

# FCC SAR Test Report

APPLICANT : Acer Incorporated  
EQUIPMENT : Notebook computer  
BRAND NAME : acer  
MODEL NAME : N18H2  
FCC ID : Contains FCC ID : PPD-QCNFA344AH  
STANDARD : FCC 47 CFR Part 2 (2.1093)  
ANSI/IEEE C95.1-1992  
IEEE 1528-2013

The product was installed a module during the test: 802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card (Brand Name: Qualcomm Atheros, Model Name: QCNFA344A, FCC ID: PPD-QCNFA344AH).

The product was received on Aug. 23, 2018 and testing was started from Nov. 12, 2018 and completed on Nov. 13, 2018. We, Sporton International (Shenzhen) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Shenzhen) Inc., the test report shall not be reproduced except in full.



Approved by: Mark Qu / Manager



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**Sporton International (Shenzhen) Inc.**

## 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Acer Incorporated, Notebook computer, N18H2**, are as follows.

Highest Standalone 1g SAR Summary			
Equipment Class	Frequency Band		Body Gap(0mm)
			1g SAR (W/kg)
DTS	WLAN	2.4GHz WLAN	0.71
NII		5GHz WLAN	<b>0.94</b>
DSS	Bluetooth	Bluetooth	<0.10
Highest SAR Summary Highest Simultaneous Transmission 1g SAR (W/kg)			
DTS (MIMO)		<b>1.33</b>	
NII (MIMO)		0.94	
DTS+DSS		0.65	
NII+DSS		0.75	
Date of Testing:		2018/11/12~2018/11/13	

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

## 2. Administration Data

Testing Laboratory	
Test Site	Sporton International (Shenzhen) Inc.
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen City, Guangdong Province 518055, China TEL: +86-755-8637-9589 FAX: +86-755-8637-9595

Applicant	
Company Name	Acer Incorporated
Address	8F ,88, Sec.1 Xintai 5th Rd. Xizhi, New Taipei City 221, Taiwan, R.O.C

Manufacturer	
Company Name	Acer Incorporated
Address	8F ,88, Sec.1 Xintai 5th Rd. Xizhi, New Taipei City 221, Taiwan, R.O.C

## 3. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r02

## **4. Equipment Under Test (EUT) Information**

### **4.1 General Information**

Product Feature & Specification	
Equipment Name	Notebook computer
Brand Name	acer
Model Name	N18H2
FCC ID	Contains FCC ID: PPD-QCNFA344AH
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	WLAN 2.4GHz : 802.11b/g/n/ac HT20/HT40/VHT20/VHT40 WLAN 5GHz : 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
EUT Stage	Identical Prototype
<b>Remark:</b> <ol style="list-style-type: none"> <li>The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.</li> <li>This device has no voice function.</li> <li>The modulation and bandwidth are similar for 802.11n mode for 20MHz (40MHz) and 802.11ac mode for 20MHz (40MHz), therefore investigated worst case which is 802.11 ac mode to representative mode in test report.</li> <li>There are three samples. For SAR tests, we only evaluated sample 1 for full test, sample 2 and sample 3 only verified the worst case of sample 1.</li> </ol>	

Module Feature & Specification	
Equipment	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Brand Name	Qualcomm Atheros
Model Name	QCFA344A
FCC ID	PPD-QCNFA344AH

## **5. RF Exposure Limits**

### **5.1 Uncontrolled Environment**

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

### **5.2 Controlled Environment**

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

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

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

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

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

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

## **6. Specific Absorption Rate (SAR)**

### **6.1 Introduction**

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

### **6.2 SAR Definition**

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

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

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

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.



## 7. System Description and Setup

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




- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 7.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

### <EX3DV4 Probe>

<b>Construction</b>	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
<b>Frequency</b>	10 MHz – >6 GHz Linearity: $\pm 0.2$ dB (30 MHz – 6 GHz)	
<b>Directivity</b>	$\pm 0.3$ dB in TSL (rotation around probe axis) $\pm 0.5$ dB in TSL (rotation normal to probe axis)	
<b>Dynamic Range</b>	10 $\mu$ W/g – >100 mW/g Linearity: $\pm 0.2$ dB (noise: typically <1 $\mu$ W/g)	
<b>Dimensions</b>	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	

## 7.2 Data Acquisition Electronics (DAE)

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

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



**Photo of DAE**

### **7.3 Phantom**

#### **<SAM Twin Phantom>**

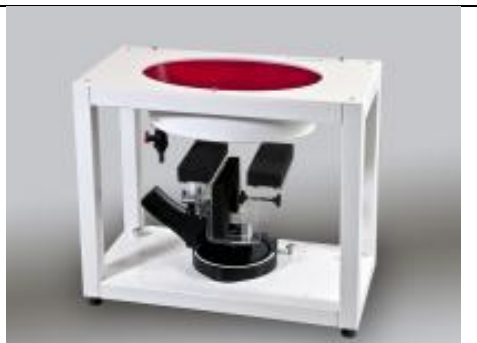
<b>Shell Thickness</b>	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm
<b>Filling Volume</b>	Approx. 25 liters
<b>Dimensions</b>	Length: 1000 mm; Width: 500 mm; Height: adjustable feet
<b>Measurement Areas</b>	Left Hand, Right Hand, Flat Phantom



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

#### **<ELI Phantom>**

<b>Shell Thickness</b>	2 ± 0.2 mm (sagging: <1%)
<b>Filling Volume</b>	Approx. 30 liters
<b>Dimensions</b>	Major ellipse axis: 600 mm Minor axis: 400 mm



The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

## 7.4 Device Holder

### <Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.



Mounting Device for Hand-Held Transmitters



Mounting Device Adaptor for Wide-Phones

### <Mounting Device for Laptops and other Body-Worn Transmitters>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.



Mounting Device for Laptops

## **8. Measurement Procedures**

The measurement procedures are as follows:

### <Conducted power measurement>

- (a) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
- (b) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

### <SAR measurement>

- (a) Use base station simulator to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix D demonstrates.
- (c) Set scan area, grid size and other setting on the DASY software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band
- (f) Measure SAR results for other channels in worst SAR testing position if the reported 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:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

### **8.1 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:

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

## **8.2 Power Reference Measurement**

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

## **8.3 Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

### 8.4 Zoom Scan

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

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

### 8.5 Volume Scan Procedures

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

### 8.6 Power Drift Monitoring

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



## 9. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	924	2018/3/22	2019/3/21
SPEAG	5000MHz System Validation Kit	D5GHzV2	1167	2018/8/3	2019/8/2
SPEAG	Data Acquisition Electronics	DAE4	1437	2018/10/15	2019/10/14
SPEAG	Dosimetric E-Field Probe	EX3DV4	3819	2018/1/31	2019/1/30
SPEAG	ELI4 Phantom	QD OVA 002 AA	TP-1149	NCR	NCR
SPEAG	ELI4 Phantom	QD OVA 001 BB	TP-1233	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	ENA Series Network Analyzer	E5071C	MY46111157	2018/4/17	2019/4/16
SPEAG	Dielectric Assessment Kit	DAK-3.5	1071	2017/11/28	2018/11/27
Agilent	Signal Generator	N5181A	MY50145381	2017/12/26	2018/12/25
Anritsu	Power Sensor	MA2411B	1306099	2018/7/30	2019/7/29
Anritsu	Power Meter	ML2495A	1349001	2018/7/26	2019/7/25
Anritsu	Power Sensor	MA2411B	1207253	2017/12/26	2018/12/25
Anritsu	Power Meter	ML2495A	1218010	2017/12/26	2018/12/25
R&S	CBT BLUETOOTH TESTER	CBT	100963	2017/12/26	2018/12/25
R&S	Spectrum Analyzer	FSP7	100818	2018/7/18	2019/7/17
LKM electronic	Hygrometer	DTM3000	3241	2018/8/10	2019/8/9
Anymetre	Thermo-Hygrometer	JR593	2015030904	2018/4/19	2019/4/18
ARRA	Power Divider	A3200-2	N/A	Note	
MCL	Attenuation1	BW-S10W5+	N/A	Note	
MCL	Attenuation2	BW-S10W5+	N/A	Note	
MCL	Attenuation3	BW-S10W5+	N/A	Note	
AR	Amplifier	5S1G4	333096	Note	
mini-circuits	Amplifier	ZVE-3W-83+	162601250	Note	
Agilent	Dual Directional Coupler	778D	50422	Note	
PASTERNAK	Dual Directional Coupler	PE2214-10	N/A	Note	

**Note:** Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.



## **10. System Verification**

### **10.1 Tissue Simulating Liquids**

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.1.



Fig 10.1 Photo of Liquid Height for Body SAR

## 10.2 Tissue Verification

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

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity ( $\sigma$ )	Permittivity ( $\epsilon_r$ )
For Body								
2450	68.6	0	0	0	0	31.4	1.95	52.7

### Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

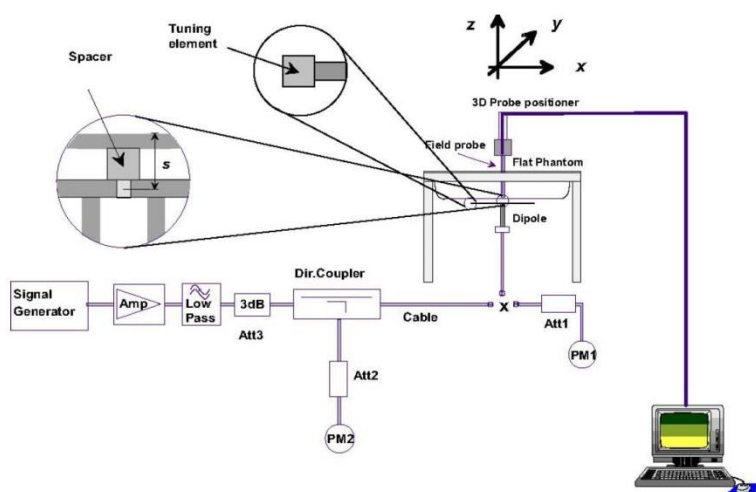
### <Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Conductivity ( $\sigma$ )	Permittivity ( $\epsilon_r$ )	Conductivity Target ( $\sigma$ )	Permittivity Target ( $\epsilon_r$ )	Delta ( $\sigma$ ) (%)	Delta ( $\epsilon_r$ ) (%)	Limit (%)	Date
2450	Body	22.5	1.992	52.291	1.95	52.70	2.15	-0.78	±5	2018/11/13
5250	Body	22.7	5.290	50.979	5.36	48.90	-1.31	4.25	±5	2018/11/12
5600	Body	22.7	5.884	50.353	5.77	48.50	1.98	3.82	±5	2018/11/12
5750	Body	22.7	6.115	50.005	5.94	48.30	2.95	3.53	±5	2018/11/12

### 10.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2018/11/13	2450	Body	250	924	3819	1437	13.40	50.70	53.60	5.72
2018/11/12	5250	Body	100	1167	3819	1437	7.42	74.40	74.20	-0.27
2018/11/12	5600	Body	100	1167	3819	1437	8.31	77.10	83.10	7.78
2018/11/12	5750	Body	100	1167	3819	1437	8.01	74.30	80.10	7.81



System Performance Check Setup



Setup Photo



## **11. RF Exposure Positions**

This DUT was tested in two positions. It is Bottom of Laptop with phantom 0 mm gap, and back of display screen with phantom 25 mm gap.

### **<EUT Setup Photos>**

Please refer to Appendix D for the test setup photos.

## **12. Conducted RF Output Power (Unit: dBm)**

### **<WLAN Conducted Power>**

#### **General Note:**

1. The modulation and bandwidth are similar for 802.11n mode for 20MHz (40MHz) and 802.11ac mode for 20MHz (40MHz), therefore investigated worst case which is 802.11 ac mode to representative mode in test report.
2. For each antenna, transmit power in SISO operation is larger than (or equal to) the power in MIMO operation, RF exposure compliance of MIMO mode can be deduced from the compliance simultaneous transmission of antennas operating in SISO mode.
3. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
4. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
5. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel for each frequency band.
6. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
  - a. When the reported SAR of 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 802.11 transmission mode combinations within the frequency band or aggregated band.
  - b. When the reported SAR of the test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is  $\leq 0.8$  W/kg or all required test position are tested.
  - c. For all positions/configurations, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.

**<2.4GHz WLAN Ant.1>**

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN Ant.1	802.11b	CH 1	2412	1Mbps	18.96	20.50	98.96
		CH 6	2437		19.44	20.50	
		CH 11	2462		19.01	20.50	
	802.11g	CH 1	2412	6Mbps	16.64	18.00	95.32
		CH 6	2437		18.42	19.50	
		CH 11	2462		16.23	18.00	
	802.11ac-VHT20	CH 1	2412	MCS0	15.13	17.00	94.66
		CH 6	2437		18.40	19.50	
		CH 11	2462		14.34	16.00	
	802.11ac-VHT40	CH 3	2422	MCS0	11.55	13.00	90.46
		CH 6	2437		17.22	18.50	
		CH 9	2452		9.25	11.00	

**<2.4GHz WLAN Ant.2>**

2.4GHz WLAN Ant.2	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11b	CH 1	2412	1Mbps	18.64	20.50	99.31
		CH 6	2437		19.47	20.50	
		CH 11	2462		18.55	20.50	
	802.11g	CH 1	2412	6Mbps	16.16	18.00	95.32
		CH 6	2437		18.38	19.50	
		CH 11	2462		16.08	18.00	
	802.11ac-VHT20	CH 1	2412	MCS0	15.43	17.00	95.36
		CH 6	2437		19.10	19.50	
		CH 11	2462		14.72	16.00	
	802.11ac-VHT40	CH 3	2422	MCS0	11.05	13.00	90.50
		CH 6	2437		16.96	18.50	
		CH 9	2452		9.21	11.00	

**<2.4GHz WLAN Ant.1+2>**

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN Ant.1+2	802.11b	CH 1	2412	1Mbps	21.52	23.50	99.31
		CH 6	2437		<b>22.09</b>	23.50	
		CH 11	2462		22.00	23.50	
	802.11g	CH 1	2412	6Mbps	19.29	21.00	95.32
		CH 6	2437		21.19	22.50	
		CH 11	2462		17.79	21.00	
	802.11ac-VHT20	CH 1	2412	MCS0	16.81	20.00	95.36
		CH 6	2437		21.56	22.50	
		CH 11	2462		16.58	19.00	
	802.11ac-VHT40	CH 3	2422	MCS0	14.17	16.00	90.50
		CH 6	2437		20.10	21.50	
		CH 9	2452		11.82	14.00	



**<5GHz WLAN Ant.1>**

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN Ant.1	802.11a	CH 36	5180	6Mbps	13.22	15.00	95.00
		CH 40	5200		<b>14.99</b>	15.00	
		CH 44	5220		14.72	15.00	
		CH 48	5240		14.82	15.00	
	802.11ac-VHT20	CH 36	5180	MCS0	13.55	15.00	94.33
		CH 40	5200		14.66	15.00	
		CH 44	5220		14.15	15.00	
		CH 48	5240		14.86	15.00	
	802.11ac-VHT40	CH 38	5190	MCS0	8.68	11.50	90.03
		CH 46	5230		14.48	14.50	
	802.11ac-VHT80	CH 42	5210	MCS0	7.97	10.50	81.90

