


AT4 wireless, S.A.

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Registro Mercantil de Málaga, Tomo 1169,
Libro 82, Folio 133, Hoja MA3729

TEST REPORT

REFERENCE STANDARDS:

FCC 47CFR Part 2.1093 (10-1-10 Edition)

FCC OET Bulletin 65, Supplement C (Edition 01-01)

IC RSS-102 Issue 4 (2010-03)

NIE	35467RRF.001
Approved by (name / position & signature)	A. Llamas / RF Lab Manager
Elaboration date	2012-02-08
Identification of item tested	Intel® Centrino® Wireless-N 2200 inside a host laptop
Trademark	Intel
Model and/or type reference	2200BNHMW / 2200BNHU
Serial number	MAC: 001500A3A594
Other identification of the product	FCC ID: PD92200BNHU / IC: 1000M-2200BNHU
Features	802.11 b/g/n
Description	Wireless Module: Intel® Centrino® Wireless-N 2200 Antenna Type: Acon DQ60HPP8P05 / DQ60HPP8P04 Host platform: Lenovo U310
Applicant	Intel Corporation
Address	100 Center Point Circle, Suite 200, Columbia, SC 29210, USA
CIF/NIF/Passport	---
Contact person:	Steven C. Hackett (Wireless Regulatory Engineer)
Telephone / Fax	803-216-2344
e-mail:	steven.c.hackett@intel.com
Test samples supplier	Same as applicant
Manufacturer	Same as applicant

Test method requested	See Standard
Standard	1. FCC 47 CFR Part 2.1093 (10-1-10 Edition). Radiofrequency radiation exposure evaluation: portable devices. 2. FCC OET Bulletin 65, Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields". 3. IC RSS-102 Issue 4 (2010-03). Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Application Notes	1. FCC OET KDB 248227 – SAR Measurements Procedures 802.11a/b/g Transmitters (May 2007 – Revised). 2. FCC OET KDB 616217 D03 – SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers – Supplement to KDB 616217 (November 2009) 3. FCC OET KDB 865664 – SAR Measurements Requirements for 3-6 GHz (October 2006). 4. FCC OET KDB 450824 – SAR Probe Calibration and System Verification Considerations for measurements at 150 MHz – 3 GHz (January 2007). 5. IC RSS-102 Supplementary Procedures (SPR)-001 (2011-01). SAR testing requirements with regard to bystanders for laptop type computers with antennas built-in on display screen (laptop mode/tablet mode).
Test procedure	PERF019
Non-standardized test method	N/A
Used instrumentation	1. Dosimetric E-field probe SPEAG ES3DV3 2. Data acquisition device SPEAG DAE4 3. Electro-optical converter SPEAG EOC3 4. 2450 MHz dipole validation kit SPEAG D2450V2 5. Robot STÄUBLI RX60BL 6. Robot controller STÄUBLI CM7MB 7. Oval flat phantom SPEAG ELI 4 8. SAR measurement software SPEAG DASY52 V52.6.2.424 9. Measurement server SPEAG DASY5 SE UMS 011 BS 10. Body Tissue Equivalent Liquids for 2450MHz band 11. Vector network analyzer Agilent E5071C 12. Dielectric probe kit Agilent 85070C 13. Power meter R&S NRVD 14. Power Sensor R&S NRV-Z51 15. Power Sensor R&S NRV-Z1 16. RF Generator Agilent ESG E4438C 17. Dual directional coupler NARDA FSCM 99899 18. Power amplifier MITEQ AMF-4D-00400600-50-30P 19. Laptop positioning extension SPEAG Laptop Holder
Report template No.	FDT08_12
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INDEX

Competences and guarantees	4
General conditions	4
Uncertainty	4
Usage of samples.....	5
Testing period	5
Environmental conditions	5
Summary	6
Remarks and comments	6
Testing verdicts	6
APPENDIX A: Test Configuration.....	7
APPENDIX B: Test results.....	15
APPENDIX C: Measurements Reports	22
APPENDIX D: Calibration Data	31
APPENDIX E: Photographs	43

Competences and guarantees

AT4 wireless is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 342.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance programme for its measurement equipment.

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the following documents:

1. FCC OET Bulletin 65, Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".
2. FCC OET KDB 865664 – SAR Measurements Requirements for 3-6 GHz (October 2006).

Usage of samples

Samples undergoing test have been selected by: **the client**.

Sample M/01 is composed of the following elements:

<u>Control N°</u>	<u>Description</u>	<u>Model</u>	<u>Serial N°</u>	<u>Date of reception</u>
35431/111	WiFi module inside a laptop PC	Intel® Centrino® Wireless- N 2200 / Lenovo U310 / Acon Antennas	MAC: 001500A3A594	2012-01-17

1. Sample M/01 has undergone the test(s) specified in subclause "Test method requested".

Testing period

The performed test started on 2012-02-06 and finished on the same day.

The tests have been performed at AT4 wireless.

Environmental conditions

In the laboratory for measurements, the following limits were not exceeded during the test:

Temperature	Min. = 20.54 °C Max. = 23.03 °C
Relative humidity	Min. = 28.66 % Max. = 31.48 %

Summary

Considering the results of the performed test according to FCC 47CFR Part 2.1093, the item under test is **IN COMPLIANCE** with the requested specifications specified in the standard.

The maximum 1g volume averaged SAR found during this test has been 0.221 W/kg, for the 2450 MHz band and 802.11n with 20MHz BW mode.

NOTE: The results presented in this Test Report apply only to the particular item under test established in page 1 of this document, as presented for test on the date(s) shown in section, "USAGE OF SAMPLES, TESTING PERIOD AND ENVIRONMENTAL CONDITIONS".

Remarks and comments

1: 802.11n = 20MHz BW / 802.11n* = 40MHz BW.

2: Testing of other channels in each band is optional when the maximum output channel SAR fulfills the testing reductions mentioned in FCC OET KDB 248227 – SAR Measurements Procedures 802.11a/b/g Transmitters (May 2007 – Revised), paragraph "Frequency Channel Configurations".

3: All the test positions of device relative to body were measured placing the device in direct contact with the phantom surface, so the requirements mentioned at RSS-102 Supplementary Procedures (SPR)-001 - SAR TESTING REQUIREMENTS WITH REGARD TO BYSTANDERS FOR LAPTOP TYPE COMPUTERS WITH ANTENNAS BUILT-IN ON DISPLAY SCREEN (LAPTOP MODE/TABLET MODE) are covered. Antenna to phantom distance during measurements was 4.1 mm (< 25 mm).

4: Only the plots of the highest SAR for each test configuration and each chain is included in appendix C, according to FCC OET Bulletin 65, Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields", appendix B.

Testing verdicts

Not applicable: NA

Pass.....: P

Fail: F

Not measured.....: NM

2450 MHz band

FCC 47CFR Part 2.1093 Paragraph	VERDICT			
	NA	P	F	NM
(d)(2) 802.11b		P		
(d)(2) 802.11g		P		
(d)(2) 802.11n ¹		P		
(d)(2) 802.11n* ¹		P		

1: See Remarks and Comments.

