

SAR TEST REPORT



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

Equipment Under Test Cellular Phone
Company Name Sharp Corporation, Mobile Communication B.U.
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 APYHRO00270
Date of Receipt Jan. 18, 2019
Date of Test(s) Jan. 18, 2019 ~ Jan. 21, 2019
Date of Issue Jan. 29, 2019

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

Clerk / Ruby Ou	Engineer / Bond Tsai	Asst. Manager / John Yeh

Date: Jan. 29, 2019

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Highest SAR Summary					
Equipment class	Frequency Band	Head (Separation 0mm)	Body-worn (Separation 10mm)	Hotspot (Separation 10mm)	Highest Simultaneous Transmission
		1g SAR(W/Kg)			
Licensed	GSM 1900	0.37	0.38	-	0.69
Licensed	GPRS 1900	-	-	0.63	
DTS	2.4GHz WLAN	0.10	0.06	0.07	
DSS	Bluetooth	0.03	0.05	-	
Date of Testing		2019/1/18~2019/1/21			

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Revision History

Report Number	Revision	Description	Issue Date
E5/2019/10034	Rev.00	Initial creation of document	Jan. 29, 2019

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1. General Information

1.1 Testing Laboratory

SGS Taiwan Ltd. Electronics & Communication Laboratory	
No. 2, Keji 1 st Rd., Guishan Township, Taoyuan County, 33383, Taiwan	
Tel	+886-2-2299-3279
Fax	+886-2-2298-0488
Internet	http://www.tw.sgs.com/

1.2 Details of Applicant

Company Name	Sharp Corporation, Mobile Communication B.U.
Company Address	2-13-1, Hachihonmatsu-lida, Higashi-hiroshima-shi, Hiroshima 739-0192, Japan

1.2.1 Details of Manufacturer

Company Name	Sharp Corporation
Company Address	1 Takumi-cho, Sakai-ku, Sakai City, Osaka 590-8522, Japan

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1.3 Description of EUT

EUT Name	Cellular Phone			
FCC ID	APYHRO00270			
Mode of Operation	☒ GSM ☒ GPRS ☒ WLAN802.11 b/g/n(20M) ☒ Bluetooth			
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)	GSM1900	1850	—	1910
	WiFi 2.4GHz	2400	—	2462
	Bluetooth	2402	—	2480
Channel Number (ARFCN)	GSM1900	512	—	810
	WiFi 2.4GHz	1	—	11
	Bluetooth	0	—	78

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Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Head	GSM 1900	0.24	0.37	☒ Left ☐ Right ☒ Cheek ☐ Tilt <u>810</u> Channel
	WLAN 802.11b	0.10	0.10	☐ Left ☒ Right ☒ Cheek ☐ Tilt <u>6</u> Channel
	Bluetooth	0.02	0.03	☐ Left ☒ Right ☒ Cheek ☐ Tilt <u>78</u> Channel

Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Body-worn	GSM 1900	0.25	0.38	☐ Front ☒ Back <u>512</u> Channel
	WLAN 802.11b	0.6	0.06	☐ Front ☒ Back <u>6</u> Channel
	Bluetooth	0.04	0.05	☐ Front ☒ Back <u>78</u> Channel

Max. SAR (1-g) (Unit: W/Kg)				
Mode	Band	Measured	Reported	Position / Channel
Hotspot mode	GPRS 1900 (1Dn4UP)	0.42	0.63	☐ Front ☒ Back ☐ Top ☐ Right ☐ Left <u>512</u> Channel
	WLAN 802.11b	0.07	0.07	☐ Front ☐ Back ☐ Top ☒ Right ☐ Left <u>6</u> Channel

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GSM 1900 - conducted power table:

EUT mode	Frequency (MHz)	CH	Max. Rated Avg. Power + Max.Tolerance (dBm)	Burst average power	Source-based time average power
				Avg. (dBm)	Avg. (dBm)
GSM1900 (GMSK)	1850.2	512	30.4	28.61	19.58
	1800	661	30.4	28.50	19.47
	1909.8	810	30.4	28.53	19.50
The division factor compared to the number of TX time slot					
Division factor				1 TX time slot	
				-9.03	

GPRS 1900 - conducted power table:

Burst average power						
Max. Rated Avg. Power + Max. Tolerance (dBm)			30.4	28.2	26.4	25.2
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP
EUT mode	Frequency (MHz)	CH	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)
GPRS 1900	1850.2	512	28.59	26.25	24.66	23.41
	1880	661	28.43	26.34	24.70	23.58
	1909.8	810	28.48	26.38	24.71	23.60
Source-based time average power						
GPRS 1900	1850.2	512	19.56	20.23	20.40	20.40
	1880	661	19.40	20.32	20.44	20.57
	1909.8	810	19.45	20.36	20.45	20.59
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 power table:

Main Antenna						
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)
2450 MHz	802.11b	1	2412	1Mbps	12.00	11.93
		2	2417		15.00	14.79
		6	2437		15.00	14.87
		10	2457		15.00	14.80
		11	2462		12.00	11.75
	802.11g	1	2412	6Mbps	12.00	11.81
		2	2417		15.00	14.95
		6	2437		15.00	14.72
		10	2457		15.00	14.79
		11	2462		12.00	11.94
	802.11n-HT20	1	2412	MCS0	12.00	11.84
		2	2417		15.00	14.94
		6	2437		15.00	14.70
		10	2457		15.00	14.83
		11	2462		12.00	11.96

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Bluetooth maximum power table:

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)			Max. Rated Avg. Power + Max. Tolerance (dBm)
			1Mbps	2Mbps	3Mbps	
BR/EDR	CH 00	2402	10.23	8.59	8.75	11.5
	CH 39	2441	10.09	9.15	8.96	
	CH 78	2480	10.41	9.21	9.24	

Mode	Channel	Frequency (MHz)	Average Output Power (dBm)	Max. Rated Avg. Power + Max. Tolerance (dBm)
			GFSK	
LE	CH 00	2402	3.67	11.5
	CH 19	2440	3.65	
	CH 39	2480	3.88	

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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 $\leq 1.2\text{ W/kg}$.
8. BT and WLAN use the same antenna path and Bluetooth can't transmit with WLAN

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simultaneously.

9. According to KDB447498D01v06, testing of other required channels is not required when the reported 1-g SAR for the highest output channel is ≤ 0.8 W/kg, when the transmission band is ≤ 100 MHz.
10. According to **KDB865664D01v01r04**, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is ≥ 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 ≥ 1.45 W/kg ($\sim 10\%$ from the 1-g SAR limit)

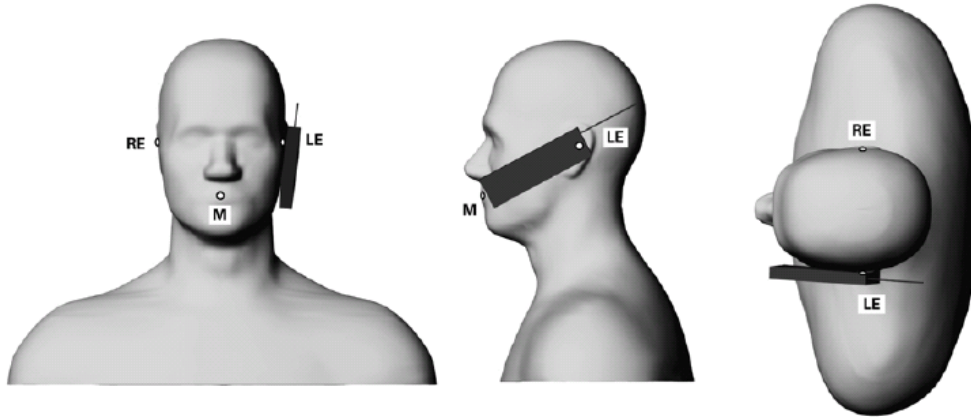
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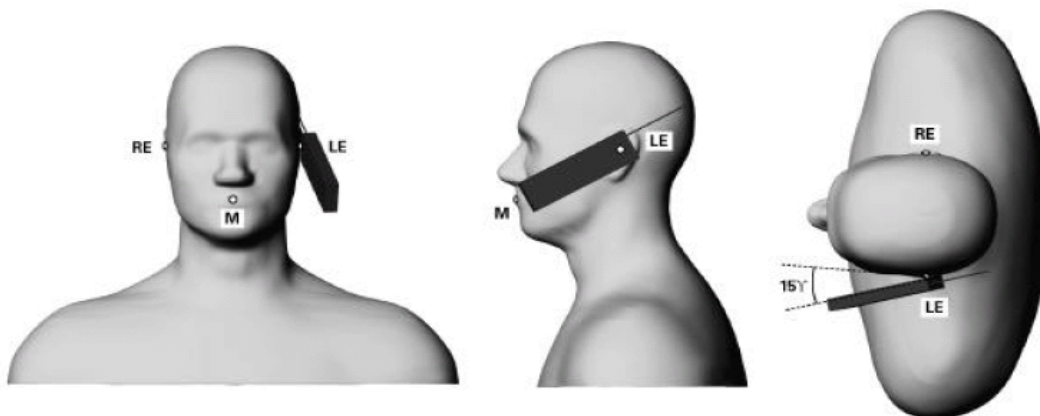
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1.6 Positioning Procedure

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) Top side
- (4) Right side
- (5) Left side

Test configurations of WLAN:

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

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3. Based on KDB941225D06v02r01, the hotspot mode and body-worn accessory SAR test configurations may overlap for handsets. When the same wireless mode transmission configurations for voice and data are required for SAR measurements, the more conservative configuration with a smaller separation distance should be tested for the overlapping SAR configurations. For WLAN, since the maximum power is the same between body-worn and hotspot mode, and the test distance of hotspot mode is the same with that of body-worn mode, hotspot mode SAR is used to support body-worn SAR. For GSM1900, since the wireless mode transmission configurations is different between body-worn and hotspot mode, body-worn SAR is performed.

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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 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

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the 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 σ is the conductivity, ρ 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 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

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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 ρ), 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.

References

- (1) N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
- (2) K. Meier, M. Burkhardt, T. Schmid, and N. Kuster, "Broadband calibration of E-field probes in lossy media", *IEEE Transactions on Microwave Theory and Techniques*, vol. 44, no. 10, pp. 1954-1962, Oct. 1996.
- (3) K. Jokela, P. Hyysalo, and L. Puranen, "Calibration of specific absorption rate (SAR) probes in waveguide at 900 MHz", *IEEE Transactions on Instrumentation and Measurements*, vol. 47, no. 2, pp. 432-438, Apr. 1998.

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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 σ and ρ are the conductivity and mass density of the tissue-simulant.

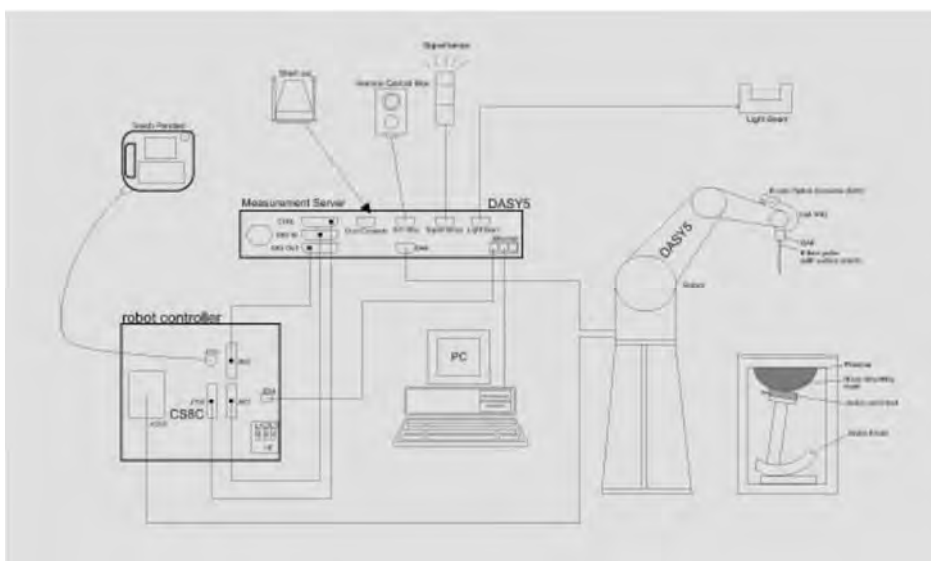


Fig. a A block diagram of the SAR measurement system

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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 HSL1900/2450MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz, Linearity: ± 0.6 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μ W/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/g)	
Dimensions	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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Phantom

Model	Twin SAM	
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 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.

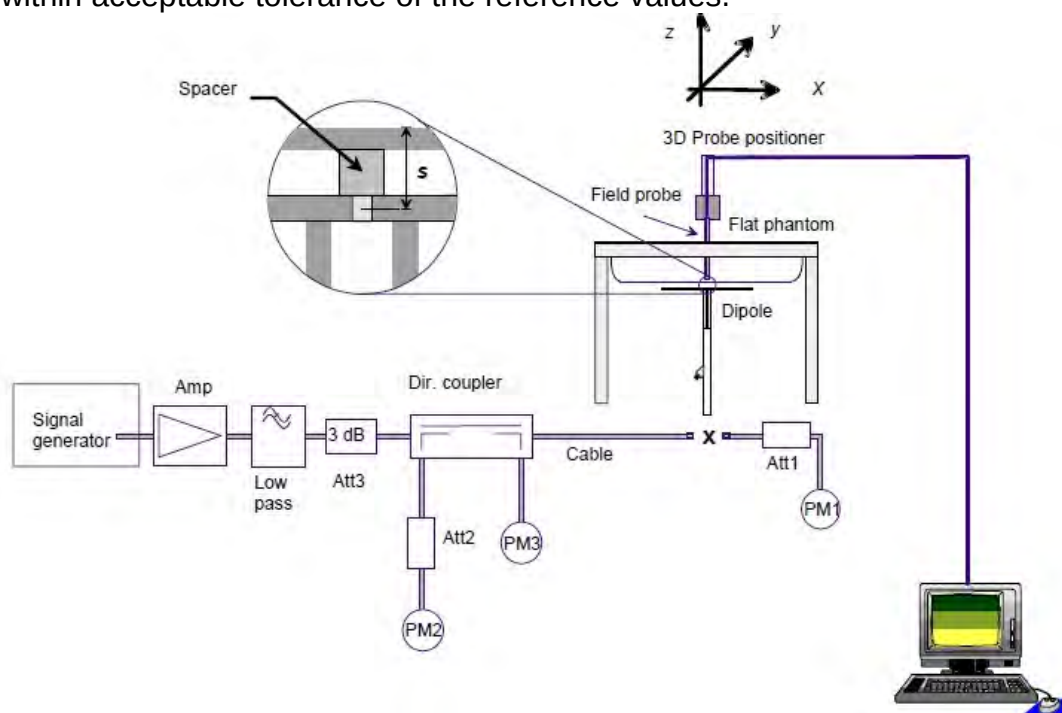


Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	Pin=250mW Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D1900V2	5d173	1900	Head	40.7	9.91	39.64	-2.60%	Jan. 21, 2019
			Body	40.9	9.91	39.64	-3.08%	Jan. 21, 2019
D2450V2	727	2450	Head	52.1	13.20	52.80	1.34%	Jan. 18, 2019
			Body	50.8	12.70	50.80	0.00%	Jan. 19, 2019

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, ϵ_r	Target Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ_r	Measured Conductivity, σ (S/m)	% dev ϵ_r	% dev σ
Head	Jan, 21. 2019	1850.2	40.000	1.400	40.405	1.407	-1.01%	-0.50%
		1880	40.000	1.400	40.429	1.411	-1.07%	-0.79%
		1900	40.000	1.400	40.436	1.412	-1.09%	-0.86%
		1909.8	40.000	1.400	40.421	1.408	-1.05%	-0.57%
	Jan, 18. 2019	2402	39.285	1.757	39.756	1.732	-1.20%	1.44%
		2412	39.268	1.766	39.710	1.748	-1.13%	1.03%
		2417	39.259	1.771	39.584	1.754	-0.83%	0.94%
		2437	39.223	1.788	39.577	1.772	-0.90%	0.92%
		2441	39.216	1.792	39.687	1.778	-1.20%	0.78%
		2450	39.200	1.800	39.634	1.783	-1.11%	0.94%
		2457	39.191	1.808	39.558	1.789	-0.94%	1.03%
		2462	39.185	1.813	39.542	1.796	-0.91%	0.94%
		2480	39.162	1.827	39.620	1.801	-1.17%	1.41%
Body	Jan, 21. 2019	1850.2	53.300	1.520	52.725	1.533	1.08%	-0.86%
		1880	53.300	1.520	52.795	1.531	0.95%	-0.72%
		1900	53.300	1.520	52.781	1.531	0.97%	-0.72%
		1909.8	53.300	1.520	52.740	1.532	1.05%	-0.79%
	Jan, 19. 2019	2402	52.764	1.904	53.133	1.927	-0.70%	-1.20%
		2412	52.751	1.914	53.121	1.934	-0.70%	-1.06%
		2417	52.744	1.918	53.109	1.946	-0.69%	-1.44%
		2437	52.717	1.938	53.080	1.955	-0.69%	-0.90%
		2441	52.712	1.941	53.078	1.958	-0.69%	-0.86%
		2450	52.700	1.950	53.070	1.974	-0.70%	-1.23%
		2457	52.691	1.960	53.051	1.985	-0.68%	-1.28%
		2462	52.685	1.967	53.006	1.986	-0.61%	-0.97%
		2480	52.662	1.993	52.969	2.007	-0.58%	-0.73%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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The composition of the tissue simulating liquid:

Frequency (MHz)	Mode	Ingredient						Total amount
		DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	
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	550 g	450 g	—	—	—	—	1.0L(Kg)
	Body	301.7 g	698.3 g	—	—	—	—	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

2.1 Decision rules

Reported measurement data comply with IEEE 1528-2013:
Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.2 Summary of Results

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	
Head (GSM)	Re Cheek	-	512	1850.2	30.40	28.61	51.01%	0.17	0.26	-
	Re Tilt	-	512	1850.2	30.40	28.61	51.01%	0.12	0.18	-
	Le Cheek	-	512	1850.2	30.40	28.61	51.01%	0.23	0.35	-
	Le Cheek	-	661	1880	30.40	28.50	54.88%	0.21	0.33	-
	Le Cheek	-	810	1909.8	30.40	28.53	53.82%	0.24	0.37	38
	Le Tilt	-	512	1850.2	30.40	28.61	51.01%	0.15	0.23	-
Body-worn (GSM)	Front side	10	512	1850.2	30.40	28.61	51.01%	0.21	0.32	-
	Back side	10	512	1850.2	30.40	28.61	51.01%	0.25	0.38	39
	Back side	10	661	1880	30.40	28.50	54.88%	0.24	0.37	-
	Back side	10	810	1909.8	30.40	28.53	53.82%	0.24	0.37	-
Hotspot (GPRS) <1Dn4Up>	Front side	10	810	1909.8	25.20	23.60	44.54%	0.30	0.43	-
	Back side	10	512	1850.2	25.20	23.41	51.01%	0.42	0.63	40
	Back side	10	661	1880	25.20	23.58	45.21%	0.36	0.52	-
	Back side	10	810	1909.8	25.20	23.60	44.54%	0.34	0.49	-
	Top side	10	810	1909.8	25.20	23.60	44.54%	0.14	0.20	-
	Right side	10	810	1909.8	25.20	23.60	44.54%	0.10	0.14	-
	Left side	10	810	1909.8	25.20	23.60	44.54%	0.23	0.33	-

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WLAN 802.11b

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	
Head	RE Cheek	-	1	2412	12	11.93	1.62%	0.05	0.05	-
	RE Cheek	-	2	2417	15	14.79	4.95%	0.08	0.08	-
	RE Cheek	-	6	2437	15	14.87	3.04%	0.10	0.10	41
	RE Cheek	-	10	2457	15	14.80	4.71%	0.09	0.09	-
	RE Cheek	-	11	2462	12	11.75	5.93%	0.04	0.04	-
	RE Tilt	-	6	2437	15	14.87	3.04%	0.05	0.05	-
	LE Cheek	-	6	2437	15	14.87	3.04%	0.08	0.08	-
	LE Tilt	-	6	2437	15	14.87	3.04%	0.04	0.04	-
Body-worn	Front side	10	6	2437	15	14.87	3.04%	0.02	0.02	-
	Back side	10	6	2437	15	14.87	3.04%	0.06	0.06	-
Hotspot	Front side	10	6	2437	15	14.87	3.04%	0.02	0.02	-
	Back side	10	6	2437	15	14.87	3.04%	0.06	0.06	-
	Top side	10	6	2437	15	14.87	3.04%	0.01	0.01	-
	Right side	10	1	2412	12	11.93	1.62%	0.03	0.03	-
	Right side	10	2	2417	15	14.79	4.95%	0.06	0.06	-
	Right side	10	6	2437	15	14.87	3.04%	0.07	0.07	42
	Right side	10	10	2457	15	14.80	4.71%	0.06	0.06	-
	Right side	10	11	2462	12	11.75	5.93%	0.03	0.03	-

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Bluetooth

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	
Head	RE Cheek	-	0	2402	11.5	10.23	33.97%	0.01	0.01	-
	RE Cheek	-	39	2441	11.5	10.09	38.36%	0.01	0.01	-
	RE Cheek	-	78	2480	11.5	10.41	28.53%	0.02	0.03	43
	RE Tilt	-	78	2480	11.5	10.41	28.53%	0.01	0.01	-
	LE Cheek	-	78	2480	11.5	10.41	28.53%	0.01	0.01	-
	LE Tilt	-	78	2480	11.5	10.41	28.53%	0.01	0.01	-
Body-worn	Front side	10	78	2480	11.5	10.41	28.53%	0.01	0.01	-
	Back side	10	0	2402	11.5	10.23	33.97%	0.03	0.04	-
	Back side	10	39	2441	11.5	10.09	38.36%	0.02	0.03	-
	Back side	10	78	2480	11.5	10.41	28.53%	0.04	0.05	44

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

2.3 Reporting statements of conformity

The conformity statement in this report is based solely on the test results, measurement uncertainty is excluded.

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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	Yes	Yes	No
GPRS + BT	No	Yes	No

Note:

1. 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.

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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.

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 ≤ 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

reported SAR WWAN and WLAN 2.4GHz, Σ SAR evaluation					
Frequency band	Position		reported SAR / W/kg		Σ SAR
			WWAN	WLAN	<1.6W/kg
GSM 1900	Head	Right cheek	0.26	0.10	0.36
		Right tilt	0.18	0.05	0.23
		Left cheek	0.37	0.08	0.45
		Left tilt	0.23	0.04	0.27
GPRS 1900 (1Dn4UP)	Hotspot	Front side	0.43	0.02	0.45
		Back side	0.63	0.06	0.69
		Top side	0.20	0.01	0.21
		Right side	0.14	0.07	0.21
		Left side	0.33	-	-

reported SAR WWAN and WLAN 2.4GHz, Σ SAR evaluation					
Frequency band	Position		reported SAR / W/kg		Σ SAR
			WWAN	WLAN	<1.6W/kg
GSM 1900	body-worn	Front side	0.32	0.02	0.34
		Back side	0.38	0.06	0.44

reported SAR WWAN and Bluetooth, Σ SAR evaluation					
Frequency band	Position		reported SAR / W/kg		Σ SAR
			WWAN	BT	<1.6W/kg
GSM 1900	Head	Right cheek	0.26	0.03	0.29
		Right tilt	0.18	0.01	0.19
		Left cheek	0.37	0.01	0.38
		Left tilt	0.23	0.01	0.24
	body-worn	Front side	0.32	0.01	0.33
		Back side	0.38	0.05	0.43

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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	Oct.24,2018	Oct.23,2019
SPEAG	System Validation Dipole	D1900V2	5d173	Apr.25,2018	Apr.25,2019
		D2450V2	727	Apr.24,2018	Apr.23,2019
SPEAG	Data acquisition Electronics	DAE4	1336	Aug.06,2018	Aug.05,2019
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	Feb.26,2018	Feb.25,2019
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	772D	MY52180142	Jul.04,2018	Jul.03,2019
		778D	MY52180302	Jul.05,2018	Jul.04,2019
Agilent	RF Signal Generator	N5181A	MY50144143	Mar.14,2018	Mar.13,2019
Agilent	Power Meter	E4417A	MY52240003	Feb.01,2018	Jan.31,2019
Agilent	Power Sensor	E9301H	MY52200003	Feb.01,2018	Jan.31,2019
			MY52200004	Feb.01,2018	Jan.31,2019
TECPEL	Digital thermometer	DTM-303A	TP130077	Mar.09,2018	Mar.08,2019
Anritsu	Radio Communication Test	MT8820C	6201061049	Apr.08,2018	Apr.07,2019

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5. Measurements

Date: 2019/1/21

GSM 1900_Head_Le Cheek_CH 810

Communication System: GSM; Frequency: 1909.8 MHz; Duty Cycle: 1:8.30042

Medium parameters used: $f = 1909.8$ MHz; $\sigma = 1.408$ S/m; $\epsilon_r = 40.421$; $\rho = 1000$ kg/m³

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.95, 7.95, 7.95); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x121x1): Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.297 W/kg

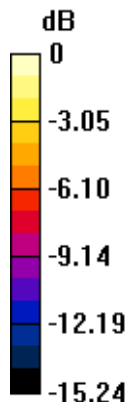
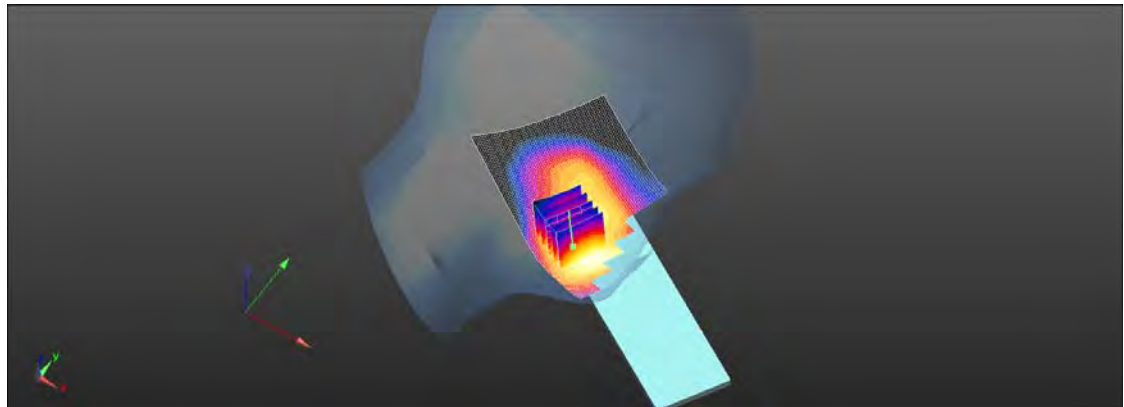
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 3.651 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.359 W/kg

SAR(1 g) = 0.235 W/kg; SAR(10 g) = 0.144 W/kg

Maximum value of SAR (measured) = 0.297 W/kg



0 dB = 0.297 W/kg = -5.27 dBW/kg

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Date: 2019/1/21

GSM 1900_Body-worn_Back side_CH 512_10mm

Communication System: GSM; Frequency: 1850.2 MHz; Duty Cycle: 1:8.30042

Medium parameters used: $f = 1850.2$ MHz; $\sigma = 1.533$ S/m; $\epsilon_r = 52.725$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.52, 7.52, 7.52); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x101x1): Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 0.367 W/kg

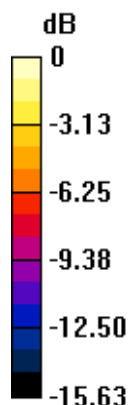
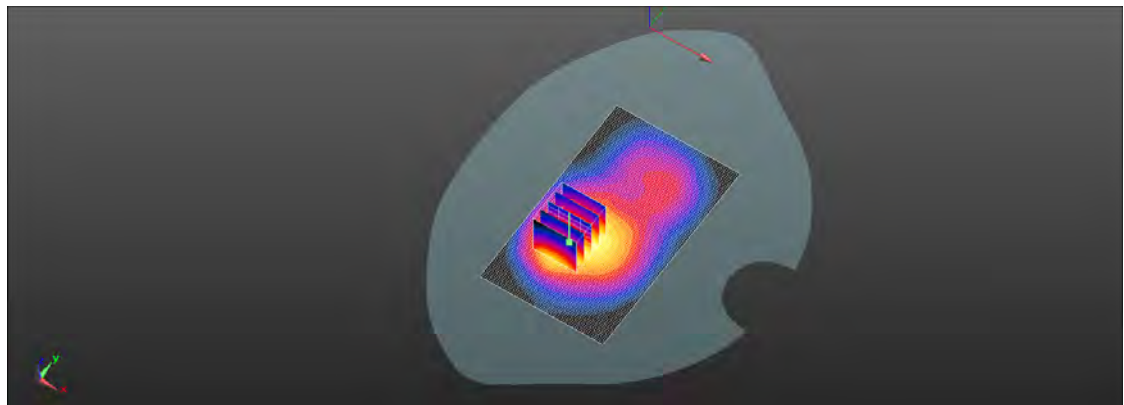
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.868 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 0.427 W/kg

SAR(1 g) = 0.253 W/kg; SAR(10 g) = 0.148 W/kg

Maximum value of SAR (measured) = 0.345 W/kg



0 dB = 0.345 W/kg = -4.62 dBW/kg

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Member of SGS Group

Date: 2019/1/21

GPRS 1900_Hotspot_Back side_CH 512_10mm

Communication System: GPRS (1Dn4Up); Frequency: 1850.2 MHz; Duty Cycle: 1:1.99986

Medium parameters used: $f = 1850.2 \text{ MHz}$; $\sigma = 1.533 \text{ S/m}$; $\epsilon_r = 52.725$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.52, 7.52, 7.52); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x101x1): Interpolated grid: $dx=15 \text{ mm}$, $dy=15 \text{ mm}$

Maximum value of SAR (interpolated) = 0.607 W/kg

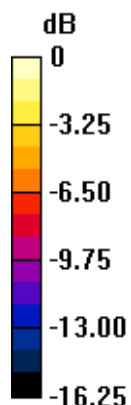
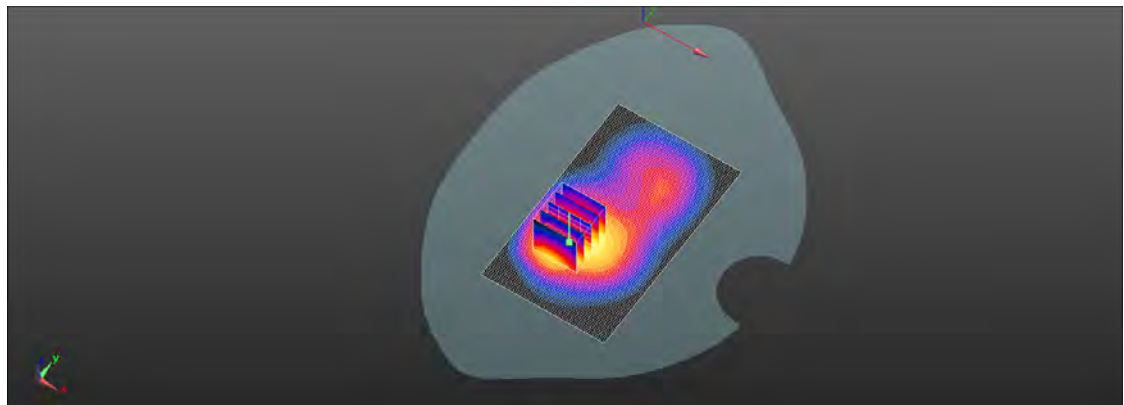
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 1.343 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.704 W/kg

SAR(1 g) = 0.417 W/kg; SAR(10 g) = 0.236 W/kg

Maximum value of SAR (measured) = 0.558 W/kg



0 dB = 0.558 W/kg = -2.53 dBW/kg

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Date: 2019/1/18

WLAN 802.11b_Head_Re Cheek_CH 6

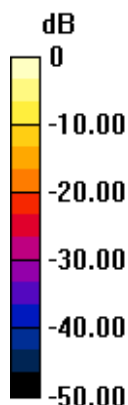
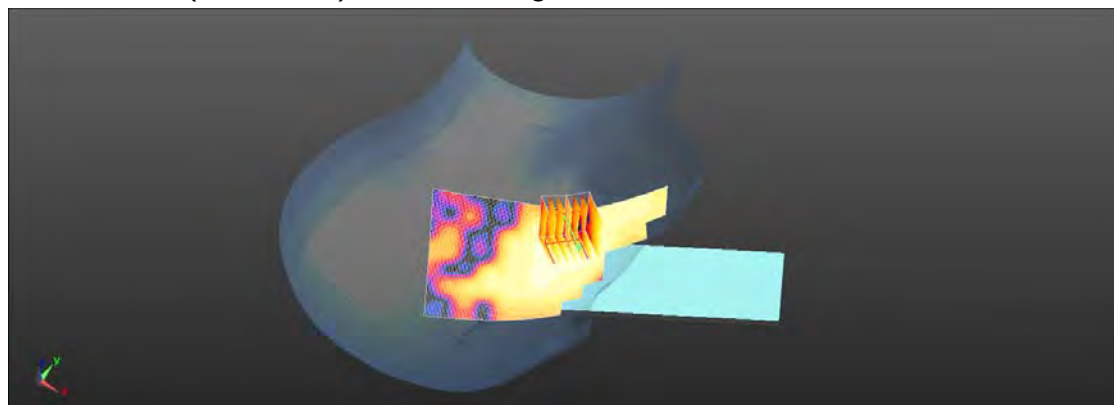
Communication System: WLAN 2.45G; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2437$ MHz; $\sigma = 1.772$ S/m; $\epsilon_r = 39.577$; $\rho = 1000$ kg/m³
Phantom section: Right Section
Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.17, 7.17, 7.17); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (71x121x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 0.138 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.741 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.168 W/kg
SAR(1 g) = 0.095 W/kg; SAR(10 g) = 0.050 W/kg
Maximum value of SAR (measured) = 0.133 W/kg



0 dB = 0.133 W/kg = -8.77 dBW/kg

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Date: 2019/1/19

WLAN 802.11b_Hotspot_Right side_CH 6_10mm

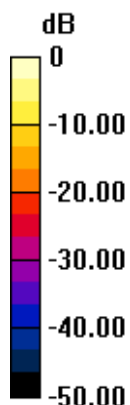
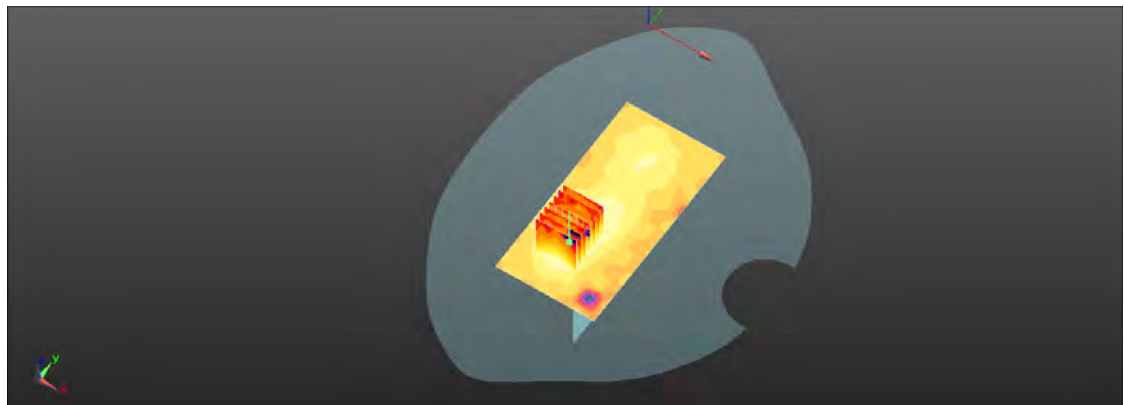
Communication System: WLAN 2.45G; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2437$ MHz; $\sigma = 1.955$ S/m; $\epsilon_r = 53.08$; $\rho = 1000$ kg/m³
Phantom section: Flat Section
Ambient temperature: 22.1°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.3, 7.3, 7.3); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (61x121x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 0.109 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.222 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 0.146 W/kg
SAR(1 g) = 0.070 W/kg; SAR(10 g) = 0.031 W/kg
Maximum value of SAR (measured) = 0.107 W/kg



0 dB = 0.107 W/kg = -9.72 dBW/kg

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Date: 2019/1/18

Bluetooth(GFSK)_Head_Re Cheek_CH 78

Communication System: Bluetooth; Frequency: 2480 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2480$ MHz; $\sigma = 1.801$ S/m; $\epsilon_r = 39.62$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.17, 7.17, 7.17); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (81x121x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 0.0387 W/kg

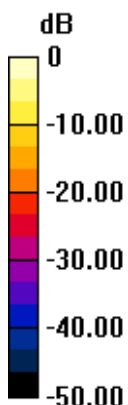
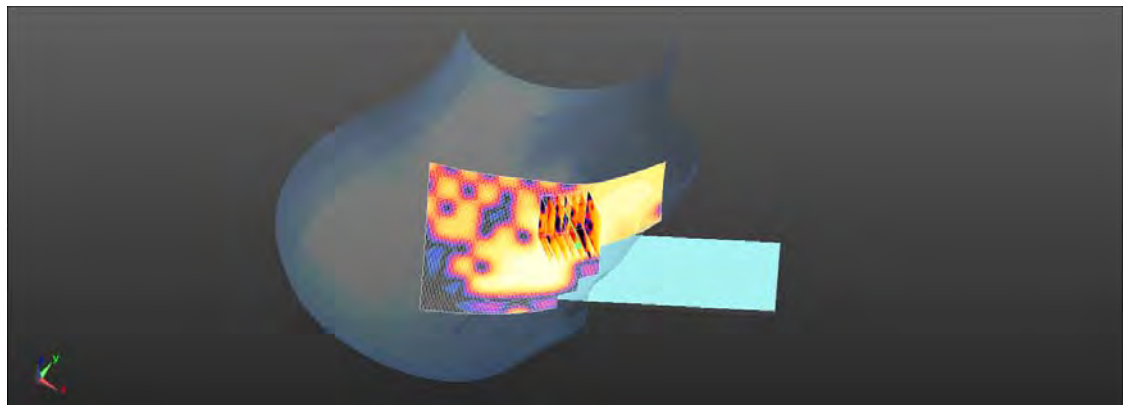
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 0.8550 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.0400 W/kg

SAR(1 g) = 0.019 W/kg; SAR(10 g) = 0.00892 W/kg

Maximum value of SAR (measured) = 0.0288 W/kg



0 dB = 0.0288 W/kg = -15.41 dBW/kg

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Date: 2019/1/19

Bluetooth(GFSK)_Body-worn_Back side_CH 78_10mm

Communication System: Bluetooth; Frequency: 2480 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2480$ MHz; $\sigma = 2.007$ S/m; $\epsilon_r = 52.969$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.3, 7.3, 7.3); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (71x121x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 0.0649 W/kg

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

Reference Value = 2.370 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 0.0820 W/kg

SAR(1 g) = 0.039 W/kg; SAR(10 g) = 0.017 W/kg

Maximum value of SAR (measured) = 0.0615 W/kg



0 dB = 0.0615 W/kg = -12.11 dBW/kg

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6. SAR System Performance Verification

Date: 2019/1/21

Dipole 1900 MHz_SN:5d173_Head

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.412$ S/m; $\epsilon_r = 40.436$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.95, 7.95, 7.95); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (41x81x1): Interpolated grid: dx=15 mm, dy=15 mm

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

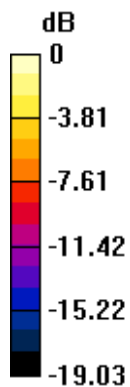
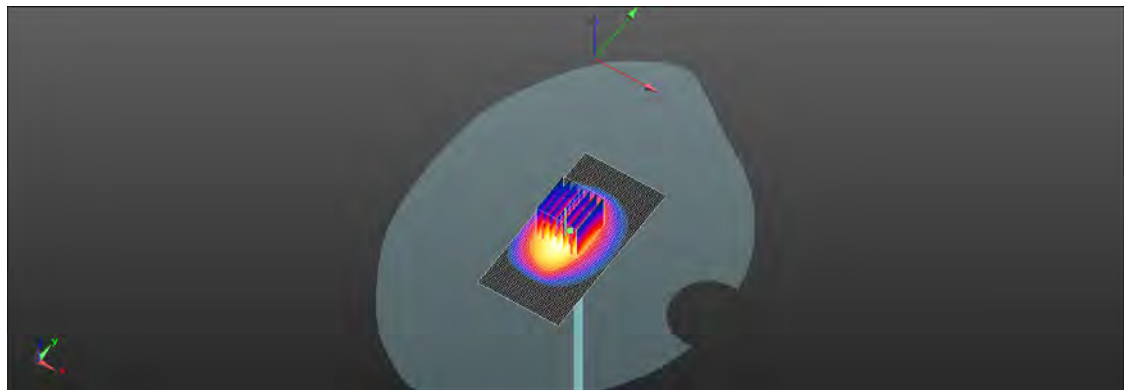
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.92 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 18.5 W/kg

SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.22 W/kg

Maximum value of SAR (measured) = 13.9 W/kg



0 dB = 13.9 W/kg = 11.21 dBW/kg

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Date: 2019/1/21

Dipole 1900 MHz_SN:5d173

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.531$ S/m; $\epsilon_r = 52.781$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.2°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.52, 7.52, 7.52); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (51x61x1): Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 13.8 W/kg

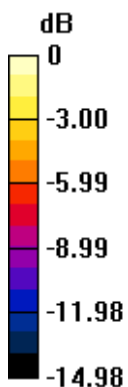
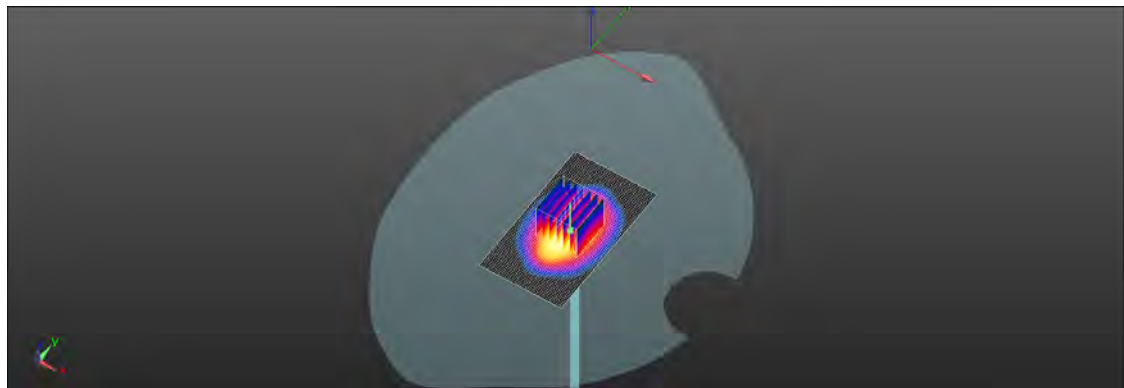
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.88 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 16.2 W/kg

SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.29 W/kg

Maximum value of SAR (measured) = 13.4 W/kg



0 dB = 13.4 W/kg = 11.12 dBW/kg

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Date: 2019/1/18

Dipole 2450 MHz_SN:727_Head

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.783$ S/m; $\epsilon_r = 39.634$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.17, 7.17, 7.17); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

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

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

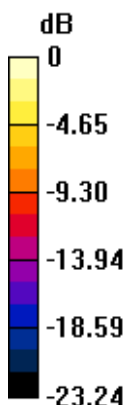
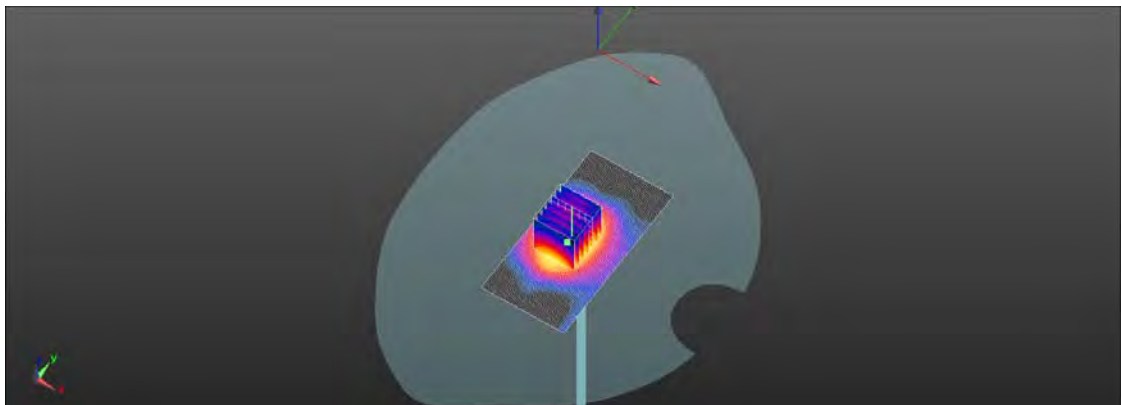
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 111.1 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.9 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.11 W/kg

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



0 dB = 20.3 W/kg = 13.23 dBW/kg

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Date: 2019/1/19

Dipole 2450 MHz_SN:727

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.974$ S/m; $\epsilon_r = 53.07$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 – SN3938; ConvF(7.3, 7.3, 7.3); Calibrated: 2018/10/24;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2018/8/6
- Phantom: SAM
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Area Scan (51x71x1): Interpolated grid: dx=12 mm, dy=12 mm

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

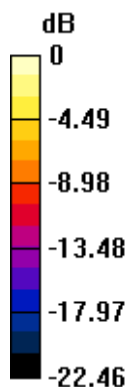
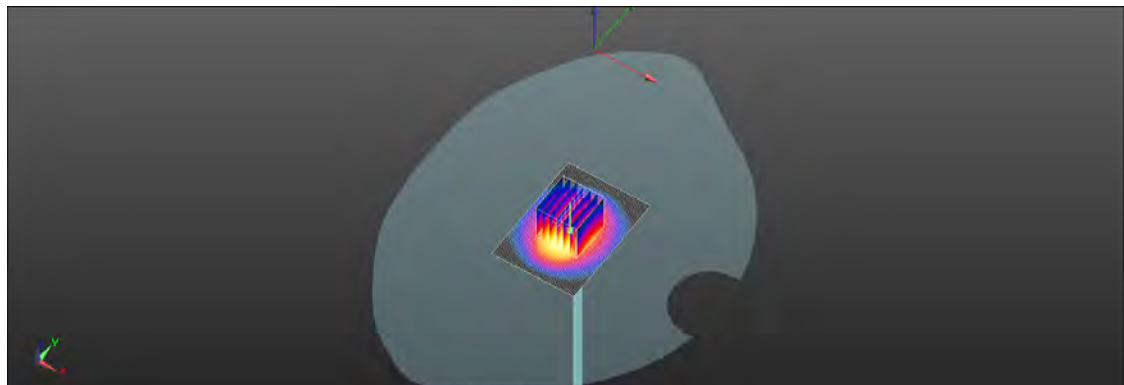
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.36 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 26.3 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.95 W/kg

Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.75 dBW/kg

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7. 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	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
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%	∞
Measurement drift (class A evaluation)	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 Mechanical restrictions	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	$\sqrt{3}$	1.732	1	1	1.67%	1.67%	∞
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%	∞
Test Sample related									
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%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	1.20%	N	1	1	0.64	0.43	0.77%	0.52%	M
Liquid Conductivity (mea.)	1.44%	N	1	1	0.6	0.49	0.86%	0.71%	M
Combined standard uncertainty		RSS					11.48%	11.44%	
Expanant uncertainty (95% confidence interval), K=2							22.95%	22.88%	

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Appendixes

Refer to separated files for the following appendixes.

E5201910034 SAR_Appendix A Photographs

E5201910034 SAR_Appendix B DAE & Probe Cal. Certificate

E5201910034 SAR_Appendix C Phantom Description & Dipole Cal. Certificate

- End of report -

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