

SAR TEST REPORT

Equipment Under Test	: Digital Camera
Model No.	: NX30
Applicant	: Samsung Electronics Co., Ltd.
Address of Applicant	: 129, Samsung-ro, Yeongtong-gu, Suwon-city, Gyeonggi-do, 443-742 Korea, Republic of
FCC ID	: A3LNX30
IC ID	: 649E-NX30
Device Category	: Portable Device
Exposure Category	: General Population/Uncontrolled Exposure
Date of Receipt	: 2013-11-27
Date of Test(s)	: 2013-12-21
Date of Issue	: 2013-12-25

Standards:

FCC OET Bulletin 65 supplement C
RSS-102 (Issue 4)
IEEE 1528, 2003
ANSI/IEEE C95.1, C95.3

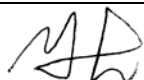
In the configuration tested, the EUT complied with the standards specified above.

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.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Korea Co., Ltd. (Gunpo Laboratory) or testing done by SGS Korea Co., Ltd. (Gunpo Laboratory) in connection with distribution or use of the product described in this report must be approved by SGS Korea Co., Ltd. (Gunpo Laboratory) in writing.

Tested by : Minhyuk Han  2013-12-25

Approved by : Nicky You  2013-12-25

Contents

1. General Information

1.1	Testing Laboratory.....	3
1.2	Details of Applicant.....	3
1.3	Version of Report.....	3
1.4	Description of EUT(s).....	3
1.5	Nominal and Maximum Output Power Specifications.....	4
1.6	Test Environment.....	4
1.7	Operation description.....	4
1.8	Evaluation procedures.....	4
1.9	SAR Measurement Procedures.....	4
1.10	The SAR Measurement System.....	6
1.11	System Components.....	8
1.12	SAR System Verification.....	10
1.13	Tissue Simulant Fluid for the Frequency Band.....	11
1.14	Test System Validation.....	12
1.15	Test Standards and Limits.....	12

2. Instruments List..... 14

3. Summary of Results..... 15

3.1	FCC Power Measurement Procedures.....	15
3.2	Measured and Reported SAR.....	15
3.3	RF Conducted Power.....	15
3.4	Test Configuration.....	17
3.5	SAR Test Exclusions Applied.....	18
3.6	SAR Data Summary.....	19

APPENDIX

- A. DASY4 SAR Report
- B. Uncertainty Analysis
- C. Calibration certificate

1. General Information

1.1 Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, 435-040, Korea
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371
Homepage : All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>

1.2 Details of Manufacturer

Manufacturer : Samsung Electronics Co., Ltd.
Address : 129, Samsung-ro, Yeongtong-gu, Suwon-city, Gyeonggi-do, 443-742 Korea, Republic of
Contact Person : JeongHwan-Kim
Phone No. : 82-31-277-3308
E-mail : jh85.kim@samsung.com

1.3 Version of Report

Version Number	Date	Revision
00	2013-12-25	Initial issue

1.4 Description of EUT(s)

EUT Type	: Digital Camera		
Model	: NX30		
Serial Number	: NX30PV1-024		
Mode of Operation	: WLAN		
Duty Cycle	: 1(WLAN)		
Body worn Accessory	: None		
Tx Frequency Range	: 2412 MHz~ 2462 MHz (WLAN_11b/g/n) : 5180 MHz ~ 5240 MHz, 5260 MHz ~ 5320 MHz (WLAN_11a/n) : 5500 MHz ~ 5700 MHz, 5745 MHz ~ 5825 MHz (WLAN_11a/n)		
Battery Type	: 3.7 V d.c. (Lithium-ion Battery)		
Equipment Class	Band	Measured Conducted Power [dB m]	Reported SAR
			1g Body-Worn (W/kg)
DTS	2.4 GHz WLAN	13.33	0.849
Simultaneous SAR per KDB 690783 D01v01r02			N/A

1.5 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 44798 D01v05.

Average power for Production						
Mode		Nominal & Maximum	b	g	n	
802.11		Maximum	10	14.0	13.0	
		Nominal	8.5	12.5	11.5	
802.11a						
Mode	Nominal & Maximum		5.2 GHz	5.3 GHz	5.5 GHz	5.8 GHz
Bluetooth	Maximum		6.5	7.0	8.0	8.0
	Nominal		5.0	5.5	6.5	6.5
Tune-up Tolerance: -1.5 dB / + 1.5 dB						

1.6 Test Environment

Ambient temperature	: (22 ± 2) ° C
Tissue Simulating Liquid	: (22 ± 2) ° C
Relative Humidity	: (55 ± 5) % R.H.

1.7 Operation Configuration

The client provided a special driver and test program which can control the frequency and power of the WLAN module. Measurements were performed at the lowest, middle and highest channels of the operating band. The EUT was set to maximum power level during all tests and at the beginning of each test the battery was fully charged.

The DASY4 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement. Based on the RF Power and antenna separation distance, stand-alone BT SAR and simultaneous SAR evaluation are not required.

1.8 EVALUATION PROCEDURES

- Power Reference Measurement Procedures

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 2.5 mm for an EX3DV4 probe type).

1.9 SAR Measurement Procedures

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm.

This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2 and 3: Area Scan & Zoom Scan 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 1 g and 10 g.

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01 >

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx _{Area} , Δy _{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx _{Zoom} , Δy _{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: Δz _{Zoom} (n)		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	Δz _{Zoom} (1): between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		Δz _{Zoom} (n>1): between subsequent points	≤ 1.5·Δz _{Zoom} (n-1)	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.				
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

1.10 The SAR Measurement System

A photograph of the SAR measurement System is given in Fig. a. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (Speag DASY4 professional system). A Model EX3DV4 3791 is used to determine the internal electric fields. The SAR can be obtained from the equation $SAR = \sigma (|E_i|^2) / \rho$ where σ and ρ are the conductivity and mass density of the tissue-simulant. The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimeter 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.
- 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.

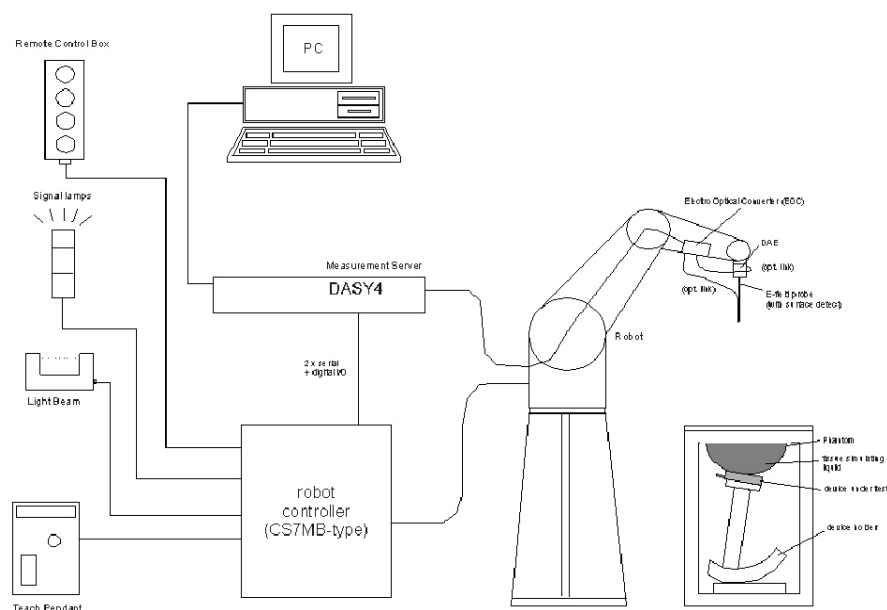


Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The ELI phantom enabling testing body usage.
- The device holder for flat phantom.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

1.11 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 835 and HSL1900.
 Additional CF-Calibration for other liquids and frequencies upon request.
- Frequency** : 10 MHz to 6 GHz; Linearity: ± 0.2 dB (30 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 Range** : 10 μ W/g to > 100 m W/g;
 Linearity: ± 0.2 dB(noise: typically < 1 μ W/g)
- Dimensions** : Overall length: 337 mm (Tip length: 20 mm)
 Tip diameter: 2.5 mm (Body diameter: 12 mm)
 Distance from probe tip to dipole centers: 1 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%
- Construction** : Symmetrical design with triangular core.
 Built-in shielding against static charges.
 PEEK enclosure material (resistant to organic solvents, e.g., DGBE)



EX3DV4 E-Field Probe

ELI Phantom

Construction: Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure



ELI Phantom

Shell Thickness: 2.0 mm $\pm$ 0.2 mm

Dimensions Major axis: 600 mm
 Minor axis: 400 mm

DEVICE HOLDER

Construction

In combination with the Twin SAM PhantomV4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Device Holder

1.12 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 ELI phantom. A SAR measurement was performed to see if the measured SAR was within $\pm 10\%$ from the target SAR values. These tests were done at 2450 MHz. The tests for EUT were conducted within 24 hours after each Verification. The obtained results from the system accuracy verification are displayed in the table 1. During the tests, the ambient temperature of the laboratory was in the range $(22 \pm 2)^\circ\text{C}$, the relative humidity was in the range $(55 \pm 5)\%$ R.H. and the liquid depth above the ear reference points was above 15 cm 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.

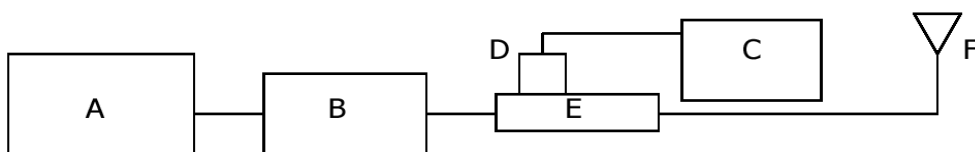


Fig b. The microwave circuit arrangement used for SAR system verification

- A. Agilent Model E8247C Signal Generator
- B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
- C. Agilent Model E4419B Power Meter
- D. Agilent Model 9300H Power Sensor
- E. Agilent Model 86205A Directional RF Bridges
- F. Reference dipole Antenna



Photo of the dipole Antenna

System Verification Results

Verification Kit	Probe S/N	Tissue	Target SAR 1 g from Calibration Certificate (1 W)	Measured SAR 1 g (0.1 W)	Normalized SAR 1 g (1 W)	Deviation (%)	Date	Liquid Temp. ($^\circ\text{C}$)
D2450V2 S/N: 892	3791	2450 MHz Body	50.1 W/kg	5.02 W/kg	50.2 W/kg	0.20	12-21-2013	22.1

Table 1. Results system Verification

1.13 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the SPEAG Model DAK-3.5 Dielectric Probe (rates frequency band 200 MHz to 20 GHz) in conjunction with Agilent E5071C Network Analyzer(300 kHz - 6 GHz) by using a procedure detailed in Section V.

f (MHz)	Tissue type	Limits / Measured	Dielectric Parameters		
			Permittivity	Conductivity	Simulated Tissue Temp(°C)
2450	Body	Measured, 12-21-2013	51.3	1.94	22.1
		Recommended Limits	52.7	1.95	21.0 ~ 23.0
		Deviation(%)	-2.66	-0.51	-
2412		Measured, 12-21-2013	51.4	1.89	22.1
		Deviation(%)	-2.47	-3.08	-
2437		Measured, 12-21-2013	51.3	1.92	22.1
		Deviation(%)	-2.66	-1.54	-
2462		Measured, 12-21-2013	51.3	1.95	22.1
		Deviation(%)	-2.66	0.00	-

The composition of the brain tissue simulating liquid

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Water	Mineral oil	Emulsifiers	Additives and Salt
78	11	9	2

Salt: 99 % Pure Sodium Chloride

Sugar: 98 % Pure Sucrose

Water: De-ionized, 16 MΩ⁺ resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99 % Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

1.14 Test System Validation

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the require tissue-equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01. Since frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters has been included.

f (MHz)	Date	Probe S/N	Probe Cal point	Tissue Type	Dielectric Parameters		CW Validation			Modulated Validation		
					Permitt ivity	Condu ctivity	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
2450	06/20/2013	3791	2450	Body	50.9	1.97	PASS	PASS	PASS	OFDM	N/A	PASS

< SAR System Validation Summary >

1.15 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 C95.3–2003, Copyright 2003 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 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). 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 .4)

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

Table .2 RF exposure limits

2. Instruments List

Manufacturer	Device	Type	Serial Number	Cal Date	Cal Interval	Cal Due
Stäubli	Robot	RX90BL	F03/5W05A1/A/01	N/A	N/A	N/A
Schmid& Partner Engineering AG	Dosimetric E-Field Probe	EX3DV4	3791	06/04/2013	Annual	06/04/2014
Schmid& Partner Engineering AG	2450 MHz System Verification Dipole	D2450V2	892	09/26/2013	Biennial	09/26/2015
Schmid& Partner Engineering AG	Data acquisition Electronics	DAE3	567	01/25/2013	Annual	01/25/2014
Schmid& Partner Engineering AG	Software	DASY4 V4.7	-	N/A	N/A	N/A
Schmid& Partner Engineering AG	Phantom	ELI Phantom	TP-1169	N/A	N/A	N/A
Agilent	Network Analyzer	E5071C	MY46111535	07/03/2013	Annual	07/03/2014
Schmid& Partner Engineering AG	Dielectric Assessment Kit	DAK-3.5	1108	03/05/2013	Annual	03/05/2014
Agilent	Power Meter	E4419B	GB43311125	06/27/2013	Annual	06/27/2014
Agilent	Power Sensor	E9300H	MY41495314	09/10/2013	Annual	09/10/2014
			MY41495307	09/10/2013	Annual	09/10/2014
Agilent	Signal Generator	E8247C	MY43321024	06/26/2013	Annual	06/26/2014
Empower RF Systems	Power Amplifier	2001-BBS3Q7ECK	1032 D/C 0336	03/29/2013	Annual	03/29/2014
Agilent	Directional RF Bridges	86205A	MY31402302	06/29/2013	Annual	06/29/2014
Microlab	LP Filter	LA-30N	N/A	09/09/2013	Annual	09/09/2014
Agilent	Attenuator	8491B	50566	09/09/2013	Annual	09/09/2014
JUMBP	Hygro-Thermometer	RT-811E	SGS-RSS-TM02	04/01/2013	Annual	04/01/2014
LKM Electronic	Digital Thermometer	DTM3000	3027	07/01/2013	Annual	07/01/2014

3. Summary of Results

3.1 FCC Power Measurement Procedures

The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5 % occurred, the tests were repeated.

3.2 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

3.3 RF Conducted Power

WLAN

Mode	Freq. (MHz)	Ch. #	Rate	Measured Power [dB m]
802.11b	2412	1	1	9.12
	2437	6	1	9.56
	2462	11	1	9.87
802.11g	2412	1	6	13.33
	2437	6	6	13.50
	2462	11	6	13.72
802.11n HT20	2412	1	MCS0	11.76
	2437	6	MCS0	12.01
	2462	11	MCS0	12.22
802.11a	5180	36	6	5.41
	5200	40	6	6.12
	5220	44	6	5.07
	5240	48	6	4.50
	5260	52	6	4.80
	5280	56	6	6.25
	5300	60	6	6.80
	5320	64	6	6.49

802.11a	5500	100	6	6.65
	5520	104	6	6.14
	5540	108	6	5.99
	5560	112	6	6.89
	5580	116	6	7.62
	5660	132	6	7.05
	5680	136	6	6.78
	5700	140	6	5.85
	5745	149	6	6.95
	5765	153	6	6.67
	5785	157	6	6.73
	5805	161	6	7.11
	5825	165	6	7.58
802.11n HT20	5180	36	MCS0	4.24
	5200	40	MCS0	4.16
	5220	44	MCS0	3.85
	5240	48	MCS0	2.98
	5260	52	MCS0	3.54
	5280	56	MCS0	4.61
	5300	60	MCS0	5.12
	5320	64	MCS0	4.92
	5500	100	MCS0	5.56
	5520	104	MCS0	5.11
	5540	108	MCS0	4.64
	5560	112	MCS0	5.27
	5580	116	MCS0	6.04
	5660	132	MCS0	5.22
	5680	136	MCS0	5.38
	5700	140	MCS0	4.48
	5745	149	MCS0	5.61
	5765	153	MCS0	5.36
	5785	157	MCS0	5.43
	5805	161	MCS0	5.83
	5825	165	MCS0	5.87
802.11n HT40	5190	38	MCS0	3.30
	5230	46	MCS0	3.53
	5270	54	MCS0	3.37
	5310	62	MCS0	4.32
	5510	102	MCS0	4.97
	5550	110	MCS0	4.93
	5670	134	MCS0	4.82
	5755	151	MCS0	4.95
	5795	159	MCS0	4.26

3.4 SAR Test Configuration

IEEE 802.11 Transmitters

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channel 1, 6, and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15 ~ 5.25 GHz band, channels 52 and 64 in the 5.25 ~ 5.35 GHz band, channels 104, 116, 124 and 136 in the 5.470 ~ 5.725 GHz band, and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

Mode	GHz	Channel	Turbo Channel	"Default Test Channels"		UNII
				§15.247 802.11b	802.11g	
802.11 b/g	2.412	1*		✓	▽	
	2.437	6	6	✓	▽	
	2.462	11*		✓	▽	
802.11a	5.18	36				✓
	5.20	40	42 (5.21 GHz)			•
	5.22	44				•
	5.24	48	50 (5.25 GHz)			✓
	5.26	52				✓
	5.28	56	58 (5.29 GHz)			•
	5.30	60				•
	5.32	64				✓
	5.500	100	Unknown			•
	5.520	104				✓
	5.540	108				•
	5.560	112				•
	5.580	116				✓
	5.600	120				•
	5.620	124				✓
	5.640	128				•
	5.660	132				•
	5.680	136				✓
	5.700	140				•
	5.745	149		✓		✓
	5.765	153	152 (5.76 GHz)		•	•
	5.785	157		✓		•
	5.805	161	160 (5.80 GHz)		•	✓
	5.825	165		✓		

- ✓ = "default test channels"
- = possible 802.11 a channels with maximum average output > the "default test channels"
- ▽ = possible 802.11 g channels with maximum average output ¼ dB ≥ the "default test channels"
- * = when output power is reduced for channel 1 and/or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested

3.5 SAR Test Exclusions Applied

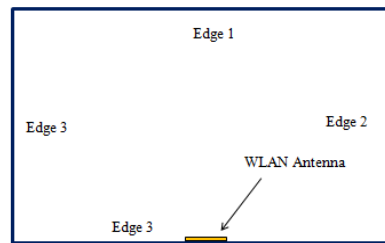
Per FCC KDB 447498 D01v05, the SAR exclusion threshold for distances < 50 mm is defined by the following equation:

$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Distance (mm)}} * \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

Per FCC KDB 447498 D01v05, At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following

$$[(\text{Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) * 10] \text{ mW at } > 1500 \text{ MHz and } \leq 6 \text{ GHz}$$

<The Distance information of Antenna to Edges of EUT>



Note: Specific antenna dimensions and separation distances are shown in the antenna distance document.

Based on the maximum tune-up tolerance limit of WLAN the antenna to use separation distance Table “EXEMPT” SAR was not required and Table “Measure” SAR was required.

Mode	Frequency (MHz)	Output power ^{Notes 2, 4}		Separation distances (mm) ^{Notes 1 and 6}						SAR Exemption ^{Notes 3 and 4}					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
802.11b	2462	10.00	10							1.43 EXEMPT	482mW EXEMPT	166mW EXEMPT	Measure	225mW EXEMPT	1.05 EXEMPT
802.11g	2462	14.00	25							Measure	482mW EXEMPT	166mW EXEMPT	Measure	225mW EXEMPT	2.62 EXEMPT
802.11n	2462	13.00	20							2.85 EXEMPT	482mW EXEMPT	166mW EXEMPT	Measure	225mW EXEMPT	2.09 EXEMPT
802.11a	5260	6.50	4							0.83 EXEMPT	452mW EXEMPT	136mW EXEMPT	1.83 EXEMPT	195mW EXEMPT	0.61 EXEMPT
802.11a	5320	7.00	5							1.05 EXEMPT	451mW EXEMPT	135mW EXEMPT	2.31 EXEMPT	194mW EXEMPT	0.77 EXEMPT
802.11a	5700	8.00	6							1.30 EXEMPT	449mW EXEMPT	133mW EXEMPT	2.86 EXEMPT	192mW EXEMPT	0.95 EXEMPT
802.11a	5825	8.00	6							1.32 EXEMPT	448mW EXEMPT	132mW EXEMPT	2.90 EXEMPT	191mW EXEMPT	0.97 EXEMPT

Note

1. For distances < 5mm, a distance of 5mm is used to determine SAR exclusion and estimated SAR value.
2. Output power is the maximum rated power (including tune-up or manufacturing tolerances).
3. If the antenna separation distance is > 50mm then the value listed is the output power threshold, above which SAR measurement is required. For separation ≤ 50mm the value is the KDB 447498 calculated value and must be less than 3 for SAR exemption.
4. Formulas round separation distance to nearest mm and power to nearest mW before calculating thresholds or exemption values.

3.6 SAR Data Summary

Ambient Temperature (°C)	23.6
Liquid Temperature (°C)	22.1
Date	12-21-2013

WLAN Body SAR

Test Mode	EUT Position	Traffic Channel		Distance (mm)	Power(dBm)		1-g SAR (W/kg)		1 g SAR Limits (W/kg)
		Frequency (MHz)	Channel		Measured Power	Tune-Up Limit	Measured SAR	Scaled SAR	
802.11b	Edge3	2462	11	0	9.87	10.0	0.396	0.408	1.6
802.11g	Edge3	2462	11	0	13.72	14.0	0.742	0.791	
		2412	1	0	13.33	14.0	0.728	0.849	
		2437	6	0	13.50	14.0	0.739	0.829	
	Rear	2462	11	0	13.72	14.0	0.027	0.029	
802.11n	Edge3	2462	11	0	12.22	13.0	0.570	0.682	
		2612	1	0	11.76	13.0	0.548	0.729	
		2637	6	0	12.01	13.0	0.541	0.680	

Notes

- The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC/OET Bulletin 65, Supplement C [June 2001] and FCC KDB Publication 447498 D01v05.
- All modes of operation were investigated, and worst-case results are reported.
- Battery is fully charged for all readings and the standard batteries are the only options.
- The EUT is tested 2nd hot-spot peak, if it is less than 2 dB below the highest peak.
- The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
- SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
- For 2.4 GHz, justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11b modes
- Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is < 1.6 W/kg and the reported 1g averaged SAR is < 0.8 W/kg, SAR testing on other default channels was not required.
- According to KDB248227 D01v01, when the maximum average output channel in each frequency band is not include in the “default test channels”, the maximum average output power channel should be tested instead of an adjacent “default test channels”.
- According to KDB447498 D01v05 the 1-g SAR for the highest output channel is less than 0.8 W/kg, where the transmission band corresponding to all channels is ≤ 100 MHz, testing for the other channels is not required.

Appendix

List

Appendix A	DASY4 Report (Plots of the SAR Measurements)	- 2450 MHz Verification Test - WLAN Test
Appendix B	Uncertainty Analysis	
Appendix C	Calibration Certificate	- PROBE - DAE - DIPOLE



Report File No. : F690501/RF-SAR002142
Date of Issue : 2013-12-25
Page : 21 / 56

Appendix A

Test Plot – DASY4 Report

2450 MHz Verification Test_Body

Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [Verification 2450 MHz da4](#)

Input Power : 100 mW

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:892
 Program Name: Verification 2450 MHz

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.94$ mho/m; $\epsilon_r = 51.3$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Verification 2450 MHz/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
 Maximum value of SAR (interpolated) = 8.14 mW/g

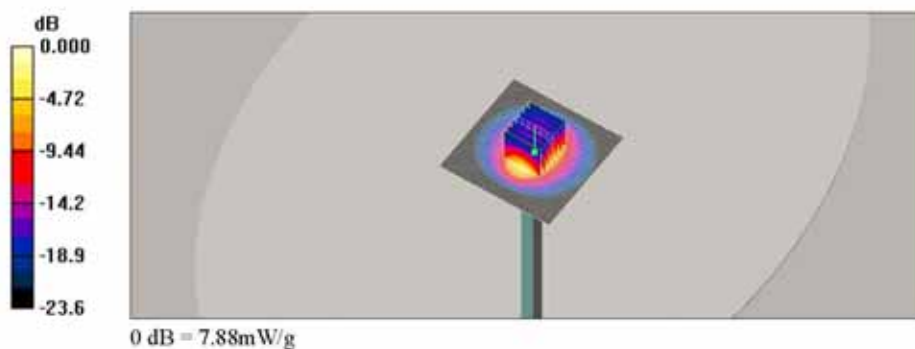
Verification 2450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 64.7 V/m; Power Drift = -0.196 dB

Peak SAR (extrapolated) = 10.9 W/kg

SAR(1 g) = 5.02 mW/g; SAR(10 g) = 2.23 mW/g

Maximum value of SAR (measured) = 7.88 mW/g



WLAN 2.4 GHz Body SAR Test

Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11b_1Mbps_Ch11_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

Communication System: WLAN; Frequency: 2462 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11b_1Mbps_Ch11_Edge3/Area Scan (91x131x1): Measurement grid:

$dx=10\text{mm}$, $dy=10\text{mm}$

Maximum value of SAR (interpolated) = 0.714 mW/g

WLAN_Body_802.11b_1Mbps_Ch11_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

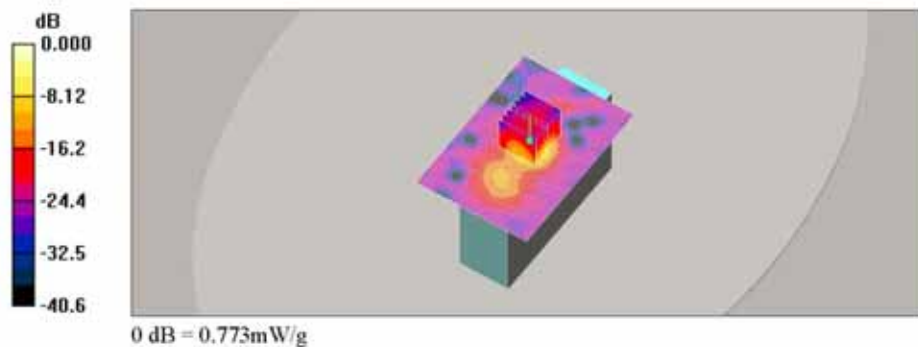
$dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 17.4 V/m; Power Drift = -0.102 dB

Peak SAR (extrapolated) = 1.29 W/kg

SAR(1 g) = 0.396 mW/g; SAR(10 g) = 0.124 mW/g

Maximum value of SAR (measured) = 0.773 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11g_6Mbps_Ch11_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

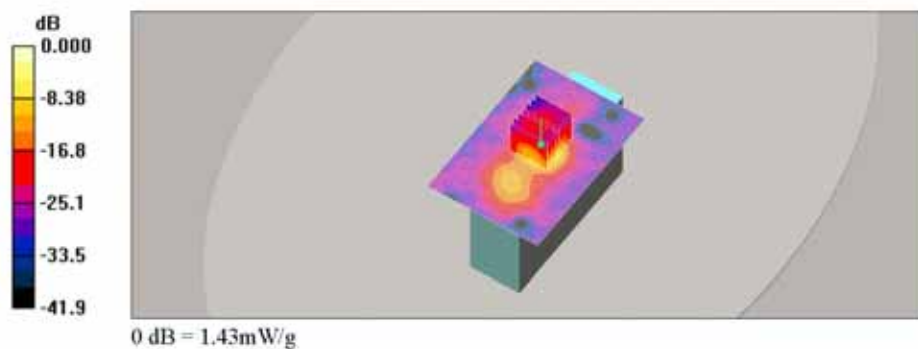
Communication System: WLAN; Frequency: 2462 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11g_6Mbps_Ch11_Edge3/Area Scan (91x131x1): Measurement grid:
 $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 1.33 mW/g

WLAN_Body_802.11g_6Mbps_Ch11_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
 $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 24.1 V/m; Power Drift = -0.050 dB
 Peak SAR (extrapolated) = 2.38 W/kg
SAR(1 g) = 0.742 mW/g; SAR(10 g) = 0.232 mW/g
 Maximum value of SAR (measured) = 1.43 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11g_6Mbps_Ch1_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

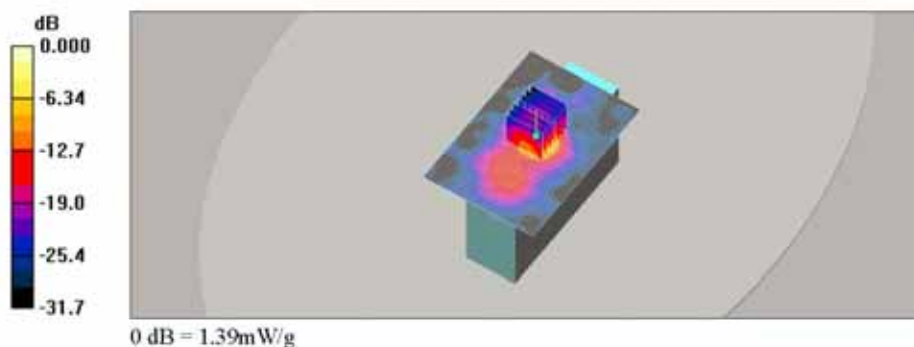
Communication System: WLAN; Frequency: 2412 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2412 \text{ MHz}$; $\sigma = 1.89 \text{ mho/m}$; $\epsilon_r = 51.4$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11g_6Mbps_Ch1_Edge3/Area Scan (91x131x1): Measurement grid:
 $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 1.36 mW/g

WLAN_Body_802.11g_6Mbps_Ch1_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
 $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 25.0 V/m; Power Drift = -0.018 dB
 Peak SAR (extrapolated) = 2.25 W/kg
SAR(1 g) = 0.728 mW/g; SAR(10 g) = 0.237 mW/g
 Maximum value of SAR (measured) = 1.39 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11g_6Mbps_Ch6_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

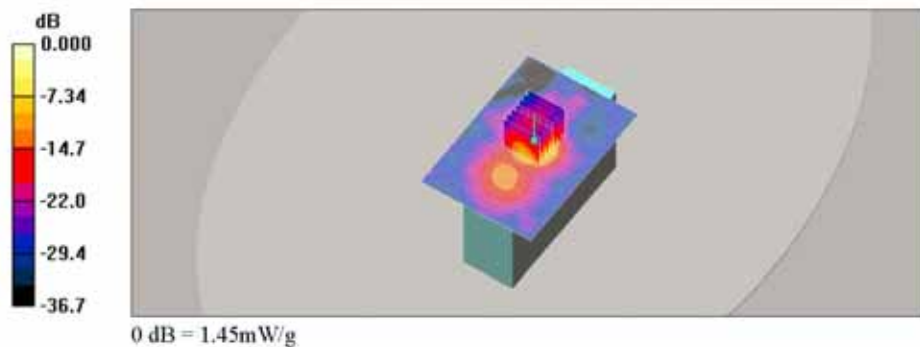
Communication System: WLAN; Frequency: 2437 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2437 \text{ MHz}$; $\sigma = 1.92 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11g_6Mbps_Ch6_Edge3/Area Scan (91x131x1): Measurement grid:
 $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 1.28 mW/g

WLAN_Body_802.11g_6Mbps_Ch6_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
 $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 24.3 V/m; Power Drift = -0.016 dB
 Peak SAR (extrapolated) = 2.37 W/kg
SAR(1 g) = 0.739 mW/g; SAR(10 g) = 0.235 mW/g
 Maximum value of SAR (measured) = 1.45 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Rear_802.11g_6Mbps_CH11.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN_Body

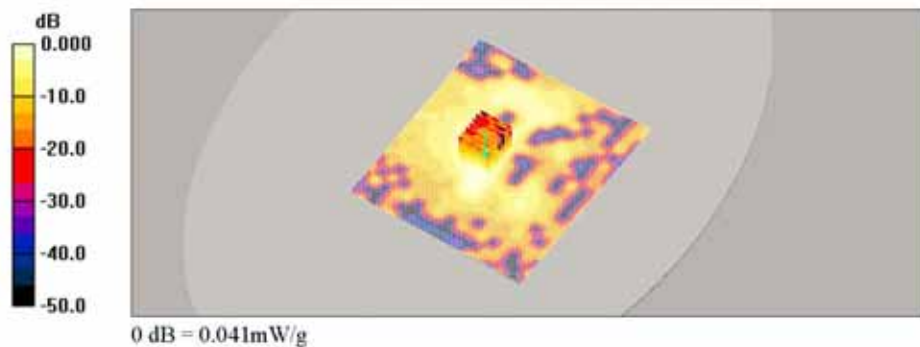
Communication System: WLAN; Frequency: 2462 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Rear_802.11g_6Mbps_CH11/Area Scan (161x181x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 0.044 mW/g

WLAN_Rear_802.11g_6Mbps_CH11/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 4.52 V/m; Power Drift = -0.063 dB
 Peak SAR (extrapolated) = 0.062 W/kg
SAR(1 g) = 0.027 mW/g; SAR(10 g) = 0.013 mW/g
 Maximum value of SAR (measured) = 0.041 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11n_MCS0_Ch11_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

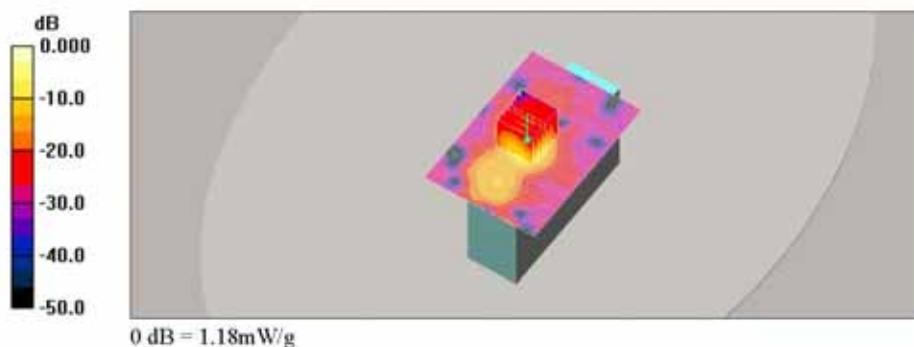
Communication System: WLAN; Frequency: 2462 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2462 \text{ MHz}$; $\sigma = 1.95 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11n_MCS0_Ch11_Edge3/Area Scan (91x131x1): Measurement grid:
 $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 0.913 mW/g

WLAN_Body_802.11n_MCS0_Ch11_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
 $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 14.8 V/m; Power Drift = -0.008 dB
 Peak SAR (extrapolated) = 1.90 W/kg
SAR(1 g) = 0.570 mW/g; SAR(10 g) = 0.180 mW/g
 Maximum value of SAR (measured) = 1.18 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11n_MCS0_Ch1_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

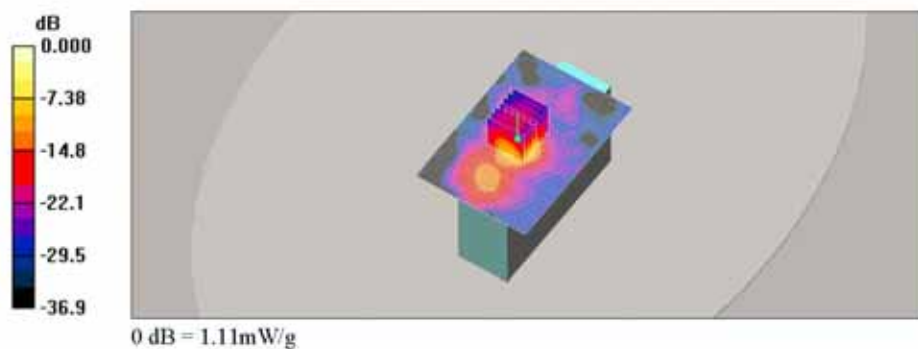
Communication System: WLAN; Frequency: 2412 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2412 \text{ MHz}$; $\sigma = 1.89 \text{ mho/m}$; $\epsilon_r = 51.4$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11n_MCS0_Ch1_Edge3/Area Scan (91x131x1): Measurement grid:
 $dx=10\text{mm}$, $dy=10\text{mm}$
 Maximum value of SAR (interpolated) = 0.843 mW/g

WLAN_Body_802.11n_MCS0_Ch1_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
 $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 14.2 V/m; Power Drift = -0.015 dB
 Peak SAR (extrapolated) = 1.77 W/kg
SAR(1 g) = 0.548 mW/g; SAR(10 g) = 0.179 mW/g
 Maximum value of SAR (measured) = 1.11 mW/g



Date: 2013-12-21

Test Laboratory: SGS Korea (Gunpo Laboratory)
 File Name: [WLAN_Body_802.11n_MCS0_Ch6_Edge3.da4](#)

Ambient Temp : 23.6 °C Tissue Temp : 22.1 °C

DUT: NX30; Type: Digital Camera; Serial: NX30PV1-024
 Program Name: WLAN Body

Communication System: WLAN; Frequency: 2437 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 2437 \text{ MHz}$; $\sigma = 1.92 \text{ mho/m}$; $\epsilon_r = 51.3$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3791; ConvF(6.62, 6.62, 6.62); Calibrated: 2013-06-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1169
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

WLAN_Body_802.11n_MCS0_Ch6_Edge3/Area Scan (91x131x1): Measurement grid:

$dx=10\text{mm}$, $dy=10\text{mm}$

Maximum value of SAR (interpolated) = 0.841 mW/g

WLAN_Body_802.11n_MCS0_Ch6_Edge3/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

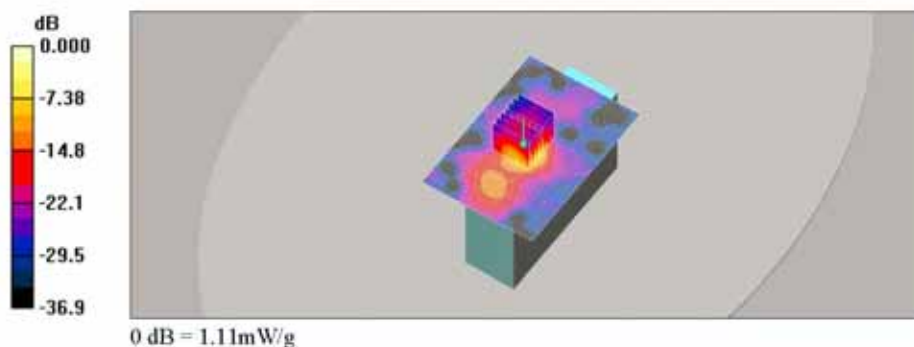
$dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 14.2 V/m; Power Drift = -0.002 dB

Peak SAR (extrapolated) = 1.79 W/kg

SAR(1 g) = 0.541 mW/g; SAR(10 g) = 0.173 mW/g

Maximum value of SAR (measured) = 1.11 mW/g



Appendix B

Uncertainty Analysis

a	b	c	d	e = f(d,k)	g	i = cxg/e	k
Uncertainty Component	Section in P1528	Tol (%)	Prob . Dist.	Div.	Ci (1g)	1g ui (%)	Vi (Veff)
Probe calibration	E.2.1	5.9	N	1	1	5.90	∞
Axial isotropy	E.2.2	0.5	R	1.73	0.71	0.20	∞
hemispherical isotropy	E.2.2	2.6	R	1.73	0.71	1.06	∞
Boundary effect	E.2.3	1.0	R	1.73	1	0.58	∞
Linearity	E.2.4	0.6	R	1.73	1	0.35	∞
System detection limit	E.2.5	1.0	R	1.73	1	0.58	∞
Readout electronics	E.2.6	0.3	N	1	1	0.30	∞
Response time	E.2.7	0.8	R	1.73	1	0.46	∞
Integration time	E.2.8	2.6	R	1.73	1	1.50	∞
RF ambient Condition -Noise	E.6.1	3	R	1.73	1	1.73	∞
RF ambient Condition - reflections	E.6.1	3	R	1.73	1	1.73	∞
Probe positioning- mechanical tolerance	E.6.2	0.4	R	1.73	1	0.23	∞
Probe positioning- with respect to phantom	E.6.3	2.9	R	1.73	1	1.67	∞
Max. SAR evaluation	E.5.2	1.0	R	1.73	1	0.58	∞
Test sample positioning	E.4.2	1.45	N	1	1	1.45	19
Device holder uncertainty	E.4.1	3.6	N	1	1	3.60	∞
Output power variation -SAR drift measurement	6.6.3	5	R	1.73	1	2.89	∞
Phantom uncertainty (shape and thickness tolerances)	E.3.1	6.6	R	1.73	1	3.81	∞
Liquid conductivity - deviation from target values	E.3.2	5	R	1.73	0.64	1.85	∞
Liquid conductivity - measurement uncertainty	E.3.2	1.91	N	1	0.64	1.22	5
Liquid permittivity - deviation from target values	E.3.3	5	R	1.73	0.6	1.73	∞
Liquid permittivity - deviation from target values	E.3.3	1.91	N	1	0.6	1.15	5
Combined standard uncertainty				RSS		9.78	25969
Expanded uncertainty (95% CONFIDENCE INTERVAL)				k=2		19.56	



Report File No. : F690501/RF-SAR002142
Date of Issue : 2013-12-25
Page : 32 / 56

Appendix C

Calibration Certificate

- PROBE

- DAE

- 2450 MHz, 5 GHz DIPOLE

- PROBE Calibration Certificate

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



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

Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **EX3-3791_Jun13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3791**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4**
 Calibration procedure for dosimetric E-field probes

Calibration date: **June 4, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP B648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: June 4, 2013			

Certificate No: EX3-3791_Jun13

Page 1 of 11

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



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

Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ 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 probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.



Report File No. : F690501/RF-SAR002142
Date of Issue : 2013-12-25
Page : 35 / 56

EX3DV4 – SN:3791

June 4, 2013

Probe EX3DV4

SN:3791

Manufactured: February 18, 2011
Calibrated: June 4, 2013

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

EX3DV4- SN:3791

June 4, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$) ^A	0.55	0.54	0.53	± 10.1 %
DCP (mV) ^B	103.1	99.9	101.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu V}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	168.0	±2.7 %
		Y	0.0	0.0	1.0		165.4	
		Z	0.0	0.0	1.0		171.3	

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%.

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter; uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3791

June 4, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	41.5	0.90	8.46	8.46	8.46	0.28	1.10	± 12.0 %
900	41.5	0.97	8.33	8.33	8.33	0.61	0.68	± 12.0 %
1750	40.1	1.37	7.85	7.85	7.85	0.58	0.71	± 12.0 %
1900	40.0	1.40	7.61	7.61	7.61	0.57	0.70	± 12.0 %
2450	39.2	1.80	6.74	6.74	6.74	0.49	0.77	± 12.0 %
2600	39.0	1.96	6.56	6.56	6.56	0.36	0.92	± 12.0 %
5200	36.0	4.66	4.71	4.71	4.71	0.45	1.80	± 13.1 %
5300	35.9	4.76	4.68	4.68	4.68	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.52	4.52	4.52	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.31	4.31	4.31	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.24	4.24	4.24	0.45	1.90	± 13.1 %

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3791

June 4, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	55.2	0.97	8.70	8.70	8.70	0.66	0.68	± 12.0 %
900	55.0	1.05	8.58	8.58	8.58	0.77	0.66	± 12.0 %
1750	53.4	1.49	7.52	7.52	7.52	0.35	0.92	± 12.0 %
1900	53.3	1.52	7.15	7.15	7.15	0.25	1.06	± 12.0 %
2450	52.7	1.95	6.62	6.62	6.62	0.76	0.60	± 12.0 %
2600	52.5	2.16	6.33	6.33	6.33	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.23	4.23	4.23	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.07	4.07	4.07	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.95	3.95	3.95	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.79	3.79	3.79	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.00	4.00	4.00	0.50	1.90	± 13.1 %

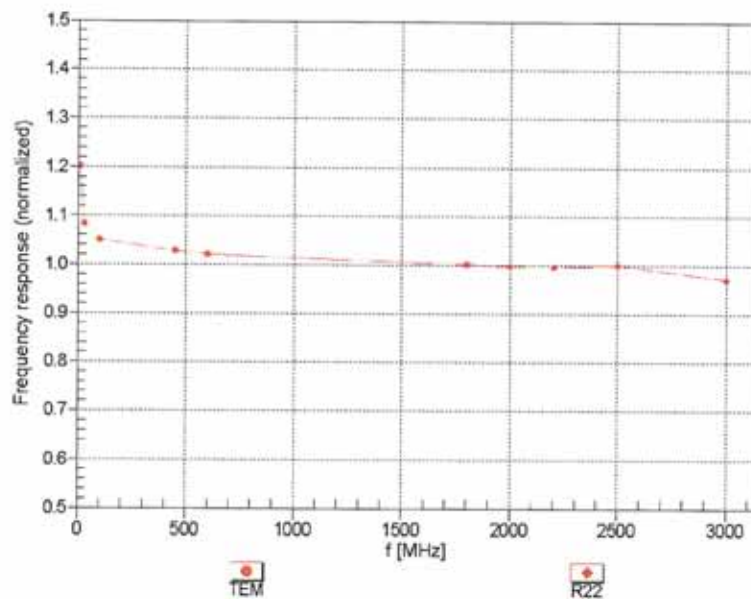
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3791

June 4, 2013

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

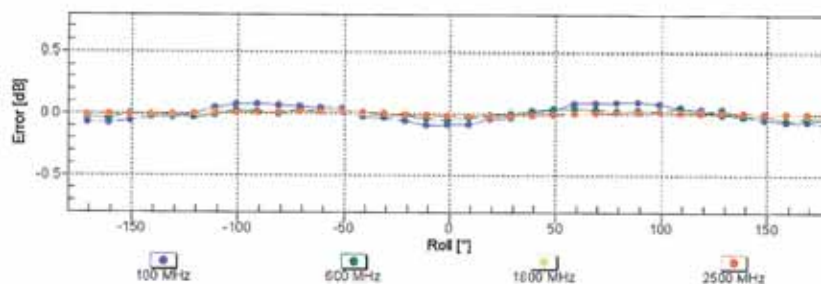
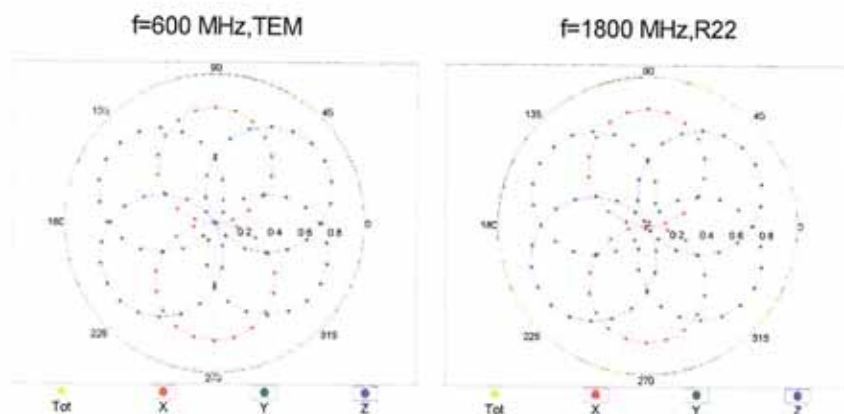


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3791

June 4, 2013

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

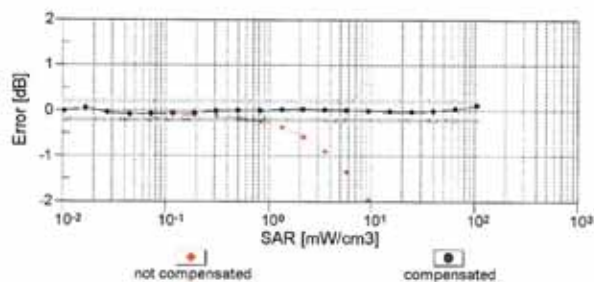
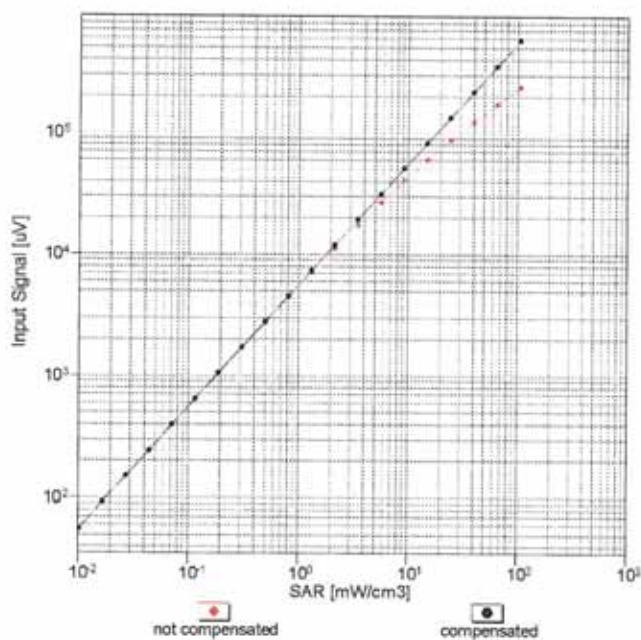


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4- SN:3791

June 4, 2013

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$)

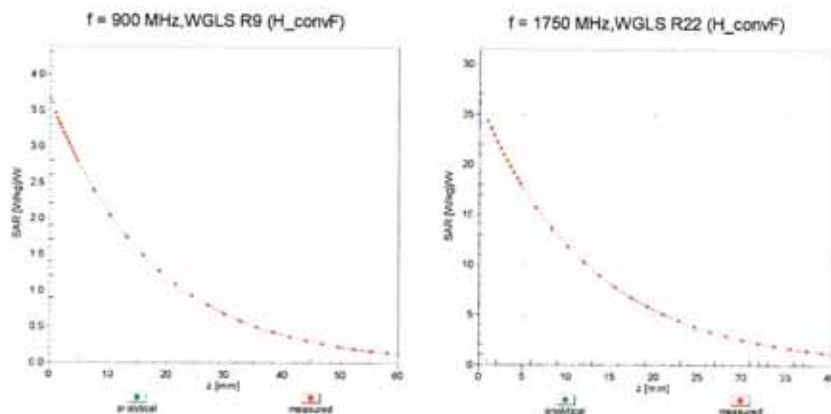


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

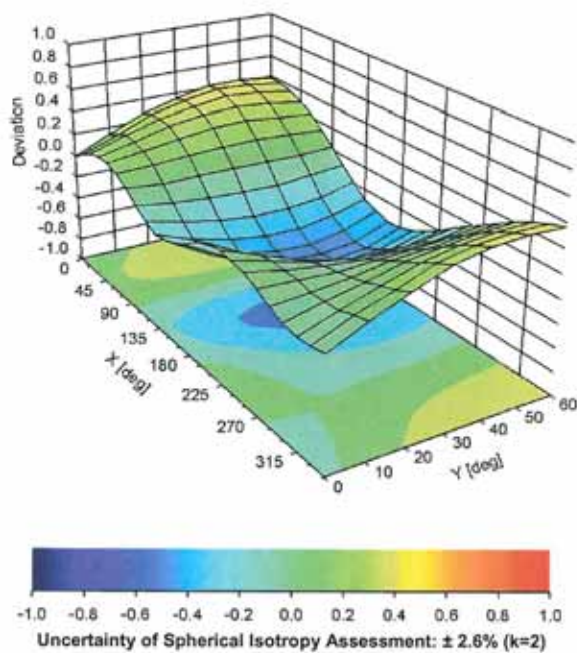
EX3DV4- SN:3791

June 4, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ , θ), $f = 900$ MHz



EX3DV4- SN:3791

June 4, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3791

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-111.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

- DAE3 Calibration Certificate

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



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

Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **DAE3-567_Jan13**

CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 567**

Calibration procedure(s) **QA CAL-06.v25**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **January 25, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0610278	02-Oct-12 (No:12728)	Oct-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001	07-Jan-13 (in house check)	In house check: Jan-14
	SE UMS 006 AA 1002	07-Jan-13 (in house check)	In house check: Jan-14

Calibrated by:	Name R. Mayoral	Function Technician	Signature
Approved by:	Name Fin Bornholt	Function Deputy Technical Manager	Signature

Issued: January 25, 2013

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

Certificate No: **DAE3-567_Jan13**

Page 1 of 5

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



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

Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV
 Low Range: 1LSB = 61nV , full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	404.652 ± 0.02% (k=2)	404.401 ± 0.02% (k=2)	404.491 ± 0.02% (k=2)
Low Range	3.95362 ± 1.55% (k=2)	3.97148 ± 1.55% (k=2)	3.96078 ± 1.55% (k=2)

Connector Angle

Connector Angle to be used in DASY system	7 ° ± 1 °
---	-----------

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199995.32	-0.62	-0.00
Channel X	+ Input	20002.46	1.32	0.01
Channel X	- Input	-19998.40	1.69	-0.01
Channel Y	+ Input	199997.71	1.34	0.00
Channel Y	+ Input	19999.63	-1.28	-0.01
Channel Y	- Input	-19997.89	2.47	-0.01
Channel Z	+ Input	199996.03	0.01	0.00
Channel Z	+ Input	19998.99	-1.92	-0.01
Channel Z	- Input	-19998.51	1.81	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2002.18	0.83	0.04
Channel X	+ Input	201.83	0.08	0.04
Channel X	- Input	-198.32	-0.18	0.09
Channel Y	+ Input	2001.92	0.81	0.04
Channel Y	+ Input	201.24	-0.29	-0.15
Channel Y	- Input	-199.03	-0.72	0.36
Channel Z	+ Input	2001.88	0.72	0.04
Channel Z	+ Input	200.70	-0.97	-0.48
Channel Z	- Input	-199.17	-0.97	0.49

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	3.30	1.64
	- 200	0.20	-1.94
Channel Y	200	-0.21	-0.42
	- 200	0.96	0.59
Channel Z	200	4.66	3.87
	- 200	-5.94	-6.09

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	-	-0.86	-3.62
Channel Y	200	7.58	-	-0.08
Channel Z	200	5.96	5.73	-

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	16316	14587
Channel Y	16163	15684
Channel Z	15966	15490

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.52	-0.92	1.43	0.45
Channel Y	-0.20	-2.46	1.17	0.46
Channel Z	-0.70	-1.79	0.17	0.39

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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

- 2450 MHz Dipole Calibration Certificate

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



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



Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No. : SCS 108

아동현
 2013. 10. 14

Client **SGS (Dymstec)**

Certificate No: D2450V2-892_Sep13

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 892**

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

Calibration date: **September 26, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by: **Jeton Kastrati** Name: **Jeton Kastrati** Function: **Laboratory Technician** Signature:

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager** Signature:

Issued: September 27, 2013

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

Certificate No: D2450V2-892_Sep13

Page 1 of 8

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



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

Accredited by the Swiss Accreditation Service (SAS)
 The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.4 $\pm$ 6 %	1.83 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.4 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.4 W/kg $\pm$ 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.2 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.85 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.2 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 2.2 j Ω
Return Loss	- 27.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 4.3 j Ω
Return Loss	- 27.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.125 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 06, 2011

DASY5 Validation Report for Head TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 39.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

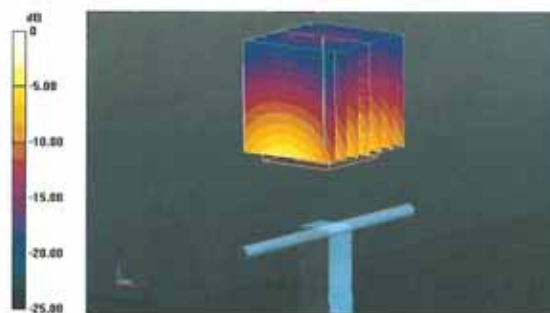
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.764 V/m; Power Drift = 0.04 dB

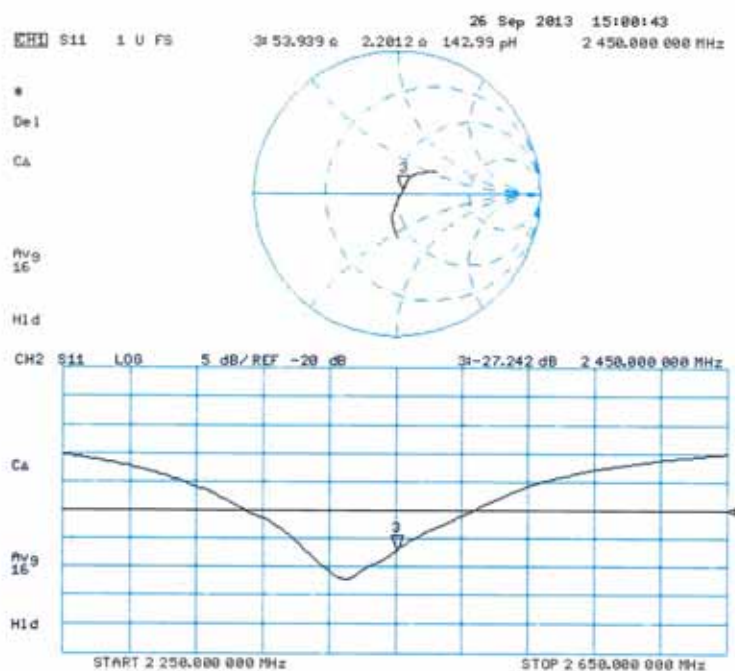
Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg

Maximum value of SAR (measured) = 16.9 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2$ S/m; $\epsilon_r = 52.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

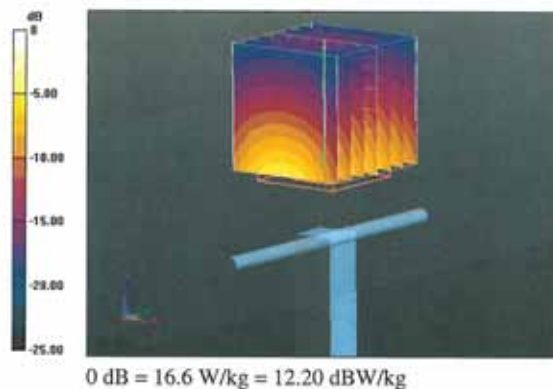
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.764 V/m; Power Drift = 0.01 dB

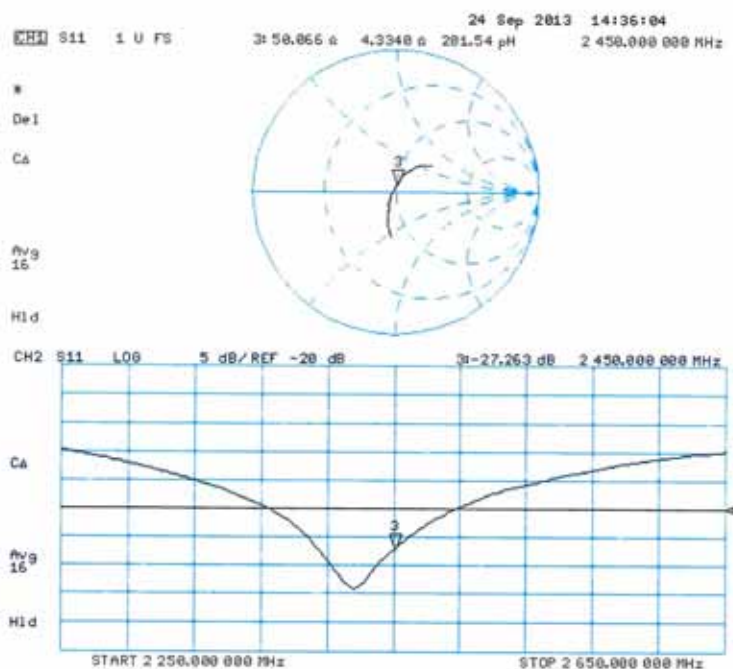
Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.85 W/kg

Maximum value of SAR (measured) = 16.6 W/kg



Impedance Measurement Plot for Body TSL



-THE END-