

ANSI/IEEE Std. C95.1-1992
In accordance with the requirements of FCC Report and Order:
ET Docket 93-62 ; FCC 47 CFR Part 2 (2.1093)

FCC SAR TEST REPORT

For

Product Name: Wireless LAN Adapter

Brand Name: SONY

Model No.: CBK-WA02

Series Model: N/A

Test Report Number: C150504S05-SF

Issued for

Sony Corporation

1-7-1 Konan Minato-ku Tokyo 108-0075 Japan

Issued by

Compliance Certification Services Inc.

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Revision History

Revision	REPORT NO.	Date	Page Revised	Contents
Original	C150504S05-SF	June 8, 2015	N/A	N/A
01	C150504S06-SF	August 13, 2015	26 to 31	Update output power form
			38 to 39	Add simultaneous transmission Form
02	C150504S06-SF	August 18, 2015	All report	Add KDB248227D01v02r01 related description

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1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

Product Name:	Wireless LAN Adapter
Brand Name:	SONY
Model Name.:	CBK-WA02
Series Model:	N/A
Devices supporting GPRS/EDGE:	No support
Description Test Modes(worst case):	No SIM Card
Device Category:	PORTABLE DEVICES
Exposure Category:	GENERAL POPULATION/UNCONTROLLED EXPOSURE
Date of Test:	June 2, 2015 to June 6, 2015 and August 18, 2015
Applicant: Address:	Sony Corporation 1-7-1 Konan Minato-ku Tokyo 108-0075 Japan
Manufacturer: Address:	Sony Corporation 1-7-1 Konan Minato-ku Tokyo 108-0075 Japan
Application Type:	Certification

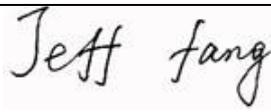
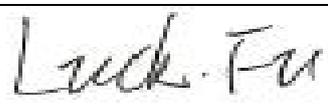
APPLICABLE STANDARDS AND TEST PROCEDURES

STANDARDS AND TEST PROCEDURES	TEST RESULT
ANSI/IEEE C95.1-1992	No non-compliance noted

Deviation from Applicable Standard

None

The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in KDB 865664 The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:	Tested by:
	
Jeff Fang RF Manager Compliance Certification Services Inc.	Luck.Fu Test Engineer Compliance Certification Services Inc.

2. EUT DESCRIPTION

Product Name:	Wireless LAN Adapter
Brand Name:	SONY
Model Name.:	CBK-WA02
Series Model:	N/A
Model Discrepancy:	N/A
FCC ID:	AK8-CBK-WA02
Power reduction:	NO
DTM Description:	Not support
Device Category:	Production unit
Frequency Range:	IEEE 802.11b 2.4GHz: 2412 ~ 2462 MHz IEEE 802.11a 5.2GHz: 5180 MHz ~ 5240 MHz IEEE 802.11a 5.3GHz: 5260 MHz ~ 5320 MHz IEEE 802.11a 5.5GHz: 5500 MHz ~ 5700 MHz IEEE 802.11a 5.8GHz: 5745 MHz ~ 5825 MHz
Max. Reported SAR(1g):	Body : Wi-Fi 802.11 b: 0.790 W/kg Wi-Fi 802.11 a: 0.430 W/kg
Modulation Technique:	IEEE 802.11a: OFDM(BPSK/QPSK/16QAM/64QAM) 802.11b mode: DSSS (1,2,5.5 and 11 Mbps) 802.11g mode: DSSS /OFDM (6,9,12,18,24,36,48 and 54 Mbps) 802.11n HT20 mode: OFDM (6.5,13,19.5,26,39,52,58.5 and 65 Mbps) 802.11n HT40 mode: OFDM (13.5,27,40.5,54,81,108,121.5 and 135 Mbps)
Accessories:	DC 5V Powered from PC via USB port
Antenna Specification:	Antenna 0: PCB antenna Antenna 1: PCB antenna
Operating Mode:	Maximum continuous output

3. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC

The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 W/Kg for an uncontrolled environment and 8.0 W/Kg for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992.

4. TEST METHODOLOGY

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
- KDB 248227 D01v2r01
- KDB 447498 D01v05r02
- KDB 447498 D02v02
- KDB 865664 D01v01r03
- KDB 865664 D02v01r01

5. TEST CONFIGURATION

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting

For WLAN SAR testing, WLAN engineering test software installed on the EUT can provide continuous transmitting RF signal and the duty cycle is 98%.

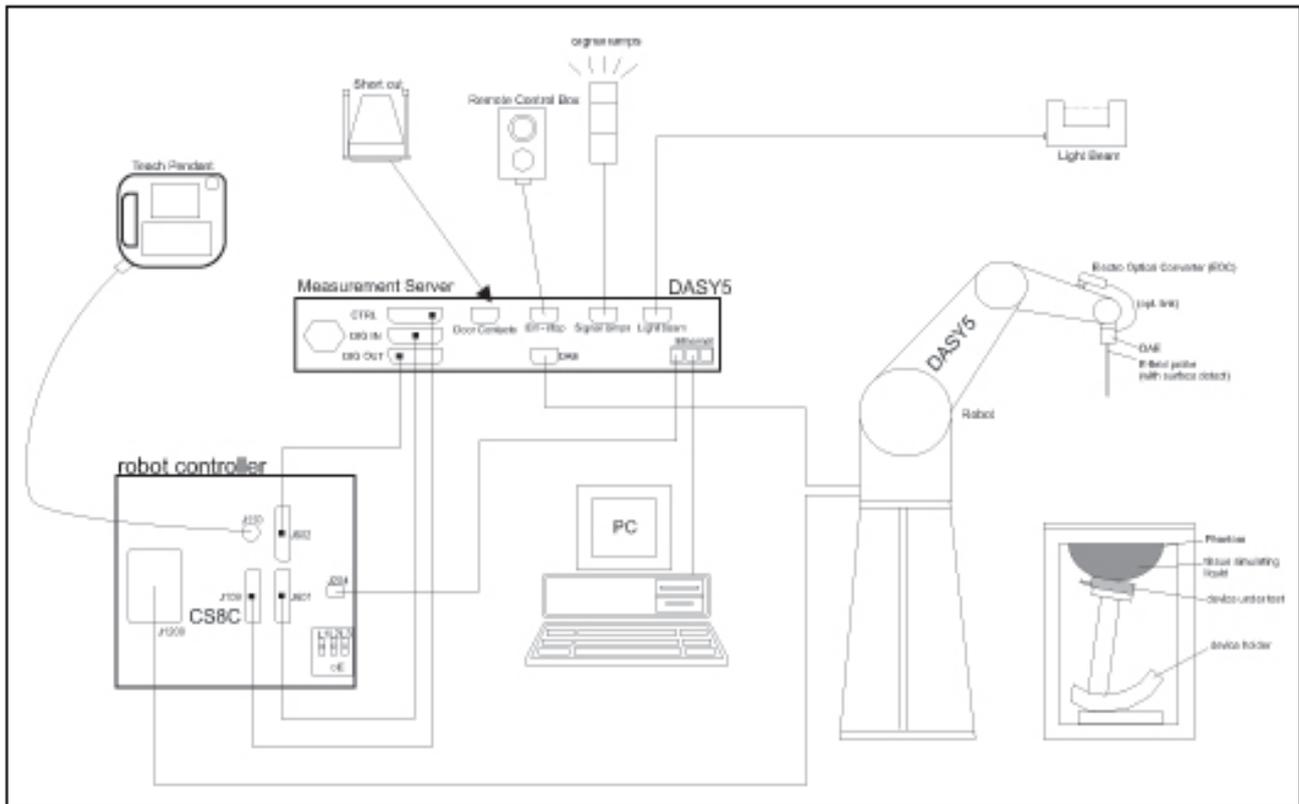
6. DOSIMETRIC ASSESSMENT SETUP

These measurements were performed with the automated near-field scanning system DASY 5 from ATTENNESSA. The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the E-field PROBE EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than $\pm 10\%$. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ± 0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEE P1528

The following table gives the recipes for tissue simulating liquids.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

6.1 MEASUREMENT SYSTEM DIAGRAM



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

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASYS software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

6.2 SYSTEM COMPONENTS



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV celeron, 128MB chip-disk and 128 MB RAM. The necessary circuits for communication with either the DAE4(or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.



The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

Data Acquisition Electronics (DAE)



The data acquisition electronics (DAE4) 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 mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements



Construction: Symmetrical design with triangular core
 Built-in shielding against static charges
 PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Calibration: Basic Broad Band Calibration in air: 10-3000 MHz.
 Conversion Factors (CF) for HSL 900 and HSL 1800
 CF-Calibration for other liquids and frequencies upon request.

Frequency: 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.3 dB in HSL (rotation around probe axis)
 ± 0.5 dB in HSL (rotation normal to probe axis)

Dynamic Range: 10 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB
 (noise: typically < 1 μ W/g)

Dimensions: Overall length: 337 mm (Tip: 9 mm)
Tip diameter: 2.5 mm (Body: 10 mm)
Distance from probe tip to dipole centers:
1 mm

Application: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



Interior of probe

SAM Twin Phantom

Construction:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50360 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.



Shell Thickness: 2 ± 0.2 mm

Filling Volume: Approx. 25 liters

Dimensions: Height: 850mm; Length: 1000mm; Width: 750mm

SAM Phantom (ELI4 v4.0)

Description Construction:

Phantom 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 the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4/DASY5.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles



Shell Thickness: 2.0 ± 0.2 mm (sagging: <1%)

Filling Volume: Approx. 25 liters

Dimensions: Major ellipse axis: 600 mm

Minor axis: 400 mm 500mm

Device Holder for SAM Twin Phantom

Construction: In combination with the Twin SAM Phantom, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).

**System Validation Kits for SAM Twin Phantom**

Construction: Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 900, 1800, 2450, 5800 MHz

ReTune loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions:

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300mm

**System Validation Kits for ELI4 phantom**

Construction: Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 900, 1800, 2450, 5800 MHz

ReTune loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions:

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm



7. EVALUATION PROCEDURES

7.1 DATA EVALUATION

The DASYS 5 post processing software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASYS 5 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

with	V_i	= Compensated signal of channel i (i = x, y, z)
	U_i	= Input signal of channel i (i = x, y, z)
	cf	= Crest factor of exciting field (DASY 5 parameter)
	dcp_i	= Diode compression point (DASY 5 parameter)

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

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

H-field probes:

$$H_i = \sqrt{V_i} \cdot \frac{a_{i10} + a_{i11}f + a_{i12}f^2}{f}$$

with	V_i	= Compensated signal of channel i (i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i (i = x, y, z) $\mu V/(V/m)^2$ for E0field Probes
	$ConvF$	= Sensitivity enhancement in solution
	a_{ij}	= Sensor sensitivity factors for H-field probes
	f	= Carrier frequency (GHz)
	E_i	= Electric field strength of channel i in V/m
	H_i	= Magnetic field strength of channel i in A/m

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

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

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

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

with SAR = local specific absorption rate in mW/g

E_{tot} = total field strength in V/m

σ = conductivity in [mho/m] or [Siemens/m]

ρ = equivalent tissue density in g/cm³

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

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

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

with P_{pwe} = Equivalent power density of a plane wave in mW/cm²

E_{tot} = total electric field strength in V/m

H_{tot} = total magnetic field strength in A/m

7.2 SAR EVALUATION PROCEDURES

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

- **Power Reference Measurement**

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

- **Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY 5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY 5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

7.3 SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g.

The DASY 5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp\left(-\frac{z}{a}\right) \cos\left(\pi \frac{z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors S_b (parameter Alpha in the DASY 5 software) and a (parameter Delta in the DASY 5 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30° to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY 5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

8. EXPOSURE LIMIT

(A). Limits for Occupational/Controlled Exposure (W/kg)

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

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

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

Note: 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.

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

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

NOTE
GENERAL POPULATION/UNCONTROLLED EXPOSURE
PARTIAL BODY LIMIT
1.6 W/kg

9. EUT ARRANGEMENT

9.1 BODY-SUPPORTED DEVICE

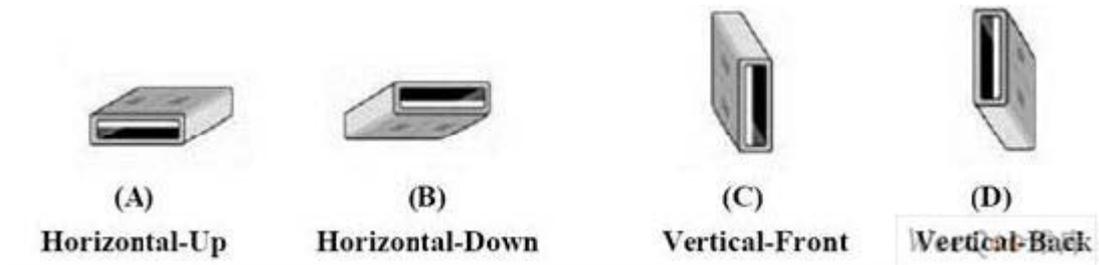
A typical example of a body supported device is a wireless enabled laptop device that among other orientations may be supported on the thighs of a sitting user. To represent this orientation, the device shall be positioned with its base against the flat phantom. Other orientations may be specified by the manufacturer in the user instructions. If the intended use is not specified, the device shall be tested directly against the flat phantom in all usable orientations.

A typical example of a body supported device is a wireless enabled laptop device that among other orientations may be supported on the thighs of a sitting user. To represent this orientation, the device shall be positioned with its base against the flat phantom. Other orientations may be specified by the manufacturer in the user instructions. If the intended use is not specified, the device shall be tested directly against the flat phantom in all usable orientations.

The screen portion of the device shall be in an open position at a 90° angle as seen in Figure 7a (left side), or at an operating angle specified for intended use by the manufacturer in the operating instructions. Where a body supported device has an integral screen required for normal operation, then the screen-side will not need to be tested if it ordinarily remains 200 mm from the body. Where a screen mounted antenna is present, this position shall be repeated with the screen against the flat phantom as shown in Figure 7a) (right side), if this is consistent with the intended use.

Other devices that fall into this category include tablet type portable computers and credit card transaction authorisation terminals, point-of-sale and/or inventory terminals. Where these devices may be torso or limb-supported, the same principles for body-supported devices are applied.

9.2 USB DONGLE PROCEDURES



Test all USB orientations [see figure up: (A) Horizontal-Up, (B) Horizontal-Down, (C) Vertical-Front and (D) Vertical-Back] with a device-to-phantom separation distance of 5 mm or less. These test orientations are intended for the exposure conditions found in typical laptop/notebook/netbook or tablet computers with either horizontal or vertical USB connector configurations at various locations in the keyboard section of the computer. Current generation portable host computers should be used to establish the required SAR measurement separation distance. The test separation distance must be used to test all frequency bands and modes in each USB orientation. typical Horizontal-Up USB connection (A), found in the majority of host computers, must be tested an appropriate host computer. A host computer with either Vertical-Front (C) or Vertical-Back (D) connection should be used to test one of the vertical USB orientations. If a suitable host computer available for testing the Horizontal-Down (B) or the remaining Vertical USB orientation, a high quality USB cable, 12 inches or less, may be used for testing these other orientations.

10. MEASUREMENT RESULTS

10.1 TEST LIQUIDS CONFIRMATION

SIMULATED TISSUE LIQUID PARAMETER CONFIRMATION

The dielectric parameters were checked prior to assessment using the HP85070C dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

IEEE SCC-34/SC-2 P1528 RECOMMENDED TISSUE DIELECTRIC PARAMETERS

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in P1528

Target Frequency (MHz)	Head		Body	
	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	45.3	5.27	48.2	6.00

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

10.2 LIQUID MEASUREMENT RESULTS

The following table show the measuring results for simulating liquid:

Liquid Type	Liquid Temp. (°C)	Parameters	Target	Measured	Deviation (%)	Limited (%)	Measured Date
2450 MSL	21.5	Permittivity(ϵ)	52.70	51.682	-1.93	± 5	2015-6-6
		Conductivity(σ)	1.95	1.945	-0.26	± 5	
5200 MSL	21.5	Permittivity(ϵ)	49.00	48.913	-0.18	± 5	2015-6-2
		Conductivity(σ)	5.30	5.233	-1.26	± 5	
5300 MSL	21.5	Permittivity(ϵ)	48.90	48.673	-0.46	± 5	2015-6-2
		Conductivity(σ)	5.42	5.346	-1.37	± 5	
5500 MSL	21.5	Permittivity(ϵ)	48.60	48.202	-0.82	± 5	2015-6-3
		Conductivity(σ)	5.65	5.632	-0.32	± 5	
5600 MSL	21.5	Permittivity(ϵ)	48.50	47.973	-1.09	± 5	2015-6-3
		Conductivity(σ)	5.77	5.773	0.05	± 5	
5800 MSL	21.5	Permittivity(ϵ)	48.20	47.521	-1.41	± 5	2015-6-3
		Conductivity(σ)	6.00	6.071	1.18	± 5	

Liquid Type	Liquid Temp. (°C)	Parameters	Target	Measured	Deviation (%)	Limited (%)	Measured Date
Body2462	21.5	Permittivity(ϵ)	52.68	50.372	-4.39	± 5	2015-8-18
		Conductivity(σ)	1.97	2.023	2.90	± 5	
Body5270	21.5	Permittivity(ϵ)	48.94	48.879	-0.12	± 5	2015-8-18
		Conductivity(σ)	5.43	5.400	-0.59	± 5	
Body5700	21.5	Permittivity(ϵ)	48.34	47.962	-0.78	± 5	2015-8-18
		Conductivity(σ)	5.90	6.037	2.32	± 5	
Body5825	21.5	Permittivity(ϵ)	47.99	47.689	-0.63	± 5	2015-8-18
		Conductivity(σ)	6.03	6.232	3.35	± 5	

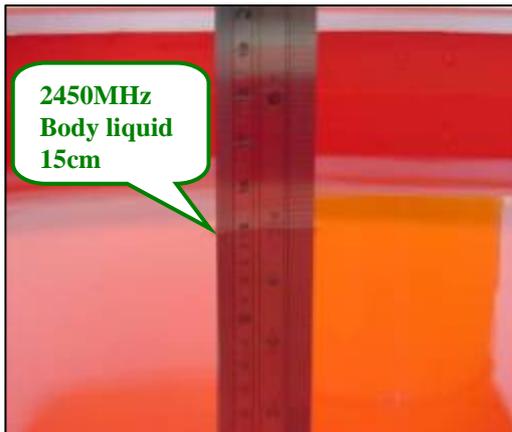
10.3 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of $\pm 10\%$. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

SYSTEM PERFORMANCE CHECK MEASUREMENT CONDITIONS

- The measurements were performed in the flat section of the SAM twin phantom filled with head and body simulating liquid of the following parameters.
- The DASY5 system withan E-fileld probe EX3DV4 SN: 3798/3661 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx= 5 mm, dy= 5 mm, dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 2 mm.
- The dipole input power was 250mW $\pm 3\%$.
- The results are normalized to 1 W input power.

Depth of Liquid



- Note: For SAR testing, the depth is 15cm shown above
- Note: For SAR testing, above than 3G the liquid depth is 10cm shown above

10.4 SYSTEM PERFORMANCE CHECK RESULTS

Liquid Type	Ambient Temp. (°C)	Liquid Temp. (°C)	Input Power (W)	Measured SAR _{1g} (W/Kg)	1W Target SAR _{1g} (W/Kg)	1W Normalized SAR _{1g} (W/Kg)	Deviation (%)	Limited (%)	Date
2450 MSL	22	21.5	0.25	13.10	49.20	52.40	6.50	± 10	2015-6-6
5200 MSL	22	21.5	0.1	7.30	74.60	73	-2.14	± 10	2015-6-2
5300 MSL	22	21.5	0.1	7.23	76.00	72.3	-4.87	± 10	2015-6-2
5500 MSL	22	21.5	0.1	7.89	79.10	78.9	-0.25	± 10	2015-6-3
5600 MSL	22	21.5	0.1	8.21	77.80	82.1	5.53	± 10	2015-6-3
5800 MSL	22	21.5	0.1	7.29	75.00	72.9	-2.80	± 10	2015-6-3

Liquid Type	Ambient Temp. (°C)	Liquid Temp. (°C)	Input Power (W)	Measured SAR _{1g} (W/Kg)	1W Target SAR _{1g} (W/Kg)	1W Normalized SAR _{1g} (W/Kg)	Deviation (%)	Limited (%)	Date
Body2450	22	21.5	0.25	12.80	49.20	51.20	4.07	± 10	2015-8-18
Body5200	22	21.5	0.1	7.69	74.60	76.9	3.08	± 10	2015-8-18
Body5300	22	21.5	0.1	7.90	76.00	79	3.95	± 10	2015-8-18
Body5500	22	21.5	0.1	8.15	79.10	81.5	3.03	± 10	2015-8-18
Body5600	22	21.5	0.1	8.07	77.80	80.7	3.73	± 10	2015-8-18
Body5800	22	21.5	0.1	7.86	75.00	78.6	4.80	± 10	2015-8-18

11. MEASUREMENT UNCERTAINTY

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

12. EUT TUNE-UP PROCEDURES AND TEST MODE

Conducted output power(dBm):

General Note:

- 1 Power must be measured at each transmit antenna port according to the DSSS and OFDM transmission configurations in each standalone and aggregated frequency band.
- 2 Power measurement is required for the transmission mode configuration with the highest maximum output power specified for production units.
 - 1) When the same highest maximum output power specification applies to multiple transmission modes, the largest channel bandwidth configuration with the lowest order modulation and lowest data rate is measured.
 - 2) When the same highest maximum output power is specified for multiple largest channel bandwidth configurations with the same lowest order modulation or lowest order modulation and lowest data rate, power measurement is required for all equivalent 802.11 configurations with the same maximum output power.
- 3 For each transmission mode configuration, power must be measured for the highest and lowest channels; and at the mid-band channel(s) when there are at least 3 channels. For configurations with multiple mid-band channels, due to an even number of channels, both channels should be measured.

WLAN 2.4G Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 b	1	2412	13.5	±1	14.5	13.15
	6	2437	13.5	±1	14.5	13.45
	11	2462	13.5	±1	14.5	13.23
802.11 g	1	2412	12	±1	13	Not required
	6	2437	12	±1	13	
	11	2462	12	±1	13	
802.11 n 20MHz	1	2412	12	±1	13	
	6	2437	12	±1	13	
	11	2462	12	±1	13	
802.11 n 40MHz	3	2422	9.5	±1	10.5	
	6	2437	9.5	±1	10.5	
	9	2452	9.5	±1	10.5	

Note:1. Output Power and SAR is not required for 802.11g/n HT20/HT40 Chain0 channels 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.

WLAN 2.4G Chain1

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 b	1	2412	13.5	±1	14.5	13.94
	6	2437	13.5	±1	14.5	13.85
	11	2462	13.5	±1	14.5	14.05
802.11 g	1	2412	12	±1	13	Not required
	6	2437	12	±1	13	
	11	2462	12	±1	13	
802.11 n 20MHz	1	2412	12	±1	13	
	6	2437	12	±1	13	
	11	2462	12	±1	13	
802.11 n 40MHz	3	2422	9.5	±1	10.5	
	6	2437	9.5	±1	10.5	
	9	2452	9.5	±1	10.5	

Note:1. Output Power and SAR is not required for 802.11g/n HT20/HT40 Chain1 channels 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.

WLAN 2.4G Chain0+1 MIMO

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 n 20MHz	1	2412	14.5	±1	15.5	14.74
	6	2437	14.5	±1	15.5	14.77
	11	2462	14.5	±1	15.5	15.10
802.11 n 40MHz	3	2422	12	±1	13	12.95
	6	2437	12	±1	13	12.73
	9	2452	12	±1	13	12.88

Note:

1. SAR is not required for MIMO 802.11 HT40 channels when the highest *reported* SAR for DSSS is adjusted by the ratio of HT20 to HT40 specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Band 5.2G Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average Power (dBm)
802.11 a	36	5180	11	±1	12	11.17
	40	5200	11	±1	12	11.46
	44	5220	11	±1	12	11.27
	48	5240	11	±1	12	11.45
802.11 n 20MHz	36	5180	11	±1	12	Not required
	40	5200	11	±1	12	
	44	5220	11	±1	12	
	48	5240	11	±1	12	
802.11 n 40MHz	38	5190	10.5	±1	11.5	
	46	5230	10.5	±1	11.5	
802.11 ac80	42	5210	10	±1	11	

Note:

- Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.
- When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest *reported* SAR for UNII band 2A is ≤ 1.2 W/kg, SAR is not required for UNII band I
 > 1.2 W/kg, both bands should be tested independently for SAR.

So UNII band I Chain0 SAR Test is not required.

Band 5.2G Chain1

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average Power (dBm)
802.11 a	36	5180	11	±1	12	11.87
	40	5200	11	±1	12	11.84
	44	5220	11	±1	12	11.88
	48	5240	11	±1	12	11.97
802.11 n 20MHz	36	5180	11	±1	12	Not required
	40	5200	11	±1	12	
	44	5220	11	±1	12	
	48	5240	11	±1	12	
802.11 n 40MHz	38	5190	10.5	±1	11.5	
	46	5230	10.5	±1	11.5	
802.11 ac80	42	5210	10	±1	11	

Note:

- Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.
- When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest *reported* SAR for UNII band 2A is ≤ 1.2 W/kg, SAR is not required for UNII band I
 > 1.2 W/kg, both bands should be tested independently for SAR.

So UNII band I Chain1 SAR Test is not required.

Band 5.2G Chain0+1 MIMO

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average Power (dBm)
802.11 n 20MHz	36	5180	13.5	±1	14.5	14.29
	40	5200	13.5	±1	14.5	14.31
	44	5220	13.5	±1	14.5	14.25
	48	5240	13.5	±1	14.5	14.39
802.11 n 40MHz	38	5190	13.5	±1	14.5	13.95
	46	5230	13.5	±1	14.5	14.02
802.11 ac80	42	5210	12	±1	13	12.22

Note:

- When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest reported SAR for UNII band 2A is ≤ 1.2 W/kg, SAR is not required for UNII band I > 1.2 W/kg, both bands should be tested independently for SAR.

So UNII band I MIMO SAR Test is not required.

Band 5.3G Chain0

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	52	5260	11	±1	12	11.76
	56	5280	11	±1	12	11.84
	60	5300	11	±1	12	11.72
	64	5320	11	±1	12	11.86
802.11 n 20MHz	52	5260	11	±1	12	Not required
	56	5280	11	±1	12	
	60	5300	11	±1	12	
	64	5320	11	±1	12	
802.11 n 40MHz	54	5270	10.5	±1	11.5	
	62	5310	10.5	±1	11.5	
802.11 ac80	58	5290	10	±1	11	

Note:

- Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.3G Chain1

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	52	5260	11	±1	12	11.62
	56	5280	11	±1	12	11.44
	60	5300	11	±1	12	11.51
	64	5320	11	±1	12	11.91
802.11 n 20MHz	52	5260	11	±1	12	Not required
	56	5280	11	±1	12	
	60	5300	11	±1	12	
	64	5320	11	±1	12	
802.11 n 40MHz	54	5270	10.5	±1	11.5	
	62	5310	10.5	±1	11.5	
802.11 ac80	58	5290	10	±1	11	

Note:

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.3G Chain0+1

Mode	Channel	Frequency (MHZ)	Chain0 Target power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 n 20MHz	52	5260	13.5	±1	14.5	14.02
	56	5280	13.5	±1	14.5	14.12
	60	5300	13.5	±1	14.5	14.35
	64	5320	13.5	±1	14.5	14.38
802.11 n 40MHz	54	5270	14.5	±1	15.5	15.28
	62	5310	14.5	±1	15.5	14.27
802.11 ac80	58	5290	12	±1	13	12.36

Note:

1. SAR is not required for MIMO 802.11 HT20;ac80 channels when the highest *reported* SAR for MIMO 802.11 HT20;ac80 is adjusted by the ratio of HT40 specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Band 5.5G Chain0

Mode	Channel	Frequency MHZ	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	100	5500	11	±1	12	11.37
	120	5600	11	±1	12	11.12
	140	5700	11	±1	12	11.25
802.11 n 20MHz	100	5500	11	±1	12	Not required
	120	5600	11	±1	12	
	140	5700	11	±1	12	
802.11 n 40MHz	102	5510	10	±1	11	
	118	5550	10	±1	11	
	134	5570	10	±1	11	
802.11 ac80	106	5530	10	±1	11	
	122	5610	10	±1	11	

Note:

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.5G Chain1

Mode	Channel	Frequency MHZ	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	100	5500	11	±1	12	11.67
	120	5600	11	±1	12	11.77
	140	5700	11	±1	12	11.98
802.11 n 20MHz	100	5500	11	±1	12	Not required
	120	5600	11	±1	12	
	140	5700	11	±1	12	
802.11 n 40MHz	102	5510	10.5	±1	11.5	
	118	5550	10.5	±1	11.5	
	134	5570	10.5	±1	11.5	
802.11 ac80	106	5530	10	±1	11	
	122	5610	10	±1	11	

Note:

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.5G Chain0+1

Mode	Channel	Frequency MHz	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 n 20MHz	100	5500	13.5	±1	14.5	14.18
	120	5600	13.5	±1	14.5	14.12
	140	5700	13.5	±1	14.5	14.40
802.11 n 40MHz	102	5510	13	±1	14	13.46
	118	5550	13	±1	14	13.51
	134	5570	13	±1	14	13.58
802.11 ac80	106	5530	11	±1	12	11.87
	122	5610	11	±1	12	11.81

Note:

1. SAR is not required for MIMO 802.11 HT40;ac80 channels when the highest reported SAR for MIMO 802.11 HT40;ac80 is adjusted by the ratio of HT20 specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Band 5.8G Chain0

Mode	Channel	Frequency	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	149	5745	5	±1	6	5.25
	157	5785	5	±1	6	4.94
	165	5825	5	±1	6	5.15
802.11 n 20MHz	149	5745	5	±1	6	Not required
	157	5785	5	±1	6	
	165	5825	5	±1	6	
802.11 n 40MHz	151	5755	4.5	±1	5.5	
	159	5795	4.5	±1	5.5	
802.11 ac80	155	5775	4.5	±1	5.5	

Note:

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.8G Chain1

Mode	Channel	Frequency	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 a	149	5745	5	±1	6	5.26
	157	5785	5	±1	6	5.15
	165	5825	5	±1	6	5.27
802.11 n 20MHz	149	5745	5	±1	6	Not required
	157	5785	5	±1	6	
	165	5825	5	±1	6	
802.11 n 40MHz	151	5755	4	±1	5	
	159	5795	4	±1	5	

802.11 ac80	155	5775	4.5	±1	5.5	
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Note:

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 and ac80 channels when the specified tune-up tolerances for 802.11n HT20/HT40 and ac80 are lower than 802.11a and the measured SAR is ≤ 1.2 W/Kg.

Band 5.8G Chain0+1

Mode	Channel	Frequency	Chain0 Average power(dBm)	Turn up tolerance (dBm)	Maximum Turn up power (dBm)	Average power (dBm)
802.11 n 20MHz	149	5745	8	±1	9	7.67
	157	5785	8	±1	9	8.02
	165	5825	8	±1	9	8.71
802.11 n 40MHz	151	5755	7	±1	8	7.01
	159	5795	7	±1	8	7.87
802.11 ac80	155	5775	7	±1	8	7.88

Note:

1. SAR is not required for MIMO 802.11 HT40;ac80 channels when the highest *reported* SAR for MIMO 802.11 HT40;ac80 is adjusted by the ratio of HT20 specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

According to KDB447498 D01: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

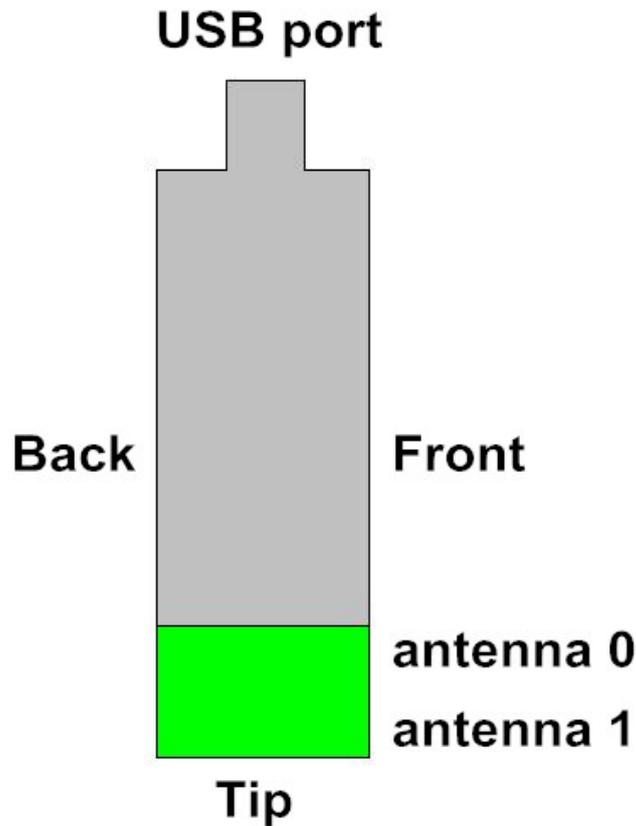
$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation²⁵
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below
- If the test separation distance (antenna-user) is < 5 mm, 5mm is used for excluded SAR calculation

	Wireless Interface	WiFi
	Tune-up Maximum power (dBm)	6
	Tune-up Maximum rated power (mW)	3.98
Body	Antenna to user (mm)	5
	Frequency(GHz)	5.825
	SAR exclusion threshold	1.926

Per KDB 447498 D01 exclusion thresholds is $1.926 < 3$, 5.8GHz WiFi Standalone RF exposure evaluation is not required.

12.1 ANTENNA POSITION



Device dimensions (H x W): 90 x 30 x11 mm

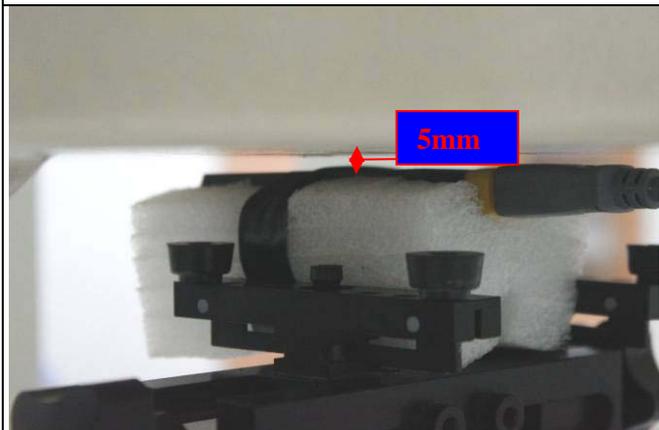
Antennas	Wireless Interface
Antenna 0	WLAN 2.4G&5G
Antenna 1	WLAN 2.4G&5G

Test Mode

WLAN 2.4G&5G	Data transmission mode
--------------	------------------------

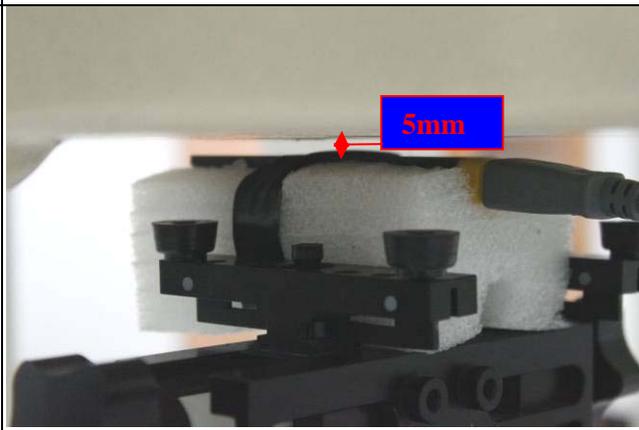
12.2 EUT SETUP PHOTO

Up in body position



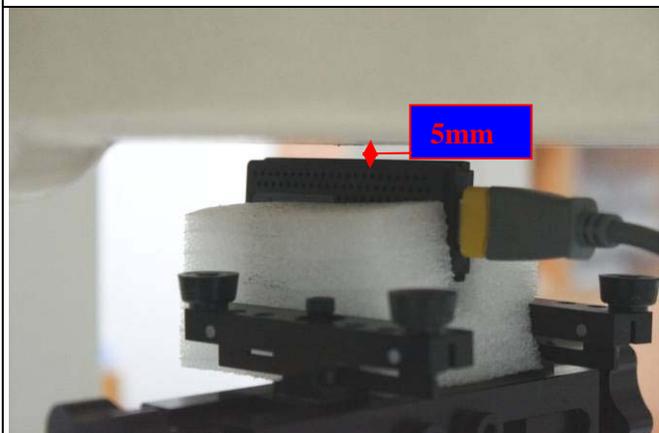
EUT Setup Configuration 1

Down in body position



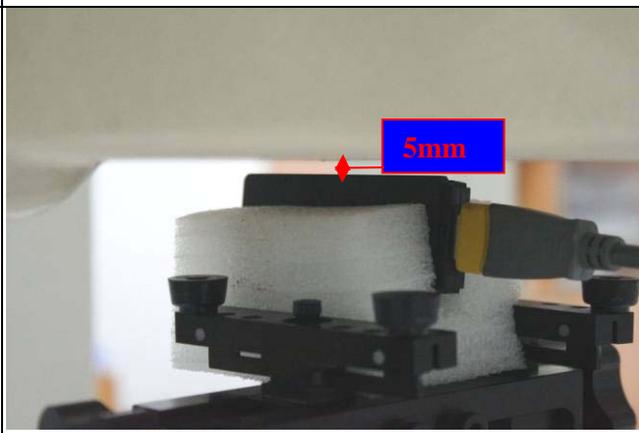
EUT Setup Configuration 2

Front in body position



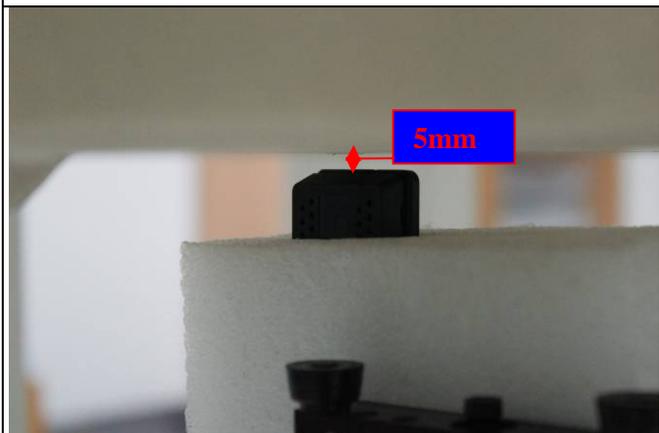
EUT Setup Configuration 3

Back in body position



EUT Setup Configuration 4

Tip in body position



EUT Setup Configuration 5

12.3 SAR MEASUREMENT RESULTS

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

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

KDB 248227 D01 SAR meas for 802.11 v02r01:

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

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

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

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

The relative SAR levels of multiple exposure test positions can be established by area scan measurements on the highest measured output power channel to determine the initial test position. The area scans must be measured using the same SAR measurement configurations, including test channel, maximum output power, probe sensor to phantom shell distance, scan resolution etc. for the results to be comparable. The highest SAR at each peak SAR location is extrapolated to the phantom surface. The exposure test position with the highest extrapolated SAR is used for the initial test position. Instead of extrapolated SAR, the 1-g estimated SAR procedures (fast SAR) in KDB Publication 447498 may be used instead. The extrapolated or 1-g estimated SAR must be scaled according to reported SAR requirements to determine the most conservative exposure test position.

WLAN 2.4G SAR

Band	Mode	Test Position	Ant	Dist. (mm)	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty Cycle Compensation Factor	Area scan SAR1g (mW/g)	Power Drift (dB)	Zoom scan SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 2.4G	802.11 b	Up	0	5	6	2437	13.45	14.5	1.303	1.020	0.512	0.12	0.533	0.693
WLAN 2.4G	802.11 b	Down	0	5	6	2437	13.45	14.5	1.303	1.020	0.585	-0.08	0.608	0.790
WLAN 2.4G	802.11 b	Front	0	5	6	2437	13.45	14.5	1.303	1.020	0.214	--	--	--
WLAN 2.4G	802.11 b	Back	0	5	6	2437	13.45	14.5	1.303	1.020	0.0317	--	--	--
WLAN 2.4G	802.11 b	Tip	0	5	6	2437	13.45	14.5	1.303	1.020	0.125	--	--	--
WLAN 2.4G	802.11 b	Up	1	5	11	2462	14.05	14.5	1.109	1.020	0.524	0.01	0.507	0.574
WLAN 2.4G	802.11 b	Down	1	5	11	2462	14.05	14.5	1.109	1.020	0.417	-0.13	0.398	0.450
WLAN 2.4G	802.11 b	Front	1	5	11	2462	14.05	14.5	1.109	1.020	0.03	--	--	--
WLAN 2.4G	802.11 b	Back	1	5	11	2462	14.05	14.5	1.109	1.020	0.207	--	--	--
WLAN 2.4G	802.11 b	Tip	1	5	11	2462	14.05	14.5	1.109	1.020	0.132	--	--	--
WLAN 2.4G	802.11 n20	Up	0+1	5	11	2462	15.10	15.5	1.096	1.020	0.568	0.00	0.562	0.629
WLAN 2.4G	802.11 n20	Down	0+1	5	11	2462	15.10	15.5	1.096	1.020	0.532	0.01	0.517	0.578
WLAN 2.4G	802.11 n20	Front	0+1	5	11	2462	15.10	15.5	1.096	1.020	0.224	--	--	--
WLAN 2.4G	802.11 n2	Back	0+1	5	11	2462	15.10	15.5	1.096	1.020	0.042	--	--	--
WLAN 2.4G	802.11 n20	Tip	0+1	5	11	2462	15.10	15.5	1.096	1.020	0.113	--	--	--

Note:

1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest reported SAR is > 0.4 W/kg. Due to the highest reported SAR for this test position, other test positions in standalone exposure condition were evaluated until a SAR ≤ 0.8 W/kg was reported.

WLAN 5.3G SAR

Band	Mode	Test Position	Ant	Dist. (mm)	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty cycle Compensation Factor	Area scan SAR1g (mW/g)	Power Drift (dB)	SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 5G	802.11 a	Up	0	5	64	5320	11.86	12	1.033	1.020	0.358	0.08	0.364	0.384
WLAN 5G	802.11 a	Down	0	5	64	5320	11.86	12	1.033	1.020	0.347	--	--	--
WLAN 5G	802.11 a	Front	0	5	64	5320	11.86	12	1.033	1.020	0.285	--	--	--
WLAN 5G	802.11 a	Back	0	5	64	5320	11.86	12	1.033	1.020	0.024	--	--	--
WLAN 5G	802.11 a	Tip	0	5	64	5320	11.86	12	1.033	1.020	0.087	--	--	--
WLAN 5G	802.11 a	Up	1	5	64	5320	11.91	12	1.021	1.020	0.339	0.019	0.334	0.348
WLAN 5G	802.11 a	Down	1	5	64	5320	11.91	12	1.021	1.020	0.265	--	--	--
WLAN 5G	802.11 a	Front	1	5	64	5320	11.91	12	1.021	1.020	0.041	--	--	--
WLAN 5G	802.11 a	Back	1	5	64	5320	11.91	12	1.021	1.020	0.212	--	--	--
WLAN 5G	802.11 a	Tip	1	5	64	5320	11.91	12	1.021	1.020	0.066	--	--	-
WLAN 5G	802.11 n40	Up	1	5	54	5270	15.28	15.5	1.052	1.020	0.324	-0.01	0.320	0.343
WLAN 5G	802.11 n40	Down	1	5	54	5270	15.28	15.5	1.052	1.020	0.317	--	--	--
WLAN 5G	802.11 n40	Front	1	5	54	5270	15.28	15.5	1.052	1.020	0.225	--	--	--
WLAN 5G	802.11 n40	Back	1	5	54	5270	15.28	15.5	1.052	1.020	0.197	--	--	--
WLAN 5G	802.11 n40	Tip	1	5	54	5270	15.28	15.5	1.052	1.020	0.073	--	--	-

Note:

1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.

WLAN 5.5G SAR

Band	Mode	Test Position	Ant	Dist. (mm)	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty cycle Compensation Factor	Area scan SAR1g (mW/g)	Power Drift (dB)	SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 5G	802.11 a	Up	0	5	140	5700	11.37	12	1.156	1.020	0.369	0.10	0.365	0.430
WLAN 5G	802.11 a	Down	0	5	140	5700	11.37	12	1.156	1.020	0.295	0.00	0.294	0.347
WLAN 5G	802.11 a	Front	0	5	140	5700	11.37	12	1.156	1.020	0.276	--	--	--
WLAN 5G	802.11 a	Back	0	5	140	5700	11.37	12	1.156	1.020	0.045	--	--	--
WLAN 5G	802.11 a	Tip	0	5	140	5700	11.37	12	1.156	1.020	0.065	--	--	--
WLAN 5G	802.11 a	Up	1	5	140	5700	11.98	12	1.005	1.020	0.408	0.12	0.406	0.416
WLAN 5G	802.11 a	Down	1	5	140	5700	11.98	12	1.005	1.020	0.382	0.08	0.377	0.386
WLAN 5G	802.11 a	Front	1	5	140	5700	11.98	12	1.005	1.020	0.071	--	--	--
WLAN 5G	802.11 a	Back	1	5	140	5700	11.98	12	1.005	1.020	0.391	--	--	--
WLAN 5G	802.11 a	Tip	1	5	140	5700	11.98	12	1.005	1.020	0.121	--	--	--
WLAN 5G	802.11 n20	Up	0+1	5	140	5700	14.40	14.5	1.023	1.020	0.319	0.18	0.314	0.328
WLAN 5G	802.11 n20	Down	0+1	5	140	5700	14.40	14.5	1.023	1.020	0.243	--	--	--
WLAN 5G	802.11 n20	Front	0+1	5	140	5700	14.40	14.5	1.023	1.020	0.196	--	--	--
WLAN 5G	802.11 n20	Back	0+1	5	140	5700	14.40	14.5	1.023	1.020	0.273	--	--	--
WLAN 5G	802.11 n20	Tip	0+1	5	140	5700	14.40	14.5	1.023	1.020	0.089	--	--	--

Note:

1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.

WLAN 5.8G SAR

Band	Mode	Test Position	Ant	Dist. (mm)	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Duty cycle Compensation Factor	Area scan SAR1g (mW/g)	Power Drift (dB)	SAR1g (mW/g)	Scaled SAR1g (mW/g)
WLAN 5G	802.11 n20	Up	0+1	5	165	5825	8.71	9	1.069	1.020	0.322	0.16	0.318	0.347
WLAN 5G	802.11 n20	Down	0+1	5	165	5825	8.71	9	1.069	1.020	0.274	--	--	--
WLAN 5G	802.11 n20	Front	0+1	5	165	5825	8.71	9	1.069	1.020	0.193	--	--	--
WLAN 5G	802.11 n20	Back	0+1	5	165	5825	8.71	9	1.069	1.020	0.154	--	--	--
WLAN 5G	802.11 n20	Tip	0+1	5	165	5825	8.71	9	1.069	1.020	0.105	--	--	--

Note:

1. Highest reported SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.

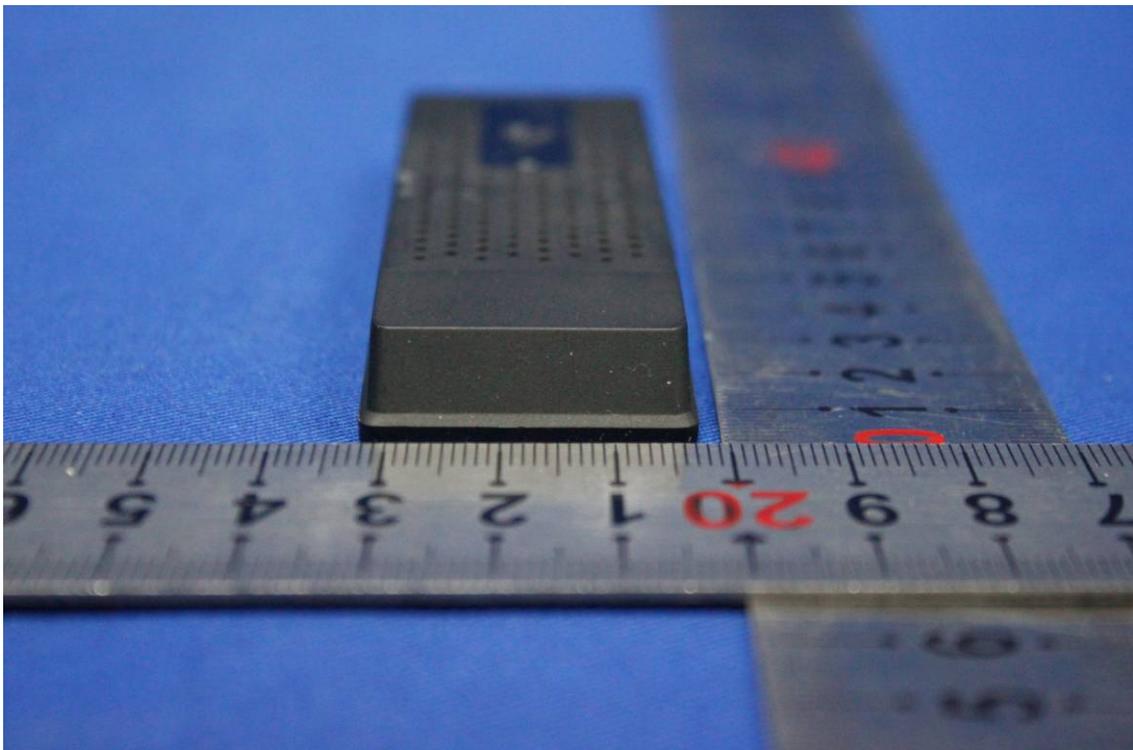
12.4 REPEATED SAR MEASUREMENT

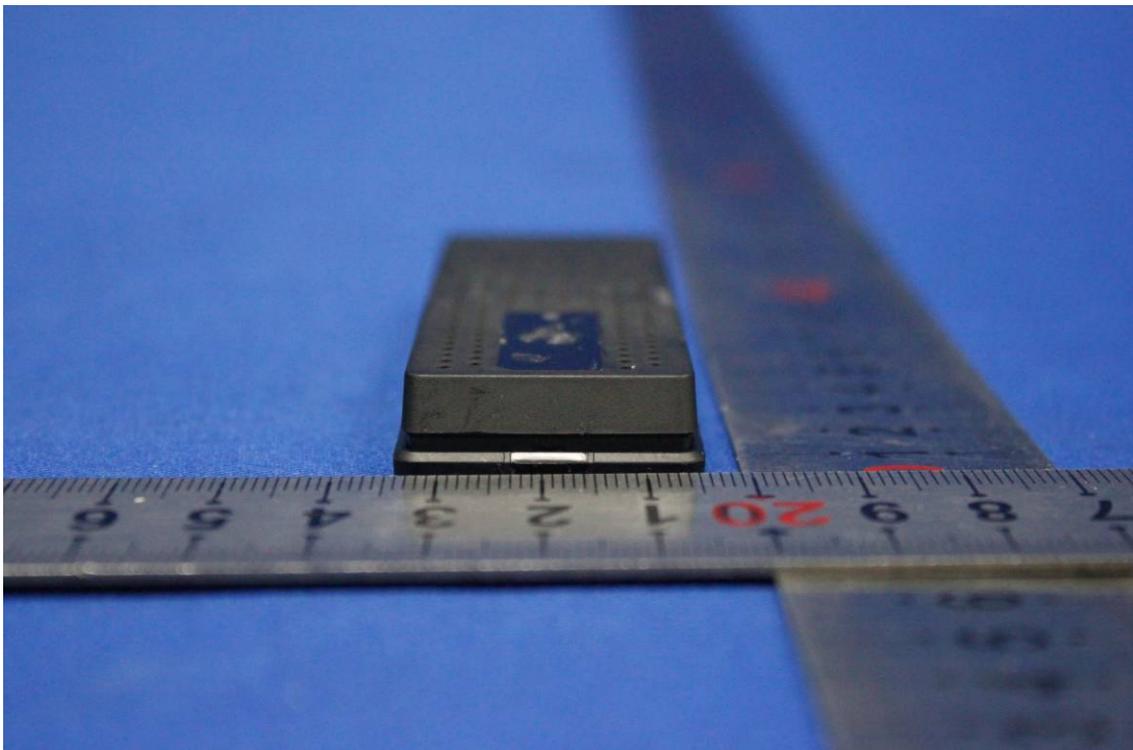
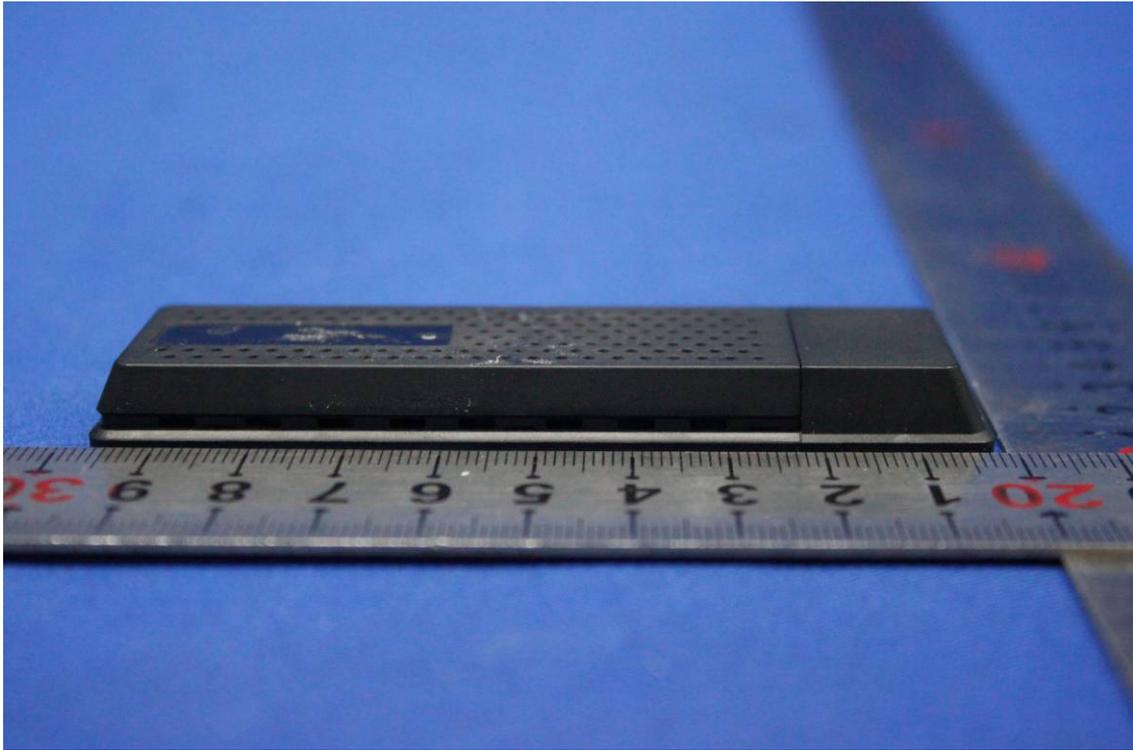
Band	Mode	Test Position	Dist. (mm)	Ch.	Original Measured SAR1g (mW/g)	1st Repeated SAR1g (mW/g)	Ratio	Original Measured SAR1g (mW/g)	2nd Repeated SAR1g (mW/g)	Ratio
--	--	--	--	--	--	--	--	--	--	--

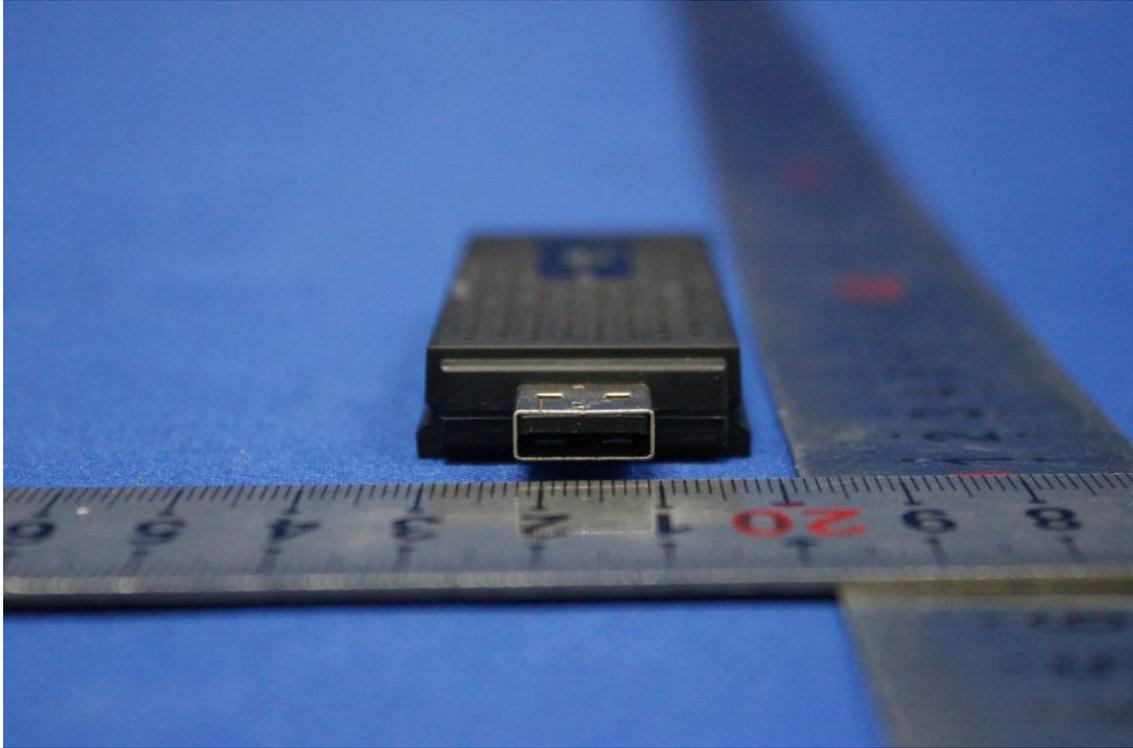
Note:

1. Per KDB 865664 D01v01, 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 D01v01, if the ratio of largest to smallest SAR for the original and first repeated measurement is ≤ 1.2 and the measured SAR $< 1.45\text{W/Kg}$, only one repeated measurement is required.
3. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is $\geq 1.45\text{W/kg}$
4. The ratio is the difference in percentage between original and repeated measured SAR.

13. EUT PHOTO







14. EQUIPMENT LIST & CALIBRATION STATUS

Name of Equipment	Manufacturer	Type/Model	Serial Number	Last Calibration	Calibration Due
P C	HP	Core(rm)3.16G	CZCO48171H	N/A	N/A
Signal Generator	Agilent	83732B	US37101915	05/29/2015	05/28/2016
S-Parameter Network Analyzer	Agilent	E5071B	MY42301382	03/03/2015	03/02/2016
Power Meter	Agilent	E4416A	GB41292714	03/03/2015	03/02/2016
Peak & Average sensor	Agilent	E9327A	us40441788	03/03/2015	03/02/2016
E-field PROBE	SPEAG	EX3DV4	3798	07/28/2014	07/27/2015
DAE	SPEAG	DEA4	1245	07/22/2014	07/23/2015
E-field PROBE	SPEAG	EX3DV4	3661	04/24/2015	04/23/2016
DAE	SPEAG	DEA4	918	12/29/2014	12/28/2015
DIPOLE 2450MHZ ANTENNA	SPEAG	D2450V2	817	07/31/2013	07/28/2016
DIPOLE 5GHZ ANTENNA	SPEAG	D5GHzV2	1095	05/31/2013	05/28/2016
DUMMY PROBE	SPEAG	DP_2	SPDP2001AA	N/A	N/A
SAM PHANTOM (ELI4 v4.0)	SPEAG	QDOVA001BB	1102	N/A	N/A
Twin SAM Phantom	SPEAG	QD000P40CD	1609	N/A	N/A
ROBOT	SPEAG	TX60	F10/5E6AA1/A101	N/A	N/A
ROBOT KRC	SPEAG	CS8C	F10/5E6AA1/C101	N/A	N/A
LIQUID CALIBRATION KIT	ANTENNESSA	41/05 OCP9	00425167	N/A	N/A

15. FACILITIES

All measurement facilities used to collect the measurement data are located at

No.10, Weiye Rd., Innovation Park, Eco & Tec. Development Part, Kunshan City, Jiangsu Province, China.

16. REFERENCES

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APPENDIX A: PLOTS OF PERFORMANCE CHECK

The plots are showing as followings.

Test Laboratory: Compliance Certification Services Inc.

Date: 6/6/2015

System Performance Check-Body D2450**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 817**

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.945$ S/m; $\epsilon_r = 51.682$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(6.82, 6.82, 6.82); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 17.7 W/kg

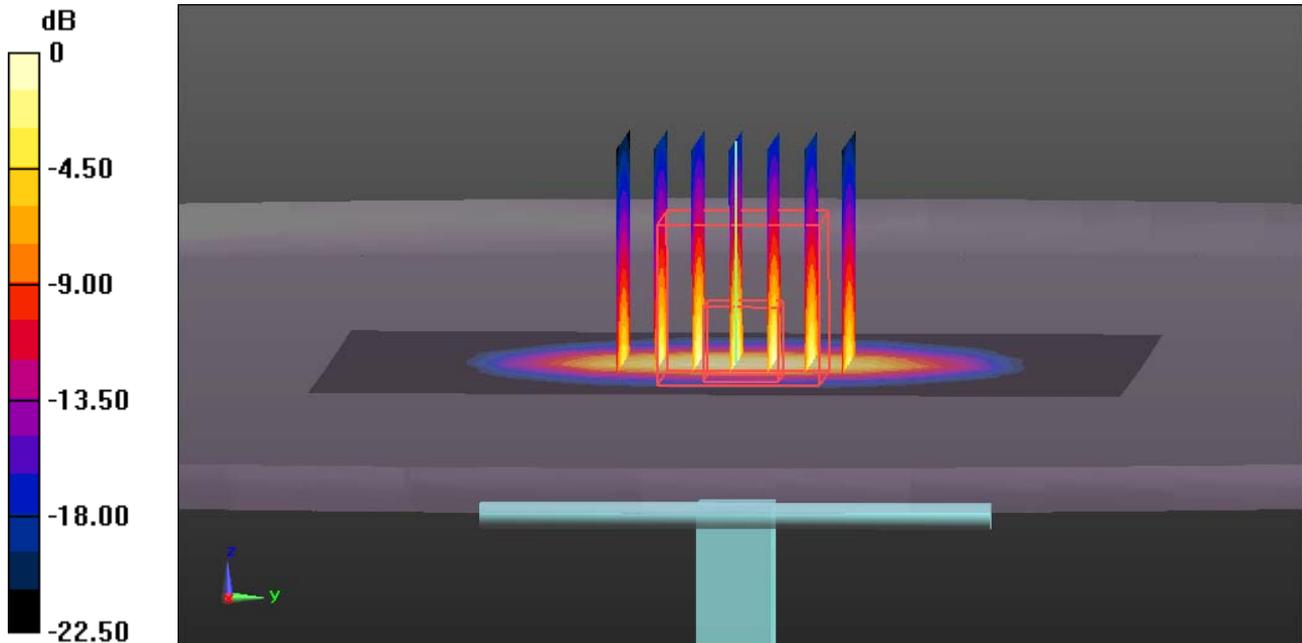
System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.2 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.6 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6 W/kg

Maximum value of SAR (measured) = 20.2 W/kg



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

Test Laboratory: Compliance Certification Services Inc.

Date: 6/2/2015

System Performance Check- Body D5200

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5200 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.233$ S/m; $\epsilon_r = 48.913$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.41, 4.41, 4.41); Calibrated: 7/28/2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 13.7 W/kg

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

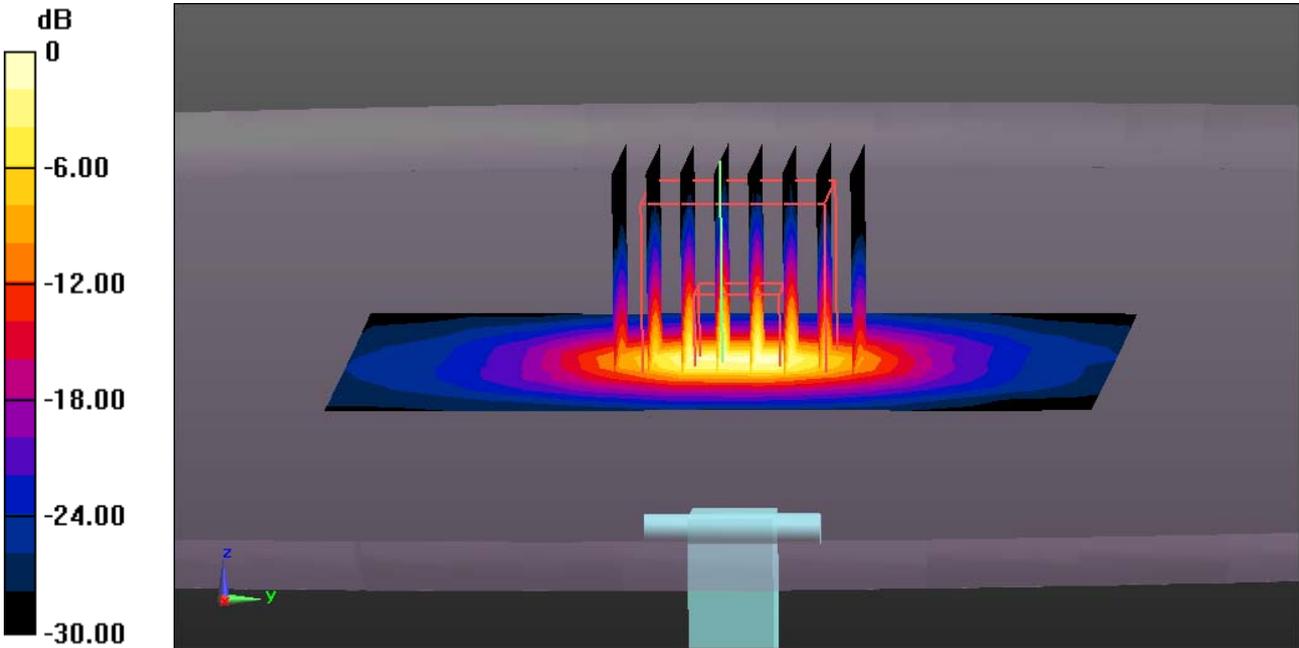
Reference Value = 70.67 V/m; Power Drift = -0.55 dB

Peak SAR (extrapolated) = 29.9 W/kg

Peak SAR (extrapolated) = 29.9 W/kg

SAR(1 g) = 7.3 W/kg; SAR(10 g) = 2.07 W/kg

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



0 dB = 17.6 W/kg = 12.46 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 6/2/2015

System Performance Check- Body D5300

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5300 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5300$ MHz; $\sigma = 5.364$ S/m; $\epsilon_r = 48.673$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(4.23, 4.23, 4.23); Calibrated: 7/28/2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 14.9 W/kg

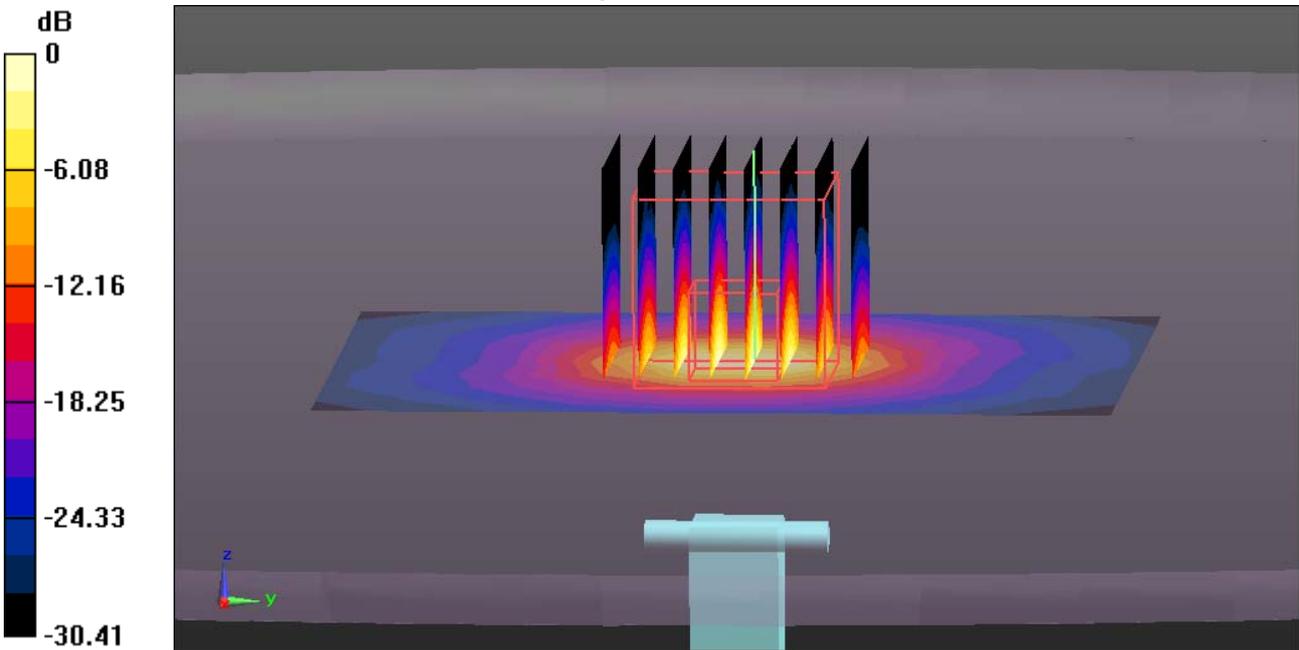
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.48 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.3 W/kg

SAR(1 g) = 7.23 W/kg; SAR(10 g) = 2.03 W/kg

Maximum value of SAR (measured) = 17.0 W/kg



0 dB = 17.0 W/kg = 12.30 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 6/3/2015

System Performance Check- Body D5500

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5500 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.632$ S/m; $\epsilon_r = 48.202$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(3.91, 3.91, 3.91); Calibrated: 7/28/2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm
 Maximum value of SAR (measured) = 15.8 W/kg

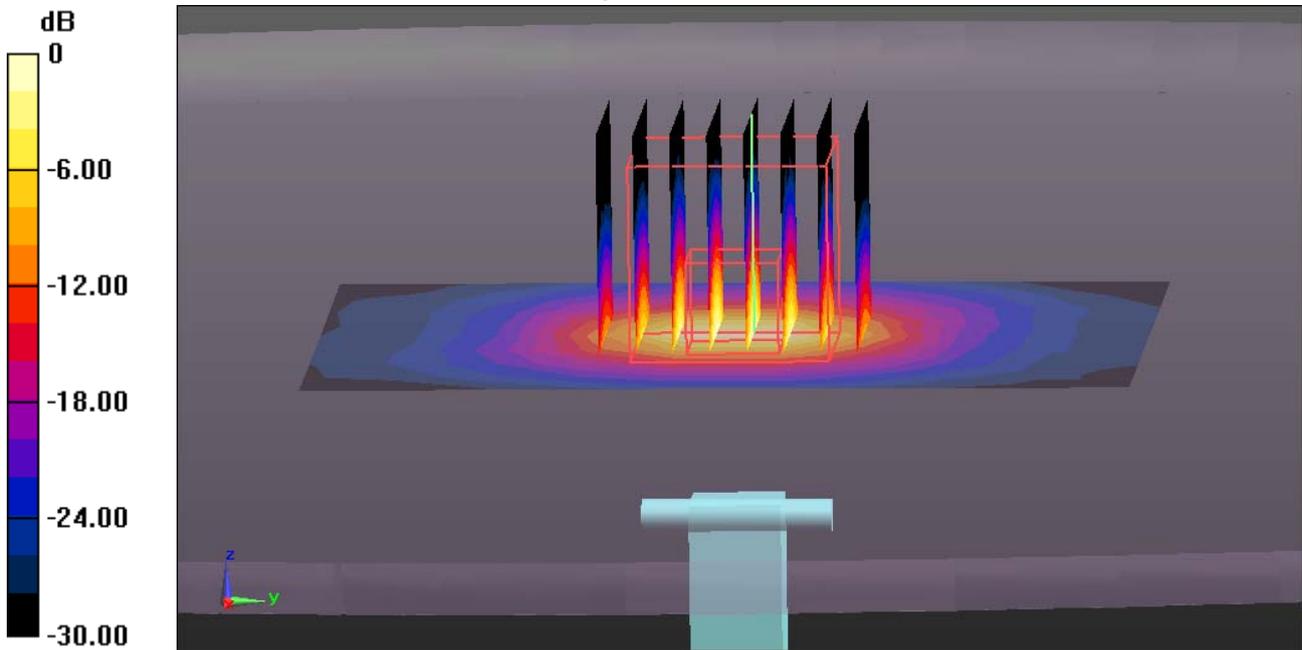
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.74 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 33.8 W/kg

SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.21 W/kg

Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 6/3/2015

System Performance Check- Body D5600

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz);
Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.773$ S/m; $\epsilon_r = 47.973$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(3.75, 3.75, 3.75); Calibrated: 7/28/2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.6 W/kg

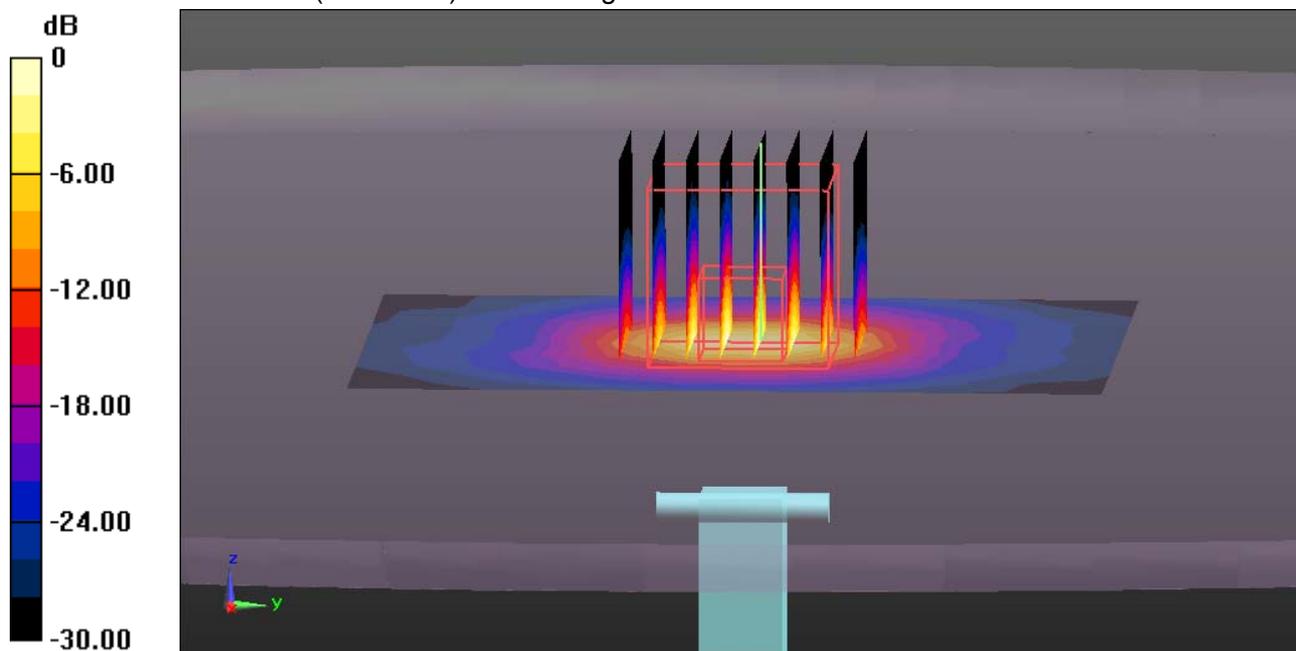
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.34 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 36.4 W/kg

SAR(1 g) = 8.21 W/kg; SAR(10 g) = 2.29 W/kg

Maximum value of SAR (measured) = 20.2 W/kg



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

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-Body D2450

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: 817

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz);

Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.009$ S/m; $\epsilon_r = 50.424$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(7.31, 7.31, 7.31); Calibrated: 4/24/2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1): Measurement grid: dx=12mm, dy=12mm

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

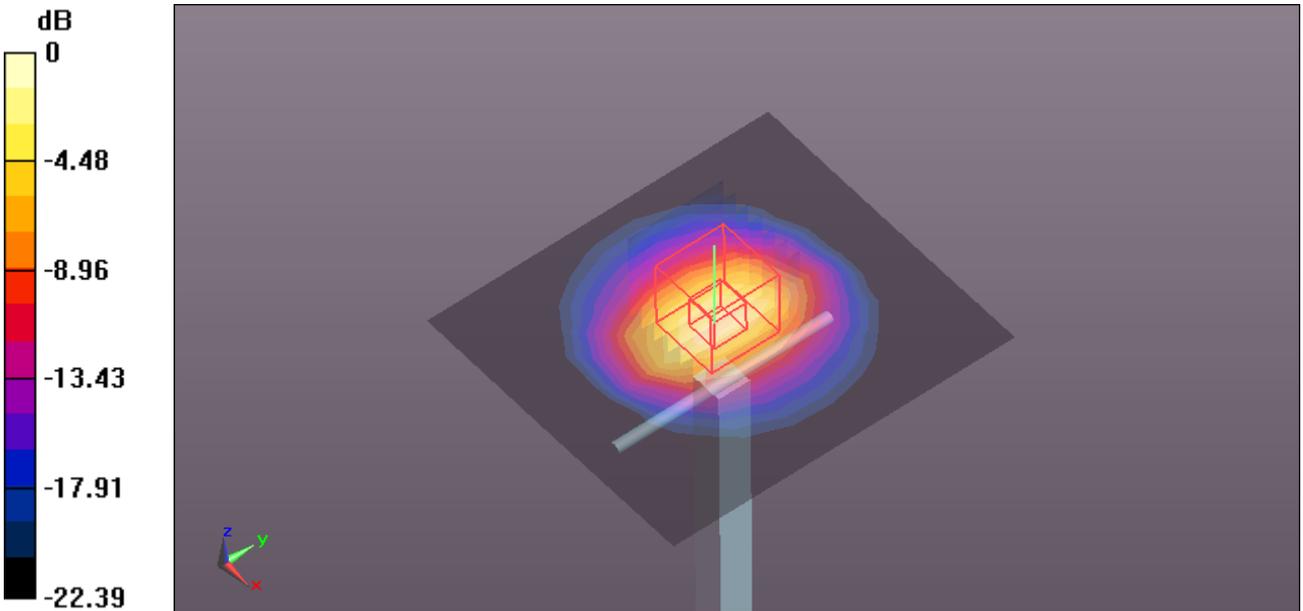
System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.7 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 6.06 W/kg

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



0 dB = 20.6 W/kg = 13.14 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-D5200

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5200 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.291$ S/m; $\epsilon_r = 49.073$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(4.92, 4.92, 4.92); Calibrated: 4/24/2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz 20/Area Scan (10x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 15.2 W/kg

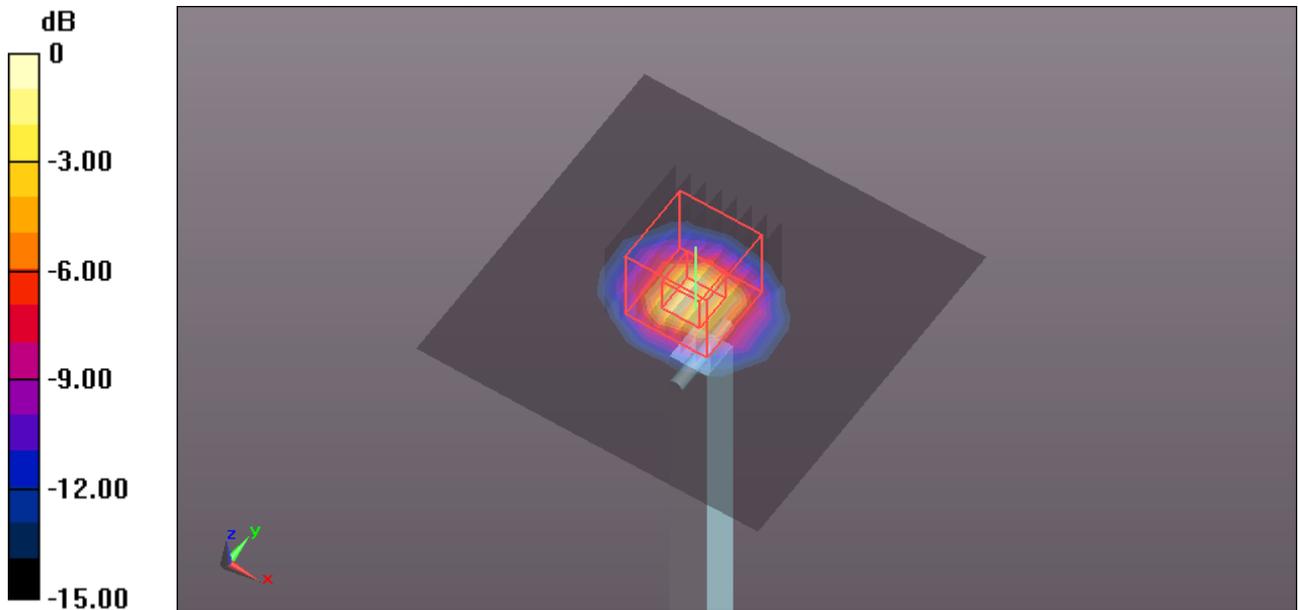
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5200 MHz 20/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.93 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 39.1 W/kg

SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 21.0 W/kg



0 dB = 21.0 W/kg = 13.22 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-D5300

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5300 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5300$ MHz; $\sigma = 5.436$ S/m; $\epsilon_r = 48.828$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(4.64, 4.64, 4.64); Calibrated: 4/24/2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300 MHz 19.5 2/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.2 W/kg

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5300 MHz 19.5 2/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0:

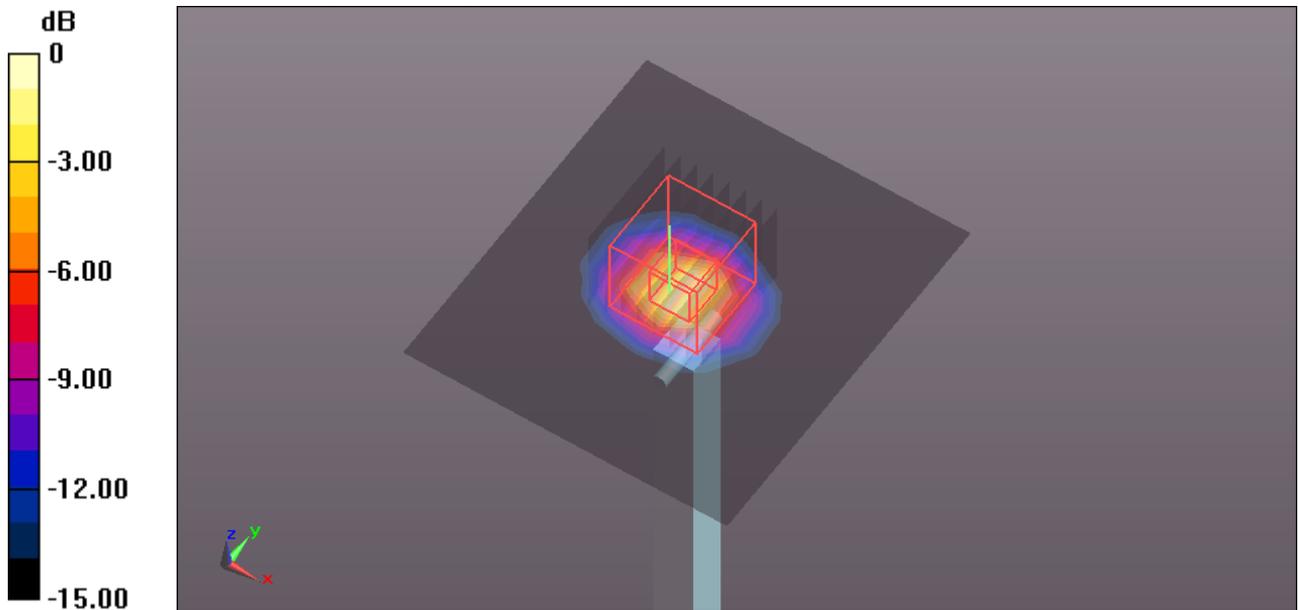
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.14 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 39.7 W/kg

SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.13 W/kg

Maximum value of SAR (measured) = 21.2 W/kg



0 dB = 21.2 W/kg = 13.26 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-D5500

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5500 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.723$ S/m; $\epsilon_r = 48.36$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(4.33, 4.33, 4.33); Calibrated: 4/11/2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 20.9 W/kg

