

# SAR TEST REPORT



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

Equipment Under Test	Tablet Computer
Marketing Name	SW1-011***(* means 0~9; a-z; A-Z; / ; - ; or blank) /
	OK0DM
Brand Name	acer
Model No.	N16P6
Company Name	Acer Incorporated
Company Address	8F., No. 88, Sec. 1, Xintai 5th Rd., Xizhi, New Taipei City 22181, Taiwan (R.O.C)
Standards	IEEE /ANSI C95.1 , C95.3, IEEE 1528,
	KDB447498D01v06, KDB616217D04v01r02,
	KDB248227D01v02r02,KDB865664D01v01r04,
	KDB865664D02v01r02
FCC ID	HLZN16P6
Date of Receipt	Jun. 01, 2016
Date of Test(s)	Jun. 02, 2016
Date of Issue	Jun. 13, 2016
In the configuration tested, the EU	Γ 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

Bond Tsai Poroce Date: Jun. 13, 2016 Supervisor

John Teh

John Yeh Date: Jun. 13, 2016

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# **Revision History**

Report Number	Revision	Description	Issue Date
E5/2016/60004	Rev.00	Initial creation of document	Jun. 07, 2016
E5/2016/60004	Rev.01	1 <sup>st</sup> modification	Jun. 13, 2016

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# **1. General Information**

## 1.1 Testing Laboratory

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No.134, Wu Kung Ro	ad, New Taipei Industrial Park, Wuku District, New Taipei			
City, Taiwan				
Tel	Tel +886-2-2299-3279			
Fax +886-2-2298-0488				
Internet http://www.tw.sgs.com/				

## **1.2 Details of Applicant**

Company Name	Acer Incorporated
	8F., No. 88, Sec. 1, Xintai 5th Rd., Xizhi, New Taipei City 22181, Taiwan (R.O.C)

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## **1.3 Description of EUT**

				1
Equipment Under Test	Tablet Computer			
Marketing Name	SW1-011***(* means 0~9; a-z; A-Z; / ; · OK0DM	- ; or bla	ank) /	
Brand Name	acer			
Model No.	N16P6			
FCC ID	HLZN16P6			
Antenna Designation (Maximum Gain)	2.45GHz: 2.02dBi			
Mode of Operation	⊠WLAN802.11 b/g/n(20M/40M) ⊠Bluetooth			
	WLAN802.11 b	97.65		
	WLAN802.11 g 87.43			3
Duty Cycle	WLAN802.11 n(20M/40M) 86.70		)	
	Bluetooth		1	
	WLAN802.11 b/g/n(20M)	2412	_	2462
TX Frequency Range (MHz)	WLAN802.11 n(40M)	2422	_	2452
(	Bluetooth	2402	_	2480
	WLAN802.11 b/g/n(20M)	1	_	11
Channel Number (ARFCN)	WLAN802.11 n(40M)	3	_	9
	Bluetooth	0	_	78

Max. SAR (1 g) (Unit: W/Kg)						
Band Measured Reported Channel Position						
WLAN802.11b	1.120	1.125	6	Back side		
Bluetooth(BLE)	0.294	0.307	19	Back side		

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

802.11 b		Max. Rated Avg.	Average conducted output power (dBm)
СН	Frequency Fower + Max.		Data Rate (Mbps)
СП	(MHz)		1
1	2412	14.5	14.49
6	2437	14.5	14.48
11	2462	14.5	14.26

802.11 g		Max. Rated Avg.	Average conducted output power (dBm)
СН	Frequency	Power + Max. Tolerance (dBm)	Data Rate (Mbps)
СП	(MHz)		6
1	2412	14	13.99
6	2437	14	13.93
11	2462	14	13.94

802.11 n(20M)		Max. Rated Avg.	Average conducted output power (dBm)
СН	Frequency	Power + Max.	Data Rate (Mbps)
СП	(MHz) Tolerance (dBm)		6.5
1	2412	14	13.88
6	2437	14	13.88
11	2462	14	13.94

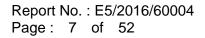
802.11 n(40M)		Max. Rated Avg.	Average conducted output power (dBm)
СН	Frequency Fower + Max.		Data Rate (Mbps)
СП	(MHz)		6.5
3	2422	14	13.97
6	2437	14	13.89
9	2452	14	13.96

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#### Bluetooth conducted power table:

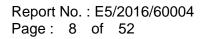
Frequency	Data	Max power(dBm)		Avg.	
(MHz)	Rate	······	dBm	mW	
2402	1	2	1.38	1.374	
2441	1	2	1.78	1.507	
2480	1	2	1.82	1.521	
2402	2	2	0.86	1.219	
2441	2	2	0.98	1.253	
2480	2	2	0.56	1.138	
2402	3	2	0.74	1.186	
2441	3	2	0.76	1.191	
2480	3	2	1.12	1.294	

		Pe	eak
Frequency (MHz)	Max. power(dBm)	BT	4.0
		dBm	mW
2402	8	7.75	5.957
2442	8	7.81	6.039
2480	8	7.71	5.902

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#### **1.4 Test Environment**

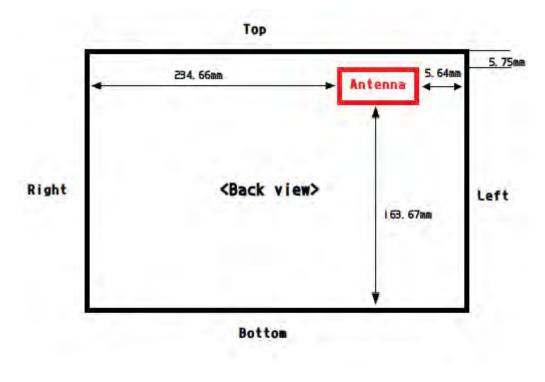
Ambient Temperature: 22±2° C Tissue Simulating Liquid: 22±2° C

## **1.5 Operation Description**

Use chipset specific software to control the EUT, and makes it transmit in maximum power. 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.

EUT was tested in the following configurations:

### WLAN: back/top/left sides with test distance 0mm.



Back view of tablet

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Note:

802.11b DSSS SAR Test Requirements:

- 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.
- 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:

3. 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.

Initial Test Configuration:

- 4. An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band.
- 5. SAR is measured using the highest measured maximum output power channel. When the reported SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.
- 6. WLAN and BT share the same antenna path and they can't transmit simultaneously.
- 7. According to KDB447498 D01, testing of other required channels is not required when the reported 1-g SAR for the highest output channel is  $\leq$  0.8 W/kg, when the transmission band is  $\leq$  100 MHz.
- 8. According to KDB865664 D01, 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)

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- 9. Based on KDB447498D01,
  - (1) SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances≤ 50 mm are determined by:

```
\frac{\text{Max.tune up power(mW)}}{\text{Min.test separation distance(mm)}} \times \sqrt{f(\text{GHz})} \le 3
```

When the minimum test separation distance is < 5mm, 5mm is applied to determine SAR test exclusion.

- (2) For test separation distances > 50 mm, and the frequency at 100 MHz to 1500MHz, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B of KDB447498 D01.
   [(Threshold at 50mm in step1) + (test separation distance-50mm)x(<sup>f(NHe)</sup>/<sub>1E0</sub>)](mW),
- (3) For test separation distances > 50 mm, and the frequency at >1500MHz to 6GHz, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B of KDB447498 D01.

				Top side			Right side			Left side	
Mode	Max. tune-up power(dBm)	Max. tune-up power(mW)	Test separation distance (mm)	Calculation value	Require SAR testing?	Test separation distance (mm)	>20cm	Require SAR testing?	Test separation distance (mm)	Calculation value	Require SAR testing?
WLAN Main 2.45GHz	14.5	28.184	5.75	7.691	YES	234.66	YES	NO	5.64	7.841	YES
BT	8	6.310	5.75	1.728	NO	234.66	YES	NO	5.64	1.762	NO
				Bottom side			Back side				
Mode	Max. tune-up power(dBm)	Max. tune-up power(mW)	Test separation distance (mm)	Calculation value	Require SAR testing?	Test separation distance (mm)	Calculation value	Require SAR testing?			
WLAN Main 2.45GHz	14.5	28.184	163.67	1137.584	NO	less than 5	8.845	YES			
BT	8	6.310	163.67	1136.899	NO	less than 5	1.987	NO			

[(Threshold at 50mm in step1) + (test separation distance-50mm)x10](mW),

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#### 1.6 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). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR=  $\sigma$  (|Ei|<sup>2</sup>)/  $\rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant.

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 intissue simulating liquid. The probe is equipped with an optical surface detector system.
- 3. A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

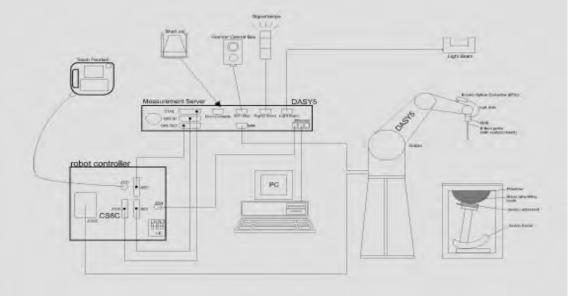


Fig. a The block diagram of SAR system

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- 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 Windows 7.
- 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.
- Tissue simulating liquid mixed according to the given recipes. 12.
- 13. Validation dipole kits allowing to validate the proper functioning of the system.

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### **1.7 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 HSL 2450 MHz Additional CF for other liquids and frequencies upon request
Frequency	10 MHz to > 6 GHz
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic	$10 \mu\text{W/g}$ 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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#### **SAM PHANTOM V4.0C**

Construction	cover prevents evaporation of th	AM) phantom defined in IEEE tion of left and right hand phone usage at the flat phantom region. A le liquid. Reference markings on setup of all predefined phantom
Shell Thickness	2 ± 0.2 mm	
	Approx. 25 liters	All and a second
Dimensions	Height: 850 mm; Length: 1000 mm; Width: 500 mm	

### **DEVICE HOLDER**

Construction	The device holder (Supporter) for Notebook is made by POM (polyoxymethylene resin ) , which is non-metal and non-conductive. The height can be adjusted to fit varies kind of notebooks.	
		Device Holder

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#### **1.8 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% from the target SAR values. These tests were done at 2450MHz. 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 (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was 21.7°C, the relative humidity was 62% and the liquid depth above the ear reference points was  $\geq$  15 cm  $\pm$  5 mm (frequency  $\leq$  3 GHz) or  $\geq$  10 cm  $\pm$  5 mm (frequency > 3 G Hz) 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.

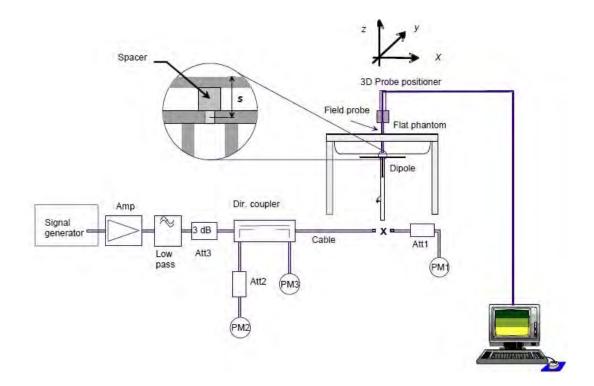


Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequ (Mł	•	1W Target SAR-1g (mW/g)	Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D2450V2	727	2450	Body	49.6	12.9	51.6	4.03%	Jun. 02, 2016

Table 1. Results of system validation

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

The dielectric properties for this body-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 (30 KHz-6000 MHz).

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  $\geq$  15 cm ± 5 mm (Frequency  $\leq$ 3G) or  $\geq$  10 cm ± 5 mm (Frequency >3G) during all tests. (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
		2402	52.764	1.904	51.690	1.923	2.03%	-0.99%
		2412	52.751	1.914	51.689	1.933	2.01%	-0.99%
		2437	52.717	1.938	51.688	1.957	1.95%	-0.98%
Body	Jun. 2, 2016	2442	52.711	1.942	51.656	1.962	2.00%	-1.01%
		2450	52.700	1.950	51.647	1.969	2.00%	-0.99%
		2462	52.685	1.967	51.620	1.988	2.02%	-1.05%
		2480	52.662	1.993	51.603	2.012	2.01%	-0.98%

#### Table 2. Dielectric Parameters of Tissue Simulant Fluid

	111					g ngara.		
				Ingr	edient			Tatal
Frequency (MHz)	Mode	DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	Total amount
2450M	Body	301.7ml	698.3ml		—	-	-	1.0L(Kg)

The composition of the tissue simulating liquid:

 Table 3. Recipes for Tissue Simulating Liquid

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## 1.10 Evaluation Procedures

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

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

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

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

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

The measured volume of 30x30x30mm contains about 30g of tissue.

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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.

### **1.11 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:

## 1.11.1 Transfer Calibration with Temperature Probes

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

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

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

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

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- The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept small.
- The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
- The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures (~ 2% for c; much better for ρ), there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed ±5%.
- Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

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

## 1.11.2 Calibration with Analytical Fields

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

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

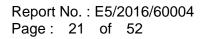
- The setup must enable accurate determination of the incident power.
- The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.

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• 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.

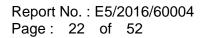
#### References

- 1. N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
- 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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## **1.12 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 an 10 grams of tissue (defined as a tissue volume in the shape of a cube).
- Occupational/Controlled limits apply when persons are exposed as a (2) 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.
- Limits for General Population/Uncontrolled exposure: 0.08 W/kg as (3) averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not

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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 4.)

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

Table 4. RF exposure limits

Notes:

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

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# 2. Summary of Results

## WLAN

Antenna	Mode	Position	Distance (mm)	СН	Freq. (MHz)	Max. Rated Avg. Power + Max.	Measured Avg. Power	Scaling		AR over 1g ′kg)	Plot
			(11111)		(11112)	Tolerance (dBm)	(dBm)		Measured	Reported	page
		Back side	0	1	2412	14.50	14.49	0.23%	0.862	0.864	-
		Back side	0	6	2437	14.50	14.48	0.46%	1.120	1.125	26
	WLAN802.11 b	Back side*	0	6	2437	14.50	14.48	0.46%	1.050	1.055	-
Main		Top side	0	1	2412	14.50	14.49	0.23%	0.225	0.226	-
IVIAILI		Left side	0	1	2412	14.50	14.49	0.23%	0.501	0.502	-
		Back side	0	19	2442	8.00	7.81	4.47%	0.294	0.307	27
	Bluetooch(BLE)	Top side	0	19	2442	8.00	7.81	4.47%	0.055	0.057	-
		Left side	0	19	2442	8.00	7.81	4.47%	0.120	0.125	-

\* - repeated at the highest SAR measurement according to the KDB 865664 D01

Note:

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

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

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# 3. Instruments List

Manufacturer	Device	Туре	Serial number	Date of last calibration	Date of next calibration
Schmid & Partner Engineering AG	Dosimetric E-Field Probe	EX3DV4	3923	Aug.27,2015	Aug.26,2016
Schmid & Partner Engineering AG	System Validation Dipole	D2450V2	727	Apr.19,2016	Apr.20,2017
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	1374	Oct.23,2015	Oct.22,2016
Schmid & Partner Engineering AG	Software	DASY 52 V52.8.8	N/A	Calibration not required	Calibration not required
Schmid & Partner Engineering AG	Phantom	SAM	N/A	Calibration not required	Calibration not required
Agilent	Network Analyzer	E5071C	MY46107530	Jan.07,2016	Jan.06,2017
Agilent	Dielectric Probe Kit	85070E	MY44300677	Calibration not required	Calibration not required
Agilopt	Dual-directional	772D	MY46151242	Jul.15,2015	Jul.14,2016
Agilent	coupler	778D	MY48220468	Jul.16,2015	Jul.15,2016
Agilent	RF Signal Generator	N5181A	MY50144143	Jul.16,2015	Jul.15,2016
Agilent	Power Meter	E4417A	MY52240003	Jul.15,2015	Jul.14,2016
Agilent	Power Sensor	E9301H	MY52200004	Jul.15,2015	Jul.14,2016
TECPEL	Digital thermometer	DTM-303A	TP130073	Feb.26,2016	Feb.25,2017

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# 4. Measurements

Date: 2016/6/2

# WLAN 802.11b\_Body\_Back side\_CH 6\_Main\_0mm

Communication System: WLAN(2.45G); Frequency: 2437 MHz Medium parameters used: f = 2437 MHz;  $\sigma$  = 1.957 S/m;  $\epsilon_r$  = 51.688;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

DASY5 Configuration:

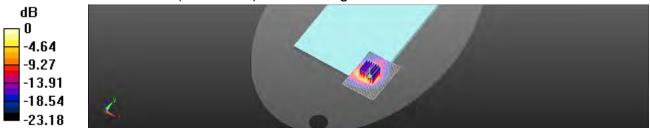
- Probe: EX3DV4 SN3923; ConvF(7.63, 7.63, 7.63); Calibrated: 2015/8/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1374; Calibrated: 2015/10/23
- Phantom: Body
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**Configuration/Body/Area Scan (61x81x1):** Interpolated grid: dx=12 mm, dy=12 mm Maximum value of SAR (interpolated) = 1.81 W/kg

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

dy=5mm, dz=5mm Reference Value = 1.300 V/m; Power Drift = 0.18 dB Peak SAR (extrapolated) = 2.87 W/kg SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.479 W/kg

Maximum value of SAR (measured) = 1.87 W/kg



0 dB = 1.87 W/kg = 2.71 dBW/kg

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Date: 2016/6/2

# Bluetooth(BLE)\_Body\_Back side\_CH 19\_Main\_0mm

Communication System: Bluetooth ; Frequency: 2442 MHz Medium parameters used: f = 2442 MHz;  $\sigma$  = 1.962 S/m;  $\epsilon_r$  = 51.656;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

## **DASY5** Configuration:

- Probe: EX3DV4 SN3923; ConvF(7.63, 7.63, 7.63); Calibrated: 2015/8/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1374; Calibrated: 2015/10/23
- Phantom: Body
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

# **Configuration/BODY/Area Scan (61x81x1):** Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 0.457 W/kg

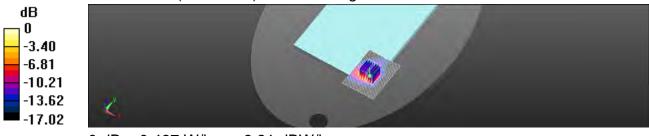
# Configuration/BODY/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm,

dy=5mm, dz=5mm

Reference Value = 1.268 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 0.667 W/kg

- SAR(1 g) = 0.294 W/kg; SAR(10 g) = 0.137 W/kg
- Maximum value of SAR (measured) = 0.467 W/kg



0 dB = 0.467 W/kg = -3.31 dBW/kg

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Report No. : E5/2016/60004 Page : 28 of 52

Date: 2016/6/2

# 5. SAR System Performance Verification

# Dipole 2450 MHz\_SN:727

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.969 S/m;  $\epsilon_r$  = 51.647;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section

DASY5 Configuration:

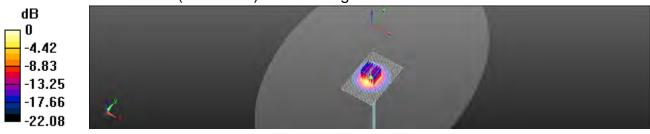
- Probe: EX3DV4 SN3923; ConvF(7.63, 7.63, 7.63); Calibrated: 2015/8/27;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1374; Calibrated: 2015/10/23
- Phantom: Body
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

# **Configuration/Pin=250mW/Area Scan (61x91x1):** Interpolated grid: dx=12 mm, dy=12 mm

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

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

dx=5mm, dy=5mm, dz=5mm Reference Value = 96.14 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 25.5 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.08 W/kg Maximum value of SAR (measured) = 19.1 W/kg



0 dB = 19.1 W/kg = 12.80 dBW/kg

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# 6. DAE & Probe Calibration Certificate

	oh, Switzerland	Sand S	Swiss Calibration Service
ocredited by the Swiss Accredit he Swiss Accreditation Servic fulfiliateral Agreement for the	e is one of the signatories	s to the EA	to:: SCS 0108
Sient SGS - TW (Au			DAE4-1374_Oct15
CALIBRATION			
Object	DAE4 - SD 000 D	004 BM - SN: 1374	
Californition procedure(s)	QA CAL-06.v29 Calibration proces	dure for the data acquisition electr	ronics (DAE)
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Calibration Laboratory of Schmid & Partner Engineering AG Zénehundrasen 43, 8004 Zurich, Bietzerland

According by Yar Swire Accreditation Service (SAS)



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Accreditation No.: SCS 0108

#### 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

The Swim Accreditation Service is one of the signatones to the EA Mulmateral Agreement for the recognition of salibration certification

- DC Voltage Measurement: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- Connector angle: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a
  result from the performance test and require no uncertainty.
  - DC Voltage Measurement Linearity; Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - Common mode sensitivity: Influence of a positive or negative common mode voltage on the differential measurement.
  - Channel separation: Influence of a voltage on the neighbor channels not subject to an input voltage.
  - AD Converter Values with inputs shorted: Values on the internal AD converter corresponding to zero input voltage
  - Input Offset Measurement: Output voltage and statistical results over a large number of zero voltage measurements.
  - Input Offset Current: Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - Input resistance: Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - Low Battery Alarm Voltage: Typical value for information. Below this voltage, a battery alarm signal is generated.
  - Power consumption: Typical value for information. Supply currents in various operating modes.

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#### DC Voltage Measurement

A/D - Converter Reso	ilution nominal			
High Range:	1LSB =	6.1µV,	fuil range =	-100+300 mV
Low Range:	1LSB =	61nV .		-1+3mV
DASY measurement	parameters: Aut	o Zero Time: 3	sec; Measuring t	time: 3 sec

Calibration Factors	x	Y	z
High Range	403.597 ± 0.02% (k=2)	403.842 ± 0.02% (k=2)	404.121 ± 0.02% (k=2)
Low Range	3.98111 ± 1.50% (k=2)	3.96638 ± 1.50% (k=2)	3.96936 ± 1.50% (k=2)

#### Connector Angle

Connector Angle to be used in DASY system	41.0°±1°

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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	200033.09	-0.21	-0.00
Channel X	+ Input	20006.43	2.25	0.01
Channel X	- Input	-20003.08	2.09	-0.01
Channel Y	+ Input	200033.11	-0.07	-0.00
Channel Y	+ Input	20001.24	-2.89	-0.01
Channel Y	- Input	-20006.12	-0.87	0.00
Channel Z	+ Input	200032.98	-0.38	-0.00
Channel Z	+ Input	20001.71	-2.35	-0.01
Channel Z	- Input	-20007.05	-1.72	0.01

Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2000.72	0.10	0.00
Channel X + Input	200.90	0.07	0.04
Channel X - Input	-198.32	0.99	-0.50
Channel Y + Input	2000.56	-0.00	-0.00
Channel Y + Input	199.87	-0.82	-0.41
Channel Y - Input	-199.92	-0.51	0.26
Channel Z + Input	2000.72	0.21	0.01
Channel Z + Input	199.48	-1.11	-0.56
Channel Z - Input	-200.66	-1.13	0.57

#### 2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)
Channel X	200	6.36	3.97
	- 200	-2.21	-4.58
Channel Y	200	7.13	6.98
	- 200	-8.29	-8.73
Channel Z	200	6.37	6.35
	- 200	-9.60	-9.25

#### 3. Channel separation

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	-2.02	-1.56
Channel Y	200	4.68		-1.06
Channel Z	200	11.09	1.5B	-

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

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

	High Range (LSB)	Low Range (LSB)
Channel X	15950	15957
Channel Y	16166	15762
Channel Z	16101	16123

#### 5. Input Offset Measurement

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

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.61	-0.78	1.59	0.44
Channel Y	-0.47	-2.13	0.46	0.39
Channel Z	-0.68	-1.72	0.64	0.41

#### 6. Input Offset Current

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

#### 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 (+ Vec)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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Accredited by the Swas Accred The Swiss Accreditation Serv Multilateral Agreement for the	ice is one of the eignatoria	is to the EA	creditation No.: SCS 0108
Chant SGS-TW (Aut			EX3-3923_Aug15
CALIBRATION	CERTIFICAT	E	
Object	EX3DV4 - SN:3923		
Calibration proceedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes		
Calibrator date	August 27, 2016		
		$\gamma$ tooffy; an economic temperature (22 $\pm$ 3/1C $_{\rm 2}$	arrd humidily < 70%.
Calibration Equipment used (N	&TE cristal for calibration)		
Self-ration Equipment used (Ab Primery Standards	&TE critical for calibrator)	Car Date (Centricate No.)	Schulding Csibration
Selfsteinn Equipment used (Ab Primery Stantlands Power meter E44198	ATE critical for calibrator)	Carbain (Centricite No.) 01-Ap-15 (No.217-02128)	Sichurland Colempon Met-18
Selfreinn Egypmeint weed (N) Primery Blanderds Polier meter E44198 Polier Bensin E44124	8TE concer (or calibration) ID GB41293874 NY41408087	Car Dain (Centricate No.) 01-Ap-15 (No. 217-02(28) 01-Ap-15 (No. 217-02(28)	SicPaintulanet Coldennyton Mait-36 Mar-30
Selfration Equipment used (A) Primery Glandards Power meter E44198 Power lanses E44194 Reference 3 dB Attenuator	87E concer for calibration) 10 GB41253874 MY41408087 SN: 50054 (3c)	Gai Dale (Centricite No.) 01-Ap-15 (No. 217-02125) 01-Ap-16 (No. 217-02128) 01-Ap-15 (No. 217-02128)	Schaland Cstbrates Mat-16 Mar-10 Mar-10
Selfration Equipment used (A) Primery Stantlands Power moter E44198 Power lenses E44124 Reference 3 40 Attemptor Rollevence 20 dll Attemptor	ZTE trilleall for calibration) ID GB4-1293874 MY4-1486087 SN: 59054 (3k) SN: 59054 (3k)	Gai, Dalin (Centricine No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132)	Schistolog Cstbrason Mar-36 Mar-36 Mar-36 Mar-16
Selfration Equipment used (A) Primery Stantlands Power meter E44198 Power sensor E4412A Rolmanda 3 dB Attenuator Rolmanda 32 dB Attenuator Rolmanda 20 dB Attenuator	ZTE trilletal for calibration) ID G841293874 MY4408087 SN, 5054 (St) SN, 5054 (St) SN, 5128 (Str)	Cai Date (CentRotte No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02139) 01-Apr-15 (No. 217-02139)	Schuldard Coldmater Mat-10 Mar-10 Mar-10 Mar-10 Mar-10 Mar-16
Calibration Equipment used (A) Primery Stantlands Power moter E44198 Power lansor E4419A Rolemania 3 dB Alternuator Rolemania 20 dB Atternuator Rolemania 30 dD Atternuator Rolemania 30 dD Atternuator Rolemania 90 dD Atternuator	ZTE trilleall for calibration) ID GB4-1293874 MY4-1486087 SN: 59054 (3k) SN: 59054 (3k)	Gai, Dalin (Centricine No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02132)	Schieland Cstbrason Mar-36 Mar-36 Mar-16
Calibration Equipment used (A) Primery Glanitards Power mieter E44198 Power mieter E44198 Power tension: E4412A Reference 3 dB Attenuator Rolesence 20 dB Attenuator Rolesence Probe E530A2 DAE4	8TE triacal (or calibration) G84-1293874 MV4448687 SN, 59054 (3c) SN, 59054 (3c) SN, 59054 (3c) SN, 56129 (3c) SN, 56129 (3c) SN, 56151 SN, 660	Car Dain (CentRitate No.) 01-Apr-15 (No. 217-02 (28) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02138) 01-Apr-15 (No. 217-02132) 01-Apr-15 (No. 217-0213) 30-Opc-14 (No. ES3-3013, Dec14)	Schultaisel Calémation Mill-16 Mar-10 Mar-10 Mar-10 Mar-16 Dec-15
Calibration Equipment used (A) Promary Glantbards Power moder E44108 Forest unases E44124 Reference 3 dB Attenuator Reference 30	ATE trincal for calibration) ID GB4-1293874 MY4-1488087 SN: 59054 (Str) SN: 59054 (Str) SN: 59054 (Str) SN: 59129 (Str) SN: 59129 SN: 960 ID	Gai Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02130) 30-Doc-14 (No. E33-3013, Dec14) 14-380-15 (No. DAE4-680, Jan15) Check Date (in fromk)	Scheiteisel Csidmason Mit-36 Mar-30 Mar-36 Mar-16 Mar-16 Dec-15 Jan-16 Scheduliet Check
Calibration Equipment used (A) Promary Stantilards Power lansor E44192 Rollmania 20 dll Attenuator Rollmania 20 dll Attenuator Rollmania 20 dll Attenuator Rollmania Probe ESSCA2 DAE4 Secondary Standards RF generator HE 86480	ATE trilical for calibration) ID G841253874 MY44466687 SN: 5054 (3c) SN: 5054 (3c) SN: 5054 (3c) SN: 660 ID IS SN: 660 ID IS	Cai Date (CentAcate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02130) 00-Doc-14 (No. ESA-3013, Dec14) 14-Jan-15 (No. DAE4-666, Jan-15) Check Date (in fourit) 4-Aug-90 (in litruse theok Apr-13)	Schulding Celéngion Mer-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan 16 Jan 16
Calibration Equipment used (A) Promary Stantilards Power lansor E44192 Rollmania 20 dll Attenuator Rollmania 20 dll Attenuator Rollmania 20 dll Attenuator Rollmania Probe ESSCA2 DAE4 Secondary Standards RF generator HE 86480	ATE trincal for calibration) ID GB4-1293874 MY4-1488087 SN: 59054 (Str) SN: 59054 (Str) SN: 59054 (Str) SN: 59129 (Str) SN: 59129 SN: 960 ID	Gai Date (Certificate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02139) 30-Doc-14 (No. E33-3013, Dec14) 14-380-15 (No. DAE4-680, Jan15) Check Date (in fromk)	Scheduled Caldresson Mat-36 Mar-30 Mar-36 Mar-16 Mar-16 Dec-15 Jan-16 Scheduled Check
Calibration Equipment used (A) Promary Glantiards Power motor E44108 Power tankow E44124 Rofernance 31 dB Attenuator Rofernance 30 dB Attenuator Rofernance 30 dB Attenuator Rofernance 30 dB Attenuator Rofernance 4Pote ESSCA/2 DAE4 Secondary Glandards RF generator HF 86480 Network Anonyser HP 87506	ATE trincal for calibration) ID GB4/1293874 MY41488087 SN: 50054 (3k) SN: 50054 (3k) SN: 50054 (3k) SN: 50054 (3k) SN: 50128 (300) SN: 50128 (300) SN: 50128 SN: 660 ID I.538542001700 V\$37380585 Name	Cai Date (CentAcate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02130) 00-Doc-14 (No. ESA-3013, Dec14) 14-Jan-15 (No. DAE4-666, Jan-15) Check Date (in fourit) 4-Aug-90 (in litruse theok Apr-13)	Scheiteles Csibrese Mei-10 Mer-10 Mer-10 Mer-16 Mer-16 Dec-15 Jan 16 Schedulet Check In house check. Apr-18
Calibration Equipment used (Ab Primery Giantilards Power isensor E44198 Power isensor E44192 Reference 30 dB Attenuator Reference	ATE threat for calibration) ID G84-12938774 MY4-1486087 SN, 50054 (3k) SN, 5054 (3k) SN, 56128 (3kn) SN, 56128 (3kn) SN, 5612 SN, 660 ID I.53642J01700 V/537390586	Gai Date (Centilicate No.) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02123) 01-Apr-15 (No. 217-02132) 00-Dec-14 (No. ES3-3013, Dec14) 14-301-15 (No. DAE4-660, Jam15) Check Date (in feams) 4-Aug-99 (in itase check Apr-15) 19-Oct-01 (in house check Apr-15)	Schultund Caldmason Mar-10 Mar-10 Mar-10 Mar-16 Dec-15 Jan-16 Schieduliet Check In house check Apr-18 In house check. Col-15
Calibration Equipment used (Ab Primery Stantlands Power encour E44198 Power encour E44198 Power encours E44198 Reference 30 dB Attempator Reference 30 dB Attempator Reference 30 dB Attempator Reference 30 dB Attempator Reference Probe E530A2 DAE4 Secondary Standards AF generator HF 86480 Network Analyzer HP 8250F Calibrated by:	ATE trincal for calibration) ID GB4/1293874 MY41488087 SN: 50054 (3k) SN: 50054 (3k) SN: 50054 (3k) SN: 50054 (3k) SN: 50128 (300) SN: 50128 (300) SN: 50128 SN: 660 ID I.538542001700 V\$37380585 Name	Cal Date (Certificate No.) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 01-Apr-15 (No. 217-02125) 00-Doc-14 (No. E33-3013, Dec14) 14-301-15 (No. DAE4-680, Jan15) 00-Doc-14 (No. E33-3013, Dec14) 14-301-15 (No. DAE4-680, Jan15) 00-Doc-14 (No. E33-3013, Dec14) 14-301-15 (No. DAE4-680, Jan15) 00-Doc-14 (No. DAE4-680, Jan15) 18-Dot-01 (In House shock Oct-14) Function	Schultuinet Caldmaton Mit-16 Mar-10 Mar-10 Mar-16 Mar-16 Dec-15 Jan-16 Schleduilet Check In house check Apr-16 In noisen check Cot-15 Signature
Calibration Equipment used (A) Primery Glantlands Power restor E44198 Power lensor E44124 Roferance 30 Alternator Roferance 30 Alternator Roferance 30 Alternator Roferance 30 Alternator Roferance Stock ES3CV2 DAE4 Secondary Glandarcs AF generator HF 86480	ATE trincal for calibration) ID G041223974 MY41498087 SN: 50054 (St) SN: 50054 (St) SN: 56129 (Stn) SN: 56129 (Stn) SN: 660 ID IS3042001700 US37380586 Name Invite Sheroig	Car Daiw (Centilicate No.) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02128) 01-Apr-15 (No. 217-02139) 01-Apr-15 (No. 217-02139) 00-0ec 14 (No. ESS-3013, Dec14) 14-348-15 (No. DAE4-680, Jam15) Dieck Date (in terem) 4-Aug-90 (in itmuse check Apr-15) 10-Det-61 (in terem) 4-Aug-90 (in itmuse check Apr-15) 10-Det-61 (in terem) Labinationy Technician	Schulding Coldmajor Mil-16 Mar-16 Mar-16 Mar-16 Mar-16 Dec-15 Jan-16 Jan-16 Schledoller Chiesk In house check Apr-16 In house check Col-15 Signatory

Certificate No: EX3-3923\_Aug15

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#### Report No. : E5/2016/60004 Page: 35 of 52

Calibration Laboratory of Schmid & Partner Engineering AG Zaugt



- Schweizenacher Kalbrierdienst S C
  - Service suluse d'étalorange Servicio sylazero di taratuni
  - Swise Calibration Service

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Accounting on No. SCS 0108

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#### Glossary:

18.	Lesse simulating liquid
NORMAYE	sensitivity in the space
ConvF	sersitivity in TSL / NORMX, V.2
DCP	didde compression point
CF	crest factor (1/duty_cycle) of the RF signal
A.B.C.D	modulation dependent linearization parameters
Polanzation ()	g rotation arrand probe axis
Polarization 9	9 rotation around an axis that is in the plane normal to probe axis (at measurement center), or, 0 = 0 is normal to probe axis.
Contraction of the local sector of the local s	conflict a more method and proble and p

Corrector Angle information used in DASY system to align probe sensor X to the roliot coordinate system

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

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatta-Averaged Spectre 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 dowcos used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- EC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wheless communication devices used in close proximity to the flumen body (frequency range of 30 MHz to 6 GHz)", March 2010
   KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Methods Applied and Interpretation of Parameters:

- NORMx.y.z: Assessed for E-field polarization a = 0 (/ < 900 MHz in TEM-cell; / > 1800 MHz R22 waveguide). NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not effect the E<sup>-</sup>field uncertainty (rolds TSL (see below ConvF).
- NDRM(f)x,y,z = NORMx,y,z = frequency\_responde (see Frequency Response Libert). This linearization is inclemented in DASY4 software versions later than 4.2. The uncertainty of the response response is included In the stated uncertainty of ConvF.
- OCPX, y.z: DCP are numerical invariation parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- 6.1 PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristica
- Ax, y. z; Bx, y. z; Cx, y. z; Dy, y. z; VRx, y. z; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS validage across the dioce.
- ConvF and Boundary Effect Personalers: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f < 600 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve suche accuracy close to the boundary. The sensibility in TSL corresponds to NORMs, y,z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent. ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHE
- Spherical isotropy (3D deviation from Isotropy): in a field of live gradients realized using a Net phantom exposed by a patch antenna.
- Sensor Diffsat. The sensor officer corresponds to the officer of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the WDRMs (no. uncertainty required.

Certificate No. EX3-3933 AurolS

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EX3DV4 - SN:3923

August 27, 2015

# Probe EX3DV4

# SN:3923

Manufactured: Calibrated:

March 8, 2013 August 27, 2015

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

Certificate No: EX3-3923\_Aug15

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August 27, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3923

#### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m) <sup>2</sup> ) <sup>A</sup>	0.57	0.48	0.47	± 10.1 %
DCP (mV) <sup>8</sup>	103.6	96.4	101.3	

#### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	ĉ	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	153.8	±3.3 %
		Y	0.0	0.0	1.0		155.6	
		Z	0.0	0.0	1.0		157.0	

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

The uncertainties of Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (are Pages 5 and 0).

- <sup>9</sup> Numerical linearization parameter: uncatainty not required.
  <sup>9</sup> Numerical linearization parameter: uncatainty not required.
  <sup>9</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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August 27, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3923

f (MHz) <sup>c</sup>	Relative Permittivity"	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>0</sup>	Depth <sup>C</sup> (mm)	Unc (k=2)
750	41.9	0.89	10.66	10.66	10.66	0.34	1.00	± 12.0 %
835	41.5	0.90	10.45	10.45	10.45	0.42	0.80	± 12.0 %
900	41,5	0.97	10.07	10.07	10.07	0.35	1.00	± 12.0 %
1750	40.1	1.37	8.71	8.71	8.71	0.19	1.12	± 12.0 %
1900	40.0	1.40	8.43	8.43	8.43	0.36	0.90	± 12.0 %
2000	40.0	1.40	8.48	8.48	8.48	0.35	0.80	± 12.0 %
2300	39.5	1.67	8.05	8.05	8.05	0.36	0.80	± 12.0 %
2450	39.2	1.80	7.57	7.57	7.57	0.40	0.80	± 12.0 %
2600	39.0	1.96	7.45	7.45	7.45	0.39	0.80	± 12.0 %
5250	35.9	4.71	5.22	5.22	5.22	0.35	1.80	±13.1%
5300	35.9	4.76	5.08	5.08	5.08	0.35	1.80	±13.1%
5600	35.6	5.07	4.78	4.78	4.78	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.81	4.81	4.81	0.40	1.80	±13.1 %

#### Calibration Parameter Determined in Head Tissue Simulating Media

<sup>6</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the Com/F uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz. for Com/F assessments at 30, 64, 128, 160 and 220 MHz respectively. Above 5 GHz frequency validity on the extended to ± 110 MHz.
<sup>7</sup> At frequencies below 3 GHz, the validity of tissue parameters (s and o) can be relaxed to ± 100 MHz.
<sup>8</sup> At frequencies below 3 GHz, the validity of tissue parameters (s and o) is restricted to ± 5%. The uncertainty is the RSS of the Com/F uncertainty is the RSS of the Com/F uncertainty is related to ± 5%. The uncertainty is the RSS of the Com/F uncertainty is related to ± 5%. The uncertainty is the RSS of the Com/F uncertainty is related to a service of the com/F uncertainty is indicated larget (ssue parameters).
<sup>9</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the proba 6p diameter frequency.

diameter from the boundary

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August 27, 2015

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3923

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>6</sup>	Depth <sup>®</sup> (mm)	Unc (k=2)
750	55.5	0.96	10.50	10.50	10.50	0.43	0.86	± 12.0 %
835	55.2	0.97	10.48	10.48	10.48	0.21	1.42	± 12.0 %
900	55.0	1.05	10.33	10.33	10.33	0.30	1.08	± 12.0 %
1750	53.4	1.49	8.40	8.40	8.40	0.39	0.87	± 12.0 %
1900	53.3	1.52	8.11	<u>8.</u> 11	8.11	0.41	0.80	± 12.0 %
2000	53.3	1.52	8.31	8.31	8.31	0.29	1.02	± 12.0 %
2300	52.9	1.81	7.90	7.90	7.90	0.30	0.91	± 12.0 %
2450	52.7	1.95	7.63	7.63	7.63	0.29	0.90	± 12.0 %
2600	52.5	2.16	7.49	7.49	7.49	0.25	0.95	± 12.0 %
5250	48.9	5.36	4.68	4.68	4.68	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.56	4.56	4.56	0.40	1.90	± 13.1 %
5600	48.5	5.77	4.10	4.10	4.10	0.45	1.90	± 13.1 %
5750	48.3	5.94	4.30	4.30	4.30	0.45	1.90	± 13.1 %

#### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>6</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 60 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity walify can be extended to ± 110 MHz.
<sup>6</sup> All frequencies below 3 GHz, the validity of issue parameters (*s* and *s*) can be released to ± 10% if liquid compensation formula is applied to the validity of the validi

The requestions denote a Grid, we ventily or issue parameters (c and c) can be reased to ± 10% if liquid compensation formula is applied to measured SAR values. All frequencies above 3 GHz, the validity of tissue parameters (c and c) is restricted to ± 5%. The uncertainty is the RSS of the Corref uncertainty for indicated target issue parameters. <sup>6</sup> AphaDapth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance targer than half the probe tip clamater from the boundary.

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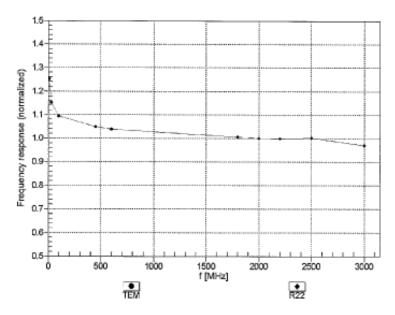
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August 27, 2015

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



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

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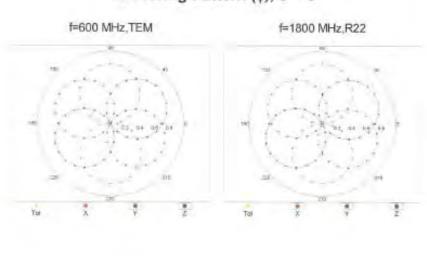
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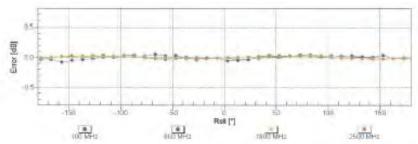
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EX3DV4- SN:3923

August 27, 2015



## Receiving Pattern (\$), 9 = 0°



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

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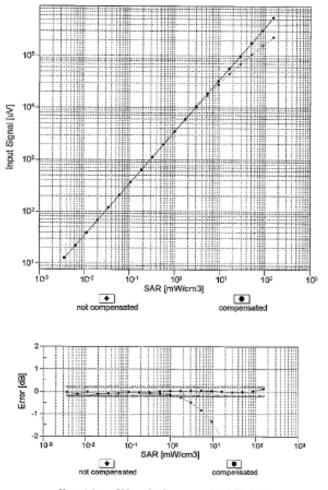


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EX3DV4- SN:3923

August 27, 2015





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

Certificate No: EX3-3923\_Aug15

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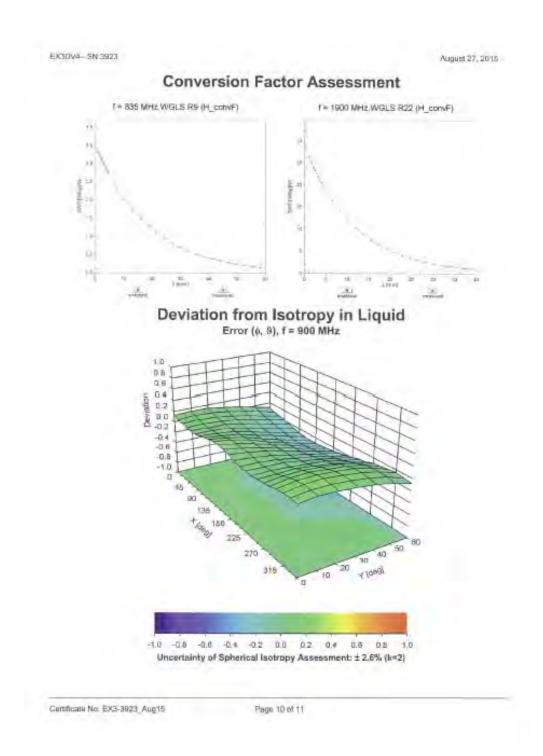
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August 27, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3923

#### Other Probe Parameters

Triangular
123
enabled
disabled
337 mm
10 mm
9 mm
2.5 mm
1 mm
1 mm
1 mm
1.4 mm

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# 7. Uncertainty Budget

А	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	6.00%	Ν	1	1	1	1	6.00%	6.00%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Isotropy , Axial	3.50%	R	√3	1.732	1	1	2.02%	2.02%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
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%	8
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%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Readout Electronics	0.30%	Ν	1	1	1	1	0.30%	0.30%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Response time	0.80%	R	$\sqrt{3}$	1.732	1	1	0.46%	0.46%	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Integration Time	2.60%	R	√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%	$\infty$
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	$\infty$
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	$\infty$
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	$\infty$
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%	$\infty$
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 Uncertaintv	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%	$\infty$
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	$\infty$
Liquid permittivity (mea.)	2.03%	N	1	1	0.64	0.43	1.30%	0.87%	м
Liquid Conductivity (mea.)	1.05%	Ν	1	1	0.6	0.49	0.63%	0.51%	М
Combined standard uncertainty		RSS					11.51%	11.45%	
Expant uncertainty (95% confidence							23.02%	22.91%	

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

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# 8. Phantom Description

Schmid & Panner Engineering AG

s е а n

Zeughaussbiases 43, 8004 Zunch, Switzerlan Phone +41 1 245 9706, Fax +41 1 245 9779 Hild@geeg.com.http://www.sbeeg.com

Certificate of Conformity / First Article Inspection

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

#### Tests

The series production process used allows the similation to test of first articles. Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been releated using further series items (called samples) or are tested at each item.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness of shell	Compliant with the requirements according to the standards	2mm +/- 0,2mm in flat and specific areas of head section	First article, Samples, TP-1314 ff.
Material thickness at ERP	Compliant with the requirements according to the standards	6mm +/- 0.2mm at ERP	First article, All itema
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz: Relative psrmittivity < 5, Loss tangent < 0.05	Material samples
Material resistivity	The material has been lested to be compatible with the liquids defined in line attandards 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 filled with 155mm of HSL000 and without DUT below	Prototypes, Sample testing

Standards

- CENELEC EN 50361 IEEE Std 1528-2003 IEC 62209 Part I

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

Conformity

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

07.07.2005

Date

Signature / Stamp



Diversion 881-00 000 P40 C-F

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Pege 3.00

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# 9. System Validation from Original Equipment Supplier

			Swiss Calibration Service
credited by the Swiss Accredite the Swiss Accreditation Service utiliateral Agreement for the n	e is one of the signatorie	s to the EA	coreditation No.: SCS 0108
ient SGS-TW (Aude	HD)	Gartilioste N	a: D2450V2-727_Apr16
CALIBRATION C	ERTIFICATE	5	
loject.	D2450V2 - SN:72	27	
Subration procedure(s)	OA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
albration date:	April 19, 2016		
andrasion date:	April 19, 2010		
Vi calibrations have been condu	cted in the closed laborato	ry lacilly; why connect temperature (22 $\pm$ 3)*	C and humidity = 70%
Calibration Equipment used (M&	TE onlical for calibration)		
		ry lacility: environment tompetature (22 ± 3) <sup>4</sup> Cal Date (Certificate No.) 06-Apr-16 (No. 217-02288/02289)	C and humidity = 70%. Scheduled Calibration Apr-17
Calibration Equipment used (M& Intrary Standards Power mister NRP Power sensor NRP-291	TE oritical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Certilicate No.) 06-Apr-16 (No. 217-02288/02289) 06-Apr-16 (No. 217-02288)	Scheduled Calibration Apr-17 Apr-17
alibration Equipment used (M& mmary Standards over meter NRP over sensor NRP-291 over sensor NRP-291	TE oritical for calibration) ID # SN: 104778 SN: 103244 SN: 103245	Cel Dale (CertBonie No.) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02288)	Soficilited Calibration Apr-17 Apr-17 Apr-17
alibration Equipment used (M8 Inimary Standards Swer rensor NRP Iower sensor NRP-Z91 Iower sensor NRP-Z91 Ioterance 20 dB Abenuator	TE onlical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cel Date (Certilicate No.) 06-Apr-16 (No. 217-02288/062288) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02282)	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17
Laibration Equipment used (M& himary Standards- Yower neter NRP- Yower sensor NRP-Z91 Yower sensor NRP-Z91 Informate 20 dB Attornator Yope-N mismatch combination	TE onitical for calibration) ID 4 SN: 104778 SN: 103244 SN: 103245 SN: 5038 (20k) SN: 5047.2 / 06327	Cel Date (Certilicate No.) 06-Apr-16 (No. 217-02280/02288) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02280) 06-Apr-16 (No. 217-02286)	Softextured Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Apr-17
Calibration Equipment used (M& Inmary Standards Inwar mater NRP Power sensor NRP-291 Inver sensor NRP-291 Reformed 29 dB Attenuator Type-N mismatch combination Reforence Probe EX3DV4	TE onlical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cel Date (Certilicate No.) 06-Apr-16 (No. 217-02288/062288) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02282)	Softeduled Calibration Apr-17 Apr-17 Apr-17 Apr-17
Lailbration Equipment used (M& <sup>2</sup> nimary Standards <sup>2</sup> ower meter NRP <sup>2</sup> ower sensor NRP-291 <sup>2</sup> ower sensor NRP-291 <sup>3</sup> owe	TE oritical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5038 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	Cel Dale (Certilicate No.) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02286) 31-Dec-15 (No. EX3-7349_Dec16) 30-Dec-15 (No. EX4-601_Dec15)	Schlickuled Calibitation Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Disc-16
Calibration Equipment used (M8 Primary Standards Power winter NRIP Power sensor NRIP-291 Power sensor NRIP-291 Paterance 29 dB Abenuator type-N mismatch combination Paterance Probe EX30V4 DAE4 Secondary Standards	TE oritical for calibration) ID 4 SN: 104778 SN: 103244 SN: 103245 SN: 5038 (20k) SN: 5047.2 / 06327 SN: 7349	Cal Date (Certificate No.) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02286) 31-Dec-15 (No. EX3-7349_Dec16)	Setladuled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-16 Dec-16
Lailbration Equipment used (M8 Primary Standards Power sensor NRIP-Z91 Power sensor NRIP-Z91 Power sensor NRIP-Z91 Power sensor NRIP-Z91 Power sensor NRIP-Z91 Power motor Standards Power motor EPM-442A	TE onlical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 05327 SN: 7349 SN: 601 ID 4	Cel Dale (CertBonte No.) 06-Apr-16 (No. 217-02288/02288) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 05-Apr-16 (No. 217-02289) 31-Dec-15 (No. EX3-7349_Dec16) 30-Dec-15 (No. DAE4-601_Dec15) Check Date (in house)	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-16 Dec-16 Scheduled Creck
Calibration Equipment used (M& Primary Standards Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Type-N mismatch combination Reference Probe EX3DV4 VAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A	TE onitical for calibration) ID # SN: 104776 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID 4 SN: 0837460704	Cal Date (Certilicate No.) C6-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 05-Apr-16 (No. 217-02289) 31-Dect 15 (No. 217-02289) 30-Dect 15 (No. 217-02229) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222)	Scheduled Calibration Apr 17 Apr 17 Apr 17 Apr 17 Apr 17 Apr 17 Dec-16 Dec-16 Dec-16 Scheduled Check In house check: Oct-16 In house check: Oct-16 In house check: Oct-16
Calibration Equipment used (M&	TE onitical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 5038 (204) SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 601 ID.4 SN: 0837480704 SN: US37282789	Cal Date (Certificate No.) C6-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02288) 31-Dect-15 (No. 217-02285) 30-Dect-15 (No. 217-02282) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222)	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Dec-16 Dec-16 Dec-16 Scheduled Check In house check: Opt-16 In house check: Opt-16
Calibration Equipment used (M& Primary Standards Power sensor NRIP-291 Power sensor NRIP-291 Power sensor NRIP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 VAE4 Secondary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	TE oritical for calibration) ID # SN: 104778 SN: 103244 SN: 5038 (20k) SN: 5047,2 / 06327 SN: 5047,2 / 06327 SN: 7349 SN: 601 ID # ID # SN: 0837480704 SN: 0837480704 SN: 093728070	Cel Dale (Certificate No.) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02288) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 31-Dec-15 (No. 217-02289) 31-Dec-15 (No. 217-0228) Check Dale (in Insuse) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02220) 15-Jun-15 (in Insuse check Jun-15)	Sofiaduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Dec-16 Dec-16 Schaduled Check In house check: Oct-16 In house check: Oct-16 In house check: Oct-16 In house check: Oct-16 In house check: Oct-16
Calibration Equipment used (M& Primary Standards Power sensor NRIP-291 Power sensor NRIP-291 Power sensor NRIP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 VAE4 Secondary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A	TE onitical for calibration) ID 4 SN: 104778 SN: 103244 SN: 103245 SN: 5047.2 / 06327 SN: 5047.2 / 06327 SN: 601 ID 4 SN: 0857480704 SN: 0857480704	Cal Date (Cartilicate No.) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02280/02289) 06-Apr-16 (No. 217-02289) 06-Apr-16 (No. 217-02289) 05-Apr-16 (No. 217-02289) 05-Apr-16 (No. 217-02289) 31-Dec-15 (No. 217-02289) 30-Dec-15 (No. 217-02282) 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) 07-Oct-16 (No. 217-02222) 07-Oct-16 (No. 217-02222) 07-Oct-16 (No. 217-02222) 07-Oct-16 (No. 217-02222) 15-Jun-15 (in induse check Jon-15) 18-Oct-01 (in induse check Oct-15)	Scheduled Calibration Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Apr-17 Diec-16 Diec-16 Scheduled Check In house check: Oct-10 In house check: Oct-16 In house check: Oct-16
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Calibration Laboratory of Schmid & Partner Engineering AG Zeuchausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdien C Service salsen d'étaionnage Servizio evizzero di faratura S seris Calibration Service

Accentitudion No.: SCS 0108

According by the Swiss Accordination Service (SAS)

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

TSL

N/A

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
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)" February 2005
- c) 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.
- Anterina Parameters with TSL: The dipole is mounted with the spacer to position its feed
  point exactly below the center marking of the flat phantom section, with the arms oriented
  parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole
  positioned under the liquid filled phantom. The impedance stated is transformed from the
  measurement at the SMA connector to the feed point. The Return Loss ensures low
  reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

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

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#### Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	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	40.0 ± 6 %	1.83 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>2</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	12.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.0 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	5.93 W/kg

#### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mbo/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.7 ± 6 %	1.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>2</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.5 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.6 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	5.86 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	55.3 Ω + 2.0 jΩ
Return Loss	- 25.4 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	52.1 Ω + 4.8 jΩ	
Return Loss	- 25.9 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small and caps are added to the dipole arms in order to improve metching 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: 19.04.2016

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;  $\sigma = 1.83$  S/m;  $\epsilon_r = 40$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.76, 7.76, 7.76); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015.
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 112.1 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 25.7 W/kg SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.93 W/kg

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



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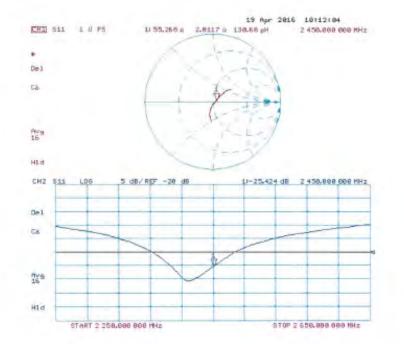
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### Impedance Measurement Plot for Head TSL



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

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