



SAR TEST REPORT

No. I14Z46912-SEM03

For

TCT Mobile Limited

Wi-Fi dual-band tablet

Model Name: D819

With

Hardware Version: PIO

Software Version: vJ58

FCC ID: RAD494

Issued Date: 2014-09-12



Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of TMC Beijing.

Test Laboratory:

TMC Beijing, Telecommunication Metrology Center of MIIT

No. 52, Huayuan Bei Road, Haidian District, Beijing, P. R. China 100191.

Tel: +86(0)10-62304633-2079, Fax: +86(0)10-62304633 Email: welcome@emcite.com. www.emcite.com

©Copyright. All rights reserved by TMC Beijing.

Revision Version

Report Number	Revision	Date	Memo
I14Z46912-SEM03	0	2014-08-12	Initial creation of test report
I14Z46912-SEM03	1	2014-09-12	1. Change the model name from D819X to D819 on page 1/6/8 2. Update the step size on page 29/31 3. Add the output power for U-NII band 3 on page 20/21 4. Supplement the SAR measurement for WLAN-5G that be presented in table 12.3

TABLE OF CONTENT

1 TEST LABORATORY	5
1.1 TESTING LOCATION	5
1.2 TESTING ENVIRONMENT.....	5
1.3 PROJECT DATA	5
1.4 SIGNATURE.....	5
2 STATEMENT OF COMPLIANCE	6
3 CLIENT INFORMATION	7
3.1 APPLICANT INFORMATION	7
3.2 MANUFACTURER INFORMATION	7
4 EQUIPMENT UNDER TEST (EUT) AND ANCILLARY EQUIPMENT (AE)	8
4.1 ABOUT EUT	8
4.2 INTERNAL IDENTIFICATION OF EUT USED DURING THE TEST	8
4.3 INTERNAL IDENTIFICATION OF AE USED DURING THE TEST	8
5 TEST METHODOLOGY	9
5.1 APPLICABLE LIMIT REGULATIONS	9
5.2 APPLICABLE MEASUREMENT STANDARDS.....	9
6 SPECIFIC ABSORPTION RATE (SAR).....	10
6.1 INTRODUCTION.....	10
6.2 SAR DEFINITION	10
7 TISSUE SIMULATING LIQUIDS	11
7.1 TARGETS FOR TISSUE SIMULATING LIQUID	11
7.2 DIELECTRIC PERFORMANCE	11
8 SYSTEM VERIFICATION	13
8.1 SYSTEM SETUP.....	13
8.2 SYSTEM VERIFICATION.....	14
9 MEASUREMENT PROCEDURES	15
9.1 TESTS TO BE PERFORMED	15
9.2 GENERAL MEASUREMENT PROCEDURE.....	17
9.3 BLUETOOTH & WI-FI MEASUREMENT PROCEDURES FOR SAR	18
9.4 POWER DRIFT	18
10 CONDUCTED OUTPUT POWER.....	19
10.1 MANUFACTURING TOLERANCE	19
10.2 WI-FI AND BT MEASUREMENT RESULT	19
11 TEST EXCLUSION CONSIDERATIONS	22
11.1 TRANSMIT ANTENNA SEPARATION DISTANCES	22

11.2 STANDALONE SAR TEST EXCLUSION CONSIDERATIONS	23
12 SAR TEST RESULT	24
13 SAR MEASUREMENT VARIABILITY	26
14 MEASUREMENT UNCERTAINTY	27
15 MAIN TEST INSTRUMENTS.....	29
ANNEX A GRAPH RESULTS.....	30
ANNEX B SYSTEM VERIFICATION RESULTS	34
ANNEX C SAR MEASUREMENT SETUP	41
ANNEX D POSITION OF THE WIRELESS DEVICE IN RELATION TO THE PHANTOM	47
ANNEX E EQUIVALENT MEDIA RECIPES	50
ANNEX F SYSTEM VALIDATION	51
ANNEX G PROBE CALIBRATION CERTIFICATE.....	52
ANNEX H DIPOLE CALIBRATION CERTIFICATE	74

1 Test Laboratory

1.1 Testing Location

Company Name: TMC Beijing, Telecommunication Metrology Center of MIIT
Address: No 52, Huayuan beilu, Haidian District, Beijing,P.R.China
Postal Code: 100191
Telephone: +86-10-62304633
Fax: +86-10-62304793

1.2 Testing Environment

Temperature: 18°C~25 °C,
Relative humidity: 30%~ 70%
Ground system resistance: < 0.5 Ω
Ambient noise & Reflection: < 0.012 W/kg

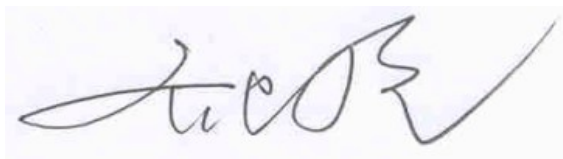
1.3 Project Data

Project Leader: Qi Dianyuan
Test Engineer: Lin Xiaojun
Testing Start Date: July 3, 2014
Testing End Date: July 4, 2014

1.4 Signature



Lin Xiaojun
(Prepared this test report)



Qi Dianyuan
(Reviewed this test report)



Xiao Li
Deputy Director of the laboratory
(Approved this test report)

2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for TCT Mobile Limited Wi-Fi dual-band tablet D819 are as follows:

Table 2.1: Highest Reported SAR (1g)

Exposure Configuration	Technology Band	Highest Reported SAR 1g (W/Kg)	Equipment Class
Body (Separation Distance 5mm)	WLAN 2.4 GHz	1.58	DTS
	WLAN 5 GHz	1.05	UNII

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1999.

According to the client requirement, we perform the body SAR measurement with a minimum separation distance of 5 mm between this device and the phantom.

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report. The highest reported SAR value is obtained at the case of **(Table 2.1)**, and the values are: **1.58 W/kg (1g)**.

3 Client Information

3.1 Applicant Information

Company Name:	TCT Mobile Limited
Address /Post:	5F, C building, No. 232, Liang Jing Road ZhangJiang High-Tech Park, Pudong Area Shanghai, P.R. China. 201203
City:	ShangHai
Postal Code:	201203
Country:	P.R.China
Contact:	Gong Zhizhou
Email:	zhizhou.gong@tcl.com
Telephone:	0086-21-51798260
Fax:	0086-21-61460602

3.2 Manufacturer Information

Company Name:	TCT Mobile Limited
Address /Post:	5F, C building, No. 232, Liang Jing Road ZhangJiang High-Tech Park, Pudong Area Shanghai, P.R. China. 201203
City:	ShangHai
Postal Code:	201203
Country:	P.R.China
Contact:	Gong Zhizhou
Email:	zhizhou.gong@tcl.com
Telephone:	0086-21-51798260
Fax:	0086-21-61460602

4 Equipment Under Test (EUT) and Ancillary Equipment (AE)

4.1 About EUT

Description:	Wi-Fi dual-band tablet
Model Name:	D819
Operating mode(s):	BT, Wi-Fi,
Tested Tx Frequency:	2412 – 2462 MHz (Wi-Fi 2.4G)
	5180 – 5700 MHz (Wi-Fi 5G)
Test device Production information:	Production unit
Device type:	Portable device
Antenna type:	Integrated antenna
Accessories configurations:	Headset
Hotspot mode:	Support simultaneous transmission of hotspot and voice(or data)
Form factor:	209 mm × 122 mm

4.2 Internal Identification of EUT used during the test

EUT ID*	IMEI	HW Version	SW Version
EUT1	864480020001706	PIO	vJ58
EUT2	864480020001805	PIO	vJ58
EUT3	864480020001979	PIO	vJ58

*EUT ID: is used to identify the test sample in the lab internally.

Note1: It is performed to test SAR with the EUT1 and conducted power with the EUT2.

Note2: It is performed to test SAR for Supplement with the EUT3

4.3 Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
AE1	Battery	CAC4060002C2	/	SCUD
AE2	Headset	CCB3001A1BC2	/	Juwei
AE3	Headset	CCB3001A1CC2	/	Juwei

*AE ID: is used to identify the test sample in the lab internally.

5 TEST METHODOLOGY

5.1 Applicable Limit Regulations

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2 Applicable Measurement Standards

IEEE 1528–2013: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.

KDB447498 D01: General RF Exposure Guidance v05r02: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB648474 D04 Handset SAR v01r02: SAR Evaluation Considerations for Wireless Handsets.

KDB616217 D04 SAR for laptop and tablets v01r01: SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers.

KDB248227: SAR measurement procedures for 802.112abg transmitters

KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03: SAR Measurement Requirements for 100 MHz to 6 GHz.

KDB 865664 D02 RF Exposure Reporting v01r01: RF Exposure Compliance Reporting and Documentation Considerations

6 Specific Absorption Rate (SAR)

6.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

6.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$SAR = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dv} \right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c \left(\frac{\delta T}{\delta t} \right)$$

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7 Tissue Simulating Liquids

7.1 Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

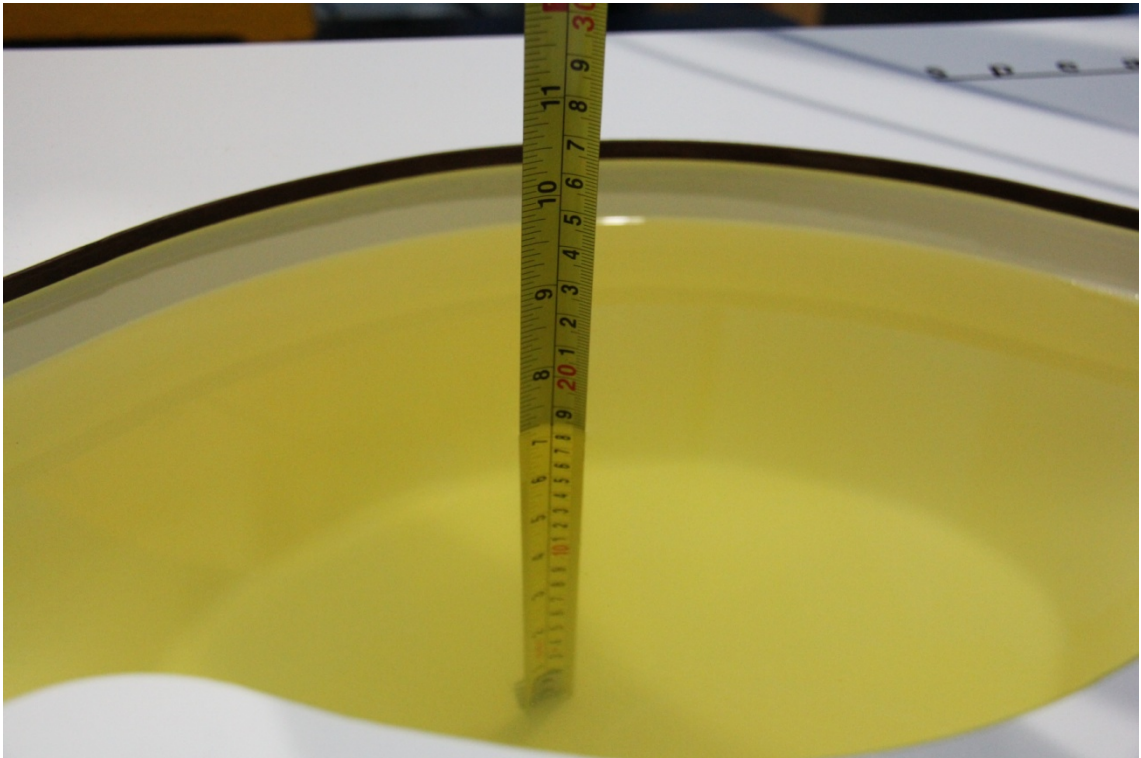
Frequency(MHz)	Liquid Type	Conductivity(σ)	$\pm 5\%$ Range	Permittivity(ϵ)	$\pm 5\%$ Range
2450	Body	1.95	1.85~2.05	52.7	50.1~55.3
5200	Body	5.30	5.04~5.56	49.0	46.6~51.4
5300	Body	5.42	5.15~5.69	48.9	46.46~51.34
5600	Body	5.77	5.48~6.06	48.5	46.08~50.92
5800	Body	6.00	5.70~6.30	48.2	45.8~50.6

7.2 Dielectric Performance

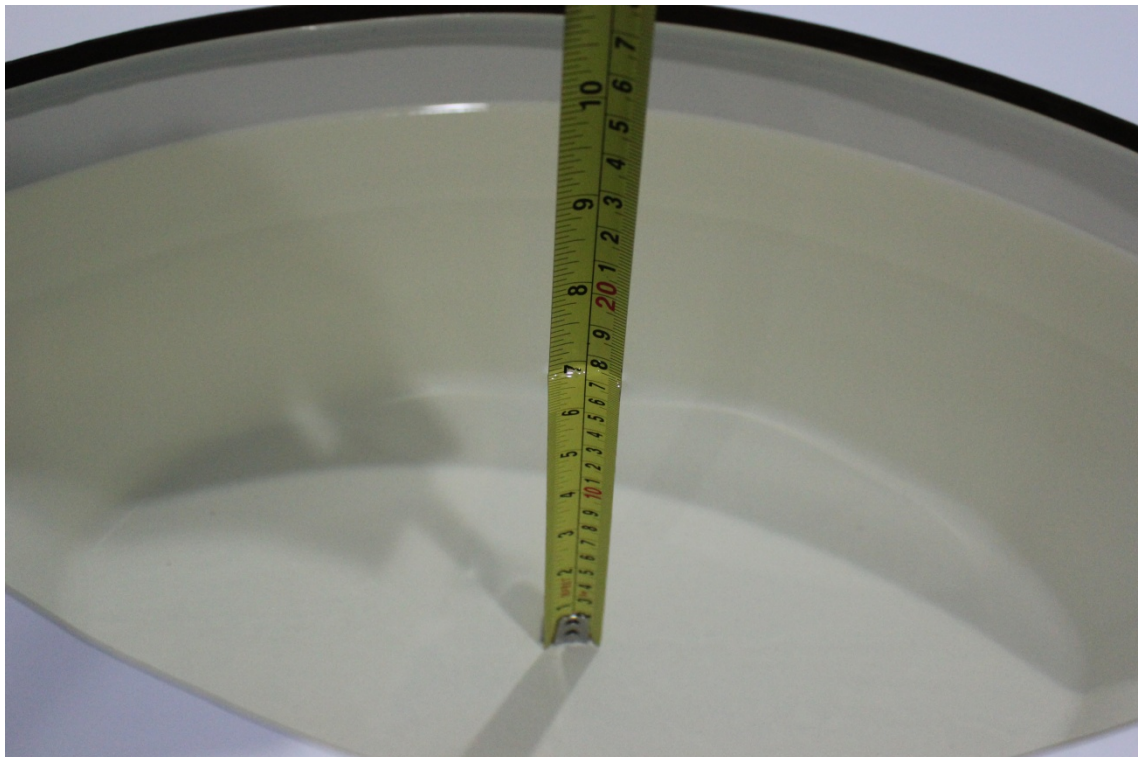
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ϵ	Drift (%)	Conductivity σ (S/m)	Drift (%)
2014-07-03	Body	2450 MHz	53.28	1.10	1.973	1.18
2014-07-04	Body	5200 MHz	48.76	-0.49	5.133	-3.15
	Body	5300 MHz	48.55	-0.72	5.282	-2.55
	Body	5600 MHz	47.88	-1.28	5.696	-1.28
2014-09-10	Body	5300 MHz	47.8	-2.25	5.253	-3.08
	Body	5600 MHz	47.15	-2.78	5.729	-0.71
	Body	5800 MHz	46.71	-3.09	6.058	0.97