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN Ant.1	802.11a	CH 52	5260	6Mbps	<b>14.94</b>	15.00	95.00
		CH 56	5280		14.58	15.00	
		CH 60	5300		14.63	15.00	
		CH 64	5320		13.79	15.00	
	802.11ac-VHT20	CH 52	5260	MCS0	14.80	15.00	94.33
		CH 56	5280		13.82	15.00	
		CH 60	5300		14.50	15.00	
		CH 64	5320		14.16	15.00	
	802.11ac-VHT40	CH 54	5270	MCS0	14.46	14.50	90.03
		CH 62	5310		11.71	14.00	
	802.11ac-VHT80	CH 58	5290	MCS0	9.75	12.00	81.90

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN Ant.1	802.11a	CH 100	5500	6Mbps	13.30	15.00	95.00
		CH 116	5580		14.80	15.00	
		CH 124	5620		14.69	15.00	
		CH 132	5660		14.33	15.00	
		CH 140	5700		13.75	15.00	
		CH 144	5720		9.43	15.00	
	802.11ac-VHT20	CH 100	5500	MCS0	12.80	15.00	94.33
		CH 116	5580		14.68	15.00	
		CH 124	5620		14.36	15.00	
		CH 132	5660		14.48	15.00	
		CH 140	5700		13.65	15.00	
		CH 144	5720		9.83	15.00	
	802.11ac-VHT40	CH 102	5510	MCS0	9.06	11.50	90.03
		CH 110	5550		14.20	14.50	
		CH 126	5630		14.17	14.50	
		CH 134	5670		12.77	14.50	
		CH 142	5710		8.56	14.50	
	802.11ac-VHT80	CH 106	5530	MCS0	9.60	12.00	81.90
		CH 122	5610		13.34	14.50	
		CH 138	5690		8.05	14.50	

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN Ant.1	802.11a	CH 149	5745	6Mbps	13.56	15.00	95.00
		CH 157	5785		14.82	15.00	
		CH 165	5825		14.97	15.00	
	802.11ac-VHT20	CH 149	5745	MCS0	12.61	14.50	94.33
		CH 157	5785		14.75	15.00	
		CH 165	5825		14.45	15.00	
	802.11ac-VHT40	CH 151	5755	MCS0	9.76	11.50	90.03
		CH 159	5795		14.32	14.50	
	802.11ac-VHT80	CH 155	5775	MCS0	8.13	10.00	81.90

**<5GHz WLAN Ant.2>**

5.2GHz WLAN Ant.2	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a	CH 36	5180	6Mbps	14.05	15.00	94.77
		CH 40	5200		14.98	15.00	
		CH 44	5220		14.53	15.00	
		CH 48	5240		14.86	15.00	
	802.11ac-VHT20	CH 36	5180	MCS0	13.87	15.00	94.42
		CH 40	5200		14.73	15.00	
		CH 44	5220		14.21	15.00	
		CH 48	5240		14.72	15.00	
	802.11ac-VHT40	CH 38	5190	MCS0	9.39	11.50	89.88
		CH 46	5230		14.48	14.50	
	802.11ac-VHT80	CH 42	5210	MCS0	8.74	10.50	81.35

5.3GHz WLAN Ant.2	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a	CH 52	5260	6Mbps	14.73	15.00	94.77
		CH 56	5280		14.66	15.00	
		CH 60	5300		14.77	15.00	
		CH 64	5320		13.58	15.00	
	802.11ac-VHT20	CH 52	5260	MCS0	14.61	15.00	94.42
		CH 56	5280		14.24	15.00	
		CH 60	5300		14.53	15.00	
		CH 64	5320		14.25	15.00	
	802.11ac-VHT40	CH 54	5270	MCS0	14.43	14.50	89.88
		CH 62	5310		11.51	14.00	
	802.11ac-VHT80	CH 58	5290	MCS0	9.94	12.00	81.35

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN Ant.2	802.11a	CH 100	5500	6Mbps	13.84	15.00	94.77
		CH 116	5580		14.98	15.00	
		CH 124	5620		14.67	15.00	
		CH 132	5660		14.59	15.00	
		CH 140	5700		14.20	15.00	
		CH 144	5720		9.00	15.00	
	802.11ac-VHT20	CH 100	5500	MCS0	13.41	15.00	94.42
		CH 116	5580		14.95	15.00	
		CH 124	5620		14.75	15.00	
		CH 132	5660		14.81	15.00	
		CH 140	5700		13.83	15.00	
		CH 144	5720		9.57	15.00	
	802.11ac-VHT40	CH 102	5510	MCS0	9.66	11.50	89.88
		CH 110	5550		14.13	14.50	
		CH 126	5630		13.88	14.50	
		CH 134	5670		13.60	14.50	
		CH 142	5710		8.96	14.50	
	802.11ac-VHT80	CH 106	5530	MCS0	10.07	12.00	81.35
		CH 122	5610		13.55	14.50	
		CH 138	5690		7.90	14.50	

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN Ant.2	802.11a	CH 149	5745	6Mbps	13.07	15.00	94.77
		CH 157	5785		14.81	15.00	
		CH 165	5825		14.37	15.00	
	802.11ac-VHT20	CH 149	5745	MCS0	12.19	14.50	94.42
		CH 157	5785		14.80	15.00	
		CH 165	5825		14.35	15.00	
	802.11ac-VHT40	CH 151	5755	MCS0	9.29	11.50	89.88
		CH 159	5795		14.48	14.50	
	802.11ac-VHT80	CH 155	5775	MCS0	7.76	10.00	81.35

**<5GHz WLAN Ant.1+2>**

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN Ant.1+2	802.11a	CH 36	5180	6Mbps	16.05	18.00	95.77
		CH 40	5200		17.85	18.00	
		CH 44	5220		17.59	18.00	
		CH 48	5240		17.92	18.00	
	802.11ac-VHT20	CH 36	5180	MCS0	16.61	18.00	95.50
		CH 40	5200		17.34	18.00	
		CH 44	5220		16.93	18.00	
		CH 48	5240		17.81	18.00	
	802.11ac-VHT40	CH 38	5190	MCS0	12.07	14.50	91.25
		CH 46	5230		17.49	17.50	
	802.11ac-VHT80	CH 42	5210	MCS0	11.20	13.50	83.59

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN Ant.1+2	802.11a	CH 52	5260	6Mbps	17.49	18.00	95.77
		CH 56	5280		17.17	18.00	
		CH 60	5300		17.21	18.00	
		CH 64	5320		16.06	18.00	
	802.11ac-VHT20	CH 52	5260	MCS0	17.28	18.00	95.50
		CH 56	5280		16.95	18.00	
		CH 60	5300		17.32	18.00	
		CH 64	5320		16.72	18.00	
	802.11ac-VHT40	CH 54	5270	MCS0	16.70	17.50	91.25
		CH 62	5310		13.21	17.00	
	802.11ac-VHT80	CH 58	5290	MCS0	12.29	15.00	83.59

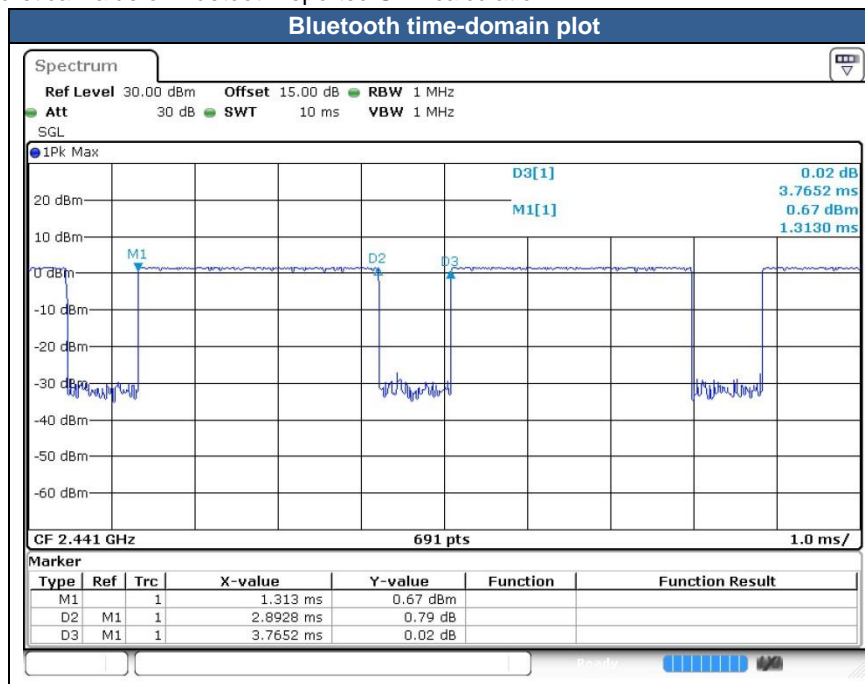
	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN Ant.1+2	802.11a	CH 100	5500	6Mbps	16.14	18.00	95.77
		CH 116	5580		17.58	18.00	
		CH 124	5620		16.94	18.00	
		CH 132	5660		16.94	18.00	
		CH 140	5700		15.84	18.00	
		CH 144	5720		11.44	14.00	
	802.11ac-VHT20	CH 100	5500	MCS0	15.33	18.00	95.50
		CH 116	5580		17.56	18.00	
		CH 124	5620		17.33	18.00	
		CH 132	5660		17.44	18.00	
		CH 140	5700		15.59	18.00	
		CH 144	5720		11.98	18.00	
	802.11ac-VHT40	CH 102	5510	MCS0	11.70	14.50	91.25
		CH 110	5550		16.53	17.50	
		CH 126	5630		16.30	17.50	
		CH 134	5670		16.03	17.50	
		CH 142	5710		11.06	17.50	
	802.11ac-VHT80	CH 106	5530	MCS0	12.50	15.00	83.59
		CH 122	5610		15.41	17.50	
		CH 138	5690		10.08	17.50	

	Mode	Channel	Frequency (MHz)	Data Rate	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN Ant.1+2	802.11a	CH 149	5745	6Mbps	16.02	18.00	95.77
		CH 157	5785		17.94	18.00	
		CH 165	5825		17.65	18.00	
	802.11ac-VHT20	CH 149	5745	MCS0	14.76	17.50	95.50
		CH 157	5785		17.82	18.00	
		CH 165	5825		17.06	18.00	
	802.11ac-VHT40	CH 151	5755	MCS0	11.08	14.50	91.25
		CH 159	5795		17.04	17.50	
	802.11ac-VHT80	CH 155	5775	MCS0	10.27	13.00	83.59

## <2.4GHz Bluetooth>

### General Note:

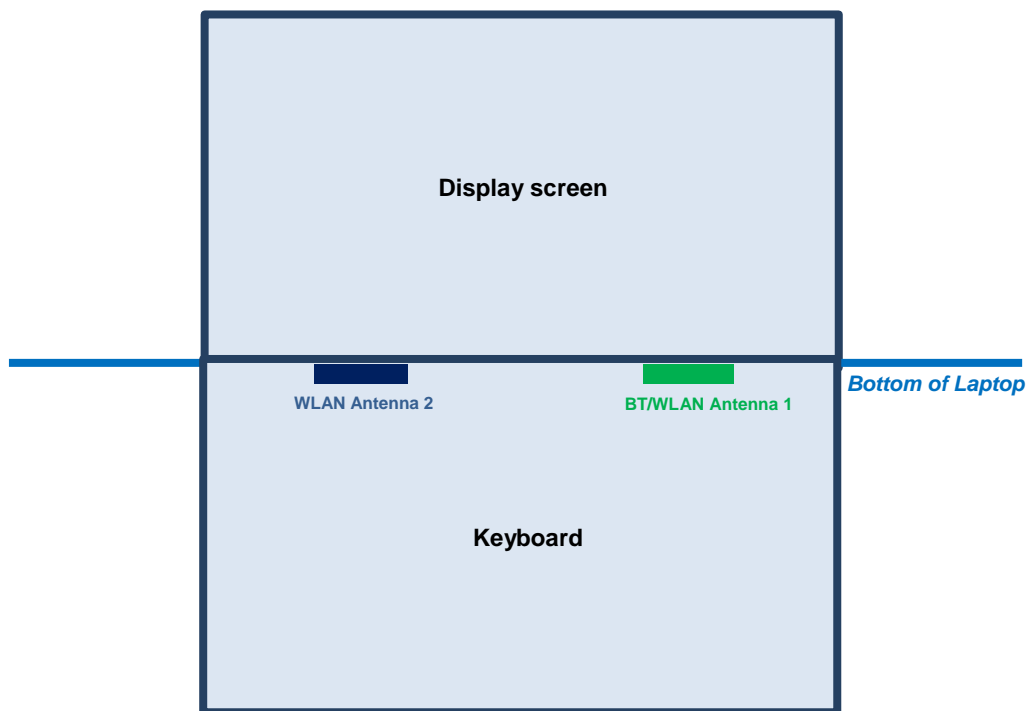
1. For 2.4GHz Bluetooth SAR testing was selected 1Mbps, due to its highest average power.
2. The Bluetooth duty cycle is 76.83% as following figure, according to 2016 Oct. TCB workshop for Bluetooth SAR scaling need further consideration and the theoretical duty cycle is 83.3%, therefore the actual duty cycle will be scaled up to the theoretical value of Bluetooth reported SAR calculation.



Mode	Channel	Frequency (MHz)	Average power (dBm)
			1Mbps
BR / EDR	CH 00	2402	6.04
	CH 39	2441	6.59
	CH 78	2480	6.85
Tune-up limit (dBm)			7.00

Mode	Channel	Frequency (MHz)	Average power (dBm)
			GFSK
LE	CH 00	2402	2.90
	CH 19	2440	3.11
	CH 39	2480	2.98
Tune-up limit (dBm)			4.50

### 13. Antenna Location





## 14. SAR Test Results

### General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
  - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
  - b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
  - c. For WLAN/Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)\* Duty Cycle scaling factor \* Tune-up scaling factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
  - $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
  - $\leq 0.6$  W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
  - $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8$  W/kg.

