SAR EVALUATION REPORT

For

SEPURA PLC.

Radio House, St. Andrews Road, Cambridge CB4 1GR, UK

FCC ID: XX6SEP8050

Report Type: Original Report		**Product Type:** Portable DMR Two Way Radio
Prepared By:	Bell Hu Test Engineer	Bell. Hu
Report Number:	R15082520-FCC SAR	
Report Date:	2015-10-30	
Reviewed By:	Simon Ma RF Lead	Simon Ma
	Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: (408) 732-9162 Fax: (408) 732 9164	

<table>
<tr><th colspan="4">Summary of Test Results</th></tr>
<tr><td>Rule Part(s):</td><td colspan="3">FCC §2.1093</td></tr>
<tr><td>Test Procedure(s):</td><td colspan="3">IEEE 1528: 2013, IEC62209-2:2010, KDB 643646, KDB 447498,KDB 865664</td></tr>
<tr><td>Device Category:
Exposure Category:</td><td colspan="3">Portable Device
Occupational/Controlled</td></tr>
<tr><td>Device Type:</td><td colspan="3">Portable Device</td></tr>
<tr><td>Modulation Type:</td><td colspan="3">FM/4FSK</td></tr>
<tr><td>TX Frequency Range:</td><td colspan="3">450-520 MHz</td></tr>
<tr><td>Maximum Conducted Power Measured:</td><td colspan="3">36.00dBm</td></tr>
<tr><td>Antenna Type(s) Tested:</td><td colspan="3">External Antenna</td></tr>
<tr><td>Body-Worn Accessories:</td><td colspan="3">Belt Clip & RSM; Belt Clip & Earphone</td></tr>
<tr><td>Face-Head Accessories:</td><td colspan="3">None</td></tr>
<tr><td>Std. Battery:</td><td colspan="3">Li-Ion: 7.4V/2000mAh</td></tr>
<tr><td>High capacity Battery:</td><td colspan="3">Li-Ion: 7.4V/2500mAh</td></tr>
<tr><td rowspan="5">Max.1-g Reported SAR Level (s):</td><td>Level (W/Kg)</td><td>Position</td><td>Operational Mode</td></tr>
<tr><td>1.809</td><td>Face-up</td><td rowspan="2">Digital</td></tr>
<tr><td>2.922</td><td>Body-Worn</td></tr>
<tr><td>3.54</td><td>Face-up</td><td rowspan="2">Analog 12.5KHz</td></tr>
<tr><td>5.7</td><td>Body-Worn</td></tr>
</table>

TABLE OF CONTENTS

1 GENERAL DESCRIPTION 6
1.1 PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) 6
1.2 EUT TECHNICAL SPECIFICATION 6

2 TEST FACILITY 7

3 REFERENCE, STANDARDS AND GUIDELINES 8
3.1 SAR LIMITS 9

4 EQUIPMENT LIST AND CALIBRATION 10
4.1 EQUIPMENT LIST & CALIBRATION INFO 10

5 EUT TEST STRATEGY AND METHODOLOGY 11
5.1 TEST POSITIONS FOR BODY-SUPPORTED DEVICE AND OTHER CONFIGURATIONS 11
5.2 CHEEK/TOUCH POSITION 12
5.3 EAR/TILT POSITION 12
5.4 TEST POSITIONS FOR BODY-WORN AND OTHER CONFIGURATIONS 13
5.5 SAR EVALUATION PROCEDURE 14
5.6 TEST METHODOLOGY 14

6 DASY4 SAR EVALUATION PROCEDURE 15
6.1 POWER REFERENCE MEASUREMENT 15
6.2 AREA SCAN 15
6.3 ZOOM SCAN 16
6.4 POWER DRIFT MEASUREMENT 16
6.5 Z-SCAN 16

7 DESCRIPTION OF TEST SYSTEM 17
7.1 TISSUE DIELECTRIC PARAMETERS 18
7.2 MEASUREMENT SYSTEM DIAGRAM 19
7.3 SYSTEM COMPONENTS 20

8 SAR MEASUREMENT SYSTEM VERIFICATION 28
8.1 SYSTEM ACCURACY VERIFICATION 28
8.2 SAR SYSTEM VERIFICATION SETUP AND PROCEDURE 28
8.3 LIQUID AND SYSTEM VALIDATION 29

9 SAR MEASUREMENT RESULTS 30
9.1 TEST ENVIRONMENTAL CONDITIONS 30
9.2 TEST RESULTS 30

10 APPENDIX A – MEASUREMENT UNCERTAINTY 32

11 APPENDIX B – PROBE CALIBRATION CERTIFICATES 34

12 APPENDIX C – DIPOLE CALIBRATION CERTIFICATES 45

13 APPENDIX D - TEST SYSTEM VERIFICATIONS SCANS 53

14 APPENDIX E – SAR PLOTS (SUMMARY OF THE HIGHEST SAR VALUES) 55

15 APPENDIX F– OUTPUT POWER MEASUREMENT 59

16 APPENDIX G – TEST SETUP PHOTOS 60
16.1 FACE-UP 2.5 CM SEPARATION TO FLAT PHANTOM SETUP PHOTO 60
16.2 BODY-WORN-BELT CLIP 0.0 CM SEPARATION TO FLAT PHANTOM SETUP PHOTO 60

17 APPENDIX H – EUT PHOTOS 61

17.1 EUT – FRONT VIEW 61
17.2 EUT – BACK VIEW 61
17.3 EUT – LEFT VIEW 62
17.4 EUT – RIGHT VIEW 62
17.5 EUT – TOP VIEW 63
17.6 EUT – BOTTOM VIEW 63
17.7 EUT – UNCOVERED VIEW 64
17.8 STANDARD BATTERY VIEW (2000MAH) 64
17.9 HIGH CAPACITY BATTERY VIEW (2500MAH) 65
17.10 EUT – ANTENNA : 450-520MHZ 65
17.11 EUT – BELT CLIP 66
17.12 EUT – REMOTE SPEAKER MICROPHONE, S/N:300-00389 66
17.13 EUT –HEADSET, S/N: 300-00428 67
17.14 EUT –UNCOVER VIEW 67
17.15 EUT –COVER OFF VIEW 68
17.16 EUT –MAIN BOARD TOP VIEW 68
17.17 EUT –MAIN BOARD TOP UNCOVER VIEW 69
17.18 EUT –MAIN BOARD BOTTOM VIEW 69
17.19 EUT –SUB BOARD TOP VIEW 70
17.20 EUT –SUB BOARD BOTTOM VIEW 70
17.21 EUT –SCREEN VIEW 71

18 APPENDIX I - INFORMATIVE REFERENCES 72

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R15082520-FCC SAR	Initial Report	2015-10-30

1 General Description

1.1 Product Description for Equipment under Test (EUT)

This test and measurement report was prepared on behalf of *Sepura plc*, and their product, FCC ID: *XX6SEP8050*, model: *SEP8050*, or the "EUT" as referred to in this report, *is a DMR Two Way Radio*.

1.2 EUT Technical Specification

Item	Description
Modulation Type:	FM/4FSK
TX Frequency Range:	450-520 MHz
Maximum Conducted Power Measured:	36.00 dBm
Dimensions (L*W*H):	150mm (L) x 63mm (W) x 37 mm (H)
Std. Battery:	Li-Ion: 7.4V/2000mAh
High capacity Battery:	Li-Ion: 7.4V/2500mAh
Normal Operation:	Face up and Body Worn

The test data gathered are from typical production sample, Sample S/N: 7PR131530GA0555 provided by manufacturer.

2 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:
1- An independent Commercial Test Laboratory accredited to **ISO 17025: 2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminares and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65: 1996** by **A2LA** to certify:
1- Unlicensed, Licensed radio frequency devices and Telephone Terminal Equipment for the FCC. Scope A1, A2, A3, A4, B1, B2, B3, B4 & C.
2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.
3. Radio Communication Equipment for Singapore.
4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.
5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).
6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s),Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997, and Article 8 of the VCCI regulations on December 25, 1997. The test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2009, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b

3 Reference, Standards and Guidelines

FCC:

The Report and Order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 “Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

CE:

The CE requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 2 mW/g as recommended by the EN50360 for an uncontrolled environment. According to the Standard, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits? SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in Europe is 2 mW/g average over 10 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

3.1 SAR Limits

FCC Limit (1g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

CE Limit (10g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 10 g of tissue)	2.0	10
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

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

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).

Occupational/Controlled environments Spatial Peak limit 8.0 W/kg (FCC/IC) & 10 W/kg (CE) applied to the EUT.

4 Equipment List and Calibration

4.1 Equipment List & Calibration Info

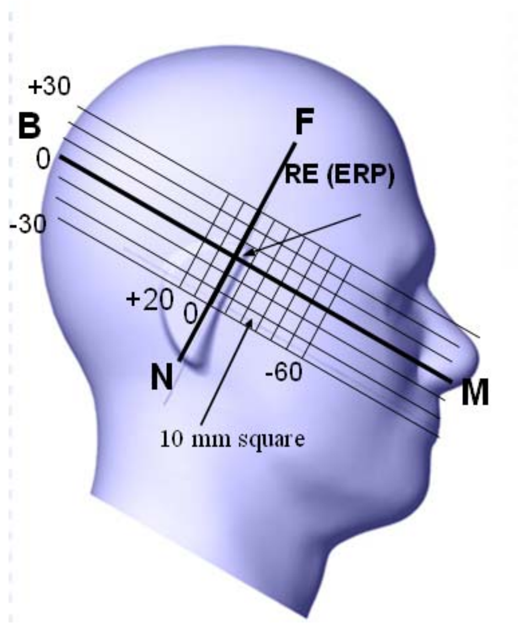
Type/Model	Cal. Due Date	S/N
DASY4 Professional Dosimetric System	N/A	N/A
Robot RX60L	N/A	CS7MBSP / 467
Robot Controller	N/A	F01/5J72A1/A/01
Dell Computer Dimension 3000	N/A	N/A
SPEAG DAE4	2016-08-17	704
DASY4 Measurement Server	N/A	1176
SPEAG E-Field Probe ET3DV6	2016-08-18	3019
Antenna, Dipole, D450V2	2017-08-19	1010
SPEAG Twin SAM Phantom	N/A	TP-1032
Head Equivalent Matter (450 MHz)	Each Time	N/A
Body Equivalent Matter (450 MHz)	Each Time	N/A
Agilent, Spectrum Analyzer E4440A	2016-06-22	MY44303352
Mini Circuits, Amplifier	2015-10-17	N605601404
Power Sensor HP 8481A	2016-05-19	2702A72334
HP, Signal Generator, 83650B	2016-08-19	3614A00276
HP, Analyzer, Network, 8753D	2015-10-28	3410A04346
Dielectric Probe Kit HP85070C	2016-03-06	US99360201
HP, Directional Coupler 779D	2015-10-28	1144A05102
SMA cable, C0001	Each time	-
SMA cable, C0002	Each time	-
SMA cable, C0003	Each time	-

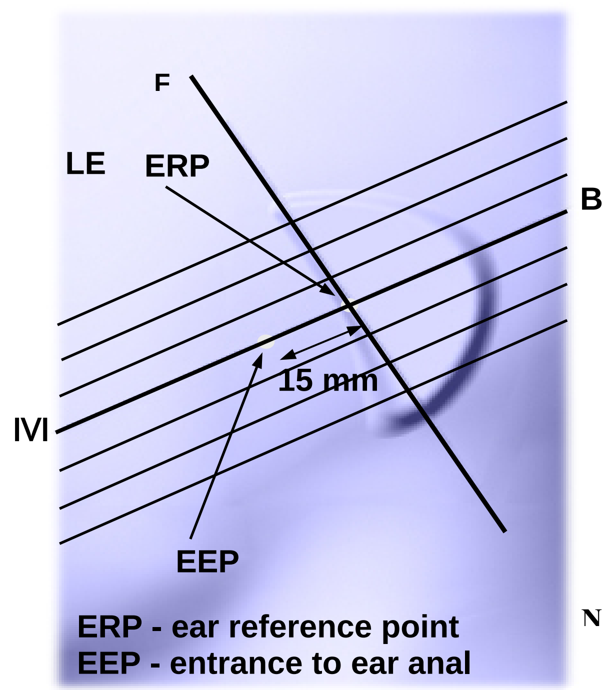
5 EUT Test Strategy and Methodology

5.1 Test positions for body-supported device and other configurations

This category includes most wireless handsets with fixed, retractable or internal antennas located toward the top half of the device, with or without a foldout, sliding or similar keypad cover. The handset should have its earpiece located within the upper ¼ of the device, either along the centerline or off-centered, as perceived by its users. This type of handset should be positioned in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point". The "test device reference point" should be located at the same level as the center of the earpiece region. The "vertical centerline" should bisect the front surface of the handset at its top and bottom edges. An "ear reference point" is located on the outer surface of the head phantom on each ear spacer. It is located 1.5 cm above the center of the ear canal entrance in the "phantom reference plane" defined by the three lines joining the center of each "ear reference point" (left and right) and the tip of the mouth.