Note: The liquid temperature is 22.0°C



Picture 7-1 Liquid depth in the Flat Phantom (2450MHz)

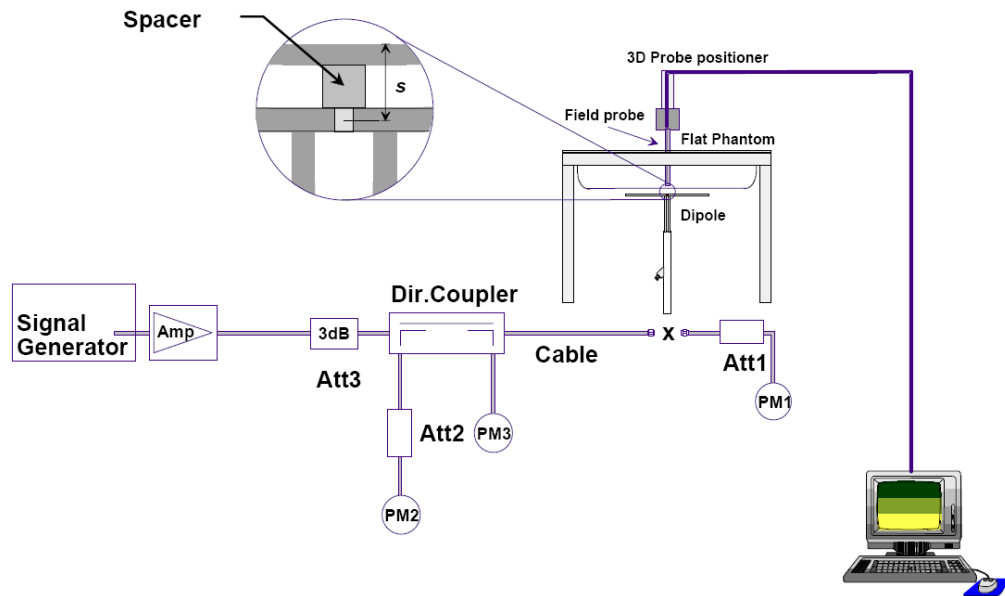


Picture 7-2 Liquid depth in the Flat Phantom (5GHz)

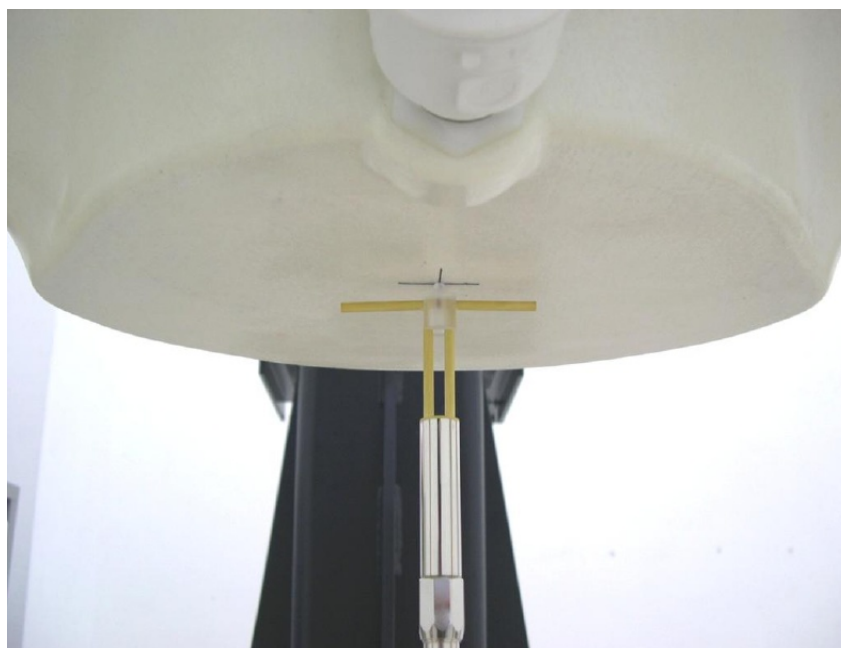
8 System verification

8.1 System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 8.1 System Setup for System Evaluation



Picture 8.2 Photo of Dipole Setup

8.2 System Verification

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

The system verification results are required that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR. The details are presented in annex B.

Table 8.1: System Verification of Body

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value (W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2014-07-03	2450 MHz	23.4	50.4	22.72	48.40	-2.91%	-3.97%
2014-07-04	5200 MHz	21.7	77.8	21.20	74.80	-2.30%	-3.86%
	5300 MHz	22.0	79.1	21.70	77.00	-1.36%	-2.65%
	5600 MHz	22.9	82.7	22.70	80.80	-0.87%	-2.30%
2014-09-10	5300 MHz	22.0	79.1	21.50	77.10	-2.27%	-2.53%
	5600 MHz	22.9	82.7	22.40	80.70	-2.18%	-2.42%
	5800 MHz	21.3	77.3	20.90	75.40	-1.88%	-2.46%

9 Measurement Procedures

9.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

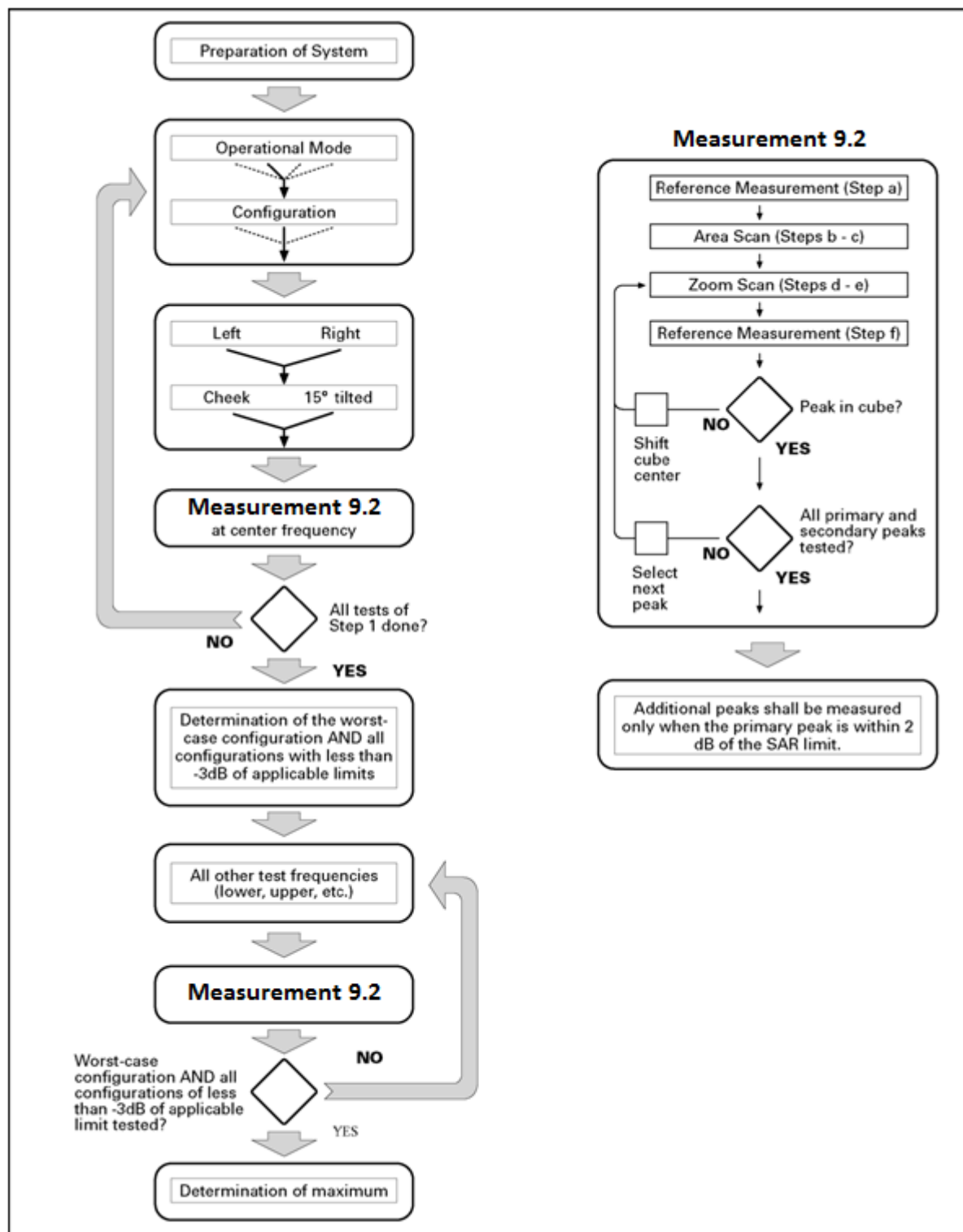
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

- a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),
- b) all configurations for each device position in a), e.g., antenna extended and retracted, and
- c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_c > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 9.1 Block diagram of the tests to be performed

9.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

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

9.3 Bluetooth & Wi-Fi Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.4 Power Drift

To control the output power stability during the SAR test, DASY4 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 12.1 to Table 12.3 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10 Conducted Output Power

10.1 Manufacturing tolerance

Table 10.1: Bluetooth

GFSK			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	6	6	6
Tune-up (dBm)	7	7	7

Table 10.2: WiFi

Band	Target (dBm)	Tune-up (dBm)
802.11a	15	16
802.11b	18	18.5
802.11g	15	16
802.11n HT20	15	16
802.11n HT40, Channel 3, MCS0	12.5	13
802.11n HT40, Channel 3, MCS6	8.5	9
802.11n HT40, Others	14.5	15

10.2 Wi-Fi and BT Measurement result

The output power of BT antenna is as following:

Mode	Conducted Power (dBm)		
	Channel 0 (2402MHz)	Channel 39 (2441MHz)	Channel 78 (2480MHz)
GFSK	5.53	5.74	6.60

The average conducted power for Wi-Fi is as following:

802.11b (dBm)

Channel\data rate	1Mbps	2Mbps	5.5Mbps	11Mbps
1	18.08	17.98	17.84	17.52
6	17.90	/	/	/
11	17.82	/	/	/

802.11g (dBm)

Channel\data rate	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps
1	14.78	/	/	/	/	/	/	/
6	15.51	/	/	/	/	/	/	/
11	15.88	14.15	15.64	15.70	15.87	15.84	15.62	15.83

802.11n (dBm) - HT20 (2.4G)

Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
1	14.75	/	/	/	/	/	/	/
6	15.45	/	/	/	/	/	/	/
11	15.85	15.57	15.67	15.63	15.60	15.61	15.85	15.80

802.11n (dBm) - HT40 (2.4G)

Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
3	12.21	/	/	/	/	/	8.88	/
6	14.48	/	/	/	/	/	14.69	/
9	14.68	14.63	14.62	14.56	14.57	14.90	14.94	14.90

802.11a (dBm)

Channel\data rate	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps
36(5180 MHz)	15.07	/	/	/	/	/	14.93	/
40(5200 MHz)	15.42	/	/	/	/	/	15.12	/
44(5220 MHz)	15.39	/	/	/	/	/	15.52	/
48(5240 MHz)	15.59	14.93	15.62	15.77	13.94	13.32	15.82	15.61
52(5260 MHz)	15.16	/	15.39	/	/	/	/	/
56(5280 MHz)	15.31	14.14	15.55	15.40	13.67	13.78	15.48	14.81
60(5300 MHz)	15.19	/	15.28	/	/	/	/	/
64(5320 MHz)	14.67	/	14.91	/	/	/	/	/
100(5500 MHz)	15.41	/	15.63	/	/	/	/	/
104(5520 MHz)	15.35	/	15.55	/	/	/	/	/
108(5540 MHz)	14.88	/	15.08	/	/	/	/	/
112(5560 MHz)	15.41	/	15.64	/	/	/	/	/
116(5580 MHz)	15.41	/	15.60	/	/	/	/	/
120(5600 MHz)	15.04	/	15.29	/	/	/	/	/
124(5620 MHz)	15.18	/	15.38	/	/	/	/	/
128(5640 MHz)	14.67	/	14.87	/	/	/	/	/
132(5660 MHz)	15.26	/	15.49	/	/	/	/	/
136(5680 MHz)	15.52	14.07	15.76	15.75	13.96	13.99	15.70	15.61
140(5700 MHz)	14.95	/	15.18	/	/	/	/	/
149(5745 MHz)	15.86	13.55	15.54	15.11	13.52	13.45	15.27	15.46
153(5765 MHz)	15.55	/	/	/	/	/	/	/
157(5785 MHz)	15.30	/	/	/	/	/	/	/
161(5805 MHz)	15.33	/	/	/	/	/	/	/
165(5825 MHz)	15.66	/	/	/	/	/	/	/

20M 802.11n (dBm)

Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
36(5180 MHz)	15.07	/	/	/	/	/	15.26	/
40(5200 MHz)	15.10	/	/	/	/	/	15.34	/
44(5220 MHz)	15.27	/	/	/	/	/	15.16	/
48(5240 MHz)	15.48	15.44	14.94	15.18	15.10	15.18	15.65	15.55
52(5260 MHz)	15.32	15.47	15.37	15.38	15.33	15.23	15.56	15.05
56(5280 MHz)	15.22	/	/	/	/	/	15.03	/
60(5300 MHz)	15.21	/	/	/	/	/	15.22	/

