



# A Test Lab Techno Corp.

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## SAR EVALUATION REPORT



Test Report No.	: 1612FS12
Applicant	: Hill-Rom Services Pte Ltd
Applicant Address	: 1 Yishun Avenue 7 Singapore 768923
Product Type	: WIFI DONGLE , USB
Trade Name	: HILL-ROM
Model Number	: 198658
Date of Received	: Sep. 19, 2016
Test Period	: Nov. 15 ~ Nov. 21, 2016
Date of Issued	: Dec. 14, 2016
Test Environment	: Ambient Temperature : $22 \pm 2$ °C Relative Humidity : 40 - 70 %
Standard	: ANSI/IEEE C95.1-1992 / IEEE Std. 1528-2013 47 CFR Part §2.1093 / KDB 248227 D01 v02r02 KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02 KDB 447498 D01 v06 / KDB 447498 D02 v02r01
Test Lab Location	: Chang-an Lab (FCC Accredited Test Site Number: 510205)



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Approved By

(Bill Hu)

Tested By

(Mark Duan)



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## 1. Summary of Maximum Reported SAR Value

Equipment Class	Mode	Highest Reported			
		Head SAR <sub>1g</sub> (W/kg)	Body-Worn SAR <sub>1g</sub> (1.0 cm) (W/kg)	Body-Worn stand alone SAR <sub>1g</sub> (1.0 cm) (W/kg)	Hotspot SAR <sub>1g</sub> (1.0 cm Gap) (W/kg)
DTS	2.4GHz WLAN	N/A	N/A	0.41	N/A
NII	5GHz U-NII-1	N/A	N/A	N/A	N/A
	5GHz U-NII-2A	N/A	N/A	0.24	N/A
	5GHz U-NII-2C	N/A	N/A	0.62	N/A
	5GHz U-NII-3	N/A	N/A	0.52	N/A
Highest Simultaneous Transmission SAR		Head (W/kg)	Body-Worn (W/kg)	Body-Worn Stand alone (W/kg)	Hotspot (W/kg)
DTS+NII		N/A	N/A	0.94	N/A

NOTE: 1. The N/A is EUT not apply to the assessment of the exposure conditions.

- The test procedures, as described in American National Standards, Institute ANSI/IEEE C95.1 were employed and they specify the maximum exposure limit of Body is SAR<sub>1g</sub> 1.6 W/kg of tissue for portable devices being used within 20cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.
- For body worn operation, this device has been tested and meets FCC RF exposure guidelines, test all USB orientations [Horizontal-Up, Horizontal-Down, Vertical-Front and Vertical-Back] with a device-to-phantom separation distance of 5 mm or less, according to KDB Publication 447498 D01 requirements.

## 2. Description of Equipment under Test (EUT)

Applicant	Hill-Rom Services Pte Ltd 1 Yishun Avenue 7 Singapore 768923		
Manufacture	Hill-Rom Services Pte Ltd 1 Yishun Avenue 7 Singapore 768923		
Product Type	WIFI DONGLE , USB		
Trade Name	HILL-ROM		
Model Number	198658		
FCC ID	2AJKO198658		
RF Function	IEEE 802.11b / 802.11g / 802.11n 2.4GHz 20MHz		
	IEEE 802.11a / IEEE 802.11n 5GHz 20MHz		
Tx Frequency	Band	Operate Frequency (MHz)	
	IEEE 802.11b / 802.11g / 802.11n 2.4GHz 20MHz	2412 - 2462	
	IEEE 802.11a / 802.11n 5GHz 20MHz	5180 - 5825	
RF Conducted Power	Band	Power	
		(W)	(dBm)
(Avg.)	IEEE 802.11b	0.029	14.62
	IEEE 802.11g	0.010	9.88
	IEEE 802.11n 2.4GHz 20MHz	0.008	8.82
	IEEE 802.11a	0.022	13.42
	IEEE 802.11n 5GHz 20MHz	0.015	11.62
Antenna Type	PCB Antenna		
Device Category	Portable Device		
Application Type	Certification		

Note: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

### 3. Introduction

The A Test Lab Techno Corp. has performed measurements of the maximum potential exposure to the user of **Hill-Rom Services Pte Ltd Trade Name : HILL-ROM Model(s) : 198658**. The test procedures, as described in American National Standards, Institute C95.1-1999 [ 1 ] were employed and they specify the maximum exposure limit of 1.6mW/g as averaged over any 1 gram of tissue for portable devices being used within 20cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

#### 3.1 SAR Definition

Specific Absorption Rate (SAR) is defined as 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 ( $\rho$ ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Figure 2).

$$\text{SAR} = \frac{d}{dt} \left( \frac{dw}{dm} \right) = \frac{d}{dt} \left( \frac{dw}{\rho dv} \right)$$

Figure 2. SAR Mathematical Equation

SAR is expressed in units of Watts per kilogram (W/kg)

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

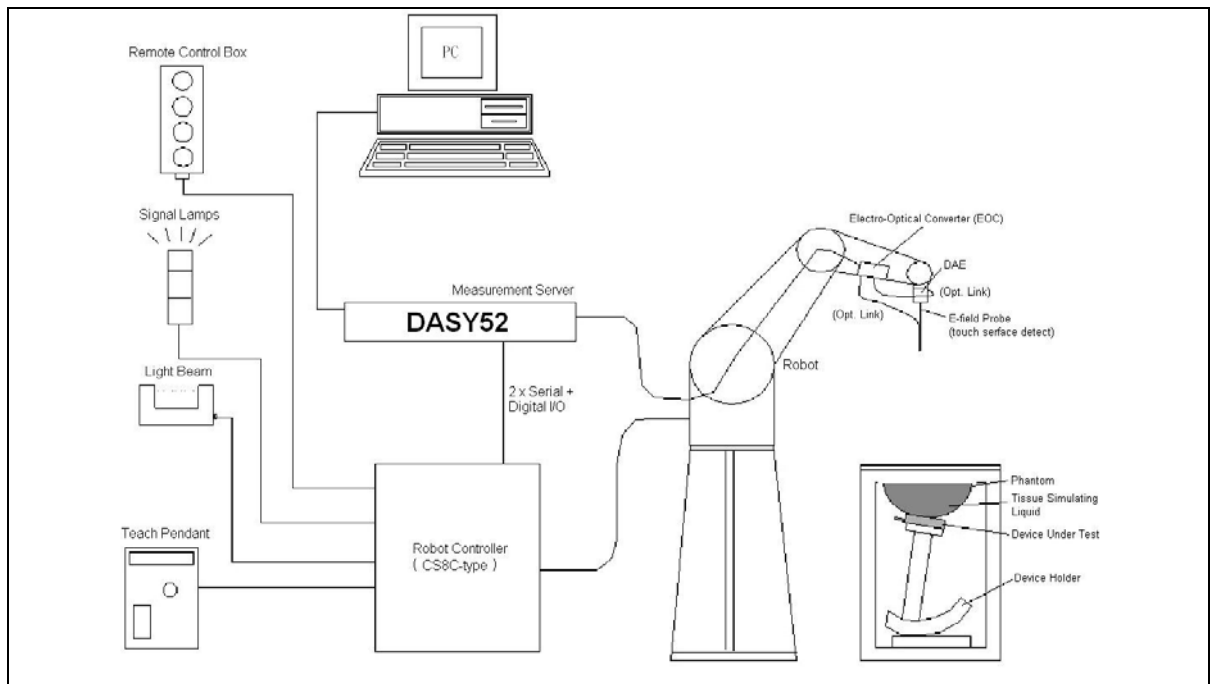
Where :

- $\sigma$  = conductivity of the tissue (S/m)
- $\rho$  = mass density of the tissue (kg/m<sup>3</sup>)
- $E$  = RMS electric field strength (V/m)

\* Note :

The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane [ 2 ]

#### 4. SAR Measurement Setup



The DASY52 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli TX family) with controller, teach pendant 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 electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
5. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
6. A computer operating Windows 2000 or Windows XP.
7. DASY52 software.
8. Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The SAM twin phantom enabling testing 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. Validation dipole kits allowing validating the proper functioning of the system.

## 4.1 DASY E-Field Probe System

The SAR measurements were conducted with the dosimetric probe (manufactured by SPEAG), designed in the classical triangular configuration [ 3 ] and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

### 4.1.1 E-Field Probe Specification

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to > 6 GHz Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)
Directivity	$\pm 0.3$ dB in brain tissue (rotation around probe axis) $\pm 0.5$ dB in brain tissue (rotation normal probe axis)
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm

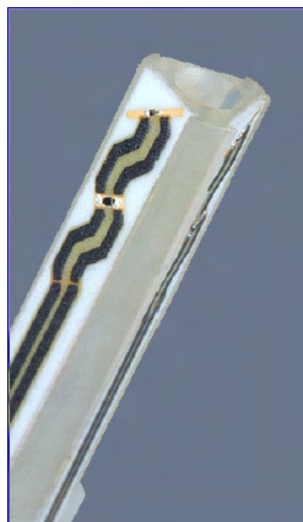


Figure 3. E-field Probe

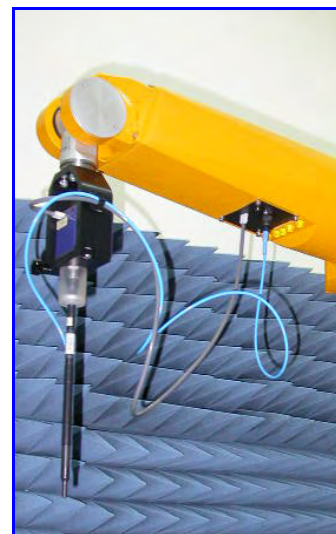


Figure 4. Probe setup on robot





#### 4.1.2 E-Field Probe Calibration process

##### Dosimetric Assessment Procedure

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm<sup>2</sup>) using an RF Signal generator, TEM cell, and RF Power Meter.

##### Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm<sup>2</sup>.

##### Temperature Assessment

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated head tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

Where :

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

C = Heat capacity of tissue (head or body),

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

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

Where :

$\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density (kg/m<sup>3</sup>).

## 4.2 Data Acquisition Electronic (DAE) System

Model :	DAE3, DAE4
Construction :	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range :	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage :	< 5 $\mu$ V (with auto zero)
Input Bias Current :	< 50 fA
Dimensions :	60 x 60 x 68 mm

## 4.3 Robot

Positioner :	Stäubli Unimation Corp. Robot Model: TX90XL
Repeatability :	$\pm 0.02$ mm
No. of Axis :	6

## 4.4 Measurement Server

Processor :	PC/104 with a 400MHz intel ULV Celeron
I/O-board :	Link to DAE4 (or DAE3) 16-bit A/D converter for surface detection system Digital I/O interface Serial link to robot Direct emergency stop output for robot

## 4.5 Device Holder

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

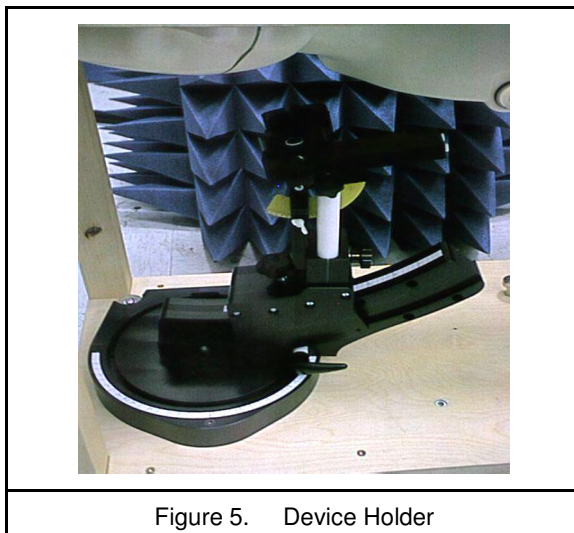


Figure 5. Device Holder

## 4.6 Oval Flat Phantom - ELI 4.0

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (Oval Flat) phantom defined in IEEE 1528-2013, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of wireless portable device usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness	$2 \pm 0.2$ mm
Filling Volume	Approx. 30 liters
Dimensions	190×600×400 mm (H×L×W)
Table 1. Specification of ELI 4.0	

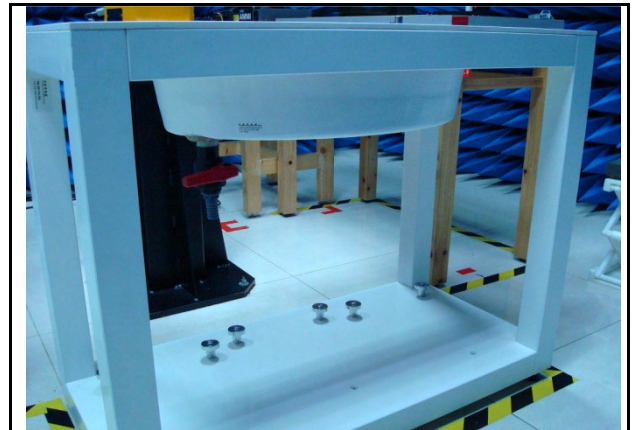


Figure 6. Oval Flat Phantom

## 4.7 Data Storage and Evaluation

### 4.7.1 Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension DA4 or DA5. The post processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

#### 4.7.2 Data Evaluation

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

- Probe parameters :    - Sensitivity       $Norm_i, ai0, ai1, ai2$   
                               - Conversion factor     $ConvFi$   
                               - Diode compression point    $dcp_i$
- Device parameters :    - Frequency       $f$   
                               - Crest factor       $cf$
- Media parameters :    - Conductivity     $\sigma$   
                               - Density         $\rho$

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

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as :

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

- With       $V_i$       = compensated signal of channel i (i = x, y, z)  
              $U_i$       = input signal of channel i (i = x, y, z)  
              $cf$       = crest factor of exciting field (DASY parameter)  
              $dcp_i$     = diode compression point (DASY parameter)

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

$$E\text{-field probes : } E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

*H-field probes :*

with  $V_i$  = compensated signal of channel i (i = x, y, z)  
*Normi* = sensor sensitivity of channel i (i = x, y, z)  
 $\mu V/(V/m)^2$  for *E-field Probes*  
*ConvF* = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
 $f$  = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with  $SAR$  = local specific absorption rate in mW/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

\* Note : That the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

The power flow density is calculated assuming the excitation field to be a free space field.

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

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

## 5. Tissue Simulating Liquids

The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the tissue.

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an E5071B Network Analyzer.

### IEEE SCC-34/SC-2 in 1528 recommended Tissue Dielectric Parameters

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in human head. Other head and body tissue parameters that have not been specified in 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equation and extrapolated according to the head parameter specified in 1528.

Target Frequency	Head		Body	
(MHz)	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 - 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00
( $\epsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m <sup>3</sup> )				

Table 2. Tissue dielectric parameters for head and body phantoms



## 5.1 Ingredients

The following ingredients are used:

- Water: deionized water (pure H<sub>2</sub>O), resistivity  $\geq 16 \text{ M } \Omega$  -as basis for the liquid
- Sugar: refined white sugar (typically 99.7 % sucrose, available as crystal sugar in food shops)  
-to reduce relative permittivity
- Salt: pure NaCl -to increase conductivity
- Cellulose: Hydroxyethyl-cellulose, medium viscosity (75-125 mPa.s, 2% in water, 20 °C), CAS # 54290 -to increase viscosity and to keep sugar in solution.
- Preservative: Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 -to prevent the spread of bacteria and molds
- DGBE: Diethylenglycol-monobutyl ether (DGBE), Fluka Chemie GmbH, CAS # 112-34-5 -to reduce relative permittivity

## 5.2 Recipes

The following tables give the recipes for tissue simulating liquids to be used in different frequency bands.

Note: The goal dielectric parameters (at 22 °C) must be achieved within a tolerance of  $\pm 5\%$  for  $\epsilon$  and  $\pm 5\%$  for  $\sigma$ .

Ingredients (% by weight)	Frequency (MHz)												Frequency (GHz)	
	750		835		1750		1900		2450		2600		5GHz	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	39.28	51.30	41.45	52.40	54.50	40.20	54.90	40.40	62.70	73.20	60.30	71.40	65.5	78.6
Salt (NaCl)	1.47	1.42	1.45	1.50	0.17	0.49	0.18	0.50	0.50	0.10	0.60	0.20	0.00	0.00
Sugar	58.15	46.18	56.00	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HEC	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bactericide	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.2	10.7
DGBE	0.00	0.00	0.00	0.00	45.33	59.31	44.92	59.10	36.80	26.70	39.10	28.40	0.00	0.00
Dielectric Constant	41.88	54.60	42.54	56.10	40.10	53.60	39.90	54.00	39.80	52.50	39.80	52.50	0.00	0.00
Conductivity (S/m)	0.90	0.97	0.91	0.95	1.39	1.49	1.42	1.45	1.88	1.78	1.88	1.78	0.00	0.00
Diethylene Glycol Mono-hexlether	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.3	10.7

Salt: 99+% Pure Sodium Chloride

Sugar: 98+% Pure Sucrose

Water: De-ionized,  $16 \text{ M } \Omega$  resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

### 5.3 Liquid Depth

According to KDB865664 ,the depth of tissue-equivalent liquid in a phantom must be  $\geq 15.0$  cm with  $\leq \pm 0.5$  cm variation for SAR measurements  $\leq 3$  GHz and  $\geq 10.0$  cm with  $\leq \pm 0.5$  cm variation for measurements  $> 3$  GHz.



