SAR TEST REPORT

Test Report No. : 10184711H

Applicant	:	**OLYMPUS IMAGING CORP.**
Type of Equipment	:	**Wireless LAN Module**
Model No.	:	**O-W092**
FCC ID	:	**YSKXW1**
Test regulation	:	**FCC47CFR 2.1093**
Test Result	:	**Complied**
Reported SAR(1g) Value		**The highest reported SAR(1g)** **FCC Part15.247** Body : 0.088W/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.

Date of test: January 16, 2014

Representative test engineer: H. Sato

Hisayoshi Sato
Engineer of WiSE Japan,
UL Verification Service

Approved by : T. Hatakeda

Takahiro Hatakeda
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

REVISION HISTORY

Original Test Report No.: 10184711H

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10184711H	January 29, 2014	-	-

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SECTION 1: Customer information

Company Name	:	OLYMPUS IMAGING CORP.
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Contact Person	:	Keisuke Hasegawa

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

2.1 Identification of E.U.T.

<Information of the EUT>

Type of Equipment	:	Wireless LAN module
Model No.	:	O-W092
Serial No.	:	78617CC9DD83
Rating	:	DC 3.3V
Country of Mass-production	:	Philippines
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.	:	SH-1
Serial No.	:	1 003
Rating	:	Li-ion Battery (M/N: LI-90B) DC 3.6V, 1270mAh * The test was performed with the EUT operated by battery.
Option Battery	:	N/A
Body-worn accessory	:	N/A
Size of EUT	:	W: 108mm, D: 31mm, H: 60mm
Receipt Date of Sample	:	January 17, 2014
Country of Mass-production	:	Indonesia
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

2.2 Product description

General Specification

<EUT>

Clock frequency(ies) in the system	:	26MHz

<Host device>

Clock frequency(ies) in the system	:	48MHz and 32.768kHz for main system 26MHz for Wireless LAN

Radio Specification

WLAN (IEEE802.11b/g/n)

Equipment Type	Transceiver
Frequency of Operation	2412-2462MHz
Clock Frequency	20MHz
Type of Modulation	DSSS, OFDM
Antenna Type	2.4GHz Pattern Antenna
Antenna Gain	0.41dBi (max.)

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.
: **Published RF exposure KDB procedures**

☑ **KDB450824 D01(v01r01)**	SAR Prob Cal and Ver Meas
☑ **KDB450824 D02(v01r01)**	Dipole SAR Validation Verification
☑ **KDB447498D01(v05r01)**	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
☐ **KDB447498D02(v02)**	SAR Measurement Procedures for USB Dongle Transmitters
☐ **KDB648474D04(v01r01)**	SAR Evaluation Considerations for Wireless Handsets
☐ **KDB941225D01(v02)**	SAR Measurement Procedures for 3G Devices
☐ **KDB941225D02(v02r02)**	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(v02r02)**	SAR for LTE Devices
☐ **KDB941225D06(v01r01)**	SAR test procedures for devices incorporating SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities (Hot Spot SAR)
☐ **KDB941225D07(v01r01)**	SAR Evaluation Procedures for UMPC Mini-Tablet Devices
☐ **KDB 616217 D04(v01r01)**	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
☑ **KDB865664 D01(v01r02)**	SAR Measurement Requirements for 100MHz to 6 GHz
☑ **KDB248227 D01(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 (Schmid & Partner Engineering AG).

3.2 Procedure

Transmitter	**WLAN**
Test Procedure	Published RF exposure KDB procedures
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
UL Japan, Inc. Head Office EMC Lab. *NVLAP Lab. code: 200572-0
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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]
Maximum tune-up tolerance limit is 12.71mW(11.04dBm) by the specification from a customer.
Refer to the “Tune-up procedure for WLAN” for Maximum tune-up tolerance limit.

Mode	Measured maximum power [mW]*1	Maximum tune-up tolerance limit [mW]	Measured SAR [W/kg]	Reported SAR [W/kg]
WLAN 11b/g/n (2.4GHz)	12.56	12.71	0.087	0.088

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

Mode	Duty cycle	Frequency Band	Test Frequency	Modulation
IEEE802.11b	100%	2412-2462MHz	2412MHz (1ch) 2437MHz(6ch) 2462MHz(11ch)	DSSS (DBPSK.DQPSK.CCK)
IEEE802.11g	100%	2412-2462MHz	2412MHz (1ch) 2437MHz(6ch) 2462MHz(11ch)	OFDM (BPSK.QPSK.16QAM,64QAM)
IEEE802.11n20 (2.4G)	100%	2412-2462MHz	2412MHz (1ch) 2437MHz(6ch) 2462MHz(11ch)	

WLAN

*Power of the EUT was set by the software as following;
[Power Setting]
11b: 11dBm
11g: 11dBm
11n-20(2.4GHz): 9dBm
Software: SG852 wireless test
Version: ver20131226

*The above setting 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.

5.2 Output power measurement results

Output power measurement for WLAN

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

[IEEE802.11b] Rate Check

Rate [Mbps]	Freq. [MHz]	Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1.0	2437	-0.08	0.63	10.08	10.63	11.56
2.0	2437	0.03	0.63	10.08	10.74	11.86
5.5	2437	0.08	0.63	10.08	10.79	11.99
11.0	2437	0.06	0.63	10.08	10.77	11.94

:Worst data rate

IEEE802.11b 1Mbps

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	0.18	0.63	10.08	10.89	12.27
6	2437	-0.08	0.63	10.08	10.63	11.56
11	2462	0.15	0.63	10.08	10.86	12.19

IEEE802.11b 5.5Mbps

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	0.28	0.63	10.08	10.99	12.56
6	2437	0.08	0.63	10.08	10.79	11.99
11	2462	0.19	0.63	10.08	10.90	12.30

:SAR test channel

[IEEE802.11g] Rate Check

Rate [Mbps]	Frequency [MHz]	Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
6.0	2437	-0.80	0.63	10.08	9.91	9.79
9.0	2437	-0.83	0.63	10.08	9.88	9.73
12.0	2437	-0.87	0.63	10.08	9.84	9.64
18.0	2437	-0.84	0.63	10.08	9.87	9.71
24.0	2437	-0.91	0.63	10.08	9.80	9.55
36.0	2437	-0.73	0.63	10.08	9.98	9.95
48.0	2437	-0.69	0.63	10.08	10.02	10.05
54.0	2437	-0.73	0.63	10.08	9.98	9.95

:Worst data rate

IEEE802.11g 6Mbps

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	-0.62	0.63	10.08	10.09	10.21
6	2437	-0.80	0.63	10.08	9.91	9.79
11	2462	-0.81	0.63	10.08	9.90	9.77

IEEE802.11g 48Mbps

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	-0.86	0.63	10.08	9.85	9.66
6	2437	-0.69	0.63	10.08	10.02	10.05
11	2462	-0.65	0.63	10.08	10.06	10.14

Sample Calculation:
Result = Reading + Cable Loss + Attenuator

[IEEE802.11n-20] Rate Check

Rate	Frequency [MHz]	Reading [dBm] AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
MCS0	2437	-2.82	0.63	10.08	7.89	6.15
MCS1	2437	-2.76	0.63	10.08	7.95	6.24
MCS2	2437	-2.70	0.63	10.08	8.01	6.32
MCS3	2437	-2.74	0.63	10.08	7.97	6.27
MCS4	2437	-2.77	0.63	10.08	7.94	6.22
MCS5	2437	-2.81	0.63	10.08	7.90	6.17
MCS6	2437	-2.59	0.63	10.08	8.12	6.49
MCS7	2437	-2.64	0.63	10.08	8.07	6.41

:Worst data rate

IEEE802.11n-20 MCS0

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	-2.44	0.63	10.08	8.27	6.71
6	2437	-2.82	0.63	10.08	7.89	6.15
11	2462	-2.45	0.63	10.08	8.26	6.70

IEEE802.11n-20 MCS6

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	-2.49	0.63	10.08	8.22	6.64
6	2437	-2.59	0.63	10.08	8.12	6.49
11	2462	-2.49	0.63	10.08	8.22	6.64

Correlation of output power with original report(Test report No.: 33AE0097-HO)

IEEE802.11b 2Mbps (Output power(time average) of original test report)

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG
1	2412	0.14	0.88	10.00	11.02

IEEE802.11b 2Mbps (This time)

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Deviation [dB]
1	2412	0.16	0.63	10.08	10.87	-0.15

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

1) SAR measurement for WLAN

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

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

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

Mode	Test Frequency	Modulation	Crest factor	Note
IEEE802.11b	2412MHz(1ch)	DBPSK(1Mbps) CCK(5.5Mbps)	1	*1
IEEE802.11g	Not required			*2
IEEE802.11n20 (2.4G)	Not required			*2
WLAN				
*Power of the EUT was set by the software as following; [Power Setting] 11b: 11dBm 11g: 11dBm 11n-20(2.4GHz): 9dBm Software: SG852 wireless test Version: ver20131226 *The above setting 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.				

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

*2 The 11b mode was maximum average power. The 11g/n 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.

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.

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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.

Mode	Standalone SAR tested	Positiom	Upper frequency of band *1	Maximum tune-up tolerance limit *5	Min distance *2	Calculation of exclusion *3
WLAN(2.4 GHz band)	☑	Right side	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	5.2 [mm]	4
WLAN(2.4 GHz band)	☐	Top	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	9.1 [mm]	2
WLAN(2.4 GHz band)	☐	Rear(LCD)	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	29.9 [mm]	1
WLAN(2.4 GHz band)	☑	Front(Lens)	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	5.0 [mm]	4

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

Mode	Standalone SAR tested	Positiom	Upper frequency of band *1	Maximum tune-up tolerance limit *5	Min distance *2	Calculation of threshold*4
WLAN(2.4 GHz band)	☐	Left side	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	98.9 [mm]	584 [mW]
WLAN(2.4 GHz band)	☐	Bottom	2462 [MHz] (11ch)	11.04 [dBm] 12.71 [mW] 13 [mW]*6	49.9 [mm]	94 [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. The result is rounded to one decimal place for comparison
*4 $[(3 \cdot 50)/(\sqrt{f_{(GHz)}})]$ + (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. The result is rounded to one decimal place for comparison
*5 The maximum tune-up tolerance limit is by the specification from a customer.
*6 Maximum tune-up tolerance limit(mW) is rounded to one decimal place.

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 KDB447498 D01 (Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies)

ii)Test mode

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

iii)Test position

No.	Position	Test distance	WLAN		
			Tested	Antenna	Separation from user
1	Right side	0mm	☑	Fixed	5.2mm
2	Top	0mm	☐	Fixed	9.1mm
3	Rear(LCD)	0mm	☐	Fixed	29.9mm
4	Front(Lens)	0mm	☑	Fixed	4.5mm
5	Left side	0mm	☐	Fixed	98.9mm
6	Bottom	0mm	☐	Fixed	49.9mm

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.

<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	2
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.)	+	2.7	Rectangular	1	0.64	+	1.7	∞
Liquid permittivity (target)	±	5.0	Rectangular	√3	0.6	±	1.7	∞
Liquid permittivity (meas.)	-	3.9	Rectangular	1	0.6	-	2.3	∞
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						±	**11.977**	
Expanded Uncertainty (k=2)						±	**24.0**	

SECTION 9 : Measurement results

9.1 WLAN Body SAR (2.4G)

(1)Method of measurement

Step.1 The searching for the worst transmit rate
The test was performed in position of Front(Lens)
Step.2 The searching for the worst position.
The test was performed at the worst transmit rate of Step.1.

Note:
1)The other channel was not required since maximum average output power channel SAR value is less than 0.8W/kg in according to KDB447498D01.
2) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg.
When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit) in accordance to KDB865664 D01.

(2)Simulated Tissue Liquid Parameter confirmation

The dielectric parameters were checked prior to assessment using the HP85070D dielectric 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 [%]
16-Jan	24.0	57	MSL 2450	23.5	2412	εr	52.8	50.7	-3.9	+/-5
						σ [mho/m]	1.91	1.97	2.7	+/-5

εr: Relative Permittivity / σ : Coductivity
*1 The Target value is a parameter defined in KDB 865664D01.

(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 of multi-peak	Maximum of multi-peak
Step.1 Worst rate searching												
1	2412	11b 5.5Mbps	10.99	12.56	11.04	12.71	Flat	Fixed	Front(Lens)	0	**0.087**	**0.088**
1	2412	11b 1Mbps	10.89	12.27	11.04	12.71	Flat	Fixed	Front(Lens)	0	**0.085**	**0.088**
Step.2 Position change												
1	2412	11b 5.5Mbps	10.99	12.56	11.04	12.71	Flat	Fixed	Rightside	0	**0.038**	**0.038**

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

SECTION 10 Test instruments

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MPM-08	Power Meter	Anritsu	ML2495A	6K00003338	Power Measurement	2013/10/15 * 12
MPSE-11	Power sensor	Anritsu	MA2411B	011737	Power Measurement	2013/10/15 * 12
MAT-23	Attenuator(10dB) 1-18GHz	Orient Microwave	BX10-0476-00	-	Power Measurement	2013/03/21 * 12
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	SAR	2013/09/09 * 12
MOS-37	Digital thermometer	LKM electronic	DTM3000	-	SAR	2013/07/29 * 12
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	SAR	2013/09/07 * 12
MDPK-01	Dielectric probe kit	Agilent	85070D	702	SAR	2013/09/09 * 12
COTS-MSAR-02	S-Parameter Network Analyzer	Agilent	-	-	SAR	-
MPM-14	Power meter	Virginia Diodes, Inc.	PM4	137V	SAR	2013/09/27 * 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	Agilent	87300B	14893A	SAR(2-18GHz)	Pre Check
MRFA-24	Pre Amplifier	R&K	R&K CGA020M602-2633R	B30550	SAR	2013/06/06 * 12
MSG-13	Signal Genelator	Rohde & Schwarz	SMA 100A	103764	SAR	2013/06/05 * 12
MDA-07	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	713	SAR(D2450)	2013/09/10 * 12
MDAE-01	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	509	SAR	2013/07/16 * 12
MPB-07	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3825	SAR	2013/12/13 * 12
MPSAM-02	SAM Phantom	Schmid&Partner Engineering AG	SAM Twin Phantom V4.0	1333	SAR	2013/05/25 * 12
MPF-02	2mmOval Flat Phantom ERI 4.0	Schmid&Partner Engineering AG	QD VA 001B (ERI4.0)	1045	SAR	2013/05/25 * 12
MDH-01	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	Pre Check
MOS-10	Digtal thermometer	HANNA	Checktemp-2	MOS-10	SAR	2013/08/23 * 12
MOS-26	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q29	SAR	2013/05/16 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY5	-	SAR	-
MSL2450					Daily check Target value ± 5%	
SAR room					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 for below 3GHz and a volume of 28 mm x 28mm x 22.5mm or more was assessed by measuring 8 x 8 x 6(ratio step method (*1)) points at least for 5GHz band.

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(EX3DV4) 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.

***1. Ratio step method parameters used;**
The first measurement point: 2mm from the phantom surface, the initial grid separation: 2mm, subsequent graded grid ratio: 1.5
These parameters comply with the requirement of the KDB 865664.
In the section of SAR Scan Procedures-Zoom Scan, in KDB 865664 D02v01: SAR Measurement Requirements for 100MHz to 6GHz, the graded grids requirement is as follows;
“When graded grids are used (z), the first measurement point should be within 3mm of the phantom surface for measurements below 4.5GHz and within 2mm at or above 4.5GHz. The initial grid separation, closest to the phantom, should be 2.0mm. A subsequent graded ration of 1.5 is recommended and less than 2.0 is required. “

2. Measurement data

i) WLAN Body

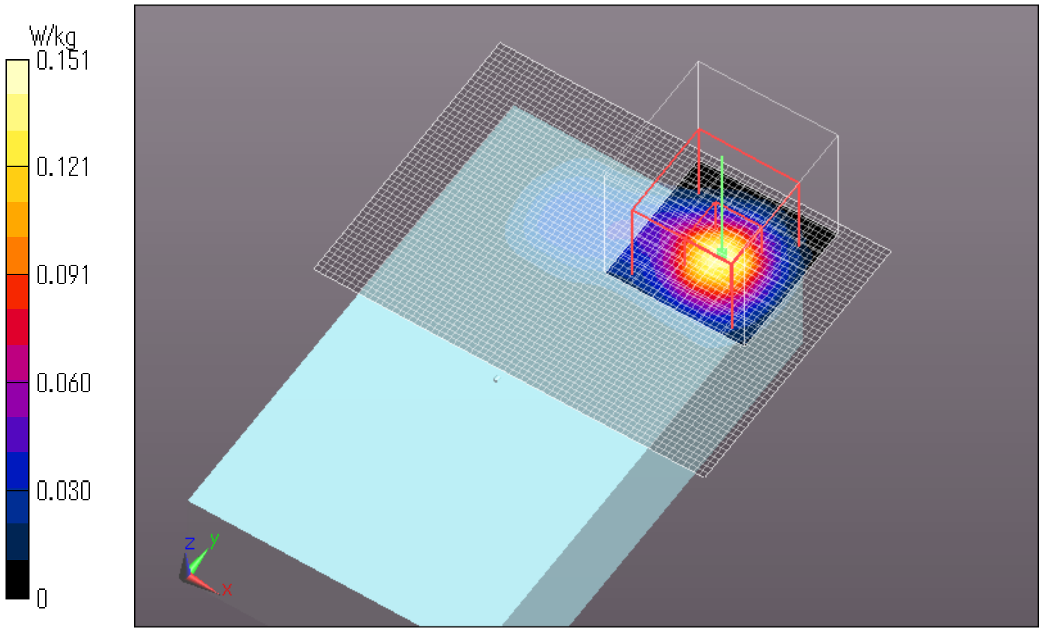
Front 11b 5.5Mbps 2412MHz
Communication System: UID 0, WLAN 11a/b/g/n ; Communication System Band: WLAN 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.966 S/m; ε_r = 50.717; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3825; ConvF(7.23, 7.23, 7.23); Calibrated: 2013/12/13;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn509; Calibrated: 2013/07/16
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Area Scan 2 2 (71x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.162 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.821 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 0.227 W/kg
SAR(1 g) = 0.087 W/kg; SAR(10 g) = 0.032 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.151 W/kg
Date: 2014/01/16
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.

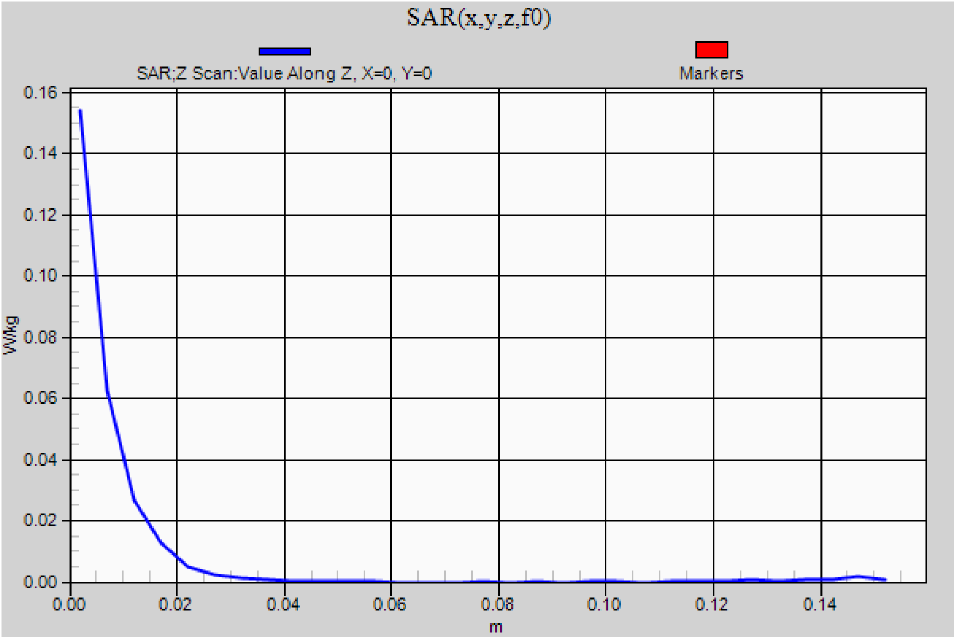


Z Scan at Maximum BODY SAR position in WLAN 2.4GHz band

Front 11b 5.5Mbps 2412MHz
Communication System: UID 0, WLAN 11a/b/g/n ; Communication System Band: WLAN 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.966 S/m; ε_r = 50.717; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3825; ConvF(7.23, 7.23, 7.23); Calibrated: 2013/12/13;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn509; Calibrated: 2013/07/16
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

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

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.154 W/kg
Date: 2014/01/16
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



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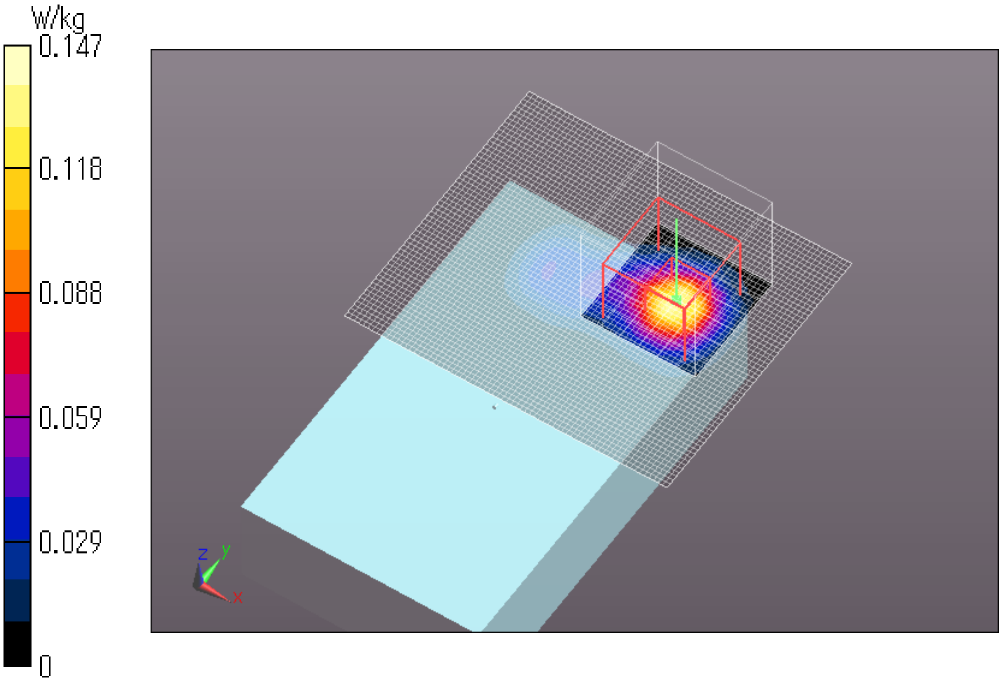
Front 11b 1Mbps 2412MHz
Communication System: UID 0, WLAN 11a/b/g/n ; Communication System Band: WLAN 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.966 S/m; ε_r = 50.717; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3825; ConvF(7.23, 7.23, 7.23); Calibrated: 2013/12/13;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn509; Calibrated: 2013/07/16
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Area Scan 2 2 (71x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.175 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 8.804 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 0.220 W/kg
SAR(1 g) = 0.085 W/kg; SAR(10 g) = 0.031 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.147 W/kg
Date: 2014/01/16
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



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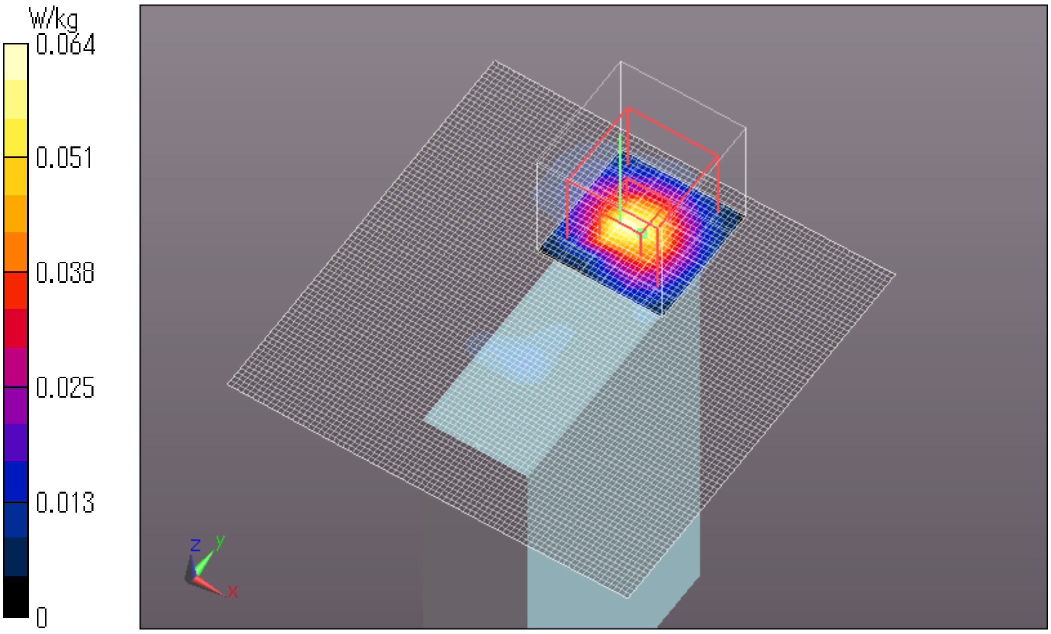
Right side 11b 5.5Mbps 2412MHz
Communication System: UID 0, WLAN 11a/b/g/n ; Communication System Band: WLAN 11b/g/n; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.966 S/m; ε_r = 50.717; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3825; ConvF(7.23, 7.23, 7.23); Calibrated: 2013/12/13;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn509; Calibrated: 2013/07/16
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0639 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.452 V/m; Power Drift = 0.20 dB
Peak SAR (extrapolated) = 0.0940 W/kg
SAR(1 g) = 0.038 W/kg; SAR(10 g) = 0.014 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0636 W/kg
Date: 2014/01/16
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



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APPENDIX2 : System check

1. System check 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 [%]
16-Jan	24.0	57	MSL 2450	23.5	2450	εr	52.7	50.6	-4.0	+/-5
						σ [mho/m]	1.95	2.01	2.8	+/-5

εr: Relative Permittivity / σ : Coductivity
*1 The Target value is a parameter defined in KDB 865664D01.

DIELECTRIC PARAMETERS MEASUREMENT RESULTS										
Date	Ambient Temp. [deg.c]	Relative Humidity [%]	Liquid type	Liquid Temp. [deg.c]	Measured Frequency [MHz]	Parameters	Target Value*2	Measured	Deviation [%]	Limit*3 [%]
16-Jan	24.0	57	MSL 2450	23.5	2450	εr	52.2	50.6	-3.1	+/-6
						σ [mho/m]	2.00	2.01	0.3	+/-6

εr: Relative Permittivity / σ : Coductivity
*2 The target value is the calibrated dipole Body TSL parameters. (D2450V2 SN:713, Measured Body TSL parameters)
*3 The limit is for deviation provided by manufacture.

System check result (for calibration by manufacture)

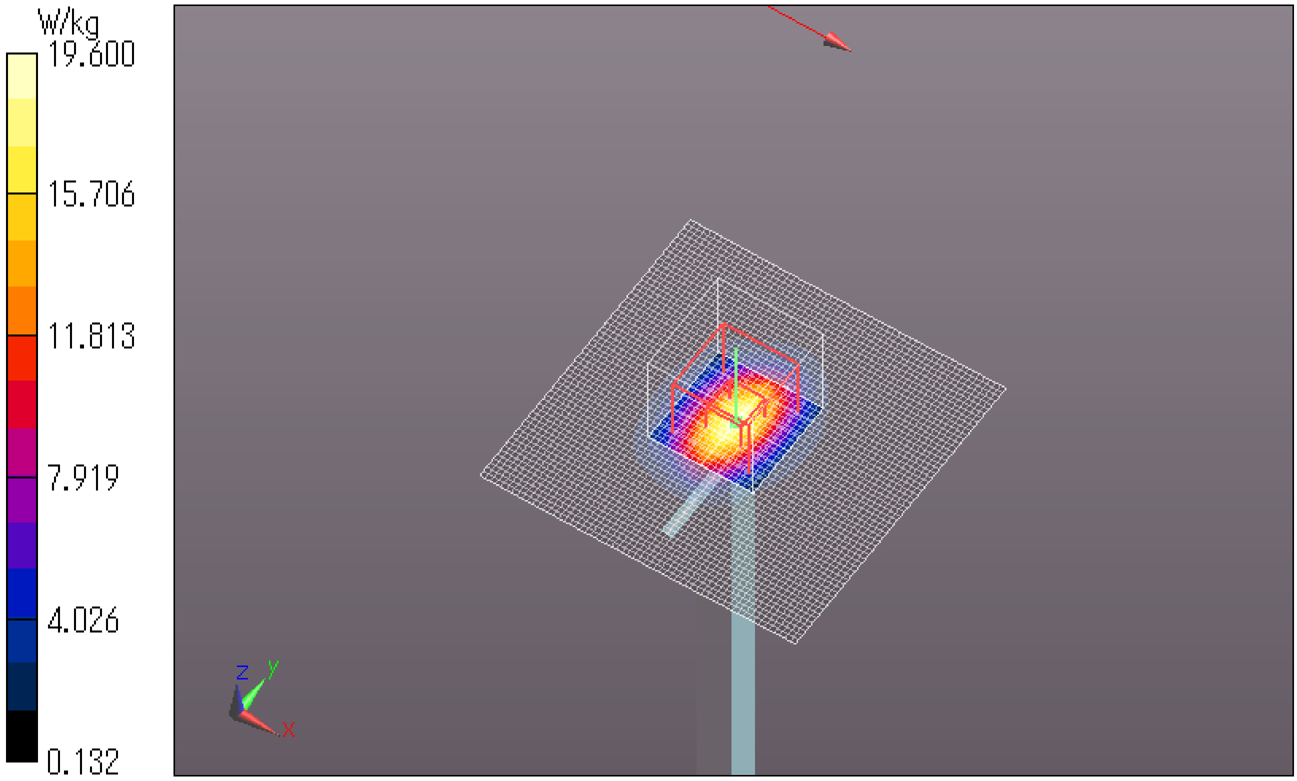
SYSTEM VALIDATION						
Date	Frequency [MHz]	SAR 1g [W/kg]				
		Forward Power 250mW Measured	Conversion 1W Calculation	Target 1W *4	Deviation [%]	Limit [%]
16-Jan	2450.00	12.80	51.20	50.40	1.6	+/-10

*4 The taget value is the parameter defined in SAR mesured x 4(12.6 x 4 = 50.4) in manufacturer calibrated dipole (D2450V2 SN:713)
Please refer to " SAR result with Body TSL of Appendix 2 2. System Check Dipole (D2450V2,S/N: 713)".

Body 2450MHz System check DATA / Dipole2.4GHz / Forward Conducted Power : 250mW
SystemPerformanceCheck-D2450_20140117
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 2.005 S/m; ε_r = 50.589; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3825; ConvF(7.23, 7.23, 7.23); Calibrated: 2013/12/13;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn509; Calibrated: 2013/07/16
Phantom: ELI 4.0; Type: QDOVA001BA;
Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 19.0 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.136 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 26.5 W/kg
SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.9 W/kg
Maximum value of SAR (measured) = 19.6 W/kg
Date: 2014/01/16
Ambient Temp. : 24.0 degree.C.   Liquid Temp.; 23.5 degree.C.



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2. System check Dipole (D2450V2,S/N:713)

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 **UL Japan (PTT)**

Certificate No: **D2450V2-713_Sep13**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 713
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 10, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: September 10, 2013

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

Certificate No: D2450V2-713_Sep13 Page 1 of 8

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)
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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) KDB 865664, “SAR Measurement Requirements for 100 MHz to 6 GHz”

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the 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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 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	39.4 ± 6 %	1.83 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.1 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.2 ± 6 %	2.00 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	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.7 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.89 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.4 W/kg ± 16.5 % (k=2)**

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Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.8 Ω + 0.7 jΩ
Return Loss	- 34.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.7 Ω + 2.8 jΩ
Return Loss	- 30.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.162 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 05, 2002

UL Japan, Inc.
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DASY5 Validation Report for Head TSL

Date: 10.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

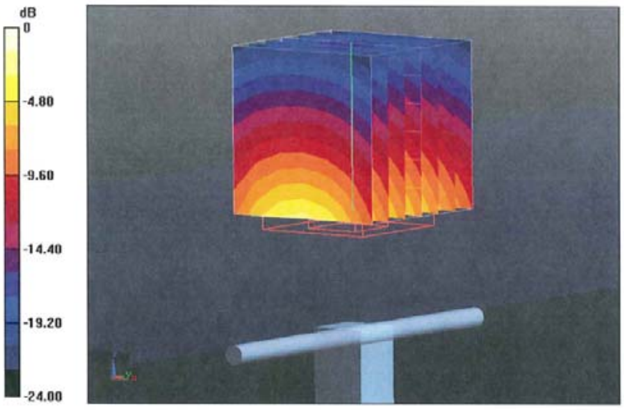
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 713

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma = 1.83$ S/m; $\varepsilon_r = 39.4$; $\rho = 1000$ 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: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

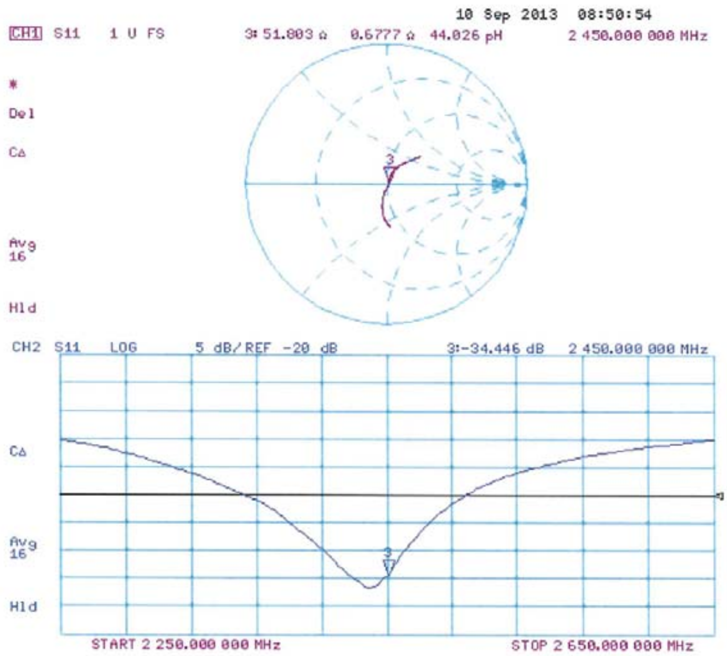
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.095 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 26.7 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.05 W/kg
Maximum value of SAR (measured) = 17.0 W/kg



0 dB = 17.0 W/kg = 12.30 dBW/kg

Certificate No: D2450V2-713_Sep13 Page 5 of 8

Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 10.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 713

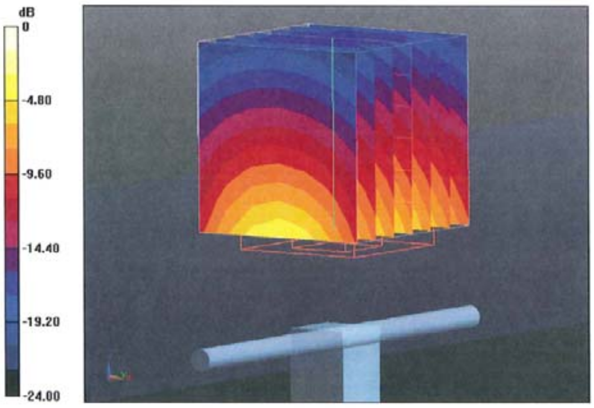
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2 S/m; ε_r = 52.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.095 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 26.1 W/kg
SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.89 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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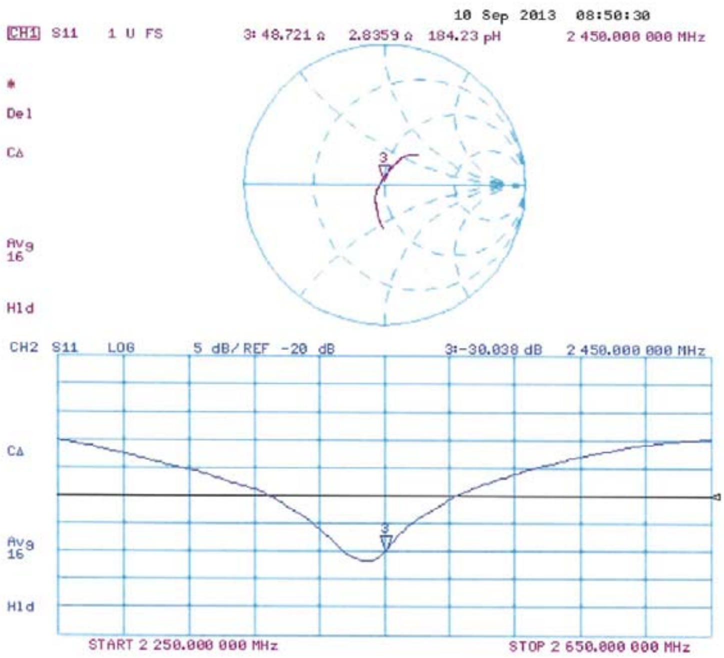
Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-713_Sep13 Page 8 of 8

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3. System check 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.

Repeatability Budget for System Check for the 0.3 - 3GHz range

Error Description	Uncertai value ±		Probability distribution	divisor	(ci) 1g	Standard (1g)		vi or veff
Measurement System								
Probe calibration	±	1.8	Normal	1	1	±	1.80	∞
Axial isotropy of the probe	±	0.0	Rectangular	√3	1	±	0.0	∞
Spherical isotropy of the probe	±	0.0	Rectangular	√3	0	±	0.0	∞
Boundary effects	±	0.0	Rectangular	√3	1	±	0.0	∞
Probe linearity	±	0.0	Rectangular	√3	1	±	0.0	∞
Detection limit	±	0.0	Rectangular	√3	1	±	0.0	∞
Modulation response	±	0.0	Rectangular	√3	1	±	0.0	∞
Readout electronics	±	0.0	Normal	1	1	±	0.0	∞
Response time	±	0.0	Rectangular	√3	1	±	0.0	∞
Integration time	±	0.0	Rectangular	√3	1	±	0.0	∞
RF ambient Noise	±	0.0	Rectangular	√3	1	±	0.0	∞
RF ambient Reflections	±	0.0	Rectangular	√3	1	±	0.0	∞
Probe Positioner	±	0.4	Rectangular	√3	1	±	0.2	∞
Probe positioning	±	2.9	Rectangular	√3	1	±	1.7	∞
Max.SAR Eval.	±	0.0	Rectangular	√3	1	±	0.0	∞
Dipole Related								
Deviation of exp.dipole	±	0.0	Rectangular	√3	1	±	0.0	∞
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	0.26	-	1.3	∞
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						±	**5.548**	
Expanded Uncertainty (k=2)						±	**11.1**	

Note: This uncertainty budget for system check is worst-case.

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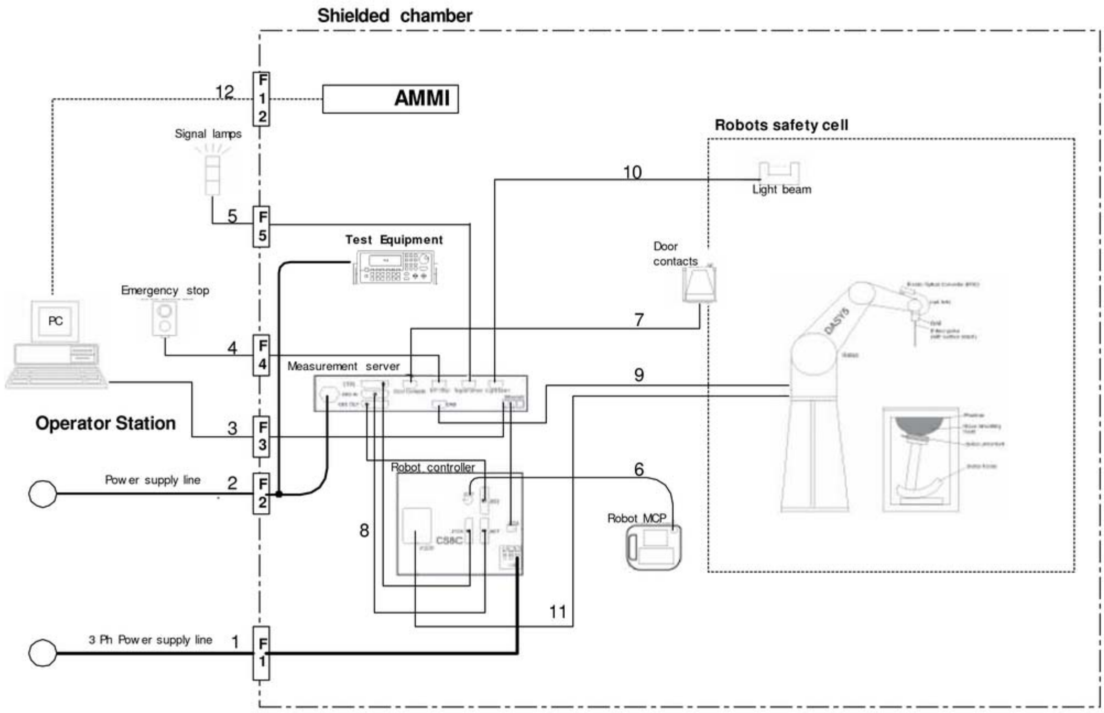
APPENDIX 3 : System specifications

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.

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	:	Schmid & 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	:	Schmid & Partner Engineering AG

d)Electro-Optic Converter (EOC)

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

g)Software

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

h)Robot Control 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	:	Schmid & 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	:	Schmid & 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 (liquid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

Mixture (%)	Frequency(MHz)	
	650&750	1450
Tissue Type	**Head and Body**	**Head and Body**
Water	35-58%	52-75%
Sugar	40-60%	-
Cellulose	<0.3%	-
Salt (NaCl)	0-6%	<1%
Preventol	0.1-0.7%	-
DGMBE	-	25-48%

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 650MHz and 750MHz

In the current standards (e.g., IEC62209-2, IEEE P1528, KDB 865664D01, 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 650MHz and 750MHz(The frequency for the system check) 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
600	42.7	0.88	56.1	0.95	Interpolated
750	41.9	0.89	55.5	0.96	Interpolated
835	41.5	0.90	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, KDB 865664D01, 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 system check) was decided as following.

f (MHz)	Head Tissue		Body Tissue		Reference
	ε r	σ [mho/m]	Εr	σ [mho/m]	
1450	40.5	1.20	54.0	1.30	Standard
1610	40.3	1.29	53.8	1.40	Standard
1750	40.1	1.37	53.4	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, KDB 865664D01, 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 5000 to 5800 MHz were obtained using linear interpolation.
Therefore the dielectric parameters of 5200MHz, 5300MHz, 5600MHz and 5500MHz(The frequency for the system check) 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: 3825)

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 UL Japan (PTT)

Certificate No: **EX3-3825_Dec13**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3825

Calibration procedure(s): QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: December 13, 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	13-Dec-13 (No. DAE4-660_Dec13)	Dec-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-13)	In house check: Oct-14

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

Issued: December 14, 2013

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

Certificate No: EX3-3825_Dec13 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
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
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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

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.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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Probe EX3DV4

SN:3825

Manufactured: September 6, 2011
Calibrated: December 13, 2013

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

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.43	0.39	0.43	± 10.1 %
DCP (mV)[B]	100.5	105.0	99.0	

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	198.2	±2.2 %
		Y	0.0	0.0	1.0		196.8	
		Z	0.0	0.0	1.0		147.6	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 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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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825

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 [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	9.84	9.84	9.84	0.27	0.95	± 12.0 %
835	41.5	0.90	9.58	9.58	9.58	0.29	0.97	± 12.0 %
900	41.5	0.97	9.44	9.44	9.44	0.80	0.50	± 12.0 %
1750	40.1	1.37	8.13	8.13	8.13	0.42	0.74	± 12.0 %
1810	40.0	1.40	7.90	7.90	7.90	0.75	0.56	± 12.0 %
1900	40.0	1.40	7.93	7.93	7.93	0.79	0.57	± 12.0 %
2000	40.0	1.40	7.94	7.94	7.94	0.56	0.65	± 12.0 %
2450	39.2	1.80	7.25	7.25	7.25	0.39	0.76	± 12.0 %
2600	39.0	1.96	7.06	7.06	7.06	0.45	0.75	± 12.0 %
5200	36.0	4.66	5.17	5.17	5.17	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.87	4.87	4.87	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.82	4.82	4.82	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.61	4.61	4.61	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.57	4.57	4.57	0.40	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.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825

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 [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	9.44	9.44	9.44	0.80	0.61	± 12.0 %
835	55.2	0.97	9.41	9.41	9.41	0.42	0.86	± 12.0 %
900	55.0	1.05	9.23	9.23	9.23	0.62	0.67	± 12.0 %
1750	53.4	1.49	7.86	7.86	7.86	0.46	0.69	± 12.0 %
1810	53.3	1.52	7.77	7.77	7.77	0.48	0.71	± 12.0 %
1900	53.3	1.52	7.66	7.66	7.66	0.49	0.72	± 12.0 %
2000	53.3	1.52	7.83	7.83	7.83	0.27	0.97	± 12.0 %
2450	52.7	1.95	7.23	7.23	7.23	0.79	0.55	± 12.0 %
2600	52.5	2.16	7.02	7.02	7.02	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.38	4.38	4.38	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.23	4.23	4.23	0.50	1.90	± 13.1 %
5500	48.6	5.65	3.92	3.92	3.92	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.90	3.90	3.90	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.05	4.05	4.05	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.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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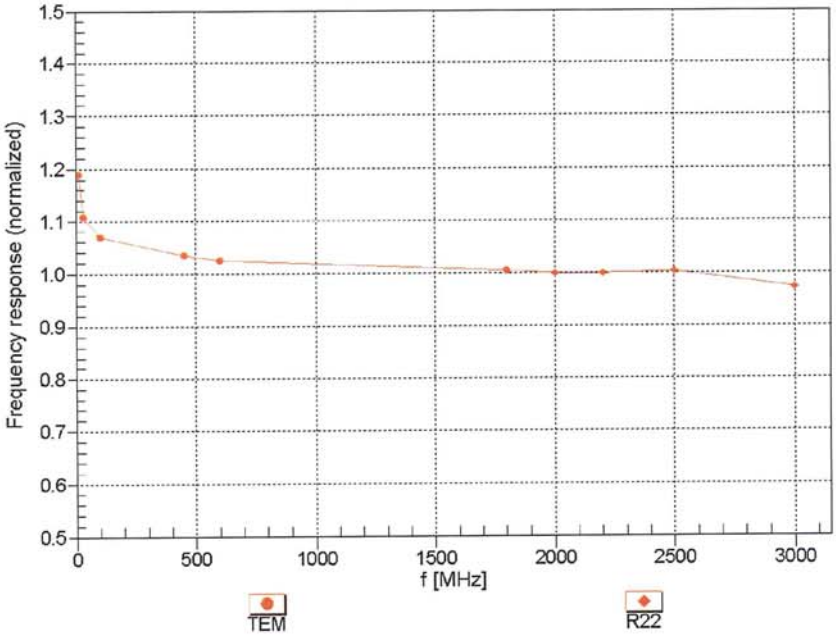
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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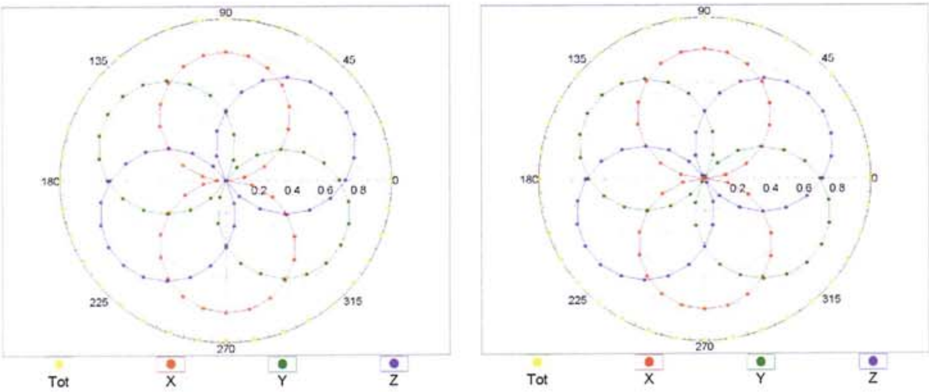
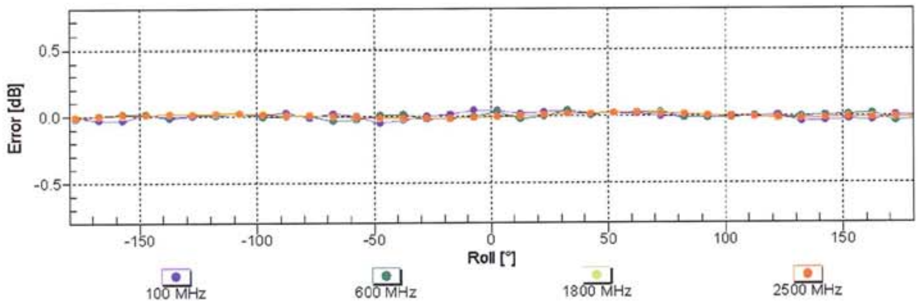
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM f=1800 MHz,R22





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

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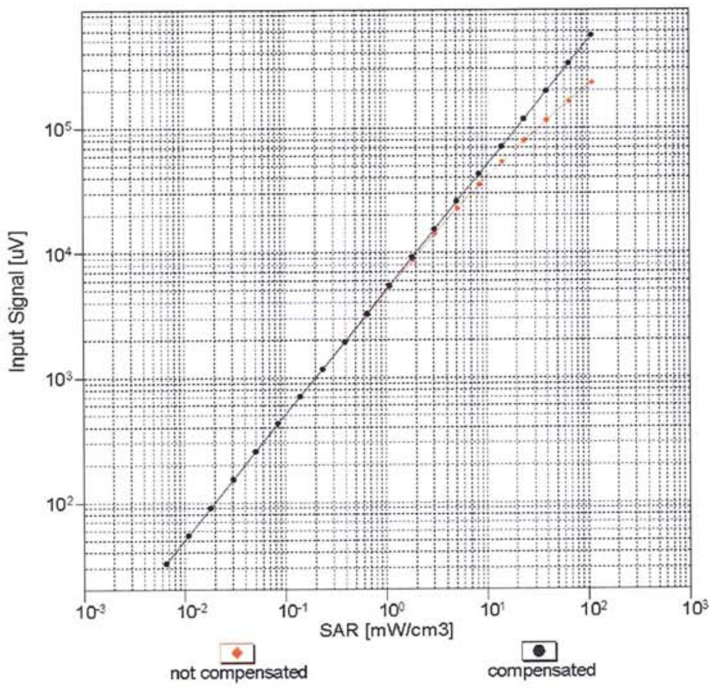
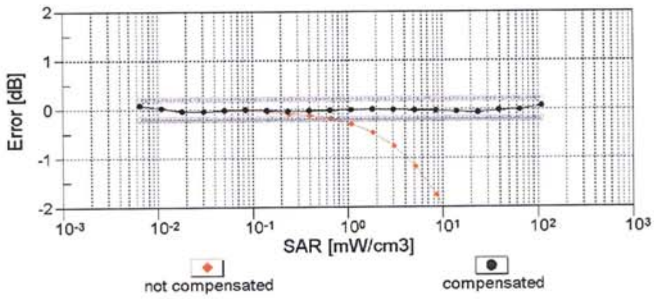
Dynamic Range f(SAR_{head})
(TEM cell , f = 900 MHz)





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

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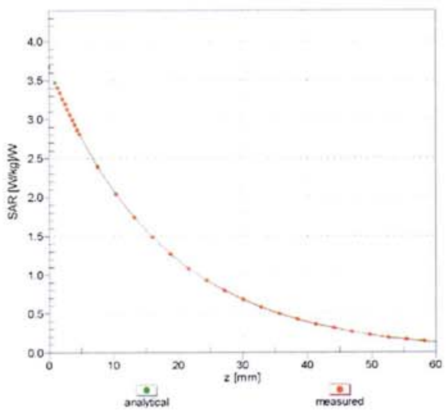
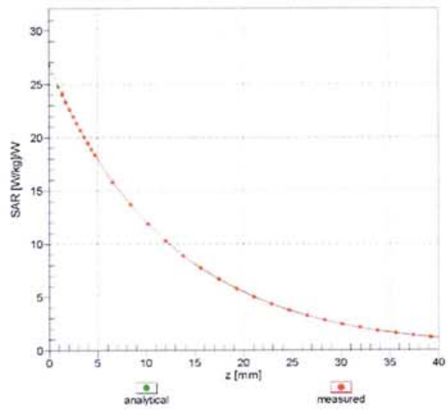
Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

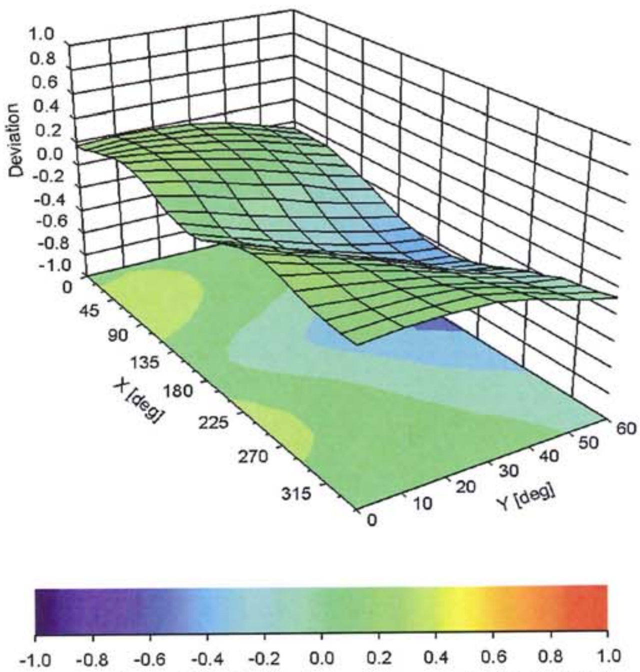


f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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DASY/EASY - Parameters of Probe: EX3DV4 - SN:3825

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-27.5
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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