APPENDIX A: Test Configuration

INDEX

1. GENERAL INTRODUCTION	9
1.1. Application Standard.....	9
1.2. General requirements	9
1.3. Measurement system and phantom requirements	9
1.4. Measurement Liquids requirements.	9
2. MEASUREMENT SYSTEM.....	10
2.1. Measurement System.....	10
2.2. Test Positions of device relative to body ³	11
2.3. Test to be performed	11
2.4. Description of interpolation/extrapolation scheme.....	11
2.5. Determination of the largest peak spatial-average SAR	11
2.6. System Validation	12
3. UNCERTAINTY	13
4. SAR LIMIT	14

1. GENERAL INTRODUCTION

1.1. Application Standard

The Federal Communications Commission (FCC) sets the limits for General Population / Uncontrolled exposure to radio frequency electromagnetic fields for transmitting devices designed to be used within 20 centimetres of the user body under FCC 47 CFR Part 2.1093 - "Radiofrequency radiation exposure evaluation: portable devices", paragraph (d)(2).

Specific requirements and procedure for SAR assessment are describe under FCC OET Bulletin 65, Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields", and all the FCC OET Knowledge Database documents referred at the beginning of this document.

1.2. General requirements

The SAR measurement has been performed continuing the following considerations and environment conditions:

- The ambient temperature shall be in the range of 18°C to 25°C and the variation shall not exceed +/-2°C during the test.
- The ambient humidity shall be in the range of and 30% - 70%.
- The device battery shall be fully charged before each measurement.

1.3. Measurement system and phantom requirements

The measurement system used for SAR tests fulfils the procedural and technical requirements described at the reference standards used.

The phantom is a simplified representation of the human anatomy and comprised of material with electrical properties similar to the corresponding tissues in human body.

1.4. Measurement Liquids requirements.

The liquids used to simulate the human tissues, must fulfils the requirements of the dielectric properties required. These target dielectric properties per FCC OET KDB 450824 instructions come from the dipole and probe calibration data which are included in Appendix B, Section 2, of this document.

As indicated in FCC OET KDB 450824, it is allowed a 5% variation of the above mentioned level at the 2450 MHz band.

2. MEASUREMENT SYSTEM

2.1. Measurement System

Manufacturer	Device	Type
Schmid & Partner Engineering AG	Dosimetric E-Fiel Probe	ES3DV3
Schmid & Partner Engineering AG	Data Acquisition Electronics	DAE4
Schmid & Partner Engineering AG	Electro-Optical Converter	EOC5
Schmid & Partner Engineering AG	2450 MHz System Validation Dipole	D2450V2
Stäubli	Robot	RX60BL
Stäubli	Robot controller	CM7MB
Schmid & Partner Engineering AG	Oval flat phantom	ELI 4
Schmid & Partner Engineering AG	Measurement Software	DASY52 V52.6.2.424
Schmid & Partner Engineering AG	Measurement Server	DASY5 SE UMS 011 BS
Agilent	Vector Network Analyser	E5071C
Agilent	Dielectric Probe Kit	85070C
Rohde & Schwarz	Power Meter	NRVD
Rohde & Schwarz	Power Sensor	NRV-Z51
Rohde & Schwarz	Power Sensor	NRV-Z1
Agilent	RF Generator	ESG E4438C
NARDA	Dual directional coupler	FSCM 99899
MITEQ	Power amplifier	AMF-4D-00400600-50-30P
Schmid & Partner Engineering AG	Laptop Holder	SM LH1 001 AC

Table 1: Measurement Equipment

2.2. Test Positions of device relative to body³

The laptop device was tested in one position for all tests, with the bottom face placed directly against the phantom so the position of the laptop would be used (normal use condition). Further analysis was performed to determine the location which showed the highest SAR.

The antennas on the laptop are located within the edge screen. According to FCC OET Bulletin 65 – Supplement C, the antennas which would be applied in the test are antennas or radiating structures in direct contact with the user's body within 20 centimetres of the body of a user under normal operating conditions.

2.3. Test to be performed

In all operating modes and bands the measurements have to be performed on the "default test channels" defined at FCC OET KDB 248227 – SAR Measurements Procedures 802.11a/b/g Transmitters (May 2007 – Revised), except those channels defined as "required test channels" at the same document..

2.4. Description of interpolation/extrapolation scheme

The local SAR inside the Phantom is measured using small dipole sensing elements inside a probe element. The probe tip must not be in contact with the Phantom's surface in order to minimise measurement errors, but the highest local SAR is obtained from measurements at a certain distance from the shell through extrapolation. The accurate assessment of the maximum SAR averaged over 1 gr. and 10 gr. requires a very fine resolution in the three dimensional scanned data array. Since the measurements have to be performed over a limited time, the measured data have to be interpolated to provide an array of sufficient resolution.

The interpolation of 2D area scan is used after the initial area scan, at a fixed distance from the Phantom shell wall. The initial scan data is collected with a proper spatial resolution and this interpolation is used to find the location of the local maximum for positioning the subsequent 3D scanning to within a 1mm resolution.

For the 3D scan, data is collected on a spatially regular 3D grid having 5mm steps in both lateral directions, and 5mm in depth direction for the 2450MHz band. After the data collection by the SAR probe, the data are extrapolated in the depth direction to assign values to points in the 3D array closer to the shell wall. A notional extrapolation value is also assigned to the first point outside the shell wall so that subsequent interpolation schemes will be applicable right up to the shell wall boundary.

2.5. Determination of the largest peak spatial-average SAR

To determine the maximum value of the peak spatial-average SAR of a EUT, all device positions, configurations and operational modes should be tested for each frequency band.

According to FCC 47 CFR Part 2.1093, the averaging volume shall be chosen as 1 g of contiguous tissue. The cubic volumes, over which the SAR measurements are averaged after extrapolation and interpolation, are chosen in order to include the highest values of local SAR.

The maximum SAR level for the EUT will be the maximum level obtained of the performed measurements, and indicated in the previous points.

2.6. System Validation

Prior to the SAR measurements, system verification is done daily to verify the system accuracy. As FCC OET Bulletin 65 – Supplement C, Appendix D “SAR measurement procedures” Paragraph “System Verification” specifies, a complete SAR evaluation is done using a half-wavelength dipole as source with the frequency of the mid-band channel of the operating band, or within 100MHz of this channel.

The measured one-gram SAR should be within 10% of the expected target values specified in the calibration certificate of the dipole, for the specific tissue and frequency used.

3. UNCERTAINTY

Uncertainty for 300 MHz – 6 GHz

ERROR SOURCES	Uncertainty value (%)	Probability distribution	Divisor	(c _i) 1g	(c _i) 10g	Standard uncertainty (1g) (%)	Standard uncertainty (10g) (%)	V _i V _{eff}
Measurement Equipment								
Probe Calibration	±4.480	Normal	1	1	1	±4.480	±4.480	∞
Axial Isotropy	±7.558	Rectangular	√3	1	1	±4.364	±4.364	∞
Hemispherical Isotropy	±2.000	Rectangular	√3	1	1	±1.155	±1.155	∞
Boundary effect	±4.700	Rectangular	√3	1	1	±2.714	±2.714	∞
Linearity	±1.000	Rectangular	√3	1	1	±0.577	±0.577	∞
System detection limits	±0.300	Rectangular	√3	1	1	±0.300	±0.300	∞
Readout electronics	±1.010	Normal	1	1	1	±0.583	±0.583	∞
Response time	±2.600	Rectangular	√3	1	1	±1.501	±1.501	∞
Integration time	±3.000	Rectangular	√3	1	1	±1.732	±1.732	∞
RF Ambien conditions	±3.000	Rectangular	√3	1	1	±1.732	±1.732	∞
Probe positioner	±0.800	Rectangular	√3	1	1	±0.462	±0.462	∞
Probe positioning	±9.900	Rectangular	√3	1	1	±5.716	±5.716	∞
Maximum SAR evaluation	±1.000	Rectangular	√3	1	1	±0.577	±0.577	∞
Test Sample Related								
Device positioning	±2.900	Normal	1	1	1	±2.900	±2.900	145
Device Holder	±3.600	Normal	1	1	1	±3.600	±3.600	5
Power Drift	±5.000	Rectangular	√3	1	1	±2.887	±2.887	∞
Phantom and Setup								
Phantom uncertainty	±4.000	Rectangular	√3	1	1	±2.309	±2.309	∞
Liquid conductivity (deviation from target)	±5.000	Rectangular	√3	0.64	0.43	±1.848	±1.241	∞
Liquid conductivity (measurement error)	±3.100	Normal	1	0.64	0.43	±1.984	±1.333	∞
Liquid permittivity (deviation from target)	±5.000	Rectangular	√3	0.64	0.43	±1.848	±1.241	∞
Liquid permittivity (measurement error)	±4.410	Normal	1	0.64	0.43	±2.822	±1.896	∞
Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^m c_i^2 \cdot u_i^2}$					±11.99	±11.56	330
Expanded uncertainty (confidence interval of 95%)	$ue = 2.00 u_c$					±23.98	±23.11	

Table 2: Uncertainty Assessment for 300 MHz - 6 GHz

4. SAR LIMIT

Having a worst case measurement, the SAR limit is valid for general population/uncontrolled exposure.

The SAR values have to be averaged over a mass of 1 gr. (SAR_{1 gr.}) with the shape of a cube. This level couldn't exceed the values indicated in the application Standard:

Standard	SAR	SAR Limit (W/Kg)
FCC 47 CFR Part 2.1093 Paragraph (d)(2)	SAR _{1 gr.}	1.6

Table 3: SAR limit

APPENDIX B: Test results

INDEX

1.	TEST CONDITIONS	17
1.1.	Temperature (°C):	17
1.2.	Test signal, Output Power and Frequencies.....	17
1.3.	DUT information	17
2.	TISSUE PARAMETERS MEASUREMENTS.....	18
3.	SYSTEM VALIDATION MEASUREMENTS	18
3.1.	Validation results in 2450 MHz Band for Body TSL.....	18
4.	CONDUCTED AVERAGE POWER MEASUREMENTS	18
5.	MEASUREMENT RESULTS FOR SAR (SPECIFIC ABSORPTION RATE)	19
5.1.	Summary maximum results.....	19
5.2.	Results for 2450 MHz Band	19
5.2.1.	Lapheld Mode.....	19
5.3.	Simultaneous transmission considerations.....	21

1. TEST CONDITIONS

1.1. Temperature (°C):

$$T_n = +20.54 \text{ to } +23.03$$

The subscript n indicates normal test conditions.

1.2. Test signal, Output Power and Frequencies

The device was put into operation by using an own control software to program the test mode required for select the continuous transmission with 100% duty cycle.

In all operating bands the measurements were performed on the “default test channels” defined at FCC OET KDB 248227 – SAR Measurements Procedures 802.11a/b/g Transmitters (May 2007 – Revised), except those that fulfil the frequency channel selection criteria mentioned on paragraph “Frequency Channel Configuration” at the same document.

The output power of the device was set to maximum power level for all tests; a fully charged battery was used for every test sequence.

The maximum average conducted power of the device was measured with a Power meter R&S NRVD and a thermocoupled Power sensor NRV-Z51.

1.3. DUT information

The device under test was the Intel® Centrino® Wireless-N 2200 card located inside a host laptop (Lenovo U310) computer which utilises a set of Acon antennas (DQ60HPP8P05 / DQ60HPP8P04). The card was operated utilizing proprietary software (DRTU version 1.5.3-0322) and each channel was measured using a broadband power meter to determine the maximum average power.

According to host device manufacturer, the source-based time-averaged output power of the Bluetooth device is far bellow the SAR threshold ($60/f(\text{GHz}) \text{ mW}$). Therefore, neither SAR testing nor co-transmission evaluation is required for the Bluetooth transmitter, following the guidelines stated at FCC OET KDB 616217 D03 – SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers – Supplement to KDB 616217 (November 2009), paragraph 4).

Collocation with WWAN transmitter has not been considered following grantee request because this collocation will be considered in the WWAN transmitter SAR testing.

2. TISSUE PARAMETERS MEASUREMENTS

Frequency (MHz)	Target Body Tissue: Parameters used in Probe Calibration		Target Body Tissue: Parameters used in Dipole Calibration		Measured Body Tissue		Measured Date
	Permittivity	Conductivity [S/m]	Permittivity	Conductivity [S/m]	Permittivity	Conductivity [S/m]	
2450	52.7 ± 5%	1.95 ± 5%	51.8 ± 6%	2.02 ± 6%	51.38	2.01	2012-02-06

Note: The dielectric properties have been measured by the contact probe method at 22° C.

3. SYSTEM VALIDATION MEASUREMENTS

3.1. Validation results in 2450 MHz Band for Body TSL

SAR	Target SAR (W/kg)	Measured SAR (W/kg)	Drift (%)	Limit (%)
1 gr.	52.10	55.45	6.44	± 10
10 gr.	24.40	24.87	1.94	± 10

4. CONDUCTED AVERAGE POWER MEASUREMENTS

Band	Mode	Channel	Frequency (MHz)	Conducted Power (dBm)	
				Chain A	Chain B
2450 MHz	802.11b	1	2412	15.45	14.70
		6	2437	15.72	15.48
		11	2462	15.54	15.34
	802.11g	1	2412	14.12	14.07
		6	2437	16.17	16.55
		11	2462	14.26	14.30
	802.11n ¹	1	2417	13.45	12.98
		6	2437	16.74	16.80
		11	2457	13.12	12.95
	802.11n* ¹	3	2422	10.14	9.55
		6	2437	13.92	13.84
		9	2452	10.70	10.15

1: See Remarks and Comments.

5. MEASUREMENT RESULTS FOR SAR (SPECIFIC ABSORPTION RATE)

5.1. Summary maximum results

Band	Chain	Mode	Channel	Frequency (MHz)	Measured SAR 1g (W/Kg)	SAR limit 1g (W/Kg)
2450 MHz	A	802.11n ¹	6	2437	0.182	1.6
	B	802.11n ¹	6	2437	0.221	1.6

1: See Remarks and Comments.

5.2. Results for 2450 MHz Band

5.2.1. Lapheld Mode

Mode	Chain	Channel	Frequency (MHz)	SAR averaged over 1g (W/Kg)	Power Drift (%)
802.11b	A	1	2412	NM ²	-
		6	2437	0.165	0.01
		11	2462	NM ²	-
	B	1	2412	NM ²	-
		6	2437	0.194	-0.17
		11	2462	NM ²	-
802.11g	A	1	2412	NM ²	-
		6	2437	0.166	0.30
		11	2462	NM ²	-
	B	1	2412	NM ²	-
		6	2437	0.199	0.72
		11	2462	NM ²	-

1 and 2: See Remarks and Comments.

Mode	Chain	Channel	Frequency (MHz)	SAR averaged over 1g (W/Kg)	Power Drift (%)
802.11n ¹	A	1	2412	NM ²	-
		6	2437	0.182	0.36
		11	2462	NM ²	-
	B	1	2412	NM ²	-
		6	2437	0.221	0.31
		11	2462	NM ²	-
802.11n* ¹	A	3	2422	NM ²	-
		6	2437	0.098	-0.16
		9	2452	NM ²	-
	B	3	2422	NM ²	-
		6	2437	0.100	-2.28
		9	2452	NM ²	-

1 and 2: See Remarks and Comments.

5.3. Simultaneous transmission considerations

As stated at FCC OET KDB 616217 D03 – SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers – Supplement to KDB 616217 (November 2009), paragraph 4), the simultaneous SAR transmission evaluation is not required when:

1. The sum of stand-alone 1-g SAR is < SAR limit
or
2. The separation distance between each antenna is greater than $5 \cdot [(SAR_1 + SAR_2) / 1.6]^{1.5}$.

The WLAN operation only admits the simultaneous transmission between antennas when both of them use the same channel, so the sum of stand-alone SAR was evaluated considering the highest result for each antenna and the corresponding value of the other one with the same channel.

Transmission Mode	Band	Channel	Frequency	Chain	Max. SAR averaged over 1g (W/kg)	$\sum SAR_i$ 1g (W/Kg)	SAR limit 1g (W/Kg)
802.11n ¹	2.4 GHz	6	2437 MHz	A	0.182	0.403	1.6
				B	0.221		

According to host device manufacturer, the source-based time-averaged output power of the Bluetooth device is far bellow the SAR threshold ($60/f(\text{GHz})$ mW). Therefore, neither SAR testing nor co-transmission evaluation is required for the Bluetooth transmitter, following the guidelines stated at FCC OET KDB 616217 D03 – SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers – Supplement to KDB 616217 (November 2009), paragraph 4).

Collocation with WWAN transmitter has not been considered following grantee request because this collocation will be considered in the WWAN transmitter SAR testing.

APPENDIX C: Measurements Reports

2450 MHz Band – 802.11b. Channel 6 – Chain A

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps); Frequency: 2437 MHz; Duty Cycle: 1:1.53886

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain A, 802.11b, 1Mbps, Channel 6/Area Scan (71x251x1): Measurement grid:
dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.199 mW/g

SAR 2450MHz band/Chain A, 802.11b, 1Mbps, Channel 6/Zoom Scan (7x8x7)/Cube 0: Measurement grid:
dx=5mm, dy=5mm, dz=5mm

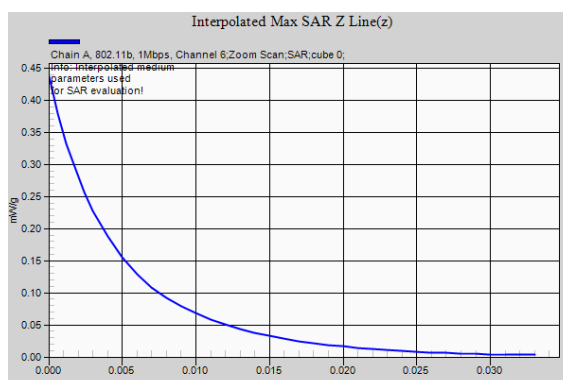
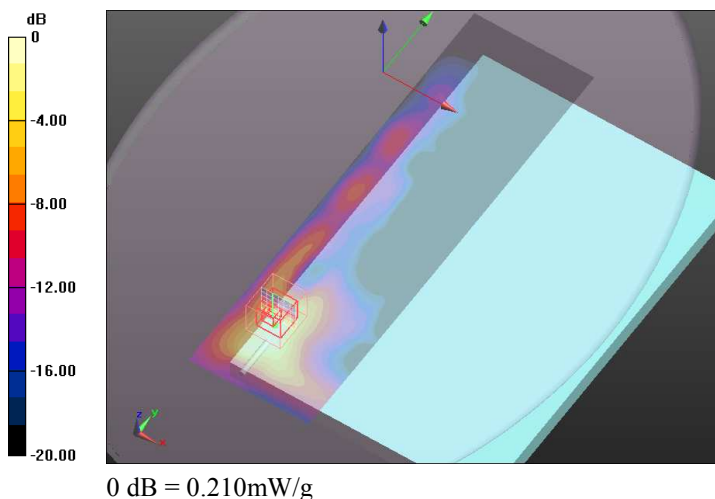
Reference Value = 9.593 V/m; Power Drift = 0.00098 dB

Peak SAR (extrapolated) = 0.436 W/kg

SAR(1 g) = 0.165 mW/g; SAR(10 g) = 0.076 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.215 mW/g



2450 MHz Band – 802.11b Channel 6 – Chain B

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps); Frequency: 2437 MHz; Duty Cycle: 1:1.53886

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain B, 802.11b, 1Mbps, Channel 6/Area Scan (71x251x1): Measurement grid:

$dx=15$ mm, $dy=15$ mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.239 mW/g

SAR 2450MHz band/Chain B, 802.11b, 1Mbps, Channel 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

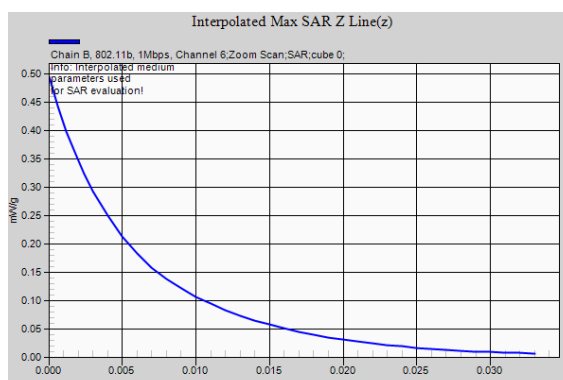
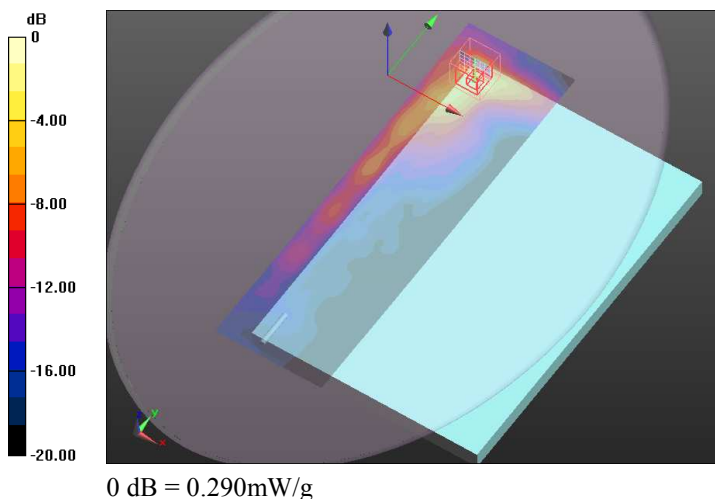
Reference Value = 10.838 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.495 W/kg

SAR(1 g) = 0.194 mW/g; SAR(10 g) = 0.085 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.287 mW/g



2450 MHz Band – 802.11g Channel 6 – Chain A

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps); Frequency: 2437 MHz; Duty Cycle: 1:12.9772

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain A, 802.11g, 6Mbps, Channel 6/Area Scan (71x251x1): Measurement grid:

$dx=15$ mm, $dy=15$ mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.192 mW/g

SAR 2450MHz band/Chain A, 802.11g, 6Mbps, Channel 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid:

$dx=5$ mm, $dy=5$ mm, $dz=5$ mm

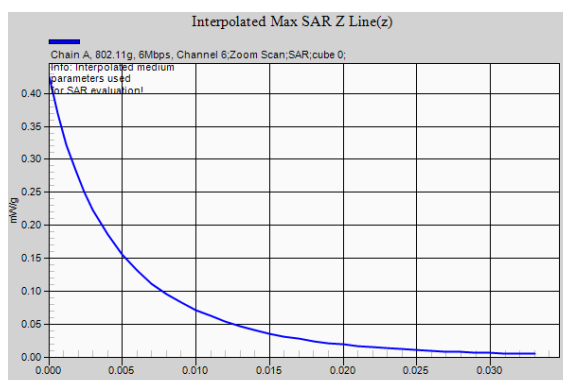
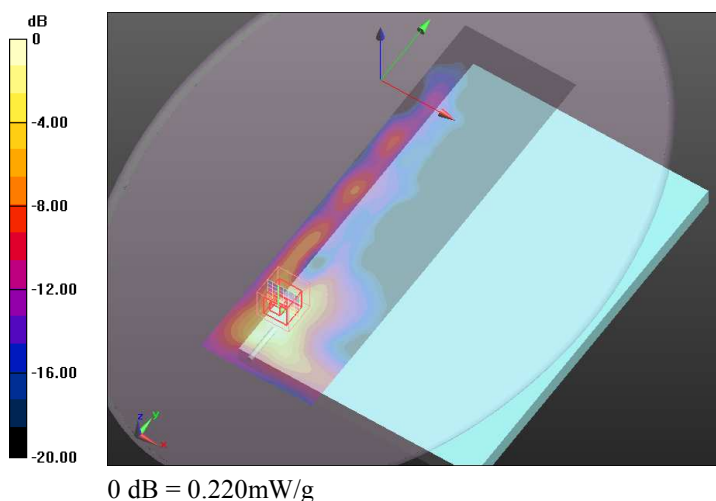
Reference Value = 9.490 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.425 W/kg

SAR(1 g) = 0.166 mW/g; SAR(10 g) = 0.078 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.218 mW/g



2450 MHz Band – 802.11g Channel 6 – Chain B

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps); Frequency: 2437 MHz; Duty Cycle: 1:12.9772

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain B, 802.11g, 6Mbps, Channel 6/Area Scan (71x251x1): Measurement grid:
dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.290 mW/g

SAR 2450MHz band/Chain B, 802.11g, 6Mbps, Channel 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
dx=5mm, dy=5mm, dz=5mm

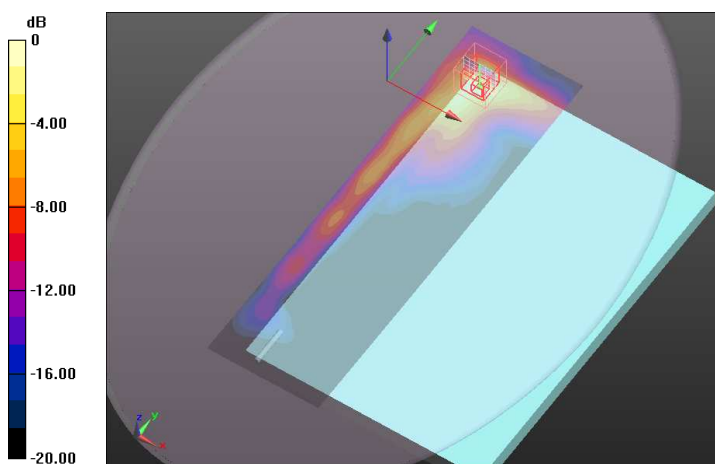
Reference Value = 10.717 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.478 W/kg

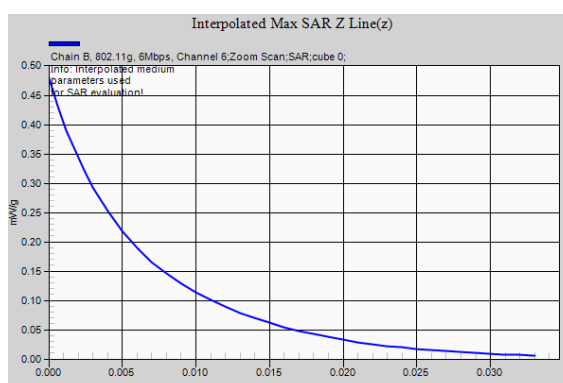
SAR(1 g) = 0.199 mW/g; SAR(10 g) = 0.091 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.292 mW/g



0 dB = 0.290mW/g



2450 MHz Band – 802.11n Channel 6 – Chain A

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK); Frequency: 2437 MHz; Duty Cycle: 1:10.4713

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain A, 802.11n20, HT0, Channel 6/Area Scan (71x251x1): Measurement grid:
dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.187 mW/g

SAR 2450MHz band/Chain A, 802.11n20, HT0, Channel 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
dx=5mm, dy=5mm, dz=5mm

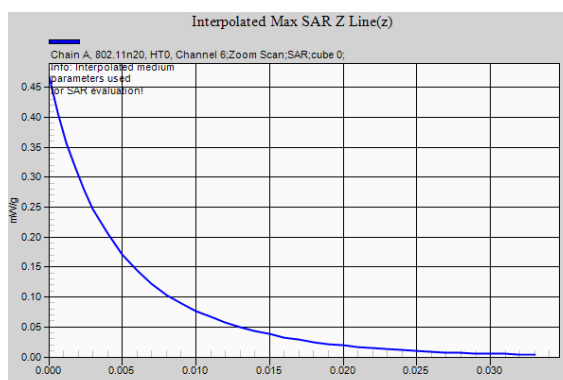
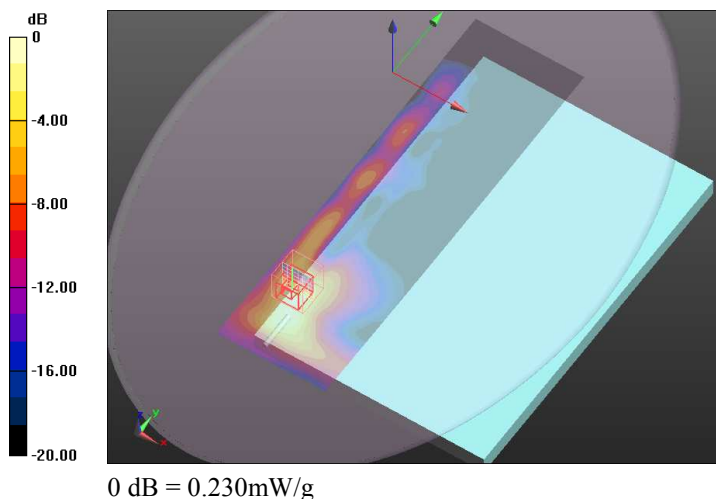
Reference Value = 9.351 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.467 W/kg

SAR(1 g) = 0.182 mW/g; SAR(10 g) = 0.085 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.233 mW/g



2450 MHz Band – 802.11n Channel 6 – Chain B

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK); Frequency: 2437 MHz; Duty Cycle: 1:10.4713

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain B, 802.11n20, HT0, Channel 6/Area Scan (71x251x1): Measurement grid:
dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.287 mW/g

SAR 2450MHz band/Chain B, 802.11n20, HT0, Channel 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid:
dx=5mm, dy=5mm, dz=5mm

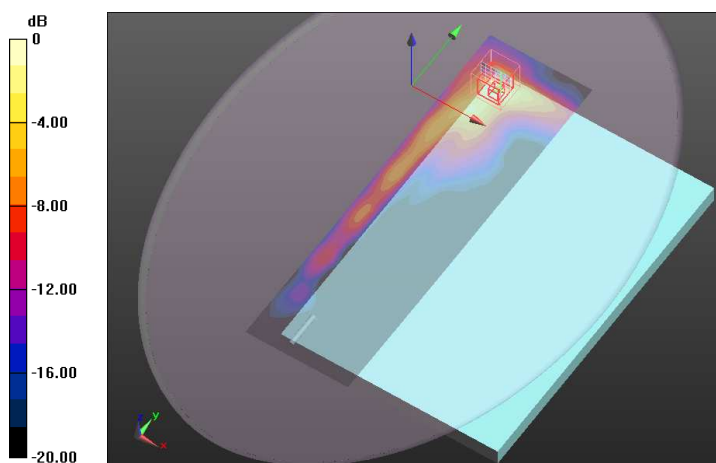
Reference Value = 11.239 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.528 W/kg

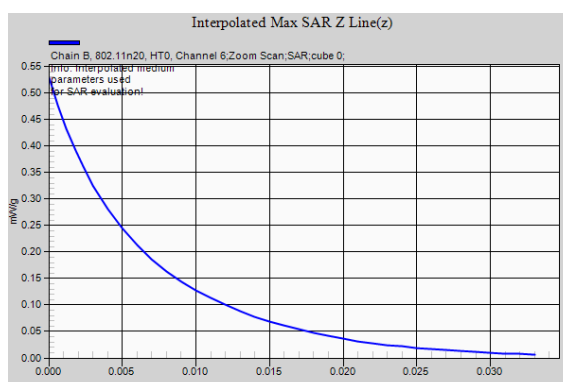
SAR(1 g) = 0.221 mW/g; SAR(10 g) = 0.099 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.303 mW/g



0 dB = 0.300mW/g



2450 MHz Band – 802.11n* Channel 6 – Chain A

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK); Frequency: 2437 MHz; Duty Cycle: 1:11.4815

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR 2450MHz band/Chain A, 802.11n40, HT0, Channel 6/Area Scan (71x251x1): Measurement grid:
dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.113 mW/g

SAR 2450MHz band/Chain A, 802.11n40, HT0, Channel 6/Zoom Scan (7x8x7)/Cube 0: Measurement grid:
dx=5mm, dy=5mm, dz=5mm

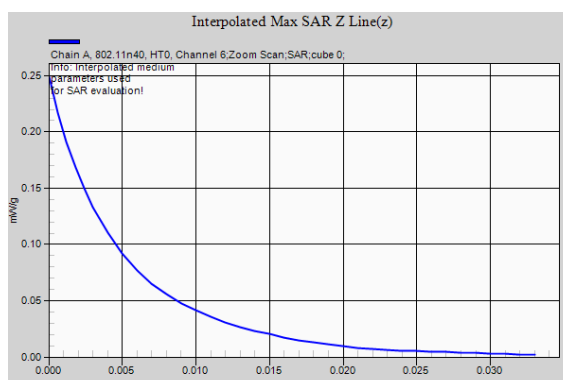
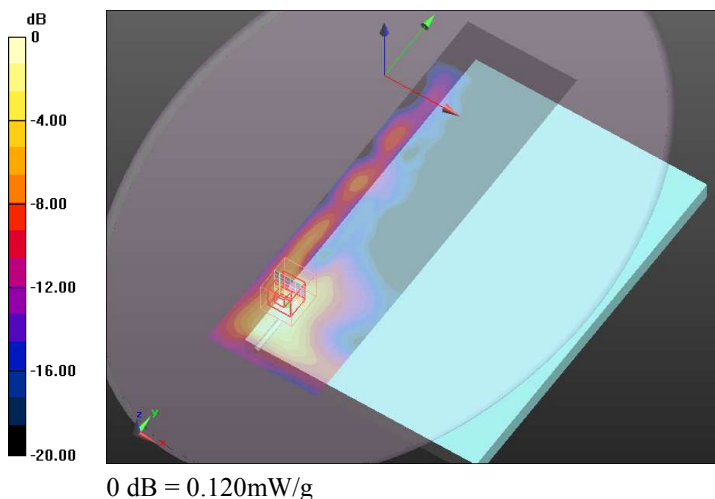
Reference Value = 6.803 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 0.249 W/kg

SAR(1 g) = 0.098 mW/g; SAR(10 g) = 0.046 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.125 mW/g



2450 MHz Band – 802.11n* Channel 6 – Chain B

DUT: Lenovo U310 + 2200BNHMW + Acon; Type: Laptop; Serial: QB04286064

Communication System: IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK); Frequency: 2437 MHz; Duty Cycle: 1:11.4815

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.987$ mho/m; $\epsilon_r = 51.409$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3052; ConvF(4.15, 4.15, 4.15); Calibrated: 23/11/2011
- Sensor-Surface: 3mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn669; Calibrated: 23/11/2011
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1060
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.4 (2829)

SAR Pre-scan - 2450MHz band/Chain B, 802.11n40, HT0, Channel 6/Area Scan (71x251x1): Measurement grid: dx=15mm, dy=15mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 0.129 mW/g

SAR Pre-scan - 2450MHz band/Chain B, 802.11n40, HT0, Channel 6/Zoom Scan (7x7x7)/Cube 0:

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

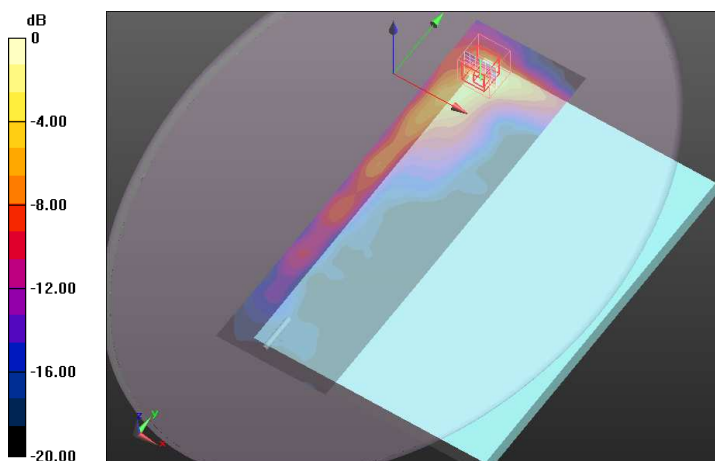
Reference Value = 7.955 V/m; Power Drift = -0.20 dB

Peak SAR (extrapolated) = 0.240 W/kg

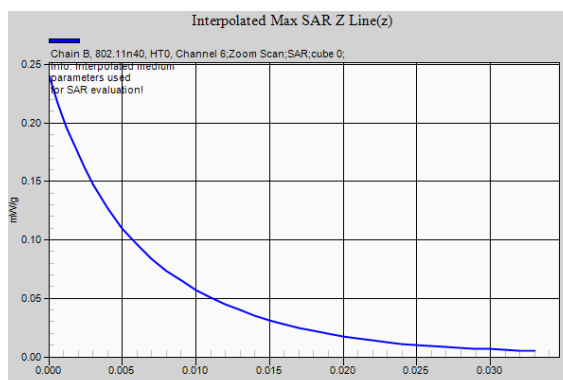
SAR(1 g) = 0.100 mW/g; SAR(10 g) = 0.047 mW/g

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.137 mW/g



0 dB = 0.140mW/g



APPENDIX D: Calibration Data

**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 **AT4 wireless**

Certificate No: **ES3-3052_Nov11**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3052**

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

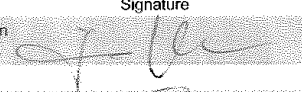
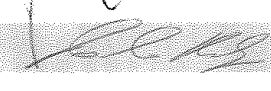
Calibration date: **November 23, 2011**

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
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: November 23, 2011			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Probe ES3DV3

SN:3052

Manufactured: September 30, 2003
Calibrated: November 23, 2011

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3052

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.11	1.16	1.17	$\pm 10.1 \%$
DCP (mV) ^B	103.1	100.4	101.0	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	300.0	$\pm 1.5 \%$
			Y	0.00	0.00	1.00	300.0	
			Z	0.00	0.00	1.00	300.0	
10011	UMTS-FDD (WCDMA)	3.40	X	3.50	65.9	18.3	111.8	$\pm 0.5 \%$
			Y	3.49	65.3	17.7	119.9	
			Z	3.53	65.8	18.2	117.0	
10012	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	1.87	X	2.98	68.7	18.9	114.9	$\pm 0.7 \%$
			Y	3.27	69.4	18.7	123.6	
			Z	3.11	69.2	18.9	119.9	
10013	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	11.13	X	12.63	72.1	25.3	109.4	$\pm 4.6 \%$
			Y	12.98	72.6	25.4	120.8	
			Z	12.85	72.9	25.9	113.7	
10021	GSM-FDD (TDMA, GMSK)	9.20	X	25.22	99.4	28.3	136.4	$\pm 1.2 \%$
			Y	16.15	90.8	25.7	103.3	
			Z	24.23	99.8	28.2	133.6	
10023	GPRS-FDD (TDMA, GMSK, TN 0)	9.40	X	15.00	89.2	24.4	129.8	$\pm 1.7 \%$
			Y	17.74	91.6	25.5	99.4	
			Z	13.38	87.9	23.6	128.5	
10024	GPRS-FDD (TDMA, GMSK, TN 0-1)	6.40	X	41.65	99.6	24.9	110.1	$\pm 2.2 \%$
			Y	42.81	99.6	25.1	127.5	
			Z	44.23	99.6	24.2	110.8	
10025	EDGE-FDD (TDMA, 8PSK, TN 0)	9.40	X	9.23	79.5	19.6	124.8	$\pm 2.5 \%$
			Y	10.50	80.0	19.8	141.5	
			Z	6.55	74.4	16.8	123.8	
10026	EDGE-FDD (TDMA, 8PSK, TN 0-1)	6.40	X	4.19	67.4	12.6	107.7	$\pm 1.4 \%$
			Y	6.66	71.8	14.7	127.3	
			Z	6.26	72.2	14.0	109.9	
10027	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	4.60	X	62.82	99.7	22.8	121.3	$\pm 2.5 \%$
			Y	59.26	99.9	23.3	137.6	
			Z	16.58	84.6	18.3	123.3	
10028	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	3.40	X	57.16	99.9	22.6	128.1	$\pm 2.2 \%$
			Y	8.77	77.0	15.7	144.3	
			Z	76.33	99.6	21.3	131.3	
10029	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	7.80	X	18.77	99.5	33.3	121.9	$\pm 2.5 \%$
			Y	14.93	92.1	30.2	140.8	
			Z	17.43	99.3	33.5	124.2	

ES3DV3- SN:3052

November 23, 2011

10048	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	13.80	X	15.82	96.5	31.7	102.6	±1.9 %
			Y	14.21	92.7	30.4	80.8	
			Z	14.80	96.9	31.8	99.8	
10049	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	10.80	X	18.15	94.2	27.8	122.6	±1.2 %
			Y	17.25	92.1	27.2	137.0	
			Z	18.28	95.5	28.0	121.1	
10058	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	6.60	X	14.90	93.9	30.4	129.8	±1.7 %
			Y	12.30	87.5	27.5	148.3	
			Z	17.73	99.4	32.7	133.0	
10098	UMTS-FDD (HSUPA)	5.23	X	5.38	66.1	19.1	118.4	±0.9 %
			Y	5.48	66.2	18.9	128.4	
			Z	5.48	66.4	19.2	124.5	
10108	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	8.22	X	8.27	68.4	21.9	123.0	±2.7 %
			Y	8.41	68.5	21.8	134.0	
			Z	8.43	69.0	22.3	129.6	
10109	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	9.07	X	9.60	69.8	23.0	130.5	±3.5 %
			Y	9.71	69.8	22.9	142.6	
			Z	9.75	70.3	23.4	137.7	
10110	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	7.24	X	7.21	67.4	20.8	120.4	±1.9 %
			Y	7.30	67.4	20.6	130.6	
			Z	7.27	67.6	21.0	126.5	
10111	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	7.91	X	8.26	68.4	21.6	126.6	±2.5 %
			Y	8.43	68.6	21.5	138.6	
			Z	8.39	68.8	21.8	133.6	
10112	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	8.95	X	9.63	69.8	23.0	132.3	±3.5 %
			Y	9.76	70.0	22.9	144.8	
			Z	9.77	70.4	23.3	139.2	
10113	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	9.15	X	9.50	69.7	23.1	128.3	±3.5 %
			Y	9.64	69.7	22.9	140.3	
			Z	9.66	70.2	23.5	135.1	
10117	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	10.60	X	12.56	71.7	24.6	113.2	±4.1 %
			Y	12.60	71.6	24.4	124.1	
			Z	12.79	72.3	25.0	119.7	
10154	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	7.40	X	7.32	67.4	20.9	120.4	±1.9 %
			Y	7.43	67.5	20.8	130.8	
			Z	7.42	67.7	21.1	126.6	
10155	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	8.10	X	8.46	68.6	21.9	127.1	±2.7 %
			Y	8.57	68.6	21.7	138.4	
			Z	8.55	68.9	22.0	133.7	
10156	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	7.40	X	7.08	67.1	20.8	117.5	±1.9 %
			Y	7.21	67.2	20.7	127.6	
			Z	7.17	67.4	21.0	123.3	
10157	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	8.37	X	8.34	68.4	22.0	122.3	±2.7 %
			Y	8.52	68.7	21.9	134.1	
			Z	8.49	69.0	22.3	128.7	

Certificate No: ES3-3052_Nov11

Page 5 of 13

ES3DV3- SN:3052

November 23, 2011

10158	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	9.15	X	9.50	69.7	23.1	128.2	±3.5 %
			Y	9.62	69.7	22.9	140.1	
			Z	9.65	70.2	23.4	135.1	
10159	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	8.40	X	8.47	68.7	22.1	123.3	±2.7 %
			Y	8.63	68.8	22.0	134.8	
			Z	8.58	69.1	22.4	129.3	
10175	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	6.50	X	5.83	68.1	21.1	146.3	±1.4 %
			Y	5.52	66.0	19.6	114.5	
			Z	5.46	66.3	20.0	110.2	
10176	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	7.20	X	6.60	69.4	22.1	146.3	±1.9 %
			Y	6.25	67.1	20.6	114.6	
			Z	6.15	67.4	21.0	109.6	
10177	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	6.53	X	5.84	68.0	21.1	146.1	±1.4 %
			Y	5.57	66.1	19.7	114.5	
			Z	5.52	66.4	20.2	109.8	
10178	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	7.73	X	7.03	69.6	22.6	145.8	±2.5 %
			Y	6.68	67.4	21.1	114.5	
			Z	6.58	67.6	21.4	109.5	
10179	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	7.62	X	6.96	69.6	22.5	146.0	±2.2 %
			Y	6.59	67.4	21.0	114.2	
			Z	6.48	67.6	21.3	109.7	
10180	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	7.62	X	6.97	69.6	22.5	146.2	±2.2 %
			Y	6.57	67.3	20.9	113.8	
			Z	6.47	67.5	21.3	109.7	
10196	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	10.20	X	11.73	70.7	23.9	108.2	±3.8 %
			Y	11.83	70.7	23.7	118.4	
			Z	11.89	71.2	24.2	113.8	
10225	UMTS-FDD (HSPA+)	6.70	X	7.71	67.8	20.5	133.7	±1.7 %
			Y	7.91	68.2	20.5	146.6	
			Z	7.79	68.1	20.6	140.1	

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 E^2 -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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3052

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)
750	41.9	0.89	6.10	6.10	6.10	0.34	1.62	± 12.0 %
835	41.5	0.90	5.85	5.85	5.85	0.23	2.15	± 12.0 %
900	41.5	0.97	5.83	5.83	5.83	0.50	1.33	± 12.0 %
1750	40.1	1.37	5.07	5.07	5.07	0.31	2.06	± 12.0 %
1900	40.0	1.40	4.85	4.85	4.85	0.41	1.68	± 12.0 %
2000	40.0	1.40	4.80	4.80	4.80	0.48	1.50	± 12.0 %
2450	39.2	1.80	4.23	4.23	4.23	0.72	1.25	± 12.0 %
2600	39.0	1.96	4.10	4.10	4.10	0.80	1.15	± 12.0 %

^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.

DASY/EASY - Parameters of Probe: ES3DV3- SN:3052

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)
750	55.5	0.96	6.05	6.05	6.05	0.45	1.44	± 12.0 %
835	55.2	0.97	5.92	5.92	5.92	0.34	1.77	± 12.0 %
900	55.0	1.05	5.90	5.90	5.90	0.68	1.20	± 12.0 %
1750	53.4	1.49	4.77	4.77	4.77	0.28	2.52	± 12.0 %
1900	53.3	1.52	4.55	4.55	4.55	0.28	2.81	± 12.0 %
2000	53.3	1.52	4.60	4.60	4.60	0.37	2.04	± 12.0 %
2450	52.7	1.95	4.15	4.15	4.15	0.80	0.66	± 12.0 %
2600	52.5	2.16	3.97	3.97	3.97	0.80	0.50	± 12.0 %

^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.

Calibration Laboratory of
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Accreditation No.: **SCS 108**

Client **AT4 wireless**

Certificate No: **D2450V2-756_Aug11**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 756**

Calibration procedure(s) **QA CAL-05.v8**
Calibration procedure for dipole validation kits above 700 MHz

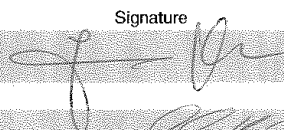
Calibration date: **August 25, 2011**

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
Power meter EPM-442A	GB37480704	06-Oct-10 (No. 217-01266)	Oct-11
Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check: Oct-11
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: August 25, 2011

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

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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:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

DASY Version	DASY5	V52.6.2
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	

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	51.8 $\pm$ 6 %	2.02 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	52.1 mW / g $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.17 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.4 mW / g $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$52.1 \, \Omega + 4.1 \, j\Omega$
Return Loss	- 26.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.126 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.

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	April 22, 2004