | Used | Used |
| Last Cal. Date | 2014/11/26 | 2014/11/28 | 2014/11/28 | 2014/11/27 | 2014/11/27 | 2014/12/4 |

## 1.3 EUT Photos

D835V2

D1750V2

| D1900V2 |
| --- |
| |
| D2450V2 |
| |
| D2600V2 |
| |
| D5GHzV2 |
| |

## 2 SIMULATING LIQUID VERIFICATION

| Liquid Type | Fre. (MHz) | Meas. Conductivity (σ) (S/m) | Meas. Permittivity (ε) | Target Conductivity (σ) (S/m) | Target Permittivity (ε) | Conductivity Tolerance (%) | Permittivity Tolerance (%) |
|---|---|---|---|---|---|---|---|
| Head | 835 | 0.89 | 41.83 | 0.90 | 41.50 | -1.11 | 0.80 |
| Body | 835 | 0.98 | 53.88 | 0.97 | 55.20 | 1.03 | -2.39 |
| Head | 1750 | 1.38 | 39.23 | 1.37 | 40.10 | 0.73 | -2.17 |
| Body | 1750 | 1.45 | 51.75 | 1.49 | 53.40 | -2.68 | -3.09 |
| Head | 1900 | 1.43 | 39.44 | 1.40 | 40.00 | 2.14 | -1.40 |
| Body | 1900 | 1.55 | 51.61 | 1.52 | 53.30 | 1.97 | -3.17 |
| Head | 2450 | 1.84 | 38.53 | 1.80 | 39.20 | 2.22 | -1.71 |
| Body | 2450 | 1.99 | 51.17 | 1.95 | 52.70 | 2.05 | -2.90 |
| Head | 2600 | 1.97 | 38.09 | 1.96 | 39.00 | 0.51 | -2.33 |
| Body | 2600 | 2.20 | 50.81 | 2.16 | 52.50 | 1.85 | -3.22 |
| Head | 5200 | 4.78 | 36.52 | 4.66 | 35.99 | 2.58 | 1.47 |
| Body | 5200 | 5.38 | 48.74 | 5.30 | 49.01 | 1.51 | -0.55 |
| Head | 5600 | 5.20 | 35.06 | 5.07 | 35.53 | 2.56 | -1.32 |
| Body | 5600 | 5.72 | 46.31 | 5.77 | 48.47 | -0.87 | -4.46 |
| Head | 5800 | 5.42 | 34.40 | 5.27 | 35.30 | 2.85 | -2.55 |
| Body | 5800 | 5.92 | 46.06 | 6.00 | 48.20 | -1.33 | -4.44 |

# 3 DIPOLE IMPEDANCE AND RETURN LOSS

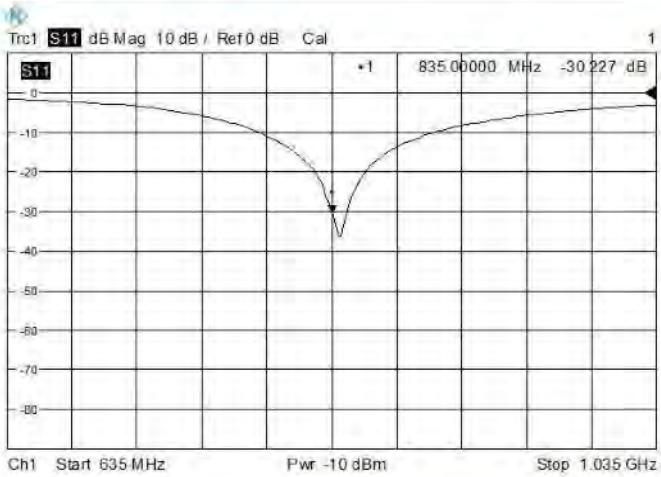
The dipoles are designed to have low return loss when presented against a flat phantom at the specified distance. A Vector Network Analyser was used to perform a return loss measurement on the specific dipole when in the measurement location against the phantom and the distance was specified by the manufacturer with a special, low loss and low relative permittivity spacer.
The impedance was measured at the SMA-connector with the network analyser.

## 3.1 D835V2

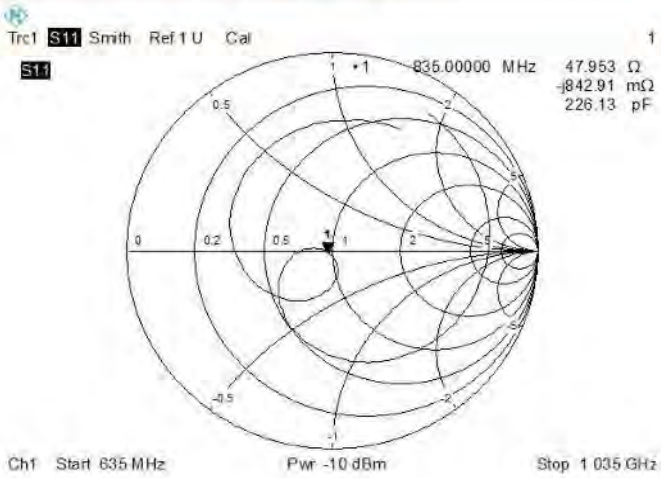
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 835 | -30.227 | -20 | 48.0 Ω - 0.842 jΩ |

Return Loss



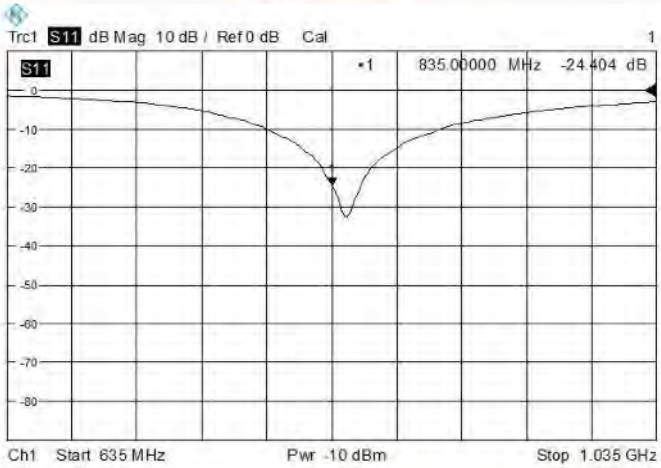

Impedance



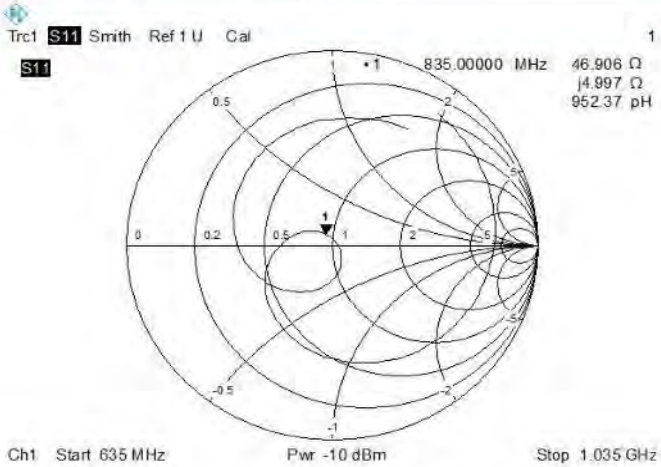
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 835 | -24.404 | -20 | 46.9 Ω + 4.997 jΩ |

Return Loss




Impedance

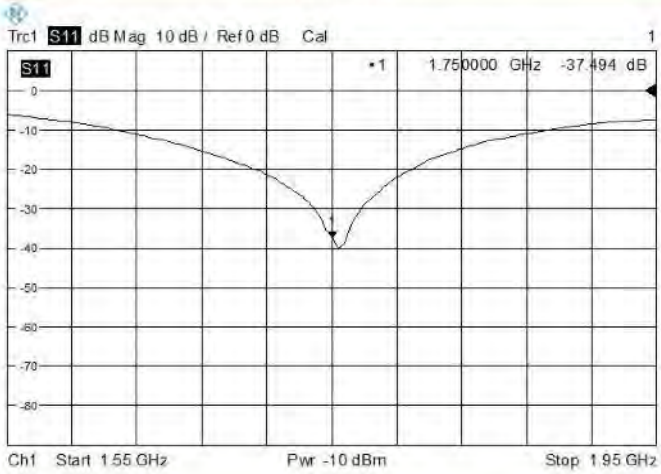


## 3.2 D1750V2

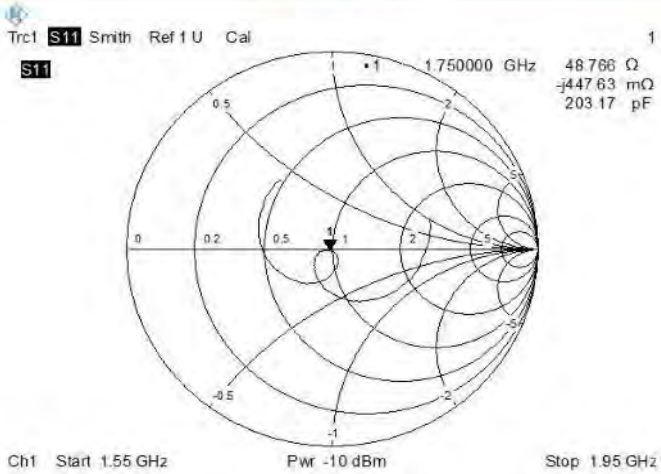
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1750 | -37.494 | -20 | 48.8 Ω - 0.448 jΩ |

