

FCC SAR Test Report

APPLICANT : Acer Incorporated
EQUIPMENT : Notebook computer
BRAND NAME : acer
MODEL NAME : N17H2
FCC ID : Contains FCC ID : HLZ9560D2W
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: WLAN and BT, 2*2 PCIe M.2 1216 SD adapter card (Brand Name: acer, Model Name: 9560D2W, FCC ID: HLZ9560D2W) during test.

We, Sporton International (Shenzhen) Inc., would like to declare that the tested sample has been evaluated in accordance with the procedures and had 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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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA880301	Rev. 01	Initial issue of report	Sep. 26, 2018

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Acer Incorporated, Notebook computer, N17H2**, are as follows.

Highest Standalone 1g SAR Summary			
Equipment Class	Frequency Band		Body
			1g SAR (W/kg)
DTS	WLAN	2.4GHz WLAN	0.26
NII		5GHz WLAN	1.11
DSS	Bluetooth	Bluetooth	0.10
Highest SAR Summary Highest Simultaneous Transmission 1g SAR (W/kg)			
DTS (MIMO)		0.46	
NII (MIMO)		1.59	
DTS+DSS		0.36	
NII+DSS		0.58	
Date of Testing:		2018/9/5~2018/9/7	

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	N17H2
FCC ID	Contains FCC ID :HLZ9560D2W
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2472 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5700 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	WLAN 2.4GHz : 802.11b/g/n HT20/HT40 WLAN 5GHz : 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80/VHT160 Bluetooth BR/EDR/LE
EUT Stage	Identical Prototype
Remark: 1. This device has no voice function. 2. This EUT has two typical use conditions which are laptop mode and tablet mode.	

Module Feature & Specification	
Equipment Name	WLAN and BT, 2*2 PCIe M.2 1216 SD adapter card
Brand Name	acer
Model Name	9560D2W
FCC ID	HLZ9560D2W

4.2 Component List

There three types of EUT, the differences between them are as below table. According to the difference, we chose sample 1 to perform full SAR test, sample 2 and sample 3 only verified the worst case of sample 1.

Component	Sample 1 SKUC	Sample 2 SKUA	Sample 3 SKUB
CPU	N5000	N5000	N4000
BT/WIFI Module	9560D2W	9560D2W	9560D2W
RAM	HYNIX LPD4_2GB(200b_D4x32) H9HCNNNBPUMLHR-NME	HYNIX LPD4_2GB(200b_D4x32) H9HCNNNBPUMLHR-NME	MICRON LPD4_2GB(200b_D2x32) MT53E512M32D2NP-046 WT:E
EMMC	SANDISK NAND 128GB SDINADF4-128G-1220	SANDISK NAND 64GB SDINBDA4-64-1220V	SANDISK NAND 64GB SDINBDA4-64-1220V
Camera front	6SF009N2	6SF009N2	6SF009N2
LCD	ZC-116A-1227BT	ZC-116A-1227BT	ZC-116A-1227BT
Battery	AP16L5J	AP16L5J	AP16L5J

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:

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

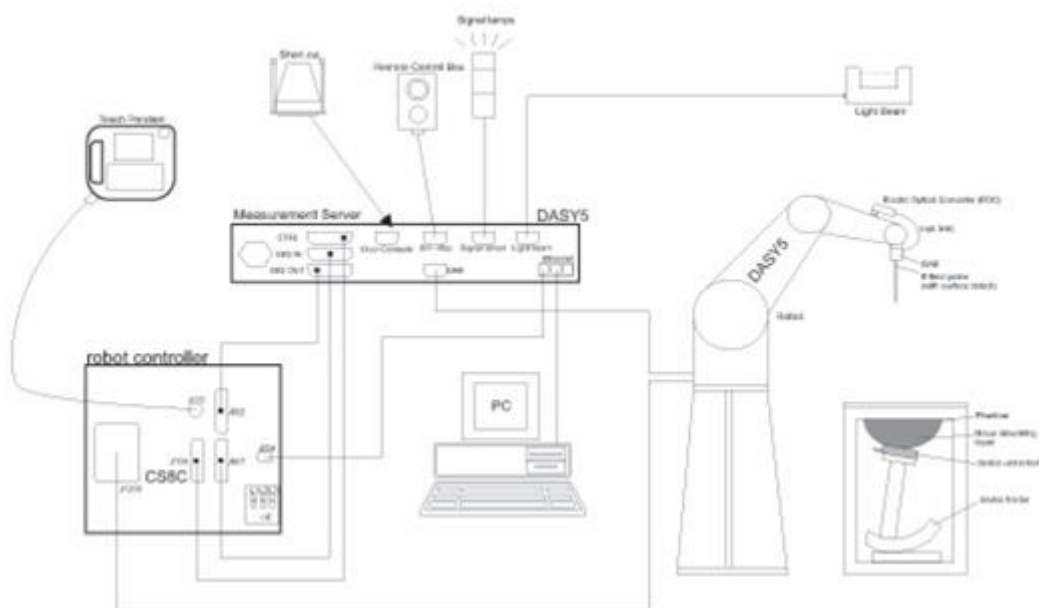
SAR is expressed in units of Watts per kilogram (W/kg)

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

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>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ± 0.2 dB (30 MHz – 6 GHz)	
Directivity	± 0.3 dB in TSL (rotation around probe axis) ± 0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 μ W/g – >100 mW/g Linearity: ± 0.2 dB (noise: typically <1 μ W/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

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>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	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>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	
Filling Volume	Approx. 30 liters	
Dimensions	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.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ 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: Δx_{Area} , Δy_{Area}	≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm	$3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ 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.

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 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		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ 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 ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 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	Mar. 22, 2018	Mar. 21, 2019
SPEAG	5000MHz System Validation Kit	D5GHzV2	1167	Aug. 03, 2018	Aug. 02, 2019
SPEAG	Data Acquisition Electronics	DAE4	1303	Dec. 19, 2017	Dec. 18, 2018
SPEAG	Dosimetric E-Field Probe	EX3DV4	3958	Jan. 11, 2018	Jan. 10, 2019
SPEAG	ELI4 Phantom	ELI5.0	1225	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	Wireless Communication Test Set	E5515C	MY50267224	Sep. 12, 2017	Sep. 11, 2018
Agilent	Network Analyzer	E5071C	MY46523671	Oct. 18, 2017	Oct. 17, 2018
Speag	Dielectric Assessment KIT	DAK-3.5	1071	Nov. 28, 2017	Nov. 27, 2018
Agilent	Signal Generator	N5181A	MY50145381	Dec. 26, 2017	Dec. 25, 2018
Anritsu	Power Sensor	MA2411B	1306099	Jul. 30, 2018	Jul. 29, 2019
Anritsu	Power Meter	ML2495A	1349001	Jul. 26, 2018	Jul. 25, 2019
R&S	CBT BLUETOOTH TESTER	CBT	100963	Dec. 26, 2017	Dec. 25, 2018
R&S	Spectrum Analyzer	FSP7	100818	Jul. 18, 2018	Jul. 17, 2019
LKM electronic	Hygrometer	DTM3000	3241	Aug. 10, 2018	Aug. 09, 2019
Anymetre	Thermo-Hygrometer	JR593	2015102801	Jan. 01, 2018	Dec. 31, 2018
ARRA	Power Divider	A3200-2	N/A	Note	
MCL	Attenuation1	BW-S10W5	N/A	Note	
Weinschel	Attenuation2	3M-20	N/A	Note	
Zhongjilianhe	Attenuation3	MVE2214-03	N/A	Note	
mini-circuits	Amplifier	ZHL-42W+	QA1341002	Note	
mini-circuits	Amplifier	ZVE-3W-83+	599201528	Note	
PASTERNAK	Dual Directional Coupler	PE2214-10	N/A	Note	
Agilent	Dual Directional Coupler	778D	50422	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 (σ)	Permittivity (ϵ_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%

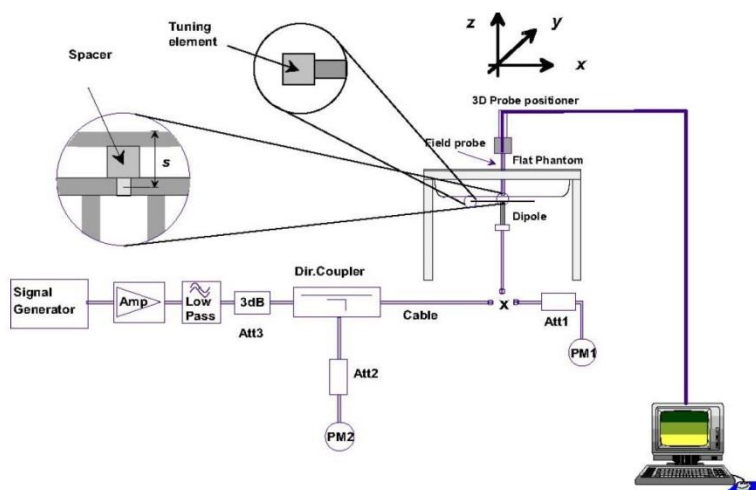
<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Conductivity (σ)	Permittivity (ϵ_r)	Conductivity Target (σ)	Permittivity Target (ϵ_r)	Delta (σ) (%)	Delta (ϵ_r) (%)	Limit (%)	Date
2450	Body	22.5	1.992	52.302	1.95	52.70	2.15	-0.76	±5	2018/9/7
5250	Body	22.4	5.359	48.090	5.36	48.95	-0.02	-1.76	±5	2018/9/5
5600	Body	22.6	5.817	47.504	5.77	48.50	0.81	-2.05	±5	2018/9/5
5750	Body	22.7	6.047	47.349	5.94	48.28	1.80	-1.93	±5	2018/9/6

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 (%)
2018/9/7	2450	Body	250	924	3958	1303	12.20	50.70	48.8	-3.75
2018/9/5	5250	Body	100	1167	3958	1303	7.05	74.40	70.5	-5.24
2018/9/5	5600	Body	100	1167	3958	1303	8.39	77.10	83.9	8.82
2018/9/6	5750	Body	100	1167	3958	1303	7.07	74.30	70.7	-4.85



System Performance Check Setup



Setup Photo



11. RF Exposure Positions

This DUT has two typical use conditions which are laptop mode and tablet mode, so the DUT were tested in bottom and back of display screen were tested for laptop mode; bottom face and edge3 for tablet mode.

<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. 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.
2. 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.
3. 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).
4. 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.
5. 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 ≤ 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 ≤ 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 ≤ 1.2 W/kg or all required channels are tested.

<2.4GHz WLAN Ant.1>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	11.78	12.00	96.93
		6	2437	11.75	12.00	
		11	2462	11.65	12.00	
		12	2467	11.61	12.00	
		13	2472	11.64	12.00	
	802.11g 6Mbps	1	2412	11.55	11.80	86.72
		6	2437	11.70	11.80	
		11	2462	11.50	11.80	
		12	2467	11.54	11.80	
		13	2472	-5.52	-5.00	
	802.11n-HT20 MCS0	1	2412	11.53	11.80	86.93
		6	2437	11.56	11.80	
		11	2462	11.41	11.80	
		12	2467	11.54	11.80	
		13	2472	-8.54	-8.00	
	802.11n-HT40 MCS0	3	2422	11.73	11.80	86.40
		6	2437	11.59	11.80	
		9	2452	11.65	11.80	
		10	2457	9.07	10.00	
		11	2462	0.87	1.00	

<2.4GHz WLAN Ant.2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	11.56	12.00	96.92
		6	2437	11.54	12.00	
		11	2462	11.42	12.00	
		12	2467	11.34	12.00	
		13	2472	11.44	12.00	
	802.11g 6Mbps	1	2412	11.46	11.80	86.96
		6	2437	11.48	11.80	
		11	2462	11.25	11.80	
		12	2467	11.22	11.80	
		13	2472	-6.30	-6.00	
	802.11n-HT20 MCS0	1	2412	11.51	11.80	86.97
		6	2437	11.32	11.80	
		11	2462	11.23	11.80	
		12	2467	11.23	11.80	
		13	2472	-9.25	-9.00	
	802.11n-HT40 MCS0	3	2422	11.28	11.50	86.35
		6	2437	11.35	11.50	
		9	2452	11.34	11.50	
		10	2457	8.80	9.00	
		11	2462	0.17	1.00	

<2.4GHz WLAN Ant.1+2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11n-HT20 MCS8	1	2412	14.57	15.00	86.49
		6	2437	14.50	15.00	
		11	2462	14.36	15.00	
		12	2467	14.42	15.00	
		13	2472	-5.84	-5.50	
	802.11n-HT40 MCS8	3	2422	14.56	14.70	85.86
		6	2437	14.53	14.70	
		9	2452	14.55	14.70	
		10	2457	11.99	12.50	
		11	2462	3.58	4.00	

<5GHz WLAN Ant.1>

5.2GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	36	5180	14.13	15.30	86.94
		40	5200	13.93	15.30	
		44	5220	14.46	15.30	
		48	5240	14.39	15.30	
	802.11n-HT20 MCS0	36	5180	12.95	13.50	84.94
		40	5200	12.90	13.50	
		44	5220	12.96	13.50	
		48	5240	12.94	13.50	
	802.11n-HT40 MCS0	38	5190	13.33	13.50	84.71
		46	5230	14.05	14.50	
	802.11ac-VHT20 MCS0	36	5180	12.92	13.50	85.00
		40	5200	12.88	13.50	
		44	5220	12.94	13.50	
		48	5240	12.91	13.50	
	802.11ac-VHT40 MCS0	38	5190	13.33	13.50	84.44
		46	5230	14.03	14.50	
	802.11ac-VHT80 MCS0	42	5210	8.56	9.00	84.08
	802.11ac-VHT160 MCS0	50	5250	11.76	12.00	83.65

5.3GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	52	5260	14.97	15.30	86.94
		56	5280	14.75	15.30	
		60	5300	14.65	15.30	
		64	5320	14.65	15.30	
	802.11n-HT20 MCS0	52	5260	15.06	15.20	84.94
		56	5280	14.72	15.20	
		60	5300	14.71	15.20	
		64	5320	14.68	15.20	
	802.11n-HT40 MCS0	54	5270	15.06	15.20	84.71
		62	5310	13.73	15.20	
	802.11ac-VHT20 MCS0	52	5260	15.02	15.20	85.00
		56	5280	14.70	15.20	
		60	5300	14.67	15.20	
		64	5320	14.66	15.20	
	802.11ac-VHT40 MCS0	54	5270	15.05	15.20	84.44
		62	5310	13.69	14.00	
	802.11ac-VHT80 MCS0	58	5290	11.24	11.50	84.08

5.5GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	100	5500	13.16	13.50	86.94
		116	5580	12.97	13.50	
		124	5620	13.02	13.50	
		132	5660	13.06	13.50	
		140	5700	12.96	13.50	
	802.11n-HT20 MCS0	100	5500	13.26	13.30	84.94
		116	5580	13.10	13.30	
		124	5620	12.90	13.30	
		132	5660	13.15	13.30	
		140	5700	13.11	13.30	
	802.11n-HT40 MCS0	102	5510	12.17	13.30	84.71
		110	5550	12.09	13.30	
		126	5630	13.10	13.30	
		134	5670	13.17	13.30	
	802.11ac-VHT20 MCS0	100	5500	13.22	13.30	85.00
		116	5580	13.07	13.30	
		124	5620	12.88	13.30	
		132	5660	13.11	13.30	
		140	5700	13.06	13.30	
	802.11ac-VHT40 MCS0	102	5510	12.13	13.30	84.44
		110	5550	12.07	13.30	
		126	5630	13.05	13.30	
		134	5670	13.16	13.30	
	802.11ac-VHT80 MCS0	106	5530	10.15	10.50	84.08
		122	5610	13.20	13.30	
	802.11ac-VHT160 MCS0	114	5570	10.59	11.00	83.65

5.8GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	149	5745	12.73	13.00	86.94
		157	5785	12.70	13.00	
		165	5825	12.83	13.00	
	802.11n-HT20 MCS0	149	5745	12.69	12.90	84.94
		157	5785	12.65	12.90	
		165	5825	12.74	12.90	
	802.11n-HT40 MCS0	151	5755	12.71	12.90	84.71
		159	5795	12.74	12.90	
	802.11ac-VHT20 MCS0	149	5745	12.67	12.90	85.00
		157	5785	12.62	12.90	
		165	5825	12.72	12.90	
	802.11ac-VHT40 MCS0	151	5755	12.68	12.90	84.44
		159	5795	12.74	12.90	
	802.11ac-VHT80 MCS0	155	5775	12.76	12.90	84.08

