


**MOTOROLA SOLUTIONS**

**CERTIFICATE 2518.01**
**DECLARATION OF COMPLIANCE SAR ASSESSMENT Part 1 of 2**

**Motorola Solutions Inc.**  
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**Date of Report:** 3/10/2016  
**Report Revision:** B

**Responsible Engineer:** Tiong Nguk Ing  
**Report Author:** Tiong Nguk Ing  
**Date/s Tested:** 09/26/2015, 09/29/2015, 10/12/2015, 10/16/2015, 1/28/2016  
**Manufacturer:** Motorola Solutions Inc.  
**DUT Description:** 450-520 MHz 1-5W, 136-174 MHz 1-6W, 6.25K/12.5K/25  
 Basic Top Display Model W/GPS. Capable of digital and analog  
 FM transmission. Also capable of TDMA transmission  
**Test TX mode(s):** CW (PTT)  
**Max. Power output:** 5.6 W (UHF R2), 6.6 W (VHF)  
**Nominal Power:** 5.0 W (UHF R2), 6.0 W (VHF)  
**Tx Frequency Bands:** 450-520 MHz (UHF R2), 136-174 MHz (VHF)  
**Signaling type:** FM, TDMA  
**Model(s) Tested:** H97TGD9PW1AN (MNUT1015A)  
**Model(s) Certified:** H97TGD9PW1AN (MNUT1015A)  
**Serial Number(s):** CA11004W9P  
**Classification:** Occupational/Controlled  
**FCC ID:** AZ489FT4893 ; UHF R2 450-512 MHz, VHF 150.8-173.4 MHz  
 This report contains results that are immaterial for FCC equipment approval, which are  
 clearly identified.  
**IC:** 109U-89FT4893; This report contains results that are immaterial for IC equipment  
 approval, which are identified.

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.

*Tiong*  
**Tiong Nguk Ing**  
**Deputy Technical Manager**  
**Approval Date:** 3/10/2016

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**Certification No.:** 160104AD

**Part 1 of 2**

|        |                                                                |    |
|--------|----------------------------------------------------------------|----|
| 1.0    | Introduction.....                                              | 4  |
| 2.0    | FCC SAR Summary.....                                           | 4  |
| 3.0    | Abbreviations / Definitions.....                               | 4  |
| 4.0    | Referenced Standards and Guidelines .....                      | 5  |
| 5.0    | SAR Limits .....                                               | 6  |
| 6.0    | Description of Device Under Test (DUT) .....                   | 6  |
| 7.0    | Optional Accessories and Test Criteria .....                   | 7  |
| 7.1    | Antennas .....                                                 | 7  |
| 7.2    | Battery.....                                                   | 7  |
| 7.3    | Body worn Accessories .....                                    | 7  |
| 7.4    | Audio Accessories .....                                        | 7  |
| 8.0    | Description of Test System.....                                | 8  |
| 8.1    | Descriptions of Robotics/Probes/Readout Electronics .....      | 8  |
| 8.2    | Description of Phantom(s).....                                 | 9  |
| 8.3    | Description of Simulated Tissue.....                           | 9  |
| 9.0    | Additional Test Equipment.....                                 | 10 |
| 10.0   | SAR Measurement System Validation and Verification .....       | 11 |
| 10.1   | System Validation.....                                         | 11 |
| 10.2   | System Verification .....                                      | 11 |
| 10.3   | Equivalent Tissue Test Results .....                           | 12 |
| 11.0   | Environmental Test Conditions .....                            | 12 |
| 12.0   | DUT Test Setup and Methodology .....                           | 13 |
| 12.1   | Measurements .....                                             | 13 |
| 12.2   | DUT Configuration(s) .....                                     | 13 |
| 12.3   | DUT Positioning Procedures .....                               | 14 |
| 12.3.1 | Body .....                                                     | 14 |
| 12.3.2 | Head .....                                                     | 14 |
| 12.3.3 | Face.....                                                      | 14 |
| 12.4   | DUT Test Channels .....                                        | 14 |
| 12.5   | SAR Result Scaling Methodology.....                            | 14 |
| 12.6   | DUT Test Plan .....                                            | 15 |
| 13.0   | DUT Test Data.....                                             | 15 |
| 13.1   | Assessment at the Body and Face for VHF (150.8-173.4 MHz)..... | 15 |
| 13.2   | Assessment at the Body and Face for UHF R2 (450-512 MHz) ..... | 15 |
| 13.3   | Assessment outside FCC Part 90 .....                           | 16 |
| 13.4   | Shortened Scan Assessment .....                                | 17 |
| 14.0   | Results Summary .....                                          | 17 |
| 15.0   | Variability Assessment .....                                   | 17 |
| 16.0   | System Uncertainty .....                                       | 19 |

**APPENDICES**

|   |                                       |    |
|---|---------------------------------------|----|
| A | Measurement Uncertainty Budget .....  | 20 |
| B | Probe Calibration Certificates.....   | 23 |
| C | Dipole Calibration Certificates ..... | 52 |

## Part 2 of 2

## APPENDICES

|   |                                                  |    |
|---|--------------------------------------------------|----|
| D | System Verification Check Scans.....             | 2  |
| E | DUT Scans.....                                   | 8  |
| F | Shorten Scan of Highest SAR Configuration .....  | 15 |
| G | DUT Test Position Photos .....                   | 17 |
| H | DUT, Body worn and audio accessories Photos..... | 20 |

### Report Revision History

| Date      | Revision | Comments                                         |
|-----------|----------|--------------------------------------------------|
| 2/16/2016 | A        | PCII Report for new battery PMNN4485A            |
| 3/10/2016 | B        | Update version number for reference standard KDB |

## 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 portable model number H97TGD9PW1AN (MNUT1015A). This device is classified as Occupational/Controlled. The information herein is to show evidence of Class II Permissive Change compliance base on SAR evaluation of a new introduced battery PMNN4485A.

## 2.0 FCC SAR Summary

**Table 1**

| Equipment Class | Frequency band (MHz) | Max Calc at Body (W/kg) |         | Max Calc at Face (W/kg) |         |
|-----------------|----------------------|-------------------------|---------|-------------------------|---------|
|                 |                      | 1g-SAR                  | 10g-SAR | 1g-SAR                  | 10g-SAR |
| TNF             | 150.8-173.4 MHz      | 2.09                    | 0.93    | 1.05                    | 0.80    |
|                 | 450-512 MHz          | 3.58                    | 2.66    | 2.24                    | 1.65    |

## 3.0 Abbreviations / Definitions

CNR: Calibration Not Required  
 CW: Continuous Wave  
 DSP: Digital Signal Processor  
 DUT: Device Under Test  
 EME: Electromagnetic Energy  
 FM: Frequency Modulation  
 LMR: Land Mobile Radio  
 NA: Not Applicable  
 PSM: Public Safety Microphone  
 PTT: Push to Talk  
 SAR: Specific Absorption Rate  
 TDMA: Time Division Multiple Access  
 TNF: Licensed Non-Broadcast Transmitter Held to Face

**Audio accessories:** These accessories allow communication while the DUT is worn on the body.

**Body worn accessories:** These accessories allow the DUT to be worn on the body of the user.

**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 (2013), 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 (2015), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- RSS-102 (Issue 5) – Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2014)
- 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 – 643646 D01 SAR Test for PTT Radios v01r03
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB – 865664 D02 RF Exposure Reporting v01r02
- FCC KDB – 447498 D01 General RF Exposure Guidance v06

## 5.0 SAR Limits

**Table 2**

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

## 6.0 Description of Device Under Test (DUT)

This portable transmits using FM (frequency modulation) and incorporates traditional simplex two-way radio transmission protocol. Its normal use is to be 5-5-90 (5% TX, 5% RX and 90% standby). It is also capable of TDMA transmission.

The TDMA technique requires sophisticated algorithms and a digital signal processor (DSP) to perform voice compressions/decompressions and RF modulation/demodulation. Duty cycle is 2:1, 2 slots TDMA with transmit taking 1 slot.

The LMR bands in this device operate in a half duplex system. A half duplex system only allows the user to transmit or receive. This device cannot transmit and receive simultaneously. The user must stop transmitting in order to receive a signal or listen for a response, regardless of PTT button or use of voice activated audio accessories. This type of operation, along with the RF safety booklet, which instructs the user to transmit no more than 50% of the time, justifies the use of 50% duty factor for this device.

The intended operating positions are “at the face” with the DUT at least 2.5cm from the mouth, and “at the body” by means of the offered body worn accessories. Body worn audio and PTT operation is accomplished by means of optional remote accessories that are connected to the radio. Operation at the body without an audio accessory attached is possible by means of BT accessories.

## 7.0 Optional Accessories and Test Criteria

This device is offered with optional accessories. The following sections identify the test criteria and details for each accessory category applicable for this PCII filling only. Please refer to previous filling for a detailed listing of all approved offered accessories.

### 7.1 Antennas

There are two antennas applicable for this PCII filling. This antenna was approved offered antennas in previous filling. The table below lists their descriptions.

**Table 3**

| Antenna Models | Description                                                   | Selected for test | Tested |
|----------------|---------------------------------------------------------------|-------------------|--------|
| PMAT4001A      | VHF/UHF/GPS 136-174 MHz, 380-520 MHz, 1575 MHz, ¼ Wave, -8dBd | Yes               | Yes    |
| PMAE4065A      | UHF/GPS 380-520 MHz, 1575 MHz, ¼ Wave, -2dBd                  | Yes               | Yes    |

### 7.2 Battery

This is new offered battery for this PCII filling. The table below lists it description.

**Table 4**

| Battery Models | Description                              | Selected for test | Tested |
|----------------|------------------------------------------|-------------------|--------|
| PMNN4485A      | Battery Impress 2 Li-ion R IP68 2550 mAh | Yes               | Yes    |

### 7.3 Body worn Accessories

The table below lists the body worn accessories considered in order to demonstrate PCII compliance.

**Table 5**

| Body worn Models | Description                           | Selected for test | Tested |
|------------------|---------------------------------------|-------------------|--------|
| HLN6875A         | 3.0" Belt Clip                        | Yes               | Yes    |
| AY000222A01      | Boston leather carry case with D-ring | Yes               | Yes    |
| RLN4570A         | Break-A-Way Chest Pack                | Yes               | Yes    |

### 7.4 Audio Accessories

The table below lists the audio accessories considered in order to demonstrate PCII compliance.

**Table 6**

| Audio Acc. Models | Description                           | Selected for test | Tested |
|-------------------|---------------------------------------|-------------------|--------|
| RMN5058A          | Lightweight Headset                   | Yes               | Yes    |
| PMMN4059B         | Wind porting Public Safety Microphone | Yes               | Yes    |

## 8.0 Description of Test System



### 8.1 Descriptions of Robotics/Probes/Readout Electronics

**Table 7**

| Dosimetric System type                             | System version | DAE type | Probe Type                    |
|----------------------------------------------------|----------------|----------|-------------------------------|
| Schmid & Partner<br>Engineering AG<br>SPEAG DASY 5 | 52.8.8.1222    | DAE4     | ES3DV3<br>EX3DV4<br>(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 8**

| Phantom Type | Phantom(s) Used | Material Parameters                                         | Phantom Dimensions LxWxD (mm) | Material Thickness (mm) | Support Structure Material | Loss Tangent (wood) |
|--------------|-----------------|-------------------------------------------------------------|-------------------------------|-------------------------|----------------------------|---------------------|
| Triple Flat  | NA              | 200MHz -6GHz;<br>Er = 3-5,<br>Loss Tangent = $\leq 0.05$    | 280x175x175                   | 2mm<br>+/- 0.2mm        | Wood                       | < 0.05              |
| SAM          | NA              | 300MHz -6GHz;<br>Er = < 5,<br>Loss Tangent = $\leq 0.05$    | Human Model                   |                         |                            |                     |
| Oval Flat    | √               | 300MHz -6GHz;<br>Er = 4+/- 1,<br>Loss Tangent = $\leq 0.05$ | 600x400x190                   |                         |                            |                     |

## 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 9. 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 9**

| Ingredients        | 150 MHz |      | 450 MHz |       |
|--------------------|---------|------|---------|-------|
|                    | Head    | Body | Head    | Body  |
| Sugar              | 55.4    | 49.7 | 56.00   | 46.50 |
| Diacetin           | 0       | 0    | 0       | 0     |
| De ionized – Water | 38.35   | 46.2 | 39.10   | 50.53 |
| Salt               | 5.15    | 3.00 | 3.80    | 1.87  |
| HEC                | 1       | 1    | 1.00    | 1.00  |
| Bact.              | 0.10    | 0.10 | 0.10    | 0.10  |

## 9.0 Additional Test Equipment

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

**Table 10**

| Equipment Type                                 | Model Number | Serial Number | Calibration Date | Calibration Due Date |
|------------------------------------------------|--------------|---------------|------------------|----------------------|
| Speag Probe                                    | ES3DV3       | 3147          | 5/27/2015        | 5/27/2016            |
| Speag Probe                                    | EX3DV4       | 3638          | 1/26/2015        | 1/26/2016*           |
| Speag DAE                                      | DAE4         | 729           | 4/27/2015        | 4/27/2016            |
| Power Meter                                    | E4419B       | MY50000505    | 9/2/2015         | 9/2/2017             |
| E-Series Avg. Power Sensor                     | E9301B       | MY41495594    | 4/14/2015        | 4/14/2016            |
| E-Series Avg. Power Sensor                     | E9301B       | MY50280001    | 8/5/2015         | 8/5/2016             |
| Power Meter                                    | E4418B       | MY4107917     | 5/7/2015         | 5/7/2016             |
| E-Series Avg. Power Sensor                     | E9301B       | MY50290001    | 9/18/2015        | 9/18/2016            |
| Power Meter                                    | E4418B       | US39251150    | 2/5/2015         | 2/5/2016             |
| Power Sensor                                   | 8481B        | 3318A10982    | 4/13/2015        | 4/13/2016            |
| Signal Generator                               | E4438C       | MY42081753    | 1/17/2014        | 1/17/2016*           |
| Bi-Directional Coupler                         | 3020A        | 40295         | 9/22/2015        | 9/22/2017            |
| Power Amplifier                                | 10WD1000     | 28782         | CNR              | CNR                  |
| Dickson Temperature Recorder                   | TM325        | 12121144      | 6/17/2015        | 6/17/2016            |
| Omega Digital Thermometer with J Type TC Probe | HH200A       | 20857         | 10/21/2014       | 10/21/2015*          |
| Omega Digital Thermometer with J Type TC Probe | HH200A       | 48870         | 6/16/2015        | 6/16/2016            |
| Omega Digital Thermometer with J Type TC Probe | HH202A       | 18800         | 4/6/2015         | 4/6/2016             |
| Omega Digital Thermometer with J Type TC Probe | HH202A       | 18801         | 6/16/2015        | 6/16/2016            |
| Omega Digital Thermometer with J Type TC Probe | HH202A       | 18812         | 6/24/2015        | 6/24/2016            |
| Temperature Probe                              | DTM3000      | 2959          | 4/24/2015        | 4/24/2016            |
| Network Analyzer                               | N5230C       | MY49002155    | 8/3/2015         | 8/3/2016             |
| Dielectric Probe Kit (DAK)                     | DAK-3.5      | 1059          | 4/21/2015        | 4/21/2016            |
| Dielectric Probe Kit (DAK)                     | DAK-12       | 1013          | 4/21/2015        | 4/21/2016            |
| Speag Dipole                                   | D450V3       | 1075          | 7/7/2015         | 7/7/2017             |
| Speag Dipole                                   | CLA150       | 4005          | 7/8/2015         | 7/8/2017             |

\* Equipment used for test dates prior to equipment calibration due date.