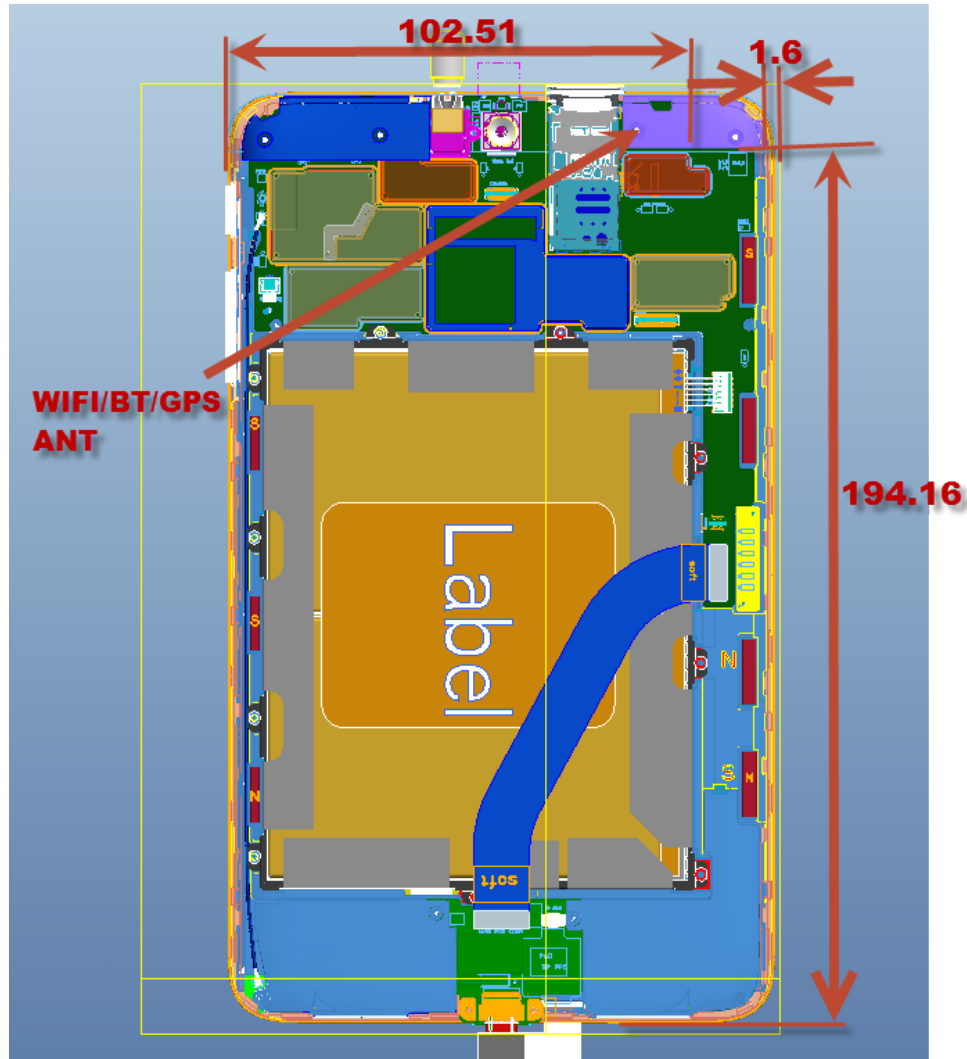
64(5320 MHz)	15.13	/	/	/	/	/	15.33	/
100(5500 MHz)	14.82	/	/	/	/	/	/	15.06
104(5520 MHz)	15.19	/	/	/	/	/	/	15.39
108(5540 MHz)	15.40	/	/	/	/	/	/	15.29
112(5560 MHz)	14.94	/	/	/	/	/	/	15.11
116(5580 MHz)	15.07	/	/	/	/	/	/	15.29
120(5600 MHz)	15.00	/	/	/	/	/	/	14.88
124(5620 MHz)	14.88	/	/	/	/	/	/	15.10
128(5640 MHz)	15.27	/	/	/	/	/	/	15.44
132(5660 MHz)	15.34	/	/	/	/	/	/	15.14
136(5680 MHz)	15.60	/	/	/	/	/	/	15.81
140(5700 MHz)	15.61	15.52	15.40	15.39	15.39	15.81	15.28	15.83
149(5745 MHz)	15.14	/	/	/	/	/	/	/
153(5765 MHz)	15.28	/	/	/	/	/	/	/
157(5785 MHz)	15.43	/	/	/	/	/	/	/
161(5805 MHz)	15.71	14.86	14.98	14.98	14.78	15.32	15.13	15.54
165(5825 MHz)	15.00	/	/	/	/	/	/	/

40M 802.11n (dBm)

Channel\data rate	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
38(5190 MHz)	14.21	/	/	/	/	/	/	14.24
46(5230 MHz)	14.55	14.41	13.94	14.11	14.23	14.43	14.47	14.65
54(5270 MHz)	14.26	14.37	14.35	13.65	13.71	14.36	14.41	14.35
62(5310 MHz)	14.04	/	/	/	/	/	14.22	/
102(5510 MHz)	14.06	/	/	/	/	/	14.28	/
110(5550 MHz)	14.11	/	/	/	/	/	14.35	/
118(5590 MHz)	14.08	/	/	/	/	/	14.30	/
126(5630 MHz)	14.00	/	/	/	/	/	14.22	/
134(5670 MHz)	14.22	14.39	14.47	13.75	14.19	14.38	14.42	14.36
151(5755 MHz)	14.37	/	/	/	/	/	/	/
159(5795 MHz)	14.42	14.33	14.30	14.02	13.86	14.20	14.21	14.33

11 Test Exclusion Considerations

11.1 Transmit Antenna Separation Distances



Picture 11.1 Antenna Locations

11.2 Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR, where

- $f(\text{GHz})$ 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

Table 11.1: Standalone SAR test exclusion considerations

Band/Mode	F(GHz)	Position	SAR test exclusion threshold (mW)	RF output power		SAR test exclusion
				dBm	mW	
Bluetooth	2.441	Head	9.60	6.6	4.57	Yes
		Body	19.20	6.6	4.57	Yes
2.4GHz WLAN 802.11 b	2.45	Head	9.58	18.08	64.27	No
		Body	19.17	18.08	64.27	No
WLAN 5GHz	5.2	Head	6.58	15.82	38.19	No
		Body	13.16	15.82	38.19	No
	5.3	Head	6.52	15.56	35.97	No
		Body	13.03	15.56	35.97	No
	5.6	Head	6.34	15.83	38.28	No
		Body	12.68	15.83	38.28	No
	5.8	Head	6.23	15.86	38.55	No
		Body	12.46	15.86	38.55	No

12 SAR Test Result

Table 12.1: SAR Values (Wi-Fi 802.11b - Body)

Ambient Temperature: 22.4 °C						Liquid Temperature: 21.9 °C				
Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
2462	11	Front	/	17.82	18.5	0.497	0.58	1.04	1.22	0.13
2437	6	Front	/	17.90	18.5	0.581	0.67	1.15	1.32	-0.12
2412	1	Front	/	18.08	18.5	0.472	0.52	0.911	1.00	0.15
2462	11	Rear	Fig.1	17.82	18.5	0.615	0.72	1.35	1.58	0.04
2437	6	Rear	/	17.90	18.5	0.560	0.64	1.21	1.39	0.17
2412	1	Rear	/	18.08	18.5	0.493	0.54	1.13	1.24	0.10
2437	6	Left	/	17.90	18.5	0.343	0.39	0.694	0.80	0.00
2437	6	Right	/	17.90	18.5	0.025	0.03	0.045	0.05	-0.16
2437	6	Top	/	17.90	18.5	0.153	0.18	0.306	0.35	-0.05
2437	6	Bottom	/	17.90	18.5	0.020	0.02	0.038	0.04	0.11

Note1: The distance between the EUT and the phantom bottom is 5mm.

Table 12.2: SAR Values (Wi-Fi 802.11a - Body)

Ambient Temperature: 22.3 °C						Liquid Temperature: 21.8 °C				
Frequency		Test Position	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.									
5240	48	Front	/	15.59	16	0.130	0.14	0.355	0.39	0.01
5240	48	Rear	/	15.59	16	0.167	0.18	0.595	0.65	0.12
5240	48	Left	/	15.59	16	0.099	0.11	0.290	0.32	0.02
5240	48	Right	/	15.59	16	0.024	0.03	0.052	0.06	-0.16
5240	48	Top	/	15.59	16	0.109	0.12	0.269	0.30	-0.15
5240	48	Bottom	/	15.59	16	0.023	0.03	0.052	0.06	0.16
5280	56	Front	/	15.31	16	0.114	0.13	0.299	0.35	0.10
5280	56	Rear	/	15.31	16	0.228	0.27	0.784	0.92	0.13
5280	56	Left	/	15.31	16	0.123	0.14	0.306	0.36	0.19
5280	56	Right	/	15.31	16	0.024	0.03	0.055	0.06	-0.17
5280	56	Top	/	15.31	16	0.068	0.08	0.166	0.19	0.08
5280	56	Bottom	/	15.31	16	0.024	0.03	0.052	0.06	0.09
5680	136	Front	/	15.52	16	0.036	0.04	0.093	0.10	0.15
5680	136	Rear	Fig.2	15.52	16	0.279	0.31	0.937	1.05	0.16
5680	136	Left	/	15.52	16	0.100	0.11	0.258	0.29	0.15
5680	136	Right	/	15.52	16	0.032	0.04	0.073	0.08	0.12
5680	136	Top	/	15.52	16	0.098	0.11	0.262	0.29	0.05
5680	136	Bottom	/	15.52	16	0.024	0.03	0.054	0.06	0.11

Note1: The distance between the EUT and the phantom bottom is 5mm.

Table 12.3: SAR Values (Wi-Fi 802.11a - Body) - Supplement

Ambient Temperature: 22.3 °C Liquid Temperature: 21.8 °C									
Frequency		Test Position	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)
MHz	Ch.								
5300	60	Rear	15.19	16	0.151	0.18	0.462	0.56	0.09
5500	100	Rear	15.41	16	0.136	0.16	0.457	0.52	0.14
5580	116	Rear	15.41	16	0.119	0.14	0.392	0.45	0.04
5620	124	Rear	15.18	16	0.164	0.20	0.708	0.86	0.06
5745	149	Front	15.86	16	0.051	0.05	0.221	0.23	-0.09
5745	149	Rear	15.86	16	0.128	0.13	0.531	0.55	0.08
5745	149	Left	15.86	16	0.059	0.06	0.156	0.16	0.05
5745	149	Right	15.86	16	0.009	0.01	0.026	0.03	0.18
5745	149	Top	15.86	16	0.063	0.07	0.180	0.19	-0.12
5745	149	Bottom	15.86	16	0.006	0.01	0.017	0.02	0.16

Note1: The distance between the EUT and the phantom bottom is 5mm.

13 SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
- 3) 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).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

Table 13.1: SAR Measurement Variability for Body Wi-Fi 802.11b (1g)

Frequency		Test Position	Spacing (mm)	Original SAR (W/kg)	First Repeated SAR (W/kg)	The Ratio	Second Repeated SAR (W/kg)
MHz	Ch.						
2462	11	Rear	5	1.35	1.32	1.02	/

Table 13.2: SAR Measurement Variability for Body Wi-Fi 802.11a (1g)

Frequency		Test Position	Spacing (mm)	Original SAR (W/kg)	First Repeated SAR (W/kg)	The Ratio	Second Repeated SAR (W/kg)
MHz	Ch.						
5680	136	Rear	5	0.937	0.921	1.02	/

14 Measurement Uncertainty

14.1 Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system										
1	Probe calibration	B	5.5	N	1	1	1	5.5	5.5	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. restrictions	B	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∞
12	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Test sample related										
14	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
15	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
16	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
19	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43
20	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521

Combined standard uncertainty	$u_c' = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$					9.25	9.12	257
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$					18.5	18.2	

14.2 Measurement Uncertainty for Normal SAR Tests (3~6GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system										
1	Probe calibration	B	6.5	N	1	1	1	6.5	6.5	∞
2	Isotropy	B	4.7	R	$\sqrt{3}$	0.7	0.7	1.9	1.9	∞
3	Boundary effect	B	2.0	R	$\sqrt{3}$	1	1	1.2	1.2	∞
4	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
5	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
6	Readout electronics	B	0.3	R	$\sqrt{3}$	1	1	0.3	0.3	∞
7	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
8	Integration time	B	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∞
9	RF ambient conditions-noise	B	0	R	$\sqrt{3}$	1	1	0	0	∞
10	RF ambient conditions-reflection	B	0	R	$\sqrt{3}$	1	1	0	0	∞
11	Probe positioned mech. restrictions	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
12	Probe positioning with respect to phantom shell	B	6.7	R	$\sqrt{3}$	1	1	3.9	3.9	∞
13	Post-processing	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
Test sample related										
14	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	71
15	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
16	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
17	Phantom uncertainty	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
18	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
19	Liquid conductivity (meas.)	A	2.06	N	1	0.64	0.43	1.32	0.89	43

20	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
21	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	1.0	0.8	521
Combined standard uncertainty		$u_c' = \sqrt{\sum_{i=1}^{21} c_i^2 u_i^2}$						10.8	10.7	257
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$						21.6	21.4	

15 MAIN TEST INSTRUMENTS

Table 15.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	February 15, 2014	One year
02	Power meter	NRVD	102083	September 11, 2013	One year
03	Power sensor	NRV-Z5	100542		
04	Power meter	NRVD	102196	March 14, 2014	One year
05	Power sensor	NRV-Z5	100596		
06	Signal Generator	E4438C	MY49070393	November 08, 2013	One Year
07	Amplifier	60S1G4	0331848	No Calibration Requested	
08	E-field Probe	SPEAG EX3DV4	3846	September 03, 2013	One year
09	E-field Probe	SPEAG EX3DV4	3801	June 18, 2014	One year
10	DAE	SPEAG DAE4	771	November 12, 2013	One year
11	Dipole Validation Kit	SPEAG D2450V2	853	July 08, 2013	One year
12	Dipole Validation Kit	SPEAG D5GHzV2	1040	June 20, 2014	One year

END OF REPORT BODY

ANNEX A Graph Results

Wifi 802.11b Body Rear Channel 11

Date: 2014-7-3

Electronics: DAE4 Sn771

Medium: Body 2450 MHz

Medium parameters used (interpolated): $f = 2462$ MHz; $\sigma = 1.987$ S/m; $\epsilon_r = 53.196$; $\rho = 1000$ kg/m³

Ambient Temperature: 22.4°C Liquid Temperature: 21.9°C

Communication System: WLan 2450 Frequency: 2462 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(6.73, 6.73, 6.73)

Rear/Area Scan (91x141x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.55 W/kg

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

Reference Value = 6.963 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 2.89 W/kg

SAR(1 g) = 1.35 W/kg; SAR(10 g) = 0.615 W/kg

Maximum value of SAR (measured) = 1.49 W/kg

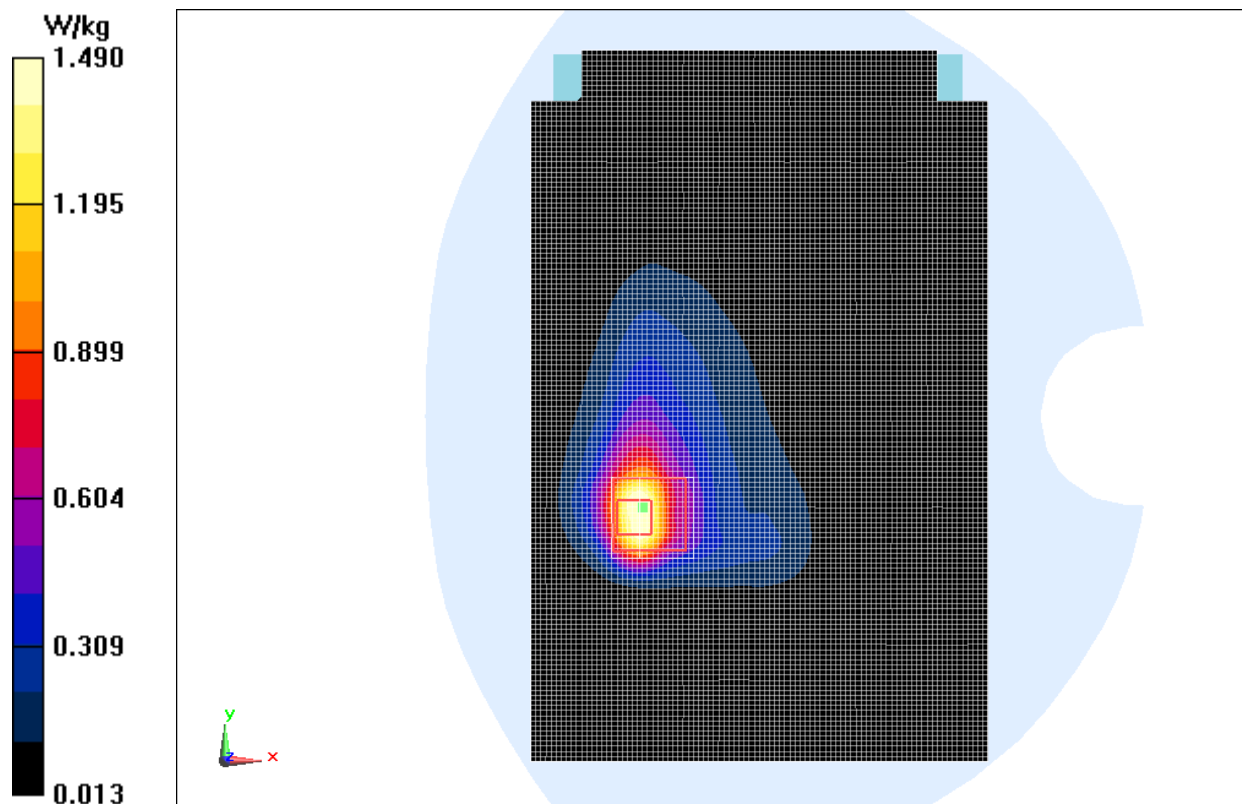


Fig.1 2450 MHz CH11

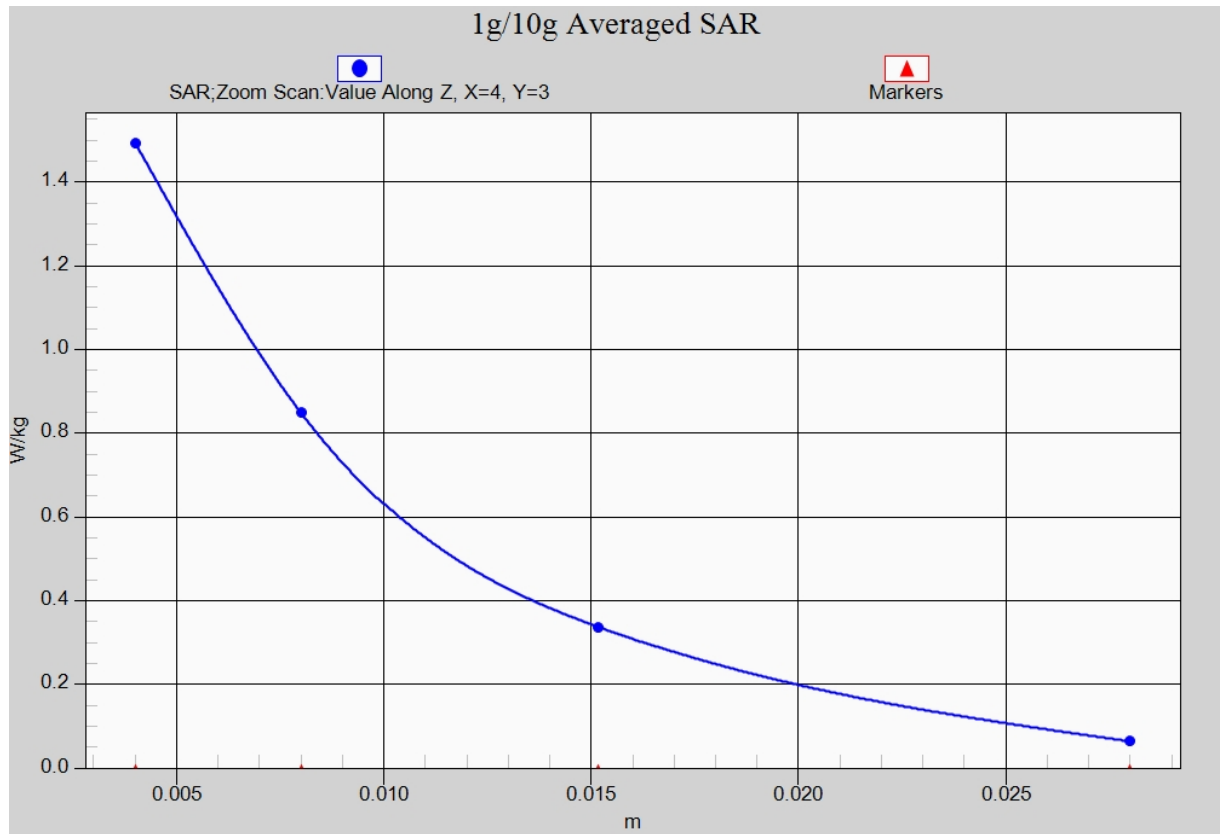


Fig. 1-1 Z-Scan at power reference point (2450 MHz CH11)

Wifi 802.11a Rear Channel 136

Date: 2014-7-4

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5680$ MHz; $\sigma = 5.822$ mho/m; $\epsilon_r = 47.673$; $\rho = 1000$ kg/m³

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: WLAN 5G Frequency: 5680 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(3.77, 3.77, 3.77)

Rear/Area Scan (141x211x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.02 W/kg

Rear/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 2.379 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 4.45 W/kg

SAR(1 g) = 0.937 W/kg; SAR(10 g) = 0.279 W/kg

Maximum value of SAR (measured) = 0.964 W/kg

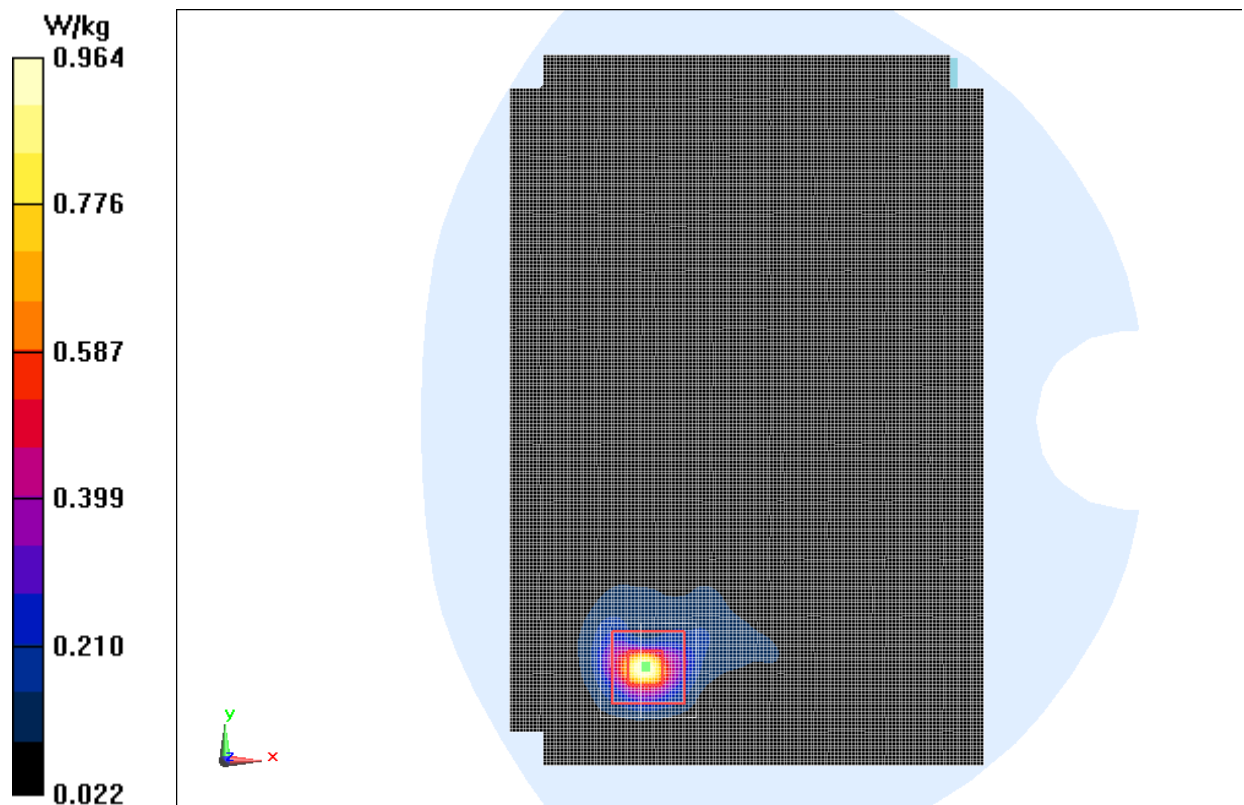


Fig.2 5GHz CH136

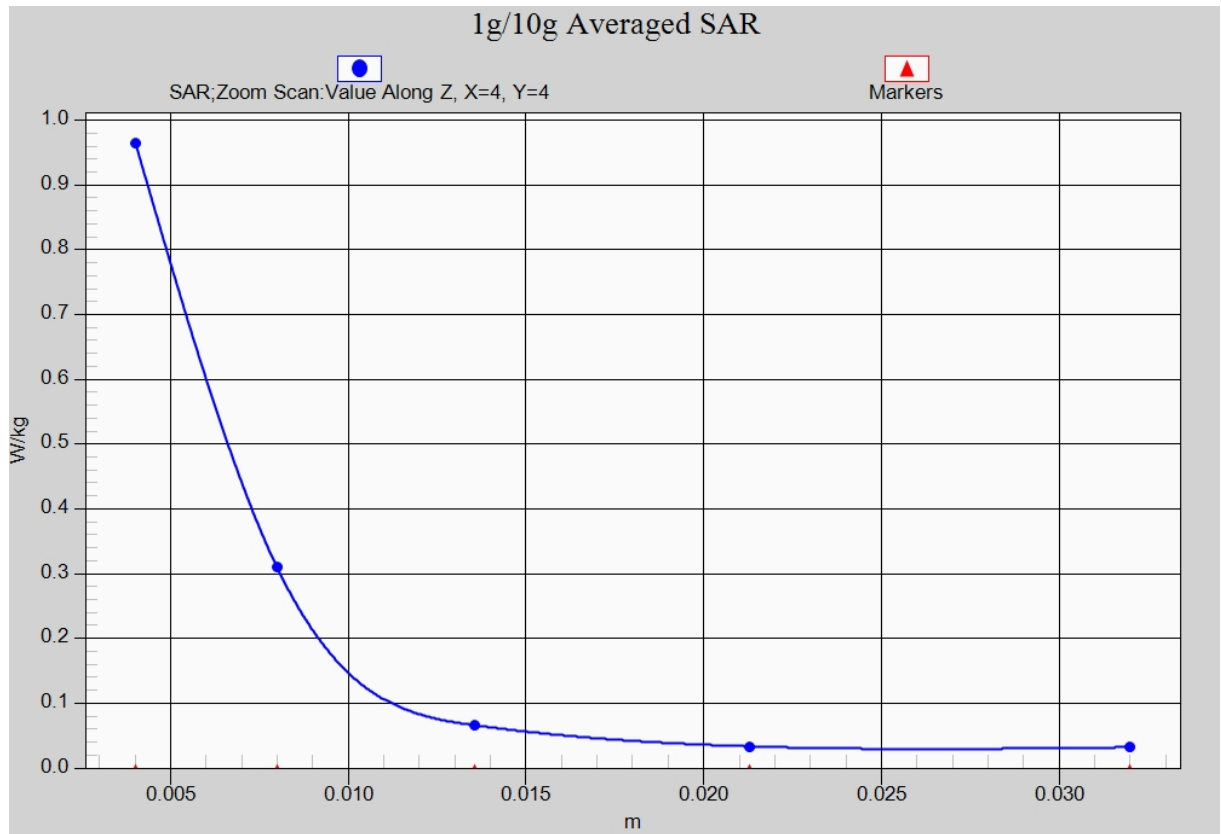


Fig. 2-1 Z-Scan at power reference point (5GHz CH136)

ANNEX B System Verification Results

2450MHz

Date: 2014-7-3

Electronics: DAE4 Sn771

Medium: Body 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.973$ S/m; $\epsilon_r = 53.28$; $\rho = 1000$ kg/m³

Ambient Temperature: 22.4°C Liquid Temperature: 21.9°C

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(6.73, 6.73, 6.73)

System Validation/Area Scan (81x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 13.8 W/kg

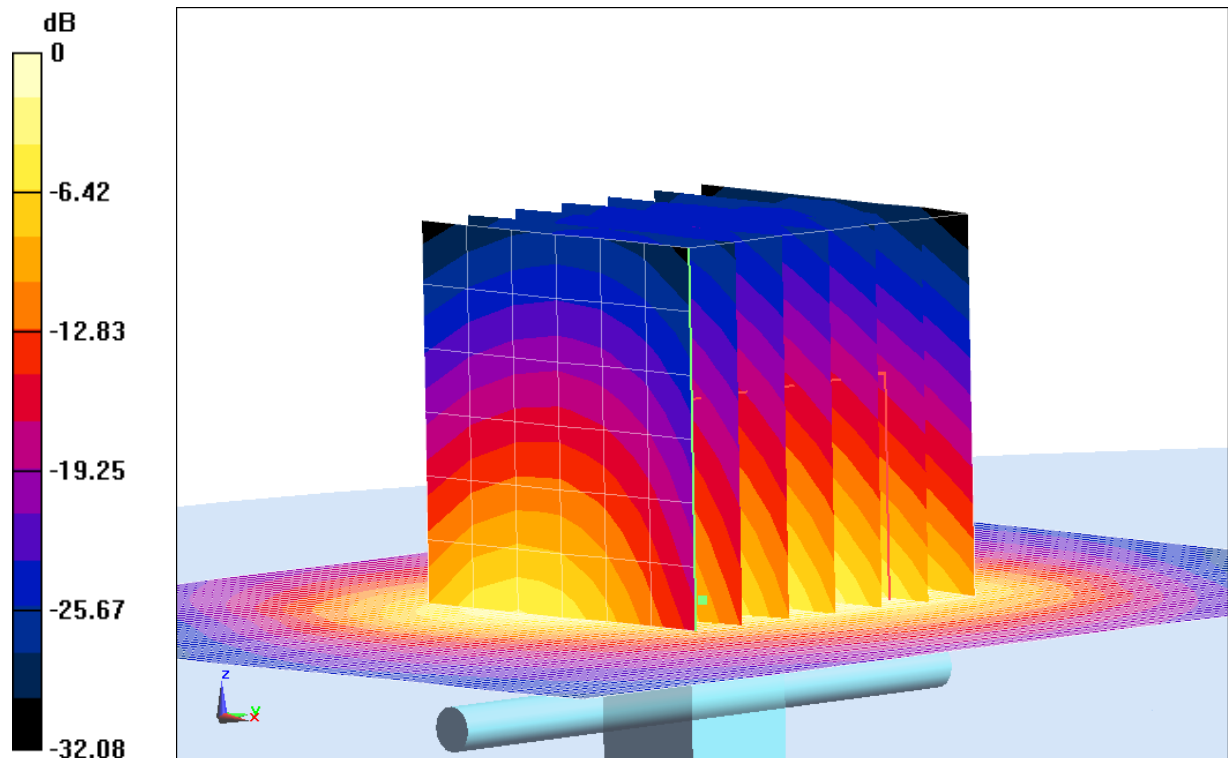
System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 85.449 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 24.3 W/kg

SAR(1 g) = 12.1 W/kg; SAR(10 g) = 5.68 W/kg

Maximum value of SAR (measured) = 13.9 W/kg



0 dB = 13.8 W/kg = 11.39 dB W/kg

Fig.B.1 validation 2450MHz 250mW

5200MHz

Date: 2014-7-4

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5200 \text{ MHz}$; $\sigma = 5.133 \text{ mho/m}$; $\epsilon_r = 48.76$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5200 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(4.36, 4.36, 4.36)

System Validation /Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$
Maximum value of SAR (interpolated) = 17.5 W/kg

System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 65.005 V/m ; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 7.48 W/kg ; SAR(10 g) = 2.12 W/kg

Maximum value of SAR (measured) = 17.4 W/kg



$0 \text{ dB} = 17.4 \text{ W/kg} = 12.41 \text{ dB W/kg}$

Fig.B.2 validation 5200MHz 100mW

5300MHz

Date: 2014-7-4

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5300 \text{ MHz}$; $\sigma = 5.282 \text{ mho/m}$; $\epsilon_r = 48.55$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5300 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(4.17, 4.17, 4.17)

System Validation /Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$
Maximum value of SAR (interpolated) = 18.1 W/kg

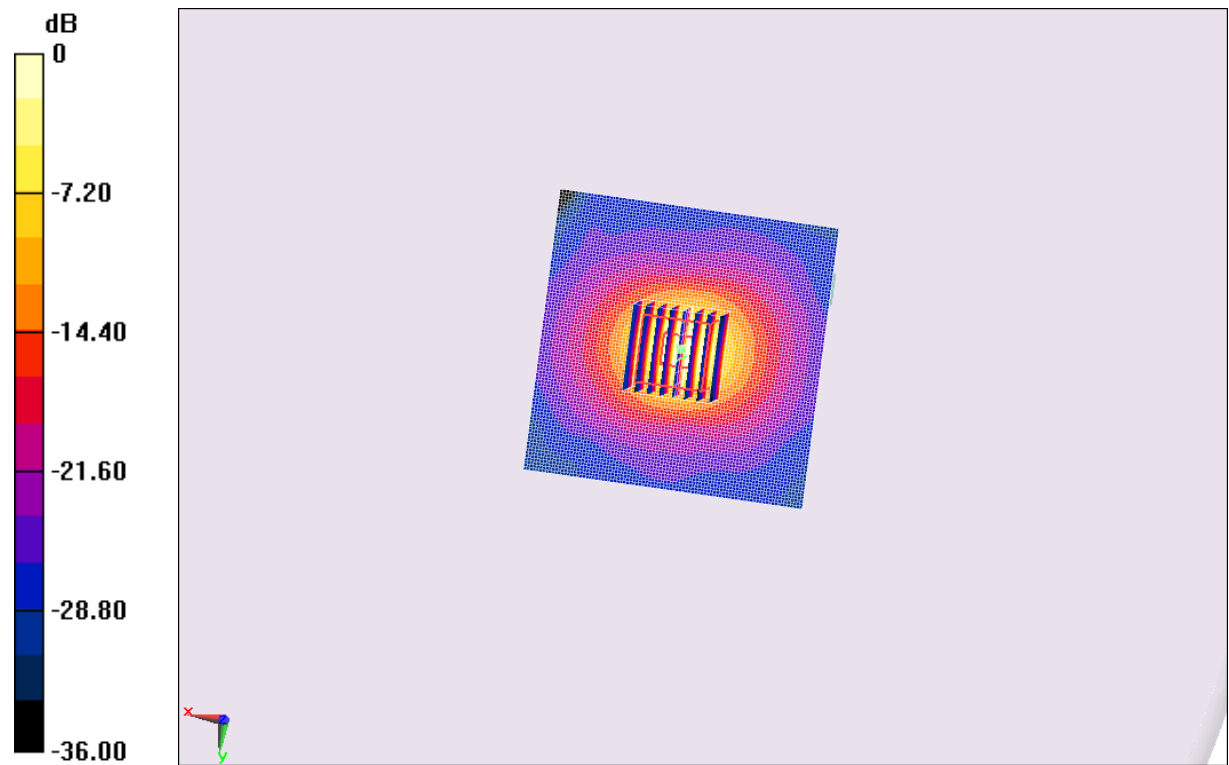
System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 65.871 V/m ; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 32.8 W/kg

SAR(1 g) = 7.7 W/kg ; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 18.3 W/kg



$0 \text{ dB} = 18.3 \text{ W/kg} = 12.62 \text{ dB W/kg}$

Fig.B.3 validation 5300MHz 100mW

5600MHz

Date: 2014-7-4

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5600 \text{ MHz}$; $\sigma = 5.696 \text{ mho/m}$; $\epsilon_r = 47.88$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5600 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3846 ConvF(3.77, 3.77, 3.77)

System Validation /Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$
Maximum value of SAR (interpolated) = 19.7 W/kg

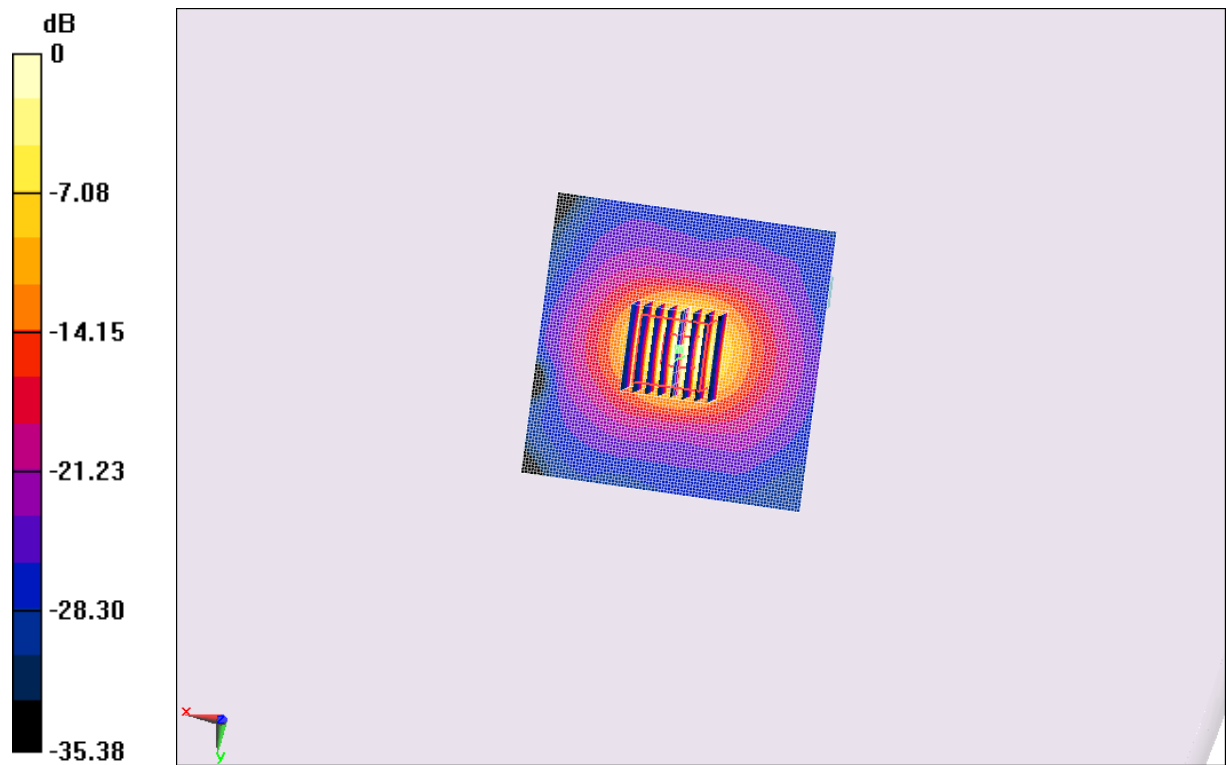
System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 65.323 V/m ; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 38.4 W/kg

SAR(1 g) = 8.08 W/kg ; SAR(10 g) = 2.27 W/kg

Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dB W/kg

Fig.B.4 validation 5600MHz 100mW

5300MHz

Date: 2014-9-10

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5300 \text{ MHz}$; $\sigma = 5.253 \text{ mho/m}$; $\epsilon_r = 47.8$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5300 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3801 ConvF(4.03, 4.03, 4.03)

System Validation /Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$
Maximum value of SAR (interpolated) = 18.1 W/kg

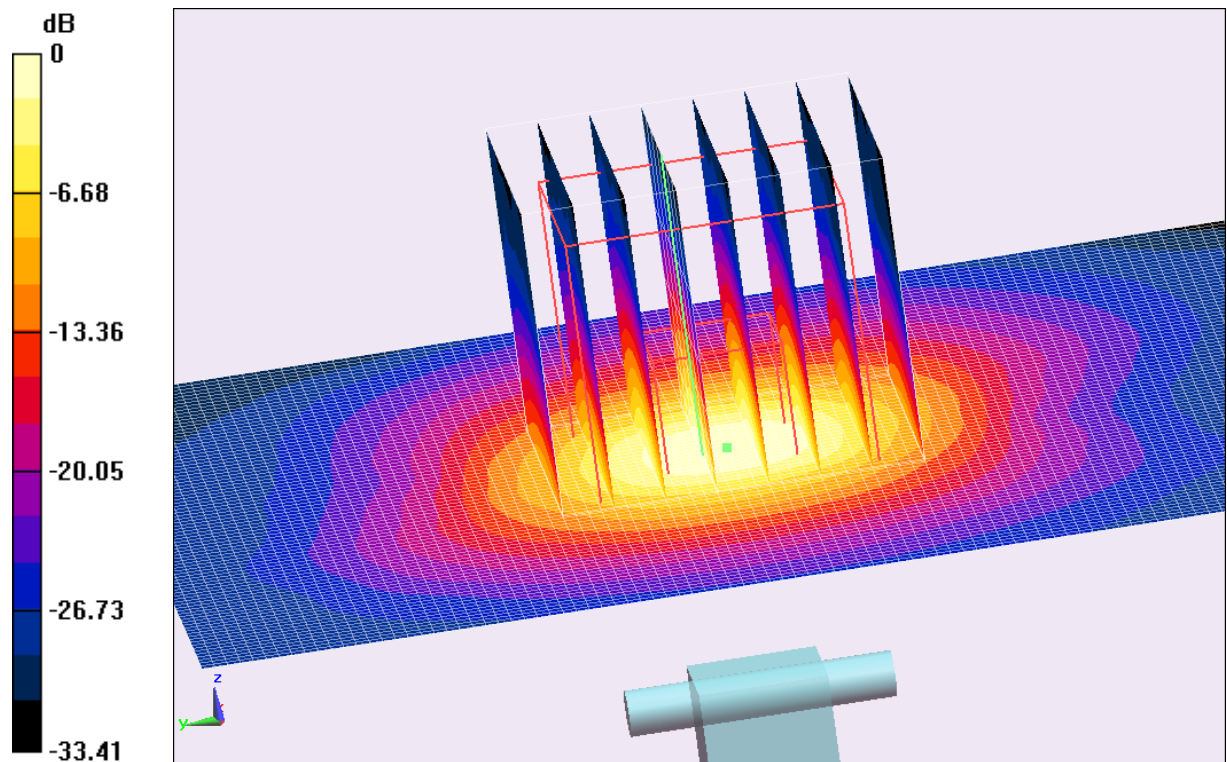
System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 65.911 V/m ; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 32.82 W/kg

SAR(1 g) = 7.71 W/kg ; SAR(10 g) = 2.15 W/kg

Maximum value of SAR (measured) = 18.3 W/kg



$0 \text{ dB} = 18.3 \text{ W/kg} = 12.62 \text{ dB W/kg}$

Fig.B.5 validation 5300MHz 100mW

5600MHz

Date: 2014-9-10

Electronics: DAE4 Sn771

Medium: Body 5GHz

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.729$ mho/m; $\epsilon_r = 47.15$; $\rho = 1000$ kg/m³

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5600 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3801 ConvF(3.84, 3.84, 3.84)

System Validation /Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 19.7 W/kg

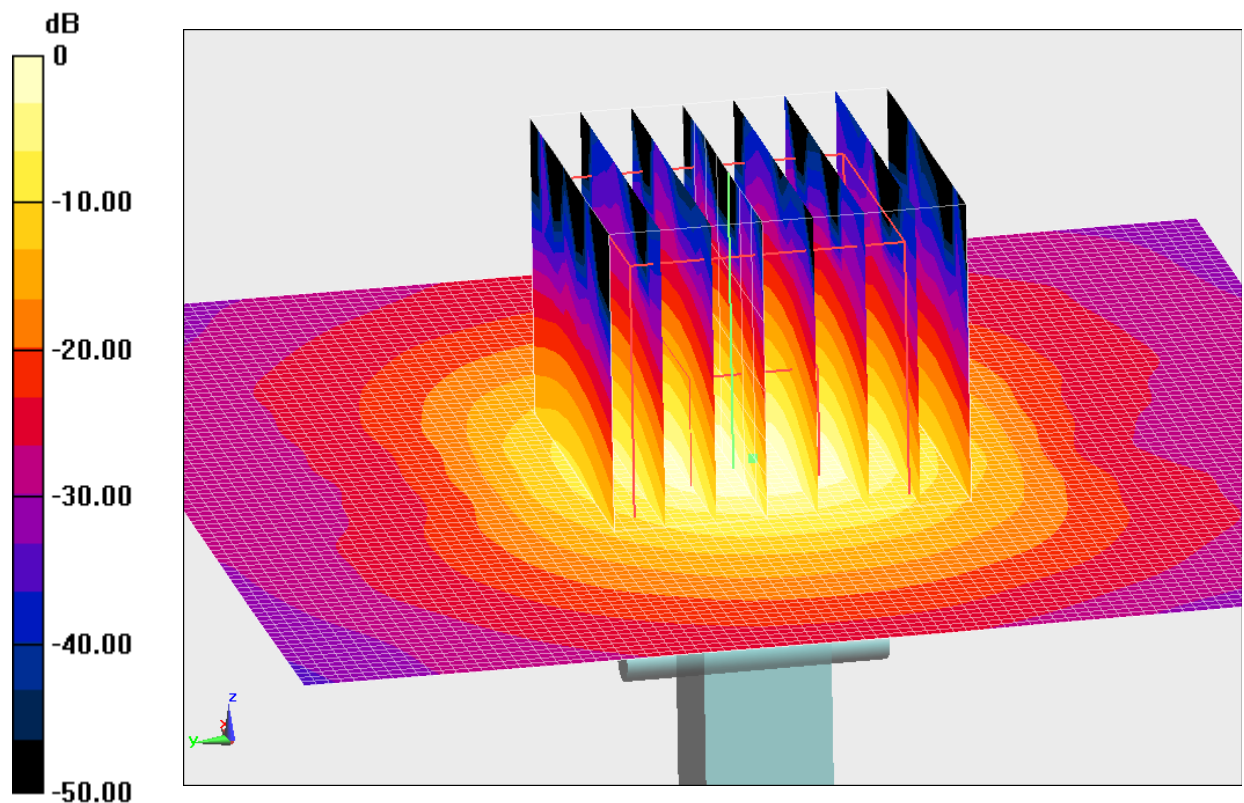
System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.197 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 38.38 W/kg

SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dB W/kg

Fig.B.6 validation 5600MHz 100mW

5800MHz

Date: 2014-9-10

Electronics: DAE4 Sn771

Medium: Body 5 GHz

Medium parameters used: $f = 5800 \text{ MHz}$; $\sigma = 6.058 \text{ mho/m}$; $\epsilon_r = 46.71$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.3°C Liquid Temperature: 21.8°C

Communication System: CW Frequency: 5800 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN3801 ConvF(3.94, 3.94, 3.94)

System Validation /Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$
Maximum value of SAR (interpolated) = 17.9 W/kg

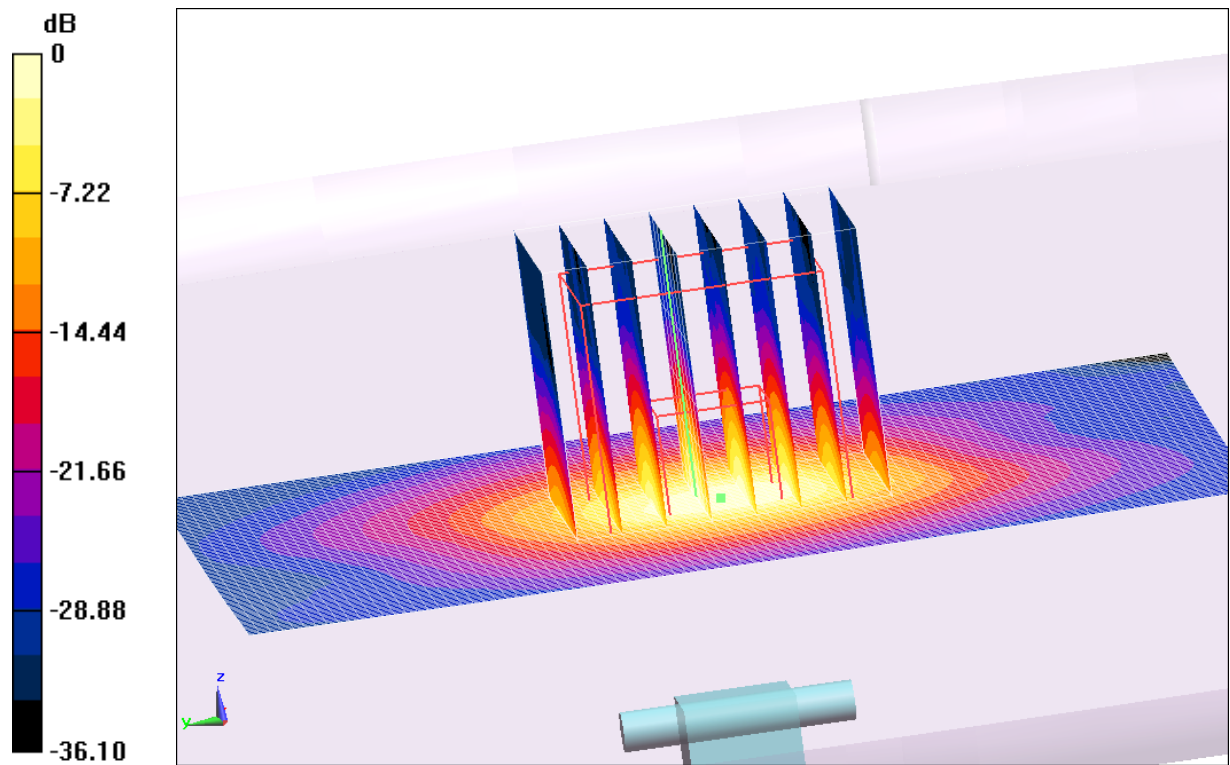
System Validation /Zoom Scan (8x8x7)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 63.369 V/m ; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 32.41 W/kg

SAR(1 g) = 7.54 W/kg ; SAR(10 g) = 2.09 W/kg

Maximum value of SAR (measured) = 18.1 W/kg



$0 \text{ dB} = 18.1 \text{ W/kg} = 12.58 \text{ dB W/kg}$

Fig.B.7 validation 5800MHz 100mW

C.2 Dasy4 or DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 or DASY5 software reads the reflection during a software approach and looks for the maximum using 2nd order curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:

Model:	ES3DV3, EX3DV4
Frequency	10MHz — 6.0GHz(EX3DV4)
Range:	10MHz — 4GHz(ES3DV3)
Calibration:	In head and body simulating tissue at Frequencies from 835 up to 5800MHz
Linearity:	± 0.2 dB(30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB(30 MHz to 4 GHz) for ES3DV3
Dynamic Range:	10 mW/kg — 100W/kg
Probe Length:	330 mm
Probe Tip	
Length:	20 mm
Body Diameter:	12 mm
Tip Diameter:	2.5 mm (3.9 mm for ES3DV3)
Tip-Center:	1 mm (2.0mm for ES3DV3)
Application:	SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields



Picture C.2 Near-field Probe



Picture C.3 E-field Probe

C.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm²) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed

in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm².

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m³).

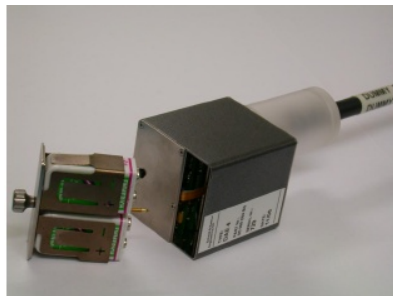
C.4 Other Test Equipment

C.4.1 Data Acquisition Electronics(DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



PictureC.4: DAE

C.4.2 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90XL; DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)



Picture C.5 DASY 4



Picture C.6 DASY 5

C.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU board with CPU (dasy4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128MB), RAM (DASY4: 64 MB, DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.



Picture C.7 Server for DASY 4



Picture C.8 Server for DASY 5

C.4.4 Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of $\pm 0.5\text{mm}$ would produce a SAR uncertainty of $\pm 20\%$. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss

POM material having the following dielectric

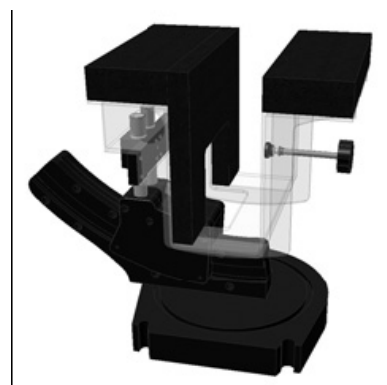
parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It 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 and ELI phantoms.



Picture C.9-1: Device Holder



Picture C.9-2: Laptop Extension Kit

C.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90th percentile of the population. The phantom enables the dissymmetric evaluation

of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness: 2 ± 0.2 mm

Filling Volume: Approx. 25 liters

Dimensions: 810 x 1000 x 500 mm (H x L x W)

Available: Special

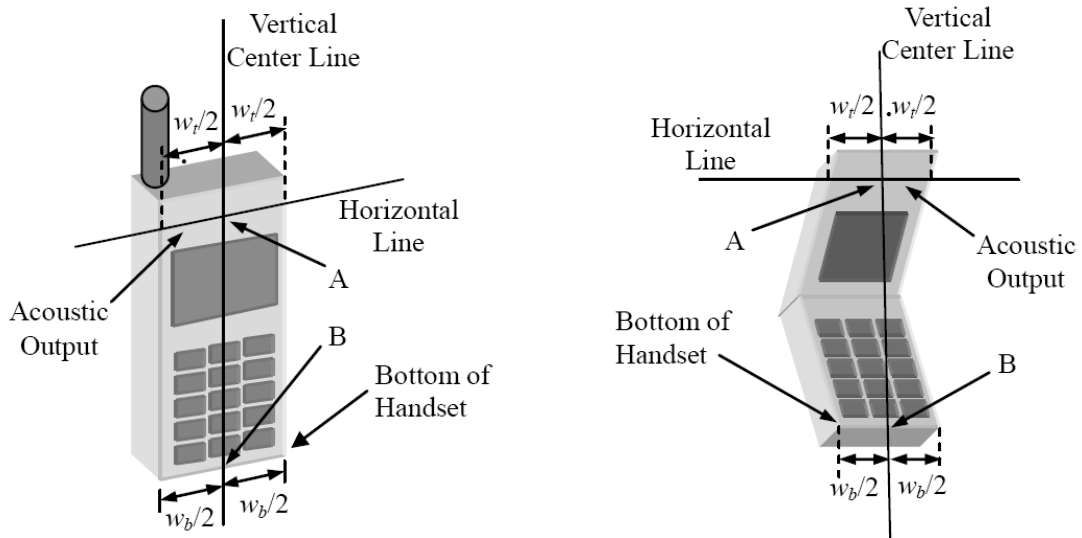


Picture C.10: SAM Twin Phantom

ANNEX D Position of the wireless device in relation to the phantom

D.1 General considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



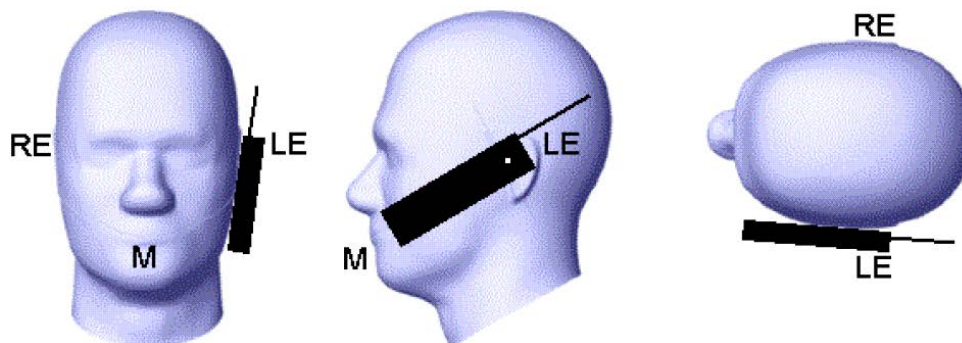
w_t Width of the handset at the level of the acoustic

w_b Width of the bottom of the handset

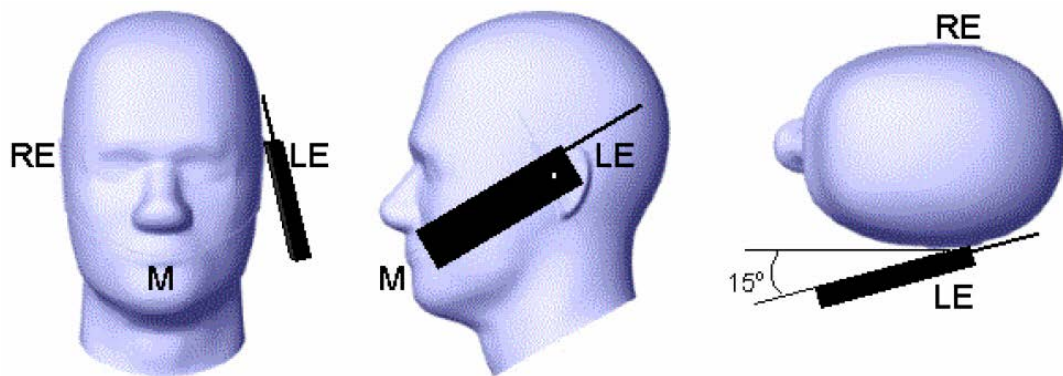
A Midpoint of the width w_t of the handset at the level of the acoustic output

B Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical “fixed” case handset Picture D.1-b Typical “clam-shell” case handset



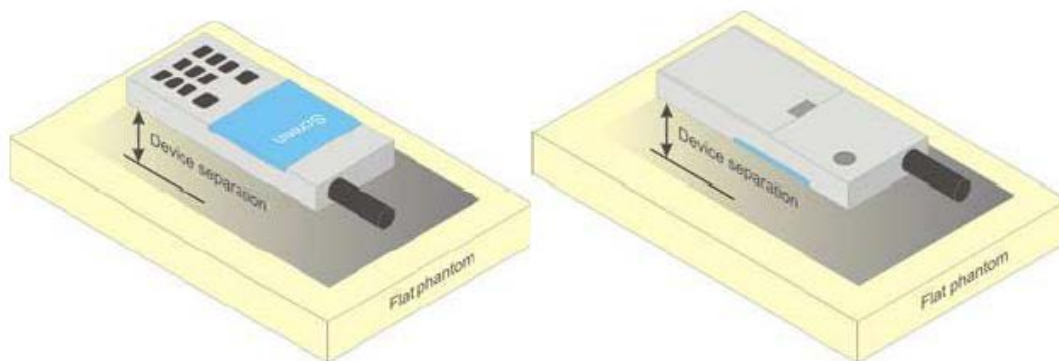
Picture D.2 Cheek position of the wireless device on the left side of SAM



Picture D.3 Tilt position of the wireless device on the left side of SAM

D.2 Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.

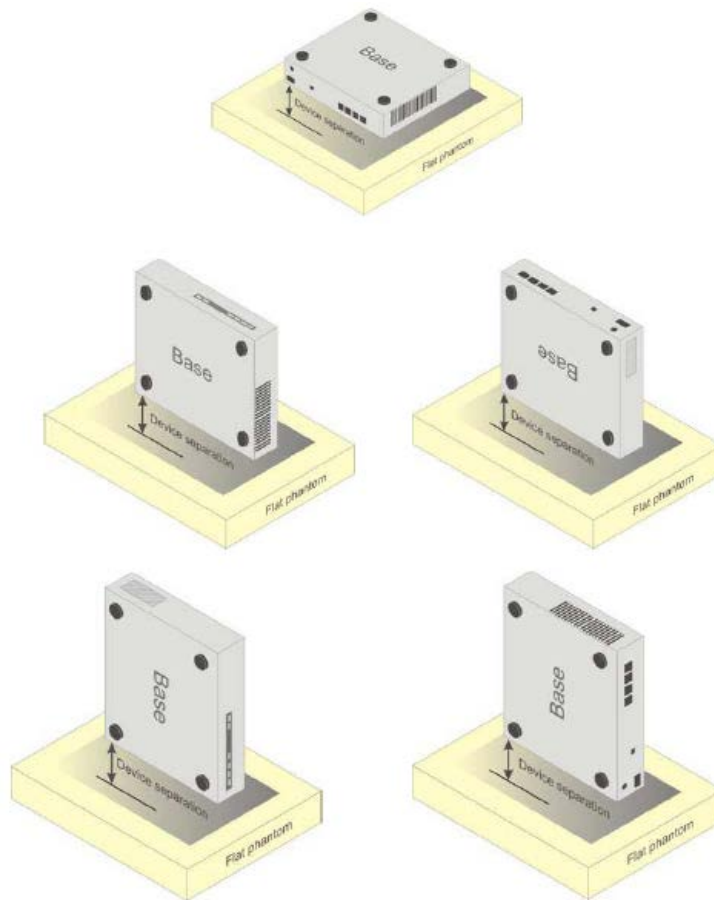


Picture D.4 Test positions for body-worn devices

D.3 Desktop device

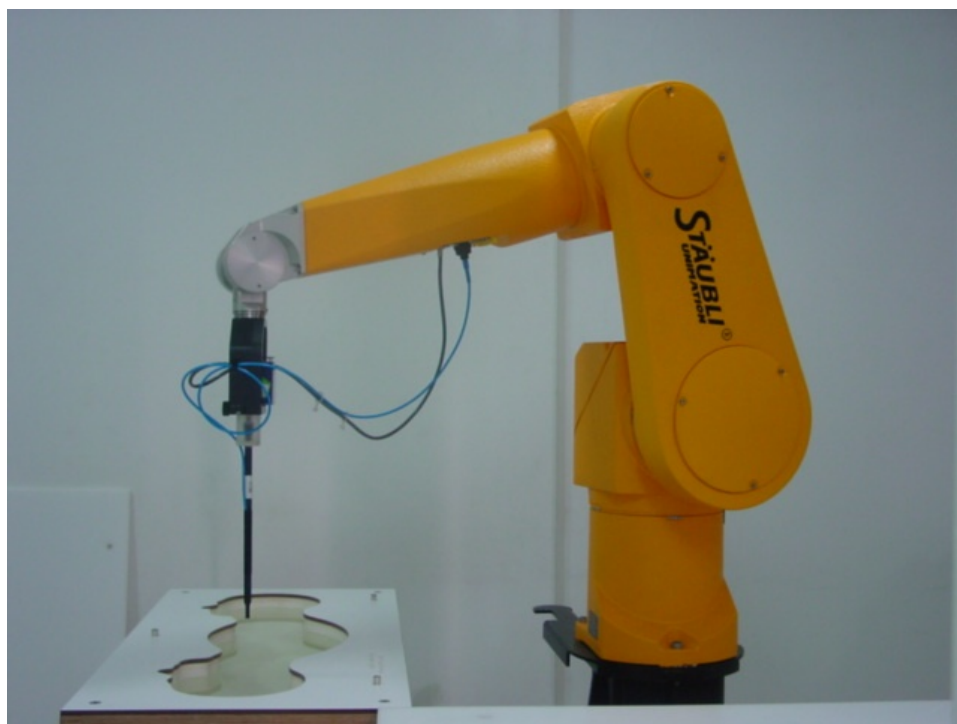
A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 8.5 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



Picture D.5 Test positions for desktop devices

D.4 DUT Setup Photos



Picture D.6

ANNEX E Equivalent Media Recipes

The liquid used for the frequency range of 800-3000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

Frequency (MHz)	835 Head	835 Body	1900 Head	1900 Body	2450 Head	2450 Body	5800 Head	5800 Body
Ingredients (% by weight)								
Water	41.45	52.5	55.242	69.91	58.79	72.60	65.53	65.53
Sugar	56.0	45.0	\	\	\	\	\	\
Salt	1.45	1.4	0.306	0.13	0.06	0.18	\	\
Preventol	0.1	0.1	\	\	\	\	\	\
Cellulose	1.0	1.0	\	\	\	\	\	\
Glycol Monobutyl	\	\	44.452	29.96	41.15	27.22	\	\
Diethylenglycol monohexylether	\	\	\	\	\	\	17.24	17.24
Triton X-100	\	\	\	\	\	\	17.24	17.24
Dielectric Parameters Target Value	$\epsilon=41.5$ $\sigma=0.90$	$\epsilon=55.2$ $\sigma=0.97$	$\epsilon=40.0$ $\sigma=1.40$	$\epsilon=53.3$ $\sigma=1.52$	$\epsilon=39.2$ $\sigma=1.80$	$\epsilon=52.7$ $\sigma=1.95$	$\epsilon=35.3$ $\sigma=5.27$	$\epsilon=48.2$ $\sigma=6.00$

ANNEX F System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

Table F.1: System Validation

Probe SN.	Liquid name	Validation date	Frequency point	Status (OK or Not)
3846	Head 750MHz	Mar. 06, 2014	750 MHz	OK
3846	Head 850MHz	Mar. 06, 2014	850 MHz	OK
3846	Head 900MHz	Mar. 01, 2014	900 MHz	OK
3846	Head 1750MHz	Mar. 03, 2014	1750 MHz	OK
3846	Head 1810MHz	Mar. 03, 2014	1810 MHz	OK
3846	Head 1900MHz	Mar. 07, 2014	1900 MHz	OK
3846	Head 1950MHz	Mar. 04, 2014	1950 MHz	OK
3846	Head 2000MHz	Mar. 04, 2014	2000 MHz	OK
3846	Head 2100MHz	Mar. 05, 2014	2100 MHz	OK
3846	Head 2300MHz	Mar. 05, 2014	2300 MHz	OK
3846	Head 2450MHz	Mar. 02, 2014	2450 MHz	OK
3846	Head 2550MHz	Mar. 08, 2014	2550 MHz	OK
3846	Head 2600MHz	Mar. 08, 2014	2600 MHz	OK
3846	Head 3500MHz	Mar. 09, 2014	3500 MHz	OK
3846	Head 3700MHz	Mar. 09, 2014	3700 MHz	OK
3846	Head 5200MHz	Mar. 10, 2014	5200 MHz	OK
3846	Head 5500MHz	Mar. 10, 2014	5500 MHz	OK
3846	Head 5800MHz	Mar. 10, 2014	5800 MHz	OK
3846	Body 750MHz	Mar. 06, 2014	750 MHz	OK
3846	Body 850MHz	Mar. 06, 2014	850 MHz	OK
3846	Body 900MHz	Mar. 01, 2014	900 MHz	OK
3846	Body 1750MHz	Mar. 03, 2014	1750 MHz	OK
3846	Body 1810MHz	Mar. 03, 2014	1810 MHz	OK
3846	Body 1900MHz	Mar. 07, 2014	1900 MHz	OK
3846	Body 1950MHz	Mar. 04, 2014	1950 MHz	OK
3846	Body 2000MHz	Mar. 04, 2014	2000 MHz	OK
3846	Body 2100MHz	Mar. 05, 2014	2100 MHz	OK
3846	Body 2300MHz	Mar. 05, 2014	2300 MHz	OK
3846	Body 2450MHz	Mar. 02, 2014	2450 MHz	OK
3846	Body 2550MHz	Mar. 08, 2014	2550 MHz	OK
3846	Body 2600MHz	Mar. 08, 2014	2600 MHz	OK
3846	Body 3500MHz	Mar. 09, 2014	3500 MHz	OK
3846	Body 3700MHz	Mar. 09, 2014	3700 MHz	OK
3846	Body 5200MHz	Mar. 10, 2014	5200 MHz	OK
3846	Body 5500MHz	Mar. 10, 2014	5500 MHz	OK
3846	Body 5800MHz	Mar. 10, 2014	5800 MHz	OK

ANNEX G Probe Calibration Certificate

Probe 3846 Calibration Certificate

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



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

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

Accreditation No.: SCS 108

Client **TMC-BJ (Auden)**

Certificate No: **EX3-3846_Sep13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3846**

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**

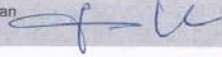
Calibration date: **September 3, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: September 5, 2013			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

EX3DV4 – SN:3846

September 3, 2013

Probe EX3DV4

SN:3846

Manufactured:	October 25, 2011
Repaired:	August 28, 2013
Calibrated:	September 3, 2013

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

EX3DV4- SN:3846

September 3, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.39	0.43	0.49	$\pm 10.1 \%$
DCP (mV) ^B	107.1	101.1	100.8	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.7	$\pm 3.3 \%$
		Y	0.0	0.0	1.0		152.2	
		Z	0.0	0.0	1.0		165.8	

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.

EX3DV4- SN:3846

September 3, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.32	9.32	9.32	0.47	0.82	± 12.0 %
850	41.5	0.92	8.92	8.92	8.92	0.20	1.19	± 12.0 %
900	41.5	0.97	8.96	8.96	8.96	0.41	0.85	± 12.0 %
1450	40.5	1.20	8.23	8.23	8.23	0.68	0.63	± 12.0 %
1750	40.1	1.37	7.85	7.85	7.85	0.39	0.81	± 12.0 %
1810	40.0	1.40	7.63	7.63	7.63	0.49	0.72	± 12.0 %
1900	40.0	1.40	7.57	7.57	7.57	0.35	0.87	± 12.0 %
2000	40.0	1.40	7.58	7.58	7.58	0.65	0.64	± 12.0 %
2100	39.8	1.49	7.68	7.68	7.68	0.28	0.93	± 12.0 %
2300	39.5	1.67	7.21	7.21	7.21	0.40	0.79	± 12.0 %
2450	39.2	1.80	6.78	6.78	6.78	0.52	0.68	± 12.0 %
2600	39.0	1.96	6.68	6.68	6.68	0.37	0.83	± 12.0 %
3500	37.9	2.91	6.67	6.67	6.67	0.59	0.77	± 13.1 %
3700	37.7	3.12	6.37	6.37	6.37	0.43	0.92	± 13.1 %
5200	36.0	4.66	5.25	5.25	5.25	0.25	1.80	± 13.1 %
5300	35.9	4.76	5.04	5.04	5.04	0.25	1.80	± 13.1 %
5500	35.6	4.96	4.80	4.80	4.80	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.52	4.52	4.52	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.51	4.51	4.51	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. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

EX3DV4- SN:3846

September 3, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	8.96	8.96	8.96	0.38	0.91	± 12.0 %
850	55.2	0.99	8.73	8.73	8.73	0.80	0.61	± 12.0 %
900	55.0	1.05	8.71	8.71	8.71	0.80	0.59	± 12.0 %
1450	54.0	1.30	7.82	7.82	7.82	0.80	0.59	± 12.0 %
1750	53.4	1.49	7.56	7.56	7.56	0.71	0.65	± 12.0 %
1810	53.3	1.52	7.27	7.27	7.27	0.47	0.83	± 12.0 %
1900	53.3	1.52	7.03	7.03	7.03	0.30	1.04	± 12.0 %
2000	53.3	1.52	7.52	7.52	7.52	0.38	0.90	± 12.0 %
2100	53.2	1.62	7.54	7.54	7.54	0.43	0.82	± 12.0 %
2300	52.9	1.81	7.00	7.00	7.00	0.76	0.61	± 12.0 %
2450	52.7	1.95	6.73	6.73	6.73	0.80	0.56	± 12.0 %
2600	52.5	2.16	6.59	6.59	6.59	0.80	0.50	± 12.0 %
3500	51.3	3.31	6.18	6.18	6.18	0.38	1.06	± 13.1 %
3700	51.0	3.55	5.99	5.99	5.99	0.43	1.02	± 13.1 %
5200	49.0	5.30	4.36	4.36	4.36	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.17	4.17	4.17	0.40	1.90	± 13.1 %
5500	48.6	5.65	3.81	3.81	3.81	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.77	3.77	3.77	0.35	1.90	± 13.1 %
5800	48.2	6.00	3.94	3.94	3.94	0.45	1.90	± 13.1 %

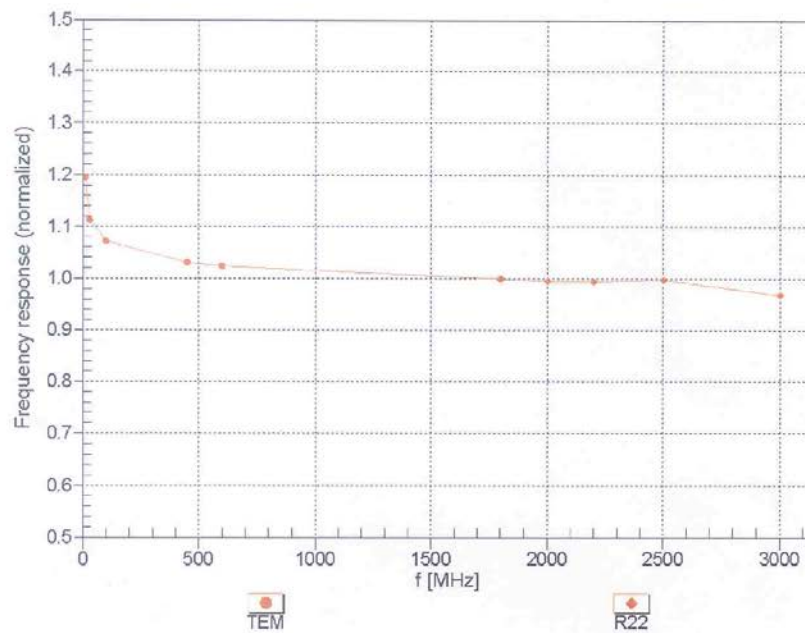
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

EX3DV4- SN:3846

September 3, 2013

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



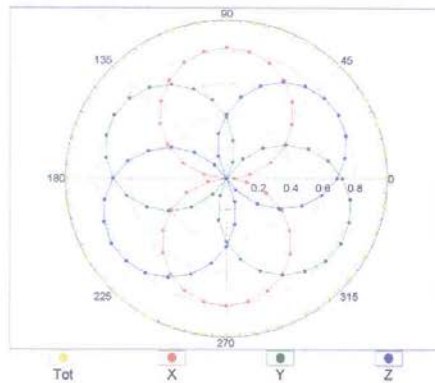
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3846

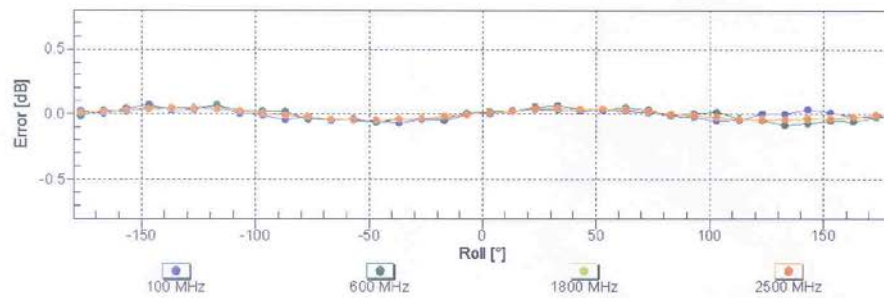
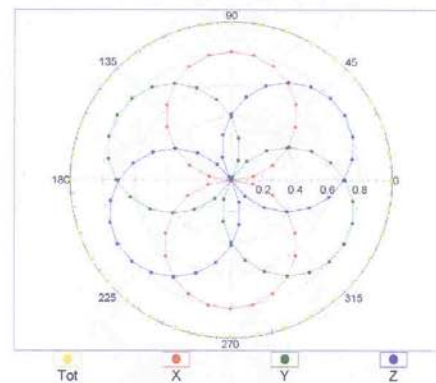
September 3, 2013

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

f=600 MHz,TEM



f=1800 MHz,R22

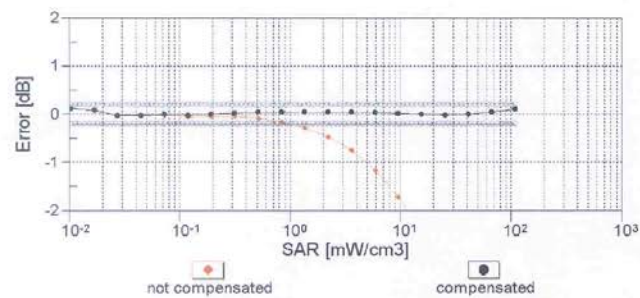
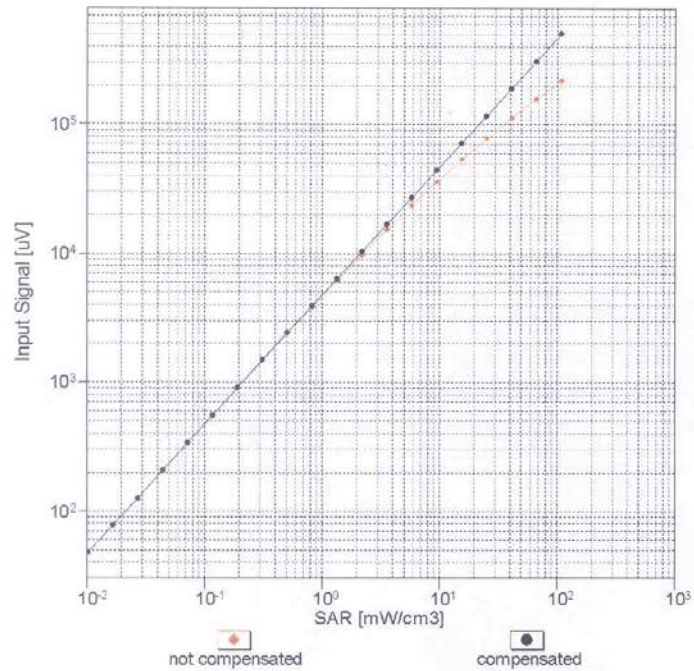


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EX3DV4- SN:3846

September 3, 2013

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

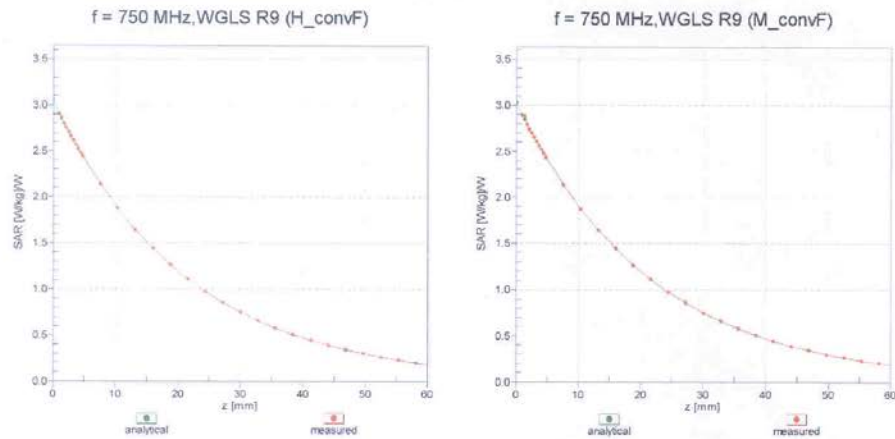


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

EX3DV4- SN:3846

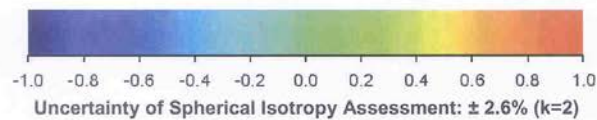
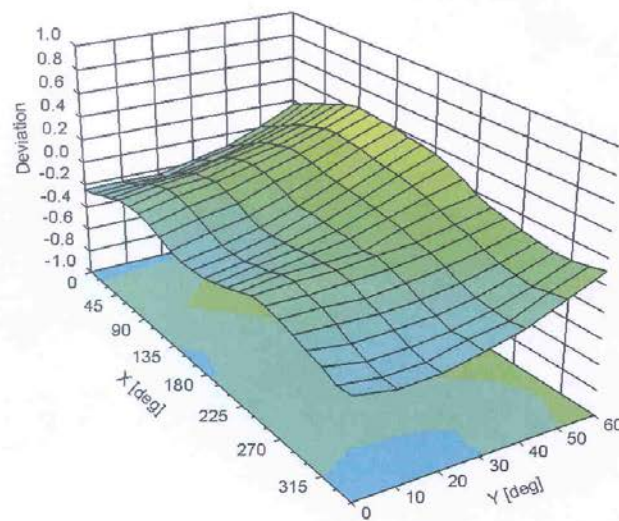
September 3, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), $f = 900 \text{ MHz}$



EX3DV4-- SN:3846

September 3, 2013

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3846

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	3.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

Probe 3801 Calibration Certificate

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



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

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

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **EX3-3801_Jun14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3801**

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

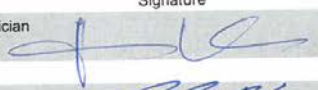
Calibration date: **June 18, 2014**

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:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
Issued: June 18, 2014			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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



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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

- 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; A, B, C, D** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3801

June 18, 2014

Probe EX3DV4

SN:3801

Manufactured: April 5, 2011
Calibrated: June 18, 2014

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

EX3DV4- SN:3801

June 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.53	0.60	0.53	± 10.1 %
DCP (mV) ^B	100.2	98.4	100.9	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^C (k=2)
0	CW	X	0.0	0.0	1.0	0.00	128.0	±2.7 %
		Y	0.0	0.0	1.0		134.4	
		Z	0.0	0.0	1.0		146.7	

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

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

^B Numerical linearization parameter; uncertainty not required.

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

EX3DV4- SN:3801

June 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

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	9.44	9.44	9.44	0.35	1.00	± 12.0 %
835	41.5	0.90	9.15	9.15	9.15	0.80	0.64	± 12.0 %
900	41.5	0.97	8.92	8.92	8.92	0.50	0.79	± 12.0 %
1450	40.5	1.20	7.90	7.90	7.90	0.41	1.02	± 12.0 %
1750	40.1	1.37	7.82	7.82	7.82	0.80	0.58	± 12.0 %
1900	40.0	1.40	7.51	7.51	7.51	0.76	0.59	± 12.0 %
2000	40.0	1.40	7.55	7.55	7.55	0.80	0.57	± 12.0 %
2300	39.5	1.67	7.25	7.25	7.25	0.44	0.75	± 12.0 %
2450	39.2	1.80	6.85	6.85	6.85	0.53	0.70	± 12.0 %
2600	39.0	1.96	6.76	6.76	6.76	0.63	0.66	± 12.0 %
5200	36.0	4.66	4.96	4.96	4.96	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.74	4.74	4.74	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.73	4.73	4.73	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.54	4.54	4.54	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.45	4.45	4.45	0.40	1.80	± 13.1 %

^C Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^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:3801

June 18, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

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	9.11	9.11	9.11	0.65	0.75	± 12.0 %
835	55.2	0.97	9.12	9.12	9.12	0.80	0.66	± 12.0 %
900	55.0	1.05	8.91	8.91	8.91	0.80	0.67	± 12.0 %
1450	54.0	1.30	7.97	7.97	7.97	0.54	0.76	± 12.0 %
1750	53.4	1.49	7.62	7.62	7.62	0.63	0.71	± 12.0 %
1900	53.3	1.52	7.29	7.29	7.29	0.60	0.71	± 12.0 %
2000	53.3	1.52	7.47	7.47	7.47	0.37	0.90	± 12.0 %
2300	52.9	1.81	7.18	7.18	7.18	0.80	0.60	± 12.0 %
2450	52.7	1.95	6.90	6.90	6.90	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.74	6.74	6.74	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.17	4.17	4.17	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.03	4.03	4.03	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.93	3.93	3.93	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.84	3.84	3.84	0.45	1.90	± 13.1 %
5800	48.2	6.00	3.94	3.94	3.94	0.50	1.90	± 13.1 %

^C Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

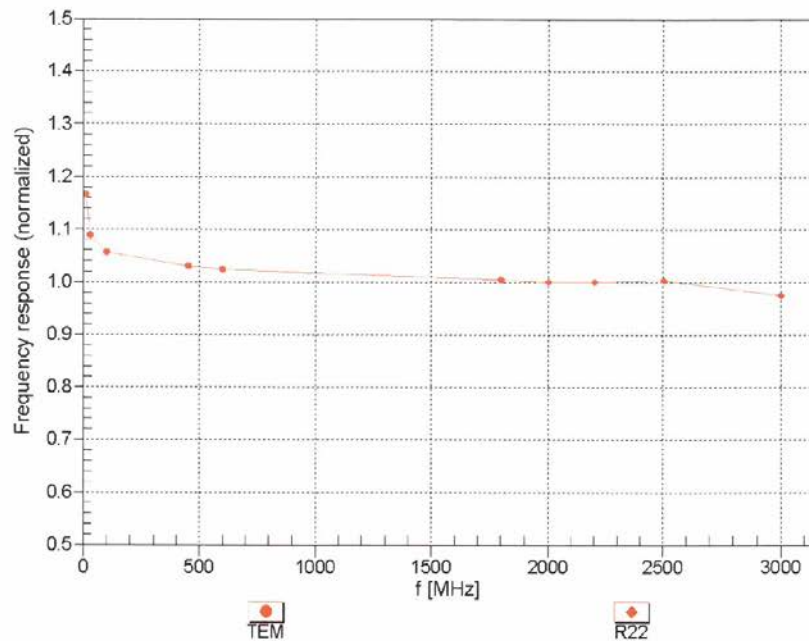
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty 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:3801

June 18, 2014

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



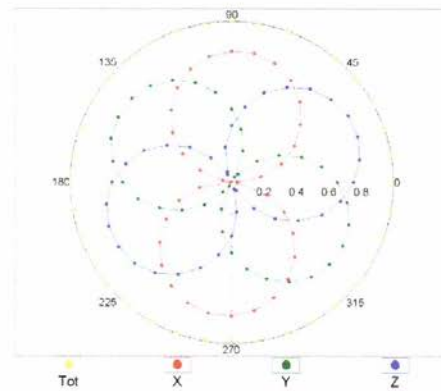
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

EX3DV4- SN:3801

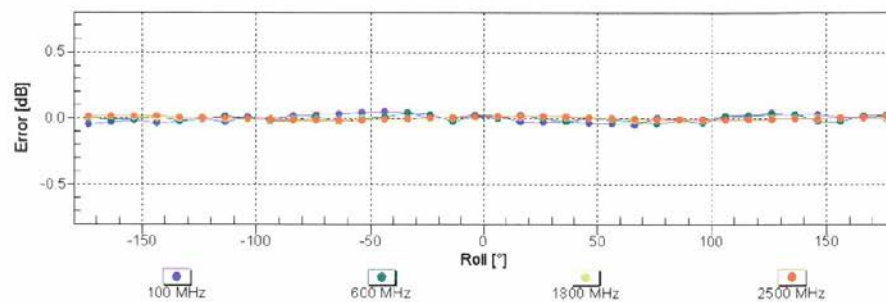
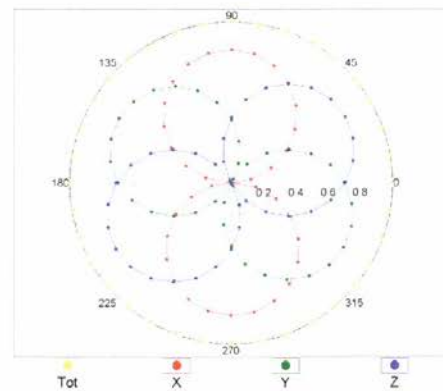
June 18, 2014

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

f=600 MHz,TEM



f=1800 MHz,R22



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