<5GHz WLAN Ant.2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	14.27	15.50	86.76
		40	5200	14.23	15.50	
		44	5220	14.42	15.50	
		48	5240	14.77	15.50	
	802.11n-HT20 MCS0	36	5180	13.08	13.50	84.72
		40	5200	13.02	13.50	
		44	5220	12.90	13.50	
		48	5240	13.23	13.50	
	802.11n-HT40 MCS0	38	5190	13.31	14.50	84.71
		46	5230	14.18	14.50	
	802.11ac-VHT20 MCS0	36	5180	13.07	13.50	84.78
		40	5200	13.00	13.50	
		44	5220	12.87	13.50	
		48	5240	13.22	13.50	
	802.11ac-VHT40 MCS0	38	5190	13.25	13.50	84.83
		46	5230	14.15	14.50	
	802.11ac-VHT80 MCS0	42	5210	8.94	9.50	84.13
	802.11ac-VHT160 MCS0	50	5250	12.21	12.5	83.65

5.3GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	52	5260	15.29	15.50	86.76
		56	5280	15.11	15.50	
		60	5300	14.76	15.50	
		64	5320	14.73	15.50	
	802.11n-HT20 MCS0	52	5260	15.26	15.30	84.72
		56	5280	14.98	15.30	
		60	5300	14.63	15.30	
		64	5320	14.67	15.30	
	802.11n-HT40 MCS0	54	5270	15.27	15.30	84.71
		62	5310	13.50	14.00	
	802.11ac-VHT20 MCS0	52	5260	15.21	15.30	84.78
		56	5280	14.95	15.30	
		60	5300	14.62	15.30	
		64	5320	14.65	15.30	
	802.11ac-VHT40 MCS0	54	5270	15.23	15.30	84.83
		62	5310	13.47	14.00	
	802.11ac-VHT80 MCS0	58	5290	10.92	11.50	84.13

5.5GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	100	5500	13.48	13.80	86.76
		116	5580	13.20	13.80	
		124	5620	13.36	13.80	
		132	5660	13.45	13.80	
		140	5700	13.25	13.80	
	802.11n-HT20 MCS0	100	5500	13.46	13.60	84.72
		116	5580	13.16	13.60	
		124	5620	13.00	13.60	
		132	5660	13.13	13.60	
		140	5700	13.23	13.60	
	802.11n-HT40 MCS0	102	5510	12.18	13.60	84.71
		110	5550	12.10	13.60	
		126	5630	13.42	13.60	
		134	5670	13.47	13.60	
	802.11ac-VHT20 MCS0	100	5500	13.43	13.60	84.78
		116	5580	13.13	13.60	
		124	5620	12.97	13.60	
		132	5660	13.11	13.60	
		140	5700	13.22	13.60	
	802.11ac-VHT40 MCS0	102	5510	12.12	13.60	84.83
		110	5550	12.06	13.60	
		126	5630	13.38	13.60	
		134	5670	13.44	13.60	
	802.11ac-VHT80 MCS0	106	5530	10.22	10.50	84.13
		122	5610	13.34	13.60	
	802.11ac-VHT160 MCS0	114	5570	10.10	11.00	83.65

5.8GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11a 6Mbps	149	5745	12.58	13.00	86.76
		157	5785	12.55	13.00	
		165	5825	12.68	13.00	
	802.11n-HT20 MCS0	149	5745	12.53	12.70	84.72
		157	5785	12.52	12.70	
		165	5825	12.63	12.70	
	802.11n-HT40 MCS0	151	5755	12.57	12.70	84.71
		159	5795	12.53	12.70	
	802.11ac-VHT20 MCS0	149	5745	12.52	12.70	84.78
		157	5785	12.48	12.70	
		165	5825	12.60	12.70	
	802.11ac-VHT40 MCS0	151	5755	12.52	12.70	84.83
		159	5795	12.50	12.70	
	802.11ac-VHT80 MCS0	155	5775	12.58	12.70	84.13

<5GHz WLAN Ant.1+2>

5.2GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11n-HT20 MCS8	36	5180	16.06	16.50	86.54
		40	5200	16.14	16.50	
		44	5220	15.98	16.50	
		48	5240	16.15	16.50	
	802.11n-HT40 MCS8	38	5190	16.42	18.40	85.79
		46	5230	17.16	17.40	
	802.11ac-VHT20 MCS0	36	5180	16.04	16.50	86.26
		40	5200	16.11	16.50	
		44	5220	15.95	16.50	
		48	5240	16.13	16.50	
	802.11ac-VHT40 MCS0	38	5190	16.40	17.30	85.93
		46	5230	17.13	17.30	
	802.11ac-VHT80 MCS0	42	5210	11.83	12.00	83.81
	802.11ac-VHT160 MCS0	50	5250	15.52	16.00	75.81

5.3GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11n-HT20 MCS8	52	5260	18.19	18.30	86.54
		56	5280	18.05	18.30	
		60	5300	17.72	18.30	
		64	5320	17.73	18.30	
	802.11n-HT40 MCS8	54	5270	18.19	18.40	85.79
		62	5310	16.66	17.40	
	802.11ac-VHT20 MCS0	52	5260	18.18	18.30	86.26
		56	5280	18.02	18.30	
		60	5300	17.71	18.30	
		64	5320	17.71	18.30	
	802.11ac-VHT40 MCS0	54	5270	18.18	18.30	85.93
		62	5310	16.63	18.30	
	802.11ac-VHT80 MCS0	58	5290	14.18	14.50	83.81

5.5GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11n-HT20 MCS8	100	5500	16.41	16.60	86.54
		116	5580	16.17	16.60	
		124	5620	16.04	16.60	
		132	5660	16.28	16.60	
		140	5700	16.20	16.60	
	802.11n-HT40 MCS8	102	5510	15.20	16.50	85.79
		110	5550	15.12	16.50	
		126	5630	16.36	16.50	
		134	5670	16.37	16.50	
	802.11ac-VHT20 MCS0	100	5500	16.39	16.50	86.26
		116	5580	16.15	16.50	
		124	5620	16.01	16.50	
		132	5660	16.24	16.50	
		140	5700	16.17	16.50	
	802.11ac-VHT40 MCS0	102	5510	15.18	16.50	85.93
		110	5550	15.10	16.50	
		126	5630	16.34	16.50	
		134	5670	16.34	16.50	
	802.11ac-VHT80 MCS0	106	5530	13.27	13.50	83.81
		122	5610	16.42	16.50	
	802.11ac-VHT160 MCS0	114	5570	13.83	14.00	75.81

5.8GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
	802.11n-HT20 MCS8	149	5745	15.65	16.00	86.63
		157	5785	15.62	16.00	
		165	5825	15.74	16.00	
	802.11n-HT40 MCS8	151	5755	15.71	15.80	85.89
		159	5795	15.73	15.80	
	802.11ac-VHT20 MCS0	149	5745	15.63	15.80	86.73
		157	5785	15.62	15.80	
		165	5825	15.72	15.80	
	802.11ac-VHT40 MCS0	151	5755	15.70	15.80	85.93
		159	5795	15.71	15.80	
	802.11ac-VHT80 MCS0	155	5775	15.75	15.80	84.49

<2.4GHz Bluetooth>
General Note:

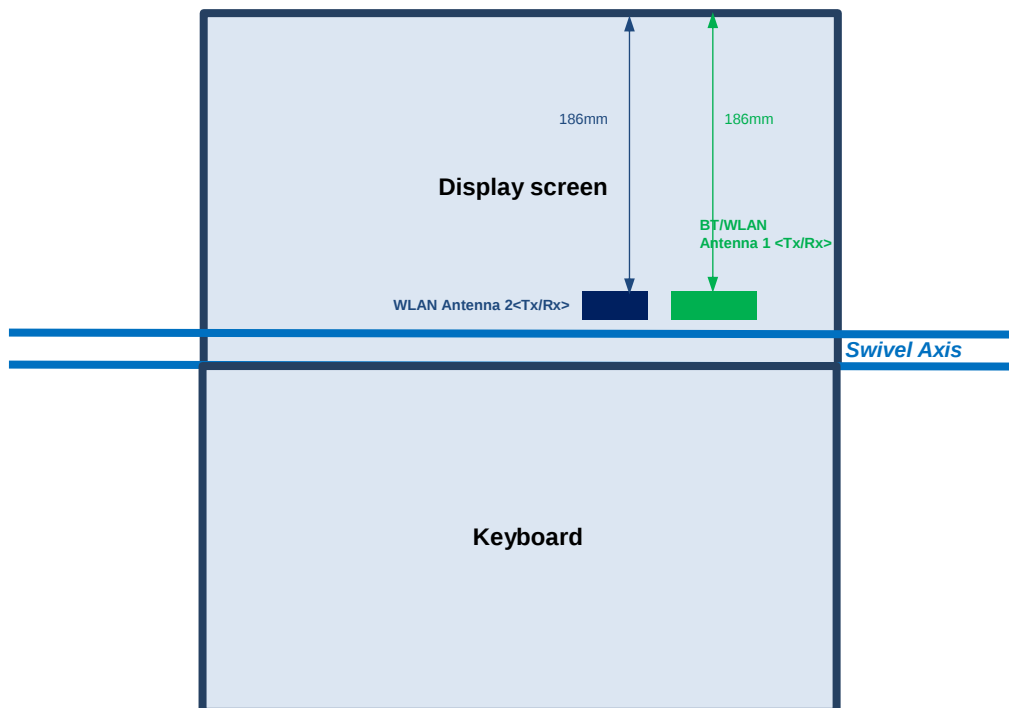
1. For 2.4GHz Bluetooth SAR testing was selected 1Mbps, due to its highest average power.
2. The Bluetooth duty cycle is 76.74 % as following figure, according to 2016 Oct. TCB workshop for Bluetooth SAR scaling need further consideration and the theoretical duty cycle is 83.3%, therefore the actual duty cycle will be scaled up to the theoretical value of Bluetooth reported SAR calculation.

Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up limit (dBm)
			1Mbps	
BR / EDR	CH 00	2402	7.95	9.50
	CH 39	2441	9.12	10.00
	CH 78	2480	9.83	10.00

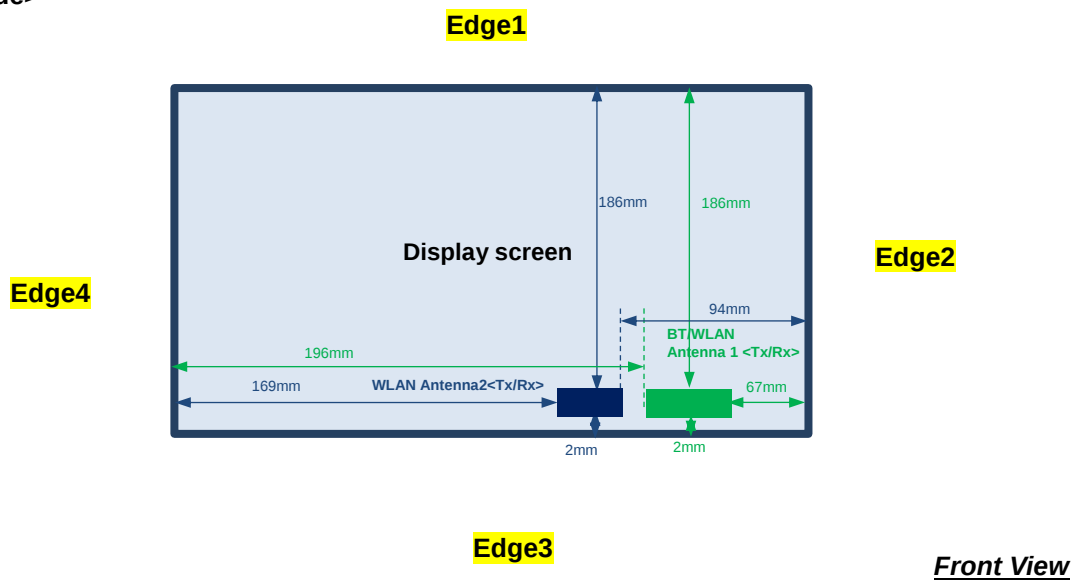
Mode	Channel	Frequency (MHz)	Average power (dBm)
			GFSK
LE	CH 00	2402	4.87
	CH 19	2440	5.42
	CH 39	2480	5.31
Tune-up limit (dBm)			6.00

13. Antenna Location

<Laptop Mode>



<Tablet Mode>



Front View

General Note:

1. The below table, when the distance is < 50 mm exclusion threshold is "Ratio", when the distance is > 50 mm exclusion threshold is "mW"
2. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
3. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
4. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold.
5. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$$
 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
 - f(GHz) is the RF channel transmit frequency in GHz
 - Power and distance are rounded to the nearest mW and mm before calculation
 - The result is rounded to one decimal place for comparison
6. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following
 - a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
 - b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · 10] mW at > 1500 MHz and ≤ 6 GHz

For Laptop Mode

Exposure Position	Wireless Interface	Bluetooth Ant.1	WLAN2.4GHz Ant.1	WLAN5GHz Ant.1	WLAN2.4GHz Ant.2	WLAN5GHz Ant.2
	Calculated Frequency (MHz)	2480	2472	5825	2472	5825
	Maximum power (dBm)	10	12	15.3	12	15.5
	Maximum rated power(mW)	5.0	16.0	34.0	16.0	35.0
Bottom	Separation Distance(mm)	0			0	
	Exclusion Threshold	3.2	5.0	16.4	5.0	16.9
	Testing required?	Yes	Yes	Yes	Yes	Yes
Bottom of Laptop	Separation Distance(mm)	0			0	
	Exclusion Threshold	3.2	5.0	16.4	5.0	16.9
	Testing required?	Yes	Yes	Yes	Yes	Yes

For Tablet Mode

Exposure Position	Wireless Interface	Bluetooth Ant.1	WLAN2.4GHz Ant.1	WLAN5GHz Ant.1	WLAN2.4GHz Ant.2	WLAN5GHz Ant.2
	Calculated Frequency (MHz)	2480	2472	5825	2472	5825
	Maximum power (dBm)	10	12	15.3	12	15.5
	Maximum rated power(mW)	5.0	16.0	34.0	16.0	35.0
	Separation Distance(mm)	0			0	
Bottom Face	Exclusion Threshold	3.2	5.0	16.4	5.0	16.9
	Testing required?	Yes	Yes	Yes	Yes	Yes
	Separation Distance(mm)	186			186	
Edge 1	Exclusion Threshold	1455.0	1456.0	1422.0	1456.0	1422.0
	Testing required?	No	No	No	No	No
	Separation Distance(mm)	67			94	
Edge 2	Exclusion Threshold	265.0	266.0	232.0	536.0	502.0
	Testing required?	No	No	No	No	No
	Separation Distance(mm)	2			2	
Edge 3	Exclusion Threshold	3.2	5.0	16.4	5.0	16.9
	Testing required?	Yes	Yes	Yes	Yes	Yes
	Separation Distance(mm)	196			169	
Edge 4	Exclusion Threshold	1555.0	1556.0	1522.0	1286.0	1252.0
	Testing required?	No	No	No	No	No
	Separation Distance(mm)					

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:
 - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - ≤ 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
 - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8 W/kg.
4. This EUT has two typical use conditions which are laptop mode and tablet mode.
5. According to the normal usage, we didn't evaluate the distance SAR at laptop of bottom.
6. There are three samples, based on the similarity of three samples, we only chose sample 1 to do full SAR testing, sample 2 and sample 3 verified the worst case of sample 1.