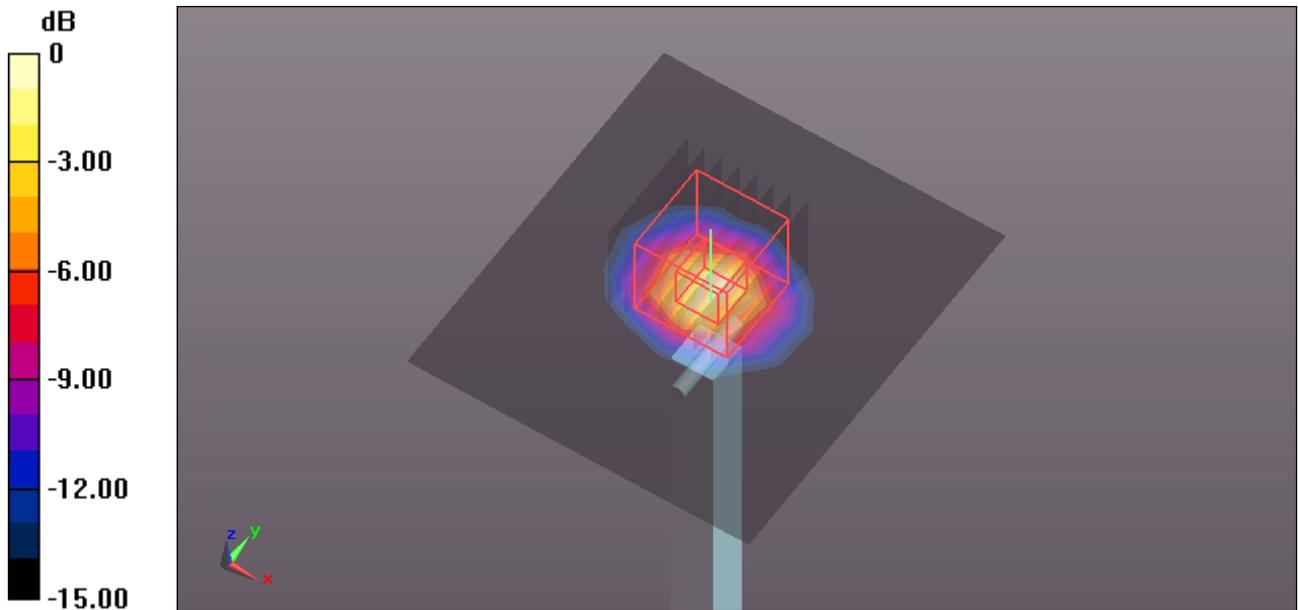
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.95 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 39.2 W/kg

SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 20.8 W/kg



0 dB = 20.8 W/kg = 13.18 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-D5600**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095**

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.881$ S/m; $\epsilon_r = 48.153$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(4.26, 4.26, 4.26); Calibrated: 4/11/2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 19.5 W/kg

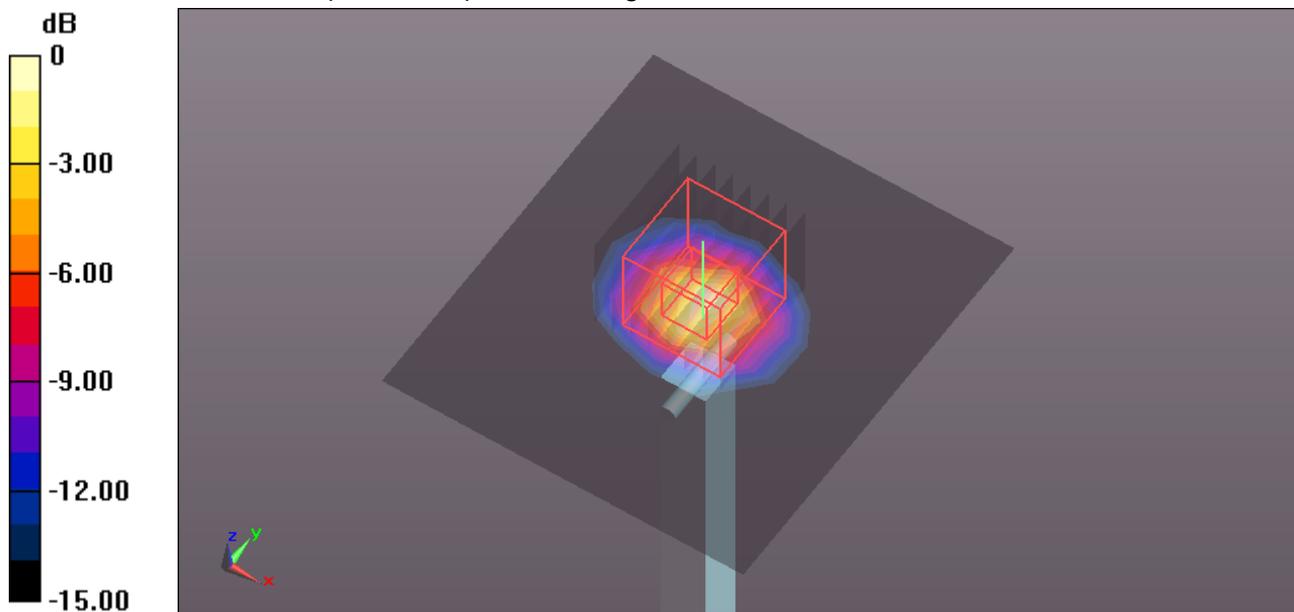
System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5600 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 66.83 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 39.4 W/kg

SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.21 W/kg

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



0 dB = 20.6 W/kg = 13.14 dBW/kg

Test Laboratory: Compliance Certification Services Inc.

Date: 8/18/2015

System Performance Check-D5800

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: 1095

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5800$ MHz; $\sigma = 6.205$ S/m; $\epsilon_r = 47.721$; $\rho = 1000$ kg/m³

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

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

DASY Configuration:

- Probe: EX3DV4 - SN3661; ConvF(4.35, 4.35, 4.35); Calibrated: 4/11/2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 12/29/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800 MHz/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

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

System Performance Check with D5GHzV2 Dipole (graded grid)/d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (8x8x7)/Cube 0: Measurement grid:

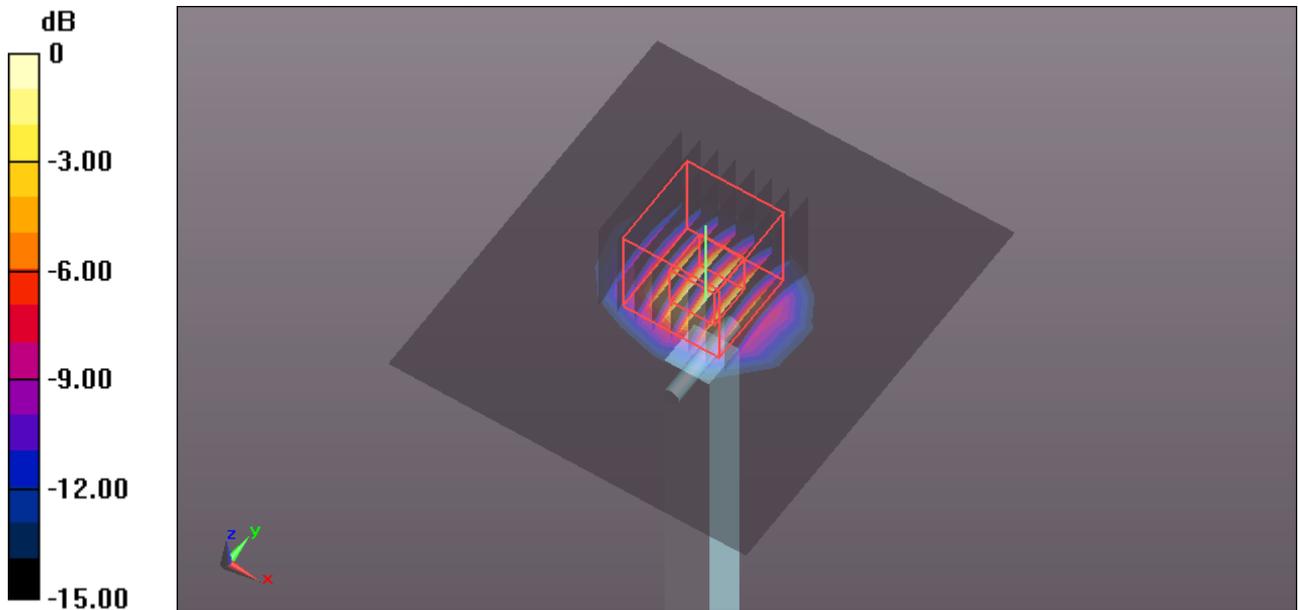
dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.64 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 39.7 W/kg

SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.16 W/kg

Maximum value of SAR (measured) = 20.3 W/kg



0 dB = 20.3 W/kg = 13.07 dBW/kg

APPENDIX B: DASY CALIBRATION CERTIFICATE

The DASY Calibration Certificates are showing as followings .

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



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

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

Accreditation No.: **SCS 108**

Client **CCS-CN (Auden)**

Certificate No: **D2450V2-817_Jul13**

CALIBRATION CERTIFICATE

Object: **D2450V2 - SN: 817**

Calibration procedure(s): **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **July 31, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37460704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 31, 2013

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

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



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

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	$dx, dy, dz = 5$ mm	
Frequency	2450 MHz \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	37.8 \pm 6 %	1.81 mho/m \pm 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.6 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	50.5 \pm 6 %	2.01 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.2 W/kg \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.87 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.1 W/kg \pm 16.5 % (k=2)

Appendix**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.5 Ω + 2.9 j Ω
Return Loss	- 27.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.7 Ω + 4.5 j Ω
Return Loss	- 27.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 23, 2007

DASY5 Validation Report for Head TSL

Date: 31.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 817

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ S/m; $\epsilon_r = 37.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

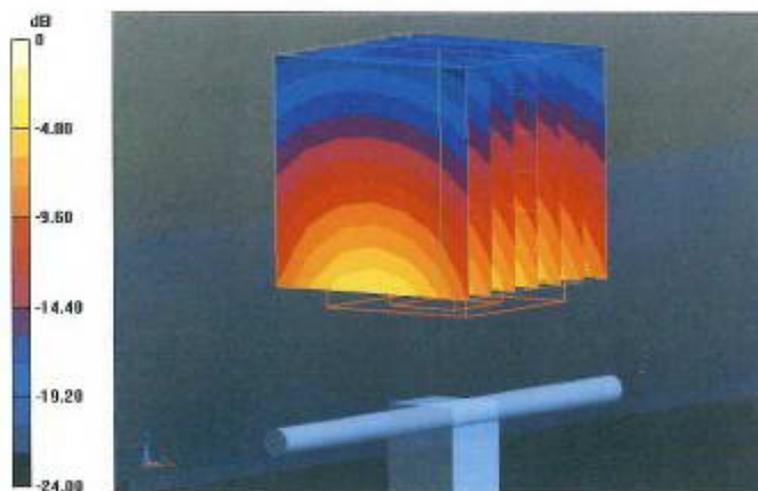
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.781 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.7 W/kg

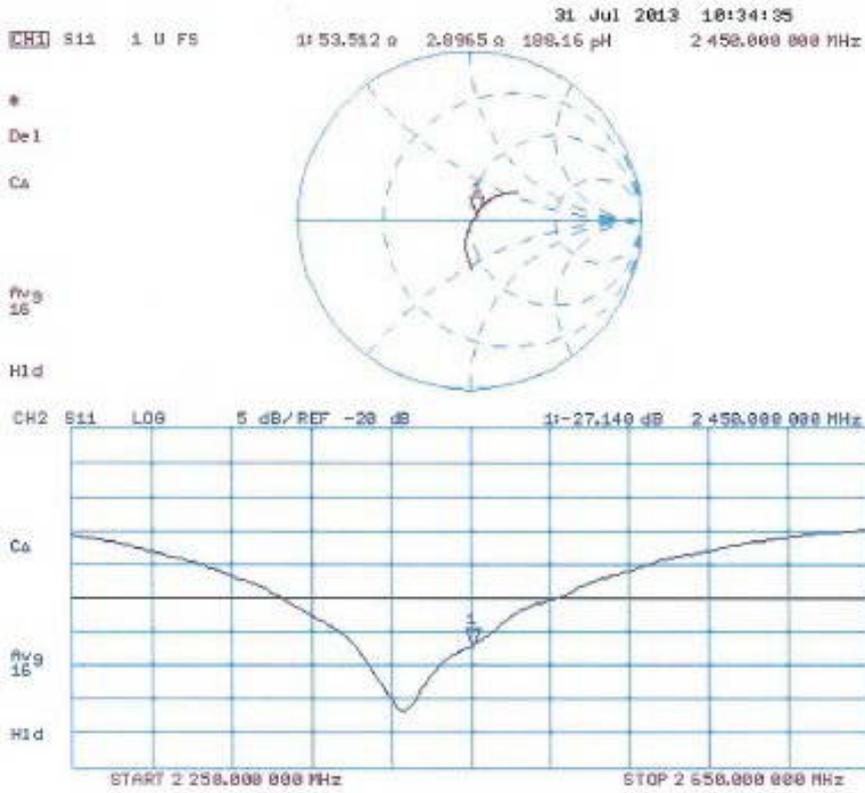
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.18 W/kg

Maximum value of SAR (measured) = 16.8 W/kg



0 dB = 16.8 W/kg = 12.25 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 31.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 817

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.01$ S/m; $\epsilon_r = 50.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

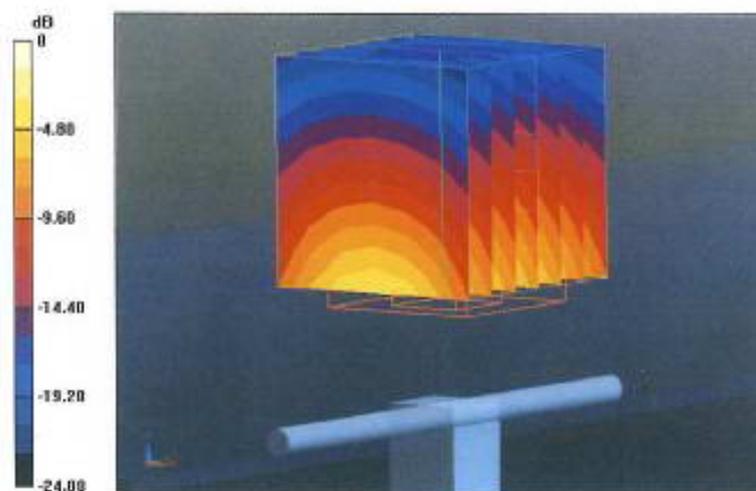
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.151 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 26.3 W/kg

SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.87 W/kg

Maximum value of SAR (measured) = 16.7 W/kg

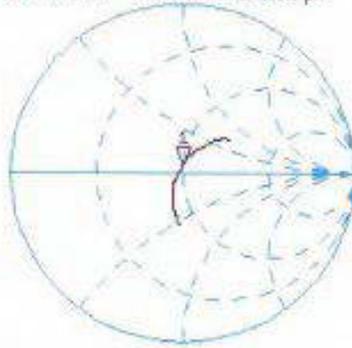


0 dB = 16.7 W/kg = 12.23 dBW/kg

Impedance Measurement Plot for Body TSL

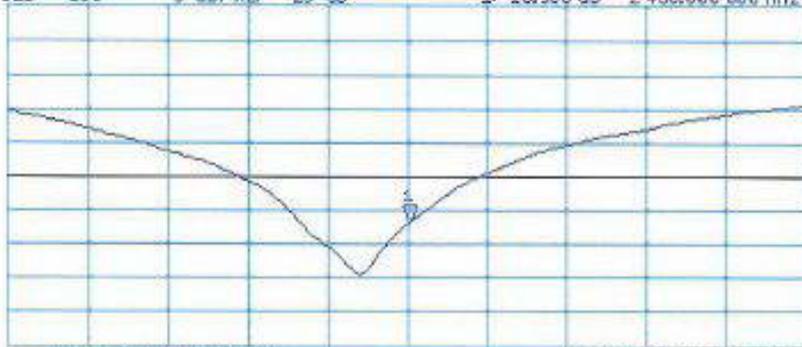
31 Jul 2013 18:33:59
S11 1 U FS 1: 49.723 Ω 4.4648 Ω 296.04 μH 2 458.000 000 MHz

De1
Ca
Avg 16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1: -26.958 dB 2 458.000 000 MHz

Ca
Avg 16
H1d



D2450V2, Serial No.817 Extended Dipole Calibrations

Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement.

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

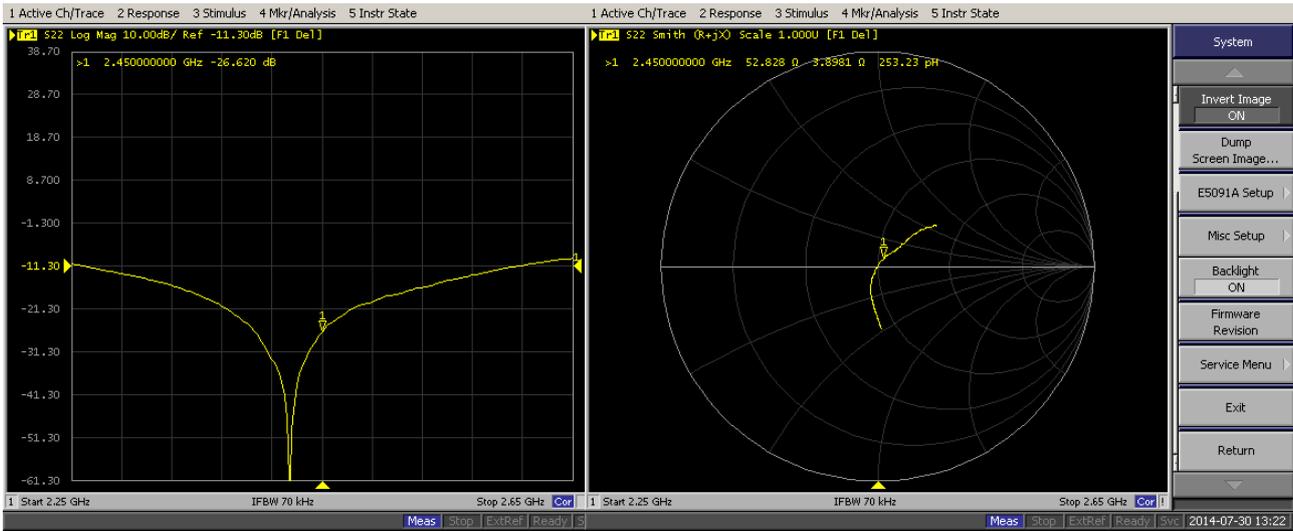
Justification of the extended calibration

D2450V2 Serial No.817						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-27.140	--	53.512	--	2.897	--
7.30.2014	-26.620	1.92	52.828	0.684	3.898	0.911

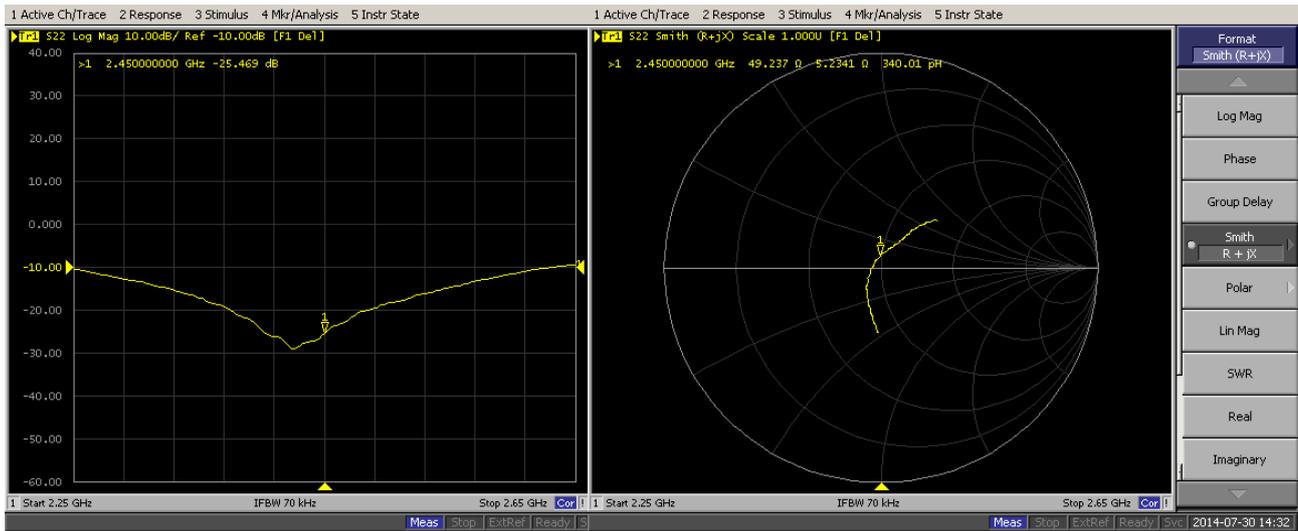
D2450V2 Serial No.817						
2450 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-26.968	--	49.723	--	4.465	--
7.30.2014	-25.469	5.56	49.237	0.486	5.234	0.769

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

Dipole Verification Data D2450V2 Serial No.817 2450 MHz-Head



2450 MHz-Body



Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement.

