

# SAR TEST REPORT



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

Equipment Under Test	Smart phone
Company Name	SHARP CORPORATION, IoT Communication BU
Company Address	2-13-1, Hachihonmatsu-Iida, Higashi-hiroshima-shi, Hiroshima, 739-0192, Japan
Standards	IEEE/ANSI C95.1-1992, IEEE 1528-2013,
	KDB248227D01v02r02,KDB865664D01v01r04,
	KDB865664D02v01r02,KDB941225D01v03r01,
	KDB941225D06v02r01,KDB447498D01v06,
	KDB648474D04v01r03
FCC ID	APYHRO00257
Date of Receipt	Oct. 03, 2017
Date of Test(s)	Nov. 02, 2017 ~ Nov. 07, 2017
Date of Issue	Nov. 22, 2017
In the configuration texted, the EL	IT complied with the standards specified above

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

#### Remarks:

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

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#### Signed on behalf of SGS

Engineer

Sondhrin

Bond Tsai

Supervisor

John Teh

<u>John Yeh</u> Date: Nov. 22, 2017

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	Highest SAR Summary				
Equipment class	Frequency Band	Head (Separation 0mm)	Body-worn (Separation 10mm)	Hotspot (Separation 10mm)	Highest Simultaneous Transmission 1g SAR(W/Kg)
			1g S/	AR(W/Kg)	
Licensed	GSM850	0.12	0.21	0.26	
Licensed	GSM1900	0.16	0.47	0.61	
DTS	2.4GHz WLAN	0.25	0.05	0.05	0.66
NII	5GHz WLAN	0.00	0.07	-	
DSS	ВТ	0.16	0.03	-	
Date	of Testing	2017/11/2~2017/11/7			

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Report No. : E5/2017/A0006 Page : 3 of 131

## **Revision History**

Report Number	Revision	Description	Issue Date
E5/2017/A0006	Rev.00	Initial creation of document	Nov. 13, 2017
E5/2017/A0006	Rev.01	1 <sup>st</sup> modification	Nov. 20, 2017
E5/2017/A0006	Rev.02	2 <sup>nd</sup> modification	Nov. 22, 2017

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## **1. General Information**

## 1.1 Testing Laboratory

SGS Taiwan Ltd. Electronics & Communication Laboratory			
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Tel	+886-2-2299-3279		
Fax	+886-2-2298-0488		
Internet	http://www.tw.sgs.com/		

## **1.2 Details of Applicant**

Company Name	SHARP CORPORATION, IoT Communication BU
1 Ombony / Adross	2-13-1, Hachihonmatsu-Iida, Higashi-hiroshima-shi, Hiroshima, 739-0192, Japan

#### 1.2.1 Details of Manufacturer

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

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## 1.3 Description of EUT

EUT Name	Smart phone				
FCC ID	APYHRO00257				
FCC Registration Number and Designation number	735305 / TW0002				
Mode of Operation					
	Bluetooth XWLAN802.11 a/b	/g/n/ac(2	0M/40	M/80M)	
	GSM (DTM multi class B)		1/8.3		
Duty Cycle	GPRS (support multi class 12 max)	1/2 (1Dn4UP) 1/2.76 (1Dn3UP) 1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)		3UP) 2UP)	
	WLAN802.11				
	a/b/g/n/ac(20M/40M/80M)	1			
	Bluetooth		1		
	GSM850	824	_	849	
	GSM1900	1850	_	1910	
TX Frequency Range	WiFi 2.4GHz	2400	_	2462	
(MHz)	WiFi 5GHz	5150	_	5350	
	Bluetooth	2402	_	2480	
	GSM850	128	—	251	
	GSM1900	512	_	810	
Channel Number (ARFCN)	WiFi 2.4GHz	1	—	11	
	WiFi 5GHz	36	_	140	
	Bluetooth	0	_	78	

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Max. SAR (1-g) (Unit: W/Kg)						
Mode	Band	Measured	Reported	Position / Channel		
	GSM 850	0.10	0.12	Left Right Cheek Tilt <u>251</u> Channel		
	GSM 1900	0.14	0.16	Left Right Cheek Tilt <u>512</u> Channel		
	WLAN802.11 b	0.24	0.25	Left		
Head	WLAN802.11ac(80M)5.2G	0.00	0.00	Left Right Cheek Tilt <u>42</u> Channel		
	WLAN802.11ac(80M)5.3G	0.00	0.00	∐Left ☐Right ☐Cheek ☐Tilt 58 Channel		
	WLAN802.11ac(80M)5.6G	0.00	0.00	Left Right Cheek Tilt <u>122</u> Channel		
	Bluetooth	0.10	0.16	☐Left ☐Right ☐Cheek ☐Tilt 78 Channel		

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Max. SAR (1-g) (Unit: W/Kg)						
Mode	Band	Measured	Reported	Position / Channel		
	GSM 850	0.17	0.21	☐Front ⊠Back <u>251</u> Channel		
	GSM 1900	0.41	0.47	☐Front ⊠Back <u>512</u> Channel		
	WLAN802.11 b	0.05	0.05	⊠Front ⊡Back <u>6</u> _Channel		
Body-worn	WLAN802.11ac(80M)5.2G	0.02	0.02	☐Front ⊠Back <u>42</u> Channel		
	WLAN802.11ac(80M)5.3G	0.03	0.03	☐Front ⊠Back <u>58</u> Channel		
	WLAN802.11ac(80M)5.6G	0.07	0.07	☐Front ⊠Back Channel		
	Bluetooth	0.02	0.03	⊠Front		

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Max. SAR (1-g) (Unit: W/Kg)						
Mode	Band	Measured	Reported	Position / Channel		
	GPRS 850 (1Dn2UP)	0.22	0.26	☐Front ☐Back ☐Bottom ☐Right ☑Left <u>190</u> Channel		
Hotspot mode	GPRS 1900 (1Dn2UP)	0.52	0.61	Front Back Bottom Right Left <u>512</u> Channel		
	WLAN802.11 b	0.05	0.05	Front Back Top Right Left <u>6</u> Channel		

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#### GSM 850 - conducted power table:

EUT mode	СН	Max. Rated Avg.	Burst average power	Source-based time average power	
	(MHz)		Power + Max.	Avg. (dBm)	Avg. (dBm)
	824.2	128	33.5	32.52	23.49
GSM850	024.2	120	33.5	32.32	23.49
(GMSK)	836.6	190	33.5	32.60	23.57
	848.8	251	33.5	32.67	23.64
	The division factor compared to the number of TX time slot				
Division factor			1 TX time slot		
	DIVISIO	Taciol		-9.	03

#### GPRS 850 - conducted power table:

	Burst average power								
	Max. Rated Avg. Power + Max. Tolerance (dBm)		33.5	31.5	29.5	28			
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP			
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)	Avg. (dBm)			
GPRS	824.2	128	32.52	30.50	28.31	26.82			
850	836.6	190	32.60	30.77	28.51	27.13			
000	848.8	251	32.67	30.75	28.62	27.00			
		Sc	ource-based tim	e average powe	er				
GPRS	824.2	128	23.49	24.48	24.05	23.81			
850	836.6	190	23.57	24.75	24.25	24.12			
050	848.8	251	23.64	24.73	24.36	23.99			
	The division factor compared to the number of TX time slot								
Division factor		1 TX time slot -9.03	2 TX time slot -6.02	3 TX time slot -4.26	4 TX time slot -3.01				

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#### GSM 1900 - conducted power table:

EUT mode	EUT mode		Max. Rated Avg.	Burst average power	Source-based time average power	
(MHz)			Power + Max.	Avg. (dBm)	Avg. (dBm)	
0014000	1850.2	512	30.5	29.89	20.86	
GSM1900 (GMSK)	1800	661	30.5	29.63	20.60	
(Civiory)	1909.8	810	30.5	29.69	20.66	
	The divisior	n factor com	npared to the	e number of TX tir	ne slot	
	Divisio	n factor	1 TX time slot			
	DIVISIO	Tacloi		-9.03		

#### GPRS 1900 - conducted power table:

	Burst average power								
	Max. Rated Avg. Power + Max. Tolerance (dBm)		30.5	28.5	26.2	25.5			
			1Dn1UP	1Dn2UP	1Dn3UP	1Dn4UP			
EUT mode	Frequency (MHz)	СН	Avg. (dBm)	A∨g. (dBm)	Avg. (dBm)	Avg. (dBm)			
GPRS	1850.2	512	29.89	27.84	25.84	24.36			
1900	1880	661	29.63	27.76	25.77	24.27			
1900	1909.8	810	29.69	27.78	25.60	24.25			
		Sc	ource-based tim	e average powe	er				
GPRS	1850.2	512	20.86	21.82	21.58	21.35			
1900	1880	661	20.60	21.74	21.51	21.26			
1900	1909.8	810	20.66	21.76	21.34	21.24			
	The div	ision fa	actor compared	to the number of	of TX time slot				
Div	ision factor				3 TX time slot				
			-9.03	-6.02	-4.26	-3.01			

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	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		1	2412		13.50	13.17			
	802.11b	6	2437	1Mbps	13.50	13.24			
		11	2462		13.50	13.20			
		1	2412	6Mbps	11.50	11.48			
	802.11g	6	2437		11.50	11.43			
2450 MHz		11	2462		11.50	11.46			
2430 1011 12		1	2412		11.50	11.43			
	802.11n-HT20	6	2437	MCS0	11.50	11.39			
		11	2462		11.50	11.45			
		3	2422		11.50	11.48			
	802.11n-HT40	6	2437	MCS0	11.50	11.44			
		9	2452		11.50	11.37			

#### WLAN802.11 a/b/g/n/ac(20M/40M/80M) conducted output power table:

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	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		36	5180		11.50	11.48			
	802.11a	44	5220	6Mbps	11.50	11.45			
		48	5240		11.50	11.47			
		36	5180	MCS0	11.50	11.40			
	802.11n-HT20	44	5220		11.50	11.43			
		48	5240		11.50	11.32			
5.15-5.25 GHz		36	5180		11.50	11.33			
0.15-5.25 GHz	802.11n-VHT20	44	5220	MCS0	11.50	11.38			
		48	5240		11.50	11.27			
	802.11n-HT40	38	5190	MCS0	11.50	11.27			
		46	5230	WC30	11.50	11.40			
	802.11n-VHT40	38	5190	MCS0	11.50	11.19			
	002.111-011140	46	5230	NIC30	11.50	11.37			
	802.11n-VHT80	42	5210	MCS0	11.50	11.23			

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	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		52	5260		11.50	11.41			
	802.11a	60	5300	6Mbps	11.50	11.46			
		64	5320		11.50	11.36			
		52	5260	MCS0	11.50	11.36			
	802.11n-HT20	60	5300		11.50	11.42			
		64	5320		11.50	11.37			
5.25-5.35 GHz		52	5260		11.50	11.31			
0.20-0.00 0112	802.11n-VHT20	60	5300	MCS0	11.50	11.32			
		64	5320		11.50	11.34			
	802.11n-HT40	54	5270	MCS0	11.50	11.42			
		62	5310	WC30	11.50	11.35			
	802.11n-VHT40	54	5270	MCS0	11.50	11.38			
	002.111 <del>-</del> 011140	62	5310		11.50	11.20			
	802.11n-VHT80	58	5290	MCS0	11.50	11.31			

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	Main Antenna								
Band	Mode	Channel	Frequency (MHz)	Data Rate	Max. Rated Avg. Power + Max. Tolerance (dBm)	Average power (dBm)			
		100	5500		11.50	11.42			
	802.11a	116	5580	6Mbps	11.50	11.31			
		140	5700		11.50	11.38			
		100	5500		11.50	11.41			
	802.11n-HT20	116	5580	MCS0	11.50	11.31			
		140	5700		11.50	11.34			
		100	5500	MCS0	11.50	11.30			
	802.11n-VHT20	116	5580		11.50	11.28			
5600 MHz		140	5700		11.50	11.24			
		102	5510		11.50	11.29			
	802.11n-HT40	110	5550	MCS0	11.50	11.31			
		134	5670		11.50	11.34			
		102	5510		11.50	11.26			
	802.11n-VHT40	110	5550	MCS0	11.50	11.20			
		134	5670		11.50	11.25			
	802.11n-VHT80	106	5530	MCS0	11.50	11.34			
	002.1111 011100	122	5610	10000	11.50	11.42			

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#### Bluetooth conducted power table:

Mode	Channel	Frequency		Average Output Power (dBm)			
Mode Channel	(MHz)	1Mbps	2Mbps	3Mbps	Power + Max. Tolerance (dBm)		
	CH 00	2402	9.35	4.82	4.42		
BR/EDR	CH 39	2441	9.31	4.69	4.72	11.5	
	CH 78	2480	9.53	4.92	4.92		

Modo	Channel	Frequency	Average Output Power (dBm)	Max. Rated Avg. Power + Max.
Mode Channel	(MHz)	GFSK	Tolerance (dBm)	
	CH 00	2402	0.87	
LE	LE CH 19		1.26	6
	CH 39	2480	2.26	

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## 1.4 Test Environment

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

## **1.5 Operation Description**

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

#### WLAN

802.11b DSSS SAR Test Requirements:

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

802.11g/n OFDM SAR Test Exclusion Requirements:

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

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#### Other

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

Mode	Position	Max. Power (dBm)	f(GHz)	Calculation	SAR exclusion threshold	SAR test exclusion
BT	Body-worn	11.5	2.48	2.224	3	yes
BT	Head	11.5	2.48	4.449	3	no

12. For WLAN antenna, 5.2 ac(80) / 5.3ac(80) / 5.6ac(80) are chosen to be the initial test configurations.

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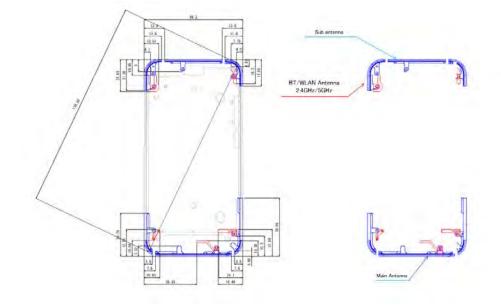
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The location of the antennas (Back View)

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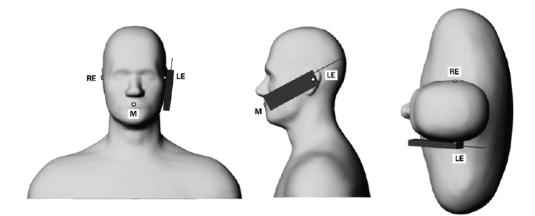
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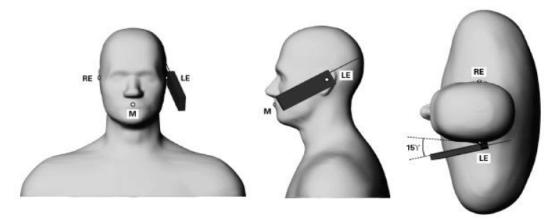
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### **1.6 Positioning Procedure**

Head SAR measurement statement



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



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

Cheek/Touch Position:

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

Ear/Tilt Position:

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

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#### **Body SAR measurement statement**

1. Body-worn exposure: 10mm

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

2. Hotspot exposure: 10mm

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

Test configurations of WWAN:

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

Test configurations of WLAN:

- (1) Front side
- (2) Back side
- (3) Top side
- (4) Right side
- 3. Phablet SAR test consideration

Since the device is not a phablet (overall diagonal dimension < 16.0 cm), phablet SAR procedure is not required for this device.

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4. Based on KDB941225D06v02r01, the hotspot mode and body-worn accessory SAR test configurations may overlap for handsets. When the same wireless mode transmission configurations for voice and data are required for SAR measurements, the more conservative configuration with a smaller separation distance should be tested for the overlapping SAR configurations. For WCDMA /WLAN, since the maximum power is the same between body-worn and hotspot mode, and the test distance of hotspot mode is the same with that of body-worn mode, hotspot mode SAR is used to support body-worn SAR. For GSM850/1900, since the wireless mode transmission configurations is different between body-worn and hotspot mode, body-worn SAR is performed.

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## 1.7 Evaluation Procedures

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

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

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

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

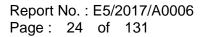
The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved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

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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.

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

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

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

- 2. The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
- 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%.
- 4. Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

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

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## **1.8.2 Calibration with Analytical Fields**

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

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

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

## References

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

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#### 1.9 The SAR Measurement System

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

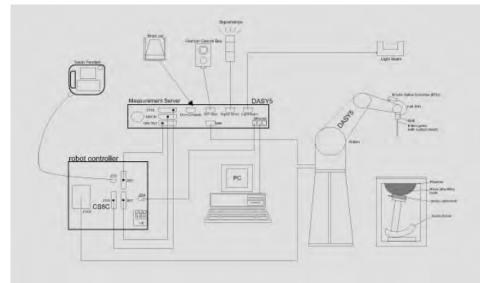


Fig. a A block diagram of the SAR measurement system

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

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

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## 1.10 System Components

#### EX3DV4 E-Field Probe

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)				
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL835/ 1900/2450/5200/5300/5600 MHz Additional CF for other liquids and frequencies upon request				
Frequency	10 MHz to > 6 GHz, Linearity: ± 0.6 dB				
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)				
Dynamic	10 μW/g to > 100 mW/g				
Range	Linearity: $\pm$ 0.2 dB (noise: typically < 1 $\mu$ W/g)				
Dimensions	Tip diameter: 2.5 mm				
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.				

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#### Phantom

Model	Twin SAM
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.
Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Height: 850 mm; Length: 1000 mm; Width: 500 mm

## DEVICE HOLDER

Construction	In combination with the Twin SAM Phantom	1-
	V4.0/V4.0C or Twin SAM, the Mounting	ALC: NO.
	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	and the second se
	be easily and accurately positioned	-
	according to IEC, IEEE, CENELEC, FCC or	
	other specifications. The device holder can	
	be locked at different phantom locations	Device Holder
	(left head, right head, flat 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 KDB865664D01) from the target SAR values.

These tests were done at 835/1900/2450/5200/5300/5600 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. During the tests, the liquid depth above the ear reference points was above 15 cm ( $\leq$ 3G) or 10 cm (>3G) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

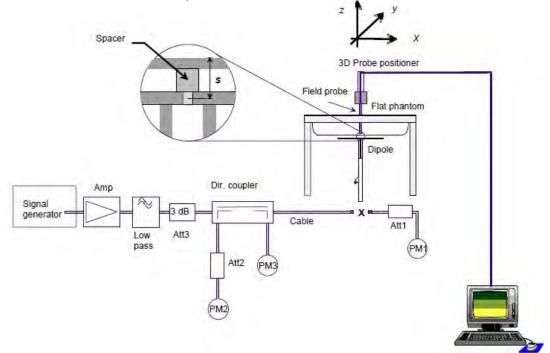


Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequ (MF	-	1W Target SAR-1g (mW/g)	Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date			
D835V2	4d063	835	Head	9.34	2.41	9.64	3.21%	Nov. 05, 2017			
D03372	40005	000	Body	9.57	2.46	9.84	2.82%	Nov. 02, 2017			
D1900V2	54172	54173	5d173	54173	1900	Head	40.7	9.94	39.76	-2.31%	Nov. 05, 2017
D1900v2	50175	1900	Body	40.2	10.20	40.80	1.49%	Nov. 02, 2017			
D2450V2	D2450V2 727	27 2450	Head	52.2	12.90	51.60	-1.15%	Nov. 06, 2017			
D2430V2	121	2430	Body	50.6	12.70	50.80	0.40%	Nov. 04, 2017			
	/2 1023		5200	Head	75.2	7.57	75.70	0.66%	Nov. 07, 2017		
		5200	Body	72.8	7.33	73.30	0.69%	Nov. 03, 2017			
D5GHzV2		1023 5300	Head	81.8	8.23	82.30	0.61%	Nov. 07, 2017			
			Body	76.1	7.68	76.80	0.92%	Nov. 03, 2017			
		5600	Head	81.7	8.22	82.20	0.61%	Nov. 07, 2017			
		5600	Body	79.6	8.05	80.50	1.13%	Nov. 03, 2017			

Table 1. Results of system validation

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## **1.12 Tissue Simulant Fluid for the Frequency Band**

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

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

Tissue Type	Measurement Date	Measured Frequency (MHz)	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	% dev ɛr	% dev σ
		835	41.500	0.900	41.932	0.909	-1.04%	-1.00%
	Nov, 05. 2017	848.8	41.500	0.915	41.923	0.924	-1.02%	-1.00%
	1000, 03. 2017	1850.2	40.000	1.400	39.220	1.358	1.95%	3.00%
		1900	40.000	1.400	39.204	1.357	1.99%	3.07%
		2437	39.223	1.788	38.823	1.761	1.02%	1.53%
	Nov, 06. 2017	2450	39.200	1.800	38.820	1.773	0.97%	1.50%
Head		2480	39.162	1.827	38.800	1.799	0.92%	1.51%
		5200	35.986	4.655	35.259	4.537	2.02%	2.53%
		5210	35.974	4.665	35.244	4.547	2.03%	2.53%
	Nov, 07. 2017	5290	35.883	4.747	35.180	4.631	1.96%	2.45%
	NOV, 07.2017	5300	35.871	4.758	35.154	4.640	2.00%	2.47%
		5600	35.529	5.065	34.825	4.939	1.98%	2.49%
		5610	35.517	5.075	34.817	4.950	1.97%	2.47%
		835	55.200	0.970	56.112	0.959	-1.65%	1.13%
		836.6	55.195	0.972	56.084	0.961	-1.61%	1.13%
	Nov, 02. 2017	848.8	55.158	0.987	56.068	0.976	-1.65%	1.11%
		1850.2	53.300	1.520	51.994	1.489	2.45%	2.04%
		1900	53.300	1.520	51.989	1.493	2.46%	1.78%
		2437	52.717	1.938	51.515	1.980	2.28%	-2.19%
Body	Nov, 04. 2017	2450	52.700	1.950	51.493	1.992	2.29%	-2.15%
		2480	52.662	1.993	51.466	2.036	2.27%	-2.18%
		5200	49.014	5.299	47.622	5.407	2.84%	-2.03%
		5210	49.001	5.311	47.638	5.416	2.78%	-1.98%
	Nov 02 2017	5290	48.892	5.404	47.523	5.515	2.80%	-2.05%
	Nov, 03. 2017	5300	48.879	5.416	47.510	5.523	2.80%	-1.97%
		5600	48.471	5.766	47.119	5.882	2.79%	-2.00%
		5610	48.458	5.778	47.111	5.891	2.78%	-1.95%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

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		Ingredient						
Frequency (MHz)	Mode	DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	Total amount
050	Head		532.98 g	18.3 g	2.4 g	3.2 g	766 g	1.3L(Kg)
850	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)

#### Simulating Liquids for 5 GHz, Manufactured by SPEAG:

•								
Ingredients	Water	Esters, Emulsifiers, Inhibitors	Sodium and Salt					
(% by weight)	60-80	20-40	0-1.5					

Table 3. Recipes for tissue simulating liquid

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#### 1.13 Test Standards and Limits

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

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

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

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

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

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

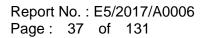
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Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube).

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

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

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

#### Table 4. RF exposure limits

#### Notes:

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

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## 2. Summary of Results

#### **GSM 850**

Mode	Position	Distanc e (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power	Scaling	1	SAR over g ⁄kg)	Plot page
		()				(dBm)		Measured	Reported	
	Re Cheek	-	251	848.8	33.50	32.67	21.06%	0.10	0.12	-
Head	Re Tilt	-	251	848.8	33.50	32.67	21.06%	0.06	0.07	-
(GSM)	Le Cheek	-	251	848.8	33.50	32.67	21.06%	0.10	0.12	46
	Le Tilt	-	251	848.8	33.50	32.67	21.06%	0.05	0.06	-
Body-worn	Front side	10	251	848.8	33.50	32.67	21.06%	0.16	0.19	-
(GSM)	Back side	10	251	848.8	33.50	32.67	21.06%	0.17	0.21	47
	Front side	10	190	836.6	31.50	30.77	18.30%	0.17	0.20	-
Hotspot	Back side	10	190	836.6	31.50	30.77	18.30%	0.18	0.21	-
(GPRS) <1Dn2Up>	Bottom side	10	190	836.6	31.50	30.77	18.30%	0.01	0.01	-
	Left side	10	190	836.6	31.50	30.77	18.30%	0.22	0.26	48

#### **GSM 1900**

Mode	Position	Distanc e (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power	Scaling	1	SAR over g /kg)	Plot page
		(11111)				(dBm)		Measured	Reported	
	Re Cheek	-	512	1850.2	30.50	29.89	15.08%	0.04	0.05	-
Head	Re Tilt	-	512	1850.2	30.50	29.89	15.08%	0.02	0.02	-
(GSM)	Le Cheek	-	512	1850.2	30.50	29.89	15.08%	0.14	0.16	49
	Le Tilt	-	512	1850.2	30.50	29.89	15.08%	0.02	0.02	-
Body-worn	Front side	10	512	1850.2	30.50	29.89	15.08%	0.39	0.45	-
(GSM)	Back side	10	512	1850.2	30.50	29.89	15.08%	0.41	0.47	50
	Front side	10	512	1850.2	28.50	27.84	16.41%	0.52	0.61	51
Hotspot (GPRS)	Back side	10	512	1850.2	28.50	27.84	16.41%	0.44	0.51	-
<1Dn2Up>	Bottom side	10	512	1850.2	28.50	27.84	16.41%	0.43	0.50	-
	Left side	10	512	1850.2	28.50	27.84	16.41%	0.17	0.20	-

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Mode	Position	Distanc e (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Avg. Power	Scaling	<u> </u>	SAR over g ⁄kg)	Plot page
		()				(dBm)		Measured	Reported	
	RE Cheek	-	6	2437	13.50	13.24	6.17%	0.07	0.07	-
Head	RE Tilt	-	6	2437	13.50	13.24	6.17%	0.03	0.03	-
Tieau	LE Cheek	-	6	2437	13.50	13.24	6.17%	0.24	0.25	52
	LE Tilt	-	6	2437	13.50	13.24	6.17%	0.03	0.03	-
Body-worn	Front side	10	6	2437	13.50	13.24	6.17%	0.05	0.05	53
Body-worn	Back side	10	6	2437	13.50	13.24	6.17%	0.04	0.04	-
	Front side	10	6	2437	13.50	13.24	6.17%	0.05	0.05	53
Hotspot	Back side	10	6	2437	13.50	13.24	6.17%	0.04	0.04	-
rioispoi	Top side	10	6	2437	13.50	13.24	6.17%	0.04	0.04	-
	Right side	10	6	2437	13.50	13.24	6.17%	0.03	0.03	-

#### WLAN 2.4GHz – WLAN802.11b

#### Bluetooth

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged S (W/	-	Plot page
		. ,		, , ,	Tolerance (dBm)	(dBm)		Measured	Reported	
	RE Cheek	-	78	2480	11.50	9.53	57.40%	0.03	0.05	-
Head	RE Tilt	-	78	2480	11.50	9.53	57.40%	0.01	0.02	-
neau	LE Cheek	-	78	2480	11.50	9.53	57.40%	0.10	0.16	54
	LE Tilt	-	78	2480	11.50	9.53	57.40%	0.01	0.02	-
Body-	Front side	10	78	2480	11.50	9.53	57.40%	0.02	0.03	55
worn	Back side	10	78	2480	11.50	9.53	57.40%	0.02	0.03	-

#### WiFi 5GHz - WLAN802.11ac(80M)5.2G

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged S (W/	-	Plot page
					Tolerance (dBm)	(dBm)		Measured	Reported	
	RE Cheek	-	42	5210	11.50	11.23	6.41%	0.00	0.00	-
Head	RE Tilt	-	42	5210	11.50	11.23	6.41%	0.00	0.00	-
neau	LE Cheek	-	42	5210	11.50	11.23	6.41%	0.00	0.00	56
	LE Tilt	-	42	5210	11.50	11.23	6.41%	0.00	0.00	-
Body-	Front side	10	42	5210	11.50	11.23	6.41%	0.02	0.02	-
worn	Back side	10	42	5210	11.50	11.23	6.41%	0.02	0.02	57

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#### WiFi 5GHz – WLAN802.11ac(80M)5.3G

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged S (W/	-	Plot page
					Tolerance (dBm)	(dBm)		Measured	Reported	
	RE Cheek	-	58	5290	11.50	11.31	4.47%	0.00	0.00	-
Head	RE Tilt	-	58	5290	11.50	11.31	4.47%	0.00	0.00	-
neau	LE Cheek	-	58	5290	11.50	11.31	4.47%	0.00	0.00	58
	LE Tilt	-	58	5290	11.50	11.31	4.47%	0.00	0.00	-
Body-	Front side	10	58	5290	11.50	11.31	4.47%	0.02	0.02	-
worn	Back side	10	58	5290	11.50	11.31	4.47%	0.03	0.03	59

#### WiFi 5GHz - WLAN802.11ac(80M)5.6G

Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling	Averaged S (W/		Plot page
					Tolerance (dBm)	(dBm)		Measured	Reported	
	RE Cheek	-	122	5610	11.5	11.42	1.86%	0.00	0.00	-
Head	RE Tilt	-	122	5610	11.5	11.42	1.86%	0.00	0.00	-
Tieau	LE Cheek	-	122	5610	11.5	11.42	1.86%	0.00	0.00	60
	LE Tilt	-	122	5610	11.5	11.42	1.86%	0.00	0.00	-
Body-	Front side	10	122	5610	11.5	11.42	1.86%	0.06	0.06	-
worn	Back side	10	122	5610	11.5	11.42	1.86%	0.07	0.07	61

Note:

Scaling = 
$$\frac{\text{reported SAR}}{\text{measured SAR}} = \frac{P2(mW)}{P1(mW)} = 10^{\left(\frac{P2-P1}{10}\right)(dBm)}$$

Reported SAR = measured SAR \* (scaling) Where P2 is maximum specified power, P1 is measured conducted power

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## 3. Simultaneous Transmission Analysis

Simultaneous Transmit Configurations	Head	Body-Worn	Hotspot
GSM + 2.4GHz Wi-Fi	Yes	Yes	No
GPRS + 2.4GHz Wi-Fi	No	No	Yes
GSM + 5GHz Wi-Fi	Yes	Yes	No
GPRS + 5GHz Wi-Fi	No	Yes	No
GSM + BT	Yes	Yes	No
GPRS + BT	No	Yes	No

#### Simultaneous Transmission Scenarios:

Note:

1. The device does not support DTM function. Body-worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.

2. Based on KDB447498D01 note 36, when SAR test exclusion is allowed by other published RF exposure KDB procedures, such as the 2.5 cm hotspot mode SAR test exclusion for an edge or surface, then estimated SAR is not required to determine simultaneous SAR test exclusion.

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#### 3.1 Estimated SAR calculation

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

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

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

#### 3.2 SPLSR evaluation and analysis

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

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

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

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

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

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reporte		WAN and WL			uation					
Frequency		10	reported S	AR / W/kg	ΣSAR					
band	P	osition	WWAN	WLAN	<1.6W/kg					
		Right cheek	0.12	0.07	0.19					
GSM 850	Head	Right tilt	0.07	0.03	0.10					
GSIVI 850		Left cheek	0.12	0.25	0.37					
		Left tilt	0.06	0.03	0.09					
		Front side	0.20	0.05	0.25					
	GPRS 850 (1Dp2UP) Hotspot				l latan ct		Back side	0.21	0.04	0.25
(1Dn2UP)		Bottom side	0.01	0.04	0.05					
(1201201)		Right side	-	0.03	-					
		Left side	0.26	-	-					
		Right cheek	0.05	0.07	0.12					
GSM 1900	Head	Right tilt	0.02	0.03	0.05					
GSW 1900	Tieau	Left cheek	0.16	0.25	0.41					
		Left tilt	0.02	0.03	0.05					
		Front side	0.61	0.05	0.66					
		Back side	0.51	0.04	0.55					
GPRS 1900 (1Dn2UP)	Hotspot	Bottom side	0.50	0.04	0.54					
(1211201)		Right side	-	0.03	-					
		Left side	0.20	-	-					

#### Simultaneous Transmission Combination

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repor	ted SAR W	WAN and WL	AN 5GHz, Σ	SAR evalua	tion
Frequency	De	sition	reported S	AR / W/kg	ΣSAR
band	FU	SILION	WWAN	WLAN	<1.6W/kg
		RE Cheek	0.12	0.00	0.12
GSM 850	Head	RE Tilt	0.07	0.00	0.07
GSIM 850	neau	LE Cheek	0.12	0.00	0.12
		LE Tilt	0.06	0.00	0.06
GPRS 850	Body-worn	Front side	0.19	0.06	0.25
(1Dn2Up)	Bouy-worn	Back side	0.21	0.07	0.28
		RE Cheek	0.05	0.00	0.05
GSM 1900	Head	RE Tilt	0.02	0.00	0.02
GSW 1900	neau	LE Cheek	0.16	0.00	0.16
		LE Tilt	0.02	0.00	0.02
GPRS 1900	Body-worn	Front side	0.45	0.06	0.51
(1Dn2Up)	Bouy-wom	Back side	0.47	0.07	0.54

reported	reported SAR WWAN and Bluetooth, $\Sigma$ SAR evaluation									
Frequency		reported SAR / W/kg ΣS/								
band	Po	sition	WWAN	Bluetooth	<1.6W/kg					
		Right cheek	0.12	0.05	0.17					
GSM 850	Head	Right tilt	0.07	0.02	0.09					
G3W 030	Tieau	Left cheek	0.12	0.16	0.28					
		Left tilt	0.06	0.00	0.06					
		Right cheek	0.05	0.05	0.10					
GSM 1900	Head	Right tilt	0.02	0.02	0.04					
GSW 1900	GSW 1900 Flead		0.16	0.16	0.32					
		Left tilt	0.02	0.00	0.02					

reported SAR WWAN and Bluetooth, ΣSAR evaluation								
Frequency band	Position		reported SAR / W/kg		ΣSAR			
			WWAN	Bluetooth	<1.6W/kg			
GSM 850	Body-worn	Front	0.16	0.03	0.19			
		Back	0.41	0.03	0.44			
GSM 1900	Body-worn	Front	0.46	0.03	0.49			
		Back	0.50	0.03	0.53			

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## 4. Instruments List

Manufacturer	Device	Туре	Serial number	Date of last calibration	Date of next calibration
SPEAG	Dosimetric E-Field Probe	EX3DV4	3831	Jan.23,2017	Jan.22,2018
SPEAG	System Validation Dipole	D835V2	4d063	Aug.21,2017	Aug.20,2018
		D1900V2	5d173	May.31,2017	May.30,2018
		D2450V2	727	Apr.21,2017	Apr.20,2018
		D5GHzV2	1023	Jan.20,2017	Jan.19,2018
SPEAG	Data acquisition Electronics	DAE4	1336	Nov.22,2016	Nov.21,2017
SPEAG	Software	DASY 52 V52.8.8	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	SAM	N/A	Calibration not required	Calibration not required
Network Analyzer	Agilent	E5071C	MY46107530	Jan.20,2017	Jan.19,2018
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	772D	MY52180142	Apr.13,2017	Apr.12,2018
		778D	MY52180302	Apr.13,2017	Apr.12,2018
Agilent	RF Signal Generator	N5181A	MY50144143	Mar.01,2017	Feb.28,2018
Agilent	Power Meter	E4417A	MY51410006	Jan.20,2017	Jan.19,2018
Agilent	Power Sensor	E9301H	MY51470001	Jan.20,2017	Jan.19,2018
		E9301H	MY51470002	Jan.20,2017	Jan.19,2018
TECPEL	Digital thermometer	DTM-303A	TP130077	Mar.17,2017	Mar.16,2018
Anritsu	Radio Communication Test	MT8820C	6201061049	Apr.08,2017	Apr.07,2018

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## 5. Measurements

Date: 2017/11/5

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

Communication System: GSM; Frequency: 848.8 MHz; Duty Cycle: 1:8.3 Medium parameters used: f = 849 MHz;  $\sigma$  = 0.924 S/m;  $\epsilon_r$  = 41.923;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

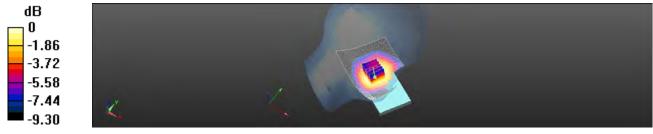
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(9.15, 9.15, 9.15); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x111x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.116 W/kg

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

Reference Value = 3.466 V/m; Power Drift = -0.14 dB Peak SAR (extrapolated) = 0.125 W/kg SAR(1 g) = 0.099 W/kg; SAR(10 g) = 0.075 W/kg Maximum value of SAR (measured) = 0.114 W/kg



0 dB = 0.114 W/kg = -9.44 dBW/kg

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## GSM 850\_Body-worn\_Back side\_CH 251\_10mm

Communication System: GSM; Frequency: 848.8 MHz; Duty Cycle: 1:8.3 Medium parameters used: f = 849 MHz;  $\sigma$  = 0.976 S/m;  $\epsilon_r$  = 56.068;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

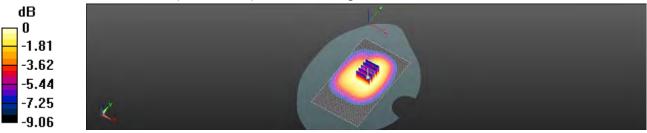
#### **DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(9.25, 9.25, 9.25); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x121x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.201 W/kg

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

Reference Value = 13.29 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 0.222 W/kg SAR(1 g) = 0.171 W/kg; SAR(10 g) = 0.127 W/kg Maximum value of SAR (measured) = 0.201 W/kg



0 dB = 0.201 W/kg = -6.98 dBW/kg

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### GPRS 850\_Hotspot\_Left side\_CH 190\_10mm

Communication System: GPRS (1Dn2Up); Frequency: 836.6 MHz; Duty Cycle: 1:4.1 Medium parameters used: f = 837 MHz;  $\sigma$  = 0.961 S/m;  $\epsilon_r$  = 56.084;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

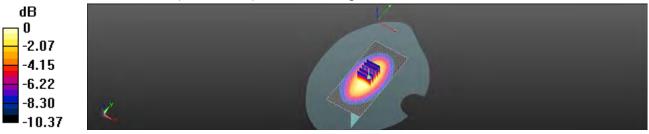
#### DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(9.25, 9.25, 9.25); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (51x111x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.266 W/kg

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

Reference Value = 15.58 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 0.310 W/kg SAR(1 g) = 0.215 W/kg; SAR(10 g) = 0.144 W/kg Maximum value of SAR (measured) = 0.267 W/kg



0 dB = 0.267 W/kg = -5.74 dBW/kg

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

Communication System: GSM; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3 Medium parameters used: f = 1850.2 MHz;  $\sigma$  = 1.358 S/m;  $\epsilon_r$  = 39.22;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

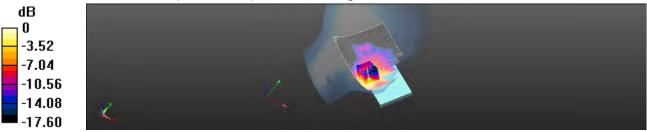
#### DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.86, 7.86, 7.86); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x121x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.168 W/kg

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

Reference Value = 2.866 V/m; Power Drift = -0.15 dB Peak SAR (extrapolated) = 0.219 W/kg SAR(1 g) = 0.144 W/kg; SAR(10 g) = 0.087 W/kg Maximum value of SAR (measured) = 0.187 W/kg



0 dB = 0.187 W/kg = -7.29 dBW/kg

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### GSM 1900\_Body-worn\_Back side\_CH 512\_10mm

Communication System: GSM; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3 Medium parameters used: f = 1850.2 MHz;  $\sigma$  = 1.489 S/m;  $\epsilon_r$  = 51.994;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

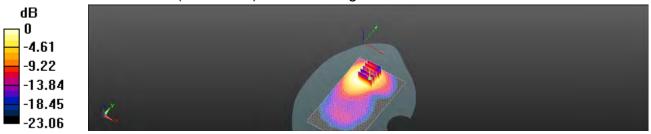
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.53, 7.53, 7.53); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x121x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.596 W/kg

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

Reference Value = 3.924 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 0.745 W/kg SAR(1 g) = 0.406 W/kg; SAR(10 g) = 0.209 W/kg Maximum value of SAR (measured) = 0.529 W/kg



0 dB = 0.529 W/kg = -2.77 dBW/kg

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## GPRS 1900\_Hotspot\_Front side\_CH 512\_10mm

Communication System: GPRS (1Dn2Up); Frequency: 1850.2 MHz; Duty Cycle: 1:4.1 Medium parameters used: f = 1850.2 MHz;  $\sigma$  = 1.489 S/m;  $\epsilon_r$  = 51.994;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

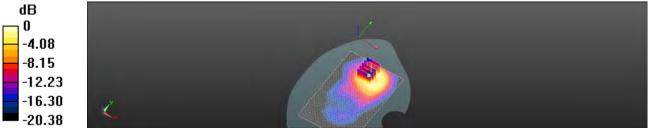
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.53, 7.53, 7.53); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (81x121x1):** Interpolated grid: dx=15 mm, dy=15 mm Maximum value of SAR (interpolated) = 0.632 W/kg

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

Reference Value = 4.167 V/m; Power Drift = 0.08 dB Peak SAR (extrapolated) = 0.878 W/kg SAR(1 g) = 0.516 W/kg; SAR(10 g) = 0.275 W/kg Maximum value of SAR (measured) = 0.671 W/kg



0 dB = 0.671 W/kg = -1.73 dBW/kg

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## WLAN 802.11b\_Head\_Le Cheek\_CH 6

Communication System: WLAN(2.4G); Frequency: 2437 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2437 MHz;  $\sigma$  = 1.761 S/m;  $\epsilon_r$  = 38.823;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

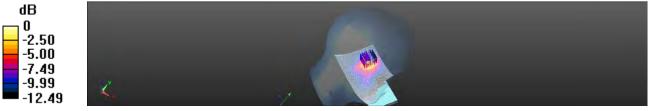
**DASY5** Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.21, 7.21, 7.21); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (81x141x1):** Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.349 W/kg

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

Reference Value = 6.653 V/m; Power Drift = -0.15 dB Peak SAR (extrapolated) = 0.502 W/kg SAR(1 g) = 0.240 W/kg; SAR(10 g) = 0.129 W/kg Maximum value of SAR (measured) = 0.347 W/kg



0 dB = 0.347 W/kg = -4.60 dBW/kg

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### WLAN 802.11b\_Hotspot\_Front side\_CH 6\_10mm

Communication System: WLAN(2.4G); Frequency: 2437 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2437 MHz;  $\sigma$  = 1.98 S/m;  $\epsilon_r$  = 51.515;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.3°C; Liquid temperature: 21.9°C

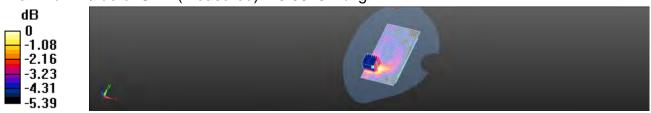
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.3, 7.3, 7.3); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x131x1):** Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.0679 W/kg

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

Reference Value = 3.358 V/m; Power Drift = -0.10 dB Peak SAR (extrapolated) = 0.0910 W/kg SAR(1 g) = 0.048 W/kg; SAR(10 g) = 0.035 W/kg Maximum value of SAR (measured) = 0.0649 W/kg



0 dB = 0.0649 W/kg = -11.88 dBW/kg

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## Bluetooth(GFSK)\_Head\_Le Cheek\_CH 78

Communication System: WLAN(2.4G); Frequency: 2480 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2480 MHz;  $\sigma$  = 1.799 S/m;  $\epsilon_r$  = 38.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section

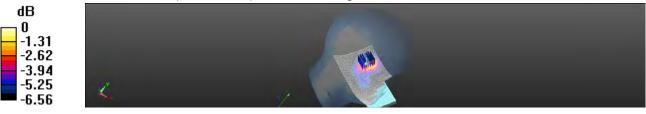
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.21, 7.21, 7.21); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (81x141x1):** Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.128 W/kg

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

Reference Value = 5.607 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 0.181 W/kg SAR(1 g) = 0.096 W/kg; SAR(10 g) = 0.063 W/kg Maximum value of SAR (measured) = 0.126 W/kg



0 dB = 0.126 W/kg = -8.99 dBW/kg

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## Bluetooth(GFSK)\_Body-worn\_Front side\_CH 78\_10mm

Communication System: Bluetooth; Frequency: 2480 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2480 MHz;  $\sigma$  = 2.036 S/m;  $\epsilon_r$  = 51.466;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.3°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(7.3, 7.3, 7.3); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (71x131x1):** Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 0.0298 W/kg

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

Reference Value = 1.691 V/m; Power Drift = -0.10 dB Peak SAR (extrapolated) = 0.0400 W/kg SAR(1 g) = 0.021 W/kg; SAR(10 g) = 0.015 W/kg Maximum value of SAR (measured) = 0.0285 W/kg



0 dB = 0.0285 W/kg = -15.44 dBW/kg

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## WLAN 802.11ac(80M) 5.2G\_Head\_Le Cheek\_CH 42

Communication System: WLAN 5G; Frequency: 5210 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5210 MHz;  $\sigma$  = 4.547 S/m;  $\epsilon_r$  = 35.244;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

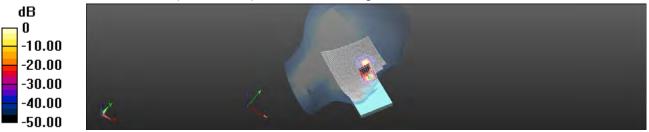
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.46, 4.46, 4.46); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (101x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.0109 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0.8432 V/m; Power Drift = 0.09 dB Peak SAR (extrapolated) = 0.00350 W/kg SAR(1 g) = 0.00286 W/kg; SAR(10 g) = 0.000851 W/kg Maximum value of SAR (measured) = 0.00462 W/kg



0 dB = 0.00462 W/kg = -23.36 dBW/kg

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## WLAN 802.11ac(80M) 5.2G\_Body-worn\_Back side\_CH 42\_10mm

Communication System: WLAN 5G; Frequency: 5210 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5210 MHz;  $\sigma$  = 5.416 S/m;  $\epsilon_r$  = 47.638;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

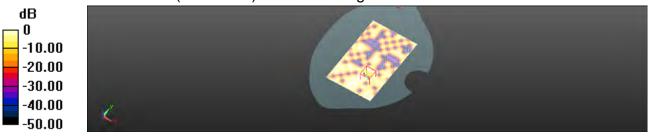
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(5.02, 5.02, 5.02); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (101x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.0390 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 2.243 V/m; Power Drift = 0.10 dB Peak SAR (extrapolated) = 0.300 W/kg SAR(1 g) = 0.024 W/kg; SAR(10 g) = 0.00737 W/kg Maximum value of SAR (measured) = 0.0341 W/kg



0 dB = 0.0341 W/kg = -14.67 dBW/kg

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## WLAN 802.11ac(80M) 5.3G\_Head\_Le Cheek\_CH 58

Communication System: WLAN 5G; Frequency: 5290 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5290 MHz;  $\sigma$  = 4.631 S/m;  $\epsilon_r$  = 35.18;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

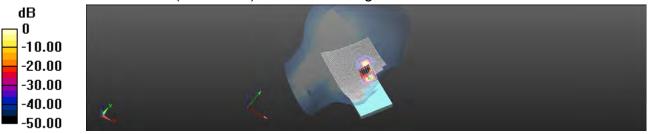
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.7, 4.7, 4.7); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (101x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.0117 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0.8923 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 0.00376 W/kg SAR(1 g) = 0.00305 W/kg; SAR(10 g) = 0.000915 W/kg Maximum value of SAR (measured) = 0.00495 W/kg



0 dB = 0.00495 W/kg = -23.05 dBW/kg

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## WLAN 802.11ac(80M) 5.3G\_ Body-worn \_Back side\_CH 58\_10mm

Communication System: WLAN 5G; Frequency: 5290 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5290 MHz;  $\sigma$  = 5.515 S/m;  $\epsilon_r$  = 47.523;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

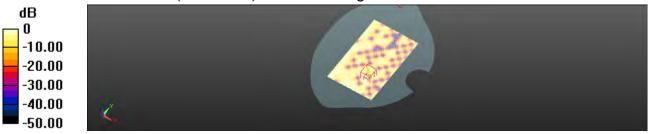
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.21, 4.21, 4.21); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (101x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.0864 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0.4612 V/m; Power Drift = 0.11 dB Peak SAR (extrapolated) = 0.282 W/kg SAR(1 g) = 0.026 W/kg; SAR(10 g) = 0.011 W/kg Maximum value of SAR (measured) = 0.0530 W/kg



0 dB = 0.0530 W/kg = -12.76 dBW/kg

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## WLAN 802.11ac(80M) 5.6G\_Head\_Le Cheek\_CH 122

Communication System: WLAN 5G; Frequency: 5610 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5610 MHz;  $\sigma$  = 4.95 S/m;  $\epsilon_r$  = 34.817;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Left Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

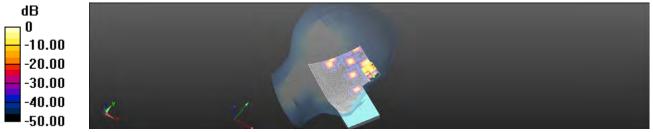
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(4.51, 4.51, 4.51); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (111x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.0521 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0.1392 V/m; Power Drift = 0.16 dB Peak SAR (extrapolated) = 0.2100 W/kg SAR(1 g) = 0.000514 W/kg; SAR(10 g) = 0.000154 W/kg Maximum value of SAR (measured) = 0.0697 W/kg



0 dB = 0.0697 W/kg = -11.57 dBW/kg

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## WLAN 802.11ac(80M) 5.6G\_ Body-worn \_Back side\_CH 122\_10mm

Communication System: WLAN 5G; Frequency: 5610 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5610 MHz;  $\sigma$  = 5.891 S/m;  $\epsilon_r$  = 47.111;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

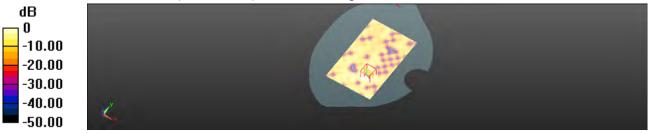
DASY5 Configuration:

- Probe: EX3DV4 SN3831; ConvF(3.67, 3.67, 3.67); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Area Scan (101x161x1):** Interpolated grid: dx=10 mm, dy=10 mm Maximum value of SAR (interpolated) = 0.176 W/kg

**Configuration/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0.8640 V/m; Power Drift = -0.17 dB Peak SAR (extrapolated) = 0.315 W/kg SAR(1 g) = 0.071 W/kg; SAR(10 g) = 0.026 W/kg Maximum value of SAR (measured) = 0.142 W/kg



0 dB = 0.142 W/kg = -8.49 dBW/kg

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## 6. SAR System Performance Verification

Date: 2017/11/5

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

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium parameters used: f = 835 MHz;  $\sigma$  = 0.909 S/m;  $\epsilon_r$  = 41.932;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

DASY5 Configuration:

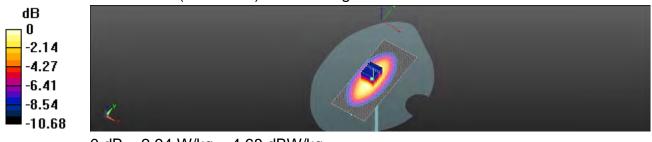
- Probe: EX3DV4 SN3831; ConvF(9.15, 9.15, 9.15); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=250mW/Area Scan (51x121x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 2.95 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 53.96 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.49 W/kg SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.51 W/kg Maximum value of SAR (measured) = 2.94 W/kg



0 dB = 2.94 W/kg = 4.68 dBW/kg

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

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium parameters used: f = 835 MHz;  $\sigma$  = 0.959 S/m;  $\epsilon_r$  = 56.112;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

#### DASY5 Configuration:

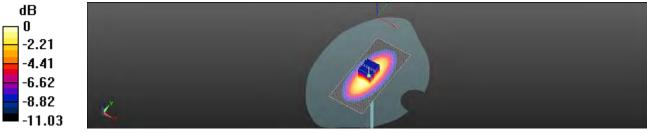
- Probe: EX3DV4 SN3831; ConvF(9.25, 9.25, 9.25); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

# **Configuration/Pin=250mW/Area Scan (51x111x1):** Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 3.20 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 60.11 V/m; Power Drift = -0.18 dB Peak SAR (extrapolated) = 3.84 W/kg SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.55 W/kg Maximum value of SAR (measured) = 3.25 W/kg



0 dB = 3.25 W/kg = 5.12 dBW/kg

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

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.357 S/m;  $\epsilon_r$  = 39.204;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

#### DASY5 Configuration:

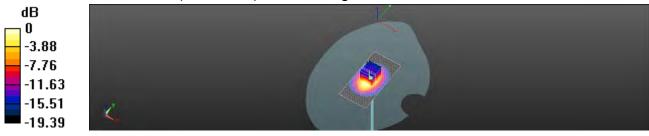
- Probe: EX3DV4 SN3831; ConvF(7.86, 7.86, 7.86); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

# **Configuration/Pin=250mW/Area Scan (41x81x1):** Interpolated grid: dx=15 mm, dy=15 mm

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

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 100.3 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 18.5 W/kg SAR(1 g) = 9.94 W/kg; SAR(10 g) = 5.19 W/kg Maximum value of SAR (measured) = 14.1 W/kg



0 dB = 14.1 W/kg = 11.49 dBW/kg

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

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.493 S/m;  $\epsilon_r$  = 51.989;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.2°C; Liquid temperature: 21.4°C

#### DASY5 Configuration:

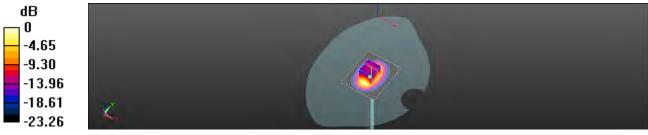
- Probe: EX3DV4 SN3831; ConvF(7.53, 7.53, 7.53); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

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

Maximum value of SAR (interpolated) = 16.0 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 98.18 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.22 W/kg Maximum value of SAR (measured) = 14.7 W/kg



0 dB = 14.7 W/kg = 11.66 dBW/kg

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### Dipole 2450 MHz\_SN:727\_Head

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.773 S/m;  $\epsilon_r$  = 38.82;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.6°C

#### DASY5 Configuration:

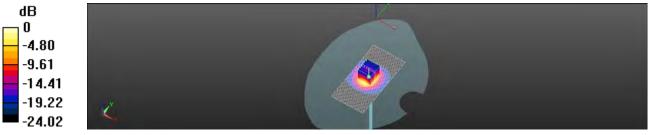
- Probe: EX3DV4 SN3831; ConvF(7.21, 7.21, 7.21); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

# **Configuration/Pin=250mW/Area Scan (61x121x1):** Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 20.7 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 105.9 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 28.0 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.09 W/kg Maximum value of SAR (measured) = 20.2 W/kg



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

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.992 S/m;  $\epsilon_r$  = 51.493;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.3°C; Liquid temperature: 21.9°C

#### DASY5 Configuration:

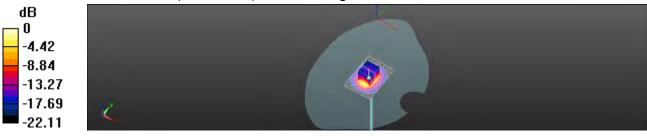
- Probe: EX3DV4 SN3831; ConvF(7.3, 7.3, 7.3); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

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

Maximum value of SAR (interpolated) = 21.3 W/kg

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 99.80 V/m; Power Drift = -0.10 dB Peak SAR (extrapolated) = 26.5 W/kg SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.98 W/kg Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dBW/kg

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#### Dipole 5200 MHz\_SN:1023\_Head

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5200 MHz;  $\sigma$  = 4.537 S/m;  $\epsilon_r$  = 35.259;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

#### DASY5 Configuration:

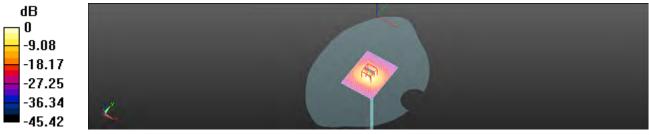
- Probe: EX3DV4 SN3831; ConvF(4.46, 4.46, 4.46); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (71x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

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

#### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 60.40 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 34.6 W/kg SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.21 W/kg Maximum value of SAR (measured) = 16.3 W/kg



0 dB = 16.3 W/kg = 12.13 dBW/kg

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### Dipole 5200 MHz\_SN:1023\_Body

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5200 MHz;  $\sigma$  = 5.407 S/m;  $\epsilon_r$  = 47.622;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

#### DASY5 Configuration:

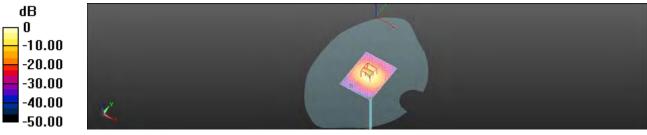
- Probe: EX3DV4 SN3831; ConvF(5.02, 5.02, 5.02); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (71x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

Maximum value of SAR (interpolated) = 15.0 W/kg

#### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 56.71 V/m; Power Drift = -0.13 dB Peak SAR (extrapolated) = 25.6 W/kg SAR(1 g) = 7.33 W/kg; SAR(10 g) = 2.06 W/kg Maximum value of SAR (measured) = 14.8 W/kg



0 dB = 14.8 W/kg = 11.70 dBW/kg

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### Dipole 5300 MHz\_SN:1023\_Head

Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5300 MHz;  $\sigma$  = 4.64 S/m;  $\epsilon_r$  = 35.154;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

#### **DASY5** Configuration:

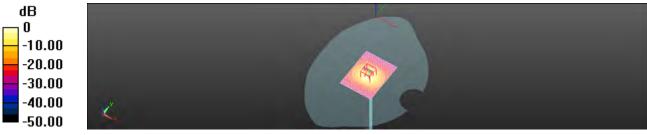
- Probe: EX3DV4 SN3831; ConvF(4.7, 4.7, 4.7); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (71x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

Maximum value of SAR (interpolated) = 18.0 W/kg

#### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 60.12 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 37.6 W/kg SAR(1 g) = 8.23 W/kg; SAR(10 g) = 2.35 W/kg Maximum value of SAR (measured) = 17.1 W/kg



0 dB = 17.1 W/kg = 12.34 dBW/kg

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## Dipole 5300 MHz\_SN:1023\_Body

Communication System: CW; Frequency: 5300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5300 MHz;  $\sigma$  = 5.523 S/m;  $\epsilon_r$  = 47.51;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

#### DASY5 Configuration:

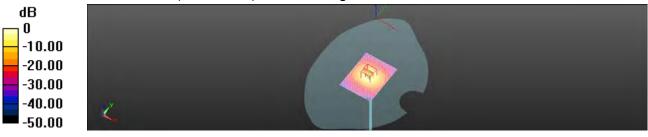
- Probe: EX3DV4 SN3831; ConvF(4.21, 4.21, 4.21); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (71x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

Maximum value of SAR (interpolated) = 15.7 W/kg

#### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 56.45 V/m; Power Drift = -0.13 dB Peak SAR (extrapolated) = 27.8 W/kg SAR(1 g) = 7.68 W/kg; SAR(10 g) = 2.17 W/kg Maximum value of SAR (measured) = 15.3 W/kg



0 dB = 15.3 W/kg = 11.86 dBW/kg

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#### Dipole 5600 MHz\_SN:1023\_Head

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5600 MHz;  $\sigma$  = 4.939 S/m;  $\epsilon_r$  = 34.825;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.5°C; Liquid temperature: 21.8°C

#### DASY5 Configuration:

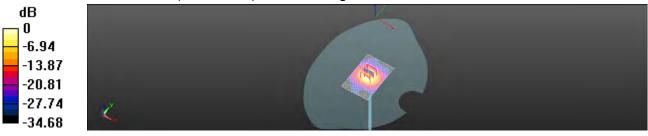
- Probe: EX3DV4 SN3831; ConvF(4.51, 4.51, 4.51); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (61x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

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

#### Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 61.95 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 35.5 W/kg SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.29 W/kg Maximum value of SAR (measured) = 17.3 W/kg



0 dB = 17.3 W/kg = 12.39 dBW/kg

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Date: 2017/11/3

## Dipole 5600 MHz\_SN:1023\_Body

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1 Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.882 S/m;  $\epsilon_r$  = 47.119;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Ambient temperature: 22.1°C; Liquid temperature: 21.8°C

## DASY5 Configuration:

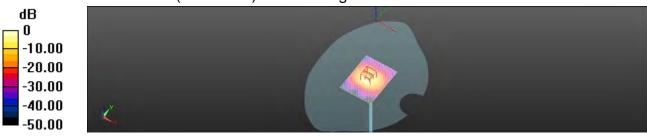
- Probe: EX3DV4 SN3831; ConvF(3.67, 3.67, 3.67); Calibrated: 2017/1/23;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1336; Calibrated: 2016/11/22
- Phantom: Head
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

**Configuration/Pin=100mW/Area Scan (71x91x1):** Interpolated grid: dx=10 mm, dy=10 mm

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

## Configuration/Pin=100mW/Zoom Scan (7x7x12)/Cube 0: Measurement grid:

dx=4mm, dy=4mm, dz=2mm Reference Value = 54.26 V/m; Power Drift = -0.14 dB Peak SAR (extrapolated) = 33.3 W/kg SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.27 W/kg Maximum value of SAR (measured) = 16.8 W/kg



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

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## 7. DAE & Probe Calibration Certificate

credited by the Swiss Accredit e Swiss Accreditation Service utilizational Agreement for the r	e is one of the signatories	to the EA.	No.: SCS 0108
ilent SGS - TW (Au			DAE4-1336_Nov16
ALIBRATION	CERTIFICATE		
bject	DAE4 - SD 000 D	04 BM - SN: 1336	
Calibration procedure(k)	QA CAL-06.v29 Calibration proces	ture for the data acquisition elect	ronics (DAE)
Calibration date:	November 22, 20	16	
The measurements and the uno	ertainties with confidence pro ucted in the closed laboratory	anal standards, which realize the physical unit obsbilly are given on the following pages and y tacility: environment temperature (22 + 3)°C	are part of the certificate.
The measurements and the uno NI calibrations have been condu Calibration Equipment used (M6	ertainties with confidence pro ucted in the closed laboratory	obsbility are given on the following pages and	are part of the certificate.
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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 ۰. 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 vollage.
  - 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	= agrun Ilut	-100 +300 ml
Low Range	ILSE =	61nV	full minge =	-1+3mV

Calibration Factors	x	Y	Z
High Range	403.332 ± 0.02% (k=2)	403.635 ± 0.02% (k=2)	403,121 ± 0.02% (fe=2)
Low Range	3.95216 ± 1.50% (k=2)	3.98718±1.50% (k=2)	3.99680 ± 1.50% (k=2)

**Connector Angle** 

Connector Angle to be used in DASY system	122.0 <sup>+</sup> ± 1 <sup>+</sup>
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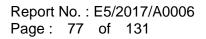
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#### Appendix (Additional assessments outside the scope of SCS0108)

#### 1. DC Voltage Linearity

High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199996.24	0.16	0.00
Cisannel X + Input	20001.25	-0.04	-0.00
Channel X - Input	-19999.81	1.36	-0.01
Channel Y + Input	199994.04	-1.88	-6.00
Channel Y + Input	20000.69	-0.82	+0.00
Channel Y - Input	-20002.64	-1.77	0.01
Channel Z + Input	199997.44	1.49	D.00
Channel Z + Input	19999.78	-1.82	-0,01
Channel Z + Input	-20003.24	-2.19	0.01

Low Range	Reading (µV)	Difference (µV)	Ervor (%)
Channel X + Input	2001.87	0.66	0.03
Channel X + Input	201.39	-0.11	-0.06
Channel X - Input	-198.27	0.04	-0.02
Channel Y + Input	2001.34	-0,04	-0.00
Channel Y + Input	201.35	-0.36	-0.18
Channel Y - Input	-198.77	-0.62	0.31
Channel Z + Input	2001.30	0,10	10,0
Channel Z + Input	200.72	-0,71	+0.35
Channel Z - Input	-199.12	-0.78	0.39

#### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Renge Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	5.23	3.90
	: 200	-3.72	-5.31
Channel Y	200	-4.23	-3,73
	-200	2.71	2.31
Channel Z	500	20.93	21,36
-	- 200	-23.91	-24.44

#### 3. Channel separation

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	e - 11	6.47	+1.27
Channel Y	200	7.97	-	6.72
Channel Z	200	7.94	5,96	1 A.

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#### 4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15660	15881
Channel Y	15906	15597
Channel Z	(5853	15173

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec Input 10Mi0

- C.	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-0.26	+1.07	0.37	0.38
Channel Y	-0.22	-0.92	0.62	0.34
Channel Z	-0.97	-1.73	0.29	0.36

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels <251A

#### 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 (- Vec)	-0.01	-8	-9

Cartificate No: DAE4-1936\_Nov16

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Primary Blancants Primary Blancants Promer meller NRP Power sector NRP 201 Power sector NRP 201 Reference 20 dil Alexandor	ID SN: 104778 SN: 104778	Cal Dole (Certificate No.) (6: Apr. 16 (No. 217-02288/02289) 06: Apr. 16 (No. 217-02288) 06: Apr. 16 (No. 217-02284) 05: Apr. 16 (No. 217-02283)	Scheduleri Caltration Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (Mr Premary Remember Prover sector NRP Power sector NRP-281 Power server NRP-291 Reference 20 dB Assonation	10 5N: 104778 5N: 104778 5N: 104778 5N: 104244 3N: 103245	Cal Dole (Certificate No.) 16-Apr-16 (No. 217-02389/12289) 16-Apr-16 (No. 217-02388) 16-Apr-16 (No. 217-02388) 15-Apr-16 (No. 217-02388) 11-Dec-16 (No. ES-3013, Doc16)	Schedulet Caltration Por17 Apr-17 Apr-17 Apr-17 Onc-17 Dec-17
Calibration Equipment used (My Premary Riansants Promer mediar NRP Power service NRP-201 Power-service NRP-201	ID SNL 104778 SNL 104778 SNL 104778 SNL 103244 SNL 103245 SNL 103245	Cal Dole (Certificate No.) (6: Apr. 16 (No. 217-02288/02289) 06: Apr. 16 (No. 217-02288) 06: Apr. 16 (No. 217-02284) 05: Apr. 16 (No. 217-02283)	Scheduleri Caltration Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (MP Premary Blancents Promer minim NBP Power sensor NBP-291 Power sensor NBP-291 Reference 20 dB Allenuator Radiotecu Phote ES30V2 DAE4	(D) SN: 104778 SN: 104778 SN: 104778 SN: 104778 SN: 104778 SN: 30245 SN: 35277 (20x) SN: 350 SN: 550	Cal Dele (Certificate NA) Di-Apr-16 (No. 217-02288/02289) Di-Apr-16 (No. 217-02288) Di-Apr-16 (No. 217-02288) Di-Apr-16 (No. 217-02288) Ti-Dec-16 (No. 217-02280) Ti-Dec-16 (No. DAE4-860, Dec16)	Scheduling Calibration Age-17 Age-17 Age-17 Age-17 Dec-17 Dec-17 Dec-17
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Calibration Equipment used (MP Premary Remember Prover sector NRP-281 Power sector NRP-281 Reference 20 dB Assenuator Reference 20 dB Assenuetor Reference 2	1D SN: 104778 SN: 104778 SN: 104778 SN: 103245 SN: 55277 (20x) SN: 55277 (20x) SN: 5527 SN: 5527	Cal Dole (Certificate No.) Di-Apr-16 (No. 217-02389/12289) Di-Apr-16 (No. 217-02389) Di-Apr-16 (No. 217-02389) Di-Apr-16 (No. 217-02389) Di-Den-16 (No. 218-3013, Doc16) 7-Den-16 (No. 248-3013, Doc16) 7-Den-16 (No. 248-3013, Doc16) Dreak Date (in Police) Di-Apr-16 (in Doce check Jun-16)	Schedulet Caltration Apr-17 Apr-17 Apr-17 Dec-17 Dec-17 Dec-17 Schedulet Dieck In house check: Jon-18
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#### **Calibration Laboratory of** Schmid & Partner Engineering AG migheusstrappe 43, 4004 Zurich, Sentenland



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Adventibution No. SCS 0108

According by the Sware According Service (BAS) The Swias Accreditation Service to one of the signatories to the LA Multivismal Agreement for the Acception of calibration pertilicates.

#### Glossary

Glossary.	
75L	tissue simulating liquid
NORMX, y.z	sansbrity in free space
ConvE	seramyity in TSI_7 NORMa, y, z
DCP	diade compression point
CF	crest factor (1/daty_cycle) of the RF signal
AB.CD	modulation dependent lindarization parameters
Polatization in	a rolation around probe axis
Polarization 8	s rotation around an axis that is in the plant minimal is probe sats (all measurement center),
	i.e., 9 – 0 is normal to probe due
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

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

- Ibration is Performed According to the Following Standards:
  IEEE Stid 1528-2013, 'IEEE Recommanded Practice for Determining the Peak Spatial Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measuremant Techniques', June 2013.
  IEC 42209-1, 'Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used inclose proximity to the sar (hequency mings of 300 MHz to 2 OHz)'', February 2005.
  IEC 42209-2, 'Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used inclose proximity to the sar (hequency mings of 300 MHz to 2 OHz)'', February 2005.
  IEC 42209-2, 'Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 5 GHz)'', March 2010.
  MDB 855664, 'SAR Measurement Requirements for 100 MHz to 6 GHz''.

#### Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field operation 0 = 0 (f ± 900 MHz in TEM-cell, r > 1800 MHz; R22 waveguide) NORMx,y,z are only intermediate values, Le. (the uncertainties of NORMx,y,z does not affect the E<sup>2</sup> field uncertainty inside TSL (see bolicy CorvF).
- uncertainty inside TSL take bolizw Conv/ I. NORM(I)x,y,z = NORMA, y,z \* frequency response (see Frequency Response Charl). 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 DGPx,y,z: DCP are numerical linearization parameters assessed based on the data of power aware with CW
- equal (no incertainty required). DCP does not depend on frequency nor media PVP: PAR is the Peak = Avmage Ratio that is not calibrated but determined based on the signal.
- tharacteristics
- characteristics *Ax*, *y*, *z*, *Bx*, *y*, *z*, *Cx*, *y*, *z*, *A*, *B*, *C*, *D* are normalization parameters appeared based on the data of power sweep for specific modulation nightal. The parameters op not depend on frequency nor-modia. VR is the multitum calibration range symposed in RMS votage across the diade. *ConvF* and *Boundary Effect Parameters*: Assessed in flat phantom using Effold for Temperature Transfer *ConvF* and *Boundary Effect Parameters*: Assessed in flat phantom using Effold for Temperature (2004)
- Conversion and accuracy check Parameters. Assessed in ital prientom using E-field (or Temperature Transfer Standard for f ± 000 MHz) and incide wavequints using analytical field distributions based on dowlet measurements for f = 800 MHz. The same setups are used for assessment of the parameters applied for boundary componenties for 1 = 800 MHz. The same setups are used for assessment of the parameters applied for boundary componenties for 1 = 800 MHz. The same setups are used in DASY4 software to improve probe ecouracy close to the boundary. The sensitivity in TSL corresponde is NORMary, z \* Conver whereby the uncertainty corresponds to that given for Conver A frequency dependent Conver 5 used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz. MHz.
- Spherical isolropy (3D deviation from isolropy); In a hold of low gradients realized using a fist phentom exposed by a patch antenna
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe lip (on probe axis). No tolerance required
- Connector Angle: The angle is assessed using the information gained by determining the NORMir (no Uncertainty required]

-Certilicate No: EX3-3831\_Jan11

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EX3DV4 - SV 3034

sanitary 28, 2017

# Probe EX3DV4

## SN:3831

Manufactured: September 6, 2011 Calibrated:

January 23, 2017

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

Centilisere No. EK3-3831 Jan17

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EX30V4- SN:3E31

January 25 2017

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

	Sensor X	Sensor Y	Sensor Z	Une (k=2
Norm (uV/(V/m) <sup>2</sup> ) <sup>n</sup>	0.43	0.41	0.42	# 102.1 %
DCP (mV)"	101.7	#02.0	100.6	

#### Modulation Calibration Parameters

nin	Communication System Name		A	B dBõV	c	D dS	VR mV	Una" (k=2)
0 5	EW	x	0.0	0.0	1.0	0.00	149,3	47.2 %
		¥	0.0	0.0	1.0		138 4	
_	1	Z	0.0	0.0	1.0		142.6	

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 85%.

The unusharder of Norm X.Y.Z no mit ellest, two E-Ded uncestainty more TCL (well Pages E and B). Numerical theorization performer uncestanty you required, Unsertiery is obtaining using the max, sensition from the much supplying including and distribution and is expressed for the insurance the field volum

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EX30VM- SN 3631

January 23, 2017

f (MHz) =	Relative Permittivity	Conductivity (S/m)	Convil X	ConvF Y	ConvF.Z.	Alpisa <sup>10</sup>	Depth <sup>G</sup> (mm)	Unc (k=2)
750	41.9	0.89	9.63	£8.8	9.63	0,57	0.80	± 42.0 %
835	41.5	0.90	9.15	9,15	9.15	0.53	0.21	± 12.0 %
900	41.5	70.0	9.08	9.08	9,08	0.42	0,86	± 12.0 %
1450	40.5	1,29	8.41	8.41	8.41	0.35	0,80	1 12,0 %
1760	40.1	1.37	8.17	8.17	8,17	0.32	0.80	= 12.0 %
1900	40,0	1.40	7.86	7:85	7.86	0.39	0.80	= 12.0 %
2000	40.0	1.40	7.80	7,80	7.80	0.35	0.80	3 12.0 %
2300	39.5	1.87	7.59	7.59	7.69	0.26	1.02	± 12.0 %
2450	39.2	1.80	7.21	7,21	7.21	0.40	0.80	± 12.0.%
2600	39.0	1,96	69.9	8.99	6,99	D.38	0,80	£12.05
3500	37.9	2.91	6.55	8.55	6,55	0.30	1.20	£ 13,7 %
5200	36.0	4.66	5.02	5.02	5.02	0,30	1.80	=13,1.5
5300	35.9	4.76	4.70	4.70	4.70	0.35	1.80	±131.8
5600	35.5	5.07	4.51	4.59	4.51	0.40	1.80	±18.1 %
5800	35.3	6.27	4,45	4.46	4.48	0.40	T.80	± 13:1 %

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

<sup>1</sup> Frequency validity playe 300 M/Hz of a 110 M/Hz only applies for DASY v8.4 and higher (van Page 2), essel is realization to ± 50 M/Hz. The innertiantly article SS of the Cover function of a transmission of the innertiant to the induced to ± 50 M/Hz. The innertiantly article S00 M/Hz is ± 10, 25, 40, 50 and 20 M/Hz base 50 m/Hz base strengther wildly below 200 M/Hz base 50 m/Hz base 50

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EX00VA-SN 3831

Jammary 21, 2017

(MHz)<	Relative Permittivity	Conductivity (S/m)	ConvF X	ConvFY	ConvF Z	Alpha	Depth C (min)	Unc (k=2)
750	55.5	0.96	9.59	9.69	9.59	0.46	0.80	±12.0 %
835	55.2	0.97	9.25	9.25	9.25	0.48	0.80	±12.0 %
900	35.0	1,05	0,15	B/16	9.15	8.35	0.80	± 12.0 %
1750	53.4	1,49	7.78	7.78	7.78	0.36	0.80	1 12.0 %
1900	53.3	1,52	7.63	7.53	7.53	0.38	0.80	1 12.0 %
2000	63.3	1.52	7.66	7.65	7.66	0.32	0.80	± 12.0 %
2300	62.9	181	7.32	7.32	7.32	0.28	1.00	± 12.0 %
2450	52.7	1.95	7.30	7.30	7.30	0.33	0.80	±12:0.9
2800	52.5	2.16	7.05	7.05	7.05	D.30	0.80	± 12.0.1
5200	49,0	5.30	4.47	4.47	4.87	0.40	1,90	±13.15
5380	48.9	5.42	4.21	4.21	4.21	0.45	1,90	= 13.1 9
5600	48.5	5,77	3.67	3,67	3.67	0.50	1.90	± 13.1 1
5800	48.2	6.00	3.67	3.87	3,87	0.50	1.90	±13.4 9

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

Frequency validity access 300 MHz of a 100 MHz only enclose for DASY v4.4 and higher (see Page 2), also () a restricted to a 50 MHz. The encentrarily in the RS8 of the Crew functionality at calibration themesty and the uncentancy for the adopted frequency baid. Frequency within back 300 MHz (a 10, 26, 40, 50 and 10 MHz the Crew for an encoded at 10, 64, 120, 150 and (20 MHz respective). Above 6 CHz frequency addet y on the extended to 14 MHz. The intercented EAR values. At Requestes atows 2 CH2, the validity of taxoe premises (a and b) is extended to 156. If taxoes the RS8 of the messare) EAR values. At Requestes atows 1 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is in the RS8 of the messare) EAR values. At Requestes atows 1 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is the RS8 of the messare) EAR values. At Requestes atows 2 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is the RS8 of the messare) EAR values. At Requestes atows 2 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is the messare) EAR values. At Requestes atows 2 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is the RS8 of the messare) EAR values. At Requestes atows 2 CH2, the validity of taxoe premises (a and b) is extended to 156. The uncertainty is the RS8 of the messare) and the uncertainty is the indicated target taxoe premises. The advertee the taxoe of the taxoe at the taxoe of the second second taxoes taxoes in the taxoes is the taxoe. The indicated target taxoe of the taxoes at the taxoes at the taxoes at the taxoe at the taxoes the manual taxoes is the taxoe of the taxoe of the taxoes at the taxoes at the taxoes at the taxoes taxoes taxoes taxoes is the taxoes taxoes is the taxoes taxoes

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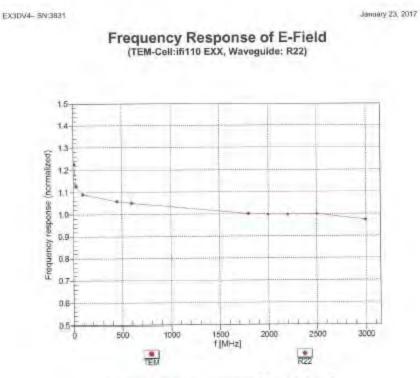
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Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)



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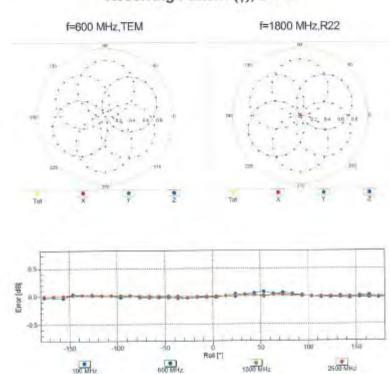
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EX3DV4-SN:3831

January 23, 2017



Receiving Pattern (\$), 9 = 0°

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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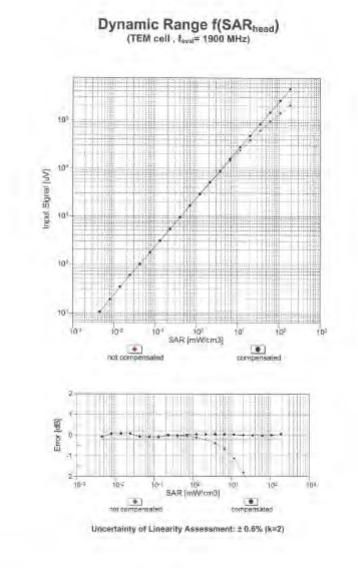
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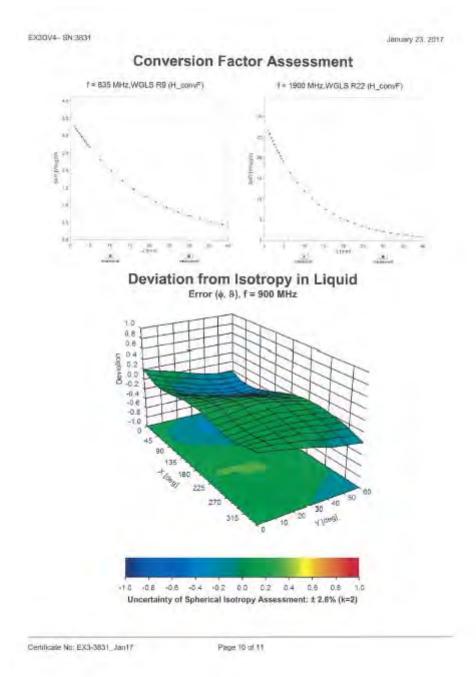
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EKODV4-SN(3831

January 25, 2017

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3831

#### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (*)	-16.8
Mechanical Surface Datection Mode	enabled
Optical Surface Datection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	3 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Celibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	7 mm
Probe Tip to Sensor Z Calibration Ppint	Tirim
Recommended Measurement Distance from Surface	1.4 mm

Certificate No: EX3-3831 Jan17

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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 template for DUT SAR test (3-6G)

	1		-						
A	с	D	е		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probabilit V	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	00
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	œ
Isotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	œ
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	~
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	œ
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	œ
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	œ
Readout Electronics	0.30%	Ν	1	1	1	1	0.30%	0.30%	œ
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	<b>x</b> 0
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	<b>x</b> 0
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	<b>x</b> 0
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	œ
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	œ
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	<b>x</b> 0
Probe Positioning with respect to phantom	2.90%	R	√3	1.732	1	1	1.67%	1.67%	<b>x</b> 0
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	<b>x</b> 0
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	8
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	œ
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	œ
Liquid permittivity (mea.)	2.84%	N	1	1	0.64	0.43	1.82%	1.22%	М
Liquid Conductivity (mea.)	2.53%	N	1	1	0.6	0.49	1.52%	1.24%	М
Combined standard uncertainty		RSS					11.95%	11.84%	
Expant uncertainty (95% confidence							23.91%	23.67%	

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A	<u>_</u>	D	•		f	a	h=c * f / e	i=c * g / e	k
	c Tolerance/	Probabilit	е			g	Standard	standard	
Source of Uncertainty	Uncertainty	y y	Div	Div Value	ci (1g)	ci (10g)	uncertainty	uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.00%	Ν	1	1	1	1	6.00%	6.00%	8
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	$\infty$
lsotropy, Hemispherical	9.60%	R	√3	1.732	1	1	5.54%	5.54%	~
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	~
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	8
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	$\infty$
Readout Electronics	0.30%	Ν	1	1	1	1	0.30%	0.30%	8
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	8
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	$\infty$
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	8
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	8
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	8
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	~
Probe Positioning with respect to phantom	2.90%	R	√3	1.732	1	1	1.67%	1.67%	~
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	~
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Uncertainty Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	~
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	$\infty$
Liquid permittivity (mea.)	2.46%	N	1	1	0.64	0.43	1.57%	1.06%	М
Liquid Conductivity (mea.)	3.07%	N	1	1	0.6	0.49	1.84%	1.50%	М
Combined standard uncertainty		RSS					11.67%	11.56%	
Expant uncertainty (95% confidence							23.34%	23.11%	

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

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## 9. Phantom Description

Sohmus & Panner Engineering AG

Zoughquestmaser 43, 8004 Zurich, Switzerlan Phone +41 1 245 9700, Fax +41 1 245 9779 Info@space\_com. http://www.space\_com

Certificate of Conformity / First Article Inspection

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

Tests. The series production process used allows the imitation to test of first articles. Complete tests were made on the pre-series Type No. GD 000 P40 AA. Serial No. TP-1001 and on the series first article Type No. GD 000 P40 BA, Serial No. TP-1008. 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.	(TIS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards	2mm +/- 0.2mm in flat and specific areas of head section	First article, Samples, TP-1314 ff,
Material thickness at ERP	Compliant with the requirements according to the standarda	6mm +/- 0.2mm at ERP	First article, All items
Material parameters	taterial Dielectric parameters for required 300 M		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 simulating liquid	< 1% typical < 0.8% if filed with 155mm of HSL900 and without OUT below	Prototypes, Sample testing

5tandards [1] CENELEC EN 50361 [2] IEEE Std 1528-2003 [3] IEC 62208 Part I

1234

FCC OET Builetin 65, Supplement C, Edition 01-01 The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

Conformity

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

Date Signature / Stamp	07.07.2005	Salphi & Bagawi Enginee Integrand AG Salphi & Salphi & Enginee Integrand AG Salphi ausopticated and Automaticated Phone add a Salphi Salphi Add Salphi Add Salphi Into Prepares.com. http://www.apeeg.com
Doc He MIT - 00 000 P40 C + *		Page 111

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

Engineering AG aughawastrasse 43, 8694 Zurich	y of n, Switzerland		Schweizerischer Kalibrierdienet Bervice suisse d'étalionnage Servizio svizzero di taratura Swiss Calibration Service
coredited by the Swiss Accredite he Swiss Accreditation Service Nultilational Agreement for the re	is one of the signatorie	s to the EA	otreditation No.: SCS 0108
liert SGS-TW (Aude	n)	Cartificate No	» D835V2-4d063_Aug17
CALIBRATION C	ERTIFICATE		and the
Diet	D635V2 - SN:4d0	063	
Calibration procedure(s)	QA CAL-05.v9		-
	Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration data	August 21, 2017		
All calibrations have been conduc	oted in the closed laboratio	ry facility, environment temperature (22 ± 3)*	C and humidity = 70%.
Calibration Equipment used (M&)	TE critical for calibration)		
Calibration Equipment used (M&) Primary Standards	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (M&) Primary Standards Power meter NRP	TE critical for calibration)		
Cationation Equipment used (M&) Primery Standards Rower meter NRP Power sensor NRP-291	TE critical for calibration)	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522)	Scheduled Calibration Apri-18
Calibration Equipment used (M&) Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251	TE ortical for calibration( ID # SN: 104778 SN: 103244	Cal Date (Certificate Nr.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521)	Scheduled Calibration Apt-18 Apt-18
Calibration Equipment used (M&) Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Reforence 20 del Artenuator Type-N mismatch combination	TE critical for calibration) D 8 SN: 104778 SN: 103244 SN: 103244 SN: 103246 SN: 5056 (20k) SN: 5047.2 ( 08327	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528)	Scheduled Calibration Apr-18 Apr-10 Apr-16 Apr-18
Calibration Equipment used (M8) Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Reference 20 d5 Attenuator Type-N mismisch combination Reference Probe EX3DV4	EE critical for calibration( D 8 SN: 104778 SN: 103244 SN: 103246 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 7349	Cal Date (Certificate Nr.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 31-May-17 (No. EX3-7340_May17)	Scheduled Calibration Apr-18 Apr-18 Apr-10 Apr-18 Apr-18 May-18
Calibration Equipment used (M8) Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Reference 20 d5 Attenuator Type-N mismisch combination Reference Probe EX3DV4	TE critical for calibration) D 8 SN: 104778 SN: 103244 SN: 103244 SN: 103246 SN: 5056 (20k) SN: 5047.2 ( 08327	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528)	Scheduled Calibration Apr-18 Apr-10 Apr-10 Apr-18 Apr-18
Calibration Equipment used (MKT Primery Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-1 mismetch combination Reference Probe EX3CV4 DRE4	EE critical for calibration( D 8 SN: 104778 SN: 103244 SN: 103246 SN: 5058 (20k) SN: 5058 (20k) SN: 5058 (20k) SN: 7349	Cal Date (Certificate Nr.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 31-May-17 (No. EX3-7340_May17)	Scheduled Calibration Apr-18 Apr-18 Apr-10 Apr-18 Apr-18 May-18
Calibration Equipment used (M8) Primary Standards Power sensor NRP-281 Power sensor NRP-251 References 20 dis Asenuator Type-N mismatch combination Reference Probe EX3034 DAEA Secondary Standards	TE celleal for calibration) D # SN: 104778 SN: 103246 SN: 103246 SN: 5058 (20k) SN: 5058 (20k) SN: 5047.2 / 05327 SN: 5047 SN: 601	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02529) 31-May-17 (No. EX3-7340_May17) 28-Mar-17 (No. DAE4-601_shar17)	Scheduled Calibration Apr-18 Apr-18 Apr-10 Apr-18 Apr-18 May-18 May-18
Cationation Equipment used (M8) Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismetch combination Reference Probe EX30V4 DAEA Secondary Standards Power meter EPM-442A Power meter EPM-442A Power sensor HP 8481A	TE critical for castration) D # SN: 104778 SN: 103244 SN: 103246 SN: 5056 (20k) SN: 5056 (20k) SN: 5049 SN: 601 (D # SN: GB37400704 SN: US37252783	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 51-Aby-17 (No. EX3-7340_May17) 28-Mar-17 (No. DAE4-601_blar17) Check Date (In house) 07-0c1-15 (In house check Oct-16) 07-0c1-15 (In house check Oct-16)	Scheduled Calibration Api-18 Api-18 Api-18 Api-18 Api-18 May-18 Mar-18 Scheduled Check In house check. Oct-18 In house check. Oct-18
Calibration Equipment used (MKT Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAEA Secondary Standards Power meter EPM-442A Power sensor HP 6481A Power sensor HP 6481A	TE critical for cashration( D # SN: 104778 SN: 103244 SN: 103246 SN: 5055 (20k) SN: 5047.2 ( 05327 SN: 5047.2 ( 05327 SN: 6011 ID # SN: 6837400704 SN: US37292783 SN: US37292783 SN: MIY41092317	Cal Date (Certificate No.) 04-Apt-17 (No. 217-02521/02522) 04-Apt-17 (No. 217-02521) 04-Apt-17 (No. 217-02522) 07-Apt-17 (No. 217-02522) 07-Apt-17 (No. 217-02529) 31-May-17 (No. 217-02529) 31-May-17 (No. 247-02529) 31-May-17 (No. 247-02529) 28-Mat-17 (No. 247-02529) 07-Oct-15 (In house check Oct-16) 07-Oct-15 (In house check Oct-16) 07-Oct-15 (In house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 May-18 May-18 May-18 Mar-18 Scheduled Check In house check. Oct-18 In house check. Oct-18
All calibrations have been conduc Calibration Equipment used (MKT Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Power sensor NRP-251 Raterance 20 dB Attenuator Type-N mismetch combination Reference Probe EX30X4 DAEA Secondary Standards Power meter EPM-442A Power sensor HP 6481A RF generator R&S SMT-06 Network Analyzor HP 67538	TE critical for castration) D # SN: 104778 SN: 103244 SN: 103246 SN: 5056 (20k) SN: 5056 (20k) SN: 5049 SN: 601 (D # SN: GB37400704 SN: US37252783	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 51-Aby-17 (No. EX3-7340_May17) 28-Mar-17 (No. DAE4-601_blar17) Check Date (In house) 07-0c1-15 (In house check Oct-16) 07-0c1-15 (In house check Oct-16)	Scheduled Calibration Api-18 Api-18 Api-18 Api-18 Api-18 May-18 Mar-18 Scheduled Check In house check. Oct-18 In house check. Oct-18
Calibration Equipment used (M8) Primary Standards Power sensor NRP-285 Power sensor NRP-255 Power sensor NRP-255 References 20 dB Adexnuator Type-N mismitch combination References Probe EX303/44 DAEA Secondary Standards Power meter EPM-442A Power sensor HP 6481A Power sensor HP 6481A RE generator R&S SMT-06	TE critical for calibration) D # SN: 104778 SN: 103244 SN: 103246 SN: 5047.2 / 08327 SN: 5047.2 / 08327 SN: 6047.2 / 08327 SN: 6047.2 / 08327 SN: 60537400704 SN: 08375400704 SN: 0837400704 SN: 100972	Cal Date (Certificate No.) 04-Api-17 (No. 217-02521/02522) 04-Api-17 (No. 217-02521) 04-Api-17 (No. 217-02521) 07-Api-17 (No. 217-02528) 07-Api-17 (No. 217-02528) 31-May-17 (No. 217-02528) 31-May-17 (No. 2X3-7349_May17) 28-Mai-17 (No. DAE4-601_May17) 28-Mai-17 (No. DAE4-601_May17) 29-Mai-17 (No. DAE4-601_May17) 19-04-16 (In house check Oct-16) 15-Jan-15 (In house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-10 Apr-16 Apr-18 May-18 May-18 May-18 Scheduled Check In house check. Oct-18 In house check. Oct-18 In house check. Oct-18 In house check. Oct-18
Calibration Equipment used (M8) Primary Standards Power sensor NRP-281 Power sensor NRP-291 Power sensor NRP-291 References 20 dB Adexnuator Type-N mismitch combination References Probe EX303/4 DAEA Secondary Standards Power meter EPM-442A Power sensor HP 6481A Power sensor HP 6481A RE generator R83 SMT-06	EE critical for calibration) D # SN: 104778 SN: 103244 SN: 103244 SN: 5058 (20k) SN: 5058 (20k) SN: 601 D # SN: 6837409704 SN: 0837292783 SN: 04741092217 SN: 100972 SN: 0537390986	Cal Date (Certificate Nr.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 07-Apr-17 (No. 217-02529) 07-Apr-17 (No. 217-02529) 07-Apr-17 (No. 217-02529) 07-Oct-15 (In house check Oct-16) 07-Oct-15 (In house check Oct-16) 07-Oct-16 (In house check Oct-16) 15-Jan-15 (In house check Oct-16) 16-Oct-01 (In house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 May-18 May-18 Mar-18 Scheduled Check In house check. Oct-18 In house check. Oct-17
Calibration Equipment used (M8) Primary Standards Power meter NRP Power sensor NRP-251 Reference 20 dB Abenuator Type-N mismisch combination Reference Probe EX30V4 DAEA Secondary Standards Power meter EPM-442A Power meter EPM-442A Power sensor HP 6481A Power sensor HP 6481A RF generator R&S SMT-06 Network Analyzor HP 67536 Calibrated by	TE critical for castration) D # SN: 104778 SN: 103244 SN: 103246 SN: 5055 (20k) SN: 5047.2 (03327 SN: 6017 D # SN: 6837400704 SN: 0537292783 SN: 04741002317 SN: 106972, SN: 10537390666 Name	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02522) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-0252) 07-Apr-17 (No. 217-0	Scheduled Calibration Api-18 Api-18 Api-18 Api-18 Api-18 May-18 May-18 May-18 Scheduled Check In house check. Oct-16 In house check. Oct-18 In house check. Oct-18 In house check. Oct-18 In house check. Oct-18 In house check. Oct-17
Calibration Equipment used (MK) Primary Standards Power meter NRP Power sensor NRP-251 Power sensor NRP-251 Power sensor NRP-251 Reference 20 dB Arbenuator Type-N mismistic combination Reference Probe EX30V4 DAE4 Secondary Standards Power meter EPM-442A Power meter EPM-442A Power sensor HP 6481A Power sensor HP 6481A RE ganerator R&S SNT-06 Network Analyzer HP 9753E	EE critical for castration) D # SN: 104778 SN: 103244 SN: 103244 SN: 5058 (20k) SN: 5058 (20k) SN: 601 D # SN: GB37400704 SN: US37292783 SN: US37390586 Name Clausio Leubler	Cal Date (Certificate Nr.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02529) 31-May-17 (No. EX3-7340_May17) 28-Mar-17 (No. EX3-7340_May17) 18-Oct-16 (In house check Oct-16) 07-Oct-15 (In house check Oct-16) 07-Oct-15 (In house check Oct-16) 15-Jan-15 (In house check Oct-16) 15-Jan-15 (In house check Oct-16) 15-Jan-15 (In house check Oct-16) 16-Oct-101 (In house check Oct-16) 18-Oct-101 (In house check Oct-16)	Scheduled Calibration Api-18 Api-18 Api-18 Api-18 Api-18 May-18 May-18 May-18 Scheduled Check In house check. Oct-16 In house check. Oct-18 In house check. Oct-18 In house check. Oct-18 In house check. Oct-18 In house check. Oct-17

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Calibration Laboratory of Schmid & Partner Engineering AG Zeughaussbasse 43, 8064 Zurich, Beitzetand



Schweizerischer Kalibrierdiensi Service suisse d'étélennage Servizie svizzere di taratura Swiss Calibration Service

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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatorise 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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
     c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless
  - c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
  - d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end
  of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole
  positioned under the liquid filled phantom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty regulred.
- 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	DASYS	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, d2 = 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 minuter
Moasured Head TSL parameters	(22.0±0.2) C	40.9±6%	0.93 mho/m ± 8 %
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	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9,34 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>1</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>1</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	1.55 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	55.3±6%	0.98 mbo/m ± 5 %
Body TSL temperature change during test	< 0,5 °C		

SAR result with Body TSL

SAR averaged over 1 cm <sup>1</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.41 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.57 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	1,68 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point.	51.7 17 - 2.7 (2
Return Loss	- 30.6 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.2 Ω - 5,2 jΩ
Return Loss	-24.4 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.367 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-circulard 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 cipcle arms, because they might bend or the soldered connections near the teedpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 27, 2006

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Date: 18.08.2017

#### DASY5 Validation Report for Head TSL

Test Laboratory: SPEAG, Zurich, Switzerland

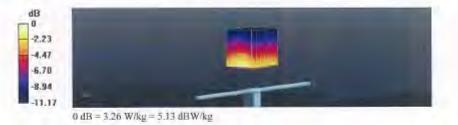
#### DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d063

Communication System: UID 0 – CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 0.93 S/m;  $\epsilon_c$  = 40.9;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANS) C63,19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA: Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 61.74.V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.71 W/kg SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.55 W/kg Maximum value of SAR (measured) = 3.26 W/kg



Certificate No: D835V2-4d063, Aug17

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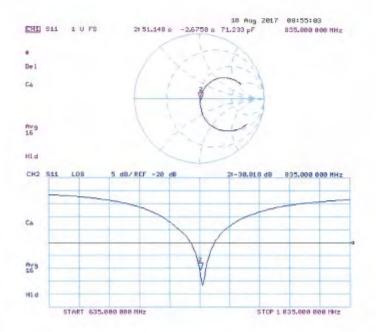
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#### Impedance Measurement Plot for Head TSL



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Date: 21.08.2017

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

Test Laboratory: SPEAG, Zurich, Switzerland

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

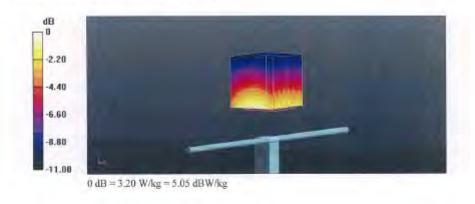
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma = 0.98$  S/m;  $\epsilon_r = 55.3$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.2, 10.2, 10.2); Calibrated: 31.05.2017;
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

#### 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 = 59.86 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 3.64 W/kg SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.58 W/kg Maximum value of SAR (measured) = 3.20 W/kg



Certificate No: D835V2-4d063\_Aug17

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## 21 Mug 2017 11136111 CHI S11 1 U FS 11 47.154 c -5.1504 a 07.000 pF 835.000 000 HHz ٠ D#1 Cà #¥9 #Ld CH2 511 LOD 5 d0/REF -20 d 11-24.365 dB 835.008 008 MHz Ċ4 169 HIG START 535.000 000 NH2 STOP 1 835.000 000 PHz Certificate No: D835V2-4d063\_Aug17 Page 8 of 8

#### Impedance Measurement Plot for Body TSL

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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 6004 Zurich, Switzerland



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Accreditation No.: SCS 0108

Accredited by the Swiss Accredition Service (SAS)

The Swiss Accreditation Service is one of the regulation of the EA Multimiteral 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.
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

e) 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 uncortainty 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	V52,10,0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phanlom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MH2 ± 1 MH2	

#### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22,0 °C	40.0	1.40 milia/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	413±6%	1.40 mho/m ±.6 %
Head TSL temperature change during test	< 0.5 °C	in the second second	

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.7 W/kg ± 17.0 % (k=2)
SAR everaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR everaged over 10 cm <sup>2</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	5.26 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	54,2±6%	1.51 mha/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		· · · · · · · · · · · · · · · · · · ·

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	e.ae Wikg
SAR for nominal Body TSL parameters	nonmalized to 1W	40.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5,30 W/kg

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

#### Antenna Parameters with Head TSL

Impedance, transformed to food point	51,3 Ω + 4,9 JΩ
Return Loss.	- 26.1 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to find point	47,5 IQ + 6,0 jQ
Return Loss	- 23.5 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small and 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 feedbolni may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 06, 2012

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Date: 31.05.2017

#### DASY5 Validation Report for Head TSL

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;  $\sigma$  = 1.4 S/m;  $\epsilon_{e}$  = 41.3;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7460; ConvF(7.98, 7.98, 7.98); Calibrated: 19.05.2017;
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 107.7 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.26 W/kg Maximum value of SAR (measured) = 15.3 W/kg



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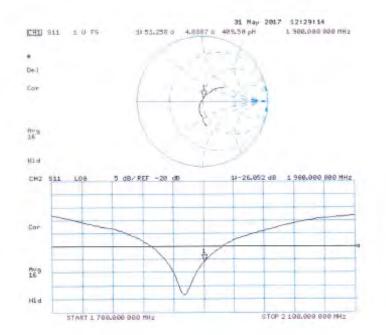
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#### Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d173\_May17

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#### DASY5 Validation Report for Body TSL

Date: 31.05.2017

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;  $\sigma = 1.51$  S/m;  $e_r = 54.2$ ;  $\rho = 1000$  kg/m<sup>2</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7460; ConvF(7.82, 7.82, 7.82); Calibrated: 19.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type; QD 000 P50 AA; Scrial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

## 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 = 102.9 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 17.5 W/kg SAR(1 g) = 9.98 W/kg; SAR(10 g) = 5.3 W/kg Maximum value of SAR (measured) = 14.3 W/kg



Certificate No: D1900V2-5d173\_May17

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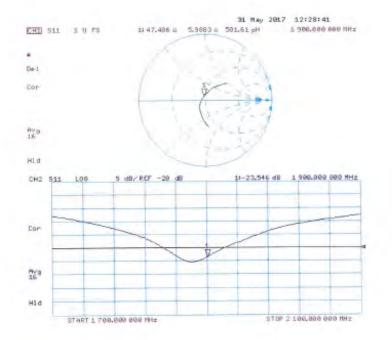
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#### Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d173\_May17

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CALIBRATION C	ERTIFICATE		
Dijad	D2450V2 - SN: 7	27	
Calibration procedure(s)	GA CAL-05.v9 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date.	April 21, 2017		
	cted in the closed laborato	ry facility: environment temperature (22 $\pm$ 3)	C and humidity < 70%.
NI calibrations have been conduc Calibration Equipment used (M&T		ry facility: environment temperature (22 ± 3) <sup>4</sup> Cal Data (Certificate No.)	C and fremidity < 70%.
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards	TE critical for calibration)		
NI calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NFIP	TE critical for calibration)	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521)	Schedulet Calibration Apr-18 Apr-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Pawer sensor NRP-291	TE critical for calibration)	Cal Data (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522)	Schedulet Calibration Apr-18 Apr-18 Apr-18
All calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291	TE chilepi for calibration) 10 # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Data (Cartificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 01-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	Schedulet Caliterion Apr-18 Apr-18 Apr-18 Apr-18
All calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NITP Power sensor NITP-291 Power sensor NITP-291 Relations-20 dB Attacuator Type-N mismatch combination	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 08327	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NEP Power sensor NEP-281 Power sensor NEP-281 Power sensor NEP-281 Pateronce 20 dB Attacuator Type-N mismatch combination Pacteronce Probe EX3DV4	TE chilepi for calibration) 10 # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Data (Cartificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 01-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	Schedulet Calibration Apr-18 Apr-18 Apr-18 Apr-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Pever sensor NRP-291 Paver sensor NR	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20%) SN: 5058 (20%) SN: 5047.8 / 063827 SN: 7346	Cal Data (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 31-Dec-16 (No. EX3-7349, Dec16)	Schedulert Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-17
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NEP Power sensor NEP-281 Power sensor NEP-281 Power sensor NEP-281 Pateronce 20 dB Attacuator Type-N mismatch combination Pacteronce Probe EX3DV4	TE collegi for calibration) ID # SN: 104778 SN: 104778 SN: 103245 SN: 103245 SN: 5056 (20k) SN: 5047.2 / 06387 SN: 5047.2 / 06387 SN: 5047.2 / 06387 SN: 5047.2 / 06387 SN: 601	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 31-Dec-16 (No. EX3-7348, Dec16) 28-Mar-17 (No. DAE4-601, Mar17)	Schedulest Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-16 Dec-17 Misr-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Relorence 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 50458 (28k) SN: 5047.2 / 08387 SN: 5047.2 / 08387 SN: 5047.2 / 08387 SN: 601	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 31-Dec-16 (No. EX3-7349, Dec16) 28-Mar-17 (No. DAE4-601, Mar17) Check Date (in house)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-17 Mar-18 Dec-17 Mar-18 Scheduled Check
All calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attacuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standards Power meter EPM-442A	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5056 (20k) SN: 5047.2 / 08327 SN: 5047.2 / 08327 SN: 601 ID # SN: 601 ID # SN: 601 ID # SN: 001	Cal Date (Certificate No.) 04.Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 31-Ote-16 (Wie EX3-7348, Dec16) 28-Mar-17 (No. DAE4-601_Mar17) Check Date (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Schedulert Calibertion Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-17 Msr-18 Schedulert Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power sensor NRP-281 Power sensor NRP-281 Power sensor NRP-281 Power sensor NRP-281 Power sensor NRP-281 Reference Probe EX30V4 OAE4 Secondary Standards Power meler EPM-442A Power sensor HP 8481A	TE critical for calibration) ID # SN: 104778 SN: 102244 SN: 102245 SN: 102245 SN: 102245 SN: 102245 SN: 10245 SN: 10245 SN: 5047.2708327 SN: 2045 SN: 00372 SN: 100972	Cal Data (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02529) 07-Apr-17 (No. 217-02529) 31-Dec-16 (No.	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-16 Dec-17 Msr-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Patenence 20 dB Attanuato' Type-N mismatch combination Pacterise 20 dB Attanuato' Type-N mismatch combination Pacterise Probe EX3DV4 DAE4 Secondary Standards Power sensor HP 6481A Power sensor HP 6481A	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5056 (20k) SN: 5047.2 / 08327 SN: 5047.2 / 08327 SN: 601 ID # SN: 601 ID # SN: 601 ID # SN: 0037292783 SN: MY41092317	Cal Date (Certificate No.) 04.Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 31-Ote-16 (Wie EX3-7348, Dec16) 28-Mar-17 (No. DAE4-601_Mar17) Check Date (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Schedulert Calibertion Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-17 Msr-18 Schedulert Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
All calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor HP 6491A Power sensor HP 6491A RF generator R&S SMT-06 Nativort Analyzer HP 8753E	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5056 (20k) SN: 5047.2 / 08327 SN: 5047.2 / 08327 SN: 601 ID # SN: 6837480704 SN: 0837292783 SN: 00972 SN: 00972 SN: 00972 SN: 0837390585 Name	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-0258) 07-Apr-17 (No. 217	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-16 Dec-17 Msr-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
MI calibrations have been conduc Calibration Equipment used (MST Primary Standards Power meter NRIP Power sensor NRIP-291 Power sensor NRIP-291 Power sensor NRIP-291 Palvennes 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HIP 6481A Power sensor HIP 6481A Power sensor HIP 6481A RF generator R&S SMT-06	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103246 SN: 5058 (20k) SN: 5047.8 / 03827 SN: 7346 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: 10337280566	Cal Date (Certificate No.)           04-Apr-17 (No. 217-02521/02522)           04-Apr-17 (No. 217-02521)           04-Apr-17 (No. 217-02522)           07-Apr-17 (No. 217-02528)           07-Apr-17 (No. 217-02528)           07-Apr-17 (No. 217-02529)           31-Dec-16 (W), EX3-7348, Dec16)           28-Mar-17 (No. DAE4-601, Mar 17)           Check: Date (in house check Oct-16)           07-Oct-15 (in house check Oct-16)           07-Oct-15 (in house check Oct-16)           07-Oct-15 (in house check Oct-16)           15-Jun-15 (in house check Oct-16)           19-Oct-01 (in house check Oct-16)	Schedulert Calibonion Apri 18 Apri 18 Apri 18 Apri 18 Apri 18 Dec-17 Mar-18 Dec-17 Mar-18 Scheduled Check In house check: Oct-18 In house check: Oct-18
Calibration Equipment used (MST Primary Standards Power reliter NRP Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor NRP-291 Power sensor HP 6481A Power sensor HP 6481A	TE critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5056 (20k) SN: 5047.2 / 08327 SN: 5047.2 / 08327 SN: 601 ID # SN: 6837480704 SN: 0837292783 SN: 00972 SN: 00972 SN: 00972 SN: 0837390585 Name	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-0258) 07-Apr-17 (No. 217	Schedulert Calibonion Apri 18 Apri 18 Apri 18 Apri 18 Apri 18 Dec-17 Mar-18 Dec-17 Mar-18 Scheduled Check In house check: Oct-18 In house check: Oct-18

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Accreditation No.1 SCS 0108

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## Glossary:

TSL

N/A

ConvF

tissue simulating liquid sensitivity in TSL / NORM x,y,z 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held b) devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)\*, February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)<sup>4</sup>, March 2010 d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

e) 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	V52.10.0
Extrapolation	Advanced Extrapolation	V32.10.0
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	37.7 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

Condition	
250 mW input power	13.4 W/kg
normalized to 1W	52.2 W/kg ± 17.0 % (k=2)
condition	
	250 mW input power normalized to 1W

SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.3 W/kg ± 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.5 ± 6 %	2.03 mha/m ± 6 %

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## SAR result with Body TSL

Body TSL temperature change during test

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	6.01 W/kg

< 0.5 °C

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.3 Ω + 2.1 jΩ
Return Loss	- 24.0 dB

#### Antenna Parameters with Body TSL

impedance, transformed to feed point	51.1 Ω + 4.1 jΩ
Return Loss	- 27.5 dB

#### General Antenna Parameters and Design

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

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

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

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	January 09, 2003

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## DASY5 Validation Report for Head TSL

Date: 21.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

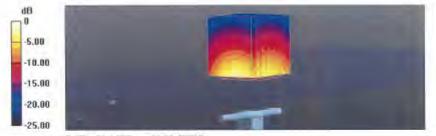
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.87 S/m;  $\epsilon_r$  = 37.7; p = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- · Phantom: Flat Phantom 5.0 (front): Type: QD 000 P50 AA: Serial: 1001
- DASY52 52,10.0(1442); SEMCAD X 14.6.10(7413)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.8 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 27.3 W/kg SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.18 W/kg Maximum value of SAR (measured) = 21.1 W/kg



0 dB = 21.1 W/kg = 13.24 dBW/kg

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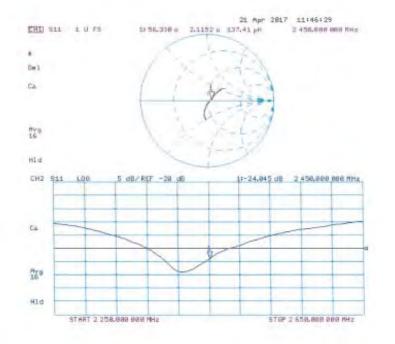
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Impedance Measurement Plot for Head TSL



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

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Date; 21.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

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

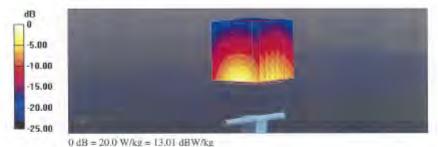
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used; f = 2450 MHz;  $\sigma$  = 2.03 S/m;  $\epsilon_1$  = 52.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section; Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 31.12,2016;
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

## 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 = 105.0 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 25.4 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.01 W/kg Maximum value of SAR (measured) = 20.0 W/kg



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Certificate No: D2450V2-727\_Apr17

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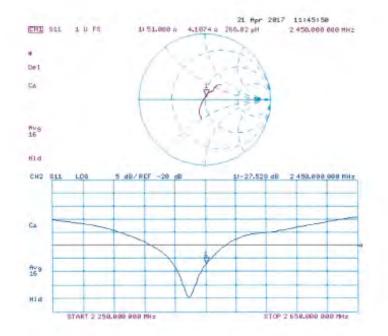
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Impedance Measurement Plot for Body TSL



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CALIBRATION C	ERTIFICATE		
Objec)	D5GHzV2 - SN:1	023	
Calibration procedurals)	QA CAL-22.v2		
	Calibration proce	dure for dipole validation kits bety	ween 3-6 GHz
Calibration date:	January 20, 2017		
The measurements and the unco	mainties with confidence p	ional standards, which realize the physical un robability are given on the following pages an	d are part of the certificate
Vi calibrations have been condu	cted in the closed laboratio	ry facility, any ionmont temperature $(22\pm3)^{\circ}$	C and humidity < 797%.
	TE ortical for calibration)		
Calibration Equipment used (M&	TE orbcal for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (M& Primary Standards Power meter NPP	TE ortical for calibration)	Cal Date [Certificate No.] 06-Apr16 (No. 217-02289/02289)	Scheduled Calibration Apr-17
Calibration Equipment used (M8 Primary Standards Power meter MPP Power sensor MPP-291	TE ortical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Centificate No.) 08-Apr-96 (No. 217-02289/02289) 08-Apr-96 (No. 217-02289)	Scheduled Calibration Apr-17 Apr-17
Calibration Equipment used (M8 Primary Standards Power meter NPP Power sensor NPP-Z91 Power sensor NPP-Z91	TE ortical for calibration) ID # SNc 104778 SNc 103244 SNI 103245	Cal Date [Certificate No.] 06-Apr-16 [No. 217-02289/02289] 06-Apr-16 [No. 217-02289] 06-Apr-16 [No. 217-02289]	Scheduled Calibunity Apr-17 Apr-17 Apr-17
Calibration Equipment used (M& Primary Standards Power meter NPP Power sensor NPP-Z31 Power sensor NPP-Z31 Reference 20 dB Attenuator	TE onteal for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Date (Centilicate No.) 06-Apr-16 (No. 217-02289/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02280)	Schepsiled Calibunity Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (MS Primary Standards Power meter NPP Power sensor NPP-/291 Power sensor NPP-/291 Reference 20 dB Attenuator Type-N mismatch combination	TE ortical for calibration) ID + SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 5062001 SN: 5047.2 / 06327	Col Date [Contificate No.] 06-Apr-16 [No. 217-02289/02289] (N-Apr-16 [No. 217-02280) 06-Apr-16 [No. 217-02280) 05-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280]	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (M8 Primary Standards Power meter NRP Power sensor NRP-231 Power sensor NRP-231 Reference 20 dB Attenuator Type-N mismatch combination Fielemence Probe EX3DV4	TE onteal for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Date (Centilicate No.) 06-Apr-16 (No. 217-02289/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02280)	Schepsikel Calibunity Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (M8 Power meter NPP Power sensor NPP-291 Power sensor NPP-291 Power sensor NPP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4	E ortical for calibration) ID # SR: 104778 SR: 103244 SN: 103245 SN: 5085 (20k) SN: 5047.2 / 06827 SN: 3503 SN: 801	Cal Date (Contilicate No.) 06-Apr-96 (No. 217-02209/02289) 06-Apr-96 (No. 217-02289) 06-Apr-96 (No. 217-02280) 05-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02280) 01-Dec-16 (No. 217-02295) 01-Jec-16 (No. 206-8503_Dec16) 01-Jen-17 (No. DAE4-601_Jan17)	Schenaled Calibution Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Jan-18
Calibration Equipment used (MS Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Stancards	TE ortical for calibration) ID + SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 5047.2 / 06327 SN: 3603 SN: 801 ID +	Cal Date [Centificate No.] 06-Apr-16 [No. 217-02289/02289] 06-Apr-16 [No. 217-02289] 06-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02290] 05-Apr-16 [No. 217-02295] 31-Dec-16 [No. 217-02295] 31-Dec-16 [No. 217-02295] 31-Dec-17 [No. DAE4-Got_Jan17] Chuck Date (in house)	Scheduled Calburgen Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Jan-18 Scheduled Check
Calibration Equipment used (M8 Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Followance Probe EX3DV4 DAE4 Secondary Stanzards Power meter EPM-442A	TE ortical for calibration) ID # SNc 104778 SNc 103244 SNi 103245 SNi 5058 (25k) SNi 5058 (25k) SNi 5058 SNi 801 ID # SNk 6857480704	Cal Date [Centificate No.] 06-Apr-16 [No. 217-02289/02289] 06-Apr-16 [No. 217-02289] 06-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 91-Dec-16 [No. 217-02280] 91-Dec-16 [No. 217-02280] 01-cen-17 [No. DAE4-601_Jan17] Chuck Date (in house) 07-Det-16 [in house check Dot-16]	Scheduled Calibuniton Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Dec-17 Jan-18 Scheduled Check In house check: Dct-18
Calibration Equipment used (M8 Primary Standards Power meter MPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attanuator Type-N mismatch combinetion Falerance Probe EX30V4 DAE4 Secondary Stancards Power meser EPM-442A Power sensor HP 9481A	TE ortical for calibration) ID + SNc 104778 SNc 103244 SNi 103244 SNi 103245 SNi 5058 (20k) SNi 50547 2 / 06327 SNi 3609 SNi 601 ID # SNi 601 ID #	Cal Date [Cartificate No.] OG-Apt-96 [No. 217-02289/02289] (06-Apt-96 [No. 217-02289] OG-Apt-96 [No. 217-02280] DS-Apt-96 [No. 217-02290] DS-Apt-96 (No. 217-02290] D1-Dec-16 [No. 217-02290] D7-Oct-16 [In house check Dct-16] 07-Oct-16 [In house check Dct-16]	Scheduled Calburgen Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Jan-18 Scheduled Check
Calibration Equipment used (M8 Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standards Power sensor HP 9481A Power sensor HP 9481A	TE ortical for calibration) ID # SRc 104778 SRc 104778 SRc 103244 SRi 103245 SRi 5047 2 k) SRi 5047 2 k) SRi 5047 SRi 363 SRi 6037480704 SRi US37292789 SRi US37292789 SRi MY41092317	Cal Date (Centificate No.] 06-Apr-96 (No. 217-02289/02289) 06-Apr-96 (No. 217-02289) 06-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02282) 05-Apr-16 (No. 217-02292) 05-Apr-16 (No. 217-02292) 05-Apr-16 (No. 217-02292) 05-Apr-16 (No. 217-02292) 05-Apr-17 (No. DAE4-601_Jan17) Chuck Date (In house) 07-Oct-16 (In house chuck Dot-16) 07-Oct-16 (In house chuck Dot-16) 07-Oct-15 (In house chuck Dot-16) 07-Oct-15 (In house chuck Dot-16)	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Dec-17 Jan-18 Scheduled Check In house check, Oct-18 In house check, Oct-18
Calibration Equipment used (M8 Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Falemance Probe EX3DV4 DAE4 Secondary Stanzants Power meter EPM-442A	TE ortical for calibration) ID + SNc 104778 SNc 103244 SNi 103244 SNi 103245 SNi 5058 (20k) SNi 50547 2 / 06327 SNi 3609 SNi 601 ID # SNi 601 ID #	Cal Date [Cartificate No.] OG-Apt-96 [No. 217-02289/02289] (06-Apt-96 [No. 217-02289] OG-Apt-96 [No. 217-02280] DS-Apt-96 [No. 217-02290] DS-Apt-96 (No. 217-02290] D1-Dec-16 [No. 217-02290] D7-Oct-16 [In house check Dct-16] 07-Oct-16 [In house check Dct-16]	Schesaled Calibution Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Jan-18 Schesaled Check In house check Dct-18 In house check Dct-18 In house check Dct-18
Calibration Equipment used (MS Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Power sensor NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standards Power meser EPM-442A Power sensor HP 9481A Power sensor HP 9481A RF generator HP 9481A	TE ortical for calibration) ID + SN: 104778 SN: 103244 SN: 103245 SN: 5047.2 / 06327 SN: 3603 SN: 801 ID # SN: 0897480704 SN: US3/29278 SN: 100972	Cal Date [Centificate No.] 06-Apr16 [No. 217-02289/02289] 06-Apr16 [No. 217-02289] 06-Apr16 [No. 217-02280] 05-Apr16 [No. 217-02295] 05-Apr16 [No. 217-02295] 01-Dec-16 [No. 217-02295] 07-Oct-16 [No. 217-02295] 07-Oct-16 [In house check Oct-16] 07-Oct-16 [In house check Oct-16] 07-Oct-15 [In house check Oct-16]	Schemiled Calibution Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Jan-18 Schemiled Check In house check Oct-18 In house check Oct-18 In house check Oct-18
Calibration Equipment used (MS Primary Standards Power meter NPP Power sensor NPP-231 Power sensor NPP-231 Reference NPP-231 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX30V4 DAE4 Secondary Standards Power meser EPM-442A Power sensor HP 9481A RF generator HP 9481A RF generator HP 9481A	TE ortical for calibration) ID 4 SNc 104778 SNc 103244 SNi 103245 SNi 103245 SNi 103245 SNi 103245 SNi 3603 SNi 801 ID 8 SNi 6037480704 SNi 0537282177 SNi 100572 SNi 10337290585	Cal Date [Certificate No.] 06-Apr-16 [No. 217-02289/02289] 06-Apr-16 [No. 217-02280] 06-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 05-Apr-16 [No. 217-02280] 05-Apr-17 [No. DAE4-601_Jan177] Check Date (in house) 07-0ct-16 [in house check Oct-16] 07-0ct-15 [in house check Oct-16] 07-0ct-15 [in house check Oct-16] 07-0ct-15 [in house check Oct-16] 15-Jun-15 [in house check Oct-16] 19-0ct-01 [in house check Oct-16]	Scheduled Calibution Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Dec-17 Jan-18 Scheduled Check In house check Cot-18 In house check Cot-18
Calibration Equipment used (M8 Primary Standants Power meter MPP Power sensor NRP-231 Power sensor NRP-231 Power sensor NRP-231 Power sensor NRP-231 Power sensor NRP-231 Reference 20 dB Attanuator Type-N mismitch combination Reference 20 dB Attanuator Type-N mismitch combination Reference 20 dB Attanuator Type-N mismitch combination Reference 20 dB Attanuator Power sensor PM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R85 SMT-00 Notwork Analyzer HP 8753E	TE ortical for calibration) ID 4 SNc 104778 SNc 103244 SNi 103244 SNi 103245 SNi 5058 (20k) SNi 5057 2 (06327 SNi 3609 SNi 601 ID 8 SNi 0057480704 SNi 0537292780 SNi 100972 SNi 103729555 Name	Cal Date (Certificate No.) 06-Apr-96 (No. 217-02289/02289) 04-Apr-96 (No. 217-02289) 05-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02280) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 05-Apr-16 (No. 217-02290) 07-Oct-15 (In No.228 (No. 2001) 07-Oct-15 (In Nouse check Oct-16) 07-Oct-15 (In Nouse check Oct-16) 07-Oct-15 (In Nouse check Oct-16) 15-Oct-01 (In Nouse check Oct-16) 15-Oct-01 (In Nouse check Oct-16) 15-Oct-01 (In Nouse check Oct-16)	Scheduled Calibution Apr-17 Apr-17 Apr-17 Apr-17 Dec-17 Dec-17 Jan-18 Scheduled Check In house check Cot-18 In house check Cot-18
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Accreditation Net: SCS 0108

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#### Glossary: TSL

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SL	tissue simulating liquid
onvF	sensitivity in TSL / NORM x.y.z.
I/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 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30, MHz to 6 GHz)", March 2010
- 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 conter 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 Illied 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	DASYS	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Specer
Zoom Scan Resolution	dx, dy = 4,0 mm, dz = 1,4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	1200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz 5800 MHz ± 1 MHz	

#### Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	38.0	4.66 mha/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	4.45 mho/m ± 6.%
Hend TSL temperature change during test	<05°C		

## SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR mensured	100 mW input power	7.55 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	75.2 W/kg ± 19.9 % (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	noitibress	.2.16 W/kg

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## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Parmitbvity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35,2 ± 6 %	4.55 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.8 W / kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
	condition 100 mW input power	2.35 W/kg

#### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mhc/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	347 = 5 %	4.85 mho/m ± β %
Head TSL temperature change during test	< 0.5 °C	-	1000

## SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.7 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL. SAR massured	condition 100 mW input power	2.33 W/kg

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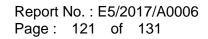
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#### Head TSL parameters at 5800 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	72.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	$34.4\pm6~\%$	5.05 mha/m± 6 %
Head TSL temperature change during test	< 0.5 °C	-	-

## SAR result with Head TSL at 5800 MHz.

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.82 W/kg
SAR for nominal Head TSL parameters	Wf of bezilemon	77.6 W/kg ± 19.9 % (k=2)
and the original state ( de ) and ( de )		
SAR averaged over 10 cm <sup>2</sup> (10 g) of Head TSL	condition	
	condition 100 mW input power	2.22 W/kg

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#### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 %	49.0	5.30 mhalm
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.5±6%	5.36 mito/m ± 6 %
Body TSL temperature change during test	<0.5 ℃		-

## SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7,32 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	72.8 W/kg ± 19.9 % (k=2)
territe the first the stand of the first state of the		
	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2:05 W/kg

#### Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.42 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.3±6%	5,50 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL at 5300 MHz

SAR averaged over 1 cm2 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.68 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	76.1 W/kg ± 19.9 % (k=2)
Status instant	and the second	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
	condition 100 mW input power	2 15 W/kg

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#### Body TSL parameters at 5600 MHz

 The following parameters and calculations were applied.
 Temperature
 Permittivity
 Conductivity

 Nominal Body TSL parameters
 22.0 °C
 48.5
 5.77 mbo/m

 Measured Body TSL parameters
 (22.0 ± 0.2) °C
 46.6 ± 6 %
 5.90 mbo/m ± 6 %

 Body TSL temperature change during test
 < 0.5 ©</td>
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## SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAB for nominal Body TSL parameters	normalized to 1W	79.6 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Bady TSL	condition	
SAB measured	100 mW input power	2.26 W/kg
CAD ins annual Book TSL parameters	munstrad to 1W	22.4 W/kg + 19.5 % (k=2)

#### Body TSL parameters at 5800 MHz

 Temperature
 Permittivity
 Conductivity

 Nominal Body TSL parameters
 22.0 °C
 48.2
 6.00 mho/m

 Measured Body TSL parameters
 (22.0 ± 0.2) °C
 45.3 ± 5 %
 6.17 mho/m ± 6 %

 Body TSL temperature change during test
 < 0.5 °C</td>
 —
 —

## SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm2 (1 g) of Body TSL	Condition	
SAR measured	100 mW Input power	7.64 W/Kg
SAR for nominal Body TSL parameters	normalized to 1W	75.9 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>2</sup> (10 g) of Body TSL SAR measured	condition 100 mW input power	2.13 W/kg

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

#### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	49.6 Ω - 6.7 jΩ	
Return Loss	- 23.4 dB	

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	49.0 Ω = 1.8 jΩ
Return Loss	-33.5 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.1 Ω - 0,2 jΩ
Fieturn Loss	- 28.2 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.4 Q + 2.8 jQ
Fletum Loss	- 24.8 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	48.9 Ω - 7.0 jΩ
Return Loss	= 22.9 dB

Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	51.0 Ω - 1.0 jΩ
Return Loss	- 37.0 dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	55.6 Ω + 1,5 jΩ	
Return Loss	- 25.2 dB	_

#### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to food point	56.6 Ω + 2.7 jΩ
Return Loss	- 23.6 dB

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#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 05, 2004

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## DASV5 Validation Report for Head TSL

Date: 20.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1023

```
Communication System: UID 0 - CW;

Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz,

Medium parameters used: f = 5200 MHz; \sigma = 4.45 S/m; \epsilon_{e} = 35.4; \rho = 1000 kg/m<sup>3</sup>.

Medium parameters used: f = 5300 MHz; \sigma = 4.55 S/m; \epsilon_{e} = 35.2; \rho = 1000 kg/m<sup>3</sup>.

Medium parameters used: f = 5600 MHz; \pi = 4.85 S/m; \epsilon_{e} = 34.7; \rho = 1000 kg/m<sup>3</sup>.

Medium parameters used: f = 5800 MHz; \pi = 5.05 S/m; \epsilon_{e} = 34.4; \rho = 1000 kg/m<sup>3</sup>.

Medium parameters used: f = 5800 MHz; \pi = 5.05 S/m; \epsilon_{e} = 34.4; \rho = 1000 kg/m<sup>3</sup>.

Medium parameters used: f = 5800 MHz; \pi = 5.05 S/m; \epsilon_{e} = 34.4; \rho = 1000 kg/m<sup>3</sup>.
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DASY52 Configuration:

- Probe; EX3DV4 SN3503; ConvF(5.76, 5.76, 5.76); Calibrated: 31.12.2016, ConvF(5.35, 5.35, 5.35); Calibrated: 31.12.2016, ConvF(5.09, 5.09); Calibrated: 31.12.2016, ConvF(5.0). 5.01); Calibrated: 31.12.2016;
- · Sensor-Surface: L4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01,2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 70.58 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 27.6 W/kg SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.16 W/kg Miximum value of SAR (measured) = 17.4 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.01 V/m; Power Dr/ft = -0.05 dB Peak SAR (extrapolated) = 31.6 W/kg SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2.35 W/kg Maximum value of SAR (measured) = 19.3 W/kg.

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scau, dist=1.4mm (8x8x7)/Cnbe 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.94 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 33.2 W/kg SAR(1 g) = 8.22 W/kg; SAR(10 g) = 2,33 W/kg Maximum value of SAR (measured) = 19.8 W/kg

Cemticate No: 05GHzV2-1023\_Jan17.

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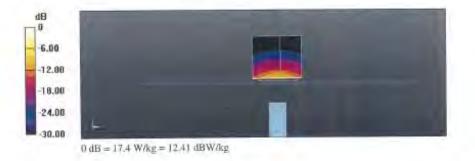
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Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.84 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 32.7 W/kg SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.22 W/kg Maximum value of SAR (measured) = 19.5 W/kg



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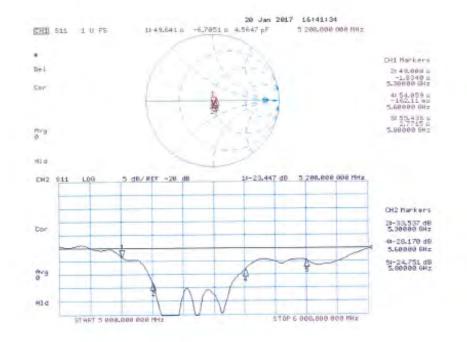
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#### Impedance Measurement Plot for Head TSL



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

Date: 19/01/2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1023

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz, Medium parameters used: f = 5200 MHz;  $\sigma = 5.36$  S/m;  $c_r = 47.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>. Medium parameters used: f = 5300 MHz;  $\sigma = 5.5$  S/m;  $c_r = 47.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma = 5.9$  S/m;  $c_r = 46.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>. Medium parameters used: f = 5800 MHz;  $\sigma = 5.9$  S/m;  $c_r = 46.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>. Medium parameters used: f = 5800 MHz;  $\sigma = 6.17$  S/m;  $c_r = 46.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>. Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; CouvF(5.29, 5.29, 5.29); Calibrated) 31 12.2016, CouvF(5.04, 5.04, 5.04); Calibrated: 31.12.2016, ConvF(4.57, 4.57, 4.57); Calibrated: 11.12.2016, ConvF(4.48, 4.48, 4.48); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601, Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.54 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 28.1 W/kg SAR(1 g) = 7.32 W/kg; SAR(10 g) = 2.05 W/kg Maximum value of SAR (measured) = 16.6 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1,4mm Reference Value = 66.93 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 30.1 W/kg SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg Maximum value of SAR (measured) = 17.6 W/kg

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 67.09 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 33.7 W/kg SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.26 W/kg

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

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Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.14 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 34.0 W/kg SAR(1 g) = 7.64 W/kg; SAR(10 g) = 2.13 W/kg Maximum value of SAR (measured) = 18.3 W/kg



0 dB = 16.6 W/kg = 12.20 dBW/kg

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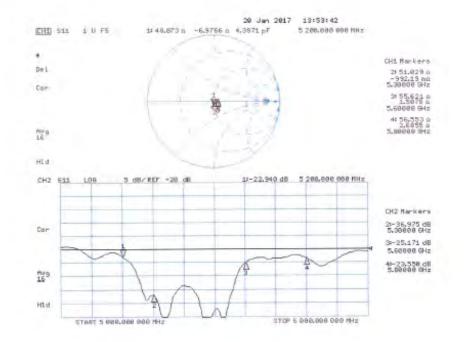
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## Impedance Measurement Plot for Body TSL





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