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 ≤ 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 ≤ 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 ≤ 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 ≤ 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.	EUT Type	Ant. Port	Sample	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)
	Laptop	1	1	WLAN2.4GHz	802.11b 1Mbps	Bottom	0	1	2412	11.78	12.00	1.052	96.93	1.032	0.02	0.052	0.057
	Laptop	1	1	WLAN2.4GHz	802.11b 1Mbps	Back of Display Screen	25	1	2412	11.78	12.00	1.052	96.93	1.032	0.06	0.011	0.012
	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0	1	2412	11.78	12.00	1.052	96.93	1.032	-0.03	0.061	0.066
01	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	1	2412	11.78	12.00	1.052	96.93	1.032	0.03	0.186	0.202
	Tablet	1	2	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	1	2412	11.78	12.00	1.052	96.93	1.032	-0.02	0.141	0.153
	Tablet	1	3	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	1	2412	11.78	12.00	1.052	96.93	1.032	0.05	0.140	0.152
	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	6	2437	11.75	12.00	1.059	96.93	1.032	0.01	0.162	0.177
	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	11	2462	11.65	12.00	1.084	96.93	1.032	0.02	0.146	0.163
	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	12	2467	11.61	12.00	1.095	96.93	1.032	0.04	0.140	0.158
	Tablet	1	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	13	2472	11.64	12.00	1.088	96.93	1.032	0.01	0.144	0.162
	Laptop	2	1	WLAN2.4GHz	802.11b 1Mbps	Bottom	0	1	2412	11.56	12.00	1.108	96.92	1.032	0.06	0.032	0.037
	Laptop	2	1	WLAN2.4GHz	802.11b 1Mbps	Back of Display Screen	25	1	2412	11.56	12.00	1.108	96.92	1.032	0.04	0.016	0.019
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0	1	2412	11.56	12.00	1.108	96.92	1.032	0.05	0.064	0.073
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	1	2412	11.56	12.00	1.108	96.92	1.032	0.08	0.140	0.160
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	6	2437	11.54	12.00	1.113	96.92	1.032	0.01	0.174	0.200
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	11	2462	11.42	12.00	1.144	96.92	1.032	0.02	0.191	0.225
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	12	2467	11.34	12.00	1.165	96.92	1.032	0.04	0.195	0.234
	Tablet	2	2	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	12	2467	11.34	12.00	1.165	96.92	1.032	0.02	0.209	0.251
02	Tablet	2	3	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	12	2467	11.34	12.00	1.165	96.92	1.032	0.02	0.215	0.259
	Tablet	2	1	WLAN2.4GHz	802.11b 1Mbps	Edge 3	0	13	2472	11.44	12.00	1.139	96.92	1.032	0.02	0.191	0.224

<WLAN5G SAR>

Plot No.	EUT Type	Ant. Port	Sample	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)
	Laptop	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom	0	52	5260	14.97	15.30	1.080	86.94	1.150	0.05	0.523	0.649
	Laptop	1	1	WLAN5.3GHz	802.11a 6Mbps	Back of Display Screen	25	52	5260	14.97	15.30	1.080	86.94	1.150	-0.06	0.074	0.092
	Tablet	1	1	WLAN5.3GHz	802.11a 6Mbps	Bottom Face	0	52	5260	14.97	15.30	1.080	86.94	1.150	0.05	0.370	0.459
	Tablet	1	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	14.97	15.30	1.080	86.94	1.150	0.02	0.851	1.056
	Tablet	1	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	56	5280	14.75	15.30	1.135	86.94	1.150	0.04	0.810	1.057
	Tablet	1	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	60	5300	14.65	15.30	1.162	86.94	1.150	0.06	0.750	1.002
	Tablet	1	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	64	5320	14.65	15.30	1.162	86.94	1.150	0.03	0.823	1.100
	Tablet	1	2	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	64	5320	14.65	15.30	1.162	86.94	1.150	0.02	0.718	0.960
	Tablet	1	2	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	14.97	15.30	1.080	86.94	1.150	-0.05	0.817	1.014
	Tablet	1	2	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	56	5280	14.75	15.30	1.135	86.94	1.150	-0.05	0.807	1.053
	Tablet	1	2	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	60	5300	14.65	15.30	1.162	86.94	1.150	-0.01	0.760	1.016
03	Tablet	1	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	64	5320	14.65	15.30	1.162	86.94	1.150	0.04	0.828	1.107
	Tablet	1	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	14.97	15.30	1.080	86.94	1.150	0.01	0.868	1.078
	Tablet	1	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	56	5280	14.75	15.30	1.135	86.94	1.150	0.07	0.847	1.106
	Tablet	1	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	60	5300	14.65	15.30	1.162	86.94	1.150	-0.03	0.827	1.105
	Laptop	2	1	WLAN5.3GHz	802.11a 6Mbps	Bottom	0	52	5260	15.29	15.50	1.050	86.76	1.153	-0.05	0.120	0.145
	Laptop	2	1	WLAN5.3GHz	802.11a 6Mbps	Back of Display Screen	25	52	5260	15.29	15.50	1.050	86.76	1.153	0.02	0.075	0.091
	Tablet	2	1	WLAN5.3GHz	802.11a 6Mbps	Bottom Face	0	52	5260	15.29	15.50	1.050	86.76	1.153	0.01	0.234	0.283
04	Tablet	2	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	15.29	15.50	1.050	86.76	1.153	0.02	0.401	0.486
	Tablet	2	2	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	15.29	15.50	1.050	86.76	1.153	-0.03	0.396	0.480
	Tablet	2	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	15.29	15.50	1.050	86.76	1.153	0.01	0.400	0.484
	Tablet	2	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	56	5280	15.11	15.50	1.094	86.76	1.153	-0.05	0.384	0.484
	Tablet	2	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	60	5300	14.76	15.50	1.187	86.76	1.153	0.03	0.350	0.479



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Tablet	2	1	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	64	5320	14.73	15.50	1.195	86.76	1.153	0.04	0.352	0.485
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Plot No.	EUT Type	Ant. Port	Sample	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)
	Laptop	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom	0	100	5500	13.16	13.50	1.082	86.94	1.150	0.04	0.502	0.625
	Laptop	1	1	WLAN5.5GHz	802.11a 6Mbps	Back of Display Screen	25	100	5500	13.16	13.50	1.082	86.94	1.150	0.09	0.084	0.104
	Tablet	1	1	WLAN5.5GHz	802.11a 6Mbps	Bottom Face	0	100	5500	13.16	13.50	1.082	86.94	1.150	0.15	0.180	0.224
	Tablet	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	100	5500	13.16	13.50	1.082	86.94	1.150	0.07	0.809	1.007
	Tablet	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	116	5580	12.97	13.50	1.130	86.94	1.150	-0.05	0.798	1.037
	Tablet	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	132	5660	13.06	13.50	1.107	86.94	1.150	0.08	0.661	0.841
05	Tablet	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	140	5700	12.96	13.50	1.133	86.94	1.150	0.05	0.840	1.094
	Laptop	2	1	WLAN5.5GHz	802.11a 6Mbps	Bottom	0	100	5500	13.48	13.80	1.077	86.76	1.153	0.06	0.106	0.132
	Laptop	2	1	WLAN5.5GHz	802.11a 6Mbps	Back of Display Screen	25	100	5500	13.48	13.80	1.077	86.76	1.153	0.02	0.042	0.052
	Tablet	2	1	WLAN5.5GHz	802.11a 6Mbps	Bottom Face	0	100	5500	13.48	13.80	1.077	86.76	1.153	0.09	0.129	0.160
	Tablet	2	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	100	5500	13.48	13.80	1.077	86.76	1.153	0.09	0.282	0.350
	Tablet	2	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	116	5580	13.20	13.80	1.149	86.76	1.153	0.04	0.286	0.379
	Tablet	2	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	132	5660	13.45	13.80	1.084	86.76	1.153	0.06	0.324	0.405
06	Tablet	2	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	140	5700	13.25	13.80	1.136	86.76	1.153	0.03	0.357	0.468

Plot No.	EUT Type	Ant. Port	Sample	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)
	Laptop	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom	0	165	5825	12.83	13.00	1.040	86.94	1.150	0.07	0.545	0.652
	Laptop	1	1	WLAN5.8GHz	802.11a 6Mbps	Back of Display Screen	25	165	5825	12.83	13.00	1.040	86.94	1.150	-0.05	0.091	0.109
	Tablet	1	1	WLAN5.8GHz	802.11a 6Mbps	Bottom Face	0	165	5825	12.83	13.00	1.040	86.94	1.150	-0.03	0.116	0.139
07	Tablet	1	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	165	5825	12.83	13.00	1.040	86.94	1.150	0.02	0.738	0.883
	Tablet	1	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	149	5745	12.73	13.00	1.065	86.94	1.150	0.11	0.662	0.811
	Tablet	1	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	157	5785	12.70	13.00	1.072	86.94	1.150	0.03	0.673	0.830
	Laptop	2	1	WLAN5.8GHz	802.11a 6Mbps	Bottom	0	165	5825	12.68	13.00	1.077	86.76	1.153	0.03	0.111	0.138
	Laptop	2	1	WLAN5.8GHz	802.11a 6Mbps	Back of Display Screen	25	165	5825	12.68	13.00	1.077	86.76	1.153	0.05	0.013	0.016
	Tablet	2	1	WLAN5.8GHz	802.11a 6Mbps	Bottom Face	0	165	5825	12.68	13.00	1.077	86.76	1.153	0.02	0.063	0.078
	Tablet	2	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	165	5825	12.68	13.00	1.077	86.76	1.153	0.01	0.283	0.352
	Tablet	2	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	149	5745	12.58	13.00	1.102	86.76	1.153	0.04	0.298	0.379
08	Tablet	2	1	WLAN5.8GHz	802.11a 6Mbps	Edge 3	0	157	5785	12.55	13.00	1.110	86.76	1.153	0.09	0.346	0.443

<Bluetooth SAR>

Plot No.	EUT Type	Ant. Port	Sample	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)
	Laptop	1	1	Bluetooth	1Mbps	Bottom	0	78	2480	9.83	10.00	1.040	76.74	1.085	0.09	0.046	0.051
	Laptop	1	1	Bluetooth	1Mbps	Back of Display Screen	25	78	2480	9.83	10.00	1.040	76.74	1.085	0.06	0.008	0.009
	Tablet	1	1	Bluetooth	1Mbps	Bottom Face	0	78	2480	9.83	10.00	1.040	76.74	1.085	-0.02	0.026	0.030
09	Tablet	1	1	Bluetooth	1Mbps	Edge 3	0	78	2480	9.83	10.00	1.040	76.74	1.085	-0.01	0.086	0.097
	Tablet	1	2	Bluetooth	1Mbps	Edge 3	0	78	2480	9.83	10.00	1.040	76.74	1.085	-0.05	0.021	0.023
	Tablet	1	3	Bluetooth	1Mbps	Edge 3	0	78	2480	9.83	10.00	1.040	76.74	1.085	0.09	0.017	0.020
	Tablet	1	1	Bluetooth	1Mbps	Edge 3	0	0	2402	7.95	9.50	1.429	76.74	1.085	-0.06	0.054	0.083
	Tablet	1	1	Bluetooth	1Mbps	Edge 3	0	39	2441	9.12	10.00	1.225	76.74	1.085	-0.03	0.063	0.084

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14.2 Repeated SAR Measurement

No.	Ant. Port	Sample	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	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	14.97	15.30	1.080	86.94	1.150	0.01	0.868	1	1.078
2nd	1	3	WLAN5.3GHz	802.11a 6Mbps	Edge 3	0	52	5260	14.97	15.30	1.080	86.94	1.150	-0.02	0.862	1.007	1.070
1st	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	140	5700	12.96	13.50	1.133	86.94	1.150	0.05	0.840	1	1.094
2nd	1	1	WLAN5.5GHz	802.11a 6Mbps	Edge 3	0	140	5700	12.96	13.50	1.133	86.94	1.150	0.01	0.828	1.014	1.079

General Note:

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is $\geq 0.8\text{W/kg}$.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR $< 1.45\text{W/kg}$, 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 reported SAR summation is calculated based on the same configuration and test position.
4. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
 - i) Scalar SAR summation < 1.6W/kg.
 - ii) $SPLSR = (SAR1 + SAR2)^{1.5} / (\text{min. separation distance, mm})$, 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 $SPLSR \leq 0.04$, simultaneously transmission SAR measurement is not necessary.
 - iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.

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)	1g SAR (W/kg)	Summed 1g SAR (W/kg)	Summed 1g SAR (W/kg)	Summed 1g SAR (W/kg)	Summed 1g SAR (W/kg)
Bottom at 0mm	0.057	0.037	0.652	0.145	0.051	0.09	0.80	0.09	0.20
Bottom Face at 0mm	0.066	0.073	0.459	0.283	0.030	0.14	0.74	0.10	0.31
Edge 3 at 0mm	0.202	0.259	1.107	0.486	0.097	0.46	1.59	0.36	0.58
Back of Display Screen at 25mm	0.012	0.019	0.109	0.091	0.009	0.03	0.20	0.03	0.10

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



Appendix A. Plots of System Performance Check

The plots are shown as follows.

System Check_Body_2450MHz_180907**DUT: D2450V2-SN:924**

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

Medium: MSL_2450_180907 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.992$ S/m; $\epsilon_r = 52.302$;
 $\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(8, 8, 8); Calibrated: 2018.01.11;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- 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) = 18.1 W/kg

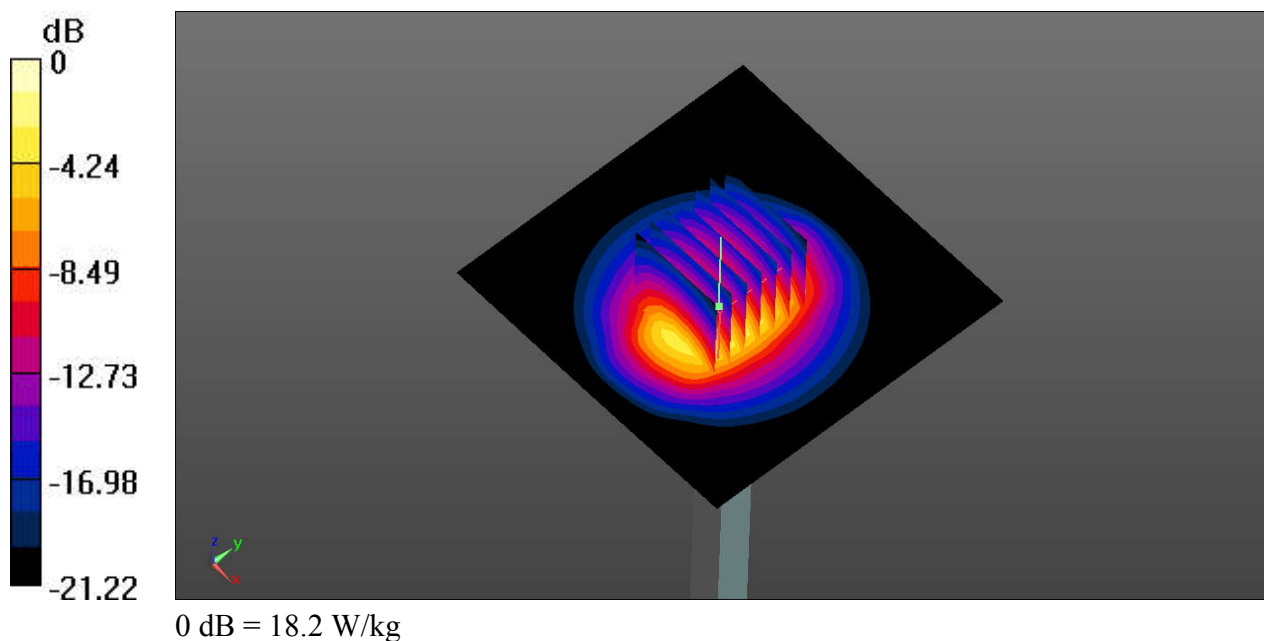
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 79.85 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 23.8 W/kg

SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.74 W/kg

Maximum value of SAR (measured) = 18.2 W/kg



System Check_Body_5250MHz_180905**DUT: D5GHzV2-SN:1167-5250**

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

Medium: MSL_5250_180905 Medium parameters used: $f = 5250$ MHz; $\sigma = 5.359$ S/m; $\epsilon_r = 48.09$; $\rho = 1000$ kg/m³

Ambient Temperature : 23.5 °C ; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(5.2, 5.2, 5.2); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- 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) = 16.9 W/kg