## 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 11**

| Dates     | Probe Calibration Point |     | Probe SN | Measured Tissue Parameters |              | Validation  |           |          |
|-----------|-------------------------|-----|----------|----------------------------|--------------|-------------|-----------|----------|
|           |                         |     |          | $\sigma$                   | $\epsilon_r$ | Sensitivity | Linearity | Isotropy |
| CW        |                         |     |          |                            |              |             |           |          |
| 2/10/2015 | Body                    | 150 | 3638     | 0.80                       | 63.7         | Pass        | Pass      | Pass     |
| 2/11/2015 |                         |     |          | 0.80                       | 62.8         |             |           |          |
| 2/10/2015 | Head                    | 150 |          | 0.79                       | 52.7         | Pass        | Pass      | Pass     |
| 6/18/2015 | Body                    | 450 | 3147     | 0.93                       | 55.5         | Pass        | Pass      | Pass     |
| 6/18/2015 | Head                    | 450 |          | 0.85                       | 43.2         | 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 12**

| 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 |
|----------------|---------------|-----------------------|---------------------|--------------------------------------|--------------------------------------------------------|-------------|
| 3638           | FCC Body      | SPEAG CLA150 / 4005   | 3.88 +/- 10%        | 3.84                                 | 3.84                                                   | 10/12/2015  |
|                | IEEE/IEC Head |                       | 3.83 +/- 10%        | 3.47                                 | 3.57                                                   | 10/16/2015  |
| 3147           | FCC Body      | SPEAG D450V3 / 1075   | 4.41 +/- 10%        | 1.13                                 | 4.52                                                   | 9/26/2015   |
|                |               |                       |                     | 1.13                                 | 4.52                                                   | 1/28/2016   |
|                | IEEE/IEC Head |                       | 4.46 +/- 10%        | 1.10                                 | 4.40                                                   | 9/29/2015   |

### 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 13**

| Frequency (MHz) | Tissue Type       | Conductivity Target (S/m) | Dielectric Constant Target | Conductivity Meas. (S/m) | Dielectric Constant Meas. | Tested Date |
|-----------------|-------------------|---------------------------|----------------------------|--------------------------|---------------------------|-------------|
| 136             | FCC Body          | 0.79<br>(0.75-0.83)       | 62.3<br>(59.1-65.4)        | 0.80                     | 60.3                      | 10/12/2015  |
| 142             | IEEE/<br>IEC Head | 0.75<br>(0.72-0.79)       | 52.7<br>(50.0-55.3)        | 0.76                     | 53.9                      | 10/16/2015  |
| 150             | FCC Body          | 0.80<br>(0.76-0.84)       | 61.9<br>(58.8-65.0)        | 0.81                     | 59.8                      | 10/12/2015  |
|                 | IEEE/<br>IEC Head | 0.76<br>(0.72-0.80)       | 52.3<br>(49.7-54.9)        | 0.77                     | 53.4                      | 10/16/2015  |
| 173             | FCC Body          | 0.82<br>(0.78-0.86)       | 61.3<br>(58.3-64.4)        | 0.82                     | 59.0                      | 10/12/2015  |
|                 | IEEE/<br>IEC Head | 0.78<br>(0.74-0.82)       | 51.2<br>(48.7-53.8)        | 0.79                     | 52.1                      | 10/16/2015  |
| 450             | FCC Body          | 0.94<br>(0.89-0.99)       | 56.7<br>(53.9-59.5)        | 0.89                     | 54.5                      | 9/26/2015   |
|                 |                   |                           |                            | 0.95                     | 54.8                      | 1/28/2016   |
|                 | IEEE/<br>IEC Head | 0.87<br>(0.83-0.91)       | 43.5<br>(41.3-45.7)        | 0.88                     | 44.5                      | 9/29/2015   |
| 466             | IEEE/<br>IEC Head | 0.87<br>(0.83-0.91)       | 43.4<br>(41.2-45.6)        | 0.90                     | 44.2                      | 9/29/2015   |
| 520             | FCC Body          | 0.95<br>(0.90-0.99)       | 56.4<br>(53.6-59.2)        | 0.95                     | 53.6                      | 9/26/2015   |
|                 | IEEE/<br>IEC Head | 0.87<br>(0.83-0.92)       | 43.1<br>(41.0-45.3)        | 0.92                     | 42.8                      | 9/29/2015   |

### 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°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 14**

|                     | Target     | Measured                             |
|---------------------|------------|--------------------------------------|
| Ambient Temperature | 18 – 25 °C | Range: 21.4 – 22.0°C<br>Avg. 21.7 °C |
| Tissue Temperature  | NA         | Range: 21.4 – 22.0°C<br>Avg. 21.7 °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. Oval 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 15**

| Description                                                                                                                                                                                                                                                                                   |                                    | $\leq 3$ GHz                                                                                                                                                                                                                                                           | $> 3$ GHz                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface                                                                                                                                                                                        |                                    | $5 \pm 1$ mm                                                                                                                                                                                                                                                           | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm                         |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location                                                                                                                                                                                                     |                                    | $30^\circ \pm 1^\circ$                                                                                                                                                                                                                                                 | $20^\circ \pm 1^\circ$                                                     |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$                                                                                                                                                                                                                   |                                    | $\leq 2$ GHz: $\leq 15$ mm<br>2 – 3 GHz: $\leq 12$ mm                                                                                                                                                                                                                  | 3 – 4 GHz: $\leq 12$ mm<br>4 – 6 GHz: $\leq 10$ mm                         |
|                                                                                                                                                                                                                                                                                               |                                    | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                                            |
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$                                                                                                                                                                                                                   |                                    | $\leq 2$ GHz: $\leq 8$ mm<br>2 – 3 GHz: $\leq 5$ mm*                                                                                                                                                                                                                   | 3 – 4 GHz: $\leq 5$ mm*<br>4 – 6 GHz: $\leq 4$ mm*                         |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                               | uniform grid: $\Delta z_{Zoom}(n)$ | $\leq 5$ mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: $\leq 4$ mm<br>4 – 5 GHz: $\leq 3$ mm<br>5 – 6 GHz: $\leq 2$ mm |
| Note: $\delta$ 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 $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ 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. |                                    |                                                                                                                                                                                                                                                                        |                                                                            |

### 12.2 DUT Configuration(s)

The DUT is a portable device operational at the body and face as described in section 6.0 while using the applicable accessories listed in section 7.0. All accessories listed in section 7.0 of this report were considered when implementing the guidelines specified in KDB 643646.

## 12.3 DUT Positioning Procedures

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

### 12.3.1 Body

The DUT was positioned in normal use configuration against the phantom with the offered body worn accessory.

### 12.3.2 Head

Not applicable.

### 12.3.3 Face

The DUT was positioned with its' front and back sides 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.

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

Where

$N_c$  = Number of channels

$F_{\text{high}}$  = Upper channel

$F_{\text{low}}$  = 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. Appendix F includes a shortened scan to justify SAR scaling for drift. For this device the “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” are scaled using the following formula:

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

$P_{\text{max}}$  = Maximum Power (W)

$P_{\text{int}}$  = 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

50% duty cycle is applied for PTT operation

Note: for conservative results, the following are applied:

If  $P_{\text{int}} > P_{\text{max}}$ , then  $P_{\text{max}}/P_{\text{int}} = 1$ .

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 50% duty cycle was applied to PTT configurations in the final results.

## 13.0 DUT Test Data

### 13.1 Assessment at the Body and Face for VHF (150.8-173.4 MHz)

The new battery PMNN4485A was assessed using the accessories indicated in section 7.0 which represent the highest applicable configuration at the body and face found during previous compliance assessment on file with the FCC. SAR plots of the highest results are presented in Appendix E.

**Table 16**

| Antenna                | Battery   | Carry Accessory                | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | 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#               |
|------------------------|-----------|--------------------------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|--------------------|
| Assessment at the Body |           |                                |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAT4001A              | PMNN4485A | HLN6875A                       | RMN5058A        | 150.800         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 158.300         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 165.900         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 173.400         | 6.35         | -0.28          | 3.77                | 1.67                 | 2.09                    | 0.93                     | HvH-Ab-151012-07   |
| Assessment at the Face |           |                                |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAT4001A              | PMNN4485A | None; Front DUT facing phantom | None            | 150.800         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 158.300         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 165.900         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                |                 | 173.400         | 6.34         | -0.54          | 1.78                | 1.35                 | 1.05                    | 0.80                     | HvH-Face-151016-05 |

### 13.2 Assessment at the Body and Face for UHF R2 (450-512 MHz)

The new battery PMNN4485A was assessed using the accessories indicated in section 7.0 which represent the highest applicable configuration at the body and face found during previous compliance assessment on file with the FCC. SAR plots of the highest results are presented in Appendix E.

**Table 17**

| Antenna                | Battery   | Carry Accessory                  | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | 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#               |
|------------------------|-----------|----------------------------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|--------------------|
| Assessment at the Body |           |                                  |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAE4065A              | PMNN4485A | AY000222A01                      | None            | 450.000         | 5.29         | -0.03          | 6.72                | 4.99                 | 3.58                    | 2.66                     | PS-AB-160128-06    |
|                        |           |                                  |                 | 465.500         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                  |                 | 481.000         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                  |                 | 496.500         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                  |                 | 512.000         |              |                |                     |                      |                         |                          |                    |
| Assessment at the Face |           |                                  |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAE4065A              | PMNN4485A | None; PSM's front facing phantom | PMMN4059B       | 450.000         |              |                |                     |                      |                         |                          | HvH-Face-150929-04 |
|                        |           |                                  |                 | 465.500         | 5.52         | -0.10          | 4.31                | 3.17                 | 2.24                    | 1.65                     |                    |
|                        |           |                                  |                 | 481.000         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                  |                 | 496.500         |              |                |                     |                      |                         |                          |                    |
|                        |           |                                  |                 | 512.000         |              |                |                     |                      |                         |                          |                    |

### 13.3 Assessment outside FCC Part 90

Assessment of outside FCC Part 90 with new battery PMNN4485A. SAR plots of the highest results are presented in Appendix E.

**Table 18**

| Antenna                       | Battery   | Carry Accessory           | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | 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#               |
|-------------------------------|-----------|---------------------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|--------------------|
| <b>Assessment at the Body</b> |           |                           |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAT4001A                     | PMNN4485A | HLN6875A                  | RMN5058A        | 136.000         | 6.28         | -0.10          | 7.68                | 3.44                 | 4.13                    | 1.85                     | HvH-Ab-151012-09   |
| PMAE4065A                     | PMNN4485A | RLN4570A                  | None            | 520.000         | 5.59         | -0.02          | 13.20               | 9.64                 | 6.64                    | 4.85                     | HvH-Ab-150926-07   |
| <b>Assessment at the Face</b> |           |                           |                 |                 |              |                |                     |                      |                         |                          |                    |
| PMAT4001A                     | PMNN4485A | None, Back facing phantom | None            | 142.300         | 6.39         | -0.55          | 2.02                | 1.55                 | 1.18                    | 0.91                     | HvH-Face-151016-07 |
| PMAE4065A                     | PMNN4485A | None, Back facing phantom | None            | 520.000         | 5.59         | 0.04           | 4.20                | 3.11                 | 2.10                    | 1.56                     | HvH-Face-150929-06 |

### 13.4 Shortened Scan Assessment

A “shortened” scan using the highest SAR configuration overall from above was performed to validate the SAR drift of the full DASY5™ coarse and zoom scans. Note that the shortened scan represents the zoom scan performance result; this is obtained by first running a coarse scan to find the peak area and then, using a newly charged battery, a zoom scan only was performed. The results of the shortened cube scan presented in Appendix D demonstrate that the scaling methodology used to determine the calculated SAR results presented herein are valid. The SAR result from the Table below is provided in Appendix F.

**Table 19**

| Antenna   | Battery   | Carry Accessory | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | 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#            |
|-----------|-----------|-----------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|-----------------|
| PMAE4065A | PMNN4485A | AY000222A01     | None            | 450.000         | 5.30         | -0.02          | 6.60                | 4.91                 | 3.50                    | 2.61                     | PS-AB-160128-07 |

### 14.0 Results Summary

The highest Operational Maximum Calculated 1-gram and 10-gram average SAR values found for this filing:

**Table 20**

| Designator | Frequency band (MHz) | Max Calc at Body (W/kg) |         | Max Calc at Face (W/kg) |         |
|------------|----------------------|-------------------------|---------|-------------------------|---------|
|            |                      | 1g-SAR                  | 10g-SAR | 1g-SAR                  | 10g-SAR |
| VHF        |                      |                         |         |                         |         |
| FCC        | 150.8-173.4          | 2.09                    | 0.93    | *1.05                   | 0.80    |
| IC         | 138-174              | 2.09                    | 0.93    | 1.18                    | 0.91    |
| Overall    | 136-174              | 4.13                    | 1.85    | 1.18                    | 0.91    |
| UHF R2     |                      |                         |         |                         |         |
| FCC        | 450-512              | 3.58                    | 2.66    | 2.24                    | 1.65    |
| IC         | 450-470              | 3.58                    | 2.66    | 2.24                    | 1.65    |
| Overall    | 450-520              | 6.64                    | 4.85    | 2.24                    | 1.65    |

All results are scaled to the maximum output power.

**\* The FCC “Max Calc at the Face” for VHF reflects the new SAR compliance value at the head for this FCC ID. (Previous filled SAR value for VHF head is 0.8 W/kg).**

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 results are 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**

**Table A.1: Uncertainty Budget for Device Under Test, for 150 MHz and 450 MHz**

| <i>a</i>                                              | <i>b</i>                | <i>c</i>         | <i>d</i>     | <i>e</i> =<br><i>f</i> ( <i>d</i> , <i>k</i> ) | <i>f</i>                      | <i>g</i>                       | <i>h</i> =<br><i>c</i> × <i>f</i> / <i>e</i> | <i>i</i> =<br><i>c</i> × <i>g</i> / <i>e</i> | <i>k</i>             |
|-------------------------------------------------------|-------------------------|------------------|--------------|------------------------------------------------|-------------------------------|--------------------------------|----------------------------------------------|----------------------------------------------|----------------------|
| Uncertainty Component                                 | IEEE<br>1528<br>section | Tol.<br>(±<br>%) | Prob<br>Dist | Div.                                           | <i>c<sub>i</sub></i><br>(1 g) | <i>c<sub>i</sub></i><br>(10 g) | 1 g<br><i>u<sub>i</sub></i><br>(±%)          | 10 g<br><i>u<sub>i</sub></i><br>(±%)         | <i>v<sub>i</sub></i> |
| <b>Measurement System</b>                             |                         |                  |              |                                                |                               |                                |                                              |                                              |                      |
| Probe Calibration                                     | E.2.1                   | 6.7              | N            | 1.00                                           | 1                             | 1                              | 6.7                                          | 6.7                                          | ∞                    |
| 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                                          | ∞                    |
| <b>Test sample Related</b>                            |                         |                  |              |                                                |                               |                                |                                              |                                              |                      |
| 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                                          | ∞                    |
| <b>Phantom and Tissue Parameters</b>                  |                         |                  |              |                                                |                               |                                |                                              |                                              |                      |
| 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                                          | ∞                    |
| <b>Combined Standard Uncertainty</b>                  |                         |                  | RSS          |                                                |                               |                                | 11                                           | 11                                           | 477                  |
| <b>Expanded Uncertainty</b><br>(95% CONFIDENCE LEVEL) |                         |                  | <i>k</i> =2  |                                                |                               |                                | 23                                           | 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) *c<sub>i</sub>* - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.

g) *u<sub>i</sub>* – SAR uncertainty

h)  $v_i$  - degrees of freedom for standard uncertainty and effective degrees of freedom for the expanded uncertainty

**Table A.2: Uncertainty Budget for System Validation (dipole & flat phantom) for 150MHz and 450 MHz**

| <i>a</i>                                              | <i>b</i>                | <i>c</i>      | <i>d</i>     | <i>e</i> =<br><i>f</i> ( <i>d</i> , <i>k</i> ) | <i>f</i>                      | <i>g</i>                       | <i>h</i> =<br><i>c</i> x <i>f</i><br>/ <i>e</i> | <i>i</i> =<br><i>c</i> x<br><i>g</i> / <i>e</i> | <i>k</i>             |
|-------------------------------------------------------|-------------------------|---------------|--------------|------------------------------------------------|-------------------------------|--------------------------------|-------------------------------------------------|-------------------------------------------------|----------------------|
| Uncertainty Component                                 | IEEE<br>1528<br>section | Tol.<br>(± %) | Prob<br>Dist | Div.                                           | <i>c<sub>i</sub></i><br>(1 g) | <i>c<sub>i</sub></i><br>(10 g) | 1 g<br><i>U<sub>i</sub></i><br>(±%)             | 10 g<br><i>U<sub>i</sub></i><br>(±%)            | <i>v<sub>i</sub></i> |
| <b>Measurement System</b>                             |                         |               |              |                                                |                               |                                |                                                 |                                                 |                      |
| Probe Calibration                                     | E.2.1                   | 6.7           | N            | 1.00                                           | 1                             | 1                              | 6.7                                             | 6.7                                             | ∞                    |
| Axial Isotropy                                        | E.2.2                   | 4.7           | R            | 1.73                                           | 1                             | 1                              | 2.7                                             | 2.7                                             | ∞                    |
| Spherical Isotropy                                    | E.2.2                   | 9.6           | R            | 1.73                                           | 0                             | 0                              | 0.0                                             | 0.0                                             | ∞                    |
| 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                   | 0.0           | R            | 1.73                                           | 1                             | 1                              | 0.0                                             | 0.0                                             | ∞                    |
| 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 Mechanical 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                                             | ∞                    |
| <b>Dipole</b>                                         |                         |               |              |                                                |                               |                                |                                                 |                                                 |                      |
| Dipole Axis to Liquid Distance                        | 8, E.4.2                | 2.0           | R            | 1.73                                           | 1                             | 1                              | 1.2                                             | 1.2                                             | ∞                    |
| Input Power and SAR Drift Measurement                 | 8, 6.6.2                | 5.0           | R            | 1.73                                           | 1                             | 1                              | 2.9                                             | 2.9                                             | ∞                    |
| <b>Phantom and Tissue Parameters</b>                  |                         |               |              |                                                |                               |                                |                                                 |                                                 |                      |
| 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           | R            | 1.73                                           | 0.64                          | 0.43                           | 1.2                                             | 0.8                                             | ∞                    |
| 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           | R            | 1.73                                           | 0.6                           | 0.49                           | 0.6                                             | 0.5                                             | ∞                    |
| <b>Combined Standard Uncertainty</b>                  |                         |               | RSS          |                                                |                               |                                | 10                                              | 9                                               | 99999                |
| <b>Expanded Uncertainty</b><br>(95% CONFIDENCE LEVEL) |                         |               | <i>k</i> =2  |                                                |                               |                                | 19                                              | 18                                              |                      |

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) *c<sub>i</sub>* - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.

g) *u<sub>i</sub>* – SAR uncertainty

h)  $v_i$  - 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 0108**

Client **Motorola EME**

Certificate No: **ES3-3147\_May15**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3147**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,  
 QA CAL-25.v6  
 Calibration procedure for dosimetric E-field probes**

Calibration date: **May 27, 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 ( $22 \pm 3$ )°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: 060         | 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:                                                                                                  | Jeton Kastrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic  | Technical Manager     |           |
| Issued: May 28, 2015                                                                                            |                |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                |                       |           |

Certificate No: ES3-3147\_May15

Page 1 of 14

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



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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

#### Glossary:

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                                |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                               |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                              |
| DCP                      | diode compression point                                                                                                                                 |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                            |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                           |
| Polarization $\varphi$   | $\varphi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle          | information used in DASY system to align probe sensor X to the robot coordinate system                                                                  |

#### Calibration is Performed According to the Following Standards:

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

#### Methods Applied and Interpretation of Parameters:

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

ES3DV3 – SN:3147

May 27, 2015

# Probe ES3DV3

## SN:3147

Manufactured: July 12, 2007  
Calibrated: May 27, 2015

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

ES3DV3- SN:3147

May 27, 2015

**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3147****Basic Calibration Parameters**

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|----------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>A</sup> | 1.25     | 1.19     | 1.18     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                              | 100.8    | 103.2    | 101.5    |               |

**Modulation Calibration Parameters**

| UID       | Communication System Name                  |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C    | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----------|--------------------------------------------|---|---------|------------------------------|------|---------|----------|---------------------------|
| 0         | CW                                         | X | 0.0     | 0.0                          | 1.0  | 0.00    | 208.2    | $\pm 3.5 \%$              |
|           |                                            | Y | 0.0     | 0.0                          | 1.0  |         | 201.7    |                           |
|           |                                            | Z | 0.0     | 0.0                          | 1.0  |         | 204.1    |                           |
| 10100-CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)   | X | 6.19    | 66.3                         | 18.6 | 5.67    | 133.9    | $\pm 1.7 \%$              |
|           |                                            | Y | 6.32    | 67.2                         | 19.5 |         | 131.5    |                           |
|           |                                            | Z | 6.30    | 66.9                         | 19.2 |         | 132.6    |                           |
| 10101-CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM) | X | 7.36    | 67.1                         | 19.4 | 6.42    | 145.2    | $\pm 2.2 \%$              |
|           |                                            | Y | 7.49    | 67.8                         | 20.2 |         | 142.9    |                           |
|           |                                            | Z | 7.46    | 67.5                         | 19.8 |         | 143.4    |                           |
| 10102-CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM) | X | 7.64    | 67.3                         | 19.6 | 6.60    | 147.4    | $\pm 2.2 \%$              |
|           |                                            | Y | 7.81    | 68.2                         | 20.5 |         | 145.3    |                           |
|           |                                            | Z | 7.76    | 67.7                         | 20.0 |         | 145.4    |                           |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)   | X | 6.10    | 66.0                         | 18.6 | 5.80    | 132.0    | $\pm 1.4 \%$              |
|           |                                            | Y | 6.25    | 67.0                         | 19.6 |         | 131.0    |                           |
|           |                                            | Z | 6.26    | 66.7                         | 19.3 |         | 130.9    |                           |
| 10109-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM) | X | 7.13    | 66.8                         | 19.3 | 6.43    | 140.5    | $\pm 1.9 \%$              |
|           |                                            | Y | 7.23    | 67.5                         | 20.1 |         | 139.4    |                           |
|           |                                            | Z | 7.24    | 67.2                         | 19.7 |         | 139.5    |                           |
| 10110-CAC | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)    | X | 5.80    | 65.5                         | 18.4 | 5.75    | 128.7    | $\pm 1.4 \%$              |
|           |                                            | Y | 5.94    | 66.4                         | 19.3 |         | 128.1    |                           |
|           |                                            | Z | 5.95    | 66.1                         | 19.0 |         | 127.7    |                           |
| 10111-CAC | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)  | X | 6.87    | 66.5                         | 19.2 | 6.44    | 136.7    | $\pm 1.9 \%$              |
|           |                                            | Y | 7.00    | 67.3                         | 20.0 |         | 135.6    |                           |
|           |                                            | Z | 6.97    | 66.8                         | 19.6 |         | 134.7    |                           |
| 10112-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM) | X | 7.40    | 67.1                         | 19.5 | 6.59    | 141.9    | $\pm 2.2 \%$              |
|           |                                            | Y | 7.54    | 67.9                         | 20.4 |         | 141.5    |                           |
|           |                                            | Z | 7.48    | 67.4                         | 19.9 |         | 141.2    |                           |
| 10113-CAC | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)  | X | 7.11    | 66.7                         | 19.3 | 6.62    | 137.6    | $\pm 1.9 \%$              |
|           |                                            | Y | 7.26    | 67.6                         | 20.3 |         | 137.2    |                           |
|           |                                            | Z | 7.22    | 67.1                         | 19.8 |         | 136.8    |                           |
| 10140-CAB | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM) | X | 7.57    | 67.3                         | 19.5 | 6.49    | 145.4    | $\pm 1.9 \%$              |
|           |                                            | Y | 7.72    | 68.1                         | 20.4 |         | 146.0    |                           |
|           |                                            | Z | 7.67    | 67.6                         | 19.9 |         | 144.9    |                           |
| 10141-CAB | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM) | X | 7.71    | 67.4                         | 19.6 | 6.53    | 147.4    | $\pm 2.2 \%$              |
|           |                                            | Y | 7.89    | 68.3                         | 20.5 |         | 147.8    |                           |
|           |                                            | Z | 7.83    | 67.8                         | 20.0 |         | 146.6    |                           |

Certificate No: ES3-3147\_May15

Page 4 of 14

ES3DV3- SN:3147

May 27, 2015

|           |                                             |   |      |      |      |      |       |        |
|-----------|---------------------------------------------|---|------|------|------|------|-------|--------|
| 10142-CAC | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)     | X | 5.90 | 66.3 | 18.8 | 5.73 | 148.9 | ±1.9 % |
|           |                                             | Y | 5.81 | 66.4 | 19.4 |      | 126.7 |        |
|           |                                             | Z | 6.03 | 66.9 | 19.4 |      | 148.3 |        |
| 10143-CAC | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)   | X | 6.61 | 66.2 | 19.0 | 6.35 | 132.3 | ±1.7 % |
|           |                                             | Y | 6.75 | 67.1 | 19.9 |      | 132.8 |        |
|           |                                             | Z | 6.76 | 66.8 | 19.5 |      | 131.7 |        |
| 10144-CAC | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)   | X | 6.95 | 66.6 | 19.3 | 6.65 | 134.5 | ±1.9 % |
|           |                                             | Y | 7.09 | 67.4 | 20.2 |      | 134.1 |        |
|           |                                             | Z | 7.11 | 67.1 | 19.8 |      | 133.6 |        |
| 10145-CAC | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)   | X | 5.65 | 66.0 | 18.7 | 5.76 | 144.5 | ±1.7 % |
|           |                                             | Y | 5.73 | 66.9 | 19.7 |      | 145.0 |        |
|           |                                             | Z | 5.73 | 66.4 | 19.2 |      | 143.2 |        |
| 10146-CAC | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM) | X | 6.33 | 66.1 | 19.0 | 6.41 | 127.1 | ±1.7 % |
|           |                                             | Y | 6.48 | 67.3 | 20.1 |      | 126.3 |        |
|           |                                             | Z | 6.47 | 66.6 | 19.4 |      | 126.5 |        |
| 10147-CAC | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM) | X | 6.60 | 66.3 | 19.2 | 6.72 | 127.6 | ±1.9 % |
|           |                                             | Y | 6.75 | 67.4 | 20.3 |      | 126.0 |        |
|           |                                             | Z | 6.77 | 66.9 | 19.8 |      | 126.9 |        |
| 10149-CAB | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)   | X | 7.11 | 66.7 | 19.3 | 6.42 | 139.8 | ±1.9 % |
|           |                                             | Y | 7.25 | 67.6 | 20.1 |      | 138.6 |        |
|           |                                             | Z | 7.20 | 67.1 | 19.7 |      | 137.9 |        |
| 10150-CAB | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)   | X | 7.37 | 67.0 | 19.4 | 6.60 | 142.2 | ±2.2 % |
|           |                                             | Y | 7.52 | 67.8 | 20.3 |      | 141.2 |        |
|           |                                             | Z | 7.48 | 67.4 | 19.9 |      | 140.6 |        |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)     | X | 5.81 | 65.5 | 18.4 | 5.75 | 128.5 | ±1.7 % |
|           |                                             | Y | 5.98 | 66.6 | 19.4 |      | 127.9 |        |
|           |                                             | Z | 6.19 | 67.1 | 19.5 |      | 149.9 |        |
| 10155-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)   | X | 6.87 | 66.4 | 19.1 | 6.43 | 136.3 | ±1.9 % |
|           |                                             | Y | 7.00 | 67.3 | 20.1 |      | 135.0 |        |
|           |                                             | Z | 6.97 | 66.8 | 19.6 |      | 134.6 |        |
| 10156-CAC | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)      | X | 5.84 | 66.1 | 18.8 | 5.79 | 147.1 | ±1.7 % |
|           |                                             | Y | 5.98 | 67.2 | 19.9 |      | 148.4 |        |
|           |                                             | Z | 5.98 | 66.7 | 19.4 |      | 146.6 |        |
| 10157-CAC | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)    | X | 6.60 | 66.2 | 19.0 | 6.49 | 130.9 | ±1.9 % |
|           |                                             | Y | 6.73 | 67.1 | 20.0 |      | 130.1 |        |
|           |                                             | Z | 6.76 | 66.8 | 19.6 |      | 130.8 |        |
| 10158-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)   | X | 7.14 | 66.8 | 19.4 | 6.62 | 137.8 | ±1.9 % |
|           |                                             | Y | 7.28 | 67.6 | 20.3 |      | 136.5 |        |
|           |                                             | Z | 7.24 | 67.1 | 19.8 |      | 136.8 |        |
| 10159-CAC | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)    | X | 6.75 | 66.4 | 19.2 | 6.56 | 132.2 | ±1.7 % |
|           |                                             | Y | 6.87 | 67.3 | 20.1 |      | 131.5 |        |
|           |                                             | Z | 6.88 | 66.9 | 19.7 |      | 131.7 |        |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)     | X | 6.22 | 66.0 | 18.6 | 5.82 | 133.1 | ±1.7 % |
|           |                                             | Y | 6.41 | 67.1 | 19.6 |      | 132.8 |        |
|           |                                             | Z | 6.37 | 66.6 | 19.2 |      | 132.5 |        |

ES3DV3- SN:3147

May 27, 2015

|           |                                            |   |      |      |      |      |       |        |
|-----------|--------------------------------------------|---|------|------|------|------|-------|--------|
| 10161-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)  | X | 7.20 | 66.9 | 19.3 | 6.43 | 141.3 | ±1.9 % |
|           |                                            | Y | 7.36 | 67.8 | 20.3 |      | 140.2 |        |
|           |                                            | Z | 7.31 | 67.3 | 19.8 |      | 139.9 |        |
| 10162-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)  | X | 7.41 | 67.1 | 19.5 | 6.58 | 142.6 | ±1.9 % |
|           |                                            | Y | 7.57 | 67.9 | 20.4 |      | 141.7 |        |
|           |                                            | Z | 7.53 | 67.5 | 19.9 |      | 141.7 |        |
| 10166-CAC | LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)   | X | 5.02 | 65.5 | 18.3 | 5.46 | 138.0 | ±1.4 % |
|           |                                            | Y | 5.15 | 66.7 | 19.5 |      | 138.1 |        |
|           |                                            | Z | 5.16 | 66.1 | 19.0 |      | 137.4 |        |
| 10167-CAC | LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM) | X | 6.02 | 66.9 | 19.3 | 6.21 | 142.3 | ±1.7 % |
|           |                                            | Y | 6.15 | 68.1 | 20.5 |      | 141.5 |        |
|           |                                            | Z | 6.17 | 67.4 | 19.8 |      | 142.1 |        |
| 10168-CAC | LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM) | X | 6.51 | 67.2 | 19.8 | 6.79 | 142.8 | ±2.2 % |
|           |                                            | Y | 6.59 | 68.2 | 20.9 |      | 141.2 |        |
|           |                                            | Z | 6.65 | 67.7 | 20.3 |      | 142.6 |        |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)      | X | 4.86 | 65.5 | 18.5 | 5.73 | 132.0 | ±1.4 % |
|           |                                            | Y | 4.98 | 66.8 | 19.8 |      | 131.4 |        |
|           |                                            | Z | 5.01 | 66.2 | 19.2 |      | 130.9 |        |
| 10170-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)    | X | 5.66 | 66.8 | 19.5 | 6.52 | 132.0 | ±1.9 % |
|           |                                            | Y | 5.75 | 67.9 | 20.7 |      | 130.4 |        |
|           |                                            | Z | 5.84 | 67.5 | 20.2 |      | 131.7 |        |
| 10171-AAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)    | X | 5.66 | 66.8 | 19.5 | 6.49 | 132.3 | ±1.7 % |
|           |                                            | Y | 5.77 | 68.0 | 20.7 |      | 131.0 |        |
|           |                                            | Z | 5.84 | 67.6 | 20.2 |      | 132.2 |        |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)      | X | 4.86 | 65.5 | 18.5 | 5.72 | 131.7 | ±1.4 % |
|           |                                            | Y | 4.99 | 66.9 | 19.9 |      | 131.2 |        |
|           |                                            | Z | 5.00 | 66.2 | 19.1 |      | 130.6 |        |
| 10176-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)    | X | 5.66 | 66.8 | 19.5 | 6.52 | 132.1 | ±1.7 % |
|           |                                            | Y | 5.75 | 67.9 | 20.7 |      | 130.7 |        |
|           |                                            | Z | 5.81 | 67.3 | 20.1 |      | 130.8 |        |
| 10177-CAE | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)       | X | 4.87 | 65.5 | 18.5 | 5.73 | 131.8 | ±1.4 % |
|           |                                            | Y | 4.97 | 66.8 | 19.8 |      | 130.8 |        |
|           |                                            | Z | 5.00 | 66.2 | 19.1 |      | 130.8 |        |
| 10178-CAC | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)     | X | 5.66 | 66.8 | 19.5 | 6.52 | 132.3 | ±1.9 % |
|           |                                            | Y | 5.77 | 68.0 | 20.7 |      | 130.1 |        |
|           |                                            | Z | 5.83 | 67.4 | 20.2 |      | 130.9 |        |
| 10179-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)    | X | 5.67 | 66.9 | 19.5 | 6.50 | 132.7 | ±1.9 % |
|           |                                            | Y | 5.74 | 67.9 | 20.6 |      | 130.6 |        |
|           |                                            | Z | 5.83 | 67.5 | 20.1 |      | 131.3 |        |
| 10180-CAC | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)     | X | 5.68 | 67.0 | 19.6 | 6.50 | 133.2 | ±1.9 % |
|           |                                            | Y | 5.74 | 67.9 | 20.6 |      | 130.8 |        |
|           |                                            | Z | 5.81 | 67.4 | 20.1 |      | 130.6 |        |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)      | X | 4.87 | 65.6 | 18.5 | 5.72 | 132.4 | ±1.4 % |
|           |                                            | Y | 4.97 | 66.8 | 19.8 |      | 131.0 |        |
|           |                                            | Z | 5.01 | 66.2 | 19.2 |      | 130.1 |        |

ES3DV3- SN:3147

May 27, 2015

|           |                                          |   |      |      |      |      |       |        |
|-----------|------------------------------------------|---|------|------|------|------|-------|--------|
| 10182-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)  | X | 5.66 | 66.8 | 19.5 | 6.52 | 132.7 | ±1.9 % |
|           |                                          | Y | 5.79 | 68.0 | 20.8 |      | 130.4 |        |
|           |                                          | Z | 5.82 | 67.4 | 20.1 |      | 130.9 |        |
| 10183-AAA | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)  | X | 5.65 | 66.8 | 19.5 | 6.50 | 132.7 | ±1.9 % |
|           |                                          | Y | 5.76 | 68.0 | 20.7 |      | 130.6 |        |
|           |                                          | Z | 5.83 | 67.5 | 20.1 |      | 131.5 |        |
| 10184-CAC | LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)     | X | 4.86 | 65.5 | 18.5 | 5.73 | 132.2 | ±1.4 % |
|           |                                          | Y | 4.98 | 66.8 | 19.8 |      | 130.8 |        |
|           |                                          | Z | 5.02 | 66.3 | 19.2 |      | 130.6 |        |
| 10185-CAC | LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)   | X | 5.64 | 66.7 | 19.4 | 6.51 | 132.0 | ±1.7 % |
|           |                                          | Y | 5.78 | 68.0 | 20.7 |      | 130.2 |        |
|           |                                          | Z | 5.83 | 67.4 | 20.2 |      | 131.0 |        |
| 10186-AAC | LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM)   | X | 5.68 | 66.9 | 19.6 | 6.50 | 132.5 | ±1.9 % |
|           |                                          | Y | 5.79 | 68.1 | 20.7 |      | 130.7 |        |
|           |                                          | Z | 5.82 | 67.5 | 20.1 |      | 131.4 |        |
| 10187-CAC | LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)   | X | 4.86 | 65.5 | 18.5 | 5.73 | 131.7 | ±1.4 % |
|           |                                          | Y | 5.00 | 66.9 | 19.8 |      | 130.9 |        |
|           |                                          | Z | 5.02 | 66.3 | 19.2 |      | 131.1 |        |
| 10188-CAC | LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM) | X | 5.67 | 66.8 | 19.5 | 6.52 | 131.9 | ±1.9 % |
|           |                                          | Y | 5.77 | 67.9 | 20.8 |      | 130.6 |        |
|           |                                          | Z | 5.83 | 67.4 | 20.1 |      | 131.2 |        |
| 10189-AAC | LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM) | X | 5.67 | 66.9 | 19.6 | 6.50 | 132.2 | ±1.7 % |
|           |                                          | Y | 5.77 | 68.0 | 20.7 |      | 131.5 |        |
|           |                                          | Z | 5.83 | 67.5 | 20.2 |      | 132.1 |        |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)  | X | 6.12 | 66.1 | 18.7 | 5.81 | 130.9 | ±1.7 % |
|           |                                          | Y | 6.27 | 67.0 | 19.7 |      | 130.1 |        |
|           |                                          | Z | 6.23 | 66.6 | 19.2 |      | 129.2 |        |
| 10298-AAB | LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)   | X | 5.71 | 66.1 | 18.7 | 5.72 | 146.5 | ±1.7 % |
|           |                                          | Y | 5.85 | 67.2 | 19.8 |      | 146.0 |        |
|           |                                          | Z | 5.84 | 66.6 | 19.3 |      | 144.8 |        |
| 10299-AAB | LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM) | X | 6.46 | 66.3 | 19.0 | 6.39 | 129.6 | ±1.7 % |
|           |                                          | Y | 6.59 | 67.2 | 20.0 |      | 128.5 |        |
|           |                                          | Z | 6.58 | 66.7 | 19.5 |      | 128.4 |        |
| 10300-AAB | LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM) | X | 6.64 | 66.4 | 19.2 | 6.60 | 129.3 | ±1.7 % |
|           |                                          | Y | 6.81 | 67.5 | 20.3 |      | 129.1 |        |
|           |                                          | Z | 6.81 | 67.0 | 19.7 |      | 128.8 |        |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.67 | 66.7 | 19.0 | 6.06 | 136.4 | ±1.9 % |
|           |                                          | Y | 6.89 | 67.8 | 20.1 |      | 135.8 |        |
|           |                                          | Z | 6.78 | 67.1 | 19.5 |      | 134.8 |        |

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

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 8 and 9).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ES3DV3- SN:3147

May 27, 2015

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3147

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth (mm) <sup>G</sup> | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 7.08    | 7.08    | 7.08    | 0.04               | 1.50                    | ± 13.3 %    |
| 220                  | 49.0                               | 0.81                            | 7.13    | 7.13    | 7.13    | 0.05               | 1.10                    | ± 13.3 %    |
| 300                  | 45.3                               | 0.87                            | 7.37    | 7.37    | 7.37    | 0.15               | 1.90                    | ± 13.3 %    |
| 450                  | 43.5                               | 0.87                            | 6.72    | 6.72    | 6.72    | 0.24               | 2.50                    | ± 13.3 %    |
| 750                  | 41.9                               | 0.89                            | 6.31    | 6.31    | 6.31    | 0.26               | 2.20                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 5.84    | 5.84    | 5.84    | 0.57               | 1.41                    | ± 12.0 %    |
| 1810                 | 40.0                               | 1.40                            | 5.06    | 5.06    | 5.06    | 0.51               | 1.48                    | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 4.85    | 4.85    | 4.85    | 0.53               | 1.42                    | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 4.67    | 4.67    | 4.67    | 0.80               | 1.20                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.36    | 4.36    | 4.36    | 0.80               | 1.25                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.25    | 4.25    | 4.25    | 0.80               | 1.26                    | ± 12.0 %    |
| 3500                 | 37.9                               | 2.91                            | 4.17    | 4.17    | 4.17    | 0.80               | 1.20                    | ± 13.1 %    |
| 3700                 | 37.7                               | 3.12                            | 3.97    | 3.97    | 3.97    | 0.80               | 1.30                    | ± 13.1 %    |

<sup>C</sup> 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.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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.

ES3DV3- SN:3147

May 27, 2015

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3147

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 6.71    | 6.71    | 6.71    | 0.04               | 1.50                    | ± 13.3 %    |
| 220                  | 60.2                               | 0.86                            | 6.62    | 6.62    | 6.62    | 0.04               | 1.50                    | ± 13.3 %    |
| 300                  | 58.2                               | 0.92                            | 7.08    | 7.08    | 7.08    | 0.12               | 1.20                    | ± 13.3 %    |
| 450                  | 56.7                               | 0.94                            | 6.96    | 6.96    | 6.96    | 0.12               | 2.20                    | ± 13.3 %    |
| 750                  | 55.5                               | 0.96                            | 6.03    | 6.03    | 6.03    | 0.55               | 1.45                    | ± 12.0 %    |
| 900                  | 55.0                               | 1.05                            | 5.85    | 5.85    | 5.85    | 0.41               | 1.66                    | ± 12.0 %    |
| 1810                 | 53.3                               | 1.52                            | 4.76    | 4.76    | 4.76    | 0.37               | 1.90                    | ± 12.0 %    |
| 1950                 | 53.3                               | 1.52                            | 4.81    | 4.81    | 4.81    | 0.56               | 1.53                    | ± 12.0 %    |
| 2300                 | 52.9                               | 1.81                            | 4.43    | 4.43    | 4.43    | 0.79               | 1.25                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 4.28    | 4.28    | 4.28    | 0.72               | 1.16                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 4.14    | 4.14    | 4.14    | 0.80               | 1.00                    | ± 12.0 %    |
| 3500                 | 51.3                               | 3.31                            | 3.66    | 3.66    | 3.66    | 0.80               | 1.35                    | ± 13.1 %    |
| 3700                 | 51.0                               | 3.55                            | 3.47    | 3.47    | 3.47    | 0.84               | 1.55                    | ± 13.1 %    |

<sup>C</sup> 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.

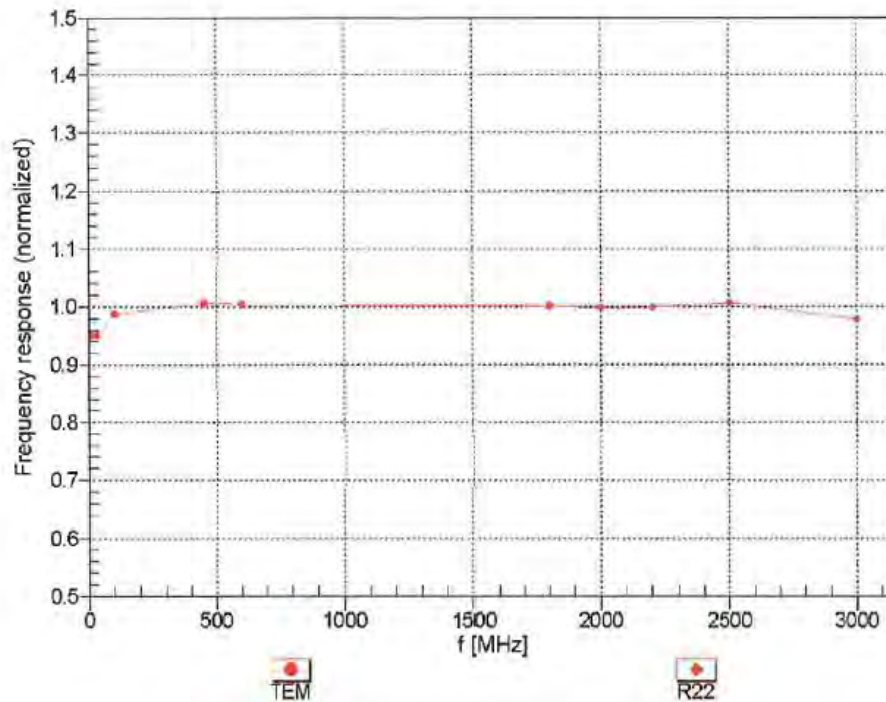
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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.

ES3DV3-SN:3147

May 27, 2015

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

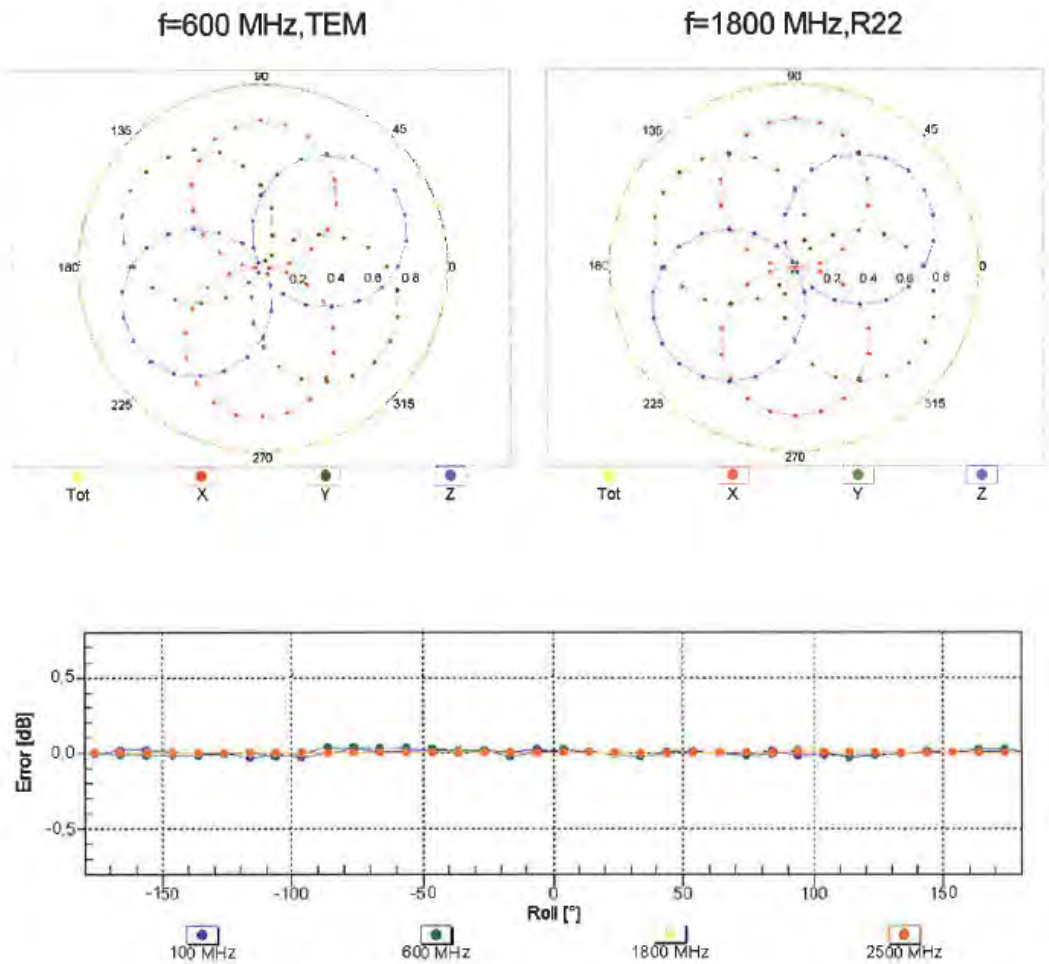


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

ES3DV3- SN:3147

May 27, 2015

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

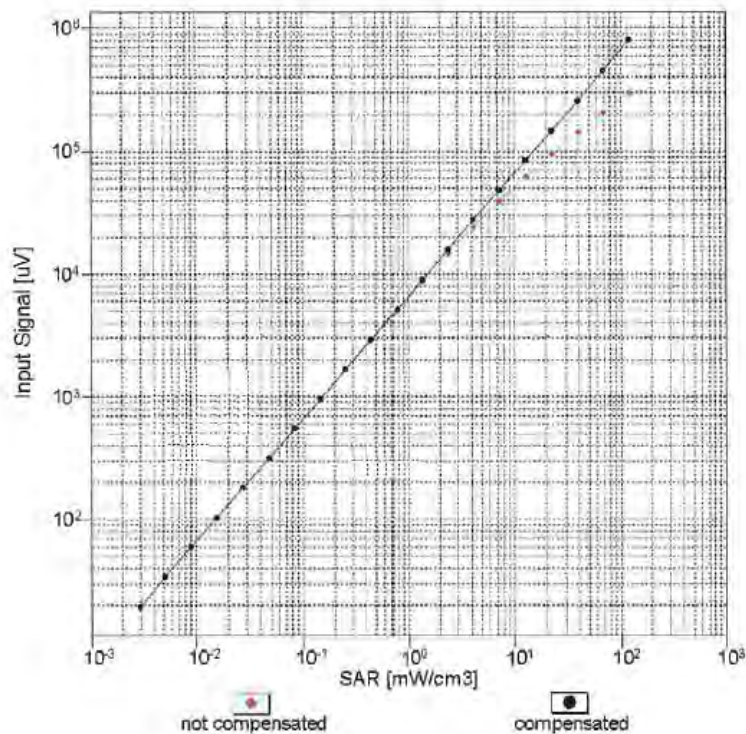
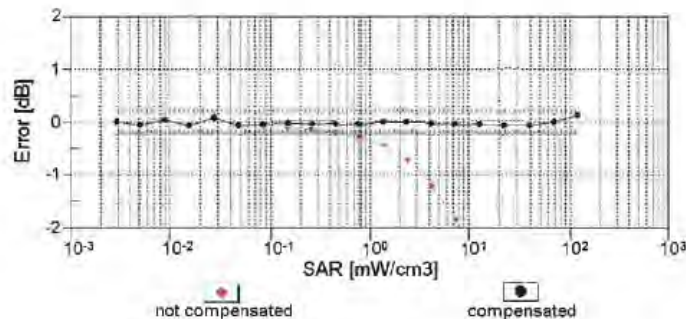


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

ES3DV3- SN:3147

May 27, 2015

Dynamic Range f(SAR<sub>head</sub>)  
(TEM cell , f<sub>eval</sub>= 1900 MHz)

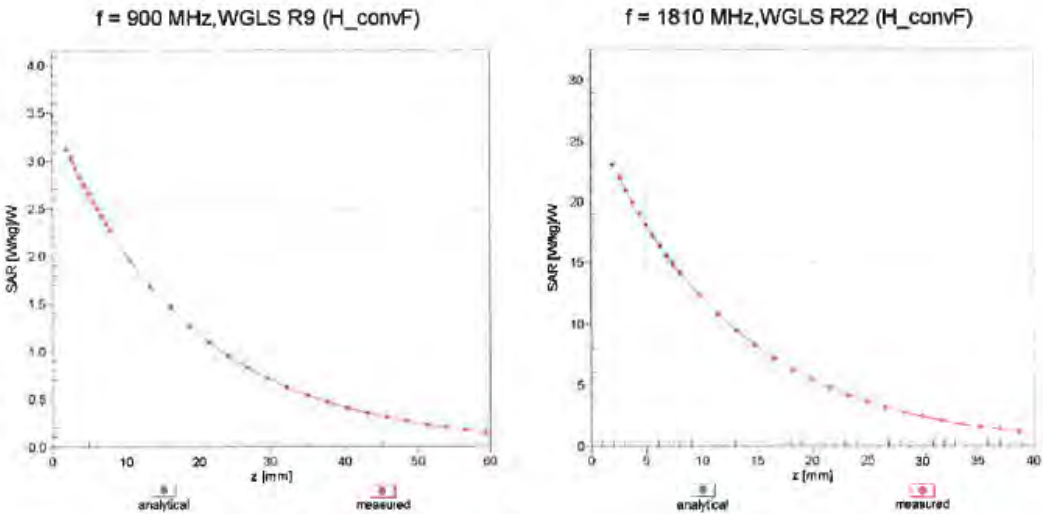


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

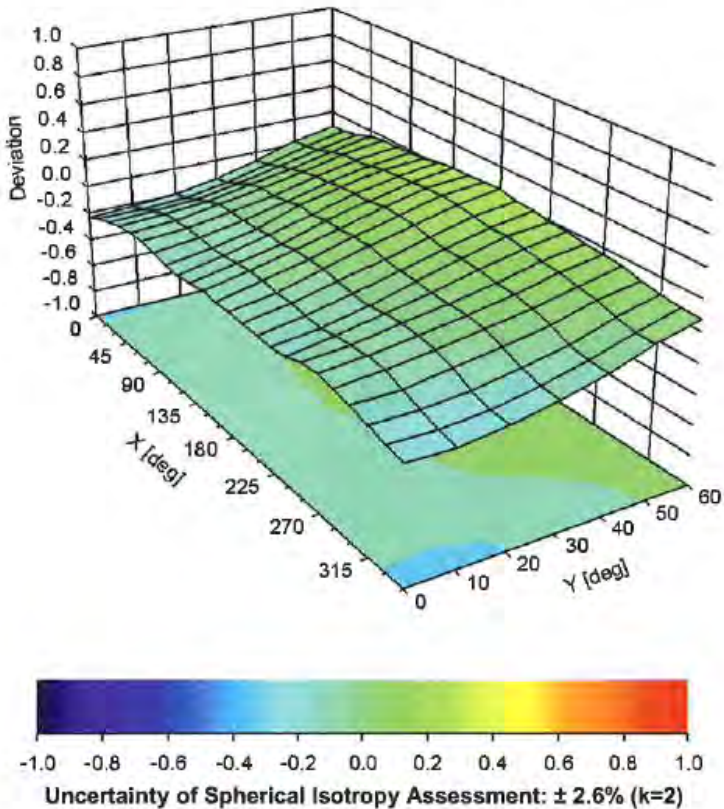
ES3DV3- SN:3147

May 27, 2015

Conversion Factor Assessment



Deviation from Isotropy in Liquid  
Error ( $\phi$ ,  $\theta$ ), f = 900 MHz



ES3DV3-- SN:3147

May 27, 2015

**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3147****Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 13.8       |
| 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       |

**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

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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 **Motorola EME**

Certificate No: **EX3-3638\_Jan15**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3638**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,  
QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **January 26, 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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Power sensor E4412A        | MY41498087      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920)         | Apr-15                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-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:                                                                                                  | Jeton Kastrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic  | Technical Manager     |           |
| Issued: January 27, 2015                                                                                        |                |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                |                       |           |

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#### Glossary:

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                                |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                               |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                              |
| DCP                      | diode compression point                                                                                                                                 |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                            |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                           |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                       |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle          | information used in DASY system to align probe sensor X to the robot coordinate system                                                                  |

#### Calibration is Performed According to the Following Standards:

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

#### Methods Applied and Interpretation of Parameters:

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

EX3DV4 – SN:3638

January 26, 2015

# Probe EX3DV4

## SN:3638

Manufactured: November 1, 2007  
Calibrated: January 26, 2015

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

EX3DV4- SN:3638

January 26, 2015

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3638****Basic Calibration Parameters**

|                                       | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu V/(V/m)^2$ ) <sup>A</sup> | 0.45     | 0.21     | 0.39     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                 | 100.6    | 100.6    | 96.4     |           |

**Modulation Calibration Parameters**

| UID       | Communication System Name                     |   | A<br>dB | B<br>dB√μV | C    | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----------|-----------------------------------------------|---|---------|------------|------|---------|----------|---------------------------|
| 0         | CW                                            | X | 0.0     | 0.0        | 1.0  | 0.00    | 141.6    | ±3.0 %                    |
|           |                                               | Y | 0.0     | 0.0        | 1.0  |         | 148.3    |                           |
|           |                                               | Z | 0.0     | 0.0        | 1.0  |         | 145.0    |                           |
| 10012-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)      | X | 2.80    | 67.4       | 17.9 | 1.87    | 145.3    | ±0.9 %                    |
|           |                                               | Y | 2.78    | 68.4       | 19.0 |         | 133.4    |                           |
|           |                                               | Z | 2.24    | 61.9       | 14.2 |         | 129.1    |                           |
| 10013-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 10.63   | 68.8       | 21.9 | 9.46    | 137.9    | ±3.3 %                    |
|           |                                               | Y | 10.44   | 68.3       | 21.7 |         | 127.8    |                           |
|           |                                               | Z | 10.29   | 68.2       | 21.4 |         | 138.1    |                           |
| 10059-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)      | X | 2.84    | 67.4       | 18.0 | 2.12    | 145.6    | ±0.9 %                    |
|           |                                               | Y | 3.02    | 69.8       | 19.8 |         | 133.4    |                           |
|           |                                               | Z | 2.30    | 62.3       | 14.5 |         | 128.0    |                           |
| 10060-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)    | X | 3.60    | 75.6       | 21.9 | 2.83    | 127.7    | ±0.7 %                    |
|           |                                               | Y | 3.43    | 77.0       | 23.2 |         | 138.1    |                           |
|           |                                               | Z | 2.17    | 64.6       | 15.8 |         | 132.2    |                           |
| 10061-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)     | X | 3.93    | 72.8       | 20.8 | 3.60    | 127.3    | ±0.9 %                    |
|           |                                               | Y | 3.49    | 72.4       | 21.4 |         | 137.6    |                           |
|           |                                               | Z | 2.68    | 64.7       | 16.2 |         | 129.4    |                           |
| 10062-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)      | X | 10.37   | 68.7       | 21.3 | 8.68    | 142.8    | ±3.3 %                    |
|           |                                               | Y | 10.21   | 68.2       | 21.2 |         | 131.7    |                           |
|           |                                               | Z | 10.05   | 68.1       | 20.8 |         | 145.6    |                           |
| 10063-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)      | X | 10.26   | 68.7       | 21.4 | 8.63    | 142.1    | ±3.0 %                    |
|           |                                               | Y | 10.08   | 68.2       | 21.2 |         | 130.9    |                           |
|           |                                               | Z | 9.97    | 68.1       | 20.9 |         | 147.4    |                           |
| 10064-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)     | X | 10.75   | 69.2       | 21.9 | 9.09    | 145.8    | ±3.3 %                    |
|           |                                               | Y | 10.60   | 68.7       | 21.7 |         | 136.1    |                           |
|           |                                               | Z | 10.40   | 68.5       | 21.3 |         | 147.6    |                           |
| 10065-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)     | X | 10.37   | 68.8       | 21.6 | 9.00    | 137.6    | ±3.3 %                    |
|           |                                               | Y | 10.20   | 68.3       | 21.5 |         | 131.3    |                           |
|           |                                               | Z | 10.05   | 68.2       | 21.1 |         | 145.1    |                           |
| 10066-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)     | X | 10.59   | 69.0       | 22.0 | 9.38    | 138.2    | ±3.3 %                    |
|           |                                               | Y | 10.41   | 68.6       | 21.8 |         | 129.9    |                           |
|           |                                               | Z | 10.21   | 68.3       | 21.4 |         | 141.0    |                           |
| 10067-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)     | X | 11.10   | 69.4       | 22.7 | 10.12   | 137.9    | ±3.5 %                    |
|           |                                               | Y | 10.83   | 68.7       | 22.4 |         | 128.0    |                           |
|           |                                               | Z | 10.67   | 68.7       | 22.1 |         | 139.7    |                           |

Certificate No: EX3-3638\_Jan15

Page 4 of 14

EX3DV4- SN:3638

January 26, 2015

|           |                                                |   |       |      |      |       |       |        |
|-----------|------------------------------------------------|---|-------|------|------|-------|-------|--------|
| 10068-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)      | X | 10.92 | 69.3 | 22.7 | 10.24 | 131.5 | ±3.3 % |
|           |                                                | Y | 10.84 | 69.2 | 22.7 |       | 147.6 |        |
|           |                                                | Z | 10.47 | 68.5 | 22.1 |       | 135.2 |        |
| 10069-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)      | X | 11.14 | 69.3 | 22.9 | 10.56 | 130.0 | ±3.5 % |
|           |                                                | Y | 11.08 | 69.2 | 23.0 |       | 147.0 |        |
|           |                                                | Z | 10.73 | 68.6 | 22.4 |       | 135.7 |        |
| 10071-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)  | X | 10.69 | 68.9 | 22.2 | 9.83  | 134.8 | ±3.3 % |
|           |                                                | Y | 10.52 | 68.4 | 22.0 |       | 128.8 |        |
|           |                                                | Z | 10.42 | 68.5 | 21.8 |       | 142.5 |        |
| 10072-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps) | X | 10.15 | 68.4 | 21.8 | 9.62  | 126.2 | ±3.0 % |
|           |                                                | Y | 10.19 | 68.5 | 22.0 |       | 145.1 |        |
|           |                                                | Z | 9.88  | 67.9 | 21.4 |       | 136.2 |        |
| 10073-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps) | X | 10.31 | 69.0 | 22.4 | 9.94  | 145.2 | ±3.0 % |
|           |                                                | Y | 10.06 | 68.3 | 22.1 |       | 138.8 |        |
|           |                                                | Z | 9.76  | 67.7 | 21.5 |       | 129.2 |        |
| 10074-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps) | X | 10.34 | 69.0 | 22.7 | 10.30 | 140.6 | ±3.3 % |
|           |                                                | Y | 10.08 | 68.3 | 22.4 |       | 134.4 |        |
|           |                                                | Z | 9.93  | 68.2 | 22.1 |       | 146.5 |        |
| 10075-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps) | X | 10.37 | 69.0 | 23.0 | 10.77 | 134.8 | ±3.5 % |
|           |                                                | Y | 10.16 | 68.5 | 22.9 |       | 149.4 |        |
|           |                                                | Z | 9.94  | 68.1 | 22.4 |       | 140.7 |        |
| 10076-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps) | X | 10.29 | 68.8 | 23.0 | 10.94 | 132.0 | ±3.3 % |
|           |                                                | Y | 10.03 | 68.2 | 22.8 |       | 145.6 |        |
|           |                                                | Z | 9.84  | 67.9 | 22.4 |       | 136.6 |        |
| 10077-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps) | X | 10.25 | 68.8 | 23.0 | 11.00 | 130.7 | ±3.3 % |
|           |                                                | Y | 9.99  | 68.2 | 22.8 |       | 144.5 |        |
|           |                                                | Z | 9.79  | 67.8 | 22.4 |       | 134.4 |        |
| 10114-CAB | IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)  | X | 10.38 | 68.7 | 20.9 | 8.10  | 149.3 | ±2.7 % |
|           |                                                | Y | 10.43 | 68.7 | 21.0 |       | 147.1 |        |
|           |                                                | Z | 9.96  | 67.7 | 20.2 |       | 135.5 |        |
| 10115-CAB | IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM)  | X | 10.51 | 68.3 | 20.9 | 8.46  | 125.0 | ±3.0 % |
|           |                                                | Y | 10.50 | 68.3 | 21.0 |       | 123.8 |        |
|           |                                                | Z | 10.41 | 68.0 | 20.6 |       | 136.2 |        |
| 10116-CAB | IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM) | X | 10.39 | 68.8 | 21.0 | 8.15  | 149.1 | ±2.7 % |
|           |                                                | Y | 10.43 | 68.7 | 21.0 |       | 145.2 |        |
|           |                                                | Z | 9.93  | 67.6 | 20.2 |       | 133.1 |        |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)       | X | 10.32 | 68.6 | 20.9 | 8.07  | 147.2 | ±2.7 % |
|           |                                                | Y | 10.38 | 68.6 | 20.9 |       | 145.7 |        |
|           |                                                | Z | 9.88  | 67.5 | 20.1 |       | 129.8 |        |
| 10118-CAB | IEEE 802.11n (HT Mixed, 81 Mbps, 16-QAM)       | X | 10.55 | 68.2 | 20.9 | 8.59  | 122.3 | ±3.3 % |
|           |                                                | Y | 11.03 | 69.2 | 21.5 |       | 149.5 |        |
|           |                                                | Z | 10.43 | 67.9 | 20.6 |       | 132.4 |        |
| 10119-CAB | IEEE 802.11n (HT Mixed, 135 Mbps, 64-QAM)      | X | 10.36 | 68.7 | 20.9 | 8.13  | 146.6 | ±2.7 % |
|           |                                                | Y | 10.43 | 68.7 | 21.1 |       | 144.1 |        |
|           |                                                | Z | 9.88  | 67.5 | 20.1 |       | 128.9 |        |

EX3DV4- SN:3638

January 26, 2015

|           |                                                               |   |       |      |      |      |       |        |
|-----------|---------------------------------------------------------------|---|-------|------|------|------|-------|--------|
| 10193-CAB | IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)                  | X | 10.03 | 68.5 | 20.9 | 8.09 | 140.6 | ±2.5 % |
|           |                                                               | Y | 9.97  | 68.3 | 20.9 |      | 137.2 |        |
|           |                                                               | Z | 9.48  | 67.2 | 20.0 |      | 124.1 |        |
| 10194-CAB | IEEE 802.11n (HT Greenfield, 39 Mbps, 16-QAM)                 | X | 10.04 | 68.5 | 20.9 | 8.12 | 141.3 | ±3.0 % |
|           |                                                               | Y | 10.03 | 68.3 | 20.9 |      | 138.9 |        |
|           |                                                               | Z | 9.83  | 68.0 | 20.5 |      | 147.9 |        |
| 10195-CAB | IEEE 802.11n (HT Greenfield, 65 Mbps, 64-QAM)                 | X | 10.16 | 68.6 | 21.0 | 8.21 | 141.1 | ±3.0 % |
|           |                                                               | Y | 10.17 | 68.5 | 21.1 |      | 139.7 |        |
|           |                                                               | Z | 9.97  | 68.2 | 20.6 |      | 149.7 |        |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)                       | X | 9.97  | 68.4 | 20.8 | 8.10 | 140.4 | ±3.0 % |
|           |                                                               | Y | 9.95  | 68.3 | 20.9 |      | 135.9 |        |
|           |                                                               | Z | 9.81  | 68.1 | 20.5 |      | 149.4 |        |
| 10197-CAB | IEEE 802.11n (HT Mixed, 39 Mbps, 16-QAM)                      | X | 10.06 | 68.5 | 20.9 | 8.13 | 141.6 | ±2.5 % |
|           |                                                               | Y | 10.07 | 68.5 | 21.0 |      | 139.0 |        |
|           |                                                               | Z | 9.54  | 67.2 | 20.1 |      | 125.5 |        |
| 10198-CAB | IEEE 802.11n (HT Mixed, 65 Mbps, 64-QAM)                      | X | 10.17 | 68.5 | 21.0 | 8.27 | 140.6 | ±2.7 % |
|           |                                                               | Y | 10.23 | 68.6 | 21.2 |      | 139.6 |        |
|           |                                                               | Z | 9.67  | 67.3 | 20.2 |      | 125.3 |        |
| 10219-CAB | IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)                       | X | 9.83  | 68.2 | 20.7 | 8.03 | 138.8 | ±2.5 % |
|           |                                                               | Y | 9.86  | 68.3 | 20.9 |      | 135.0 |        |
|           |                                                               | Z | 9.36  | 67.1 | 19.9 |      | 124.0 |        |
| 10220-CAB | IEEE 802.11n (HT Mixed, 43.3 Mbps, 16-QAM)                    | X | 10.04 | 68.4 | 20.9 | 8.13 | 142.4 | ±2.7 % |
|           |                                                               | Y | 10.05 | 68.4 | 21.0 |      | 138.3 |        |
|           |                                                               | Z | 9.54  | 67.2 | 20.0 |      | 126.0 |        |
| 10221-CAB | IEEE 802.11n (HT Mixed, 72.2 Mbps, 64-QAM)                    | X | 10.23 | 68.7 | 21.1 | 8.27 | 141.7 | ±3.0 % |
|           |                                                               | Y | 10.24 | 68.6 | 21.1 |      | 139.7 |        |
|           |                                                               | Z | 9.68  | 67.3 | 20.1 |      | 125.8 |        |
| 10222-CAB | IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)                        | X | 10.25 | 68.5 | 20.8 | 8.06 | 145.7 | ±2.5 % |
|           |                                                               | Y | 10.34 | 68.6 | 21.0 |      | 142.1 |        |
|           |                                                               | Z | 9.85  | 67.5 | 20.1 |      | 130.7 |        |
| 10223-CAB | IEEE 802.11n (HT Mixed, 90 Mbps, 16-QAM)                      | X | 10.80 | 69.0 | 21.2 | 8.48 | 149.2 | ±3.3 % |
|           |                                                               | Y | 10.86 | 69.0 | 21.3 |      | 145.7 |        |
|           |                                                               | Z | 10.34 | 67.9 | 20.5 |      | 134.6 |        |
| 10224-CAB | IEEE 802.11n (HT Mixed, 150 Mbps, 64-QAM)                     | X | 10.28 | 68.7 | 20.9 | 8.08 | 145.4 | ±2.7 % |
|           |                                                               | Y | 10.30 | 68.5 | 20.9 |      | 141.1 |        |
|           |                                                               | Z | 9.81  | 67.4 | 20.1 |      | 129.4 |        |
| 10315-AAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)     | X | 2.84  | 68.1 | 18.3 | 1.71 | 141.5 | ±0.9 % |
|           |                                                               | Y | 3.08  | 70.8 | 20.2 |      | 136.4 |        |
|           |                                                               | Z | 2.21  | 62.0 | 14.2 |      | 131.9 |        |
| 10316-AAB | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle) | X | 10.09 | 68.4 | 21.0 | 8.36 | 137.4 | ±3.0 % |
|           |                                                               | Y | 10.07 | 68.3 | 21.1 |      | 133.1 |        |
|           |                                                               | Z | 9.93  | 68.1 | 20.7 |      | 147.9 |        |
| 10317-AAB | IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)       | X | 10.09 | 68.4 | 21.0 | 8.36 | 137.5 | ±3.3 % |
|           |                                                               | Y | 10.10 | 68.4 | 21.1 |      | 135.7 |        |
|           |                                                               | Z | 9.98  | 68.2 | 20.8 |      | 149.3 |        |

Certificate No: EX3-3638\_Jan15

Page 6 of 14

EX3DV4- SN:3638

January 26, 2015

|           |                                                                                |   |       |      |      |      |       |        |
|-----------|--------------------------------------------------------------------------------|---|-------|------|------|------|-------|--------|
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)                      | X | 2.79  | 68.1 | 18.3 | 1.54 | 141.2 | ±0.9 % |
|           |                                                                                | Y | 3.44  | 73.2 | 21.2 |      | 135.6 |        |
|           |                                                                                | Z | 2.13  | 61.6 | 13.9 |      | 131.3 |        |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)                  | X | 10.00 | 68.3 | 20.9 | 8.23 | 136.7 | ±3.3 % |
|           |                                                                                | Y | 10.00 | 68.2 | 21.0 |      | 131.7 |        |
|           |                                                                                | Z | 9.86  | 68.0 | 20.5 |      | 147.5 |        |
| 10417-AAA | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle)                      | X | 9.99  | 68.3 | 20.9 | 8.23 | 137.3 | ±3.0 % |
|           |                                                                                | Y | 9.98  | 68.2 | 20.9 |      | 133.2 |        |
|           |                                                                                | Z | 9.89  | 68.1 | 20.6 |      | 149.7 |        |
| 10418-AAA | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Long preamble)  | X | 9.87  | 68.2 | 20.8 | 8.14 | 136.4 | ±3.0 % |
|           |                                                                                | Y | 9.86  | 68.1 | 20.9 |      | 131.8 |        |
|           |                                                                                | Z | 9.74  | 68.0 | 20.5 |      | 148.1 |        |
| 10419-AAA | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Short preamble) | X | 9.95  | 68.3 | 20.9 | 8.19 | 137.9 | ±3.3 % |
|           |                                                                                | Y | 9.99  | 68.3 | 21.0 |      | 135.7 |        |
|           |                                                                                | Z | 9.81  | 68.0 | 20.5 |      | 147.9 |        |

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 8 and 9).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4- SN:3638

January 26, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3638

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth <sup>g</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 12.32   | 12.32   | 12.32   | 0.00               | 1.00                    | ± 13.3 %    |
| 220                  | 49.0                               | 0.81                            | 11.28   | 11.28   | 11.28   | 0.00               | 1.00                    | ± 13.3 %    |
| 2450                 | 39.2                               | 1.80                            | 6.90    | 6.90    | 6.90    | 0.35               | 0.85                    | ± 12.0 %    |
| 4950                 | 36.3                               | 4.40                            | 5.26    | 5.26    | 5.26    | 0.40               | 1.80                    | ± 13.1 %    |
| 5200                 | 36.0                               | 4.66                            | 4.98    | 4.98    | 4.98    | 0.40               | 1.80                    | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.66    | 4.66    | 4.66    | 0.40               | 1.80                    | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.61    | 4.61    | 4.61    | 0.45               | 1.80                    | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.35    | 4.35    | 4.35    | 0.45               | 1.80                    | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.43    | 4.43    | 4.43    | 0.45               | 1.80                    | ± 13.1 %    |

<sup>c</sup> 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.

<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3638

January 26, 2015

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3638

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 11.55   | 11.55   | 11.55   | 0.00               | 1.00                    | ± 13.3 %    |
| 220                  | 60.2                               | 0.86                            | 10.80   | 10.80   | 10.80   | 0.00               | 1.00                    | ± 13.3 %    |
| 2450                 | 52.7                               | 1.95                            | 7.12    | 7.12    | 7.12    | 0.80               | 0.50                    | ± 12.0 %    |
| 4950                 | 49.4                               | 5.01                            | 4.49    | 4.49    | 4.49    | 0.50               | 1.90                    | ± 13.1 %    |
| 5200                 | 49.0                               | 5.30                            | 4.36    | 4.36    | 4.36    | 0.50               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.16    | 4.16    | 4.16    | 0.50               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 3.79    | 3.79    | 3.79    | 0.55               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.66    | 3.66    | 3.66    | 0.55               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.00    | 4.00    | 4.00    | 0.55               | 1.90                    | ± 13.1 %    |

<sup>C</sup> 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.

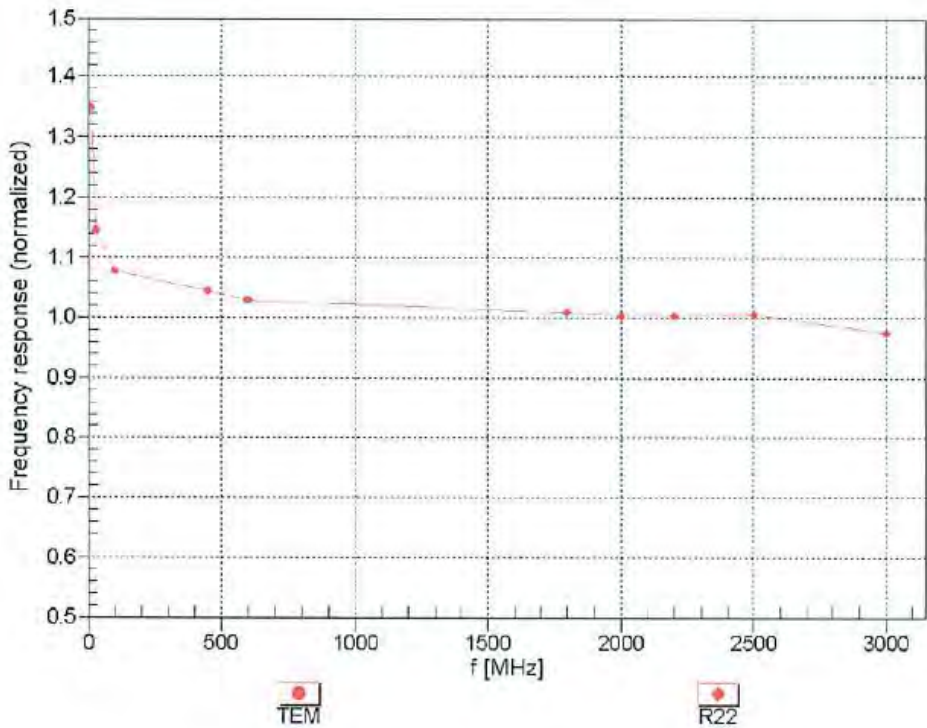
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3638

January 26, 2015

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



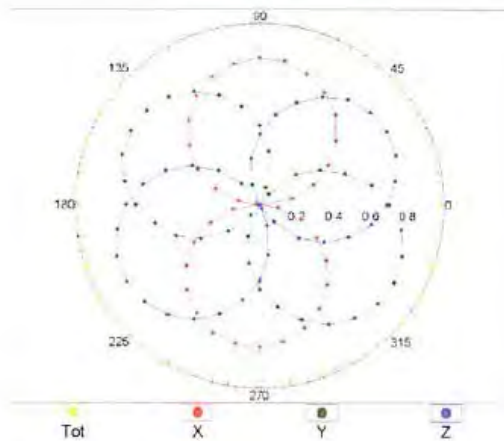
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

EX3DV4- SN:3638

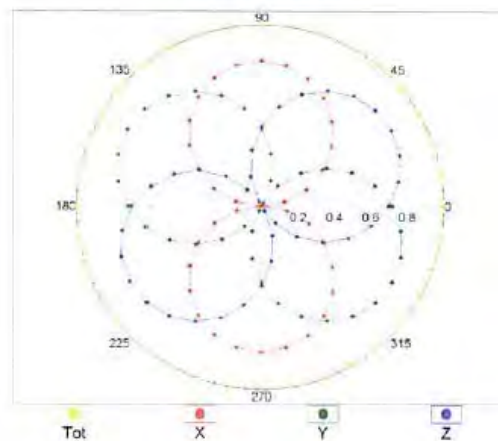
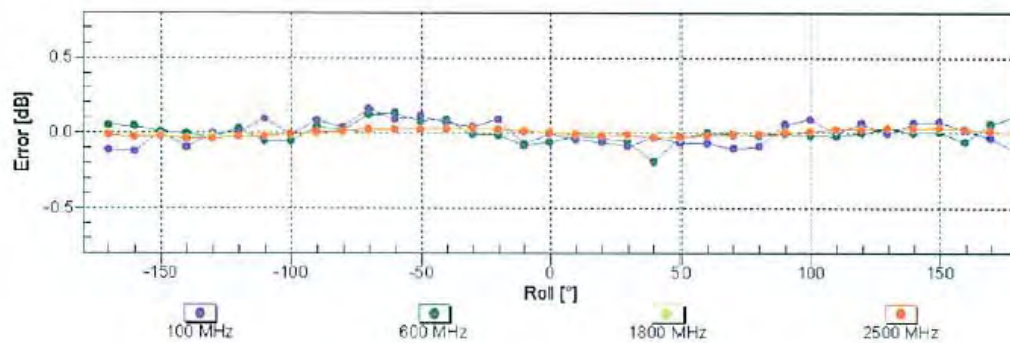
January 26, 2015

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

f=600 MHz,TEM



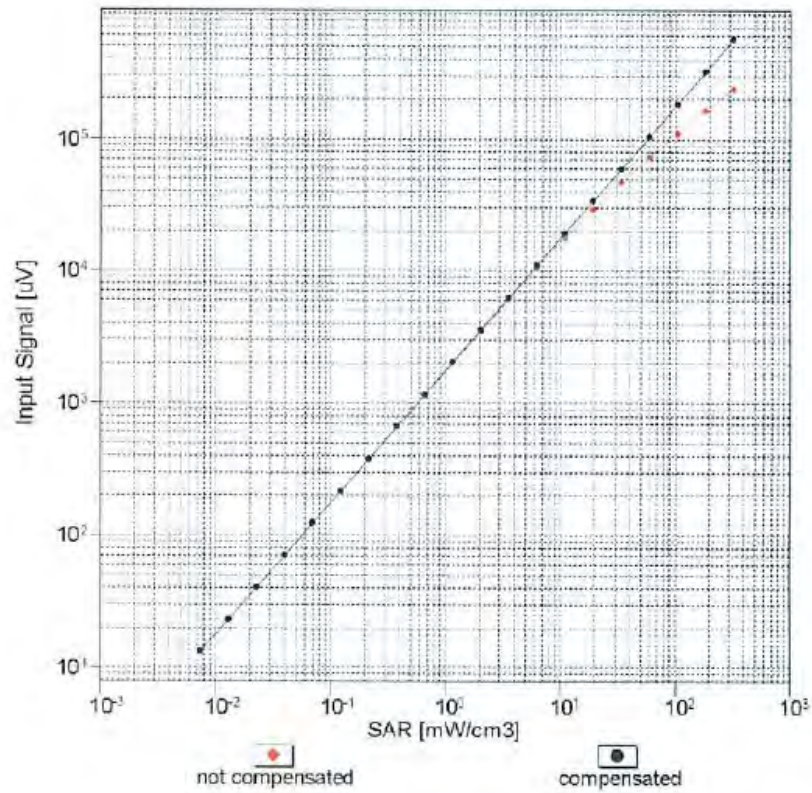
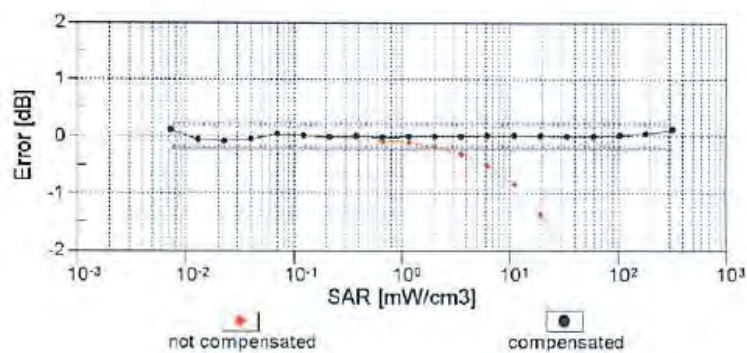
f=1800 MHz,R22

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

EX3DV4- SN:3638

January 26, 2015

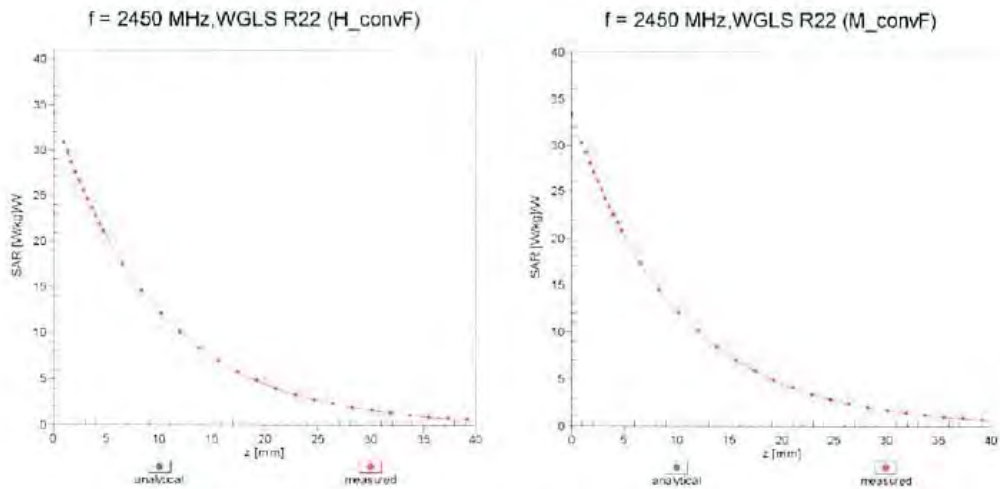
### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}} = 1900 \text{ MHz}$ )

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

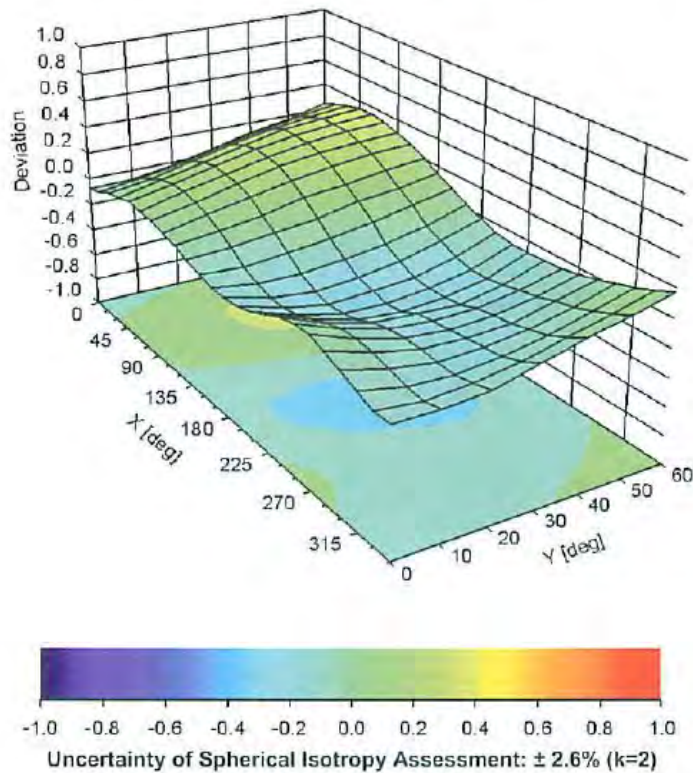
EX3DV4—SN:3638

January 26, 2015

Conversion Factor Assessment



Deviation from Isotropy in Liquid  
Error ( $\phi, \theta$ ), f = 900 MHz



EX3DV4- SN:3638

January 26, 2015

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3638****Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -30.3      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 9 mm       |
| Tip Diameter                                  | 2.5 mm     |
| Probe Tip to Sensor X Calibration Point       | 1 mm       |
| Probe Tip to Sensor Y Calibration Point       | 1 mm       |
| Probe Tip to Sensor Z Calibration Point       | 1 mm       |
| Recommended Measurement Distance from Surface | 1.4 mm     |

## **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)

Accreditation No.: **SCS 0108**

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

Client **Motorola EME**

Certificate No: **CLA150-4005\_Jul15**

## CALIBRATION CERTIFICATE

Object **CLA150 - SN: 4005**

Calibration procedure(s) **QA CAL-15.v8**  
Calibration procedure for system validation sources below 700 MHz

Calibration date: **July 08, 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 ( $22 \pm 3$ )°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: S5058 (20k)    | 01-Apr-15 (No. 217-02131)      | Mar-16                |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-15 (No. 217-02134)      | Mar-16                |
| Reference Probe EX3DV4      | SN: 3877           | 09-Jan-15 (No. EX3-3877_Jan15) | Jan-16                |
| DAE4                        | SN: 654            | 22-Jun-15 (No. DAE4-654_Jun15) | Jun-16                |

| 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-14) | In house check: Oct-15 |

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

Issued: July 15, 2015

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

Certificate No: CLA150-4005\_Jul15

Page 1 of 8

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

#### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:** This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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.

|                             |                                  |                                  |
|-----------------------------|----------------------------------|----------------------------------|
| <b>DASY Version</b>         | DASY5                            | V52.8.8                          |
| <b>Extrapolation</b>        | Advanced Extrapolation           |                                  |
| <b>Phantom</b>              | ELI4 Flat Phantom                | Shell thickness: $2 \pm 0.2$ mm  |
| <b>EUT Positioning</b>      | Touch Position                   |                                  |
| <b>Zoom Scan Resolution</b> | $dx, dy = 4.0$ mm, $dz = 1.4$ mm | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>            | 150 MHz $\pm$ 1 MHz              |                                  |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity           |
|------------------------------------------------|---------------------|----------------|------------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 52.3           | 0.76 mho/m             |
| <b>Measured Head TSL parameters</b>            | $(22.0 \pm 0.2)$ °C | $50.2 \pm 6$ % | $0.77$ mho/m $\pm 6$ % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                   |

**SAR result with Head TSL**

|                                                             |                  |                                                |
|-------------------------------------------------------------|------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition        |                                                |
| SAR measured                                                | 1 W input power  | 3.90 W/kg                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W | <b>3.83 W/kg <math>\pm</math> 18.4 % (k=2)</b> |

|                                                               |                  |                                                |
|---------------------------------------------------------------|------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition        |                                                |
| SAR measured                                                  | 1 W input power  | 2.57 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W | <b>2.53 W/kg <math>\pm</math> 18.0 % (k=2)</b> |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity           |
|------------------------------------------------|---------------------|----------------|------------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 61.9           | 0.80 mho/m             |
| <b>Measured Body TSL parameters</b>            | $(22.0 \pm 0.2)$ °C | $60.1 \pm 6$ % | $0.84$ mho/m $\pm 6$ % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                   |

**SAR result with Body TSL**

|                                                             |                  |                                                |
|-------------------------------------------------------------|------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition        |                                                |
| SAR measured                                                | 1 W input power  | 4.06 W/kg                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W | <b>3.88 W/kg <math>\pm</math> 18.4 % (k=2)</b> |

|                                                               |                  |                                                |
|---------------------------------------------------------------|------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition        |                                                |
| SAR measured                                                  | 1 W input power  | 2.68 W/kg                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W | <b>2.57 W/kg <math>\pm</math> 18.0 % (k=2)</b> |

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL at 149.5 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 35.3 $\Omega$ - 5.4 j $\Omega$ |
| Return Loss                          | - 14.8 dB                      |

**Antenna Parameters with Head TSL at 150.0 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 41.6 $\Omega$ - 2.1 j $\Omega$ |
| Return Loss                          | - 20.5 dB                      |

**Antenna Parameters with Head TSL at 150.5 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.8 $\Omega$ + 0.8 j $\Omega$ |
| Return Loss                          | - 33.7 dB                      |

**Antenna Parameters with Body TSL at 149.5 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 36.8 $\Omega$ - 7.0 j $\Omega$ |
| Return Loss                          | - 15.3 dB                      |

**Antenna Parameters with Body TSL at 150.0 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 43.3 $\Omega$ - 4.2 j $\Omega$ |
| Return Loss                          | - 21.4 dB                      |

**Antenna Parameters with Body TSL at 150.5 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.3 $\Omega$ - 2.0 j $\Omega$ |
| Return Loss                          | - 32.5 dB                      |

**Additional EUT Data**

|                 |                 |
|-----------------|-----------------|
| Manufactured by | SPEAG           |
| Manufactured on | August 23, 2013 |

DASY5 Validation Report for Head TSL

Date: 08.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4005

Communication System: UID 0 - CW; Frequency: 150 MHz  
Medium parameters used:  $f = 150 \text{ MHz}$ ;  $\sigma = 0.768 \text{ S/m}$ ;  $\epsilon_r = 50.203$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

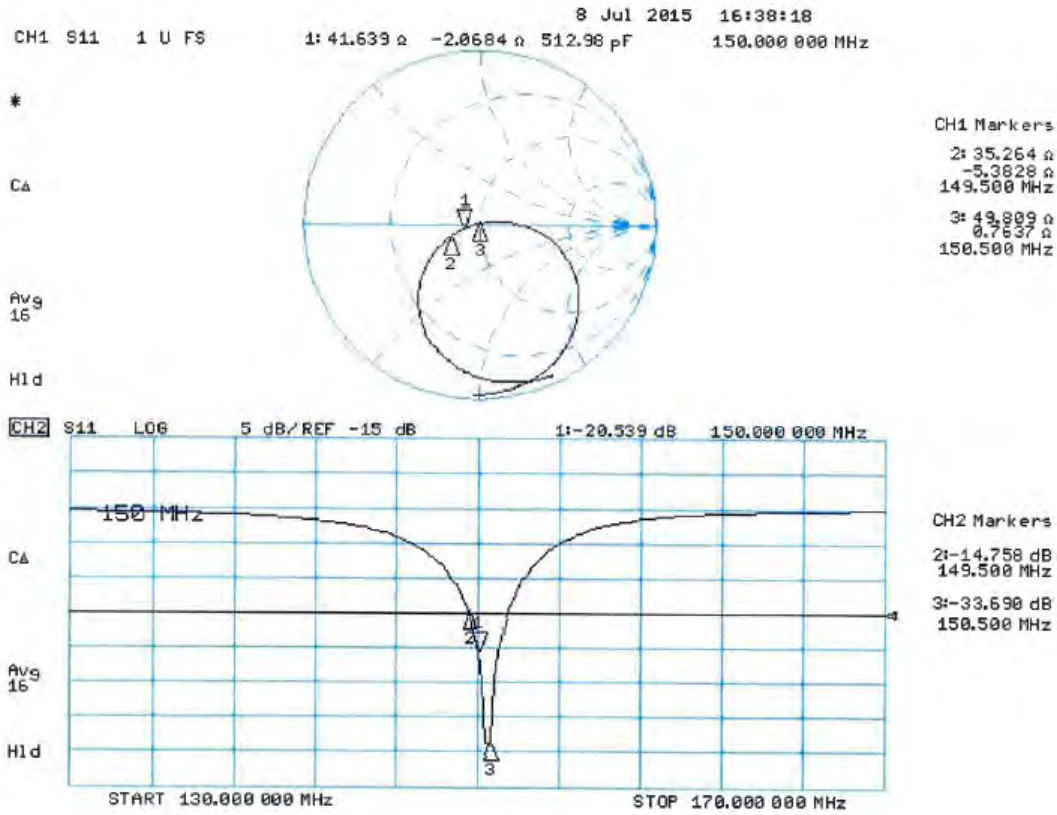
- Probe: EX3DV4 - SN3877; ConvF(12, 12, 12); Calibrated: 09.01.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 22.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 5.53 W/kg

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x9x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$   
Reference Value = 77.52 V/m; Power Drift = 0.04 dB  
Peak SAR (extrapolated) = 7.54 W/kg  
**SAR(1 g) = 3.9 W/kg; SAR(10 g) = 2.57 W/kg**  
Maximum value of SAR (measured) = 5.48 W/kg



Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 08.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4005**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150$  MHz;  $\sigma = 0.84$  S/m;  $\epsilon_r = 60.08$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.42, 11.42, 11.42); Calibrated: 09.01.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 22.06.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan****(81x81x1):** Interpolated grid:  $dx=1.500$  mm,  $dy=1.500$  mm

Maximum value of SAR (interpolated) = 5.10 W/kg

**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,****dist=1.4mm (8x9x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 77.99 V/m; Power Drift = -0.01 dB

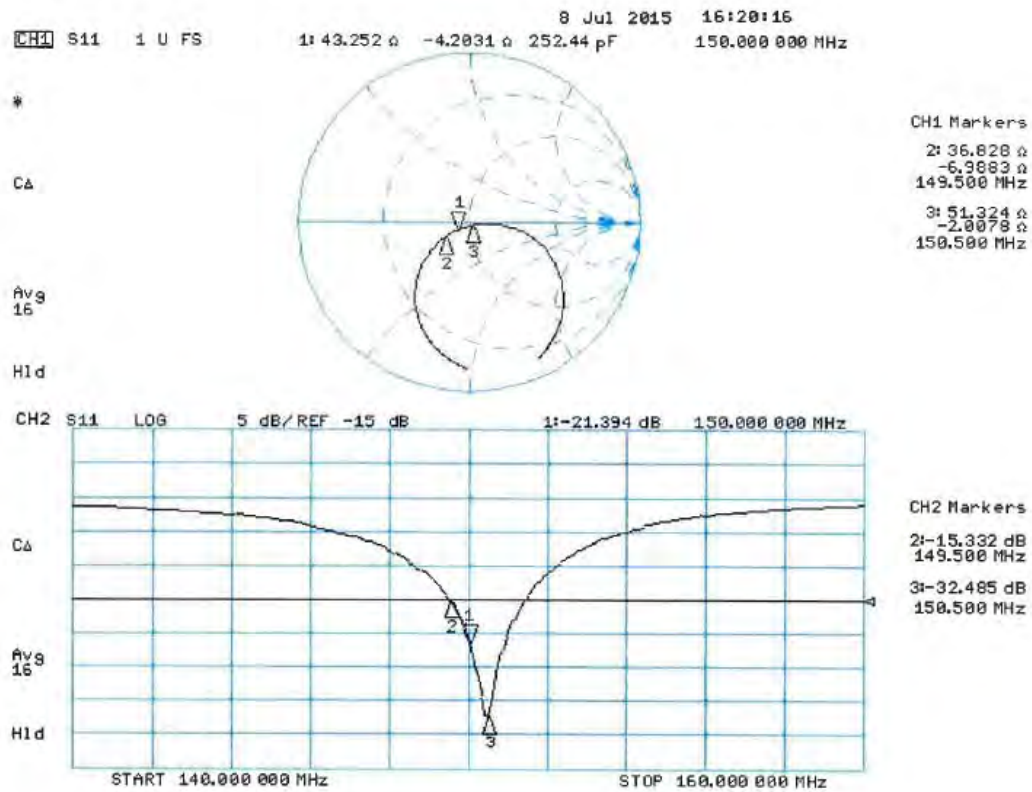
Peak SAR (extrapolated) = 7.76 W/kg

**SAR(1 g) = 4.06 W/kg; SAR(10 g) = 2.68 W/kg**

Maximum value of SAR (measured) = 5.73 W/kg



## Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 0108**

Client **Motorola EME**

Certificate No: **D450V3-1075\_Jul15**

## CALIBRATION CERTIFICATE

Object **D450V3 - SN:1075**

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

Calibration date: **July 07, 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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter E4419B          | GB41293874         | 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: S5058 (20k)    | 01-Apr-15 (No. 217-02131)         | Mar-16                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-15 (No. 217-02134)         | Mar-16                 |
| Reference Probe ET3DV6      | SN: 1507           | 30-Dec-14 (No. ET3-1507_Dec14)    | Dec-15                 |
| DAE4                        | SN: 789            | 16-Mar-15 (No. DAE4-789_Mar15)    | Mar-16                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator HP B648C       | 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-14) | In house check: Oct-15 |

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

Issued: July 8, 2015

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Certificate No: D450V3-1075\_Jul15

Page 1 of 8

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Accreditation No.: **SCS 0108**

#### 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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- 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.

|                                     |                        |                                 |
|-------------------------------------|------------------------|---------------------------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8                         |
| <b>Extrapolation</b>                | Advanced Extrapolation |                                 |
| <b>Phantom</b>                      | ELI4 Flat Phantom      | Shell thickness: $2 \pm 0.2$ mm |
| <b>Distance Dipole Center - TSL</b> | 15 mm                  | with Spacer                     |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |                                 |
| <b>Frequency</b>                    | 450 MHz $\pm$ 1 MHz    |                                 |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 43.5           | 0.87 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 42.7 $\pm$ 6 % | 0.87 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                 |

**SAR result with Head TSL**

|                                                             |                    |                                                |
|-------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                | 250 mW input power | 1.12 W/kg                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>4.46 W/kg <math>\pm</math> 18.1 % (k=2)</b> |

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                |
| SAR measured                                                  | 250 mW input power | 0.745 W/kg                                     |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>2.97 W/kg <math>\pm</math> 17.6 % (k=2)</b> |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 56.7           | 0.94 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 55.0 $\pm$ 6 % | 0.95 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                 |

**SAR result with Body TSL**

|                                                             |                    |                                                |
|-------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                                |
| SAR measured                                                | 250 mW input power | 1.12 W/kg                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>4.41 W/kg <math>\pm</math> 18.1 % (k=2)</b> |

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                                |
| SAR measured                                                  | 250 mW input power | 0.733 W/kg                                     |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>2.90 W/kg <math>\pm</math> 17.6 % (k=2)</b> |

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL**

|                                      |                                 |
|--------------------------------------|---------------------------------|
| Impedance, transformed to feed point | 57.6 $\Omega$ - 1.6 $\mu\Omega$ |
| Return Loss                          | - 22.8 dB                       |

**Antenna Parameters with Body TSL**

|                                      |                                 |
|--------------------------------------|---------------------------------|
| Impedance, transformed to feed point | 54.4 $\Omega$ - 7.6 $\mu\Omega$ |
| Return Loss                          | - 21.5 dB                       |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.355 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 | June 24, 2010 |

**DASY5 Validation Report for Head TSL**

Date: 06.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1075**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.87$  S/m;  $\epsilon_r = 42.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.58, 6.58, 6.58); Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn789; Calibrated: 16.03.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- 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:**

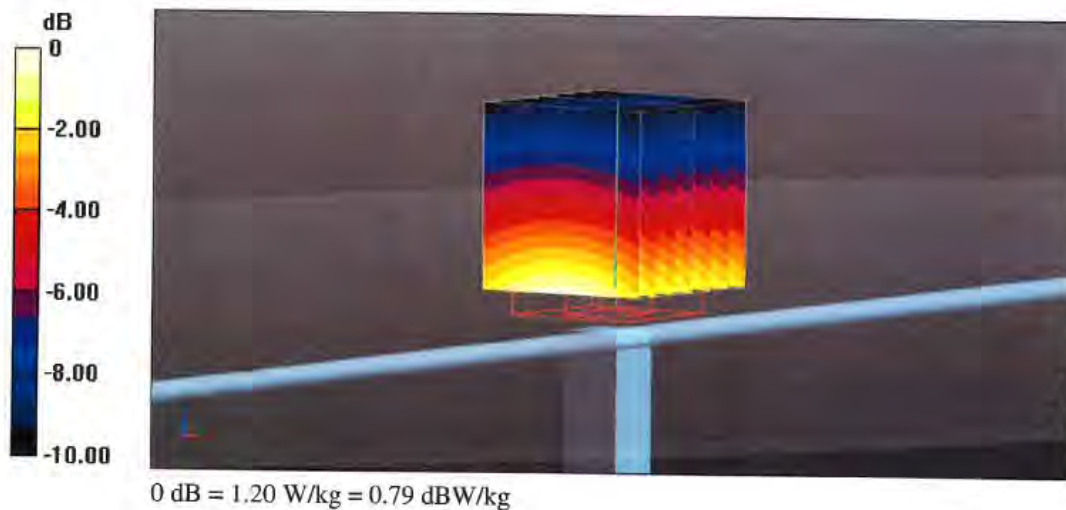
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.21 V/m; Power Drift = -0.02 dB

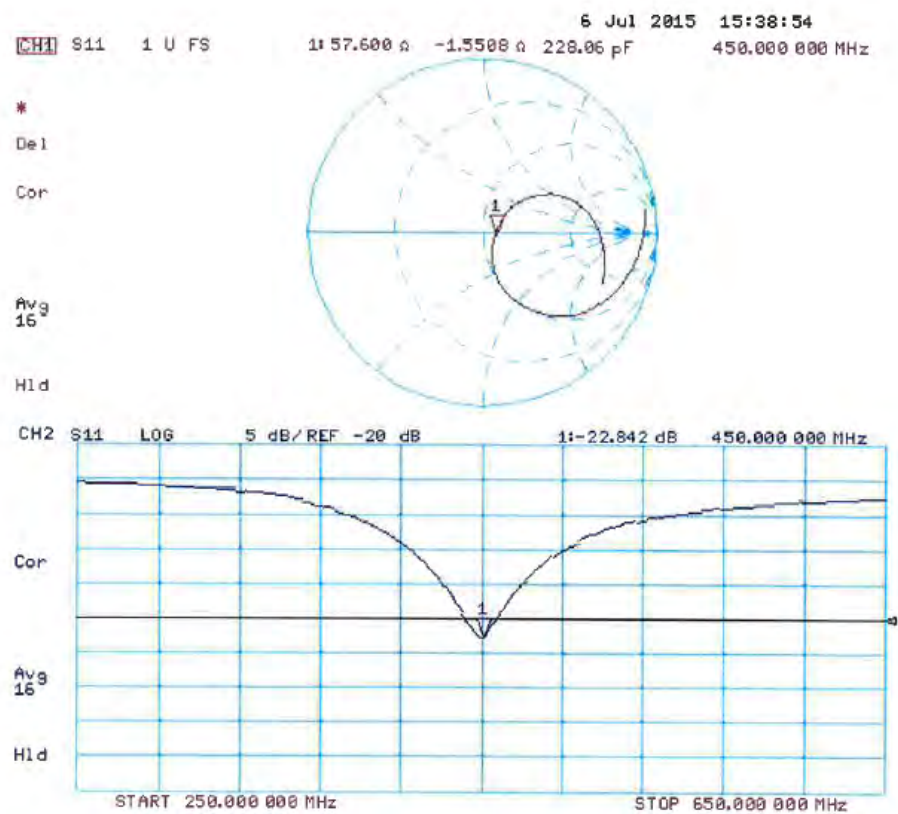
Peak SAR (extrapolated) = 1.61 W/kg

**SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.745 W/kg**

Maximum value of SAR (measured) = 1.20 W/kg



Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 07.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1075**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.95$  S/m;  $\epsilon_r = 55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.05, 7.05, 7.05); Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn789; Calibrated: 16.03.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- 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:**

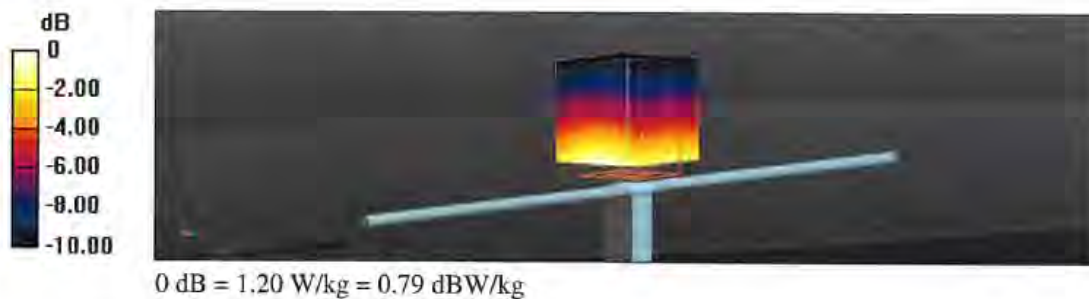
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 36.52 V/m; Power Drift = -0.05 dB

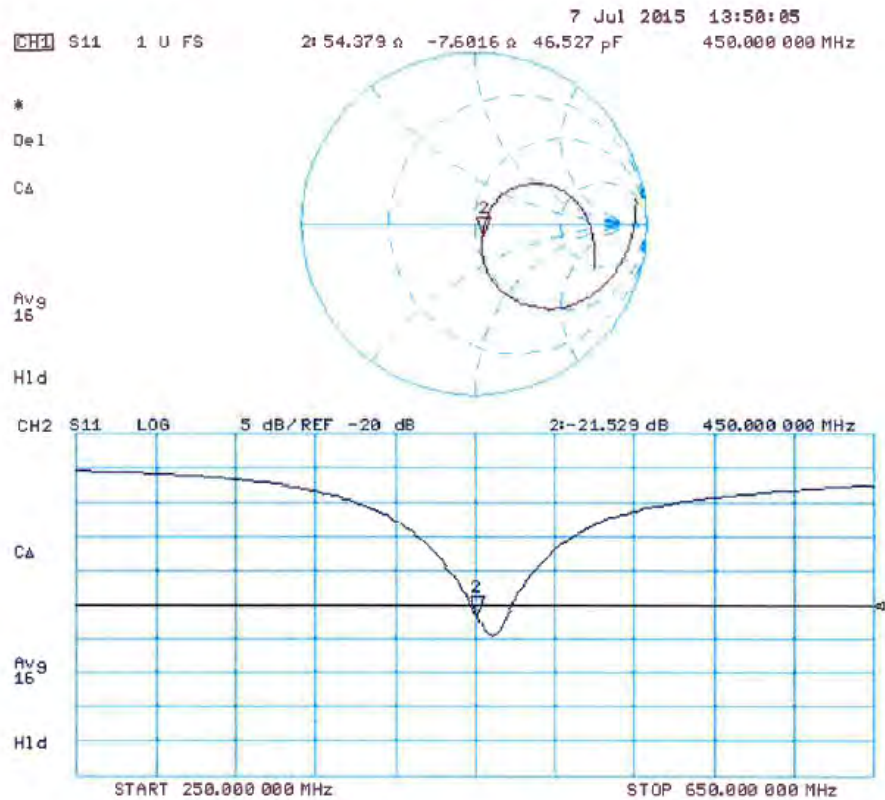
Peak SAR (extrapolated) = 1.82 W/kg

**SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.733 W/kg**

Maximum value of SAR (measured) = 1.20 W/kg



Impedance Measurement Plot for Body TSL



## Dipole Data

As stated in KDB 865664, only dipoles used for longer calibration intervals required to provide supporting information and measurement to qualify for extended calibration interval.

Both dipoles CLA 150 and D450V3 do not exceed the annual calibration data, therefore validation for impedance and return loss is not required.