### WLAN Note:

1. Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n/ac SAR testing is not required 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.
2. Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band.
3. When the reported SAR of the test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is  $\leq 0.8$  W/kg or all required test position are tested.
4. For all positions / configurations, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test positions / configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.
5. For WLAN SAR testing was performed on single antenna RF power in SISO mode is larger or equal to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode.
6. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

**14.1 Body SAR****<WLAN2.4GHz SAR>**

Plot No.	Sample	Ant. Port	Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	1	1	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	6	2437	19.44	20.50	1.278	98.96	1.011	0.09	0.546	0.705
	1	1	WLAN2.4GHz	802.11b 1Mbps	Back of Display Screen	25	6	2437	19.44	20.50	1.278	98.96	1.011	0.02	0.001	0.001
01	1	1	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	1	2412	18.96	20.50	1.427	98.96	1.011	0.05	0.493	<b>0.711</b>
	1	1	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	11	2462	19.01	20.50	1.411	98.96	1.011	0.03	0.497	0.709
	1	2	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	6	2437	19.47	20.50	1.268	99.31	1.007	0.05	0.487	0.622
	1	2	WLAN2.4GHz	802.11b 1Mbps	Back of Display Screen	25	6	2437	19.47	20.50	1.268	99.31	1.007	0	<0.001	<0.001
	1	2	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	1	2412	18.64	20.50	1.535	99.31	1.007	0.04	0.401	0.620
	1	2	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0	11	2462	18.55	20.50	1.567	99.31	1.007	0.08	0.321	0.506



## &lt;WLAN5GHz SAR&gt;

Plot No.	Sample	Ant. Port	Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	52	5260	14.94	15.00	1.013	95.00	1.053	0.05	0.357	0.381
	1	1	WLAN5.3GHz	802.11a 6Mbps	Back of Display Screen	25	52	5260	14.94	15.00	1.013	95.00	1.053	0	<0.001	<0.001
	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	56	5280	14.58	15.00	1.102	95.00	1.053	0.04	0.272	0.315
	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	60	5300	14.63	15.00	1.088	95.00	1.053	0.08	0.263	0.301
	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	64	5320	13.79	15.00	1.320	95.00	1.053	0.09	0.224	0.311
	1	2	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	60	5300	14.77	15.00	1.054	94.77	1.055	0.09	0.383	0.426
	1	2	WLAN5.3GHz	802.11a 6Mbps	Back of Display Screen	25	60	5300	14.77	15.00	1.054	94.77	1.055	0	<0.001	<0.001
02	1	2	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	52	5260	14.73	15.00	1.063	94.77	1.055	0.02	0.512	0.574
	1	2	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	56	5280	14.66	15.00	1.081	94.77	1.055	0.05	0.420	0.479
	1	2	WLAN5.3GHz	802.11a 6Mbps	Bottom of Laptop	0	64	5320	13.58	15.00	1.386	94.77	1.055	0.04	0.293	0.428
	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	116	5580	14.80	15.00	1.046	95.00	1.053	0.09	0.586	0.646
	1	1	WLAN5.5GHz	802.11a 6Mbps	Back of Display Screen	25	116	5580	14.80	15.00	1.046	95.00	1.053	0	0.001	0.001
	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	100	5500	13.30	15.00	1.478	95.00	1.053	0.03	0.300	0.467
03	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	124	5620	14.69	15.00	1.074	95.00	1.053	0.04	0.778	0.880
	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	132	5660	14.33	15.00	1.167	95.00	1.053	0.06	0.486	0.597
	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	140	5700	13.75	15.00	1.333	95.00	1.053	0.06	0.557	0.782
	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	144	5720	9.43	15.00	3.604	95.00	1.053	0.01	0.203	0.770
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	116	5580	14.98	15.00	1.004	94.77	1.055	0.03	0.686	0.727
	1	2	WLAN5.5GHz	802.11a 6Mbps	Back of Display Screen	25	116	5580	14.98	15.00	1.004	94.77	1.055	0.02	0.002	0.002
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	100	5500	13.84	15.00	1.305	94.77	1.055	0.05	0.429	0.591
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	124	5620	14.67	15.00	1.079	94.77	1.055	0.08	0.623	0.709
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	132	5660	14.59	15.00	1.099	94.77	1.055	0.03	0.570	0.661
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	140	5700	14.20	15.00	1.201	94.77	1.055	0.06	0.443	0.561
	1	2	WLAN5.5GHz	802.11a 6Mbps	Bottom of Laptop	0	144	5720	9.00	15.00	3.978	94.77	1.055	0.08	0.087	0.366
	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	165	5825	14.97	15.00	1.007	95.00	1.053	0.01	0.560	0.594
	1	1	WLAN5.8GHz	802.11a 6Mbps	Back of Display Screen	25	165	5825	14.97	15.00	1.007	95.00	1.053	0.07	0.001	0.001
04	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	149	5745	13.56	15.00	1.392	95.00	1.053	0.07	0.640	0.938
	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.82	15.00	1.042	95.00	1.053	0.04	0.832	0.913
	2	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	165	5825	14.97	15.00	1.007	95.00	1.053	0.03	0.624	0.662
	2	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	149	5745	13.56	15.00	1.392	95.00	1.053	0.05	0.476	0.698
	2	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.82	15.00	1.042	95.00	1.053	0.08	0.738	0.810
	3	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	165	5825	14.97	15.00	1.007	95.00	1.053	0.03	0.541	0.574
	3	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	149	5745	13.56	15.00	1.392	95.00	1.053	0.05	0.459	0.673
	3	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.82	15.00	1.042	95.00	1.053	0.08	0.587	0.644
	1	2	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.81	15.00	1.045	94.77	1.055	0.03	0.520	0.573
	1	2	WLAN5.8GHz	802.11a 6Mbps	Back of Display Screen	25	157	5785	14.81	15.00	1.045	94.77	1.055	0	<0.001	<0.001
	1	2	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	149	5745	13.07	15.00	1.558	94.77	1.055	0.06	0.387	0.636
	1	2	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	165	5825	14.37	15.00	1.155	94.77	1.055	0.05	0.463	0.564

**<Bluetooth SAR>**

Plot No.	Sample	Ant. Port	Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
05	1	1	Bluetooth	1Mbps	Bottom of Laptop	0	78	2480	6.85	7.00	1.034	76.83	1.084	0.06	0.022	<b>0.025</b>
	1	1	Bluetooth	1Mbps	Back of Display Screen	25	78	2480	6.85	7.00	1.034	76.83	1.084	0	<0.001	<0.001
	1	1	Bluetooth	1Mbps	Bottom of Laptop	0	0	2402	6.04	7.00	1.034	76.83	1.084	0.05	0.015	0.020
	1	1	Bluetooth	1Mbps	Bottom of Laptop	0	39	2441	6.59	7.00	1.034	76.83	1.084	0.03	0.016	0.019

**14.2 Repeated SAR Measurement**

No.	Sample	Ant. Port	Band	Mode	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.82	15.00	1.042	95.00	1.053	0.04	0.832	1	0.913
2nd	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom of Laptop	0	157	5785	14.82	15.00	1.042	95.00	1.053	0.08	0.826	1.007	0.907

**General Note:**

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8$ W/kg.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is  $\leq 1.2$  and the measured SAR  $< 1.45$ W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

## 15. Simultaneous Transmission Analysis

No.	Simultaneous Transmission Configurations	Body
1.	WLAN2.4GHz Ant.1(data) + WLAN2.4GHz Ant.2(data)	Yes
2.	WLAN5GHz Ant.1(data) + WLAN5GHz Ant.2(data)	Yes
3.	WLAN2.4GHz Ant.2(data) + Bluetooth Ant.1(data)	Yes
4.	WLAN5GHz Ant.2(data) + Bluetooth Ant.1(data)	Yes

### General Note:

1. WLAN Ant.1 and Bluetooth share the same antenna, and cannot transmit simultaneously.
2. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
3. The worst case 5 GHz WLAN reported SAR for each configuration was used for SAR summation.
4. The reported SAR summation is calculated based on the same configuration and test position.
5. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
  - i) Scalar SAR summation  $< 1.6\text{W/kg}$ .
  - ii)  $\text{SPLSR} = (\text{SAR1} + \text{SAR2})^{1.5} / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where  $(x1, y1, z1)$  and  $(x2, y2, z2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan.
  - iii) If  $\text{SPLSR} \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.
  - iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR  $< 1.6\text{W/kg}$ .
  - v) The SPLSR calculated results please refer to section 15.2.

### **15.1 Body Exposure Conditions**

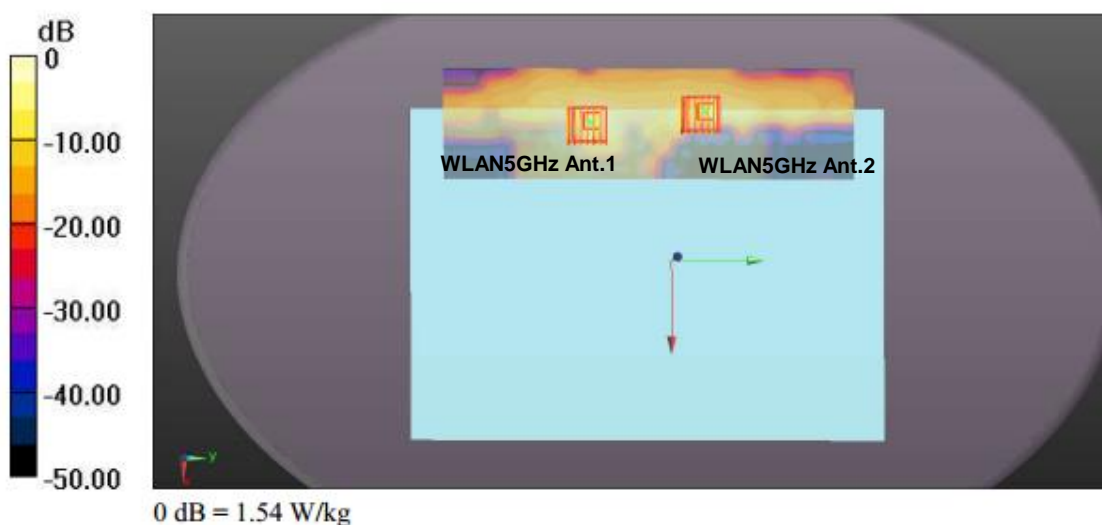
Exposure Position	1	2	3	4	5	1+2	3+4			2+5	4+5
	2.4GHz WLAN Ant 1	2.4GHz WLAN Ant 2	5GHz WLAN Ant 1	5GHz WLAN Ant 2	Bluetooth Ant 1						
	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	Estimated 1g SAR (W/kg)	Summed 1g SAR (W/kg)	Summed 1g SAR (W/kg)	SPLSR	Case No	Summed 1g SAR (W/kg)	Summed 1g SAR (W/kg)
Bottom of Laptop at 0mm	0.711	0.622	0.938	0.727	0.025	1.33	1.67	0.03	#1	0.65	0.75
Back of Display Screen at 25mm	0.001	<0.001	0.001	0.002	<0.001	<0.10	<0.10			<0.10	<0.10

## 15.2 SPLSR Evaluation and Analysis

### General Note:

1. When standalone SAR is measured for both antennas in the pair, the peak location separation distance is computed by the square root of  $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$ , where  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  are the coordinates in the area scans or extrapolated peak SAR locations in the zoom scans, as appropriate.
2.  $SPLSR = (SAR_1 + SAR_2)^{1.5} / (\text{min. separation distance, mm})$ . If  $SPLSR \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.

Case #1	Band	Position	SAR (W/kg)	Gap (mm)	SAR peak location (m)			3D distance (mm)	Summed SAR (W/kg)	SPLSR Results	Simultaneous SAR
					X	Y	Z				
	WLAN5GHz Ant.1	Bottom of Laptop	0.938	0	-0.097	-0.036	-0.18	72.3	1.67	0.03	Not required
	WLAN5GHz Ant.2		0.727	0	-0.104	0.036	-0.18				



Test Engineer : Johnny Chen

## **16. Uncertainty Assessment**

Per KDB 865664 D01 SAR measurement 100MHz to 6GHz, when the highest measured 1-g SAR within a frequency band is  $< 1.5$  W/kg. The expanded SAR measurement uncertainty must be  $\leq 30\%$ , for a confidence interval of  $k = 2$ . If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. For this device, the highest measured 1-g SAR is less 1.5W/kg. Therefore, the measurement uncertainty table is not required in this report.



## **17. References**

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] 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", Sep 2013
- [4] SPEAG DASY System Handbook
- [5] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.
- [6] FCC KDB 865664 D02 v01r02, "RF Exposure Compliance Reporting and Documentation Considerations" Oct 2015.
- [7] FCC KDB 447498 D01 v06, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", Oct 2015
- [8] FCC KDB 248227 D01 v02r02, "SAR Guidance for IEEE 802.11 (WiFi) Transmitters", Oct 2015.
- [9] FCC KDB 616217 D04 v01r02, "SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers", Oct 2015



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## ***Appendix A. Plots of System Performance Check***

The plots are shown as follows.

## System Check\_Body\_2450MHz

### DUT: D2450V2-SN:924

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

Medium: MSL\_2450\_181113 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.992$  S/m;  $\epsilon_r = 52.291$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.5 °C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3819; ConvF(7.46, 7.46, 7.46); Calibrated: 2018.01.31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM2; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (81x81x1):** Interpolated grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 20.6 W/kg

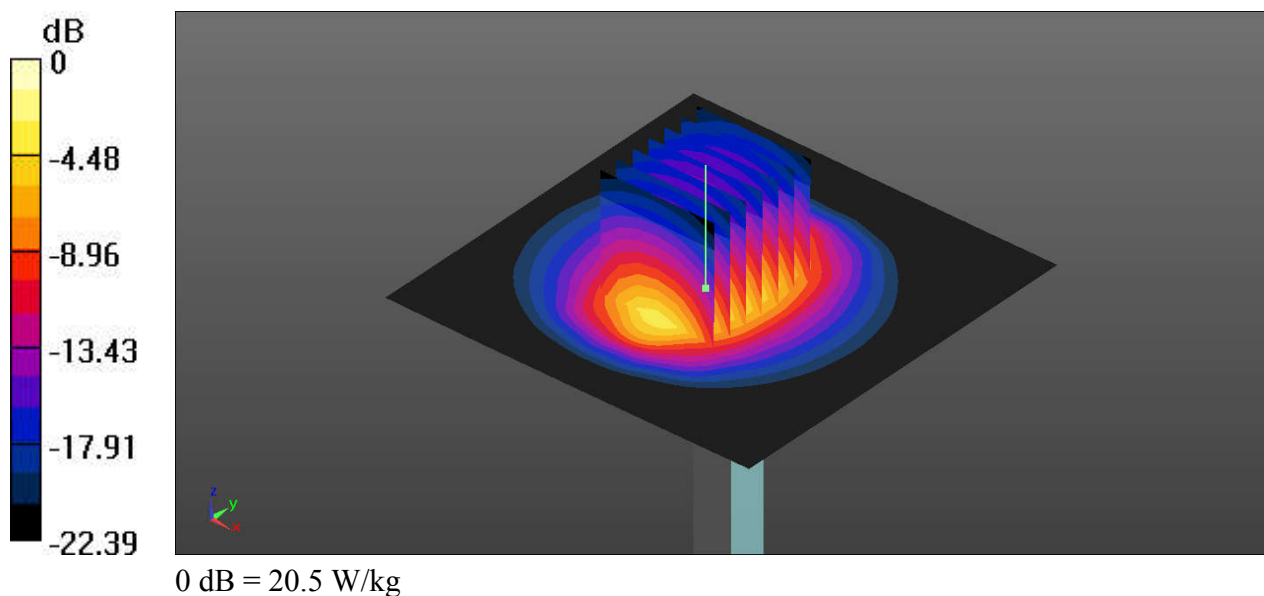
**Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 86.88 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.7 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.17 W/kg**