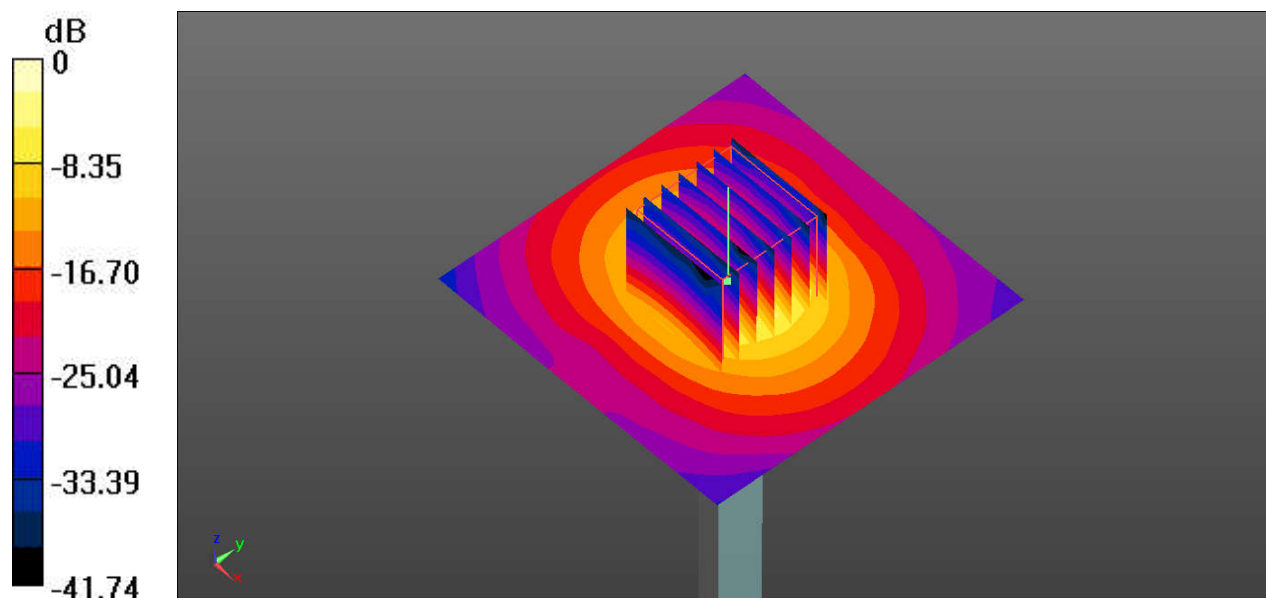
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 45.70 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 29.6 W/kg

SAR(1 g) = 7.05 W/kg; SAR(10 g) = 1.94 W/kg

Maximum value of SAR (measured) = 17.5 W/kg



System Check_Body_5600MHz_180905**DUT: D5GHzV2-SN:1167-5600**

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

Medium: MSL_5600_180905 Medium parameters used: $f = 5600$ MHz; $\sigma = 5.817$ S/m; $\epsilon_r = 47.504$;

$\rho = 1000$ kg/m³

Ambient Temperature : 23.4 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.3, 4.3, 4.3); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- 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) = 20.6 W/kg

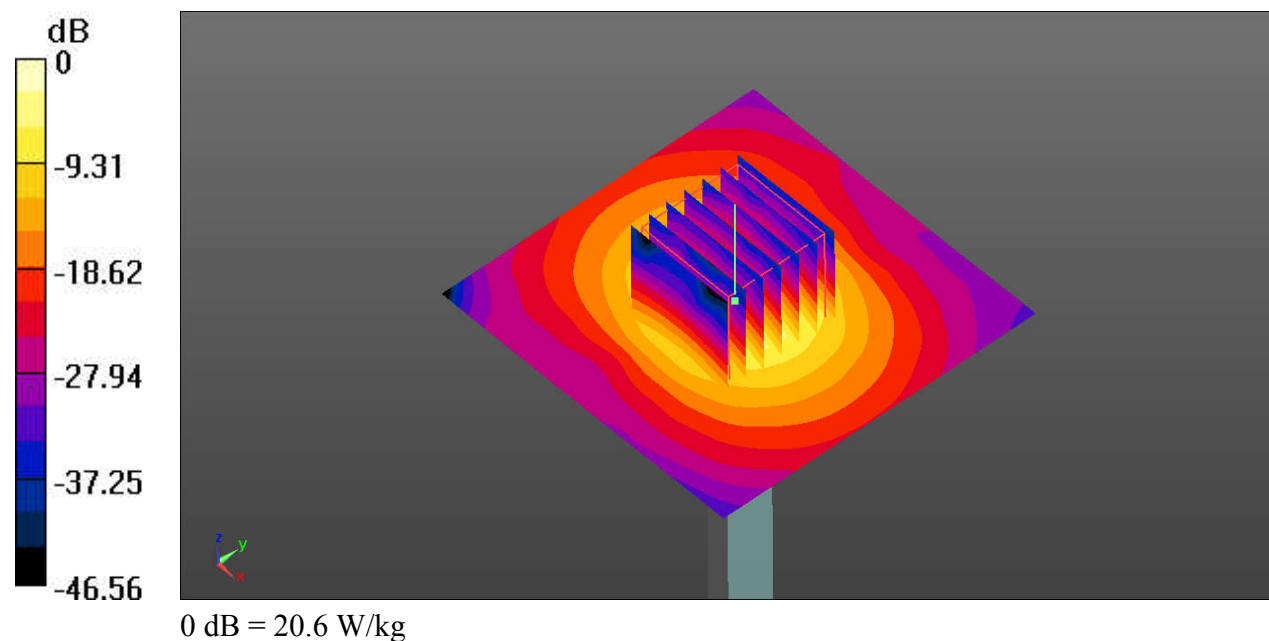
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 48.75 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 36.6 W/kg

SAR(1 g) = 8.39 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 21.6 W/kg



System Check_Body_5750MHz_180906**DUT: D5GHzV2-SN:1167-5750**

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

Medium: MSL_5750_180906 Medium parameters used: $f = 5750$ MHz; $\sigma = 6.047$ S/m; $\epsilon_r = 47.349$;
 $\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.4, 4.4, 4.4); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- 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) = 17.9 W/kg

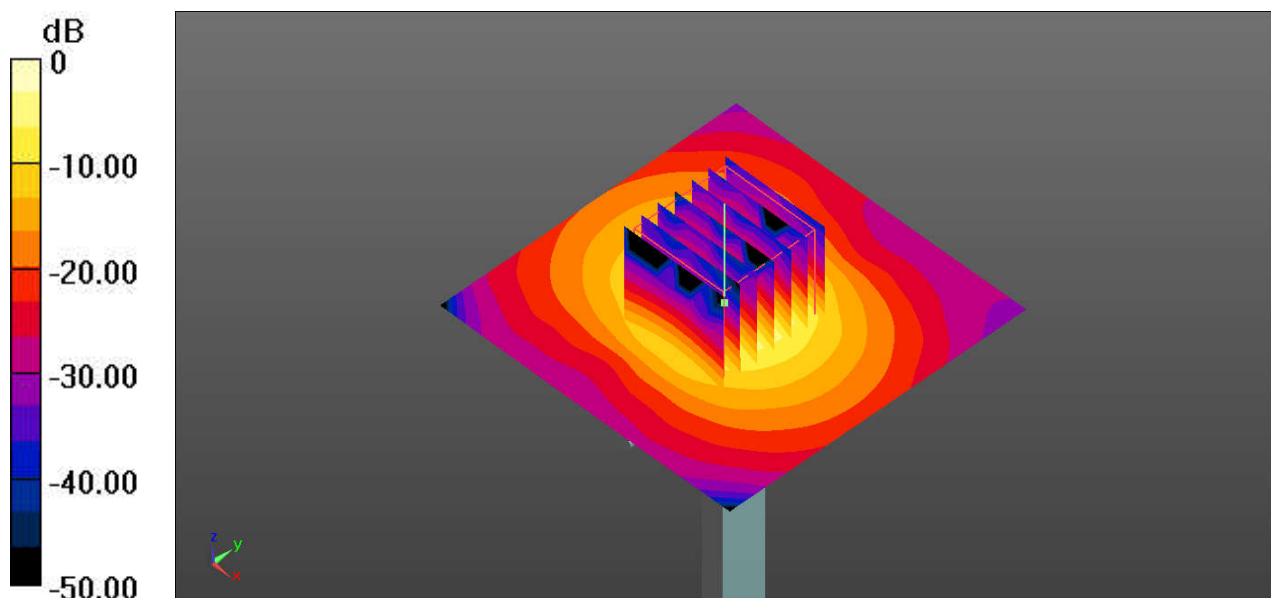
Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 42.30 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 32.0 W/kg

SAR(1 g) = 7.07 W/kg; SAR(10 g) = 1.92 W/kg

Maximum value of SAR (measured) = 18.6 W/kg



0 dB = 17.9 W/kg



Appendix B. Plots of High SAR Measurement

The plots are shown as follows.

01_WLAN2.4GHz_802.11b 1Mbps_Edge 3_0mm_Ch1

Communication System: UID 0, WIFI (0); Frequency: 2412 MHz; Duty Cycle: 1:1.032

Medium: MSL_2450_180907 Medium parameters used: $f = 2412$ MHz; $\sigma = 1.946$ S/m; $\epsilon_r = 52.465$;

$\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(8, 8, 8); Calibrated: 2018.01.11;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch1/Area Scan (41x91x1): Interpolated grid: dx=12mm, dy=12mm

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

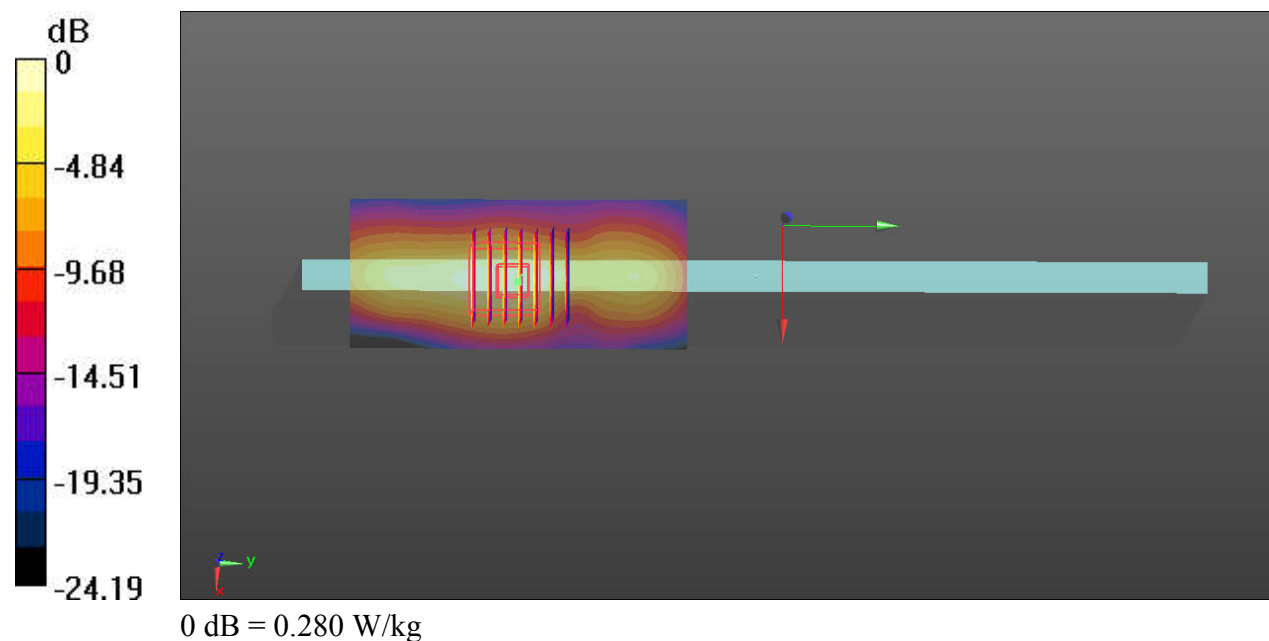
Ch1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0.6450 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.374 W/kg

SAR(1 g) = 0.186 W/kg; SAR(10 g) = 0.088 W/kg

Maximum value of SAR (measured) = 0.280 W/kg



02_WLAN2.4GHz_802.11b 1Mbps_Edge 3_0mm_Ch12

Communication System: UID 0, WIFI (0); Frequency: 2467 MHz; Duty Cycle: 1:1.032

Medium: MSL_2450_180907 Medium parameters used: $f = 2467$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 52.206$; $\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(8, 8, 8); Calibrated: 2018.01.11;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch12/Area Scan (41x91x1): Interpolated grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 0.254 W/kg

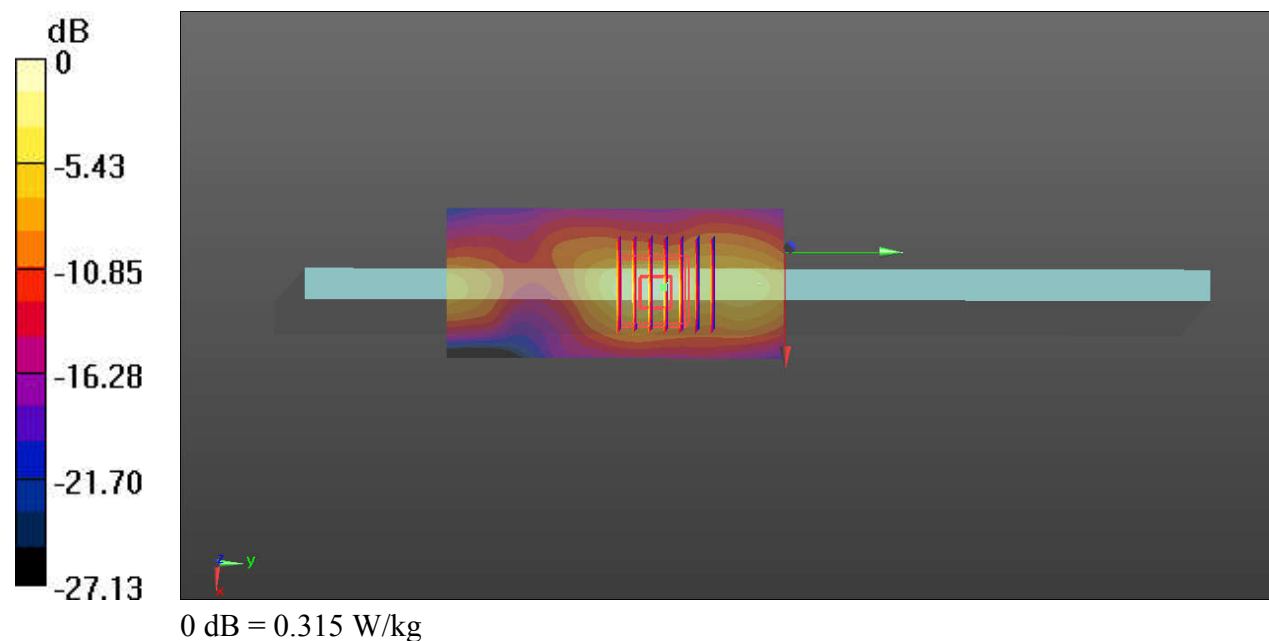
Ch12/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.300 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.490 W/kg

SAR(1 g) = 0.215 W/kg; SAR(10 g) = 0.085 W/kg

Maximum value of SAR (measured) = 0.315 W/kg



03_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch64

Communication System: UID 0, WIFI (0); Frequency: 5320 MHz; Duty Cycle: 1:1.15

Medium: MSL_5250_180905 Medium parameters used: $f = 5320$ MHz; $\sigma = 5.442$ S/m; $\epsilon_r = 48.073$;

$\rho = 1000$ kg/m³

Ambient Temperature : 23.5 °C ; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(5.2, 5.2, 5.2); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch64/Area Scan (61x151x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.91 W/kg

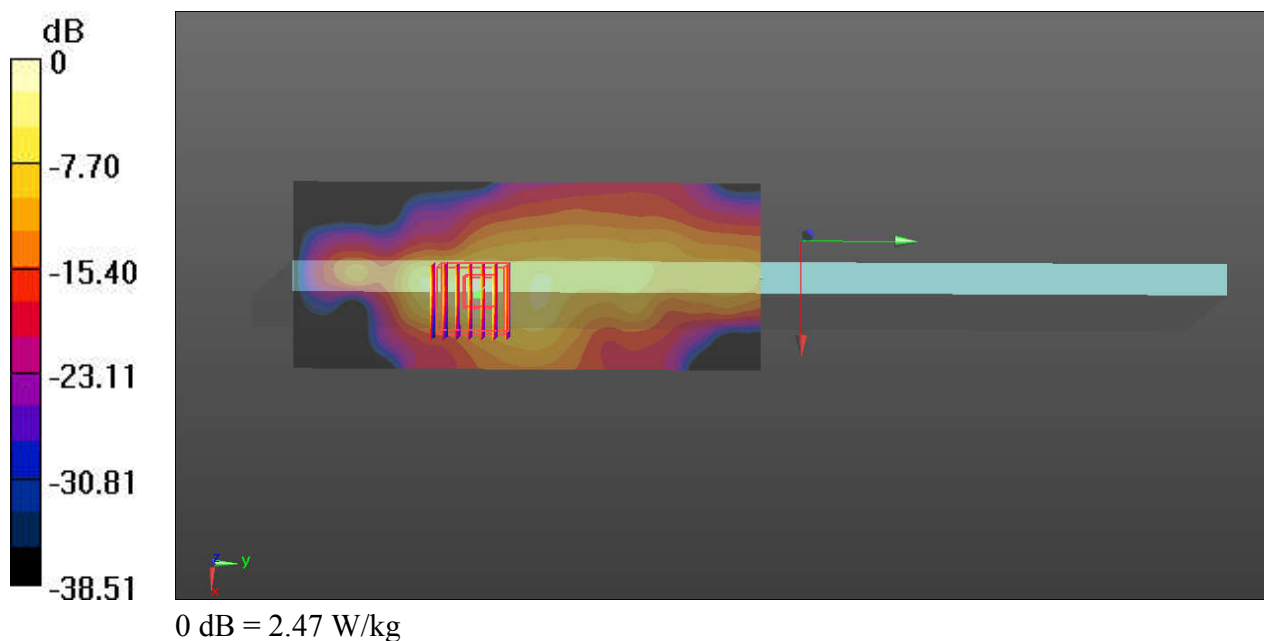
Ch64/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 1.002 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 4.00 W/kg

