MOTOROLA SOLUTIONS

ACCREDITED
TESTING CERT # 2518.01

DECLARATION OF COMPLIANCE SAR ASSESSMENT

Motorola Solutions Inc.
EME Test Laboratory
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Date of Report: 06/05/2014
Report Revision: A

Responsible Engineer:	Stephen C. Whalen (Principal Staff Engineer/Manager)
Report Author:	Stephen C. Whalen (Principal Staff Engineer/Manager)
Date/s Tested:	05/05/2014
Manufacturer/Location:	Motorola Solutions Inc., TEMCO , Japan
Sector/Group/Div.:	Radio Product & Accessories (RPA), Business Light
Date submitted for test:	02/12/2014
DUT Description:	Handheld Speaker Microphone – Frequency bands; Bluetooth 2.402-2.480GHz
Test TX mode(s):	CW
Max. Power output:	18dBm (63mW)
Nominal Power:	17dBm (50mW)
Tx Frequency Bands:	Bluetooth 2.402-2.480GHz
Signaling type:	FHSS (Bluetooth)
Model(s) Tested:	PMMN4097A
Model(s) Certified:	PMMN4097A
Serial Number(s):	ACS#1
Classification:	Occupational/Controlled
FCC ID:	AZ492FT6012; Rule Part 15 (2.402-2.480GHz)
IC:	109U-92FT6012

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of OET Bulletin 65. The 10 grams result is not applicable to FCC filing. The test results clearly demonstrate compliance with ICNIRP (1998) Guidelines for limiting exposure in time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 74, 494-522 RF Exposure limits of 10 W/kg averaged over 10grams of contiguous tissue.

Based on the information and the testing results provided herein, the undersigned certifies that when used as stated in the operating instructions supplied, said product complies with the national and international reference standards and guidelines listed in section 4.0 of this report. This report shall not be reproduced without written approval from an officially designated representative of the Motorola Solutions Inc EME Laboratory.
I attest to the accuracy of the data and assume full responsibility for the completeness of these measurements. This reporting format is consistent with the suggested guidelines of the TIA TSB-150 December 2004. The results and statements contained in this report pertain only to the device(s) evaluated.

edc015@motorolasolutions.com

Deanna Zakharia
EMS EME Lab Senior Resource Manager,
Laboratory Director
Approval Date: 6/05/2014

Certification Date: 6/05/2014

Certification No.: L1140605P

APPENDICES

APPENDICES (continued)

Report Revision History

Date	Revision	Comments
05/30/2014	O	Initial release
06/05/2014	A	Updated FCC ID and IC number

1.0 Introduction

This report details the utilization, test setup, test equipment, and test results of the Specific Absorption Rate (SAR) measurements performed at the Motorola Solutions Inc. EME Test Laboratory for handheld speaker microphone model number PMMN4097A. This device is classified as Occupational/Controlled.

2.0 FCC SAR Summary

Table 1

Equipment Class	Frequency band (GHz)	Max Calc at Body (W/kg)		Max Calc at Face (W/kg)	
		1g-SAR	10g-SAR	1g-SAR	10g-SAR
DSS	2.402-2.480	NA	NA	0.04	0.02

3.0 Abbreviations / Definitions

BT: Bluetooth
CNR: Calibration Not Required
DUT: Device Under Test
EME: Electromagnetic Energy
FHSS: Frequency Hopping Spread Spectrum
GFSK: Gaussian Frequency-Shift Keying
NA: Not Applicable
PTT: Push to Talk
SAR: Specific Absorption Rate

Maximum Power: Defined as the upper limit of the production line final test station.

4.0 Referenced Standards and Guidelines

This product is designed to comply with the following applicable national and international standards and guidelines.

- IEC62209-1 (2005) Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
- Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C.: 1997.
- IEEE 1528 (2003), Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronics Engineers (IEEE) C95.1-2005
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6 (2009), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2003)
- ANATEL, Brazil Regulatory Authority, Resolution No. 303 of July 2, 2002 "Regulation of the limitation of exposure to electrical, magnetic, and electromagnetic fields in the radio frequency range between 9 kHz and 300 GHz." and “Attachment to resolution # 303 from July 2, 2002”
- IEC62209-2 Edition 1.0 2010-03, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 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).
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r02 (12/05/2013)

  D02 RF Exposure Reporting v01r01 (05/28/2013)
- FCC KDB – 447498 D01 General RF Exposure Guidance v05r01 (05/28/2013)

5.0 SAR Limits

Table 2

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average - ANSI - (averaged over the whole body)	0.08	0.4
Spatial Peak - ANSI - (averaged over any 1-g of tissue)	1.6	8.0
Spatial Peak – ICNIRP/ANSI - (hands/wrists/feet/ankles averaged over 10-g)	4.0	20.0
Spatial Peak - ICNIRP - (Head and Trunk 10-g)	2.0	10.0

6.0 Description of Device Under Test (DUT)

This handheld speaker microphone incorporates a Class 1 Bluetooth device which is a Frequency Hopping Spread Spectrum (FHSS) technology. The Bluetooth radio modem is used as wireless link. The maximum actual transmission duty cycle is imposed by the Bluetooth standard. The maximum duty cycle for BT is 77% with a maximum output power of 18dBm (63mW).

The intended operating position is “at the face” with the DUT at least 2.5cm from the mouth.

7.0 Accessories and Test Criteria

The following sections identify the test criteria and details for accessory options.

7.1 Antenna

There is one antenna offered for this product. The table below lists its description.

Table 3

Antenna Models	Description	Selected for test	Tested
85009293001	2402-2480MHz, ¼ wave, 1.5dBi	Yes	Yes

7.2 Battery

This section is not applicable since this device connects to a vehicular mobile radio which provides power to the DUT.

7.3 Body worn Accessory

This section is not applicable since this device is mounted inside a vehicle and not worn on the user.

8.0 Description of Test System

8.1 Descriptions of Robotics/Probes/Readout Electronics

Table 4

Dosimetric System type	System version	DAE type	Probe Type
Schmid & Partner Engineering AG SPEAG DASY 5	52.8.2.969	DAE4	ES3DV3 (E-Field)

The DASY5™ system is operated per the instructions in the DASY5™ Users Manual. The complete manual is available directly from SPEAG™. All measurement equipment used to assess SAR compliance was calibrated according to ISO/IEC 17025 A2LA guidelines. Section 9.0 presents additional test equipment information. Appendices B and C present the applicable calibration certificates. The E-field probe first scans a coarse grid over a large area inside the phantom in order to locate the interpolated maximum SAR distribution. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The subsequent scan can directly use this position as reference for the cube evaluations.