Maximum value of SAR (measured) = 20.5 W/kg



## System Check\_Body\_5250MHz

### DUT: D5GHzV2-SN:1167

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: MSL\_5250\_181112 Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.29$  S/m;  $\epsilon_r = 50.979$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C; Liquid Temperature : 22.7 °C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3819; ConvF(4.7, 4.7, 4.7); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 17.6 W/kg

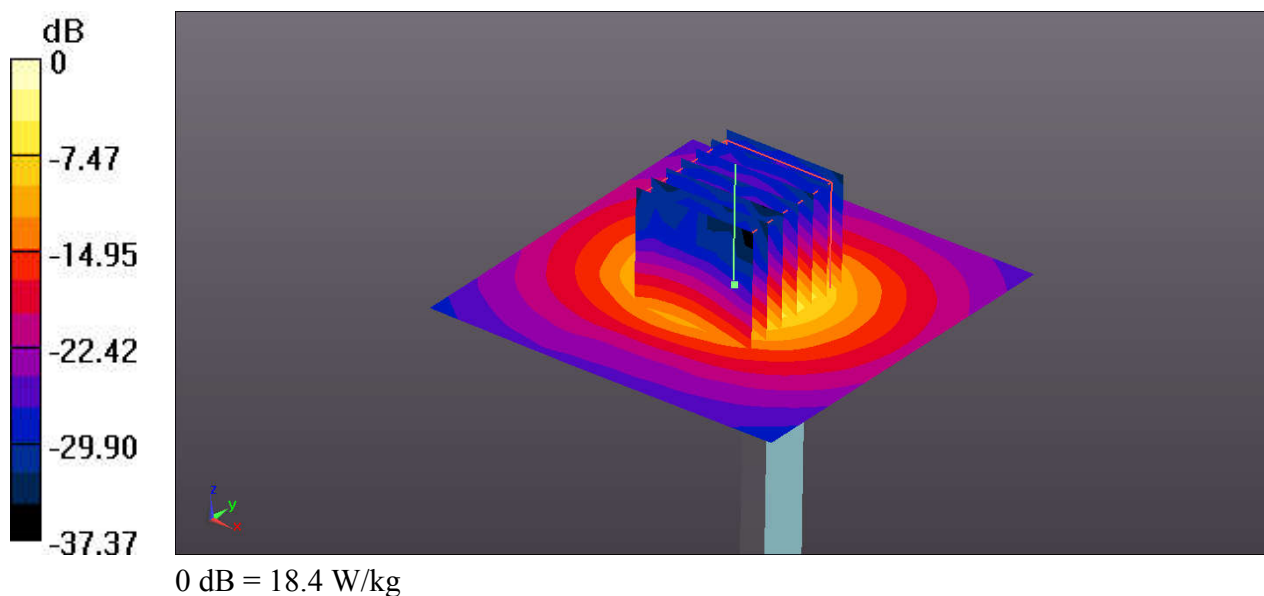
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 46.44 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 33.1 W/kg

**SAR(1 g) = 7.42 W/kg; SAR(10 g) = 2.01 W/kg**

Maximum value of SAR (measured) = 18.4 W/kg



## System Check\_Body\_5600MHz

### DUT: D5GHzV2-SN:1167

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: MSL\_5600\_181112 Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.884$  S/m;  $\epsilon_r = 50.353$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C; Liquid Temperature : 22.7 °C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3819; ConvF(4.18, 4.18, 4.18); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 20.7 W/kg

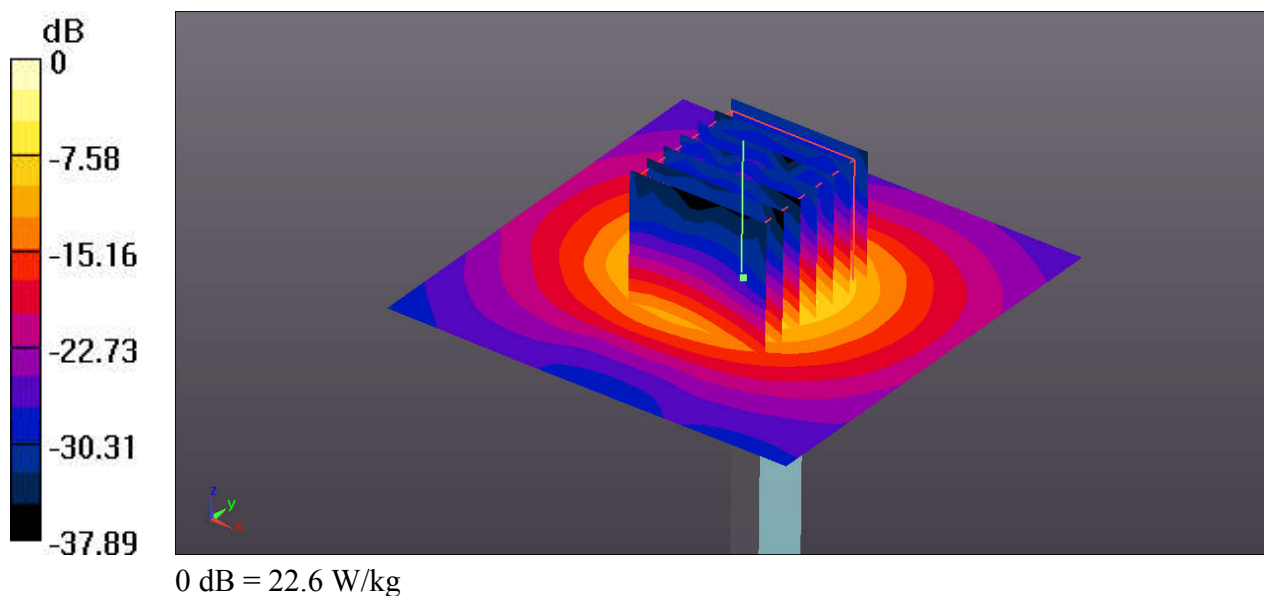
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 46.20 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 40.7 W/kg

**SAR(1 g) = 8.31 W/kg; SAR(10 g) = 2.26 W/kg**

Maximum value of SAR (measured) = 22.6 W/kg



## System Check\_Body\_5750MHz

### DUT: D5GHzV2-SN:1167

Communication System: UID 0, CW (0); Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: MSL\_5750\_181112 Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.115$  S/m;  $\epsilon_r = 50.005$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.7 °C ; Liquid Temperature : 22.7 °C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3819; ConvF(4.32, 4.32, 4.32); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=10mm, dy=10mm

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

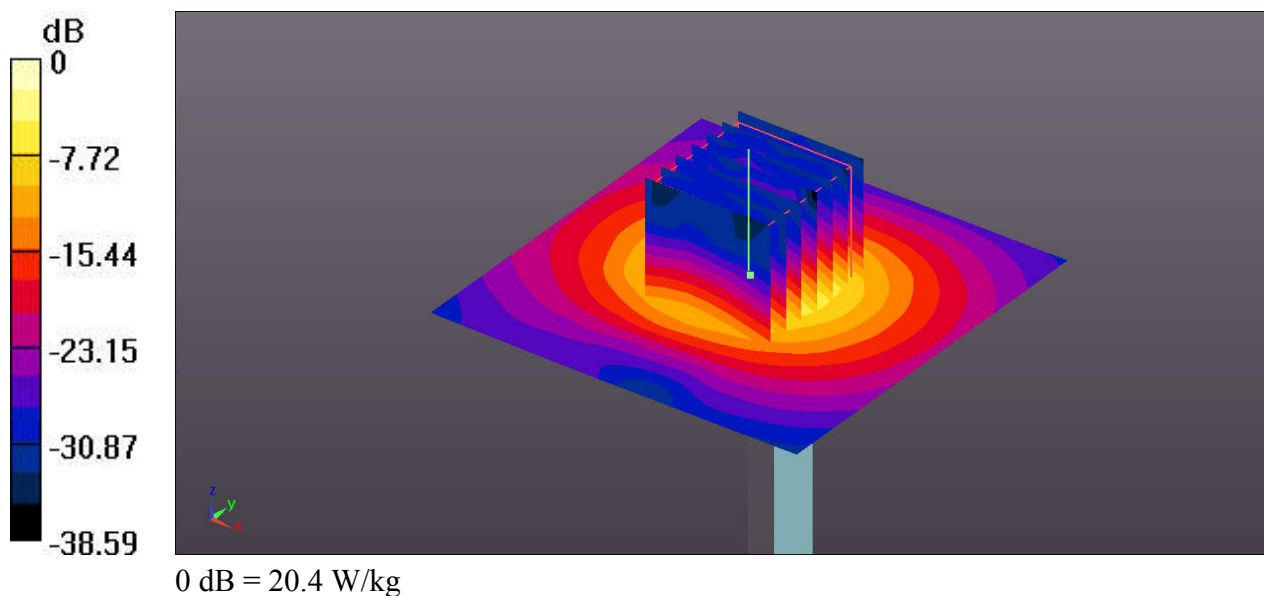
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 42.88 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 40.7 W/kg

**SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.21 W/kg**

Maximum value of SAR (measured) = 20.4 W/kg





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***Appendix B. Plots of High SAR Measurement***

The plots are shown as follows.

**01\_WLAN2.4GHz\_802.11b 1Mbps\_Bottom of Laptop\_0mm\_Ch1**

Communication System: UID 0, WIFI (0); Frequency: 2412 MHz; Duty Cycle: 1:1.011  
Medium: MSL\_2450\_181113 Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.947$  S/m;  $\epsilon_r = 52.455$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>  
Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.5 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3819; ConvF(7.46, 7.46, 7.46); Calibrated: 2018.01.31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM2; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch1/Area Scan (61x201x1):** Interpolated grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 0.704 W/kg

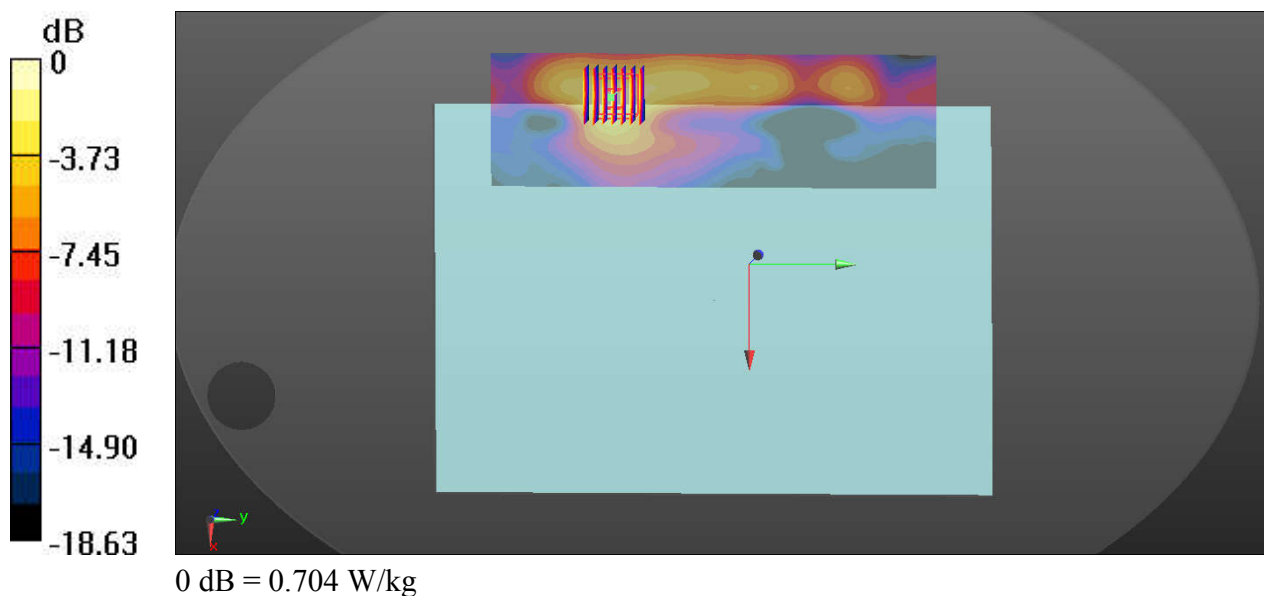
**Ch1/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 3.056 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 1.00 W/kg

**SAR(1 g) = 0.493 W/kg; SAR(10 g) = 0.239 W/kg**

Maximum value of SAR (measured) = 0.734 W/kg





**02\_WLAN5.3GHz\_802.11a 6Mbps\_Bottom of Laptop\_0mm\_Ch52**

Communication System: UID 0, WIFI (0); Frequency: 5260 MHz; Duty Cycle: 1:1.055  
Medium: MSL\_5250\_181112 Medium parameters used:  $f = 5260$  MHz;  $\sigma = 5.308$  S/m;  $\epsilon_r = 50.974$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>  
Ambient Temperature : 23.5 °C; Liquid Temperature : 22.7 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3819; ConvF(4.7, 4.7, 4.7); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch52/Area Scan (71x261x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.12 W/kg

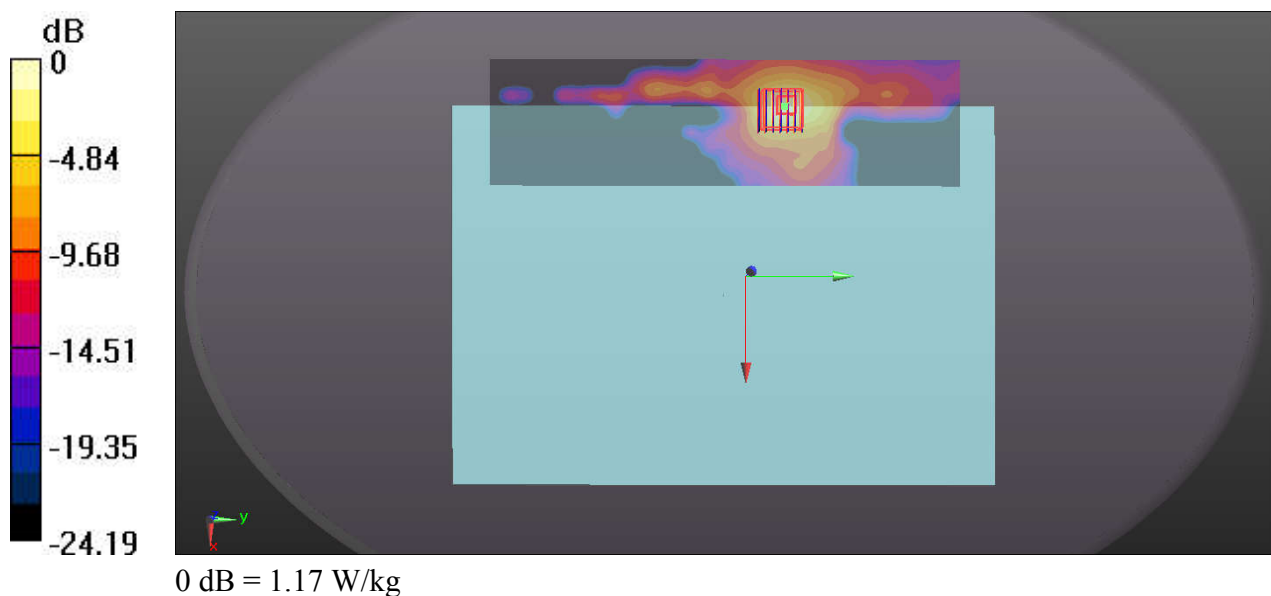
**Ch52/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.02 W/kg

**SAR(1 g) = 0.512 W/kg; SAR(10 g) = 0.177 W/kg**

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



**03\_WLAN5.5GHz\_802.11a 6Mbps\_Bottom of Laptop\_0mm\_Ch124**

Communication System: UID 0, WIFI (0); Frequency: 5620 MHz; Duty Cycle: 1:1.053  
Medium: MSL\_5600\_181112 Medium parameters used:  $f = 5620$  MHz;  $\sigma = 5.912$  S/m;  $\epsilon_r = 50.332$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>  
Ambient Temperature : 23.6 °C; Liquid Temperature : 22.7 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3819; ConvF(4.18, 4.18, 4.18); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch124/Area Scan (71x261x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.83 W/kg

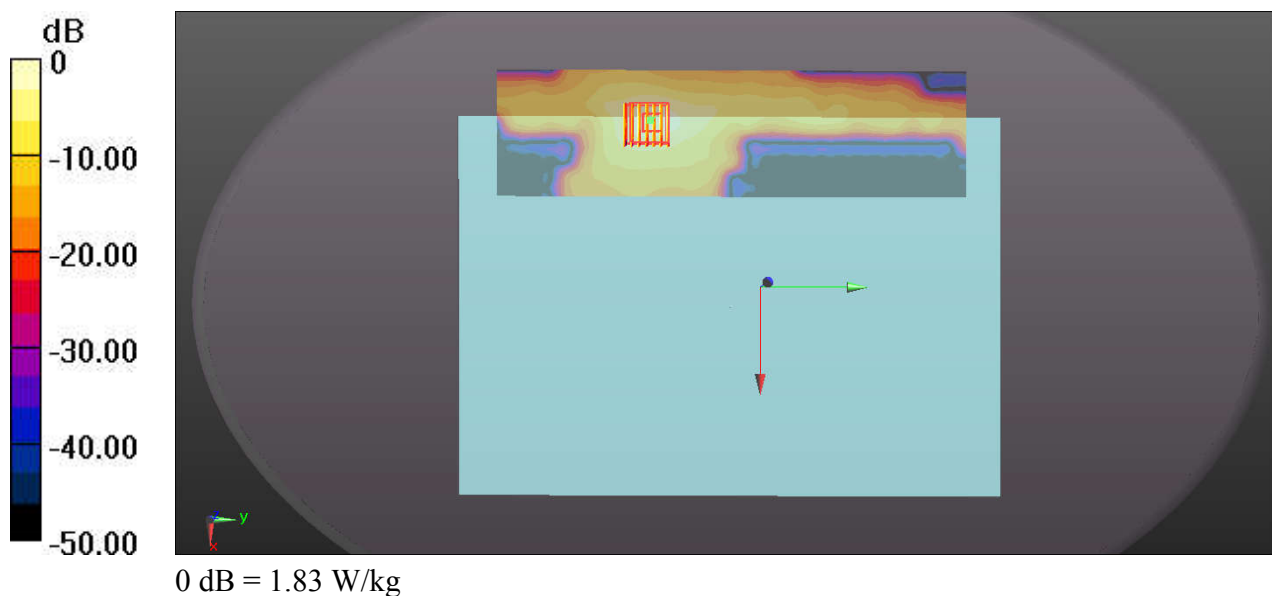
**Ch124/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 1.611 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 3.20 W/kg

**SAR(1 g) = 0.778 W/kg; SAR(10 g) = 0.269 W/kg**

Maximum value of SAR (measured) = 1.78 W/kg



**04\_WLAN5.8GHz\_802.11a 6Mbps\_Bottom of Laptop\_0mm\_Ch149**

Communication System: UID 0, WIFI (0); Frequency: 5745 MHz; Duty Cycle: 1:1.053  
Medium: MSL\_5750\_181112 Medium parameters used:  $f = 5745$  MHz;  $\sigma = 6.107$  S/m;  $\epsilon_r = 50.017$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>  
Ambient Temperature : 23.7 °C; Liquid Temperature : 22.7 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3819; ConvF(4.32, 4.32, 4.32); Calibrated: 2018.01.31;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM3; Type: QDOVA002AA; Serial: TP:1149
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch149/Area Scan (71x261x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.54 W/kg

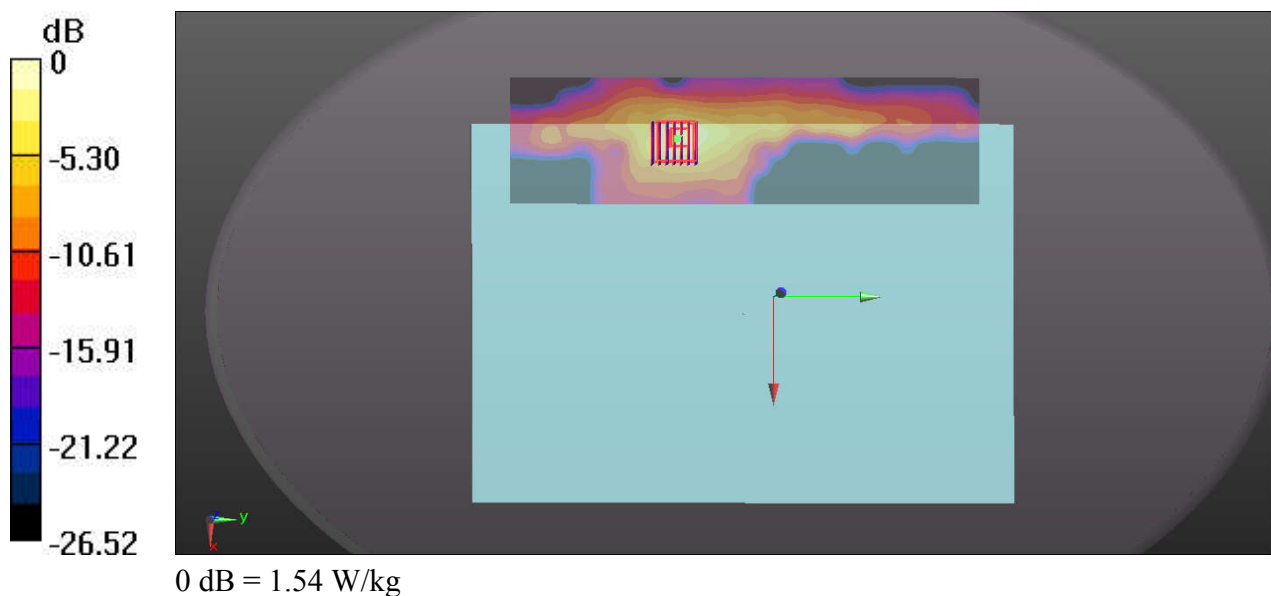
**Ch149/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0.8170 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 2.72 W/kg

**SAR(1 g) = 0.640 W/kg; SAR(10 g) = 0.222 W/kg**

Maximum value of SAR (measured) = 1.51 W/kg



**05\_Bluetooth\_1Mbps\_Bottom of Laptop\_0mm\_Ch78**

Communication System: UID 0, Bluetooth (0); Frequency: 2480 MHz; Duty Cycle: 1:1.302  
Medium: MSL\_2450\_181113 Medium parameters used:  $f = 2480$  MHz;  $\sigma = 2.044$  S/m;  $\epsilon_r = 52.129$ ;  
 $\rho = 1000$  kg/m<sup>3</sup>  
Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.5 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3819; ConvF(7.46, 7.46, 7.46); Calibrated: 2018.01.31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1437; Calibrated: 2018.10.15
- Phantom: SAM2; Type: QDOVA001BB; Serial: TP:1233
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch78/Area Scan (61x201x1):** Interpolated grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 0.0320 W/kg

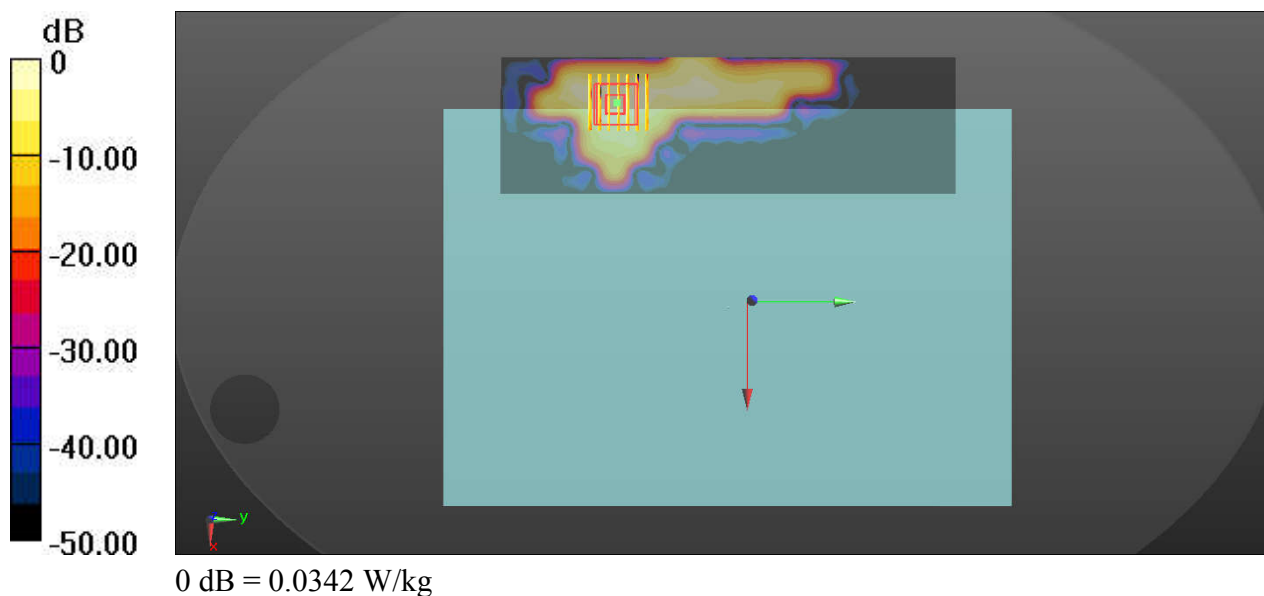
**Ch78/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0.3080 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.0480 W/kg

**SAR(1 g) = 0.022 W/kg; SAR(10 g) = 0.0094 W/kg**

Maximum value of SAR (measured) = 0.0342 W/kg





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**Appendix C.     DASY Calibration Certificate**

The DASY calibration certificates are shown as follows.



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Client

**Sporton**

Certificate No: **Z18-60051**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 924**

Calibration Procedure(s) **FF-Z11-003-01**  
**Calibration Procedures for dipole validation kits**

Calibration date: **March 22, 2018**

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRVD	102083	01-Nov-17 (CTTL, No.J17X08756)	Oct-18
Power sensor NRV-Z5	100542	01-Nov-17 (CTTL, No.J17X08756)	Oct-18
Reference Probe EX3DV4	SN 7464	12-Sep-17(SPEAG,No.EX3-7464_Sep17)	Sep-18
DAE4	SN 1525	02-Oct-17(SPEAG,No.DAE4-1525_Oct17)	Oct-18
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL, No.J18X00560)	Jan-19
NetworkAnalyzer E5239A	MY55491241	29-Jun-17 (CTTL, No.J18X00561)	Jun-18

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 25, 2018

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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, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- 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.

DASY Version	DASY52	52.10.0.1446
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.3 $\pm$ 6 %	1.84 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	51.8 mW / g $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.98 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	23.9 mW / g $\pm$ 18.7 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	51.3 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.7 mW / g $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.88 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.3 mW / g $\pm$ 18.7 % (k=2)





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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.9Ω+ 4.08jΩ
Return Loss	- 27.7dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8Ω+ 4.69jΩ
Return Loss	- 26.5dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.060 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

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## DASY5 Validation Report for Head TSL

Date: 03.22.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.841$  S/m;  $\epsilon_r = 40.32$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

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

### DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(7.89, 7.89, 7.89); Calibrated: 9/12/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

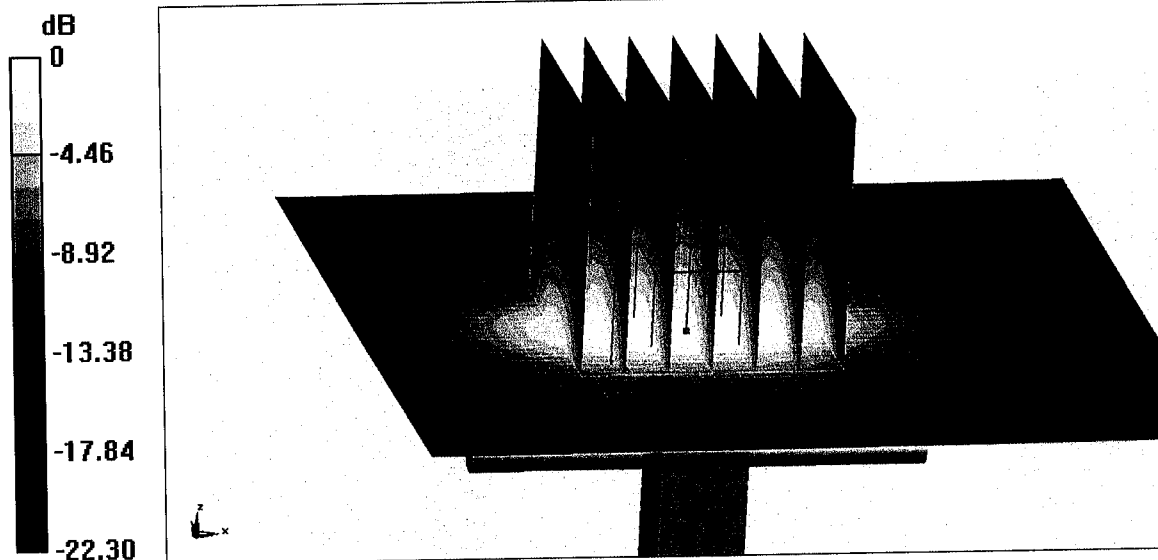
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 101.2 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.2 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 5.98 W/kg**

Maximum value of SAR (measured) = 22.0 W/kg

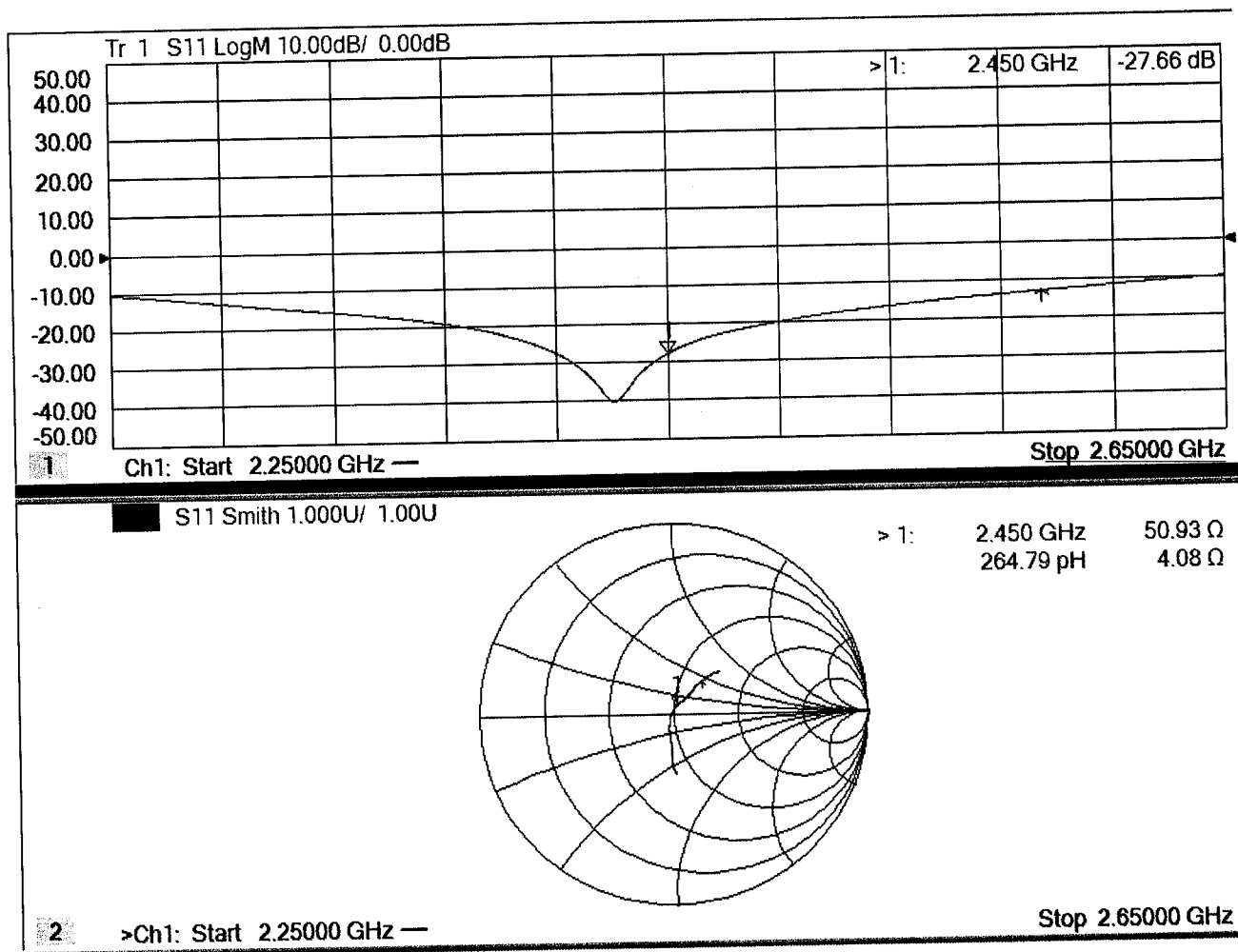


**0 dB = 22.0 W/kg = 13.42 dBW/kg**



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## Impedance Measurement Plot for Head TSL





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## DASY5 Validation Report for Body TSL

Date: 03.22.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.998$  S/m;  $\epsilon_r = 51.28$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

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

### DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.09, 8.09, 8.09); Calibrated: 9/12/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

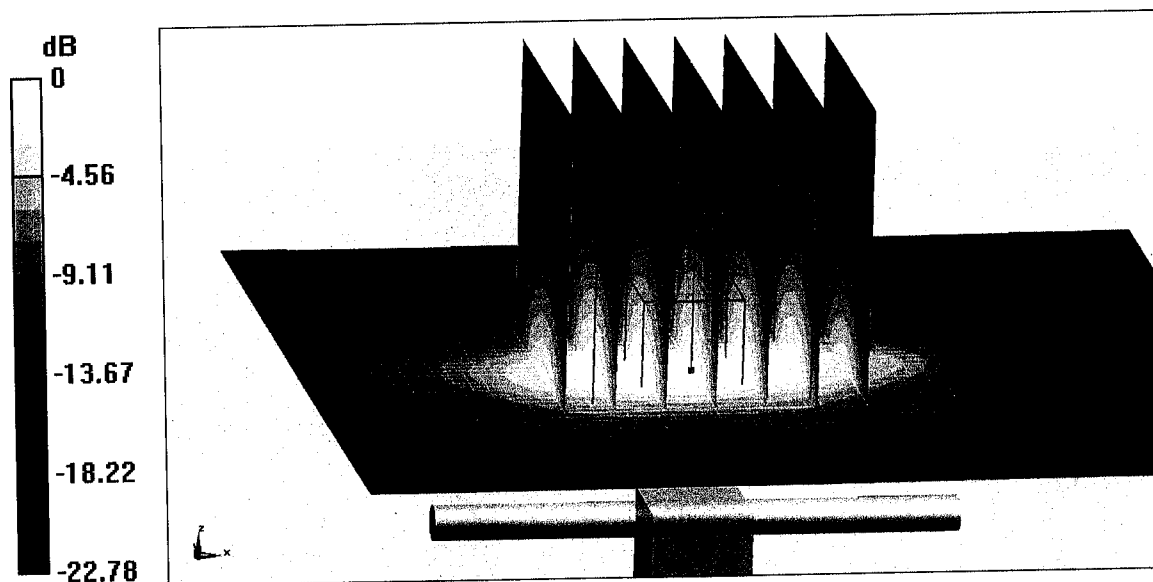
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 98.09 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 27.1 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.88 W/kg**

Maximum value of SAR (measured) = 21.5 W/kg



**0 dB = 21.5 W/kg = 13.32 dBW/kg**



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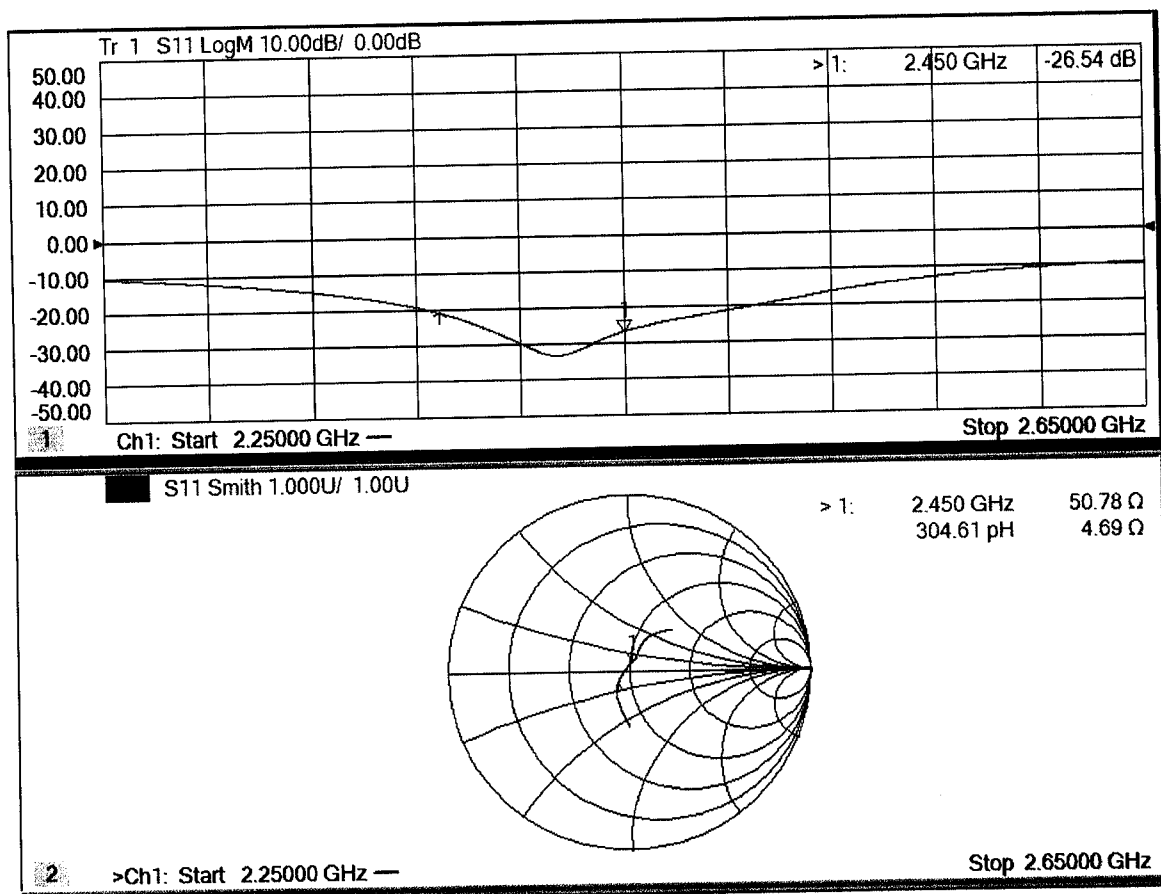
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## Impedance Measurement Plot for Body TSL





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Client

**Sporton**

Certificate No: **Z18-60259**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1167**

Calibration Procedure(s) **FF-Z11-003-01**  
**Calibration Procedures for dipole validation kits**

Calibration date: **August 03, 2018**

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	102083	01-Nov-17 (CTTL, No.J17X08756)	Oct-18
Power sensor NRP-Z91	100542	01-Nov-17 (CTTL, No.J17X08756)	Oct-18
ReferenceProbe EX3DV4	SN 7464	12-Sep-17(SPEAG,No.EX3-7464_Sep17)	Sep-18
DAE4	SN 1524	13-Sep-17(SPEAG,No.DAE4-1524_Sep17)	Sep-18
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL, No.J18X00560)	Jan-19
NetworkAnalyzerE5071C	MY46110673	24-Jan-18 (CTTL, No.J18X00561)	Jan-19

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: August 6, 2018

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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, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- 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.

DASY Version	DASY52	52.10.1.1476
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz	

## Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.9 $\pm$ 6 %	4.82 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

## SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.69 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	77.0 mW / g $\pm$ 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.20 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.0 mW / g $\pm$ 24.2 % (k=2)





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**Head TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

**SAR result with Head TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.09 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	80.8 mW / g ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.32 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	23.2 mW / g ± 24.2 % (k=2)

**Head TSL parameters at 5750 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	5.37 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

**SAR result with Head TSL at 5750 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.70 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	76.9 mW / g ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.17 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	21.6 mW / g ± 24.2 % (k=2)



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**Body TSL parameters at 5250 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.4 ± 6 %	5.32 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

**SAR result with Body TSL at 5250 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.46 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	74.4 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.10 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.9 mW /g ± 24.2 % (k=2)

**Body TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.79 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

**SAR result with Body TSL at 5600 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.73 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	77.1 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.16 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.5 mW /g ± 24.2 % (k=2)



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### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.5 ± 6 %	5.93 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C	----	----

### SAR result with Body TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.43 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	74.3 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.08 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.8 mW /g ± 24.2 % (k=2)



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	50.3 $\Omega$ - 9.42j $\Omega$
Return Loss	- 20.6dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	58.1 $\Omega$ - 7.15j $\Omega$
Return Loss	- 20.0dB

### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	53.5 $\Omega$ - 7.66j $\Omega$
Return Loss	- 21.8dB

### Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	49.5 $\Omega$ - 7.40j $\Omega$
Return Loss	- 22.6dB

### Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.0 $\Omega$ - 6.37j $\Omega$
Return Loss	- 20.5dB

### Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	54.5 $\Omega$ - 7.07j $\Omega$
Return Loss	- 21.9dB



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## General Antenna Parameters and Design

Electrical Delay (one direction)	1.065 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: 07.27.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1167**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,  
Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.822$  S/m;  $\epsilon_r = 35.92$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.184$  S/m;  $\epsilon_r = 35.14$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.365$  S/m;  $\epsilon_r = 34.88$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Center Section

### **DASY5 Configuration:**

- Probe: EX3DV4 - SN7464; ConvF(5.68, 5.68, 5.68) @ 5250 MHz; Calibrated: 9/12/2017, ConvF(4.98, 4.98, 4.98) @ 5600 MHz; Calibrated: 9/12/2017, ConvF(5.04, 5.04, 5.04) @ 5750 MHz; Calibrated: 9/12/2017,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 65.09 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 32.4 W/kg  
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.2 W/kg**  
Maximum value of SAR (measured) = 18.0 W/kg

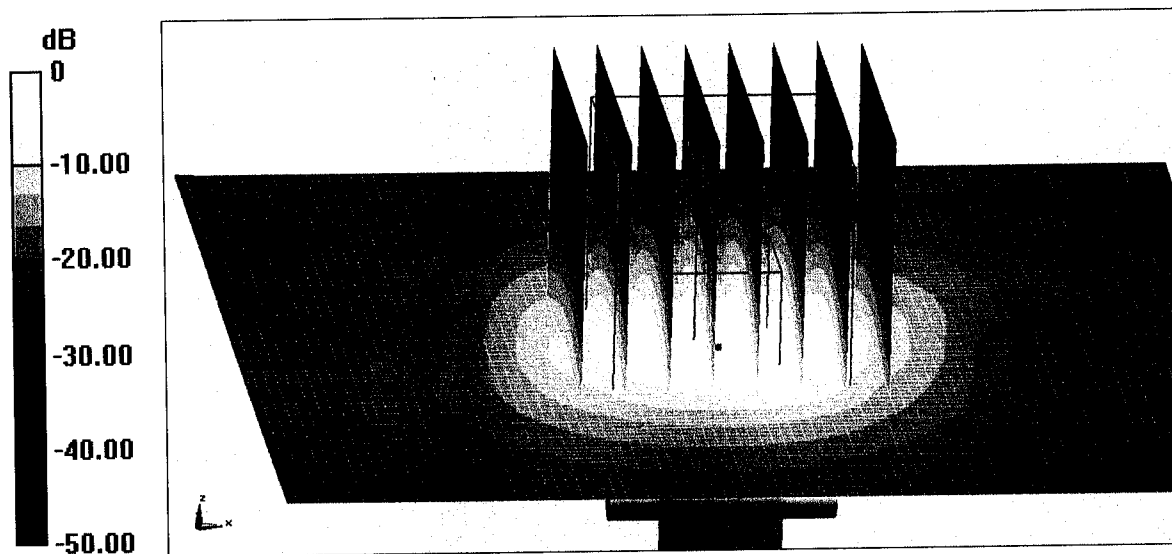
**Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 63.53 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 36.2 W/kg  
**SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.32 W/kg**  
Maximum value of SAR (measured) = 19.7 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 63.79 V/m; Power Drift = 0.01 dB  
Peak SAR (extrapolated) = 36.2 W/kg  
**SAR(1 g) = 7.7 W/kg; SAR(10 g) = 2.17 W/kg**  
Maximum value of SAR (measured) = 19.0 W/kg