SAR(1 g) = 0.828 W/kg; SAR(10 g) = 0.251 W/kg

Maximum value of SAR (measured) = 2.47 W/kg



04_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch52

Communication System: UID 0, WIFI (0); Frequency: 5260 MHz; Duty Cycle: 1:1.153
Medium: MSL_5250_180905 Medium parameters used: $f = 5260$ MHz; $\sigma = 5.382$ S/m; $\epsilon_r = 48.077$;
 $\rho = 1000$ kg/m³
Ambient Temperature : 23.5 °C; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(5.2, 5.2, 5.2); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch52/Area Scan (61x121x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.11 W/kg

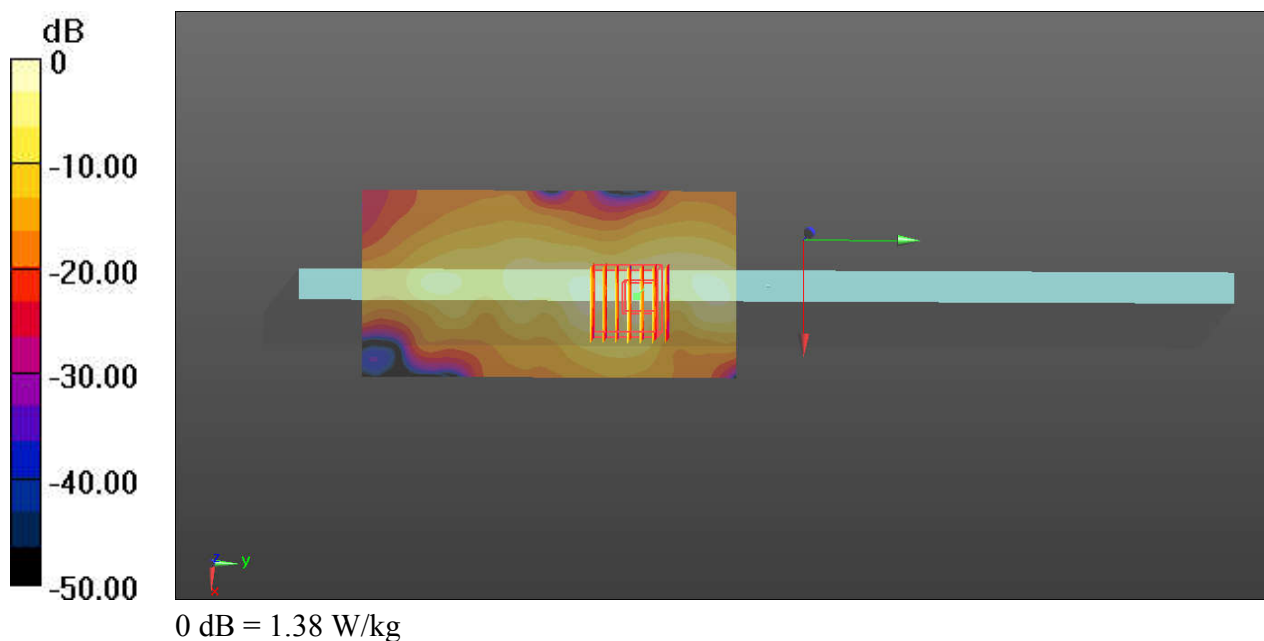
Ch52/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 1.773 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 2.58 W/kg

SAR(1 g) = 0.401 W/kg; SAR(10 g) = 0.158 W/kg

Maximum value of SAR (measured) = 1.38 W/kg



05_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch140

Communication System: UID 0, WIFI (0); Frequency: 5700 MHz; Duty Cycle: 1:1.15

Medium: MSL_5600_180905 Medium parameters used: $f = 5700$ MHz; $\sigma = 5.939$ S/m; $\epsilon_r = 47.357$;

$\rho = 1000$ kg/m³

Ambient Temperature : 23.4 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.3, 4.3, 4.3); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch140/Area Scan (61x151x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.77 W/kg

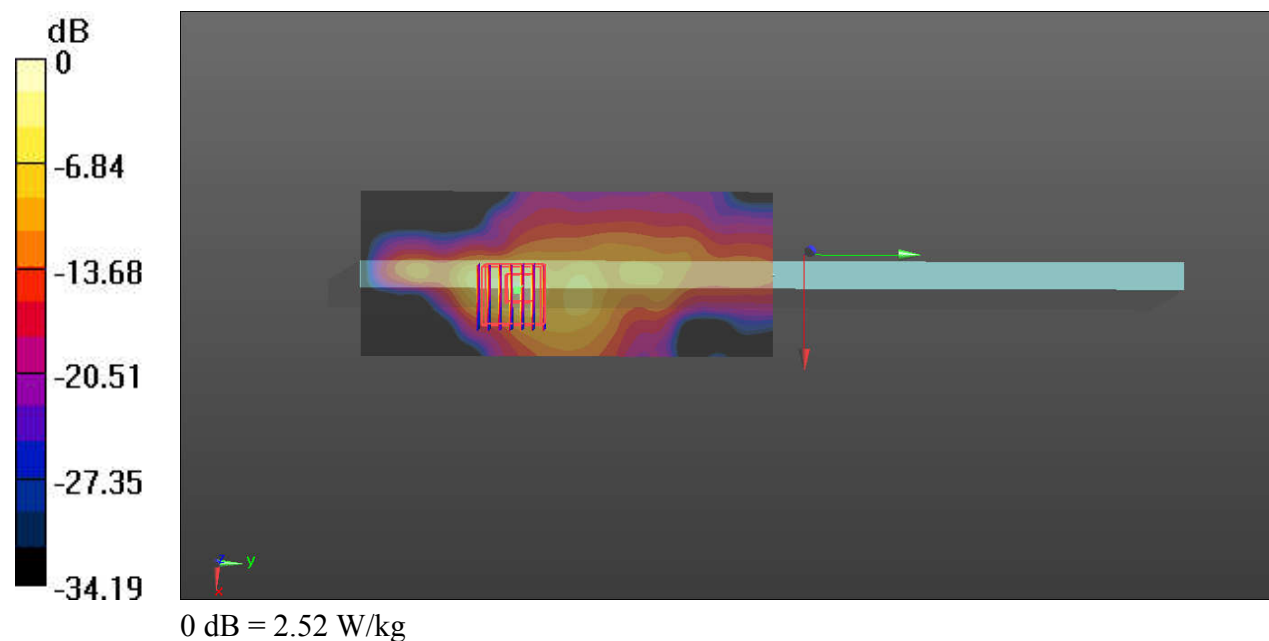
Ch140/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0.6710 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 4.57 W/kg

SAR(1 g) = 0.840 W/kg; SAR(10 g) = 0.220 W/kg

Maximum value of SAR (measured) = 2.52 W/kg



06_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch140

Communication System: UID 0, WIFI (0); Frequency: 5700 MHz; Duty Cycle: 1:1.153
Medium: MSL_5600_180905 Medium parameters used: $f = 5700$ MHz; $\sigma = 5.939$ S/m; $\epsilon_r = 47.357$;
 $\rho = 1000$ kg/m³
Ambient Temperature : 23.4 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.3, 4.3, 4.3); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch140/Area Scan (61x151x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.747 W/kg

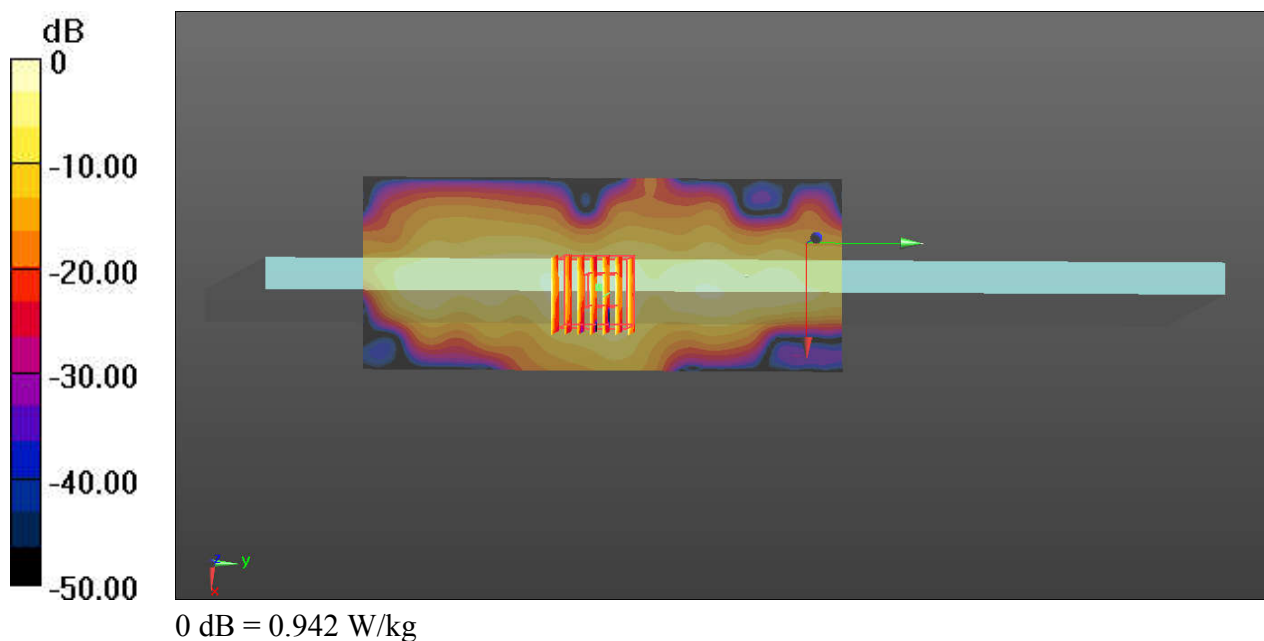
Ch140/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 2.00 W/kg

SAR(1 g) = 0.357 W/kg; SAR(10 g) = 0.118 W/kg

Maximum value of SAR (measured) = 0.942 W/kg



07_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch165

Communication System: UID 0, WIFI (0); Frequency: 5825 MHz; Duty Cycle: 1:1.15

Medium: MSL_5750_180906 Medium parameters used: $f = 5825$ MHz; $\sigma = 6.118$ S/m; $\epsilon_r = 47.133$;

$\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.4, 4.4, 4.4); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch165/Area Scan (61x151x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 1.82 W/kg

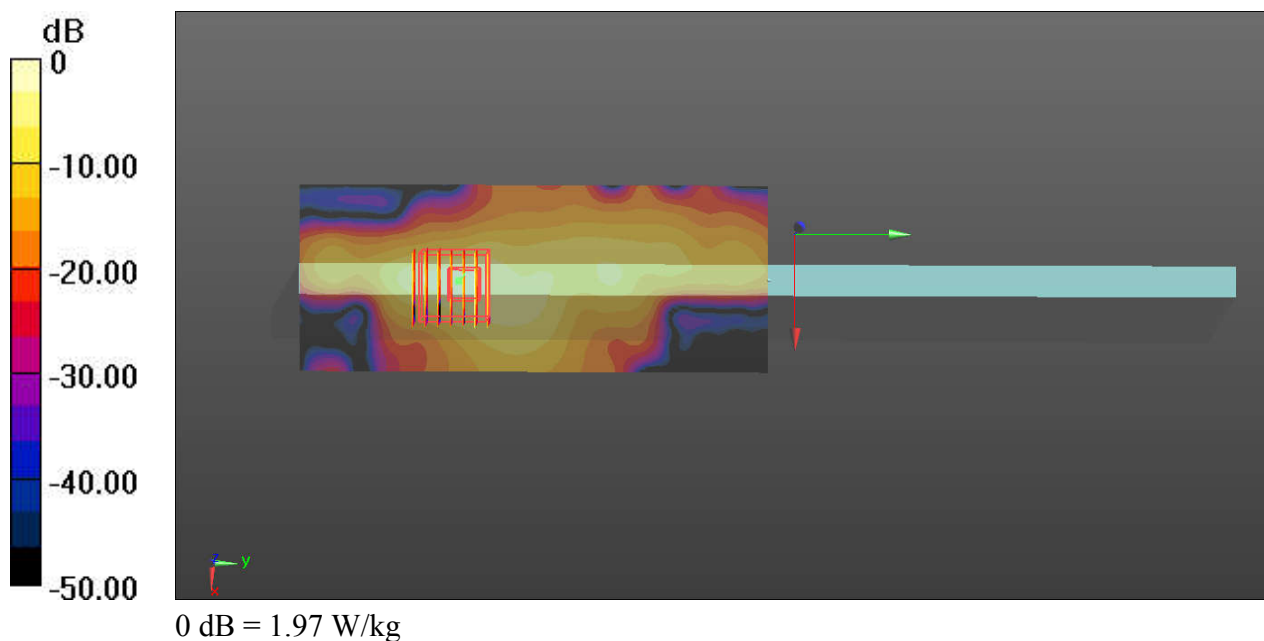
Ch165/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0.6530 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.89 W/kg

SAR(1 g) = 0.738 W/kg; SAR(10 g) = 0.203 W/kg

Maximum value of SAR (measured) = 1.97 W/kg



08_WLAN5GHz_802.11a 6Mbps_Edge 3_0mm_Ch157

Communication System: UID 0, WIFI (0); Frequency: 5785 MHz; Duty Cycle: 1:1.153

Medium: MSL_5750_180906 Medium parameters used: $f = 5785$ MHz; $\sigma = 6.062$ S/m; $\epsilon_r = 47.333$;

$\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(4.4, 4.4, 4.4); Calibrated: 2018.01.11;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch157/Area Scan (61x151x1): Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.883 W/kg

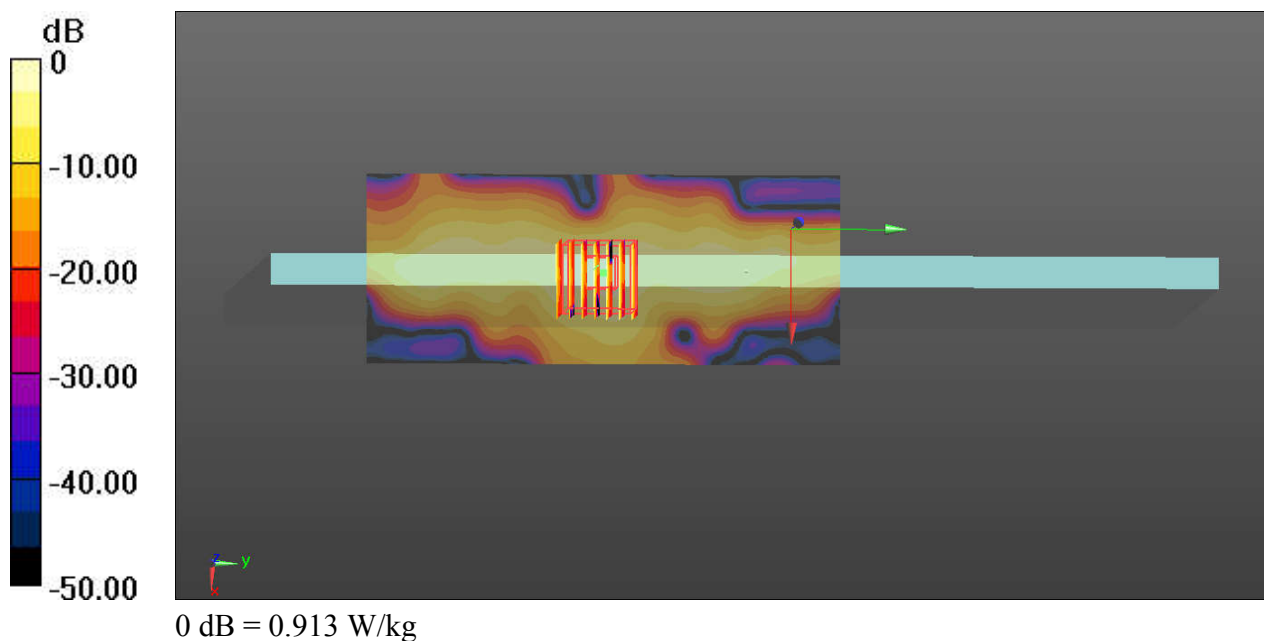
Ch157/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 0 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 1.87 W/kg