Return Loss



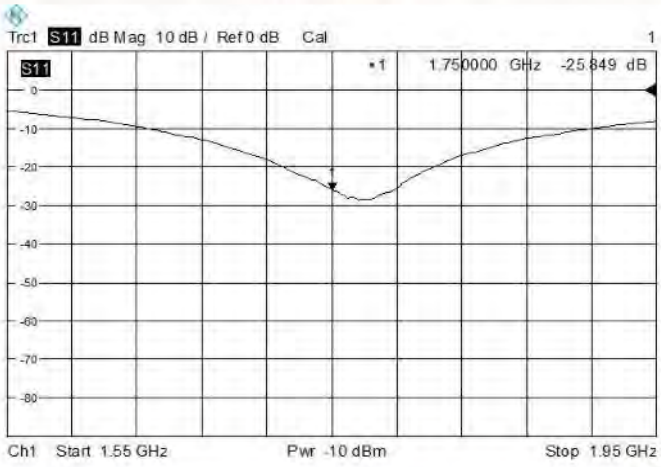

Impedance



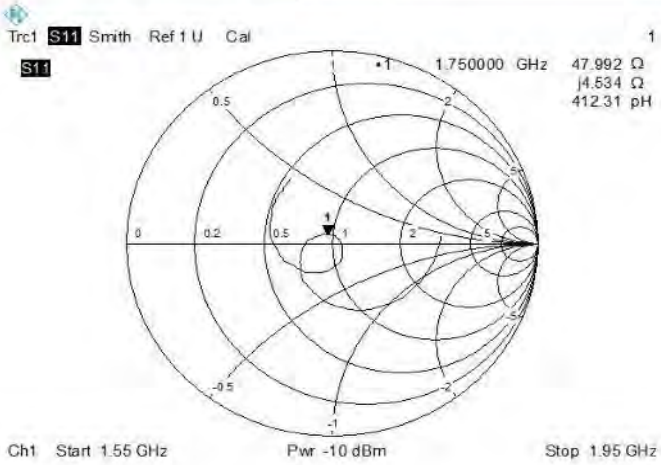
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1750 | -25.849 | -20 | 48.0 Ω + 4.534 jΩ |

Return Loss




Impedance

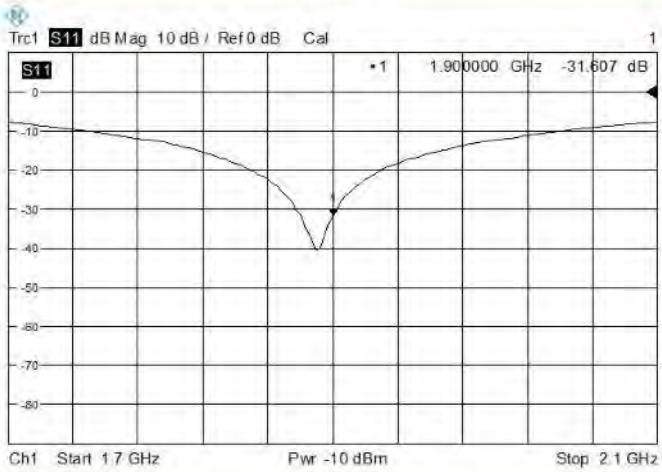


## 3.3 D1900V2

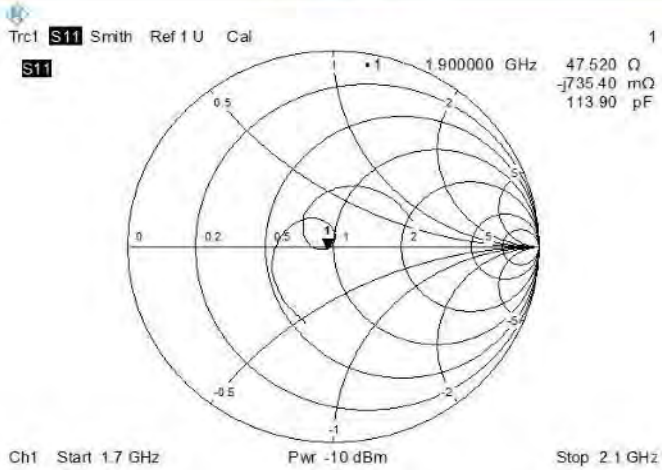
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss(dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -31.607 | -20 | 47.520 Ω-0.735 jΩ |

Return Loss



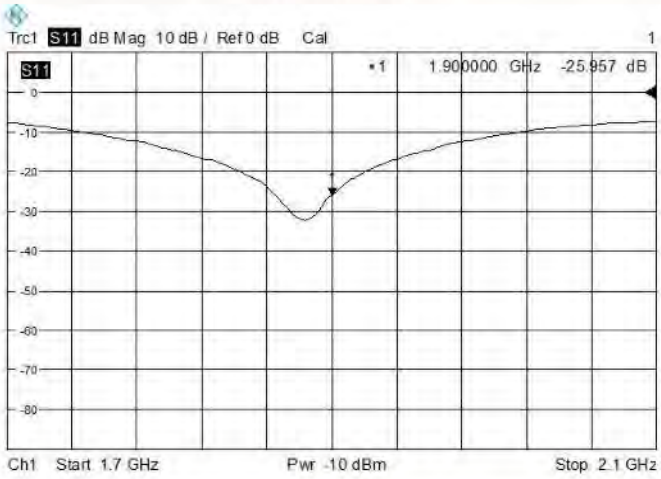

Impedance



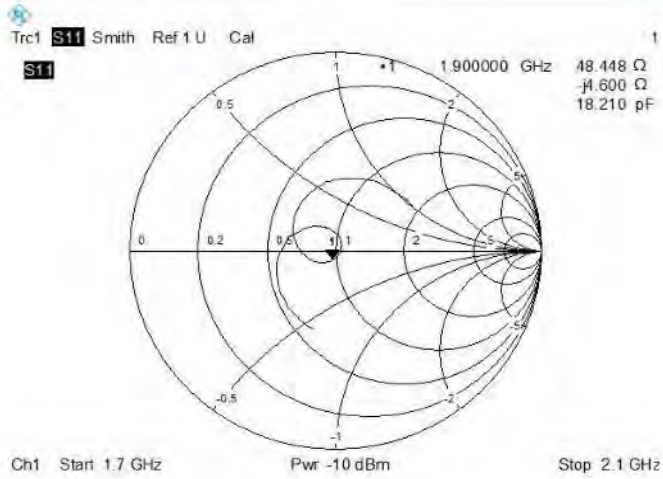
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -25.957 | -20 | 48.4 Ω - 4.6 jΩ |

Return Loss




Impedance

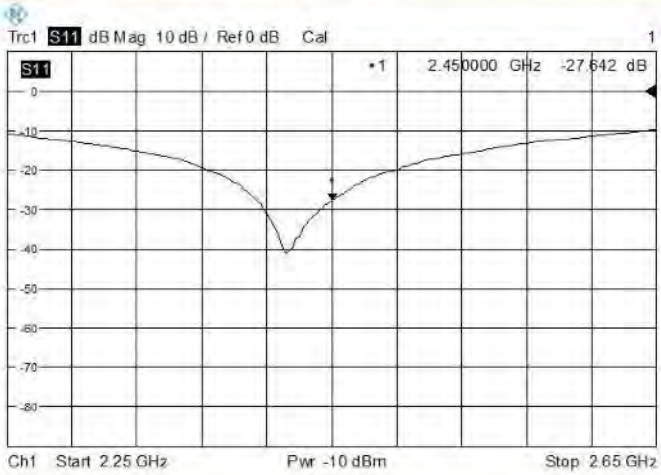


## 3.4 D2450V2

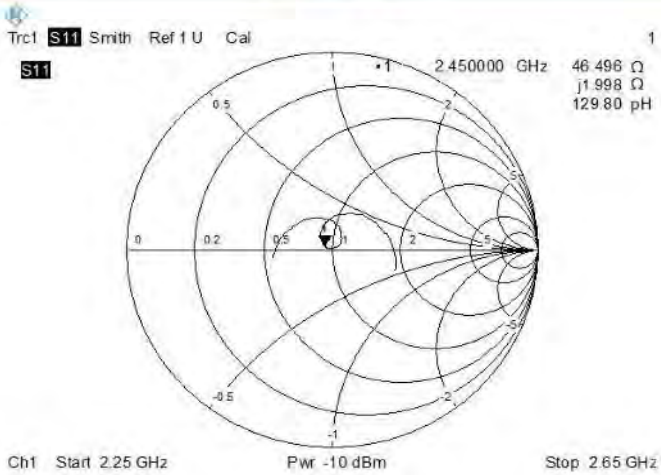
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -27.642 | -20 | 46.5 Ω + 1.998 jΩ |

Return Loss



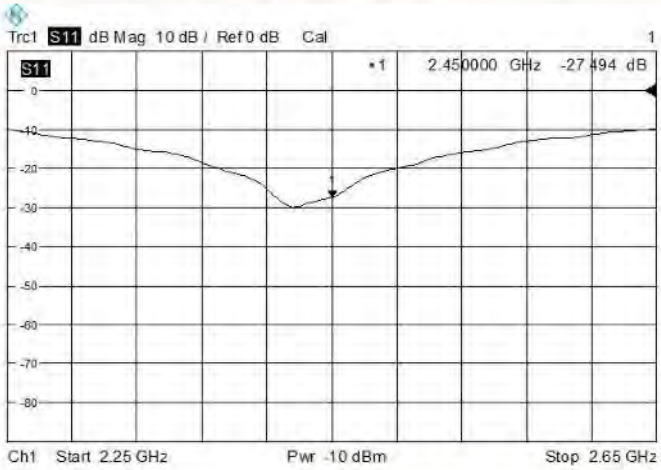

Impedance



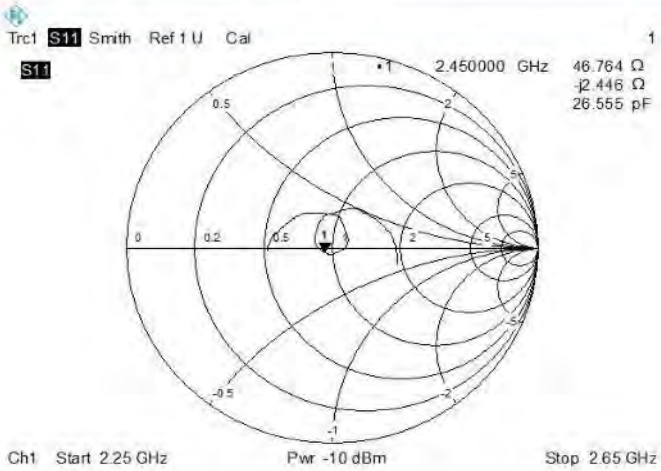
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -27.494 | -20 | 46.8 Ω - 2.446 jΩ |

Return Loss




Impedance

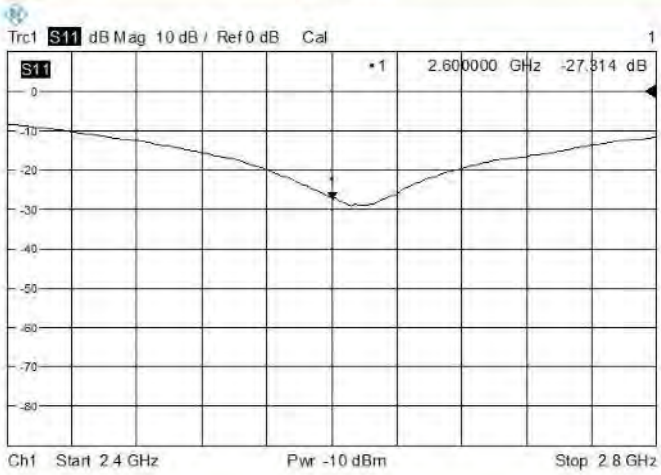


## 3.5 D2600V2

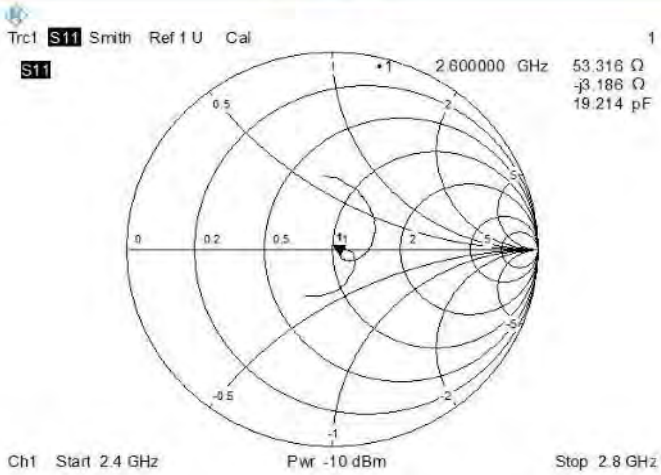
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2600 | -27.314 | -20 | 53.3 Ω - 3.186 jΩ |

Return Loss



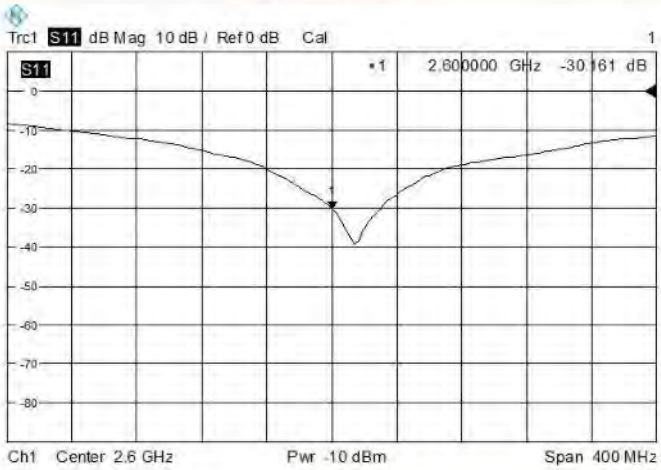

Impedance



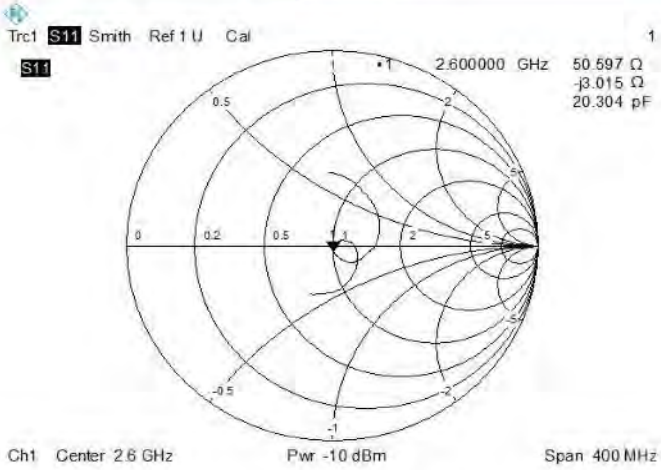
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2600 | -30.161 | -20 | 50.6 Ω - 3.015 jΩ |

Return Loss




Impedance

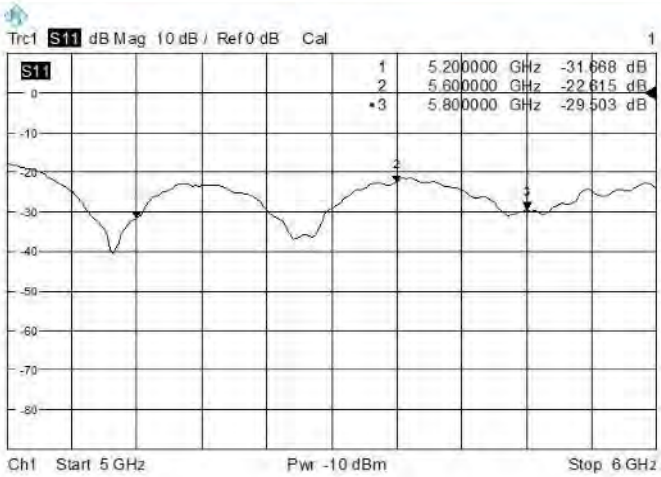


## 3.6 D5GHzV2

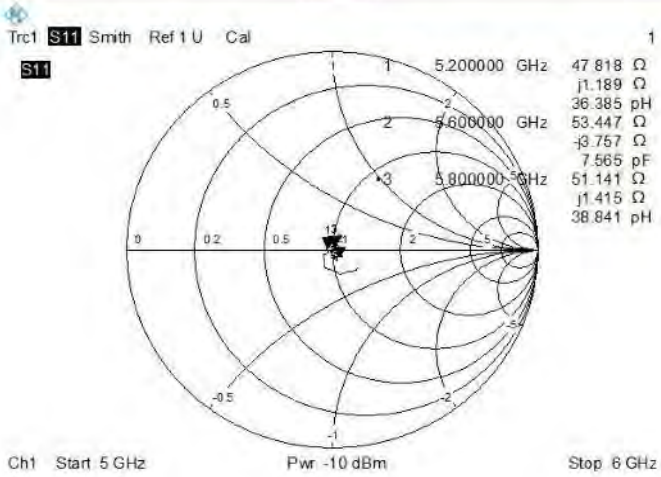
***RETURN LOSS AND IMPEDANCE IN HEAD LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 5200 | -31.668 | -20 | 47.8 Ω + 1.189 jΩ |
| 5600 | -22.615 | -20 | 53.4 Ω - 3.757 jΩ |
| 5800 | -29.503 | -20 | 51.1 Ω + 1.415 jΩ |

Return Loss



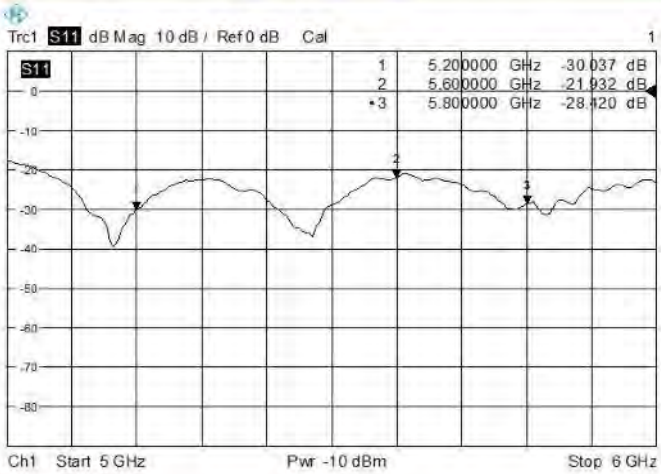

Impedance



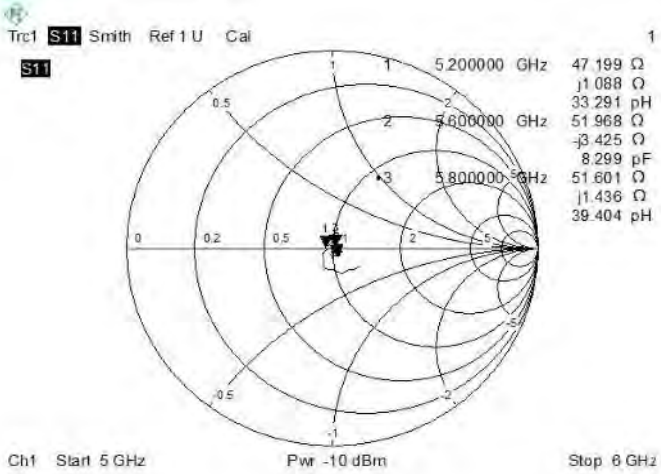
***RETURN LOSS AND IMPEDANCE IN BODY LIQUID***

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 5200 | -30.037 | -20 | 47.2 Ω + 1.088 jΩ |
| 5600 | -21.932 | -20 | 52.0 Ω - 3.425 jΩ |
| 5800 | -28.420 | -20 | 51.6 Ω + 1.436 jΩ |

Return Loss

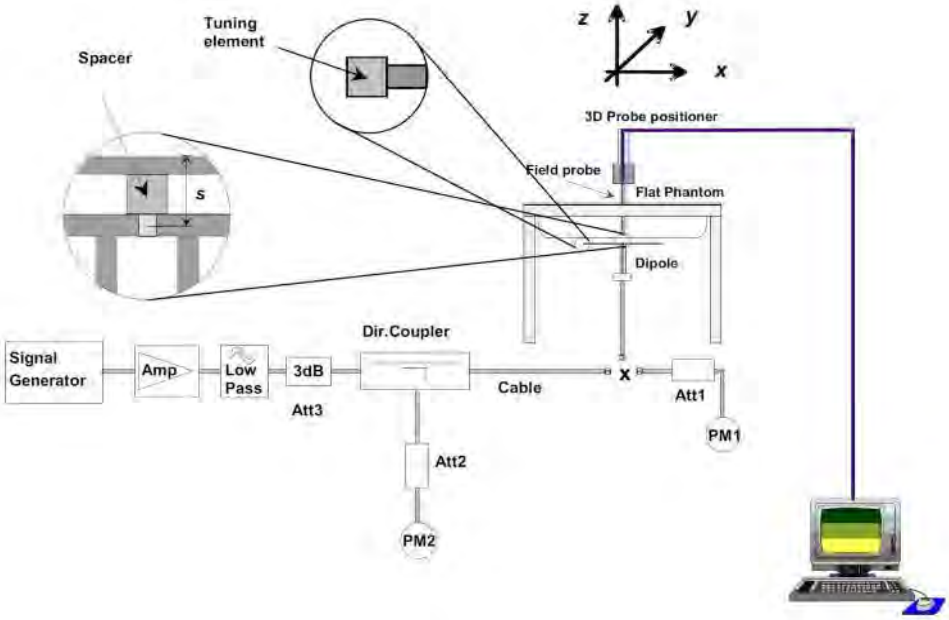



Impedance



# 4 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.




## 4.1 Dipole SAR Validation Measurement Result

| Freq. (MHz) | Liquid Type | Power (mW) | 1 g Measured SAR (W/kg) | Normalized SAR (W/kg) | 10 g Measured SAR (W/kg) | Normalized SAR (W/kg) | 1 g Targeted SAR (W/kg) | Tolerance (%) | 10 g Targeted SAR (W/kg) | Tolerance (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 835 | Head | 100 | 0.959 | 9.59 | 0.627 | 6.27 | 9.56 | 0.31 | 6.22 | 0.80 |
| | Body | 100 | 0.961 | 9.61 | 0.634 | 6.34 | 9.56 | 0.52 | 6.22 | 1.93 |
| 1750 | Head | 100 | 3.440 | 34.40 | 1.810 | 18.10 | 36.40 | -5.49 | 19.30 | -6.22 |
| | Body | 100 | 3.660 | 36.60 | 1.950 | 19.50 | 36.40 | 0.55 | 19.30 | 1.04 |
| 1900 | Head | 100 | 3.960 | 39.60 | 2.070 | 20.70 | 39.70 | -0.25 | 20.50 | 0.98 |
| | Body | 100 | 4.010 | 40.10 | 2.090 | 20.90 | 39.70 | 1.01 | 20.50 | 1.95 |
| 2450 | Head | 100 | 5.260 | 52.60 | 2.410 | 24.10 | 52.40 | 0.38 | 24.00 | 0.42 |
| | Body | 100 | 5.130 | 51.30 | 2.330 | 23.30 | 52.40 | -2.10 | 24.00 | -2.92 |
| 2600 | Head | 100 | 5.410 | 54.10 | 2.360 | 23.60 | 55.30 | -2.17 | 24.60 | -4.07 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Body | 100 | 5.580 | 55.80 | 2.420 | 24.20 | 55.30 | 0.90 | 24.60 | -1.63 |
| 5200 | Head | 100 | 8.220 | 82.20 | 2.240 | 22.40 | 76.50 | 7.45 | 21.60 | 3.70 |
| | Body | 100 | 8.320 | 83.20 | 2.280 | 22.80 | 76.50 | 8.76 | 21.60 | 5.56 |
| 5600 | Head | 100 | 8.240 | 82.40 | 2.260 | 22.60 | | | | |
| | Body | 100 | 8.410 | 84.10 | 2.330 | 23.30 | | | | |
| 5800 | Head | 100 | 7.280 | 72.80 | 2.120 | 21.20 | 78.0 | -6.67 | 21.90 | -3.20 |
| | Body | 100 | 8.240 | 82.40 | 2.300 | 23.00 | 78.0 | 5.64 | 21.90 | 5.02 |

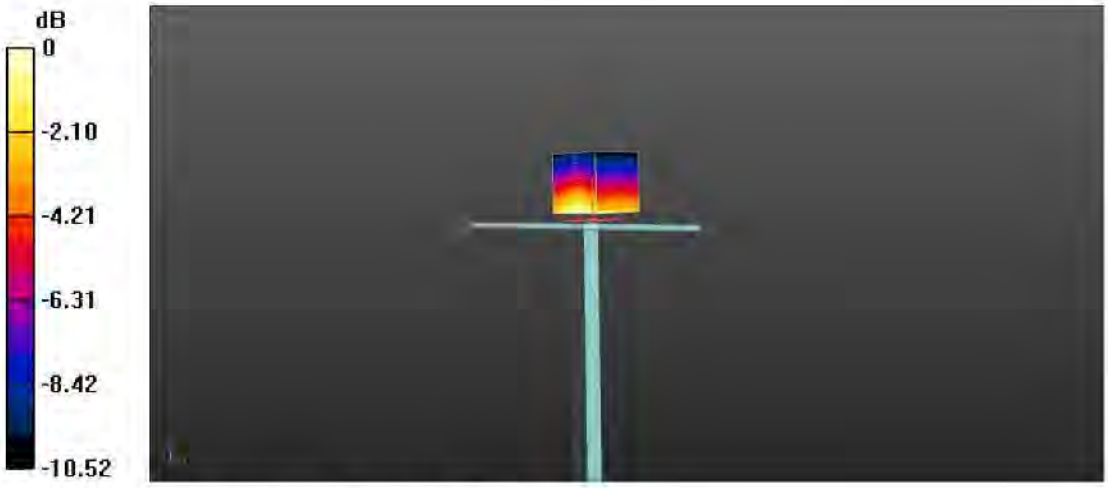
## 4.2 D835V2

### 4.2.1 Dipole 835 MHz Validation Measurement for Head Tissue

**Dipole 835 MHz; Type: D835V2; Serial: D835V2-SN: 4d187**
Date/Time: 10/25/2015
Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.89 S/m; $\varepsilon_r$ = 41.83; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature: 21.4 Liquid Temperature: 20.8
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.56, 9.56, 9.56);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW , d=15mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 34.03 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 1.44 W/kg
**SAR(1 g) = 0.959 W/kg; SAR(10 g) = 0.627 W/kg**
Maximum value of SAR (measured) = 1.03 W/kg



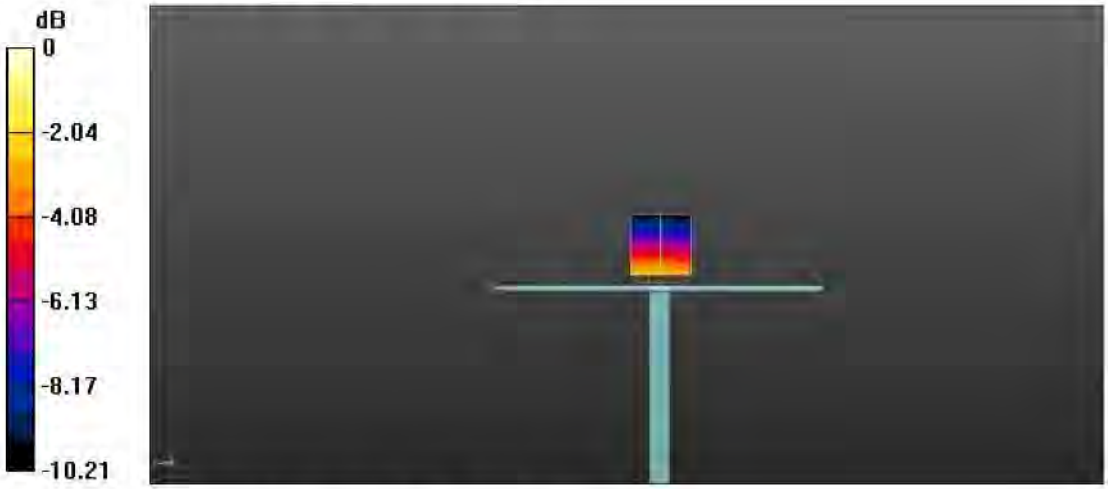

0 dB = 1.03 W/kg = 0.13 dBW/kg

### 4.2.2 Dipole 835 MHz Validation Measurement for Body Tissue

**Dipole 835 MHz; Type: D835V2; Serial: D835V2-SN: 4d187**
Date/Time: 10/25/2015
Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.98 S/m; $\varepsilon_r$ = 53.88; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature: 22.4 Liquid Temperature: 21.8
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.83, 9.83, 9.83);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW , d=15mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 31.63 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 1.40 W/kg
**SAR(1 g) = 0.961 W/kg; SAR(10 g) = 0.634 W/kg**
Maximum value of SAR (measured) = 1.04 W/kg




0 dB = 1.04 W/kg = 0.17 dBW/kg

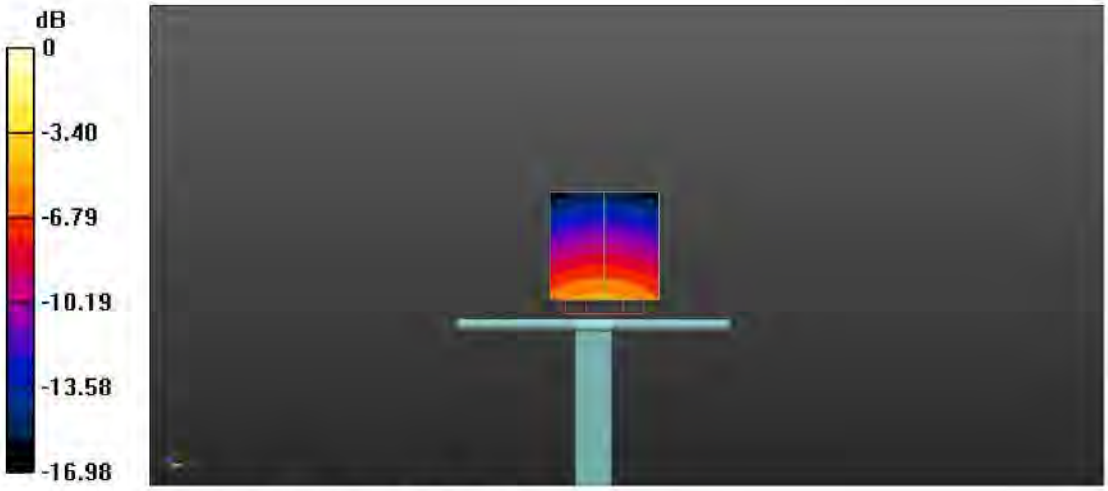
## 4.3 D1750V2

### 4.3.1 Dipole 1750 MHz Validation Measurement for Head Tissue

**Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2-SN: 1130**
Date/Time: 10/23/2015
Communication System Band: D1750 (1750.0 MHz); Frequency: 1750 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.38 S/m; $\varepsilon_r$ = 39.23; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.8 Liquid Temperature:21.2
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(9.13, 9.13, 9.13);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 40.68 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 6.42 W/kg
**SAR(1 g) = 3.44 W/kg; SAR(10 g) = 1.81 W/kg**
Maximum value of SAR (measured) = 3.87 W/kg



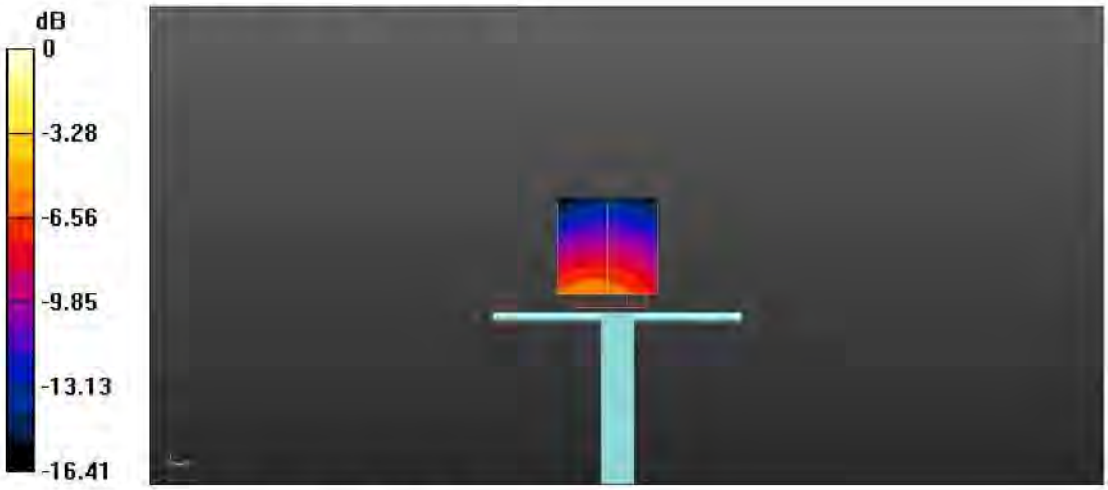

0 dB = 3.87 W/kg = 5.88 dBW/kg

### 4.3.2 Dipole 1750 MHz Validation Measurement for Body Tissue

**Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2-SN: 1130**
Date/Time: 10/22/2015
Communication System Band: D1750 (1750.0 MHz); Frequency: 1750 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.45 S/m; $\varepsilon_r$ = 51.75; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.8 Liquid Temperature:21.2
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.87, 7.87, 7.87);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 38.41 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 6.61 W/kg
**SAR(1 g) = 3.66 W/kg; SAR(10 g) = 1.95 W/kg**
Maximum value of SAR (measured) = 4.14 W/kg




0 dB = 4.14 W/kg = 6.17 dBW/kg

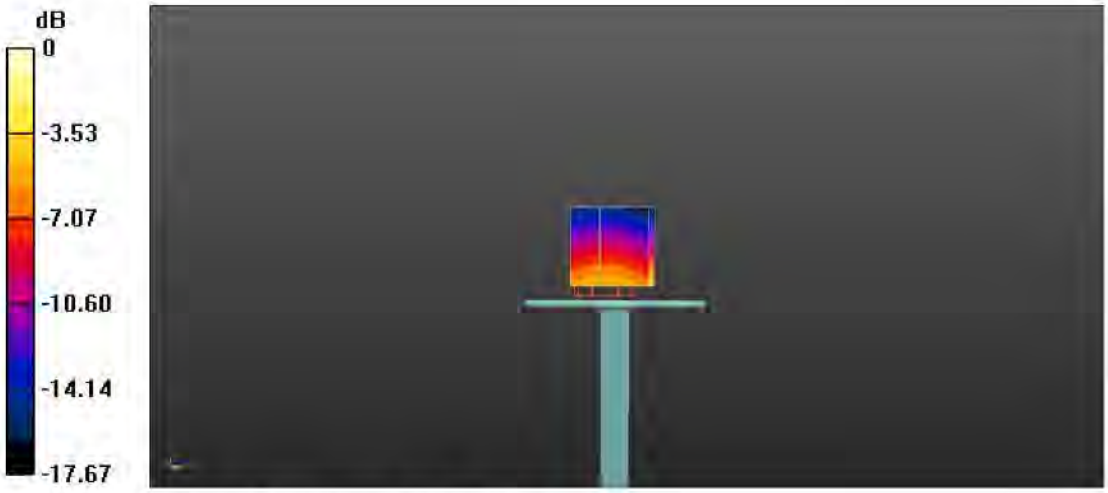
## 4.4D1900V2

### 4.4.1 Dipole 1900 MHz Validation Measurement for Head Tissue

**Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2-SN: 5d193**
Date/Time: 10/25/2015
Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.43 S/m; $\varepsilon_r$ = 39.75; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.7 Liquid Temperature:20.9
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(8.15, 8.15, 8.15);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 48.36 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 7.33 W/kg
**SAR(1 g) = 3.96 W/kg; SAR(10 g) = 2.07 W/kg**
Maximum value of SAR (measured) = 4.40 W/kg



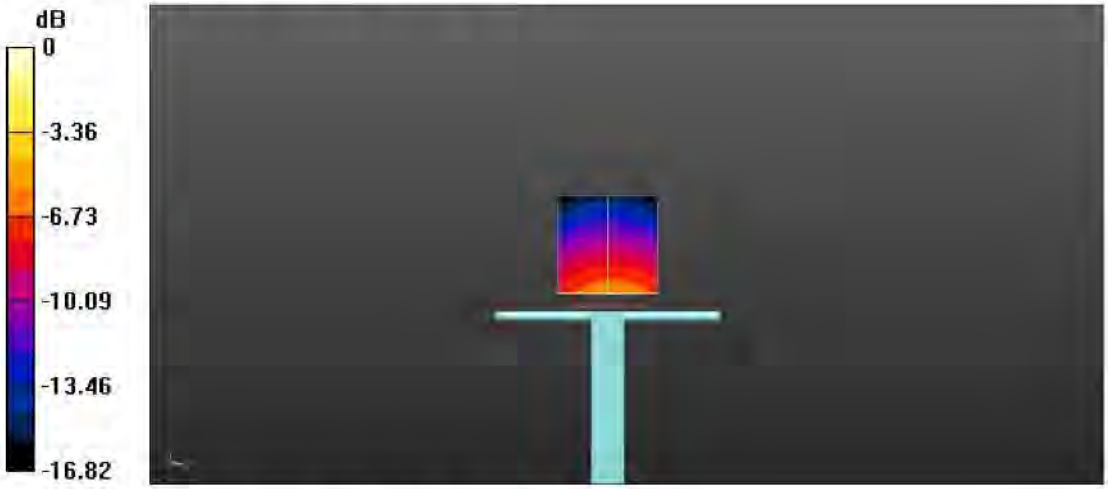

0 dB = 4.40 W/kg = 6.43 dBW/kg

### 4.4.2 Dipole 1900 MHz Validation Measurement for Body Tissue

**Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2-SN: 5d193**
Date/Time: 10/25/2015
Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.55 S/m; $\varepsilon_r$ = 51.61; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.7 Liquid Temperature:20.9
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.51, 7.51, 7.51);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 48.99 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 7.27 W/kg
**SAR(1 g) = 4.01 W/kg; SAR(10 g) = 2.09 W/kg**
Maximum value of SAR (measured) = 4.55 W/kg




0 dB = 4.55 W/kg = 6.58 dBW/kg

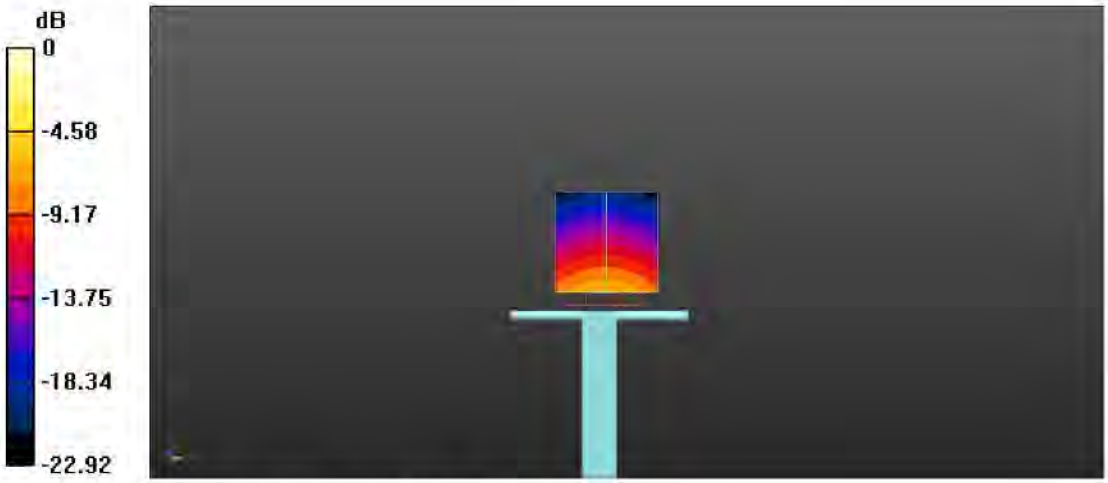
## 4.5 D2450V2

### 4.5.1 Dipole 2450 MHz Validation Measurement for Head Tissue

**Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2-SN: 952**
Date/Time: 10/24/2015
Communication System Band: CD2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.84 S/m; $\varepsilon_r$ = 38.53; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.1 Liquid Temperature:21.2
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.62, 7.62, 7.62);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.74 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 11.3 W/kg
**SAR(1 g) = 5.26 W/kg; SAR(10 g) = 2.41 W/kg**
Maximum value of SAR (measured) = 6.00 W/kg



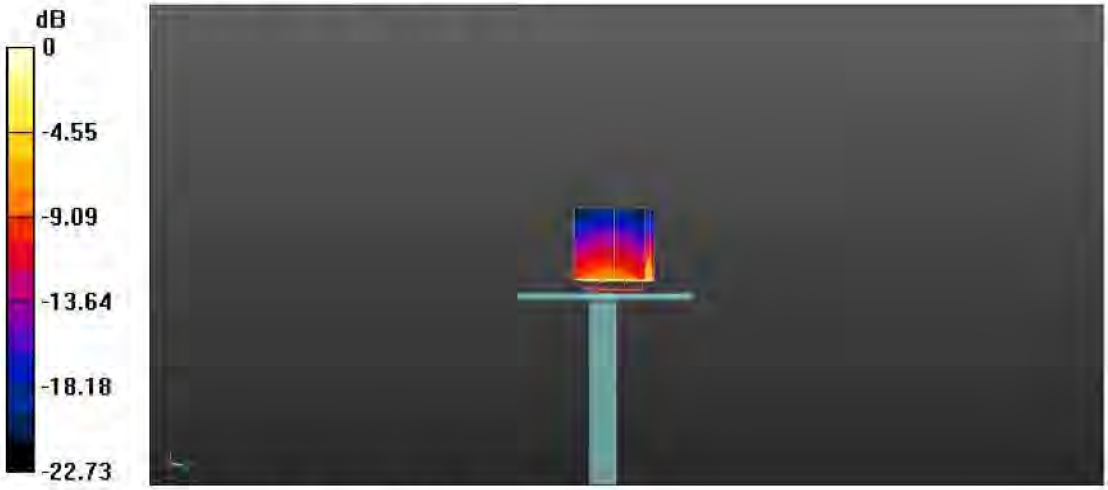

0 dB = 6.00 W/kg = 7.78 dBW/kg

### 4.5.2 Dipole 2450 MHz Validation Measurement for Body Tissue

**Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2-SN: 952**
Date/Time: 10/24/2015
Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.99 S/m; $\varepsilon_r$ = 51.17; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.1 Liquid Temperature:21.2
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 50.42 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 10.8 W/kg
**SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.33 W/kg**
Maximum value of SAR (measured) = 5.91 W/kg




0 dB = 5.91 W/kg = 7.72 dBW/kg

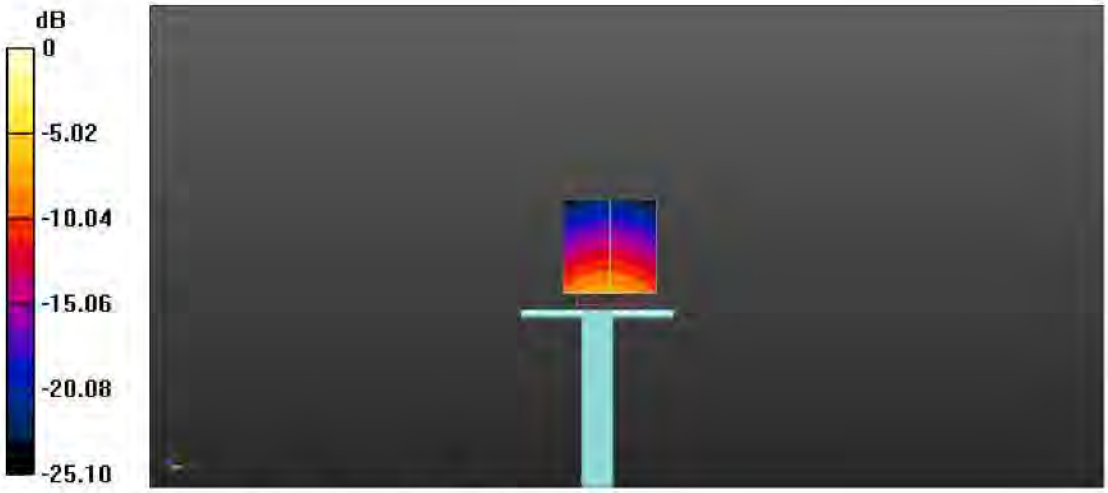
## 4.6 D2600V2

### 4.6.1 Dipole 2600 MHz Validation Measurement for Head Tissue

**Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2-SN: 1095**
Date/Time: 10/24/2015
Communication System Band: D2600 (2600.0 MHz); Frequency: 2600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2600 MHz; $\sigma$ = 1.97 S/m; $\varepsilon_r$ = 38.09; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.5 Liquid Temperature:20.6
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.64, 7.64, 7.64);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 52.69 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 12.2 W/kg
**SAR(1 g) = 5.41 W/kg; SAR(10 g) = 2.36 W/kg**
Maximum value of SAR (measured) = 6.17 W/kg



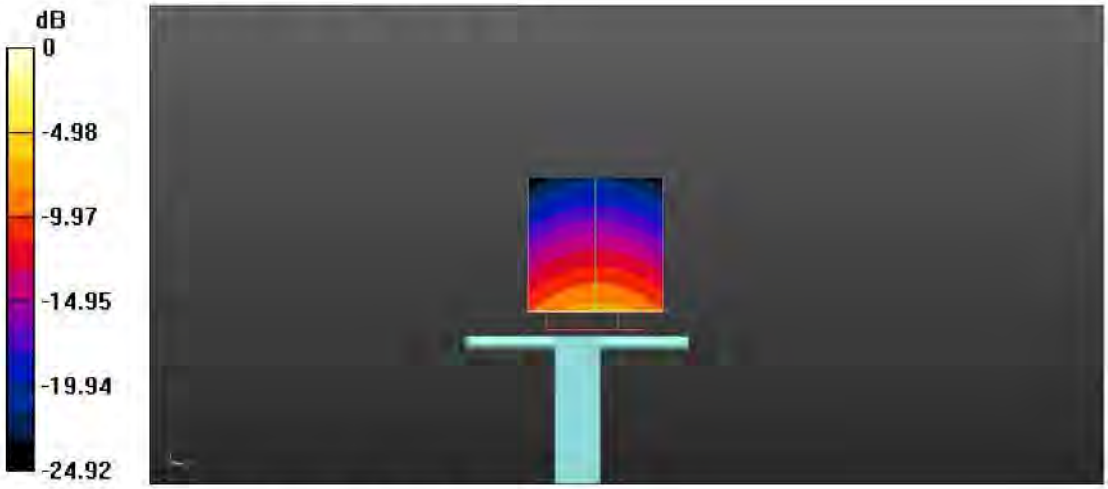

0 dB = 6.17 W/kg = 7.90 dBW/kg

### 4.6.2 Dipole 2600 MHz Validation Measurement for Body Tissue

**Dipole 2600 MHz; Type: D2600V2; Serial: D835V2-SN: 1095**
Date/Time: 10/24/2015
Communication System Band: D2600 (2600.0 MHz); Frequency: 2600 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2600 MHz; $\sigma$ = 2.20 S/m; $\varepsilon_r$ = 50.81; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:21.5 Liquid Temperature:20.6
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(7.11, 7.11, 7.11);
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW ,d=10mm /Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 52.33 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 12.3 W/kg
**SAR(1 g) = 5.58 W/kg; SAR(10 g) = 2.42 W/kg**
Maximum value of SAR (measured) = 6.45 W/kg




0 dB = 6.45 W/kg = 8.10 dBW/kg

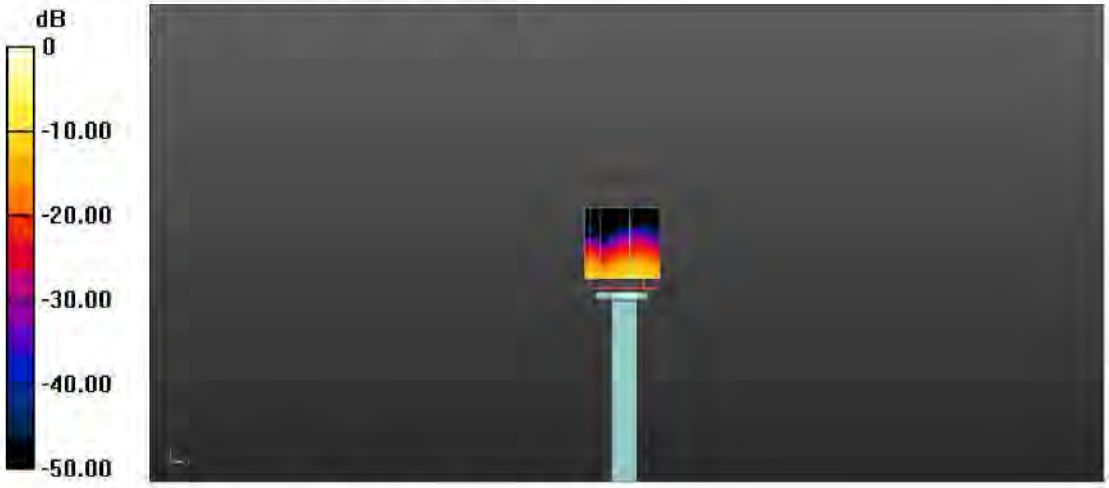
## 4.7 D5GHzV2

### 4.7.1 Dipole 5 GHz Validation Measurement for Head Tissue

**Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2-SN: 1200**
Date/Time: 10/26/2015
Communication System Band: D5GHz (5000.0 - 6000.0 MHz);
Frequency: 5200 MHz,
Frequency: 5600 MHz,
Frequency: 5800 MHz;
Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; $\sigma$ = 4.78 S/m; $\varepsilon_r$ = 36.52; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 5.20 S/m; $\varepsilon_r$ = 35.06; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5800 MHz; $\sigma$ = 5.42 S/m; $\varepsilon_r$ = 34.40; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.0 Liquid Temperature:20.3
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(5.33, 5.33, 5.33); ConvF(4.70, 4.70, 4.70); ConvF(4.68, 4.68, 4.68);
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Head Tissue/Pin= 100mW ,dist=10mm,f=5200 MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.80 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 25.9 W/kg
**SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.24 W/kg**
Maximum value of SAR (measured) = 9.71 W/kg

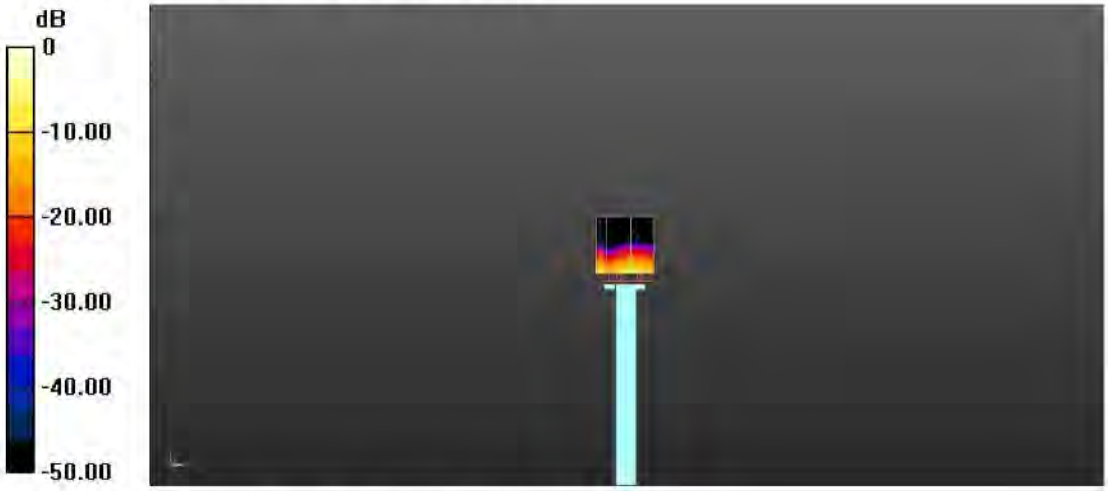



0 dB = 9.71 W/kg = 9.87 dBW/kg

**Dipole validation measurement for Head Tissue/Pin= 100mW ,dist=10mm,f=5600 MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 44.02 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 28.3 W/kg
**SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.29 W/kg**
Maximum value of SAR (measured) = 9.45 W/kg

0 dB = 9.45 W/kg = 9.75 dBW/kg

**Dipole Calibration for Head Tissue/Pin= 100mW ,dist=10mm,f=5800 MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 39.70 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 24.4 W/kg
**SAR(1 g) = 7.28 W/kg; SAR(10 g) = 2.12 W/kg**
Maximum value of SAR (measured) = 8.38 W/kg



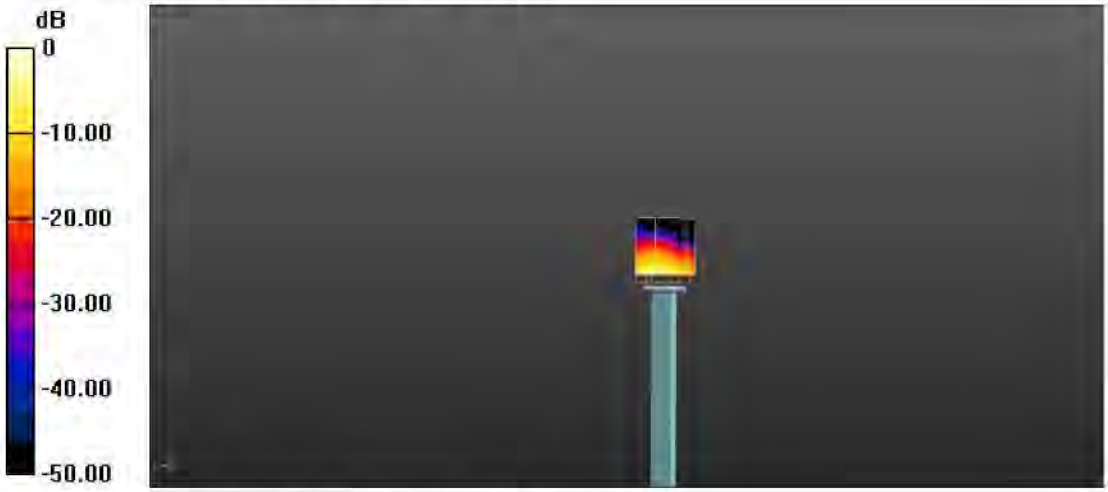

0 dB = 8.79 W/kg = 9.44 dBW/kg

### 4.7.2 Dipole 5 GHz Validation Measurement for Body Tissue

**Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2-SN: 1200**
Date/Time: 10/26/2015
Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5200 MHz; Frequency: 5600 MHz; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; $\sigma$ = 5.38 S/m; $\varepsilon_r$ = 48.74; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: f = 5600 MHz; $\sigma$ = 5.72 S/m; $\varepsilon_r$ = 46.31; $\rho$ = 1000 kg/m$^3$, Medium parameters used: f = 5800 MHz; $\sigma$ = 5.92 S/m; $\varepsilon_r$ = 46.06; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4
DASY5 Configuration:

- Probe: EX3DV4 - SN7340; ConvF(4.56, 4.56, 4.56);ConvF(3.98, 3.98, 3.98); ConvF(4.15, 4.15, 4.15);
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454;
- Phantom: SAM (30deg probe tilt) with CRP v5.0 on left 1859; Type: QD000P40CD; Serial: TP:1859
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole validation measurement for Body Tissue/Pin= 100mW ,dist=10mm,f=5200 MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 45.58 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 26.9 W/kg
**SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.28 W/kg**
Maximum value of SAR (measured) = 9.86 W/kg

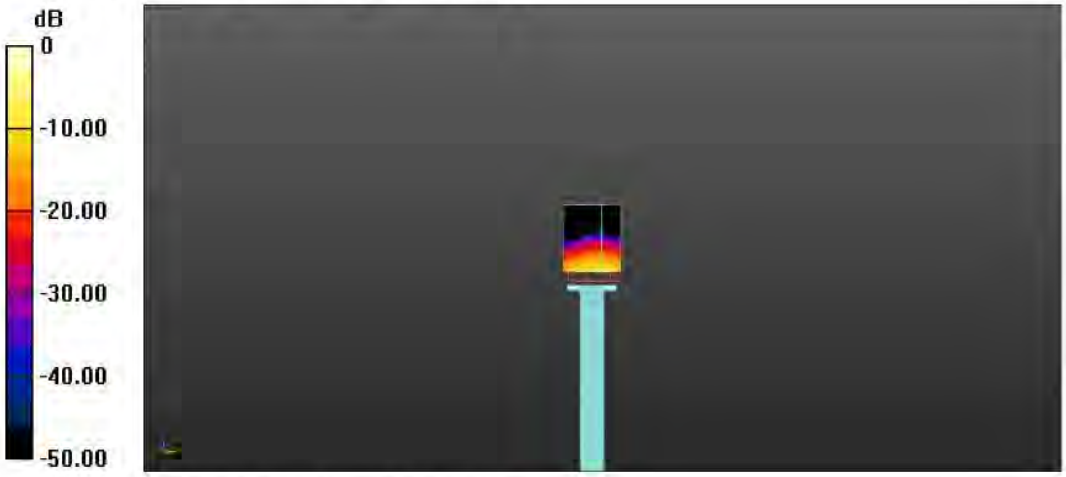



0 dB = 9.86 W/kg = 9.94 dBW/kg

**Dipole validation measurement for Body Tissue/Pin= 100mW , dist=10mm,f=5600 MHz /Zoom Scan (7x7x21)/Cube 0:**
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 47.14 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 35.1 W/kg
**SAR(1 g) = 8.41 W/kg; SAR(10 g) = 2.33 W/kg**
Maximum value of SAR (measured) = 10.3 W/kg

0 dB = 10.3 W/kg = 9.90 dBW/kg

**Dipole validation measurement for Body Tissue/Pin= 100mW ,dist=10mm,f=5800 MHz /Zoom Scan (7x7x21)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 41.88 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 28.9 W/kg
**SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.3 W/kg**
Maximum value of SAR (measured) = 9.33 W/kg




0 dB = 9.33 W/kg = 9.70 dBW/kg

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