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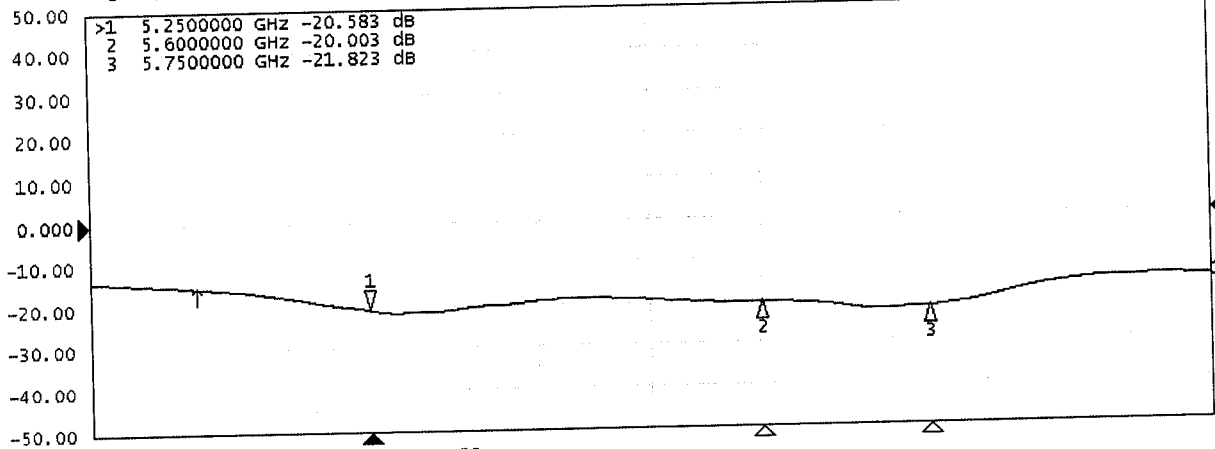
0 dB = 19.0 W/kg = 12.79 dBW/kg



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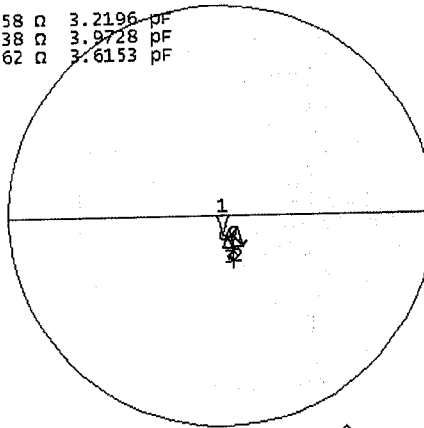
## Impedance Measurement Plot for Head TSL

Tr1 S11 Log Mag 10.00dB/ Ref 0.000dB [F1]



Tr2 S11 Smith (R+jX) scale 1.000U [F1 Del]

>1	5.250000 GHz	50.314 $\Omega$	-9.4158 $\Omega$	3.2196 pF
2	5.600000 GHz	58.136 $\Omega$	-7.1538 $\Omega$	3.9728 pF
3	5.750000 GHz	53.485 $\Omega$	-7.6562 $\Omega$	3.6153 pF







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Date: 08.02.2018

## **DASY5 Validation Report for Body TSL**

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1167**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,  
Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.316$  S/m;  $\epsilon_r = 48.42$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.789$  S/m;  $\epsilon_r = 47.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.926$  S/m;  $\epsilon_r = 48.45$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

### **DASY5 Configuration:**

- Probe: EX3DV4 - SN7464; ConvF(5.29, 5.29, 5.29) @ 5250 MHz; Calibrated: 9/12/2017, ConvF(4.5, 4.5, 4.5) @ 5600 MHz; Calibrated: 9/12/2017, ConvF(4.59, 4.59, 4.59) @ 5750 MHz; Calibrated: 9/12/2017,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 64.14 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 31.9 W/kg  
**SAR(1 g) = 7.46 W/kg; SAR(10 g) = 2.1 W/kg**  
Maximum value of SAR (measured) = 17.6 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 62.32 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 36.3 W/kg  
**SAR(1 g) = 7.73 W/kg; SAR(10 g) = 2.16 W/kg**  
Maximum value of SAR (measured) = 19.1 W/kg

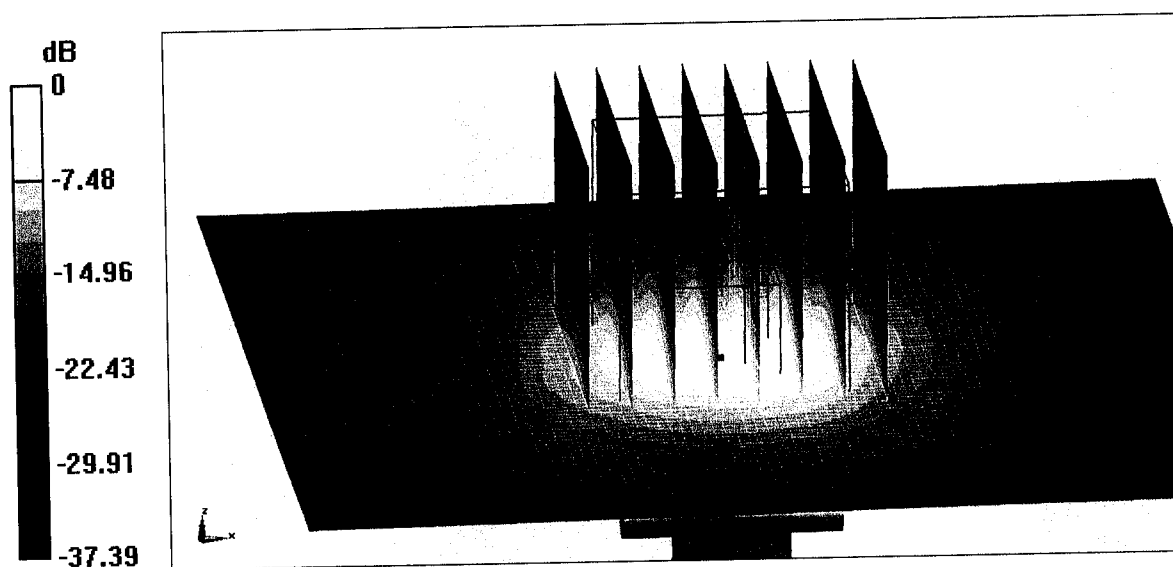
**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 63.99 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 35.2 W/kg  
**SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.08 W/kg**  
Maximum value of SAR (measured) = 18.0 W/kg



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0 dB = 18.0 W/kg = 12.55 dBW/kg



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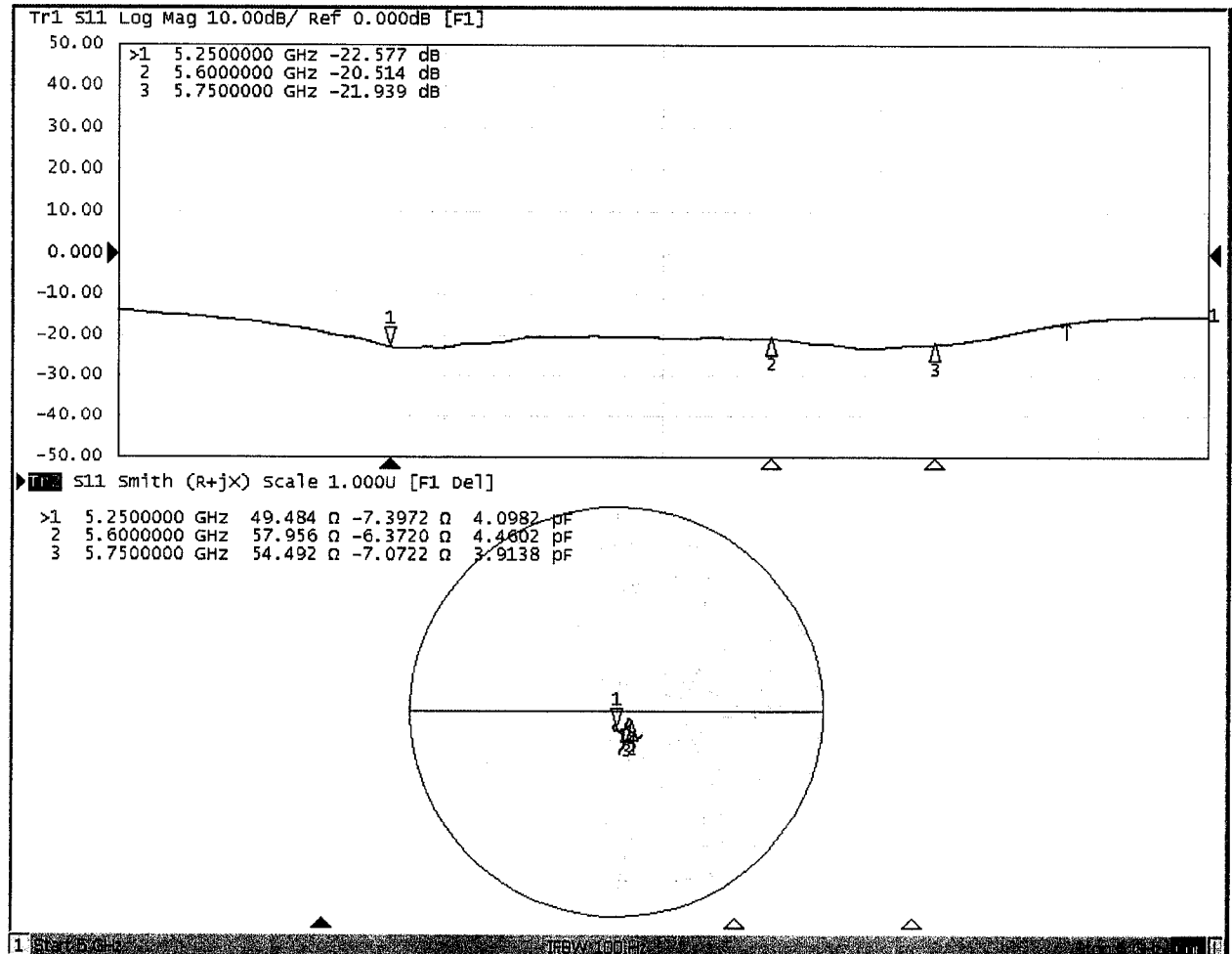
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## Impedance Measurement Plot for Body TSL





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Client : **Sporton**

Certificate No: **Z18-60389**

## CALIBRATION CERTIFICATE

Object **DAE4 - SN: 1437**

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

Calibration date: **October 15, 2018**

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( $22\pm 3$ )°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	20-Jun-18 (CTTL, No.J18X05034)	June-19

	Name	Function
Calibrated by:	Yu Zongying	SAR Test Engineer
Reviewed by:	Lin Hao	SAR Test Engineer
Approved by:	Qi Dianyuan	SAR Project Leader

Signature

Issued: October 17, 2018

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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 $\mu$ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	404.020 $\pm$ 0.15% (k=2)	403.552 $\pm$ 0.15% (k=2)	403.969 $\pm$ 0.15% (k=2)
Low Range	3.95263 $\pm$ 0.7% (k=2)	3.94039 $\pm$ 0.7% (k=2)	3.90670 $\pm$ 0.7% (k=2)

## Connector Angle

Connector Angle to be used in DASY system	64.5° $\pm$ 1 °
---	-----------------



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

Accreditation No.: **SCS 0108**

Client **Sporton (Auden)**

Certificate No: **EX3-3819\_Jan18**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3819**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6  
 Calibration procedure for dosimetric E-field probes**

Calibration date: **January 31, 2018**

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	30-Dec-17 (No. ES3-3013_Dec17)	Dec-18
DAE4	SN: 660	21-Dec-17 (No. DAE4-660_Dec17)	Dec-18
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18

Calibrated by:	Name Leif Klysner	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 1, 2018

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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 Multilateral Agreement for the recognition of calibration certificates

### 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 $\vartheta$	$\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- 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  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-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 with CW signal (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>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D 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  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values 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  $\pm 50$  MHz to  $\pm 100$  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).



# Probe EX3DV4

## SN:3819

Manufactured: September 2, 2011  
Calibrated: January 31, 2018

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3819

## Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.46	0.40	0.46	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	102.4	100.5	103.0	

## 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	153.8	$\pm 3.0 \%$
		Y	0.0	0.0	1.0		150.9	
		Z	0.0	0.0	1.0		157.4	

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  $E^2$ -field uncertainty inside TSL (see Pages 5 and 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:3819

### 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)	Unc (k=2)
750	41.9	0.89	10.06	10.06	10.06	0.49	0.80	± 12.0 %
835	41.5	0.90	9.66	9.66	9.66	0.45	0.84	± 12.0 %
1750	40.1	1.37	8.37	8.37	8.37	0.36	0.80	± 12.0 %
1900	40.0	1.40	8.13	8.13	8.13	0.27	0.87	± 12.0 %
2000	40.0	1.40	8.13	8.13	8.13	0.32	0.85	± 12.0 %
2300	39.5	1.67	7.69	7.69	7.69	0.34	0.84	± 12.0 %
2450	39.2	1.80	7.40	7.40	7.40	0.21	1.04	± 12.0 %
2600	39.0	1.96	7.21	7.21	7.21	0.33	0.84	± 12.0 %
3500	37.9	2.91	7.09	7.09	7.09	0.25	1.20	± 13.1 %
5250	35.9	4.71	5.15	5.15	5.15	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.78	4.78	4.78	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.80	4.80	4.80	0.40	1.80	± 13.1 %

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

<sup>F</sup> At frequencies 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 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:3819

### 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)	Unc (k=2)
750	55.5	0.96	9.70	9.70	9.70	0.36	0.91	± 12.0 %
835	55.2	0.97	9.49	9.49	9.49	0.43	0.86	± 12.0 %
1750	53.4	1.49	7.93	7.93	7.93	0.36	0.80	± 12.0 %
1900	53.3	1.52	7.69	7.69	7.69	0.30	0.95	± 12.0 %
2300	52.9	1.81	7.53	7.53	7.53	0.34	0.85	± 12.0 %
2450	52.7	1.95	7.46	7.46	7.46	0.23	0.96	± 12.0 %
2600	52.5	2.16	6.92	6.92	6.92	0.26	1.00	± 12.0 %
3500	51.3	3.31	6.69	6.69	6.69	0.28	1.20	± 13.1 %
5250	48.9	5.36	4.70	4.70	4.70	0.35	1.90	± 13.1 %
5600	48.5	5.77	4.18	4.18	4.18	0.40	1.90	± 13.1 %
5750	48.3	5.94	4.32	4.32	4.32	0.40	1.90	± 13.1 %

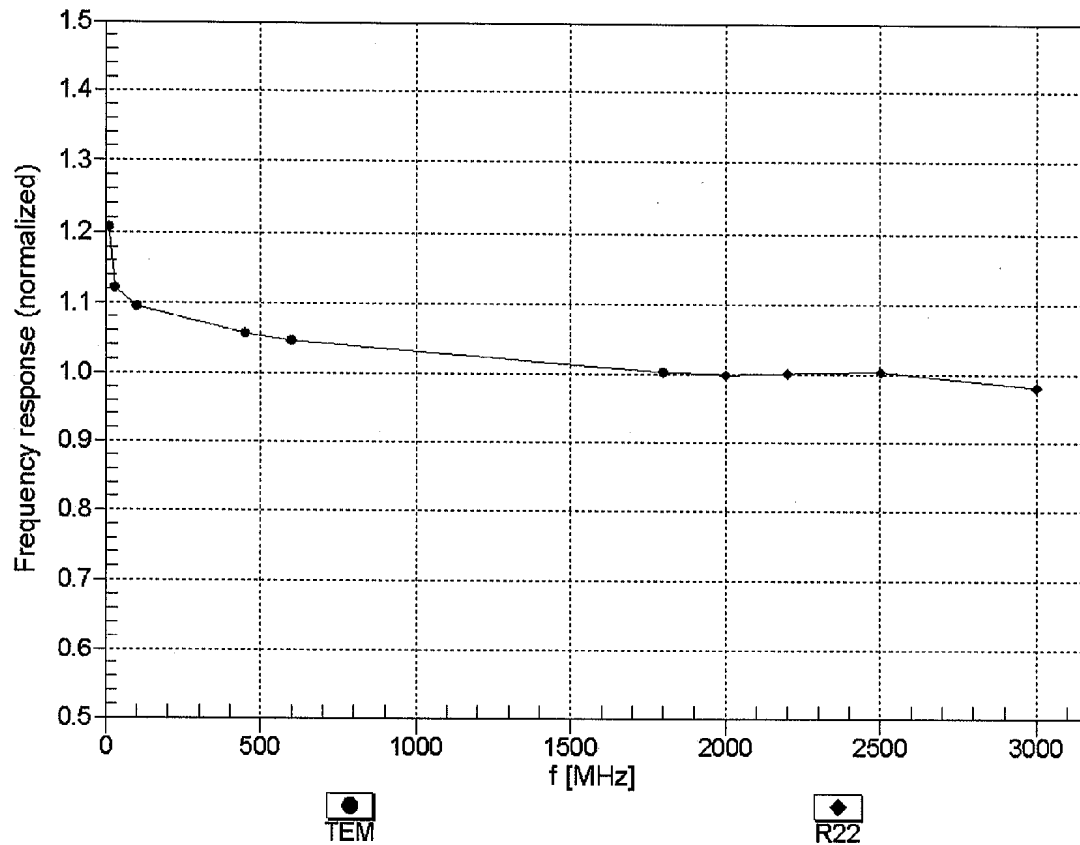
<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below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

<sup>F</sup> At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## Frequency Response of E-Field

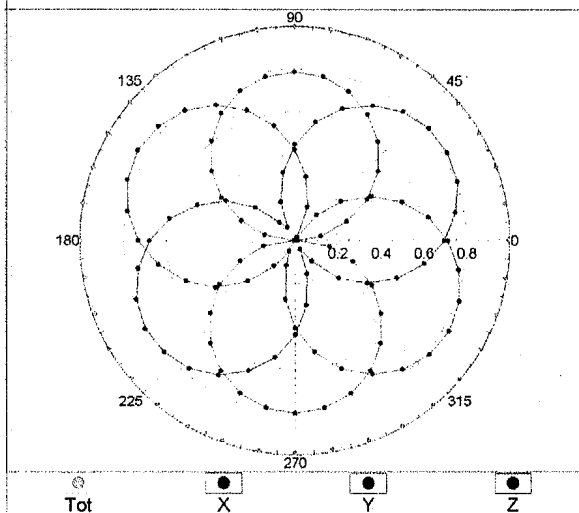
(TEM-Cell: ifi110 EXX, Waveguide: R22)



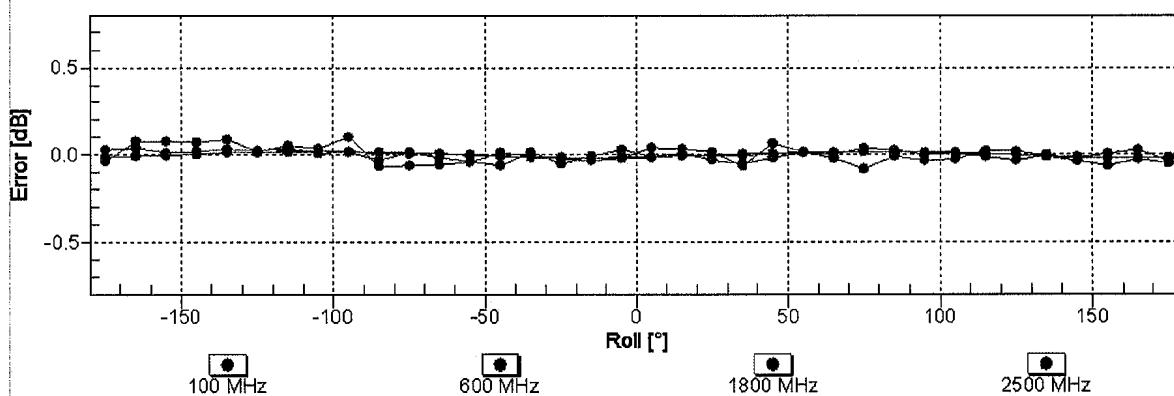
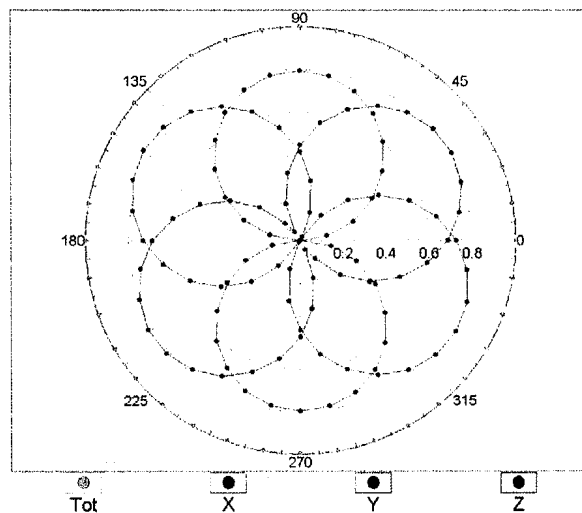
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

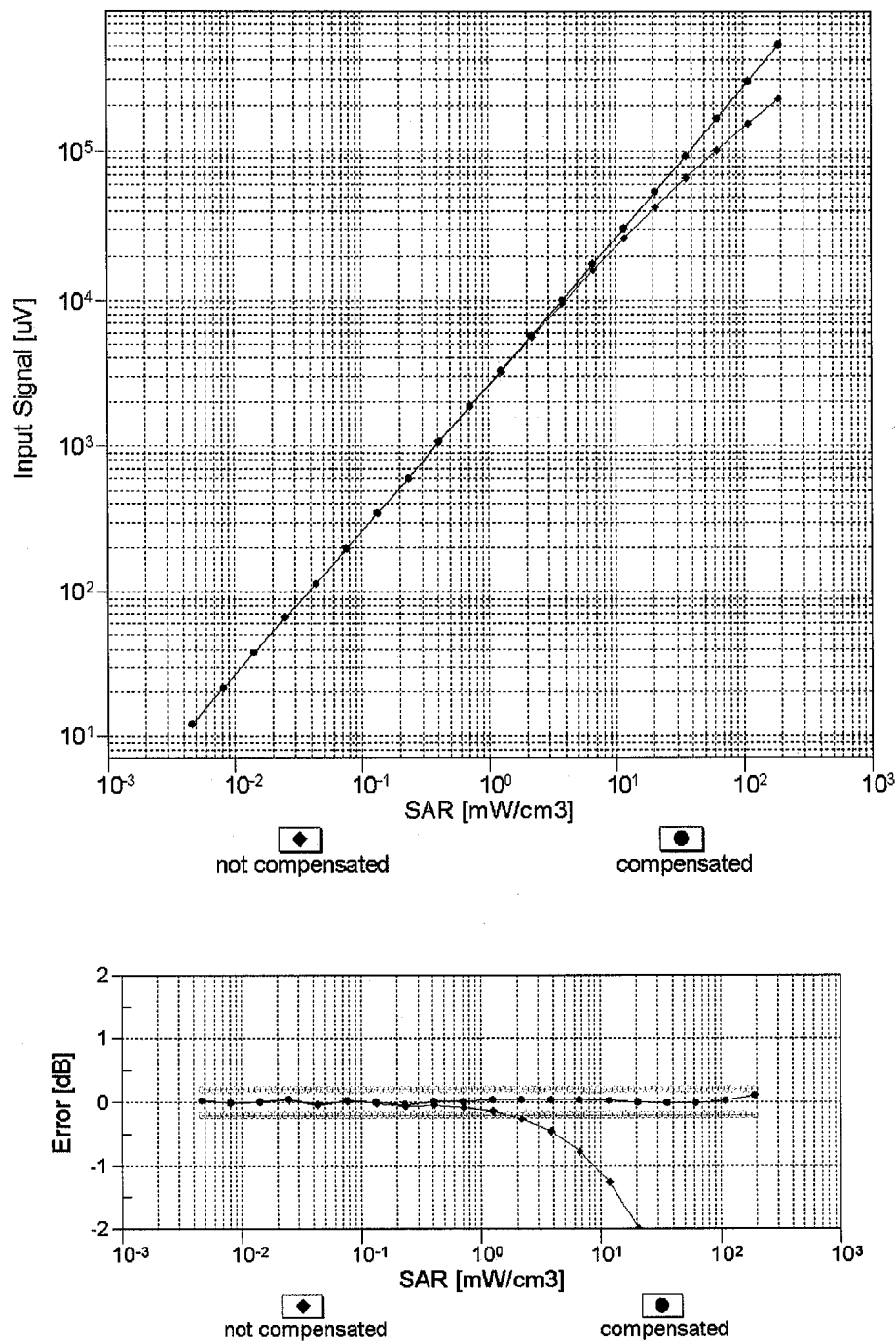


f=1800 MHz,R22



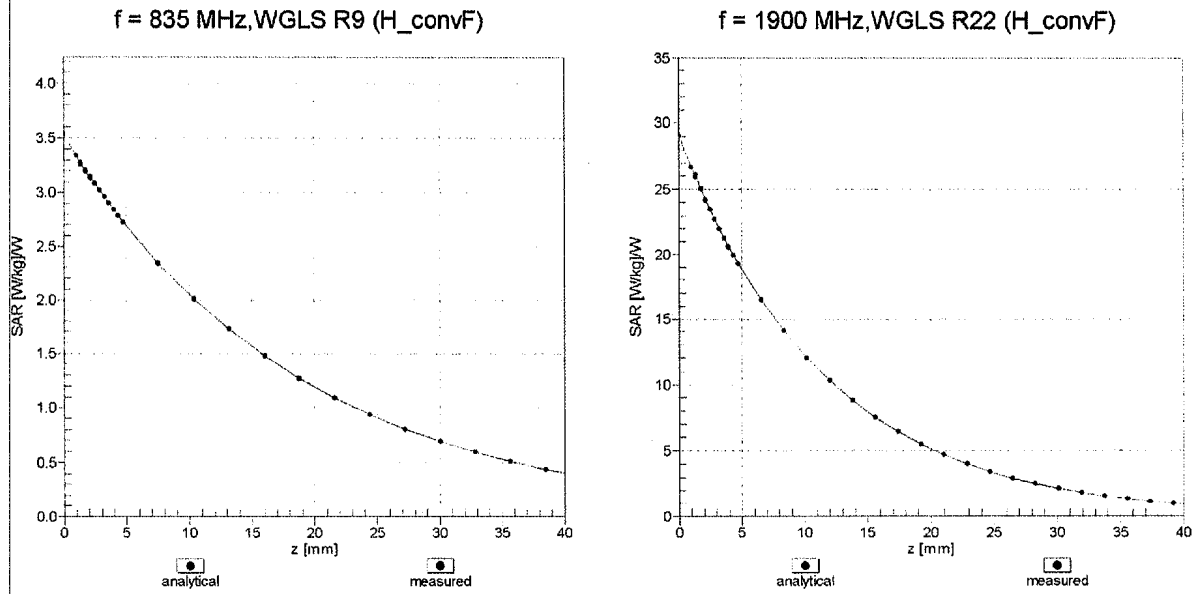
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

Dynamic Range f(SAR<sub>head</sub>)  
(TEM cell , f<sub>eval</sub>= 1900 MHz)

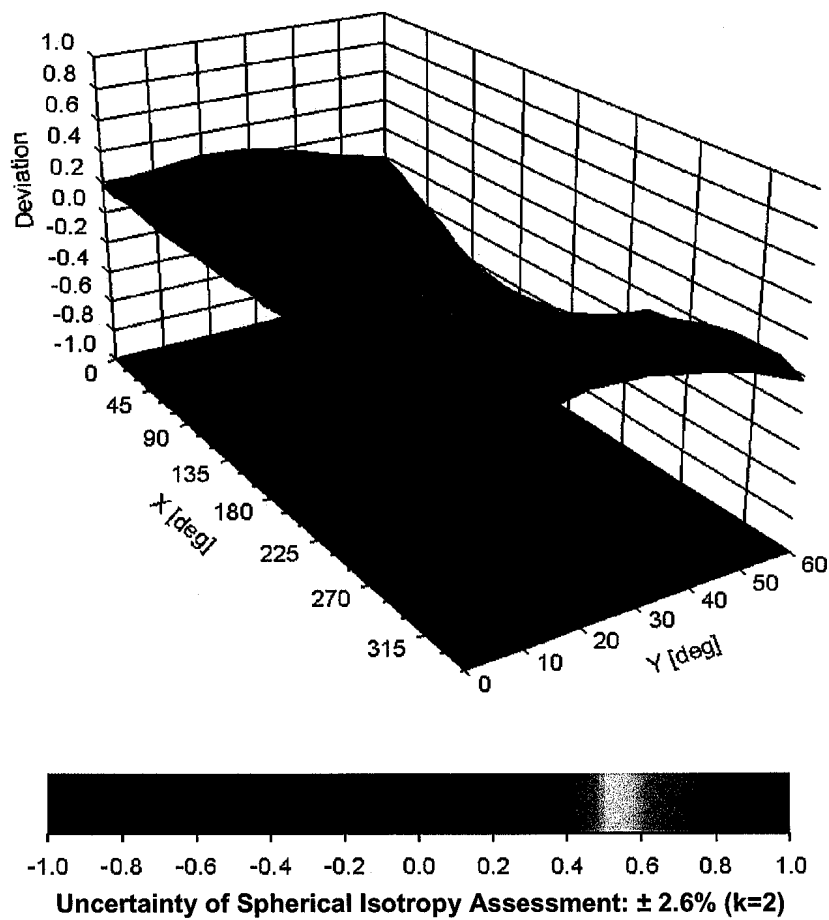


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

# Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi$ , $\theta$ ), f = 900 MHz





## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3819

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	115.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm