SAR TEST REPORT

Test Report No. : 10447653H-A-R2

Applicant	:	**RICOH IMAGING COMPANY, LTD.**
Type of Equipment	:	**Wireless LAN Module**
Model No.	:	**P-W092**
FCC ID	:	**2ACZS-WG30W01**
Test regulation	:	**FCC47CFR 2.1093**
Test Result	:	**Complied**
Reported SAR(1g) Value		**The highest reported SAR(1g)** **WLAN 11b/g/n** Body : 0.033W/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 test report covers SAR technical requirements. It does not cover administrative issues such as Manua or non-SAR test related Requirements. (if applicable)
7. This report is a revised version of 10447653H-A-R1. 10447653H-A-R1 is replaced with this report.

Date of test: October 6 and 7, 2014

Representative test engineer: H. Sato

Hisayoshi Sato
Engineer
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Approved by : T. Hatakeda

Takahiro Hatakeda
Leader
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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.: 10447653H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10447653H-A	October 29, 2014	-	-
1	10447653H-A-R1	November 17, 2014	P.5	Setion 3.1 Comment *1 added.
1	10447653H-A-R1	November 17, 2014	P.15	Section 6.1 The table was corrected.
1	10447653H-A-R1	November 17, 2014	P.16	Section 7.1 The table was corrected.
1	10447653H-A-R1	November 17, 2014	P.18	Section 9.1 The statement of Step1 was corrected in (1) Method of measurement. Note 1) was corrected.
1	10447653H-A-R1	November 17, 2014	P.19	Section 9.1 (3) SAR correction for deviations of complex permittivity from target was corrected.
1	10447653H-A-R1	November 17, 2014	P.20	Section 9.1 Table of (4) Result of Body SAR was corrected.
2	10447653H-A-R2	November 19, 2014	P.20	Section 9.1 Table of (4) Result of Body SAR was corrected. ⊿SAR(%): 0.63⇒1.11

CONTENTS PAGE

SECTION 1: Customer information

Company Name	:	RICOH IMAGING COMPANY, LTD.
Address	:	2-35-7, Maeno-cho, Itabashi-ku Tokyo Japan 174-8639
Telephone Number	:	+81-3-3960-5624
Facsimile Number	:	+81-3-3960-5704
Contact Person	:	Atsushi Sato

*Remarks:
RICOH IMAGING COMPANY, LTD. designates MITSUMI ELECTRIC CO., LTD as manufacturer of the product (Wireless LAN Module).

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

2.1 Identification of E.U.T.

Type of Equipment	:	Wireless LAN Module
Model No.	:	P-W092
Serial No.	:	M17
Rating	:	DC 3.3V
Receipt Date of Sample	:	September 30, 2014
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

2.2 Product description

General Specification

Clock frequency(ies) in the system	:	26MHz

Radio Specification

Radio Type	:	Transceiver
Power Supply (inner)	:	DC3.3V

Specification of Wireless LAN (IEEE802.11b/g/n-20)

Type of radio	IEEE802.11b	IEEE802.11g	IEEE802.11n (20 M band)
Frequency of operation	2412-2462MHz		
Type of modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (64QAM, 16QAM, QPSK, BPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK)
Channel spacing	5MHz		
Antenna type	Pattern antenna		
Antenna Gain	Max 0.41dBi		
Antenna Connector type	N/A		

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**

☑	**KDB447498D01(v05r02)**	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
☐	**KDB447498D02(v02)**	SAR Measurement Procedures for USB Dongle Transmitters
☐	**KDB648474D04(v01r02)**	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(v02r03)**	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)*1**	SAR Evaluation Procedures for UMPC Mini-Tablet Devices
☐	**KDB616217D04(v01r01)**	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
☑	**KDB865664D01(v01r03)**	SAR Measurement Requirements for 100MHz to 6 GHz
☑	**KDB248227D01(v01r02)**	SAR Measurement Procedures for 802.11a//b/g Transmitters

*1 Since host devise was Digital Camera, KDB941225D07 was applied to this test report.

Reference

[1]SPEAG uncertainty document (AN 15-7/AN19-17) for DASY 5 System from SPEAG (Schmid & Partner Engineering AG).
[2] IEEE Std 1528-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.
(The reference for Uncertainty in SAR correction for deviations in permittivity and conductivity, in clause E.3.2.)

3.2 Procedure

Transmitter	**WLAN**
Test Procedure	Published RF exposure KDB procedures
	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
UL Japan, Inc. Ise EMC Lab. *NVLAP Lab. code: 200572-04383-326
Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
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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 power [mW] · Measured SAR [W/kg]

Maximum tune-up tolerance limit is by the specification from a customer.

Mode	Frequency	Measured power [mW]*1	Maximum tune-up tolerance limit [mW]	Measured SAR [W/kg]	Reported SAR [W/kg]
WLAN 11b	2412MHz	12.30	12.71	0.032	0.033

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 power is included the tune-up tolerance range.

WLAN Maximum tune-up tolerance limit

Mode	Maximum tune-up tolerance limit [dBm]	Maximum tune-up tolerance limit [mW]
WLAN 11b	11.04	12.71
WLAN 11g	10.22	10.52
WLAN 11n (2.4G)	8.17	6.56

SECTION 5 : Description of the operating mode

5.1 Output power operating modes

Mode	Frequency Band	Test Frequency	Modulation
IEEE802.11b	2412-2462MHz	2412MHz (1ch) 2437MHz(6ch) 2462MHz(11ch)	DSSS (DBPSK.DQPSK.CCK)
IEEE802.11g IEEE802.11n20 (2.4G)	2412-2462MHz	2412MHz (1ch) 2437MHz(6ch) 2462MHz(11ch)	OFDM (BPSK.QPSK.16QAM,64QAM)
WLAN			
*Power of the EUT was set by the software as follows; Software / version: C486A wireless test firmware v1.0 Power setting: 11b/g=11dBm, 11n-20=9dBm *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	Freq.	Reading [dBm]	Cable Loss	Atten.	Result	
					[dBm]	[mW]
[Mbps]	[MHz]	AVG	[dB]	[dB]	AVG	AVG
1.0	2437	-0.59	0.92	10.00	10.33	10.79
2.0	2437	-0.14	0.92	10.00	10.78	11.97
5.5	2437	-0.03	0.92	10.00	10.89	12.27
11.0	2437	-0.07	0.92	10.00	10.85	12.16

:Worst data rate

IEEE802.11b 1Mbps

Ch	Frequency	P/M Reading	Cable Loss	Atten.	Result	
					[dBm]	[mW]
	[MHz]	AVG	[dB]	[dB]	AVG	AVG
1	2412	-0.58	0.92	10.00	10.34	10.81
6	2437	-0.59	0.92	10.00	10.33	10.79
11	2462	-0.54	0.92	10.00	10.38	10.91

IEEE802.11b 5.5Mbps

Ch	Frequency	P/M Reading	Cable Loss	Atten.	Result	
					[dBm]	[mW]
	[MHz]	AVG	[dB]	[dB]	AVG	AVG
1	2412	-0.02	0.92	10.00	10.90	12.30
6	2437	-0.03	0.92	10.00	10.89	12.27
11	2462	-0.15	0.92	10.00	10.77	11.94

: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	-1.50	0.92	10.00	9.42	8.75
9.0	2437	-1.56	0.92	10.00	9.36	8.63
12.0	2437	-1.50	0.92	10.00	9.42	8.75
18.0	2437	-1.45	0.92	10.00	9.47	8.85
24.0	2437	-1.53	0.92	10.00	9.39	8.69
36.0	2437	-1.61	0.92	10.00	9.31	8.53
48.0	2437	-1.48	0.92	10.00	9.44	8.79
54.0	2437	-1.54	0.92	10.00	9.38	8.67

: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	-1.45	0.92	10.00	9.47	8.85
6	2437	-1.50	0.92	10.00	9.42	8.75
11	2462	-1.51	0.92	10.00	9.41	8.73

IEEE802.11g 18Mbps

Ch	Frequency [MHz]	P/M Reading AVG	Cable Loss [dB]	Atten. [dB]	Result [dBm] AVG	Result [mW] AVG
1	2412	-1.28	0.92	10.00	9.64	9.20
6	2437	-1.45	0.92	10.00	9.47	8.85
11	2462	-1.30	0.92	10.00	9.62	9.16

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	-3.20	0.92	10.00	7.72	5.92
MCS1	2437	-3.41	0.92	10.00	7.51	5.64
MCS2	2437	-3.30	0.92	10.00	7.62	5.78
MCS3	2437	-3.31	0.92	10.00	7.61	5.77
MCS4	2437	-3.32	0.92	10.00	7.60	5.75
MCS5	2437	-3.31	0.92	10.00	7.61	5.77
MCS6	2437	-3.30	0.92	10.00	7.62	5.78
MCS7	2437	-3.34	0.92	10.00	7.58	5.73

: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	-3.00	0.92	10.00	7.92	6.19
6	2437	-3.20	0.92	10.00	7.72	5.92
11	2462	-3.24	0.92	10.00	7.68	5.86

Correlation of output power with original test 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	0.92	10.00	10.76	-0.26

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		
802.11a/n20	UNII	5.18	36			√	
		5.20	40				*
		5.22	44				*
		5.24	48			√	
		5.26	52			√	
		5.28	56				*
		5.30	60				*
		5.32	64			√	
		5.50	100				*
		5.52	104			√	
		5.54	108				*
		5.56	112				*
		5.58	116			√	
		5.60	120				*
		5.62	124			√	
		5.64	128				*
		5.66	132				*
		5.68	136			√	
		5.70	140				*
	UNII or FCC 15.247	5.745	149	√		√	
		5.765	153		*		*
		5.785	157	√			*
		5.805	161		*	√	
	FCC 15.247	5.825	165	√			

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

Mode	Test Frequency	Modulation	Crest factor	Note
IEEE802.11b	2462MHz(11ch)	DBPSK(1Mbps)	1	*2
	2412MHz(1ch)	CCK(5.5Mbps)	1	*2
IEEE802.11g	Not required			*1
IEEE802.11n20 (2.4G)	2412MHz(1ch)	BPSK(MCS0)	1	*2 *3
WLAN				
*Power of the EUT was set by the software as follows; Software / version: C486A wireless test firmware v1.0 Power setting: 11b/g=11dBm, 11n-20=9dBm *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 11b mode was maximum average power. According to KDB248227D01, the 11g 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 Because 11n20 mode is maximum band width, SAR test of 11n20 mode was measured.

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 measuring the e-filed at the same location at beginning and the end of the scan measurement for each test position.

DASY5 system calculation 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

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6.1 Standalone SAR test exclusion considerations

Based on KDB941225D07, UMPC mini-tablet devices must be tested for 1-g SAR on all surfaces and side edges with a transmitting antenna located at ≤ 25 mm from that surface or edge, at 5 mm separation from a flat phantom, for the data modes, wireless technologies and frequency bands supported by the device to determine SAR compliance.

No.	Position	WLAN		
		Test required	Antenna	Separation of antenna to EUT's surfaces and edges
1	Top	☑	Internal	6.44mm
2	Front	☑	Internal	8.06mm
3	Rear	☑	Internal	6.90mm
4	Left side	☑	Internal	18.16mm
5	Right side	☐	Internal	60.34mm
6	Bottom	☐	Internal	53.38mm

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 941225 D07 (SAR Evaluation Procedures for UMPC Mini-Tablet Devices).

ii) Test mode

WLAN 2.4G	**Data transmission mode (11b/n-20)**

iii) Test position

No.	Position	WLAN		
		Tested	Antenna	Test separation distance (Separation of a flat phantom to EUT's surfaces and edges)*1
1	Top	☑	Internal	5mm
2	Front	☑	Internal	5mm
3	Rear	☑	Internal	5mm
4	Left side	☑	Internal	5mm
5	Right side	☐	Internal	-
6	Bottom	☐	Internal	-

*1 Test separation distance is separation of a flat phantom to EUT's surfaces and edges.
Based on KDB941225D07, test separation distance is 5mm.

SECTION 8 : Test surrounding

8.1 Measurement uncertainty

This measurement uncertainty budget is suggested by IEEE Std 1528(2013)[2] and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget[1]). Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01 Section 2.8.1., when the highest measured SAR(1g) within a frequency band is < 1.5W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std.1528 (2013) is not required in SAR reports submitted for equipment approval.
<0.3 – 3GHz range Body>

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	± 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	± 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	± 0.4	Rectangular	√3	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	√3	1	± 1.7	∞
Max.SAR Eval.	± 2.0	Rectangular	√3	1	± 1.2	∞
Test Sample Related						
Device positioning	± 2.9	Normal	1	1	± 2.9	5
Device holder uncertainty	± 3.6	Normal	1	1	± 3.6	3
Power drift	± 5.0	Rectangular	√3	1	± 2.9	∞
Power Scaling	+ 0.0	Rectangular	√3	1	± 0.0	∞
Phantom and Setup						
Phantom uncertainty	± 6.1	Rectangular	√3	1	± 3.5	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	± 1.9	Normal	1	1	± 1.9	∞
Liquid conductivity (meas.)	+ 1.9	Rectangular	1	0.78	+ 1.5	∞
Liquid permittivity (meas.)	- 0.8	Rectangular	1	0.23	- 0.2	∞
Liquid conductivity - temp.unc (below 2deg.C.)	± 5.2	Rectangular	√3	0.78	± 2.3	∞
Liquid permittivity - temp.unc (below 2deg.C.)	± 0.8	Rectangular	√3	0.23	± 0.1	∞
Combined Standard Uncertainty					± **11.359**	
Expanded Uncertainty (k=2)					± **22.7**	

*. Table of uncertainties are listed for ISO/IEC 17025.

SECTION 9 : Measurement results

9.1 WLAN Body SAR (2.4G)

(1)Method of measurement

Step.1 The searching for the worst data rate

SAR value of 1Mbps(lowest transfer rate) and 5.5Mbps(higher output power data rate than other rate) is compared.
The test was performed with the highest output power channel.

Step2. The changing to other positions

The test was performed with the worst data rate of Step.1.

Step3. The changing to 11n-20 mode

The test was performed with the worst position of Step.1 to 2.

Note:
1) According to KDB 447498 D01 General RF Exposure Guidance v05, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is
≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

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).

(2)Simulated Tissue Liquid Parameter confirmation

The dielectric parameters were checked prior to assessment using the R140 Reflectometer and DAKS-3.5 probe.
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	Measured	Deviation [%]	Limit [%]	Remark
-	-	-	-	-	2000	εr	53.3	-	-	-	*1
						σ [mho/m]	1.52	-	-	-	
6-Oct	24	58	MSL 2450	23.5	2412	εr	52.8	52.5	-0.5	+/-5	*2
						σ [mho/m]	1.91	1.88	-1.4	+/-5	
7-Oct	24	51	MSL 2450	23.5	2412	εr	52.8	52.4	-0.8	+/-5	*2
						σ [mho/m]	1.91	1.95	1.9	+/-5	
6-Oct	24	58	MSL 2450	23.5	2450	εr	52.7	52.4	-0.6	+/-5	*1
						σ [mho/m]	1.95	1.94	-0.4	+/-5	
6-Oct	24	58	MSL 2450	23.5	2462	εr	52.7	52.3	-0.7	+/-5	*2
						σ [mho/m]	1.97	1.96	-0.5	+/-5	
-	-	-	-	-	3000	εr	52.0	-	-	-	*1
						σ [mho/m]	2.73	-	-	-	

εr: Relative Permittivity / σ : Coductivity
*1 The Target value is a parameter defined in KDB 865664D01.
*2 The dielectric parameters should be linearly interpolated between the closest pair of target frequencies to determine the applicable dielectric parameters corresponding to the device test frequency.

(3)SAR correction for deviations of complex permittivity from target

According to KDB865664D01 section 2.6, when nominal tissue dielectric parameters are recorded in the probe calibration data; for example, only target values and tolerance are reported, the measured εr and σ of the liquid used in routine measurements must be:

- ≤ the target εr and ≥ the target σ values and also within 5% of the required target dielectric parameters(3-1), or
- within +5% and -10% of the target εr, and also within -5% and +10% of the target σ values, when the measured SAR is compensated for tissue dielectric deviations(3-2).

ΔSAR which is a correction(compensation) coefficient is calculated using the following expression.
The coefficients are parameters defined in E.3.2.2 IEEE Std 1528(2013).

$\Delta SAR = c\varepsilon\ \Delta\varepsilon r + c\sigma\ \Delta\sigma$

<1g>

$C\varepsilon = -7.854\times10^{-4}f^3 + 9.402\times10^{-3}f^2 - 2.742\times10^{-2}f - 0.2026$

$C\sigma = 9.804\times10^{-3}f^3 - 8.661\times10^{-2}f^2 + 2.981\times10^{-2}f + 0.7829$

<10g>

$C\varepsilon = 3.456\times10^{-3}f^3 - 3.531\times10^{-2}f^2 + 7.675\times10^{-2}f - 0.1860$

$C\sigma = 4.479\times10^{-3}f^3 - 1.586\times10^{-2}f^2 - 0.1972f + 0.7717$

'f ' is the frequency in GHz.

Date		6-Oct
	f(GHz)=	2.412
	⊿εr(%)=	-0.50
	⊿σ(%)=	-1.40
1g	Cε=	-0.2251
	Cσ=	0.4885
	⊿SAR(%)=	-0.57
10g	Cε=	-0.1578
	Cσ=	0.2666
	⊿SAR(%)=	-0.29

(3-2) applied.
Therefore, the measured SAR results are corrected. Corrected SAR(1g) = Measured SAR(1g) *1.0057

Date		6-Oct
	f(GHz)=	2.462
	⊿εr(%)=	-0.70
	⊿σ(%)=	-0.50
1g	Cε=	-0.2248
	Cσ=	0.4776
	⊿SAR(%)=	-0.08
10g	Cε=	-0.1595
	Cσ=	0.2569
	⊿SAR(%)=	-0.02

(3-2) applied.
Therefore, the measured SAR results are corrected. Corrected SAR(1g) = Measured SAR(1g) *1.0008

Date		7-Oct
	f(GHz)=	2.412
	⊿εr(%)=	-0.80
	⊿σ(%)=	1.90
1g	Cε=	-0.2251
	Cσ=	0.4885
	⊿SAR(%)=	1.11
10g	Cε=	-0.1578
	Cσ=	0.2666
	⊿SAR(%)=	0.63

(3-1) applied.
Therefore, corrected calculation is not performed

(4)Result of Body SAR

BODY SAR MEASUREMENT RESULTS														
Frequency		Modulation	Measured power		Maximum tune-up tolerance limit		Phantom Section	EUT Set-up Conditions			⊿SAR (%)	Measured SAR(1g) [W/kg]	Measured SAR(1g) ⊿SAR correct [W/kg] *1	Reported SAR(1g) *2 [W/kg]
Channel	[MHz]		[dBm]	[mW]	[dBm]	[mW]		Antenna	Position	Separation [mm]				
Step.1 Worst data rate searching														
11	2462	11b 1Mbps	10.38	10.91	11.04	12.71	Flat	Main	Top	5	-0.08	**0.028**	**0.028**	**0.032**
1	2412	11b 5.5Mbps	10.90	12.30	11.04	12.71	Flat	Main	Top	5	-0.57	**0.032**	**0.032**	**0.033**
Step.2 Position change														
1	2412	11b 5.5Mbps	10.90	12.30	11.04	12.71	Flat	Main	Front	5	-0.57	**0.029**	**0.029**	**0.030**
1	2412	11b 5.5Mbps	10.90	12.30	11.04	12.71	Flat	Main	Rear	5	-0.57	**0.030**	**0.030**	**0.031**
1	2412	11b 5.5Mbps	10.90	12.30	11.04	12.71	Flat	Main	Left side	5	1.11	**0.014**	**N/A**	**0.014**
Step.3 Mode change														
1	2412	11n20 MCS0	7.92	6.19	8.17	6.56	Flat	Main	Top	5	1.11	**0.018**	**N/A**	**0.018**

*1 Refer to clause 9.1 (3).
*2 Reported SAR= Maximum tune-up tolerance limit [mW] / Measured power [mW] · Measured SAR(⊿SAR correct) [W/kg]

SECTION 10 Test instruments

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MOS-37	Digital thermometer	LKM electronic	DTM3000	-	SAR	2014/07/06 * 12
MVNA-01	Vector Network Analyzer	Schmid&Partner Engineering AG	PLANAR R140	0030913	SAR	2014/01/09 * 12
MDPK-03	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK-3.5 Probe	0008	SAR	2014/03/04 * 12
COTS-MSAR-04	Dielectric assessment kit	Schmid&Partner Engineering AG	DAK		SAR	-
MPM-15	Power Meter	Agilent	N1914A	MY53060017	SAR	2014/06/20 * 12
MPSE-20	Power sensor	Agilent	N8482H	MY53050001	SAR	2014/06/20 * 12
MPSE-21	Power sensor	Agilent	N8482H	MY52460010	SAR	2014/07/02 * 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	2014/06/19 * 12
MSG-13	Signal Generator	Rohde & Schwarz	SMA 100A	103764	SAR	2014/06/19 * 12
MDA-07	Dipole Antenna	Schmid&Partner Engineering AG	D2450V2	713	SAR(D2450)	2013/09/10 * 24
MDAE-02	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	1369	SAR	2014/05/14 * 12
MPB-08	Dosimetric E-Field Probe	Schmid&Partner Engineering AG	EX3DV4	3917	SAR	2014/05/14 * 12
MPF-04	2mm Oval Flat Phantom	Schmid&Partner Engineering AG	QDOVA001BB	1207	SAR	2014/06/03 * 12
MDH-04	Device holder	Schmid&Partner Engineering AG	Mounting device for transmitter	-	SAR	Pre Check
MOS-30	Thermo-Hygrometer	Custom	CTH-201	3001	SAR	2014/07/06 * 12
MOS-35	Digital thermometer	HANNA	Checktemp 4	-	SAR	2014/07/06 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY5	-	SAR	-
MRBT-03	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F13/5PP1D1/A/01	SAR	2014/06/24 * 12
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.

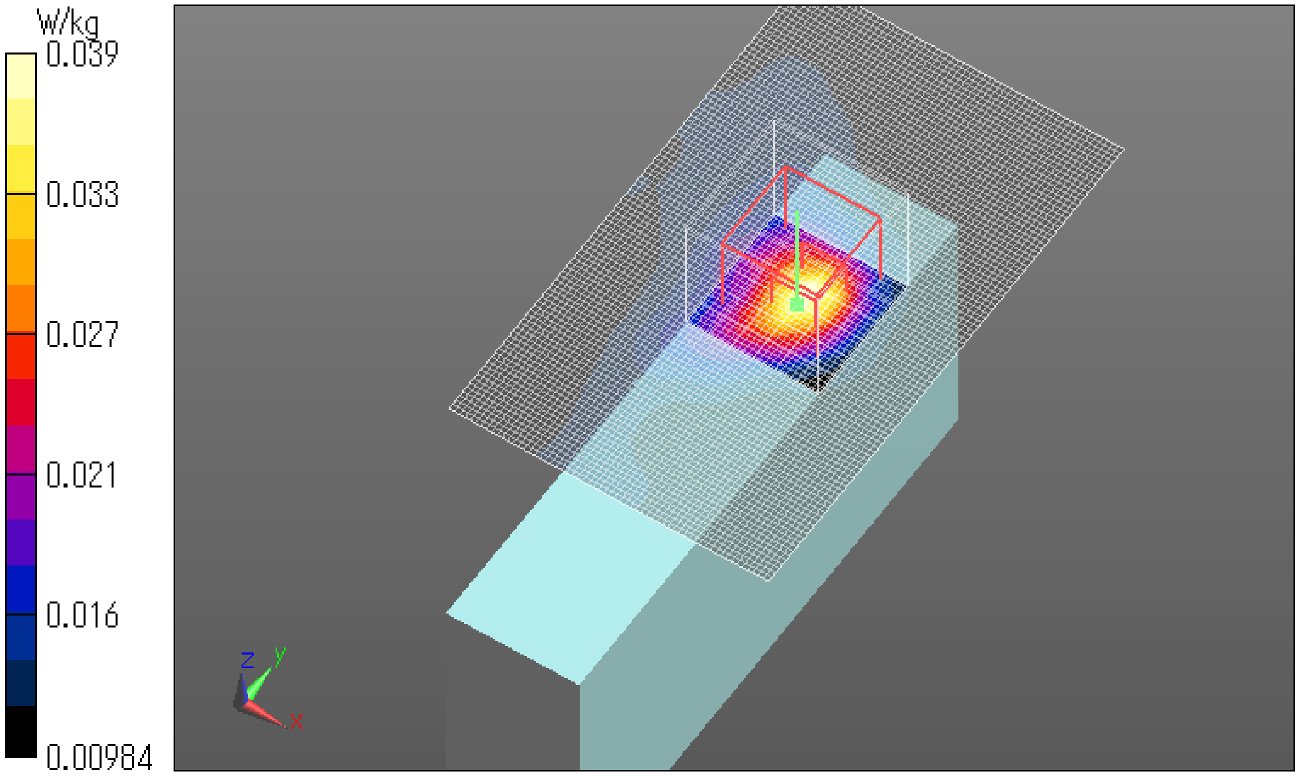
***1. Ratio step method parameters used;**
The first measurement point: 2mm from the phantom surface, the initial grid separation: 2mm, subsequent graded grid ratio: 1.5
These parameters comply with the requirement of the KDB 865664D01.

2. Measurement data

WLAN 11b 1Mbps Top 5mm 2462MHz
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: f = 2462 MHz; σ = 1.96 S/m; ε_r = 52.327; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0373 W/kg

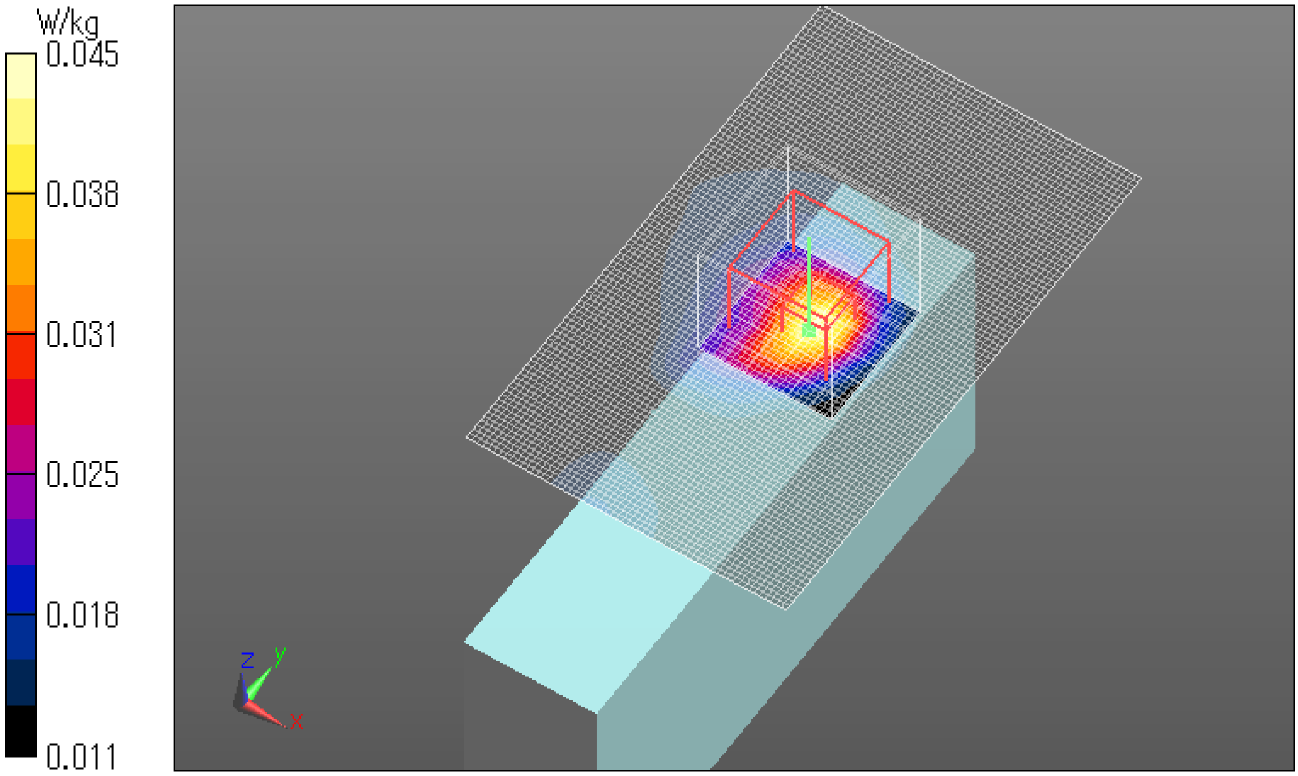
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.610 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 0.0580 W/kg
SAR(1 g) = 0.0278 W/kg; SAR(10 g) = 0.0174 W/kg
Maximum value of SAR (measured) = 0.0389 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



WLAN 11b 5.5Mbps Top 5mm 2412MHz
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n;
Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.883 S/m; ε_r = 52.512; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0447 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.945 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.0710 W/kg
SAR(1 g) = 0.032 W/kg; SAR(10 g) = 0.020 W/kg
Maximum value of SAR (measured) = 0.0453 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C.   Liquid Temp.: 23.5 degree.C.



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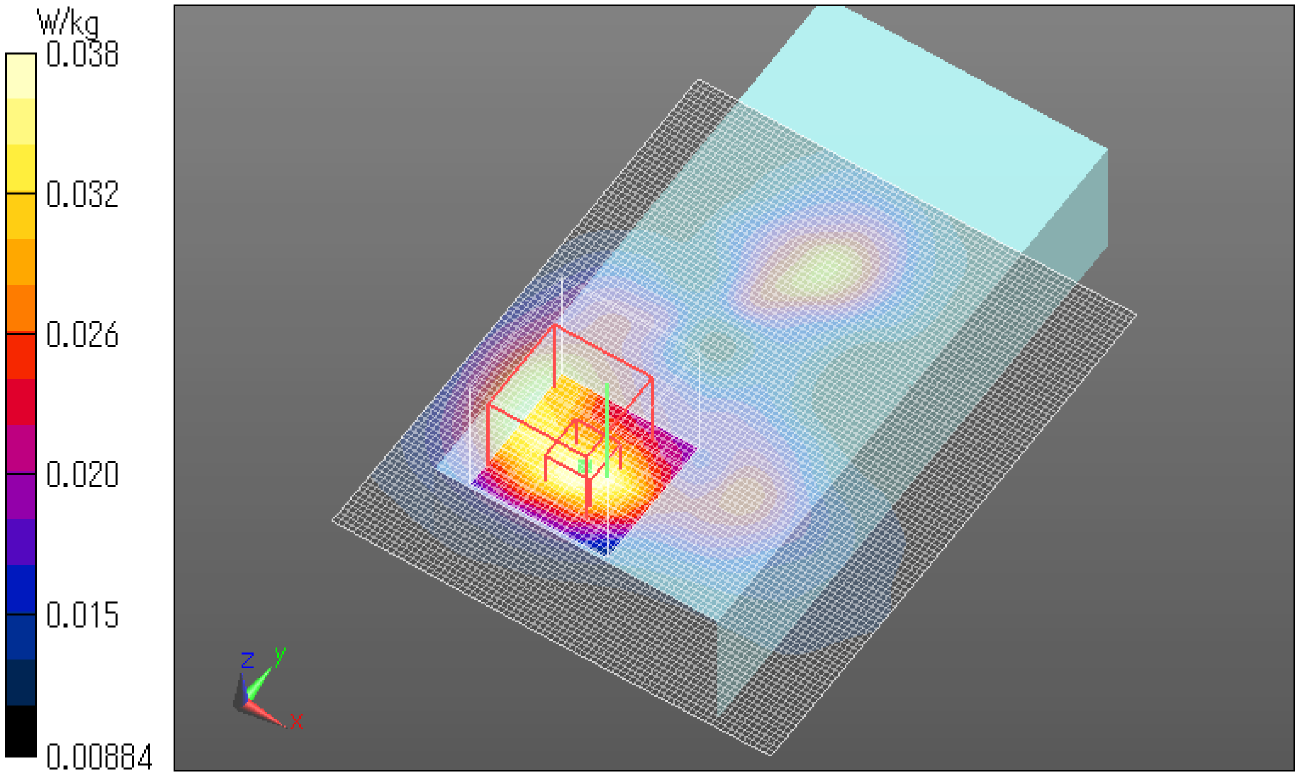
WLAN 11b 5.5Mbps Front 5mm 2412MHz
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n;
Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.883 S/m; ε_r = 52.512; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (81x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0402 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.723 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 0.0480 W/kg
SAR(1 g) = 0.029 W/kg; SAR(10 g) = 0.019 W/kg
Maximum value of SAR (measured) = 0.0379 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C.   Liquid Temp.: 23.5 degree.C.



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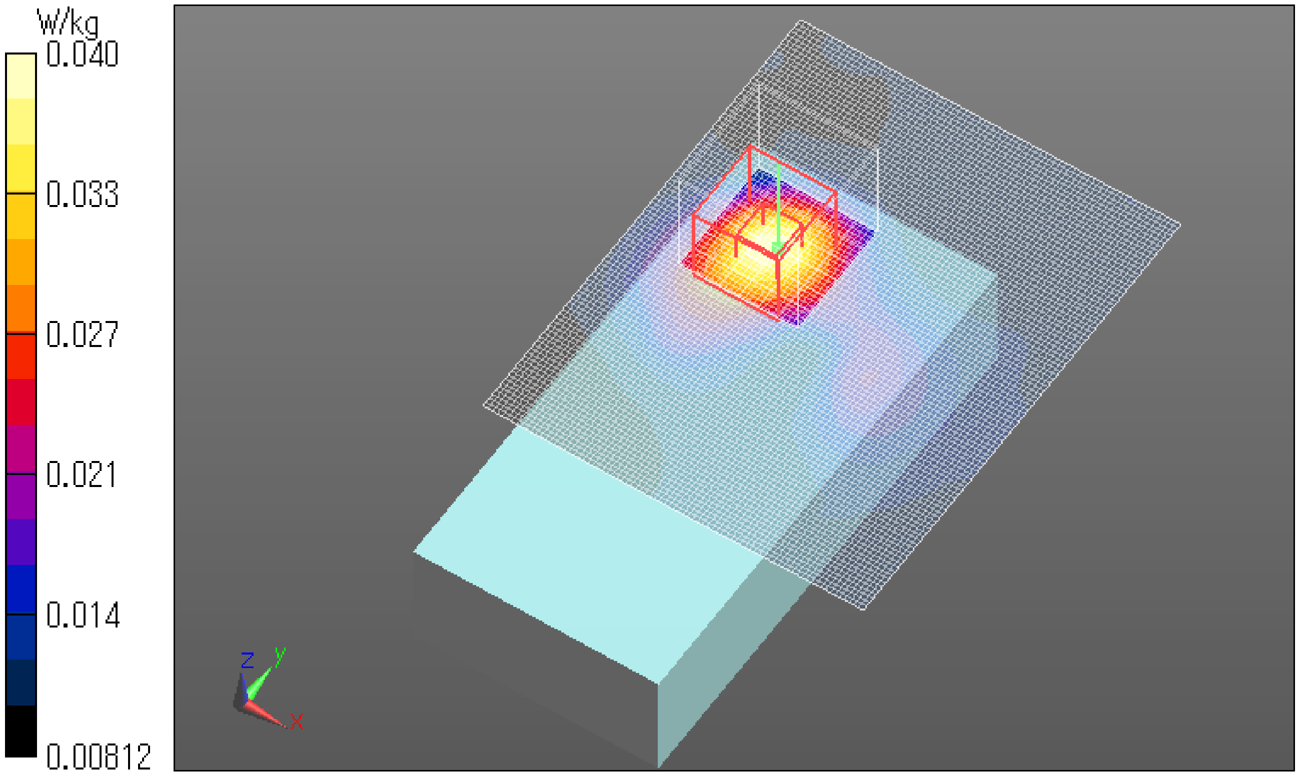
WLAN 11b 5.5Mbps Rear 5mm 2412MHz
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n;
Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.883 S/m; ε_r = 52.512; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (81x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0451 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.634 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 0.0530 W/kg
SAR(1 g) = 0.030 W/kg; SAR(10 g) = 0.019 W/kg
Maximum value of SAR (measured) = 0.0398 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



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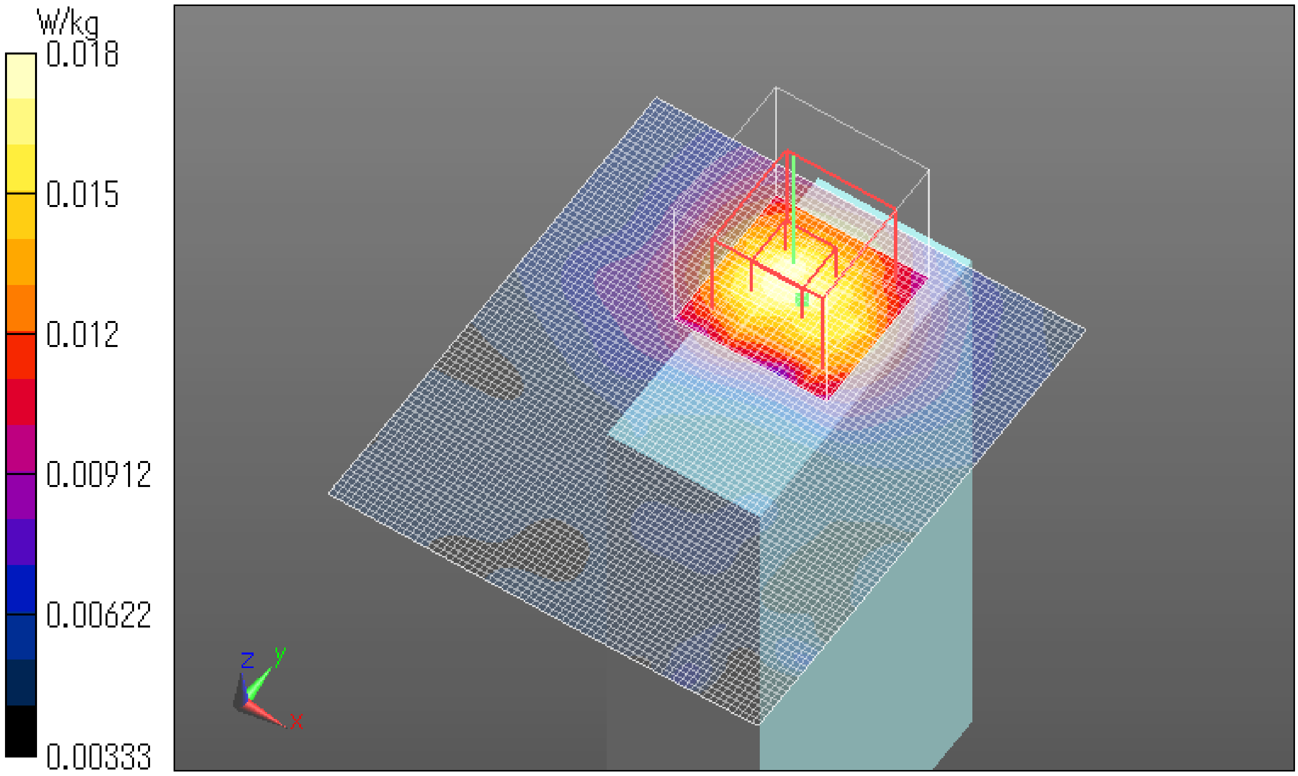
WLAN 11b 5.5Mbps Left side 5mm 2412MHz
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n;
Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.947 S/m; ε_r = 52.394; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (71x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0183 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.941 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 0.0230 W/kg
SAR(1 g) = 0.014 W/kg; SAR(10 g) = 0.00903 W/kg
Maximum value of SAR (measured) = 0.0178 W/kg
Date: 2014/10/07
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



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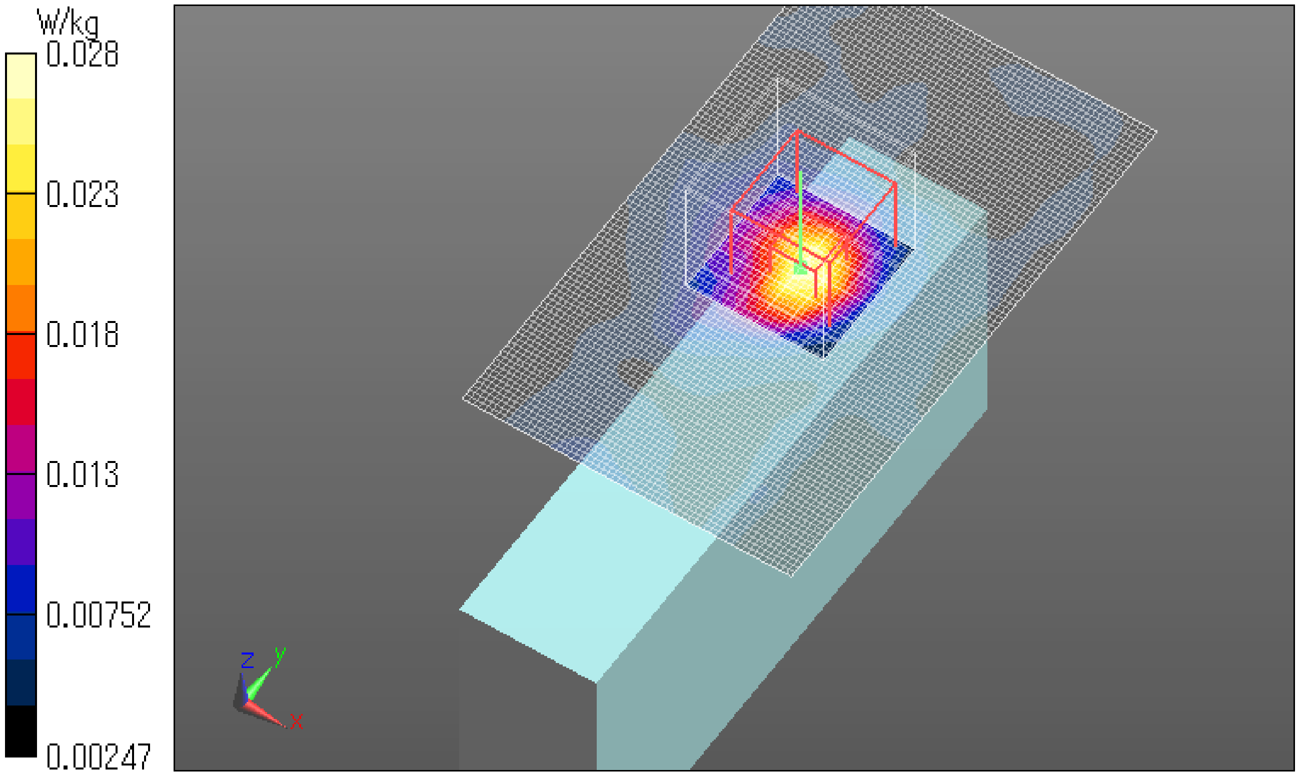
WLAN 11n20 MCS0 Top 5mm 2412MHz
Communication System: UID 0, WLAN 2.4G 11b/g/n (0); Communication System Band: WLAN 2.4G 11b/g/n;
Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.947 S/m; ε_r = 52.394; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.0302 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.840 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.0460 W/kg
SAR(1 g) = 0.018 W/kg; SAR(10 g) = 0.00912 W/kg
Maximum value of SAR (measured) = 0.0277 W/kg
Date: 2014/10/07
Ambient Temp. : 24.0 degree.C.   Liquid Temp.: 23.5 degree.C.



APPENDIX2 : System Check

1. System check result Body 2450MHz

(1) 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	Measured	Deviation [%]	Limit [%]	Remark
6-Oct	24	57	MSL 2450	23.5	2450	εr	52.7	52.4	-0.6	+/-5	*1
						σ [mho/m]	1.95	1.94	-0.4	+/-5	
7-Oct	24	51	MSL 2450	23.5	2450	εr	52.7	52.2	-0.9	+/-5	*1
						σ [mho/m]	1.95	2.00	2.4	+/-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	Measured	Deviation [%]	Limit [%]	Remark
6-Oct	24	57	MSL 2450	23.5	2450	εr	52.2	52.4	0.3	+/-6	*2 *3
						σ [mho/m]	2.00	1.94	-2.9	+/-6	
7-Oct	24	51	MSL 2450	23.5	2450	εr	52.2	52.2	0.0	+/-6	*2 *3
						σ [mho/m]	2.00	2.00	-0.2	+/-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.

(2) SAR correction for deviations of complex permittivity from target

The measured SAR results are corrected with target value of KDB865664D01.
Corrected SAR(1g) = Measured SAR(1g) x (100-⊿SAR)/100

$\Delta SAR = c\varepsilon\, \Delta\varepsilon r + c\sigma\, \Delta\sigma$

<1g>
$C\varepsilon = -7.854\times10^{-4}f^3 + 9.402\times10^{-3}f^2 - 2.742\times10^{-2}f - 0.2026$
$C\sigma = 9.804\times10^{-3}f^3 - 8.661\times10^{-2}f^2 + 2.981\times10^{-2}f + 0.7829$
<10g>
$C\varepsilon = 3.456\times10^{-3}f^3 - 3.531\times10^{-2}f^2 + 7.675\times10^{-2}f - 0.1860$
$C\sigma = 4.479\times10^{-3}f^3 - 1.586\times10^{-2}f^2 - 0.1972f + 0.7717$
'f ' is the frequency in GHz.

Date		6-Oct
	f(GHz)=	2.45
	⊿εr(%)=	-0.6
	⊿σ(%)=	-0.4
1g	Cε=	-0.2249
	Cσ=	0.4802
	⊿SAR(%)=	-0.06
10g	Cε=	-0.1591
	Cσ=	0.2592
	⊿SAR(%)=	-0.01

Date		7-Oct
	f(GHz)=	2.45
	⊿εr(%)=	-0.9
	⊿σ(%)=	2.4
1g	Cε=	-0.2249
	Cσ=	0.4802
	⊿SAR(%)=	1.35
10g	Cε=	-0.1591
	Cσ=	0.2592
	⊿SAR(%)=	0.77

(3) System check result (for calibration by manufacture)

SYSTEM CHECK

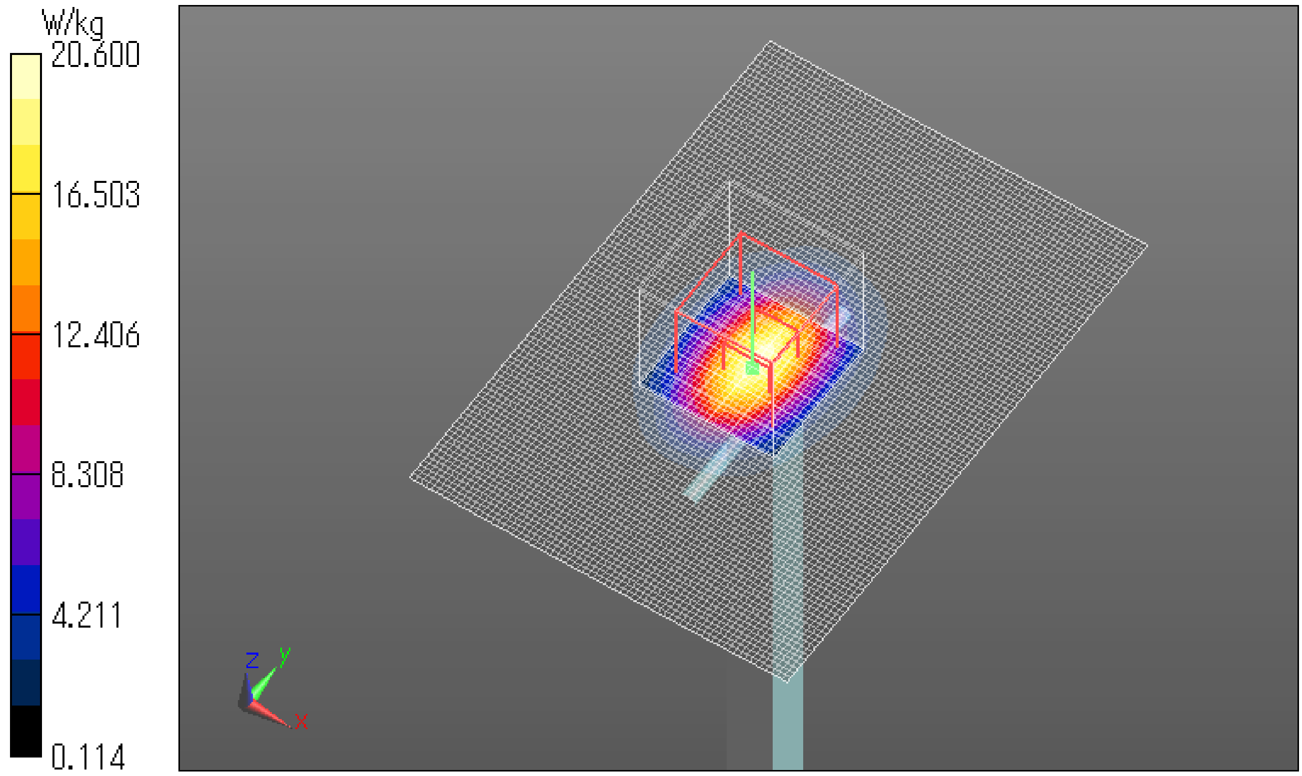
Date	Frequency [MHz]	SAR 1g [W/kg]				Deviation [%]	Limit [%]	Remark
		Forward Power 250mW		Conversion 1W	Target Value(1W)			
		Measured	⊿SAR corrected	Calculation				
6-Oct	2450.00	13.50	13.51	54.03	49.70	8.7	+/-10	*4
7-Oct	2450.00	13.40	13.22	52.88	49.70	6.4	+/-10	*4

*4 The taget value is the parameter defined in SAR for nominal Body TSL parameters in manufacturer calibrated dipole (D2450V2 SN:713)
Please refer to " SAR result with Body TSL of Appendix 2 2. System Check Dipole (D2450V2 SN:713)".

Body 2450MHz System Check DATA / Dipole2450MHz / Forward Conducted Power : 250mW
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 = 1.942 S/m; ε_r = 52.376; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (71x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 21.5 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.7 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 28.5 W/kg
SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.24 W/kg
Maximum value of SAR (measured) = 20.6 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



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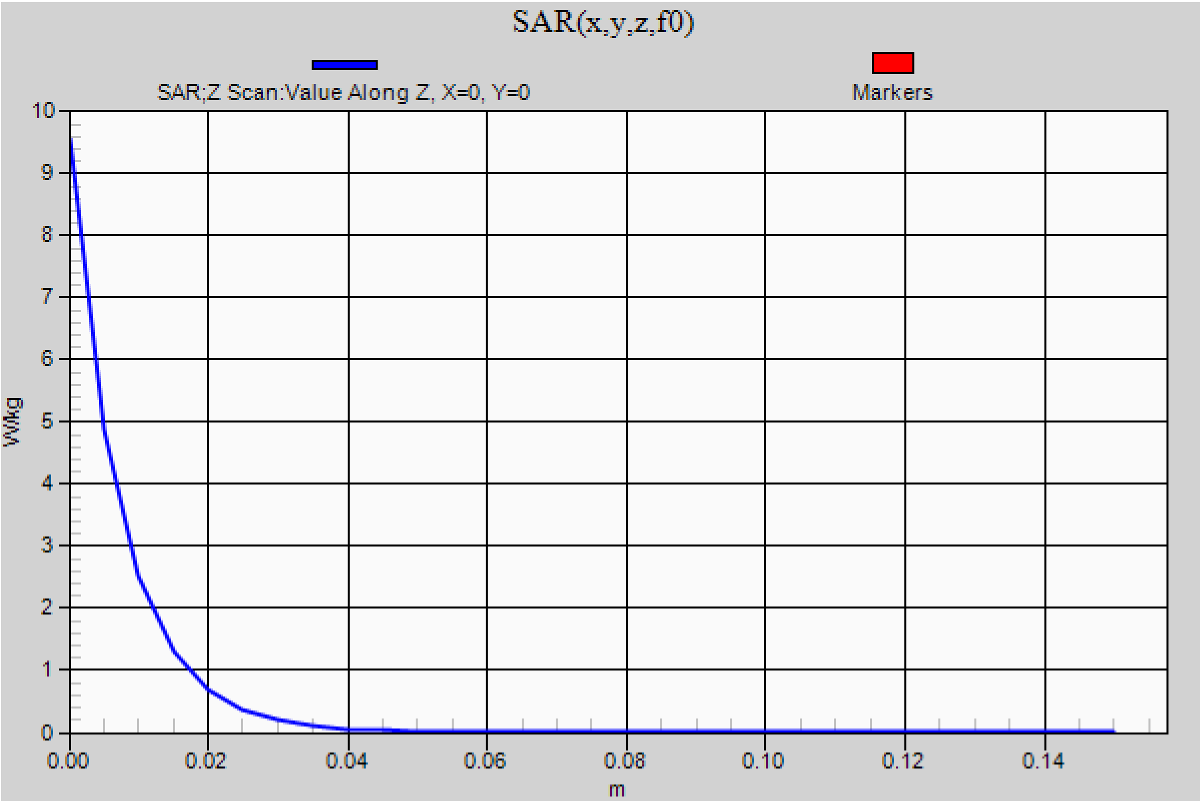
Body 2450MHz System Check DATA / Dipole2450MHz / Forward Conducted Power : 250mW
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.942 S/m; ε_r = 52.376; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

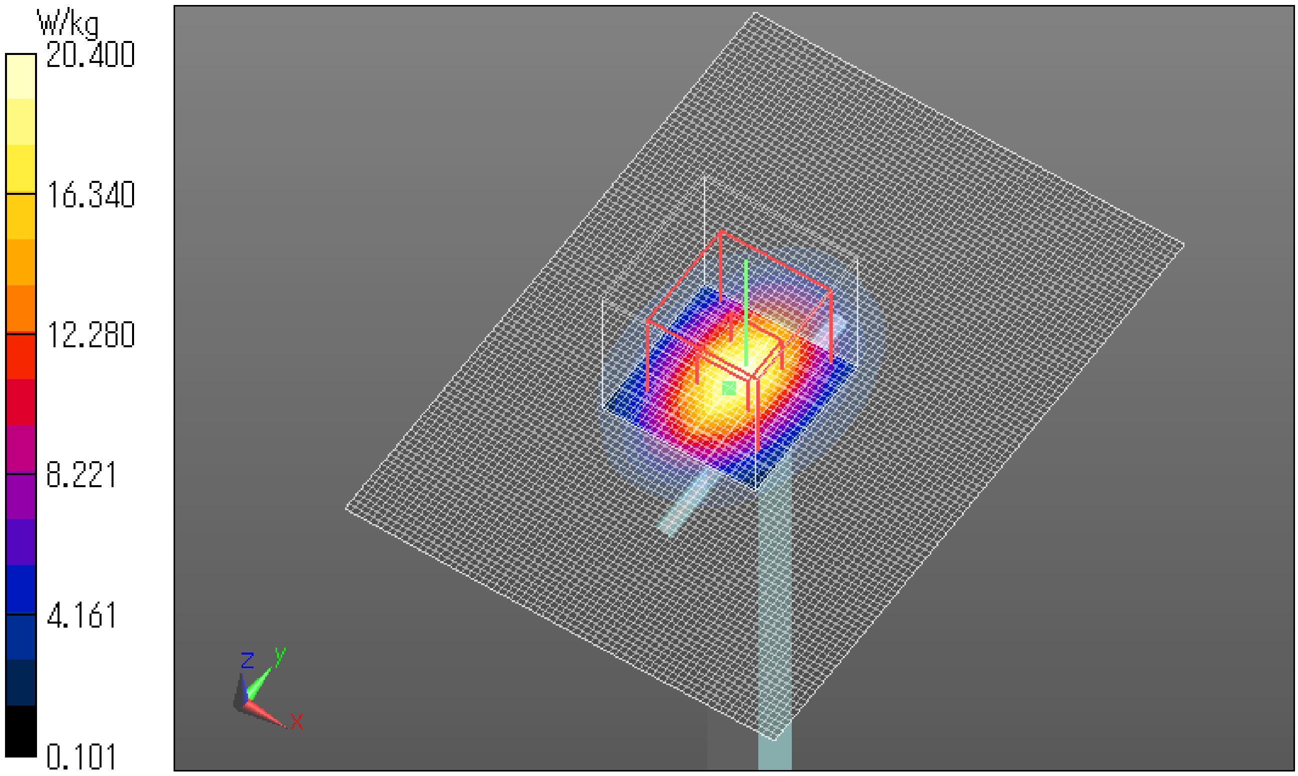
Z Scan (1x1x31): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 9.55 W/kg
Date: 2014/10/06
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



Body 2450MHz System Check DATA / Dipole2450MHz / Forward Conducted Power : 250mW
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 = 1.996 S/m; ε_r = 52.221; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Area Scan (71x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 21.4 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 102.3 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 28.2 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.16 W/kg
Maximum value of SAR (measured) = 20.4 W/kg
Date: 2014/10/07
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



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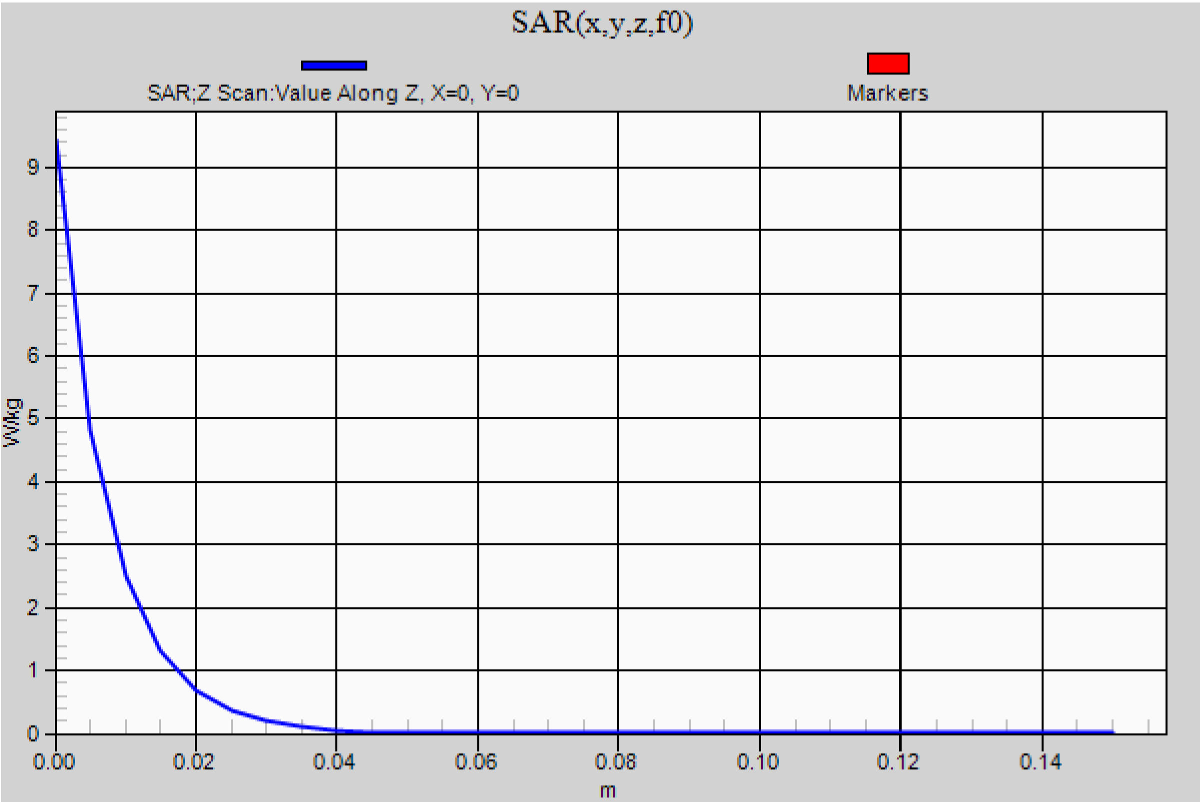
Body 2450MHz System Check DATA / Dipole2450MHz / Forward Conducted Power : 250mW
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.996 S/m; ε_r = 52.221; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.2, 7.2, 7.2); Calibrated: 2014/05/14;
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1369; Calibrated: 2014/05/14
Phantom: ELI v5.0 SN1203; Type: QDOVA002AA; Serial: TP:1203
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Z Scan (1x1x31): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 9.43 W/kg
Date: 2014/10/07
Ambient Temp. : 24.0 degree.C. Liquid Temp.: 23.5 degree.C.



2. System check uncertainty

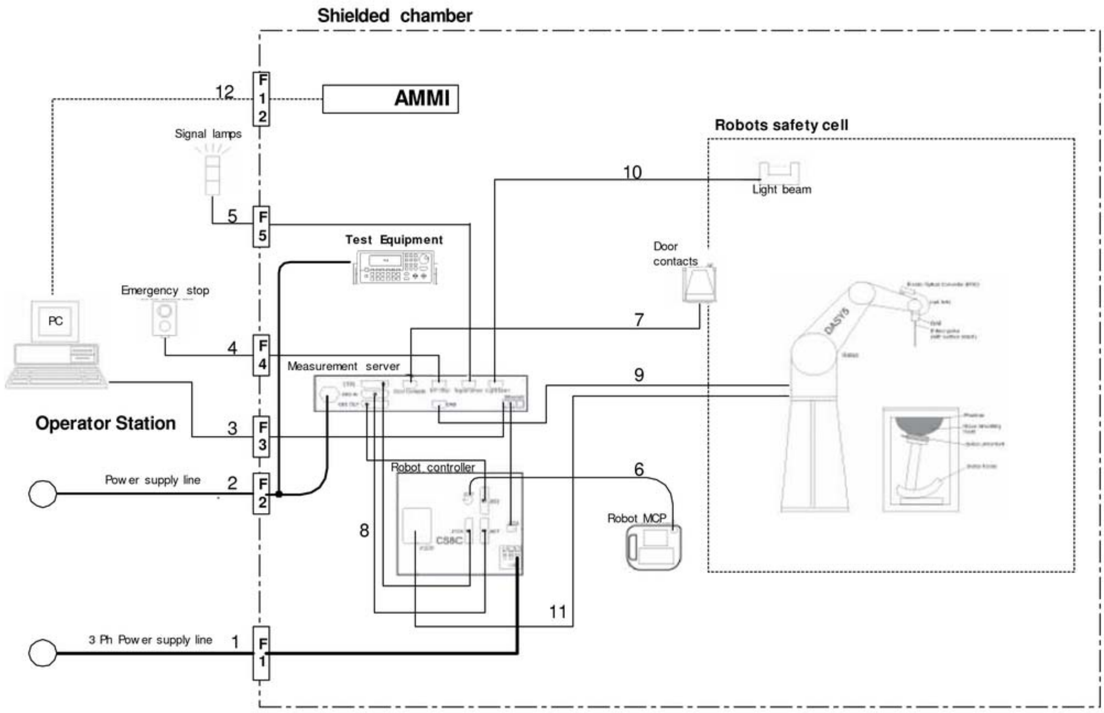
The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[1] and is given in the following Table.

Repeatability Budget for System Check
<0.3 – 3GHz range Body>

Error Description	Uncertainty value ± %	Probability distribution	divisor	(ci) 1g	Standard (1g)	vi or veff
Measurement System						
Probe calibration	± 1.8	Normal	1	1	± 1.8	∞
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	± 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	∞
Test Sample Related						
Deviation of	± 0.0	Normal	√3	1	± 0.0	∞
Dipole Axis to Liquid Distance	± 2.0	Normal	√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	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	± 1.9	Normal	1	1	± 1.9	∞
Liquid conductivity (meas.)	± 5.0	Rectangular	1	0.78	+ 3.9	∞
Liquid permittivity (meas.)	± 5.0	Rectangular	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					± **6.144**	
Expanded Uncertainty (k=2)					± **12.3**	

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

EX3DV4 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

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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

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_May14**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3917
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	May 14, 2014

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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
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-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 15, 2014

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

Certificate No: EX3-3917_May14 Page 1 of 11

Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland

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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:3917

Manufactured: December 18, 2012
Calibrated: May 14, 2014

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

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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]	0.54	0.41	0.46	± 10.1 %
DCP (mV)[B]	97.9	104.3	102.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	148.1	±3.0 %
		Y	0.0	0.0	1.0		148.4	
		Z	0.0	0.0	1.0		136.2	

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: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 [G]	Depth [G] (mm)	Unct. (k=2)
650	42.5	0.89	10.31	10.31	10.31	0.11	1.10	± 13.3 %
750	41.9	0.89	10.11	10.11	10.11	0.36	0.93	± 12.0 %
835	41.5	0.90	9.75	9.75	9.75	0.27	1.10	± 12.0 %
900	41.5	0.97	9.57	9.57	9.57	0.25	1.05	± 12.0 %
1450	40.5	1.20	9.17	9.17	9.17	0.43	0.92	± 12.0 %
1640	40.3	1.29	8.63	8.63	8.63	0.80	0.57	± 12.0 %
1750	40.1	1.37	8.46	8.46	8.46	0.42	0.80	± 12.0 %
1810	40.0	1.40	8.21	8.21	8.21	0.42	0.81	± 12.0 %
1900	40.0	1.40	8.14	8.14	8.14	0.76	0.61	± 12.0 %
1950	40.0	1.40	7.84	7.84	7.84	0.59	0.67	± 12.0 %
2450	39.2	1.80	7.24	7.24	7.24	0.64	0.65	± 12.0 %
2600	39.0	1.96	6.91	6.91	6.91	0.46	0.77	± 12.0 %
5200	36.0	4.66	5.45	5.45	5.45	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.27	5.27	5.27	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.91	4.91	4.91	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.71	4.71	4.71	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.82	4.82	4.82	0.35	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. Above 5 GHz frequency validity can be extended to ± 110 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:3917

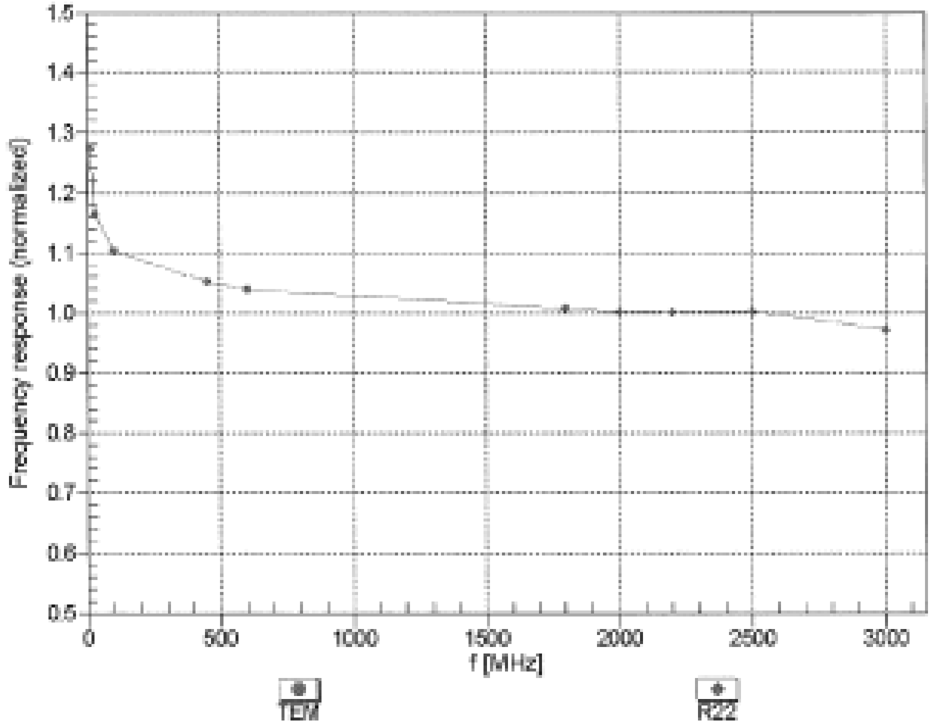
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
650	55.9	0.96	9.92	9.92	9.92	0.05	1.05	± 13.3 %
750	55.5	0.96	9.81	9.81	9.81	0.61	0.68	± 12.0 %
835	55.2	0.97	9.64	9.64	9.64	0.29	1.07	± 12.0 %
900	55.0	1.05	9.38	9.38	9.38	0.26	1.12	± 12.0 %
1450	54.0	1.30	8.35	8.35	8.35	0.37	0.88	± 12.0 %
1640	53.8	1.40	8.50	8.50	8.50	0.39	0.86	± 12.0 %
1750	53.4	1.49	7.88	7.88	7.88	0.45	0.85	± 12.0 %
1810	53.3	1.52	7.74	7.74	7.74	0.68	0.68	± 12.0 %
1900	53.3	1.52	7.68	7.68	7.68	0.30	1.02	± 12.0 %
1950	53.3	1.52	7.93	7.93	7.93	0.51	0.77	± 12.0 %
2450	52.7	1.95	7.20	7.20	7.20	0.76	0.57	± 12.0 %
2600	52.5	2.16	7.01	7.01	7.01	0.80	0.50	± 12.0 %
5200	49.0	5.30	5.02	5.02	5.02	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.82	4.82	4.82	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.46	4.46	4.46	0.35	1.90	± 13.1 %
5600	48.5	5.77	4.26	4.26	4.26	0.35	1.90	± 13.1 %
5800	48.2	6.00	4.52	4.52	4.52	0.40	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. Above 5 GHz frequency validity can be extended to ± 110 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.

EX3DV4– SN:3917 May 14, 2014

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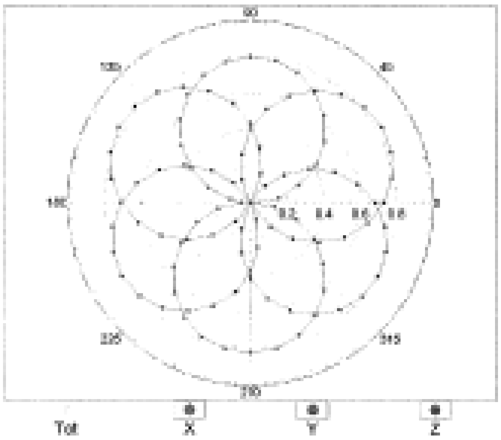
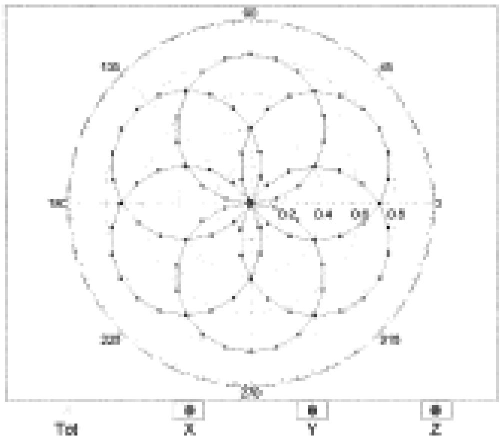
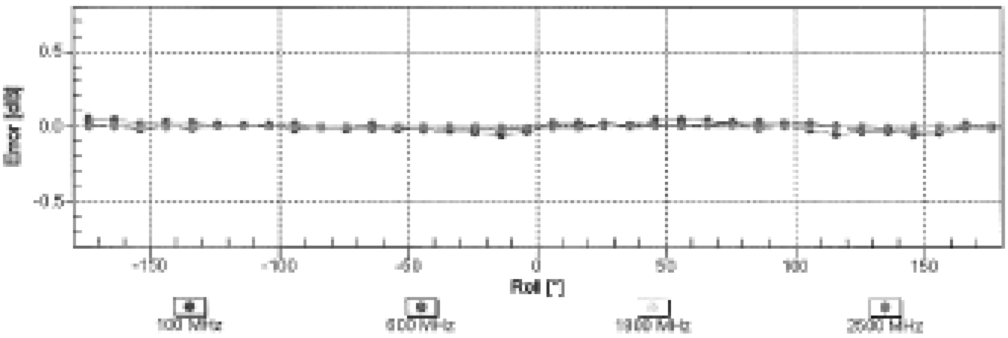
Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



f=1800 MHz,R22





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

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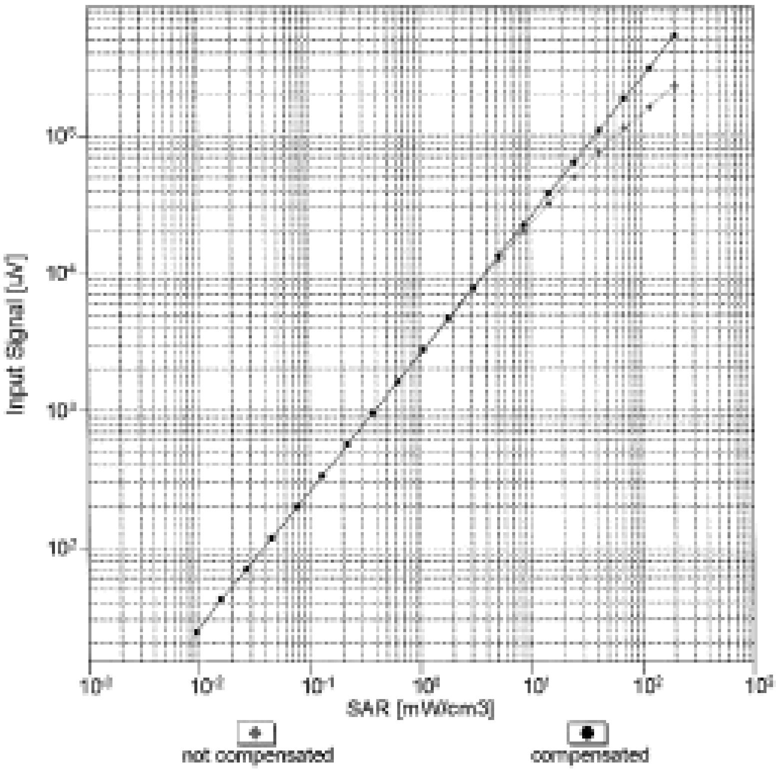
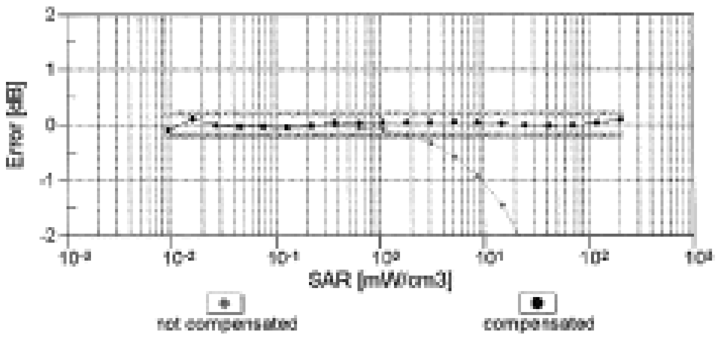
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)





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

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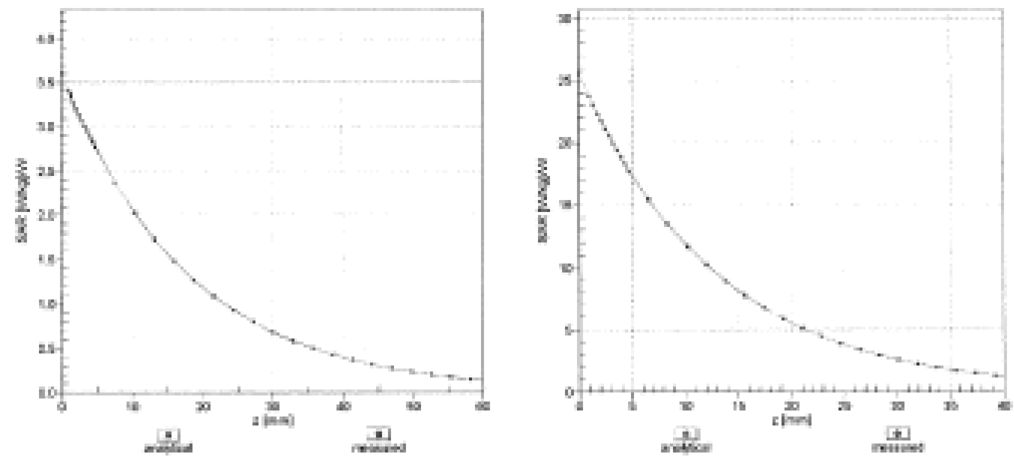
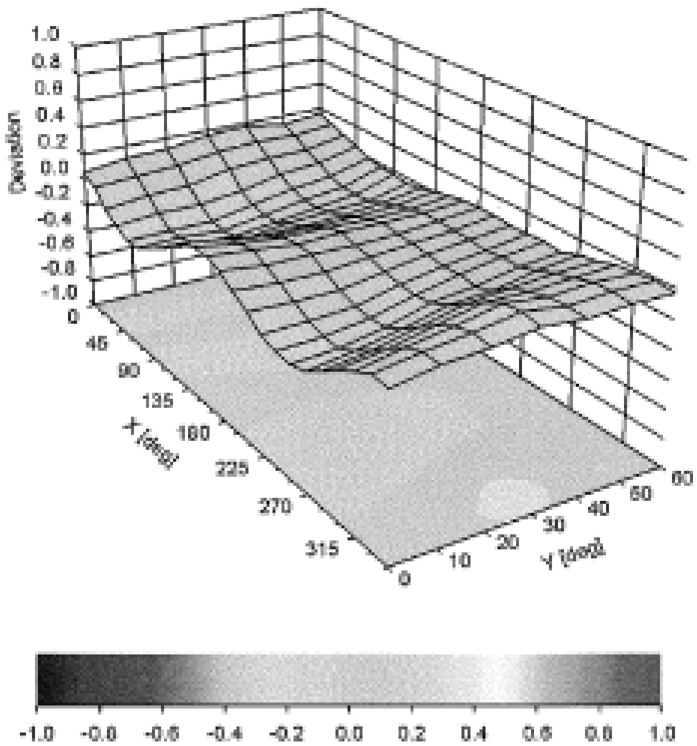
EX3DV4– SN:3917 May 14, 2014

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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-114
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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4. 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
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: 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
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) 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

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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

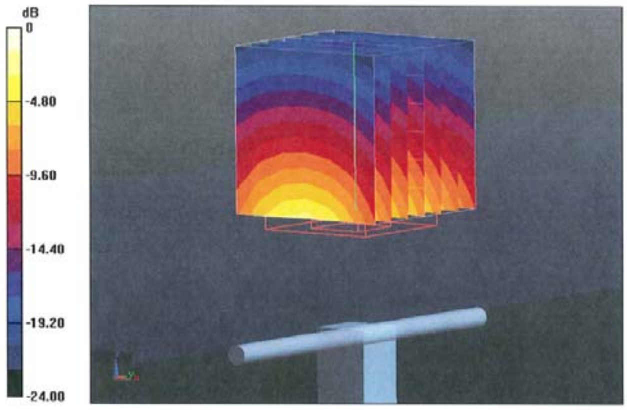
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.83 S/m; ε_r = 39.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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: 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

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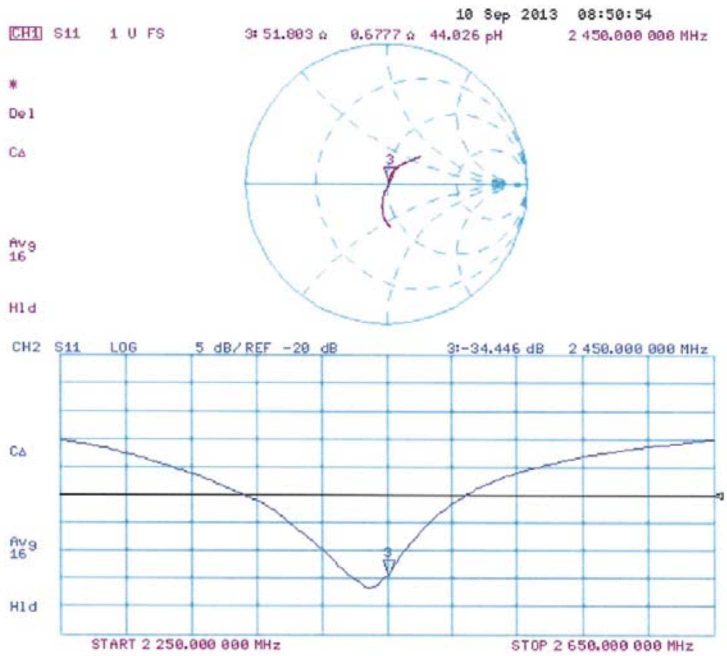
Impedance Measurement Plot for Head TSL



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

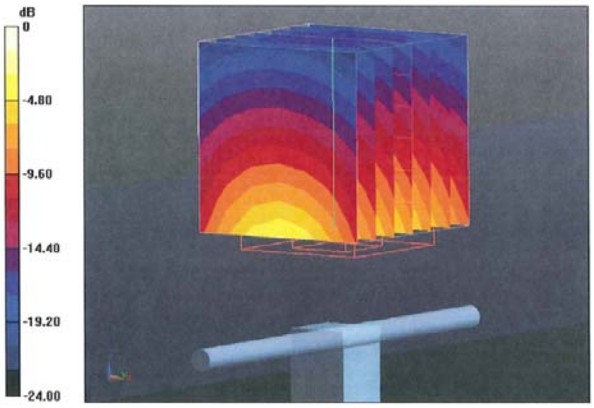
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2 S/m; ε_r = 52.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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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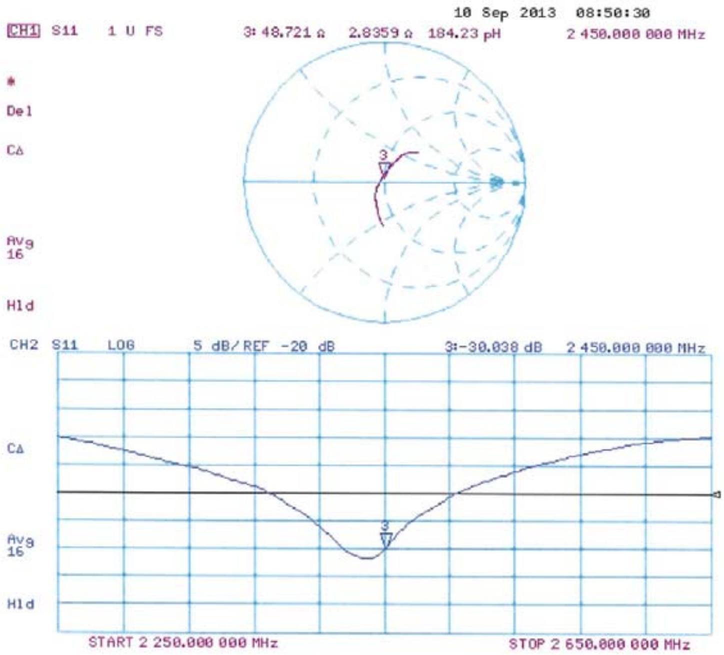
Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-713_Sep13 Page 8 of 8

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D2450V2 Calibration for Impedance and Return-loss

Tested by	Yoshinori Ishida

1. Test environment

Date	September 18, 2014		
Ambient Temperature	24.0 deg.C	Relative humidity	50%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	SAR	2014/08/21 * 12
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	SAR	2014/08/18 * 12
EST-46	3.5mm ECONOMY CALIBRATION KIT	Agilent	85052D	MY43252869	SAR	2014/08/15 * 12
MPSAM-03	SAM Phantom	Schmid&Partner Engineering AG	QD000P40CD	1764	SAR	2014/06/03 * 12
MPF-03	2mmOval Flat Phantom ERI 5.0	Schmid&Partner Engineering AG	QDOVA001BB	1203	SAR	2014/06/03 * 12
MOS-30	Thermo-Hygrometer	Custom	CTH-201	3001	SAR	2014/07/06 * 12
MOS-35	Digital thermometer	HANNA	Checktemp 4	-	SAR	2014/07/06 * 12
HSL2450						Daily check
MSL2450						Daily check
SAR room1						Daily check

3. Test Result

Impeadance,Transformed to feed point	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/09/10	51.8 Ω+0.7jΩ	-	-	-
Calibration(ULJ)2014/9/18	51.5Ω+0.9jΩ	-0.3Ω+0.2jΩ	+/-5Ω+/-5jΩ	Complied

Return loss	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/09/10	-34.4dB	-	-	-
Calibration(ULJ)2014/9/18	-35.3dB	-0.9dB	-34.4 *+/-20%	Complied

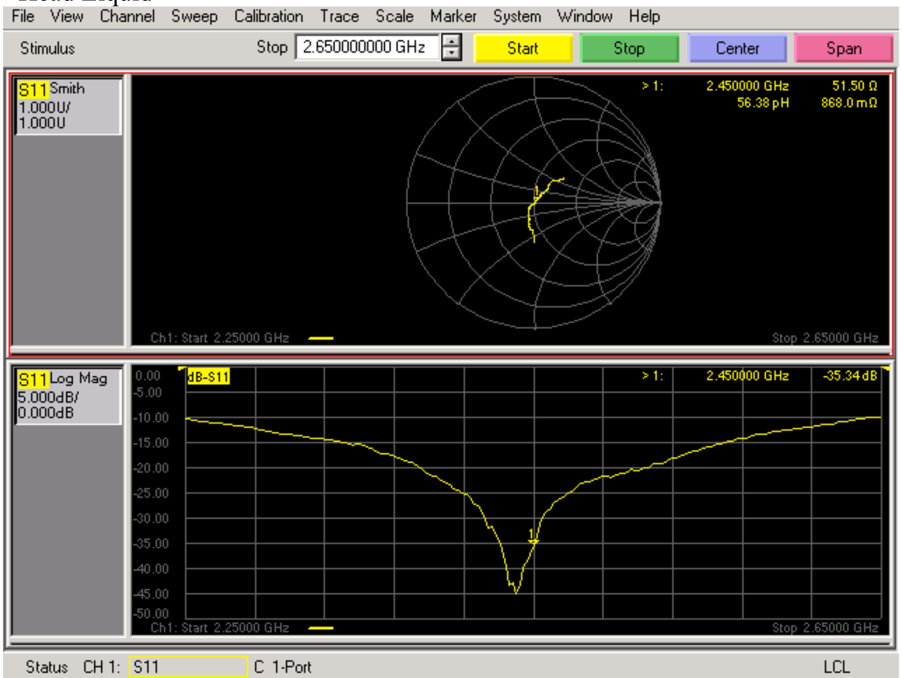
Impeadance,Transformed to feed point	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/09/10	48.7Ω+2.8jΩ	-	-	-
Calibration(ULJ)2014/9/18	49.6Ω+2.8jΩ	+0.9Ω+/-0jΩ	+/-5Ω+/-5jΩ	Complied

Return loss	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/09/10	-30.0dB	-	-	-
Calibration(ULJ)2014/9/18	-31.0dB	-1.0dB	-30.0 *+/-20%	Complied

*Tolerance : According to the KDB450824D02

Measurement Plots

<Head Liquid>



<Body Liquid>