A handset should be initially positioned with the earpiece region pressed against the ear spacer of a head phantom. For the SCC-34/SC-2 head phantom, the device should be positioned parallel to the "N-F" line defined along the base of the ear spacer that contains the "ear reference point". For interim head phantoms, the device should be positioned parallel to the cheek for maximum RF energy coupling. The "test device reference point" is aligned to the "ear reference point" on the head phantom and the "vertical centerline" is aligned to the "phantom reference plane". This is called the "initial ear position". While maintaining these three alignments, the body of the handset is gradually adjusted to each of the following positions for evaluating SAR:





5.2 Cheek/Touch Position

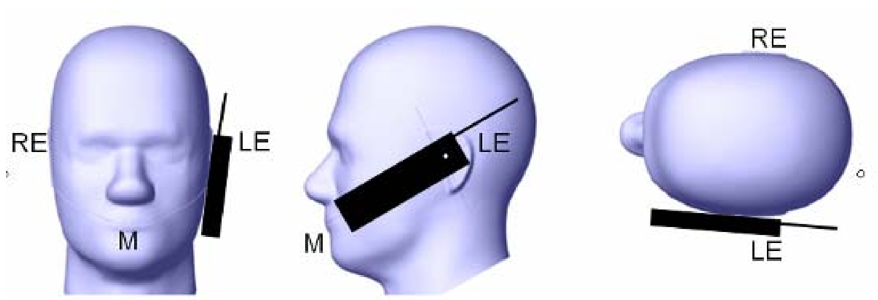
The device is brought toward the mouth of the head phantom by pivoting against the "ear reference point" or along the "N-F" line for the SCC-34/SC-2 head phantom.

This test position is established:

- When any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom.
- (or) When any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.

For existing head phantoms – when the handset loses contact with the phantom at the pivoting point, rotation should continue until the device touches the cheek of the phantom or breaks its last contact from the ear spacer.

Cheek /Touch Position



5.3 Ear/Tilt Position

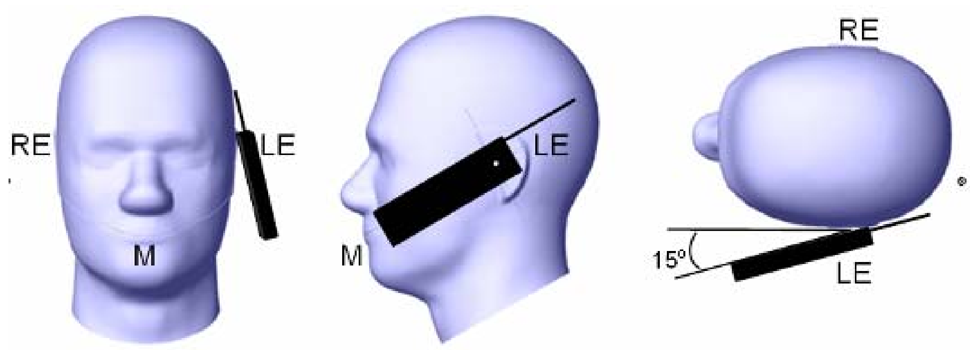
1) If the earpiece of the handset is not in full contact with the phantom's ear spacer (in the "Cheek/Touch position") and the peak SAR location for the "Cheek/Touch" position is located at the ear spacer region or corresponds to the earpiece region of the handset, the device should be returned to the "initial ear position" by rotating it away from the mouth until the earpiece is in full contact with the ear spacer.

2) (Otherwise) The handset should be moved (translated) away from the cheek perpendicular to the line passes through both "ear reference points" (note: one of these ear reference points may not physically exist on a split head model) for approximate 2-3 cm. While it is in this position, the device handset is tilted away from the mouth with respect to the "test device reference point" until the inside angle between the vertical centerline on the front surface of the phone and the horizontal line passing through the ear reference point isby 15 80°. After the tilt, it is then moved (translated) back toward the head perpendicular to the line passes through both "ear reference points" until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously. This test position may require a device holder or positioner to achieve the translation and tilting with acceptable positioning repeatability.

If a device is also designed to transmit with its keypad cover closed for operating in the head position, such positions should also be considered in the SAR evaluation. The device should be tested on the left and right side of the head phantom in the "Cheek/Touch" and "Ear/Tilt" positions. When applicable, each configuration should be tested with the antenna in its fully extended and fully retracted positions. These test configurations should be tested at the high, middle and low frequency channels of each operating mode; for example, AMPS, CDMA, and TDMA. If the SAR measured at the middle channel for each test configuration (left, right, Cheek/Touch, Tile/Ear, extended and retracted) is at least 2.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

If the transmission band of the test device is less than 10 MHz, testing at the high and low frequency channels is optional.

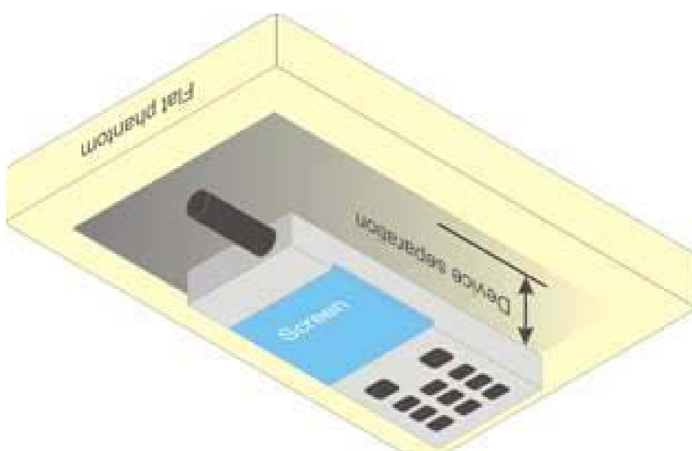
Ear /Tilt 15° Position



5.4 Test positions for body-worn and other configurations

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., the same metallic belt-clip used with different holsters with no other metallic components), only the accessory that dictates the closest spacing to the body must be tested.

Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.



5.5 SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop. The SAR at this point is measured at the start of the test and then again at the end of the testing.

Step 2: The SAR distribution at the exposed side of the head was measured at a distance of 4 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 15 mm x 15 mm. Based on these data, the area of the maximum absorption was determined by line interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.

Step 3: Around this point, a volume of 30 mm x 30 mm x 21 mm was assessed by measuring 5 x 5 x 7 points. 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 1.2 mm 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. 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). The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the averages.

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

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

5.6 Test Methodology

- KDB 447498 D01 (General SAR Guidance)
- KDB 643646 D01(SAR Test for PTT Radios v01r01)
- KDB 865664 D01 (SAR Measurements up to 6 GHz)

6 DASY4 SAR Evaluation Procedure

6.1 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurement jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. By default, the Minimum distance of probe sensors to surface is 4mm. This distance can be modified by the user, but cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 2.7mm for an ET3DV6 probe type).

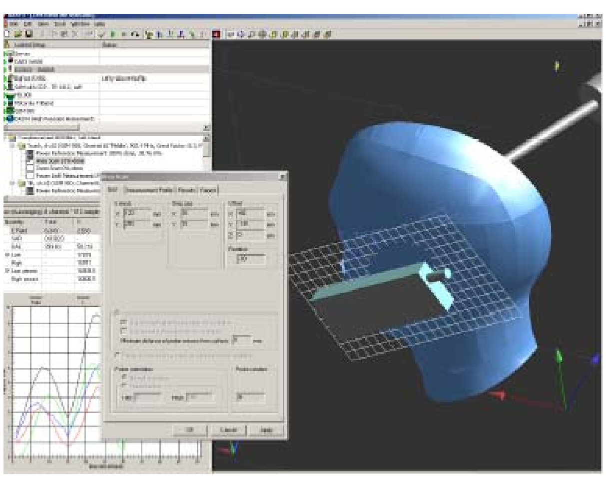
6.2 Area Scan

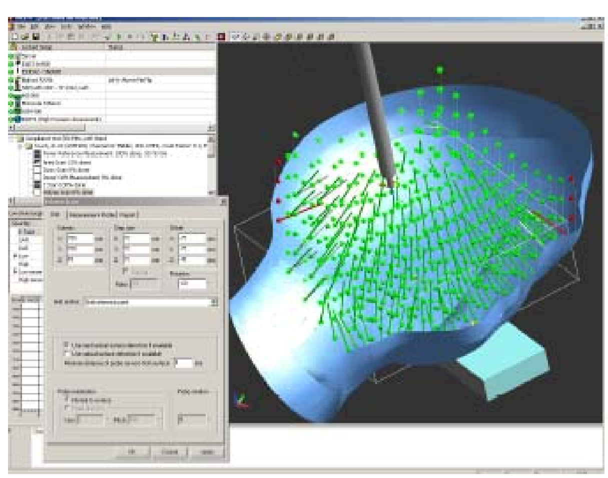
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids.

The scanning area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the Area Scan's property sheet is brought-up, grid settings can be edited by a user.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

After measurement is completed, all maxima and their coordinates are listed in the Results property page. The maximum selected in the list is highlighted in the 3-D view. For the secondary maxima returned from an Area Scan, the user can specify a lower limit (peak SAR value), in addition to the Find secondary maxima within x dB condition. Only the primary maximum and any secondary maxima within x dB from the primary maximum and above this limit will be measured.





6.3 Zoom Scan

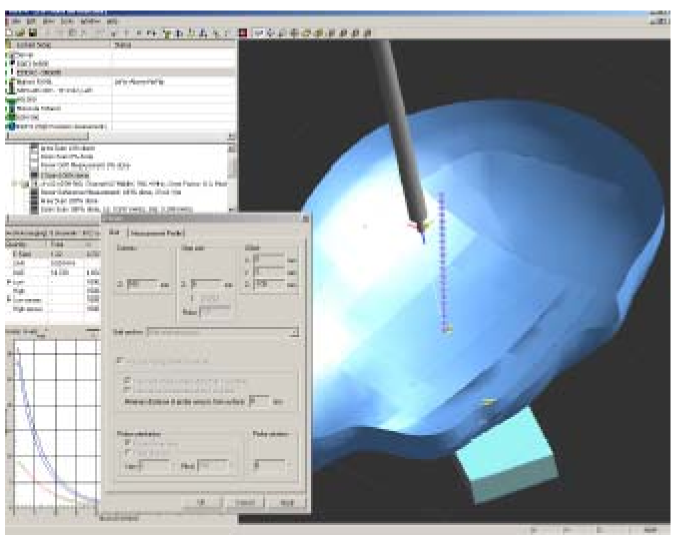
Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

6.4 Power drift measurement

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

6.5 Z-Scan

The Z Scan job measures points along a vertical straight line. The line runs along the Z axis of a one-dimensional grid. A user can anchor the grid to the section reference point, to any defined user point or to the current probe location. As with any other grids, the local Z axis of the anchor location establishes the Z axis of the grid.



7 Description of Test System

These measurements were performed with the automated near-field scanning system DASY4 from Schmid & Partner Engineering AG (SPEAG) which is the fourth generation of the system shown in the figure hereinafter:

The system is based on a high precision robot (working range greater than 0.9m), which positions the probes with a positional repeatability of better than ±0.02mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

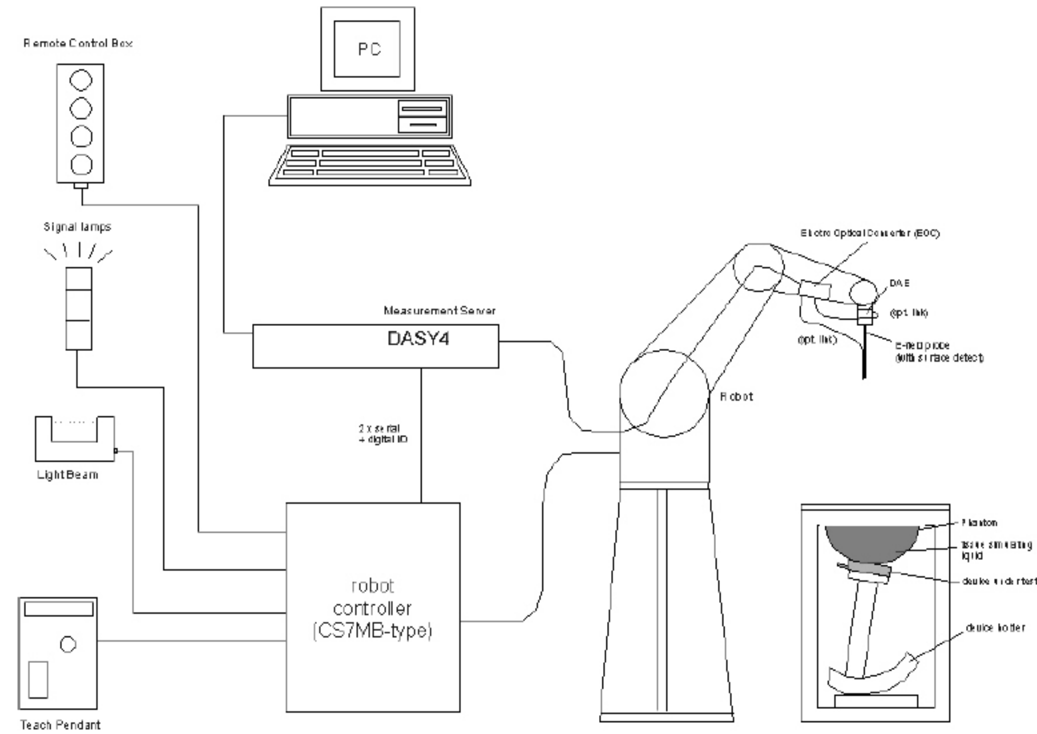
The SAR measurements were conducted with the dosimetric probe ET3DV6 SN: 1604 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure and found to be better than ±0.25dB.

7.1 Tissue Dielectric Parameters

IEEE SCC-34/SC-2 P1528 Recommended Tissue Dielectric Parameters

Frequency (MHz)	Head Tissue		Body Tissue	
	εr	Ơ (S/m)	εr	Ơ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

7.2 Measurement System Diagram



The DASY4 system for performing compliance tests consists of the following items:

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

• A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

• A data acquisition electronics (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.

• 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.

• 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.

• A probe alignment unit which improves the (absolute) accuracy of the probe positioning.

• A computer operating Windows 2000 or Windows XP.

• DASY4 software.

• Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.

• The SAM twin phantom enabling testing left-hand and right-hand usage.

• The device holder for handheld mobile phones.

• Tissue simulating liquid mixed according to the given recipes.

• Validation dipole kits allowing system validation.

7.3 System Components

• DASY4 Measurement Server
• Data Acquisition Electronics
• Probes
• Light Beam Unit
• Medium
• SAM Twin Phantom
• Device Holder for SAM Twin Phantom
• System Validation Kits
• Robot

DASY4 Measurement Server

The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE4 (or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 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 for 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 two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pin out and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server.

Data Acquisition Electronics

The data acquisition electronics DAE3 consists 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 and 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.

Probes

The DASY system can support many different probe types.

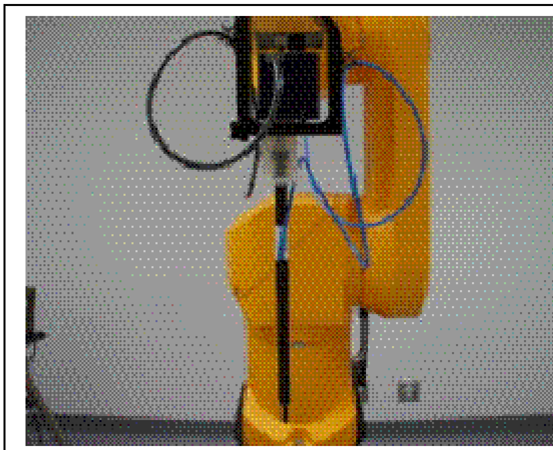
Dosimetric Probes: These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor (±2 dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

Free Space Probes: These are electric and magnetic field probes specially designed for measurements in free space. The z-sensor is aligned to the probe axis and the rotation angle of the x-sensor is specified. This allows the DASY system to automatically align the probe to the measurement grid for field component measurement. The free space probes are generally not calibrated in liquid. (The H-field probes can be used in liquids without any change of parameters.)

Temperature Probes: Small and sensitive temperature probes for general use. They use a completely different parameter set and different evaluation procedures. Temperature rise features allow direct SAR evaluations with these probes.

ET3DV6 Probe Specification

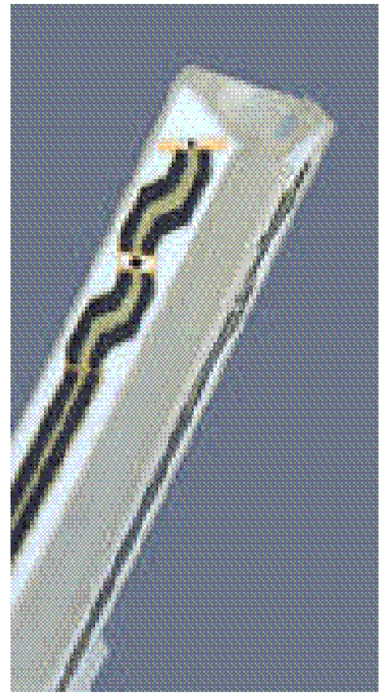
Construction Symmetrical design with triangular core
Built-in optical fiber for surface detection System
Built-in shielding against static charges
Calibration In air from 10 MHz to 2.5 GHz
In brain and muscle simulating tissue at
Frequencies of 450 MHz, 900 MHz and
1.8 GHz (accuracy ± 8%)
Frequency 10 MHz to > 6 GHz; Linearity: ± 0.2 dB
(30 MHz to 3 GHz)
Directivity ± 0.2 dB in brain tissue (rotation around
probe axis)
± 0.4 dB in brain tissue (rotation normal probe axis)
Dynamic 5 mW/g to > 100 mW/g;
Range Linearity: ± 0.2 dB
Surface ± 0.2 mm repeatability in air and clear liquids
Detection over diffuse reflecting surfaces.
Dimensions Overall length: 330 mm
Tip length: 16 mm



Photograph of the probe

Body diameter: 12 mm
Tip diameter: 6.8 mm
Distance from probe tip to dipole centers: 2.7 mm
Application General dosimetric up to 3 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms

The SAR measurements were conducted with the dosimetric probe ET3DV6 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 multi-fiber 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 DASY3 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.



Inside view of ET3DV6 E-field Probe

E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a waveguide 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.

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

Data Evaluation

The DASY4 post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.
The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

With Vi = compensated signal of channel i (i =x, y, z)
Ui = input signal of channel i (i =x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\mathrm{E-fieldprobes:} \qquad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\mathrm{H-fieldprobes:} \qquad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

With Vi = compensated signal of channel i (i =x, y, z)
$Norm_i$ = sensor sensitivity of channel i (i =x, y, z)
µV/ $(V/m)^2$ for E-field probes
ConF = sensitivity enhancement in solution
a_{ij} = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strenggy of channel i in V/m
H_i = diode compression point (DASY parameter)

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

With SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/meter] or [Siemens/meter]
ρ = equivalent tissue density in g/cm^3

Note that the density is normally set to 1, to account for actual brain density rather than the density of the simulation liquid.

Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

Medium

The parameters of the tissue simulating liquid strongly influence the SAR in the liquid. The parameters for the different frequencies are defined in the corresponding compliance standards (e.g., EN 50361, IEEE 1528-2003).

Parameter measurements

Several measurement systems are available for measuring the dielectric parameters of liquids:

- The open coax test method (e.g., HP85070 dielectric probe kit) is easy to use, but has only moderate acuracy. It is calibrated with open, short, and deionized water and the calibrations a critical process.

- The transmission line method (e.g., model 1500T from DAMASKOS, INC.) measures the transmission and reflection in a liquid filled high precision line. It needs standard two port calibration and is probably more accurate than the open coax method.

- The reflection line method measures the reflection in a liquid filled shorted precision lined.The method is not suitable for these liquids because of its low sensitivity.

- The slotted line method scans the field magnitude and phase along a liquid filled line. The evaluation is straight forward and only needs a simple response calibration. The method is very accurate, but can only be used in high loss liquids and at frequencies above 100 to 200MHz. Cleaning the line can be tedious.

SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

• Left hand
• Right hand
• Flat phantom

The phantom table comes in two sizes: A 100 x 50 x 85 cm (L x W x H) table for use with free standing robots (DASY4 professional system option) or as a second phantom and a 100 x 75 x 85 cm(L x W x H) table with reinforcements for table mounted robots (DASY4 compact system option) .
The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is necessary if two phantoms are used (e.g., for different liquids) A white cover is provided to tap the phantom during o_-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

The phantom can be used with the following tissue simulating liquids:

• Water-sugar based liquids can be left permanently in the phantom. Always cover the liquid if the system is not used, otherwise the parameters will change due to water evaporation.

• Glycol based liquids should be used with care. As glycol is a softener for most plastics, the liquid should be taken out of the phantom and the phantom should be dried when the system is not used (desirable at least once a week).

• Do not use other organic solvents without previously testing the phantom's compatibility.

Device Holder for SAM Twin 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 in 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. An 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 different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the 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 has been made out of low-loss POM material having the following dielectric parameters: relative permittivity "=3 and loss tangent _=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.

System Validation Kits

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. For that purpose a well defined SAR distribution in the flat section of the SAM twin phantom is produced.

System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder. Dipoles are available for the variety of frequencies between 300MHz and 6 GHz (dipoles for other frequencies or media and other calibration conditions are available upon request).

The dipoles are highly symmetric and matched at the center frequency for the specified liquid and distance to the flat phantom (or flat section of the SAM-twin phantom). The accurate distance between the liquid surface and the dipole center is achieved with a distance holder that snaps on the dipole.

Robot

The DASY4 system uses the high precision industrial robots RX60L, RX90 and RX90L, as well as the RX60BL and RX90BL types out of the newer series from Stäubli SA (France). The RX robot series offers 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 synchronous motors; no stepper motors)
• Low ELF interference (the closed metallic construction shields against motor control fields)

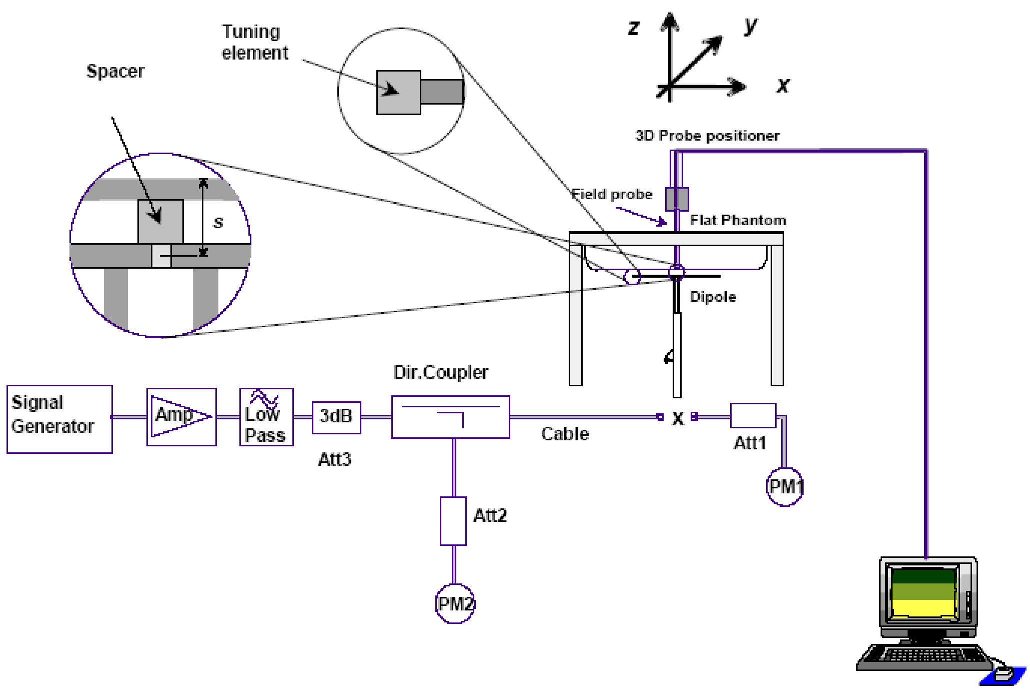
For the newly delivered DASY4 systems as well as for the older DASY3 systems delivered since 1999, the CS7MB robot controller version from Stäubli is used. Previously delivered systems have either a CS7 or CS7M controller; the differences to the CS7MB are mainly in the hardware, but some procedures in the robot software from Stäubli are also not completely the same. The following descriptions about robot hard- and software correspond to CS7MB controller with software version 13.1 (edit S5). The actual commands, procedures and configurations, also including details in hardware, might differ if an older robot controller is in use. In this case please also refer to the Stäubli manuals for further information.

8 SAR Measurement System Verification

8.1 System Accuracy Verification

SAR system verification is required to confirm measurement accuracy. The system verification must be performed for each frequency band. System verification must be performed before each series of SAR measurements.

8.2 SAR System Verification Setup and procedure



Procedure:

1) The SAR system verification measurements were performed in the flat section of TWIN SAM or flat phantom with shell thickness of 2±0.2mm filled with head or body liquid.

2) The depth of liquid in phantom must be ≥15 cm for SAR measurement less than 3 GHz and ≥10 cm for SAR measurement above 3 GHz.

3) The dipole was mounted below the center of flat phantom, and oriented parallel to the Y-Axis. The standard measurement distance is 15mm (below 1 GHz) and 10mm (above 1 GHz) from dipole center to the liquid surface.

4) The dipole input power was 250 mW or 100 mW.

5) The SAR results are normalized to 1 Watt input power.

6) Compared the normalized the SAR results to the dipole calibration results.

8.3 Liquid and System Validation

Date	Simulant	Freq. [MHz]	Parameters	Liquid Temp [ºC]	Target Value	Measured Value	Deviation [%]	Limits [%]
09/03/2015	Head	450	εr	22	43.50	42.84	-1.52	± 5
			σ	22	0.87	0.88	1.15	± 5
			1-g SAR	22	4.93	4.7	-4.67	± 10
		469.9875	εr	22	43.40	42.75	-1.50	± 5
			σ	22	0.87	0.88	1.15	± 5
		485.0125	εr	23	43.32	42.60	-1.66	± 5
			σ	23	0.87	0.88	1.15	± 5
		502.0125	εr	22	43.23	43.55	0.74	± 5
			σ	22	0.87	0.87	0.00	± 5
		519.9875	εr	22	43.14	42.37	-1.78	± 5
			σ	22	0.88	0.90	2.27	± 5
	Body	450	εr	22	56.70	55.65	-1.85	± 5
			σ	22	0.94	0.95	1.06	± 5
			1-g SAR	22	4.80	4.54	-5.42	± 10
		469.9875	εr	22	56.62	55.47	-2.03	± 5
			σ	22	0.94	0.95	1.06	± 5
		485.0125	εr	22	56.56	55.12	-2.55	± 5
			σ	22	0.94	0.94	0.00	± 5
		502.0125	εr	22	56.50	55.03	-2.60	± 5
			σ	22	0.94	0.95	1.06	± 5
		519.9875	εr	23	56.43	54.98	-2.57	± 5
			σ	23	0.95	0.96	1.05	± 5

εr = relative permittivity, σ = conductivity and ρ=1000 kg/m^3

9 SAR Measurement Results

This page summarizes the results of the performed dosimetric evaluation. The plots with the corresponding SAR distributions, which reveal information about the location of the maximum SAR with respect to the device, could be found in Appendix E.

9.1 Test Environmental Conditions

Temperature:	23 °C
Relative Humidity:	35 %
ATM Pressure:	101.5 kPa

Testing was performed by Bell Hu on 2015-09-03 in SAR chamber.

9.2 Test Results

Digital (Modulation 4FSK; Channel Spacing 12.5 kHz):

Frequency (MHz)	Battery	Phantom Type	Power Drift (dB)	Power (dBm)		Scaled factor	1g SAR (W/Kg)				
				Meas.	Tune up limit		Mea.	Scaled	50%	Limit	Plot
Face Up (2.5cm)											
450.0125	Higher Capacity	Twin SAM	0.157	35.98	36.00	1.005	1.670	1.678	0.839	8.0	/
469.9875		Twin SAM	0.11	35.99	36.00	1.002	3.610	3.618	**1.809**	8.0	**#1**
485.0125		Twin SAM	-0.231	36.00	36.00	1.000	2.690	2.690	1.345	8.0	/
502.0125		Twin SAM	0.106	36.00	36.00	1.000	1.940	1.940	0.970	8.0	/
519.9875		Twin SAM	0.225	35.99	36.00	1.002	1.720	1.724	0.862	8.0	/
Body-Back with Belt Clip(0.0cm)											
450.0125	Std. Capacity	Twin SAM	0.06	35.98	36.00	1.005	3.18	3.195	1.597	8.0	/
469.9875		Twin SAM	-0.128	35.99	36.00	1.002	5.83	5.843	**2.922**	8.0	**#2**
485.0125		Twin SAM	-0.139	36.00	36.00	1.000	4.75	4.750	2.375	8.0	/
502.0125		Twin SAM	0.204	36.00	36.00	1.000	3.52	3.520	1.760	8.0	/
519.9875		Twin SAM	0.08	35.99	36.00	1.002	2.98	2.987	1.493	8.0	/

Analog (Modulation FM; Channel Spacing 12.5 kHz):

Frequency (MHz)	Battery	Phantom Type	Power Drift (dB)	Power (dBm)		Scaled factor	1g SAR (W/Kg)				
				Meas.	Tune up limit		Mea.	Scaled	50%	Limit	Plot
Face Up (2.5cm)											
450.0125	Higher Capacity	Twin SAM	-0.051	35.98	36.00	1.005	4.44	4.460	2.230	8.0	/
469.9875		Twin SAM	-0.09	36.00	36.00	1.000	7.08	7.080	**3.540**	8.0	**#3**
485.0125		Twin SAM	-0.082	36.00	36.00	1.000	5.24	5.240	2.620	8.0	/
502.0125		Twin SAM	0.138	36.00	36.00	1.000	3.76	3.760	1.880	8.0	/
519.9875		Twin SAM	-0.141	36.00	36.00	1.000	3.23	3.230	1.615	8.0	/
Body-Back with Belt Clip(0.0cm)											
450.0125	Std. Capacity	Twin SAM	0.205	35.98	36.00	1.005	6.59	6.620	3.310	8.0	/
469.9875		Twin SAM	-0.163	36.00	36.00	1.000	11.4	11.40	**5.700**	8.0	**#4**
485.0125		Twin SAM	0.06	36.00	36.00	1.000	9.56	9.560	4.780	8.0	/
502.0125		Twin SAM	-0.129	36.00	36.00	1.000	6.61	6.610	3.305	8.0	/
519.9875		Twin SAM	0.138	36.00	36.00	1.000	6.15	6.150	3.075	8.0	/

Note:

1. *When the 1-g SAR tested is ≤ 3.5W/Kg (corrected by Multiplying 50% for a Simplex radio), testing for other channels are optional.*
2. *KDB643646, when multiple batteries are supplied with a radio, the thickest battery with the highest capacity is considered the default battery for head SAR and the thinnest battery is considered the default battery for Body SAR.*
3. *Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios.*
4. *The whole antenna and radiating structures that may contribute to the measured SAR or influence the SAR distribution has been included in the area scan.*

10 Appendix A – Measurement Uncertainty

The uncertainty budget has been determined for the DASY4 measurement system and is given in the following Table.

DASY4 Uncertainty Budget According to IEEE 1528								
Error Description	Uncertainty Value (± %)	Prob. Dist.	Div.	(c i) 1g	(c i) 10g	Std. Unc. ±%, (1g)	Std. Unc. ±%, (10g)	(v i) veff
Measurement System								
Probe Calibration	6.7	N	1	1	1	6.7	6.7	∝
Axial Isotropy	0.25	R	$\sqrt{3}$	0.7	0.7	0.1	0.1	∝
Hemispherical Isotropy	1.3	R	$\sqrt{3}$	0.7	0.7	0.5	0.5	∝
Boundary Effects	0.5	R	$\sqrt{3}$	1	1	0.3	0.3	∝
Linearity	0.3	R	$\sqrt{3}$	1	1	0.2	0.2	∝
System Detection Limits	2	R	$\sqrt{3}$	1	1	1.2	1.2	∝
Modulation Response	1.65	R	$\sqrt{3}$	1	1	1.0	1.0	∝
Readout Electronics	0.8	N	1	1	1	0.8	0.8	∝
Response Time	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∝
Integration Time	3	R	$\sqrt{3}$	1	1	1.7	1.7	∝
RF Ambient Noise	3	R	$\sqrt{3}$	1	1	1.7	1.7	∝
RF Ambient Conditions	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∝
Probe Positioner	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∝
Probe Positioning	1	R	$\sqrt{3}$	1	1	0.6	0.6	∝
Max. SAR Eval.	0	R	$\sqrt{3}$	1	1	0	0	∝
Test Sample Related								
Device Positioning	2.9	N	1	1	1	2.9	2.9	145
Device Holder	3.6	N	1	1	1	3.6	3.6	5
Power Drift	5	R	$\sqrt{3}$	1	1	2.9	2.9	∝
Phantom and Setup								
Phantom Uncertainty	4	R	$\sqrt{3}$	1	1	2.3	2.3	∝
SAR Correction	1.2	N	1	1	0.84	1.2	1.0	∝
Liquid Conductivity (Target)	2.5	N	1	0.78	0.71	2.0	1.8	∝
Liquid Conductivity (meas.)	5	R	$\sqrt{3}$	0.78	0.71	2.3	2.0	∝
Liquid Permittivity (Target)	2.5	N	1	0.23	0.26	0.6	0.7	∝
Liquid Permittivity (Target)	5	R	$\sqrt{3}$	0.23	0.26	0.7	0.8	∝
Combined Std. Uncertainty	-	RSS	-	-	-	9.9	9.7	330
Expanded STD Uncertainty	-	2	-	-	-	19.7	19.4	-

DASY4 Uncertainty Budget Below 3 GHz According to IEC 62209-2								
Error Description	Uncertainty Value (± %)	Prob. Dist.	Div.	(c i) 1g	(c i) 10g	Std. Unc. ±%, (1g)	Std. Unc. ±%, (10g)	(v i) veff
Measurement System								
Probe Calibration	6.7	N	1	1	1	6.7	6.7	∝
Isotropy	9.36	R	$\sqrt{3}$	1	1	5.4	5.4	∝
Linearity	0.3	R	$\sqrt{3}$	1	1	0.2	0.2	∝
Modulation Response	1.65	R	$\sqrt{3}$	1	1	1.0	1.0	∝
System Detection Limits	2	R	$\sqrt{3}$	1	1	1.2	1.2	∝
Boundary Effects	0.5	R	$\sqrt{3}$	1	1	0.3	0.3	∝
Readout Electronics	0.8	N	1	1	1	0.8	0.8	∝
Response Time	2.6	R	$\sqrt{3}$	1	1	1.5	1.5	∝
Integration Time	3	R	$\sqrt{3}$	1	1	1.7	1.7	∝
RF Ambient Noise	3	R	$\sqrt{3}$	1	1	1.7	1.7	∝
RF Ambient Reflections	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∝
Probe Positioner	0.4	R	$\sqrt{3}$	1	1	0.2	0.2	∝
Probe Positioning	1	R	$\sqrt{3}$	1	1	0.6	0.6	∝
Post-processing	1	R	$\sqrt{3}$	1	1	0.6	0.6	∝
Test Sample Related								
Device Holder	3.6	N	1	1	1	3.6	3.6	5
Test Sample Positioning	2.9	N	1	1	1	2.9	2.9	145
SAR Drift Measurement	5	R	$\sqrt{3}$	1	1	2.9	2.9	∝
Phantom and Setup								
Phantom Uncertainty	4	R	$\sqrt{3}$	1	1	0.6	0.6	∝
SAR Correction	1.2	N	1	1	0.84	1.2	1.0	
Liquid Conductivity meas.	5	R	$\sqrt{3}$	0.78	0.71	2.3	2.0	∝
Liquid Permittivity meas.	5	R	$\sqrt{3}$	0.23	0.26	0.7	0.8	∝
Liquid Conductivity-Temp.	2.5	N	1	0.78	0.71	2.0	1.8	∝
Liquid Permittivity-Temp.	2.5	N	1	0.23	0.26	0.6	0.7	∝
Combined Std. Uncertainty	-	RSS	-	-	-	11.3	11.2	330
Expanded Uncertainty	-	2	-	-	-	22.6	22.4	-

11 Appendix B – Probe Calibration Certificates

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 0108**

Client **BACL**

Certificate No: **ES3-3019_Aug15**

CALIBRATION CERTIFICATE

Object: ES3DV2 - SN:3019

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: August 19, 2015

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	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ES3DV2	SN: 3013	30-Dec-14 (No. ES3-3013_Dec14)	Dec-15
DAE4	SN: 660	14-Jan-15 (No. DAE4-660_Jan15)	Jan-16
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-14)	In house check: Oct-15

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

Issued: August 20, 2015

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

Certificate No: ES3-3019_Aug15 Page 1 of 11

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

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

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

Accreditation No.: **SCS 0108**

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
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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).

Certificate No: ES3-3019_Aug15 Page 2 of 11

Probe ES3DV2

SN:3019

Manufactured: December 5, 2002
Calibrated: August 19, 2015

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

ES3DV2– SN:3019

August 19, 2015

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3019

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.03	1.15	0.96	± 10.1 %
DCP (mV)[B]	106.1	103.8	104.7	

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	184.6	±3.3 %
		Y	0.0	0.0	1.0		195.7	
		Z	0.0	0.0	1.0		186.6	

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

[A] The uncertainties of Norm X,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.

Certificate No: ES3-3019_Aug15 Page 4 of 11

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3019

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)	Unc (k=2)
450	43.5	0.87	6.75	6.75	6.75	0.18	1.70	± 13.4 %
750	41.9	0.89	6.54	6.54	6.54	0.21	2.00	± 12.0 %
835	41.5	0.90	6.23	6.23	6.23	0.34	1.49	± 12.0 %
1750	40.1	1.37	5.11	5.11	5.11	0.53	1.28	± 12.0 %
1900	40.0	1.40	4.86	4.86	4.86	0.63	1.16	± 12.0 %
2450	39.2	1.80	4.16	4.16	4.16	0.45	1.62	± 12.0 %
2600	39.0	1.96	4.00	4.00	4.00	0.70	1.30	± 12.0 %

[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.

ES3DV2– SN:3019

August 19, 2015

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3019

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)	Unc (k=2)
450	56.7	0.94	7.03	7.03	7.03	0.13	1.50	± 13.4 %
750	55.5	0.96	6.34	6.34	6.34	0.19	2.28	± 12.0 %
835	55.2	0.97	6.25	6.25	6.25	0.35	1.60	± 12.0 %
1750	53.4	1.49	4.71	4.71	4.71	0.38	1.66	± 12.0 %
1900	53.3	1.52	4.48	4.48	4.48	0.45	1.52	± 12.0 %
2450	52.7	1.95	3.95	3.95	3.95	0.66	1.25	± 12.0 %
2600	52.5	2.16	3.79	3.79	3.79	0.79	1.07	± 12.0 %

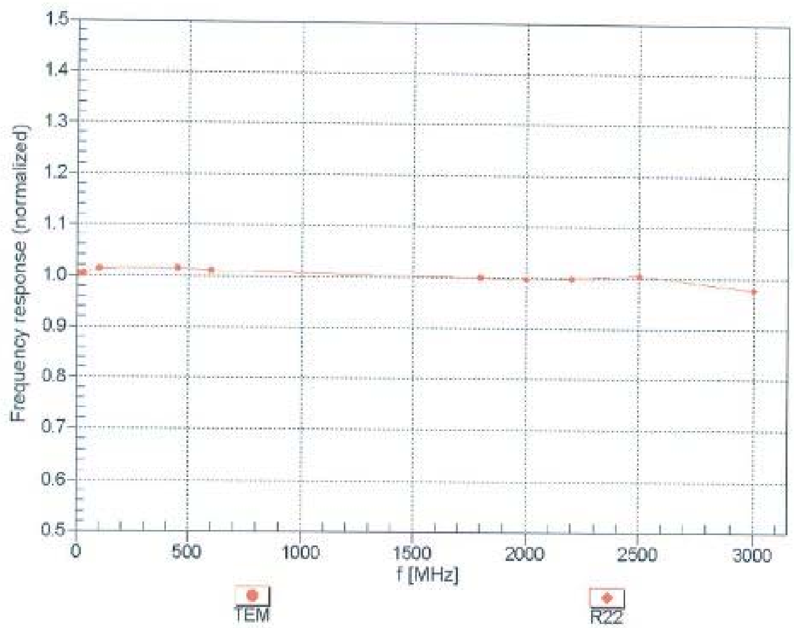
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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.

Certificate No: ES3-3019_Aug15 Page 6 of 11

ES3DV2– SN:3019

August 19, 2015

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

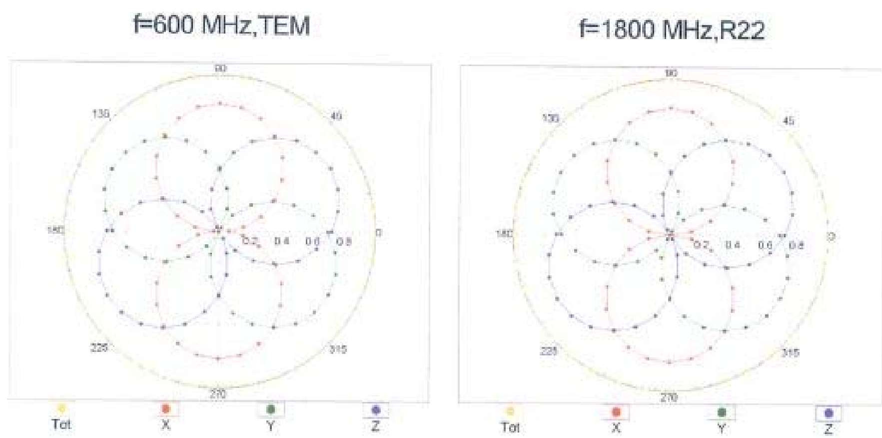


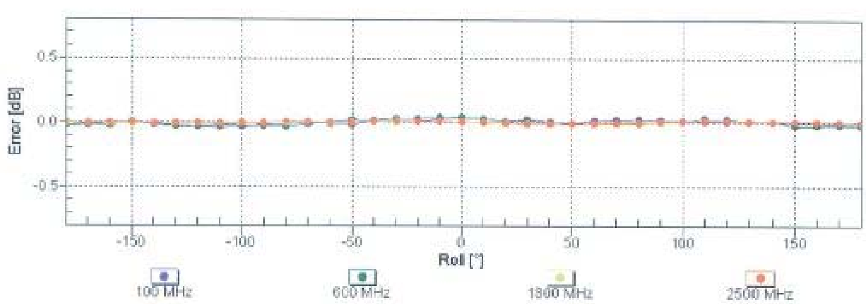
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Certificate No: ES3-3019_Aug15 Page 7 of 11

ES3DV2– SN:3019 August 19, 2015

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

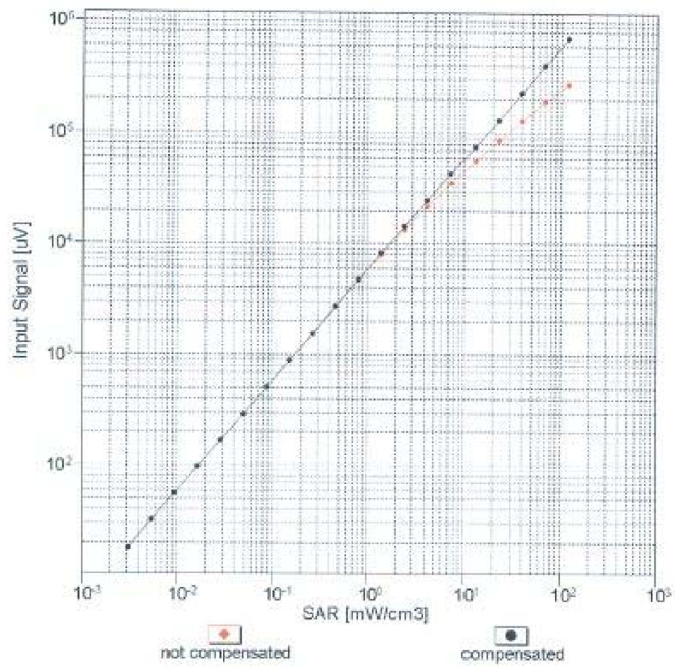


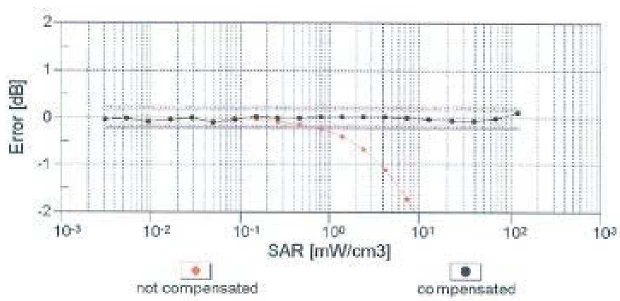


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

ES3DV2– SN:3019 August 19, 2015

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





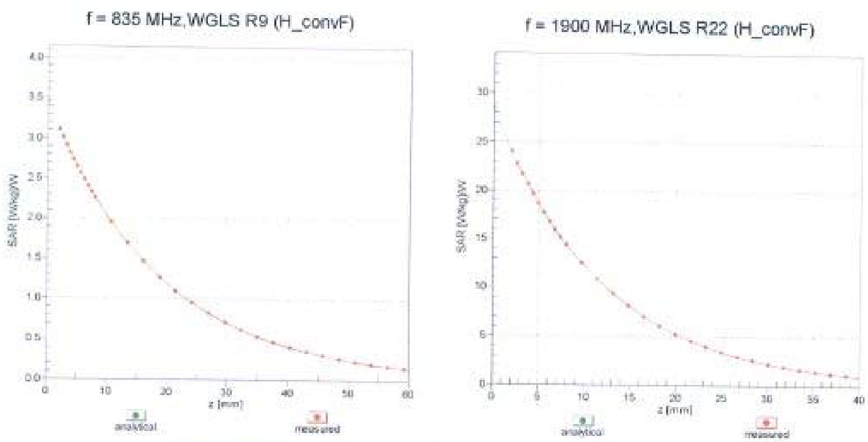
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Certificate No: ES3-3019_Aug15 Page 9 of 11

ES3DV2– SN:3019

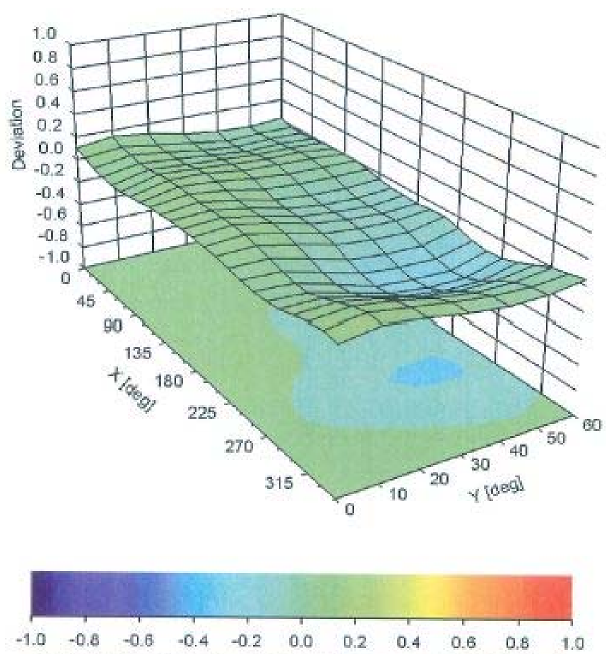
August 19, 2015

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: ES3-3019_Aug15 Page 10 of 11

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3019

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	110.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

12 Appendix C – Dipole Calibration Certificates

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 **BACL**

Certificate No: **D450V2-1010_Aug14**

CALIBRATION CERTIFICATE

Object: D450V2 - SN:1010

Calibration procedure(s): QA CAL-15.v8
Calibration procedure for dipole validation kits below 700 MHz

Calibration date: August 19, 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: S5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ET3DV6	SN: 1507	30-Dec-13 (No. ET3-1507_Dec13)	Dec-14
DAE4	SN: 654	30-Jun-14 (No. DAE4-654_Jun14)	Jun-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	04-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585 S4206	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: August 19, 2014

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

Certificate No: D450V2-1010_Aug14 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 1528-2013, "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
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%.

Certificate No: D450V2-1010_Aug14 Page 2 of 8

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Flat Phantom V4.4	Shell thickness: 6 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	44.4 ± 6 %	0.89 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	1.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**4.93 W/kg ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.825 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**3.26 W/kg ± 17.6 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	56.7	0.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	56.8 ± 6 %	0.96 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	1.22 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**4.80 W/kg ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.810 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**3.19 W/kg ± 17.6 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.7 Ω - 4.8 jΩ
Return Loss	- 23.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	54.0 Ω - 7.8 jΩ
Return Loss	- 21.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.359 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	November 18, 2002

DASY5 Validation Report for Head TSL

Date: 19.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

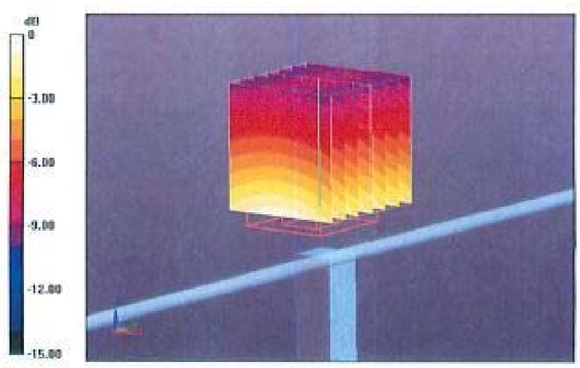
DUT: Dipole 450 MHz; Type: D450V2; Serial: D450V2 - SN:1010

Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma = 0.89$ S/m; $\varepsilon_r = 44.4$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.65, 6.65, 6.65); Calibrated: 30.12.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: Flat Phantom 4.4 ; Type: Flat Phantom 4.4; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

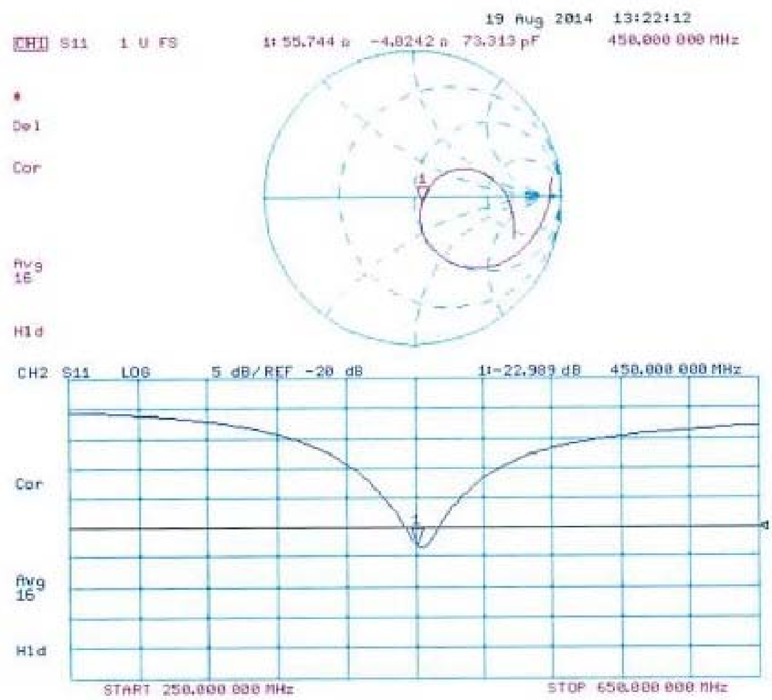
Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 39.79 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 1.92 W/kg
SAR(1 g) = 1.25 W/kg; SAR(10 g) = 0.825 W/kg
Maximum value of SAR (measured) = 1.33 W/kg



0 dB = 1.33 W/kg = 1.24 dBW/kg

Certificate No: D450V2-1010_Aug14 Page 5 of 8

Impedance Measurement Plot for Head TSL



Certificate No: D450V2-1010_Aug14 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 19.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

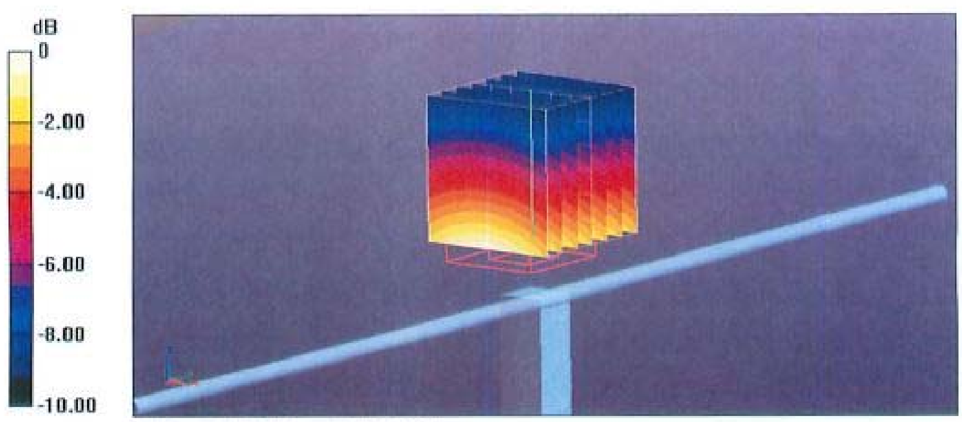
DUT: Dipole 450 MHz; Type: D450V2; Serial: D450V2 - SN:1010

Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; σ = 0.96 S/m; ε_r = 56.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.1, 7.1, 7.1); Calibrated: 30.12.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: Flat Phantom 4.4 ; Type: Flat Phantom 4.4; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

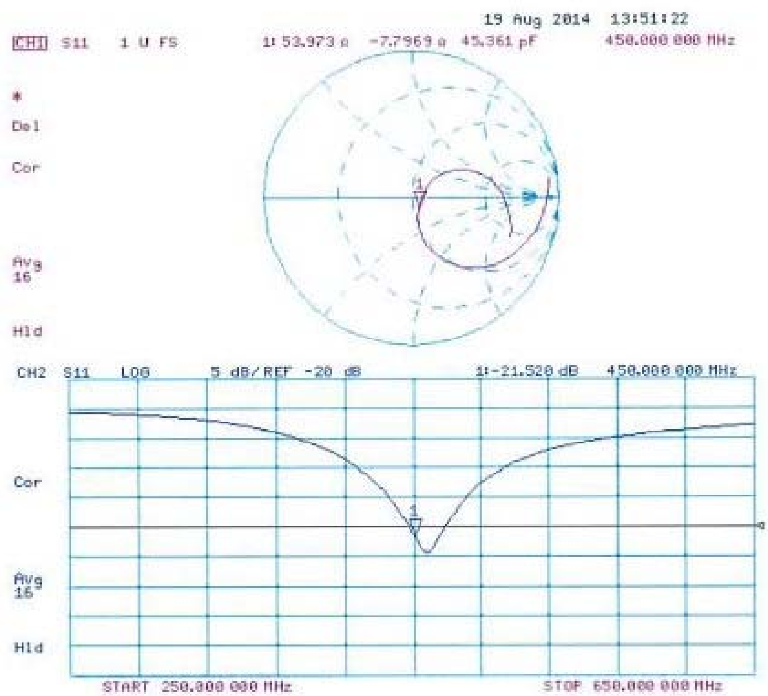
Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 37.28 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 1.92 W/kg
SAR(1 g) = 1.22 W/kg; SAR(10 g) = 0.810 W/kg
Maximum value of SAR (measured) = 1.30 W/kg



0 dB = 1.30 W/kg = 1.14 dBW/kg

Certificate No: D450V2-1010_Aug14 Page 7 of 8

Impedance Measurement Plot for Body TSL



Certificate No: D450V2-1010_Aug14 Page 8 of 8

13 Appendix D - Test System Verifications Scans

Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

System Performance Test (450 MHz Head)

DUT: Dipole 450 MHz; Type: D450V2; Serial: D450V2 - SN: 1010

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 450 MHz; σ = 0.88 mho/m; ε_r =42.84; ρ = 1000 kg/m^3
Phantom section: Flat Section

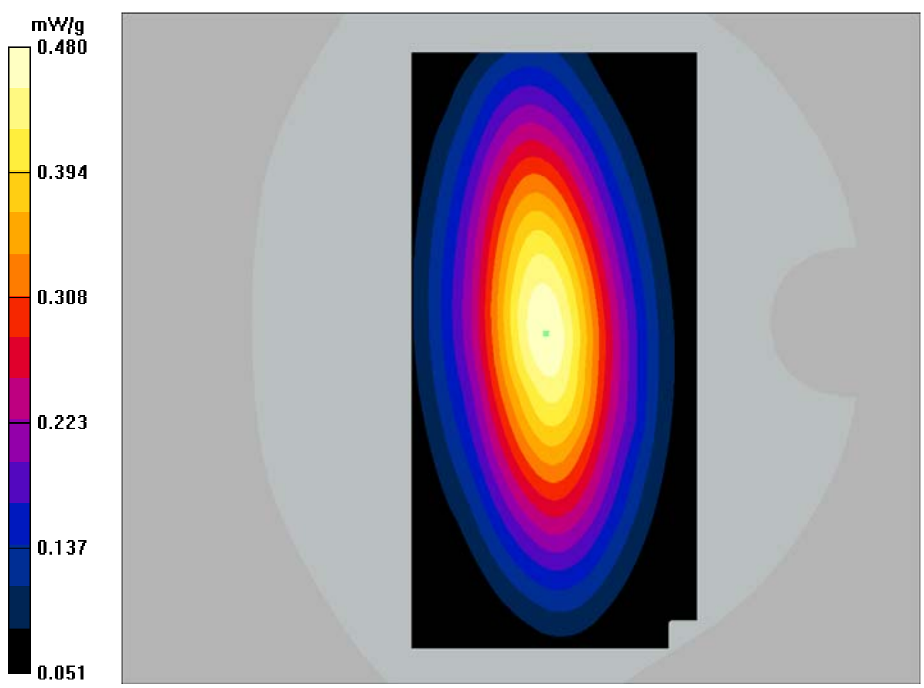
DASY4 Configuration:

- Probe: ES3DV2- SN3019; ConvF(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

d =15 mm, Pin = 0.1W /Area Scan (81x141x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.478 mW/g

d =15 mm, Pin = 0.1 W/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 23.6 V/m; Power Drift = 0.016 dB
Peak SAR (extrapolated) = 0.669 W/kg

SAR(1 g) = 0.470 mW/g; SAR(10 g) = 0.301 mW/g
Maximum value of SAR (measured) = 0.480 mW/g



Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

System Performance Test (450 MHz Body)

DUT: Dipole 450 MHz; Type: D450V2; Serial: D450V2 - SN: 1010

Communication System: CW; Frequency: 450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 450 MHz; σ = 0.95 mho/m; ε_r =55.65; ρ = 1000 kg/m^3
Phantom section: Flat Section

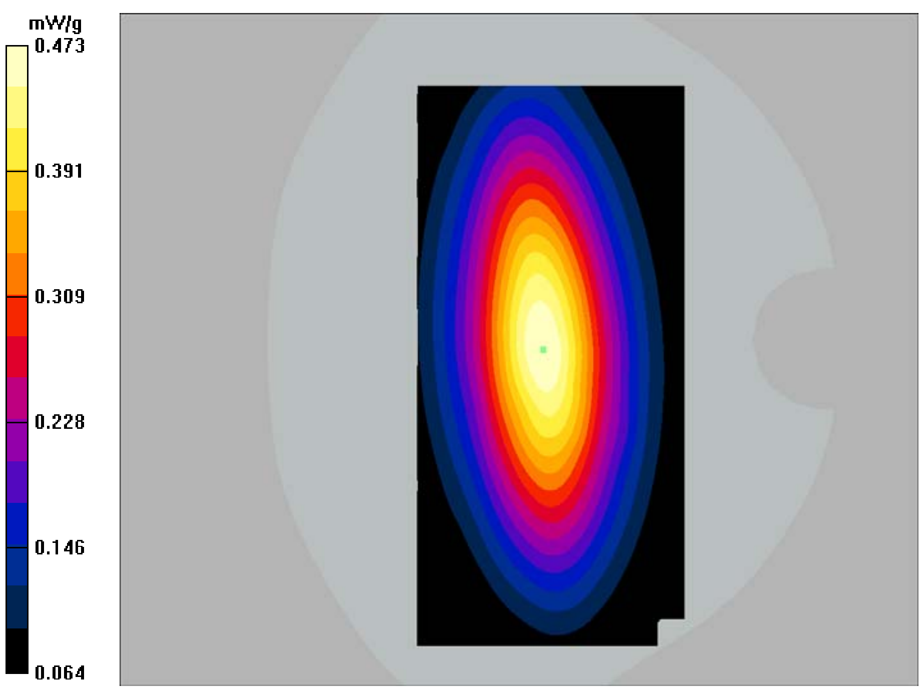
DASY4 Configuration:

- Probe: ES3DV2- SN3019; ConvF(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

d =15 mm, Pin = 0.1W /Area Scan (81x141x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.470 mW/g

d =15 mm, Pin = 0.1 W/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.1 V/m; Power Drift = 0.053 dB
Peak SAR (extrapolated) = 0.658 W/kg

SAR(1 g) = 0.454 mW/g; SAR(10 g) = 0.304 mW/g
Maximum value of SAR (measured) = 0.473 mW/g



14 Appendix E – SAR plots (Summary of the Highest SAR Values)

Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

Face-Up 2.5cm (Digital 12.5k-469.9875MHz)

DUT: DMR Two Way Radio; Model: SEP8050; Serial: 7PR131530GA0555

Communication System: 450-520; Frequency: 469.9875 MHz; Duty Cycle: 1:2
Medium parameters used: f = 469.9875 MHz; σ = 0.88 mho/m; ε_r =42.75; ρ = 1000 kg/m^3
Phantom section: Flat Section

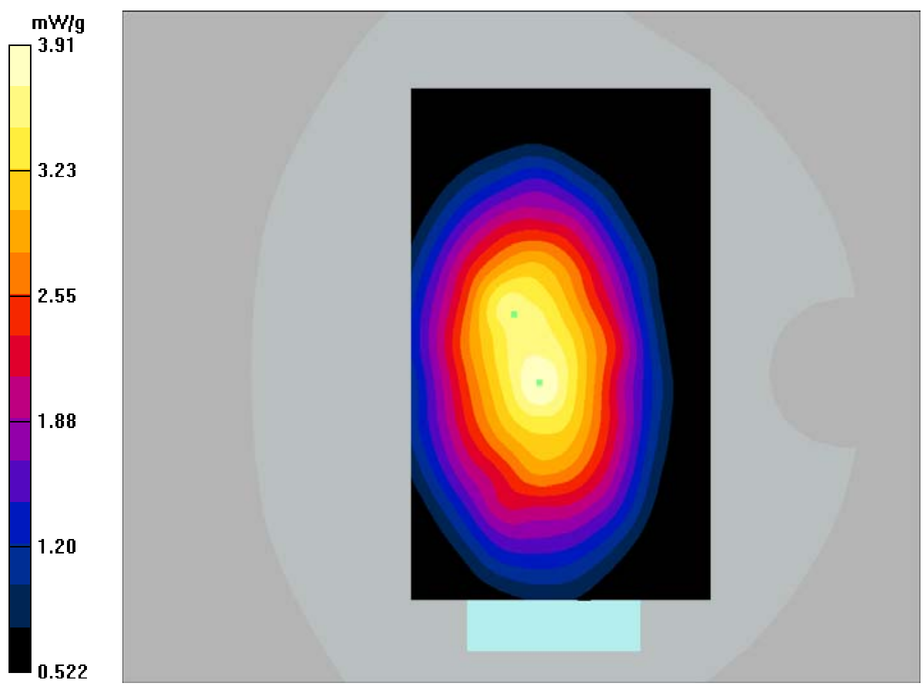
DASY4 Configuration:

- Probe: ES3DV2- SN3019; Conv F(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

Face-Up 2.5cm /Area Scan (71x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 3.98 mW/g

Face-Up 2.5cm /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 59.6 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 4.98 W/kg

SAR(1 g) = 3.61 mW/g; SAR(10 g) = 2.62 mW/g
Maximum value of SAR (measured) = 3.91 mW/g



#1

Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

Body-Worn-Belt Clip (Digital 12.5k-469.9875MHz)

DUT: DMR Two Way Radio; Model: SEP8050; Serial: 7PR131530GA0555

Communication System: 450-520; Frequency: 469.9875 MHz; Duty Cycle: 1:2
Medium parameters used: f = 469.9875 MHz; σ = 0.95 mho/m; ε_r =55.47; ρ = 1000 kg/m^3
Phantom section: Flat Section

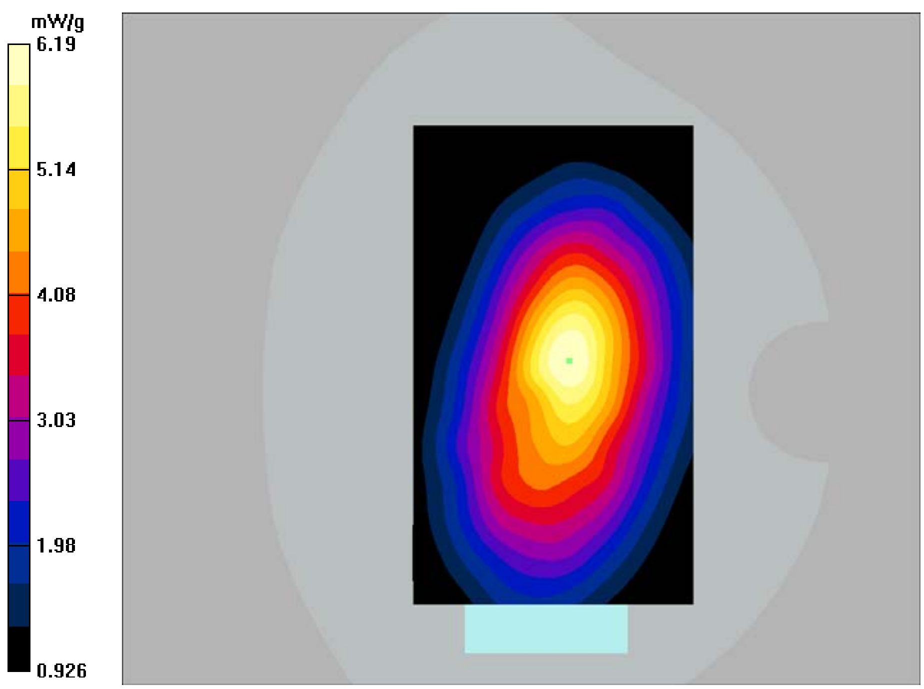
DASY4 Configuration:

- Probe: ES3DV2- SN3019; Conv F(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

Body-Worn-Belt Clip /Area Scan (71x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 6.41 mW/g

Body-Worn-Belt Clip /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 75.7 V/m; Power Drift = -0.128 dB
Peak SAR (extrapolated) = 8.06 W/kg

SAR(1 g) = 5.83 mW/g; SAR(10 g) = 4.32 mW/g
Maximum value of SAR (measured) = 6.19 mW/g



#2

Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

Face-Up 2.5cm (Analog 12.5k-469.9875MHz)

DUT: DMR Two Way Radio; Model: SEP8050; Serial: 7PR131530GA0555

Communication System: 450-520; Frequency: 469.9875 MHz; Duty Cycle: 1:1
Medium parameters used: f = 469.9875 MHz; σ = 0.88 mho/m; ε_r =42.75; ρ = 1000 kg/m^3
Phantom section: Flat Section

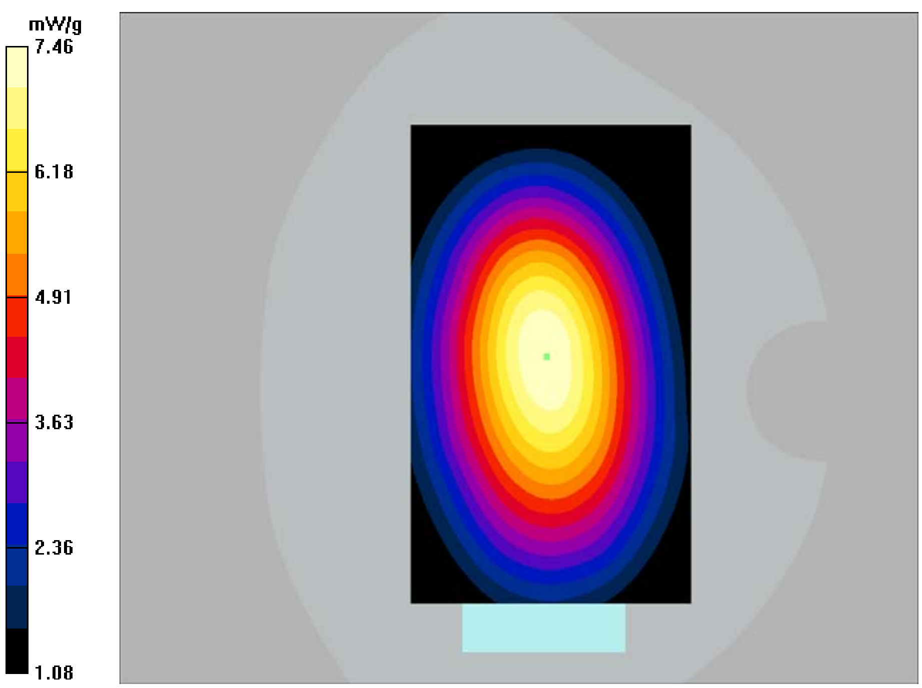
DASY4 Configuration:

- Probe: ES3DV2- SN3019; Conv F(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

Face-Up 2.5cm /Area Scan (71x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 7.81 mW/g

Face-Up 2.5cm /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.4 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 9.42 W/kg

SAR(1 g) = 7.08 mW/g; SAR(10 g) = 5.21 mW/g
Maximum value of SAR (measured) = 7.46 mW/g



#3

Test Laboratory: Bay Area Compliance Lab Corp. (BACL)

Body-Worn-Belt Clip (Analog 12.5k-469.9875MHz)

DUT: DMR Two Way Radio; Model: SEP8050; Serial: 7PR131530GA0555

Communication System: 450-520; Frequency: 469.9875 MHz; Duty Cycle: 1:1
Medium parameters used: f = 469.9875 MHz; σ = 0.95 mho/m; ε_r =55.47; ρ = 1000 kg/m^3
Phantom section: Flat Section

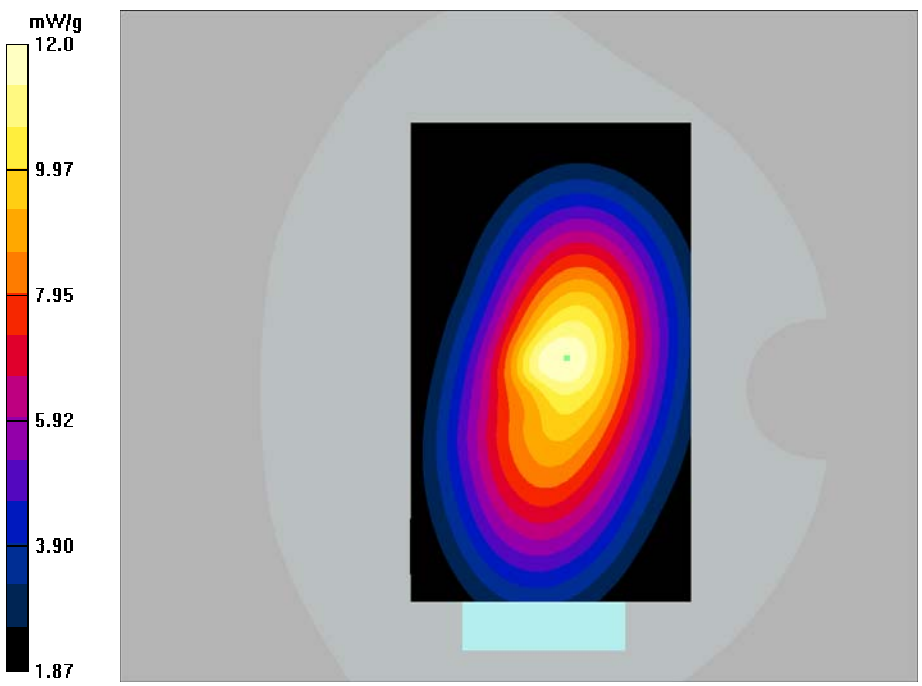
DASY4 Configuration:

- Probe: ES3DV2- SN3019; Conv F(6.75, 6.75, 6.75); Calibrated: 8/19/2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn704; Calibrated: 8/18/2015
- Phantom: SAM with CRP; Type: Twin SAM; Serial: TP-1032
- Measurement SW: DASY4, V4.7 Build 71; Post processing SW: SEMCAD, V1.8 Build 186

Body-Worn-Belt Clip /Area Scan (71x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 12.6 mW/g

Body-Worn-Belt Clip /Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 119.4 V/m; Power Drift = -0.163 dB
Peak SAR (extrapolated) = 15.8 W/kg

SAR(1 g) = 11.4 mW/g; SAR(10 g) = 8.3 mW/g
Maximum value of SAR (measured) = 12.0 mW/g



#4

15 Appendix F– Output Power Measurement

Mode	Frequency Spacing (kHz)	Frequency (MHz)	Output Power (dBm)		Power level
			Meas. Power (dBm)	Turn-up Limit (dBm)	
Digital	12.5	450.0125	35.98	36.00	High
		469.9875	35.99	36.00	High
		485.0125	36.00	36.00	High
		502.0125	36.00	36.00	High
		519.9875	35.99	36.00	High
Analog	12.5	450.0125	35.98	36.00	High
		469.9875	36.00	36.00	High
		485.0125	36.00	36.00	High
		502.0125	36.00	36.00	High
		519.9875	36.00	36.00	High

16 Appendix G – Test Setup Photos

16.1 Face-Up 2.5 cm Separation to Flat Phantom Setup Photo

16.2 Body-Worn-Belt Clip 0.0 cm Separation to Flat Phantom Setup Photo

17 Appendix H – EUT Photos

17.1 EUT – Front View

17.2 EUT – Back View

17.3 EUT – Left View

17.4 EUT – Right View

17.5 EUT – Top View

17.6 EUT – Bottom View

17.7 EUT – Uncovered View

17.8 Standard Battery View (2000mAh)

17.9 High Capacity Battery View (2500mAh)

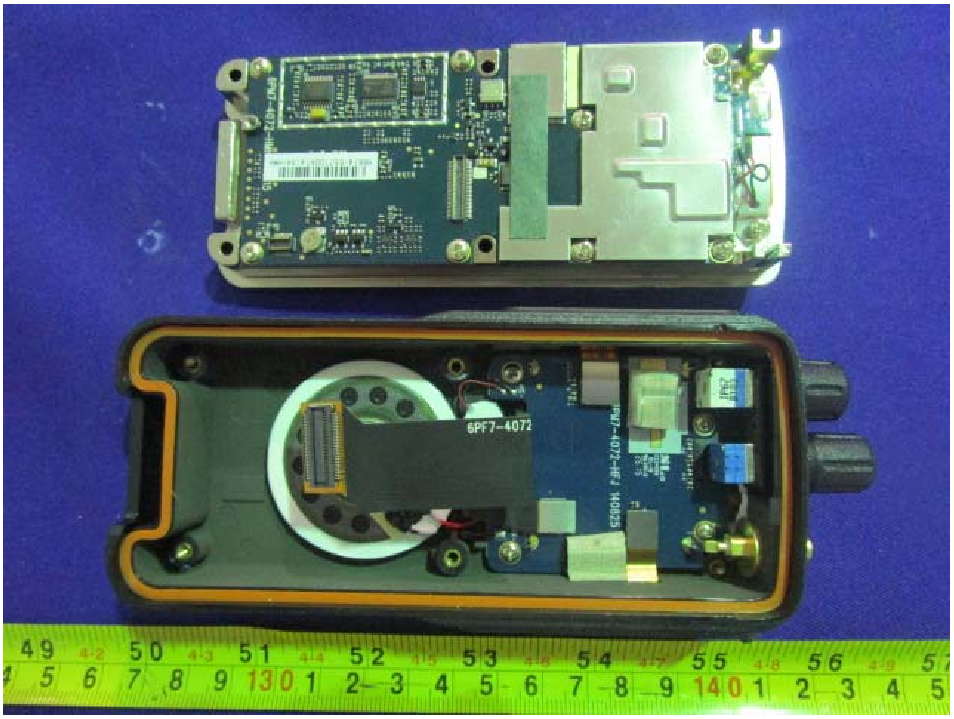
17.10 EUT – Antenna : 450-520MHz

17.11 EUT – Belt Clip

17.12 EUT – Remote Speaker Microphone, S/N:300-00389

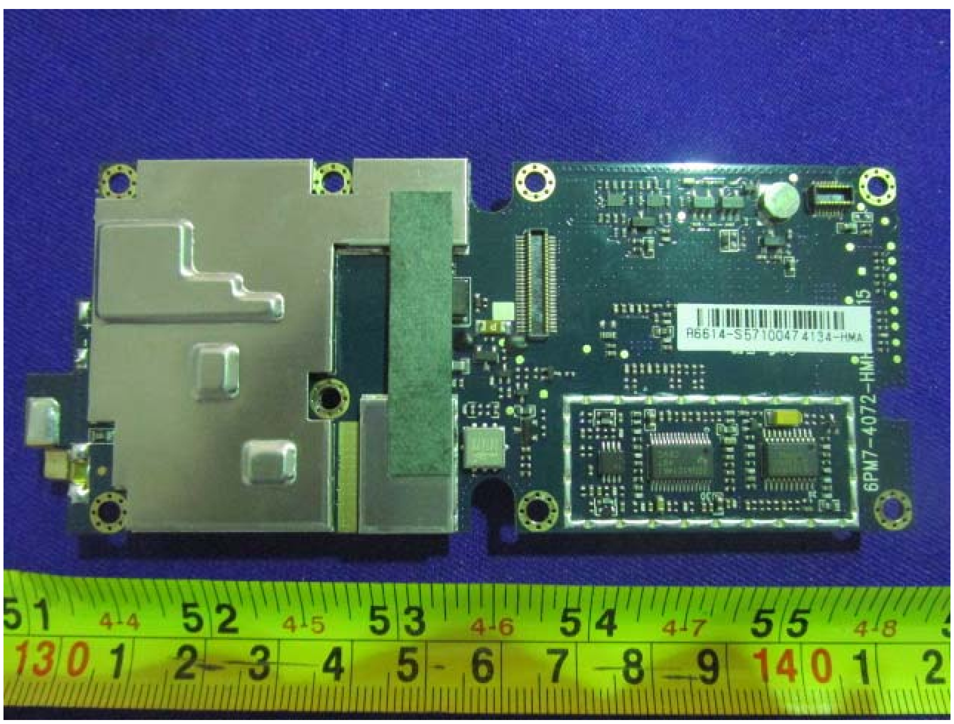
17.13 EUT –Headset, S/N: 300-00428

17.14 EUT –Uncover view

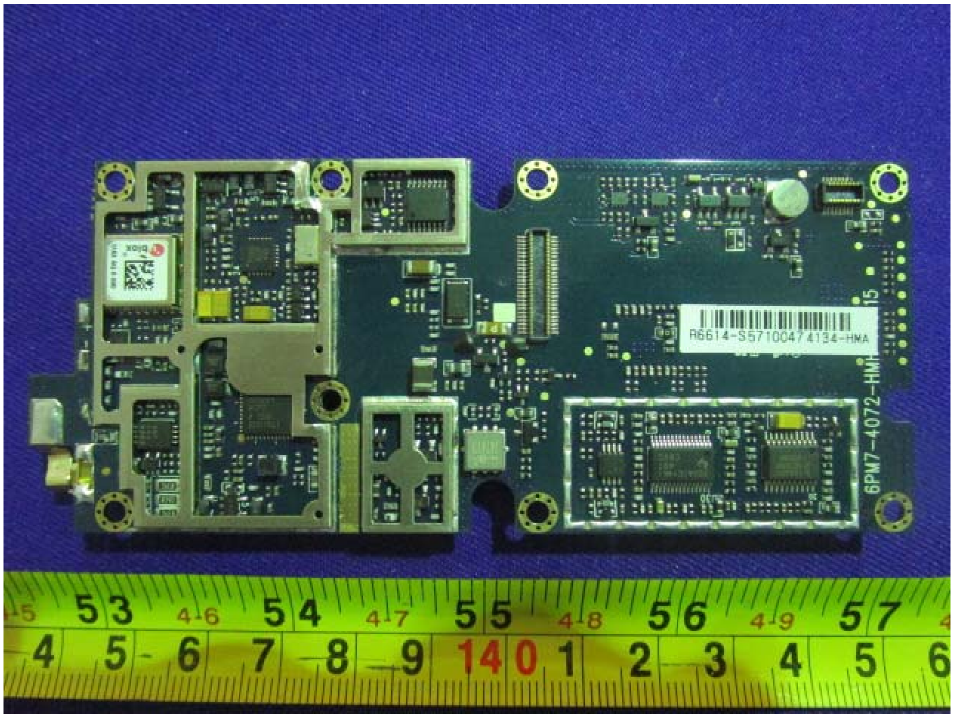


17.15 EUT –cover off view

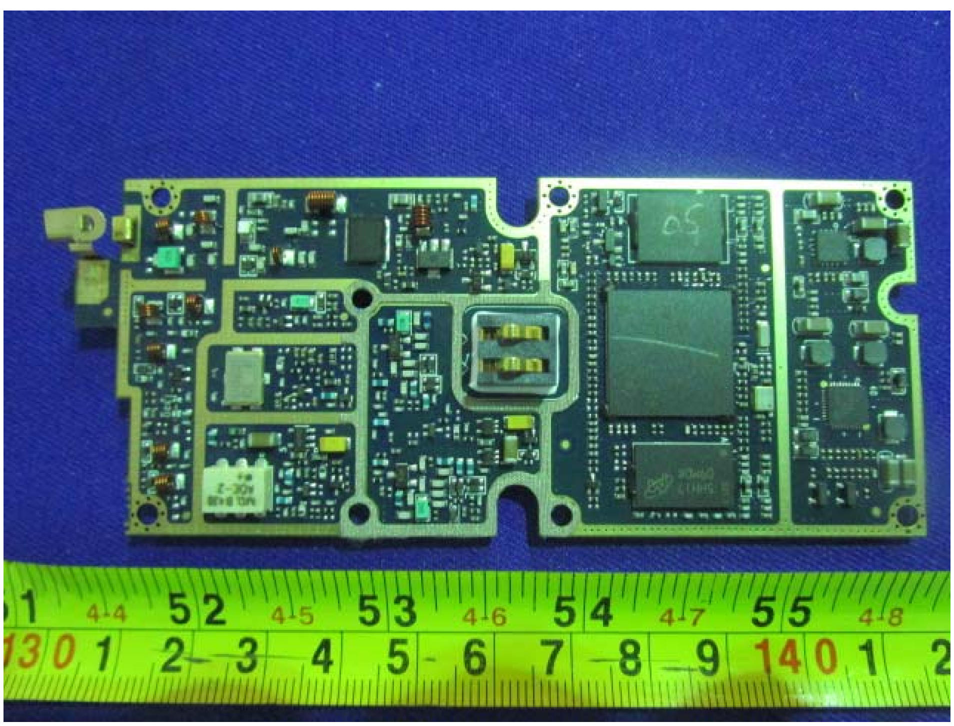
17.16 EUT –Main board top view



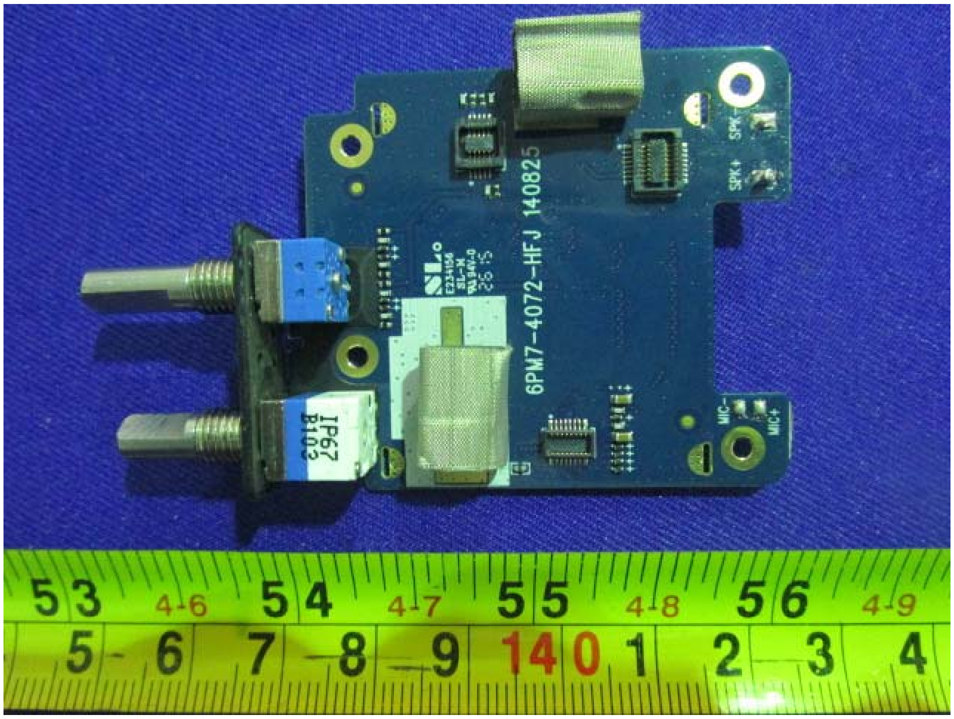
17.17 EUT –Main board top uncover view



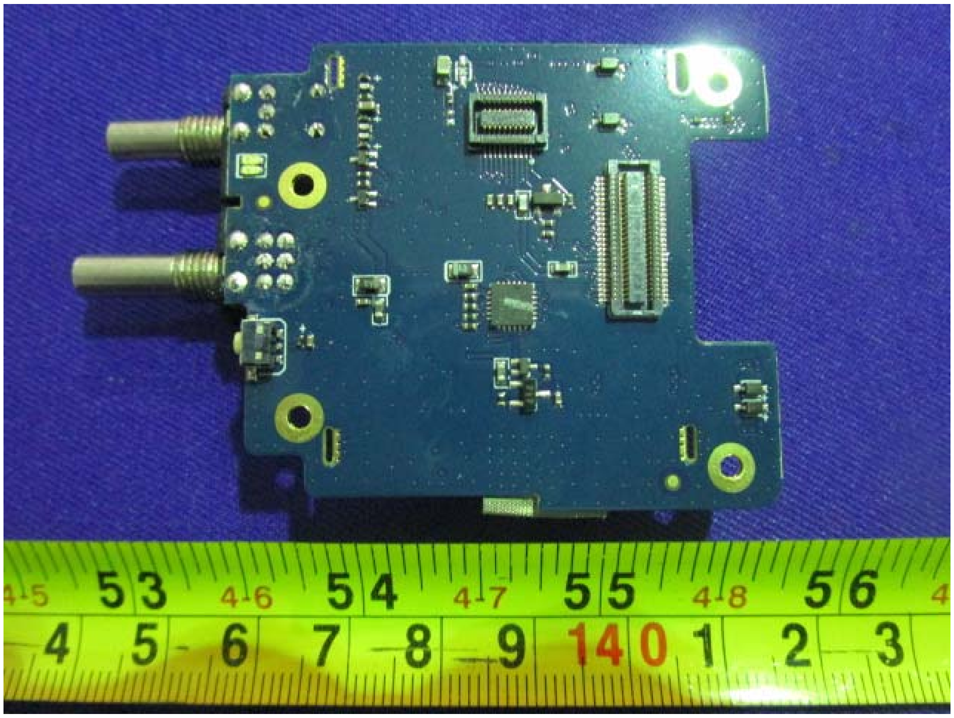
17.18 EUT –Main board Bottom view



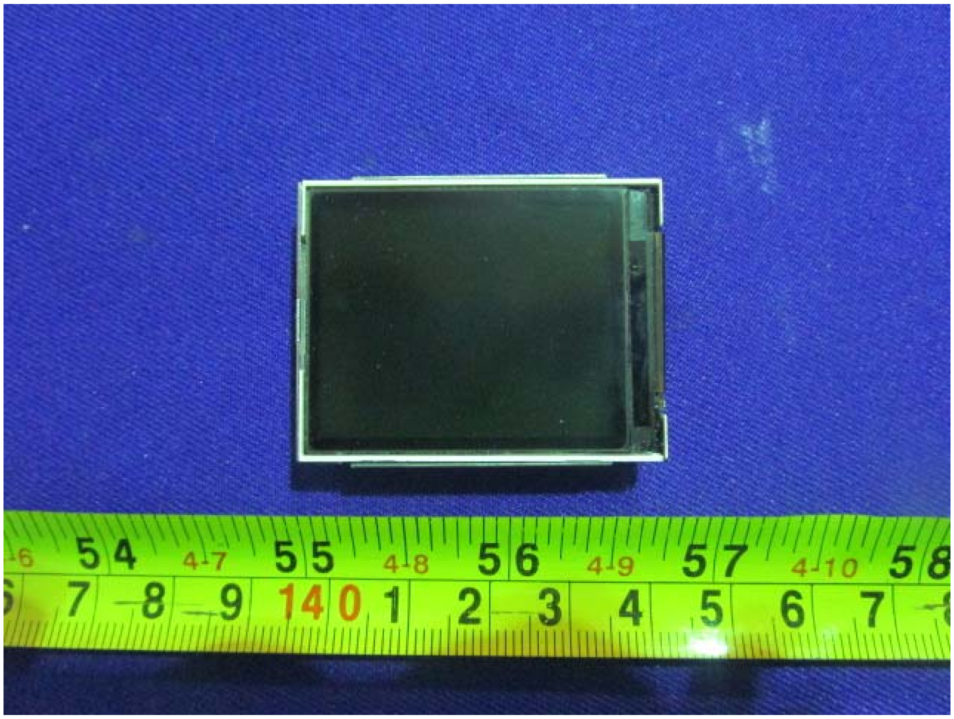
17.19 EUT –Sub board Top view



17.20 EUT –Sub board Bottom view



17.21 EUT –Screen view



18 Appendix I - Informative References

[1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.

[2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, O_ce of Engineering & Technology, Washington, DC, 1997.

[3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-_eld scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.

[4] Niels Kuster, Ralph K.astle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.

[5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.

[6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.

[7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM _ 97, Dubrovnik, October 15{17, 1997, pp. 120-24.

[8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172-175.

[9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The depen-dence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.

[10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.

[11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.

[12] W. H. Press, S. A. Teukolsky,W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.Dosimetric Evaluation of Sample device, month 1998 9

[13] NIS81 NAMAS, \The treatment of uncertainity in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.

[14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10.

--- END OF REPORT ---