

## SAR TEST REPORT



The following samples were submitted and identified on behalf of the client as:

**Equipment Under Test** Smart Phone  
**Brand Name** SHARP  
**Model No.** 606SH  
**Company Name** Sharp Corporation, IoT Communication BU  
**Company Address** 2-13-1, Hachihonmatsu-lida, Higashi-hiroshima-shi, Hiroshima, 739-0192, Japan  
**Standards** IEEE/ANSI C95.1-1992, IEEE 1528-2013, KDB248227D01v02r02, KDB865664D01v01r04, KDB865664D02v01r02, KDB941225D01v03r01, KDB941225D06v02r01, KDB447498D01v06, KDB648474D04v01r03,  
**FCC ID** APYHRO00250  
**Date of Receipt** Jun. 09, 2017  
**Date of Test(s)** Jun. 09, 2017 ~ Jun. 12, 2017  
**Date of Issue** Jun. 20, 2017

In the configuration tested, the EUT complied with the standards specified above.

**Remarks:**

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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**Signed on behalf of SGS****Engineer****Matt Kuo****Date: Jun. 20, 2017****Supervisor****John Yeh****Date: Jun. 20, 2017**

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## Revision History

Report Number	Revision	Description	Issue Date
E5/2017/60004	Rev.00	Initial creation of document	Jun. 16, 2017
E5/2017/60004	Rev.01	Modified TCB comments	Jun. 20, 2017

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## 1. General Information

### 1.1 Testing Laboratory

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### 1.2 Details of Applicant

Company Name	Sharp Corporation, IoT Communication BU
Company Address	2-13-1, Hachihonmatsu-lida, Higashi-hiroshima-shi, Hiroshima, 739-0192, Japan

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### 1.3 Description of EUT

EUT Name	Smart Phone		
Brand Name	SHARP		
Model No.	606SH		
FCC ID	APYHRO00250		
Mode of Operation	<input checked="" type="checkbox"/> GSM <input checked="" type="checkbox"/> GPRS <input checked="" type="checkbox"/> WLAN802.11 b/g/n (20M) <input checked="" type="checkbox"/> Bluetooth		
IMEI	004401116120540 (WWAN) 004401116120557 (WLAN/BT)		
Duty Cycle	GSM (DTM multi class B)	1/8.3	
	GPRS (support multi class 12 max)	1/2 (1Dn4UP) 1/2.76 (1Dn3UP) 1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)	
	WLAN802.11 b/g/n(20M)	1	
	Bluetooth	1	
TX Frequency Range (MHz)	GSM850	824	— 849
	GSM1900	1850	— 1910
	WLAN802.11 b/g/n(20M)	2412	— 2462
	Bluetooth	2402	— 2480
Channel Number (ARFCN)	GSM850	128	— 251
	GSM1900	512	— 810
	WLAN802.11 b/g/n(20M)	1	— 11
	Bluetooth	0	— 78

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Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Head	GSM 850	0.08	0.11	<input checked="" type="checkbox"/> Left <input type="checkbox"/> Right <input checked="" type="checkbox"/> Cheek <input type="checkbox"/> Tilt 128 Channel
	GSM 1900	0.40	0.51	<input type="checkbox"/> Left <input checked="" type="checkbox"/> Right <input checked="" type="checkbox"/> Cheek <input type="checkbox"/> Tilt 810 Channel
	WLAN802.11 b	0.24	0.29	<input type="checkbox"/> Left <input checked="" type="checkbox"/> Right <input checked="" type="checkbox"/> Cheek <input type="checkbox"/> Tilt 1 Channel

Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Body-worn	GSM 850	0.20	0.27	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 128 Channel
	GSM 1900	0.36	0.46	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back 810 Channel

Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Hotspot mode	GPRS 850 (1Dn4UP)	0.26	0.35	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back <input type="checkbox"/> Bottom <input type="checkbox"/> Right <input type="checkbox"/> Left 128 Channel
	GPRS 1900 (1Dn4UP)	0.46	0.48	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back <input type="checkbox"/> Bottom <input type="checkbox"/> Right <input type="checkbox"/> Left 810 Channel
	WLAN802.11 b	0.26	0.31	<input type="checkbox"/> Front <input checked="" type="checkbox"/> Back <input type="checkbox"/> Top <input type="checkbox"/> Right <input type="checkbox"/> Left 1 Channel

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## GSM/GPRS Conducted Output Power Table:

GSM 850 conducted output power:

EUT mode	Frequency (MHz)	CH	Max. Rated Avg. Power + Max.	Burst average power	Source-based time average power
				Avg. (dBm)	Avg. (dBm)
GSM850 (GMSK)	824.2	128	33.4	32.01	22.98
	836.6	190	33.4	31.99	22.96
	848.8	251	33.4	31.83	22.80
The division factor compared to the number of TX time slot					
Division factor				1 TX time slot	
				-9.03	

GPRS 850 conducted output power:

Burst average power						
Max. Rated Avg. Power + Max. Tolerance (dBm)			33.4	31	29.6	28.7
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)
GPRS 850	824.2	128	32.01	29.99	28.16	27.42
	836.6	190	31.99	29.93	28.19	27.31
	848.8	251	31.83	29.87	28.12	27.23
Source-based time average power						
GPRS 850	824.2	128	22.98	23.97	23.90	24.41
	836.6	190	22.96	23.91	23.93	24.30
	848.8	251	22.80	23.85	23.86	24.22
The division factor compared to the number of TX time slot						
Division factor			1 TX time slot	2 TX time slot	3 TX time slot	4 TX time slot
			-9.03	-6.02	-4.26	-3.01

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GSM 1900 conducted output power:

EUT mode	Frequency (MHz)	CH	Max. Rated Avg. Power + Max.	Burst average power	Source-based time average power
				Avg. (dBm)	Avg. (dBm)
GSM1900 (GMSK)	1850.2	512	30.4	29.18	20.15
	1800	661	30.4	29.22	20.19
	1909.8	810	30.4	29.32	20.29
The division factor compared to the number of TX time slot					
Division factor				1 TX time slot	
				-9.03	

GPRS 1900 conducted output power:

Burst average power						
Max. Rated Avg. Power + Max. Tolerance (dBm)			30.4	27.9	25.9	25.2
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)
GPRS 1900	1850.2	512	29.18	27.26	25.45	24.79
	1800	661	29.22	27.20	25.48	24.83
	1909.8	810	29.32	27.36	25.65	25.01
Source-based time average power						
GPRS 1900	1850.2	512	20.15	21.24	21.19	21.78
	1800	661	20.19	21.18	21.22	21.82
	1909.8	810	20.29	21.34	21.39	22.00
The division factor compared to the number of TX time slot						
Division factor			1 TX time slot	2 TX time slot	3 TX time slot	4 TX time slot
			-9.03	-6.02	-4.26	-3.01

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**WLAN802.11 b/g/n(20M) conducted output power table:**

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max.	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	16.50	15.73
		6	2437		16.50	15.02
		11	2462		16.50	15.28
	802.11g	1	2412	6Mbps	12.00	11.12
		6	2437		12.00	10.78
		11	2462		12.00	10.82
	802.11n-HT20	1	2412	MCS0	12.00	11.19
		6	2437		12.00	10.63
		11	2462		12.00	10.89

**Bluetooth conducted power table:**

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)			Max. Rated Avg. Power + Max. Tolerance
			1Mbps	2Mbps	3Mbps	
BR/EDR	CH 00	2402	10.31	8.92	8.89	11.5
	CH 39	2441	9.47	8.08	8.07	
	CH 78	2480	9.22	7.83	7.81	

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)	Max. Rated Avg. Power + Max. Tolerance
			GFSK	
LE	CH 00	2402	-0.63	3.5
	CH 19	2440	-1.37	
	CH 39	2480	-1.65	

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## 1.4 Test Environment

Ambient Temperature:  $22 \pm 2^{\circ}\text{C}$   
Tissue Simulating Liquid:  $22 \pm 2^{\circ}\text{C}$

## 1.5 Operation Description

1. The EUT is controlled by using a Radio Communication Tester (MT8820C), and the communication between the EUT and the tester is established by air link.
2. Measurements are performed respectively on the lowest, middle and highest channels of the operating band(s). The EUT is set to maximum power level during all tests, and at the beginning of each test the battery is fully charged.
3. During the SAR testing, the DASY 5 system checks power drift by comparing the e-field strength of one specific location measured at the beginning with that measured at the end of the SAR testing.
4. SAR test reduction for GPRS mode is determined by the source-based time-averaged output power. The data mode with highest specified time-averaged output power should be tested for SAR compliance.

### WLAN

#### 802.11b DSSS SAR Test Requirements:

5. SAR is measured for 2.4 GHz 802.11b DSSS mode using the highest measured maximum output power channel, when the reported SAR of the highest measured maximum output power channel for the exposure configuration is  $\leq 0.8\text{ W/kg}$ , no further SAR testing is required for 802.11b DSSS in that exposure configuration.
6. When the reported SAR is  $> 0.8\text{ W/kg}$ , SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is  $> 1.2\text{ W/kg}$ , SAR is required for the third channel; i.e., all channels require testing.

#### 802.11g/n OFDM SAR Test Exclusion Requirements:

7. SAR is not required for 802.11g/n since the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2\text{ W/kg}$ .

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## Other

8. BT and WLAN use the same antenna path and Bluetooth can't transmit simultaneously with WLAN.
9. According to **KDB447498D01v06**, testing of other required channels is not required when the reported 1-g SAR for the highest output channel is  $\leq 0.8$  W/kg, when the transmission band is  $\leq 100$  MHz.
10. According to **KDB865664D01v01r04**, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is  $\geq 0.8$  W/kg, repeated that measurement once. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit)
11. According to **KDB447498D01v06** – The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  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  $\leq 7.5$  for product specific 10-g SAR.

Mode	Position	Max. Power (dBm)	f(GHz)	Calculation	SAR exclusion threshold	SAR test exclusion
BT	Body-worn	11.5	2.48	2.224	3	yes

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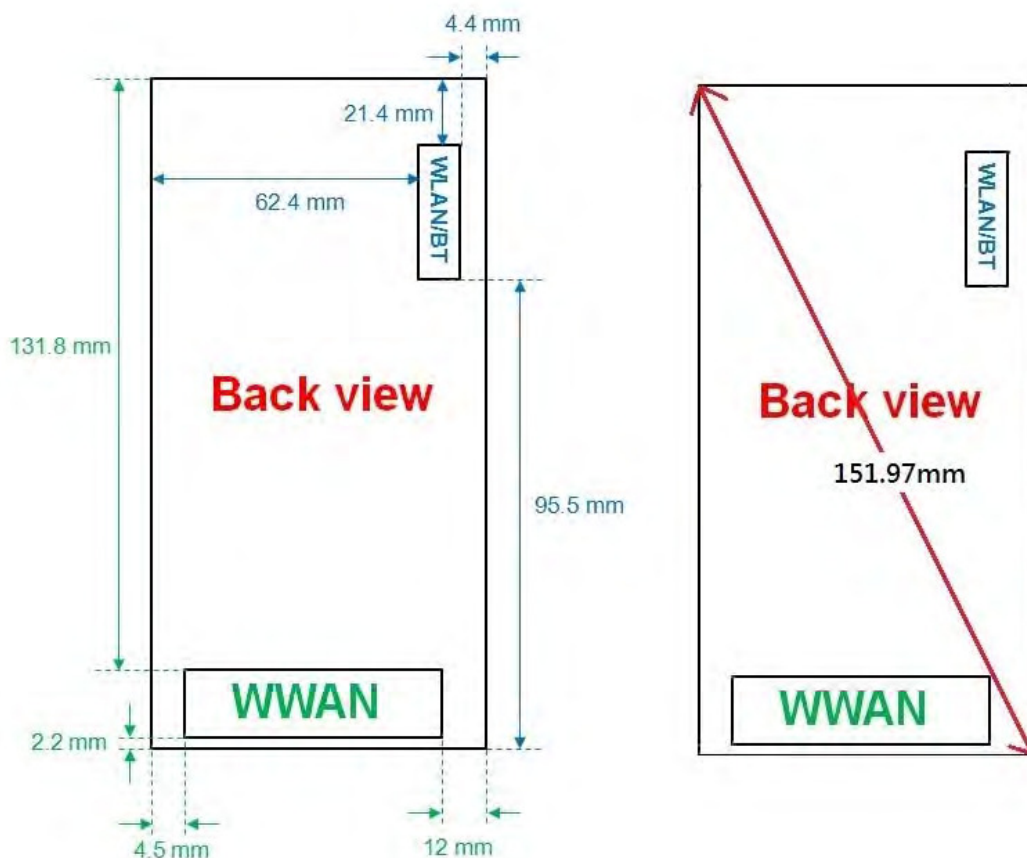
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The location of the antennas (Back View)