SAR(1 g) = 0.346 W/kg; SAR(10 g) = 0.109 W/kg

Maximum value of SAR (measured) = 0.913 W/kg



09_Bluetooth_DH5 1Mbps_Edge3_0mm_Ch78

Communication System: UID 0, Bluetooth (0); Frequency: 2480 MHz; Duty Cycle: 1:1.303

Medium: MSL_2450_180907 Medium parameters used: $f = 2480$ MHz; $\sigma = 2.044$ S/m; $\epsilon_r = 52.15$; $\rho = 1000$ kg/m³

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3958; ConvF(8, 8, 8); Calibrated: 2018.01.11;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1303; Calibrated: 2017.12.19
- Phantom: ELI v5.0(Right); Type: QDOVA001BB; Serial: TP:1225
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch78/Area Scan (51x101x1): Interpolated grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 0.142 W/kg

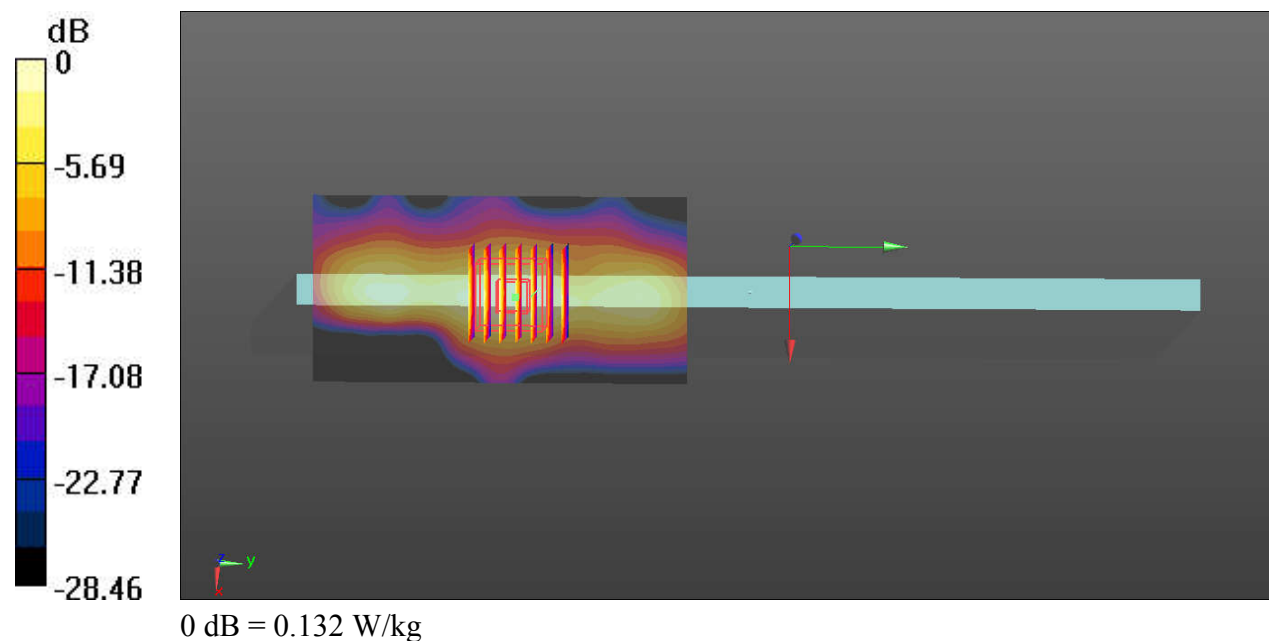
Ch78/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0.2570 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.184 W/kg

SAR(1 g) = 0.086 W/kg; SAR(10 g) = 0.040 W/kg

Maximum value of SAR (measured) = 0.132 W/kg





Appendix C. DASYS Calibration Certificate

The DASYS calibration certificates are shown as follows.



In Collaboration with
s p e a g
CALIBRATION LABORATORY



中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

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 _{x,y,z}
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 cm³ (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 cm³ (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 cm³ (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 cm³ (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/m³

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)

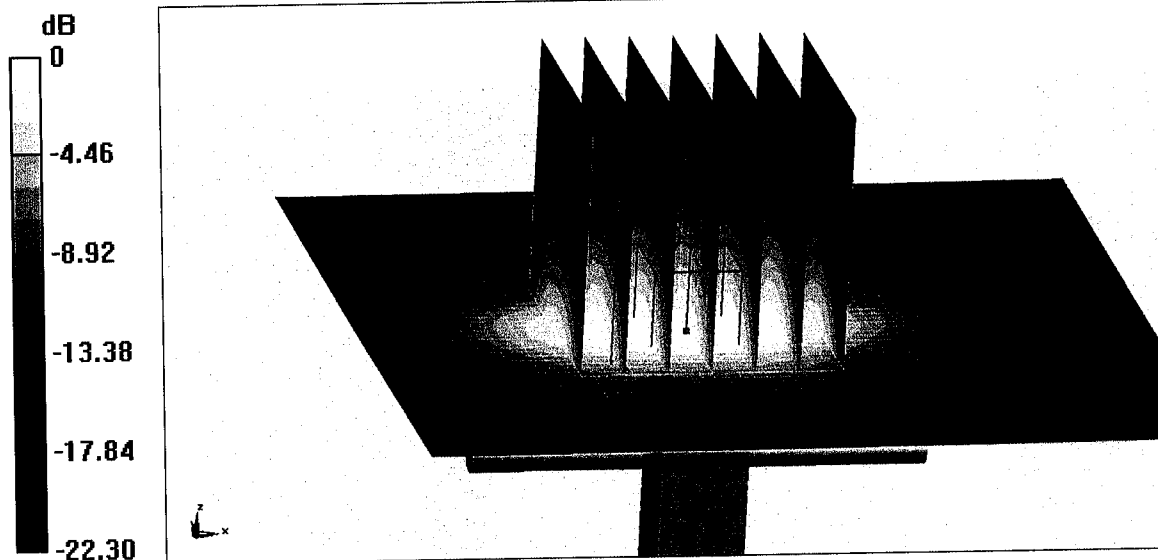
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

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

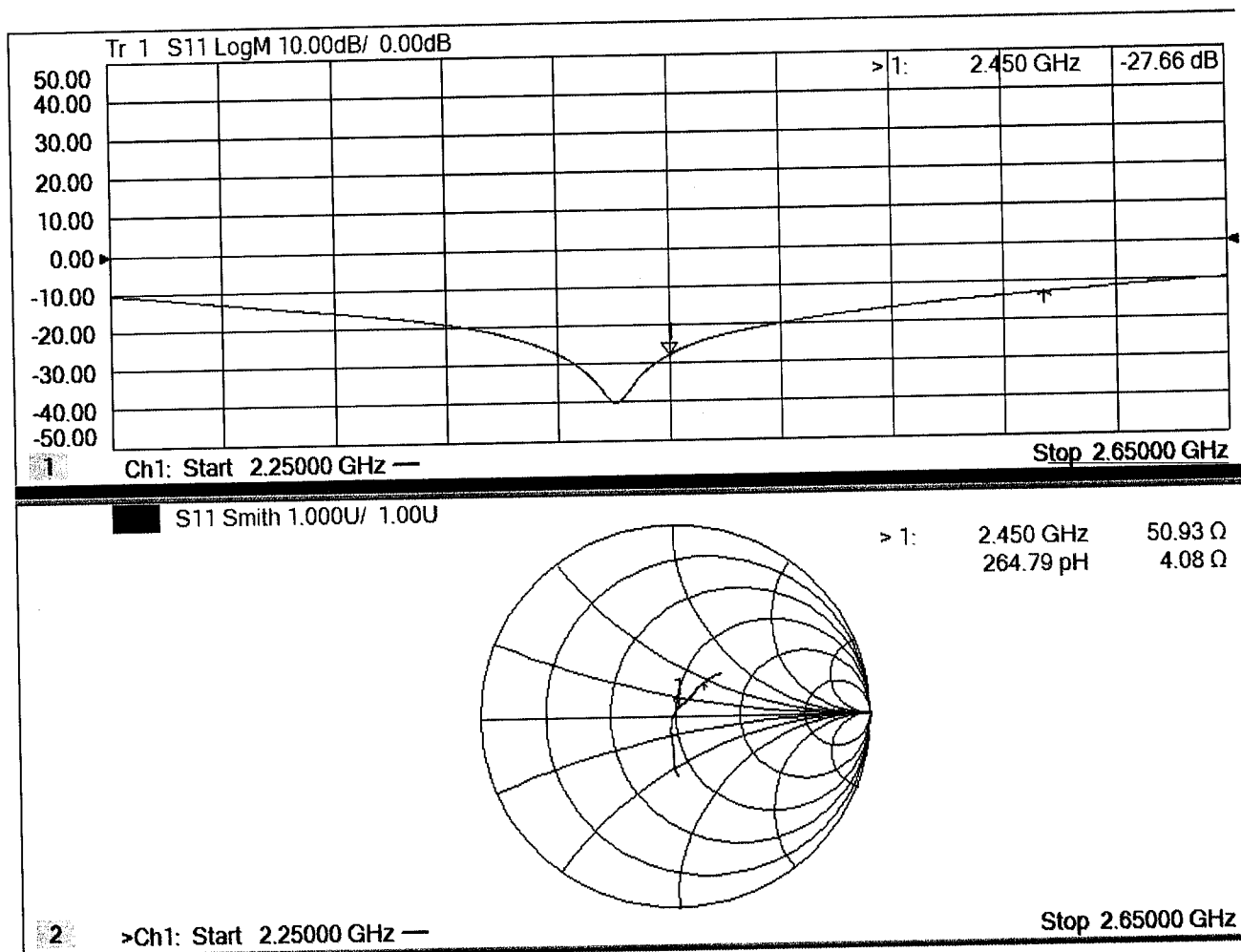


0 dB = 22.0 W/kg = 13.42 dBW/kg



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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/m³

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)

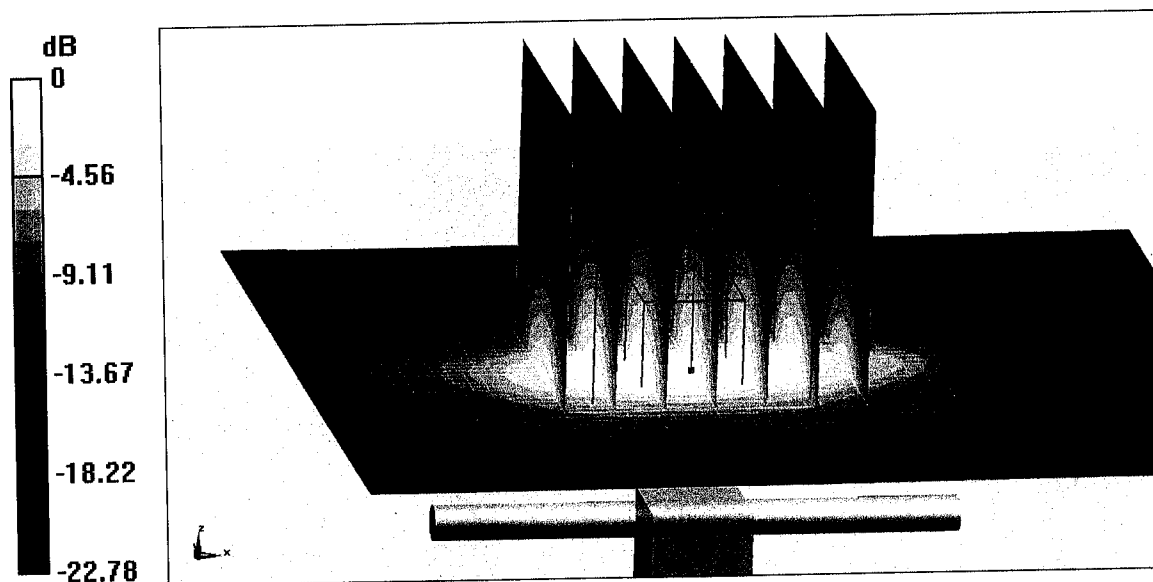
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

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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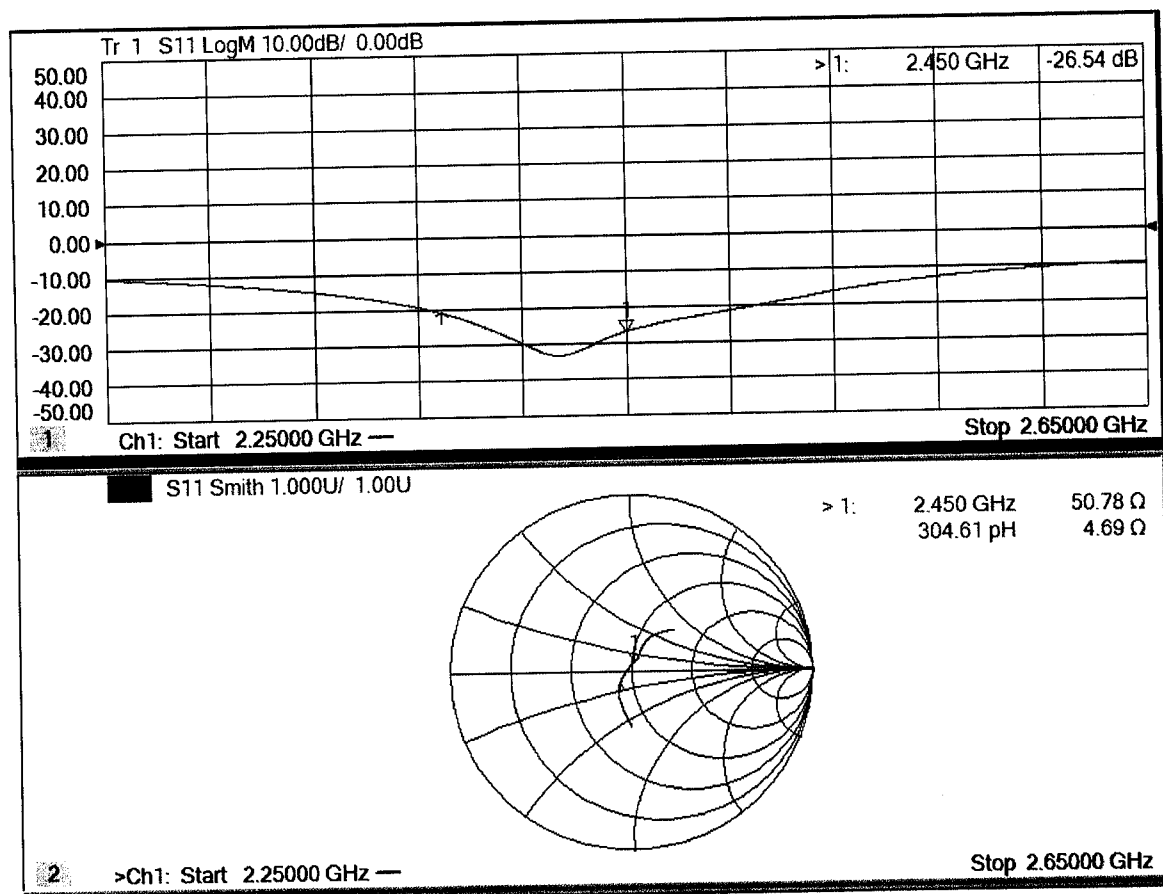
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Impedance Measurement Plot for Body TSL





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Client

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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 _{x,y,z}
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 cm³ (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 cm³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 ³ (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 Ω - 9.42j Ω
Return Loss	- 20.6dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	58.1 Ω - 7.15j Ω
Return Loss	- 20.0dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	53.5 Ω - 7.66j Ω
Return Loss	- 21.8dB

Antenna Parameters with Body TSL at 5250 MHz

Impedance, transformed to feed point	49.5 Ω - 7.40j Ω
Return Loss	- 22.6dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.0 Ω - 6.37j Ω
Return Loss	- 20.5dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	54.5 Ω - 7.07j Ω
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

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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/m³,
Medium parameters used: $f = 5600$ MHz; $\sigma = 5.184$ S/m; $\epsilon_r = 35.14$; $\rho = 1000$ kg/m³,
Medium parameters used: $f = 5750$ MHz; $\sigma = 5.365$ S/m; $\epsilon_r = 34.88$; $\rho = 1000$ kg/m³,

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

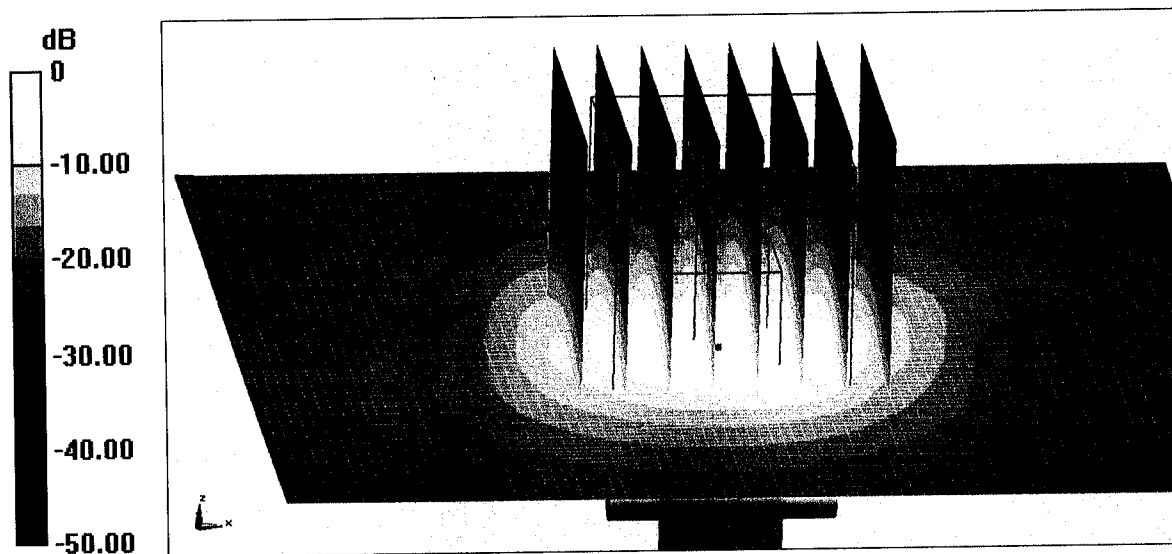
Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.53 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 36.2 W/kg
SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.32 W/kg
Maximum value of SAR (measured) = 19.7 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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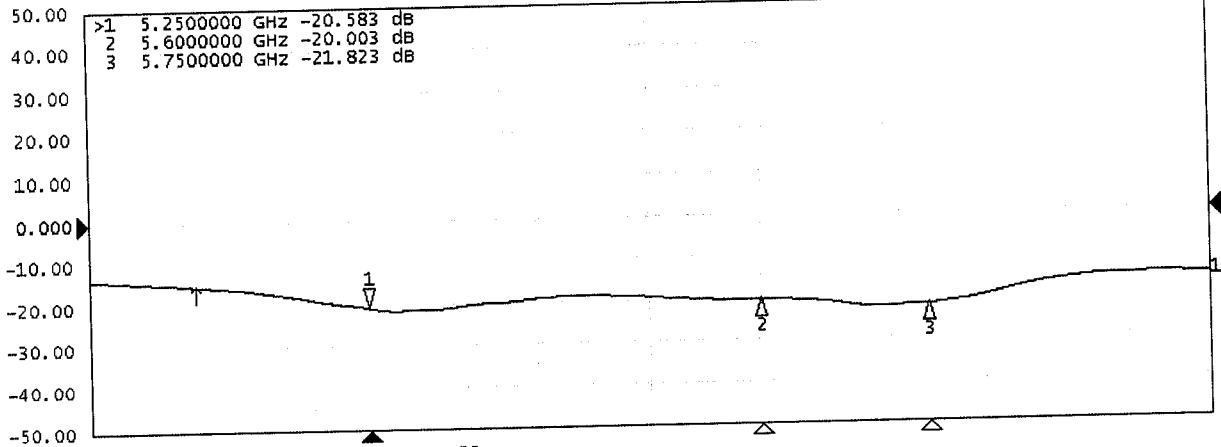
0 dB = 19.0 W/kg = 12.79 dBW/kg



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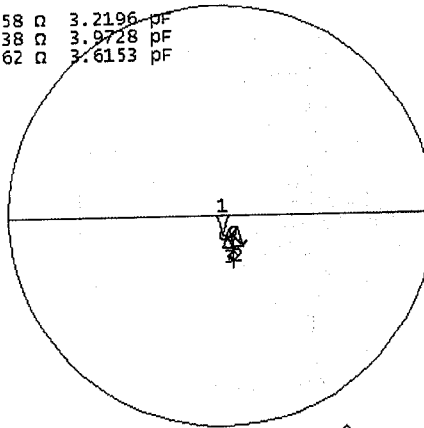
Impedance Measurement Plot for Head TSL

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 Ω	-9.4158 Ω	3.2196 pF
2	5.600000 GHz	58.136 Ω	-7.1538 Ω	3.9728 pF
3	5.750000 GHz	53.485 Ω	-7.6562 Ω	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/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.789$ S/m; $\epsilon_r = 47.7$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 5.926$ S/m; $\epsilon_r = 48.45$; $\rho = 1000$ kg/m³,

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

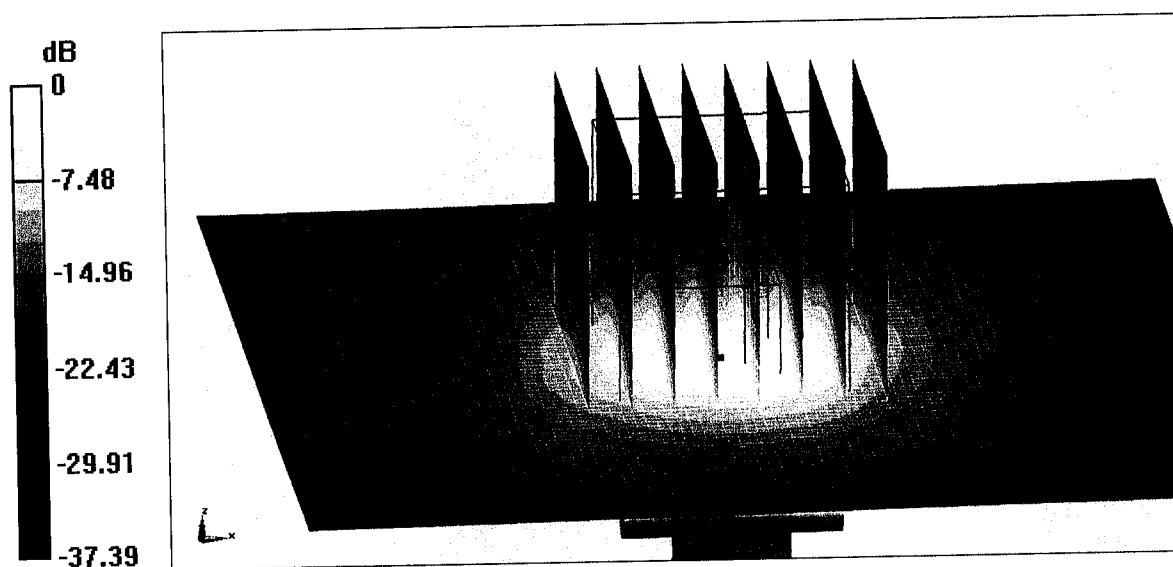
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.99 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 35.2 W/kg
SAR(1 g) = 7.43 W/kg; SAR(10 g) = 2.08 W/kg
Maximum value of SAR (measured) = 18.0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



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



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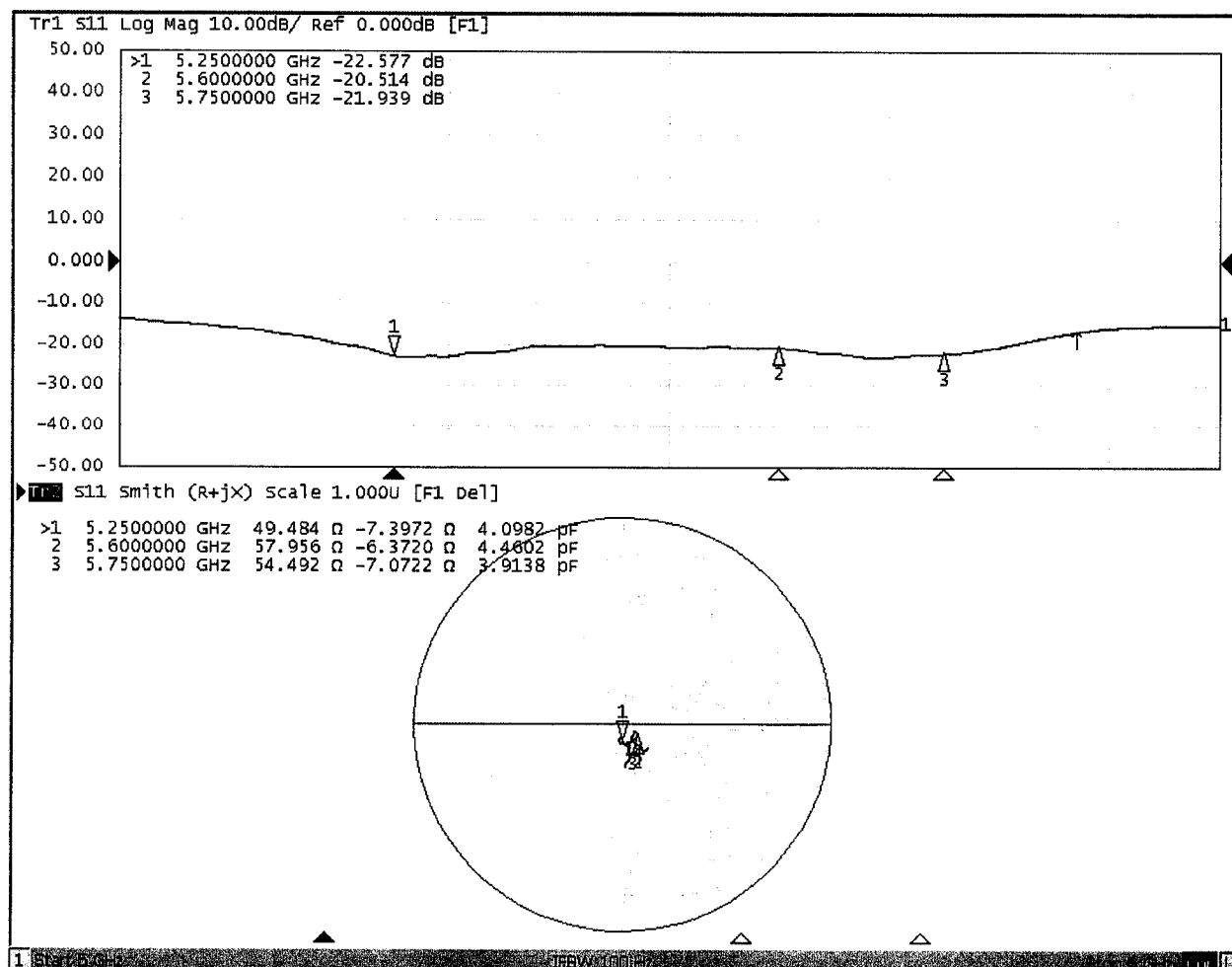
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Impedance Measurement Plot for Body TSL





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Client : **Sporton**

Certificate No: **Z17-97269**

CALIBRATION CERTIFICATE

Object **DAE4 - SN: 1303**

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

Calibration date: **December 19, 2017**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3) $^{\circ}\text{C}$ 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	27-Jun-17 (CTTL, No.J17X05859)	June-18

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

Signature

Issued: December 22, 2017

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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 μ 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	405.569 $\pm$ 0.15% (k=2)	403.452 $\pm$ 0.15% (k=2)	404.893 $\pm$ 0.15% (k=2)
Low Range	3.96471 $\pm$ 0.7% (k=2)	3.99229 $\pm$ 0.7% (k=2)	4.01287 $\pm$ 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	36.5° $\pm$ 1 °
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Client

Sporton

Certificate No: **Z17-97273**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3958**

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

Calibration date: **January 11, 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	101919	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101547	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Power sensor NRP-Z91	101548	27-Jun-17 (CTTL, No.J17X05857)	Jun-18
Reference10dBAttenuator	18N50W-10dB	13-Mar-16(CTTL,No.J16X01547)	Mar-18
Reference20dBAttenuator	18N50W-20dB	13-Mar-16(CTTL, No.J16X01548)	Mar-18
Reference Probe EX3DV4	SN 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
SignalGeneratorMG3700A	6201052605	27-Jun-17 (CTTL, No.J17X05858)	Jun-18
Network Analyzer E5071C	MY46110673	13-Jan-17 (CTTL, No.J17X00285)	Jan -18

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

Issued: January 13, 2018

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Glossary:

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

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "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_{x,y,z}**: Assessed for E-field polarization $\theta=0$ ($f \leq 900\text{MHz}$ in TEM-cell; $f > 1800\text{MHz}$: waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}; A,B,C** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800\text{MHz}$) and inside waveguide using analytical field distributions based on power measurements for $f > 800\text{MHz}$. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from $\pm 50\text{MHz}$ to $\pm 100\text{MHz}$.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



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Probe EX3DV4

SN: 3958

Calibrated: January 11, 2018

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3958

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.50	0.46	0.54	$\pm 10.0\%$
DCP(mV) ^B	103.2	105.3	105.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	171.2	$\pm 2.4\%$
		Y	0.0	0.0	1.0		161.3	
		Z	0.0	0.0	1.0		175.2	

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

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

^B Numerical linearization parameter: uncertainty not required.

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



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3958

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	10.59	10.59	10.59	0.40	0.70	± 12.1%
835	41.5	0.90	10.31	10.31	10.31	0.12	1.46	± 12.1%
900	41.5	0.97	10.17	10.17	10.17	0.12	1.51	± 12.1%
1750	40.1	1.37	8.79	8.79	8.79	0.23	1.04	± 12.1%
1900	40.0	1.40	8.43	8.43	8.43	0.23	1.05	± 12.1%
2000	40.0	1.40	8.50	8.50	8.50	0.33	0.86	± 12.1%
2300	39.5	1.67	8.38	8.38	8.38	0.47	0.75	± 12.1%
2450	39.2	1.80	7.92	7.92	7.92	0.55	0.72	± 12.1%
2600	39.0	1.96	7.82	7.82	7.82	0.65	0.67	± 12.1%
5200	36.0	4.66	6.01	6.01	6.01	0.40	1.40	± 13.3%
5300	35.9	4.76	5.77	5.77	5.77	0.40	1.45	± 13.3%
5500	35.6	4.96	5.39	5.39	5.39	0.45	1.40	± 13.3%
5600	35.5	5.07	5.16	5.16	5.16	0.40	1.30	± 13.3%
5800	35.3	5.27	5.24	5.24	5.24	0.40	1.60	± 13.3%

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

^F At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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



DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3958

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz] ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	10.52	10.52	10.52	0.40	0.80	±12.1%
835	55.2	0.97	10.19	10.19	10.19	0.16	1.48	±12.1%
1750	53.4	1.49	8.61	8.61	8.61	0.24	1.05	±12.1%
1900	53.3	1.52	8.27	8.27	8.27	0.20	1.18	±12.1%
2300	52.9	1.81	8.14	8.14	8.14	0.40	0.98	±12.1%
2450	52.7	1.95	8.00	8.00	8.00	0.30	1.35	±12.1%
2600	52.5	2.16	7.84	7.84	7.84	0.45	0.88	±12.1%
5200	49.0	5.30	5.50	5.50	5.50	0.45	1.55	±13.3%
5300	48.9	5.42	5.20	5.20	5.20	0.45	1.50	±13.3%
5500	48.6	5.65	4.50	4.50	4.50	0.55	1.60	±13.3%
5600	48.5	5.77	4.30	4.30	4.30	0.50	1.85	±13.3%
5800	48.2	6.00	4.40	4.40	4.40	0.55	1.35	±13.3%

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

^F At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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