Figure 7. Body-Position





## 6. SAR Testing with RF Transmitters

### 6.1 SAR Testing with 802.11 Transmitters

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

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

- $\leq 0.4$  W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- $> 0.4$  W/kg, SAR is repeated using the same wireless mode test configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the reported SAR is  $\leq 0.8$  W/kg or all required test positions are tested.
  - For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is  $> 0.8$  W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required test channels are considered.
  - The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.
- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is  $\leq 1.2$  W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is  $\leq 1.2$  W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

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



## 6.2 Conducted Power

Band	Data Rate (Mbps)	CH	Frequency (MHz)	Average Power (dBm)
IEEE 802.11b	1	1	2412	14.62
		6	2437	14.43
		11	2462	14.26
	2	6	2437	14.31
	5.5	6	2437	14.23
	11	6	2437	14.12
IEEE 802.11g	6	1	2412	9.88
		6	2437	9.48
		11	2462	9.26
	9	6	2437	9.37
	12	6	2437	9.31
	18	6	2437	9.24
	24	6	2437	9.17
	36	6	2437	9.12
	48	6	2437	9.08
IEEE 802.11n 2.4 GHz 20MHz	6.5	1	2412	8.82
		6	2437	8.34
		11	2462	8.11
	13	6	2437	8.22
	19.5	6	2437	8.11
	26	6	2437	8.02
	39	6	2437	7.92
	52	6	2437	7.83
	58.5	6	2437	7.71
	65	6	2437	7.62

Band	Data Rate (Mbps)	CH	Frequency (MHz)	Average Power (dBm)
IEEE 802.11a	6	36	5180	13.13
		40	5200	13.14
		44	5220	13.30
		48	5240	13.32
		52	5260	13.42
		56	5280	13.40
		60	5300	11.53
		64	5320	11.68
		100	5500	7.07
		104	5520	10.92
		108	5540	11.10
		112	5560	11.06
		116	5580	11.27
		120	5600	11.47
		124	5620	11.63
		128	5640	11.62
		132	5660	11.73
		136	5680	11.74
		140	5700	9.94
		149	5745	5.80
		153	5765	8.71
		157	5785	8.92
		161	5805	9.33
		165	5825	9.37
	54	36	5180	12.92
		40	5200	12.90
		44	5220	13.13
		48	5240	13.18
		52	5260	13.30
		56	5280	13.25
		60	5300	11.40
		64	5320	11.45
		100	5500	6.95
		104	5520	10.78
		108	5540	10.92
		112	5560	10.95
		116	5580	11.13
		120	5600	11.29
		124	5620	11.35
		128	5640	11.31
		132	5660	11.45
		136	5680	11.50
		140	5700	9.83
		149	5745	5.68
		153	5765	8.64
		157	5785	8.78
		161	5805	9.12
		165	5825	9.18

Band	Data Rate (Mbps)	CH	Frequency (MHz)	Average Power (dBm)
IEEE 802.11n 5GHz 20MHz	6.5	36	5180	11.52
		40	5200	11.59
		44	5220	11.62
		48	5240	11.61
		52	5260	11.41
		56	5280	11.32
		60	5300	10.66
		64	5320	10.85
		100	5500	5.56
		104	5520	10.36
		108	5540	10.32
		112	5560	10.34
		116	5580	10.52
		120	5600	10.55
		124	5620	10.46
		128	5640	10.69
		132	5660	10.46
		136	5680	10.51
		140	5700	6.54
		149	5745	4.36
		153	5765	6.00
		157	5785	6.44
		161	5805	6.74
		165	5825	7.81
	65	36	5180	11.28
		40	5200	11.38
		44	5220	11.45
		48	5240	11.40
		52	5260	11.12
		56	5280	11.09
		60	5300	10.47
		64	5320	10.62
		100	5500	5.32
		104	5520	10.08
		108	5540	10.02
		112	5560	10.09
		116	5580	10.38
		120	5600	10.31
		124	5620	10.25
		128	5640	10.37
		132	5660	10.19
		136	5680	10.37
		140	5700	6.41
		149	5745	4.15
		153	5765	5.78
		157	5785	6.33
		161	5805	6.54
		165	5825	7.53

### 6.3 Stand-alone SAR Evaluate

Stand-alone transmission configurations as below:

Band	Horizontal-UP	Horizontal-Down	Vertical-Front	Vertical-Back
IEEE 802.11b	V	V	V	V
IEEE 802.11g	---	---	---	---
IEEE 802.11n 2.4GHz 20MHz	---	---	---	---
IEEE 802.11a	V	V	V	V
IEEE 802.11n 5GHz 20MHz	---	---	---	---

Note: The "-" on behalf of Stand-alone SAR is not required (Refer to KDB447498 D01 v06 4.3.1 for the Standalone SAR test exclusion considerations)

Antenna	Operate Band	Channel	Frequency (GHz)	Tune-Power		Evaluate Distance of Ant.To User (mm)			
				(dBm)	(mW)	Horizontal-UP	Horizontal-Down	Vertical-Front	Vertical-Back
WLAN ANT	IEEE 802.11b	11	2.462	15	32	5	5	5	5
	IEEE 802.11g	11	2.462	10	10	5	5	5	5
	IEEE 802.11n 2.4GHz 20MHz	11	2.462	9	8	5	5	5	5
	IEEE 802.11a Band I	48	5.240	13.5	22	5	5	5	5
	IEEE 802.11a Band II-A	64	5.320	13.5	22	5	5	5	5
	IEEE 802.11a Band II-C	128	5.640	12	16	5	5	5	5
	IEEE 802.11a Band III	165	5.825	10	10	5	5	5	5
	IEEE 802.11n 5GHz 20MHz Band I	48	5.240	12	16	5	5	5	5
	IEEE 802.11n 5GHz 20MHz Band II-A	64	5.320	12	16	5	5	5	5
	IEEE 802.11n 5GHz 20MHz Band II-C	128	5.640	11	13	5	5	5	5
	IEEE 802.11n 5GHz 20MHz Band III	165	5.825	8	6	5	5	5	5

Antenna	Operate Band	Channel	Frequency (GHz)	Tune-Power		Calculated value and evaluated result (mm)			
				(dBm)	(mW)	Horizontal-UP	Horizontal-Down	Vertical-Front	Vertical-Back
WLAN ANT	IEEE 802.11 b	11	2.462	15	32	10	10	10	10
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11 g	11	2.462	10	10	3.1	3.1	3.1	3.1
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11 n 20M (2.4GHz)	11	2.462	9	8	2.5	2.5	2.5	2.5
						EXEMPT	EXEMPT	EXEMPT	EXEMPT
	IEEE 802.11a Band I	48	5.24	13.5	22	10.1	10.1	10.1	10.1
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11a Band II-A	64	5.32	13.5	22	10.1	10.1	10.1	10.1
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11a Band II-C	128	5.64	12	16	7.6	7.6	7.6	7.6
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11a Band III	165	5.825	10	10	4.8	4.8	4.8	4.8
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11n 5GHz 20MHz Band I	48	5.24	12	16	7.3	7.3	7.3	7.3
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11n 5GHz 20MHz Band II-A	64	5.32	12	16	7.4	7.4	7.4	7.4
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11n 5GHz 20MHz Band II-C	128	5.64	11	13	6.2	6.2	6.2	6.2
						MEASURE	MEASURE	MEASURE	MEASURE
	IEEE 802.11n 5GHz 20MHz Band III	165	5.825	8	6	2.9	2.9	2.9	2.9
						EXEMPT	EXEMPT	EXEMPT	EXEMPT

- Note: 1. Calculated Value include string "mW", that is mean through compare output power with threshold, if the output power more than threshold value the SAR test should be perform. Otherwise, the SAR test could be exempt. (> 50mm).
2. Calculated Value only include number format, that is mean through compare output power with threshold, if the Calculated value more than 3, the SAR test should be perform. Otherwise, the SAR test could be exempt. (<50mm).
3. When an antenna qualifies for the standalone SAR test exclusion of KDB 447498 section 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to KDB 447498 section "4.3.2. Simultaneous transmissions SAR test exclusion considerations b) ".
4. The channel and frequency used highest frequency, that result should be evaluated the worst case.
5. Power and distance are rounded to the nearest mW and mm before calculation.
6. The result is rounded to one decimal place for comparison.

## 6.4 Simultaneous Transmitting Evaluate

### 6.4.1 Sum of 1-g SAR of all simultaneously transmitting

When the sum of 1-g SAR of all simultaneously transmitting antennas in and operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration.

Sum of 1-g SAR of summary as below:

Phantom Position		Spacing (mm)	ASSY	WLAN Antenna		WLAN Antenna		$\sum SAR_{1g}$ (W/kg)	Event
				Band	$SAR_{1g}$ (W/kg)	Band	$SAR_{1g}$ (W/kg)		
Flat	Horizontal-UP	5	N/A	IEEE 802.11b	0.41	IEEE 802.11a	0.53	0.94	<1.6
	Horizontal-Down	5	N/A	IEEE 802.11b	0.289	IEEE 802.11a	0.26	0.549	<1.6
	Vertical-Front	5	N/A	IEEE 802.11b	0.299	IEEE 802.11a	0.62	0.919	<1.6
	Vertical-Back	5	N/A	IEEE 802.11b	0.205	IEEE 802.11a	0.53	0.735	<1.6

Note: 1. \* = Estimated SAR.

2. \*\*The Estimated SAR 0.4W/Kg, test separation distances is > 50 mm.

3. When the sum of 1-g SAR of all simultaneously transmitting antennas in and operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration.

### 6.4.2 SAR to peak location separation ratio (SPLSR)

When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio. The ratio is determined by  $(SAR_1 + SAR_2)^{1.5/R_i}$ , rounded to two decimal digits, and must be  $\leq 0.04$  for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

**All of sum of SAR < 1.6 W/kg, therefore SPLSR is not required.**



## 6.5 SAR test reduction according to KDB

General:

- The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC, Supplement C [June 2001], IEEE1528-2013.
- All modes of operation were investigated, and worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plots.
- Batteries are fully charged for all readings.
- When the Channel's SAR 1g of maximum conducted power is  $> 0.8$  mW/g, low, middle and high channel are supposed to be tested.

KDB 447498:

- The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to IEEE1528-2013.

KDB 865664:

- Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg.
- When the original highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
- Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg.
- Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

KDB 248227:

- Refer 6.1 SAR Testing with 802.11 Transmitters.



## 7. System Verification and Validation

### 7.1 Symmetric Dipoles for System Verification

Construction	Symmetrical dipole with 1/4 balun enables measurement of feed point impedance with NWA matched for use near flat phantoms filled with head simulating solutions Includes distance holder and tripod adaptor Calibration Calibrated SAR value for specified position and input power at the flat phantom in head simulating solutions.
Frequency	2450, 5200, 5500 and 5800 MHz
Return Loss	> 20 dB at specified verification position
Power Capability	> 100 W ( $f < 1\text{GHz}$ ); > 40 W ( $f > 1\text{GHz}$ )
Options	Dipoles for other frequencies or solutions and other calibration conditions are available upon request
Dimensions	D2450V2: dipole length 51.5 mm; overall height 300 mm D5GHzV2: dipole length 20.6 mm; overall height 300 mm

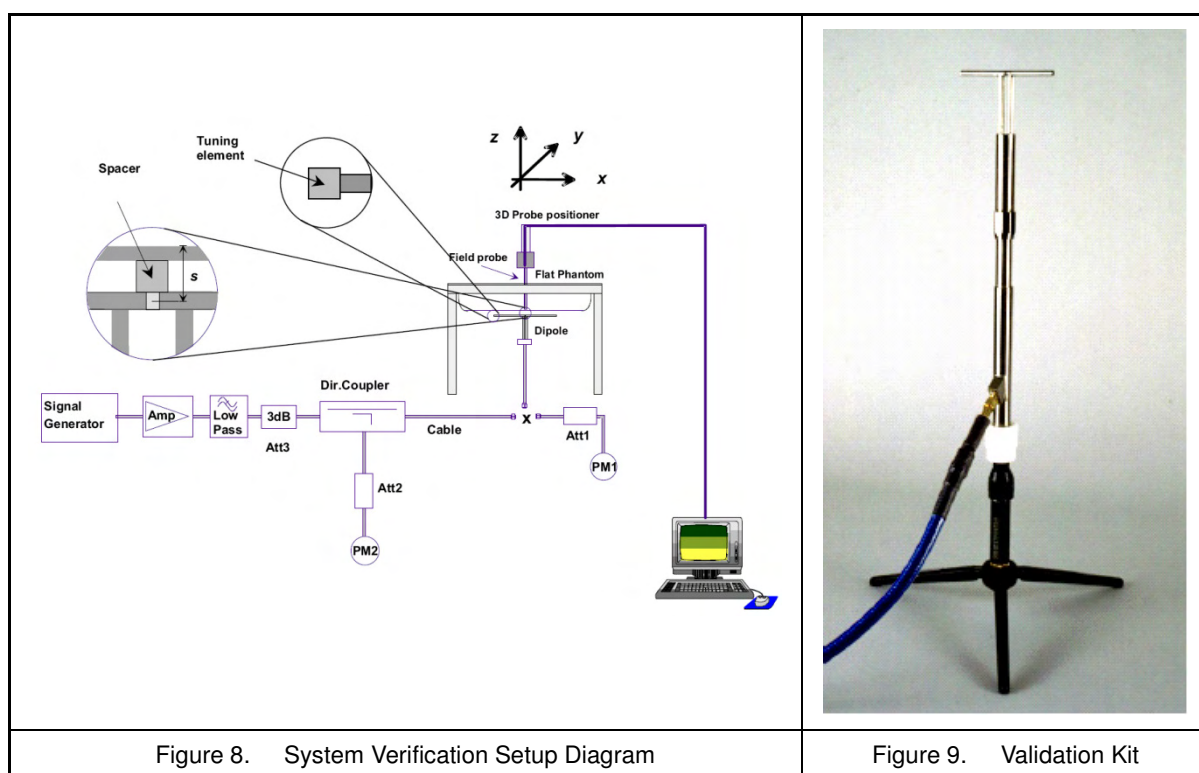


Figure 8. System Verification Setup Diagram

Figure 9. Validation Kit

## 7.2 Liquid Parameters

Liquid Verify								
Ambient Temperature : 22 $\pm$ 2 $^{\circ}$ C ; Relative Humidity : 40 -70%								
Liquid Type	Frequency	Temp ( $^{\circ}$ C)	Parameters	Target Value	Measured Value	Deviation (%)	Limit (%)	Measured Date
2450MHz (Body)	2400MHz	22.0	$\epsilon_r$	52.77	52.71	-0.19	$\pm$ 5	Nov. 15, 2016
			$\sigma$	1.902	1.919	1.05	$\pm$ 5	
	2450MHz	22.0	$\epsilon_r$	52.70	52.40	-0.57	$\pm$ 5	
			$\sigma$	1.950	1.964	0.51	$\pm$ 5	
	2500MHz	22.0	$\epsilon_r$	52.64	52.42	-0.38	$\pm$ 5	
			$\sigma$	2.021	2.049	1.49	$\pm$ 5	
5200MHz (Body)	5150MHz	22.0	$\epsilon_r$	49.08	48.80	-0.61	$\pm$ 5	Nov. 18, 2016
			$\sigma$	5.241	5.167	-1.34	$\pm$ 5	
	5200MHz	22.0	$\epsilon_r$	49.01	48.77	-0.41	$\pm$ 5	
			$\sigma$	5.299	5.245	-0.94	$\pm$ 5	
	5250MHz	22.0	$\epsilon_r$	48.95	48.59	-0.61	$\pm$ 5	
			$\sigma$	5.358	5.304	-1.12	$\pm$ 5	
5500MHz (Body)	5450MHz	22.0	$\epsilon_r$	48.68	48.23	-1.03	$\pm$ 5	Nov. 20, 2016
			$\sigma$	5.591	5.634	0.72	$\pm$ 5	
	5500MHz	22.0	$\epsilon_r$	48.61	48.07	-1.03	$\pm$ 5	
			$\sigma$	5.650	5.683	0.53	$\pm$ 5	
	5550MHz	22.0	$\epsilon_r$	48.54	47.95	-1.24	$\pm$ 5	
			$\sigma$	5.708	5.785	1.40	$\pm$ 5	
5800MHz (Body)	5750MHz	22.0	$\epsilon_r$	48.27	47.46	-1.66	$\pm$ 5	Nov. 20, 2016
			$\sigma$	5.942	6.036	1.68	$\pm$ 5	
	5800MHz	22.0	$\epsilon_r$	48.20	47.28	-1.87	$\pm$ 5	
			$\sigma$	6.000	6.131	2.17	$\pm$ 5	
	5850MHz	22.0	$\epsilon_r$	48.20	47.23	-2.08	$\pm$ 5	
			$\sigma$	6.000	6.202	3.33	$\pm$ 5	

Table 3. Measured Tissue dielectric parameters for body phantoms -1



### 7.3 Verification Summary

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 7\%$ . The verification was performed at 2450MHz, 5200MHz, 5500MHz and 5800MHz.

Mixture Type	Frequency (MHz)	Power	SAR <sub>1g</sub> (W/Kg)	SAR <sub>10g</sub> (W/Kg)	Drift (dB)	Difference percentage		Probe Model / Serial No.	Dipole Model / Serial No.	1W Target		Date
						SAR <sub>1g</sub>	SAR <sub>10g</sub>			SAR <sub>1g</sub> (mW/g)	SAR <sub>10g</sub> (mW/g)	
Body	2450	250 mW	12.9	6.02	0.01	-1.00%	-1.70%	EX3DV4 SN:3977	D2450V2 SN:712	52.10	24.50	Nov. 15, 2016
		Normalize to 1 Watt	51.60	24.08								
Body	5200	100 mW	7.77	2.18	0.16	2.60%	1.90%	EX3DV4 SN:3977	D5GHZV2 SN:1021	75.70	21.40	Nov. 18, 2016
		Normalize to 1 Watt	77.70	21.80								
Body	5500	100 mW	8.16	2.3	0.05	-0.90%	0.00%	EX3DV4 SN:3977	D5GHZV2 SN:1021	82.30	23.00	Nov. 20, 2016
		Normalize to 1 Watt	81.60	23.00								
Body	5800	100 mW	7.8	2.17	-0.07	0.90%	1.40%	EX3DV4 SN:3977	D5GHZV2 SN:1021	77.30	21.40	Nov. 20, 2016
		Normalize to 1 Watt	78.00	21.70								

### 7.4 Validation Summary

Per FCC KDB 865664 D02 v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2013 and FCC KDB 865664 D01v01r04. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters as below.

Probe Type Model / Serial No.	Prob Cal. Point (MHz)	Head / Body	Cond.	Perm.	CW Validation			Mod. Validation			Date
			$\epsilon_r$	$\sigma$	Sensitivity	Probe	Probe	Mod. Type	Duty Factor	PAR	
						Linearity	Isotropy				
EX3DV4 SN:3977	2450	Body	52.40	1.964	Pass	Pass	Pass	DSSS	N/A	Pass	Nov. 15, 2016
EX3DV4 SN:3977	5200	Body	48.77	5.245	Pass	Pass	Pass	OFDM	N/A	Pass	Nov. 18, 2016
EX3DV4 SN:3977	5500	Body	48.07	5.683	Pass	Pass	Pass	OFDM	N/A	Pass	Nov. 20, 2016
EX3DV4 SN:3977	5800	Body	47.28	6.131	Pass	Pass	Pass	OFDM	N/A	Pass	Nov. 20, 2016

## 8. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	712	Apr. 01, 2016	Apr. 01, 2017
SPEAG	5GHz System Validation Kit	D5GHZV2	1021	Apr. 08, 2016	Apr. 08, 2017
SPEAG	Dosimetric E-Field Probe	EX3DV4	3977	Mar. 09, 2016	Mar. 09, 2017
SPEAG	Data Acquisition Electronics	DAE4	779	Mar. 02, 2016	Mar. 02, 2017
SPEAG	Device Holder	N/A	N/A	NCR	
SPEAG	Measurement Server	SE UMS 011 AA	1025	NCR	
SPEAG	Phantom (ELI V4.0)	QDOVA001BB	TP: 1036	NCR	
SPEAG	Robot	Staubli TX90XL	F07/564ZA1/C/01	NCR	
SPEAG	Software	DASY52 V52.8 (8)	N/A	NCR	
SPEAG	Software	SEMCAD X V14.6.10 (7331)	N/A	NCR	
Agilent	Dielectric Probe Kit	85070C	US99360094	NCR	
Agilent	ENA Series Network Analyzer	E5071B	MY42404655	Apr. 13, 2016	Apr. 13, 2017
R&S	Power Sensor	NRP-Z22	100179	NCR	
Agilent	Power Sensor	8481H	3318A20779	Jun. 06, 2016	Jun. 06, 2017
Agilent	Power Meter	EDM Series E4418B	GB40206143	Jun. 06, 2016	Jun. 06, 2017
Anritsu	Power Meter	ML2495A	1135009	Aug. 24, 2016	Aug. 24, 2017
Agilent	MXF-G-B RF Vector Signal Generator	N5182B	MY53050382	May 20, 2016	May 20, 2017
Agilent	Dual Directional Coupler	778D	50334	NCR	
Mini-Circuits	Power Amplifier	ZHL-42W-SMA	D111103#5	NCR	
Mini-Circuits	Power Amplifier	ZVE-8G-SMA	D042005 671800514	NCR	
Aisi	Attenuator	IEAT 3dB	N/A	NCR	

Table 4. Test Equipment List



## **9. Measurement Uncertainty**

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental. However, we estimate the measurement uncertainties in SAR<sub>1g</sub> to be less than  $\pm 21.76\%$  for 300MHz ~3GHz and 3GHz ~ 6GHz  $\pm 25.68\%$  [ 8 ] .

According to Std. C95.3 [ 9 ], the overall uncertainties are difficult to assess and will vary with the type of meter and usage situation. However, accuracy's of  $\pm 1$  to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least  $\pm 2$ dB can be expected.

Uncertainty of a Measure SAR of EUT with DASY System

Item	Uncertainty Component	Uncertainty Value	Prob. Dist	Div.	$c_i$ (1g)	$c_i$ (10g)	Std. Unc. (1-g)	Std. Unc. (10-g)	$V_i$ or $V_{eff}$
Measurement System									
u1	Probe Calibration ( $k=1$ )	$\pm 6.0\%$	Normal	1	1	1	$\pm 6.0\%$	$\pm 6.0\%$	$\infty$
u2	Axial Isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	$\infty$
u3	Hemispherical Isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	
u4	Boundary Effect	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
u5	Linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
u6	System Detection Limit	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
u7	Readout Electronics	$\pm 0.3\%$	Normal	1	1	1	$\pm 0.3\%$	$\pm 0.3\%$	$\infty$
u8	Response Time	$\pm 0.8\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$	$\infty$
u9	Integration Time	$\pm 1.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.1\%$	$\pm 1.1\%$	$\infty$
u10	RF Ambient Conditions	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
u11	RF Ambient Reflections	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
u12	Probe Positioner Mechanical Tolerance	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	$\infty$
u13	Probe Positioning with respect to Phantom Shell	$\pm 2.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
u14	Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
Test sample Related									
u15	Test sample Positioning	$\pm 3.6\%$	Normal	1	1	1	$\pm 3.6\%$	$\pm 3.6\%$	89
u16	Device Holder Uncertainty	$\pm 2.7\%$	Normal	1	1	1	$\pm 2.7\%$	$\pm 2.7\%$	5
u17	Output Power Variation - SAR drift measurement	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.9\%$	$\pm 2.9\%$	$\infty$
Phantom and Tissue Parameters									
u18	Phantom Uncertainty ( shape and thickness tolerances)	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	$\infty$
u19	Liquid Conductivity - deviation from target values	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	$\infty$
u20	Liquid Conductivity - measurement uncertainty	$\pm 2.5\%$	Normal	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.08\%$	69
u21	Liquid Permittivity - deviation from target values	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	$\infty$
u22	Liquid Permittivity - measurement uncertainty	$\pm 2.5\%$	Normal	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.23\%$	69
Combined standard uncertainty			RSS				$\pm 10.88\%$	$\pm 10.66\%$	313
Expanded uncertainty (95% CONFIDENCE LEVEL )			$k=2$				$\pm 21.76\%$	$\pm 21.31\%$	

Table 5. Uncertainty Budget for frequency range 300MHz to 3GHz

Uncertainty of a Measure SAR of EUT with DASY System

Item	Uncertainty Component	Uncertainty Value	Prob. Dist	Div.	$c_i$ (1g)	$c_i$ (10g)	Std. Unc. (1-g)	Std. Unc. (10-g)	$V_i$ or $V_{eff}$
Measurement System									
u1	Probe Calibration ( $k=1$ )	$\pm 6.5\%$	Normal	1	1	1	$\pm 6.5\%$	$\pm 6.5\%$	$\infty$
u2	Axial Isotropy	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	$\infty$
u3	Hemispherical Isotropy	$\pm 9.6\%$	Rectangular	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	
u4	Boundary Effect	$\pm 2.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.2\%$	$\pm 1.2\%$	$\infty$
u5	Linearity	$\pm 4.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	$\infty$
u6	System Detection Limit	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	$\infty$
u7	Readout Electronics	$\pm 0.0\%$	Normal	1	1	1	$\pm 0.0\%$	$\pm 0.0\%$	$\infty$
u8	Response Time	$\pm 0.8\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$	$\infty$
u9	Integration Time	$\pm 2.8\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.8\%$	$\pm 2.8\%$	$\infty$
u10	RF Ambient Conditions	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
u11	RF Ambient Reflections	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
u12	Probe Positioner Mechanical Tolerance	$\pm 0.7\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.7\%$	$\pm 0.7\%$	$\infty$
u13	Probe Positioning with respect to Phantom Shell	$\pm 9.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 5.7\%$	$\pm 5.7\%$	$\infty$
u14	Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation	$\pm 3.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	$\infty$
Test sample Related									
u15	Test sample Positioning	$\pm 3.6\%$	Normal	1	1	1	$\pm 3.6\%$	$\pm 3.6\%$	89
u16	Device Holder Uncertainty	$\pm 2.7\%$	Normal	1	1	1	$\pm 2.7\%$	$\pm 2.7\%$	5
u17	Output Power Variation - SAR drift measurement	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.9\%$	$\pm 2.9\%$	$\infty$
Phantom and Tissue Parameters									
u18	Phantom Uncertainty ( shape and thickness tolerances)	$\pm 4.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	$\infty$
u19	Liquid Conductivity - deviation from target values	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	$\infty$
u20	Liquid Conductivity - measurement uncertainty	$\pm 2.5\%$	Normal	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.08\%$	69
u21	Liquid Permittivity - deviation from target values	$\pm 5.0\%$	Rectangular	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	$\infty$
u22	Liquid Permittivity - measurement uncertainty	$\pm 2.5\%$	Normal	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.23\%$	69
Combined standard uncertainty			RSS				$\pm 12.84\%$	$\pm 12.65\%$	313
Expanded uncertainty (95% CONFIDENCE LEVEL )			$k=2$				$\pm 25.68\%$	$\pm 25.29\%$	

Table 6. Uncertainty Budget for frequency range 3GHz to 6GHz

## **10. Measurement Procedure**

The measurement procedures are as follows:

1. For WLAN function, engineering testing software installed on Notebook can provide continuous transmitting signal.
2. Measure output power through RF cable and power meter
3. Set scan area, grid size and other setting on the DASY software
4. Find out the largest SAR result on these testing positions of each band
5. Measure SAR results for other channels in worst SAR testing position if the SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

1. Power reference measurement
2. Area scan
3. Zoom scan
4. Power drift measurement

### **10.1 Spatial Peak SAR Evaluation**

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages

1. Extraction of the measured data (grid and values) from the Zoom Scan
2. Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. Generation of a high-resolution mesh within the measured volume
4. Interpolation of all measured values from the measurement grid to the high-resolution grid
5. Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. Calculation of the averaged SAR within masses of 1g and 10g



## 10.2 Area & Zoom Scan Procedures

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 measures points and step size follow as below. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g.

Grid Type	Frequency		Step size (mm)			X*Y*Z (Point)	Cube size			Step size		
			X	Y	Z		X	Y	Z	X	Y	Z
uniform grid	$\leq 3\text{GHz}$	$\leq 2\text{GHz}$	$\leq 8$	$\leq 8$	$\leq 5$	5*5*7	32	32	30	8	8	5
		2G - 3G	$\leq 5$	$\leq 5$	$\leq 5$	7*7*7	30	30	30	5	5	5
	3 - 6GHz	3 - 4GHz	$\leq 5$	$\leq 5$	$\leq 4$	7*7*8	30	30	28	5	5	4
		4 - 5GHz	$\leq 4$	$\leq 4$	$\leq 3$	8*8*10	28	28	27	4	4	3
		5 - 6GHz	$\leq 4$	$\leq 4$	$\leq 2$	8*8*12	28	28	22	4	4	2

(Our measure settings are refer KDB Publication 865664 D01v01r04)

## 10.3 Volume Scan Procedures

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

## 10.4 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation. Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

## 10.5 Power Drift Monitoring

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



## 11. SAR Test Results Summary

1. According KDB 447498 D01 V06 section 4.1.4, the “Reported” explanation as below:  
“When SAR or MPE is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported.”
2. If actual power less than tune-up power that Scaling SAR is required.
3. The formula of Reported SAR, that represent as below:  
$$\text{Reported SAR} = \text{Original SAR} * 10^{[(\text{Tune-up power} - \text{Actual power})/10]}$$
4. When the reported SAR of the highest measured maximum output power channel is  $\leq 0.8$  W/kg, no further SAR testing is required for IEEE 802.11b DSSS.
5. When SAR measurement is required for 2.4 GHz IEEE 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.
  - (a) When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.
  - (b) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.
6. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band.
7. SAR is measured using the highest measured maximum output power channel.
8. SAR test reduction for subsequent highest output test channels is determined according to reported SAR of the initial test configuration.
9. When SAR test exclusion provisions of KDB Publication 447498 D01 are applicable and SAR measurement is not required for the initial test configuration, SAR is also not required for the next highest maximum output power transmission mode subsequent test configuration(s) in that frequency band or aggregated band and exposure configuration.
10. When the highest reported SAR for the initial test configuration (when applicable, include subsequent highest output channels), according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg, SAR is not required for that subsequent test configuration.
10. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements.  
If the highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.

### 11.1 Head Measurement SAR

Evaluated head SAR is not available.

## 11.2 Body Measurement SAR

Index	Position	Band	Data Rate (Mbps)	Ch.	Test Position	Spacing (mm)	SAR <sub>1g</sub> (W/kg)	Power Drift	Burst Avg Power	Max tune-up	Reported SAR <sub>1g</sub> (W/kg)
#1	Flat	IEEE 802.11b	1	1	Honrizontal-UP	5	0.377	0.1	14.62	15	0.41
#2	Flat	IEEE 802.11b	1	1	Honrizontal-Down (with USB cable)	5	0.265	0.19	14.62	15	0.29
#3	Flat	IEEE 802.11b	1	1	Vertical Front (with USB cable)	5	0.274	0.01	14.62	15	0.30
#4	Flat	IEEE 802.11b	1	1	Vertical Back	5	0.188	0.03	14.62	15	0.21
#5	Flat	IEEE 802.11a	6	52	Honrizontal-UP	5	0.166	-0.12	13.42	13.5	0.17
#6	Flat	IEEE 802.11a	6	52	Honrizontal-Down (with USB cable)	5	0.076	-0.14	13.42	13.5	0.08
#7	Flat	IEEE 802.11a	6	52	Vertical Front (with USB cable)	5	0.24	-0.01	13.42	13.5	0.24
#8	Flat	IEEE 802.11a	6	52	Vertical Back	5	0.072	0.13	13.42	13.5	0.07
#9	Flat	IEEE 802.11a	6	136	Honrizontal-UP	5	0.501	-0.17	11.74	12	0.53
#10	Flat	IEEE 802.11a	6	136	Honrizontal-Down (with USB cable)	5	0.248	-0.03	11.74	12	0.26
#11	Flat	IEEE 802.11a	6	136	Vertical Front (with USB cable)	5	0.585	-0.19	11.74	12	0.62
#12	Flat	IEEE 802.11a	6	136	Vertical Back	5	0.497	-0.11	11.74	12	0.53
#13	Flat	IEEE 802.11a	6	165	Honrizontal-UP	5	0.452	0.19	9.37	10	0.52
#14	Flat	IEEE 802.11a	6	165	Honrizontal-Down (with USB cable)	5	0.201	0.14	9.37	10	0.23
#15	Flat	IEEE 802.11a	6	165	Vertical Front (with USB cable)	5	0.408	-0.06	9.37	10	0.47
#16	Flat	IEEE 802.11a	6	165	Vertical Back	5	0.36	0.14	9.37	10	0.42

## 11.3 Hot-spot mode Measurement SAR

This devise is not support Hot-spot function.