8.2 Description of Phantom(s)

Table 5

Phantom Type	Phantom(s) Used	Material Parameters	Phantom Dimensions LxWxD (mm)	Material Thickness (mm)	Support Structure Material	Loss Tangent (wood)
Triple Flat	√	200MHz -6GHz; Er = 3-5, Loss Tangent = ≤0.05	280x175x175	2mm +/- 0.2mm	Wood	< 0.05
SAM	NA					
Oval Flat	NA					

8.3 Description of Simulated Tissue

The sugar based simulate tissue is produced by placing the correct measured amount of De-ionized water into a large container. Each of the dried ingredients are weighed and added to the water carefully to avoid clumping. If the solution has a high sugar concentration, the water is pre-heated to aid in dissolving the ingredients. For Diacetin and similar type simulates, sugar and HEC ingredients are not needed. The solution is mixed thoroughly, covered, and allowed to sit overnight prior to use.

The simulated tissue mixture was mixed based on the Simulated Tissue Composition indicated in Table 6. During the daily testing of this product, the applicable mixture was used to measure the Di-electric parameters at each of the tested frequencies to verify that the Di-electric parameters were within the tolerance of the tissue specifications.

Simulated Tissue Composition (percent by mass)
Table 6

Ingredients	2450MHz	
	Head	Body
Sugar	NA	NA
Diacetin	51.0	NA
De ionized – Water	48.75	NA
Salt	0.15	NA
HEC	NA	NA
Bact.	0.1	NA

9.0 Additional Test Equipment

The table below lists additional test equipment used during the SAR assessment.

Table 7

Equipment Type	Model Number	Serial Number	Calibration Date	Calibration Due Date
Speag Probe	ES3DV3	3291	6/20/2013	6/20/2014
Speag DAE	DAE4	850	7/17/2013	7/17/2014
Power Meter (Agilent)	E4419B	MY45103725	3/3/2014	3/3/2015
E-Series Avg. Power Sensor (Agilent)	E9301B	MY41495593	3/10/2014	3/10/2015
N-Series Avg. Power Sensor (Agilent)	E9301B	MY52080004	2/3/2014	2/3/2015
Bi-Directional Coupler (NARDA)	3022	77115	2/18/2014	2/18/2015
Signal Generator (Agilent)	E4438C	MY42082269	1/22/2014	1/22/2016
AMP (ComTech PST)	AR88258-10	N1R1A00-1015	CNR	CNR
Dickson Temperature Recorder	TM325	12121144	5/8/2013	5/8/2014
Omega Digital Thermometer with J Type TC Probe	HH200A	20857	10/23/2013	10/23/2014
Omega Digital Thermometer with J Type TC Probe	HH200A	48870	5/14/2013	5/14/2014
Omega Digital Thermometer with J Type TC Probe	HH202A	18800	3/3/2014	3/3/2015
Omega Digital Thermometer with J Type TC Probe	HH202A	18801	5/14/2013	5/14/2014
Omega Digital Thermometer with J Type TC Probe	HH202A	18812	6/10/2013	6/10/2014
Agilent PNA-L Network Analyzer	N5230C	MY49002155	8/1/2013	8/1/2014
Dielectric Assessment Kit (DAK)	DAK-3.5	1059	5/28/2013	5/28/2014
Dielectric Assessment Kit (DAK)	DAK-12	1013	5/28/2013	5/28/2014
Speag Dipole	D2450V2	703	4/16/2013	4/16/2015

10.0 SAR Measurement System Validation and Verification

DASY output files of the probe/dipole calibration certificates and system verification test results are included in appendices B, C & D respectively.

10.1 System Validation

The SAR measurement system was validated according to procedures in KDB 865664. The validation status summary table is below.

Table 8

Dates	Probe Calibration Point		Probe SN	Measured Tissue Parameters		Validation		
				σ	ϵ_r	Sensitivity	Linearity	Isotropy
CW								
07/24/2013	Head	2450	3291	1.89	37.5	Pass	Pass	Pass

10.2 System Verification

System verification checks were conducted each day during the SAR assessment. The results are normalized to 1W. Appendix D includes DASY plots for each day during the SAR assessment. The table below summarizes the daily system check results used for the SAR assessment.

Table 9

Probe Serial #	Tissue Type	Dipole Kit / Serial #	Ref SAR @ 1W (W/kg)	System Check Results Measured (W/kg)	System Check Test Results when normalized to 1W (W/kg)	Tested Date
3291	IEEE/IEC Head	SPEAG D2450V2 / 703	51.8 +/- 10%	5.3	53.0	05/05/2014

10.3 Equivalent Tissue Test Results

Simulated tissue prepared for SAR measurements is measured daily and within 24 hours prior to actual SAR testing to verify that the tissue is within +/- 5% of target parameters at the center of the transmit band. This measurement is done using the applicable equipment indicated in section 9.0. The table below summarizes the measured tissue parameters used for the SAR assessment.

Table 10

Frequency (MHz)	Tissue Type	Conductivity Target (S/m)	Dielectric Constant Target	Conductivity Meas. (S/m)	Dielectric Constant Meas.	Tested Date
2450	IEEE/ IEC Head	1.80 (1.71-1.89)	39.2 (35.3-43.1)	1.88	35.7	05/05/2014
2441	IEEE/ IEC Head	1.79 (1.70-1.88)	39.2 (35.3-43.1)	1.87	35.7	05/05/2014

11.0 Environmental Test Conditions

The EME Laboratory's ambient environment is well controlled resulting in very stable simulated tissue temperature and therefore stable dielectric properties. Simulated tissue temperature is measured prior to each scan to insure it is within +/ - 2^{o}C of the temperature at which the dielectric properties were determined. The liquid depth within the phantom used for measurements was at least 15cm. Additional precautions are routinely taken to ensure the stability of the simulated tissue such as covering the phantoms when scans are not actively in process in order to minimize evaporation. The lab environment is continuously monitored. The table below presents the range and average environmental conditions during the SAR tests reported herein:

Table 11

	Target	Measured
Ambient Temperature	18 – 25 ˚C	Range: 21.5 – 22.1˚C Avg. 21.8 ˚C
Relative Humidity	30 – 70 %	Range: 47.5 – 52.1 % Avg. 49.7 %
Tissue Temperature	NA	Range: 21.3-21.3˚C Avg. 21.3˚C

Relative humidity target range is a recommended target

The EME Lab RF environment uses a Spectrum Analyzer to monitor for extraneous large signal RF contaminants that could possibly affect the test results. If such unwanted signals are discovered, the SAR scans are repeated.

12.0 DUT Test Setup and Methodology

12.1 Measurements

SAR measurements were performed using the DASY system described in section 8.0 using zoom scans. Elliptical flat phantoms filled with applicable simulated tissue were used for body and face testing.

The table below includes the step sizes and resolution of area and zoom scans per KDB 865664 requirements.

Table 12

<table>
<tr><th colspan="2">Description</th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="2">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="2">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="2" rowspan="2">Maximum area scan spatial resolution: ΔxArea, ΔyArea</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="2">Maximum zoom scan spatial resolution: ΔxZoom, ΔyZoom</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td>Maximum zoom scan spatial resolution, normal to phantom surface</td><td>uniform grid: ΔzZoom(n)</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td colspan="4">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

12.2 DUT Configuration(s)

The DUT is a handheld speaker microphone device that is operational at the face as described in section 6.0.