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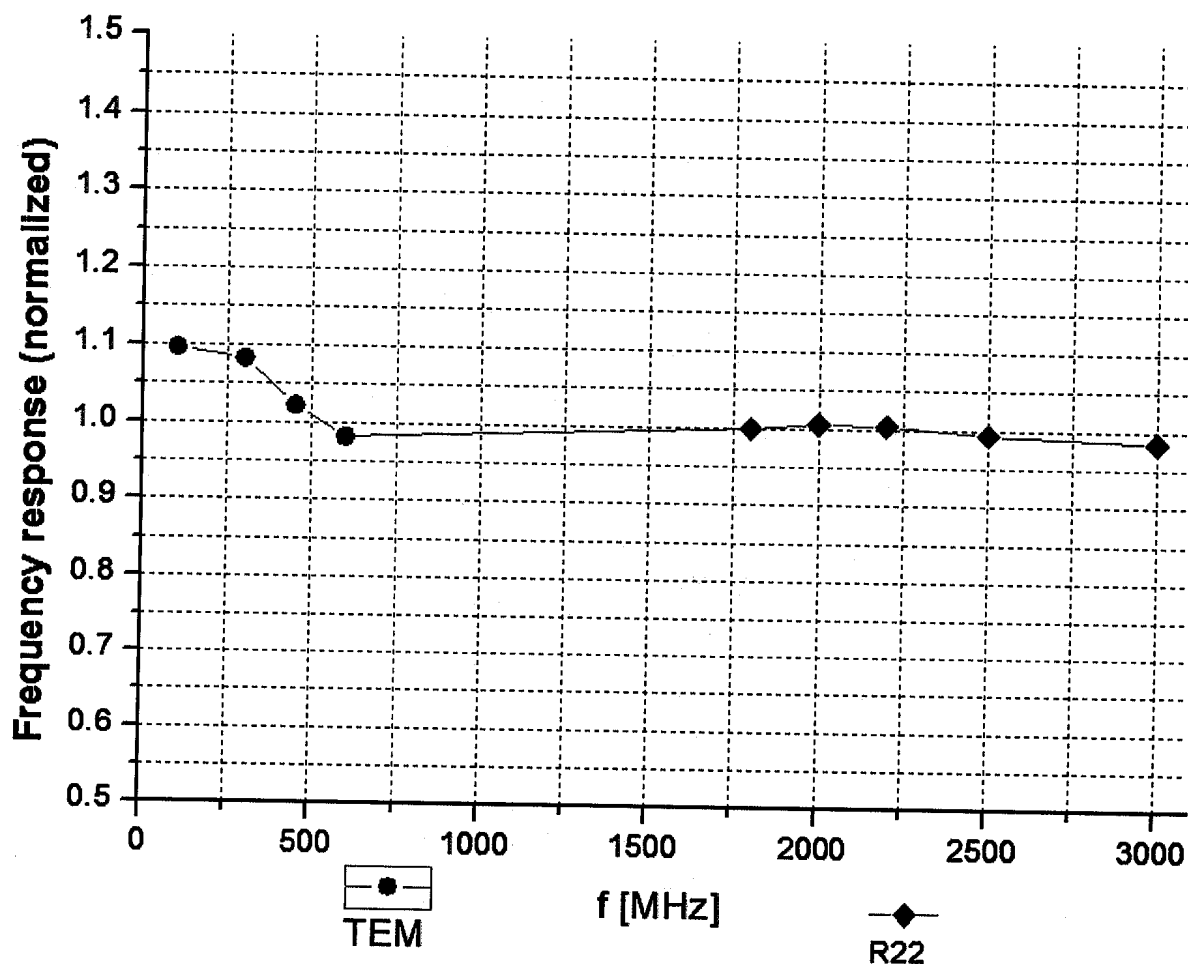
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Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: $\pm 7.4\%$ ($k=2$)



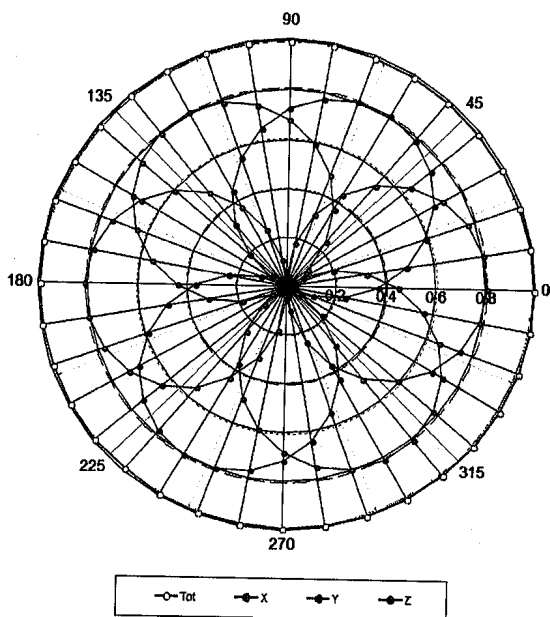
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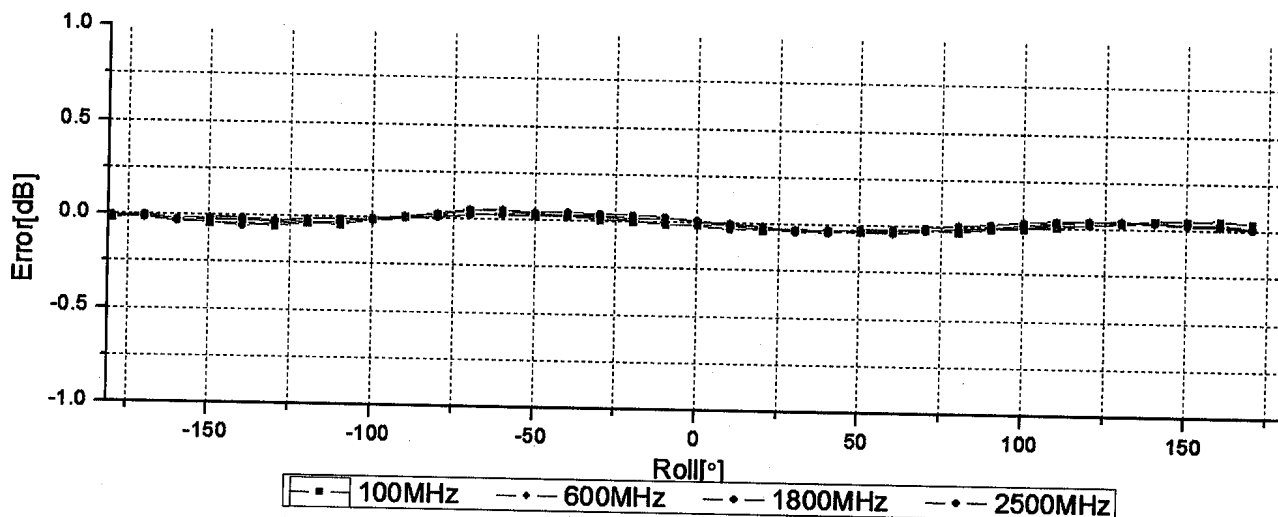
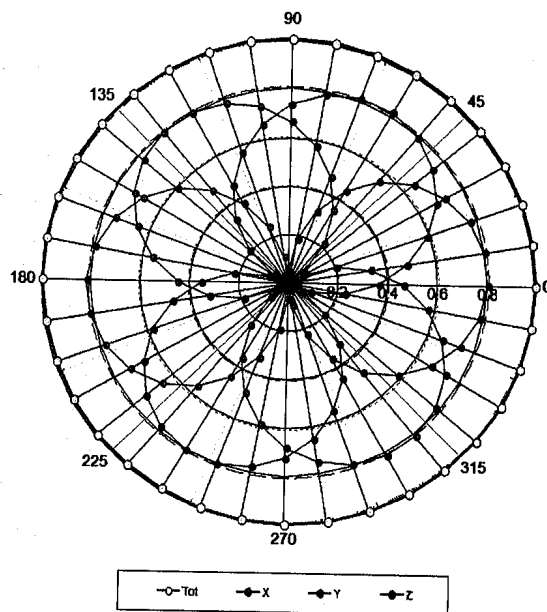
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Receiving Pattern (Φ), $\theta=0^\circ$

f=600 MHz, TEM



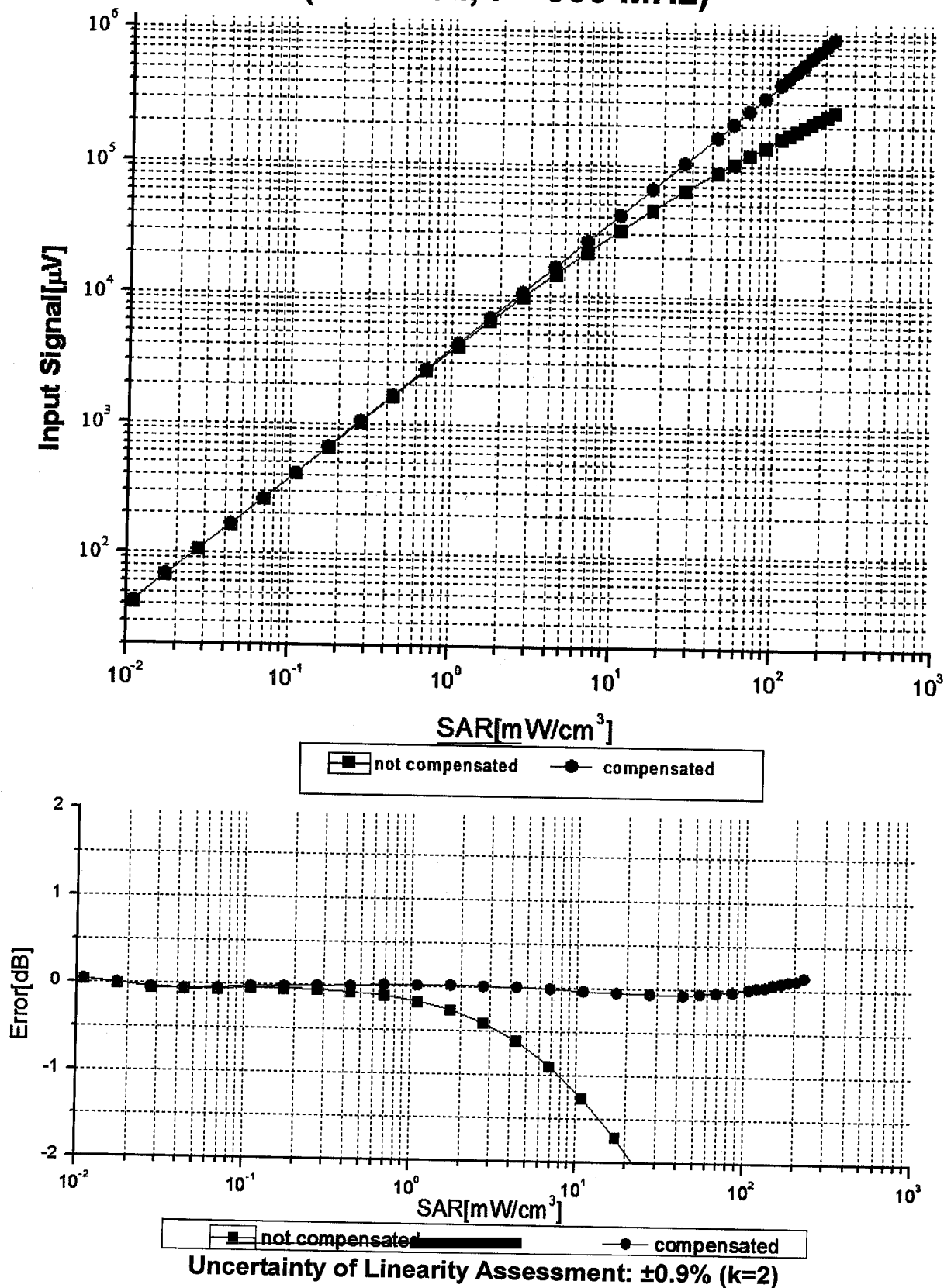
f=1800 MHz, R22



Uncertainty of Axial Isotropy Assessment: $\pm 1.2\%$ ($k=2$)



Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)





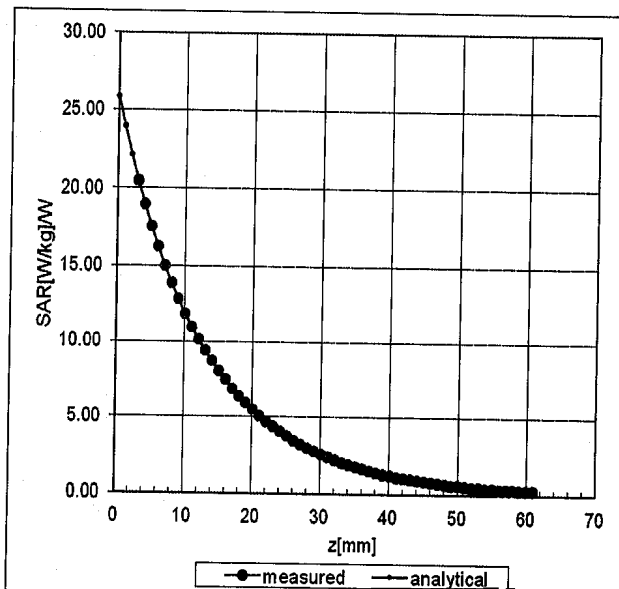
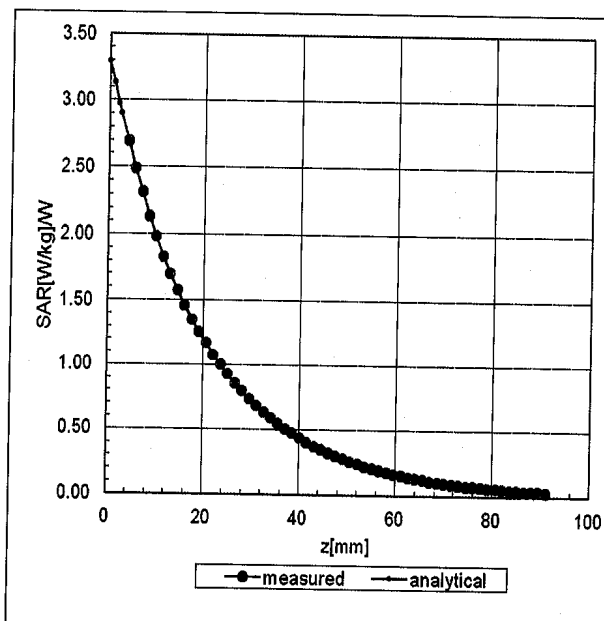
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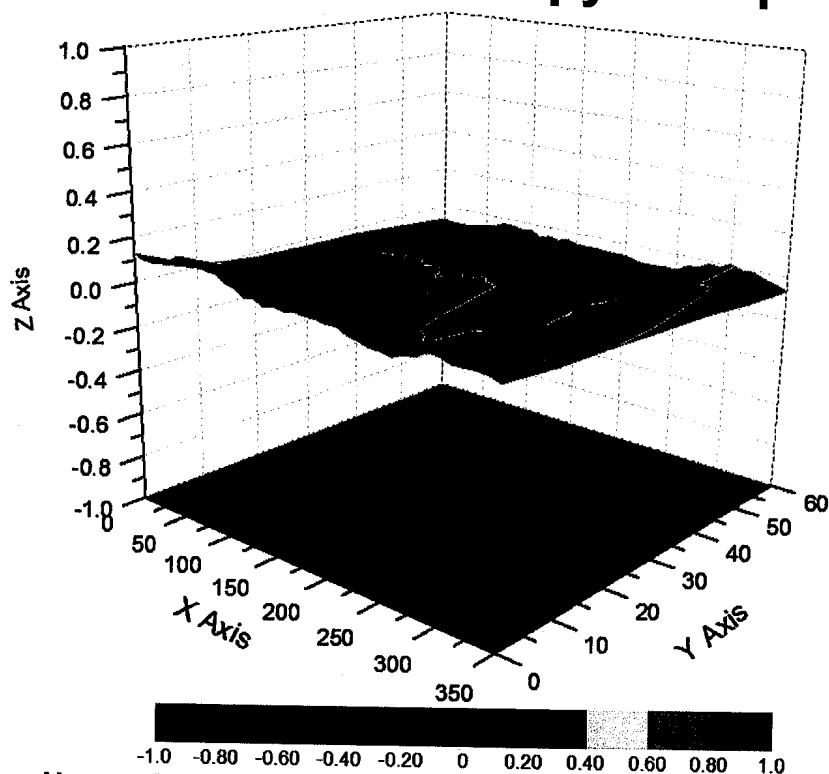
Conversion Factor Assessment

f=835 MHz, WGLS R9(H_convF)

f=1750 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: $\pm 3.2\%$ (K=2)



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3958

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	42.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm