SAR TEST REPORT

Test Report No. : 10103823H-R1

Applicant	:	**Murata Manufacturing Company, Ltd.**
Type of Equipment	:	**Communication Module**
Model No.	:	**LBWA1U5YR1**
FCC ID	:	**VPYLBYR650**
Test regulation	:	**FCC47CFR 2.1093** **Class II Permissive Change**
Test Result	:	**Complied**

FCC Part15.247 Body 0.150: W/kg

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
6. This report is a revised version of 10103823H. 10103823H is replaced with this report.

Date of test: September 2 to 3, 2013

Representative test engineer: S. Matsuyama
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Engineer of WiSE Japan,
UL Verification Service

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Leader of WiSE Japan
UL Verification Service

NVLAP LAB CODE: 200572-0

This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.
*As for the range of Accreditation in NVLAP, you may refer to the WEB address,
http://www.ul.com/japan/jpn/pages/services/emc/about/mark1/index.jsp#nvlap

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REVISION HISTORY

Original Test Report No.: 10103823H

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10103823H	October 28, 2013	-	-
1	10103823H-R1	October 30, 2013	7	Section 4.1 was corrected.

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CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	Murata Manufacturing Company, Ltd.
Address	:	10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan
Telephone Number	:	+81-75-955-6375
Facsimile Number	:	+81-75-955-6634
Contact Person	:	Takaharu Kawakatsu

SECTION 2: Equipment under test (E.U.T.)

2.1 Identification of E.U.T

<Information of the EUT>

Type of Equipment	:	Communication Module
Model No.	:	LBWA1U5YR1
Serial No.	:	9999F6F97D
Rating	:	DC 5.0V
Country of Mass-production	:	China
Condition of EUT	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT	:	No Modification by the test lab

<Information of the Host device>

Type of Equipment	:	Digital Camera
Model No.	:	D5300
Serial No.	:	0031-MPT
Rating	:	DC 7.4V
Option Battery	:	Lithium Ion Battery
Device category	:	Portable
Receipt Date of Sample	:	August 21, 2013
Country of Mass-production	:	Thailand

2.2 Product Description

Radio Specification of WLAN (IEEE802.11b/g/n)

<Information of the EUT>

Radio Type	:	Transceiver
Frequency of Operation	:	2412-2462MHz
Modulation	:	DSSS and OFDM
Power Supply (inner)	:	DC5.0V
Antenna type	:	Monopole(pattern)Antenna
Antenna Gain	:	-2.7dBi(Peak)

SECTION 3 : Test standard information

3.1 Test Specification

Title : **FCC47CFR 2.1093**
Radiofrequency radiation exposure evaluation: portable devices.

: **IEEE Std 1528-2003:**
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques Supplement C

: **Published RF exposure KDB procedures, TCB workshop updates**

In additions;

☑ **KDB450824D01(v01r01)**	SAR Prob Cal and Ver Meas
☑ **KDB450824D02(v01r01)**	Dipole SAR Validation Verification
☑ **KDB447498D01(v05)**	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
☐ **KDB447498D02(v02)**	SAR Measurement Procedures for USB Dongle Transmitters
☐ **KDB648474D04(v01)**	SAR Evaluation Considerations for Wireless Handsets
☐ **KDB941225D01(v02)**	SAR Measurement Procedures for 3G Devices
☐ **KDB941225D02(v02v01)**	3GPP R6 HSPA and R7 HSPA+ SAR Guidance
☐ **KDB941225D03(v01)**	Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE
☐ **KDB941225D04(v01)**	Evaluating SAR for GSM/(E)GPRS Dual Transfer Mode
☐ **KDB941225D05(v02)**	SAR for LTE Devices
☐ **KDB941225D06(v01)**	SAR test procedures for devices incorporating SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities (Hot Spot SAR)
☐ **KDB941225D07(v01)**	SAR Evaluation Procedures for UMPC Mini-Tablet Devices
☐ **KDB 616217D04(v01)**	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
☑ **KDB865664D01(v01)**	SAR Measurement Requirements for 100MHz to 6 GHz
☑ **KDB248227D01(v01r02)**	SAR Measurement Procedures for 802.11a//b/g Transmitters

Reference

[1]ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
[2]SPEAG uncertainty document (AN 15-7/AN19-17) for DASY 5 System from SPEAG (Shimid & Partner Engineering AG).

3.2 Procedure

Transmitter	WLAN
Test Procedure	Published RF exposure KDB procedures, TCB workshop updates
	SAR
Category	FCC47CFR 2.1093
Note: UL Japan, Inc. 's SAR Work Procedures 13-EM-W0429 and 13-EM-W0430	

3.3 Exposure limit

(A) Limits for Occupational/Controlled Exposure (W/kg)

Spatial Average (averaged over the whole body)	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.4	8.0	20.0

(B) Limits for General population/Uncontrolled Exposure (W/kg)

Spatial Average (averaged over the whole body	Spatial Peak (averaged over any 1g of tissue)	Spatial Peak (hands/wrists/feet/ankles averaged over 10g)
0.08	1.6	4.0

Occupational/Controlled Environments: are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

General Population/Uncontrolled Environments: are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

NOTE:GENERAL POPULATION/UNCONTROLLED EXPOSURE
SPATIAL PEAK(averaged over any 1g of tissue) LIMIT
1.6 W/kg

3.4 Test Location

*Shielded room for SAR testings
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SECTION 4 : Test result

4.1 Stand-alone SAR result

Reported SAR

Measured SAR is scaled to the maximum tune-up tolerance limit by the following formulas.

Reported SAR= Maximum tune-up tolerance limit [mW] / Measured maximum power [mW] · Measured SAR [W/kg]

1g Body SAR

Maximum tune-up tolerance limit is 9.29mW(9.68dBm) by the specification from a customer.

Mode	Measured maximum power [mW]*1	Maximum tune-up tolerance limit [mW]	Measured SAR [W/kg]	Reported SAR [W/kg]
WLAN 2.4GHz band	7.43	9.29	0.120	0.150

Note

*1 The sample used by the SAR test is within the tune-up tolerance but not more than 2 dB lower than the maximum tune-up tolerance limit. That is, measured maximum power is included the tune-up tolerance range.

SECTION 5 : Description of the operating mode

5.1 Output power operating modes

<table>
<tr><th>Mode</th><th>Duty cycle</th><th>Frequency Band</th><th>Test Frequency</th><th>Modulation</th></tr>
<tr><td>IEEE802.11b</td><td>100%</td><td>2412-2462MHz</td><td>2412MHz(1ch)
2437MHz(6ch)
2462MHz(11ch)</td><td>DSSS
(DBPSK.DQPSK.CCK)</td></tr>
<tr><td>IEEE802.11g</td><td>100%</td><td>2412-2462MHz</td><td>2412MHz(1ch)
2437MHz(6ch)
2462MHz(11ch)</td><td rowspan="2">OFDM
(BPSK,QPSK,16QAM,64QAM)</td></tr>
<tr><td>IEEE802.11n20
(2.4G)</td><td>100%</td><td>2412-2462MHz</td><td>2412MHz(1ch)
2437MHz(6ch)
2462MHz(11ch)</td></tr>
<tr><th colspan="5">WLAN</th></tr>
<tr><td colspan="5">*Power of the EUT was set by the software as follows;
Power settings: 10
Software: Tera Term version 4.66

*This setting of software is the worst case.
Any conditions under the normal use do not exceed the condition of setting.
In addition, end users cannot change the settings of the output power of the product.</td></tr>
</table>

5.2 Output power measurement results

Output power measurement for WLAN

1) WLAN (11b/g/n(2.4G))

Note:
1.The 11g mode was maximum average power. The 11n SAR is not required for other mode because the maximum average output power for other mode is less than 1/4dB higher than that measured 11b mode.
2.The other channels are measured if the SAR result at max. AVG power channel will be above 0.8W/kg

IEEE802.11b 1Mbps

Ch	Frequency	P/M Reading [dBm]		Cable Loss	Atten.	Result			
						[dBm]		[mW]	
	[MHz]	PK	AVG	[dB]	[dB]	PK	AVG	PK	AVG
1	2412	1.03	-2.11	0.50	10.07	11.60	8.46	14.45	7.01
6	2437	1.17	-2.02	0.50	10.07	11.74	8.55	14.93	7.16
11	2462	1.21	-1.92	0.50	10.07	11.78	8.65	15.07	7.33

:SAR test channel

IEEE802.11b 5.5Mbps

Ch	Frequency	P/M Reading [dBm]		Cable Loss	Atten.	Result			
						[dBm]		[mW]	
	[MHz]	PK	AVG	[dB]	[dB]	PK	AVG	PK	AVG
1	2412	0.09	-2.10	0.50	10.07	10.66	8.47	11.65	7.03
6	2437	0.90	-1.96	0.50	10.07	11.47	8.61	14.03	7.26
11	2462	1.14	-1.90	0.50	10.07	11.71	8.67	14.83	7.36

:SAR test channel

IEEE802.11g 6Mbps

Ch	Frequency	P/M Reading [dBm]		Cable Loss	Atten.	Result			
						[dBm]		[mW]	
	[MHz]	PK	AVG	[dB]	[dB]	PK	AVG	PK	AVG
1	2412	7.58	-2.28	0.50	10.07	18.15	8.29	65.31	6.75
6	2437	7.73	-2.02	0.50	10.07	18.30	8.55	67.61	7.16
11	2462	7.85	-1.86	0.50	10.07	18.42	8.71	69.50	7.43

:SAR test channel

IEEE802.11n-20 MCS0

Ch	Frequency	P/M Reading [dBm]		Cable Loss	Atten.	Result			
						[dBm]		[mW]	
	[MHz]	PK	AVG	[dB]	[dB]	PK	AVG	PK	AVG
1	2412	7.22	-2.52	0.50	10.07	17.79	8.05	60.12	6.38
6	2437	7.45	-2.11	0.50	10.07	18.02	8.46	63.39	7.01
11	2462	7.57	-2.05	0.50	10.07	18.14	8.52	65.16	7.11

* Power Correlation
<RF Test>
IEEE 802.11g 6.93mW(8.41dBm) * maximum average power.

<SAR Test>
IEEE 802.11g 7.43mW(8.71dBm) * maximum average power.

Average Power used for SAR testing can be regarded to be correlated with the one in RF testing as the difference between the two powers is within 0.5dB.

[IEEE802.11b] Rate Check

Rate [Mbps]	Freq. [MHz]	P/M Reading [dBm] PK	P/M Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] PK	Result [dBm] AVG	Result [mW] PK	Result [mW] AVG
1.0	2437	1.17	-2.02	0.50	10.07	11.74	8.55	14.93	7.16
2.0	2437	1.16	-1.99	0.50	10.07	11.73	8.58	14.89	7.21
5.5	2437	0.90	-1.96	0.50	10.07	11.47	8.61	14.03	7.26
11.0	2437	1.34	-1.98	0.50	10.07	11.91	8.59	15.52	7.23

:Worst data rate

[IEEE802.11g] Rate Check

Rate [Mbps]	Frequency [MHz]	P/M Reading [dBm] PK	P/M Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] PK	Result [dBm] AVG	Result [mW] PK	Result [mW] AVG
6.0	2437	7.73	-2.02	0.50	10.07	18.30	8.55	67.61	7.16
9.0	2437	7.67	-2.06	0.50	10.07	18.24	8.51	66.68	7.10
12.0	2437	7.48	-2.10	0.50	10.07	18.05	8.47	63.83	7.03
18.0	2437	7.47	-2.15	0.50	10.07	18.04	8.42	63.68	6.95
24.0	2437	7.38	-2.33	0.50	10.07	17.95	8.24	62.37	6.67
36.0	2437	7.47	-2.36	0.50	10.07	18.04	8.21	63.68	6.62
48.0	2437	7.62	-2.40	0.50	10.07	18.19	8.17	65.92	6.56
54.0	2437	7.42	-2.50	0.50	10.07	17.99	8.07	62.95	6.41

:Worst data rate

[IEEE802.11n-20] Rate Check

Rate	Frequency [MHz]	P/M Reading [dBm] PK	P/M Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] PK	Result [dBm] AVG	Result [mW] PK	Result [mW] AVG
MCS0	2437	7.45	-2.11	0.50	10.07	18.02	8.46	63.39	7.01
MCS1	2437	7.44	-2.27	0.50	10.07	18.01	8.30	63.24	6.76
MCS2	2437	7.25	-2.41	0.50	10.07	17.82	8.16	60.53	6.55
MCS3	2437	7.19	-2.45	0.50	10.07	17.76	8.12	59.70	6.49
MCS4	2437	7.37	-2.52	0.50	10.07	17.94	8.05	62.23	6.38
MCS5	2437	7.20	-2.60	0.50	10.07	17.77	7.97	59.84	6.27
MCS6	2437	7.40	-2.63	0.50	10.07	17.97	7.94	62.66	6.22
MCS7	2437	7.36	-2.66	0.50	10.07	17.93	7.91	62.09	6.18

:Worst data rate

Sample Calculation:
Result = Reading + Cable Loss + Attenuator

5.3 SAR testing operating modes

The operating mode for SAR testing was decided by the output power

SAR measurement for WLAN

Mode	Crest factor	Modulation	Test Frequency	Note
IEEE802.11b	1	DBPSK(1Mbps) CCK(5.5Mbps)	2462MHz(11ch)	
IEEE802.11g	1	BPSK(6Mbps)	2462MHz(11ch)	
IEEE802.11n20 (2.4G)	Not required			
WLAN				
*Power of the EUT was set by the software as follows; Power settings: 10 Software: Tera Term version 4.66 *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.				

Decision of SAR test channel
The operating mode for SAR testing was decided by the output power

Mode	GHz	Channel	Turbo Channel	"Default Test Channel"	
				FCC 15.247	
				802.11b	802.11g
802.11 b/g/n20	2.412	1		√	Δ
	2.437	6	6	√	Δ
	2.462	11		√	Δ

√ = "default test channels"
Δ = Possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"

*1 The 11g mode was maximum average power. The 11n SAR is not required for other mode because the maximum average output power for other mode is less than 1/4dB higher than that measured 11b mode.

*2 The other channel was not required since maximum average output power channel SAR value is less than 0.8W/kg.

*3 Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg.

5.4 Confirmation after SAR testing

It was checked that the power drift [W] is within +/-5%.The verification of power drift during the SAR test is that DASY5 system calculates the power drift by measureing the e-filed at the same location at beginning and the end of the scan measurement for each test position.

DASY5 system calucation Power drift value[dB] =20log(Ea)/(Eb)
Before SAR testing : Eb[V/m]
After SAR testing : Ea[V/m]

Limit of power drift[W] =+/-5%
X[dB]=10log[P]=10log(1.05/1)=10log(1.05)-10log(1)=0.212dB

from E-filed relations with power.
p=E^2/η=E^2/
Therefore, The correlation of power and the E-filed
XdB=10log(P)=10log(E)^2=20log(E)

Therefore,
The calculated power drift of DASY5 System must be the less than +/-0.212dB.

SECTION 6 SAR test exclusion considerations

6.1 Standalone SAR test exclusion considerations

1)The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
 f(GHz) is the RF channel transmit frequency in GHz
 Power and distance are rounded to the nearest mW and mm before calculation.
 The result is rounded to one decimal place for comparison.
The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Band	Standalone SAR tested	Positiom	Upper frequency of band *1	Maximum tune-up tolerance limit	Min distance *2	Calculation of exclusion *3
WLAN (2.4GHz band)	☑	Top	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	5 [mm]	-
WLAN (2.4GHz band)	☑	Top + Left corner	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	5 [mm]	-
WLAN (2.4GHz band)	☐	Top + Right corner	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	33.44 [mm]	0.4
WLAN (2.4GHz band)	☐	Front	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	15.87 [mm]	0.9
WLAN (2.4GHz band)	☐	Rear	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	27.7 [mm]	0.5
WLAN (2.4GHz band)	☐	Left side	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	26.9 [mm]	0.5

2) At 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following.
a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

Band	Standalone SAR tested *5	Positiom	Upper frequency of band *1	Maximum tune-up tolerance limit	Min distance *2	Calculation of threshold*4
WLAN (2.4GHz band)	☐	Bottom	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	86.72 [mm]	462.8 [mW]
WLAN (2.4GHz band)	☐	Right side	2462 [MHz] (11ch)	9.68 [dBm] 9.29 [mW]	94.04 [mm]	536.0 [mW]

*1 The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
*2 When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. Refer to Appendix 4.
*3 [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·[√f(GHz)] ≤ 3.0
If it is Calculation of exclusion ≤ 3.0 standalone SAR test is excluded.
*4 [(3·50)/($\sqrt{f_{(GHz)}}$)) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz
If it is maximum tune-up tolerance limit < Threshold, standalone SAR test is excluded.
*5 When Maximum tune-up tolerance limit < Calculation of threshold, standalone SAR measurement is excluded.

SECTION 7 : Description of the Body setup

7.1 Test position for Body setup

i)Procedure for SAR testing

The tested procedure was performed according to the KDB 447498 D01 (Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies)

ii)Test mode

WLAN	**Data transmission mode (11b/g)**

iii)Test position

No.	Position*	Test distance	WLAN		
			Tested	Antenna	Separation from user
1	Top	0mm	☑	Fixed	< 25mm
2	Top + Left corner	0mm	☑	Fixed	< 25mm
3	Top + Right corner	0mm	☐	Fixed	> 25mm
4	Front	0mm	☐	Fixed	< 25mm
5	Rear	0mm	☐	Fixed	> 25mm
6	Bottom	0mm	☐	Fixed	> 25mm
7	Right Side	0mm	☐	Fixed	> 25mm
8	Left Side	0mm	☐	Fixed	> 25mm

SECTION 8 : Test surrounding

8.1 Measurement uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[2] and is given in the following Table. Table of uncertainties are listed for ISO/IEC 17025

<0.3 – 3GHz range>

Error Description	Uncertai value ±		Probability distribution	divisor	(ci) 1g	Standard (1g)		vi or veff
Measurement System								
Probe calibration	±	6.00	Normal	1	1	±	6.00	∞
Axial isotropy of the probe	±	4.7	Rectangular	√3	0.7	±	1.9	∞
Spherical isotropy of the probe	±	9.6	Rectangular	√3	0.7	±	3.9	∞
Boundary effects	±	2.0	Rectangular	√3	1	±	1.2	∞
Probe linearity	±	4.7	Rectangular	√3	1	±	2.7	∞
Detection limit	±	1.0	Rectangular	√3	1	±	0.6	∞
Modulation response	±	2.4	Rectangular	√3	1	±	1.4	∞
Readout electronics	±	0.3	Normal	1	1	±	0.3	∞
Response time	±	0.8	Rectangular	√3	1	±	0.5	∞
Integration time	±	2.6	Rectangular	√3	1	±	1.5	∞
RF ambient Noise	±	3.0	Rectangular	√3	1	±	1.7	∞
RF ambient Reflections	±	3.0	Rectangular	√3	1	±	1.7	∞
Probe Positioner	±	0.8	Rectangular	√3	1	±	0.5	∞
Probe positioning	±	6.7	Rectangular	√3	1	±	3.9	∞
Max.SAR Eval.	±	4.0	Rectangular	√3	1	±	2.3	∞
Test Sample Related								
Device positioning	±	2.9	Normal	1	1	±	2.9	3
Device holder uncertainty	±	3.6	Normal	1	1	±	3.6	1
Power drift	±	5.0	Rectangular	√3	1	±	2.9	∞
Power Scaling	+	0.0	Rectangular	√3	1	±	0.0	∞
Phantom and Setup								
Phantom uncertainty	±	4.0	Rectangular	√3	1	±	2.3	∞
Liquid conductivity (target)	±	5.0	Rectangular	√3	0.64	±	1.8	∞
Liquid conductivity (meas.)	+	1.0	Rectangular	1	0.64	+	0.6	∞
Liquid permittivity (target)	±	5.0	Rectangular	√3	0.6	±	1.7	∞
Liquid permittivity (meas.)	-	1.0	Rectangular	1	0.6	-	0.6	∞
Liquid conductivity - temp.unc (below 2deg.C.)	±	1.7	Rectangular	√3	0.78	±	0.8	∞
Liquid permittivity - temp.unc (below 2deg.C.)	±	0.3	Rectangular	√3	0.23	±	0.0	∞
Combined Standard Uncertainty						±	**11.651**	
Expanded Uncertainty (k=2)						±	**23.3**	

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SECTION 9 : Measurement results

9.1 WLAN Body SAR

(1)Method of measurement

Step1. The searching for the worst position
The test was performed in minimum rate and maximum average output power mode.
Step2. The changing of the transmitter mode
The test was performed at the worst position of Step1.

Note:
1) The BODY SAR is not required for 11n mode because the maximum average output power for 11n mode is less than 1/4dB higher than that measured 11b mode.
2) The other channel was not required since maximum average output power channel SAR value is less than 0.8W/kg.

(2)Simulated Tissue Liquid Parameter confirmation

The dielectric parameters were checked prior to assessment using the DAK-3.5 probe kit.
The dielectric parameters measurement is reported in each correspondent section.

DIELECTRIC PARAMETERS MEASUREMENT RESULTS										
Date	Ambient Temp. [deg.c]	Relative Humidity [%]	Liquid type	Liquid Temp. [deg.c]	Measured Frequency [MHz]	Parameters	Target Value*1	Measured	Deviation [%]	Limit [%]
2-Sep	24.0	56	MSL 2450	23.5	2462	εr	52.7	52.1	-1.0	+/-5
						σ [mho/m]	1.97	1.99	1.0	+/-5
3-Sep	24.0	59	MSL 2450	23.5	2462	εr	52.7	52.2	-1.0	+/-5
						σ [mho/m]	1.97	1.97	-0.1	+/-5

εr: Relative Permittivity / σ : Coductivity
*1 The Target value is a parameter defined in KDB865664.

(3)Result of Body SAR

BODY SAR MEASUREMENT RESULTS												
Frequency		Modulation	Max power(Meas)		Maximum tune-up tolerance limit		Phantom Section	EUT Set-up Conditions			Measured SAR(1g) [W/kg]	Reported SAR(1g) *1 [W/kg]
Channel	[MHz]		[dBm]	[mW]	[dBm]	[mW]		Antenna	Position	Separation [mm]	Maximum value of multi-peak	Maximum value of multi-peak
Step.1 Position searching												
11	2462	11g 6Mbps	8.71	7.43	9.68	9.29	Flat	Fixed	Top	0	**0.026**	**0.033**
11	2462	11g 6Mbps	8.71	7.43	9.68	9.29	Flat	Fixed	Top+Left corner	0	**0.120**	**0.150**
Step.2 Mode change												
11	2462	11b 1Mbps	8.65	7.33	9.68	9.29	Flat	Fixed	Top+Left corner	0	**0.115**	**0.146**
11	2462	11b 5.5Mbps	8.67	7.36	9.68	9.29	Flat	Fixed	Top+Left corner	0	**0.111**	**0.140**

SECTION 10 Test instruments

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MDAE-02	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	1369	SAR	2013/05/13 * 12
MPB-08	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3917	SAR	2013/05/14 * 12
MPF-04	Oval Flat Phantom ERI 5.0	Schmid&Partner Engineering AG	QD OVA 002 A (ELI5.0)	1207	SAR	2013/06/18 * 12
MDH-04	Device Holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	Pre Check
MOS-30	Thermo-Hygrometer	Custom	CTH-201	-	SAR	2013/07/29 * 12
MOS-35	Digital Thermometer	HANNA	Checktemp 4	-	SAR	2013/07/29 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY5	-	SAR	-
EST-30	Network Analyzer	Agilent	N5230A	MY46400314	SAR	2012/11/01 * 12
MDPK-02	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK-3.5 Probe	1114	SAR	2013/05/14 * 12
MOS-37	Digital Thermometer	LKM electronic	DTM3000	-	SAR	2013/07/29 * 12
MPM-15	Power Meter	Agilent	N1914A	MY53060017	SAR	2013/06/05 * 12
MPSE-20	Power Sensor	Agilent	N8482H	MY53050001	SAR	2013/06/05 * 12
MPSE-21	Power Sensor	Agilent	N8482H	MY52460010	SAR	2013/06/05 * 12
MHDC-22	Directional Coupler (2-18GHz)	Agilent	87300B	14893A	SAR	Pre Check
MRFA-24	Pre Amplifier	R & K company Limited.	R&K CGA020M602-2633R	B30550	SAR	2013/06/06 * 12
MSG-13	Signal Generator	Rohde & Schwarz	SMA 100A	103764	SAR	2013/06/05 * 12
MRENT-110	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	765	SAR	2013/08/22 * 12
MPM-12	Power Meter	Anritsu	ML2495A	0825002	Power Measurement	2013/06/12 * 12
MPSE-17	Power Sensor	Anritsu	MA2411B	0738285	Power Measurement	2013/06/12 * 12
MAT-24	Attenuator(10dB)(above 1GHz)	Agilent	8493C	71389	Power Measurement	2013/06/05 * 12
MSL2450				Daily check Target value ± 5%		
SAR room1				Daily check Ambient Noise<0.012W/kg		

The expiration date of the calibration is the end of the expired month.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

APPENDIX 1 : SAR Measurement data

1. Evaluation procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the E-field at a fixed location above the ear point or central position of flat phantom was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and the horizontal grid spacing was 15 mm x 15 mm, 12 mm x 12 mm or 10mm x 10mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

Step 3: Around this point found in the Step 2 (area scan) , a volume of 30mm x 30mm x 30mm or more was assessed by measuring 7 x 7 x 7 points at least. And for any secondary peaks found in the Step2 which are within 2dB of maximum peak and not with this Step3 (Zoom scan) is repeated. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

(1). The data at the surface were extrapolated, since the center of the dipoles is 1mm(EX3DV3) away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm [4]. A polynomial of the fourth order was calculated through the points in z-axes.
This polynomial was then used to evaluate the points between the surface and the probe tip.

(2). The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot"-condition (in x, y and z-directions) [4], [5]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

(3). All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the E-field at the same location as in Step 1.

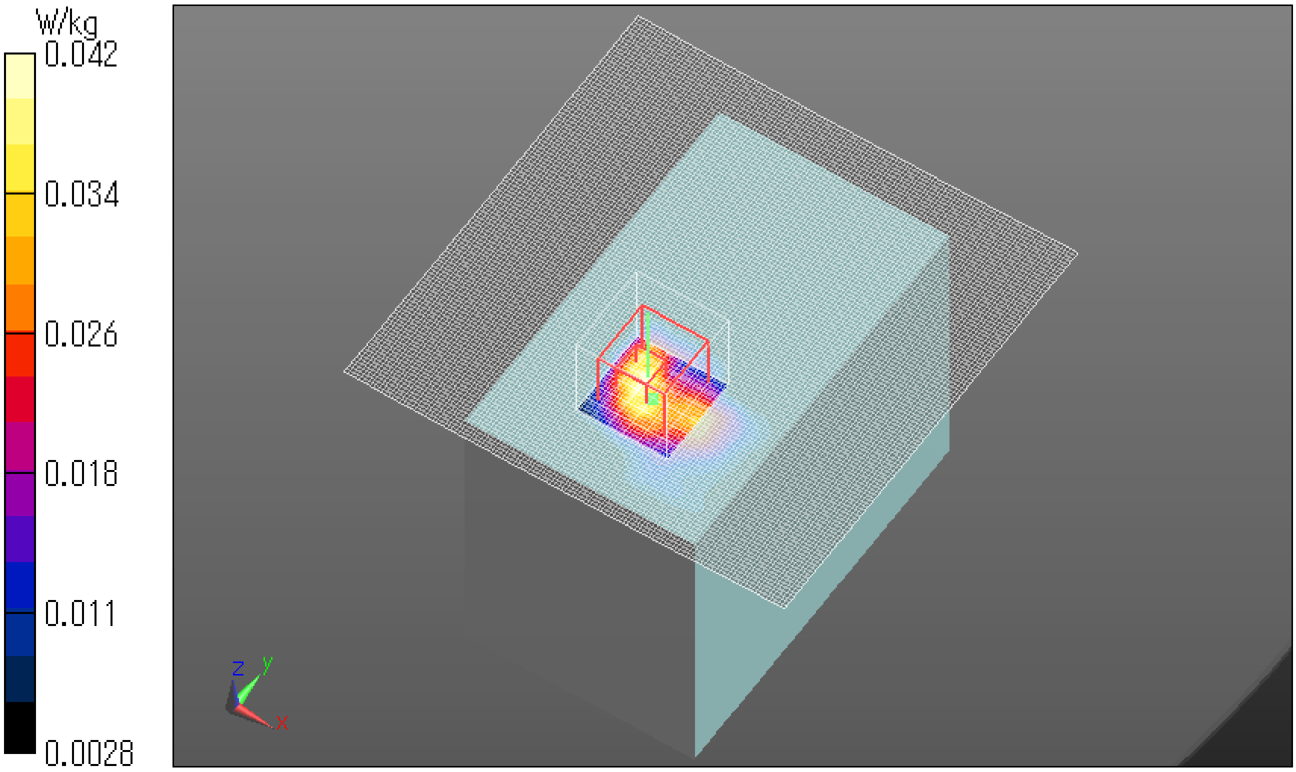
2. Measurement data

WLAN 11g 6Mbps 2462MHz Top
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.989 S/m; ε_r = 52.133; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (121x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0473 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.278 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.0620 W/kg
SAR(1 g) = 0.026 W/kg; SAR(10 g) = 0.014 W/kg

Maximum value of SAR (measured) = 0.0418 W/kg
Date: 2013/09/02
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



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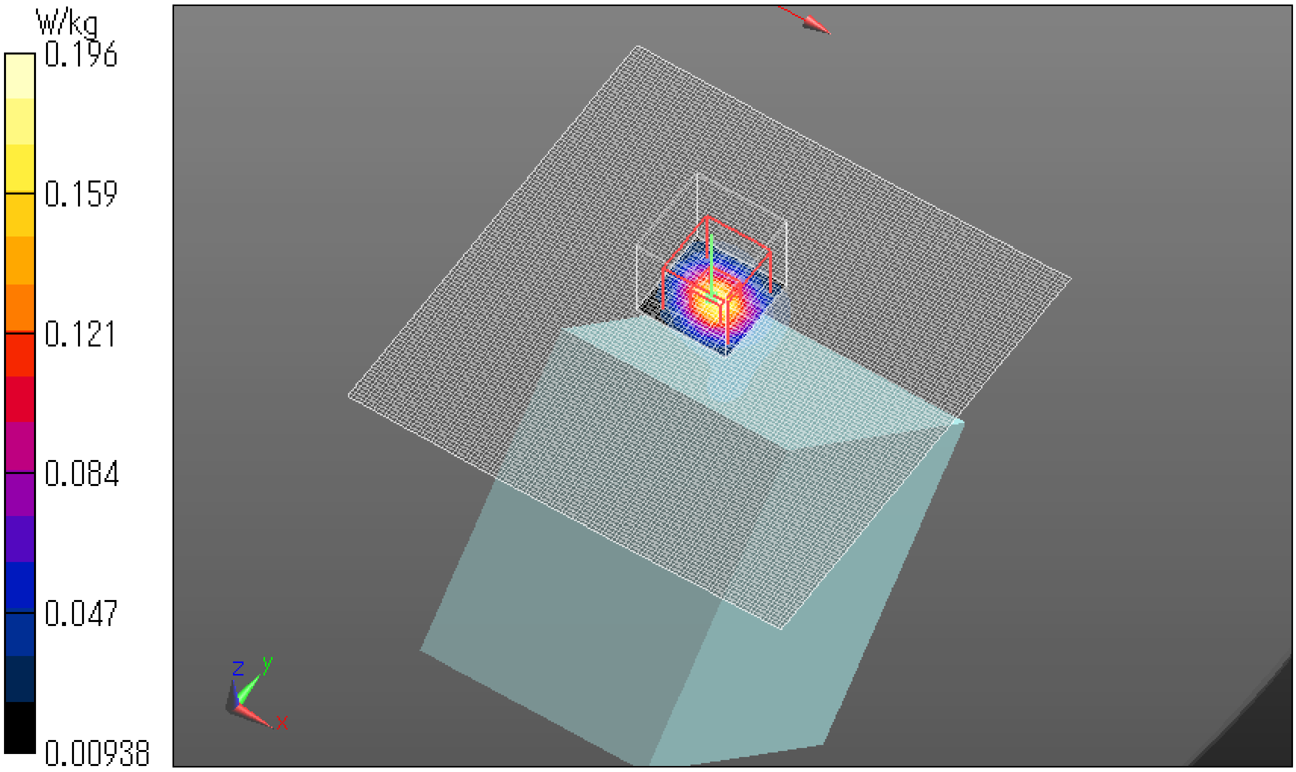
WLAN 11g 6Mbps 2462MHz Top + Left corner
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.969 S/m; ε_r = 52.165; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (121x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.182 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.123 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 0.304 W/kg
SAR(1 g) = 0.120 W/kg; SAR(10 g) = 0.050 W/kg
Maximum value of SAR (measured) = 0.196 W/kg
Date: 2013/09/03
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.

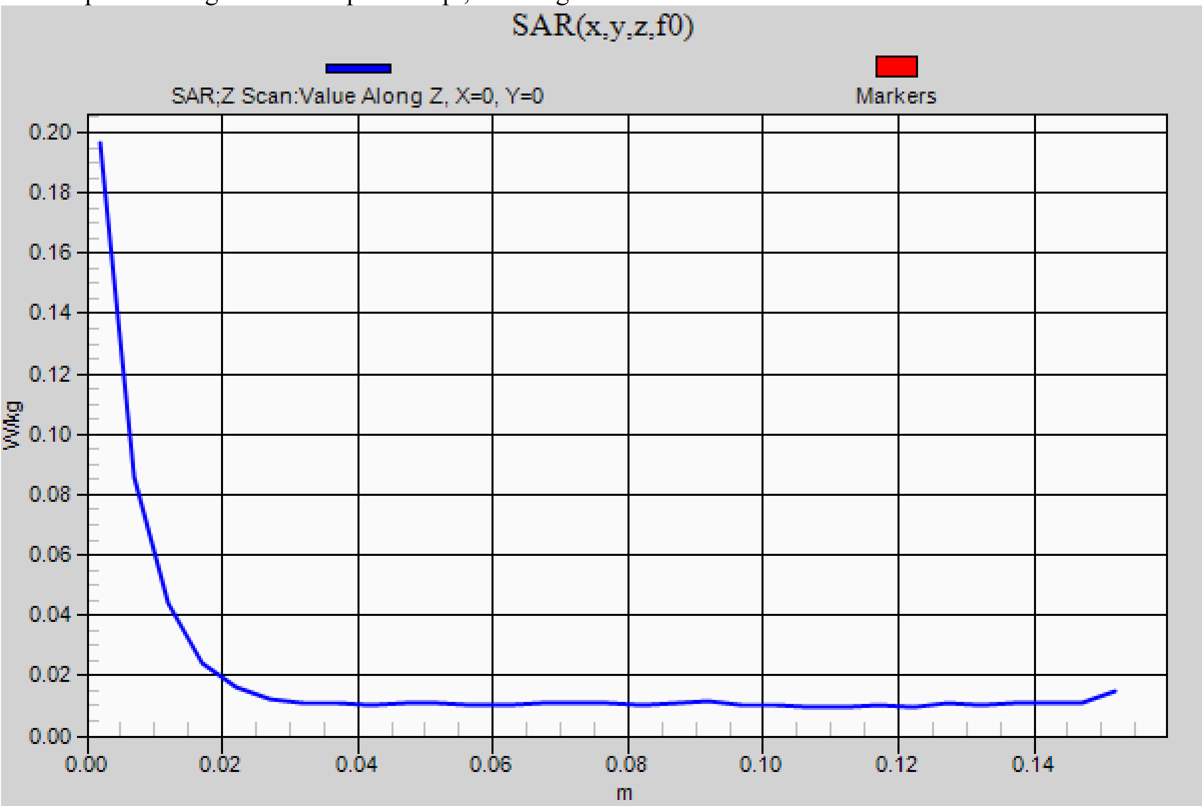


Z Scan at Maximum Body SAR in WLAN 2.4GHz band

WLAN 11g 6Mbps 2462MHz Top + Left corner
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.969 S/m; ε_r = 52.165; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Z Scan (1x1x31): Measurement grid: dx=20mm, dy=20mm, dz=5mm

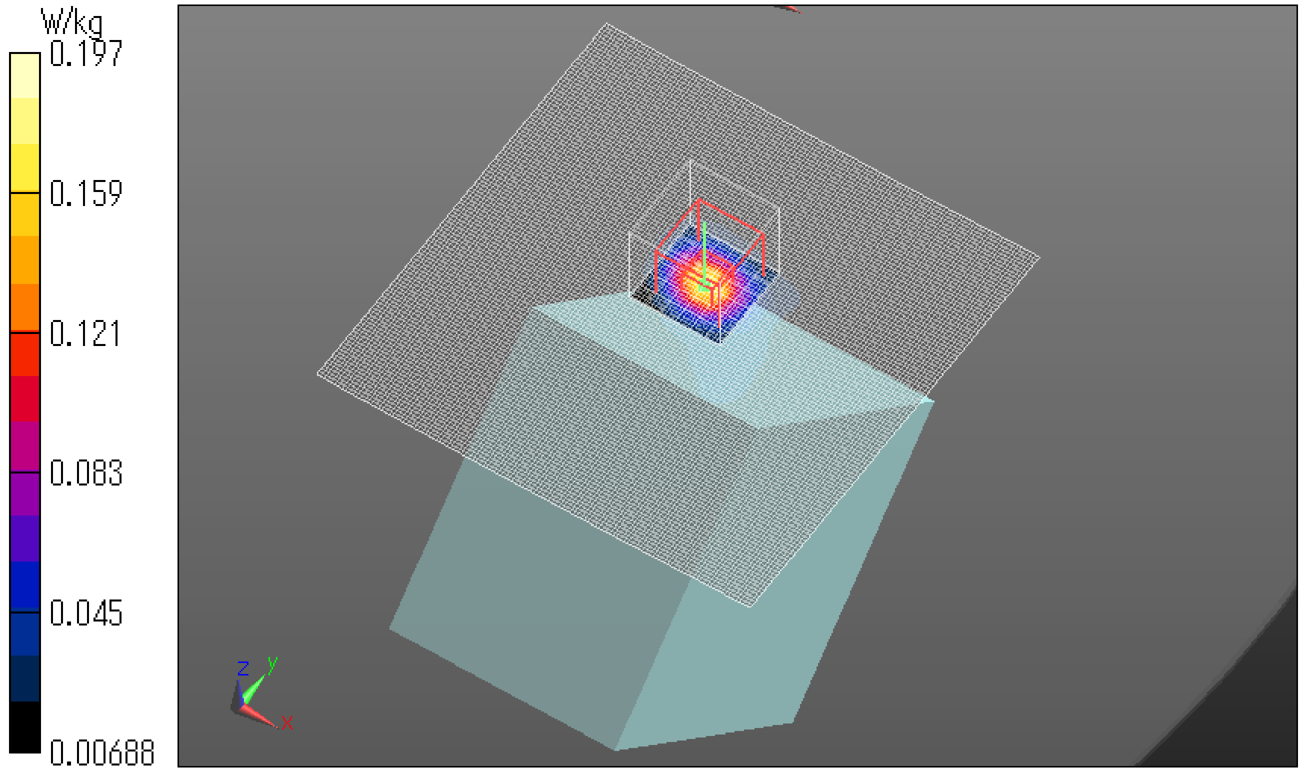
Maximum value of SAR (measured) = 0.196 W/kg
Date: 2013/09/03
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



WLAN 11b 1Mbps 2462MHz Top + Left corner
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.969 S/m; ε_r = 52.165; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (121x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.211 W/kg

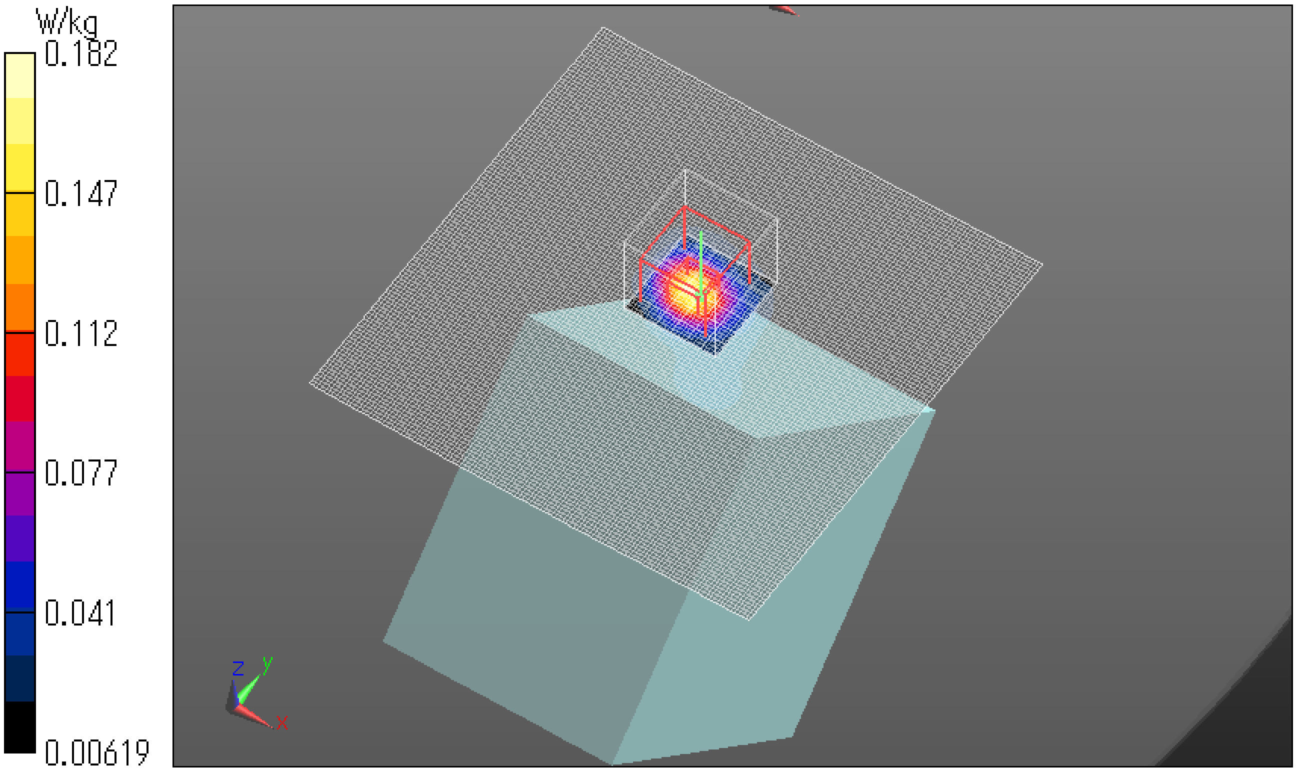
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.192 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 0.289 W/kg
SAR(1 g) = 0.115 W/kg; SAR(10 g) = 0.047 W/kg
Maximum value of SAR (measured) = 0.197 W/kg
Date: 2013/09/03
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



WLAN 11b 5.5Mbps 2462MHz Top + Left corner
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.969 S/m; ε_r = 52.165; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (121x121x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.192 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.746 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.286 W/kg
SAR(1 g) = 0.111 W/kg; SAR(10 g) = 0.044 W/kg
Maximum value of SAR (measured) = 0.182 W/kg
Date: 2013/09/03
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.



APPENDIX 2 : System Validation

1. System validation result for 2450MHz

System validation result Body 2450
Simulated Tissue Liquid Parameter confirmation

DIELECTRIC PARAMETERS MEASUREMENT RESULTS										
Date	Ambient Temp. [deg.c]	Relative Humidity [%]	Liquid type	Liquid Temp. [deg.c]	Measured Frequency [MHz]	Parameters	Target Value*1	Measured	Deviation [%]	Limit [%]
2-Sep	24.0	56	MSL 2450	23.5	2450	εr	52.7	52.2	-1.0	+/-5
						σ [mho/m]	1.95	1.98	1.3	+/-5
3-Sep	24.0	59	MSL 2450	23.5	2450	εr	52.7	52.2	-0.9	+/-5
						σ [mho/m]	1.95	1.95	0.1	+/-5

εr: Relative Permittivity / σ : Coductivity
*1 The Target value is a parameter defined in KDB865664.

System validation result (for calibration by manufacture)

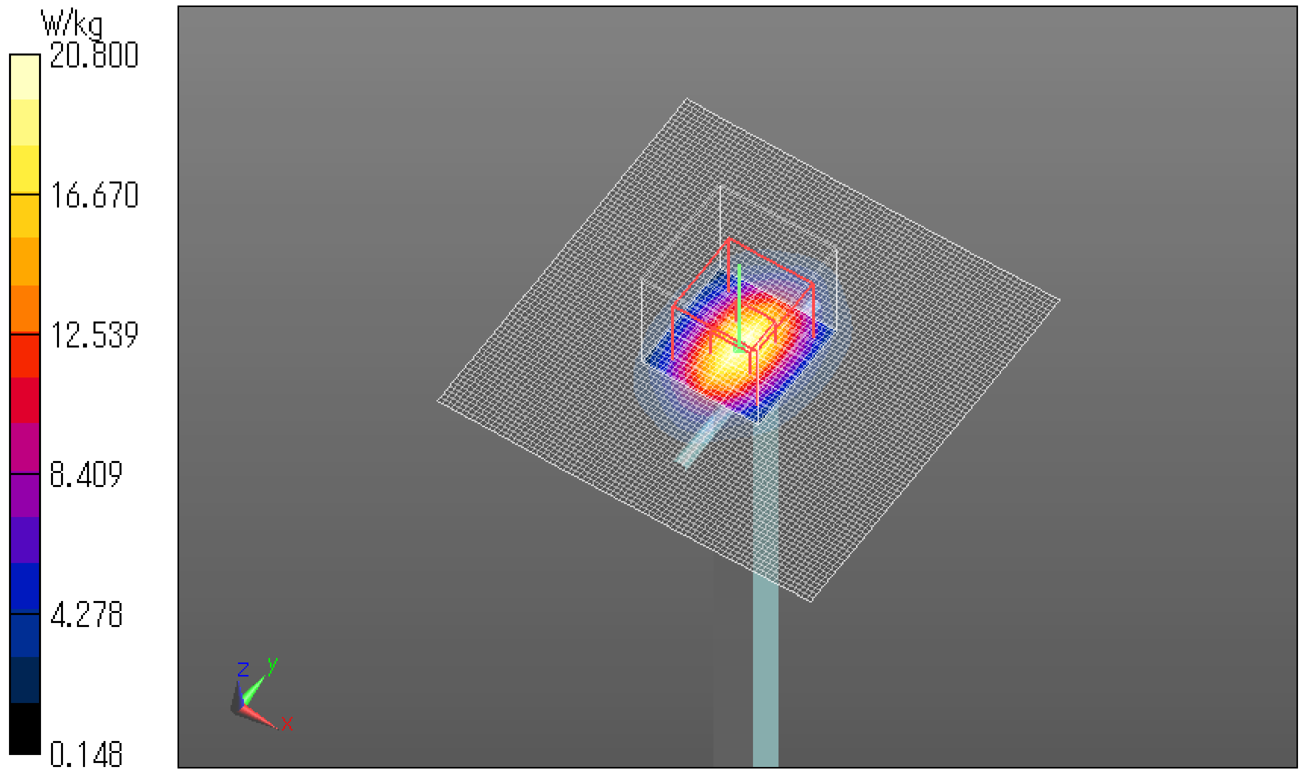
SYSTEM VALIDATION						
Date	Frequency [MHz]	SAR 1g [W/kg]			Deviation [%]	Limit [%]
		Forward Power 250mW Measured	Conversion 1W Calculation	Target 1W *1		
2-Sep	2450.00	13.60	54.40	49.60	9.7	+/-10
3-Sep	2450.00	13.10	52.40	49.60	5.6	+/-10

*1 The taget value is the parameter defined in 1g SAR (normalizes to 1W) in manufacturer calibrated dipole (D2450V2 SN:765)

Body 2450MHz System Validation DATA / Dipole2.4GHz / Forward Conducted Power : 250mW
Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.975 S/m; ε_r = 52.184; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 20.9 W/kg

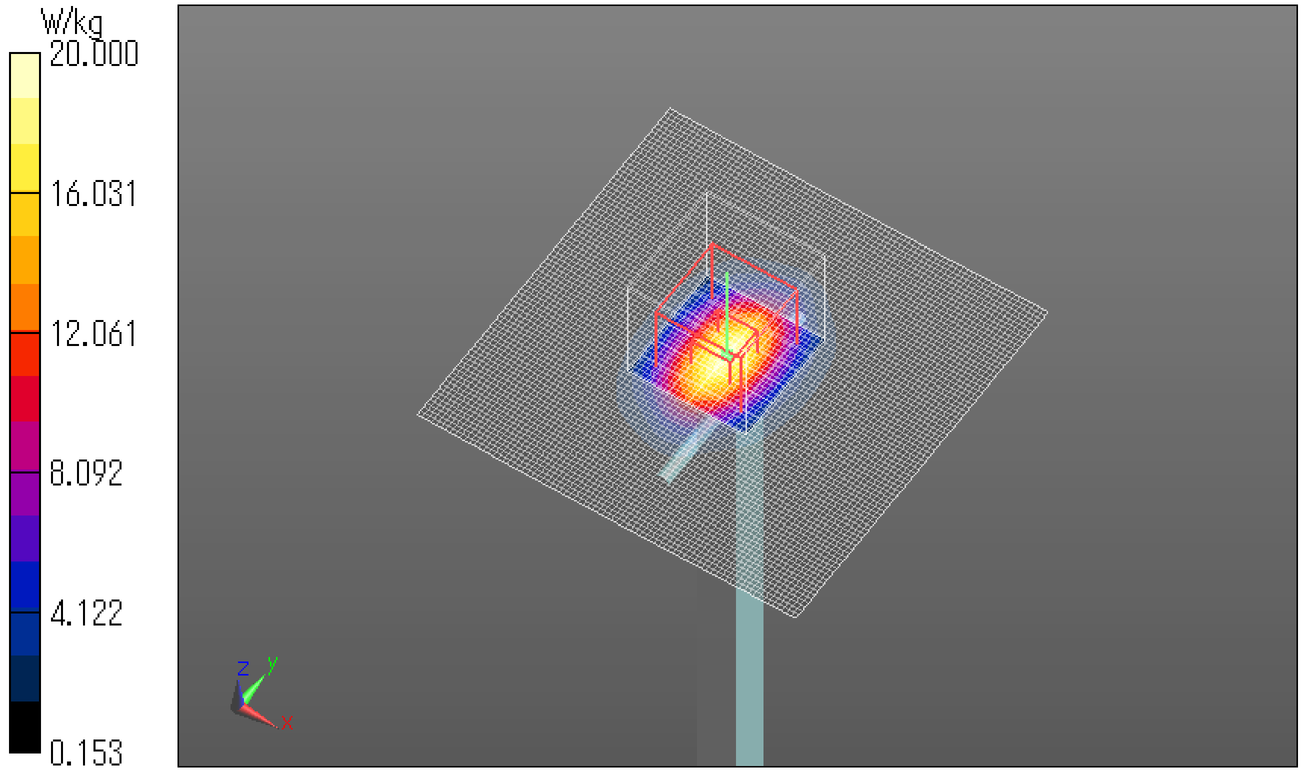
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.8 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 28.2 W/kg
SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.33 W/kg
Maximum value of SAR (measured) = 20.8 W/kg
Date: 2013/09/02
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



Body 2450MHz System Validation DATA / Dipole2.4GHz / Forward Conducted Power : 250mW
Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.951 S/m; ε_r = 52.209; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.27, 7.27, 7.27); Calibrated: 2013/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2013/05/13
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (7);

Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 20.1 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.7 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.09 W/kg
Maximum value of SAR (measured) = 20.0 W/kg
Date: 2013/09/03
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



2. System Validation Dipole (D2450V2,S/N:765)

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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 PTT

Certificate No: D2450V2-765_Mar13

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 765
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	March 06, 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)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13

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

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 6, 2013

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

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S Schweizerischer Kalibrierdienst
C 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:

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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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Measurement Conditions

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

DASY Version	DASY5	V52.8.5
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.85 mho/m ± 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	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**53.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.8 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.7 ± 6 %	2.01 mho/m ± 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	**49.6 W/kg ± 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	**23.1 W/kg ± 16.5 % (k=2)**

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DASY5 Validation Report for Head TSL

Date: 06.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

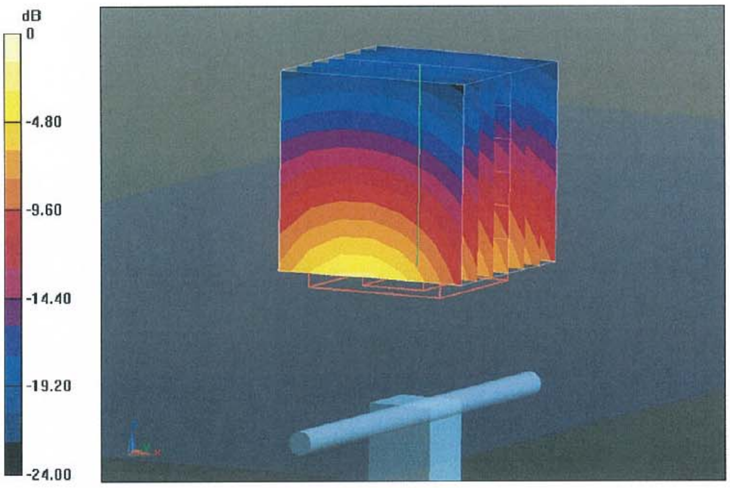
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 765

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.85 S/m; ε_r = 37.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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 = 94.304 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 28.6 W/kg
SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.29 W/kg
Maximum value of SAR (measured) = 17.4 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg

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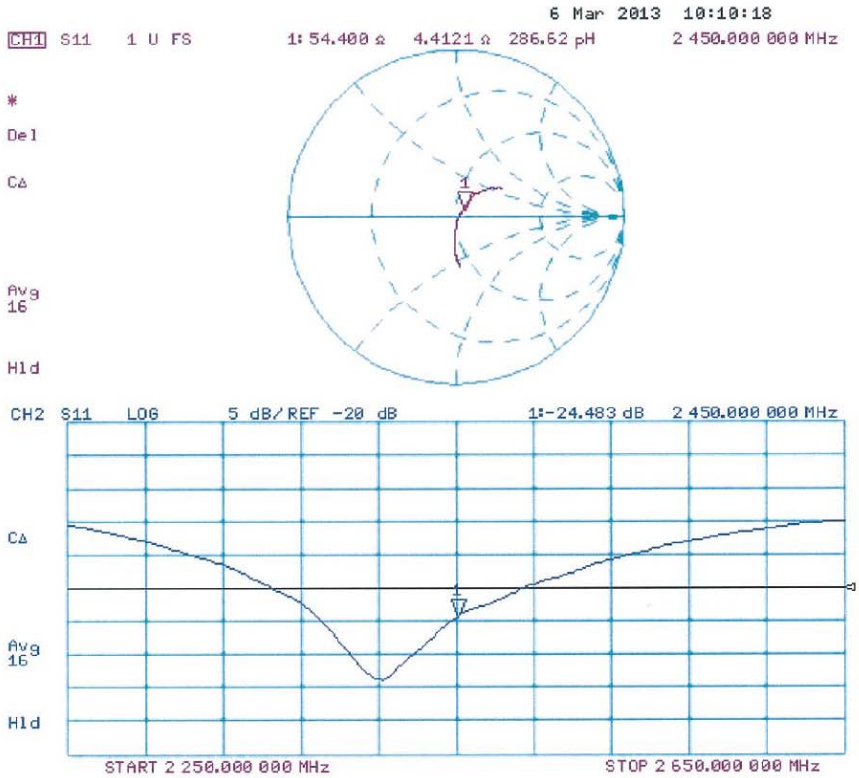
Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 06.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 765

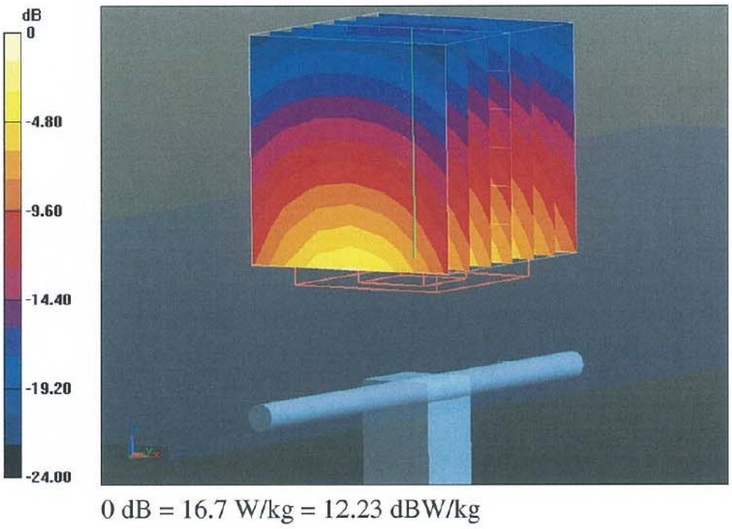
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.01 S/m; ε_r = 50.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.304 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 26.7 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.85 W/kg
Maximum value of SAR (measured) = 16.7 W/kg



0 dB = 16.7 W/kg = 12.23 dBW/kg

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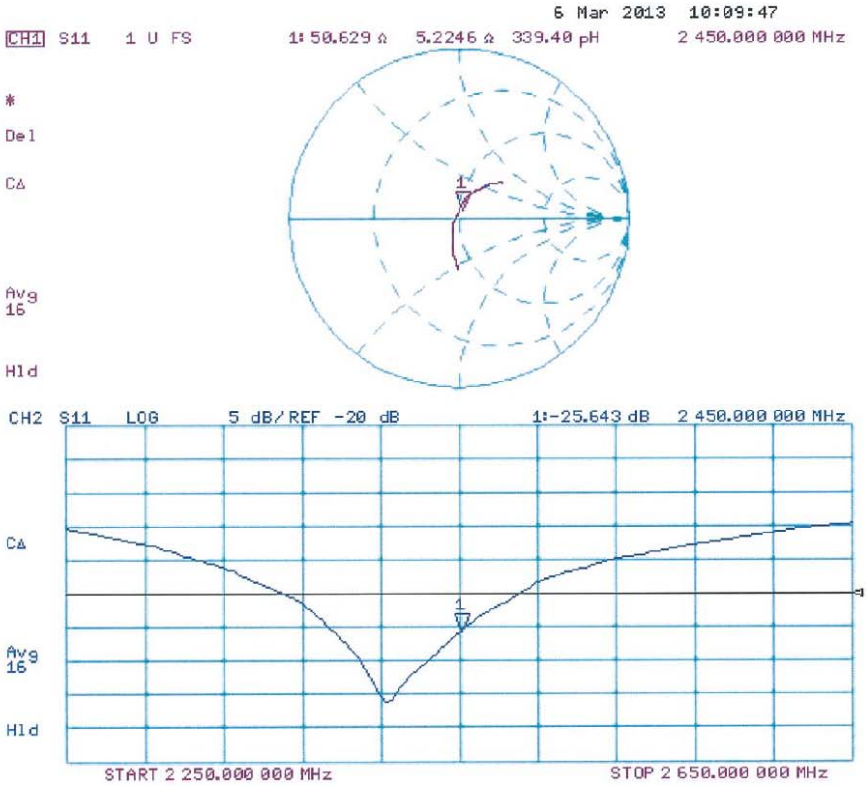
Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-765_Mar13 Page 8 of 8

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3. Validation uncertainty

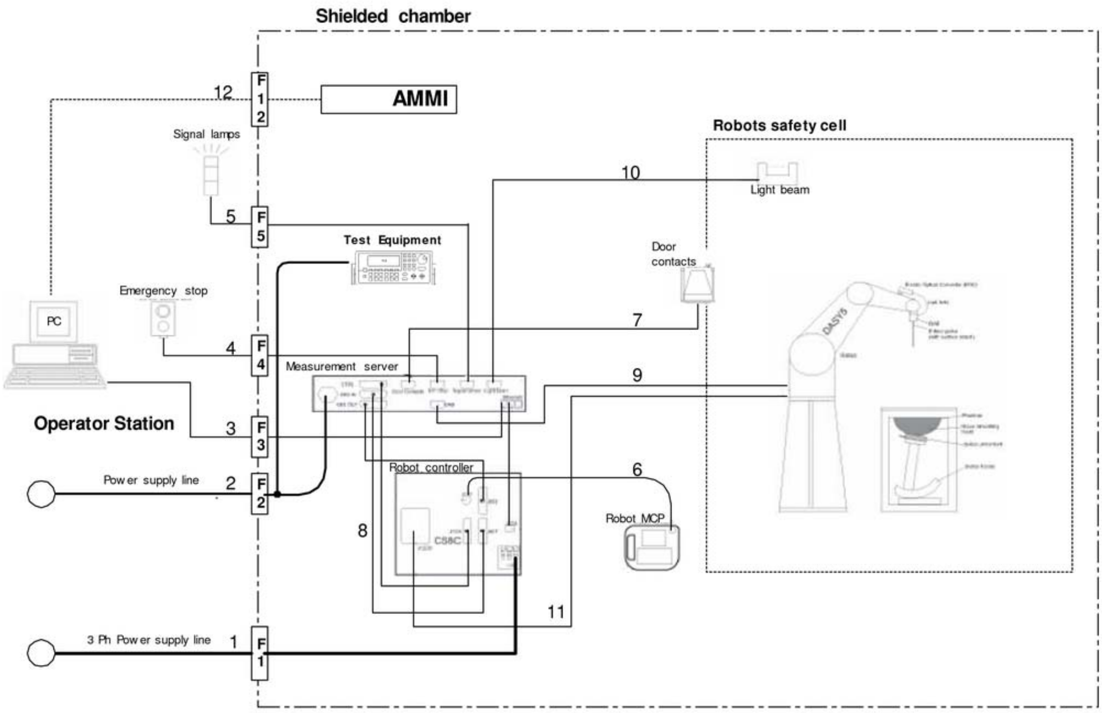
The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[2] and is given in the following Table.

Error Description	Uncertai value ±	Probability distribution	divisor	(ci) 1g	Standard (1g)	vi or veff
Measurement System						
Probe calibration	± 6.55	Normal	1	1	± 6.55	∞
Axial isotropy of the probe	± 4.7	Rectangular	√3	1	± 2.7	∞
Spherical isotropy of the probe	± 9.6	Rectangular	√3	0	± 0.0	∞
Boundary effects	± 1.0	Rectangular	√3	1	± 0.6	∞
Probe linearity	± 4.7	Rectangular	√3	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	√3	1	± 0.6	∞
Modulation response	± 0.0	Rectangular	√3	1	± 0.0	∞
Readout electronics	± 0.3	Normal	1	1	± 0.3	∞
Response time	± 0.0	Rectangular	√3	1	± 0.0	∞
Integration time	± 0.0	Rectangular	√3	1	± 0.0	∞
RF ambient Noise	± 1.0	Rectangular	√3	1	± 0.6	∞
RF ambient Reflections	± 1.0	Rectangular	√3	1	± 0.6	∞
Probe Positioner	± 0.8	Rectangular	√3	1	± 0.5	∞
Probe positioning	± 6.7	Rectangular	√3	1	± 3.9	∞
Max.SAR Eval.	± 2.0	Rectangular	√3	1	± 1.2	∞
Dipole Related						
Deviation of exp.dipole	± 5.5	Rectangular	√3	1	± 3.2	∞
Dipole Axis to Liquid Distance	± 2.0	Rectangular	√3	1	± 1.2	∞
Input power and SAR drift meas.	± 3.4	Rectangular	√3	1	± 2.0	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	√3	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	√3	0.78	± 2.3	∞
Liquid conductivity (meas.)	+ 5.0	Normal	1	0.26	+ 1.3	∞
Liquid permittivity (target)	± 5.0	Rectangular	√3	0.78	± 2.3	∞
Liquid permittivity (meas.)	- 5.0	Normal	1	0.23	- 1.2	∞
Liquid conductivity - temp.unc (below 2deg.C.)	± 1.7	Rectangular	√3	0.78	± 0.8	∞
Liquid permittivity - temp.unc (below 2deg.C.)	± 0.3	Rectangular	√3	0.23	± 0.0	∞
Combined Standard Uncertainty					± **10.491**	
Expanded Uncertainty (k=2)					± **21.0**	

Note: This uncertainty budget for validation is worst-case.

APPENDIX 3 : System specifications

1. Configuration and peripherals



The DASY5 system for performing compliance tests consist of the following items:

a) A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
An arm extension for accommodating the data acquisition electronics (DAE).

b) An isotropic field probe optimized and calibrated for the targeted measurement.

c) A data acquisition electronic (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.

d) 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.

e) 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.

f) The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

g) A computer running WinXP and the DASY5 software.

h) Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

i) The phantom, the device holder and other accessories according to the targeted measurement.

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2. Specifications

a)Robot TX60L

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manufacture	:	Stäubli Robotics

b)E-Field Probe

Model	:	EX3DV4
Serial No.	:	3917
Construction	:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol ether)
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 probe axis)
Dynamic Range	:	10uW/g to > 100 mW/g;Linearity +/-0.2 dB(noise: typically < 1uW/g)
Dimensions	:	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	:	Highprecision dosimetric measurement in any exposure scenario (e.g., very strong gradient fields).Only probe which enables compliance testing for frequencies up to 6GHz with precision of better 30%.
Manufacture	:	Schimid & Partner Engineering AG

EX3DV4 E-field Probe

c)Data Acquisition Electronic (DAE4)

Features	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) Two step probe touch detector for mechanical surface detection and emergency robot stop
Measurement Range	:	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset voltage	:	< 5 µV (with auto zero)
Input Resistance	:	200 MΩ
Input Bias Current	:	< 50 fA
Battery Power	:	> 10 h of operation (with two 9.6 V NiMH accus)
Dimension	:	60 x 60 x 68 mm
Manufacture	:	Schimid & Partner Engineering AG

d)Electro-Optic Converter (EOC)

Version	:	EOC 61
Descrption	:	for TX60 robot arm, including proximity sensor
Manufacture	:	Schimid & Partner Engineering AG

e)DASY5 Measurement server

Features	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
Dimensions (L x W x H)	:	440 x 241 x 89 mm
Manufacture	:	Schimid & Partner Engineering AG

f) Light Beam Switches

Version	:	LB5
Dimensions (L x H)	:	110 x 80 mm
Thickness	:	12 mm
Beam-length	:	80 mm
Manufacture	:	Schimid & Partner Engineering AG

g)Software

Item	:	Dosimetric Assesment System DASY5
Type No.	:	SD 000 401A, SD 000 402A
Software version No.	:	DASY52, Version 52.6 (1)
Manufacture / Origin	:	Schimid & Partner Engineering AG

h)Robot Controll Unit

Weight	:	70 Kg
AC Input Voltage	:	selectable
Manufacturer	:	Stäubli Robotics

i)Phantom and Device Holder

Phantom

Type	:	SAM Twin Phantom V4.0
Description	:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
Material	:	Vinylester, glass fiber reinforced (VE-GF)
Shell Material	:	Fiberglass
Thickness	:	2.0 +/-0.2 mm
Dimensions	:	Length: 1000 mm Width: 500 mm Height: adjustable feet
Volume	:	Approx. 25 liters
Manufacture	:	Schimid & Partner Engineering AG

Type	:	2mm Flat phantom ERI4.0
Description	:	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 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 supported by software version DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles.
Material	:	Vinylester, glass fiber reinforced (VE-GF)
Shell Thickness	:	2.0 ± 0.2 mm (sagging: <1%)
Filling Volume	:	approx. 30 liters
Dimensions	:	Major ellipse axis: 600 mm Minor axis: 400 mm
Manufacture	:	Schimid & Partner Engineering AG

Device Holder

In combination with the Twin SAM Phantom V4.0/V4.0c or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

Material : POM

Laptio Extensions kit

Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM, ELI4 Phantoms.

Material : POM, Acrylic glass, Foam

Urethane

For this measurement, the urethane foam was used as device holder.

j)Simulated Tissues (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 required for routine SAR evaluation.

Mixture (%)	Frequency (MHz)									
	450		900		1800		1950		2450	
Tissue Type	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**	**Head**	**Body**
Water	38.91	46.21	40.29	50.75	55.24	70.17	55.41	69.79	55.0	68.64
Sugar	56.93	51.17	57.90	48.21	-	-	-	-	-	-
Cellulose	0.25	0.18	0.24	0.00	-	-		-	-	-
Salt (NaCl)	3.79	2.34	1.38	0.94	0.31	0.39	0.08	0.2	-	-
Preventol	0.12	0.08	0.18	0.10	-				-	-
DGMBE	-	-	-	-	44.45	29.44	44.51	30.0	45.0	31.37
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

Note:DGMBE(Diethylenglycol-monobuthyl ether)

The simulated tissue (liguid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

Mixture (%)	Frequency(MHz)
	750
Tissue Type	**Head and Body**
Water	35-58%
Sugar	40-60%
Cellulose	<0.3%
Salt (NaCl)	0-6%
Preventol	0.1-0.7%
DGMBE	-

Mixture (%)	Frequency(MHz)	
	5800	
Tissue Type	**Head**	**Body**
Water	64.0	78.0
Mineral Oil	18.0	11.0
Emulsifiers	15.0	9.0
Additives and salt	3.0	2.0

Decision on Simulated Tissues of 750MHz

In the current standards (e.g., IEC62209-2, IEEE P1528), the dielectric parameters suggested for head and body tissue simulating liquid are given at 450MHz and 835MHz. As an intermediate solution,
dielectric parameters for the frequencies between 450 to 835MHz were obtained using linear interpolation.
Therefore the dielectric parameter of 750MHz(The frequency for the validation) was decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	ε r	σ [mho/m]	ε r	σ [mho/m]	
450	43.5	0.87	56.7	0.94	Standard
750	41.94	0.89	55.5	0.96	Interpolated
835	41.5	0.9	55.2	0.97	Standard

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range 450 to 835MHz.

Decision on Simulated Tissues of 1750MHz

In the current standards (e.g., IEC62209-2, IEEE P1528), the dielectric parameters suggested for head and body tissue simulating liquid are given at 1610MHz and 1800MHz. As an intermediate solution,
dielectric parameters for the frequencies between 1610 to 1800MHz were obtained using linear interpolation.
Therefore the dielectric parameter of 1750MHz(The frequency for the validation) was decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	ε r	σ [mho/m]	E r	σ [mho/m]	
1450	40.5	0.87	54.0	1.30	Standard
1610	40.3	1.29	53.8	1.40	Standard
1750	40.08	1.37	53.43	1.49	Interpolated
1800	40.0	1.40	53.3	1.52	Standard

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range
1610 to 1800MHz.

Decision on Simulated Tissues of 5GHz band

In the current standards (e.g., IEC62209-2, IEEE P1528), the dielectric parameters suggested for head and body tissue simulating liquid are given at 3000MHz and 5800MHz. As an intermediate solution, dielectric parameters for the frequencies between 5000to 5800 MHz were obtained using linear interpolation.
Therefore the dielectric parameters of 5200MHz,5300MHz,5600MHz and 5500MHz(The frequency for the validation) were decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	ε r	σ [mho/m]	ε r	σ [mho/m]	
3000	38.5	2.40	52.0	2.73	Standard
5800	35.3	5.27	48.2	6.00	Standard
5000	36.2	4.45	49.3	5.07	Interpolated
5100	36.1	4.55	49.1	5.18	Interpolated
5200	36.0	4.66	49.0	5.30	Interpolated
5300	35.9	4.76	48.9	5.42	Interpolated
5400	35.8	4.86	48.7	5.53	Interpolated
5500	35.6	4.96	48.6	5.65	Interpolated
5600	35.5	5.07	48.5	5.77	Interpolated
5700	35.4	5.17	48.3	5.88	Interpolated

Standard and interpolated dielectric parameters for head and body tissue simulating liquid in the frequency range
3000 to 5800MHz.

3. Dosimetric E-Field Probe Calibration (EX3DV4, S/N: 3917)

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: UL Japan (PTT)

Certificate No: EX3-3917_May13

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3917
Calibration procedure(s)	QA CAL-01.v8, QA CAL-12.v7, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	May 14, 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 8648C	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:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 15, 2013

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

Certificate No: EX3-3917_May13 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
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization 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., ϑ = 0 is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3917

Manufactured: December 18, 2012
Calibrated: May 14, 2013

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

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EX3DV4– SN:3917

May 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3917

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.53	0.43	0.45	± 10.1 %
DCP (mV)[B]	99.4	103.6	100.9	

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	174.0	±3.5 %
		Y	0.0	0.0	1.0		147.1	
		Z	0.0	0.0	1.0		153.5	

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.

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EX3DV4– SN:3917 May 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3917

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)
300	45.3	0.87	11.89	11.89	11.89	0.21	0.72	± 13.4 %
450	43.5	0.87	10.41	10.41	10.41	0.14	1.00	± 13.4 %
650	42.5	0.89	10.42	10.42	10.42	0.10	1.00	± 13.4 %
750	41.9	0.89	10.07	10.07	10.07	0.73	0.63	± 12.0 %
835	41.5	0.90	9.66	9.66	9.66	0.76	0.59	± 12.0 %
900	41.5	0.97	9.69	9.69	9.69	0.41	0.84	± 12.0 %
1450	40.5	1.20	8.47	8.47	8.47	0.26	1.22	± 12.0 %
1640	40.3	1.29	8.77	8.77	8.77	0.59	0.68	± 12.0 %
1750	40.1	1.37	8.41	8.41	8.41	0.51	0.73	± 12.0 %
1810	40.0	1.40	8.09	8.09	8.09	0.37	0.85	± 12.0 %
1900	40.0	1.40	7.98	7.98	7.98	0.65	0.65	± 12.0 %
1950	40.0	1.40	7.77	7.77	7.77	0.48	0.75	± 12.0 %
2000	40.0	1.40	7.90	7.90	7.90	0.59	0.67	± 12.0 %
2450	39.2	1.80	7.20	7.20	7.20	0.41	0.82	± 12.0 %
2600	39.0	1.96	7.00	7.00	7.00	0.32	0.96	± 12.0 %
5200	36.0	4.66	5.28	5.28	5.28	0.40	1.80	± 13.1 %
5300	35.9	4.76	5.05	5.05	5.05	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.74	4.74	4.74	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.54	4.54	4.54	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.61	4.61	4.61	0.45	1.80	± 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.

Certificate No: EX3-3917_May13 Page 5 of 11

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3917

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)
300	58.2	0.92	11.80	11.80	11.80	0.18	1.12	± 13.4 %
450	56.7	0.94	11.00	11.00	11.00	0.05	1.20	± 13.4 %
650	55.9	0.96	10.01	10.01	10.01	0.05	1.50	± 13.4 %
750	55.5	0.96	9.99	9.99	9.99	0.37	0.91	± 12.0 %
835	55.2	0.97	9.76	9.76	9.76	0.32	0.98	± 12.0 %
900	55.0	1.05	9.75	9.75	9.75	0.80	0.57	± 12.0 %
1450	54.0	1.30	8.59	8.59	8.59	0.76	0.59	± 12.0 %
1640	53.8	1.40	8.76	8.76	8.76	0.54	0.75	± 12.0 %
1750	53.4	1.49	7.91	7.91	7.91	0.74	0.65	± 12.0 %
1810	53.3	1.52	7.73	7.73	7.73	0.46	0.84	± 12.0 %
1900	53.3	1.52	7.62	7.62	7.62	0.75	0.65	± 12.0 %
1950	53.3	1.52	7.84	7.84	7.84	0.48	0.79	± 12.0 %
2000	53.3	1.52	7.74	7.74	7.74	0.49	0.77	± 12.0 %
2450	52.7	1.95	7.27	7.27	7.27	0.80	0.55	± 12.0 %
2600	52.5	2.16	7.04	7.04	7.04	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.72	4.72	4.72	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.56	4.56	4.56	0.45	1.90	± 13.1 %
5500	48.6	5.65	4.15	4.15	4.15	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.00	4.00	4.00	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.33	4.33	4.33	0.50	1.90	± 13.1 %

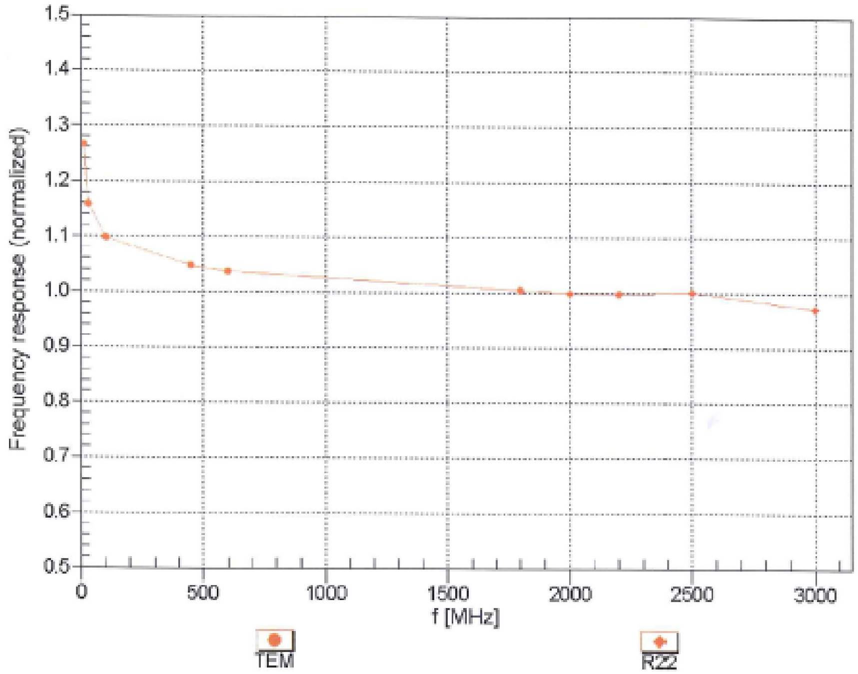
[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of 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:3917

May 14, 2013

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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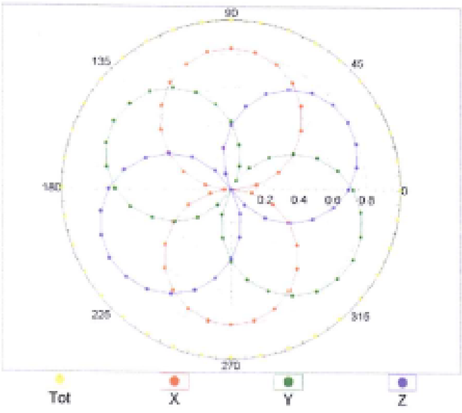
EX3DV4– SN:3917

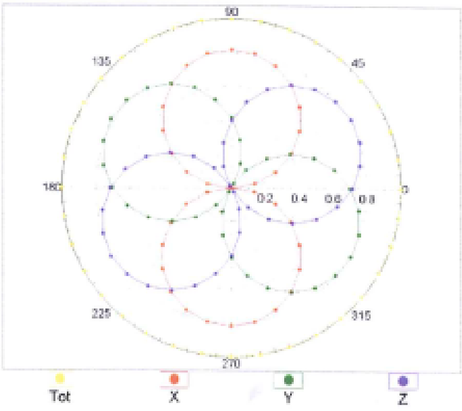
May 14, 2013

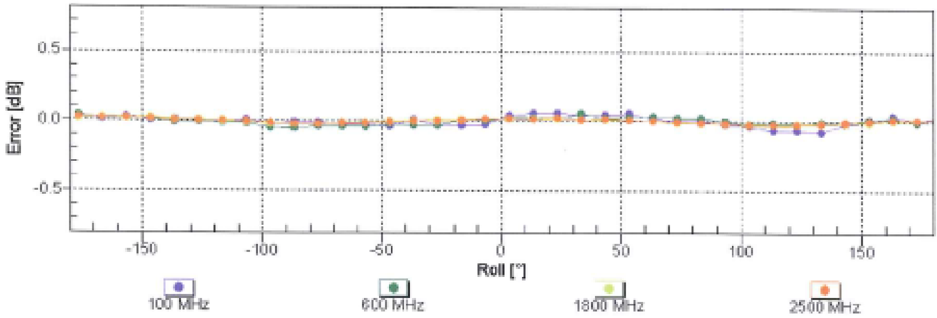
Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM

f=1800 MHz,R22







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

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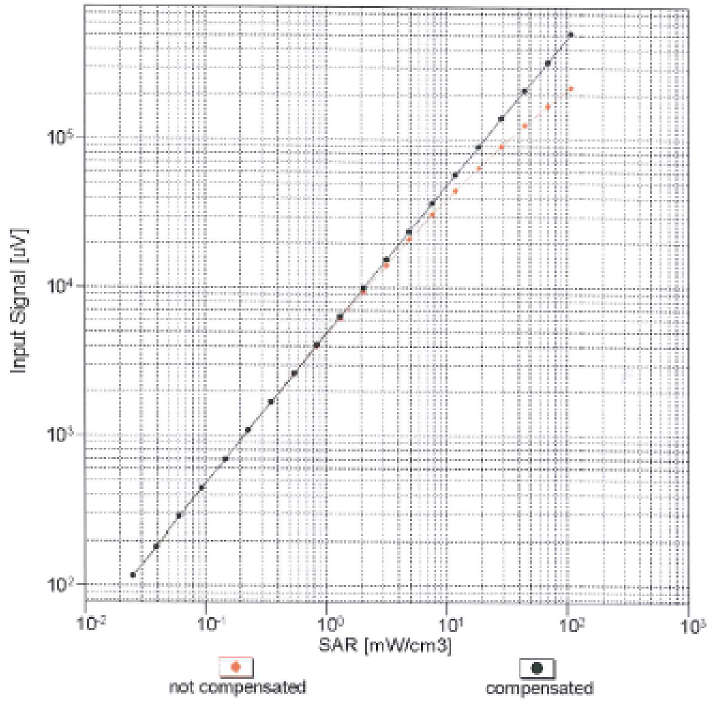
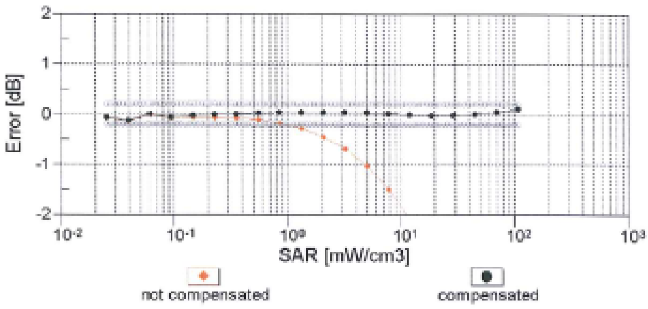
EX3DV4– SN:3917

May 14, 2013

Dynamic Range f(SAR$_{head}$)

(TEM cell , f = 900 MHz)





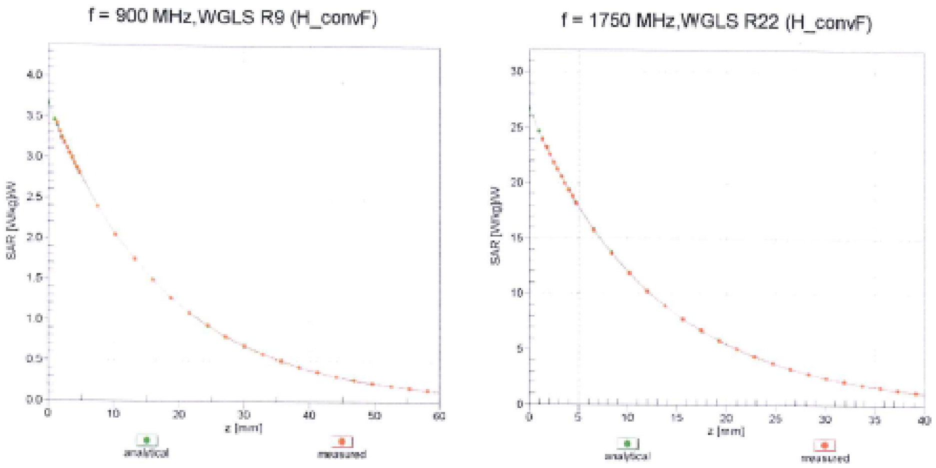
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Certificate No: EX3-3917_May13 Page 9 of 11

EX3DV4– SN:3917

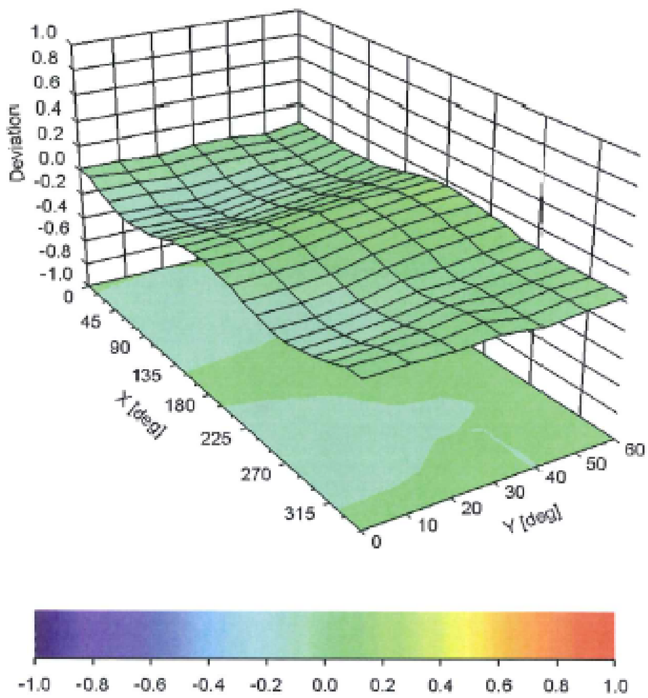
May 14, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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EX3DV4– SN:3917

May 14, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3917

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	63.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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