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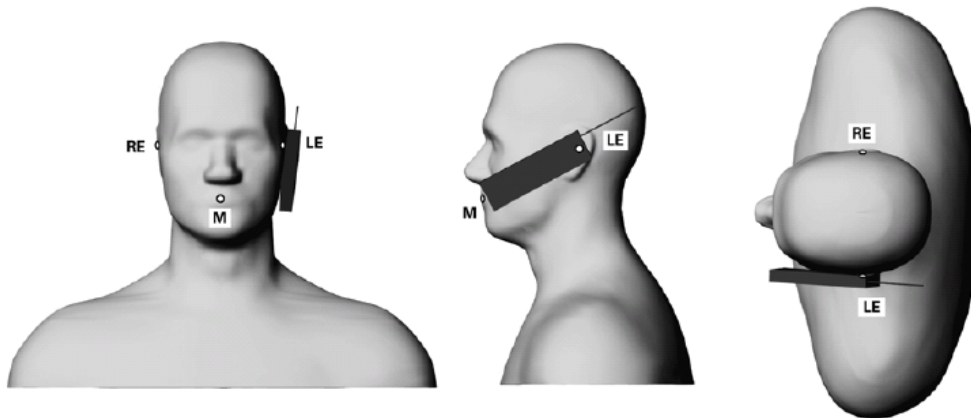
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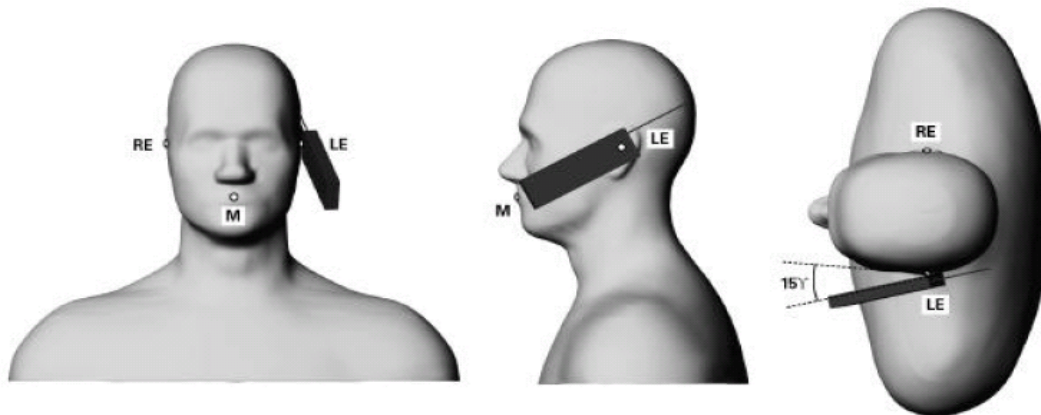
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## 1.6 Positioning Procedure

### Head SAR measurement statement



Phone position 1, “cheek” or “touch” position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning.



Phone position 2, “tilted position.” The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning.

#### Cheek/Touch Position:

The handset was brought toward the mouth of the head phantom by pivoting against the ear reference point until any point of the mouthpiece or keypad touched the phantom.

#### Ear/Tilt Position:

With the phone aligned in the Cheek/Touch position, the handset was tilted away from the mouth with respect to the test device reference point by 15 degrees.

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## Body SAR measurement statement

### 1. Body-worn exposure: 10mm

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB Publication 447498 D01 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. When the same wireless transmission configuration is used for testing body-worn accessory and hotspot mode SAR, respectively, in voice and data mode, SAR results for the most conservative test separation distance configuration may be used to support both SAR conditions. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is  $> 1.2 \text{ W/kg}$ , the highest reported SAR configuration for that wireless mode and frequency band should be repeated for the body-worn accessory with a headset attached to the handset.

### 2. Hotspot exposure: 10mm

A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge when the form factor of a handset is larger than  $9 \text{ cm} \times 5 \text{ cm}$ ,

#### Test configurations of WWAN:

- (1) Front side
- (2) Back side
- (3) Bottom side
- (4) Right side
- (5) Left side

#### Test configurations of WLAN:

- (1) Front side
- (2) Back side
- (3) Top side
- (4) Left side

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## 1.7 Evaluation Procedures

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

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

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within -2 dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5mm.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7x7x7 scans.

The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30x30x30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points

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between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is then moved around until the highest averaged SAR is found.

If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

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## 1.8 Probe Calibration Procedures

For the calibration of E-field probes in lossy liquids, an electric field with an accurately known field strength must be produced within the measured liquid. For standardization purposes it would be desirable if all measurements which are necessary to assess the correct field strength would be traceable to standardized measurement procedures. In the following two different calibration techniques are summarized:

### 1.8.1 Transfer Calibration with Temperature Probes

In lossy liquids the specific absorption rate (SAR) is related both to the electric field ( $E$ ) and the temperature gradient ( $\delta T / \delta t$ ) in the liquid.

$$SAR = C \frac{\delta T}{\delta t},$$

Whereby  $\sigma$  is the conductivity,  $\rho$  the density and  $c$  the heat capacity of the liquid.

Hence, the electric field in lossy liquid can be measured indirectly by measuring the temperature gradient in the liquid. Non-disturbing temperature probes (optical probes or thermistor probes with resistive lines) with high spatial resolution ( $<1-2$  mm) and fast reaction time ( $<1$  s) are available and can be easily calibrated with high precision [1]. The setup and the exciting source have no influence on the calibration; only the relative positioning uncertainties of the standard temperature probe and the E-field probe to be calibrated must be considered. However, several problems limit the available accuracy of probe calibrations with temperature probes:

1. The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects

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cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept small.

2. The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
3. The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures ( $\sim 2\%$  for  $c$ ; much better for  $\rho$ ), there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed  $\pm 5\%$ .
4. Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

Considering these problems, the possible accuracy of the calibration of E-field probes with temperature gradient measurements in a carefully designed setup is about  $\pm 10\%$  (RSS) [2]. Recently, a setup which is a combination of the waveguide techniques and the thermal measurements was presented in [3]. The estimated uncertainty of the setup is  $\pm 5\%$  (RSS) when the same liquid is used for the calibration and for actual measurements and  $\pm 7-9\%$  (RSS) when not, which is in good agreement with the estimates given in [2].

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### 1.8.2 Calibration with Analytical Fields

In this method a technical setup is used in which the field can be calculated analytically from measurements of other physical magnitudes (e.g., input power). This corresponds to the standard field method for probe calibration in air; however, there is no standard defined for fields in lossy liquids.

When using calculated fields in lossy liquids for probe calibration, several points must be considered in the assessment of the uncertainty:

1. The setup must enable accurate determination of the incident power.
2. The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
3. Due to the small wavelength in liquids with high permittivity, even small setups might be above the resonant cutoff frequencies. The field distribution in the setup must be carefully checked for conformity with the theoretical field distribution.

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- (1) N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
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## 1.9 The SAR Measurement System

A block diagram of the SAR measurement system is given in Fig. a. This SAR measurement system uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 5 professional system). Model EX3DV4 field probes are used to determine the internal electric fields. The SAR can be obtained from the equation  $SAR = \sigma (|E_i|^2) / \rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant.

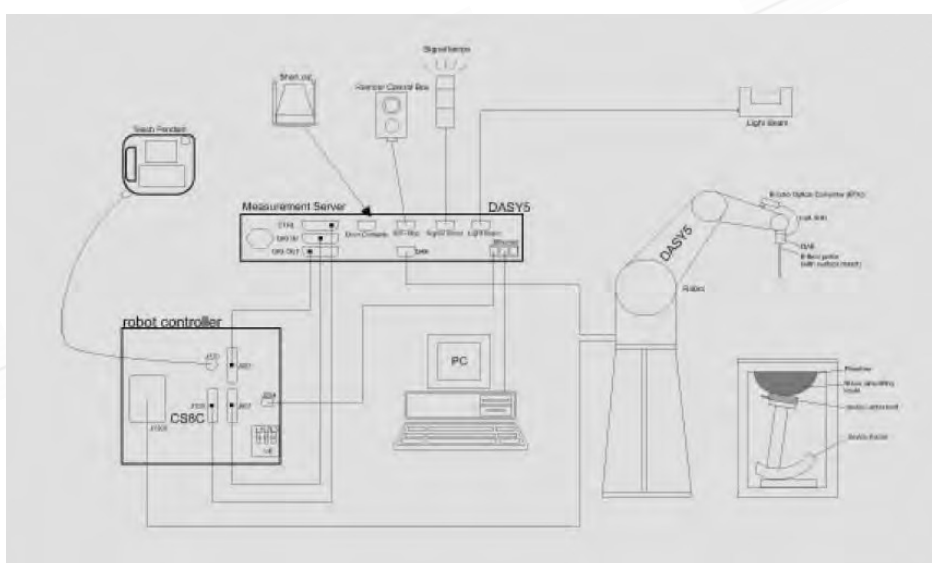


Fig. a A block diagram of the SAR measurement system

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The DASY 5 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. Data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. The 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.
5. 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.
6. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
7. A computer operating Windows7
8. DASY 5 software.
9. Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
10. The SAM twin phantom enabling testing left-hand and right-hand usage.
11. The device holder for handheld mobile phones.
12. Tissue simulating liquid mixed according to the given recipes.
13. Validation dipole kits allowing to validate the proper functioning of the system.

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## 1.10 System Components

### EX3DV4 E-Field Probe

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 Conversion Factors (CF) for HSL835/1900/2450 MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz, Linearity: $\pm 0.6$ dB	
Directivity	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 $\mu$ W/g to > 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)	
Dimensions	Tip diameter: 2.5 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%.	

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## SAM PHANTOM V4.0C

Construction:	<p>The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209.</p> <p>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.</p>	
Shell Thickness:	2 ± 0.2 mm	
Filling Volume:	Approx. 25 liters	
Dimensions:	Height: 850 mm; Length: 1000 mm; Width: 500 mm	

## DEVICE HOLDER

Construction	<p>In combination with the Twin SAM Phantom V4.0/V4.0C or Twin SAM, 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, flat phantom).</p>	 <p>Device Holder</p>
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## 1.11 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within  $\pm 10\%$  (according to KDB865664D01) from the target SAR values.

These tests were done at 835/1900/2450 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. During the tests, the liquid depth above the ear reference points was above 15 cm ( $\leq 3G$ ) or 10 cm ( $> 3G$ ) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

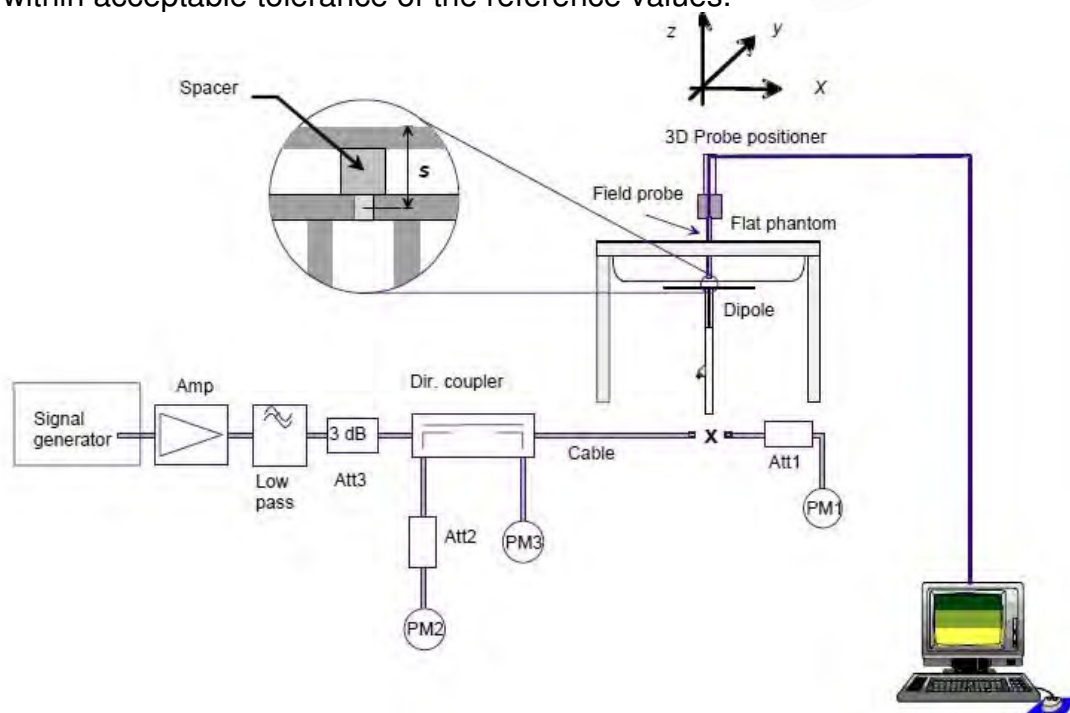


Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D835V2	4d063	835	Head	9.4	2.41	9.64	2.55%	Jun. 11, 2017
			Body	9.57	2.42	9.68	1.15%	Jun. 10, 2017
D1900V2	5d142	1900	Head	39.8	9.59	38.36	-3.62%	Jun. 11, 2017
			Body	40.2	9.89	39.56	-1.59%	Jun. 09, 2017
D2450V2	727	2450	Head	52.2	13.1	52.4	0.38%	Jun. 12, 2017
			Body	50.6	12.4	49.6	-1.98%	Jun. 12, 2017

Table 1. Results of system validation

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## 1.12 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this Head-simulant fluid were measured by using the Agilent Model 85070E Dielectric Probe (rates frequency band 200 MHz to 20 GHz) in conjunction with Network Analyzer.