## 11.4 Extremity Measurement SAR

Evaluated extremity SAR is not available.

## 11.5 Std. C95.1-1992 RF Exposure Limit

Human Exposure	Population Uncontrolled Exposure ( W/kg ) or (mW/g)	Occupational Controlled Exposure ( W/kg ) or (mW/g)
Spatial Peak SAR* (head)	1.60	8.00
Spatial Peak SAR** (Whole Body)	0.08	0.40
Spatial Peak SAR*** (Partial-Body)	1.60	8.00
Spatial Peak SAR**** (Hands / Feet / Ankle / Wrist )	4.00	20.00

Table 7. Safety Limits for Partial Body Exposure

### Notes :

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

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

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

## 12. References

- [1] Std. C95.1-1999, "American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300KHz to 100GHz", New York.
- [2] NCRP, National Council on Radiation Protection and Measurements, "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields", NCRP report NO. 86, 1986.
- [3] T. Schmid, O. Egger, and N. Kuster, "Automatic E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp, 105-113, Jan. 1996.
- [4] K. Pokovi<sup>c</sup>, T. Schmid, and N. Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequency", in ICECOM'97, Dubrovnik, October 15-17, 1997, pp.120-124.
- [5] K. Pokovi<sup>c</sup>, T. Schmid, and N. Kuster, "E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp.172-175.
- [6] N. Kuster, and Q. Balzano, "Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz", IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.
- [7] Robert J. Renka, "Multivariate Interpolation Of Large Sets Of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988 , pp. 139-148.
- [8] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.
- [9] Std. C95.3-1991, "IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, Aug. 1992.
- [10] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10KHz-300GHz, Jan. 1995.
- [11] IEEE Std 1528™-2013 - IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head From Wireless Communications Devices: Measurement Techniques

## Appendix A - System Performance Check

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/15 PM 03:44:10

System Performance Check at 2450MHz\_20161115\_Body

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:712

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.964$  S/m;  $\epsilon_r = 52.402$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2011)

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(7.3, 7.3, 7.3); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASYS52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

System Performance Check at 2450MHz/Area Scan (61x61x1):

Interpolated grid:  $dx=1.500$  mm,  $dy=1.500$  mm

Maximum value of SAR (interpolated) = 19.4 W/kg

System Performance Check at 2450MHz/Zoom Scan (7x7x7)/Cube 0:

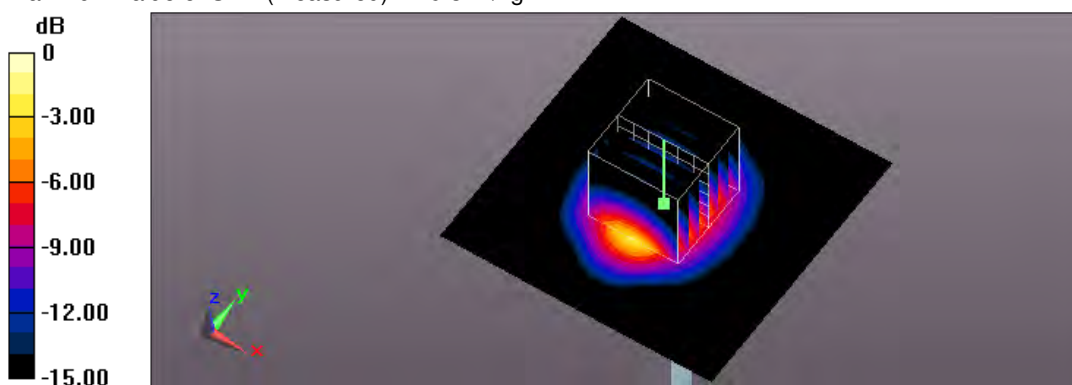
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 102.6 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 25.1 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.02 W/kg

Maximum value of SAR (measured) = 19.3 W/kg



0 dB = 19.3 W/kg = 12.86 dBW/kg

Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/18 AM 09:33:17  
 System Performance Check at 5200MHz\_20161118\_Body  
 DUT: Dipole 5GHzV2; Type: D5GHz; Serial: 1021

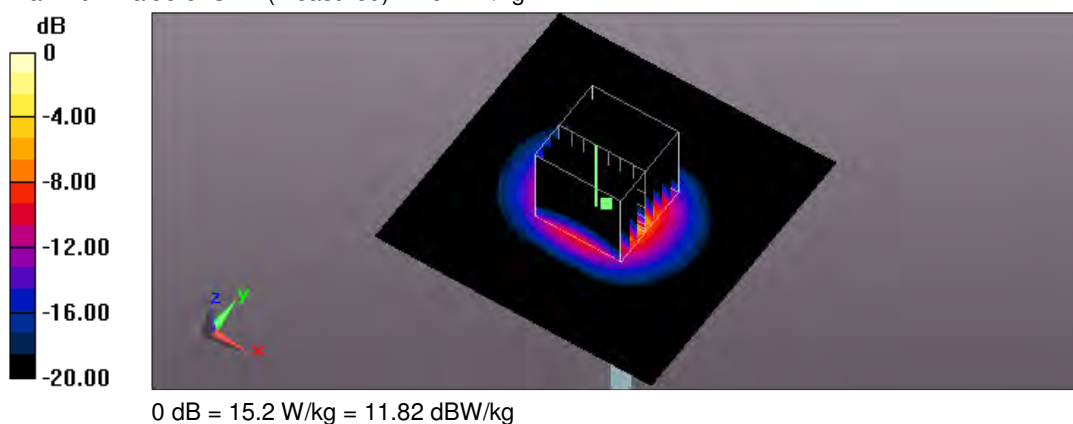
Communication System: UID 0, CW (0); Frequency: 5200 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.245$  S/m;  $\epsilon_r = 48.766$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.81, 4.81, 4.81); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASYS52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

System Performance Check at 5200MHz/Area Scan (91x91x1):  
 Interpolated grid: dx=1.000 mm, dy=1.000 mm  
 Maximum value of SAR (interpolated) = 14.8 W/kg

System Performance Check at 5200MHz/Zoom Scan (8x8x7)/Cube 0:  
 Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 58.62 V/m; Power Drift = 0.16 dB  
 Peak SAR (extrapolated) = 33.5 W/kg  
 SAR(1 g) = 7.77 W/kg; SAR(10 g) = 2.18 W/kg  
 Maximum value of SAR (measured) = 15.2 W/kg



Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/20 AM 10:15:44  
 System Performance Check at 5500MHz\_20161120\_Body  
 DUT: Dipole 5GHzV2; Type: D5GHz; Serial: 1021

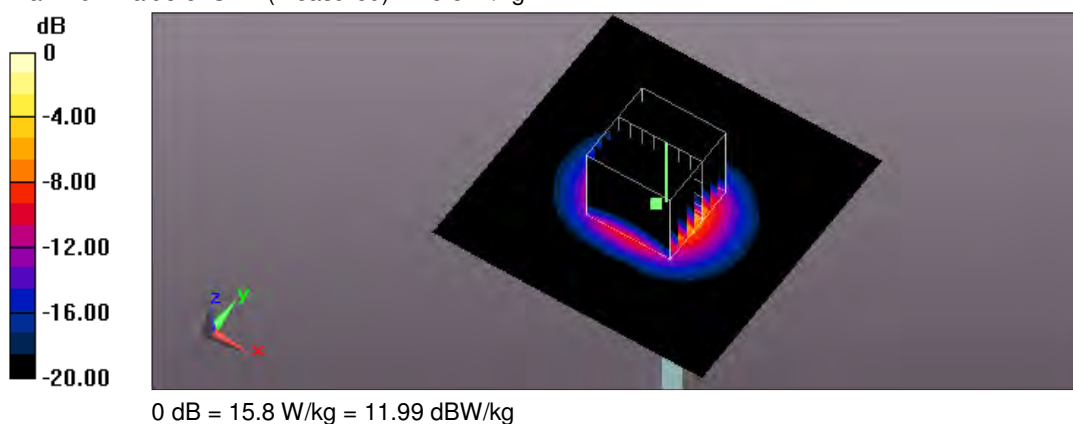
Communication System: UID 0, CW (0); Frequency: 5500 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.683$  S/m;  $\epsilon_r = 48.069$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.31, 4.31, 4.31); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASYS52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

System Performance Check at 5500MHz/Area Scan (91x91x1):  
 Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm  
 Maximum value of SAR (interpolated) = 15.7 W/kg

System Performance Check at 5500MHz/Zoom Scan (8x8x7)/Cube 0:  
 Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm  
 Reference Value = 57.97 V/m; Power Drift = 0.05 dB  
 Peak SAR (extrapolated) = 33.1 W/kg  
 SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.3 W/kg  
 Maximum value of SAR (measured) = 15.8 W/kg







Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 AM 11:10:57

System Performance Check at 5800MHz\_20161120\_Body

DUT: Dipole 5GHzV2; Type: D5GHz; Serial: 1021

Communication System: UID 0, CW (0); Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.131$  S/m;  $\epsilon_r = 47.276$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.33, 4.33, 4.33); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

System Performance Check at 5800MHz/Area Scan (91x91x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 15.3 W/kg

System Performance Check at 5800MHz/Zoom Scan (8x8x7)/Cube 0:

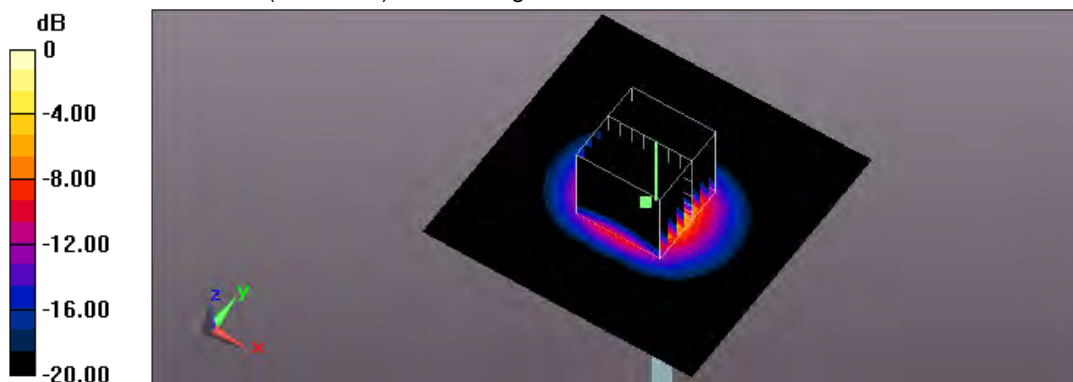
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 54.59 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 34.2 W/kg

SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 15.5 W/kg



0 dB = 15.5 W/kg = 11.90 dBW/kg

## Appendix B - SAR Measurement Data

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/15 PM 05:11:33

1\_ IEEE 802.11b CH1\_1M\_Horizontal-UP\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11b (0); Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.935$  S/m;  $\epsilon_r = 52.681$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2011)

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(7.3, 7.3, 7.3); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASYS52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.527 W/kg

Flat/Zoom Scan (7x7x7)/Cube 0:

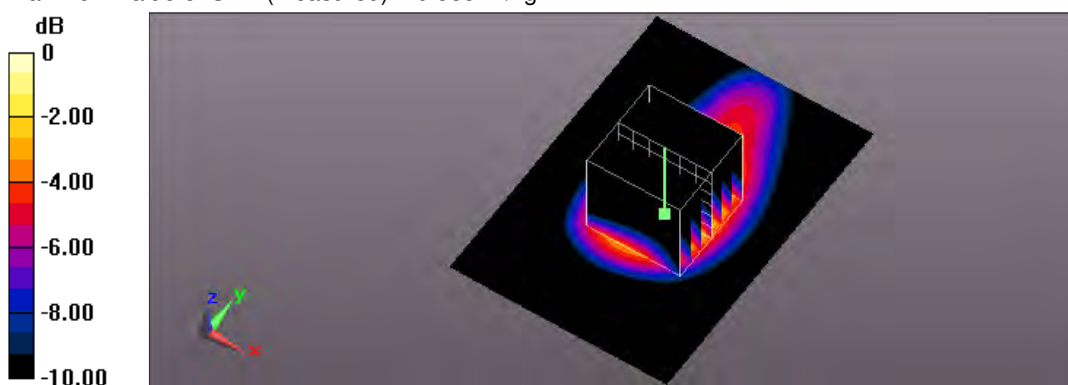
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 13.86 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.667 W/kg

SAR(1 g) = 0.377 W/kg; SAR(10 g) = 0.192 W/kg

Maximum value of SAR (measured) = 0.535 W/kg



0 dB = 0.535 W/kg = -2.72 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/16 AM 10:18:18

2\_ IEEE 802.11b CH1\_1M\_USB cable\_Honrizontal-Down\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11b (0); Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.935 \text{ S/m}$ ;  $\epsilon_r = 52.681$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(7.3, 7.3, 7.3); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 0.316 W/kg

Flat/Zoom Scan (7x7x7)/Cube 0:

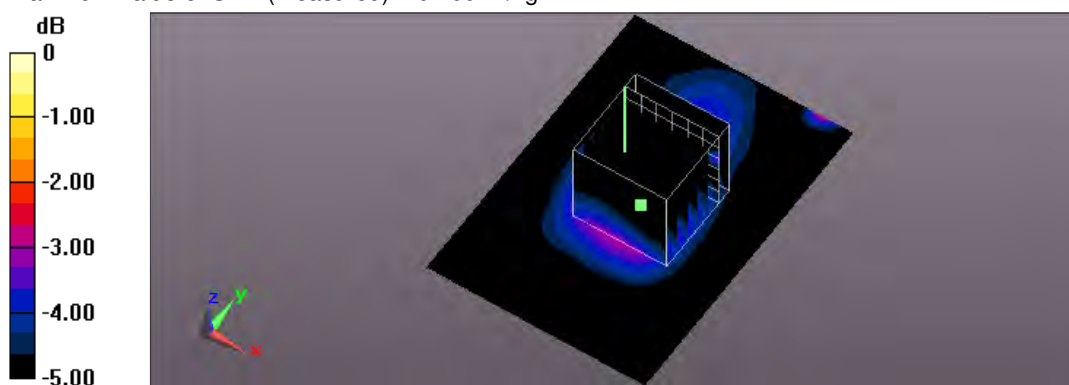
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 14.48 V/m; Power Drift = 0.19 dB

Peak SAR (extrapolated) = 0.499 W/kg

SAR(1 g) = 0.265 W/kg; SAR(10 g) = 0.211 W/kg

Maximum value of SAR (measured) = 0.499 W/kg



0 dB = 0.499 W/kg = -3.02 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/16 PM 01:21:29

3\_ IEEE 802.11b CH1\_1M\_USB cable\_Vertical Front\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11b (0); Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.935$  S/m;  $\epsilon_r = 52.681$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(7.3, 7.3, 7.3); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.334 W/kg

Flat/Zoom Scan (7x7x7)/Cube 0:

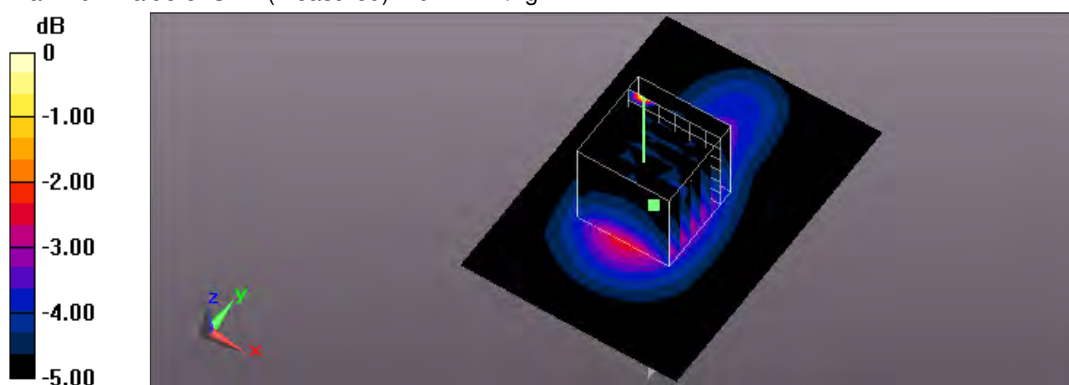
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 11.98 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.444 W/kg

SAR(1 g) = 0.274 W/kg; SAR(10 g) = 0.208 W/kg

Maximum value of SAR (measured) = 0.444 W/kg



0 dB = 0.444 W/kg = -3.53 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/16 PM 01:50:45

