

# SAR TEST REPORT

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

Equipment Under Test	Smartphone
Marketing Name	Desire 310
Brand Name	HTC
Model No.	0PA2110
Company Name	HTC Corporation
Company Address	1F, 6-3 Baoqiang Road, Xindian District, New Taipei City,
	Taiwan
Standards	OET 65 supplement C, IEEE / ANSI C95.1, C95.3, IEEE 1528
FCC ID	NM80PA2110
Date of Receipt	Jan. 17, 2014
Date of Test(s)	Feb. 04, 2014 ~ Feb. 10, 2014
Date of Issue	Feb. 21, 2014

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

This report details the results of the testing carried out on two samples, 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

evin Li Kevin Li

Date: Feb. 21, 2014

台灣檢驗科技股份有限公司

Sr. Engineer

John Teh

<u>John Yeh</u> Date: Feb. 21, 2014

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# Version

Report Number	Revision	Description	Issue Date
E5/2014/10002	00	Initial Version	Feb. 21, 2014

This test report contains a reference to the previous version test report that it replaces.

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## **1. General Information**

## 1.1 Testing Laboratory

SGS Taiwan Ltd. El	SGS Taiwan Ltd. Electronics & Communication Laboratory				
No.134, Wu Kung F	No.134, Wu Kung Road, New Taipei Industrial Park				
Wuku District, New	Wuku District, New Taipei City, Taiwan				
Tel	+886-2-2299-3279				
Fax +886-2-2298-0488					
Internet	http://www.tw.sgs.com/				

#### **1.2 Details of Applicant**

Company Name	HTC Corporation
Company Address	1F, 6-3 Baoqiang Road, Xindian District, New Taipei City, Taiwan

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#### 1.3 Description of EUT

EUT Name	Smartphone							
Marketing Name	Desire 310							
Brand Name	НТС							
Model No.	0PA2110							
HW Version	DVT							
SW Version	0.84.161.2							
IMEI Code	35191206000397801							
FCC ID	NM80PA2110							
Mode of	⊠GSM ⊠GPRS ⊠ED	GE						
Operation	🖾 WLAN802.11 b/g/n (20M) [	Bluetooth						
	GSM	1/8.3						
		1/2 (1Dn4UP)						
	GPRS	1/2.76 (1Dn3UP)						
	(support multi class 12 max)	1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)						
Duty Cycle		1/2 (1Dn4UP)						
	EDGE	1/2.76 (1Dn3UP)						
	(support multi class 12 max)	1/4.1 (1Dn2UP)						
		1/8.3 (1Dn1UP)						
	WLAN 802.11 b/g/n(20M)	1						
	Bluetooth	1						
	GSM850	824.2 — 848.8						
TX Frequency Range	GSM1900	1850.2 — 1909.8						
(MHz)	WLAN 802.11 b/g/n(20M)	2412 — 2462						
<b>,</b>	Bluetooth	2402 — 2480						
	GSM850	128 — 251						
Channel Number	GSM1900	512 — 810						
(ARFCN)	WLAN 802.11 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				
	GSM 850	0.43	0.636	Left Right Cheek Tilt <u>251</u> Channel				
Head	GSM 1900	0.198	0.293	Left Right Cheek Tilt <u>512</u> Channel				
	WLAN802.11 b	0.106	0.132	Left Right Cheek Tilt <u>11</u> Channel				
Body worn	GSM 850	0.44	0.651	Front Back <u>251</u> Channel				
(speech mode)	GSM 1900	0.153	0.242	Front Back <u>810</u> Channel				
	GPRS 850 1Dn4UP	0.455	0.6	Front Back Bottom Right Left 251_Channel				
Hotspot mode	GPRS 1900 1Dn4UP	0.523	0.658	Front Back Bottom Right Left 661 Channel				
	WLAN802.11 b	0.038	0.047	☐Front ⊠Back ☐Top ☐Right ☐Left <u>11</u> Channel				

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#### #. GSM/GPRS/EDGE conducted power table:

EUT mode	Frequency	СН	Max. Rated Avg.	Burst average power	Source-based time average power		
	Frequency (MHz)	СП	Power + Max. Tolerance (dBm)	Avg.(dBm)	Avg.(dBm)		
GSM 850	824.2	128	34.2	32.60	23.57		
	836.6	190	34.2	32.60	23.57		
(GIVISK)	(GMSK) 848.8 251	251	34.2	32.50	23.47		
	The division factor compared to the number of TX time slot						
Division factor				1 TX time slot			
	DIVISIO	IIIIacii	ונ	-9.03			

Burst average power							
Max. Rated Avg. Power + Max. Tolerance (dBm)			34.2	33	31	29	
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP	
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	
GPRS 850	824.2	128	32.60	30.50	29.00	28.10	
(GMSK)	836.6	190	32.60	30.40	28.90	27.90	
(GIVISK)	848.8	251	32.50	30.30	28.80	27.80	
		S	ource-based tim	e average powe	er		
GPRS 850	824.2	128	23.57	24.48	24.74	25.09	
(GMSK)	836.6	190	23.57	24.38	24.64	24.89	
(GIVISK)	848.8	251	23.47	24.28	24.54	24.79	
	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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Burst average power							
Max. Rated Avg. Power + Max. Tolerance (dBm)			29	27.5	27.5	26.5	
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP	
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	
EDGE 850	824.2	128	27.00	24.20	24.20	24.20	
EDGE 000	836.6	190	26.90	24.00	24.00	24.00	
	848.8 251		26.90	24.00	24.00	24.00	
		S	ource-based tim	e average powe	er		
EDGE 850	824.2	128	17.97	18.18	19.94	21.19	
EDGE 000	836.6	190	17.87	17.98	19.74	20.99	
	848.8	251	17.87	17.98	19.74	20.99	
	The div	vision fa	actor compared	to the number o	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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EUT mode Frequence (MHz)	Frequency		Max. Rated Avg. Power + Max. Tolerance (dBm)	Burst average power	Source-based time average power	
	(MHz)			Avg.(dBm)	Avg.(dBm)	
GSM 1900	1850.2	512	31.5	29.80	20.77	
	1880	661	31.5	29.70	20.67	
(GMSK) 1909.8	1909.8	810	31.5	29.50	20.47	
	The div	ision fa	ctor compared to	the number of TX time	e slot	
Division factor				1 TX time slot		
	DIVISION	Tactor		-9.03		

Burst average power							
Max. Rated Avg. Power + Max. Tolerance (dBm)			31.5	28.5	27	25	
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP	
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	
GPRS	1850.2	512	29.80	26.30	25.10	23.90	
1900	1880	661	29.70	26.40	25.10	24.00	
(GMSK)	1909.8	810	29.50	26.40	25.10	24.10	
		S	ource-based tim	e average powe	er		
GPRS	1850.2	512	20.77	20.28	20.84	20.89	
1900	1880	661	20.67	20.38	20.84	20.99	
(GMSK)	1909.8	810	20.47	20.38	20.84	21.09	
	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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Burst average power										
Max. Rated Avg. Power + Max. Tolerance (dBm)			28	25	25	25				
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP				
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)				
EDGE	1850.2	512	26.00	22.20	22.20	22.30				
1900	1880	661	26.00	22.30	22.30	22.30				
	1909.8	810	25.90	22.30	22.30	22.30				
		S	ource-based tim	e average powe	er					
EDGE	1850.2	512	16.97	16.18	17.94	19.29				
1900	1880	661	16.97	16.28	18.04	19.29				
	1909.8	810	16.87	16.28	18.04	19.29				
	The div	vision fa	actor compared	to the number c	of TX time slot					
Div	Division factor			2 TX time slot	3 TX time slot	4 TX time slot				
			-9.03	-6.02	-4.26	-3.01				

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	802.11b	Max. Rated Avg.	Average Power Output (dBm)								
СН	Frequency	Power + Max.	Data Rate (Mbps)								
(MHz)	(MHz) Tolerance (dBm)		2	5.5	11						
1	2412	18.00	16.55	16.46	16.42	16.35					
6	2437	18.00	16.01	15.98	15.96	15.93					
11	2462	18.00	17.06	16.93	16.90	16.82					

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

	802.11g	Max. Rated Avg.	Average Power Output(dBm)							
CU	Frequency			Data Rate (Mbps)						
CH (MHz)	Tolerance (dBm)	6	9	12	18	24	36	48	54	
1	2412	13.00	11.08	11.04	10.93	10.82	10.68	10.55	10.53	10.48
6	2437	13.00	10.75	10.71	10.58	10.50	10.44	10.33	10.30	10.25
11	2462	13.00	11.41	11.30	11.24	11.15	11.10	11.07	10.99	10.88

802	2.11n (20M)	Max. Rated Avg.	Average Power Output(dBm)									
СН	Frequency	Power + Max.		Data Rate (Mbps)								
СП	CH (MHz)	Tolerance (dBm)		13	19.5	26	39	52	58.5	65		
1	2412	13.00	11.20	11.06	10.94	10.93	10.86	10.74	10.69	10.61		
6	2437	13.00	10.98	10.88	10.79	10.74	10.72	10.67	10.54	10.42		
11	2462	13.00	11.36	11.23	11.16	11.05	10.96	10.91	10.87	10.83		

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#### #. Bluetooth conducted power table:

Frequency	Peak (dBm)							
(MHz)	BDR	4DPSK	8DPSK					
2402	-0.35	-0.63	-0.48					
2441	0.31	0.05	0.21					
2480	0.38	0.1	0.3					

Frequency	Avg. (dBm)		
(MHz)	BT4.0		
2402	-5.64		
2442	-5.16		
2480	-4.96		

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## 1.4 Test Environment

Ambient Temperature : 22±2° C Tissue Simulating Liquid: 22±2° C

## **1.5 Operation Description**

## General:

- 1. The EUT is controlled by using a Radio Communication Tester (R&S CMU200), 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. Testing head, body-worn, and hotspot SAR at the highest maximum output power channel in each band firstly, and then test the lowest & highest channel at highest SAR position in head, body-worn, and hotspot exposure in each band.
- Testing body-worn speech mode SAR of GSM850 & GSM1900 by separating the EUT and the phantom **15mm** distance.

Body-worn SAR test positions: front side and back side.

- Testing body-worn speech mode SAR(15mm) of WLAN 802.11b/g/n(20M) is not required due to hotspot mode SAR(10mm) of WLAN 802.11b/g/n(20M) has been tested(see Item 7.) and the distance of hotspot SAR(10mm) is smaller than the distance of body-worn SAR(15mm).
- Testing hotspot mode SAR by separating the EUT and the phantom 10mm distance.
   #. The SAR testing for portable devices with wireless router capability is referred to KDB 941225 D06v01 (SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities).
  - #. According to **KDB 941225 D06v01** when the overall device length and width are  $\geq$ 9 cm x 5 cm, a test separation of 10 mm is required. SAR must be measured for

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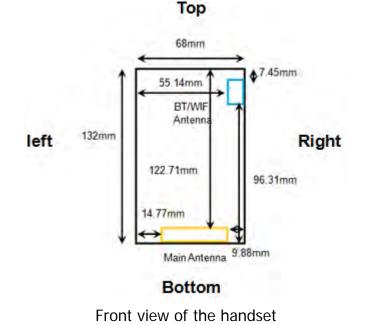
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all sides and surfaces with a transmitting antenna located within 25 mm from that surface or edge, for the data modes, wireless technologies and frequency bands supporting hotspot mode.

Test configurations:

- (1) Front side
- (2) Back side
- (3) Top side.(WWAN antenna to top side distance >25mm, SAR measurement is not required for top side)
- (4) Bottom side. (WLAN antenna to bottom side distance >25mm, SAR measurement is not required for bottom side)
- (5) Right side.
- (6) Left side.(WLAN antenna to left side distance >25mm, SAR measurement is not required for left side)



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8. According to KDB447498 D01v05 – The 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances≤ 50 mm are determined by: [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. Based on the maximum power of Bluetooth and the min. test separation distance, Bluetooth SAR was not required.</p>

(Max. power of channel: 0.38dBm (1.091mW), min. test separation distance=15mm, f=2480MHz,  $[(1.091/15)* \sqrt{2.48}]=0.115 \le 3.0$ 

According to KDB447498 D01v05 – 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: [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]  $\cdot [\sqrt{f(GHz)} / 7.5]$  for test separation distances 50 mm. From above, the highest standalone SAR of BT can be estimated as follows:

Mode	Frequency (MHz)	Maximum Power (dBm)	Separation Distance (Body) (mm)	Estimated SAR (Body) (W/kg)
Bluetooth	2480	0.38	15	0.015

- 9. Bluetooth can only be transmitted simultaneously with WWAN Main antenna according to client's operation description.
- 10. Simultaneous transmission SAR test exclusion can be applied due to the sum of the 1-g SAR for all the simultaneous transmitting antennas in the same test configuration is ≤ 1.6 W/kg.(See 3.Simultaneous Transmission Analysis)
- 11. According to FCC KDB248227 and October 10, 2012 TCB Workshop, SAR test is not required for 802.11g/n(20M) channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.
- 12. According to FCC KDB248227, for each band, testing at higher data rates and higher order modulation is not required when the maximum average output power for each of these configurations is less than 1/4 dB higher than those measured at the lowest data rate.

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- 13. Due to the maximum average output power of higher data rates is less than 1/4 dB higher than lowest data rate, thus only lowest data rate is required for SAR test.
- 14. Due to the maximum average output power of 802.11 g/n(20M) is less than 1/4 dB higher than 802.11b, thus 802.11 g/n(20M) is not required for SAR test.
- 15. According to KDB447498 D01v05, 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.
- 16. According to KDB865664 D01v01, 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 (~ 10% from the 1-g SAR limit)
- 17. SAR measurement variability is not required for assessment due to the original highest measured SAR is  $\leq$  0.8 W/kg.

## Additional configuration (Head exposure):

- 18. For highest SAR configuration in WWAN Main antenna repeated with external memory card inside. (GSM 850 Left cheek position CH251)
- 19. For highest SAR configuration in WLAN antenna repeated with external memory card inside. (802.11b Left cheek position CH11)

## Additional configuration (Body-worn exposure):

- 20. For highest SAR configuration in WWAN Main antenna repeated with external memory card inside. (GSM 850 Front side position CH251)
- 21. For highest SAR configuration in WWAN Main antenna repeated with headset 1 & headset 2. (GSM 850 Front side position CH251)

## Additional configuration (Hotspot exposure):

- 22. For highest SAR configuration in WWAN Main antenna repeated with external memory card inside. (GPRS 1900\_4UP Bottom side position CH661)
- 23. For highest SAR configuration in WWAN Main antenna repeated with headset 1 & headset 2. (GPRS 1900\_4UP Bottom side position CH661)

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- 24. For highest SAR configuration in WLAN antenna repeated with external memory card inside. (802.11b Back side position CH11)
- 25. For highest SAR configuration in WLAN antenna repeated with headset 1 & headset 2. (802.11b – Back side position – CH11)

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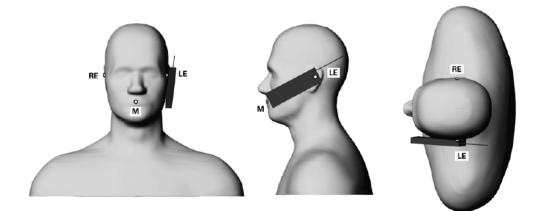
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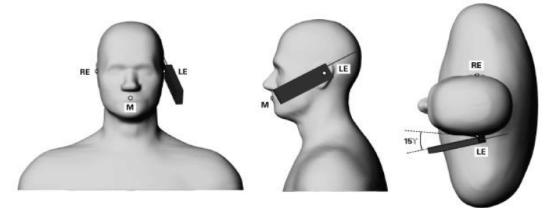


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#### **1.6 Positioning Procedure**



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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## **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

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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 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.

$$SAR = \frac{\sigma}{\rho} \left| E \right|^2 = C \frac{\delta T}{\delta t}$$

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:

• 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 small.

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- 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.
- 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 (~ 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 ±5%.
- 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].

## 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:

• The setup must enable accurate determination of the incident power.

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- The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
- 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=  $\sigma$  ( $|Ei|^2$ )/ $\rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant.

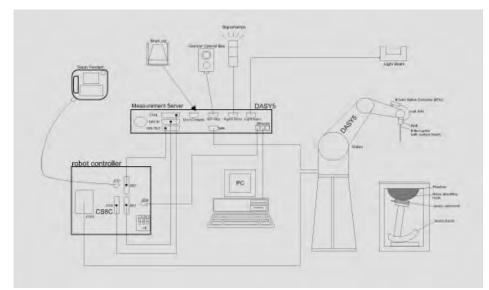


Fig. a A block diagram of the SAR measurement system

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

- 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).
- 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.
- 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.

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- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7
- DASY 5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing 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
	HSL835/1900/2450MHz Additional CF for other
	liquids and frequencies upon request
Frequency	10 MHz to > 6 GHz, Linearity: $\pm$ 0.6 dB (EX3DV4)
Directivity	± 0.3 dB in HSL (rotation around probe axis)
	± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic	10 μW/g to > 100 mW/g
Range	Linearity: $\pm$ 0.2 dB (noise: typically < 1 $\mu$ W/g)
Dimensions	Tip diameter: 4 mm (ES3DV3)
	Tip diameter: 2.5 mm (EX3DV4)
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:	The shell corresponds to the specifications of the Specific								
	Anthropomorphic Mannequin (SAM) phantom defined in IEEE								
	1528-200X, CENELEC 50361 and IE	528-200X, CENELEC 50361 and IEC 62209.							
	It enables the dosimetric evaluation	n of left and right hand phone							
	usage as well as body mounted usa	ige at the flat phantom region. A							
	cover prevents evaporation of the li	iquid. Reference markings on the							
	phantom allow the complete setup of	of all predefined phantom positions							
	and measurement grids by manuall	y teaching three points with the							
	robot.								
Shell Thickness:	2 ± 0.2 mm								
Filling Volume:	Approx. 25 liters	and the							
Dimensions:	Height: 210 mm;	T III							
	Length: 1000 mm;								
	Width: 500 mm								

### **DEVICE HOLDER**

Construction	In combination with the Twin SAM Phantom	
	V4.0/V4.0C or Twin SAM, the Mounting	- Change
	<b>. . . .</b>	
	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,	A STATE
	CENELEC, FCC or other specifications. The	
	device holder can be locked at different	
	phantom locations (left head, right head, flat	Device Holder
	phantom).	

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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 +/- 10% (according to KDB865664 D01) 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 ambient temperature of the laboratory was 21.7°C, the relative humidity was 62% and 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.

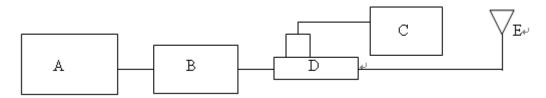


Fig. b The block diagram of system verification

- A. Signal Generator
- B. Amplifier
- C. Power Sensor
- D. Dual Directional Coupling
- E. Reference Dipole Antenna



Photograph of the Dipole Antenna

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Validation Kit	S/N	Frequency (MHz)		Target SAR (1g) (Pin=250mW)	Measured SAR (1g)(mW/g)	Deviation (%)	Measured Date
D835V2	4d161	835	Head	2.46	2.55	-3.66%	Feb. 08, 2014
D033V2			Body	2.4	2.38	0.83%	Feb. 06, 2014
D1900V2	5d173	1900	Head	9.82	9.66	1.63%	Feb. 08, 2014
D1900V2		1900	Body	10.1	10.1	0.00%	Feb. 10, 2014
D2450V2	922	22 2450	Head	13.3	13.8	-3.76%	Feb. 04, 2014
	922	2430	Body	12.9	13	-0.78%	Feb. 10, 2014

Table 1. System validation (follow manufacture target value)

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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 conjuncation 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)

Measured Frequency (MHz)	Tissue Type	Target Dielectric Constant, Er	Target Conductivity, σ (S/m)	Measured Dielectric Constant,	Measured Conductivity, σ (S/m)	% dev εr	% dev σ	Measurement Date
824.2		41.556	0.899	43.382	0.885	-4.39%	1.57%	
835	Head	41.500	0.900	43.199	0.913	-4.09%	-1.44%	Feb. 08, 2014
836.6	пеаи	41.500	0.902	43.184	0.916	-4.06%	-1.58%	reb. 06, 2014
848.8		41.500	0.915	42.949	0.973	-3.49%	-6.35%	
824.2		55.242	0.969	53.474	0.98	3.20%	-1.14%	
835	Body	55.200	0.970	53.312	1.005	3.42%	-3.61%	Feb. 06, 2014
836.6	Bouy	55.195	0.972	53.294	1.007	3.44%	-3.60%	Teb. 00, 2014
848.8		55.158	0.987	53.189	1.01	3.57%	-2.33%	
1850.2		40.000	1.400	41.31	1.411	-3.28%	-0.79%	
1880	Head	40.000	1.400	41.177	1.417	-2.94%	-1.21%	Feb. 08, 2014
1900	Heau	40.000	1.400	41.005	1.439	-2.51%	-2.79%	Teb. 00, 2014
1909.8		40.000	1.400	40.935	1.447	-2.34%	-3.36%	
1850.2		53.300	1.520	51.911	1.507	2.61%	0.86%	
1880	Dodu	53.300	1.520	51.824	1.539	2.77%	-1.25%	Feb. 10, 2014
1900	Body	53.300	1.520	51.792	1.561	2.83%	-2.70%	rep. 10, 2014
1909.8		53.300	1.520	51.769	1.572	2.87%	-3.42%	

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Measured Frequency (MHz)	Tissue Type	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, Er	Measured Conductivity, σ (S/m)	% dev ɛr	% dev σ	Measurement Date
2412		39.268	1.766	38.301	1.729	2.46%	2.11%	
2437	Head	39.223	1.788	38.242	1.759	2.50%	1.65%	Feb. 04, 2014
2450		39.2	1.8	38.191	1.771	2.57%	1.61%	reb. 04, 2014
2462		39.185	1.813	38.108	1.801	2.75%	0.67%	
2412	37 50 Body	52.751	1.914	52.119	1.915	1.20%	-0.07%	
2437		52.717	1.938	52.038	1.947	1.29%	-0.49%	Feb. 10, 2014
2450		52.7	1.95	51.992	1.962	1.34%	-0.62%	160. 10, 2014
2462		52.685	1.967	51.958	1.979	1.38%	-0.61%	

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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Frequency (MHz)			Total					
	Mode	DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	Total amount
850	Head		532.98 g	18.3 g	2.4 g	3.2 g	766 g	1.0L(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)

The composition of the brain tissue simulating liquid:

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 C95.1–1992, Copyright 1992 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.

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(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).

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 m W/g	8.00 m W/g		
Spatial Average SAR (Whole Body)	0.08 m W/g	0.40 m W/g		
Spatial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 m W/g	20.00 m W/g		

#### 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 MHz**

Mode Position		Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged SAR over 1g (W/kg)		Plot page
					Tolerance (dBm)	(dBm)		Measured	Reported	
	RE Cheek	-	190	836.6	34.2	32.6	44.54%	0.299	0.432	-
	RE Tilt	-	190	836.6	34.2	32.6	44.54%	0.184	0.266	-
	LE Cheek	-	128	824.2	34.2	32.6	44.54%	0.254	0.367	-
GSM	LE Cheek	-	190	836.6	34.2	32.6	44.54%	0.318	0.460	-
(Head)	LE Cheek	-	251	848.8	34.2	32.5	47.91%	0.43	0.636	43
	LE Cheek* -with memory card	-	251	848.8	34.2	32.5	47.91%	0.359	0.531	-
	LE Tilt	-	190	836.6	34.2	32.6	44.54%	0.183	0.265	-
	Back	15mm	190	836.6	34.2	32.6	44.54%	0.33	0.477	-
	Front	15mm	128	824.2	34.2	32.6	44.54%	0.375	0.542	-
	Front	15mm	190	836.6	34.2	32.6	44.54%	0.404	0.584	-
	Front	15mm	251	848.8	34.2	32.5	47.91%	0.44	0.651	44
GSM (Body-worn speech mode)	Front* -with headset_1	15mm	251	848.8	34.2	32.5	47.91%	0.204	0.302	-
	Front* -with headset_2	15mm	251	848.8	34.2	32.5	47.91%	0.299	0.442	-
	Front* -with memory card	15mm	251	848.8	34.2	32.5	47.91%	0.43	0.636	-
	Back side	10mm	128	824.2	29	28.1	23.03%	0.379	0.466	-
	Front side	10mm	128	824.2	29	28.1	23.03%	0.386	0.475	-
GPRS (Hotspot) (1Dn4UP)	Front side	10mm	190	836.6	29	27.9	28.82%	0.412	0.531	-
	Front side	10mm	251	848.8	29	27.8	31.83%	0.455	0.600	45
	Bottom side	10mm	128	824.2	29	28.1	23.03%	0.074	0.091	-
	Right side	10mm	128	824.2	29	28.1	23.03%	0.348	0.428	-
	Left side	10mm	128	824.2	29	28.1	23.03%	0.38	0.468	-

# Using KDB941225 D03v01 and KDB941225 D04v01 to exclude SAR test requirements for EDGE modes due to the source-based time-averaged output power for EDGE mode is lower than that in the GPRS mode.

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# According to KDB447498 D01v05 the 1-g SAR for the highest output channel is less than 0.8 W/kg, where the transmission band corresponding to all channels is ≤ 100 MHz, testing for the other channels is not required.

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#### **GSM 1900 MHz**

Mode	Position	Distance (mm)	СН	CH Freq. (MHz) Max. Rated Avg. Measured Power + Max. Avg. Power Tolerance (dBm) (dBm)		Scaling	Averaged S (W/ Measured	•	Plot page	
	RE Cheek	-	512	1850.2	31.5	29.8	47.91%	0.189	0.280	-
	RE Tilt	-	512	1850.2	31.5	29.8	47.91%	0.09	0.133	-
GSM	LE Cheek	-	512	1850.2	31.5	29.8	47.91%	0.198	0.293	46
(Head)	LE Cheek	-	661	1880	31.5	29.7	51.36%	0.168	0.254	-
	LE Cheek	-	810	1909.8	31.5	29.5	58.49%	0.154	0.244	-
	LE Tilt	-	512	1850.2	31.5	29.8	47.91%	0.062	0.092	-
0014	Bcak side	15mm	512	1850.2	31.5	29.8	47.91%	0.141	0.209	-
GSM (Body-worn	Front side	15mm	512	1850.2	31.5	29.8	47.91%	0.157	0.232	-
speech mode)	Front side	15mm	661	1880	31.5	29.7	51.36%	0.158	0.239	47
opocon modo)	Front side	15mm	810	1909.8	31.5	29.5	58.49%	0.153	0.242	-
	Back side	10mm	810	1909.8	25	24.1	23.03%	0.242	0.298	-
	Front side	10mm	810	1909.8	25	24.1	23.03%	0.209	0.257	-
	Bottom side	10mm	512	1850.2	25	23.9	28.82%	0.435	0.560	-
	Bottom side	10mm	661	1880	25	24	25.89%	0.523	0.658	48
GPRS	Bottom side* -with headset_1	10mm	661	1880	25	24	25.89%	0.486	0.612	-
(Hotspot) (1Dn4UP)	Bottom side* -with headset_2	10mm	661	1880	25	24	25.89%	0.42	0.529	-
	Bottom side* -with memory card	10mm	661	1880	25	24	25.89%	0.512	0.645	-
	Bottom side	10mm	810	1909.8	25	24.1	23.03%	0.516	0.635	-
	Right side	10mm	810	1909.8	25	24.1	23.03%	0.079	0.097	-
	Left side	10mm	810	1909.8	25	24.1	23.03%	0.076	0.094	-

- # Using KDB941225 D03v01 and KDB941225 D04v01 to exclude SAR test requirements for EDGE modes due to the source-based time-averaged output power for EDGE mode is lower than that in the GPRS mode.
- # According to KDB447498 D01v05 the 1-g SAR for the highest output channel is less than 0.8 W/kg, where the transmission band corresponding to all channels is ≤ 100 MHz, testing for the other channels is not required.

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#### WLAN802.11 b

Mode Position		Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged S (W/	0	Plot
		(11111)			Tolerance (dBm)	(dBm)		Measured	Reported	page
	RE Cheek	-	11	2462	18	17.06	24.17%	0.047	0.058	-
	RE Tilt	-	11	2462	18	17.06	24.17%	0.035	0.043	-
	LE Cheek	-	1	2412	18	16.55	39.64%	0.025	0.035	-
	LE Cheek	-	6	2437	18	16.01	58.12%	0.047	0.074	-
Head	LE Cheek	-	11	2462	18	17.06	24.17%	0.106	0.132	49
	LE Cheek* -with memory card	-	11	2462	18	17.06	24.17%	0.096	0.119	-
	LE Tilt	-	11	2462	18	17.06	24.17%	0.035	0.043	-
	Back side	10mm	1	2412	18	16.55	39.64%	0.012	0.017	-
	Back side	10mm	6	2437	18	16.01	58.12%	0.02	0.032	-
	Back side	10mm	11	2462	18	17.06	24.17%	0.038	0.047	50
	Back side* -with headset_1	10mm	11	2462	18	17.06	24.17%	0.033	0.041	-
Hotspot	Back side* -with headset_2	10mm	11	2462	18	17.06	24.17%	0.032	0.040	-
	Back side* -with memory card	10mm	11	2462	18	17.06	24.17%	0.034	0.042	-
	Front side	10mm	11	2462	18	17.06	24.17%	0.011	0.014	-
	Top side	10mm	11	2462	18	17.06	24.17%	0.015	0.019	-
	Right side	10mm	11	2462	18	17.06	24.17%	0.00978	0.012	-

- # Using KDB248227 D01v01-SAR is not required for 802.11 g/HT20 channels when the maximum average output power is higher than that measured on the corresponding 802.11b channels but increase less than 1/4 dB.
- # According to KDB447498 D01v05 the 1-g SAR for the highest output channel is less than 0.8 W/kg, where the transmission band corresponding to all channels is  $\leq$  100 MHz, testing for the other channels is not required.

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# 3. Simultaneous Tramsmission Analysis

#### Simultaneous Tramsmission Scenarios:

Simultar	neous Transmit Configurations	Head	Body-worn	Hot spot		
GSM85	0/1900 Voice + 2.4GHz Wi-Fi	Yes	Yes	No		
GSM8	GSM850/1900 Voice + 2.4GHz BT No			No		
GPRS8	50/1900 Data + 2.4GHz Wi-Fi	No	No	Yes		
	Notes:					
	1. GSM and WiFi/BT used the different antenna and can transmit simultaneously					
	2. Bluetooth and 2.4GHz WiFi share transmit simultaneously	the same ante	enna path and	cannot		

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#### Simultaneous Transmission Combination:

#### #. Head SAR simultaneous transmission analysis

Simultaneous tx	Configuration	GSM850 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
	Right cheek	0.432	0.058	0.49
Head SAR	Right tilt	0.266	0.043	0.309
Head SAR	Left cheek	0.636	0.132	0.768
	Left tilt	0.265	0.043	0.308

Simultaneous tx	Configuration	GSM1900 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
	Right cheek	0.28	0.058	0.338
Head SAR	Right tilt	0.133	0.043	0.176
Head SAR	Left cheek	0.293	0.132	0.425
	Left tilt	0.092	0.043	0.135

#### #. Body-worn SAR simultaneous transmission analysis

Simultaneous tx	Configuration	GSM850 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
Pody worp SAD	Back_15mm	0.477	<0.047	<0.524
Body-worn SAR	Front_15mm	0.651	<0.014	<0.665

Simultaneous tx	Configuration	GSM1900 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
Pody worp SAD	Back_15mm	0.209	<0.047	<0.256
Body-worn SAR	Front_15mm	0.242	<0.014	<0.256

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Simultaneous tx	Configuration	GSM850 Reported SAR (W/kg)	BT Reported SAR (W/kg)	ΣSAR(W/kg) Reported
Body-worn SAR	Back_15mm	0.477	0.015	0.492
	Front_15mm	0.651	0.015	0.666

Simultaneous tx Configuration		GSM1900 Reported SAR (W/kg)	BT Reported SAR (W/kg)	ΣSAR(W/kg) Reported
Pody worp SAD	Back_15mm	0.209	0.015	0.224
Body-worn SAR	Front_15mm	0.242	0.015	0.257

#### #. Hotspot SAR simultaneous transmission analysis

Simultaneous tx	Configuration	GPRS850 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
	Back_10mm	0.466	0.047	0.513
	Front_10mm	0.6	0.014	0.614
Hotspot SAR	Top_10mm	-	0.019	0.019
	Bottom_10mm	0.091	-	0.091
	Right_10mm	0.428	0.012	0.44
	Left_10mm	0.468	-	0.468

Simultaneous tx	Configuration	GPRS1900 Reported SAR (W/kg)	WLAN Reported SAR (W/kg)	ΣSAR(W/kg) Reported
	Back_10mm	0.298	0.047	0.345
	Front_10mm	0.257	0.014	0.271
Hotspot SAR	Top_10mm	-	0.019	0.019
	Bottom_10mm	0.658	-	0.658
	Right_10mm	0.097	0.012	0.109
	Left_10mm	0.094	-	0.094

# The above summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit, therefore the simultaneous transmission SAR is not required.

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## 4. Instruments List

Manufacturer	Device	Туре	Serial number	Date of last calibration	Date of next calibration
Schmid & Partner Engineering AG	Dosimetric E-Field Probe	EX3DV4	3938	Aug.02,2013	Aug.01,2014
Sabmid & Dartpar	835/1900/2450	D835V2	4d161	Nov.01,2013	Oct.31,2014
Schmid & Partner Engineering AG	MHz System	D1900V2	5d173	Jun.10,2013	Jun.09,2014
Engineering AG	Validation Dipole	D2450V2	922	Nov.05,2013	Nov.04,2014
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	1374	Jun.03,2013	Jun.02,2014
Schmid & Partner Engineering AG	Software	DASY 52 V52.8	N/A	Calibration not required	Calibration not required
Schmid & Partner Engineering AG	Phantom	SAM	N/A	Calibration not required	Calibration not required
Agilent	Network Analyzer	E5071C	MY46107530	Feb.22,2013	Feb.21,2014
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilopt	Dual-directional	772D	MY52180142	Sep.19,2013	Sep.18,2014
Agilent	coupler	778D	MY52180302	Sep.25,2013	Sep.24,2014
Agilent	RF Signal Generator	N5181A	MY50145142	Oct.03,2013	Oct.02,2014
Agilent	Power Meter	E4417A	MY52240003	May 07,2013	May.06,2014
Agilent	Power Sensor	E9301H	MY52200003	May 07,2013	May.06,2014
R&S	Radio Communication Test	CMU200	122498	Jul. 17,2013	Jul. 16,2014
TECPEL	Digital thermometer	DTM-303A	TP130074	Mar.04,2013	Mar.03,2014

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## 5. Measurements

Date: 2014/2/8

## GSM 850\_Head\_Le Cheek\_CH 251

Communication System: GSM; Communication System Band: GSM850; Frequency: 848.8 MHz; Medium parameters used: f = 849 MHz;  $\sigma$  = 0.973 S/m;  $\epsilon$ r = 42.949;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

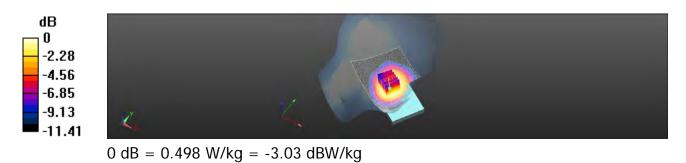
- Probe: EX3DV4 SN3938; ConvF(9.21, 9.21, 9.21); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/HEAD/Area Scan (71x111x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.491 W/kg

## Configuration/HEAD/Zoom Scan (5x5x7)/Cube 0: Measurement grid:

dx=8mm, dy=8mm, dz=5mm Reference Value = 6.972 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 0.545 W/kg SAR(1 g) = 0.430 W/kg; SAR(10 g) = 0.316 W/kg Maximum value of SAR (measured) = 0.498 W/kg



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Date: 2014/2/6

## GSM 850\_Body-worn\_Front\_CH 251\_15mm

Communication System: GSM; Communication System Band: GSM850; Frequency: 848.8 MHz; Medium parameters used: f = 849 MHz;  $\sigma$  = 1.01 S/m;  $\epsilon$ r = 53.189;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

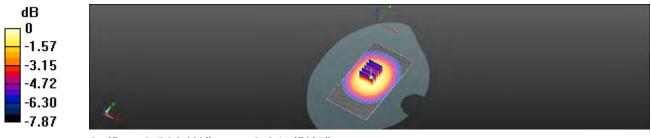
- Probe: EX3DV4 SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Body/Area Scan (61x111x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.504 W/kg

## Configuration/Body/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm,

dy=8mm, dz=5mm Reference Value = 22.486 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 0.560 W/kg SAR(1 g) = 0.440 W/kg; SAR(10 g) = 0.335 W/kg Maximum value of SAR (measured) = 0.508 W/kg



0 dB = 0.508 W/kg = -2.94 dBW/kg

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## GPRS 850\_Hotspot\_Front\_CH 251\_10mm

Communication System: GPRS-12; Communication System Band: GPRS850; Frequency: 848.8 MHz;Medium parameters used: f = 849 MHz;  $\sigma$  = 1.01 S/m;  $\epsilon$ r = 53.189;  $\rho$  = 1000 kg/m<sup>3</sup>

DASY 5 Configuration:

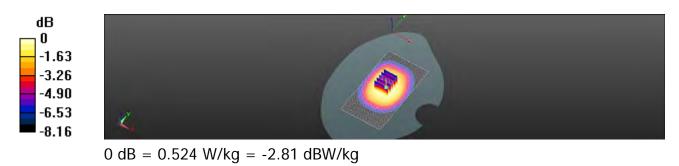
- Probe: EX3DV4 SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Body/Area Scan (61x111x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.528 W/kg

## Configuration/Body/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm,

dy=8mm, dz=5mm Reference Value = 22.670 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 0.581 W/kg SAR(1 g) = 0.455 W/kg; SAR(10 g) = 0.347 W/kg Maximum value of SAR (measured) = 0.524 W/kg



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## GSM 1900\_Head\_Le Cheek\_CH 512

Communication System: GSM; Communication System Band: GSM1900; Frequency: 1850.2 MHz;Medium parameters used (interpolated): f = 1850.2 MHz;  $\sigma$  = 1.411 S/m;  $\epsilon_r$  = 41.31;  $\rho$  = 1000 kg/m<sup>3</sup>

DASY 5 Configuration:

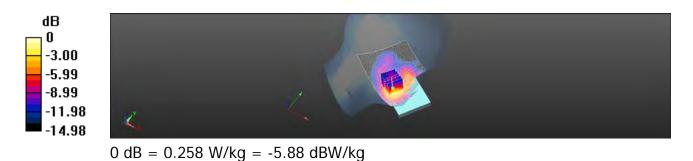
- Probe: EX3DV4 SN3938; ConvF(7.61, 7.61, 7.61); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/HEAD/Area Scan (71x111x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.267 W/kg

#### Configuration/HEAD/Zoom Scan (5x5x7)/Cube 0: Measurement grid:

dx=8mm, dy=8mm, dz=5mm Reference Value = 3.984 V/m; Power Drift = 0.15 dB Peak SAR (extrapolated) = 0.324 W/kg SAR(1 g) = 0.198 W/kg; SAR(10 g) = 0.112 W/kg Maximum value of SAR (measured) = 0.258 W/kg



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## GSM 1900\_Body-worn\_Front\_CH 661\_15mm

Communication System: GSM; Communication System Band: GSM1900; Frequency: 1880 MHz; Medium parameters used: f = 1880 MHz;  $\sigma$  = 1.539 S/m;  $\epsilon_r$  = 51.824;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

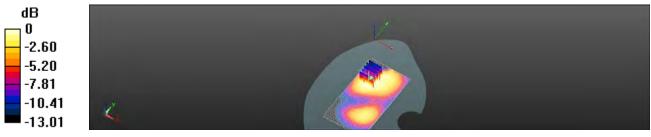
- Probe: EX3DV4 SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Body/Area Scan (61x111x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.210 W/kg

## Configuration/Body/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm,

dy=8mm, dz=5mm Reference Value = 4.922 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 0.241 W/kg SAR(1 g) = 0.158 W/kg; SAR(10 g) = 0.101 W/kg Maximum value of SAR (measured) = 0.198 W/kg



0 dB = 0.198 W/kg = -7.03 dBW/kg

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## GPRS 1900\_Hotspot\_Bottom\_CH 661\_10mm

Communication System: GPRS-12; Communication System Band: GPRS1900; Frequency: 1880 MHz;Medium parameters used: f = 1880 MHz;  $\sigma$  = 1.539 S/m;  $\epsilon_r$  = 51.824;  $\rho$  = 1000 kg/m<sup>3</sup>

DASY 5 Configuration:

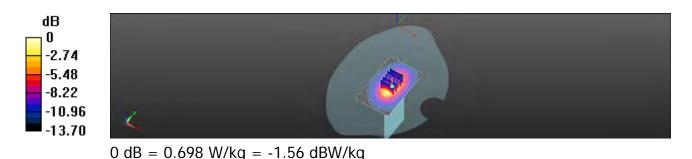
- Probe: EX3DV4 SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Body/Area Scan (51x81x1): Interpolated grid: dx=1.500 mm,

dy=1.500 mm Maximum value of SAR (interpolated) = 0.711 W/kg

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

Reference Value = 17.897 V/m; Power Drift = -0.11 dB Peak SAR (extrapolated) = 0.856 W/kg SAR(1 g) = 0.523 W/kg; SAR(10 g) = 0.295 W/kg Maximum value of SAR (measured) = 0.698 W/kg



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## WLAN 802.11b\_Head\_Le Cheek\_CH 11

Communication System: WLAN(2.45G); Communication System Band: WLAN802.11 b; Frequency: 2462 MHz; Medium parameters used: f = 2462 MHz;  $\sigma = 1.801$  S/m;  $\epsilon r = 38.108$ ;  $\rho = 1000 \text{ kg/m}^3$ 

**DASY 5 Configuration:** 

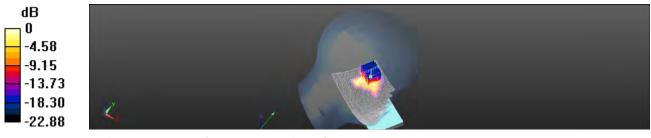
- Probe: EX3DV4 SN3938; ConvF(6.97, 6.97, 6.97); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

#### Configuration/HEAD/Area Scan (81x131x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.164 W/kg

## Configuration/HEAD/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

dx=5mm, dy=5mm, dz=5mmReference Value = 3.632 V/m; Power Drift = 0.12 dB Peak SAR (extrapolated) = 0.279 W/kg SAR(1 g) = 0.106 W/kg; SAR(10 g) = 0.038 W/kgMaximum value of SAR (measured) = 0.173 W/kg



0 dB = 0.173 W/kg = -7.63 dBW/kg

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## WLAN 802.11b\_Hotspot\_Back\_CH 11\_10mm

Communication System: WLAN(2.45G); Communication System Band: WLAN802.11 b; Frequency: 2462 MHz; Medium parameters used: f = 2462 MHz;  $\sigma = 1.979$  S/m;  $\epsilon_r = 51.958$ ;  $\rho = 1000 \text{ kg/m}^3$ 

DASY 5 Configuration:

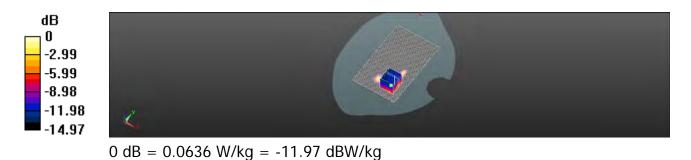
- Probe: EX3DV4 SN3938; ConvF(6.94, 6.94, 6.94); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Body/Area Scan (81x131x1): Interpolated grid: dx=1.200 mm,

dy=1.200 mm Maximum value of SAR (interpolated) = 0.155 W/kg

#### Configuration/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dv=5mm, dz=5mm

Reference Value = 2.610 V/m; Power Drift = 0.09 dBPeak SAR (extrapolated) = 0.121 W/kg SAR(1 q) = 0.038 W/kq; SAR(10 q) = 0.010 W/kq.Maximum value of SAR (measured) = 0.0636 W/kg



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# 6. System Verification

Date: 2014/2/8

#### Dipole 835 MHz\_SN: 4d161\_Head

Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.913 S/m;  $\epsilon_r$  = 43.199;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

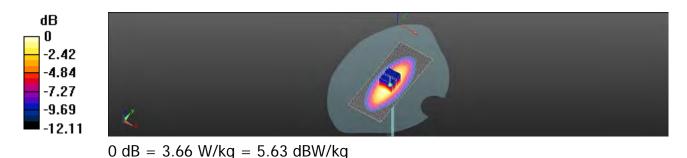
- Probe: EX3DV4 SN3938; ConvF(9.21, 9.21, 9.21); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (51x121x1): Interpolated grid:

dx=1.500 mm, dy=1.500 mm Maximum value of SAR (interpolated) = 3.47 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 62.458 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 4.54 W/kg SAR(1 g) = 2.55 W/kg; SAR(10 g) = 1.61 W/kg Maximum value of SAR (measured) = 3.66 W/kg



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Date: 2014/2/6

#### Dipole 835 MHz\_SN: 4d161\_Body

Communication System: CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 1.005 S/m;  $\epsilon_r$  = 53.312;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

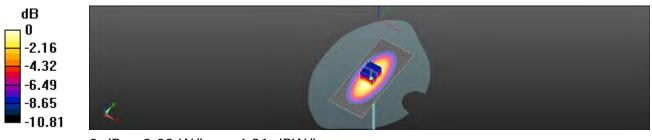
- Probe: EX3DV4 SN3938; ConvF(9.37, 9.37, 9.37); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (51x121x1): Interpolated grid:

dx=1.500 mm, dy=1.500 mm Maximum value of SAR (interpolated) = 2.99 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 56.125 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 3.55 W/kg SAR(1 g) = 2.38 W/kg; SAR(10 g) = 1.55 W/kg Maximum value of SAR (measured) = 3.03 W/kg



 $0 \, dB = 3.03 \, W/kg = 4.81 \, dBW/kg$ 

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Date: 2014/2/8

#### Dipole 1900 MHz\_SN: 5d173\_Head

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.439 S/m;  $\epsilon_r$  = 41.005;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

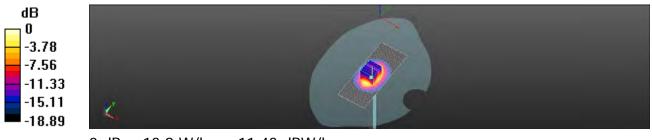
- Probe: EX3DV4 SN3938; ConvF(7.61, 7.61, 7.61); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (41x101x1): Interpolated grid:

dx=1.500 mm, dy=1.500 mm Maximum value of SAR (interpolated) = 14.1 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 100.8 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 17.8 W/kg SAR(1 g) = 9.66 W/kg; SAR(10 g) = 5.03 W/kg Maximum value of SAR (measured) = 13.9 W/kg



0 dB = 13.9 W/kg = 11.43 dBW/kg

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Date: 2014/2/10

#### Dipole 1900 MHz\_SN: 5d173\_Body

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.561 S/m;  $\epsilon_r$  = 51.792;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

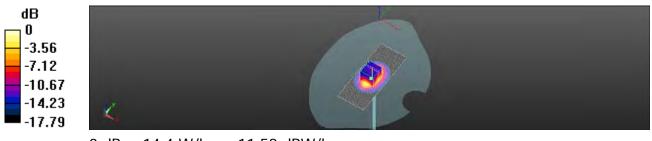
- Probe: EX3DV4 SN3938; ConvF(7.29, 7.29, 7.29); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (41x101x1): Interpolated grid:

dx=1.500 mm, dy=1.500 mm Maximum value of SAR (interpolated) = 14.6 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 97.574 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 18.3 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.29 W/kg Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

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Date: 2014/2/4

#### Dipole 2450 MHz\_SN: 922\_Head

Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.771 S/m;  $\epsilon_r$  = 38.191;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

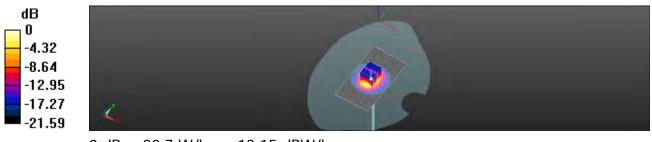
- Probe: EX3DV4 SN3938; ConvF(6.97, 6.97, 6.97); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (51x91x1): Interpolated grid:

dx=1.200 mm, dy=1.200 mm Maximum value of SAR (interpolated) = 22.5 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 110.3 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 27.6 W/kg SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.46 W/kg Maximum value of SAR (measured) = 20.7 W/kg



0 dB = 20.7 W/kg = 13.15 dBW/kg

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Date: 2014/2/10

#### Dipole 2450 MHz\_SN: 922\_Body

Communication System: CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.962 S/m;  $\epsilon_r$  = 51.992;  $\rho$  = 1000 kg/m<sup>3</sup> DASY 5 Configuration:

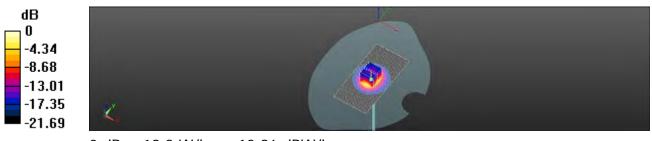
- Probe: EX3DV4 SN3938; ConvF(6.94, 6.94, 6.94); Calibrated: 2013/8/2;
- Sensor-Surface: 2mm (Mechanical Surface Detection),
- Electronics: DAE4 Sn1374; Calibrated: 2013/6/3
- Phantom: Head;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Configuration/Pin=250mW/Area Scan (51x101x1): Interpolated grid:

dx=1.200 mm, dy=1.200 mm Maximum value of SAR (interpolated) = 19.7 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 101.4 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 26.6 W/kg SAR(1 g) = 13 W/kg; SAR(10 g) = 6.09 W/kg Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.8 W/kg = 12.96 dBW/kg

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## 7. DAE & Probe Calibration Certificate

	ch, Switzerland	Hac-MRA (C Z Z C Prioration S	Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
accredited by the Swiss Accredit he Swiss Accreditation Servic fultilateral Agreement for the	e is one of the signatories	s to the EA	4o.: SCS 108
Client SGS-TW (Aud	5-14 		DAE4-1374_Jun13
CALIBRATION	CERTIFICATE		
Object	DAE4 - SD 000 D	04 BJ - SN: 1374	
Calibration procedure(s)	QA CAL-06.v26 Calibration proces	dure for the data acquisition electr	onics (DAE)
Calibration date:	June 03, 2013		
The measurements and the unc	ertainties with confidence pricted in the closed laboratory	onal standards, which realize the physical units obability are given on the following pages and $\gamma$ facility: environment (emperature (22 ± 3)°C i	are part of the certificate.
The measurements and the unco All calibrations have been condu Calibration Equipment used (M&	ertainties with confidence pricted in the closed laboratory	obability are given on the following pages and	are part of the certificate. and humidity < 70%,
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence proceed in the closed laboratory TE critical for calibration)	obability are given on the following pages and $\gamma$ facility: environment (emperature (22 $\pm$ 3) $^{\circ}\mathrm{G}$	are part of the certificate.
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001	ertainties with confidence price of the closed laboratory TE critical for calibration)	obability are given on the following pages and ( facility: environment (emperature (22 ± 3)°C i Cat Date (Cartificate No.) 02-Oct-12 (No: 12728) Check Date (in house)	are part of the certificate. and humidity < 70%, Scheduled Calibration
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards Auto DAE Calibration Unit	ertainties with confidence price of the confidence of the confiden	obability are given on the following pages and       /         / facility: environment (emperature (22 ± 3)°C ;	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards	ertainties with confidence on cted in the closed laboratory TE critical for calibration) ID # SN: 0810278 ID # SE UWS 053 AA 1001 SE UMS 006 AA 1002	obability are given on the following pages and ( facility: environment temperature (22 ± 3)°C i Cat Date (Certificate No.) 02-Oct-12 (No:12728) Check Date (in house) 07-Jan-13 (in house check) 07-Jan-13 (in house check)	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13 Scheduled Check In house check; Jan-14 In house check; Jan-14
The measurements and the uno All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards Auto DAE Calibration Unit Calibrator Box V2.1	ertainties with confidence price of the confidence of the confiden	obability are given on the following pages and ( facility: environment temperature (22 ± 3)°C i Cal Date (Certificate No.) 02-Oct-12 (No: 12728) Check Date (in house) 07-Jan-13 (in house check)	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13 Scheduled Check In house check: Jan-14 In house check: Jan-14 Signature
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards Auto DAE Calibration Unit Calibrator Box V2.1	ID # SE UWS 053 AA 1002 Name	obability are given on the following pages and ( facility: environment (emperature (22 ± 3)°C i Cat Date (Certificate No.) 02-Oct-12 (No:12728) Check Date (in house) 07-Jan-13 (in house check) 07-Jan-13 (in house check) 07-Jan-13 (in house check)	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13 Scheduled Check In house check: Jan-14 In house check: Jan-14 Signature
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithlay Multimeter Type 2001 Secondary Standards Auto DAE Calibration Unit Calibrator Box V2.1 Calibrated by:	ID # SE UWS 053 AA 1002 Name	obability are given on the following pages and ( facility: environment (emperature (22 ± 3)°C i Cat Date (Certificate No.) 02-Oct-12 (No:12728) Check Date (in house) 07-Jan-13 (in house check) 07-Jan-13 (in house check) 07-Jan-13 (in house check)	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13 Scheduled Check In house check: Jan-14 In house check: Jan-14 Signature
The measurements and the unor All calibrations have been condu Calibration Equipment used (M& Primary Standards Keithley Multimeter Type 2001 Secondary Standards Auto DAE Calibration Unit Calibrator Box V2.1 Calibrated by:	ertainties with confidence pri- cted in The closed laboratory TE critical for calibration) ID # SN: 0810278 ID # SE UWS 053 AA 1001 SE UWS 053 AA 1001 SE UMS 006 AA 1002 Name Enc Hainfeld Fin Bombolt	Debility are given on the following pages and     Iacility: environment temperature (22 ± 3)*C a     Cat Date (Certificate No.)     O2-Oct-12 (No:12728)     Check Date (In house)     O7-Jan-13 (In house check)     O7-Jan-13 (In house check)     Function     Technician	are part of the certificate. and humidity < 70%, Scheduled Calibration Oct-13 Scheduled Check In house check; Jan-14 In house check; Jan-14

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



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Swiss Calibration Service

Accreditation No.: SCS 108

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#### Glossary

DAE Connector angle data acquisition electronics 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

High Range:	1LSB =	6.1µV,	full range =	100*300 mV
Low Range:	1LSB =	61nV .	full range =	+1+3mV
DASY measurement	paramelers: Au	to Zero Time: 3		

<b>Calibration Factors</b>	x	Y	z
High Range	404.597 ± 0.02% (k=2)	405.252 ± 0.02% (k=2)	404.637 ± 0.02% (k=2)
Low Range	3.99874 ± 1.50% (k=2)	4.00831 ± 1.50% (k=2)	3.95007 ± 1.50% (k=2)

#### **Connector Angle**

Connector Angle to be used in DASY system	241.0 ° ± 1 °
Connector Angle to be used in DASY system	241.0 ° ± 1 °

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#### Appendix

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199992.07	-3.43	-0.00
Channel X + Input	20002.96	2.28	0.01
Channel X - Input	-19998.37	2.29	-0.01
Channel Y + Input	199993.84	-1.97	-0,00
Channel Y + Input	20000.33	-0.19	-0.00
Channel Y - Input	-20001.84	-1.12	0.01
Channel Z + Input	199994.33	-1.63	-0.00
Channel Z + Input	19998.59	-1.84	-0.01
Channel Z - Input	-20002.39	-1.62	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2002.45	1.56	0.08
Channel X + Input	201.83	0.44	0.22
Channel X - Input	-198.44	0.26	-0.13
Channel Y + Input	2002.11	1.27	0.06
Channel Y + Input	200.40	-0.84	-0.42
Channel Y - Input	-199.57	-0.72	0.36
Channel Z + Input	2001.68	0.77	0.04
Channel Z + Input	199.45	-1.75	-0.87
Channel Z - Input	-200.85	-2.04	1.02

#### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	-2.27	-3.74
	+ 200	4.97	3.23
Channel Y	200	9.68	9.30
	- 200	-11.44	-11.91
Channel Z	200	6.77	6.83
	- 200	-10.92	-11.26

#### 3. Channel separation

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	×	5,60	-1.27
Channel Y	200	9.02	5	7.06
Channel Z	200	8.83	6.67	~

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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	15890	16495
Channel Y	16032	16698
Channel Z	15908	16765

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input 10M $\Omega$ 

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	1.75	0.84	3.69	0.41
Channel Y	0.08	-1.11	0.96	0.35
Channel Z	-0.02	0.92	1.82	.0.48

#### 6. Input Offset Current

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

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

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

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

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

#### 9. Power Consumption (Typical values for information)

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

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Engineering AG eughausstrasse 43, 8004 Zur	ich, Switzerland	C C Z C S	Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
ccredited by the Swiss Accredit he Swiss Accreditation Servi fulfilateral Agreement for the	ce is one of the signatorie	s to the EA	No.: SCS 108
lient SGS-TW (Aud	len)	Certificate No:	EX3-3938_Aug13
CALIBRATION	CERTIFICATI	E	
Object	EX3DV4 - SN:39	38	
Calibration procedure(s)		DA CAL-14.v3, QA CAL-23.v4, QA dure for dosimetric E-field probes	CAL-25.v4
Calibration date:	August 2, 2013		
		robability are given on the following pages and in ry facility: environment temperature $(22 \pm 3)$ °C c	
All calibrations have been cond	ucted in the closed laborator		
All calibrations have been cond	ucted in the closed laborator	ty facility: environment temperature (22 $\pm$ 3)*C a	
All calibrations have been cond Calibration Equipment used (Mi Primary Standards	ucted in the closed laborator &TE critical for calibration)	y facility: environment temperature (22 ± 3)°C a	and humidity < 70%.
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198	ucted in the closed laborator &TE cotical for calibration)	y facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733)	and humidity < 70%. Scheduled Galibration Apr-14
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A	ID GB41293674	vy facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733)	and humidity < 70%.
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E4419B Power sensor E4412A Reference 3 dB Attenuator	In the closed laborator ID IID III GB41293874 MY41498087	y facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733)	and humidity < 70%. Scheduled Calibration Apr-14 Apr-14
All calibrations have been cond Calibration Equipment used (Mi	ID GB41293674 MY41498087 SN: S6054 (3c)	vy facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737)	Scheduled Galibration Apr-14 Apr-14 Apr-14
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ID GB41253674 MY41498087 SN: S6054 (3c) SN: S5277 (20x)	vy facility: environment temperature (22 ± 3)°C e Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01735)	Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator	ID GB41293674 MY41498087 SN: S6054 (3c) SN: S60577 (20x) SN: S5129 (30b)	v facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01736)	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E44198 Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Standards Secondary Standards	ID GB41293674 MY41498087 SN: 56054 (3c) SN: 560577 (20x) SN: 55129 (30b) SN: 3013 SN: 660 ID	v facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013, Dec12)	Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Dec-13
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference 97 obe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C	Uncted in the closed laborator &TE contical for calibrationy GB41293674 MY41498087 SN: \$56574 (3c) SN: \$56577 (20x) SN: \$55277 (20x) SN: \$5129 (30b) SN: 3013 SN: 660	ry facility: environment temperature (22 ± 3)°C e Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013, Dec12) 31-Jan-13 (No. DAE4-680_Jan13)	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 20 dB Attenuator Reference Standards DA24 Secondary Standards	ID GB41293674 MY41498087 SN: 56054 (3c) SN: 560577 (20x) SN: 55129 (30b) SN: 3013 SN: 660 ID	ry facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01736) 28-Dec-12 (No. ES3-5013, Dec12) 31-Jan-13 (No. DAE4-860_Jan13) Check Date (in house)	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4419A Reference 30 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference 91 ob Attenuator Reference	Uncted in the closed laborator &TE critical for calibrationy ID GB41293874 MY41498087 SN: 56054 (3c) SN: 55277 (20x) SN: 55128 (30b) SN: 3013 SN: 660 ID US3642U01700	ry facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01737) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013, Dec12) 31-Jan-13 (No. DAE4-860, Jan13) Check Date (in house) 4-Aug-99 (in house check Apr-13)	Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check In house check: Apr-15
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	Uncted in the closed laborator &TE critical for calibrationy ID GB41293874 MY41498087 SN: 56054 (3c) SN: 55277 (20x) SN: 55277 (20x) SN: 5529 (30b) SN: 560 ID US3642U01700 US37390585 Name	ry facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013, Dec12) 31-Jan-13 (No. DAE4-660, Jan 13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-12) Function	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check In house check: Dcl-13
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E44198 Power sensor E4412A Reference 3 dB Attenuator Reference 30 dB Attenuator Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E Calibrated by.	Uncted in the closed laborator &TE critical for calibrationy ID GB41293874 MY41498087 SN: 56054 (3c) SN: 55277 (20x) SN: 55277 (20x) SN: 5529 (30b) SN: 560 ID US3642U01700 US37390585 Name	ry facility: environment temperature (22 ± 3)°C a Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013, Dec12) 31-Jan-13 (No. DAE4-660, Jan 13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-12) Function	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check In house check: Dcl-13
All calibrations have been cond Calibration Equipment used (Mi Primary Standards Power meter E44198 Power sensor E4412A Reference 20 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	ID GB41293874 MY41498087 SN: 56054 (3c) SN: 560577 (20x) SN: 55277 (20x) SN: 55277 (20x) SN: 55129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37900585 Name Katja Pókovic	ry facility: environment temperature (22 ± 3)°C e Cal Date (Certificate No.) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01733) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01736) 28-Dec-12 (No. ES3-5013, Dec12) 31-Jan-13 (No. DAE4-660, Jan13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Det-01 (in house check Apr-13) 18-Det-01 (in house check Cd-12) Function Technical Manager	and humidity < 70%. Scheduled Galibration Apr-14 Apr-14 Apr-14 Apr-14 Dec-13 Jan-14 Scheduled Check In house check: Dcl-13

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#### Report No. : E5/2014/10002 Page: 63 of 98

#### Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 1004 Zurich, Switzerland



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Accreditation No.: SCS 108

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Glossary TS

Glussaly	
TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMX,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization (p.	@ rotation around probe axis
Polarization 8	9 rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., 9 = 0 is normal to probe axis
	ties a - was normal to probe axis

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

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement a)
- Techniques", December 2003 IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005 6)

#### Methods Applied and Interpretation of Parameters:

- NORMx, y.z: Assessed for E-field polarization 9 = 0 (I ≤ 900 MHz in TEM-cell; I > 1800 MHz R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)x.y.z = NORMx.y.z \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for I > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx.y.z.\* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHZ.
- Spherical isotropy (3D deviation from isotropy): In a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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EX30V4 - SN:3938

August 2, 2013

# Probe EX3DV4

# SN:3938

Manufactured: M Calibrated: A

May 2, 2013 August 2, 2013

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

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EX30V4- 5N:3938

August 2, 2013

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^{A}$	0.52	0.58	0.34	± 10.1 %
DCP (mV) <sup>8</sup>	100.4	99.5	102.6	

#### Modulation Calibration Parameters

din	Communication System Name		A dB	B dBõV	С	D	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	168.9	±2.5 %
		Y	0.0	0.0	1.0	-	132.5	
_		2	0.0	0.0	1.0		133.2	

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

<sup>4</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6). <sup>8</sup> Numerical linearization parameter: uncertainty not required: <sup>10</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the expuse of the field value. Ť.

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EX30V4- SN:3938

August 2, 2013

(MHz) <sup>C</sup>	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.49	9,49	9.49	0.57	0.75	± 12.0 %
835	41.5	0.90	9.21	9.21	9.21	0.46	0.82	± 12.0 %
900	41.5	0.97	9.06	9.06	9.06	0.68	0.68	± 12.0 %
1750	40.1	1.37	7.86	7.86	7.86	0.54	0.64	± 12.0 %
1900	40.0	1,40	7.61	7.61	7,61	0.69	0.62	± 12.0 %
2000	40.0	1.40	7.62	7.62	7.62	0.37	0.80	± 12.0 %
2300	39.5	1.67	7.35	7.35	7.35	0.67	0.59	± 12,0 %
2450	39.2	1.80	6.97	6,97	6.97	0.38	08.0	± 12.0 %
5200	36.0	4.66	5.18	5.18	5.18	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.96	4.96	4.96	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.86	4.86	4.86	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.63	4.63	4.63	0.30	1.80	± 13.1 %
5800	35.3	5.27	4.65	4.65	4.65	0.32	1.80	± 13.1 %

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938

Calibration Parameter Determined in Head Tissue Rimulation Media

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
<sup>T</sup> At frequencies below 3 GHz, the validity of tissue parameters (a and a) can be relaxed to ± 10% (if iquid companisation formula is applied to measured SAR values. At frequencies active 3 GHz, the validity of tissue parameters (a and a) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target liasue parameters.

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EX3DV4- SN:3938

August 2, 2013

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.45	9.45	9,45	0.45	0.84	± 12.0 %
835	55.2	0.97	9.37	9.37	9.37	0.74	0.66	± 12.0 %
900	55.0	1.05	9.19	9,19	9.19	0,59	0.72	± 12.0 %
1750	53.4	1.49	7.60	7.60	7.60	0.45	D.82	± 12.0 9
1900	53.3	1.52	7.29	7.29	7,29	0.48	0.74	± 12.0 %
2000	53.3	1,52	7.44	7.44	7.44	0.53	0.72	± 12.0 %
2300	52.9	1.81	7.16	7.16	7.16	0.80	0.50	± 12.0 9
2450	52.7	1.95	6.94	6.94	6.94	0.80	0,50	± 12.0 %
5200	49.0	5.30	4.44	4.44	4,44	0.36	1.90	± 13,1 9
5300	48.9	5.42	4.29	4.29	4.29	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.05	4.05	4.05	0.38	1.90	± 13,1 %
5600	48.5	5.77	4.02	4.02	4.02	0.33	1.90	± 13.1 %
5800	48.2	6.00	4.17	4.17	4.17	0.40	1.90	± 13.1 9

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938

Calibration Parameter Determined in Rody Tiesus Simulating Media

<sup>5</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty at the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. At frequencies below 3 GHz, the validity of taske parameters (c and e) can be releved to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (c and e) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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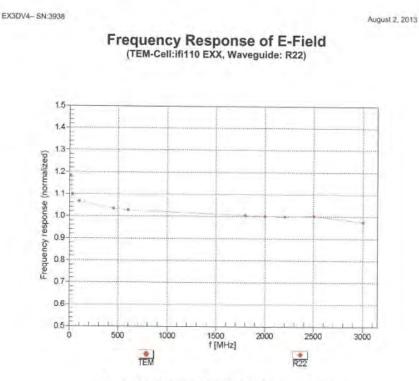
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Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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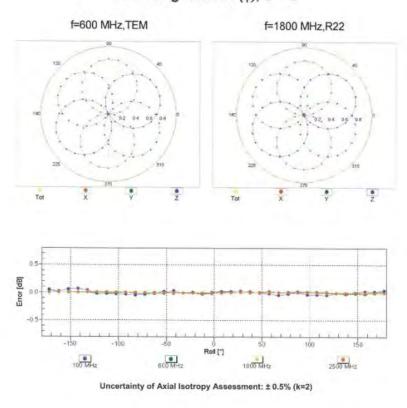
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#### Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$

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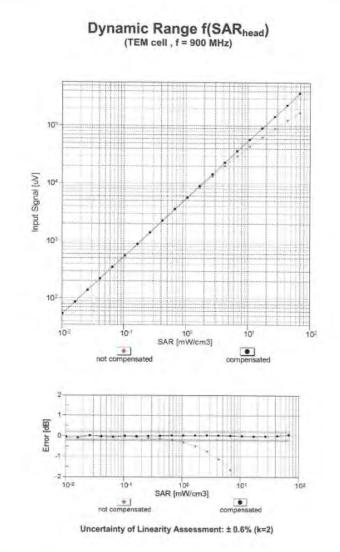
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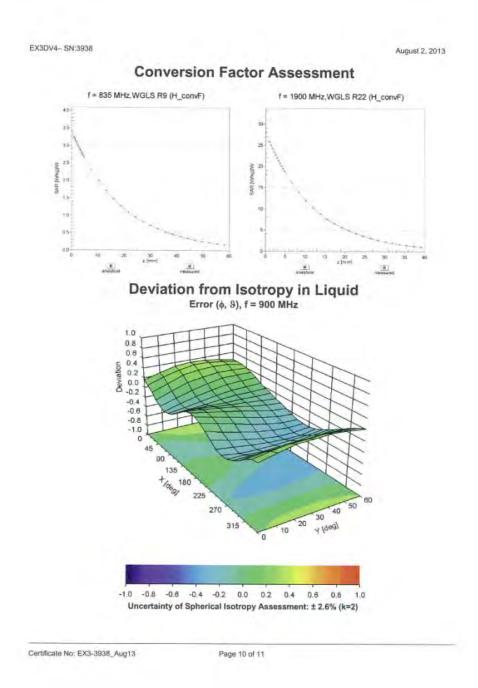
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EX3DV4- SN:3938

August 2, 2013

#### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3938

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (")	-32.4
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	2 mm

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台灣檢驗科技股份有限公司

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# 8. Uncertainty Budget

Measurement Uncertainty evaluation

62209-2 : 2010			-		-				
A	с	D	e = f(d,k)		f	g	h=c * f / e	i=c * g / e	k
Source of	Tolerance	Probabilit					Standard	Standard	vi, or
Uncertainty	1	у	Div.	Div Value	ci (1g)	ci (10g)	uncertainty	uncertainty	Vi, Ol Veff
oncertainty	Uncertaint	Distributi					+ %. (1 a)	+ %. (10 a)	VCII
Measurement									
system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Isotropy	3.50%	R	√3	1.732	1	1	2.02%	2.02%	00
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	~~~
Probe modulation									
response	2.40%	R	√3	1.732	1	1	1.39%	1.39%	~~
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	~~~
Boundary effect	2.00%	R	√3	1.732	1	1	1.15%	1.15%	~~~
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	~~~~
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	~~~
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	~~~~
RF ambient	2.00%	ĸ	√ <b>3</b>	1.732			1.50 %	1.50 %	~
condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	~~
RF ambient			-						
conditions -	3.00%	R	√3	1.732	1	1	1.73%	1.73%	~~
Probe positioner	0.400/		<i>(</i> _2	1 700	1	1	0.000/	0.000/	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
mech. restrictions	0.40%	R	√3	1.732	I	I	0.23%	0.23%	00
Probe positioning									
with respect to	2.90%	R	√3	1.732	1	1	1.67%	1.67%	~~
phantom shell			_						
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	$\infty$
Test sample									
related									
Device holder	2 ( 00(	N	1	1	1	1	2 ( 00(	2 ( 00(	M 1
uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Test sample	2.90%	Ν	1	1	1	1	2.90%	2.90%	M-1
positionina									
Power scaling	0.00%	R	√3	1.732	1	1	0.00%	0.00%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Drift of output	5.00%	R	√3	1.732	1	1	2.89%	2.89%	~~~
power (measured			, -						
Phantom and									
set-up									
Phantom									
Uncertainty (shape	4.00%	R	√3	1.732	1	1	2.31%	2.31%	$\infty$
and thickness									
Algorithm for									
correcting SAR for	1.90%	N	1	1	1	0.84	1.90%	1.60%	~~~
deviations in	1.90%	IN	1	I	1	0.84	1.90%	1.60%	
permittivity and conductivity									
Liquid conductivity									
(meas.)	4.71%	N	1	1	0.78	0.71	3.67%	3.34%	M-1
Liquid permitivity	4.20%	N	1	1	0.23	0.26	0.97%	1.09%	М
(meas.)	4.20%	IN	1	1	0.23	0.26	0.97%	1.09%	IVI
Liquid conductivity -			_						
temperature	3.40%	R	√3	1.732	0.78	0.71	1.53%	1.39%	~~
uncertaintv									
Liquid permitivity -	0.40%	R	<i>∠</i> 2	1.732	0.23	0.26	0.05%	0.0494	~~
temperature	0.40%	к	√3	1.732	0.23	0.26	0.05%	0.06%	00
uncertainty Combined standard			-		-				
uncertainty		RSS					11.19%	11.03%	
Expant uncertainty									
(95% confidence							22.37%	22.05%	
interval).K=2									

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# 9. Phantom Description

Schmid & Partner Engineering AG

Zeugheusstrasse 43, 8004 Zurich, Switzerand Phone +41 1 245 9700, Pax +41 1 245 9778 m/o@speeg.com, http://www.apsag.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	
Manufacturar	SPEAG Zeughausstrasse 43 CH-8004 Zorich 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, Semples, TP-1314 ff.
Material thickness at ERP	Compliant with the requirements according to the standards	6mm +/- 0.2mm at ERP	First article, All 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.	DEGMBE 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 almulating liquid.	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

- Standards [1] CENELEC EN 50381 [2] IEEE Std 1528-2003 [3] IEC 62209 Part I [1] [2] [3] [4]

FCC DET Bulletin 65, Supplement C, Edition 01-01 The IT1S 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	<u>speag</u>
Signature / Stamp		Belgentd % Paparet Engineering AG 1990 Russidense 53, 2004 2010 Switzerland Phone 541, 2010 Stock Stark Sci 235 9179 Info Septeg.com, http://www.sbaeg.com

Dechip MIT-OD DOD PAD C ... P

1201

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# **10. System Validation from Original Equipment Supplier**

credited by the Swiss Accrediti	Inn Service (RAS)	Anonditation	No.: SCS 108
e Swiss Accreditation Servic altilateral Agreement for the r	e is one ul the signatories	to the EA	
Gant SGS-TW (Aud	en)	Certificate No	D835V2-4d161_Nov13
C.C. Burne and Carry			
CALIBRATION (	CERTIFICATE		
Ditiect	D835V2 - SN: 4d	161	
pulou	1000442 - 014. 40	131	
	01 01 05.0		
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits abo	No 700 MHz
	Summer proces	date for apple vandanen nito des	ine rue in iz
Calibration date	November 01, 20	13	
Californion date:	November 01, 20	13	
The measurements and the Linc	enailities with confidence p	onal standards, which realize the physical un robability are given on the following pages an 1000000000000000000000000000000000000	d are part of the certificate.
The measurements and the unc	artainties with confidence p actual in the closed laboration	robability are given on the following pages an	d are part of the certificate.
The measurements and the lunc All calibrations have been condu Calibration Equipment used (Md Primary Standards	ectainties with confidence p acted in the closed laboration ATE or fidal for calibration(	robability are given on the following pages an ty lookity, environment temperature ( $22 \pm 3$ )*( Eal Date (Certificate No.)	d are part of the certificate. 2 and humiany < 70%. Scheduled Calibration
The measurements and the lunc All calibrations have been contro Calibration Equipment used (Ma Finnery Standards Power meter EPM-442A	ectaintees with confidence p actind in the closed laboration ATE childed for calibration( 10 e GB37490704	robability are given on the following pages an ry laolity: environment temperature (22 = 3)*( <u>Cal Date (Centificate No.)</u> (8-Det-13 (No. 217-01827)	d are part of the certificate. 2 and humiany < 70% Scheduled Calibration Oct-14
The maasurements and the lunc All califications have been contri- Calification Equipment used (Ma Primary Standards Prover meter EPM-442A Power sensor HP 8481A	ectaintees with confidence p includ in the closed laboration INTE orticlel for calibration) INTE orticlel for calibration) GB37490704 US37292783	robability are given on the following pages an y lability: environment temperature (22 = 3)*( Ca( Date (Centificate No.) 08-Oet-13 (No. 217-01827) 08-Oet-13 (No. 217-01827)	d are part of the certificate. C and humidity < 70%. Schedbled Calibration Oct-14 Oct-14
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The measurements and the land All califications have been contri- Calification Equipment used (Ma Primary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Reference 20 68 Amenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	etaintees with confidence p acted in the cideed laboration XTE critical for calibration (B37/400704 US37292/783 MY41092317 SN: 5058 (20k) SN: 5047.3 / 06327 SN: 3205 SN: 501	Indebility are given on the following pages an solution of the following pages and Eal Date (Certificate No.). (0)-Oct-13 (No. 217-01827) 00-Oct-13 (No. 217-01827) 00-Oct-13 (No. 217-01828) 04-Apr-13 (No. 217-01786) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 20-Occ-12 (No. ESS-3206, Dec12) 25-Apr-13 (No. DAE4-601_Apr13)	d are part of the certificate. 2 and humidity < 70%. Schuduled Calibration Oct-14 Oct-14 Oct-14 Apr-14 Apr-14 Dec-13 Apr-14
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#### Calibration Laboratory of Schmid & Partner Engineering AG sstrasse 43, 8004 Zurich, Switzerland ugi



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Accreditation No.: SCS 108

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

#### 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:

- a) 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
- b) 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz" C)

#### Additional Documentation:

d) 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%.

Certificate No: D835V2-4d161\_Nov13

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#### Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 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	$40.8 \pm 6 \%$	0.94 mho/m ± 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	2.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.49 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	1.59 W/kg

### 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 mha/m ± 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	2.40 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.32 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	1.57 W/kg

Certificate No: D835V2-4d161\_Nov13

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω - 2.4 jΩ
Return Loss	- 27.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 Ω - 5.1 jΩ
Return Loss	- 24.8 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.425 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	December 28, 2012

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#### **DASY5 Validation Report for Head TSL**

Date: 01.11,2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d161

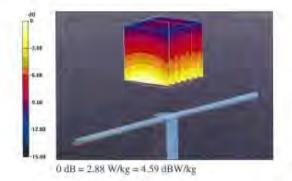
Communication System: UID 0 - CW ; Frequency; 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.94 S/m;  $\epsilon_r$  = 40.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- · Electronics: DAE4 Sn601: Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7)64)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 56,867 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.75 W/kg SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.59 W/kg Maximum value of SAR (measured) = 2.88 W/kg



Certificate No: DB35V2-4d161\_Nov13

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### 31 Oct 2013 17:46:25 78.385 pF CHI SIL 1 U FS 11 53.869 a -2.4316 a 835**.866 888 MHz** ٠ Del C.A Avg 16 H1d CH2 5 dB/ RET -20 dE 11-27.121 dl 035.000 000 MHz \$11 1.09 Ca ent ent HId START 635.000 000 MH: STOP 1 835.000 000 MHz

Impedance Measurement Plot for Head TSL

Certificate No: D835V2-4d161\_Nov13

Page 6 of 8

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

Date: 01.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d161

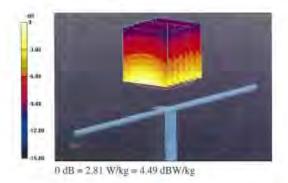
Communication System: UID 0 - CW ; Frequency, 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 1.007$  S/m;  $v_i = 54.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface; 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 55.021 V/m; Power Drift = 40.05 dB Peak SAR (extrapolated) = 3.55 W/kg

SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.57 W/kg Maximum value of SAR (measured) = 2.81 W/kg



Certificate No: D835V2-4d161\_Nov13

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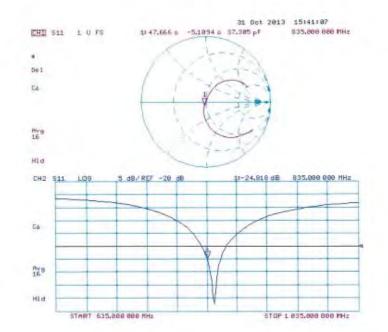
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#### Impedance Measurement Plot for Body TSL



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



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

Accreditation No.: SCS 108

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 cartificates

#### 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:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques\*, December 2003
- b) 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
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

#### Additional Documentation:

d) 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

DAGT system computation, as far as not g	iven on page 1.
DASY Version	DASY5

DASY5	V52.8.7
Advanced Extrapolation	
Modular Flat Phantom	
10 mm	with Spacer
dx, dy, dz = 5 mm	
1900 MHz ± 1 MHz	
	Advanced Extrapolation Modular Flat Phantom 10 mm dx, dy, dz = 5 mm

#### 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 ± 0.2) °C	39.3 ± 6 %	1.34 mho/m ± 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	9.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	1 1 1 1 1 1
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	5.17 W/kg

#### **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 ± 0.2) °C	53.7±6%	1.50 mho/m ± 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	40.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition .250 mW input power	5.42 W/kg

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### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.2 Ω + 5.4 jΩ
Return Loss	- 24.8 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.3 Ω + 5.8 jΩ	
Return Loss	- 23.6 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1,200 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 semingid 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	June 08, 2012

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#### **DASY5 Validation Report for Head TSL**

Date: 10.06.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d173

Communication System: UID 0 - CW ; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.34 S/m;  $\epsilon_r$  = 39.3;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63,19-2007)

**DASY52** Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial; 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 96.647 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 17.8 W/kg SAR(1 g) = 9.82 W/kg; SAR(10 g) = 5.17 W/kg Maximum value of SAR (measured) = 12.2 W/kg



0 dB = 12.2 W/kg = 10.86 dBW/kg

Certificate No: D1900V2-5d173\_Jun13

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### 10 Jun 2013 12:14:50 CHI S11 1 U FS 1: 52.240 0 5.4375 g 455,48 pH 1 908.808 008 MHz . De1 Cor Avg 16 HId CH2 511 LOG 5 dB/REF -20 dB 11-24.813 dB 1 900.000 000 MHz Cor Avg 16 HId START 1 708.000 808 MHz STOP 2 186.888 888 MHz

#### Impedance Measurement Plot for Head TSL

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

Date: 10.06.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d173

Communication System: UID 0 - CW ; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.5 S/m;  $\epsilon_r$  = 53.7;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 96.647 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 17.3 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.42 W/kg Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.07 dBW/kg

Certificate No: D1900V2-5d173\_Jun13

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## 10 Jun 2013 12:14:24 CHI S11 1 U FS 1: 47.335 0 5.8496 g 490.00 pH 1 900.000 000 MHz . De 1 Cor Avg 16 HId CH2 \$11 LOG 5 dB/REF -28 dB 11-23.619 dB 1 900.000 000 MHz Cor Avg 16 Hld START 1 700,000 000 MHz STOP 2 100.000 000 MHz

#### Impedance Measurement Plot for Body TSL

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Chmid & Partner Engineering AG oughausstrasse 43, 6004 Zurich	y of h. Switzerland	Hac MRA	S Schweizerischer Kalibrierdienst Service suisse drétalonnage Servizio svizzero di taratura Swiss Calibration Service
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CALIBRATION C	ERTIFICATE	E	
Dbject	D2450V2-SN:9	22	
Calibration procedure(s)	QA CAL-05,v9 Calibration proce	dure for dipole validation kits a	above 700 MHz
Calibration date:	November 05, 20	013	
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Accreditation No.: SCS 108

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

#### 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:

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

d) 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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 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 ± 0.2) °C	39.7 ± 6 %	1.84 mho/m ± 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.8 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.13 W/kg

#### 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 ± 0.2) °C	52.1 ± 6 %	2.02 mho/m ± 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 ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5.96 W/kg

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω + 3.5 jΩ
Return Loss	- 26.5 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	51.0 Ω + 5.0 jΩ
Return Loss	- 25.9 dB

#### General Antenna Parameters and Design

Elect	trical Delay (one direction)	1.161 ns

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

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

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

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 26, 2013

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#### **DASY5 Validation Report for Head TSL**

Date: 05.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

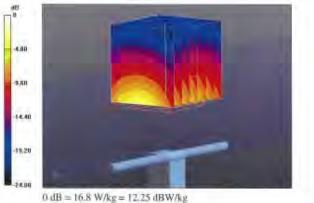
#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 922

Communication System: UID 0 - CW: Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.84 \text{ S/m}$ ;  $\epsilon_r = 39.7$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection) .
- Electronics: DAE4 Sn601; Calibrated; 25.04,2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 98.82 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 27.7 W/kg SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.13 W/kg Maximum value of SAR (measured) = 16.8 W/kg



Certificate No: D2450V2-922\_Nov13.

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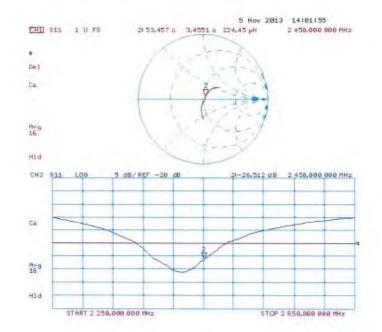
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Impedance Measurement Plot for Head TSL

Certificate No: D2450V2-922\_Nov13

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

Date: 01.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 922

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.02 S/m;  $t_n$  = 52.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28,12,2012;
- · Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 94.218 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 27.0 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.96 W/kg Maximum value of SAR (measured) = 16.9 W/kg



Certificate No: D2450V2-922\_Nov13

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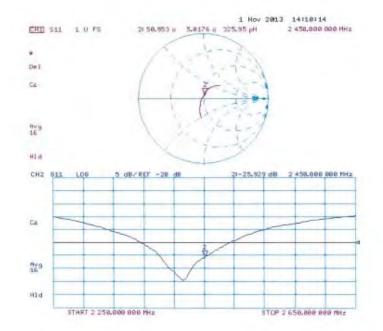
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#### Impedance Measurement Plot for Body TSL

Certificate No: D2450V2-922\_Nov13

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

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