All dielectric parameters of tissue simulates were measured within 24 hours of SAR measurements. The depth of the tissue simulant in the flat section of the phantom was at least 15 cm ( $\leq 3G$ ) or 10 cm ( $> 3G$ ) during all tests. (Appendix Fig. 2)

Tissue Type	Measurement Date	Measured Frequency (MHz)	Target Dielectric Constant, $\epsilon_r$	Target Conductivity, $\sigma$ (S/m)	Measured Dielectric Constant, $\epsilon_r$	Measured Conductivity, $\sigma$ (S/m)	% dev $\epsilon_r$	% dev $\sigma$
Head	Jun. 11, 2017	824.2	41.556	0.899	41.293	0.872	0.63%	3.02%
		835	41.500	0.900	41.158	0.883	0.82%	1.89%
	Jun. 11, 2017	1900	40.000	1.400	39.982	1.384	0.05%	1.14%
		1909.8	40.000	1.400	39.946	1.390	0.14%	0.71%
	Jun. 12, 2017	2412	39.268	1.766	40.294	1.793	-2.61%	-1.52%
		2450	39.200	1.800	40.133	1.839	-2.38%	-2.17%
Body	Jun. 10, 2017	824.2	55.242	0.969	56.261	0.998	-1.84%	-2.98%
		835	55.200	0.970	56.212	1.010	-1.83%	-4.12%
	Jun. 9, 2017	1900	53.300	1.520	51.766	1.524	2.88%	-0.26%
		1909.8	53.300	1.520	51.758	1.534	2.89%	-0.92%
	Jun. 12, 2017	2412	52.751	1.914	53.632	1.952	-1.67%	-2.00%
		2450	52.700	1.950	53.237	1.995	-1.02%	-2.31%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

The composition of the tissue simulating liquid:

Frequency (MHz)	Mode	Ingredient						Total amount
		DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	
850	Head	—	532.98 g	18.3 g	2.4 g	3.2 g	766 g	1.3L(Kg)
	Body	—	631.68 g	11.72 g	1.2 g	—	600 g	1.0L(Kg)
1900	Head	444.52 g	552.42 g	3.06 g	—	—	—	1.0L(Kg)
	Body	300.67 g	716.56 g	4.0 g	—	—	—	1.0L(Kg)
2450	Head	550ml	450ml	—	—	—	—	1.0L(Kg)
	Body	301.7ml	698.3ml	—	—	—	—	1.0L(Kg)

Table 3. Recipes for tissue simulating liquid

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### 1.13 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1, By the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.

These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter.

Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

1. Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over a 10 grams of tissue (defined as a tissue volume in the shape of a cube).

Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

2. Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube).

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Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube).

General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure.

Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.(Table .6)

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR (Brain)	1.60 W/kg	8.00 W/kg
Spatial Average SAR (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 W/kg	20.00 W/kg

Table 4. RF exposure limits

Notes:

1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

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## 2. Summary of Results

### GSM 850

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 1g (W/kg)		Plot page
								Measured	Reported	
GSM850 (Head)	Right Cheek	-	128	824.2	33.4	32.01	37.72%	0.074	0.102	-
	Right Tilt	-	128	824.2	33.4	32.01	37.72%	0.051	0.070	-
	Left Cheek	-	128	824.2	33.4	32.01	37.72%	0.076	0.105	36
	Left Tilt	-	128	824.2	33.4	32.01	37.72%	0.050	0.069	-
GSM850 (Body-Worn)	Front side	10	128	824.2	33.4	32.01	37.72%	0.151	0.208	-
	Back side	10	128	824.2	33.4	32.01	37.72%	0.197	0.271	37
GPRS850 (Hotspot) (1Dn4UP)	Front side	10	128	824.2	28.7	27.42	34.28%	0.169	0.227	-
	Back side	10	128	824.2	28.7	27.42	34.28%	0.262	0.352	38
	Bottom side	10	128	824.2	28.7	27.42	34.28%	0.017	0.023	-
	Right side	10	128	824.2	28.7	27.42	34.28%	0.160	0.215	-
	Left side	10	128	824.2	28.7	27.42	34.28%	0.103	0.138	-

### GSM 1900

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 1g (W/kg)		Plot page
								Measured	Reported	
GSM1900 (Head)	Right Cheek	-	810	1909.8	30.4	29.32	28.23%	0.396	0.508	39
	Right Tilt	-	810	1909.8	30.4	29.32	28.23%	0.106	0.136	-
	Left Cheek	-	810	1909.8	30.4	29.32	28.23%	0.192	0.246	-
	Left Tilt	-	810	1909.8	30.4	29.32	28.23%	0.114	0.146	-
GSM1900 (Body-Worn)	Front side	10	810	1909.8	30.4	29.32	28.23%	0.322	0.413	-
	Back side	10	810	1909.8	30.4	29.32	28.23%	0.355	0.455	40
GPRS1900 (Hotspot) (1Dn4UP)	Front side	10	810	1909.8	25.2	25.01	4.47%	0.460	0.481	-
	Back side	10	810	1909.8	25.2	25.01	4.47%	0.462	0.483	41
	Bottom side	10	810	1909.8	25.2	25.01	4.47%	0.122	0.127	-
	Right side	10	810	1909.8	25.2	25.01	4.47%	0.325	0.340	-
	Left side	10	810	1909.8	25.2	25.01	4.47%	0.047	0.049	-

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# WLAN802.11 b

Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Scaling	Averaged SAR over 1g (W/kg)		Plot page
								Measured	Reported	
WLAN 802.11b (Head)	Right Cheek	-	1	2412	16.5	15.73	19.40%	0.239	0.285	42
	Right Tilt	-	1	2412	16.5	15.73	19.40%	0.092	0.110	-
	Left Cheek	-	1	2412	16.5	15.73	19.40%	0.072	0.086	-
	Left Tilt	-	1	2412	16.5	15.73	19.40%	0.042	0.050	-
WLAN 802.11b (Hotspot )	Front side	10	1	2412	16.5	15.73	19.40%	0.051	0.061	-
	Back side	10	1	2412	16.5	15.73	19.40%	0.256	0.306	43
	Top side	10	1	2412	16.5	15.73	19.40%	0.015	0.018	-
	Left side	10	1	2412	16.5	15.73	19.40%	0.172	0.205	-

Note:

$$\text{Scaling} = \frac{\text{reported SAR}}{\text{measured SAR}} = \frac{P_2(\text{mW})}{P_1(\text{mW})} = 10^{\left(\frac{P_2 - P_1}{10}\right)} (\text{dBm})$$

Reported SAR = measured SAR \* (scaling)

Where P2 is maximum specified power, P1 is measured conducted power

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### 3. Simultaneous Transmission Analysis

#### Simultaneous Transmission Scenarios:

Simultaneous Transmit Configurations	Head	Body-Worn	Hotspot
GSM + 2.4GHz Wi-Fi	Yes	Yes	No
GPRS + 2.4GHz Wi-Fi	No	No	Yes
GSM + BT	No	Yes	No
GPRS + BT	No	No	No

**Note:**

1. The device does not support DTM function. Body-worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
2. Based on KDB447498D01 note 36, when SAR test exclusion is allowed by other published RF exposure KDB procedures, such as the 2.5 cm hotspot mode SAR test exclusion for an edge or surface, then estimated SAR is not required to determine simultaneous SAR test exclusion.
3. Held to ear configuration is not applicable to Bluetooth and therefore were not considered for simultaneous transmission.

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### 3.1 Estimated SAR calculation

According to KDB447498 D01v06 – When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$$\text{Estimated SAR} = \frac{\text{Max.tune up power (mW)}}{\text{Min.test separation distance(mm)}} \times \frac{\sqrt{f(\text{GHz})}}{7.5}$$

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

Mode	Position	Max. Power (dBm)	f(GHz)	Distance (mm)	x	Estimated SAR
BT	Body-worn	11.5	2.48	10	7.5	0.297 (1g)

### 3.2 SPLSR evaluation and analysis

Per KDB447498D01, when the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR sum to peak location separation ratio(SPLSR).

The simultaneous transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion.

The ratio is determined by  $(\text{SAR1} + \text{SAR2})^{1.5}/R_i$ , rounded to two decimal digits, and must be  $\leq 0.04$  for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

SAR1 and SAR2 are the highest reported or estimated SAR for each antenna in the pair, and  $R_i$  is the separation distance between the peak SAR locations for the antenna pair in mm.

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna.

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## Simultaneous Transmission Combination

### WWAN + WiFi 2.4GHz

reported SAR WWAN and WLAN 2.4GHz, SAR evaluation					
Frequency band	Position		reported SAR / W/kg		ΣSAR
			WWAN	WLAN	<1.6W/kg
GSM 850	Head	Right Cheek	0.102	0.285	0.39
		Right Tilt	0.070	0.110	0.18
		Left Cheek	0.105	0.086	0.19
		Left Tilt	0.069	0.050	0.12
GSM 850	Body-worn	Front	0.208	0.061	0.27
		Back	0.271	0.306	0.58
GPRS 850 (1Dn4UP)	Hotspot	Front	0.227	0.061	0.29
		Back	0.352	0.306	0.66
		Top	-	0.018	-
		Bottom	0.023	-	-
		Right	0.215	-	-
		Left	0.138	0.205	0.34
GSM 1900	Head	Right Cheek	0.508	0.285	0.79
		Right Tilt	0.136	0.110	0.25
		Left Cheek	0.246	0.086	0.33
		Left Tilt	0.146	0.050	0.20
GSM 1900	Body-worn	Front	0.413	0.061	0.47
		Back	0.455	0.306	0.76
GPRS 1900 (1Dn4UP)	Hotspot	Front	0.481	0.061	0.54
		Back	0.483	0.306	<b>0.79</b>
		Top	-	0.018	-
		Bottom	0.127	-	-
		Right	0.340	-	-
		Left	0.049	0.205	0.25

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## WWAN + Bluetooth

reported SAR WWAN and Bluetooth, $\Sigma$ SAR evaluation					
Frequency band	Position		reported SAR / W/kg		$\Sigma$ SAR
			WWAN	Bluetooth	<1.6W/kg
GSM 850	Body-worn	Front	0.208	0.297	0.51
		Back	0.271	0.297	0.57
GSM 1900	Body-worn	Front	0.413	0.297	0.71
		Back	0.455	0.297	0.75

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## 4. Instruments List

Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Dosimetric E-Field Probe	EX3DV4	3938	Nov.25,2016	Nov.24,2017
SPEAG	System Validation Dipole	D835V2	4d063	Aug.25,2016	Aug.24,2017
		D1900V2	5d142	Jun.23,2016	Jun.22,2017
		D2450V2	727	Apr.21,2017	Apr.20,2018
SPEAG	Data acquisition Electronics	DAE4	1336	Nov.22,2016	Nov.21,2017
SPEAG	Software	DASY 52 V52.8.8	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	SAM	N/A	Calibration not required	Calibration not required
Network Analyzer	Agilent	E5071C	MY46107530	Jan.20,2017	Jan.19,2018
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	772D	MY52180142	Apr.13,2017	Apr.12,2018
		778D	MY52180302	Apr.13,2017	Apr.12,2018
Agilent	RF Signal Generator	N5181A	MY50144143	Mar.01,2017	Feb.28,2018
Agilent	Power Meter	E4417A	MY51410006	Jan.20,2017	Jan.19,2018
Agilent	Power Sensor	E9301H	MY51470001	Jan.20,2017	Jan.19,2018
		E9301H	MY51470002	Jan.20,2017	Jan.19,2018
TECPEL	Digital thermometer	DTM-303A	TP130077	Mar.17,2017	Mar.16,2018
Anritsu	Radio Communication Test	MT8820C	6201061049	Apr.08,2017	Apr.07,2018

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## 5. Measurements

Date: 2017/6/11

### GSM 850\_Head\_Left Cheek\_CH 128

Communication System: GSM; Frequency: 824.2 MHz; Duty Cycle: 1:8.3

Medium parameters used:  $f = 824.2$  MHz;  $\sigma = 0.872$  S/m;  $\epsilon_r = 41.293$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

Ambient temperature: 22.2°C; Liquid temperature: 21.9°C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.74, 9.74, 9.74); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (81x131x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.0858 W/kg

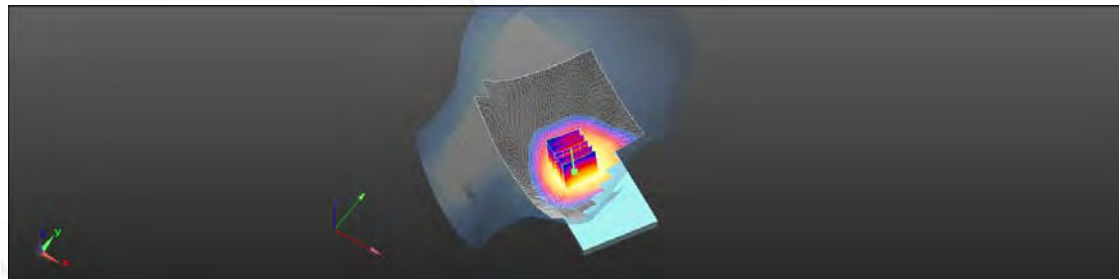
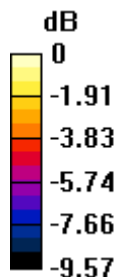
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 2.659 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.0940 W/kg

**SAR(1 g) = 0.076 W/kg; SAR(10 g) = 0.058 W/kg**

Maximum value of SAR (measured) = 0.0861 W/kg



0 dB = 0.0861 W/kg = -10.65 dBW/kg

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Date: 2017/6/10

**GSM 850\_Body-worn\_Back side\_CH 128\_10mm**

Communication System: GSM; Frequency: 824.2 MHz; Duty Cycle: 1:8.3

Medium parameters used:  $f = 824.2$  MHz;  $\sigma = 0.998$  S/m;  $\epsilon_r = 56.261$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.3°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(9.33, 9.33, 9.33); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (71x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.241 W/kg

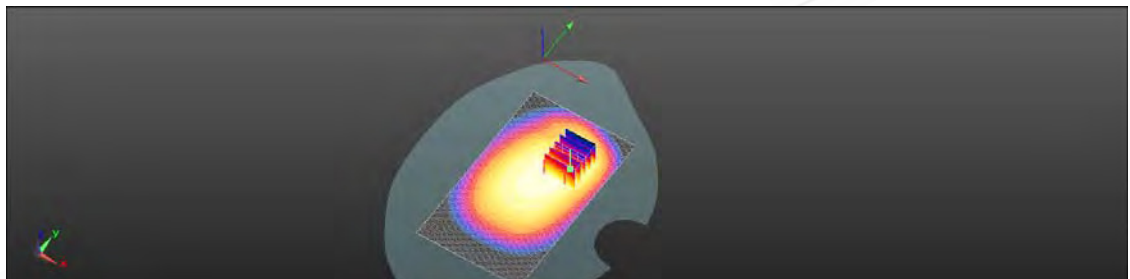
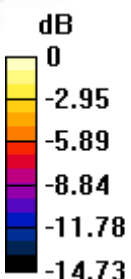
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 14.16 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 0.285 W/kg

**SAR(1 g) = 0.197 W/kg; SAR(10 g) = 0.134 W/kg**

Maximum value of SAR (measured) = 0.239 W/kg



0 dB = 0.239 W/kg = -6.22 dBW/kg

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Date: 2017/6/10

**GPRS 850\_Hotspot\_Back side\_CH 128\_10mm**

Communication System: GPRS (1Dn4Up); Frequency: 824.2 MHz; Duty Cycle: 1:2  
Medium parameters used:  $f = 824.2$  MHz;  $\sigma = 0.998$  S/m;  $\epsilon_r = 56.261$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Ambient temperature: 22.3°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(9.33, 9.33, 9.33); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (71x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.320 W/kg

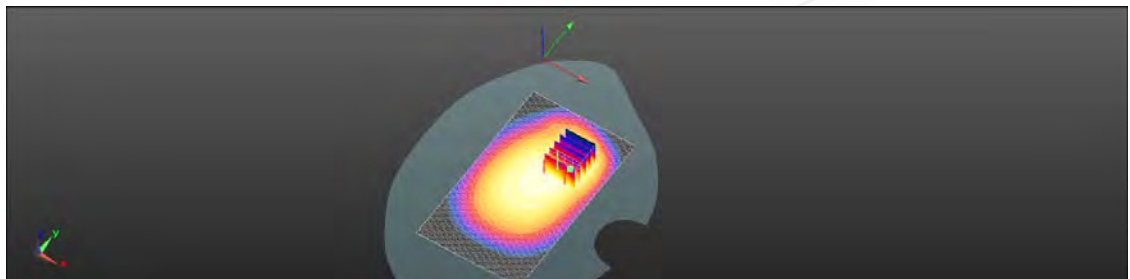
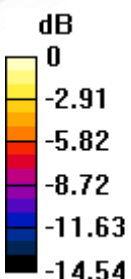
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 16.26 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.382 W/kg

**SAR(1 g) = 0.262 W/kg; SAR(10 g) = 0.176 W/kg**

Maximum value of SAR (measured) = 0.317 W/kg



0 dB = 0.317 W/kg = -4.99 dBW/kg

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Date: 2017/6/11

**GSM 1900\_Head\_Right Cheek\_CH 810**

Communication System: GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium parameters used:  $f = 1910$  MHz;  $\sigma = 1.39$  S/m;  $\epsilon_r = 39.946$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(8.15, 8.15, 8.15); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (81x131x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.565 W/kg

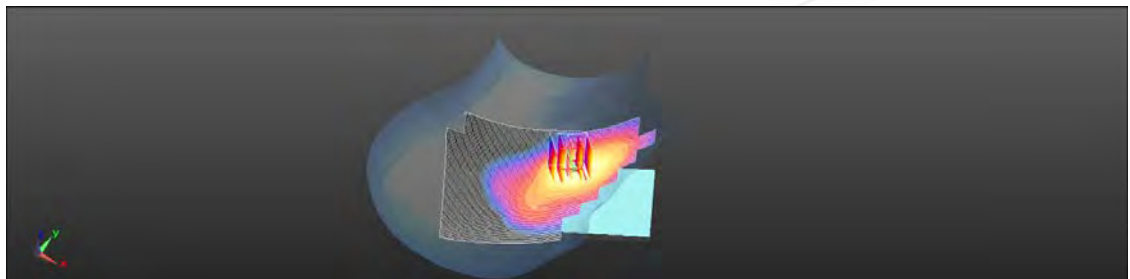
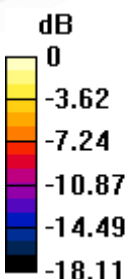
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.254 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.606 W/kg

**SAR(1 g) = 0.396 W/kg; SAR(10 g) = 0.243 W/kg**

Maximum value of SAR (measured) = 0.512 W/kg



0 dB = 0.512 W/kg = -2.91 dBW/kg

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Date: 2017/6/9

**GSM 1900\_Body-worn\_Back side\_CH 810\_10mm**

Communication System: GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium parameters used:  $f = 1910$  MHz;  $\sigma = 1.534$  S/m;  $\epsilon_r = 51.758$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.77, 7.77, 7.77); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (81x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.493 W/kg

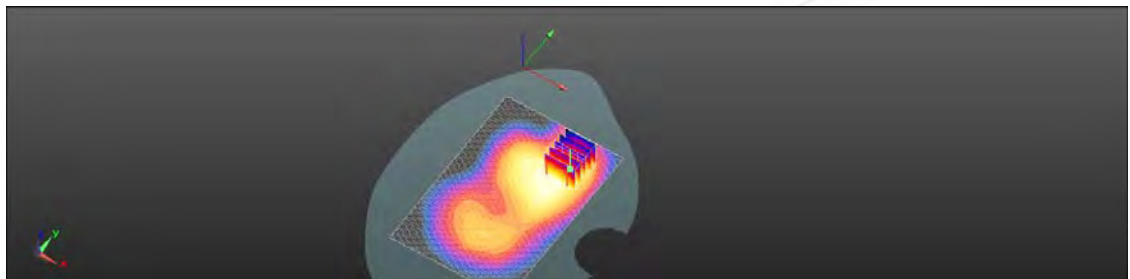
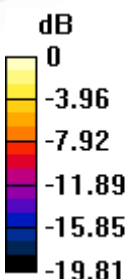
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.596 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.593 W/kg

**SAR(1 g) = 0.355 W/kg; SAR(10 g) = 0.209 W/kg**

Maximum value of SAR (measured) = 0.471 W/kg



0 dB = 0.471 W/kg = -3.27 dBW/kg

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Date: 2017/6/9

**GPRS 1900\_Hotspot\_Back side\_CH 810\_10mm**

Communication System: GPRS (1Dn4Up); Frequency: 1909.8 MHz; Duty Cycle: 1:2  
Medium parameters used:  $f = 1910$  MHz;  $\sigma = 1.534$  S/m;  $\epsilon_r = 51.758$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.77, 7.77, 7.77); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (81x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.644 W/kg

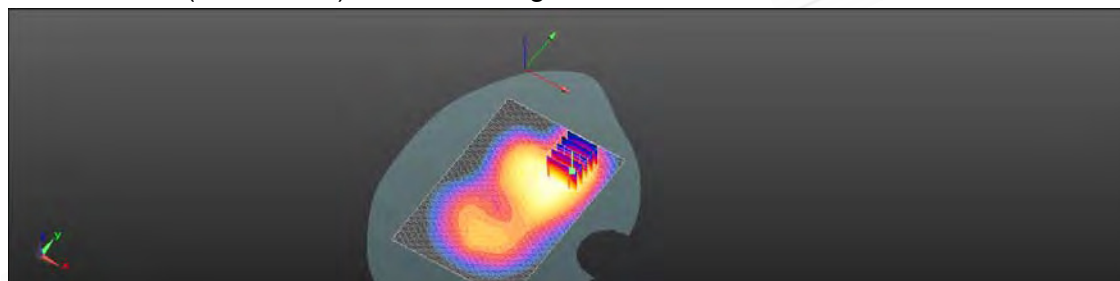
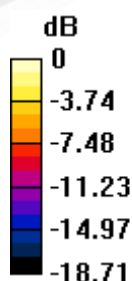
**Configuration/Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 8.755 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 0.774 W/kg

**SAR(1 g) = 0.462 W/kg; SAR(10 g) = 0.272 W/kg**

Maximum value of SAR (measured) = 0.615 W/kg



0 dB = 0.615 W/kg = -2.11 dBW/kg

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Date: 2017/6/12

**WLAN 802.11b\_Head\_Right Cheek\_CH 1**

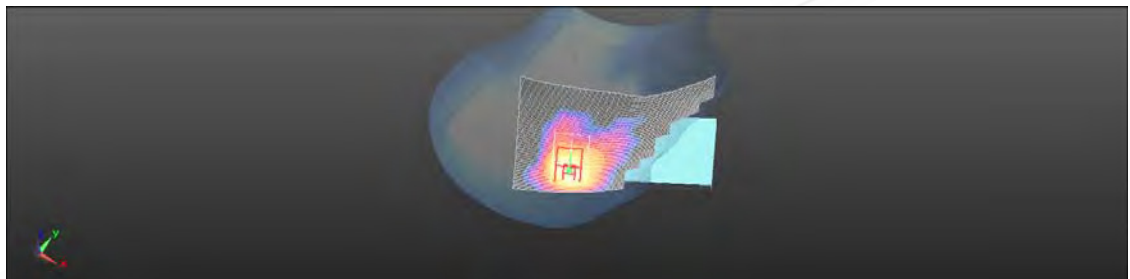
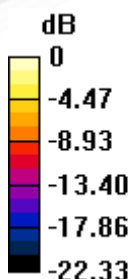
Communication System: WLAN 2.4G; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.793 \text{ S/m}$ ;  $\epsilon_r = 40.294$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Right Section

Ambient temperature:  $22.1^\circ\text{C}$ ; Liquid temperature:  $21.9^\circ\text{C}$ **DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.36, 7.36, 7.36); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (91x151x1):** Interpolated grid:  $dx=12 \text{ mm}$ ,  $dy=12 \text{ mm}$ Maximum value of SAR (interpolated) =  $0.376 \text{ W/kg}$ **Configuration/Head/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ Reference Value =  $4.201 \text{ V/m}$ ; Power Drift =  $0.09 \text{ dB}$ Peak SAR (extrapolated) =  $0.566 \text{ W/kg}$ **SAR(1 g) =  $0.239 \text{ W/kg}$ ; SAR(10 g) =  $0.110 \text{ W/kg}$** Maximum value of SAR (measured) =  $0.395 \text{ W/kg}$  $0 \text{ dB} = 0.395 \text{ W/kg} = -4.03 \text{ dBW/kg}$ 

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Date: 2017/6/12

**WLAN 802.11b\_Hotspot\_Back side\_CH 1\_10mm**

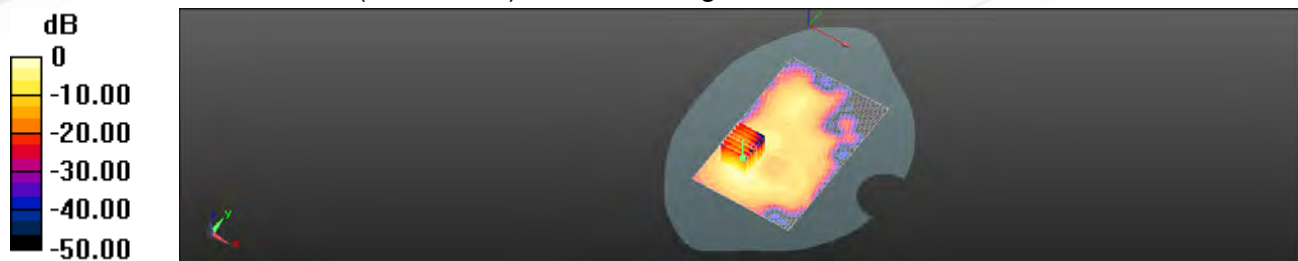
Communication System: WLAN(2.4G); Frequency: 2412 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.952 \text{ S/m}$ ;  $\epsilon_r = 53.632$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Ambient temperature:  $22.1^\circ\text{C}$ ; Liquid temperature:  $21.7^\circ\text{C}$ **DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.4, 7.4, 7.4); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Head/Area Scan (91x141x1):** Interpolated grid:  $dx=12 \text{ mm}$ ,  $dy=12 \text{ mm}$ Maximum value of SAR (interpolated) =  $0.407 \text{ W/kg}$ **Configuration/Head/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ Reference Value =  $4.360 \text{ V/m}$ ; Power Drift =  $0.03 \text{ dB}$ Peak SAR (extrapolated) =  $0.559 \text{ W/kg}$ **SAR(1 g) =  $0.256 \text{ W/kg}$ ; SAR(10 g) =  $0.109 \text{ W/kg}$** Maximum value of SAR (measured) =  $0.410 \text{ W/kg}$  $0 \text{ dB} = 0.410 \text{ W/kg} = -3.87 \text{ dBW/kg}$ 

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## 6. SAR System Performance Verification

Date: 2017/6/11

### Dipole 835 MHz\_SN:4d063\_Head

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.883$  S/m;  $\epsilon_r = 41.158$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.9°C

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(9.74, 9.74, 9.74); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (41x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 3.03 W/kg

**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:

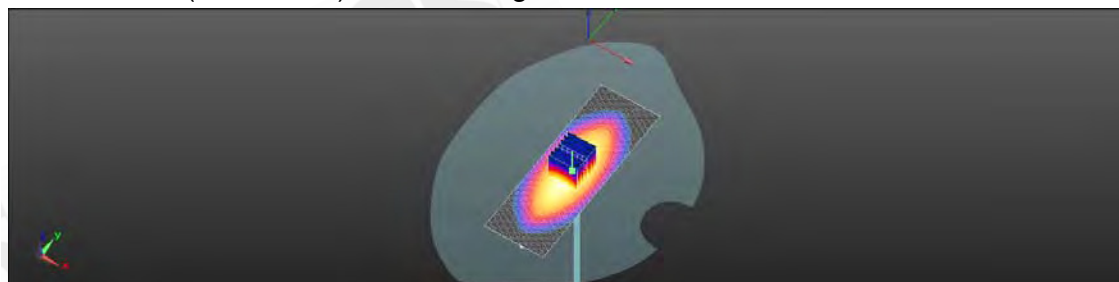
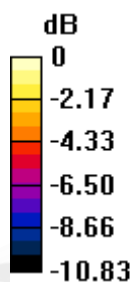
dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.74 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.56 W/kg

**SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 3.05 W/kg



0 dB = 3.05 W/kg = 4.85 dBW/kg

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Date: 2017/6/10

**Dipole 835 MHz\_SN:4d063\_Body**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.01 \text{ S/m}$ ;  $\epsilon_r = 56.212$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Ambient temperature: 22.3°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(9.33, 9.33, 9.33); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (51x111x1):** Interpolated grid:  $dx=15 \text{ mm}$ ,  $dy=15 \text{ mm}$ 

Maximum value of SAR (interpolated) = 3.03 W/kg

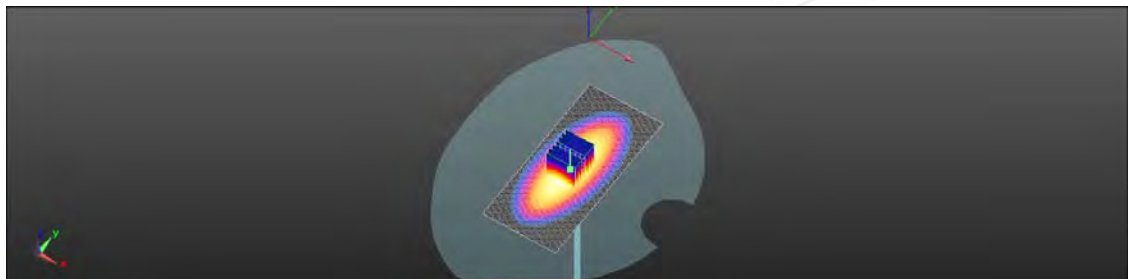
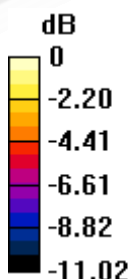
**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 56.63 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.63 W/kg

**SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 3.08 W/kg



0 dB = 3.08 W/kg = 4.88 dBW/kg

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Date: 2017/6/11

**Dipole 1900 MHz\_SN:5d142\_Head**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.384$  S/m;  $\epsilon_r = 39.982$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.8°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(8.15, 8.15, 8.15); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (51x61x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 13.5 W/kg

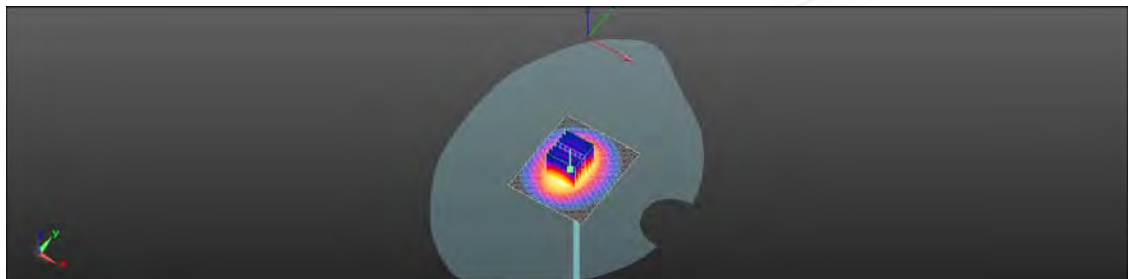
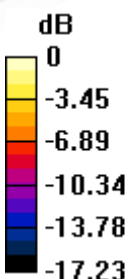
**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.2 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 16.7 W/kg

**SAR(1 g) = 9.59 W/kg; SAR(10 g) = 5.19 W/kg**

Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.2 W/kg = 11.22 dBW/kg

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Date: 2017/6/9

**Dipole 1900 MHz\_SN:5d142\_Body**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.524$  S/m;  $\epsilon_r = 51.766$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.77, 7.77, 7.77); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (51x61x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 14.8 W/kg

**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:

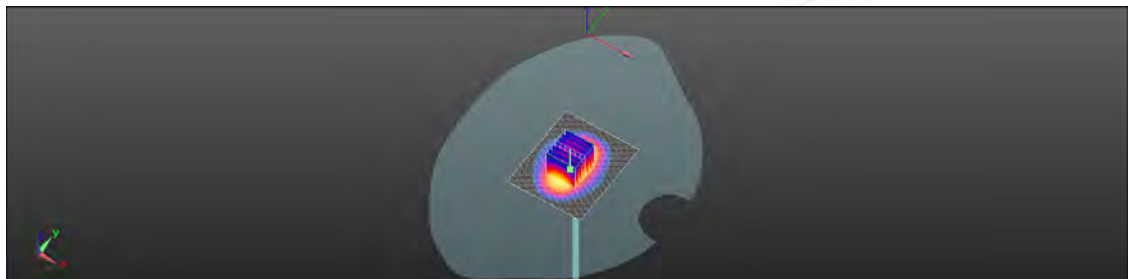
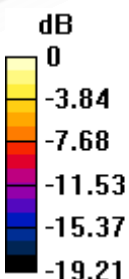
dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.89 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 18.2 W/kg

**SAR(1 g) = 9.89 W/kg; SAR(10 g) = 5.12 W/kg**

Maximum value of SAR (measured) = 14.2 W/kg



0 dB = 14.2 W/kg = 11.51 dBW/kg

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Date: 2017/6/12

## Dipole 2450 MHz\_SN:727\_Head

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.839$  S/m;  $\epsilon_r = 40.133$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.1°C; Liquid temperature: 21.9°C

### DASY5 Configuration:

- Probe: EX3DV4 - SN3938; ConvF(7.36, 7.36, 7.36); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (71x111x1):** Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 21.1 W/kg

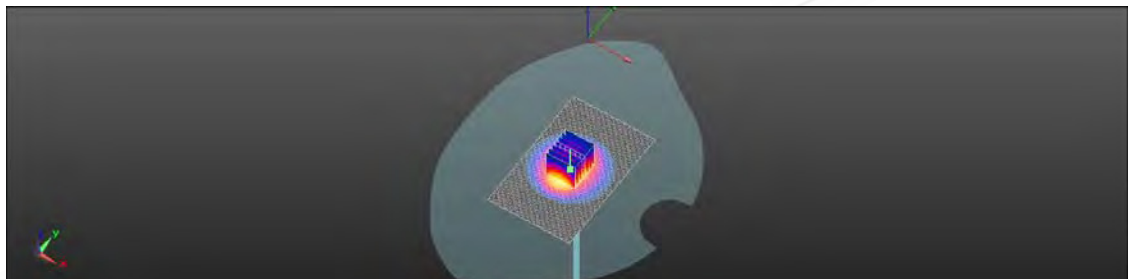
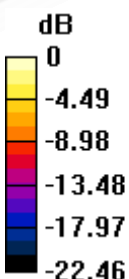
**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.5 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 27.3 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.03 W/kg**

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



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

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Date: 2017/6/12

**Dipole 2450 MHz\_SN:727\_Body**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.995$  S/m;  $\epsilon_r = 53.237$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient temperature: 22.1°C; Liquid temperature: 21.7°C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3938; ConvF(7.4, 7.4, 7.4); Calibrated: 2016/11/25;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (51x71x1):** Interpolated grid: dx=12 mm, dy=12 mm

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

**Configuration/Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:

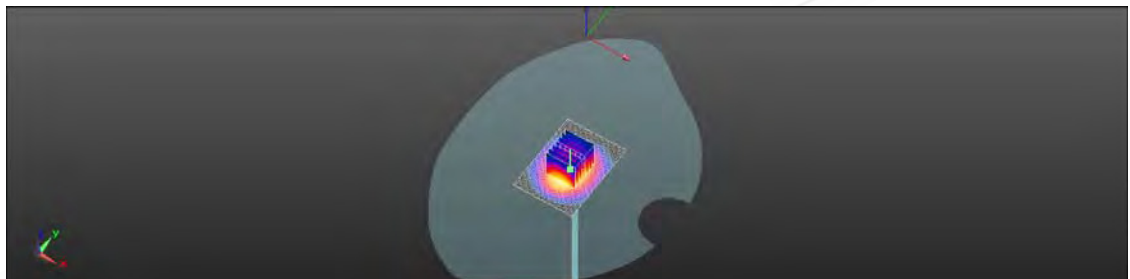
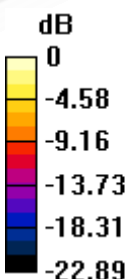
dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.24 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 25.2 W/kg

**SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.77 W/kg**

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



0 dB = 18.4 W/kg = 12.65 dBW/kg

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## 7. DAE & Probe Calibration Certificate

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

Schweizerischer Kalibrierdienst  
Service suisse d'étalonnage  
Servizio svizzero di taratura  
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 0108

Client: **SGS - TW (Auden)** Certificate No.: **DAE4-1336\_Nov16**

### CALIBRATION CERTIFICATE

Object: **DAE4 - SD 000 D04 BM - SN: 1336**

Calibration procedure(s): **QA CAL-06.v29**  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **November 22, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Kethley Multimeter Type 2001	SN: 0610276	09-Sep-16 (No:19065)	Sep-17

Secondary Standards	ID #	Check Date (In house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 003 AA 1001	05-Jan-16 (In house check)	In house check: Jan-17
Calibrator Box V2.1	SE UMS 006 AA 1002	06-Jan-16 (In house check)	In house check: Jan-17

Calibrated by: **Adrian Gatzert** Function: **Technician** Signature: 

Approved by: **Fin Bommert** Deputy Technical Manager: 

Issued: November 22, 2016

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

Certificate No: DAE4-1336\_Nov16

Page 1 of 5

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**C** Service suisse d'étalonnage  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

### 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.

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**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V full range = -100. ...+300 mV  
Low Range: 1LSB = 61nV full range = -1 ...+3mV

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

Calibration Factors	X	Y	Z
High Range	403.332 $\pm$ 0.02% (k=2)	403.635 $\pm$ 0.02% (k=2)	403.121 $\pm$ 0.02% (k=2)
Low Range	3.95216 $\pm$ 1.50% (k=2)	3.98718 $\pm$ 1.50% (k=2)	3.99680 $\pm$ 1.50% (k=2)

**Connector Angle**

Connector Angle to be used in DASY system:	122.0 $^{\circ}$ $\pm$ 1 $^{\circ}$
--	-------------------------------------

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## Appendix (Additional assessments outside the scope of SCS0108)

## 1. DC Voltage Linearity

High Range	Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X + Input	199996.24	0.16	0.00
Channel X + Input	20001.25	-0.04	-0.00
Channel X - Input	-19999.61	1.36	-0.01
Channel Y + Input	199994.04	-1.88	-0.00
Channel Y + Input	20000.88	-0.82	-0.00
Channel Y - Input	-20002.64	-1.77	0.01
Channel Z + Input	199997.44	1.49	0.00
Channel Z + Input	19999.78	-1.62	-0.01
Channel Z - Input	-20003.24	-2.19	0.01

Low Range	Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X + Input	2001.87	-0.68	0.03
Channel X + Input	201.38	-0.11	-0.06
Channel X - Input	-198.27	0.04	-0.02
Channel Y + Input	2001.34	-0.04	-0.00
Channel Y + Input	201.35	-0.36	-0.18
Channel Y - Input	-198.77	-0.62	0.31
Channel Z + Input	2001.30	0.10	0.01
Channel Z + Input	200.72	-0.71	-0.35
Channel Z - Input	-199.12	-0.78	0.39

## 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 ( $\mu\text{V}$ )	Low Range Average Reading ( $\mu\text{V}$ )
Channel X	200	6.23	3.90
	-200	-3.72	-5.31
Channel Y	200	-4.23	-3.73
	-200	2.71	2.31
Channel Z	200	20.93	21.36
	-200	-23.91	-24.44

## 3. Channel separation

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

	Input Voltage (mV)	Channel X ( $\mu\text{V}$ )	Channel Y ( $\mu\text{V}$ )	Channel Z ( $\mu\text{V}$ )
Channel X	200	-	6.47	-1.27
Channel Y	200	7.97	-	6.72
Channel Z	200	7.84	6.96	-

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**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	15660	15861
Channel Y	15906	15597
Channel Z	15853	15173

**5. Input Offset Measurement**

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

Input 10M $\Omega$ 

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	-0.26	-1.07	0.97	0.33
Channel Y	-0.22	-0.92	0.62	0.24
Channel Z	-0.97	-1.73	0.29	0.36

**6. Input Offset Current**

Nominal input circuitry offset current on all channels: &lt;25fA

**7. Input Resistance** (Typical values for information)

	Zeroing (k $\Omega$ m)	Measuring (M $\Omega$ m)
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	-6	-9

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Accreditation No.: SCS 0108

Client: **SGS-TW (Aiden)**

Certificate No.: **EX3-3938 Nov16**

## CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3938**

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: **November 25, 2016**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $22 \pm 3^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (MATE: initial for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	05-Apr-16 (No. 217-02268/02269)	Apr-17
Power sensor NRP-Z91	SN: 103244	05-Apr-16 (No. 217-02268)	Apr-17
Power sensor NRP-Z91	SN: 103245	05-Apr-16 (No. 217-02269)	Apr-17
Reference 20 dB Attenuator	SN: SS277 (20x)	05-Apr-16 (No. 217-02263)	Apr-17
Reference Probe ES3DV2	SN: 3913	31-Dec-15 (No. ES3-3513, Dec15)	Dec-16
DAE4	SN: 690	23-Dec-15 (No. DAE4-680, Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: 0641203874	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: MY41468087	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
RF generator HP 6848C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by	Name	Function	Signature
	Jens Kamm	Laboratory Technician	
Approved by	Name	Function	Signature
	Karla Polzin	Technical Manager	

Issued: November 29, 2016

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Certificate No.: **EX3-3938 Nov16**

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Accreditation No.: SCS 0108

#### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\beta$	$\beta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\beta = 0$ 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 1526-2013, "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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>: Assessed for E-field polarization  $\beta = 0$  ( $f \leq 900$  MHz in TEM-cell,  $f = 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>, B<sub>x,y,z</sub>, C<sub>x,y,z</sub>, D<sub>x,y,z</sub>, VR<sub>x,y,z</sub>: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 900$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 100$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

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EX3DV4-SN3938

November 25, 2016

## Probe EX3DV4

SN:3938

Manufactured: May 2, 2013  
Calibrated: November 25, 2016Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

Certificate No: EX3-3938-Nov16

Page 3 of 1

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EX3DV4- SN:3938

November 25, 2016

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>a</sup>	0.51	0.57	0.33	$\pm 10.1\%$
DCCP (mV) <sup>b</sup>	100.5	101.3	104.0	

**Modulation Calibration Parameters**

UID	Communication System Name		A dB	B dB- $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>c</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	140.2	$\pm 2.2\%$
		Y	0.0	0.0	1.0		129.7	
		Z	0.0	0.0	1.0		146.0	

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

<sup>a</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup> field uncertainty inside TSL (see Pages 6 and 8).<sup>b</sup> Numerical linearization parameter: uncertainty not required.<sup>c</sup> Uncertainty is determined using full max. deviation from linear response applying rectangular distribution and is expressed in the state of all field values.

Certificate No: EX3-3938\_Nov16

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EX3DV4- SN:3938

November 25, 2018

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) <sup>c</sup>	Relative Permittivity <sup>e</sup>	Conductivity (S/m) <sup>f</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>g</sup>	Depth <sup>h</sup> (mm)	Unc (k=2)
750	41.9	0.89	10.14	10.14	10.14	0.61	0.80	± 12.0 %
835	41.5	0.90	9.74	9.74	9.74	0.45	0.91	± 12.0 %
900	41.5	0.87	9.64	9.64	9.64	0.51	0.80	± 12.0 %
1450	40.5	1.20	8.45	8.45	8.45	0.43	0.80	± 12.0 %
1750	40.1	1.37	8.20	8.20	8.20	0.31	0.80	± 12.0 %
1900	40.0	1.40	8.15	8.15	8.15	0.36	0.80	± 12.0 %
2000	40.0	1.40	8.06	8.06	8.06	0.35	0.80	± 12.0 %
2300	39.5	1.87	7.74	7.74	7.74	0.35	0.60	± 12.0 %
2450	39.2	1.80	7.36	7.36	7.36	0.33	0.92	± 12.0 %
2800	39.0	1.96	7.09	7.09	7.09	0.44	0.80	± 12.0 %
5250	35.9	4.71	5.21	5.21	5.21	0.38	1.80	± 13.1 %
5600	35.5	5.07	4.53	4.53	4.53	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.79	4.79	4.79	0.40	1.80	± 13.1 %

<sup>c</sup> Frequency validity above 300 MHz or ± 100 MHz only applies to 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, 120, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

<sup>h</sup> AlphaDepth is 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.

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EX3DV4 - SN:3938

November 25, 2016

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Calibration Parameter Determined in Body Tissue Simulating Media**

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth (mm)	Unc (k=2)
750	55.5	0.96	9.51	9.51	9.51	0.38	0.93	± 12.0 %
835	55.2	0.97	9.33	9.33	9.33	0.47	0.80	± 12.0 %
900	55.0	1.05	9.23	9.23	9.23	0.35	0.98	± 12.0 %
1450	54.0	1.30	8.18	8.18	8.18	0.39	0.80	± 12.0 %
1750	53.4	1.49	7.98	7.98	7.98	0.43	0.81	± 12.0 %
1900	53.3	1.52	7.77	7.77	7.77	0.27	1.06	± 12.0 %
2000	53.3	1.52	7.63	7.63	7.63	0.40	0.80	± 12.0 %
2500	52.9	1.81	7.58	7.56	7.56	0.42	0.80	± 12.0 %
2450	52.7	1.85	7.40	7.40	7.40	0.38	0.80	± 12.0 %
2600	52.5	2.18	7.14	7.14	7.14	0.34	0.80	± 12.0 %
5250	46.9	5.30	4.41	4.41	4.41	0.40	1.90	± 13.1 %
5600	46.5	5.77	3.83	3.83	3.83	0.50	1.90	± 13.1 %
5750	46.3	5.94	4.02	4.02	4.02	0.50	1.90	± 13.1 %

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

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 50% if (just compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 10%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

Certificate No: EX3-3938\_Nov16

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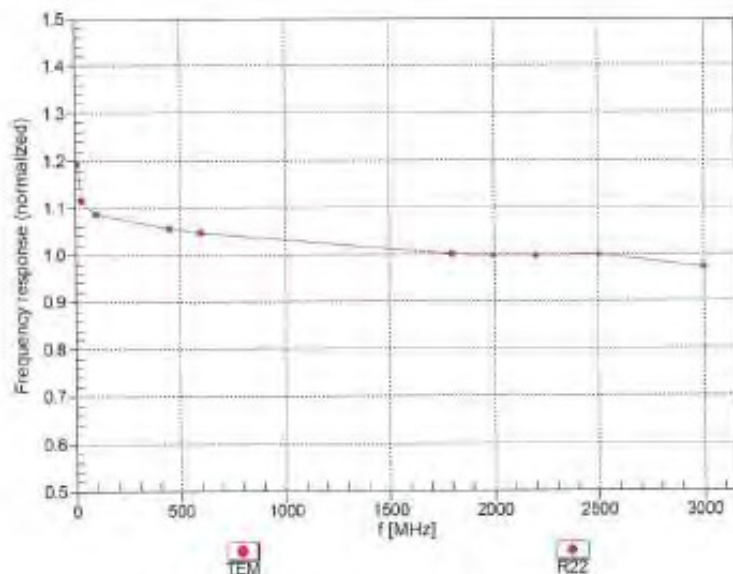
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EX3DV4- SN:3938

November 25, 2016

**Frequency Response of E-Field**  
(TEM-Cell:ifi110 EXX, Waveguide: R22)Uncertainty of Frequency Response of E-field;  $\pm 6.3\%$  ( $k=2$ )

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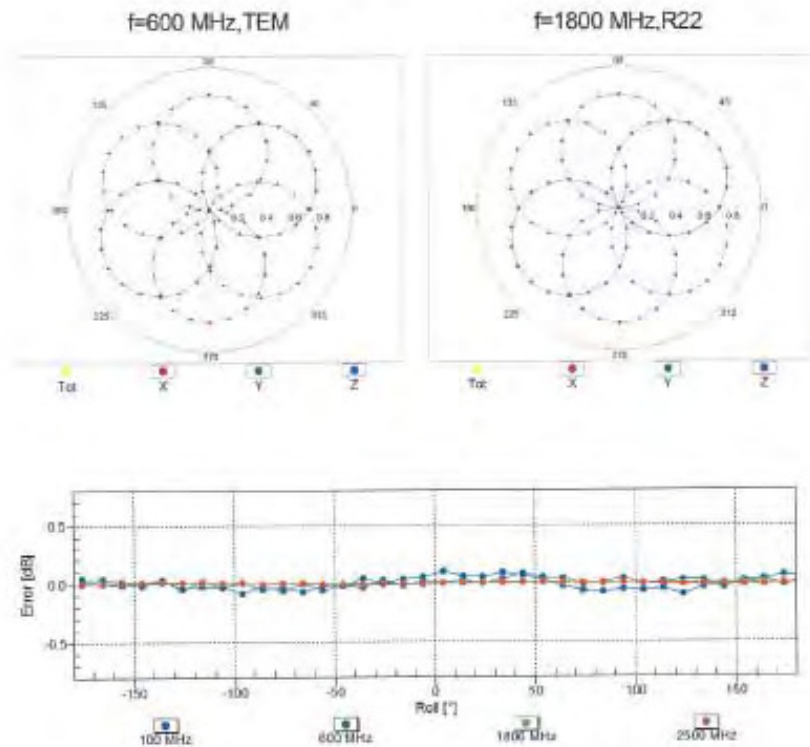
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EX3DV4-SN:3938

November 25, 2016

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



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

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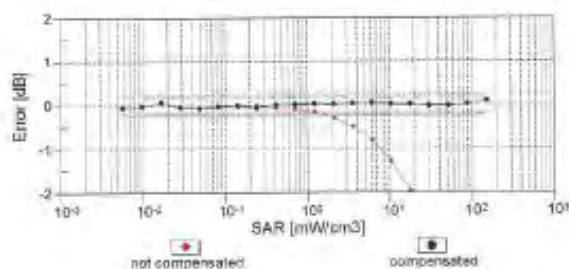
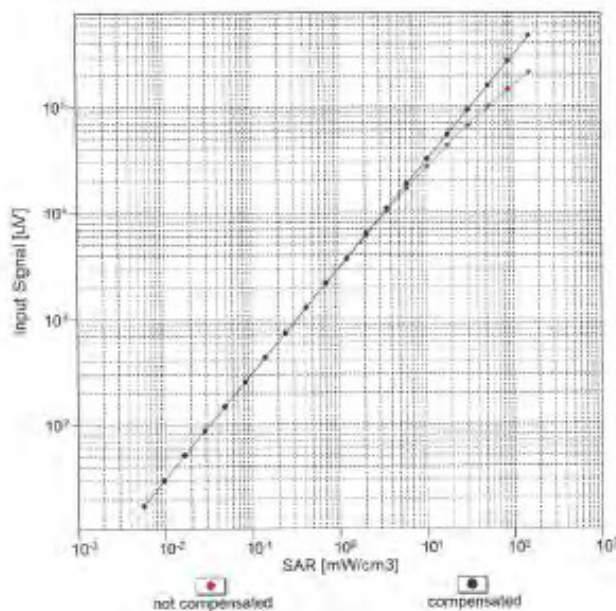
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EX3DV4-SN:3938

November 25, 2016

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



Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

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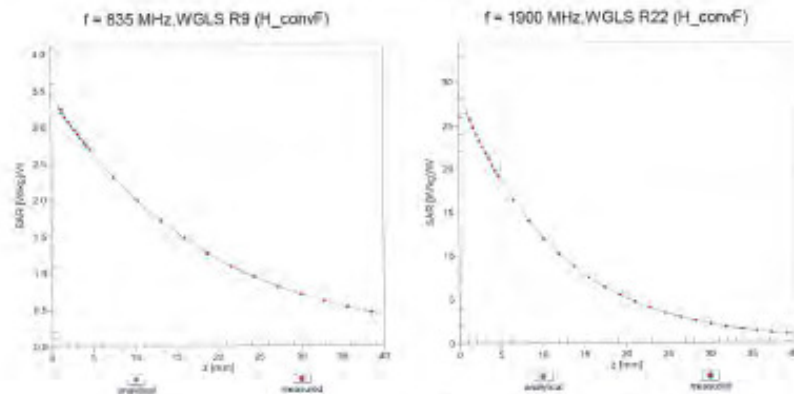
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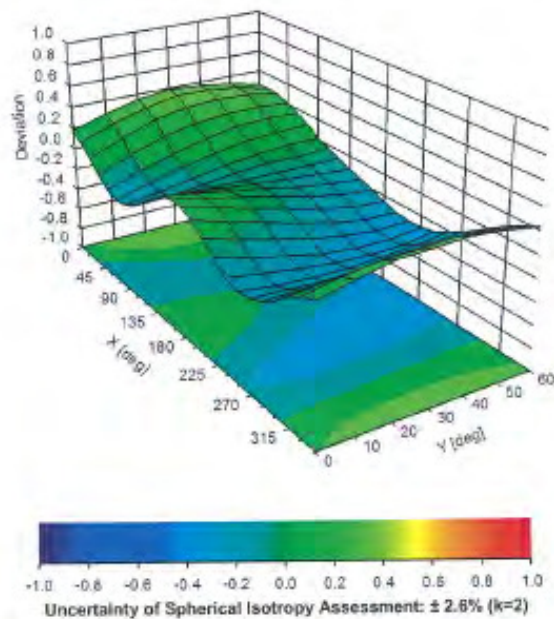
EX3DV4- SN:3938

November 25, 2016

## Conversion Factor Assessment



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



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EX3DV4-SN:3938

November 25, 2018

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-25.9
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

Certificate No: EX3-3938\_Nov18

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## 8. Uncertainty Budget

Measurement Uncertainty evaluation template for DUT SAR test (0.3-3G)

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probabilit y	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
<b>Measurement system</b>									
Probe calibration	6.00%	N	1	1	1	1	6.00%	6.00%	∞
<i>Isotropy , Axial</i>	3.50%	R	$\sqrt{3}$	1.732	1	1	2.02%	2.02%	∞
<i>Isotropy, Hemispherical</i>	9.60%	R	$\sqrt{3}$	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	$\sqrt{3}$	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	$\sqrt{3}$	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	$\sqrt{3}$	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	∞
<b>Measurement drift (class A evaluation)</b>	1.75%	R	$\sqrt{3}$	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
Probe positioner	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	∞
Mechanical restrictions	2.90%	R	$\sqrt{3}$	1.732	1	1	1.67%	1.67%	∞
Probe Positioning with respect to phantom	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
<b>Test Sample related</b>									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1.732	1	1	2.89%	2.89%	∞
<b>Phantom and Setup</b>									
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.89%	N	1	1	0.64	0.43	1.85%	1.24%	M
Liquid Conductivity (mea.)	4.12%	N	1	1	0.6	0.49	2.47%	2.02%	M
Combined standard uncertainty		RSS					11.83%	11.65%	
Expan uncertainty (95% confidence)							23.66%	23.30%	

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## 9. Phantom Description

Schmid &amp; Partner Engineering AG

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Phone: +41 1 245 9700, Fax: +41 1 245 9773  
info@speag.com, http://www.speag.com

### Certificate of Conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zurich Switzerland

#### Tests

The series production process used allows the limitation to test of first articles.

Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series items (called samples) or are tested at each item.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT IS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards	2mm +/- 0.2mm in flat and specific areas of head section	First article, Samples, TP-1314 ff.
Material thickness at ERP	Compliant with the requirements according to the standards	6mm +/- 0.2mm at ERP	First article, A3 items
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz; Relative permittivity < 5; Loss tangent < 0.05	Material samples
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe technical Note for material compatibility.	DEGMRE based simulating liquids	Pre-series, First article, Material samples
Sagging	Compliant with the requirements according to the standards. Sagging of the flat section when filled with tissue simulating liquid	< 1% typical < 0.6% if filled with 155mm of HSL900 and without OUT below	Prototypes, Sample testing

#### Standards

- (1) CENELEC EN 50361
- (2) IEEE Std 1528-2003
- (3) IEC 62209 Part 1
- (4) FCC OET Bulletin 65, Supplement C, Edition 01-01

(\*) The IT IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

#### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standards [1] to [4].

Date 07.07.2005

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Signature / Stamp

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Doc No: SE1 - QD 000 P40 C -

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## 10. System Validation from Original Equipment Supplier

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



S Schweizerischer Kalibrierdienst  
C Service suisse d'étalonnage  
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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 0108

Client: SGS-TW (Auden)

Certificate No: D835V2-4d063\_Aug16

### CALIBRATION CERTIFICATE

Object: D835V2 - SN:4d063

Calibration procedure(s): QA-CAL-05\_V9  
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: August 25, 2016

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

All calibrations have been conducted in the process 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 NRP	SN: 104778	05-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103241	05-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103240	05-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: 6637480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8461A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8461A	SN: MY41002317	07-Oct-15 (No. 217-02222)	In house check: Oct-16
RF generator F&S SMT-06	SN: 100972	15-Jun-15 (In house check Jun-16)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37393585	18-Oct-01 (In house check: Oct-15)	In house check: Oct-16

Calibrated by: Name: Michael Weber Function: Laboratory Technician

Signature:

Approved by: Katja Pokorny Technician Manager

Issued: August 29, 2016

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

Certificate No: D835V2-4d063\_Aug16

Page 1 of 3

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Accreditation No.: SCS 0108

#### Glossary:

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

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

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

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

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**Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	±5 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.1 ± 6 %	0.93 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	—	—

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.40 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.05 W/kg ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.7 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	—	—

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.57 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.28 W/kg ± 16.5 % (k=2)

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## Appendix (Additional assessments outside the scope of SCS 0108)

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	$51.2 \Omega - 2.6 j\Omega$
Return Loss	-30.3 dB

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	$47.3 \Omega - 5.5 j\Omega$
Return Loss	-24.0 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.392 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	November 27, 2006

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## DASY5 Validation Report for Head TSL

Date: 25.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d063**

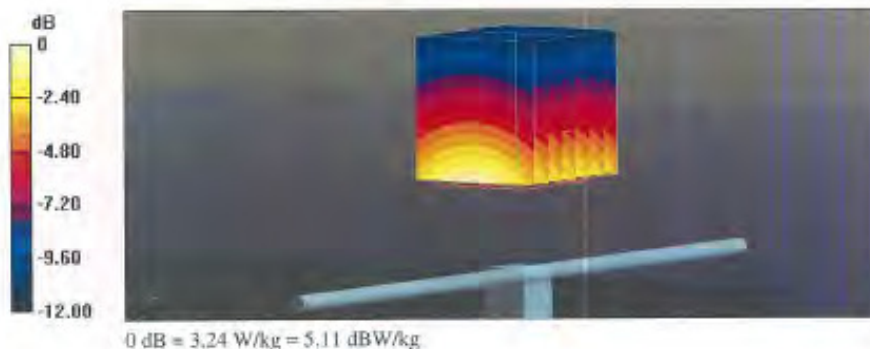
Communication System: UID 0 - CW; Frequency: 835 MHz  
Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.93 \text{ S/m}$ ;  $\epsilon_r = 42$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 61.75 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 3.65 W/kg  
**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.54 W/kg**  
Maximum value of SAR (measured) = 3.24 W/kg



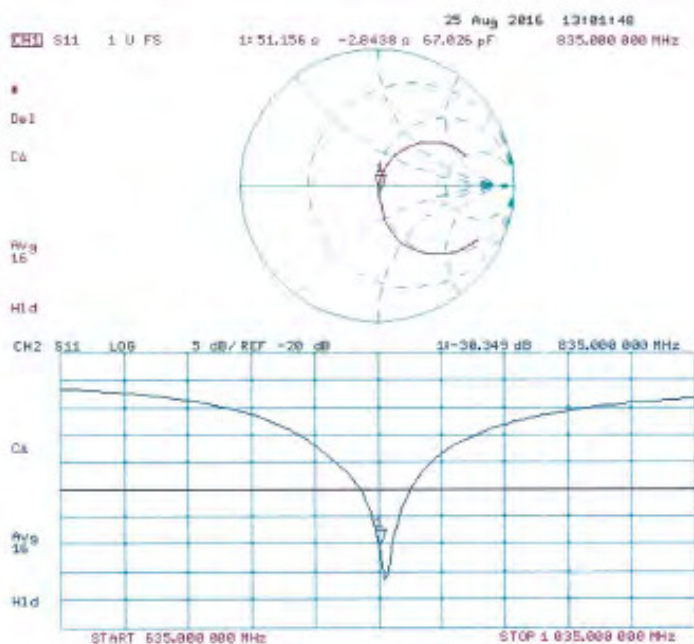
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## Impedance Measurement Plot for Head TSL



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## DASY5 Validation Report for Body TSL

Date: 25.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d063

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.01 \text{ S/m}$ ;  $\epsilon_r = 54.7$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

## DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49A.A; Serial: 1001
- DASY52 52.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/ $P_{in}=250 \text{ mW}$ ,  $d=15\text{mm}$ /Zoom Scan (7x7x7)/Cube 0:Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 59.83 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.63 W/kg

SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.61 W/kg

Maximum value of SAR (measured) = 3.25 W/kg

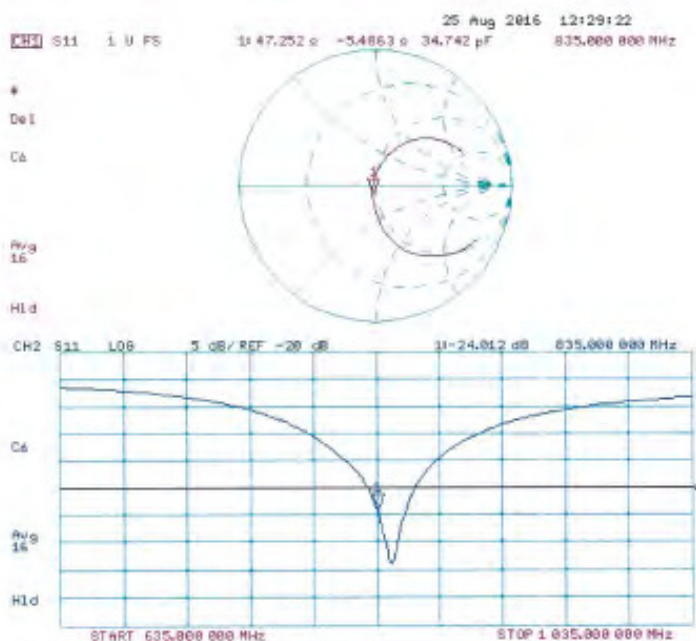


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## Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client **Auden**

Certificate No: D1900V2-5d142\_Jun16

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN:5d142**

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

Calibration date: **June 23, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047 2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by: **Michael Weber**      Function: **Laboratory Technician**

Approved by: **Katja Pokovic**      Technical Manager

Signature

*Michael Weber*

*Katja Pokovic*

Issued: June 27, 2016

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Certificate No: D1900V2-5d142\_Jun16

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



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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

**Glossary:**

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

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

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

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**Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	40.1 $\pm$ 6 %	1.39 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.91 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.8 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.8 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	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.1 $\pm$ 6 %	1.53 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.36 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.4 W/kg $\pm$ 16.5 % (k=2)

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**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.2 $\Omega$ + 5.8 j $\Omega$
Return Loss	- 23.9 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	49.1 $\Omega$ + 7.5 j $\Omega$
Return Loss	- 22.3 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.197 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	March 11, 2011

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## DASY5 Validation Report for Head TSL

Date: 23.06.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d142**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.39 \text{ S/m}$ ;  $\epsilon_r = 40.1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

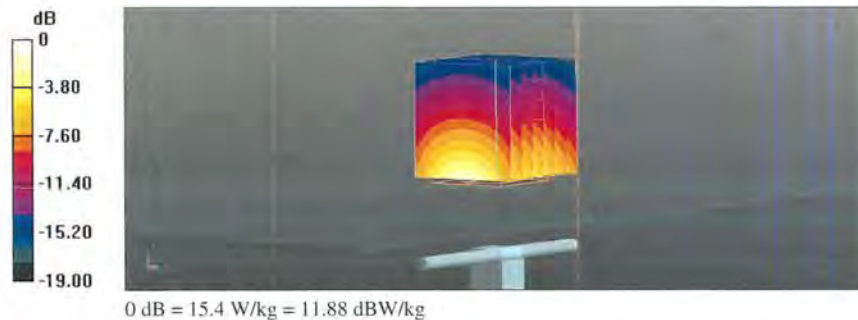
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.9 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 18.8 W/kg

**SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.19 W/kg**

Maximum value of SAR (measured) = 15.4 W/kg

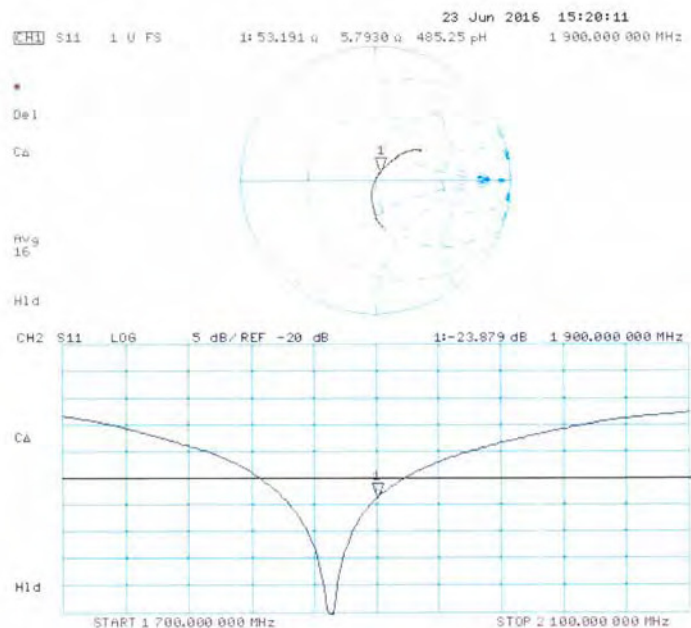


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## Impedance Measurement Plot for Head TSL



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**DASY5 Validation Report for Body TSL**

Date: 23.06.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d142**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.53 \text{ S/m}$ ;  $\epsilon_r = 53.1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

**DASY52 Configuration:**

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

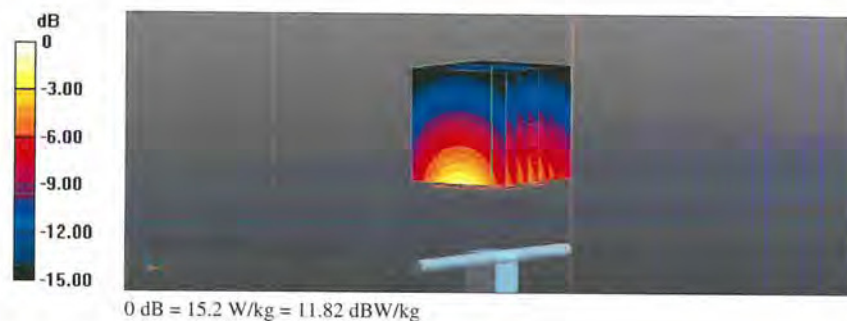
**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 104.1 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 17.6 W/kg

**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.36 W/kg**

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

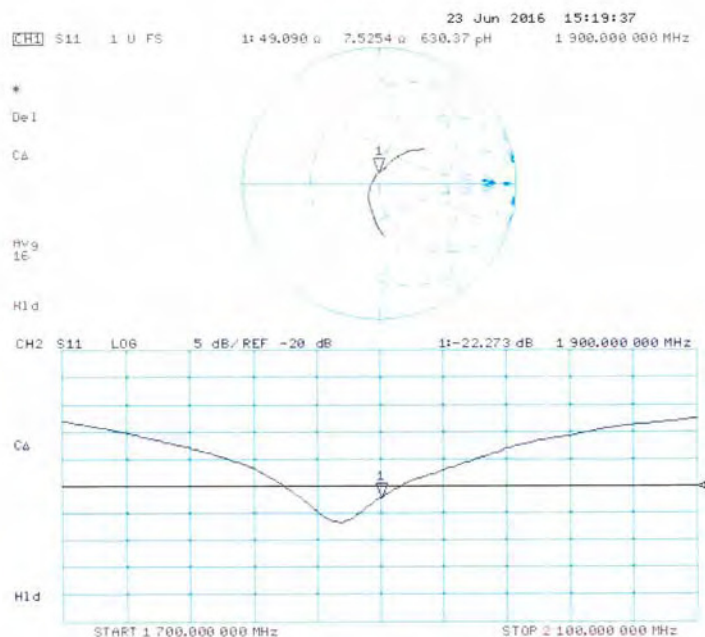


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## Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client SGS-TW (Auden)

Certificate No: D2450V2-727\_Apr17

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 727

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

Calibration date: April 21, 2017

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by:	Name Michael Weber	Function Laboratory Technician	Signature 
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 21, 2017

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

Certificate No: D2450V2-727\_Apr17

Page 1 of 8

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Accreditation No.: **SCS 0108**

#### Glossary:

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

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

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

#### 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.
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- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
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**Measurement Conditions**

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

DASY Version	DASY5	V52.10.0
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	37.7 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (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	24.3 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	52.5 $\pm$ 6 %	2.03 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.01 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.8 W/kg $\pm$ 16.5 % (k=2)

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**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	56.3 $\Omega$ + 2.1 j $\Omega$
Return Loss	- 24.0 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	51.1 $\Omega$ + 4.1 j $\Omega$
Return Loss	- 27.5 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.148 ns
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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	January 09, 2003

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**DASY5 Validation Report for Head TSL**

Date: 21.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 727**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 37.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

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

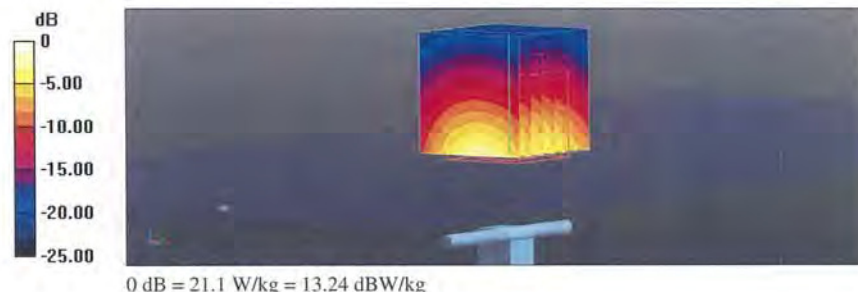
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.8 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 27.3 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 21.1 W/kg

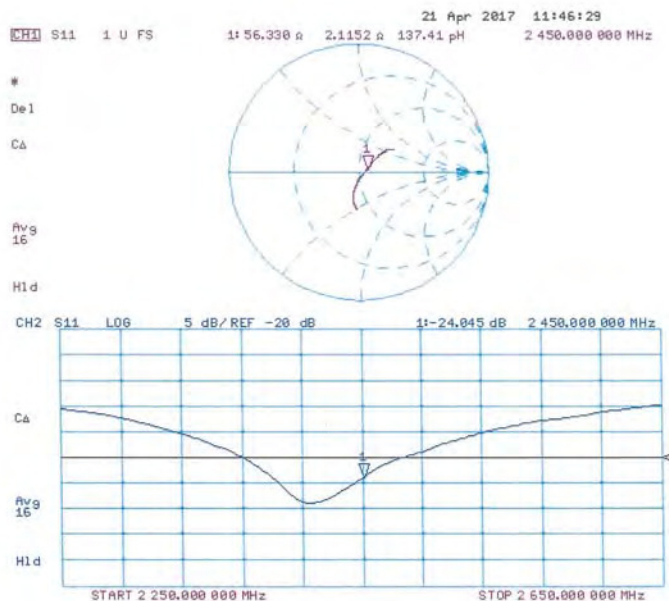


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## Impedance Measurement Plot for Head TSL



- End of 1<sup>st</sup> part of report -

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