12.3 DUT Positioning Procedures

The positioning of the device for each body location is described below and illustrated in Appendix F.

12.3.1 Body

Not applicable.

12.3.2 Head

Not applicable.

12.3.3 Face

The DUT was positioned with its’ front side separated 2.5cm from the phantom.

12.4 DUT Test Channels

The number of test channels was determined by using the following IEEE 1528 equation. The use of this equation produces the same or more test channels compared to the FCC KDB 447498 number of test channels formula.

$$N_c = 2 * roundup[10 * (f_{high} - f_{low}) / f_c] + 1$$

Where
N_c = Number of channels
F_{high} = Upper channel
F_{low} = Lower channel
F_c = Center channel

12.5 SAR Result Scaling Methodology

The calculated 1-gram and 10-gram averaged SAR results indicated as “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” in the data tables is determined by scaling the measured SAR to account for power leveling variations and drift. For this device the “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” are scaled using the following formula:

$$Max\_Calc = SAR\_meas \cdot 10^{\frac{-Drift}{10}} \cdot \frac{P\_\max}{P\_\text{int}} \cdot DC$$

P_max = Maximum Power (W)
P_int = Initial Power (W)
Drift = DASY drift results (dB)
SAR_meas = Measured 1-g or 10-g Avg. SAR (W/kg)
DC = Transmission mode duty cycle in % where applicable

Note: for conservative results, the following are applied:
If P_int > P_max, then P_max/P_int = 1.
Drift = 1 for positive drift

Additional SAR scaling was applied using the methodologies outlined in FCC KDB 865664 using tissue sensitivity values. SAR was scaled for conditions where the tissue permittivity was measured above the nominal target and for tissue conductivity that was measured below the nominal target. Negative or reduced SAR scaling is not permitted.

12.6 DUT Test Plan

The guidelines and requirements outlined in section 4.0 were used to assess compliance of this device. All modes of operation identified in section 6.0 were considered during the development of the test plan. All tests were performed in CW and 77% duty cycle was applied to the final results.

13.0 DUT Test Data

13.1 Assessment at the Face for 2.402-2.480GHz band

The center channel was tested which is also the highest powered channel. SAR plot of the result is presented in Appendix E.

Table 13

Test Freq (GHz)	Power (mW)
2.402	59.6
2.441	61.9
2.480	53.5

Table 14

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (GHz)	Init Pwr (mW)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
Internal 85009293001	NA	DUT front @ 2.5cm	PMMN4097	2.402							
				2.441	61.9	-0.06	0.05	0.03	0.04	0.02	HvH-Face-140505-02
				2.480							

14.0 Results Summary

Based on the test guidelines from section 4.0 and satisfying frequencies within FCC bands and Industry Canada Frequency bands, the highest Operational Maximum Calculated 1-gram and 10-gram average SAR values found for this filing:

Table 15

Designator	Frequency band (GHz)	Max Calc at Body (W/kg)		Max Calc at Face (W/kg)	
		1g-SAR	10g-SAR	1g-SAR	10g-SAR
BT	2.402-2.480	NA	NA	0.04	0.02

All results are scaled to the maximum output power.

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of OET Bulletin 65. The 10 grams result is not applicable to FCC filing.

15.0 Variability Assessment

Per the guidelines in KDB 865664 SAR variability assessment is not required because SAR result is below 4.0W/kg (Occupational).

16.0 System Uncertainty

A system uncertainty analysis is not required for this report per KDB 865664 because the highest report SAR value for Occupational exposure is less than 7.5W/kg.

Per the guidelines of ISO 17025 a reported system uncertainty is required and therefore measurement uncertainty budget is included in Appendix A.

Appendix A
Measurement Uncertainty Budget

Uncertainty Budget for Device Under Test, for 750 MHz to 2.6 GHz

a	*b*	*c*	*d*	*e = f(d,k)*	*f*	*g*	*h = c x f / e*	*i = c x g / e*	*k*
Uncertainty Component	**IEEE 1528 section**	**Tol. (± %)**	**Prob Dist**	**Div.**	c_i **(1 g)**	c_i **(10 g)**	**1 g** u_i **(±%)**	**10 g** u_i **(±%)**	v_i
Measurement System									
Probe Calibration	E.2.1	6.0	N	1.00	1	1	6.0	6.0	∞
Axial Isotropy	E.2.2	4.7	R	1.73	0.707	0.707	1.9	1.9	∞
Hemispherical Isotropy	E.2.2	9.6	R	1.73	0.707	0.707	3.9	3.9	∞
Boundary Effect	E.2.3	1.0	R	1.73	1	1	0.6	0.6	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	0.3	N	1.00	1	1	0.3	0.3	∞
Response Time	E.2.7	1.1	R	1.73	1	1	0.6	0.6	∞
Integration Time	E.2.8	1.1	R	1.73	1	1	0.6	0.6	∞
RF Ambient Conditions - Noise	E.6.1	3.0	R	1.73	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	0.0	R	1.73	1	1	0.0	0.0	∞
Probe Positioner Mech. Tolerance	E.6.2	0.4	R	1.73	1	1	0.2	0.2	∞
Probe Positioning w.r.t Phantom	E.6.3	1.4	R	1.73	1	1	0.8	0.8	∞
Max. SAR Evaluation (ext., int., avg.)	E.5	3.4	R	1.73	1	1	2.0	2.0	∞
Test sample Related									
Test Sample Positioning	E.4.2	3.2	N	1.00	1	1	3.2	3.2	29
Device Holder Uncertainty	E.4.1	4.0	N	1.00	1	1	4.0	4.0	8
SAR drift	6.6.2	5.0	R	1.73	1	1	2.9	2.9	∞
Phantom and Tissue Parameters									
Phantom Uncertainty	E.3.1	4.0	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity (target)	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (measurement)	E.3.3	3.3	N	1.00	0.64	0.43	2.1	1.4	∞
Liquid Permittivity (target)	E.3.2	5.0	R	1.73	0.6	0.49	1.7	1.4	∞
Liquid Permittivity (measurement)	E.3.3	1.9	N	1.00	0.6	0.49	1.1	0.9	∞
Combined Standard Uncertainty			RSS				11	11	419
Expanded Uncertainty (95% CONFIDENCE LEVEL)			*k*=2				22	22	

Notes for uncertainty budget Tables:
a) Column headings *a*-*k* are given for reference.
b) Tol. - tolerance in influence quantity.
c) Prob. Dist. – Probability distribution
d) N, R - normal, rectangular probability distributions
e) Div. - divisor used to translate tolerance into normally distributed standard uncertainty
f) *ci* - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.
g) *ui* – SAR uncertainty
h) *vi* - degrees of freedom for standard uncertainty and effective degrees of freedom for the expanded uncertainty