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

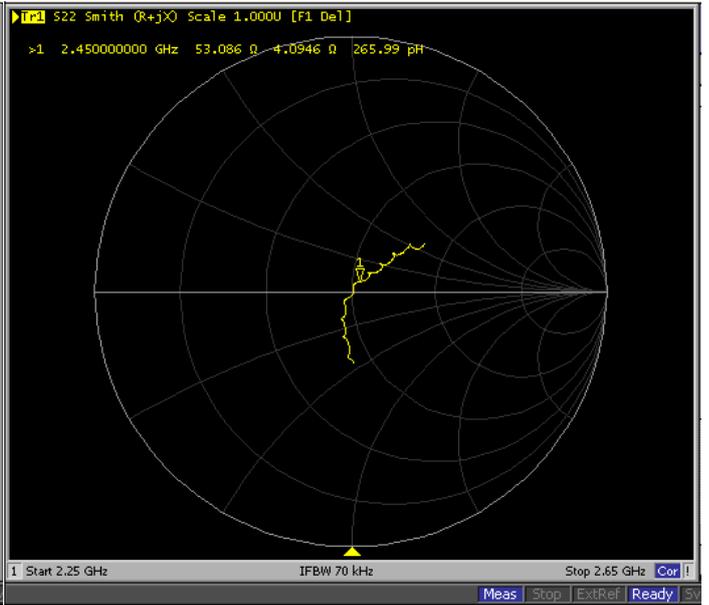
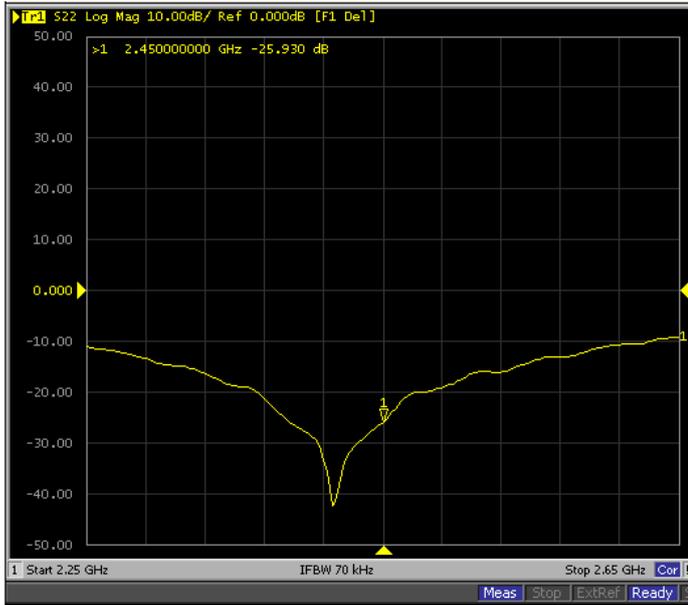
Justification of the extended calibration

D2450V2 Serial No.817						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-27.140	--	53.512	--	2.897	--
7.30.2014	-26.620	1.92	52.828	0.684	3.898	0.911
7.29.2015	-25.93	2.59	53.086	0.258	4.095	0.197

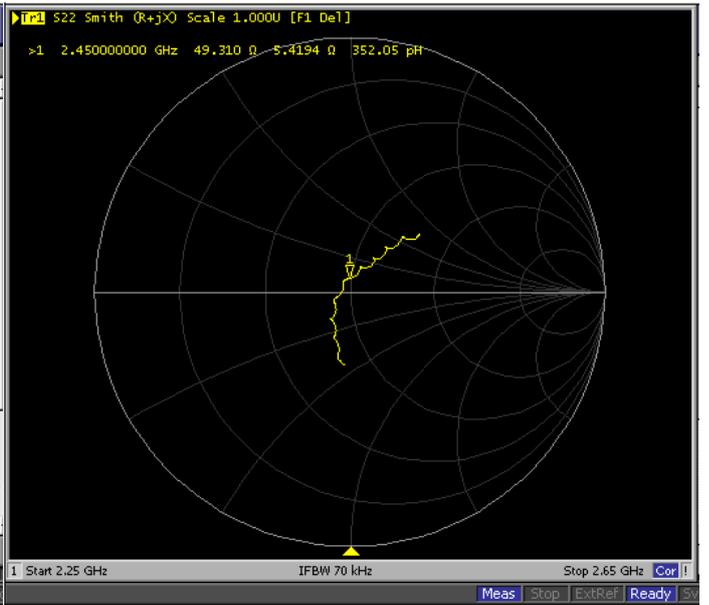
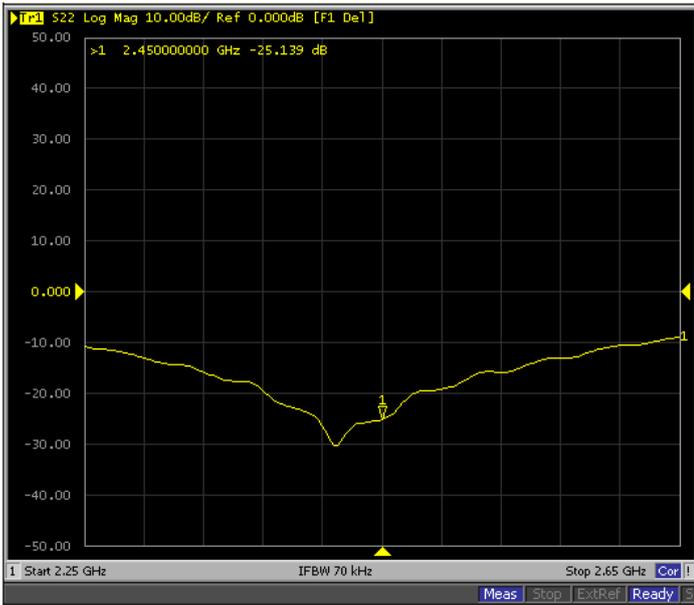
D2450V2 Serial No.817						
2450 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-26.968	--	49.723	--	4.465	--
7.30.2014	-25.469	5.56	49.237	0.486	5.234	0.769
7.29.2015	-25.139	1.30	49.31	0.073	5.419	0.185

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

Dipole Verification Data D2450V2 Serial No.817
2450 MHz-Head



2450 MHz-Body



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



S Schweizerischer Kalibrierdienst
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S Servizio svizzero di taratura
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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **CCS-CN (Auden)**

Certificate No: **D5GHzV2-1095_May13**

CALIBRATION CERTIFICATE

Object: **D5GHzV2 - SN: 1095**

Calibration procedure(s): **QA CAL-22.v2
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **May 31, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe EX3DV4	SN: 3503	28-Dec-12 (No. EX3-3503_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 31, 2013

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

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.5 ± 6 %	4.50 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.1 W / kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.7 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.1 ± 6 %	4.79 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	84.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg ± 19.5 % (k=2)

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	36.0 ± 6 %	4.89 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °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	8.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.7 ± 6 %	5.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.86 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.7 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.6 ± 6 %	5.41 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	74.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.08 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.4 ± 6 %	5.53 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.58 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.3 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.1 ± 6 %	5.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	79.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.19 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	22.0 W/kg ± 19.5 % (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	49.0 ± 6 %	5.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °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	7.76 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	77.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.6 W/kg ± 19.5 % (k=2)

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.6 ± 6 %	6.24 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	75.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.06 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.7 W/kg ± 19.5 % (k=2)

Appendix**Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	50.2 Ω - 6.4 j Ω
Return Loss	- 23.9 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.2 Ω - 3.3 j Ω
Return Loss	- 29.6 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	53.2 Ω - 2.2 j Ω
Return Loss	- 28.5 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	56.0 Ω - 1.1 j Ω
Return Loss	- 24.8 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.4 Ω - 2.8 j Ω
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	50.7 Ω - 5.3 j Ω
Return Loss	- 25.5 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	50.8 Ω - 1.5 j Ω
Return Loss	- 35.5 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	53.8 Ω - 1.2 j Ω
Return Loss	- 28.4 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	56.2 Ω + 1.1 j Ω
Return Loss	- 24.5 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	55.6 Ω + 0.3 j Ω
Return Loss	- 25.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.208 ns
----------------------------------	----------

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 24, 2010

DASY5 Validation Report for Head TSL

Date: 30.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1095

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.5$ S/m; $\epsilon_r = 36.5$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 4.6$ S/m; $\epsilon_r = 36.3$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 4.79$ S/m; $\epsilon_r = 36.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 4.89$ S/m; $\epsilon_r = 36$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 5.11$ S/m; $\epsilon_r = 35.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41); Calibrated: 28.12.2012, ConvF(5.1, 5.1, 5.1); Calibrated: 28.12.2012, ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.76, 4.76, 4.76); Calibrated: 28.12.2012, ConvF(4.81, 4.81, 4.81); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 65.153 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 29.3 W/kg

SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.27 W/kg

Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 65.596 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 31.2 W/kg

SAR(1 g) = 8.3 W/kg; SAR(10 g) = 2.37 W/kg

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

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 65.084 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 33.1 W/kg

SAR(1 g) = 8.42 W/kg; SAR(10 g) = 2.4 W/kg

Maximum value of SAR (measured) = 20.0 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.341 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 32.9 W/kg

SAR(1 g) = 8.24 W/kg; SAR(10 g) = 2.34 W/kg

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

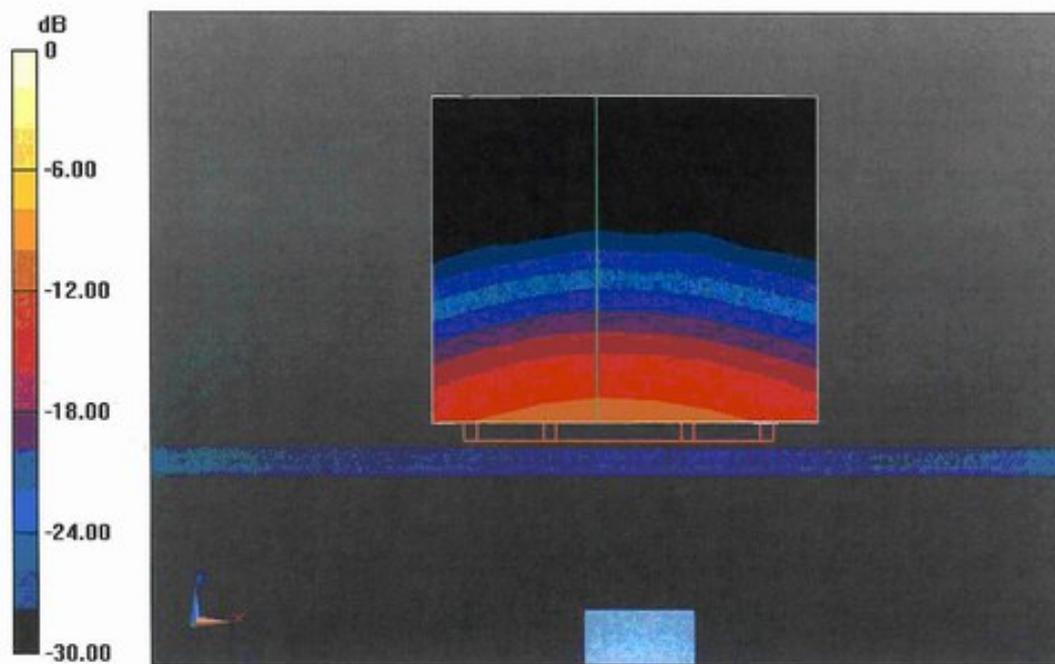
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.473 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 32.8 W/kg

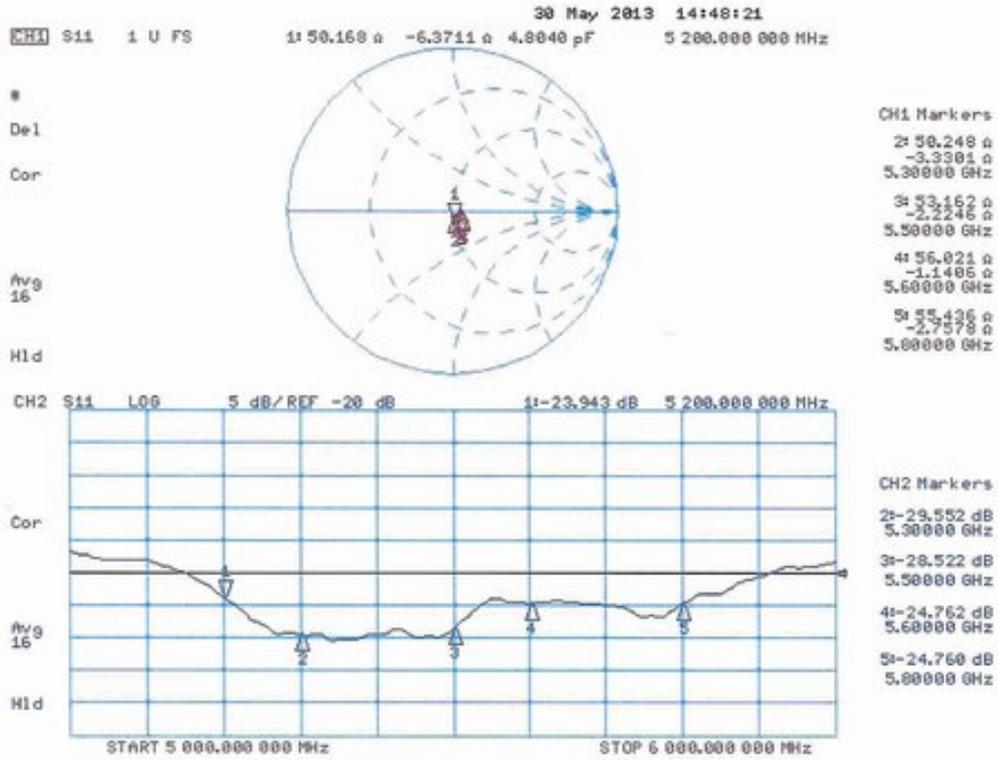
SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 19.2 W/kg = 12.83 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 31.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1095

Communication System: UID 0 - CW ; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.41$ S/m; $\epsilon_r = 49.6$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5300$ MHz; $\sigma = 5.53$ S/m; $\epsilon_r = 49.4$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5500$ MHz; $\sigma = 5.8$ S/m; $\epsilon_r = 49.1$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.8$ S/m; $\epsilon_r = 49$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5800$ MHz; $\sigma = 6.24$ S/m; $\epsilon_r = 48.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91); Calibrated: 28.12.2012, ConvF(4.67, 4.67, 4.67); Calibrated: 28.12.2012, ConvF(4.43, 4.43, 4.43); Calibrated: 28.12.2012, ConvF(4.22, 4.22, 4.22); Calibrated: 28.12.2012, ConvF(4.38, 4.38, 4.38); Calibrated: 28.12.2012;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 58.744 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 29.0 W/kg

SAR(1 g) = 7.44 W/kg; SAR(10 g) = 2.08 W/kg

Maximum value of SAR (measured) = 17.0 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 58.871 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 30.4 W/kg

SAR(1 g) = 7.58 W/kg; SAR(10 g) = 2.12 W/kg

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

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:

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

Reference Value = 58.666 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 33.6 W/kg

SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.19 W/kg

Maximum value of SAR (measured) = 18.7 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 58.108 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 34.2 W/kg

SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.15 W/kg

Maximum value of SAR (measured) = 18.5 W/kg

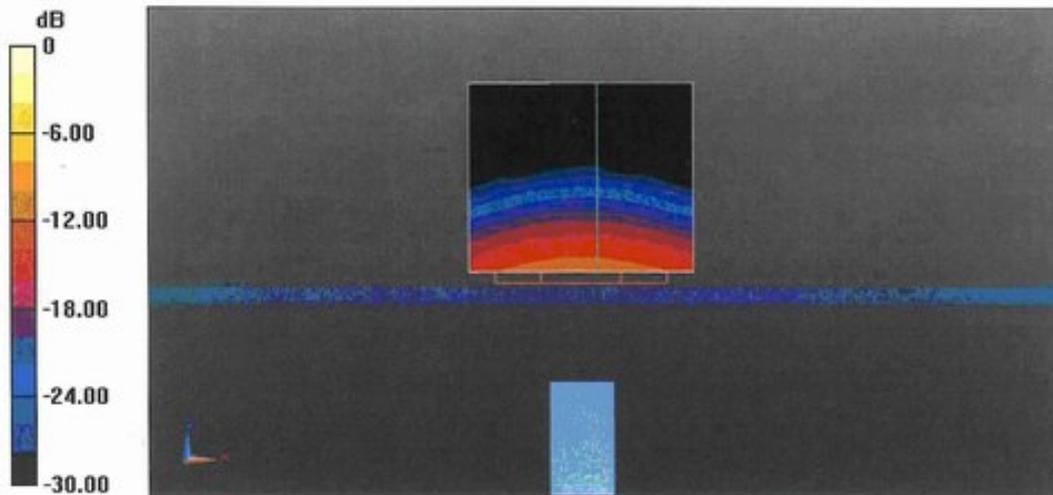
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 55.451 V/m; Power Drift = -0.03 dB

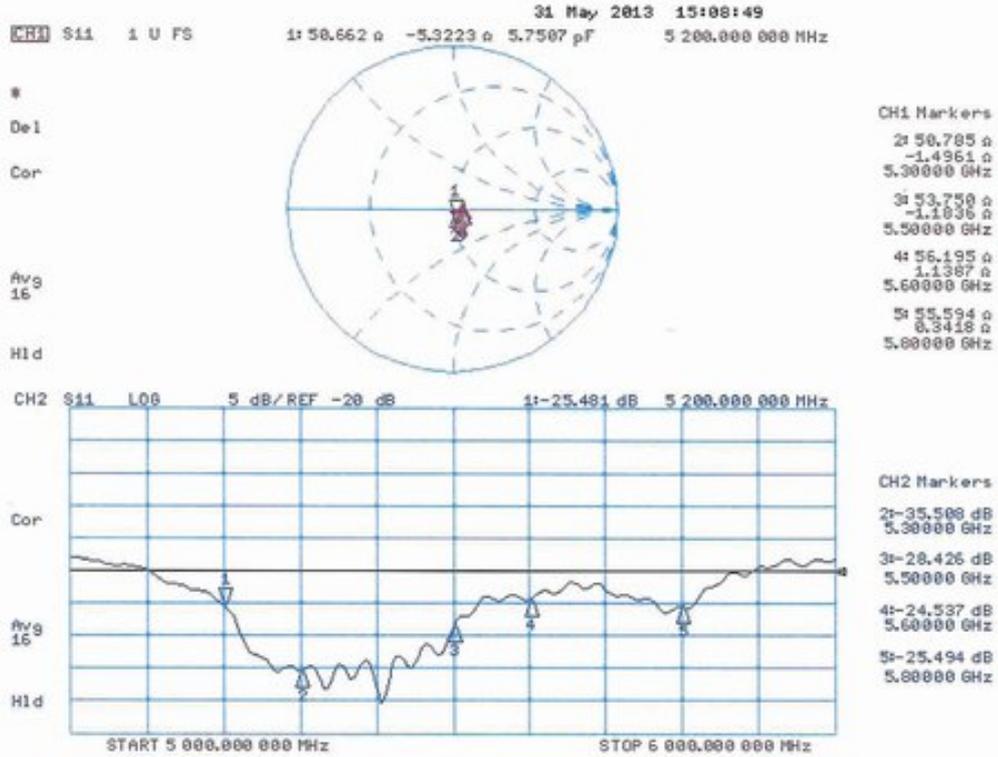
Peak SAR (extrapolated) = 34.6 W/kg

SAR(1 g) = 7.47 W/kg; SAR(10 g) = 2.06 W/kg

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



Impedance Measurement Plot for Body TSL



D5GHzV2,Serial No.1095 Extended Dipole Calibrations

Per IEEE Std 1528-2003,the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement

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

Justification of the extended calibration

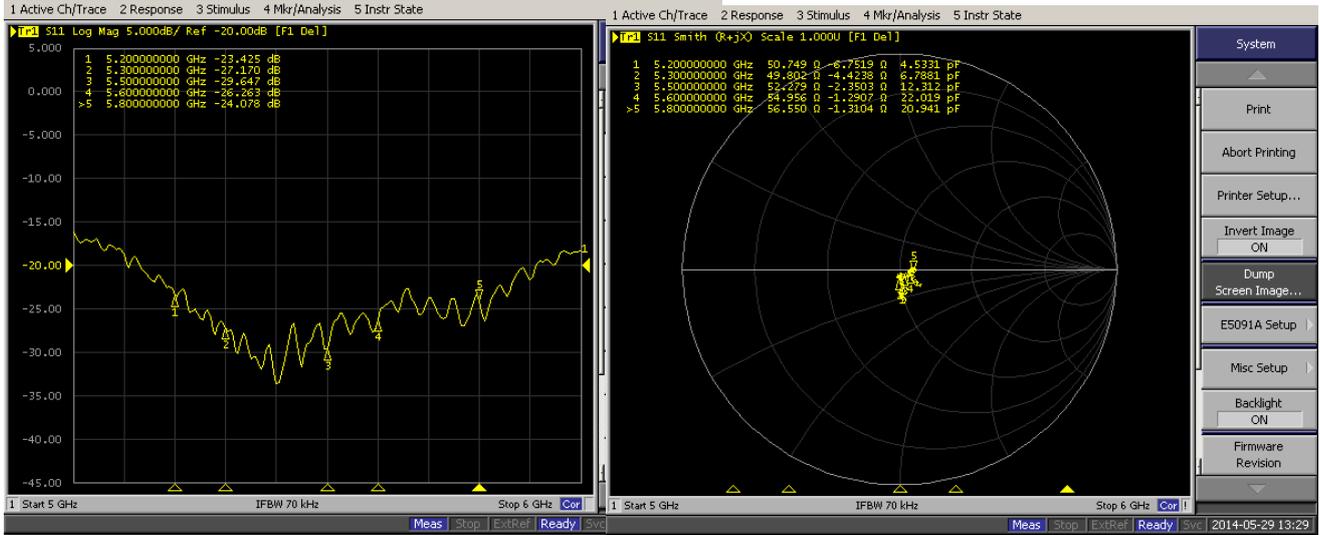
D5GHzV2 Serial No.1095							
Head							
Date of Measurement		Return Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
5200MHz	5.31.2013	-23.943	--	50.168	--	-6.371	--
	5.29.2014	-23.425	2.16	50.749	0.581	-6.752	0.381
5300MHz	5.31.2013	-29.552	--	50.248	--	-3.330	--
	5.29.2014	-27.170	8.06	49.802	0.446	-4.424	1.094
5500MHz	5.31.2013	-28.522	--	53.162	--	-2.225	--
	5.29.2014	-29.647	3.94	52.249	0.913	-2.350	0.125
5600MHz	5.31.2013	-24.762	--	56.021	--	-1.141	--
	5.29.2014	-26.263	6.06	54.956	1.065	-1.291	0.150
5800MHz	5.31.2013	-24.760	--	55.436	--	-2.758	--
	5.29.2014	-24.078	2.75	56.550	1.114	-1.310	1.448

D5GHzV2 Serial No.1095							
Body							
Date of Measurement		Return Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
5200MHz	5.31.2013	-25.481	--	50.662	--	-5.322	--
	5.29.2014	-23.945	6.03	50.975	0.313	-6.336	1.014
5300MHz	5.31.2013	-35.508	--	50.785	--	-1.496	--
	5.29.2014	-31.173	12.21	49.992	0.793	-2.732	1.236
5500MHz	5.31.2013	-28.426	--	53.750	--	-1.184	--
	5.29.2014	-28.353	0.26	52.867	0.883	-2.742	1.558
5600MHz	5.31.2013	-24.537	--	56.195	--	1.139	--
	5.29.2014	-24.330	0.84	56.344	0.149	0.347	0.792
5800MHz	5.31.2013	-25.494	--	55.594	--	0.342	--
	5.29.2014	-24.908	2.30	55.887	0.293	-1.203	1.545

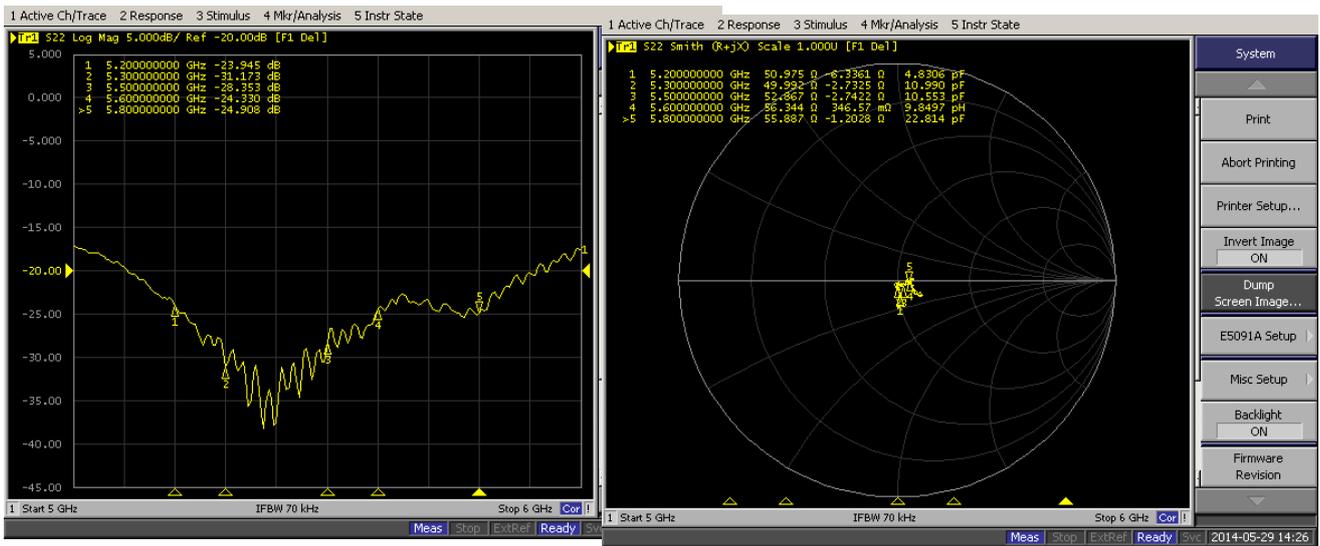
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data D5GHzV2 Serial No.1095

D5GHzV2-Head



D5GHzV2-Body



Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement

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

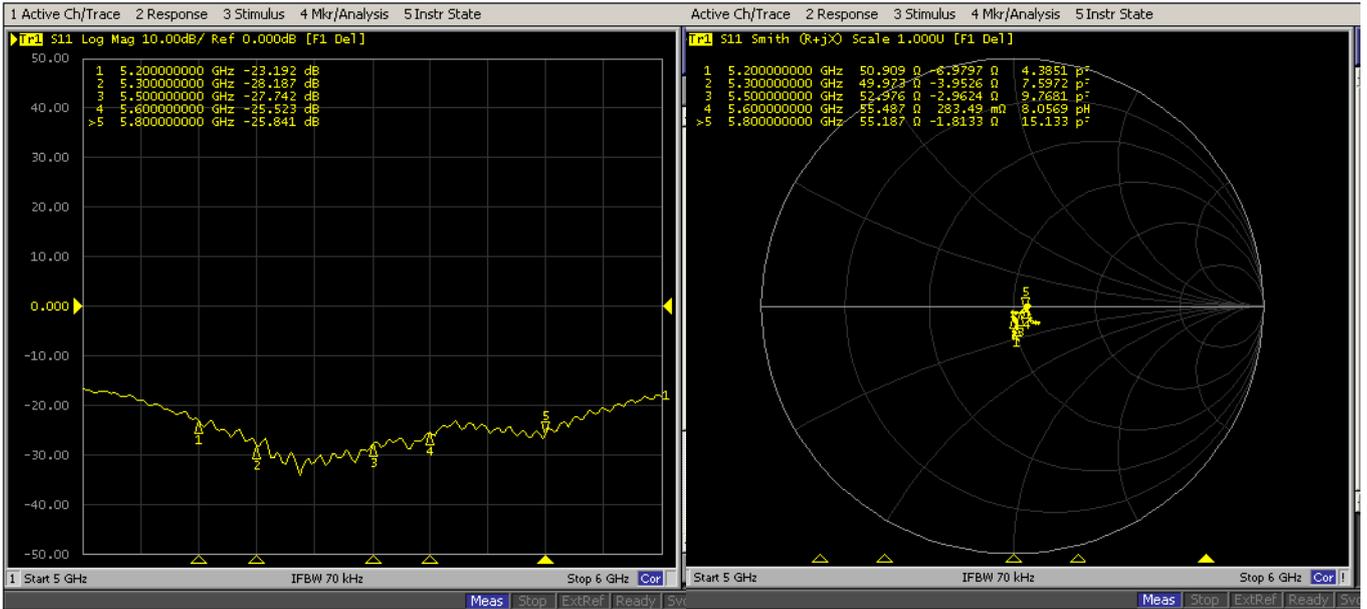
Justification of the extended calibration

D5GHzV2 Serial No.1095							
Head							
Date of Measurement		Return Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
5200MHz	5.31.2013	-23.943	--	50.168	--	-6.371	--
	5.29.2014	-23.425	2.16	50.749	0.581	-6.752	0.381
	5.28.2015	-23.192	0.99	50.909	0.16	-6.980	0.228
5300MHz	5.31.2013	-29.552	--	50.248	--	-3.330	--
	5.29.2014	-27.170	8.06	49.802	0.446	-4.424	1.094
	5.28.2015	-28.187	3.74	49.973	0.171	-3.953	0.471
5500MHz	5.31.2013	-28.522	--	53.162	--	-2.225	--
	5.29.2014	-29.647	3.94	52.249	0.913	-2.350	0.125
	5.28.2015	-27.742	6.43	52.976	0.727	-2.962	0.612
5600MHz	5.31.2013	-24.762	--	56.021	--	-1.141	--
	5.29.2014	-26.263	6.06	54.956	1.065	-1.291	0.150
	5.28.2015	-25.523	2.82	55.487	0.531	0.283	1.008
5800MHz	5.31.2013	-24.760	--	55.436	--	-2.758	--
	5.29.2014	-24.078	2.75	56.550	1.114	-1.310	1.448
	5.28.2015	-25.841	7.32	55.187	1.363	-1.813	0.503

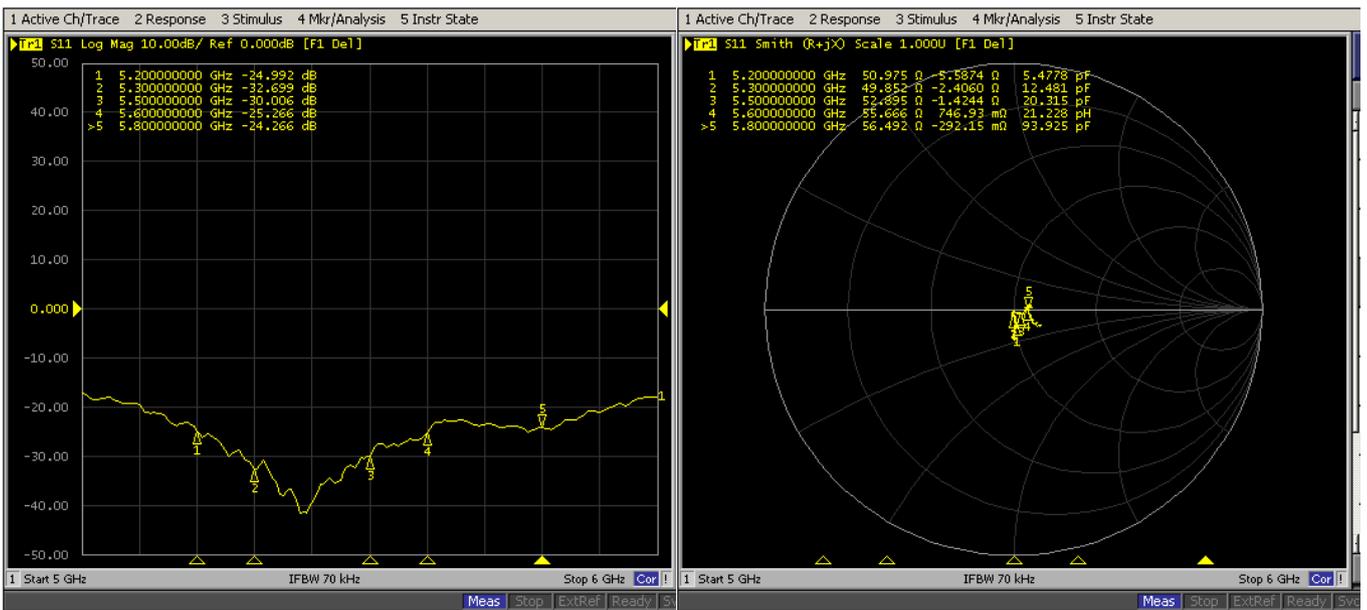
D5GHzV2 Serial No.1095							
Body							
Date of Measurement		Return Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
5200MHz	5.31.2013	-25.481	--	50.662	--	-5.322	--
	5.29.2014	-23.945	6.03	50.975	0.313	-6.336	1.014
	5.28.2015	-24.992	4.37	50.975	0	-5.587	0.749
5300MHz	5.31.2013	-35.508	--	50.785	--	-1.496	--
	5.29.2014	-31.173	12.21	49.992	0.793	-2.732	1.236
	5.28.2015	-32.699	4.90	49.852	0.14	-2.406	0.326
5500MHz	5.31.2013	-28.426	--	53.750	--	-1.184	--
	5.29.2014	-28.353	0.26	52.867	0.883	-2.742	1.558
	5.28.2015	-30.006	5.83	52.895	0.028	-1.424	1.318
5600MHz	5.31.2013	-24.537	--	56.195	--	1.139	--
	5.29.2014	-24.330	0.84	56.344	0.149	0.347	0.792
	5.28.2015	-25.266	3.85	55.666	0.678	0.746	0.399
5800MHz	5.31.2013	-25.494	--	55.594	--	0.342	--
	5.29.2014	-24.908	2.30	55.887	0.293	-1.203	1.545
	5.28.2015	-24.266	2.58	56.492	0.605	-0.292	0.911

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

Dipole Verification Data D5GHzV2 Serial No.1095 D5GHzV2-Head



D5GHzV2-Body





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 E-mail: ctt@chinattl.com <http://www.chinattl.cn>



Client

Auden

Certificate No: Z15-97057

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3661
 Calibration Procedure(s): FD-Z11-2-004-01
 Calibration Procedures for Dosimetric E-field Probes
 Calibration date: April 24, 2015

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101547	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101548	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Reference10dBAttenuator	18N50W-10dB	13-Mar-14(TMC,No.JZ14-1103)	Mar-16
Reference20dBAttenuator	18N50W-20dB	13-Mar-14(TMC,No.JZ14-1104)	Mar-16
Reference Probe EX3DV4	SN 3617	28-Aug-14(SPEAG,No.EX3-3617_Aug14)	Aug-15
DAE4	SN 777	17-Sep-14 (SPEAG, DAE4-777_Sep14)	Sep -15
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	01-Jul-14 (CTTL, No.J14X02145)	Jun-15
Network Analyzer E5071C	MY46110673	03-Feb-15 (CTTL, No.J15X00728)	Feb-16

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

Issued: April 26, 2015

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



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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, 'Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)', February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta=0$ (fs900MHz in TEM-cell; f>1800MHz: 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≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to 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 ±50MHz to ±100MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
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E-mail: entl@chinatl.com <http://www.chinatl.cn>

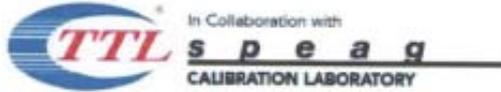
Probe EX3DV4

SN: 3661

Calibrated: April 24, 2015

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
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 E-mail: ctf@chinatl.com [Http://www.chinatl.cn](http://www.chinatl.cn)

DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3661

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm($\mu V/(V/m)^2$) ^A	0.48	0.51	0.48	±10.8%
DCP(mV) ^B	102.1	100.0	101.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB· μV	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	199.7	±2.0%
		Y	0.0	0.0	1.0		206.6	
		Z	0.0	0.0	1.0		200.9	

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 E²-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: 3661

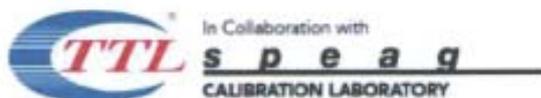
Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	9.71	9.71	9.71	0.12	1.00	±12%
835	41.5	0.90	9.60	9.60	9.60	0.10	1.57	±12%
900	41.5	0.97	9.37	9.37	9.37	0.11	1.49	±12%
1450	40.5	1.20	8.76	8.76	8.76	0.07	1.88	±12%
1750	40.1	1.37	8.43	8.43	8.43	0.13	1.73	±12%
1900	40.0	1.40	7.94	7.94	7.94	0.20	1.11	±12%
2000	40.0	1.40	7.74	7.74	7.74	0.21	1.12	±12%
2450	39.2	1.80	7.17	7.17	7.17	0.22	1.85	±12%
2600	39.0	1.96	7.10	7.10	7.10	0.26	1.38	±12%
5200	36.0	4.66	5.47	5.47	5.47	0.47	1.22	±13%
5300	35.9	4.76	5.17	5.17	5.17	0.49	1.14	±13%
5500	35.6	4.96	5.02	5.02	5.02	0.50	1.16	±13%
5600	35.5	5.07	4.96	4.96	4.96	0.50	1.15	±13%
5800	35.3	5.27	4.78	4.78	4.78	0.49	1.20	±13%

^C Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

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



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3661

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz] ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	9.72	9.72	9.72	0.15	1.25	±12%
835	55.2	0.97	9.68	9.68	9.68	0.13	1.59	±12%
900	55.0	1.05	9.37	9.37	9.37	0.21	1.18	±12%
1450	54.0	1.30	8.23	8.23	8.23	0.14	1.34	±12%
1750	53.4	1.49	7.92	7.92	7.92	0.15	1.56	±12%
1900	53.3	1.52	8.08	8.08	8.08	0.14	1.93	±12%
2000	53.3	1.52	7.68	7.68	7.68	0.15	2.17	±12%
2450	52.7	1.95	7.31	7.31	7.31	0.27	1.42	±12%
2600	52.5	2.16	7.24	7.24	7.24	0.29	1.20	±12%
5200	49.0	5.30	4.92	4.92	4.92	0.54	0.99	±13%
5300	48.9	5.42	4.64	4.64	4.64	0.55	0.90	±13%
5500	48.6	5.65	4.33	4.33	4.33	0.50	1.30	±13%
5600	48.5	5.77	4.26	4.26	4.26	0.49	1.43	±13%
5800	48.2	6.00	4.35	4.35	4.35	0.50	1.67	±13%

^C Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

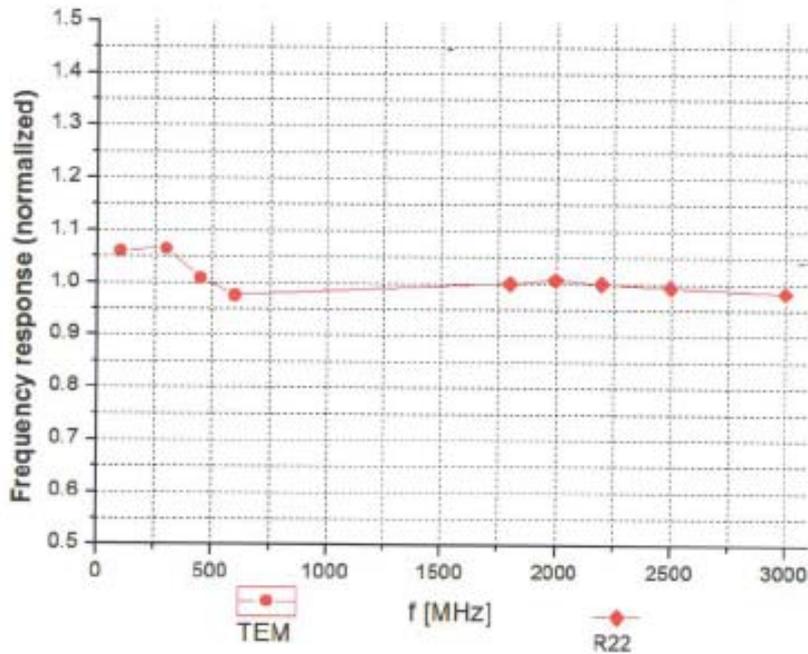
^F At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty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

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



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

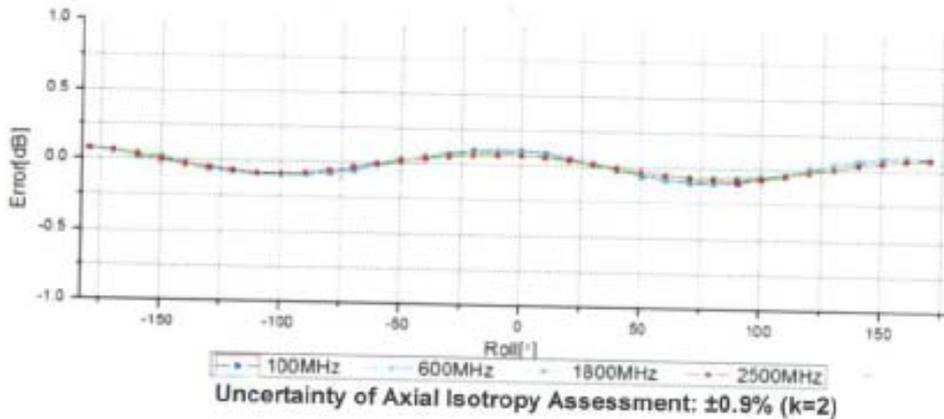
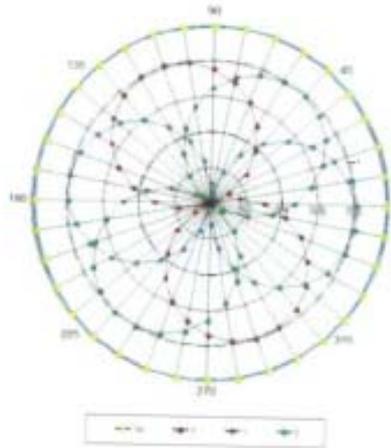
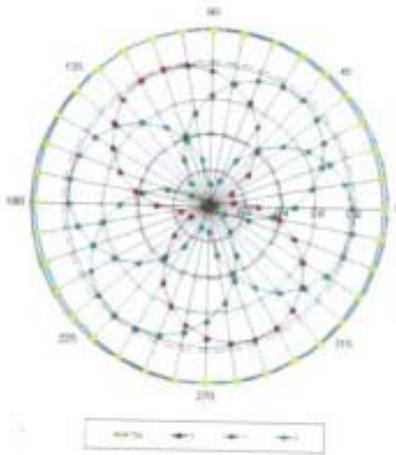


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Receiving Pattern (Φ), $\theta=0^\circ$

f=600 MHz, TEM

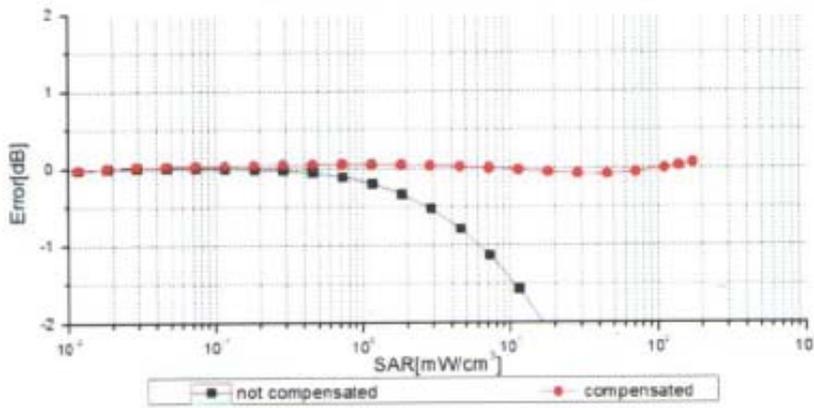
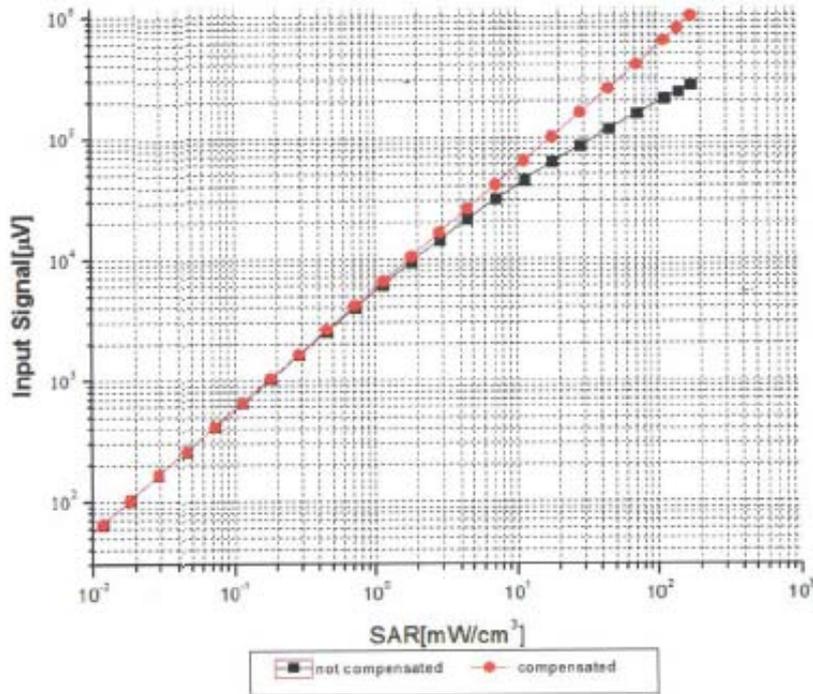
f=1800 MHz, R22





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



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

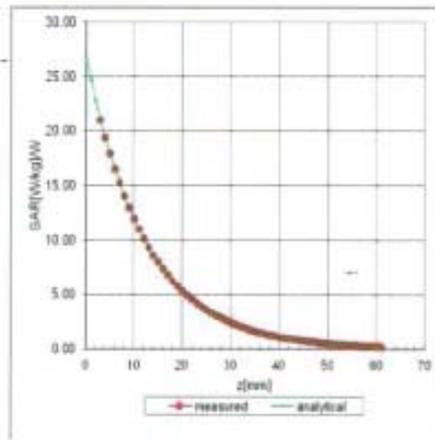
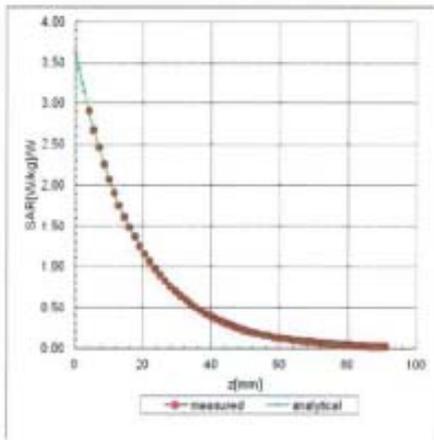


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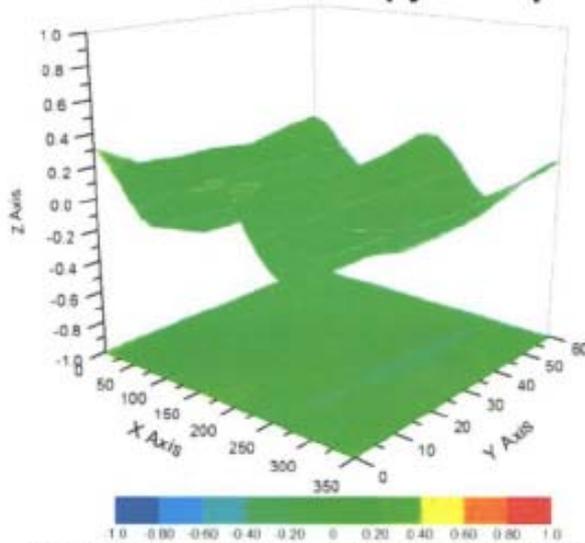
Conversion Factor Assessment

f=900 MHz, WGLS R9(H_convF)

f=1750 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid



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



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3661

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	131.7
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

Schmid & Partner Engineering AG

s p e a g

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IMPORTANT NOTICE

USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:

To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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TN_BR040315AD DAE4.doc

11.12.2009

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **DAE4-918_Dec14**

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BK - SN: 918																						
Calibration procedure(s)	QA CAL-06.v28 Calibration procedure for the data acquisition electronics (DAE)																						
Calibration date:	December 29, 2014																						
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Keithley Multimeter Type 2001</td> <td>SN: 0810278</td> <td>03-Oct-14 (No:15573)</td> <td>Oct-15</td> </tr> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> <tr> <td>Auto DAE Calibration Unit</td> <td>SE UWS 053 AA 1001</td> <td>07-Jan-14 (in house check)</td> <td>In house check: Jan-15</td> </tr> <tr> <td>Calibrator Box V2.1</td> <td>SE UMS 006 AA 1002</td> <td>07-Jan-14 (in house check)</td> <td>In house check: Jan-15</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Keithley Multimeter Type 2001	SN: 0810278	03-Oct-14 (No:15573)	Oct-15	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15	Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15
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Calibrated by:	Name Eric Hainfeld	Function Technician	Signature 																				
Approved by:	Name Fin Bomholt	Function Deputy Technical Manager	Signature 																				
			Issued: December 29, 2014																				
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																							

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Accreditation No.: **SCS 108**

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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
 - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
 - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
 - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
 - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - **Input resistance:** Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
 - **Power consumption:** Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	404.263 ± 0.02% (k=2)	404.441 ± 0.02% (k=2)	403.975 ± 0.02% (k=2)
Low Range	3.99223 ± 1.50% (k=2)	3.98766 ± 1.50% (k=2)	3.99058 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	321.5 ° ± 1 °
---	---------------

Appendix (Additional assessments outside the scope of SCS108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200032.31	-4.38	-0.00
Channel X	+ Input	20003.84	-0.13	-0.00
Channel X	- Input	-20004.78	1.10	-0.01
Channel Y	+ Input	200032.27	-4.06	-0.00
Channel Y	+ Input	20002.00	-1.87	-0.01
Channel Y	- Input	-20006.00	0.05	-0.00
Channel Z	+ Input	200034.27	-2.10	-0.00
Channel Z	+ Input	20002.22	-1.48	-0.01
Channel Z	- Input	-20008.25	-2.23	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.31	0.03	0.00
Channel X	+ Input	200.99	0.68	0.34
Channel X	- Input	-198.48	1.20	-0.60
Channel Y	+ Input	2000.13	0.00	0.00
Channel Y	+ Input	199.66	-0.39	-0.20
Channel Y	- Input	-199.91	-0.16	0.08
Channel Z	+ Input	1999.95	-0.05	-0.00
Channel Z	+ Input	198.93	-1.21	-0.60
Channel Z	- Input	-201.20	-1.44	0.72

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	5.38	3.39
	- 200	-1.40	-3.69
Channel Y	200	11.47	11.14
	- 200	-12.53	-12.38
Channel Z	200	-14.52	-14.40
	- 200	11.50	11.86

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.57	-5.19
Channel Y	200	8.22	-	0.42
Channel Z	200	9.83	6.01	-

4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15962	16466
Channel Y	16023	17247
Channel Z	15984	16328

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.60	-2.24	1.43	0.75
Channel Y	1.14	-0.87	2.02	0.43
Channel Z	-0.52	-1.84	0.61	0.42

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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s p e a g

1245

IMPORTANT NOTICE

USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

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TN_BR040315AD DAE4.doc

11.12.2009

**Calibration Laboratory of
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **CCS-CN (Auden)**

Certificate No: **DAE4-1245_Jul14**

CALIBRATION CERTIFICATE

Object: **DAE4 - SD 000 D04 BM - SN: 1245**

Calibration procedure(s): **QA CAL-06.v26
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **July 22, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	01-Oct-13 (No:13876)	Oct-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE LWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 008 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

Calibrated by:	Name R.Mayraz	Function Technician	Signature <i>R. Mayraz</i>
Approved by:	Name Fin Bornholt	Function Deputy Technical Manager	Signature <i>F. Bornholt</i>

Issued: July 22, 2014

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Accreditation No.: SCS 108

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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
 - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
 - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
 - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
 - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
 - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

Calibration Factors	X	Y	Z
High Range	405.988 ± 0.02% (k=2)	404.710 ± 0.02% (k=2)	405.849 ± 0.02% (k=2)
Low Range	4.00335 ± 1.50% (k=2)	3.98492 ± 1.50% (k=2)	4.02547 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	30.5 ° ± 1 °
---	--------------

Appendix (Additional assessments outside the scope of SCS108)
1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	199996.75	-0.27	-0.00
Channel X + Input	20001.39	1.15	0.01
Channel X - Input	-20000.78	0.74	-0.00
Channel Y + Input	199998.13	1.27	0.00
Channel Y + Input	20000.37	0.12	0.00
Channel Y - Input	-20002.24	-0.66	0.00
Channel Z + Input	199998.24	1.21	0.00
Channel Z + Input	20000.36	0.20	0.00
Channel Z - Input	-20001.75	-0.03	0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2000.33	-0.09	-0.00
Channel X + Input	200.90	0.40	0.20
Channel X - Input	-198.83	0.46	-0.23
Channel Y + Input	2000.00	-0.26	-0.01
Channel Y + Input	199.61	-0.91	-0.45
Channel Y - Input	-200.08	-0.81	0.41
Channel Z + Input	2001.30	1.40	0.07
Channel Z + Input	200.05	-0.31	-0.15
Channel Z - Input	-200.89	-1.31	0.66

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-7.83	-9.32
	- 200	10.88	9.44
Channel Y	200	-7.71	-8.33
	- 200	5.77	5.63
Channel Z	200	-5.90	-5.96
	- 200	4.79	4.74

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	2.85	-2.60
Channel Y	200	9.53	-	4.34
Channel Z	200	9.98	6.64	-

4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15875	16740
Channel Y	16455	16504
Channel Z	15939	16860

5. Input Offset Measurement

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

Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.16	-0.50	2.34	0.49
Channel Y	-0.81	-2.25	0.40	0.49
Channel Z	-0.59	-1.82	0.83	0.56

6. Input Offset Current

Nominal input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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Accreditation No.: **SCS 108**

Client **CCS-CN (Auden)**

Certificate No: **EX3-3798_Jul14**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3798**

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

Calibration date: **July 28, 2014**

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

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

Calibration Equipment used (M&E critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: July 28, 2014

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Accreditation No.: SCS 108

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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), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}:** Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR:** PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics ϕ .
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}:** A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters:** Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f \geq 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{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 ± 50 MHz to ± 100 MHz.
- Spherical Isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle:** The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3798

July 28, 2014

Probe EX3DV4

SN:3798

Manufactured: April 5, 2011
Calibrated: July 28, 2014

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

EX3DV4- SN:3798

July 28, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.54	0.51	0.59	$\pm 10.1 \%$
DCP (mV) ^B	97.6	99.3	96.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.7	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		142.0	
		Z	0.0	0.0	1.0		132.7	

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

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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

EX3DV4- SN:3798

July 28, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798**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 (mm) ^G	Uncl. (k=2)
835	41.5	0.90	9.30	9.30	9.30	0.28	1.12	± 12.0 %
900	41.5	0.97	9.13	9.13	9.13	0.58	0.68	± 12.0 %
1810	40.0	1.40	7.82	7.82	7.82	0.41	0.81	± 12.0 %
1900	40.0	1.40	7.75	7.75	7.75	0.40	0.83	± 12.0 %
2450	39.2	1.80	7.04	7.04	7.04	0.33	0.92	± 12.0 %
5200	36.0	4.66	4.81	4.81	4.81	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.60	4.60	4.60	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.67	4.67	4.67	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.56	4.56	4.56	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.55	4.55	4.55	0.40	1.80	± 13.1 %

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

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

EX3DV4- SN:3798

July 28, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798**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 (mm) ^g	Unct. (k=2)
835	55.2	0.97	9.22	9.22	9.22	0.32	1.07	± 12.0 %
900	55.0	1.05	8.96	8.96	8.96	0.55	0.76	± 12.0 %
1810	53.3	1.52	7.26	7.26	7.26	0.46	0.80	± 12.0 %
1900	53.3	1.52	7.09	7.09	7.09	0.38	0.87	± 12.0 %
2450	52.7	1.95	6.82	6.82	6.82	0.77	0.58	± 12.0 %
5200	49.0	5.30	4.41	4.41	4.41	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.23	4.23	4.23	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.91	3.91	3.91	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.75	3.75	3.75	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.09	4.09	4.09	0.50	1.90	± 13.1 %

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

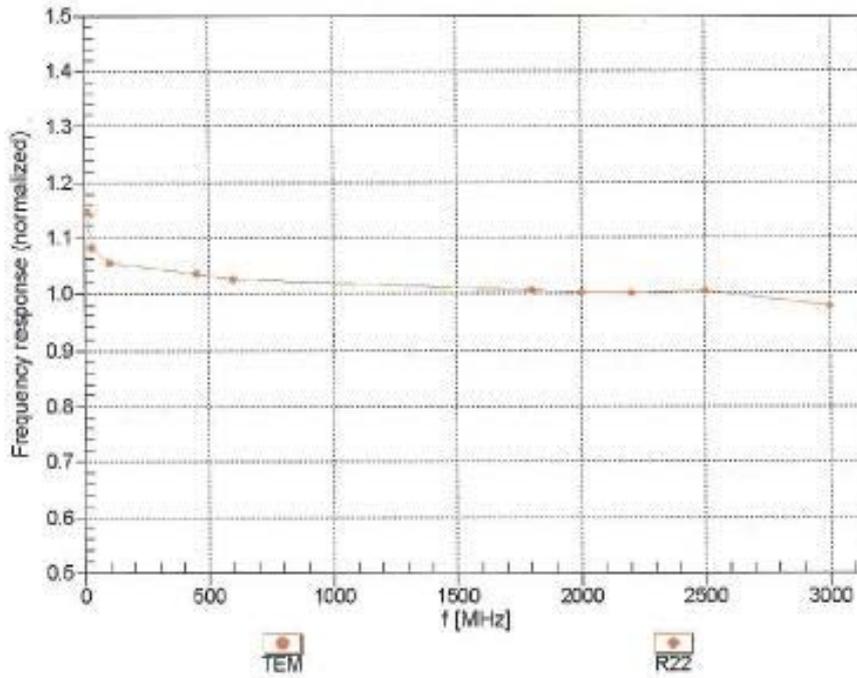
^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3798

July 28, 2014

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



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

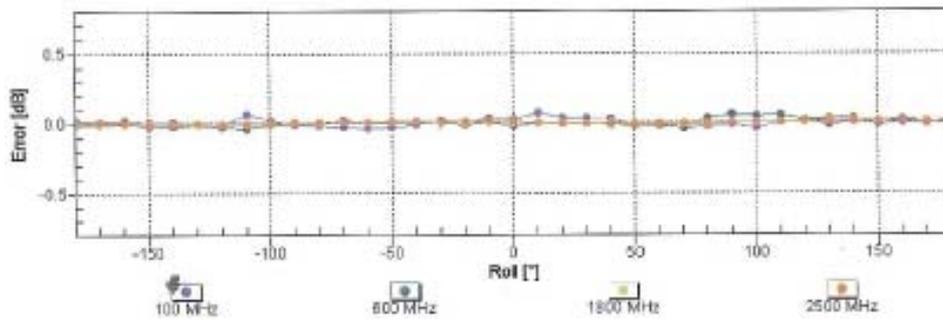
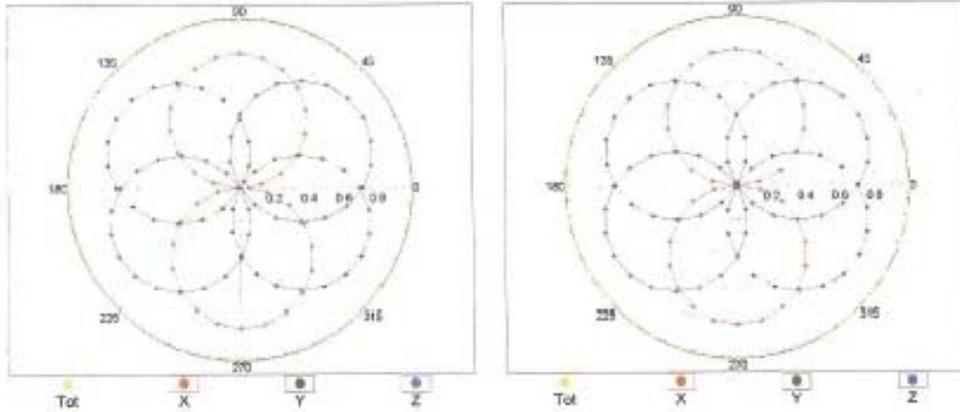
EX3DV4- SN:3796

July 28, 2014

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

f=600 MHz,TEM

f=1800 MHz,R22

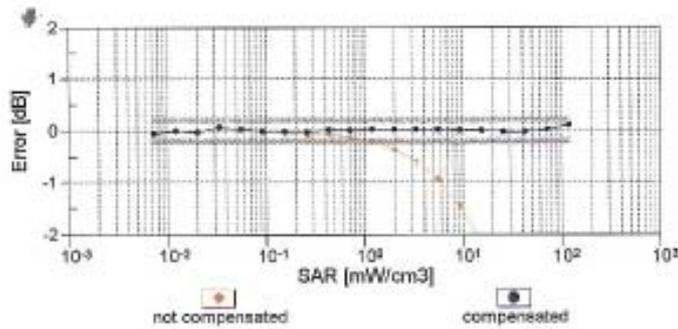
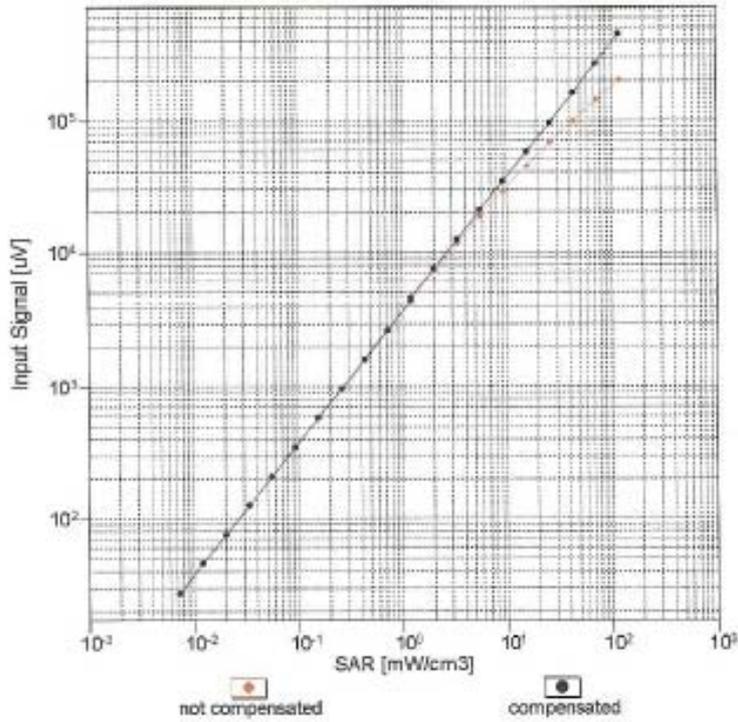


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EX3DV4- SN:3798

July 28, 2014

Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)



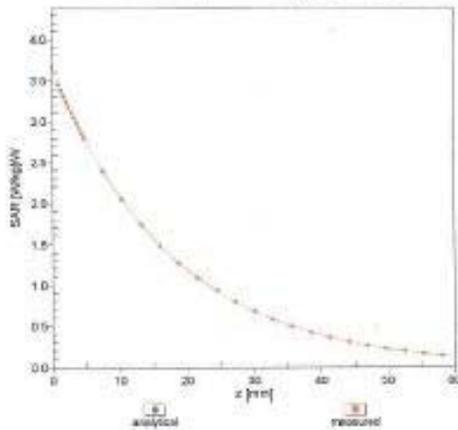
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

EX3DV4- SN:3798

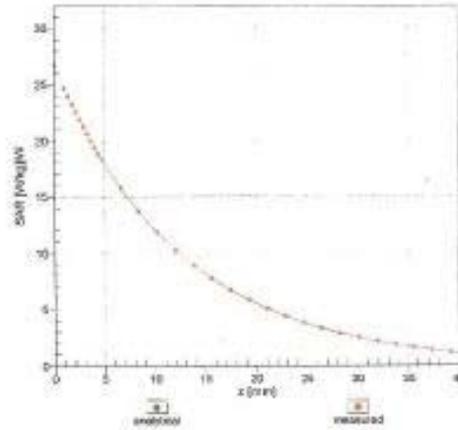
July 28, 2014

Conversion Factor Assessment

f = 900 MHz, WGLS R9 (H_convF)

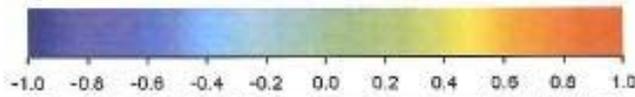
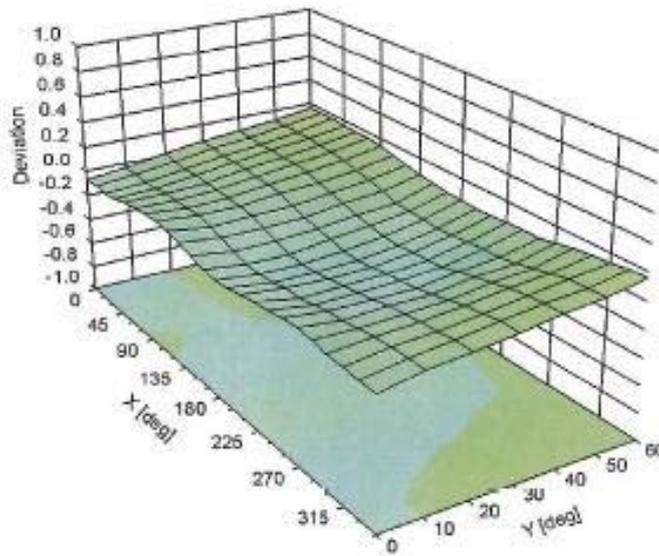


f = 1810 MHz, WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ , θ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)

EX3DV4- SN:3798

July 28, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-39.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

APPENDIX C: PLOTS OF SAR TEST RESULT

The plots are showing in the file named Appendix C Plots of SAR Test Result

END REPORT