4\_ IEEE 802.11b CH1\_1M\_Verical Back\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11b (0); Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.935$  S/m;  $\epsilon_r = 52.681$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(7.3, 7.3, 7.3); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.215 W/kg

Flat/Zoom Scan (7x7x7)/Cube 0:

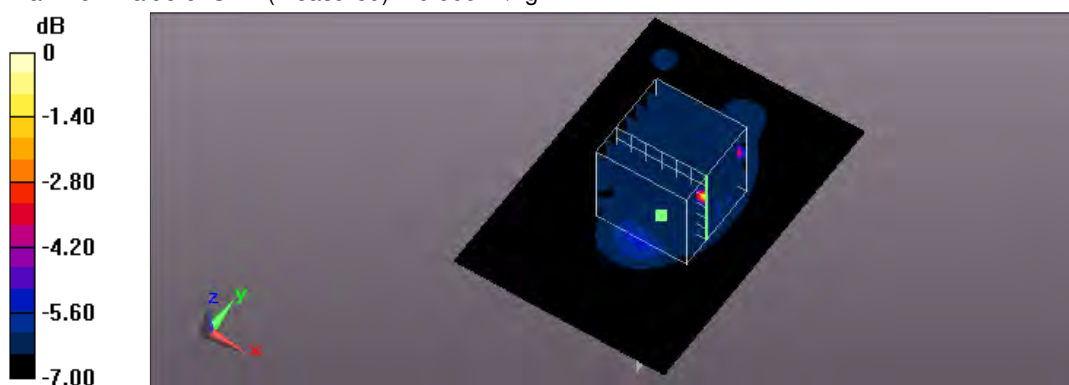
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 9.921 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.606 W/kg

SAR(1 g) = 0.188 W/kg; SAR(10 g) = 0.161 W/kg

Maximum value of SAR (measured) = 0.606 W/kg



0 dB = 0.606 W/kg = -2.18 dBW/kg

Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/18 PM 04:15:38  
 5\_ IEEE 802.11a CH52\_6M\_Horizontal-UP\_5mm  
 DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

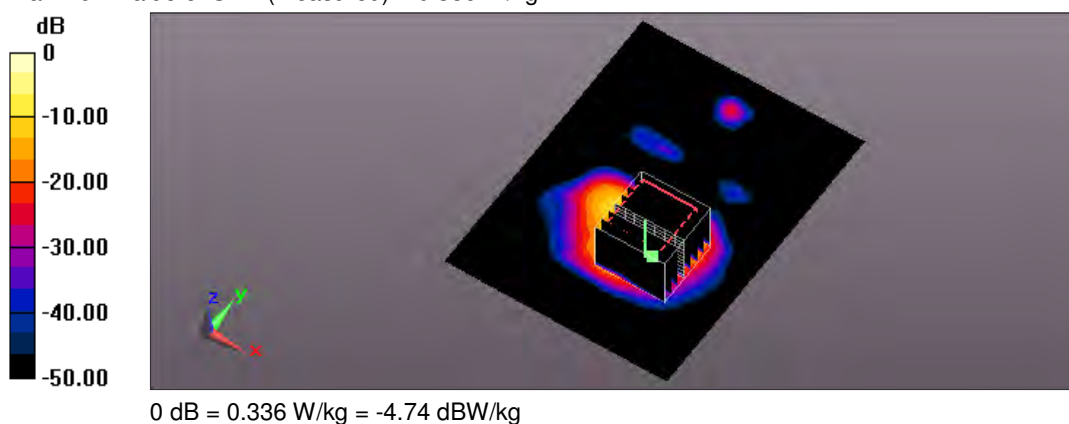
Communication System: UID 0, IEEE 802.11a (0); Frequency: 5260 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 5260$  MHz;  $\sigma = 5.325$  S/m;  $\epsilon_r = 48.545$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.61, 4.61, 4.61); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):  
 Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm  
 Maximum value of SAR (interpolated) = 2.02 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:  
 Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm  
 Reference Value = 10.79 V/m; Power Drift = -0.12 dB  
 Peak SAR (extrapolated) = 0.597 W/kg  
 SAR(1 g) = 0.166 W/kg; SAR(10 g) = 0.044 W/kg  
 Maximum value of SAR (measured) = 0.336 W/kg



Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/18 PM 08:16:59

6\_ IEEE 802.11a CH52\_6M\_USB cable\_Horizontal-Down\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5260 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5260$  MHz;  $\sigma = 5.325$  S/m;  $\epsilon_r = 48.545$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.61, 4.61, 4.61); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.151 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

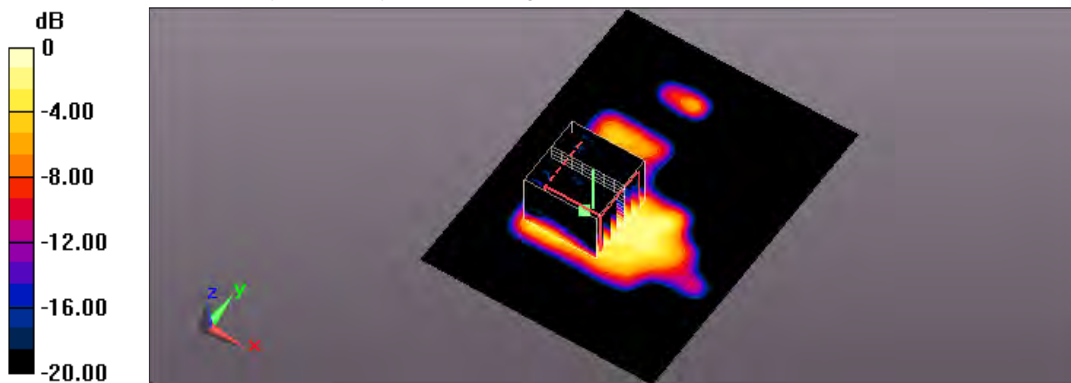
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 1.978 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 0.276 W/kg

SAR(1 g) = 0.076 W/kg; SAR(10 g) = 0.027 W/kg

Maximum value of SAR (measured) = 0.146 W/kg



0 dB = 0.146 W/kg = -8.36 dBW/kg



Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/18 PM 09:09:33

7\_ IEEE 802.11a CH52\_6M\_USB cable\_Vertical Front\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5260 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5260$  MHz;  $\sigma = 5.325$  S/m;  $\epsilon_r = 48.545$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.61, 4.61, 4.61); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.461 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

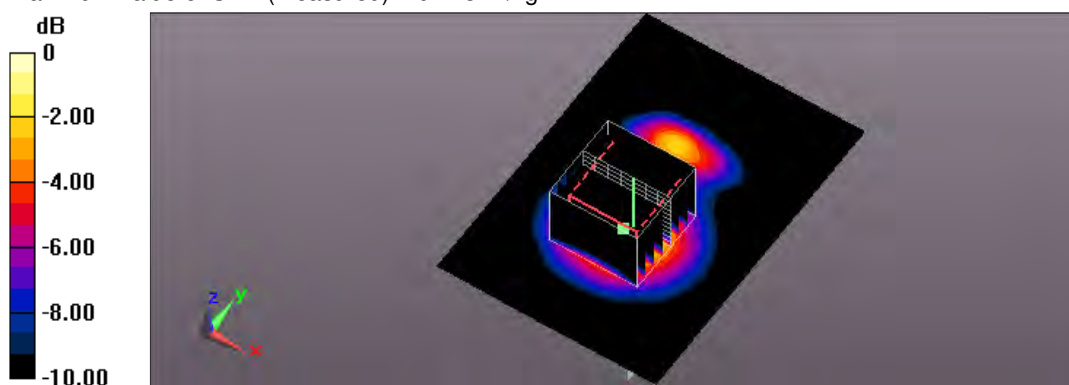
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 3.256 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.925 W/kg

SAR(1 g) = 0.240 W/kg; SAR(10 g) = 0.084 W/kg

Maximum value of SAR (measured) = 0.443 W/kg



0 dB = 0.443 W/kg = -3.54 dBW/kg



Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/18 PM 10:01:54  
 8\_ IEEE 802.11a CH52\_6M\_Verical Back\_5mm  
 DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

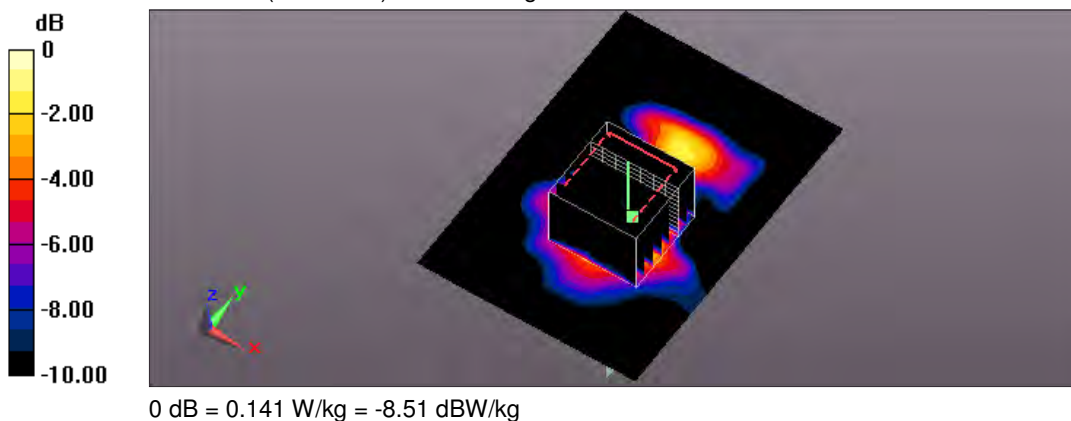
Communication System: UID 0, IEEE 802.11a (0); Frequency: 5260 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 5260 \text{ MHz}$ ;  $\sigma = 5.325 \text{ S/m}$ ;  $\epsilon_r = 48.545$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.61, 4.61, 4.61); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):  
 Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$   
 Maximum value of SAR (interpolated) = 0.150 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:  
 Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=2\text{mm}$   
 Reference Value = 1.877 V/m; Power Drift = 0.13 dB  
 Peak SAR (extrapolated) = 0.266 W/kg  
 $\text{SAR}(1 \text{ g}) = 0.072 \text{ W/kg}$ ;  $\text{SAR}(10 \text{ g}) = 0.025 \text{ W/kg}$   
 Maximum value of SAR (measured) = 0.141 W/kg



Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 PM 12:21:18

9\_ IEEE 802.11a CH136\_6M\_Horizontal-UP\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5680 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5680$  MHz;  $\sigma = 5.97$  S/m;  $\epsilon_r = 47.636$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.21, 4.21, 4.21); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.04 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 4.111 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 2.03 W/kg

SAR(1 g) = 0.485 W/kg; SAR(10 g) = 0.147 W/kg

Maximum value of SAR (measured) = 0.947 W/kg

Flat/Zoom Scan (8x8x12)/Cube 1:

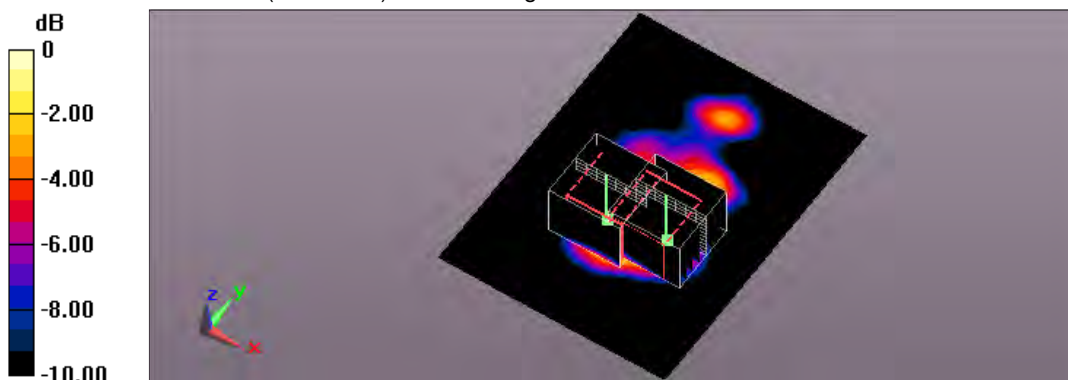
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 4.111 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 2.05 W/kg

SAR(1 g) = 0.501 W/kg; SAR(10 g) = 0.173 W/kg

Maximum value of SAR (measured) = 0.978 W/kg



0 dB = 0.978 W/kg = -0.10 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 PM 02:30:16

10\_ IEEE 802.11a CH136\_6M\_USB cable\_Honrizontal-Down\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5680 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5680$  MHz;  $\sigma = 5.97$  S/m;  $\epsilon_r = 47.636$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.21, 4.21, 4.21); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.457 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

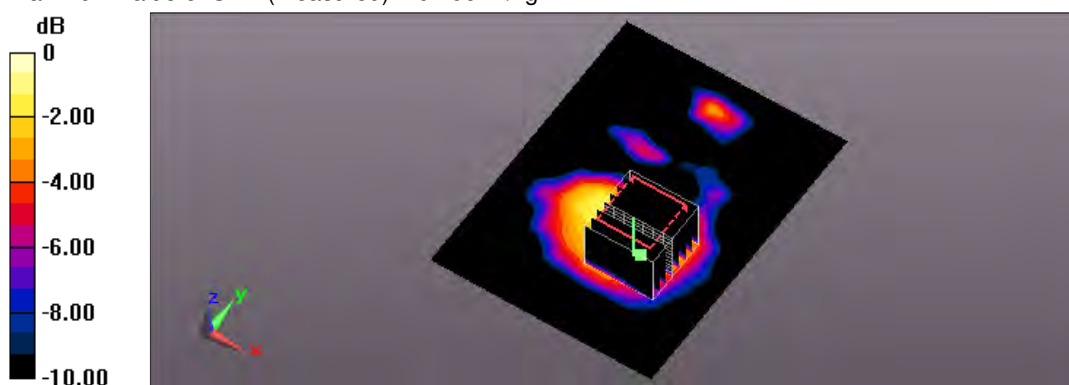
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 4.152 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.15 W/kg

SAR(1 g) = 0.248 W/kg; SAR(10 g) = 0.094 W/kg

Maximum value of SAR (measured) = 0.496 W/kg



0 dB = 0.496 W/kg = -3.05 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 PM 04:13:38

11\_ IEEE 802.11a CH136\_6M\_USB cable\_Vertical Front\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5680 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5680$  MHz;  $\sigma = 5.97$  S/m;  $\epsilon_r = 47.636$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.21, 4.21, 4.21); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 1.17 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.951 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 2.37 W/kg

SAR(1 g) = 0.585 W/kg; SAR(10 g) = 0.187 W/kg

Maximum value of SAR (measured) = 1.16 W/kg

Flat/Zoom Scan (8x8x12)/Cube 1:

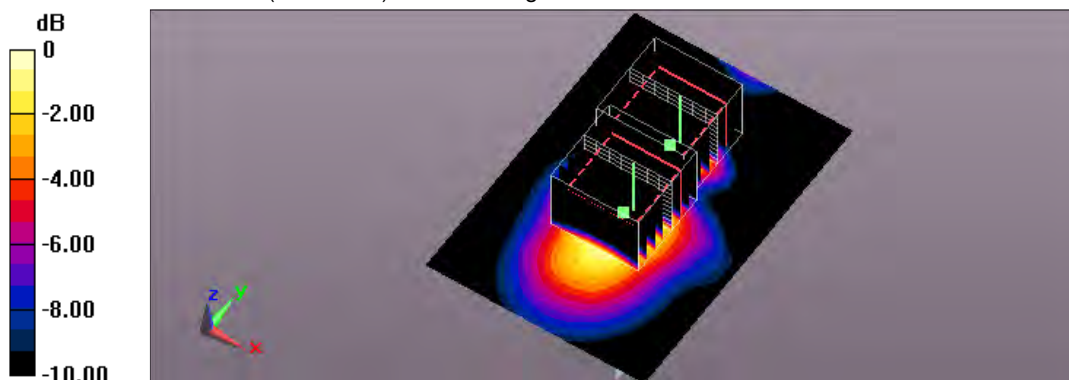
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.951 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 1.82 W/kg

SAR(1 g) = 0.360 W/kg; SAR(10 g) = 0.097 W/kg

Maximum value of SAR (measured) = 0.718 W/kg



0 dB = 0.718 W/kg = -1.44 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/21 AM 09:25:11

12\_ IEEE 802.11a CH136\_6M\_Verical Back\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5680 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5680$  MHz;  $\sigma = 5.97$  S/m;  $\epsilon_r = 47.636$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.21, 4.21, 4.21); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.933 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.138 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 2.06 W/kg

SAR(1 g) = 0.497 W/kg; SAR(10 g) = 0.162 W/kg

Maximum value of SAR (measured) = 0.968 W/kg

Flat/Zoom Scan (8x8x12)/Cube 1:

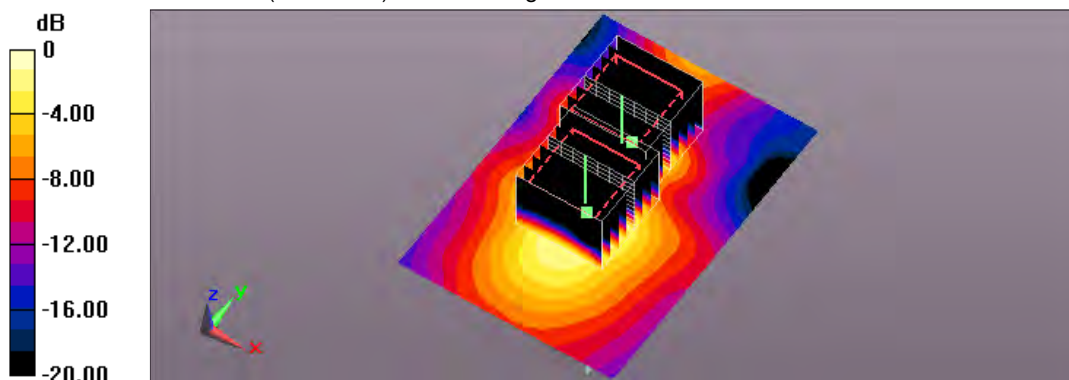
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.138 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 3.53 W/kg

SAR(1 g) = 0.324 W/kg; SAR(10 g) = 0.091 W/kg

Maximum value of SAR (measured) = 0.642 W/kg



0 dB = 0.642 W/kg = -1.92 dBW/kg

Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/20 PM 01:24:54  
 13\_ IEEE 802.11a CH165\_6M\_Honrizontal-UP\_5mm  
 DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5825 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 5825$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 47.256$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

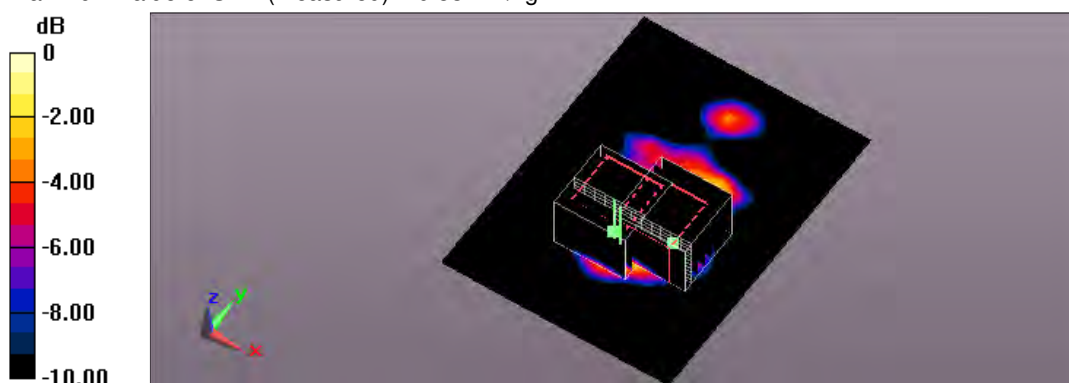
#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.33, 4.33, 4.33); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):  
 Interpolated grid: dx=1.000 mm, dy=1.000 mm  
 Maximum value of SAR (interpolated) = 0.935 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:  
 Measurement grid: dx=4mm, dy=4mm, dz=2mm  
 Reference Value = 3.668 V/m; Power Drift = 0.19 dB  
 Peak SAR (extrapolated) = 2.21 W/kg  
 SAR(1 g) = 0.452 W/kg; SAR(10 g) = 0.154 W/kg  
 Maximum value of SAR (measured) = 0.925 W/kg

Flat/Zoom Scan (8x8x12)/Cube 1:  
 Measurement grid: dx=4mm, dy=4mm, dz=2mm  
 Reference Value = 3.668 V/m; Power Drift = 0.19 dB  
 Peak SAR (extrapolated) = 2.06 W/kg  
 SAR(1 g) = 0.360 W/kg; SAR(10 g) = 0.113 W/kg  
 Maximum value of SAR (measured) = 0.837 W/kg



0 dB = 0.837 W/kg = -0.77 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 PM 03:12:22

14\_ IEEE 802.11a CH165\_6M\_USB cable\_Honrizontal-Down\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5825 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 5825$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 47.256$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.33, 4.33, 4.33); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (91x121x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.396 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:

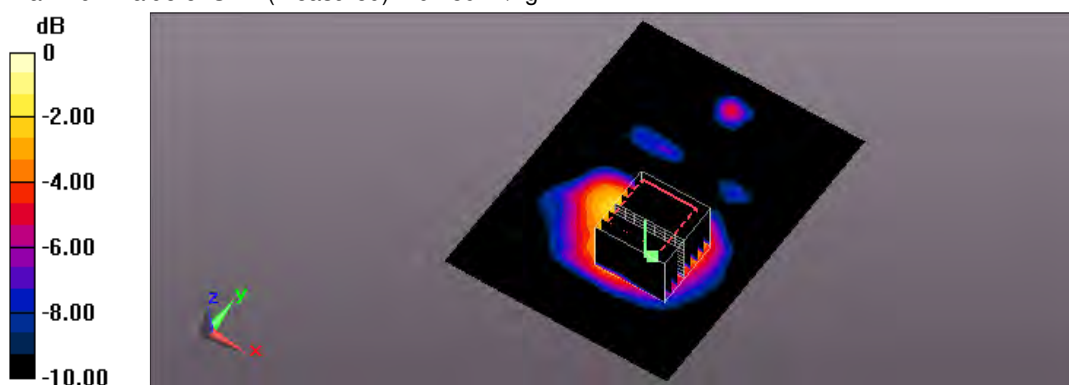
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 3.080 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 0.899 W/kg

SAR(1 g) = 0.201 W/kg; SAR(10 g) = 0.075 W/kg

Maximum value of SAR (measured) = 0.459 W/kg



0 dB = 0.459 W/kg = -3.38 dBW/kg



Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2016/11/20 PM 05:14:51

15\_ IEEE 802.11a CH165\_6M\_USB cable\_Vertical Front\_5mm

DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5825 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 5825$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 47.256$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.33, 4.33, 4.33); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

#### Flat/Area Scan (71x101x1):

Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 0.783 W/kg

#### Flat/Zoom Scan (8x8x12)/Cube 0:

Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.283 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.94 W/kg

SAR(1 g) = 0.408 W/kg; SAR(10 g) = 0.128 W/kg

Maximum value of SAR (measured) = 0.803 W/kg

#### Flat/Zoom Scan (8x8x12)/Cube 1:

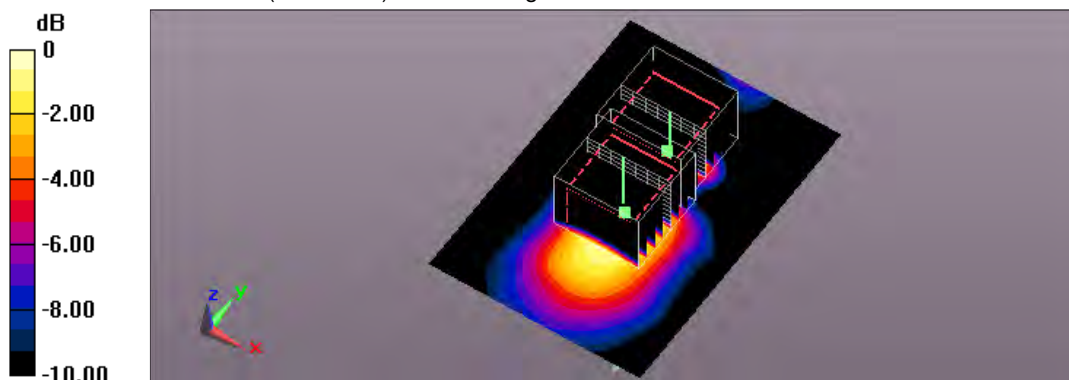
Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm

Reference Value = 5.283 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.12 W/kg

SAR(1 g) = 0.252 W/kg; SAR(10 g) = 0.068 W/kg

Maximum value of SAR (measured) = 0.549 W/kg



0 dB = 0.549 W/kg = -2.60 dBW/kg



Test Laboratory: A Test Lab Techno Corp.  
 Date/Time: 2016/11/21 AM 10:23:02  
 16\_ IEEE 802.11a CH165\_6M\_Verical Back\_5mm  
 DUT: 198658; Type: WIFI DONGLE; FCC ID: 2AJKO198658

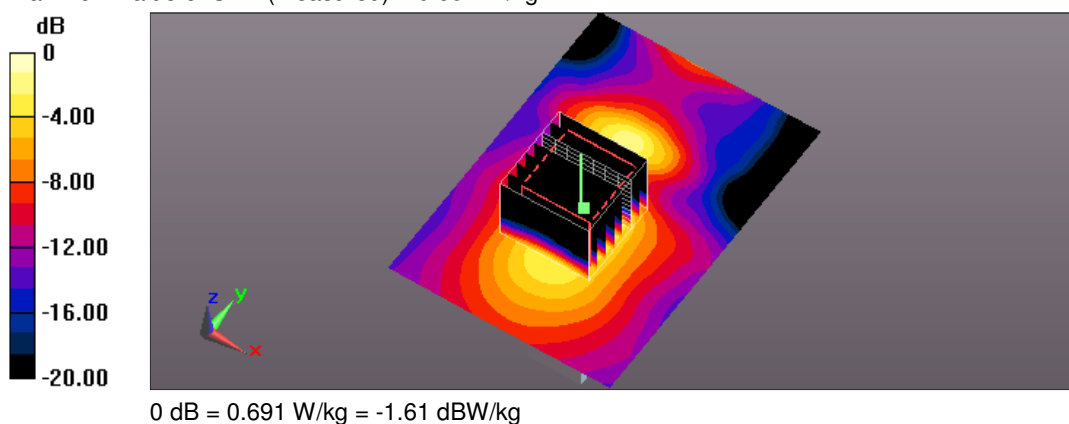
Communication System: UID 0, IEEE 802.11a (0); Frequency: 5825 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 5825$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 47.256$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3977; ConvF(4.33, 4.33, 4.33); Calibrated: 2016/3/9;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn779; Calibrated: 2016/3/2
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1036
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Flat/Area Scan (71x101x1):  
 Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm  
 Maximum value of SAR (interpolated) = 0.671 W/kg

Flat/Zoom Scan (8x8x12)/Cube 0:  
 Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=2$ mm  
 Reference Value = 4.394 V/m; Power Drift = 0.14 dB  
 Peak SAR (extrapolated) = 1.58 W/kg  
 SAR(1 g) = 0.360 W/kg; SAR(10 g) = 0.121 W/kg  
 Maximum value of SAR (measured) = 0.691 W/kg





## ***Appendix C - Calibration***

All of the instruments Calibration information are listed below.

- Dipole \_ D2450V2 SN:712 Calibration No.Z16-97032
- Dipole \_ D5GHzV2 SN:1021 Calibration No.Z16-97033
- Probe \_ EX3DV4 SN:3977 Calibration No. Z16-97020
- DAE \_ DAE4 SN: 779 Calibration No. Z16-97019



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Client

ATL

Certificate No: Z16-97032

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 712

Calibration Procedure(s) FD-Z11-2-003-01  
Calibration Procedures for dipole validation kits

Calibration date: April 1, 2016

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Power sensor NRP-Z91	101547	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Reference Probe EX3DV4	SN 7307	19-Feb-16(SPEAG,No.EX3-7307_Feb16)	Feb-17
DAE4	SN 771	02-Feb-16(CTTL-SPEAG,No.Z16-97011)	Feb-17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-16 (CTTL, No.J16X00893)	Jan-17
Network Analyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan-17

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: April 6, 2016

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

Certificate No: Z16-97032

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#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### Additional Documentation:

- 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%.



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### Measurement Conditions

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

<b>DASY Version</b>	DASY52	52.8.8.1258
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Triple Flat Phantom 5.1C	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz $\pm$ 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	40.3 $\pm$ 6 %	1.82 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>52.4 mW / g <math>\pm</math> 20.8 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	6.12 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>24.5 mW / g <math>\pm</math> 20.4 % (k=2)</b>

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.7	1.95 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	52.3 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	13.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>52.1 mW / g <math>\pm</math> 20.8 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	6.16 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>24.5 mW / g <math>\pm</math> 20.4 % (k=2)</b>



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.4Ω+ 5.10jΩ
Return Loss	- 25.7dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.6Ω+ 6.31jΩ
Return Loss	- 23.9dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.255 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
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# **DASY5 Validation Report for Head TSL**

Date: 04.01.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 712**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.822$  S/m;  $\epsilon_r = 40.25$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.36, 7.36, 7.36); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

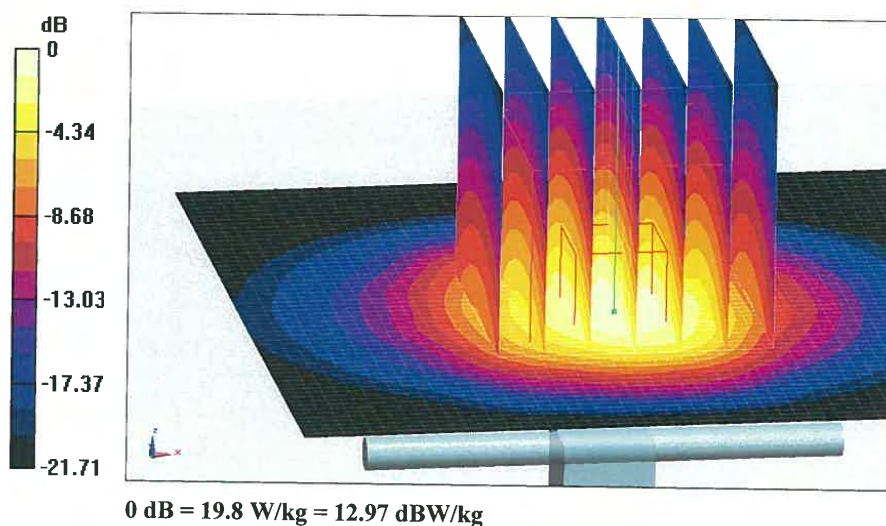
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.0 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.5 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.12 W/kg**

Maximum value of SAR (measured) = 19.8 W/kg

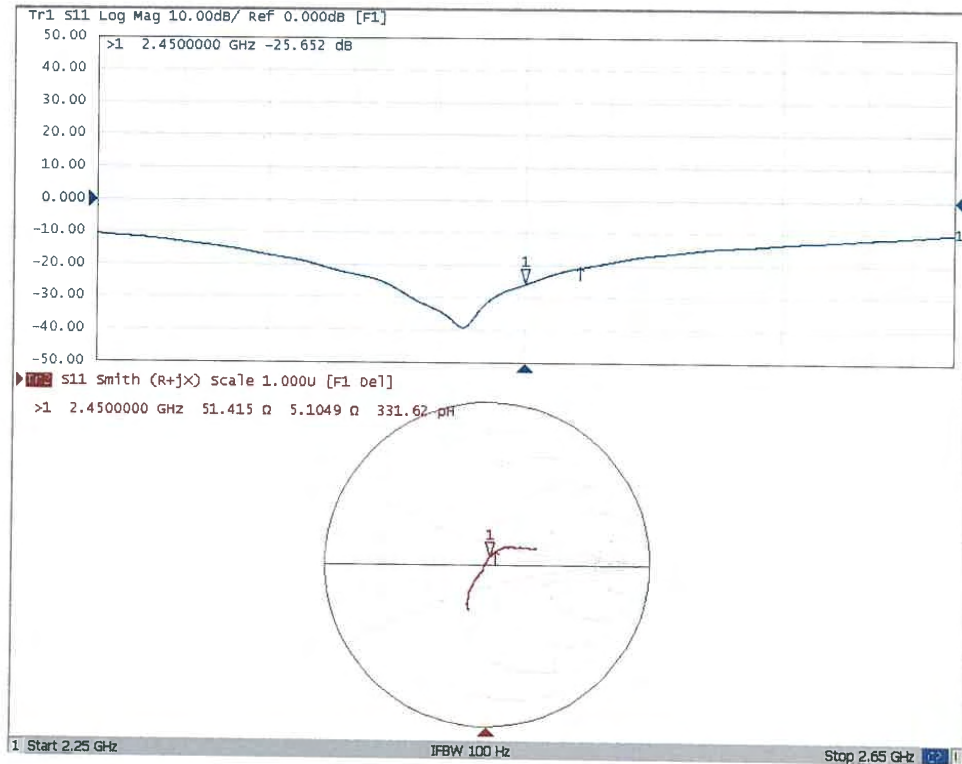




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### Impedance Measurement Plot for Head TSL







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# **DASY5 Validation Report for Body TSL**

Date: 04.01.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 712**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.996 \text{ S/m}$ ;  $\epsilon_r = 52.25$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.22, 7.22, 7.22); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

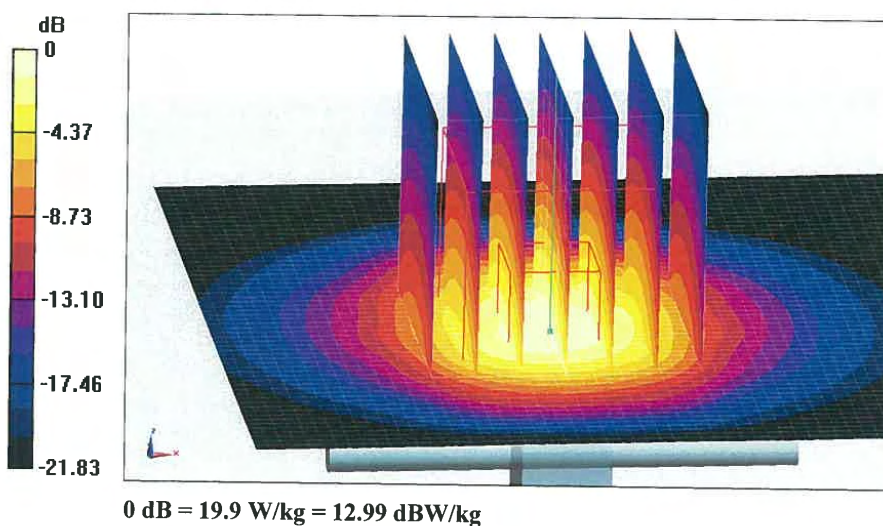
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 97.15 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.6 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.16 W/kg**

Maximum value of SAR (measured) = 19.9 W/kg

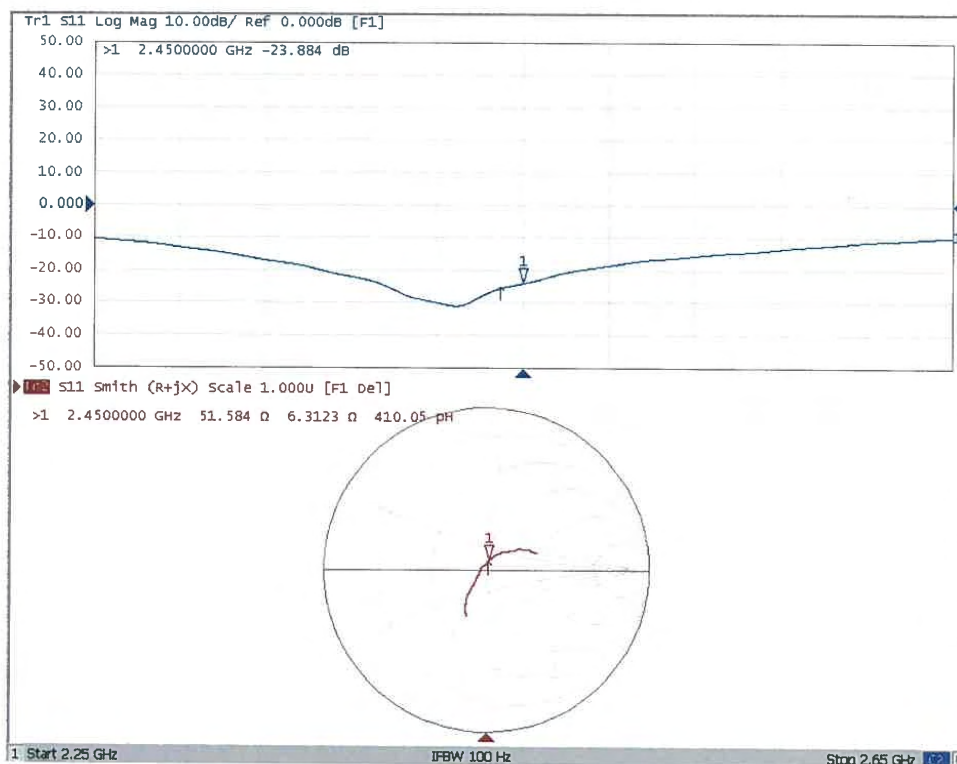




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### Impedance Measurement Plot for Body TSL





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Client

ATL

Certificate No: Z16-97033

## CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1021

Calibration Procedure(s) FD-Z11-2-003-01  
Calibration Procedures for dipole validation kits

Calibration date: April 8, 2016

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Power sensor NRP-Z91	101547	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
ReferenceProbe EX3DV4	SN 3617	26-Aug-15(SPEAG,No.EX3-3617_Aug15)	Aug-16
DAE4	SN 771	02-Feb-16(CTTL-SPEAG,No.Z16-97011)	Feb-17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-16 (CTTL, No.J16X00893)	Jan-17
NetworkAnalyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan-17

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: April 13, 2016

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Certificate No: Z16-97033

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#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### Additional Documentation:

- 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.

<b>DASY Version</b>	DASY52	52.8.8.1258
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Triple Flat Phantom 5.1C	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	5200 MHz $\pm$ 1 MHz 5500 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

### Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	36.4 $\pm$ 6 %	4.60 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.88 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>79.0 mW /g <math>\pm</math> 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	2.24 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.5 mW /g <math>\pm</math> 22.2 % (k=2)</b>



#### Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.6	4.96 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	36.0 ± 6 %	4.89 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

#### SAR result with Head TSL at 5500 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	8.15 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>81.7 mW / g ± 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	2.31 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.2 mW / g ± 22.2 % (k=2)</b>

#### Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	35.3	5.27 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	36.0 ± 6 %	5.16 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

#### SAR result with Head TSL at 5800 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.98 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>80.0 mW / g ± 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	2.25 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.6 mW / g ± 22.2 % (k=2)</b>

### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	49.0	5.30 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	49.7 ± 6 %	5.36 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	7.55 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>75.7 mW /g ± 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	2.13 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.4 mW /g ± 22.2 % (k=2)</b>

### Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.6	5.65 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	49.6 ± 6 %	5.73 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL at 5500 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	8.19 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>82.3 mW /g ± 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	2.29 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>23.0 mW /g ± 22.2 % (k=2)</b>



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#### Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.2	6.00 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	49.3 ± 6 %	6.10 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

#### SAR result with Body TSL at 5800 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	7.69 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>77.3 mW /g ± 23.0 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	2.13 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.4 mW /g ± 22.2 % (k=2)</b>



## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.4Ω - 6.48jΩ
Return Loss	- 23.8dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	53.5Ω - 3.96jΩ
Return Loss	- 25.8dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.4Ω - 2.19jΩ
Return Loss	- 24.0dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	51.8Ω - 6.34jΩ
Return Loss	- 23.8dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	54.4Ω - 1.35jΩ
Return Loss	- 27.1dB

### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	56.9Ω - 1.98jΩ
Return Loss	- 23.4dB



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### General Antenna Parameters and Design

Electrical Delay (one direction)	1.305 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
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## **DASY5 Validation Report for Head TSL**

Date: 04.07.2016

Test Laboratory: CCTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1021**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz,

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.599$  mho/m;  $\epsilon_r = 36.41$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.891$  mho/m;  $\epsilon_r = 36.03$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.163$  mho/m;  $\epsilon_r = 35.97$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

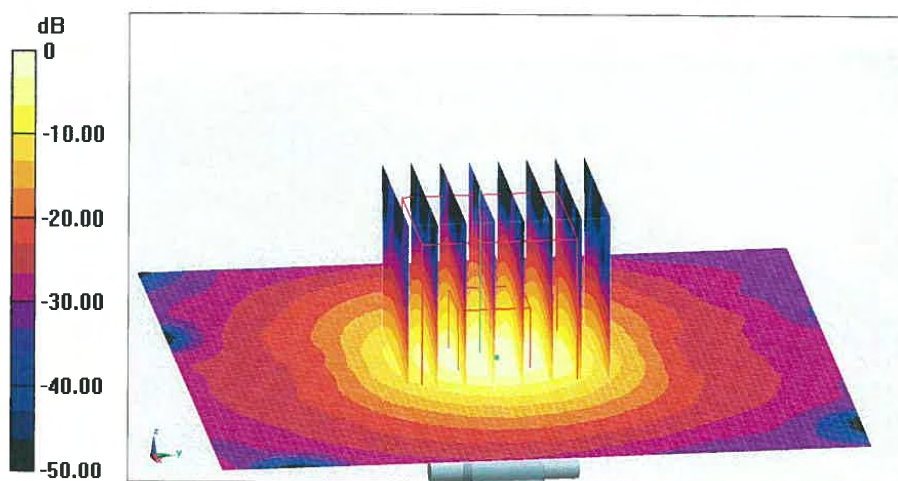
### **DASY5 Configuration:**

- Probe: EX3DV4 - SN3617; ConvF(5.46,5.46,5.46); Calibrated: 2015/8/26, ConvF(5.05,5.05,5.05); Calibrated: 2015/8/26, ConvF(4.85,4.85,4.85); Calibrated: 2015/8/26,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016/2/02
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

**Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 71.81 V/m; Power Drift = 0.05 dB  
Peak SAR (extrapolated) = 32.7 W/kg  
**SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.24 W/kg**  
Maximum value of SAR (measured) = 18.8 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 70.82 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 37.0 W/kg  
**SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.31 W/kg**  
Maximum value of SAR (measured) = 19.7 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 68.77 V/m; Power Drift = 0.04 dB  
Peak SAR (extrapolated) = 37.2 W/kg  
**SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.25 W/kg**  
Maximum value of SAR (measured) = 20.2 W/kg

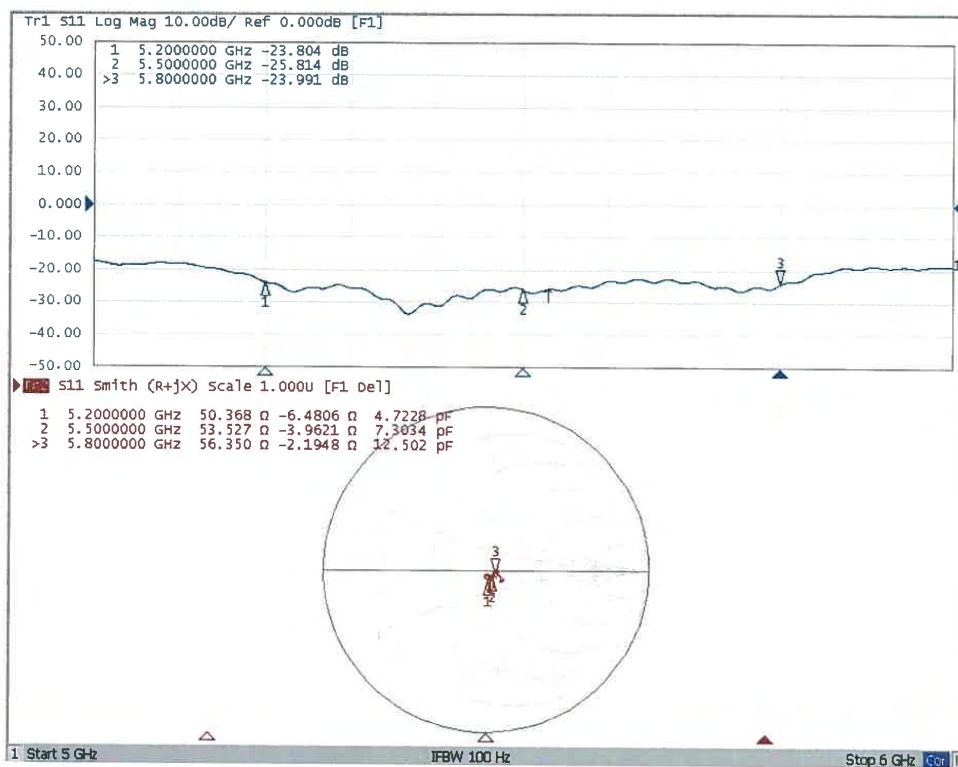


0 dB = 20.2 W/kg = 13.05 dBW/kg



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### Impedance Measurement Plot for Head TSL



# **DASY5 Validation Report for Body TSL**

Date: 04.08.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1021**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz,

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.355$  mho/m;  $\epsilon_r = 49.72$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.726$  mho/m;  $\epsilon_r = 49.58$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.096$  mho/m;  $\epsilon_r = 49.25$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

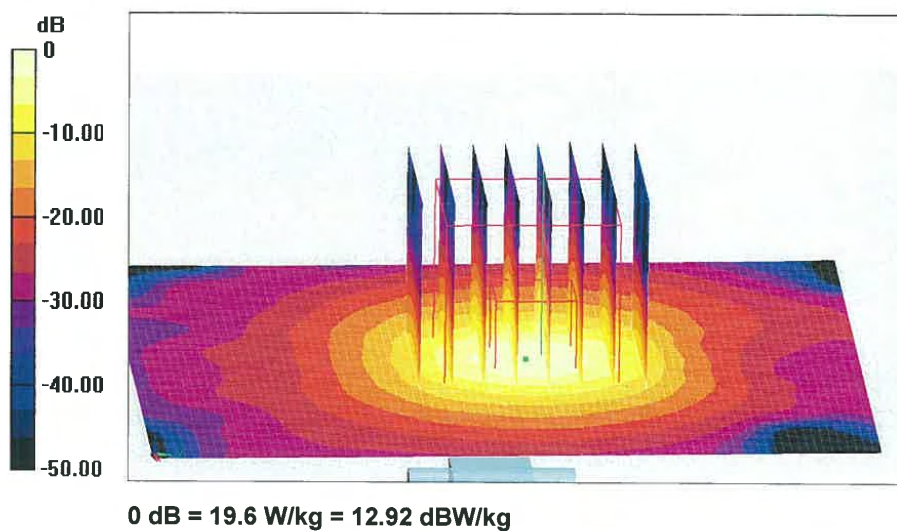
## **DASY5 Configuration:**

- Probe: EX3DV4 - SN3617; ConvF(4.88,4.88,4.88); Calibrated: 2015/8/26, ConvF(4.41,4.41,4.41); Calibrated: 2015/8/26, ConvF(4.41,4.41,4.41); Calibrated: 2015/8/26,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016/2/02
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

**Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 61.18 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 30.9 W/kg  
**SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.13 W/kg**  
Maximum value of SAR (measured) = 17.6 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 66.40 V/m; Power Drift = -0.04 dB  
Peak SAR (extrapolated) = 37.4 W/kg  
**SAR(1 g) = 8.19 W/kg; SAR(10 g) = 2.29 W/kg**  
Maximum value of SAR (measured) = 20.2 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 58.24 V/m; Power Drift = -0.00 dB  
Peak SAR (extrapolated) = 37.0 W/kg  
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.13 W/kg**  
Maximum value of SAR (measured) = 19.6 W/kg



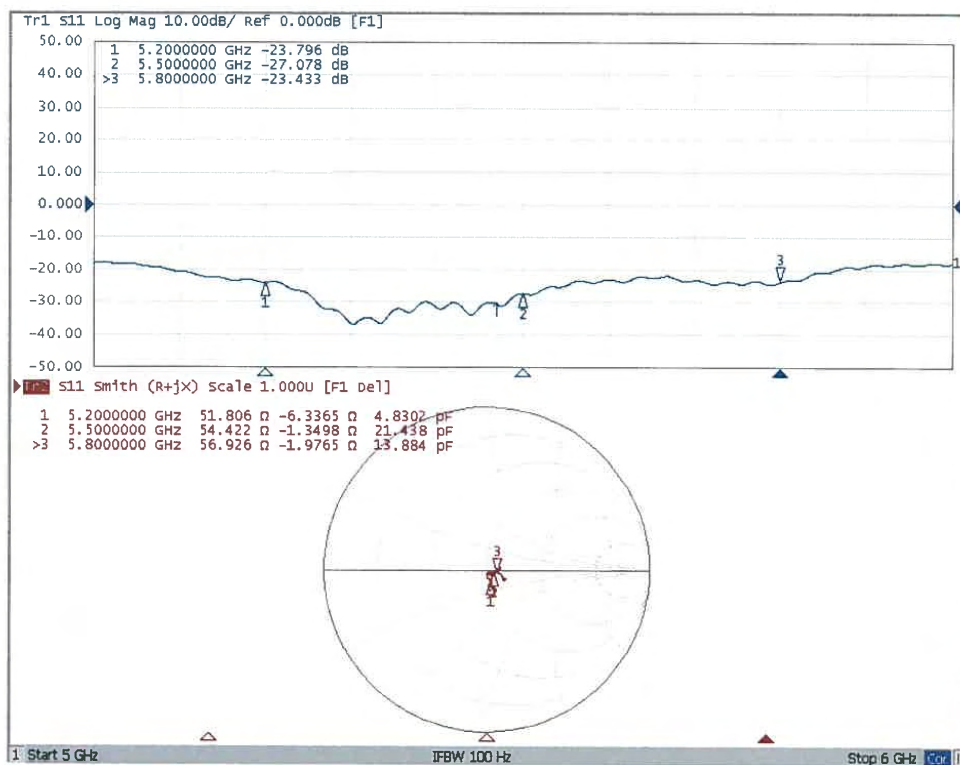




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### Impedance Measurement Plot for Body TSL







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Client

ATL

Certificate No: Z16-97020

## CALIBRATION CERTIFICATE

Object

EX3DV4 - SN:3977

Calibration Procedure(s)

FD-Z11-2-004-01

Calibration Procedures for Dosimetric E-field Probes

Calibration date:

March 09, 2016

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	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 3617	26-Aug-15(SPEAG,No.EX3-3617_Aug15)	Aug-16
DAE4	SN 1331	21-Jan-16(SPEAG, No.DAE4-1331_Jan15)	Jan -17
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	26-Jan-16 (CTTL, No.J16X00894)	Jan -17

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

Issued: March 10, 2016

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

Certificate No: Z16-97020

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### Glossary:

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

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

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

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

### Methods Applied and Interpretation of Parameters:

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



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# Probe EX3DV4

## SN: 3977

Calibrated: March 09, 2016

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3977

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.53	0.58	0.51	±10.8%
DCP(mV) <sup>B</sup>	102.9	103.1	100.6	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	208.7	±2.2%
		Y	0.0	0.0	1.0		215.6	
		Z	0.0	0.0	1.0		202.6	

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

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

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

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



## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3977

### Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.82	9.82	9.82	0.30	0.75	± 12%
835	41.5	0.90	9.62	9.62	9.62	0.15	1.37	± 12%
900	41.5	0.97	9.55	9.55	9.55	0.12	1.62	± 12%
1750	40.1	1.37	8.36	8.36	8.36	0.14	1.88	± 12%
1900	40.0	1.40	8.02	8.02	8.02	0.14	1.96	± 12%
2000	40.0	1.40	8.02	8.02	8.02	0.12	2.81	± 12%
2300	39.5	1.67	7.69	7.69	7.69	0.37	0.92	± 12%
2450	39.2	1.80	7.28	7.28	7.28	0.29	1.21	± 12%
2600	39.0	1.96	7.18	7.18	7.18	0.31	1.20	± 12%
5200	36.0	4.66	5.45	5.45	5.45	0.48	1.28	± 13%
5300	35.9	4.76	5.25	5.25	5.25	0.48	1.32	± 13%
5500	35.6	4.96	5.05	5.05	5.05	0.48	1.25	± 13%
5600	35.5	5.07	4.82	4.82	4.82	0.50	1.33	± 13%
5800	35.3	5.27	4.83	4.83	4.83	0.50	1.41	± 13%

<sup>C</sup> 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.

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

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

## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3977

### Calibration Parameter Determined in Body Tissue Simulating Media

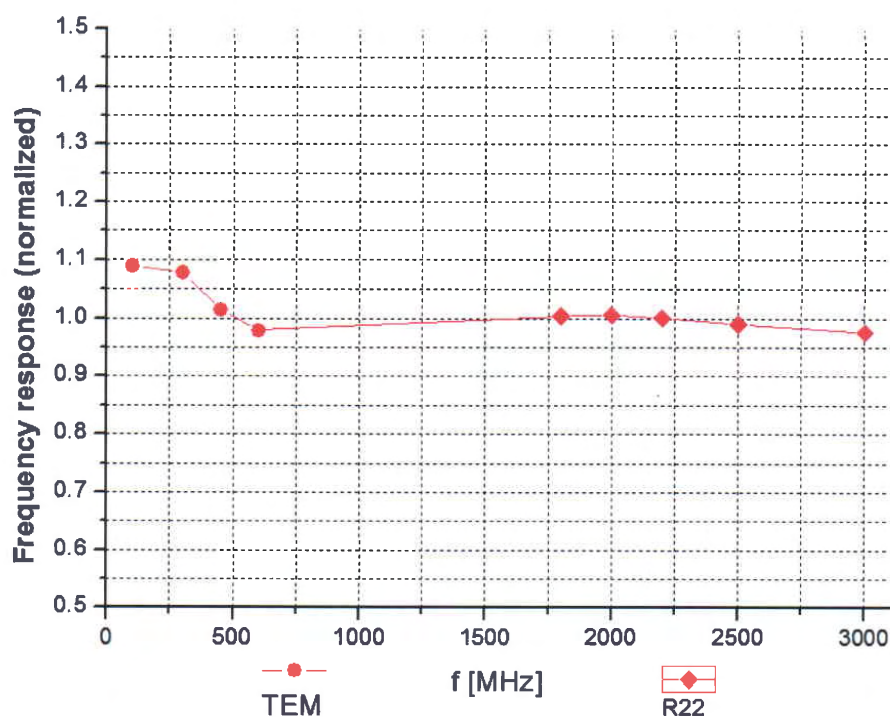
f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.95	9.95	9.95	0.38	0.82	± 12%
835	55.2	0.97	9.82	9.82	9.82	0.14	1.60	± 12%
900	55.0	1.05	9.67	9.67	9.67	0.18	1.35	± 12%
1750	53.4	1.49	8.00	8.00	8.00	0.15	2.18	± 12%
1900	53.3	1.52	7.66	7.66	7.66	0.15	2.66	± 12%
2000	53.3	1.52	7.80	7.80	7.80	0.15	3.21	± 12%
2300	52.9	1.81	7.33	7.33	7.33	0.28	1.43	± 12%
2450	52.7	1.95	7.30	7.30	7.30	0.30	1.40	± 12%
2600	52.5	2.16	7.08	7.08	7.08	0.37	1.05	± 12%
5200	49.0	5.30	4.81	4.81	4.81	0.44	1.58	± 13%
5300	48.9	5.42	4.61	4.61	4.61	0.44	1.80	± 13%
5500	48.6	5.65	4.31	4.31	4.31	0.46	1.80	± 13%
5600	48.5	5.77	4.21	4.21	4.21	0.48	1.85	± 13%
5800	48.2	6.00	4.33	4.33	4.33	0.50	1.60	± 13%

<sup>C</sup> 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.

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

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

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

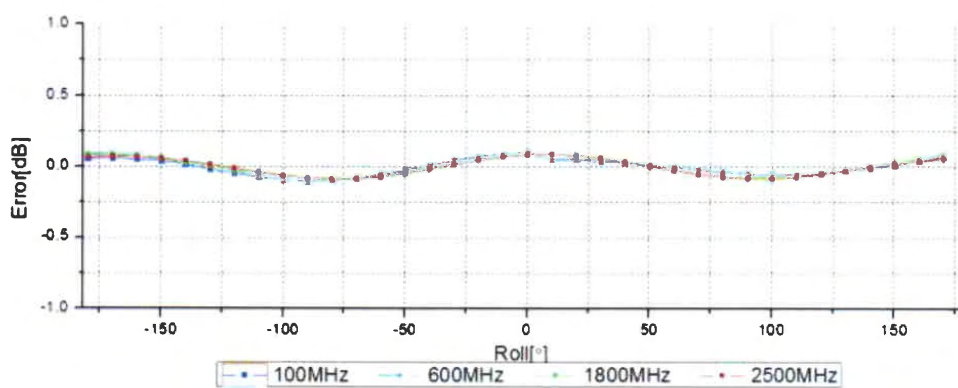
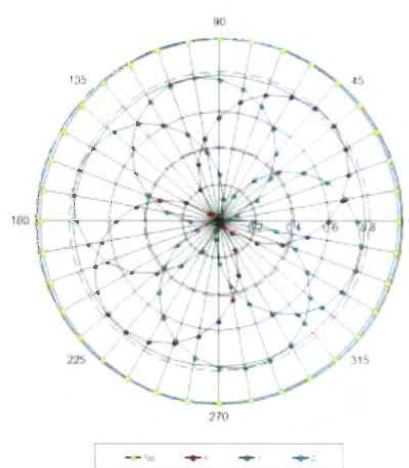
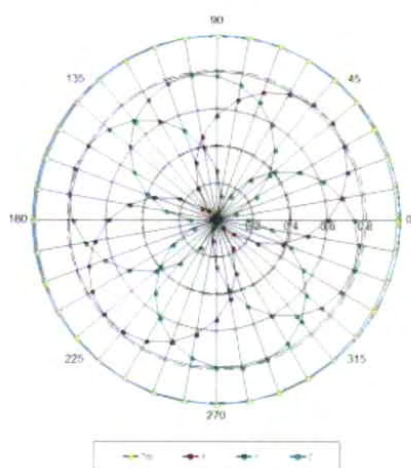


Uncertainty of Frequency Response of E-field:  $\pm 7.5\%$  ( $k=2$ )

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

**f=600 MHz, TEM**

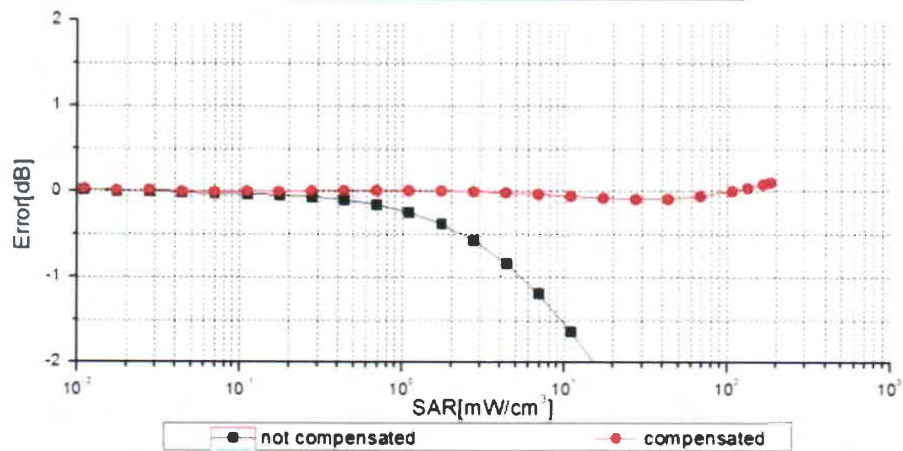
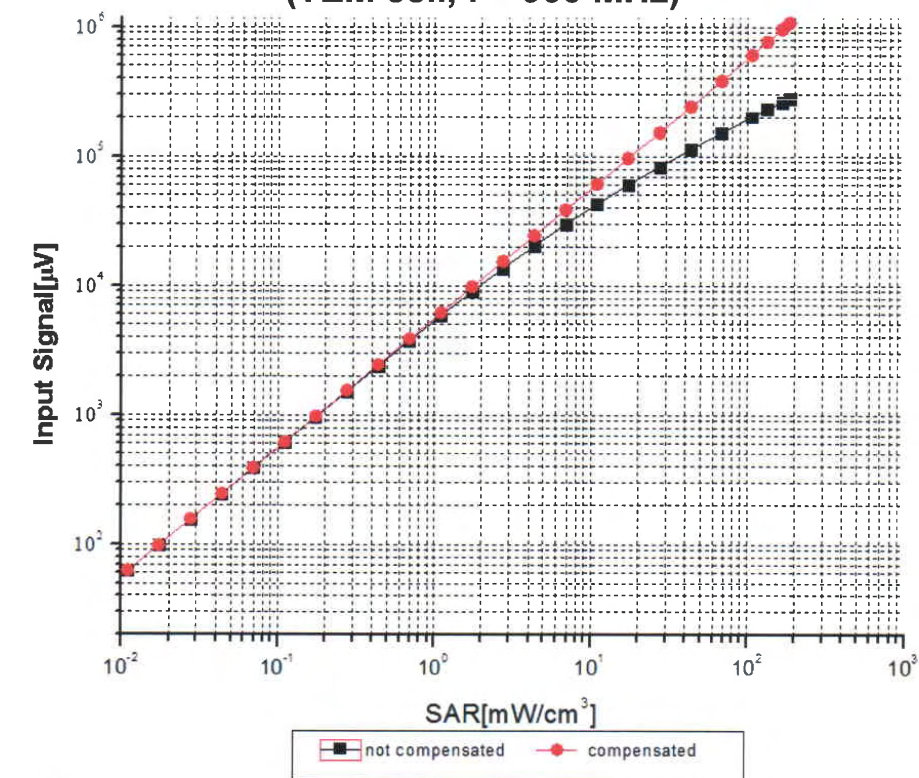
**f=1800 MHz, R22**



Uncertainty of Axial Isotropy Assessment:  $\pm 0.9\%$  ( $k=2$ )



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

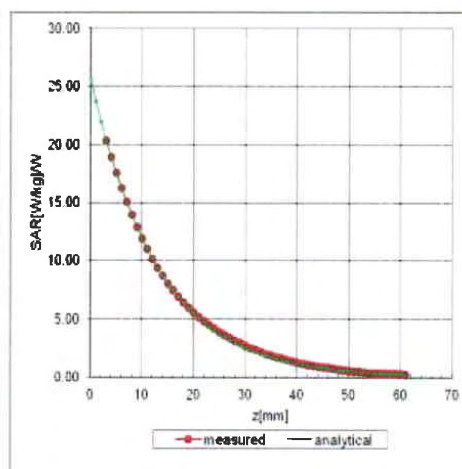
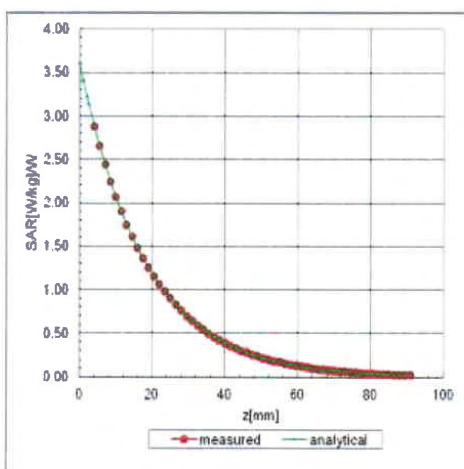


Uncertainty of Linearity Assessment:  $\pm 0.9\%$  (k=2)

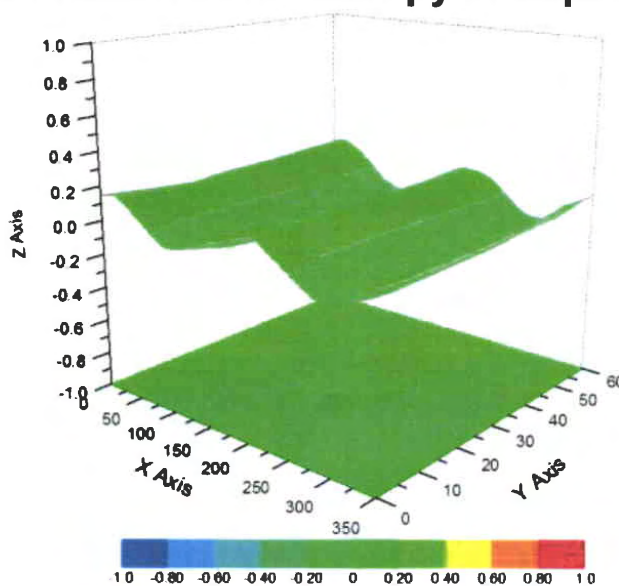
## Conversion Factor Assessment

f=900 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.8\%$  (K=2)



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3977

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	26.4
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



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Client : **ATL**

Certificate No: **Z16-97019**

## CALIBRATION CERTIFICATE

Object **DAE4 - SN: 779**

Calibration Procedure(s) **FD-Z11-2-002-01**  
Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: **March 2, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	06-July-15 (CTTL, No:J15X04257)	July-16

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

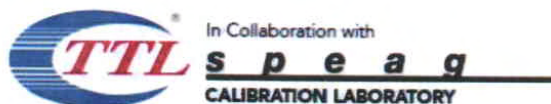
Issued: **March 3, 2016**

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

Certificate No: Z16-97019

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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 =  $6.1\mu\text{V}$ , full range = -100...+300 mV

Low Range: 1LSB =  $61\text{nV}$ , full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	$404.044 \pm 0.15\% (k=2)$	$403.722 \pm 0.15\% (k=2)$	$403.947 \pm 0.15\% (k=2)$
Low Range	$3.97041 \pm 0.7\% (k=2)$	$3.98123 \pm 0.7\% (k=2)$	$3.99689 \pm 0.7\% (k=2)$

### Connector Angle

Connector Angle to be used in DASY system	$158 \pm 1^\circ$
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