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 108**

Client **Motorola EME**

Certificate No: **ES3-3291_Jun13/2**

CALIBRATION CERTIFICATE (Replacement of No: ES3-3291_Jun13)

Object: ES3DV3 - SN:3291

Calibration procedure(s): QA CAL-01.v8, QA CAL-12.v7, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes

Calibration date: June 20, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: July 11, 2013

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

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

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3291

Manufactured: July 6, 2010
Calibrated: June 20, 2013

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3291

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)²)^A	0.86	1.38	0.83	± 10.1 %
DCP (mV)^B	102.4	102.0	103.3	

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	132.6	±3.5 %
		Y	0.0	0.0	1.0		166.5	
		Z	0.0	0.0	1.0		163.7	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	5.91	65.7	18.6	5.80	111.7	±1.4 %
		Y	6.42	67.5	19.7		148.8	
		Z	6.36	67.4	19.6		143.7	
10109-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	6.94	66.6	19.4	6.43	118.1	±1.2 %
		Y	6.81	66.0	19.1		110.1	
		Z	6.74	66.0	19.1		106.3	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.59	65.2	18.4	5.75	108.6	±1.4 %
		Y	6.07	66.9	19.4		145.0	
		Z	6.04	67.0	19.5		140.9	
10111-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	6.66	66.4	19.3	6.44	114.1	±1.4 %
		Y	6.54	65.6	18.9		107.8	
		Z	7.08	68.0	20.3		148.2	
10112-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	X	7.18	66.9	19.6	6.59	118.7	±1.4 %
		Y	7.11	66.4	19.4		112.5	
		Z	7.01	66.4	19.4		107.7	
10113-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	X	6.83	66.4	19.3	6.62	114.4	±1.4 %
		Y	6.83	66.0	19.3		109.9	
		Z	7.31	68.2	20.5		149.8	
10142-CAB	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	X	5.42	65.0	18.3	5.73	106.4	±1.2 %
		Y	5.92	66.8	19.5		143.8	
		Z	5.85	66.9	19.5		136.4	
10143-CAB	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	6.31	66.0	19.0	6.35	109.6	±1.2 %
		Y	6.37	65.8	19.0		106.3	
		Z	6.80	67.9	20.3		142.0	
10145-CAB	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	X	5.63	66.9	19.4	5.76	143.9	±1.2 %
		Y	5.62	66.4	19.3		138.5	
		Z	5.50	66.5	19.3		130.9	
10146-CAB	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	6.49	67.9	20.1	6.41	141.9	±1.4 %
		Y	6.59	67.7	20.2		144.4	
		Z	6.41	67.8	20.2		134.0	

10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.07	67.0	19.4	5.75	146.2	±1.4 %
		Y	6.16	67.2	19.7		147.2	
		Z	6.04	67.0	19.6		138.4	
10155-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	6.55	66.0	19.0	6.43	108.1	±1.4 %
		Y	6.67	66.1	19.3		110.0	
		Z	7.05	67.9	20.3		145.7	
10156-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	X	5.82	66.8	19.4	5.79	143.0	±1.4 %
		Y	5.91	66.8	19.6		144.4	
		Z	5.77	66.7	19.5		134.1	
10157-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	6.85	68.0	20.3	6.49	148.2	±1.4 %
		Y	6.93	67.8	20.4		149.5	
		Z	6.77	67.9	20.3		139.8	
10158-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	X	6.77	66.2	19.3	6.62	109.0	±1.4 %
		Y	6.87	66.1	19.4		109.5	
		Z	7.32	68.2	20.5		146.9	
10159-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	X	6.37	66.0	19.2	6.56	105.3	±1.7 %
		Y	7.03	67.9	20.4		149.9	
		Z	6.86	67.9	20.4		139.9	
10166-CAB	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	X	4.95	66.2	19.0	5.46	132.2	±1.2 %
		Y	4.97	65.8	18.9		131.6	
		Z	4.98	66.5	19.3		125.1	
10167-CAB	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	5.82	67.6	20.0	6.21	132.9	±1.2 %
		Y	5.89	67.1	19.8		133.3	
		Z	5.75	67.4	20.1		125.4	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	4.67	66.0	19.1	5.72	125.6	±0.9 %
		Y	4.79	66.0	19.2		125.0	
		Z	4.65	65.9	19.3		118.8	
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	5.27	66.8	19.9	6.52	122.4	±1.2 %
		Y	5.53	67.1	20.1		123.0	
		Z	5.27	66.8	20.1		116.7	
10177-CAC	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	4.71	66.2	19.2	5.73	125.2	±0.9 %
		Y	4.78	65.9	19.2		124.6	
		Z	4.70	66.2	19.4		118.9	
10178-CAB	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	5.30	66.9	20.0	6.52	122.5	±1.2 %
		Y	5.52	67.0	20.1		123.0	
		Z	5.26	66.7	20.1		116.6	
10179-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	X	5.26	66.8	19.9	6.50	121.9	±1.2 %
		Y	5.50	67.1	20.2		122.6	
		Z	5.21	66.6	20.0		115.8	
10180-CAB	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	X	5.27	66.9	19.9	6.50	122.0	±1.2 %
		Y	5.47	66.9	20.0		122.3	
		Z	5.21	66.6	20.0		115.4	

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10184-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	X	4.68	66.1	19.1	5.73	125.6	±0.9 %
		Y	4.83	66.1	19.3		124.3	
		Z	4.69	66.0	19.4		118.4	
10185-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	X	5.27	66.8	19.9	6.51	123.4	±1.2 %
		Y	5.52	67.1	20.2		122.5	
		Z	5.22	66.5	19.9		116.0	
10187-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	X	4.70	66.1	19.2	5.73	125.8	±0.9 %
		Y	4.81	66.0	19.2		124.6	
		Z	4.73	66.3	19.6		118.5	
10188-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	X	5.34	67.1	20.1	6.52	123.7	±1.2 %
		Y	5.50	66.9	20.0		122.9	
		Z	5.29	66.9	20.2		116.1	
10298-AAA	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	X	5.67	66.8	19.4	5.72	140.1	±1.4 %
		Y	5.72	66.6	19.4		138.7	
		Z	5.64	66.8	19.6		131.5	
10299-AAA	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	X	6.65	68.1	20.3	6.39	144.5	±1.4 %
		Y	6.74	67.9	20.3		145.0	
		Z	6.62	68.2	20.5		136.3	

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

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 7 and 8).
[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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3291

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	45.3	0.87	7.38	7.38	7.38	0.23	1.10	± 13.4 %
450	43.5	0.87	7.12	7.12	7.12	0.18	2.04	± 13.4 %
750	41.9	0.89	6.69	6.69	6.69	0.24	2.30	± 12.0 %
900	41.5	0.97	6.32	6.32	6.32	0.70	1.22	± 12.0 %
1810	40.0	1.40	5.25	5.25	5.25	0.40	1.71	± 12.0 %
1950	40.0	1.40	5.04	5.04	5.04	0.48	1.55	± 12.0 %
2300	39.5	1.67	4.84	4.84	4.84	0.73	1.28	± 12.0 %
2450	39.2	1.80	4.54	4.54	4.54	0.80	1.23	± 12.0 %
2600	39.0	1.96	4.46	4.46	4.46	0.80	1.30	± 12.0 %
3500	37.9	2.91	4.37	4.37	4.37	1.00	1.00	± 13.1 %
3700	37.7	3.12	3.99	3.99	3.99	1.00	0.93	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3291

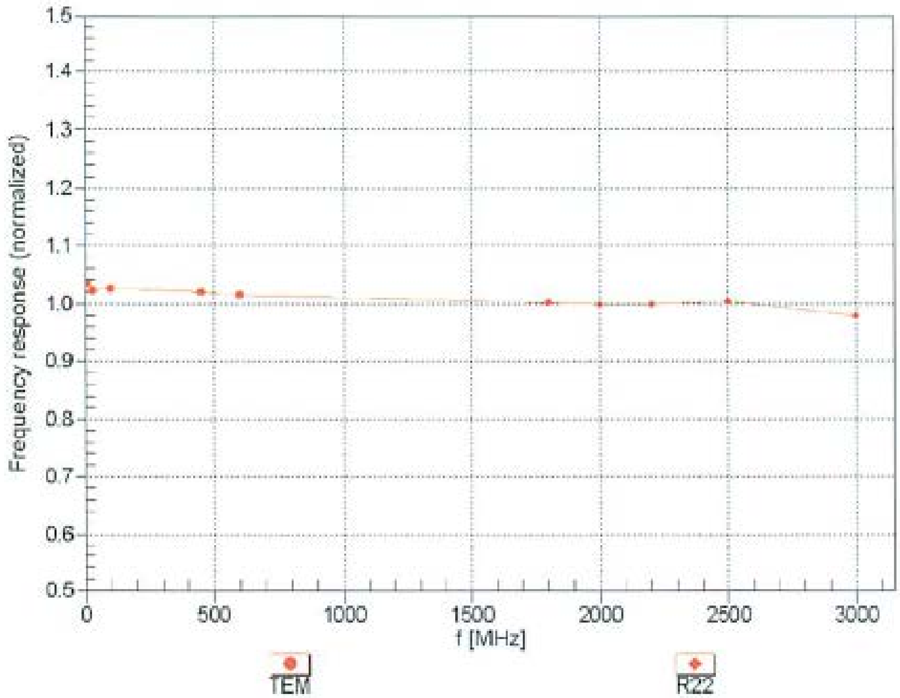
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	58.2	0.92	7.42	7.42	7.42	0.22	1.52	± 13.4 %
450	56.7	0.94	7.35	7.35	7.35	0.11	1.00	± 13.4 %
750	55.5	0.96	6.47	6.47	6.47	0.80	1.16	± 12.0 %
900	55.0	1.05	6.34	6.34	6.34	0.80	1.19	± 12.0 %
1810	53.3	1.52	4.98	4.98	4.98	0.60	1.39	± 12.0 %
1950	53.3	1.52	4.93	4.93	4.93	0.72	1.28	± 12.0 %
2300	52.9	1.81	4.58	4.58	4.58	0.67	1.18	± 12.0 %
2450	52.7	1.95	4.36	4.36	4.36	0.66	0.99	± 12.0 %
2600	52.5	2.16	4.17	4.17	4.17	0.60	0.84	± 12.0 %
3500	51.3	3.31	3.65	3.65	3.65	1.00	1.20	± 13.1 %
3700	51.0	3.55	3.54	3.54	3.54	1.00	1.25	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

Frequency Response of E-Field

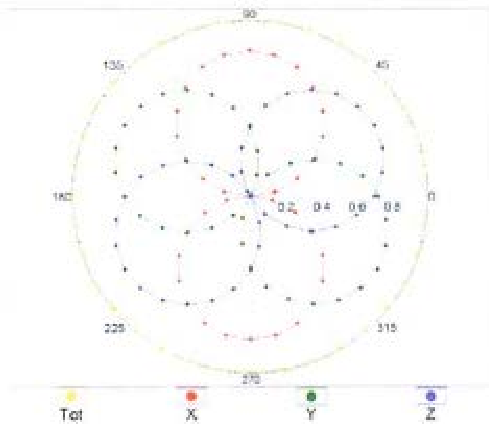
(TEM-Cell:ifi110 EXX, Waveguide: R22)



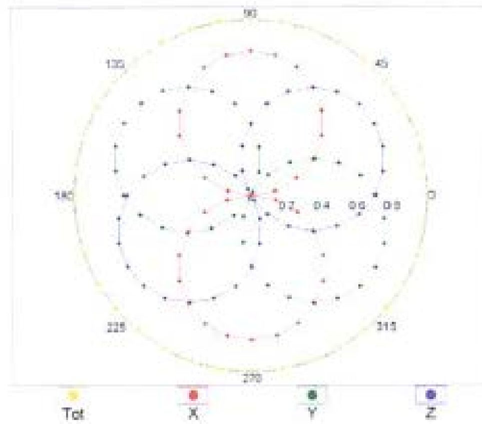
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

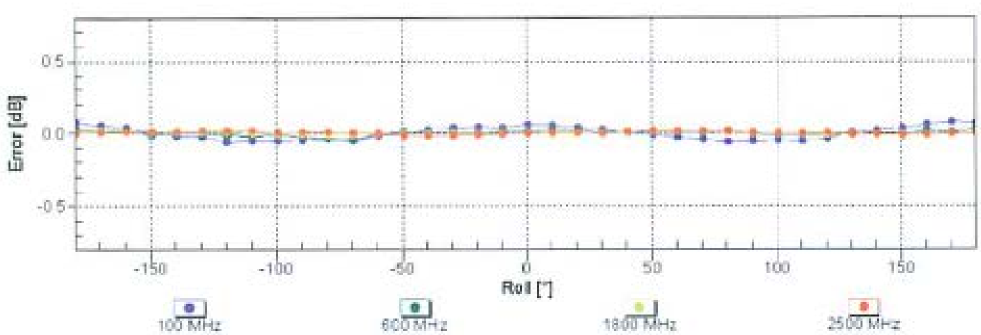
Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



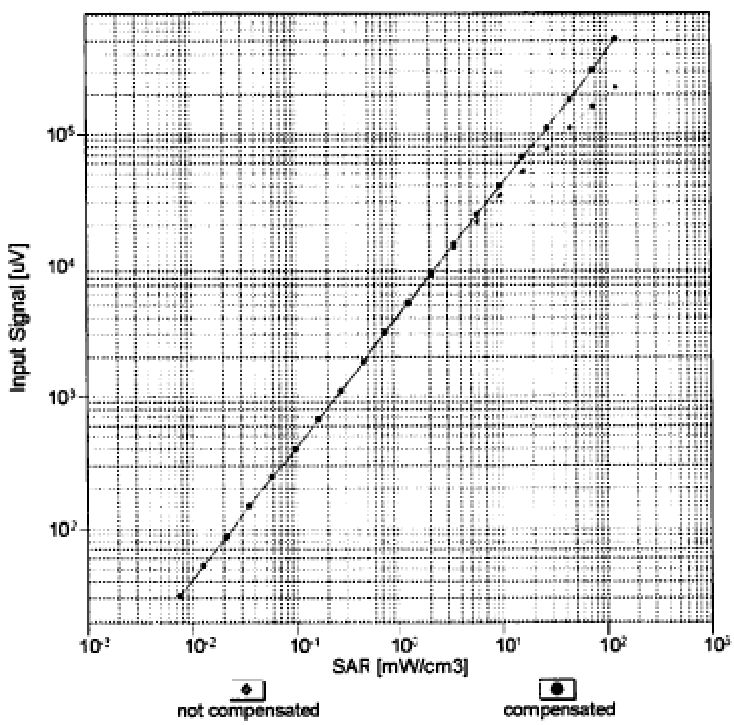
f=1800 MHz,R22

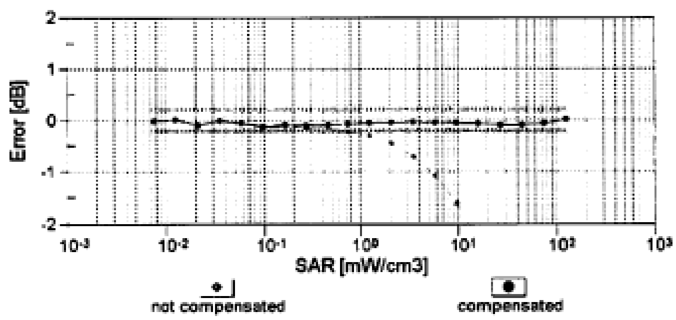




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

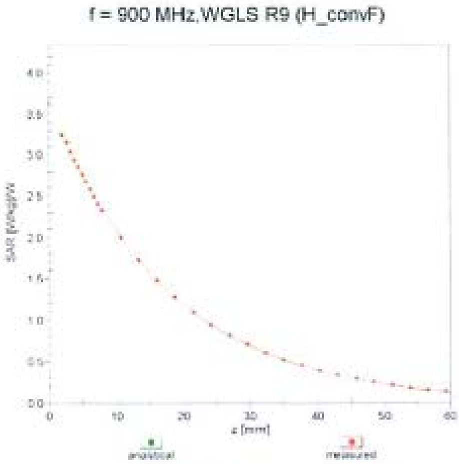


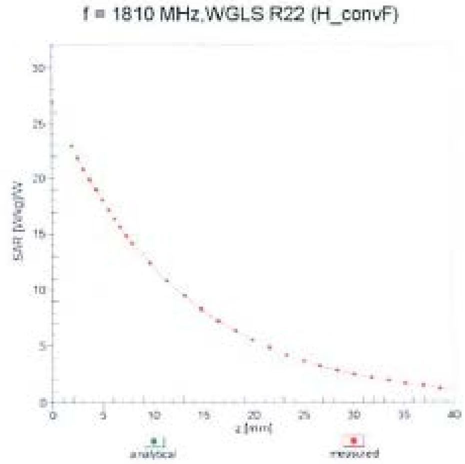


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

ES3DV3– SN:3291 June 20, 2013

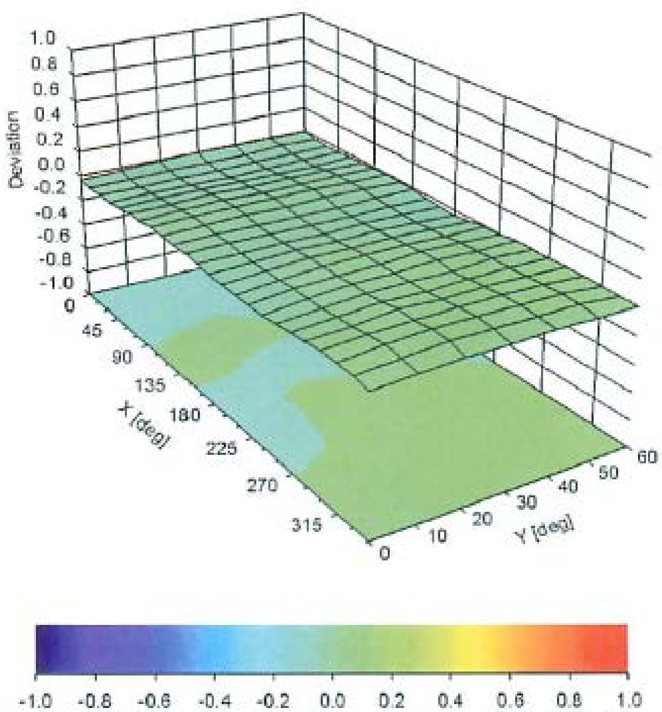
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: ES3-3291_Jun13/2 Page 12 of 13

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3291

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-59.4
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

Schmid & Partner Engineering AG

s p e a g

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info@speag.com, http://www.speag.com

Additional Conversion Factors

for Dosimetric E-Field Probe

Type:	**ES3DV3**
Serial Number:	**3291**
Place of Assessment:	**Zurich**
Date of Assessment:	**June 22, 2013**
Probe Calibration Date:	**June 20, 2013**

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 450, 900 or at 1810 MHz.

Assessed by:

Schmid & Partner Engineering AG

s p e a g

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Dosimetric E-Field Probe ES3DV3 SN:3291

Conversion factor (± standard deviation)

150 ± 50 MHz	*ConvF*	**8.59 ± 10%**	ε_r = 52.3 ± 5% σ = 0.76 ± 5% mho/m (head tissue)
250 ± 50 MHz	*ConvF*	**8.00 ± 10%**	ε_r = 47.6 ± 5% σ = 0.83 ± 5% mho/m (head tissue)
150 ± 50 MHz	*ConvF*	**8.18 ± 10%**	ε_r = 61.9 ± 5% σ = 0.80 ± 5% mho/m (body tissue)
250 ± 50 MHz	*ConvF*	**7.86 ± 10%**	ε_r = 59.4 ± 5% σ = 0.88 ± 5% mho/m (body tissue)

Important Note:

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also DASY Manual.

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
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 **Motorola EME**

Certificate No: **D2450V2-703_May13**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 703
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	May 16, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

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

Issued: May 16, 2013

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

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

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

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.6 ± 6 %	1.81 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**51.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.2 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	1.99 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	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**51.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.9 W/kg ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.0 Ω + 2.9 jΩ
Return Loss	- 25.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 5.4 jΩ
Return Loss	- 25.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.125 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	March 22, 2001

DASY5 Validation Report for Head TSL

Date: 15.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

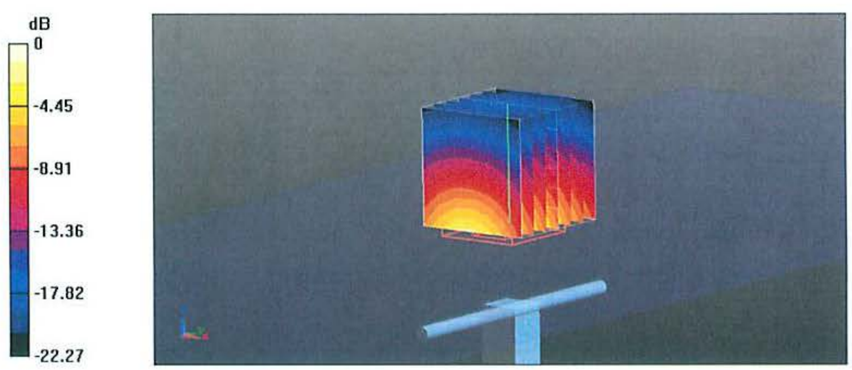
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 703

Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.81 S/m; ε_r = 37.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

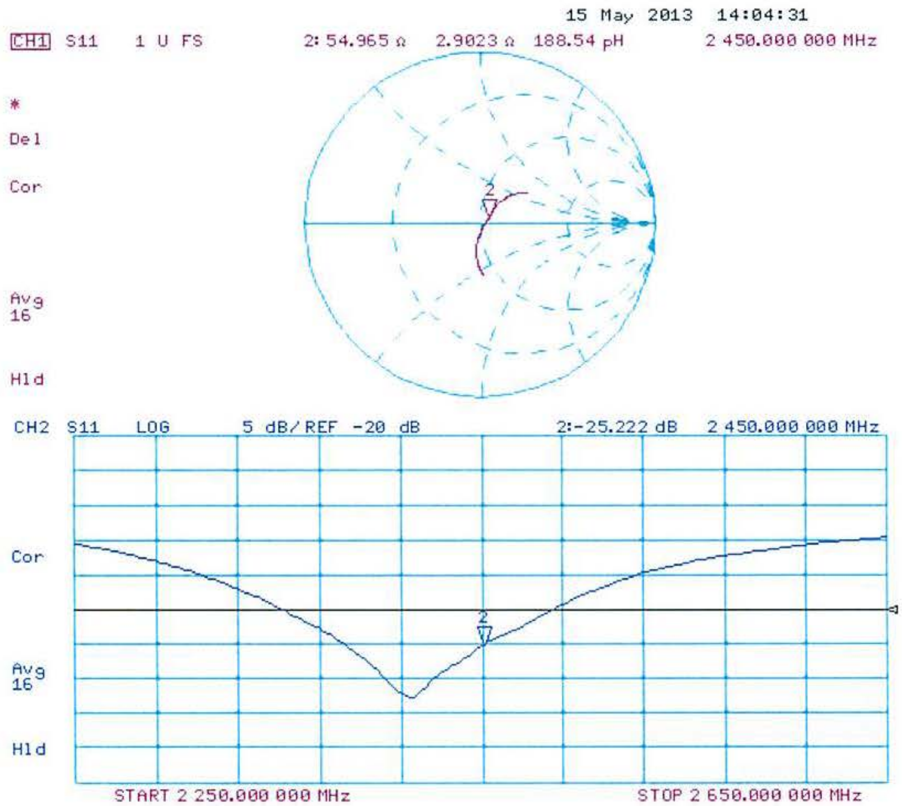
- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.6 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.11 W/kg
Maximum value of SAR (measured) = 17.2 W/kg



0 dB = 17.2 W/kg = 12.36 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.05.2013

Test Laboratory: SPEAG, Zurich, Switzerland

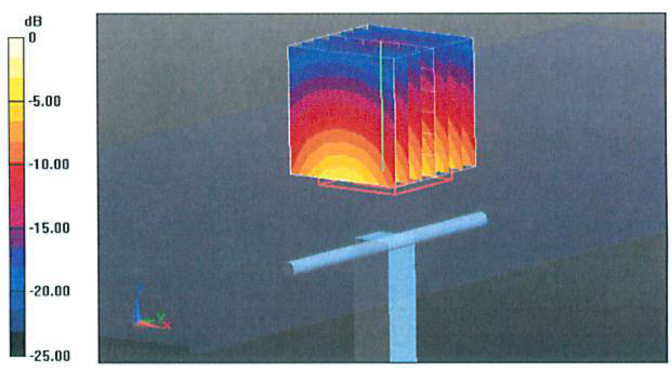
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 703

Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.99 S/m; ε_r = 51; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

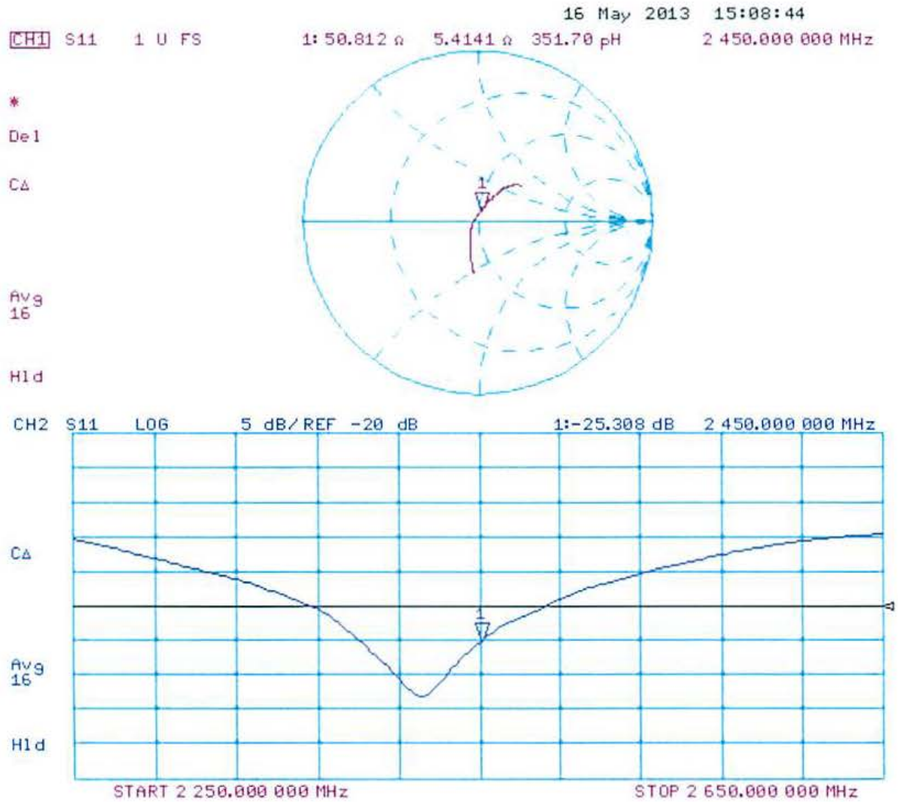
- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.620 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg
Maximum value of SAR (measured) = 17.2 W/kg



0 dB = 17.2 W/kg = 12.36 dBW/kg

Impedance Measurement Plot for Body TSL



Appendix D
System Verification Check Scans

Motorola Solutions, Inc. EME Laboratory
Date/Time: 5/5/2014 9:40:56 AM

Robot#: DASY5-FL-2 | Run#: AvG-SYSP-2450H-140505-01
Dipole Model# D2450V2
Phantom#: Triple 1117-1
Tissue Temp: 21.3 (C)
Serial#: 703
Test Freq: 2450 (MHz)
Start Power: 100 (mW)
Rotation (1D): 0.036 dB
Adjusted SAR (1W): 53.00 mW/g (1g)

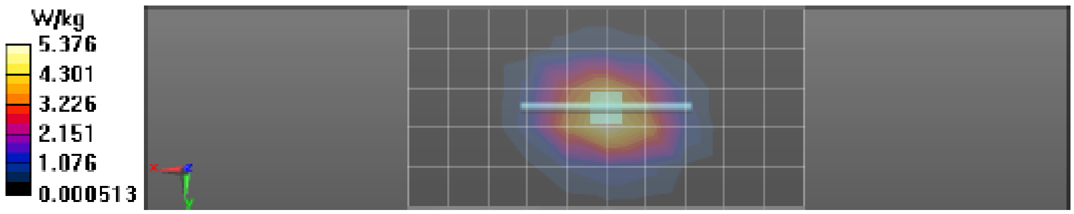
Comments:

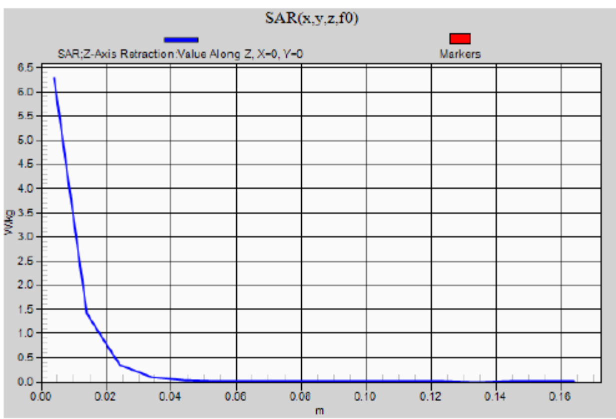
Duty Cycle: 1:1, Medium parameters used: f = 2450 MHz; σ = 1.88 S/m; ϵ_r = 35.7; ρ = 1000 kg/m^3
Probe: ES3DV3 - SN3291, , Frequency: 2450 MHz, ConvF(4.54, 4.54, 4.54); Calibrated: 6/20/2013
Electronics: DAE4 Sn850, Calibrated: 7/17/2013

2-3 GHz-Rev.1/System Performance Check/Dipole Area Scan 2 (51x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 58.597 V/m; Power Drift = 0.02 dB
Fast SAR: SAR(1 g) = **5.29** W/kg; SAR(10 g) = **2.55** W/kg (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 6.52 W/kg

2-3 GHz-Rev.1/System Performance Check/0-Degree Cube (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 58.597 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 12.2 W/kg
SAR(1 g) = **5.3** W/kg; SAR(10 g) = **2.44** W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 6.22 W/kg

2-3 GHz-Rev.1/System Performance Check/Z-Axis Retraction (1x1x17): Measurement grid: dx=20mm, dy=20mm, dz=10mm
Maximum value of SAR (measured) = 6.28 W/kg





Appendix E
DUT Scans

Motorola Solutions, Inc. EME Laboratory
Date/Time: 5/5/2014 1:33:01 PM

Robot#: DASY5-FL-2 | Run#: HvH-Face-140505-02
Model#: PMMN4097A
Phantom#: TRIPLE1117-1
Tissue Temp: 21.3 (C)
Serial#: ACS#1
Antenna: Internal 85009293001
Test Freq: 2441 (MHz)
Battery: N/A
Carry Acc: DUT front @ 2.5cm
Audio Acc: PMMN4097A
Start Power: 0.0619 (W)

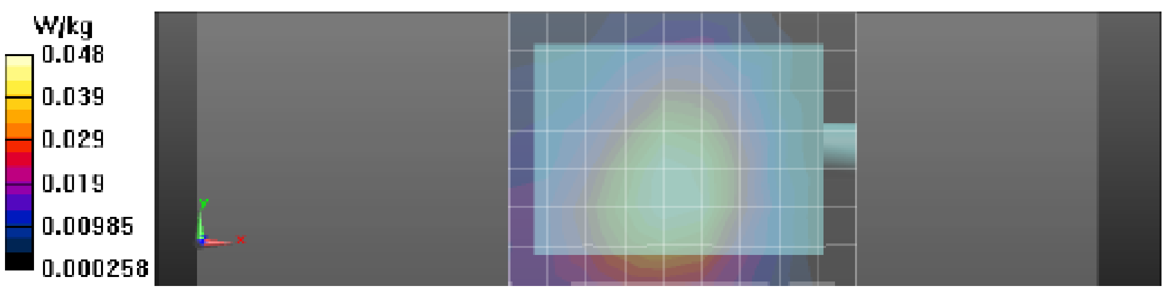
Comments:

Duty Cycle: 1:1, Medium parameters used: f = 2441 MHz; σ = 1.87 S/m; ε_r = 35.7; ρ = 1000 kg/m^3
Probe: ES3DV3 - SN3291, , Frequency: 2441 MHz, ConvF(4.54, 4.54, 4.54); Calibrated: 6/20/2013
Electronics: DAE4 Sn850, Calibrated: 7/17/2013

2-3 GHz-Rev.1/Ab Scan/1-Area Scan (91x71x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Reference Value = 4.387 V/m; Power Drift = 0.03 dB
Fast SAR: **SAR(1 g) = 0.047 W/kg; SAR(10 g) = 0.027 W/kg** (SAR corrected for target medium)
Maximum value of SAR (interpolated) = 0.0507 W/kg

2-3 GHz-Rev.1/Ab Scan/3-Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.387 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.0840 W/kg
SAR(1 g) = 0.045 W/kg; SAR(10 g) = 0.025 W/kg (SAR corrected for target medium)
Maximum value of SAR (measured) = 0.0484 W/kg

2-3 GHz-Rev.1/Ab Scan/4-Z-Axis Scan (1x1x17): Measurement grid: dx=20mm, dy=20mm, dz=10mm
Maximum value of SAR (measured) = 0.0467 W/kg



APPENDIX F
DUT and Test Position Photos

DUT

Test Position - Speaker Microphone 2.5cm from phantom